ConMed™

HELIX·AR™ ABC®

Electrosurgical Generator with Argon Beam Coagulation (ABC®)

SERVICE MANUAL

LIMITED WARRANTY

For a period of two years following the date of delivery, CONMED Corporation warrants the CONMED HelixAR™ ABC® Electrosurgical Generator with Argon Beam Coagulation (HelixAR ABC System) against any defects in material or workmanship and will repair or replace (at CONMED's discretion) the same without charge, provided the routine maintenance as specified in this manual has been performed using replacement parts approved by CONMED. This warranty is void if the product is used in a manner or for purposes other than intended.

525 French Road
Utica, NY 13502-5994 USA

For Technical Service, to set up a Service Request or to Order Repair Parts:
Phone: 727-399-5597 or 1-800-552-0138 Ext. 3
Fax: 727-399-5269
Email: ElectrosurgeryTechServices@conmed.com
http://www.conmed.com/conmed-service.php
Or contact your CONMED representative.

For Customer Service, Return Authorization or to Order Disposables:
Phone: 1-800-552-0138 Ext. 3
Or Contact Your CONMED representative.

European Authorized Representative -
internationalcustomerservice@conmed.com

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The revision level of this manual is specified by the highest revision letter found on either the inside front cover or enclosed errata pages (if any).

Manual Number: 60-8802-ENG Rev. AC

Unit Serial Number: _____

Table of Contents

Section 1
GENERAL INFORMATION

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GENERAL INFORMATION

This service manual provides the information needed for preventive maintenance, calibration and service of the HelixAR Electrosurgical Unit (ESU). It is suggested that this manual be used in conjunction with the Operator's Manual as each has a specific purpose and content. Any service or repairs to the HelixAR can only be performed by qualified Hospital Biomedical Technicians or Service Centers. The safe and effective use of this equipment requires the understanding of and compliance with all warnings, precautionary notices, and instructions marked on the product or included in either the Operator's Manual or this Service Manual.

The CONMED HelixAR ABC system is a state-of-the-art, radio frequency (RF)-isolated electrosurgical generator. It is designed for enhanced control of bleeding and for the electrosurgical destruction of the tissue in multispecialty procedures in the operating room or endoscopy suite.

The CONMED HelixAR ABC system combines conventional electrosurgical features (Monopolar Cut, Monopolar Coagulation and Bipolar with Argon Beam Coagulation) in a full-capability, mobile electrosurgical system.

Recommendations for Preventative Maintenance

Preventative maintenance (PM) should be performed by qualified service personnel at least every 12 months. (See Periodic Preventative Maintenance Section 3.3)

During the PM, the following items should be included:

- Correlation between output and the settings
- Leakage Current
- Automatic Return Monitor (A.R.M.™)
- Blocking Capacitors

1.1 System Information

Reference the Operator's Manual for more detailed information on the system, modes, setup, operation and warnings. The Operator's Manual is to be used in conjunction with this Service Manual. The Operator's Manual has the following sections:

Section 1: General Information

Section 2: Controls, Displays and Connectors

Section 3: Setup for Use

Section 4: Operation (Cleaning and Maintenance)

Section 5: Installation

Section 6: Specifications

WARNING: Any tampering or modifications to this device is strictly prohibited.

The HelixAR ABC system consists of two major sub-assemblies integrated into one system:

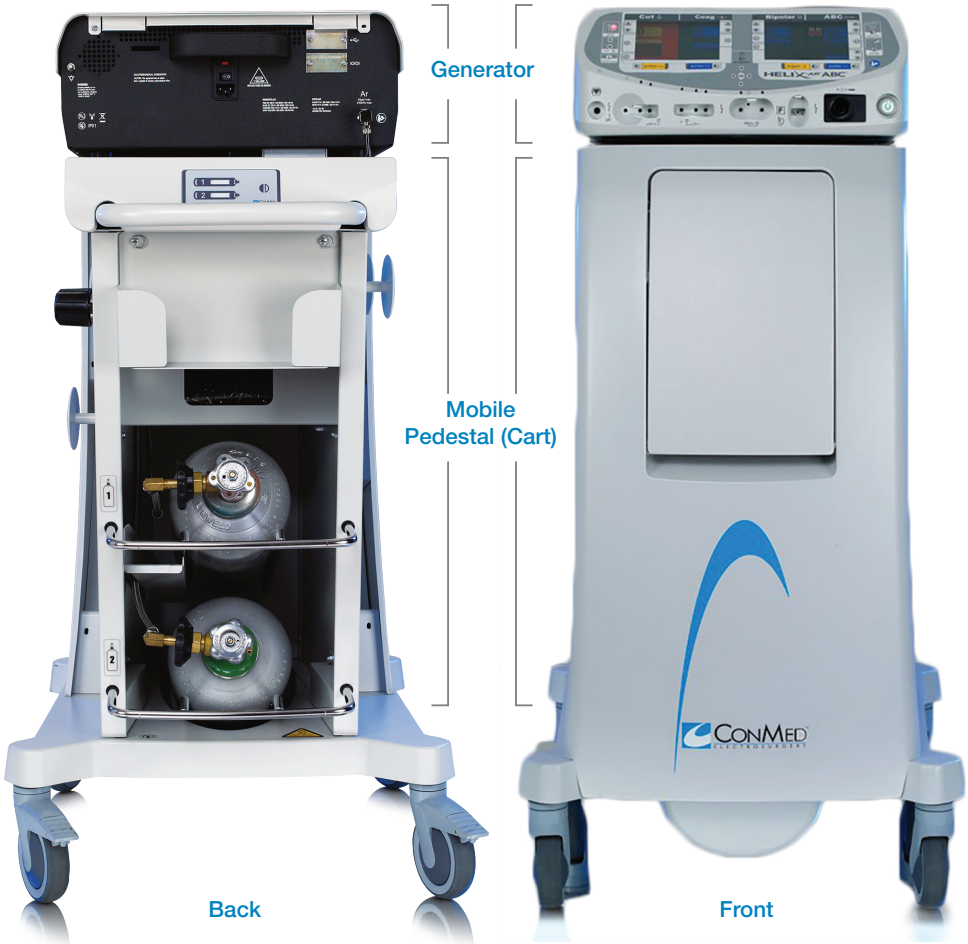
- Generator
- Mobile Pedestal (Cart)

1.2 Generator

The Generator Assembly houses the power supplies, power amplifiers, control circuits, logic circuits, and microprocessor circuits, as well as the control circuits and low pressure pneumatic devices for the argon gas delivery system. The Generator Assembly also contains the User Interface Panel and the Output Receptacle Bar for connection of Accessories.

The HelixAR ABC System provides a broad range of capabilities in a single electrosurgical generator.

- Three monopolar cutting modes:
  - *Pure, Blend and Pulse*
- Four monopolar coagulation modes:
  - *Standard, Spray, Pinpoint and Pulse*
- Two bipolar modes:
  - *Micro and Macro*
- Four Argon Flow options
  - *ABC®Flex: Limits the argon to 2 slpm max*
  - *LAP: Limits the argon to 4 slpm max*
  - *OPEN: Argon flow adjusts automatically to the power setting (10 slpm max)*
  - *MANUAL: Argon flow can be manually adjusted within limits based on the power setting (10 slpm max)*
- Two Argon Beam modes:
  - *Argon Beam Coagulation – non-pulsed*
  - *Pulsed Argon Beam Coagulation (4 pulsed options)*
- Argon Dissect (4 argon options)
- Radio Frequency (RF) isolated and independent outputs.
- The proven Automatic Return Monitor (A.R.M.) contact quality monitoring system.
- Continuous microprocessor safety monitoring.



1.3 Contact Quality Monitor (A.R.M.)

- The Automatic Return Monitor allows for either a single or dual foil dispersive electrode to be connected.
- Single foil dispersive electrode or pad is a two wire continuity detector. The only failure that can be detected using single foil pads is a broken wire.
- Dual dispersive electrodes use a two wire resistance monitor with a typical acceptance range of 10 to 150 ohms and a trip threshold typically 30% higher than the initial pad site resistance. When dual foil pads are used, they can detect change at the pad site caused by pad peel or drying of the conductive gel.
- Indicators are green for acceptable limits and red for unacceptable limits. When the pad indicator is red, RF (radio frequency) current is inhibited until the situation is rectified.
- The A.R.M. is considered a safety circuit and does require a PM check annually at a minimum.

WARNING: When single dispersive electrode is used, the pad indicator status or alarm does not provide any indication of the contact quality between the single dispersive electrode and the patient.

1.4 Power and Standby Switch

The HelixAR has both a Mains switch and a standby switch. The Mains switch located on the back panel opens both Line and Neutral and is the main power switch. The switch on the front is a standby switch and does not isolate the system from Mains, but it does power off all the internal circuitry.

CAUTION: When servicing the interior of the system, ensure the power cord is disconnected to prevent potential electrical shock.

1.5 Wireless Footswitch Option

The HelixAR has the option of adding two wireless footswitches. Installation instructions for the footswitches are provided in the footswitch packaging. Instructions for pairing wireless footswitches are also available in the Service Mode when a wireless receiver is detected. Wireless footswitches must be “paired” with a specific receiver if they are not paired when received. The receiver is installed inside the HelixAR. Instructions for the wireless footswitch are in Section 3.

1.6 Battery Life

A Lithium battery is used for the internal real-time-clock where the date and time are maintained even when the system power is off. This battery will hold a charge for about 2 months when fully charged and the charge time takes about 6 hrs. *The battery only charges when the unit is powered on*.

On power up, when the battery is low, a message will be displayed stating an internal power failure – replace battery. If this message disappears after a few seconds, then the battery needs charging. If after charging the message continues to be displayed, then a problem has been detected with the battery and the charging circuit for the battery is disconnected internally. The battery is tested on every power up and so if this message continues to be displayed then the battery needs to be replaced. The battery is only used to add a time stamp to the activation and fault log.

1.7 Mobile Pedestal

The Mobile Pedestal provides a base as well as housing of the high pressure pneumatics for the Generator. The Mobile Pedestal contains recesses and bins for storage of footswitches, accessories, and houses two argon tanks.

The HelixAR is designed to operate while attached to a Mobile Pedestal. A bulk head connector provides an electrical interface from the Mobile Pedestal to the generator for the footswitches and argon tank pressure.

The generator is to be fastened to the Mobile Pedestal using the fastener that is located on the top-inside of the argon tank compartment. This fastener not only secures the generator to the Cart, but provides electrical continuity

between the housing of both the generator and the Mobile Pedestal.

The Mobile Pedestal provides the electrical interface and storage for the three (3) footswitches. It holds two argon tanks and has a pressure regulator for each tank.

The Mobile Pedestal has an option to add the CONMED smoke evacuation system through special order. Instructions for this installation will be provided with the installation kit.

1.8 Argon Gas Connection

The argon input pressure to the generator is rated for 40 ± 5 psi. The argon supply connector is located on the back panel of the generator and the argon supply tubing is within the Cart. Pass the tubing through the hole located just beneath the connector on the generator before connecting.

Tank pressure rating:
Up to 3000 psi/200 bars with a CGA-580 connection valve.

The pressure regulators have automatic switchover from one tank to the other when the tank pressure of the initial tank drops below 100 psi. The tank pressure of both tanks is displayed on the LCD display when system power is applied.

Only use medical grade argon gas rated for a 99.998% minimum purity.

The Mobile Pedestal has a battery operated tank pressure display located on the back side of the Cart which is only operational when the unit is *not powered on*. The 9 V Battery is non-rechargeable.

1.9 General Instructions for Use

NOTE: The User Manual has additional warnings that are not listed in this Service Manual, but those warnings are based on clinical application using the HelixAR and associated accessories.

- Use the power cord provided with the unit. Replacement power cords may be obtained from CONMED. Use only a hospital-grade, three-prong power cord rated to meet the specifications in Section 5.2 —and all of the requirements for safe grounding of the ESU. The user should verify that the power receptacle with which this ESU is used is properly grounded, correctly polarized and of the proper frequency per Section 6. Do not use ground “cheater plugs” or extension cords.
- Prior to initial use, performance of the device should be tested.
- Do not stack other devices or equipment on top of or adjacent to the HelixAR ABC system unless the proper stacking adapter is employed.
- For cooling, 2 inches (5 cm) of clearance is required on each side and the back of the ESU.
- When transporting the device, push the system only with the designated features provided for transportation, such as the handle on the Cart.
- To prevent possible overheating and damage to the Generator, do not obstruct the air vents.
- Ensure the power switch in the rear of the unit is always accessible.

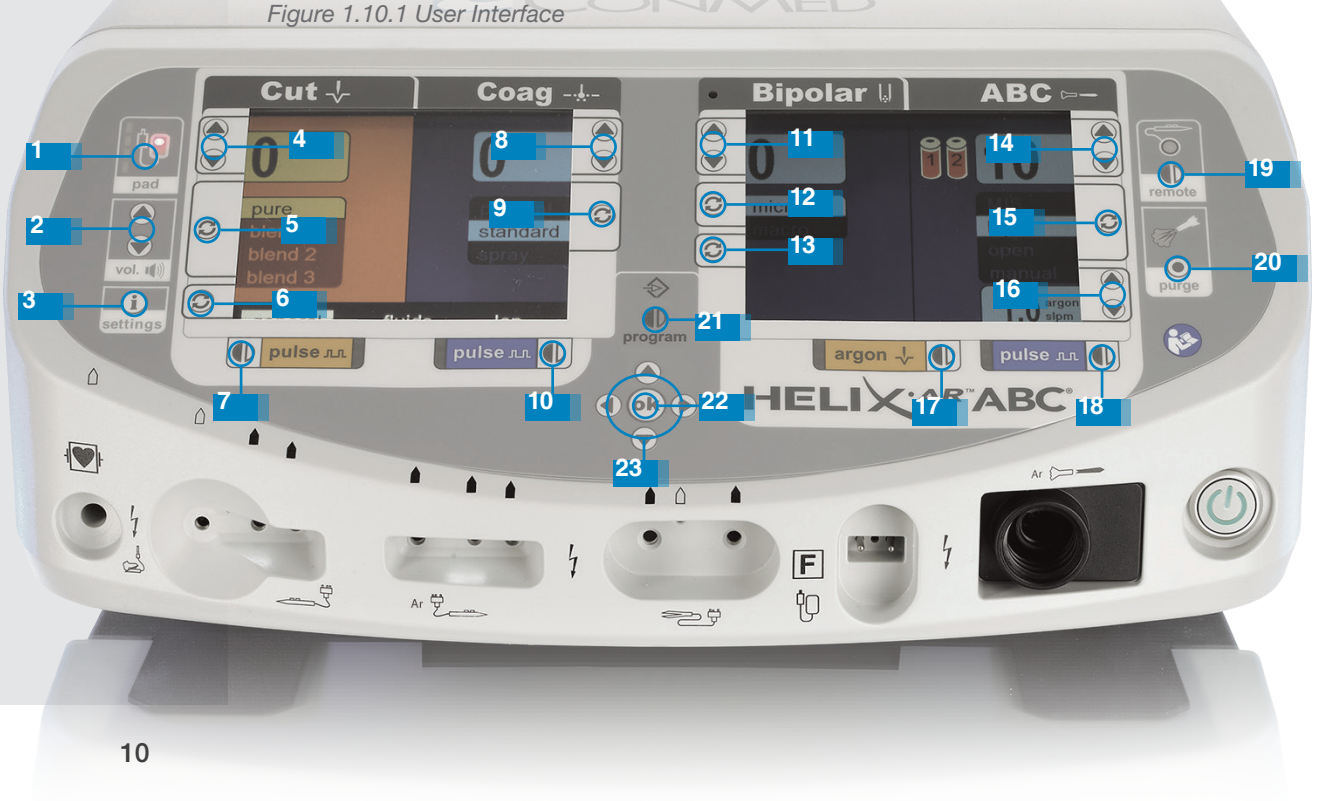
WARNING: When a Single-Foil Dispersive Electrode is used, the Pad Indicator status or alert does not provide any indication of the contact quality between the Single-Foil Dispersive Electrode and the patient.

1.10 Controls, Displays, Connectors and Symbols

User Interface

1. **Dispersive Electrode (Pad) Status Indicator:** Indicates the status of a Dispersive Electrode when connected to the ESU.
   - The Dispersive Status Indicator will flash red prior to the connection of any Dispersive Electrode or connection of a Dual-Foil Dispersive Electrode that is not applied to the patient.
   - This indicator will illuminate flashing green after a Dual-Foil Dispersive Electrode is applied to the patient and the contact quality of the Dual-Foil Dispersive Electrode is at an acceptable level.
     - *The bar graph to the left of the Dispersive Electrode Status Indicator will indicate the quality of the dispersive electrode connection to the patient (1-4 bars) when a Dual-Foil Dispersive Electrode is first connected.*
     - *All four bar Indicators will be illuminated upon first activation, indicating that the initial contact of the Dual-Foil Dispersive Electrode is at an acceptable level. If, during a procedure, the contact quality decreases, bar indicators will be extinguished as the contact quality worsens. If all four indicators are extinguished, a Dispersive Electrode alert will occur and the Dispersive Electrode Status Indicator will turn red.*
   - Single-Foil Dispersive Electrodes are not recommended in most situations since they do not provide A.R.M.™ feedback. The HelixAR ABC System is shipped with Single-Foil Dispersive Electrode use disabled. See Section 3, #20 if the facility routinely uses Single-Foil Dispersive Electrodes and wishes to enable their use. If not enabled, the HelixAR ABC System will display a message when it detects a Single-Foil Dispersive Electrode requesting a confirmation from the user that they intend to use a Single-Foil Dispersive Electrode.
     - *The Pad Indicator will turn green when a Pad is connected, but the bar graph will not illuminate. The Generator only senses that a Pad is connected but cannot sense if the Pad is on the patient, or the quality of the connection between the Pad and the patient when a Single-Foil Dispersive Electrode is used.*
2. **Volume Control:** Push the up arrow to increase the volume and the down arrow to decrease the volume. The volume of certain alerts cannot be silenced.
3. **Settings:** Press to change the System's default settings.

Figure 1.10.1 User Interface



4. **Monopolar Cut Power Adjustment Keys:** Adjusts the output power setting of the selected Cut Mode.
5. **Minor Cut Mode Selection Key:** Cycle through Pure Cut, Blend 1, Blend 2 and Blend 3.
6. **Specialty Mode Selection Key:** Selections include General, Fluids and Laparoscopic Mode.
7. **Pulse Cut Selection Key:** Toggles between Pulse Cut on and off.
8. **Monopolar Coag Adjustment Keys:** Adjusts the output power setting of the selected Coag Mode.
9. **Minor Coag Selection Key:** Cycles through Standard, Pinpoint and Spray.
10. **Pulse Coag Selection Key:** Toggles between Pulse Coag on and off.
11. **Bipolar Power Adjustment Keys:** Adjusts the output power settings of the selected Bipolar Mode.
12. **Minor Bipolar Selection Key:** Cycles between Micro and Macro Bipolar.
13. **Autobipolar Tone Selection:** Cycles through to sound alerts at on and off levels (available in Macro Bipolar only).
14. **ABC Power Adjustment Keys:** Adjusts the output power settings.
15. **ABC Mode Selection Key:** Cycles through Lap, Open, Manual and ABC®Flex Modes.

    Also allows selection of Argon Dissect Modes when the Argon Dissect Key is on (#17). The following modes are available with Argon Dissect Mode:

    - Pure
    - Low
    - Med
    - High

    Also allows selection of ABC Pulse Modes when the Pulse ABC key is on (#18). The following modes are available for Pulse Argon:

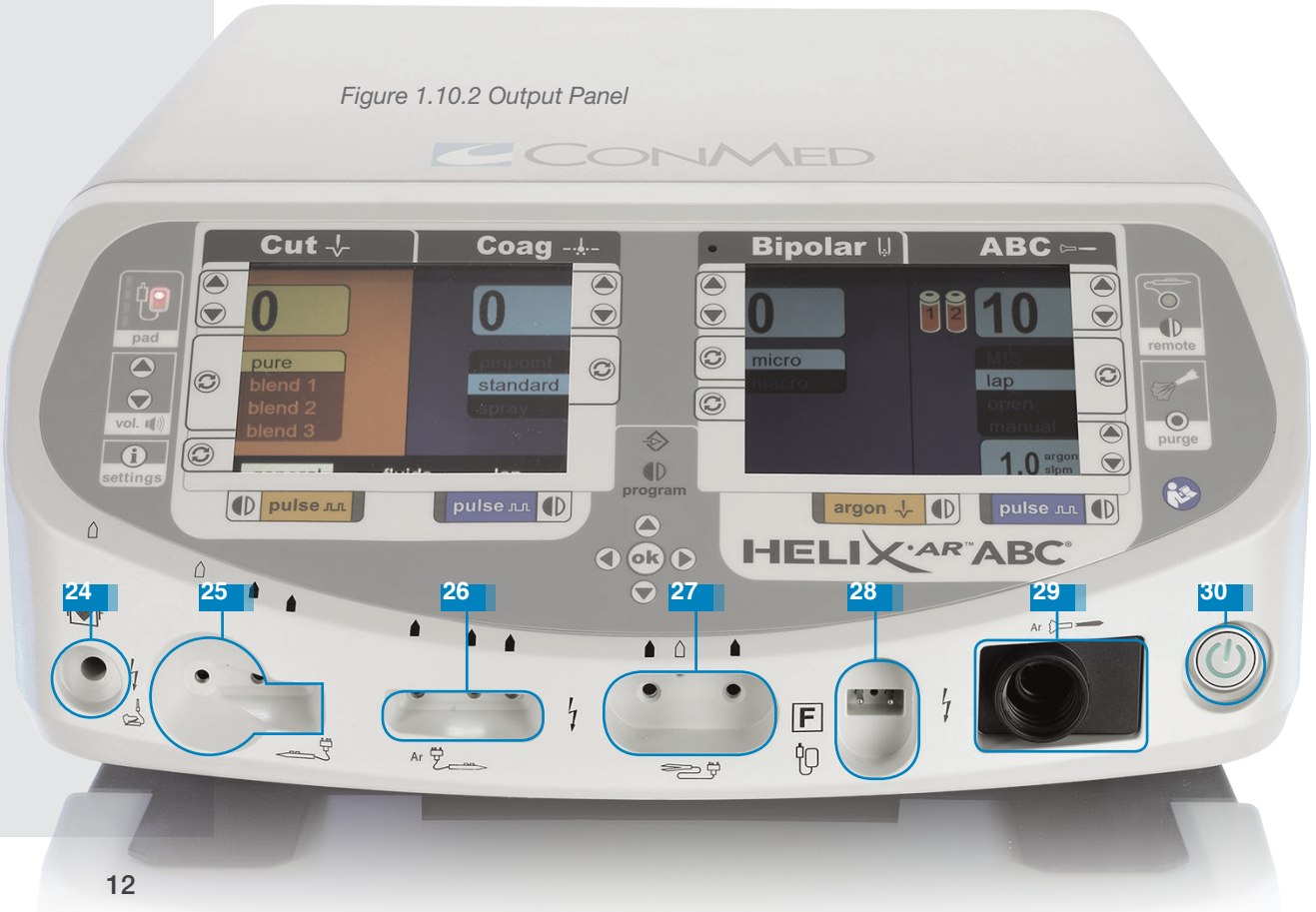
    - Single Shot
    - 200 mS
    - 400 mS
    - 600 mS
16. **Argon Flow Adjustment Keys:** Adjusts the flow of argon in Manual, Lap and ABC®Flex Modes.
17. **Argon Dissect Selection Key:** Toggles between Argon Dissect on and off.
18. **ABC Pulse Selection Key:** Toggles between ABC Pulse on and off.
19. **Remote Power Control Key (must be enabled through Settings prior to use):** Pressing this key will select or deselect remote power control. The Remote Power Control Indicator illuminates when remote power control is selected.
20. **Purge Switch:** Primes the attached ABC Handpiece with argon gas. The key will illuminate during the cycle, which typically lasts a few seconds.
21. **Program Selection Key:** Enters the Program Mode (See Section 3, #19). The Program symbol will illuminate while in Program Mode.
22. **OK Key:** Chooses the indicated option on the screen.
23. **Navigation Keys:** Allows navigation on certain screens.

Output Panel

The output panel contains the power switch and the accessory receptacles. The receptacles are illuminated to aid in the insertion of the connectors in low light conditions. Refer to Figure 1.10.2.

24. **Footswitch Accessory Receptacle:** This receptacle accepts accessory cables equipped with standard active (Bovie #12) plugs. When a cable is inserted into this receptacle, the Monopolar 1 Receptacle cannot be used.
25. **Monopolar 1/Footcontrol Receptacle:** This receptacle accepts 4 mm banana plugs, pin-tip style connectors or standard three-prong handswitched accessory connectors.
26. **Monopolar 2/ABC Handpiece Receptacle:** This receptacle accepts a standard three-prong handswitched accessory connector or a three-pronged ABC handswitching accessory connector.
27. **Bipolar Accessory Receptacle:** The bipolar output is activated by the Bipolar Footswitch or by hand-controlled bipolar accessories. CONMED accessories with fixed connection style plugs are recommended for this receptacle. For legacy connections with two banana plug leads, connect these active bipolar forceps leads to the outside connections.
28. **Patient Dispersive Electrode Receptacle:** Accepts a standard two-pin Single-Foil or Dual-Foil Dispersive Electrode plug.
29. **ABC Handpiece Receptacle:** Connection for ABC accessories.
30. **Power Standby Switch:** Turns the ESU on and off.

Figure 1.10.2 Output Panel



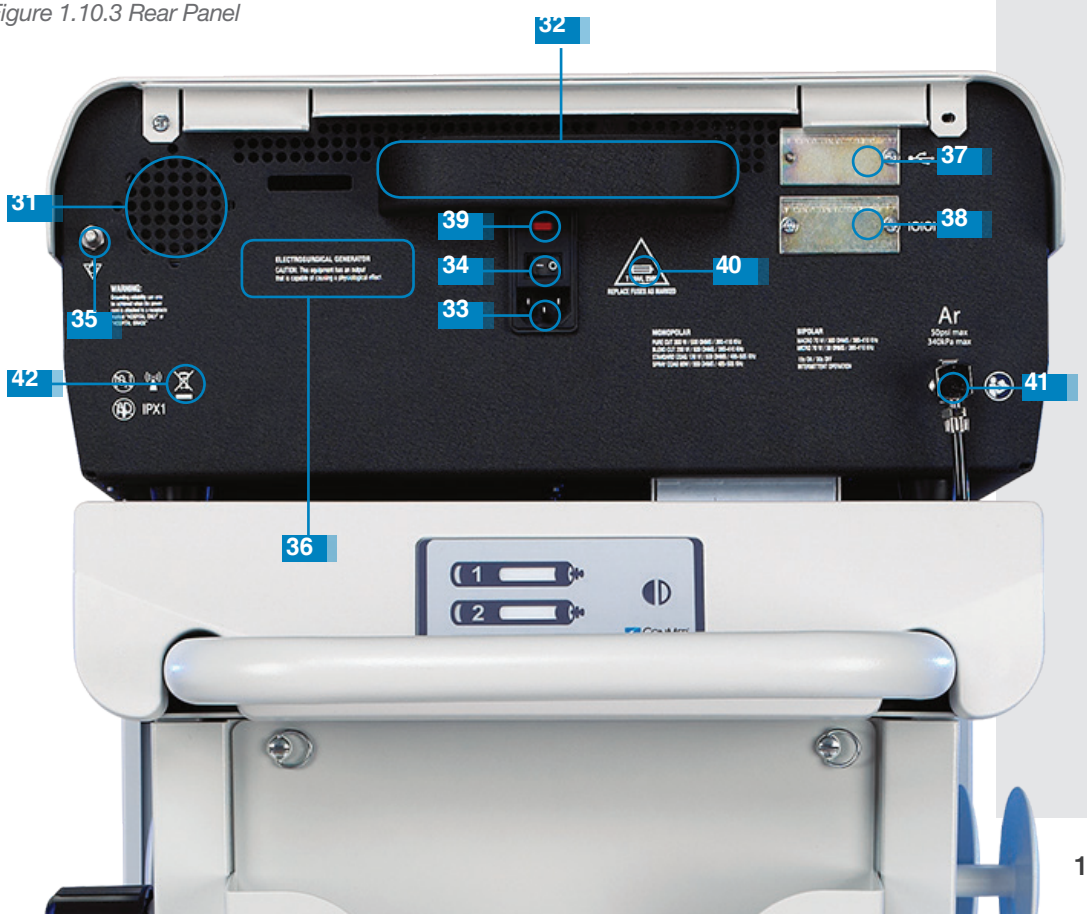
Rear Panel

The rear panel contains the power connector, the pneumatics connector and a carrying handle. All the features of the rear panel are described below.

31. Speaker: Sound from the speaker emanates from this location.
32. Carrying Handle
33. Power Inlet: Supplies AC mains power to the ESU. It should only be connected to a source of power corresponding to those listed on the nameplate.
34. Master Power Switch: The primary power switch. By turning the switch on, the ESU is placed on standby (see #30). By turning the switch off, the unit is isolated from the supply mains on all poles simultaneously.
35. Equipotential Ground Connector: Chassis ground connection suitable for attachment of standard auxiliary grounding cable when required for additional protection against Low-frequency risk current.
36. Nameplate: Specifies model number, serial number, nominal line voltages, frequency, current and fuse rating information along with CONMED contact information.
37. USB Port: This connector provides a means for upgrading software in the energy source. Upgrades should only be carried out by a Hospital-Qualified Biomedical Technician or a CONMED Technical Representative. Only CONMED-provided devices should be connected to this receptacle.
38. ORCC (Operating Room Control Center) Serial Interface Connector: Communications port for factory use only.
39. Mains Fuses
40. Power and Fuse Rating Label
41. Argon Gas Input (Max Pressure: 40 psi)
42. WEEE (Waste Electrical and Electronic Equipment) Symbol: The symbol on the product or on its packaging indicates that this product must not be disposed of with regular waste. Instead, it is the operator's responsibility to dispose of waste equipment according to the local laws. The separate collection and recycling of the waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For information about where the operator can drop off the waste equipment for recycling, please contact your local CONMED Representative.

WARNING: The USB Port is designed to interface only with USB memory sticks provided by CONMED. Do not connect any other type of USB device to this port.

Figure 1.10.3 Rear Panel



Explanation of Symbols

Control Panel


Argon Beam Coagulation


Remote Power


Pulse

Monopolar Cut/
Argon Dissect Pure

Blend 1 Argon Dissect Low

Blend 2 Argon Dissect Med

Blend 3 Argon Dissect High


Monopolar Coagulation


Bipolar
Coagulation

Argon Tank Level

Low Tank Warning


Purge Accessory of Air
and Replace with
Argon Gas


Dispersive Electrode Status

User Function of
Changing System
Defaults


Volume Control


Refer to Instruction
Manual Prior to Placing
Equipment in Service

Rear Panel (S/N Plate)


Explosion Risk if
Used with Flammable
Anesthetics


Do Not Operate in
Oxygen-Enriched
Environments


Equipotential Ground Stud


This Equipment Intentionally
Supplies Non-Ionizing
Radio-Frequency Energy for
Physiological Effect


Refer to Instruction
Manual Prior to
Placing Equipment
in Service

Replace Fuse Only
with Type and Rating
as Shown


USB Connector

Serial Interface
Connector

Argon Input

Enclosure Resists
Entry of Vertically
Falling Water Drops

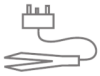

WEEE (Waste Electrical and
Electronic Equipment) Symbol

Output Panel

Handswitched Output:
Connection for Handswitched
Monopolar Accessories

Footswitched Output:
Connection for Footswitched
Monopolar Accessories

Argon Beam Coagulation



Bipolar Output:
Connection for Bipolar
Accessories

Return Electrode:
Connection for Monopolar
Dispersive Electrode

Caution: Dangerous
Voltage! Refer Servicing
to Qualified Personnel

Radio Frequency Isolated:
Patient Connections Are Isolated
from Earth at High Frequency

Type CF: Patient Connections Are
Isolated from Earth and Resist
the Effects of Defibrillator
Discharge

Standby Button

Section 2
INSTALLATION AND USER SETTINGS

Section 2
INSTALLATION AND USER SETTINGS

This section contains initial installation and preliminary checks for the HelixAR ABC System.

2.1 Initial Unpacking and Inspection

- The HelixAR ABC System consisting of the Generator and Mobile Pedestal (Cart) will be shipped in separate boxes.
- Unpack the HelixAR ABC System upon receipt and physically inspect it for any obvious damage that may have occurred during shipment.
- A Hospital-Qualified Biomedical Technician should perform this inspection. Notify the carrier and your CONMED Representative immediately if any damage is found.

2.2 Installation Steps

- Remove the Backpanel on the rear of the Cart.
- Set the Generator on the Cart and align the feet with the corresponding slots on the Cart.
- Ensure the self-aligning electrical connection is seated properly.
- Secure the Generator to the Cart by reaching under the top of the Cart and tightening the hand nut. This hand nut not only secures the Generator to the Cart, but also provides a ground connection for the Cart.
- Connect the low argon gas line from the Cart to the argon gas input on the back panel of the Generator.
- Replace the Backpanel on the rear of the Cart.

Initial Power-On Display

When the unit is powered on, there is about a 15 second delay in which the unit is downloading software from Flash memory into the internal programmable devices. Once the programs are downloaded, the system then conducts system diagnostic tests. If one of these tests fails, the system will require service before it can be used. The detected failure is displayed with possible corrective actions. In many cases it only requires the *power to be cycled off and then back on*.

NOTE: If an internal supply voltage fault is displayed, it typically means the battery is low on charge. The battery is used to maintain time and date information when power is not applied to the system. To charge the battery, the system needs to be powered on and left on for at least 4 to 6 hours.

The displays are not touch screen. All selections are made by pressing dome switches that are aligned along of the edge of the displays.

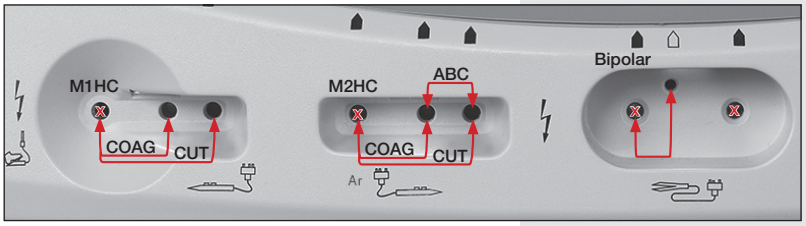
All mode options available are displayed when the system is powered on. The active modes are clearly highlighted to indicate current mode selection.

2.3 Preliminary Checkout

The following checks are recommended upon initial installation of the equipment to confirm the basic operations of the HelixAR:

1. Ensure the power switch is off and no accessories are connected
2. Connect the power cable to a properly grounded and polarized mating power receptacle rated from 100 V to 240 V.
3. Connect a CONMED dual-pedal Monopolar Footswitch, a CONMED Single–Pedal ABC Footswitch and a CONMED Single-Pedal Bipolar Footswitch to their mating connectors on the lower sides of the Cart.
4. Make no connection to the dispersive Electrode Receptacle at this time.
5. Power-on the unit. The Main power switch located on the back panel must be flipped to the ON position and then press the Standby switch on the right-front panel. It is not necessary to turn the Main switch to the OFF position between uses.
6. As the unit goes through its internal self-diagnostics, it should respond by:
   - o *Illuminating thirteen LEDs on the control panel [Pad (6), Program, Remote Power, Pulse Cut, Pulse Coag, Argon Dissect, Pulse ABC and Purge]*
   - o *The unit will display the software revision levels on both screens and will display the progress of the Power-On Self-Test (POST).*
   - o *If there are no errors detected, normal operational parameters will then be displayed while sounding a series of test tones.*
7. Press the Cut pedal of the Monopolar Footswitch. The Dispersive Electrode alert should sound and the Dispersive Electrode Indicators should flash red. Release the Cut Footswitch and the tone should stop.
8. Press each switch on the Control Panel. For every switch that is pressed, there should be a tone and for all switches except the program group, there is also a visual feedback. The tone is sufficient to verify the switch is functioning correctly.
9. Depress the Bipolar Footswitch. Confirm the Bipolar display remains bright while the other displays dim and an activation tone is sounded. (Bipolar can be activated without a dispersive electrode connected)
10. With Bipolar power set to 0 W, using a hand-switchable Bipolar Forceps, activate the bipolar mode. There should be an activation tone. If a hand-switchable Bipolar Forceps is not available, a jumper can be used when connected between the center and left-hand Bipolar Accessory Receptacle on the output panel.
11. Connect a Single-Foil Dispersive Electrode -or- Dispersive Electrode adaptor. Confirm the Pad Status indicator turns from a flashing red to a steady green.
12. Monopolar activation checks should be done for both hand and foot control devices. To reduce the risk of unintentional burn, conduct the following tests with the power set at 0 W (10 W ABC). This test is not intended to confirm RF power output, but only to confirm all activation requests are detected. Activate the following and confirm the display intensity for the mode activated is brighter than the others -and- an activation tone occurs.

NOTE: If a handcontrol accessory is not available, the following handcontrol checks can be conducted using a jumper connected as shown below.



- Any Cut mode using the left handcontrol (M1HC)
- Any Coag mode using the left handcontrol (M1HC)
- Any Cut mode using the right handcontrol (M2HC)
- Any Coag mode using the right handcontrol (M2HC)

- ABC using the right handcontrol (M2HC)
  - o *If the argon gas is not connected or turned on, an argon flow alarm will occur. This is okay as this test is only testing activation recognition.*
  - o *If an ABC handcontrol is not available, ABC can be activated using a jumper between the two ports that are on the right of M2HC -or- the two ports that are closest together.*
    NOTE: No RF power is delivered from these two ports.
- Either Bipolar mode using a hand-activated bipolar handcontrol or jumper (Bipolar)
- Any Cut mode using the Monopolar footswitch
- Any Coag mode using the Monopolar footswitch
- Either Bipolar mode using the Bipolar footswitch
- Any ABC mode using the ABC footswitch

13. Ensure the argon tanks are connected and one of the tanks is turned on. Press "PURGE" on the Control Panel and confirm argon flow occurs without any fault messages.

2.4 Preliminary Performance Testing

Performance testing should be conducted on a unit before it is placed into service. The following testing is best conducted by using an Electrosurgical Test Analyzer for measuring RF output power. Test each mode at each power that is listed in the output power table within the Periodic Preventive Maintenance section. It is highly recommended that all modes be tested for power accuracy before the HelixAR is placed in service.

2.5 System Settings

By pressing the ***Settings*** switch located on the lower left, the system defaults can be changed. These settings are available for the O.R. staff to change the factory default settings. The menu is on the left screen (cut & coag display) and options for each menu selection are on the right screen (bipolar & ABC display). Follow the instructions as listed on the right screen.

- Brightness: Increase or decrease the backlight intensity. Auto Dimming is available when enabled where the backlight brightness is adjusted based on the ambient light available.
- Dispersive Electrode: Default is the Dual Foil Pad at power up but can be changed for a Single Foil Pad default setting at power up.
- Date/Time: Set the time and date. This information is used to time stamp system faults and the activation log. The time and date are displayed during power up.
- Language: There are several language options that can be selected for the displays. Default is English.
- Dual Cut Activation: Dual Cut is disabled by default, but can be enabled. When Dual Cut is in use, the displayed power is split between the two active accessories.
- Dual Coag Activation: Dual Coag is enabled by default, but can be disabled. When Dual Coag is in use, the displayed power is split between the two active accessories.
- Last Settings: Power settings are set to minimum on power up but last modes selected on previous power down are preserved. This can be changed so that the last power settings are preserved on each power up.

- Remote Power: Remote power can be enabled or disabled. When enabled it allows the surgeon to change power settings using switches on the active accessory. With this enabled, it still requires the Remote Power to be enabled on the Control Panel each time the system is powered on. When disabled, the selection on the Control Panel is inhibited as a user option.
- Settings Exit: To exit Settings, press the ***Settings*** switch. The system will automatically exit ***Settings*** if idle for one minute or if an RF activation request occurs while in ***Settings***.

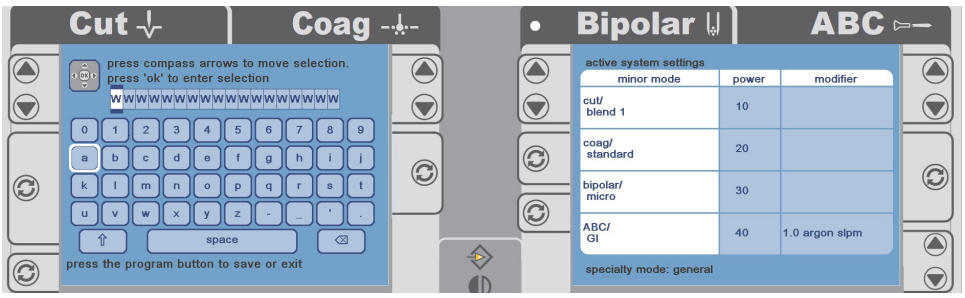
2.6 Program Mode

The HelixAR allows up to 100 user specific programs to be stored. To store a program, set the preferred modes and power settings on the Control Panel to be stored; then press the program switch located in the center of the Control Panel. All system settings on the Control Panel can be programmed into the system memory.

On the front panel, press the Program Button to save the active settings, to recall the previously saved program -or- to delete a previously saved program. *Before entering the program mode, set all preferred settings on the Control Panel (select all modes, power settings, remote power option, pulsed vs non-pulsed, etc)*.

1. To save the active settings:
   - Make all selections on the Control Panel. Select the modes, power settings, Specialty modes (General, Fluids -or- Lap), argon flow, etc. Then press the program switch on the Control Panel.
   - Press the left middle circular button on the left screen to select “Save the active settings” and press OK. The settings to be saved will be displayed on the Bipolar/ABC screen.
   - Use the “compass” arrow keys to navigate the keyboard in the Cut/Coag screen, and press OK to enter a letter and move to the next character. When satisfied with the name, scroll to the bottom of the keyboard and select “finish and save”.
   - Confirm the selection on the Bipolar/ABC screen.
2. To recall the previously saved program:
   - Press the left middle circular button on the left screen to select “Recall a saved program” and press OK.
   - Scroll through the saved program and select the desired program by pressing OK.
3. To delete a previously saved program:
   - Press the left middle circular button on the left screen to select “Delete a saved program” and press OK.
   - Scroll through the saved program and select the program to delete by pressing OK.
   - Confirm the selection on the left screen.

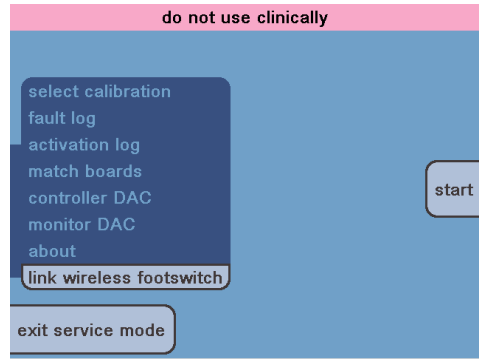
The program mode is quite useful for saving settings for conducting PM checks. For example, to check all modes at low power settings, set cut, Coag, bipolar and ABC power at 20 W. Name this program PM LOW. Then set each mode to a mid-power setting and name that program PM MEDIUM. The third program to set up and save is PM HIGH where all modes will be set to maximum power setting. When conducting power checks during preventative maintenance, recall each of the save programs independently when conducting power checks. The modes and power settings are in the PM section of this Service Manual.



2.7 Service Menu

The Service Menu is for Hospital-Qualified Biomedical Technicians or service personnel only.

Press the Volume UP and Volume DOWN keys simultaneously to enter the Service Menu. In this menu you can do the following:



- Select Calibration: Used to enter the system calibration mode.
- Fault Log: Lists the last 100 system faults recorded with date and time stamps.
- Activation Log: Lists the last 100 activations with date and time stamps, showing modes activated and power settings.
- Match Boards: This message occurs if a circuit board is replaced. This is an indicator that calibration should be performed. By selecting this option, the system will match the new circuit board to the system.
- View Monitor DAC: Used for development only
- View Controller DAC: Used for development only
- About: Lists all software revisions loaded.
- Link Wireless Footswitch: This option is only listed if a wireless footswitch receiver is detected. Use this option to pair wireless footswitches to this system.
- Exit Service Mode: Exits the service menu and returns the ESU to normal operation *or run mode.*

2.8 Test Mode

The Service Menu is for Hospital-Qualified Biomedical Technician or service personnel only.

The Test Mode inhibits most of the monitoring circuits that will inhibit system activation when a fault is detected. This mode is used for calibration of new circuit boards and for troubleshooting circuit failures. *With a persistent fault message displayed, selecting Test Mode will remove the message and allow a modified system functionality. Test mode is only to be enable for troubleshooting purposes and not to be enable in the operating room.*

To enter Test Mode, press the Program UP and Down keys simultaneously. A message will be displayed on top of both screens “Do Not Use Clinically”. The Service Screen is accessible from the Test Mode by pressing the volume Up and Down keys simultaneously.

2.9 Remote Power

In the upper right corner of the system is a switch labeled Remote Power. To enable Remote Power, first it must be enabled in ***Settings***; then for each power up, the Remote Power switch needs to be selected. Remote Power provides a means to change Cut, Coag and ABC power using the accessory activation switches.

On the hand-controlled accessory:

- Rapid double click the Cut button to change cut power.
- Rapid double the Coag button to change Coag power.
- Rapid double the ABC button to change ABC power.
- A -tone- will sound to indicate Remote Power is active.
- Continuously press the Cut button to increase power.
- Continuously press the Coag button, to decreases power.
- Rapid double click of any of the buttons will exit Remote Power -or- no action for 3-5 seconds will exit Remote Power.

2.10 Wireless Footswitch

A wireless footswitch that can be purchased through CONMED is an option available for the HelixAR. The receiver for the wireless footswitch is installed inside the unit by a Hospital Qualified Biomedical Technician or service personnel.

When the system recognizes that a receiver has been added, the user interface changes to accommodate them. In the Settings menu an additional line item is added for -pairing- the footswitches to the system. This is a menu driven task. The displays provide very clear instructions for pairing and enabling wireless footswitches. The only caution to be made aware of is the timing. When -start- is pressed, only one of the wireless footswitches (dual or single pedal) needs to be tilted close to 90° in about 2 seconds or less. The display will show that -pairing- is in progress and then switch to pair the remaining footswitch. This footswitch must be tilted 90° in about 2 seconds or less. Have the second footswitch ready to tilt as soon as the display changes and place the first footswitch flat. The display will indicate whether or not a pairing was successful.

If the pairing is unsuccessful, wait at least three minutes before attempting to re-pair the footswitches as the transmitters have a timed lockout whenever they are tilted. After getting a successful pairing message, power the system off and then back on. If the pairing was successful a message will be displayed that a wireless footswitch has been detected. If only a dual pedal was paired, then only one message on the systems right display will have the message; if two footswitches were paired each display will have a message displayed that a wireless footswitch has been detected.

NOTE: The system is actually only seeing the receiver and that the receiver has been paired to either one or two wireless footswitches. It does not actually see a footswitch until the instructions on the display are completed by the user.

Wireless footswitches that are located in another room than the HelixAR can sometimes be detected. To use the wireless footswitches, the displays will prompt to “enable” or “disable” them. If they are enabled, then a pedal on each footswitch must be pressed within a 30 second period of time in order for the device to be used.

Section 3
MAINTENANCE

3.1 Service Cautions & Warnings:

- Any tampering or modifications to this device is strictly prohibited.
- **WARNING:** High voltages developed within the ESU are accessible when the top cover is removed. These voltages are potentially dangerous and should be treated with extreme caution.
- **WARNING:** Always unplug the power cord before servicing the unit.
- **WARNING:** Avoid contact with the output leads when the ESU is activated. Periodically inspect the test leads used for the output connections for obvious defects.
- **WARNING:** Never use the unit clinically when in *Test* -or- *Service* Modes.
- Although this ESU will withstand momentary short circuits on the output, prolonged short circuits may damage the ESU. Short-circuiting the output should be avoided since it is neither necessary nor desirable.
- When testing, it is recommended that duty cycles be limited to 15 seconds of activation with delays of 30 seconds between activations.
- Activating the HelixAR ABC system in other than its normal operating position impairs the heat dissipation capability of the heat sink.
- Ensure the two top-cover screws are tightened. Always perform a power-up check to confirm a normal power-up sequence before returning the ESU to use.
- Improperly connecting test equipment can cause shock and destruction of equipment.
- Turn the unit off and wait 10 seconds until storage capacitors have discharged before connecting test equipment.
- Ensure casters on the Cart are locked when removing or placing argon gas cylinders.
- Confirm ESU is securely fastened to the Cart prior to use or transport.
- Failure to replace the fuses with the fuse specified may result in risk of fire or smoke.
- Use of incorrect fuses or shorting IEC bars can cause electrical safety hazard.

3.2 Periodic Inspection

The HelixAR ABC system should be inspected at least once every year by a Hospital-Qualified Biomedical Technician.

This inspection should include checks for:

- Damage to power cord
- Damage to plug
- Tightness of the power plug
- Proper mating, cleanliness and absence of damage to the patient connectors
- Obvious external damage to the ESU
- Accumulation of lint or debris within the ESU
- Control panel cuts, punctures or dents

The exterior of the system and footswitches may be cleaned by wiping with a cloth that has been dampened (not dripping) using a mild detergent or mild disinfecting solution.

- Mild detergent such as Windex® or Formula 409®
- 70% isopropyl alcohol
- 5% sodium hypochlorite (Clorox®)

3.3 Periodic Preventive Maintenance

In order to confirm that the device is performing correctly, preventative maintenance should be performed by a Hospital-Qualified Biomedical Technician or service personnel at least every 12 months.

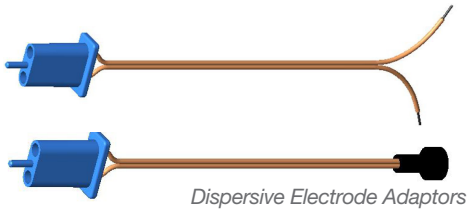
If any of these checks fail to meet the requirement, then the unit shall be decommissioned until it can be fixed by a Hospital Qualified Biomedical Technician or authorized service center.

Each unit is supplied with a serialized production Test Data Sheet, which tabulates the results of the factory tests performed on the system. The data may be used as a reference for subsequent tests and should be made available to the person conducting the tests.

1. Chassis Ground Integrity
   Connect a standard ohm meter between the earth ground prong on the power plug and the equipotential ground connection located on the back of the system. Compensate for the lead resistance. Confirm measured resistance is less than 0.2 ohms.
2. Displays, Alerts and Commands
   Perform the Preliminary Checkout procedure described in Section 2.3 to verify proper operation of displays, alerts and commands. In this section, it is verified that the displays are in working order; all the Control Panel switches work; Control Panel LEDs illuminate when the associated mode is selected, and that activation request is recognized on all handpiece ports and footswitch connectors.
3. Output Power
   To measure radio-frequency (RF) currents and voltages, use measuring devices able to register true root means square (rms) with a total accuracy of 5% of reading or better from 10 KHz to at least 3 MHz within 3 seconds of application of the measured signal. To measure RF rms power, it is suggested to use a commercial ESU Analyzer with selectable loads of at least 50,300 and 500 ohms.

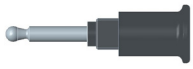
Equipment List:
Monopolar Footswitch
Bipolar Footswitch
ABC Footswitch
Dispersive Electrode Adapter (Dispersive electrode cable with a banana jack connected)
A.R.M. Dispersive Electrode Adapter (Dispersive electrode cable with the two wires stripped to allow connection to a DRB (Decade Resistance Box) or a means to connect resistors.
ABC RF Adapter (ABC handpiece cut to a short length of approximately 12” and a banana jack soldered to the conductor)
ESU Analyzer (ESA) (Loads of 50,300 and 500 ohms are required)
Two Banana plug to Banana plug test leads

ABC Test Connector



Dispersive Electrode Adaptors

Two Test Leads



Footcontrol Adapter (Optional)

Procedure for RF Output Power Checks:

Cut: Pure and 3 Blend modes

Coag: Pinpoint, Standard and Spray
Use the test leads to connect from the ESU Footswitch RF output port to an ESU Analyzer (ESA) and from the return electrode output to the ESA.

Perform the monopolar power tests indicated in the table below. The acceptance range is given in both watts and amps to accommodate available test equipment. It is not necessary to test for both power and current. Power in Pulse cut and coag does not get tested for power accuracy.

ABC: (Argon Dissect and Pulsed Modes do not need power checks)
Connect the test leads to the ABC adaptor and the return electrode output. To test ABC it is required that argon gas is connected and turned on or enter Test Mode so a flow alarm does not occur. When using the ABC test adaptor, it is necessary to cut a small hole in the tubing so that the gas can escape or a flow alarm will occur.

Perform the ABC power checks indicated in the table below. The acceptable limits for both power and current are listed.

Bipolar: 2 Bipolar Modes
Disconnect the leads from the ESU and connect them to the bipolar accessory outputs on the ESU.

Perform the bipolar power tests indicated in the table below. The acceptable limits for both power and current are listed.

Table 3.3.1 Monopolar RF Output Power Table

Mode 500Ω	Dial	Power (W)		Current (mA)	
		Min	Max	Min	Max
Pure	10	7	13	99	183
	150	128	173	467	625
	300	255	345	658	890
Blend 1	10	7	13	99	183
	100	85	115	380	514
	200	170	230	537	727
Blend 2	10	7	13	99	183
	100	85	115	380	514
	200	170	230	537	727
Blend 3	10	7	13	99	183
	100	85	115	380	514
	200	170	230	537	727
Pinpoint	10	7	13	99	183
	30	25.5	34.5	208	281
	120	102	138	416	563
Standard	10	7	13	99	183
	30	25.5	34.5	208	281
	120	102	138	416	563
Spray	10	7	13	99	183
	30	25.5	34.5	208	281
	80	68	92	340	460
ABC	15	12	18	121	225
	76	65	87	331	448
	150	128	173	465	630

Table 3.3.2 Bipolar RF Output Power Table

Mode 50Ω	Dial	Power (W)		Current (mA)	
		Min	Max	Min	Max
Micro	10	8	12	357	536
	35	28	42	711	962
	70	57	85	963	1.436
Mode 300Ω	Dial	Power (W)		Current (mA)	
		Min	Max	Min	Max
Macro	10	8	12	146	219
	46	39	53	332	451
	90	76	103	462	626

4. Radio Frequency Leakage Measurement

WARNING: RF burn hazard exists if cables are not properly insulated or the operator comes in contact with any of the conductors connected to the RF outputs.

RF Leakage can present a hazard in the operating room because electrosurgical currents can flow to the patient and operation room staff through unintended paths, which can cause injury. RF Leakage occurs because the total energy in the output voltage waveform is provided with a conductive path through stray parasitic capacitance distributed within the generator and along the length of the leads.

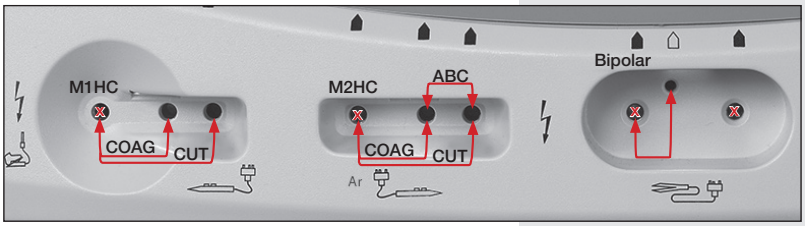
Equipment List for RF Leakage Measurements:

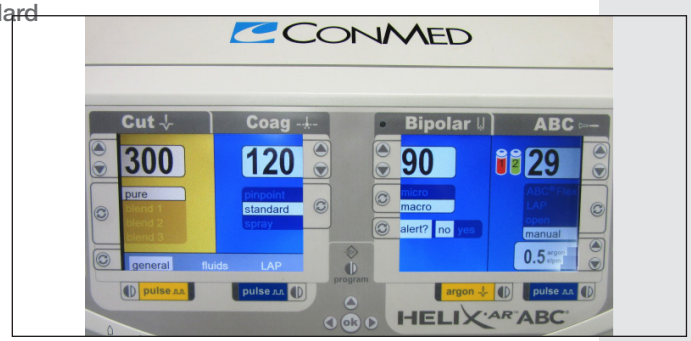
- ESU Analyzer (ESA) with RF Leakage function -or- a 0-250 mA RF ammeter if an ESA is not available.
- 200 ohm 10 W non-inductive resistor
- 2 - test leads, 60 cm or 2 ft max length
- 1 - test lead 15 cm max length

Procedure for RF Leakage Measurements:

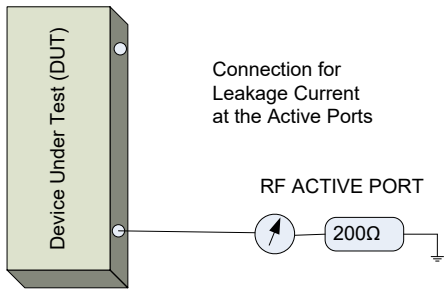
Place the ESA on the work bench so that it is at least 0.5 m away from the unit or a conductive surface.

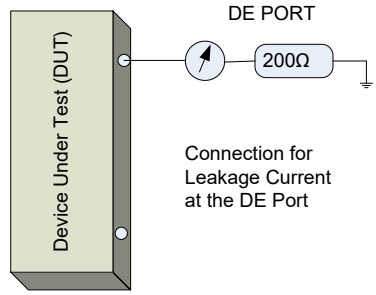
- Set to full power Pure Cut, Standard Coag, and Macro Bipolar.
- Set ABC to 29 W, flow mode to manual, flow rate to 0.5 SLPM
- Connect the 200Ω resistor in series with the ESA or RF ammeter. Connect these in series with the Equipotential Ground Stud on the back of the unit and each of the RF ports listed in the table below.
- Use a short test lead to activate Cut and Coag. ABC and Bipolar can also be activated with a test lead if footswitches are not available.
  - *RF active ports for measurement are shown with an "X"*
  - *Use a short test lead to activate each mode as shown.*
  - *ABC RF leakage is measured at the ABC connector using an adaptor and can be activated using a short test lead at M2HC.*





The table for “Allowable RF Leakage Current to Ground” lists the ports where the measurement is to be made along with which port to activate and the modes to be activated. The two block diagrams show the connection for measuring RF Leakage Current to ground.





RF Leakage Table (acronyms)

- DE: Dispersive Electrode
- M1HC: Monopolar 1/ Footswitch Receptacle
- M2HC: Monopolar 2/ABC Handpiece Receptacle
- R-BIP: R Bipolar port
- L-BIP: L Bipolar port
- ABC: RF leakage is measured for ABC at the ABC Active RF Port (requires ABC adaptor)

Table 3.3.3 Allowable RF Leakage Current to Earth Ground

RF Port Measured	RF Port Activated	Mode	RF Leakage (mA) Max
DE	M1HC	Standard Coag	<100
	M1HC	Pure Cut	<100
	M2HC	Standard Coag	<100
	ABC Port	ABC	<100
M1HC	M1HC	Standard Coag	<100
M2HC	M2HC	Standard Coag	<100
ABC	M2HC	ABC	<100
R-BIP	Bipolar	Bipolar Macro	<65
L-BIP	Bipolar	Bipolar Macro	<65

5. RF Leakage Current from Inactive Outputs
   - Set to full power Standard Coag, and Macro Bipolar.
   - Set ABC to 29 W, flow mode to manual, flow rate to 0.5 SLPM

   - Connect the 200Ω resistor in series with the ESA. Connect these in series with the Dispersive Electrode and each of the RF ports listed in the table below.
   - To measure the RF Leakage current from inactive bipolar outputs, connect the 200Ω resistor in series with the ESA between the two Bipolar RF Outputs.
   - Use a short test lead to activate Cut and Coag. ABC and Bipolar can also be activated with a test lead if footswitches are not available.

Table 3.3.4 Allowable RF Leakage Current to Ground – Inactive Monopolar to Dispersive Electrode

RF Port Measured	RF Port Activated	Mode	RF Leakage (mA) Max
M1HC	M2HC	Standard Coag	<150
	ABC	ABC	<150
	Bipolar	BP Macro	<150
M2HC	M1HC	Standard Coag	<150
	ABC	ABC	<150
	Bipolar	BP Macro	<150
ABC	M1HC	Standard Coag	<150
	M2HC	Standard Coag	<150
	Bipolar	BP Macro	<150
L-BIP	M1HC	Standard Coag	<50
	M2HC	Standard Coag	<50
	ABC	ABC	<50
L-BIP to R-BIP	M1HC	Standard Coag	<50

6. Mains Frequency Leakage Measurement

CAUTION: To prevent radio-frequency current from destroying the test equipment and/or affecting leakage readings, set all power settings to zero.

WARNING: Electrocution Hazard. Do not disconnect circuit ground from Earth Ground unless using an isolated Mains power supply.

Circuit ground and mains neutral must be connected for mains leakage testing. This is done within the electrical safety analyzer.

Equipment List: These tests are performed most conveniently using any qualified biomedical electrical safety analyzer.

Procedure:

a. Connect the electrical safety analyzer to make the measurements indicated in the tables below.

b. Measure the leakage for both chassis and bipolar to earth as this can be done without activating the unit.

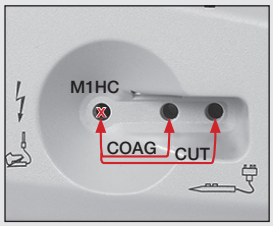
c. Since the HelixAR systems monopolar active outputs are disconnected by relays when the unit is not activated, active to earth leakage tests must be performed with the unit activated in order to be valid.

d. With all power controls set to zero, measure the leakage current from each of the three active output terminals to earth (see table below) while that output is activated in cut by a hand-control jumper as done in the previous step.

Table 3.3.5 Mains Frequency Allowable Leakage – Chassis and Bipolar Outputs

Measured Terminal	Line	GND	Limit (Max)
Equipotential Ground	Normal	Closed	10 uA
	Reverse	Closed	10 uA
	Normal	Open	230 uA
	Reverse	Open	230 uA
BIP Output	Normal	Closed	2 uA
	Reverse	Closed	2 uA
	Normal	Open	5 uA
	Reverse	Open	5 uA

NOTE: Measure the bipolar connections shorted together.



Mains Leakage Table (acronyms)

- DE: Dispersive Electrode
- M1HC: Monopolar 1/ Footswitch Receptacle
- M2HC: Monopolar 2/ABC Handpiece Receptacle
- R-BIP: R Bipolar port
- L-BIP: L Bipolar port
- ABC: Mains leakage is measured for ABC at the ABC Active RF Port (requires ABC adaptor)

Table 3.3.6 Mains Frequency Allowable Leakage – Monopolar Outputs

Measured Terminal	Line	GND	Activation	Limit (Max)
DE	Normal	Closed	M1HC CUT	5 uA
	Reverse	Closed		5 uA
	Normal	Open		12 uA
	Reverse	Open		12 uA
M1HC	Normal	Closed		5 uA
	Reverse	Closed		5 uA
	Normal	Open		12 uA
	Reverse	Open		12 uA
M2HC	Normal	Closed	M2HC CUT	5 uA
	Reverse	Closed		5 uA
	Normal	Open		12 uA
	Reverse	Open		12 uA

7. Automatic Return Monitor (A.R.M.) Check

Equipment List:

- Decade Resistance Box (DRB) – or- four Dispersive Electrode plugs with the cable cut off leaving only enough cable to solder a resistor across the two conductors. The values would be [4Ω - 7Ω], [13Ω - 15Ω], [135Ω - 144Ω] and [158Ω - 165Ω] each connected to a plug.
- Dispersive electrode adaptor if using a DRB - this is a dispersive electrode adaptor plug. Cut the cable off leaving only 3” to 6” of conductor on the plug. Strip the ends to allow connection to the DRB.

A.R.M. has two specific ranges that will be tested initially, after which the circuit will be tested to verify the circuit measures dissipative electrode resistance. For this test, only a Decade Resistance Box (DRB) and a Dispersive electrode cable adapter are required. Connect the DRB to the Dispersive electrode receptacle using the Dispersive electrode cable adaptor.

A.R.M. may be reset by disconnecting the dispersive electrode adaptor from the system or adjusting the DRB above 10 K ohms until the single and dual-foil Dispersive electrode status/alert indicator is red. Allow approximately 2 seconds after the DRB is changed before proceeding to the next step in the procedure.

A.R.M. indicators not mentioned in the procedure must be off for each test.

Dual-Foil Dispersive Electrode Alert Limit: Set the DRB to 158 ohms, then connect it to the Dispersive electrode adaptor and verify that the Dispersive electrode status/alert indicator is red.

Dual-Foil Dispersive Electrode Upper Limit: Set the DRB to 144 ohms and verify that the Dispersive status indicator is flashing green.

Dual-Foil Dispersive Electrode Lower Limit: Set the DRB to 15 ohms and verify that the Dispersive status indicator is green and all four LED segments are illuminated.

Single-Foil Dispersive Electrode Upper Limit: Set the DRB to 7 ohms, then reset A.R.M. (disconnect then reconnect the adaptor) and verify the Dispersive Electrode status indicator is green.

8. Output Coupling Capacitor Check

NOTE: Not all capacitance meters will read properly for this test. The test frequency should be at or below 1 kHz for best accuracy. The following meters have been tried successfully: Fluke 189, Extech 285, Sencor C75 and HP4284A (1 kHz settling or below).

a. Connect the Dispersive Electrode shorting plug to the Dispersive Electrode receptacle.

b. Set cut and coag power levels to zero.
CAUTION: Risk of injury to personnel and test equipment may occur if power settings are not set to "0" watts before conducting this test.

c. Connect the Capacitance meter across the Dispersive Electrode shorting plug -and- the Footcontrol RF Port using test leads 6" or shorter. Verify the un-keyed capacitance listed in Table 3.4.1

d. Activate the unit in any cut mode and measure the keyed capacitance per Table 3.4.1

e. Activate the unit in any coag mode and measure the keyed capacitance per Table 3.4.1

f. Connect the capacitance meter across the bipolar accessory RF terminals. Verify the un-keyed capacitance per Table 3.4.1

Table 3.4.1 Output Capacitance

TEST	Capacitance
Footcontrol – un-keyed	0.5 nF Max
Footcontrol – keyed - Cut	0.8 – 1.6 nF
Footcontrol – keyed - Coag	1.0 – 2.4 nF
Bipolar – un-keyed	1.8 – 3.2 nF

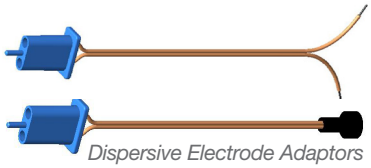
3.4 Calibration

System calibration is required when performing maintenance on the system and a parameter is found to be out of the specified ratings. Calibration is also required if any of the circuit boards are replaced. Calibration is not required if all major modes have a green "✓" and the unit meets performance specifications – unless- a circuit board has been replaced.

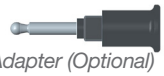
NOTE: When any of the circuit boards are replaced, a message will be displayed of a "board mismatch". This is an indicator that the unit should be recalibrated even though in the calibration menu all modes have a green check mark.

Equipment List Required for Calibration:
Monopolar Footswitch
Bipolar Footswitch
ABC Footswitch
Dispersive Electrode Adapter (Dispersive electrode cable with a banana jack connected)
A.R.M. Dispersive Electrode Adapter (Dispersive electrode cable with the two wires stripped to allow connection to a DRB (Decade Resistance Box) or a means to connect resistors.
ABC RF Adapter (ABC handpiece cut to a short length of approximately 12" and a banana jack soldered to the conductor)
ABC argon flow adapter (ABC handpiece cut to a short length of approximately 12" and adapted to connect to the argon flow meter)
Decade Resistance Box (or 10 ohm and 150 ohm resistors)
Commercial ESU Analyzer (ESA) with 50 and 300 ohm loads for bipolar modes and a 500 ohm load for monopolar modes.
Flow meter calibrated for argon gas.
1000X scope probes (optional) or differential probe rated for 6 KV.


ABC Test Connector


Dispersive Electrode Adaptors


Two Test Leads


Footcontrol Adapter (Optional)

1. Calibration Sequence – Modes (Power)

Use test leads to connect the Dispersive Electrode RF receptacle and the active port under test to the ESU Tester for RF power measurements. Use the footswitches to activate the system for all power checks. The left handcontrol active port allows for a banana plug to be inserted into the active port where a handcontrol is normally connected. For Cut and Coag calibration, use the left handcontrol.

WARNING: RF burn hazard exists if cables are not properly insulated or the operator comes in contact with any of the conductors connected to the RF outputs.

There are two means of entering the Calibration Screen. Once the unit has powered up, on the Control Panel, under the Program Key, press the ***UP*** and ***DOWN*** arrow at the same time to enter Test Mode. A ***Do Not Use Clinically*** message will appear at the top of both screens. Press the Volume Up and Down keys at the same time to enter the Service menu.

Ensure "calibration" is highlighted and then press start. By pressing start, the major modes calibration menu will be displayed. Within most of the major mode calibration options are minor modes that require calibration. Calibration can be performed on any of the major modes listed but this will include all the minor modes of the selected major mode. The calibration sequence for each major mode is automatic, meaning when one minor mode calibration is complete the unit will automatically go to the next minor mode within that major mode.

Example: Major Mode → Cut
Minor Modes of Cut → Blend 1, 2 & 3.

Do not select ABC voltage calibration if a differential probe rated for 6 kV is not available. If this mode is selected by error, then press the "exit settings" to exit out of calibration. Instructions for calibrating ABC voltage are at the end of this section.

The calibration sequence is menu driven with instructions for each step displayed on the right screen.

NOTE: Do not interrupt activation until after OK has been pressed. (See the example below)

1. Connect 500 ohm load to ESA
2. Display power (watts) on ESA
3. Activate cut footswitch
4. Adjust power until ESA indicates 150 Watts
5. Press ok
6. Release footswitch.

When the footswitch is released, the system automatically switches to the next minor mode in the cut calibration menu option.

NOTE: All minor modes have to be calibrated within a major mode selection.

If a calibration value is incorrect, a message will be displayed that calibration failed. It is important to ensure the correct load is connected and the power is adjusted as shown on each screen.

- A "✓" is displayed next to all modes that have been calibrated successfully.
- An "X" is displayed next to all modes that require calibration.

2. Calibration Sequence – A.R.M.

- In the calibration menu scroll down and select ***Perform ARM Calibration*** then press ***Start***.
- Connect the A.R.M. Dispersive Electrode Adapter (conductors need to be stripped)
- Connect 10 ohms and then press ***ok***
- Connect 150 ohms and the press ***ok***
- Exit A.R.M. calibration

3. Calibration Sequence – Argon Flow

Do not select argon calibration if a flow meter calibrated for argon is not available. If this mode is selected by error, press the "exit settings" to exit out of calibration.

NOTE: Only perform argon flow if a calibrated argon flow meter is available.

- Connect the argon calibrated flow meter
- In the calibration menu scroll down and select perform argon calibration then press start.
- The argon flow will automatically start flowing at 0.5 slpm. Adjust the flow rate for 0.5 slpm then press ok.
- When successful calibration of the three flow rates (0.5, 1.0, & 8.0) is complete, exit flow calibration.

4. Calibration Sequence – ABC Voltage

With ABC Voltage highlighted in the calibration screen, press start.

To calibrate ABC voltage, a scope with a 500 MHz BW and 2.5 GS/s and a differential probe rated for 6 kV should be used. Two probes rated for 1 kV can be used but they must be configured differentially.

ABC has two separate voltage amplitudes when activated without a load connected to the RF output ports. One voltage level is approximately 2 kV and the other is approximately 6 kV and it is this voltage that is to be calibrated. Set the scope to trigger at an amplitude of 4 kV or greater.

Set the amplitude for 1 kV/Div; time base for 10 mS/Div or 20 mS/Div to capture the 6 KV group of pulses. This pulse group only consists of 32 pulses whereas the 2 kV pulse group is 1100 pulses, so the 6 kV pulse group is much narrower.

Set the horizontal cursors at 6 KV. Activate ABC mode and adjust the peak voltage to 6 kVpk and then press OK.

At this point, all calibration functions should have a check mark. Exit calibration screens.

3.5 Repairs & Upgrades

CONMED Corporation is responsible for all necessary repairs and upgrades for the system while it is under factory warranty. The software in this unit is field upgradeable; therefore, if a software upgrade is available, CONMED will provide the storage medium for the upgrade to be performed by a Qualified Hospital Biomedical Technician or have it conducted by an authorized CONMED service center.

Replacement parts for the HelixAR are listed in this chapter. All components must be replaced with parts of identical construction and value acquired from CONMED Customer Service Centers. Only the key components will be listed by part number. If the component you are looking for is not listed, contact CONMED Customer Service Center for assistance.

There are five printed circuit board assemblies within the HelixAR. Four of the five board assemblies are primarily surface mount technology. CONMED does not recommend nor supply components for field replacement of surface-mount components.

For units that are not under warranty, it is likely the boards will be replaced should CONMED perform the repairs. The RF Amp board will be repaired -or- replaced based on the failure.

1. Error Messages

System failures will be displayed along with a suggested corrective action. When a failure is detected and the error message remains on the screen, it will be necessary to cycle the power to clear the error. A suggestion to cycle the power is displayed on the screen for all error messages. If it is an actual system failure, then the system will throw the error again and the unit will need to be returned for service. It is always a good idea to cycle the power a couple times as it is not unusual for the system to throw a false error message.

Faults are maintained along with a time stamp in the fault log. To get access to the fault log, press the volume up & down keys simultaneously and select fault log.

2. Bezel Disassembly

CAUTION: This unit has ESD sensitive components. It is necessary to be properly grounded using ESD straps when handling any of the circuits within the system. Electronic circuits should only be transported in ESD protective bags.

a. The cover is held in place by two screws located on the back of the unit. With the screws removed, slide the cover towards the back while slightly lifting up on the back edge of the cover.

b. The Bezel must be removed:

- To service or remove the power board
- To replace either of the two board assemblies within the Bezel
- To replace either of the two LCD modules
- To replace the Control Panel

If none of these actions are necessary, do not remove the Bezel from the system.

c. To remove the Front Bezel, remove the two screws that are holding it in place, one on each side of the unit. Disconnect the large ribbon cable that connects the front panel board assemblies to the power board. Disconnect this cable at the power board end and then lay the ribbon cable over the face of the Control Panel.

d. Disconnect the three (3) ground wires (green/yellow) that attach from the bezel assembly to the unit chassis.

Pull the bezel forward about an inch. There are four cable connections from the bezel to the power board. Reach inside and disconnect the four cable assemblies and slide the bezel forward to remove it from the system base.

e. A shield covers what is referred to as the Controller Stack, which consists of 2 board assemblies. Remove the cable clamp on the ribbon cable and then loosen the two fasteners from the connector so that the ribbon cable can be removed.

To gain access to the board stack, remove the screws holding the shield in place. It will be necessary to remove the three ground wires that are attached to the shield.

To remove the board stack or gain access to the LCD display, the two flex cables will need to be disconnected. The connectors for the flex cables are very delicate and are easily damaged. The locking mechanism slides toward the flex cable to unlock it. Apply even force to both sides when unlocking this tab. This mechanism only moves a small distance to unlock.

NOTE: The contacts for the flex cable face toward the board assembly or face down when re-assembling.

f. To remove the top board (61-8157-001), remove the screws holding it in place. By applying even force to the four corners of the board assembly, lift up and out of the headers on each end.

g. To remove the bottom board (61-8257-001), disconnect the two harnesses on each end of the board assembly and then remove the standoffs holding the board in place.

h. With the boards removed, access to the LCD displays is possible. The LCD display is held in place with two brackets that once removed; allow the display to be removed.

i. The flex cable contacts face down or towards the display. The locking mechanism is hinged and flips up. This mechanism will likely break if flipped 90°, so use a small tool such as an Exacto knife to lift the locking mechanism just enough to pull the flex cable out.

Do note how the displays are in the Bezel so that when re-assembling the Bezel, the displays are placed in correctly.

Do note the two flex cables have different lengths. The longer flex cable is on your right when facing the back of the displays.

j. Ensure the double sided tape remains with the bezel bracket.

3. Bezel Re-assembly

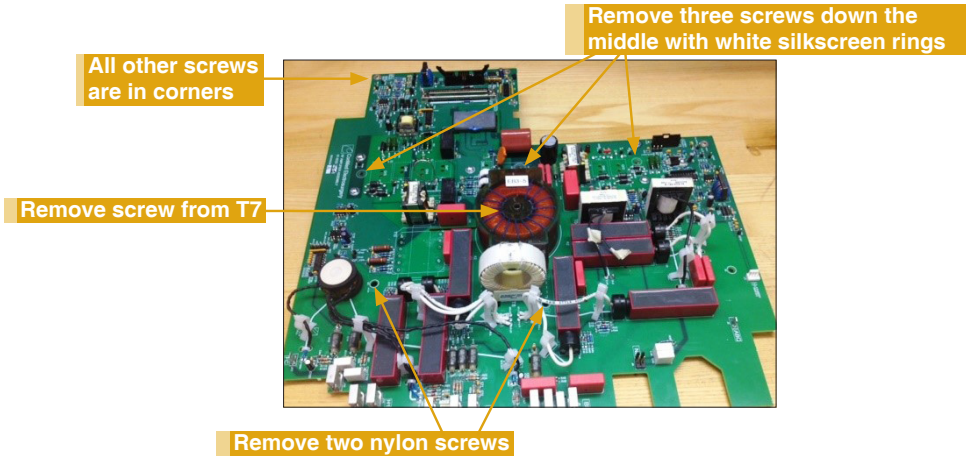
To replace the bezel assembly, just reverse the order. When placing the bottom board assembly, route the left flex cable though the slot. The right flex routes around the end. The large ribbon cable connector is towards the top side of the Bezel so that when looking at the silk-screen, with the bezel sitting upright, the lettering is correctly oriented. Re-connect the two harnesses that connect from the bottom board to the Control Panel.

To place the top board assembly, carefully route the left flex cable through the slot, then align the connectors and press down. The silkscreen should be properly oriented with the Bezel in the upright position. Carefully slide each flex cable into the connector and ensure it is in straight. To lock it in place, slide the locking mechanism of the connector by applying equal force on both ends of the connector locking mechanism away from the flex cable.

Replace the remaining hardware, ground cables, ribbon cable and shield. Ensure all hardware is snug, but not over-tightened.

To replace the Bezel on the unit, notice on the front of the chassis are three tabs extending the full width of the unit. The two outer tabs go under the bottom or outside of the Bezel and the middle tab goes on the inside of the Bezel. If the tabs are not placed correctly, the holes for the screws will not line up properly. Once the tabs are correctly placed, do not slide the Bezel all the way into place. Reach inside and reconnect the four harnesses that attach from the Bezel to the power board. Once these are attached, slide the Bezel in place and fasten it down. Attach the three ground wires from the shield to the side of the chassis.

Remove the following screws to pull the RF Amp out of the chassis:



4. Removal of RF Amplifier (Power Board)

The Bezel has to be removed before the RF Amplifier (Power Board) can be removed. Follow the previous instructions to remove the Bezel and then set it aside.

The picture above identifies the screws that will need to be removed from the power board.

- Three nylon screws near the front edge of the board assembly
- Four screws on corners along the sides and back edge of the board assembly
- One screw from T7 – the larger circular transformer
- Three screws down the middle of the board. The heatsink for the RF Amplifier is attached underneath the printed circuit board by several screws. DO NOT remove these screws, but do remove the three screws that have a white silkscreen outline (see picture above) .

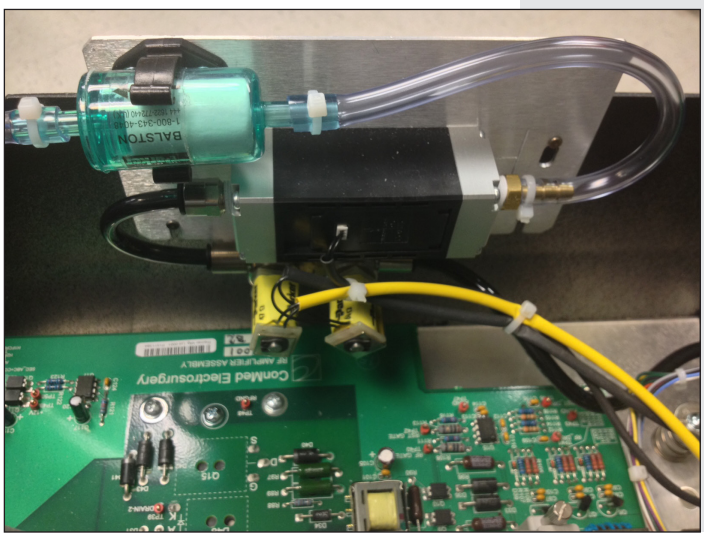
Disconnect the two harnesses along the back edge of the power board. The 10 pin harness does have a locking tab that must be pinched to be removed. Carefully lift the board assembly up and out toward the front of the unit.

5. Disassembly of the Backpanel and Pneumatic Platform

The Backpanel board is only held into place using a single screw. This screw is not only used to hold the Backpanel in place, but also serves as a ground for this circuit. All harnesses connected to this board assembly are keyed so that they cannot be connected incorrectly. When removing the connectors, pull on the housing, not the cables.

The pneumatic assembly consists of the flow sensor and two flow control valves. One valve is a solenoid valve (on or off) and the other valve (marked 47 ohm) is the flow control valve.

The Pneumatic assembly is only held into place with a single screw. When removing the pneumatic assembly, disconnect the three harnesses from the Backpanel board.



3.6 Replacement Component List

Table 3.6.1 Pneumatic Components

Part Number	Description
62-8426-001	Mass Flow Sensor
07-0220-003	Filter, Argon
61-8273-001	Flow Valves, HelixAR

Table 3.6.2 Printed Circuit Board Assemblies

Part Number	Description
61-8160-00X	Assy, HelixAR Backpanel
62-8250-00X	Power Supply, HelixAR
61-8232-00X	Assy, HelixAR RF Amplifier
61-8257-00X	Assy, HelixAR Control Main
61-8157-00X	Assy, HelixAR Control Daughter
61-8180-00X	Assy, Helix Cart Display

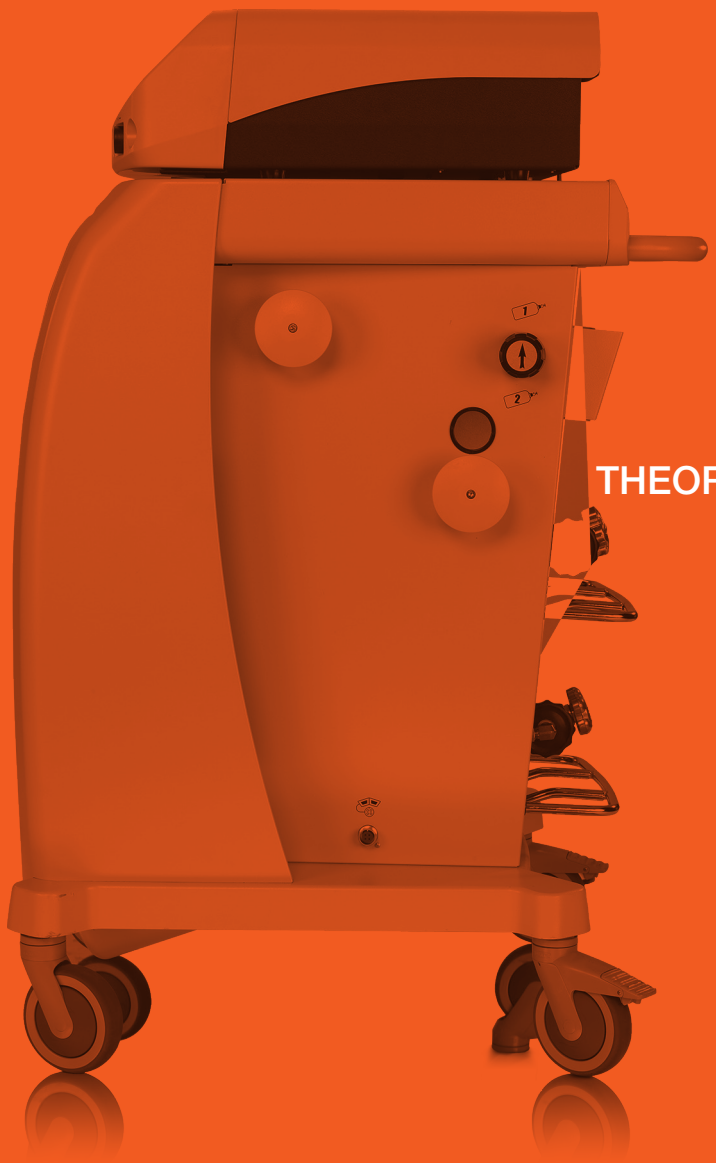
Table 3.6.3 Bezel and Components

Part Number	Description
62-8339-00X	NGA Bezel
62-8477-001	Fiber Optic Cable, NGA Bezel
62-8325-001	LCD Assy
62-8265-002	Flex Cable, LCD, 4”
62-8265-001	Flex Cable, LCD, 3”
62-8175-00X	NGA Control Panel
61-8270-001	Harness, Standy Switch, HelixAR
61-7120-002	ABC Connector Assembly

NOTE: Where there is an X means this number may have changed since purchase of your unit.

Additional documentation for trouble-shooting or ordering components not listed above can be made available upon request by contacting CONMED customer service.

The schematic and component list for the RF Amplifier are in the back of this manual.



Section 4
THEORY OF OPERATION - OVERVIEW

Controller Assembly Overview

This section will provide an overview of the HelixAR circuits.

The system consists of 5 printed circuit assemblies; Controller-Daughter Assembly, Controller Main Assembly, Backpanel Assembly, High Voltage Power Supply, and RF Amplifier Assembly. The Daughter and Main are called the Controller stack as they are stacked and located behind the Control Panel and displays. The RF Output is attached to the base of the chassis and is the largest PCB assembly in the unit.

4.1 System Controller & Monitor

There are two programmable electronic subsystems in the HelixAR: System Controller and System Monitor. Each consists of a Microcontroller, FPGA (Field Programmable Gate Array), and a Microcontroller on the Backpanel assembly. These are two similar, yet independent, circuits designed for one to control system functions and performance while the other monitors system functions and performance. The System Controller interrogates the User Interface. From this it sets what is displayed on the right display on the system, provides specific tones, controls argon gas flow rate, determines the RF Output Waveform and RF output Power. The System Monitor typically receives operating parameters from the System Controller. From this it sets what is displayed on the left display on the system, verifies a tone occurs when an activation request is made, verifies the argon flow rate is within operating parameters, and verifies the correct waveform and RF output power. The System Monitor will inhibit both RF Output and argon gas flow when it detects a signal outside specific parameters.

The Controller Stack (Daughter & Main Assemblies) can be treated as common circuit separated on two different Printed Circuit Boards. The Main is the bottom and largest board of the two. The Main board consists of the power sources (1.2 V, 1.8 V, 3.3 V, 5 V and two 3.3 V references) required to operate the circuits on the Stack Assembly. The Main also has the scaling resistors for voltage and current signals used for RF Output power control, river for the Control Panel LEDs, over-voltage monitor for the afore mentioned power sources, and system reset circuit. There are no programmable devices on this board assembly.

The Daughter board has four programmable devices (2-microcontrollers, 2-FPGAs), EEPROM for program storage, volatile RAM memory, USB driver, LCD/ LCD Backlight Drivers, and a CODEC for tone generation. Details on specifics of these devices are beyond the scope of this overview but each of the microcontrollers has a subordinate FPGA assigned to it. The FPGAs sense a ratio of the output voltage and current that is delivered to the patient and use digital filtering to convert these into a proportional rms value. The rms of the voltage and current can then be multiplied, with the product term being power. The System Controller uses this product term for controlling RF Output power and the System Monitor uses this product term to ensure the RF Output power is within specific limits based on the mode selected and power setting. The System Controller provides the RF Drive to the amplifier and the System Monitor can inhibit the RF drive should a problem be detected with the output waveform, voltage or power. Neither of the FPGAs are decision makers, but they do pass data collected to their associated microcontroller to be acted upon.

Much of the system control and monitoring is done using serial communications of I^2C, SPI, UART, RS232 and USB. When a communication link cannot be established between devices on any of these serial buses, the system will be placed in a safe state and a communication error message will be displayed.

LCD's are driven using 16 bit data lines. Connection from the Daughter board to the LCD modules is done using a 40 pin ZIF connector. This connector is very fragile and care needs to be taken when disconnecting the flex cable from the ZIF connector.

4.2 RF Power Assembly Overview

The RF Power Assembly is made up of four functional blocks: The RF Amplifier, ABC/Coag RF Output, Cut/Blend RF Output, and the dedicated Bipolar RF Amplifier.

The amplifier is a switched mode resonant flyback amplifier that converts power from the HVPS to the RF energy necessary for electrosurgery. This circuit uses two fast MOSFET transistors in series to pulse current through a resonant circuit, which is formed by the primary of the output transformer together with capacitors in a tank circuit configuration. The MOSFET transistors are driven by a signal from the controller logic (labeled RF_DRV) at the corresponding RF frequency, duty cycle, and repetition rate for each mode of operation.

The ABC/Coag RF output circuits are the secondary side of the ABC/Coag RF Output transformer. This output powers the high voltage operating modes, namely ABC and Coagulation. It is best to describe one end of the secondary windings as Active and the other side as Return. In all monopolar modes, the Active side is the one that delivers power to the electrosurgical accessory and the return connects to the patient pad. Both the Active and Return have low frequency blocking capacitors with equivalent capacitance for the galvanic isolation needed to prevent neuromuscular stimulation of the patient. High voltage relays steer the output power to the respective RF Output port and provide discrete outputs so that energy is only delivered to the accessory that is activated. The relay drives originate from the Controller and are labeled with a “K”.

The RF Output Power is controlled by sampling a ratio of the RF Output Voltage and Current. The RF Output Voltage and current are sensed on the primary side of the RF Output transformer. On the Controller, the System Controller and Monitor each sample the voltage and current from different transformers and conditioning circuits. The conditioning circuits filter the signal and scale them to normalize the sense signal amplitudes for the range of output voltages and currents of each mode of operation.

The Cut/Blend RF output is identical in operation to the ABC/Coag RF Output, with a different turns ratio in the transformer. This turns ratio is optimized for low voltage outputs and is used to power the low voltage modes, namely Cut and Blends. In Monopolar cut mode, the Active side is the one that delivers power to the electrosurgical accessory and the return connects to the patient pad. The current is sensed with the same circuits as the ABC/Coag RF Output.

The Bipolar RF output is identical in operation as the Cut/Blend RF Output, with a different turns-ratio in the transformer. This turns ratio is optimized for low voltage outputs and is used to power the low voltage bipolar modes, namely Micro and Macro. In bipolar mode, both the active and return sides connect to the bipolar accessory. The current is sensed with the same circuits as the other RF Outputs. This output has dedicated voltage sense circuits.

In Cut and Bipolar modes the amplifier is driven at 400 kHz with a matching fundamental frequency. The output power is varied by adjusting the HVPS from near zero to 155 VDC and by pulse width modulation. In these modes the amplifier is operated as a classic Class D amplifier. To obtain the blend waveforms, a modulation frequency is introduced, thus reducing the duty cycle in various proportions to obtain each blend effect. Maximum hemostasis is obtained at the lower duty cycle.

In Coag mode, the amplifier is driven with single pulses at 20 kHz or 40 kHz, or in bursts of 400 kHz pulses in 25 kHz intervals. The tank circuit is designed to resonate with no load at 550 kHz ± 50 kHz. The output power is varied by adjusting the HVPS from near zero to 155 VDC and by pulse width modulation.

In ABC mode, the amplifier is driven with single pulses at 31.25 kHz and the tank circuit is designed to resonate with no load at 575 kHz ± 50 kHz. When the ABC mode is activated, the HVPS is fixed at 200 V ± 2 V and the power is controlled by pulse width. The pulse width to output power is relatively linear allowing calibration at two different points and setting the slope from low power to maximum power. The RF output is combined with argon gas at the output receptacle.

The current sense transformer on the primary is used to detect arc initiation. With an open circuit or light load, the RF output is a damped sinusoid. The peaks of the resonate circuit are compared to

a threshold. If 4 or more peaks exceed the threshold the output is considered to be unloaded. When the ionized argon gas stream is about 1 cm from the load, the peaks are loaded and drop in amplitude and the system changes from the Target Mode to the Active Mode.

In Fluids Mode, an initial burst of energy is provided when activation is initiated. This is achieved by setting the output power to a predetermined higher level for a fixed time. This burst of energy is intended to facilitate initiation of the electrosurgical arc (clinical effect) for surgical procedures conducted in fluid mediums.

In Lap Mode, the peak output voltage of all Cut, Blend, and Coag monopolar modes are reduced to decrease the potential for capacitive coupling in laparoscopic procedures. The level each voltage is reduced varies per mode with an absolute maximum output voltage of 2,700 Vpk.

The A.R.M. circuit monitors the continuity or contact quality of the patient return circuit. The A.R.M. circuit consists of an actively driven impedance measurement circuit and is monitored by the System Controller using the signal labeled C_VARM+ and by the System Monitor using the signal labeled M_VARM+. The measurement circuit operates at a fixed frequency and is driven by a constant current source.

In the 0-8Ω range, the A.R.M. functions as a continuity monitor (CM) detecting the presence of a single foil dispersive electrode. In the 12-150Ω range the A.R.M. functions as a contact quality monitor (CQM) detecting the presence and contact quality of a dual foil dispersive electrode. The A.R.M. must be able to measure resistance up to 180Ω; beyond that the system declares an open circuit or no-pad state (no dispersive electrode connected).

Handcontrol activation request circuits selectively detect a switch closure at the accessory terminals and are referenced to the Active Output of each patient circuit. The circuits are powered by an unregulated switching converter with a dedicated winding for each port. The isolation transformer and optocouplers provide isolation between the patient circuits and the system logic.

4.3 High Voltage Power Supply Overview

The power supply in the HelixAR is a self-contained assembly made up of three separate converters, as follows:

Power Factor Correction (PFC): The PFC is an off-line switch-mode boost converter that maintains a constant DC output voltage (approximately 400 V). The PFC shapes the input current to match the phase and shape of the line voltage for the purpose of reducing the harmonic distortion and limiting voltage fluctuations and flicker in the mains supply system. This circuit can be enabled from the Controller with the signal labeled/PFC-EN.

High Voltage Power Supply (HVPS): The HVPS is a switch-mode converter that converts the PFC output to an adjustable DC voltage for use by the RF amplifiers. The HVPS converter provides two means of patient protection from the mains. The output voltage and current are controlled by PWM controller. The control signal/V-EN from the Controller enable the HVPS, and HV-CONTROL also from the Controller sets the output voltage level.

Low Voltage Power Supply (LVPS): The LVPS is an off-line switch-mode converter that maintains a constant 12.75 V DC output voltage. The LVPS converter provides two means of patient protection from the mains. On power up, the LVPS is normally disabled. The control signal/STBY from the Controller enables and disables the LVPS according to hardware-programmed timings.

4.4 Back Panel Assembly Overview

The back panel PCB consists of the Flow Control circuit, Proportioning Valve Amplifier, header for the Wireless Footswitch interface, USB connector, 15-pin RS232 connector and Footswitch Isolation circuits. The pneumatic and solenoid valve, along with Flow Valve will be a different assembly, but do interface to the Backpanel PCB via connectors.

Microcontrollers: The Backpanel PCBA has two independent microcontrollers with one dedicated to control functions and the other to monitoring functions. These microcontrollers interface with the Backpanel circuits directly and receive commands from and send information to the main system controller and monitor via RS232 serial communications.

The System Controller sends commands to the Backpanel Controller for argon flow control and receives from the Backpanel Controller activation requests, measured argon flow rate, proportional valve operating current and argon tank pressures. The argon flow rate is controlled using a current controlled electro-mechanical valve.

When the System Controller receives an activation command for ABC, it transmits to the Backpanel argon flow information. For the duration of argon flow, the System Controller requests from the Backpanel Controller the measured argon flow rate and uses this information to transmit a correction in order to regulate the flow.

The System Monitor interfaces with the Backpanel Monitor for the measured argon flow rate, activation requests and enables argon flow by enabling a solenoid valve. For the duration of argon flow, the System Monitor requests argon flow updates and valve current information in order to monitor that these signals are within specific limits. When a failure is detected, the System Monitor transmits a signal to inhibit flow by turning off the solenoid valve.

4.5 Pneumatic Assembly

The pneumatic assembly is mounted to the side wall and consists of a flow sensor, solenoid valve and proportional valve for flow control. The flow sensor is a mass flow sensor with an idle voltage (no flow) at 1 V with a linear increase as the flow rate increases. The solenoid valve is used only to turn flow on or off and is used as an additional means to inhibit argon flow. The proportional valve is a linear flow control valve that operates from 0 V to 12 V for a flow range of 0 slpm to 12 slpm maximum.

The Backpanel microcontrollers each operate one of these valves, with the Controller operating the flow control valve and the Monitor operating the solenoid valve. These valves are independently tested at every power cycle and should either valve fail to fully close, RF energy and argon flow is inhibited.

4.6 Cart Circuits

The Backpanel interfaces with the Cart circuits using isolated Opto Isolators and an isolated I^2C serial communication port for reading argon tank pressure.

The Cart has a circuit board located on the backside under the handle. Each argon tank has a pressure sensor and the outputs of these sensors connect to the Cart circuit board. When the unit is not powered on the tank pressure status can be checked by pressing the switch that is over the circuit board. These indicators are green, amber or red only. Green indicates sufficient argon gas for most cases and yellow indicates the tank is low and should be replaced before a case starts. When tanks are empty, the color will be red. When the unit is powered on, this circuit is disabled and the tank status is displayed on the left LCD screen.

Section 5
TECHNICAL INFORMATION

5.1 Accessory Compatibility

Monopolar Footswitch: 60-6700-001

Bipolar Footswitch: 60-1650-001 and 60-1650-002

ABC Footswitch: 60-8475-001

Wireless Footswitch: 60-8480-001

Monopolar Accessories (Hand pieces): evaluated to IEC 60601-2-2:2009 with a minimum voltage rating of 5 kVpk.

Bipolar Accessories (Hand pieces): evaluated to IEC 60601-2-2:2009 with a minimum voltage rating of 600 Vpk.

ABC Accessories (Hand Pieces): evaluated to IEC 60601-2-2:2009 with a minimum voltage rating of 6.5 kVpk.

Dispersive Electrodes: evaluated to IEC 60601-2-2:2009

Argon Gas Cylinder: 136050 or 136051

5.2 General Specifications

- Input Rating: 100-240 VAC, 6.5 A max, 50/60 Hz
- Line Regulation: Power change < 1%/V for the range of line voltages specified
- Power Cord: All units are supplied with an IEC-320 250 V 10 A 65°C mains inlet connector.
- Power cords can be ordered from CONMED Electrosurgery
- Fuses: Two T10.0 AH, 250 V, Type 215 fuses (made by Littlefuse).
- Power Accuracy: ± 10% of displayed power or 3 W, whichever is greater
- Operation: Intermittent 15 sec on/30 sec off
- Weight: 14.65 lb. (6.65 kg)
- Height: 6.08 inches (15.44 cm); Width: 13 inches (33 cm); Depth: 18 inches (45.72 cm) including handle
- Argon Gas:
  - *99.998% minimum purity (Medical Grade)*
  - *Cylinder Specifications:*
  - *Service Pressure: 3000 psi (200 bars) maximum*
  - *Connection Valve: CGA-580*

Table 5.2.1 Power Cord Specifications

Region	Specification	Description		Standard
USA, Canada	Any UL, CSA manufacturer	SJT or better	250 VAC, minimum 16 AWG, 3 Conductor, maximum length 20 feet (6 m)	UL817
Europe	Any HAR cord manufacturer	<HAR>H05WF3G1.0	Copper 1.0 mm 2 minimum cross sectional area, maximum length 20 feet (6 m)	IEC60799

5.3 Environmental

- Operating Conditions: 10°C to 40°C, 95% RH Non-condensing maximum at altitudes from -60 meters to 3050 meters above mean sea level
- Degree of protection against Ingress of Water: IPX1 (Protection against vertically falling water drops)
- Mounting Restriction: 2-inch (5 cm) clearance required on each side, back and above the ESU for cooling
- Cooling: Natural convection, conduction, and radiation
- Storage Conditions: -34°C to 65°C, at altitudes from –60 to +4500 meters above mean sea level when sealed in original poly bag, packing material and shipping Carton
- Prior to shipment or storage, the ESU should be enclosed and sealed in a polyethylene bag and placed in original Carton using original packaging materials.

5.4 Regulatory Compliance

- Designed to comply with Medical Electrical Equipment Standards (IEC 60601-1 Ed. 3.0 b:2005, IEC 60601-1-2 Ed 3.0 b:2007, IEC 60601-1-6 Ed. 3.0 b:2010, IEC 60601-1-8 Ed. 2.0 b:2006, IEC 60601-2-2 Ed. 5.0 b:2009, ISO 14971: 2007)
- Manufactured in an ISO 13485: 2003 Registered Facility
- Type of protection against electric shock: IEC Class 1
- Degree of protection against electric shock: Type CF
- Non-Ionizing Radiation
- RF Leakage: < 100 mA per IEC60601-2-2: 2009

5.5 Monopolar Enhanced Options: General, LAP and Fluids

These modes only affect monopolar modes of Cut and Coag to provide specific advantages.

General: Intended primarily for open procedures and is the most common electrosurgical selection.

LAP: LAP limits the maximum voltage to < 2800 Vpk and is intended for Laparoscopic procedures.

Fluids: For a very short period of time, the output power is boosted to create a vapor layer between the electrode and fluids to enhance arc initiation and is intended for surgical procedures within a fluid environment.

5.6 Cut Modes

[Open Circuit voltage is shown as xxx for General setting; (xxx) for Lap setting – Ex: xxx (xxx)]

Cut modes are designed to vaporize soft tissue resulting in an incision with minimal tissue necrosis. The minor mode “Pure” provides the closest affect to a scalpel and each Blend setting provides slightly more hemostasis than the previous mode (Blend 1 provides more hemostasis than Pure).

Table 5.6.1

Mode	Power Range (W)	Rated Load (Ω)	Repetition Rate ±2 uS (uS)	Duty Cycle (on/off) ± 2 uS Power: <100 W	Duty Cycle (on/off) ± 2 uS Power: ≥ 100 W	Frequency (KHz)	Max Voltage Open Circuit Vpk (Lap Mode Selected)
Pure	0 - 300	500	Continuous	Continuous	Continuous	400 ± 15	1000 (800)
Blend 1	0 - 200	500	50	38 / 12	40 / 10	400 ± 15	1200 (900)
Blend 2	0 - 200	500	50	28 / 22	33 / 17	400 ± 15	1400 (1000)
Blend 3	0 - 200	500	50	18 / 32	28 /22	400 ± 15	1600 (1100)

5.7 Pulse Cut

This selection is available in all four of the cut modalities and is intended for use in GI procedures. The cycle time for Pulse Cut is 600 mS with an on time of 70 mS and an off time of 530 mS. The duty cycle provides ability for very precise incisions when used in delicate procedures such as ERCP procedures. The power is displayed as peak and average where the average is the average power for each cycle.

5.8 Coag Modes

[Maximum voltage is shown as xxx for General setting; (xxx) for Lap setting – xxx (xxx)]

Coag modes are designed to "dry" the tissue to minimize or stop bleeding. Most coag modes are versatile in application as they can be used in contact with the tissue or non-contact with the tissue. When a coag mode is applied in contact with the tissue, the effect can be desiccation or dissection with an increase of hemostasis from that provided by cut modes.

Pinpoint coag is intended to be used in-contact for desiccation only of localized tissue.

Standard is intended for non-contact coagulation but is designed for contact desiccation with increased hemostasis than that provided by a blended cut. Standard has a greater peak voltage than Pinpoint coag.

Spray coag is intended for non-contact coagulation but will dissect with increased hemostasis than that provided by Standard coag. Spray has the greatest peak voltage except when the LAP mode is selected.

5.9 Pulse Coag

This selection is available in all Standard and Spray modes and has a 50% duty cycle at 200 Hz rate. This selection provides a peak voltage for arc initiation while limiting RF energy to limit depth of penetration. The power displayed is both peak power and average power for each cycle.

5.10 Bipolar Modes

Bipolar modes are used for desiccation when thermal spread is to be minimized using forceps. The forceps provide the "active" and "return" of the RF current, therefore a return pad is not required.

Micro mode is intended to be used with small jeweler type forceps.

Macro mode is intended to be used with larger bayonet type forceps.

Table 5.8.1

Mode	Power Range (W)	Rated Load (Ω)	Repetition Rate ± 2 uS	Duty Cycle (on/off) ± 2 uS	Frequency (KHz)	Peak Max Voltage (Open Circuit), Vpk (Lap Mode Selected)
Pinpoint	0 - 120	500	40	8 / 32	400 ± 15	2400 (2000)
Standard	0 - 120	500	25	Single Pulse	550 ± 50	3200 (2700)
Spray	0 - 80	500	50	Single Pulse	550 ± 50	5000 (2700)

Table 5.10.1

Mode	Power Range (W)	Rated Load (Ω)	Repetition Rate	(ON/OFF)	Frequency (KHz)	(Open Circuit), Vpk
Micro	0 - 70	50	Continuous	Continuous	400 ± 15	175
Macro	0 - 90	300	Continuous	Continuous	400 ± 15	600

5.11 Argon Dissect

Argon dissect provides a means to dissect and desiccate tissue using an electrode with minimal smoke plume by applying argon gas over the electrode. With Dissect Med and Dissect High selected, then Argon Dissect will also operate in a non-contact mode delivering argon enhanced coagulation where the arcing is more controlled than a coag mode without an argon shroud.

5.12 Argon Beam Coagulation (ABC)

ABC is a non-contact coagulation intended to provide rapid hemostasis or minimal thermal damage when needed. This mode uses a laminar like argon flow to conduct the RF current to the tissue for superficial coagulation.

- Open Circuit Voltage has two voltage levels: 6 kVpk for 2 mS and 2 kVpk for 68 mS repetitive. The 6 kV is called Booster Pulses and is used to initiate the Beam. The Booster pulses are then turned off.
- Open/Manual/Lap & ABC®Flex are argon flow modes and are covered below.

5.13 Pulse ABC

- Pulse ABC is intended for low energy applications of RF energy where thermal damage must be minimal. Pulsed ABC energy is delivered precisely on fixed time intervals where the timer starts only when the argon beam is initiated. Energy can be controlled by time and power setting. Pulse ABC is available for all four of the argon flow selections.
- Single Shot: A one-second delivery of argon beam energy. An application for this mode is polypectomies where depth of penetration of RF energy must be controlled. At the conclusion of the one-second activation period, the system will not re-initiate a beam until a new activation request occurs.
- 200 mS: A repetitive cycle of 200 mS of RF energy with a minimum of 1 second off time. It does not require the user to re-initiate an activation request.
- 400 mS: A repetitive cycle of 400 mS of RF energy with a minimum of 1 second off time. It does not require the user to re-initiate an activation request.
- 600 mS: A repetitive cycle of 600 mS of RF energy with a minimum of 1 second off time. It does not require the user to re-initiate an activation request.

Table 5.11.1

Mode	Power Range (W)	Rated Load (Ω)	Repetition Rate ± 2 uS	Duty Cycle (on/off) ± 2 uS	Frequency (KHz)	Peak Max Voltage (Open Circuit), Vpk
Dissect Pure	100	500	Continuous	Continuous	400 ± 15	600
Dissect Low	100	500	50	28 / 22	400 ± 15	1100
Dissect Med	100	500	50	18/32	400 ± 15	1250
Dissect High	100	500	25	Single Pulse	550 ± 50	2700

Table 5.12.1

Mode	Power Range (W)	Rated Load (Ω)	Repetition Rate ± 2 uS	Frequency (KHz)	Peak Max Voltage (Open Circuit), Vpk
Open/Manual/LAP	150	500	32	500 - 600	6000
ABC®Flex	80	500	32	500 - 600	6000

5.14 Argon Flow Control

The table below lists the flow ranges for each of the four (4) argon flow modes. Power setting always over-rides the argon flow rate and the argon flow rate is limited based on the power setting.

Table 5.14.1

	Open		Manual		Laparoscopic (Lap)			
General Description	Automatically adjusts gas flow to match power settings. Used in open procedures		Allows surgeon to independently adjust power and gas within certain parameters		Caps gas flow for use in laparoscopic procedures		Caps gas flow for use in Gastrointestinal procedures	
Power and Gas Flow Parameters	**Power (W)**	**SLPM**	**Power (W)**	**SLPM**	**Power (W)**	**SLPM**	**Power (W)**	**SLPM**
	10-19	1	10-39	0.5-4	10-39	1-2	10-80	0.5-2
	20-24	2	40-78	2-8	40-78	1-4		
	25-29	3	80-150	4 -10	80-150	2-4		
	30-34	4						
	35-39	5						
	40-48	6						
	50-88	7						
	90-105	8						
	110-125	9						
	130-150	10						

Open is only to be used for Open Procedures. The argon flow rate is too high for Minimally Invasive Procedures.

5.15 Output Characteristic Curves

The following graphs illustrate output power and voltage characteristics for all modes.

Load Curves: Illustrations of the output power delivered to a range of load resistances for each mode.

Maximum Peak Voltage: Illustrates the maximum peak voltage available at a given output mode and power setting in the General and Lap Specialty modes.

Output Power vs Power Setting: Illustrates the output power at rated load for all dial settings and modes.

1. Load Curves

Figure 5.15.1 Load Regulation, Monopolar Pure Cut – General

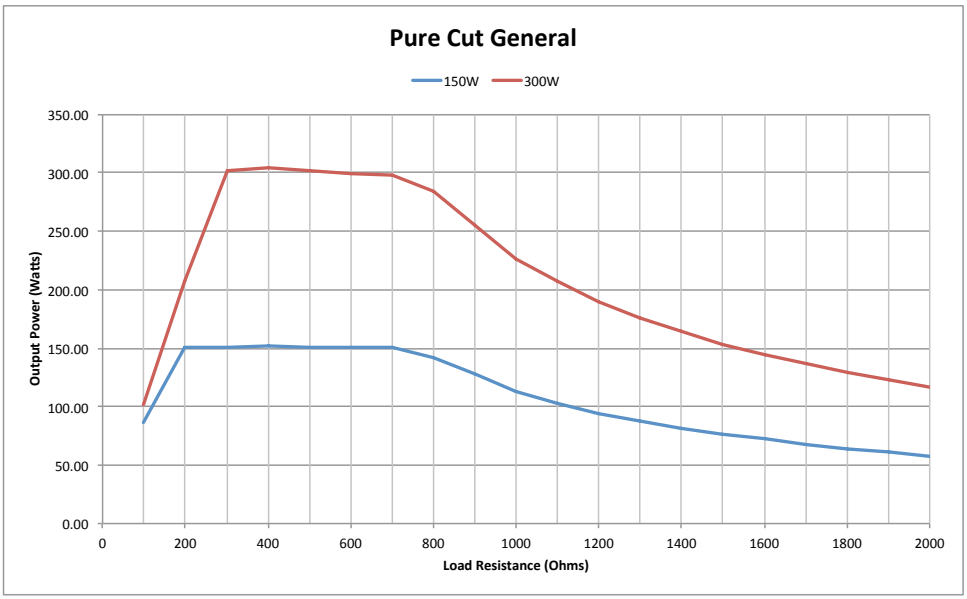


Figure 5.15.2 Load Regulation, Monopolar Pure Cut – Lap

Figure 5.15.3 Load Regulation, Monopolar Blend 1 – General

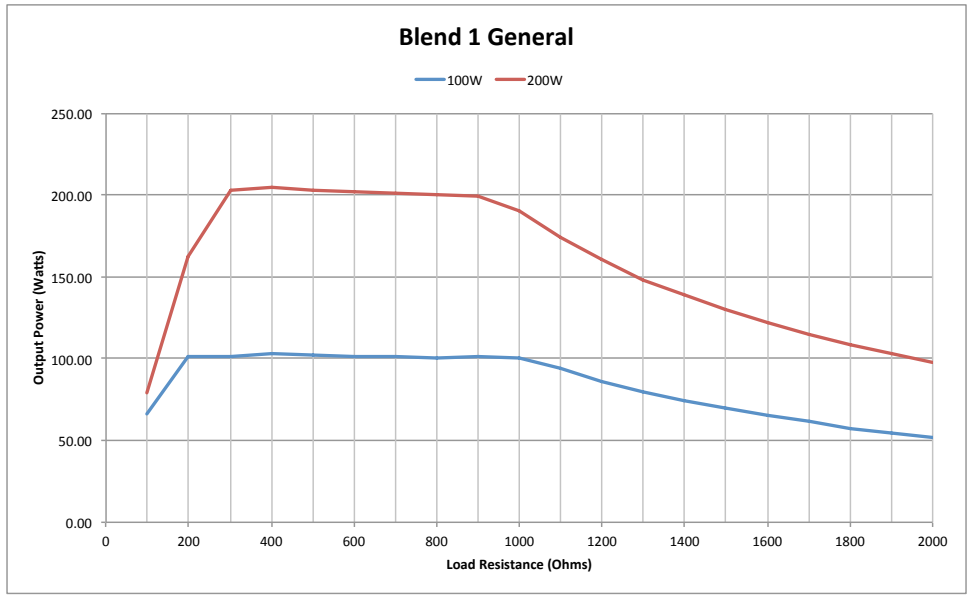


Figure 5.15.4 Load Regulation, Monopolar Blend 1 – Lap

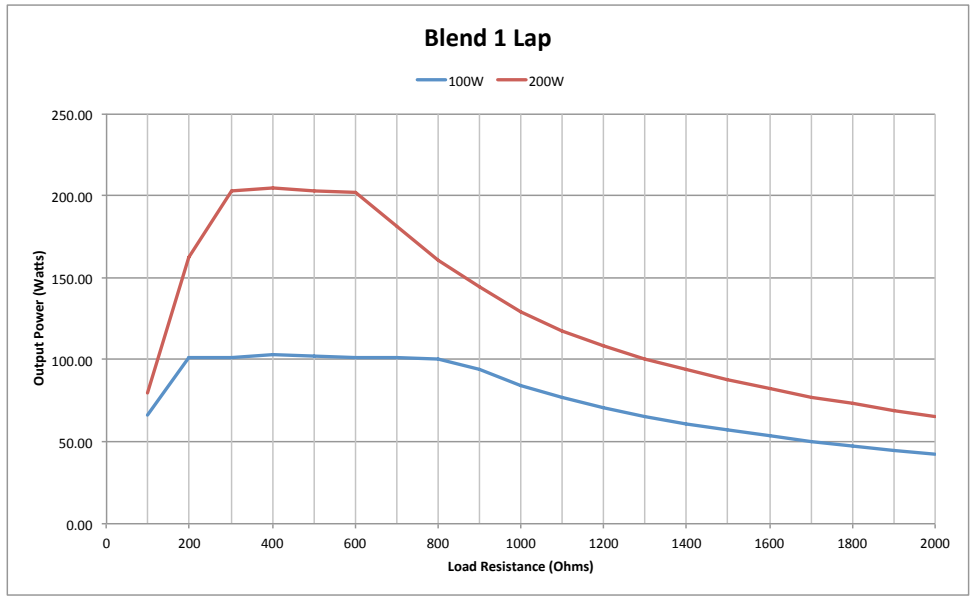


Figure 5.15.5 Load Regulation, Monopolar Blend 2 – General

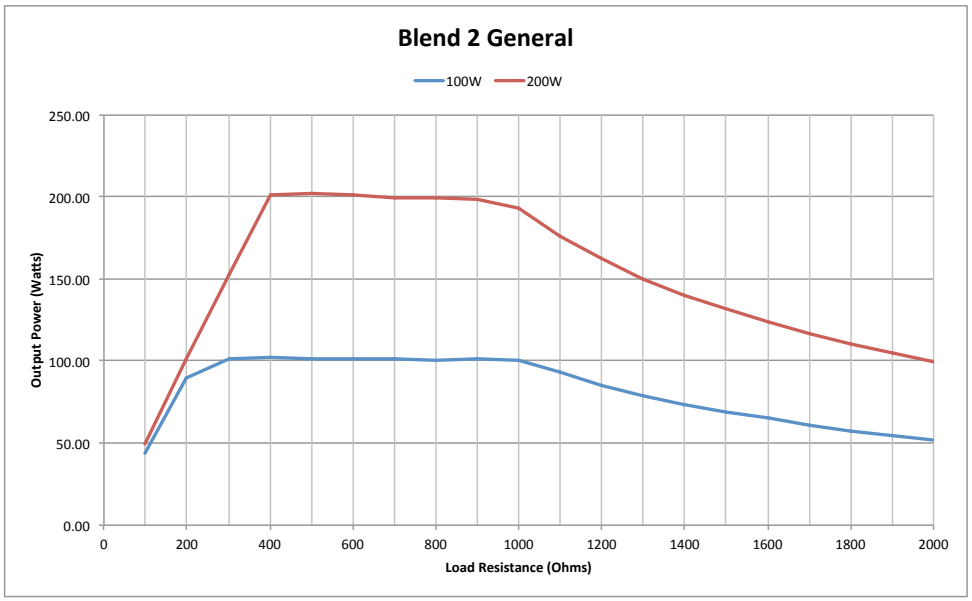


Figure 5.15.6 Load Regulation, Monopolar Blend 2 – Lap

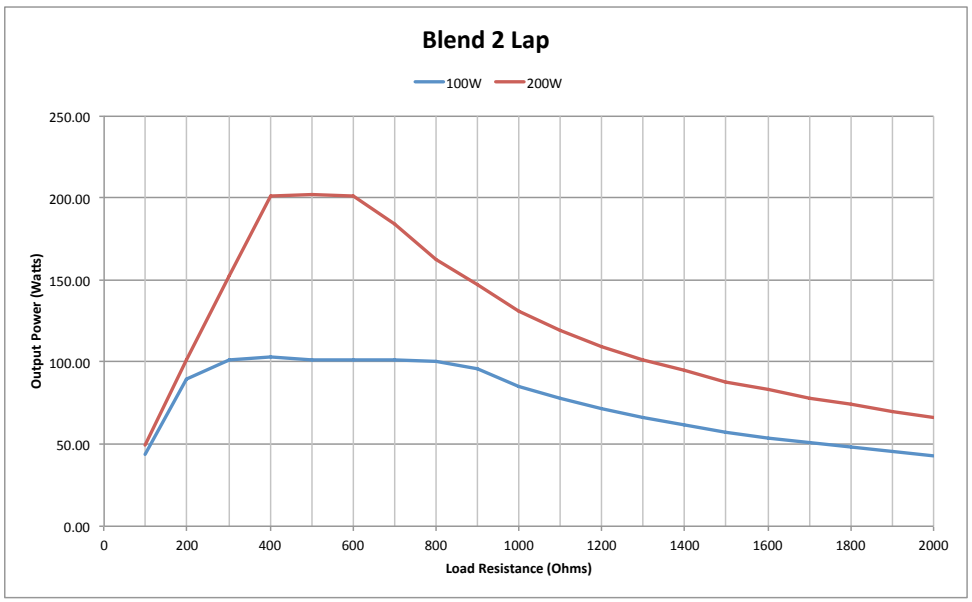


Figure 5.15.7 Load Regulation, Monopolar Blend 3 – General

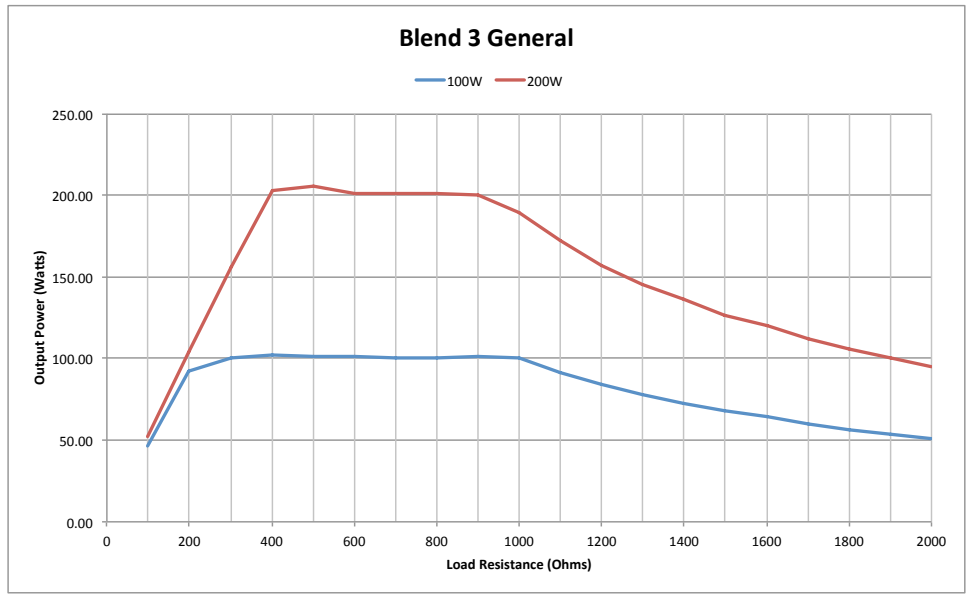


Figure 5.15.8 Load Regulation, Monopolar Blend 3 – Lap

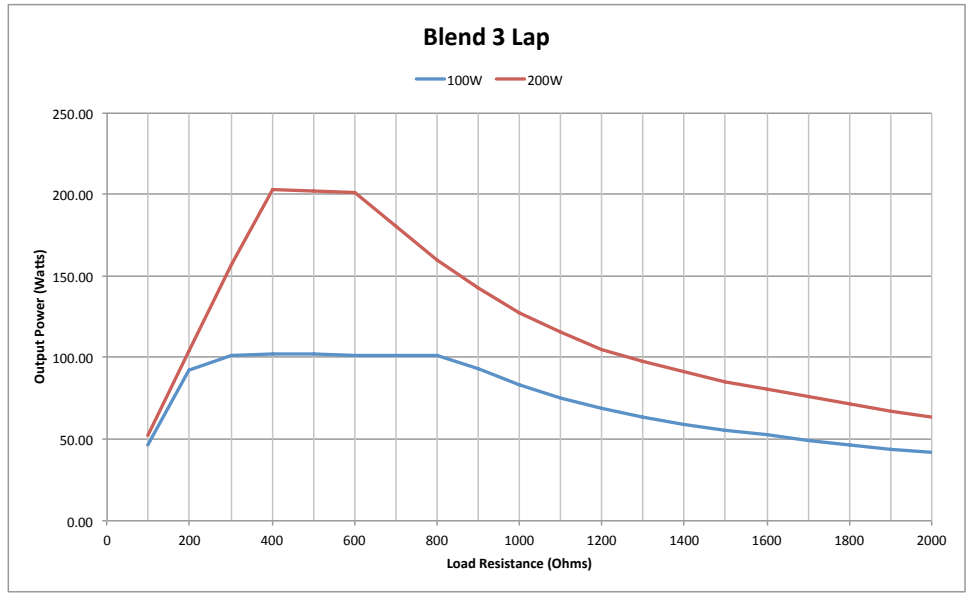


Figure 5.15.9 Load Regulation, Monopolar Pinpoint Coag – General

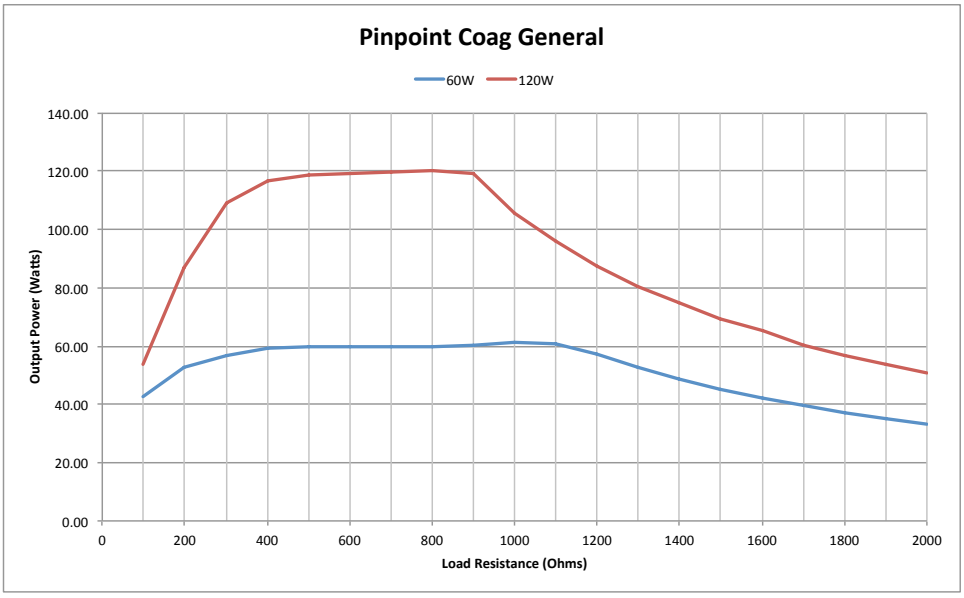


Figure 5.15.10 Load Regulation, Monopolar Pinpoint Coag – Lap

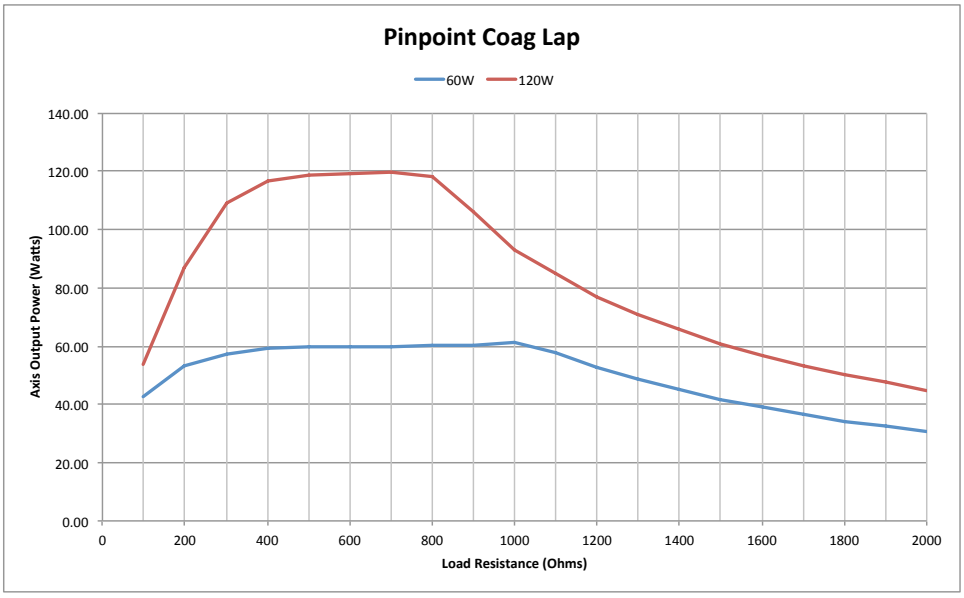


Figure 5.15.11 Load Regulation, Monopolar Standard Coag – General

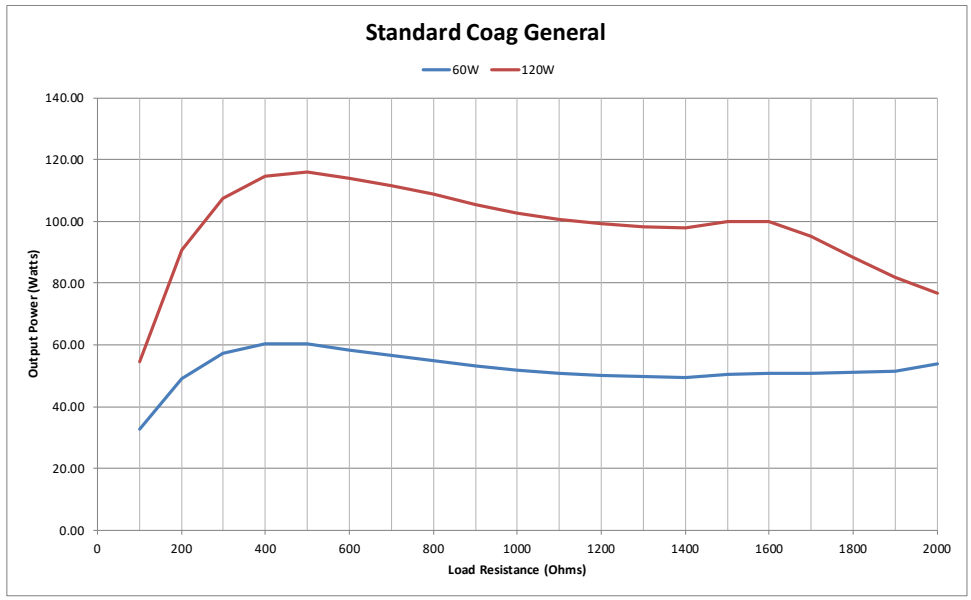


Figure 5.15.12 Load Regulation, Monopolar Standard Coag – Lap

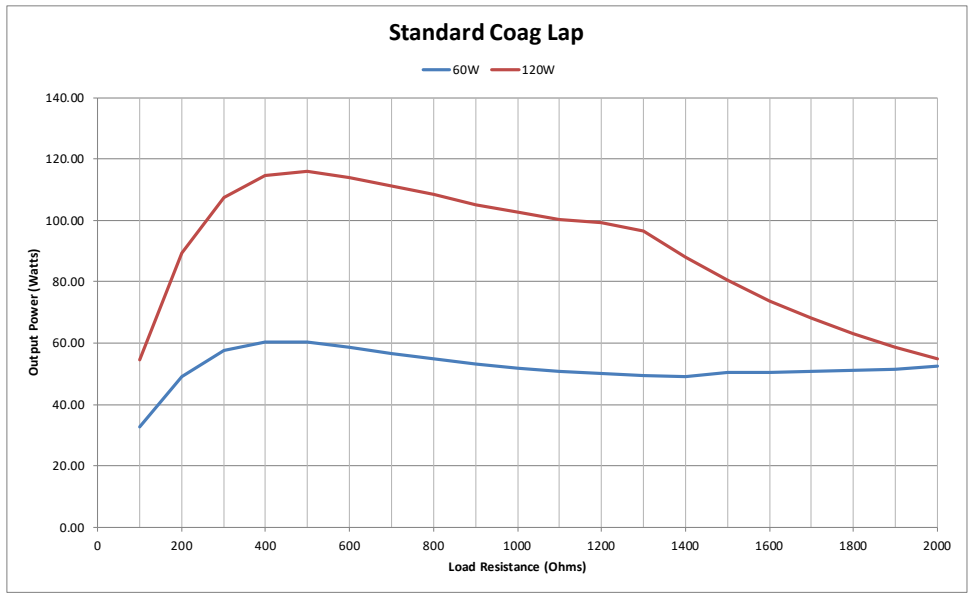


Figure 5.15.13 Load Regulation, Monopolar Spray Coag – General

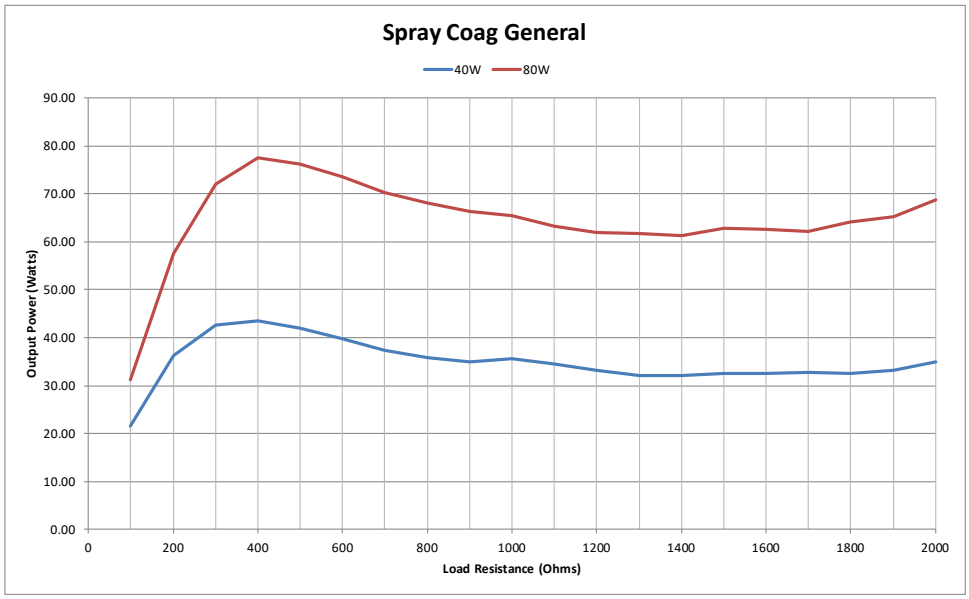


Figure 5.15.14 Load Regulation, Monopolar Spray Coag – Lap

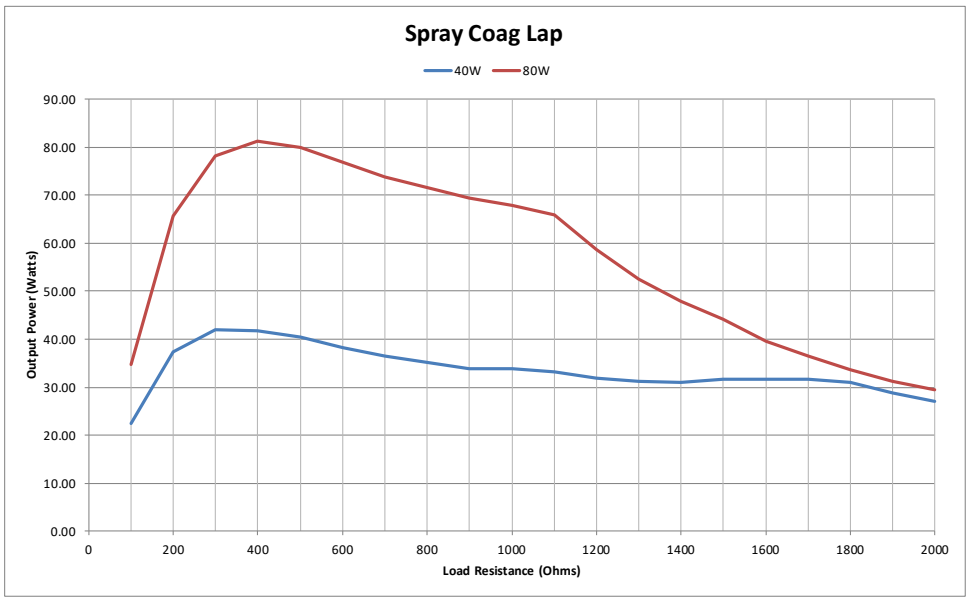


Figure 5.15.15 Load Regulation, Monopolar Argon Dissect Pure

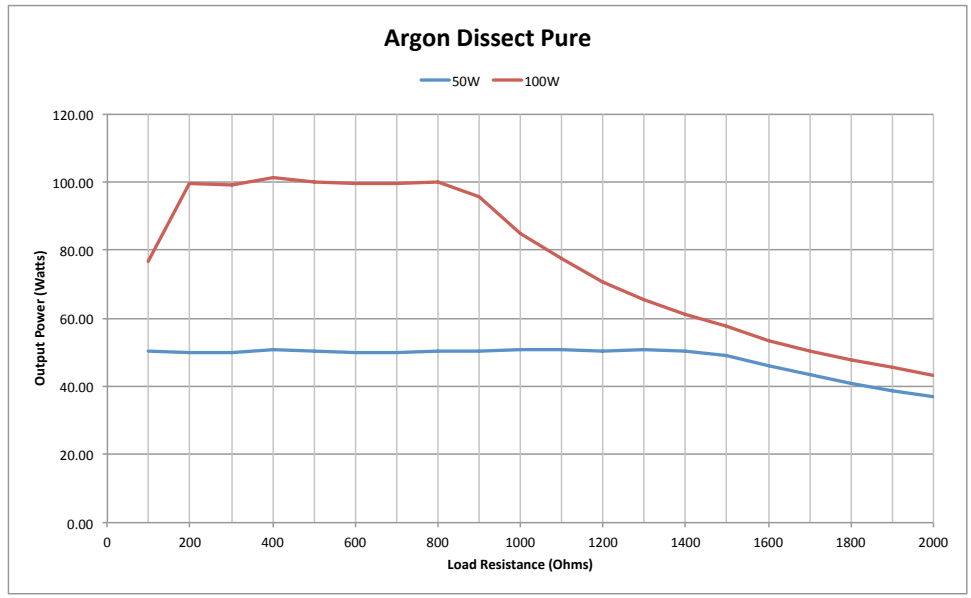


Figure 5.15.16 Load Regulation, Monopolar Argon Dissect Low

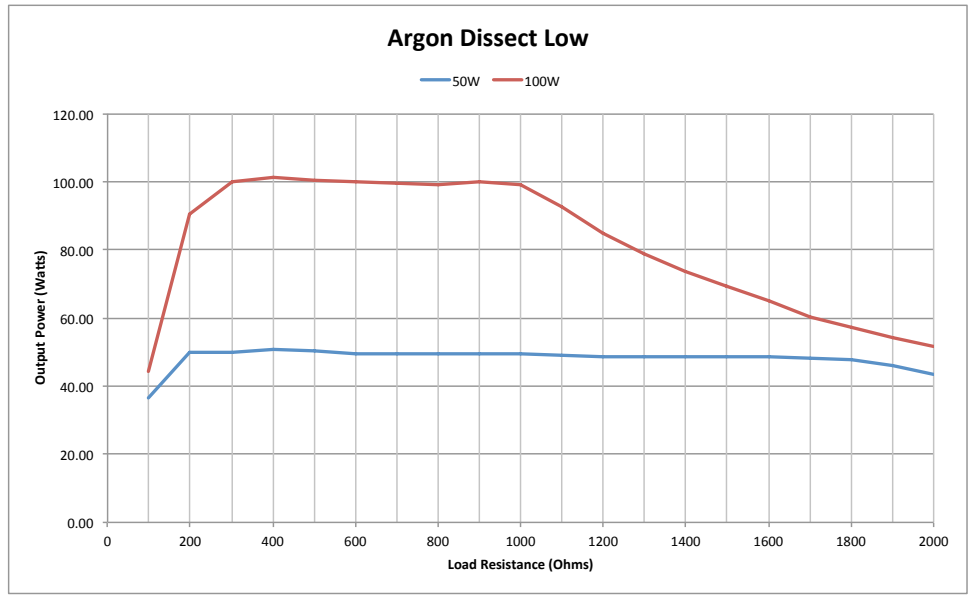


Figure 6.15.17 Load Regulation, Monopolar Argon Dissect Med

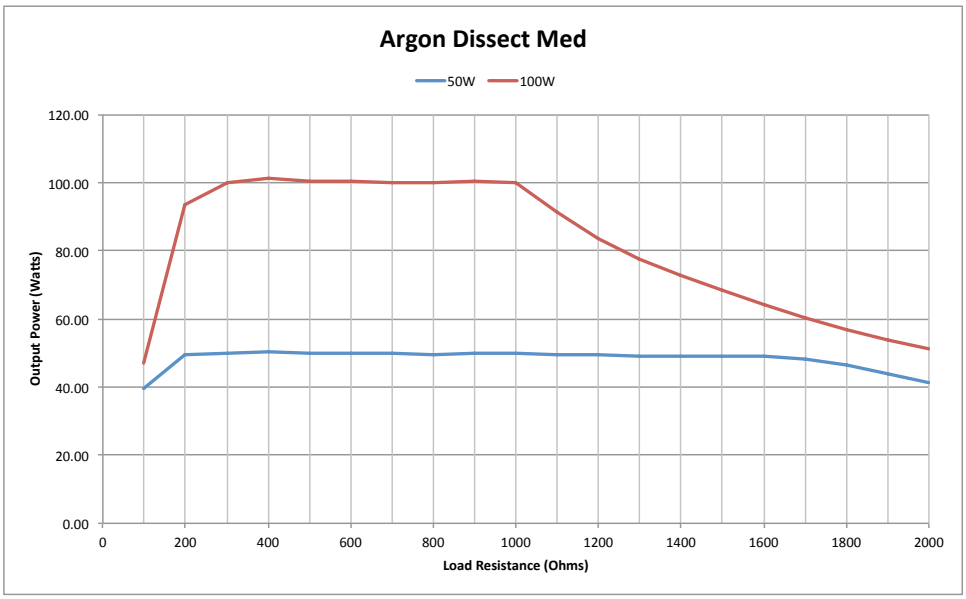


Figure 5.15.18 Load Regulation, Monopolar Argon Dissect High

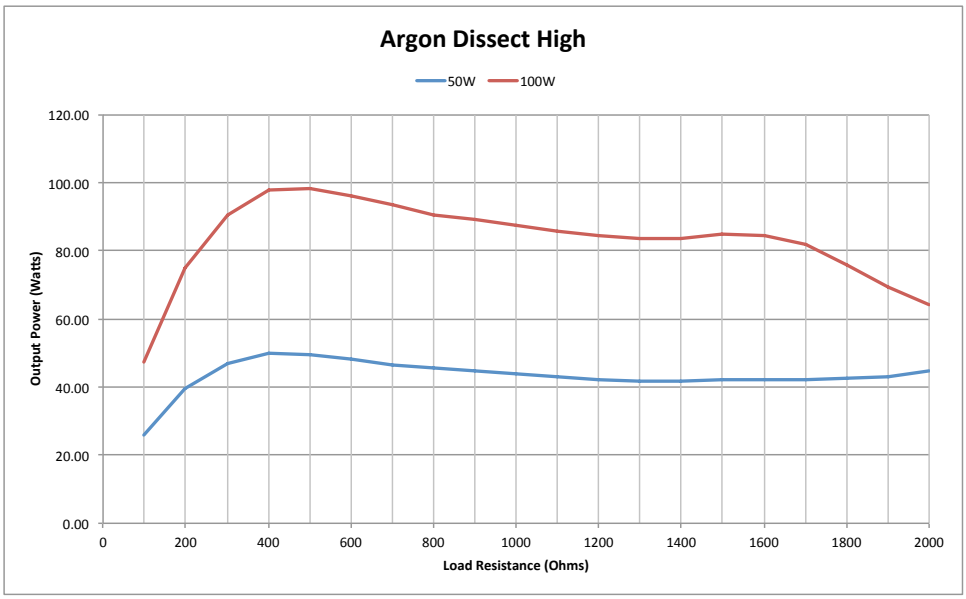


Figure 5.15.19 Load Regulation, Bipolar Micro

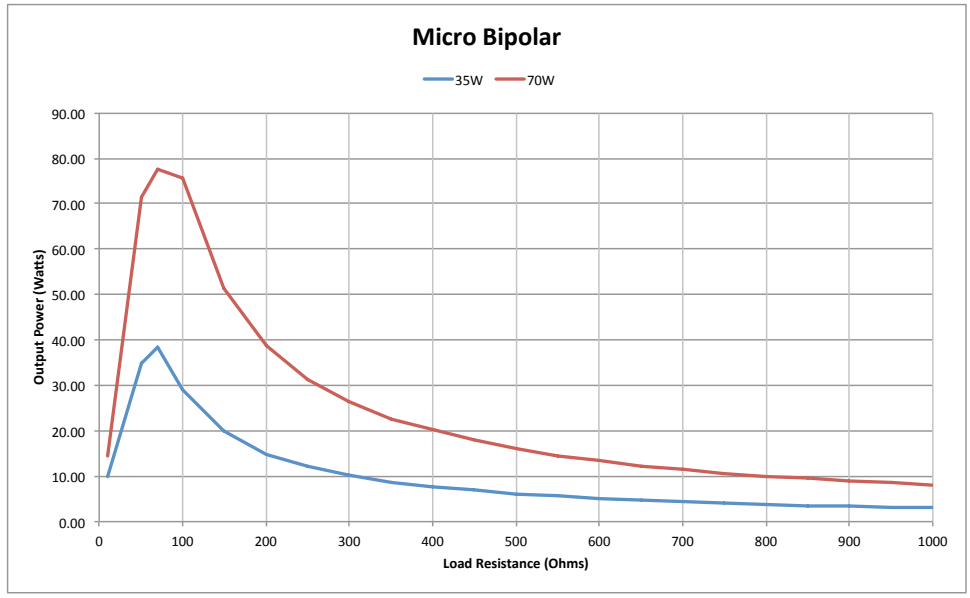
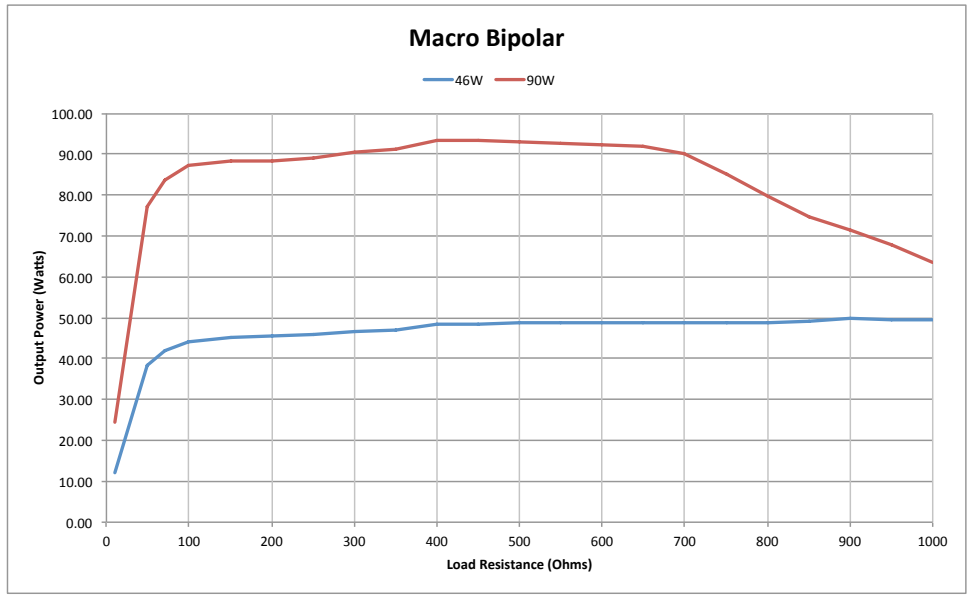
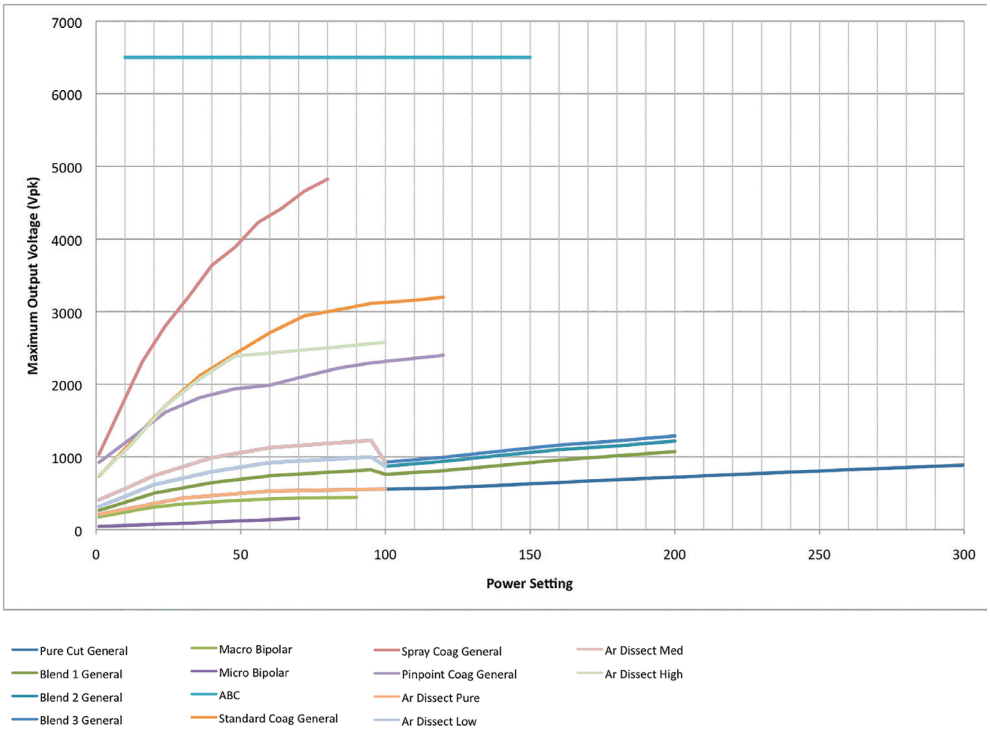


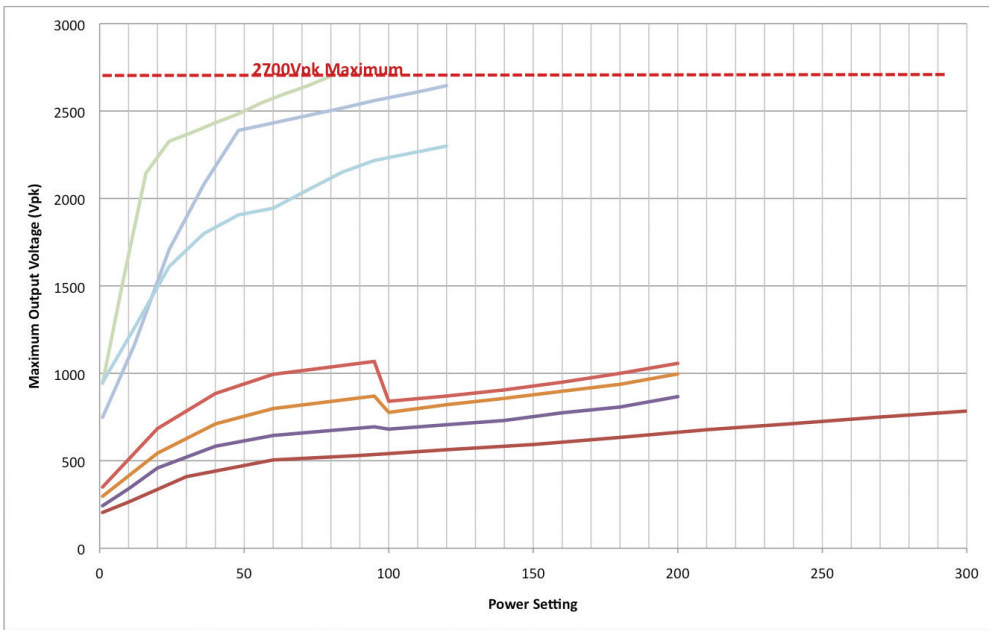
Figure 5.15.20 Load Regulation, Bipolar Macro



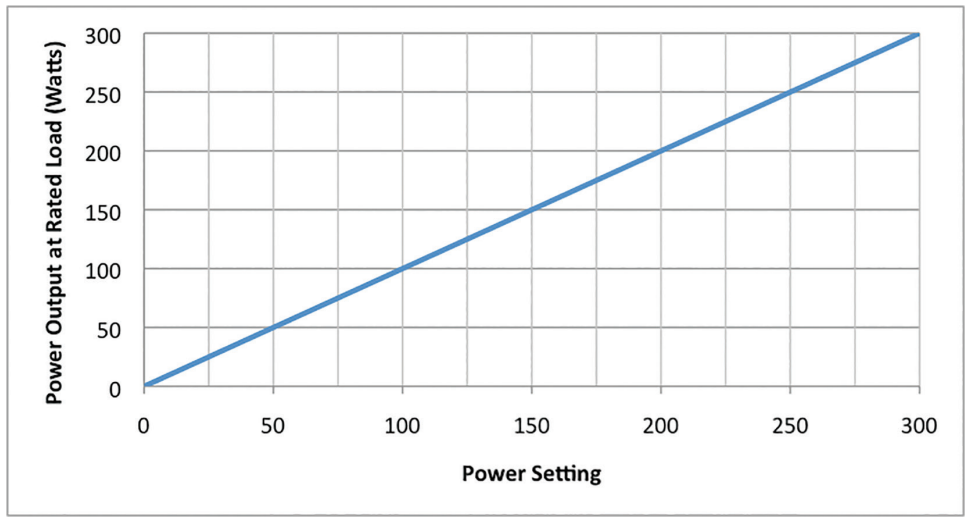
2. Maximum Peak Voltages (With General Mode Selected)



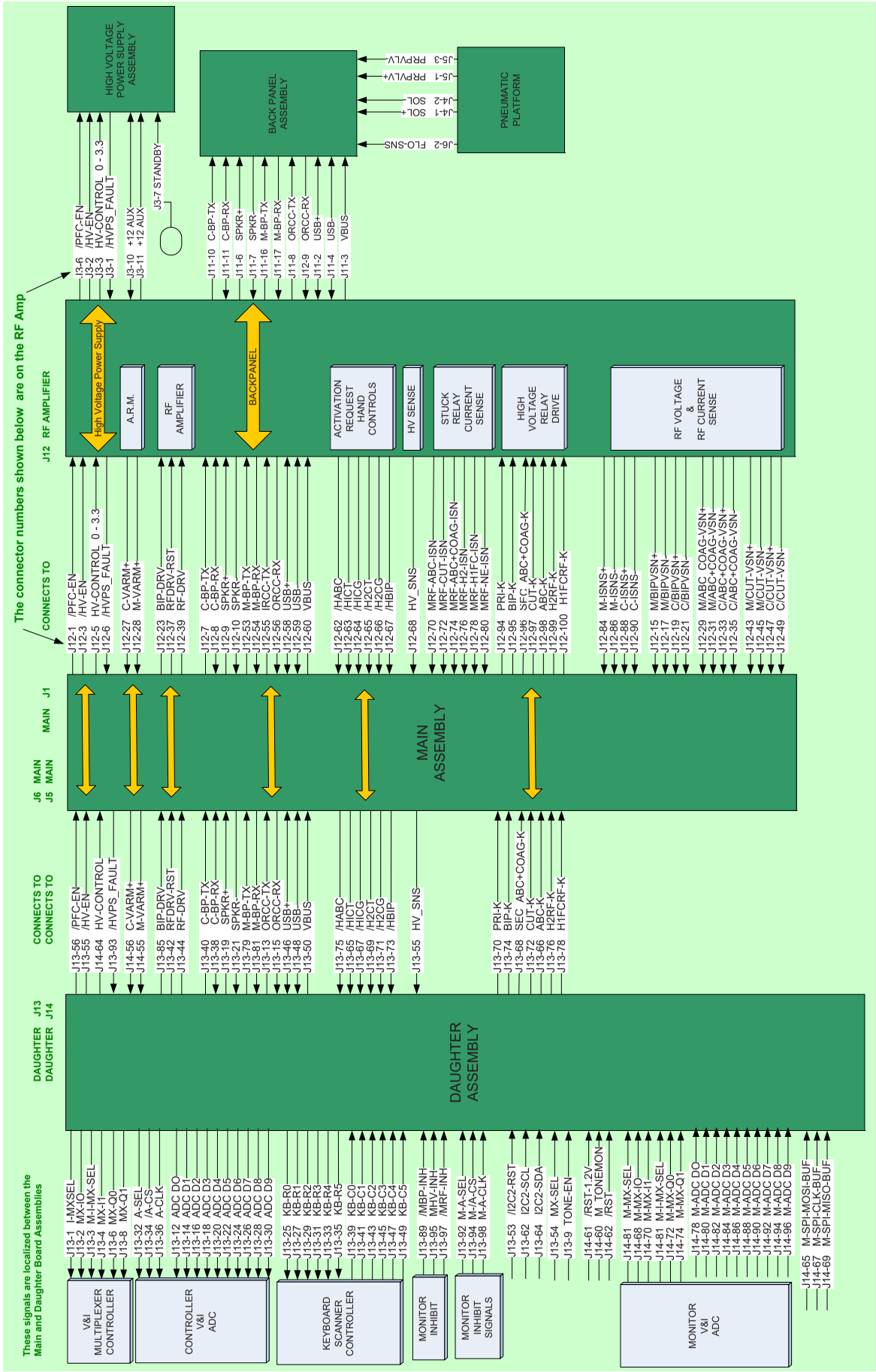
3. Maximum Peak Voltages (With Lap Mode Selected)



4. Output Power vs Power



5.16 System Block Diagram



Section 6
FAULT LIST

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FAULT LIST

The following table provides brief information and action for fault messages that may be displayed during power up or operation of the HelixAR.

When a fault is detected, the system is always placed in a safe state where the RF output power is terminated and argon flow is inhibited. It is not uncommon with the presence of RF to have false fault reporting and because this is known, all faults suggest the cycle the power.

TEST MODE: When the unit is placed in Test Mode, the Monitor circuits are inhibited allowing the unit to be active for troubleshooting purposes.

WARNING: All safety monitoring circuits are OFF and a message is displayed stating the unit is not to be used clinically.

If a fault message is displayed during POST, press the UP & DOWN arrows in the Program section on the Control Panel. This will place the unit in a TEST MODE to allow unit operation for troubleshooting.

Circuit Board Assemblies

Part Number	Official Assembly Name	Referenced Name in Table
61-8160-001	Assy, HelixAR Backpanel	Backpanel Assy
62-8250-001	Power Supply, HelixAR	High Voltage Power Supply (HVPS)
61-8232-001	Assy, HelixAR RF Amplifier	RF Amp
61-8257-001	Assy, HelixAR Control Main	Main Assy
61-8157-001	Assy, HelixAR Control Daughter	Daughter Assy

Fault Message	Fault #	Description of Fault	Checked By	Action
For all persistent faults displayed – attempt to cycle the power one or two times. It is not uncommon to get false faults in a high RF environment.				
HVPS over-voltage fault	1	High voltage power supply (HVPS) is over its maximum limit while activating	Monitor	Try other modes and power settings. (Daughter Board, RF Amp or HVPS). If the problem persists for other modes, replace the HVPS
HVPS under-voltage fault	2	High voltage power supply (HVPS) is under its minimum limit while activating	Monitor	Try other modes and power settings. (Daughter Board, RF Amp or HVPS). If the problem persists for other modes, replace the HVPS (Problem can be with Daughter Board, RF Amp or HVPS)
HVPS control fault	3	High voltage power supply (HVPS) fault control check	POST	Problem can be with HVPS, RF Amp or Daughter Board Assy
HVPS self-fault	4	Fault declared by high voltage power supply (HVPS)	Monitor	Replace High Voltage Power Supply
Relay fault action	7	Current in active accessory doesn't match common return current	Monitor	Replace/repair RF Amp Assy
Supply voltage fault	8	One of the two Backpanel reference voltages is out of expected range.	Monitor, Controller	1. Verify 3.3 V for both voltage references. 2. Replace Backpanel Assy if either reference voltage is outside of 3.3 V ± 0.1 V.
Supply voltage fault	9	Battery charging voltage out of expected range.	Monitor	Charge the battery by leaving the system powered on for 4 to 6 hours. If the message is present on the next power, replace the battery on the Daughter Assy
Supply voltage fault	10	Reference voltage out of expected range. There are two voltage references on the Main Assy. Both of these references are tested on the Daughter Assy.	Monitor, Controller	1. Replace Daughter Assy if the reference voltages on the Main or 3.3 V ± 0.1 V 2. Replace the Main Assy if either of the references are not within 3.3 V ± 0.1 V
Argon flow high	11	Argon flow sensed when argon should not be enabled.	POST	1. Check Flow Sensor output in idle – should be 1 V 2. Problem can be Flow Sensor or Backpanel Assy
Over voltage fault	12	Standard Coag: Output voltage of active accessory violates open circuit limit during standard monopolar activation.	Monitor	1. Try other modes and power settings [Cut, ABC & Bipolar 2. Problem can be Daughter Board, Main Board, RF Amp or HVPS • If other modes test good – is not HVPS or RF Amp
Over voltage fault	13	ABC: Output voltage of active accessory violates open circuit limit during ABC monopolar activation (Active phase).	Monitor	1. Try other modes and power settings [Cut, Coag & Bipolar 1. Problem can be Daughter Board, Main Board, RF Amp or HVPS • If other modes test good – is not HVPS or RF Amp
Over voltage fault	14	ABC Target: Output voltage of active accessory violates open circuit limit during ABC monopolar activation (Active phase).	Monitor	1. Try other modes and power settings [Cut, Coag & Bipolar 2. Problem can be Daughter Board, Main Board, RF Amp or HVPS • If other modes test good – is not HVPS or RF Amp

Fault Message	Fault #	Description of Fault	Checked By	Action
For all persistent faults displayed – attempt to cycle the power one or two times. It is not uncommon to get false faults in a high RF environment.				
Over voltage fault	15	ABC Booster: Output voltage of active accessory violates open circuit limit during ABC monopolar activation (Active phase).	Monitor	1. Try other modes and power settings [Cut, Coag & Bipolar 2. Problem can be Daughter Board, Main Board, RF Amp or HVPS • If other modes test good – is not HVPS or RF Amp
Over power fault	16	Active accessory power exceeds IEC over-power limit (based on dial power setting)	Monitor	1. Try other modes and power settings. 2. Problem can be Daughter Board, Main Board, RF Amp or HVPS • If other modes test good – is not HVPS or Daughter Board
Activation agreement fault	18	Accessory activation state determined by Monitor is different than state reported by Controller	Monitor	1. Test both Handcontrol 1 and 2, Cut & Coag 2. Replace Daughter Board Assy
Power mismatch fault	19	Monitor power disagrees with Controller power during activation.	Monitor	1. Try other modes and power settings. 2. Problem can be Daughter Board, Main Board, RF Amp or HVPS • If only occurs in one mode – is not HVPS or Daughter Board.
Voltage mismatch fault	20	Monitor primary voltage disagrees with Controller voltage during activation.	Monitor	1. Try other modes and power settings. 2. Problem can be Daughter Board, Main Board, or RF Amp • If only occurs in one mode – is not Daughter Board.
Current mismatch fault	21	Monitor primary current disagrees with Controller primary current during activation.	Monitor	1. Try other modes and power settings. 2. Problem can be Daughter Board, Main Board, or RF Amp • If only occurs in one mode – is not Daughter Board.
Waveform fault	22	RF Drive PRI outside of expected range for minor mode and power level.	POST Monitor	1. Enter Test Mode Try other modes and power settings. 2. Problem can be Main Board, RF Amp or HVPS • If only occurs in one mode – is not HVPS Board.
Waveform fault	23	Minor mode waveform duration is less than expected	POST Monitor	Problem can be Daughter Board Assy
Waveform fault	24	Minor mode pulse waveform On-time is more than expected	POST Monitor	Problem can be Daughter Board Assy
Waveform fault	25	Minor mode pulse waveform Off-time is more than expected	POST Monitor	Problem can be Daughter Board Assy
Waveform fault	26	ABC booster phase duration outside of expected range.	POST Monitor	Problem can be Daughter Board Assy
Waveform fault	27	ABC target phase duration outside of expected range.	POST Monitor	Problem can be Daughter Board Assy

Fault Message	Fault #	Description of Fault	Checked By	Action
For all persistent faults displayed – attempt to cycle the power one or two times. It is not uncommon to get false faults in a high RF environment.				
No tone when expected fault	28	Unable to detect tone playing at startup.	POST Monitor	1. Check CODEC output on Daughter Assy– replace Daughter Assy if a sine wave does not occur 2. Check Speaker Amp on Main Assy for a sine wave on the input and the output of the amplifier. 3. Check speaker connection located on the Backpanel
Tone when not expected fault	29	Detected tone playing while idle.	Monitor	Check Speaker Amplifier output on Main Assy for a signal above 0.2 V – should be no signal in idle Check Tone Monitor output on Main Assy for a signal above 0.3 V – should be no signal in idle
No tone when expected fault	30	Tone is not playing during an activation	Monitor	1. Check CODEC output on Daughter Assy 2. Check Speaker Amplifier input and output on Main Assy 3. Check speaker connection on Backpanel Assy.
Temperature fault	31	System temperature is greater than maximum allowed.	Monitor	1. Unit temperature is checked on the Main Board (U28). • If the unit has been running for a time; or brought in from outside on a warm day, allow the unit to cool and retry. 2. Replace Main Assy
ARM fault	32	General failure condition in ARM circuit	Pad Monitor	The problem could be RF Amp or Daughter Assy
No dispersive electrode detected	33	No Pad connected during activation.	Pad Monitor	1. Connect a pad or disconnect and then reconnect pad to reset ARM 2. If the problem is not corrected by connecting a correct Pad, the problem could be RF Amp or Daughter Assy
Dispersive electrode high impedance fault	34	Fault while ARM is in dual-pad mode.	Pad Monitor	1. This fault can occur when a Pad is applied to a patient if not properly applied or patient prep. Some patients can have contact impedance above the limits set in the HelixAR. 2. Follow the ARM checkout procedure in the PM Section to determine if ARM circuit has failed. 3. The problem could be RF Amp or Daughter Assy
Single foil dispersive electrode fault	35	Fault while ARM is in single-pad mode.	Pad Monitor	1. Follow the ARM checkout procedure in the PM Section to determine if ARM circuit has failed. 2. The problem could be RF Amp or Daughter Assy
Monitor critical variable fault	36	Monitor critical variable corruption detected via CRC check.	Checked when Monitor Status values are updated / accessed,	Replace Daughter Board Assy
Controller critical variable fault	37	Controller critical variable corruption detected via CRC check.	Controller Synchronizer when Control Status updates are passed to Monitor.	Replace Daughter Board Assy

Fault Message	Fault #	Description of Fault	Checked By	Action
For all persistent faults displayed – attempt to cycle the power one or two times. It is not uncommon to get false faults in a high RF environment.				
Diagnostic critical variable fault	38	Diagnostic settings critical variable corruption detected via CRC check.	Monitor	Replace Daughter Board Assy
Lost communications from monitor	39	Controller not receiving communications from Monitor.	Controller	Failed microcontroller - replace Daughter Board Assy
Lost communications from controller	40	Monitor not receiving communications from Controller when active.	Monitor	Failed microcontroller - replace Daughter Board Assy
Lost communications from controller backpanel	41	Controller not receiving communications from Backpanel.	Controller	Failed RS232 driver on either Daughter Board Assy or Backpanel Assy
Lost communication from monitor backpanel	42	Monitor not receiving communications from Backpanel.	Monitor	Failed RS232 driver on either Daughter Board Assy or Backpanel Assy
Lost communication from controller logic	43	Controller not receiving communications from Logic.	Controller	• Failed FPGA or microcontroller • Replace Daughter Board Assy
Lost communication from monitor logic	44	Monitor not receiving communications from Logic	Monitor	• Failed FPGA or microcontroller • Replace Daughter Board Assy
Argon flow low	46	Flow outside of limits during ABC activation.	Monitor, Controller	• Test that flow sensor is 1 V at idle • Replace Backpanel Assy
Argon flow high	47	Flow outside of limits during ABC activation.	Monitor, Controller	• Test that flow sensor is 1 V at idle • Replace Backpanel Assy
Controller I2C bus #1 fault	48	Failure to communicate with ICs on Controller I^2C bus 1.	POST	Failed I^2C driver or microcontroller Replace Daughter Board Assy
Controller i2c bus #2 failed	49	Failure to communicate with ICs on Controller I^2C bus 2.	POST	Failed I^2C driver or microcontroller Replace Main Board Assy
Controller SPI bus fault	50	Failure to communicate with ICs on Controller SPI bus 2.	POST	Failed microcontroller Replace Daughter Board Assy
Monitor I2C bus #1 fault	51	Failure to communicate with ICs on Monitor I^2C bus 1.	POST	Failed I^2C driver or microcontroller Replace Daughter Board Assy
Monitor I2C bus #2 fault	52	Failure to communicate with ICs on Monitor I^2C bus 2.	POST	Failed I^2C driver or microcontroller Replace Daughter Board Assy
Monitor SPI bus fault	53	Failure to communicate with ICs on Monitor SPI bus 2.	POST	Failed microcontroller Replace Daughter Board Assy
GPIO communication fault	54	Failure to get positive confirmation of Logic control fault signal.	POST	Failed microcontroller or FPGA Replace Daughter Board Assy

Fault Message	Fault #	Description of Fault	Checked By	Action
For all persistent faults displayed – attempt to cycle the power one or two times. It is not uncommon to get false faults in a high RF environment.				
Board mismatch fault	55	Failure to confirm that all boards were calibrated as a set.	POST	• Enter the Service Screen and scroll down to board mismatch. Press Start • This message occurs when a board assembly has been replaced and indicates the unit should be recalibrated before use.
Stuck front panel key	56	Keypad has stuck key.	POST	• Control panel has a failed dome switch if this problem is persistent.
Stuck #1 cut handswitch	57	Accessory yellow button stuck	POST	• Release or replace the hand control accessory If problem persists – failed Opto Coupler on the RF Output board
Stuck #2 cut handswitch	58	Accessory yellow button stuck	POST	• Release or replace the hand control accessory If problem persists – failed Opto Coupler on the RF Output board
Stuck #1 coag handswitch	59	Accessory blue button stuck	POST	• Release or replace the hand control accessory If problem persists – failed Opto Coupler on the RF Output board
Stuck #2 coag handswitch	60	Accessory blue button stuck	POST	• Release or replace the hand control accessory If problem persists – failed Opto Coupler on the RF Output board
Stuck bipolar handswitch	61	Bipolar activation request	POST	If problem persists – failed Opto Coupler on the RF Output board
Stuck ABC handswitch	62	Accessory blue button stuck	POST	• Release or replace the hand control accessory If problem persists – failed Opto Coupler on the RF Output board already in safe state during POST.
Stuck cut footswitch	63	Accessory button stuck	POST	• Ensure Foot switches are not stacked If problem persists replace backpanel
Stuck coag footswitch	64	Footswitch pedal stuck	POST	• Ensure Foot switches are not stacked If problem persists replace backpanel
Stuck bipolar footswitch	65	Footswitch pedal stuck	POST	• Ensure Foot switches are not stacked If problem persists replace backpanel
Stuck ABC footswitch	66	Footswitch pedal stuck	POST	• Ensure Foot switches are not stacked If problem persists replace backpanel
Stuck wireless cut footswitch	67	Footswitch pedal stuck	POST	• Ensure Foot switches are not stacked If problem persists remove wireless footswitch receiver If problem persists replace backpanel
Stuck wireless coag footswitch	68	Footswitch pedal stuck	POST	• Ensure Foot switches are not stacked If problem persists remove wireless footswitch receiver If problem persists replace backpanel
Stuck wireless ABC footswitch	69	Footswitch pedal stuck	POST	Preventative check. System already in safe state during POST.
Power setting invalid for minor mode	70	Activation power setting outside of range.	Monitor	Replace Daughter Board Assy

Fault Message	Fault #	Description of Fault	Checked By	Action
For all persistent faults displayed – attempt to cycle the power one or two times. It is not uncommon to get false faults in a high RF environment.				
Unrecognized USB device	72	Detection of a USB device	Controller	Only connect USB devices properly formatted for the purpose of software updates. The USB stick then cannot be larger than 8 GB.
System not fully calibrated	74	System not completely calibrated.	POST	One or more modes need calibrated. Enter the Service Mode to find what needs calibrated.
Backpanel I2C bus fault	75	Backpanel I²C BUS Failure detected will result in loss of tank pressure detection	Controller	• Ensure the generator is properly seated on the bulk head connector of the cart Ensure the hand nut is tight that fastens the generator to the cart Replace the backpanel Assy
Incomplete POST fault	76	POST checks not fully completed.	POST	Replace Daughter Board Assy
Waveform fault	77	RF Drive pulse mode off time period outside of expected range for minor mode.	Monitor	Replace Daughter Board
Waveform fault	78	RF Drive pulse mode on time period outside of expected range for minor mode.	Monitor	Replace Daughter Board
Waveform fault	79	RF Drive in active mode outside of expected range.	Monitor	Replace Daughter Board
Waveform fault	80	RF Drive pulse mode duration outside of expected range for minor mode.	Monitor	Replace Daughter Board
Unable to control flow of argon fault	81	Periodic confirmation of active flow control during ABC activation.	Controller	• Check harness connections Replace Backpanel Assy
Supply voltage fault	82	Backpanel reference voltage out of spec while idle.	Monitor, Controller	Replace backpanel Assy
Supply voltage fault	83	Reference voltage out of spec while idle.	Monitor, Controller	Replace backpanel Assy
Lost communication from controller logic	84	Controller not receiving communications from Logic	Controller	Replace daughter board Assy
Lost communication from controller backpanel	85	Controller not receiving communications from Backpanel	Controller	• Check harness connections Replace Backpanel Assy
Lost communication from monitor	86	Controller not receiving communications from Monitor	Controller	Replace daughter board Assy
Backpanel I²C bus fault	87	Backpanel I²C BUS Failure detected will result in loss of pressure detection.	Controller	• Check harness connections Replace Backpanel Assy
Supply voltage fault	88	Battery charging circuit voltage out of spec.	Monitor	• Charge battery Replace battery if it does not charge
Lost communication from monitor backpanel	89	Monitor not receiving communications from Backpanel	Controller	• Check harness connections Replace Backpanel Assy

Fault Message	Fault #	Description of Fault	Checked By	Action
For all persistent faults displayed – attempt to cycle the power one or two times. It is not uncommon to get false faults in a high RF environment.				
Lost communication from controller	90	Monitor not receiving communications from Controller while idle	Monitor	Replace daughter board Assy
Lost communication from monitor logic	91	Monitor not receiving communications from Logic while idle	Monitor	Replace daughter board Assy
HVPS self fault	92	Fault declared by high voltage power supply	Monitor	Replace high voltage power supply
Temperature fault	93	System temperature is greater than maximum allowed	Monitor	Power system down and allow system to cool down
HVPS over-voltage fault	94	High voltage power supply is over its maximum limit (idle or active)"	Monitor	• Identify if this occurs in a particular mode or power setting If occurs at post or while idle replace high voltage power supply
Power setting invalid for minor mode	95	Power setting in conflict with expected limits for minor mode while idle.	Monitor	Replace Daughter Board Assy
Lost communication form controller backpanel	96	Controller Backpanel terminated flow due to not receiving communications from Controller when idle	Monitor, Controller	• Check harness connections Replace Backpanel Assy
Lost communication form controller backpanel	97	Controller Backpanel terminated flow due to not receiving communications from Controller when active	Controller	• Check harness connections Replace Backpanel Assy
Lost communication from monitor backpanel	98	Monitor Backpanel terminated flow due to not receiving communications from Monitor when idle	Monitor	• Check harness connections Replace Backpanel Assy
Lost communication from monitor backpanel	99	Monitor Backpanel terminated flow due to not receiving communications from Monitor when active	Monitor	• Check harness connections Replace Backpanel Assy
Logic Fault	100	RF PID Control failure indicates Logic unable to control power correctly.	Controller	• Probable causes: High Voltage Power Supply – low voltage Daughter Board Assy
Dispersive Electrode Fault	104	Detection of short condition in dual dispersive electrode (pad)	Monitor, Controller	• Replace Dispersive Electrode Fault on RF Amp – A.R.M. circuit
Logic Fault	105	Arc detection fault – Controller and Monitor do not agree on Arc Detection	Monitor	• Replace Daughter Board Assy

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