

HOGEN® H SERIES HYDROGEN GENERATOR



Service Manual

=====*Hydrogen By Wire™*=====

*HOGEN H Series Hydrogen Generator
Service Manual*

Model Numbers:

2, 4, 6 NM³

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Gas Generating Equipment
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HOGEN H Series Hydrogen Generator SERVICE MANUAL

Prepared by
PROTON ENERGY SYSTEMS, INC.

CONTENTS

1	Introduction	7
1.1	Key Definitions, Acronyms, and Abbreviations Used in this Document.....	9
2	General Procedures.....	10
2.1	Lockout/Tagout Procedure.....	11
2.2	Tools Required	13
2.3	Parker CPI™ Compression Tube Fitting Information	14
3	Service Bypass Mode	15
4	Hardwired Safety Shutdowns.....	16
5	Warning and error codes	20
5.1	Troubleshooting.....	22
6	Pump Impeller Replacement Instructions	26
7	CG Sensor Replacement	31
8	Power Supply Replacement.....	32
9	Power Supply Fuse Replacement Procedure	40
10	Cell Stack Isolation Check	46
11	Cell Stack Replacement.....	48
12	System Pressure Adjustment	52
13	A200 Level Sensor (LS201) Replacement	54
14	Temperature Control Valve Adjustment.....	57
15	Preparation for Long-Term Storage or Decommissioning.....	59
15.1	Long-Term Storage with Generator Installed and Hooked Up to Facilities	59
15.2	Decommissioning of the Generator.....	61
15.3	Cell Stack Hydration	62
16	APPENDIX A: Remote Access.....	63
16.1	Remote Monitoring Software Installation	64
16.1.1	Network Specifications.....	67
16.1.2	Cabling	67
16.2	LAN (Local Area Network) Installation	68
16.2.1	PC Parameters.....	68
16.2.2	LAN Configuration Instructions.....	71
16.3	Electrical Connections for LAN Installation	74
16.4	Remote Monitoring Setup.....	74
16.4.1	Remote Software Monitoring Feature.....	74
16.5	How to Navigate Through the Screens.....	75
16.5.1	Data Logging Feature.....	76
16.5.2	Loading Calibration Files.....	77
16.5.3	Loading Configuration Files.....	79
16.6	Remote Monitoring Upgrade Instructions.....	80
17	APPENDIX B: Overall System Breakdown	82
17.1	Water and Oxygen Management Subsystem (WOMS).....	83
17.2	Hydrogen Gas Management Subsystem (HGMS).....	85
17.3	Power Distribution Panel.....	87

17.4	Controller Assembly.....	89
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FIGURES

Figure 1	HOGEN H Series Hydrogen Generator	7
Figure 2	Cell Stack Voltage Dissipating Tool in Use.....	12
Figure 3	Parker CPI Compression Tube Fitting Assembly.....	14
Figure 4	Key in Service Bypass Mode.....	15
Figure 5	Fluids and Electrical Enclosures.....	16
Figure 6	User Interface with Emergency E-Stop.....	16
Figure 7	Under/Over Voltage Relay.....	17
Figure 8	Under/Over Voltage Relay LED Status	17
Figure 9	Pressure Switches (PSW121 A&B).....	18
Figure 10	LS101 E&F.....	18
Figure 11	Pump Location.....	26
Figure 12	Pump Outlet Line Location.....	27
Figure 13	Two (2) Screws at Base of Pump Mounting Bracket	27
Figure 14	Pump Housing Cover.....	28
Figure 15	One of Three Screws on the Fan Shroud	28
Figure 16	Removing the Fan from the Pump Motor Shaft	29
Figure 17	Removing the Impeller with a Strap Wrench	29
Figure 18	Direction Arrow.....	30
Figure 19	CG220 Sensor Location.....	31
Figure 20	Cap and CG220 Sensor	31
Figure 21	Location of Screws on Front Access Panel.....	32
Figure 22	Power Supply Frame Top Screen	32
Figure 23	Removing Sense Lead Wires to the Bus Bars.....	33
Figure 24	Location of the Power Source Connector.....	33
Figure 25	Positive Output Cable Location.....	34
Figure 26	Negative Output Cable Location	34
Figure 27	Ground Cable Location	35
Figure 28	DB25 I/O Serial Connector Cable Location.....	35
Figure 29	Routing the Ground Wires	36
Figure 30	Support Plate Screws Location.....	36
Figure 31	Location of Screw that Connects Power Supply to Positive and Negative Bus Bars.....	37
Figure 32	Location of Screws that Connect Power Supply to Support Plate	37
Figure 33	Removing Four (4) of the Five (5) Screws.....	40

Figure 34 Removing Screw in Front Plate	40
Figure 35 Power Supply on its Side	41
Figure 36 Removing the Screws from the Insulator	41
Figure 37 Sliding the Insulator Up.....	42
Figure 38 Removing Interface Connector Cable.....	42
Figure 39 Fuse Location	43
Figure 40 Removing the Fuses	43
Figure 41 Snapping Fuses into Place.....	44
Figure 42 Positioning of the Wires.....	45
Figure 43 Support Rail Sliding into Power Supply Frame Track.....	38
Figure 44 Sliding the Power Supply Module into the Frame	38
Figure 45 Flow Switch Location	46
Figure 46 Unplugging the Flow Switch.....	46
Figure 47 Cell Stack and Connection Locations	49
Figure 48 Cell Stack with Caps and Hose.....	50
Figure 49 Cell Stacks Connected	51
Figure 50 Removing the Locknut on BPR310	52
Figure 51 Adjusting System Pressure.....	52
Figure 52 Level Sensor (LS201) Location in the H Series Hydrogen Generators	54
Figure 53 Unplugging the Conexal Plug.....	55
Figure 54 Removing the Old Level Sensor (LS201)	55
Figure 55 Installing New Level Sensor (LS201).....	56
Figure 56 DI Water Temperature Display	57
Figure 57 Temperature Control Valve Location	57
Figure 58 CG220 Oxygen Vent Tube	59
Figure 59 Hose Connected to the Inlet and Outlet of Cell Stack.....	61
Figure 60 First Screen in Installation Wizard.....	64
Figure 61 Second Screen in Installation Wizard.....	65
Figure 62 Installation of Software Screen.....	65
Figure 63 Installation Initializing Screen.....	66
Figure 64 Installation Completed Screen.....	66
Figure 65 Ethernet Cable Pinout	67
Figure 66 Remote Monitoring Wiring.....	68
Figure 67 FTP://169.254.123.2 In Browser.....	69
Figure 68 [TCP_Stack_Config] Location	70
Figure 69 Overwriting the Existing “NI-RT.INI” File.....	71

<i>Figure 70 H Series Remote Comm Folder Location</i>	<i>72</i>
<i>Figure 71 Support Files Folder Location.....</i>	<i>72</i>
<i>Figure 72 IP Addresses.ini Location</i>	<i>73</i>
<i>Figure 73 IP Address Location</i>	<i>73</i>
<i>Figure 74 Remote Monitoring Software P&ID Screen</i>	<i>74</i>
<i>Figure 75 Navigating Through the Screens.....</i>	<i>75</i>
<i>Figure 76 Remote Monitoring System Main Screen.....</i>	<i>75</i>
<i>Figure 77 Enable/Disable Switch for Data Logging Feature</i>	<i>76</i>
<i>Figure 78 .CSV File Example.....</i>	<i>76</i>
<i>Figure 79 Data Log Example in Excel.....</i>	<i>77</i>
<i>Figure 80 How to find the Calibrate Option</i>	<i>78</i>
<i>Figure 81 Calibrate Screen.....</i>	<i>78</i>
<i>Figure 82 How to Find the Configure Option</i>	<i>79</i>
<i>Figure 83 Uninstall Wizard.....</i>	<i>80</i>
<i>Figure 84 System Uninstalling Software</i>	<i>81</i>
<i>Figure 85 Uninstall Process Completed.....</i>	<i>81</i>
<i>Figure 86 Water and Oxygen Management Subsystem (WOMS) P&ID</i>	<i>83</i>
<i>Figure 87 Water Oxygen Management Subsystem (WOMS).....</i>	<i>84</i>
<i>Figure 88 Hydrogen Gas Management Subsystem (HGMS).....</i>	<i>85</i>
<i>Figure 89 Hydrogen Gas Management Subsystem (HGMS).....</i>	<i>86</i>
<i>Figure 90 Power Distribution Panel</i>	<i>88</i>
<i>Figure 91 Controller Assembly</i>	<i>90</i>

TABLES

<i>Table 1 Specialized Tools Required for Scheduled Maintenance.....</i>	<i>13</i>
<i>Table 2 Tube Fitting Assembly Details.....</i>	<i>14</i>
<i>Table 3 Auto-Hardwired Safety Shutdowns.....</i>	<i>19</i>
<i>Table 4 Error and Warning Codes</i>	<i>21</i>
<i>Table 5 Troubleshooting Matrix.....</i>	<i>25</i>
<i>Table 6 Network Specifications</i>	<i>67</i>
<i>Table 7 Standard Ethernet Cable Wiring Connections for Normal and Crossover Cables</i>	<i>67</i>
<i>Table 8 Controller Assembly Modules and Channels</i>	<i>89</i>

1 INTRODUCTION

The HOGEN H Series industrial hydrogen generator (see Figure 1) is a Proton Exchange Membrane, or PEM, water electrolysis system packaged for rapid onsite installation and ease of use. Configured with up to three PEM stacks, the HOGEN H Series hydrogen generator is designed to deliver up to 6 NM³/h (228 SCFH) of 99.9995 percent pure hydrogen at a maximum pressure of 15 barg (225 psig) to meet customer need. Hydrogen generation is continuously available and follows customer demand as long as power and deionized, or DI, water are available. The HOGEN H Series hydrogen generator is designed to operate in a well-ventilated, non-classified, indoor environment.

Proton Energy Systems, Inc. (PROTON) has provided this manual to guide the service of a HOGEN H Series hydrogen generator. It is intended for a Service Department that has the experience to work with high voltage electronics, pressurized combustible gas, and hydraulic systems. Only authorized personnel should be carrying out these procedures and have access to this manual. Please take some time to familiarize yourself with the basic installation, operating and scheduled maintenance procedures in addition to this manual before proceeding with any maintenance procedure.



IT IS THE CUSTOMER'S RESPONSIBILITY TO CONSULT WITH THE LOCAL AUTHORITY HAVING JURISDICTION (AHJ) REGARDING LOCAL CODE REQUIREMENTS FOR INSTALLATION AND OPERATION OF THIS EQUIPMENT.



DO NOT USE THE HOGEN H SERIES HYDROGEN GENERATOR IN A MANNER NOT SPECIFIED BY PROTON ENERGY SYSTEMS.



Figure 1 HOGEN H Series Hydrogen Generator

This manual attempts to answer most of the frequently asked questions with regards to the service of the unit. However, should you have any questions, the PROTON technical staff or your local service provider/supplier stands ready to answer them and support the successful deployment of this equipment. Please call **(203) 949-8697** and ask for technical service support, email customerservice@protonenergy.com, or call your local service provider/supplier for more information. Please have the model number and serial number of your unit available.



If freezing conditions exist at your site, you must take measures to prevent condensation from freezing and obstructing the H₂ vent line and freezing the water supply and drain lines.



For conductive dust environments (e.g. coal dust), clean the electrical interface using an explosive-proof vacuum rated for conductive dust environments whenever the electrical enclosure doors are opened.



After performing any service or maintenance work, make sure the doors to the enclosure are completely closed and the enclosure panels are replaced prior to the startup operation of your generator.



Check for DI water content in the hoses every 30 days. If DI water is not present in the hoses, rehydrate the hoses as needed. A hydration kit is available through PROTON (KT-1000-0022).



It is the customer's responsibility to organize a backup hydrogen supply to bridge critical times during maintenance and service.



PROTON can offer a full range of service training. Contact PROTON Customer Service at 203-949-8697 or your local service provider/supplier for more information.

1.1 Key Definitions, Acronyms, and Abbreviations Used in this Document

PROTON® – Registered TM Proton Energy Systems, Inc.

ASME – American Society of Mechanical Engineers

NM³/h – Normal cubic meter per hour (International Normal conditions are 1.01325 bar and 0 Celsius)

SCFH – Standard cubic foot per hour (US Standard conditions for air are 14.7 psia and 70°F)

Bar – 14.5 PSI or 100 KPa (KiloPascals or Newton/cm), a unit of system pressure.

Standard atmosphere = 1.01325 bar = 14.696 psi

PSI – Pounds force per square inch ($\text{lb}_f/\text{in}^2=6894.7 \text{ Pa}$), a unit of pressure

L/m – Liters per minute flow (for hydrogen, calculated at normal conditions)

cc – Cubic centimeter

KW – Kilowatt

KVA – Kilovolt -ampere

μS/cm – MicroSiemen per centimeter, a measure of water conductivity

HOGEN® - Registered TM of Proton Energy Systems Inc. for packaged water electrolysis based hydrogen generators

FPT – Female Pipe Thread

MPT – Male Pipe Thread

NPT – National Pipe Thread

NFPA – National Fire Protection Association, a Standards Organization

CPI – Chemical Process Instrumentation

VDC – Volts Direct Current

VAC – Volts Alternating Current

NEC – National Electric Code, NFPA 70

LAN – Local Area Network

HGMS – Hydrogen Gas Management Subsystem

WOMS – Water/Oxygen Management Subsystem



- Notes contain helpful suggestions or references.



- Indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices. This could result in equipment damage or loss of data.



- Indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury. The reader is in a situation that could cause bodily injury.

2 GENERAL PROCEDURES

Prior to performing scheduled maintenance, the following measures should be taken:

- Make sure the work area is clean before beginning any maintenance work.
- Personal Protective Equipment (e.g. safety glasses, gloves, etc...) should be put on prior to beginning service of the system.

When hydrogen lines have been altered in any way, a system leak check is to be performed using a liquid gas detection method.



Take special care to avoid introducing dust or metal particles into the water system. This may cause damage to the system.



Take special care to avoid damaging the doors and enclosure panels of the hydrogen generator. Visually inspect for dents, cracks, broken plastic, and other signs of damage on a regular basis. Contact PROTON or your local service provider/supplier to determine if damaged parts need to be replaced.



Check for DI water content in the hoses every 30 days. If DI water is not present in the hoses, rehydrate the hoses as needed. A hydration kit is available through PROTON (KT-1000-0022).



THE CELL STACK RETAINS A SIGNIFICANT CAPACITIVE CHARGE EVEN WHEN THE SYSTEM IS DISCONNECTED FROM POWER. CARE SHOULD BE TAKEN WHEN WORKING NEAR THE CELL STACK TO AVOID SHORT CIRCUITING THE TERMINALS.



IT IS ESSENTIAL THAT THE SAFETY SYSTEM IS NOT BYPASSED. CONTINUED OPERATION COULD RESULT IN SERIOUS INJURY AND/OR DAMAGE TO THE GENERATOR.



FAILURE TO CHECK FOR LEAKS IN THE SYSTEM AFTER MAINTENANCE TO HYDROGEN COMPONENTS MAY RESULT IN A SYSTEM SHUTDOWN AND MAY LEAD TO A DANGEROUS SITUATION.

2.1 Lockout/Tagout Procedure

The lockout/tagout procedure is intended to prevent injuries during machine or equipment service and maintenance operations. Lockout/tagout prevents injuries that can be caused by the unexpected energization or start-up of machines or equipment, or the release of stored energy during maintenance and service jobs. This procedure should be applied anytime maintenance or service work is done on the HOGEN H Series hydrogen generator.



Follow the lockout/tagout policy for the facility where the H Series hydrogen generator is installed.

The following steps outline the Lockout/Tagout Procedure:

1. Prepare for shutdown.
Before the authorized or affected employee turns off the HOGEN H Series hydrogen generator, the authorized employee must know the type and magnitude of the energy and its hazards and must know how to control the energy. Before lockout/tagout devices can be applied, either the employer or the authorized employee must notify the affected employees.
2. Shutdown.
The HOGEN H Series hydrogen generator must be turned off according to the established procedures. Shutting down the machine must not create any increased hazards from equipment stoppage.
3. Isolate the equipment.
The authorized employee, who is performing the servicing or maintenance work, must isolate the HOGEN H Series hydrogen generator from its energy sources. The energy-isolating device must be physically located and operated by the authorized employee.
4. Apply Lockout/Tagout devices.
The authorized employee is to apply lockout/tagout devices to the energy-isolating device. Lockout devices must hold the switch in the “OFF” position. If a Tagout system is used, the tags must clearly show that moving the energy-isolating device from the “OFF” position is not allowed.
5. Release stored energy.
Any potentially hazardous stored or residual energy from all sources and components must be released, relieved, disconnected, or restrained to make sure they are safe.

The cell stack holds a capacitive charge for an extended period of time. The charge may be as high as 44 volts DC immediately after the unit is shutdown. This DC potential is exposed at the positive terminal of the cell stack and the positive DC terminals on the Integrated Power Supply Rack. It is important to prevent electric shock by waiting for charge to dissipate naturally, which may

take several hours, or use a Cell Stack Voltage Dissipating Tool (P/N 69-0101-0001). (Refer to Figure 2.)

To use the Cell Stack Voltage Dissipating Tool, attach the alligator clips to the positive and negative terminals on the cell stack or the power supply DC buss bars. Perform this procedure to one cell stack/power supply set at a time. DC voltage below 10 volts DC is considered safe.

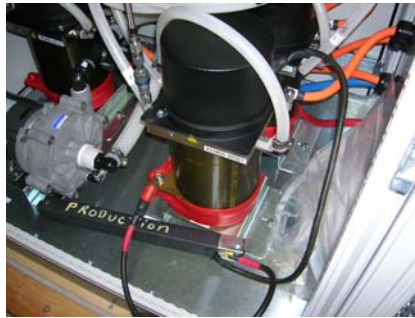


Figure 2 Cell Stack Voltage Dissipating Tool in Use



Personnel with pacemakers, defibrillators or other electrical medical equipment should not perform any cell stack or power supply maintenance.

6. Verification.

The authorized employee must verify that the lockout/tagout procedure successfully isolated the HOGEN H Series hydrogen generator from its energy sources before electrical work begins. To verify that power is disconnected, use a voltage meter to check for no voltage.

To release the HOGEN H Series hydrogen generator from lockout/tagout, use the following steps:

1. Check the HOGEN H Series hydrogen generator.
Before any lockout/tagout devices are removed, the authorized employee must replace all machine guards and remove all tools and nonessential items from the area. Remove any blocking devices that were inserted. Make sure the HOGEN H Series hydrogen generator is intact and ready to operate.
2. Check for employees.
The authorized employee must check the work area to make sure all employees are in a safe place away from the HOGEN H Series hydrogen generator before any lockout/tagout devices are removed.
3. Remove lockout/tagout devices.
The authorized employee who applied the lockout/tagout device is the only person to remove it. After the lockout/tagout devices are removed and before the generator is started, the affected employees must be notified that the lockout/tagout devices have been removed.

2.2 Tools Required

Most service procedures require basic hand tools: SAE wrenches, screwdrivers, pliers, etc. Some specialized tools are required and are listed in Table 1. A detailed description on how to use the tool in its application can be found in the section where the tool is used. Before beginning any maintenance procedure, it is good practice to review the appropriate section of the manual to ensure the proper tools are assembled before beginning a maintenance procedure.

Tools Required	Function
Basic Hand Tools: SAE Wrenches, Screwdrivers, Pliers, etc.	General Maintenance
Liquid Leak Detector (TRAX) (P/N 19-0101-0002)	General Maintenance
60 ohm, 1000 Watt Resistor and Spring Clips (P/N 69-0101-0001)	Cell Stack Discharge
Calibration Gas (For Manual Calibration Option): 2 Percent Hydrogen in Air Regulated to 50 psig	Combustible Gas Detector Calibration
Calibration Gas Replacement Cylinder (For Auto Calibration Option) (P/N 02-3400-0002)	Combustible Gas Detector Calibration
Hand Held Combustible Gas Detector (P/N 19-0101-0004) and Charger (P/N 19-0101-0005 for 115V or P/N 19-0101-0006 for 220V)	Fault Analysis
Multimeter/ DC Amp Clamp (P/N 19-0102-0001)	Fault Analysis
Filter Wrench (P/N 19-0200-0004)	Guard Bed Filter Replacement
Krytox® (03-0300-0001)	O-Ring Replacement
Solenoid Spanner Wrench	Solenoid Replacement
Key, Enclosure, #5 Double Bit (P/N 16-1203-0000)	
Wrench, Spanner 15, 20, 30, 50, 80 (P/N 19-0200-0003)	
Wrench, Spanner 70 (P/N 19-0200-0005)	
Wrench, Spanner, HGMS (P/N 19-0200-0006)	
Grounded Wrist Strap	

Table 1 Specialized Tools Required for Scheduled Maintenance

® Krytox is a registered trademark of E. I. du Pont de Nemours and Company

2.3 Parker CPI™ Compression Tube Fitting Information

The HOGEN H Series hydrogen generator is designed to produce hydrogen that contains no more than 5 PPM of water and 1 PPM of other contaminants. Hydrogen can be delivered at pressures ranging from 0 to 15 barg (218 psig) and up to the unit's rated flow rate. The product hydrogen port uses a Parker CPI compression tube fitting for 1/4" OD tubing .035 wall stainless steel. These fittings are reusable when used properly, according to the procedures included in this section.

To ensure proper connections, use the following procedure and refer to Figure 3:

1. Mark the fitting and nut for assembly reference.
2. Use the appropriate SAE wrench to loosen the nut.
3. Completely unthread the nut from the fitting before pulling off the nut.
4. When reassembling the fitting, make sure the assembly has been inserted into the fitting until the ferrule sits in the fitting.
5. Re-tighten the nut by hand.
6. Using an appropriately sized SAE wrench, tighten the nut until the reference marks are aligned (A noticeable increase in mechanical resistance should be felt.).
7. Tighten the nut an additional 1/12th of a turn (equal to 1/2 a flat surface on the nut).

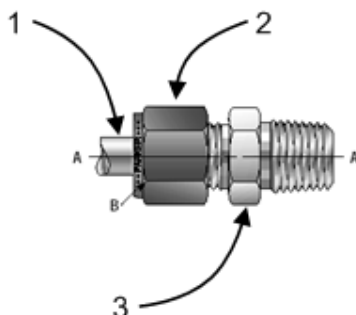


Figure 3 Parker CPI Compression Tube Fitting Assembly

Reference	Detail
A	Reference Marks Made
B	1/12 th Extra Turn of Nut
1	Tubing
2	Nut
3	Fitting

Table 2 Tube Fitting Assembly Details

™ Parker CPI is a trademark of the Parker Hannifin Company

3 SERVICE BYPASS MODE

The service bypass mode can be used to view some system parameters and, for the purpose of service, allow the hydrogen generator to operate with the fluid doors open without losing power to the unit.

In order to activate the service bypass mode on the H Series hydrogen generator, turn the key in the control panel area to the right. (In normal operating mode, the key must be positioned to the left.)



Figure 4 Key in Service Bypass Mode



AUTHORIZED SERVICE PERSONNEL SHOULD ONLY CARRY OUT THIS PROCEDURE. EXTREME CARE SHOULD BE TAKEN IN WORKING IN THE VICINITY OF ELECTRICAL COMPONENTS. NEVER OPERATE THE SYSTEM IN A POORLY VENTILATED AREA. IF A HYDROGEN LEAK IS SUSPECTED, ON NO ACCOUNT USE THIS FEATURE AS AN OVERRIDE.



DO NOT START THE GENERATOR IN SERVICE BYPASS MODE. THE UNIT NEEDS TO BE IN NORMAL OPERATING MODE FOR STARTUP.

4 HARDWIRED SAFETY SHUTDOWNS

The unit is designed with seven hardwired safety shutdowns. In the event of a safety shutdown, the unit does not generate an error code. The unit, in turn, maintains power to the ventilation fan, but does not power the user interface panel. Therefore, the safety fault must be remedied before starting the unit back up.

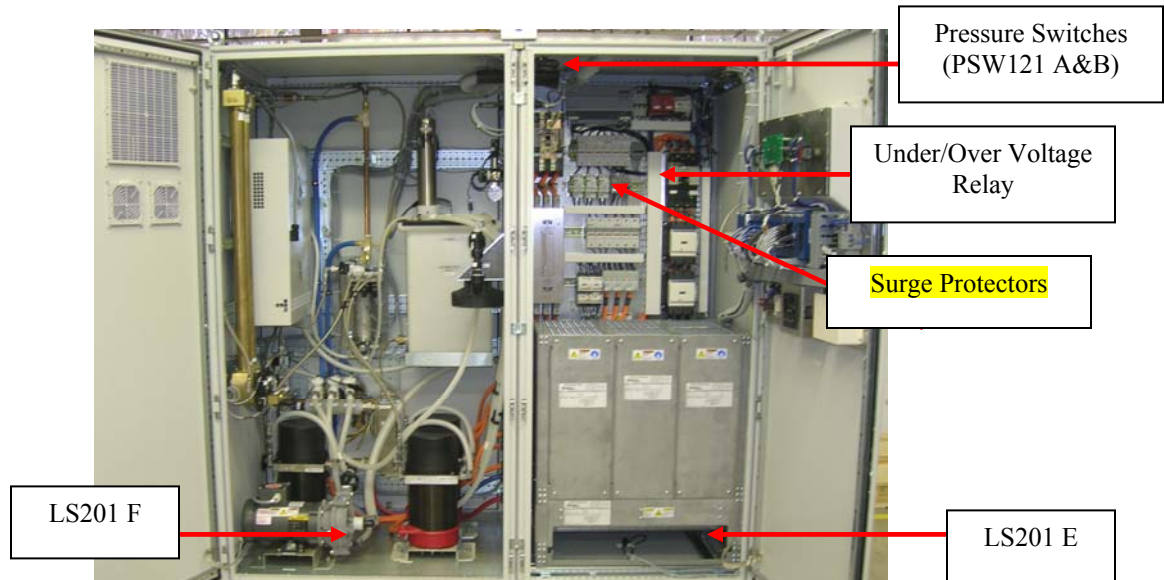


Figure 5 Fluids and Electrical Enclosures

The seven hardwired safety shutdowns are the following:

- Emergency E-Stop



Figure 6 User Interface with Emergency E-Stop

- Customer Remote E-Stop (If Used)
- Under/Over Voltage Relay

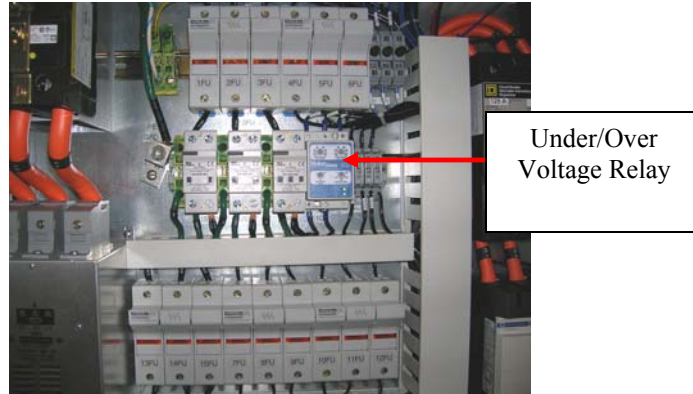


Figure 7 Under/Over Voltage Relay




RUN	GREEN	LED STATUS
RESTART DELAY	 GREEN	
REVERSE PHASE	 RED	
UNBALANCE / SINGLE PHASE	 RED	
HIGH / LOW VOLTAGE	RED	

Figure 8 Under/Over Voltage Relay LED Status



If the Light Emitting Diodes (LEDs) are both red, there is a phase imbalance or an out of range voltage.

- Surge Protectors

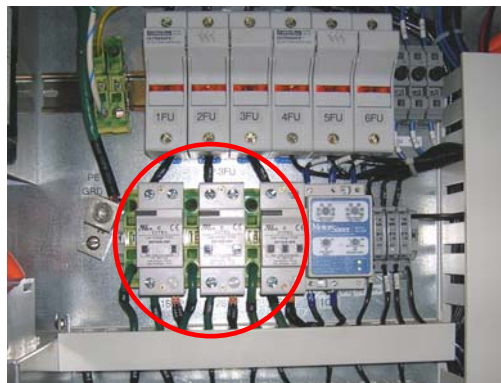


Figure 9 Surge Protectors

- Pressure Switches (PSW121 A&B) for Ventilation System



Figure 10 Pressure Switches (PSW121 A&B)



On initial startup, the pressure switches (PSW121 A&B) work in conjunction with the 31-second 1TR dilution timer, which allows the system to enter Normal Operating Mode after 31 seconds.

- Level Sensor (LS101 E) for Flooding Detection in Electrical Compartment
- Level Sensor (LS101 F) for Flooding Detection in Fluids Compartment



Figure 11 LS101 E&F

Shutdown	Description	Potential Shutdown Causes	Indication
Emergency E-Stop	<p>The E-stop is a normally closed circuit. Engaging the E-Stop trips the contactor, which stops hydrogen production and removes power to safety-critical components and circuits, but leaves some components and circuits inside the electrical enclosure energized. The generator safely depressurizes when the E-Stop is engaged.</p> <p>NOTE: THE VENTILATION FAN REMAINS ENERGIZED.</p>	Emergency E-Stop is Engaged Faulty E-Stop	Blank Display
Phase Reversal Relay	The phase reversal relay catches phases out of order and disables power to the unit as part of the safety circuit.	Unit Wired Out Of Phase Loss of Phase(s) High/Low Line Voltage	Blank Display
Pressure Switches (PSW121 A&B) for Ventilation System	The pressure switches measure the pressure in the fluids cabinet relative to the atmosphere.	Insufficient Ventilation due to the following: 1. Clogged Ventilation Filters 2. Fan Failure Faulty Pressure Switch	Blank Display
Level Sensor (LS101 E)	The level sensor detects flooding in the electrical cabinet.	Coolant Leak	Blank Display
Level Sensor (LS101 F)	The level sensor detects flooding in the fluids cabinet.	Coolant Leak DI Water Leak	Blank Display
Customer Remote E-Stop	<p>The E-stop is a normally closed circuit. Engaging the E-Stop trips the contactor, which stops hydrogen production and removes power to safety-critical components and circuits, but leaves some components and circuits inside the electrical enclosure energized. The generator safely depressurizes when the E-Stop is engaged.</p> <p>NOTE: THE VENTILATION FAN REMAINS ENERGIZED.</p>	Emergency E-Stop is Engaged Faulty E-Stop	Blank Display
Surge Protectors	One surge protector is tied to each phase of line voltage. If a voltage spike is experienced, these surge protectors safely short the transient to ground.	Excessive magnitude and/or frequency of transients may damage the surge protector, which inhibits system operation.	Blank Display

Table 3 Auto-Hardwired Safety Shutdowns

5 WARNING AND ERROR CODES

In the event the control system detects a fault that may require the unit to cease operation, the unit will automatically shutdown. The graphical display will output any one of the following error codes. Please contact the Customer Service department immediately at **(203) 949-8697** and ask for field service technical support, email customerservice@protonenergy.com, or call your local service provider/supplier for more information.

Code	Labview Error /Warning Message
W4	Coolant Temp Low
W5	Coolant Temp High
W6	System Temp Warm
W7	Poor Water Quality
W12	Power Supply A1 Failed
W13	Power Supply A2 Failed
W14	Power Supply A3 Failed
W15	Power Supply B1 Failed
W16	Power Supply B2 Failed
W17	Power Supply B3 Failed
W18	Power Supply C1 Failed
W19	Power Supply C2 Failed
W20	Power Supply C3 Failed
W21	CG in O2 High & Increasing
W22	Calibration Due and/or CG Level Reading Negative
W26	Cal Gas Pressure Low
W27	Cal Gas Failed During Calibration
W34	Electronics Cabinet Overheat
W35	Calibration Cancelled
W38	PT307 Low on Pressurize
E1	Cell Stack A Voltage High
E2	Cell Stack B Voltage High
E3	Cell Stack C Voltage High
E4	Cell Stack A Voltage Low
E5	Cell Stack B Voltage Low
E6	Cell Stack C Voltage Low
E7	A200 Empty
E8	A200 Flooded
E9	A300 Empty
E10	A300 Flooded
E14	Unrecoverable Bad Water Quality
E15	Repeated Bad Water Quality
E16	System Pressure High
E17	System Pressure Low
E21	Open Thermocouple
E22	CG Calibration Expired + Two Weeks

Code	Labview Error /Warning Message
E23	Water Frozen Shutdown
E24	System Temp Shutdown
E25	A200 Not Filling
E41	Stack A Low Current Fault
E42	Stack B Low Current Fault
E43	Stack C Low Current Fault
E46	Stack A High Current Fault
E47	Stack B High Current Fault
E48	Stack C High Current Fault
E50	LS201 Invalid
E51	LS301 Invalid
E52	Electronics Cabinet Overheat
E53	PT307 Out of Range
E66	H2 in Oxygen

Table 4 Error and Warning Codes



Warnings do not shut down the unit. Warnings alert that an undesirable condition exists and may result in an error. A corrective action should be taken to eliminate the warning before an error code results.



E1 – E6 and E41 – E48 shuts down the individual stack(s), but the unit still operates at partial capacity.

5.1 Troubleshooting

Warnings	Description	Limits	Potential Causes
W4	Coolant Temp Low	< 5° C	Low Temp Coolant Feed
W5	Coolant Temp High	> 35° C	High Temp Coolant Feed
W6	System Temp Warm	60° C	High Temp Coolant Feed Thermal Control Valve Setting Clogged Heat Exchanger High Cell Stack Voltage
W7	Poor Water Quality NOTE: Stagnant System Will Generate Alarm 5 Drain and Fill Cycles = E11 5 Initiations of D&F Cycles in 24 hrs = E14	1 Meg Ohm-cm	Poor Feed Water Quality System Contamination Failed Water Quality Relay Box
W12-20	A1-3, B1-3, C1-3 Power Supply Failure	< 1 amp/ Power Supply	Power Supply Failure Overheated Power Supply Bad Electrical Connection
W21	Combustible Gas Sensor (CG220) in Oxygen High	≥ 30 Percent	CG Sensor Out of Calibration Failed Cell Stack System/Cabinet Hydrogen Leak
W22	Calibration Due	3 Months Past First Cal	Time/Negative CG Reading
W26	Calibration Gas Pressure Low	< 150 psi	Empty Cal Gas Cylinder Leak Open Circuit Configuration For Auto Cal, No Hardware
W27	Failed Calibration	Change of .2 to 1 Volt	Failure to Apply Gas at Appropriate Time Interruption of Calibration Procedure Loss of Cal Gas Pressure Cal Gas Line Removed from Sensor Wrong Cal Gas Percent Bad Solenoid Valve (SV801)
W34	Electronic Cabinet Over Temp	> 60° C	High Temp Coolant Feed Low Coolant Differential Pressure Excessive Heat from Power Supply(s) Nonfunctioning Fan Assembly Clogged Heat Exchanger
W35	Calibration Cancelled	Manual Stop	Stop Button Depressed During Calibration
W38	Low System Pressure on Startup	< 170 psi (2) < 180 psi (4,6)	HGMS Leak Internal HGMS Leak System Leak
E1, 2,3	Cell Stack A, B, C Voltage High	> 2.8 Volts/Cell	Power Supply Failure Open Circuit Stack Loose Connection Stack Contamination (EOL)

Warnings	Description	Limits	Potential Causes
E4, 5,6	Cell Stack A, B, C Voltage Low	< 1.2 Volts/Cell	Power Supply Failure Low Water Flow Short Circuit Flow Switch Failure Faulty Sense Wiring
E7	A200 Empty	Level Sensor (LS201-1) Open	Low/No Facility Water Feed Water Leak Failed Water Fill Valve (SV510) Failed Water Drain Valve (SV211) Bad Level Sensor Faulty Wiring Clogged Filter (F506)
E8	A200 Flooded	Level Sensor (LS201-4) Open	Bad Level Sensor Failed Water Fill Valve (SV510) Faulty Wiring
E9	A300 Empty	Level Sensor (LS301-1) Open	Water Leak Failed Drain Valve (SV309) Bad Level Sensor Faulty Wiring
E10	A300 Flooded	Level Sensor (LS301-4) Open	Low System Pressure Failed Drain Valves (SV303/309) Clogged Filter (F365) Clogged Orifice (OR336) Bad Level Sensor
E14	Unrecoverable Water Quality	5 Attempts <1MgOhm Within 1 Event	Poor Feed Water Quality System Contamination Overheating, Stagnant, Bad Resistivity Sensor (RS209) Failed Water Quality Relay Box Faulty Wiring
E15	Repeated Bad Water Quality	5 Cleanup Attempts Within 24 hrs	Guard Bed (GB208) System Contamination Overheating, Stagnant, Bad Resistivity Sensor (RS209) Failed Water Quality Relay Box Faulty Wiring

Warnings	Description	Limits	Potential Causes
E16	System Pressure High	260 psi	Clogged Vent Line HGMS Throttle Valve (TV326) Orifice (OR330) Check Valve (CV333) Check Valve (CV334) Solenoid Valve (SV343) Solenoid Valve (SV344) Solenoid Valve (SV336) Check Valve (CV345) Filter (F363) Orifice (OR304)
E17	System Pressure Low	2m: 170 psi All Others 180 psi	HGMS Leak Internal HGMS External Leak Low Stack Current = E41, 42,43 Cell Stack Failure - Leak Cell Stack Failure - Electrical
E21	Open Thermocouple	Open Signal	Thermocouple (TC 601,159,128,218)
E22	CG Cal Expire + 2 Wks	104 Days from Last Cal	104 Days from Last Cal
E23	Water Frozen Shutdown	Thermocouple (TC 218) < 3° C	Low Ambient Temp Failed Heated Purge DI Source < 3° C
E24	System Temp Shutdown	Thermocouple (TC 218) > 65° C	No Coolant Loop Flow High Coolant Temp Improperly Set Thermocouple (TCV601)
E25	A200 Not Filling	30 Minutes	Water Supply not Operating Fill Valve (SV510) Not Operating Clogged Filter (F506) Water Leak Drain Valve (SV211) Stuck Open Level Sensor (LS201) Faulty
E41-E43	Low Stack Current (A, B, C)	< 1 amp	Faulty Flow Switch (FSW250 A, B, C) Reference E13 Entire Power Supply Bank A, B, C Failure PLC Module 5 Failure Faulty Wiring
E46-E48	High Stack Current (A, B, C)	165 amps	Faulty Power Supply PLC Module 5 Failure PLC Module 6 Failure Faulty Wiring
E50	LS201 Invalid	Illogical Level Sensor States	Faulty Level Sensor (LS201) Faulty Wiring PLC Module 4 Failure
E51	LS301 Invalid	Illogical Level Sensor States	Faulty Level Sensor (LS301) Faulty Wiring PLC Module 4 Failure

Warnings	Description	Limits	Potential Causes
E52	Electronics Cabinet Overheat	> 65° C	Coolant Temp is too High Reference W5
E53	PT307 Out of Range	Invalid State	Faulty Wiring Faulty Transducer PLC Module 1 Failure Faulty Calibration File
E66	CG220 Hydrogen in Oxygen	> 50 Percent of LFL	Out of Calibration Leak in Stack A, B, C Faulty Wiring PLC Module 1 Failure

Table 5 Troubleshooting Matrix



For troubleshooting assistance, contact PROTON at **(203) 949-8697** and ask for technical service support, email customerservice@protonenergy.com, or call your local service provider/supplier. Please have the model number and serial number of your unit available.

6 PUMP IMPELLER REPLACEMENT INSTRUCTIONS

Use the following instructions to replace the pump impeller:



DO NOT HIT THE CELL STACK POSITIVE TERMINALS OR PULL THE CELL STACK BOOT BACK. CELL STACKS MAINTAIN A CAPACITIVE CHARGE. CELL STACKS CAN BE DISSIPATED OF ALL ELECTRICAL CHARGE THROUGH THE USE OF A STACK DISSIPATION BAR.

1. Power on the unit by turning the main power disconnect switch to the ON (I) position.
2. Drain the unit.
3. Shut down the unit by turning the main power disconnect to the OFF (O) position.
4. Remove facility power to the unit.
5. Shut off the facility water supply to the unit.
6. Perform all necessary lockout/tagout procedures.
7. Open the fluids side of the cabinet and locate the pump. (Refer to Figure 12.)

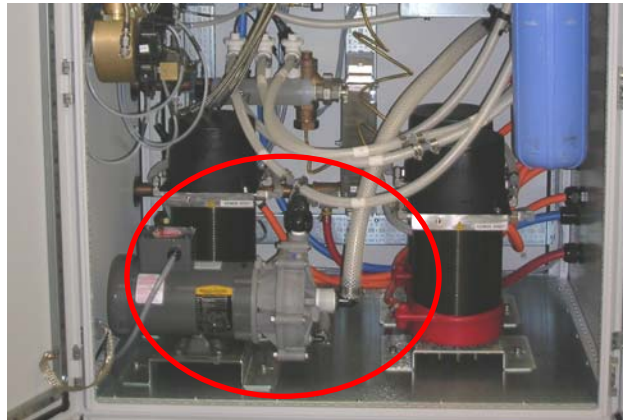


Figure 12 Pump Location

8. Loosen the hose clamp and remove the pump outlet line. (Refer to Figure 13.)

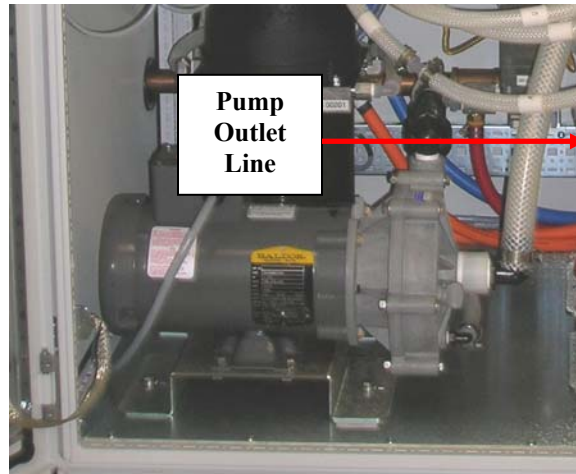


Figure 13 Pump Outlet Line Location

9. Remove the two (2) screws at the base of the pump mounting bracket and slide the pump 2" to the right. (Refer to Figure 14.)



Figure 14 Two (2) Screws at Base of Pump Mounting Bracket

10. Using a 9/16" wrench, remove the six (6) nuts and washers that secure the pump housing cover. Place the pump housing cover to the side. (Refer to Figure 15.)

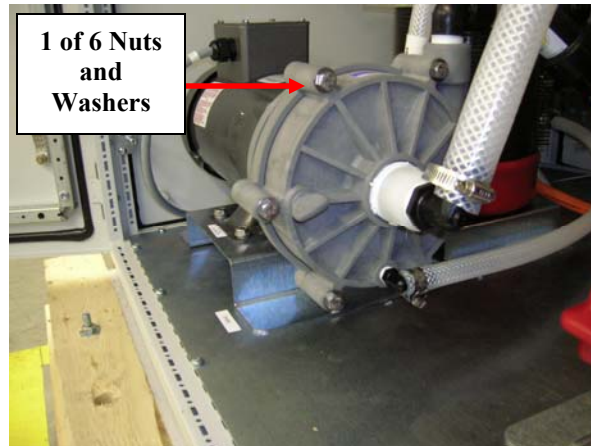


Figure 15 Pump Housing Cover

11. Using a flat head screwdriver or a 5/16" nutdriver, remove the three (3) screws, located 120° apart, on the fan shroud. Remove the fan shroud from the pump motor shaft. (Refer to Figure 16.)



Figure 16 One of Three Screws on the Fan Shroud



12. With the housing removed, inspect for damage.

Only one impeller is required dependent on the pump model (50 Hz or 60 Hz).

13. Using a 1/4" socket wrench, remove the fan from the pump motor shaft. (Refer to Figure 17.)

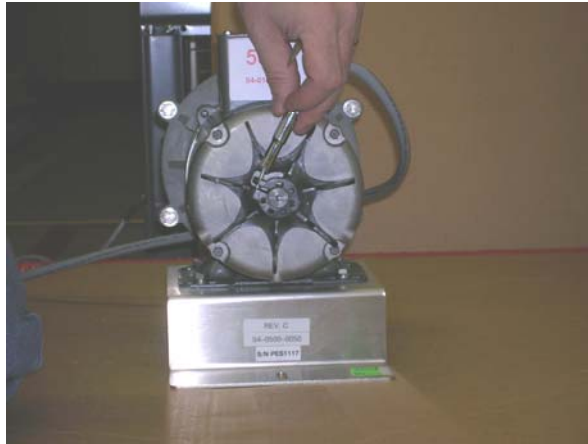


Figure 17 Removing the Fan from the Pump Motor Shaft

14. To ensure stability, hold the pump motor shaft in place from the back of the motor and remove the impeller by turning it counterclockwise using a strap wrench. (Refer to Figure 18.)

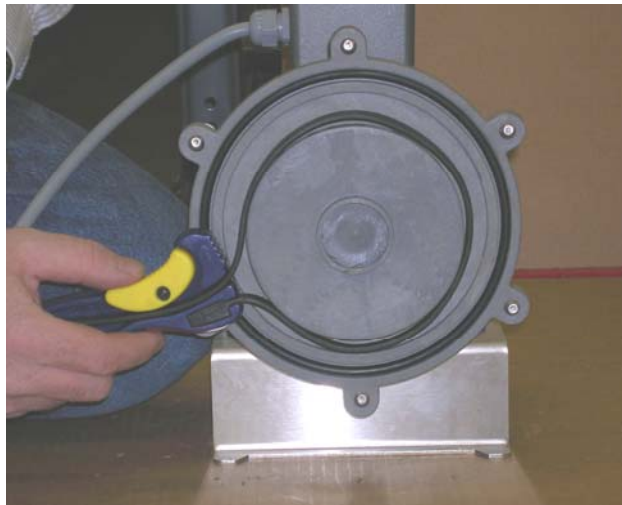


Figure 18 Removing the Impeller with a Strap Wrench

15. To remove the impeller, follow the direction arrow located on the top of the pump. (Refer to Figure 19.)



Figure 19 Direction Arrow



Take care not to damage the seal. The new impeller does not include a new seal.

16. Hold the pump motor shaft with a flathead screwdriver and thread the impeller back onto the shaft until the mechanical seal on the impeller makes contact with the seal on the pump. The torque required is 45 to 50 lbs. Spin the motor manually.
17. Reinstall the fan to the pump motor shaft. Tighten with a ¼” screwdriver.
18. Using a 5/16” screwdriver, reinstall the fan shroud to the pump motor shaft and secure with the three (3) screws from Step 11.
19. With the impeller reinstalled on the shaft, reinstall the pump housing cover. Tighten the six (6) nuts and washers on the outside of the pump gradually using a crisscross “star” pattern to ensure even compression on the housing. Torque to 45 lbs. Be sure that the O-ring is seated in its groove.
20. Connect the pump outlet line back to the pump housing.
21. Secure the pump mounting bracket with the two (2) screws from Step 9.
22. Power on the unit by turning the main power disconnect switch to the ON (I) position.
23. Return facility power back to the unit.
24. Return the facility DI water supply to the unit.
25. Fill the unit.
26. Circulate and check for leaks.

7 CG SENSOR REPLACEMENT

To replace CG220, use the following instructions:

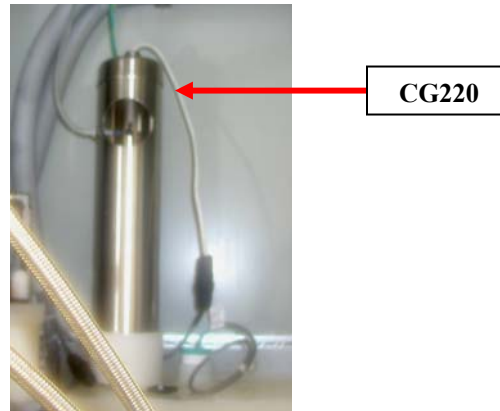


Figure 20 CG220 Sensor Location

1. Shut down the unit.
2. Remove power to the system.
3. Lockout/Tagout the unit.
4. Unplug the electrical connection.
5. Using a Phillips screwdriver, unscrew the stainless steel cap from the stainless steel tube by removing the ground screw and cap retainer screw.
6. Remove the cap and the sensor (located inside the cap) from top of the tube.
7. Unthread the fastening collar from the sensor by rotating it counterclockwise.



Figure 21 Cap and CG220 Sensor

8. Remove the sensor.
9. Install the new sensor into the cap by reversing Step 7. Pay particular attention to your order (Refer to Figure 21).
10. Reinstall the cap and sensor to the top of the tube.
11. Refasten the ground wire and cap retainer screw.
12. Reconnect the electrical connection to the sensor. Ensure that a discernible “click” is felt when reattaching the electrical connector.

8 POWER SUPPLY REPLACEMENT

Use the following instructions to replace the power supply located in the H Series hydrogen generator:



POWER IS STILL PRESENT AT THE CIRCUIT BREAKER (Electrical Schematic Tag CB101) IN THE GENERATOR UNTIL THE FACILITY MAIN POWER DISCONNECT IS SWITCHED TO THE OFF POSITION.

1. Shut down the unit.
2. Remove power to the unit.
3. Perform all necessary lockout/tagout procedures.
4. Using a Phillips screwdriver, remove the four (4) screws from the power supply module front access panel.

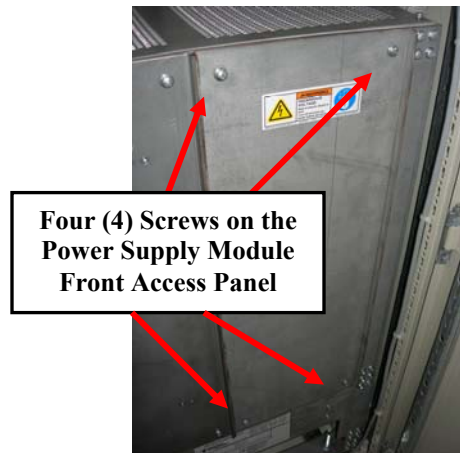


Figure 22 Location of Screws on Front Access Panel

5. Uninstall the power supply frame's top screen by removing eleven (11) screws using a Phillips screwdriver.



Figure 23 Power Supply Frame Top Screen



DO NOT HIT THE CELL STACK POSITIVE TERMINALS OR PULL THE CELL STACK BOOT BACK. CELL STACKS MAINTAIN A CAPACITIVE CHARGE. CELL STACKS CAN BE DISSIPATED OF ALL ELECTRICAL CHARGE THROUGH THE USE OF A STACK DISSIPATION BAR. (Refer to Figure 26 and Figure 27.)

6. Remove the two (2) sense lead wires to the bus bars. (Refer to Figure 24.)



Figure 24 Removing Sense Lead Wires to the Bus Bars

7. Disconnect the three (3) black power source connectors. (Refer to Figure 25.)

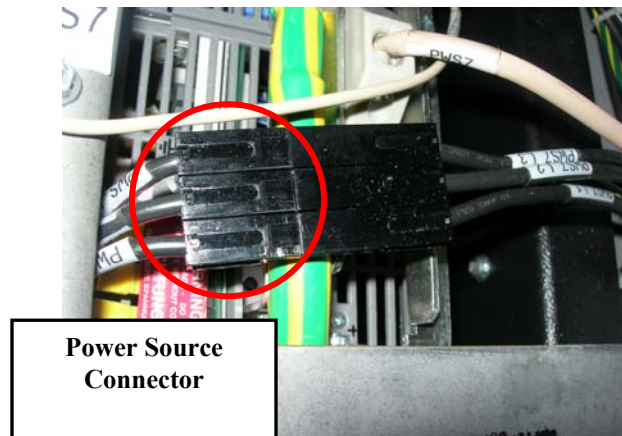


Figure 25 Location of the Power Source Connector

8. Disconnect the positive lead cable from the power supply module's right side bus bar by removing the two (2) 7/16" hex bolts. (Refer to Figure 26.)

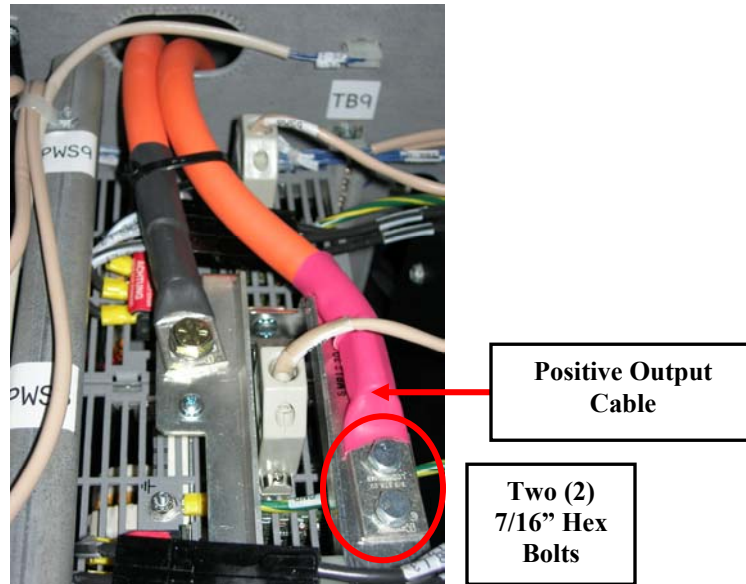


Figure 26 Positive Output Cable Location

9. Disconnect the negative output cable from the power supply module's left side bus bar by removing the one (1) 9/16" hex bolt. (Refer to Figure 27.)

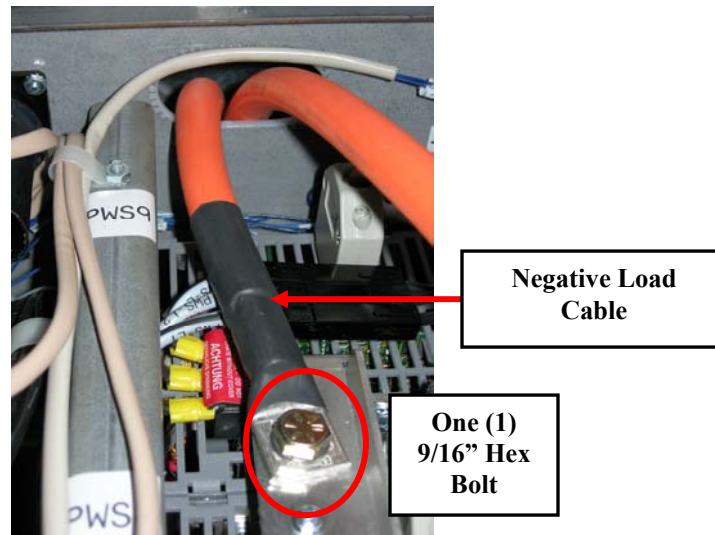


Figure 27 Negative Output Cable Location

10. Disconnect the ground cable from the power supply module's left side bus bar by removing the one (1) head screw using a Phillips screwdriver. (Refer to Figure 28.)



Figure 28 Ground Cable Location

11. Remove the three (3) DB25 I/O serial connector cables from the power supply. The cable is secured by two (2) micro flat screws. (Refer to Figure 29.)

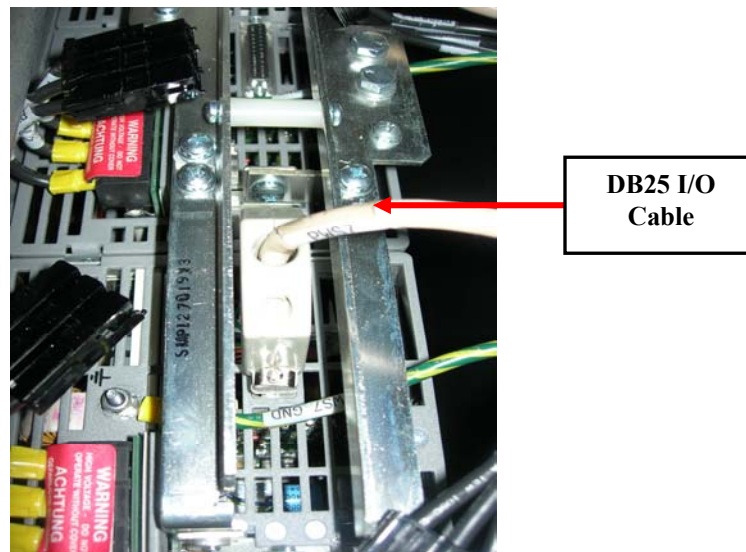


Figure 29 DB25 I/O Serial Connector Cable Location

12. Disconnect the three (3) green and yellow striped ground wires from the power supply. There is one ground wire per bank. Route/position the ground wires underneath the bus bars. (Refer to Figure 30.)

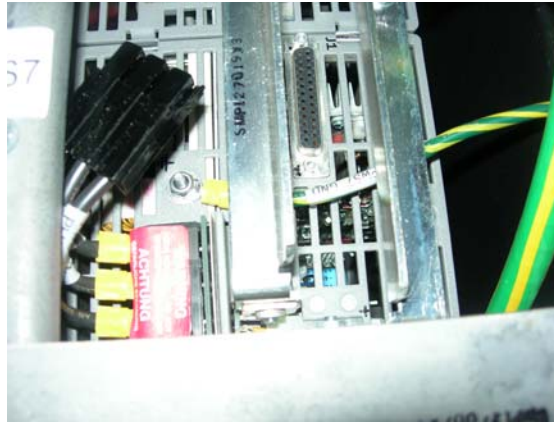


Figure 30 Routing the Ground Wires

13. Carefully remove the power supply module from the power supply frame. Be aware of the wires and cables surrounding the bank as it is extracted from the power supply frame.
14. Reverse the above instructions to reconstruct the power supply and install it in the HOGEN hydrogen generator.
15. Position the power supply module so that the support plate screws can be accessed for removal. (Refer to Figure 31.)



Figure 31 Support Plate Screws Location

16. Remove the two (2) screws that connect the individual power supply to the positive and negative bus bars using a Phillips screwdriver. (Refer to Figure 32.)

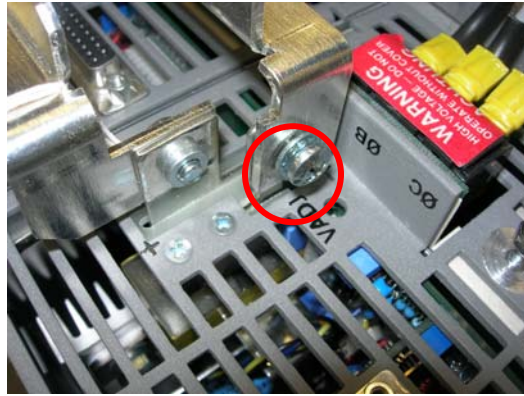


Figure 32 Location of Screw that Connects Power Supply to Positive and Negative Bus Bars

17. Remove the six screws that secure the individual power supply to the support plate using a Phillips screwdriver. (Refer to Figure 33.)



Figure 33 Location of Screws that Connect Power Supply to Support Plate

18. Remove the power supply from the support plate.
19. Position the power supply module so the upper left support rail slides into the power supply frame's track. (Refer to Figure 34.)



Figure 34 Support Rail Sliding into Power Supply Frame Track

20. Carefully slide the power supply module into the power supply frame. (Refer to Figure 35.)



Ensure that the unit does not pinch or damage any interface cables.



The ground cable at the rear slightly touches the back of the power supply brick.



Figure 35 Sliding the Power Supply Module into the Frame

21. Level the power supply module with the power supply frame. Secure power supply front access panel with four (4) screws using a Phillips screwdriver. (Refer to Figure 22.)
22. Reverse Steps 6 through 12 to reinstall the power supply module.
23. Reinstall the power supply frame's protective cover and secure with eleven (11) screws using a Phillips screwdriver. (Refer to Figure 23.)

9 POWER SUPPLY FUSE REPLACEMENT PROCEDURE

Use the following instructions to replace the power supply fuses located in the H Series hydrogen generator:



Proton Part Number KT-0900-0006 is required to perform this procedure.



POWER IS STILL PRESENT AT THE CIRCUIT BREAKER (Electrical Schematic Tag CB101) IN THE GENERATOR UNTIL THE FACILITY MAIN POWER DISCONNECT IS SWITCHED TO THE OFF POSITION.



1. Remove the individual power supply as shown in Section 8.

Before removing screws, ensure you are using a grounded wrist strap.

2. Using a magnetically tipped #1 Phillips screwdriver, remove the five (5) screws from the power supply. One (1) screw is located in the front plate and the four (4) other screws are located in the corners at the end of the power supply near the output bus bars. Store the five (5) screws aside in a safe place. (Refer to Figure 36 and Figure 37.)

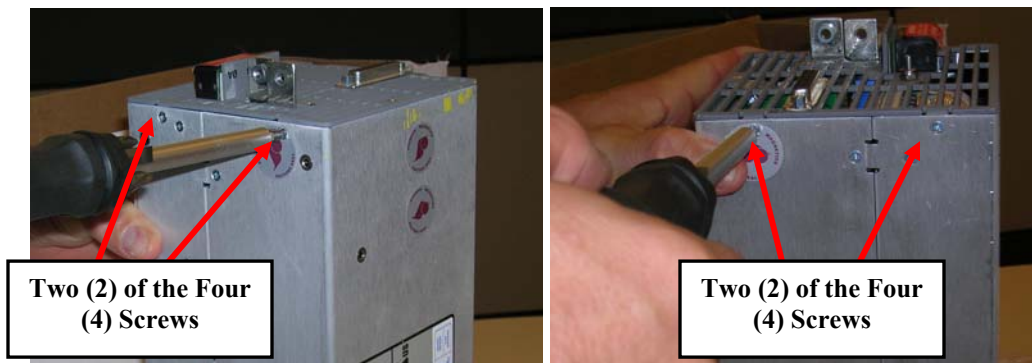


Figure 36 Removing Four (4) of the Five (5) Screws

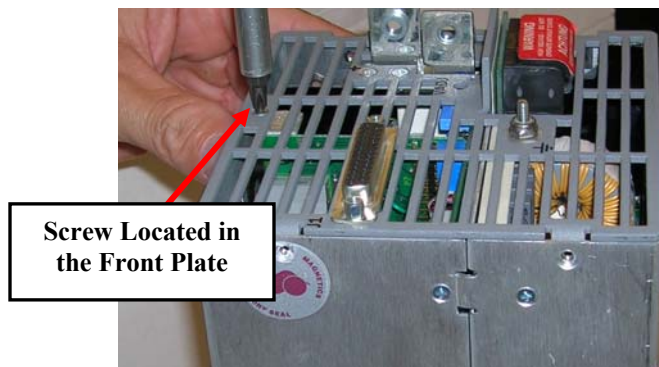


Figure 37 Removing Screw in Front Plate

3. Lay the power supply on its side so it is horizontal. (Refer to Figure 38.)



Figure 38 Power Supply on its Side

4. Slowly remove the two (2) screws retaining the bus bar insulator while holding the back of the insulator to prevent it from dropping into the power supply. (Refer to Figure 39.)



Figure 39 Removing the Screws from the Insulator

5. When both screws are removed, slide the insulator up and set it aside in a safe place. (Refer to Figure 40.)

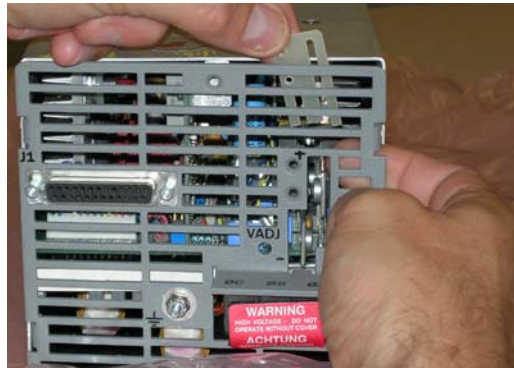


Figure 40 Sliding the Insulator Up

6. Carefully remove the interface connector cable from the PC board by exerting an upward force. (Refer to Figure 41.)

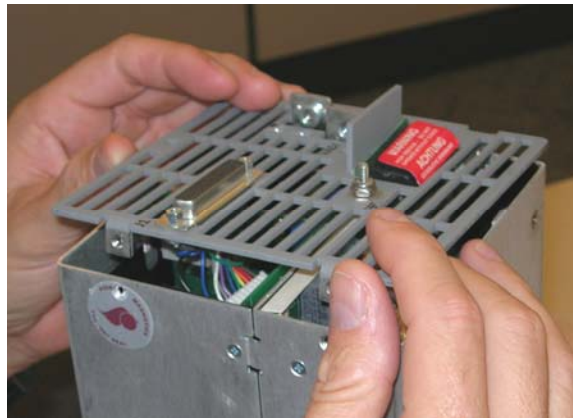


Figure 41 Removing Interface Connector Cable



Do not bend the pins on the PC board when removing the interface connector cable.

7. Position power supply so the AC voltage input connector is on top.
8. Locate the fuses, which are now visible on the power supply PC board. (Refer to Figure 42.)

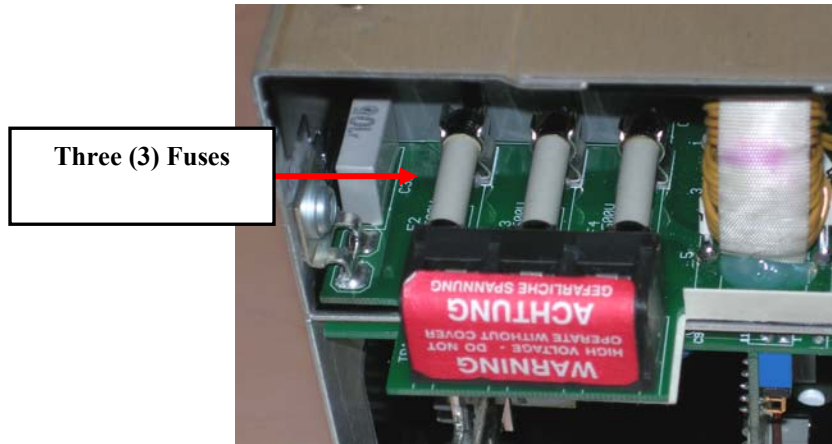


Figure 42 Fuse Location

9. Carefully pry all three (3) fuses out with a non-metallic device, such as a plastic screwdriver. Discard all three (3) fuses. (Refer to Figure 43.)



Figure 43 Removing the Fuses

10. Using the fuses provided in the replacement kit (Proton P/N 08-0301-0028, Buss P/N FWH-020A6F), snap each replacement fuse to the fuse clip by exerting a downward pressure on the fuse until it snaps into the clip. Perform this step for all three (3) fuse locations. (Refer to Figure 44.)



Figure 44 Snapping Fuses into Place



Use only the fuses provided as they are special 20 Amp, 500V fuses.

11. Reverse the above instructions to reconstruct the power supply and install it in the HOGEN hydrogen generator.



Ensure the connector wires are straightened so they align properly with the connector socket.

12. For warranty purposes, record the Serial Number of the modified power supply and email it to Proton Energy at the following email address:
customerservice@protonenergy.com.
13. Place a date sticker (Proton P/N 64-0200-0060) on the power supply repaired, which indicates the date the fuses were replaced. Enter the date the fuses were replaced in the space on the provided label.

THIS MUST BE PERFORMED - FAILURE TO DO THIS VOIDS YOUR WARRANTY.

14. To reinstall the power supply, position the power supply interface cables so they do not interfere with the insertion of the power supply into the power supply module. (Refer to Figure 45.)

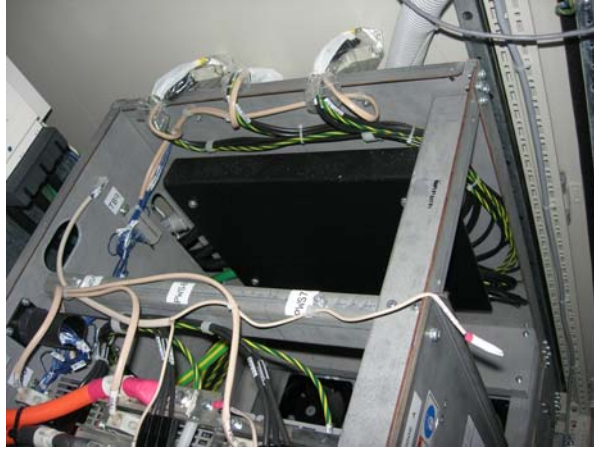


Figure 45 Positioning of the Wires

10 CELL STACK ISOLATION CHECK

Use the following procedure to determine which cell stack(s) has an issue:

1. Shut down the unit.
2. Remove power to the Main Power Disconnect.

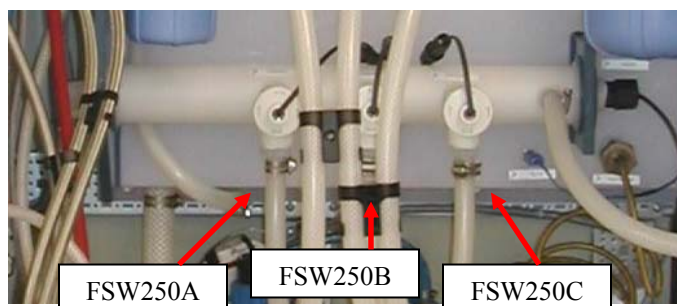


Figure 46 Flow Switch Location

3. Open the fluid-side doors and disconnect the flow switches to stacks B and C by unplugging FSW250B and FSW250C. (Refer to Figure 47.)



Figure 47 Unplugging the Flow Switch

4. Close the fluid-side doors and return power to the Main Power Disconnect. Once the “Ready to Start” prompt appears on the user interface, start the unit.
5. Using the left or right arrow key on the user interface or the remote diagnostics software, view the CG220 % LEL.



When the unit electrolyzes, the following error and warning codes appear:

Stack B: E-5 and/or E-42, W-15, W-16 and W-17

Stack C: E-6 and/or E-43, W-18, W-19 and W-20

6. Record the CG220 % LEL reading (Stack A % LEL = ____). If the unit shuts down on an E-66 error, record the shutdown.
7. Manually shut down the unit and wait for the “Ready to Start” prompt to appear on the user interface. Remove power to the Main Power Disconnect.
8. Open the fluid-side doors and reconnect flow switch FSW250B and disconnect the flow switch to Stack A by unplugging FSW250A. (Refer to Figure 47.)
9. Close the fluid-side doors and return power to the Main Power Disconnect. Once the “Ready to Start” prompt appears on the user interface, start the unit.
10. Using the left or right arrow key on the user interface or the remote diagnostics software, view the CG220 % LEL.



When the unit electrolyzes, the following error and warning codes appear:

Stack A: E-4 and/or E-41, W-12, W-13 and W-14

Stack C: E-6 and/or E-43, W-18, W-19 and W-20

11. Record the CG220 % LEL reading (Stack B % LEL = ____). If the unit shuts down on an E-66 error, record the shutdown.
12. Manually shut down the unit and wait for the “Ready to Start” prompt to appear on the user interface. Remove power to the Main Power Disconnect.
13. Open the fluid-side doors and reconnect flow switch FSW250C and disconnect the flow switch to Stack B by unplugging FSW250B. (Refer to Figure 47.)
14. Close the fluid-side doors and return power to the Main Power Disconnect. Once the “Ready to Start” prompt appears on the user interface, start the unit.
15. Using the left or right arrow key on the user interface or the remote diagnostics software, view the CG220 % LEL.



When the unit electrolyzes, the following error and warning codes appear:

Stack A: E-4 and/or E-41, W-12, W-13 and W-14

Stack B: E-5 and/or E-42, W-15, W-16 and W-17

16. Record the CG220 % LEL reading (Stack C % LEL = ____). If the unit shuts down on an E-66 error, record the shutdown.
17. Manually shut down the unit and wait for the “Ready to Start” prompt to appear on the user interface. Remove power to the Main Power Disconnect.
18. Open the fluid-side doors and reconnect the flow switches that did not give an E-66 error shut down.
19. Close the fluid-side doors and return power to the Main Power Disconnect. Once the “Ready to Start” prompt appears on the user interface, start the unit.
20. Contact Proton at 203-949-8697 regarding the stack with the E-66 error for further details.

11 CELL STACK REPLACEMENT

Use the following instructions for replacing the cell stack(s) on the HOGEN H Series hydrogen generator:

Customers with 4- or 6-meter units have up to two additional cell stacks (Cell Stack B and Cell Stack C, respectively).



POWER IS STILL PRESENT AT THE CIRCUIT BREAKER (Electrical Schematic Tag CB101) IN THE GENERATOR UNTIL THE FACILITY MAIN POWER DISCONNECT IS SWITCHED TO THE OFF POSITION.

15. Drain the system. (Refer to Section 2.1.)
16. Shut down the unit.
17. Remove power to the unit.
18. Perform all necessary lockout/tagout procedures. (Reference Section 2.2.)



THE CELL STACK RETAINS A SIGNIFICANT CAPACITIVE CHARGE EVEN WHEN THE SYSTEM IS DISCONNECTED FROM POWER. CARE SHOULD BE TAKEN WHEN WORKING NEAR THE CELL STACK TO AVOID SHORT CIRCUITING THE TERMINALS.



IT IS ESSENTIAL THAT THE SAFETY SYSTEM IS NOT BYPASSED. CONTINUED OPERATION COULD RESULT IN SERIOUS INJURY AND/OR DAMAGE TO THE GENERATOR.



FAILURE TO CHECK FOR LEAKS IN THE SYSTEM AFTER MAINTENANCE TO HYDROGEN COMPONENTS MAY RESULT IN A SYSTEM SHUTDOWN AND MAY LEAD TO A DANGEROUS SITUATION.

19. Allow the HOGEN hydrogen generator to stand idle for 30 minutes after shutdown to dissipate some of the stored electrical charge.
20. Using a multimeter set for DC measurements, check the voltage between the positive buss connection on the cell stack and ground (stainless steel manifold plate). (Refer to Figure 48.) It should read approximately 20 volts.



If the unit has not been running, check to see if the DC volts are two (2) VDC or lower.

21. Carefully connect a power resistor (60 ohm, > 1000 Watts; Proton Part Number 69-0101-0001) with clip leads across the positive and negative current leads to discharge the cell stack.
22. Allow to discharge for 10 minutes.
23. Test the stack voltage again. It should be less than two (2) volts before attempting to remove the stack from the unit.



It is important to follow the discharge procedure before removing the cell stack. If the positive buss plate were to make contact with the cabinet during the removal process, an electrical charge could damage the system and cause personal injury.



Change one stack at a time to avoid a connection mix-up.

24. Disconnect the inlet hose on the stack from FSW250 A, B or C, depending on which cell stack needs to be replaced, using a flat-head screwdriver. (The inlet hose is located in the back of the cell stack.) (Refer to Figure 48.)
25. Disconnect the outlet hose from the cell stack. (The outlet is located in front of the cell stack.) (Refer to Figure 48.)

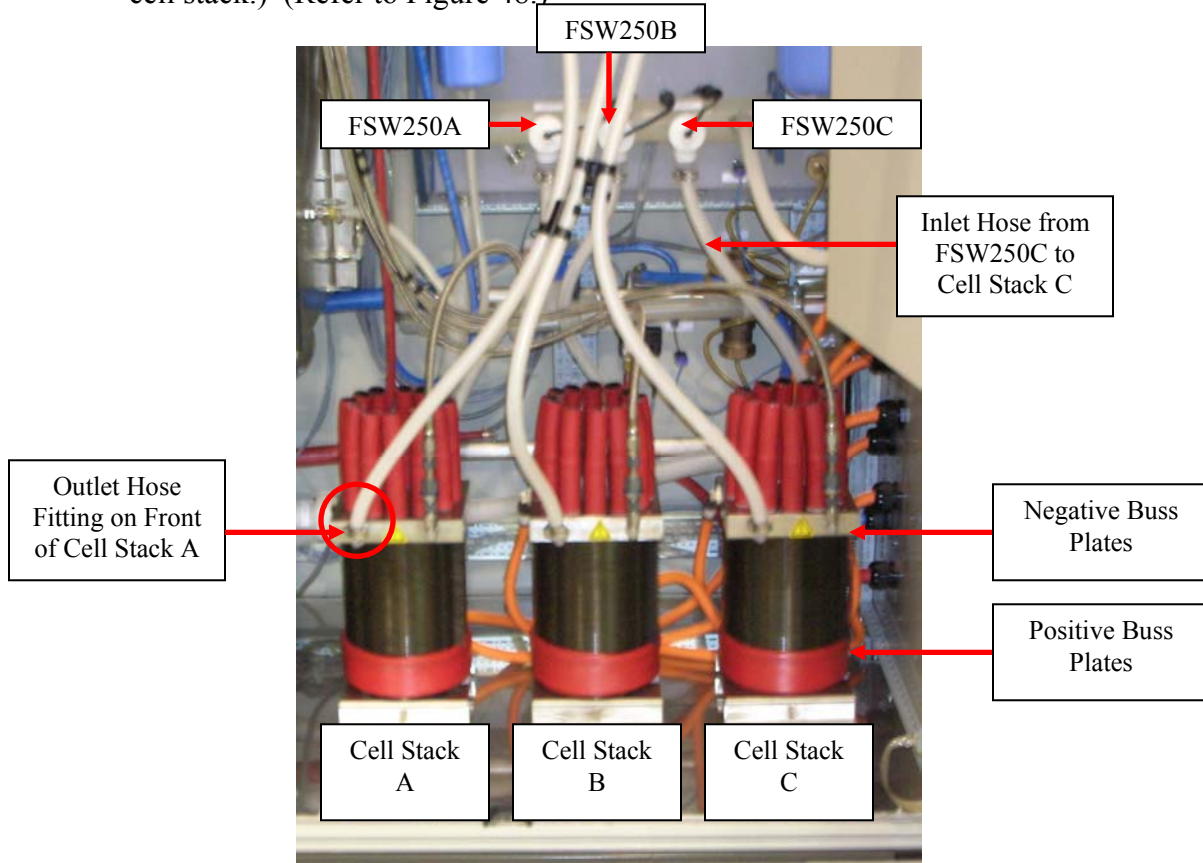


Figure 48 Cell Stack and Connection Locations



There may be some residual water in the inlet and outlet hoses.

26. Disconnect the hydrogen product line from the stack.
27. Disconnect the positive and negative leads.
28. Remove the two (2) bolts that hold the cell stack to the enclosure floor.
29. Slide the stack out of the unit.



The cell stack weighs 57.5 lbs (26.1 kg). Do not attempt to remove it without proper support.

30. Immediately after removal, cap the four (4) connections to the cell stack(s) using the caps and hoses provided with the new stack (Proton Part Number 02-0212-0000, 3/8" 37° Flare Cap).

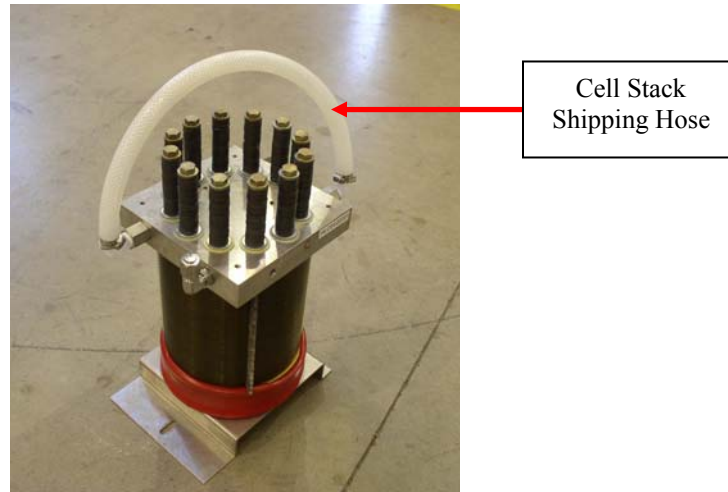


Figure 49 Cell Stack with Caps and Hose



Fill the cell stack shipping hose with DI water immediately after removal to hydrate the cell stack.

31. Slide the new cell stack into position.
32. Reinstall the two (2) bolts that hold the cell stack to the enclosure floor.
33. Connect the inlet hose from FSW250 A, B or C, depending on which cell stack needs to be replaced, to the new cell stack. Tighten the hose clamp with a flat-head screwdriver.
34. Connect the outlet hose to the cell stack. Tighten the hose clamp. (The outlet is located in front of the cell stack.)



Verify the inlet and outlet hoses are connected properly.

35. Reconnect and tighten the positive and negative leads.



Ensure that the positive and negative leads are connected correctly. The positive lead is connected to the bottom buss plate (gold) of the cell stack and the negative lead is connected to the top manifold (stainless steel) of the cell stack. Irreparable damage may occur to the cell stack if the leads are connected in the wrong locations.



Do not over-tighten the fittings.

36. If one or more additional cell stacks need to be replaced, repeat steps 10 through 21.

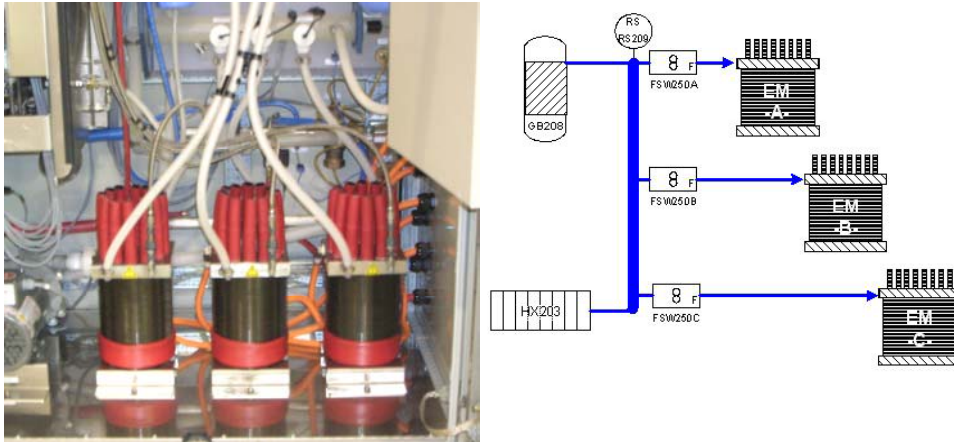


Figure 50 Cell Stacks Connected



Refer to Section 3.15 in the H Series Installation and Operations Manual, PD-0100-0030, for instructions on starting up the system for the first time.

12 SYSTEM PRESSURE ADJUSTMENT

System pressure is to be maintained at the specified range of 207 ± 7 psig.

To adjust the Back Pressure Regulator (BPR310) to the required setting, use the following instructions:



Run the HOGEN hydrogen generator at maximum flow capacity to allow for an accurate setting.

1. Place the generator in service bypass mode. (Refer to Section 3.)
2. Using a $\frac{1}{2}$ " wrench, loosen the locknut on the top of BPR310. Remove the locknut.

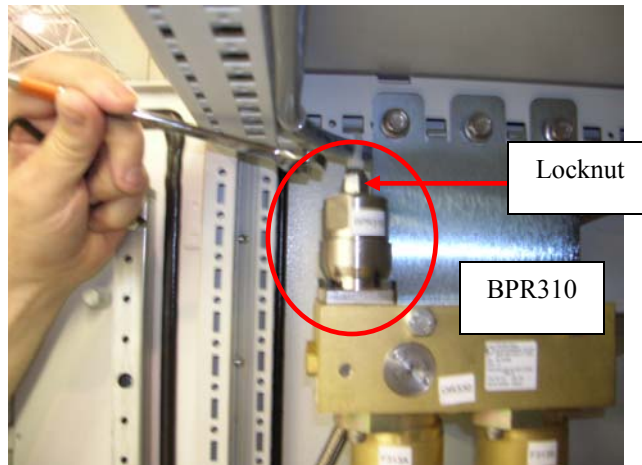


Figure 51 Removing the Locknut on BPR310

3. Position a $\frac{5}{32}$ " hexagonal wrench into the top of BPR310 and turn clockwise to increase system pressure or turn counterclockwise to decrease system pressure.



Figure 52 Adjusting System Pressure

4. Once the system pressure reaches 207 ± 7 psig, remove the 5/32" hexagonal wrench from the top of BPR310.



System pressure can be viewed on the Viewport or on the Remote Diagnostics screen.

5. Finger-tighten the locknut back to the top of BPR310. Gently tighten further with a 1/2" wrench.



The system pressure decreases anytime the dryer or the A300 cycles.

13 A200 LEVEL SENSOR (LS201) REPLACEMENT

Use the following instructions to install the new level sensor (LS201):



POWER IS STILL PRESENT AT THE CIRCUIT BREAKER (ELECTRICAL SCHEMATIC TAG CB101) IN THE GENERATOR UNTIL THE MAIN POWER DISCONNECT IS SWITCHED TO THE OFF POSITION.

1. Shut down the unit.
2. Remove power to the unit by switching the main power disconnect to the OFF position.
3. Perform all necessary lockout/tagout procedures.
4. Open the fluid-side doors and locate the level sensor (LS201), which is found on top of the WOMS tank. (Refer to Figure 53.)

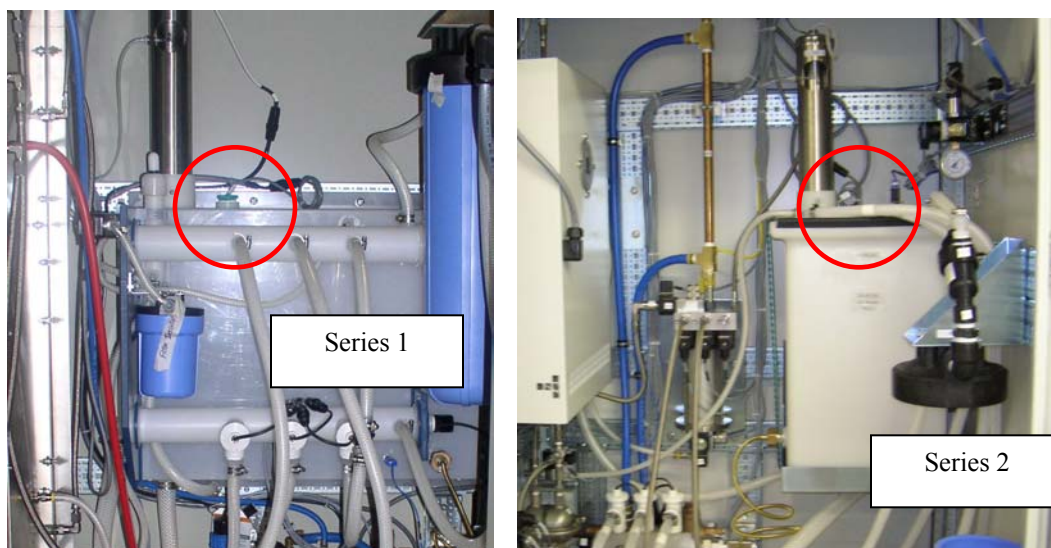


Figure 53 Level Sensor (LS201) Location in the H Series Hydrogen Generators

5. Turning the lock ring counterclockwise, unplug the Conexal plug. (Refer to Figure 54.)

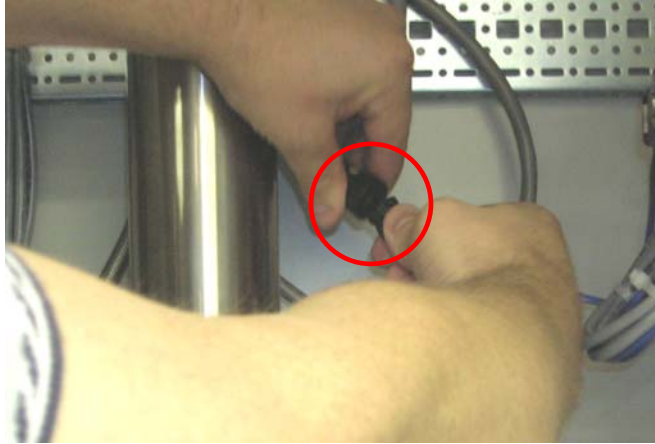


Figure 54 Unplugging the Conexal Plug



The Conexal plug should snap. Once the snap is heard, pull the two pieces apart gently.

6. Using a wrench, loosen the level sensor by turning counterclockwise. Remove and discard the old, plastic level sensor.



Figure 55 Removing the Old Level Sensor (LS201)

7. Remove the packaging from the new, stainless steel level sensor (LS201).
8. Install the new level sensor (LS201) into the top of the WOMS tank, in the same location as the old level sensor (LS201).

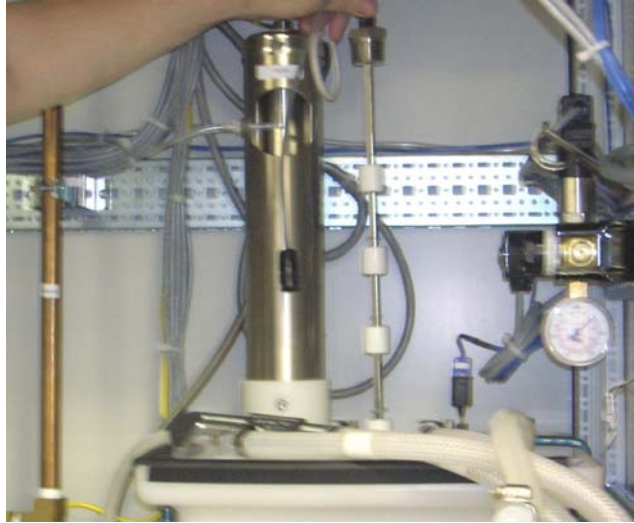


Figure 56 Installing New Level Sensor (LS201)

9. Finger-tighten the new level sensor (LS201) by turning clockwise. Lightly tighten further with a wrench.
10. Line up the notches on the two pieces of the Conexal plug and snap the lock ring together by turning clockwise.

14 TEMPERATURE CONTROL VALVE ADJUSTMENT

Remote monitoring software is required to assist in adjusting the temperature control valve. The remote monitoring software displays the DI water temperature in the circulation loop via Display TE218.

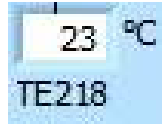


Figure 57 DI Water Temperature Display



For maximum efficiency, PROTON recommends adjusting the temperature control valve to operate within the DI water temperature range of $45^{\circ}\text{C} \pm 5$.



If remote monitoring software is not available, an infrared temperature probe may be used.



It is difficult to keep the system temperature in range ($45^{\circ}\text{C} \pm 5$) if the coolant temperature and pressure fluctuate coming into the unit.



Exceeding the operating temperature of the DI water could result in irreparable damage to the system.



All adjustments should be done with the HOGEN hydrogen generator creating maximum hydrogen to vent with maximum heat load to the heat exchanger.

To adjust the temperature control valve, use the following instructions:

1. Place the generator in Service Bypass Mode.
2. Locate the temperature control valve on the fluids side of the cabinet near the flow switches. (Refer to Figure 58.)



Figure 58 Temperature Control Valve Location

3. Using a very wide (1/2" wide), short, flat-headed screwdriver or an offset screwdriver, turn the valve in a clockwise direction to increase the temperature in the DI water circulation loop or turn the valve in a counterclockwise direction to decrease the temperature in the DI water circulation loop. The target adjust temperature is $45^{\circ}\text{C} \pm 5$.



It takes approximately 30 minutes to see a temperature change/stabilization after making an adjustment. All adjustments affect the circulation temperature in relation to the supplied cooling water.

15 PREPARATION FOR LONG-TERM STORAGE OR DECOMMISSIONING

15.1 Long-Term Storage with Generator Installed and Hooked Up to Facilities

Use the following instructions if the H Series hydrogen generator is to be non-operational for several weeks or longer:



Cell stacks cannot be allowed to be dry. They must always be fully hydrated.



1. Check the DI water level in the A200 on a weekly basis.
2. If the DI water level appears to be less than 6" high (15 cm), the A200 must be filled either manually or automatically using the controls option.

Verify that the DI water supply is turned on.



Ensure that the hydrogen vent line is intact.

- a. Manual Fill
 - i. Shut down the generator.
 - ii. Remove power to the unit.
 - iii. Remove the SS CG220 Oxygen Vent Tube Assembly.
 1. Remove retainer screw at the base of the SS tube (refer to Figure 59).
 2. Lift off entire tube assembly.
 - iv. Manually fill the A200 with DI water to the height of 6" (25 cm) from the top of the tank.
 - v. Replace the SS CG220 Oxygen Vent Tube Assembly. Replace the retainer screw.



Retainer
Screw

Figure 59 CG220 Oxygen Vent Tube

- b. Automatic Fill with Controls Option
 - i. Power on the generator.
 - ii. Press the green START “I” button.
Press the red STOP “O” button when the unit displays
“GENERATE/VENT.”



If out of calibration, the automatic fill is not available. In the event the generator is out of calibration, use the manual fill.



Check for DI water content in the hoses every thirty days. If DI water is not present in the hoses, re-hydrate the hoses as needed. A hydration kit is available through PROTON (PROTON part number KT-1000-0022).

15.2 Decommissioning of the Generator

To decommission the HOGEN H Series hydrogen generator, use the following instructions:

1. Drain the DI water system manually or use the automatic drain option on the controls. (Refer to Section 2.1 in the Maintenance Manual PD-0200-0004).
2. Once the system is drained, disconnect the hoses from FSW250 A, B and C using a screwdriver. (Refer to Figure 60.)
3. Remove the cell stack outlet hoses from the cell stack(s). (The outlet is located in front of the cell stack.)
4. Take the hoses that were connected to FSW250 A, B and C and fill them with DI water.
5. Connect the end of the FSW250 A, B, and C hoses to the cell stack outlets. The hoses are now connected to the inlets and outlets of the cell stacks.
6. Check hoses monthly for water level and refill as necessary.
 - a. Alternatively, use the 34-Cell Stack Hydration Kit, KT-1000-0022. Keep the hydration kit topped off.
 - b. If the stack is removed from unit, the hydrogen outlet connection must be capped (PROTON Part number 02-0212-0000 for 3/8" 37° Flare Cap).



Figure 60 Hose Connected to the Inlet and Outlet of Cell Stack



The cell stack(s) cannot be allowed to freeze. If the stored unit has the potential to freeze, then the cell stack(s) must be removed to an indoor protected location.



Check for DI water content in the hoses every thirty days. If DI water is not present in the hoses, re-hydrate the hoses as needed. A hydration kit is available through PROTON (PROTON part number KT-1000-0022).

15.3 Cell Stack Hydration

If the HOGEN hydrogen generator is not going to be placed in service upon receipt or is going to be decommissioned for a prolonged period of time, the cell stack must be properly hydrated during non-operation. Ensure that proper electrical power is applied to the system and that DI water, meeting the specifications required, is connected to the water inlet. Use the following procedure if power and DI water are available to keep the cell stack hydrated:

1. Apply power to the generator, by turning the breaker to the “ON” position.
2. Wait for the “Ready to Start” message on the display.
3. Press the “START” button.
4. After 30 seconds, press the red “STOP” button. DO NOT use the “EMERGENCY STOP” button to shut the system down.



If you do not want to generate hydrogen, it is important to press the red “STOP” button within 30 seconds before the system goes into generate state.

5. The system will circulate water through the cell stack for 60 seconds after the “STOP” has been pressed.

Repeat this procedure at intervals of thirty days or less while the system is idle.



Check for DI water content in the hoses every thirty days. If DI water is not present in the hoses, re-hydrate the hoses as needed. A hydration kit is available through PROTON (PROTON part number KT-1000-0022).

16 APPENDIX A: REMOTE ACCESS

16.1 Remote Monitoring Software Installation

To install the remote monitoring software, use the following instructions:

1. Load the software CD onto your computer.
2. Open the ZIP folder and double click on the “setup.exe” file.
3. Run the Installation Wizard. (Refer to Figure 61.)

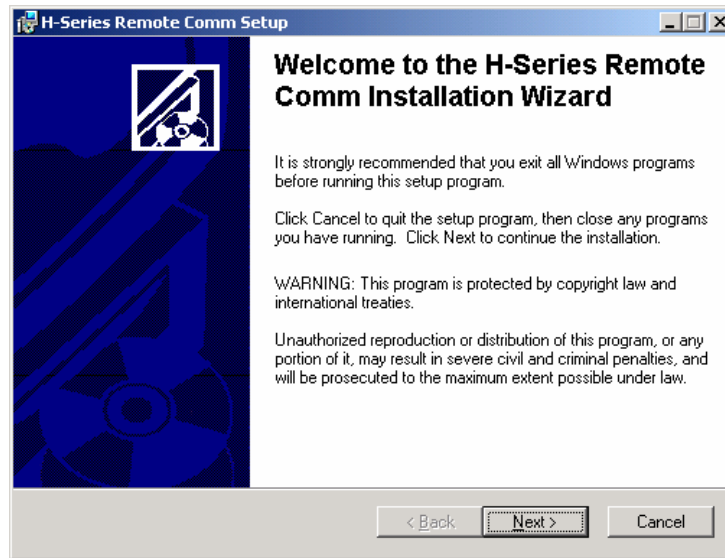


Figure 61 First Screen in Installation Wizard

4. Click “Next>” to continue to the next screen.
5. Select a folder where the software application will be installed. (Refer to Figure 62.) Click “Next>” to continue to the next screen.



If you do not choose a folder through the “Browse” button, the software will be installed in the default folder, which in this case is “C:\Program Files\H-Series Remote Comm\.”

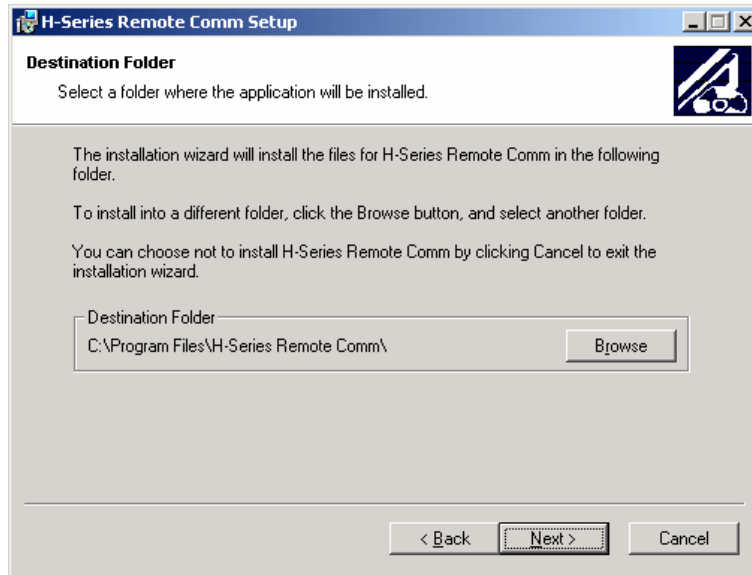


Figure 62 Second Screen in Installation Wizard

6. Install the software. (Refer to Figure 63.)



If you need to change the destination of where you plan to save installation, click “<Back.”

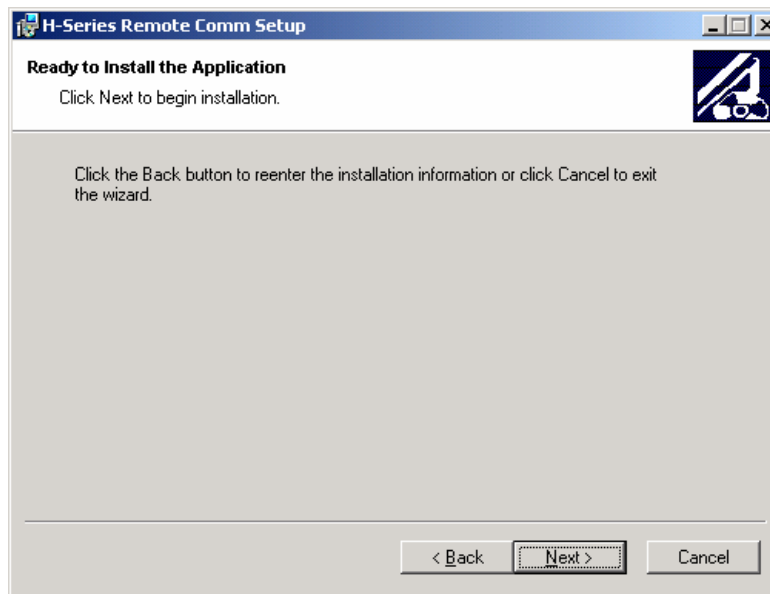


Figure 63 Installation of Software Screen

7. The next screen shows the system processing the installation request. (Refer to Figure 64.)

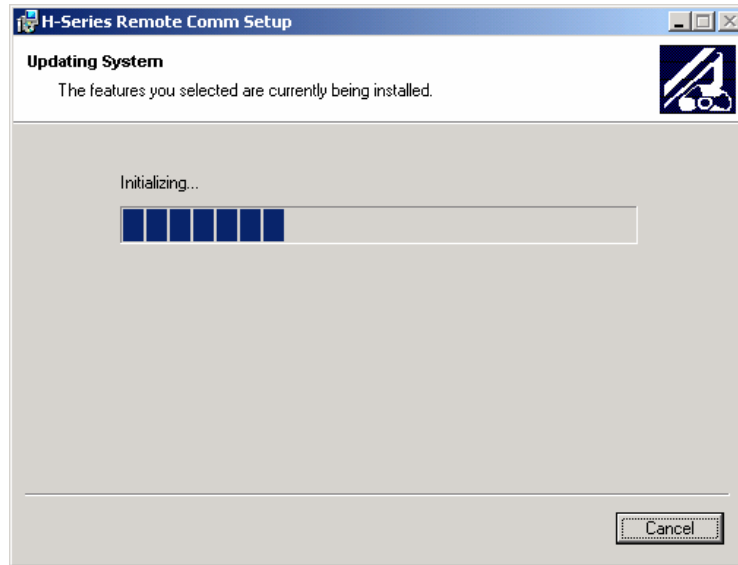


Figure 64 Installation Initializing Screen

8. Click "Finish" when the installation is completed. (Refer to Figure 65.)

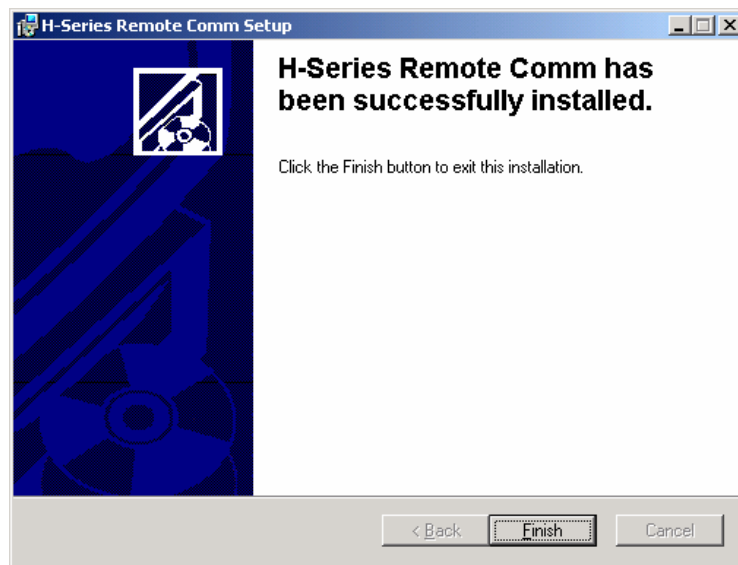


Figure 65 Installation Completed Screen

16.1.1 Network Specifications

Specifications	
Network Interface	10BaseT and 100BaseTX Ethernet
Compatibility	IEEE802.3
Communication Rates	10 Mbps, 100 Mbps, Auto-Negotiated
Maximum Cabling Distance	100 m/Segment
Maximum Power to Connected I/O Modules	9 W
Maximum Number of Banks	Determined by Network Topology

Table 6 Network Specifications

16.1.2 Cabling

Pin	Connector 1	Connector 2 (Normal)	Connector 2 (Crossover)
1	White/Orange	White/Orange	White/Green
2	Orange	Orange	Green
3	White/Green	White/Green	White/Orange
4	Blue	Blue	Blue
5	White/Blue	White/Blue	White/Blue
6	Green	Green	Orange
7	White/Brown	White/Brown	White/Brown
8	Brown	Brown	Brown

Table 7 Standard Ethernet Cable Wiring Connections for Normal and Crossover Cables

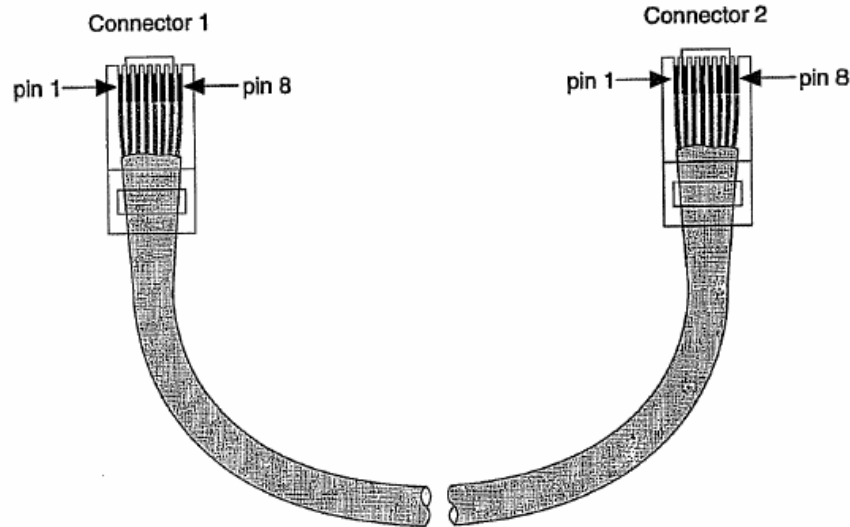


Figure 66 Ethernet Cable Pinout

16.2 LAN (Local Area Network) Installation

16.2.1 PC Parameters

To change the IP address for the H-Series Remote Monitoring Software (once the unit is installed per PROTON requirements for facility power), use the following instructions:

1. Plug the crossover cable in the Central Processing Unit (CPU).

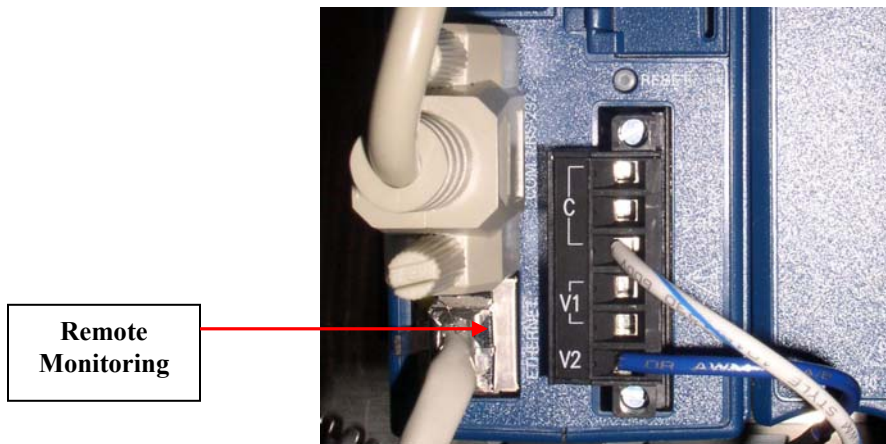


Figure 67 Remote Monitoring Wiring

2. Hookup the crossover cable to the PC using the Ethernet port.



NOTE

Ensure that the H Series Remote Monitoring Software is loaded onto the PC before configuring the unit to operate on the Local Area Network (LAN).

3. Open up Windows Explorer and type [FTP://169.254.123.2](ftp://169.254.123.2) in the browser.



NOTE

Windows Explorer must be in the “Folders” view.

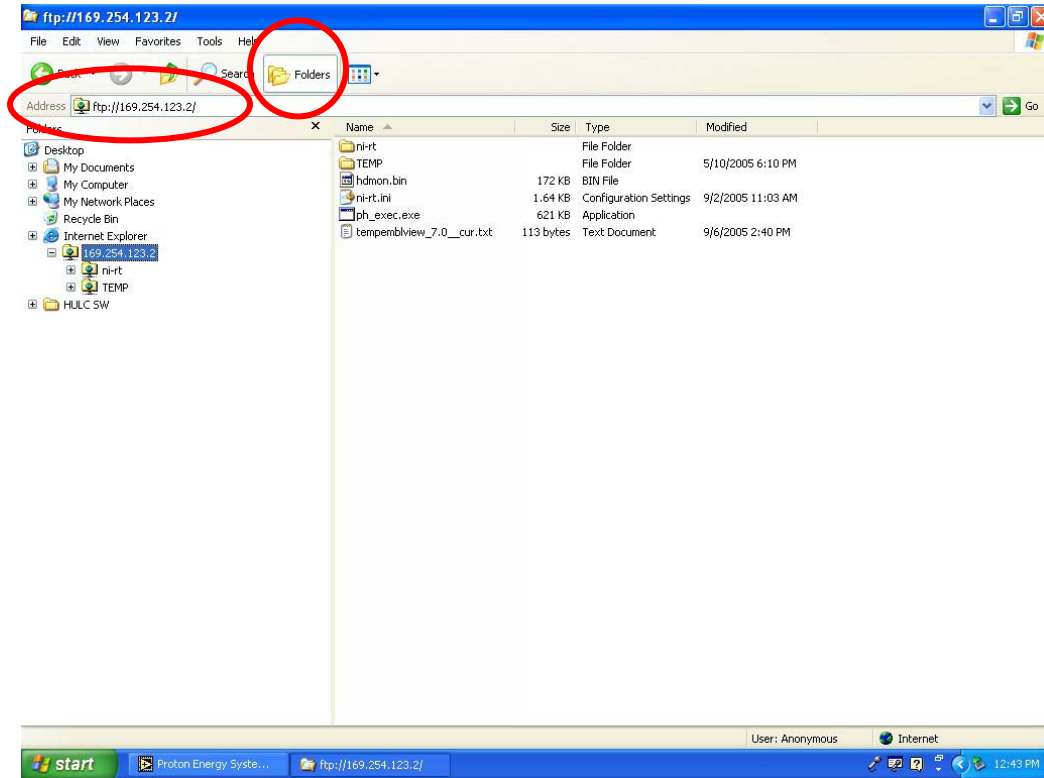


Figure 68 [FTP://169.254.123.2](ftp://169.254.123.2/) In Browser

4. Right click on “NI-RT.INI” and copy the file and paste it on the hard drive.
5. Once the paste is complete, double click on “NI-RT.INI” to open the file on the local hard drive.
6. Located near the bottom of the page in the file, look for the paragraph beginning with “[TCP_Stack_Config].”



- Page 70 of 90

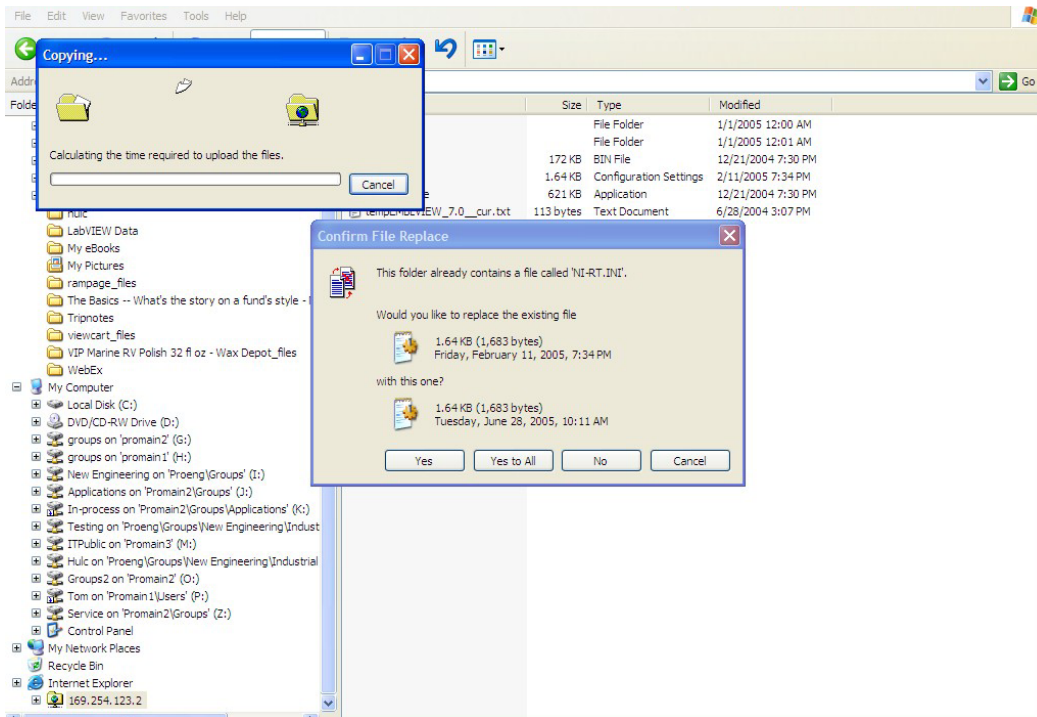


Figure 70 Overwriting the Existing “NI-RT.INI” File

12. Remove the crossover cable and connect the unit to the LAN with a network cable via a hub or other network server device.

16.2.2 LAN Configuration Instructions

To configure the Remote Monitoring Software for the LAN, use the following instructions:

1. Locate the folder labeled “H Series Remote Comm” on the local drive.

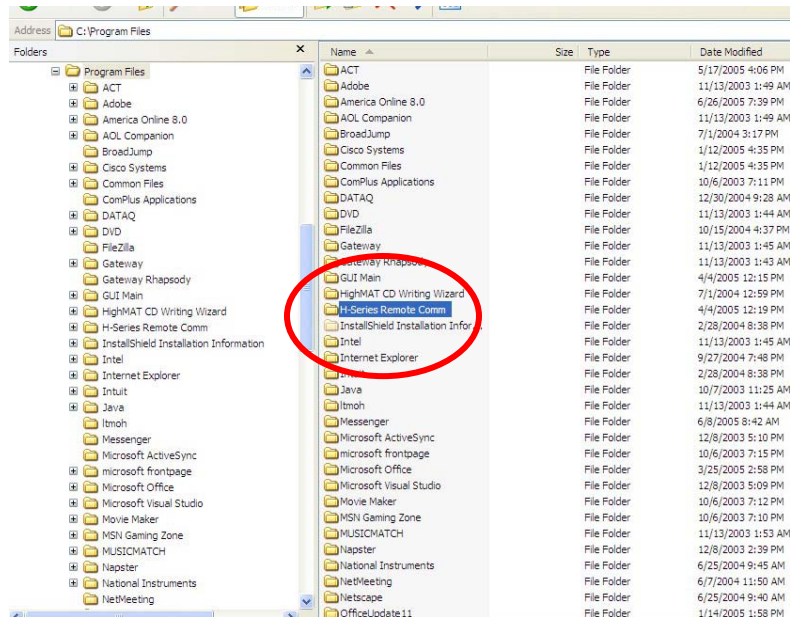


Figure 71 H Series Remote Comm Folder Location

- Open the “H Series Remote Comm” folder and locate the folder labeled “Support Files.”

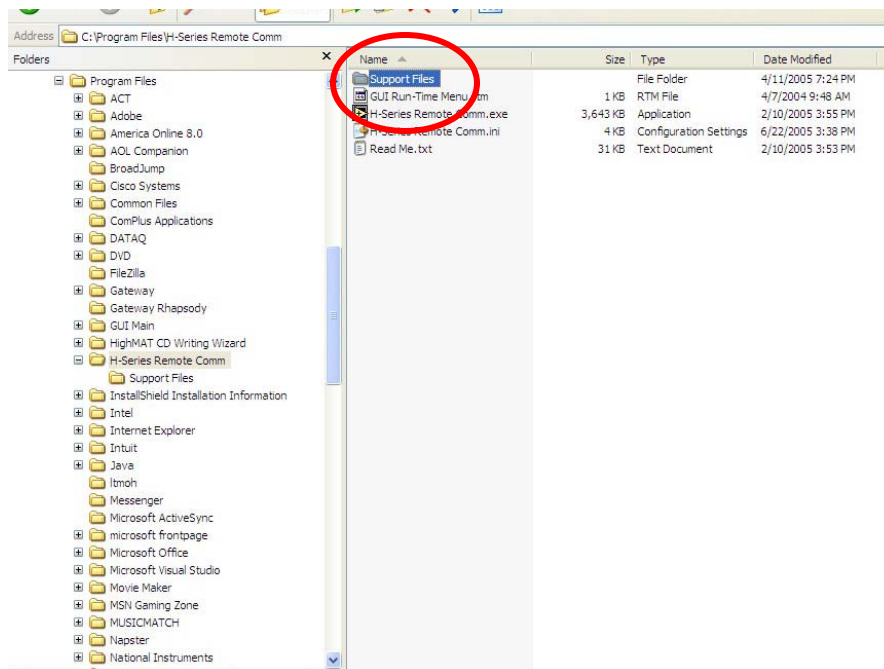


Figure 72 Support Files Folder Location

- Open the “Support Files” folder and double-click on “IP Addresses.ini” to open the file.

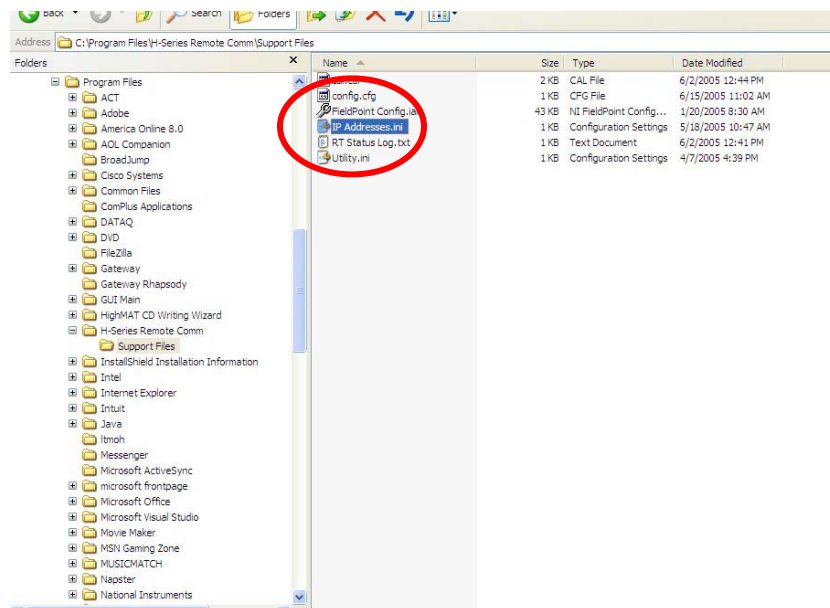


Figure 73 IP Addresses.ini Location

4. Add the new IP address and delete the old IP addresses.

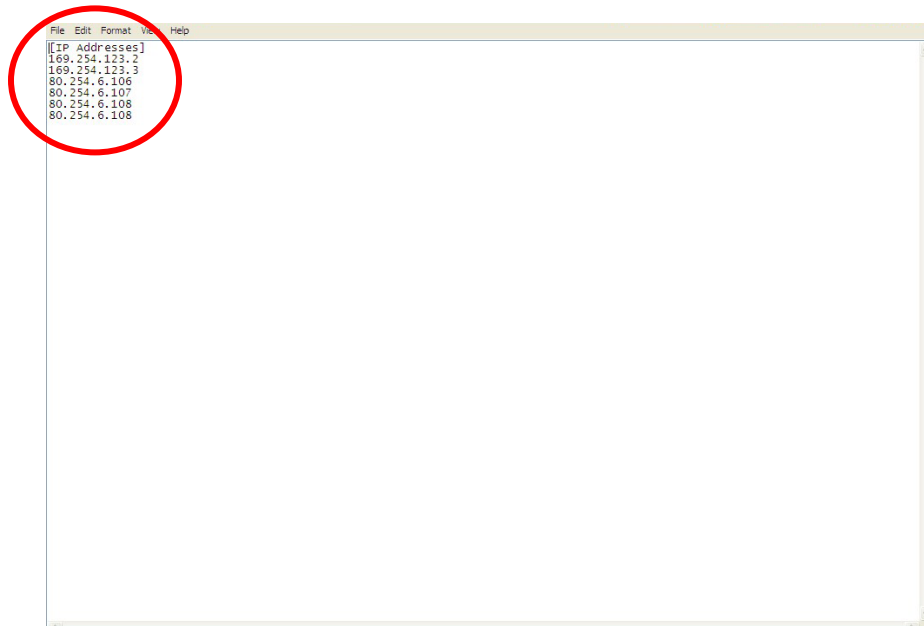


Figure 74 IP Address Location

5. Go to "File" at the top of the page and scroll down to find "Save." Click on "Save" to save the changes.

16.3 Electrical Connections for LAN Installation

Refer to Section 3.8 in the Maintenance Manual (PD-0200-0004) for the electrical connections.

16.4 Remote Monitoring Setup

Remote monitoring software (KT-1000-0012) allows the HOGEN H Series hydrogen generator to connect to a Local Area Network (LAN) via Ethernet for remote monitoring and diagnostics. Remote monitoring software also includes a data logging feature for trending and troubleshooting.

16.4.1 Remote Software Monitoring Feature

Monitoring can be done using the P&ID screen (Figure 75) of the remote monitoring software or the main screen, which is seen in Figure 77. This screen has the same information as the P&ID Screen, but it is just in a different format.

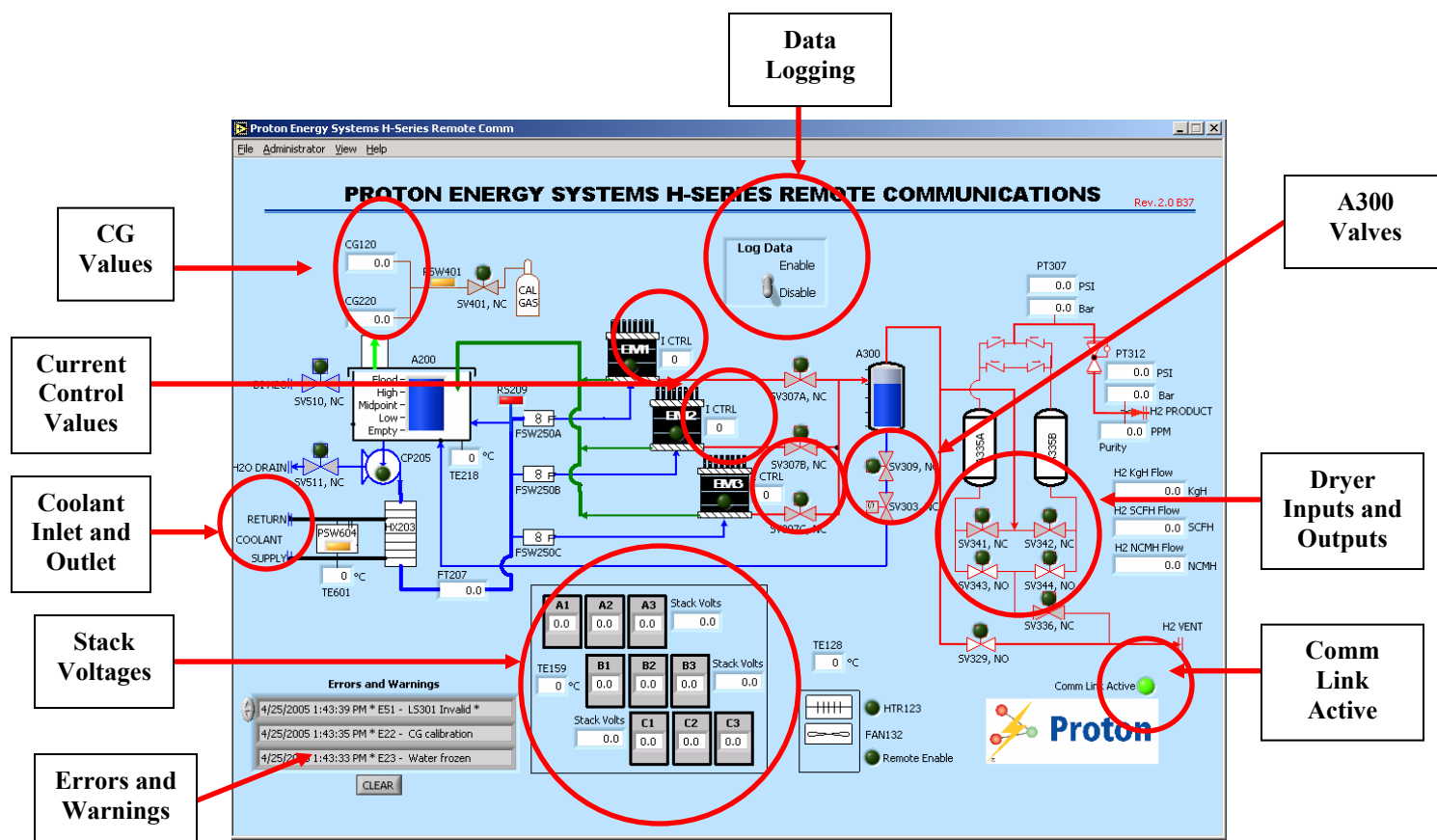


Figure 75 Remote Monitoring Software P&ID Screen

16.5 How to Navigate Through the Screens

Use the following instructions to navigate through the screens of the remote monitoring software:

1. Click on “View,” which is located on the top toolbar.
2. On the pull down menu, select the screen. (Refer to Figure 76.)

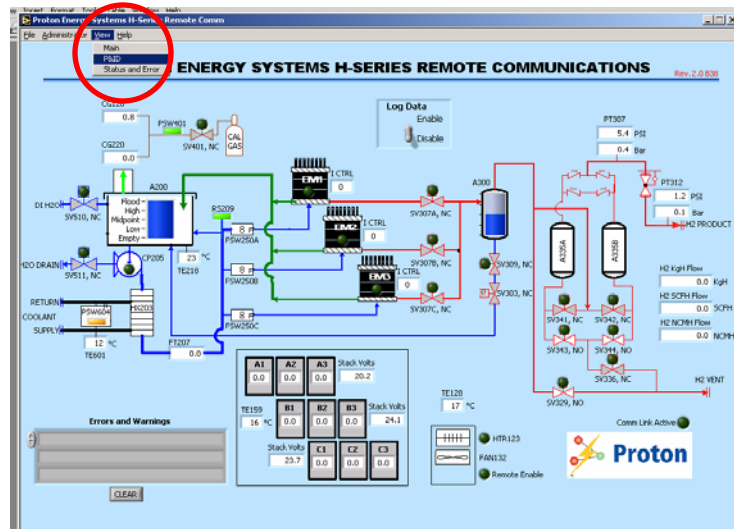


Figure 76 Navigating Through the Screens



If the valves are energized, then the node is turned green, like the Comm Link Active node in Figure 75 and Figure 77.

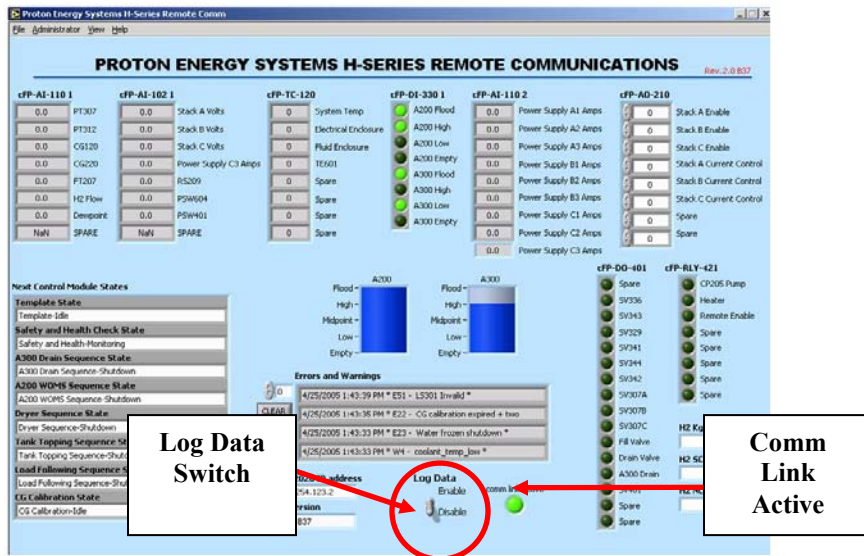


Figure 77 Remote Monitoring System Main Screen

16.5.1 Data Logging Feature

To use the data logging feature, refer to the following instructions:

1. Double click on your desktop icon for the latest software to bring up the remote monitoring software main screen. (Refer to Figure 77.)
2. Initiate data logging by clicking on the “Log Data” switch located on the main screen. (Refer to Figure 77 and Figure 78.) The “Enable” and “Disable” switch enables the system to take data or disables the system so it does not log information.



The default data rate (the fastest sampling rate) is once a minute (every 60 seconds). The data logging rate can be modified on the configuration screen, which is a password protected area. If there is a need to change the data logging rate, please contact PROTON or your local service provider for access.



Figure 78 Enable/Disable Switch for Data Logging Feature

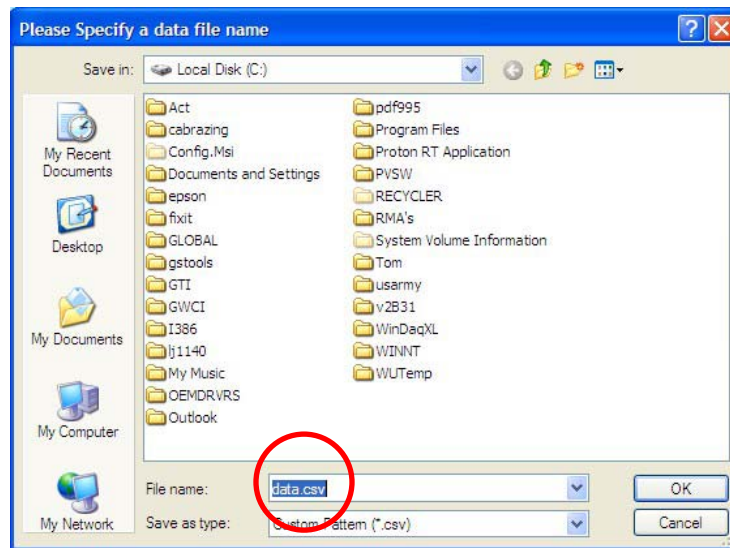


Figure 79 .CSV File Example

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Date/Time	PT207 (PS)	PT212 (PS)	CG120 (%)	CG220 (%)	FT207 (L/HQ)	Flow (A-H)	110 (1 C)	Stack A (V)	Stack B (V)	Stack C (V)	Power (W)	RS209	PSV104 (PS)	
2	9/17/2004 15:11	225.2	225.6	2.5	-0.7	51.4	NaH ₂	NaH ₂	57.8	57.6	57.8	6.2	20	0	
3	9/17/2004 15:12	225.4	225.9	2.4	-0.8	50.4	NaH ₂	NaH ₂	56.8	56.7	56.9	4.6	20	0	
4	9/17/2004 15:13	231.4	231.5	2.5	-1.7	52.3	NaH ₂	NaH ₂	57	56.9	57.1	5	20	0	
5	9/17/2004 15:14	224.6	224.9	2.4	-0.8	51	NaH ₂	NaH ₂	59.5	59.4	59.5	9.7	20	0	
6	9/17/2004 15:15	225.6	225.8	2.4	-0.9	51.5	NaH ₂	NaH ₂	57.9	57.8	57.9	6.6	20	0	
7	9/17/2004 15:16	224.9	225.4	2.4	-0.5	50.6	NaH ₂	NaH ₂	57.3	57.2	57.3	5.5	20	0	
8	9/17/2004 15:17	225.4	225.6	2.4	-0.8	50	NaH ₂	NaH ₂	58.9	58.8	58.9	8.5	20	0	
9	9/17/2004 15:18	225.4	226	2.4	-0.8	50.9	NaH ₂	NaH ₂	57	56.8	57	5	20	0	
10	9/17/2004 15:19	225.1	225.5	2.4	-0.8	52	NaH ₂	NaH ₂	58.2	58.1	58.3	7.3	20	0	
11	9/17/2004 15:20	224.7	225.5	2.4	-0.7	51.8	NaH ₂	NaH ₂	57.4	57.3	57.4	5.6	20	0.1	
12	9/17/2004 15:21	224.5	224.8	2.4	-0.8	49.9	NaH ₂	NaH ₂	58.7	58.5	58.7	8	20	0	
13	9/17/2004 15:22	225.9	225.8	2.4	-0.9	50	NaH ₂	NaH ₂	58.9	58.8	59	8.6	20	0	
14	9/17/2004 15:23	225.7	225.8	2.4	-1.6	53.2	NaH ₂	NaH ₂	55	54.9	55.1	1.9	20	0.1	
15	9/17/2004 15:24	224.8	225	2.5	-0.7	51.7	NaH ₂	NaH ₂	58.6	58.5	58.7	7.9	20	0	
16	9/17/2004 15:25	224.5	225.3	2.4	-0.9	50.8	NaH ₂	NaH ₂	58	57.9	58	6.8	20	0	
17	9/17/2004 15:26	225.4	225.5	2.4	-1	51.2	NaH ₂	NaH ₂	58	57.9	58.1	6.9	20	0.1	
18	9/17/2004 15:27	224.6	225.1	2.5	-0.7	50.7	NaH ₂	NaH ₂	58.6	58.5	58.7	7.9	20	0	
19	9/17/2004 15:28	224.7	224.9	2.4	-0.4	50.9	NaH ₂	NaH ₂	58.6	58.5	58.7	7.9	20	0.1	
20	9/17/2004 15:29	225.3	225.3	2.4	-0.9	50.3	NaH ₂	NaH ₂	57	56.8	57	4.7	20	0	
21	9/17/2004 15:30	224.4	225	2.4	-0.8	50.5	NaH ₂	NaH ₂	59.3	59.2	59.3	9.3	20	0	
22	9/17/2004 15:31	225.8	226.5	2.5	-0.5	51.2	NaH ₂	NaH ₂	58	57.9	58	6.7	20	0	
23	9/17/2004 15:32	224.4	224.7	2.5	-0.4	50.4	NaH ₂	NaH ₂	59.2	59	59.2	9	20	0	
24	9/17/2004 15:33	230.7	231.3	2.5	-0.8	52.2	NaH ₂	NaH ₂	55	54.9	55.1	2	20	0	
25	9/17/2004 15:34	225	225.6	2.4	-1	50.8	NaH ₂	NaH ₂	58.3	58.2	58.3	7.4	20	0.1	
26	9/17/2004 15:35	225	225.5	2.4	-0.8	50.8	NaH ₂	NaH ₂	58	57.9	58	6.6	20	0	
27	9/17/2004 15:36	224.9	225.4	2.5	-0.5	50.5	NaH ₂	NaH ₂	59	58.9	59	8.6	20	0	
28	9/17/2004 15:37	225.4	225.7	2.4	-0.6	50.9	NaH ₂	NaH ₂	57.6	57.5	57.7	6	20	0	
29	9/17/2004 15:38	223.9	224.9	2.4	-0.9	50.2	NaH ₂	NaH ₂	59.8	59.7	59.8	10.4	20	0	
30	9/17/2004 15:39	224.6	224.9	2.4	-0.9	50.4	NaH ₂	NaH ₂	59.4	59.3	59.4	9.5	20	0	
31	9/17/2004 15:40	225.3	225.4	2.5	-0.8	50.8	NaH ₂	NaH ₂	58.7	58.6	58.8	8	20	0.1	
32	9/17/2004 15:41	224.1	224.3	2.4	-0.6	50.5	NaH ₂	NaH ₂	59.5	59.4	59.6	9.8	20	0	
33	9/17/2004 15:42	225	225.4	2.4	-0.7	50.5	NaH ₂	NaH ₂	58.7	58.6	58.8	8.1	20	0	

Figure 80 Data Log Example in Excel

3. Move the lever to “Enable.” The system prompts the naming of the file and a location to save the file. Name file and click OK. (Refer to Figure 79.)
4. The system begins to log information.
5. The data file can be open and viewed using Microsoft Excel. (Refer to Figure 80.)

16.5.2 Loading Calibration Files



Users should only load calibration files when instructed by PROTON service personnel for the sole purposes of troubleshooting, service and repair.

To load calibration files, use the following instructions:

1. Double click on your desktop icon for the latest software to bring up the remote monitoring software main screen.
2. Click on “Administrator” and scroll down to choose “Calibrate.”

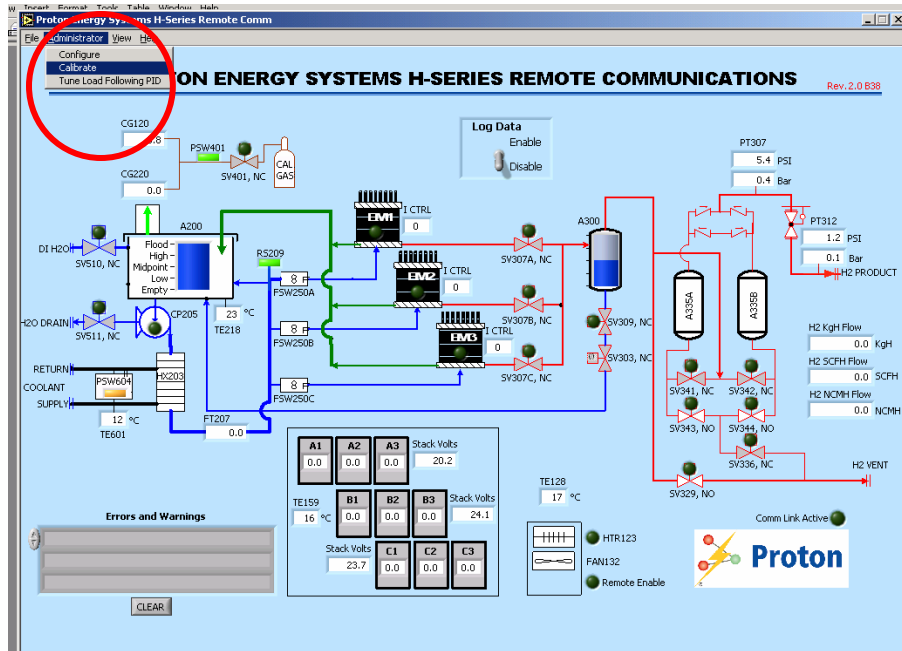


Figure 81 How to find the Calibrate Option

3. Enter the given password and click “Accept.”



PROTON service personnel provide the password at the time they provide troubleshooting, service and repair assistance.

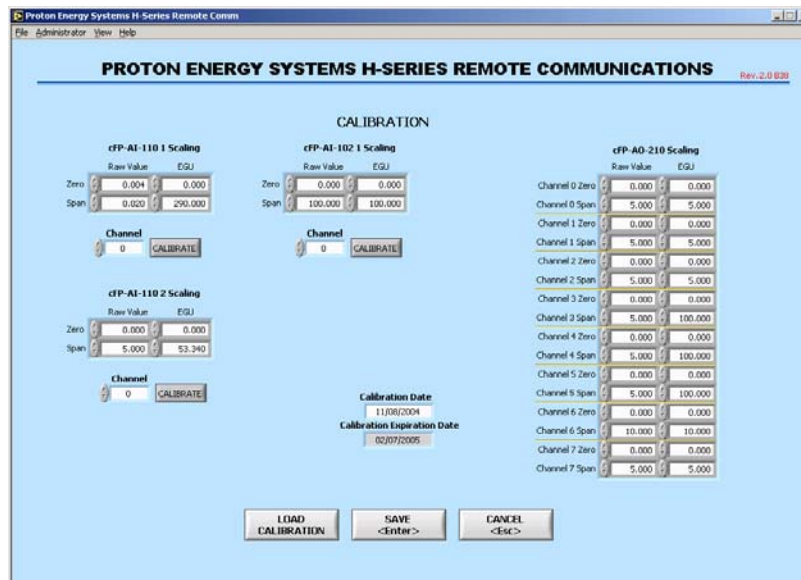


Figure 82 Calibrate Screen

4. Click on “Load Calibration.”



5. Find the folder with the new calibration files and click OK.

The folder with the new calibration files will most likely be a 57-9900-XXXX number.

6. Once the new calibration files are loaded into the system, click Save. Rename the file (include date) and save it to a desired location. Click OK.



The CG sensor information is overwritten once new calibration files are loaded into the system. PROTON recommends performing a calibration of the CG sensors after loading calibration files. (Refer to Section 4.3 in the H Series Maintenance Manual, PD-0200-0004, for calibration instructions.)

16.5.3 Loading Configuration Files

Users should only load configuration files when instructed by PROTON service personnel for the sole purposes of troubleshooting, service and repair.

To load configuration files, use the following instructions:

1. Double click on your desktop icon for the latest software to bring up the remote monitoring software main screen.
2. Click on “Administrator” and scroll down to choose “Configure.”

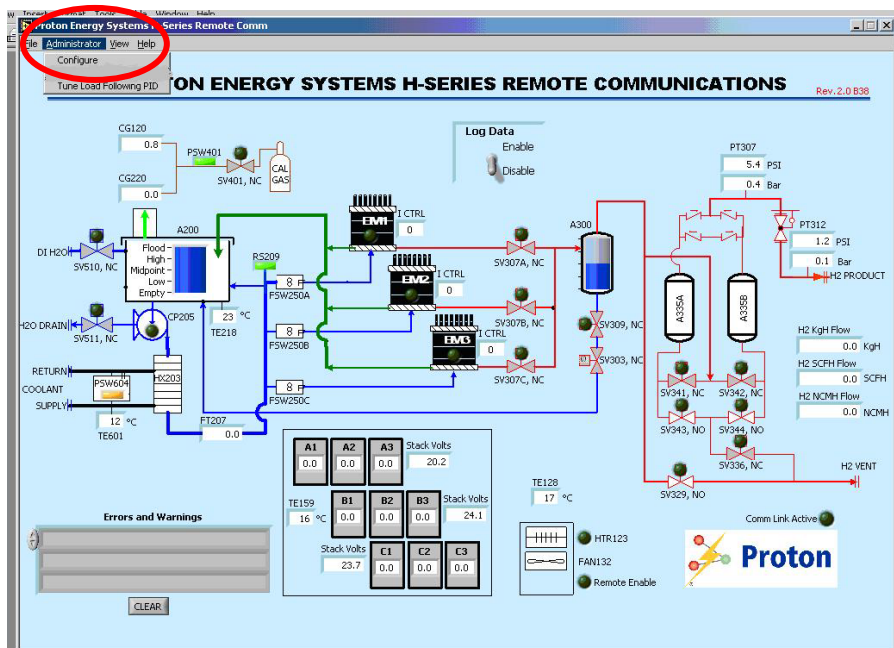


Figure 83 How to Find the Configure Option

3. Enter the given password and click “Accept.”



PROTON service personnel provide the password at the time they provide troubleshooting, service and repair assistance.



4. Click on “Load Configuration.”
5. Find the folder with the new configuration files and click OK.

The folder with the new configuration files will most likely be a 57-9900-XXXX number.

6. Once the new configuration files are loaded into the system, click Save.
Rename the file (include date) and save it to a desired location. Click OK.

16.6 Remote Monitoring Upgrade Instructions

To install the remote monitoring software upgrade, use the following instructions:

1. Load the upgraded software CD onto your computer.
2. Open the ZIP folder and double click on the “setup.exe” file.
3. Run the Uninstall Wizard. (Refer to Figure 84.)



If you are upgrading from one software version to another, the Uninstall Wizard uninstalls the old software before you can install the new software.

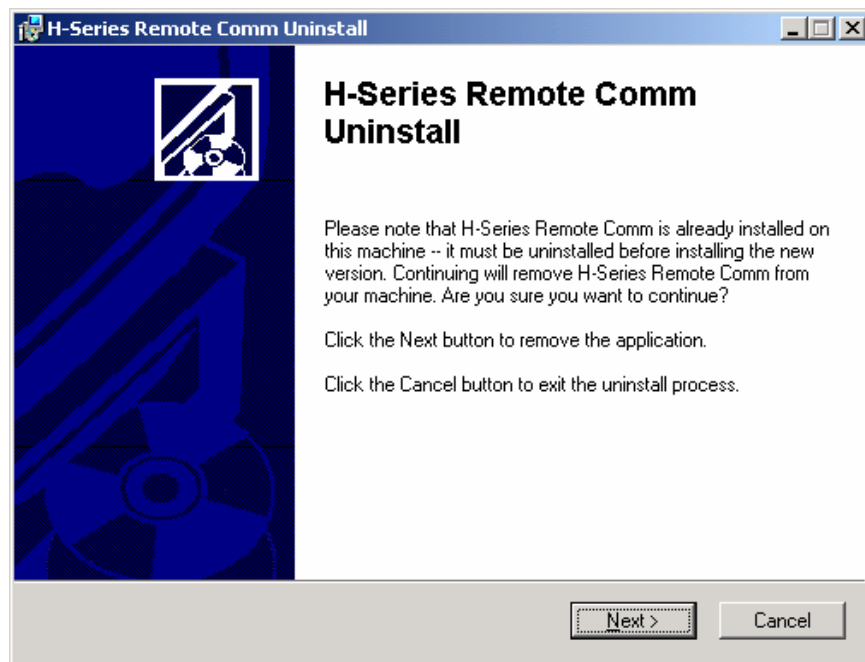


Figure 84 Uninstall Wizard

4. Click “Next>” to continue to the next screen.
5. The old software version is removed from your computer. (Refer to Figure 85.)

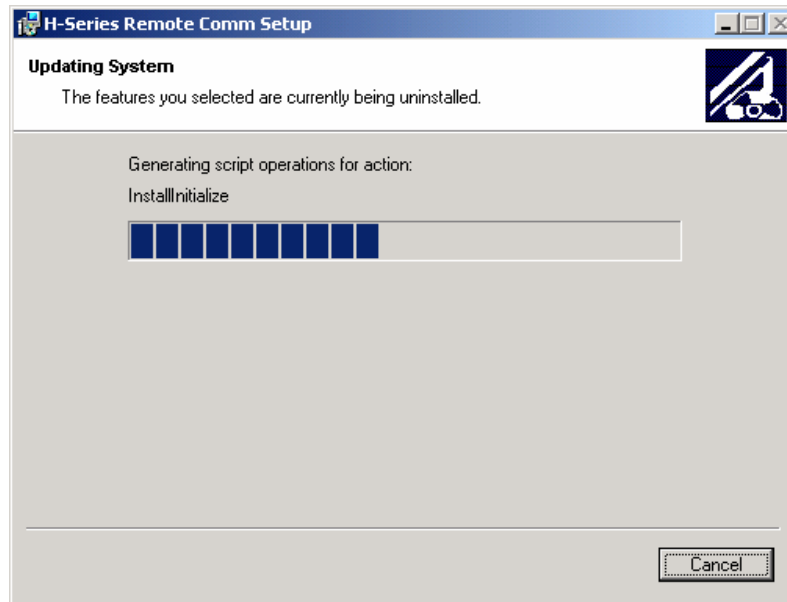


Figure 85 System Uninstalling Software

6. Click “Finish” to complete the uninstall process.

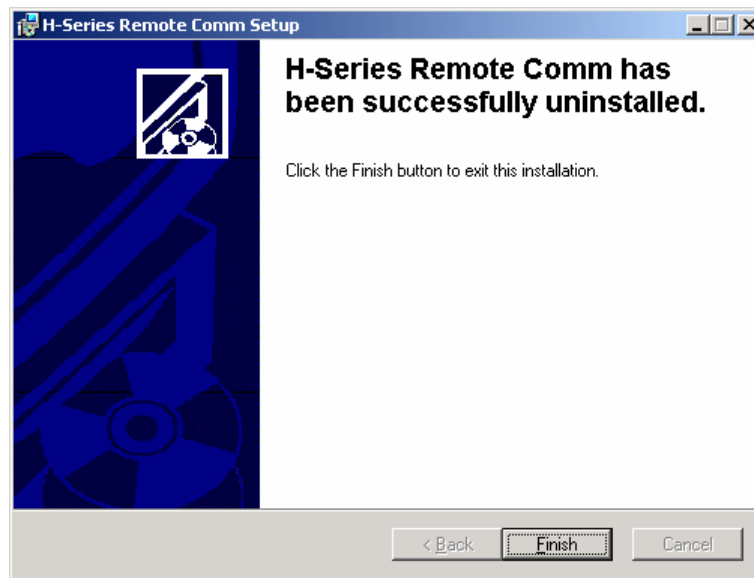


Figure 86 Uninstall Process Completed

7. Open the ZIP folder and double click on the “startup.exe” file.
8. Run the Installation Wizard. (Refer to Figure 61.)
9. Follow the steps 4 through 8 in Section 16.1.

17 APPENDIX B: OVERALL SYSTEM BREAKDOWN

17.1 Water and Oxygen Management Subsystem (WOMS)

The Water and Oxygen Management Subsystem (WOMS) (see Figure 87) separates a two-phase mixture of oxygen gas and water from the electrolysis cell stacks. The oxygen may normally contain up to 0.5 percent hydrogen by volume. A combustible gas sensor (P&ID Tag CG220) monitors percent LEL of hydrogen in oxygen. In the event of a failure, the system shuts down if 50 percent LEL is detected. The WOMS subsystem:

- Minimizes Evaporation
- Allows Draining of Water
- Maintains and Monitors Water Quality
- Manages Water Inventory
- Prevents/Accommodates Hazard from Cell Stack Failure
- Accepts Two-Phase Water and Hydrogen Stream from the Hydrogen Management System (HGMS)
- Delivers Cooled and Filtered Water Streams to the Three Cell Stacks
- Rejects Heat via a Process Water Interface
- Vents Oxygen

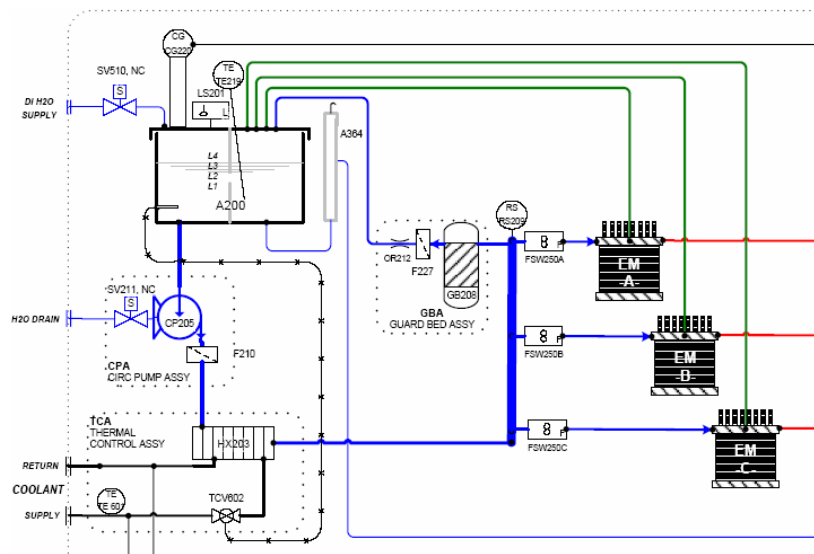


Figure 87 Water and Oxygen Management Subsystem (WOMS) P&ID



Figure 88 Water Oxygen Management Subsystem (WOMS)

17.2 Hydrogen Gas Management Subsystem (HGMS)

The Hydrogen Gas Management Subsystem (HGMS) (see Figure 89) separates product hydrogen from water and delivers high purity dry hydrogen product at pressure. The HGMS subsystem:

- Accepts a Two-Phase Pressurized Hydrogen/Water Stream
- Delivers a Single-Phase Hydrogen Gas Stream of at Least 99.999 Percent Purity
- Delivers a Liquid Water Stream (Which typically includes Dissolved Hydrogen Gas) to the WOMS

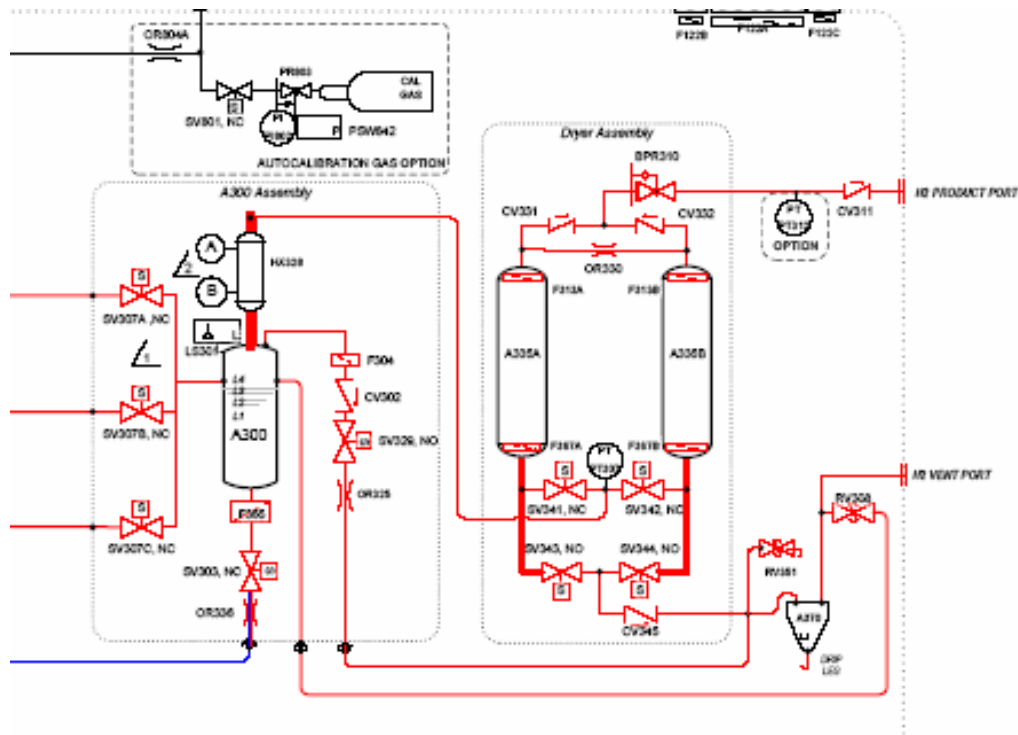


Figure 89 Hydrogen Gas Management Subsystem (HGMS)

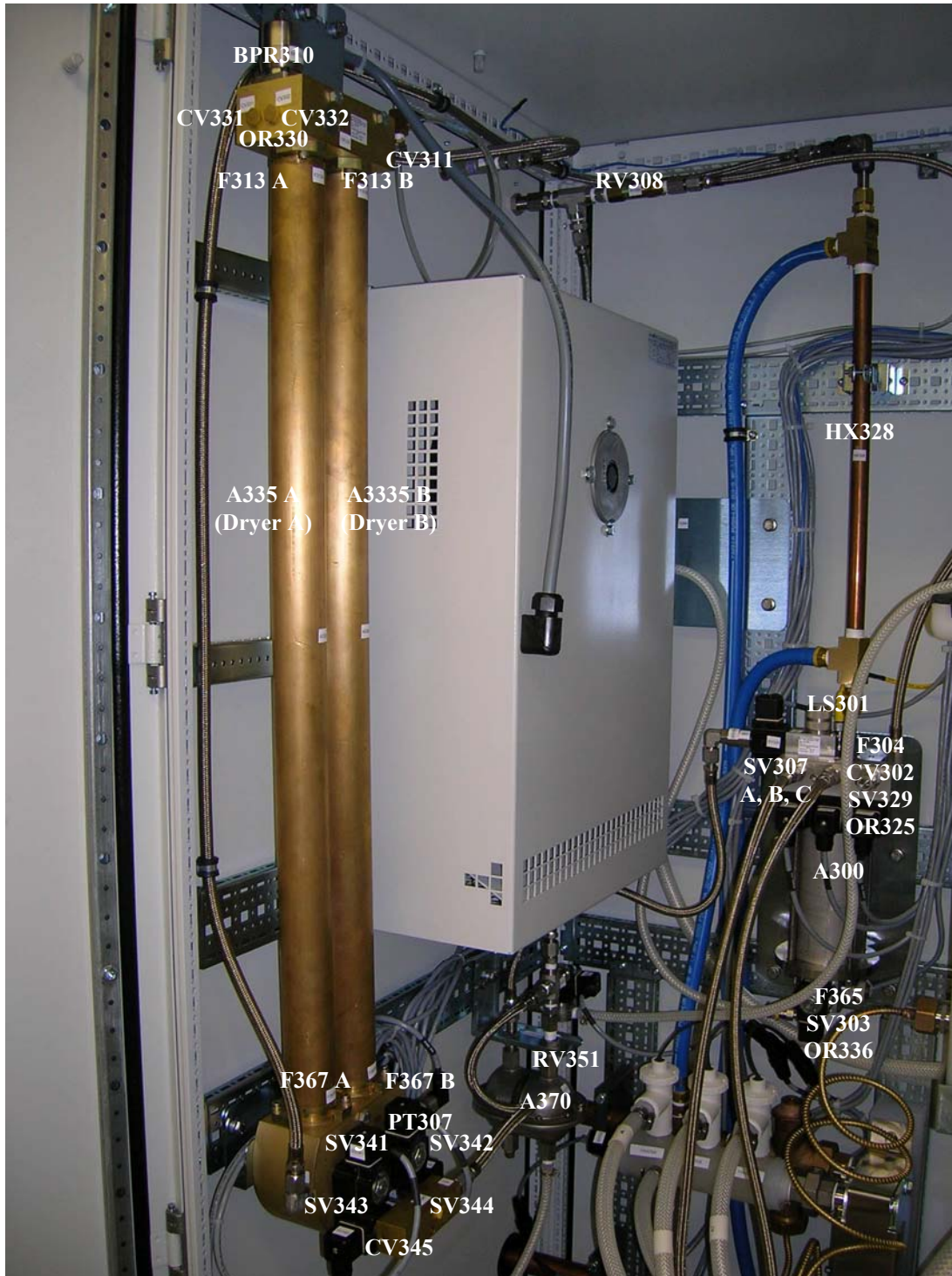


Figure 90 Hydrogen Gas Management Subsystem (HGMS)

17.3 Power Distribution Panel

The power distribution panel consists of power distribution equipment sufficient to supply necessary power to all HOGEN H Series hydrogen generator system subassemblies. It is designed for 3-phase AC operation from 380 to 480VAC. In addition, the power distribution panel includes wiring and components essential for the implementation of a minimum Category III safety circuit. The power distribution panel mounts in the electrical cabinet.

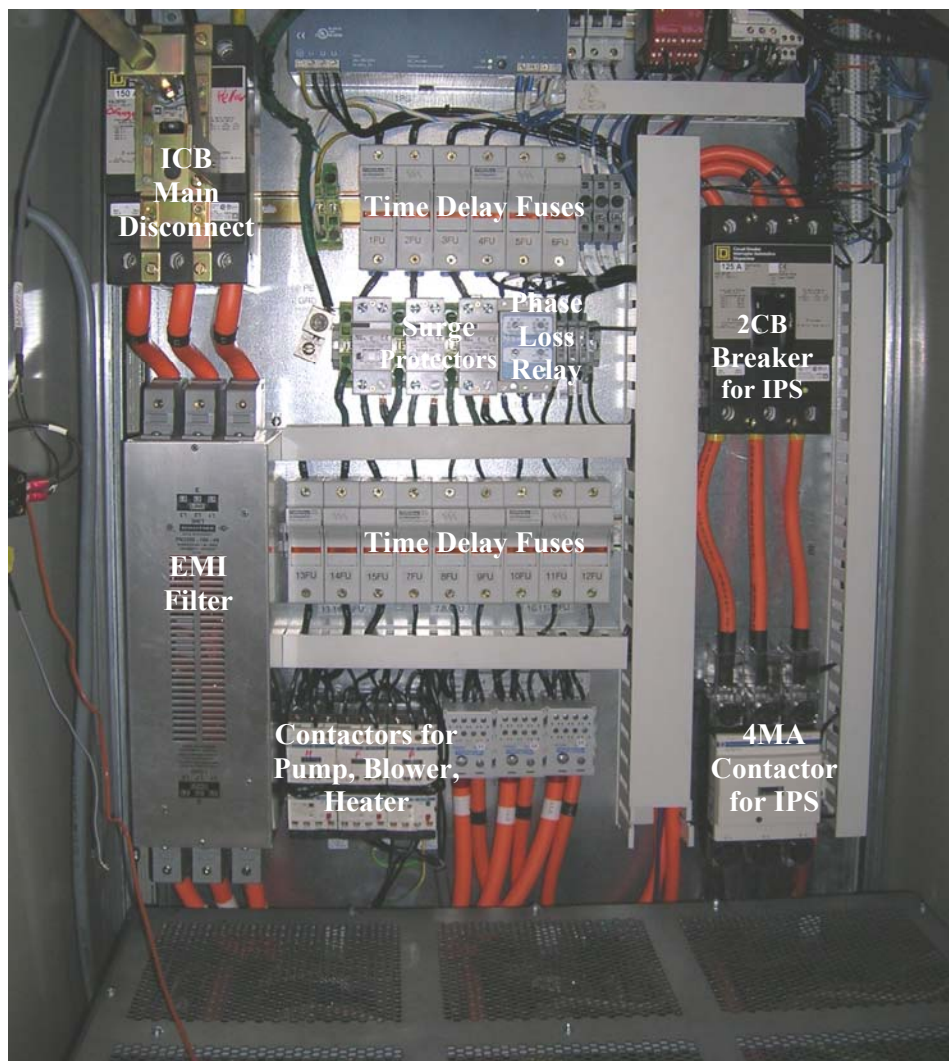


Figure 91 Power Distribution Panel

17.4 Controller Assembly

The control scope covers process monitoring and control, power supply interface, user interface, service personnel interface, and remote communications. The controls shall support one, two and three cell stack configurations.

Module Number	Instrumentation
1	PT307 CG220
2	Stack Volts A, B, C RS209 Power Supply Amps C3 PSW401
3	System Temp (TE219) Electrical Enclosure Temp (TE159) Fluid Enclosure Temp (TE128) Coolant Temp (TE601)
4	A300 Level Sensor (LS301) A300 Drain Valve (SV303) A200 Level Sensor (LS201)
5	Power Supply Amps A1-3, B1-3, C1-2
6	Cell Stack A, B, C Enable Signal Cell Stack A, B, C Current Control
7	SV343 SV329 SV341 SV344 SV342 SV307A-C SV510 SV211 SV401
8	CP205 HTR132 Remote Alarm Relay SV303

Table 8 Controller Assembly Modules and Channels

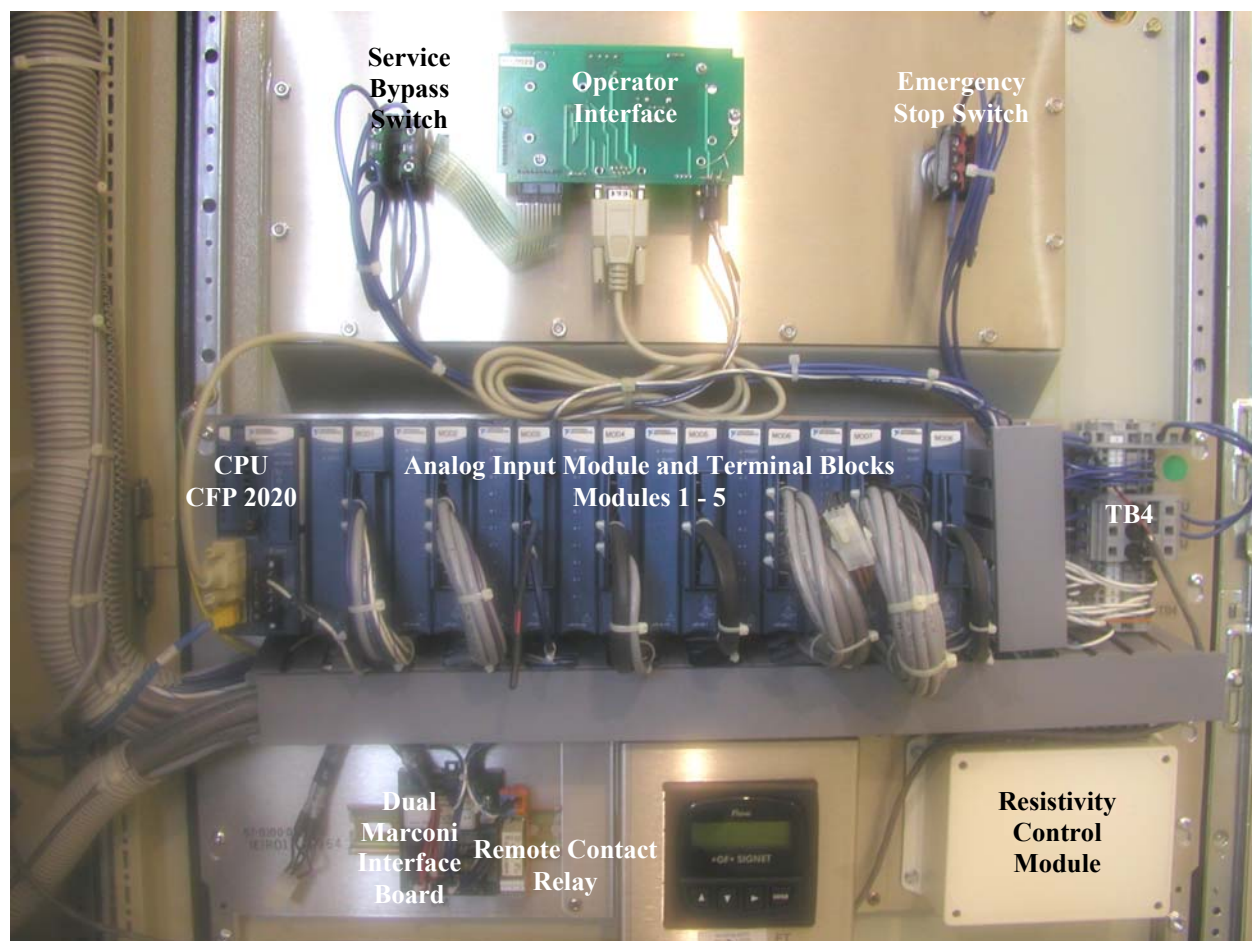


Figure 92 Controller Assembly