




Para Hydrogen Generator

- BPHG 90
User Manual
Version 002



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1 About This Manual

This manual enables safe and efficient handling of the device.

This manual is an integral part of the device, and must be kept in close proximity to the device where it is permanently accessible to personnel. In addition, instructions concerning labor protection laws, operator regulations tools and supplies must be available and adhered to.

Before starting any work, personnel must read the manual thoroughly and understand its contents. Compliance with all specified safety and operating instructions, as well as local work safety regulations, are vital to ensure safe operation.

The figures shown in this manual are designed to be general and informative and may not represent the specific Bruker model, component or software/firmware version you are working with. Options and accessories may or may not be illustrated in each figure.

1.1 Policy Statement

It is the policy of Bruker to improve products as new techniques and components become available. Bruker reserves the right to change specifications at any time.

Every effort has been made to avoid errors in text and figure presentation in this publication. In order to produce useful and appropriate documentation, we welcome your comments on this publication. Support engineers are advised to regularly check with Bruker for updated information.

Bruker is committed to providing customers with inventive, high quality products and services that are environmentally sound.

1.2 Symbols and Conventions

Safety instructions in this manual and labels of devices are marked with symbols. .

The safety instructions are introduced using indicative words which express the extent of the hazard.

In order to avoid accidents, personal injury or damage to property, always observe safety instructions and proceed with care.

DANGER



DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

This is the consequence of not following the warning.

1. This is the safety condition.
 - ▶ This is the safety instruction.

WARNING



WARNING indicates a hazardous situation, which, if not avoided, could result in death or serious injury.

This is the consequence of not following the warning.

1. This is the safety condition.
 - ▶ This is the safety instruction.

CAUTION



CAUTION indicates a hazardous situation, which, if not avoided, may result in minor or moderate injury or severe material or property damage.

This is the consequence of not following the warning.

1. This is the safety condition.
 - ▶ This is the safety instruction.

NOTICE

NOTICE indicates a property damage message.

This is the consequence of not following the notice.

1. This is a safety condition.
 - ▶ This is a safety instruction.

SAFETY INSTRUCTIONS

SAFETY INSTRUCTIONS are used for control flow and shutdowns in the event of an error or emergency.

This is the consequence of not following the safety instructions.

1. This is a safety condition.
 - ▶ This is a safety instruction.



This symbol highlights useful tips and recommendations as well as information designed to ensure efficient and smooth operation.

1.3 Font and Format Conventions

Type of Information	Font	Examples
Shell Command, Commands, “All what you can enter”	Arial bold	Type or enter fromjdx zg
Button, Tab, Pane and Menu Names “All what you can click”	Arial bold, initial letters capitalized	Use the Export To File button. Click OK . Click Processing...
Windows, Dialog Windows, Pop-up Windows Names	Arial, initial letters capitalized	The Stacked Plot Edit dialog will be displayed.
Path, File, Dataset and Experiment Names Data Path Variables Table Column Names Field Names (within Dialog Windows)	Arial Italics	<i>\$tshome/exp/stan/nmr/</i> <i>lists</i> <i>expno, procno,</i>
Parameters	Arial in Capital Letters	VCLIST
Program Code Pulse and AU Program Names Macros Functions Arguments Variables	Courier	go=2 au_zgte edmac CalcExpTime() XAU(prog, arg) disk2, user2
AU Macro	Courier in Capital Letters	REX PNO

Table 1.1: Font and Format Conventions

2 Introduction

The **BPHG 90** Parahydrogen Generator is an instrument designed to enrich the content of parahydrogen (p-H₂) in normal hydrogen gas. It is intended to be used for the generation of parahydrogen in a laboratory environment. An example of laboratory use of parahydrogen is for the production of hyperpolarized substrates for NMR spectroscopy or pre-clinical MRI.

The BPHG 90 integrates into a single metal cabinet the following components: a valve controlled gas routing system, a conversion chamber in a vacuum enclosure, a vacuum pump, a cryo-cooler, a closed loop secondary cooling system, and an electronic unit. The instrument is connected to the mains power supply and to a supply of high purity hydrogen gas.

2.1 Intended Use

The device has been designed and constructed solely for the generation of parahydrogen in a laboratory environment.

Intended use also includes compliance with all specifications within this manual.

Any use which exceeds or differs from the intended use shall be considered improper use.

No claims of any kind for damage will be entertained if such claims result from improper use.

2.2 Limitation of Liability

All specifications and instructions in this manual have been compiled taking account of applicable standards and regulations, the current state of technology and the experience and insights we have gained over the years.

The manufacturer accepts no liability for damage due to:

- Failure to observe this manual.
- Improper use.
- Deployment of untrained personnel.
- Unauthorized modifications.
- Technical modifications.
- Use of unauthorized spare parts.

The actual scope of supply may differ from the explanations and depictions in this manual in the case of special designs, take-up of additional ordering options, or as a result of the latest technical modifications.

The undertakings agreed in the supply contract, as well as the manufacturer's Terms and Conditions and Terms of Delivery, and the legal regulations applicable at the time of the conclusion of the contract shall apply.

2.3 Warranty Terms

The warranty terms are included in the manufacturer's Terms and Conditions.

2.4 Customer Service

Our customer service division is available to provide technical information. See the chapter Contact for contact information.

In addition, our employees are always interested in acquiring new information and experience gained from practical application; such information and experience may help improve our products.

2.5 Product Safety and Electromagnetic Compatibility

The device complies with the standard

- IEC 61010-1 and with UL 61010-1 / CSA C22.2 No. 61010-1-04 Safety Requirements for Electrical Equipment.
- IEC 61326-1 for Electromagnetic Compatibility (EMC)

3 Safety

This section provides an overview of all the main safety aspects involved in ensuring optimal personnel protection, as well as safe and smooth operation.

Non-compliance with the action guidelines and safety instructions contained in this manual may result in serious hazards.

3.1 General

Before you start any repair inside of the device, be aware of the high 230/115V voltages. Even if these voltages are protected by security features to avoid any physical contact, it is still possible that the voltage sources can be unintentionally touched with a tool, object, etc.

Therefore, always check if you really need the power supply to be switched on during your work. Otherwise turn the device off and disconnect the power cable from the wall socket to the device. Safeguard that no one is able to re-power the system without your approval.

3.2 System Owner's Responsibility

System Owner

The term *system owner* refers to the person who operates the device for trade or commercial purposes, or who surrenders the device to a third party for use/application, and who bears the legal product liability for protecting the user, the personnel or third parties during the operation.

System Owner's Obligations

The device is used in the industrial sector, universities and research laboratories. The system owner of the device must therefore comply with statutory occupational safety requirements.

In addition to the safety instructions in this manual, the safety, accident prevention and environmental protection regulations governing the operating area of the device must be observed.

In this regard, the following requirements should be particularly observed:

- The system owner must obtain information about the applicable occupational safety regulations, and - in the context of a risk assessment - must determine any additional dangers resulting from the specific working conditions at the usage location of the device. The system owner must then implement this information in a set of operating instructions governing operation of the device.
- During the complete operating time of the device, the system owner must assess whether the operating instructions issued comply with the current status of regulations, and must update the operating instructions if necessary.
- The system owner must clearly lay down and specify responsibilities with respect to installation, operation, troubleshooting, maintenance and cleaning.
- The system owner must ensure that all personnel dealing with the device have read and understood this manual. In addition, the system owner must provide personnel with training and hazards information at regular intervals.
- The system owner must provide the personnel with the necessary protective equipment.

- The system owner must warrant that the device is operated by trained and authorized personnel as well as all other work, such as transportation, mounting, start-up, the installation, maintenance, cleaning, service, repair and shutdown, that is carried out on the device.
- All personnel who work with, or in the close proximity of the device, need to be informed of all safety issues and emergency procedures as outlined in this user manual.
- The system owner must document the information about all safety issues and emergency procedures in a laboratory SOP (Standard Operating Procedure). Routine briefings and briefings for new personnel must take place.
- The system owner must ensure that new personnel are supervised by experienced personnel. It is highly recommended to implement a company training program for new personnel on all aspects of product safety and operation.
- The system owner must ensure that personnel are regularly informed of the potential hazards within the laboratory. This is all personnel that work in the area, but in particular laboratory personnel and external personnel such as cleaning and service personnel.
- The system owner is responsible for taking measures to avoid inherent risks in the handling of dangerous substances, preventing industrial disease, and providing medical first aid in emergencies.
- The system owner is responsible for providing facilities according to the local regulations for the prevention of industrial accidents and generally accepted safety regulations according to the rules of occupational medicine.
- All substances needed for operating and cleaning the device samples, solvents, cleaning agents, gases, etc. have to be handled with care and disposed of appropriately. All hints and warnings on storage containers must be read and adhered to.
- The system owner must ensure that the work area is sufficiently illuminated to avoid reading errors and faulty operation.
- The system owner must ensure that the laboratory is equipped with an oxygen warning device, in case the device is operated with nitrogen.

Furthermore, the system owner is responsible for ensuring that the device is always in a technically faultless condition. Therefore, the following applies:

- The system owner must ensure that the maintenance intervals described in this manual are observed.
- The system owner must ensure that all (electrical, mechanical, etc.) safety devices are regularly checked to ensure full safety functionality and completeness.

3.3 Personnel Requirements



Only trained Bruker personnel are allowed to install, mount, retrofit, repair, adjust and dismantle the unit!

3.3.1 Qualifications

This manual specifies the personnel qualifications required for the different areas of work, listed below:

Laboratory Personnel

Laboratory personnel are health care professionals, technicians, and assistants staffing a research or health care facility where specimens are grown, tested, or evaluated and the results of such measures are recorded. Laboratory personnel are able to carry out assigned work and to recognize and prevent possible dangers self-reliant due to their professional training, knowledge and experience as well as profound knowledge of applicable regulations.

The workforce must only consist of persons who can be expected to carry out their work reliably. Persons with impaired reactions due to, for example, the consumption of drugs, alcohol, or medication are prohibited from carrying out work on the device.

When selecting personnel, the age-related and occupation-related regulations governing the usage location must be observed.

3.3.2 Unauthorized Persons

WARNING

Risk to life for unauthorized personnel due to hazards in the danger and working zone!



Unauthorized personnel who do not meet the requirements described in this manual will not be familiar with the dangers in the working zone. Therefore, unauthorized persons face the risk of serious injury or death.

- ▶ Unauthorized persons must be kept away from the danger and working zone.
- ▶ If in doubt, address the persons in question and ask them to leave the danger and working zone.
- ▶ Cease work while unauthorized persons are in the danger and working zone.

3.3.3 Instruction

Personnel must receive regular instruction from the owner. The instruction must be documented to facilitate improved verification.

Date	Name	Type of Instruction	Instruction Provided By	Signature

3.4 Personal Protective Equipment

Personal protective equipment is used to protect the personnel from dangers which could affect their safety or health while working.

Personnel must wear personal protective equipment while carrying out the different operations at and with the device.

This equipment will be defined by the head of the laboratory. Always comply with the instructions governing personal protective equipment posted in the work area.

3.5 Position of the Emergency Stop Button

The emergency stop button is located on the front of the BPHG 90:



Figure 3.1: Location of the Emergency Stop Button

Pressing the **Emergency Stop** button triggers an emergency stop. After the **Emergency Stop** button has been pressed, it must be pressed on in order to enable a restart.

3.6 Location of the Safety Label

The safety label is located on the rear panel of the BPHG:



Figure 3.2: Location of the Safety Label



The laboratory supervisor is responsible for ensuring that all the warning labels are maintained in their proper place any time that the device is used.

3.7 Basic Dangers

The following section specifies residual risks which may result from using the device and have been established by means of a risk assessment.

In order to minimize health hazards and avoid dangerous situations, follow the safety instructions specified here as well as in the following chapters of this manual.

WARNING

Risk of injury from flammable gas

Hydrogen is an extremely flammable gas that burns with an invisible flame. It can form explosive mixtures with air. The Lower Explosion Limit / Lower Flammability Limit (LEL/LFL) is 4%.

- ▶ The device should be installed in a sufficiently spacious, well ventilated room equipped with a permanent H₂ alarm gas sensor.
- ▶ The user is referred to MSDS safety data sheets for hydrogen gas for further information.

WARNING

Danger of Suffocation from Hydrogen Gas

If excessive amounts of H₂ gas is released in an enclosed space, hydrogen will decrease the amount of available oxygen and may cause suffocation.

- ▶ The device should be installed in a sufficiently spacious, well ventilated room equipped with a permanent H₂ alarm gas sensor.
- ▶ The user is referred to MSDS safety data sheets for hydrogen gas for further information.

WARNING

Danger of injury from electrical shock!

A life threatening shock may result when the housing is open during operation.

- ▶ Only qualified personnel should open the housing.
- ▶ Disconnect the device from the electrical power supply before opening the device. Use a voltmeter to verify that the device is not under power!
- ▶ Be sure that the power supply cannot be reconnected without notice.

3.7.1 General Workplace Dangers

WARNING



Danger to life from nonfunctional or insufficient safety devices!

If safety devices are not functioning or are disabled, there is a danger of serious injury or death.

- ▶ Check that all safety devices are fully functional and correctly installed before starting work.
- ▶ Never disable or bypass safety devices.
- ▶ Ensure that all safety devices are always accessible.

CAUTION



Danger of injury from tripping over dirt and scattered objects!

Dirt and scattered objects may cause people to slip or trip, resulting in personal injuries.

- ▶ Always keep the work area clean.
- ▶ Remove objects which are no longer required from the work area and particularly from the floor.
- ▶ Indicate unavoidable hazards using marking tape.

NOTICE

Material damage due to a software error!

Samples or the device may be damaged due to a software error causing malfunction of the control system. Users may also be shocked by abrupt malfunction or unexpected system start.

- ▶ Dummy samples must be used during installation and service.
- ▶ Personnel should be alerted to unexpected malfunctions.

NOTICE

Material damage hazard due to impacting the magnet!

Impacting the magnet may result in a quench.

- ▶ Mount the device carefully on the magnet.
- ▶ Avoid banging the magnet during installation and operation, e.g. when replacing the sample carousel.

NOTICE

Material damage due to the use of genuine samples during installation and maintenance!

Using genuine samples during installation and maintenance may result in material damage.

- ▶ Use only dummy samples during installation and maintenance.

3.7.2 Dangers from Electric Power

WARNING

Risk to life from stored charges!

Electric charges may be stored in electrical components even after the system has been switched off and disconnected from the power supply. Contact with these components may result in serious or fatal injury.

- ▶ Before working on the specified components, ensure that they have been completely disconnected from the power supply.
- ▶ Allow 10 minutes to elapse in order to ensure that the internal capacitors have been fully discharged.



WARNING

Danger of injury from electrical shock!

A life threatening shock may result when the housing is open during operation.

- ▶ Only qualified personnel should open the housing.
- ▶ Disconnect the device from the electrical power supply before opening the device. Use a voltmeter to verify that the device is not under power!
- ▶ Be sure that the power supply cannot be reconnected without notice.



WARNING

Danger to life from residual electrostatic potentials!

Friction between material being conveyed may result in significant development of electrostatic potential. Therefore, contact with parts immediately following the conveying operation may be life-threatening.

- ▶ Potential equalisation must be ensured before making contact with parts, unless such equalisation is provided by the customer.



Electrostatic discharge from friction may occur, resulting in an electric spark and loud bang. Use ESD flooring and wear ESD shoes.

WARNING

Danger to life from contact voltage!

Absent or faulty protective earth conductor may result in contact voltage. This may pose a risk of injury or death.

- ▶ Before the initial commissioning of the device, connect the main power supply to the socket and verify the complete functionality of the protective earth conductor.



3.7.3 Mechanical Dangers



CAUTION

Accident hazard from movement of mechanical parts!

The fingers or hand may be pinched due to movement of mechanical parts.

- ▶ Shut off the device before accessing.



CAUTION

Accident and material damage hazard from falling objects!

Equipment may fall down during assembly, retrofitting, or dismantling. This may result in personal injury or equipment damage.

- ▶ If necessary, assemble/disassemble the device in multiple parts.
- ▶ Use a platform with railings instead of a ladder to reach the assembly area.
- ▶ Avoid working over the head. When this can not be avoided, wear a protective hard hat.
- ▶ Follow the mounting instructions in the installation manual.

3.7.4 Dangers from Magnetic Fields

WARNING

Risk to life due to high magnetic fields

A magnetic field of more than 0.5 mT (5 Gauss) is life-threatening for people with pacemakers or active metal implants. Exposure to more than 8 T can cause damage to health. Duration of exposure (8 h/day) above the limit of 200 mT can cause damage to health. Ferromagnetic tools in the magnetic field are significantly hazardous. Disks and electronic devices may be damaged.



- ▶ Mark the magnetic field of more than 0.5 mT (5 Gauss) before start up.
- ▶ Keep people with active medical implants or heart pacemakers away from the 0.5 mT (5 Gauss) area.
- ▶ The permanent workplace of employees must be outside the 0.5 mT (5 Gauss) area.
- ▶ Do not stay or work at magnetic fields of more than 8 T.
- ▶ Prevent exposure of more than 200 mT for more than 8 h/day.
- ▶ Keep disks, credit cards and electronic devices away from the identified area.
- ▶ Do not use ferromagnetic tools or items within the identified area.
- ▶ Only use non-ferromagnetic transportation dewars or pressure cylinders for the cryogenic agents.
- ▶ Only use non-ferromagnetic ladders or steps.
- ▶ Remove magnetic items (jewelry, watches, pens etc.) before carrying out maintenance work.

3.8 Signage

The following symbols and information signs can be found in the work area. They refer to their immediate surroundings.



The identification and placement of warning labels are included in the manual. The laboratory supervisor is responsible for ensuring that all the warning labels are maintained in their proper place any time that the device is used.

Electrical Voltage



Only qualified electricians are permitted to work in a work room marked by this sign. Unauthorized persons must not enter the workplaces thus marked and must not open the marked cabinet.

Danger Spot



Warning indicating a danger spot in work rooms.
The warning label may be ordered using Bruker Part Number 67470.

3.9 Spare Parts

Loss of Guarantee

The use of non-approved spare parts will invalidate the manufacturer's guarantee.
Purchase spare parts from authorised dealers or directly from the manufacturer. See Contact for manufacturer's address.

4 Technical Data

4.1 General Information

Data	BPHG 90	Unit
Weight	approx. 52	kg
Length	66.5	cm
Width	46.5	cm
Height	68.5	cm

Table 4.1: Technical Data: General Information for the BPHG90

An electrolytic hydrogen source (EHS) is used to supply hydrogen gas to the BPHG 90:

Data	EHS	Unit
Weight	25	kg
Length	43	cm
Width	30	cm
Height	43	cm

Table 4.2: Technical Data: General Information for the EHS

4.2 BPHG 90 Connection Values

Electrical

Data	BPHG 90	Unit
Voltage	100-240	V AC
Apparent power consumption, maximum	500	VA
Circuit protection	5 A T/250V	A
Frequency	50/60	Hz

Table 4.3: Electrical Connection Values

Inlet Gas

Data	BPHG 90	Unit
Operating pressure	1 bar min, 10 bar max.	bar
Inlet gas	H ₂ gas high purity >= 99.999	%.
Inlet gas fittings	G1/8	"

Table 4.4: Inlet Gas Values

Outlet Gas

Data	BPHG 90	Unit
p-H ₂ outlet flow rate	<= 0.2 (STP)	l/min
Gas outlet	Parahydrogen fraction >= 90	%.
Outlet gas fittings	G1/8	"

Table 4.5: Outlet Gas Values

4.3 EHS Connection Values

Electrical

Data	EHS	Unit
Voltage	90-240	V AC
Apparent power consumption, maximum	450	VA
Circuit protection	3.15A T/230V	A
Frequency	50/60	Hz

Table 4.6: Electrical Connection Values

Water

Data	BPHG 90	Unit
Quality	Deionize, ASTM II y 0, 1uS	---
Supply pressure (minimum)	-0.2	bar
Supply pressure (maximum)	1	Bar
Supply flow rate (minimum/maximum)	0.2 / 1.5	l/min.
Internal tank capacity	2.3	liter

Table 4.7: Water Supply Values

Outlet H₂ Gas

Data	EHS	Unit
H ₂ purity	>99.99999%	Referred to (O ₂) dew point < -75 °C
Maximum outlet pressure	12	Bar
Maximum H ₂ flow rate	0.5 (STP)	l/min

Table 4.8: Outlet H₂ Gas Values

4.4 BPHG 90 Operating Conditions

Environment

Data	Value	Unit
Temperature range	15-32	°C
Relative humidity	10-90% non condensing	%
Operating altitude	<= 2000	m

Table 4.9: Operating Environment

Cooling Down Process

Data	Value	Unit
Conversion temperature	36 to 40	K
Cool-down time	<1 from room temperature	h

Table 4.10: Cooling Down

Warm Up Process

Data	Value	Unit
Target temperature	300	K
Warm up time	< 20	min

Table 4.11: Warm Up

4.5 EHS Operating Conditions

Environment

Data	Value	Unit
Temperature range	5-35	°C
Relative humidity	80 (at 25 °C)	%
Noise	< 39	dB(A)
Ingress protection	IP20	---
Pollution degree rating	2 (with no aromatic compounds)	---
Operating altitude	<= 2000	m

Table 4.12: Operating Environment

4.6 Rating Plate

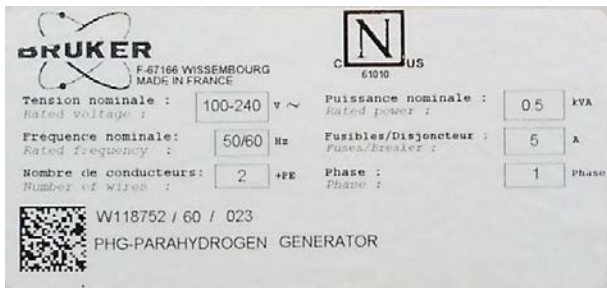


Figure 4.1: Rating Plate Example

The rating plate is located at the power input and includes the following information:

Example

- Manufacturer: Bruker Biospin France
- Rated Voltage: 200-240
- Frequency 50/60 Hz
- Wires: 2
- Rated power: 500 VA
- Fuses: 5A
- Phase: 1
- W118752 / 60 / 023
- Part Number: W118752
- Engineering Change Level (ECL): 60
- Serial Number: 023

4.7 Scope of Supply

The parahydrogen generator **BPHG 90** (P/N W123776) is delivered with the following accessories set:

P/N	Description	Quantity
3000	Cable Sect. 3P3000 NET 1.0 QMM	1
1803847	Joint Steel for Connection RS	2
1806787	IM Personal H ₂ Gas Detector	1
1807578	Stainless Steel Hose DN6 F1/8BSP-F1/8BSP L=4 m	1
1806418	Coupling G1/8-G1/8 Stainless Steel Conical 60°	1
39930	Ribbon PTFE Larg.12 mm LG.12 m	1
W127310	Manual CD H ₂ Gas Detector in English	1
W127477	Label "DANGER HYDROGEN"..	2
1807106	Wrench 7/16	1
1808576	Wrench 1/2 x 9/16	1
1904	Straight Male Pipe Coupling 8 mm 1/8 Cylindrical	2
W131498	BPHG Technical Manual Z33015	1
W131932	Nozzle Holder Grooved + Tubing	1
W131933	Tubing l = 10 m with Pump Silencer	1
1808869	Fuse Mini 5 x 20 mm 10.0 A T	1
35929	Cable Sect US 2P+T 2.00 m NR	1
1836042	PNM Fitting Stainless Steel 1/8 Inch	2
2271	Fuse Mini 5 x 20 mm 1.0 A F	1
W152232	Unit Flow Limiter Gas H ₂ +Capillaires	1
1846188	Fuse Mini 5 x 20 mm 5.0 A T	2
1810255	Hydrogen Generator WM-H2-500	1

4.7.1 The Optional Hydrogen Gas Supply Panel

The optional hydrogen gas (H_2) supply panel contains:

- a shut-off valve,
- a pressure regulator,
- a pressure gauge, and
- a flow limiter.

This optional panel can be used to supply the BPHG 90 with hydrogen gas **from a compressed cylinder**.

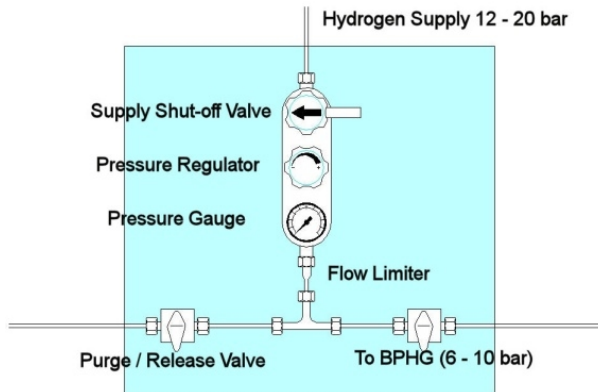


Figure 4.2: H_2 Gas Supply Panel P/N W126956

4.7.2 The Optional PH₂ Storage Kit

The optional storage kit (0.8 liter thick wall aluminium bottle) is available containing a manual valve, pressure gauge, 2 meter stainless steel hose and fittings.

The container is intended to store gas PH₂, temporarily, before being used in another place distant from the generator.



Figure 4.3: 2 p- H_2 Storage Kit P/N W126957







5 Transport, Packaging and Storage



Installation, initial commissioning, retrofitting, repairs, adjustments or dismantling of the device must only be carried out by Bruker Service or personnel authorized by Bruker. Damage due to servicing that is not authorized by Bruker is not covered by your warranty.

5.1 Symbols on the Packaging

The following symbols are affixed to the packaging material. Always observe the symbols during transport and handling.

Top		The arrow tips on the sign mark the top of the package. They must always point upwards; otherwise the content may be damaged.
Fragile		Marks packages with fragile or sensitive contents. Handle the package with care; do not allow the package to fall and do not allow it to be impacted.
Protect Against Moisture		Protect packages against moisture and keep dry.
Attach Here		Lifting gear (lifting chain, lifting strap) must only be attached to points bearing this symbol.
Center of Gravity		Marks the center of gravity of packages. Note the location of the center of gravity when lifting and transporting.
Weight, Attached Load		Indicates the weight of packages. Handle the marked package in accordance with its weight.






Permitted Stacking Load		<p>Indicates packages which are partially stackable.</p> <p>Do not exceed the maximum load-bearing capacity specified on the symbol in order to avoid damaging or destroying the content.</p>
Do not Damage Air-tight Packaging		<p>The packaging is air-tight. Damage to the barrier layer may render the contents unusable.</p> <p>Do not pierce.</p> <p>Do not use sharp objects to open.</p>
Component Sensitive to Electrostatic Discharge		<p>The packaging contains components which are sensitive to an electrostatic discharge.</p> <p>Only allow packaging to be opened by trained personnel.</p> <p>Establish potential equalization before opening.</p>
Protect from Heat		<p>Protect packages against heat and direct sunlight.</p>
Protect from Radioactive Sources		<p>Protect packages against radioactive sources.</p>

Table 5.1: Symbols on the Packaging

5.2 Inspection at Delivery

Upon receipt, immediately inspect the delivery for completeness and transport damage.

Proceed as follows in the event of externally apparent transport damage:

- Do not accept the delivery, or only accept it subject to reservation.
- Note the extent of the damage on the transport documentation or the shipper's delivery note.
- Initiate complaint procedures.



Issue a complaint in respect to each defect immediately following detection. Damage compensation claims can only be asserted within the applicable complaint deadlines.

5.3 Packaging

About Packaging

The individual packages are packaged in accordance with anticipated transport conditions. Only environmentally friendly materials have been used in the packaging.

The packaging is intended to protect the individual components from transport damage, corrosion and other damage prior to assembly. Therefore do not destroy the packaging and only remove it shortly before assembly.

Handling Packaging Materials

Keep the original container and packing assembly, at least as long the warranty is valid, in case the unit has to be returned to the factory. When the packaging material is no longer needed dispose of in accordance with the relevant applicable legal requirements and local regulations.

5.4 Storage

Storage of the Packages

Store the packages under the following conditions:

- Do not store outdoors.
- Store in dry and dust-free conditions.
- Do not expose to aggressive media.
- Protect against direct sunlight.
- Avoid mechanical shocks.
- Storage temperature: 15 to 35 °C.
- Relative humidity: max. 60%.
- If stored for longer than 3 months, regularly check the general condition of all parts and the packaging. If necessary, top-up or replace preservatives.



Under certain circumstances, storage instructions may be affixed to packages which expand the requirements specified here. Comply with these accordingly.

5.5 Preparing the EHS for Transport

Whenever needing to transport the appliance, it needs to be switched OFF, than wait until the inside circuits have depressurized, place the caps on the O2 VENT and H2 VENT at the rear and then activate the following procedure to block operation. Once these operations have been completed, the appliance can be disconnected and is ready for transport.

From the main menu, scroll the screens to the left or right until displaying the **Maintenances** submenu. Press the touchscreen for half a second. Scroll the screens to the left or right until displaying the **Set Block Machine** page.

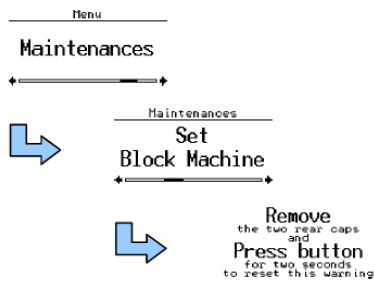


Figure 5.1: Preparing the EHS for Transport

To activate the procedure, press the touchscreen for half a second.

Once the block for transport procedure has been completed, the display will show this screen when the appliance is started the next time. To cancel this screen, hold the **START/STOP** button for 2 seconds.

6 Design and Function

6.1 Overview

The **BPHG 90** Parahydrogen Generator is an instrument designed to enrich the content of parahydrogen (p-H₂) in normal hydrogen gas. It is intended to be used for the generation of parahydrogen in a laboratory environment. An example of laboratory use of parahydrogen is for the production of hyperpolarized substrates for NMR spectroscopy or pre-clinical MRI.

6.2 Brief Description

Ortho- and parahydrogen are two spin-isomers of hydrogen which occur naturally in the ratio 3:1 at room temperature. Parahydrogen has a lower ground state energy than orthohydrogen and therefore the parahydrogen content increases at lower temperatures. The quantum-mechanical transition probability from ortho- to parahydrogen is very low unless the gas is brought into contact with a catalyst. In the BPHG 90, hydrogen gas at room temperature is cooled in the cryo-cooler to below 40K and fed through a conversion chamber with a catalyst, resulting in a parahydrogen content close to 90%.

6.3 Unit Description

The BPHG 90 consists of the following components, contained in a single metal cabinet:

- Solenoid valves making up the gas distribution circuit.
- A conversion chamber attached to a cryocooler cold head inside a vacuum enclosure.
- A vacuum pump.
- A closed loop water cooling circuit for the cryocooler.
- The control electronics.
- The instrument is connected to the mains power supply and a high purity hydrogen gas supply.



Table 6.1: BPHG 90 Front and Rear View

6.3.1 Description of the EHS

The Electrolytic Hydrogen Source (EHS) consists of a hydrogen generator used to produce hydrogen at the working pressure set on the display, when connected to the mains power supply and filled with suitable-quality deionized water. The device can be used in laboratories or light industrial environments.



Figure 6.1: The Electrolytic Hydrogen Source (EHS)

6.4 Connections

6.4.1 BPHG 90 Connections

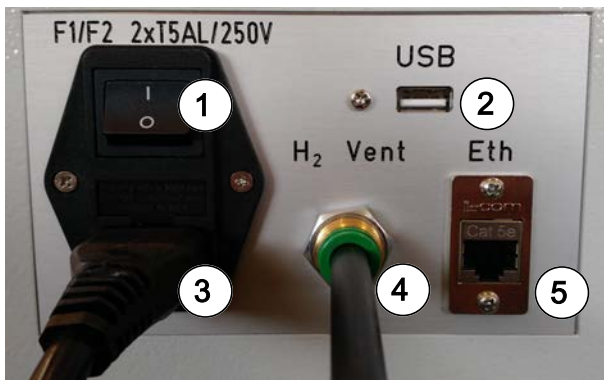


Figure 6.2: BPHG 90 Connections

1 ON/OFF Switch	4 Hydrogen Vent Outlet
2 USB Connection	5 Ethernet Connection
3 Mains Power Connection	

6.4.2 EHS Connections

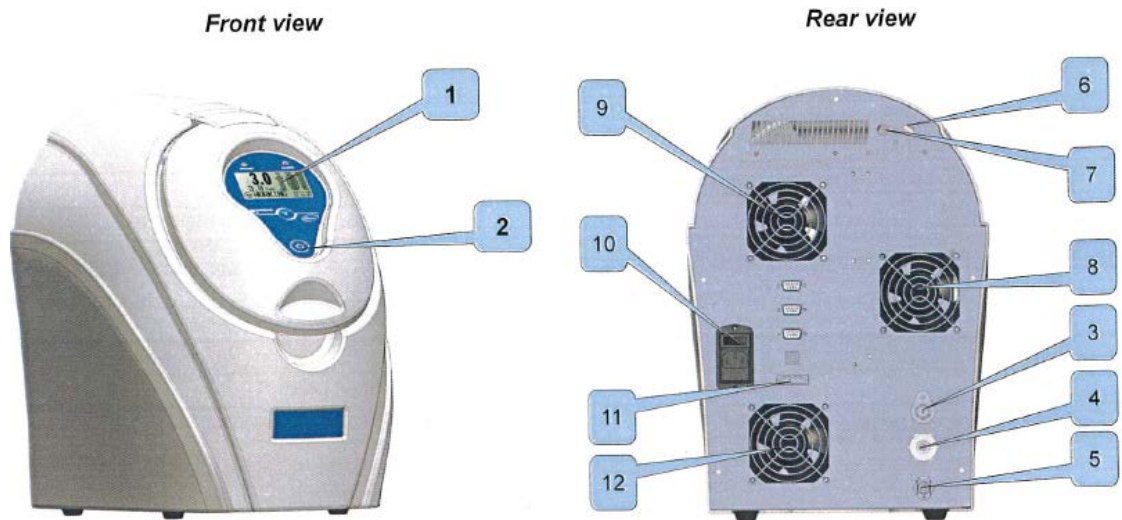


Figure 6.3: Overview of the EHS Hydrogen Generator

1	128x64 pixel LCD touchscreen	7	Oxygen vent
2	START/STOP button	8	Dryer cooling fan
3	Hydrogen outlet	9	Cooling fan air outlet
4	Pressure relief valve	10	Power connector and switch
5	Water feed connector for filling the tank	11	I/O connectors: RS485 - RS232 - USB - Digital I/O
6	Hydrogen vent	12	Cooling fan air intake

7 Site Planning and Installation

Initial installation of the instrument is performed by Bruker Service or personnel authorized by Bruker.



Installation, initial commissioning, retrofitting, repairs, adjustments or dismantling of the device must only be carried out by Bruker Service or personnel authorized by Bruker. Damage due to servicing that is not authorized by Bruker is not covered by your warranty.

7.1 Site Planning Guidelines

For the installation of the BPHG 90 it is necessary to select an appropriate location and make the required provisions for the safe operation of the instrument. Particular attention is required for the safety aspects of working with hydrogen gas.

Before installation, check to insure the following minimum conditions are provided:

- The room where the BPGH 90 is to be installed must be equipped with a permanent hydrogen detector to monitor the air and give a visual and acoustic alarm if hydrogen gas concentration is detected is higher than a safe limit.
- The permanent H₂ sensor should be subject to regular maintenance to ensure its safe operation.
- The room must be well ventilated and the air should be renewed by appropriate means.
- A provision must be in place to allow the safe removal of waste hydrogen gas from the room, e.g. through a fume cupboard. The BPHG 90 is delivered with 10 m flexible exhaust tubing for this purpose.
- If you don't use an EHS, the room must be equipped with a hydrogen gas supply (99.999%; 6 to 10 bar) to which the generator will be connected. Provisions have to be made with regards to the supply of hydrogen gas to ensure that no failure can cause a sudden release of H₂ in quantities such that the LOWER EXPLOSION LIMIT (LEL) is exceeded. The LEL for Hydrogen is 4% by volume. Large capacity hydrogen containers should be stored outside the room.
- Open flames or other ignition sources in the room are prohibited and a corresponding warning sign should be displayed.
- Warning signs must be visible near the position of the BPHG 90 and on the main entrance door. At the entrance to the room an appropriate flammable gas warning sign (H₂ flammable gas DANGER sign, of which two are delivered with the generator) must be placed and the room must be identified as a non-smoking area.
- The BPHG 90 must be connected to the mains 100-230 VAC 50/60 Hz, 500 Watt.

7.1.1 Location of the BPHG 90

The BPHG 90 must be installed indoors and in a location where there is no danger that it can be exposed to water or rain. It can be installed close to a wall or possibly below a desk (a 20 cm clearance must be observed to the rear and above, for the proper cooling of the generator). The power and Ethernet connections and the supply of H₂ gas are made on the rear of the instrument, whereas the pH₂ outlet is located on the front.

The rear side of the generator must be accessible to permit the easy attachment of the hydrogen gas capillary tube supply line.

The front panel must be easily accessible and visible for the operation of the generator.

The generator must be installed on a flat surface.

The electrolytic hydrogen source (EHS) can be placed on the back panel of the BPHG 90.

7.1.2 Location of the Hydrogen Generator

The following guidelines should be followed when locating the hydrogen generator:

- The hydrogen generator should be positioned on a flat surface that is not exposed to vibrations.
- Do not position the generator near open flames or other sources of heat.
- Always leave sufficient clearance for the circulation of air around the device, especially at the rear, where the ventilation air intake is located.
- Do not use the generator in a sealed environment or without suitable ventilation.
- Do not use the device in temperature and humidity conditions outside the limits specified in the technical specifications.

7.1.3 Hydrogen Gas Supply

When the BPHG 90 is not supplied by an electrolytic hydrogen source (EHS), then the most critical provision for the BPHG 90 is the supply of pure hydrogen.

Different sources of hydrogen gas can be used to supply the generator:

- An independent electrolytic hydrogen gas generator producing very pure hydrogen, 99.999% at sufficient pressure ($P > 4$ bar) and flow (≥ 0.4 NL/min). This option is preferable.
- A pressurised cylinder (200 bar) located in a remote room or outside the building. The cylinder with a regulator supplies a metal distribution line made of stainless steel or copper tubing. The room where the BPHG 90 is installed is equipped with an H₂ gas outlet, a manual stop valve, a pressure regulator, a pressure gauge, a purge valve, and a flow limiter. The optional hydrogen supply panel contains all necessary provisions (see section [The Optional Hydrogen Gas Supply Panel](#) [28])
- A pressurised cylinder (200 bar max.) with a suitable pressure regulator. The cylinder must be handled and secured according the prevalent safety regulations and connected to the BPHG 90 in the same way as a remote cylinder (see point 2 above).

The connection between the hydrogen supply and the BPHG 90 is made by means of a flexible stainless steel tube (supplied with instrument).

The BPHG hydrogen inlet pressure must be between 1 and 10 bar.

8 Operation

The BPHG 90 has been designed to operate in a largely automatic manner. The user has access to different modes of operation via a touch panel at the front of the instrument. The touch panel presents the user with information on operational parameters via a number of screens. A typical screen layout will present a title bar at the top of the screen, possibly some operational parameters in the main field and some buttons for control over the operation (see the next figure). Most operating screens feature a **Settings** button at the lower right hand corner, giving access to instrument set-up parameters (see the section [System Settings](#) [▶ 43](#)).

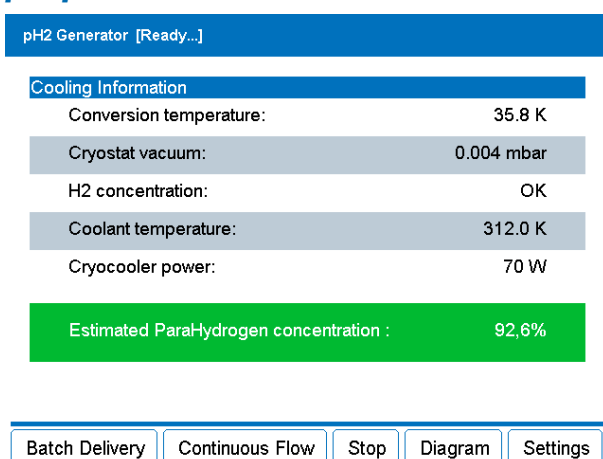


Figure 8.1: Touch Screen for Instrument Operation

The main operating parameter of the **BPHG 90** is the conversion temperature at which ortho hydrogen is converted to parahydrogen. This temperature determines the yield of parahydrogen (see the next figure).

The instrument is designed to operate between 36 and 40 K, producing H₂ gas with more than 85% parahydrogen. The conversion temperature is a user adjustable parameter (see the section [Adjustable Parameters](#) [▶ 45](#)).

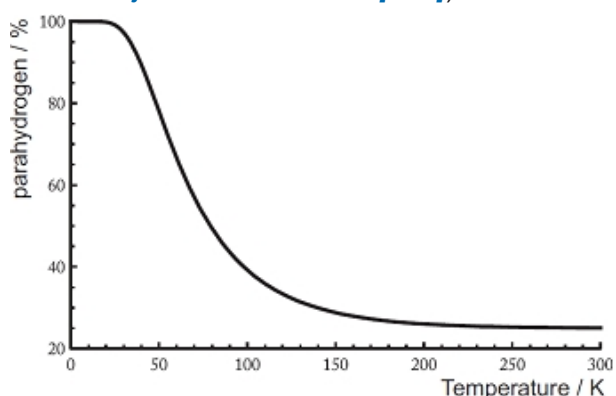


Figure 8.2: Parahydrogen Fraction Function of Conversion Temperature

8.1 Getting Started

When using an EHS, start hydrogen gas production (see [EHS Operation \[▶ 57\]](#)), or when using a pressurized gas cylinder, open the H₂ gas supply valve. Ensure that the hydrogen inlet pressure is in the correct range: 1 to 10 bar.

Switch on the BPHG 90 using the mains power switch on the front panel (see the next figure).

Next to the power on switch on the front panel of the BPHG 90 are two LEDs that provide basic status information:

- The green **Ready** LED indicates normal operation of the BPHG 90. During the cooling down of the conversion chamber, it blinks, and when the pre-set conversion temperature is reached, it will stay permanently ON.
- The red **Error** LED indicates that an error condition is present (e.g. a low coolant level, low input pressure, etc.).



Figure 8.3: Power Switch and Panel LED's

8.1.1 System Check Window

When the BPHG 90 is switched on, the instrument briefly shows a welcome screen and then performs a pre-operation **System Check** of the main components. At the end of the system check, the system displays the **System Check** window. If any of the tests does not pass, the failed test result is highlighted in **RED** and operation of the instrument is not possible until the user has taken remedial action:

pH ₂ Generator [System Check]	
Inlet pressure:	1.87 bar
Outlet pressure:	3.57 bar
Fan activity:	Running
Coolant level:	OK
Coolant temperature:	299.3 K
H ₂ concentration in cabinet:	OK
Cryostat vacuum:	1001.352 mbar
Cryocooler power supply:	OK
Conversion temperature:	294.0 K
Vacuum pump power supply:	OK

Diagram
Settings

Figure 8.4: System Check with Low Coolant Level Warning

A special case is the test for the hydrogen sensor that measures the H₂ concentration in air inside the instrument. This sensor needs about a minute to warm-up and this is indicated by a message in **ORANGE**:

pH2 Generator [System Check]	
Inlet pressure:	8.84 bar
Outlet pressure:	3.57 bar
Fan activity:	Running
Coolant level:	OK
Coolant temperature:	299.8 K
H2 concentration in cabinet:	Warming Up
Cryostat vacuum:	989.890 mbar
Cryocooler power supply:	OK
Conversion temperature:	293.9 K
Vacuum pump power supply:	OK

Diagram	Settings
---------	----------

Figure 8.5: Hydrogen Gas Sensor Warming Up

When all tests pass, the **System Check** window disappears after a few seconds and the system enters **Standby** mode (see section [Stand-by Mode \[41\]](#)).

8.1.2 Stand-by Mode

Once the instrument has successfully passed the initial automatic system check, it goes into **STANDBY** mode. First, a confirmation screen is displayed (see the next figure), asking the user to verify that the exhaust hydrogen gas tube is safely routed outside the room or to a fume cupboard.

The BPHG 90 is delivered with 10 meter of flexible exhaust plastic tubing, which is connected to the rear of the instrument and routed, for example to a fume cupboard or outside the room (see section Exhaust Line Connection).

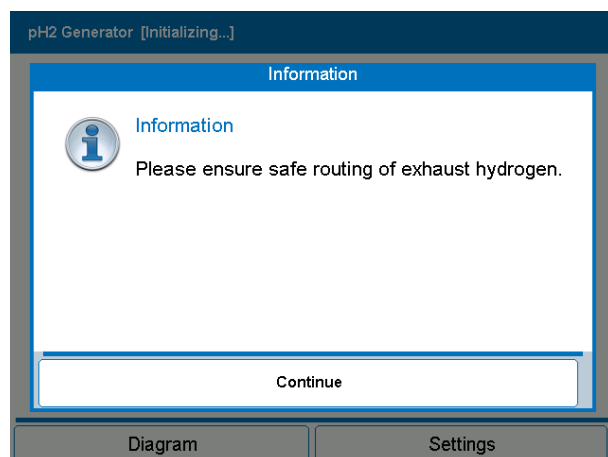


Figure 8.6: Exhaust Gas Warning Message



WARNING

Hydrogen is a very flammable gas.

The exhaust hydrogen gas must be safely routed outside the room using the tubing supplied.

Once the safety check message has been confirmed, the system switches to the **Standby** screen in which the user can select between the three main operation modes of the instrument (see the next figure): **Start**, **Purge**, and **Warm Up**.

In addition, **Settings** gives the user access to various operational information and set-up parameters.

pH₂ Generator [Stand-by]

Conversion temperature:	293.9 K
Coolant temperature:	299.9 K

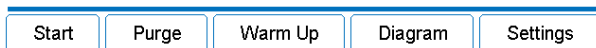


Figure 8.7: Stand-by Screen with Warm-up Conversion Chamber

The main operation of the BPHG 90 can be (re-)started by clicking the **Start** button. This action will start the cryocooler and cool down of the conversion chamber (see section [Start Function \[▶ 50\]](#)).

The automated **Purge** function is used to clear the working volume and all internal tubing of the instrument from air or other contaminants (see section [Purge Function \[▶ 47\]](#)). It is recommended to execute a purge procedure before starting the cooling of the conversion chamber. Once the conversion chamber is cold (i.e. below 280 K), a purge cannot be performed and the corresponding button is greyed-out.

Warm Up executes an automated, fast, forced warm-up of the conversion chamber with a dedicated heater (see section [Generator Shut-down \[▶ 55\]](#)). It is recommended that a warm-up be performed before the system is powered down.

The BPHG 90 monitors the operating times of maintenance critical components and checks them against their preset service intervals. If any of the service intervals are exceeded while the BPHG 90 is in operation, then a **Maintenance Warning** is issued (see section [Operating Information \[▶ 45\]](#)). It is still possible to operate the system after a non-critical maintenance warning has been issued. After a critical maintenance error, the instrument shuts down.

8.2 System Settings

The **BPHG 90** operations are controlled by a number of parameters which are factory preset. These parameters are accessible via the **Settings** function (see the next figure) which can be called up by tapping the **Settings** button at the bottom right hand corner of most operating screens. The main Settings access window has three tabs:

- **User** settings.
- **Service** settings.
- **Screen** settings.

The **Service (BRUKER)** is intended only for trained service personnel and is password protected.

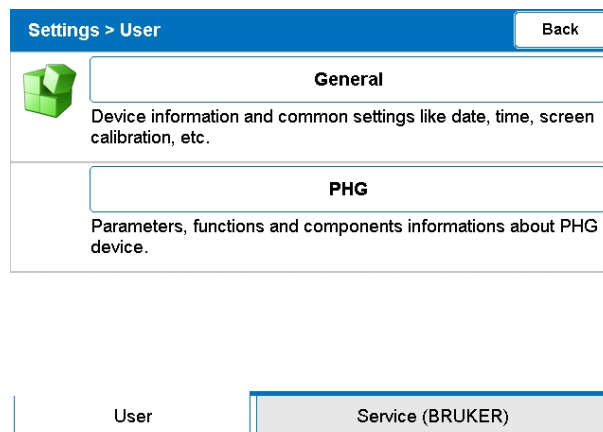


Figure 8.8: System Settings and User Settings Interface

The user has access to two settings screens: **General** or **PHG**.

The **General** button offers general system set-up functions for e.g. touch screen calibration and system date and time settings.

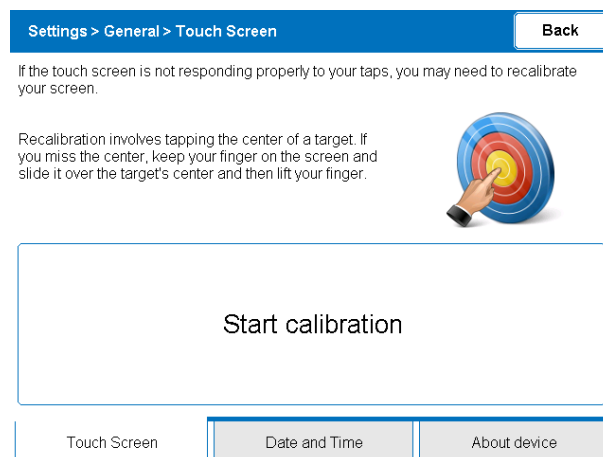


Figure 8.9: General Touch Screen Calibration

The **PHG** button presents the user accessible operating parameters. This screen has two tabs: **Settings** and **Operating Information**.

Settings > PHG > Settings Back

Conversion Temperature Setpoint:	<input type="text" value="36"/>	K	<input type="button" value="Default"/>
Batch Delivery Target Pressure:	<input type="text" value="3.0"/>	bar	<input type="button" value="Default"/>
Batch Delivery Timeout:	<input type="text" value="100"/>	Min.	<input type="button" value="Default"/>
Next Purge Included Cryostat:	<input type="button" value="No"/>		<input type="button" value="Default"/>
Min Allowed H2 Inlet Pressure:	<input type="text" value="3.0"/>	bar	<input type="button" value="Default"/>
Max Continuous Flow Pressure:	<input type="text" value="5.8"/>	bar	<input type="button" value="Default"/>
Outlet Pressure Control:	<input type="text" value="0.5"/>	bar	<input type="button" value="Default"/>

Figure 8.10: The PHG Settings Tab

Settings > PHG > Operating Information Back

Operation Times

Vacuum pump operation time:	37 h
Coolant pump operation time:	6817 h
Cryocooler operation time:	1376 h
Gas filter operation time:	2812 h

Operating Information

Coolant temperature:	302.3 K
Conversion temperature:	296.0 K
H2 concentration in cabinet:	OK

Figure 8.11: The PHG Operating Information Tab

8.2.1 Adjustable Parameters

In the **PHG > Settings** window, the user has access to the following operational parameters:

- Conversion temperature set-point (36...40K in user mode, 30-45K in service mode)), default 36 K.
- Batch delivery target pressure (0.5 bar to 0.5 < the input pressure), default 3 bar.
- Filling container delivery timeout (0... 60 min), default 60 min.

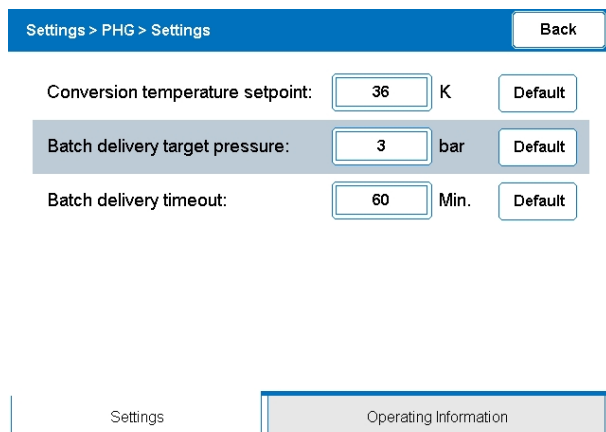


Figure 8.12: User Settings Menu with Adjustable Parameters

In order to change a parameter value, tap the parameter field. This will bring up a numerical keypad to enter the new value. The user accessible parameters have a limited value range and entering values outside this range will cause the nearest valid value to be loaded. The parameter values are stored in a non-volatile memory and user defined values will survive a power-down of the instrument. Factory preset values can be restored by tapping the **Default** button next to the value field.

8.2.2 Operating Information

The BPHG 90 has built-in timers for monitoring the operation of maintenance critical components. The tab **Operating Information** brings up an information window with the values of the operating times of these components and of the main operational parameters.

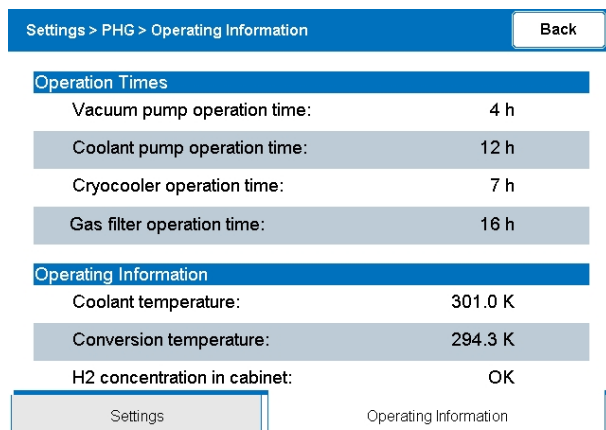


Figure 8.13: Operation Information Screen

At start-up, when the operating time of any of the maintenance critical components is within 90% of the preset service interval, then a maintenance warning is given, but the system can continue to operate. In this case, the operating information screen will display a warning triangle next to the component indicating it is near its service interval maintenance. Warnings are repeated at regular intervals, prompting the user to take remedial action before a critical maintenance error occurs.

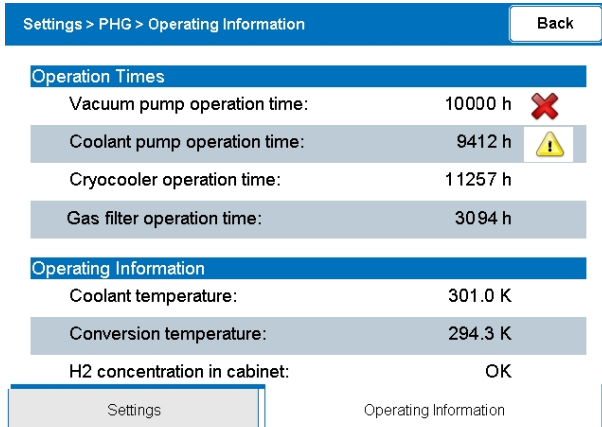


Figure 8.14: Example of Non-critical Warnings

At start-up or during operation, when any of the operating times have become equal to 100% of the preset service interval, a critical maintenance warning is issued (see the next figure) and the system shuts down. The device cannot be operated until the user has taken remedial action. The source of the critical maintenance error is indicated in the operating information screen by means of a red cross.

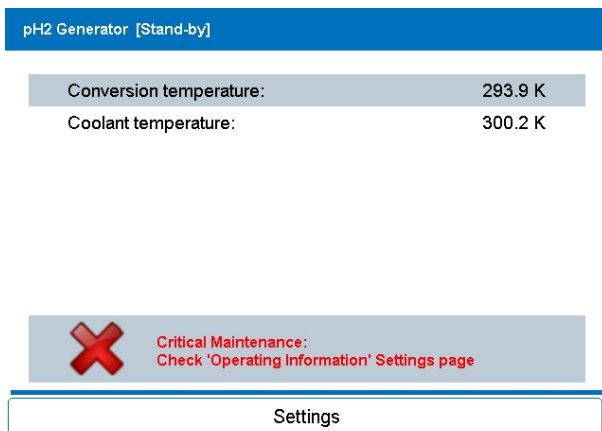


Figure 8.15: Critical Maintenance Warning



The operating times provided are sums over lifetime use of the instrument or part, and may be reset to zero only by service personnel during servicing.

8.3 Purge Function

Before the BPHG 90 can be cooled down for the first time, the instrument must ensure that no gases other than H₂ will be present in any internal tubing and in the conversion chamber. This is to avoid a blockage caused by the freezing of other gases such as CO₂, N₂, etc.

There are two purging modes:

- Purging of the internal H₂ tubing of the BPHG90.
- Purging of the internal H₂ tubing of the BPHG90 including the conversion chamber cryostat.

The purging mode can be selected from [Figure 8.10 \[▶ 44\]](#), in the field **Next Purge Included Cryostat**.

- When **No** is selected, only the H₂ tubing will be purged during the next purge.
- When **Yes** is selected the H₂ tubing and the conversion chamber cryostat will be purged during the next purge.

The user can start the purge procedure by pressing the **Purge** button on the **Standby** screen (see [Figure 8.7 \[▶ 42\]](#)).

During the process, the instrument reports progress through the **Purge in progress** screens, indicating the pass number in the title bar. The purge process can be aborted by tapping the **Abort Purge** button (see the figure *System check with low coolant level warning* in the section [System Check Window \[▶ 40\]](#)).

Purge Guidelines

Basically a simple purge should be performed:

- When the operating temperature is not reached.
- Whenever a maintenance operation is performed (e.g. a change of hydrogen supply bottle, purifier cartridge replacement) and there is the possibility that foreign gasses have entered the generator, then a purge operation must be carried out.
- Whenever the system is left off for more than 2 weeks.

A purge operation cannot be carried out when the system is cold. In this case the **Purge** button in the **Standby** screen is greyed-out and the system needs to be warmed up first (see section [Generator Shut-down \[▶ 55\]](#)).

The Purge Process

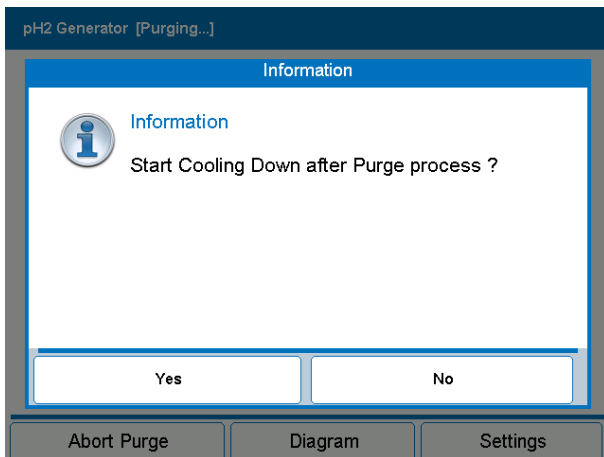


Figure 8.16: Request Start Cooling Down after Purge Process

If you want cooling down after the purge process, you should choose **Yes**. In this case the cooling down process will start automatically after the end of the purge process.

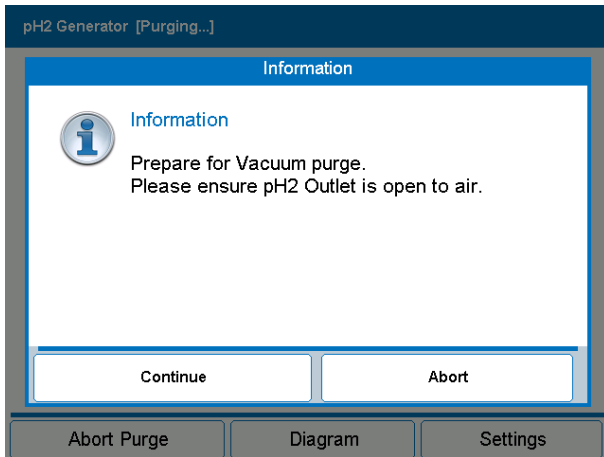


Figure 8.17: Request Prepare for Vacuum Purge

The BPHG 90 outlet needs to be open or any devices need to be disconnected during the purge process, otherwise the process will be stopped.

The following are examples of the screens that will appear during the purging process:

pH2 Generator [Purging...]

Pressures

H2 Inlet Pressure:	-0.92 bar
H2 Outlet Pressure:	-0.91 bar

Progress

Global:

Current step: Purging Supply Line...

Abort Purge Diagram Settings

Figure 8.18: Purging the Supply Line

pH2 Generator [Purging...]

Pressures

H2 Inlet Pressure:	2.17 bar
H2 Outlet Pressure:	-0.99 bar

Progress

Global:

Current step: Purging Catalyser...

Abort Purge Diagram Settings

Figure 8.19: Purging the Catalyser

pH2 Generator [Purging...]

Pressures

H2 Inlet Pressure:	4.08 bar
H2 Outlet Pressure:	1.75 bar

Progress

Global:

Current step: Filling lines with H2...

Abort Purge Diagram Settings

Figure 8.20: Filling the Lines with H2

8.4 Start Function

Once the working volume of the BPHG 90 has been purged, the **Standby** screen (see the figure *Stand-by Screen with Warm-up Conversion Chamber* in the section [Stand-by Mode \[▶ 41\]](#)) re-appears and the instrument is ready to be cooled down. The cool down procedure is initiated by tapping the **Start** button.

The conversion chamber in the BPHG 90 is contained within the vacuum space of the cryostat, to provide an effective thermal isolation from the environment. It is essential for the efficient low temperature operation of the instrument that the residual pressure in the vacuum chamber is below a pre-set limit (5 mbar) before the conversion chamber is cooled down. The system starts the cool-down procedure by testing and, if necessary, improving the vacuum. Pre-pumping of the cryostat vacuum, by the internal diaphragm pump, will take a few minutes.

8.4.1 Cool-down

When the cryostat vacuum is good (below 5 mbar), the cryocooler is automatically started.

When the cryocooler is functioning, it emits an audible noise, this noise is normal. The sound level of the BPHG 90 is below 70 dB at 1 m.

While the BPHG 90 is cooling down, relevant parameters are displayed on the cool-down screen.

The cool-down process can be interrupted using the **Abort** button. When this button is pressed, the user is asked to confirm his action before the cool-down is aborted. The system then returns to the **Standby** screen.

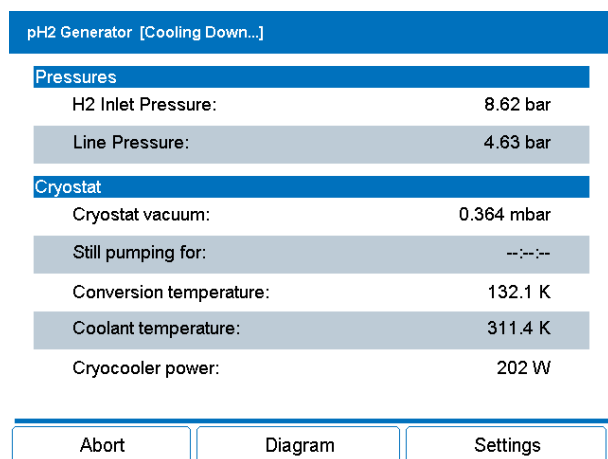


Figure 8.21: Cool Down Screen

Once the system has reached the operating temperature, the **Ready** screen appears (see [Figure 8.22 \[▶ 51\]](#)) with the main operating buttons **Batch Delivery** and **Continuous Flow** enabled.

The **BPHG 90** is then ready to deliver parahydrogen. The time required to cool the system down from room temperature is typically less than one hour.

8.5 Parahydrogen Delivery Modes

Once the conversion chamber has reached the desired conversion temperature, the BPHG 90 is ready to deliver parahydrogen in two different modes:

1. **Batch Delivery**
2. **Continuous Flow**

The **Batch Delivery** mode serves to store the produced parahydrogen gas in a container or a bottle for subsequent use at another location.

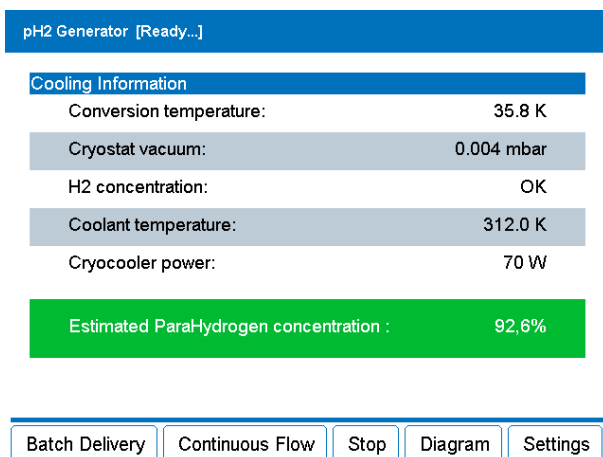


Figure 8.22: Ready to Deliver

In **Continuous Flow** mode, the instrument will continuously deliver parahydrogen to the outlet. It is therefore essential that the outlet is connected to a consumption device, such as the Bruker parahydrogen polarizer, and that any waste gas from this device is routed safely out of the laboratory, e.g. through a fume cupboard.



The BPHG90 has NO means of verifying that the delivered gas is handled in a safe manner. It is the responsibility of the user to ensure that the delivered gas is handled safely.

8.5.1 Continuous Flow Mode

In continuous flow mode, the instrument is capable of maintaining a flow of 0.2 l/min (STP) of Para hydrogen with an inlet pressure of 10 bar.

If the debit request from the device connected to the BPHG90 is *less than or equal to* 0.2 l/min, the outlet pressure is maintained between the target pressure and target **Max. Continuous Flow Pressure** minus the **Outlet Pressure Control**.

The screenshot shows the 'Settings > PHG > Settings' screen with a 'Back' button. The settings are as follows:

Conversion Temperature Setpoint:	36	K	Default
Batch Delivery Target Pressure:	3.0	bar	Default
Batch Delivery Timeout:	100	Min.	Default
Next Purge Included Cryostat:	No		Default
Min Allowed H2 Inlet Pressure:	3.0	bar	Default
Max Continuous Flow Pressure:	5.8	bar	Default
Outlet Pressure Control:	0.5	bar	Default

At the bottom, there are two tabs: 'Settings' (selected) and 'Operating Information'.

Figure 8.23: Settings: PHG Settings

If the debit request from the device connected to BPHG90 is *greater* than 0.2 liters/min, the outlet pressure will be less than the pressure set point requested until the required flow rate is less than 0.2 liters/min.

During delivery the **Continuous Flow** screen shows the operational parameters and a running chronometer (labelled **Delivery time**):

The screenshot shows the 'pH2 Generator [Continuous Flow...]' screen with a 'Delivery Information' section:

Delivery time:	00:02:14
pH2 Outlet Pressure:	0.03 bar
Conversion temperature:	36.5 K
Cryostat vacuum:	0.003 mbar
Coolant temperature:	310.0 K
Cryocooler power:	208 W
Estimated ParaHydrogen concentration :	92%

At the bottom, there are three buttons: 'Stop', 'Diagram', and 'Settings'.

Figure 8.24: Continuous Flow Progress Screen

The user can stop parahydrogen gas delivery by pressing the **Stop** button where upon the system returns to the **Ready** screen.

Based on the conversion temperature, the estimated p_{H2} yield is indicated as a percentage.

8.5.2 Batch Delivery Mode

In batch delivery mode, the BPHG 90 assumes that an **EMPTY** (defined as with < 0.1 bar pressure) container is connected to the pH_2 gas outlet on the front panel of the instrument. Ensure that the container used is parahydrogen compatible, i.e. does not contain materials that can quench the hydrogen polarization (e.g. paramagnetic materials). Aluminum bottles are recommended (a suitable aluminum bottle is an optional accessory for the BPHG 90, see section [Scope of Supply \[▶ 27\]](#)). When the user presses the button Batch Delivery, the BPHG 90 displays a dialogue screen asking for confirmation that an empty container has been connected to the p-H_2 outlet of the front panel:

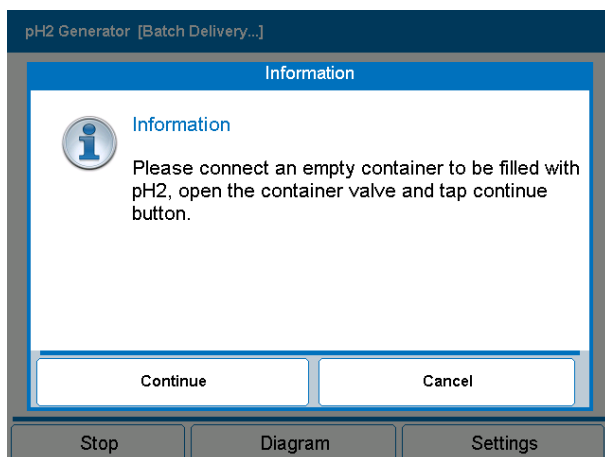


Figure 8.25: Container Connection Dialogue Window

The instrument then proceeds with evacuating the internal delivery lines and checking the internal pressure of the attached container. If the pressure in the container is too high, a warning window is displayed and the batch delivery cannot proceed:

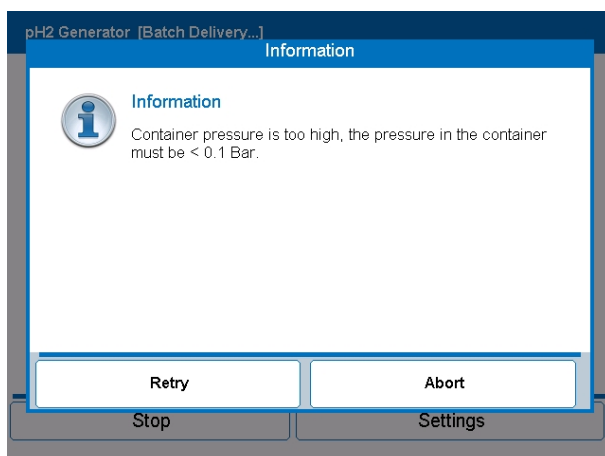


Figure 8.26: Container High Pressure Warning Screen

The user must then disconnect the container and reconnect an empty one.

Once the BPHG 90 has detected a low enough pressure in the container, the container is completely evacuated using the vacuum pump of the BPHG and the filling process with parahydrogen begins.

NOTICE

Risk of contamination and blockage of the unit.

Connecting containers with residual gases other than hydrogen can lead to contamination and blockage of the BPHG 90.

- It is the responsibility of the user to ensure only to connect containers that have been used exclusively for hydrogen.

The batch delivery continues until a pre-defined pressure has been reached or until aborted by the user. The delivery process also stops when the preset time-out has elapsed. Progress is indicated in the Batch Delivery screen:

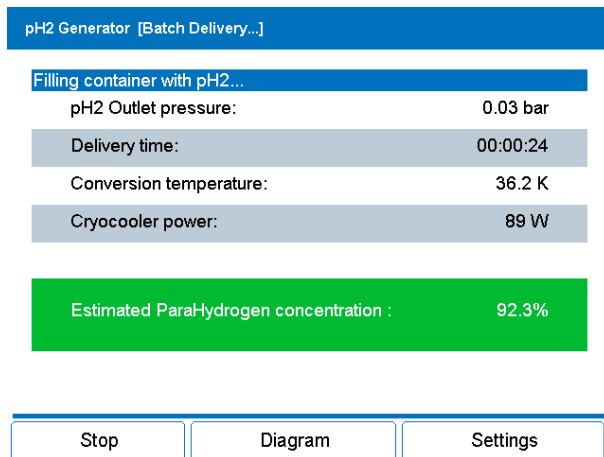


Figure 8.27: Batch Delivery Progress Screen

The pressure and time-out parameters can be set by the user (see the section [Adjustable Parameters \[► 45\]](#)). During the procedure, the elapsed time and the pressure in the container are displayed on the **Batch Delivery** screen. After completion, the user is asked to confirm that the container has been removed:

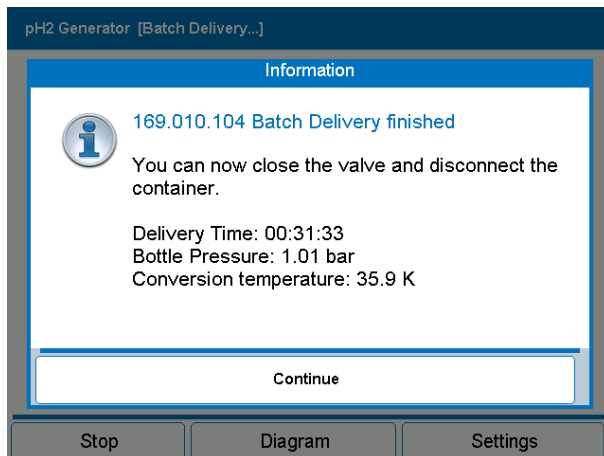


Figure 8.28: End of Batch Delivery Process

8.6 Generator Shut-down

The BPHG 90 can be left in **Ready** mode without detrimental effects to the instrument. If, however, it is envisaged that no parahydrogen is required for a prolonged period of time, it is recommended that the system be switched off. It is not recommended, however, that the BPHG 90 is switched off by means of the main power switch when the conversion chamber is cold. This could lead to pressure build up in the conversion chamber and (a small amount of) H₂ gas being released through the pressure safety valves in the instrument.

The preferred procedure for switching the system off is by first warming it up as described in the following section.

8.6.1 Warm Up

Upon terminating either of the two delivery modes, the BPHG 90 returns to the **Ready** screen (see [Figure 8.22 \[p 51\]](#)). When the user presses the **Exit** button on this screen the system will return to **Standby** from which a forced warm-up can be initiated by tapping the **Warm Up** button:

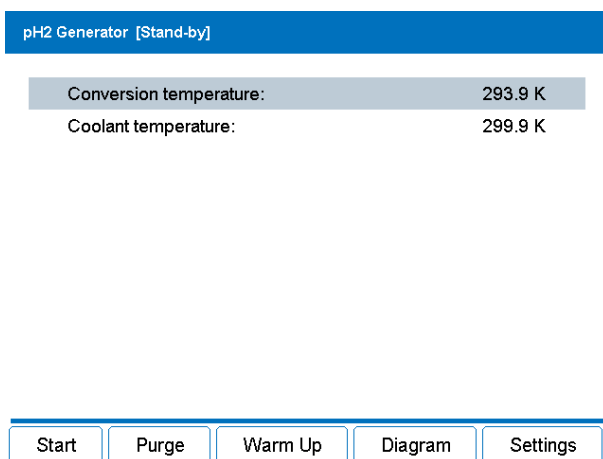


Figure 8.29: Stand-by Screen with Warm-up Conversion Chamber

The **Warm Up** procedure allows the user to warm the system up quickly to a system defined temperature in order to clear a suspected conversion chamber blockage, or in preparation for a system shut-down.

A forced warm-up takes typically less than 20 minutes. When the **Warm-up** button is pressed, the system asks for a user confirmation (see following figure) and then proceeds to heat the conversion chamber under continuous pumping on the working volume.

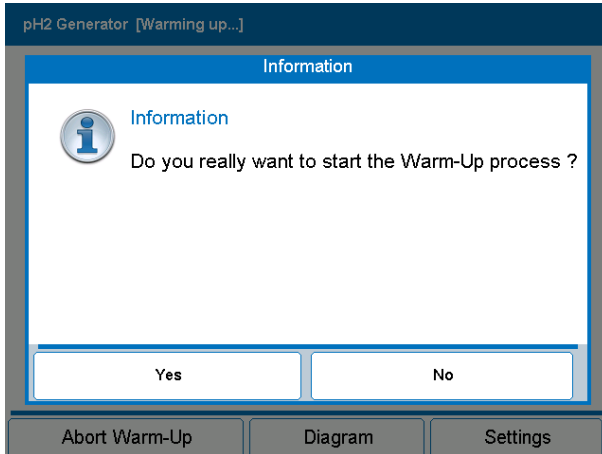


Figure 8.30: Warm-up Dialogue and Information Screen

The warm-up procedure stops when the system defined warm-up temperature has been reached. Progress is indicated in the **Warming up** screen. If desired, the process can be aborted by tapping the **Abort** button (see the figure below).

Once the warm-up system defined temperature has been reached, the system returns to the **Standby** screen. Then the generator can be safely turned off using the main power switch.

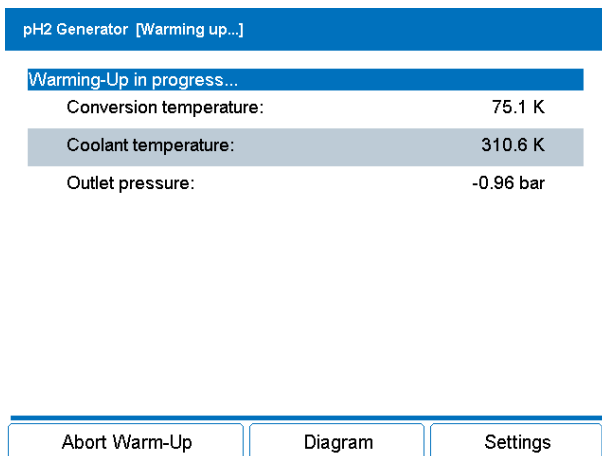


Figure 8.31: Warm-up Progress Screen with Abort Function

8.7 EHS Operation

The following descriptions refer to operation of the electrolytic hydrogen source (EHS).

8.7.1 The Hydrogen Generator Touchscreen

Users can interact with the EHS hydrogen generator system using the 128 x 64 pixel resistive touchscreen display. There is also a button on the front of the device, used to start or stop hydrogen production at any time.

Users can scroll the various menus displayed on the touchscreen as follows:

- Swipe to the right or left to select the various options in the current menu level.
- Press any point (half a second) to access the current menu or set a value.
- Wipe down to go back up one level, or exit a setting without saving the changes.
- At the bottom of each menu, there is a bar highlighting the position of the selected item with reference to all the items in the current menu.
- The color of the display or the status LEDs may change, depending on the current status.
 - In normal operation the display is white and the status LED blinks.
 - When an alarm is in progress (hydrogen production stopped), the red alarm LED and the display blinks quickly.
 - When a pre-alarm is signaled (production continues), the alarm LED and the display blink slowly.
 - If dryer regeneration has been scheduled, the display blinks 24 hours before the procedure starts.

NOTICE

Risk of material damage to the touchscreen due to incorrect usage

The use of hard or sharp object to operate the touchscreen may result in damage to the screen.

- ▶ Do not use tools or other objects to operate the touchscreen.

8.7.2 The Summary Screen

Normally the touchscreen display shows the summary screen, where users can monitor the most important system values:

- System status.
- Working pressure.
- Water level.
- Water quality.
- Swiping to the right or left directly accesses the two diagnostics screens.
- Pressing any point on the screen for at least half a second accesses the main menu.

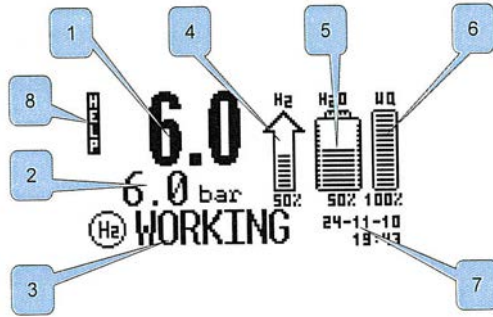


Figure 8.32: The Touchscreen Summary Screen

Number	Description
1	Effective outlet pressure.
2	Working pressure set point.
3	System status and pre-alarm messages.
4	Percent of H2 production flow.
5	Water level in the tank.
6	Water quality as a percentage (100% good, 0% bad).
7	Date-time.
8	Touching HELP displays the help screens.

8.7.2.1 System Status

Signal	Description
OFF	The system is off and not producing H2.
STARTING	The system is generating the required internal pressure before opening the outlet valve.
CHECKING	The system is running an automatic check for any internal leaks.
FILLING	The system is filling the line connected to the outlet at the maximum flow rate available.
WORKING	The system is on and line pressure has reached the set point.
STANDBY	The system is internally pressurized and ready, but the outlet valve is closed.

Table 8.1: Touchscreen System Status

8.7.3 Starting and Stopping Hydrogen Production

When the display shows the summary screen, pressing the START/STOP button on the front panel will display one of the following control screens. The table below shows the control screen corresponding to each system status.

To scroll between the screens, swipe to the right or left.

System Status	Control Screen	Description
OFF	START OPEN/ START CLOSE	When the device is OFF (no production), to START operation and open the valve as soon as the system is pressurized, press START/OPEN , while to simply activate pressurization press START/CLOSE .
STARTING WORKING FILLING	STOP/CLOSE	During normal operation, to stop production press STOP , or to close the outlet valve press CLOSE .
STANDBY	STOP/OPEN	If the system is in STANDBY (pressurized with the valve close), to stop production press STOP , or to open the valve press OPEN .

Table 8.2: Control Screen Functions

8.7.4 Function: Constant Flow Generation Mode

Activating this mode generates a constant flow of hydrogen, irrespective of line pressure. The flow-rate generated, expressed as a % respect of maximum flow, can be adjusted at any time. From the main menu, scroll the screens to the left or right until displaying the Function submenu. Press the touchscreen for half a second. The Flow Mode page will be displayed:

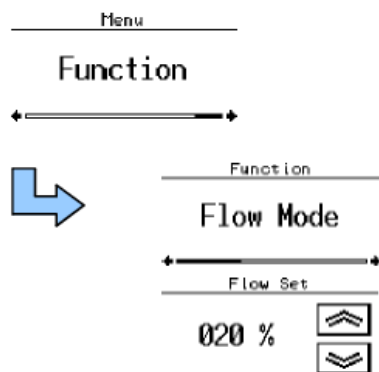


Figure 8.33: Constant Flow Generation Mode

This mode sets the generator to fill an external tank at maximum flow-rate. Touch the arrow keys to modify the value. To start the function, press the center of the screen for at least half a second. To exit without starting the function, swipe the screen from the top down.

9 Troubleshooting

The following table list potential problems and indicates possible causes and remedies.

Problem	Cause	Remedy
High H ₂ gas alarm.	Internal hydrogen gas leak.	Shut off the hydrogen supply and contact Bruker service.
	Hydrogen gas sensor failure.	Contact Bruker service.
	Control electronics failure.	Contact Bruker service.
Main display does not come on.	Rear power switch is not on.	Switch on the rear power switch (section Mains Power Connection).
	Mains fuses are blown.	Replace the line fuses with the same fuse type (section Fuses Replacement).
	Controller or display failure.	Contact Bruker service.
System check does not pass.	The hydrogen inlet pressure is out of range.	Adjust the inlet pressure.
	Low coolant level in reservoir.	Fill the coolant (section Cryocooler Coolant Circuit [▶ 67]).
	All other system check failures.	Contact Bruker service.
No coolant flow detected.	Coolant pump failure.	Contact Bruker service.
	Coolant flow sensor failure.	Contact Bruker service.
Cryocooler does not start.	Cryocooler fuse blown.	Check or replace the cryocooler fuse (see Warm Up [▶ 55]).
	Cryocooler power supply failure.	Contact Bruker service.
Cannot reach the target conversion temperature.	Poor vacuum in cryostat.	Execute a warm-up (section Warm Up [▶ 55]), then a purge (Purge Function [▶ 47]). If the problem persists, contact Bruker service.
	Conversion chamber temperature sensor failure.	Contact Bruker service.
	Cryocooler failure.	Contact Bruker service.
Coolant temperature is too high.	Cryocooler overheating.	Contact Bruker service.

Problem	Cause	Remedy
	Low coolant level.	Refill coolant reservoir (see section Cryocooler Coolant Circuit [▶ 67]).
	Radiator dirty.	Clean the radiator with a vacuum cleaner (see section Cleaning Instructions).
	Incorrect fan speed.	Contact Bruker service.
	Defective water pump.	Contact Bruker service.
	Coolant temperature sensor failure.	Contact Bruker service.
When ready, cannot deliver parahydrogen in continuous flow mode.	Conversion chamber blockage.	Execute a warm-up (section Warm Up [▶ 55]), then a purge (Purge Function [▶ 47]).
	Outlet valve malfunction.	Contact Bruker service.
Batch delivery container evacuation fails.	Leak in container connections.	Check / remake all connections to the container.
Time out while filling container.	Conversion chamber is blocked.	Execute a warm-up (section Warm Up [▶ 55]), then a purge (Purge Function [▶ 47]).
Repeated conversion chamber blockages.	H ₂ gas purity problem.	Use high purity H ₂ gas: 99.999% or better.
	Purge not executed prior to cool-down.	Execute a warm-up (section Warm Up [▶ 55]), then a purge (Purge Function [▶ 47]).
	Purifier cartridge saturated.	Contact Bruker service.

Table 9.1: BPHG 90 Troubleshooting Chart

9.1 EHS Alarms and Pre-Alarms

During operation, the system carries out several automatic checks. In the event case of serious anomalies, the display and the red ALARM LED flashing, the buzzer sounds rapidly and intermittently, a message identifying the problem is displayed and hydrogen production stops immediately. In the event of minor anomalies, the LCD display and the red ALARD LED flashing, the buzzer sounds every 5 seconds and pre-alarm messages are displayed.

Message Displayed	Cause	Solution
Power Supply T. Too High	Temperature of electronic power supply too high.	Make sure that room temperature where the system is operating is less than 35 °C Make sure that the intake/ventilation ports are open and that the corresponding filters are clean.
Bad Water Quality	Poor quality of the water in the tank.	Change the water with higher quality water. Replace the deionizer bag + water filter.
Water Tank Level Low	Water level less than 5% of tank capacity.	Top up the tank or activate automatic filling, if available.
Dryer Saturated	Dryer saturated. This alarm continues until a dryer regeneration cycle is completed.	Start a dryer regeneration cycle.
Clock Not Settled	Internal clock not set or not working properly.	Reset the system date and time.
Check A. Refill	Failed attempt to automatically fill the water tank.	Make sure that the external tank is connected correctly.
Check Power Supply	Input power voltage not correct.	Try switching the system off and on again. If the problem persists, contact service.
Change Deionizer	Water deionization filter saturated.	Replace the deionizer bag + water filter and reset the filer life hour counter.
Int. Flow Error	Small internal hydrogen leak detected.	Try stopping and starting production again, if the problem persists run the internal leak test and/or contact service.
Fan Damage	Internal fans blocked or broken	Check that the fans are not blocked by foreign matter at the rear.
H2 Leak Detected	The H2 sensor (optional) has measured a hydrogen concentration greater than 0.05%.	Stop hydrogen production, ventilate the room and check the gas line outside of the generator. Run the external leak test.

Message Displayed	Cause	Solution
H2 Sensor Com. Error	Communication error with OPT.H2.SENS module.	Check correct connection of the RS485 cable between the generator and the OPT.H2.SENS module.
Parallel Mode Failure	Communication error with OPT.H2.PBOX controller.	Try switching the system off and on again. If the problem persists, contact service.

Table 9.2: EHS Pre-alarms

Refer to the H2 Generator User Manual for more information on alarms.

10 Maintenance

The BPHG 90 is a low maintenance instrument and the critical components have been selected to ensure a long operating life time. Periodic maintenance should be carried out on a yearly basis by trained service personnel.

User maintenance is limited to cleaning the instrument, ensuring an adequate level of coolant for the closed loop cooling system is maintained, and replacing fuses when needed. A full description of these actions is given in section [Hydrogen Gas Sensor \[▶ 67\]](#).

10.1 Cleaning

10.1.1 Before Cleaning

1. Stop the device from doing any actions.
2. Switch the power off.
3. Disconnect the power supply.

10.1.2 Cleaning the Outside of the Device Chassis and Units

Clean the cabinet and screen using a mild soap and water mixture. Use a soft cloth or sponge slightly moistened with the mixture. Note that the enclosure of the BPHG is not water tight and avoid using excessive amounts of cleaning fluid.

Do not use harsh cleaners, solvents, or detergents. Never spray the cleaning fluid directly onto the touch-screen.

Ensure the radiator on the rear panel does not become clogged with dust. It can be cleaned using a vacuum cleaner.

10.1.3 Other Cleaning Operations

For all other cleaning operations contact Bruker service for advice and support. It may be necessary to send in the device for a cleaning service.

No special precautions have been taken in the device to avoid contamination from leaking samples. Bruker accepts no responsibility for any damage which may occur when samples are used containing radioactive or other hazardous materials.

In case of an accident with toxic, radioactive, explosive, or biologically active substances, the device and associated equipment must be cleaned in such a way that no danger emanates from the device and associated equipment, especially for all uninformed personnel. If a device has to be cleaned of all remains of a substance for safety reasons, contact Bruker service for advice and support.

Note that in serious cases it may be necessary for the owner to exchange the device with a new one, contact Bruker service for details.

10.2 Preventative Maintenance

Several system components of the generator (H₂ gas sensor, coolant pump, fans, H₂ purifier cartridge) may need a periodic maintenance. The instrument monitors the operating time of the active components and, when their service time interval has elapsed, maintenance warnings are shown (see section [Operating Information \[▶ 45\]](#)).

A first (non-critical) maintenance warning occurs when the operating time has reached 90% of the service interval of a component. After such a warning the instrument will continue to operate normally but maintenance warnings are repeated at preset intervals until the operating time has reached 100% of the service interval. At that point the instrument can no longer be operated until service has been carried out.

The periodic maintenance of the instruments should be carried out by Bruker Service. It is recommended to arrange a service visit immediately following the first maintenance warning.

10.2.1 Hydrogen Gas Sensor

The internal hydrogen gas sensor must be tested every 12 months by a trained service technician. It is located inside the cabinet on the rear panel over the vacuum pump.

10.2.2 Vacuum Pump

The vacuum (diaphragm) pump needs to be checked for wear and tear every 10000 operating hours (approximately 1 year of full time operation) and replaced if necessary.

10.2.3 Coolant Circuit

10.2.3.1 Coolant Replacement

The coolant level needs to be maintained by the user (see section [Cryocooler Coolant Circuit \[▶ 67\]](#)). The cooling circuit of the cryocooler will be cleaned and the coolant replaced during the annual maintenance.

10.2.3.2 Fans and Radiator

The coolant radiator fins need to be cleaned and the fans be checked for wear and tear during the annual maintenance. They will be replaced if necessary.

10.2.3.3 Coolant Pump

The coolant pump needs to be checked for wear and tear every 10000 operating hours (approximately 1 year full time operation) and replaced if necessary.

10.2.4 Gas Purifier Cartridge Replacement

The gas purifier cartridge must be replaced every 8000 hours (approximately 12 months of operation) or if the conversion chamber is often blocked by frozen contaminants. The BPHG 90 monitors the operating time of the instrument and issues a maintenance warning if the cartridge approaches its maximum life time.

10.2.5 Cryocooler

The cryocooler needs no special maintenance. It needs to be replaced every 50000 operating hours (more than 5 years of full time operation).

10.3 User Maintenance

10.3.1 The BPHG 90 Cryocooler Coolant Circuit

The recommended coolant for the closed-loop cooling system of the BPHG 90 consists of distilled water with the addition of a small amount of algaecide to avoid organic contamination by algae.

Here is an example of an algaecide that can be used:

Product name: TETRA AQUA ALGIZIT

Article number: 800 357/2

Manufacturer:

Tetra GmbH
Postfach 1580
D-49304 Melle
Germany

The coolant system requires regular topping up. The instrument monitors the coolant level in the reservoir and issues a warning if it drops below a pre-set level. If the level is too low, the operation of the cryocooler is stopped. It is recommended to completely replace the coolant every **6 months**.

10.3.1.1 How to Drain the Cooling System

To drain the cooling system, proceed as follows:

- Stop the generator operation and power off the device (see [Generator Shut-down \[55\]](#)).
- Disconnect the power cord.
- Remove the cover on the rear panel to gain access to the coolant reservoir.
- Remove the cap of the coolant reservoir.

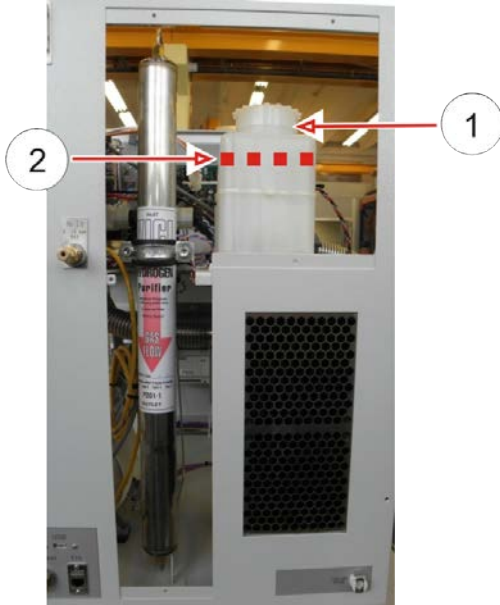


Figure 10.1: Coolant Reservoir

1	Coolant reservoir	2	Coolant high level
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- To collect the liquid, place a container of at least 1 liter volume under the drain and plug the drain tube with its fitting in the plug labelled “Coolant drain”:



Figure 10.2: Coolant Drain

The flow of coolant will start automatically.

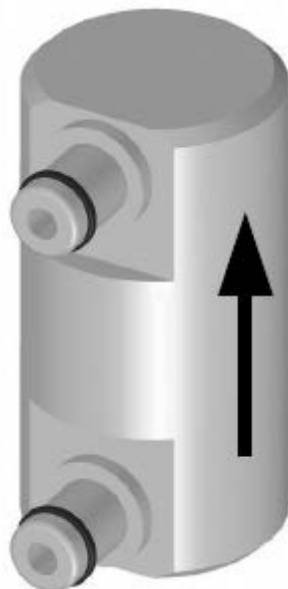
10.3.1.2 How to Fill the Cooling Circuit

The procedure is similar to the drainage procedure:

1. Stop the generator operation and power off the device (see [Generator Shut-down \[55\]](#)).
2. Disconnect the power cord.
3. Remove the cover on the rear panel to gain access to the coolant reservoir (use a Philips screwdriver).
4. Remove the cap of the coolant reservoir.
5. Fill the reservoir with coolant up to high level (approx. 2 cm from top). If some coolant is spilled, clean and dry thoroughly the inner surfaces of the generator before switching on the generator.
6. Power up the unit and check if the coolant returns into the reservoir when the pump is on. The coolant pump is on whenever the cryocooler is in operation.
7. If the coolant flow is not visible in the reservoir, stop and restart the pump until the coolant return jet can be seen in the reservoir. Repeat this operation several times if necessary. After a complete drainage of the cooling system, the tubing may contain air bubbles and coolant may not circulate immediately. If this occurs add slightly more water in the reservoir.

10.3.2 Changing the Water Deionizer Filter in the EHS

The materials required for this operation are shown in the photo below, together with the spare part numbers.



SP.H2.DBFILTER-C



Position of the deionizer filter.

The filter is located at the front part of the appliance. Open the compartment

- Press the metal quick-fit tabs (1) and remove the filter (2)

- Make that the tabs (1) are still pressed in the open position
- Fit the new filter, inserting it into the two quick-fit tabs while gently pressing down.

All filters are bidirectional but it is present an arrow situated on them that indicates a conventional sense of filters to avoid potential pollution problems in case of used filters.

Once having completed the procedure, reset the filter hour counter, used to manage the pre-alarm:

- From the main menu, scroll the screens to the left or right until displaying the **Maintenances** submenu. Press the touchscreen for half a second. The **Change Water Filter** submenu will be displayed.

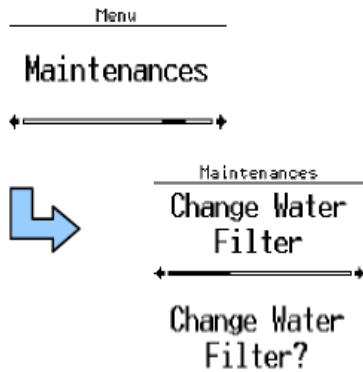


Figure 10.3: Resetting the Filter Hour Counter

- This function must be activated after changing the water deionizer filter, so as to reset the filter life hour counter and any pre-alarm messages.
- Confirm again by pressing the touchscreen for half a second.

10.3.3 EHS Water Tank Management

This section contains the relevant water tank management tasks, for more information refer to the H2 Generator User Manual delivered with the EHS.

10.3.3.1 Draining the EHS Water Tank

If needing to empty the water tank (for example, to change the water):

- Connect the drain hose provided to the special quick connector on the rear of the appliance.
- Activate the drain function from the **Water Tank** menu.

From the main menu, scroll the screens to the left or right until displaying the **Water Tank** submenu. Press the touchscreen for half a second. The **Drain Water** page will be displayed:

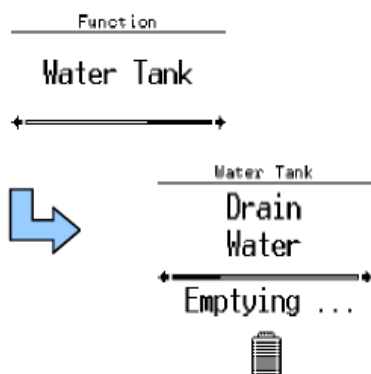


Figure 10.4: Draining the Water Tank

Selecting this item activates the function to drain the water tank. Special valves are activated to drain the water through the special connector located on the rear of the appliance.

The display will be show a symbol that represents the amount of water in the tank.

Once the tank is empty, the procedure ends automatically.

10.3.3.2 Filling the EHS Water Tank

From the main menu, scroll the screens to the left or right until displaying the **Water Tank** submenu. Press the touchscreen for half a second. Scroll the screens to the left or right until displaying the **Manual Refill** page:

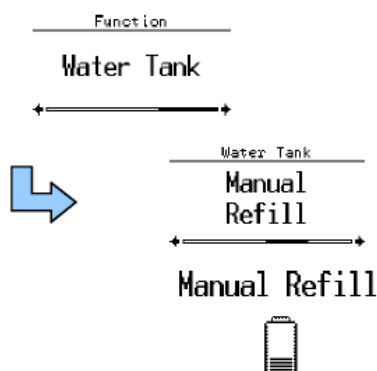


Figure 10.5: Filling the EHS Water Tank

Selecting this item activates audible and visual control of the water level in the tank, useful when filling manually.

The display will show a symbol that represents the amount of water in the tank, while the intermittent audible signal will increase in frequency as the level rises. When the tank is full, the audible signal sounds continuously.

WARNING! Fill the tank only with deionized water (ASTM II, $<0.1 \mu\text{S}$).

After filling the tank, reset the water tank alarm.

10.3.3.3 Resetting the EHS Water Tank Alarm

From the main menu, scroll the screens to the left or right until displaying the **Water Tank** submenu. Press the touchscreen for half a second. Scroll the screens to the left or right until displaying the **Reset Alarm** page:

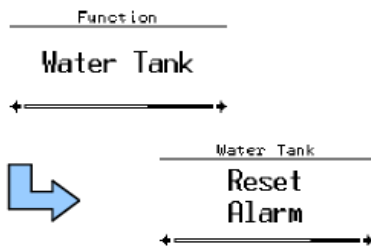


Figure 10.6: Resetting the Water Tank Alarm

Selecting this item cancels the *Check A. Refill* pre-alarm that is shown when the automatic filling procedure fails.

11 Replacement of Parts



Only trained Bruker personnel are allowed to install, mount, retrofit, repair, adjust and dismantle the unit!

11.1 User Replaceable Units

The user is authorized to replace the following fuses:

- [Power Line Fuse \[▶ 74\]](#)
- [Cryocooler Controller Fuse \[▶ 74\]](#)
- [Cryostat Vacuum Gauge Fuse \[▶ 75\]](#)

11.2 Required Parts

Part number	Description	Comments
1846188	Fuse Mini 5 x 20 mm 5.0 A T	Power line fuse.
1808869	Fuse Mini 5 x 20 mm 10.0 A T	Cryocooler controller fuse.
2271	Fuse Mini 5 x 20 mm 1.0 A F	Vacuum gauge fuse (F4).
1802701	Hydrogen gas purifier cartridge.	Removes contaminants from inlet H ₂ gas (moisture, oxygen, etc...).

Table 11.1: Spare Parts

11.3 Replacement Instructions

WARNING



Danger of injury from electrical shock!

A life threatening shock may result when the housing is open during operation.

- ▶ Only qualified personnel should open the housing.
- ▶ Disconnect the device from the electrical power supply before opening the device. Use a voltmeter to verify that the device is not under power!
- ▶ Be sure that the power supply cannot be reconnected without notice.

CAUTION



Risk of fire due to incorrect fuses usage

Replace the fuses only with the same type and electrical rating as indicated on the fuse replacement label.

11.3.1 Power Line Fuse



Figure 11.1: Line Fuses Holder

1. Power off the generator (see [Generator Shut-down \[55\]](#)) and remove the power cable from plug.
2. With a small flat screwdriver open the fuse holder.
3. Remove both fuses.
4. Install new fuses (P/N 1846188).
5. Close the fuse holder.

11.3.2 Cryocooler Controller Fuse



Figure 11.2: Cryocooler Controller Fuse

The power supply (red wire= +48V) of the cryocooler controller board is protected by a fuse located on the rear side of the cabinet.

1. Turn off the generator (see [Generator Shut-down \[55\]](#)).
2. The fuse holder is located on the rear side of the generator.
3. Unscrew the fuse holder with a flat screwdriver, remove the fuse.
4. Install new fuse (P/N 1808869).
5. Close fuse holder.

11.3.3 Cryostat Vacuum Gauge Fuse

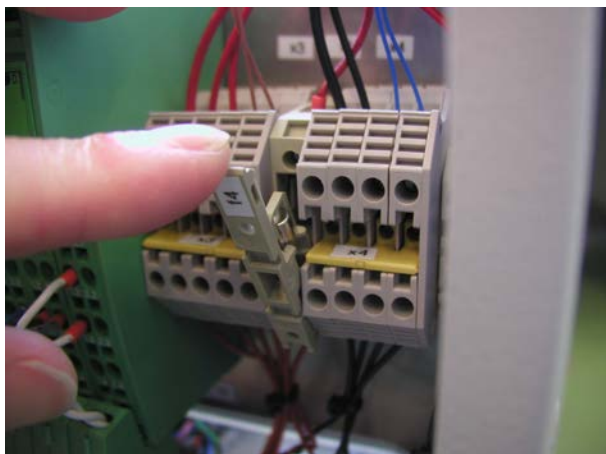


Figure 11.3: Vacuum Gauge Fuse

The vacuum gauge is protected by a fuse (F4) located on the connecting block beside the system green electronic modules.

1. Turn off the generator (see [Generator Shut-down \[▶ 55\]](#)).
2. Pull open the fuse holder.
3. Remove the fuse.
4. Install a new fuse (P/N 2271).
5. Close the fuse holder.

11.4 Returning the Unit for Repair

If the Bruker Hotline diagnoses an instrument failure that requires a part to be returned for repair, please follow the procedure listed here:

1. Contact your local Bruker office to start the repair process (see [Contact](#)). Repair is always handled by your local Bruker office. Their reply will contain all necessary information for the subsequent repair process steps.
2. They will provide you with details on the shipping address, and also in most cases a “Return Merchandise Authorization” number (RMA number) that allows references to the repair case. Always refer to this RMA number in case of questions.
3. Send the defective part to the local Bruker office and include the following documents:
 - RMA sheet (if RMA number was assigned).
 - Signed Equipment Clearance Form. The Equipment Clearance Form will be sent to you as part of step 1 (see above) with information about the returned part (part number, serial number, your contact details) already filled in.
4. Attach the relevant papers to the *outside* of the packaging, for instance in a transparent polybag.



The unit should be returned using the original container and packing assembly. If this packaging is no longer available, contact your local Bruker office for further instructions.

12 Dismantling and Disposal

Following the end of its operational life, the device must be dismantled and disposed of in accordance with the environmental regulations.



Installation, initial commissioning, retrofitting, repairs, adjustments or dismantling of the device must only be carried out by Bruker Service or personnel authorized by Bruker. Damage due to servicing that is not authorized by Bruker is not covered by your warranty.

12.1 Dismantling

Before starting dismantling:

1. Shut down the device and secure to prevent restarting.
2. Disconnect the power supply from the device; discharge stored residual energy.
3. Remove consumables, auxiliary materials and other processing materials and dispose of in accordance with the environmental regulations.
4. Clean assemblies and parts properly and dismantle in compliance with applicable local occupational safety and environmental protection regulations.

12.2 Disposal Europe

Environmental information for laboratory and industrial customers within the EU (European Union)



This laboratory product is developed and marketed for Business-to-Business (B2B), so does not fall under article 6 clause 3 of the German Act ElectroG. To meet the demands of the European Directive 2012/19/EU WEEE 2 (Waste of Electrical and Electronic Equipment) and the national Equipment Safety Act, electrical and electronic equipment that is marked with this symbol directly on or with the equipment and/or its packaging must not be disposed of together with unsorted municipal waste or at local municipal waste collecting points. The symbol indicates that the equipment should be disposed of separately from regular industrial/ domestic waste.

Correct disposal and recycling will help prevent potential negative consequences for the environment and risk to personal health. It is your responsibility to dispose of this equipment using only legally prescribed methods of disposal and at collection points defined by government or local authorities in your area.

The WEEE register number can be found on the product label of the equipment. If you need further information on the disposal of equipment or collection and recovery programs available, contact your local Bruker BioSpin sales representative. Local authorities or professional waste management companies may also provide information on specific waste disposal services available in your area.

Disposal - End of Life (EoL) information: the common procedure as defined in the sales contract with Bruker BioSpin

After the lifespan of an electrical and electronic product, Bruker BioSpin takes responsibility for final disassembly and correct disposal in accordance with the European directive 2012/19/EU WEEE 2.

Bruker BioSpin offers to take back the equipment (only for deliveries after 23.03.2006) after termination of use at the customer site upon request by the customer. This request must be affirmed when the equipment is ordered from Bruker BioSpin. Additional costs for dismantling and transport service will apply!

Only 100% pre-decontaminated equipment can and will be accepted by Bruker BioSpin. A release document for decontamination can be inquired from your nearest Bruker BioSpin contact site, also to be used when repairs, going back to Bruker sites, are requested.

In compliance with WEEE II directive: **2012/19/EU**

12.3 Disposal USA and Other Countries

Disposal of these materials may be regulated due to environmental considerations. For disposal or recycling information, please contact our local office or your local authorities, or in the U.S.A., contact the Electronics Industry Alliance web site at www.eiae.org.

13 Contact

Manufacturer:

Bruker BioSpin SAS
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67166 WISSEMBOURG Cedex
France
Phone: + 33 3 88 06 60 60
Fax: + 33 3 88 06 60 05
<http://www.bruker.com>
WEEE FR311020911

NMR Hotlines:

Contact our CMR service centers.

Bruker BioSpin CMR provides dedicated hotlines and service centers, so that our specialists can respond as quickly as possible to all your service requests, applications questions, software or technical needs.

Please select the CMR service center or hotline you wish to contact from our list available at:

<https://www.bruker.com/service/information-communication/helpdesk.html>

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