BSMS System

for AVANCE NEO

User Manual

Version 001

Innovation with Integrity

NMR

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1 Introduction

This manual is intended to be used by trained device users. This user manual contains information and safety information that are necessary for the safe operation of the device.

Any user maintenance and repairs are to be accomplished using the information in this manual.

Consider all safety references!

1.1 Intended Use

The device has been designed and constructed solely for the intended use as electronic subsystem of the AVANCE NEO NMR spectrometers series of Bruker.

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.

1.2 Policy Statement

It is Bruker's policy 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. Field Service Engineers are advised to check regularly with Bruker for updated information.

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

1.3 Installation and Initial Commissioning

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.

1.4 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 conclusion of the contract shall apply.

1.5 Warranty Terms

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

1.6 Customer Service

Our customer service division is available to provide technical information. See the chapter *Contact [▸ 221]* 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.

1.7 Product Safety and Electromagnetic Compatibility

The device complies with the following safety requirements:

- IEC 61010-1:2010+AMD1:2016
- EN 61010-1:2010
- UL 61010-1 3rd edition (2012-05-11)
- CAN/CSA-C22.2 NO. 61010-1-12 (R2017)

2 Safety

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

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

2.1 General

Before you start any repair inside of the device, be aware of the high 230V/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 can re-power the system without your approval.

2.2 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.

2.3 Personnel Requirements

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

2.3.1 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 measurements 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.

2.3.2 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.

2.3.3 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

2.4 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.

2.5 Position of the Emergency Stop Button

The BSMS system is a subunit of the spectrometer electronics cabinet.
As such it has no mains switch or emergency stop button.

In case of an emergency use the mains power switch at the back of the electronics cabinet.

2.6 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.

2.7 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.

2.7.1 General Workplace Dangers

⚠ WARNING

Risk 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

Risk 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 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.

2.7.2 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

Risk to life 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

Risk 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

Risk 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.

Figure 2.1: Warning Labels on AV4 Fan Tray and AV4 PSM-48V

2.7.3 Mechanical Dangers

⚠ 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.

⚠ 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 it.

2.7.4 Dangers from Gases Under Pressure

⚠ WARNING

Risk of injury due to movements caused by stored pneumatic forces!

Pneumatically driven components may move unexpectedly due to stored residual forces, causing serious injuries.

- ▶ Work on the pneumatics system must only be carried out by trained pneumatics technicians.
- ▶ Before starting work on the pneumatics system, ensure that it has been completely depressurized. The pressure accumulator must be completely relieved.

⚠ WARNING

Accident hazard from asphyxiation

A break in the pneumatic hose may result in the uncontrolled exit of nitrogen into the laboratory.

- ▶ An oxygen warning device should be present in the laboratory if the device is operated with nitrogen.
- ▶ Note that leakage from the main supply line cannot be stopped by the device!

Overpressure Valve

The high pressure system includes an overpressure valve which safely reduces the excess pressure in the event of inadmissible pressure conditions developing as a result of faulty operation, component failure or other irregular events.

2.8 Environmental Protection

NOTICE

Potential environmental damage from incorrect handling of pollutants!

Incorrect handling of pollutants, particularly incorrect waste disposal, may cause serious damage to the environment.

- Always observe local environmental regulations regarding handling and disposal of pollutants.
- Take the appropriate actions immediately if pollutants escape accidentally into the environment. If in doubt, inform the responsible municipal authorities about the damage and ask about the appropriate actions to be taken.

The following pollutants are used:

Nitrogen gas Nitrogen gas may cause suffocation at high concentrations. Disposal of the empty gas cylinders must be performed by a specialist disposal company.

Cleaning liquids Cleaning liquids incorporating solvents contain toxic substances. They must not be allowed to escape into the environment. Disposal must be carried out by a specialist disposal company.

2.9 Signs and Labels

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. New signs and labels can be obtained from Bruker Service.

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

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. The warning label may be ordered using Bruker Part Number 23948.

Danger Spot

Warning indicating a danger spot in work rooms.

The warning label may be ordered using Bruker Part Number 23944.

Cold spot

Warning indicating a cold spot in work rooms.

The warning label may be ordered using Bruker Part Number 23943.

Hot spot

Warning indicating a hot spot in work rooms.

The warning label may be ordered using Bruker Part Number 23945.

Protection

Never Open!

Warning indicating.

The warning label may be ordered using Bruker Part Number Z129088.

Personal Protective Equipment

Protective Goggles (DIN EN 166, 170 & 172)

Protect the eyes from injury due to flying cold gases, liquids and parts. The safety label may be ordered using Bruker Part Number 23946.

Protective Gloves (DIN EN 388, 420 & 511)

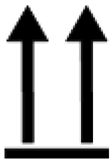
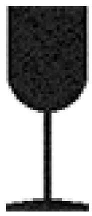
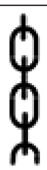
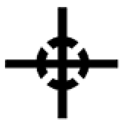
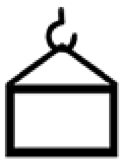
Protect the hands from injury caused by contact with extremely cold gases, liquids or surfaces and for protection from injury caused by rough edges. The safety label may be ordered using Bruker Part Number 23947.

3 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.

3.1 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.

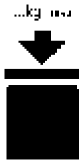
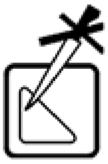
Permitted Stacking Load		Indicates packages which are partially stackable. Do not exceed the maximum load-bearing capacity specified on the symbol in order to avoid damaging or destroying the content.
Do not Damage Air-tight Packaging		The packaging is air-tight. Damage to the barrier layer may render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

Table 3.1: Symbols on the Packaging

3.2 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.

3.3 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 as 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 it in accordance with the relevant applicable legal requirements and local regulations.

3.4 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.

4 AV4 BSMS System

4.1 Introduction

During the long time period since 1998 when the BSMS/2 mainframe was introduced into market, several extensions, enhancements and adaptations have been carried out.

Shortly after the introduction of the **AVANCE II** NMR system in 2005, a wide-ranging modernization was taking place by enabling the BSMS/2 to be operated via ethernet TCP/IP communication and WEB based control. A major part of the classic BSMS functions was being reworked, and the the former, up to 15 years old boards like CPU/3, LCB and the various SCB7 and SCB13 shim current boards were replaced by new units. The successor boards where developed based on the latest technology available, and they where therefore higher integrated and provided better performance, higher resolution and increased stability.

The next spectrometer generation **AVANCE III** focused mainly on the design and the performance of the pulse and frequency generation. On the BSMS side, the use of the new BSMS/2 GAB/2, which provided integrated preemphasis control, became mandatory, and the development for the replacement of the old Lock RF units L-TX, L-RX and the 19F Lock Option was started at that time.

Latest since introduction of the **AVANCE III HD** generation, spectrometers have been delivered by default with the new Lock Transceiver, combining the former L-TX and L-RX units and providing extended Lock features such as automatic locking on multi peak solvents and the new NMR Thermometer. In addition, the Lock Transceiver provides enough RF power for 2H gradient shimming, and there is a dedicated 19F Lock Transceiver available for locking on 19F solvents.

In addition, the Variable Temperature System has been integrated into the BSMS/2. With this step the former family of BVT3000 and BVT3200 units and the former pneumatic units PNK3, PNK3S and PNK5 as well as the SLCB/2 and SLCB/3 boards have been replaced by the new Sensor & Pneumatics Board (SPB) and the Variable Power Supply Board (VPSB). This new BSVT temperature control system is mandatory for operating the new iProbe type RT probes, the heated and cooled SampleCase variants and the NMR Thermometer.

With the introduction of the **AVANCE NEO** NMR system, the BSMS chassis has been redesigned. The transformer based linear power supply section has been replaced by efficient state of the art AC/DC and DC/DC converters. The slots in the **AV4 BSMS** Chassis have been unified for more flexibility. The chassis now provides enough space and power for up to three AV4 GAB/2 and two AV4 VPSB-DC or AV4 VPSB-DC-E. The VPSB-DC-E is a compact replacement for the former, external BVT booster models.

Figure 4.1: AV4 BSMS Chassis with 3-Axis Gradient for AVANCE NEO

4.1.1 Subunits in the AV4 BSMS

Shim

The SCB20 (Shim Current Board) provides the required precision for all existing types of shim systems and can therefore replace any variant of former SCB7 and SCB13. Connectivity to the different Shim Systems is provided by a set of various adapters. For BOSS1 Shim Systems, one SCB20 is sufficient, whereas two SCB20 cover the whole range of currently available Shim Systems, including BOSS1 (the connector of the left hand side SCB20 remains open in that case).

Lock

The ELCB (Ethernet based Lock Control Board) incorporates the lock functions like the lock control algorithm and the H0 current source. In addition, this ELCB acts as communication gateway between the workstation and the various subunits inside of the BSMS. The BSMS can be directly accessed with a standard Internet browser via HTTP protocol or allows hardware independent communication with TopSpin 2.0 and higher by using a CORBA interface.

The highly integrated Lock RF unit L-TRX provides a direct digital RF transmitter and receiver and includes all what is necessary to allow gradient shimming on 2H. For locking on 19F solvents, there is a separate 19F Lock Transceiver available. The L-TRX is frequency specific, whereas the 19F Lock Transceiver covers a wide frequency range.

Gradient amplifier

With the introduction of the AVANCE NEO in 2017, the BSMS/2 GAB/2 has been replaced with the AV4 GAB/2. In addition to the built-in pre-emphasis capability, which was already available on its predecessor, the new model provides daisy chainable control (LVDS48). Together with the extendable power supply, this allows a modular gradient amplifier configuration in a single AV4 BSMS chassis driving up to three gradient coils (XYZ), and it is possible to extend the gradient control chain for external gradient amplifiers (e. g. for micro imaging).

Variable temperature control, sample handling and level monitoring

In 2010 there has been made a higher integration of the pneumatic functions for sample handling (lift, spin), the variable temperature control (power supply and various sensor interfacing, gas flow controls) and fill level monitoring for the magnet (helium and nitrogen level). These functions are now provided by the SPB / SPB-E and VPSB boards, which replace the former SLCB and PNK, the built in BVT3200 (with corresponding power supply) or any of the stand alone BVT3000 variants.

In 2011 a digital nitrogen level sensor has been introduced together with the ASCEND family of magnet systems.

With the introduction of the AVANCE NEO in 2017, the BSMS/2 VPSB was replaced with the AV4 VPSB-DC or the AV4 VPSB-DC-E. Both boards take their power and control signals directly from the backplane, no separate mains power supply and LVDS control cable are necessary anymore.

All configurations with Standard Bore (SB) can be covered with the AV4 VPSB-DC, whereas Wide Bore (WB) systems are equipped with an AV4 VPSB-DC-E, which includes the booster functionality and makes the booster BVTB3500 obsolete.

Figure 4.2: AV4 BSMS Chassis Rear View

4.1.2 Software Control of AV4 BSMS

All subunits may be accessed by a Web-based service tool, making service handling easy and comprehensive.

The ELCB has an automatic save configuration mechanism and stores all the parameters (e. g. for Lock, Shim, Lift, HE-Level measurement) within its nonvolatile memory (NVM). To be able to switch back to a known state, a saved configuration from the installation may be restored later - this fail-safe configuration can be re-activated by any user.

All activities of the AV4 BSMS and the data exchange with the TopSpin application are logged by the ELCB software. This information is accessible by the service tool and, additionally, it is periodically transferred to the workstation to keep a detailed long-term history for trouble shooting. It is configurable how detailed the activities are logged.

4.2 Rack Configurations

In the following sub chapters, there are the various standard configurations described in detail. For a list of the part numbers of the electronics units, please refer to *Replacement of Parts [▹ 215]*.

NOTICE

Units of previous BSMS generations that are not explicitly mentioned in this manual are not compatible to the AV4 BSMS Chassis!

- VME based Devices and the old Lock RF Units L-TX and L-RX will be destroyed when powered up in the AV4 BSMS Chassis.
- Examples of VME Devices: SLCB, SLCB/2, SLCB/3, PNK, BSMS 2HTX, GAB, SCB13.

AV4 Units shall only be used in the AVANCE NEO generation of NMR Spectrometers.

4.2.1 Board Location

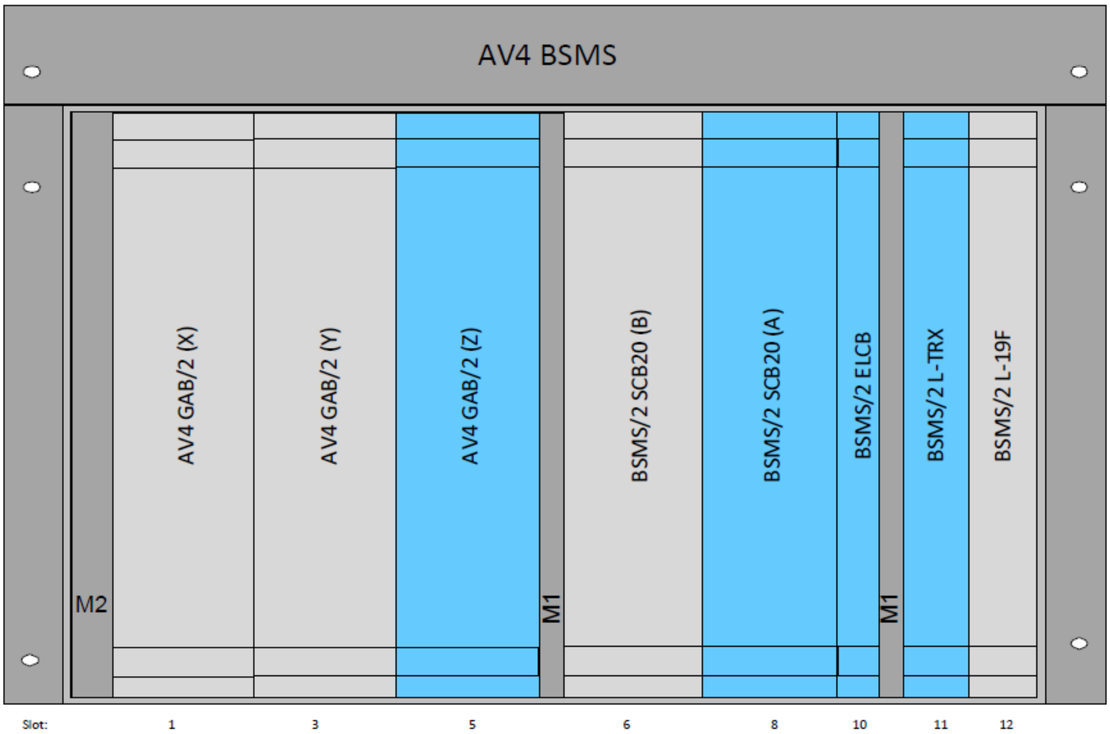


Figure 4.3: Typical Configuration, BOSS1 and Z-Gradient Shown in Blue (front side)

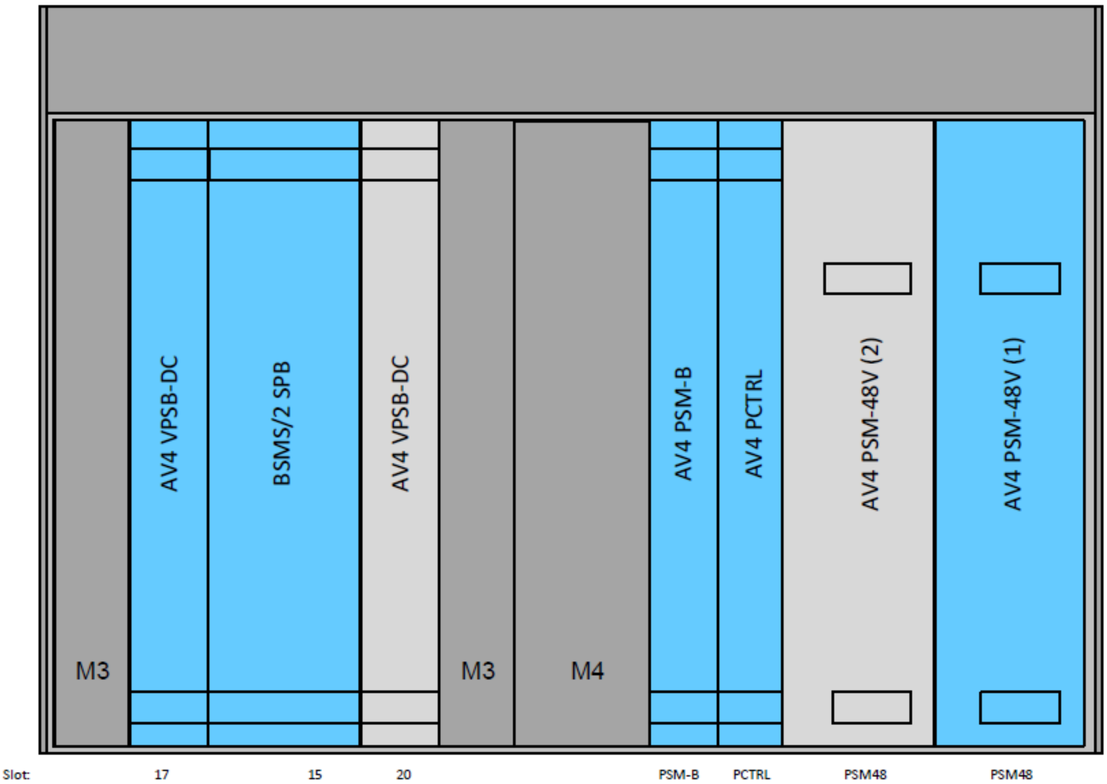


Figure 4.4: Typical SB Configuration Example, Options Shown in Gray (rear side)

An additional VPSB-DC would provide two extra heater channels, e. g. for connecting accessory heaters such as the heater for SampleCase cooled, and two additional auxiliary channels, e. g. for connecting a LN2 level measurement device.

Note: Empty slots must be covered with blind plates.

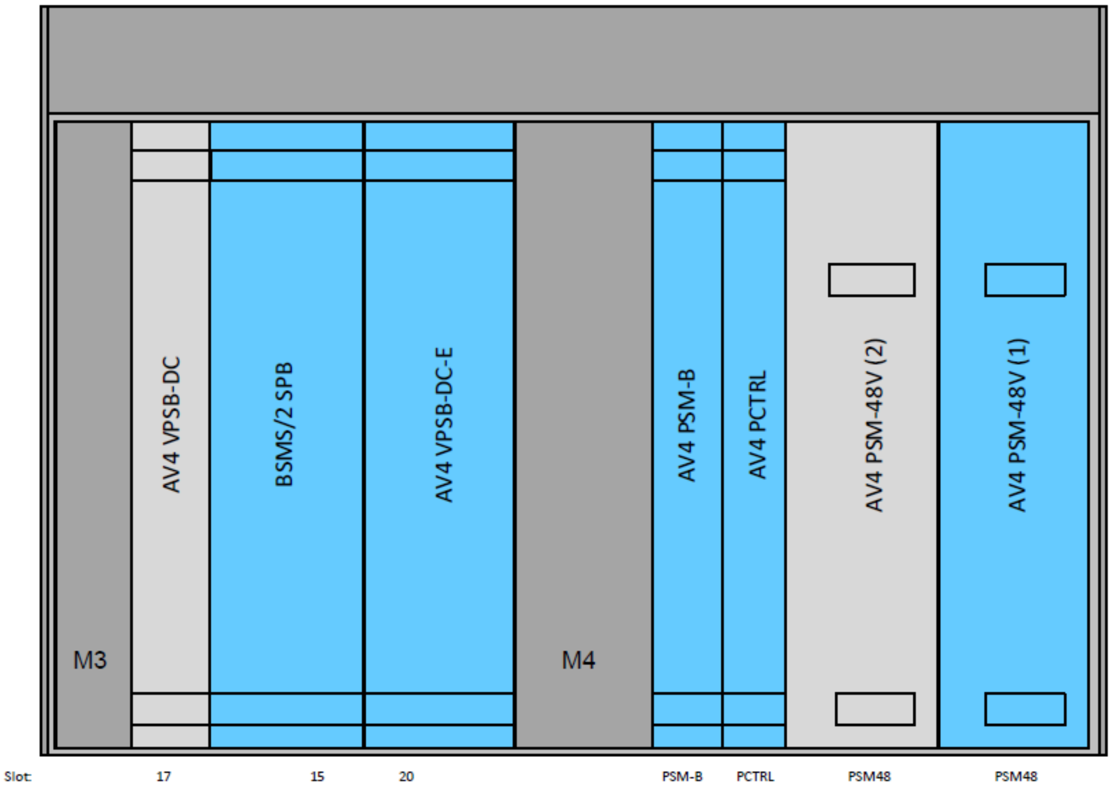


Figure 4.5: WB Configuration with SPB-E, VPSB-DC-E and Power Supply (rear side)

Pos	Part Number	Description
M1	Z13644	FRONTPLATTE BLIND 2TE
M2	Z2778	FRONTPLATTE BLIND 4TE
M3	Z12489	FRONTPLATTE BLIND 6TE
M4	Z12170	FRONTPLATTE BLIND 12TE
	Z12153	SCREW RRCH KR M2,5 x 8,5
	25958	SCREW RRCH KR M2,5 x 12,3

Table 4.1: Part Numbers of Blind Plates and Screws

4.2.2 Power Supply Requirements

For most configurations one AC/DC Power Supply **AV4 PSM-48V** delivers sufficient power for the whole AV4 BSMS System. Some extended configurations require more power which can be supplied by plugging a second AV4 PSM-48V into the chassis. The second PSM-48V unit is required if at least one of the following points apply:

- More than one AV4 GAB/2 is installed.
- More than one VPSB-DC(-E) is installed.
- Wide bore (WB) systems, which may require more than 250 W of heater power on channel 1 of the VPSB-DC-E.

4.3 System Architecture / Overview

The following diagram shows the functional system architecture from the User Interface (TopSpin and standard web browser for the service engineer) across the BSMS down to the specific hardware subsystems.

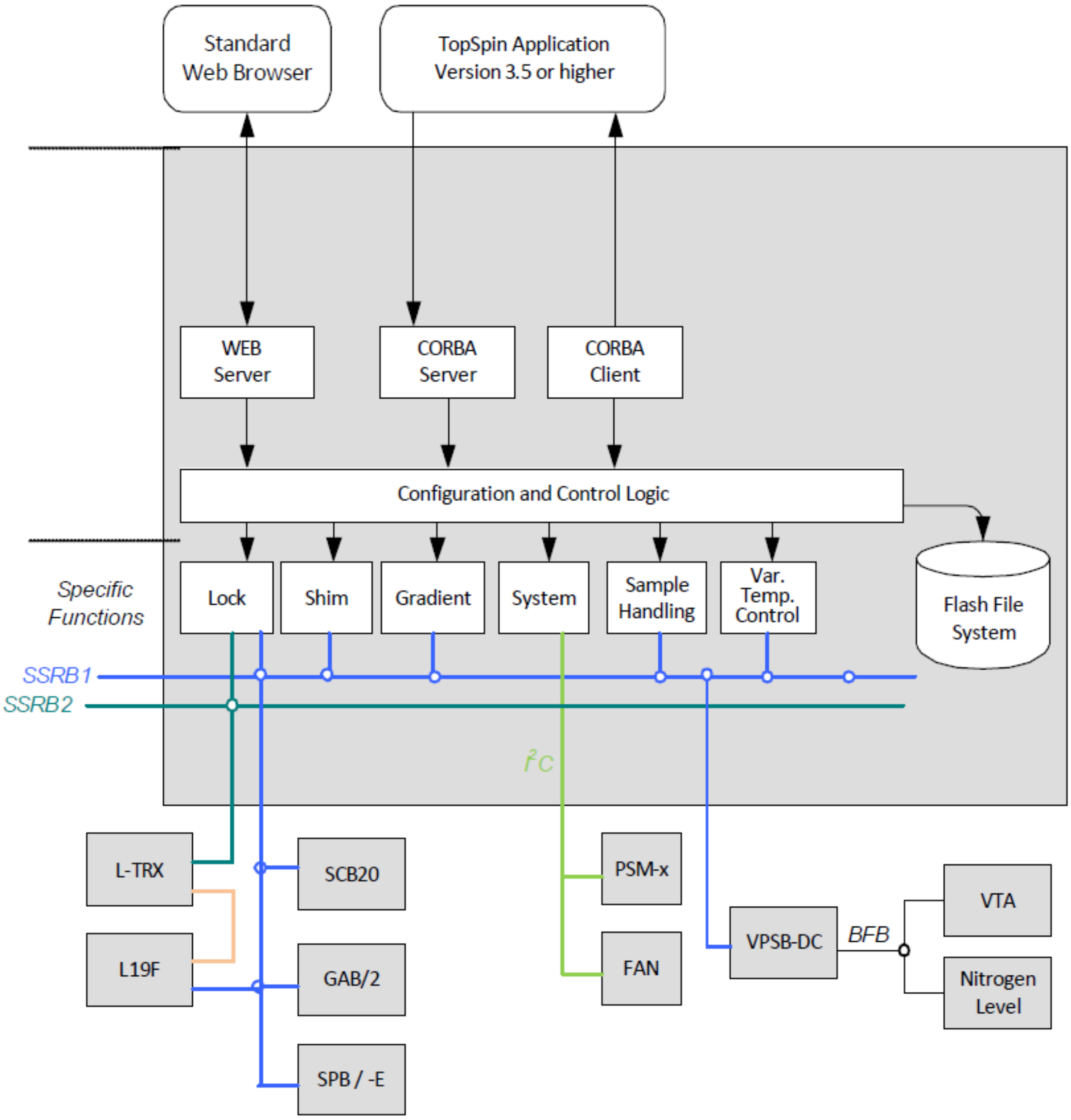


Figure 4.6: System Architecture Overview

Firmware:

- BsmsCheckDownload.txt contains the information about all required firmware versions for all installed sub units in a BSMS
- ELCB firmware provides all functions for the ELCB (mainly lock control), and in addition the control logic and driver functions for all the installed sub units.
- FPGA-Design (field downloadable) is required for L-TRX, SCB20, AV4 GAB/2, SPB(-E), and VPSB-DC.
- Additional controller software is installed on the various VT-Adapters, BSCU type cooling units and digital nitrogen level sensors, which are also connected over the BFB (Bruker Field Bus [1]).
- Additional Programmable Logic Controller program is installed on the SampleCase Controller.

4.4 Service Web

All operational functions for NMR application are provided by the CORBA interface, as described before. An additional set of operations is reserved for service engineers, e. g. for downloading new firmware, calibration and diagnostics. These functions are only available on the Service Web, which is the successor of the former BSMS tool. It is no longer necessary to use a specific client software for service access (any Web browser can be used), the new concept provides a graphical user interface and is therefore much easier and comprehensive.

4.4.1 IP Address of the AV4 BSMS

The actual IP address and port number for accessing the Service Web can be obtained by running TopSpin and typing **ha**. After scanning of the spectrometer network, which takes several seconds, all connected IP devices are listed in a dialog (e. g. the BSMS on http://149.239.99.9:10000/bsms.html).

If it is not possible to reach the AV4 BSMS by the Web browser (e. g. if a non-TopSpin DHCP server has assigned an unknown IP address to the AV4 BSMS) then the AV4 BSMS can be contacted on the fixed service IP Address 10.236.99.20 that is always available. In this case, the service computer must be directly connected to the ELCB Ethernet port or to an internal device port of the AV4 Router and the network interface must be configured accordingly.

For further details about the AV4 ETHERNET ROUTER please refer to the technical manual *AQS System for AVANCE NEO*.

[1] This peripheral bus has been introduced 2010 together with the BSVT system. Connectors can be found on BSMS/2 VPSB, AV4 VPSB-DC and SPB-E boards.

4.4.2 Main Service Page

Figure 4.7: BSMS Main Service Page

- **Service Page**: Access to the logging information and configuration of the logging. A service engineer can log in on this page (in order to get access to the extended functions/ parameters).
- **Device Setup**: Shows the hardware configuration (connected subsystems, hardware codes), the versions of the actually loaded firmware and the required firmware versions. This page provides also the links to the specific firmware download pages (see later on).
- **Calibration**: Links to the different specific calibration routines that are necessary upon installation of a spectrometer (e. g. for helium level measurement, air pressure for lift, and so on).
- **Variable temperature control** (if SPB / -E is installed): Information, activation and configuration (setting of aimed temperatures, temperature and power limits, aimed VT gas flow, regulation settings, and so on).
- **Magnet Monitoring**: Monitoring of cryo levels in the magnet. The N2 level monitoring requires an AV4 VPSB-DC or SPB-E.
- **Sample Handling**: Commands and configuration of sample lift, sample rotation and SampleCase (extended sample transport - related hardware needs to be installed for this feature).
- **Shim**: Commands and configuration of Shim system (e. g. download of BOSS file) and diagnostic functions for trouble shooting.

- **Lock**: Commands and configuration of NMR Lock (optional ^{19}F lock if this feature is installed) and diagnostic functions / self-tests for trouble shooting. This section provides also service access to the lock RF board L-TRX.
- **Gradient**: Information and configuration of gradient amplifiers if AV4 GAB/2 are installed.
- **2H-TX control**: obsolete
- **Power Supply and Fans**: Diagnostic information related to the rack power supplies and ventilation.
- **ELCB info**: Detailed info about ELCB, including ethernet info and configuration.

5 Chassis (Mainframe)

5.1 Overview

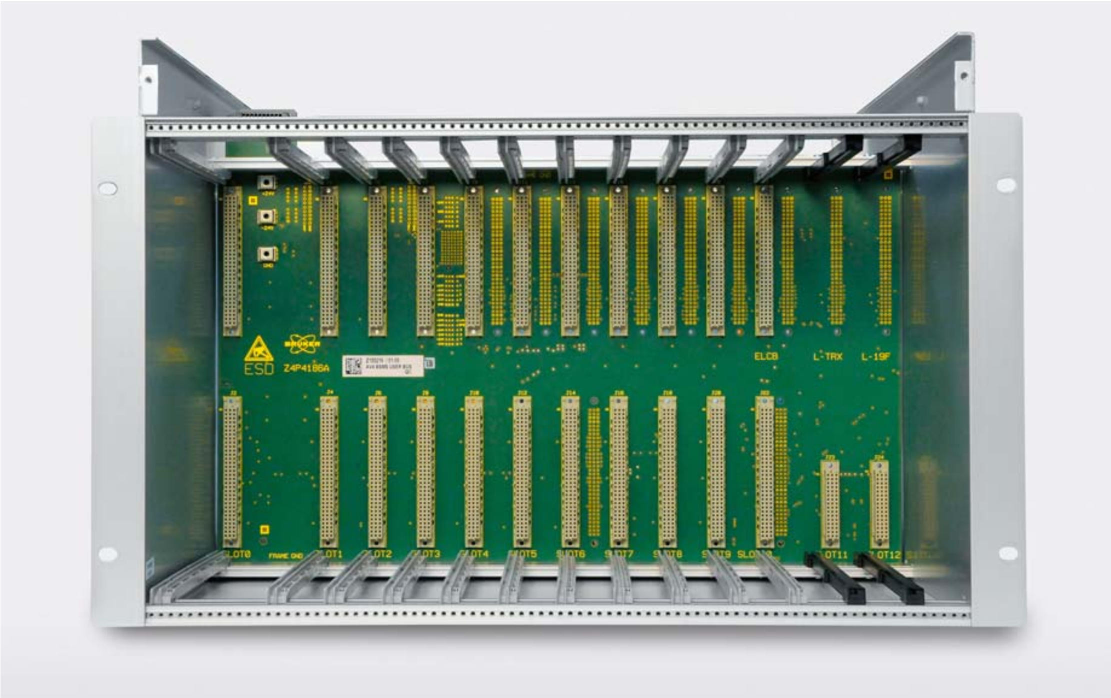


Figure 5.1: BSMS Chassis Front View

5.2 Description

The AV4 BSMS Chassis is the mainframe for the AVANCE NEO BSMS system. It contains a backplane with slots for all necessary functional units and power supplies. These include:

- ELCB Lock Control Board
- L-TRX Lock Transceiver
- L-19F 19F Lock Extension
- AV4 GAB/2 Gradient Amplifier
- SCB20 Shim Current Board
- SPB Sensor and Pneumatic Board
- AV4 VPSB-DC Variable Power Supply
- Power Supply Modules AV4 PSM-48V, AV4 PSM-B, AV4 PCTRL

Units of previous BSMS generations that are not explicitly mentioned in this manual are not compatible to the AV4 BSMS Chassis!

Cooling is provided by six fans in the AV4 BSMS Fan Tray inserted on the top. For more information about the fan tray see *Fan Tray [▸ 43]*. For details about the proper chassis configuration please refer to *Rack Configurations [▸ 30]*.

5.2.1 Power On/Off

> The BSMS Chassis has no power On/Off switch!

The AV4 BSMS Chassis has neither a mains power inlet nor a mains distribution.

The mains power is routed via the Power Distribution Unit (PDU) of the cabinet directly to each AC/DC power supply module of the chassis. The PDU controls the power-up/down cycle of the individual PSMs and thus the chassis.

> No operation without Fan Tray!

The chassis power supply does not power up if no fan tray is present. It automatically turns of (without warning) when the fan tray is removed during operation.

5.2.2 Backplane Functions

The backplane (user bus) incorporates various functions:

- Power supply distribution
- SSRB distribution and termination
- I^2C bus distribution
- Slot ID
- Auxiliary control signal and pulse distribution

There are no active components placed on the backplane. The only exception is a non-volatile memory for system identification (BIS).

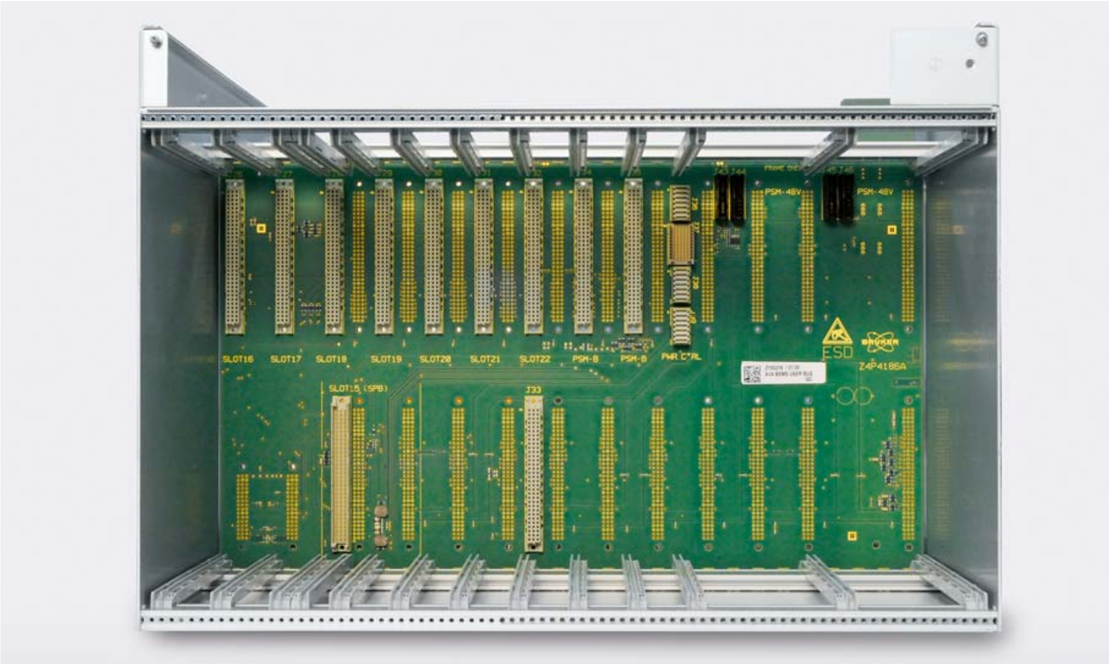


Figure 5.2: BSMS Chassis Rear View including Fan Tray

Slot	Slot ID	SSRB Address	I2C Bus No.	H0 Current	Fused 24V Section	He Supply	H0 Supply	Typical Unit
Slot 0	0	0	7		1			AV4 GAB/2 [X]
Slot 1	1	1	7		1			
Slot 2	2	2	7		1			AV4 GAB/2 [Y]
Slot 3	3	3	7		2			
Slot 4	4	4	7		2			AV4 GAB/2 [Z]
Slot 5	5	5	7		3			
Slot 6	6	6	7		3			SCB20 [B]
Slot 7	7	7	7		3			
Slot 8	8	8	1	✓	4			SCB20 [A]
Slot 9	9	9	1	✓	4			
Slot 10	10	10	Master	✓	Lock		✓	ELCB
Slot 11	11	11	-		Lock			L-TRX
Slot 12	12	12	-		-			L-19F
Slot 15	15	15	1		SPB	✓		SPB(-E)
Slot 16	16	16	2		AUX			-
Slot 17	17	17	2		AUX			AV4 VPSB-DC
Slot 18	18	18	2		AUX			-
Slot 19	19	19	2		AUX			-
Slot 20	20	20	2		AUX			AV4 VPSB-DC(-E)

Slot	Slot ID	SSRB Address	I2C Bus No.	H0 Current	Fused 24V Section	He Supply	H0 Supply	Typical Unit
Slot 21	21	21	2		AUX			-
Slot 22	22	22	2		AUX			-
Slot 23	23	23	2		AUX	✓	✓	-
Slot 24	24	24	3		AUX	✓	✓	AV4 PSM-B
Slot 25	25	-	7					AV4 PCTRL
Slot 26	-	-	5					AV4 PSM-48V [2]
Slot 27	-	-	4					AV4 PSM-48V [1]
Fan Tray	-	-	6					Fan Tray
Backplane	-	-	6					Bpl

Table 5.1: Slot Functions

5.2.3 Part Numbers

Bruker Part No.	Description
Z152144	AV4 BSMS CHASSIS

Table 5.2: Part Numbers

5.2.4 Technical Data

Technical

Number of front slots	13	Slot
Number of rear slots: 5x standard PSM (48V/B/PCTRL), 1x SPB, 4x VPSB	10	Slot
SSRB clock	10	MHz

Mechanical

Length	48.3	cm
Width – 19 inch	48.3	cm
Height 6 + 1 HU	31.1	cm
Weight	5	kg

5.3 Troubleshooting

The AV4 BSMS Chassis can only be replaced as a whole (FRU). There are no serviceable parts on the Chassis itself.

If an FRU needs to be replaced, contact your Bruker Service Representative.

Detected failures are reported with event messages. Event messages are displayed on the TopSpin screen and can be viewed on the Service Web pages. General information on trouble shooting, error handling and failure reporting is available in chapter *Troubleshooting [▶ 213]*.

6 Fan Tray

6.1 Overview

Figure 6.1: AV4 BSMS Fan Tray Top View

6.2 Description

The Fan Tray is located on top of the BSMS chassis as a separate unit. It contains six DC cooling fans. The fans are controlled and supervised by an on board control print with I^2C bus interface. It connects directly to the BSMS Chassis backplane (user bus).

Control Functions

- Fan speed control: full speed/reduced speed.
- Supervision of each individual fan: On/Off
- BIS.

6.2.1 Part Numbers

Bruker Part No.	Description
Z152145	AV4 BSMS FAN TRAY

Table 6.1: Part Numbers

6.2.2 Technical Data

Technical

Number of fans	6	
Fan supply voltage	12	Vdc

Mechanical

Length	47.0	cm
Width – 19 inch	48.3	cm
Height 1 HU	4.5	cm
Weight	2.5	kg

6.3 Troubleshooting

The Fan Tray can be replaced as a whole (FRU).

If an FRU needs to be replaced, contact your Bruker Service Representative.

Figure 6.2: Fan Tray Fan Numbering for Troubleshooting

Detected failures are reported with event messages. Event messages are displayed on the TopSpin screen and can be viewed on the Service Web pages.

6.3.1 Diagnostics

The fan status is supervised by the ELCB Software. Alternatively, it can be viewed on the Service Web page.

Fan State and Control		
Air temperature supervision state		monitoring: temperature OK
Air exhaust temperature		24.5°C
ELCB temperature		26.0°C
LTRX temperature		25.0°C
Fan speed	reduced	Toggle Fan Speed
Fan 1		rotating
Fan 2		rotating
Fan 3		rotating
Fan 4		rotating
Fan 5		rotating
Fan 6		rotating

Figure 6.3: Service Web: Fan Supervision

7 Power Supply Modules

7.1 System Overview

Figure 7.1: BSMS Power Supply Modules Overview

7.2 System Description

The basic power supply system of the AV4 BSMS Chassis consists of one or two AC/DC and one DC/DC power supply modules (PSM). Depending on the configuration one auxiliary PSB may be used.

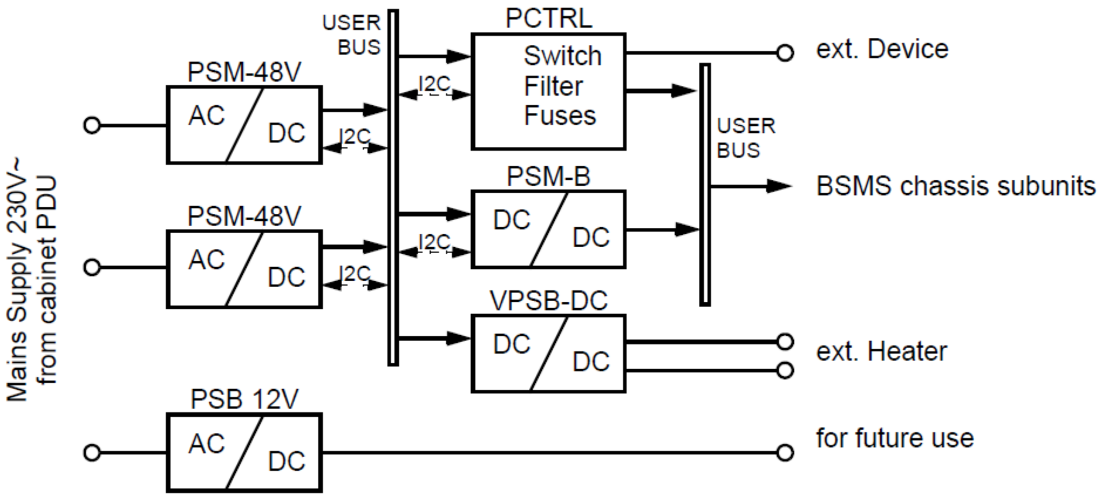


Figure 7.2: Power Supply System

7.3 Unit Description

7.3.1 AV4 PSM-48V Power Supply Module

The AC-input connector is on the front panel, the DC-output connects to the backplane.

The supply status is indicated on the front panel.

The unit has no serviceable parts or fuses.

Figure 7.3: AV4 PSM-48V Overview

7.3.2 AV4 PSM-B Power Supply Module

The supply status is indicated with one LED on the front panel.

The unit has no serviceable parts except three fuses.

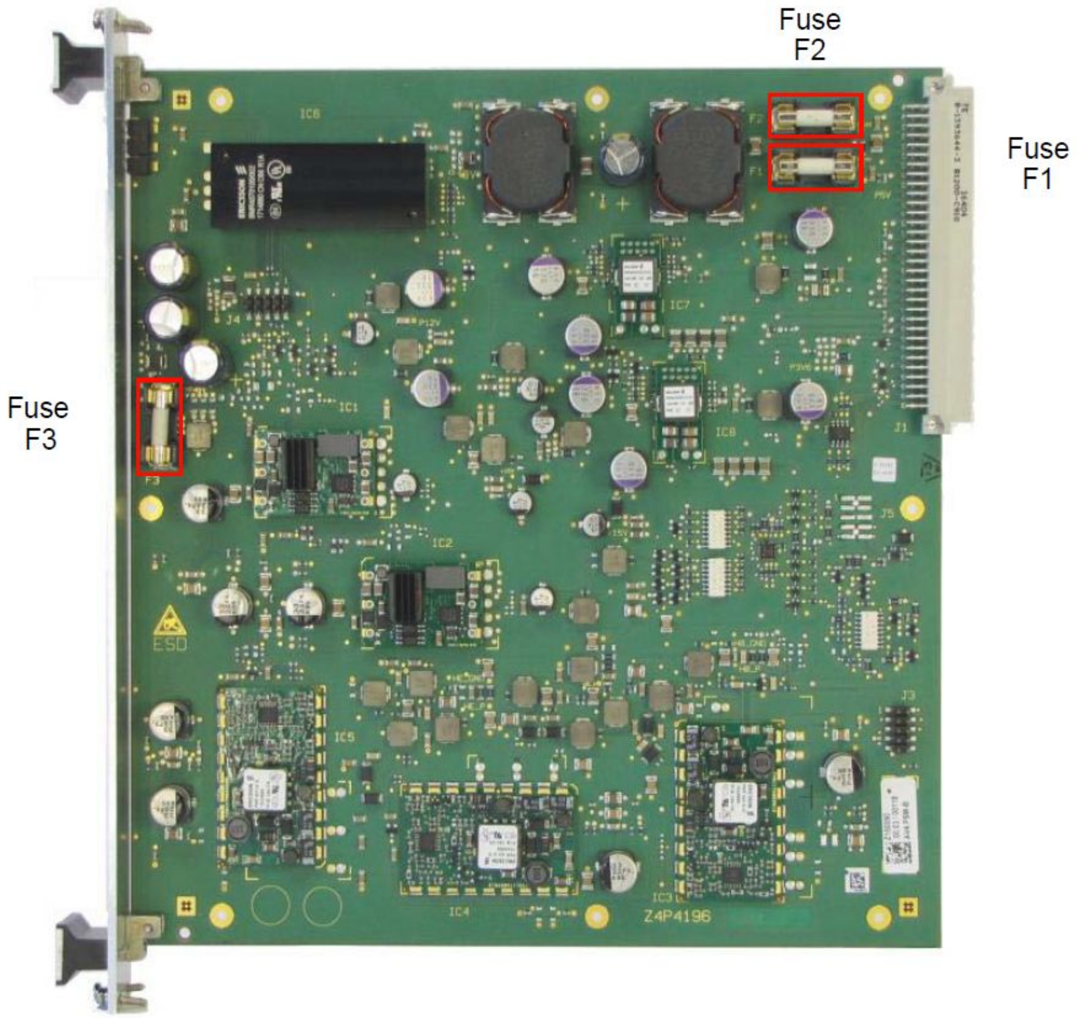


Figure 7.4: PSM-B Fuse Location

Supply	Fuse	Part No.	Value
48V Input	F1, F2	49216	8 AT H
Input to low power converters	F3	1802109	3.15 AT H

Table 7.1: Fuses AV4 PSM-B

7.3.3 AV4 PCTRL Power Control Module

The PCTRL module consists of several filters and fuses on a printed circuit board. The +/-24V input and most of the outputs connect to the backplane.

Additional features:

- Power-Switching
- Supervision (Voltage, Current, Fuses)
- I2C Active Bus Switch

The supply status is indicated with three LEDs on the front panel.

The unit has no serviceable parts except fuses.

The connectors on the front panel are reserved for future use. Do not connect.

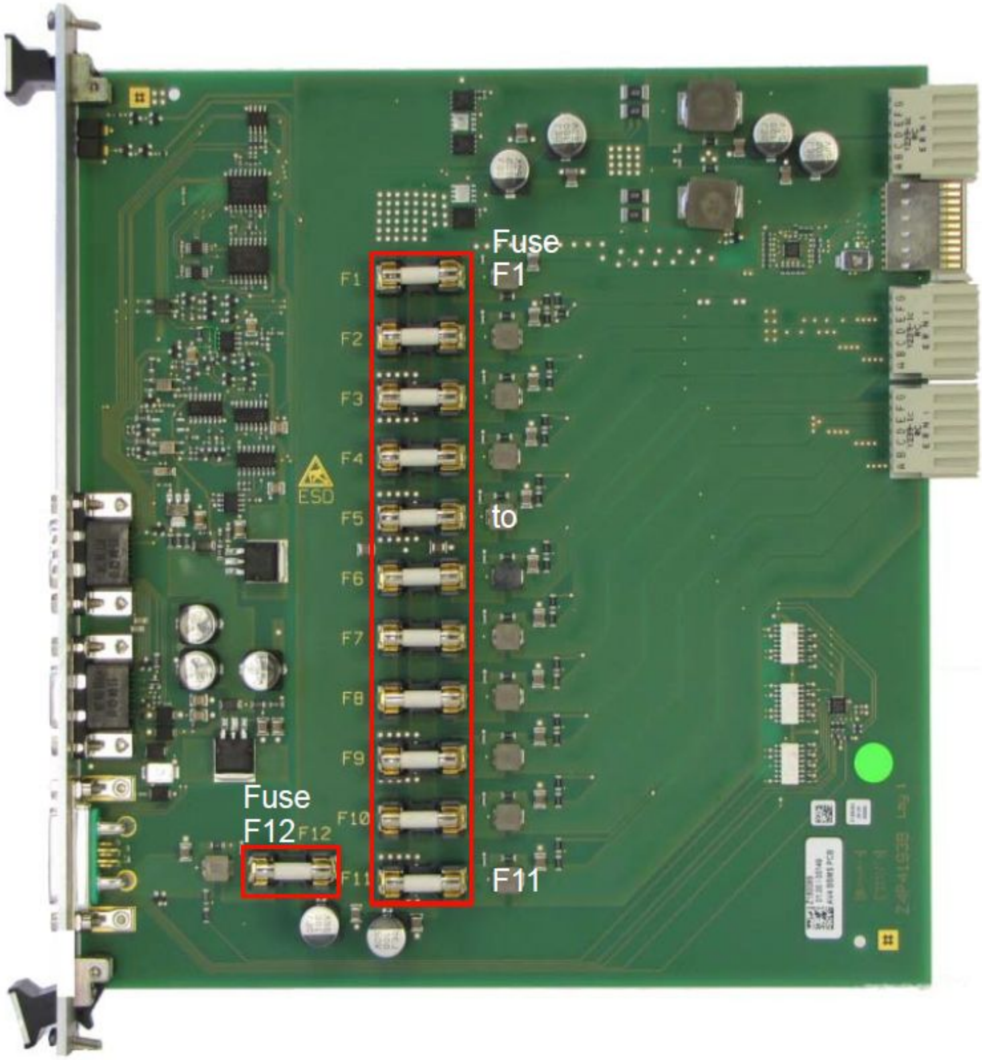


Figure 7.5: PCTRL Overview

Supply	Fuse	Part No.	Value (IEC)
+24V AUX Slot 16 .. 24	F1	49216	8.0 AT H
+24V Section 1Slot 0 .. 2	F2	49216	8.0 AT H
-24V Section 1Slot 0 .. 2	F3	49216	8.0 AT H
+24V Section 2Slot 3 .. 4	F4	49216	8.0 AT H
-24V Section 2Slot 3 .. 4	F5	49216	8.0 AT H
+24V Lock Slot 10 .. 12	F6	1802109	3.15 AT H
+24V SPB Slot 15	F7	49216	8.0 AT H
+24V Section 3Slot 5.. 7	F8	49216	8.0 AT H
-24V Section 3Slot 5.. 7	F9	49216	8.0 AT H
+24V Section 4Slot 8.. 9	F10	49216	8.0 AT H
-24V Section 4Slot 8.. 9	F11	49216	8.0 AT H
+24V Accessory Connector	F12	1801717	6.3 AT H

Table 7.2: Fuses PCTRL

7.3.4 Part Numbers

Type	Bruker Part No.	Description
AC/DC	Z149850	AV4 PSM-48V POWER SUPPLY MODULE
DC/DC	Z150090	AV4 PSM-B POWER SUPPLY
Ctrl	Z150089	AV4 BSMS POWER CONTROL BOARD

Table 7.3: BSMS Power Supply Part Numbers

BSMS/2 chassis PSM and PSB are not compatible to the AV4 BSMS chassis!

7.3.5 Technical Data (Summary)

Input specifications of AC/DC PSM see *Connection Values [▸ 219]*.

Short name	Output Voltage / Current					Power	Load
PSM-48V	+24 V 25 A	-24 V 25 A				1200 W	PSM-B, PCTRL VPSB-DC (-E)
PSM-B	+12 V 5.5 A	+5 V 11 A	+3.6 V 11 A	+15 V 1 A	-15 V 1 A	230 W	BSMS units, Fan Tray
	+29.5 V 0.3 A	-29.5 V 0.3 A	+3 0V 0.35 A				H0-Current (ELCB), He-Sensor (SPB)
PCTRL	+/- 24 V switched and fused						BSMS units

Table 7.4: Power Supply Module Output Specification

7.4 Troubleshooting

Some PSM contain fuses accessible for Bruker service personnel. See description of the individual PSM. Other than that there are no serviceable parts.

If fuses need to be replaced, contact Bruker service.

Detected failures are reported with event messages. Event messages are displayed on the TopSpin screen and can be viewed on the ServiceWeb pages General information on trouble shooting, error handling and failure reporting is available in chapter *Troubleshooting [▸ 213]*.

⚠ WARNING

Risk to life due to electrical shock

The device contains a high-voltage section. 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.

7.4.1 Diagnostics

The supply status is indicated either with one **POWER** LED for all output voltages or one LED per output voltage.

PSM with I2C bus have internal diagnostics. The overall status is supervised by the BSMS Software. Other diagnostics (voltage, current, temperature etc.) are available on the Service Web page, depending on the capabilities of the individual PSM.

8 ELCB

8.1 Introduction

The Extended Lock Control Board (ELCB) combines two former boards, the CPU and the LCB. Therefore it provides two main functions - the Digital Lock (as it is described in the Deadalus Lock Manual) and the control of the complete AV4 BSMS, (e. g. Shim, Lift, Gradient Amplifier). The latter functions are described in the AV4 BSMS chassis and related subunit chapters.

All former Lock functions have been adapted to the new hardware platform. The analog design of the current source is basically the same as on the LCB, however some of the former components have been replaced by modern ones. Therefore, the electrical performance could be improved in parts.

Using the same algorithm for evaluation of the closed loop Lock regulation, the new ELCB is fully compatible with the LCB. It has the same or a better performance for NMR experiments.

Since the new DSP has a much higher performance, it provides faster handling of real time Lock Hold pulses, which now may range down to a length of 100 microseconds.

Additionally, it was possible to implement a more sophisticated method for locking in, which is now very reliable. While the Lock is sweeping, the „wiggles“ of the Lock signal are now analyzed. This provides a simple and fast lock in. The Auto-Lock functions have been optimized as well.

8.2 Lock Parameters and Technical Data

Parameter	Min	Factory Default	Max	Unit	Notes
Lock Field (H0)	-9999 -170	+5000	+9999 +170	Field Units mA	
Lock Regulator	-99 -1.70	0	+99 +1.70	Field Units mA	
Sweep Amplitude	0	100 4000 68.0	100 4000 68.0	Sweep Units Field Units mA	
Sweep Rate	0.01	2.00	5.00	Hz	
Lock Phase	0.0	180.0	359.9	Degrees	1)
Lock Power	-50.0 -60.0 -60.0	0.0 0.0 0.0	+10.0 +0.0 +10.0	dB dB dB	2)
Lock RF Gain 2H Lock RF Gain 19F	75.0 55.0	120.0 120.0	155.0 135.0	dB dB	
Lock Shift	-200.0	0.0	200.0	ppm	
Lock Drift	-2000.0	0	2000.0	Field Units/24 hours	3)

Parameter	Min	Factory Default	Max	Unit	Notes
Current Noise			400	nA (pp)	4)
Current Source Bandwidth	600			Hz	5)
Lock Hold active	100			µs	
Lock Hold inactive	100			µs	
Lock Hold latency			100	µs	

Table 8.1: Parameter and Technical Data

General Note: Any of the values listed above may change without notice.

1. Values from -1000.0 to +1000.0 degrees are accepted, however the actual phase is evaluated modulo 360 degrees.
2. The actual range depends on the hardware code and on the frequency: The first series of RF boards (HW code 0) had a range from -50 to +10 dB, the next following series (HW code 1 and higher) had a range from -60 to +0 dB. For frequencies of 600 MHz and above, this range has been extended (-60 dB to +10 dB) on the hardware versions 6 and higher.
3. This value is used for static drift compensation with manual evaluation/definition of the drift rate (called *Manual Drift Compensation*, e. g. in solids configuration). Static/manual drift compensation is active while the lock is not sweeping.
4. Maximum Noise between 0.01 Hz and 10 Hz
5. Minimum range of -3 dB point

8.3 Configuration and Wiring

The ELCB is plugged into Slot 10, see *Figure 4.3 [▶ 31]* . The drawing below shows the front panel of an ELCB with the LED‘s and connectors. For proper operation with TopSpin, at least the Ethernet, the 10 MHz reference clock and the RCP input have to be connected accordingly.

There is a dedicated connector for the communication with an optional SampleCase automated sample changer.

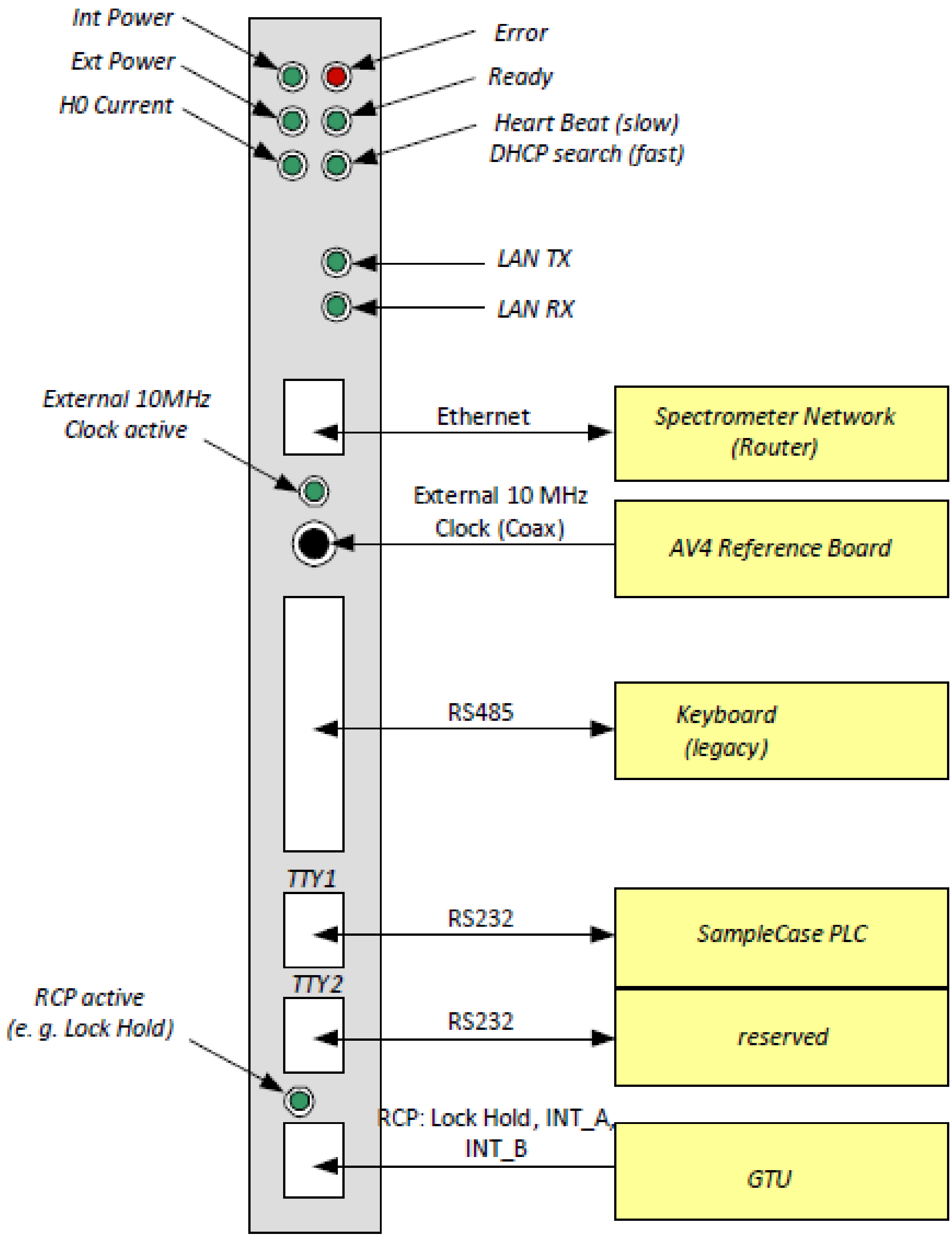


Figure 8.1: ELCB Front Panel with LED's and Connectors

8.4 System Architecture/Overview

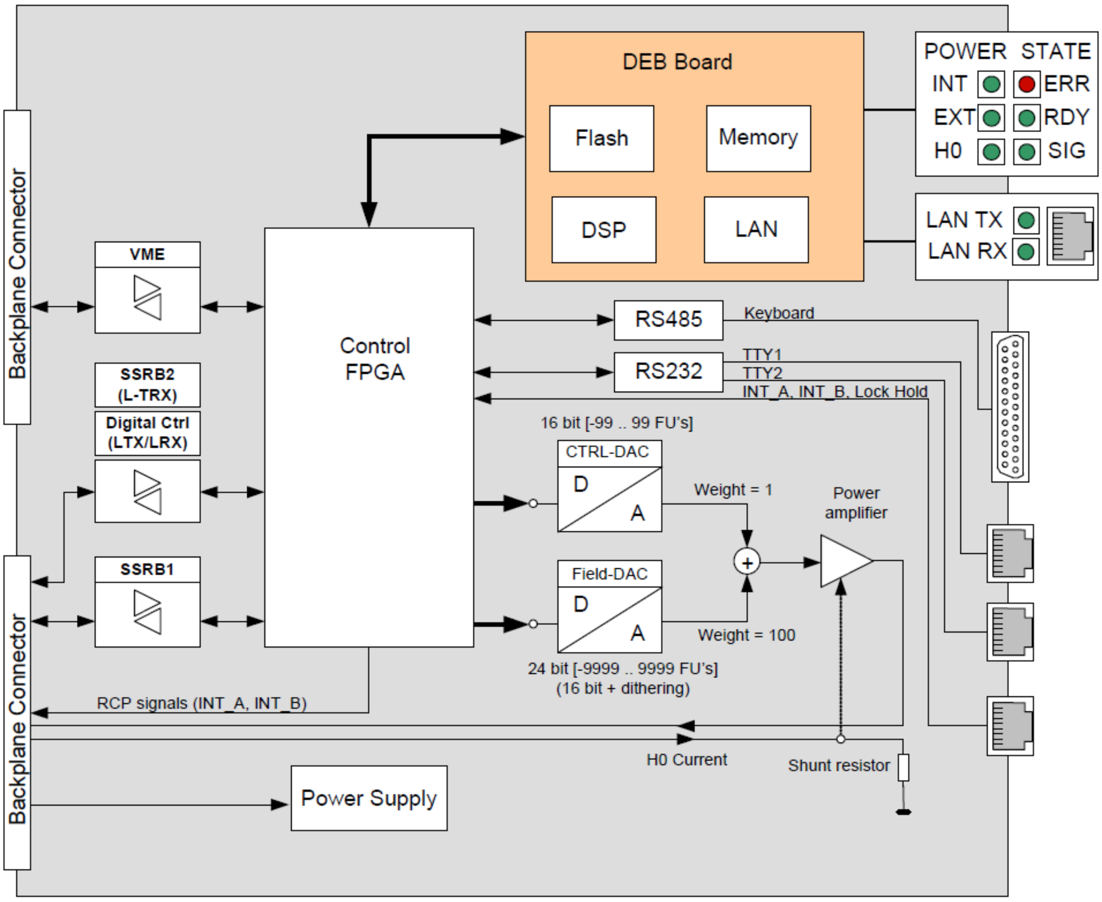


Figure 8.2: Functional System Architecture

The processor board (DSP Ethernet Board DEB) is a separate board plugged onto the base board. It contains a signal processor with memory, Flash and the electronics that provides access to the ethernet.

A central control FPGA handles the access to the peripheral hardware - actual BSMS/2 boards (e. g. SCB20, GAB/2, SPB, VPSB, L-TRX) communicate over SSRB, whereas the power supplies and fan are controlled over an I2C bus. There are three RJ45 connectors, two of them are TTY ports, which provide control for SampleCase (and similar). and Real time signals (INT_A and INT_B for RCP-Shimming, Lock Hold).

8.4.1 Protection

The power amplifier providing the lock current for the H0 coil is protected against short circuits (limiting the output current) and over temperature.

8.4.2 Lock Software Architecture

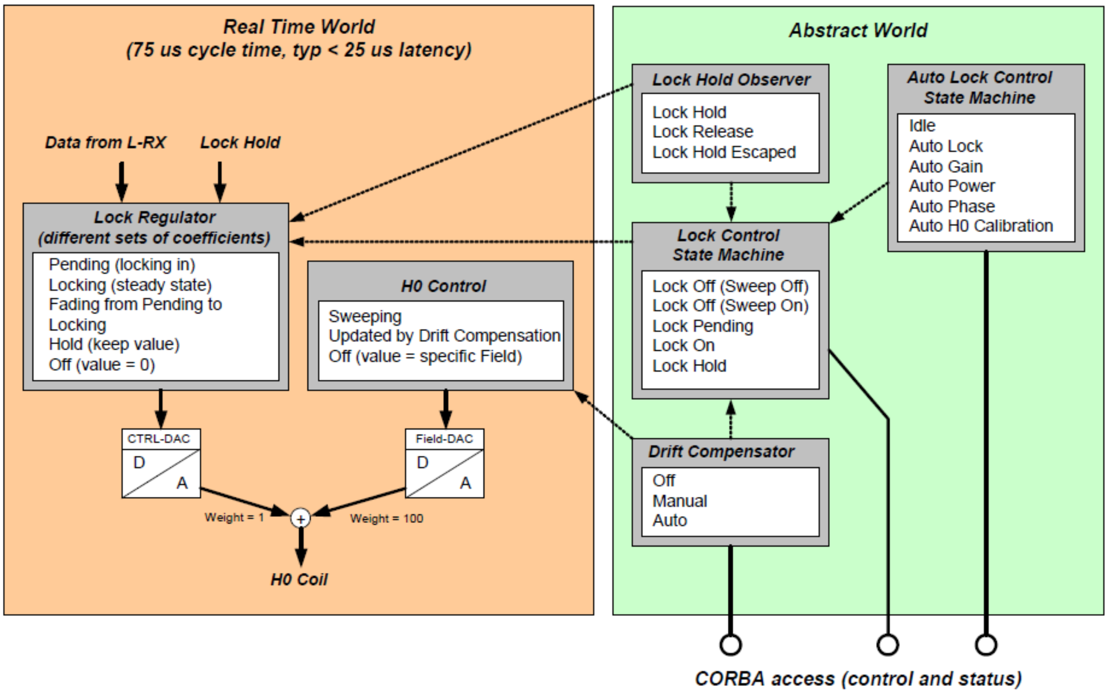


Figure 8.3: Abstract Control Domain and Real Time Domain

One part of the Lock software runs in „real time“ mode: An interrupt service routine is called every 75 microseconds. This routine reads the Lock receiver data and evaluates the corresponding Ctrl-DAC and Field-DAC values, which are applied by the Control FPGA to the hardware. The typical delay time from arrival of the receiver data to the completion of the DAC write cycle is less than 25 micro seconds.

On the other hand, there is a more abstract part, modelling the Lock behavior and controlling higher level functions, e. g. locking in, selecting the appropriate set of Regulator Coefficients, compensating the drift and so on. This part of the software is connected with the CORBA interface - it handles requests from the TopSpin application and notifies about state changes (e. g. Lock Hold). It is non-real time and may react with a delay of several milliseconds.

The Lock Hold signal affects directly the regulator, which guarantees extremely short reaction times. An external Lock Hold Observer examines every 20 milliseconds the Lock Hold state. If the regulator runs in Lock Hold mode or if a short Lock Hold pulse has been active in the mean time (Lock Hold Escaped) then the Lock Hold Observer updates the Lock Control State Machine and notifies the registered clients - even the shortest Lock Hold pulses are indicated on the keyboard (if connected) and in the TopSpin application.

8.4.3 Lock Control State Machine

The Diagram below shows the Lock Control State Machine, which handles the requests from the CORBA or Web interface and controls the transitions between the different lock states. The lock in strategy has been improved compared to the former LCB. Nevertheless, the new procedure is fully compatible with the various TopSpin operations accessing the Lock (e. g. TopShim).

While switched off, the Lock may be sweeping or not, depending on the parameter SWEEP. When the Lock is switched on, then it starts by searching signal (while sweeping) and enables the Regulator as soon as the Lock Signal has fulfilled the necessary criterion. If the Lock In trial succeeds then the state machine steps through *Try To Lock*, *Temporary Locked* and reaches in the end the state *Steady Locked*. When the lock signal gets lost in the meantime, the state machine steps back and restarts searching signal.

Lock Hold is normally issued by the Lock Hold Observer on detection of a Lock Hold pulse coming from the hardware. Alternatively, this signal can be set by the CORBA interface (intended for test purpose). The Lock Hold state can be left either by de-activating the Lock Hold signal or by switching the Lock on or off. The Lock Hold Pulse is intended to be activated when the Lock is locked in. However, the ELCB tolerates Lock Hold Pulses in any state - it returns to the original state when the Lock Hold pulse becomes inactive.

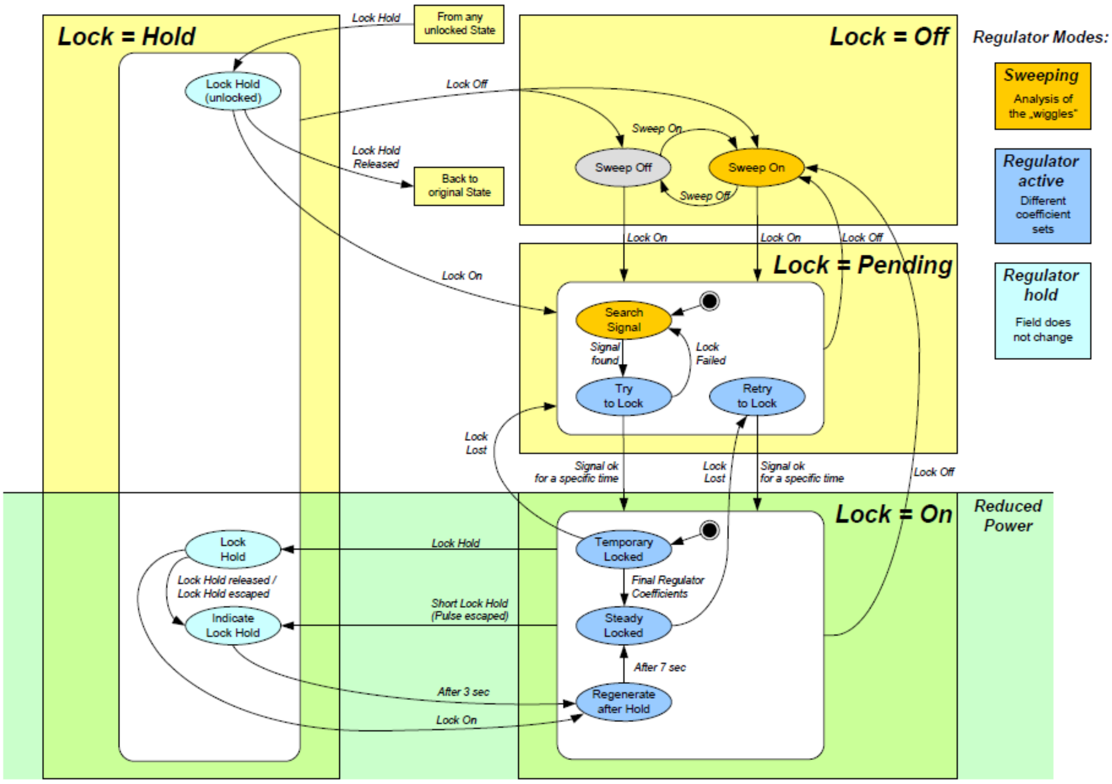


Figure 8.4: Lock State Machine

8.4.4 Handling of High Gradient Rates for Auto Shim and Drift Compensation

Auto Shim and Drift Compensation handles gradient pulses at high rates similar to the LCB - if necessary, the lock level is sampled at the optimum time.

The Auto Shim has been improved so that it is no longer necessary to adapt the Auto Shim interval to the pulse program (timing of the gradient pulses). The ELCB now guarantees automatically the specified time interval between setting of a new shim and the measurement of the resulting lock level, regardless of the pulse program.

Automatic drift compensation is held by the Lock Hold pulse as well. However, drift compensation is evaluated every second and it is not affected by gradient pulses shorter than 1 second.

8.4.5 Measurements Provided for Diagnostic

When the ELCB is started up, the following tests are performed:

H0 Current Measurement

For detection of correct H0 coil connection, it is possible to measure the current that actually flows through the shunt resistor. If the H0 coil is not properly connected, an error message is issued by the TopSpin application.

RF Board Tests (L-TRX)

The new L-TRX provides a larger set of test functions, which are run automatically after power up and can be invoked manually by the Service Web for diagnostics (see also *Diagnostic Functions [▸ 110]* in the section Service Web).

History of Lock Regulator and Drift Compensator

There is a history of the Lock Regulator and the Drift Compensator available on the ELCB (5 minutes with 1 entry per second, 5 hours with one entry per minute and 1 week with one entry per hour). The data is volatile and can be accessed by the Service Web.

Display/Download of the Latest FFA

While locking in initiated by Auto Lock, the Lock performs a simple ^{2}H experiment (alternatively ^{19}F). The resulting FID can be visualized (graph of the spectrum) and / or downloaded (as text) by the Service Web.

8.4.6 Calibration

It is user selectable whether the Lock adjusts the Field (default) or the Shift (optional) for locking in by the Auto Lock procedure. The relation between the frequency and the field depends on the Shim System (different for standard bore, wide bore and super wide bore magnets), which is defined in the BOSS file. This value may deviate additionally between different individuals of the same type.

In the Service Web there is a *push button* calibration of this relation. The calibration needs a sample containing a lock relevant solvent.

8.4.7 Front Panel - LED‘s during Start Up

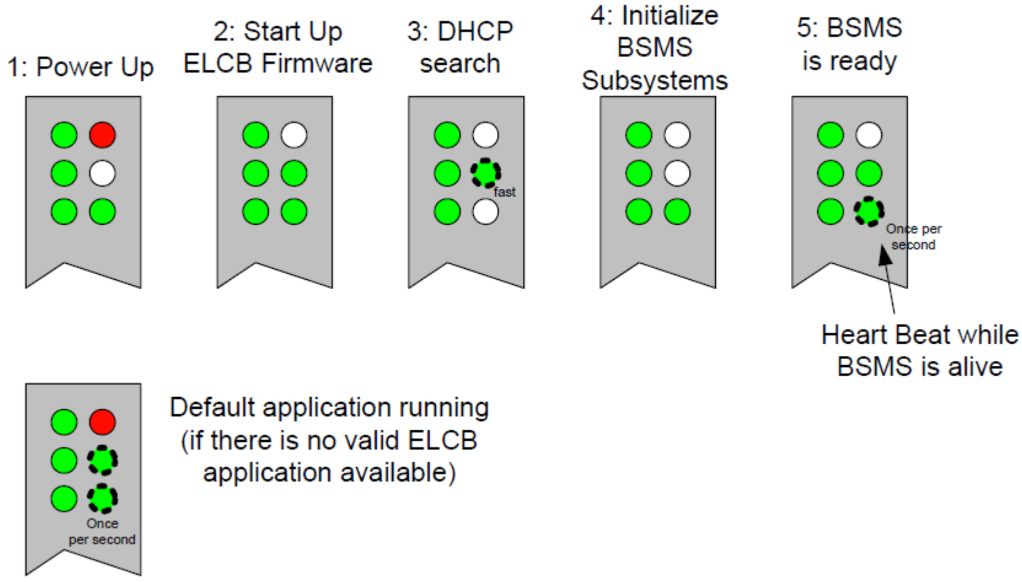


Figure 8.5: LED‘s Indicating Different States During Start Up

8.5 Bus Interface

Since the ELCB is the master of the AV4 BSMS, it controls the communication busses of the backplane, the User Bus.

8.5.1 Front Connectors

An additional RJ45 connector provides the RCP inputs, according to the figure below. The LED near the connector is active when a RCP signal is actually handled by the ELCB. Thus, this LED serves for checking if the RCP pulse signals are available and if they are handled as expected (e. g. if RCP handling is enabled for the specific signal). It is blinking e. g. during Gradient experiments (Lock Hold) or RCP shimming (INT_A).

8.6 Service Software

For service purpose, there is a Web access available (setup, calibration and diagnostic). Some of these Web functions are open for all users (e. g. clients), other functions are reserved for service engineers - it is necessary to log in and enter the required password before these functions can be accessed (description in the BSMS Service Web chapter).

8.6.1 Lock Service Web

The Submenu **Main | Lock** provides access to all service functions in connection with the ELCB and the related RF boards (L-TRX, L-19F).

Figure 8.6: Main Window for NMR Lock Functions

Most of the functions under the menu point **Lock Control** are normally handled by the TopSpin application over the CORBA interface. It is however possible to invoke all of these functions by the Service Web. Also the solvent specific parameters that are normally passed by the TopSpin application (e. g. Lock Power, Lock Phase, Lock Gain, Loop Gain, Loop Time, Loop Filter, ..) can be checked and / or defined there.

The point **Lock Configuration** provides setup of the Lock relevant parameters at installation.

Statistics displays information about Lock failures (in case that the Lock got lost), and **Diagnostics** provides the sub-menu displaying of the ^{2}H spectrum captured during the last Auto Lock trial, a sub-menu for configuration and troubleshooting of the RF boards and a sub-menu containing the history of the Lock Regulator/Drift Compensator.

8.6.2 Lock Parameters and Commands

The following dialog provides - alternatively to the TopSpin application - the setup of nucleus specific parameters and invoking of Lock/Auto Lock functions.

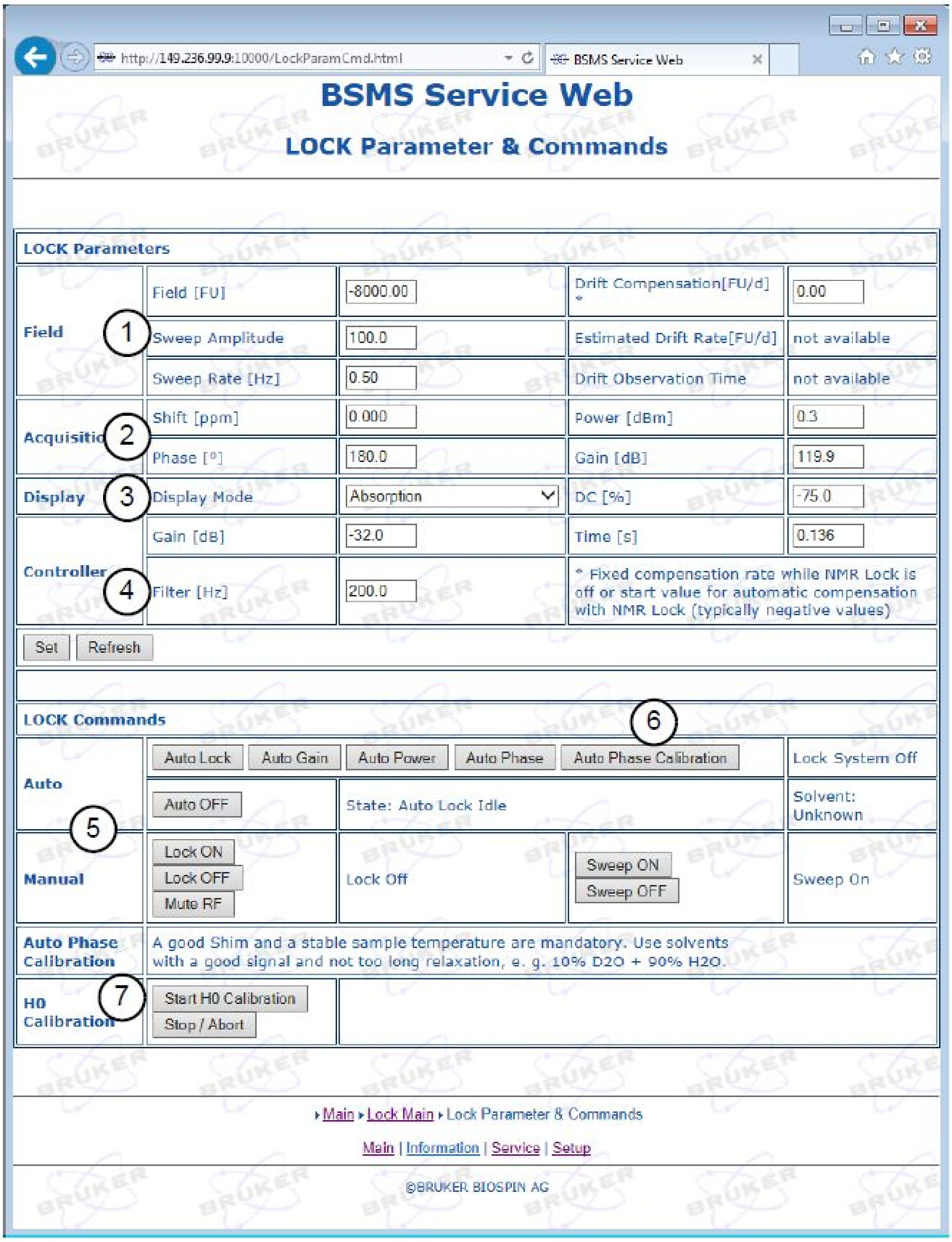


Figure 8.7: Basic Field Lock Operations by Service Web

1	All Lock Field relevant parameters can be defined here. The specified Drift value (Field Units per 24 hours) is applied / compensated while manual Drift Compensation is active. It is possible to define the behavior for Locking out (Lock Out Convention). When the default option is selected (Keep Field after Auto Lock) then the Field value of the *locked* state remains after *lock off* only if the *locked* state has been reached by the Auto Lock command (e. g. TopSpin Command **Lock** and definition of solvent). Alternatively, it is possible to force resetting the Field to the value it had before it was *locked*, or the Field value of the *locked* state can be kept always after *lock off*.

2	This section provides the setup of the solvent specific RF board settings.
3	It is possible to shift the Lock Line within the Lock Display window from top (+100%) to bottom (-100%).
4	The regulator can be configured/optimized by these three parameters. These parameters are in the EDLOCK table (solvent specific) and are evaluated alternatively by a TopSpin macro (e. g. LOCK.7).
5	All Lock commands provided by the TopSpin application (bsms display started by command **BSMSDISP**) can be invoked in this section.
6	Automatic Phase Calibration of offset between FFA method and Lock level optimization. A good Shim and a stable sample temperature are mandatory. A solvent with good signal and not too slow relaxation should be used for the calibration, e. g. 10% D_2O + 90 % H_2O.
7	The automatic calibration of the relation between H0 current and resulting field shift can be started here. There must be a sample in the magnet containing a solvent of the selected nucleus, and locking in must be basically possible.

8.6.3 Lock Configuration

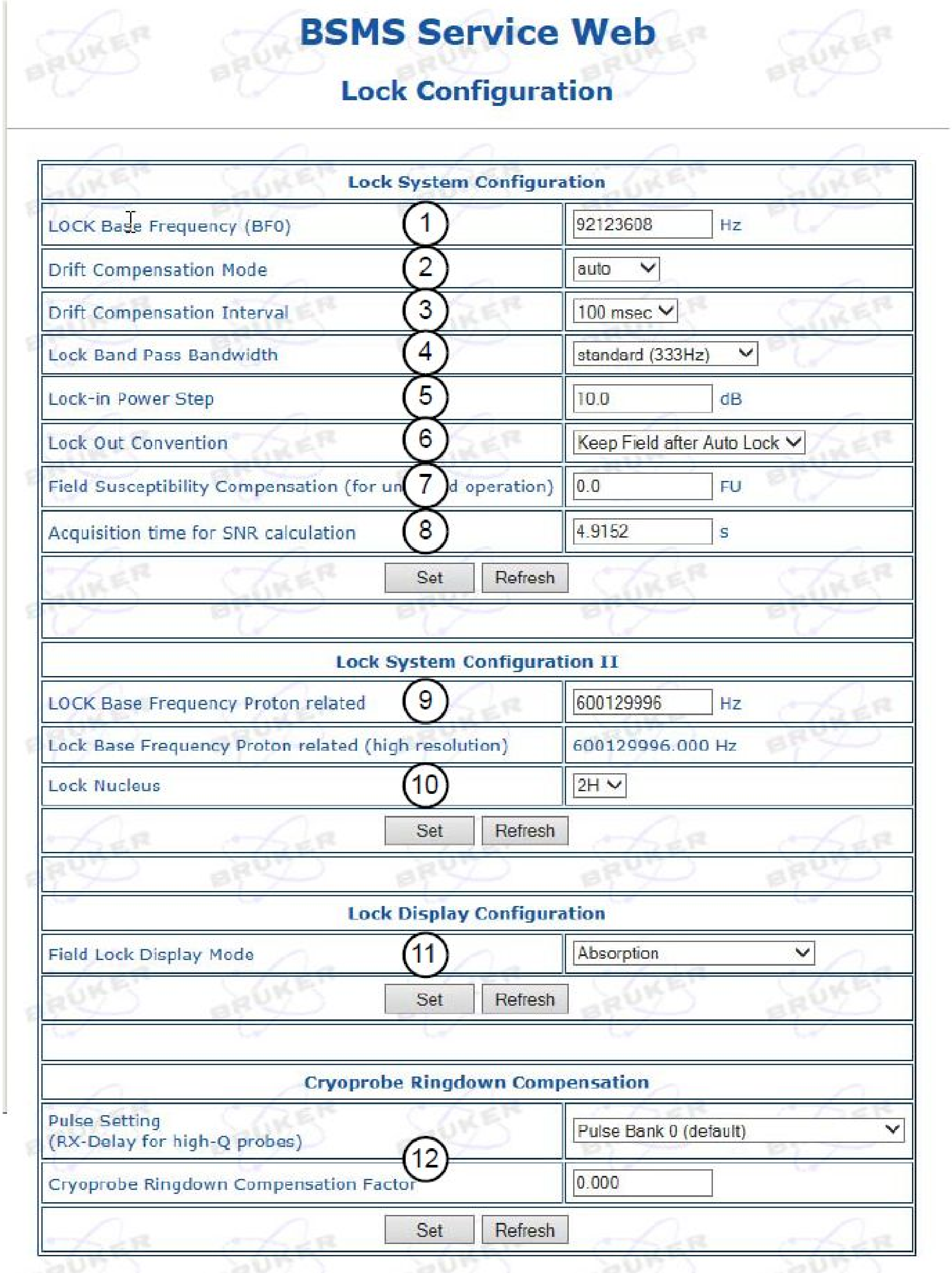


Figure 8.8: Configuration of NMR Lock

1	Base Frequency for Shift = 0 ppm, related to the currently selected nucleus (^{2}H or ^{19}F).
2	The drift can be compensated automatically - it is compensated according to the continuously estimated remaining drift rate. Alternatively, it is possible to compensate the drift at a fixed rate that can be evaluated / entered manually. As a third option, the drift compensation can be switched off.

3	The interval between two drift compensation iterations is selected here.
4	Lock receiver bandpass filter bandwidth selection.
5	The Lock In Power Step can be modified here - it is normally 10 dB. When locked in, the Lock Power is reduced by this value.
6	Convention for Locking out - according to this parameter the Lock Regulator Output (Ctrl-DAC value) is a) Either reset to zero (results in a overall Field change)b) or transferred to the H0 DAC (overall Field stays constant)If the parameter is set to *keep after Auto Lock* then Convention a) is applied when the Lock was locked in by the simple **Lock on** command, and Convention. b) Is applied when the Lock was locked by the **Auto Lock** command.
7	Field Correction for compensation of solvent specific effects (defined in the edlock table).
8	Lock SNR calculation time.
9	Base Frequency for Shift = 0 ppm, related to Proton.
10	If there is a L-19F option installed, then the nucleus for Locking can be selected by the TopSpin command **LOCNUC** and the desired nucleus ^{2}H or ^{19}F. This option reflects that selection - switching between the two nuclei simply by setting this parameter would not work. It is necessary that the TopSpin application selects also the appropriate preamplifier setup.
11	There are several options for the Lock Display (e. g. Absorption, which is the standard Lock level, Absorption Low Pass filtered, Dispersion, Regulator Output, ...). The display mode can be changed e. g. for trouble shooting.
12	Several modes of Ringdown Compensation are available. The *Compensated Pulse* modes, can be further tuned by the additional parameter RINGDOWN COMPENSATION FACTOR. This parameter has no influence on the *Pulse Bank* modes.

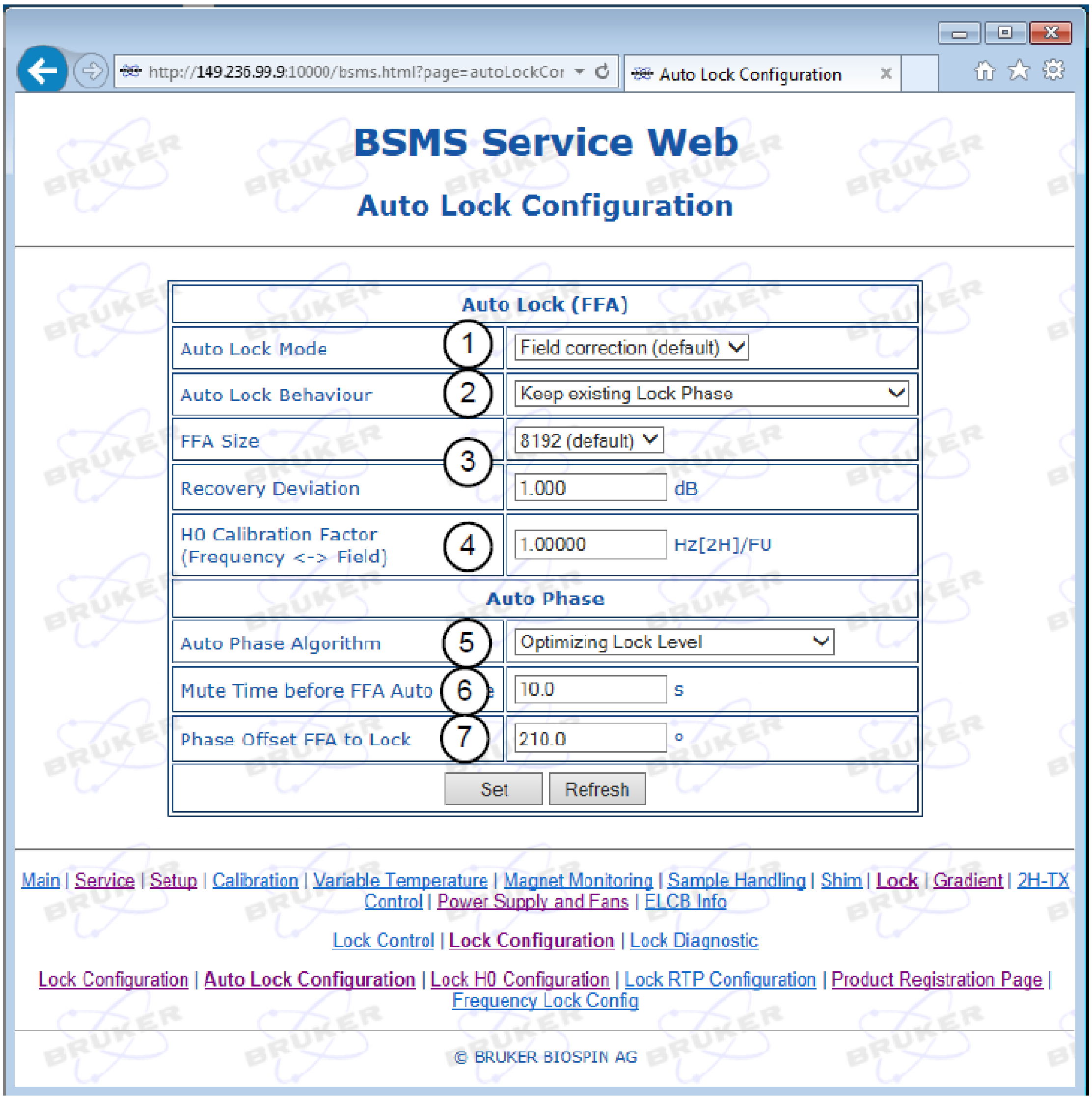


Figure 8.9: Configuration of NMR Auto Lock

1	When locking in Auto Lock mode, either the Field (default) or the Shift (optional) can be adjusted for achieving the resonance condition.
2	Auto lock may keep the actually set lock phase or the lock phase can be calculated by the auto lock algorithm.
3	Configuration of the Auto Lock algorithm. The recovery deviation influences the delay between FFA (pulsed experiment) and locking in.
4	This factor is evaluated by the automatic H0 calibration (invoked on the Field Lock Control Page). It can be set manually, e. g. for resetting the calibration (default = 1.0).
5	There are three different algorithms for the automatic lock phase optimization available:- the classic iterative lock level optimization (maximum search)- calculating the lock phase from the FFA data- a more precise version of the lock level optimization (slope evaluation).
6	For precise phase measurement, the spin system has to be relaxed. This relaxation delay is configurable.
7	The phase offset may be automatically calibrated (invoked on the Field Lock Control Page) or manually set here.

Figure 8.10: Configuration of NMR H0 Coil and H0 Current Source

1	The H0 coil type defined in the BOSS file is displayed here. It cannot be modified manually.
2	Polarity of the H0 current can be inverted for Magnets with reversed polarity.
3	For service purposes, the connection between the H0 current source and the H0 coil can be interrupted by means of opening a relay contact.

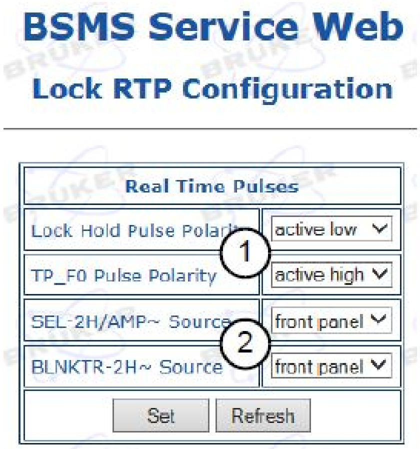


Figure 8.11: Configuration of Lock Real Time Pulses

1	Select the polarity of the RTP‘s. For Bruker standard systems, no change is necessary.
2	In most systems, the RTP‘s are wired to the L-TRX front panel. In some NanoBay type cabinets, the pulses are available on the backplane.

8.6.4 Part Numbers

Bruker Part No.	Description
Z100818	BSMS/2 ELCB EXTENDED LOCK CTRL BOARD

Table 8.2: Part Numbers: ELCB

8.6.5 Diagnostic and Troubleshooting

If there is a problem related to the Lock, the logging can be configured in the Service Menu for issuing detailed information about the Lock System. It must be made sure, that the ^{2}H path is correctly initialized by typing **ii** in the TopSpin. Additionally, all RF board tests can be run on the Lock **L-TRX Diagnostic Functions** menu.

Figure 8.12: Lock Diagnostics Menu

Since the Lock needs almost the complete spectrometer for correct operation, it is sometimes difficult to find a Lock related error. If it cannot lock in or if there are no *Lock wiggles* available on the Lock display, there are many possible reasons - the field could be completely out of range, the shims could be erroneously set, there could be a problem on the ^{2}H path/probe, some Cryoshims or even the magnet could have quenched.

For checking the magnet (if the ^{2}H FFA spectrum after a failed Auto Lock trial is completely flat), it is recommended to run a simple 1H experiment on a water sample with a very large bandwidth - if there is a peak at all, it will show up.

The diagram below shows the L-TRX Diagnostic page, indicating self-test results and several voltage and temperature measurements.

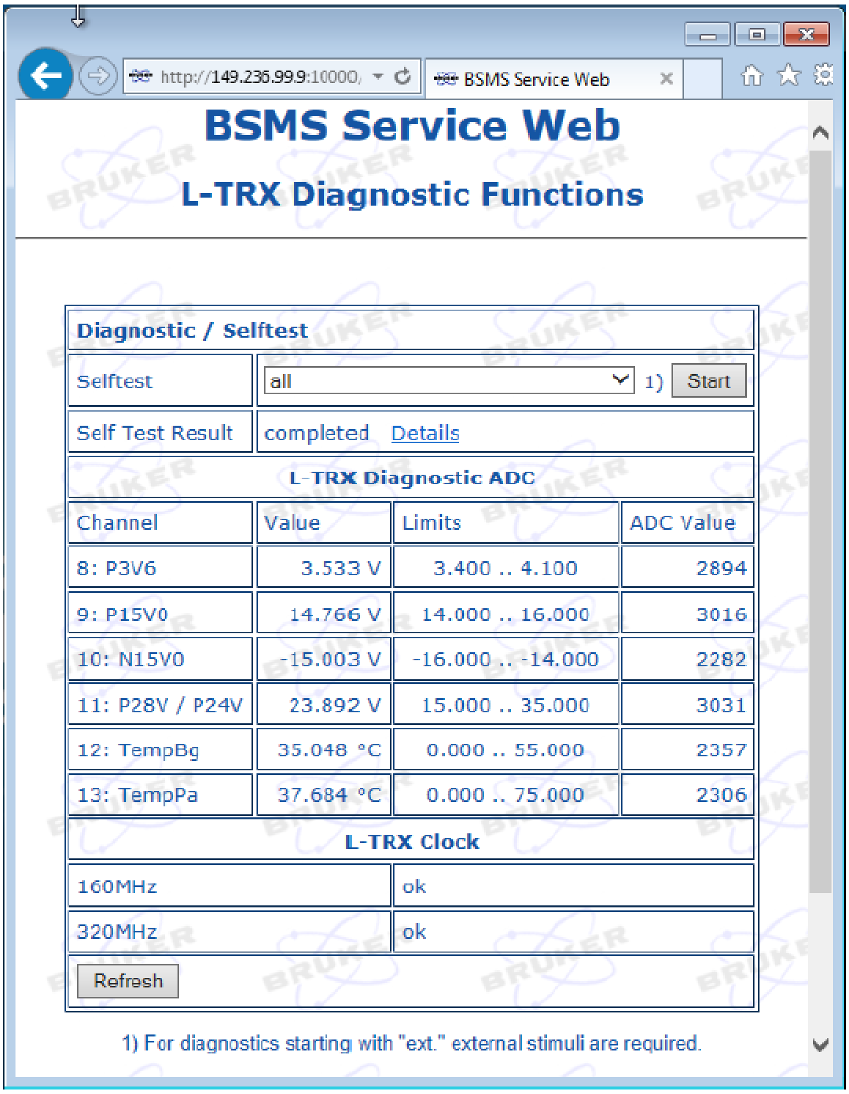


Figure 8.13: Lock RF Boards Diagnostics

9 SCB20

9.1 Introduction

The SCB20 (Shim Control Board) is the unified and highly integrated Shim Current Source. One single SCB20 can drive a BOSS1 configuration and two SCB20 are required for all other Shim Systems e.g. BOSS3.

There is exactly one standard version of SCB20, which provides the necessary performance and precision for all possible variants of connected Shim Systems.

Low level hardware functions are implemented directly on the SCB20, whereas higher level functions such as BOSS file handling, Auto Shim and RCB Shim are provided by the Software running on the ELCB.

It is possible to store a complete BOSS file on the nonvolatile memory of the ELCB. For BOSS1 Shim Systems there is a predefined BOSS matrix, which does not need to be downloaded.

The current sources of the SCB20 are unified - each current source provides a current ranging from -1 Ampere (-130‘000 current units) to +1 Ampere (+130‘000 current units). Since exchanging of Shim settings with the TopSpin application (command **rsh** and **wsh**) is based on currents, it is not possible to transfer the former SCB7/13 Shim settings directly to the new SCB20 boards. It is however possible to enter manually all shims values (Z1, Z2, ...) that are also stored in the TopSpin shim files.

9.2 Technical Data

Parameter	Min.	Type	Max	Unit	Notes
Output Current (continuous)	-1.0		+1.0	A	
Current Value, Resolution and Step Size		20 2		Bit µA	
Maximum Offset		+/- 20		µA	
Gain Error			0.5	%	1)
Maximum Offset Drift		+/- 1		µA / °C	
Gain Drift		< 11		ppm / °C	
Tolerated range of connected Shim Coil resistance	0		15	Ohm	
Required power supply voltage |VCC| and |VEE|	20		26	V	
Sum of all shim currents (sum of absolute values)			6	A	2)
Small Step Response time (Transition from -100 to 100 mA)		20		ms	3)
Large Step Response time (Transition from -1 to 1 A)		160		ms	3)

Parameter	Min.	Type	Max	Unit	Notes
Power Amplifier Temperature for Shut Down		165		°C	
Current Limit (Power Amplifier)		3.5		A	
Current Limit (shunt) for Shut Down		1.2		A	

Table 9.1: Electrical Characteristics

1. The SCB20 boards are calibrated in the factory to achieve this accuracy. The uncalibrated gain error is significantly higher.
2. The sum of all Shim currents (absolute values) of one SCB20 board must not exceed this value. Additionally, the constraints of the power supplies must be taken into account (including the dissipation loss of the SCB20). Therefore, the maximum available current sum may be further reduced in rare occasions.
3. Measured with a Z-Shim (Boss-2) and an additional Resistor of 2.7 Ohms (consideration of wiring and connectors). See the diagrams below:

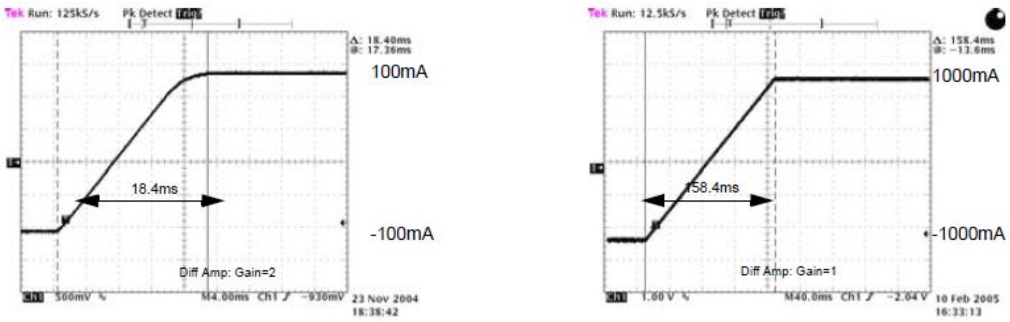


Figure 9.1: Step Response with Step Size of 200mA (left) and 2.0A (right)

9.3 Configurations

There are basically two standard configurations - one SCB20 providing the necessary number of currents for BOSS1 and two SCB20 covering all other types of shim systems.

Configuration for a specific Shim System is done by loading a specific BOSS matrix. The corresponding files are delivered with the TopSpin installation, the latest versions can be downloaded from the ftp server ftp://ftp.bruker.ch.

BOSS1 Systems do not need a BOSS file - the predefined matrix is already available in the ELCB software. It was theoretically possible to override this matrix by a specific file, however there hasn‘t been any corresponding file defined so far.

All other Shim Systems (BOSS2, BOSS3, Wide Bore) require the according BOSS data to be loaded once. This is normally handled by the TopSpin application - or it must be performed manually during the installation. The complete BOSS data remain then in the nonvolatile memory of the ELCB.

9.3.1 BOSS1 Configuration

One SCB20 is sufficient for any type of a BOSS1 Shim System. It is recommended to plug the SCB20 into slot 8/9, since the H0 Current is only available at the corresponding backplane connectors J18 and J20.

9.3.2 Configuration for BOSS2, 3 and WB

For the operation of a BOSS2, BOSS3 or BOSS-WB Shim System two SCB20 Units are required. Current „plug“-type Shim Systems can be directly connected to the SCB20, using the according Shim cables.

9.4 System Architecture/Overview

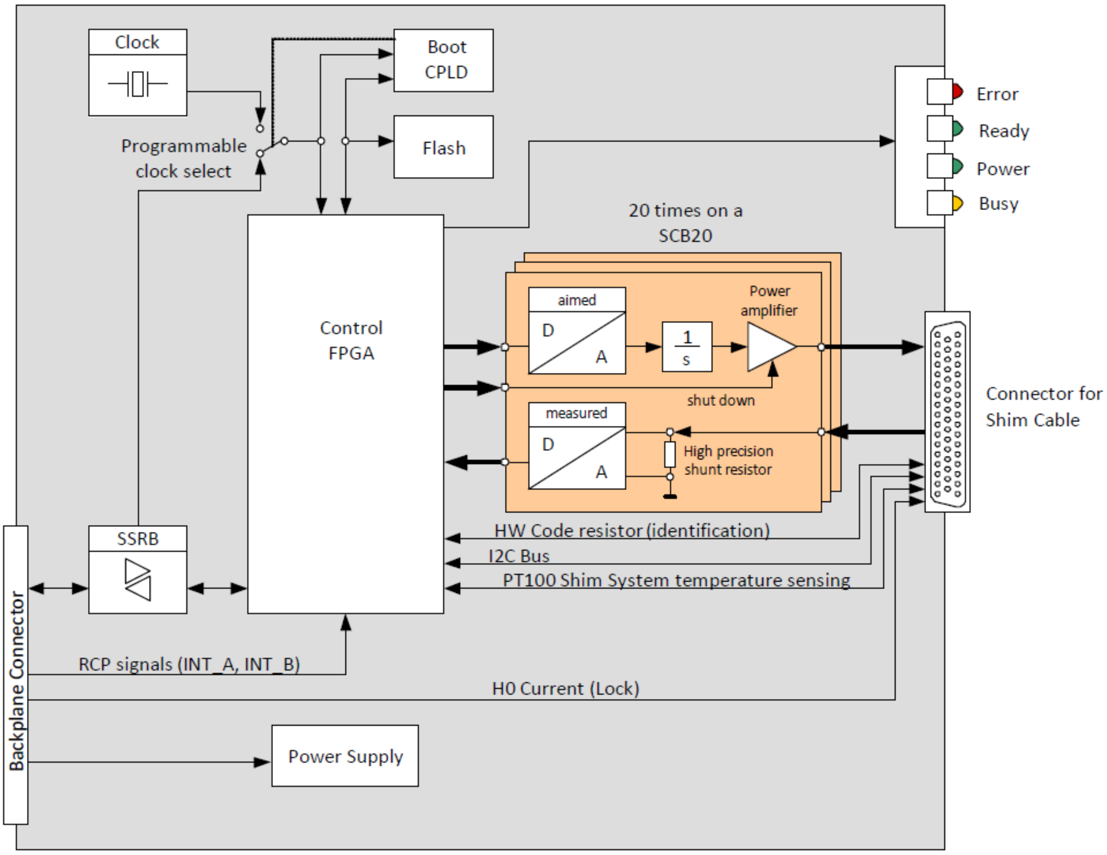


Figure 9.2: Block Diagram of the SCB20 Shim Current Board

The SCB20 is a SSRB slave and controlled by the ELCB, which is the AV4 BSMS controller/ coordinator. In addition to the SSRB and power supply, there are the synchronization signals for RCP Shimming (INT_A, INT_B) that are provided by the AV4 GTU and that are routed across the ELCB. Also, the H0 current for Locking is provided by the ELCB - it is routed by the shim cable to the Shim System, which contains also the H0 coil for the lock.

In normal configuration the SCB20 uses a common 10MHz clock that is distributed by the ELCB (this clock is typically generated by the AV4 reference board). It is possible to select alternatively a local oscillator.

When the SCB20 is starting up, then the CPLD loads at first the current FPGA design from the flash. It is therefore possible to upgrade SCB20 boards in the field (e. g. for new features). The FPGA provides coordination/control of the hardware functions (e. g. controlling the current source regulator loops, protection and real-time functions). As soon as the FPGA is ready, the corresponding embedded software of the ELCB initializes the parameter settings (e. g. values of the shim currents) and starts operation.

The yellow *Busy* light flashes whenever there is interaction with the ELCB - there is a task running on the ELCB that periodically checks the connected SCB20 boards, which results in a regular flashing of the *Busy* LED‘s.

9.4.1 Protection

The power amplifiers are protected against short circuits (limiting the output current) and over temperature. Additionally, the current sources are shut down if one of the measured currents exceeds the operating values or if the consistency check fails (e. g. if it is not possible to reach the aimed current value).

These two measures protect the SCB20 against short circuits and/or mismatched connections.

9.4.2 Measurements Provided for Diagnostic

In the following section, there is a list of possible diagnostic functions that can be invoked by SSRB commands. According to the results of the measurements the software running on the ELCB may notify the user about abnormal events.

Status/Errors

The SCB20 can perform the following checks:

- Power voltages OK.
- Short circuits/disconnected lines at the current source output.
- Current source status (operational or shut down).
- Heat sink over temperature.

Output Measurements

Both, the current and the voltage of each current source output can be retrieved over the SSRB. Additionally, the voltage after the integrator stage (U Int) can be measured for each channel. This feature provides additional information about the connected load and could potentially be used for identification.

Temperature Measurement

There is a PT100 resistor built in the shim tube providing temperature measurement. It is therefore possible to read the shim tube temperature over the SSRB bus for diagnostic purpose. If the shim tube temperature exceeds a given limit then the current sources are shut down.

9.4.3 Front Panel - Connectors and LED's

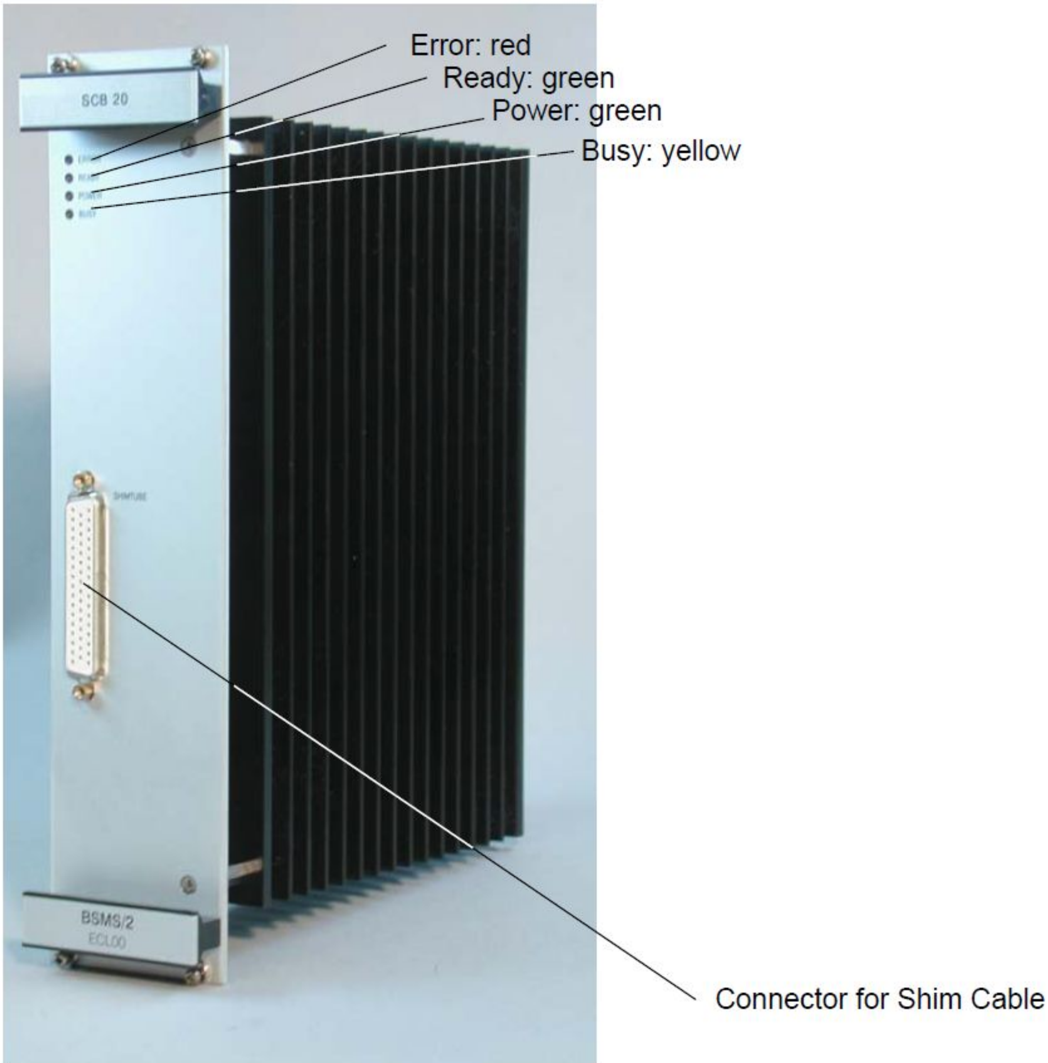


Figure 9.3: SCB20 Shim Current Board

Error LED

This LED is active after Power ON. It turns off as soon as the SCB20 is initialized (e. g. FPGA design loaded from Flash) and the communication with the ELCB is established.

Later on, an active Error LED indicates that an error occurred (e. g. short circuit, over temperature, ...) and that in consequence the current sources have been shut down.

Ready LED

This LED is active as soon as the FPGA design is loaded and valid shim values are activated (initially no current). It is turned off while the shim settings are changed (flickering during shimming).

Power LED

Indication that the SCB20 is correctly powered.

Busy LED

While the SCB20 is accessed by the ELCB (e. g. for setup, writing of new shim current values, etc.) this LED is active. Since all connected SCB20 are checked by the ELCB software in regular intervals, this LED indicates in addition the heartbeat of the shim system.

The SCB20 provides a 50 pin connector at the front panel for connecting the Shim system.

Plug or unplug this connector only when the system is powered off.

9.5 Service Software

All connected SCB20 boards in a BSMS system are controlled by the ELCB software - both, the specific low level drivers and the overall control logic is implemented there. The ELCB software provides the operational functions for the NMR application by a CORBA interface. In addition, there is a Web access available for service purpose (setup, calibration and diagnostic). Some of these Web functions are open for all users (e. g. clients), other functions are reserved for service engineers - it is necessary to log in and enter the required password before these functions can be accessed (description in the AV4 BSMS Service Web chapter).

9.5.1 Shim Service Web

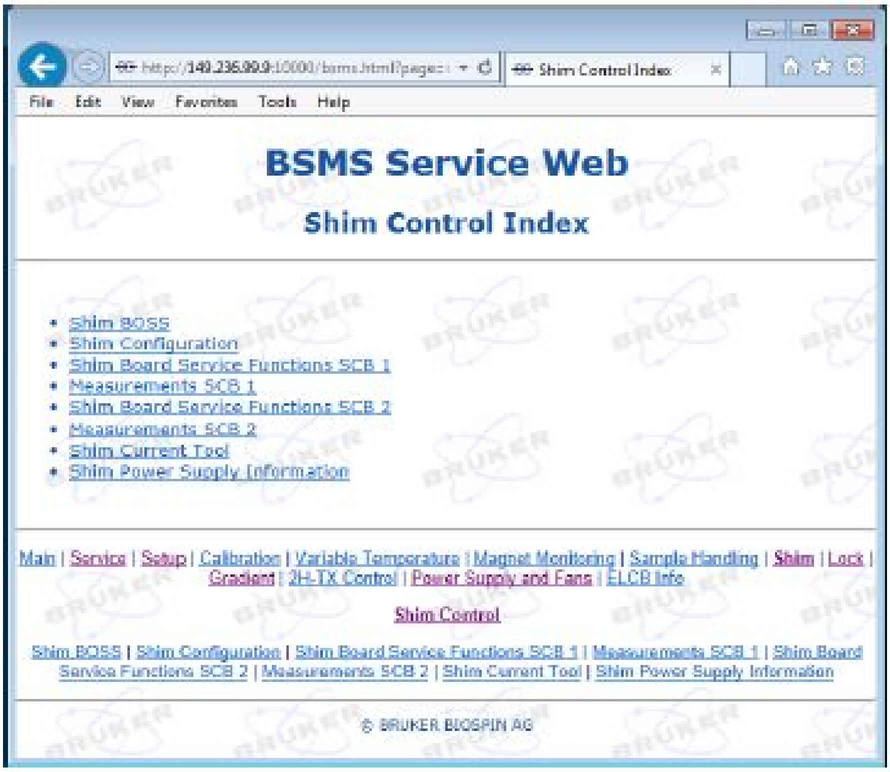


Figure 9.4: Main Menu for the Shim Subsystem

Under the menu point **Shim BOSS** it is possible to check the available shims for the currently loaded BOSS file and to modify the shims, alternatively to the TopSpin application (**bsmsdisp**). This page is helpful for double checks with the application.

Downloading of new BOSS files and setting up of specific parameters for the shim functions (e. g. pulse polarity for RCB) can be done under **Shim Configuration**.

The example shows a BSMS with two SCB20, therefore there are two according menu points for low level service functions, one for each board, providing diagnostic information in case of problems.

A further option for debugging the shim functions is the **Shim Current Tool**, which provides access to all currents - it is possible to define the strength of the currents individually, and to read the resulting current measurements on the display.

There is additionally a **Shim Power Supply Information**, which displays information about the current consumption due to the currently defined shim settings.

9.5.2 Setup the Shim Functions

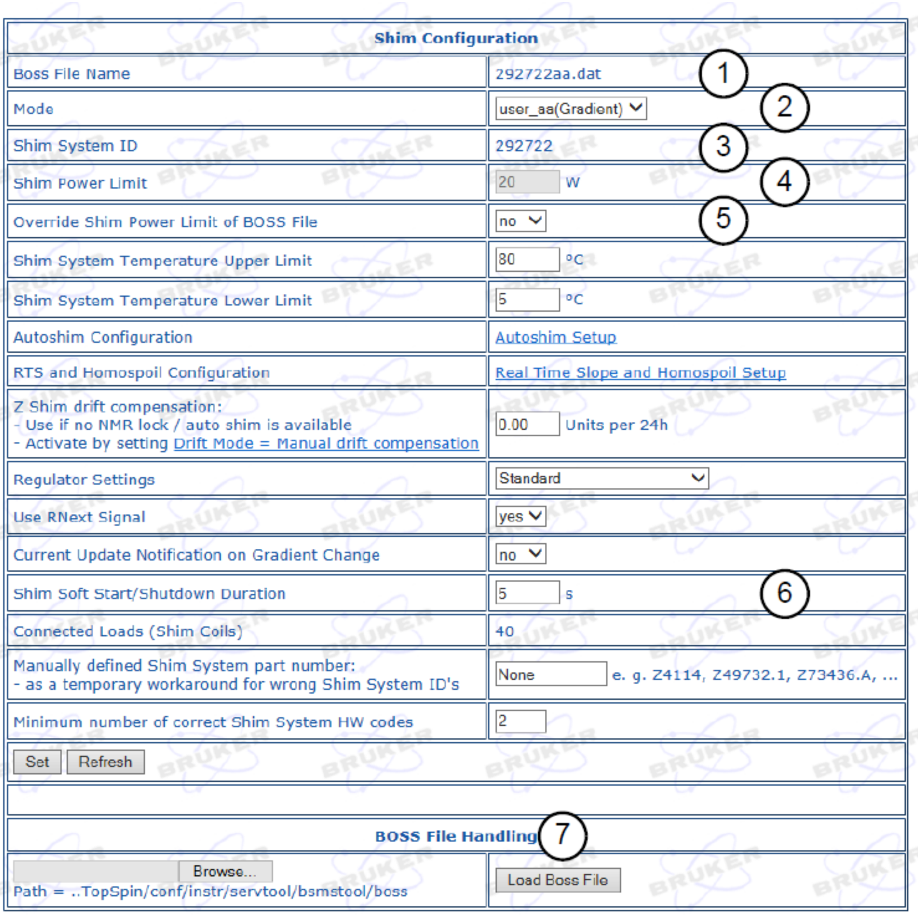


Figure 9.5: Setup and Configuration of the Shim Subsystem

1	The currently loaded BOSS file name is displayed here. If the connected Shim System is a BOSS1 then the name of the predefined data set **BOSS1** is displayed. If there is no valid BOSS data available for the connected Shim System, then this is indicated by **No BOSS Matrix loaded!**. The file names for non-BOSS1 Shim Systems start with the Shim System ID (see point 3), with two characters appended - the first character specifies the frequency range for BOSS3 and BOSS-WB systems - character **a** means no specific range. The second character indicates the version of the BOSS file (ascending for higher versions).

2	Some BOSS files provide more than one mode, which can be selected here. However, it is no longer necessary to differentiate between US and non-US systems, install mode and user mode. Typically, one mode is sufficient.
3	Here is the identification of the connected Shim System, which is based on 2 (BOSS1) or 3 hardware codes.
4	The maximum power dissipated in the Shim System - this value is defined in the BOSS file.
5	For specific situations it is possible to adapt/extend the **Shim Power Limit**. Setting this flag to **yes** allows to override the value of the BOSS file by a user specific limit (service account necessary) -> the value can then be entered under point 4.
6	Time in seconds for softly starting up / shutting down the Shim Subsystem.
7	Normally the TopSpin application makes sure that there is an appropriate BOSS file loaded - it can be however necessary to do this manually. This menu point provides selecting a specific BOSS file and loading it to the BSMS. The BOSS file is handled by the ELCB firmware - if the file is not valid (e. g. syntax errors, missing definitions), the Logging can be checked for details (kind of error, line number of the BOSS file where the error has been detected).

9.5.3 View and Modify the Shims

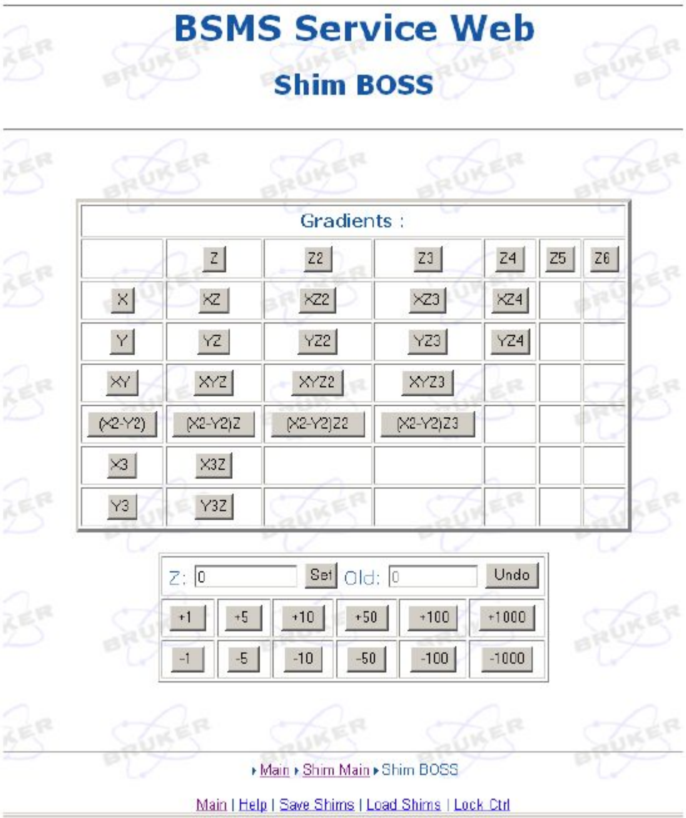


Figure 9.6: View and Manual Modification of the Shims

The example in the diagram above shows a Shim Subsystem configured for 28 available/ accessible Shims. By the small panel at the bottom, the selected Shim (**Z** in our example) can be viewed or modified manually.

Depressing the link **Save Shims** shows the complete Shim settings. It is possible to store these settings into a file. However, it is recommended to use the TopShim command **wsh** for saving the Shim settings for later use by the TopSpin application in order to guarantee compatibility.

9.5.4 Part Numbers

Bruker Part No.	Description
Z102930	BSMS/2 SCB20 SHIM CURRENT BOARD

Table 9.2: Part Numbers: SCB20

9.5.5 Diagnostic and Troubleshooting

The following diagram shows the specific Service Web page for the shim function. There is a separate Web page for each SCB20 board, indicating the hardware status and the configuration. Several operations are reserved for service engineers and need the login procedure with a correct password.

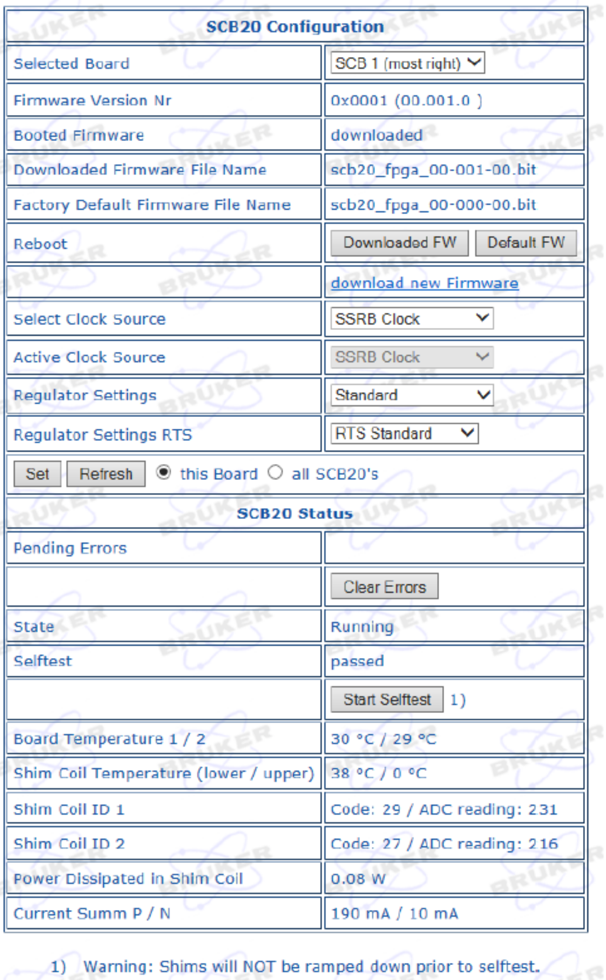
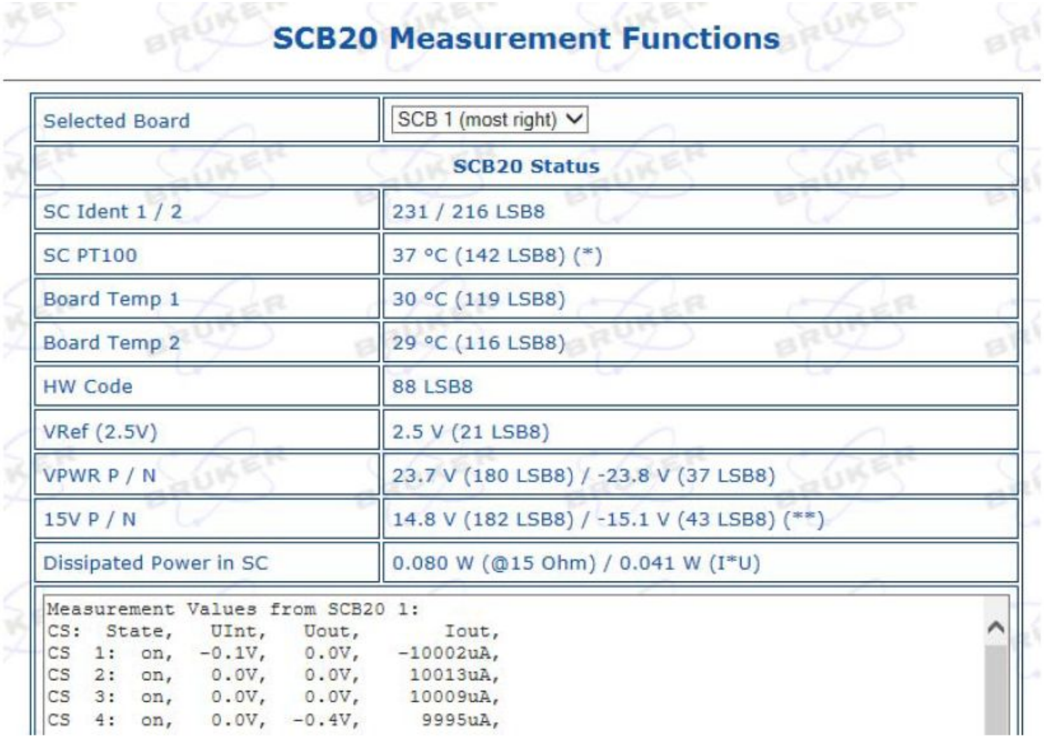


Figure 9.7: SCB20 Service Web page

For the case that there is a problem regarding the shim function (e. g. if there is an error message issued when the user wants to set or modify the value of a shim), it is possible to run the built-in self-test on each SCB20 board in order to verify that the SCB20 boards are in a correct state.

The power dissipation in the Shim Coil and the power consumption is displayed as additional information. In case of a failed attempt to set or modify a shim value, it is recommended to check if the power limit of the Shim Coil is reached or if the power supply is at its limit. It may be necessary to reset manually all currents to zero, which can be easily done by the **Shim Current Tool**.

Additional information about the consumed power and remaining margin can be retrieved under **Main | Shim | Shim Power Supply Information**.



SCB20 Measurement Functions

Selected Board	SCB 1 (most right)
SCB20 Status	
SC Ident 1 / 2	231 / 216 LSB8
SC PT100	37 °C (142 LSB8) (*)
Board Temp 1	30 °C (119 LSB8)
Board Temp 2	29 °C (116 LSB8)
HW Code	88 LSB8
VRef (2.5V)	2.5 V (21 LSB8)
VPWR P / N	23.7 V (180 LSB8) / -23.8 V (37 LSB8)
15V P / N	14.8 V (182 LSB8) / -15.1 V (43 LSB8) (**)
Dissipated Power in SC	0.080 W (@15 Ohm) / 0.041 W (I*U)

```
Measurement Values from SCB20 1:
CS:  State,   UInt,    Uout,       Iout,
CS  1:  on,  -0.1V,    0.0V,    -10002uA,
CS  2:  on,   0.0V,    0.0V,     10013uA,
CS  3:  on,   0.0V,    0.0V,     10009uA,
CS  4:  on,   0.0V,   -0.4V,      9995uA,
```

Figure 9.8: SCB20 Measurement Functions Web Page

9.5.6 No BOSS File for Currently Installed Shim System?

The procedure given here may be useful in case of an error message *Error: Shim: Cannot initialize Shim System .. with BOSS file ...* or if you cannot find an appropriate BOSS matrix file for the Shim System type that is indicated by the BSMS Service Web. It may be necessary to apply the procedure iteratively.

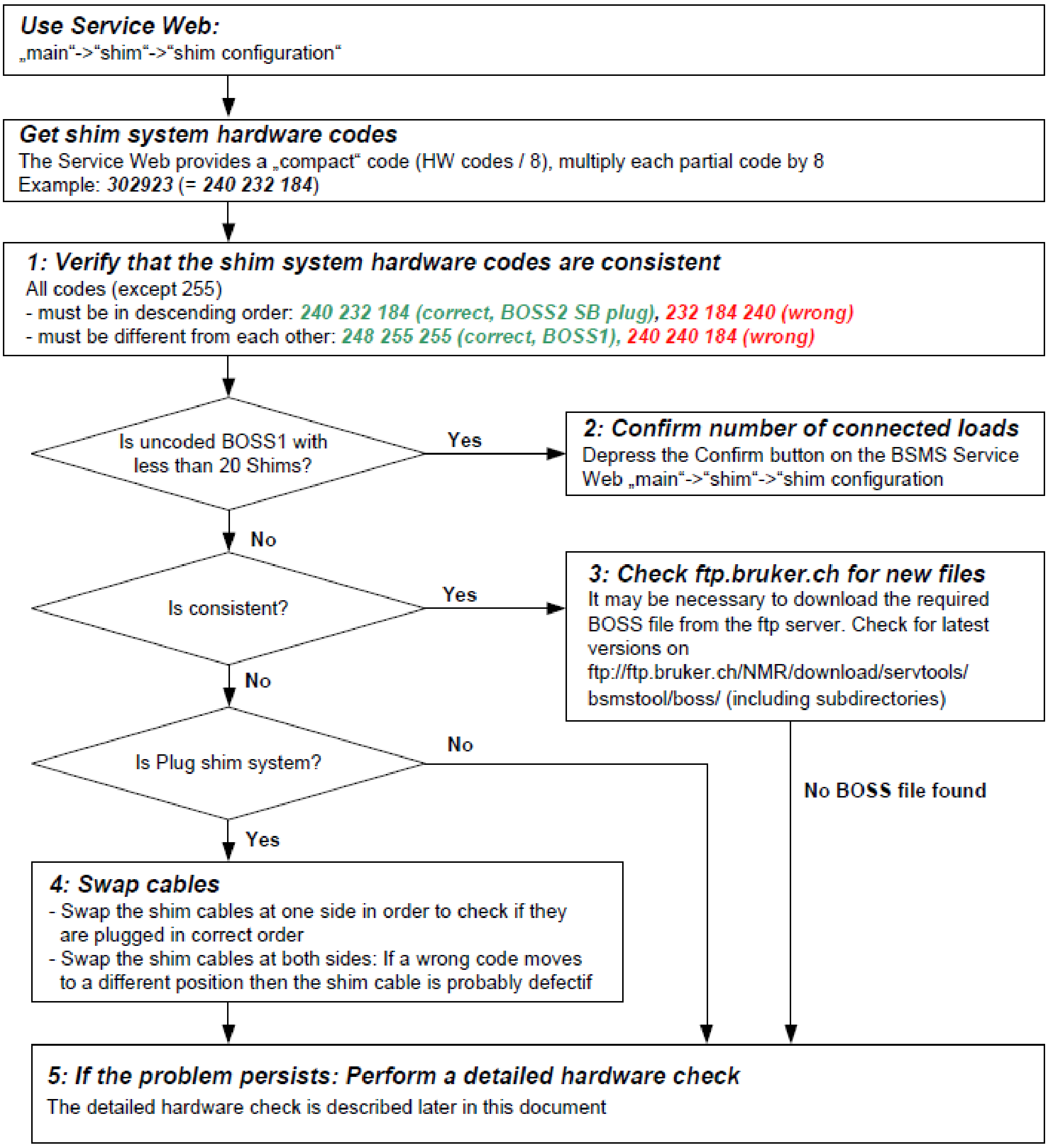


Figure 9.9: Troubleshooting Problems with Shim System and BOSS File

1. Verify that the Shim System Hardware Codes are Consistent

The *compact* Shim System code provided by ELCB based systems must be extended by multiplying each part by 8 in order to get the actual hardware codes, according to the following examples:

- „302928" -> 240, 232, 224 (BOSS2-SB NON US)
- „302923" -> 240, 232, 184 (BOSS2-SB PLUG)
- ...

Note1: In case of a connected BOSS1 Shim System, the ELCB Service Web indicates explicitly BOSS1 as connected Shim System type and does not provide the corresponding hardware codes. In this case, there is no need to download a BOSS file – the predefined BOSS1 definitions are used.

For non-BOSS1 systems, verify the following points:

- Are codes 255 only followed by further codes 255?
- Are all codes except 255 different from each other?
- Apart from values of 255, are the values of the codes decreasing from left to right?

2. Uncoded BOSS1 Shim Systems with less than 20 Shims

The ELCB firmware checks if the number of connected loads corresponds with the number of shim coils defined in the BOSS file. For BOSS1 systems, the ELCB assumes 20 loads. However, there are older, uncoded Shim Systems with less than 20 loads (e. g. only 17 shim coils). After power up, the user is informed about that by an error message. On the BSMS Service Web there is a button for confirmation of the actual number of loads of the currently connected Shim System. Afterwards, the load check is executed accordingly.

3. Check ftp.bruker.ch for New BOSS files

New BOSS files are published on the following ftp location:

ftp://ftp.bruker.ch/NMR/download/servtools/bsmstool/boss/

Check this directory (and the sub-directories) for new BOSS files and installation guides/ service information. It might be necessary to update your locally installed BOSS files.

4. Swap Cables if You Have a *Plug* >Type Shim System

The two Shim cables 'A' and 'B' could be connected in wrong order. Swapping the connectors at one side would eliminate the error. Make sure that the BSMS is switched off before swapping the cables!

In case of a defective Shim cable, swapping of the cables at both ends would move a wrong code to another position, e. g. from {<correct> <correct> <not correct>} to {<not correct> <correct> <correct>}.

Plug or unplug this connector only when the system is powered off.

5. Perform a Detailed Hardware Check

Ask your local Bruker office for assistance.

10 GAB/2

10.1 Introduction

The AV4 GAB/2 is the successor of the BSMS/2 GAB/2 gradient amplifier. It supports all its gradient functions, namely pulsed field gradients in NMR applications e.g. coherence selection, gradient shimming, spoil. Additionally, the gradient control interface can be daisy-chained, which enables triple axis gradient systems.

For the compensation of eddy current effects on the Z1, X1 or Y1 field in connection with Gradient pulses, there has been a preemphasis built into the GAB/2. The preemphasis current is based on three different exponential functions, each with a separate amplitude and time constant. These three times six parameters can be configured by the CORBA interface of the ELCB. In a multi gradient configuration, there are no cross terms available.

In spectrometers of the AV4 generation, the GTU uses the 48 bit LVDS link for real time gradient control. Shaped gradient pulses can be transmitted with a time resolution of up to one sample per microsecond.

For future applications it is possible to connect the GAB/2 with any other device issuing the required real time gradient data. It is however necessary that the connected device fulfills the LVDS interface specifications, which are given in detail later in this document.

The GAB/2 provides improved diagnostic functions and automatic offset calibration, which are both implemented in the specific GAB/2 driver. This driver is part of the BSMS software running on the ELCB.

In order to reduce distortions to a minimum, there is an improved, shielded connector for the gradient cable to the probe head.

10.2 Technical Data

Parameter	Min	Typ.	Max	Unit	Notes
Peak Current	-10.0		+10.0	A	1)
Peak Voltage	-33		33	Vs	
Fall Time (90 - 10%)			10	μs	2)
Fall Time (residual current smaller than 10 uA)			80	μs	2)
Amplitude Resolution for full range -10 A to +10 A	16	20 3)		bit	
Residual current when there is no Gradient active	-10.0		+10.0	μA	
Preemphasis time constants	0.02		20	ms	

Table 10.1: Electrical Characteristics (typical values)

Notes concerning the electrical characteristics:

1. The peak current is provided during maximum 50 ms in a timeframe of 1 second.
2. Fall Time measurements with a load of 30 μH / 1 ohm.
3. Typical resolution of 20 bit with preemphasis.

10.3 Configurations

The AV4 BSMS Chassis supports up to three AV4 GAB/2, installed in Slot 1 to Slot 7. If more than one GAB/2 is present, then two PSM-48V Power Supplies are required.

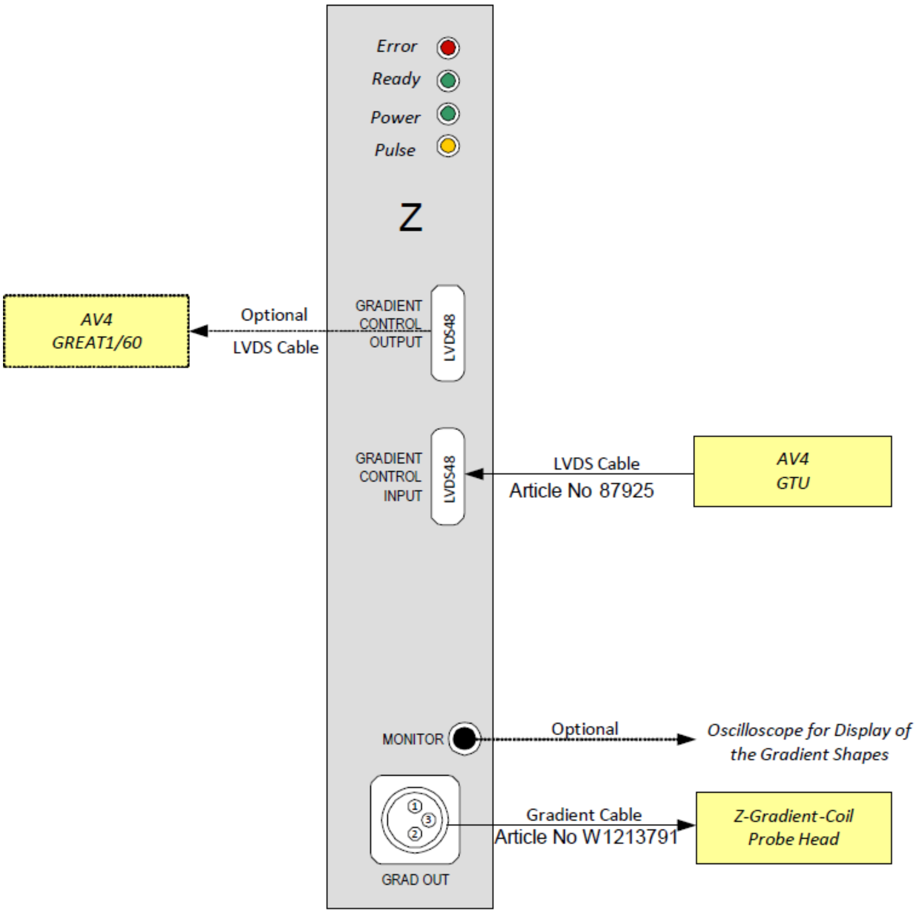


Figure 10.1: Single AV4 GAB/2 in an AVANCE NEO Spectrometer

The previous generation of integrated gradient amplifiers, the BSMS/2 GAB/2, is compatible to the AV4 BSMS CHASSIS, but does not support the LVDS daisy chain feature.

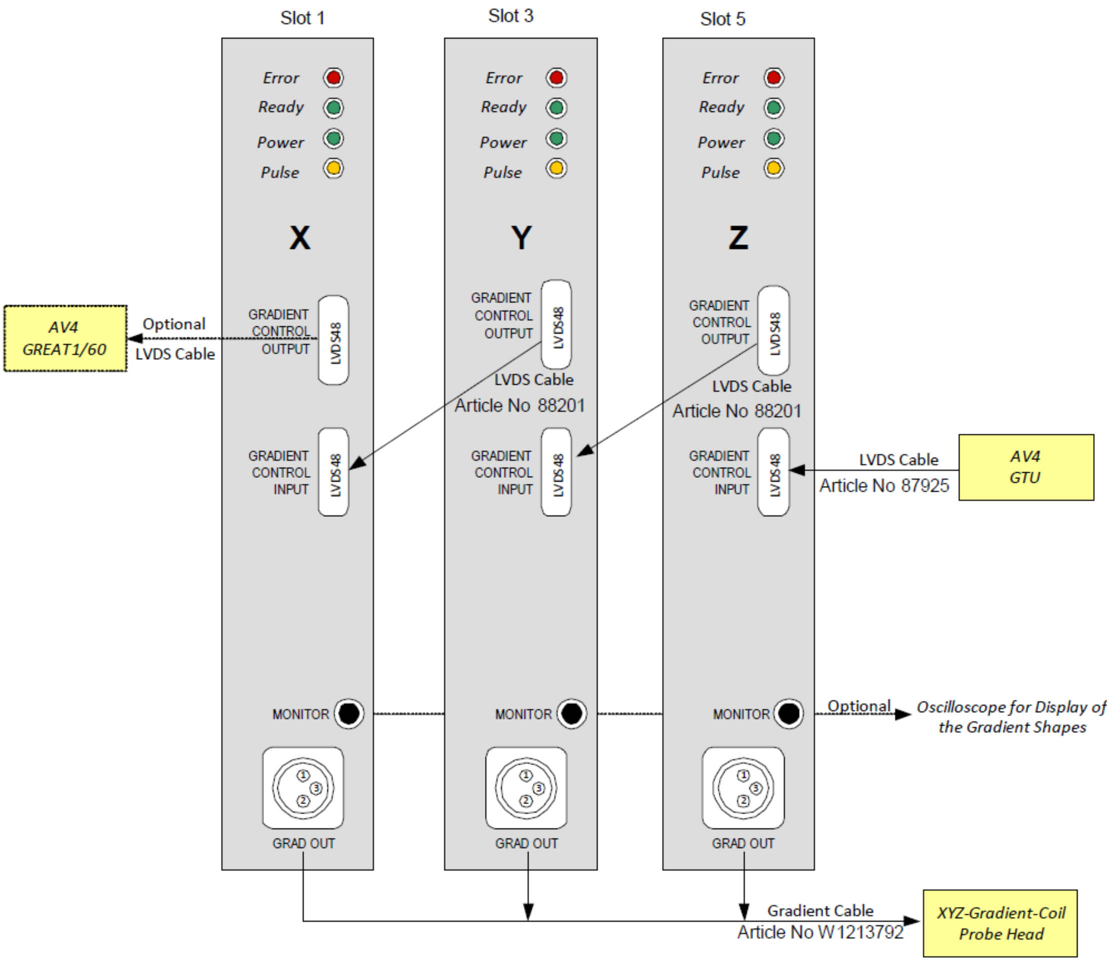


Figure 10.2: 3-Channel AV4 GAB/2 in an AVANCE NEO Spectrometer

The gradient channels are assigned as follows:

No. of Installed GAB/2's	Left Position	Middle Position	Rightmost or Single Position
1			Z
2		Y	Z
3	X	Y	Z

Table 10.2: Gradient channel assignment

10.4 Preemphasis

Each GAB/2 provides three preemphasis terms (exponential functions), each with selectable gain and time constant. Typing **setpre** in TopSpin (command line) opens a window for definition of the preemphasis parameters.

Note: The time constants by **setpre** are defined in milliseconds, whereas the BSMS Service Web provides time constant setting in seconds.

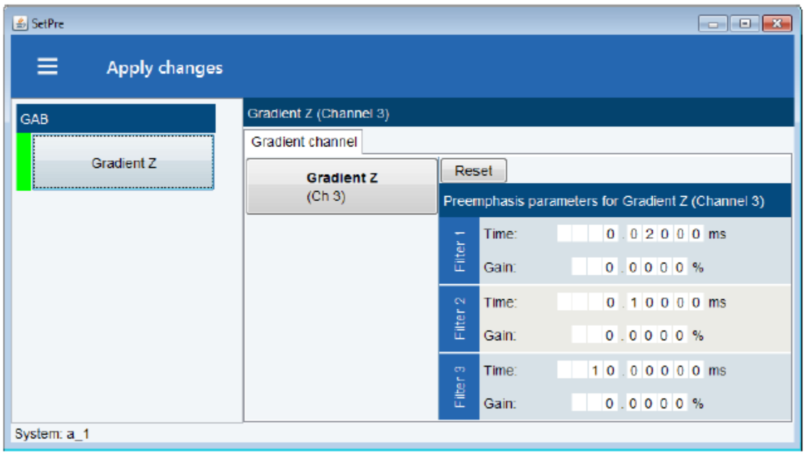


Figure 10.3: TopSpin Window for Preemphasis Settings

10.5 System Architecture/Overview

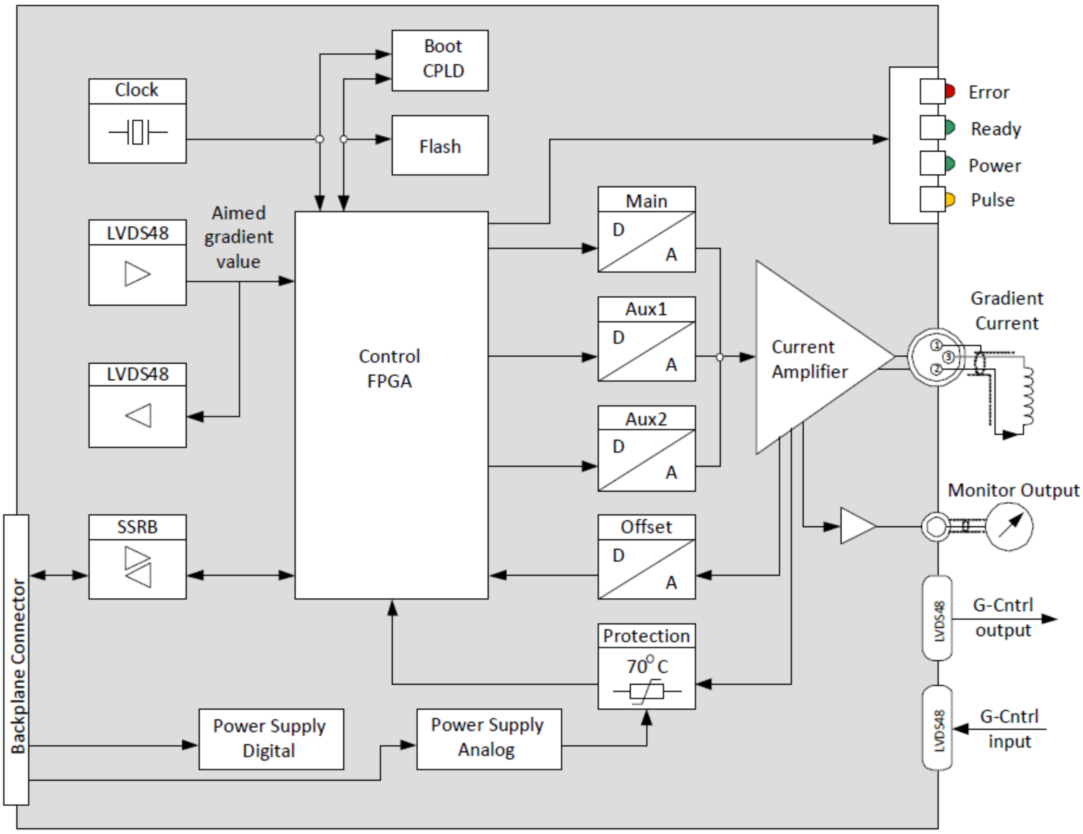


Figure 10.4: Block Diagram of the AV4 GAB/2 Gradient Amplifier Board

After power up, the design file stored in the flash is downloaded to the FPGA. During this period, all four LED‘s are on.

Then the GAB/2 is ready to be configured by the ELCB. The corresponding GAB/2 driver in the ELCB software is responsible for setting up the hardware for correct operation. The ELCB communicates over the SSRB (Synchronous Serial Rack Bus on the back plane) with the GAB/2. In addition, the error handling and service access (e. g. diagnostic functions) is part of the ELCB software.

The characteristics of the desired Gradient pulses for a specific NMR application is controlled just in time by real time commands transmitted over a LVDS link. The Gradient Controller of the AV4 GTU generates the necessary data, according to the pulse program that is running in the TopSpin application.

In compliance with the incoming LVDS data, there are the desired analog current pulses generated. The current amplifier provides the aimed current regardless of the connected load - e. g. varying resistance of the cable, or changing characteristics of the coil with temperature have no effect on the resulting current.

10.5.1 Protection

Both, the high power Gradient Connector and the monitor output are protected against short circuits and erroneously connected cables. The output current is limited (high side current measurement) and the temperature of the electronics is supervised. In case of overtemperature or overcurrent, the GAB/2 is switched off, and an error message is sent to the TopSpin application.

10.5.2 Status LED‘s on the Front Panel

POWER LED

This LED indicates the state of all internal power supplies. It is active when all power supply voltages are within the specified range.

READY LED

This LED is switched on while the GAB/2 is on / ready for issuing Gradient pulses.

ERROR LED

After power up, this LED stays active until the GAB/2 has been completely initialized by the ELCB software. If the GAB/2 could not be accessed over the SSRB then this LED remains on.

In case of a error on the GAB/2, this LED is switched on until the error is handled by the ELCB software - an error message is sent then to the TopSpin application. Therefore, the ERROR LED only flashes for a short time in case of an error.

PULSE LED

When the GAB/2 is in operation mode, the pulse LED is active as long as there is actually a Gradient current available at the Gradient connector. In any other state, this LED indicates that new data are arriving at the LVDS input.

At power up, the PULSE LED indicates an uninitialized FPGA. This LED remains active if it was not possible to load a valid FPGA file from the Flash.

10.5.3 Measurements Provided for Diagnostic

Monitor Output

The monitor output reflects the Gradient current provided by the gradient current connector. This output is intended for diagnostic purpose. It can be useful for debugging the hardware or software (pulse programs). The relation is 1 Volt (monitor voltage) per 1 Amperes (gradient current).

Logging of LVDS link

For diagnostic purpose, the GAB/2 hardware provides recording of the LVDS link data - incoming requests for specific gradient currents are logged (aimed value and time stamp in a raster of 10 ns). So, it can be checked if the real time gradient commands correspond exactly with the gradient defined by the pulse program in TopSpin. This feature is accessible over the Service Web - the logging buffer can be reset before running an experiment, and the resulting information is displayed afterwards.

10.5.4 GAB/2 Control State Machine

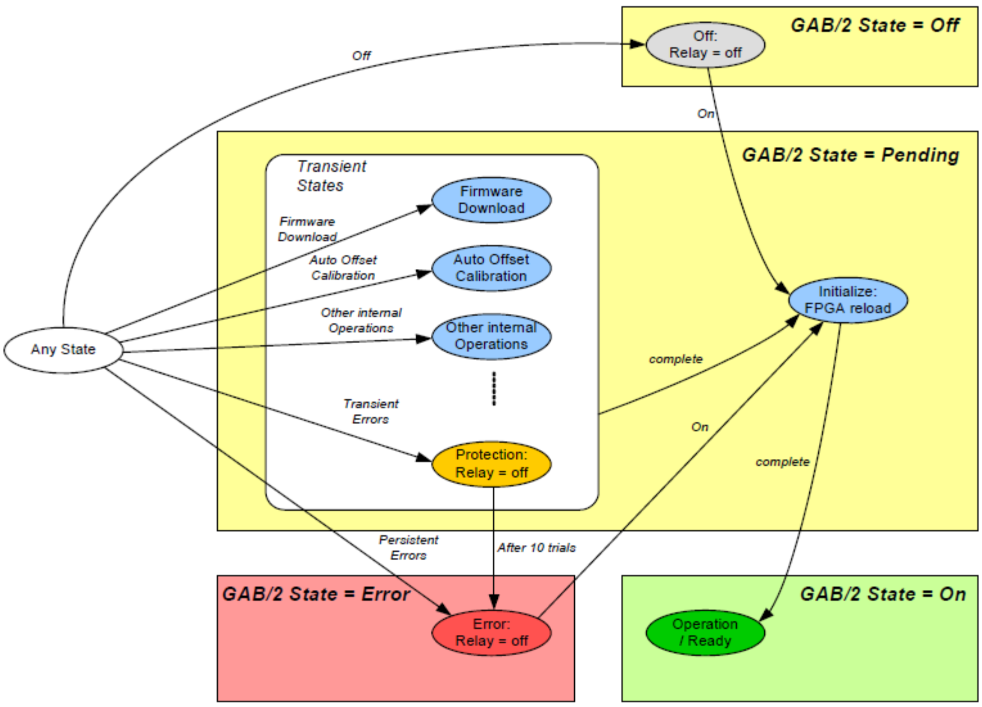


Figure 10.5: The GAB/2 Control State Machine

After Power Up of the BSMS, the GAB/2 Control State Machine steps through the necessary steps for getting operational. First, the FPGA design is reloaded from the Flash, and after correct setup of the hardware - if no error occurs - the final state *Operation* is reached. In this state the GAB/2 is ready for handling the incoming requests over LVDS.

It is possible to switch off the GAB/2 or to start some specific operations (e. g. Firmware Download or Automatic Offset Calibration) when the GAB/2 is in any state. After completion of a specific operation, the GAB/2 is re-initialized. In the end - on successful Initialization - the GAB/2 is ready/operational again.

In the state *Off* the gradient amplifier is switched off but the LVDS daisy chain is operational. During state changes, the LVDS link output may temporarily be switched off e.g. due to FPGA re-initialization.

There is a set of non severe errors (e. g. parity bit errors on 48 bit LVDS link, temporary interruption of the selected LVDS link). If such an error occurs then the GAB/2 steps into a *Protection* state - any existing Gradient current is reset (the relay is switched off). After a time-out the GAB/2 tries to re-initialize and reach the *Operate* state again.

In case of a severe error (e. g. break down of the supply voltage) the GAB/2 steps into the Error state. It remains in this state until the client (e. g. TopSpin application) re-initializes the GAB/2. Both, the severe and non-severe errors, are reported to the client (TopSpin application).

10.5.5 Front Panel - Connectors

The gradient current connector is shown in detail in the block diagram (*Figure 10.5 [▸ 88]*). Current flowing in the indicated direction induces a positive Z-Gradient. The monitor output is a simple coaxial connector, e. g. for directly connecting a scope.

Usage of all front panel connectors is described in *Configurations [▸ 84]*.

10.6 Web Interface

Both, the specific low level drivers and the overall control logic for the GAB/2 are implemented in the ELCB software. It provides setup and configuration for the operational functions for the NMR application by a CORBA interface. In addition there is a Web access available for service purpose (setup, calibration and diagnostic). Some of these Web functions are open for all users (e. g. clients), other functions are reserved for service engineers - it is necessary to log in and enter the required password before these functions can be accessed (description in the BSMS Service Web chapter).

10.6.1 GAB/2 Service Web

The Submenu **Main | GAB** provides access to all service functions for a connected GAB/2 board. Depending on the number of connected boards there is a different set of commands available.

Figure 10.6: Main Menu for the GAB/2 Subsystem

On top of the GAB/2 menu there is the link to the Gradient Amplifier Control sub-page. This page provides an overview over

- The overall state.
- The connected boards.
- Operating state (e. g. “operate“). If the GAB/2 is in state “off, protection” or “error” then the current source is disconnected by a relay.
- Channel assignment: which board should listen to which LVDS commands.

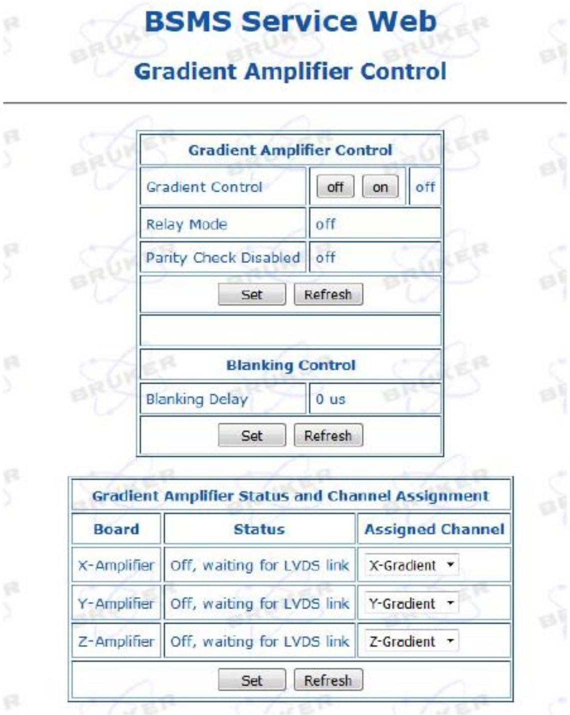


Figure 10.7: GAB/2 Subsystem Control Page

The GAB/2 service functions provide detailed information for diagnostics and a push button offset calibration (see also *Offset Re-Calibration in the Field [▸ 90]*).

There are further links for pre-emphasis parameter setting and logging of the real time gradient signals on the LVDS interface.

10.6.2 Offset Re-Calibration in the Field

During production, the GAB/2 is calibrated for minimum residual offset. This calibration is normally sufficient for a long time period and a wide temperature range. However, it may happen in rare circumstances that the dynamic offset compensator reaches its limitations. This is reported by an error message sent to the TopSpin application.

It is then necessary to go to the page **Main | GAB | GAB/2 Service Functions** and invoke the offset calibration again by depressing the button **Calibrate Offset**.

The other parameters on the GAB/2 Service Page are intended for diagnostic purpose. Service engineer access rights are necessary for modification - it is however not recommended to change these parameters under normal circumstances.

10.6.3 Preemphasis Setting by Service Web

Normally, the preemphasis parameters are defined by the **setpre** feature provided by TopSpin (see also *Preemphasis [▸ 86]*). Alternatively, the gains and time constants can be set also by the Service Web.

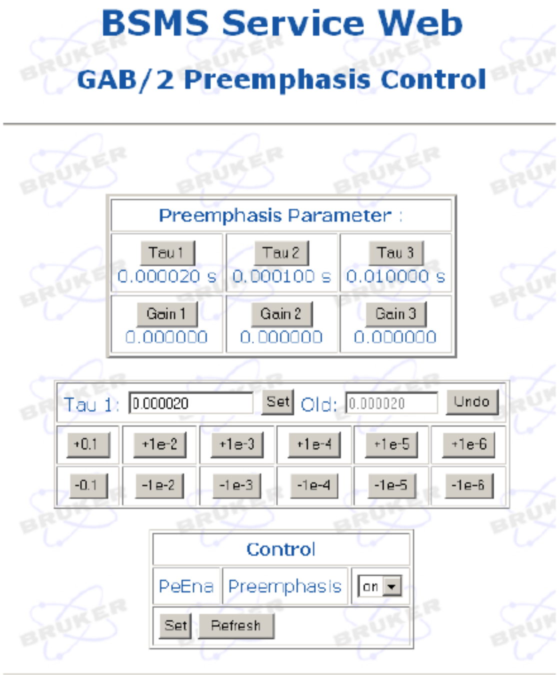


Figure 10.8: Preemphasis Settings

Note: The time constants (Tau1 .. Tau3) are defined in seconds.

10.6.4 Part Numbers

Bruker Part No.	Description
Z155150	AV4 GAB/2 GRADIENT AMPL BD

Table 10.3: Part Numbers: GAB/2

10.6.5 Troubleshooting

The following flow chart describes the suggested troubleshooting procedure in case of gradient problems.

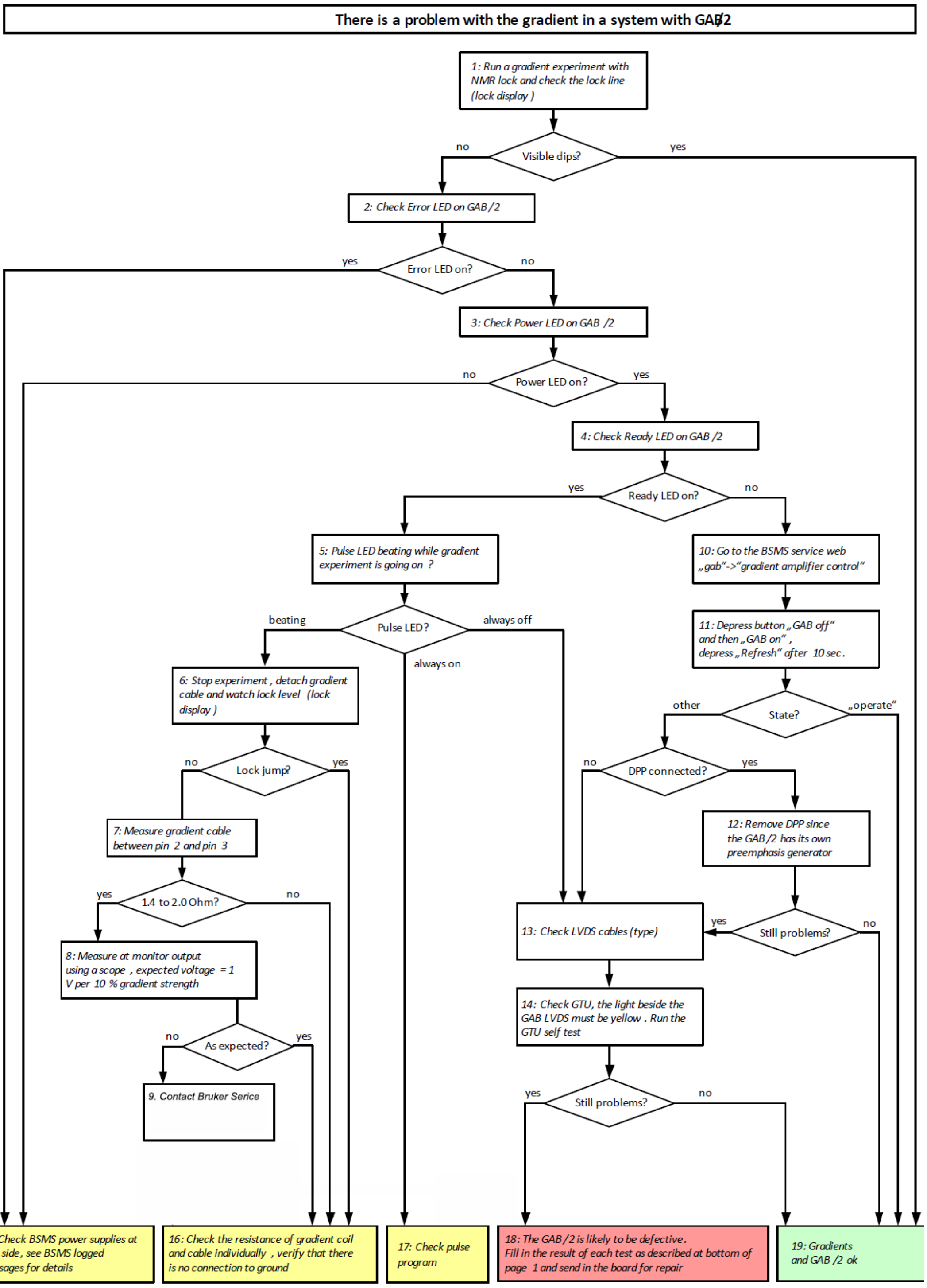


Figure 10.9: Troubleshooting Procedure for GAB/2

Some of the necessary checks are described in detail below. It depends on the preceding test results, which check actually has to be performed next. Typically, not all checks have to be executed.

1. Run a gradient experiment

Run the parameter set gradshim1d1h (rpar gradshim1d1h) and check if the resulting profile has the expected shape.

You can execute a Bruker standard experiment (e. g. gradient COSY) on a nucleus other than your lock nucleus (typically 2H for lock) with activated NMR lock. You should be able to see the deep dips in the lock level (check the lock display) while the gradient is active.

6. Check for unintended / faulty ground connection

In case of a faulty connection between one of the gradient wires and the ground potential there is typically a current flowing. This current has an influence on the Z1-Shim and disappears as soon as the gradient connector is unplugged. A perfect shim with the influence of that current would get significantly worse without, and the lock level would drop accordingly.

7. Measure gradient cable between pin 2 and 3

Unplug the gradient cable and measure at GAB/2 side. Since the resistance of the gradient (cable and coil) is very low, the measurement has to be made very carefully (at best differential measurement).

8. Connect an oscilloscope to the monitor output

The monitor output on the GAB/2 provides a voltage that represents the current actually provided by the GAB/2 current source. 1 Volt represents 1 Ampère current, which is a gradient strength of 10%. If the voltage at the monitor is only a few millivolts and very noisy, there is probably no gradient load connected. In this case, the gradient cable and the coil resistor have to be measured by an Ohm meter (see point 16).

9. Suspicion of open gradient load

If you suspect an open gradient load please contact your local Bruker office.

10. Use the BSMS Service Web to get the GAB/2 state

In TopSpin type **ha** to get access to the Service Web.

11. Restart the GAB/2 on the corresponding Service Web page.

Perform the indicated command sequence. Wait about 10 seconds before depressing the **Refresh** button. If you have no success, you may try several times.

12. If there is a DPP

The GAB/2 can operate without DPP and has its own preemphasis generator. The DPP is therefore not necessary and should be removed. Some versions of the DPP did not provide a parity bit, which would cause communication errors.

13. Check the LVDS cables

Verify that only the certified LVDS cables are used, if you are not sure about the required type, contact your Service support. You might try with a cable from a SGU/2 channel.

15. If the GAB/2 is in error state

Normally, the cause for a GAB/2 error is reported to TopSpin by an error message. One possible cause could be a missing power supply voltage. It is helpful to check also the logging provided by the BSMS Service Web (page **Service | Display logged messages**). There might be a hint why the GAB/2 is in error state.

Long term BSMS logging can be enabled on the **bsmsdisp** provided by TopSpin. The enable check box is on the service page (password required), and the logging can be viewed on the same page.

11 L-TRX/L-19F

11.1 Introduction

The BSMS/2 Lock Transceiver (L-TRX) and the optional BSMS/2 Lock Transceiver 19F (L-19F) are highly integrated units and incorporate the following functions:

- Lock RF signal generator and transmitter.
- Lock RF receiver.
- Actively gated 5W pulsed power amplifier for 2H gradient shimming purposes.
- 19F Lock option.

In addition, the L-TRX / L-19F have several new features:

- Enhanced digital transmitter and receiver.
- Power amplifier with active quiescent current control.
- Field-upgradable by firmware.
- Fast SSRB interface to ELCB.
- Real-time pulses also accessible via backplane connector.
- On board over temperature protection.
- Extended internal diagnostics.
- BIS hardware identification system.
- Milled housing with narrow form factor and optimized cooling fins.
- Dedicated up- and down converter unit for fluorine lock (L-19F).

There is one frequency selective L-TRX unit available per system frequency. The L-19F unit is a broadband design that covers the system frequency range from 300 MHz to 1000 MHz.

11.2 System Architecture / Overview

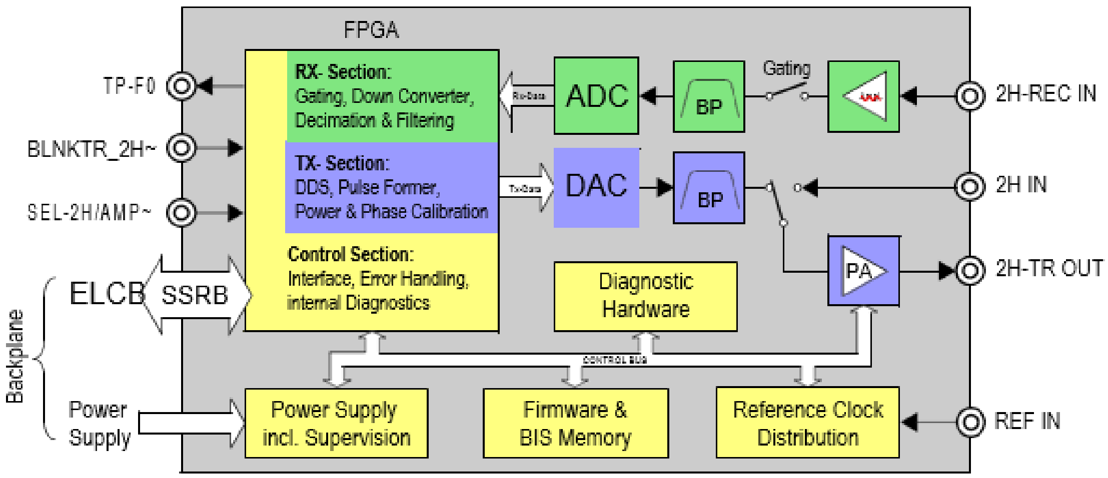


Figure 11.1: L-TRX Block Diagram

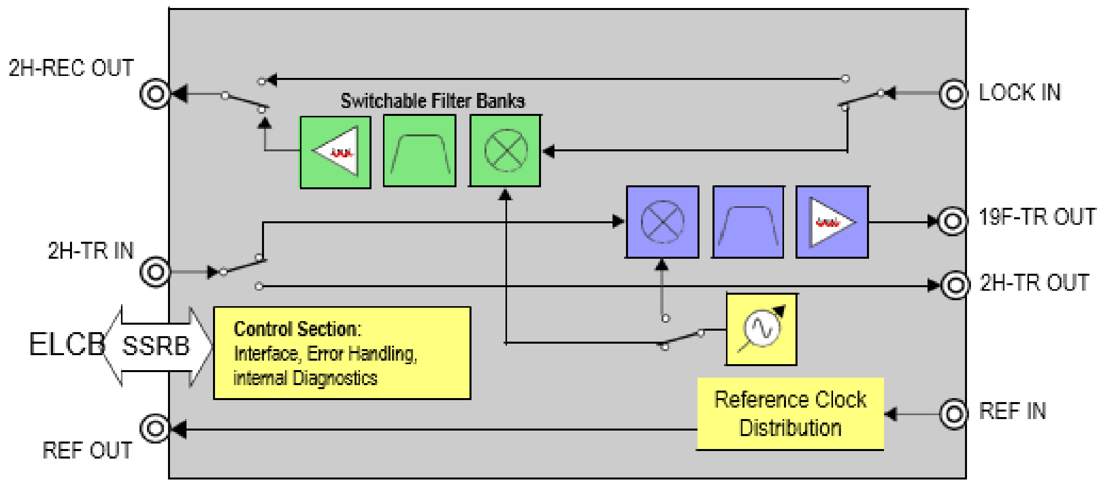


Figure 11.2: L-19F Block Diagram

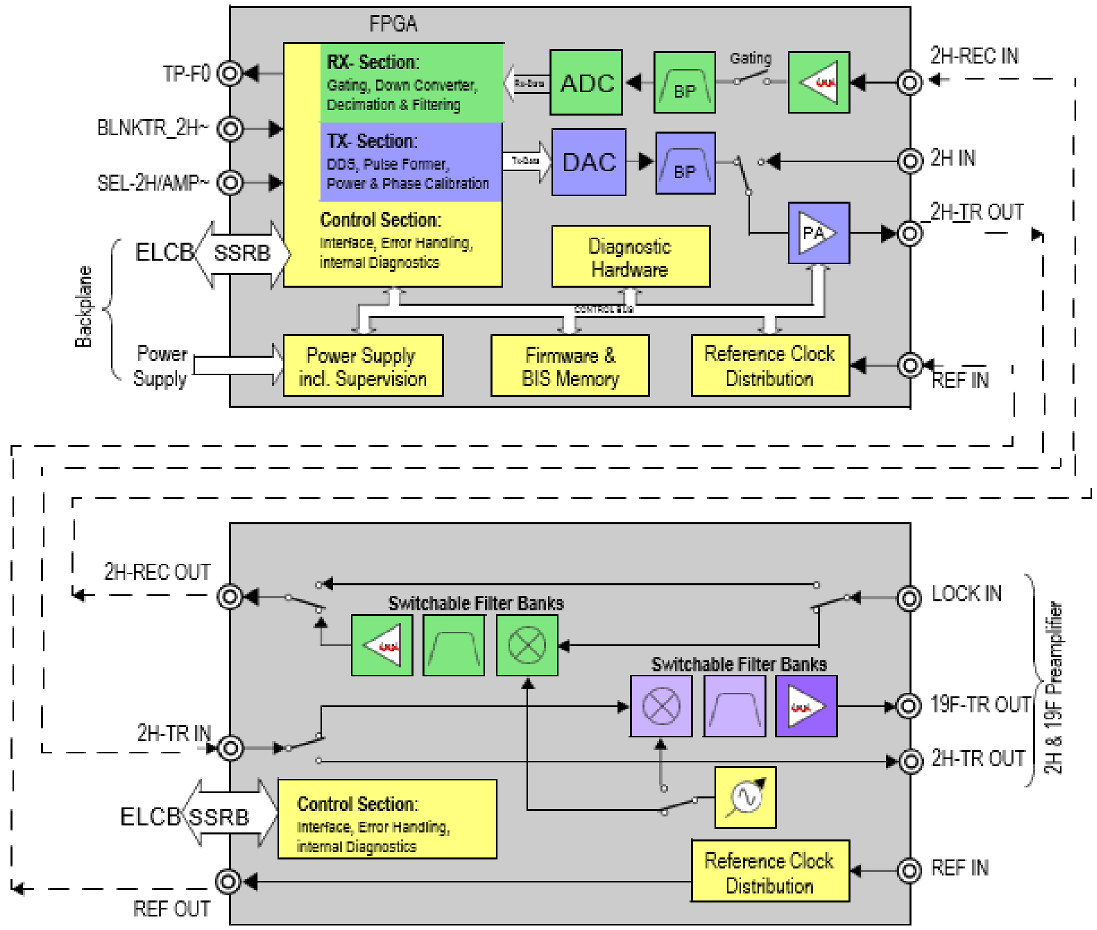


Figure 11.3: Block Diagram with Optional L-19F Unit

11.2.1 Function Description

The architecture of the L-TRX / L-19F units is significantly different to the design of the former L-TX and L-RX units. The individual signal processing and amplifier control stages are as much as possible shifted into the digital domain.

Signal processing

The transmitter consists of a direct digital synthesizer. The output power range is fully implemented with D/A-converters, which eliminates the need of real-time controlled analog attenuators.

The receiver consists of a mostly direct digital system. The receiver gain is mainly implemented in the digital section.

Deuterium Power Amplifier with Active Quiescent Current Control

The operating point of the on-board 5W power amplifier for 2H gradient shimming is matched to the different operating modes in order to reduce power dissipation. The individual quiescent current values are stored in the calibration data memory of each unit. In **2H Lock** mode the quiescent current is actively regulated.

Gradient Shimming

Together with the L-19F unit, the on-board 5W power amplifier should not be used for gradient shimming on 2H. In spectrometer configurations with the L-19F unit a high power 2H amplifier is anyway mandatory for 2H observe experiments. In this configuration the same high power 2H amplifier is used for gradient shimming.

The L-TRX / L-19F units do not support gradient shimming on 19F.

Reference Clock

The L-TRX / L-19F units requires a reference frequency mixture produced by the AV4 REFERENCE board. The former 10 MHz system clock is not required anymore.

SSRB Communication Interface with ELCB

The L-TRX / L-19F units use a dedicated SSRB (Synchronous Serial Rack Bus) interface for control and data transfer to the ELCB.

Real-Time Pulses via Backplane

The L-TRX is able to receive and transmit real-time control pulses via backplane to reduce external wiring. This feature is currently only used in the NanoBay console (BLNKTR_2H~). Other pulses and/or consoles may follow in the future.

2H-TR Power Amplifier Output Connector

The output connector is a N-type instead of SMA to avoid the risk of unintentional wrong wiring. E.g. low power RF-boards could be permanently damaged if wrongfully connected to the 5W power output of the L-TRX.

Product Firmware

The L-TRX / L-19F firmware packages are field-upgradable via ELCB. The factory configuration is stored on-board in a write protected memory section. The user can always reload the factory firmware.

Fluorine Lock

The former fluorine lock option piggy modules have been integrated into a dedicated deuterium to fluorine up and down converter unit (L-19F). While locking on a deuterated solvent, the L-19F unit is bypassed. Whereas the L-19F unit translates the deuterium lock signal into the fluorine lock signal, while locking on samples containing fluorine as lock solvent.

11.2.2 Protection

Power Supply and Reference Clock Supervision

All power supply voltages and the necessary reference clocks are internally monitored. In case of a failure the PWR/CLK LED (L-TRX) or the PWR LED (L-19F) are deactivated and an appropriate error message is generated (if still possible).

Over-Temperature Protection (L-TRX only)

The power amplifier and board temperature are monitored on-board. The ELCB can access the relevant sensors and act accordingly.

If the temperature reaches the limit of safe operation, the power amplifier is switched off immediately without intervention of the ELCB. The L-TRX enters the ERROR state. An error message is sent to TopSpin. See *Over Temperature Error [▶ 116]*.

After regaining normal temperature conditions, the L-TRX reverts to the operating mode prior to the error.

Over-Current Protection (L-TRX only)

If the power amplifier drain current exceeds the limit of safe operation, it is switched off and the L-TRX enters the ERROR state. An error message is sent to TopSpin. See *Over Current Error [▶ 116]*.

11.2.3 Internal Diagnostics

The L-TRX has extensive internal diagnostic functions which can be accessed via the Service Web. See *Service Web [▶ 114]*.

Many of the diagnostics are performed automatically during power-up and assessed by the ELCB. If a failure occurs, an appropriate error message is generated.

Due to the low complexity of the L-19F unit, the unit does not have any dedicated diagnostic functions.

11.2.4 Technical Data BSMS/2 Lock Transceiver

Transmitter (TX):		
Output power for gradient shimming @ +4 dBm input power Conditions: pulsed power only, max. pulse length = 1s, max. duty-cycle = 10 %, all independent of actual output power	min. 5	W
Output power for Lock operation:		
FFA Mode (250µs pulse)	typ. 28	dBm
Lock Mode (Lock pulse)	-60...+20	dBm
Output power resolution	typ. 0.1	dB
Frequency resolution	≤ 14	mHz
Phase resolution	≤ 0.1	°(deg)
Phase range	0..360 endless	°(deg)
Frequency range	f2H ± 1	MHz
Load mismatch:		
no damage	infinite	VSWR
for on board diagnostics	≤ 3.6	VSWR
Confamp (except for Z109887 and Z109888 with ECL< 2)	Supported	
Receiver (RX):		
Gain range	80	dB
Gain resolution	0.1	dB

11.2.5 Technical Data BSMS/2 19F Lock Transceiver

Transmitter (TX, 19F Lock Operation):		
Output power for Lock operation:		
FFA Mode (250µs pulse)	typ. +10	dBm
Lock Mode (Lock pulse)	-60...+10	dBm
Output power resolution	See *Technical Data BSMS/2 Lock Transceiver [▶ 99]*	
Frequency resolution	See *Technical Data BSMS/2 Lock Transceiver [▶ 99]*	
Phase resolution	See *Technical Data BSMS/2 Lock Transceiver [▶ 99]*	
Phase range	See *Technical Data BSMS/2 Lock Transceiver [▶ 99]*	
Frequency range	f19F ± 1	MHz
Load mismatch	See *Technical Data BSMS/2 Lock Transceiver [▶ 99]*	
Confamp	N/A	
Receiver (RX, 19F Lock Operation):		
Gain range	60	dB
Gain resolution	See *Technical Data BSMS/2 Lock Transceiver [▶ 99]*	

11.2.6 2H Lock with L-TRX Internal Power Amplifier

Minimal system for 2H lock using internal power amplifier for gradient shimming only (no 2H Observe or Decoupling capability). Set **2H-TX Control** Router Address according to your configuration (see *2H-TX Control (Router Address) [▸ 110]*).

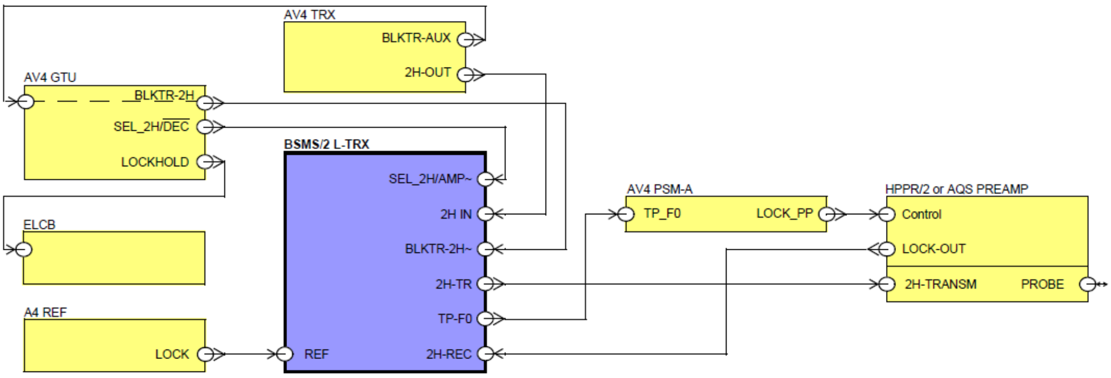


Figure 11.4: 2H Lock System with L-TRX Internal Power Amplifier for Gradient Shimming

11.2.7 2H Lock with Additional, External 2H Power Amplifier

A more powerful external amplifier can be used for 2H gradient shimming, 2H Observe and 2H Decoupling.

In order to mute the lock stimulus in real-time during 2H-Observer and 2H-Decoupling experiments, the signal SEL_2H/DEC must be connected to the 2H-Amplifier and the L- TRX unit.

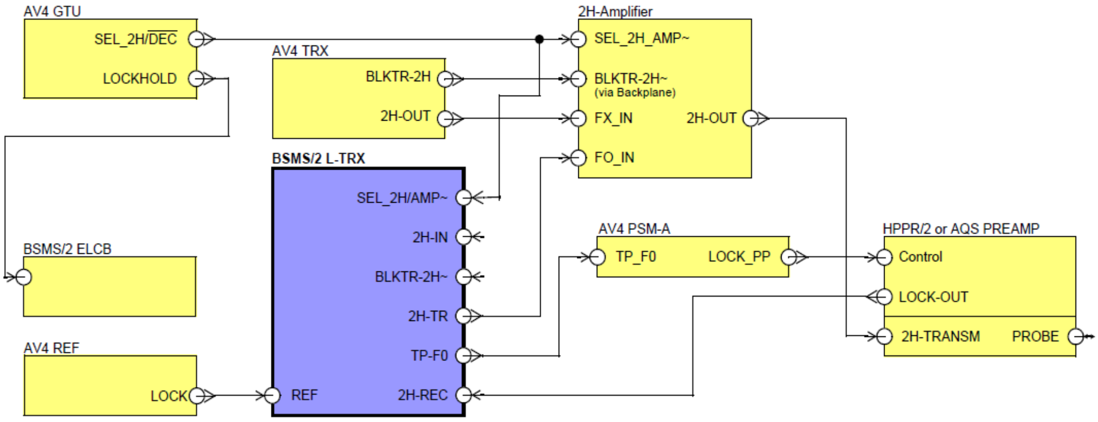


Figure 11.5: 2H Lock System with Additional, External 2H Power Amplifier

Interrupt of Lock 2H Operation with SEL_2H/AMP~ Signal in Real-Time.

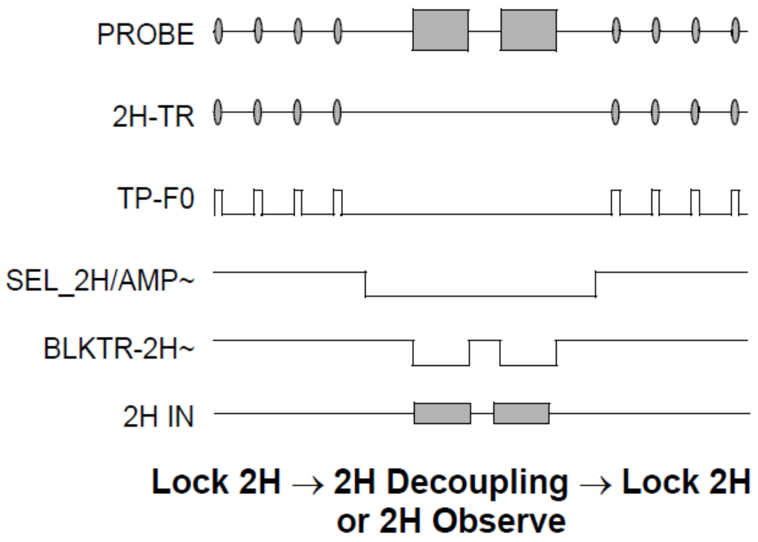


Figure 11.6: Timing Diagram of Lock 2H Operation with Interrupts for 2H Decoupling or 2H Observe

11.2.8 19F Lock with external 2H Power Amplifier

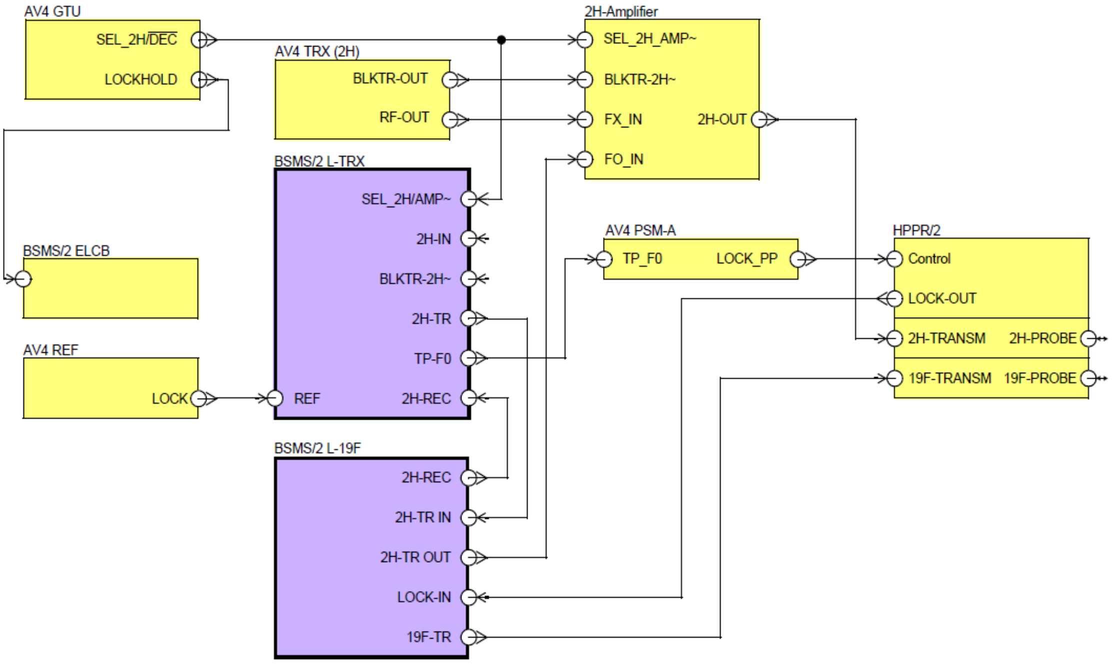


Figure 11.7: L-TRX 19F Lock System with External 2H Power Amplifier

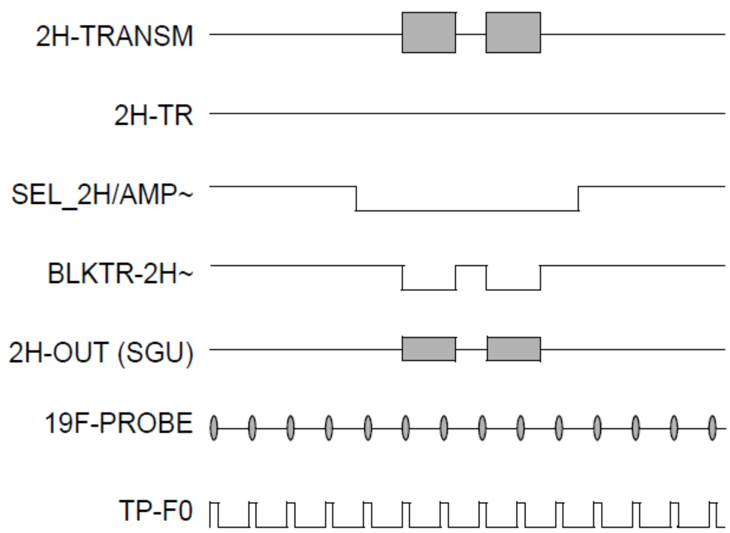


Figure 11.8: Timing Diagram of Lock 19F Operation and Simultaneous 2H Decoupling or 2H Observe

11.3 AVANCE NEO OneBay/TwoBay Configurations

The AV4 BSMS chassis is only compatible to the current generation of lock systems e.g. BSMS/2 L-TRX and BSMS/2 L-19F.

11.4 Front Panel - Connectors and LED‘s

11.4.1 BSMS/2 Lock Transceiver

Figure 11.9: View BSMS/2 Lock Transmitter 300

LED ERROR (red):

All errors detected by the L-TRX are displayed with the ERROR LED. In addition interrupt requests activate the LED for at least 250 ms. If the ELCB does not process the interrupt immediately, the LED stays active. In diagnostic mode the LED beats with approx. 2 Hz. During the Error state only a minimal set of diagnostic functions is available.

LED READY (green):

The READY LED is active if the L-TRX is successfully initialized and ready for ELCB commands. If the LED stays dark, the L-TRX FPGA initialization has failed. If an error is detected, the LED is deactivated. In addition any communication deactivates the LED for at least 250 ms.

LED PWR/CLK (green):

In case of a power supply failure or missing reference clock the PWR/CLK LED is deactivated. The L-TRX enters the ERROR state.

LED INACTIVE (yellow):

During normal operation the INACTIVE LED displays the L-TRX Lock signal generation status. The LED is continuously on when no Lock mode is active or beats with approx. 2 Hz if the signal generation is suppressed with the SEL_2H/AMP~ input.

In diagnostic mode the LED displays the transmitter (power amplifier) status. If the transmitter is switched off, the LED is active. During pulsed operation the LED beats with approx. 2 Hz. In CW signal generation mode the LED is deactivated.

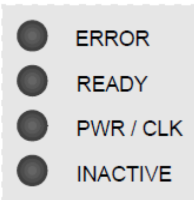
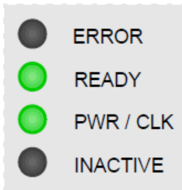
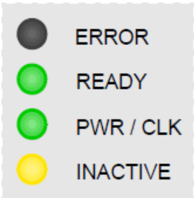
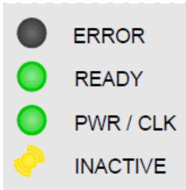
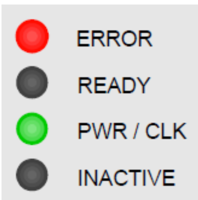
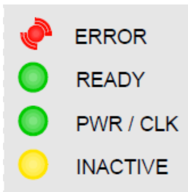
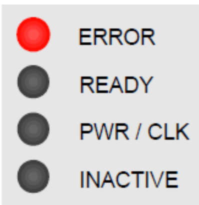
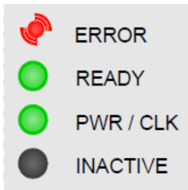
<table>
<tr><th>LED Status</th><th>Operating Mode</th><th></th><th>LED Status</th><th>Operating Mode</th></tr>
<tr><td>
</td><td>Power OFF:
The L-TRX is switched off.</td><td></td><td>
</td><td>Lock 2H:
Normal operating mode. Pulsed Lock signal gener- ated.</td></tr>
<tr><td>
</td><td>Idle:
No 2H stimulus signal, no RF-signal generated.</td><td></td><td>
</td><td>Lock 2H and Mute 2H:
L-TRX in normal Lock mode with temporary signal suppression due to active external SEL_2H/ AMP~ signal. The LED beats with approx. 2 Hz.</td></tr>
<tr><td>
</td><td>Error:
Error in L-TRX detected but neither power supply failure nor missing reference clock.
(e.g. over temperature in power amplifier)</td><td></td><td>
</td><td>Diagnostic:
Power amplifier not active respectively no output signal generated.
The ERROR LED beats with approx. 2 Hz.</td></tr>
<tr><td>
</td><td>Error:
Error in L-TRX power supply or missing reference clock.</td><td></td><td>
</td><td>Diagnostic:
Pulsed output signal generated. Both ERROR and INACTIVE LED beat with approx. 2 Hz.</td></tr>
<tr><td></td><td></td><td></td><td>
</td><td>Diagnostic:
CW output signal generated. The ERROR LED beats with approx. 2 Hz.</td></tr>
</table>

Table 11.1: L-TRX Status LED's in Different Operating Modes

2H-REC IN (J1, SMA):

2H receiver input from 2H preamplifier (HPPR/2, AQS 1H2H, LOCK-OUT)

- Maximum input power with no damage: +0 dBm

REF IN (J3, SMA):

Reference clock input from AV4 REFERENCE board or L-19F REF OUT (J3).

- Nominal input power @ 160 MHz: -0.5 ±0.5 dBm.
- Nominal input power @ 320 MHz: -3.5 ±0.5 dBm.

TP-F0 OUT (J4, SMA):

Transmitter pulse output to HPPR preamplifier (via AV4 PSM-A board).

- 5V TTL output, no damage with 50 ohm load.
  (pulse polarity see *Service Web [▸ 110]*)

BLNKTR-2H~ IN (J5, SMA):

Power amplifier blanking pulse from AV4 TRX (via NanoBay backplane or AV4 PSM-A board).

- 5V TTL input
  (high (+5 V) = power amplifier blanked, low (0 V) = power amplifier gated)

SEL-2H/AMP~(J6, SMA):

Power amplifier control signal from AV4 GTU unit (SEL_2H/DEC).

- 5V TTL input
  (high (+5 V) = 2H Lock, low (0 V) = 2H amplifier selected for gradient shimming, 2H Lock muted)

2H IN (J8, SMA):

Power amplifier input RF-signal from AV4 TRX.

- Maximum input power with no damage: +10 dBm.

2H-TR OUT (J9, N):

2H RF-output to HPPR preamplifier (2H TRANSM) or L-19F unit (2H-TR IN) depending on configuration.

- Transmitter output specification see *Technical Data BSMS/2 Lock Transceiver [▸ 99]*.

11.4.2 BSMS/2 19F Lock Transceiver

Figure 11.10: View BSMS/2 19F Lock Transceiver

LED ERROR (red):

All errors detected by the L-19F unit are displayed with the ERROR LED.

LED PWR (green):

In case of a power supply failure the PWR LED is deactivated. The L-19F unit enters the ERROR state.

LED 2H (green):

If the L-TRX & L-19F units are configured to lock on a deuterated solvent, the 2H LED is activated. The deuterium signal is bypassed by the L-19F unit.

LED 19F (green):

If the L-TRX & L-19F units are configured to lock on a solvent with fluorine, the 19F LED is activated. The L-19F unit translates the L-TRX deuterium lock signal to fluorine lock signal.

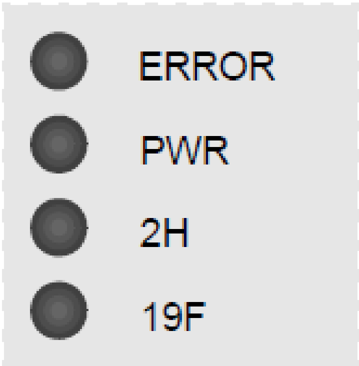
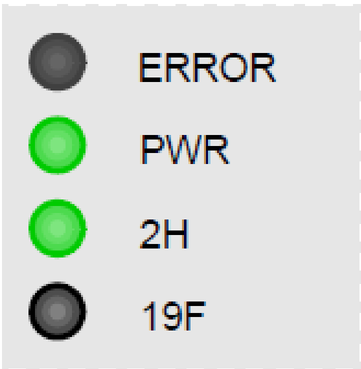
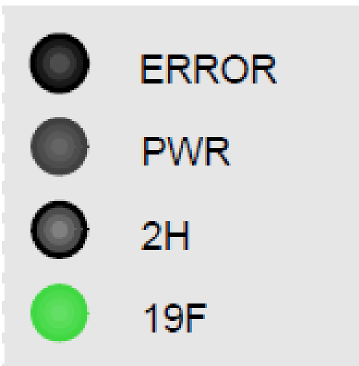
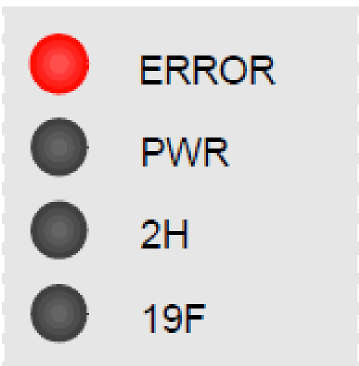
LED Status	Operating Mode
	Power OFF: The L-19F unit is switched off.
	2H: L-TRX and L-19F are configured for deuterium lock.
	19F: L-TRX and L-19F are configured for fluorine lock.
	Error: Error in L-19F power supply. At least one power supply voltage is out of range.

Table 11.2: L-19F Status LEDs in Different Operating Modes

LOCK IN (J1, SMA):

Receiver input from HPPR/2 or AQS 1H2H preamplifier (LOCK-OUT).

- Maximum input power with no damage: +0 dBm.

2H REC OUT (J2, SMA):

Receiver output to L-TRX 2H-REC IN J1.

REF IN (J3, SMA):

Reference clock input from AV4 REFERENCE board.

- Nominal input power @ 160 MHz: -0.5 ±0.5 dBm.
- Nominal input power @ 320 MHz: -3.5 ±0.5 dBm.

REF OUT (J4, SMA):

Reference clock output to L-TRX REF IN J3.

19F-TR OUT (J7, SMA):

19F RF-output to HPPR/2 19F preamplifier (19F TRANSM).

- 19F Transmitter output specification see *Technical Data BSMS/2 19F Lock Transceiver* *[▹ 100]*.

2H-TR-IN (J8, SMA):

Deuterium lock signal from L-TRX 2H-TR OUT J9.

- Maximum input power with no damage: +37 dBm (2H operation).
- Maximum input power with no damage: +10 dBm (19F operation).

2H-TR OUT (J9, N):

2H RF-output to any high power amplifier (FX-IN).

- Transmitter output specification see *Technical Data BSMS/2 19F Lock Transceiver* *[▹ 100]*.

11.5 Web Interface

The configuration, service and diagnostic functions of the L-TRX can be accessed via the ELCB Service Web.

For more information on the Lock configuration setup please refer to *Service Software [▸ 61]*.

11.5.1 Service Web

2H-TX Control (Router Address)

This setting is no longer used. The **confamp** procedure during **cf** automatically detects the amplifier connections.

Lock Configuration

Configuration settings for external pulses. For other settings please refer to *Lock Configuration [▸ 64]*.

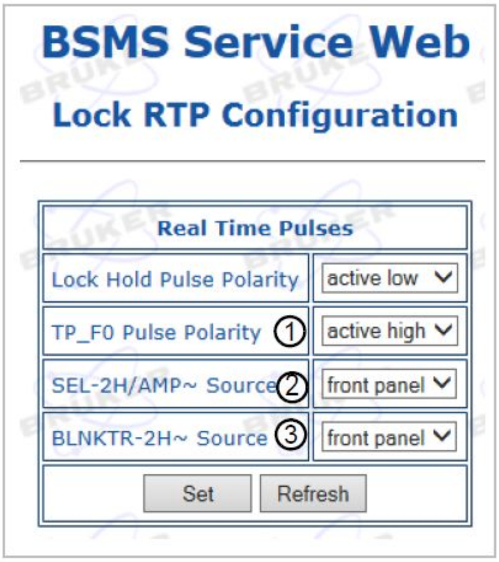


Figure 11.11: Lock Configuration

1	TP_F0 pulse polarity: select **High active** (standard) or **Low active** High active = all configurations Low active = currently not used
2	SEL-2H/AMP~ pulse source: select **Front Panel** (standard) or **Backplane** Front Panel = all configurations Backplane = currently not used
3	BLNKTR-2H~ pulse source: select **Front Panel** (standard) or **Backplane** Front Panel = MicroBay / OneBay / NanoBay NEO configuration with internal power amplifier used for gradient shimming Backplane = NanoBay-E console ECL ≥ 02 and later, (exception: NanoBay NEO)

Service Functions

Most information on this page are for service use only.

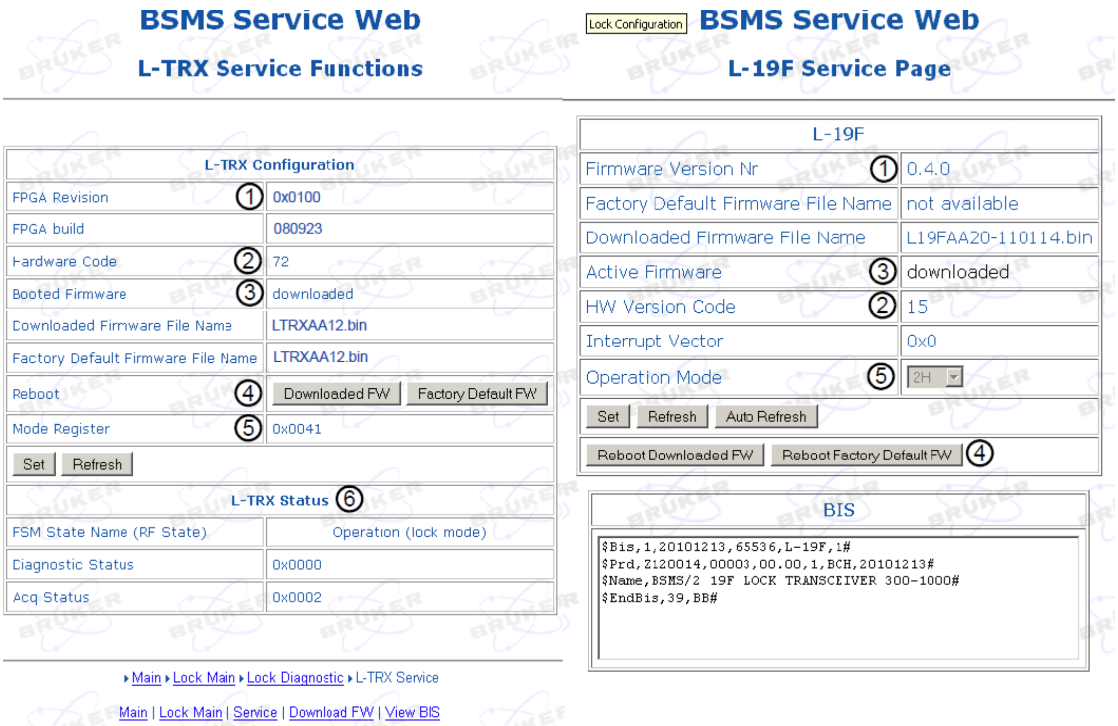


Figure 11.12: Service Functions

1	FPGA revision and build date (yymmdd).
2	Hardware code = used by ELCB to identify Lock system.
3	Firmware status and file name (download and factory default).
4	Reboot buttons: use ‚Factory Default FW' to revert to factory firmware.
5	Mode register status.
6	L-TRX status information.

Firmware Upgrade/Download

A new firmware release can be downloaded from the Bruker FTP-server. The factory firmware is retained in a write protected memory section.

To revert to the factory firmware see the table Service Functions above.

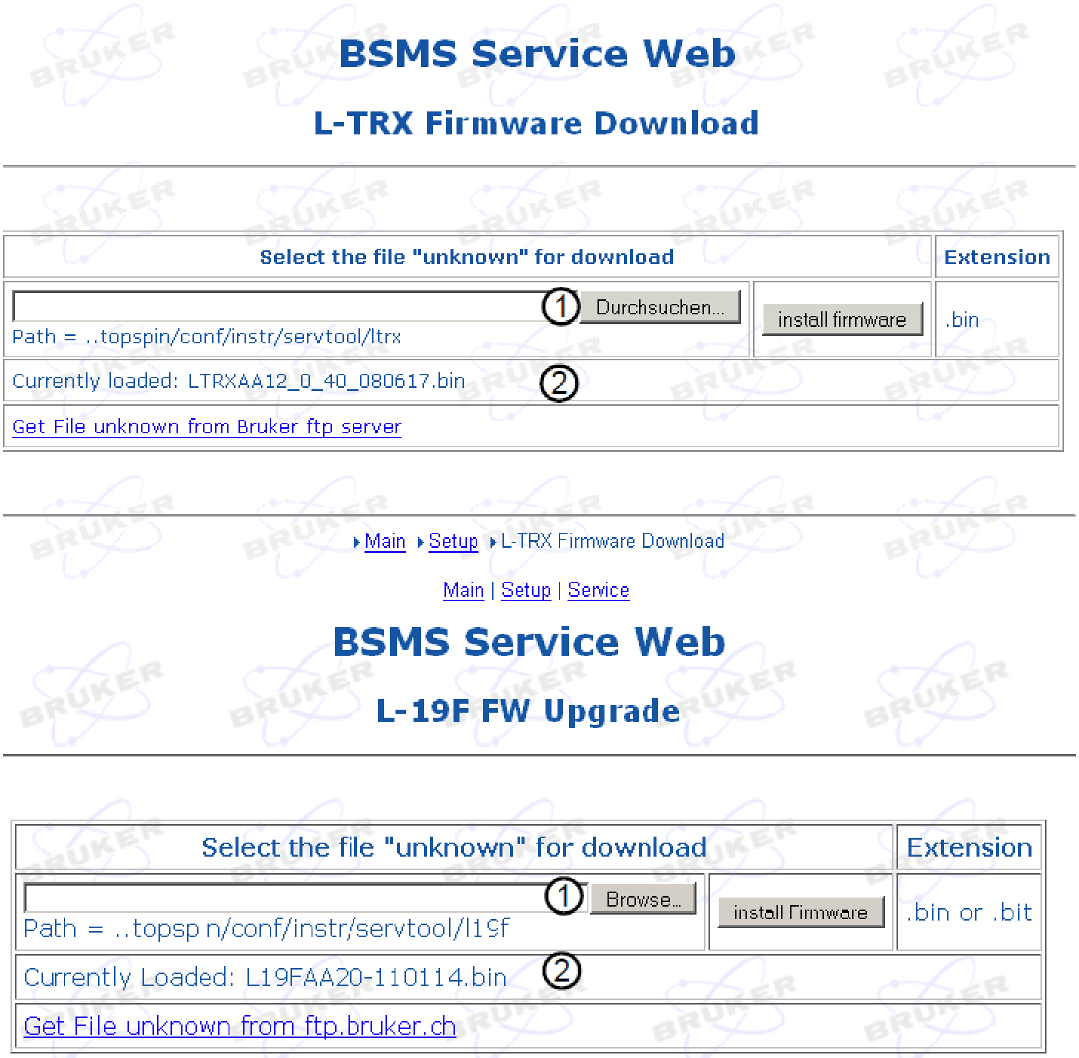


Figure 11.13: Firmware Download

1	Path and file name for firmware download (file-type = .bin).
2	Current firmware file name.

A firmware download will take up to 5 minutes.

Before upgrading the L-TRX software read the corresponding release note carefully. Different system frequencies and hardware revisions might require different software versions.

BIS Information

The BIS memory is write protected. The information can only be altered at the factory.

Figure 11.14: View BIS

Diagnostic Functions

The numbers and types of the diagnostic functions, measurements and self-tests may vary, depending on hardware level (ECL) and/or firmware release.

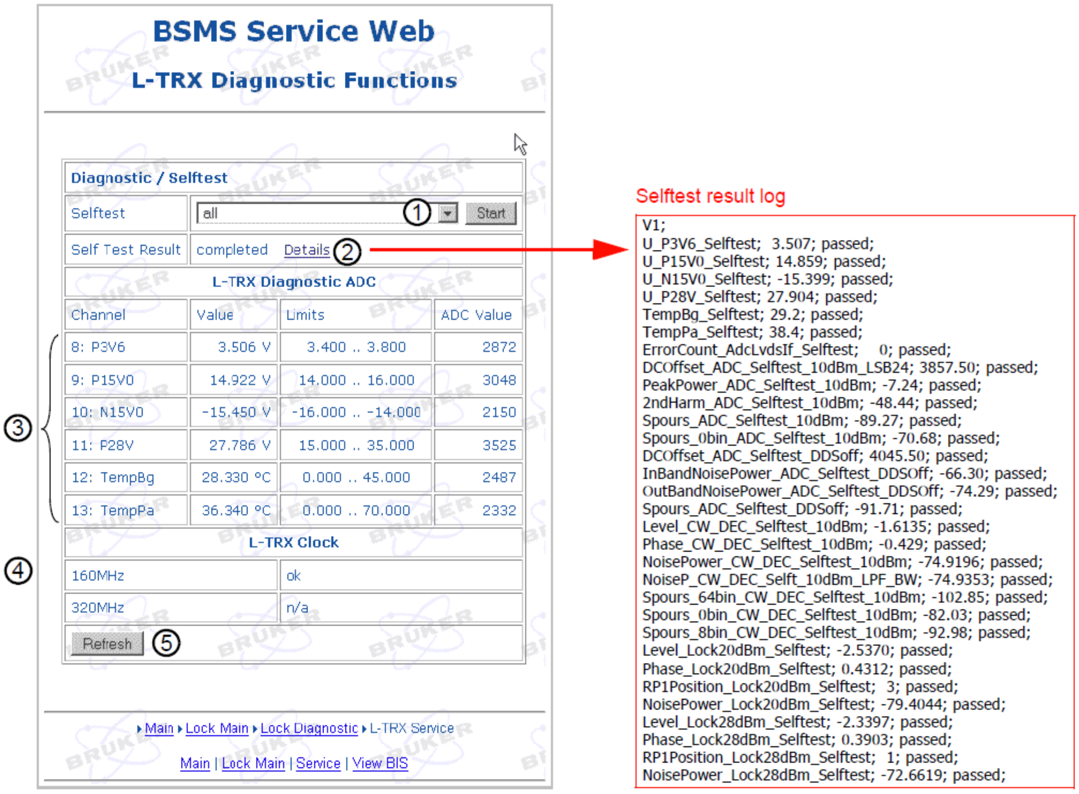


Figure 11.15: L-TRX Diagnostic Functions

1	Select selftest to be executed.
2	Selftest result summary, use ‚Details‘ to read the complete selftest result log.
3	Diagnostic ADC measurements.
4	Reference clock status.
5	Refresh (update) measurements.

	Name	Description	Preconditions
Self-test	ADC interface.	Tests LVDS interface between receiver ADC and the signal processing unit. This test does not verify the electrical performance of the ADC.	Reference clock present and power supplies within specification.
	Power supply.	Voltage measurement with diagnostic ADC.	None.
	Reference frequency.	RF-signal detector, minimal power level only.	None.
	Temperature.	Temperature measurement with sensors and diagnostic ADC.	None.
	CW-ADC diagnostic.	Verification of transmitter and receiver signal path (internal loop). Measurement bandwidth is 80 MHz, CW stimulus internally generated with +10 dBm and -Inf dBm power level.	L-TRX does not report any error and the load mismatch at output J9 2H-TR OUT is within specification (see section *Technical Data BSMS/2 Lock Transceiver [▸ 99]*).
	CW-ADC diagnostic DDS off.		
	Pulse diagnostic.	Verification of transmitter pulse shape with own receiver (internal loop).	
	CW-decimated diagnostic.	Verification of transmitter and receiver signal path (internal loop). Measurement bandwidth is 3.3 kHz (lowpass filter), CW measurement signal with +10 dBm power level.	
	Lock mode diagnostic.	Verification of transmitter and receiver signal path (internal loop). Measurement bandwidth is 330 Hz (bandpass filter), pulsed stimulus signal with +20 dBm and +28 dBm power.	
	Lock mode diagnostic, FFA power.		
	Ext. pulse power diagnostic.	Measures output power in 2H amplifier operation. Actual output power level at J9 2H-TR OUT depends on input level at J8 2H-IN.	Apply RF pulse (pulse length 1ms to 100 ms, up to 4 dBm) to J8 2H- IN, with appropriate blanking signal at input J5 BLNKTR-2H~
	Ext. RX input power CW diagnostic.	Measures receiver input power level in CW operation (lowpass filter, BW=3.3 kHz). Power level is scaled to dBFS.	Terminate J1 2H-REC IN to measure receiver noise. Connect and signal source with frequency of f2H to measure signal strength.
	Ext. RX input power gated diagnostic.	Measures receiver input power level in pulsed operation with phase alternating gating (band-pass filter, BW=330 Hz). Power level is scaled to dBFS.	

	Name	Description	Preconditions
Diagnostic ADC	Power supply input voltages.	Voltage measurement with diagnostic ADC	None.
	Board and power amplifier temperature.	Temperature measurement with sensors and diagnostic ADC	None.
	2H IN RF-signal power.	Input power measurement with RF-detector and diagnostic ADC	2H RF-signal, pulsed or CW, -15..+4 dBm

Table 11.3: Summary of Diagnostic Self Tests and ADC Functions

See also

Lock Configuration [▸ 64]

11.5.2 Troubleshooting

No 2H Lock during Firmware Download

During a firmware download all other functions are temporarily suspended.

- Do not attempt to initiate 2H Lock mode select amplifier for gradient shimming or any diagnostic mode during download.

Firmware Download Takes too Long

If the firmware download takes much longer than 5 minutes the Service Web message log configuration may be amiss.

- Check Service Web **Service | Log Configuration** that the setting for Log Specific Info: SSRB communication to slave units is set to **Off** (default).

Without this setting all communication to the L-TRX is logged in detail which extends the download time indefinitely.

Missing Reference Clock

The reference clock is vital to most operations of the L-TRX. The clock is generated by the AV4 REFERENCE board. SSRB communication with the ELCB is possible without reference clock.

In case of a missing reference clock the PWR/CLK LED is deactivated.

- Check the clock wiring and the AV4 REFERENCE board for correct operation.

Over Temperature Error

In case of power amplifier or board over temperature all operations are temporarily suspended and the L-TRX enters the ERROR state. An error message is sent to TopSpin. When the over temperature condition is past the L-TRX reverts to the operating mode prior to the error.

Error message examples:

- L-TRX interrupt: L-TRX Amplifier overtemperature error occurred.
- ELCB periodic monitoring: L-TRX Temperature **TempPA** out of range Value:

  76°C Limits: 0 °C/75 °C.

In case of an error do as follows:

- Check that no 2H Observe or Decouple experiment is running with the internal power amplifier. The internal power amplifier can only be used for gradient shimming.
- Check that the maximum duty cycle and pulse length specifications are not violated. See *Technical Data BSMS/2 Lock Transceiver [▸ 99]*.

Over Current Error

If the power amplifier drain current exceeds the limit of safe operation it is switched off and the L-TRX enters the ERROR state. An error message is sent to TopSpin.

- Reboot L-TRX to clear error state.
- The 2H-TR output (J9) of the L-TRX must be connected to a load (max. mismatch see *Technical Data BSMS/2 Lock Transceiver [▸ 99]*). Check wiring and load (i.e. 2H Amplifier). To avoid this error try to improve the matching of the 2H coil of your probe.
- Repeat your experiment.
- If the error remains it is a hardware failure. Contact your local Bruker service representative.

Duty Cycle Error and Pulse Length Error

If the power amplifier is operated over its specification in terms of maximal duty cycle or the maximal pulse length the L-TRX board issues an error and deactivates the power amplifier stage. The power amplifier is reactivated after the blanking signal has been deasserted and the measured duty cycle is within specification.

The BSMS system will report an error with the following message:

“L-TRX 2H Amplifier: RF Pulse Length or Duty Cycle violation! Please check your Pulse Program.”

11.5.3 L-TRX Specific Error Messages

Error	Description/Measures
L-TRX Power Supply error occurred	External or internal power supply failure. Check power supply board status. Check power supply diagnostic. If the power supply input voltages are within their limits a hardware failure has occurred. Replace the L-TRX and/or contact a Bruker service representative.
L-TRX 160MHz clock missing or L-TRX 320 MHz clock missing	See *Missing Reference Clock [▸ 116]*.
L-TRX Amplifier: overcurrent error occurred	See *Over Current Error [▸ 116]*
L-TRX Amplifier: bias current regulator underflow error occurred	A hardware failure has occurred. Contact your local Bruker service representative.
L-TRX Error: Signal BLKTR-2H was activated without selecting SEL_2H/DEC	Check wiring (if external power amplifier is used the BLNKTR-2H~ input must be left open). Check experiment setup (pulse program). Check Lock RTP Configuration. See *Lock Configuration [▸ 110]*.
L-TRX DSP signal chain: overflow error occurred	Contact your local Bruker service representative.
L-TRX FPGA DCM (PLL) lock error occurred	Reference clock synchronization failure. Restart BSMS (power off/on). Check reference clock (REF_IN J2) from AV4 Reference board. If the error remains a hardware failure has occurred. Contact your local Bruker service representative.
L-TRX ADC overflow occurred	Reduce Lock Power.
L-TRX Diagnostic ADC busy error occurred	Contact your local Bruker service representative.

Table 11.4: L-TRX Error Messages

11.6 Part Numbers

Bruker Part No.	Unit	Label
Z109886	BSMS/2 LOCK TRANSCEIVER 200	L-TRX 200
Z109887	BSMS/2 LOCK TRANSCEIVER 300	L-TRX 300
Z109888	BSMS/2 LOCK TRANSCEIVER 400	L-TRX 400
Z109889	BSMS/2 LOCK TRANSCEIVER 500	L-TRX 500
Z109890	BSMS/2 LOCK TRANSCEIVER 600	L-TRX 600
Z109891	BSMS/2 LOCK TRANSCEIVER 700	L-TRX 700
Z109892	BSMS/2 LOCK TRANSCEIVER 750	L-TRX 750
Z109893	BSMS/2 LOCK TRANSCEIVER 800	L-TRX 800
Z109894	BSMS/2 LOCK TRANSCEIVER 850	L-TRX 850
Z109895	BSMS/2 LOCK TRANSCEIVER 900	L-TRX 900
Z109896	BSMS/2 LOCK TRANSCEIVER 950	L-TRX 950
Z109897	BSMS/2 LOCK TRANSCEIVER 1000	L-TRX 1000
Z156126	BSMS/2 LOCK TRANSCEIVER 1100	L-TRX 1100
Z156127	BSMS/2 LOCK TRANSCEIVER 1200	L-TRX 1200

Table 11.5: Part Numbers L-TRX

Bruker Part No.	Unit	Label
Z120014	BSMS/2 19F LOCK TRANSCEIVER 300-1000	L-19F

Table 11.6: Part Numbers L-19F

12 BSVT Introduction & Configurations

12.1 Introduction

Since mid 2010 a new and higher integrated VT system is provided for all NMR applications. The so called BSVT (Bruker Smart Variable Temperature System) replaces all former standalone BVT3000 (Standard, MAS, BEST) and BSMS integrated BVT3200 variants. By using a modular BSMS/2 and AV4 BSMS integrated concept all BVT variants and also former pneumatic units like PNK3, PNK3S and PNK5 as well as the SLCB/2 and SLCB/3 boards are replaced by the newer Sensor & Pneumatics Board (SPB) and the Variable Power Supply Board (VPSB). The adaptation of the various probes and temperature control accessory interfaces is realized with smartVT interfaces (also named VTAdapters). This digital interface has also been introduced for other new digital sensors (e.g. digital liquid nitrogen level sensor).

With the introduction of the AVANCE NEO Spectrometer generation, the VPSB is replaced by the VPSB-DC. This version of the Variable Power Supply no longer requires an AC power inlet, it is powered by the system AC/DC converter PSM-48V via BSMS Backplane. The VPSB-DC is available in two power classes, the standard VPSB-DC with a total of 280 W heater power shared on two channels. The extended version VPSB-DC-E provides a total of 530 W. Thereof 500 W may be diverted to channel 1 which also provides double the output voltage.

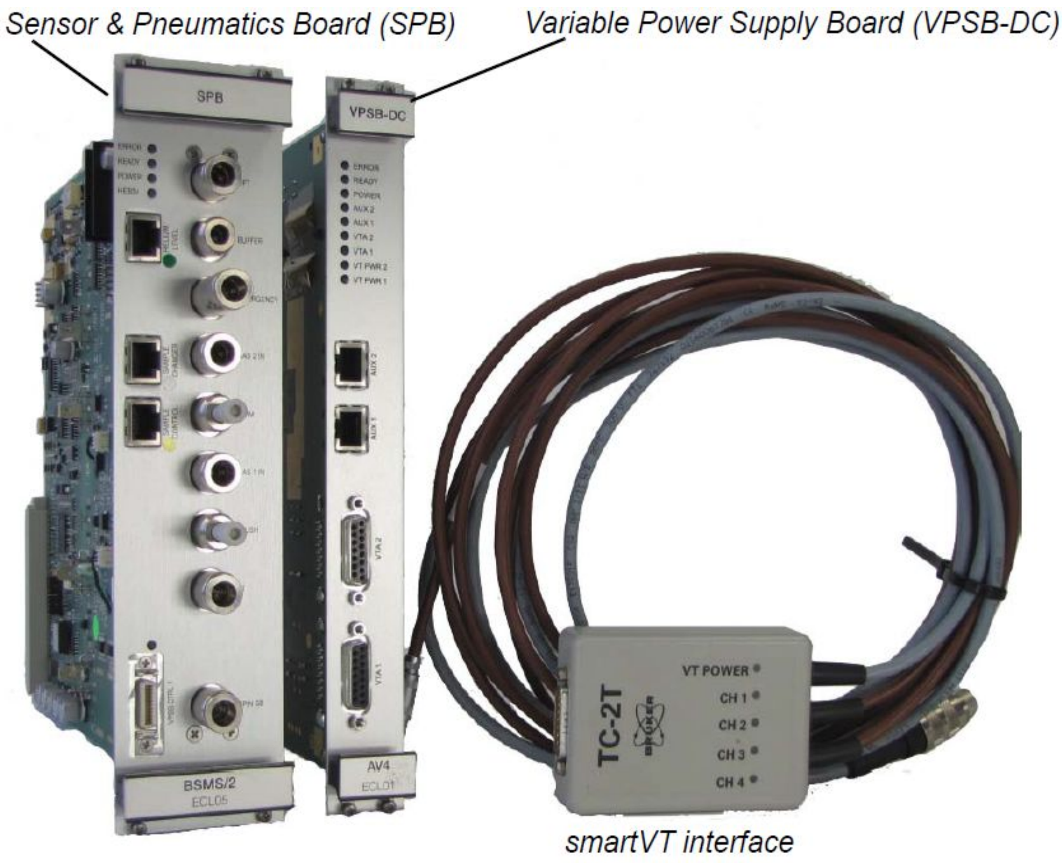


Figure 12.1: Typical BSVT Components

12.2 BSVT Hardware

The VT system consists of the following hardware:

- Sensor & Pneumatics Board (SPB or SPB-E) always required.
- Variable Power Supply Boards (VPSB-DC or VPDB-DC-E) only required for VT option.
- VT Interfaces (several styles) only required for VT option. [2]

For existing probes and existing VT accessories the corresponding VT interfaces must be ordered separately. When ordering new probes and VT accessories the VT interfaces are included if required.

These units are controlled by the BSMS/2 ELCB and are therefore fully integrated into the well-known Ethernet based communication concept including the web-based service access.

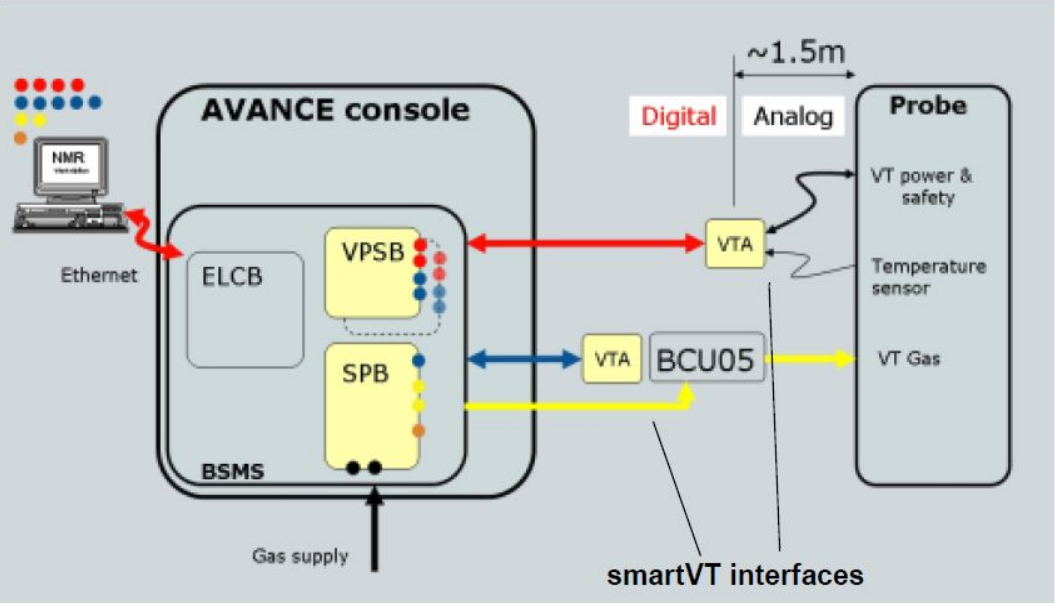


Figure 12.2: BSVT – Open/Digital VT Architecture

12.3 BSVT Software and Features

The BSVT is fully supported with TopSpin 3.0 or later by using an attractive and modern VT panel for easy user control, monitoring, configuration and other VT specific operation.

- Full client/server architecture via ELCB (Ethernet).
- Modern Topspin control with JAVA operated GUI.
- VT accessories (e.g. LN2 Exchanger, BVTE, BCU-05) are fully supported.
- Optimum performance is provided with basic configuration (no BTO-2000 required).
- Built-in gas flow control and supervision.
- Expandable in future due to modular concept (e.g. easy upgrade for Flow NMR probe).
- Up to 4 heater channels and total 9 temperature sensors channels supported.
- Plug & play operation.
- Integrated flush gas and shim cooling connections.
- No console interaction anymore during normal use (e.g. sensor style change).

[2] Mainly for interfacing existing VT accessories and NMR probes (important to check with console exchanges to have appropriate VT adapter!)

The TopSpin compliant software architecture enables a seamless integration and provides a convenient user interface with common GUI elements. The new plug & play feature makes the system to behave very smart.

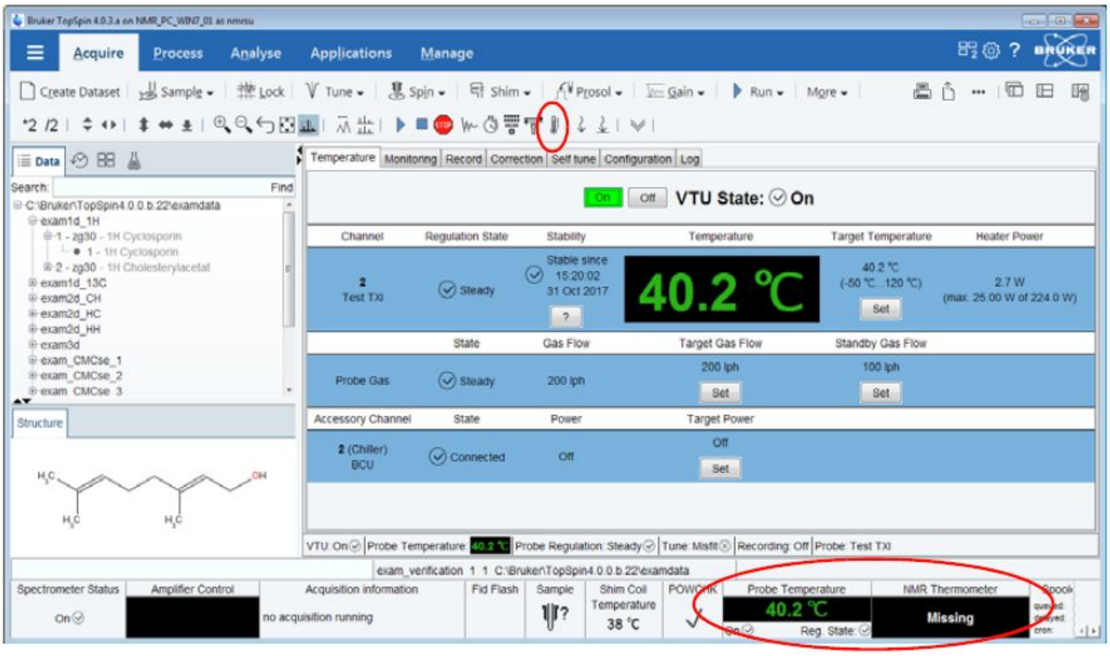


Figure 12.3: Example of the VT Panel within Topspin 4.0

12.4 BSVT Specifications

General

- Multi channel intelligent Ethernet based VT architecture (PnP).
- Up to 2 heater channels (additional 2 channels possible).
- Up to 2 sensor / cooling channels (additional 3 channels possible).
- Software controlled shim cooling.
- Software controlled flush gas operation (SPB-E version).

VT control electronics

- Temperature setting resolution of 0.1 °C (TopSpin).
- BTO-2000 equivalent temperature stability.
- Applicable temperature range (without cooling option, dew point <4 °C):
  - Min. regulated temperature approx. +30 °C with 25 °C input gas temperature.
  - Max. temperature depending on probe.

Full electronic VT gas control

- VT gas flow up to 2000 l/h (min. 4 bar of dry air or N2 gas) with SPB (for SB systems) 3000 l/h with SPB-E (for WB systems).
- Fine VT gas flow steps.
- Extended monitoring and logging capabilities.
- VT flow meter with approx. +/-5% precision.
- VT gas pressure meter with approx. +/-5% precision.

Other

- Minimum Topspin 3.0 required.
- Additional VT interfaces might be required for software control of existing probes and accessories.

Probe interfaces no longer supported

Part Number	Description
W1100255	THERMOCOUPLE HR 500WB
W1100407	THERMOCOUPLE HR 600MHZ
W1100401	THERMOCOUPLE HR 200-500MHZ
W1100884	THERMOCOUPLE HR 750MHZ
W1100024	HEATER SC FOR HP CXP/MSL
W1100316	HEATER SC ALL HR HEAD
W1100399	HEATER SC ALL HR HEAD

Table 12.1: External Probe Interfaces no Longer Supported (discontinued products)

12.5 Basic BSVT Configuration

The basic BSVT configuration includes sample transport and rotation and cryostat helium level measurement but does not include a VT system.

Part name	Part Number	ECL
AV4 BSMS Chassis including power supplies and fan tray	various	
Bsms/2 ELCB Extended Lock Cotrol Board	Z100818	>= 07.00
PNM Air Filter System AVANCE Cabinet	88437	-

Table 12.2: Minimal Requirements for all Configurations

	Sensors & Pneumatics	
Magnet System Bore	**SPB Z115191**	**SPB-E Z115192**
SB	✓	(✓)
WB	✗	✓

Table 12.3: Required Boards Depending on Magnet System

12.6 Basic BSVT Configuration with VT System Option

	Pneumatics & Sensors		Variable Power Supply	
Magnet Bore	**SPB Z115191**	**SPB-E Z115192**	**VPSB-DC Z139305**	**VPSB-DC-E Z140144**
SB	✓	(✓)	✓	(✓)
WB	✗	✓	✗	✓

Table 12.4: Required Boards for Basic BSVT Configuration with VT System Option

The basic VT system option includes a smart VT interface for 2 thermocouple type T sensors (Z119237 BSMS/2 VTA TC-2T) (see also *BSVT Probe Adaptation [▸ 126]*).

12.6.1 Support for Nitrogen Level Sensor

There are two generations of Nitrogen Level Sensors installed on BRUKER Magnet systems. The current version is equipped with a digital interface, whereas the former sensor offers an analog interface. The following table shows which units provide appropriate interfaces for these sensors.

For detailed information on nitrogen level sensor and required cables see *Nitrogen Level Sensor [▸ 195]*.

	VPSB-DC Z139305	VPSB-DC-E Z140144	SPB Z115191	SPB-E Z115192
Digital sensor	✓	✓	✗	✓
Analog sensor	✗	✗	✗	✓

Table 12.5: Support for Nitrogen Level Sensor

12.7 Required Cables for VT Options

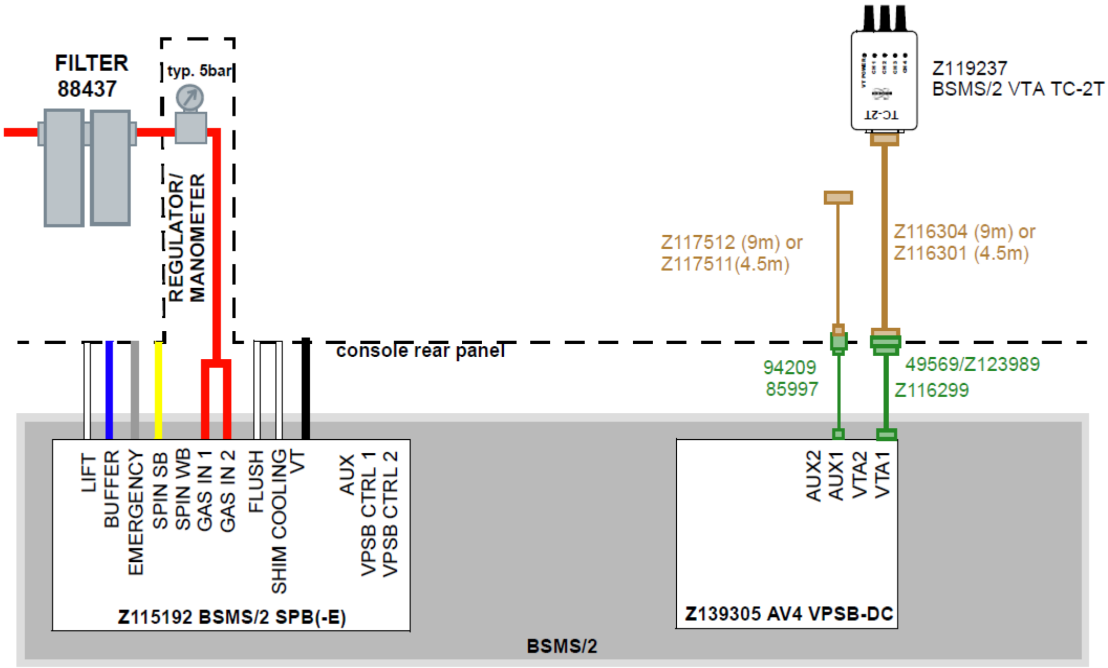


Figure 12.4: Cables for Basic AV4 BSMS Configuration with VT System Option

12.8 BSVT Probe Adaptation

The whole variety of probe temperature sensor interfaces and VT accessories can be adapted with smart VT interfaces (BSMS/2 VTA).

For the different probe or VT accessory interfaces dedicated smart VT interfaces are available, for details see the following pages.

By default, delivered systems with VT option includes one smart VT interface for up to 2 thermocouple type T sensors.

12.8.1 HR RT Probes (Thermocouple Type T)

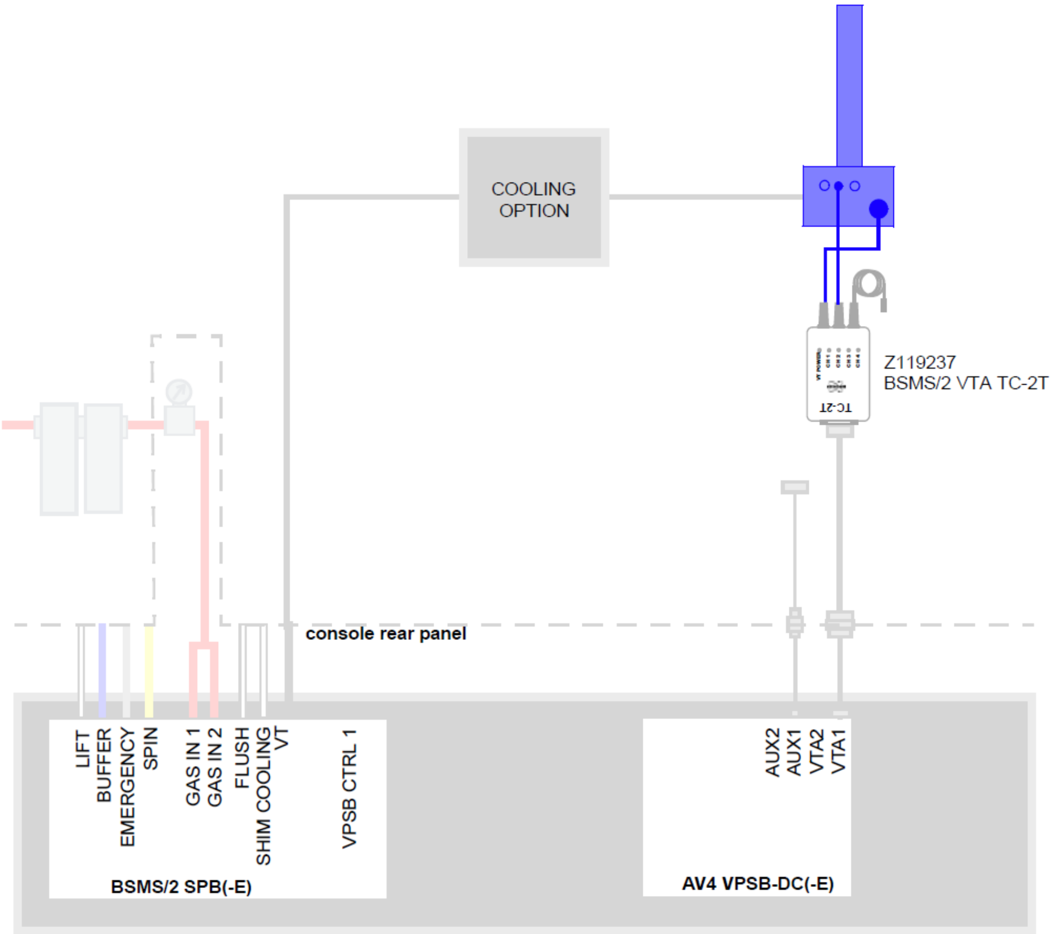


Figure 12.5: Standard HR RT Probe with Thermocouple T

RT probes are typically operated with a VTA TC-2T. One of the sensor cables is not connected. It does not matter which sensor cable is connected as the connected sensor is recognized automatically.[3]

[3] RT probes can also be operated with single Z116922 VTA TC-T. This variant is obsolete.

12.8.2 HR RT Probes (BTO2000)

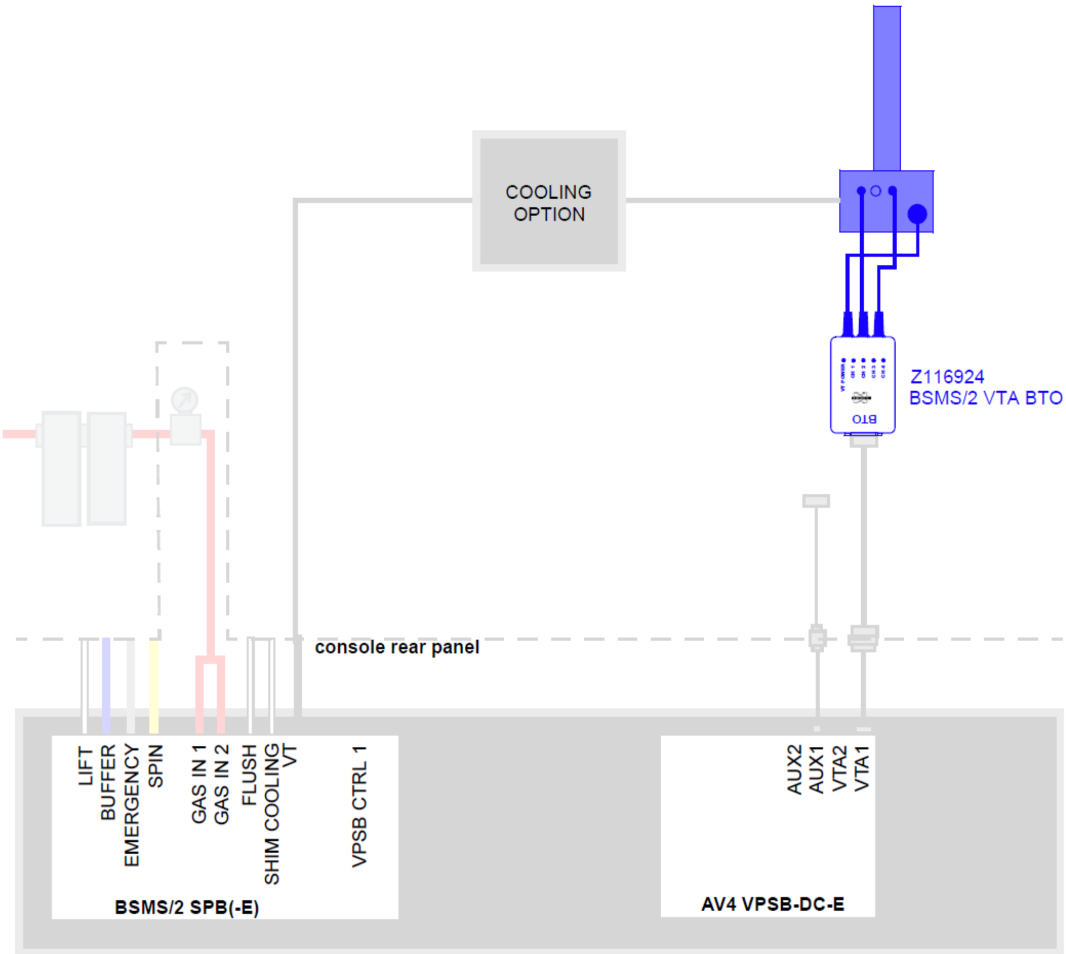


Figure 12.6: HR RT Probes (BTO2000)

12.8.3 CryoProbes

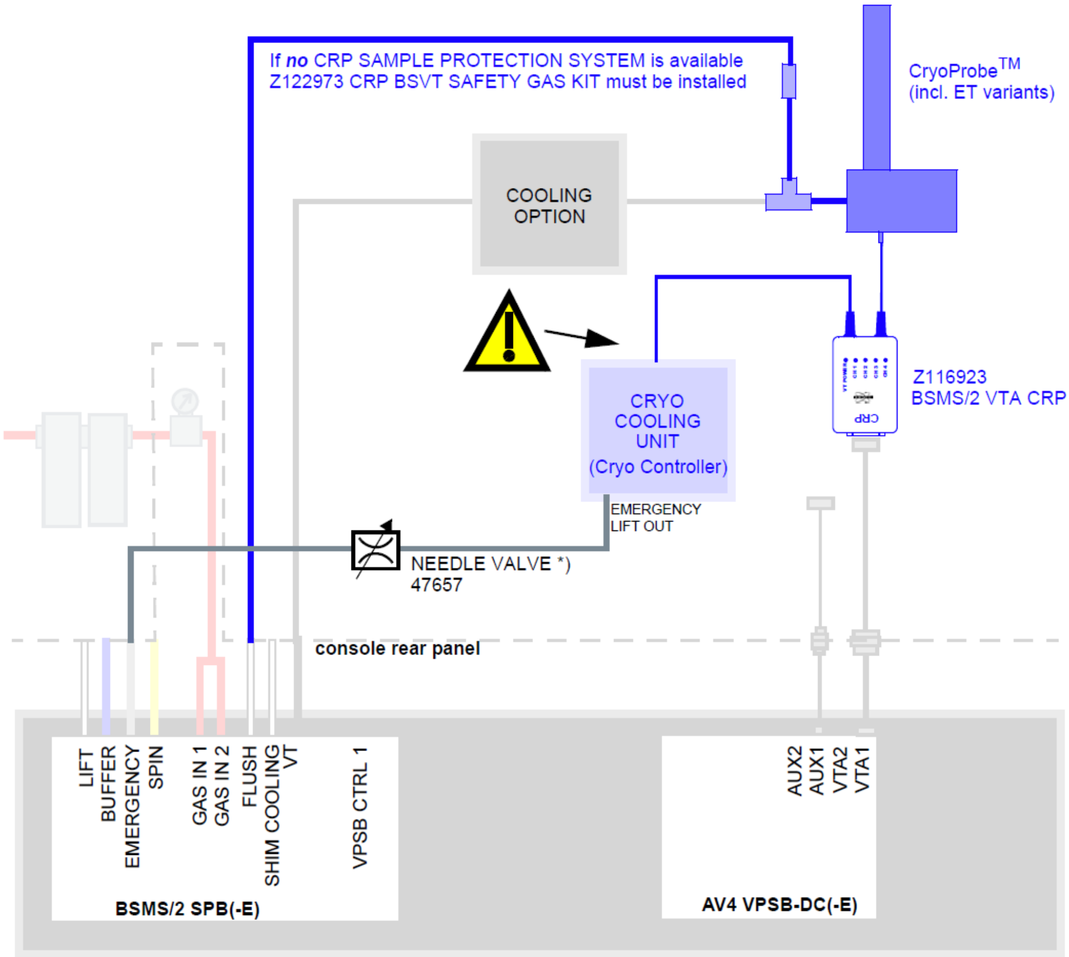


Figure 12.7: CryoProbe

The BVT connector at the Cryo Controller has 24V on the male pins. Do not plug in the VTA connector while the Cryo Controller is on; there is risk of short-circuiting. Contact your local Bruker office for assistance.

When operating a RT probe, the Z116923 BSMS/2 VTA CRP must not be disconnected from the Cryo Platform.

With BSVT the VT adapter box Z13874 is obsolete and must not be connected to the system.

12.8.4 Solids Probes (2 Thermocouple Type T)

Solids probes DVT (thermocouple type T)

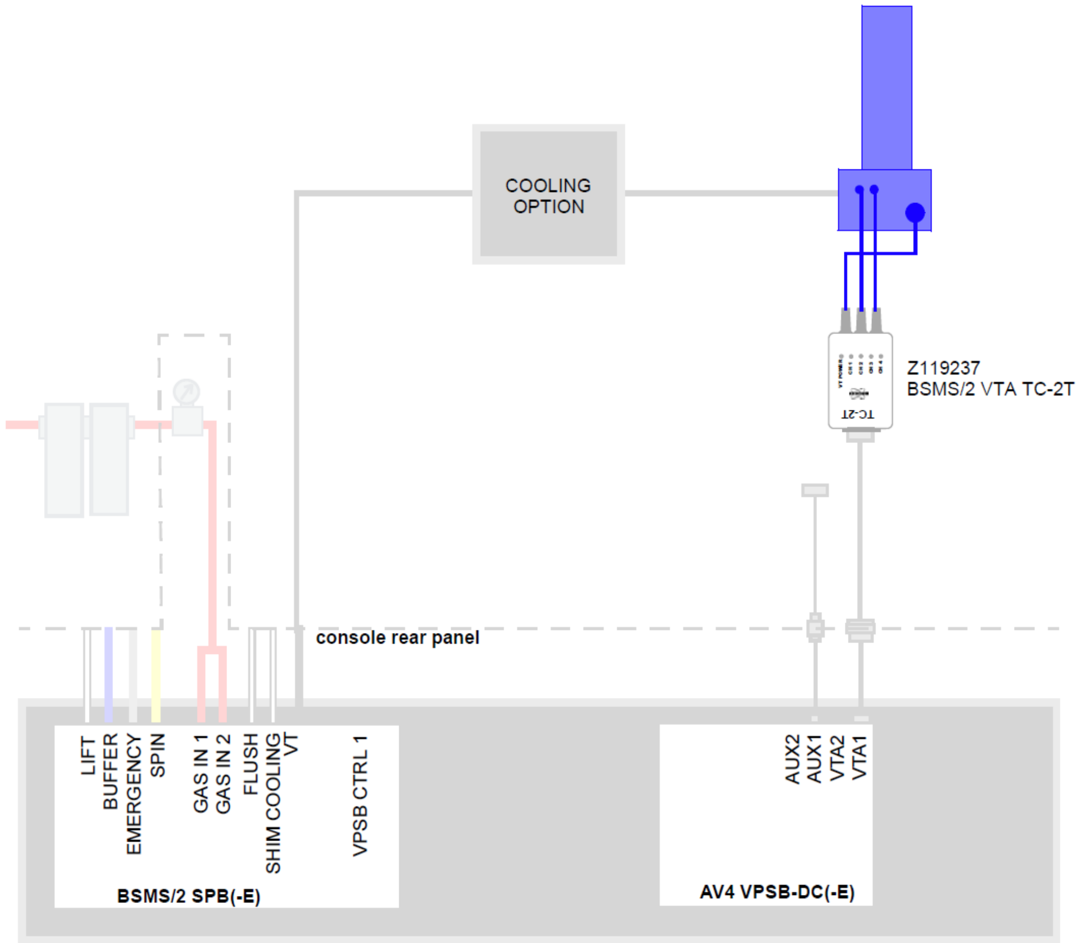


Figure 12.8: Solids Probe DVT with 2 Thermocouple T

Solids probes VTN/WVT (thermocouple type T)

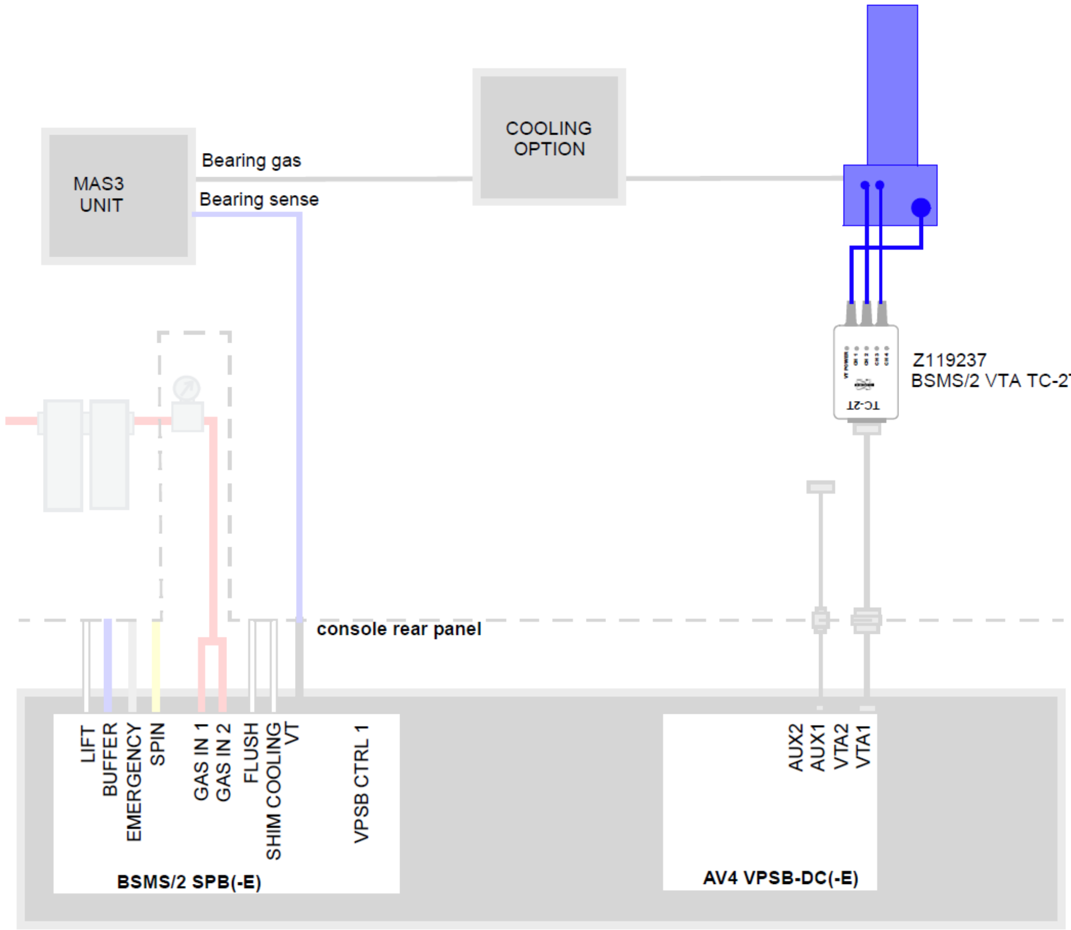


Figure 12.9: Solids Probe VTN/WVT with 2 Thermocouple T

SPB(-E) must be configured for “external VT gas”. Can be set in the BSMS service web or in the VTUDISP-interface (**vtudisp** | **configuration** | **Gas mode**)

12.9 BSVT and HT Solids Probe (High Temperature)

High Temperature Solids Probe

HT Solids Probe Heaters are directly connected to the **VTA1** (Channel 1) of the VPSB-DC-E, which provides up to 500 W of heater power. The BVTB3500 Booster option is no longer required.

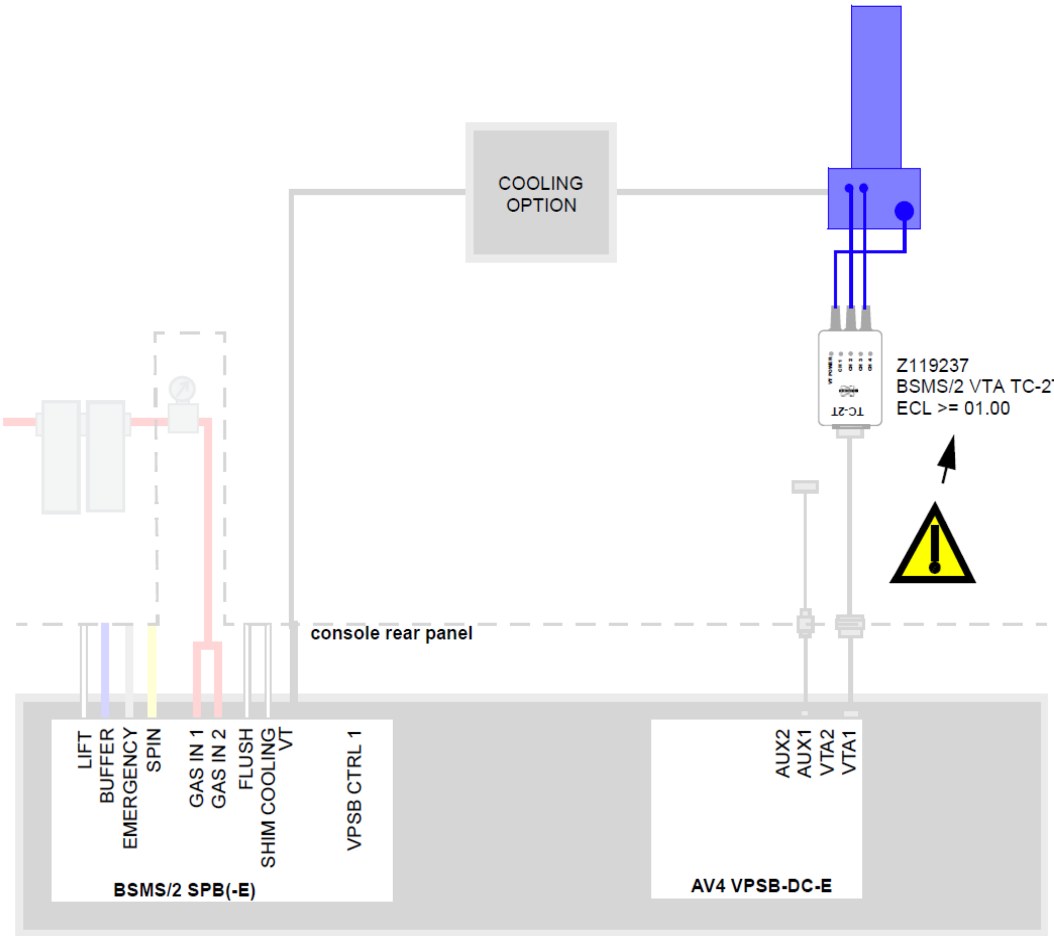


Figure 12.10: VPSB-DC-E and solids Probe (up to 500W Heater Power)

The high power operation of VPSB-DC-E will also work with other probe adaptation like VTA TC-T, VTA FLOW-NMR or VTA TC-2E etc. with appropriate ECL.

12.10 BSVT and HT Accessory (High Temperature)

BVTE3900

The BVTE3900 (P/N W1208962) is a cooling system for high temperature NMR. The Power Booster of the BVTE3900 is no longer required, the VPSB-DC-E provides enough power for the heater.

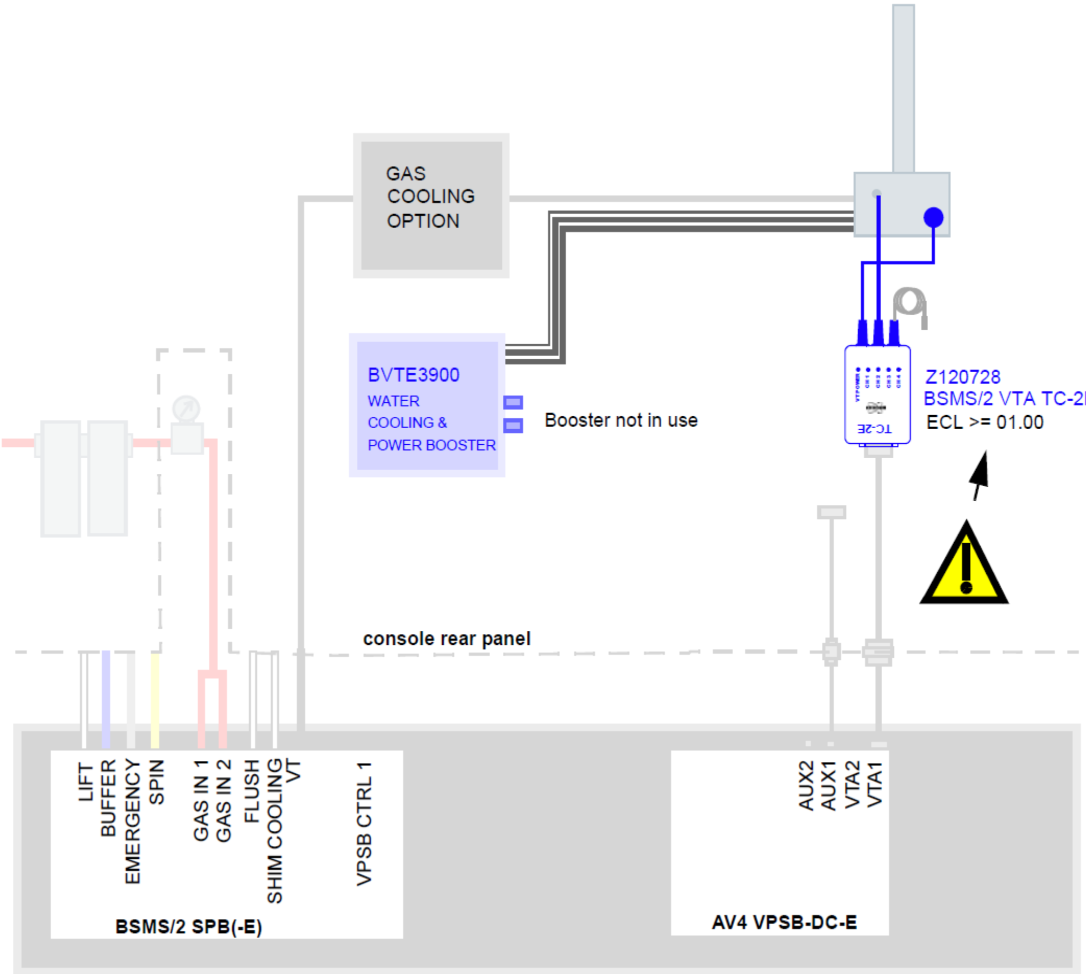


Figure 12.11: BVTE3900 and BSVT

12.11 BSVT and VT Gas Cooling Accessory Adaptation

12.11.1 BCU-I / BCU-II COOLING UNIT

Connection of BCU-I and BCU-II is identical and straightforward.

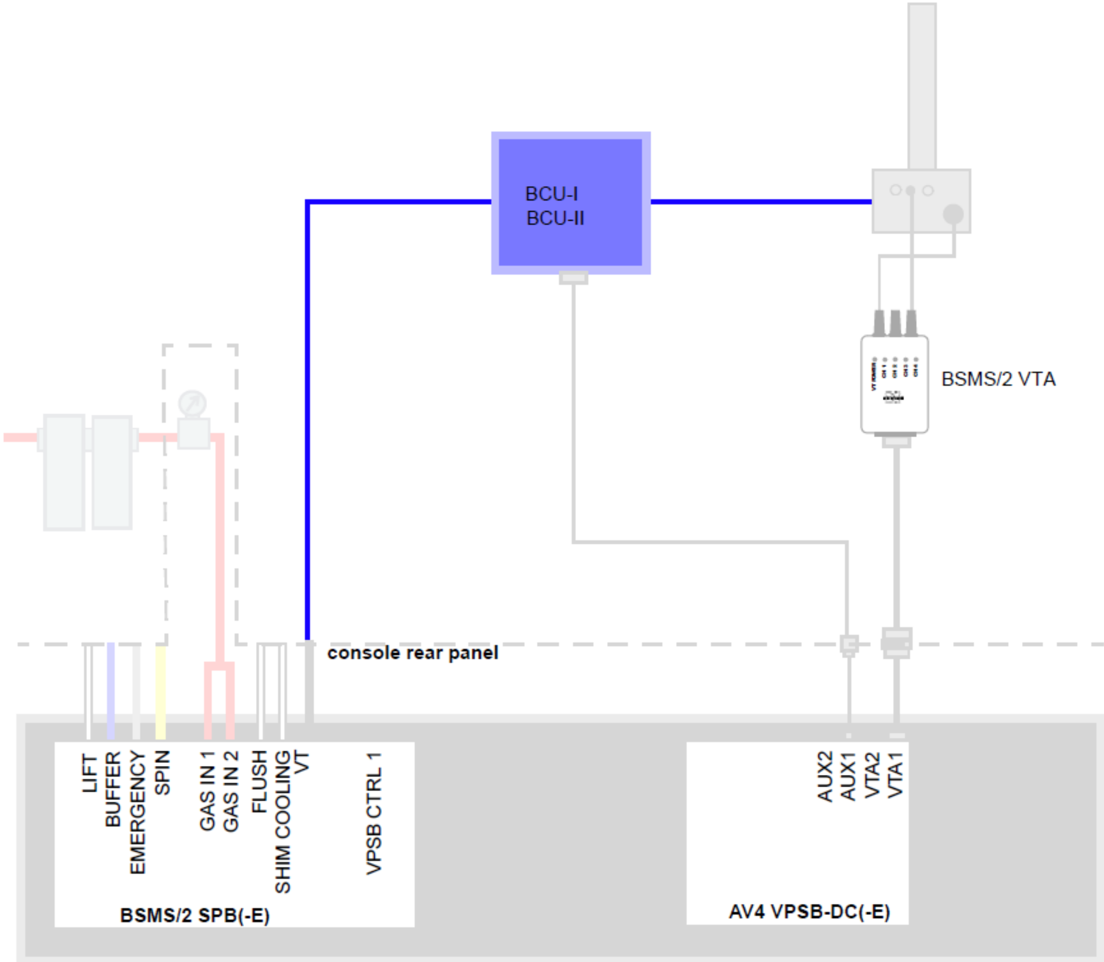


Figure 12.12: BCU-I or BCU-II Cooling Unit

12.11.2 BCU05 / BCU-X COOLING UNIT

Connection of BCU05 and BCU-X is identical using a Z116925 BSMS/2 VTA BCU.

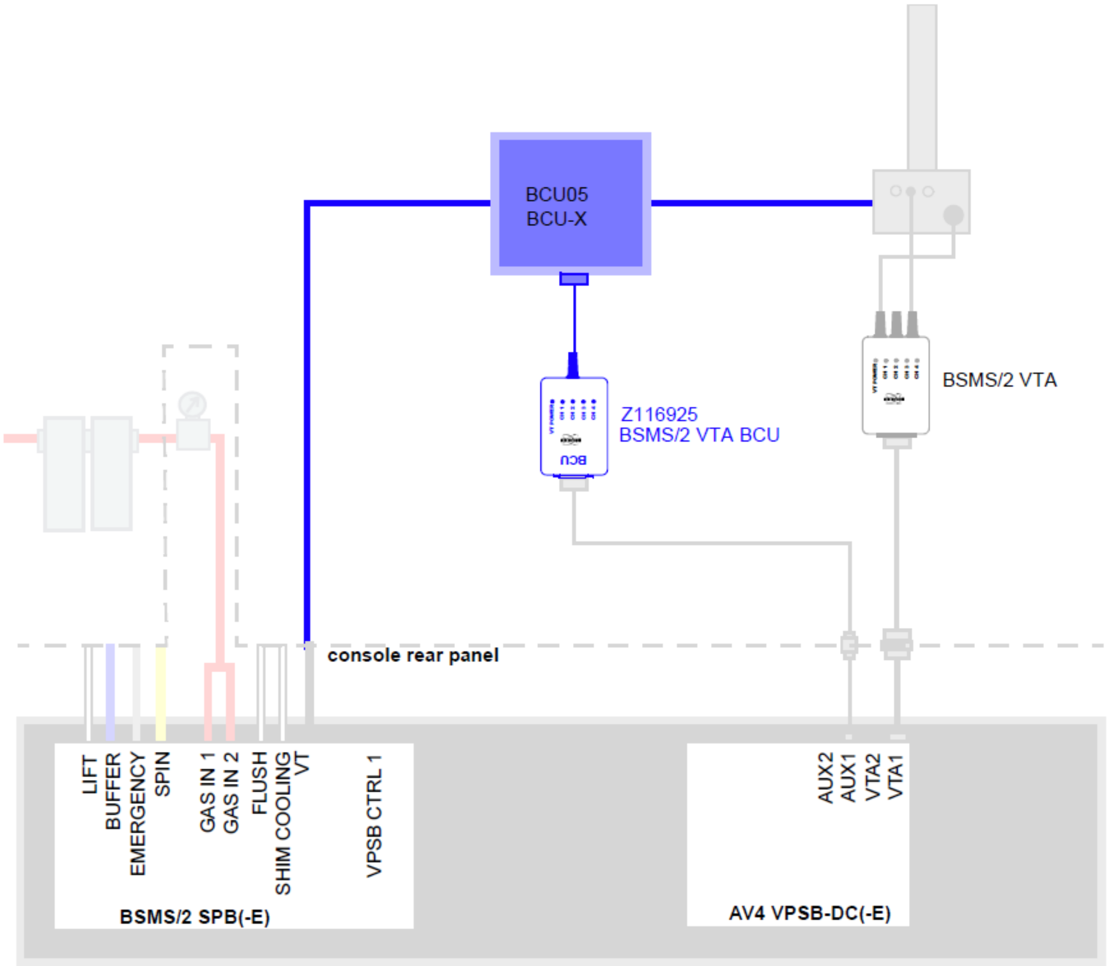


Figure 12.13: BCU05 or BCU-X Cooling Unit

Do not feed the heater power cable from the VTA thru the BSC-X. Connect the heater cable directly to the probe.

12.11.3 BVTL3200 N2 EXCHANGER

BVTL3200 N2 Exchanger is adapted to the BSMS BSVT system using a Z119238 BSMS/2 VTA LN2.

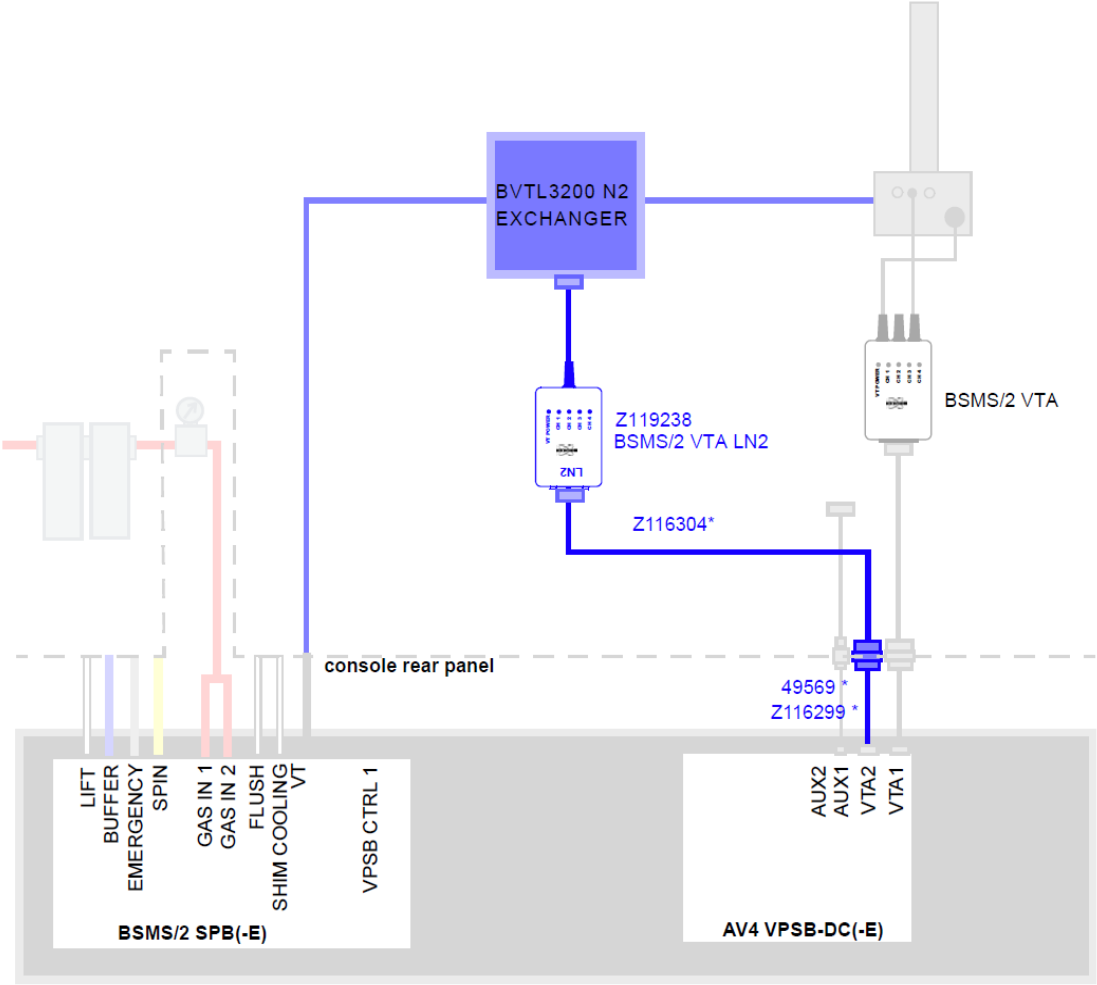


Figure 12.14: BVTL3200 N2 Exchanger

* Part of Z119854 CABLE SET BSVT AUXILIARY HEATER

12.11.4 BVTL3200 N2 Evaporator

BVTL3200 N2 Evaporator is adapted to the BSMS/2 BSVT system using a Z119238 BSMS/2 VTA LN2.

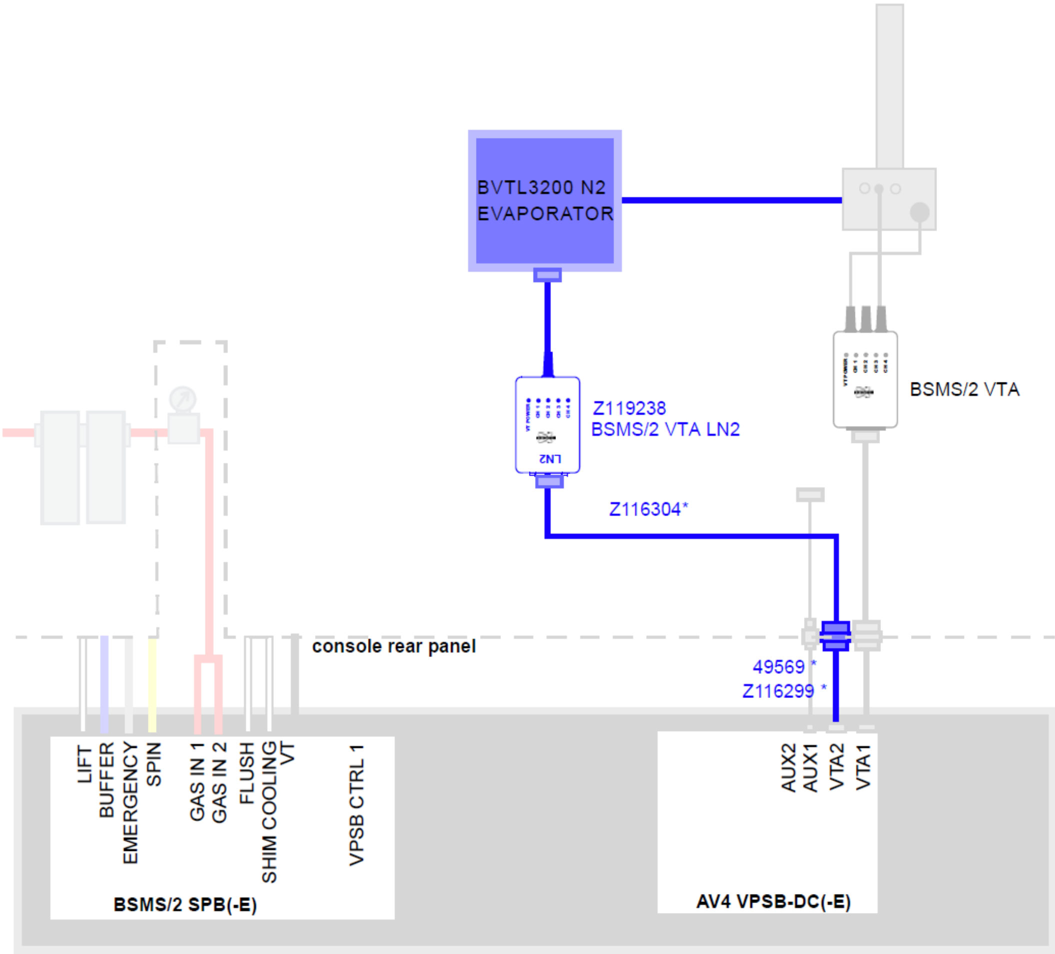


Figure 12.15: 15 BVTL3200 N2 Evaporator

* Part of Z119854 CABLE SET BSVT AUXILIARY HEATER

12.12 BSVT and Flow Probe Adaptation (FLOW-NMR)

For Flow-NMR there exist several variants. The following configurations shows typical applications.

Flow Probe with HT Heated Probe Capillary

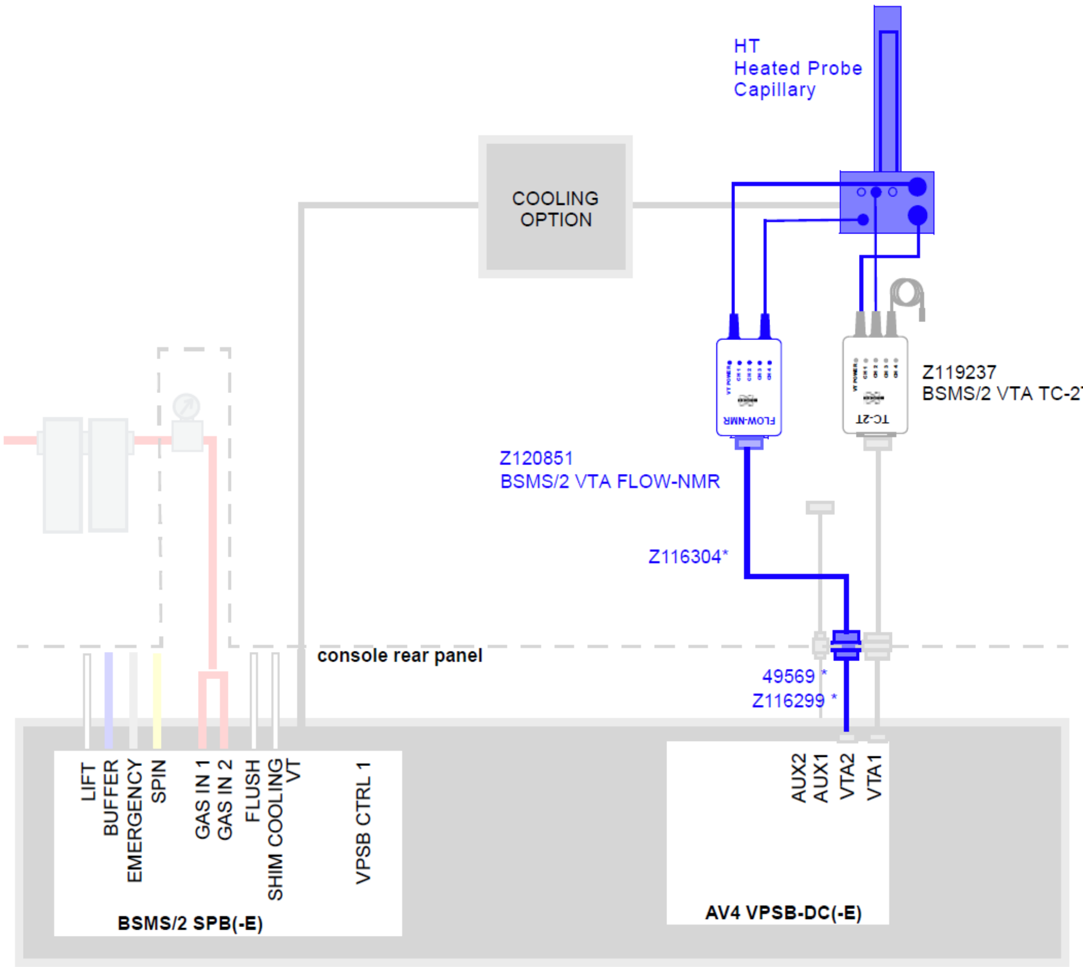


Figure 12.16: Flow Probe with HT Heated Probe Capillary

* Part of Z119854 CABLE SET BSVT AUXILIARY HEATER

Flow Probes with BTO2000 require a Z116924 BSMS/2 VTA BTO.

Flow Probe with TCTC Temperature Controlled Transfer Capillary

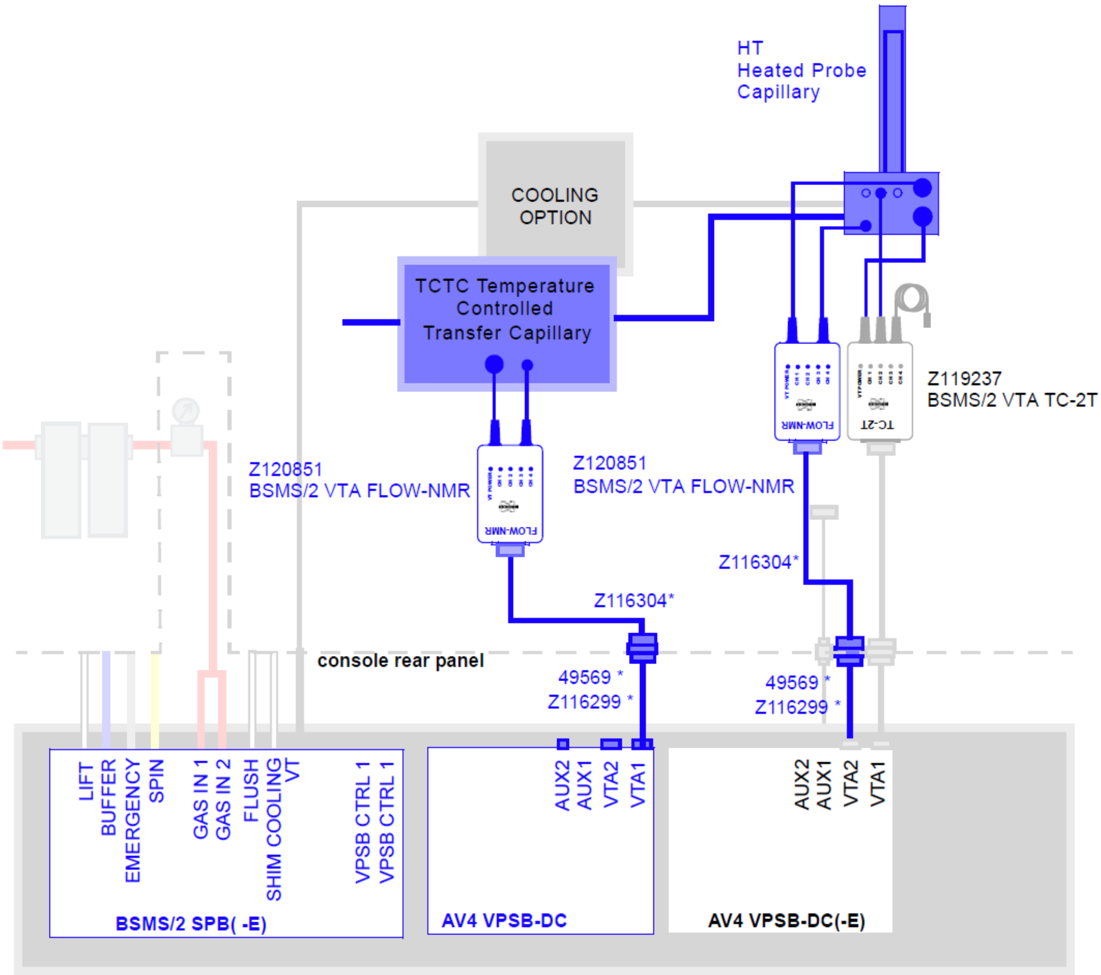


Figure 12.17: Flow Probe with TCTC Temperature Controlled Transfer Capillary

* Part of Z119854 CABLE SET BSVT AUXILIARY HEATER

Flow Probes with BTO2000 require a Z116924 BSMS/2 VTA BTO.

CryoProbe with CryoFit Preheater

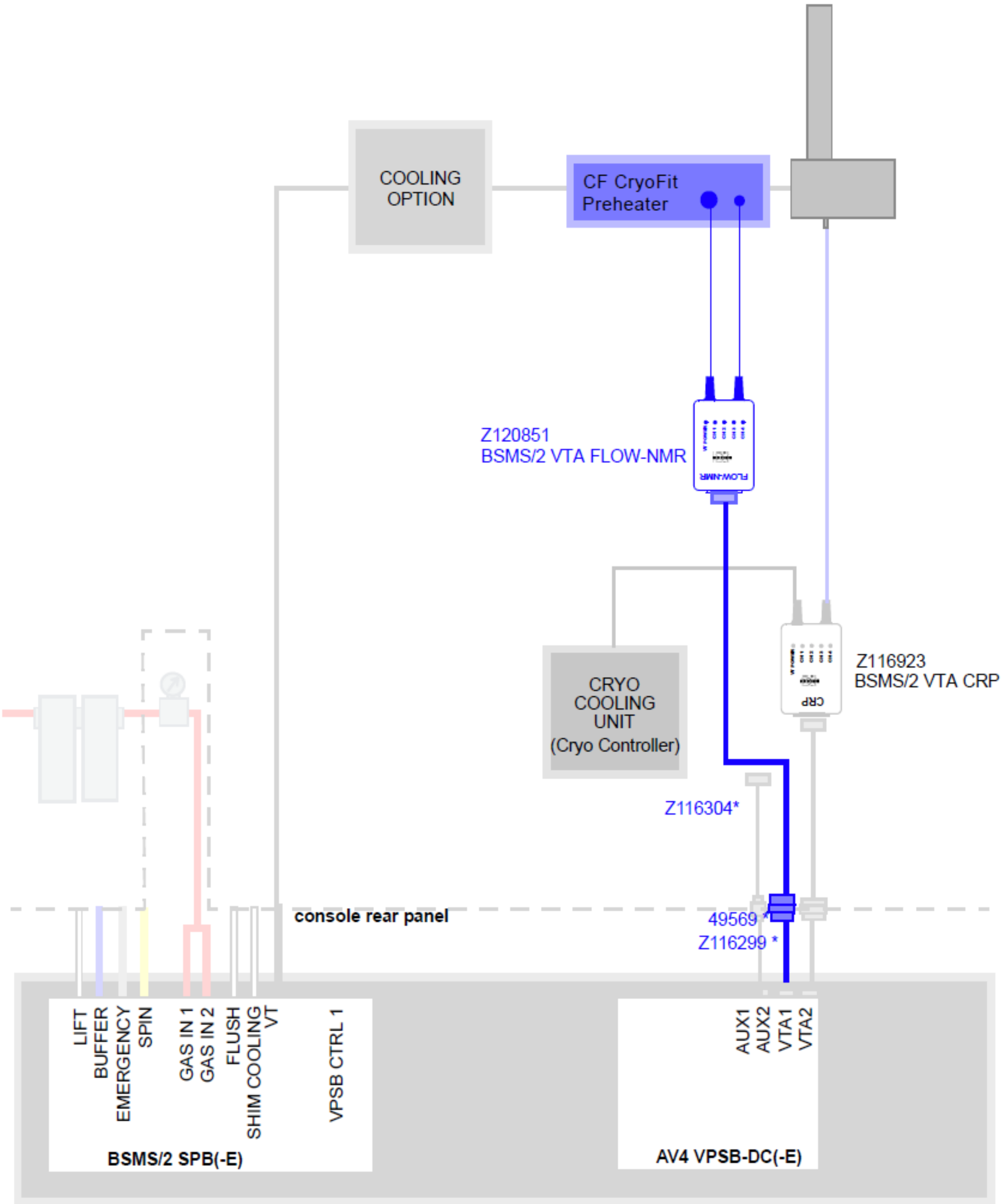


Figure 12.18: CryoProbe with CryoFit Preheater

* Part of Z119854 Cable Set BSVT Auxiliary Heater

13 BSVT Concept

13.1 Plug and Play Concept

The BSVT variable temperature control system is designed for usage with all existing and new types of BRUKER probes, chillers, pre-heaters (e. g. for flow NMR) and other accessories. Different types and numbers of temperature sensors can be connected to the appropriate VT adapters, which provide the matching cables and connectors. All VT adapters can be connected to the BSVT units in the console, either via a standard accessory cable (communication and VT adapter power supply) or via a standard heater cable (providing in addition the variable power).

After power up of the BSVT system, the VT adapters connected to the cable coming from the console are powered up and identified. The collectivity of the connected adapters (with corresponding probe, chiller, or accessory device) and the VT gas supplies (VT gas, flush gas, Shim cooling/drying) are considered as an entity, which is called BSVT configuration. The various options for BSVT configurations are described in chapter *BSVT Introduction & Configurations [▸ 121]*. It is possible to add or remove VT adapters, a probe or a chiller at any time even during operation.

The BVT connector at the Cryo Controller has 24V on the male pins. Do not plug in the VTA connector while the Cryo Controller is on; there is risk of short-circuiting. Contact your local Bruker office for assistance.

The system can detect a new adapter only when it is connected or disconnected to or from a cable coming from the console. Connecting or disconnecting accessories to or from the adapter (e.g. N2 evaporator) will not lead to a configuration change.

After a BSVT configuration change, the new devices are recognized automatically and integrated into the system with minimal user interaction.

To enable and display a changed BSVT configuration, the temperature control must be turned off and on again within the Topspin **vtudisp | edte**.

When a device involved in temperature regulation is removed then the temperature control is switched off. Adding further devices has no effect on a running temperature control process.

13.2 Control Logic of the BSVT

There is a common control logic for the complete BSVT configuration. Rather than setting the gas flow or switching on or off a specific heater, the BSVT is switched on or off as a whole.

In addition to the base states (on/off) there are additional states for system calibration/tuning (self tune), system identification (self test), exceptional situations (anti freeze protection, sample protection), errors (gas flow error, sensor error), and a check configuration state (when a device has been added or removed).

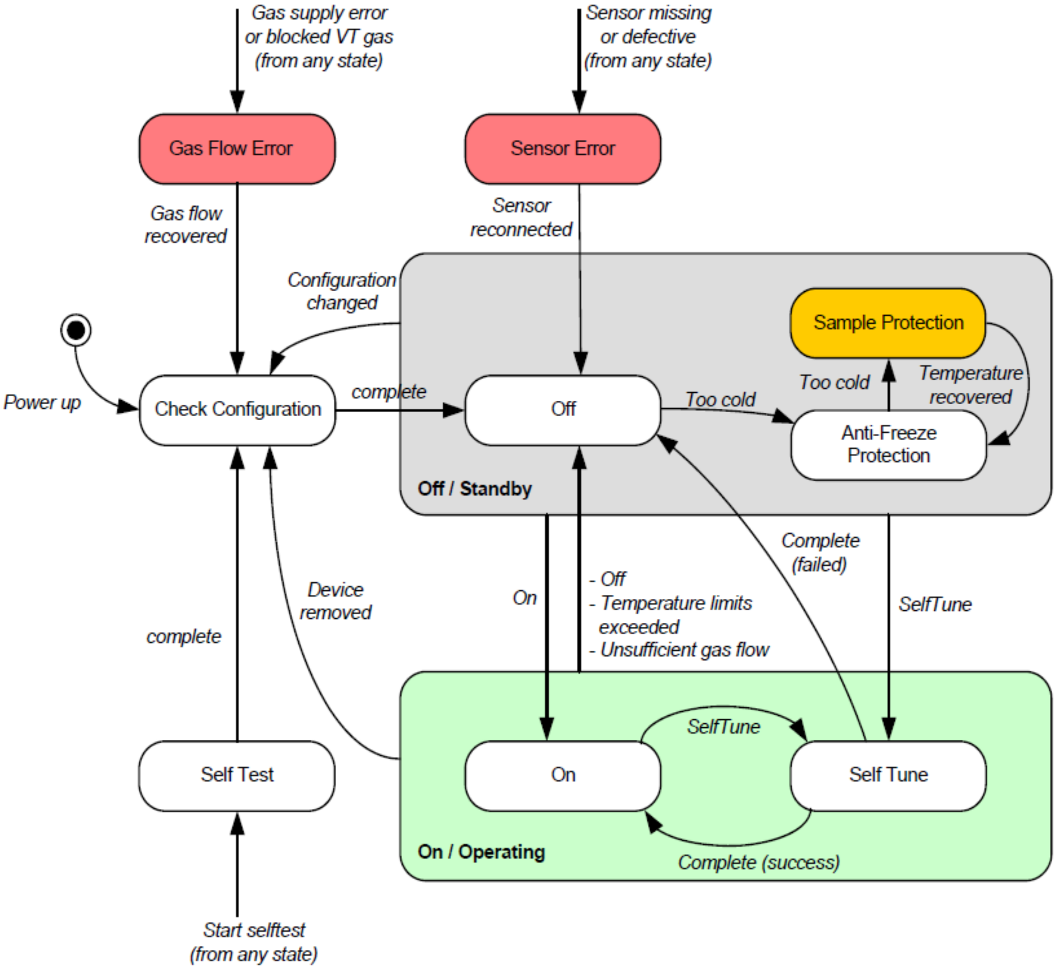


Figure 13.1: BSVT States

13.2.1 State Off / Standby

This state is active when the BSVT is switched off. In general, the thermal energy of the system is kept as steady as possible (sub state **off**):

- Heater(s) = off
- Chiller = off
- Gas flow = standby gas flow (between 0 and maximum)

Nevertheless, it is possible that the system loses energy (e. g. chilling by active CryoProbe), and the temperature drops below the minimum allowed temperature. In this case, a minimum heating is activated, and the control logic goes into the sub state **antifreeze protection**:

- Heater(s) = on, regulating for temperature next to room temperature
- Chiller = off
- Gas flow = operating gas flow (between minimum and maximum)

If the measured temperature stays below the minimum temperature even if the antifreeze heating is active, then the sample is lifted for protection (sub state **sample protection**). As soon as the temperatures are in range again, the sample is transported to its original location.

13.2.2 State On / Operating

This state is active when the BSVT is switched on. All devices of the BSVT configuration are active:

- Heater(s) = Regulating for required target temperature(s).
- Chiller = According to user settings.
- Gas flow = Operating gas flow (between minimum and maximum).

The PID controller parameters can be optimized by a self-tune operation. If the global self-tune procedure is activated, then all active channels are tuned in parallel. As soon as the self-tune of a channel is complete, the according channel is starting operational temperature regulation.

Self-tuning can be started from both states – **off** / standby and **on** / operating. If it fails in the end, then the BSVT is switched off unless the self-tuning has been started from on/operation and the measured temperatures have been close to the aimed values.

It is possible to add further devices to the BSVT configuration while the temperature control is **on** / operating. The added devices stay inoperable (no active temperature regulation) and provide only temperature measurement. As soon as the BSVT is switched off, the pending changes are handled, and the BSVT configuration is updated.

However, if devices that are involved in temperature regulation are removed during operation then the BSVT stops its activity.

13.2.3 State Sensor Error

If the connection to a sensor involved in temperature regulation gets lost then the BSVT goes into the sensor error state. However, if only one sensor of a double sensor adapter (e. g. TC-2T) is used, then the according channel runs in single sensor mode, and the unconnected sensor is not considered.

13.2.4 State Gas Flow Error

There are two possible types of gas flow errors - either the VT gas flow is blocked somewhere between the SPB and probe (VT gas tube, chiller, etc) or in the probe itself or the gas supply is too weak or out of order. In both cases, the BSVT goes into the gas flow error state. The gas flow status indicates the exact error type (blocked or missing). As soon as the VT gas flow has recovered (e. g. interrupted gas supply has been re-established and the required standby gas flow has been reached), the BSVT control goes back to the off state. There is a maximum gas pressure that can be adjusted in the Service Web - the VT gas flow regulation guarantees that this maximum pressure is never exceeded even if the VT gas is blocked somewhere.

13.2.5 State Self-Test

If there is a problem - e. g. the BSVT refuses to go into operation or some connected devices do not behave as expected, it is recommended to run a self-test. The self-test can be started on the Service Web and may last some seconds (it may be useful to check the state until the self-test is complete). In the end, there is a short self-test report available, providing information about all connected devices and their status (e. g. missing sensor connections, missing gas flow, and so on).

13.3 Specific Configurations

In the following subsections there are a few specific configurations described.

13.3.1 BSVT with CryoProbes

CryoProbes in cold state cool down the sample if there is no active VT operation. In this configuration, the auxiliary gas of the BSVT (which is designed for flushing of the RF section of room temperature probes), is used as a safety gas flow in order to prevent from sample freezing, in case the BSVT system was powered down.

For configuration/part details of the Bypass, see *CryoProbes [▸ 129]*.

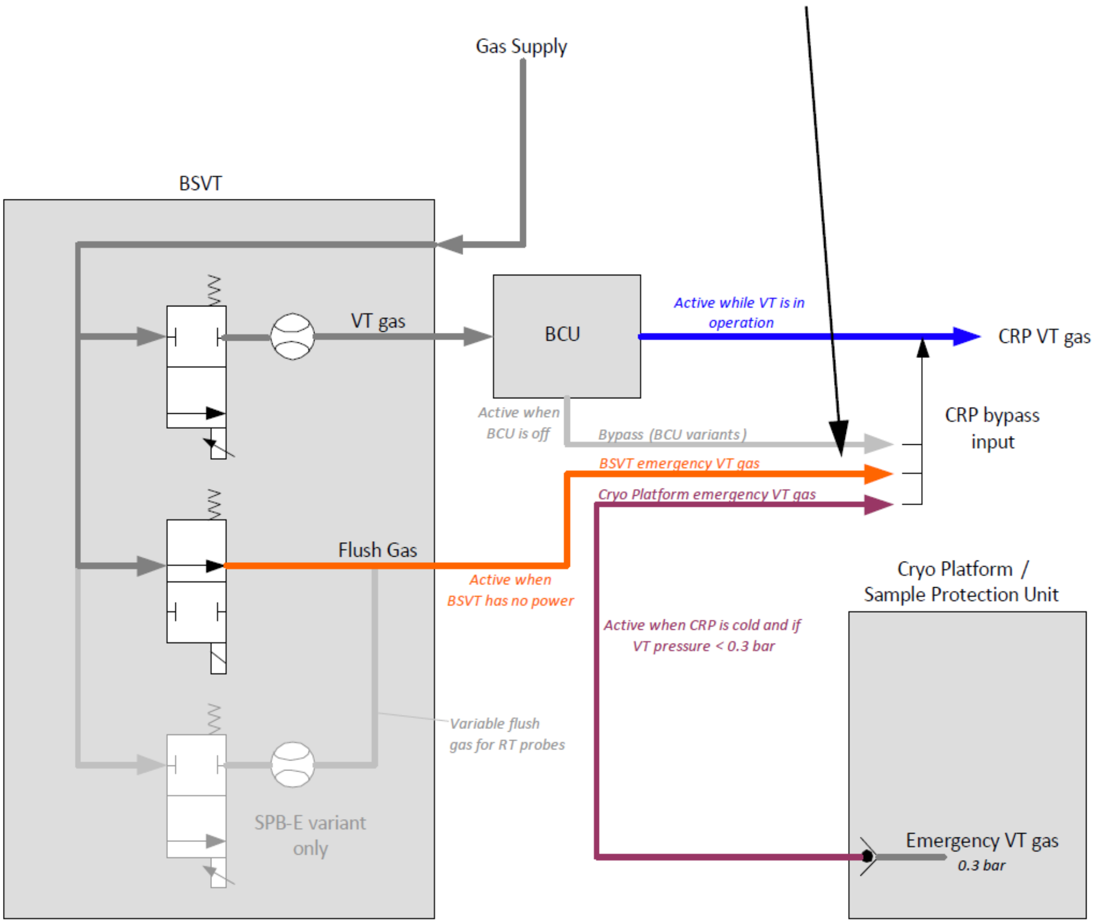


Figure 13.2: VT Emergency Gas Flow

If a CRP Sample Safety Option is installed then the Cryo Platform initiates a sample ejection in case of insufficient temperature. This operation is detected by the BSVT, and in case of safety lift initiated by the Cryo Platform, the BSVT disables its own lift function.

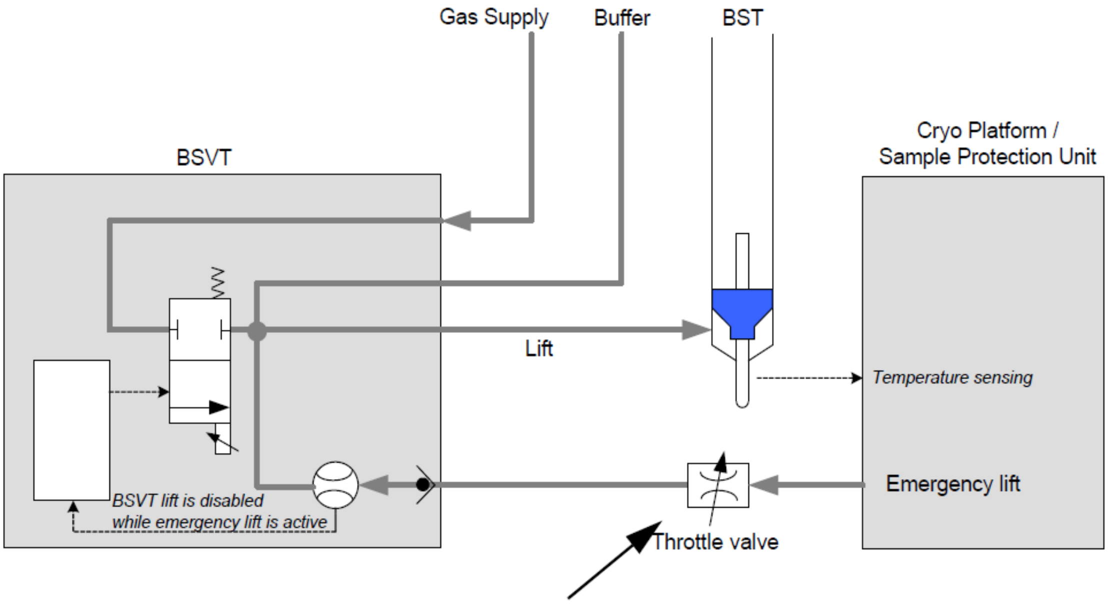


Figure 13.3: Gas Flow Diagram for Emergency Lift

For configuration/part details, see *CryoProbes [▶ 129]*.

13.3.2 MAS Probes with Tempered Bearing Gas (VTN / WVT)

Some MAS probes have no specific VT gas channel, instead they use the MAS bearing gas for temperature regulation. In these cases, the BSVT can be configured for *External VT Gas Supply*, where the probe heating is enabled as long as there is enough pressure on the bearing gas detected. The VT gas valve in the BSVT unit is closed in this operation mode.

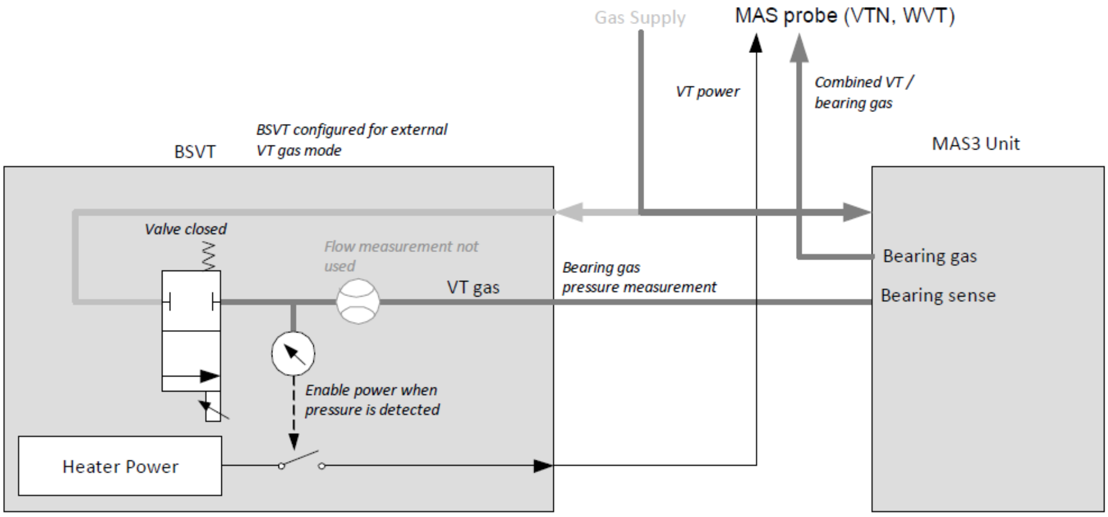


Figure 13.4: External VT Gas Supply (e. g. MAS3 Bearing Gas)

13.4 Frequently Asked Questions

- What is the difference between a power channel and an accessory channel?

  A power channel provides, in contrast to an accessory channel, a variable power, which can be controlled (VT power). The basic BSVT configuration provides 2 power channels and 2 accessory channels. BSVT configurations can be extended up to 4 power channels and 5 accessory channels.

  Both channel types have the 15 pin D-Sub connecter at the user side, but the accessory channel is connected to the back panel of the NMR cabinet by a smaller RJ45 connecter. The width of the power channel cable is quite higher than that of an accessory channel.

- What happens if a probe is connected to an accessory channel?

  A probe can be connected via the appropriate VT adapter to any channel. However, if the channel does not provide VT power then the VT temperature of the probe cannot be controlled and stabilized. Nevertheless, the temperature measurements are transferred in regular intervals to the BSVT unit and displayed within the Topspin GUI.

- What could be the reason for inoperable devices?

  It can happen that a power device connected to a power channel cannot be operated and is marked as inoperable in the Topspin GUI. Either a heater or sensor cable between VT adapter and heating device (e. g. probe) is not connected. Or the device (VT adapter) has been added while the BSVT was in operation. In that case, the BSVT stays in operation mode (if there is no device removed that was involved in temperature regulation), the new devices are integrated into the BSVT temperature control as soon as the temperature regulation is switched off next time.

- When the target strength (= cooling power) of the cooling unit is set, nothing happens, and the actual strength remains unchanged - why could this happen?

  BSVT operation is required for activation of a connected cooling unit. As soon as the BSVT is **On**, the actual cooling strength changes to the required value defined by the target strength parameter. In addition, the rotary knob of the new BSCU cooling units must be set to **Remote** position. Otherwise, the settings of the TopSpin software are ignored and the locally set strength (by rotary knob position) is considered for operation.

  Note: The BCU-X requires a minimum VT gas pressure and gas flow before it becomes active. If there is no gas flow (or no gas supply) then a connected BCU-X cannot be detected by the VT adapter.

- Which channel is the probe channel?

  Probe channel identification is set to **Auto** by default (this setting can be defined on the BSMS service Web under the menu **VT Configuration**).

  Normally, there is a single heater device in the BSVT configuration, and the mapping is therefore evident. Configurations for flow NMR applications can be handled automatically as well - additional heaters are connected via specific VT adapters, and the remaining active channel can therefore be considered as the probe channel. In applications with several VT adapters of the same type (e. g. specific MAS configurations with separate heaters for VT, bearing and rotation) it may be necessary to give an explicit definition of the probe channel.

- How is the VT power represented in the new BSVT?

  Inside the BSVT the VT power is represented in Watt (absolute power). However, the user can select alternatively a relative representation for the GUI (percent). In that case the reference power is the highest possible power that can be achieved with the connected probe and the maximum voltage (48 Volt) of the VT power supply. Example:

  – Cryo Probe heater with 48 Ohms: Imax = 1 A, Pmax = 48 Watt (= 100%)

- Has the maximum VT power setting an influence on the Self Tune?

  The Self Tune is no longer affected by the maximum VT power (if it is high enough), since the required power for Self Tune is evaluated in the beginning of the tuning automatically. If the power limit is set too low, then the Self Tune aborts with a corresponding error message (similar case if the chilling is not sufficient to reach the target temperature). The temperature control process is not stopped in case of too restrictive power limitation (or insufficient chilling), it is simply indicated in the regulator status that the heater power limitation is too strict or that the chilling is not sufficient.

- Do I still need the cable Z13874 with VT power attenuator (with heat spreader) for CryoProbes?

  For operation of the former Variable Temperature control systems (e. g. BVT3000, BVT3200) with CryoProbes, it was necessary to insert a power attenuator between the BVT and the heater of the probe. The user could select between **Low** = 10%, **High** = 50% and **ET** = 100% resulting VT power at the probe. With the new BSVT, this attenuator is no longer used, since the VT power is provided by the BSVT in high resolution down to smallest values and therefore also appropriate for direct operation with CryoProbes. Problems with overheated attenuators or full power values varying with the selected power range at the attenuator are eliminated with the BSVT.

14 SPB

14.1 Introduction

The SPB (Sensor & Pneumatic Board) is the enhanced and higher integrated replacement of the former SLCB/x (Sample & Level Control Board) and the PNK board family (PNK3, PNK3S, PNK5).

There are two versions of the SPB available: The basic version is used for Standard Bore systems whereas the extended version supports wide bore NMR magnets and additional features like the liquid nitrogen level sensor interface or control outputs for more than one VPSB.

Low level hardware functions (e.g. sample sensor interfaces, safety circuits) are implemented directly on the SPB, whereas higher level functions such as helium level calibration and measurement, sample transport control (lift), sample rotation regulation (spin) or pneumatic valve control for VT gases are provided by the software running on the ELCB.

The SPB pneumatics now include the gas flows for the variable temperature system (VT). Integrated mass flow and pressure sensors provide accurate gas flow setting.

The new electronics are fully compatible to the well known sensors for helium or nitrogen measurements or the sample detection electronics.

The SPB has additional interfaces for connecting up to 2 Variable Power Supply Boards (used by the VT system to control the probe temperature) and novel digital accessory sensors.

14.2 Configurations

Basically there are two variants, one for standard bore systems, and another one for wide bore systems or systems with optional accessory (temperature or nitrogen level sensors).

Bruker Part Number	Name	Purpose
Z115191	BSMS/2 SPB SENSOR & PNEUMATIC BD	• Standard bore systems • CryoProbe systems • Fixed gas flow for probe flushing • Fixed gas flow for shim cooling
Z115192	BSMS/2 SPB-E SENSOR & PNEUMATIC BD	• Wide bore systems • Regulated gas flow for probe flushing • Regulated gas flow for shim cooling • Support for all nitrogen level sensors (e.g. for systems with BSNL option installed before 2011)

Table 14.1: SPB Variants

Digital Nitrogen Level Sensors introduced in 2011 do not require a SPB-E anymore. The digital sensors are connected typically to AUX ports on the VPSB(-DC). However, the SPB-E support both analog and digital nitrogen level sensors. For details see *Nitrogen Level Sensor [▸ 195]*.

14.3 Technical Data

The boards differ in the number of interfaces and additional software regulated gas flows:

	SPB	SPB-E	Unit
Gas Flow VT	0..2000	0..3000	l/h
Gas Flow Probe Flush	300 (fixed)	0..600	l/h
Gas Flow Shim Cooling	1800 (fixed)	0..3000	l/h
Gas Flow Spin SB	0..720	0..720	l/h
Gas Flow Spin WB	n/a	0..1440	l/h
Gas Flow Sample Lift	0..6000	0..9000	l/h
Helium level sensor (HELIUM LEVEL)	included		
BST sensor interface (SAMPLE CONTROL)	included[a]		
BACS interface (SAMPLE CHANGER)	included	included	
Analog and digital liquid nitrogen level sensor interface (NITROGEN LEVEL)	n/a	included	
Maximum active temperature control channels (VPSB CTRL) [b]	2	4	
Auxiliary digital sensor interface (AUX)	n/a	1	

[a] Old style shim upper parts (SOT72) using Z12084 CABLE ADAPT BSMS/SOT72 can be connected to a SPB(-E) ECL02.03 and newer. Because these shim upper parts do not include a sample up light barrier, reduced functionality (sample lift speed, display) will result.

[b] Variant SPB has 1 VPSB CTRL interface to control 1 Z115193 VPSB (dual heater power supply), variant SPB-E has 2 VPSB CTRL interface to control 2 Z115193 VPSB for total 4 heater channels.

Table 14.2: Overview SPB vs. SPB-E

14.4 System Architecture / Overview

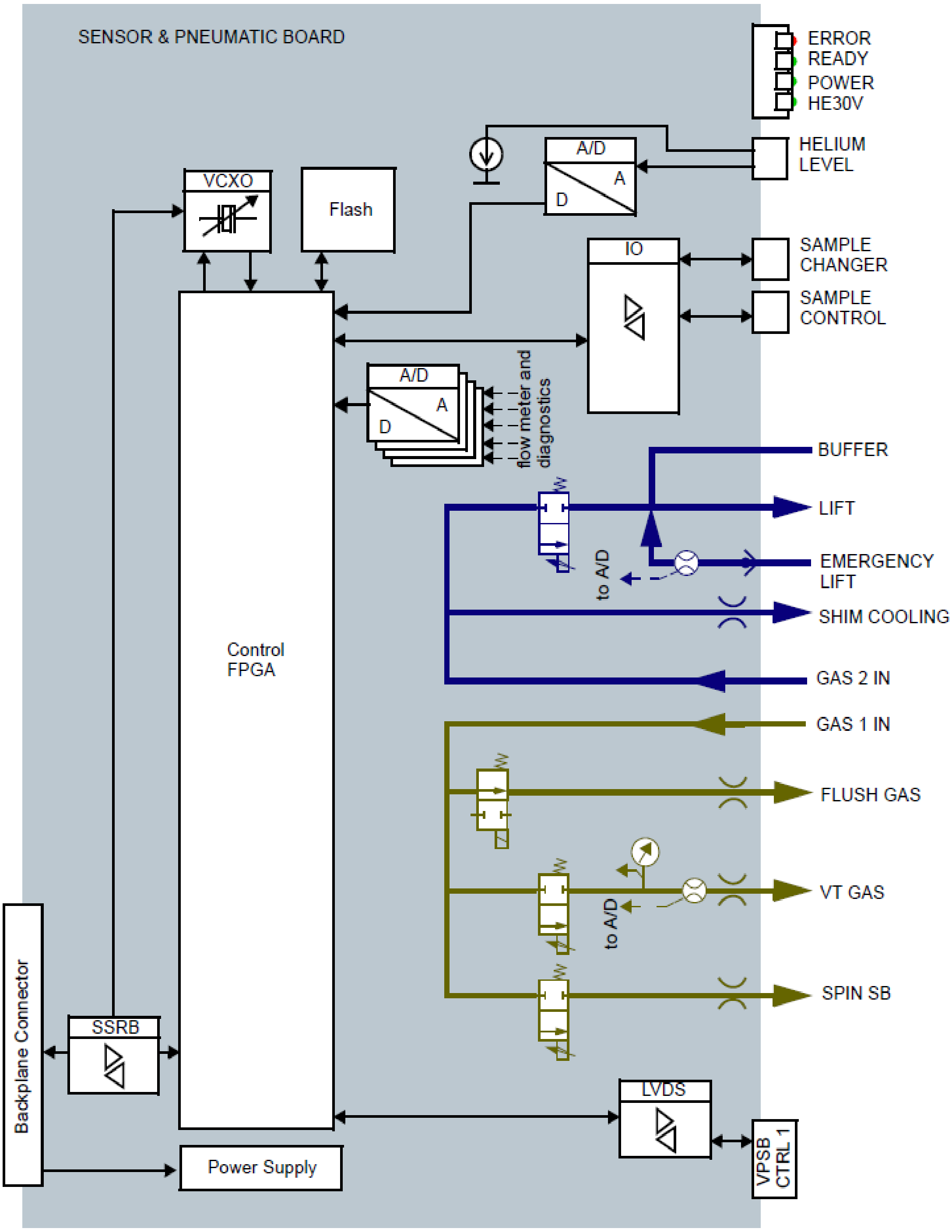


Figure 14.1: Block Diagram of the SPB

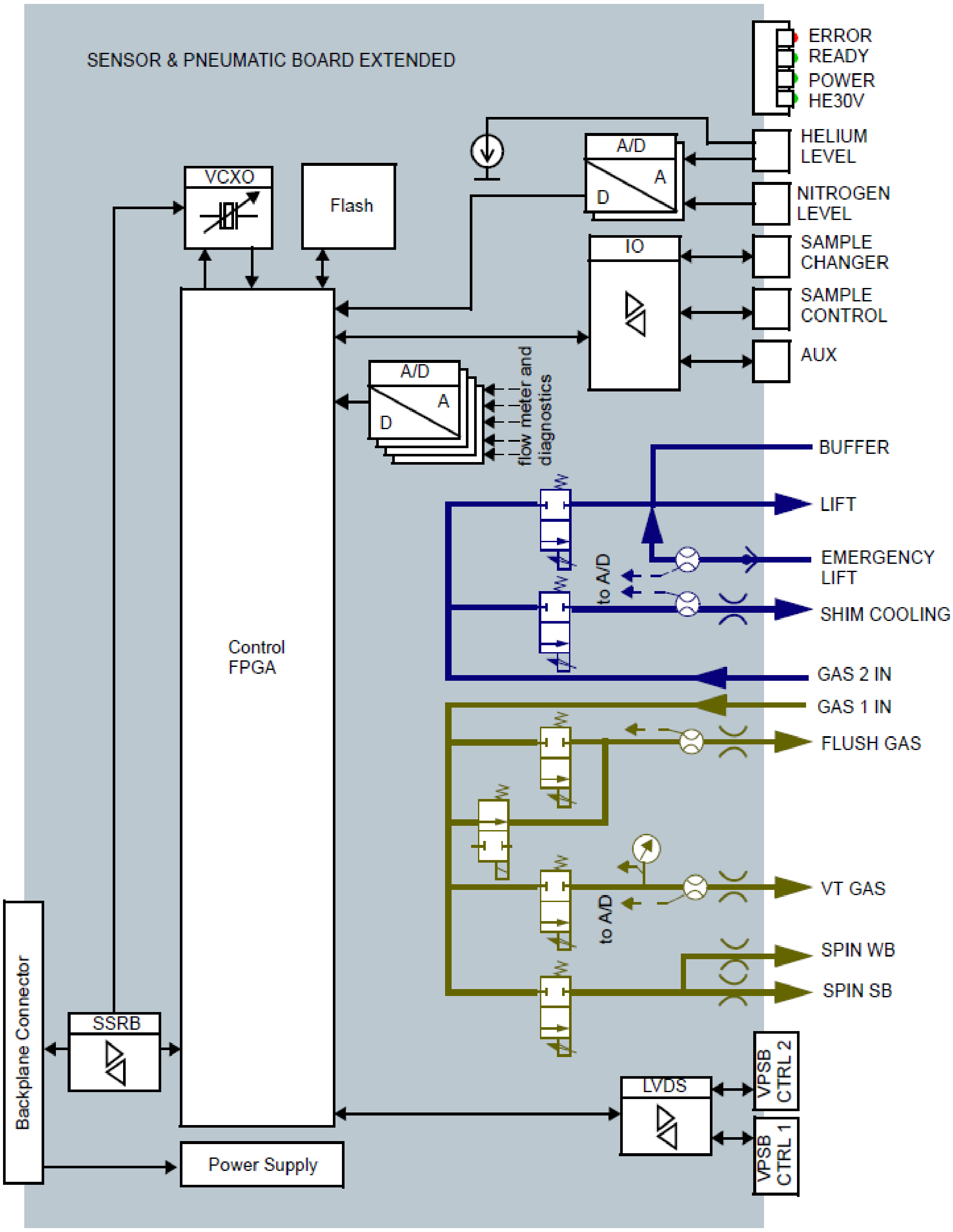


Figure 14.2: Block Diagram of the SPB-E

The SPB(-E) is controlled by the ELCB, which is the BSMS controller/coordinator. The ELCB and the SPB(-E) are connected via the BSMS backplane SSRB (Synchronous Serial Rack Bus).

In normal configuration the SPB(-E) uses a common 10 MHz clock that is distributed by the ELCB (this clock is typically generated by the AV4 reference board) for oscillator synchronization. If not available, the system is running with the on-board crystal frequency.

When the SPB(-E) is starting up, the FPGA first tries to load the design (field bit stream) from the flash memory. If not available, it loads a fully functional backup bit stream called factory bit stream whose primary purpose is to get the system up to a point where a valid bit stream can be loaded to the flash memory.

During startup the ELCB checks the SPB(-E) bit stream version.

14.4.1 Protection

All external interfaces are protected against short circuits (limiting the output current or with current measurement and power switches).

14.4.2 Measurements Provided for Diagnostics

The on-board diagnostics supervises essential board functions like power supply and clock synchronization. A watchdog mechanism checks for valid connection to the ELCB. In case of a failure the board will reset and put electronics and valves into a safe state.

The software running on the ELCB may notify the user about abnormal events.

Status/Errors

The SPB(-E) can perform the following checks:

- Power supply voltages.
- Short circuits / disconnected lines at sensor interface connectors and connection to VPSB (variable power supply board).
- Helium level measurement current source status (operational, correct current, broken sensor).
- Valve block temperature.
- Emergency lift air status (used in CryoProbe systems).

Gas Flow and Pressure Measurements

The gas flow channels for VT and probe flush gas are equipped with flow sensors. These are used for gas flow regulation and for diagnostic purposes. A pressure sensor checks VT gas pressure.

Temperature Measurement

There is a PT1000 resistor built into the valve block providing temperature measurement.

Sample Down Detection Circuit

The sample down signal is continuously measured using a fast sampling A/D converter. This feature provides superior adoption of the reflection sensor to different NMR spinners.

14.4.3 Calibration

There are no calibration settings to store on the SPB. The ELCB has full control over the SPB hardware and provides methods for setting up the sample lift, helium level measurements and nitrogen level measurement (SPB-E only). Spin calibration known from former systems is no longer necessary.

Sample Lift Calibration

Depending on the cryostat bore size and height and the NMR spinner type a different amount of gas is necessary for lifting the sample. The setup of the lift parameters is described on the according Service Web page in detail.

Helium Level Sensor Calibration

Contact your local Bruker office.

Nitrogen Level Sensor Calibration

The digital *Nitrogen Level Sensor [▸ 195]* is factory calibrated. Former analog sensors may need to be calibrated. Contact your local Bruker office.

14.4.4 Front Panel - Connectors and LED's

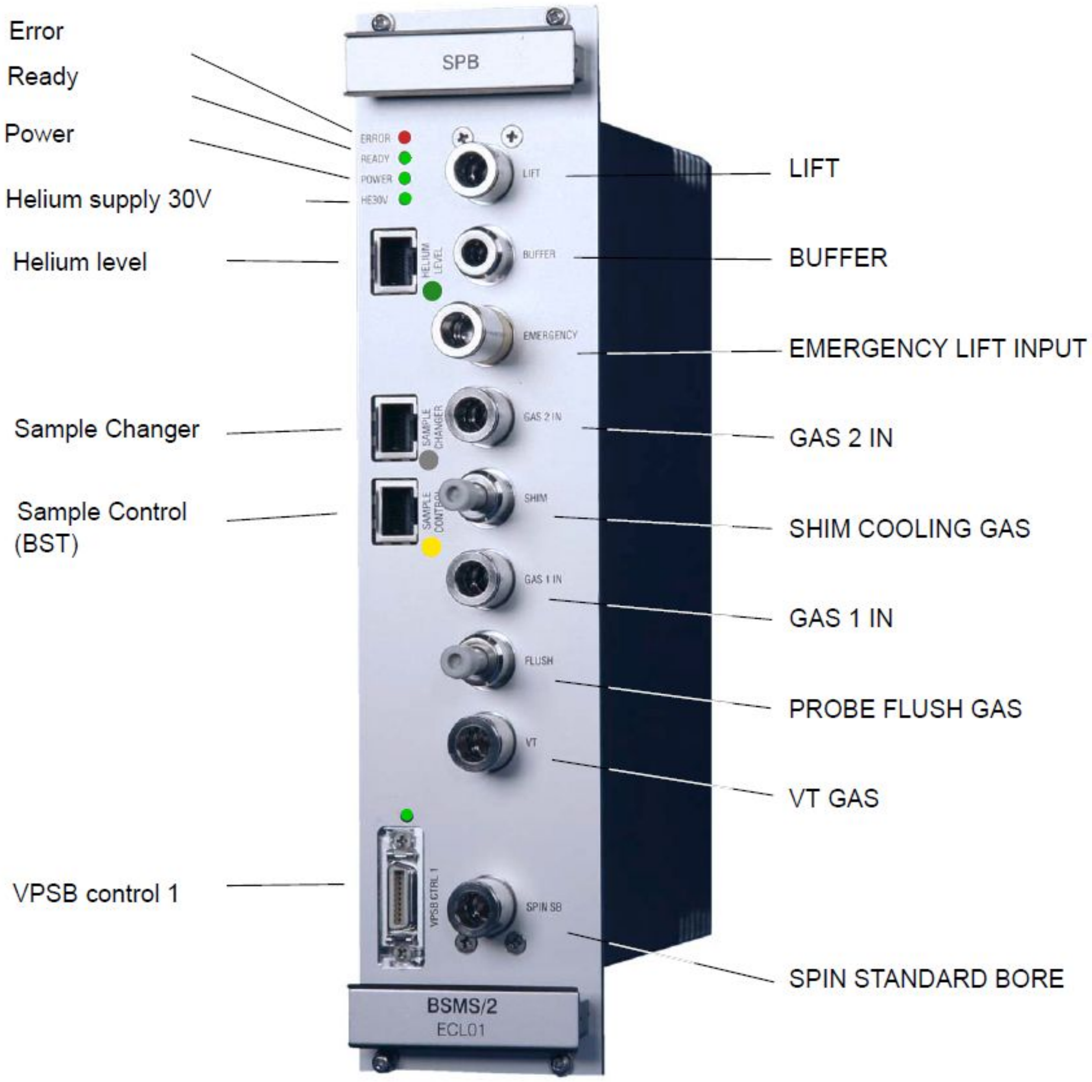


Figure 14.3: Front View of a SPB

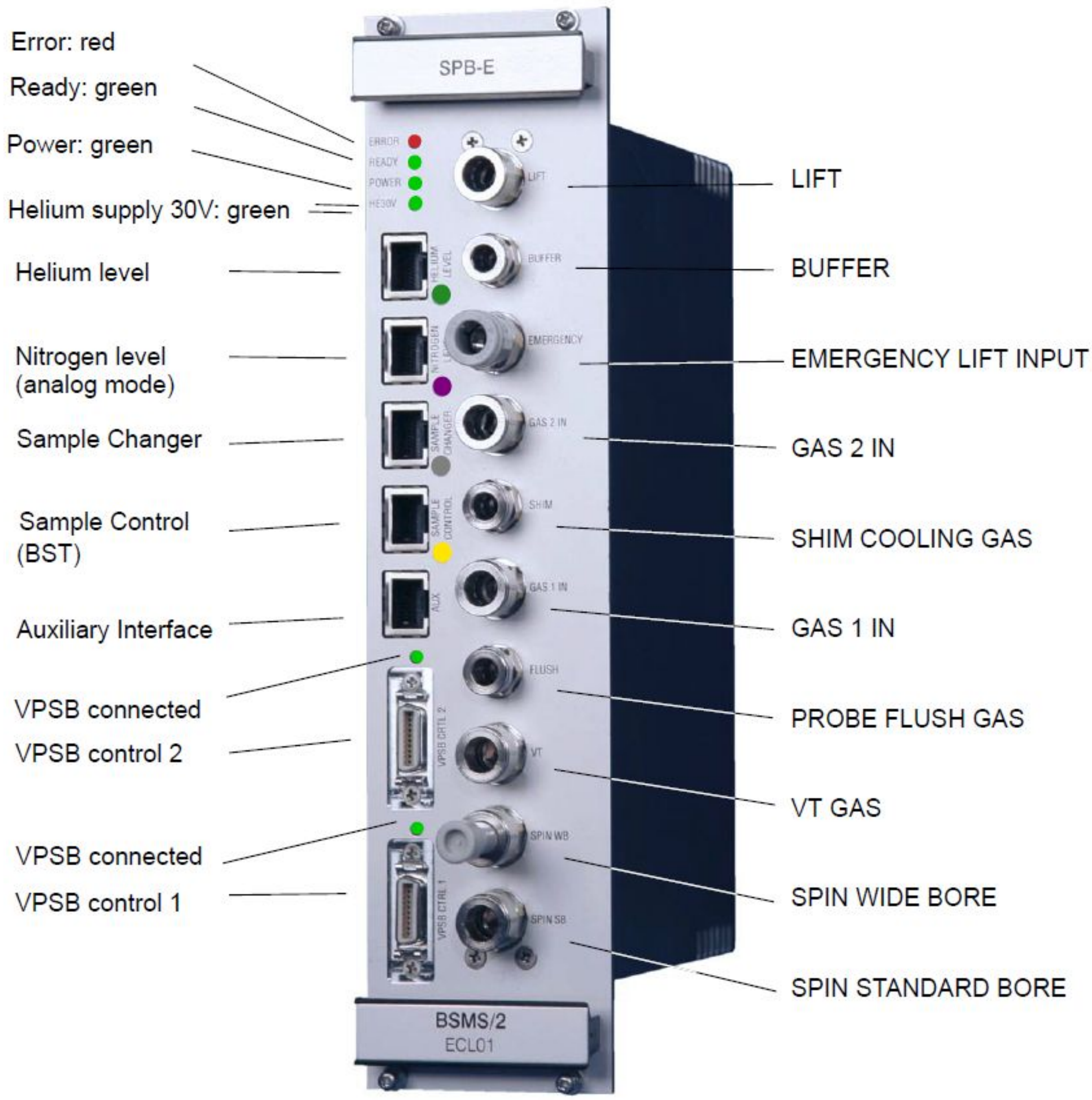


Figure 14.4: Front View of a SPB-E

Ready LED

This LED is active as soon as the FPGA design is loaded and valve and sensor inter- faces are active.

Power LED

Indication that the SPB is correctly powered.

HE30V LED

Indication that the galvanically isolated power supply for the helium level measurement is available.

VPSB connected LED

Whenever a VPSB is connected and initialized correctly, the LED above the connectors labeled VPSB CTRL will be switched on. This can used for diagnostic purpose.

Connectors

Label	Description	Note
HELIUM LEVEL	Connector for helium level sensor	
NITROGEN LEVEL	Connector for analog nitrogen level sensor	SPB-E only
SAMPLE CHANGER	External sample lift control.	
SAMPLE CONTROL	Signals from BST (upper light barrier, sample down sensor and tube version)	
AUX	Auxiliary bus connector for BSMS/2 VT adapters, digital nitrogen level sensor or future use of other accessories	SPB-E only
VPSB CTRL 2	Control signals for BSMS/2 Variable Power Supply Board (VPSB) Digital signalling is with LVDS at 10MBit/s	SPB-E only
VPSB CTRL 1	Control signals for BSMS/2 Variable Power Supply Board (VPSB) Digital signalling is with LVDS at 10MBit/s	

Table 14.3: Connectors

Connectors are protected against short-circuiting. Nevertheless, ensure correct wiring.

14.5 Function Description

14.5.1 Liquid Helium Level Measurement

For monitoring the He level, a He level sensor is inserted into the top of the helium dewar.

14.5.2 Analog Liquid Nitrogen Level Measurement (SPB-E only)

Nitrogen level measurements are performed by a sensor that is encircled by a cylindrical conductor. The sensor and surrounding conductor form a capacitor. The presence of liquid nitrogen between the sensor and conductor changes the capacitance, and this is measured and converted by the sensor electronics into a proportional voltage which is interpreted by the SPB-E to provide the reading.

The measurement circuit on the SPB-E board is separated galvanically from the other electronics.

The interface of the SPB-E is fully compatible with all models of Bruker *Nitrogen Level Sensor [▸ 195]*.

It is recommended to use the digital nitrogen level sensor and connect it to the AUX port of the SPB-E or the VPSB(-DC). For details see *Nitrogen Level Sensor [▸ 195]*.

14.5.3 Sample Down and Sample Up Detection

The interface for standard Bruker Shim Upper part (BST) is backward compatible to the former SLCB circuit. An improved signal processing for the sample down detection allows reliable detection of the various spinners. Sensor supplies are short circuit proof and wiring detection allows improved system diagnostic.

14.5.4 Version of the Shim Upper Part

The shim upper part version can be read by the SPB.

Old style shim upper parts (SOT72) using Z12084 CABLE ADAPT BSMS/SOT72 can be connected to a SPB(-E) ECL02.03 and newer. Because these shim upper parts do not include a sample up light barrier, reduced functionality (sample lift speed, display) will result.

14.5.5 Sample Changer Interface

The sample changer has its own pneumatic controller. The shim upper part (BST) is equipped with a light switch to detect whether there is a sample present for pickup. This information is then passed to the sample changer via the sample changer interface of the BSMS.

14.5.6 Control Output for BSMS/2 Variable Power Supply Board

The SPB provides 1 (SPB) or 2 (SPB-E) interfaces for connecting BSMS/2 VARIABLE POWER SUPPLY BOARDS (VPSB). These boards do not have any connections to the BSMS backplane and all control signals are carried over this interface.

On the interface connector some supply and detection signals and a high speed LVDS-based digital interface are wired. The LVDS-based interface carries the Synchronous Serial Rack Bus signals from the ELCB and BSMS backplane over the cable connection to the control FPGA on the VPSB. The interface is hot-plug capable, has automatic connect/disconnect detection and power supply signals are short-circuit proof.

Note: The new AV4 VPSB-DC(-E) does not require this interface connector.

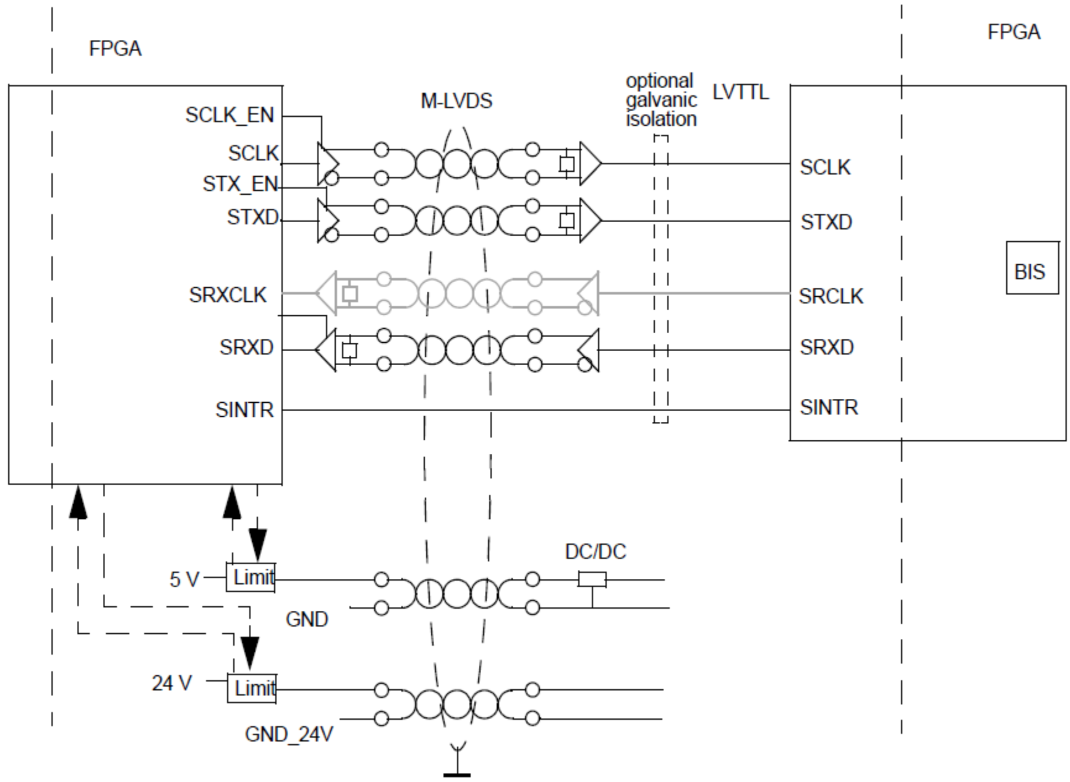


Figure 14.5: Overview of Point-to-Point Full Duplex VPSB CTRL Interface

Pin	Signal	Pin	Signal
1	GND_24V	11	+24V
2	GND_24V	11	+24V
3	GND_5V	13	FLOW_VT_GAS_ON_N
4	GND_5V	14	FLOW_VT_GAS_REQ_N
5	LVDS_SRX_P	15	LVDS_SRX_N
6	LVDS_STX_N	16	LVDS_STX_P
7	LVDS_SRXCLK_P	17	LVDS_SRXCLK_N
8	LVDS_SCLK_N	18	LVDS_SCLK_P
9	RES0	19	SINTR_N
10	GND_5V	20	+5V

Table 14.4: Pin Assignment VPSB CTRL (master interface)

14.5.7 Auxiliary Bus Connector (VT Accessory, SPB-E)

With introduction of the Bruker Sample & Variable Temperature System (BSVT) a new generation of sensor interface adaptors are available. These adapters convert sensor signals into a digital data-stream. These sensors are typically connected to the AV4 VARIABLE POWER SUPPLY BOARD DC (VPSB-DC).

The SPB-E variant is equipped with one supplementary auxiliary bus interface connector.

The interface is hot-plug capable, has automatic connect/disconnect detection and power supply signals are short-circuit proof.

14.5.8 Pneumatics

For detailed technical specifications please see *Technical Data [▸ 219]*.

NOTICE
Never supply the console with non-filtered gas.
Gas supply filter 88437 must be installed!

The SPB contains all valves, valve drivers, and pneumatic connectors necessary to control:

- Sample lift
- Sample spinner (sample rotation)
- VT gas
- Probe flush gas
- Shim system cooling gas
- Emergency lift detection

The SPB replaces the former BSMS/2 PNK3, PNK3S and PNK5 boards.

The valve drivers are galvanically isolated and the module is controlled by the ELCB which also saves the calibration values.

To provide usage of different gases for sample transport/shim cooling and delicate probe head gases (VT, spin, flush gas), these two functional groups have separate gas inputs.

For reasons of sample safety it is necessary to connect a buffer to the lift system.

With the exception of the lift system and emergency lift gas for the CryoProbe sample safety option, there are no further calibration procedures necessary. In particular spin calibration is not necessary.

Controlled gas flow

The VT gas flow on the SPB(-E) is controlled using the integrated mass flow meter a solenoid control valve. Flow variations (within physical limits, some minimal quality of gas supply must be guaranteed) of the gas supply are eliminated and as a result stable conditions for the temperature regulation are provided.

The gas flow meter is factory-calibrated and the compensation values stored on the on-board non-volatile flash memory.

Regulated Gas Flow Channel	SPB	SPB-E
VT	yes	yes
Probe flush gas	no (fixed flow)	yes
Shim Cooling gas	no (fixed flow)	yes

Table 14.5: Controlled Gas Flows

NOTICE
The mass flow controller cannot compensate for poor gas supply or insufficient input gas pressure.
The new gas flow regulation ensure stable gas flow as long as site planning specifications for pressurized gas are met.

Multifunction of probe FLUSH gas output

For safety reasons most valves are closed in fault conditions or when the BSMS system is not powered.

The probe FLUSH gas channel is equipped with a normally open bypass-valve that will ensure a certain amount of gas output even when the BSMS chassis is powered-off.

This output can be used as simple room temperature backup VT gas source for configurations where the probe flush gas is not used otherwise (e.g. CryoProbes).

In case of a power failure the room temperature gas prevents the sample inside the CryoProbe from getting too cold.

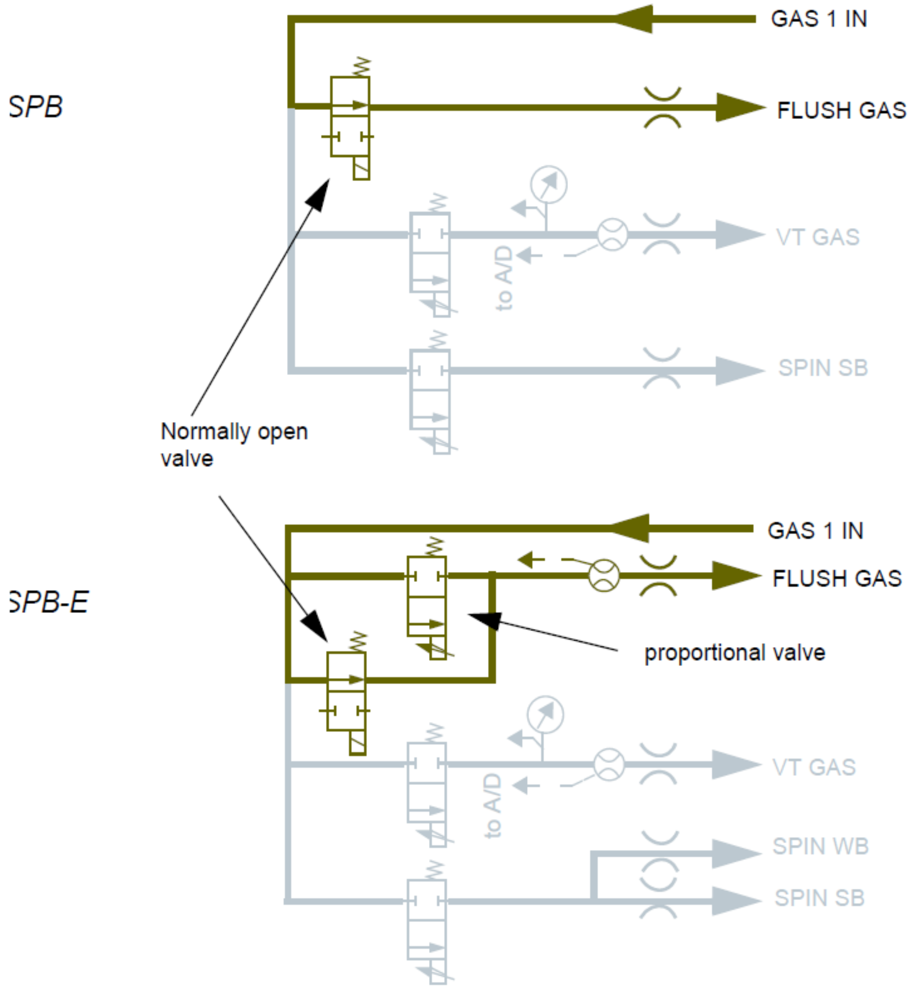


Figure 14.6: Multifunction Flush Gas Output

CryoPlatform Emergency Lift Detection

For the CryoProbe Systems there is a Sample Safety Option available. This option runs independently from the NMR console and guarantees sample tempering (in case of a power failure) and emergency sample lift (in case of vacuum breakdown).

This additional emergency lift air must NOT be fed directly into the emergency lift input as with the legacy PNK3S. Instead the emergency lift air must be carried through an external throttle valve.

As before the amount of emergency lift air flow must be adjusted with this external throttle valve. Please contact your local Bruker office for assistance.

14.6 Bus Interface

The communication with the ELCB runs exclusively over the User Bus.

14.7 Service

A connected SPB in a BSMS system is controlled by the ELCB software - both, the specific low level drivers and the overall control logic is implemented there. The ELCB software provides the operational functions for the NMR application by a CORBA interface. In addition, there is a Web access available for service purpose (setup, calibration and diagnostic). Some of these Web functions are open to all users, other functions are reserved for service engineers, it is necessary to log in and enter the required password before these functions can be accessed (description in the BSMS *Service Web [▸ 34]* chapter).

14.7.1 SPB Service Web

The SPB Service Page contains information about the board itself. Functions controlled by the ELCB are described in the corresponding chapters.

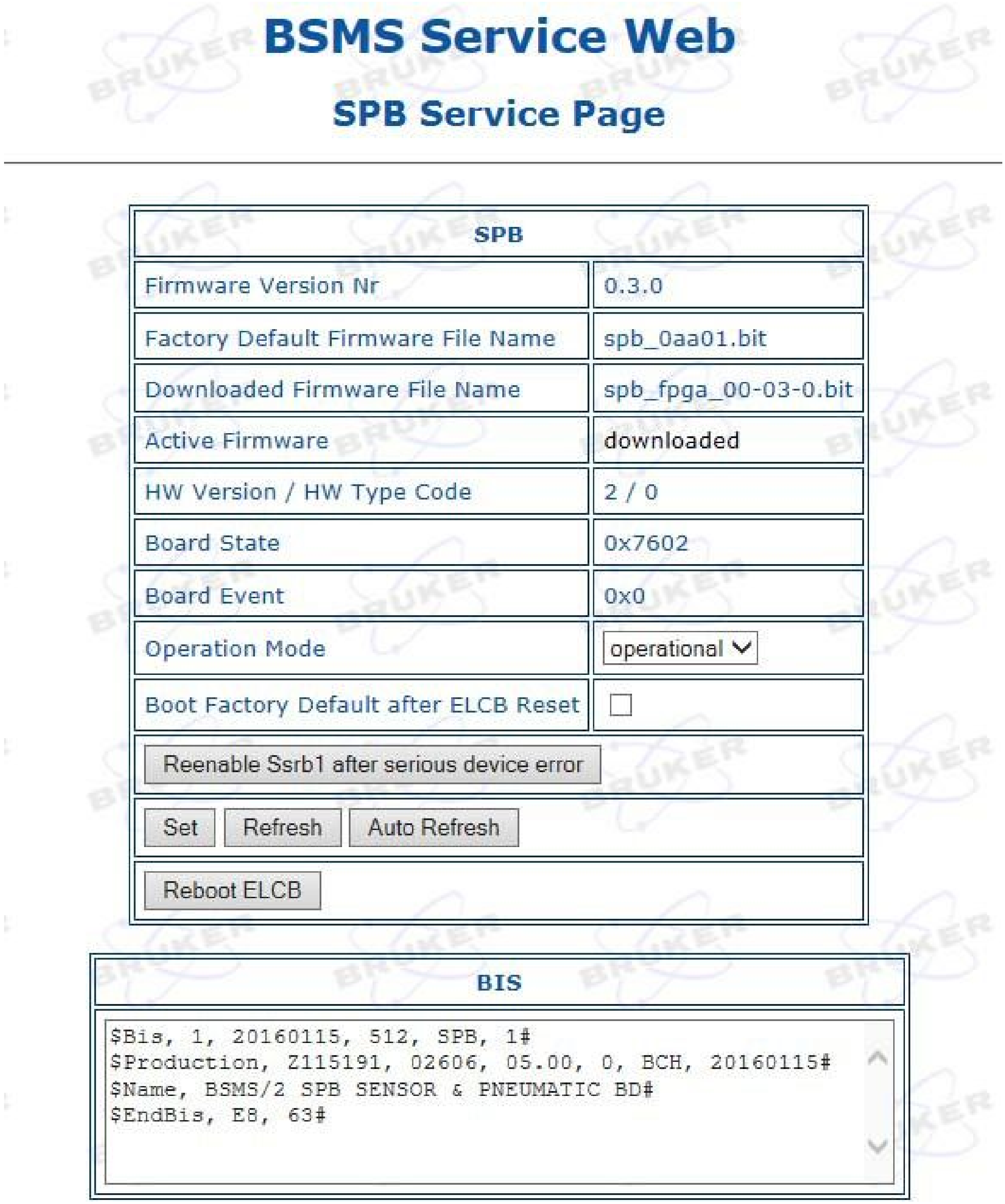


Figure 14.7: SPB Service Page

14.7.2 Diagnostic and Troubleshooting

During normal operation all important signals and supplies are supervised. In case of a fatal hardware failure the board will go to a safe state (e.g. closes all valves). This is realized with a board watchdog mechanism. Board level trouble shooting must be done in the factory.

In case of failures, always check the LEDs on the SPB front panel and the LEDs on the BSMS/2 Power Supply Boards:

- Red LED ERROR must be off.
- Green LED‘s READY, POWER and HE30V must be on.
- If a VPSB is connected, the green LED above the VPSB CTRL connector must be on.

Sample Rotation (SPIN) not Running

- Check air hoses and console gas pressure.
- Lift the sample and insert again.
- Check the sample down sensor signal threshold levels.

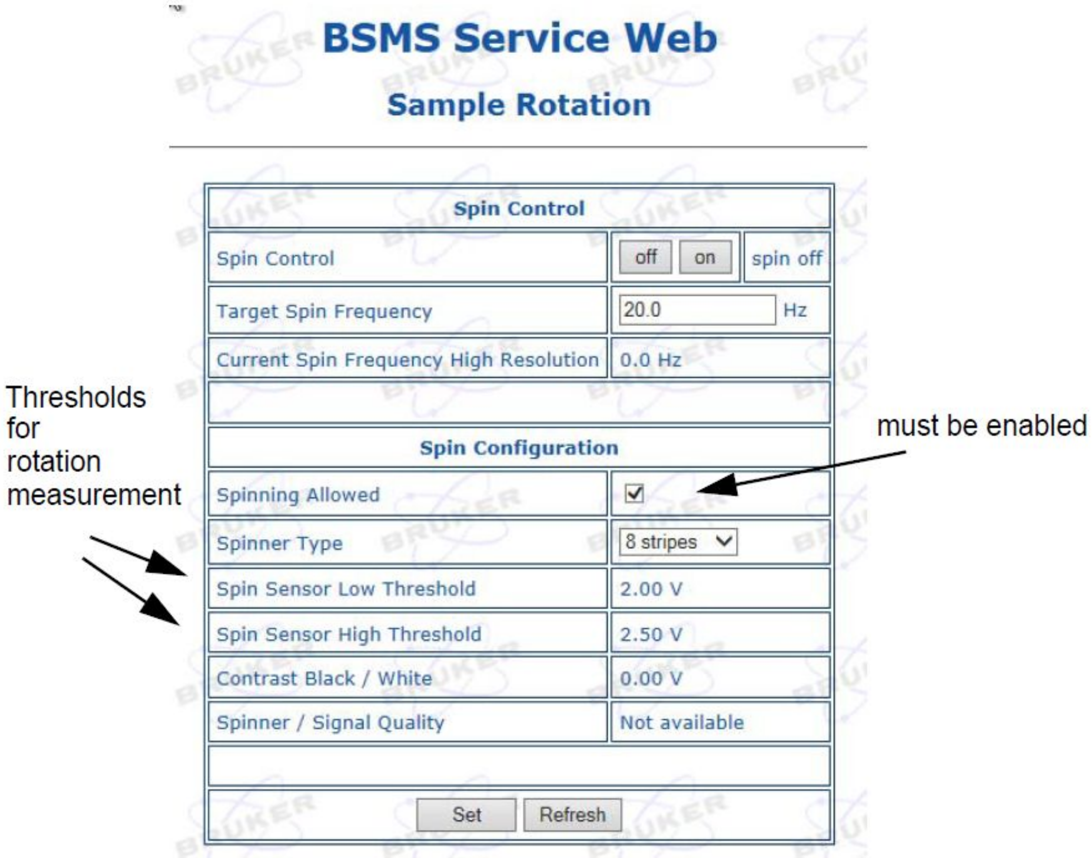


Figure 14.8: BSMS Service Web: Sample Rotation

Gas Flow Variations

- Check supply pressure.
- Check the gas pressure after console the pressure regulator, pressure must be higher than 4 bar and stable.

If the console pressure is within the specified range of 4-6 bar the flow can be stabilized. The gas supply pressure must be at minimum 1 bar higher than set with the pressure regulator of the console (margin for proper pressure regulation).

14.8 System Requirements

See Minimal requirements for all configurations in the chapter *Basic BSVT Configuration [▸ 124]*.

14.9 Ordering Information

See *Basic BSVT Configuration [▸ 124]*.

15 VPSB-DC and VPSB-DC-E

15.1 Introduction

The VPSB-DC (Variable Power Supply Board DC variant) is the successor of the Variable Power Supply Board VPSB. In contrast to the VPSB, the new VPSB-DC uses only backplane power and has no mains supply connector anymore. Also the control communication directly goes through the backplane and is not looped through the Sensor and Pneumatic Board SPB anymore.

The VPSB-DC is available in an extended version VPSB-DC-E, which includes a booster functionality for WB Systems that can supply more output power to one of the two heater power outputs.

The VPSB-DC integrates two mostly independent variable power sources in one 6TE 19“ unit, the VPSB-DC-E comes in a 12TE 19“ unit.

Low level hardware functions (e.g. safety circuits and A/D converter control) are implemented directly on the VPBS-DC(-E), whereas higher level functions such as output power control and read-out of the power monitoring are done by software running on the ELCB.

A two-stage watchdog system and a smart probe heater impedance meter circuit ensure safe operation in case of serious malfunction.

The VPSB-DC(-E) has interfaces for connecting digital accessory sensors (temperature, digital level sensors).

15.2 Configurations

There are two board variant available.

One VPSB-DC has two power outputs that allow to set-up two controlled temperature channels.

One VPSB-DC-E has two power outputs that allow to set-up two controlled temperature channels. The first channel can deliver more output power (booster functionality), if it is used with a recent VT adapter. The overlying software will check that the VT adapter supports booster operation, which is given if the device revision is at least 1. The figure below shows how the VT adapter device revision can be checked on the AV4 BSMS service web variable temperature control BFB overview.

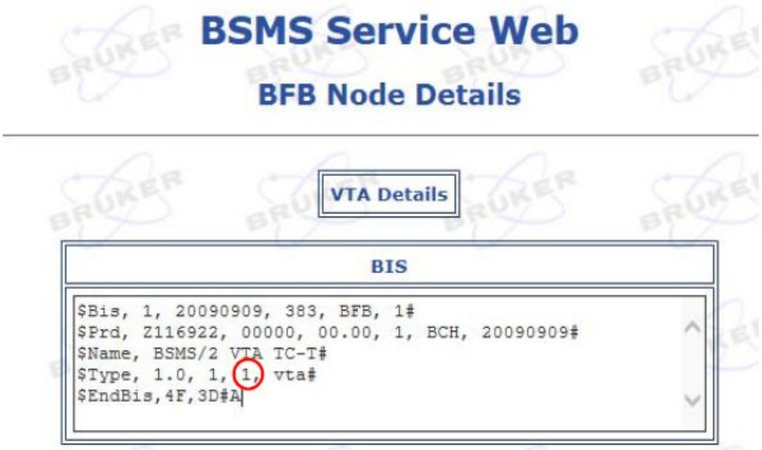


Figure 15.1: VT Adapter Device Revision 1 Necessary for VPSB-DC-E booster Support.

If more than two temperature regulation channels are needed, it is possible to have up to two VPSB-DC(-E) in one AV4 BSMS rack.

Only one single VPSB-DC(-E) is supported if the rack contains one PSM-48V. For all other configurations, a second PSM-48V is required. See also *Power Supply Requirements [▸ 33]*.

#VPSB-DC	#VPSB-DC-E	Required #PSM-48V
1	-	1
-	1	1 or 2[a]
1	1	2
2	-	2
[a] Two power supplies are only required if more than 250 W heater power are requested on channel 1 of the VPSB-DC-E		

Table 15.1: Possible VPSB-DC(-E) Configurations and Number of PSM-48V Required

15.3 Technical Data

15.3.1 Technical Data, Environment and Norms

Parameter		Min	Type	Max	Unit
Ambient operating temperature		15		45	°C
Safety	EN 61010-1				
Protection degree	IP20				

Table 15.2: VPSB-DC and VPSB-DC-E, technical data

15.3.2 Electrical Specification VPSB-DC

Parameter		Min	Type	Max	Unit
Total output power		0		280	W
Number of variable output voltage outputs		2	2	2	

Table 15.3: VPSB-DC Specification

The VPSB-DC has a maximum total output power of 280 W, which is freely shared between the two variable voltage outputs.

Both variable voltage outputs have the same specification.

Parameter		Min	Type	Max	Unit
Output power		0		250[a]	W
Output voltage	range	0		45	Vdc
Output current		0		7	A
Settling time	10...100% load			100	ms
Ripple & Noise	30MHz BW			50	mVpp
Short circuit protection	constant current				
[a] The maximum output power of the two outputs together must not exceed the total output power of 280 W.					

Table 15.4: VPSB-DC Variable Output Specification

15.3.3 Electrical Specification VPSB-DC-E

Parameter		Min	Type	Max	Unit
Total output power		0		530	W
Number of variable output voltage outputs		**2**	2	**2**	

Table 15.5: VPSB-DC-E Specification

The VPSB-DC-E has a maximum total output power of 530 W, 280 W of this power are shared between the two variable voltage outputs.

Parameter		Min	Type	Max	Unit
Output power, booster on		0		500[a]	W
Differential output voltage, booster on	range	0.2		90	Vdc
Absolute output voltage, booster on	range	-45		45	Vdc
Output power, booster off		0		250[b]	W
Output voltage, booster off	range	0		45	Vdc
Output current		0		7	A
Settling time	10...100% load			100	ms
Ripple & Noise	30MHz BW			50	mVpp
Short circuit protection	constant current				

[a] 50% of the channel 1 power are contributed by the extension board/booster. The remaining power is subject to the same power budgeting as in the VPSB-DC, see also [b].

[b] The maximum output power of the two outputs together must not exceed the total output power of 280 W.

Table 15.6: VPSB-DC-E Variable Output 1 Specification

Parameter		Min	Type	Max	Unit
Output power[a]		0		250[a]	W
Output voltage	Range	0		45	Vdc
Output current		0		7	A
Settling time	10...100% load			100	ms
Ripple & Noise	30MHz BW			50	mVpp
Short circuit protection	constant current				

[a] Subject to power budgeting.

Table 15.7: VPSB-DC-E Variable Output 2 Specification

15.4 System Architecture / Overview

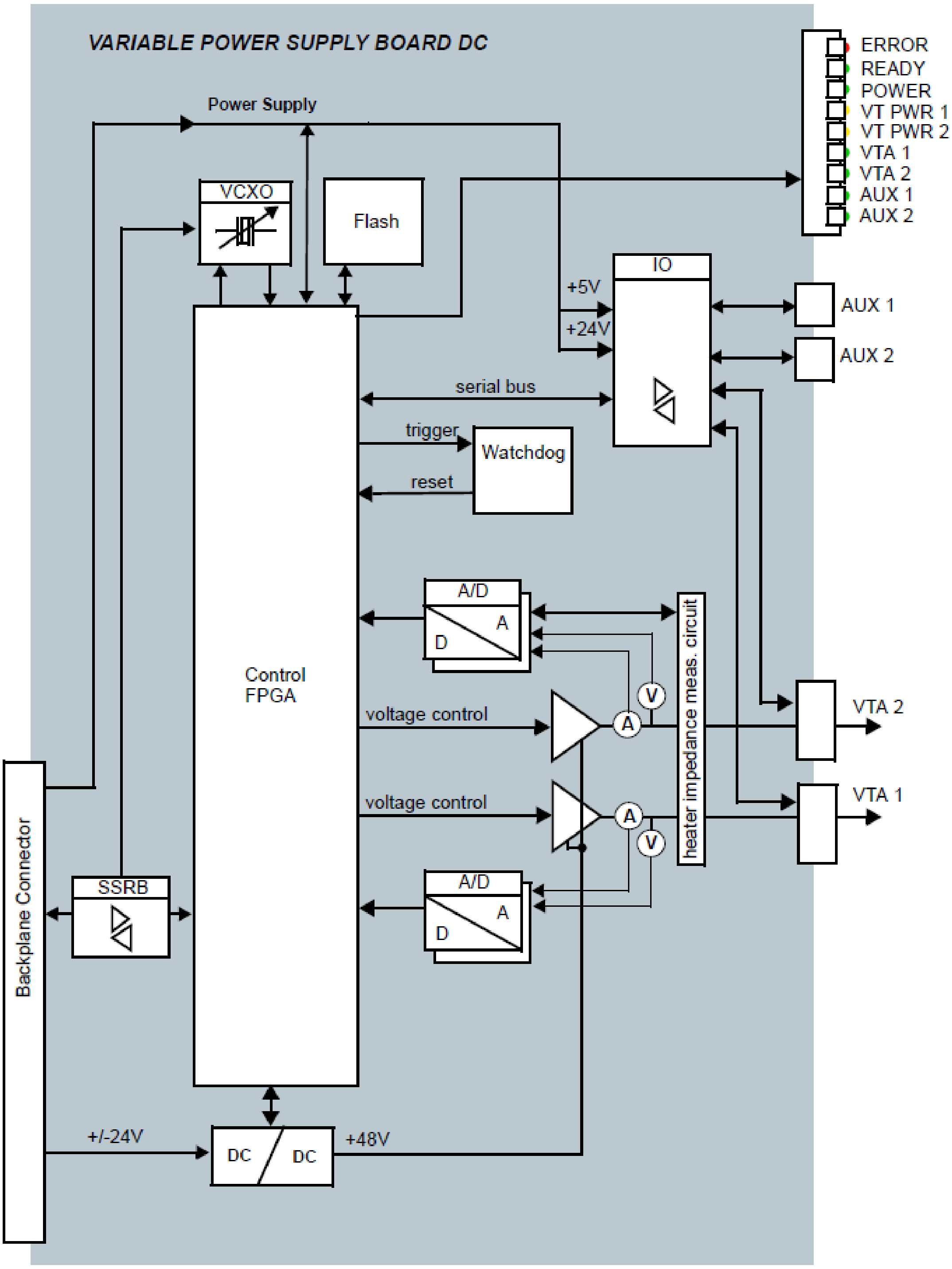


Figure 15.2: Block Diagram of the VPSB-DC

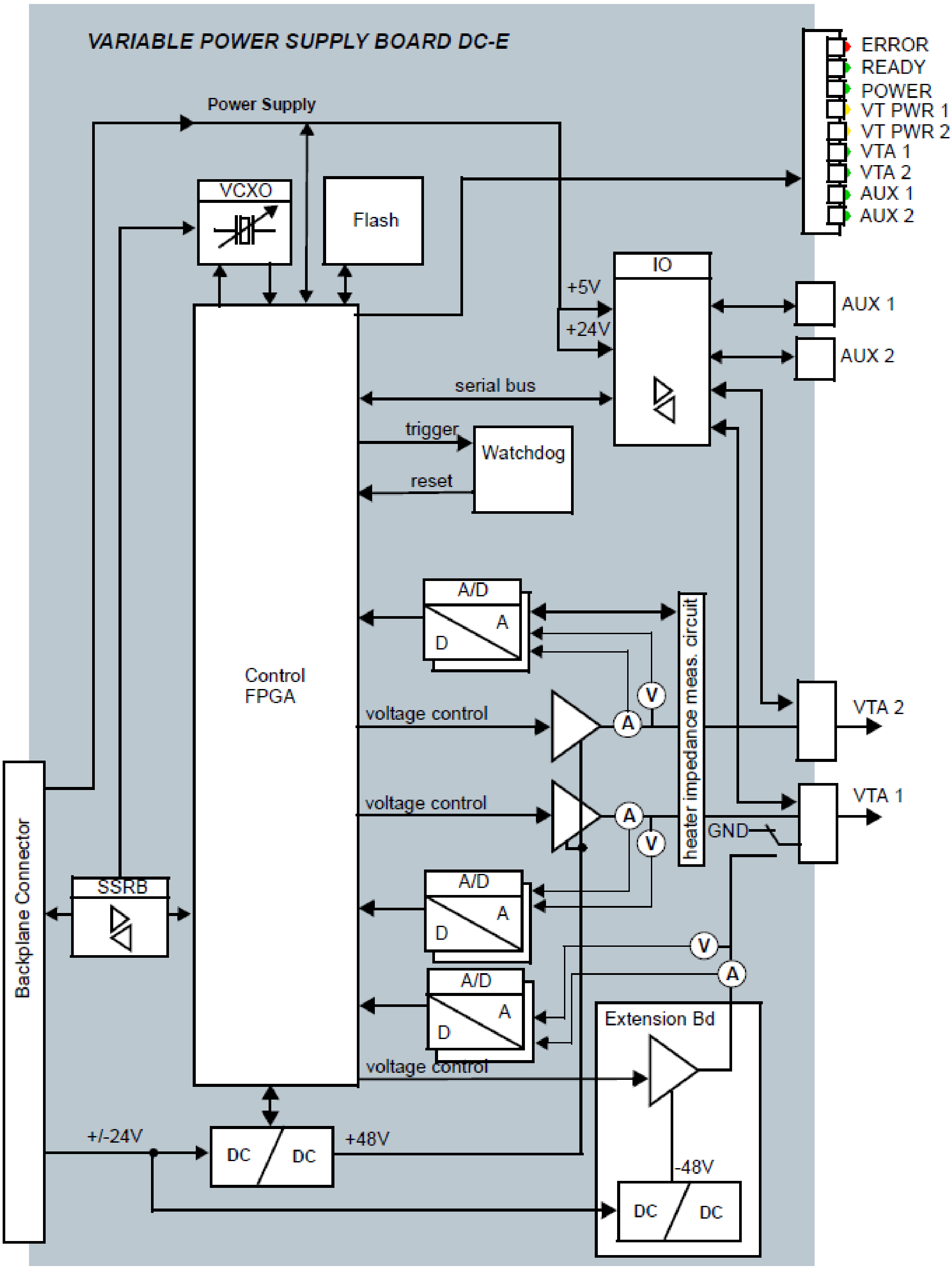


Figure 15.3: Block Diagram of the VPSB-DC-E

15.4.1 Control FPGA

The control FPGA receives commands (e.g. desired output voltage) from the ELCB via the backplane SSRB. The FPGA reads from the Analog-to-Digital converters and controls the voltage of the power stages of the variable power supplies.

15.4.2 Power Supply and Output Power Control

The total output power of the VPSB-DC is limited to 280 W by the input power DC/DC converter. Each heater channel can deliver up to 250 W, provided that the total power does not exceed 280 W. The BSVT makes the power budgeting by using and limiting the set maximum powers of the two channels, i.e. the two maximum powers added together are not allowed to exceed 280 W.

For the VPSB-DC-E, a booster is available on the first output channel. The BSVT automatically switches on the booster, if the maximum power of channel one is set to a value above 250 W. Without booster, there are the same limitations to the output power as for the VPSB-DC. If the booster is enabled, the output power of channel one is equally distributed between the VPSB-DC part of the board and the booster extension part, with the following implications on the maximum output power: Only half of the first channel's power flows into the maximum power calculation.

For example, if the first channel maximum power is set to 400W, there is still 280 W – 400 W / 2 = 80 W available for the second channel. Vice versa, if the second channel maximum power is set to 100 W, the first channel power is reduced to (280 W-100 W)*2 = 360 W.

The AV4 BSVT software will handle the power budgeting such that the currently changed maximum power has priority, i.e. the other channel's maximum power will be automatically reduced if the budget would be exceeded.

If the booster is enabled (maximum power setting > 250 W), a small offset voltage in the order of a few 100 mW will be seen on the output, even if the target voltage/power is set to zero.

The output of a VPSB-DC(-E) channel is enabled whenever a temperature regulator is operating. The two power stages can be enabled independently.

The booster can only be switched on and off if the VPSB-DC-E channel one is off. It is therefore only possible to set the maximum output power above 250 W if the temperature regulation is switched off.

Before the output power is enabled, the load resistance is measured by dedicated electronics with high precision. Afterwards, during actual VT operation, output current and voltage are measured and monitored. For a specific heater power, the voltage is evaluated based on the initial load resistance. If the load resistance changes significantly during operation (e. g. broken lines, contact problems, material faults) then the BSVT switches off and issues an error message.

The registers for output power commands are self-clearing. A control instance must therefore update the output parameters at regular intervals, otherwise the outputs are reset by a watchdog circuitry for safety reasons.

15.4.3 Protection

All external interfaces are protected against short circuits (limiting the output current or with current measurement and power switches).

The power stages are protected against over-heating.

15.4.4 Measurements Provided for Diagnostic

The on-board diagnostics supervise essential board functions like power supply and clock synchronization. A two-stage watchdog mechanism checks for valid connection to the ELCB and for valid power commands. In case of a failure the board will reset and switch off the power stages.

The software running on the ELCB may notify the user about abnormal events.

Status / Errors

The VPSB-DC(-E) can perform the following checks:

- Power voltages OK.
- Short circuits / disconnected lines at heater or sensor interface connectors.

All connectors are equipped with current-shunt monitors. These measurements allow detection of connected adapters and over-current conditions.

15.4.5 Calibration

There are no calibration settings to store on the VPSB-DC(-E).

15.4.6 Front Panel - Connectors and LED‘s

All interfaces for both the VPSB-DC and the VPSB-DC-E are the same.

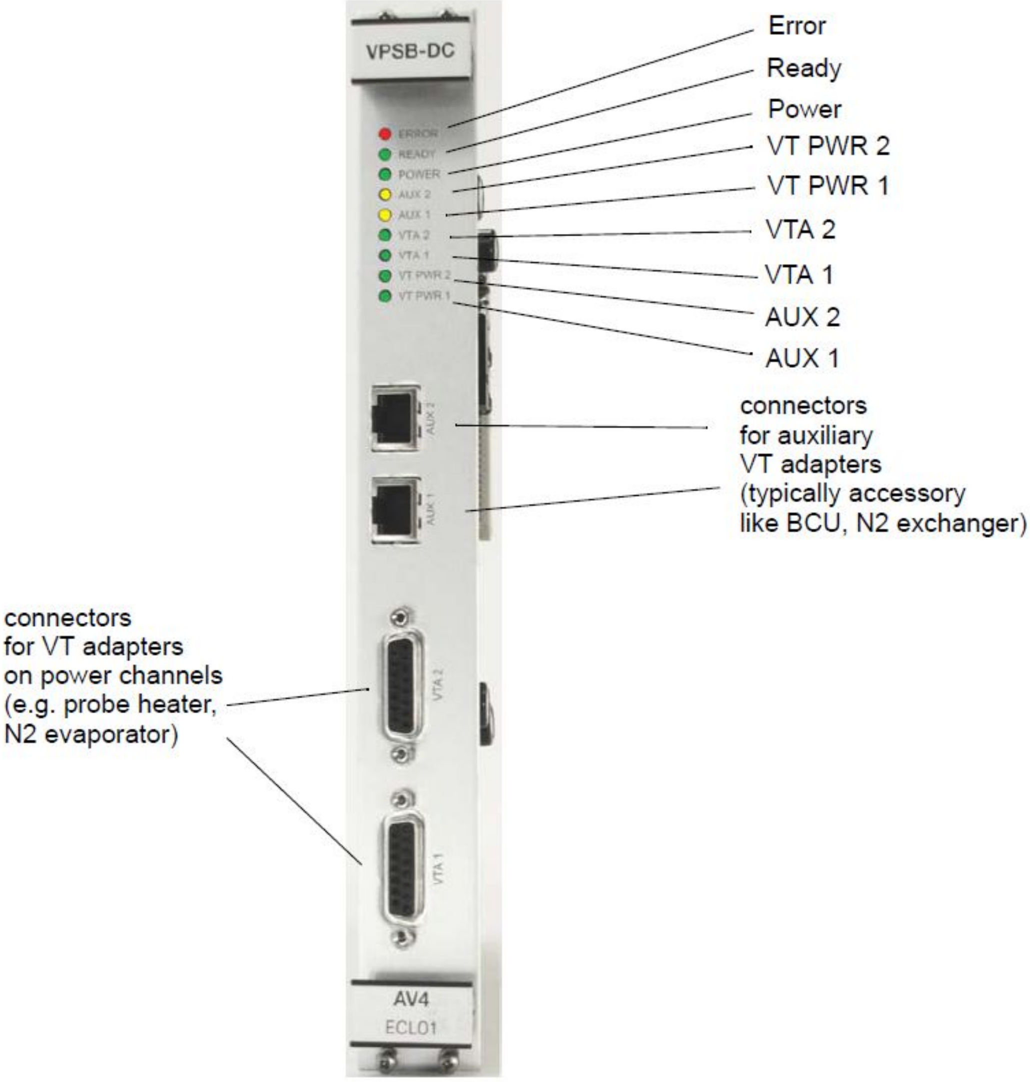


Figure 15.4: Front View of a VPSB-DC

Error LED

This LED is lit after power ON. It turns off as soon as the VPSB-DC(-E) is initialized (i.e. the FPGA has loaded its configuration from the flash memory and the communication with the ELCB is established).

Later on, an active Error LED indicates that an error has occurred (e. g. short circuit, watchdog event,...) and that in consequence the connected VTAs and the power outputs are switched off.

Ready LED

This LED is lit as soon as the FPGA program is loaded and the sensor interfaces are active

Power LED

An active Power LED indicates that the VPSB-DC(-E) is correctly powered

VT PWR 1

This LED is lit whenever the output power on the connector VTA1 is enabled

VT PWR 2

This LED is lit whenever the output power on the connector VTA2 is enabled

VTA 1 LED

Whenever a VTA is connected to the connector labeled VTA 1 and initialized correctly, the LED will be switched on

VTA 2 LED

Whenever a VTA or BSCU is connected to the connector labeled VTA 2 and initialized correctly, the LED will be switched on

AUX 1 LED

Whenever a VTA is connected to the connector labeled AUX 1 and initialized correctly, the LED will be switched on

AUX 2 LED

Whenever a VTA or BSCU is connected to the connector labeled AUX 2 and initialized correctly, the LED will be switched on

Connectors

Label	Description	Note
VTA 1	For VTA adapters that are used for power channels (e.g. probe heater, LN2 accessory)	VTA 1 will be mapped to regulator channel 1 in Topspin[a]
VTA 2		VTA 2 will be mapped to regulator channel 2 in Topspin
AUX 1	For VTA adapters that do not require heater power (e.g. BCU control)	AUX 1 will be mapped to auxiliary channel 1 in Topspin[b]
AUX 2		AUX 2 will be mapped to auxiliary channel 2 in Topspin

[a] If a 2nd VPSB-DC(-E) is in use then its VTA 1 will be mapped to regulator channel 3 and VTA 2 to regulator channel 4 respectively.

[b] If a 2nd VPSB-DC(-E) is in use then the device at AUX 1 will be mapped to auxiliary channel 3 and AUX 2 to auxiliary channel 4 respectively.

Table 15.8: VPSB-DC(-E) Front Panel Connectors

15.5 Service

A connected VPSB-DC(-E) in a BSMS system is controlled by the ELCB software - both the specific low level drivers and the overall control logic are implemented there. The ELCB software provides the operational functions for the NMR application by a CORBA interface. In addition, there is a Web access available for service purpose (setup, calibration and diagnostic). Some of these Web functions are open to all users (e. g. clients), other functions are reserved for service engineers - it is necessary to log in and enter the required password before these functions can be accessed (description in the BSMS *Service Web [▶ 34]* chapter).

15.5.1 VPSB-DC(-E) Service Web

The VPSB-DC(-E) Service Page contains information about the board itself. Functions controlled by the ELCB are described in the corresponding chapters.

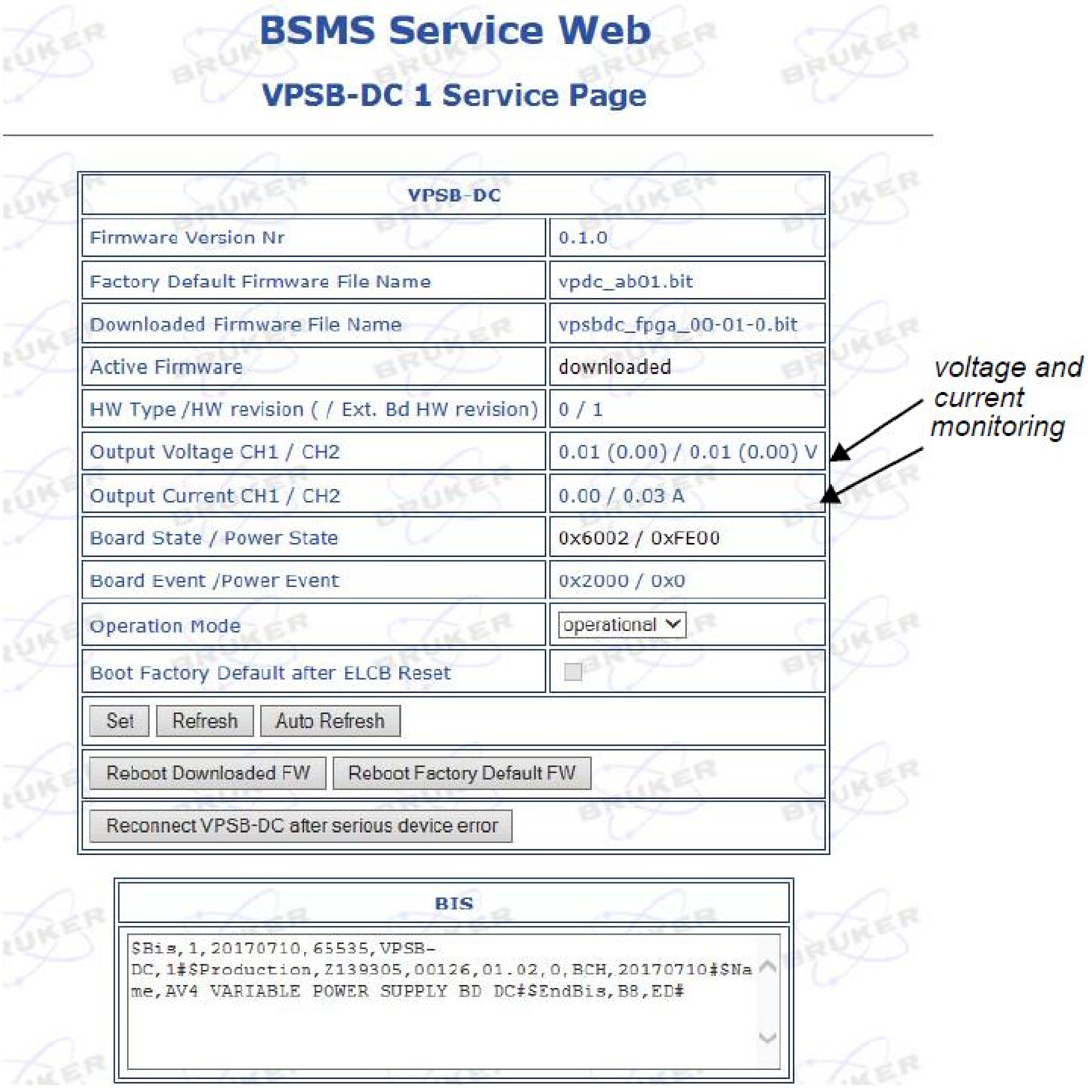


Figure 15.5: VPSB-DC Service Page

15.5.2 Diagnostic and Troubleshooting

During normal operation all important signals and supplies are supervised. In case of a fatal hardware failure the board will go to a safe state (e.g. shut down of the power conversion stages). This is implemented with a board watchdog system. Board level trouble shooting must be done in the factory.

In case of failures, always check the LEDs on the VPSB-DC(-E) front panel:

- Red ERROR LED must be off.
- Green READY LED and POWER LED must be on. If the POWER LED is off, three serviceable fuses for the VPSB-DC, and five for the VPSB-DC-E can be checked, see *Serviceable Fuses [▹ 178]*.
- If a VTA is connected, the corresponding green LED must be on.
- If the output on a channel is on (e.g. during temperature regulation) the corresponding yellow LED (VT PWR 1 or VT PWR 2) must be on. If not, check cables, connectors and firmware on connected devices.

15.5.2.1 Serviceable Fuses

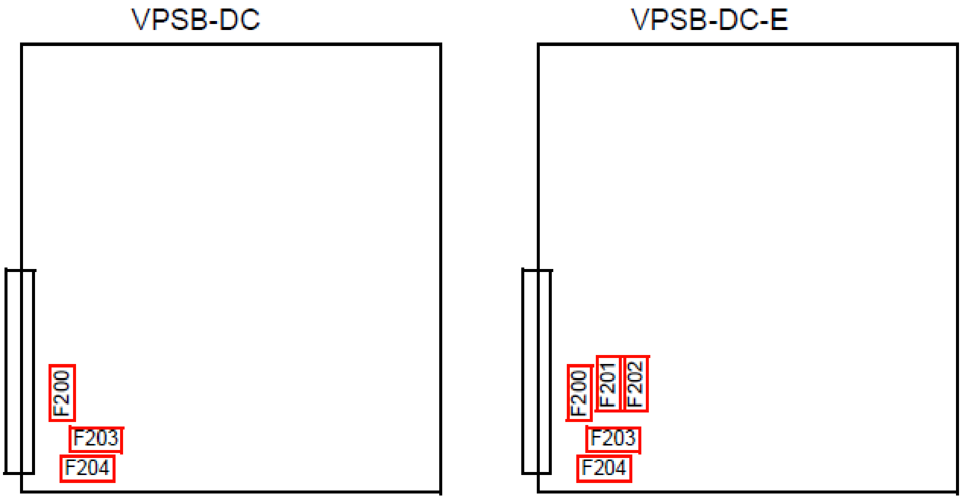


Figure 15.6: VPSB-DC(-E) Fuse Placement

Supply	Fuse	Part No.	Value
+24V Supply	F200	1802109	3.15 AT H
+/-24V power input	F203, F204	49216	8.0 AT H
VPSB-DC E only:			
+/-24V extension board power input	F201, F202	49216	8.0 AT H

Table 15.9: Fuses on VPSB-DC(-E)

15.6 System Requirements

See Minimal requirements for all configurations in the chapter *Basic BSVT Configuration [▸ 124]*.

15.7 Ordering Information

See *Basic BSVT Configuration [▸ 124]*.

16 VTA

16.1 Introduction

VTA is the abbreviation for Variable Temperature System Adapter.

For application specific needs a wide variety of temperature sensors and heater interfaces must be supported. Some NMR probes need standard thermocouple sensors type-T, others need PT100 thermistors, some need two sensors etc.

To obtain precise and accurate temperature measurement the analog sensor signal cannot be carried over long distances or have many connector contacts between sensor and electronics.

Many NMR users want to work with different NMR probes and therefore must change the sensor adaptation conveniently.

For every temperature sensor and heater adaptation variant or other accessory device a tailored VTA is available but only one type of cable connection is needed for probe to console adaptation. This cable carries wires for digital signals, low-voltage power supply and the heater power.

The VT Adapters for probe head temperature control:

- Adapt the specific sensor, convert the sensor signal to a digital temperature reading and transmit this value to the BSMS/2 ELCB.
- Measure the environmental temperature, use this value to compensate the room temperature dependencies of the specific sensor and transmit the room temperature value to the BSMS for further elimination of room temperature artefacts.

Heater power and heater safety sensor signals are fed through the VTA for three reasons:

- The heater power and the corresponding regulation sensor are bundled, thus preventing erroneous usage of a spare sensor for regulation.
- The heater over-temperature sensor can be evaluated.
- The heater current can be filtered close to the probe, suppressing RF noise picked up by the long cable running from the console to the magnet.

To connect other temperature accessories like chillers, heat exchangers, nitrogen level measurement, pressure measurement etc. there are dedicated VTAs available. These accessory adapters are connected through a thinner cable that carries digital signals and low-voltage power supply only.

16.2 Configurations

The various applications and related VTA variants are presented in the following chapters:

- *BSVT Probe Adaptation [▸ 126]*
- *BSVT and HT Solids Probe (High Temperature) [▸ 132]*
- *BSVT and VT Gas Cooling Accessory Adaptation [▸ 134]*
- *BSVT and Flow Probe Adaptation (FLOW-NMR) [▸ 138]*

Bruker Part Number	Name	Marking	Typical usage [Power or Auxiliary][a]	Typical usage Connected devices
Z119237	BSMS/2 VTA TC-2T	TC-2T	POWER	RT, Solids and Flow Probes VTN/WVT/DVT
Z116924	BSMS/2 VTA BTO	BTO	POWER	RT probes with BTO2000
Z116923	BSMS/2 VTA CRP	CRP	POWER	CryoProbe
Z120851	BSMS/2 VTA FLOW-NMR	FLOW-NMR	POWER	Flow NMR Capillary Heater
Z120728	BSMS/2 VTA TC-2E	TC-2E	POWER	Probes for solids, high temperature
Z119238	BSMS/2 VTA LN2	LN2	POWER	N2 Evaporator N2 heat exchanger
Z116925	BSMS/2 VTA BCU	BCU	AUX	BCU-05, BCU-X
[a] POWER means that this application needs heater power and therefore must be connected through a cable that contains heater power wires to an output of the VARIABLE POWER SUPPLY BOARD (VPSB-DC(-E)).				

Table 16.1: List of Available VTAs

16.3 Technical Data

VTA TC-T

Parameter		Min	Type	Max	Unit
Temperature measurement	Range	-270		400	°C
Thermocouple type T	Accuracy		+/- 0.5		°C
	Number of channels		1		
	Connector type[a]		A		
Heater	Connector type		H		
	Maximum voltage			50	V
	Maximum current			7	A
Safety temperature measurement	Range	-200		+850	°C
Thermocouple type K	Resolution		0.1		
Measurement update rate			1		s^{-1}
[a] Connector types: See *Figure 16.1 [▸ 187]*					

Table 16.2: VTA TC-T

VTA BTO

Parameter		Min	Type	Max	Unit
Temperature measurement	Range	-270		400	°C
Thermocouple type T	Accuracy		+/- 0.5		°C
	Number of channels		1		
	Connector type[a]		C		
BTO2000 Supply	Voltage		24		V
	Current			500	mA
	Connector type		D		
Heater	Connector type		H		
	Maximum voltage			50	V
	Maximum current			7	A
Safety temperature measurement	Range	-200		+850	°C
Thermocouple type K	Resolution		0.1		
Measurement update rate			1		s^{-1}
[a] Connector types: See *Figure 16.1 [▸ 187]*					

Table 16.3: VTA BTO

VTA CRP

Parameter		Min	Type	Max	Unit
Temperature measurement	Range	-200		+850	°C
PT100	Accuracy, without sensor	+/- 0.25			°C
	Number of channels		1		
	Connector type[a]		M/N		
Heater	Connector type		M/N		
	Maximum voltage			50	V
	Maximum current			2.5	A
Safety temperature measurement	Range	-200		+850	°C
PT100	Resolution		0.1		
Measurement update rate			1		s^{-1}
[a] Connector types: See *Figure 16.1 [▸ 187]*					

Table 16.4: VTA CRP

VTA TC-2T

Parameter		Min	Type	Max	Unit
Temperature measurement	Range	-270		400	°C
Thermocouple type T	Accuracy, without sensor		+/- 0.5		°C
	Number of channels		2		
	Connector type[a]		A		
Heater	Connector type		H		
	Maximum voltage			50	V
	Maximum current			7	A
Safety temperature measurement	Range	-200		+850	°C
Thermocouple type K	Resolution		0.1		
Measurement update rate			1		s^{-1}
[a] Connector types: See *Figure 16.1 [▸ 187]*					

Table 16.5: VTA TC-2T

VTA FLOW-NMR

Parameter		Min	Type	Max	Unit
Temperature measurement	Range	-200		350	°C
Thermocouple type T	Accuracy (without sensor)		+/- 0.5		°C
	Type		1		
	Number of channels		1		
	Connector type[a]		A		
Heater	Connector type		J		
	Maximum voltage			50	V
	Maximum current			7	A
Safety temperature measurement	Range	-200		+850	°C
PT100	Resolution		0.1		
Measurement update rate			1		s^{-1}
[a] Connector types: See *Figure 16.1 [▸ 187]*					

Table 16.6: VTA FLOW-NMR

VTA TC-2E

Parameter		Min	Type	Max	Unit
Temperature measurement	Range	-200		+1000	°C
Thermocouple type E	Accuracy (without sensor)		+/- 1		°C
	Number of channels		2		
	Connector type[a]		B		
Heater	Connector type		H		
	Maximum voltage			50	V
	Maximum current			7	A
Safety temperature measurement	Range	-200		+850	°C
Thermocouple type K	Resolution		0.1		
Measurement update rate			1		s^{-1}
[a] Connector types: See *Figure 16.1 [▷ 187]*					

Table 16.7: VTA TC-2E

VTA LN2

Parameter		Min	Type	Max	Unit
Level measurement	Range	0		500	ohm
Resistive PT100 type	Resolution		0.1		ohm
	Accuracy		+/- 1		ohm
	Stability				°C/°C
	Connector type[a]		J		
Heater	Connector type		J		
	Maximum voltage			50	V
	Maximum current			7	A
Safety temperature measurement	Range	-200		+850	°C
Resistive PT100 type	Resolution		0.1		°C
Measurement update rate			1		s^{-1}
[a] Connector types: See *Figure 16.1 [▷ 187]*					

Table 16.8: VTA LN2

VTA BCU

Parameter		Min	Typ e	Max	Unit
Control signal output	Max. voltage		5		V

Parameter		Min	Type	Max	Unit
	Max. current			50	mA
	Connector type[a]		K		
[a] Connector types: See *Figure 16.1 [▸ 187]*					

Table 16.9: VTA BCU

VTA MAG-RS

Parameter		Min	Type	Max	Unit
Temperature measurement	Range	-260		850	°C
	Number of channels		2		
	Connector type[a]		O		
Heater	Connector type		P		
	Maximum voltage			50	V
	Maximum current			7	A
Measurement update rate			1		s^{-1}
[a] Connector types: See *Figure 16.1 [▸ 187]*					

Table 16.10: VTA MAG-RS

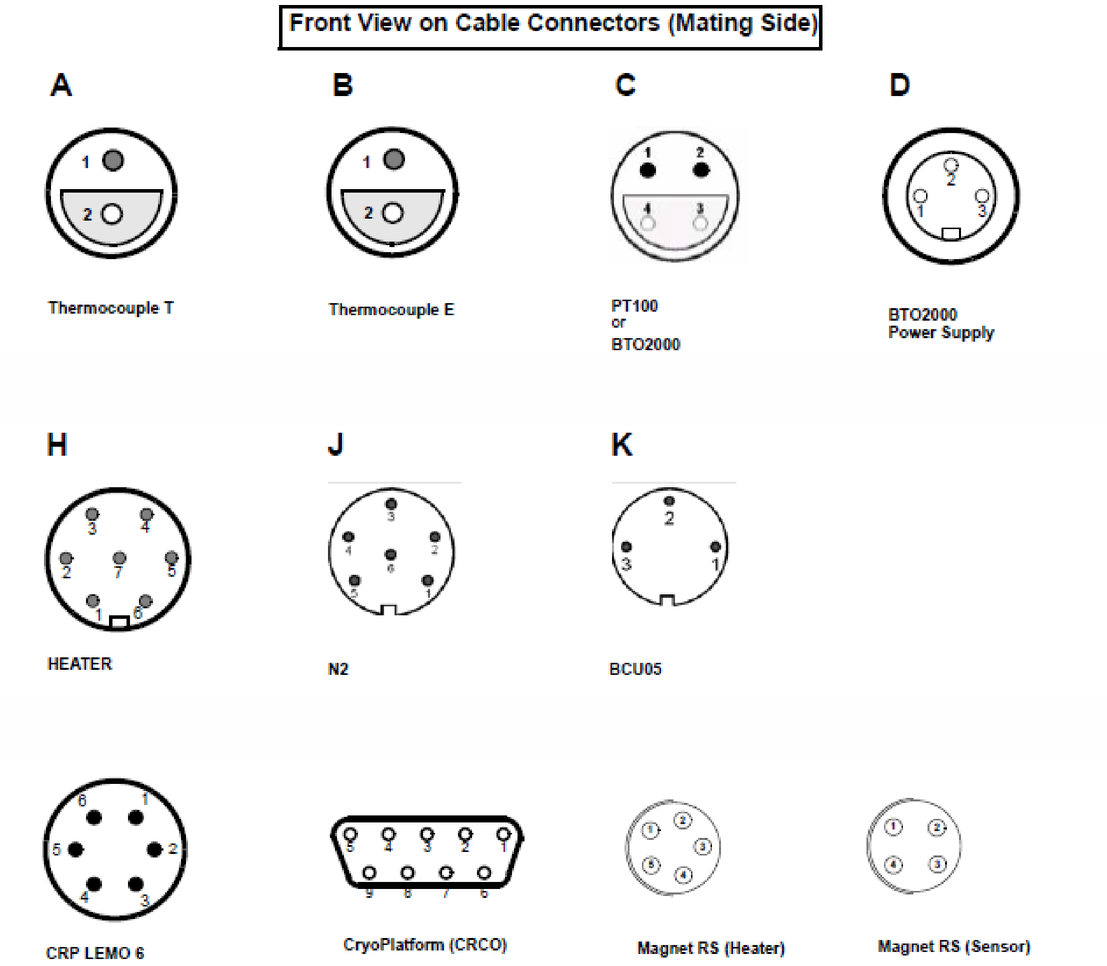


Figure 16.1: VTA Cable Connectors

16.4 System Architecture / Overview

The primary function of the VTA is to adapt the various sensors and signals of probe and chiller devices to the common interface of the BSMS integrated VT system.

Inside the VTA a common basic infrastructure for configuration, communication and board identification (BIS) is available. Depending on the specific function these are complemented by the appropriate number of ADC channels, galvanic isolation or sensor excitation signals. Some VTA (e.g. for connecting a BCU) are equipped with solid-state switches.

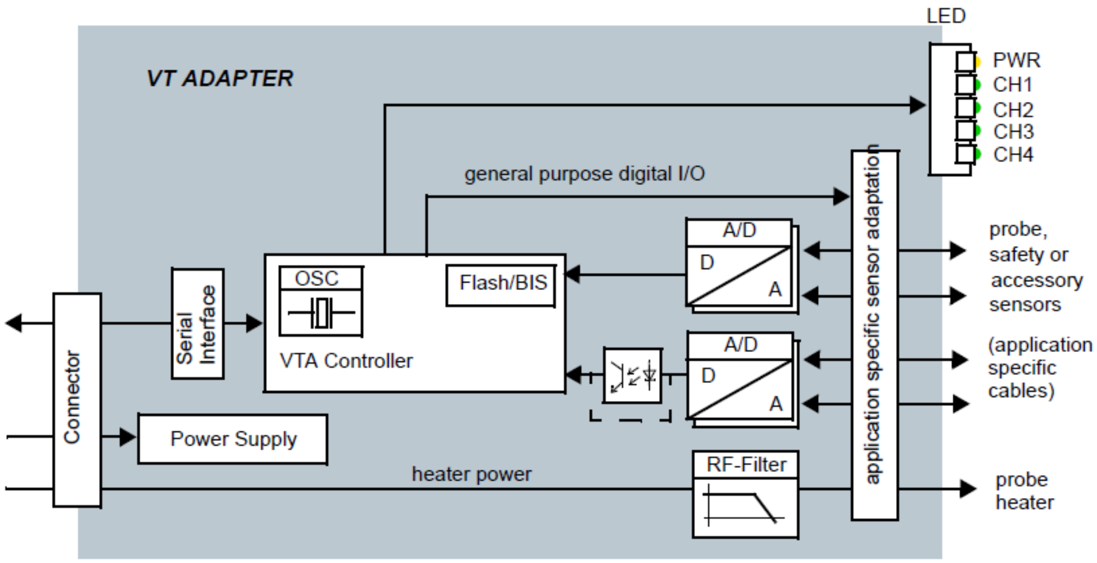


Figure 16.2: Block Diagram of the VT Adapter

Thermocouple Adaptation (VTA TC-2T, TC-2E)

The thermocouple signal from the probe is fed into the VTA where the cold-junction compensation and signal conversion is done. Simultaneous measurements of sensor temperature and cold-junction temperature leads to precise results. The heater current is fed through the VTA for RF filtering before entering the probe. A dedicated ADC channel is used for measuring the safety temperature sensor that is mounted on the heater to prevent overheating. Broken, ground-shorted or disconnected sensor lines are detected for safety and diagnostic reasons.

Mainly for Solids NMR and high temperature applications there VTA offers two thermocouple connectors. VTAs are fully operable with only one sensor connected. The open sensor line will be ignored and the VTA behaves like a single sensor type.

BTO2000 Adaptation (VTA BTO)

The cold-junction compensated signal from the BTO2000 is fed into the VTA where the signal conversion is done. The VTA BTO provides the power supply for the thermal oven and electronics of the BTO2000. Apart from that the device provides the same functionality as the TC-2T variant.

CryoProbe Adaptation (VTA CRP)

In contrast to the room temperature probes the CryoProbes use PT100 sensors for both regulator and safety temperature measurement. Their heater impedance is higher than that of a room temperature probe.

Furthermore, the analog signal from the safety sensor must be wired to the CryoPlatform which also delivers the bias current. This 'lending-out' of the safety sensor establishes a redundant system for sample temperature monitoring. To prevent ground coupling, the signals between the BSMS and the CryoPlatform are galvanically isolated. If the CryoPlatform is switched off, the VTA is unable to measure the safety sensor and thus inhibits sample heating.

Care must be taken when connecting the CryoPlatform: The male connector on the CryoPlatform side exposes a voltage of about 29 V on a pin. It is almost impossible to plug the VTA cable without shorting this pin to frame ground which can damage the CRCO and the VTA. Always switch off the CryoPlatform when connecting the VTA CRP to its rear panel! The VTA can be left connected to CryoPlatform and must not be disconnected when operating a RT probe.

BCU-05 and BCU-X Adaptation (VTA BCU)

To integrate the legacy BCU gas chillers into the new temperature system an adaptor VTA is needed. It detects the presence of such a chiller and enables remote operation.

The VTA BCU can be used for BCU05 or BCU-X (BCU-Extreme) type of cooling units and can be connected to an auxiliary control port.

New BCU I and BCU II do not need a VTA BCU adapter. They come with an embedded VTA-style interface and should be connected to an auxiliary control port.

Adaptation of Low Temperature Options (VTA LN2)

For sample temperature control far below room temperature two devices are available: the LN2 Heat Exchanger and the LN2 Evaporator.

The VTA LN2 adapts both and detects the type of the connected device. It monitors the level and safety sensors and continuously sends these values to the BSMS/2 ELCB where they are evaluated.

For LN2 Heat Exchanger and LN2 Evaporator operation heater power is required. The heater power is fed through the VTA and the heater safety sensor is monitored for safe operation. For that an additional heater cable is necessary (Z116301 CABLE RD 15P 4.5M 1:1 BSMS/2 VPSB-VTA or Z116304 CABLE RD 15P 9M 1:1 BSMS/2 VPSB-VTA).

16.4.1 Protection

All external interfaces are protected against short circuits. The monitoring takes place on the VPSB board (measurement electronics) and on the ELCB board (monitoring of low level measurements from the VPSB board).

Monitored are:

- Heater and controller temperature
- Heater -voltage and -current
- Impedance of connected devices (e.g. heater)
- Communication between VTA and VPSB

Supervision is done via status information.

If one of the measurements is outside the tolerance, the BSVT and all connected devices will switch off.

16.4.2 Measurements Provided for Diagnostic

The VTA detects shorted or disconnected lines at sensor interface connectors.

The VTA sends periodically measurement data and status information to the BSVT control software running on the ELCB board. In case of failure (e.g. missing status information) the VTA will be re-booted (power cycle on the VTA‘s 5 V).

The software running on the ELCB may notify the user about abnormal events (failures, status information). This information is sent via ethernet from the ELCB board to the workstation.

16.4.3 Calibration

There are no calibration settings to store on the VTA.

16.4.4 Connectors and LED‘s

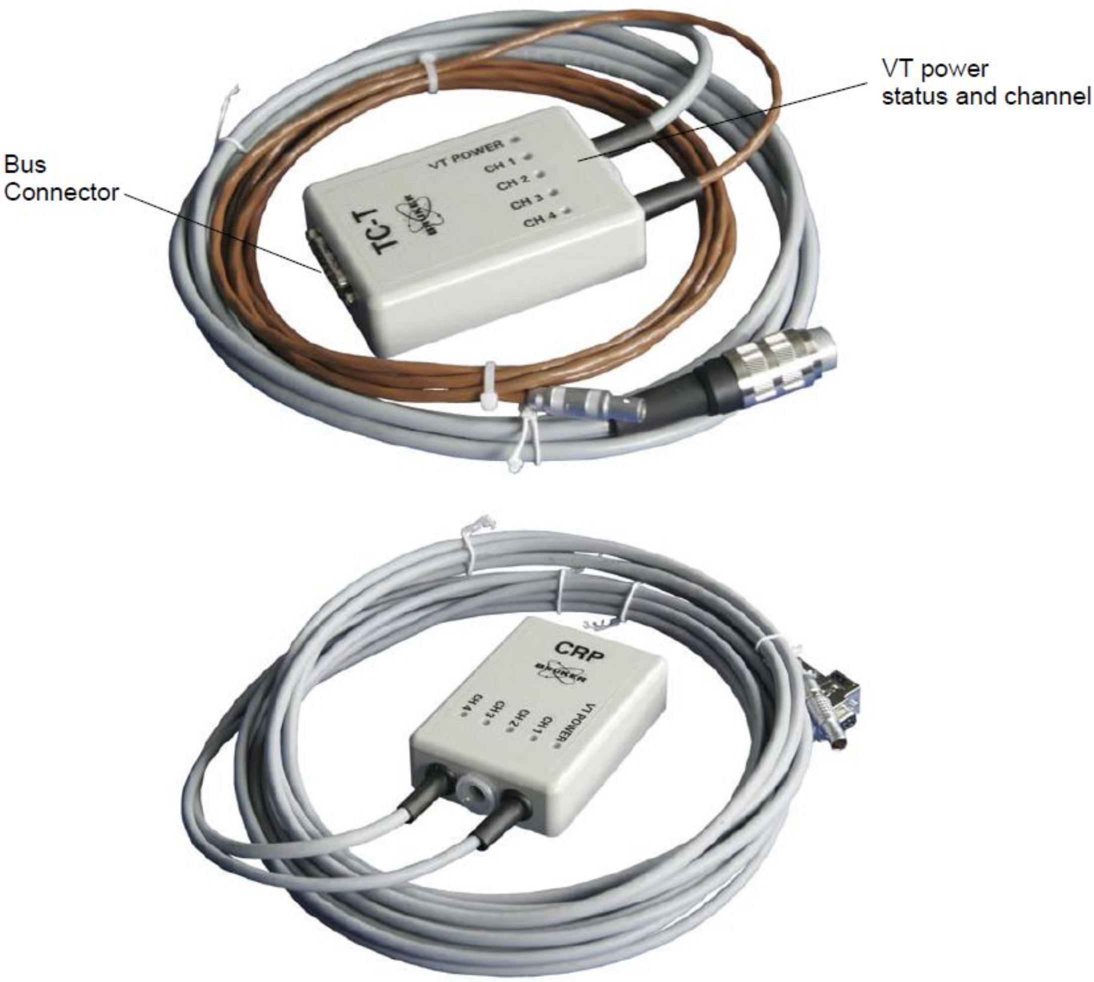


Figure 16.3: Two Typical VT Adapters

LED's CH1/2/3/4 and VT POWER

The LEDs on the VT adapters indicate the status of the adapters (connected, initialized). The indicated channel number (CH1, CH2, CH3, CH4) corresponds to the number which is displayed in the BSMS Service Web or on the **vtudisp** in TopSpin.

VT adapters can be connected or disconnected at any time. The temperature control will go to OFF state if disconnected

In general, the

- Green LED indicates the channel number and state.
- Amber LED indicates the heater status (power on, standby, on state).

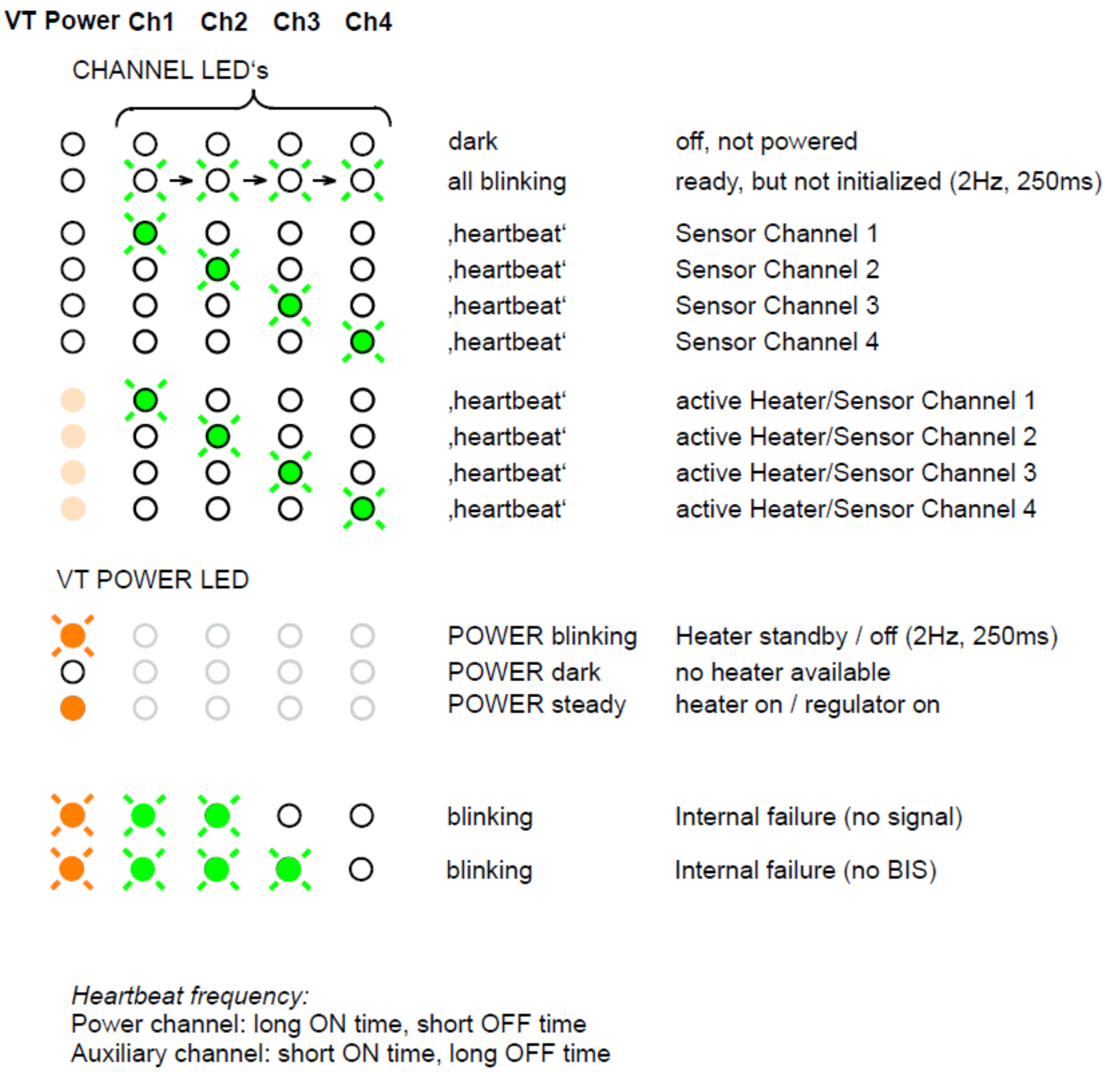


Figure 16.4: LED Code on VT Adapters

Bus Interface

VT Adapters are connected to the VPSB or SPB-E. These boards provide the necessary power supply and data interface signals.

16.5 Service

16.5.1 VTA Service Web

There is no particular web site for each connected VTA, but there is a common page listing all VTA or other devices connected to one of the peripheral bus (BFB, Bruker Field Bus) connectors:

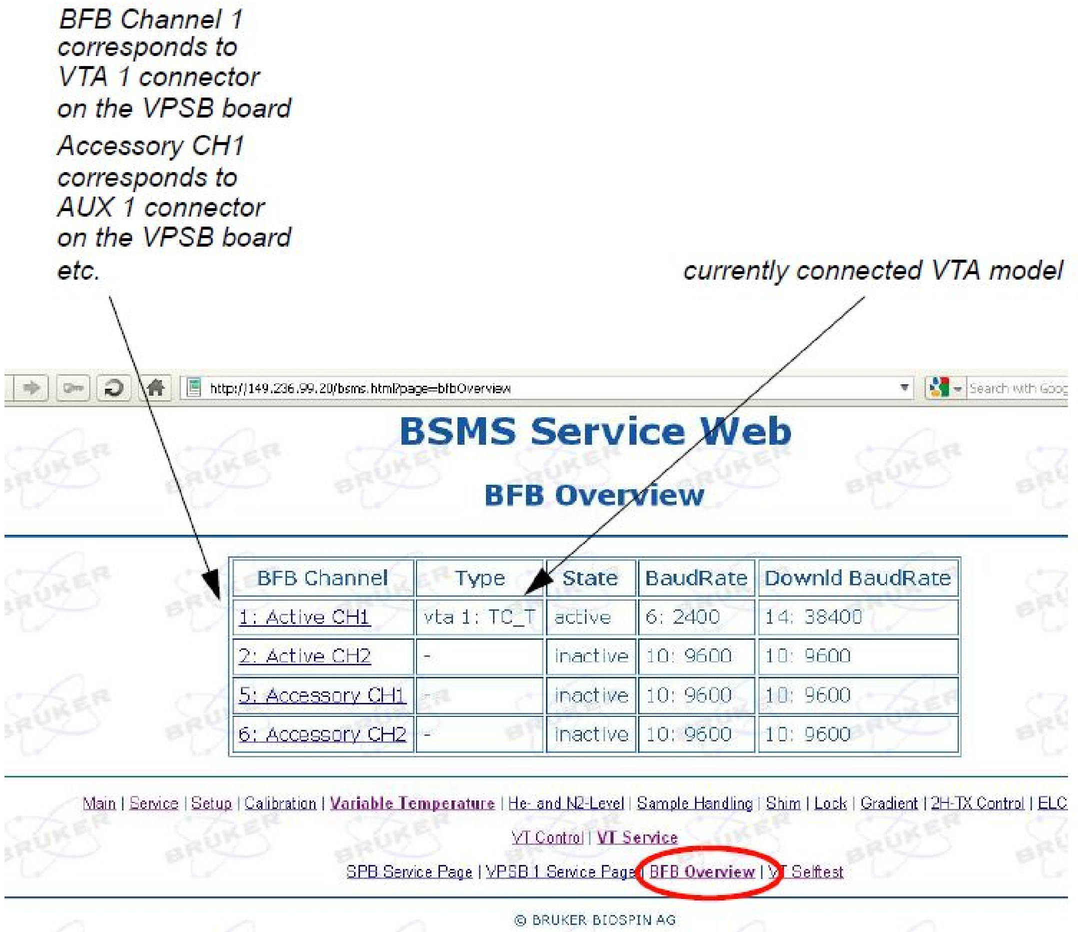


Figure 16.5: Overview of VTAs Connected to the BFB Peripheral Bus

16.5.2 Diagnostic and Troubleshooting

The device state is displayed using the 5 LED. See *Figure 16.4 [▸ 191]* for a detailed description.

In addition, on-board diagnosis data or failure events are sent to the ELCB immediately and displayed within TopSpin GUI or Logfile.

16.6 System Requirements

See Minimal requirements for all configurations in the chapter *Basic BSVT Configuration [▸ 124]*.

16.7 Ordering Information

See *Basic BSVT Configuration [▸ 124]*.

17 Nitrogen Level Sensor

17.1 Introduction

For the ASCEND family of NMR magnet systems a new digital liquid nitrogen sensor has been developed and introduced in 2010.

The new sensor is compatible with all AVANCE spectrometers with BSMS BSVT electronics (VPSB(-DC), SPB-E). For former BSMS/2 systems without BSVT, a Z108145 SLCB/3 board is necessary.

Due to its digital concept this sensor avoids effects of analogue technology and provides a user friendly plug and play operation as well as a direct on-board LED N2 level indication. It allows measuring the level of the liquid nitrogen within the corresponding cryostat of the magnet system at any time and as many times as wanted. Together with MICS software the Nitrogen level measurement allows monitoring the Nitrogen level over longer time periods and gives an estimate for the next refill date.

For easy use the sensor electronics has a built-in connector detection and automatically provides

- A digital reading of the absolute fill level in percent, or
- an analog voltage between 0 and -5V (100% to 0% fill level)

on the same connector and is therefore fully compatible with all Bruker fill level measurement units.

17.2 Configuration

For every size of cryostat an individual nitrogen level sensor length is necessary. The electronics itself does not change.

On system level there are two configurations depending on the AVANCE NEO spectrometer generation (digital or analog mode).

17.2.1 Digital Configuration (AV4 BSMS with BSVT)

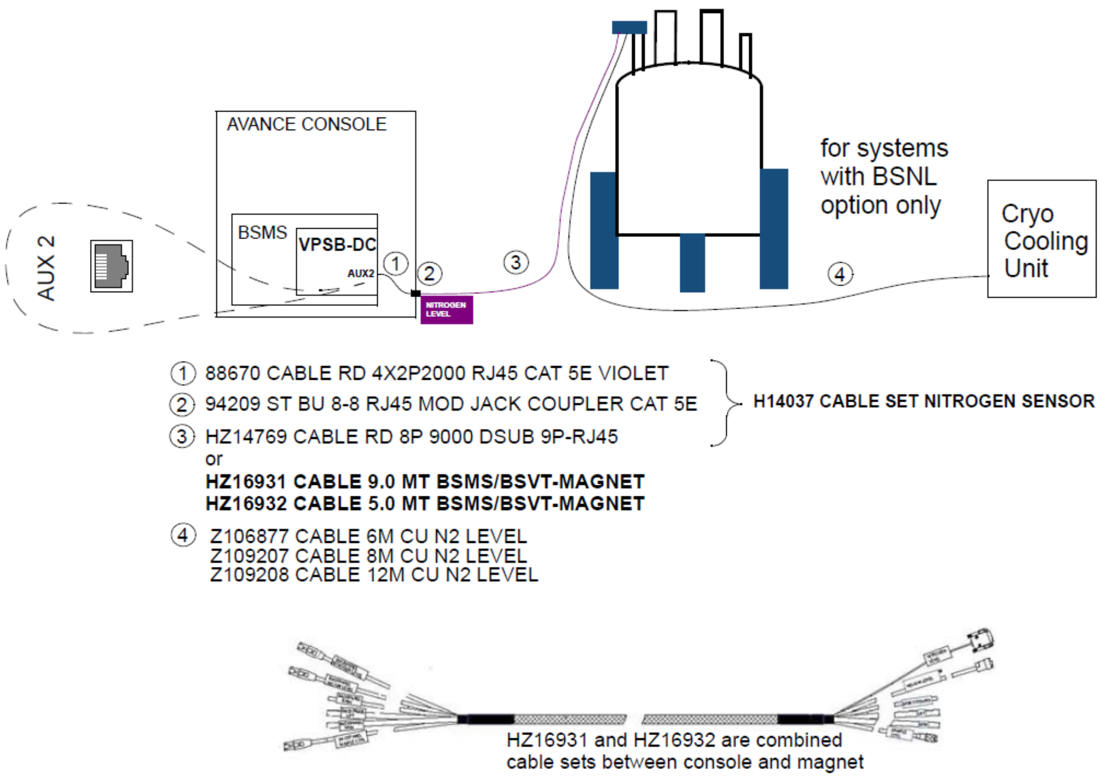


Figure 17.1: Digital Configuration

Z115192 BSMS/2 SPB-E does support the analog and digital mode. Even when a SPB-E is available it is recommended to use the digital mode and use the AUX connector (improved precision and diagnostic).

17.2.2 Protection

All external interfaces are protected against short circuits (either by limiting the output current or by current monitoring and shut down).

17.2.3 Measurements Provided for Diagnostic

The on-board diagnostics supervise essential board functions like power supply and ADC state. In case of a failure the board will reset and reboot.

The software running on the ELCB may notify the user about abnormal events.

Status/Errors

The LN2 sensor can perform the following checks:

- Communication and functionality of the ADCs.
- Power voltages.
- Shorted or disconnected lines at sensor interface connectors.

17.2.4 Calibration

Factory calibration is stored on the board (no field calibration necessary).

17.2.5 Connectors and LED‘s

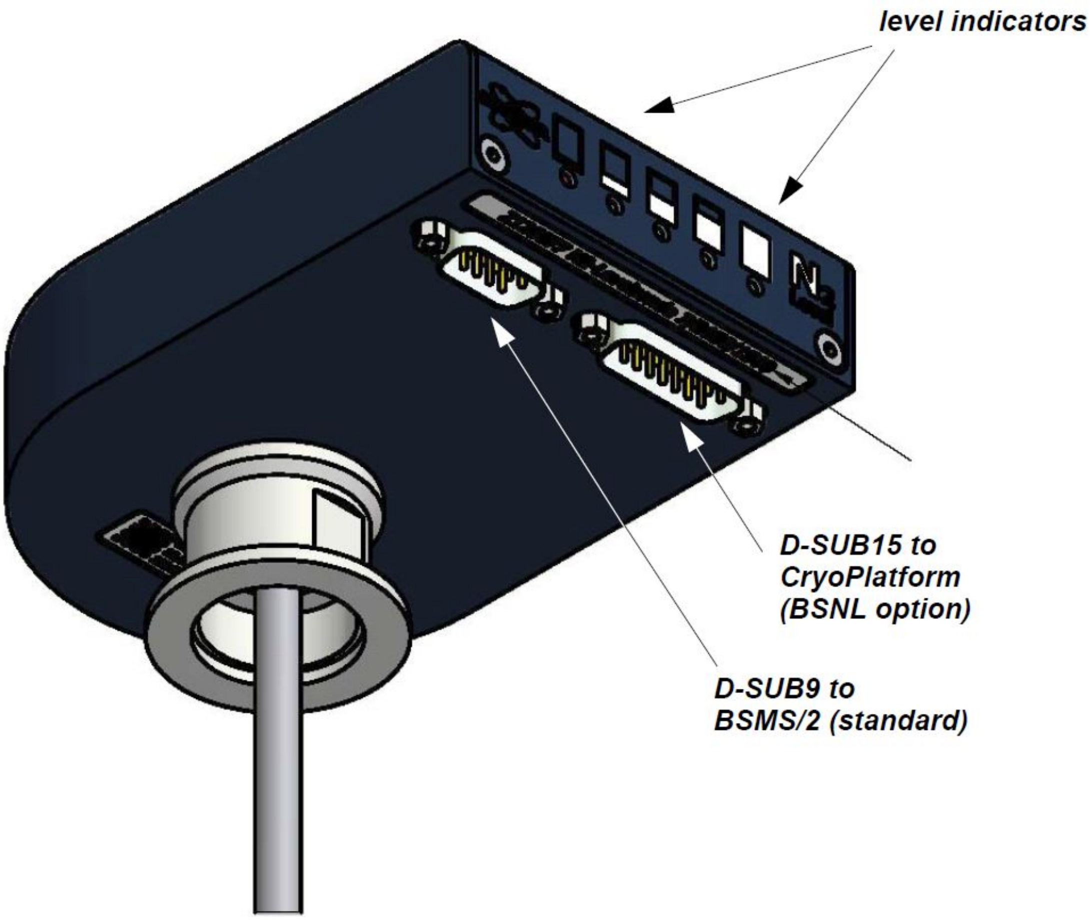


Figure 17.2: Nitrogen Level Sensor

LED‘s

Like the VT adapters the LN2 sensor can be connected or disconnected at any time.

In general, the:

- Green LED‘s indicates the current nitrogen level.
- Red LED indicate an error or low nitrogen level.

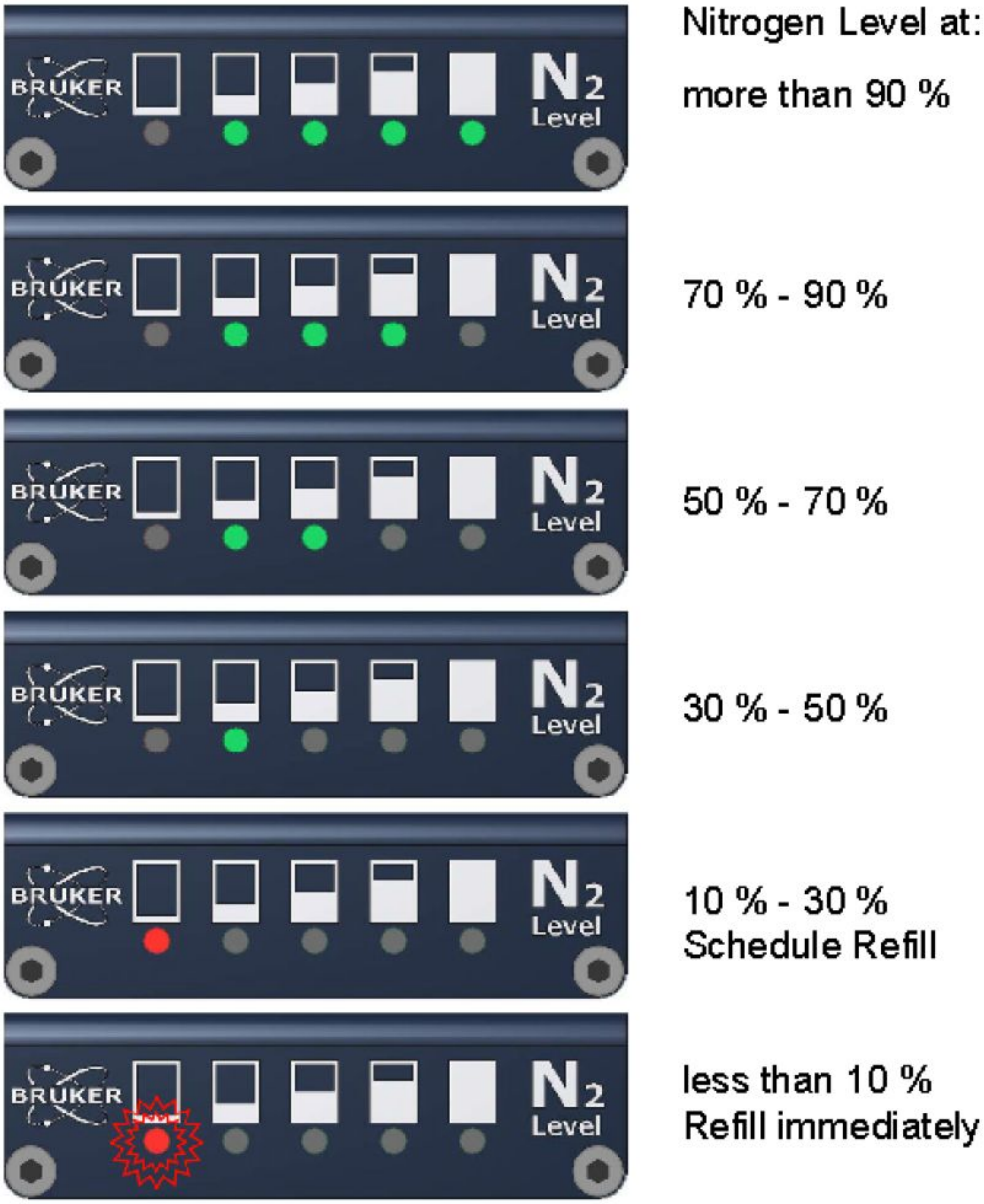


Figure 17.3: LED Code on N2 Level Sensor

Interface

The N2 level sensor is connected to the BSMS BSVT electronics (back panel RJ45 connector labeled NITROGEN LEVEL) and to the CryoPlatform if a BSNL option is installed (Bruker Smart Nitrogen Liquefier). These units provide the necessary power supply and data interface signals.

17.3 Service

This new digital nitrogen level sensor does not need any calibration in the field, the product is factory calibrated.

17.3.1 Service Web

There is an ELCB Service Web page available for the nitrogen level measurement.

17.3.2 Diagnostic and Troubleshooting

The device state is displayed using the 5 LED. See *Figure 17.3 [▸ 198]* for detailed description.

In addition, on-board diagnosis data or failure events are sent to the ELCB immediately and displayed within TopSpin GUI or log file.

17.4 System Requirements

See *Configuration [▸ 195]*.

17.5 Ordering Information

Part numbers of the sensor depend on magnet size and height. Please consult your local Bruker office.

18 Radiation Shield Temperature Monitoring (MAG-RS)

18.1 Introduction

For RS (refrigerated radiation shield) type of magnet systems the temperature of the refrigerated radiation shield inside the cryostat must be monitored during operation.

For that two PT 100 temperature sensors are mounted inside the cryostat. The temperature measurement is realized using a digital adapter that can be connected to the BSMS like other accessory (e.g. Nitrogen Level Sensor or BSMS/2 VTA).

In case of a failure the operator will receive an alarm by MICS.

18.2 Configurations and Installation

Bruker Part Number	Name	Marking	Typical usage [Power or Auxiliary][a]
Z122502	BSMS/2 VTA MAG-RS	MAG-RS	POWER
[a] POWER means that this application needs heater power and therefore must be connected through a cable that contains heater power wires to an output of the VARIABLE POWER SUPPLY BOARD (VPSB(-DC))			

Table 18.1: Available Unit

Necessary cable set: Z119854 CABLE SET BSVT AUXILIARY HEATER

18.2.1 Connection to the Console (BSMS/2 with BSVT)

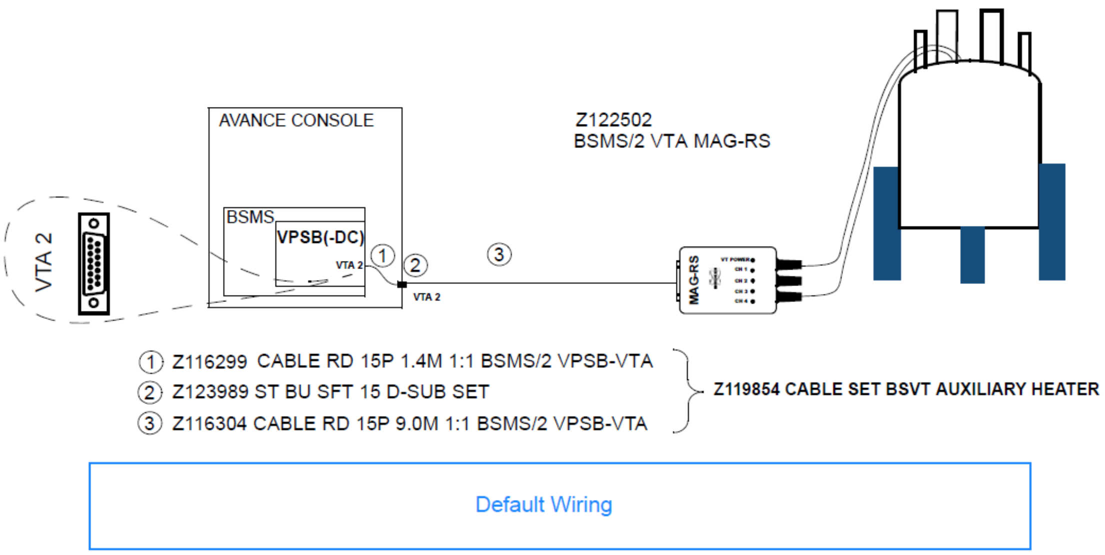
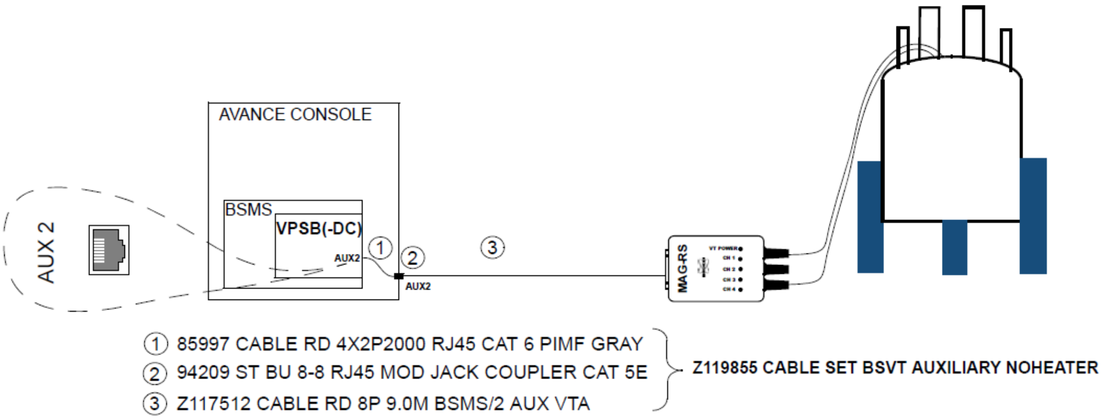


Figure 18.1: Connection to BSMS (Monitoring and Service)



Monitoring only mode and usage of the cable Z117512 CABLE RD 8P 9.0M BSMS/2 AUX VTA is applied when the „power cable“ Z116304 is used for VT accessory (e.g. LN exchanger or LN evaporator).

Figure 18.2: Connection to BSMS (Monitoring only)

18.2.2 Protection

All external interfaces are protected against short circuits (either by limiting the output current or by current monitoring and shut down).

18.2.3 Measurements Provided for Diagnostics

The on-board diagnostics supervise essential board functions like power supply and ADC state. In case of a failure the board will reset and reboot.

The software running on the ELCB may notify the user about abnormal events.

Status/Errors

The MAG-RS unit can perform the following checks:

- Communication and functionality of the ADC's.
- Power voltages.
- Shorted or disconnected lines at sensor interface connectors.

18.2.4 Calibration

Factory calibration is stored on the board (no field calibration necessary).

18.2.5 Connectors and LED's

See *Connectors and LED's [▸ 190]*.

18.2.6 Service

This unit does not need any calibration in the field, the product is factory calibrated.

18.2.6.1 Service Web

For a pulse tube replacement or service, a heater must be activated.

There is an ELCB Service Web page available for service. Please contact your local Bruker office.

18.2.6.2 Diagnostics and Troubleshooting

The device state is displayed using the 5 LED. See *LED's CH1/2/3/4 and VT POWER [▸ 190]* for a detailed description.

In addition, on-board diagnosis data or failure events are sent to the ELCB immediately and displayed within TopSpin GUI or logfile.

18.2.7 System Requirements

See *Introduction [▸ 201]*.

18.2.8 Ordering Information

Please contact your local Bruker office.

19 Installation and Initial Commissioning

Installation, initial commissioning, retrofitting, repairs, adjustments or dismantling of the device must only be carried out by Bruker authorized personnel.

All the requirements concerning environment described in the technical specifications must be met. To reduce the risk of electric shock and malfunctioning, install these devices in a temperature-controlled and humidity-controlled indoor area free of conductive contaminants.

19.1 Check/Download Firmware

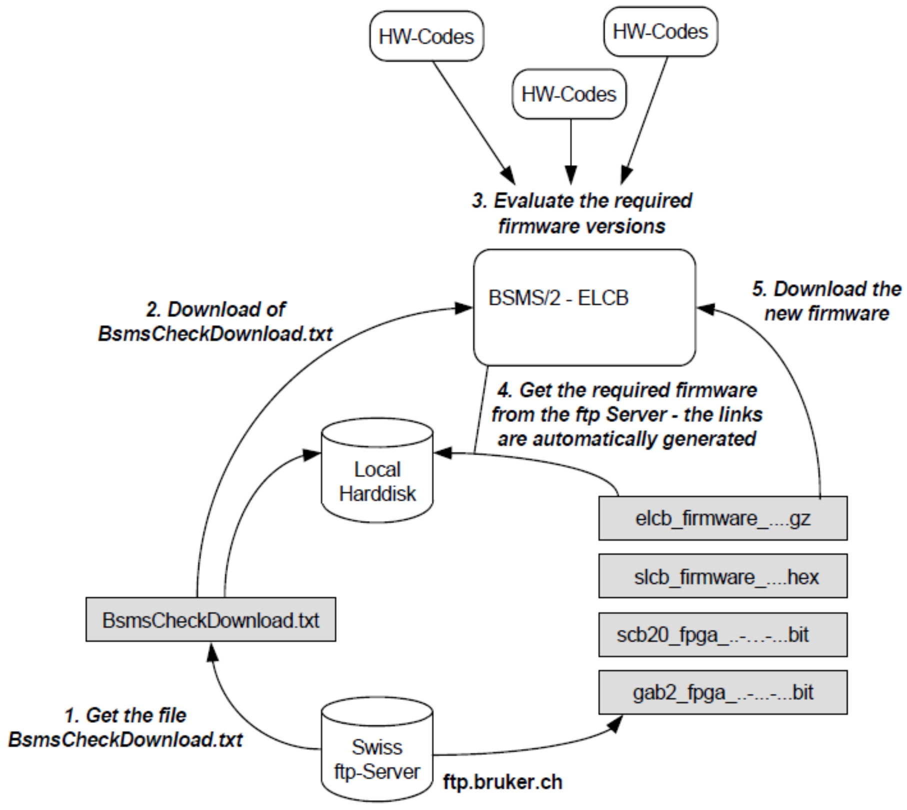
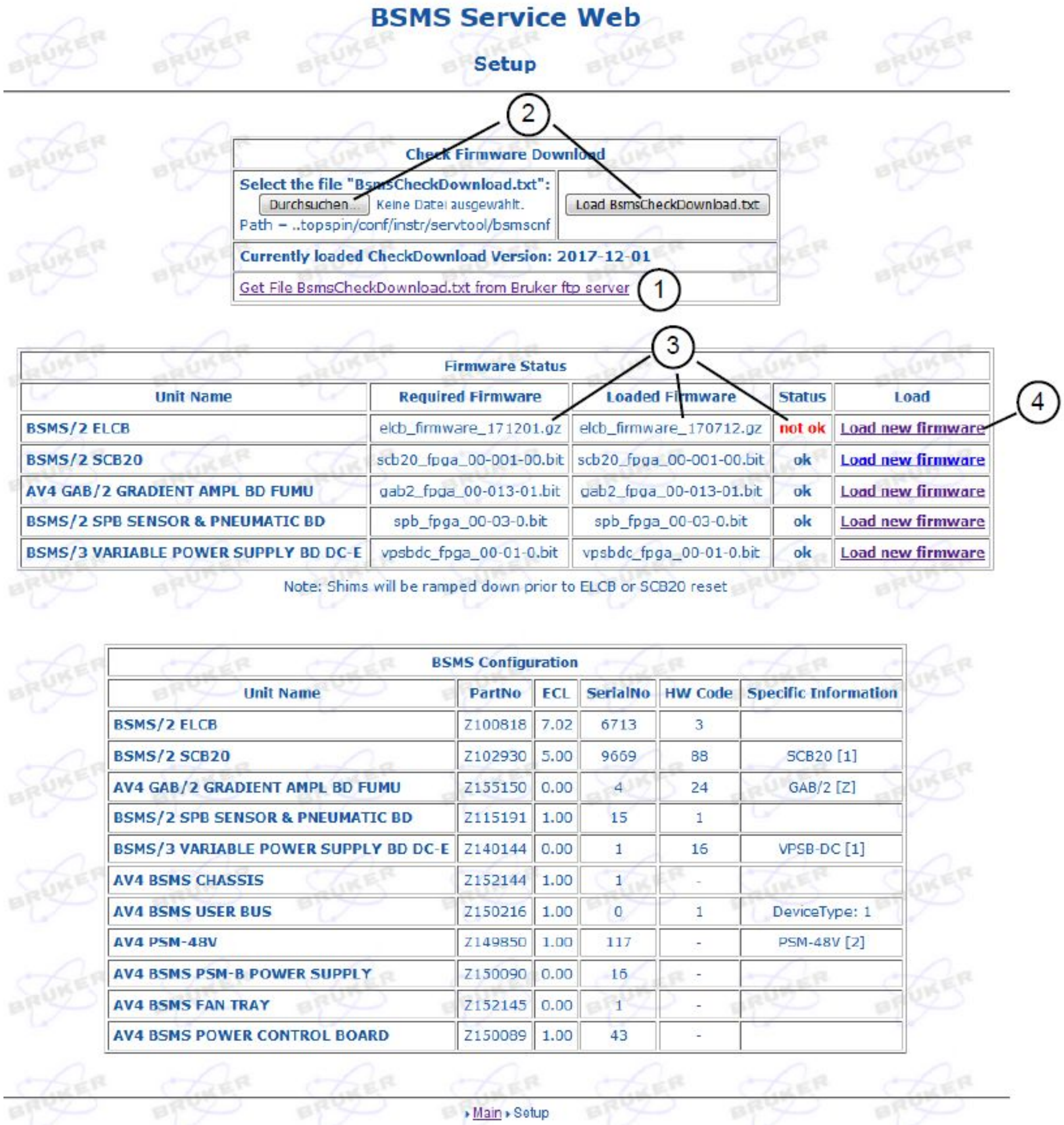


Figure 19.1: Principle of Firmware Upgrading

With every TopSpin installation there are also the necessary firmware files installed on the workstation. In addition, the latest firmware versions can be downloaded from the Swiss FTP server. The actual download to the hardware must be performed by the customer or by a service engineer. This ensures that there is no accidental overwriting of currently loaded firmware versions.

1. One must make sure that the file *BsmsCheckDownload.txt* is up to date - if necessary, this file can be downloaded from the Swiss FTP server.
2. The file *BsmsCheckDownload.txt* has to be transmitted to the BSMS.
3. According to the *BsmsCheckDownload.txt* file and the hardware codes of the connected subsystems the required firmware versions are evaluated and displayed, outdated or incompatible versions are marked as *not ok* and a related error message is issued.
4. Missing firmware files can be downloaded from the ftp.bruker.ch FTP server. When all the necessary files are available on the local hard disk, the outdated firmware components (marked as *not ok*) must be installed on the corresponding BSMS subsystems.

Note 1): When a new ELCB, SPB or SCB20 firmware is being loaded, the shim currents are ramped down slowly before the hardware reset - to minimize eddy currents in the magnet. After restart (or after power up), the shims are started up softly as well. The timing of the shim ramp can be adjusted in the Shim Configuration submenu (Shim Soft Start/Shut Down Duration).



BSMS Service Web

Setup

Check Firmware Download	
Select the file "BsmsCheckDownload.txt": Durchsuchen... Keine Datei ausgewählt. Path – ..topspin/conf/instr/servtool/bsmscnf	Load BsmsCheckDownload.txt
Currently loaded CheckDownload Version: 2017-12-01	
Get File BsmsCheckDownload.txt from Bruker ftp server	

Unit Name	Required Firmware	Loaded Firmware	Status	Load
BSMS/2 ELCB	elcb_firmware_171201.gz	elcb_firmware_170712.gz	not ok	Load new firmware
BSMS/2 SCB20	scb20_fpga_00-001-00.bit	scb20_fpga_00-001-00.bit	ok	Load new firmware
AV4 GAB/2 GRADIENT AMPL BD FUMU	gab2_fpga_00-013-01.bit	gab2_fpga_00-013-01.bit	ok	Load new firmware
BSMS/2 SPB SENSOR & PNEUMATIC BD	spb_fpga_00-03-0.bit	spb_fpga_00-03-0.bit	ok	Load new firmware
BSMS/3 VARIABLE POWER SUPPLY BD DC-E	vpsbdc_fpga_00-01-0.bit	vpsbdc_fpga_00-01-0.bit	ok	Load new firmware

Note: Shims will be ramped down prior to ELCB or SCB20 reset

BSMS Configuration

Unit Name	PartNo	ECL	SerialNo	HW Code	Specific Information
BSMS/2 ELCB	Z100818	7.02	6713	3	
BSMS/2 SCB20	Z102930	5.00	9669	88	SCB20 [1]
AV4 GAB/2 GRADIENT AMPL BD FUMU	Z155150	0.00	4	24	GAB/2 [Z]
BSMS/2 SPB SENSOR & PNEUMATIC BD	Z115191	1.00	15	1	
BSMS/3 VARIABLE POWER SUPPLY BD DC-E	Z140144	0.00	1	16	VPSB-DC [1]
AV4 BSMS CHASSIS	Z152144	1.00	1	-	
AV4 BSMS USER BUS	Z150216	1.00	0	1	DeviceType: 1
AV4 PSM-48V	Z149850	1.00	117	-	PSM-48V [2]
AV4 BSMS PSM-B POWER SUPPLY	Z150090	0.00	16	-	
AV4 BSMS FAN TRAY	Z152145	0.00	1	-	
AV4 BSMS POWER CONTROL BOARD	Z150089	1.00	43	-	

Main ▸ Setup

Figure 19.2: Setup of the BSMS Firmware

In addition to the firmware information, there is also the hardware configuration displayed on the **Setup** screen: In our example, it is a configuration with one SCB20 providing maximum 20 shims (BOSS1), GAB/2, SPB and VPSB-DC installed. All Units, including chassis and power auplies, provide BIS information, including Serial Number and ECL.

20 Operation

20.1 General Operating Guidelines

There are several general rules and procedures that should be observed while operating the device.

Prior to the first use after installation, make sure that the BSMS system is properly configured. Please refer to the chapters in this manual.

The only user operations permitted are:

- Starting up and shutting down the BSMS system.
- Operating the users software interface.
- Connecting signal and data interface cables that are accessible outside of the BSMS system.
- Replacing or installing field replaceable units (by instructed operating or service personal).

Operator Protection

The electronic circuitry of BSMS system is operating with low and safe voltages, except for the power supply and its connection to mains. Nevertheless, any electrical equipment can become a source of danger under extreme conditions.

Temperature Changes

When the ambient temperature changes significantly (for example, after moving the device from the stock room before mounting), wait at least 1 hour until the device has achieved room temperature before turning on the device.

WARNING

Risk of injury from improper operation!

Improper operation can result in serious injury and significant damage to property.

- ▶ Carry out all operating steps in accordance with the specifications and instructions in this manual.
- ▶ Before starting work, ensure that
  - All covers and safety devices are installed and functioning properly.
  - No persons are in the danger zone.
- ▶ Never disable or bypass safety devices during operation.

21 Maintenance

The sections below describe the maintenance work required to ensure optimal and smooth operation of the device.

If increased wear is found during regular checks, the required maintenance intervals should be shortened in accordance with the actual wear occurrences. Contact Bruker in the event of questions regarding maintenance work and intervals (see *Contact [▸ 221]*).

Interval	Maintenance Work	Reference
Daily	Clean the working area	Laboratory SOP
As needed	Clean Outer Shell of the Device	
	Update Firmware	

Table 21.1: Maintenance Schedule for Laboratory Personnel

21.1 Cleaning

21.1.1 Before Cleaning

1. Stop the device from doing any actions.
2. Switch the power off via PDU.
3. Switch the compressed gas supply off.
4. Disconnect the mains power cable.

21.1.2 Cleaning the Outside of the Cabinet Units

Do not use any detergent or other cleaning solvents. Use only water or neutral cleaning fluids. Usage of volatile cleaners like thinner or benzine may damage the surface of the unit.

1. Clean the outside of the units with a soft, lint-free cloth dampened in water.
2. Wait until the unit is completely dry before you reconnect the power cable!

21.1.3 Cleaning the Outer Shell of the Device

Do not use any detergent or other cleaning solvents. Use only water or neutral cleaning fluids. Usage of volatile cleaners like thinner, benzine or acetone may damage the surface of the units.

- Do not disassembly the device for cleaning.
- Clean only the outer shell of the device with a lint-free cloth dampened in water.

21.1.4 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.

21.2 Preventative Maintenance

All parts in the device have been designed to work reliably without preventative maintenance, except for the Fan Tray. The life expectancy of DC fans is usually lower than that of other electronic parts. Therefore, preventative maintenance may be useful.

Refer to chapters *Fan Tray [▸ 43]* and *Replacement of Parts [▸ 215]* for more information or contact Bruker customer service.

21.3 Bruker Service Maintenance

Bruker offers various maintenance options and packages. Contact your local Bruker customer service for more information.

21.4 Software

The device logs all information in a file. With the help of this file Bruker customer service can diagnose the system. In case of troubleshooting as a result of an unknown error, Bruker customer service may ask you to send the log files and the system data. From these files the customer service can obtain additional debugging information. These files do not contain any information about your company, samples or spectra. Bruker will not give any information to a third party.

21.4.1 Device Report File

In case of problems with the device, a report can be sent to Bruker customer service. See *Troubleshooting [▸ 213]*.

21.4.2 Firmware Update

It is recommended to regularly check for firmware upgrades. The procedure is described in the section *Check/Download Firmware [▸ 205]*.

22 Troubleshooting

The following chapter describes the possible causes of faults, and the work required to rectify them.

In the event of repeated faults, shorten the maintenance intervals in accordance with the actual load.

If a failure occurs during operation, the system interrupts the current procedure.

On the TopSpin screen an error message is displayed. Take down the complete error message. Furthermore, have ready the following information:

- Part number and ECL (Engineering change level) of the units.
- Spectrometer type and order number.
- Magnet Type.

With this information contact the customer service. See *Contact [▸ 221]* for contact details. In many service cases a copy of the logfile is very helpful, see below.

Contact the manufacturer in the event of faults which cannot be rectified in accordance with the instructions below.

22.1 Diagnostic and Troubleshooting

In case of a problem regarding the BSMS, check the following points:

- Are all power voltages ok? Check the LED‘s on each subsystem including power supplies indicating if it is correctly powered.
- Are all firmware components up to date? It may be necessary to load the current BsmsCheckDownload.txt file from the Bruker FTP server and do the checks as described before.

For further investigations, the BSMS provides a detailed logging service. The latest information can be retrieved under the menu point **Main | Service | Display logged messages**. On the same Web Page, there is a button for resetting the buffer before running a specific command sequence. How to access the Service Web pages is described in chapter *Service Web [▸ 34]*.

Additionally, it is possible to activate periodical transfer of that logging information to the hard disk of the EPU. This feature is available in TopSpin by typing the command **bsmsdisp** and selecting the **Service Tab**. There is a check box for enabling this transfer and a button for viewing the stored long term information. These files will be saved with **savelogs**.

It may be necessary to configure the logging (how detailed some events are logged), which is provided under the menu point **Main | Service | Log Configuration**.

There is a watchdog task running on the ELCB. If the application is blocked for a long time then the BSMS is rebooted. The watchdog function, which is normally active, can be disabled on the service main page (service access is necessary).

After a restart, the logging of the session before - the post mortem log - is still available

In this manual you can find separate chapters on troubleshooting in the description of the individual units e.g. ELCB, SPB, etc.

22.2 Savelogs

Savelogs is a TopSpin command that simplifies the collection of all information needed by the customer service.

Read the TopSpin User Manual chapter *Store Complete Log with | savelogs* for more information.

23 Replacement of Parts

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

Use the ESD discharge bracelets while servicing the BSMS. Don’t touch uncovered metal surfaces on the PCBs, electronic devices or connectors before being grounded by the ESD bracelet.

Loss of Guarantee

The use of non-approved spare parts will invalidate the manufacturer‘s guarantee.

Purchase spare parts from authorized dealers or directly from the manufacturer. See *Contact [▸ 221]* for manufacturer's address.

23.1 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 (BBIOF002/H152631). 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.

24 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.

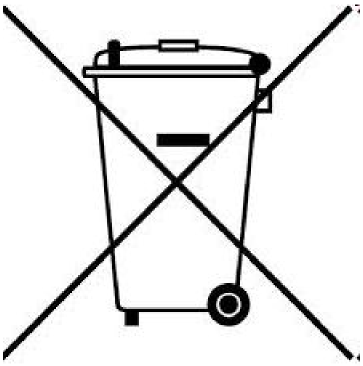
24.1 Dismantling

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 them 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.

24.2 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**

24.3 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*.

25 Technical Data

25.1 General Information

Data	Value	Unit
Weight without subunits	5	kg
Weight with subunits	40	kg
Length	51,0	cm
Width	48,3	cm
Height	31,0	cm
Sound Pressure Level[a], maximum	63	dBA
[a] Measured stand-alone, outside of the cabinet. For SPL including the cabinet and protection instructions see the applicable manuals.		

Table 25.1: Technical Data: General Information

25.2 Connection Values

The BSMS System for AVANCE NEO has no single power inlet with mains distribution within the chassis. Each power supply module with mains input is connected individually to the PDU (power distribution unit) of the cabinet. The connecting values are given per supply module.

Data	Value	Unit
Voltage range[a]	208 - 230	Vac
Apparent power consumption, rated maximum	8	A
Circuit protection[b]	10	Amps AC
Frequency	50/60	Hz
[a] Not all units within the cabinet allow input voltages as low as 100 VAC. Therefore, the usable PSM input range is smaller than on the rating plate of the AC/DC supply. [b] Two not replaceable internal fuses (L+N) per AC/DC supply, two supplies per PSM.		

Table 25.2: Electrical Connection Values: AV4 PSM-48V

Data	Value	Unit
Voltage	100 - 240	Vac
Apparent power consumption, rated maximum	4	A
Circuit protection[a]	4	Amps AC
Frequency	47 - 63	Hz
[a] Two replaceable fuses (L+N), time-lag T.		

Table 25.3: Electrical Connection Values: AV4 PSB-12V

25.3 Environmental Conditions

Data	Value	Unit
Temperature range	+5 .. +40	°C
Relative humidity at 31 °C, maximum[a]	max. 80	%
Working altitude above sea level	max. 2000	m
Supply voltage variation	max.-10 .. +10	%
Overvoltage category	II	
Temporary overvoltage	1440	V
Pollution degree	2	
[a] Decreasing linear till relative humidity < 50% at 40 °C.		

Table 25.4: Operating Environment

For the appropriate temperature see also the Bruker site planning guides.

25.4 Rating Plate

The rating plate is located near the power input of each power supply module and includes the following information:

- Manufacturer
- Type
- Voltage
- Frequency
- Apparent power consumption or input current, maximum
- PN: Part Number
- SN: Serial Number
- ECL: Engineering Change Level

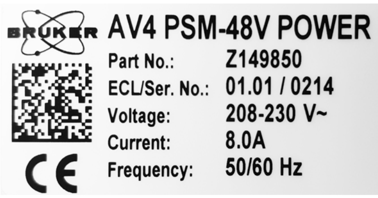


Figure 25.1: Technical Data: Rating Plate Example

26 Contact

Manufacturer

Bruker BioSpin GmbH
Silberstreifen 4
D-76287 Rheinstetten
Germany
http://www.bruker.com

WEEE DE43181702

NMR Hotlines

Contact our NMR service centers.

Bruker BioSpin NMR 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 NMR service center or hotline you wish to contact from our list available at:

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

E-mail: *nmr-support@bruker.com*

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