BRUKER

HPPR/2

Technical Manual

Version 007

NMR Spectroscopy

Innovation with Integrity

This manual was written by

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NMR Hotlines

Contact our NMR service centers.

Bruker BioSpin NMR provide 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:
http://www.bruker-biospin.com/hotlines_nmr.html

1 About

1.1 This Manual

This manual is intended to be a reference guide for operators and service technicians. It provides detailed information about the user level maintenance and service and overall use of the Bruker device.

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

Carefully read all relevant chapters before working on the device!

This manual describes parts and procedures relevant to the device version it is delivered with. For older hardware, please refer to the manual supplied at the time.

1.2 Policy Statement

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

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

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

1.3 Symbols and Conventions

Safety instructions in this manual are marked with symbols. The safety instructions are introduced using indicative words which express the extent of the harzard.

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

DANGER

This combination of symbol and signal word indicates an immediately hazardous situation which could result in death or serious injury unless avoided.

⚠ WARNING

This combination of symbol and signal word indicates a potentially hazardous situation which could result in death or serious injury unless avoided.

⚠ CAUTION

This combination of symbol and signal word indicates a possibly hazardous situation which could result in minor or slight injury unless avoided.

NOTICE

This combination of symbol and signal word indicates a possibly hazardous situation which could result in damage to property or the environment unless avoided.

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

2 Introduction

This manual is intended to be used by trained device users. It contains information about the device: operation, safety, maintenance, etc..

2.1 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.

2.2 Before You Begin

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!

Information for ordering spare parts is available in the spare parts section for from the Bruker Service Center (see contacts).

2.3 Minimum Qualifications for Operating Personnel

Type of Task	Personnel	Training and Experience
Transportation	No speical requirements.	No special.
Installation	Bruker certified personnel only.	Technically skilled, with a good knowledge of the application field.
Routine Use Daily Maintenance	Appropriately certified and experienced personnel, familiar with use of computers and automation in general	Laboratory technicians or equivalent. Training is usually done in-house. Familiar with MS Windows® environment.
Setup and optimization of program	Bruker certified personnel only.	Experienced laboratory technician. High degree of knowledge of the relevant application field.
Preventive Maintenance	Bruker certified personnel only.	Technically skilled with a basic understanding of the application.
Servicing	Bruker certified personnel only.	Background and experience in electronics/mechanics with computer knowledge.

Table 2.1 Overview Installation and Operation Requirements for Personnel

2.4 The Bruker Service

Our customer service division is available to provide technical information. See "Contact" on page 9 for contact details.

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

2.5 Transport to Manufacturer

When the HPPR/2 preamplifier assembly or a single module must be returned to the manufacturer for a major repair, use the original packaging for transportation.

Include a good description of the problem.

3 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.

3.1 Intended Use

The device has been designed and constructed solely for the intended use described here.

The HPPR/2 units must only be used for the limited purpose of transmitting, switching and amplifying of dedicated rf-signals in Bruker AVANCE spectrometers.

Intended use also includes compliance with all specifications in 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.

3.2 Owner‘s Responsibility

Owner

The term 'owner' refers to the person who himself 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.

Owner‘s Obligations

The device is used in the industrial sector, universities and research laboratories. The 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 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 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 owner must assess whether the operating instructions issued comply with the current status of regulations, and must update the operating instructions if necessary.
- The owner must clearly lay down and specify responsibilities with respect to installation, operation, troubleshooting, maintenance and cleaning.
- The owner must ensure that all personnel dealing with the device have read and understood this manual. In addition, the owner must provide personnel with training and hazards information at regular intervals.
- The owner must provide the personnel with the necessary protective equipment.
- The owner must warrant that the HPPR/2 is operated by trained and authorised personnel as well as all other work, 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 HPPR/2 device, need to be informed of all safety issues and emergency procedures as outlined in this user manual.
- The 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 owner must ensure that new personnel must be 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 owner must ensure that personnel is 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 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 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 owner must ensure that the work area is sufficiently illuminated to avoid reading errors and faulty operation.
- The owner must ensure that the laboratory is equipped with an oxygen warning device, in case the device is operated with nitrogen.

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

- The owner must ensure that the maintenance intervals described in this manual are observed.

- The owner must ensure that all safety devices are regularly checked to ensure full functionality and completeness.

3.3 Personnel Requirements

3.3.1 Qualifications

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

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

Laboratory Personnel

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

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

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

3.3.2 Unauthorized Persons

⚠ WARNING

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

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

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

3.4 Basic Dangers

High Voltage Power Supply

⚠ WARNING

Electrical hazard from electrical shock.

The HPPR/2 HPLNA preamp modules have an external 500 V power supply. Care must be taken when connecting or disconnecting these modules.

A life threatening shock may result when the power supply cable is disconnected during operation.

- ▶ Power down the spectrometer console (AQS chassis), disconnect it from the electrical mains supply and wait until the HPLNA power supply is fully discharged before disconnecting the HPPR/2 power supply cables.
- ▶ Be sure that the mains power supply cannot be reconnected without notice.

4 Technical Data

The HPPR/2 System consists of a stack of several subunits (modules) with one cover module on top. This section contains only general data of the modules. For RF-performance data of a specific module please refer to "Technical Specifications" on page 82ff.

4.1 General Information

Data		Value	Unit
Cover module	Weight	2	kg
	Height	110	mm
Preamp module [a]	Weight	2..3	kg
	Height	40..55	mm
all modules	Length	350	mm
	Width	270	mm

Table 4.1 Technical data: general information

a. depending on module type

4.2 Connection Values

All HPPR/2 modules are supplied with dc voltages from the spectrometer console. There is no mains connection.

Standard Preamp modules are supplied via the Cover module. HPLNA an ADM-modules have an additional power supply connected directly to the console.

Electrical

Data		Value	Unit
Cover module	Voltages	+ 9 + 19 - 19	Vdc Vdc Vdc
	power consumption, maximum	4	W
Preamp module standard supply	Voltages	from Cover module	
	power consumption, maximum [a]	4..20	W

Table 4.2 Electrical connection values

Data		Value	Unit
HPLNA module additional supply	Voltages	+ 500 - 5 ± 20	Vdc Vdc Vdc
	power consumption, maximum	23	W
ADM module additional supply	Voltages	+ 7.5 ± 19 - 36 - 60	Vdc Vdc Vdc Vdc
	power consumption, maximum [b]	8..40	W

Table 4.2 Electrical connection values

a. depending on module type and measurement mode

b. depending on measurement mode and connected coil assembly

4.3 Operating Conditions

Environment

Data	Value	Unit
Ambient temperature range	5..40	°C
Relative humidity at 31 °C, maximum	80	%
Relative humidity linear decreasing till 40 °C, maximum	50	%
Permissable altitude above sea level	< 2000	m

Table 4.3 Operating environment

4.4 Rating Plate

Only HPLNA Modules with additional high voltage supply have a rating plate.

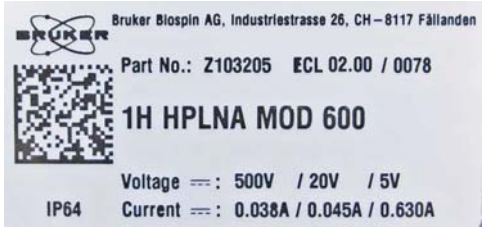


Figure 4.1 Rating plate HPLNA 1H module

5 HPPR/2

5.1 View

Figure 5.1 HPPR/2 Standard Configuration

5.2 Overview

The High Performance Preamplifier version 2 (hereafter referred as HPPR/2) consists, in the basic configuration, of a 1H module, a XBB module, a 2H module and a Cover/Display module. The basic configuration may be updated later to a maximum of nine modules (including cover).

The preamplifier modules contain a Transmitter/Receiver switch including necessary high performance filters in the transmitter and probehead paths, a rf preamplifier and an interface logic including a power supply and BIS (Bruker Information System). All preamplifier modules are 'Fourier capable'.

The display indicates on a LCD the operating status of the HPPR/2, e.g. what kind of modules are connected, what are their operating modes (observe, lock, wobble, decouple) and other information.

Cover1: The status LEDs "ERROR", "READY", "SLEEP" and "COM" indicate the current state of the Cover Module. The "COM" LED shows real data communication with the HPPR/2. When the "SLEEP" LED is on, the microcontroller and oscillator in the Cover Module are switched off. This power down state is activated by the console during the acquisition phase, thus the Cover Module is not able to disturb the measurement.

Cover2: The status LEDs "ERROR" and "READY" indicate the current state of the Cover2's host. In actual systems the host is located in the DRU.

Cover1: The T-junction LEDs indicate during operation of the wobble mode the accuracy of probehead tuning and matching and whether this must be corrected.

Cover2: The LCD's wobble tab indicate during operation of the wobble mode the accuracy of probehead tuning and matching and whether this must be corrected.

The individual modules, the power transmitter and the probehead are connected with N-plugs and shielded cables. The BNC cable for the receiver signal leads from the rear Cover/Display unit to the FT and lock receiver in the console. The connected multi-core cable supplies all DC voltages for the preamplifier modules. The cable also contains the required real time pulses (RGP_HPPR, LOCK_PP, INTERLEAVE_INCR) and a SBS-Bus (tty10) for command and data transfer between the console and the HPPR/2.

Cover1: If there are used more than three preamplifier modules an additional power supply cable is needed.

5.3 Features

- Same RF technology as the classic HPPR
- Ease of operation
- Self configuration
- Modular arrangement, up to 8 preamplifier modules per HPPR/2, even identical ones
- Enhanced noise immunity (also Cover Module)
- Enhanced display informations
- Integration of external functional modules as ATMA, Cryoprobe and QNP

5.4 Installation

5.4.1 Connection Preamplifier / QNP Modules

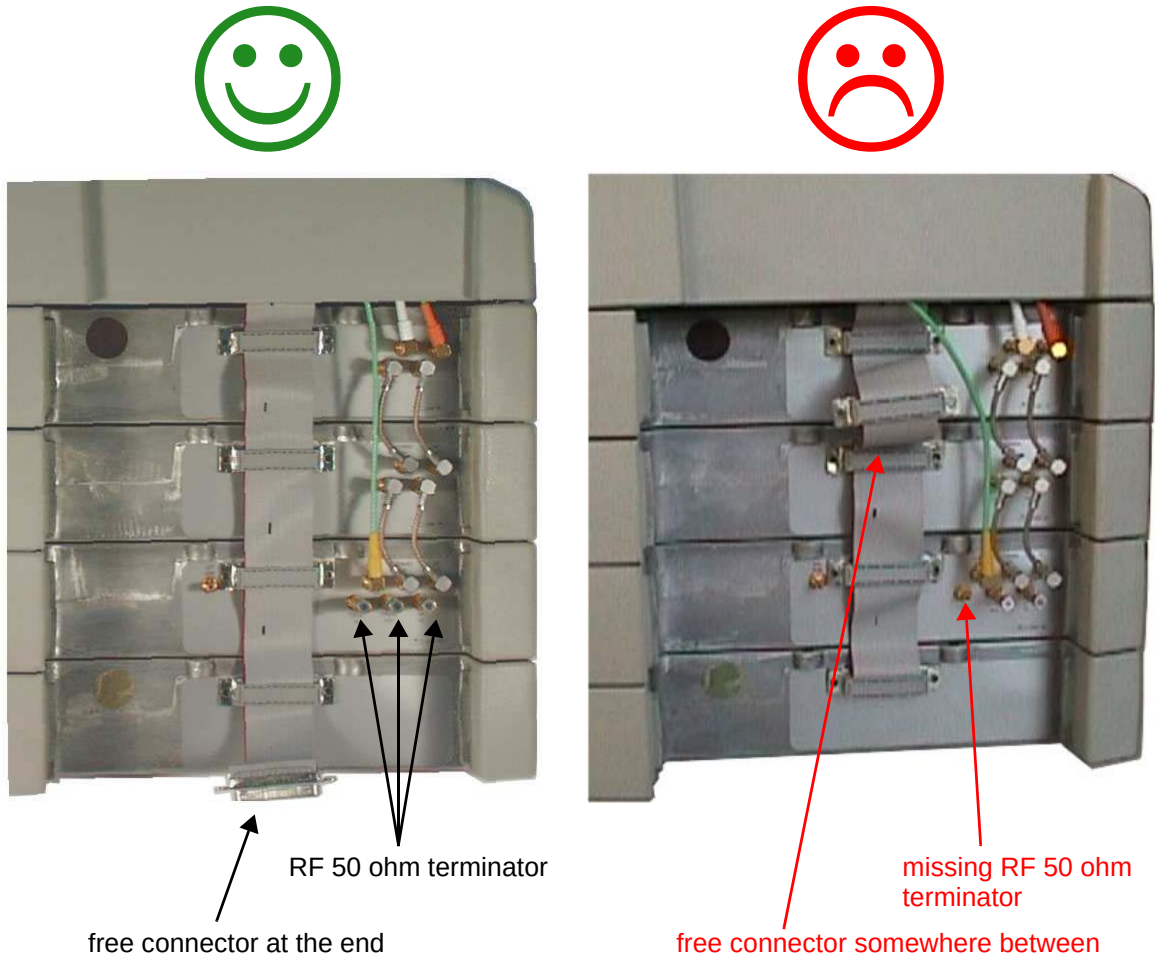


Figure 5.2 Right and wrong module connection

5.5 Wiring

5.5.1 DC-Wiring AVANCE I - II

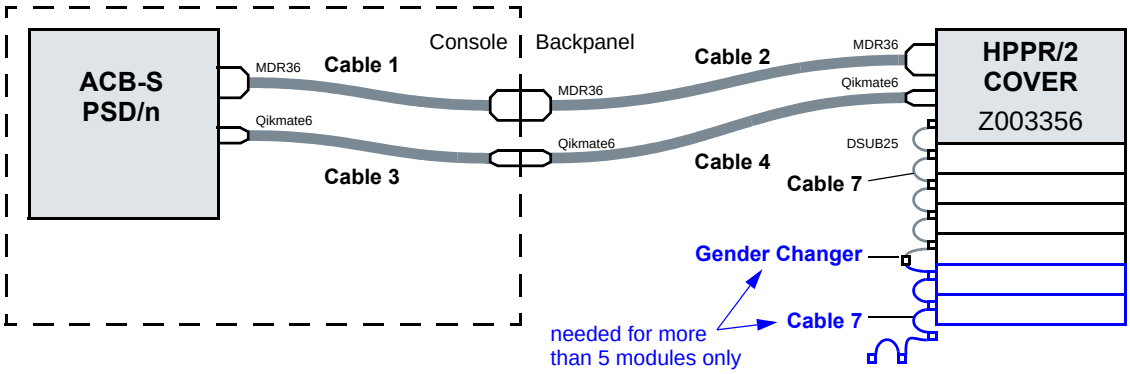


Figure 5.3 Standard wiring: AV I - II with Cover1

Id	P/N	Length	Description
Cable 1	HZ10331	2 m	CABLE RD 36/36P2000 SFT/BU
Cable 2	HZ10174	7 m	CABLE RD 36/36P7000 CENTRON HD
Cable 3	HZ10109	2 m	CABLE RD 6P2000 QIK PM PSB/BP
Cable 4	HZ10110	7 m	CABLE RD 6P7000 QIK PM HPPR/2
Cable 7	Z14091	0.29 m	CABLE FLK 25P 29CM PREAMP-BUS
-	47020	-	GENDER CHANGER M/M 25 POL

Table 5.1 Part list AV I - II wiring

5.5.2 DC-Wiring AVANCE III

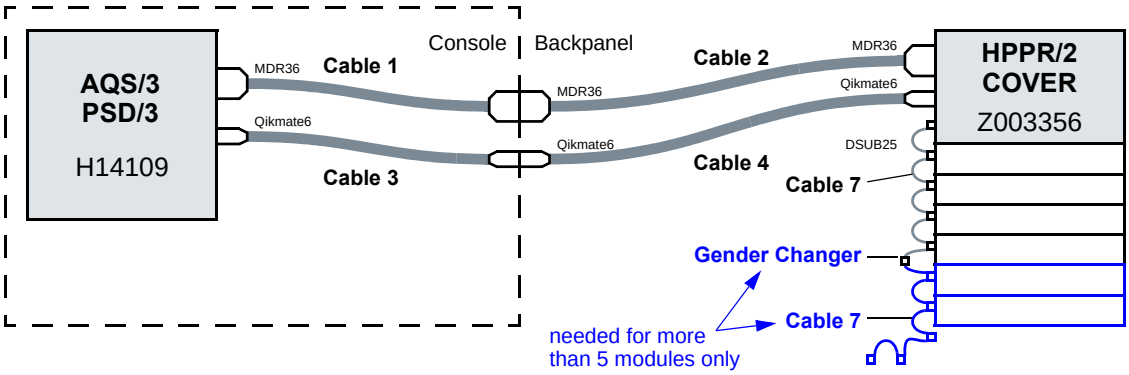


Figure 5.4 Standard wiring: AV III with Cover1

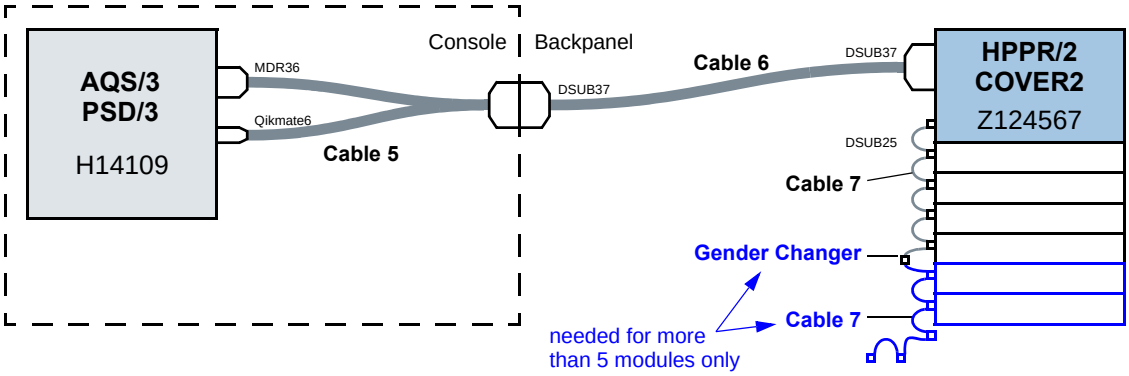


Figure 5.5 Alternate wiring: AV III with Cover2

Id	P/N	Length	Description
Cable 1	HZ10331	2 m	CABLE RD 36/36P2000 SFT/BU
Cable 2	HZ10174	7 m	CABLE RD 36/36P7000 CENTRON HD
Cable 3	HZ10109	2 m	CABLE RD 6P2000 QIK PM PSB/BP
Cable 4	HZ10110	7 m	CABLE RD 6P7000 QIK PM HPPR/2
Cable 5	Z135780	2 m	CABLE RD 36P+6P/37P2000 D-SUB PSD3/BP
Cable 6	Z134361	7 m	CABLE RD 37P7000 D-SUB SFT/BU BP/COVER2
Cable 7	Z14091	0.29 m	CABLE FLK 25P 29CM PREAMP-BUS
-	47020	-	GENDER CHANGER M/M 25 POL

Table 5.2 Part list AV III wiring

5.5.3 DC-Wiring AVANCE III HD

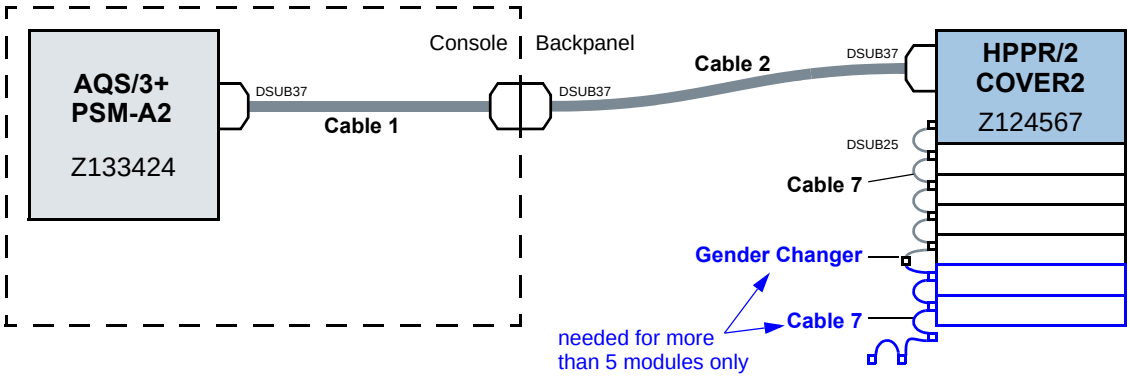


Figure 5.6 Standard wiring: AV III HD with Cover2

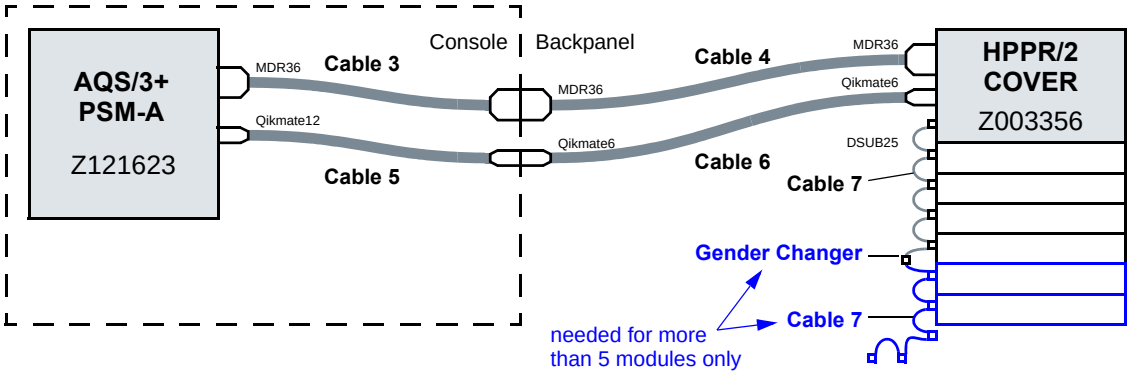


Figure 5.7 Alternate wiring: AV III HD with Cover1

Id	P/N	Length	Description
Cable 1	Z134360	2 m	CABLE RD 37P2000 D-SUB SFT/BU PSM-A2/BP
Cable 2	Z134361	7 m	CABLE RD 37P7000 D-SUB SFT/BU BP/COVER2
Cable 3	HZ10331	2 m	CABLE RD 36/36P2000 SFT/BU
Cable 4	HZ10174	7 m	CABLE RD 36/36P7000 CENTRON HD
Cable 5	Z132709	2 m	CABLE RD 12P/6P2000 QIK SFT/BU PSM-A/BP
Cable 6	HZ10110	7 m	CABLE RD 6P7000 QIK PM HPPR/2
Cable 7	Z14091	0.29 m	CABLE FLK 25P 29CM PREAMP-BUS
-	47020	-	GENDER CHANGER M/M 25 POL

Table 5.3 Part list AV III HD wiring

5.5.4 DC-Wiring MRI Systems

For MRI applications special wiring are used. This is not part of this chapter.

5.6 HPPR/2 RF Power Supervision

Introduction

Some of the recently introduced HPPR/2 modules (1H2H modules and HPLNA 1H) have a built in, calibrated RF power limit detection capability. This power limit detection capability is used to supervise the power applied to the probe (calibrated and referenced at the probe connector of the HPPR/2 module), but also to protect the appropriate HPPR/2 module from too much power applied.

The transmission of RF power through the HPPR/2 module is being monitored autonomously (supervision is enabled after power up) and in case of exceeding power, the emergency stop signal will be activated. After a latency of about 2-3us all RF pulses and RF sources will be stopped.

RF Power

In order to avoid too much power to be applied to the probe, the power limit detection thresholds of the HPPR/2 modules for continuos (CW) and peak (PK) power are set according to the probe connected to the HPPR/2.

For each probe connected to the HPPR/2 COVER or COVER2 MODULE the PICS entries of that probe are read out by the firmware of the HPPR/2. The values for continuous but also peak power are extracted from the '$PChan' group for each nucleus. Afterwards, the threshold values for the power limit detection are set for each nucleus (if power limit detection is available) according to the probe power values.

To avoid an emergency stop too close at the probe power limits, a 2 dB for peak power respectively a 3 dB for continuous power margin is added for the power limit detection thresholds.

The following diagram shows the characteristics (and the pulse length dependency) of the RF power detection.

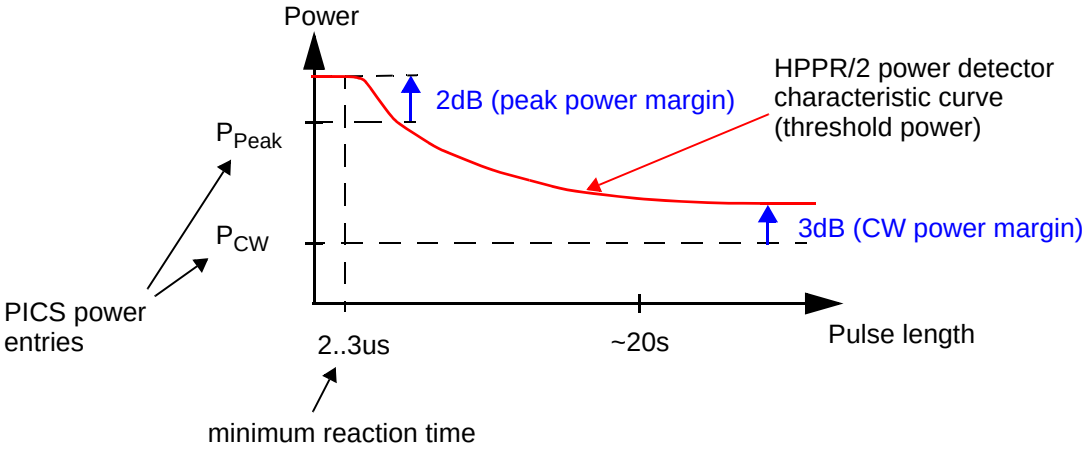


Figure 5.8 Threshold for RF power versus pulse length

The threshold value for CW pulses can be understood as the RF power of pulses of about 20s. The power limit threshold value for pulses between a few microseconds (peak power) and the very long pulses (CW power) behaves like described above (red curve).

Cover1: The setting of the threshold values can be monitored on the HPPR/2 COVER module display (see following figures).

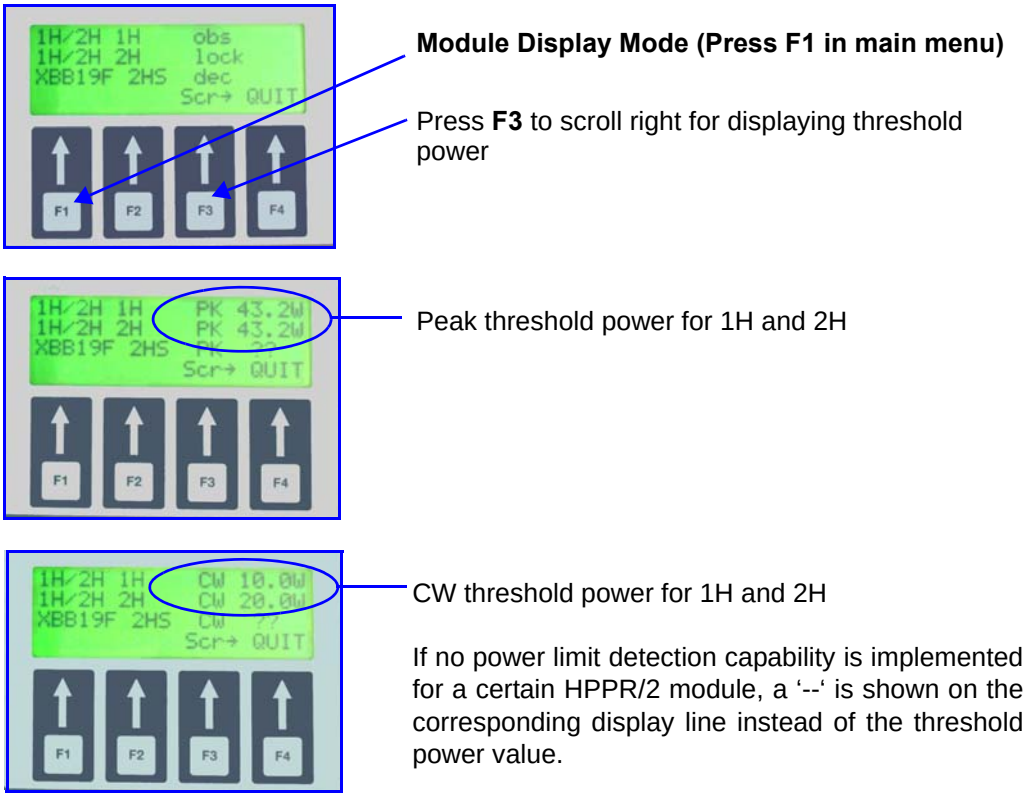
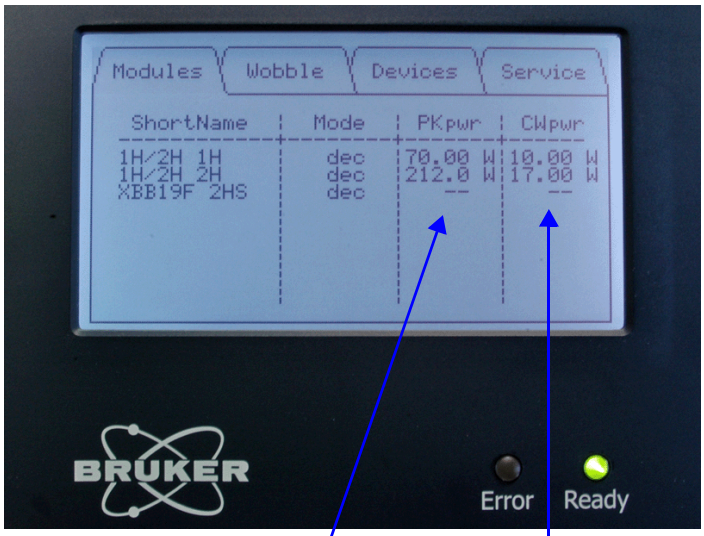


Figure 5.9 Cover1: Threshold power display

Cover2: The setting of the threshold values can be monitored on the HPPR/2 COVER2 module display (see following figures).



Modules Tab of Cover2

Peak threshold power for 1H and 2H

CW threshold power for 1H and 2H

If no power limit detection capability is implemented for a certain HPPR/2 module, a '--' is shown on the corresponding display line instead of the threshold power value.

Figure 5.10 Cover2: Threshold power display

5.6.1 FAQs

Which HPPR/2 modules are equipped with a power limit detection?

As of January 2008 the following modules are equipped with a power limit detection:

- Z003958 HPPR/2 1H2H MODULE 300, ECL>=3
- Z003959 HPPR/2 1H2H MODULE 400, ECL>=3
- all frequencies HPPR/2 1H HPLNA MODULE xxx
- all frequencies HPPR/2 19F HPLNA MODULE xxx
- all frequencies HPPR/2 1H HPLNA MODULE xxx MRI

New modules will be published by EC only.

How can I see if the supervision is activated?

Cover1: The supervision can only be disabled by UniTool until next power up. After power up the supervision is always enabled automatically (default).

Cover1: For the supervision you need at least firmware version HPPRAJ.hex for the 1H2H modules and HPPRAN.hex for the HPLNA1H modules or higher.

Cover2: The supervision can be disabled via the ‘Hosted Devices‘ --> ‘Cover2 Overview‘ --> ‘Module Settings‘ --> ‘Overload Detect‘ website. After power up the supervision is always enabled automatically (default).

What happens in case of missing power entries in the PICS?

If a value is missing in the ‘$PChan‘ group of the PICS, the maximum power rating of the corresponding HPPR/2 module will be set.

What happens in case of „incorrect“ or „corrupt“ (non numerical) power entries of the probe PICS?

The maximum power rating of the corresponding HPPR/2 module will be set.

What happens in case of higher rating of the probe than the HPPR/2 module?

The maximum power rating of the corresponding HPPR/2 module will be set.

What happens if the probe contains no PICS?

All limits of the HPPR/2 modules will be set to its corresponding maximum power ratings.

How can I check wether the supervision is available for a certain HPPR/2 module?

Check on the HPPR/2 COVER display as described in Figure 5.9 respectively on the HPPR/2 COVER2 display as described in Figure 5.10

How can I check wether the supervision is available for a certain nucleus by using the AQS integrated preamplifiers?

Check the $HpprFunc group of the module BIS. The version of the group must be at least 2.3 and the sixth entry must be set to „1“.

$HpprFunc, 2.3, FreqRange, Shortname, RefType, LowGain, RefMeter, AutoPowDet#

Version of the $HpprFunc group must be at least 2.3

0: has no automatic power detection
1: has an automatic power detection

The $HpprFunc group is valid for all HPPR/2 modules and not only for the AQS integrated preamplifiers.

When are the power limit detection threshold values set?

Cover1: All threshold values are set after power up and in addition before setting the HPPR/2 COVER into the sleep mode. In that way it is possible to set the threshold values according to the probe PICS. The only situation, which can not be handled is, if the probe PICS has been changed and RF power is being applied without setting the preamplifier into the sleep mode.

Cover2: All threshold values are set after power up and in addition by plugging/unplugging a CRP / ATMA / PICS device.

How can the supervision be deactivated?

Cover1: The following example shows, how the supervision for a certain module can be disabled. This can be done for any module, having the power limit detection feature.

Start UniTool for HPPR and select:

[P] Preamplifier Module

[5] 1H/2H 1H

[F] Set Overload Detect

(1=disable, 0=enable)

Cover2: The supervision can be disabled via the ‘Hosted Devices‘ --> ‘Cover2 Overview‘ --> ‘Module Settings‘ --> ‘Overload Detect‘ website. This can be done for any module, having the power limit detection feature.

5.7 Wobble

The recently introduced „wobb reflection“ has the following features:

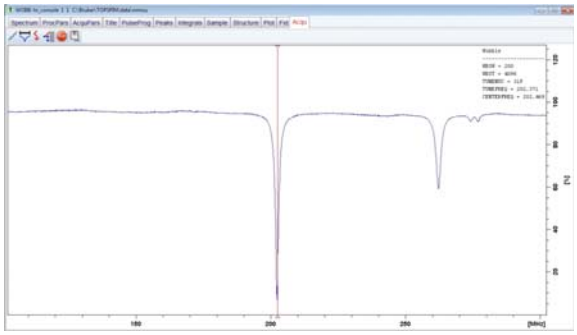
- the wobble display represents the amount of the reflection coefficient at the probe connecter of the corresponding HPPR/2 module
- a quantitative statement of the reflected power and of the probe Q can be made
- the HPPR/2 acts as a network analyzers s11 measurement

Where possible (Software Update necessary) it is recommended to use the extended version ‘wobb reflection’ (TS 3.1 required). This procedure uses the individual calibration data of the appropriate preamplifier unit to calculate the exact reflection coefficient at the HPPR ‘Probe’ port in direction to the probe (same as the s11 measurement of a network analyzer).

To do this, load the calibration data file of the individual HPPR/2 module to the spectrometer. The calibration data files are available from the Bruker-ch ftp server (ftp://ftp.bruker.ch/NMR/download/preamplifier/). Folder- and filenames are according part number and serial number of your individual HPPR/2 module. The calibration file is available for all HPPR/2 modules with a production date after 1.1.2012.

Copy the file into the appropriate spectrometer directory (conf/instr/<spect>/preamp/) and start ‘wobb reflection’.

New ,calibrated wobble curve



5.8 Abbreviations

Cover1	Z003356 “HPPR/2 COVER MODULE“ Z103945 “HPPR/2 COVER MODULE MRI“
Cover2	Z124567 “HPPR/2 COVER2 MODULE“
ADM	Active Detuning Module
ATMA	Automatic Tuning and Matching Accessory
BIS	Bruker Information System
CRP	Cryo Probe
PK	Peak (peak power)
CW	Continuos Wave (CW power)
HPPR/2	High Performance Preamplifier Version 2
HPLNA	High Power Low Noise Amplifier
IFB	HPPR/2 Interface Board (interface from the module to the Preamp-Bus)
INCR_AQ	see INTERLEAVE_INCR
INTERLEAVE_INCR	Interleave Increment Pulse
I2C	I2C bus (two wire single master bus)
PLD	Programmable Logic Device
LCD, LC-Display	Liquid Crystal Display
LOCK_PP	Lock Protection Pulse
MDR	Mini Delta Ribbon connector (e.g. from 3M)
PICS	Probehead Identification System
QNP	Quadro Nucleus Probe
RGP_HPPR	Receiver Gating Pulse for HPPR
RGP_PA	see RGP_HPPR
SBSB	Serial Bruker Spectrospin Bus (RS485 Bus)
TP_F0	see LOCK_PP

6 Cover Module

6.1 Top Side

Figure 6.1 Cover module top view

6.1.1 Versions

The HPPR/2 Cover module is available in two different versions:

- HPPR/2 COVER MODULE Z003356
- HPPR/2 COVER MODULE MRI Z103945

The MRI version powers off the entire LCD display during acquisition due to minimize electromagnetic interferences.

6.1.2 LED Description

The LEDs indicate the current state of the HPPR/2 and the tuning/matching information from the probehead (see also 6.5.4).

Label	Description
MATCHING LED TUNING LED	This display only becomes active when the HPPR/2 is in Tuning/ Matching mode and indicates the quality of the Tuning/Matching balance.
ERROR LED	Monitors HPPR/2 error state.
READY LED	Monitors microcontroller ready state.
SLEEP LED	Monitors microcontroller power down state.
COM LED	Monitors HPPR/2 communication on SBSB or AUX bus.

Table 6.1 LED description

6.1.3 LCD and KEY Description

Label	Description
LCD	The LCD is used to show user menus and some other useful information (e.g. module list, tuning/matching channel, error message).
KEY ***[F1] ... [F3]***	This keys are used to navigate in menu and to execute user functions. Key function during menu handling: ***[F1]*** : scroll clockwise through the menu. (see figure ...) ***[F2]*** *: scroll counter clockwise through the menu.* ***[F3]*** *: select this menu (**'ok'**).*
KEY ***[F4]***	Pressing this key always quits the current menu or function. NOTE: Pressing ***[F1]*** and ***[F4]*** simultaneously will always result in returning to the idle menu.

Table 6.2 LCD and KEY description

6.1.4 Menu mode

Notation

Expressions in quotation marks and in bold italic letters (e.g., ***'4. LCD illumination'***) represent what is shown on the HPPR/2 display. Expressions in square brackets and in bold capital italic letters (e.g., ***[F1]***) indicate keys.

General

The menu mode of the HPPR/2 gives a direct access to different HPPR/2 functions.

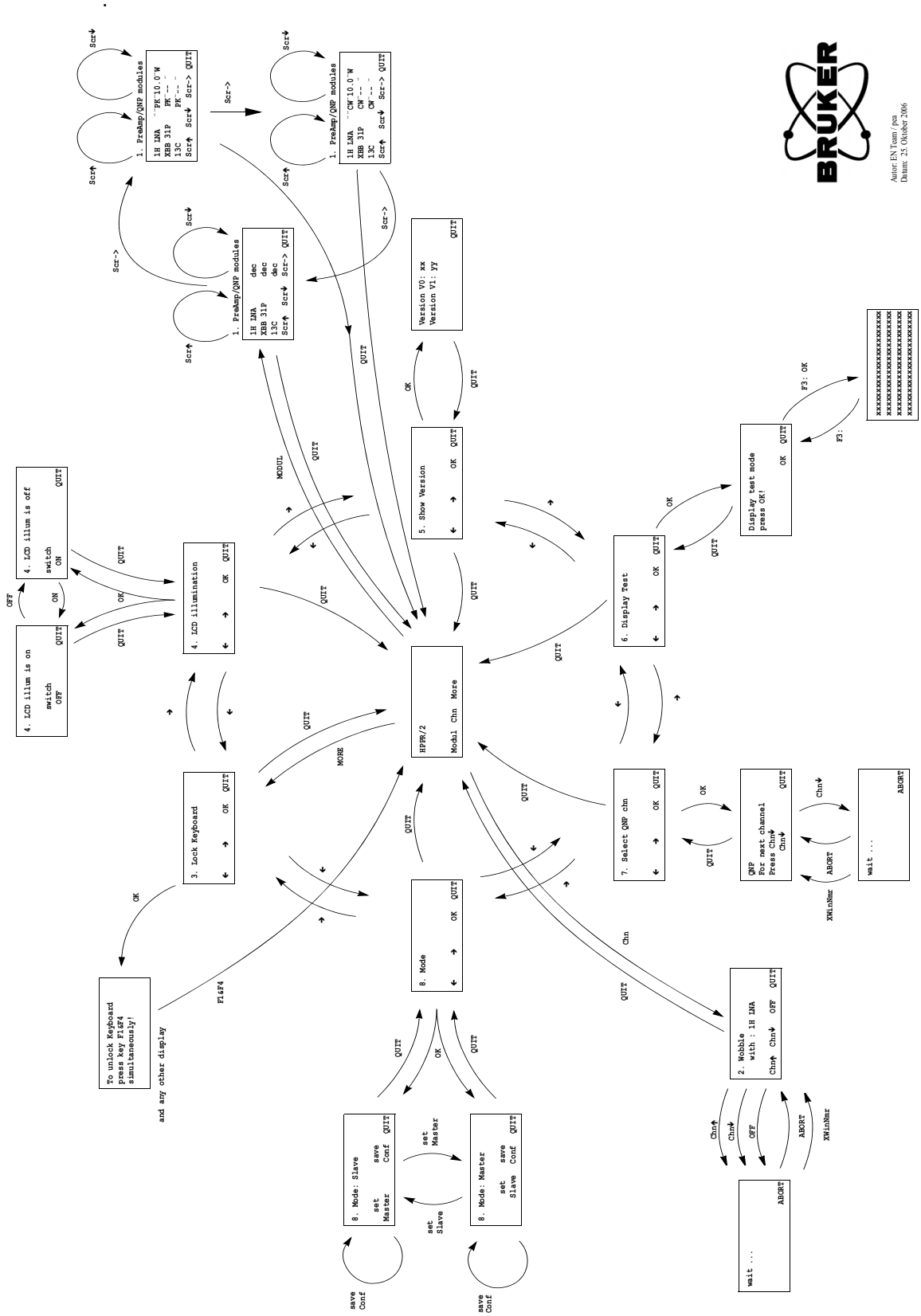


Figure 6.2 HPPR/2 menu mode

The menu navigation works very easy and is similar to other already known user interfaces like the BSMS keyboard. Therefore it won't be further explained than in .

The main menu is composed of the following submenus: ***'1. MODUL'*** (list of all preamp modules), ***'2. CHN'*** (Channel) and 'MORE'. 'More' is sub-divided into six further menu points: ***'3. Lock Keyboard'*** , ***'4. LCD illumination'***, ***'5. Show Version'***, ***'6. Display Test'***, ***'7. Select QNP chn'***, ***'8. Mode'***.

Each of these submenus have several functions, which are described below for HPPR firmware version "AJ" or later (file: e.g. hpprap.hex).

6.1.5 Menu Description

Idle Menu

After power-up and confirming 'power fail' the HPPR/2 display shows the idle menu.

Pressing ***[F1]*** or ***[F2]*** leads directly into the menu function "'1. MODUL'" or "'2. CHN'". Pressing ***[F3] 'MORE'*** leads to further menu points (3 ... 8).

'1. MODUL'

This function lists all preamp modules and their actual states actually connected to the current HPPR/2 . The following states are possible:

state	Description
'dec'	Decouple mode (default), module is not used for observe or lock and is therefore always protected from transmitting pulses.
'obs'	Observe mode, this module is used as observe channel. The protection of the module is dependent on the real time pulse "RGP_HPPR".
'lock'	Lock mode, this module is used as lock channel. The protection of the module is dependent on the real time pulse "LOCK_PP".
'wobb'	Tuning/Matching mode, this channel can be tuned and matched.
'crp ...'	Cryo probe mode, can be combined with all states described above (dec, obs, lock or wobb).
'fwd pwr'	The forward power from the reflectometer is routed to the RF out of the HPPR/2 (only implemented in HPLNA modules)
'refl pwr'	The reflected power from the reflectometer is routed to the RF out of the HPPR/2 (only implemented in HPLNA modules)
'pwr err'	Power error, a power error has occurred on this module. Check the connection to the module and the preamplifier module itself.
'stop'	Emergency stop, an emergency stop signal has occurred on this module.

Table 6.3 Module state

‘2. CHN’

This menu point shows the current wobble channel if available. It allows to change the channel for Tuning/Matching.

‘MORE’

This menu point leads to the following menu points:

‘3. Lock Keyboard’

Entering this function locks the keys on the HPPR/2 display (useful during a long experiment). ***‘To unlock press key F1&F4 simultaneously’*** appears on the display and all other key-combinations are disabled. To exit this mode, press ***[F1]*** and ***[F4]*** simultaneously.

‘4. LCD Illumination”

Enables the user to switch on or off the LCD illumination. After power-up the illumination is always switched on.

‘5. Show Version’

‘V0 = ...’ shows the current hardware version of the Preamplifier Control Board. This is the control board with the microcontroller (see 6.3.1) which is a part of the Cover Module.

‘V1 = ...’ shows the current hardware version of the Display Board which is another part of the Cover Module.

‘6. Display Test’

Tests the LCD and all LED’s.

‘7. Select QNP channel’

Allows to change the QNP channel if QNP module is connected.

‘8. Mode’

The current HPPR/2 Mode is shown: Master or Slave. Master Mode is the default setting from the factory. The other mode can be set with ***[F2] ‘set ...’*** and saved with ***[F3] ‘save Conf’***. Saving the Mode will take a few seconds.

In standard configuration (one HPPR/2) the HPPR/2 has always to be set in master mode. In configuration with two HPPR/2 only the master HPPR/2 has to be set in master mode. The other/second HPPR/2 has to be set in slave mode.

After changing the mode, the new configuration has to be saved with the function ***‘save Conf’***. After that the HPPR/2 has to be re-initalized (power-up or init command with uni-

tool). From now on the HPPR/2 is working in the selected mode.

'save Conf' saves the configuration to the FLASH PROM in the HPPR/2 Cover Module.

The HPPR/2 mode can also be set by unitool. Note that the unitool address will change when changing the mode. Therefore UniTool has to be restarted with the new address.

6.2 Rear Side

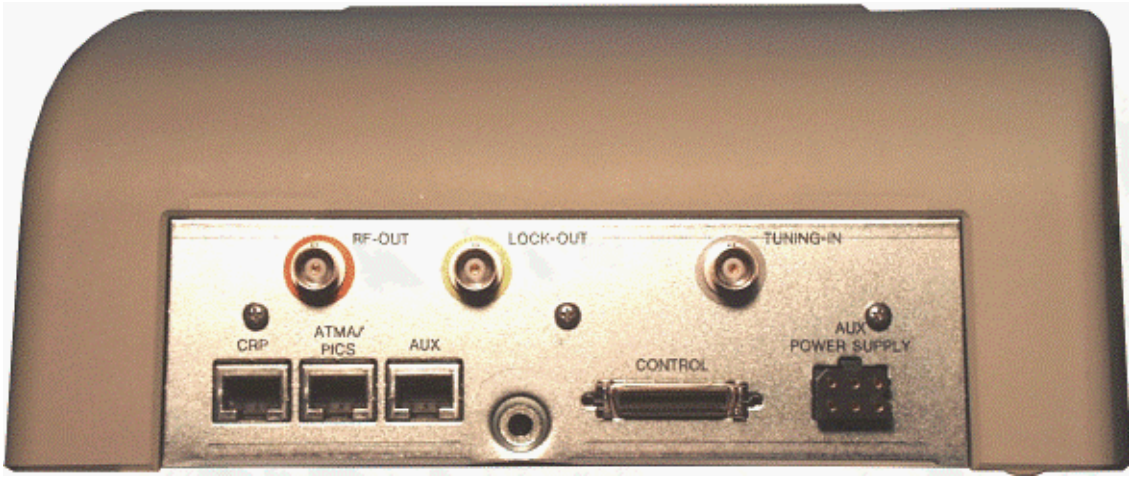


Figure 6.3 Cover module rear view

6.2.1 Connector Rear Side

Label	Connector Type	Description
CONTROL	MDR 36 pin	Control signals (SBSB, real time pulses, emergency stop) and power supply for three preamplifier modules.
AUX POWER SUPPLY	Qikmate 6 pin	Auxiliary power supply for more than three preamplifier modules.
CRP	RJ45	Connection to Cryo Probe.
ATMA/PICS	RJ45	Connection to ATMA or PICS.
AUX	RJ45	Auxiliary connection to another HPPR/2.

Table 6.4 Connectors on the rear side

6.3 Functionality

6.3.1 Topology

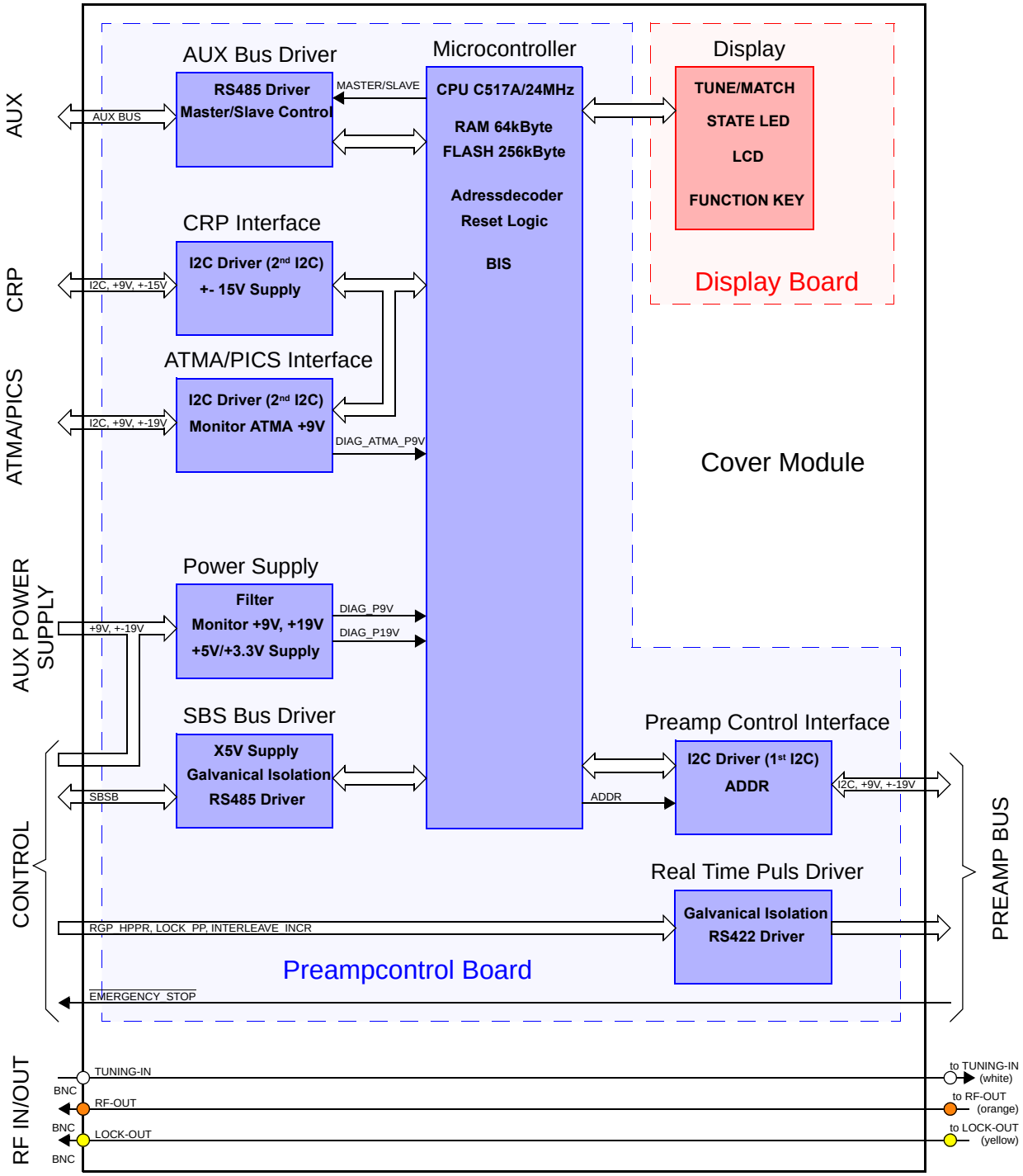


Figure 6.4 HPPR/2 Cover module blockdiagram

6.3.2 Busses

Each HPPR/2 Cover Module has 4 independent busses:

- SBSB, controlling HPPR/2 in master mode
- AUX bus, controlling HPPR/2 in slave mode
- I2C bus 1, controlling external devices as ATMA/PICS and CRP
- I2C bus 2, controlling internal devices (preamplifier modules, QNP Module)

6.3.3 Power Supply and Monitoring

All voltages supplied from the console are filtered on the HPPR/2 Cover Module.

The HPPR/2 Cover Module with ECL 01 or later is monitoring the +19V, +9V and ATMA/PICS +9V. In following case the HPPR/2 will display an error message:

Error Cause	Error Code	Description
+9V < 7.8V or +19V < 17.8V	90	The power supply +9V or +19V is too low. Check the power supply in the console (AQR or AQS) and use a special power supply cable to HPPR/2.
+9V > 10V or +19V > 20.5V	91	The power supply +9V or +19V is too high. Check the power supply in the console (AQR or AQS).
ATMA +9V < 7.6V	93	The connected ATMA or PICS might be defect or there is a wrong device connected to the ATMA/PICS connector.
-19V		No power monitoring

Table 6.5 Power supply error cause

6.3.4 Fuses

The connectors “AUX”, “ATMA/PCIS” and “CRP” are protected against short circuit. There are resetable fuses (“Multifuse”) built-in for this protection. In case of a fault condition (e.g. short circuit at the ATMA/PICS connector), excessive current flows through the “Multifuse” and heats the fuse material. As the fuse has a very large non-linear Positive Temperature Coefficient (PTC) this will increase the fuse resistance sharply.

The fuse will stay “hot”, remaining in this high resistance as long as the power is applied. The fuse will remain latched, providing continuous protection, until the fault is cleared and the power is removed.

i All power supplies contained in the Preamp-Bus are only protected with the HPPR/2 power supply fuses (see PSM1-3,5 or PSB1-3 depending on the console type).

6.3.5 Real-Time Pulse

All pulses are galvanically isolated by fast opto couplers on the HPPR/2. After that, they are driven by a RS422 driver to the preamplifier modules. The pulse delay from the pulse driver, opto couplers and transmission line to the preamplifier module is less than 300 ns.

The polarity of the real time pulses can't be modified on the HPPR/2 Cover Module.

There are following three real time pulses:

1. RGP_HPPR, Receiver Gating Pulse HPPR (also known as RGP_PA)
2. LOCK_PP, Lock Protection Pulse (also known as TP_F0)
3. INTERLEAVE_INCR, Interleave Increment (also known as INCR_AQ)

See example in chapter 8.1.6 "Interleave Increment (fast switching between different modes)" on page 68

6.3.6 Microcontroller

Before starting an experiment the microcontroller is set into power down state. After a successful processing and acquisition the controller can be woken up by the SBSB_WUP~ signal to handle system requests or new instrument initialization.

The microcontroller system boots after each reset. While the controller is booting, the HPPR/2 does not serve the serial interface. Any data received on the SBS bus is ignored. The boot time must be considered by any application and testing software.

The microcontroller system consists of a Infineon C517A / 24 MHz microcontroller, a 128K * 8 Bit Static RAM, a 4MB paged FLASH PROM and a 24 MHz clock generator. The external bus interface of the controller consists of an 8-bit data bus, a 16-bit address bus and several control lines. The address latch enable signal (ALE) is used to demultiplex address and data of port 0. The program memory is accessed by the program store enable signal (PSEN~) every second machine cycle. The read or write strobe (RD~, WR~) is used to access the external data memory.

An address decoder controls the microcontroller program and data memory ac-cesses. It enables/disables (depending on the address and control signals) differ-ent devices. The controller boots normally from one page of the FLASH memory and runs its application software from other pages. The PSEC~ control signal is asserted by the controller while it downloads more recent application software or stores later BIS or configuration data. This maps the FLASH memory into the data segment and the RAM into code segment. The controller accesses now the RAM as if it was a nonvolatile code memory. Therefore program instructions are copied from the boot partition of the FLASH memory to the RAM before starting the download procedure.

The boot software programmed in the test department is not field programmable and is protected from unwanted program and erase operations.

More recent application software can be downloaded using the BRUKER UniTool.

6.3.7 BIS

The HPPR/2 Cover Module BIS data contains information about production data, ECL, hardware type and display type.

BIS information is provided by the internal microcontroller and can be read using UniTool commands.

6.4 Connector Pinout

Signal Name	Pin No.	Remark
HPPR +19V	1, 2	HPPR/2 power supply
HPPR -19V	19, 20	
HPPR +9V	3 - 8	
GND	13, 15, 21-26, 31, 33	
EMERGENCY_STOP	32	Emergency Stop signal
$\overline{\text{EMERGENCY\_STOP}}$	14	
RGP_HPPR	18	Gating Pulse for HPPR
$\overline{\text{RGP\_HPPR}}$	36	
LOCK_PP	17	Lock Protection Pulse
$\overline{\text{LOCK\_PP}}$	35	
INTERLEAVE_INCR	16	Interleave Increment Pulse
$\overline{\text{INTERLEAVE\_INCR}}$	34	
RxD+	10	SBSB signals and power supply
RxD-	28	
TxD+	11	
TxD-	29	
$\overline{\text{WUP}}$	12	
VRS	9	
XGND	27, 30	

Table 6.6 CONTROL connector: Mini Delta Ribbon 36 pin (female)

Signal Name	Pin No.	Remark
HPPR +19V	6 [a]	HPPR/2 power supply
HPPR -19V	3	
HPPR +9V	2	
GND	1, 4, 5	

Table 6.7 AUX power supply connector: Qikmate 6 pin (female)

a.) In an older manual version, pin 2 and 6 were wrong

Signal Name	Pin No.	Remark
AUX TxD+	1	AUX bus RS485 transmitter (master mode) or receiver (slave mode) signals.
AUX TxD-	2	
AUX RxD+	3	AUX bus RS485 receiver (master mode) or transmitter (slave mode) signals.
AUX RxD-	4	
$\overline{\text{reserved}}$	5	Reserved for power supply, not connected.
$\overline{\text{AUX WUP}}$	6	Wake up signal (master mode = out; slave mode = in)
GND	7, 8	Ground

Table 6.8 AUX connector: RJ45 8 pin (female)

Signal Name	Pin No.	Remark
EN I2C	2	I2C bus clock, data and enable signal.
SCL	3	
SDA	4	
CRP P15V	1	Power supply for Cryo Probe.
CRP N15V	5	
GND	6, 7, 8	

Table 6.9 CRP connector: RJ45 8 pin (female)

Signal Name	Pin No.	Remark
EN I2C	2	I2C bus clock, data and enable signal.
SCL	3	
SDA	4	
ATMA/PICS +19V	1	Power supply for ATMA or PICS.
ATMA/PICS -19V	5	
ATMA/PICS +9V	6	
GND	7, 8	

Table 6.10 ATMA/PICS connector: RJ45 8 pin (female)

Signal Name	Pin No.	Remark
HPPR +19V	11	HPPR/2 power supply
HPPR -19V	1	
HPPR +9V	5, 6, 7	
GND	2, 3, 9, 16, 19, 20, 22	
EMERGENCY_STOP	4	Emergency Stop signal
RGP_HPPR	23	Receiver Gating Pulse
$\overline{\text{RGP\_HPPR}}$	10	
LOCK_PP	8	Lock Protection Pulse
$\overline{\text{LOCK\_PP}}$	21	
INTERLEAVE_INCR	24	Interlave Increment Pulse
$\overline{\text{INTERLEAVE\_INCR}}$	12	
SCL	15	I2C bus clock and data signal
SDA	14	
ADDR1	17	Daisy chain for addressing the modules.
ADDR2	18	
	13	Not used
TMS	25	Reserved for PLD

Table 6.11 PREAMP BUS connector: DSUB 25 pin

6.5 Test Issues

6.5.1 General

To avoid damage to the electronics the HPPR/2 Cover Module must not be opened in the field. The internal microcontroller supervises the operation of the board and detects serious malfunction. All fuses applied in HPPR/2 Cover Module are resetable and therefore have not to be exchanged.

Status information and error messages are sent to the workstation and displayed on the HPPR/2 Cover Module LCD.

6.5.2 Power Fail Error

After an ordinary power-up, a firmware-download or a power-breakdown the HPPR/2 creates a ***"power fail error"*** with error code 13. This informs the spectrometer, that the system has not yet been initialized. The error code has no further meaning for the user of the spectrometer.

6.5.3 Power supply protection / Fuse

The power supply for the "ATMA/PICS", "CRP" and "AUX" connector are protected against short circuit with resetable fuses or short circuit resistant power supplies. In case of a fault, the fault has to be cleared and the power supply has to be removed (see also 6.3.4).

6.5.4 LED States

ERROR	READY	SLEEP	Description
off	off	off	Power supply not on or HPPR/2 is still booting
off	off	on	Sleep mode (oscillator switched off)
blinking fast	on	off	HPPR/2 is in boot mode, no application software is running or a download is in process.
on	on	off	Error state, the error must be acknowledged by the master or user.
off	on	off	Normal operation mode

Table 6.12 LED states

Cover Module

7 Cover2 Module

7.1 Front View

Figure 7.1 Cover module front view

7.1.1 Versions

The HPPR/2 Cover2 module is available as:

- Z124567 “HPPR/2 COVER2 MODULE“

7.1.2 LED Description

The LEDs indicate the current state of the HPPR/2 host. On actual systems DRU is host. The LEDs do not state anything about the MRI-HWIDS interface.

ERROR	READY	Description
off	off	Power supply is off
on	off	After Power on - Cover2 is waiting for a host
on	on	After Power on the - host is downloading Cover2-firmware or - host is initializing HPPR/2 modules and connected devices or After initialization the - host is in an error state
off	on	After initialization the - host is in normal operation, no error(s) from host side

Table 7.1 LED states

7.1.3 LCD and TouchScreen Description

Label	Description
LCD	The LC-Display is used to show tabs with useful information - module list - tuning/matching channel - sockets and its corresponding connected devices - Cover2 info and an error message
Tabs on LCD	Four tabs can be selected by tipping the TouchScreen. *Tab description see below*
TouchScreen	The resistive TouchScreen allows to tip on it with one finger or a soft pen.

Table 7.2 LCD and TouchScreen description

7.1.4 Service Tab

After Power on the Service tab is shown by Cover2. The red Error LED is ON.

If downloading is necessary, the host does an upgrade respectively a downgrade. While downloading both LEDs are ON. A Cover2-Download lasts about one minute.

While initializing both LEDs are ON.

If after initializing there is an error to display on the host both LEDs stay ON.

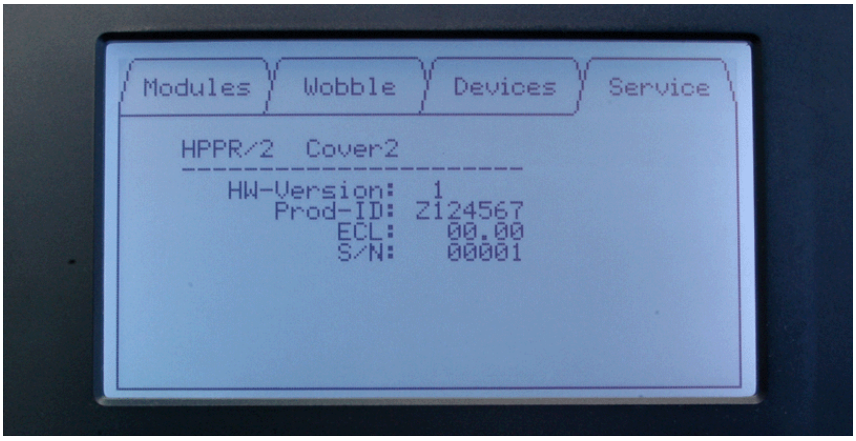


Figure 7.2 Service tab

On the Service tab you are shown the

- HW-Version: e.g. ‘1‘
- Prod-ID: e.g. ‘Z124567‘
- ECL: <nn.mm>
- S/N: <Serial Number>
- If any error is queueing on the host, the error number, error message and the ‘Quit Error‘ button is shown on Service tab. The red Error LED is ON.
- If there are a QNP module in the tower‘s configuration, a ‘QNPchn‘ button is displayed. The button is used to select the QNP channel.

If there are no errors to display after initialization the host changes to the Modules tab. At this time, only the green Ready LED is ON.

7.1.5 Modules Tab

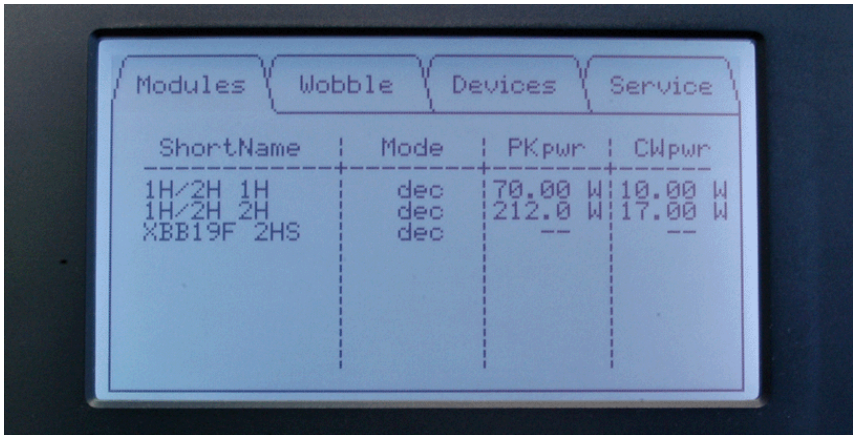


Figure 7.3 Modules tab

The following module ‘Mode‘ are possible depending on the module type:

Modul Mode	Description
‘dec’	Decouple mode (default), module is not used for observe or lock and is therefore always protected from transmit pulses.
‘obs’	Observe mode, this module is used as observe channel. The protection of the module depends on the real time pulse “RGP_HPPR”.
‘lock’	Lock mode, this module is used as lock channel. The protection of the module depends on the real time pulse “LOCK_PP”.
‘wobb’	Tuning/Matching mode: This channel can be tuned and matched.
‘crp ...’	Cryo probe modes: Can be combined with all modes described above (crp dec, crp obs, crp lock, crp wobb).
‘fwd pwr’	The forward power from the reflectometer is routed to the RF out of the HPPR/2 (implemented in HPLNA modules only)
‘refl pwr’	The reflected power from the reflectometer is routed to the RF out of the HPPR/2 (implemented in HPLNA modules only)
‘PwrErr’	Power error, a power error has occurred on this module. Check the connection to the module and the preamplifier module itself.
‘EmStop’	Emergency stop, an emergency stop signal has occurred and is queueing on this module.

Table 7.3 Modules mode

The red Error LED shows a possible error on the host.

7.1.6 Devices Tab

The Devices tab shows all the so called ‘connected devices‘ which can be connected at the rear side of Cover2.

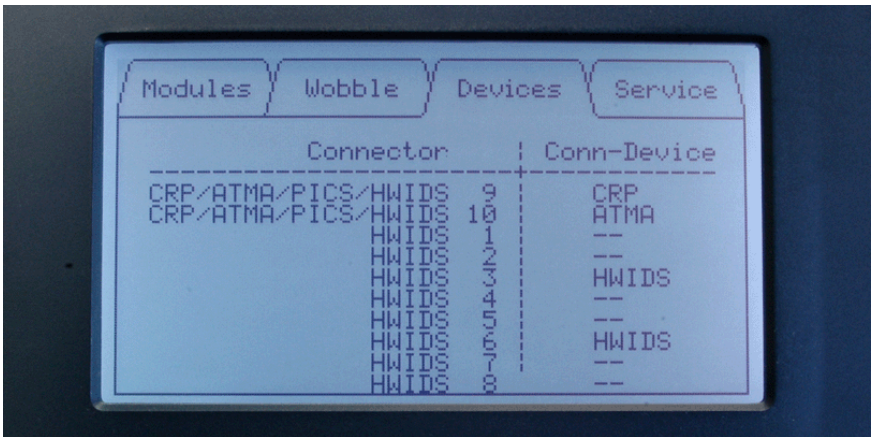


Figure 7.4 Devices tab

The rear side from left to right is shown on the LCD from top to bottom.

The following devices can be shown:

- ‘--‘ : disconnected / empty socket
- ‘CRP‘ : Cryoprobe
- ‘ATMA‘ : ATMA resp. CRP-ATMA probe
- ‘PICS‘ : Probehead Identification System
- ‘HWIDS‘ : Hardware Identification System

By connecting or disconnecting a ‘connected device‘ the host changes to the ‘Device tab‘.

The red Error LED shows a possible error on the host.

7.1.7 Wobble Tab

The Wobble tab shows the modules shortname and the corresponding wobble curve if any module is configured to wobble .

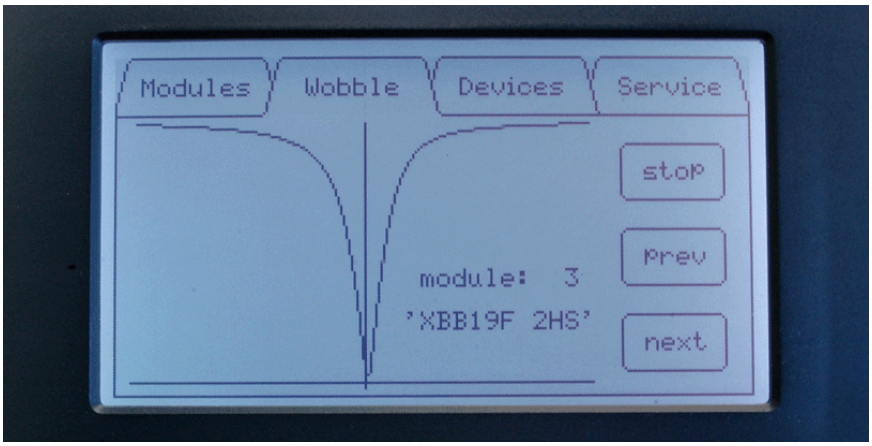


Figure 7.5 Wobble tab

If wobble is active, wobble can be

- stopped with the ‘stop‘ button or
- switched to the next (‘next‘ button) or previous (‘prev‘ button) channel if more than one channel are available.

TopSpin is able to change to the ‘Wobble tab‘ via the host.

The red Error LED shows a possible error on the host.

7.2 Rear View

Figure 7.6 Cover2 module rear view

7.2.1 Rear Side Connectors

Case Label	Connector Type	Description
RF-OUT	BNC	RF connector (output)
LOCK-OUT	BNC	RF connector (lock output)
TUNING-IN	BNC	RF connector (input)
HPPR CONTROL	D-Sub 37	Control signals (BFB, real time pulses, emergency stop) and power supply for preamplifier modules, QNP, ADM, ADM-CRP.
CRP/ATMA/PICS/HWIDS	RJ-45	Socket number 9 ... 10: - Connection either to CRP, ATMA, PICS or HWIDS
HWIDS	RJ-45	Socket number 1 ... 8: - Connection to HWIDS only

Table 7.4 Connectors on the rear side

NOTICE

Material damage hazard

Never plug in anything else other than the above mentioned ‘connected devices‘ to any of the RJ-45 connector on the Cover2 rear side.

To connect the CRP / ATMA / PICS / HWIDS devices use exclusively the following cable:

Connected Device	Cable (Material Number)
CRP	Z14362
ATMA	Z14361
PICS	Z14361
HWIDS	H135248

Table 7.5 Appropriate cable for Connected Devices

Pin	Signal	Connector Number	Specifikation (Level, Impedance, Tolerance)
1	P15V (for CRP only)	J9 / J10	max. 600 mA total all Connectors
2	P5V (for HWIDS only)	alle	max. 10 mA per Connector
3	I2C_SCL	alle	V_{IH} > 3.5 V V_{IL} < 1.5 V max. Datarate ca. 25 kBit/s
4	I2C_SDA	alle	V_{IH} > 3.5 V V_{IL} < 1.5 V max. Datarate ca 25 kBit/s
5	N15V (for CRP only)	J9 / J10	max. 165 mA total all Connectors
6	P9V (for ATMA/PICS only)	J9 / J10	1.0A @ 9V +1/-0.5V [a)]
7	GND	alle	
8	GND (for ATMA/PICS)	J9 / J10	HWIDS $\overline{\text{Sense}}$ via 5Vcurrent
8	Sense (for HWIDS only)	J1 ... J8	> 2.4 V : no Device connected < 0.6 V : Device recognized

Table 7.6 Pinout RJ-45 connector

a. Only for AQS/3+ chassis and PSM-A2 with appropriate cables

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
1	N19V_HPPR	11	GND_HPPR	20	N19V_HPPR	30	GND_HPPR
2	N19V_HPPR	12	GND_HPPR	21	N19V_HPPR	31	BFB_RX-_HPPR
3	GND	13	BFB_RX+_HPPR	22	GND	32	BFB_TX-_HPPR
4	P19V_HPPR	14	BFB_TX+_HPPR	23	P19V_HPPR	33	EMERGENCY_STOP
5	P19V_HPPR	15	EMERGENCY_STOP~	24	P19V_HPPR	34	GND_HPPR
6	GND	16	GND_HPPR	25	GND	35	INTRLVE_INCR~
7	GND_HPPR	17	INTRLVE_INCR	26	P9V_HPPR_SENSE	36	LOCK_PP~
8	P9V_HPPR	18	LOCK_PP	27	P9V_HPPR	37	RGP_HPPR~
9	P9V_HPPR	19	RGP_HPPR	28	P9V_HPPR		
10	P9V_HPPR			29	GND_HPPR_SENSE		

Table 7.7 Pinout HPPR CONTROL connector

7.2.2 Left Side Connectors

Case Label	Connector Type	Description
not labelled	D-Sub 25	PREAMP BUS connector (Flat cable is already mounted)
not labelled	D-Sub 9	Connector to MRI's HWIDS interface

Table 7.8 Connectors on the left side

Pin	Signal	Specifikation (Level, Impedance, Termination)
1	RX-	RS-422 Specifikation
2	RX+	RS-422 Specifikation
3	TX+	RS-422 Specifikation
4	TX-	RS-422 Specifikation
5	GND_5V	Digital Ground
6	reserved	internally used, may not be connected
7	NC	no contact, may not be connected
8	reserved	internally used, may not be connected
9	NC	no contact, may not be connected

Table 7.9 Pinout D-Sub9 for MRI HWIDS interface

Signal Name	Pin No.	Remark
HPPR +19V	11	HPPR/2 power supply
HPPR -19V	1	
HPPR +9V	5, 6, 7	
GND	2, 3, 9, 16, 19, 20, 22	
EMERGENCY_STOP	4	Emergency Stop signal
RGP_HPPR	23	Receiver Gating Pulse
$\overline{\text{RGP\_HPPR}}$	10	
LOCK_PP	8	Lock Protection Pulse
$\overline{\text{LOCK\_PP}}$	21	
INTERLEAVE_INCR	24	Interlave Increment Pulse
$\overline{\text{INTERLEAVE\_INCR}}$	12	
SCL	15	I2C bus clock and data signal
SDA	14	
ADDR1	17	Daisy chain for addressing the modules.
ADDR2	18	
	13	Not used
TMS	25	Reserved for PLD

Table 7.10 Pinout D-Sub 25 PREAMP BUS connector

7.3 Functionality

7.3.1 Power Supply and Monitoring

All voltages supplied from the console are filtered on the HPPR/2 Cover2 Module.

The HPPR/2 Cover2 Module is monitoring the +19V, +9V and -19V. Cover2 has the following voltage threshold to inform the host:

Error Cause	Description
+9V falls below 7.15 ... 7.55 V	The power supply +9V is too low. Check the power supply in the AQS-console.
+19V falls below 16.9 ... 17.25 V	The power supply +19V is too low. Check the power supply in the AQS-console.
-19V falls below -17.25 ... 16.9 V	The power supply -19V is too low. Check the power supply in the AQS-console.

Table 7.11 Power supply error cause

7.3.2 Real-Time Pulse

All pulses are driven to the preamplifier modules by a RS422 driver. The pulse delay from the pulse driver and transmission line to the preamplifier module is less than 300 ns.

There are following three real time pulses:

1. RGP_HPPR, Receiver Gating Pulse HPPR (also known as RGP_PA)
2. LOCK_PP, Lock Protection Pulse (also known as TP_F0)
3. INTERLEAVE_INCR, Interleave Increment (also known as INCR_AQ)

See example in chapter 8.1.6 "Interleave Increment (fast switching between different modes)" on page 68

7.3.3 BIS

The HPPR/2 Cover2 Module BIS data contains information about production data, ECL, hardware type, display type, calibration and sockets for connected devices.

BIS information is provided by the internal MCU (Micro Controller Unit) and can be read via the website respectively via the host.

7.4 Test Issues

7.4.1 Important

To avoid damage to the electronics the HPPR/2 Cover2 Module must not be opened in the field.

8 Preamplifier Modules

8.1 View

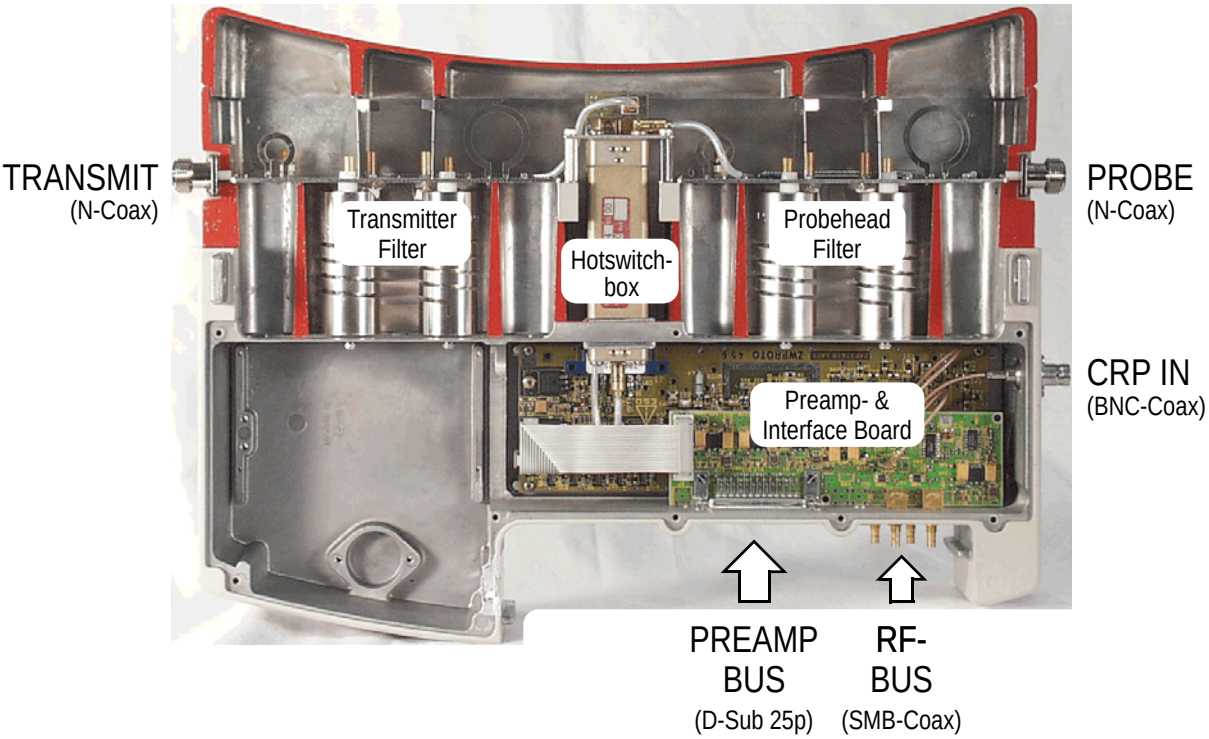


Figure 8.1 Preamp module connectors (open module)

8.1.1 1H, 3H, XBB, 31P, 13C, 15N Module

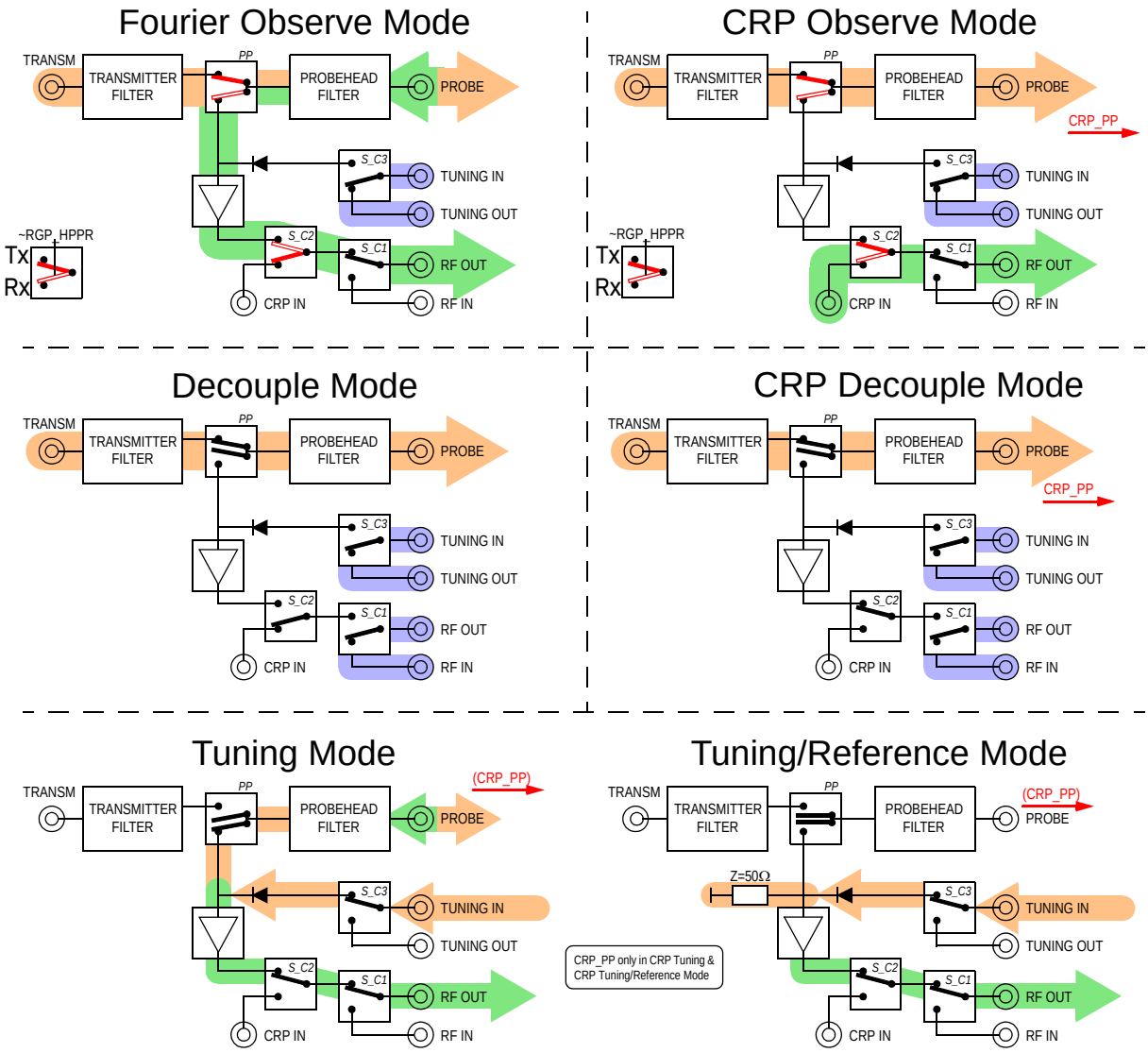


Figure 8.2 Measurement modes 1H,3H, XBB, 13C, 15N- module

8.1.2 AQS 1H PREAMP

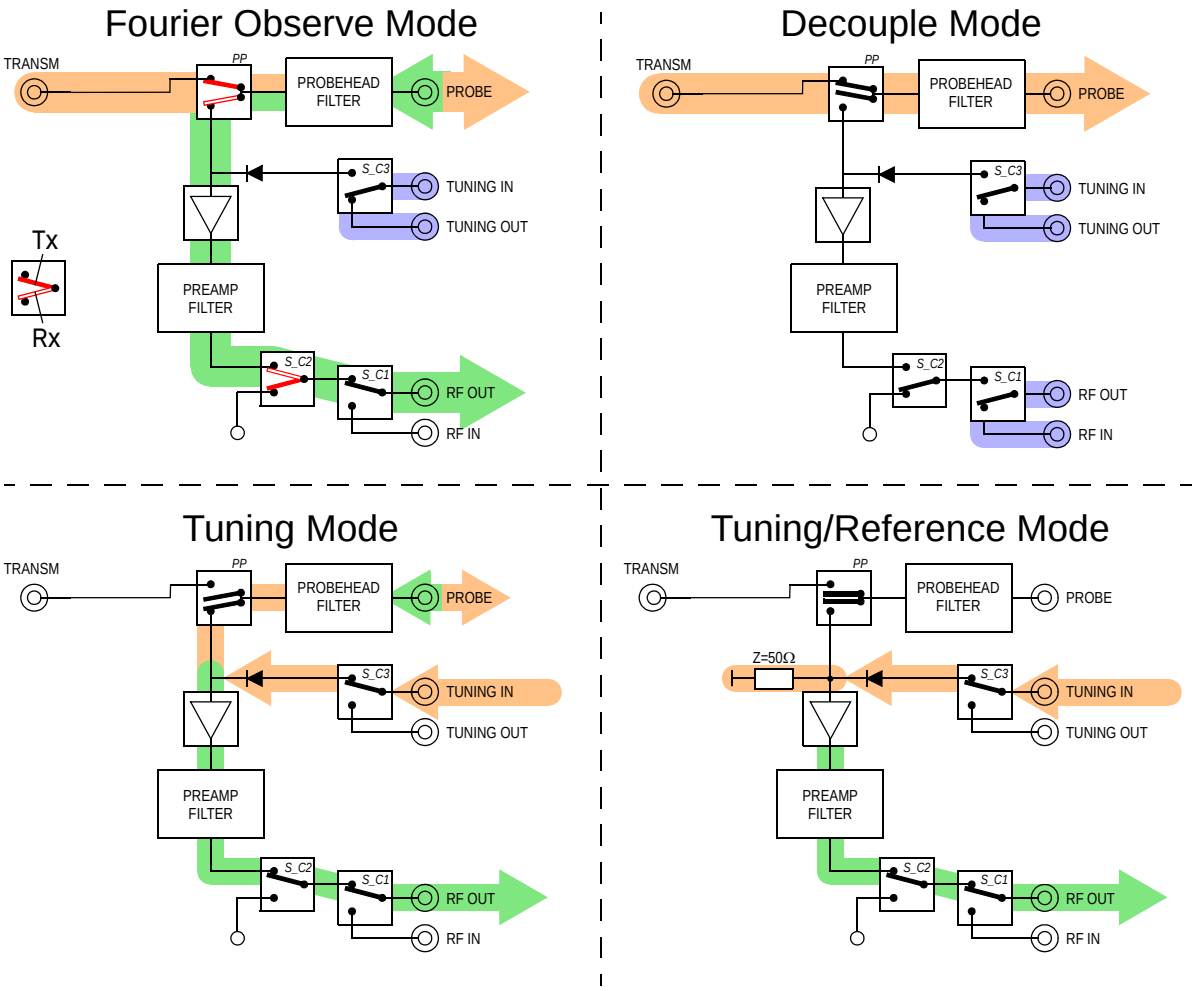


Figure 8.3 Measurement modes AQS 1H PREAMP

8.1.3 2H, 19F Module

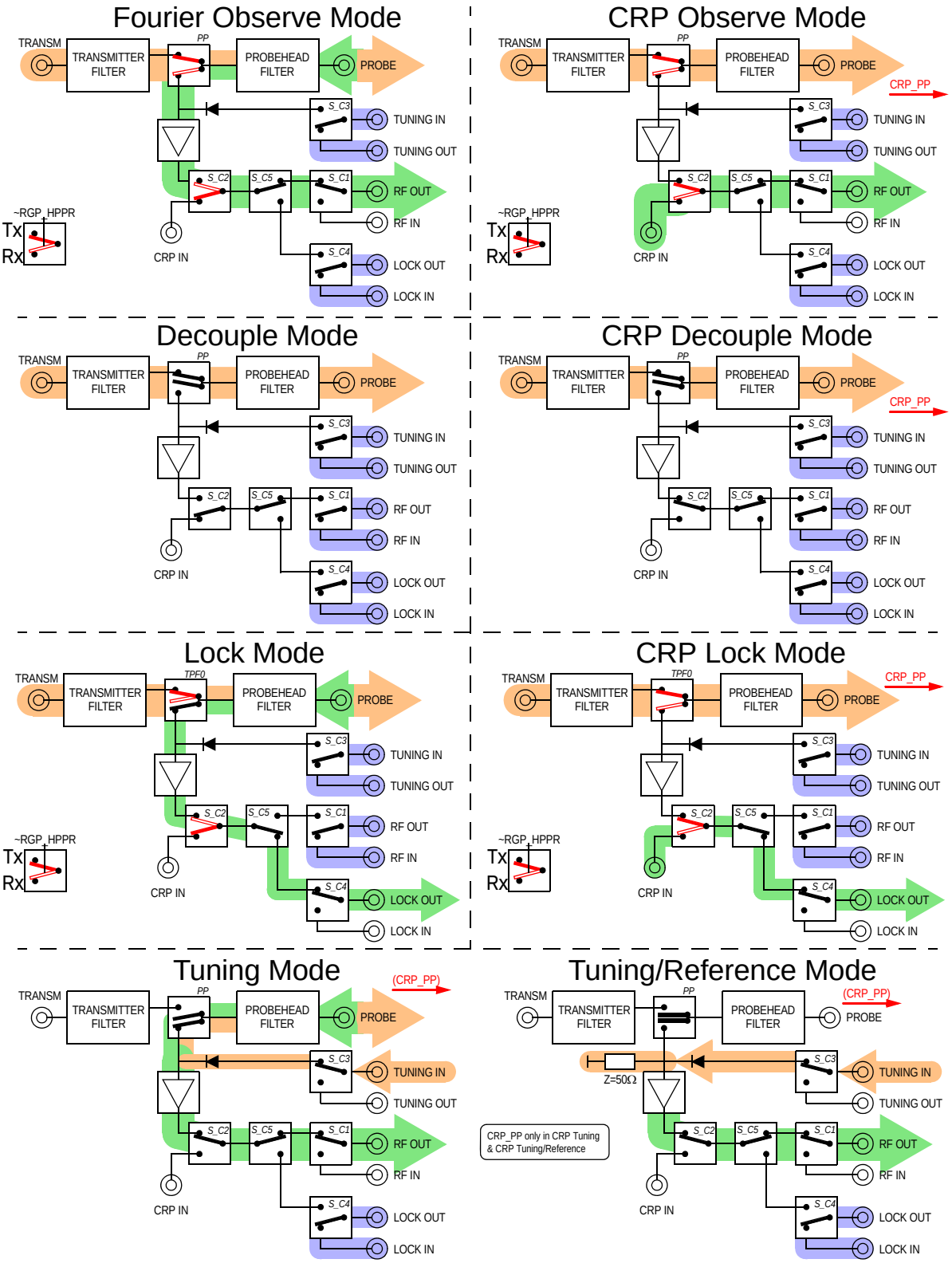


Figure 8.4 Measurement modes 2H, 19F module

8.1.4 1H2H Module

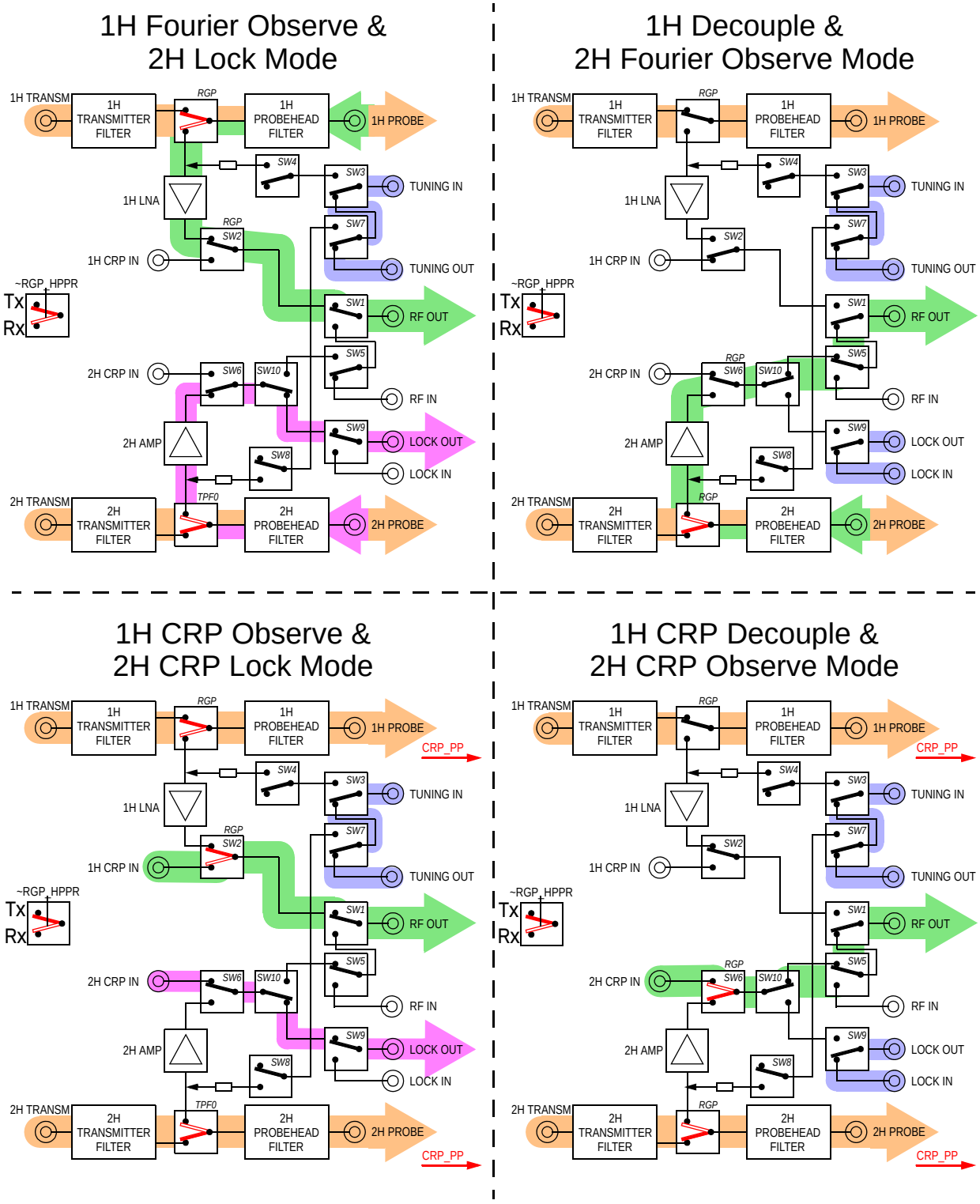


Figure 8.5 Measurement modes 1H2H module (OBS, DEC, LOCK)

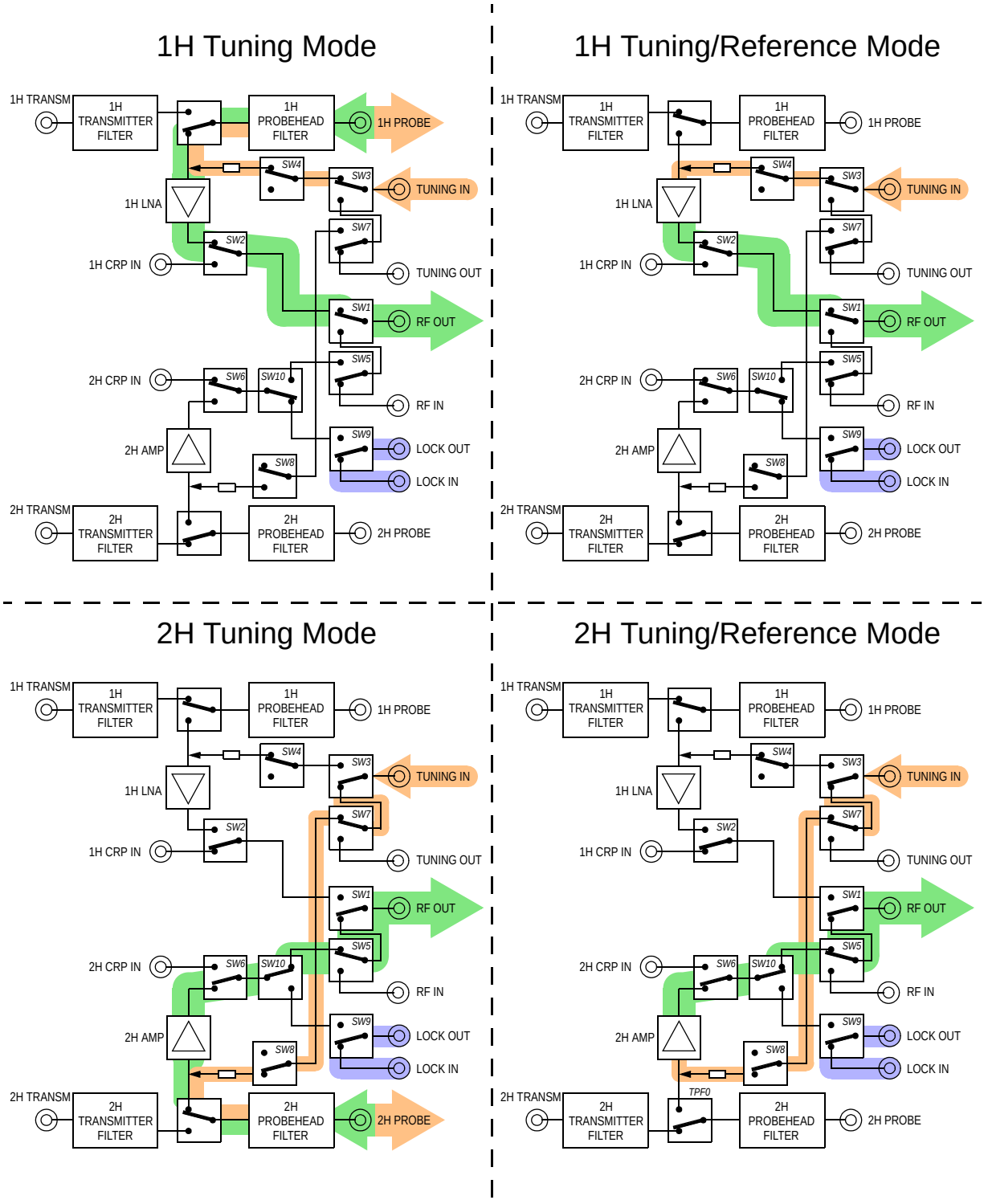


Figure 8.6 Measurement modes 1H2H module (TUN, TUN/REF)

8.1.5 1H HPLNA Module

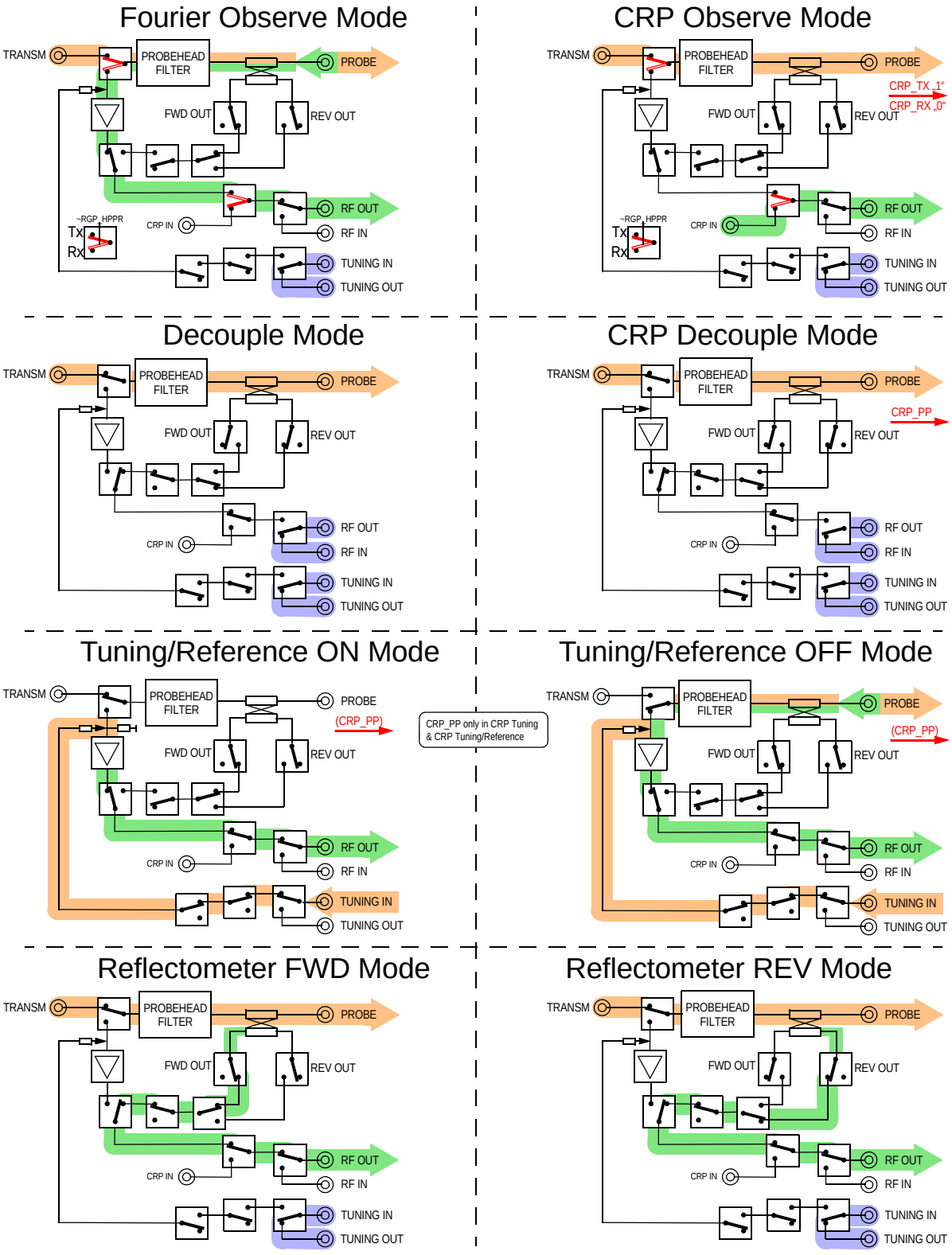


Figure 8.7 Measurement modes 19F, 1H HPLNA module

8.1.6 Interleave Increment (fast switching between different modes)

Example:

After routing the ‘2H‘ module in ‘edsp‘, TopSpin 1.3 pl 2 sets the four modes of the corresponding ‘2H‘ module for a CRP system as follows:

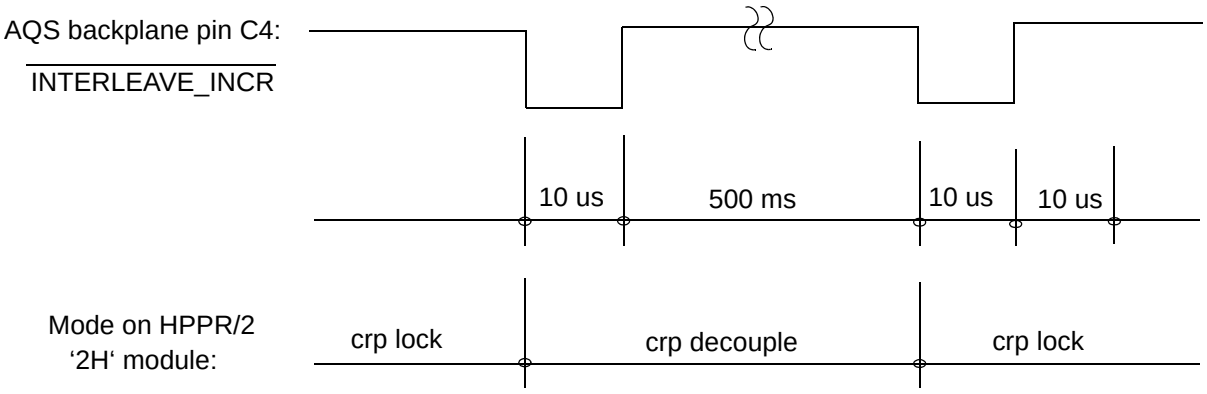
- mode 0 : crp lock
- mode 1 : crp decouple
- mode 2 : reset counter
- mode 3 : <any mode> (not used)

This short pulseprogram switches between ‘crp lock‘ and ‘crp decouple‘ mode. ‘crp decouple‘ is set for half a second (see timing diagram below).

```
1 ze
2 d1
   10u setrtp1|6
   500m setrtp1^6

   10u setrtp1|6
   10u setrtp1^6

   go=2 ph31
   30m wr #0
exit

ph1=0
ph31=0
```

setrtp1: 1 is the logical number of the observe channel. It is determined by the TopSpin command ‘edsp‘.

|6 , ^6: Set ~INTERLEAVE_INCR pulse (bit 6) on AQS backplane to low resp. to high.



8.2 HPPR/2 Modules

The figures in this section contain the blockdiagrams of the following modules:

- HPPR/2 1H2H Module
- HPPR/2 1H HPLNA Module
- AQS 1H PREAMP
- HPPR/2 19F Module
- HPPR/2 31P Module
- HPPR/2 13C Module
- HPPR/2 2H Module
- HPPR/2 15N Module
- HPPR/2 XBB19F 2HS Module
- HPPR/2 XBB19F 2HS Module
- HPPR/2 XBB31P 2HS Module
- HPPR/2 XBB31P 2HP HPLNA Module

The figures show all internal subsections and individual boards with their interconnections. Signal names, connector pin numbers and connector types are also noted.

8.2.1 1H2H Module 300, 400

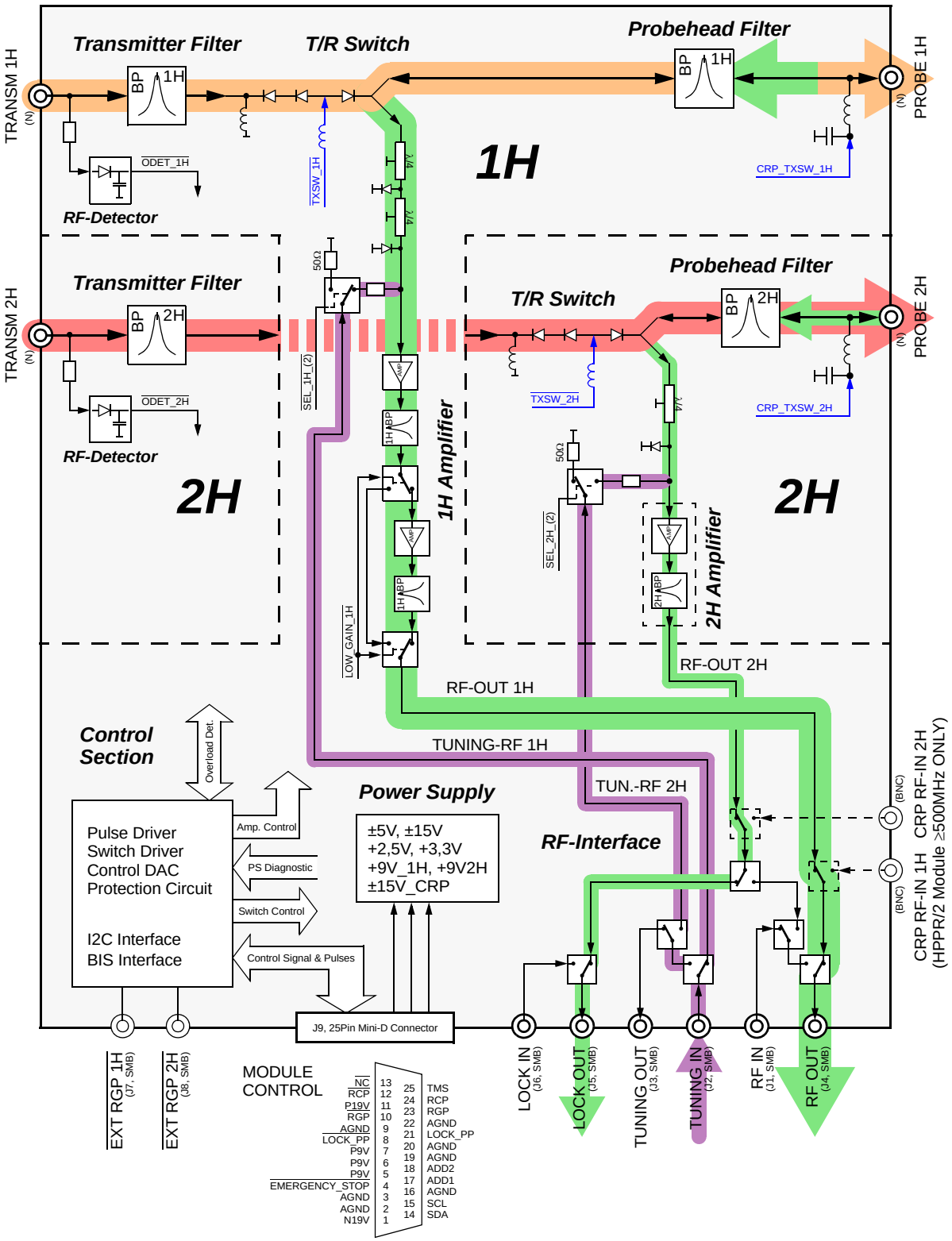


Figure 8.8 1H/2H module 300, 400 block diagram

8.2.2 1H HPLNA Module 200-1000

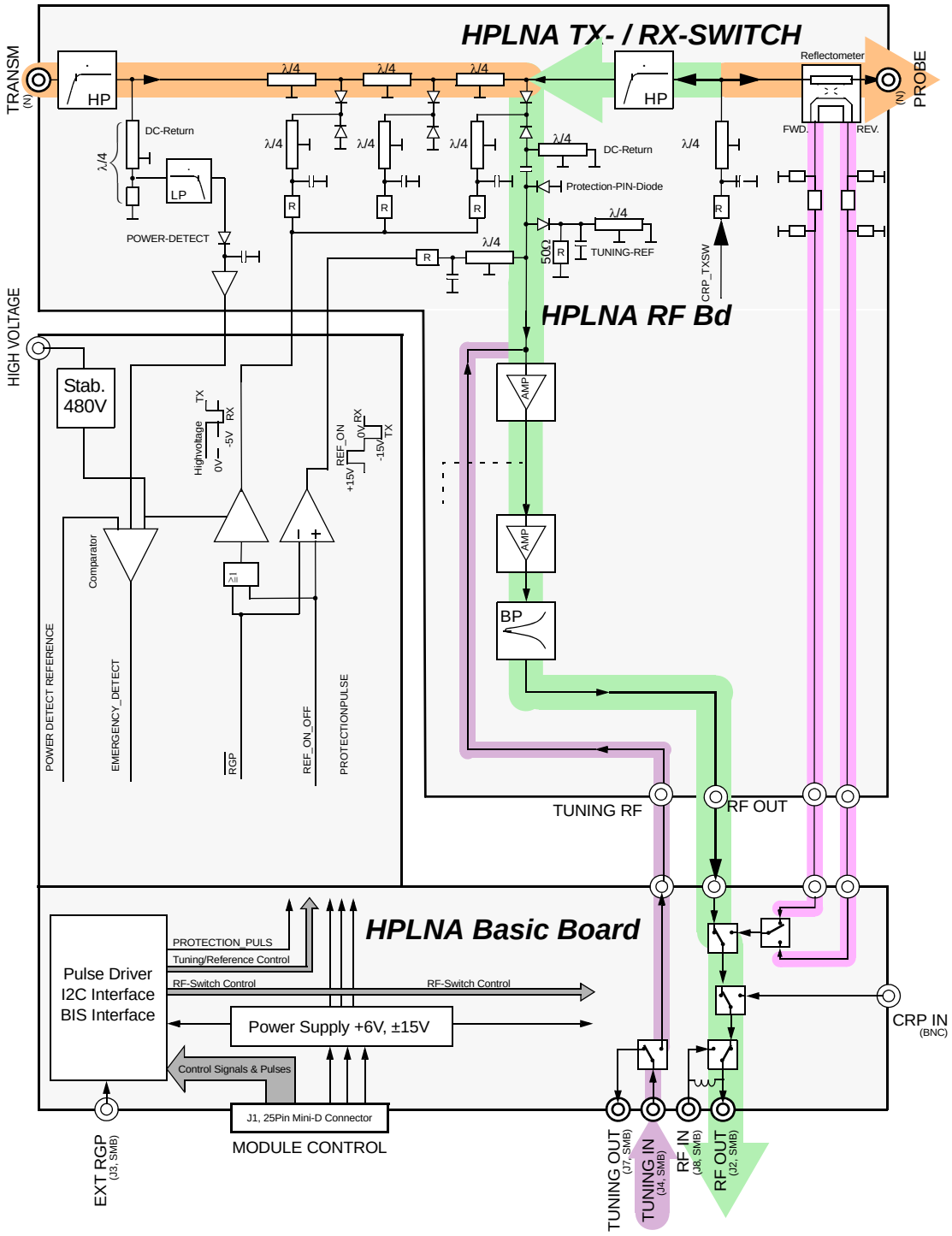


Figure 8.9 1H HPLNA module 200-1000 block diagram

8.2.3 AQS 1H Module 44.6

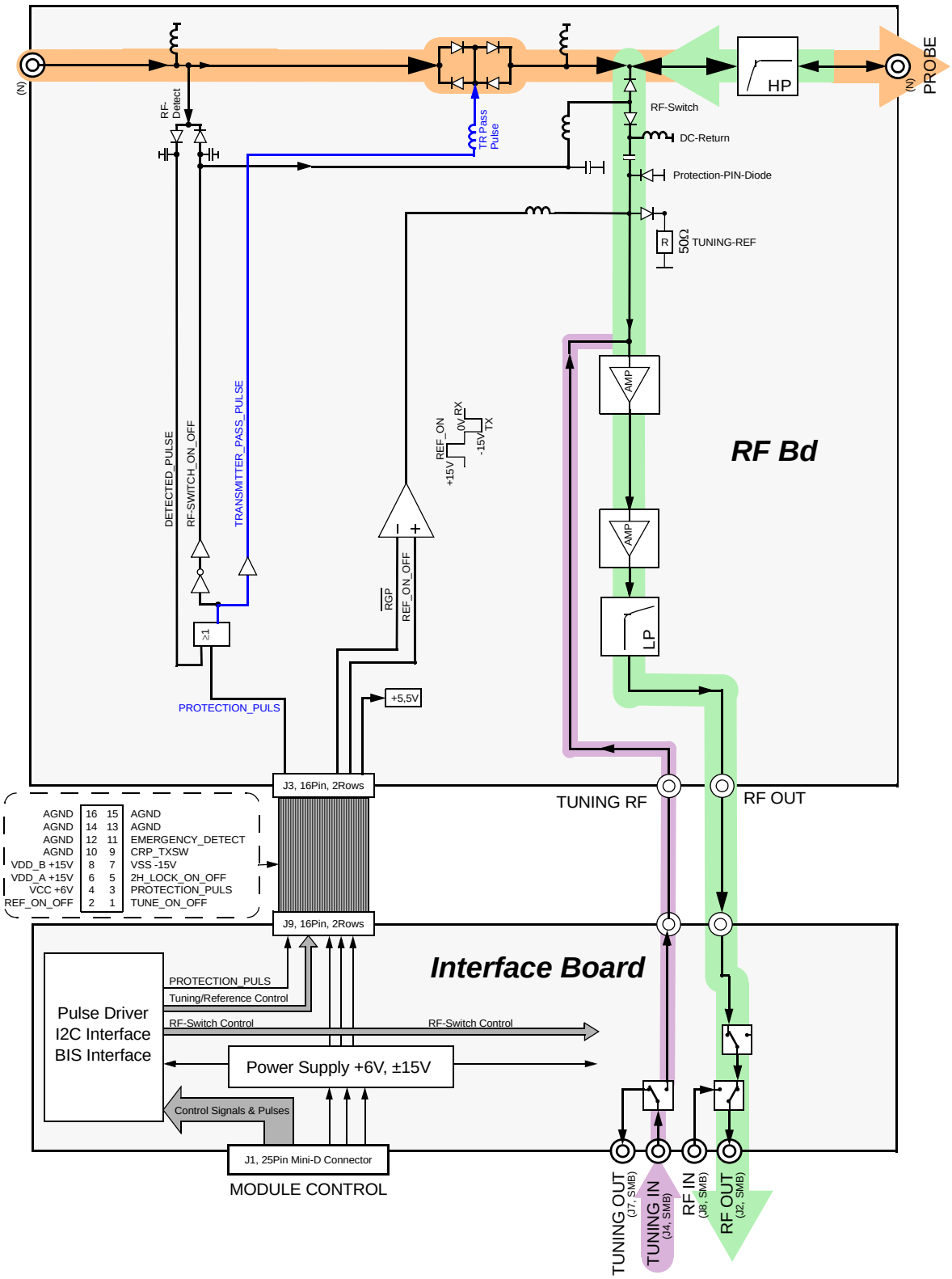


Figure 8.10 1H module 44.6 block diagram

8.2.4 19F Module 300-850

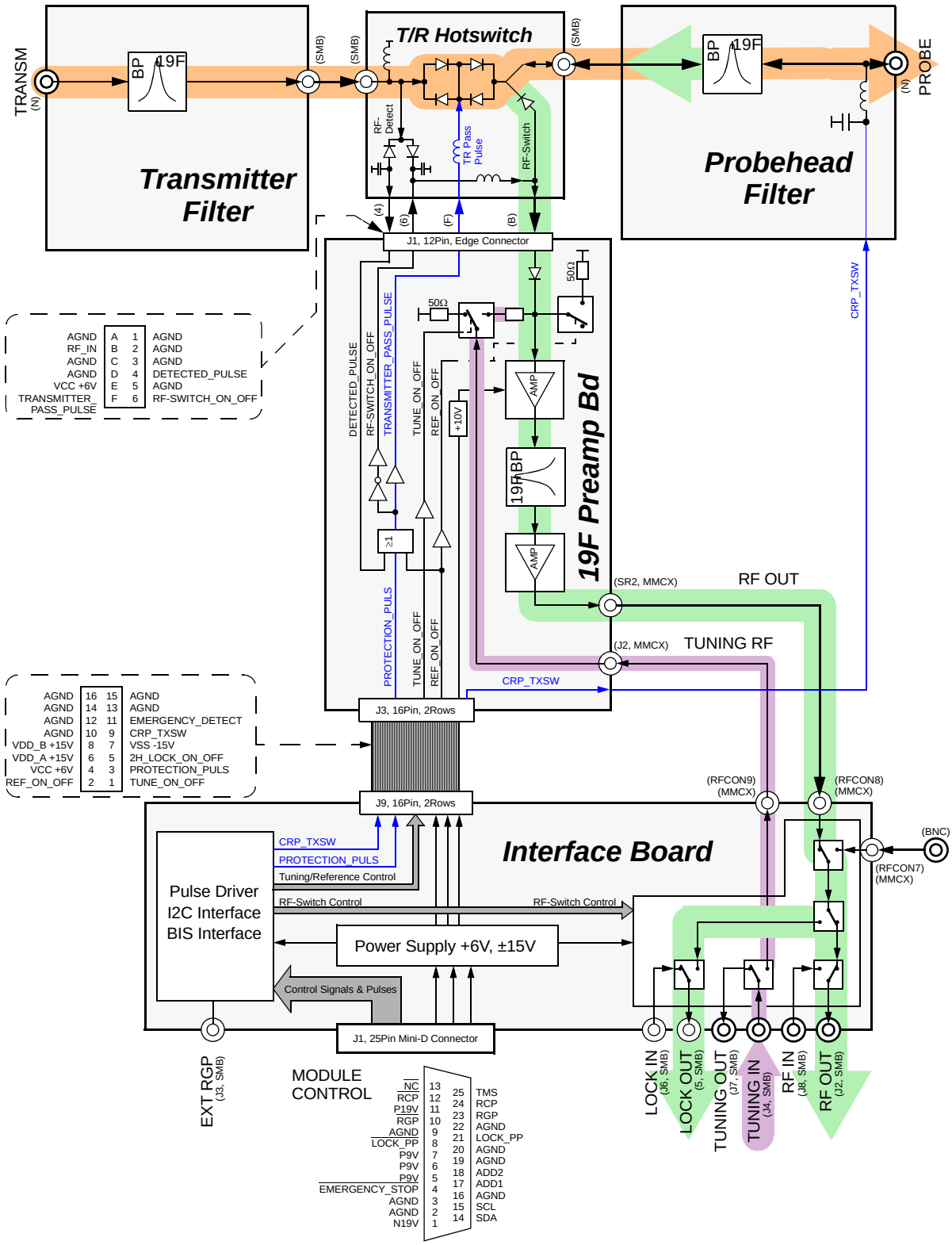


Figure 8.11 19F module 300-850 block diagram

8.2.5 31P Module 400-1000

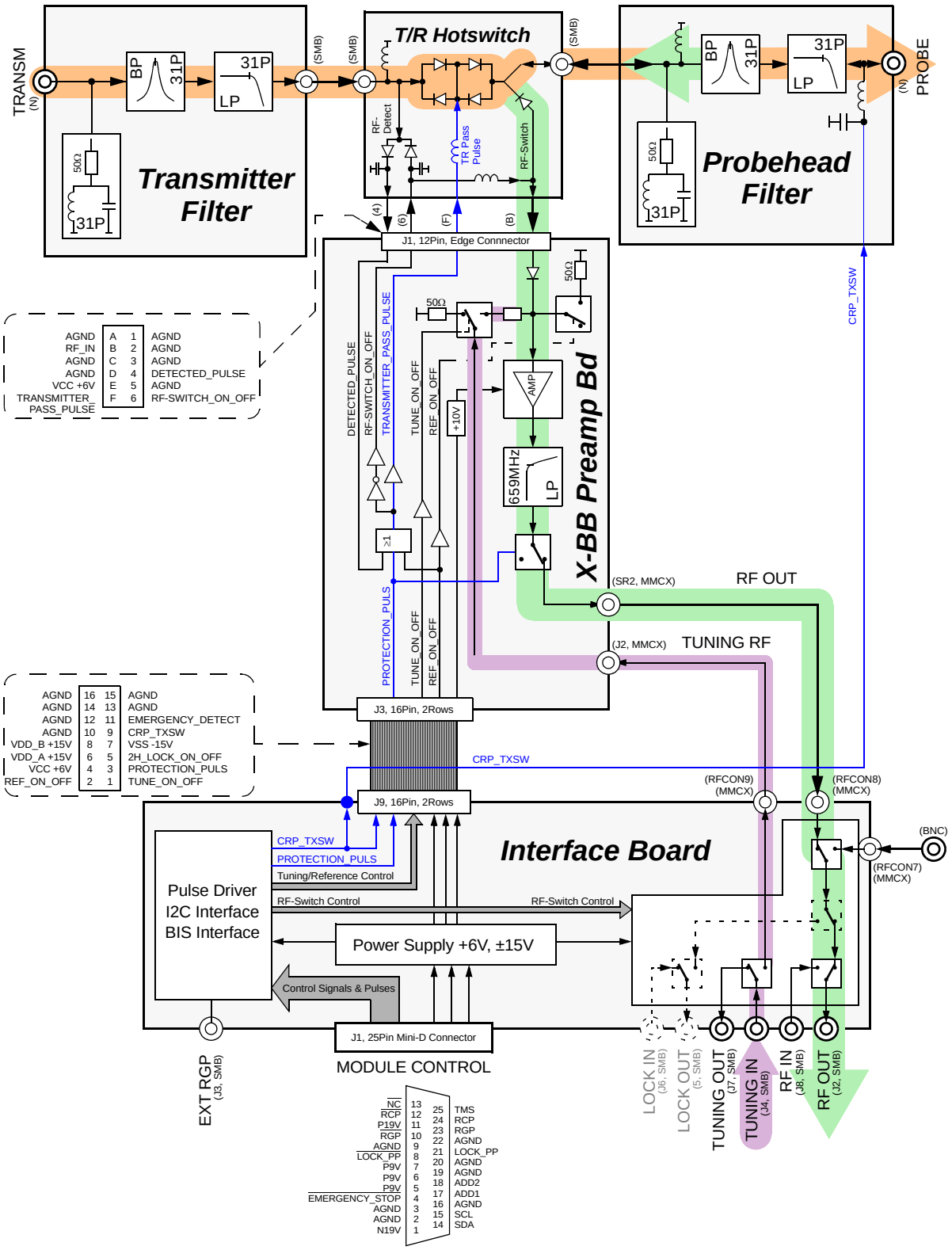


Figure 8.12 31P module 400-1000 block diagram

8.2.6 13C Module 400-1000

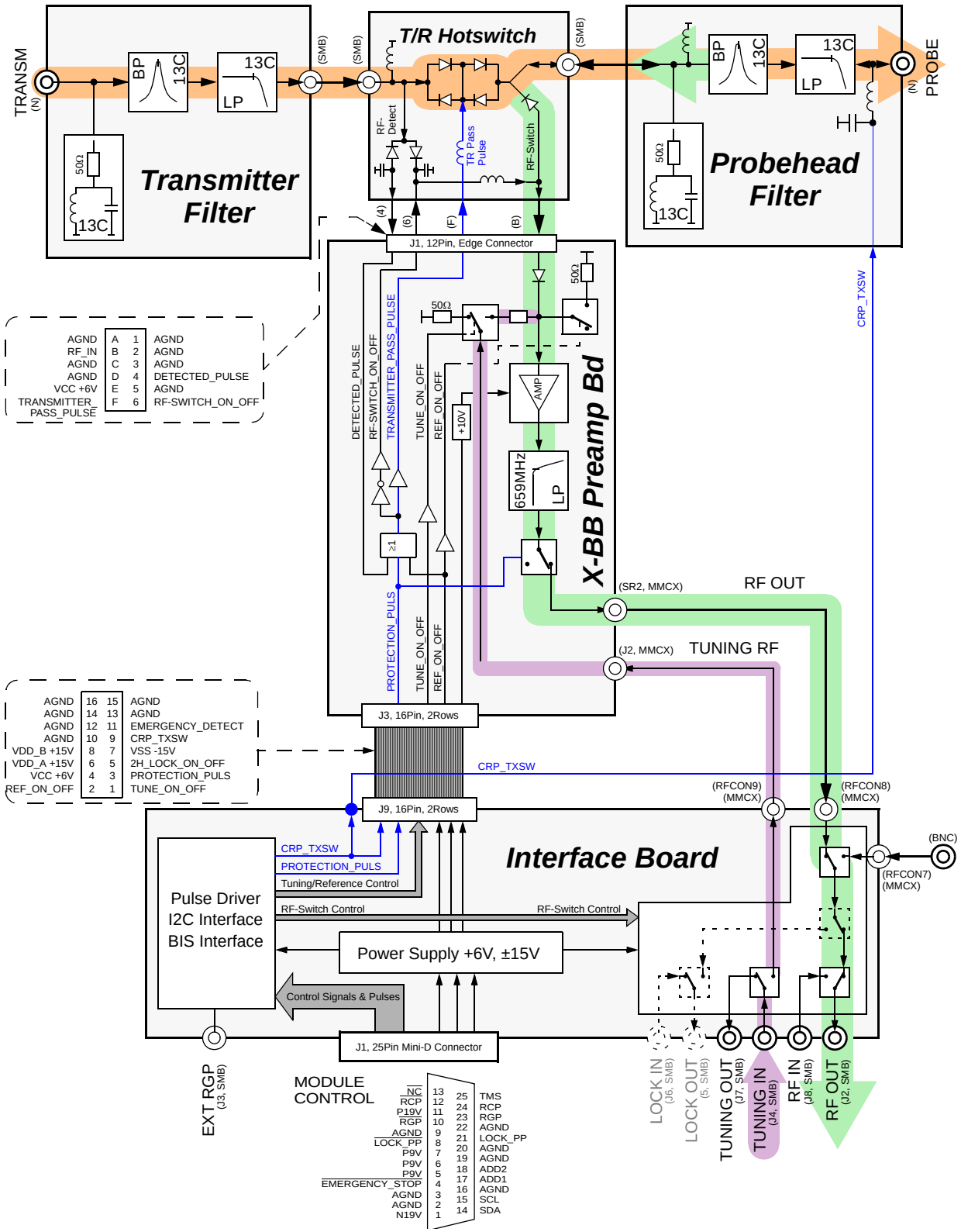


Figure 8.13 13C module 400-1000 block diagram

8.2.7 2H Module 200-1000

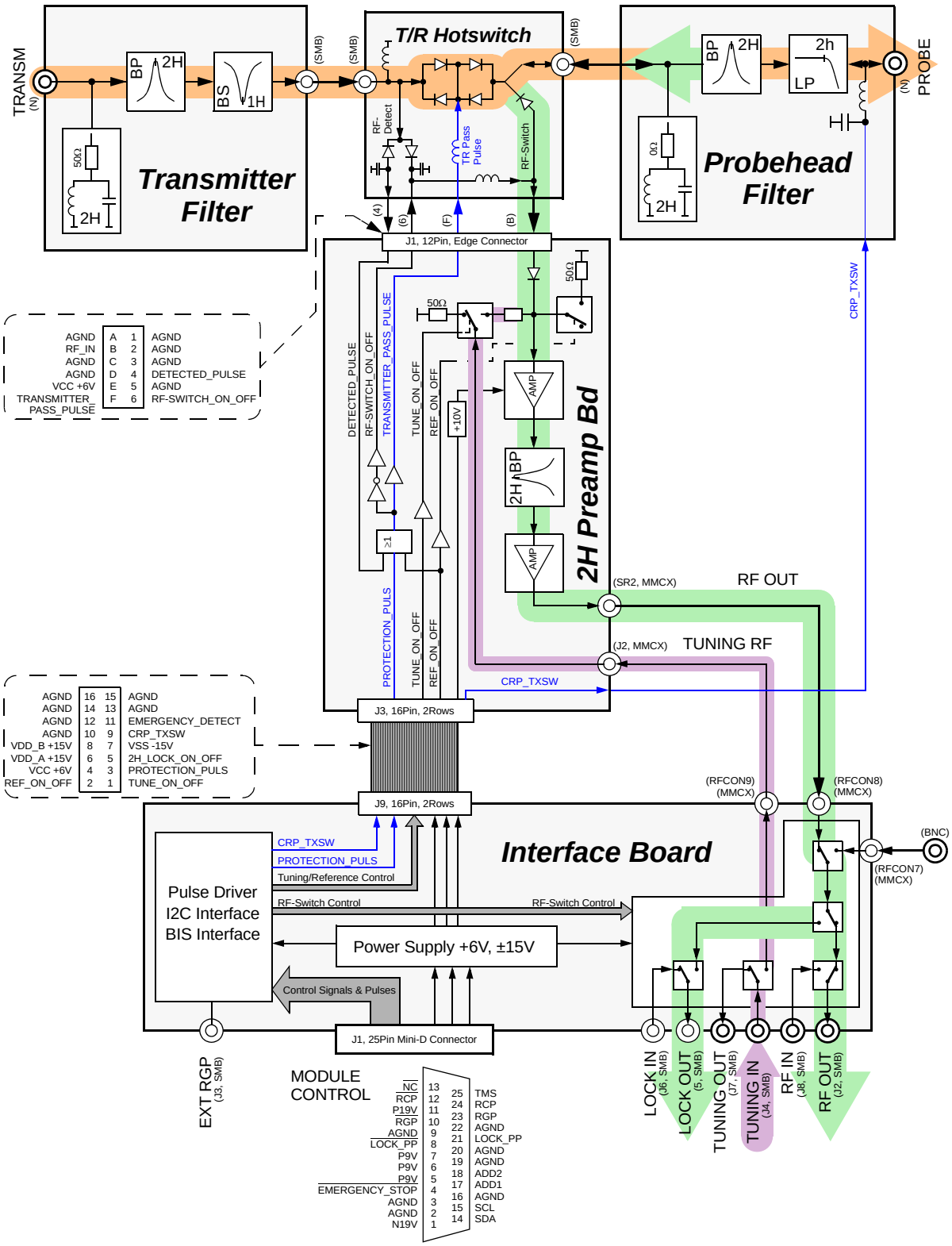


Figure 8.14 2H module 200-1000 block diagram

8.2.8 15N Module 400-1000

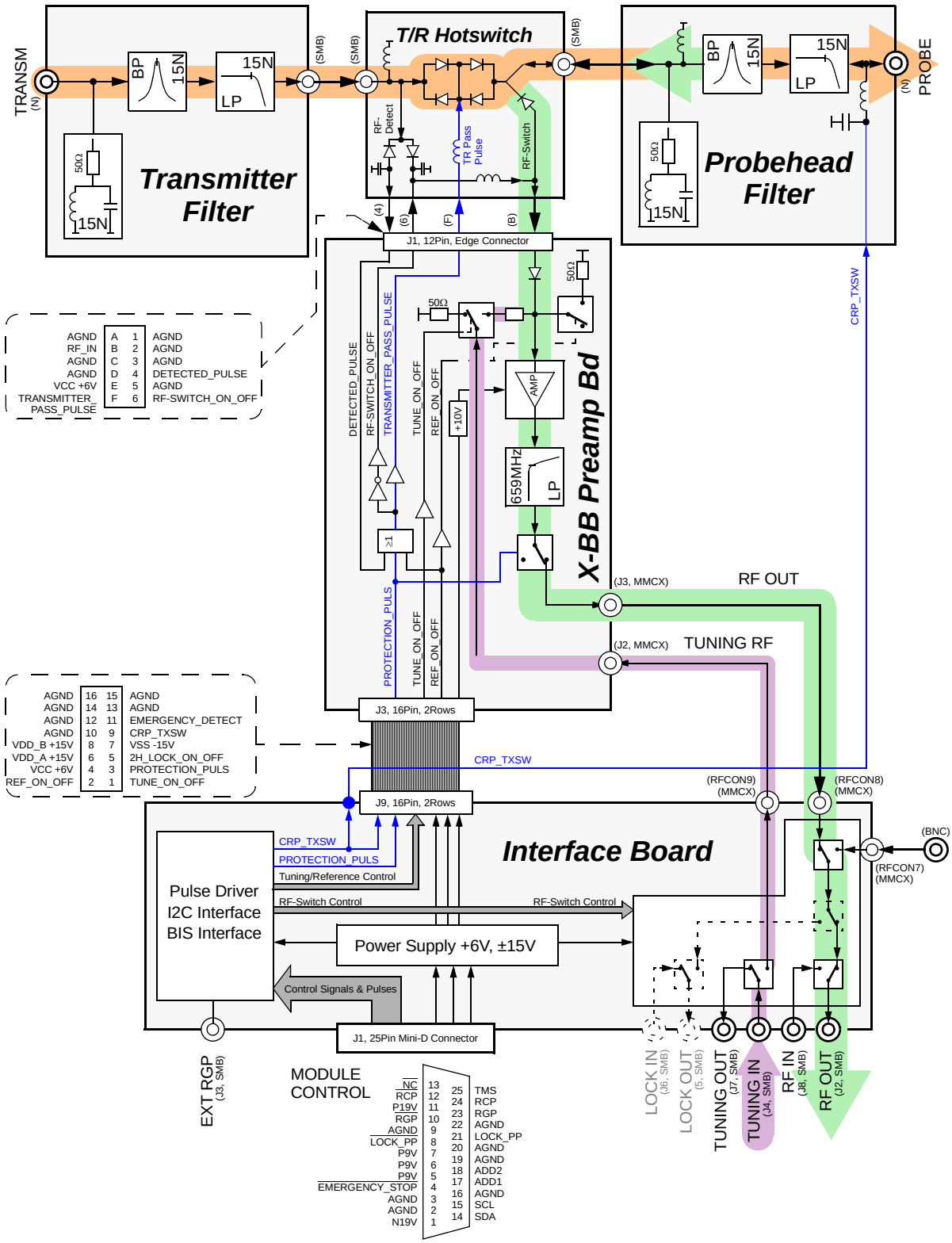


Figure 8.15 15N module 400-1000 block diagram

8.2.9 XBB19F 2HS Module 300, 400

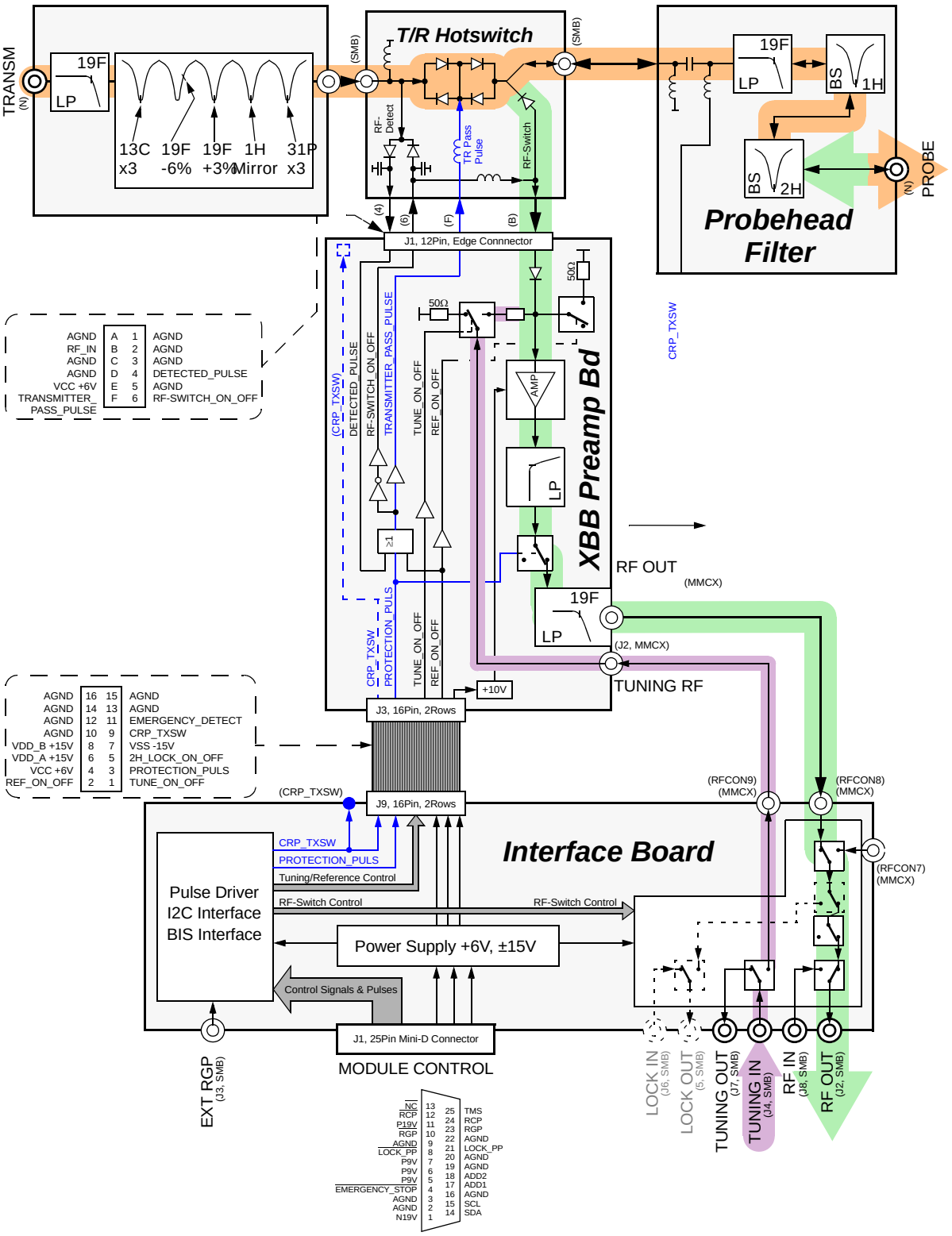


Figure 8.16 XBB-19F 2HS module 300, 400 block diagram

8.2.10 XBB19F 2HS Module 200, 250, 500-700

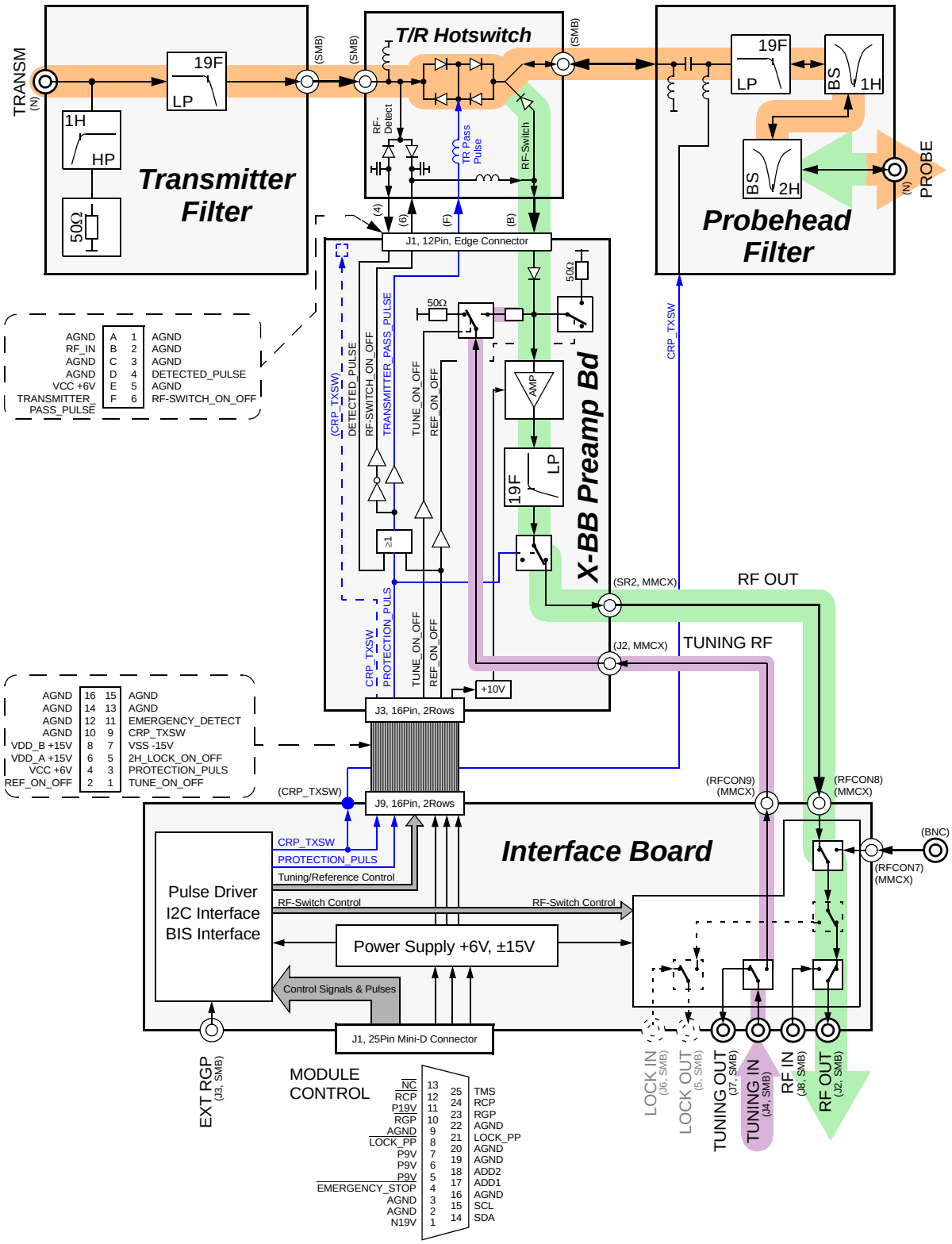


Figure 8.17 XBB-19F 2HS module 200, 250, 500-700 block diagram

8.2.11 XBB31P 2HS Module 750-1000

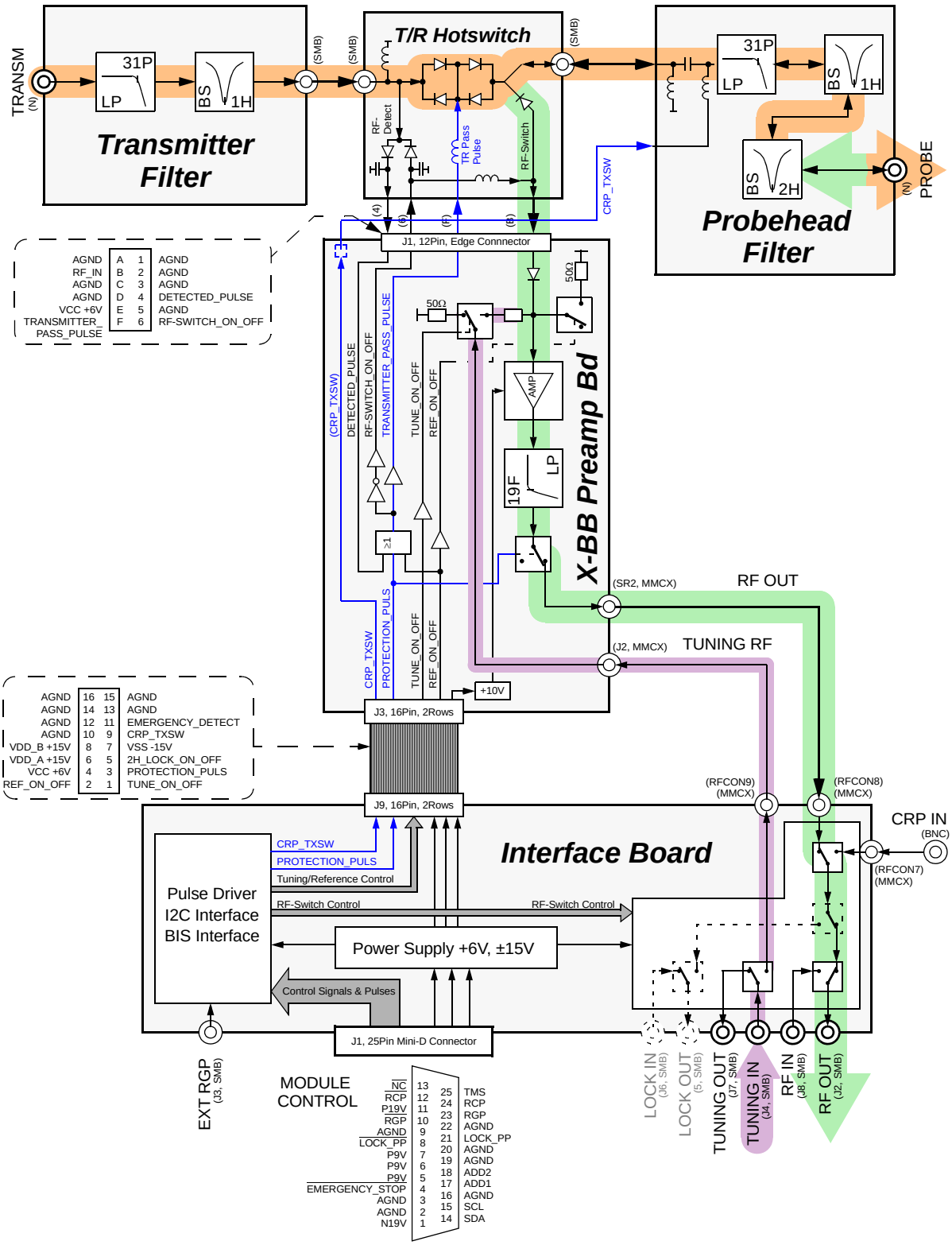


Figure 8.18 XBB-31P 2HS module 750-1000 block diagram

8.2.12 XBB31P 2HP HPLNA Module 200-1000

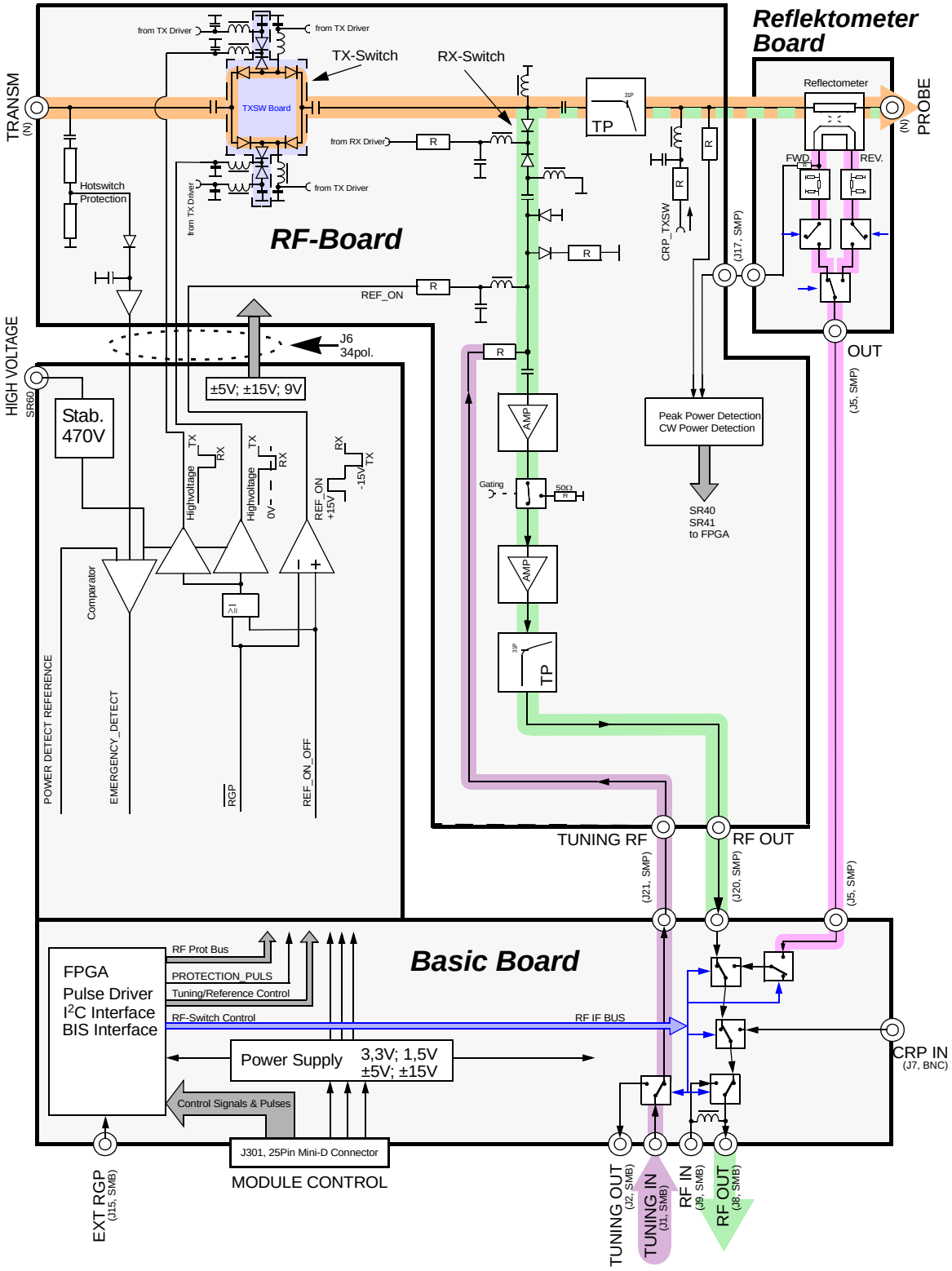


Figure 8.19 XBB31P 2HP HPLNA module 200-1000 block diagram

8.3 Technical Specifications

8.3.1 Technical Data HPPR/2 and AQS 1H2H MODULE

	300	400
1H Receive Path Performance		
Gain (typ)	30 dB	
Noise Figure (typ)	1.4 dB [a]	
1H Transmit Path Performance		
Max. Power Rating	150 W [b], 20 us, 2% Duty Cycle	
Insertion Loss 1H (typ)	2.5 dB [a]	
2H Receive Path Performance		
Gain (typ)	48 dB	
Noise Figure (typ)	1.5 dB	
2H Transmit Path Performance		
Max. Power Rating	300 W, 20 us, 2% Duty Cycle	
Insertion Loss 2H (typ)	2.2 dB	

Table 8.1 Technical data HPPR/2 and AQS 1H2H module

a. all filters included

b. valid for Z003958, Z003959 ECL>=04 and Z003950, Z003951 ECL >=03, former preamps have a maximal power rating of 100 W

8.3.2 Technical Data HPPR/2 1H HPLNA MODULE

	200	300	400	500	600	650	700	750	800	850	900	950	1000
Receive Path Performance													
Gain (typ)	28 dB												
Noise Figure (typ)	1 dB [a]												
1dB Compression Point	≥ -12 dBm (Input Power)												
Transmit Path Performance													
Max. Power Rating	4 kW, 10 ms, 4% Duty Cycle 400 W CW												
Insertion Loss 1H	≤ 0.9 dB [a]												

Table 8.2 Technical data HPPR/2 1H HPLNA module

a. without additional external filters

The following graph shows the maximum single-pulse-power and pulse-train-power (for duty cycle 10 and 50%) for all HPLNA 1H preamplifiers. The graph is based on a simple thermal model of the internal PIN-diode switch.

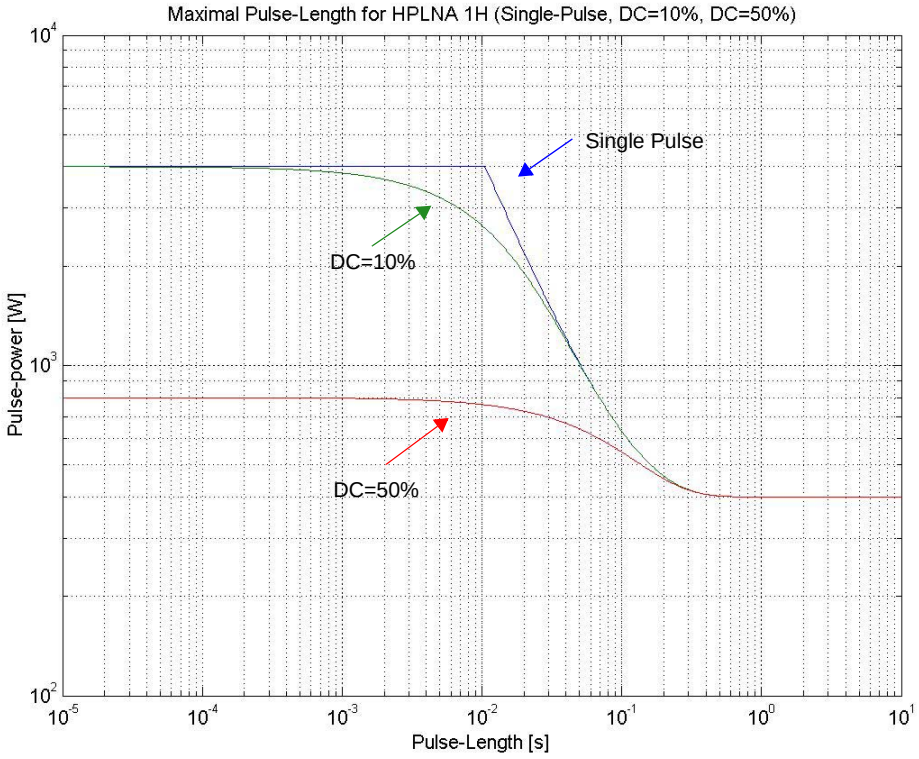


Figure 8.20 Maximum single pulse power for all HPLNA 1H preamplifiers

8.3.3 Technical Data AQS 1H PREAMP 44.6

		44,6		
Receive Path Performance				
Gain (typ)	28 dB			
Noise Figure (typ)	0.8 dB [a]			
1dB Compression Point	≥ –15 dBm (Input Power)			
Transmit Path Performance				
Max. Power Rating	400 W, 100 us, 2% Duty Cycle			
Insertion Loss 1H	≤ 0.6 dB [a]			

Table 8.3 Technical data AQS 1H PREAMP 44.6

a. without additional external filters

8.3.4 Technical Data HPPR/2 31P MODULE

	400	500	600	700	750	800	850	900	950	1000
Receive Path Performance										
Gain (typ)	28 dB									
Noise Figure (typ)	2.8 dB									
Transmit Path Performance										
Max. Power Rating	500 W, 100 us, 2% Duty Cycle									
Insertion Loss 15N	≤ 2 dB									

Table 8.4 Technical data HPPR/2 31P module

8.3.5 Technical Data HPPR/2 13C MODULE

	400	500	600	700	750	800	850	900	950	1000
Receive Path Performance										
Gain (typ)	28 dB									
Noise Figure (typ)	2.8 dB									
Transmit Path Performance										
Max. Power Rating	500 W, 100 us, 2% Duty Cycle									
Insertion Loss 13C	≤ 2 dB									

Table 8.5 Technical data HPPR/2 13C module

8.3.6 Technical Data HPPR/2 2H MODULE

	200	250	300	400	500	600	700	750	800	850	900	950	1000
Receive Path Performance													
Gain (typ)	45 dB												
Noise Figure (typ)	3dB				2.8 dB								
Transmit Path Performance													
Max. Power Rating	180 W, 100 us, 2% Duty Cycle		500 W, 100 us, 2% Duty Cycle										
Insertion Loss 2H	≤ 2dB												

Table 8.6 Technical data HPPR/2 2H module

8.3.7 Technical Data HPPR/2 15N MODULE

	400	500	600	700	750	800	850	900	950	1000
Receive Path Performance										
Gain (typ)	28 dB									
Noise Figure (typ)	2.8 dB									
Transmit Path Performance										
Max. Power Rating	500 W, 100 us, 2% Duty Cycle									
Insertion Loss 15N	≤ 2 dB									

Table 8.7 Technical data HPPR/2 15N module

8.3.8 Technical Data HPPR/2 and AQS XBB19F 2HS MODULE

	300	400	500	600	700
Receive Path Performance					
Gain (typ)	28 dB				
Noise Figure 13C (typ)	2 dB [a]				
Transmit Path Performance					
Max. Power Rating	500 W, 100 us, 2% Duty Cycle				
Insertion Loss 13C	≤ 1 dB				≤ 1.1 dB

Table 8.8 Technical data HPPR/2 and AQS[b] XBB19F 2HS module

a. all filters are included for 300 and 400MHz preamplifiers (AQS and HPPR/2)

b. for 300 and 400MHz only

The following graph shows the maximum single pulse power for the XBB19F-2HS pre-amplifier (also valid for all x-nuclei modules e.g. 15N, 13C,31P, 2H). The graph is based on a simple thermal model of the internal PIN-diode switch. If the duty cycle is low and the mean power over the entire pulse sequence doesn't exceed 10 W, the graph is valid for the power limitation.

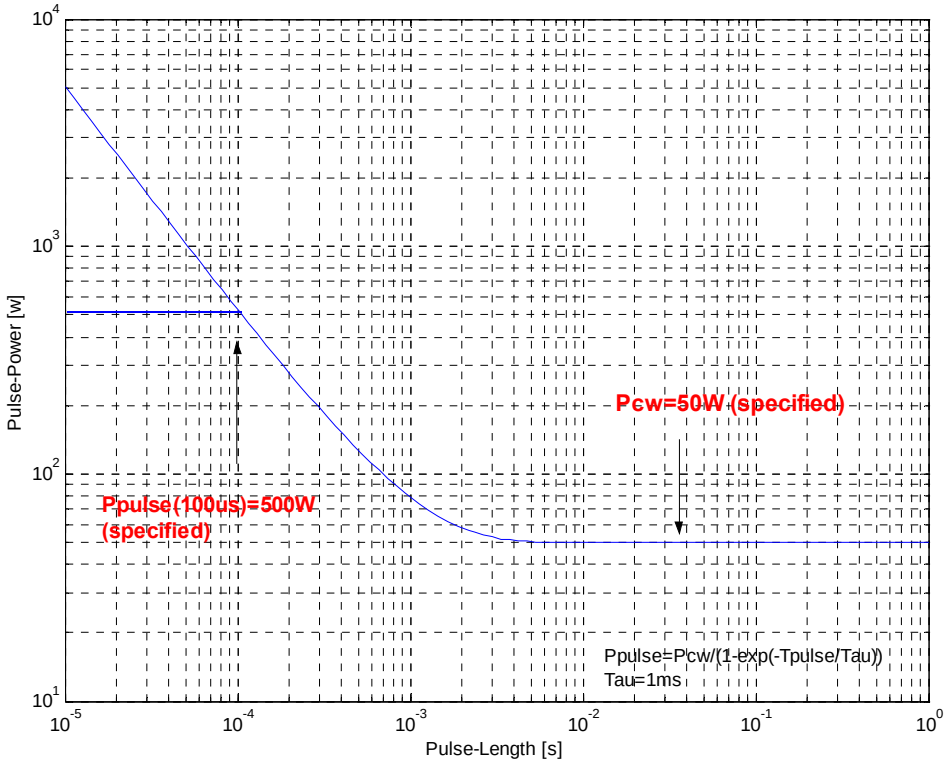


Figure 8.21 Maximum single pulse power for all x-nuclei HPPR/2 modules

8.3.9 Technical Data HPPR/2 XBB31P 2HS MODULE

	750	800	850	900	950	1000
Receive Path Performance						
Gain (typ)	28 dB					
Noise Figure 13C (typ)	2 dB					
Transmit Path Performance						
Max. Power Rating	500 W, 100 us, 2% Duty Cycle		1000 W, 100 us, 2% Duty Cycle			
Insertion Loss 13C	≤ 1.2 dB					

Table 8.9 Technical data HPPR/2 XBB31P 2HS module

8.3.10 Technical Data HPPR/2 XBB31P 2HP HPLNA MODULE

Solids	200	300	400	500	600	650	700	750	800	850	900	950	1000
Receive Path Performance													
Gain (typ)	28 dB												
Noise Figure (typ)	1.2 dB [a]												
1dB Compression Point	≥ -11 dBm (Input Power)												
Transmit Path Performance													
Max. Power Rating	4 kW, 50us, 4% Duty Cycle 70 W CW												
Insertion Loss 31P	≤ 0.6 dB [a]												

Table 8.10 Technical data HPPR/2 XBB31P 2HP HPLNA module

a. without additional external filters

The following graph shows the maximum single-pulse-power and pulse-train-power (for duty cycle 10 and 50%) for all HPLNA-XBB preamplifiers. The graph is based on a simple thermal model of the internal PIN-diode switch.

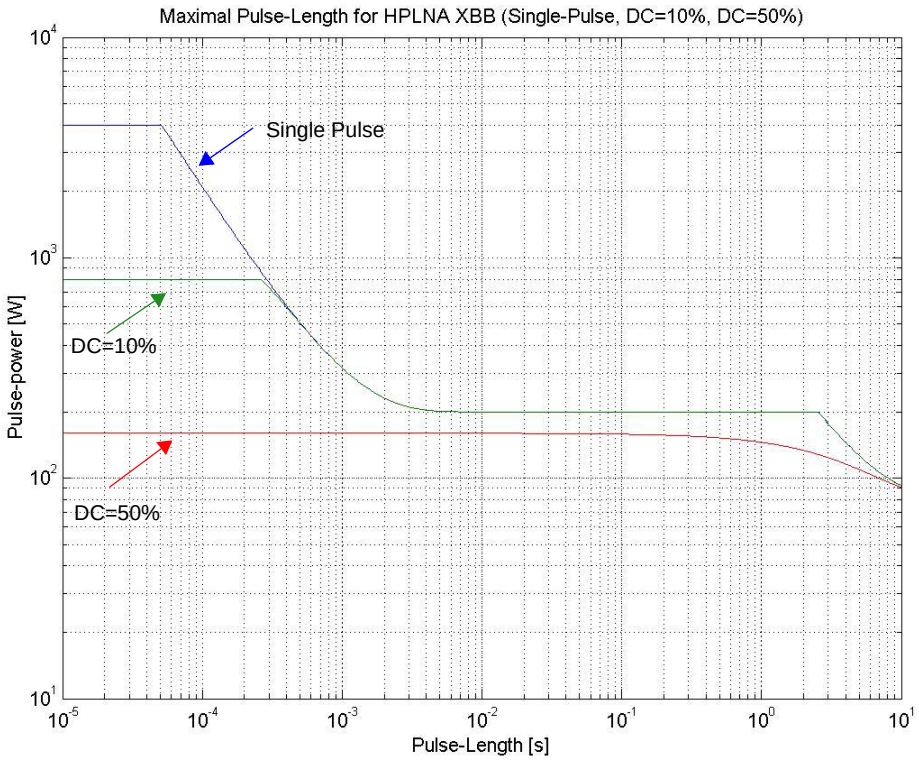


Figure 8.22 Maximum single pulse power for all HPLNA XBB preamplifiers

8.3.11 Technical Data HPHP/2 19F/1H MODULE (obsolete)

	200	300	360	400	500	600	700	750	800	900
Receive Path Performance										
Gain 1H (typ)	28 dB									
Noise Figure 1H (typ)	2.2 dB						2.4 dB			2.7dB
Transmit Path Performance										
Max. Power Rating	1000 W, 50 ms, 10% Duty Cycle									
Insertion Loss 1H	≤ 2 dB						≤ 2.3 dB			

Table 8.11 Technical data HPHP/2 19F/1H module

8.3.12 Technical Data HPHP/2 XBB31P MODULE (obsolete)

	100-360	400-750	800-1000
Receive Path Performance			
Gain 1H (typ)	32 dB		
Noise Figure[a] (typ)	1.6 dB		
Transmit Path Performance			
Max. Power Rating	1000 W, 50 ms, 10% Duty Cycle		

Table 8.12 Technical data HPHP/2 XBB31P module

a. e.g. with Filterbox Z002696 120-210MHz

8.3.13 Technical Data HPPR/2 1H LNA MODULE (obsolete)

	500	600	700	750	800	900
Receive Path Performance						
Gain (typ)	28 dB					
Noise Figure (typ)	1 dB [a]				1.15 dB [a]	
Transmit Path Performance						
Max. Power Rating	100 W, 20 us, 2% Duty Cycle					
Insertion Loss 1H	≤ 1.9 dB [a]					

Table 8.13 Technical data HPPR/2 1H LNA module

a. without additional external filters

Preamplifier Modules

9 QNP Module

9.1 General

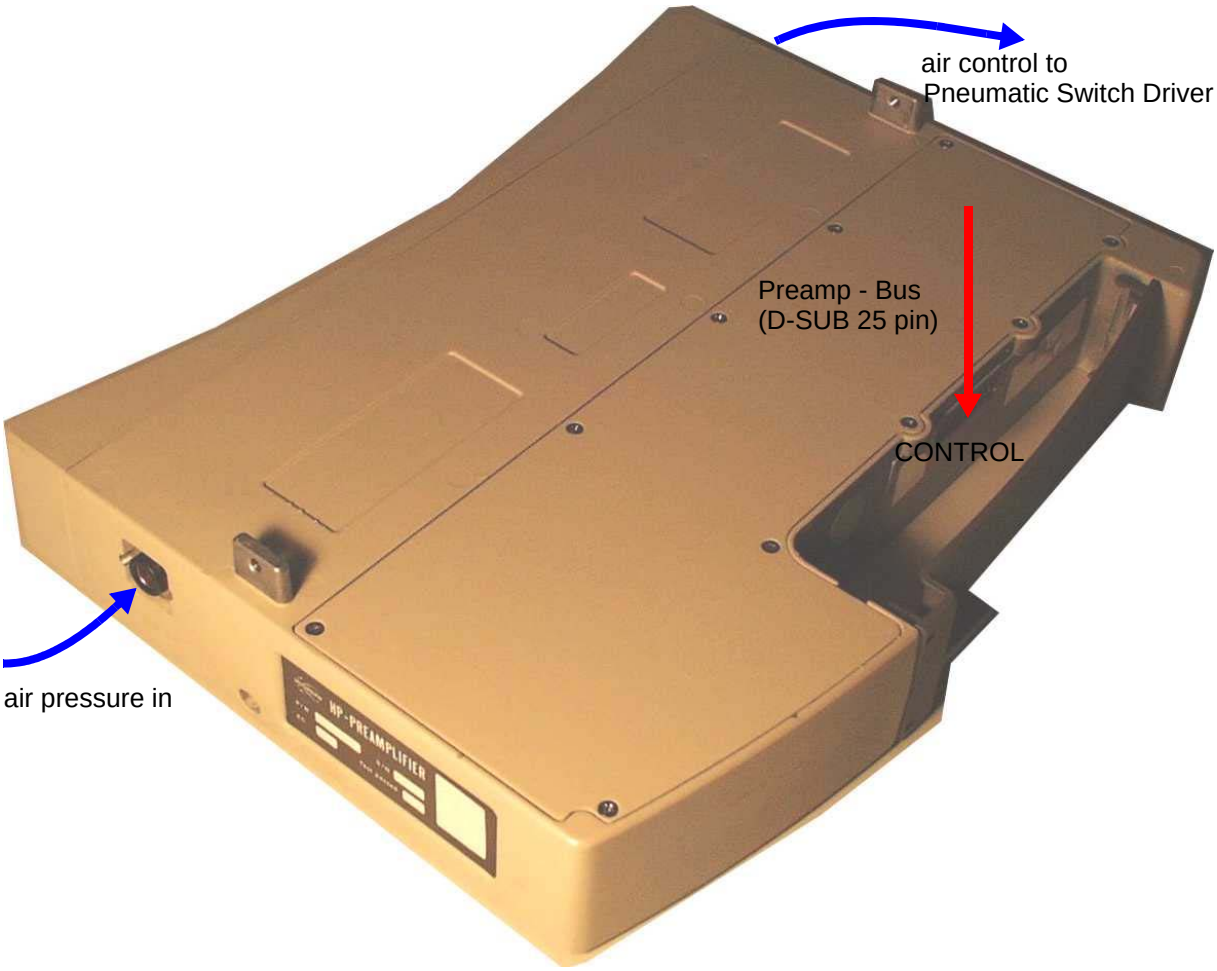


Figure 9.23 View

9.1.1 QNP Functional Description

Using only one Probehead, the QNP System (Quadro Nucleus Probe) allows the measurement of four different nuclei, 1H and three user determined nuclei, e.g. 19F / 31P / 13C or 31P / 13C / 15N. This is enabled by the triple-switchable measurement-channel in the QNP Probehead.

The QNP Module is the interface between the electronics and pneumatics. It is controlled electrically via the SBS bus (Console to Cover Module) and the Preamp bus (Cover Module to QNP Module). The LCD on the Cover Module shows the actual status. The three-level operation of the tuning-rod is controlled by two pneumatic cyclinders in the Pneumatic Switch Drive. The associated control valve is positioned in the QNP Module.

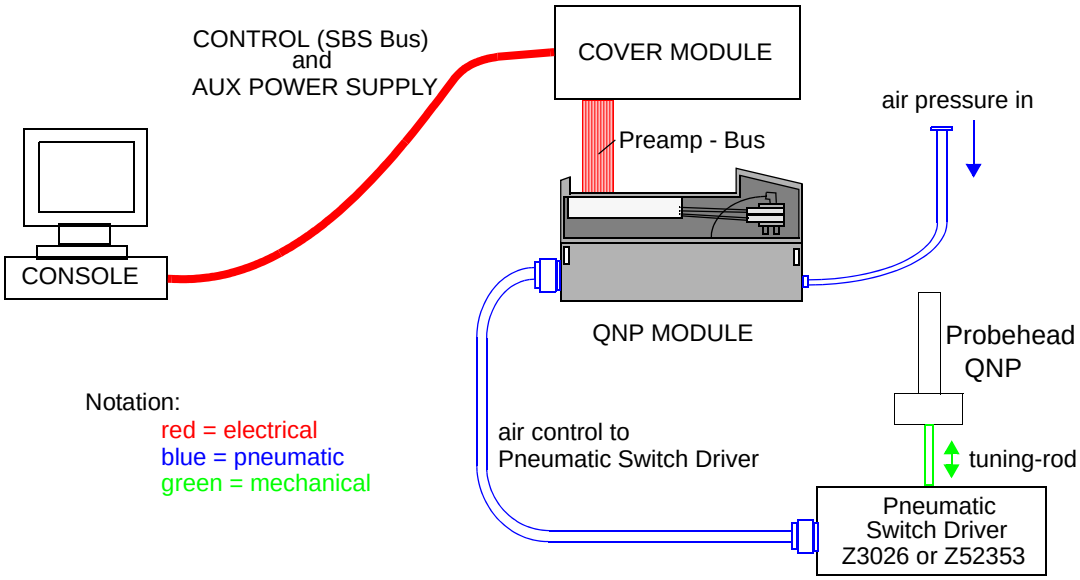


Figure 9.24 Interfaces of QNP module

9.1.2 Installation of the QNP Module

There is nothing special to know about the installation of the QNP Module. Just connect the QNP Module as bottom module and init the system with TopSpin (“cf”). Now TopSpin should have found the QNP Module and you will be able to control the QNP Probehead by switching the air current with the connected QNP Module.

9.2 Functionality

9.2.1 Topology

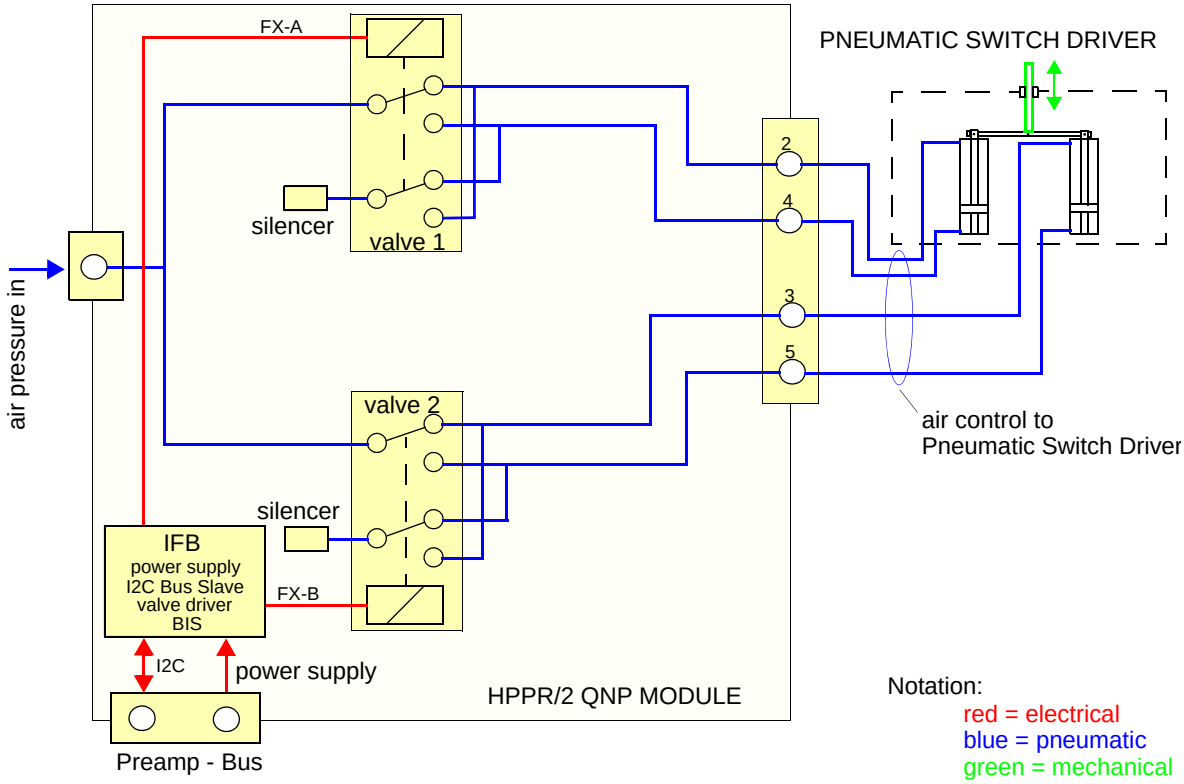


Figure 9.25 Blockdiagram HPPR/2 QNP module

9.2.2 IFB (Interface Board)

The Interface Board (IFB) is the central control board in the QNP Module. It contains following parts:

1. power supply and monitoring for internal and valve control voltage
2. I2C Bus slave interface
3. valve control driver
4. BIS (Bruker Information System)

This function blocks will be described in the following chapters.

Power Supply and Monitoring

The QNP Module uses the HPPR +9V voltage for supplying the control logic on the IFB and the HPPR +19V for controlling the pneumatic valve.

Both voltages are supplied via Preamp bus from Cover Module and are filtered and stabilized on the IFB. The operation of the on-board power stabilization is monitored. In case of failure, the HPPR/2 Cover Module will create an error and will display the corresponding error message on its LCD.

I2C Bus and Addressing

The QNP Control Module is an I2C slave device. The Cover Module is the master device which controls all slave devices on the Preamp bus. The addressing of the device is done by a daisy chain automatically. Therefore there mustn't be left any gaps in the Preamp bus connector and unused connections from the Preamp bus cable have to be after the last connected module.

Valve Control Driver

The pneumatic valve are driven by a 12 volt totem pole high current driver which is placed on the IFB.

BIS

The HPPR/2 QNP Module BIS data contains information about production data, ECL, hardware type, name and type of the module.

BIS information is provided via I2C bus to the Cover Module and can be read using UniTool commands.

9.2.3 Valve

There are used customer specified pneumatic valves for switching the air to the Pneumatic Switch Driver (for blockdiagram see). The valves are controlled by a 12 volt signal.

With these two valves it is possible to drive three different QNP Probehead positions. There are following rules:

Pos.	Valve 2	Valve 1	Switch Drive Position	Frequency
1 [a]	off	off	bottom	maximum
2 [b]	off	on	middle	medium
2	on	off	middle	medium
3	on	on	top	minimum

Table 9.14 Truth table pneumatic valve

a. default after power-up

b. not used since identical with next status

9.2.4 Connectors

Air pressure in

The air pressure is supplied at the “TRANSM” connector. There is a maximum pressure of 600 kPa (= 6 bar = 87 psi) allowed.

Air control to Pneumatic Switch Drive

There are four air hoses leading to the Pneumatic Switch Drive to control the QNP Probehead position.

The Table 9.14 shows how the position of the Pneumatic Switch Drive is controlled through the pneumatic valves and the corresponding air hoses.

Preamp-Bus

The QNP Module is fully electrically controlled via the Preamp bus. This is the same bus which is also connected to the HPPR/2 preamplifier modules.

The Preamp bus contains a I2C bus for controlling the module and a +9V / +19V for supplying the module. The Power Supply -19V, the Emergency Stop and real time pulse signals are not used for the QNP Module.

Signal Name	Pin No.	Remark
HPPR +19V	11	HPPR/2 power supply
HPPR -19V	1	
HPPR +9V	5, 6, 7	
GND	2, 3, 9, 16, 19, 20, 22	
EMERGENCY_STOP	4	Emergency Stop signal
RGP_HPPR	23	Real time pulse signals
$\overline{\text{RGP\_HPPR}}$	10	
LOCK_PP	8	
$\overline{\text{LOCK\_PP}}$	21	
INTERLEAVE_INCR	24	
$\overline{\text{INTERLEAVE\_INCR}}$	12	
SCL	15	I2C bus clock and data signal
SDA	14	
ADDR1	17	Daisy chain for addressing the modules.
ADDR2	18	

Table 9.15 Preamp bus connector: DSUB 25 pin

10 HPPR/2 Module Configurations

10.1 Introduction

The following chapter gives an introduction to commonly used HPPR/2 module configurations.

Other configurations are principally possible. To the following rules should be paid attention: The high resolution modules are always on the very top. High power modules (HPLNA XBB) are at the bottom.

The pictures below show a kind of maximal configurations with Cover2 module. Subsets are always possible. Try to keep the suggested module order, even in a subset configuration.

Configurations with the former Cover Module have the same structure.

10.2 HPPR/2 Configurations for High Resolution

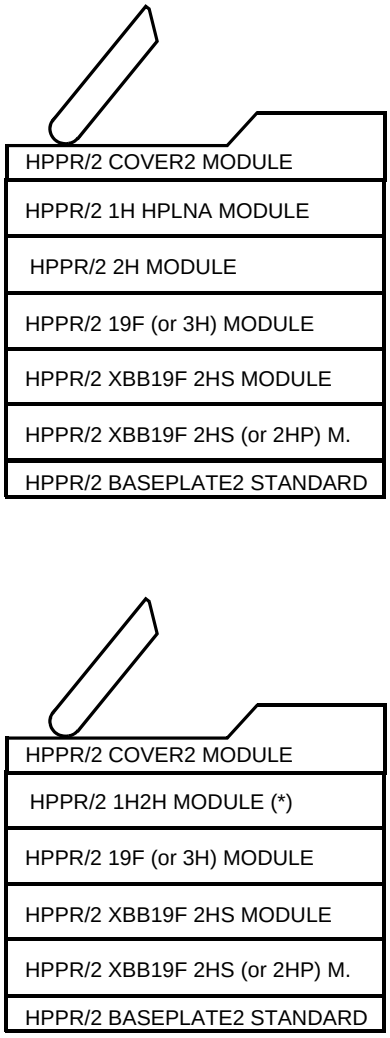


Figure 10.1 HPPR/2 configurations for high resolution

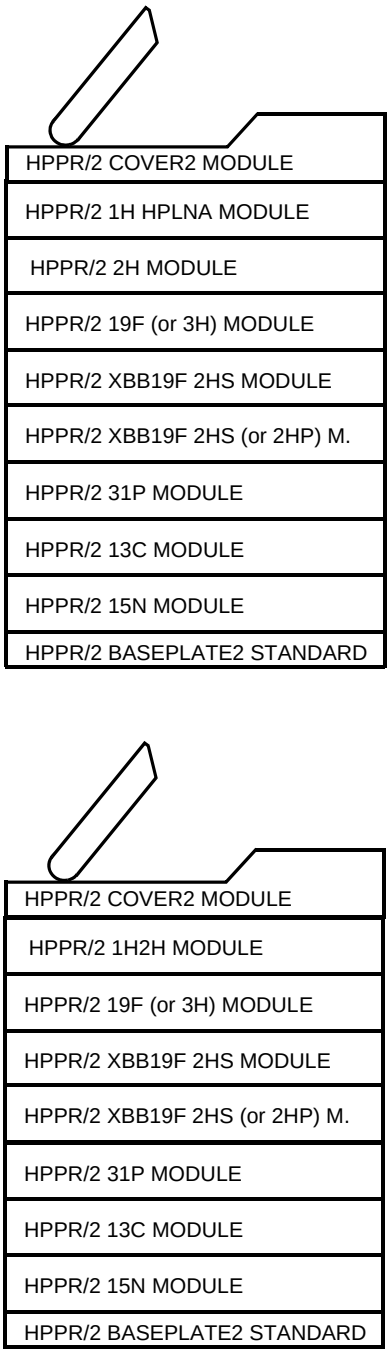


Figure 10.2 HPPR/2 configurations for cryoprobes

10.3 HPPR/2 Configurations for High Power

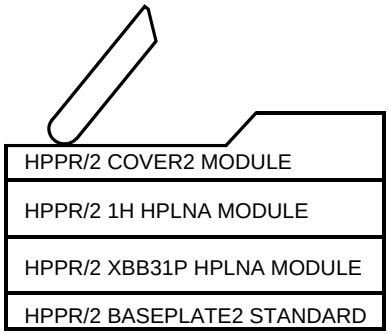


Figure 10.3 HPPR/2 configuration for high power

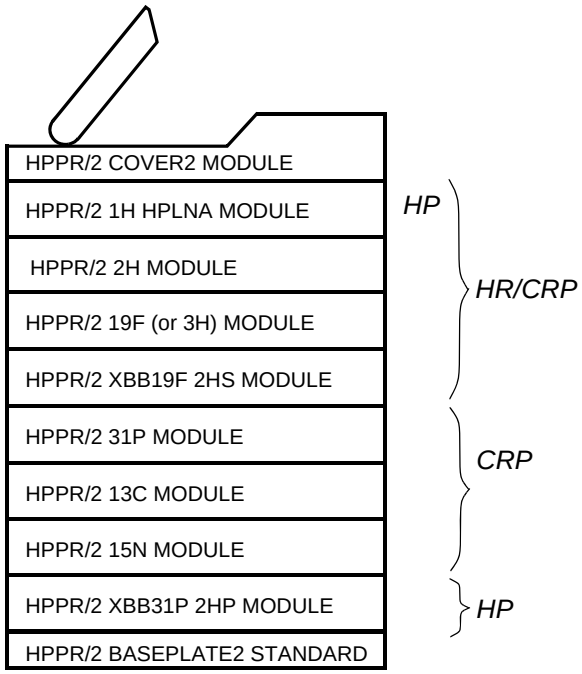


Figure 10.4 HPPR/2 configuration for high power, high resolution and CRP

10.3.1 HPPR/2 Dual-Receive RF-Wiring

The following diagram presents an exemplary Dual-Receive-Wiring for a high-resolution HPPR/2 assembly. The bottom module is being treated as separate receiving channel. On the other hand all other modules are daisy-chained to the other receiver-channel. If existing, move the 13C module to the bottom (CRP configuration). In a non-CRP assembly, wire the XBB19F-2HS or XBB31P-2HS to the separate receiving channel (RXAD1).

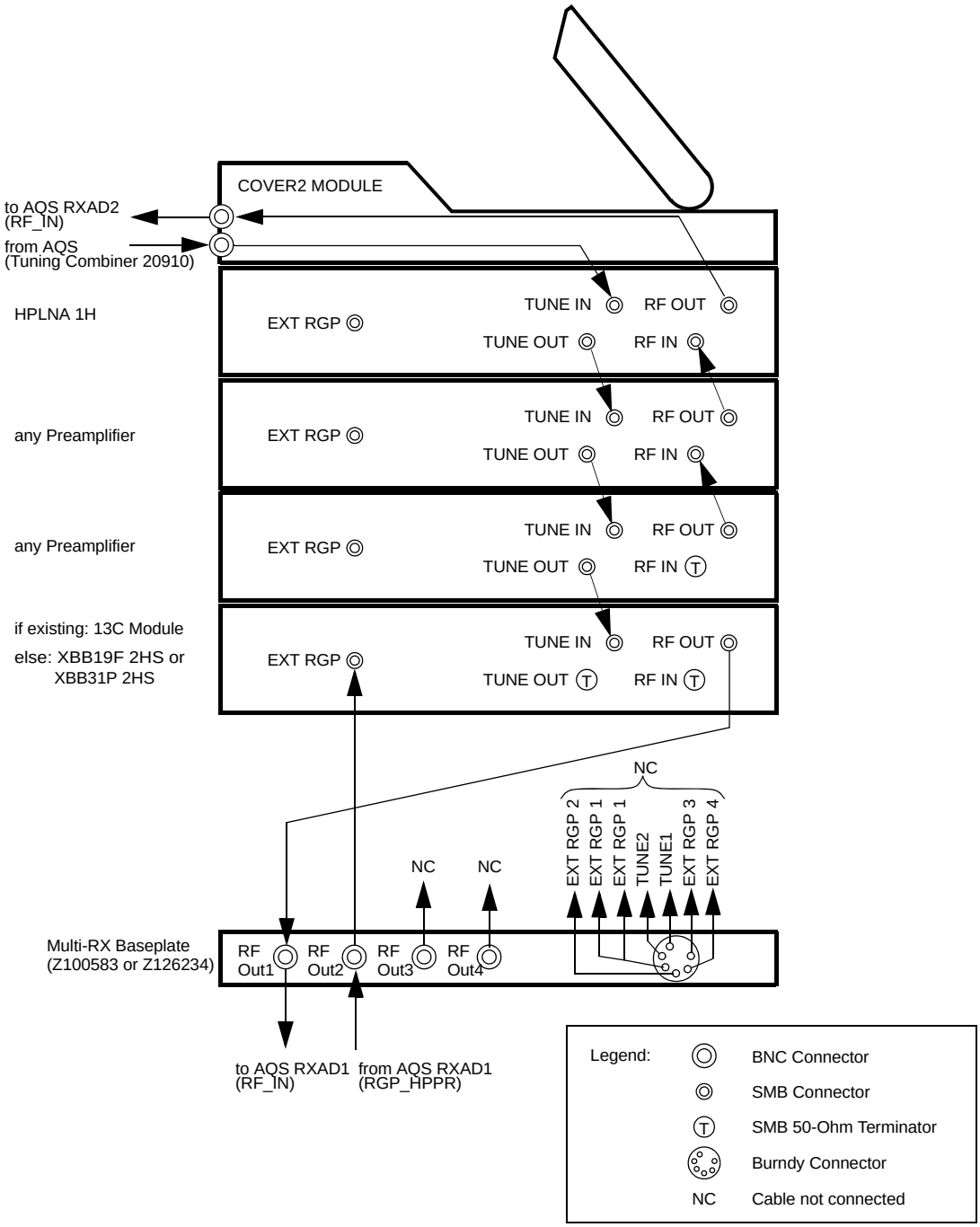


Figure 10.5 Dual-receive-wiring for high-resolution HPPR/2 assembly

The following diagram presents an exemplary Dual-Receive-Wiring for a solids only or a mixed (solids and high-resolution) HPPR/2 assembly. The bottom module in such an assembly is always a high-power broadband module (HPLNA XBB). This broadband module is being treated as separate receiving channel. On the other hand all other modules are daisy-chained to the other receiver-channel.

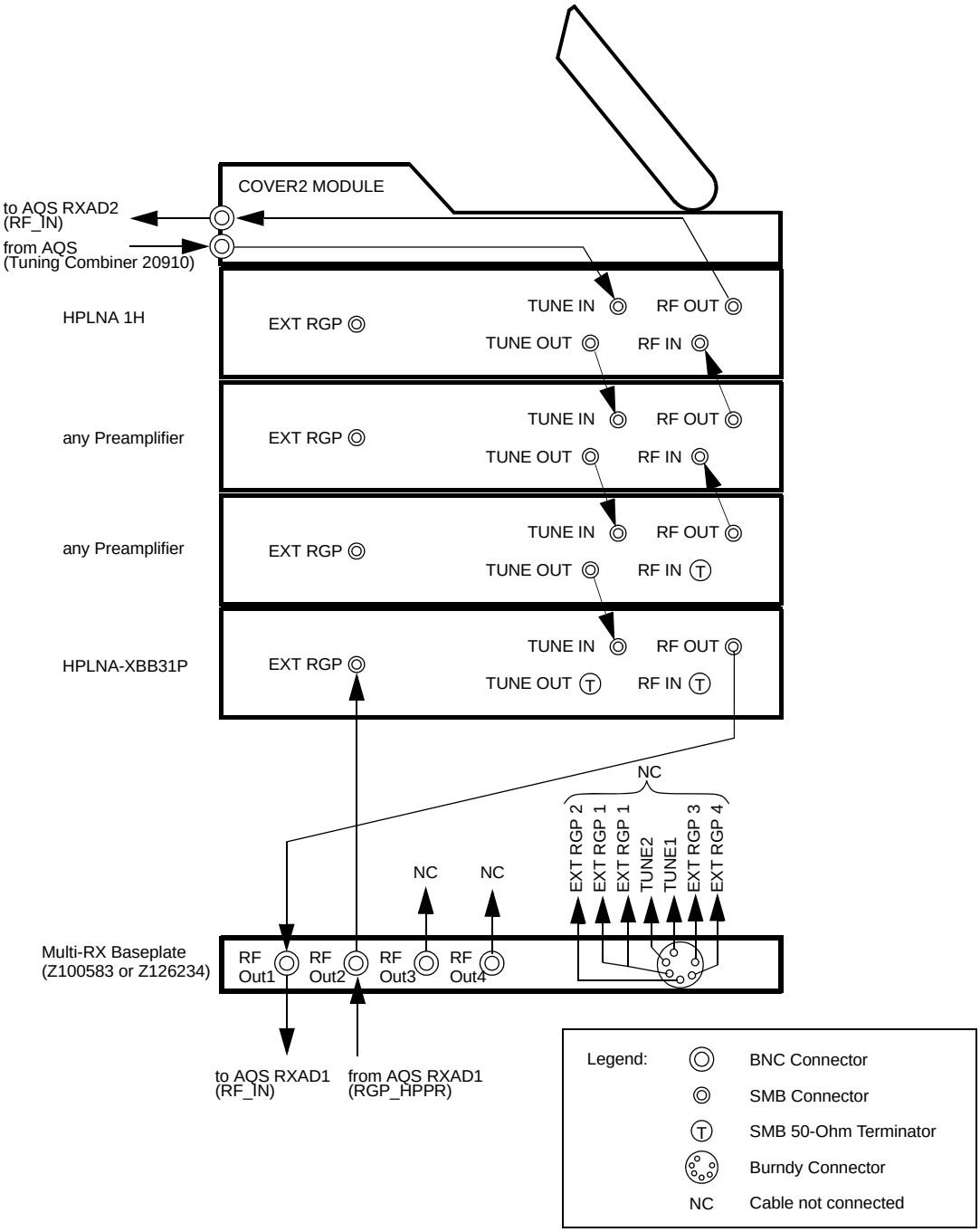


Figure 10.6 Dual-receive-wiring for solids and mixed HPPR/2 assembly

11 CRP RF-Electronics

11.1 General

The HPPR/2 plays an important role of being the provider of the Cryoprobe in terms of DC-power supply and transmit-/receive switch bias current for every active[1] CRP channel.

Following a short overview shall be given on the typical power consumption of different CRP RF-Electronics types and the transmit-/receive bias currents.

11.2 Power Consumption

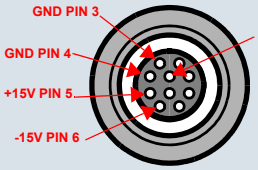
Cryoprobe	I_{typ} [A]	I_{typ} [A]
 **View: Connector Side**	**+15V** (LEMO Power Conn. Pin 5)	**-15V** (LEMO Power Conn. Pin 6)
CRP PRCONT 1H2H	.13	.02
CRP PRCONT 13C(1H31P2H15N)	.10	.01
CRP PRCONT 15N (2H13C31P1H)	.10	.01
CRP PRCONT BB15N,29SI-31P(2H,19F-1H)	.14	.01
CRP PRCONT BB15N,29SI-31P,19F(2H1H)	.14	.01
CRP PRCONT 1H(15N-31P,19F) [a]	.17	.01
CRP PRCONT 2H(15N13C31P1H) [a]	.05	.01
CRP PRCONT 1H2H(15-31P,19F)	.21	.02
CRP PRCONT 19F(15N-31P,1H)	.16	.01
CRP PRCONT 1H1H	.17	.02
CRP T/R-SWITCH CONTROL	.08	.01
CRP POWER SUPPLY BBIS/PICS	.11	.03

Table 11.1 CRP RF-electronics power consumption

a. obsolete

1. An active CRP channel (cold preamplifier) is marked in the CRP PICS with a „PRCONT“ entry. Compared to a passive channel (cold filters only) which is marked with a „CONT“ entry.

11.3 Transmit-/Receive Bias Currents

The following transmit-/receive bias currents may be measured on the transmitter coaxial line between the HPPR/2 module[1] and the corresponding Cryoprobe input, according to Table 11.2:

MODULE	Typical Bias Current @ 77K
HPPR/2 15N MODULE	95 mA
HPPR/2 2H MODULE	95mA (observe mode) 19mA (lock mode)
HPPR/2 13C MODULE	95 mA
HPPR/2 31P MODULE	95 mA
HPPR/2 XBB31P 2HS MODULE	95 mA
HPPR/2 XBB19F 2HS MODULE	95 mA
HPPR/2 XBB19F 2HP MODULE	95 mA
HPPR/2 19F MODULE	45mA (observe mode) 17 mA (lock mode)
HPPR/2 1H HPLNA MODULE	45 mA
HPPR/2 1H2H MODULE	1H: 36 mA
	2H: 36mA (observe mode) 15mA (lock mode)

Table 11.2 Cryoprobe T/R-switch bias current for the HPPR/2 family

1. The values are valid for actual produced ECLs (production date newer than 1.1.2012). For older modules see corresponding EC.

12 MRI-Interface Module

Figure 12.1 View HPPR/2 MRI-INTERFACE modules

12.1 Functionality

The MRI Interface modules provide the connection between the coil array (incl. array preamps), the preamplifier modules and the receiver boards in the AQS chassis. There are three modules:

- HPPR/2 MRI-INTERFACE MODULE RF1-4 (Z106268)
- HPPR/2 MRI-INTERFACE MODULE RF5-10 (Z106269)
- HPPR/2 MRI-INTERFACE MODULE RF11-16 (Z106270)

i These modules contain neither active components nor BIS information.

The module RF1-4 contains 4 rf-channels. Channel 1 and 2 are routed via connectors to the HPPR/2 preamplifier modules. The interconnections for two tuning signals and two external blanking pulses are also provided.

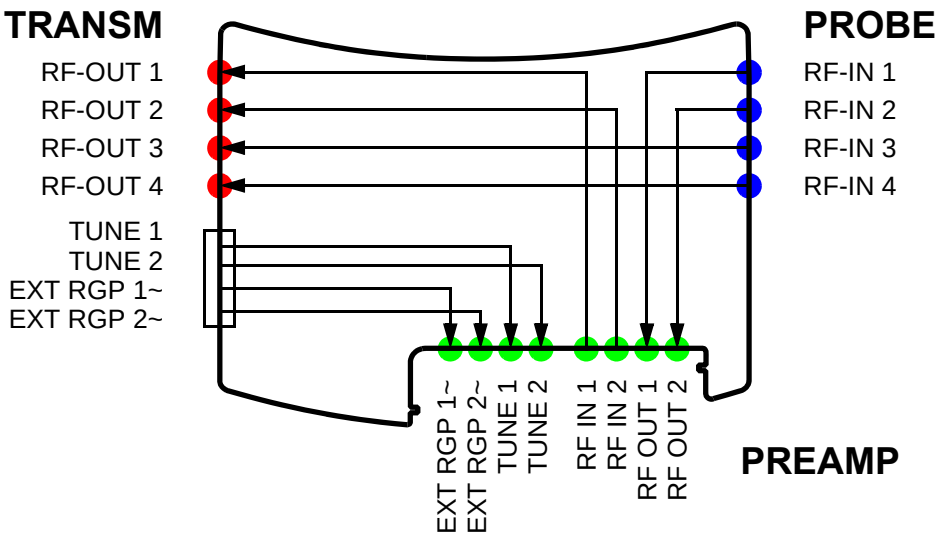


Figure 12.2 Block diagram IF-module RF1-4

The modules RF5-10 and RF11-16 contain six straight through rf-channels each. Both modules are, apart from for the connector labels, identical.

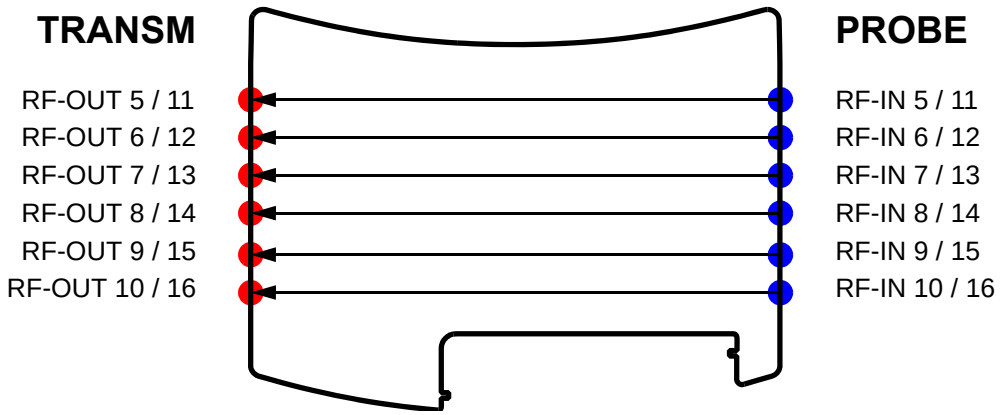


Figure 12.3 Block diagram IF-module RF5-10 & RF11-16

12.2 Connectors

Figure 12.4 View PROBE connectors

Figure 12.5 View TRANSM connectors

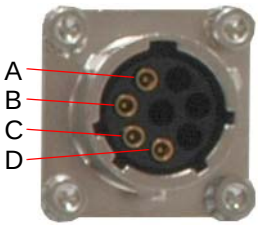
Preamp Connectors

Figure 12.6 View PREAMP connectors

Position	Label	Connector Type	Description
PROBE	RF IN	SMA (coax female)	RF input signal from coil or array preamp
TRANSM	RF OUT TUNE / EP	N (coax female) UT0 8pol. (multicoax female)	RF output signal to RXAD Receiver gating pulse from RXAD and tuning signal from SGU
PREAMP [a]	RF IN RF OUT EXT_RGP~ TUNE	SMB (coax male)	RF input from preamplifier module RF output to preamplifier module Receiver gating pulse output to preamplifier module Tuning signal output to preamplifier module

Table 12.1 Connector description

a. IF-Module RF1-4 only

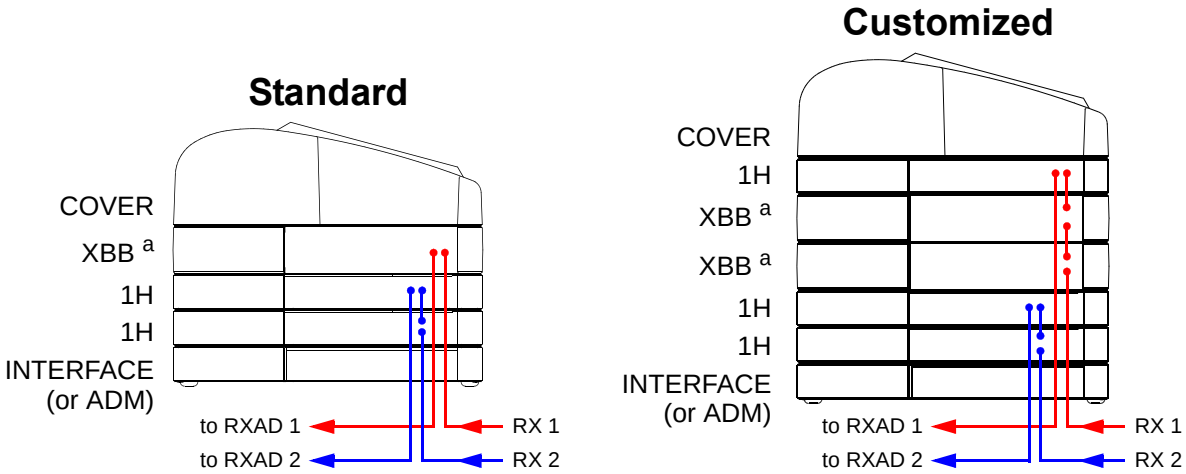


Pin	Type	Signal
A	RCDX	TUNE 1
B	RCDX	TUNE 2
C	RCDX	EXT_RGP1~
D	RCDX	EXT_RGP2~

Table 12.2 Pinout TUNE / EP connector

12.3 Wiring

The following wiring diagram depict the wiring between the MRI interface module RF1-4 and the PREAMP modules. The necessary cables and terminators are either delivered with the interface module or the PREAMP modules.



a) The ECL of HPHP/2 XBB modules must be ≥ ECL03. Older modules have a DC path to GND at the RF_IN connector, which has an impact on the remote array preamplifier supply coming from the RXAD.

Figure 12.7 MRI interface module configurations

12.4 Technical Data

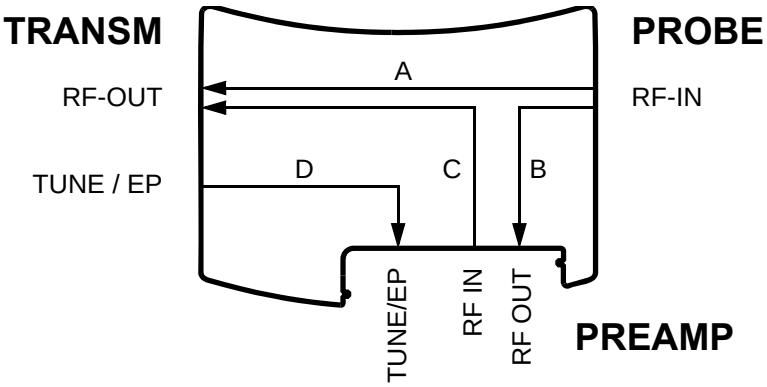


Figure 12.8 Measurement path

Insertion loss (S21): 0.005..0.5GHz / 0.5..1GHz

Path A:	max. 0.3 / 0.5	dB
Path B, C and D:	max. 0.6 / 1.0	dB

VSWR (S11): 0.005..1GHz

All connectors path A, B and C:	max. 1.2:1	-
All connectors path D:	max. 1.4:1	-

12.5 Installation

The interface modules are designed to be at the bottom of the preamplifier module stack. They can be placed directly on the floor. No additional baseplate is needed.

All interface modules are factory equipped with large rubber feet. These must be removed before the modules are stacked on top of each other. The large rubber feet remain only on the bottom module.

13 MRI Active Detuning Module

Figure 13.1 View HPPR/2 MRI ACTIVE DETUNING module

13.1 Functionality

The HPPR/2 MRI ACTIVE DETUNING Module (ADM, Z107408) belongs to the group of MRI interface modules. It combines the functionality of the former BIO ACT DEC/COIL CONTROL UNIT (T5051) and the HPPR/2 MRI-INTERFACE MODULE RF1-4 (Z106268).

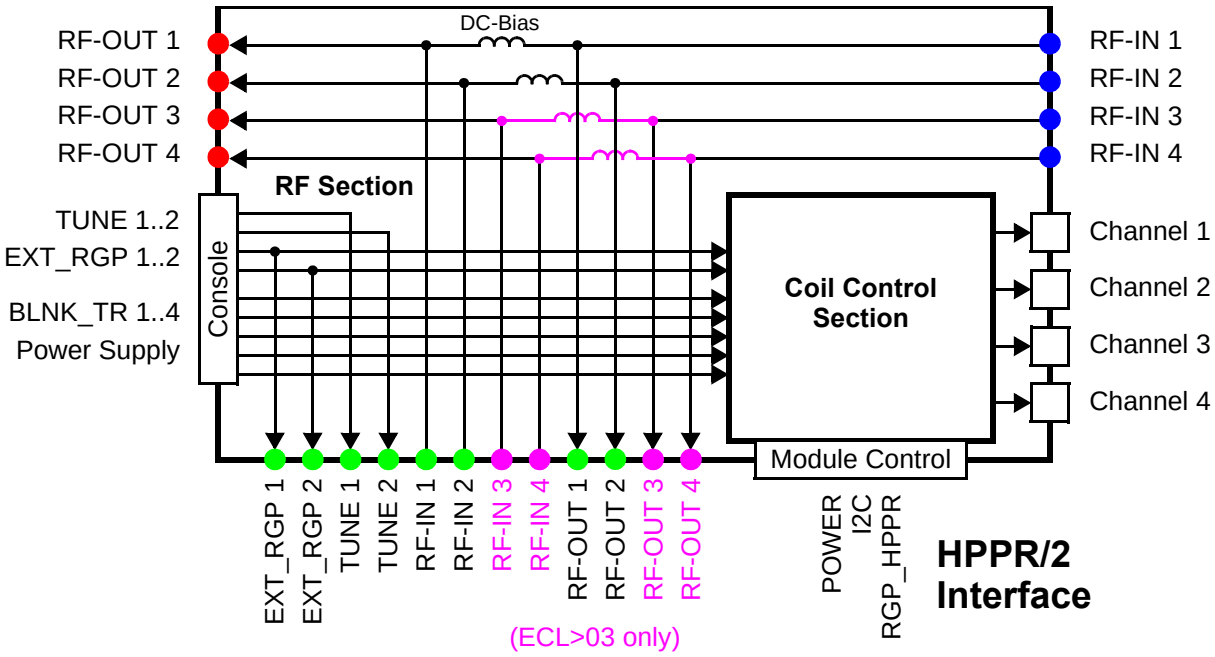


Figure 13.2 Block diagram ADM module

13.1.1 RF-Section

The ADM module rf section is basically the same as in the MRI-Interface module RF1-4. It provides the connections between the coil array (incl. array preamps), the preamplifier modules and the receiver boards in the AQS chassis.

It contains 4 rf-channels. Channel RF1 and RF2 are routed via connectors to the HPPR/2 preamplifier modules. Two dc-bias between the preamplifier connectors enables the array preamp supply current to flow through the module. From ECL03 onwards all four rf-channel are routed via the preamp connectors and each one has a dc-bias.

The interconnections for two tuning signals and two external RGP pulses are also provided. The rf-section contains no active components, only interconnections, dc-bias and coaxial cables. There is no connection to the coil control section, except for the two EXT_RGP pulses which are used as inputs.

13.1.2 Coil Control Section

The ADM module coil control section provides detuning pulses and coil control signals for four independent coil channels (coil connectors). Each channel contains four PIN-diode drivers, four tuning/matching signals, two tune control signals 0° and 90° for quad coils, one RGP signal, a LOGIC_SEL input and auxiliary power supply pins (+5 V, +9 V, -30 V).

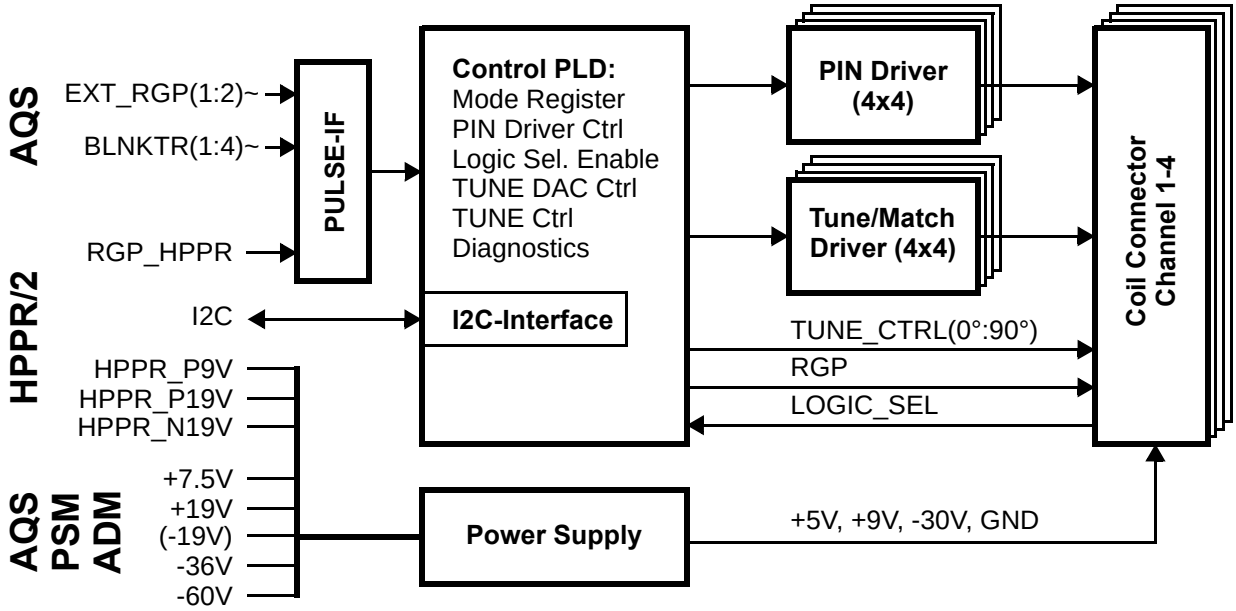


Figure 13.3 Block diagram coil control section

13.1.3 Input Pulses

The ADM module uses seven input pulses:

- RGP_HPPR: common RGP for all preamplifier modules
- EXT_RGP(1:2)~: discrete RGP from AQS RXAD1 & 2
- BLNKTR(1:4)~: discrete transmitter blanking pulse from AQS PSD

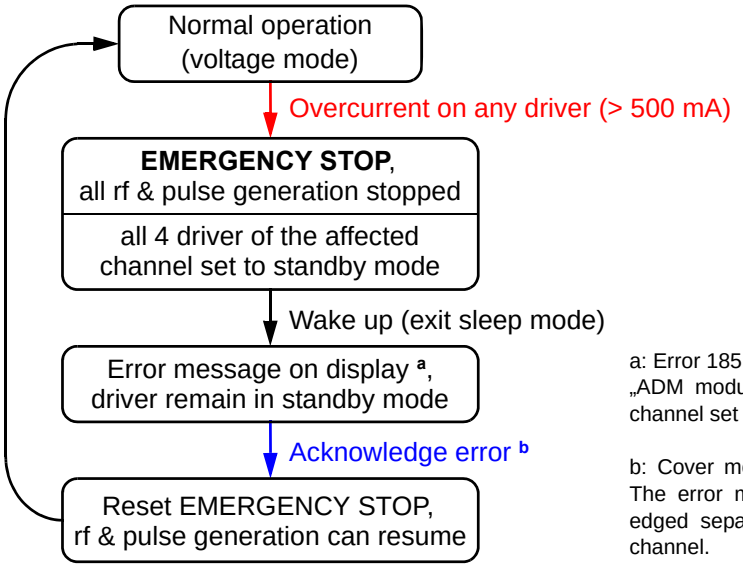
The pulses are used for PIN driver, tune/match driver and RGP output pulse control. The RGP_HPPR pulse is connected via the module control connector (flat ribbon cable), the other pulses via the console connector (coaxial cables).

13.1.4 PIN Driver Function

Each driver can be controlled independently either in static mode or by the input pulses. The seven input pulses can be OR combined via software setting. The pulse polarity is either set via the LOGIC_SEL input from the coil connector for all drivers of one channel together or via software for each driver individually.

The positive (forward) output voltage level is between +3 and +5 V, depending on the load current. In voltage mode the maximum load current is 0.5 A per driver. If the current exceeds this limit, all drivers of the channel are shut down and set into stand-by mode. In current mode the load current is limited to 100 mA per driver. The negative (reverse) output voltage level can be set either to -36 V or -60 V.

The LOGIC_SEL input enable, driver mode (voltage or current) and negative voltage level settings are always valid for all four drivers of a channel together.



a: Error 185:
„ADM module: channel X overload, channel set into standby mode“

b: Cover module: press „Quit“ (F4). The error may has to be acknowledged separately for each affected channel.

Figure 13.4 PIN-Driver overcurrent error handling

13.1.5 Tune/Match Driver Function

Each coil channel has four tuning drivers for varicap diodes: Tune 0°, Match 0°, Tune 90°and Match 90°. All drivers are DAC controlled with a resolution of 12 bits. The output voltage level is between 0 and -30 V.

Each DAC has two data registers A and B. This allows fast switching between two adjustable output voltages. To toggle between these, any OR-combination of the seven input pulses can be used. The toggle mode is set individually for each driver.

13.1.6 RGP Output Pulse

Each coil channel has one RGP output pulse. The pulse can be selected from the three input pulses RGP_HPPR, EXT_RGP(1)~ or EXT_RGP(2)~ individually for each channel.

13.1.7 Diagnostic Function

The ADM module has 48 internal diagnostic testpoints. Each one can be routed with analog switches to a 12bit ADC. The ADC output data is then converted to a voltage value by the HPPR/2 controller.

There are testpoint for all input pulses, all PIN- and tune/match driver outputs and a selection of power supply voltages.

13.1.8 Software Control

The ADM module is controlled entirely via I2C bus by the HPPR/2 controller in the cover module. The ADM has no internal microcontroller. The HPPR/2 controller receives the commands via SBSB from the host software (ParaVision or TopSpin).

For service purposes UniTool can be used with a basic set of commands, including access to the internal diagnostics.

13.2 Connectors

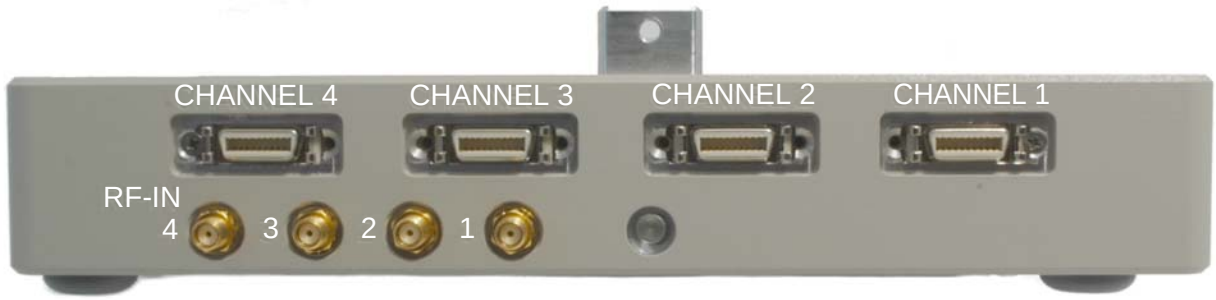


Figure 13.5 View PROBE connectors

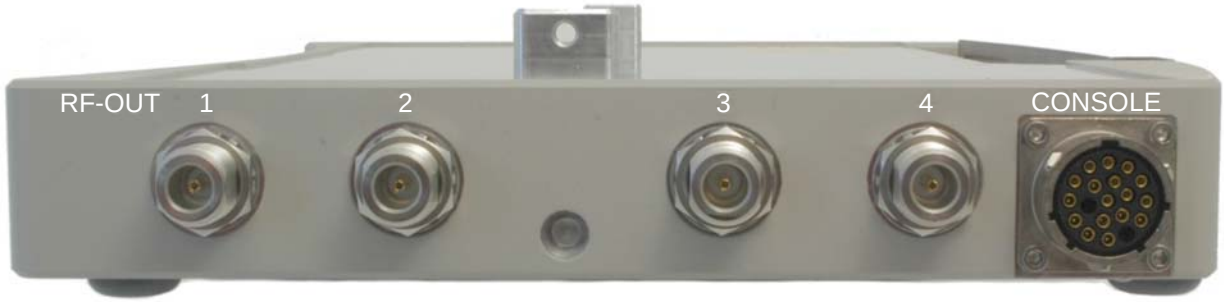


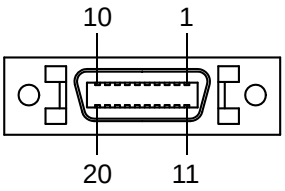
Figure 13.6 View TRANSM connectors

Preamp Connector

Figure 13.7 View PREAMP connectors

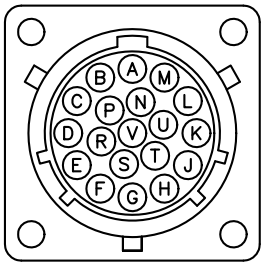
Position	Label	Connector Type	Description
PROBE	CHANNEL	MDR (mini-delta ribbon female)	Detuning output signals to coil connector
	RF IN	SMA (coax female)	RF input signal from coil or array preamp
TRANSM	RF OUT	N (coax female)	RF output signal to AQS RXAD
	CONSOLE	UT0 19pol. (multiple coax and dc contacts)	Receiver gating pulses from AQS RXAD Blanking pulses and tuning signals from AQS PSD Power supply from AQS PSM ADM
PREAMP	RF IN RF OUT EXT_RGP~ TUNE	SMB (coax male)	RF input from preamplifier module RF output to preamplifier module Receiver gating pulse output to preamplifier module Tuning signal output to preamplifier module

Table 13.1 Connector description



Pin	Signal	Pin	Signal
1	PIN DRV 1	2	PIN DRV 2
3	PIN DRV 3	4	PIN DRV 4
5	TUNE 0°	6	MATCH 0°
7	COIL +9V / 0.2A	8	COIL -30V / 20mA
9	TUNE 90°	10	MATCH 90°
11	GND	12	GND
13	*+5V*	14	*LOGIC_SEL*
15	*not connected*	16	*not connected*
17	*GND*	18	RGP
19	TUNE CONTROL 0°	20	TUNE CONTROL 90°

Table 13.2 Pinout CHANNEL connector



Pin	Type	Signal	Pin	Type	Signal
A	dc	P19V	L	dc	GND
B	dc	GND	M	dc	P7V
C	dc	P7V	N	dc	N36V
D	coax	BLNKTR(2)~	P	coax	EXT_RGP(2)~
E	coax	BLNKTR(1)~	R	dc	*IPSOT2X_SCO/$\overline{CCO}$*
F	coax	BLNKTR(4)~	S	coax	TUNE(1)
G	coax	BLNKTR(3)~	T	coax	TUNE(2)
H	dc	*N19V*	U	dc	N60V
J	coax	EXT_RGP(1)~	V	dc	NSENSE_P7V
K	dc	PSENSE_P7V	*italic = not used in ADM*		

Table 13.3 Pinout CONSOLE connector

13.3 Power Supply

The ADM module uses two power supply sources. Three voltages (HPPR_P9V, HPPR_P19V, HPPR_N19V) are supplied from the cover module via the module control connector (flat ribbon cable). Four additional voltages (+7.5V, +19V, -36V, -60V) are supplied from the new AQS PSM ADM (Z107413). This power supply is situated at the back side of the AQS chassis. It is connected to the ADM module via the console connector.

For additional information on the AQS PSM ADM please refer to the AQS technical manual.

13.4 RF-Wiring

ECL01 and ECL02:

The rf-wiring is the same as with the HPPR/2 MRI INTERFACE MODULE RF1-4. Please refer to the corresponding section of this manual.

ECL03 and onwards:

Follow the wiring instructions below.

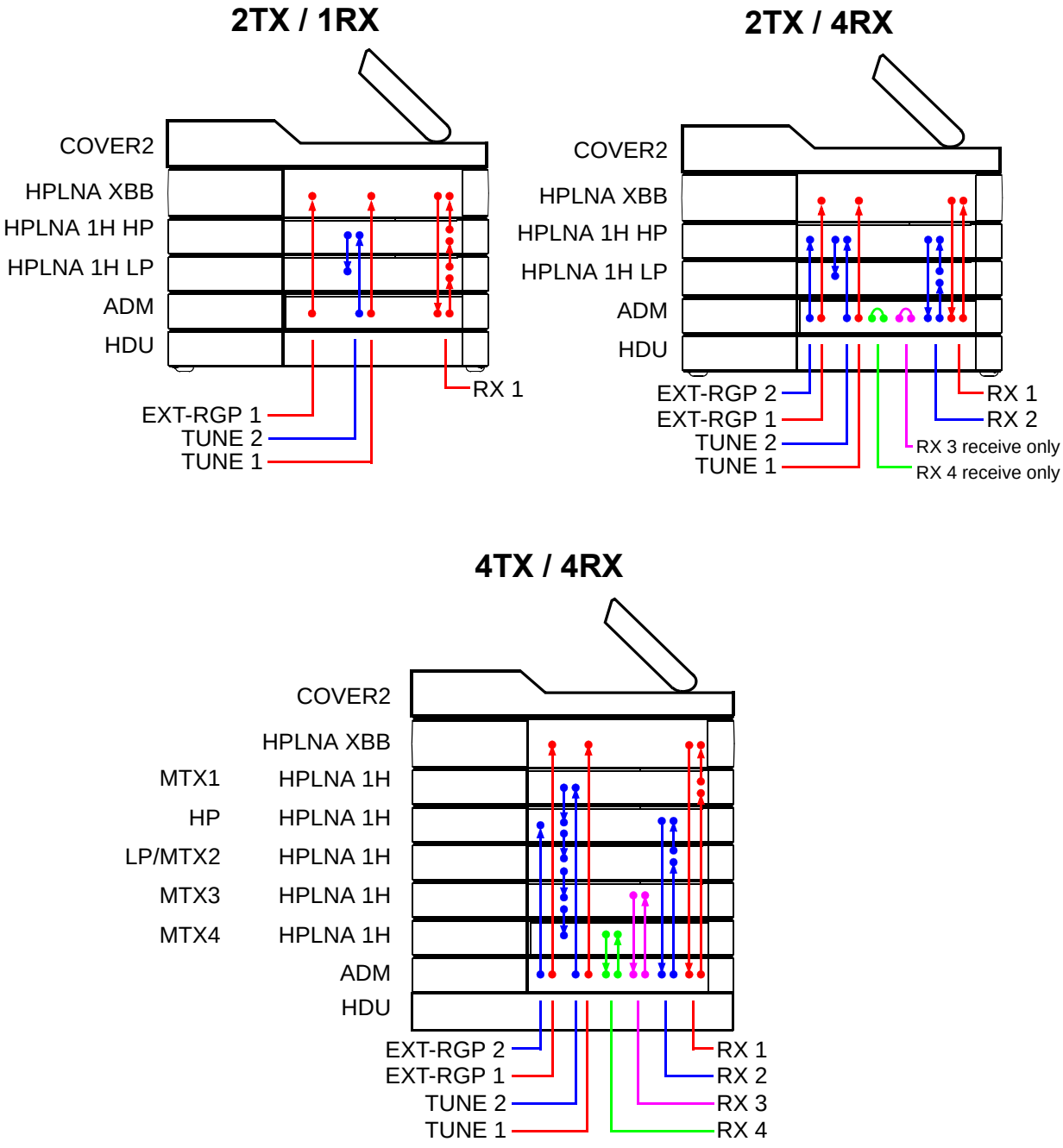


Figure 13.8 ADM module configurations ECL03 (exemplary wiring)

13.5 Technical Data

13.5.1 Coil Control Section

Inputs:		
RGP_HPPR, RGP_HPPR~: (from cover mod.)	RS-422 differential	--
EXT_RGP(1:2)~: (from RXAD)	+5V TTL	--
BLNKTR(1:4)~: (from PSD)	+5V TTL	--
LOGIC_SEL: (from coil connector)	open/1kΩ pull-down or +5V TTL	--
PIN-Diode Driver:		
Positive (forward) output voltage: (voltage mode)	+4 .. 5.5	Vdc
Positive (forward) output current: (voltage mode)	max. 500	mA
Positive (forward) output current: (current mode)	limited to 100 [1]	mA
Negative (reverse) output voltage: (-36V mode)	-36 +3/-10%	Vdc
Negative (reverse) output voltage: (-60V mode)	-60 +3/-10%	Vdc
Negative (reverse) output current: (-60V mode)	max. -50	mA
Transition time: (50% input pulse → 90% output voltage)	max. 3	us
Tune/Match Driver:		
Output voltage: (DAC 0..4095, register A or B)	0..-30	Vdc
Trans. time reg. A to B: (50% input pulse → 90% outp. volt.)	max. 6	us
Tune control output signals:	+5V TTL	--
RGP Output:		
RGP output voltage:	+5V TTL	--
Coil Supply:		
+9V output voltage: (I_{Lmax} = 200mA)	+9.0 ±0.5	Vdc
-30V output voltage: (I_{Lmax} = 20mA)	-30.0 ±0.5	Vdc
+5V output voltage: (I_{Lmax} = 50mA)	+5.0 ±0.5	Vdc

1. ECL02: max. current = 108 .. 124 mA
   ECL03: max. current = 104 .. 110 mA

13.5.2 RF-Section

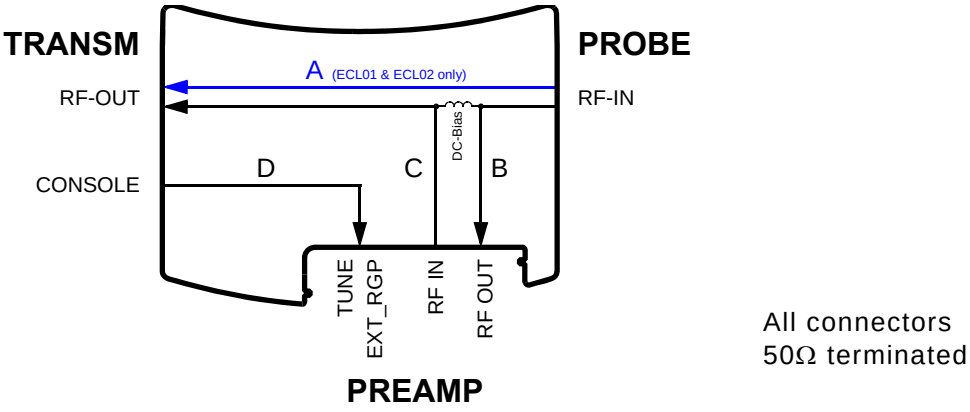


Figure 13.9 RF measurement paths

Insertion loss (S21): 0.02 - 0.4GHz / 0.4 - 1GHz

Path A:	max. 0.5 / 1.0	dB
Path B:	max. 0.4 / 0.8	dB
Path C:	max. 0.6 / 1.2	dB
Path D:	max. 0.5 / 1.0	dB

VSWR (S11): 0.005..1GHz

All connectors path A, B and C:	max. 1.2:1	-
All connectors path D:	max. 1.4:1	-

Isolation (S21): 0.005..1GHz

Path B → C and RF1 → RF2:	min. 40	dB

13.6 Installation

The ADM module is designed to be at the bottom of the preamplifier module stack. It can be placed directly on the floor. No additional baseplate is needed.

If additional interface modules are placed below the ADM, the large rubber feet must be removed before the modules are stacked on top of each other. The large rubber feet remain only on the bottom module.

14 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, i. e. a code number with a corresponding text, is displayed. Take down the code number and 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" on page 9 for contact details.

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

Troubleshooting

15 Transport, Packaging and Storage

15.1 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.

Component Sensitive to Electrostatic Charge

The packaging contains components which are sensitive to an electrostatic charge.
Only allow packaging to be opened by trained personnel.
Establish potential equalisation before opening.

15.2 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.

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

15.3 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

Dispose of packaging material in accordance with the relevant applicable legal requirements and local regulations.

15.4 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.

Transport, Packaging and Storage

16 Maintenance

16.1 Safety

⚠ WARNING

Electrical hazard from electrical shock.

- ▶ Always switch power off and disconnect all power supply cables before maintenance or cleaning.
- ▶ Never power on until all surfaces are completely dry and all cables are connected.

16.2 General

The HPPR/2 devices are practically maintenance free. There are nor replaceable parts inside the units.

16.3 Software

In case of problems, check for the newest official firmware release for the HPPR/2 Cover and for the DRU on the CH ftp server.

16.4 Cleaning

Clean the outside of the HPPR/2 with a soft, lint-free cloth dampened in water. Do not use any detergent or other cleaning solvents.

17 Dismantling and Disposal

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

i Installation, initial commissioning, retrofitting, repairs, adjustments or dismantling of the device must only be carried out by employees of the manufacturer or persons authorised by the manufacturer.

17.1 Safety

Electrical System

⚠ WARNING

Electrical hazard from electrical shock.

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

- ▶ 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.

Improper Dismanteling

⚠ WARNING

Danger of injury due to improper dismantling!

Stored residual energy, angular components, points and edges on and in the device or on the tools needed can cause injuries.

- ▶ Ensure sufficient space before starting work.
- ▶ Handle exposed, sharp-edged components with care.
- ▶ Dismantle the components properly.
- ▶ Secure components so that they cannot fall down or topple over.
- ▶ Consult the manufacturer if in doubt.

17.2 Dismantling

Before starting dismantling:

- Shut down the device and secure to prevent restarting.
- Physically disconnect the power supply from the device; discharge stored residual energy.
- Remove consumables, auxiliary materials and other processing materials and dispose of in accordance with the environmental regulations.
- Dismantle the device by following the installation instructions in reverse.

Clean assemblies and parts properly and dismantle in compliance with applicable local occupational safety and environmental protection regulations.

17.3 Disposal Instructions

If no return or disposal agreement has been made, send the dismantled components for recycling.

- Scrap metals.
- Send plastic elements for recycling.
- Sort and dispose of other components in accordance with their material composition.

NOTICE

Danger to the environment from incorrect handling of pollutants!

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

▶ Always observe the instructions below 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.

A Appendix

A.1 Warning Signs

NOTICE

Danger to the environment from incorrect handling of pollutants. 130

Never plug in anything else other than the above mentioned ' connected devices' 56

WARNING

Danger of injury due to improper dismantling! 129

Electrical hazard from electrical shock. 18, 129

Electrical hazard. Switch power off before maintenance. 127

Risk to life for unauthorized personnel due to hazards in the danger and working zone! 17

Appendix

A.2 Figures

A.3 Tables

A.4 Glossary

ADM ..... Active Detuning Module

ATMA ..... Automatic Tuning and Matching Accessory

BIS ..... Bruker Information System

CRP ..... Cryo Probe

CW ..... Continuos Wave

HPLNA ..... High Power low Noise Amplifier

HPPR/2 ..... High Performance Preamplifier Version 2

I2C ..... I2C bus (two wire single master bus)

IFB ..... HPPR/2 Interface Board

INCR_AQ ..... see INTERLEAVE_INCR

INTERLEAVE_INCR Interleave Increment Pulse

LCD ..... Liquid Crystal Display

LOCK_PP ..... Lock Protection Pulse

MDR ..... Mini Delta Ribbon connector

PICS ..... Probehead Identification System

PLD ..... Programmable Logic Device

QNP ..... Quadro Nucleus Probe

RGP_HPPR ..... Receiver Gating Pulse for HPPR

RGP_PA ..... see RGP_HPPR

SBSB ..... Serial Bruker Spectrospin Bus (RS485 Bus)

TP_F0 ..... see LOCK_PP

Appendix

A.5 Index

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