



CryoProbe RF ELECTRONICS

Technical Manual

Version 003

Bruker BioSpin

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General Description

1

Introduction

1.1

The introduction of a new family of high-performance cryogenic probes represents a major step forward in NMR instrumentation.

Developed in order to cover a huge number of chemistry applications, the Cryo-Probes offer outstanding performance with respect to signal-to-noise and measurement time.

This manual covers:

- Installation of the rf wiring for different types of CryoProbes
- Software description
- Technical data
- Some service informations

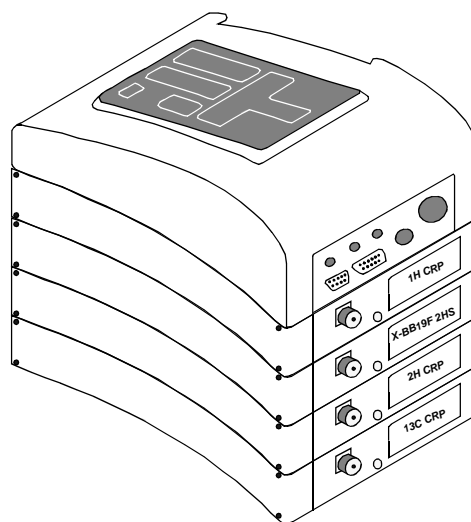
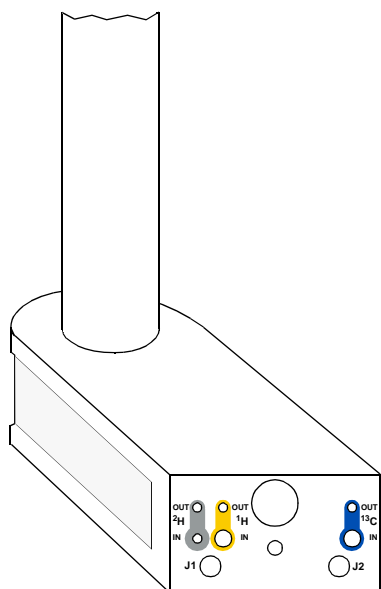
Most of the information given in the 'HPPR Technical Manual' (Z31075) and 'HPPR/2 Technical Manual' (Z31559) remains valid for the HPPR CRP MODULEs.

Features

1.2

- Practical and easy-to-use.
- Integrated cryocooled preamplifiers, filters and t/r-switches make maximum use of the significant signal-to-noise improvement in a cryogenic cooled signal detection system.
- Additional functionality is offered in conjunction with the HPPR CRP ASSEMBLY as for example:
 - Computer controlled signal routing between the CryoProbe and the HPPR CRP MODULEs respectively HPPR/2 MODULEs
 - Improved spectral purity of the rf pulses by using the built-in filters of the HPPR CRP MODULEs (HPPR/2 MODULEs)
 - Probe tuning of all nuclei
 - **PICS (Probe Identification System)**

- HPPR CRP (HPPR/2) MODULE:
 - filters the transmitted signal
 - is used for probe tuning and matching
 - selects the received signal FT-REC
 - has full functionality for conventional probes
- CRP RF UNIT:
 - contains transmit/receive switches
 - contains cryocooled preamplifiers
 - filters received signal
 - PICS



The standard HPPR CRP ASSEMBLY for a CP DUL C/H-D or CP DUI H/C-D consists of the following parts:

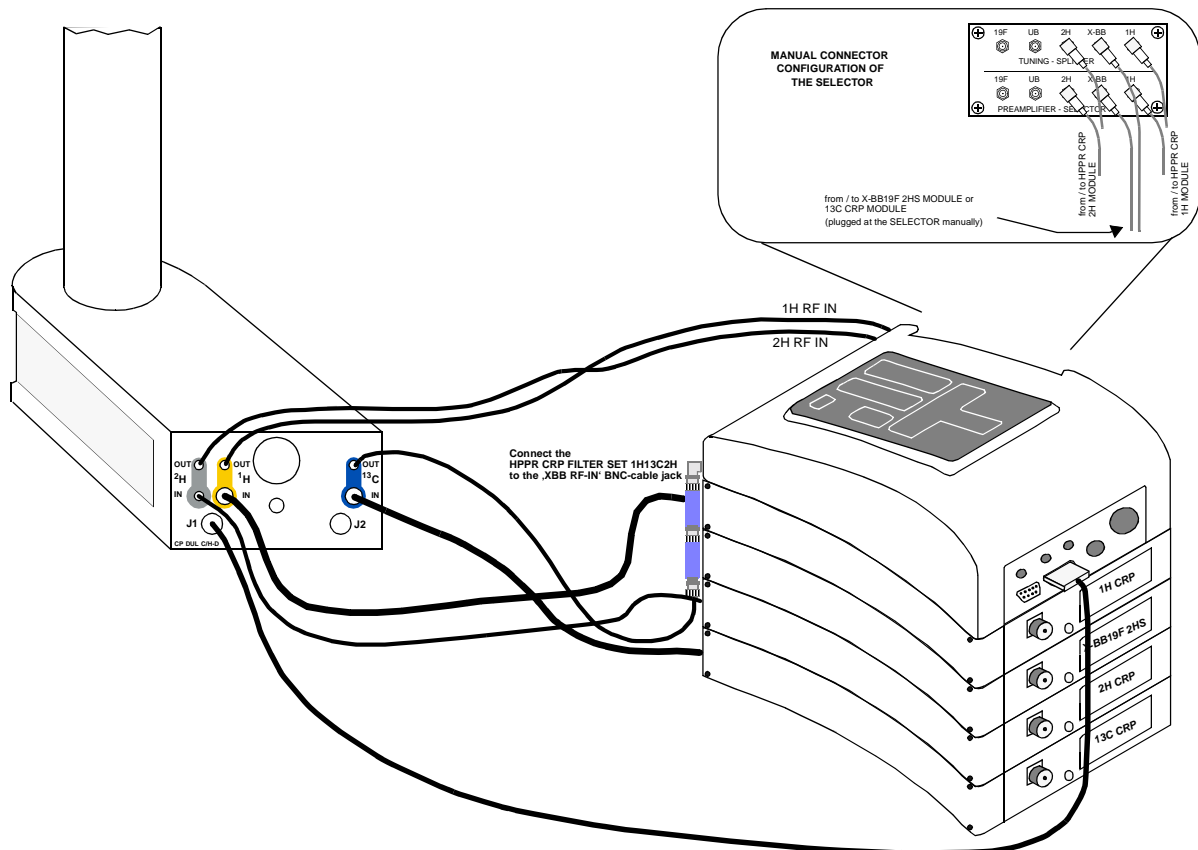
- HPPR CRP COVER MODULE
- HPPR 1H CRP MODULE
- HPPR 2H CRP MODULE
- HPPR X-BB19F 2HS MODULE
- HPPR 13C CRP MODULE

The HPPR CRP MODULES are almost identical to the well known HPPRs used for a conventional probe with exception of partly different filter characteristics and additionally included functions used for the CryoProbe. However, every HPPR CRP MODULE may be used for either CryoProbe operation or with a conventional probe. For CryoProbe operation pull the ribbon cable connectors at the JUNCTION BOARD of the HPPR X-BB19F 2HS MODULE!

NOTES:

1. The HPPR XBB19F 2HS MODULE is used ONLY for operation with a conventional probe.
2. In general, no external filters are required between the HPPR MODULES and the CryoProbe (exception: connection from CP 13C RF OUT to HPPR 13C RF IN).

Figure 1.1. RF wiring for a CP DUL C/H-D or DUI H/C-D (HPPR CRP)



The standard HPPR/2 ASSEMBLY for a CP DUL C/H-D or CP DUI H/C-D consists of the following parts:

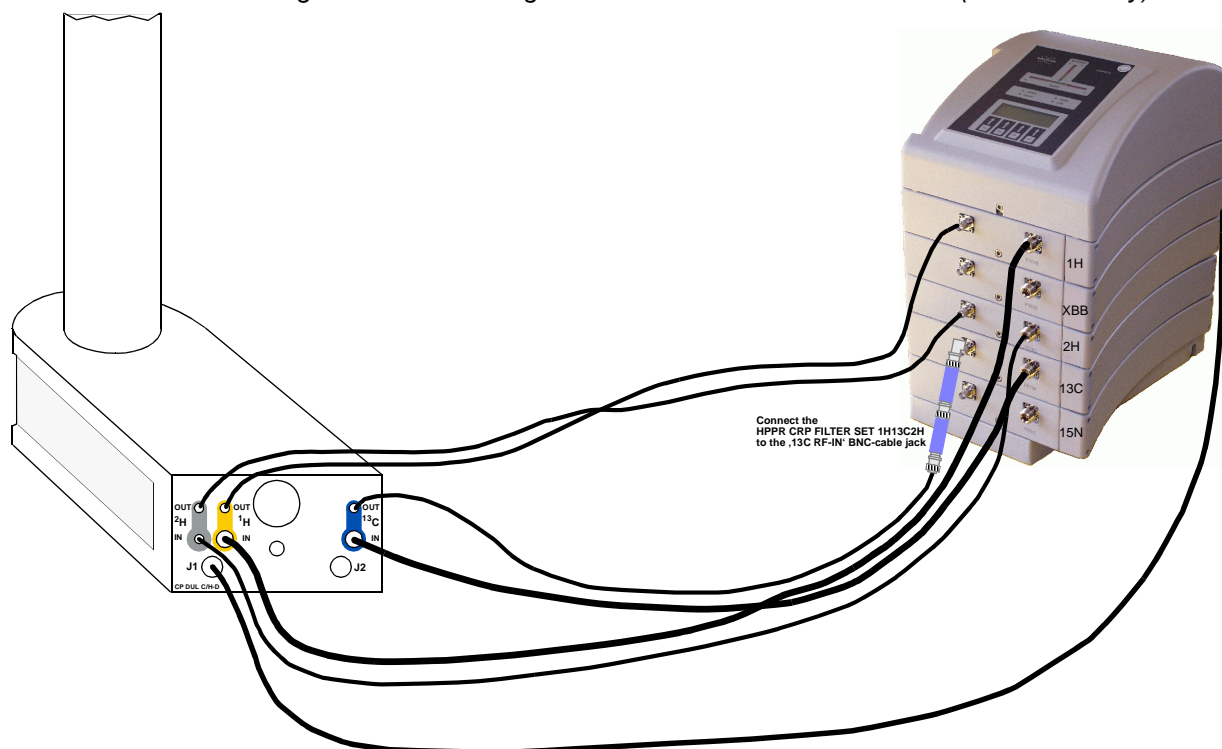
- HPPR/2 COVER MODULE
- HPPR/2 1H LNA MODULE
- HPPR/2 2H MODULE
- HPPR/2 XBB19F 2HS MODULE
- HPPR/2 13C MODULE

HPPR/2 MODULES may be used for either CryoProbe operation or with a conventional probe.

NOTES:

1. The HPPR/2 XBB19F 2HS MODULE is used ONLY for operation with a conventional probe.
2. In general, no external filters are required between the HPPR/2 MODULES and the CryoProbe (exception: connection from CP 13C RF OUT to HPPR 13C RF IN).

Figure 1.2. RF wiring for a CP DUL C/H-D or DUI H/C-D (HPPR/2 family)



The standard HPPR CRP ASSEMBLY for a CP TXI H-C/N-D consists of the following parts:

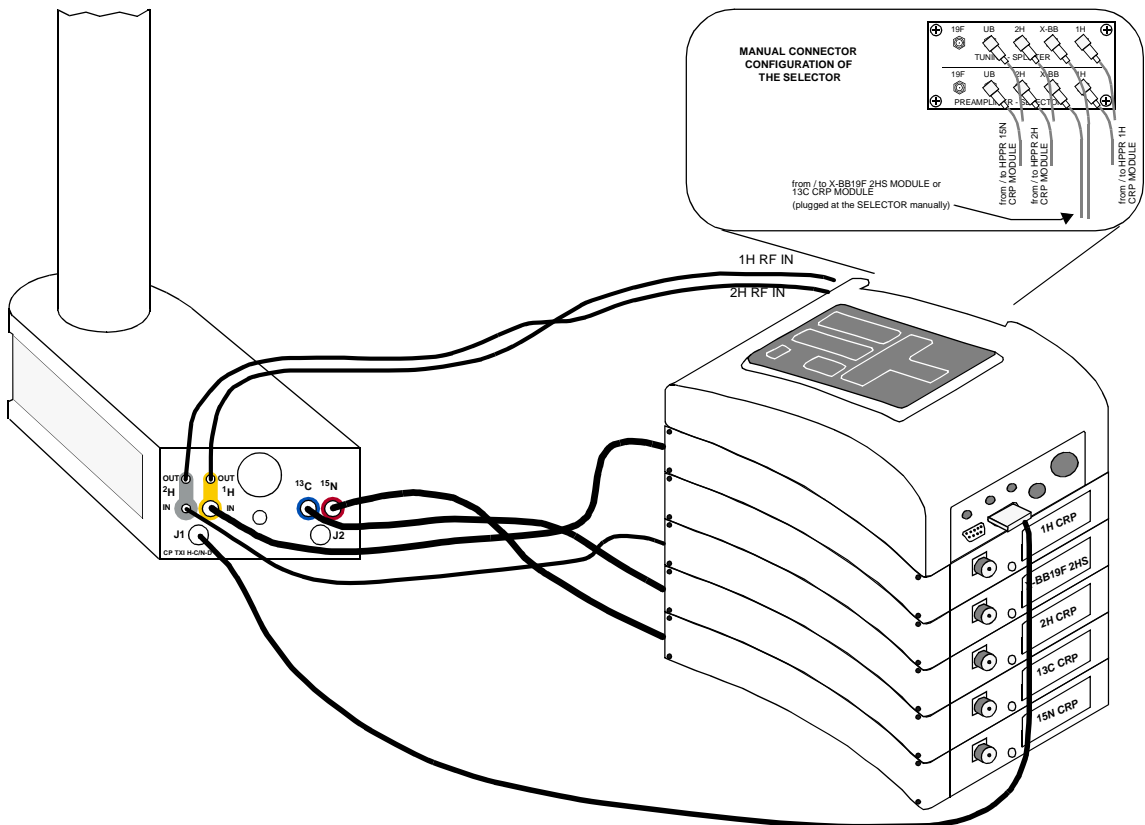
- HPPR CRP COVER MODULE
- HPPR 1H CRP MODULE
- HPPR 2H CRP MODULE
- HPPR X-BB19F 2HS MODULE
- HPPR 13C CRP MODULE
- HPPR 15N CRP MODULE

The HPPR CRP MODULES are almost identical to the well known HPPRs used for a conventional probe with exception of partly different filter characteristics and additionally included functions used for the CryoProbe. However, every HPPR CRP MODULE may be used for either CryoProbe operation or with a conventional probe. For CryoProbe operation pull the ribbon cable connectors at the JUNCTION BOARD of the HPPR X-BB19F 2HS MODULE!

NOTES:

1. The HPPR XBB19F 2HS MODULE is used ONLY for operation with a conventional probe.
2. In general, no external filters are required between the HPPR MODULES and the CryoProbe.

Figure 1.3. RF wiring for a CP TXI H-C/N-D (HPPR CRP)



The standard HPPR/2 ASSEMBLY for a CP DUL C/H-D or CP DUI H/C-D consists of the following parts:

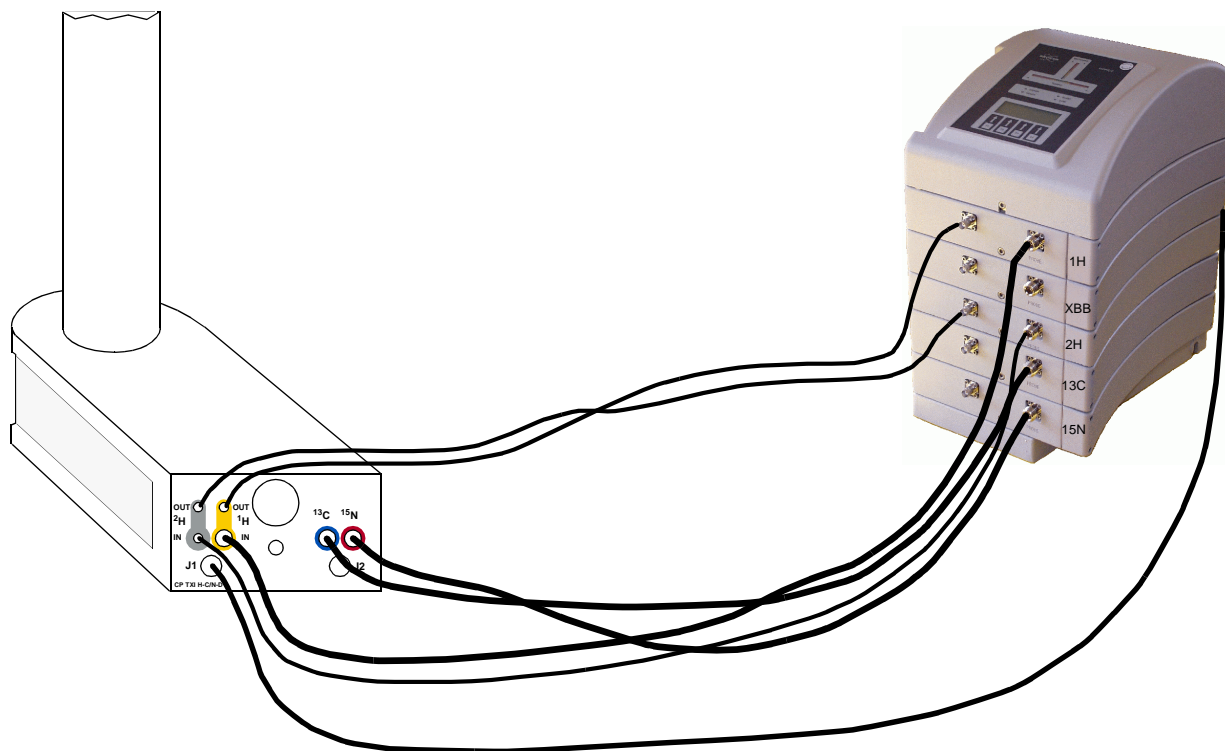
- HPPR/2 COVER MODULE
- HPPR/2 1H LNA MODULE
- HPPR/2 2H MODULE
- HPPR/2 XBB19F 2HS MODULE
- HPPR/2 13C MODULE
- HPPR/2 15N MODULE

HPPR/2 MODULES may be used for either CryoProbe operation or with a conventional probe.

NOTES:

1. The HPPR/2 XBB19F 2HS MODULE is used ONLY for operation with a conventional probe.
2. In general, no external filters are required between the HPPR/2 MODULES and the CryoProbe.

Figure 1.4. RF wiring for a CP TXI H-C/N-D (HPPR/2 family)



As mentioned earlier, a HPPR CRP ASSEMBLY may be used with a conventional probe.

However, some precautions have to be taken into consideration.

- The HPPR 1H CRP MODULE may be used without change.
- The HPPR 2H CRP MODULE may be used without change.

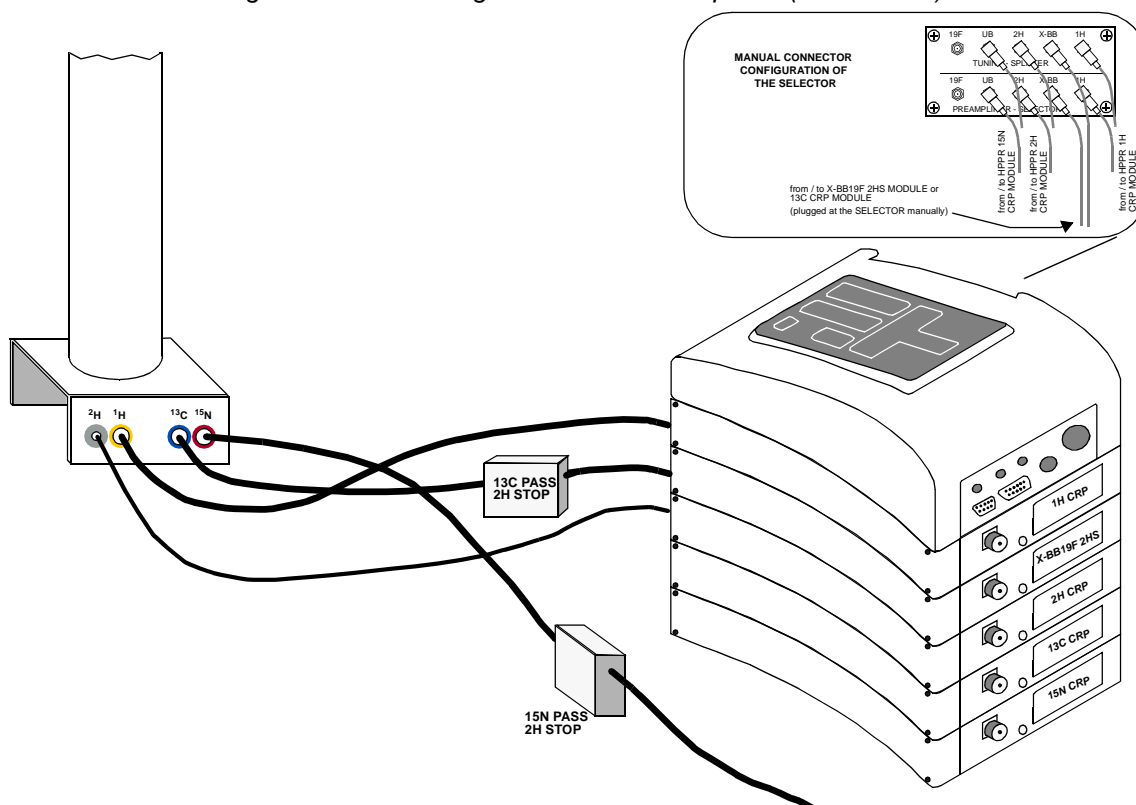
For X-nucleus the choice of module depends on the nuclei and the RF power you intend to use.

- For all other nuclei than 13C or 15N use the HPPR X-BB19F 2HS MODULE you possibly already have (if you have a BLAX 500 transmitter, please make sure that your HPPR X-BB MODULE is able to handle the 500 W). Connect the RF cables coming from or leading to the HPPR X-BB19F 2HS MODULE at the SELECTOR manually and pull the ribbon cable connectors at the JUNCTION BOARD of the HPPR 13C CRP MODULE and HPPR 15N CRP MODULE!
- For 13C or 15N nucleus you may use the HPPR 13C CRP or HPPR 15N CRP MODULE provided that you intend to use NOT MORE THAN 300 W RF power!

NOTE:

1. For the XWIN-NMR configuration, please consult the section "**XWIN-NMR selection of observe and decoupling nuclei (HPPR CRP only)**" on page 16 in the chapter "**Operation**".

Figure 1.5. RF wiring for a conventional probe (HPPR CRP)



RF Wiring in case of existing standard HPPR MODULEs

1.9

The standard HPPR CRP ASSEMBLY may be combined with already existing HPPR MODULEs. Up to five HPPR MODULEs can be powered at the same time (AVANCE spectrometers only!). Depending on whether you use the HPPR CRP MODULEs or an additional HPPR MODULE some manual signal routing has to be done at the HPPR SELECTOR/TUNING-SPLITTER as described later on.

For information about the HPPR/2 MODULE family, please consult the 'HPPR/2 Technical Manual' (Z31559).

Combination with a HPPR 19F or a 3H MODULE

1.9.1

Installation:

- Power the HPPR 19F or 3H MODULE by the ribbon cables leading from the HPPR CRP COVER MODULE to every single HPPR MODULE.
- Connect the rf cables of HPPR 19F or 3H MODULE to the 19F-connectors of the HPPR SELECTOR/TUNING-SPLITTER.

Combination with a HPPR X-BB31P 2HS MODULE

1.9.2

In case of an already existing HPPR X-BB31P 2HS MODULE the delivered HPPR X-BB19F 2HS MODULE may be used instead.

Note: If you have a BLAX 500 transmitter, please make sure that your HPPR X-BB MODULE is able to handle the 500 W. A HPPR X-BB19F 2HS MODULE delivered with the HPPR CRP ASSEMBLY is able to handle the 500W.

Combination with a HPPR X-BB19F 2HP MODULE

1.9.3

In case of an already existing HPPR X-BB19F 2HP MODULE the delivered HPPR X-BB19F 2HS MODULE may be used instead.

Note: The HPPR X-BB19F 2HP MODULE handles only 300W.

Combination with HPHP 19F/1H/3H & X-BB MODULEs

1.9.4

Installation:

- Power the HPHP 19F/1H/3H and X-BB HP MODULE by the ribbon cables leading from the HPPR CRP COVER MODULE to every single HPPR MODULE.

RF Wiring in case of existing standard HPPR MODULEs

- Connect the rf cables of HPHP 19F/1H/3H MODULE to the 19F-connectors of the HPPR SELECTOR/TUNING-SPLITTER.
- Connect the rf cables of HPHP X-BB MODULE to the UB-connectors of the HPPR SELECTOR/TUNING-SPLITTER.

General Description

The later released HPPR/2 family supports a connected CryoProbe with more comfort (needs XWINNMR 3.1 or later). There is no additional software necessary.

Observe with conventional probes

No special commands are necessary.

Observe with the CryoProbe

CryoProbe operation has to be forced by the UniTool as follows:

- `xwinnmr -e UniTool hppr`
- **[P]**reamplifier module
- **[5]** 1H, **[7]** 2H or **[8]** 13C
- **[S]**et Force-State
- **[0]** off, **[4]** cold
- **[Q]**, **[Q]**, ...

After forcing to CryoProbe operation all following commands issued by XWINNMR concerning the HPPR/2 (inclusive 'wobbling') are interpreted in order to route all signals to and from the CryoProbe.

Bypass the CryoProbe for debugging purpose

The internal CryoProbe preamplifier may be bypassed for debugging purpose as follows:

- `xwinnmr -e UniTool hppr`
- **[P]**reamplifier module
- **[5]** 1H, **[7]** 2H or **[8]** 13C
- **[S]**et Force-State
- **[0]** off, **[4]** cold, **[8]** bypass
- **[Q]**, **[Q]**, ...

The BRUKER CryoProbes are supported by a modified preamplifier assembly. The HPPR CRP ASSEMBLY (i.e. Z003422) includes a HPPR CRP COVER MODULE which has an additional RF signal selector controlled by software as described in the following sections.

Installation of the AU programs 'crpon', 'crpoff', 'crp2hon', 'crp1hxon' and 'crpwobb'

If the 'crpon', 'crpoff', 'crp2hon', 'crp1hxon' and 'crpwobb' commands do not exist on your workstation, an add-on package is available from the BRUKER ftp server (ftp.bruker.de) called:

crponoff.tar.gz

(/pub/nmr/xwinnmr/utilities/crponoff.tar.gz)

After unzipping and untaring of the package the **crponoff.readme** file gives a step by step installation guide.

Note: The original crponoff.tar file should be removed.

The new commands must be compiled in XWIN-NMR with **xau <newcommand>**, i.e. **xau crpon**.

Configuration of the HPPR CRP ASSEMBLY

The configuration of an AVANCE spectrometer with HPPR CRP ASSEMBLY follows the same rules as for a standard HPPR. The only requirement is a 'cf' configuration of the spectrometer.

The file **uxnmr.info** should look similar to:

.....

Preamplifiers:

```
- HPPR preamplifier 1 connected to DRX500:/dev/tty01
module 1: 2H Module
module 2: X-BB31P_2HS Module
module 3: 1H Module
module 4: X-BB19F_2HS Module
```

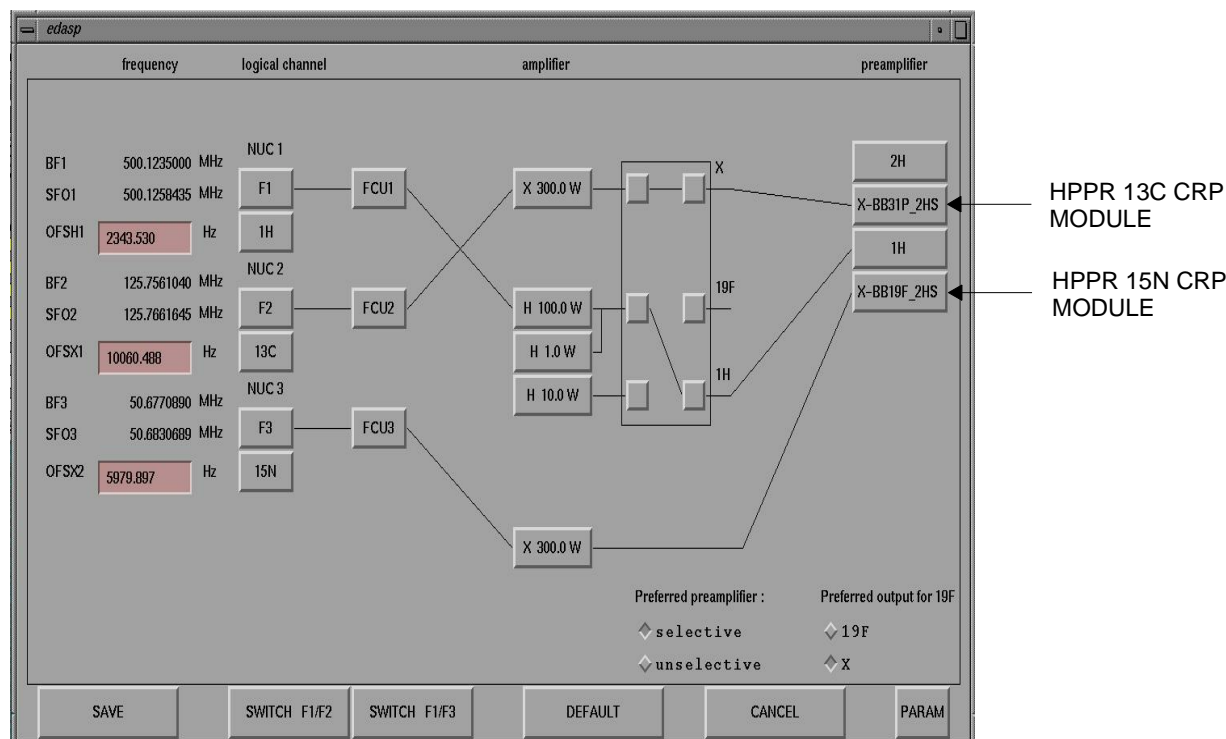
Note: For the RF wiring of a HPPR CRP ASSEMBLY with a CryoProbe or a conventional probe, please consult the chapter **"General Description" on page 5**.

Note: Whenever you do a manual reconfiguration at the HPPR CRP ASSEMBLY (pulling or connecting the ribbon cable connectors at the JUNCTION BOARD), please do it under power-off condition and make a 'cf' afterwards!

The observing nucleus can be selected in XWIN-NMR by the command `,edasp'` and by selecting the corresponding F1 nucleus. The decoupling nuclei should be

selected in F2 or/and F3. The routing for the RF should be selected manually like the following example:

Figure 2.1. 'edasp' routing example for a TXI CryoProbe



For each observable channel, a corresponding HPPR MODULE is required. The selective HPPR MODULES can be routed automatically. For X nuclei, the HPPR XBB19F or HPPR XBB31P module must be routed manually.

HPPR CRP COVER RF selection control

2.2.3

The XWIN-NMR command 'edasp' isn't aware of the existence of a CryoProbe. Therefore, the correct RF path for the observe and the lock signal has to be selected by certain AU programs called 'crpon', 'crpoff', 'crp2hon', 'crp1hxon' and 'crpwobb'. These commands control the routing in the HPPR CRP COVER MODULE. Without a HPPR CRP COVER MODULE, the AU commands will hang on and must be killed manually.

Note: The selection for the observe channel is always coupled with the lock channel. 'crpon' means: both, the observe and the lock signal come from the CryoProbe. During switching the lock signal may be temporarily lost. The usual lock gain and phase adjusting has to be done after that.

Observe with conventional probes

Conventional probes as e.g. a TXI can be used with the same HPPR CRP ASSEMBLY provided that NOT MORE THAN 300 W is used for the HPPR 13C CRP or HPPR 15N CRP MODULE. Otherwise you have to check whether your possible already existing HPPR XBB19F 2HS MODULE is able to handle 400 to 500W.

By calling up the 'crpoff' command the signals of the HPPR MODULEs are routed in the HPPR CRP COVER MODULE to the observe and lock receivers.

Note: For the RF wiring of a HPPR CRP ASSEMBLY with a conventional probe, please consult the section **"RF Wiring for a Conventional Probe (HPPR CRP)" on page 11** in the chapter **"General Description"**.

Note: For reinstallations from CryoProbe operation to conventional probes, please switch off the power supply at the AQR chassis and make a 'cf' afterwards!

Note: Default state after a power-up / reset is 'crpoff'.

Observe with the CryoProbe

- 'crpon'
 - The signals of the built-in cooled preamplifiers are routed in the HPPR CRP COVER MODULE to the observe and lock receivers.
- 'crp2hon'
 - measurement of passive channels (without built-in cooled preamplifiers), e.g. 13C or 15N depending on your type of CryoProbe.
- 'crp1hxon'
 - (for debugging only)

Wobble of a CryoProbe

A CryoProbe must be tuned and matched via the transmit channel of the corresponding HPPR CRP MODULE. The following commands are available:

- 'crpwobb'
 - wobbling of all channels, no lock signal of the CryoProbe
- 'crp2hon'
 - wobbling of observe channels (e.g. 1H, 13C, 15N), 2H lock operation.

Note: After tuning and matching of a CryoProbe, the RF path routing must be reset by the 'crpon' command.

RF UNIT 1H13C2H

Technical Data

3

General

3.1

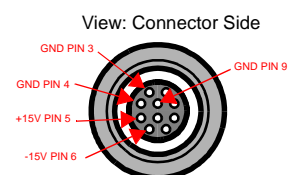
The technical data for the RF UNIT 1H13C2H applies to the CP DUL C/H-D or CP DUI H/C-D.

Power Consumption

3.2

Table 3.1. Power Consumption

Measurement	I_{MAX}
+15V (POWER Connector (LEMO), Pin 5)	+ 200 mA
-15V (POWER Connector (LEMO), Pin 6)	- 50 mA



Transmit-/Receive Bias Currents

3.3

Depending on the HPPR CRP or HPPR/2 family and the built-in Cryoprobe electronic different transmit-/receive bias currents may be measured on the transmitter coaxial line between the HPPR (HPPR/2) module and the corresponding Cryoprobe input, according to the following table:

Table 3.2. Cryoprobe T/R-switch bias current for the HPPR CRP

MODULE	Bias Current at operating temperature		Remarks
HPPR 1H CRP MODULE 500: Z003189 600: Z003190	PRCONT 1H ~ 25 mA 500: Z003154 600: Z003155	PRCONT 1H2H ~ 15 mA 500: Z003897 600: Z003898	~ 45 mA with SIH0218
HPPR 13C CRP MODULE 500: Z003246 600: Z003247	PRCONT 13C ~ 31 mA 500: Z003183 600: Z003184	PRCONT 13C ~ 18 mA 500: Z003905 600: Z003906	~ 85 mA with SIH0218
HPPR 2H CRP MODULE 500: Z003217 600: Z003218	PRCONT 2H ~ 25 mA 500: Z003300 600: Z003301	PRCONT 1H2H ~ 27 mA 500: Z003897 600: Z003898	

Table 3.3. Cryoprobe T/R-switch bias current for the HPPR/2 family

MODULE	Bias Current at operating temperature		Remarks
HPPR/2 1H LNA MODULE 500: Z003461 750: Z003464 600: Z003462 800: Z003465 700: Z003463 900: Z003466	PRCONT 1H HP ~ 59 mA 500: Z003154 600: Z003155	PRCONT 1H2H ~ 45 mA 500: Z003897 600: Z003898 800: Z003904 700: Z003914 900: Z100112	
HPPR/2 13C MODULE 500: Z003523 750: Z003526 600: Z003524 800: Z003527 700: Z003525 900: Z003528	PRCONT 13C ~ 82 mA 500: Z003183 600: Z003184	PRCONT 13C) ~ 60 mA 500: Z003905 600: Z003906	~ 95mA for ECL 01.10 and higher
HPPR/2 2H MODULE 500: Z003472 750: Z003475 600: Z003473 800: Z003476 700: Z003474 900: Z003477	PRCONT 2H) ~ 18 mA 500: Z003300 600: Z003301	PRCONT 1H2H ~ 18 mA 500: Z003897 600: Z003898 800: Z003904 700: Z003914 900: Z100112.	~ 25mA for ECL 00.05 and higher

RF UNIT 1H13C2H15N Technical Data

4

General

4.1

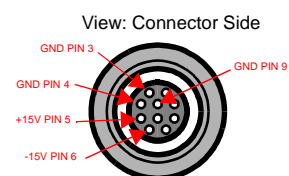
The technical data for the RF UNIT 1H13C2H15N applies to the CP TXI H-C/N-D.

Power Consumption

4.2

Table 4.1. Power Consumption

Measurement	I_{MAX}
+15V (POWER Connector (LEMO), Pin 5)	+ 200 mA
-15V (POWER Connector (LEMO), Pin 6)	- 50 mA



Transmit-/Receive Bias Currents

4.3

Depending on the HPPR CRP or HPPR/2 family and the built-in Cryoprobe electronic different transmit-/receive bias currents may be measured on the transmitter coaxial line between the HPPR (HPPR/2) module and the corresponding Cryoprobe input, according to the following table:

Table 4.2. Cryoprobe T/R-switch bias current for the HPPR CRP

MODULE	Bias Current at operating temperature		Remarks
HPPR 1H CRP MODULE 500: Z003189 600: Z003190	PRCONT 1H ~ 25 mA 500: Z003154 600: Z003155	PRCONT 1H2H ~ 15 mA 500: Z003897 600: Z003898	~ 45 mA with SIH0218
HPPR 2H CRP MODULE 500: Z003217 600: Z003218	PRCONT 2H ~ 25 mA 500: Z003300 600: Z003301	PRCONT 1H2H ~ 27 mA 500: Z003897 600: Z003898	

Table 4.3. Cryoprobe T/R-switch bias current for the HPPR/2 family

MODULE	Bias Current at operating temperature		Remarks
HPPR/2 1H LNA MODULE 500: Z003461 750: Z003464 600: Z003462 800: Z003465 700: Z003463 900: Z003466	PRCONT 1H HP ~ 59 mA 500: Z003154 600: Z003155	PRCONT 1H2H ~ 45 mA 500: Z003897 600: Z003898 800: Z003904 700: Z003914 900: Z100112	
HPPR/2 2H MODULE 500: Z003472 750: Z003475 600: Z003473 800: Z003476 700: Z003474 900: Z003477	PRCONT 2H) ~ 18 mA 500: Z003300 600: Z003301	PRCONT 1H2H ~ 18 mA 500: Z003897 600: Z003898 800: Z003904 700: Z003914 900: Z100112.	~ 25mA for ECL 00.05 and higher

The CryoProbe is designed for high reliability and has been tested thoroughly during the manufacturing process. However, a few things are valuable to know in case of trouble. Every CryoProbe is a very complex unit with electronics working at cryogenic temperature and helium leakproof vacuum technology. The special requirements for repair and successful reassembly of a CryoProbe are unlikely to be met outside of a BRUKER manufacturing facility. Irreversible damage to the probe will result, if improper techniques and tools are used.

Therefore, the CryoProbe **MUST NOT BE OPENED!** Any warranty will be invalid if an attempt is made to open the CryoProbe by a non-approved repair facility! Contact a BRUKER representative in case of problems.

Furthermore, it is advisable to perform a few checks before calling BRUKER service in order to make sure whether the CryoProbe is causing the trouble or something else.

The following hints and the block diagram should assist you in your enquiries.

- Check all connectors: Are they at the right place? Especially, is the POWER cable to the CRYOPROBE properly connected at the back of the HPPR CRP COVER?
- Does the spectrometer work satisfyingly with a conventional probe? Check in particular those functions and measurements which seem not to work properly with the CryoProbe, if possible.
- Check the PROBE TUNING function ('wobble') for all selectable channels: Do you get a tuneable dip on your display? (This check indicates if most of the signal routing to and from the CryoProbe and most of the CryoProbe itself is working)
Note: A CryoProbe must be cooled down to its operating temperature for tuning and matching. Do not try to tune a CryoProbe when warm!
- Try to reproduce a standard spectrum you successfully recorded not long ago with the same standard sample and identical experimental parameters.

For further tests you need measurement instruments like e.g. a 500 MHz oscilloscope.

- Set the spectrometer into the PROBE TUNING mode ('wobble') (in the TUNING mode you get a traceable swept signal). With help of the oscilloscope, the following block diagram and a HPPR Technical Manual you can trace the tuning rf signal and all necessary trigger pulses at the HPPR and CryoProbe interface connectors.

Figure 5.1. Block Diagram CP DUL C/H-D or CP DUI H/C-D (HPPR CRP)

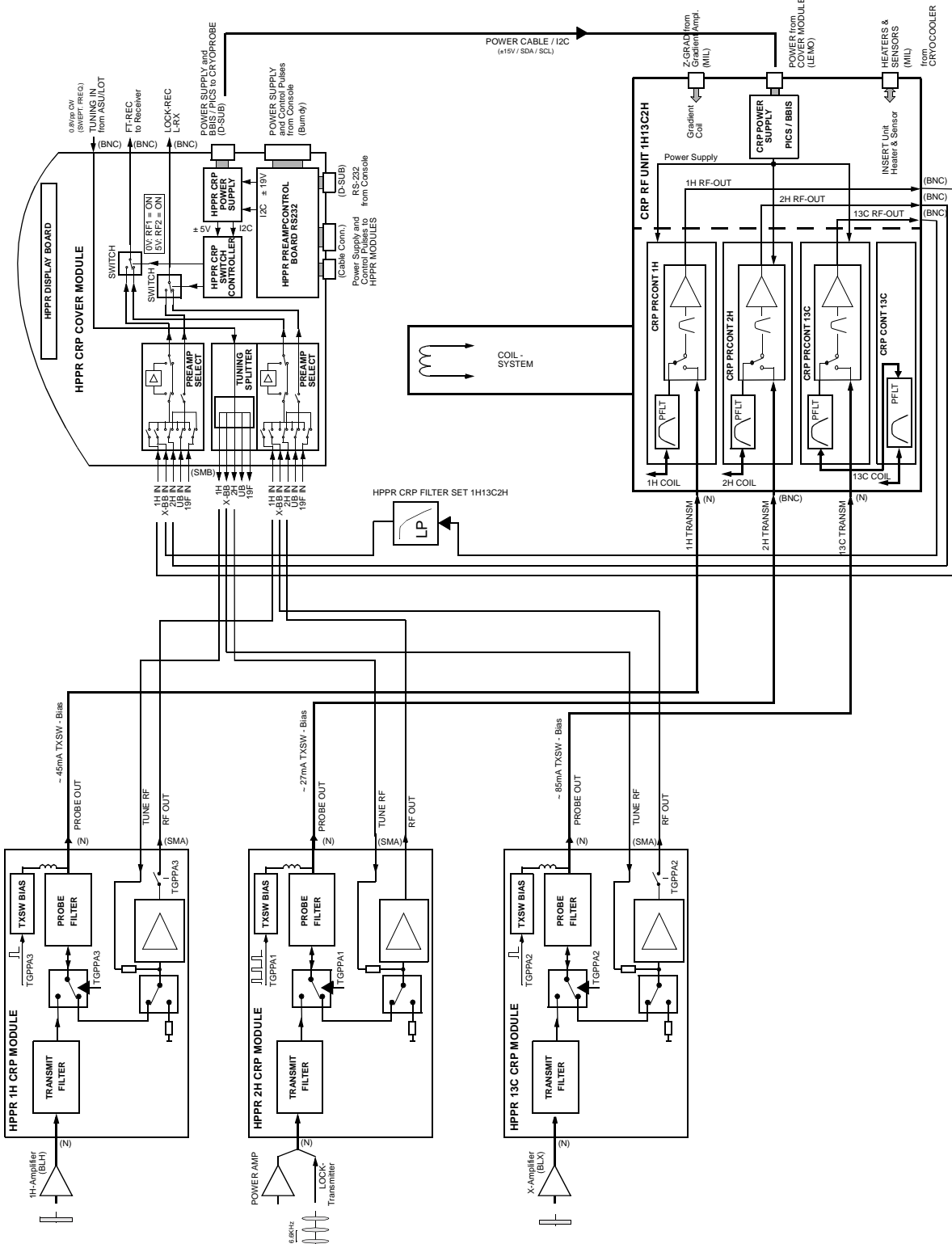


Figure 5.2. Block Diagram CP DUL C/H-D or CP DUI H/C-D (HPPR/2 family)

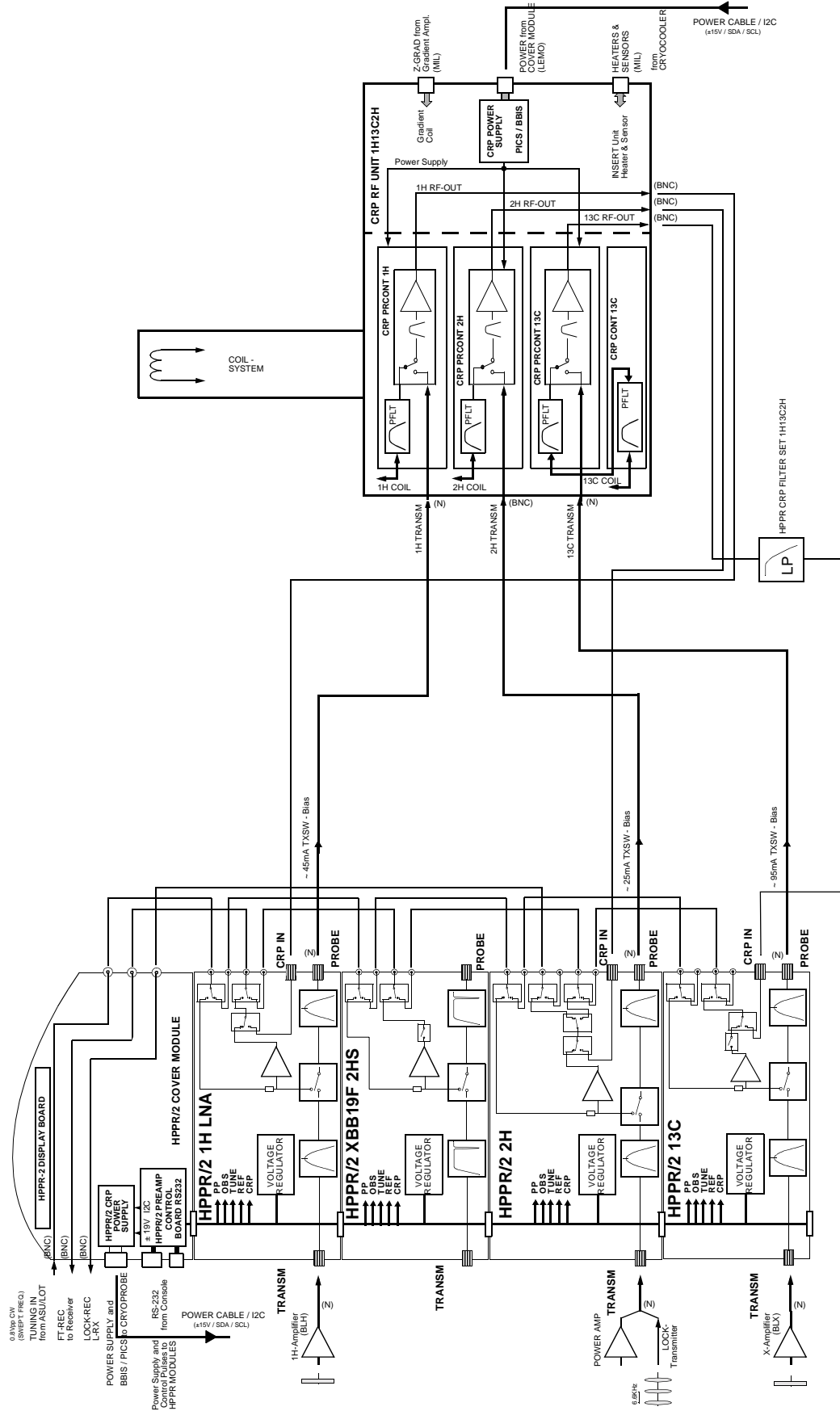


Figure 5.3. Block Diagram CP TXI H-C/N-D (HPPR CRP)

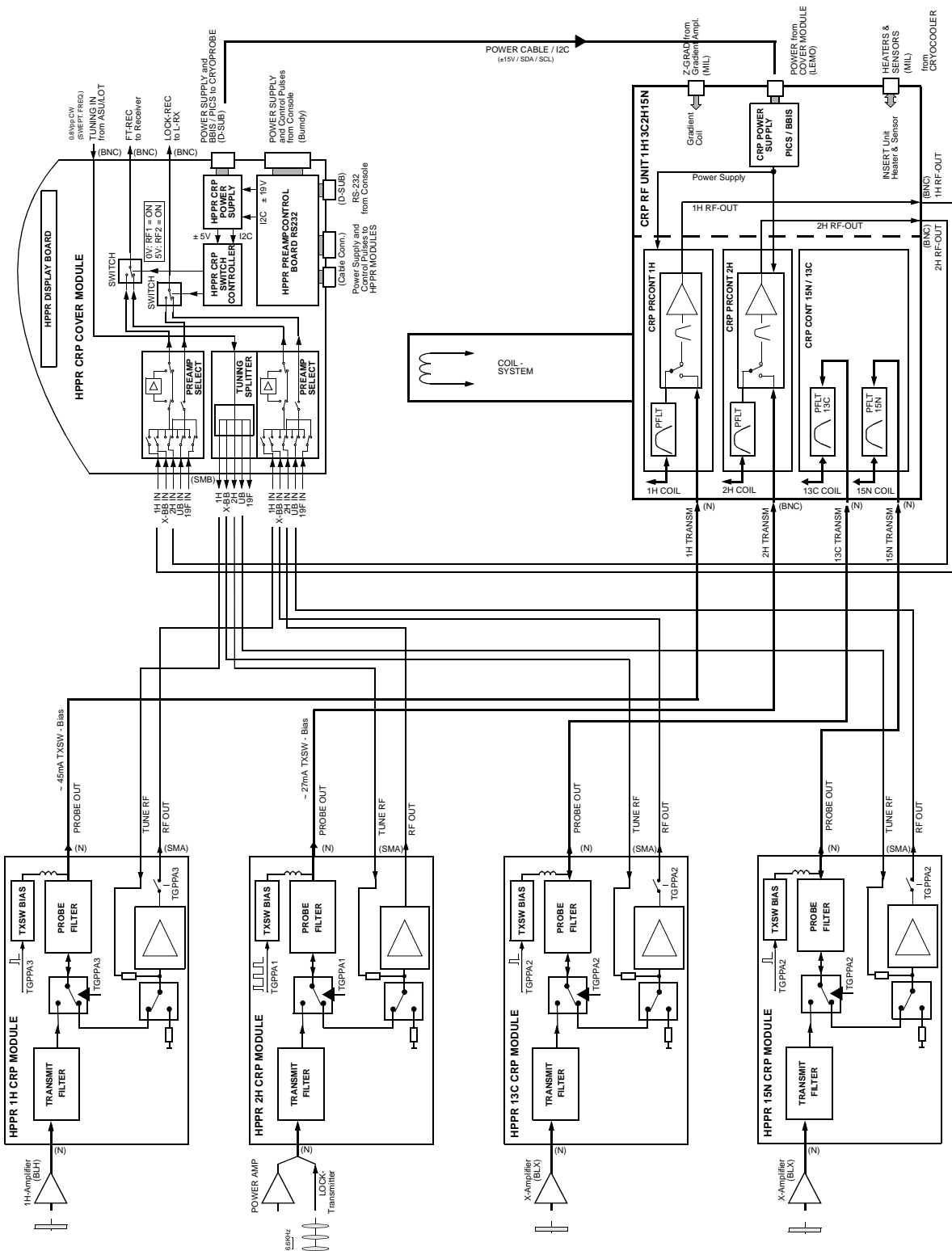
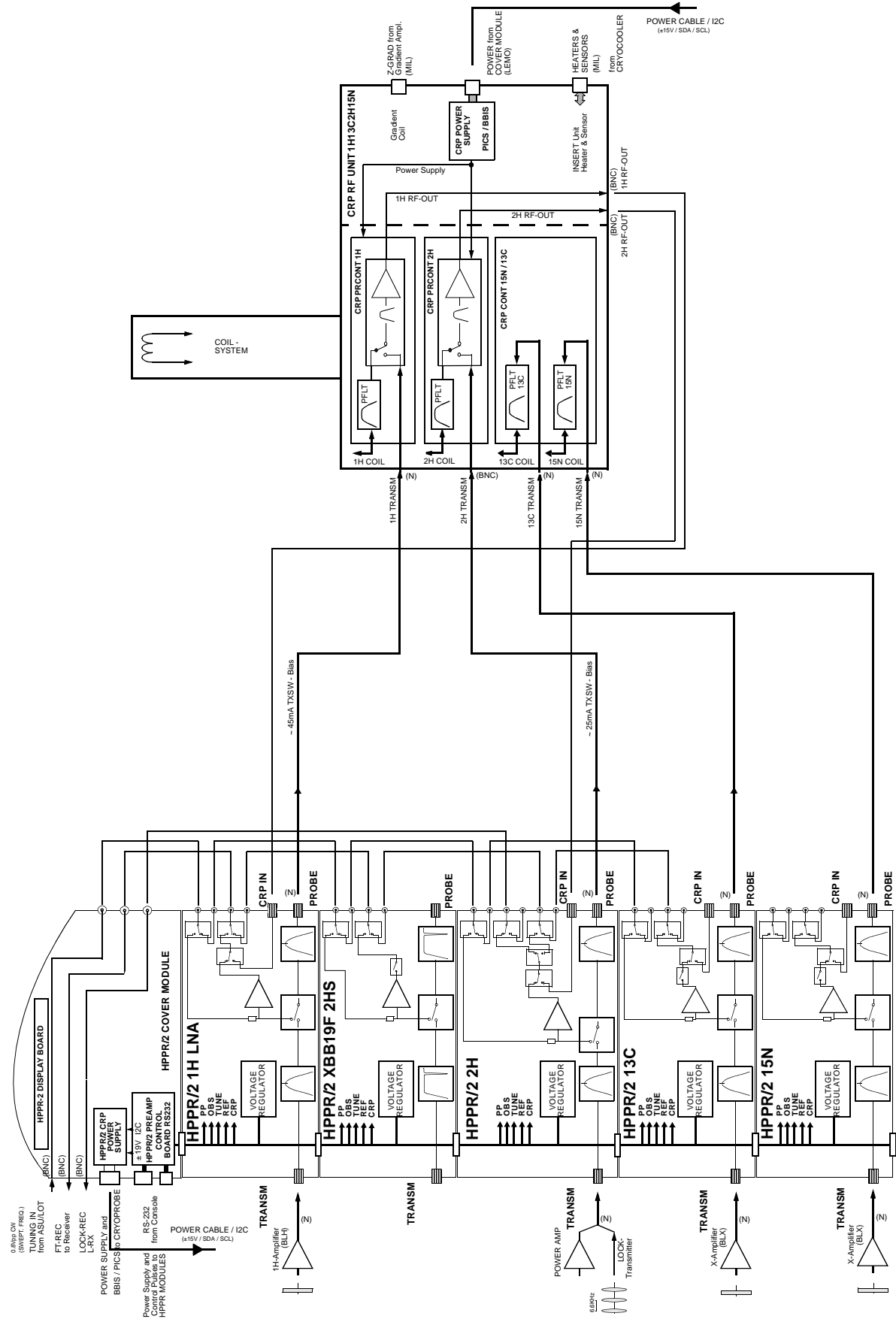


Figure 5.4. Block Diagram CP TXI H-C/N-D (HPPR/2 family)



Service Information

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