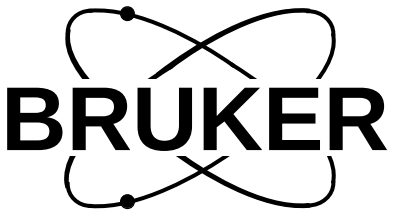

HPPR

HP-Preamplifier

Technical Manual

Version 007

This Manual was written by

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Updated for BASH 2.0 by U. Roos - December 1996

P/N: Z 31075
DWG-Nr.: 755007

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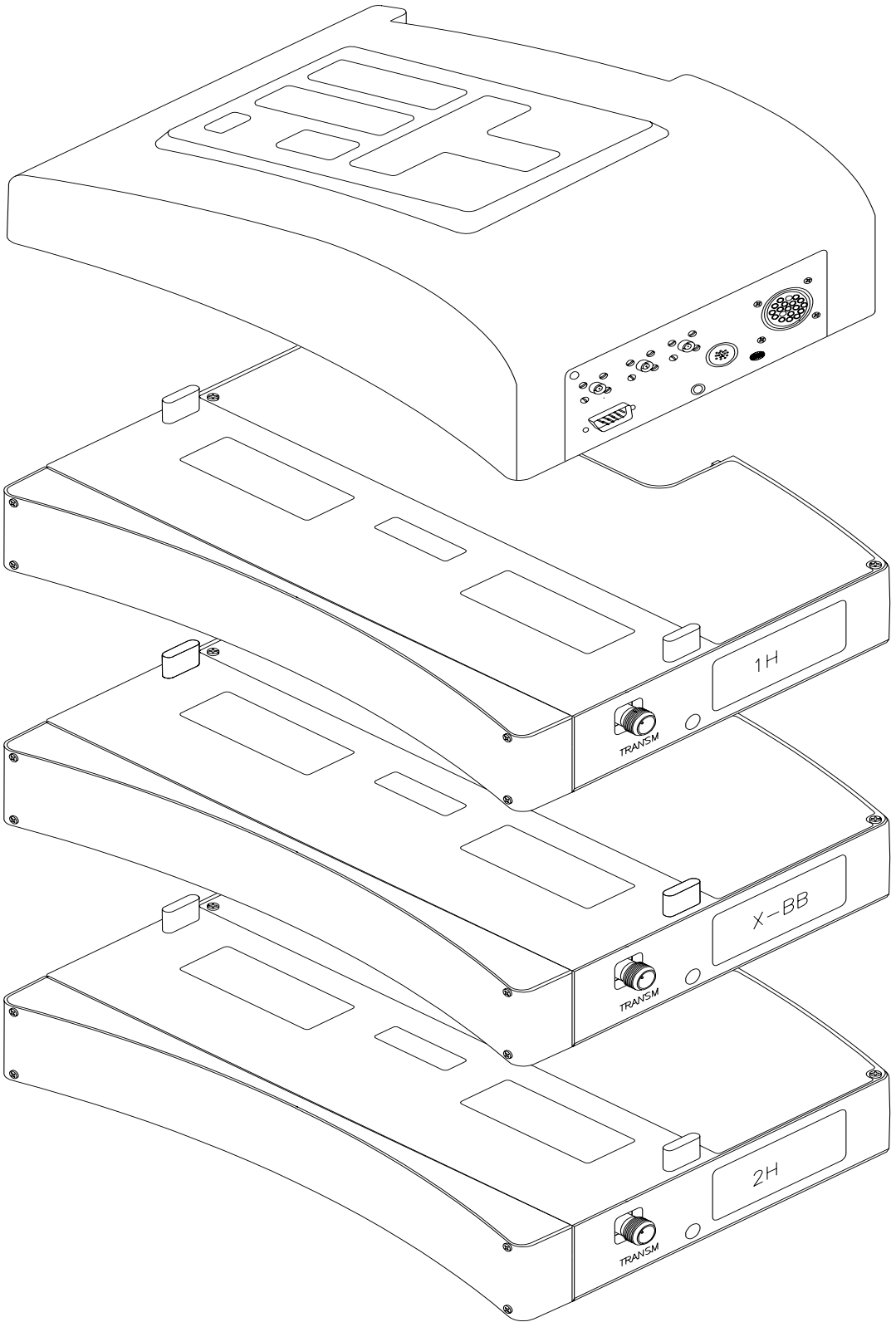
Figure 1: Exploded View



Overview 1.1

The High Performance Preamplifier Assembly (hereafter referred as HP Preamp) consists, in the basic configuration, of a ^{1}H module, a X-BB module, a ^{2}H module and a Cover/Display unit. All modules are 'Fourier capable' and are intended for use with up to 400 W transmission power. The basic configuration may later be updated with a maximum of two extra modules.

The modules, with identical casts, contain a preamplifier, and a Transmitter/Receiver switch including necessary high performance filters in the transmitter and probehead paths.

The display indicates the operating status of the HP Preamp. The observe channel, the lock channel, and other information, are indicated on the large format LED. When in progress, data communication is indicated. The T-junction LED indicates - during the operation of the tuning 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. A 19 core cable supplies all DC voltages and required transmission pulses. A RS 232C connection is used for command and data transfer between the Console and the HP Preamp.

Features 1.2

Ease of Operation

Cast aluminium housing for enhanced noise immunity

Improved lock stability through integrated lock preamplifier

FFT capable lock

Integrated filter in Transmitter and Probehead path (400 W pulse power)

Automatic routing of the Receiver and Lock channel

Modular arrangement , up to 5 modules maximum

No magnetic switches (Relays)

Communication via RS 232C with X 32

Probehead tuning (Wobblefunction)

Figure 2: HP Preamp - Block Diagram -

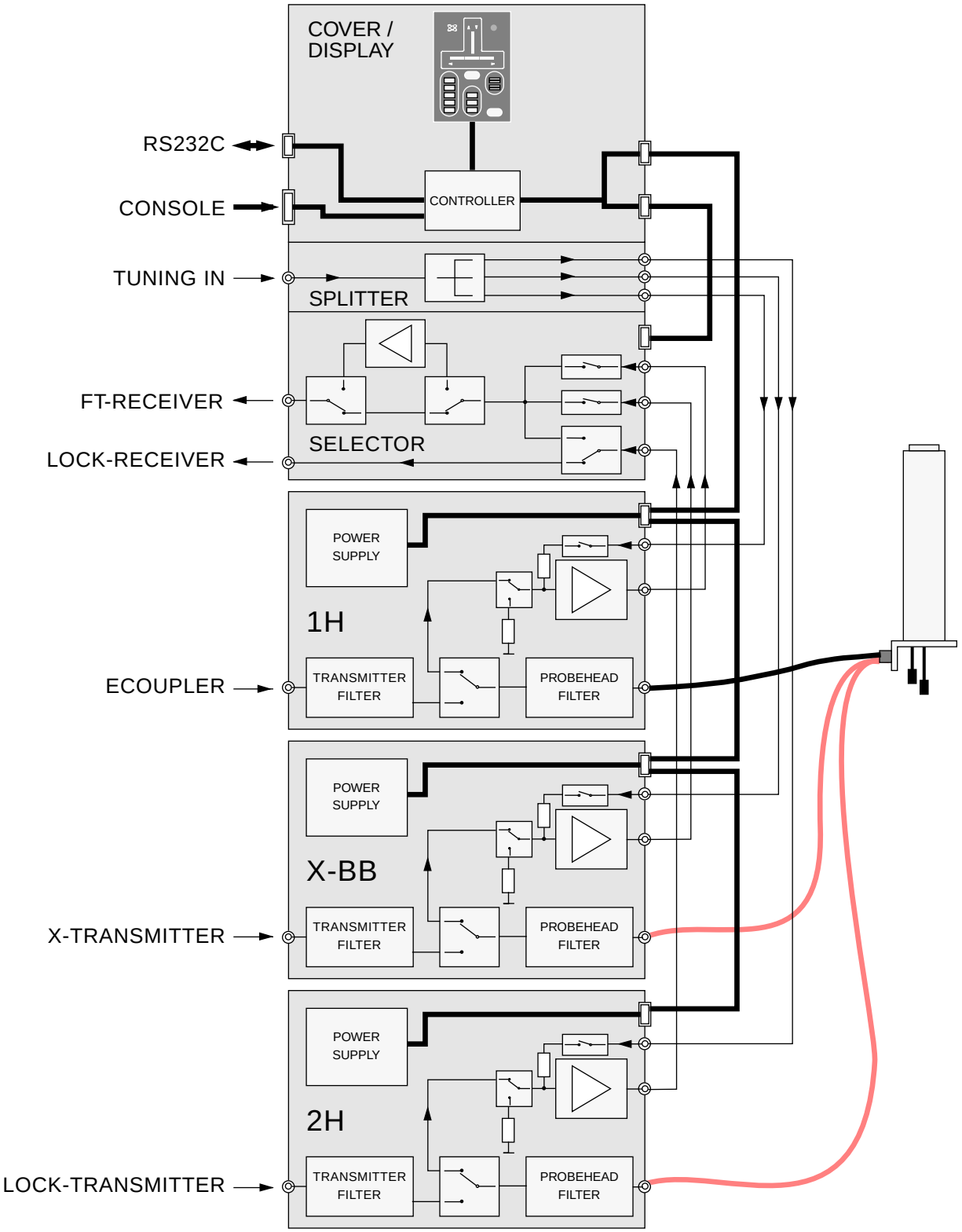
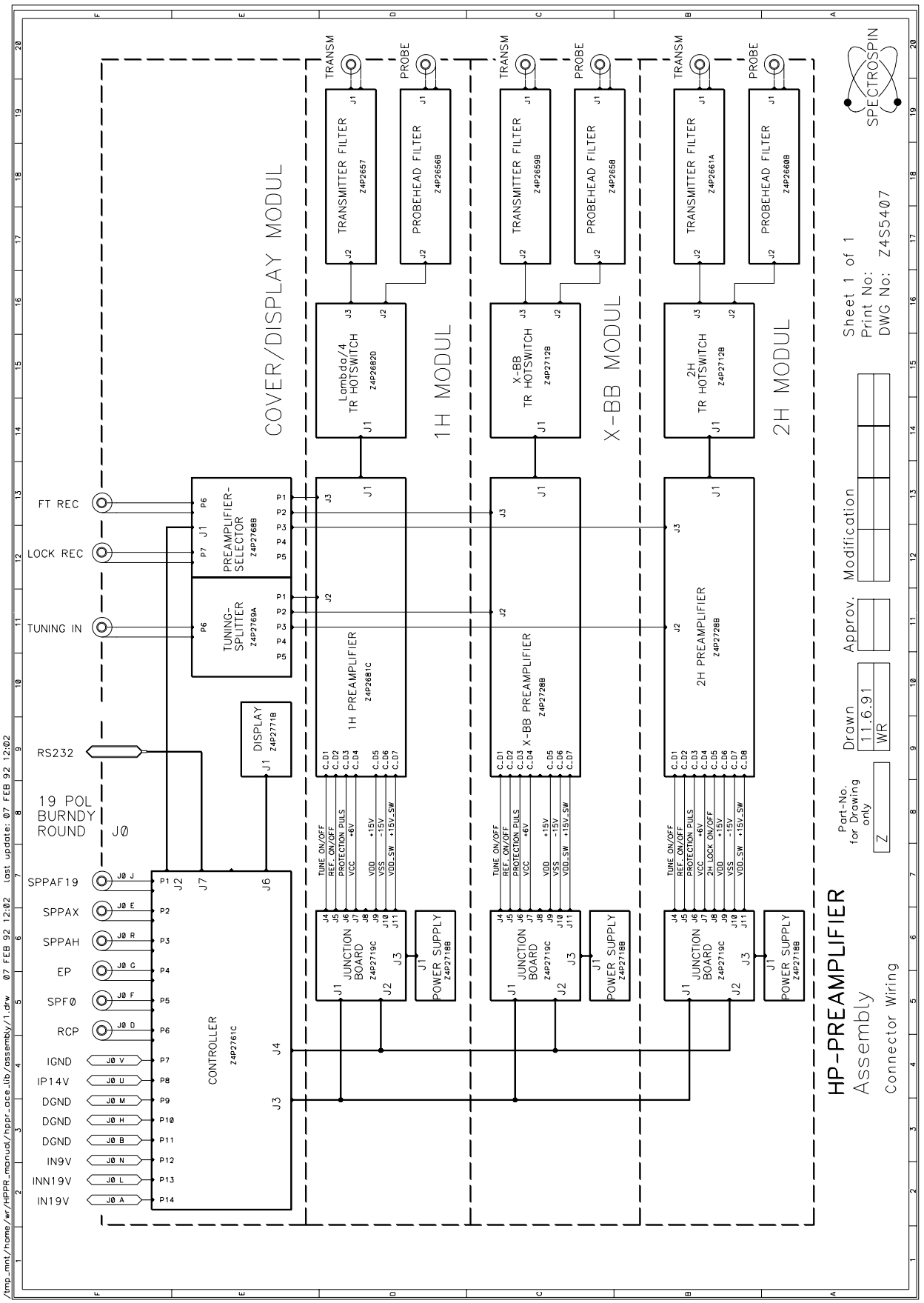


Figure 3: Connector Wiring - Block Diagram -



Cover / Display Module

Figure 4: Cover / Display Module - Exploded View -

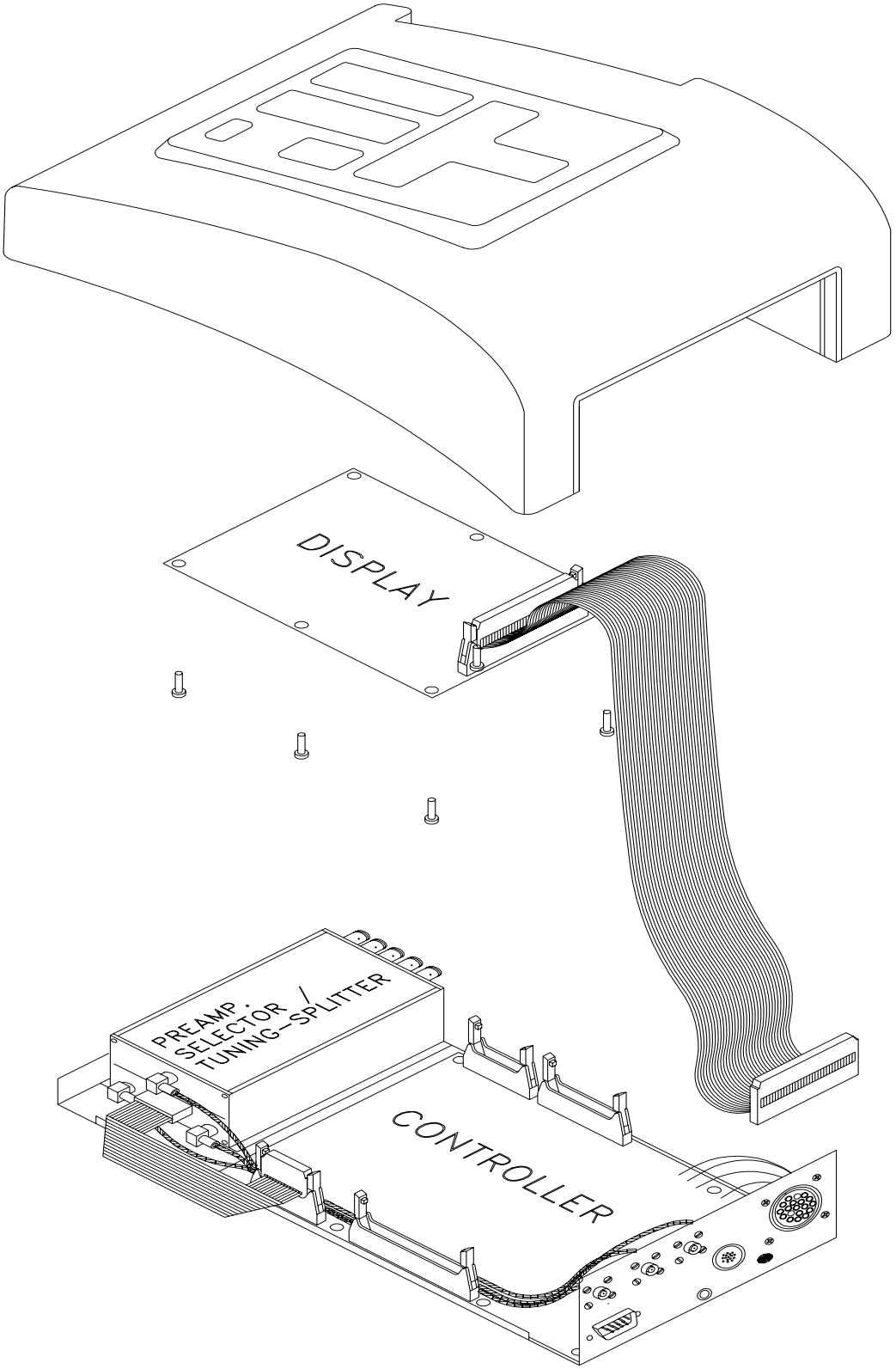
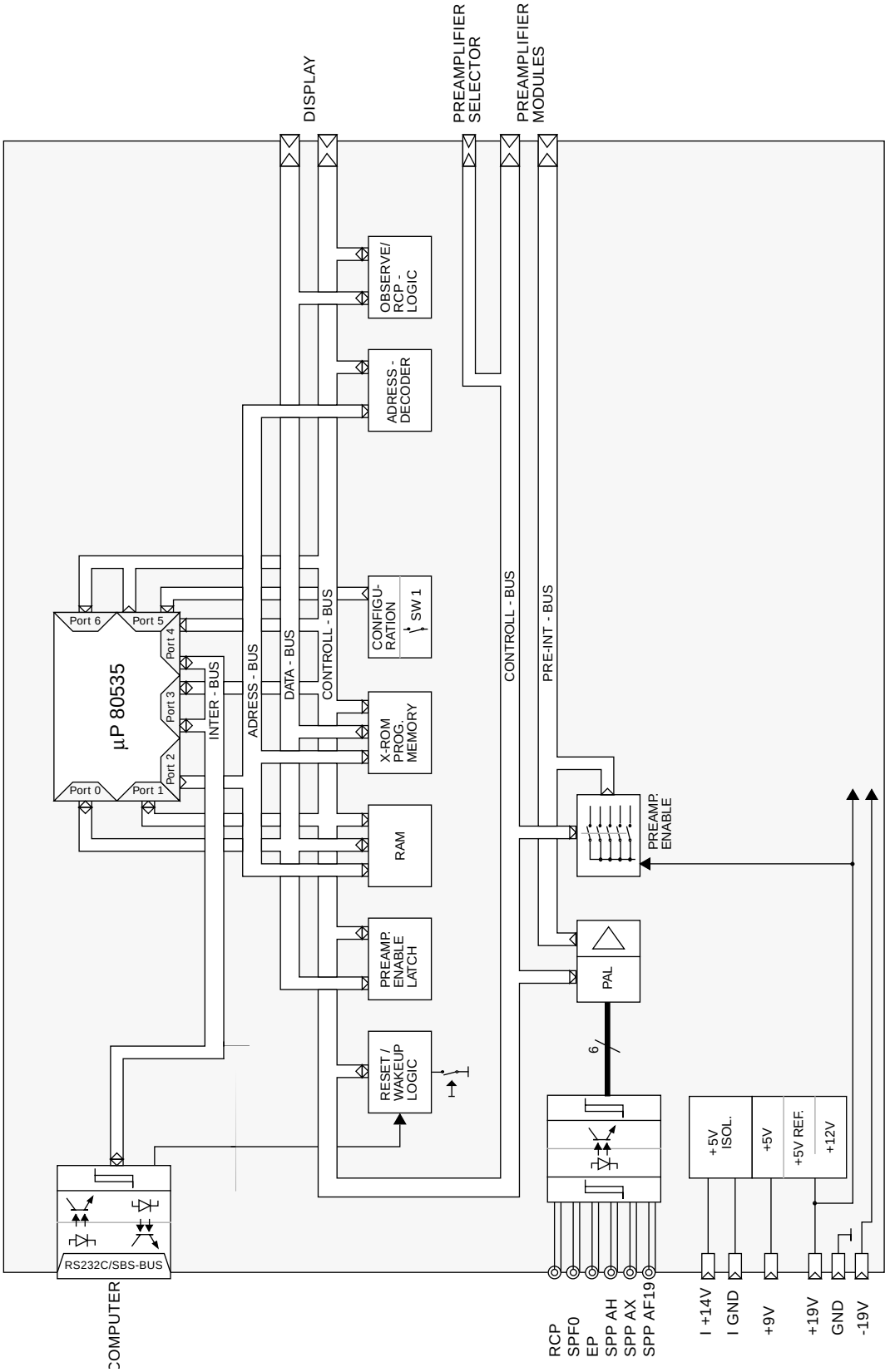


Figure 5: Controller - Block Diagram -



General

The Controller is responsible for the HF electronics in the HP Preamp. The display indicates the current status of the HP Preamp.

Microcontroller

The heart of the Controller consists of a 80C535 (12 MHz) Microcontroller, a 32k*8 SRAM, a 32k*8 EPROM, a 32k*8 or 64k*8 Flash-Memory and an address decoder. The startup and download software is found in the EPROM. The Flash memory contains the application software. The operating software can be updated to the Flash memory by downloading through the serial port.

Serial Port RS232

All commands between the X32 and the HP Preamp are transferred via the RS 232. The port isgalvanically isolated. A handshake system (RTS, DTR) which is controlled by the X32 - RS232 drivers must, in the case of the RTS and DTR lines, operate on a 12 V level. The HP Preamp communication system requires no other handshake connections (pure software handshake).

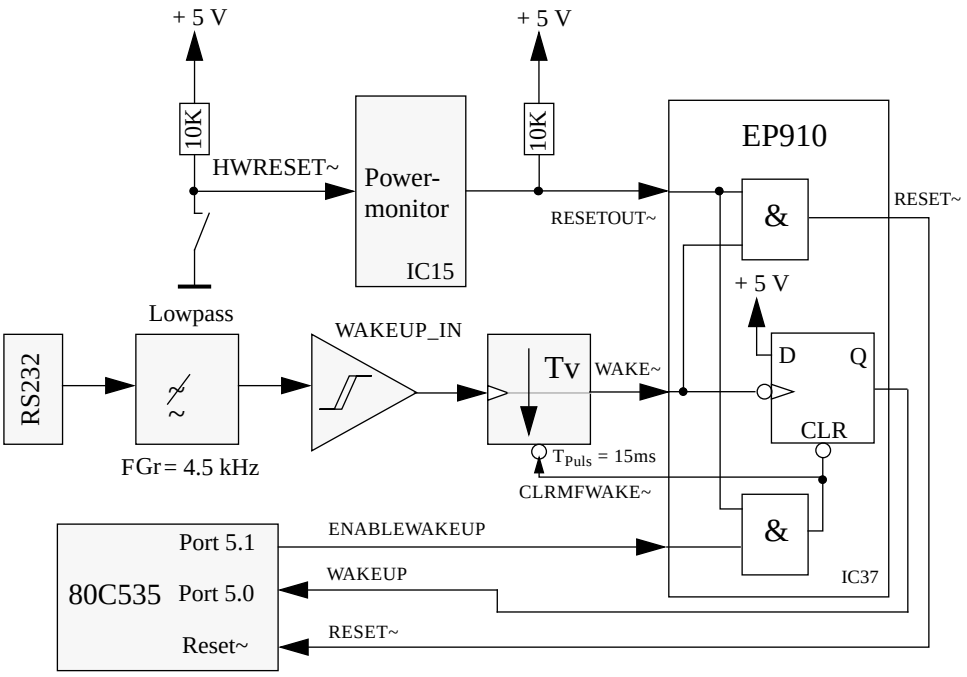
Table 1: RS232: 9-pol D-Sub connector (male)

Pin	Signal	Remark
1	CD	connected with RTS, DSR
2	TXD	
3	RXD	
4	DTR	connected with CTS
5	GND	
6	DSR	connected with CD, RTS
7	RTS	connected with CD, DSR
8	CTS	connected with DTR
9	RI	not connected

Reset and Wakeup Logic (Sleep and Normal Mode)

A power monitor chip ensures that at low voltage (less than 4.5 V) a hardware reset is made. Sleep mode for the Preamp controller can be activated on request. In this mode all oscillators from the 80C535 are deactivated, including the automatic LED intensity control. Reactivating the controller requires a hardware reset by the Wake-up Logic.

Figure 6: Reset/ Wakeup Logic



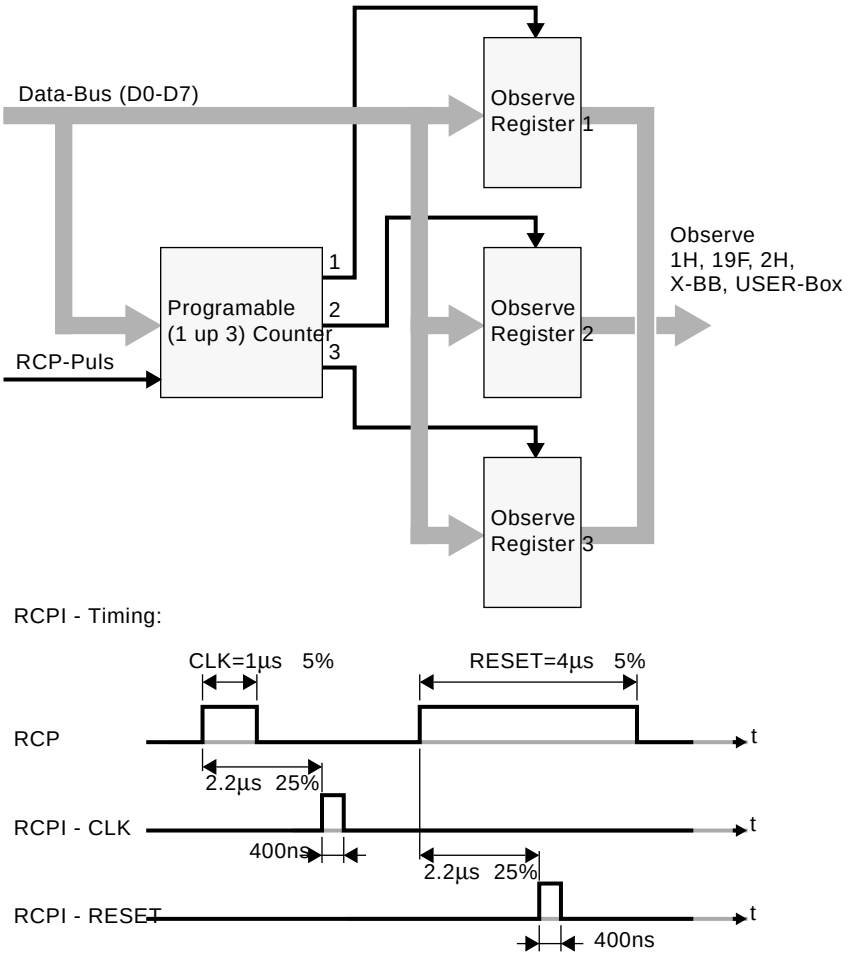
Controller Setup

Two jumpers are reserved for future options.

RCPI-Logic

The Preamp controller operates either in normal mode or in sleep mode. In the first case all commands are received from the serial port. To ensure that an experiment is not disturbed by the oscillator clock, the data communication unit sets the controller to sleep mode during measurements. For certain measurements it is necessary to change the observe channel. The RCPI logic allows a fast channel change during sleep mode. The logic consists of three registers and a programmable counter. An observe channel can be activated via the serial port in the register. The number of the observe channel change is programmed in the counter (1 ... 3). The counter is incremented (modulo channel change number) with a pulse of 1 µs (±5%) on the RCP input. With a pulse of 4 µs (± 5%) at the RCP input, the counter returns to the reset position (the configuration of register 1 is active). In the normal mode the RCPI logic is switched back. The RCP input is disabled.

Figure 7: RCPI Interface



Transmitter Gate Pulse Logic

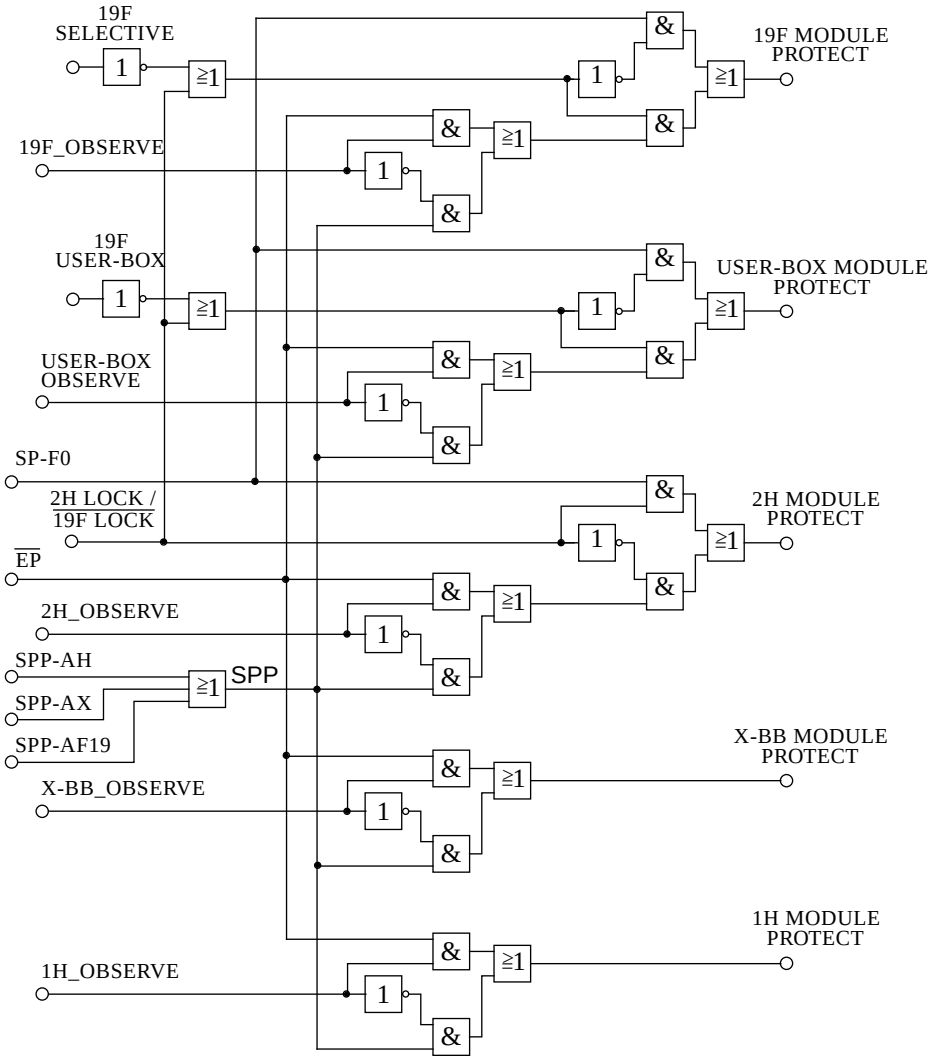
The four transmitter gate pulses: SP-F0, SPP-AH, SPP-AX und SPP-AF19 are allocated to a maximum of five Preamp modules. The ^{2}H Module, the ^{19}F Module or the corresponding USER Box Module can operate in either Fourier- or Lock mode. Depending on the system, either the SP-F0 or another gate pulse is used. In addition, ^{19}F measurements with a ^{19}F selective module or with an appropriately equipped USER-Box (QNP) may be completed.

At certain times the correct setting for the transmitter gate pulse in the module will be set by a command from the controller. The OBSERVE-Signal and the ^{2}H-Lock / ^{19}F-Lock signal control the switching.

For example: A ^{1}H experiment with BB-decoupling uses an inverted EP pulse to protect the ^{1}H Module whereas the X-BB Module is protected by the OR-transmitter gate pulse.

The principle illustrated by this example may be applied to all known experiments. The transmitter gate pulse logic is found on the controller print.

Figure 8: Transmitter gate pulse logic



PAL-Equations for the Transmitter gat pulse logic

Standard declarations

```
#           = OR
&           = AND
SPP         = (SPPAH # SPPAX # SPPAF19);
```

Transmitter Gate Pulse Equations

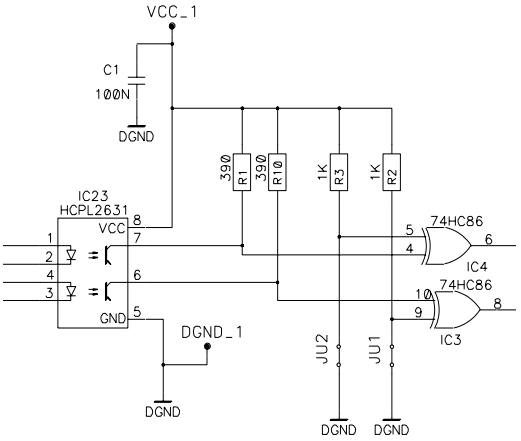
```
19FPROTECT = ((2HLOCK # !SEL19F) & ((EPFTn & OBS19F) # (!OBS19F & SPP)))
             # (SPF0 & !(2HLOCK # !SEL19F)) ;

UBPROTECT = ((2HLOCK # !UB19F) & ((EPFTn & OBSUB) # (!OBSUB & SPP)))
             # (SPF0 & !(2HLOCK # !UB19F)) ;

2HPROTECT = (!2HLOCK & ((!OBS2H & SPP) # (OBS2H & EPFTn)))
             # (SPF0 & 2HLOCK) ;

XBBPROTECT = (!OBSXBB & SPP) # (OBSXBB& EPFTn) ;

1HPROTECT = (!OBS1H & SPP) # (OBS1H & EPFTn) ;
```

General

In the new spectrometer series DMX, DSX, DRX,DPX and D.. the gate pulses SPPAH, SPPAX, SPPAF19 and RCP change from positive logic (active High) to negative logic (active Low). The SPF0 and EP pulses remain in their old positive-active state.

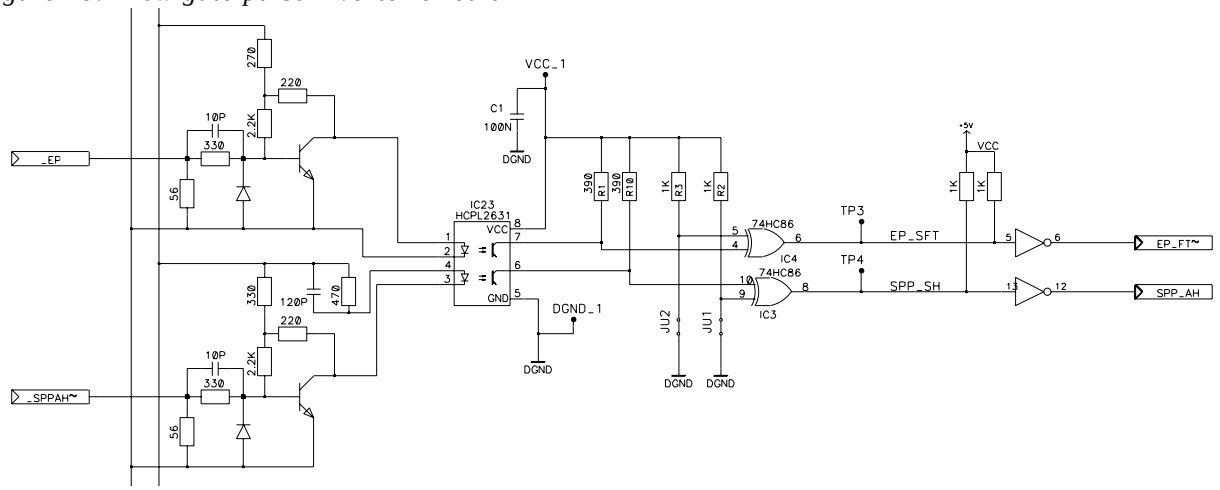
Function description

Figure 9: Puls inverter subprint (1 of 3 circuits)



The optocouplers IC14, IC23 and IC26 on the controller board have been replaced by sockets. The subprint plugged into these sockets contains the new circuits shown above.

Figure 10: New gate pulse inverter circuit



It is possible to select negative- or positive-active pulses by jumpers. Each open jumper provides an additional inverter in the designated signal path. The schematic above shows the EP and SPPAH gate pulse path. Note that the EP pulse channel of the optocoupler IC23 is different to all other optocoupler circuits. It is designed as an inverter.

Table 2: Default jumper settings for positive-active gate pulses

Input pulse		Jumper settings			Output pulse	
Name	+/- activity	JU#[1]	closed (Puls)	open ($\overline{\text{Puls}}$)	Name	+/- activity
_RCP	positive	JU4	X		RCP	positive
_SPF0	positive	JU3	X		SP_F0	positive
_EP[2]	positive	JU2	X		EP_FT ~	negative
_SPPAH	positive	JU1	X		SPP_AH	positive
_SPPAX	positive	JU6	X		SPP_AX	positive
_SPPAF19	positive	JU5	X		SPP_AF19	positive

[1] Jumper JU7 is not used (reserve)

Table 3: New jumper settings for negative-active gate pulses

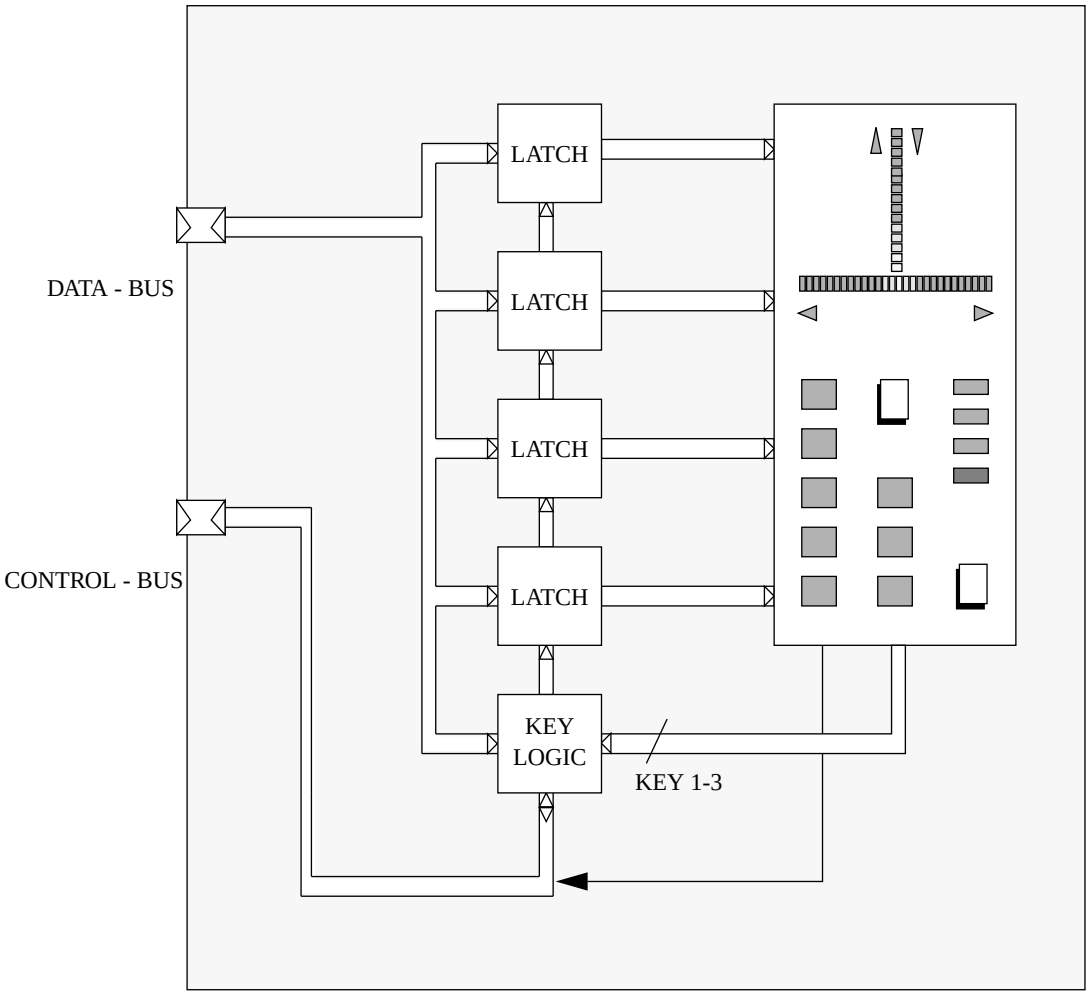
(For spectrometer series DMX, DSX, DRX and D..)

Input pulse		Jumper settings			Output pulse	
Name	+/- activity	JU#[1]	closed (Puls)	open ($\overline{\text{Puls}}$)	Name	+/- activity
_RCP ~	negative	JU4		X	RCP	positive
_SPF0	positive	JU3	X		SP_F0	positive
_EP [2]	positive	JU2	X		EP_FT ~	negative
_SPPAH ~	negative	JU1		X	SPP_AH	positive
_SPPAX ~	negative	JU6		X	SPP_AX	positive
_SPPAF19 ~	negative	JU5		X	SPP_AF19	positive

[1] Jumper JU7 is not used (reserve)
[2] The optocouplers IC23 EP pulse channel is different to the other optocoupler circuits. It is designed as an inverter. Thus the jumper JU2 has to be closed to get a negative-active pulse (EP_FT ~) at the output.

Display 2.2

Figure 11: Display - Block Diagram -



The display indicates the current status of the HP Preamp. It is divided into 6 parts:

1. Observe- and Lock channel indicator:

   Denotes the Lock- and the Observe channel (green LED)

2. Status Indicator:

COMPUTER-LED:	Data transfer via RS232
READY-LED:	Stand by for further commands
ERROR-LED:	Indicates Preamp problems

3. Tuning/Matching Indicator:

   This display only becomes active when the HP Preamp is in Tuning/Matching mode.

4. Channel Selector button:

   Allows to change channels for multiple channel Tuning/Matching.

5. Display Test button:

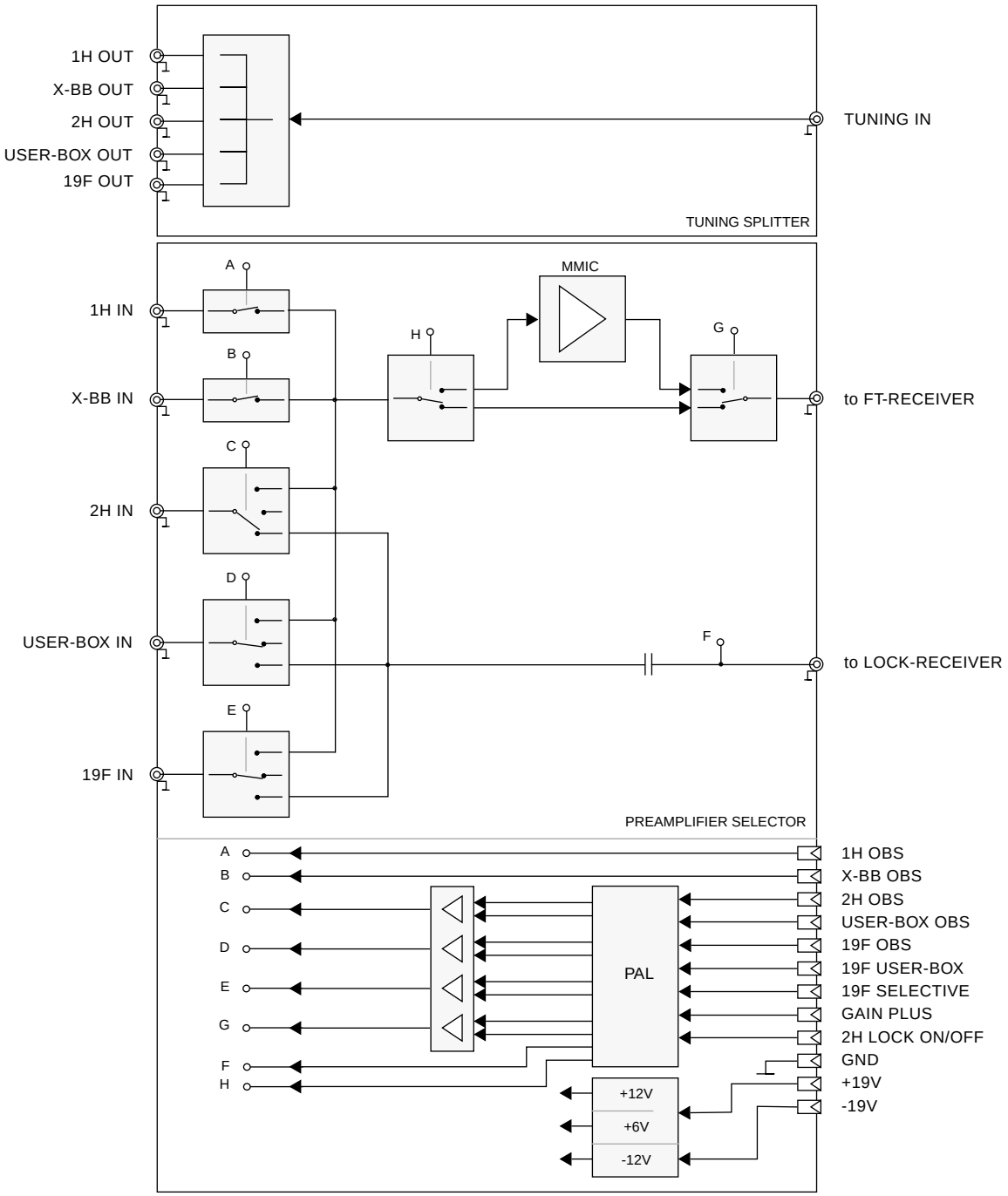
   All display elements light up whilst pressing this button. When pressing both the Channel selector and Display test buttons the OBSERVE LED's will indicate which modules are available.

6. Light Intensity Sensor: (Valid for Covermodules delivered until Q4/1994)

   Measures the ambient light intensity and adjusts the display brightness accordingly. The voltage drop over thee LDR is periodically measured. This value determines the differences in the ON/OFF ratio from the DISPBRIGHT signal. The DISPBRIGHT signal switches the indicator latches on and off and therefore also the LED.

Preamplifier Selector / Tuning Splitter 2.3

Figure 12: Preamplifier Selector / Tuning Splitter - Block Diagram -



The Preamplifier Selector

The Preamplifier Selector and the Tuning Splitter are situated in the same housing, but are electrically isolated. The selector links the outputs of the following units:

^{1}H-Module
X-BB- Module
^{2}H-Module
^{19}F-Module
User-Box

It distributes the Observe signal and the Lock signal, depending on software settings, to the two outputs for the FT- and the Lock receiver.

The ^{2}H-, the User-Box- and the ^{19}F Preamp can be switched either to the

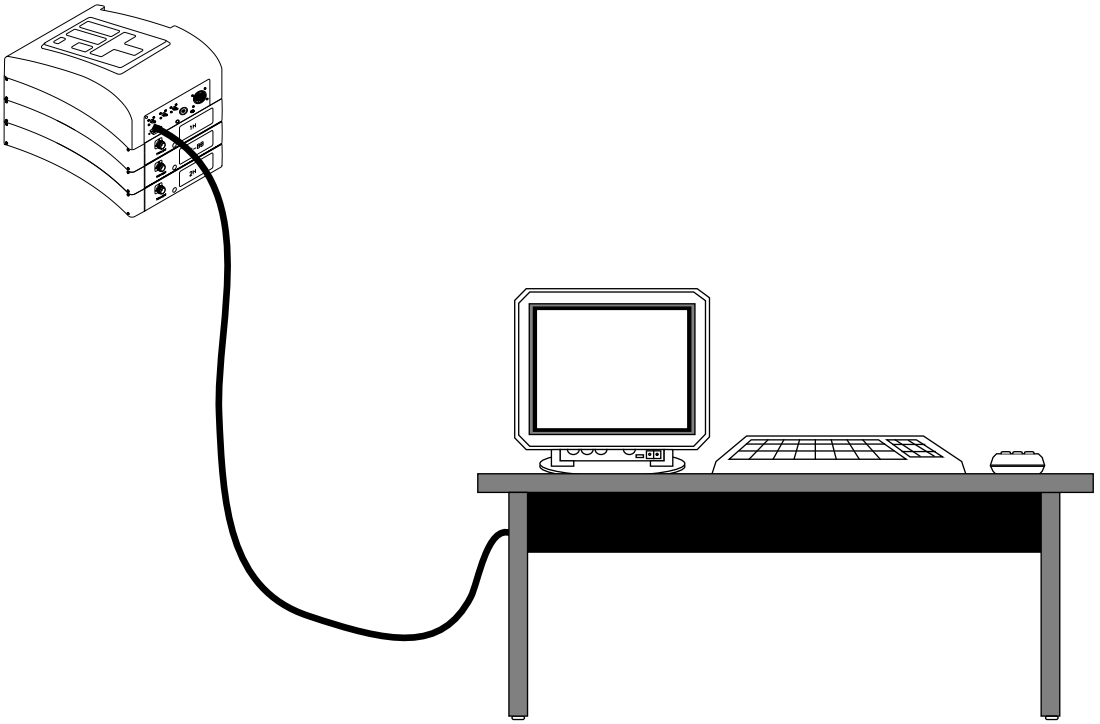
LOCK channel,

or to the FT channel.

The ^{1}H- and the X-BB Preamps may only be used with the FT channel. The HF switch matrix consists of 16 PIN diodes, two for each path. The HF switch and its controller are placed on a single multilayer print. The control signals for the HF parts are generated by a PAL (Type 18CV8) and a quad op-amp in SMD technology. Two 100 mA voltage regulators are used to stabilise the voltage from 19 V to 12 V DC.
An additional command (Gain Plus) increases the Gain for the signal to the FT receiver by about 8 - 15 dB depending on the frequency. The additional gain is mainly used in the X range for nuclei like ^{15}N, that have a low level signal.

The Tuning Splitter

The Tuning Splitter consists a broadband resistor divider. The splitting loss is about 14 dB.



Message syntax 3.1

Overview

- Command name transmitted character-string
- Command-description
- Back-message if the command executed without errors
- Example

Legend:

A - Z :	ASCII-Character ‘A’ - ‘Z’	
a - z :	ASCII-Character ‘a’ - ‘z’	
00 - ff :	Hex letter	
ch :	checksum = sum of the seven characters before the checksum	
x :	no significance	
Xi :	actual value of bytes (for example: -1 = ffh, 1 = 01h)	
Module-number:	2H	0
	X-BB	1
	1H	2
	USER-Box	3
	19F	4
	No module	5
on :	01h	
off :	00h	

Power up 3.1.1

Power up A x x x x x x ch

This command sets the HPPR into a reset-state; like a hardware-reset. Additionally, this command serves for the detection of a power-supply break. As back-message, a short identify-string „HPPA“ will be transmitted.

Back-message:
X1, X2 = 00h

A X1 X2 H P P A ch

Error accepted 3.1.2

Error accepted E x x x x x x ch

Set error-flag back in HPPR. New commands will be accepted

Back-message: E X1 x x x x x ch
X1: Error-code

Set 19F F X1 x x x x x ch
X1: Module-number

Configure the HPPR for 19F measurements by the 19F selective-module or the USER-Box module with QNP(19F) contents. (default: X1 = no module)

Back-message: F X1 x x x x x ch

Example:
for QNP(19F) F 3 x x x x x ch
for 19F-Selective F 4 x x x x x ch

Remark:
Even for 19F-Lock has to be set the 19F-selective command

Gain plus 3.1.4

Gain plus on/off G X1 x x x x x ch
X1: on/off

Switch the additional gain stage in the preamplifier-selector

Back-message: G X1 x x x x x ch

Example:		
	G 01 x x x x x ch	Gain on
	G 00 x x x x x ch	Gain off

Configuration 3.1.5

Configuration K x x x x x x ch

Read module-code of the available preamplifier-modules

Back-message:
Xi: Preamplifier-Code of Module-number i. Code=0 means: No module available
K X0 X1 X2 X3 X4 x ch

Example: K 63 5D 1B 0 0 x ch
X0 = 63h means: 2H Module available, HCL C[I]
X1 = 5Dh means: X-BB Module available, HCL E
X2 = 1Bh means: 1H Module available, HCL C
X3 = 0 means: no preamplifier available
X4 = 0 means: no preamplifier available

I. HCL = Hardware Change Level. Used for software-configuration and not correlated with ECL

Lock select 3.1.6

Lock select L X1 X2 x x x x ch
X1: W: Write-operation, R: Read-operation (X2 is ignored)
X2: Module-number of the lock-channel (no lock is 5)

Set the lock-channel (X1=W) or read the actual settings (X1=R). The corresponding preamplifier enable will be automatically activated. 2H, 19F or USER-Box are the only possible lock-channel! It is not possible to be lock-channel and observe-channel at the same time (otherwise error-message).

Back-message:
X3: Module-number of the active observe-channel
L X1 X2 X3 x x x ch

Examples:

for 2H	L W 0 x x x x ch
for 19F	L W 4 x x x x ch
for USER-Box	L W 3 x x x x ch

Observe select 3.1.7

Observe select O X1 X2 x x x x ch
X1: W: Write-operation, R: Read-operation (X2 is ignored)
X2: Module-number of the observe-channel (no module is 5)

Set the observe-channel (X1=W) or read the actual settings (X1=R). The corresponding preamplifier enable will be automatically activated. It is not possible to be observe-channel and lock-channel at the same time (otherwise error-message).

Back-message:
X3: Module-number of the active observe-channel
O X1 X2 X3 x x x ch

Examples:

for 2H	O W 0 x x x x ch
for X-BB	O W 1 x x x x ch
for 1H	O W 2 x x x x ch
for USER-Box	O W 3 x x x x ch
for 19F	O W 4 x x x x ch

Preamplifier enable on/off P X1 X2 X3 x x x ch
X1: W: Write-operation, R: Read-operation (X2 and X3 are ignored)
X2: Module-number: Module-number = no module and X3 = on means all preamplifier on
Module-number = no module and X3 = off means all preamplifier off, without the active observe- and lock-channel
X3: Preamplifier enable on/off

Set the preamplifier enable (X1 = W, switch the preamplifier-gain-modul power-supply) or read the actual settings (X1 = R).

It is not allowed to set the preamplifier enable off on a lock- or observe-channel (otherwise error-message).

Back-message:
Xi: Module-number i on/off
P X0 X1 X2 X3 X4 x ch

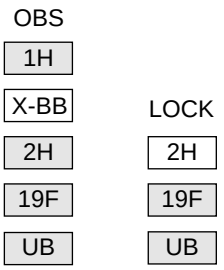
Example:
for 1H off P W 2 00 x x x ch

Command-sequences 3.2

Multinuclear Mode 3.2.1

observe nucleus : X
decoupling : 1H
lock : 2H

set 2H lock: L W 0 x x x x ch
set observe channel X: O W 1 x x x x ch

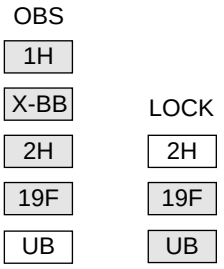


QNP Mode 3.2.2

observe nucleus : 13C, 31P, 19F
decoupling : 1H
lock : 2H

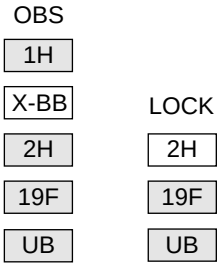
For USER-Box with X-BB19F 2HP contents

set 2H lock: L W 0 x x x x ch
set observe channel UB: O W 3 x x x x ch



For a standard X-BB19F 2HS

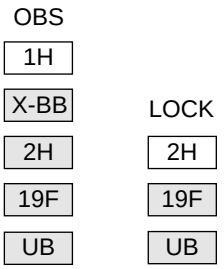
set 2H lock: L W 0 x x x x ch
set observe channel X: O W 1 x x x x ch



X - Decoupling 3.2.3

observe nucleus : 1H
decoupling : X
lock : 2H

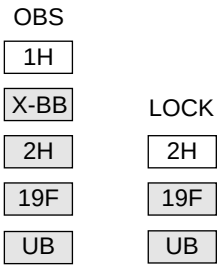
set 2H lock: L W 0 x x x x ch
set observe channel 1H: O W 2 x x x x ch



Triple Resonance Mode Inverse 3.2.4

observe nucleus : 1H
decoupling 1 : 13C
lock : 2H
decoupling 2 : 15N

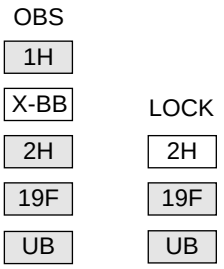
set 2H lock: L W 0 x x x x ch
set observe channel 1H: O W 2 x x x x ch



Triple Resonance Mode 13C 3.2.5

observe nucleus : 13C
decoupling 1 : 1H
lock : 2H
decoupling 2 : 15N

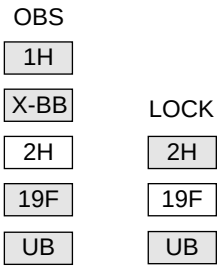
set 2H lock: L W 0 x x x x ch
set observe channel X: O W 1 x x x x ch



Deuterium with 19F Lock 3.2.6

observe nucleus : 2H
decoupling : 1H
lock : 19F

set 19F lock: L W 4 x x x x ch
set observe channel 2H: O W 0 x x x x ch
set 19F by 19F-Selective: F 4 x x x x x ch

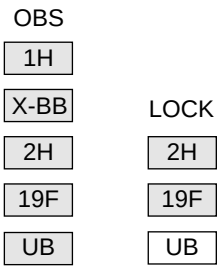


19F Lock over USER-Box 3.2.7

only possible for USER-box with X-BB19F 2HP contents

lock : 19F

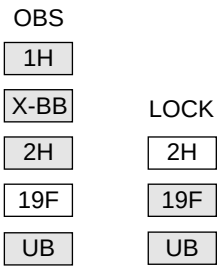
set UB lock: L W 3 x x x x ch
set 19F by USER-Box: F 3 x x x x x ch



19F Observe Mode 3.2.8

observe nucleus : 19F
decoupling : 1H
lock : 2H

set 2H lock: L W 0 x x x x ch
set observe channel 19F: O W 4 x x x x ch



		OBS		
1H:	O W 2 x x x x ch	1H		
X-BB:	O W 1 x x x x ch	X-BB	LOCK	
2H:	O W 0 x x x x ch	2H	2H	L W 0 x x x x ch
19F:	O W 4 x x x x ch	19F	19F	L W 4 x x x x ch
UB:	O W 3 x x x x ch	UB	UB	L W 3 x x x x ch

1H Module

Figure 13: 1H Module - Exploded View -

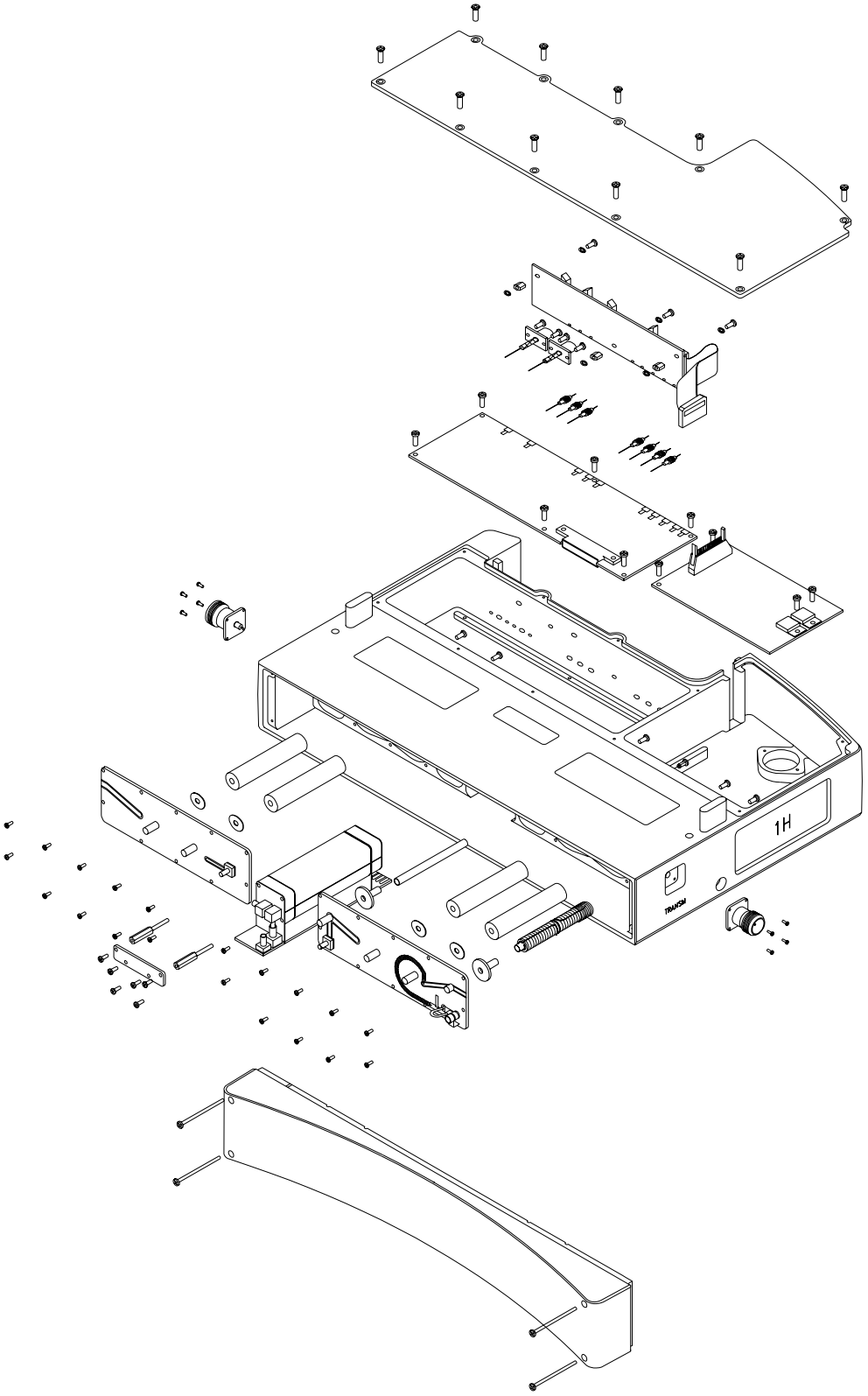
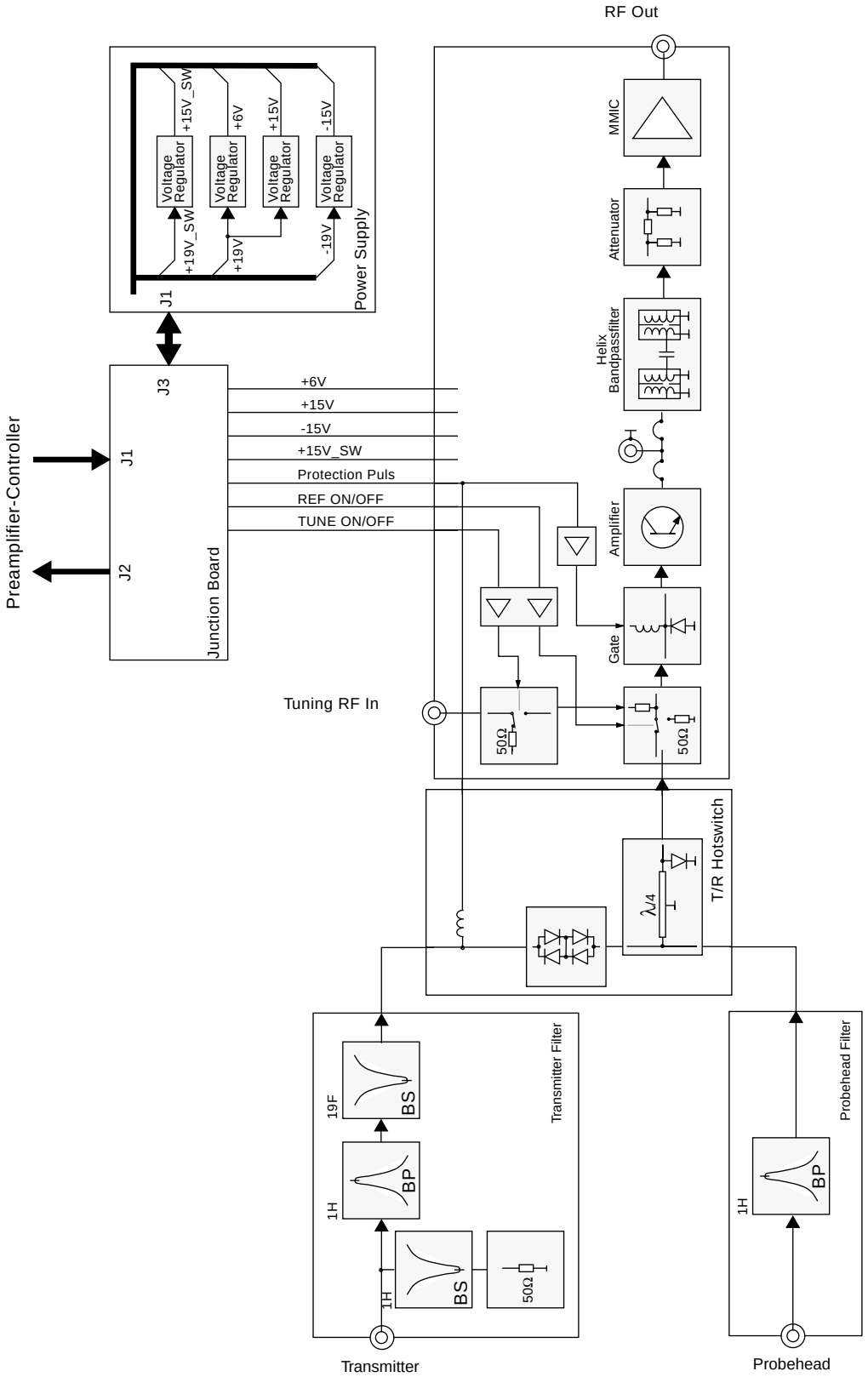


Figure 14: 1H Module - Block Diagram -



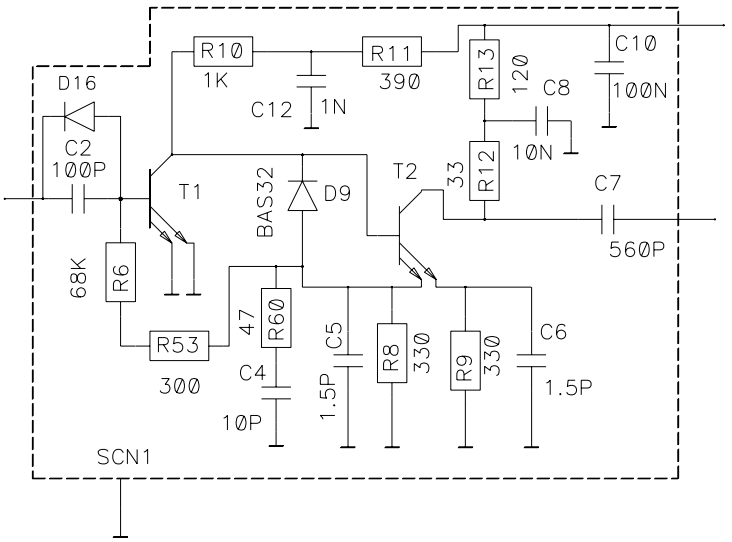
The Preamplifier 4.1.1

The newest possible components and an embrace of modern technology characterise this Preamplifier. Optimal assembly of the unit is only possible through computerised, automated, high-tech testing stations.

The HP Preamplifier is extremly sensitive to replacement and readjustment of faulty parts. Therefore we strongly recommend that necessary work be completed in service stations or at the originating plant: Spectrospin/Switzerland.

A broad or entire exchange is, however, possible for service engineers and will lead to re-establishment of HP Preamp specifications.

Figure 15: Scheme extract - Preamplifier -



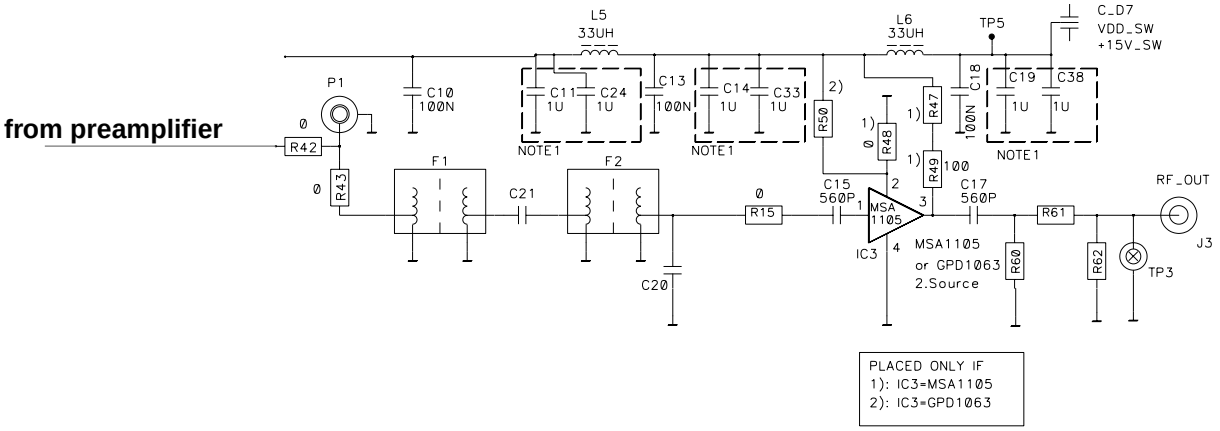
Between the Preamp and the bandpass filter there is a SMB pin plug (P1) built in parallel to the signal path. By removing the appropriate zero ohm resistors the preamplifier resp. the bandpass filter can be tested separately.

The attenuator between the bandpass filter and the MMIC matches the input impedance of the MMIC MSA1105.

The MMIC MSA1105

This is a high performance bipolar silicon Monolithic Microwave Integrated Circuit (MMIC) mounted in a SMD plastic housing. It exhibits extremely good noise performance and compensates loss through the bandfilter and the attenuator. The total gain of the ^{1}H Preamp is approx. 28 dB.

Figure 16: Scheme extract - Bandpass filter -

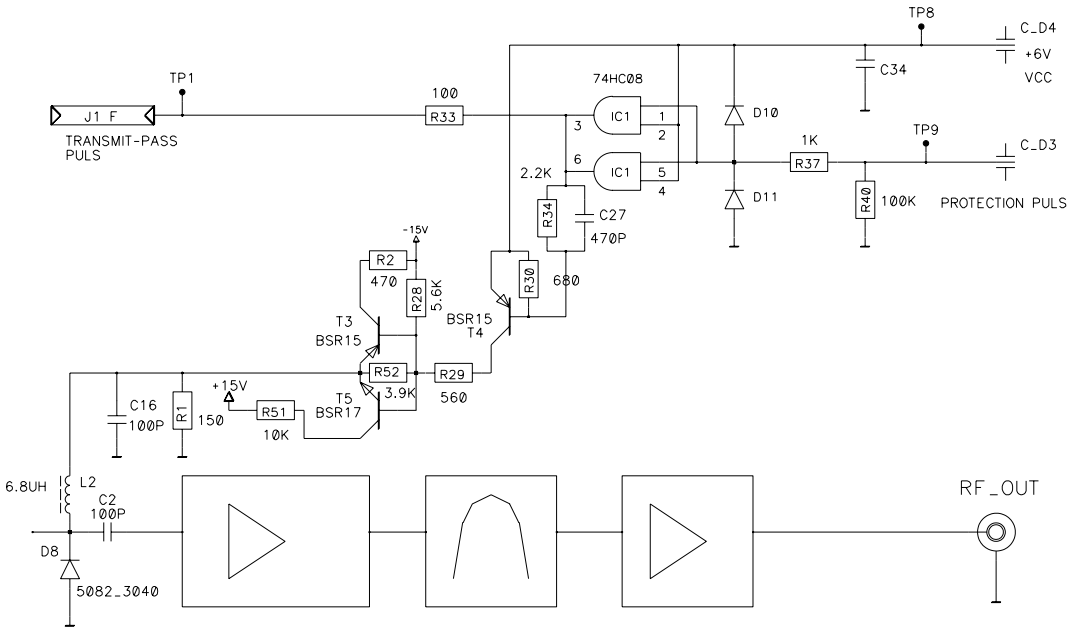


In addition to the **T**ransmitter/**R**eceiver switch (T/R switch) - mounted in the λ/4 T/R-Hotswitch Box - the Preamp has another protection switched in the transmitting phase. The protection, which is completed with a PIN diode parallel to the input, in comparison to a λ/4 power switch in the Hotswitch box, delivers a broadband protection from HF power from neighbouring frequencies.

Circuit description

The transmitter blanking switchsignal PROT_1H originates from the transmitter switch logic of the Preamp controller and comes via the connector J 1 in the Junction board, to the switch input. IC 1 contains two dual parallel switching AND gates. This allows the necessary driver current of approx. 30 mA (for the transmitter switch) in the T/R Hotswitch box to be delivered (Transmitter Pass Pulse: Check point 1). A signal to the driver switch diode D 8 runs parallel to the output pins 3 and 6 of IC 1. The driver consists of the transistors T 3, 4, 5 and the necessary resistors for biasing. A push pull amplifier uses the transistors T 3 and T 5. The strip line PIN diode D 8 is one of the NIP diodes with an anode heat sink.

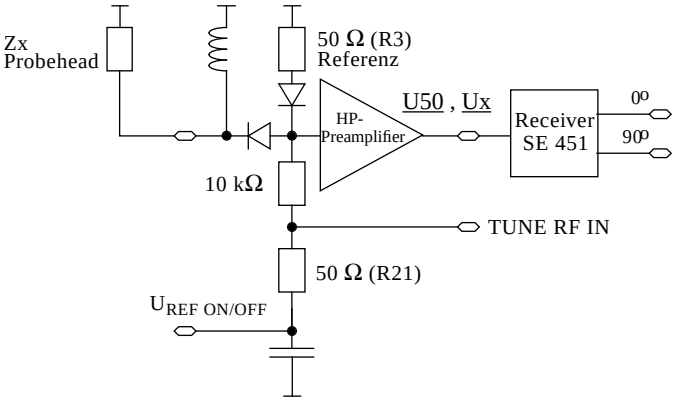
Figure 17: Scheme extract - Blanking -



A great advantage of the HP Preamp is its possibility to tune and match probeheads without additional instruments.

A HF bridge circuit will be completed with support from a PIN diode switch in the signal path to the Preamp, as is usual at any wobble testing station. During Tuning operation a sweeping HF is fed to the Preamp input via a high impedance resistor. The input is first connected to a 50 Ω reference resistor and then compared to the probehead via the connecting cable. The X32 computer, using tuning software, calculates the result of the impedance measurements. The resulting information will be displayed on both the console monitor (wobble curve) and the HP Preamp display (T-display).

Figure 18: Tuning Principle



Circuit description (see Figure 19:)

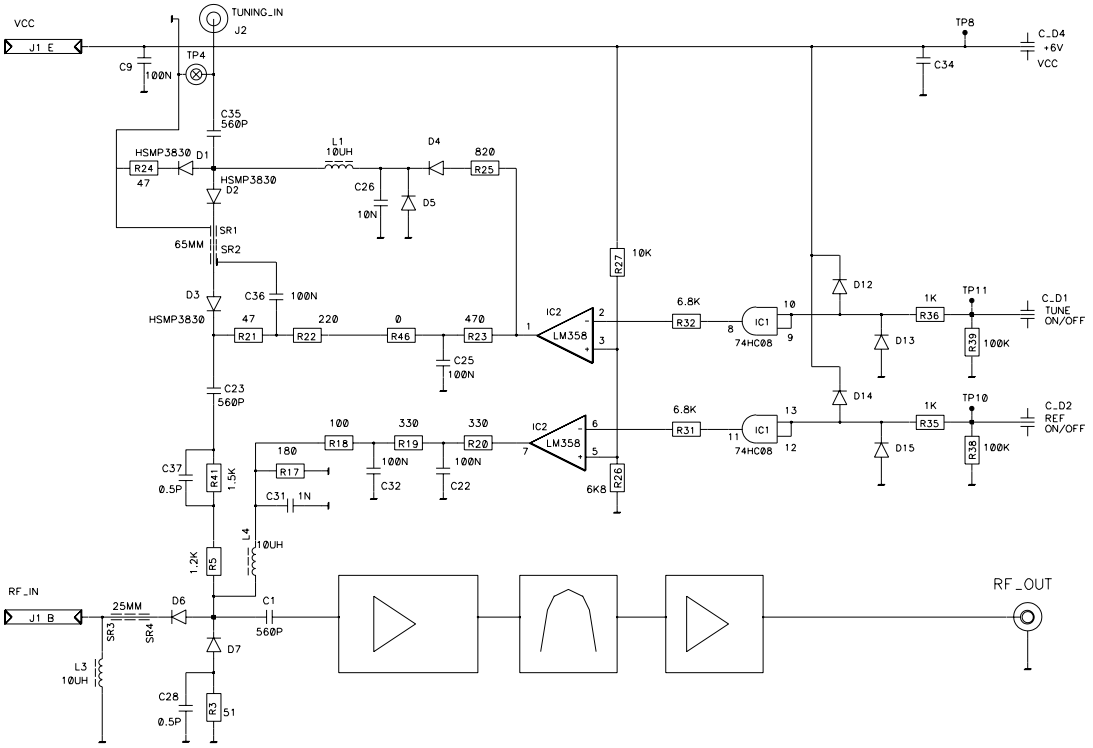
The Tuning command TUNE ON/OFF is sent from the Preamp controller via the J 1 plug on the Junction board to IC 1, which controls an op amp. This amplifier converts the Low/High information at the input into a Plus/Minus control voltage for the tuning switch. The tuning switch consists of PIN diodes D 1, 2, 3. It switches the HF during tuning operation to the high-resistive resistors R 41 and R 5. Should a positive charge be present at output (Pin 1) of IC 2 (+13 V, TUNE OFF), then D 2 and D 3 are off and D 1 is active. D 1 combines with R 24 (47 Ω), in this instance, to provide a 50 Ω terminal resistance.

If, during TUNE ON mode, Pin 1 has a negative voltage (approx. -13 V) D 1 will be off, and the diodes D 2 and D 3 will be active. The second input, called REF ON/OFF is only used during Tuning mode.

The circuitry, including the op amp, is identical with that found at the TUNE ON/OFF input. Pin 7 of IC 2 controls, via a R, C, L network, the PIN diodes D 6 and D 7.

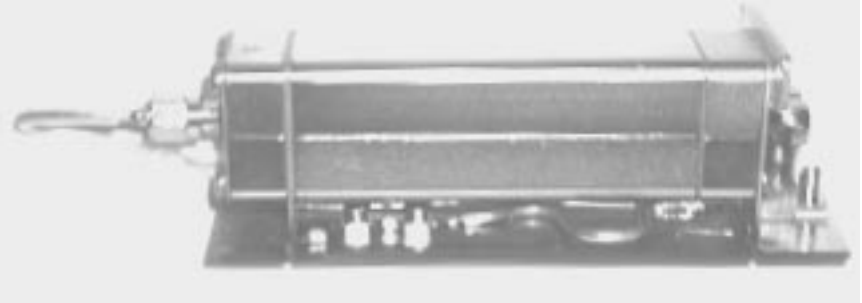
Should the output of Pin 7 from IC 2 have a positive voltage (approx. +13 V, REF OFF), then D 6 is active. The probehead is connected parallel to the Preamp via the filter and the feeder cable. Alternatively, if D 6 is off and D 7 is active (negative voltage on Pin 7) then the 50 Ω Reference resistor R 3, R 4 is parallel to the Preamp.

Figure 19: Scheme extract - Tuning -



Lambda/4 T/R-Hotswitch Box 4.2

Figure 20: Lambda/4 T/R-Hotswitchbox used in the 1H-Module



Functional description 4.2.1

The T/R switch reacts during the transmission phase to designate the probehead as the load of the power transmitter. During the receiver phase the probehead becomes the source of the signals for the Preamp. High transmission efficiency and minimal insertion loss, with an extremely good suppression, represents the advances achieved with the two switches.

The transmitter switch is constructed with two serial pairs of PIN diodes. In order to be able to transmit using high power, the diodes are well cooled.

The receiver switch is constructed as a λ/4 switch. A λ/4 line and two Stripline-PIN diode (D 5 and D6) are activated (40 mA DC) approx. 1 µs in advance of the HF transmission pulse. D 5 short circuits the λ/4 line at the output and therefore converts the input to a high impedance load, like an open switch.

Power handling capability 4.2.2

In NMR-applications there are a great number of possible pulse strings, that means, it isn't easy to define how much power can be handled by the T/R-Hotswitchbox without an instant failure. The junction temperature of a diode is dependent on peak and average power dissipated, thermal impedance of the chip, heat sink interface and the ambient temperature. Data of the transient thermal impedance rising with pulse length, are usually given by the manufacturers. So it is quite possible to give the maximal handling power for a single HF pulse with a definite duty cycle as follows.

The *Hotswitchbox* can not handle experiments with high power and long time pulses (E.g.: decoupling pulses during CPMAS).

Figure 21: Power handling capability without Probehead

Single pulse, worst case for maximum mismatch (no probehead connected) for a maximum junction temperature of 125°C and an ambient temperature of 25° C

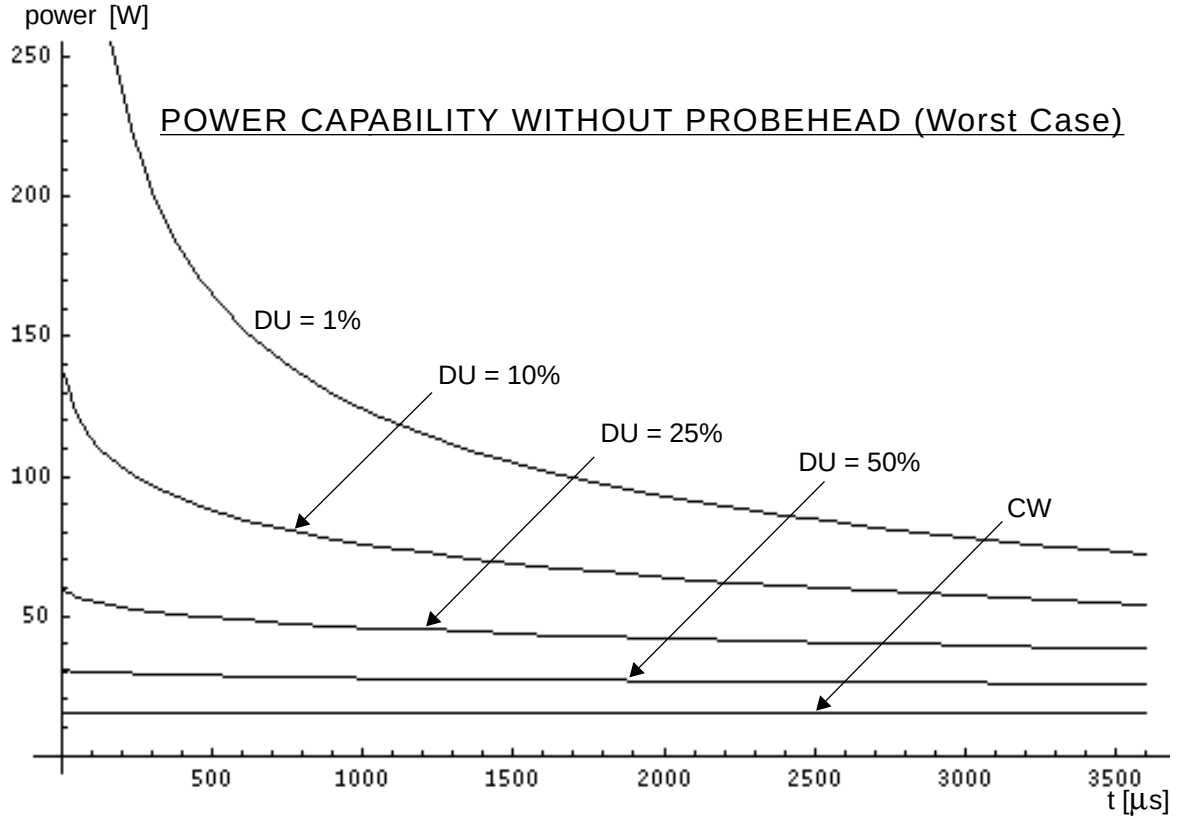


Table 4: Power handling capability: single pulse, worst case for maximum mismatch

Pulse lenght	Maximum RF power for maximum mismatch				
	DU = 1%	DU = 10%	DU = 25%	DU = 50%	CW*
100 µs	250 W	110 W	55 W	30 W	15 W
500 µs	160 W	88 W	50 W	28 W	
1 ms	120 W	75 W	45 W	27 W	
3 ms up to 10 sec.	75 W	55 W	40 W	26 W	

* for an infinite operation time

We recommend to use no more power than listed in the figures and tables above! Especially with CPMAS-Experiments.

Figure 22: Power handling capability with matched Probehead

Single pulse, standard case for best matching between probehead and transmitter and a maximum junction temperature of 125°C and an ambient temperature of 25°C

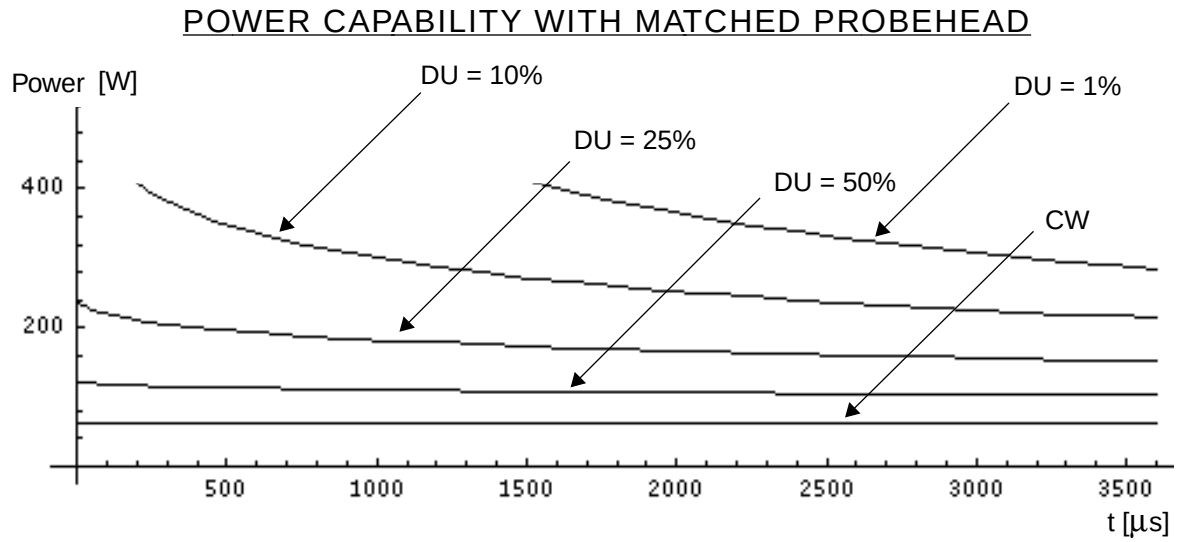


Table 5: Power handling capability: single pulse, for best matching

Pulse lenght	Maximum RF power for best matching				
	DU = 1%	DU = 10%	DU = 25%	DU = 50%	CW*
100 µs	400 W	400 W	220 W	115 W	60 W
500 µs	400 W	350 W	200 W	115 W	
1 ms	400 W	300 W	180 W	110 W	
3 ms up to 10 sec	300 W	220 W	160 W	100 W	

* for an infinite operation time

Now, for a pulse string you can do an estimation whether there is a risk or not.
For example: For a string of five 10 µs pulses of each 100 W in a shape of about 100 µs and a duty cycle of 10 % there should be no risk.

We recommend to use no more power than listed in the figures and tables above! Never start the spectrometer or UXNMR without a Probehead connected to the Preamplifier.

Connect the PowerAmplifier directly to the probehead during CP-MAS-Decoupling or other HIGH POWER experiments exceeding the values listed above.

Probehead Filter 4.3

The probehead filter is designed as a dual circuit comb band pass filter. The capacitive coupling occurs at the high point of the resonator. The coupling between the resonators functions as a band pass filter with an inductive high point coupling.

Transmitter Filter 4.4

The transmitter filter is designed as a dual circuit comb band pass filter, suppressing ^{19}F. The capacitive coupling occurs at the high point of the resonator. The coupling between the resonators functions as a band pass filter with an inductive high point coupling. At the filter input there is a special circuit for the 50 Ω matching of the higher harmonics caused by the ^{1}H transmitter.

Figure 23: High-Power 19F/1H/3F Module - Exploded View -

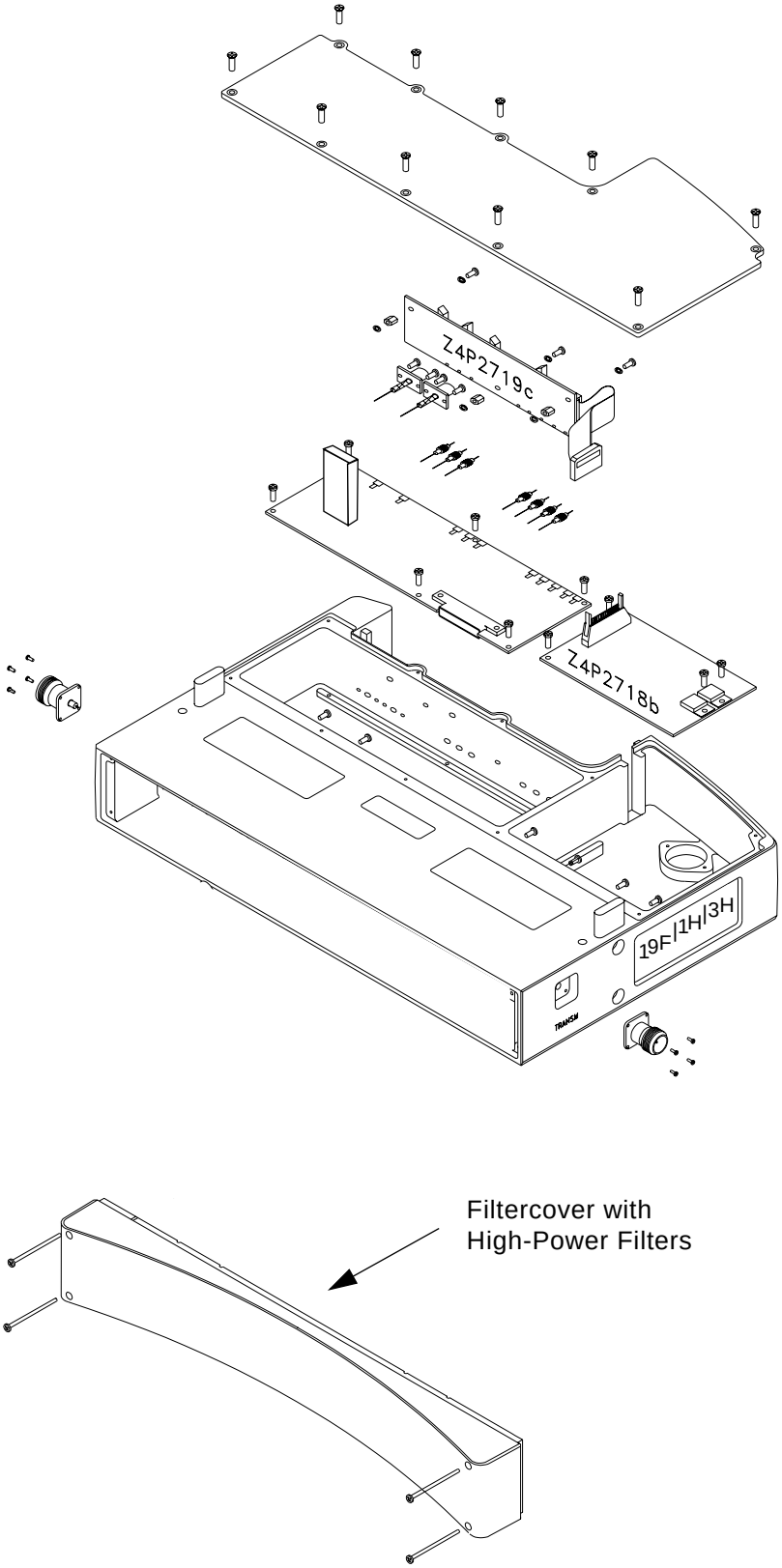
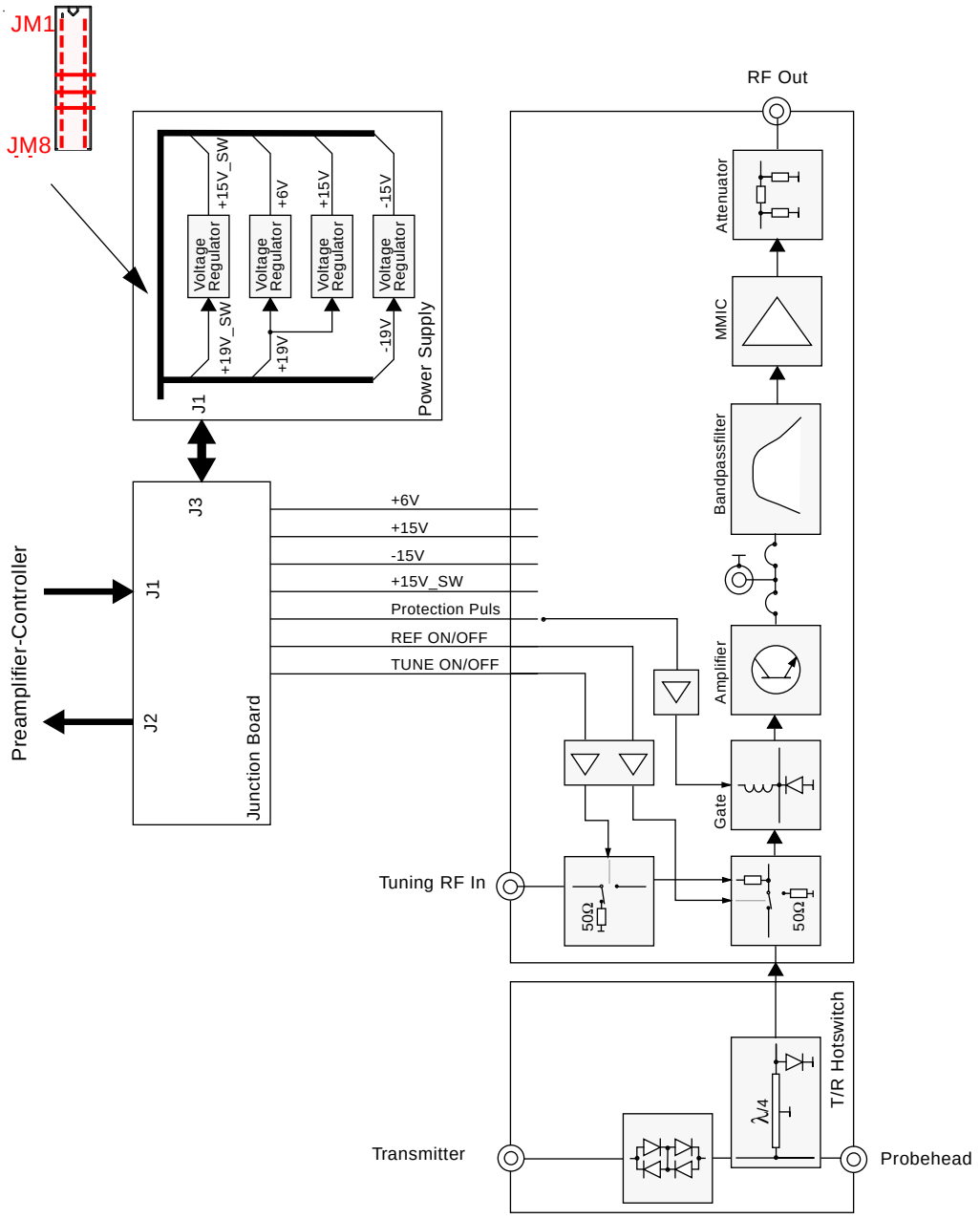


Figure 24: 19F/1H/3H Module - Block Diagram -



This modul is normally used in HIGH-POWER-Applications (Solids).

For more information about the circuits see Chapter „1H Module on page 39“.

The 19F/1H/3H-Module uses the same preamplifier circuit as the 1H Module. The component values differ from those of the 1H Module. Please refer to the corresponding section within the chapter „1H Module on page 39“ for further information. (E.g. Tuning and/or Blanking Mode).

The Bandpass filter 5.1.1

Between the Preamplifier and the bandpass filter there is a SMB pin plug (P1) built in parallel to the signal path. By removing the appropriate zero ohm resistors the preamplifier resp. the bandpass filter can be tested separately.

The bandpass filter is responsible for the selectivity of the HPHP-Preamplifier. It is not tuneable. The pass range starts at ^{19}F and ends at ^{3}H. The stop range suppresses DC until ^{31}P.

Figure 25: Scheme extract - Bandpass filter -

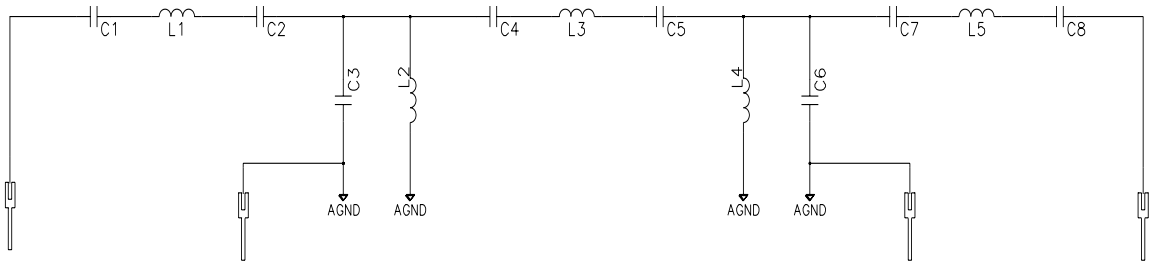


Figure 26: X-BB Module - Exploded View -

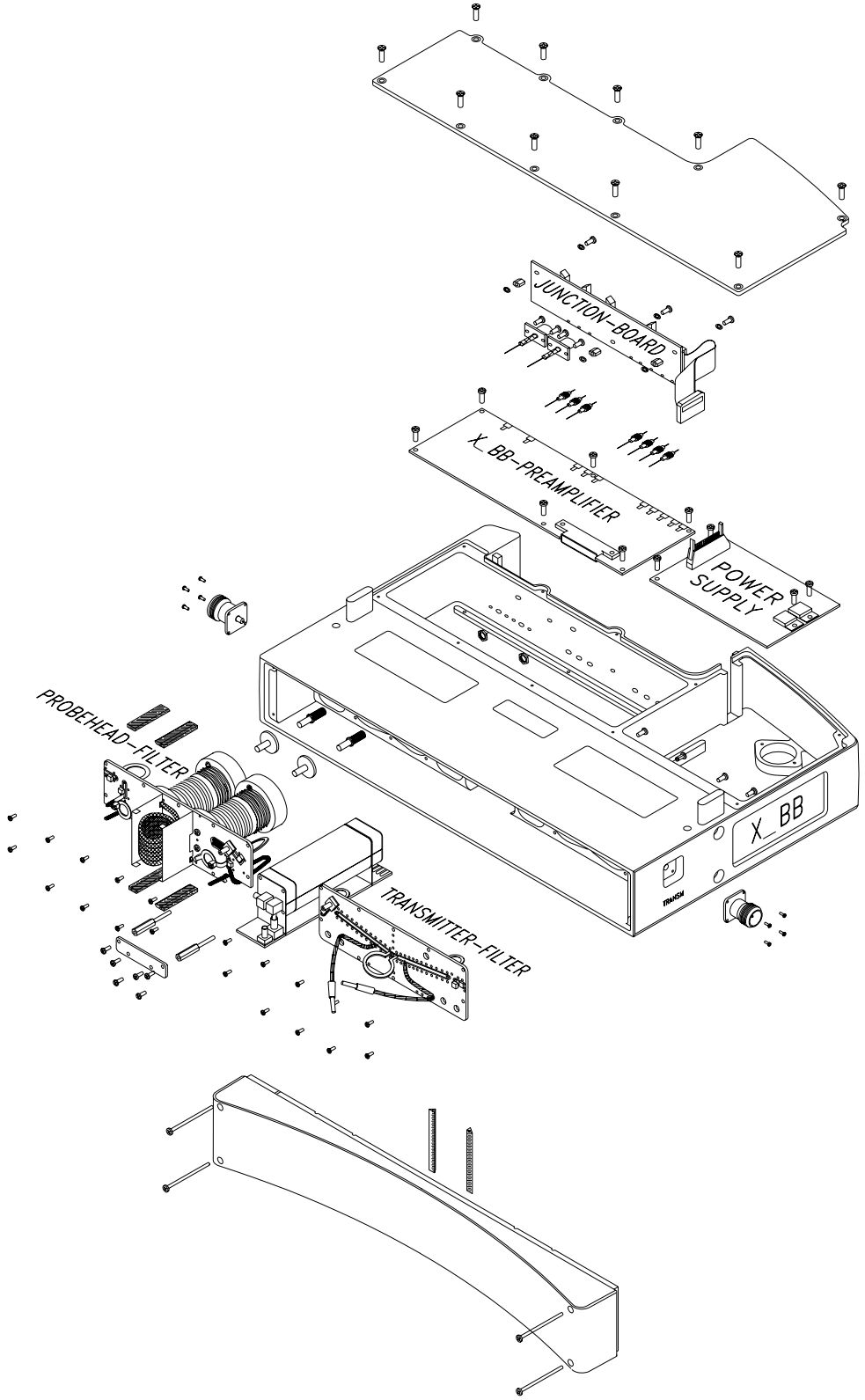
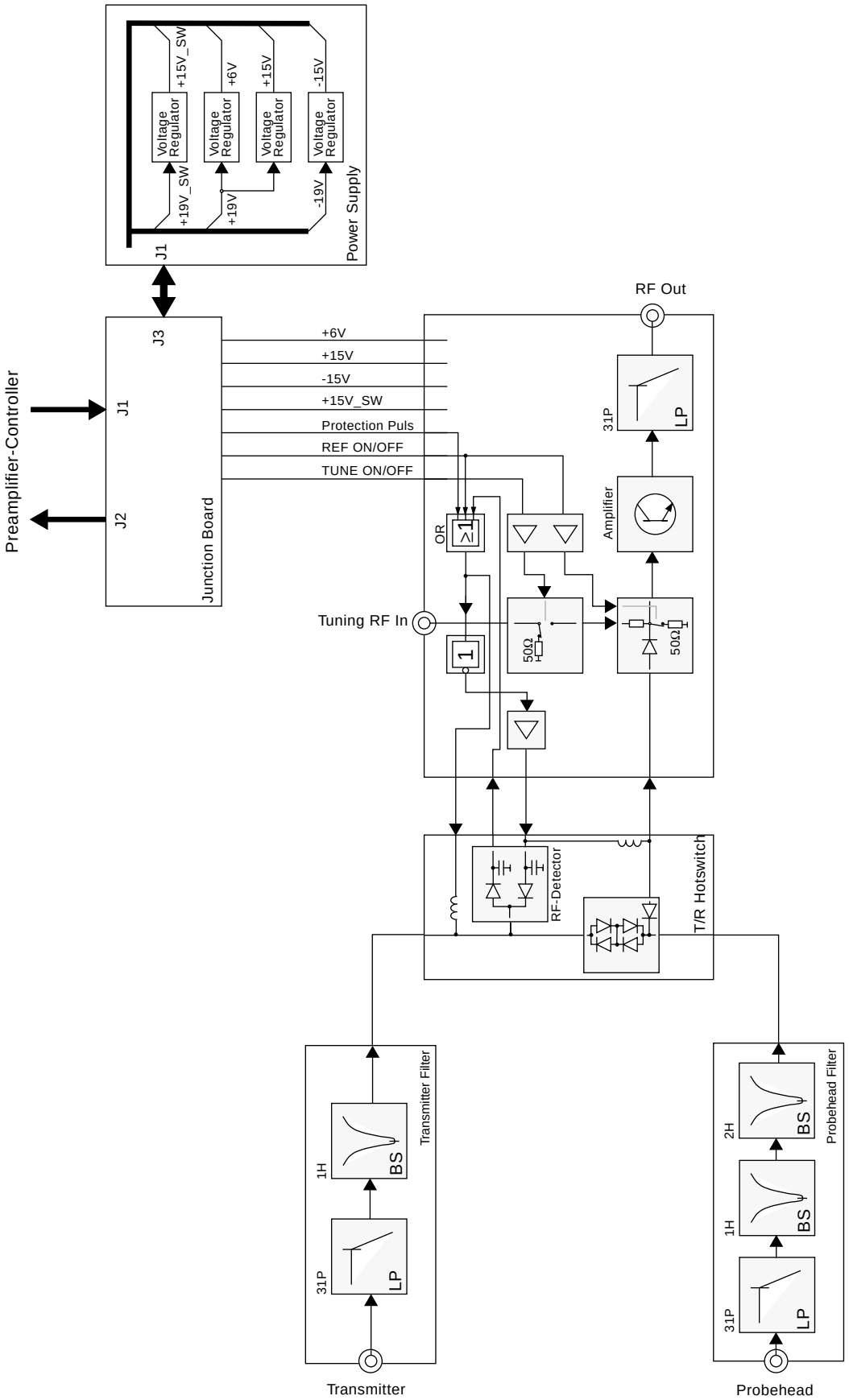


Figure 27: X-BB Module - Block Diagram -



The Preamplifier 6.1.1

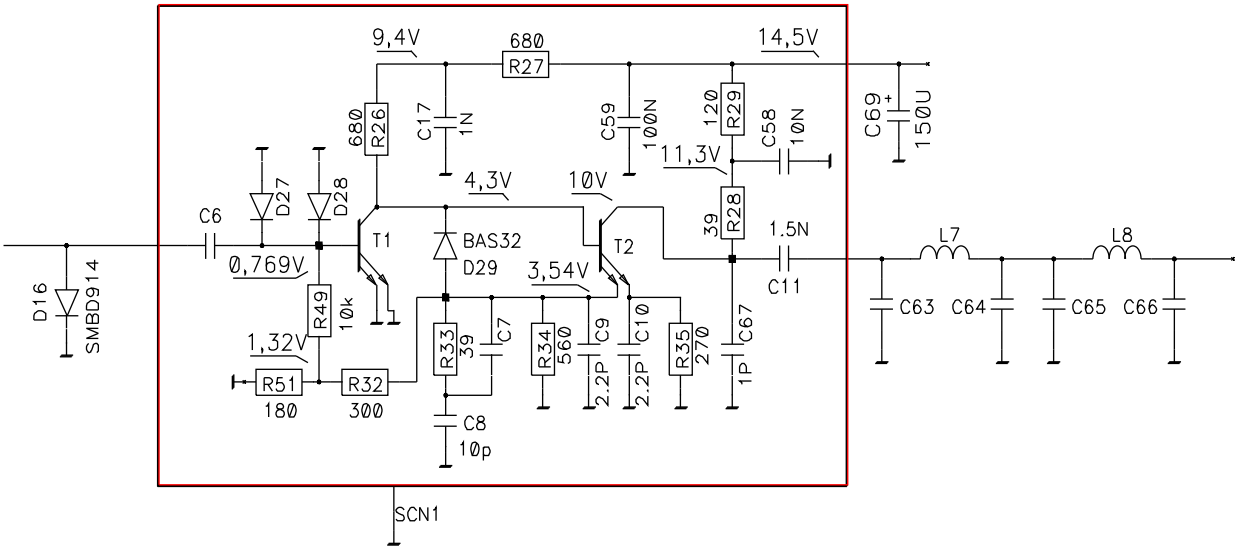
The Preamplifier illustrated below operates in a frequency range of 5 - 250 MHz.

A ^{31}P low pass filter system which suppresses ^{1}H is attached to the Preamplifier. Depending on the ^{1}H frequency different low-passes are used.

The range is divided as follows:

200 MHz - 360 MHz : f_{limit} = 150 MHz
400 MHz - 600 MHz : f_{limit} = 250 MHz

Figure 28: Scheme extract - Preamplifier -

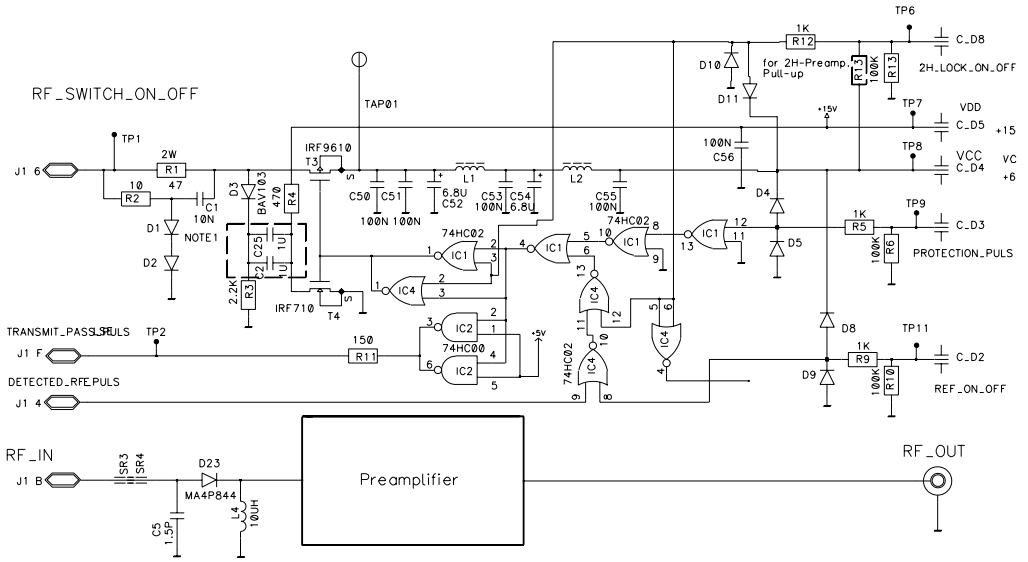


	FOR XBB31P 2HS 2H-PREAMPLIFIER		FOR XBB19F 2HS / XBB19F 2HP-PREAMPLIFIER		
1H-Frequency	-750-/-600-	-360-/-300-	-750-/-600-	-500-/-400-	-360-/-300-
Component:	-500-/-400-	-250-/-200-			-250-/-200-
L7/L8	47NH	68NH	10NH	12NH	33UH
C63/C66	5.6P	27P	1.0P	1.0P	6.8P
C64	15P	39P	3.9P	3.9P	6.8P
C65	---	4.7P	---	2.7P	6.8P
C6	270P	1.5N	270P	270P	1.5N
C7	---	---	1.2P	---	---
D16	---	SMBD914	---	---	SMBD914

The Blanking 6.1.2

The control for the T/R switch in the X-BB T/R-Hotswitch Box remains unchanged. Two parallel NAND gates from IC 2 (74HC00) deliver the necessary driver current of approximately 30 mA for the transmitter switch in the T/R-Hotswitch Box (Transmitter Pass Pulse: Check point 2).

Figure 29: Scheme extract - Blanking -



It uses the same Tuning circuit as the 1H Module. Please refer to the corresponding section for further information.

Circuit description

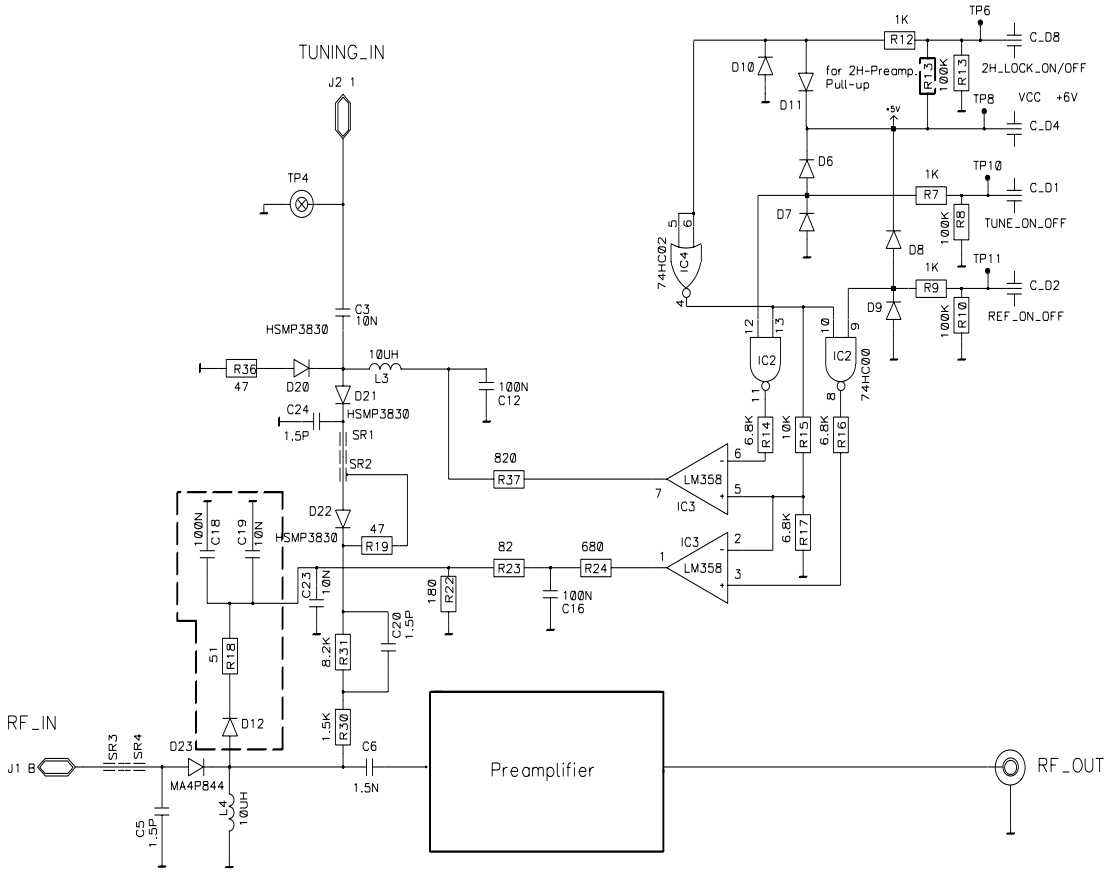
The tuning command TUNE ON/OFF is sent from the Preamp controller, via the J 1 plug on the Junction board, to IC 2, which controls an operation amplifier. This amplifier converts the Low/High information at the input into a Plus/Minus control voltage for the tuning switch. The tuning switch, which consists of PIN diodes D 20, 21, 22, switches the HF during tuning operation to the high impedance resistors R 31 and R 30. Should a positive voltage be present at Pin 7 output on IC 3 (+13 V, TUNE OFF), then D 21 and D 22 are off and D 20 is active. D 20 combines with R 36 (47 Ω), in this instance, to provide a 50 Ω terminal resistance.

If, during TUNE ON mode, Pin 7 has a negative voltage (approx. -13 V) D 20 will be off, and the diodes D 21 and D 22 will be active. The second input, called REF ON/OFF is only used during tuning mode.

The circuitry including the OP is identical to the one found at the TUNE ON/OFF input. Pin 1 of IC 3 controls, via a R, C, L network, the PIN diode D 12.

Should the output of Pin 1 from IC 3 have a positive voltage (approx. +13 V, REF OFF, Receiver switch closed), then D 12 is off. The probehead is connected parallel to the Preamp via the filter and the feeder cable. Alternatively, if D 12 is active then the 50 Ω Reference resistor R 18, R 48 is parallel to the Preamp.

Figure 30: Scheme extract - Tuning -



X-BB T/R-Hotswitch Box 6.2

The T/R switch reacts during the transmission phase to designate the probehead as the target of the power transmitter. During the receiver phase the probehead becomes the source of signals for the Preamp. High transmission efficiency and minimal insertion loss, with an extremely good suppression, represents the advances achieved with the two switches.

The transmitter switch is constructed with two serial pairs of PIN diodes. In order to be able to transmit using high power, the diodes are well cooled.

To achieve a broad band solution the receiver switch is constructed with two serial PIN diodes. One of the two PIN diodes (D 20) is found in a SMB board plug cable inlet, which is soldered directly to the aluminium box star point. The other PIN diode (D 23) is located on the X-BB Preamp board. The receiver switch is opened from the connector 6 of board plug J 1 during the receiver mode. In transmission mode the PIN diodes are biased through the unidirectional negative half-wave in the reverse direction. The electronic control on the X-BB Preamp board includes an extra protection-circuit. In case the console gating pulse fails, a gate pulse is generated by the diodes D 2, 4, 5, 6, by rectifying the HF transmitter pulse (Pin 4 of the board plug J 1).

Probehead Filter 6.3

The probehead filter is a ^{31}P low pass filter, including ^{2}H and ^{1}H stop filters, using $\lambda/4$ lines. The design of the filter has the advantage that neighbouring nuclei from ^{2}H, e.g.Lithium (^{6}Li) and Bismuth (^{209}Bi) have a band pass attenuation less than 1 dB.

Transmitter Filter 6.4

The transmitter filter is a ^{31}P low pass filter including a ^{1}H stop filter, using $\lambda/4$-lines.

Figure 31: 2H Module - Exploded View -

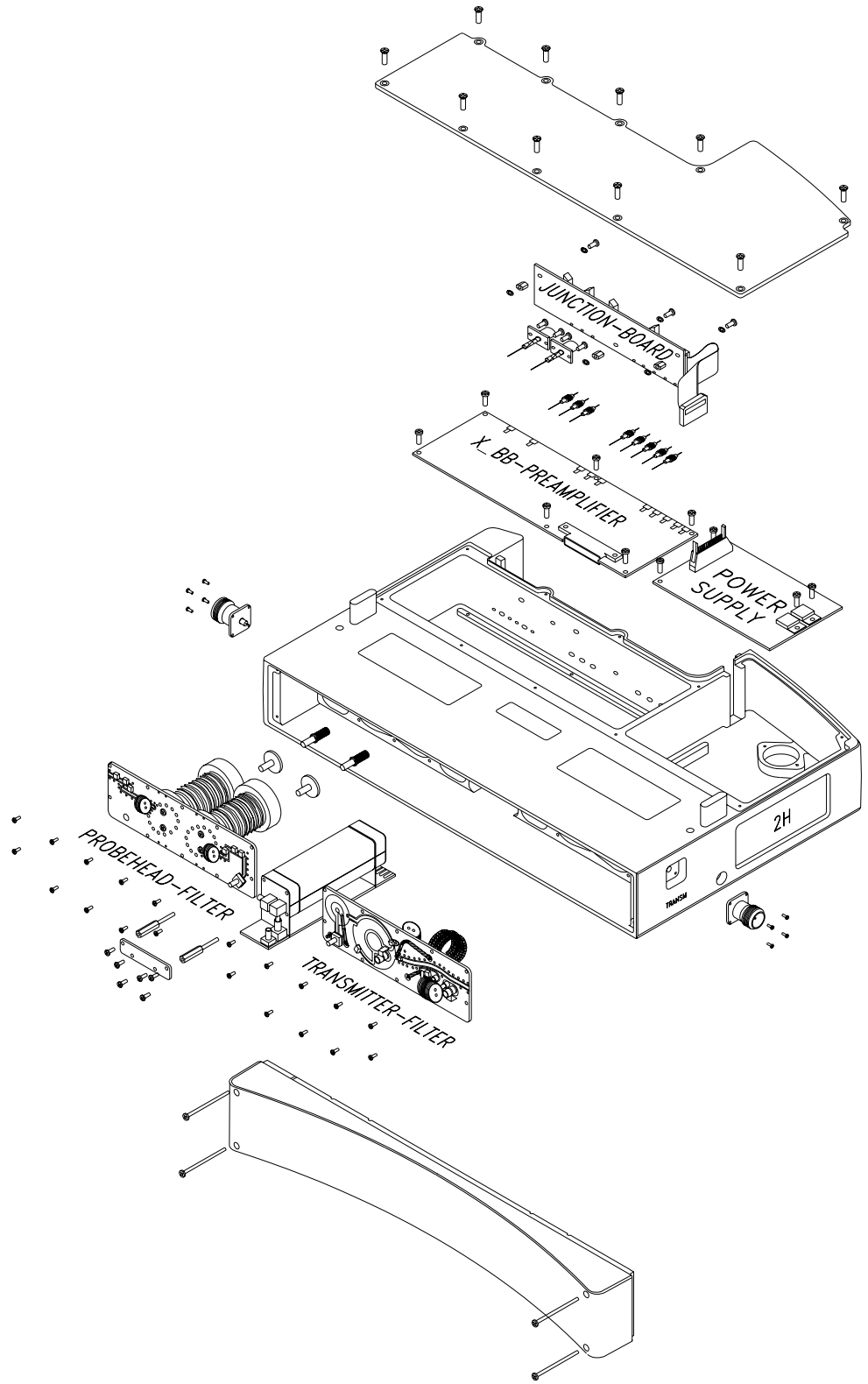
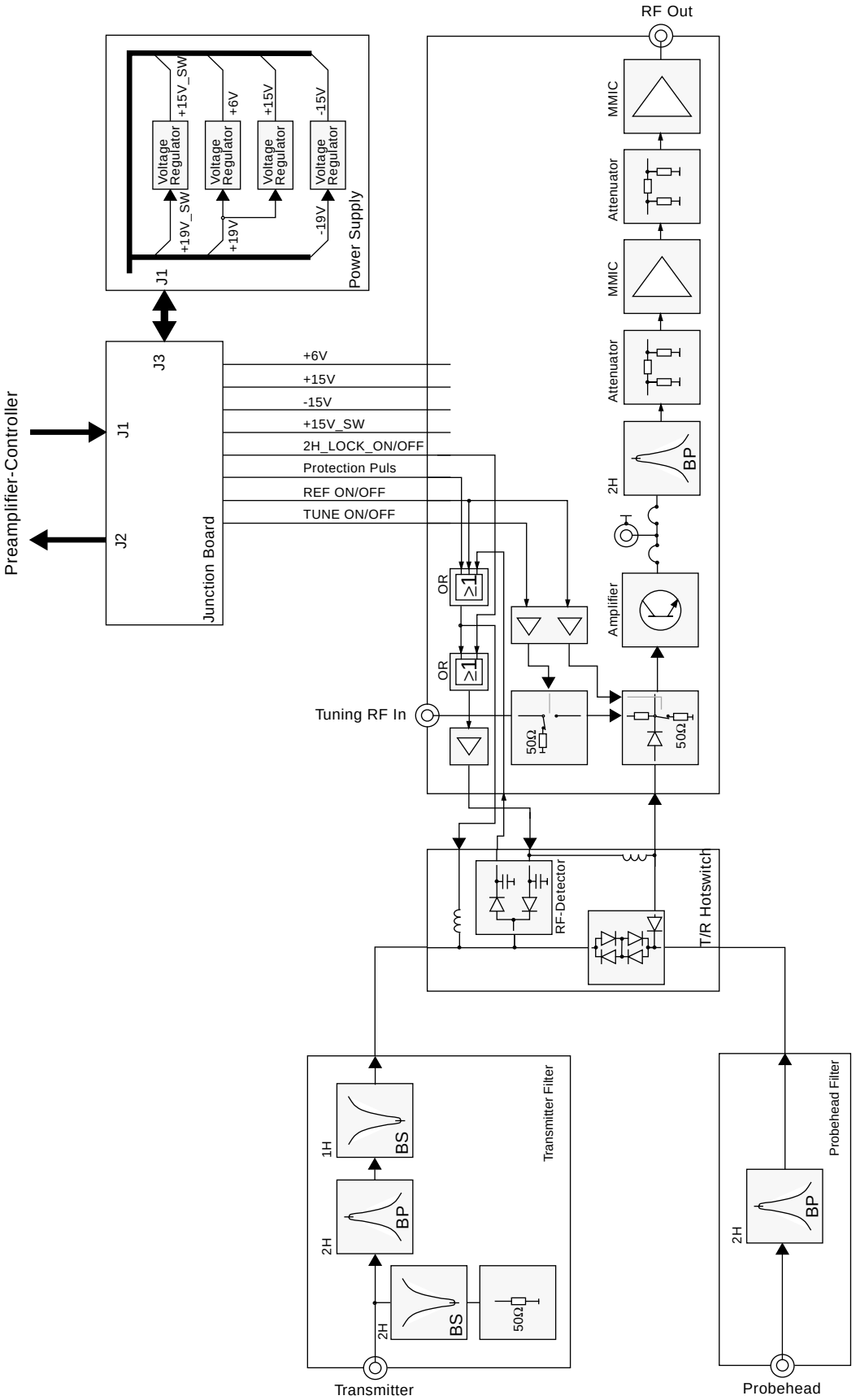


Figure 32: 2H Module - Block diagram -



For the first time the 2H Lock and its module may also be used for Fourier measurements and decoupling. A ^{19}F Lock is a prerequisite.

The same board as for the X-BB Preamp is used, but with additional components for a band pass and more amplification. Please refer to the corresponding section for further information.

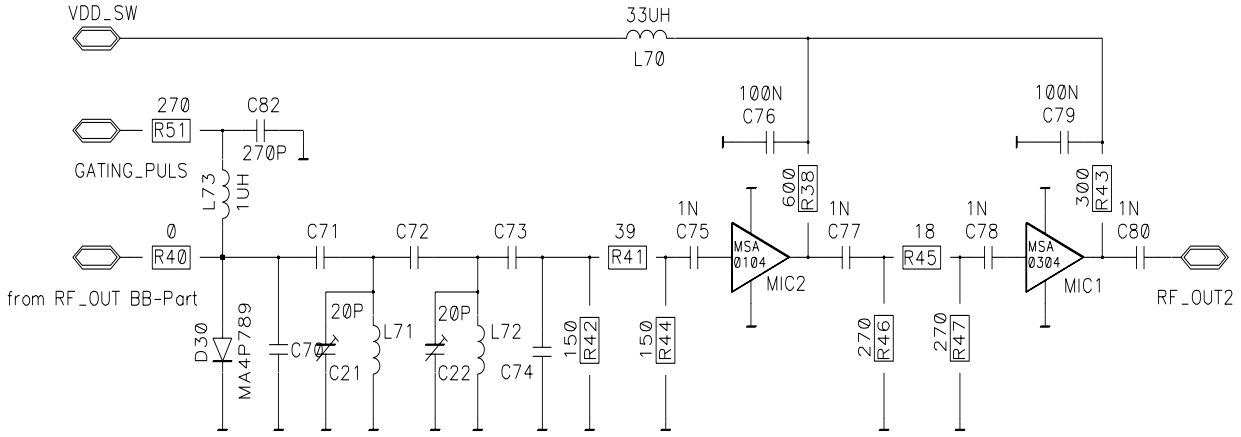
The Band pass filter

Between the Preamp and the bandpass filter there is a SMB pin plug (P1) built in parallel to the signal path. By removing the appropriate zero ohm resistors the preamplifier resp. the bandpass filter can be tested separately.

The Postamplifiers

The higher gain (typically 46 dB) of the ^{2}H Preamp is reached by using two additional MMIC.

Figure 33: Schematic extract - Band pass filter -



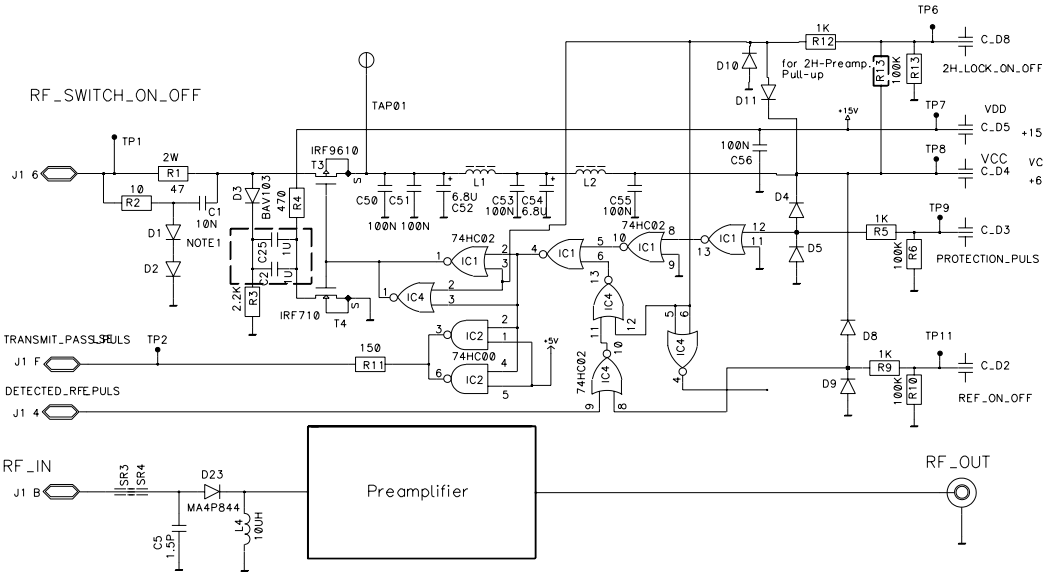
The Tuning Mode 7.1.2

The ^{2}H Preamp can be used for tuning in the same way as the X-BB Preamp. However, only if its not used as a Lock preamplifier (2H LOCK OFF). Further information about the Tuning can be found in the function description for the X-BB Preamp.

The Blanking 7.1.3

In comparison to the X-BB Preamp the ^{2}H Preamp board has one important difference - the Receiver switch in the T/R switch box is always enabled. This suppresses spikes in the region of the Lock frequency when measuring with the X-BB module. When the 2H Preamp is being used for NMR measurements the switch operates as in the X-BB Preamp. The switch command originates from the Preamp controller. Two parallel NAND gates from IC 2 supply the necessary driver current of approx. 30 mA for the transmitter switch in the T/R hot switch box (transmitter pass pulse: checkpoint 2).

Figure 34: Scheme extract - Blanking -



2H T/R-Hotswitch Box 7.2

The ^{2}H T/R-Hotswitch Box is identical to the one used in the X-BB Module. Please refer to the corresponding section for further information.

Probehead Filter 7.3

The probehead filter consists of two low pass filters with a band pass filter in between. The low pass filter improves the suppression of frequencies above ^{2}H.

Transmitter Filter 7.4

The Transmitter filter consists of a band pass filter followed by a low pass filter connected to a ^{1}H stop filter. An open $\lambda/4$ line is used as ^{1}H stop filter.

The low pass filter is formed by the cable capacity and the coils L 1 and L 2 which are etched onto the pc board. The capacitors C 1 to C 5, together with the coils L 3 to L 6, form the band pass filter.

Figure 35: 19F Selectiv Module - Exploded View -

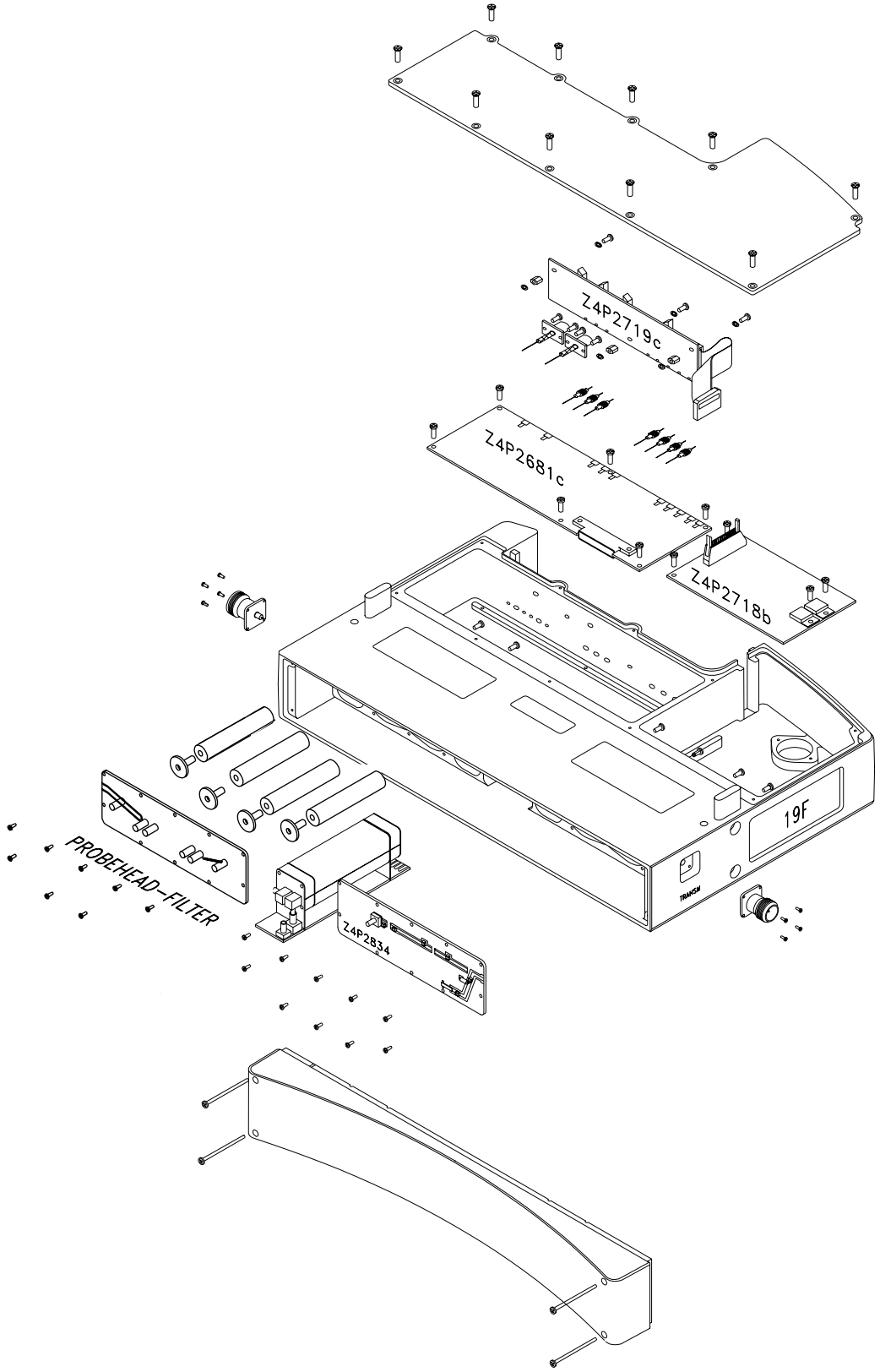
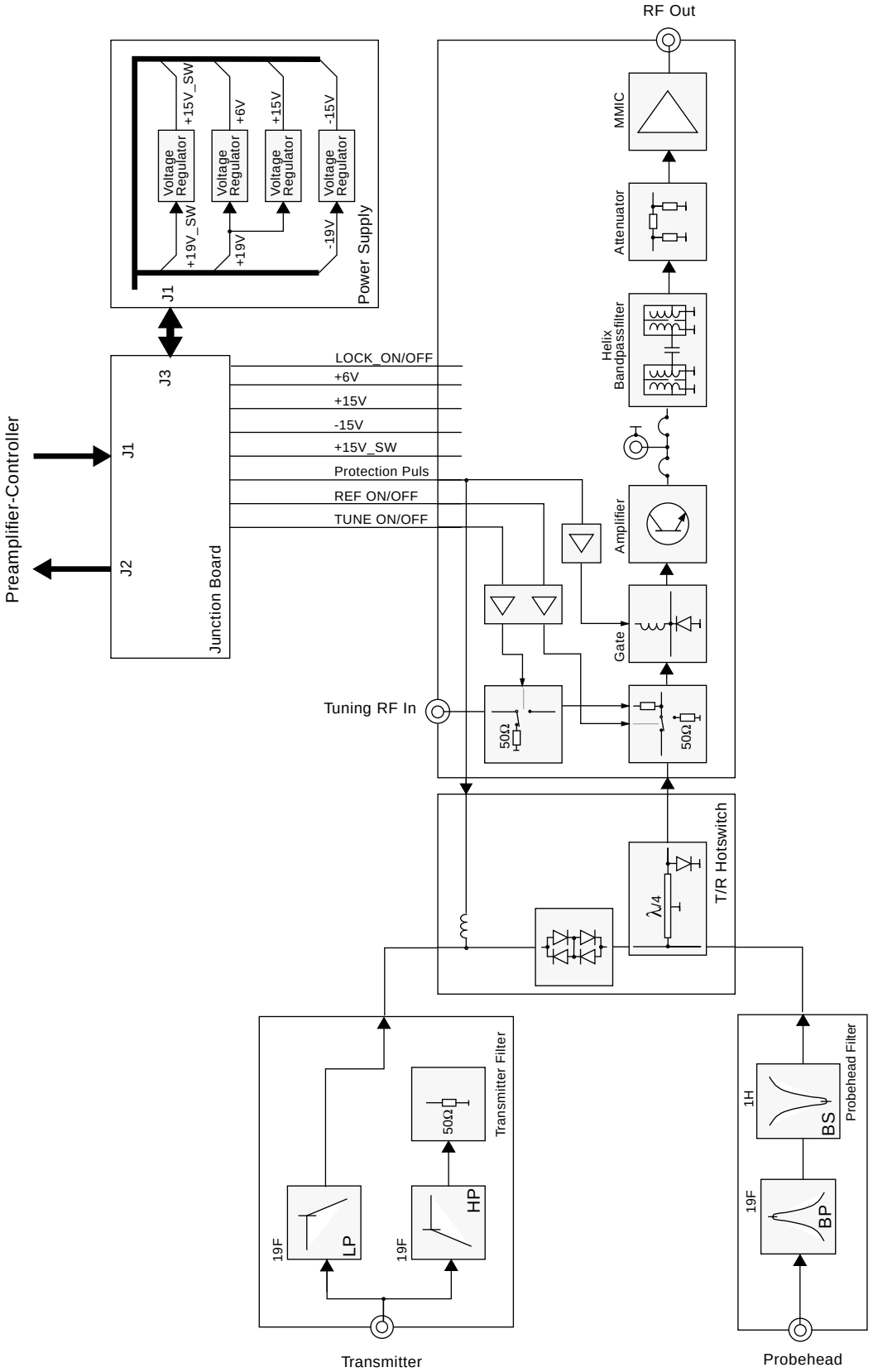


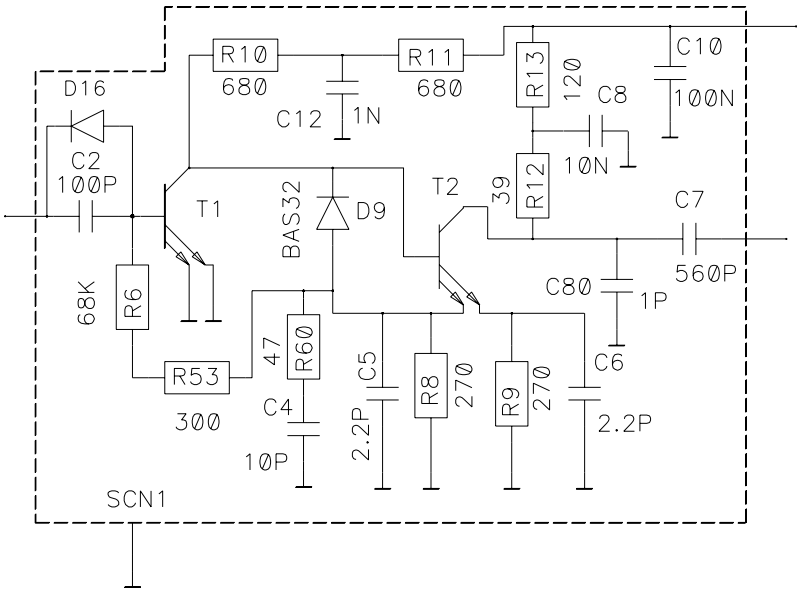
Figure 36: 19F Selectiv Module - Block Diagram -



The Preamplifier

The 19F Selective Module uses the same preamplifier as the 1H Module. Please refer to the corresponding section for further information.

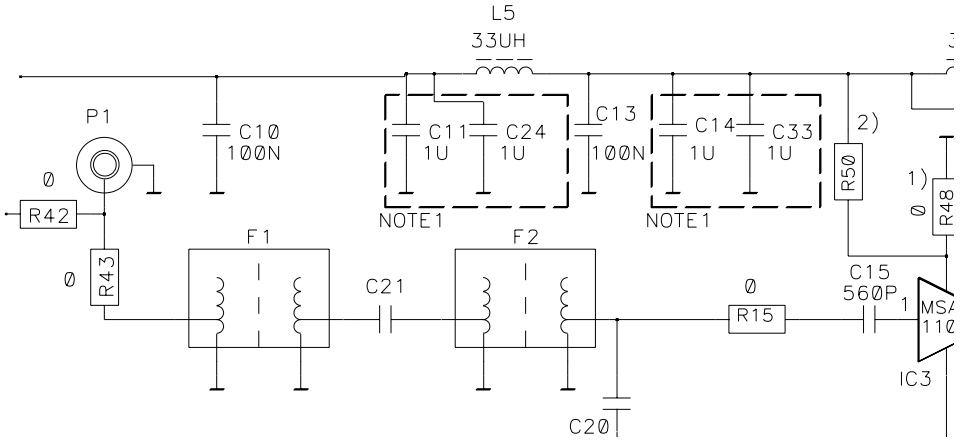
Figure 37: Scheme extract - Preamplifier -



The Bandpass filter 8.1.2

The bandpass-filter and the attenuator are the same as used in the 1H - Module. Please refer to the corresponding section for further information.

Figure 38: Scheme extract - Bandpass filter -



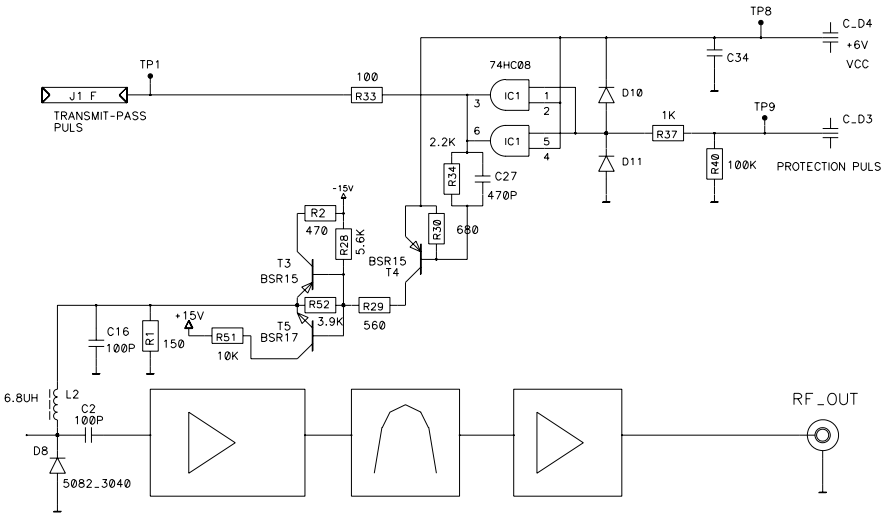
The Blanking 8.1.3

The Blanking circuit works in the same way as described in the 1H Module section.

Circuit description

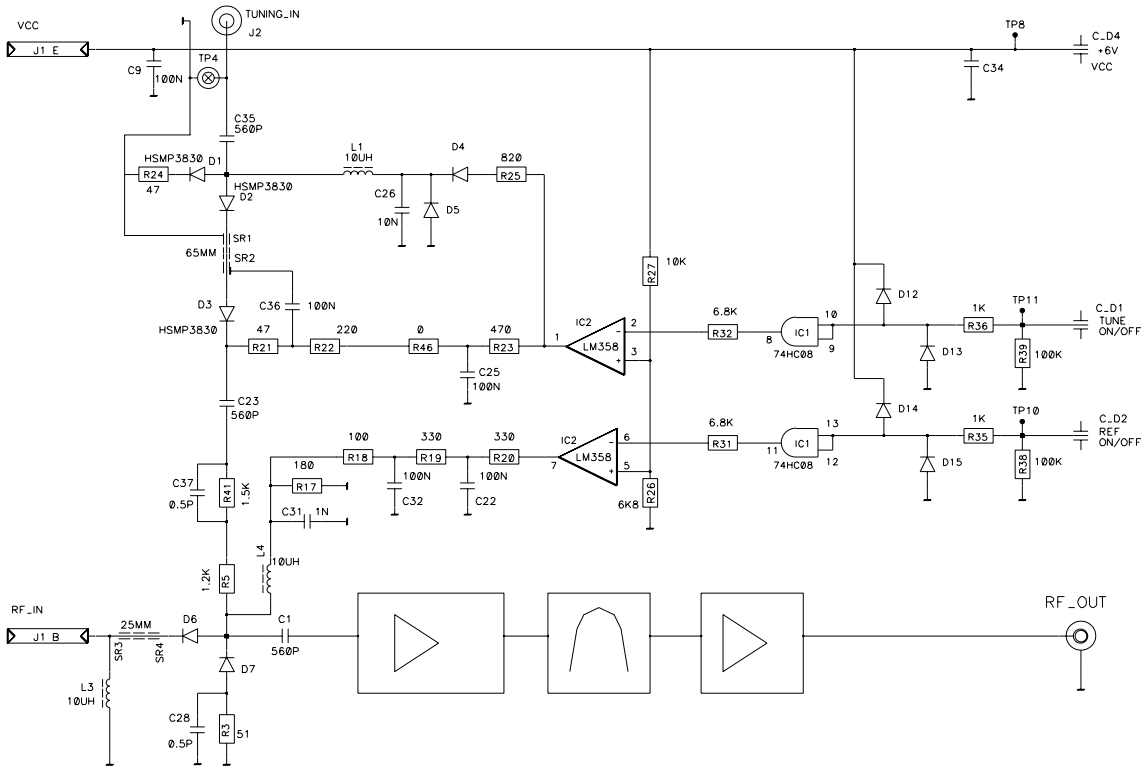
The transmitter blanking switch PROT_19F originates from the transmitter switch logic of the Preamp controller and comes via the connector J 1 in the Junction board, to the switch input. IC 1 contains two dual parallel switching AND gates. This allows for the necessary driver current of approx. 30 mA (for the transmitter switch) in the T/R Hotswitch box to be delivered (Transmitter Pass Pulse: Check point 1). A signal to the driver switch diode D 8 runs parallel to the output pins 3 and 6 of IC 1. The driver consists of the transistors T 3, 4, 5 and the necessary resistors for biasing. A push pull amplifier uses the transistors T 3 and T 5. The strip line PIN diode D 8 is one of the NIP diodes with an anode heat sink.

Figure 39: Scheme extract - Blanking -



The same Tuning circuit as in the 1H Module is used. Please refer to the corresponding section for further information.

Figure 40: Scheme extract - Tuning-



Lambda/4 T/R-Hotswitch Box 8.2

The same Lambda/4 T/R-Hotswitch Box as in the 1H Module is used. Please refer to the corresponding section for further information.

Probehead Filter 8.3

The probehead filter is designed as a dual circuit comb band pass filter. The capacitive coupling occurs at the high point of the resonator. The coupling between the resonators functions as a band pass filter with an inductive high point coupling.

Transmitter Filter 8.4

The transmitter filter is designed as a combined ^{19}F low pass filter and a ^{19}F high pass filter. The high pass filter is connected with a special circuit for the 50 Ω matching of the higher harmonics caused by the ^{19}F transmitter.

3H Module

Figure 41: 3H Module - Exploded View -

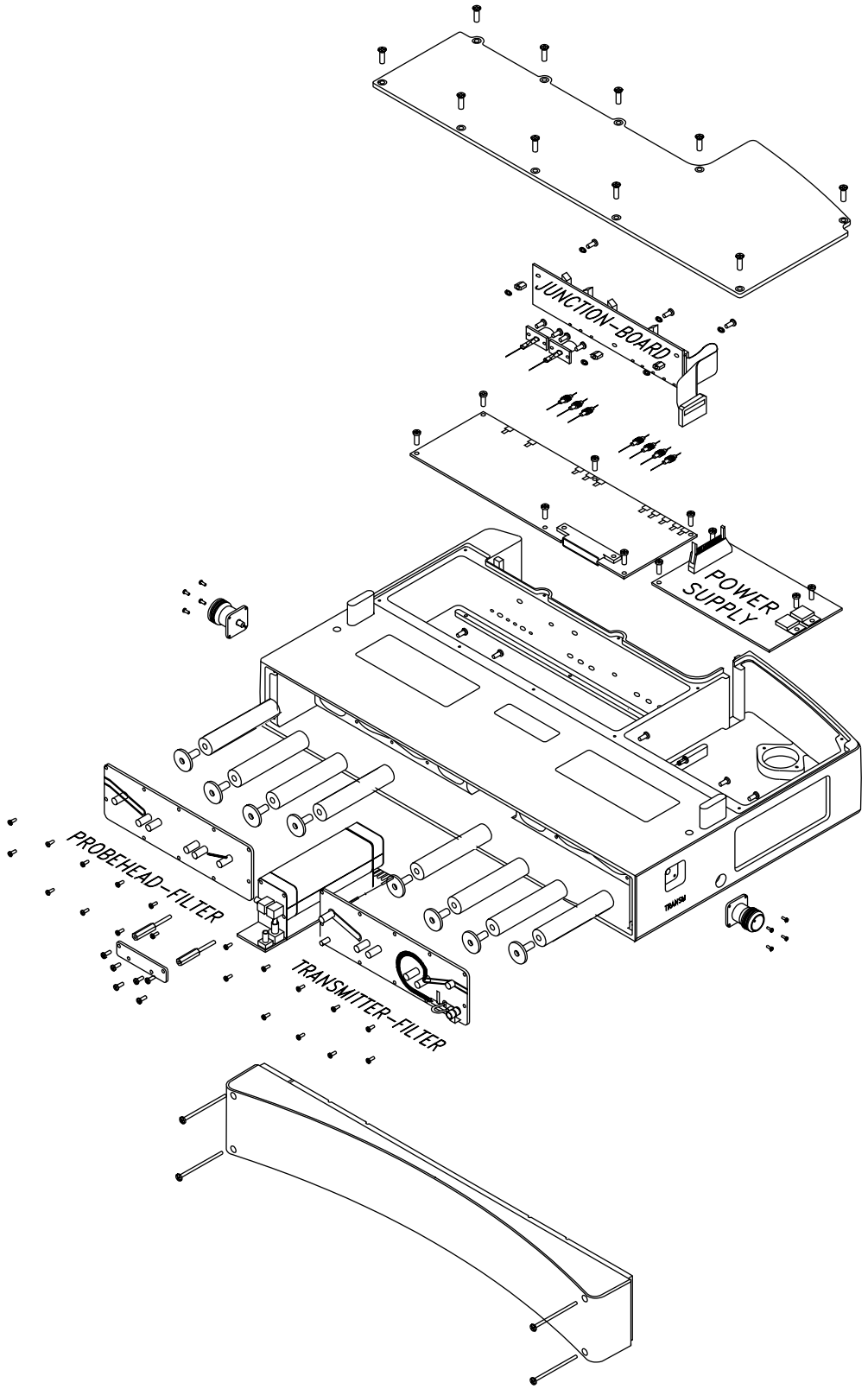
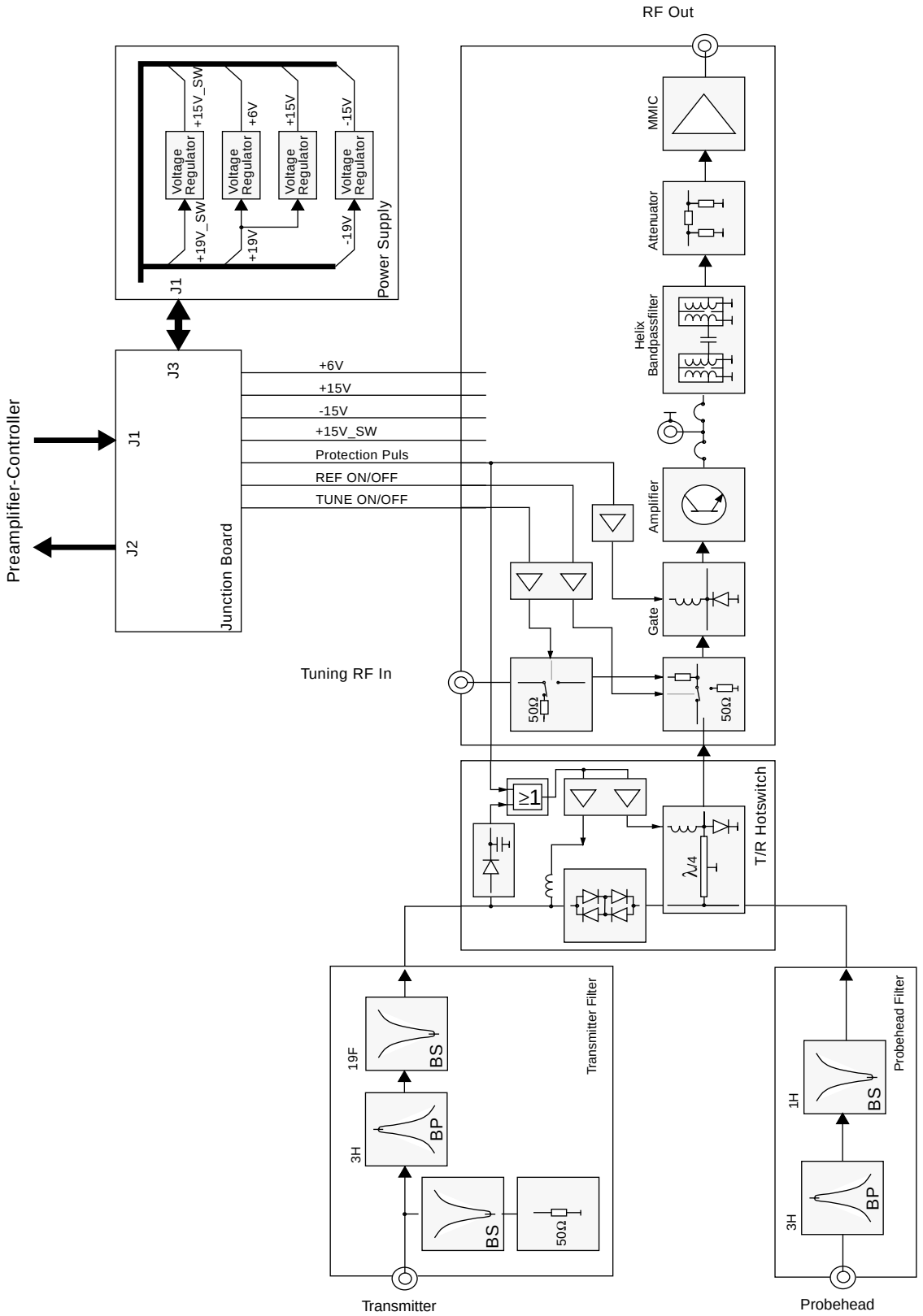


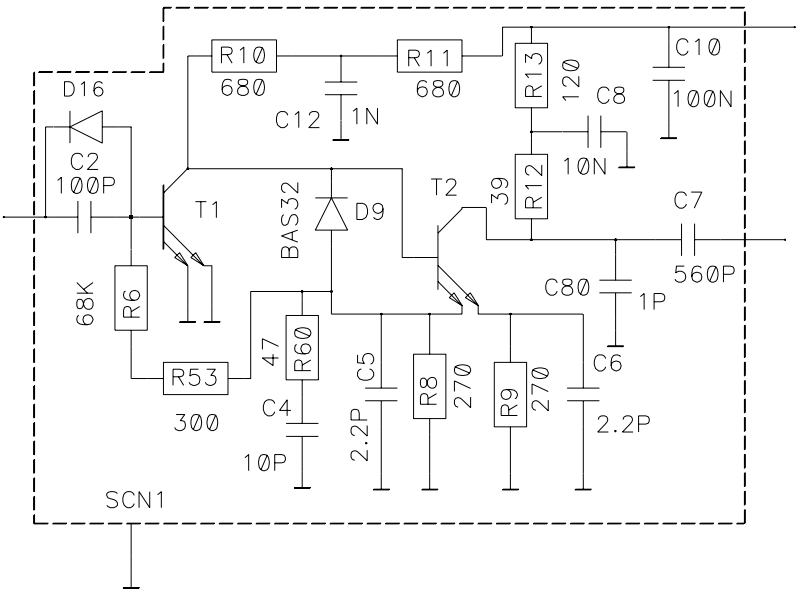
Figure 42: 3H Module - Block Diagram -



The Preamplifier

The 3H Module uses the same preamplifier as the 1H Module. Please refer to the corresponding section for further information.

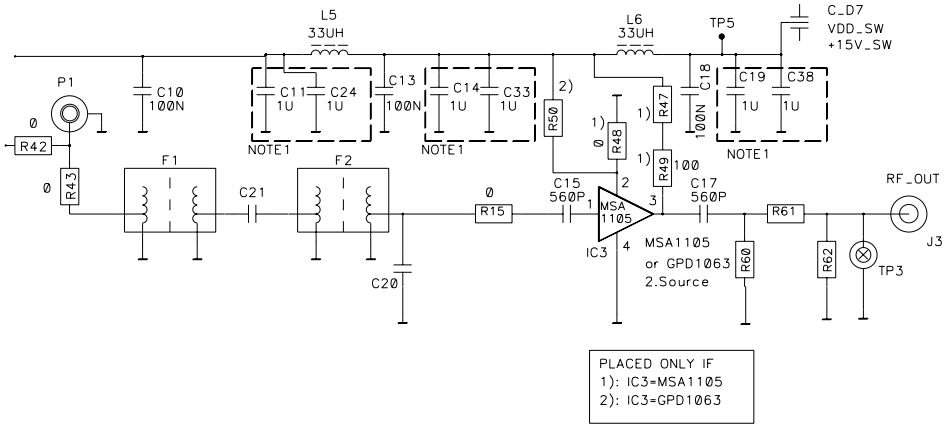
Figure 43: Scheme extract - Preamplifier -



The Bandpass filter 9.1.2

The bandpass-filter and the attenuator are the same as used in the 1H - Module. Please refer to the corresponding section for further information.

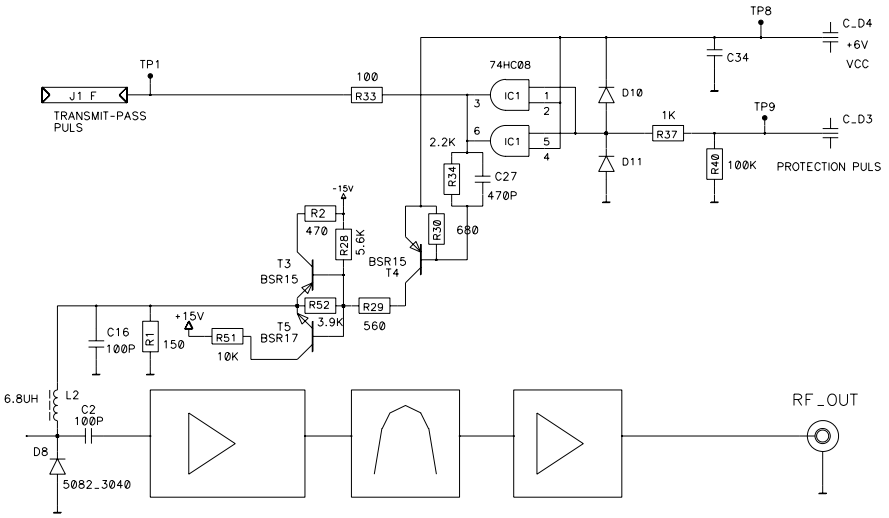
Figure 44: Scheme extract - Bandpass filter -



The Blanking 9.1.3

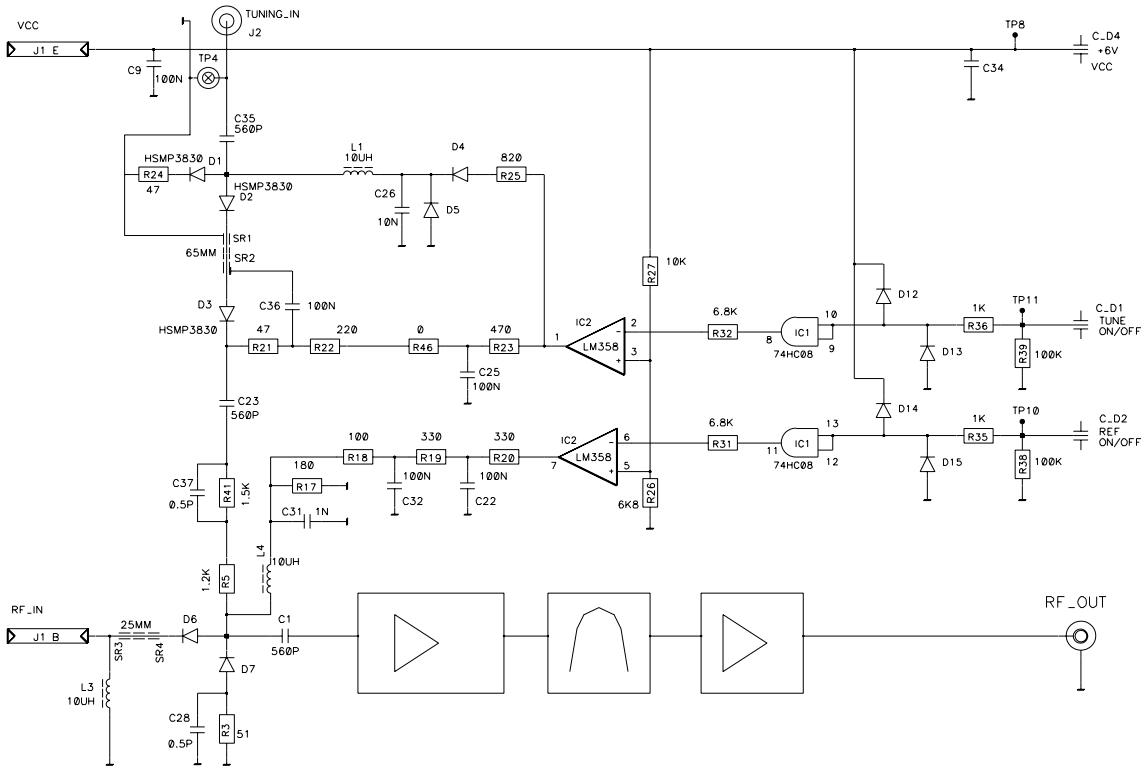
The Blanking circuit works in the same way as described in the 1H Module section.

Figure 45: Scheme extract - Blanking -



The same Tuning circuit as in the 1H Module is used. Please refer to the corresponding section for further information.

Figure 46: Scheme extract - Tuning-



Lambda/4 T/R-Hotswitch Box 9.2

The same Lambda/4 T/R-Hotswitch Box as in the 1H Module is used. Please refer to the corresponding section for further information.

Probehead Filter 9.3

The probehead filter is designed as a dual circuit comb band pass filter. The capacitive coupling occurs at the high point of the resonator. The coupling between the resonators functions as a band pass filter with an inductive high point coupling.

Transmitter Filter 9.4

The transmitter filter is designed as a dual circuit comb band pass filter, suppressing ^{19}F. The capacitive coupling occurs at the high point of the resonator. The coupling between the resonators functions as a band pass filter with an inductive high point coupling. At the filter input there is a special circuit for the 50 Ω matching of the higher harmonics caused by the ^{3}H transmitter.

Figure 47: QNP Control Module - Top View -

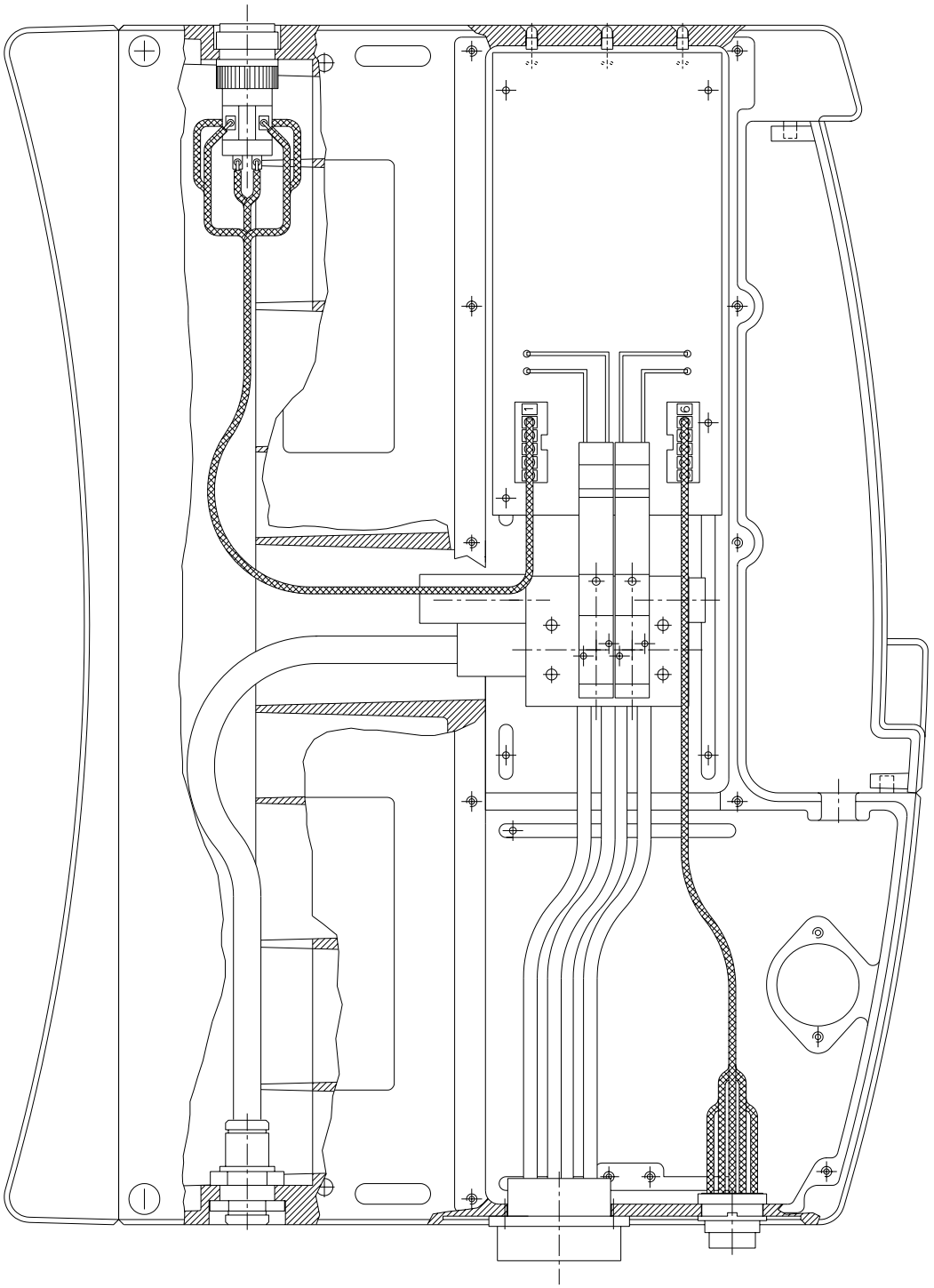
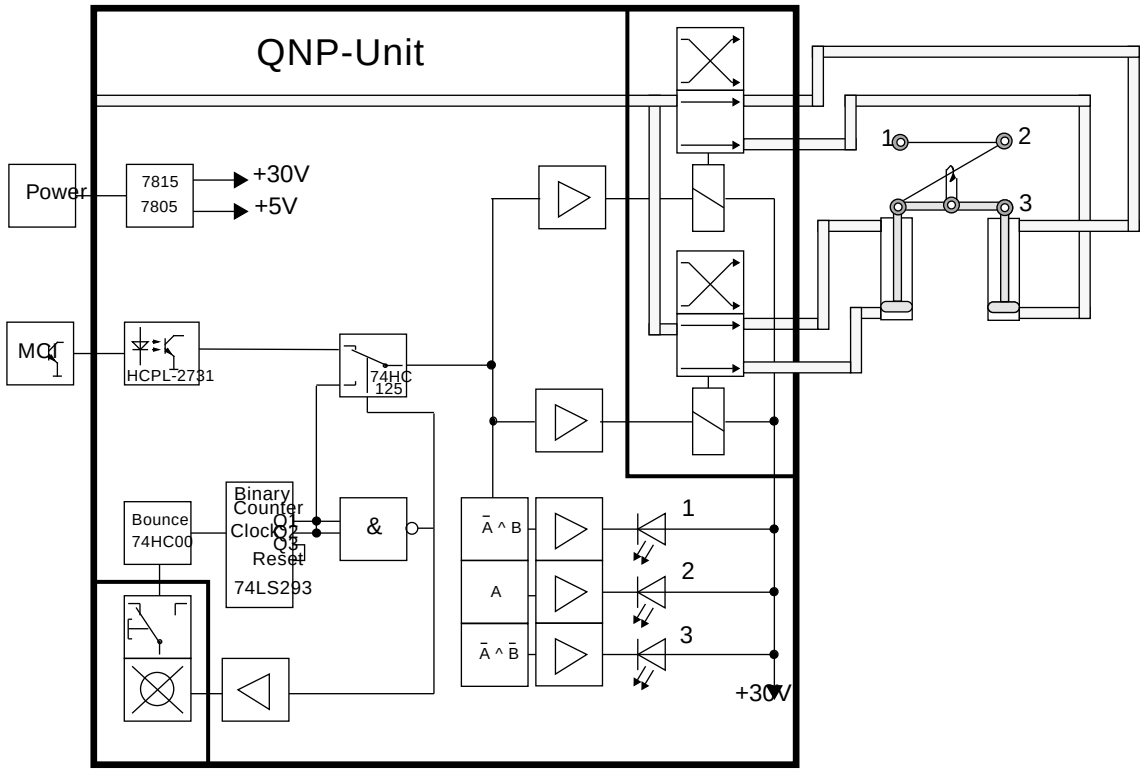


Figure 48: QNP Control Module - Block Diagram -



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, 13C and 31P. This is made possible by the triple-switchable measure-channel in the Probehead.

The QNP Control Module is the interface between the electronics and pneumatics. It is controlled manually or by the MCI via the signals Fxa and Fxb. Manual or MCI control can be chosen by a switch. The three indication LED's on the front panel show the operation state of the probehead switch. 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 Control Module.

Installation of the QNP Control Module 10.1.1

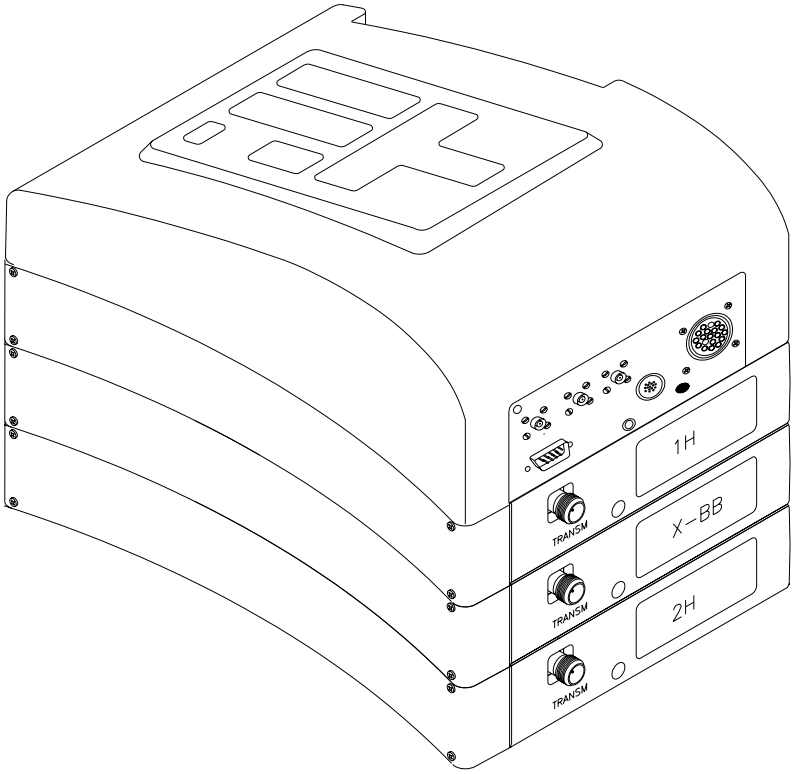
On the Multi Channel NMR Interface Board 3 C NMR I/F (H3500 or H3624), remove pins D and J on connector N1 and replace them with pins D1 (black) and J1 (violet/black). If BP2 is already occupied, the QNP cable pins must be removed and inserted in the already available connector. The QNP cable is labelled correspondingly.

Table 6: Console Connector BP2 pins

Pin	Signal
BB	Fxa
FF	Fxb
HH	DGND
KK	+30V
CC	GND

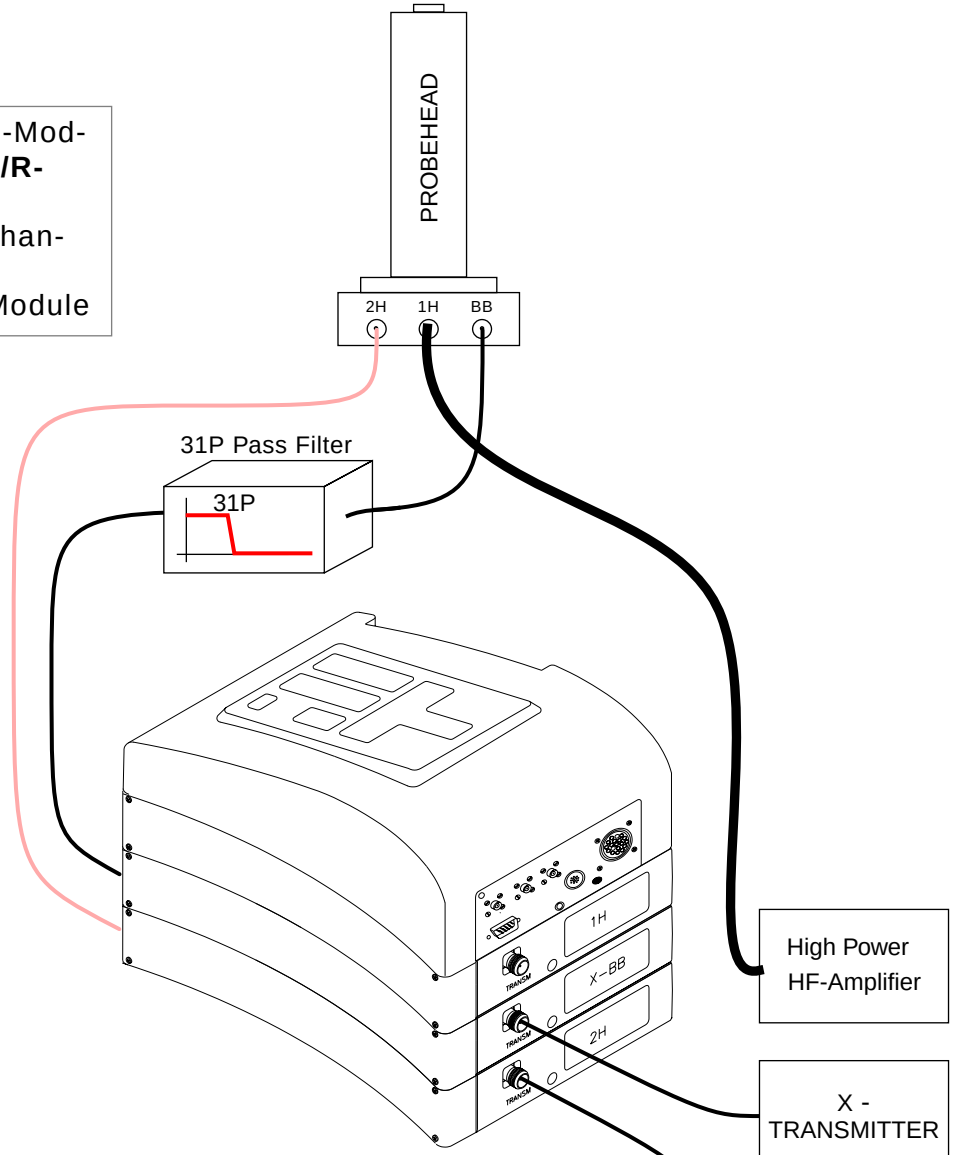
Table 7: QNP Control Signals

	Fxa	Fxb	Probehead Switch	Pneumatic Switch	Frequency
1	H	H	3	bottom	max.
2	L	H	2	middle	mid.
3	H	L	1	top	min.

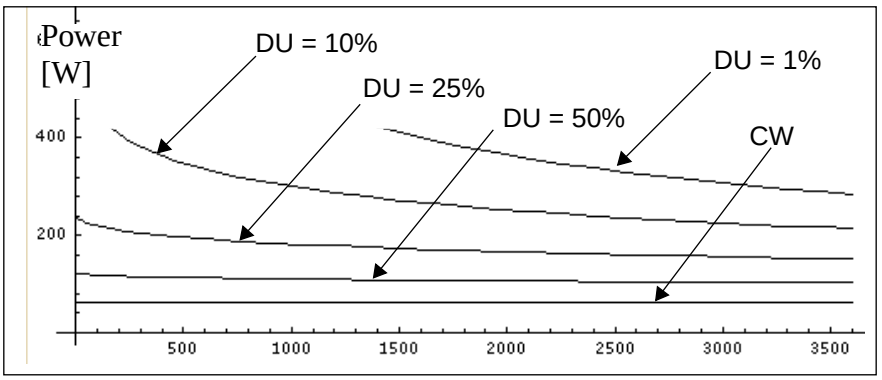

1H
X–BB
2H
TRANSM
TRANSM
TRANSM

observe nucleus:X
decoupling:1H, Pulses with more than 500mS @ 150 Watt and > 10 % Duty Cycle
(external lock:2H)

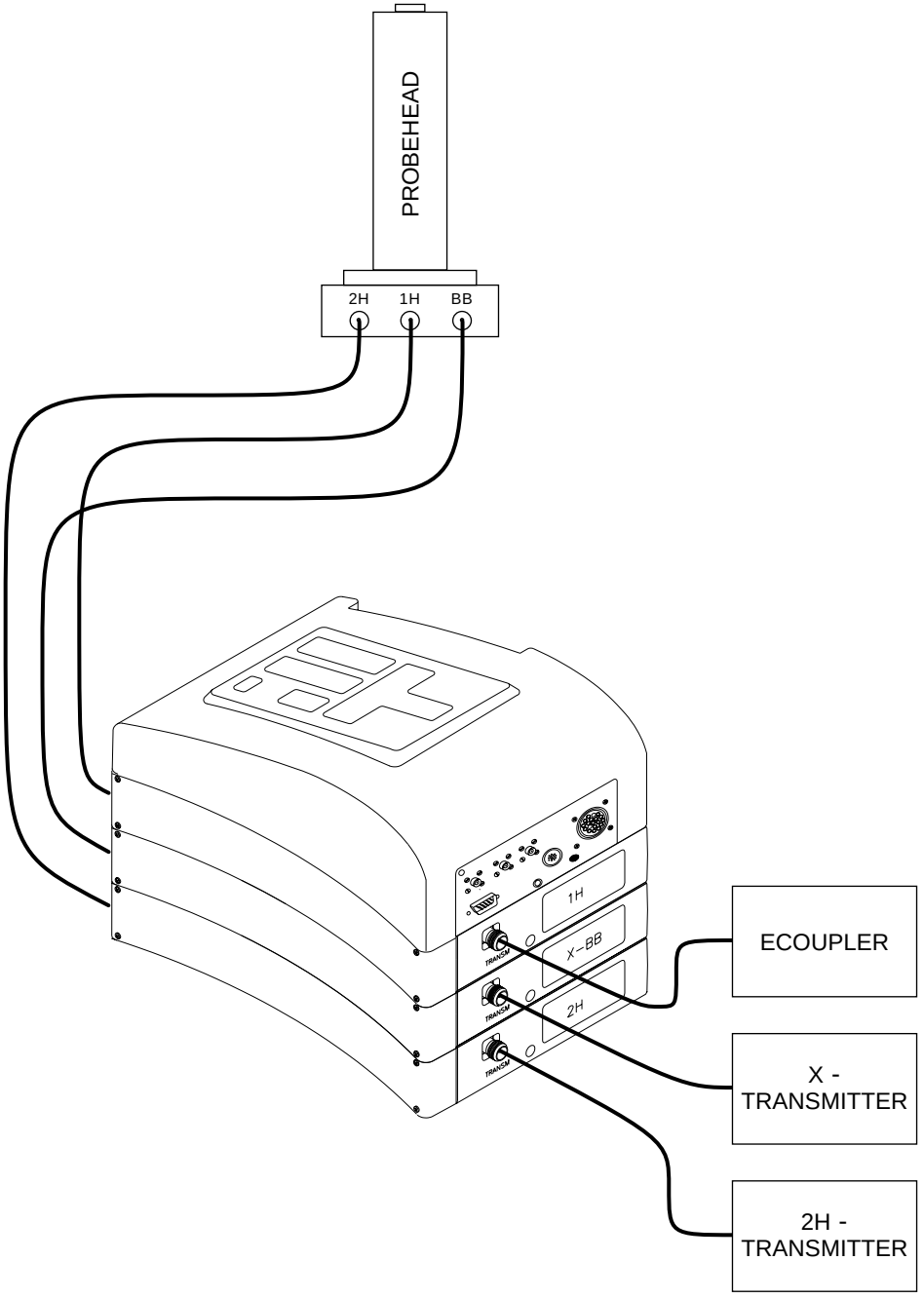
Read chapter 1H-Module (**Lambda/4 T/R-Hotswitch Box**) about the power handling capability through the 1H-Module



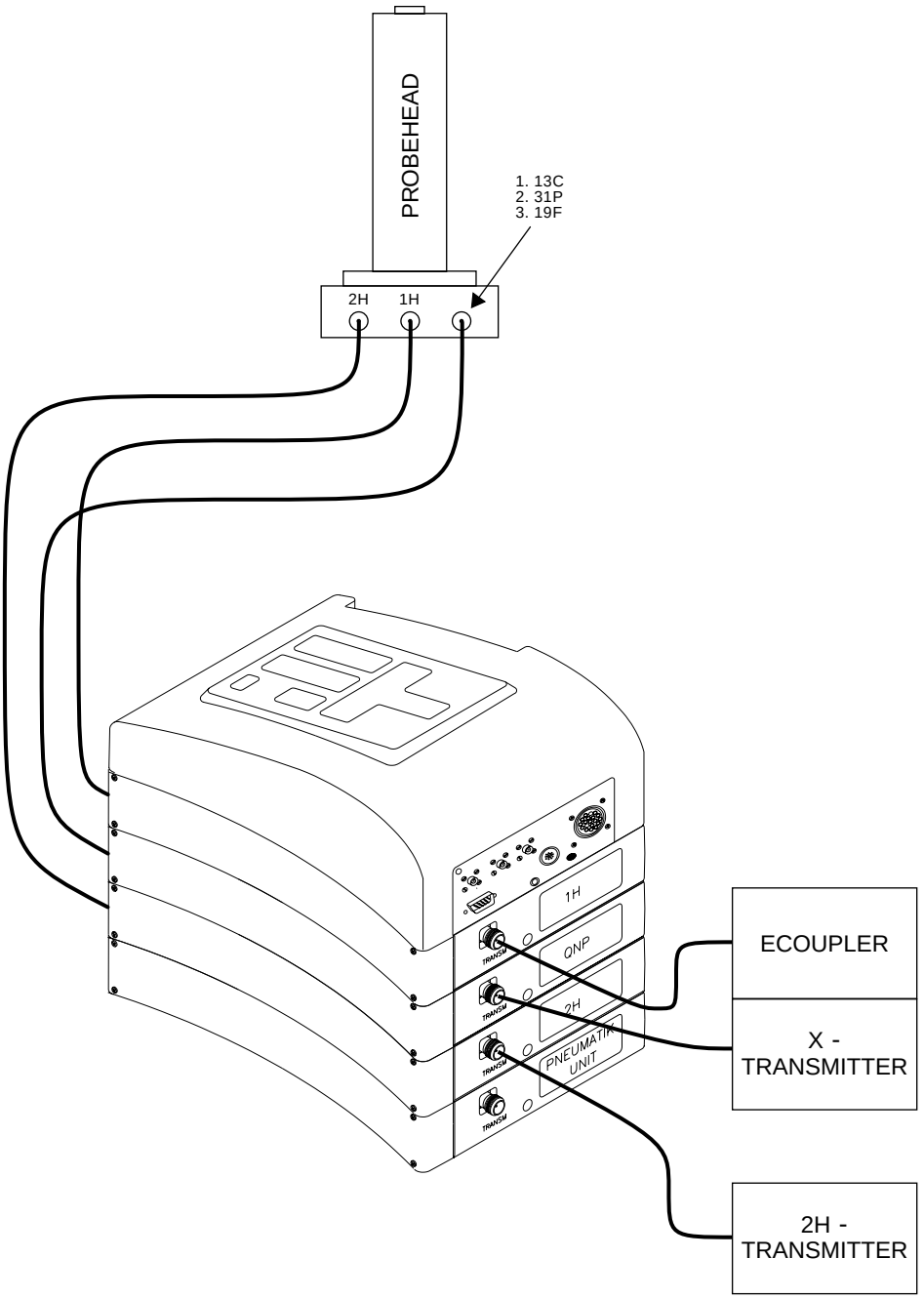
Power Handling Cap. through the 1H-Modul (matched case)



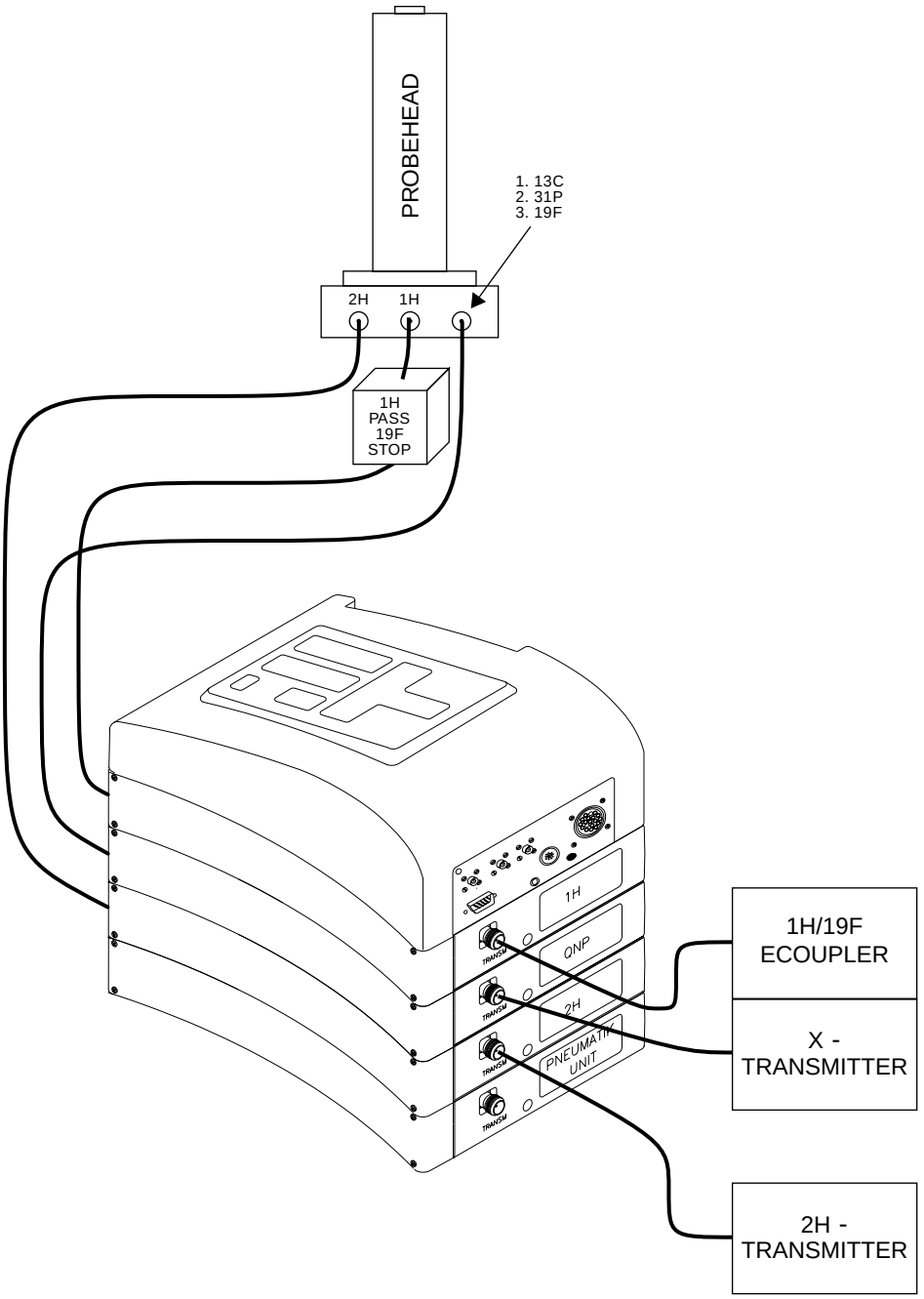
observe nucleus:X
decoupling:1H
lock:2H



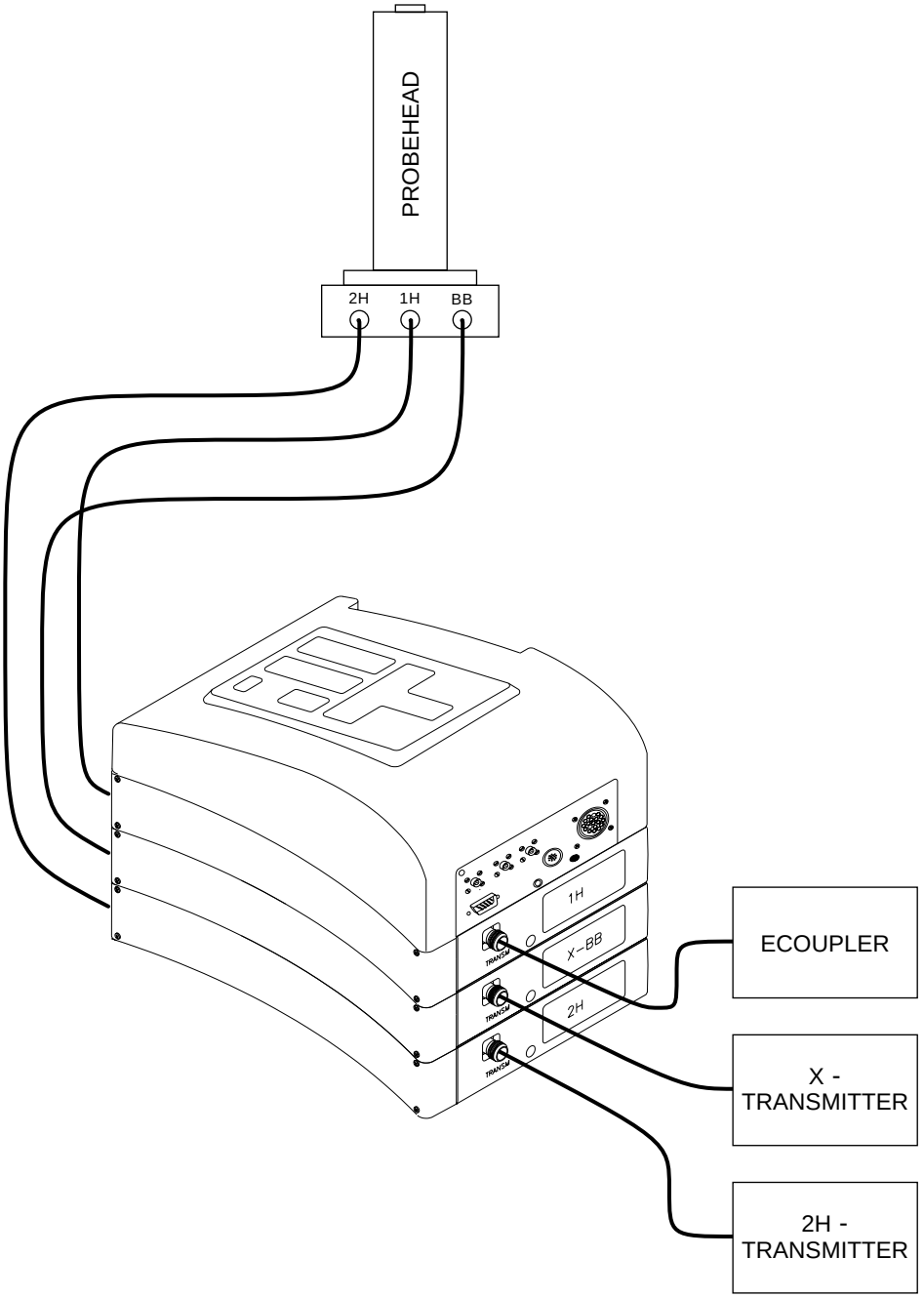
observe nucleus:13C, 31P, 19F
decoupling:1H
lock:2H



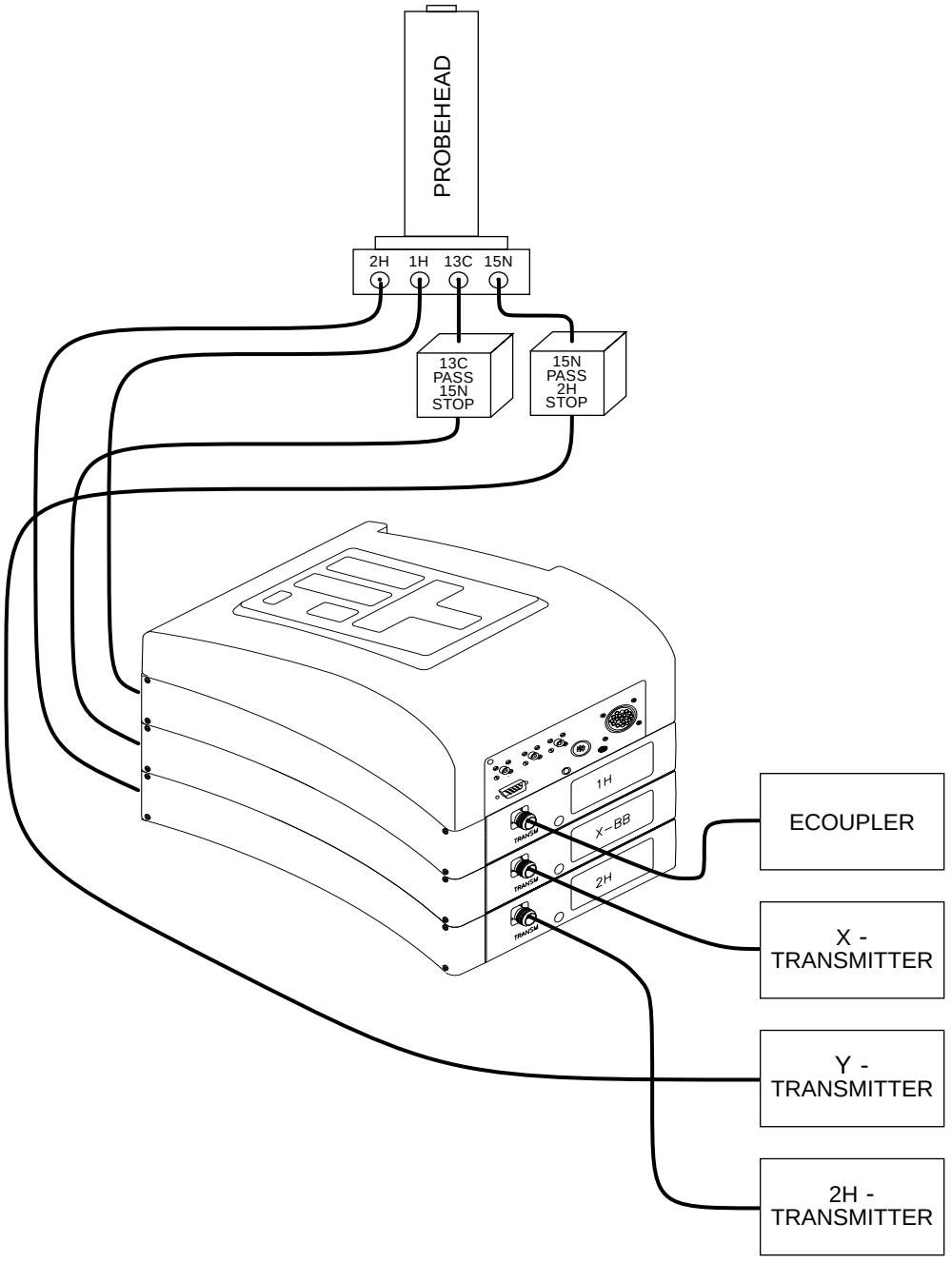
observe nucleus:13C, 31P, 1H
decoupling:19F
lock:2H



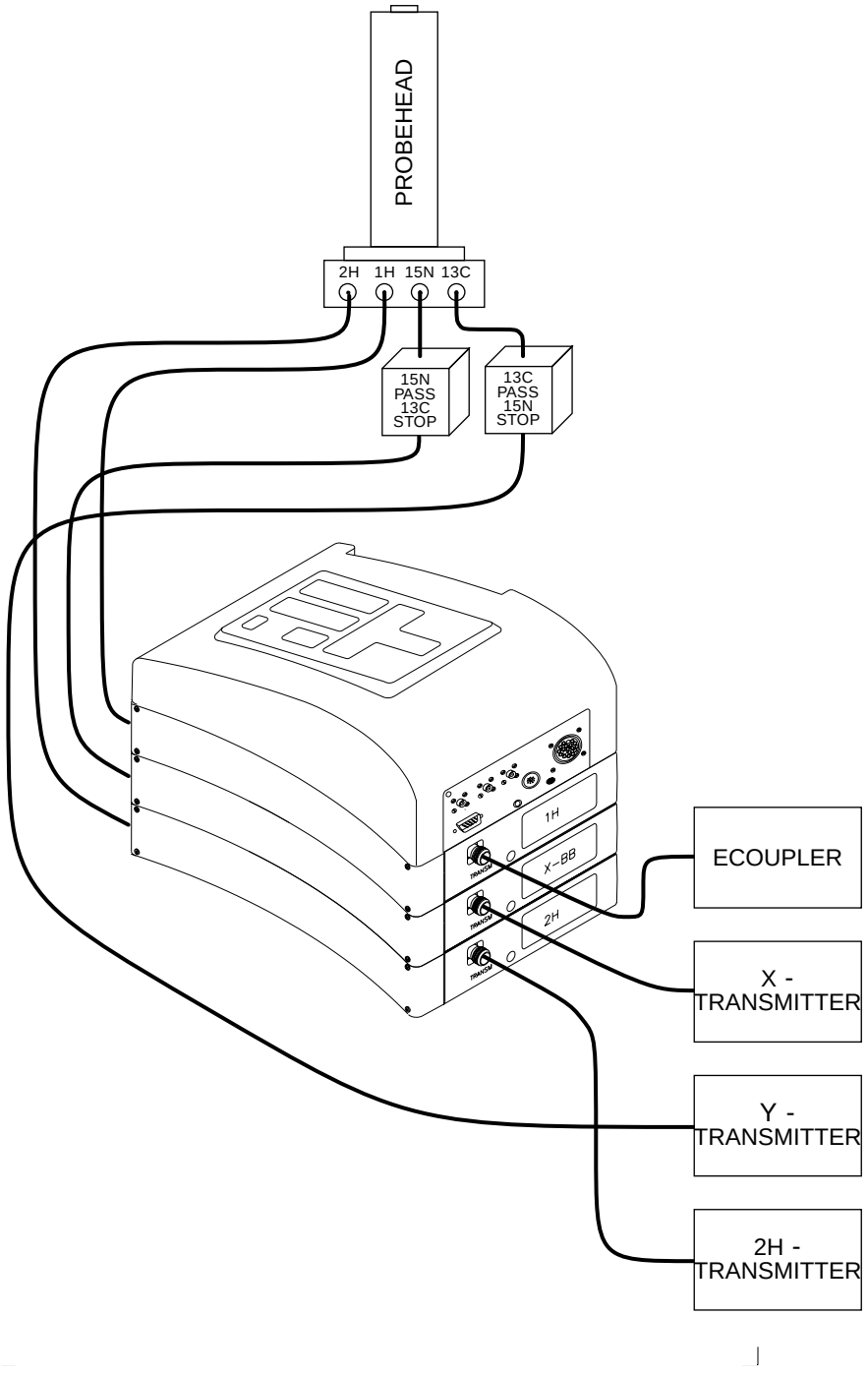
observe nucleus:1H
decoupling:X
lock:2H



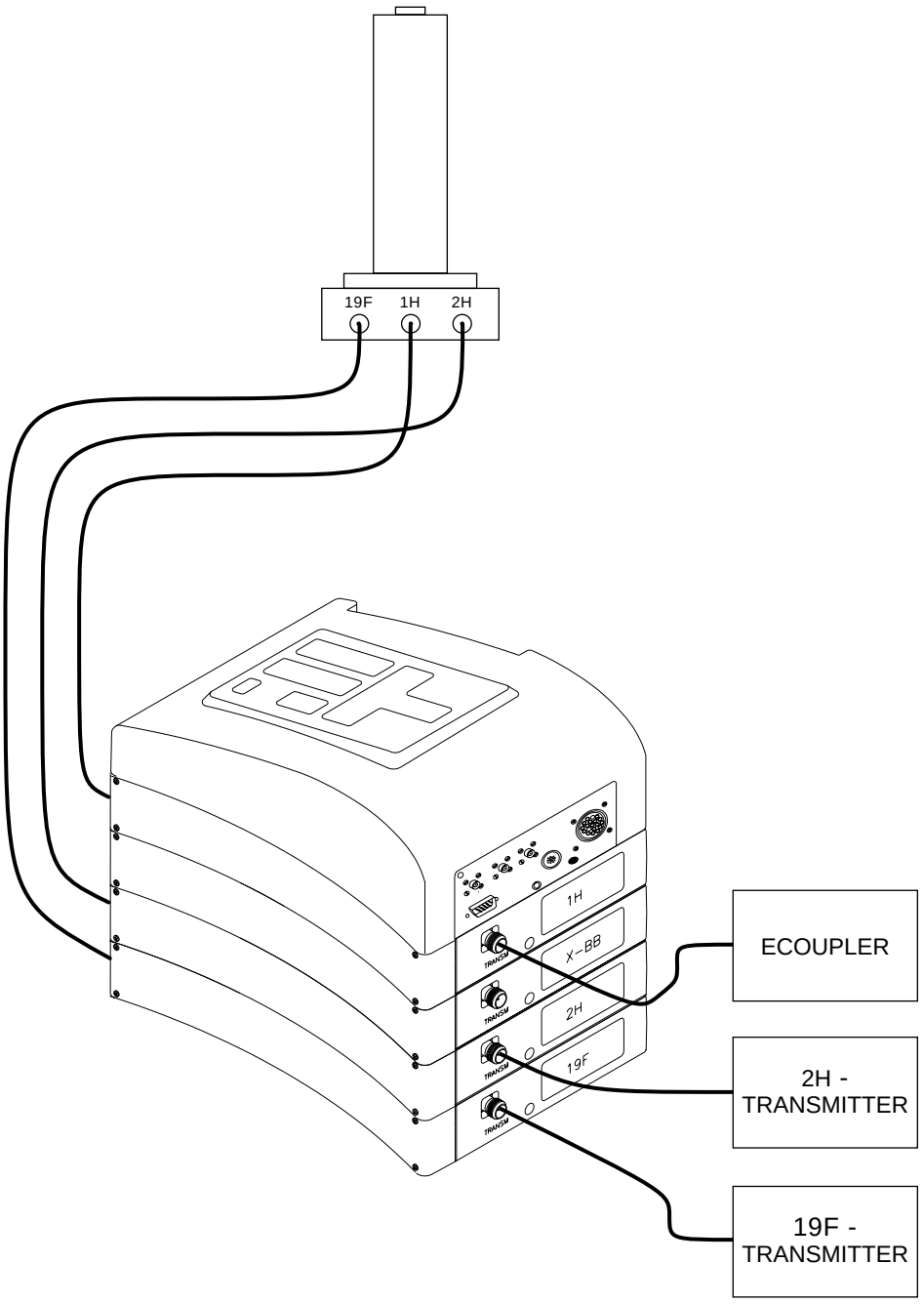
observe nucleus:1H
decoupling 1:13C
lock:2H
decoupling 2:15N



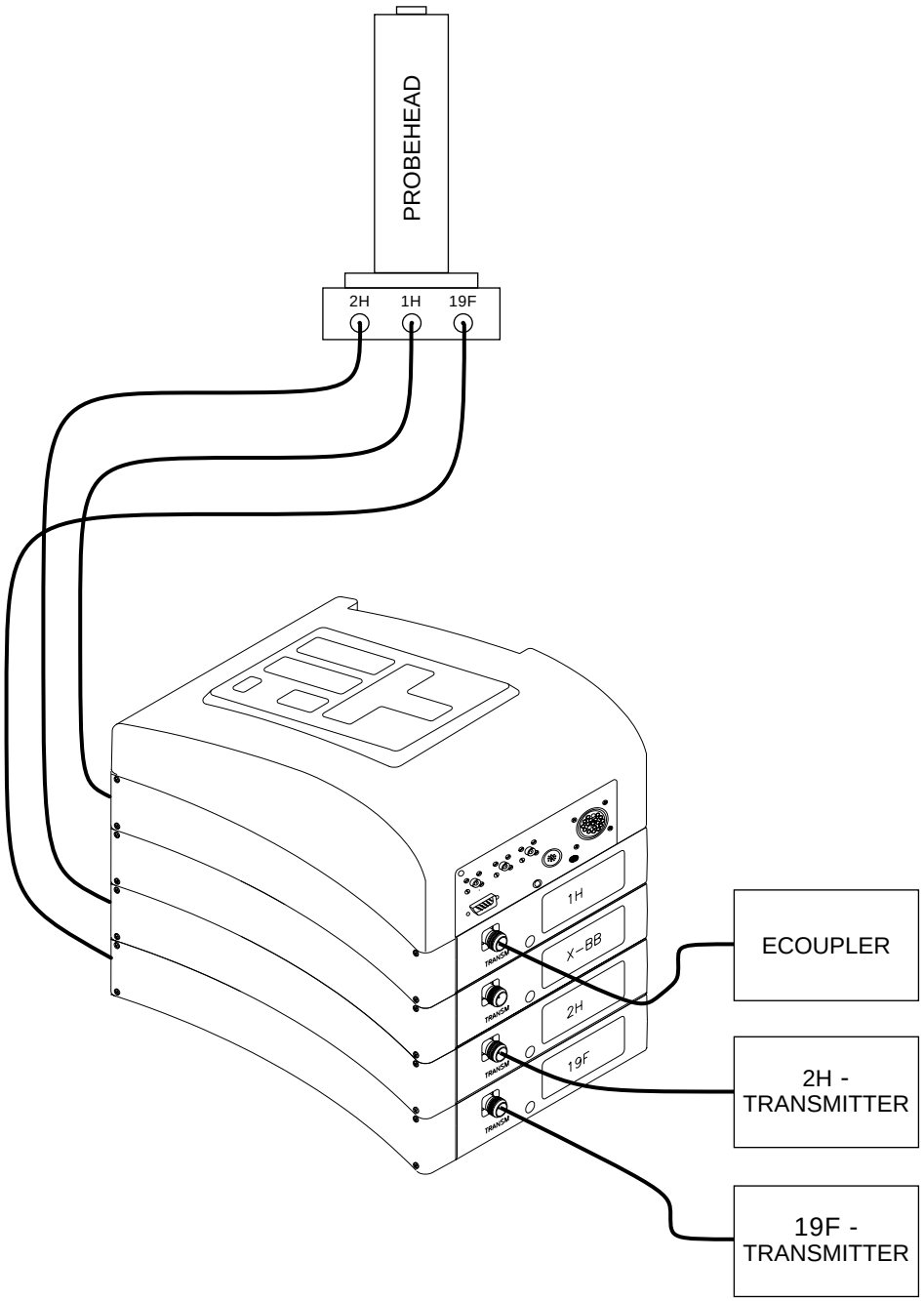
observe nucleus:13C
decoupling 1:1H
lock:2H
decoupling 2:15N



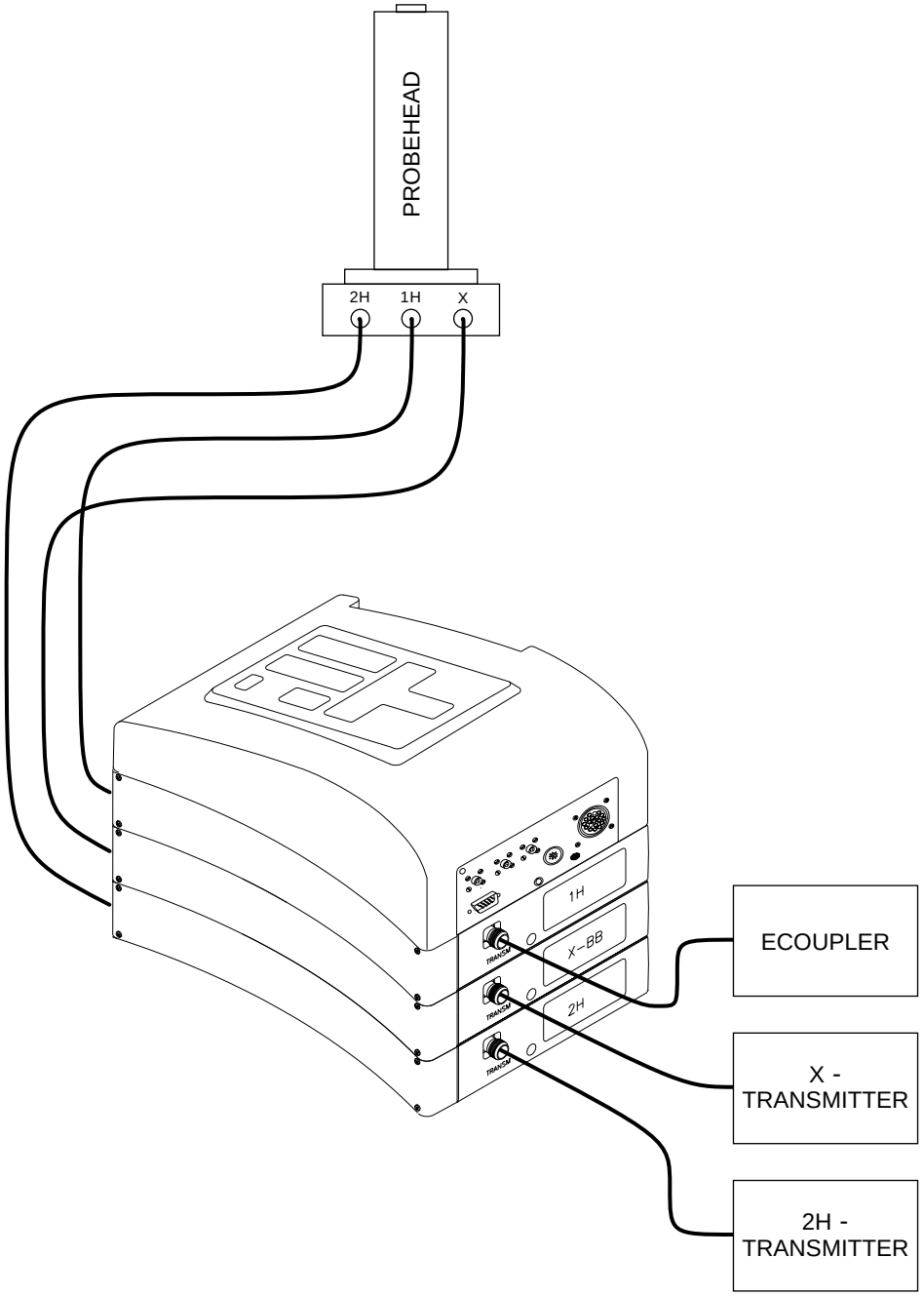
observe nucleus:2H
decoupling:1H
lock:19F



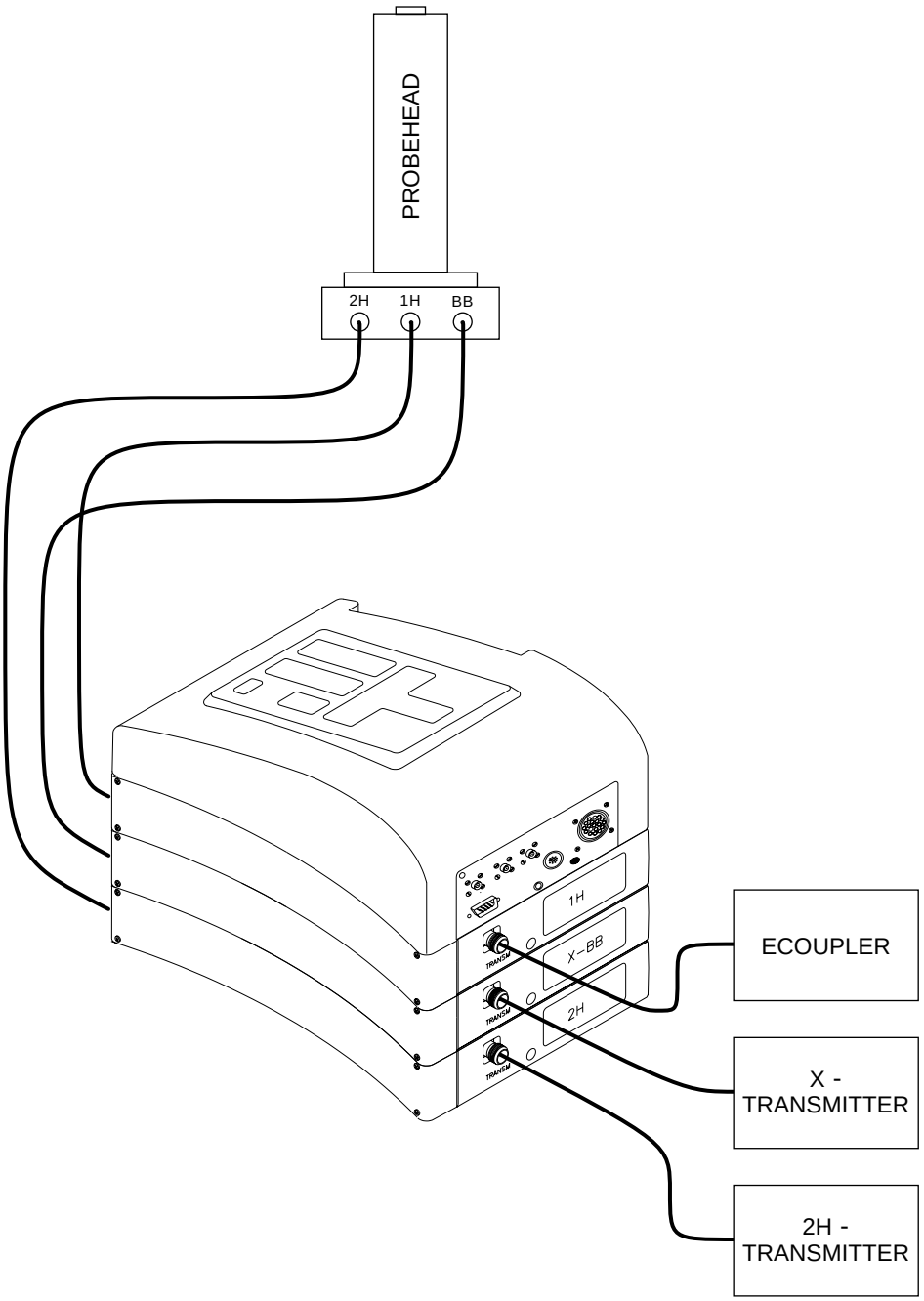
observe nucleus:19F
decoupling:1H
lock:2H



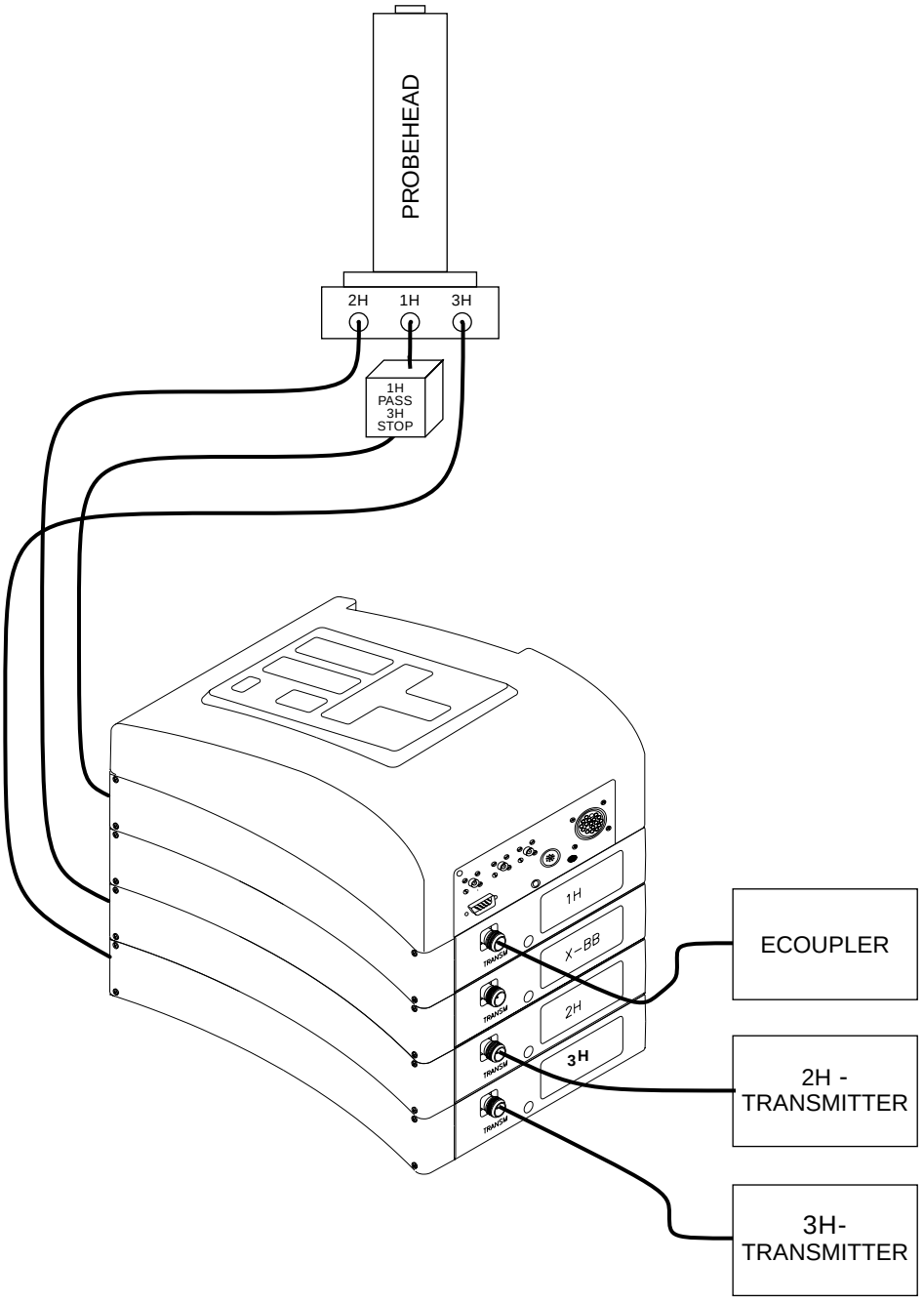
observe nucleus:X
decoupling:1H
lock:2H



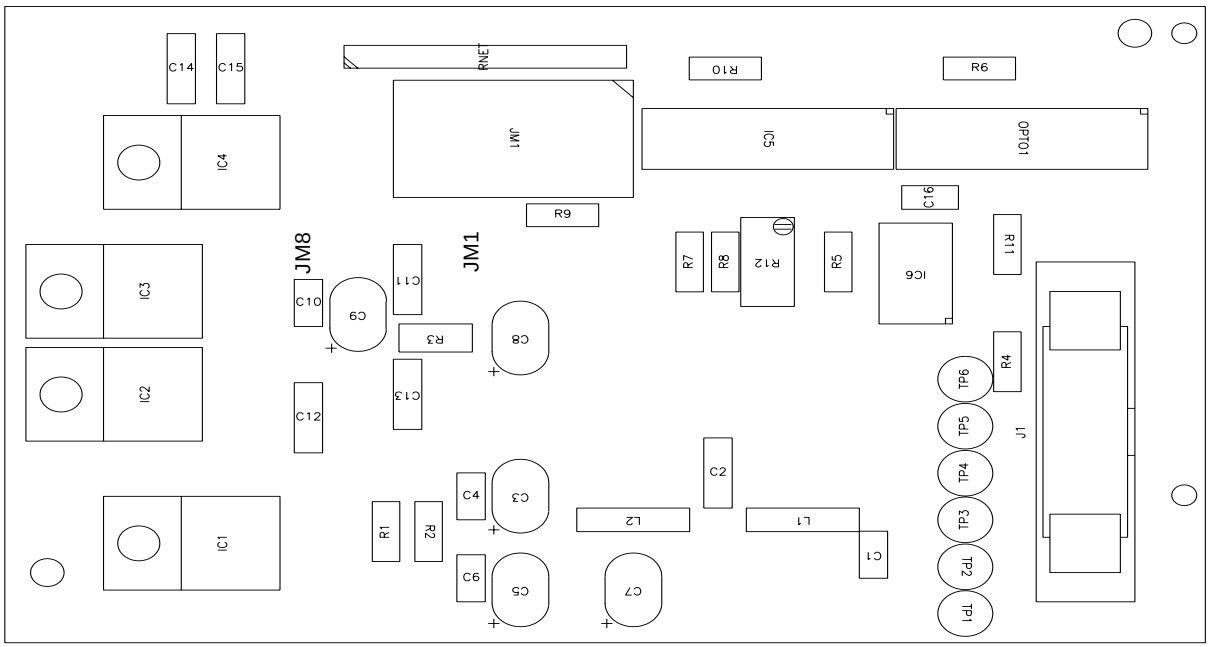
observe nucleus:1H
decoupling:X
lock:2H



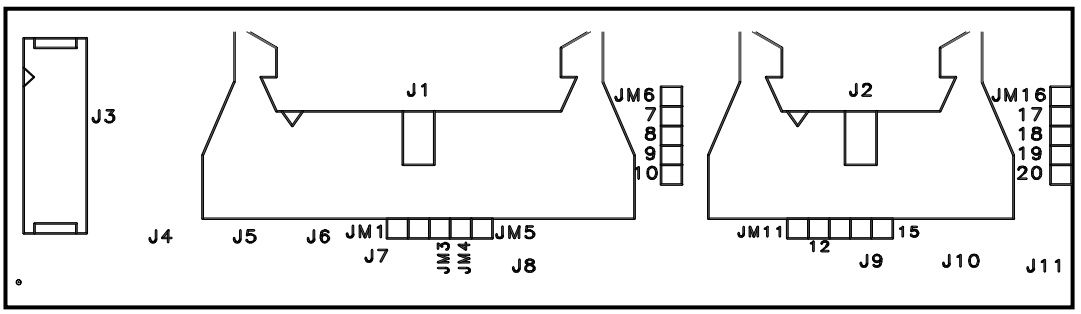
observe nucleus : 3H
decoupling : 1H
lock : 2H



Power Supply



Junction Board



Introduction 12.1

A major goal while designing each one of the various Preamplifier-Modules was to keep the number of supporting circuits as low as possible. Therefore identical Power Supply and the Junction Boards are found in all Preamplifier Modules.

Power Supply Board 12.2

Each preamplifier-module has its own Power Supply board. It is fed from the console with ± 19 V. The Power Supply delivers three stabilized voltages.

- 15 V	VDD	IC 2	TP 3
- 15 V	VSS	IC 4	TP 4
+ 6 V	VCC	IC 3	TP 2

The supply voltage for the Preamp (19 V_SW -> VDD_SW, TP 1) which is found on the controller board may be switched via software (Preamplifier En-/Disable). It is connected to the Power Supply via an additional connection other than ± 19 V.

All supplied voltages are monitored (OPTO 1 /PC 847). Should one of the three voltages above fail, the corresponding optical coupler will shut and the change of conditions will be reported to Preamp control via the VCTRL line.

The X32 computer is able to read up to 5 module information codes from the HP Preamp. A module modification index is read by the controller and sent to the X32 computer on request.

If a ^{1}H, ^{2}H, X-BB or ^{19}F preamplifier module requires an update, the **H**ardware-**C**ode-**L**evel (HCL**) index will be altered at a BRUKER facility. All of the named modules are connected to the Preamp controller via a line (PCODE, TP 5 on the Power Supply) which carries a corresponding voltage for the modification index. The identifying voltage is generated on the Power Supply board using an 8-Bit DAC (IC 5) followed by a OP stage (IC 6). The coding of the Preamp module can be achieved with solderable jumpers (JM1 - JM8).

The following tables show the Power Supply Jumper Settings for the Preamplifier Modules.

Note!

Table 8 on page 99: Hardware Code Level Detection HCL A and B for 1H, 2H, X-BB, 19F Modules only!

Table 9 on page 99: Hardware Code Level Detection HCL C and higher for all Modules!

*Table 8: **H**ardware **C**ode **L**evel Detection - HCL A and B only -*

Pos.	Jumper								Hardware Code Level Detection for 1H, 2H, X-BB, 19F Modules - HCL A and B only -
	7	6	5	4	3	2	1	0	
	JM_8	JM_7	JM_6	JM_5	JM_4	JM_3	JM_2	JM_1	
1H, 2H, X-BB, 19F MODULE									
									MODIFICATION INDEX
1	0	0	0	0	0	0	0	0	no Preamplifier available
2	X	X	X	X	0	0	0	1	Module HCL A
3	X	X	X	X	0	0	1	0	Module HCL B
									FREQUENCY IDENTIFICATION
4	X	0	1	0	X	X	X	X	- 300 -
5	X	0	1	1	X	X	X	X	- 360 -
6	X	1	0	0	X	X	X	X	- 400 -
7	X	1	0	1	X	X	X	X	- 500 -
8	X	1	1	0	X	X	X	X	- 600 -
USER-BOX									
9	0	0	0	0	0	0	0	0	no Preamplifier available
10	0	0	0	0	0	0	1	0	X-BB_19F_2HP [former QNP(19F)]

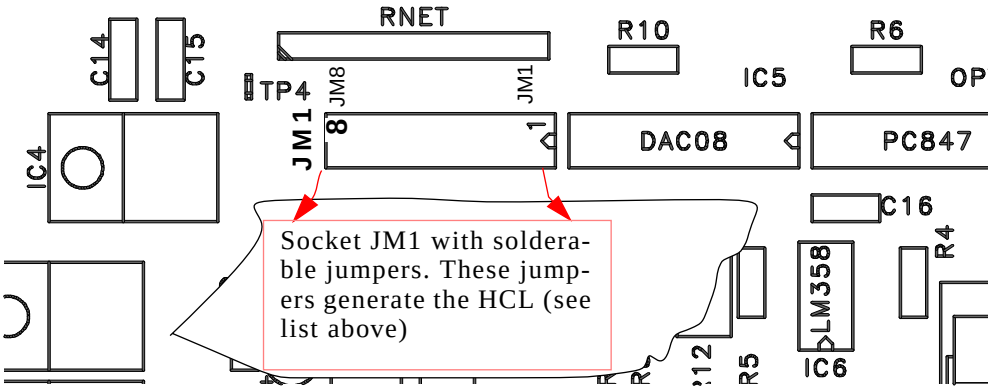
*Table 9: **H**ardware **C**ode **L**evel Detection - HCL C and higher -*

Pos.	Jumper								Hardware Code Level Detection for all Modules - HCL C and higher -
	7	6	5	4	3	2	1	0	
	JM_8	JM_7	JM_6	JM_5	JM_4	JM_3	JM_2	JM_1	
1	0	0	0	0	0	0	0	0	no Preamplifier available
2	X	X	X	X	X	0	1	1	Module HCL C
3	X	X	X	X	X	1	0	0	Module HCL D
4	X	X	X	X	X	1	0	1	Module HCL E
5	X	X	X	X	X	1	1	0	Module HCL F

Pos.	Jumper								Hardware Code Level Detection for all Modules - HCL C and higher -
	7	6	5	4	3	2	1	0	
	JM_8	JM_7	JM_6	JM_5	JM_4	JM_3	JM_2	JM_1	
6	X	X	X	X	X	1	1	1	Module HCL G
7	0	0	0	0	1	X	X	X	3H Module
8	0	0	0	1	0	X	X	X	3H Module HP (High Power)
9	0	0	0	1	1	X	X	X	1H Module
10	0	0	1	0	0	X	X	X	1H Module HP
11	0	0	1	0	1	X	X	X	19F Sel. Module
12	0	0	1	1	0	X	X	X	19F Sel. Module HP
13	0	0	1	1	1	X	X	X	19F/1H/3H Module HP
14	0	1	0	0	0	X	X	X	X-BB_19F_2HS Module
15	0	1	0	0	1	X	X	X	X-BB_19F Module HP
16	0	1	0	1	0	X	X	X	X-BB_31P_2HS Module
17	0	1	0	1	1	X	X	X	X-BB_31P Module HP
18	0	1	1	0	0	X	X	X	2H Module
19	0	1	1	0	1	X	X	X	2H Module HP
20	0	1	1	1	0	X	X	X	Reserve
21	0	1	1	1	1	X	X	X	Reserve
22	1	0	0	0	0	X	X	X	Reserve
23	1	0	0	0	1	X	X	X	Reserve
24	1	0	0	1	0	X	X	X	Reserve
25	1	0	0	1	1	X	X	X	Reserve
26	1	0	1	0	0	X	X	X	Reserve
27	1	0	1	0	1	X	X	X	Reserve
28	1	0	1	1	0	X	X	X	Reserve
29	1	0	1	1	1	X	X	X	Reserve
30	1	1	0	0	0	X	X	X	Reserve
31	1	1	0	0	1	X	X	X	Reserve
32	1	1	0	1	0	X	X	X	Reserve

Pos.	Jumper								Hardware Code Level Detection for all Modules - HCL C and higher -
	7	6	5	4	3	2	1	0	
	JM_ 8	JM_ 7	JM_ 6	JM_ 5	JM_ 4	JM_ 3	JM_ 2	JM_ 1	
33	1	1	0	1	1	X	X	X	Reserve
34	1	1	1	0	0	X	X	X	Reserve
35	1	1	1	0	1	X	X	X	Reserve
36	1	1	1	1	0	X	X	X	Reserve
37	1	1	1	1	1	X	X	X	Reserve

Figure 49: Scheme extract - Power Supply Board - with HCL socket.



Junction Board 12.3

The Junction board is located in the ‘cable channel’ (covered with a plastic shield) of the module. It connects the Preamplifier Controller with the Power Supply- and Preamplifier board. All preamplifier-modules use the same Junction Board with a specific jumper-setting (JM1 - JM20) for each module.

Caution

Tampering with the jumpers will lead to module identification problems!

The following tables show the Junction Board Jumper Settings for the most often used Preamplifier Configurations.

Table 10: Jumper Settings for Standard Preamplifiers Configurations

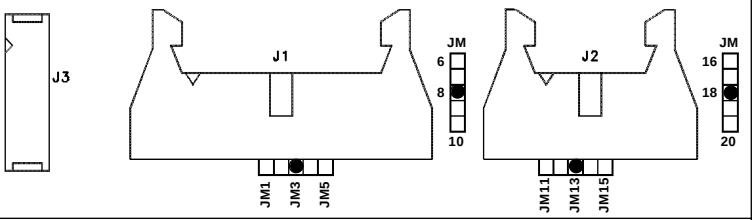
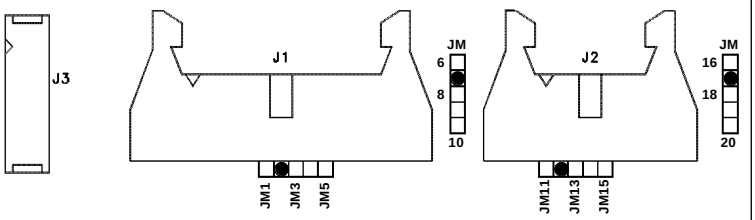
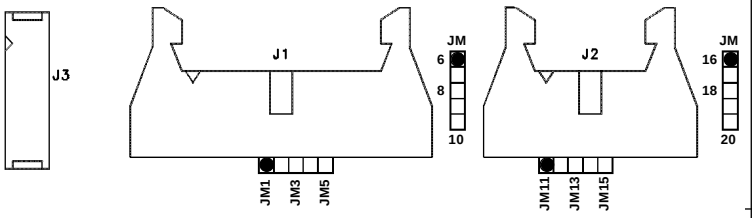
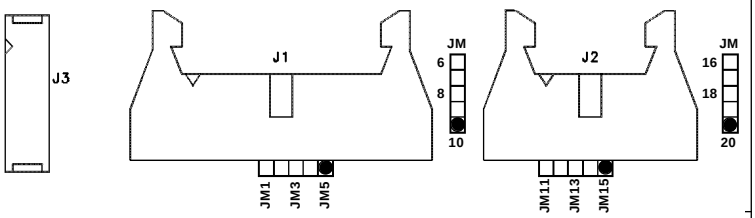
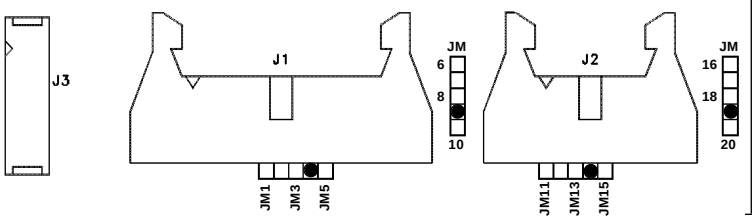
Module	Jumper	Preamp. - Position	Remarks
1H Module	JM_3, JM_8, JM_13, JM_18	1 1H X-BB 2H 19F UB	
X-BB_31P_2HS or X-BB_19F_2HS Module (X-Range up to 31P/19F with 2H-Stop; internal or external)	JM_2, JM_7, JM_12, JM_17	2 1H X-BB 2H 19F UB	
2H Module Lock/ HR	JM_1, JM_6, JM_11, JM_16	3 1H X-BB 2H 19F UB	
USER-Box Position 1: E.g.: - 19F-Sel. Module HR/Lock - 3H-Sel. Module	JM_5, JM_10, JM_15, JM_20	4 1H X-BB 2H 19F UB	
USER-Box Position 2: E.g.: - X-BB_19F_2HP Module - (special content)	JM_4, JM_9, JM_14, JM_19	5 1H X-BB 2H 19F UB	

Table 11: 1H, X-BB_31P_2HS, 2H, X-BB_19F_2HP Module

Modules	Jumper	Remarks
1H Module	JM_3, 8, 13, 18	
X-BB_31P_2HS Module (X-Range up to 31P with 2H-Stop; internal or external)	JM_2, 7, 12, 17	
2H Module Lock/HR	JM_1, 6, 11, 16	
X-BB_19F_2HP Module	JM_4, 9, 14, 19	USER-Box Position 2

Table 12: HR/HP combined Assembly

Module	Jumper	Remarks
1H Module	JM_3, 8, 13, 18	
X-BB19F_2HS Module (X-Range up to 19F with 2H-Stop; internal or external)	JM_2, 7, 12, 17	
2H Module Lock/HR	JM_1, 6, 11, 16	
19F/1H/3H Module HP	JM_5, 10, 15, 20	USER-Box Position 1
X-BB Module HP	JM_4, 9, 14, 19	USER-Box Position 2

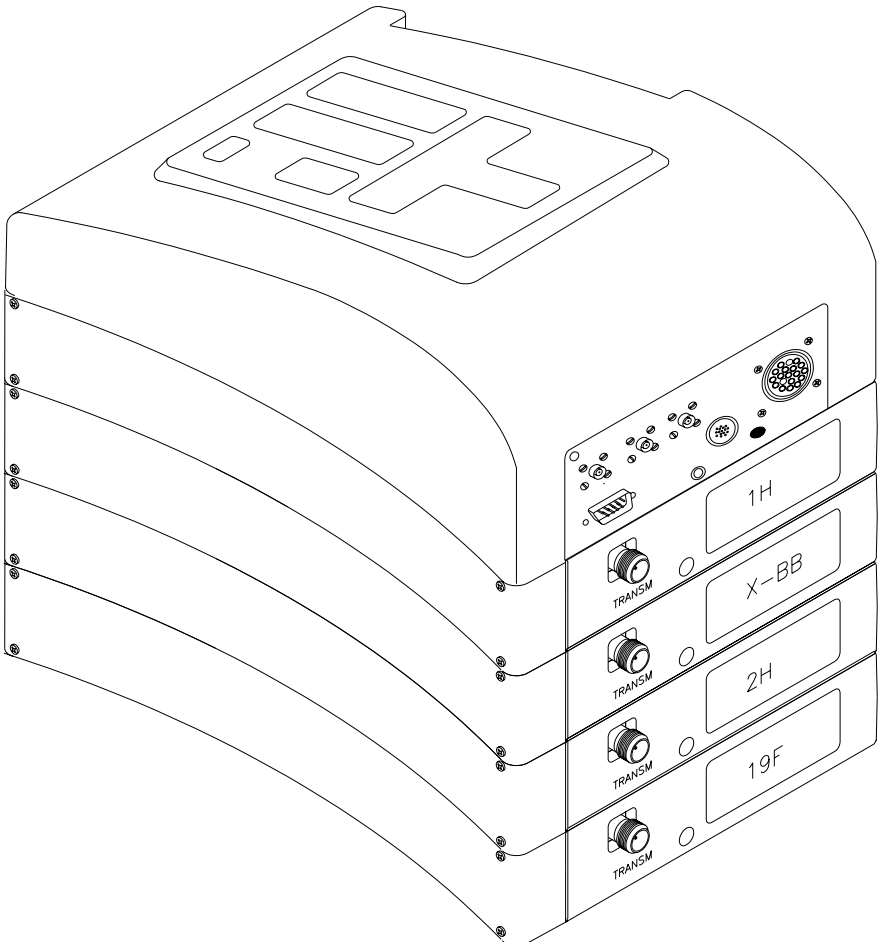

1H
X-BB
2H
19F
TRANSM
TRANSM
TRANSM
TRANSM

Table 13: 1H Preamplifier

Typical Data	- 750 -	- 600 -	- 500 -	- 400 -	- 360 -	- 300 -	- 250 -	- 200 -
Max. Noise Figure @ 1H, 50Ω Source	2.4 dB	2.3 dB	2.35 dB	2.2 dB	2.2 dB	2.2 dB	2.2 dB	2.2 dB
Gain, ± 1.5 dB at 1H	26 dB	26 dB	27 dB	27.5 dB	28.5 dB	29 dB	30 dB	30.5 dB
Output Power, 1 dB Compression	7 dBm	7 dBm	7 dBm	7 dBm	7 dBm	7 dBm	7 dBm	7 dBm
Max. Power (Probe 50 Ω matched)	400 W, 100 us 10 % duty cycle or 60 W CW							
Third Order Intercept	15 dBm	15 dBm	15 dBm	15 dBm	15 dBm	15 dBm	15 dBm	15 dBm
Filter Performance:								
Transmitter Path: 3 dB BW	35MHz	35 MHz	30 MHz	25 MHz	21 MHz	16 MHz	>10 MHz	>10 MHz
Transmitter Path: 19 F Suppression	>80 dB	> 80 dB	> 80 dB	> 80 dB	> 80 dB	> 80 dB	> 80 dB	> 80 dB
Probehead Path: 3 dB BW	16 MHz	13 MHz	14 MHz	13 MHz	>8 MHz	>4 MHz	>10 MHz	>10 MHz
Probehead Path: 60 dB BW	<80 MHz	<70 MHz	<62 MHz	<55 MHz	<44 MHz	<32 MHz	<60 MHz	<60 MHz

Figure 50: 1H -400- : Probehead Path

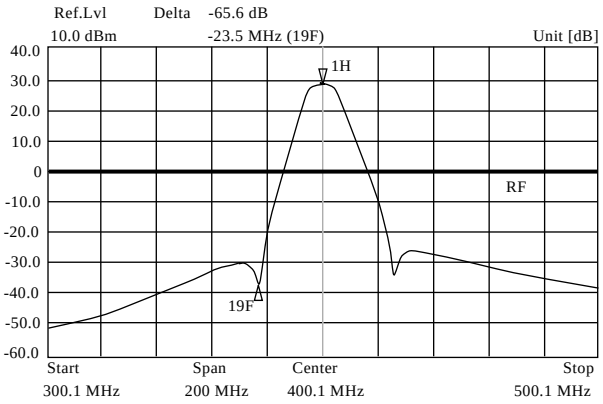


Figure 52: 1H -400- : Transmitter Path

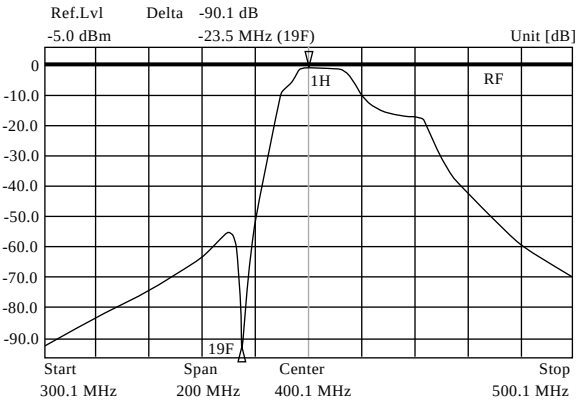


Figure 51: 1H -400- : Gain and NoiseFigure

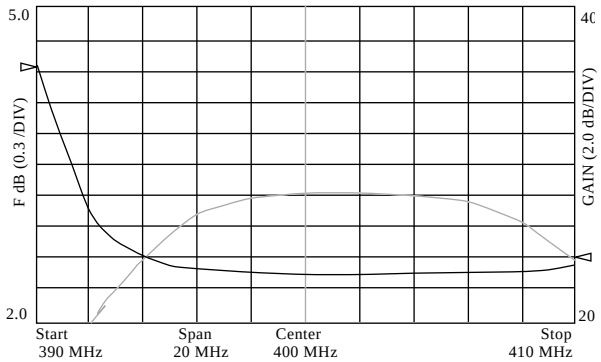


Table 14: 19F/1H/3H Preamplifier

Typical Data	- 600 -	- 500 -	- 400 -	- 360 -	- 300 -	- 200 -
Max. Noise Figure 1H, 50Ω Source	2.3 dB	2.2 dB	2.2 dB	2.2 dB	2.2 dB	2.2 dB
Max. Noise Figure 19F, 50Ω Source	2.2 dB	2.1 dB	2.1 dB	2.1 dB	2.1 dB	2.1 dB
Max. Noise Figure 3H, 50Ω Source	2.3 dB	2.2 dB	2.2 dB	2.2 dB	2.2 dB	2.2 dB
Gain, ± 1.5 dB at 1H	26 dB	27 dB	27.5 dB	28.5 dB	29 dB	30.5 dB
Gain, ± 1.5 dB at 19F	26 dB	26.5 dB	27.5 dB	27.5 dB	29 dB	30.5 dB
Gain, ± 1.5 dB at 3H	24.5 dB	26.5 dB	27.5 dB	27.5 dB	29 dB	30.5 dB
Output Power, 1 dB Compression	7 dBm	7 dBm	7 dBm	7 dBm	7 dBm	7 dBm
Max. Power (Probe 50 Ω matched)	1 kW, 50 ms 10 % duty cycle or 50 W CW					
Third Order Intercept	15 dBm	15 dBm	15 dBm	15 dBm	15 dBm	15 dBm
Filter Performance:						
Transmitter Path: Insertion Loss	< 2 dB	< 2 dB	< 2 dB	< 2 dB	< 2 dB	< 2 dB
Probehead Path: DC to 31P Suppression	> 40 dB	> 40 dB	> 50 dB	> 60 dB	> 60 dB	> 50 dB
Probehead Path: 2nd Harmonic Suppresion	> 40 dB	> 40 dB	> 40 dB	> 40 dB	> 40 dB	> 40 dB
Probehead Path: 1 dB BW Flatness 1H	> 24 MHz	> 20 MHz	> 16 MHz	> 14 MHz	> 12 MHz	> 8 MHz
Probehead Path: 1 dB BW Flatness 19F	> 24 MHz	> 20 MHz	> 16 MHz	> 14 MHz	> 12 MHz	> 8 MHz
Probehead Path: 1 dB BW Flatness 3H	> 24 MHz	> 20 MHz	> 16 MHz	> 14 MHz	> 12 MHz	> 8 MHz

Figure 53: 19F/1H/3H -500- : Probehead Path

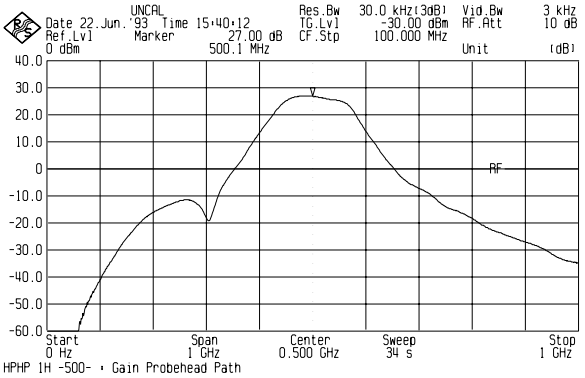


Figure 55: 19F/1H/3H -500- : Transmitter Path

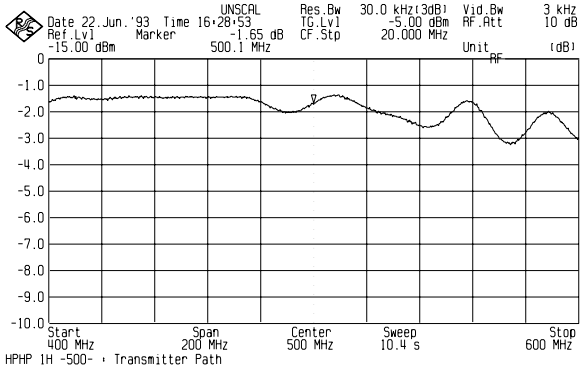


Figure 54: 19F/1H/3H -500- : Gain and Noise Figure

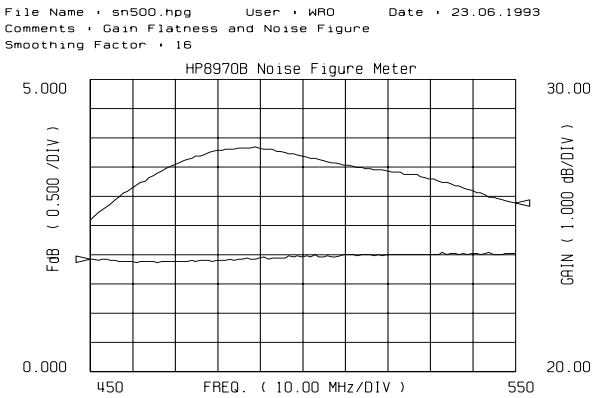


Table 15: X-BB 31P 2HS Preamplifier

Typical Data	- 750 -	- 600 -	- 500 -	- 400 -	- 360 -	- 300 -		
Max. Noise Figure 13C, 50Ω Source	1.8 dB	1.8 dB	1.8 dB	1.8 dB	1.8 dB	1.8 dB		
Gain, ± 1.5 dB	30.5 dB	30.5 dB	30.5 dB	30.5 dB	30.5 dB	30.5 dB		
Output Power, 1 dB Compression	7 dBm	7 dBm	7 dBm	7 dBm	7 dBm	7 dBm		
Max. Power (Probe 50 Ω matched)	400 W, 5 us 5 % duty cycle or 50 W CW							
Third Order Intercept	15 dBm	15 dBm	15 dBm	15 dBm	15 dBm	15 dBm		
Filter Performance:								
Transmitter Path: 1H Suppression	> 80 dB	> 80 dB	> 80 dB	> 80 dB	> 80 dB	> 80 dB		
Transmitter Path: 2H Suppression	> 70 dB	> 70 dB	> 70 dB	> 70 dB	> 70 dB	> 70 dB		
Probehead Path: 1H Suppression	> 80 dB	> 80 dB	> 80 dB	> 80 dB	> 80 dB	> 80 dB		
Probehead Path: 2H Suppression	> 70 dB	> 70 dB	> 70 dB	> 70 dB	> 70 dB	> 70 dB		
Probehead Path: Insertion Loss: 6Li	< 1 dB	< 1 dB	< 1 dB	< 1 dB	< 1 dB	< 1 dB		
Probehead Path: Insertion Loss: 209Bi	< 1 dB	< 1 dB	< 1 dB	< 1 dB	< 1 dB	< 1 dB		

Figure 56: X-BB 31P -400- : Probehead Path

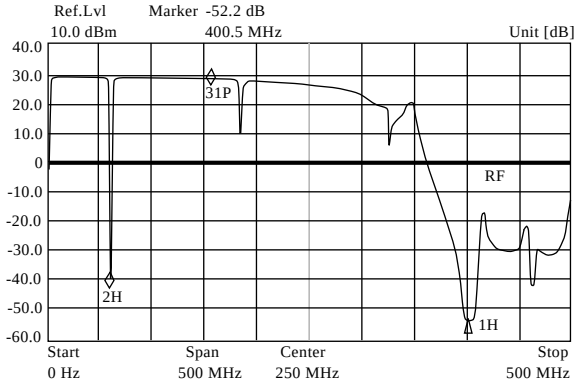


Figure 58: X-BB 31P -400- : Transmitter Path

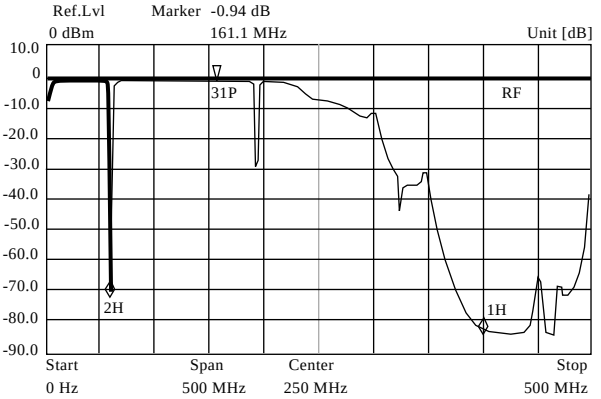


Figure 57: X-BB 31P -400- : 2H Stop Probehead Path

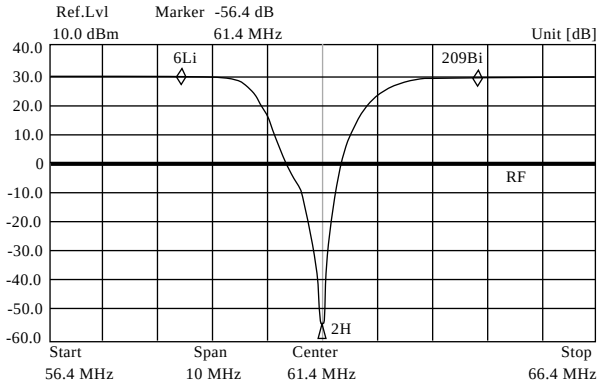


Figure 59: X-BB 31P -400- : Gain and Noise Figure

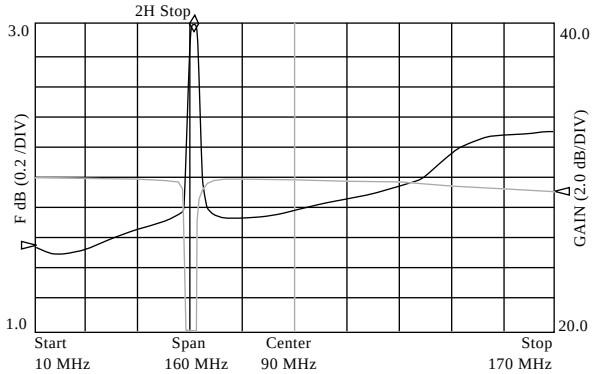


Table 16: 2H Preamplifier

Typical Data	- 750 -	- 600 -	- 500 -	- 400 -	- 360 -	- 300 -	-250-	- 200 -
Max. Noise Figure 2H, 50Ω Source	2.6 dB	2.6 dB	2.6 dB	2.6 dB	2.6 dB	2.6 dB	2.5 dB	2.5 dB
Gain, ± 1.5 dB	45.5 dB	45.5 dB	45.5 dB	45.0 dB	45.0 dB	45.0 dB	46.5 dB	46.5 dB
Output Power, 1 dB Compression	5 dBm	5 dBm	5 dBm	5 dBm	5 dBm	5 dBm	5 dBm	5 dBm
Max. Power (Probe 50 Ω matched)	400 W, 5 us 5 % duty cycle or 50 W CW							1)
Filter Performance:								
TransmitterPath: 3 dB BW	> 5 MHz	> 5 MHz	> 4 MHz	> 3 MHz	>2 MHz	> 2 MHz	> 2 MHz	> 2 MHz
TransmitterPath: 60 dB BW	<60 MHz	<45 MHz	<37 MHz	<30 MHz	<30 MHz	<30 MHz	<18 MHz	<18 MHz
Probehead Path: 3 dB BW	> 5 MHz	> 3 MHz	> 2 MHz	> 2 MHz	> 2 MHz	> 1 MHz	> 1 MHz	> 1 MHz
Probehead Path: 60 dB BW	< 45 MHz	< 35 MHz	< 29 MHz	< 22 MHz	< 20 MHz	< 17 MHz	<14 MHz	<12 MHz

1): 180 W, 5 us 5 % duty cycle or 50 W CW

Figure 60: 2H -400- : Probehead Path

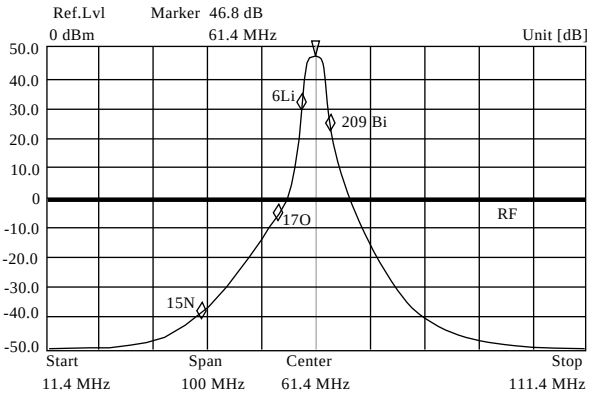


Figure 62: 2H -400- : Transmitter Path

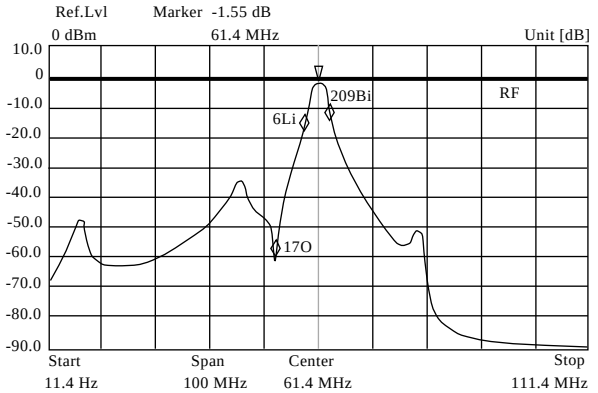


Figure 61: 2H -400- : Gain and Noise Figure

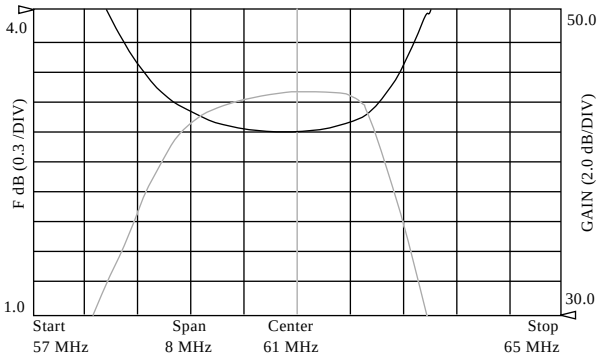


Table 17: 19F Selective Preamplifier

Typical Data		- 600 -	- 500 -	- 400 -	- 360 -	- 300 -	- 250 -	- 200 -
Max. Noise Figure 19F, 50Ω Source		2.3 dB	2.2 dB	2.2 dB	2.2 dB	2.2 dB	2.4 dB	2.6 dB
Gain, ± 1.5 dB		26.0 dB	27.0 dB	28.0 dB	28.5 dB	29.0 dB	30.0 dB	30.5 dB
Output Power, 1 dB Compression		7 dBm	7 dBm	7 dBm	7 dBm	7 dBm	7 dBm	7 dBm
Max. Power (Probe 50 Ω matched)	400 W, 100 us 10 % duty cycle or 60 W CW							
Third Order Intercept		15 dBm	15 dBm	15 dBm	15 dBm	15 dBm	15 dBm	15 dBm
Filter Performance:								
TransmitterPath: 1H Suppression		> 60 dB	> 60 dB	> 60 dB	> 60 dB	> 60 dB	> 60 d	> 60 d
Probehead Path: 1H Suppression		> 80 dB	> 80 dB	> 80 dB	> 80 dB	> 80 dB	> 80 dB	> 80 dB
Probehead Path: 3 dB BW		>11 MHz	>12 MHz	>11 MHz	> 6 MHz	> 3 MHz	>10 MHz	> 8 MHz
Probehead Path: 60 dB BW		< 66 MHz	< 55 MHz	< 38 MHz	< 36 MHz	< 38 MHz	< 43 MHz	< 32 MHz

Figure 63: 19F Selective -400- : Probehead Path

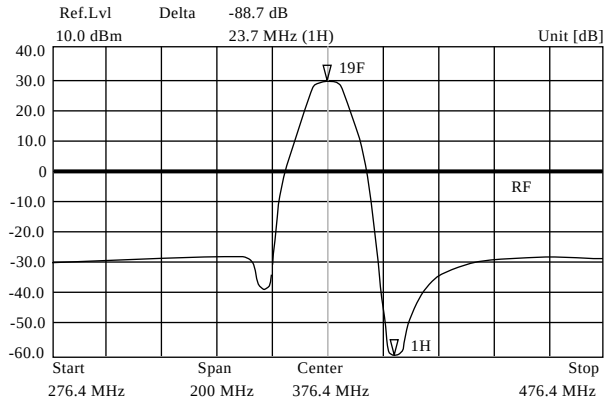


Figure 65: 19F Selective -400- : Transmitter Path

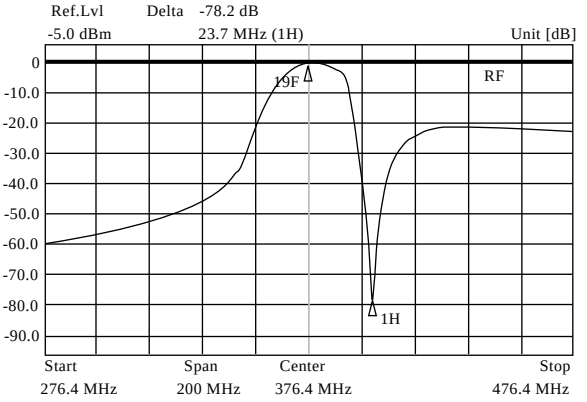


Figure 64: 19F Selective -400- : Gain a. Noise Figure

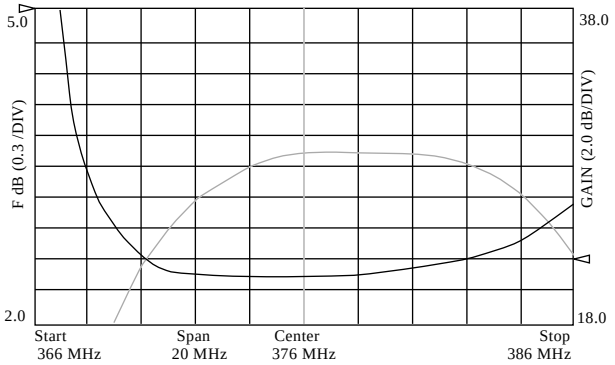


Table 18: X-BB_19F_2HP Preamplifier

Typical Data	- 600 -	- 500 -	- 400 -	- 360 -	- 300 -
Max. Noise Figure @ 13C, 50Ω Source	1.9 dB	1.9 dB	1.9 dB	1.9dB	1.9 dB
Gain, ± 1.5 dB	30.5 dB	30.5 dB	30.5 dB	30.5 dB	30.5 dB
Output Power, 1 dB Compression	7 dBm	7 dBm	7 dBm	7 dBm	7 dBm
Max. Power (Probe 50 Ω matched)	400 W, 5 us 5 % duty cycle or 50 W CW				
Third Order Intercept	15 dBm	15 dBm	15 dBm	15 dBm	15 dBm
Filter Performance:					
Transmitter Path: 1H Suppression	> 60 dB	> 60 dB	> 60 dB	> 60 dB	> 60 dB
Probehead Path: 1H Suppression	> 60 dB	> 60 dB	> 60 dB	> 60 dB	> 60 dB

Figure 66: X-BB 19F 2HP -400-: Probehead Path

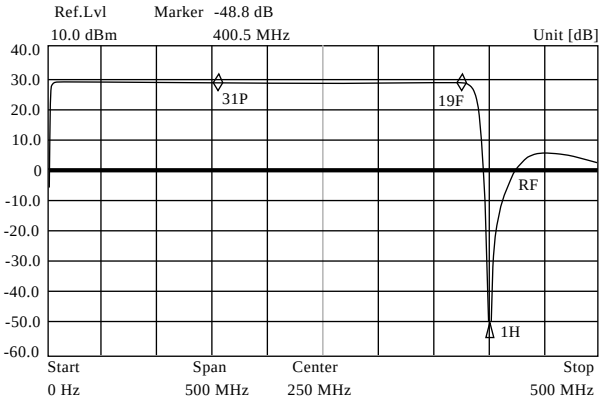


Figure 68: X-BB 19F 2HP -400-: Transmitter Path

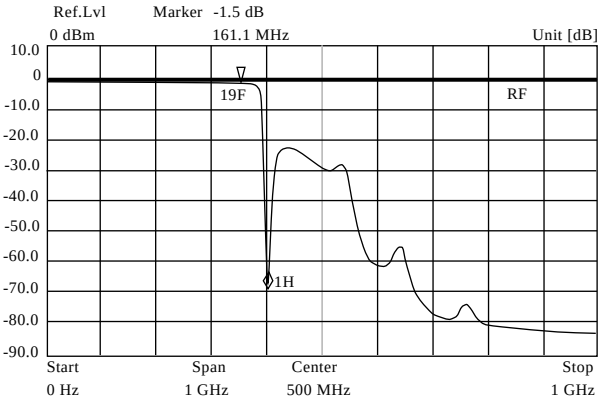


Figure 67: X-BB 19F 2HP -400-: Gain a. Noise Figure

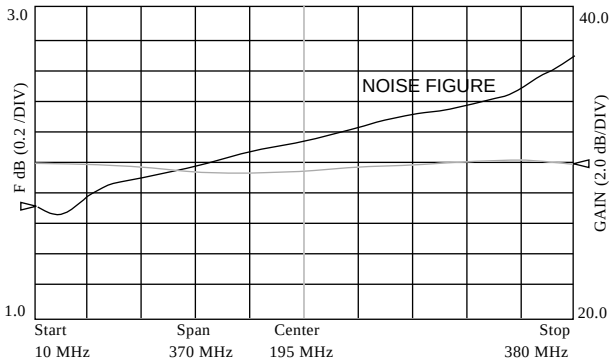


Table 19: 3H Preamplifier

Typical Data		- 600 -	- 500 -	- 400 -				
Max. Noise Figure 3H, 50Ω Source		2.5 dB	2.5 dB	2.5 dB				
Gain, ± 1.5 dB at 3H		26 dB	27 dB	28 dB				
Output Power, 1 dB Compression		7 dBm	7 dBm	7 dBm				
Max. Power (Probe 50 Ω matched)	400 W, 100 us 10 % duty cycle or 60 W CW							
Third Order Intercept		15 dBm	15 dBm	15 dBm				
Filter Performance:								
Transmitter Path: 1H Suppression		> 75 dB	> 75 dB	> 75 dB				
Transmitter Path: 19F Suppression		> 80 dB	> 80 dB	> 80 dB				
Transmitter Path: 3 dB BW		>30 MHz	>35 MHz	>20 MHz				
Probehead Path: 1H Suppression		> 80 dB	> 80 dB	> 80 dB				
Probehead Path: 3 dB BW		>17 MHz	>24 MHz	>17 MHz				
Probehead Path: 60 dB BW		<70 MHz	<80 MHz	<60 MHz				

Figure 69: 3H -500- : Probehead Path

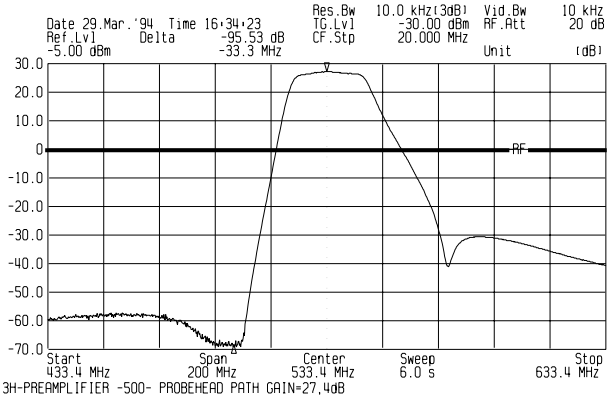


Figure 71: 3H -500- : Transmitter Path

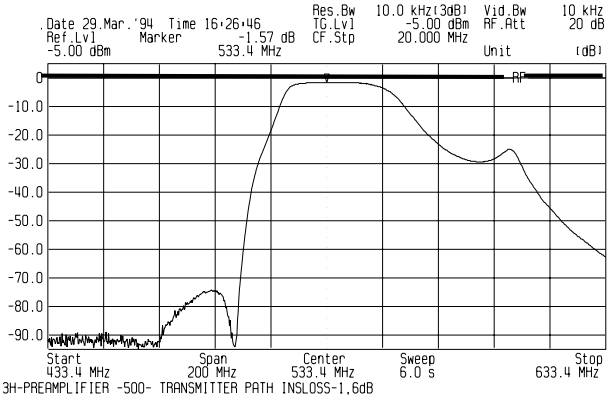
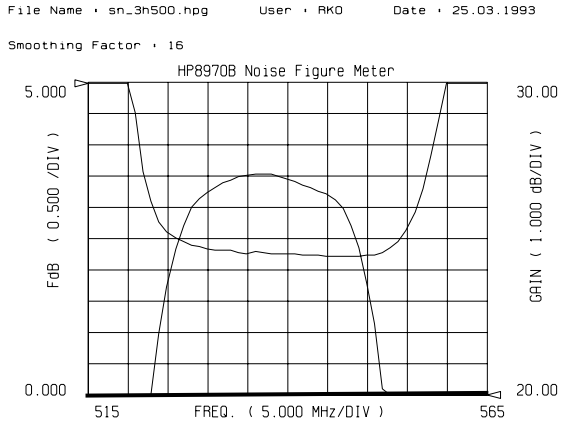


Figure 70: 3H -500- : Gain and Noise Figure



Deadtimes A.8

Table 20: Deadtimes (Beginning of pulse [#] to settled Phase @ 1Degree [$])

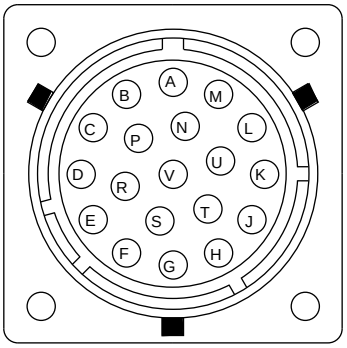
	-750-	-600-	-500-	-400-	-360-	-300-	-250-	-200-
XBB31P 2HS	<5us # <8us $	<5us # <8us $	<5us # <8us $	<5us # <8us $	<12us # <20us $	<12us # <20us $	<12us # <20us $	<12us # <20us $
XBB19F 2HS	<5us # <8us $	<5us # <8us $	<5us # <8us $	<5us # <8us $	<12us # <20us $	<12us # <20us $	<12us # <20us $	<12us # <20us $
XBB19F 2HP	<5us # <8us $	<5us # <8us $	<5us # <8us $	<5us # <8us $	<12us # <20us $	<12us # <20us $	<12us # <20us $	<12us # <20us $
2H	<5us # <8us $	<5us # <8us $	<5us # <8us $	<5us # <8us $	<12us # <20us $	<12us # <20us $	<12us # <20us $	<12us # <20us $

Power Consumption A.9

Table 21: Power Consumption

	+19V [mA]	**-19V [mA]**	**+9V [mA]**	**X9V (or +14V) [mA]**
COVER / DISPLAY MODULE	140	20	350	120
1H-PREAMPLIFIER MODULE	170	50		
X-BB-PREAMPLIFIER MODULE	250	50		
2H-PREAMPLIFIER MODULE	300	50		
1. USER MODULE	250	50		
2. USER MODULE	250	50		
MAX. TOTAL CURRENT	1360	270	350	120
BURNDY-CONNECTOR PIN	A / C	L	N	U

Figure 72: Cover module PS & Interface Connector



A	IN 19V (+19V)
B	DGND
C	IN 19V (+19V)
H	DGND
L	INN 19V (-19V)
M	DGND
N	IN 9V (+9V)
U	IP 14V (+14V floating)
V	IGND (GND floating)

Schematics

B

See List of Figures for page numbers

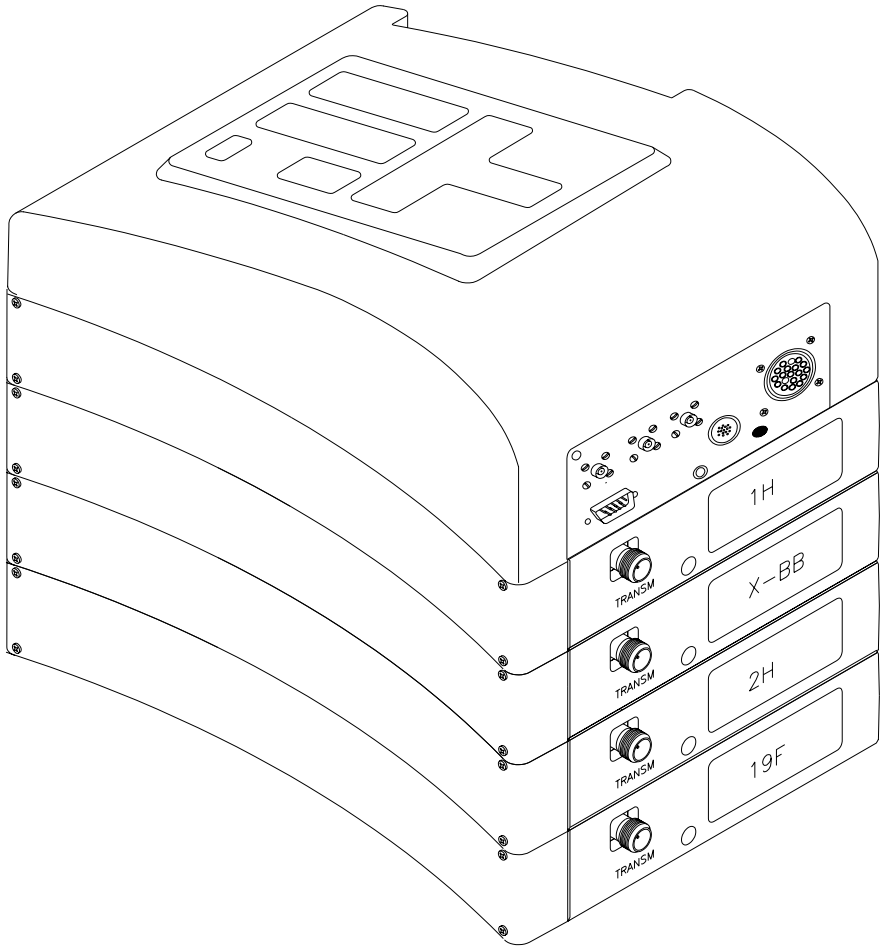


Figure 73: Connector Wiring - Block Diagram -

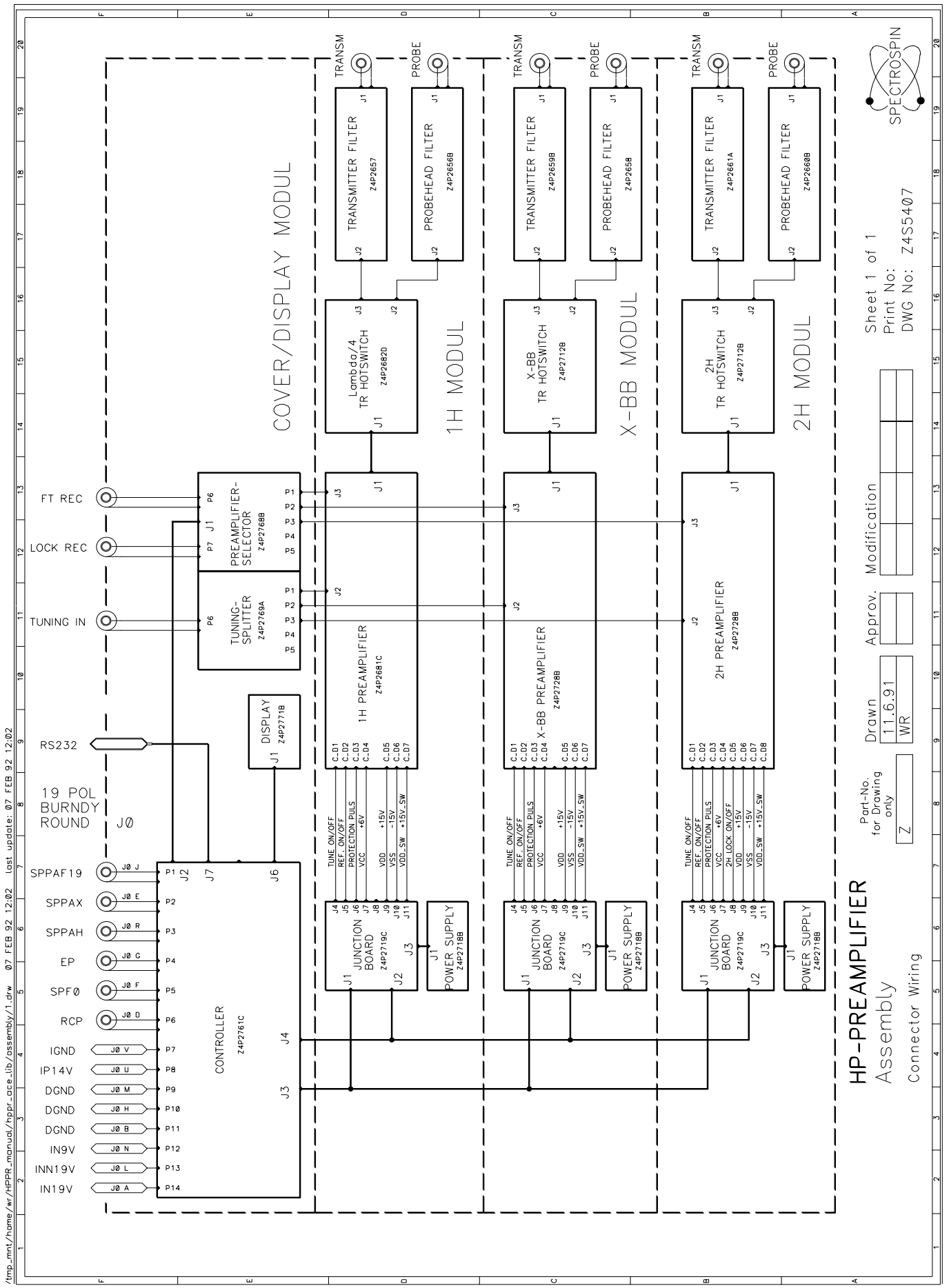
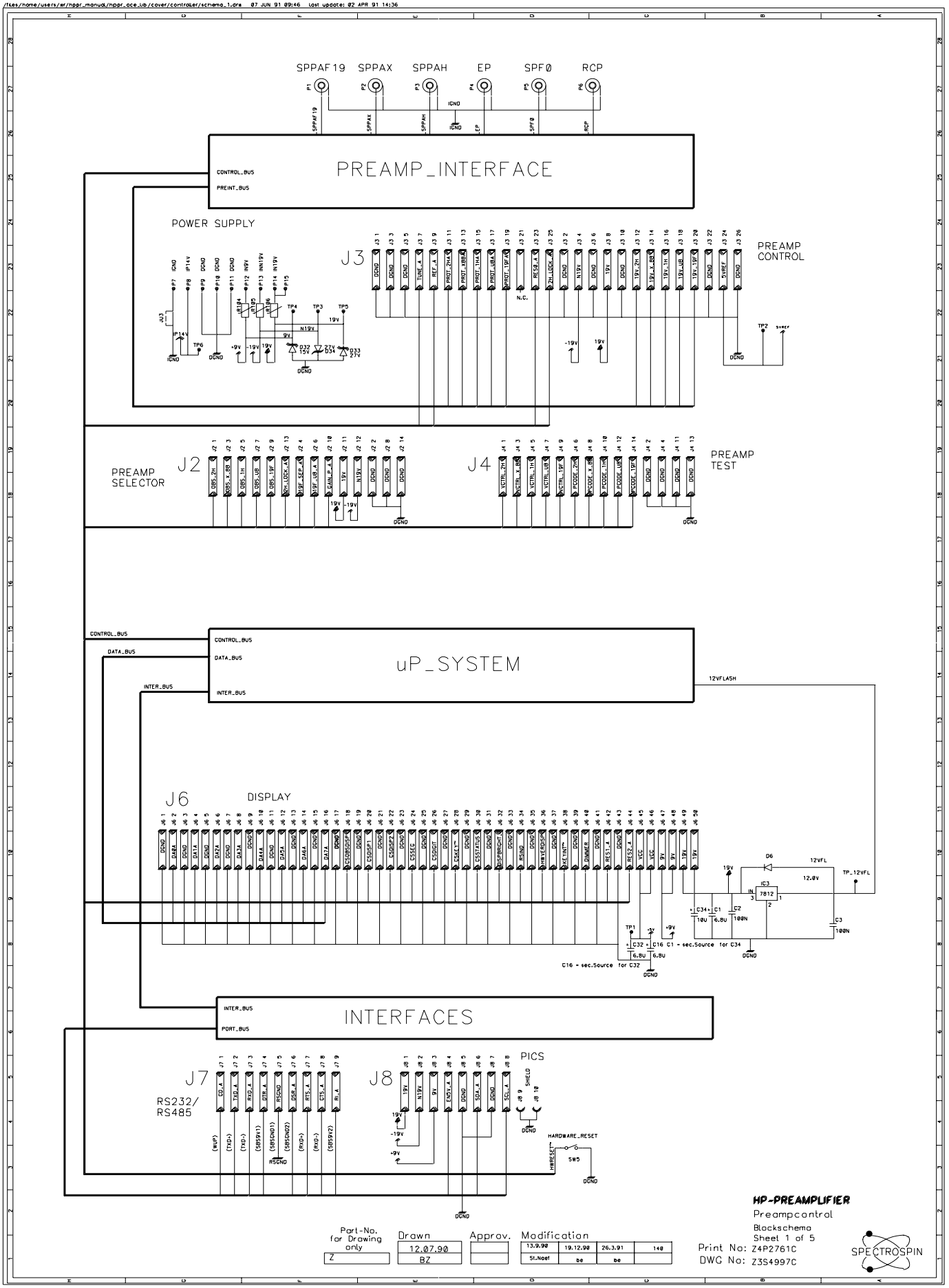
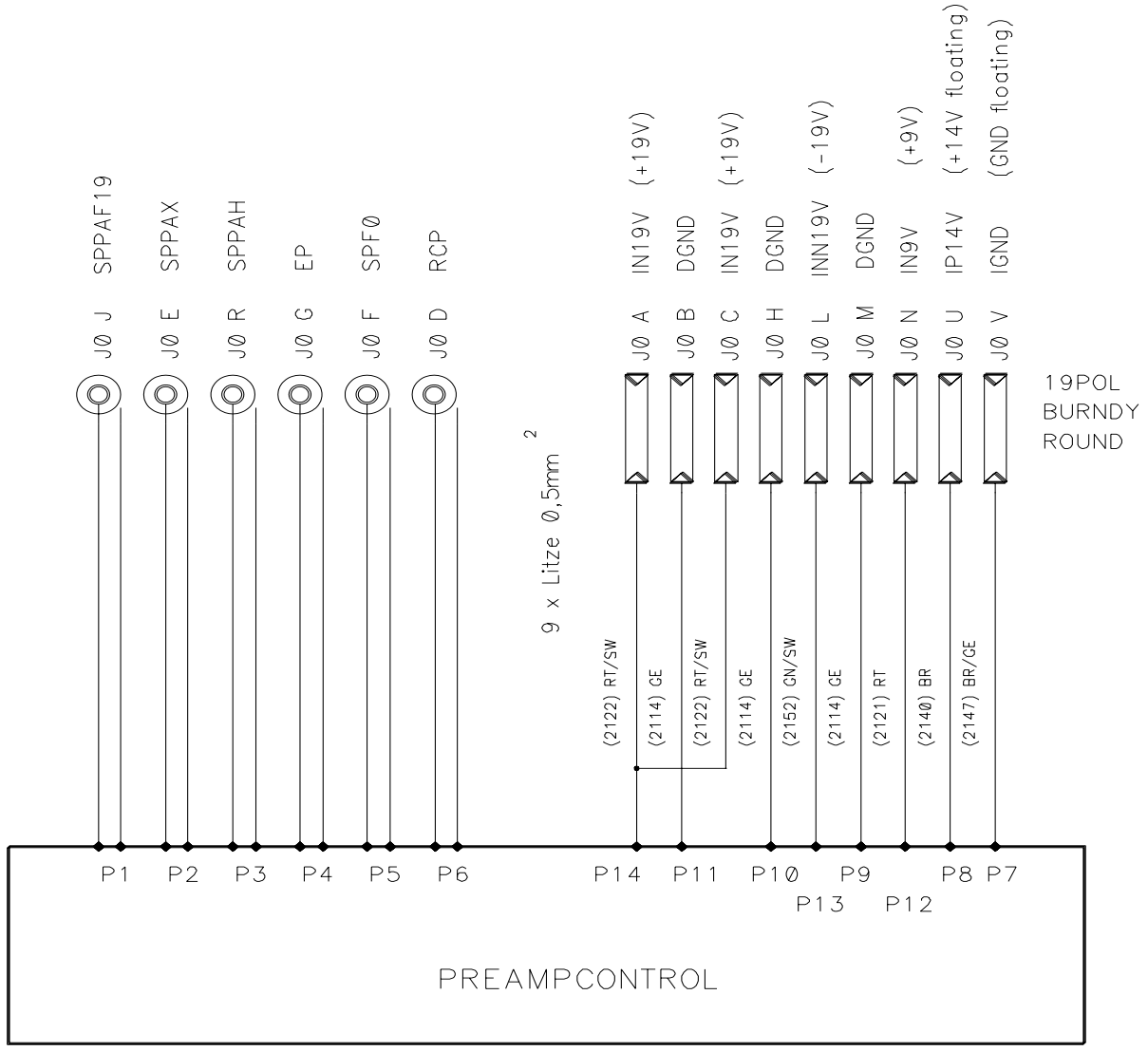


Figure 74: Block Diagram - Scheme 1 of 5 -





HP-PREAMPLIFIER

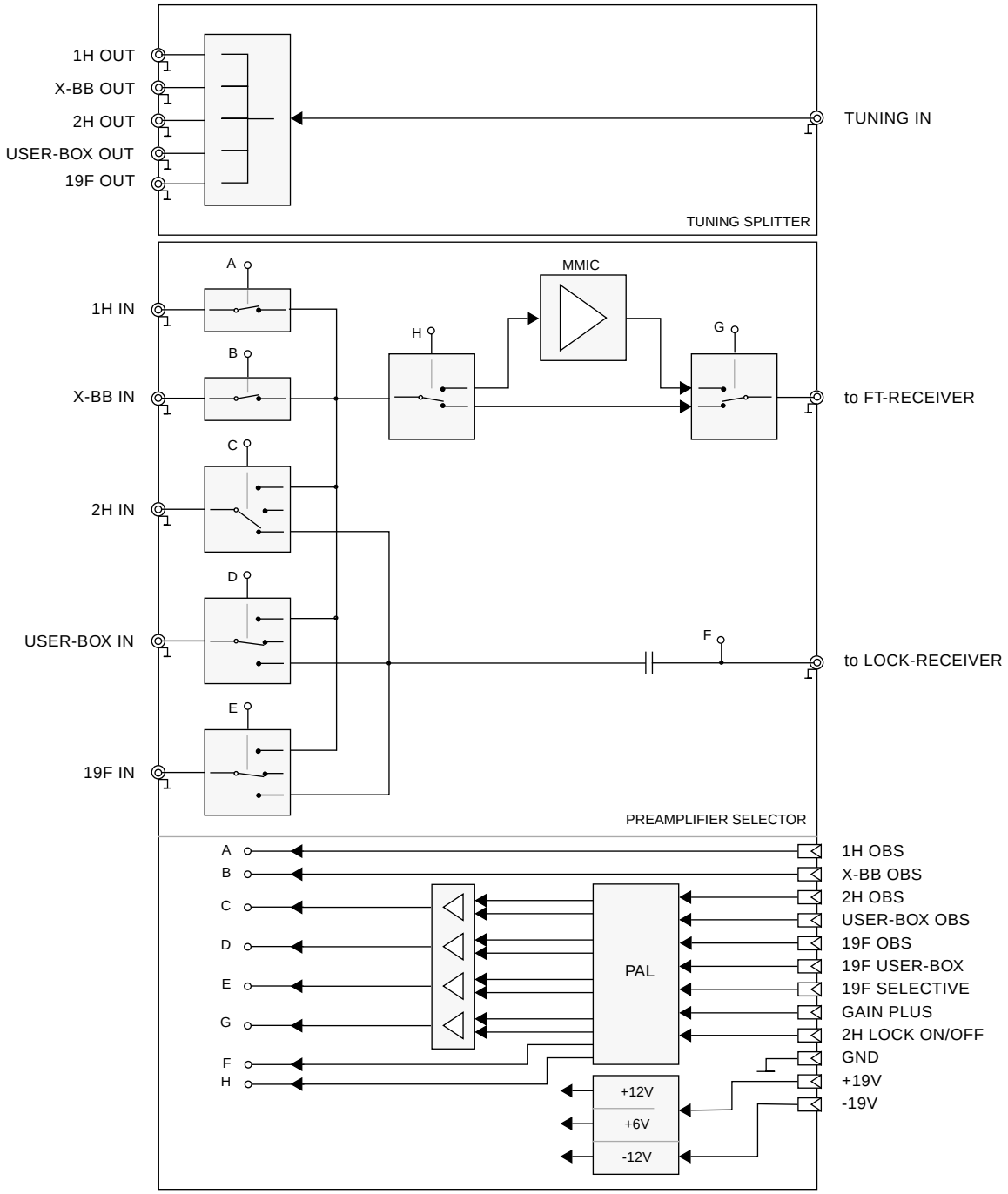
Preampcontrol

Supply Interconnection
Sheet 5 of 5
Print No: Z4P2761C
DWG No: Z4S5224

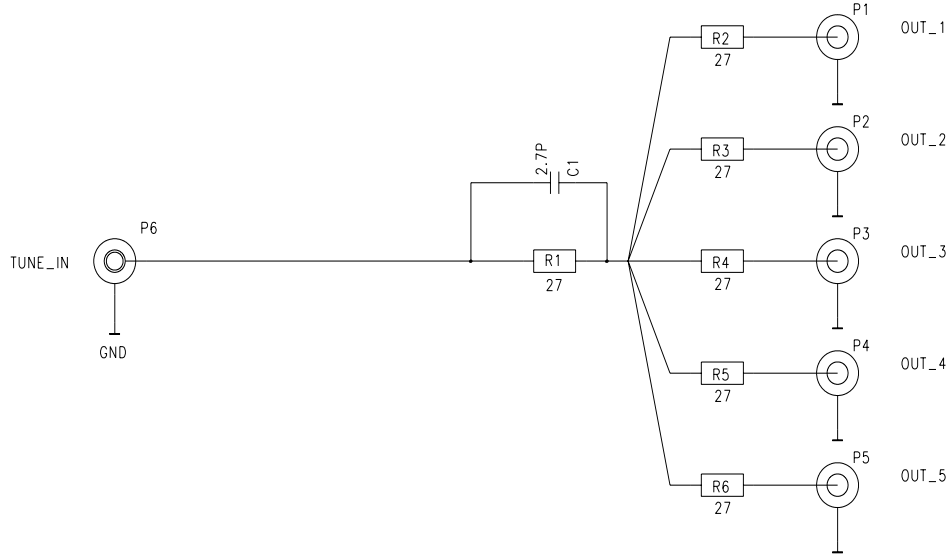
SPECTROSPIN

Part-No. for Drawing only	Drawn	Approv.	Modification			
Z	20.08.90 RO		19.12.90 be	6.1.91 WR		

Figure 76: Preamplifier Selector / Tuning Splitter - Block Diagram -



/files/home/users/wr/hppr_manual/hppr_ace_lib/cover/selector_splitter/splitter/1.drw 14 MAR 91 11:44 last update: 14 MAR 91 11:43

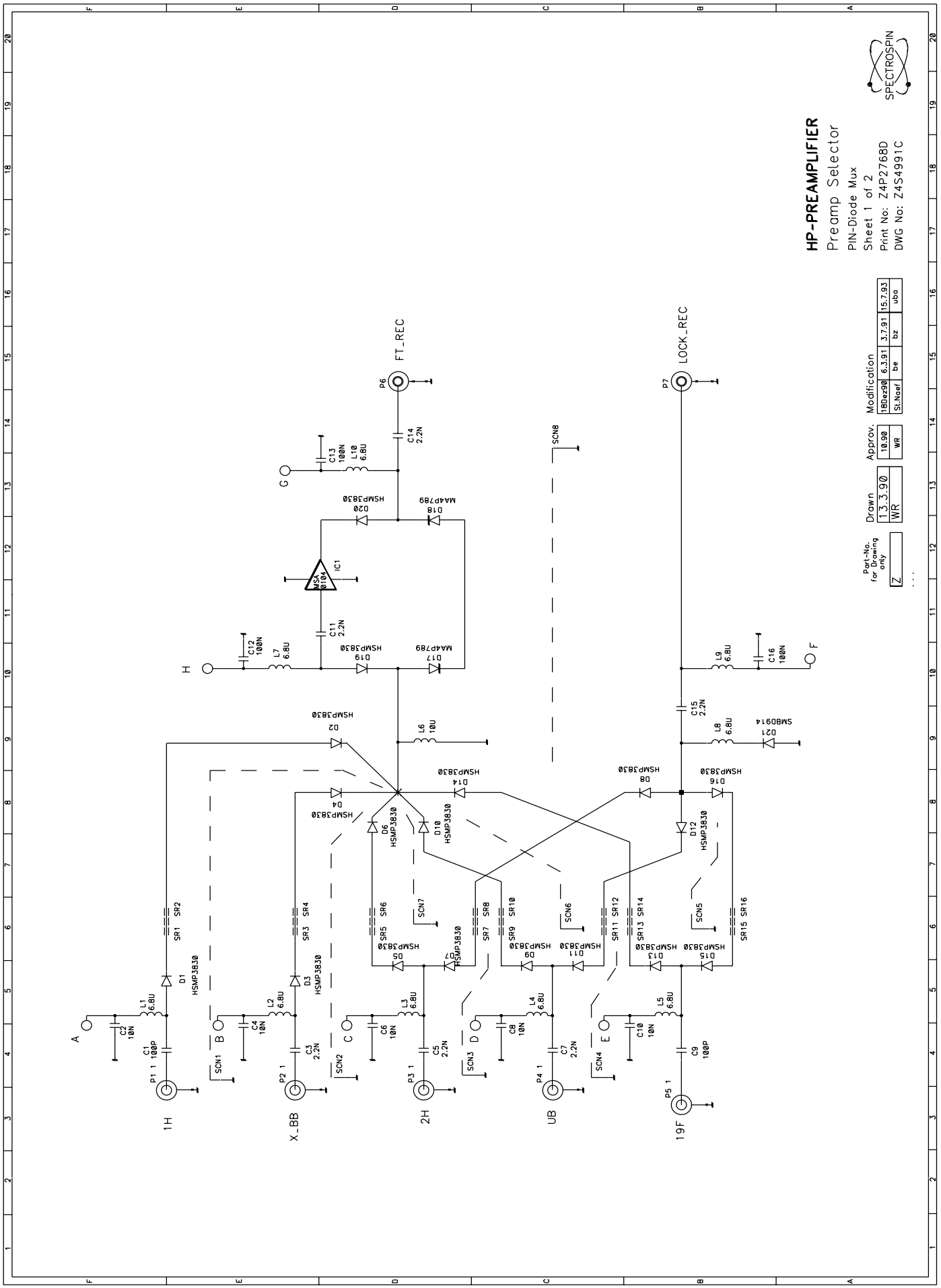


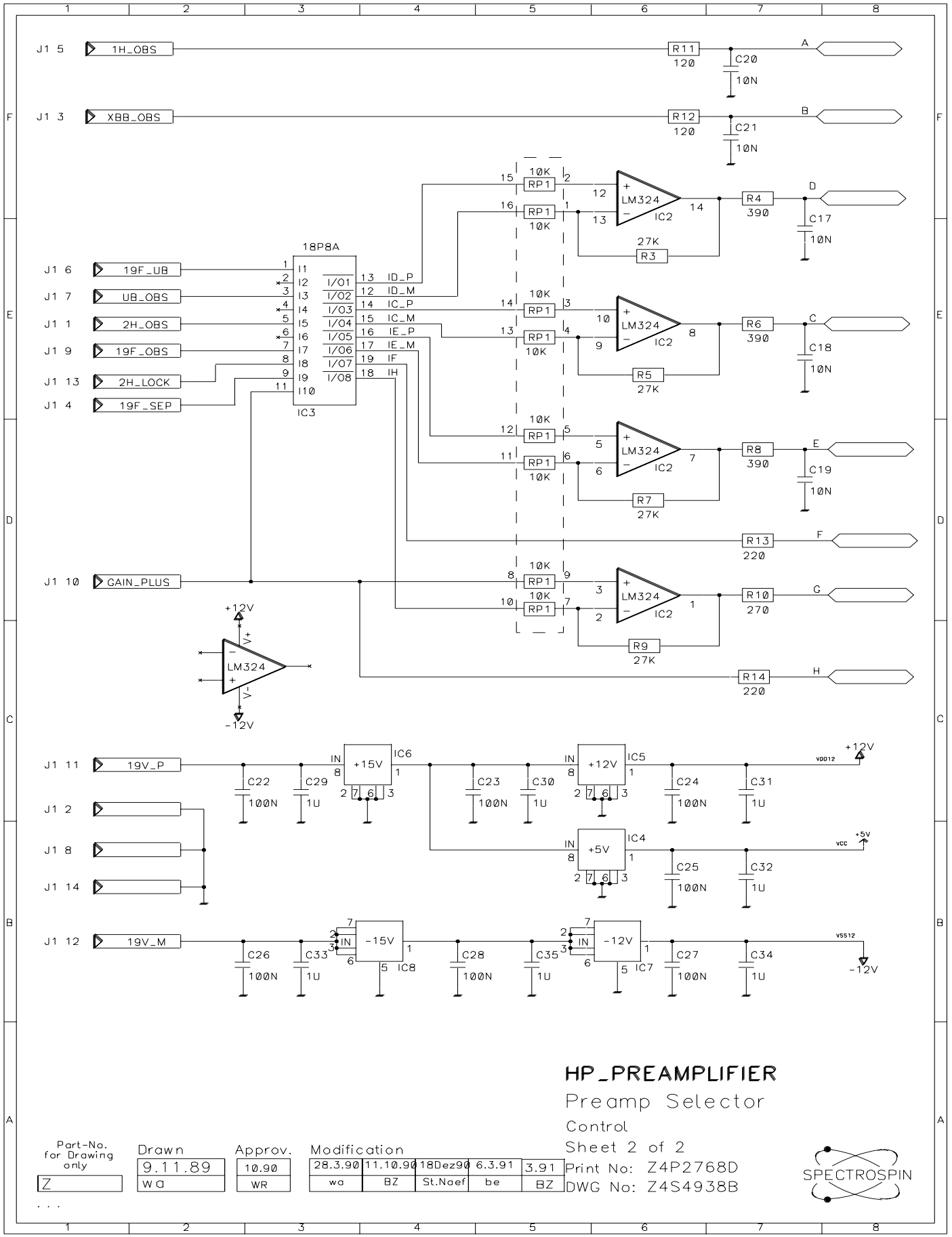
HP-PREAMPLIFIER
Tuning Splitter Board

Splitter
Sheet 1 of 1
Print No: Z4P2769A
DWG No: Z4S4994A

Part-No. for Drawing only	Drawn	Approv.	Modification
Z	13.3.90 WR		4.3.91 be

SPECTROSPIN


HP-PREAMPLIFIER
Preamp Selector
PIN-Diode Mux
Sheet 1 of 2
Print No: Z4P2768D
DWG No: Z4S4991C
SPECTROSPIN
Modification
Approv.
Drawn
Part-No. for Drawing only
FT_REC
LOCK_REC
1H
X_BB
2H
UB
19F
A
B
C
D
E
F
G
H
IC1
HSMP3830
HSMP3830
MA4P789
MSA-0104
HSMP3830
SMB0914
HSMP3830



HP_PREAMPLIFIER

Preamp Selector

Control

Sheet 2 of 2

Print No: Z4P2768D

DWG No: Z4S4938B

Part-No. for Drawing only	Drawn	Approv.	Modification				
	9.11.89	10.90	28.3.90	11.10.90	18Dez90	6.3.91	3.91
Z	WA	WR	wa	BZ	St.Naef	be	BZ

SPECTROSPIN

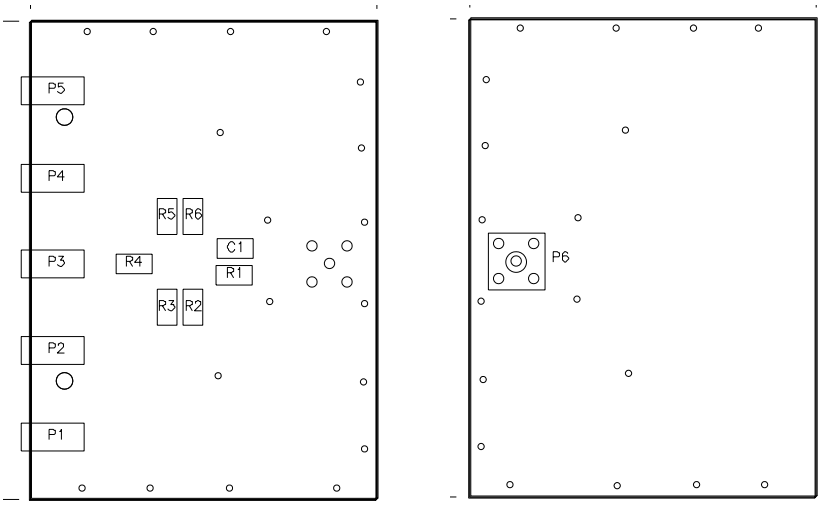


Figure 81: Selector Component plan :HF-side - Wired Components -

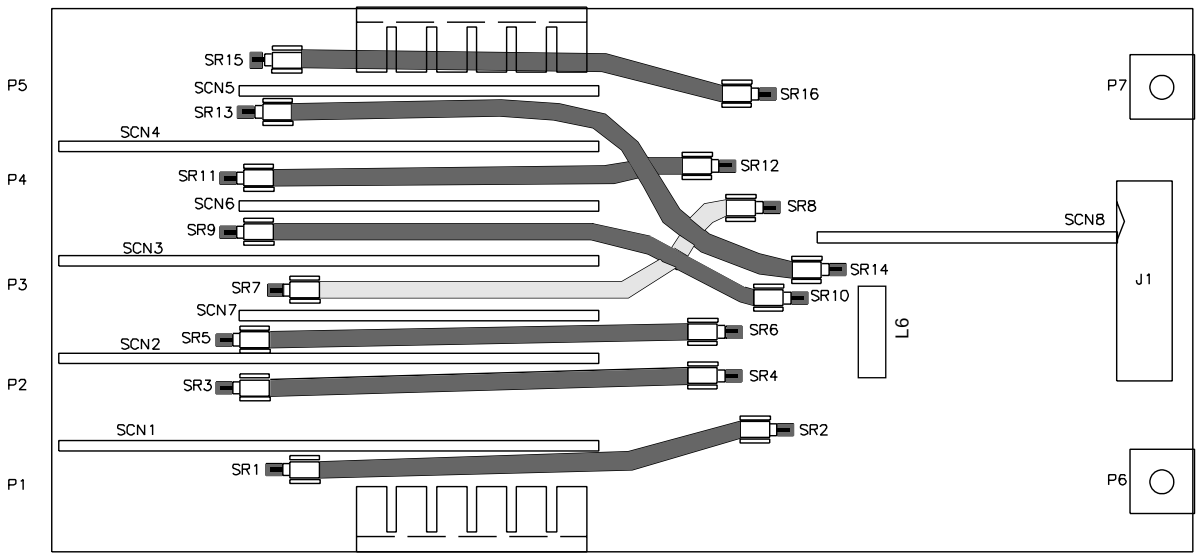
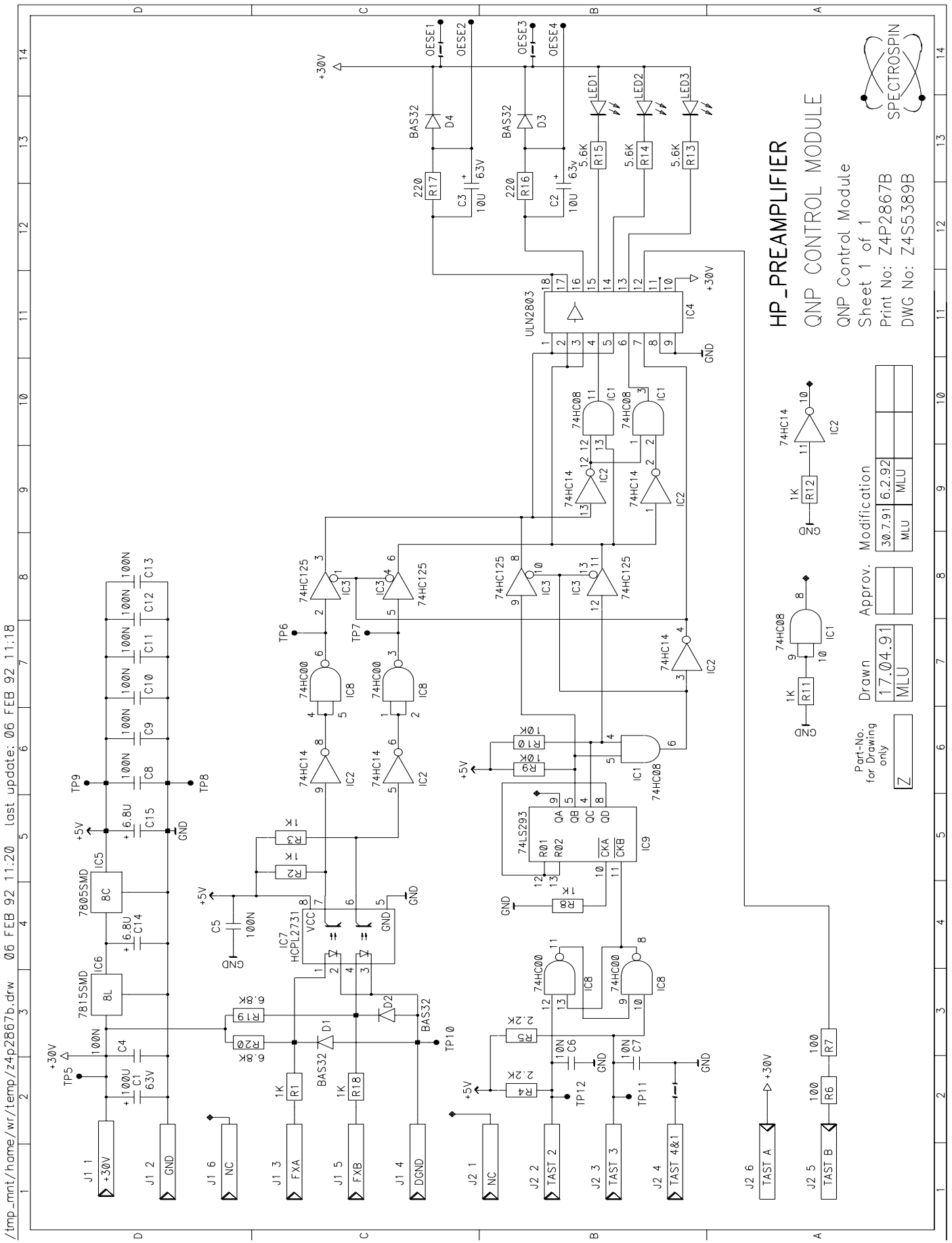
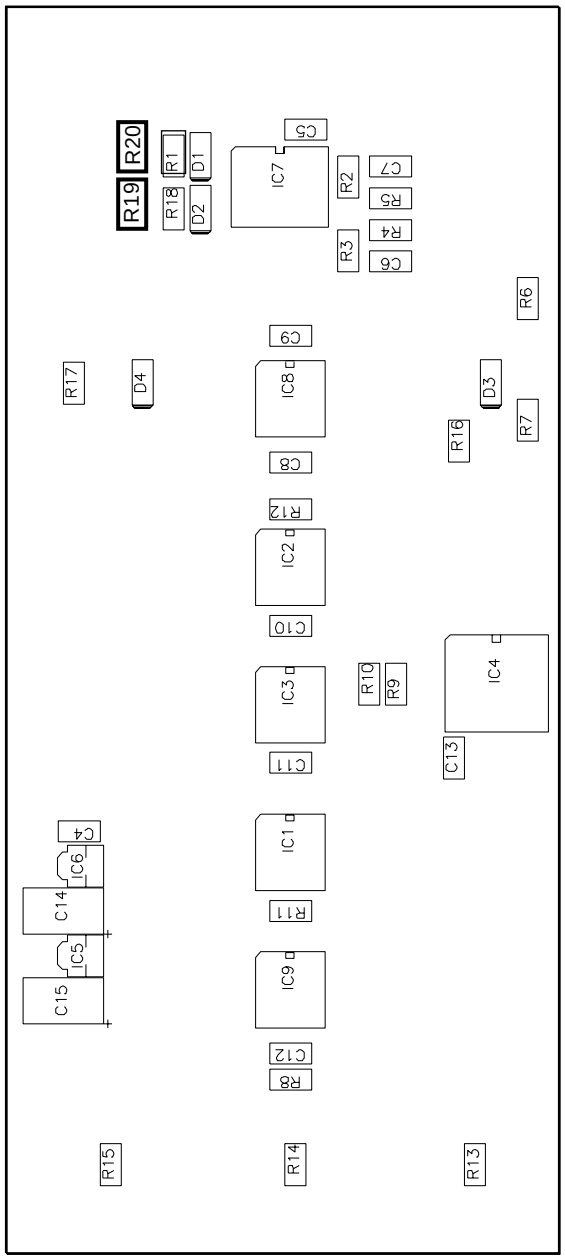


Figure 82: QNP Control Module




R19
R20
R18
R1
D1
D2
IC7
C5
R2
C7
R5
R4
R3
C6
R6
C9
IC8
R17
D4
D3
R16
R7
C8
R12
IC2
C10
IC3
R10
R9
IC4
C11
C13
IC1
C4
IC6
R11
C14
IC5
C15
IC9
C12
R8
R15
R14
R13

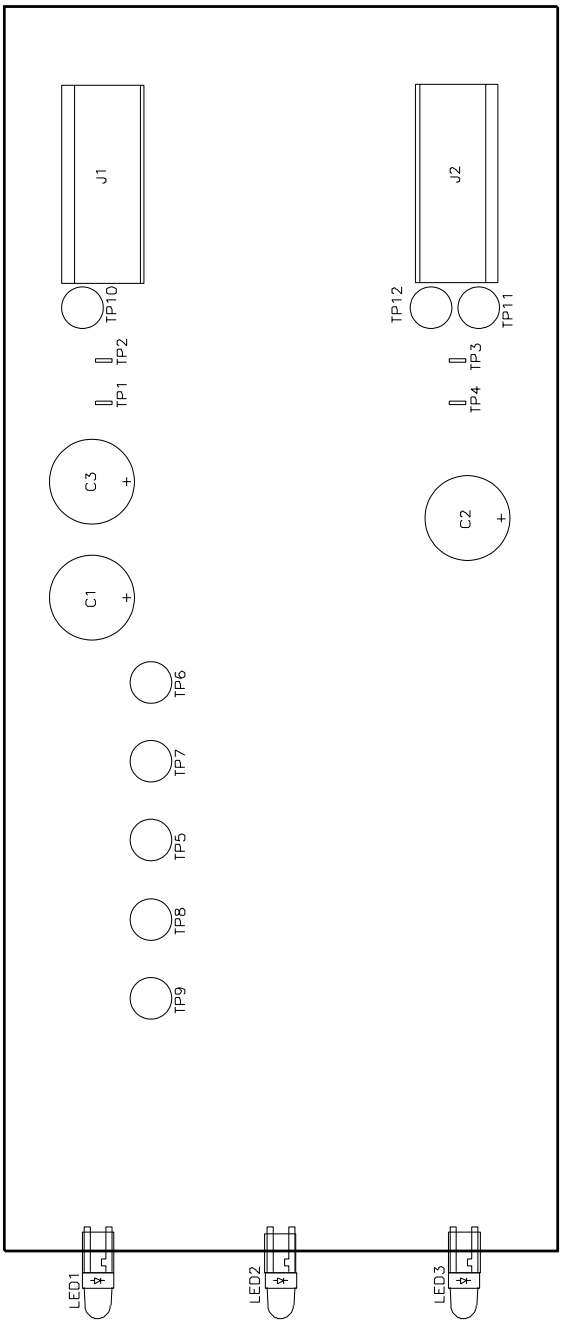
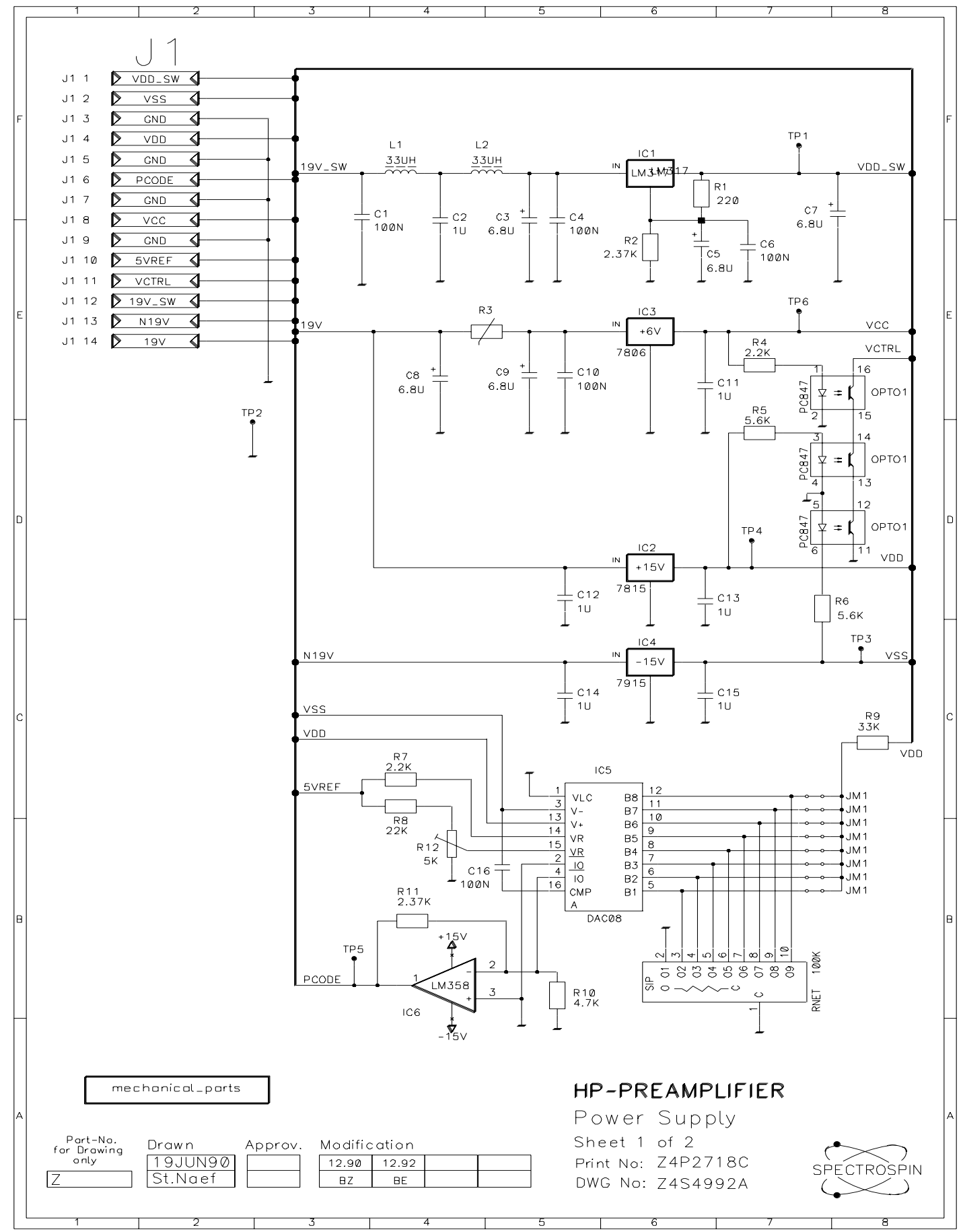
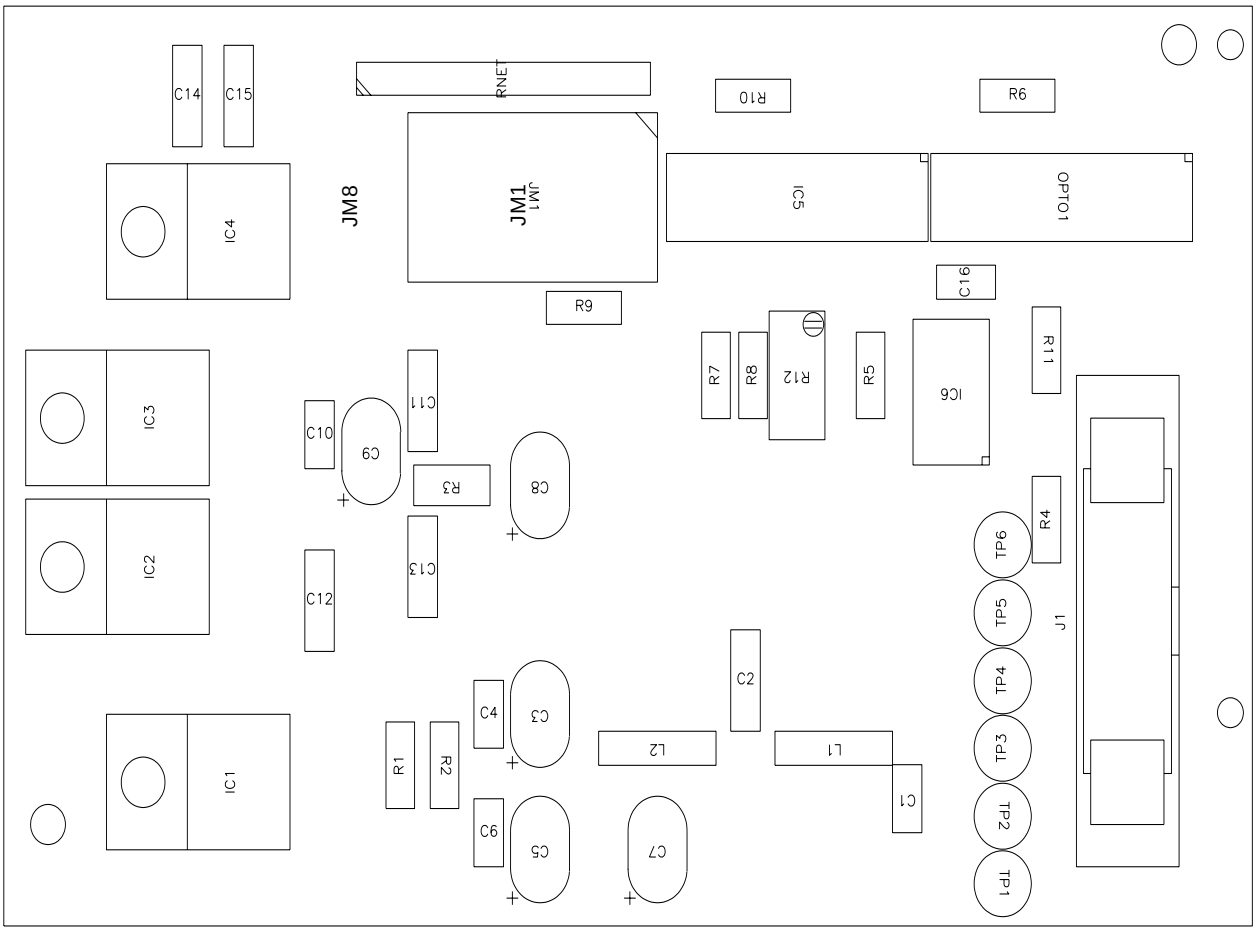
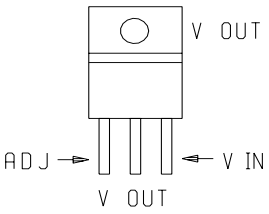

J1
J2
TP10
TP12
TP11
TP2
TP1
TP3
TP4
C3
C2
C1
TP6
TP7
TP5
TP8
TP9
LED1
LED2
LED3

Figure 84: Power Supply

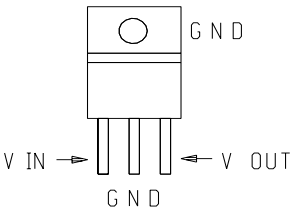



C14
C15
RNET
R10
R6
IC4
JM8
JM1
JM1
IC5
OPTO1
C16
R9
R7
R8
R12
R5
IC6
R11
IC3
C10
C9
C11
R3
C8
R4
IC2
C12
C13
TP6
TP5
TP4
TP3
TP2
TP1
J1
C2
C4
C3
L2
L1
R1
R2
C1
C6
C5
C7
IC1

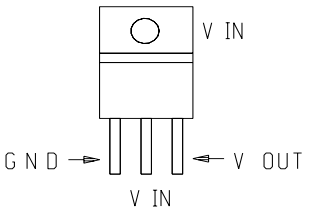
VOLTAGE REGULATORS



LM317T

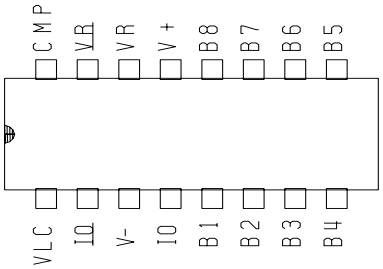


LM78XX

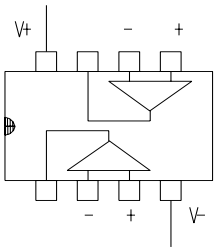


LM79XX

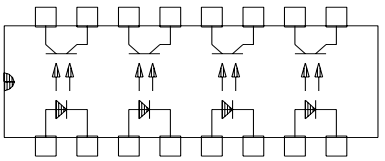
DIGITAL + LINEAR



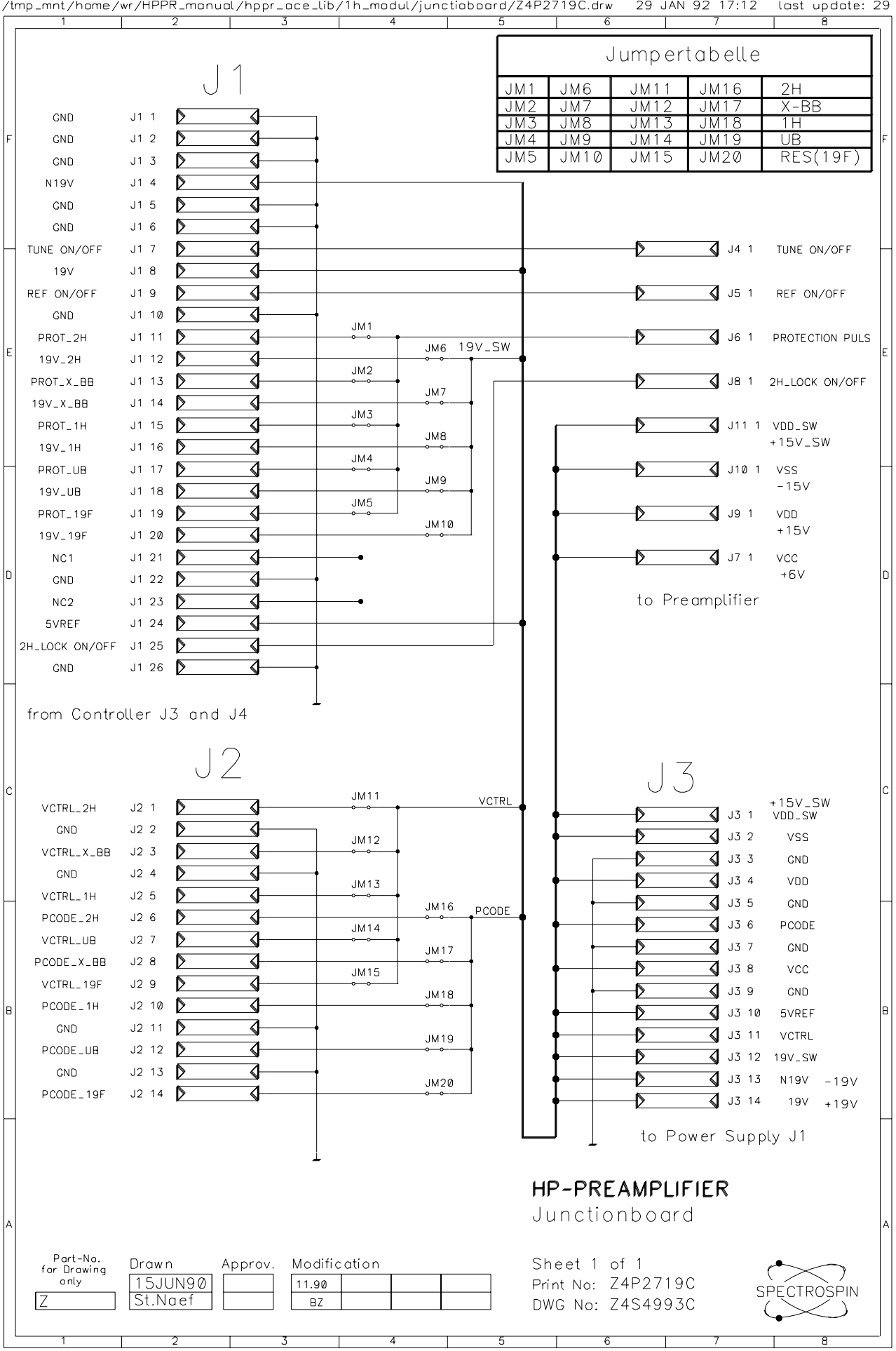
DAC-08
8-BIT D/A CONVERTER



LM 358
Dual / 1 Supply OP



PC847
OPTO COUPLER


Jumpertabelle
JM1 JM6 JM11 JM16 2H
JM2 JM7 JM12 JM17 X-BB
JM3 JM8 JM13 JM18 1H
JM4 JM9 JM14 JM19 UB
JM5 JM10 JM15 JM20 RES(19F)
J1
GND J1 1
GND J1 2
GND J1 3
N19V J1 4
GND J1 5
GND J1 6
TUNE ON/OFF J1 7
19V J1 8
REF ON/OFF J1 9
GND J1 10
PROT_2H J1 11
19V_2H J1 12
PROT_X_BB J1 13
19V_X_BB J1 14
PROT_1H J1 15
19V_1H J1 16
PROT_UB J1 17
19V_UB J1 18
PROT_19F J1 19
19V_19F J1 20
NC1 J1 21
GND J1 22
NC2 J1 23
5VREF J1 24
2H_LOCK ON/OFF J1 25
GND J1 26
JM1
JM6 19V_SW
JM2
JM7
JM3
JM8
JM4
JM9
JM5
JM10
from Controller J3 and J4
J4 1 TUNE ON/OFF
J5 1 REF ON/OFF
J6 1 PROTECTION PULS
J8 1 2H_LOCK ON/OFF
J11 1 VDD_SW +15V_SW
J10 1 VSS -15V
J9 1 VDD +15V
J7 1 VCC +6V
to Preamplifier
J2
VCTRL_2H J2 1
GND J2 2
VCTRL_X_BB J2 3
GND J2 4
VCTRL_1H J2 5
PCODE_2H J2 6
VCTRL_UB J2 7
PCODE_X_BB J2 8
VCTRL_19F J2 9
PCODE_1H J2 10
GND J2 11
PCODE_UB J2 12
GND J2 13
PCODE_19F J2 14
JM11
VCTRL
JM12
JM13
JM16
PCODE
JM14
JM17
JM15
JM18
JM19
JM20
J3
J3 1 +15V_SW VDD_SW
J3 2 VSS
J3 3 GND
J3 4 VDD
J3 5 GND
J3 6 PCODE
J3 7 GND
J3 8 VCC
J3 9 GND
J3 10 5VREF
J3 11 VCTRL
J3 12 19V_SW
J3 13 N19V -19V
J3 14 19V +19V
to Power Supply J1
HP-PREAMPLIFIER
Junctionboard
Part-No. for Drawing only
Z
Drawn
15JUN90
St.Naef
Approv.
Modification
11.90
BZ
Sheet 1 of 1
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DWG No: Z4S4993C
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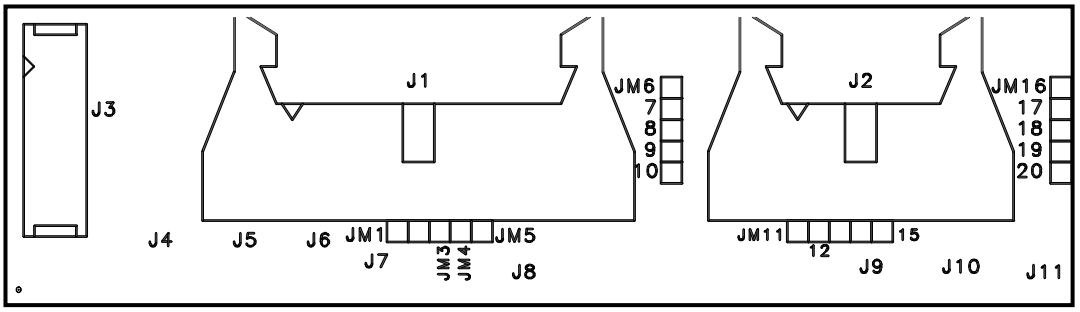

TUNE ON/OFF

REF ON/OFF

PROTECTION PULS

VCC +6V

2H_LOCK ON/OFF

VDD_SW +15V_SW

VSS -15V

VDD +15V

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