



AQS Technical Manual

Version 003

Bruker BioSpin

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Acquisition System (AQS)

1

Introduction

1.1

The AQS (Acquisition System) is the logical and succeeding design of BRUKERs AVANCE concept. The modular construction of the AQR and AQX units have been unified, higher integrated and more standardized. The flexibility of the AQS design allows that each AQS chassis can be configured to optimally support all different NMR needs and applications. Further digital implementation of important system parts leads to even higher stability, reliability and much more compact hardware.

This manual is intended for service purposes, although it mostly gives only an overview. But common NMR hardware experience allows to identify the exact details. Refer to AVANCE documentation for alternate information.

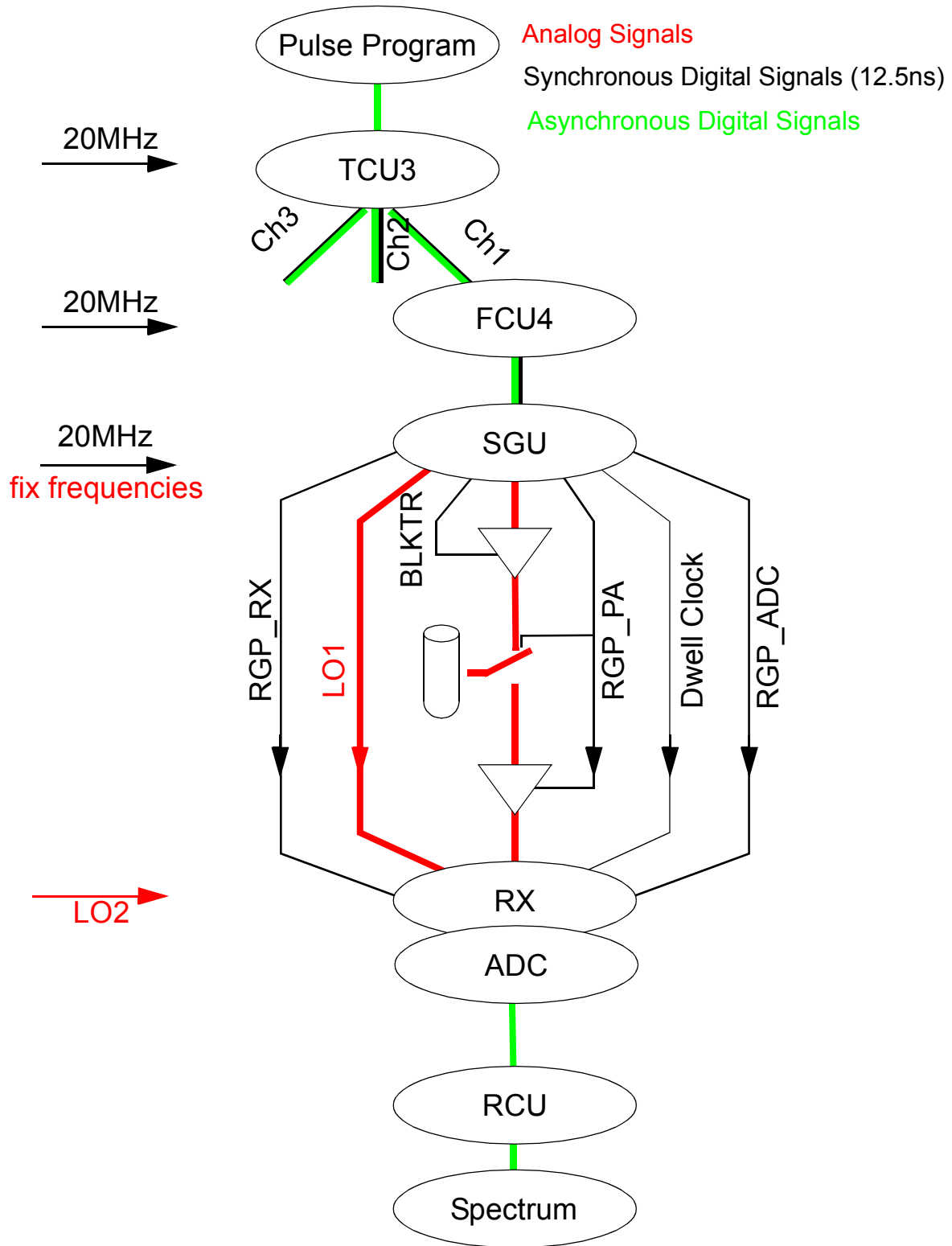
The channel concept

1.2

The AQS channel concept is the consequent integration and modularisation of the so called AQX/AQR units like the AQX FCU, the PTS or Schomandl synthesizers, the AQR LOT, the AQR ASU's and the AQR ROUTER. It was possible to reduce the control and routing of important, channel related real time events and analog and RF signals to only a few dedicated units. All these channel oriented signals (RF signals, shaping, gating and blanking pulses, dwell clocks etc.) are generated in the so called SGU (**S**ignal **G**eneration **U**nit). The SGU is controlled from the FCU4 via a digital high speed link, which represents the logical successor of the AQX FCU.

The following diagram shows the consequent implementation of this concept. The number of analog interconnections is reduced to a few dedicated units. All important RF signals, blanking pulses and dwell clock are channel related and follow a straightforward channel philosophy. In this way, extended and independent multi channel operation can be performed in a much more transparent way. Less Interfaces and units allow a general guaranteed stability and reliability.

The channel concept



AQS signal path

1.3

General AQS Chassis

1.3.1

The AQS system incorporates three different signal categories:

Analog signals: These signals are typically RF or audio signals, which may be checked with a scope. E.g. LO1 and LO2, NMR signals.

Synchronous signals: These signals are NMR control signals for each transmit but also receive channel of the spectrometer. Most important are the 10MHz, 20MHz, but also every transmitter blanking pulse, the receiver gating pulse, the dwell clock and so on.

Asynchronous signals: Asynchronous signals fall into the category of general information transfer protocol signals. These are RS232, RS485, I2C or high-speed link signals.

The AQS has been designed to support more than one AQS chassis to allow the extension of NMR channels, multireceiving capabilities and dedicated NMR application spectrometers. This may be selected with the rack address.

The AQS chassis has a left and a right side. On left side a conventional VME 32 bus with BRUKER extension (AQ-Bus, F-Bus) for 8 slots is incorporated. On right side, a AQS User Bus is able to load different AQS units.

Every slot on the AQS User Bus backplane is hardware coded, so that every unit can be addressed via its specific slot address. The rack address can be set with jumpers on the rear side of the AQS backplane (***"Jumper Setting" on page 28*** and ***"Jumper Setting" on page 35.***)

The AQS User Bus backplane connector pin assignment is the same for all eight slots of the AQS User Bus backplane. That means each signal respectively signalpath is accessible on every slot (exceptions are power supply for BLA2BB and signals for the reference board).

RS485 Buses (SBSB¹), Intra Rack Bus

1.3.2

The AQS incorporates two independent SBSB buses called SBSB_1 and SBSB_2. The first one represents the system tty10 (classical AQR RX22 control channel), the second one the tty20.

The RS485 buses are originating at the CCU (SBSB_1 and SBSB_2). They are hardwired internally in the backplanes and are not any more accessible on the AQX RS plug. The SBSB_1 is galvanic isolated (SBSB_1_TTL) on the ACB standard (ACB-S) or PSD, depending on the configuration of the AQS rack. This helps to reduce interference between NMR RF units and digital units.

The SBSB_1 bus is the main SBSB which controls most of the NMR units. This are the RX22, all SGUs and the HPPR/2 preamplifier. The SBSB_2 is used for the control of the ACB and power amplifiers.

1 SBSB: serial BRUKER SPECTROSPIN bus (historical name)

One SGU which is situated in slot 3 in the AQS User Bus (3rd from the left) serves as the 'rack master' of the AQS user bus to reduce the necessary communication to a minimum for the CCU and the subunits. However each SGU is technically absolutely equal to all others which means that they can be accessed separately by the UniTool. This master SGU recognizes its position automatically and switches into master mode whereas all other SGUs are set to slave mode. The rack master SGU reacts to master commands (e.g. power up, init...) incoming via the SBSB_1 bus from the CCU (VME backplane to user bus backplane to ACB-S). It also reacts to incoming virtual SBSB commands for devices which do not have a SBSB interface. See I2C bus.

Internal communication between SBSB devices (e.g. clearing power up errors etc.) is done via the so called Intra-Rack bus (serial asynchronous bus, TTL levels) with the rack master SGU as bus master.

The master SGU is not only rack master, but it plays also a physical channel (e.g. SGU1). As SGU1 it reacts to direct rf channel1 commands from the CCU, as well as all other SGUs' react to their specific rf channel commands. Although the CCU addresses these commands directly to the specific unit, they are routed via the rack master and sent to the receiving SGU on the Intra-Rack bus.

I2C buses, addresses

1.3.3

For units without an intelligent and powerful microprocessor, passive multimaster capable I2C technology is used as in the AVANCE AQR SADC, HADC/2 or AQR ROUTER units. The master SGU drives these I2C buses and is therefore the controller of all non microprocessor units like the AQS BLA2BB, the AQS Router, AQS REF RX22, the AQS FADC and so on. Incoming CCU (spectrometer) commands for I2C devices are converted by the master SGU to I2C commands.

Example: To set the minirouter located in the BLA2BB, the incoming SBSB command from the CCU via the SBSB_1 bus is being converted by the master SGU to a I2C command. This I2C command will set the minirouter inside the BLA2BB.

To exceed the limitation of max. 8 I2C devices a second I2C bus is located on the AQS User Bus backplane to allow the control of total 16 I2C slaves.

The control of the filter settings of the SADC and HADC/2 is an exception. It is done in the same way as in the current AVANCE AQR system units, via the I2C bus of the RCU (remark the interruption of the I2C bus in the following figures).

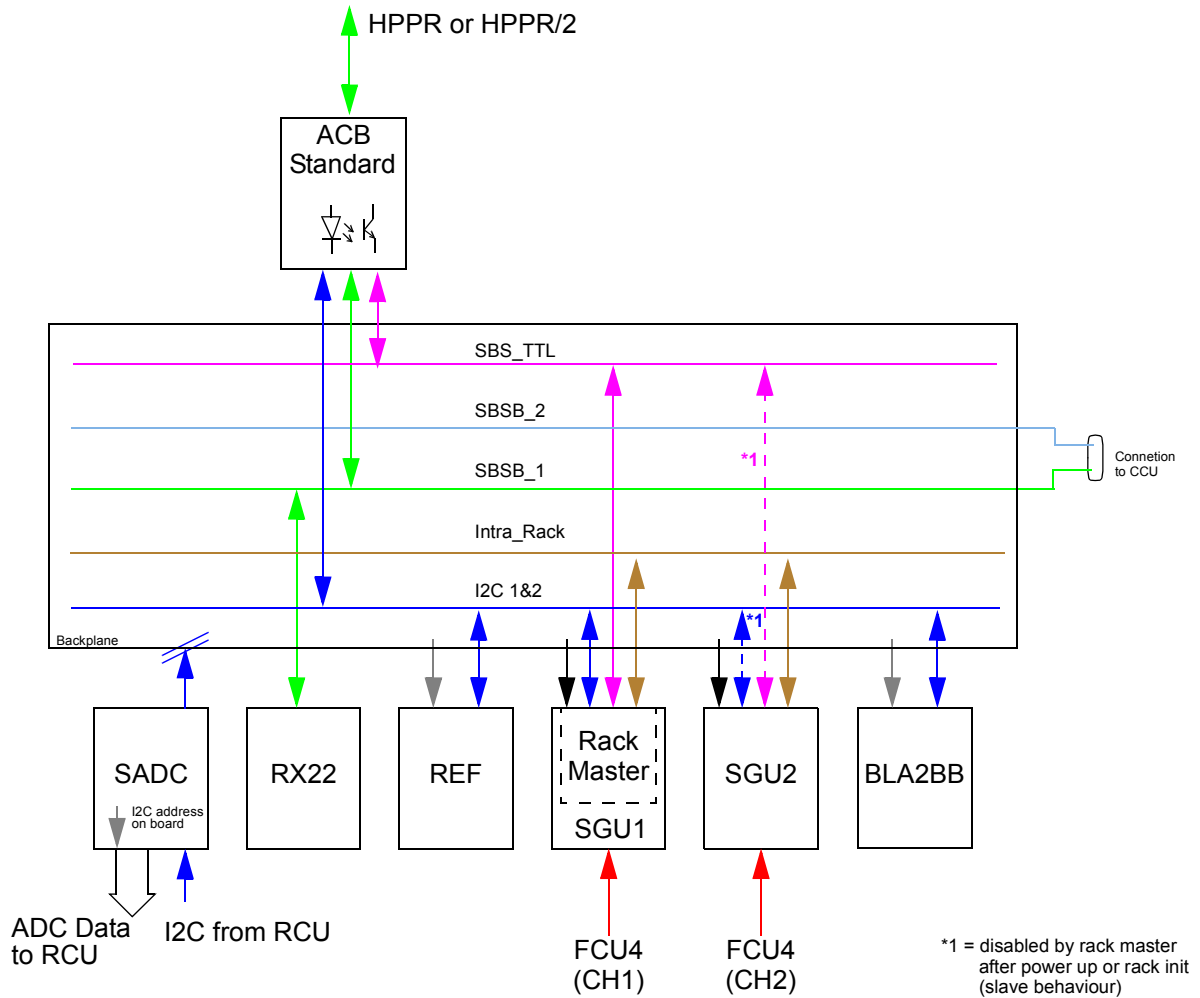
High Speed Link

1.3.4

The high speed link (LVDS¹) from FCU4 to SGU transfers all NMR relevant real time events in 50ns time slots to corresponding SGU (e.g. pulses, shapes, phase jumps, frequency jumps...). Each rf channel is controlled by a separate high speed link. It is connected via a cable on the front panels of the two units (point to point connection).

1 LVDS: Low voltage differential signaling

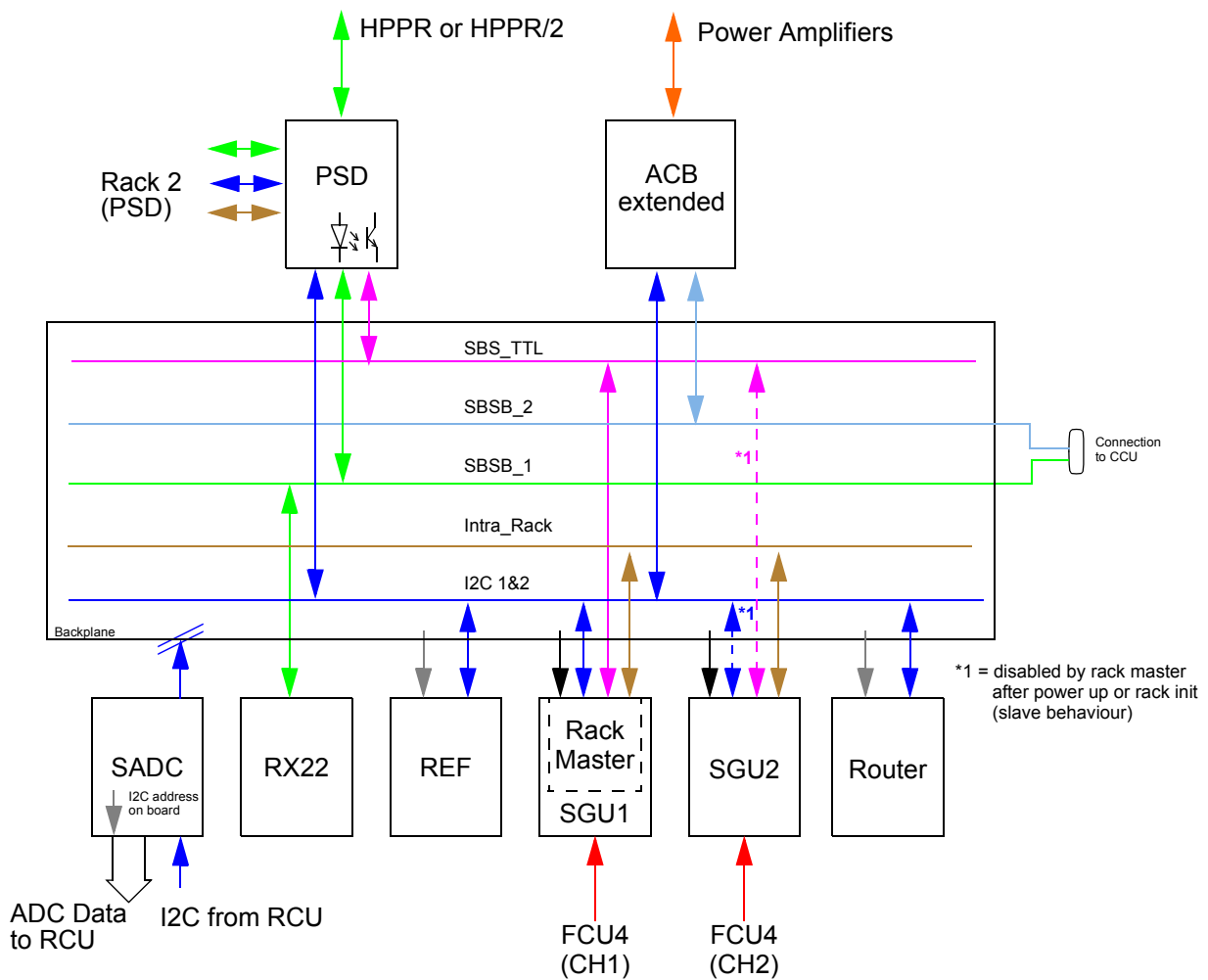
Figure 1.1. AQS Buses for a two channel system (internal BLA)



- High Speed Link
- RS485 (SBSB_1) from CCU
- RS485 (SBSB_2) from CCU
- SBS_TTL (galvanic isolated SBSB_1)
- Intra Rack Bus
- I²C (1&2)
- I²C Adresses
- Rack Addresses

Acquisition System (AQS)

Figure 1.2. AQS Buses for a two channel system (external BLA)



- High Speed Link
- RS485 (SBSB_1) from CCU
- RS485 (SBSB_2) from CCU
- SBS_TTL (galvanic isolated SBSB_1)
- SBSB_2 (only used for ACB extended to control external power amplifiers)
- Intra Rack Bus
- I²C
- I²C Addresses
- Rack Addresses

Synchronous signals**1.4****Realtime control-pulses (RCP) on the AQS User Bus****1.4.1*****BLKTRx~ (Blanking pulses for power amplifiers)***

Each BLKTR must be routed to the corresponding power amplifier. A SGU can control up to 8 power amplifiers with the corresponding BLKTR. The SGU must be initialized via SBSB before starting the experiment. Each SGU will apply under high speed link control the required BLKTR pulse in real time onto the AQS User Bus backplane. The BLKTR has wired nor logic on the backplane so that BLKTRs from different SGU can be combined to one amplifier (easy pulseprogramming, channel concept).

No additional cables are necessary to control the internal power amplifiers (e.g. BLA2BB). The BLKTR are routed directly on the backplane from the SGU to the corresponding BLA channel. BLKTR for external power amplifiers may be accessed on the front of the power supply and distribution board (PSD).

RGP_PA~ (Preamplifier receiver gating pulse)

This pulse (also mentioned as RGP_HPPR) is controlled by the SGU which is initialized as observing SGU. This signal is routed via the ACB-S standard (or PSD) to the observe module in the preamplifier HPPR or HPPR/2. All other non lock HPPR modules are in transmit or decoupling mode. In contrast to previous AVANCE systems, the preamplifier RGP will not be connected to the AQR RX22.

RGP_LO~ (Local oscillator gating pulse)

This internal pulse executes the frequency step for the local oscillator (+22MHz). The pulse is automatically generated by the observe SGU after switching to receive. It controls the AQS REFERENCE RX22 board.

RGP_RX~ (Receiver gating pulse)

This pulse controls the gating inside the receiver e.g. the AQR RX22. The pulse is driven by the observe SGU and can be delayed with the spectrometer pulseprogramme software. The signal is directly routed from the observe SGU via AQS User Bus backplane to the receiver. With this signal the receiver may be opened later in respect to the preamplifier.

RGP_ADC~ (ADC gating pulse)

This pulse (also driven by the observe SGU) controls the ADC data. If the pulse is activated and a dwell clock is applied, the ADC is converting normally. If the pulse is not activated and a dwell clock is applied, the ADC generates 'zero' data. The RGP_ADC is routed from the observe SGU via backplane to the ADC. This signal is specially used for digital homodecoupling with oversampling.

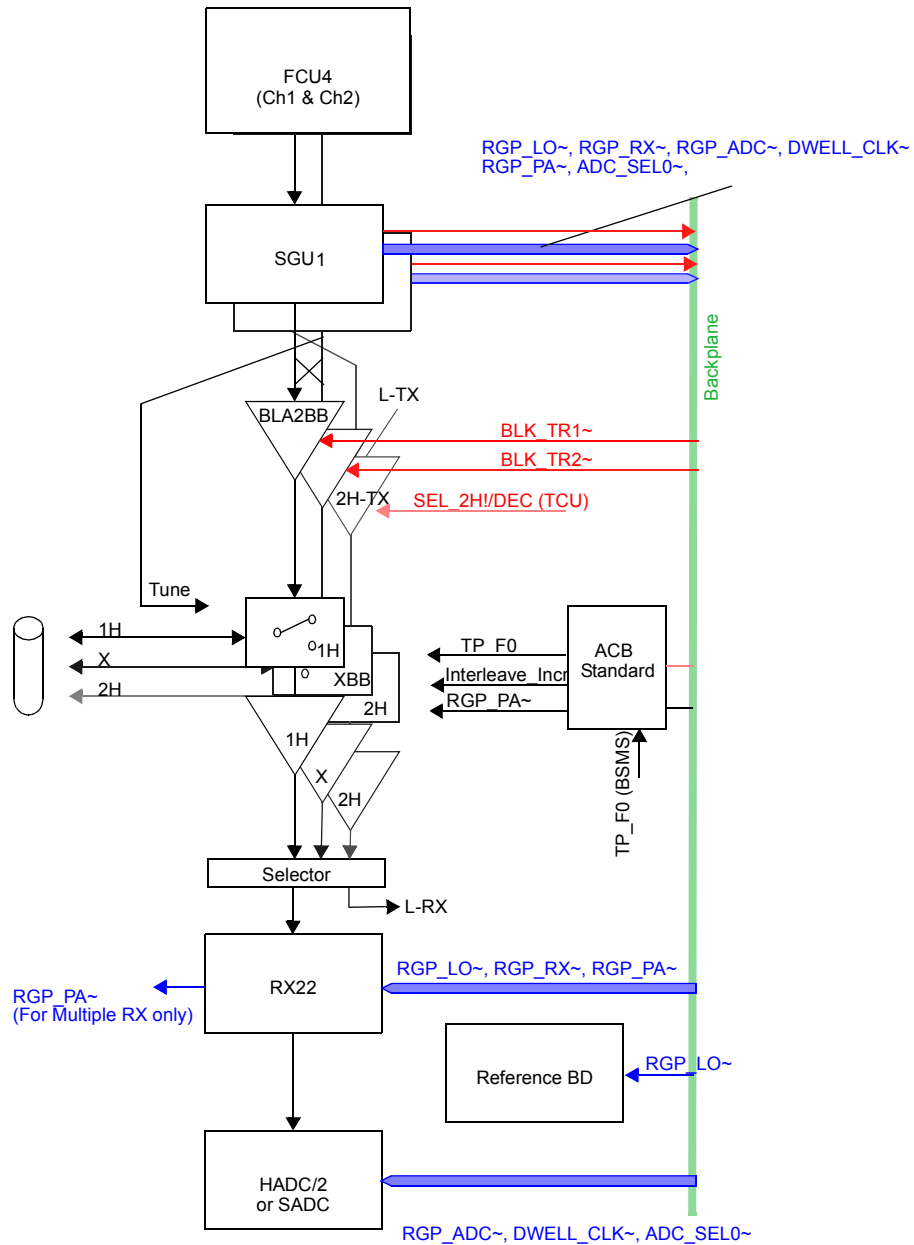
Dwell_Clk~ (ADC dwell clock)

The signal is driven by the observe SGU. Every falling edge executes an ADC conversion. The signal is not generated by a programmable hardware divider like on the AVANCE AQX RCU, but is now treated as a pulse sequence in the pulseprogram (FCU4 programmed Dwell clock loop). This loop is running on the FCU4 and every dwell clock edge is an instruction on the high speed link, which drives the pulse in the observe SGU. No additional wiring is necessary, because the pulse is routed to the ADC via backplane. Homodecoupling experiments are treat as typical pulseprograms.

SEL_ADCx~ (Select A/D converter)

The signal is applied to select a required ADC in case of configurations with more than one ADC. The signal is driven by the observe SGU and is wired directly via backplane to the specified ADCs.

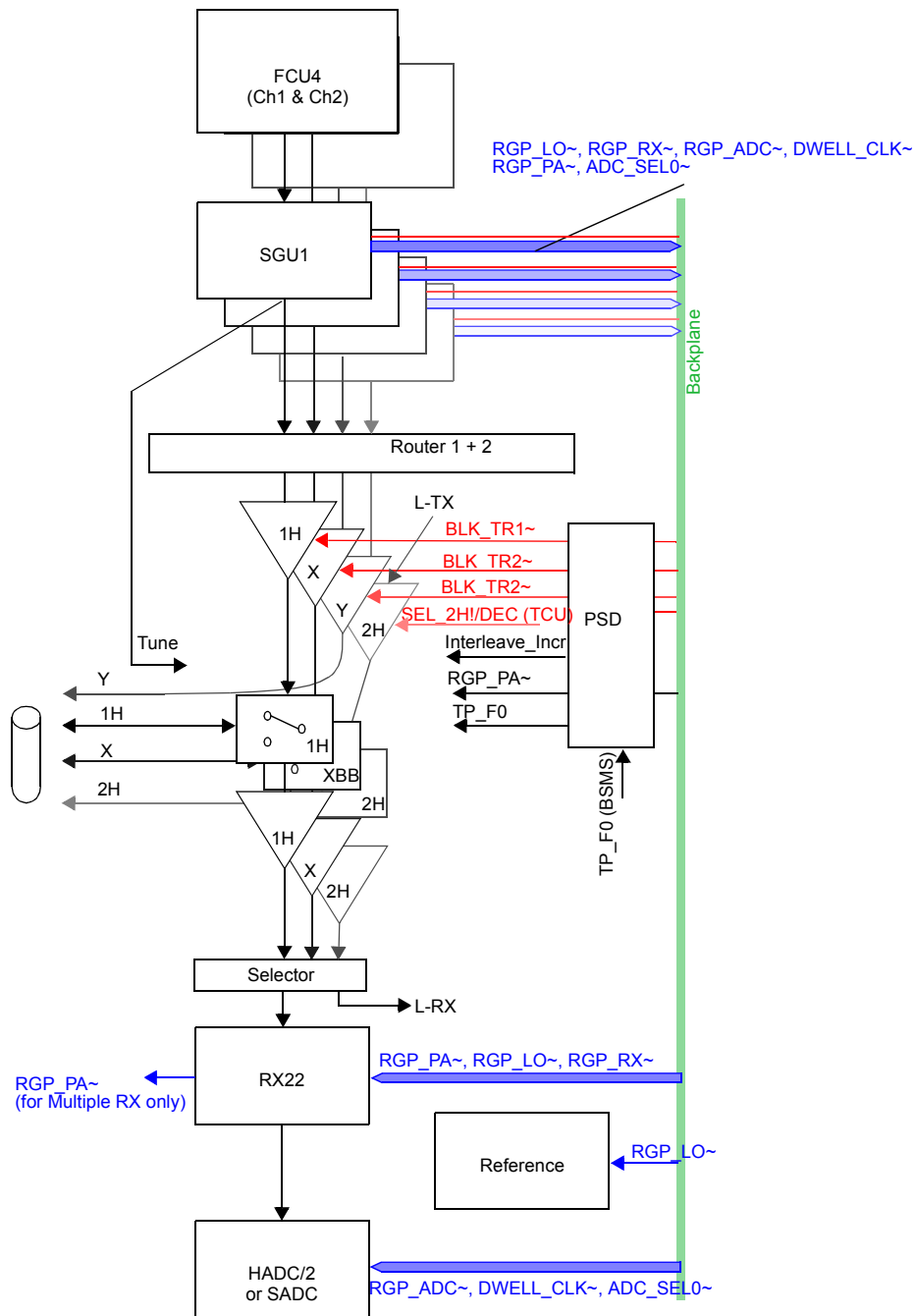
Figure 1.3. Pulse distribution on a two channel AVANCE (internal amplifiers)



In this configuration exist three amplifiers but only two SGUs. SGU2 can either be used for the BLA2BB or the 2H-TX (for 2H decoupling or 2H shimming). There is no blanking pulse required for the 2H-TX. Controlling Lock mode or 2H-TX mode is done via the signal SEL2H!/DEC) from the TCU3

Acquisition System (AQS)

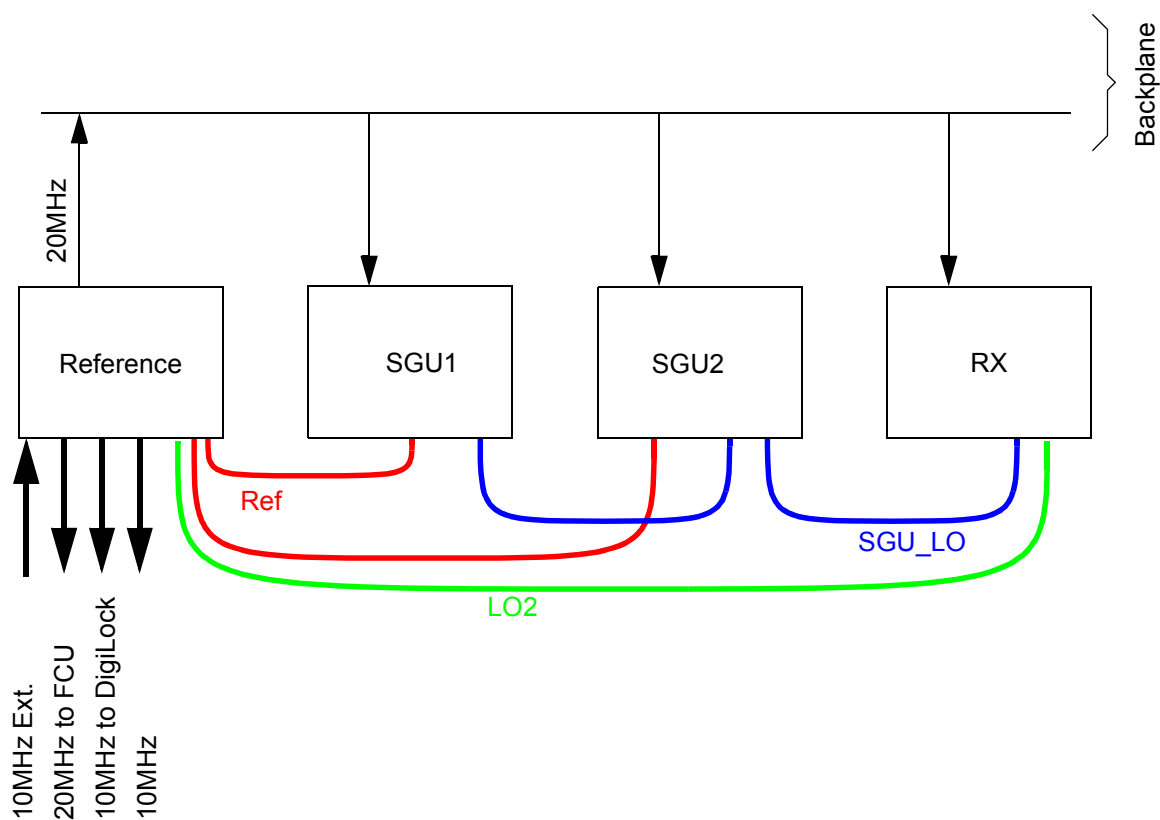
Figure 1.4. Pulse distribution on a four channel AVANCE (external amplifiers)



The following RF signals are required in a AQS system:

1. The RF output of every SGU must be connected to a power amplifier or to a router/combiner.
2. Each SGU can be initialized as observe SGU and therefore each SGU must be able to drive the local oscillator signal for the receiver. Every SGU has a local oscillator input and a local oscillator output. The LO is looped through every SGU except the observe SGU, which is driving the local oscillator.
3. Several fixed frequencies are generated on the reference board (AQS REFERENCE RX22). These signals are required for the upconversion electronics located in the SGU. One reference board can drive up to four SGUs.
4. The 10MHz output of the reference board is used to synchronize various units like the BSMS Lock. The reference board switches automatically to the external 10MHz input if a signal is applied.
5. The detection reference signal (LO 2) is directly wired from the reference board to the receiver.

Figure 1.5. RF distribution



Introduction

1.6.1

This section describes the clock distribution for all AQS units. It's very important for a synchronous system to have a clock distribution with smallest skew between the different units.

Between the clock source and the various boards the same number of drivers and the same length of cable must be used.

The FCU3 or FCU4 clock signal is looped through all FCUs and is finally terminated on the TCU3.

Blockdiagram

1.6.2

Figure 1.6. Clockdistribution for a single rack version

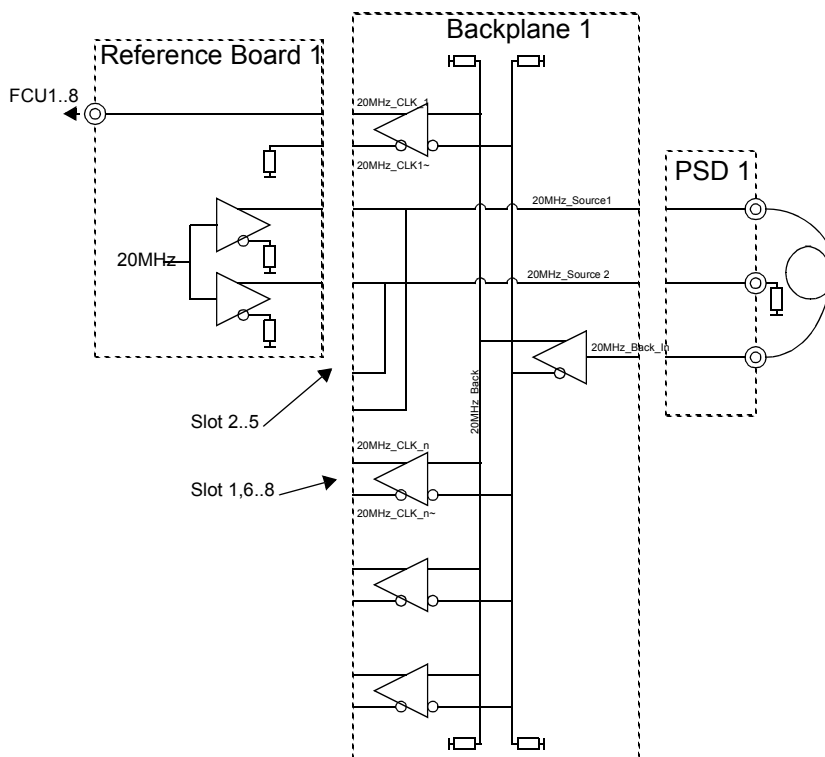
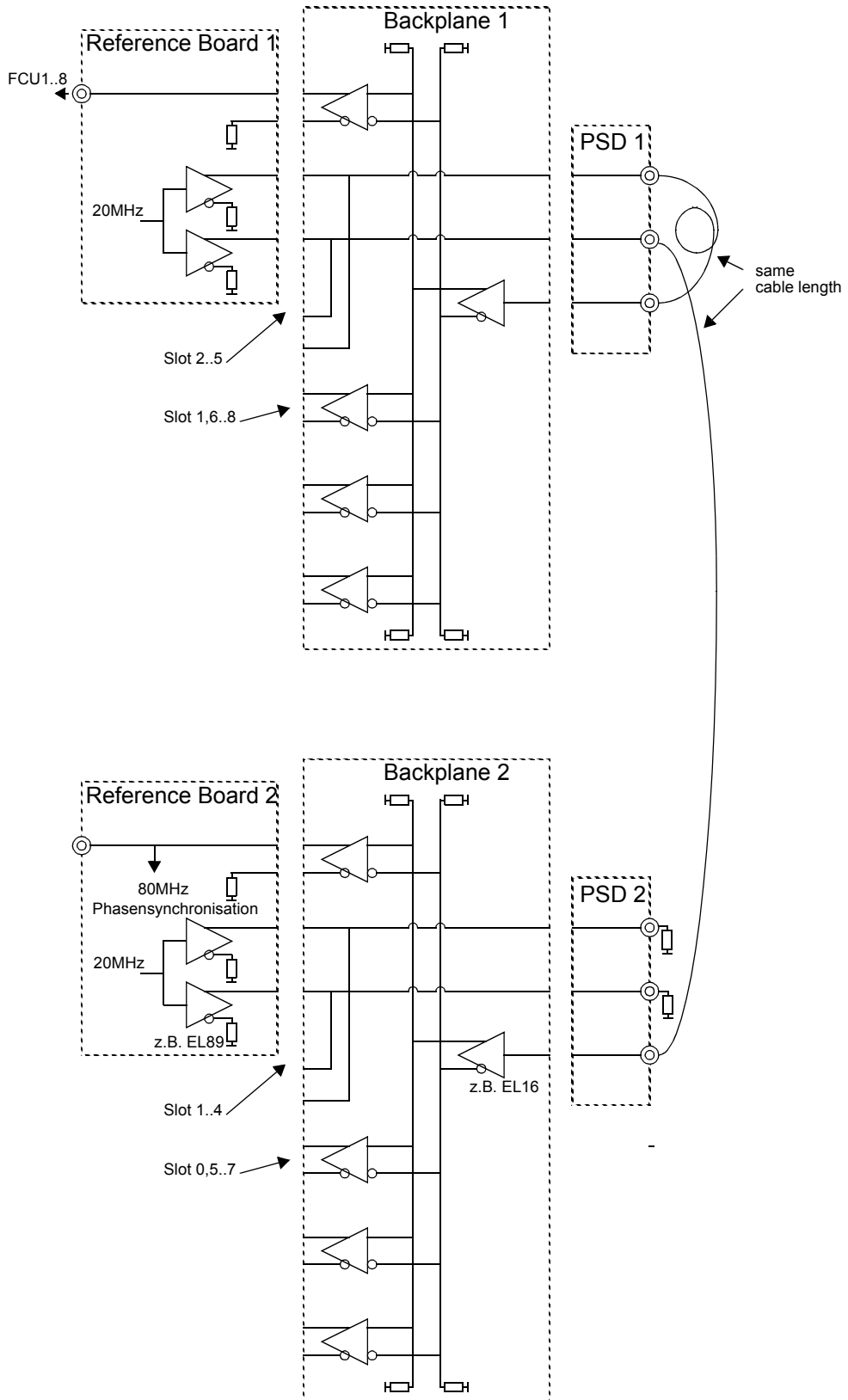


Figure 1.7. Clockdistribution for a dual rack version



AQS Configurations

2

A typical 2 Channel AQS (with internal BLA)

2.1

Bill of Material

2.1.1

Table 2.1. Bill of material

Pos.	Units	Part Number	Description	MP ^a
1	1	Z003414	AQS CHASSIS WIRED	
2	1	H9489	AQS POWER SUPPLY DIGITAL 350W	
3	1	Z12170	BSMS FRONTPLATE BLIND 12TE	MB
4	1	W1345050	AQS POWER SUPPLY BLA 28V 20A	
5	1	Z003403	AQS PSM2 POWER SUPPLY MODULE	
6	1	Z003402	AQS PSM1 POWER SUPPLY MODULE	
7	1	H9488	AQS ACB STANDARD BOARD	
8	1	H9503	AQS CCU10 COM CONTR UNIT	
9	1	H5813	AQS TCU3 TIMING CONTR BOARD	
10	1	H9773	AQS FCU4/2 CONTROLLER BOARD	
11	2	Z2778	BSMS FRONTPLATE BLIND 4TE	MB
12	1	Z003678	AQS RCU1/2 RECEIVER CONTROL BD	
13	1	Z003570	AQS SADC	
14	1	Z002810	AQR RECEIVER BOARD 22MHZ	
15	1	Z003351	AQS REFERENCE BOARD RX22	
16	2	Z003642	AQS SGU	
17	1	Z15201	AQS FRONTPLATE 1MM 16TE	MB
18	1	Z15202	AQS COVERPLATE 16TE	MB
19	1	W1345049	AQS BLA2BB150/60 20-400	
20	1	Z003348	AQS ADAPTER ADC + RX22/FTLP-4M	
-	10	25958	SCREW RRCH KR M2,5 x 12,3	MB

a MEC Part: MB = Part contained in AQS MEC-PARTS MB (Z14052)

The rack address must be set to '0x1F' (JU1A to JU1E on the AQS user bus rear side must be closed).

See **"AQS VME and User Bus (rear view)" on page 76**

Figure 2.1. AQS for 2 Channel AVANCE

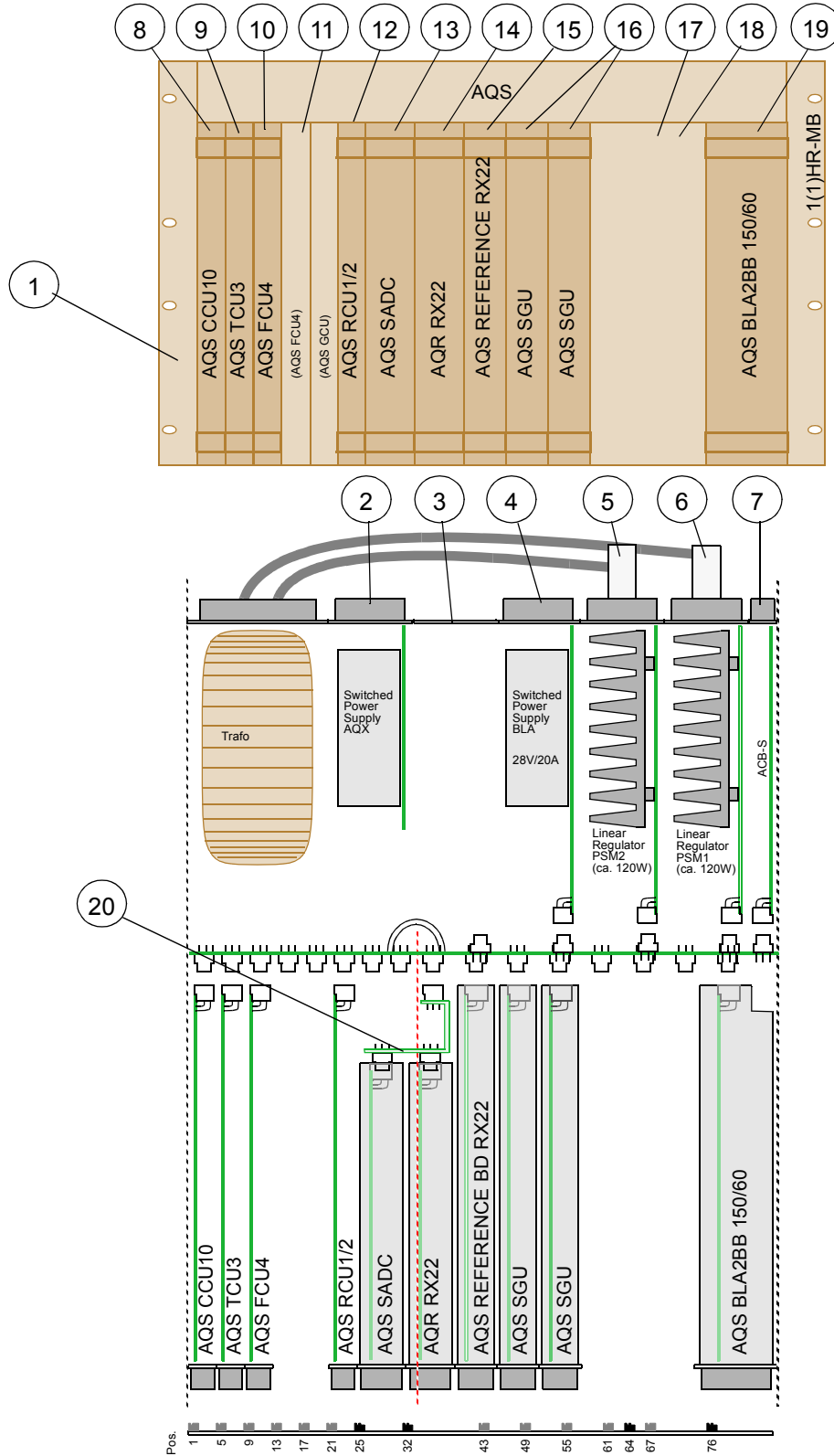


Table 2.2. Bill of material

Pos.	Units	Part Number	Description	MP ^a
1	1	Z003414	AQS CHASSIS WIRED	
2	1	H9489	AQS POWER SUPPLY DIGITAL 350W	
3	1	Z12170	BSMS FRONTPLATE BLIND 12TE	MB
4	1	W1345050	AQS POWER SUPPLY BLA 28V 20A	
5	1	Z003403	AQS PSM2 POWER SUPPLY MODULE	
6	1	Z003402	AQS PSM1 POWER SUPPLY MODULE	
7	1	H9488	AQS ACB STANDARD BOARD	
8	1	H9503	AQS CCU10 COM CONTR UNIT	
9	1	H5813	AQS TCU3 TIMING CONTR BOARD	
10	1	H9773	AQS FCU4/2 CONTROLLER BOARD	
11	2	Z2778	BSMS FRONTPLATE BLIND 4TE	MB
12	1	Z003678	AQS RCU1/2 RECEIVER CONTROL BD	
13	1	Z003570	AQS SADC	
14	1	Z002810	AQR RECEIVER BOARD 22MHZ	
15	1	Z003351	AQS REFERENCE BOARD RX22	
16	2	Z003642	AQS SGU	
17	1	Z003961	AQS PREAMP CONTROL BOARD	
18	1	Frequency dependent	AQS 1H2H PREAMP	
19	1	Frequency dependent	AQS XBB10F 2HS PREAMP	
20	1	W1345049	AQS BLA2BB150/60 20-400	
21	1	Z003348	AQS ADAPTER ADC + RX22/FTLP-4M	
-	10	25958	SCREW RRCH KR M2,5 x 12,3	MB

a MEC Part: MB = Part contained in AQS MEC-PARTS MB (Z14052)

Jumper Setting

2.2.2

The rack address must be set to '0x1F' (JU1A to JU1E on the AQS user bus rear side must be closed).

See **"AQS VME and User Bus (rear view)" on page 76**

Guide Rail changes

2.2.3

To change the guide rails correctly please follow the exact order as described below.

1. Move guide rail from pos. 64 to pos. 57
2. Move guide rail from pos. 61 to pos. 65
3. Move guide rail from pos. 67 to pos. 71

50 Ohm Terminators on AQS PREAMP's

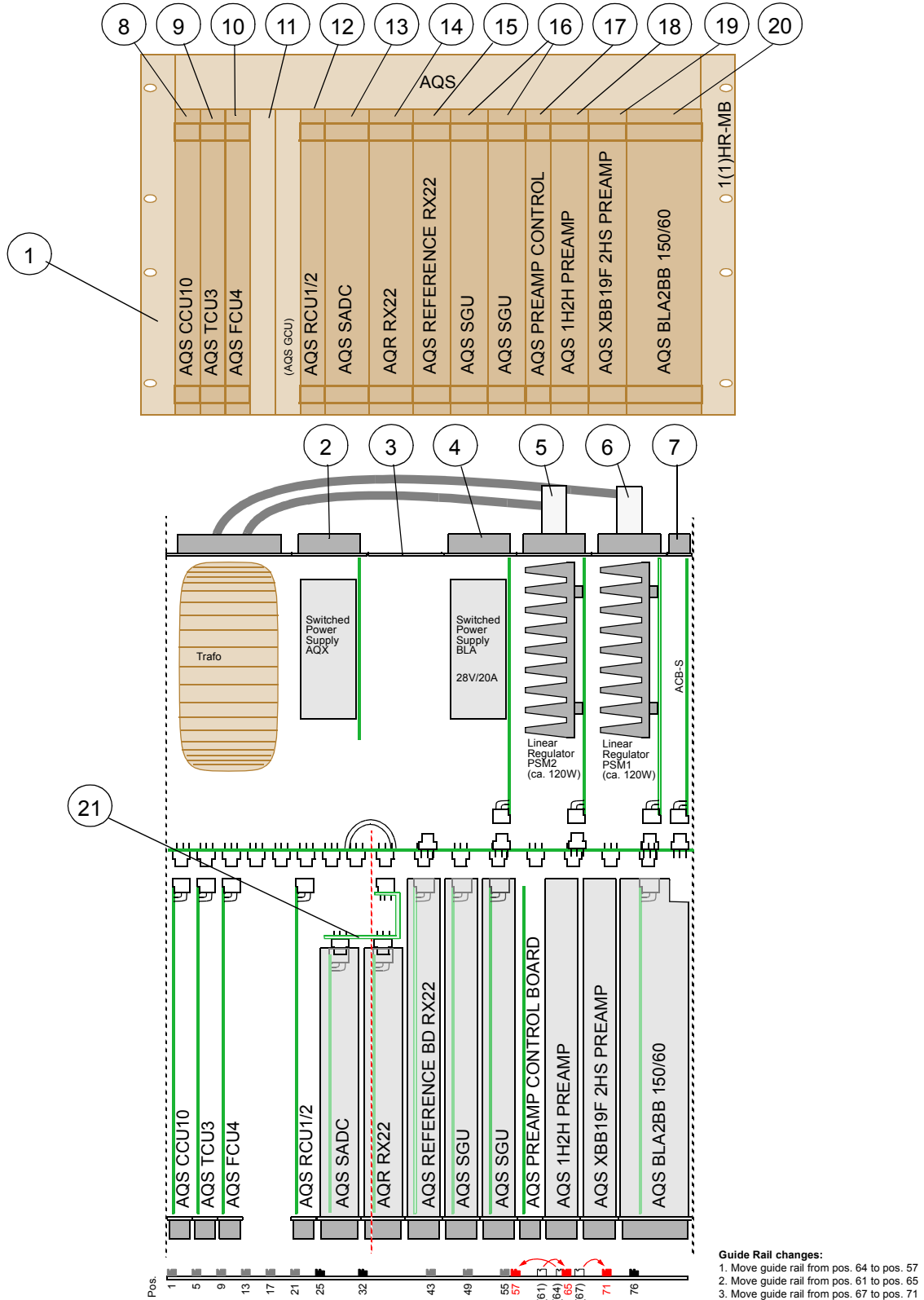
2.2.4

The AQS PREAMP modules are delivered with ext. 50 Ohm terminators (SMB plug). They must be mounted as follows:

- AQS 1H2H Preamp: LOCK IN
- AQS XBB19F 2HS PREAMP: RF IN and TUNE OUT

AQS Configurations

Figure 2.2. AQS for 2 Channel AVANCE with internal PREAMP and BLA



A typical 2 Channel AQS with internal PREAMP and BLA

Wiring Information (internal AQS PREAMP and BLA)

2.2.6

Table 2.3. Bill of material

Pos.	Units	Part Number	Description	Notes
1	1	Z100052	CABLE COAX LL1030 150MM N/N	contained in AQS CABLE SET PREAMP 1H2H-XBB (Z100183)
2	1	Z100053	CABLE COAX LL1030 250MM N/N	
3	2	Z100054	CABLE COAX RG316 260MM SMA/SMB	
4	1	Z100055	CABLE COAX RG316 800MM SMA/SMB	
5	1	Z100056	CABLE COAX LL1030 4.5M SMA/N "2H"	
6	1	Z100057	CABLE COAX LL2773 4.5M N/N "1H"	
7	1	Z100371	CABLE COAX LL2773 4.5M N/N "XBB"	
8	1	Z100138	CABLE RD 36P 1200 MDR	
9	1	Z100240	CABLE RD 5P 4.5M HPPR/2-ATMA/PICS	
10	1	HZ03806	CABLE KOAX ELSPEC 800 SMA/SMA	delivered with BSMS 2H-TX (optional)
11	2	Z100184	CABLE COAX RG316 14CM 2XSMB	delivered with XBB PREAMP
12	1	Z100058	CABLE 25P FLK AQS PREAMP BUS	delivered with PREAMP CONTROL BD
13	3	42869	ST KOAX SMB TERM.50 BU 0,25W	delivered with XBB & 1H2H PREAMP

Figur 2.3. Standard AQS 2CH Micro Bay Wiring (internal PREAMP and BLA)

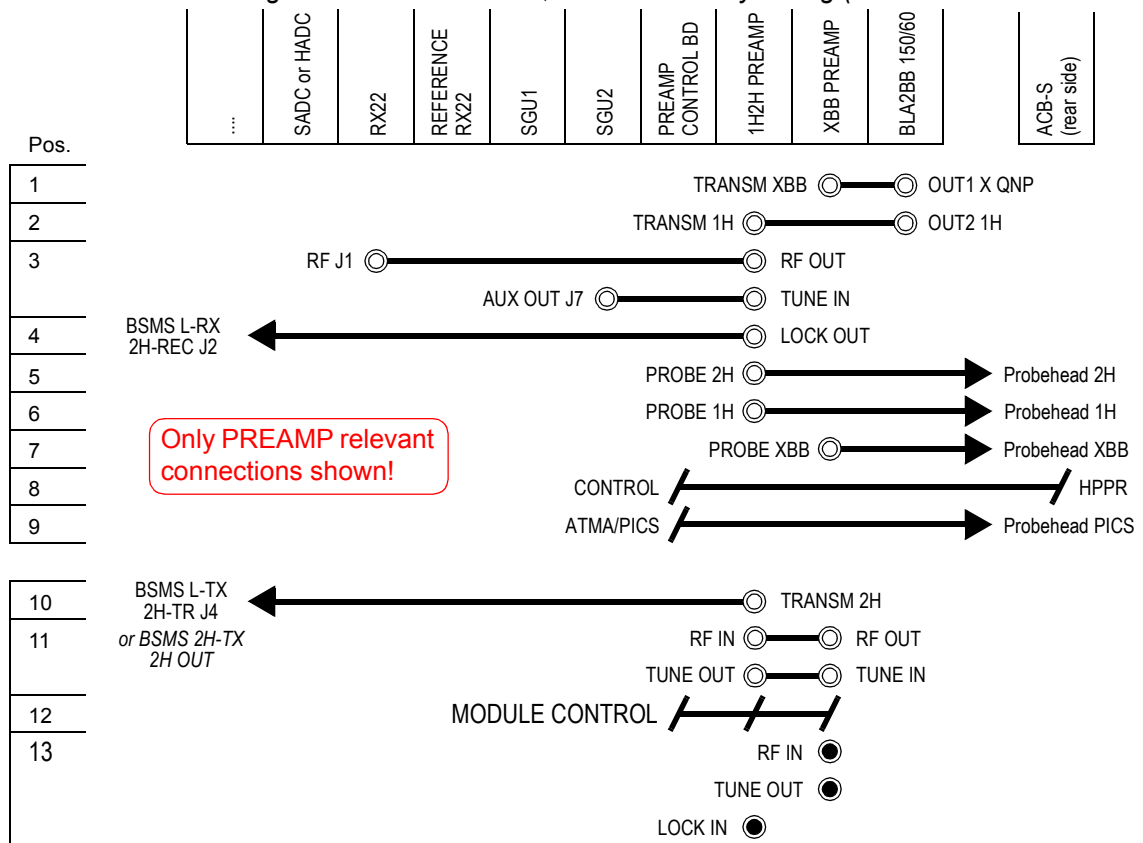


Table 2.4. Bill of material

Pos.	Units	Part Number	Description <i>Units for 3rd or 4th channel extension written in italics.</i>	MP ^a
1	1	Z003414	AQS CHASSIS WIRED	
2	1	H9520	AQS POWER SUPPLY DIGITAL 450W	
3	1	H9500	AQS ACB EXTENDED BOARD	
4	1	Z003404	AQS PSM3 POWER SUPPLY MODULE	
5	1	Z003402	AQS PSM1 POWER SUPPLY MODULE	
6	1	H9530	AQS PSD BOARD	
7	1	H9503	AQS CCU10 COM CONTR UNIT	
8	1	H5813	AQS TCU3 TIMING CONTR BOARD	
9	1	H9773 <i>H9727</i>	AQS FCU4/2 CONTROLLER BOARD <i>AQS FCU4/4 CONTROLLER BOARD</i>	
10				
11	1	Z003678	AQS RCU1/2 RECEIVER CONTROL BD	
12	1	Z003572	AQS HADC/2 ADS937	
13	1	Z002810	AQR RECEIVER BOARD 22MHZ	
14	1	Z003351	AQS REFERENCE BOARD RX22	
15	2	Z003642	AQS SGU	
16	1 1 1 1	Z14119 <i>Z003642</i> Z2778 Z14133	AQS FRONTPLATE BLIND 1MM 12TE <i>AQS SGU</i> BSMS FRONTPLATE BLIND 4TE <i>AQS FRONTPLATE BLIND 2TE</i>	OB OB OB
17 ^b	1	Z14120	AQS COVERPLATE 8TE	OB
18	1	Z003624	AQS 3-CHANNEL ROUTER BOARD	
19	1 1	Z12490 <i>Z003624</i>	AQR FRONTPLATE BLIND 7TE <i>AQS 3-CHANNEL ROUTER BOARD</i>	OB
20	1	Z13644	AQS FRONTPLATE BLIND 2TE	OB
21	1	Z003348	AQS ADAPTER ADC+RX22/FTLP-4M	
22	1	Z003349	AQS ADAPTER ROUTER DUAL	
- ^c	10	25958	SCREW RRCH KR M2,5 x 12,3	OB

- a MEC Part: OB = Part contained in AQS MEC-PARTS ONE-BAY (Z14122)
- b used only with pos. 16 as frontplate
- c used for pos. 10, 16 19 and 20

Jumper Setting

2.3.2

The rack address must be set to '0x1F' (JU1A to JU1E on the AQS user bus rear side must be closed).

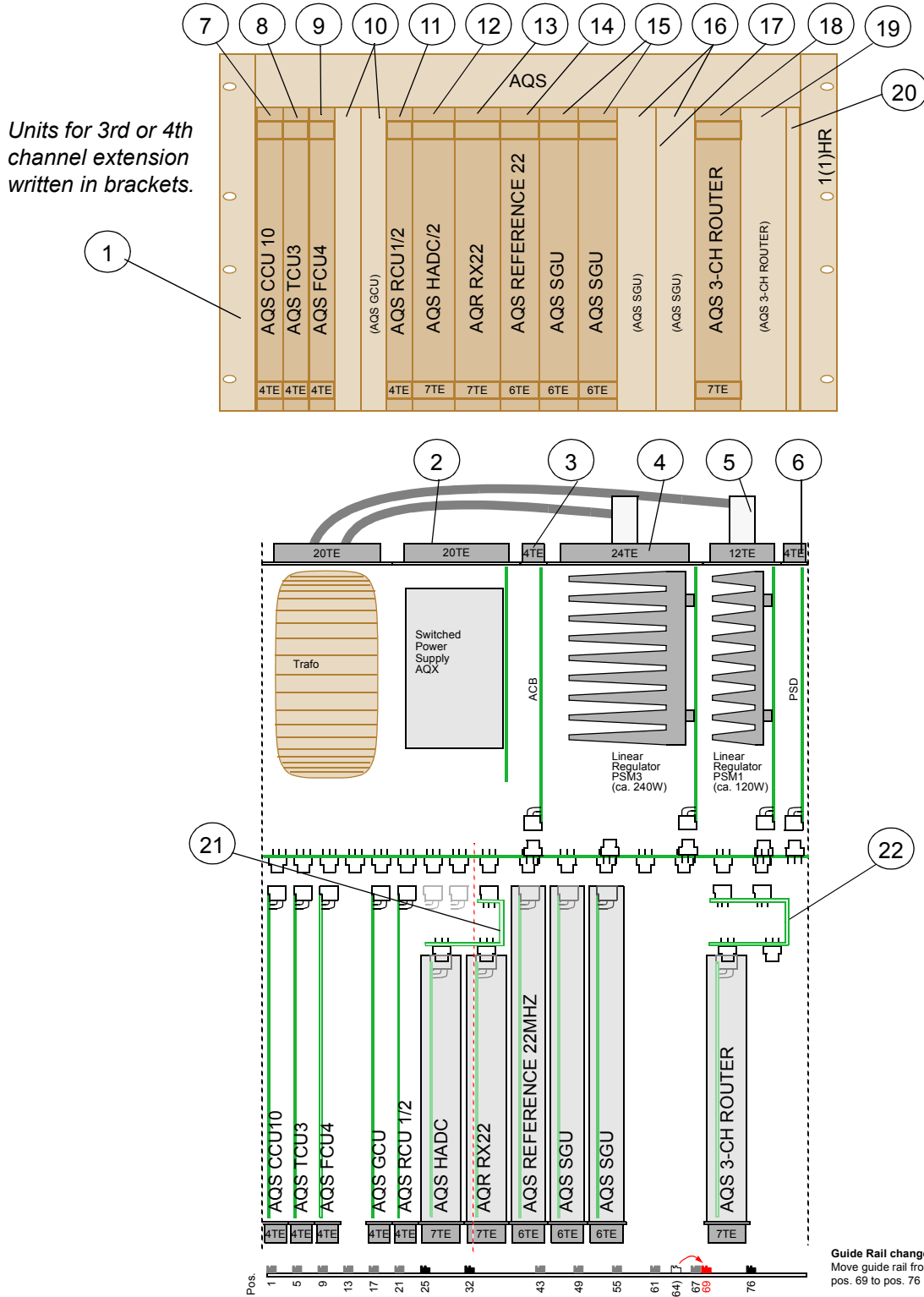
See "**AQS VME and User Bus (rear view)**" on page 76.

Guide Rail changes

2.3.3

Move guide rail from pos. 64 to pos. 69.

Figure 2.4. AQS for 2 to 4 Channel AVANCE (with ext. BLA)



A typical 5 to 6 Channel AQS (with external BLA)

2.4

Bill of Material

2.4.1

Table 2.5. Bill of material: Rack 1

Pos.	Units	Part Number	Description <i>Units for 6th channel extension written in italics.</i>	MP ^a
1	1	Z003414	AQS CHASSIS WIRED (ECL >= 04 required)	
2	1	H9520	AQS POWER SUPPLY DIGITAL 450W	
3	1	H9500	AQS ACB EXTENDED BOARD	
4	1	Z003404	AQS PSM3 POWER SUPPLY MODULE	
5	1	Z003402	AQS PSM1 POWER SUPPLY MODULE	
6	1	H9530	AQS PSD BOARD (ECL >= 01 required)	
7	1	H9503	AQS CCU10 COM CONTR UNIT	
8	1	H5813	AQS TCU3 TIMING CONTR BOARD	
9	1	H9727	AQS FCU4/4 CONTROLLER BOARD	
10	1	H9773	AQS FCU4/2 CONTROLLER BOARD	
11	3	Z2778	BSMS FRONTPLATE BLIND 4TE	OB
12	1	H9506	AQS GCU GRAD CONTR UNIT	
13	1	Z003678	AQS RCU1/2 RECEIVER CONTROL BD	
14	1	Z003572	AQS HADC/2 ADS937	
15	1	Z002810	AQR RECEIVER BOARD 22MHZ	
16	1	Z003351	AQS REFERENCE BOARD RX22 (ECL >= 02 required)	
17	3	Z003642	AQS SGU	
18	1	Z003624	AQS 3-CHANNEL ROUTER BOARD	
19	1	Z14984	AQS FRONTPLATE BLIND 3TE	2nd
20	1	Z003348	AQS ADAPTER ADC+RX22/FTLP-4M	
21	1	Z003575	AQS ADAPTER ROUTER / RX22-BB	
- ^b	4	25958	SCREW RRCH KR M2,5 x 12,3	OB
- ^c	1	25939	SPACER D2,5x16 NYLON	2nd

a MEC Part: OB = Part contained in AQS MEC-PARTS ONE-BAY (Z14122)
2nd = Part contained in AQS MEC-PARTS 2ND CHASSIS (Z14985)

b used for pos. 10

c used for pos. 19

Table 2.6. Bill of material: Rack 2

Pos.	Units	Part Number	Description <i>Units for 6th channel extension written in italics.</i>	MP ^a
30	1	Z003414	AQS CHASSIS WIRED (ECL >=04 required)	
31	1	H9520	AQS POWER SUPPLY DIGITAL 450W	
32	1	Z2778	BSMS FRONTPLATE BLIND 4TE	2nd
33	1	Z003404	AQS PSM3 POWER SUPPLY MODULE	
34	1	Z003402	AQS PSM1 POWER SUPPLY MODULE	
35	1	H9530	AQS PSD1BOARD (ECL >= 01 required)	
36	2	Z13644	BSMS FRONTPLATE BLIND 2TE	2nd
37	2	Z13955	AQS FRONTPLATE BLIND 1MM 18TE	2nd
38	2	Z13954	AQS COVERPLATE 18TE	2nd
39	1	Z003351	AQS REFERENCE BOARD RX22 (ECL >= 02 required)	
40	2	Z003642	AQS SGU	
41	1 1	Z12489 Z003642	AQR FRONTPLATE BLIND 6TE AQS SGU	2nd
42	1	Z12489	AQR FRONTPLATE BLIND 6TE	2nd
43	1	Z003624	AQS 3-CHANNEL ROUTER BOARD	
44	1 1	Z12490 Z003624	AQR FRONTPLATE BLIND 7TE AQS 3-CHANNEL ROUTER BOARD	2nd
45	1	Z003349	AQS ADAPTER ROUTER DUAL	
46	1	Z15357	SCHILD PL GE "AQS RACK ON" Z4K-4466 (Marking Z4K-4466 on left side)	2nd
47	1	Z15358	SCHILD PL GE "AQS EXT RACK ON" Z4K-4467 (Marking Z4K-4467 on right side)	2nd
- ^b	12	25958	SCREW RRCH KR M2,5 x 12,3	2nd

a MEC Part: 2nd = Part contained in AQS MEC-PARTS 2ND CHASSIS (Z14985)

b used for pos. 32, 37, 41, 42, 43 and 44

! On the AQS User Bus Mainboard Z13601 ECL03 a proposal for the jumper setting is printed that is not valid. Please refer to the following jumper settings:

Rack 1:

The rack address must be set to '0x1C' (JU1C to JU1E on the AQS user bus rear side must be closed).

See "AQS VME and User Bus (rear view)" on page 76.

Rack 2:

The rack address must be set to '0x1E' (JU1B to JU1E on the AQS user bus rear side must be closed).

See "AQS VME and User Bus (rear view)" on page 76.

! **Important Note:**

There are two kinds of guide rails within the AQS rack. Most guide rails are of the standard AQS type (Part-Nm. Z14663). They are used for all full length boards (all digital boards, AQS Reference, AQS SGU, AQS RX). All short boards (AQR RX-22, AQS SADC, AQS HADC/2, AQR FTLP/4M, AQR ROUTER) use commercial type guide rails (Part-Nm. 45456).

To change the guide rails correctly please follow the exact order as described below.

Rack 1:

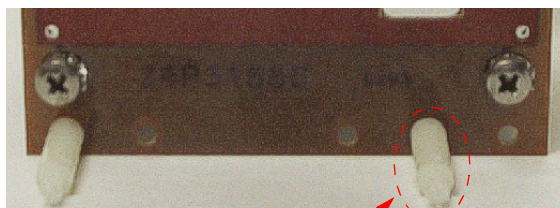
1. Move guide rail from pos. 64 to pos. 29
2. Move guide rail from pos. 49 to pos. 73
3. Move guide rail from pos. 25 to pos. 37
4. Move guide rail from pos. 43 to pos. 25
5. Move guide rail from pos. 32 to pos. 44

Rack 2:

1. Move guide rail from pos. 64 to pos. 69
2. Move guide rail from pos. 21 to pos. 20

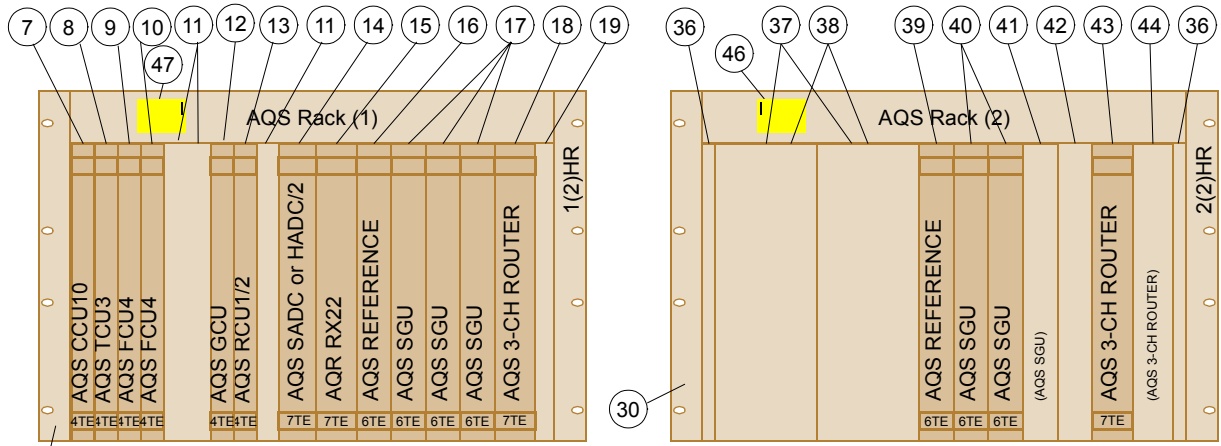
The adapter is not mounted on its standard position at the USER BUS slot 1.

To be able to mount it correctly in the 3rd slot, one of the rear spacers has to be replaced by a longer type (Part-Nm. 25939).

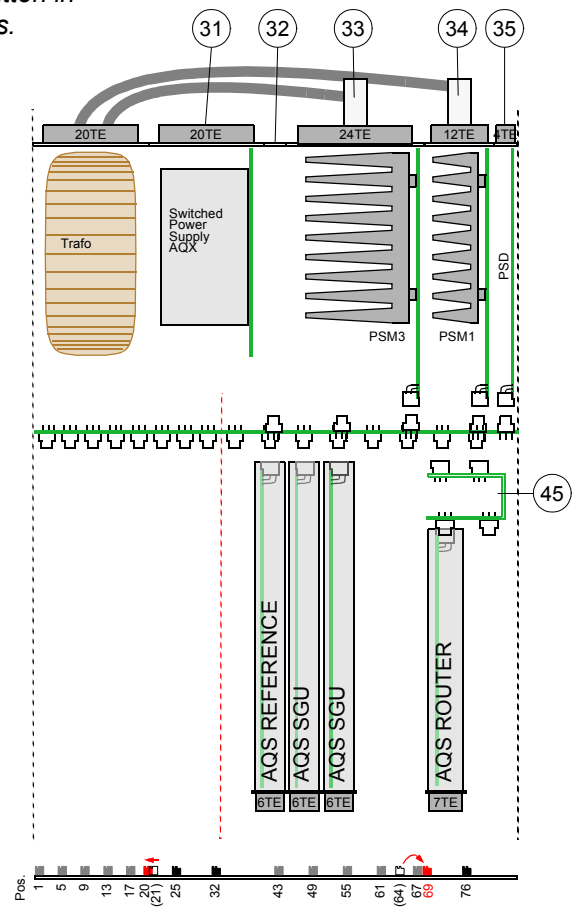
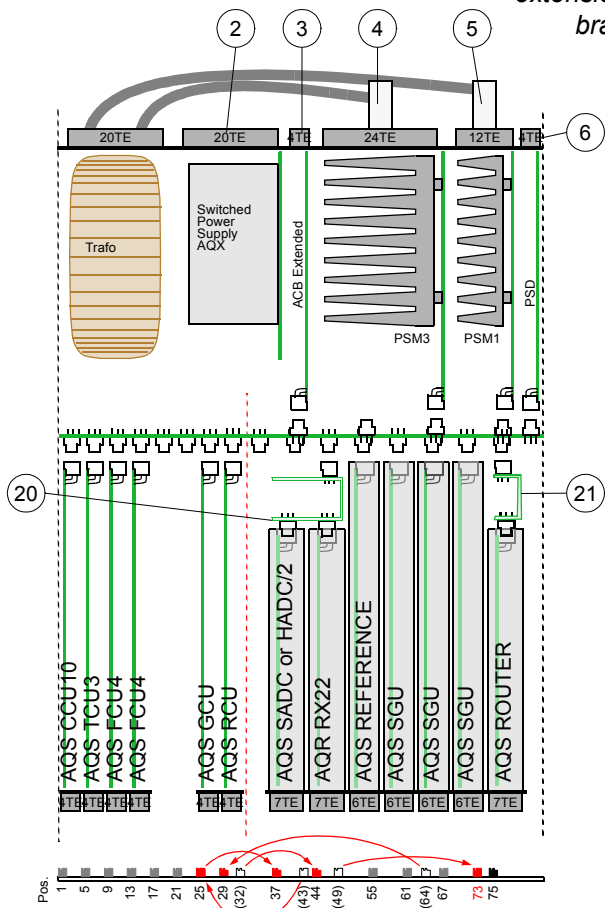


Remove black spacer and replace it with white spacer at new position.

Figure 2.5. AQS for 5 to 6 Channel AVANCE



Units for 6th channel extension written in brackets.



Guide Rail changes:

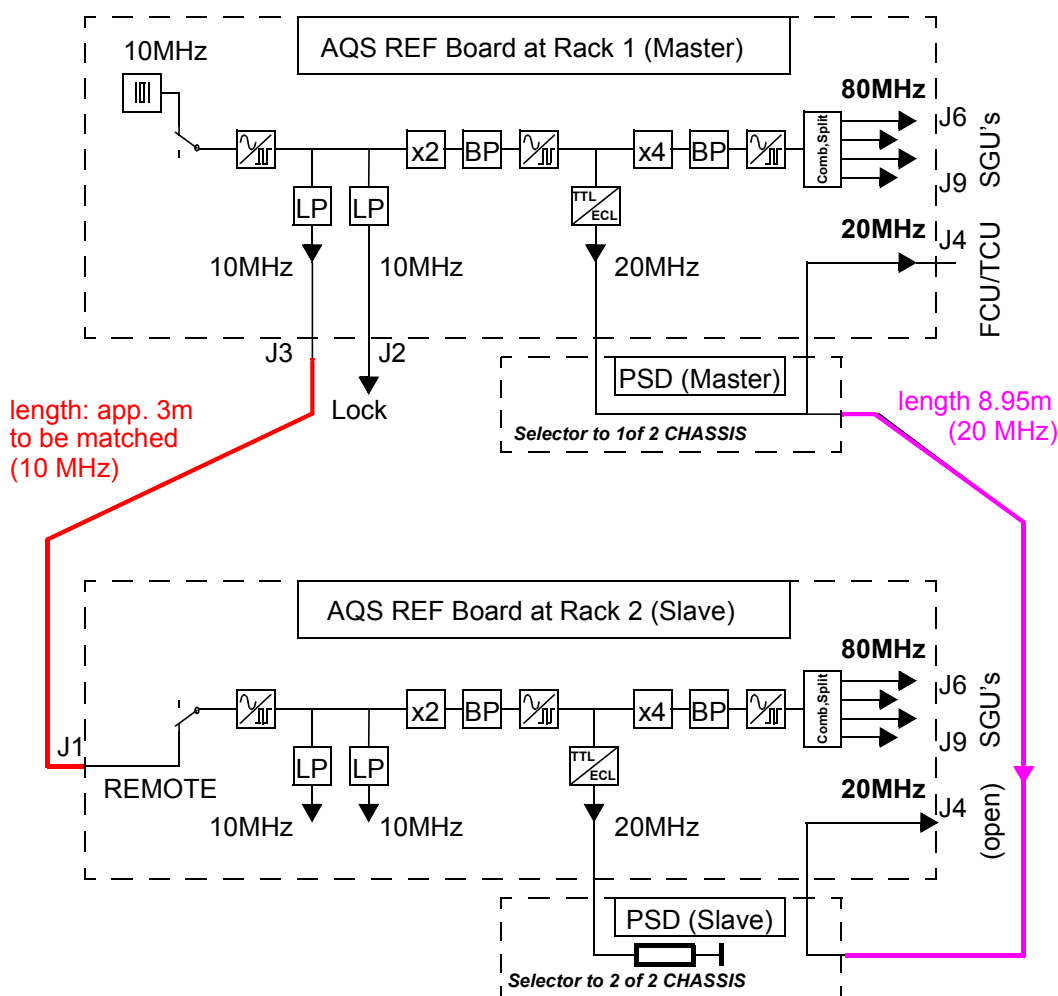
1. Move guide rail from pos. 64 to pos. 29
2. Move guide rail from pos. 49 to pos. 73
3. Move guide rail from pos. 25 to pos. 37
4. Move guide rail from pos. 43 to pos. 25
5. Move guide rail from pos. 32 to pos. 44

Guide Rail changes:

1. Move guide rail from pos. 64 to pos. 69
2. Move guide rail from pos. 21 to pos. 20

The phases of the signals 20 MHz and 80 MHz, out of the two AQS Reference Board (Z003351 or Z003265) at rack 1 and rack 2, has to be the same. The time between the negative slope of the 80 MHz and the positive slope of the 20 MHz signal is a critical value.

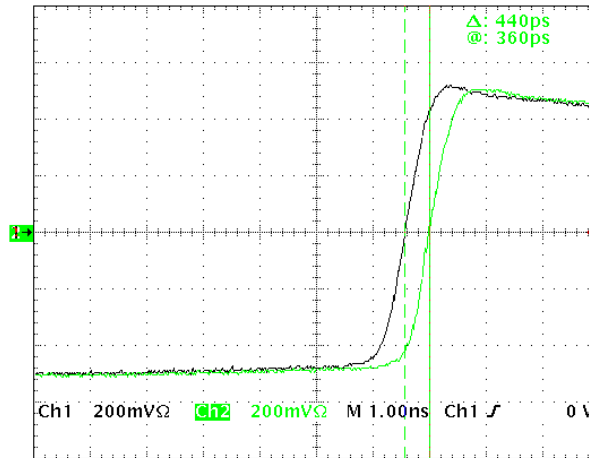
Figur 2.6. Connection between the two racks: overview



20 MHz Phase

The length of the 20 MHz interconnection (HZ10146) does influence the phase of the 20 MHz signal at AQS Reference Board / J4 (rack 2). Using a length of 8.95 m will turn the phase to 0° (360°) and a measurement by scope will show the difference (+/- 1ns max.)

Figur 2.7. Phase difference of the 20 MHz



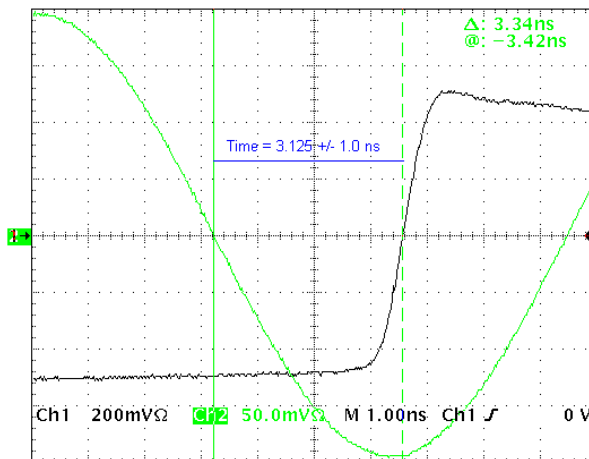
80 MHz phase

To observe the 80 MHz signals at J6...9, a bandpass filter has to be inserted. The Mini-Circuits Model SLP-90 and SHP-25 filter, together with the coaxial cable HZ04057, will select the 80 MHz out of the multiple frequency signal and change the phase app. 0° (360°). That can be easy tested by using 80 MHz out of the SGU and observe the phase difference with and without the filter combination, when the monitor is external triggered by 20 MHz.

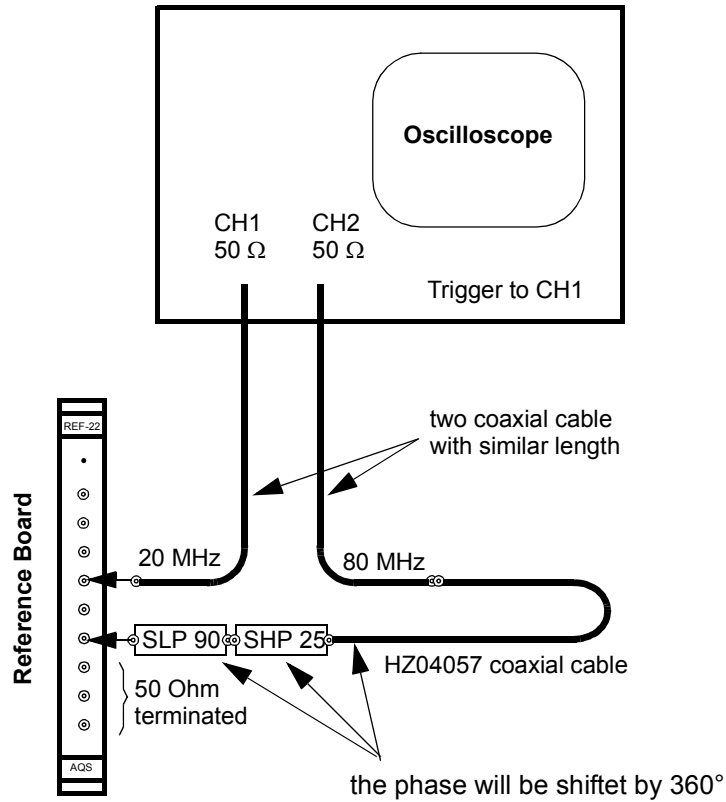
The length of the 10 MHz REMOTE interconnection does influence the phase of the 80 MHz signal on J6...9 of the rack 2. Use H10045 Cable Set 2nd REF for adjusting the optimum length. The cable set and the 80 MHz Filter is a part of the 5 to 6 Channel AVANCE Wiring.

! *Time between negative slope of 80 MHz and positive slope of 20 MHz has to be 3.125 ns ± 1 ns. The adjustment must be done after every change of a AQS Reference Board.*

Figur 2.8. Phase 20/80 MHz



measurement settings



A typical 2 to 4 Channel AQS HR with RX-BB (4-CH with only 1 Router)

A typical 2 to 4 Channel AQS HR with RX-BB (4-CH with only 1 Router) 2.5

Bill of Material

2.5.1

Table 2.7. Bill of material

Pos.	Units	Part Number	Description <i>Units for 3rd or 4th channel extension written in italics.</i>	MP ^a
1	1	Z003414	AQS CHASSIS WIRED	
2	1	H9520	AQS POWER SUPPLY DIGITAL 450W	
3	1	H9500	AQS ACB EXTENDED BOARD	
4	1	Z003404	AQS PSM3 POWER SUPPLY MODULE	
5	1	Z003402	AQS PSM1 POWER SUPPLY MODULE	
6	1	H9530	AQS PSD BOARD	
7	1	H9503	AQS CCU10 COM CONTR UNIT	
8	1	H5813	AQS TCU3 TIMING CONTR BOARD	
9	1	H9773 <i>H9727</i>	AQS FCU4/2 CONTROLLER BOARD <i>AQS FCU4/4 CONTROLLER BOARD</i>	
10	2 <i>1</i>	Z2778 <i>H9506</i>	BSMS FRONTPLATE BLIND 4TE <i>AQS GCU GRAD CONTR UNIT</i>	OB
11	1	Z003678	AQS RCU1/2 RECEIVER CONTROL BD	
12	1	Z12490	AQR FRONTPLATE BLIND 7TE	
13	1	Z003572	AQS HADC/2 ADS937	
14	1	Z003689	AQS RECEIVER BOARD RX-BB	
15	1	Z003936 Z003265 Z003937	AQS REFERENCE BOARD 600 AQS REFERENCE BOARD 400 AQS REFERENCE BOARD 1000	
16	2	Z003642 Z003831 Z003830	AQS SGU 400 AQS SGU 600 AQS SGU 1000	
17	1 <i>1</i> <i>1</i>	Z14119 <i>Z003642</i> <i>Z12489</i>	AQS FRONTPLATE BLIND 1MM 12TE <i>AQS SGU</i> <i>AQR FRONTPLATE BLIND 6TE</i>	OB OB
18 ^b	1	Z14120	AQS COVERPLATE 8TE	OB
19	1	Z003624	AQS 3-CHANNEL ROUTER BOARD	
20	1	Z14984	AQS FRONTPLATE BLIND 3TE	OB
21	1	Z003907	AQS ADAPTER HADC/2	

Table 2.7. *Bill of material*

Pos.	Units	Part Number	Description <i>Units for 3rd or 4th channel extension written in italics.</i>	MP ^a
22	1	Z003575	AQS ADAPTER ROUTER / RX22-BB	
- ^c	8	25958	SCREW RRCH KR M2,5 x 12,3	OB

a MEC Part: OB = Part contained in AQS MEC-PARTS ONE-BAY (Z14122)

b used only with pos. 17 as frontplate

c used for pos. 10, 12 and 17

Jumper Setting

2.5.2

The rack address must be set to '0x1D' (JU1A and JU1C to JU1E on the AQS user bus rear side must be closed).

See **"AQS VME and User Bus (rear view)" on page 76.**

Guide Rail changes

2.5.3

To change the guide rails correctly please follow the exact order as described below.

1. Move guide rail from pos. 64 to pos. 73.
2. Move guide rail from pos. 76 to pos. 75.

A typical 2 to 4 Channel AQS HR with RX-BB (4-CH with only 1 Router)

Figure 2.9. AQS for 2 to 4 Channel AVANCE (with RX-BB)

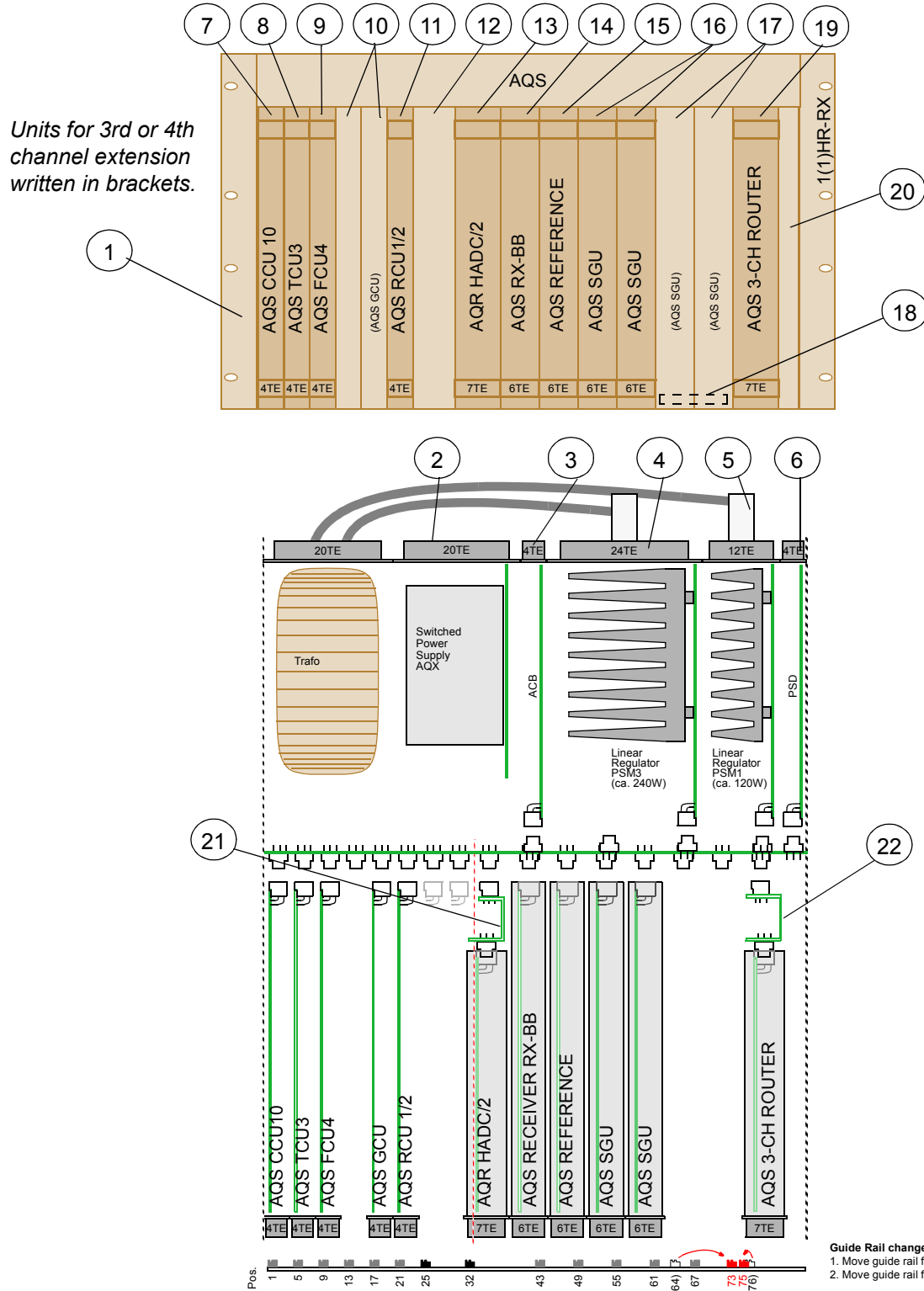


Table 2.8. Bill of material

Pos.	Units	Part Number	Description <i>Units for 3rd channel extension written in italics.</i>	MP ^a
1	1	Z003414	AQS CHASSIS WIRED (ECL >= 04 required)	
2	1	H9520	AQS POWER SUPPLY DIGITAL 450W	
3	1	H9500	AQS ACB EXTENDED BOARD	
4	1	Z003404	AQS PSM3 POWER SUPPLY MODULE	
5	1	Z003402	AQS PSM1 POWER SUPPLY MODULE	
6	1	H9530	AQS PSD BOARD	
7	1	H9503	AQS CCU10 COM CONTR UNIT	
8	1	H5813	AQS TCU3 TIMING CONTR BOARD	
9	1 1	H9773 H9727	AQS FCU4/2 CONTROLLER BOARD <i>AQS FCU4/4 CONTROLLER BOARD</i>	
10	2 1	Z2778 H9506	BSMS FRONTPLATE BLIND 4TE <i>AQS GCU GRAD CONTR UNIT</i>	SO
11	1	Z003678	AQS RCU1/2 RECEIVER CONTROL BD	
12	1	H9685	AQS FADC BOARD	
13	1	Z003572	AQS HADC/2 ADS937	
14	1	Z002812	AQR FT-FILTER BOARD SOLID	
15	1	Z003688	AQS RECEIVER BOARD RX	
16	1	Z003265	AQS REFERENCE BOARD	
17	2 1 1	Z003642 Z12489 Z003642	AQS SGU AQR FRONTPLATE BLIND 6TE <i>AQS SGU</i>	SO
18	1	Z003624	AQS 3-CHANNEL ROUTER BOARD	
19	1	Z14133	AQS FRONTPLATE BLIND 2TE	SO
20	1	Z14984	AQS FRONTPLATE BLIND 3TE	SO
21	1	Z003892	AQS ADAPTER FADC+ADC/FTLP-4M	
22	1	Z003575	AQS ADAPTER ROUTER	
- ^b	6	25958	SCREW RRCH KR M2,5 x 12,3	SO

A typical 2 to 3 Channel AQS Solids & HR (with RX-BB)

Table 2.8. Bill of material

Pos.	Units	Part Number	Description <i>Units for 3rd channel extension written in italics.</i>	MP ^a
-	2	Z14663	AQS GUIDE RAIL	
-	2	45867	PT-SCREW KA K25X14	

a MEC Part: SO = Part contained in AQS MEC-PARTS SOLIDS (Z14986)

b used for pos. 9, 10 and 17

Jumper Setting

2.6.2

The rack address must be set to '0x1D' (JU1A and JU1C to JU1E on the AQS user bus rear side must be closed).

See **"AQS VME and User Bus (rear view)" on page 76.**

Guide Rail changes

2.6.3

! Important Note:

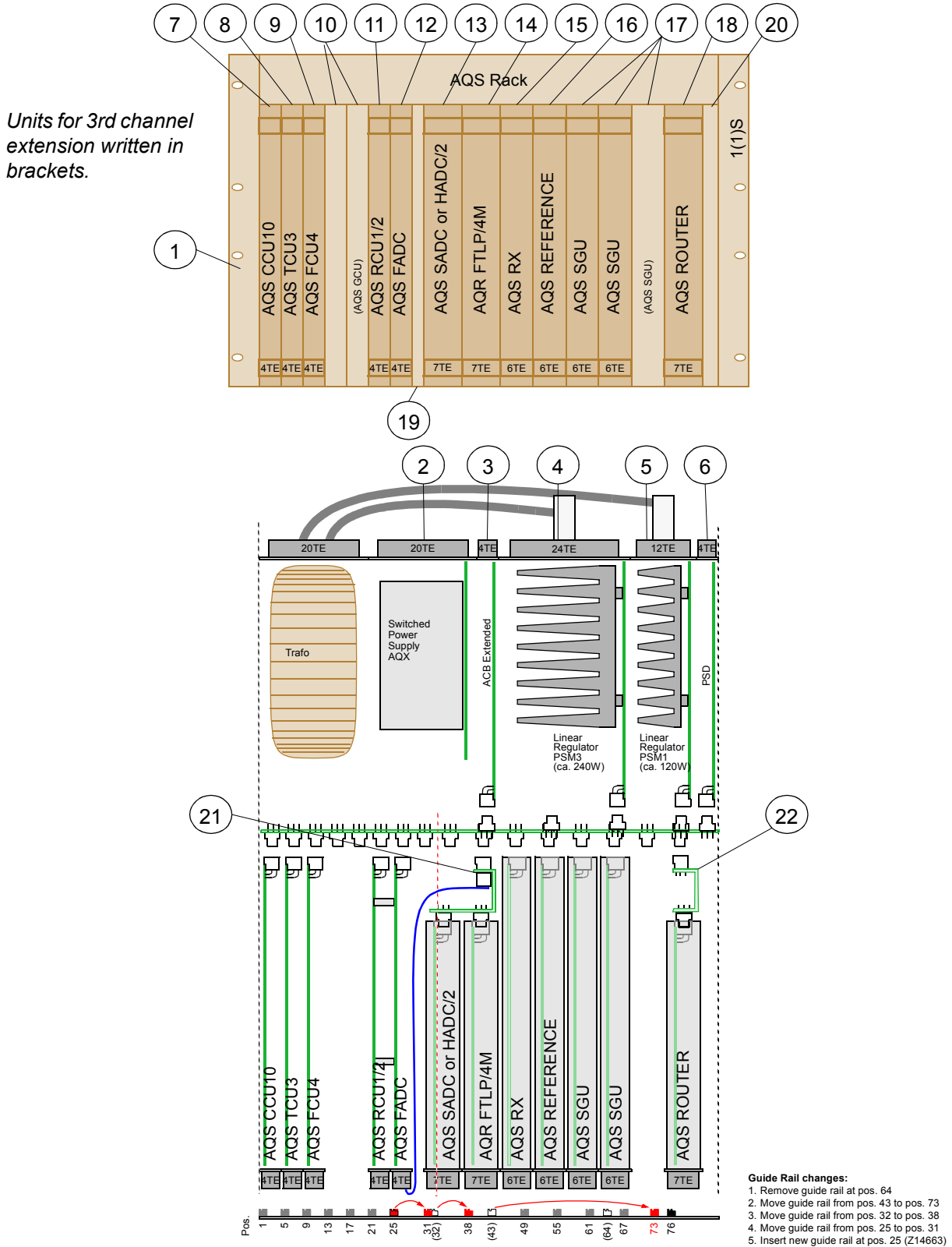
There are two kinds of guide rails within the AQS rack. Most guide rails are of the standard AQS type (Part-Nm. Z14663). They are used for all full length boards (all digital boards, AQS Reference Board, AQS SGU, AQS RX). All short boards (AQR RX-22, AQS SADC, AQS HADC/2, AQR FTLP/4M, AQR ROUTER) use commercial type guide rails (Part-Nm. 45456).

To change the guide rails correctly please follow the exact order as described below.

1. Remove guide rail at pos. 64
2. Move guide rail from pos. 43 to pos. 73
3. Move guide rail from pos. 32 to pos. 38
4. Move guide rail from pos. 25 to pos. 31
5. Insert new guide rail at pos. 25 (Z14663)

AQS Configurations

Figure 2.10. AQS for 2 to 3 Channel Solids & HR AVANCE (with RX)



A typical 4 to 6 Channel AQS Solids & HR (with RX-BB)

2.7

Bill of Material

2.7.1

Table 2.9. Bill of material: Rack 1

Pos.	Units	Part Number	Description <i>Units for 5th & 6th channel extension written in italics.</i>	MP ^a
1	1	Z003414	AQS CHASSIS WIRED (ECL >= 04 required)	
2	1	H9520	AQS POWER SUPPLY DIGITAL 450W	
3	1	H9500	AQS ACB EXTENDED BOARD	
4	1	Z003404	AQS PSM3 POWER SUPPLY MODULE	
5	1	Z003402	AQS PSM1 POWER SUPPLY MODULE	
6	1	H9530	AQS PSD BOARD (ECL >= 01 required)	
7	1	H9503	AQS CCU10 COM CONTR UNIT	
8	1	H5813	AQS TCU3 TIMING CONTR BOARD	
9	1 1	H9727 H9773	AQS FCU4/4 CONTROLLER BOARD <i>AQS FCU4/2 CONTROLLER BOARD</i>	
10	1	H9506	AQS GCU GRAD CONTR UNIT	
11	1	Z003678	AQS RCU1/2 RECEIVER CONTROL BD	
12	1	H9685	AQS FADC BOARD	
13	2	Z2778	BSMS FRONTPLATE BLIND 4TE	SO
14	1	Z003572	AQS HADC/2 ADS937	
15	1	Z002812	AQR FT-FILTER BOARD SOLID	
16	1	Z003688	AQS RECEIVER BOARD RX	
17	1	Z003265	AQS REFERENCE BOARD (ECL >= 03 required)	
18	2	Z003642	AQS SGU	
19	1	Z003624	AQS 3-CHANNEL ROUTER BOARD	
20	1	Z14984	AQS FRONTPLATE BLIND 3TE	SO
21	1	Z003892	AQS ADAPTER FADC+ADC+FTLP-4M	
22	1	Z002812	AQR FT-FILTER BOARD SOLID	
- ^b	4	Z003688	AQS RECEIVER BOARD RX	

a MEC Part: SO = Part contained in AQS MEC-PARTS SOLIDS (Z14986)

b used for pos. 9 and 13

AQS Configurations

Table 2.10. Bill of material: Rack 2

Pos.	Units	Part Number	Description <i>Units for 5th & 6th channel extension written in italics.</i>	MP ^a
30	1	Z003414	AQS CHASSIS WIRED (ECL >= 04 required)	
31	1	H9520	AQS POWER SUPPLY DIGITAL 450W	
32	1	Z2778	BSMS FRONTPLATE BLIND 4TE	2nd
33	1	Z003404	AQS PSM3 POWER SUPPLY MODULE	
34	1	Z003402	AQS PSM1 POWER SUPPLY MODULE	
35	1	H9530	AQS PSD BOARD (ECL >= 01 required)	
36	2	Z13644	BSMS FRONTPLATE BLIND 2TE	2nd
37	2	Z13955	AQS FRONTPLATE BLIND 1MM 18TE	2nd
38	2	Z13954	AQS COVERPLATE 18TE	2nd
39	1	Z003265	AQS REFERENCE BOARD (ECL >= 03 required)	
40	2	Z003642	AQS SGU	
41	1 1	Z12489 Z003642	AQR FRONTPLATE BLIND 6TE AQS SGU	2nd
42	1 1	Z12489 Z003642	AQR FRONTPLATE BLIND 6TE AQS SGU	2nd
43	1	Z003624	AQS 3-CHANNEL ROUTER BOARD	
44	1 1	Z12490 Z003624	AQR FRONTPLATE BLIND 7TE AQS 3-CHANNEL ROUTER BOARD	2nd
45	1	Z003349	AQS ADAPTER ROUTER DUAL	
46	1	Z15357	SCHILD PL GE "AQS RACK ON" Z4K-4466 (Marking Z4K-4466 on <i>left</i> side)	2nd
47	1	Z15358	SCHILD PL GE "AQS EXT RACK ON" Z4K-4467 (Marking Z4K-4467 on <i>right</i> side)	2nd
- ^b	12	25958	SCREW RRCH KR M2,5 x 12,3	2nd

a MEC Part: SO = Part contained in AQS MEC-PARTS 2ND CHASSIS (Z14985)

b used for pos. 32, 37, 41, 42, 43 and 44

! *On the AQS User Bus Mainboard Z13601 ECL03 a proposal for the jumper setting is printed that is not valid. Please refer to the following jumper settings:*

Rack 1:

The rack address must be set to '0x1B' (JU1A, JU1B, JU1D and JU1E on the AQS user bus rear side must be closed).

See **"AQS VME and User Bus (rear view)" on page 76.**

Rack 2:

The rack address must be set to '0x1E' (JU1B to JU1E on the AQS user bus rear side must be closed).

See **"AQS VME and User Bus (rear view)" on page 76.**

! **Important Note:**

There are two kinds of guide rails within the AQS rack. Most guide rails are of the standard AQS type (Part-Nm. Z14663). They are used for all full length boards (all digital boards, AQS Reference, AQS SGU, AQS RX). All short boards (AQR RX-22, AQS SADC, AQS HADC/2, AQR FTLP/4M, AQR ROUTER) use commercial type guide rails (Part-Nm. 45456).

To change the guide rails correctly please follow the exact order as described below.

Rack 1:

1. Move guide rail from pos. 64 to pos. 29
2. Move guide rail from pos. 49 to pos. 73
3. Move guide rail from pos. 25 to pos. 37
4. Move guide rail from pos. 43 to pos. 25
5. Move guide rail from pos. 32 to pos. 44

Rack 2:

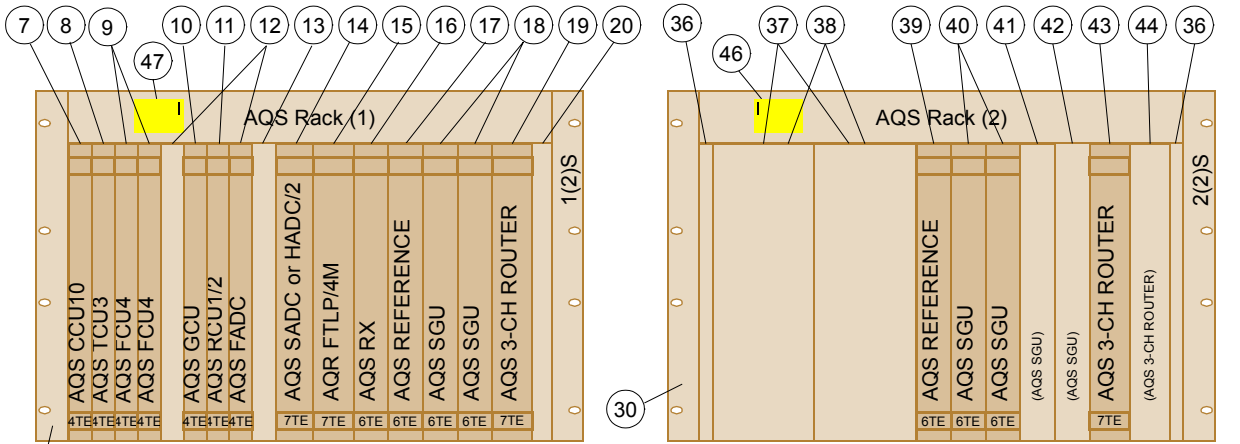
1. Move guide rail from pos. 64 to pos. 69
2. Move guide rail from pos. 21 to pos. 20

AQS Configurations

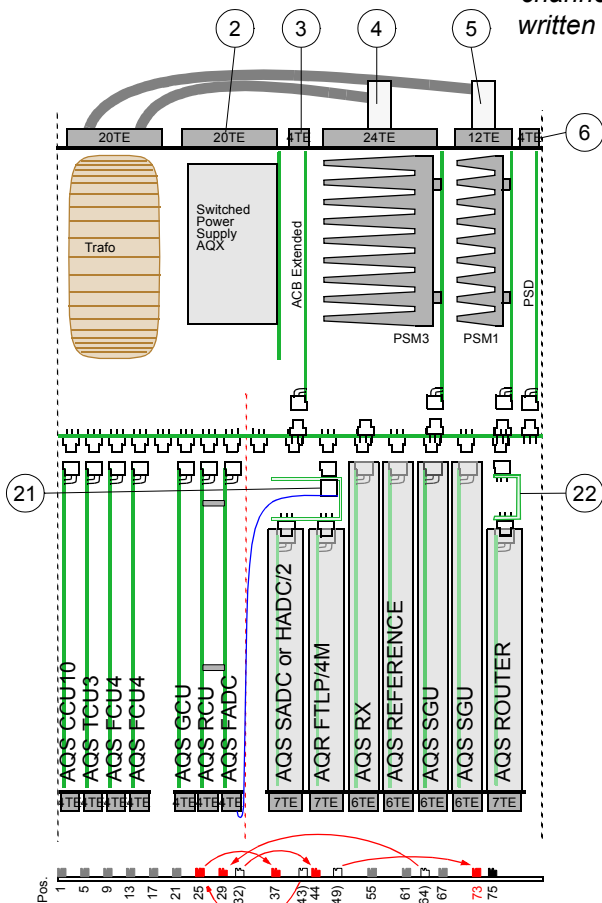
Board Location

2.7.4

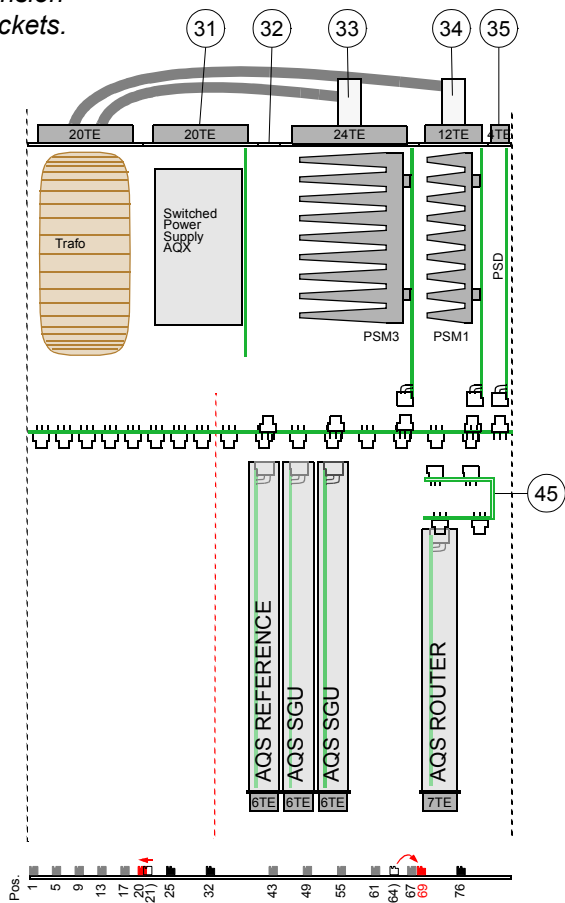
Figure 2.11. for 4 to 6 Channel Solids & HR AVANCE (with RX)



Units for 5th and 6th channel extension written in brackets.



- Guide Rail changes:**
1. Move guide rail from pos. 64 to pos. 29
 2. Move guide rail from pos. 49 to pos. 73
 3. Move guide rail from pos. 25 to pos. 37
 4. Move guide rail from pos. 43 to pos. 25
 5. Move guide rail from pos. 32 to pos. 44



- Guide Rail changes:**
1. Move guide rail from pos. 64 to pos. 69
 2. Move guide rail from pos. 21 to pos. 20

A typical 1 Channel AQS PharmaScan with 1 RX

2.8

Bill of Material

2.8.5

Table 2.11. Bill of material

Pos.	Units	Part Number	Description	MP ^a
1	1	Z003934	AQS CHASSIS MULTI-RX WIRED	
2	1	H9520	AQS POWER SUPPLY DIGITAL 450W	
3	1	H9500	AQS ACB EXTENDED BOARD	
4	1	Z003404	AQS PSM3 POWER SUPPLY MODULE	
5	1	Z003402	AQS PSM1 POWER SUPPLY MODULE	
6	1	H9530	AQS PSD BOARD	
7	1	H9503	AQS CCU10 COM CONTR UNIT	
8	1	H5813	AQS TCU3 TIMING CONTR BOARD	
9	1	H9773	AQS FCU4/2 CONTROLLER BOARD	
10	1	H9506	AQS GCU GRAD CONTR UNIT	
11	2	Z2778	BSMS FRONTPLATE BLIND 4TE	1RX
12	1	Z052488	AQX RCU1/4 RECEIVER CONTROL BD	
13	3	Z14984	AQS FRONTPLATE BLIND 3TE	1RX
14	1	Z003572	AQS HADC/2 ADS937	
15	1	Z003689	AQS RECEIVER BOARD RX-BB	
16	1	Z003642	AQS SGU 400	
17	1	Z003265	AQS REFERENCE BOARD	
18	1	Z100780	AQS TUNING COUPLER	
19	1	Z14984	AQS FRONTPLATE 1MM 16TE	1RX
20	1	Z13644	AQS COVERPLATE 16TE	1RX
21	1	Z14133	AQS FRONTPLATE BLIND 2TE	1RX
22	1	Z003907	AQS ADAPTER HADC/2	
- ^b	6	25958	SCREW RRCH KR M2,5 x 12,3	1RX

a MEC Part: 1RX = Part contained in AQS MEC-PARTS 1RX/1SGU (Z100744)

b used for pos. 11 and 19

The rack address must be set to '0x1F' (JU1A to JU1E on the AQS user bus rear side must be closed).

See **"AQS VME and User Bus (rear view)" on page 76.**

Figure 2.12. AQS for 1 Channel (TX & RX) PharmaScan AVANCE

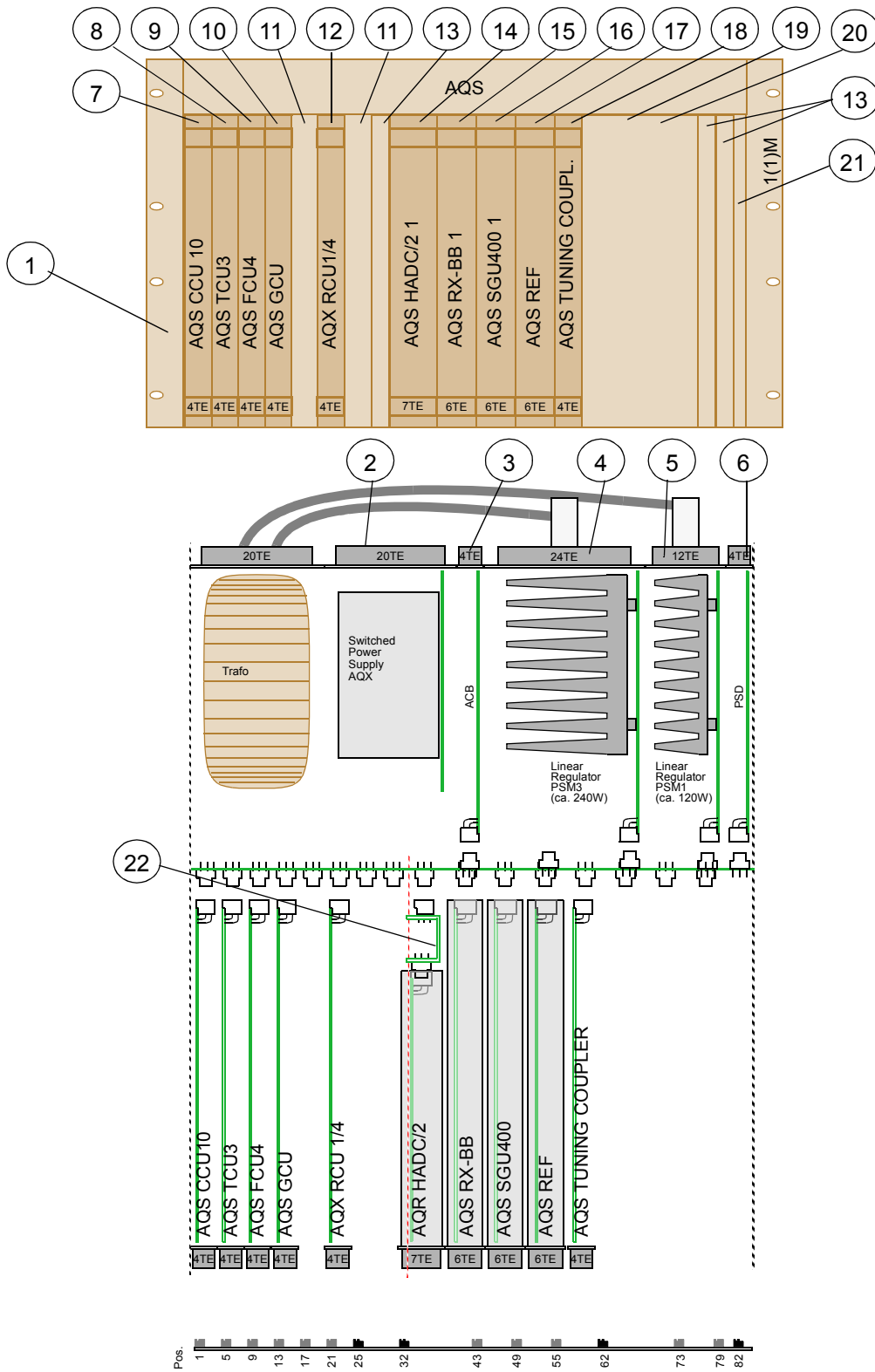


Table 2.12. Bill of material

Pos.	Units	Part Number	Description	MP ^a
1	1	Z003934	AQS CHASSIS MULTI-RX WIRED	
2	1	H9520	AQS POWER SUPPLY DIGITAL 450W	
3	1	H9500	AQS ACB EXTENDED BOARD	
4	1	Z003404	AQS PSM3 POWER SUPPLY MODULE	
5	1	Z003402	AQS PSM1 POWER SUPPLY MODULE	
6	1	H9530	AQS PSD BOARD	
7	1	H9503	AQS CCU10 COM CONTR UNIT	
8	1	H5813	AQS TCU3 TIMING CONTR BOARD	
9	1	H9773	AQS FCU4/2 CONTROLLER BOARD	
10	1	H9506	AQS GCU GRAD CONTR UNIT	
11	1	Z032488	AQX ECU EXT SYN CONTROL UNIT	
12	1	Z052488	AQX RCU1/4 RECEIVER CONTROL BD	
	1	Z062488	AQX RCU2/4 RECEIVER CONTROL BD	
13	2	Z003572	AQS HADC/2 ADS937	
14	2	Z003689	AQS RECEIVER BOARD RX-BB	
15	2	Z003642	AQS SGU 400	
16	1	Z003265	AQS REFERENCE BOARD	
17	2	Z14984	AQS FRONTPLATTE BLIND 3TE	2RX
18	1	Z13644	AQS FRONTPLATE BLIND 2TE	2RX
19	1	Z2778	BSMS FRONTPLATE BLIND 4TE	2RX
20	2	Z003907	AQS ADAPTER HADC/2	
21	1	47040	ST KOAX ADAPT SMA-I SFT-SFT	2RX
22	1	20910	HYBRID SPLITTER ZFSC-2-4	2RX
- ^b	2	25958	SCREW RRCH KR M2,5 x 12,3	2RX

a MEC Part: 2RX = Part contained in AQS MEC-PARTS 2RX/2SGU (Z15319)

b used for pos. 19

User Bus Modification (Chassis Z003414 only)

2.9.2

The AQS USER BUS SINGLE RX RACK (Z13601) in the AQS CHASSIS WIRED (Z003414) must be modified for Multi-RX applications as follows:

- Remove the resistors R6...R22 (17 pcs.)
- Add the resistors R65...R77 (13 pcs., 820ohm, 0603)

The resistors are located on the backside of the AQS USER BUS. R6..R22 are between J7 and J8, R65..R77 are left of J11.

! **Attention: Observe precautions for handling electrostatic sensitive devices (ESD).**

Jumper Setting

2.9.3

The rack address must be set to '0x1F' (JU1A to JU1E on the AQS user bus rear side must be closed).

See **"AQS VME and User Bus (rear view)" on page 76.**

Guide Rail changes (Chassis Z003414 only)

2.9.4

Move guide rails from:

- pos. 61 to pos. 79
- pos. 64 to pos. 62
- pos. 67 to pos. 73

Remove guide rail at pos. 76

External LO 2 Splitter

2.9.5

To supply two AQS RX with one Reference Board, the LO 2 signal has to be split with an external hybrid splitter.

Mount the external splitter (pos. 22) with the SMA-Adapter (pos. 21) onto J5 (LO 2) of the Reference Board.

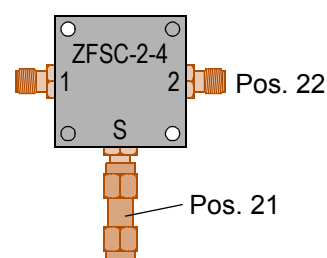
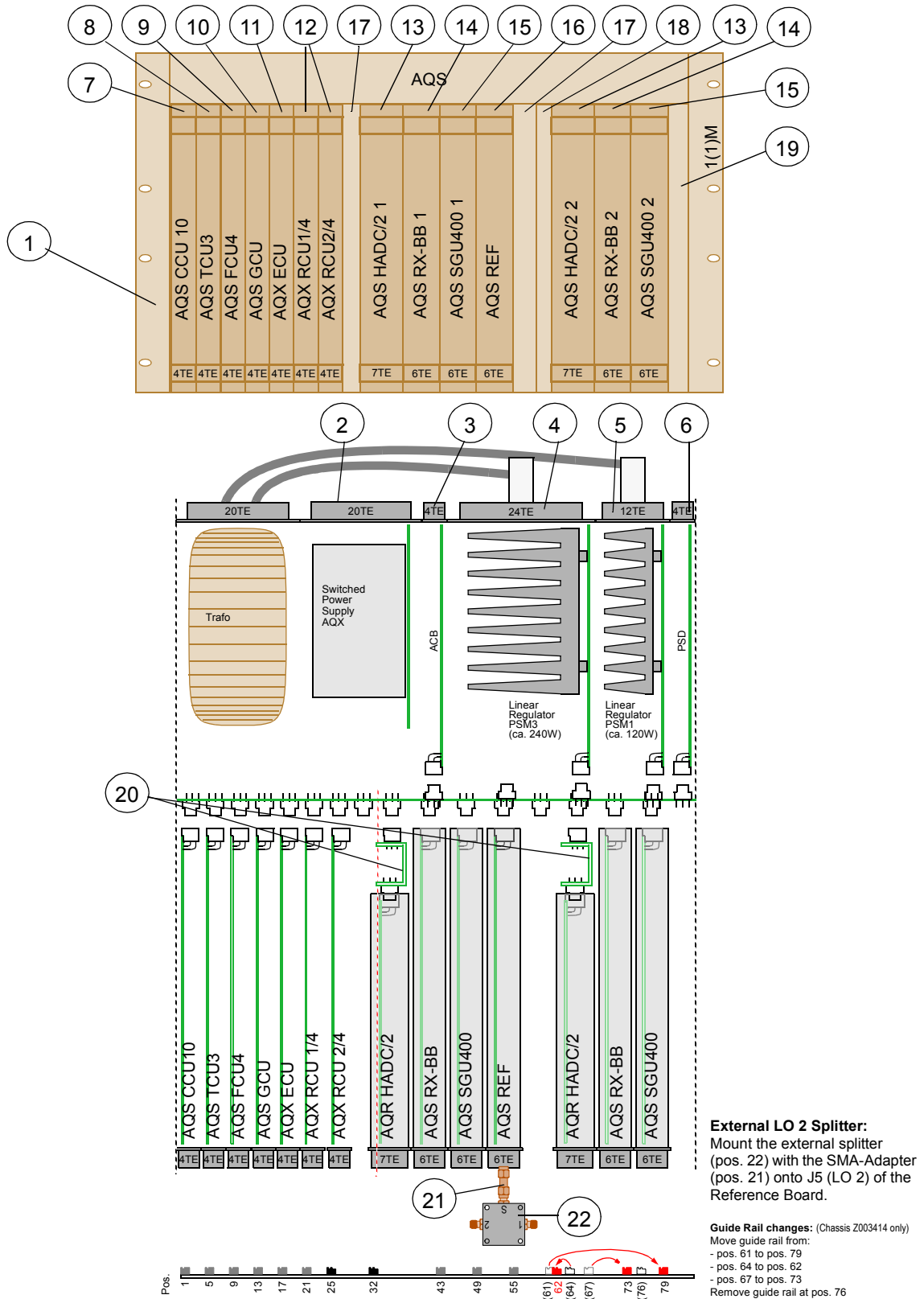


Figure 2.13. AQS for 2 Channel (TX & RX) BioSpec AVANCE



A typical 4 Channel AQS BioSpec (with 4 RX)

2.10

Bill of Material

2.10.1

Table 2.13. Bill of material: Rack 1

Pos.	Units	Part Number	Description	MP ^a
1	1	Z003934	AQS CHASSIS MULTI-RX WIRED	
2	1	H9520	AQS POWER SUPPLY DIGITAL 450W	
3	1	H9500	AQS ACB EXTENDED BOARD	
4	1	Z003404	AQS PSM3 POWER SUPPLY MODULE	
5	1	Z003402	AQS PSM1 POWER SUPPLY MODULE	
6	1	H9530	AQS PSD BOARD (ECL >= 01 required)	
7	1	H9503	AQS CCU10 COM CONTR UNIT	
8	1	H5813	AQS TCU3 TIMING CONTR BOARD	
9	1	H9727	AQS FCU4/4 CONTROLLER BOARD	
10	1	H9506	AQS GCU GRAD CONTR UNIT	
11	1	Z052488	AQX RCU1/4 RECEIVER CONTROL BD	
12	2	Z14984	AQS FRONTPLATE BLIND 3TE	4RX
13	2	Z13644	AQS FRONTPLATE BLIND 2TE	4RX
14	1	Z003572	AQS HADC/2 ADS937	
15	1	Z003688	AQS RECEIVER BOARD RX400	
16	1	Z003642	AQS SGU 400	
17	1	Z003572	AQS HADC/2 ADS937	
18	1	Z003688	AQS RECEIVER BOARD RX400	
19	1	Z003642	AQS SGU 400	
20	1	Z2778	BSMS FRONTPLATE BLIND 4TE	4RX
21	2	Z003892	AQS ADAPTER FADC+ADC+FTLP-4M	
- ^b	2	25958	SCREW RRCH KR M2,5 x 12,3	4RX

a MEC Part: 4RX = Part contained in AQS MEC-PARTS 4-RX (Z100745)

b used for pos. 20

AQS Configurations

Table 2.14. Bill of material: Rack 2

Pos.	Units	Part Number	Description	MP ^a
30	1	Z003934	AQS CHASSIS MULTI-RX WIRED	
31	1	H9520	AQS POWER SUPPLY DIGITAL 450W	
32	1	Z2778	BSMS FRONTPLATE BLIND 4TE	4RX
33	1	Z003404	AQS PSM3 POWER SUPPLY MODULE	
34	1	Z003402	AQS PSM1 POWER SUPPLY MODULE	
35	1	H9530	AQS PSD BOARD (ECL >= 01 required)	
36	1	Z14984	AQS FRONTPLATE BLIND 3TE	4RX
37	1	Z15201	AQS FRONTPLATE 1MM 16TE	4RX
38	1	Z15202	AQS COVERPLATE 16TE	4RX
39	1	Z14119	AQS FRONTPLATE 1MM 12TE	4RX
40	1	Z14120	AQS COVERPLATE 8TE	4RX
41	1	Z003572	AQS HADC/2 ADS937	
42	1	Z003688	AQS RECEIVER BOARD RX400	
43	1	Z003642	AQS SGU 400	
44	1	Z003265	AQS REFERENCE BOARD 400 (ECL >= 03 required)	
45	1	Z100477	AQS REFERENCE SPLITTER	
46	1	Z003572	AQS HADC/2 ADS937	
47	1	Z003688	AQS RECEIVER BOARD RX400	
48	1	Z003642	AQS SGU 400	
49	1	Z2778	BSMS FRONTPLATE BLIND 4TE	4RX
50	1	Z15357	SCHILD PL GE "AQS RACK ON" Z4K-4466 (Marking Z4K-4466 on <i>left</i> side)	4RX
51	1	Z15358	SCHILD PL GE "AQS EXT RACK ON" Z4K-4467 (Marking Z4K-4467 on <i>right</i> side)	4RX
52	2	Z003892	AQS ADAPTER FADC+ADC+FTLP-4M	
- ^b	6	25958	SCREW RRCH KR M2,5 x 12,3	4RX

a MEC Part: 4RX = Part contained in AQS MEC-PARTS 4RX/4sgu (Z100745)

b used for pos. 32, 37, 39 and 49

! On the AQS User Bus Mainboard Z13601 ECL03 a proposal for the jumper setting is printed that is not valid. Please refer to the following jumper settings:

Rack 1:

The rack address must be set to '0x1A' (JU1A, JU1B, JU1C and JU1E on the AQS user bus rear side must be closed).

See "[AQS VME and User Bus \(rear view\)](#)" on page 76.

Rack 2:

The rack address must be set to '0x1E' (JU1B to JU1E on the AQS user bus rear side must be closed).

See "[AQS VME and User Bus \(rear view\)](#)" on page 76.

! **Important Note:**

There are two kinds of guide rails within the AQS rack. Most guide rails are of the standard AQS type (Part-Nm. Z14663). They are used for all full length boards (all digital boards, AQS Reference, AQS SGU, AQS RX). All short boards (AQR RX-22, AQS SADC, AQS HADC/2, AQR FTLP/4M, AQR ROUTER) use commercial type guide rails (Part-Nm. 45456).

To change the guide rails correctly please follow the exact order as described below.

Rack 1:

1. Move guide rail from pos. 32 to pos. 29
2. Move guide rail from pos. 76 to pos. 38
3. Remove guide rail from pos. 43

Rack 2:

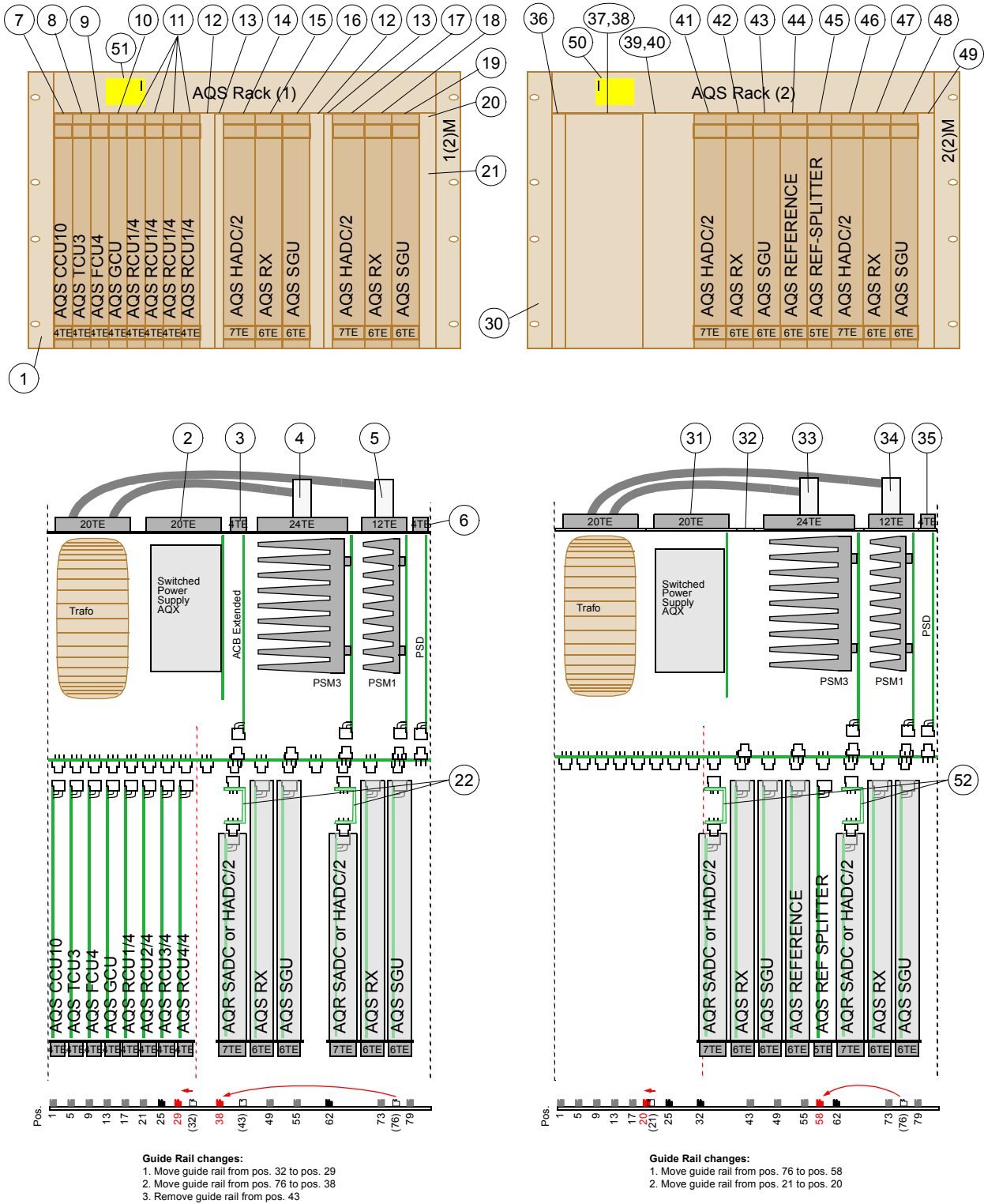
1. Move guide rail from pos. 76 to pos. 58
2. Move guide rail from pos. 21 to pos. 20

AQS Configurations

Board Location

2.10.4

Figure 2.14. for 4 Channel BioSpec (with 4 RX) AVANCE



A typical 1 and 2 Channel AQS FTMS

2.11

Bill of Material

2.11.1

Table 2.15. Bill of material

Pos.	Units	Part Number	Description <i>Units for 2nd channel extension written in italics.</i>	MP ^a
1	1	Z003414	AQS CHASSIS WIRED (ECL >= 04 required)	
2	1	H9489	AQS POWER SUPPLY DIGITAL 350W	
3	2	Z12170	BSMS FRONTPLATE BLIND 12TE	
4	1	Z003403	AQS PSM2 POWER SUPPLY MODULE	
5	1	Z003402	AQS PSM1 POWER SUPPLY MODULE	
6	1	A3144	AQS FTMS PSD	
7	1	H9503	AQS CCU10 COM CONTR UNIT	
8	1	H5813	AQS TCU3 TIMING CONTR BOARD	
9	1	H9773	AQS FCU4/2 CONTROLLER BOARD	
10	1	Z14118	AQS FRONTPLATE BLIND 8TE	
11	<i>1</i>	<i>Z022488</i>	<i>AQR RCU1/3 RECEIVER CONTROL BD</i>	
12	1	H9685	AQS FADC BOARD	
13	1	Z003570	AQS SADC	
14	1	Z002812	AQR FT-FILTER BOARD SOLID	
15	1	A3147	AQS FTMS RECEIVER BOARD	
16	1	Z003265	AQS REFERENCE BOARD 400	
17	1	Z003643	AQS SGU FTMS	
18	1	Z15201	AQS FRONTPLATE 1MM 16TE	
19	1	Z15202	AQS COVERPLATE 16TE	
20	1	Z14133	AQS FRONTPLATE BLIND 2TE	
21	1 <i>1</i>	Z12489 <i>Z003643</i>	AQR FRONTPLATE BLIND 6TE <i>AQS SGU FTMS</i>	
22	1	Z003892	AQS ADAPTER FADC+ADC/FTLP-4M	
- ^b	16	25958	SCREW RRCH KR M2,5 x 12,3	
-	2	Z14663	AQS GUIDE RAIL	
-	2	45867	PT-SCREW KA K25X14	

- a MEC Part: Not decided yet
- b used for pos. 21

Jumper Setting

2.11.2

The rack address must be set to '0x1D' (JU1A and JU1C to JU1E on the AQS user bus rear side must be closed).

See "[**AQS VME and User Bus \(rear view\)**](#)" on page 76.

Guide Rail changes

2.11.3

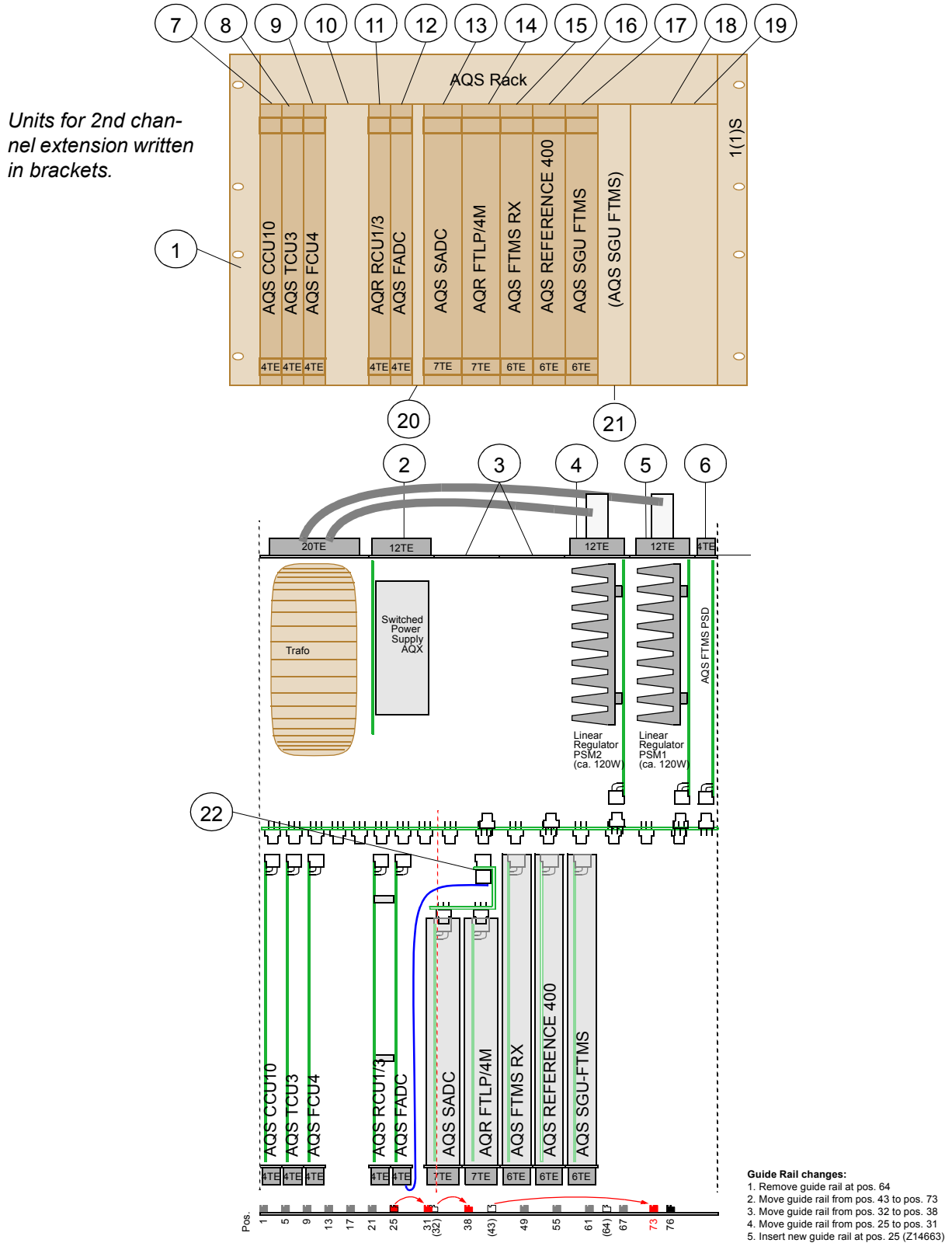
! ***Important Note:***

There are two kinds of guide rails within the AQS rack. Most guide rails are of the standard AQS type (Part-Nm. Z14663). They are used for all full length boards (all digital boards, AQS Reference, AQS SGU, AQS RX). All short boards (AQR RX-22, AQS SADC, AQS HADC/2, AQR FTLP/4M, AQR ROUTER) use commercial type guide rails (Part-Nm. 45456).

To change the guide rails correctly please follow the exact order as described below.

1. Remove guide rail at pos. 64
2. Move guide rail from pos. 43 to pos. 73
3. Move guide rail from pos. 32 to pos. 38
4. Move guide rail from pos. 25 to pos. 31
5. Insert new guide rail at pos. 25 (Z14663)

Figure 2.15. AQS for 1 and 2 Channel FTMS AVANCE

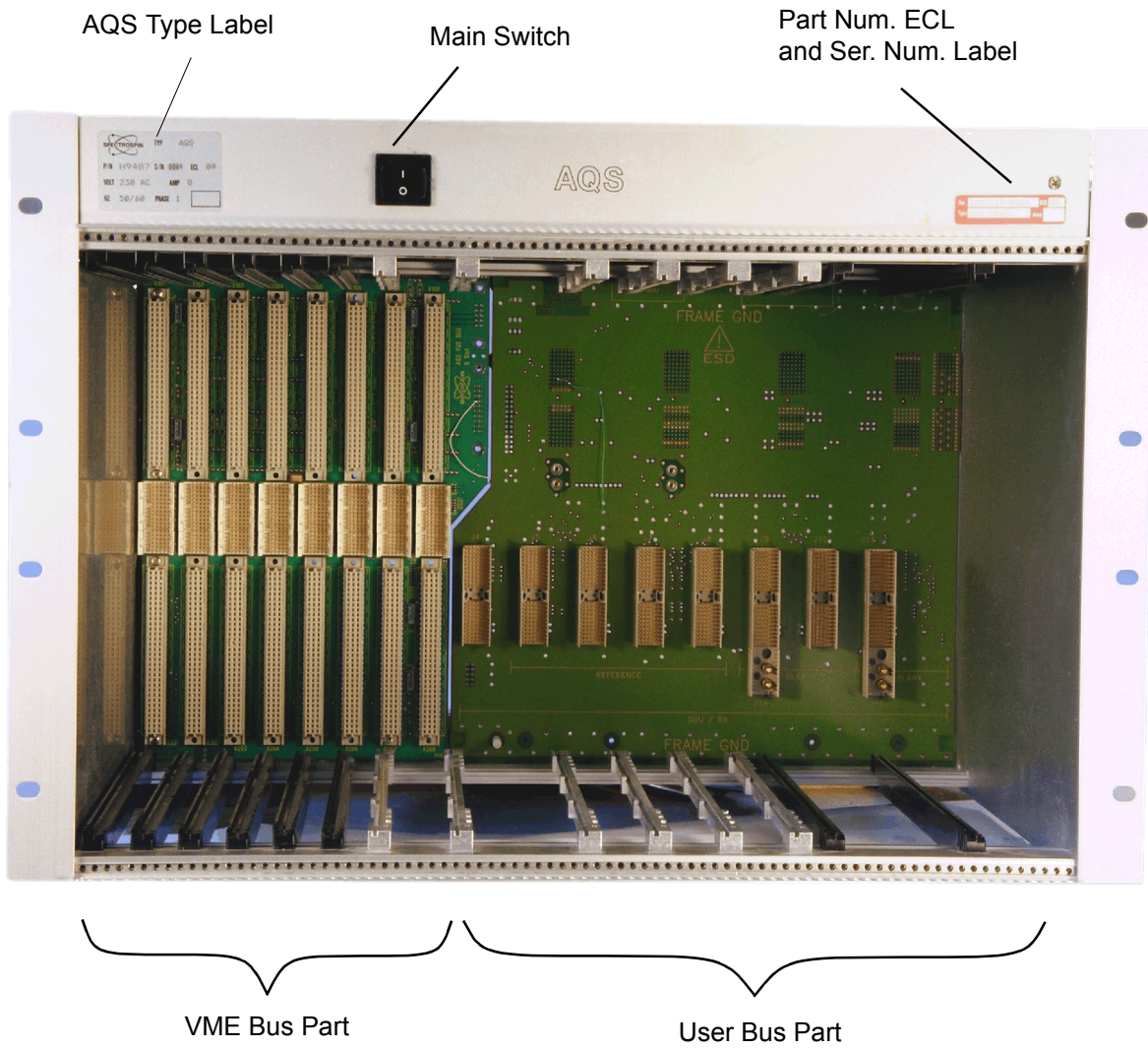


The AQS mainframe consists of a VME part and a user part (8slots). The VME part can be equipped with up to 8 VME boards (e.g. CCU, FCU, TCU, GCU, RCU). The user part is designed to be equipped with AQS RF units (e.g. SGU, Reference Board, AQS RX). Also AQR units such as RX22, 3-Channel Router, SADC, HADC/2 do fit into the AQS mainframe, however in this case special adapters (***"Adapters" on page 93***) are necessary.

On the rear side, linear power supply modules (PSM1, PSM2, PSM3) and switched power supply modules for the VME part and for the internal RF power amplifiers are placed. Also different distribution and amplifier control boards (PSD, ACB Standard, ACB Extended) depending on the rack configuration (***"AQS Configurations" on page 27***) fit into the chassis.

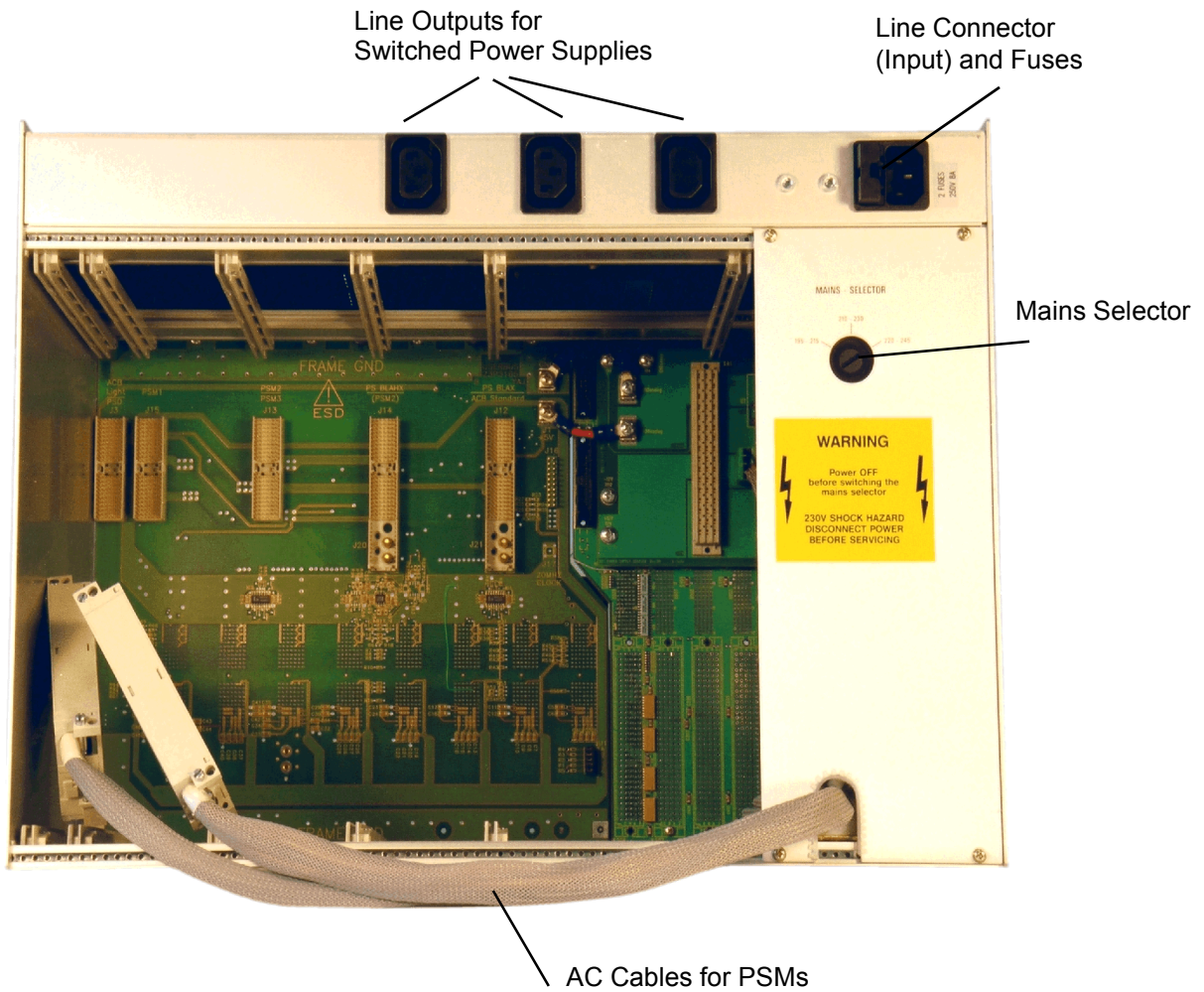
The transformer, which feeds the linear power supply modules, is part of the mainframe and is located on the rear side.

Figure 3.1. AQS Chassis front view



The rear view shows the power supply unit, housing of the power supply boards. On the right hand side is the transformer housing located with the appropriate AC cables.

Figure 3.2. AQS Chassis rear view



Preparation for Use

3.4

Prior to the first power-up of the AQS mainframe, it must be ensured that the mains selection switch is in the correct position. (see selector on the back side of the AQS)

The size of the linear power supply modules is designed for minimal power dissipation; therefore the transformer input voltage should be matched to the mains voltage at the installation site.

Generally, the mains selection switch should be set to the corresponding voltage range, even if the mains power is weak (max. fluctuations $\pm 6\%$).

- factory configuration: 220 - 245V

AC Power Line Fuses

3.5

The AQS is protected by two fuses as specified on the power supply name-plate. The fuses are located in a removable fuse holder next to the AC power connector.

Figure 3.3. AQS AC Wiring

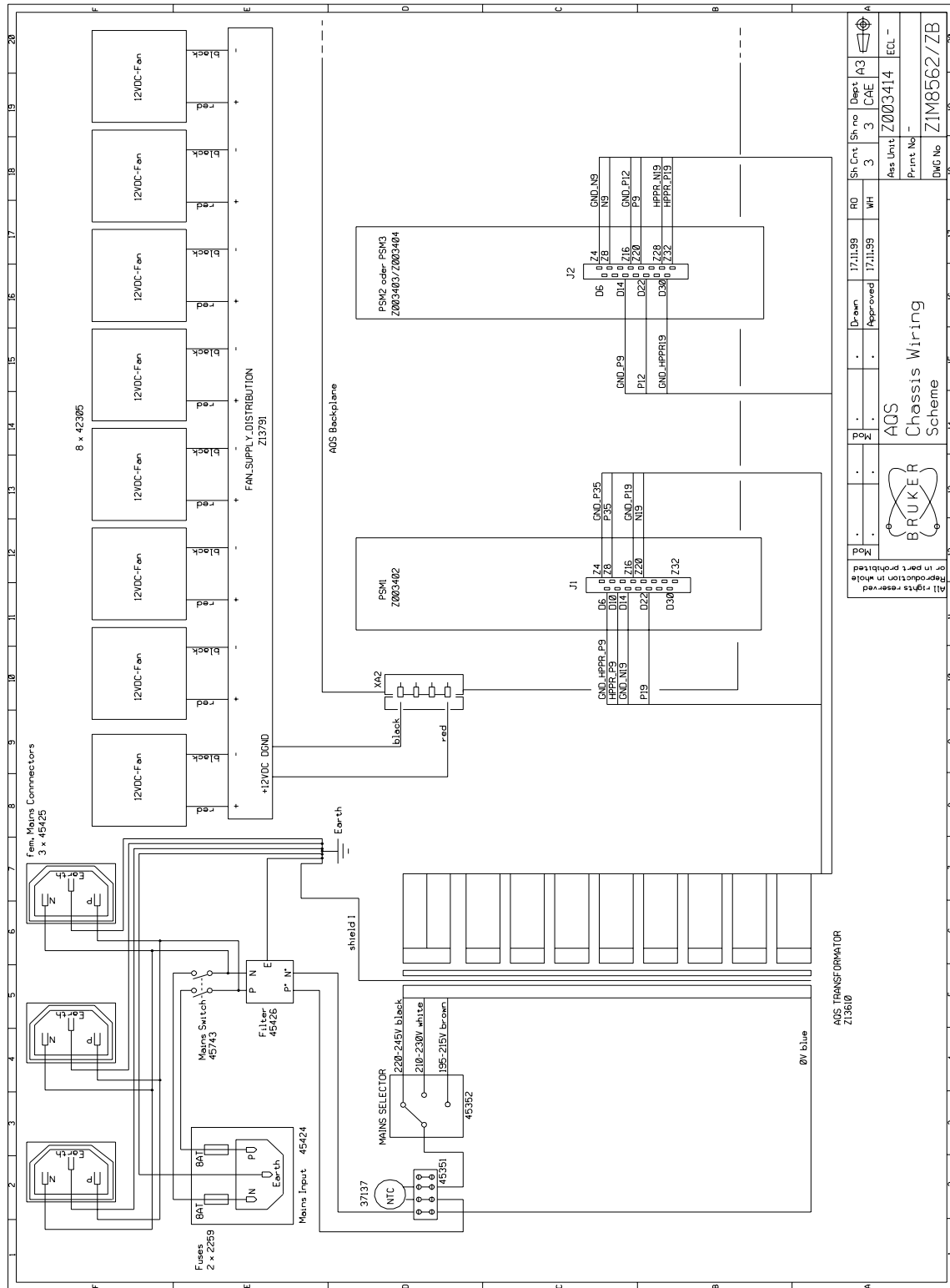


Figure 3.4. AQS Fans



The User Bus is designed to route all specific signals and power supplies to the specific boards. It represents the ground point of the AQS and is connected to the chassis frame. For detailed information about user bus signals see "[AQS signal path](#)" on page 15, "[Synchronous signals](#)" on page 19 and "[20MHz Clock Distribution](#)" on page 24

Figure 3.5. AQS VME and User Bus (front view)

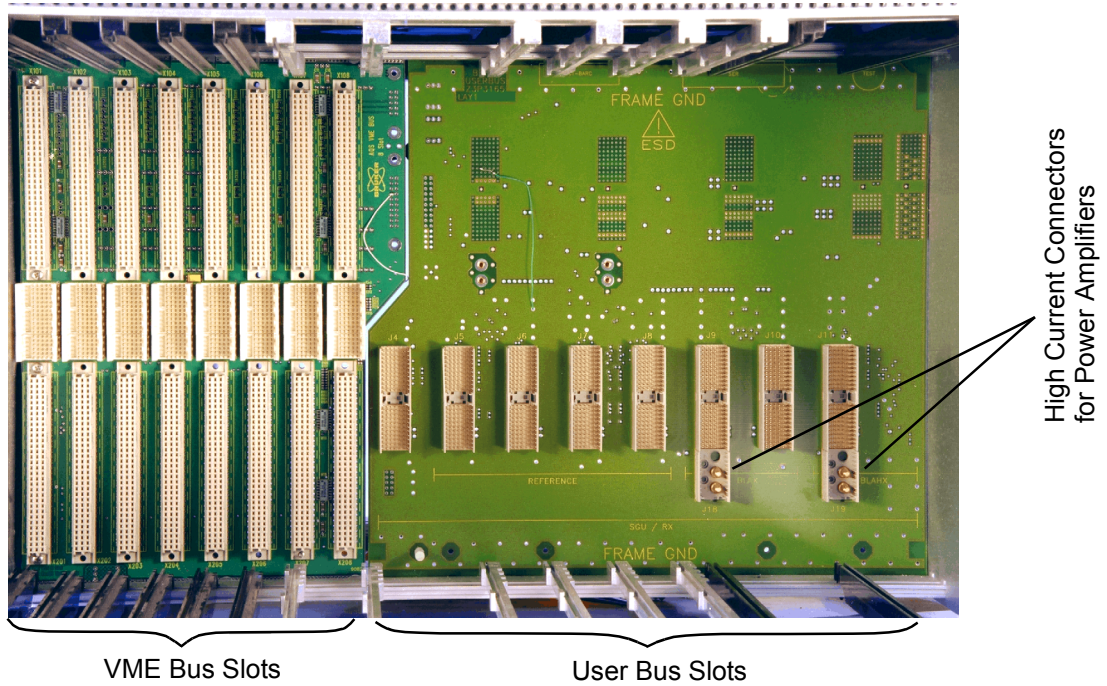


Figure 3.6. AQS VME and User Bus (rear view)

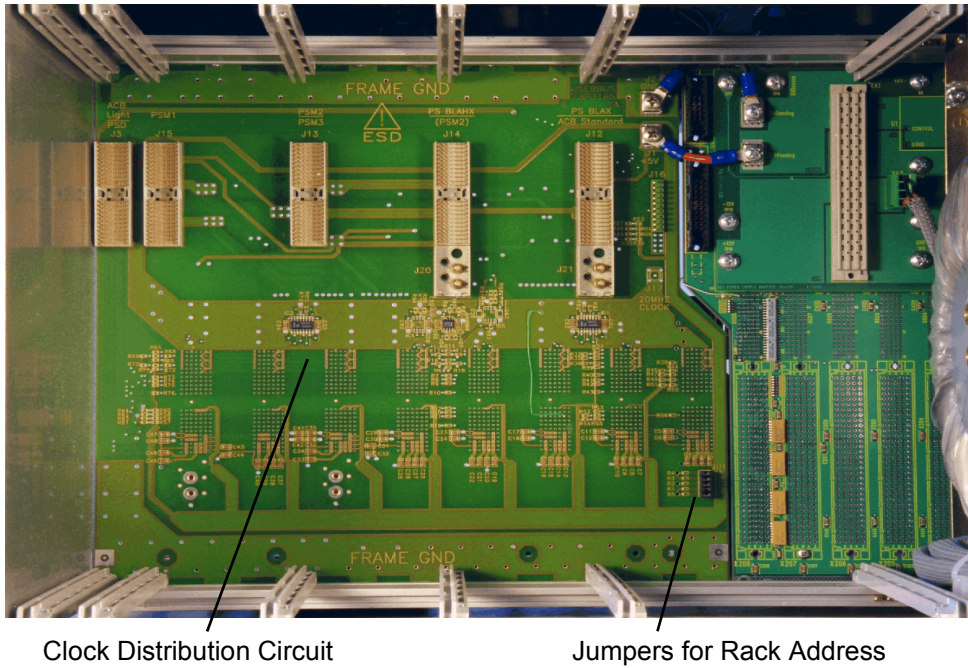


Figure 3.7. User Bus Block Diagram

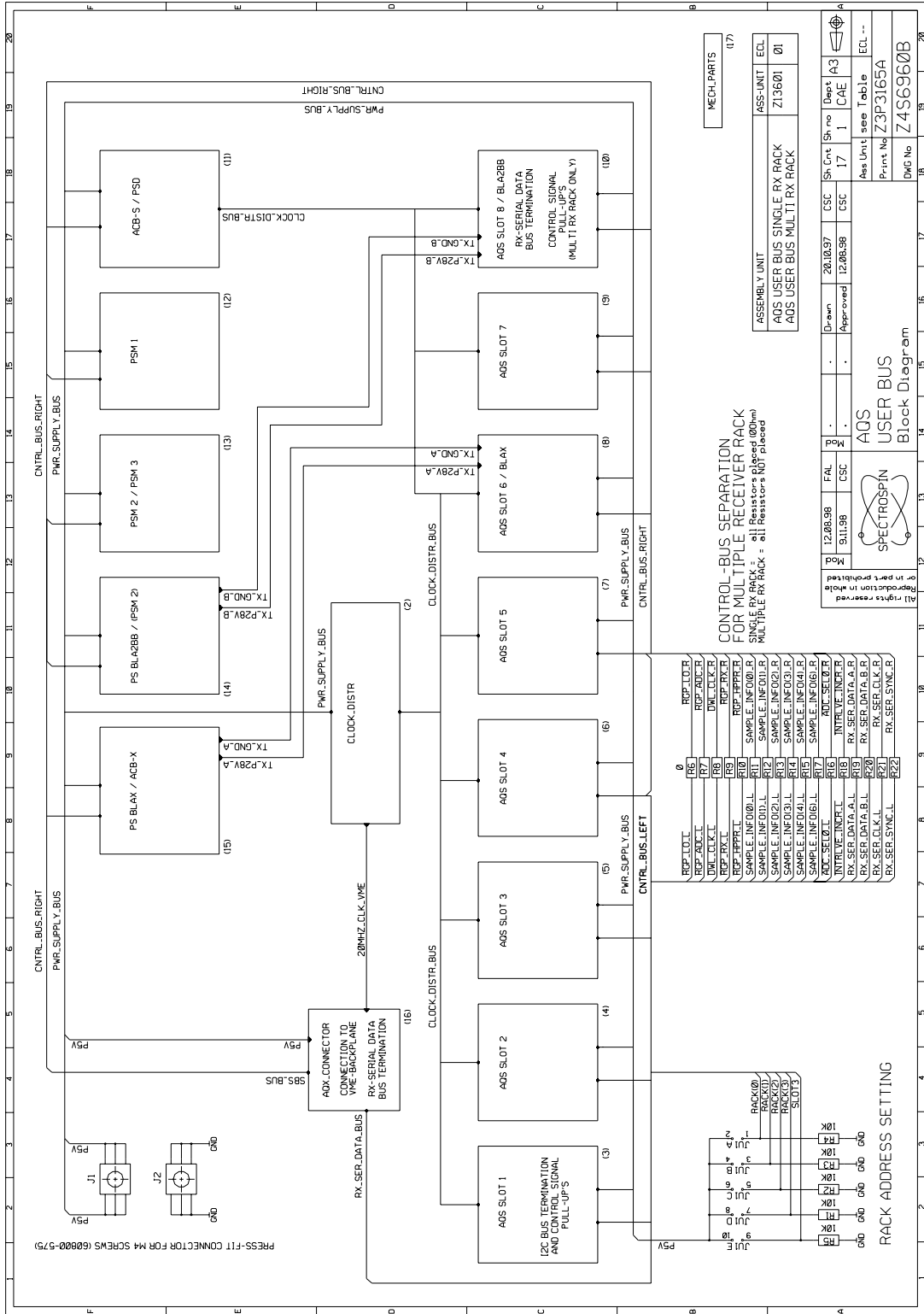
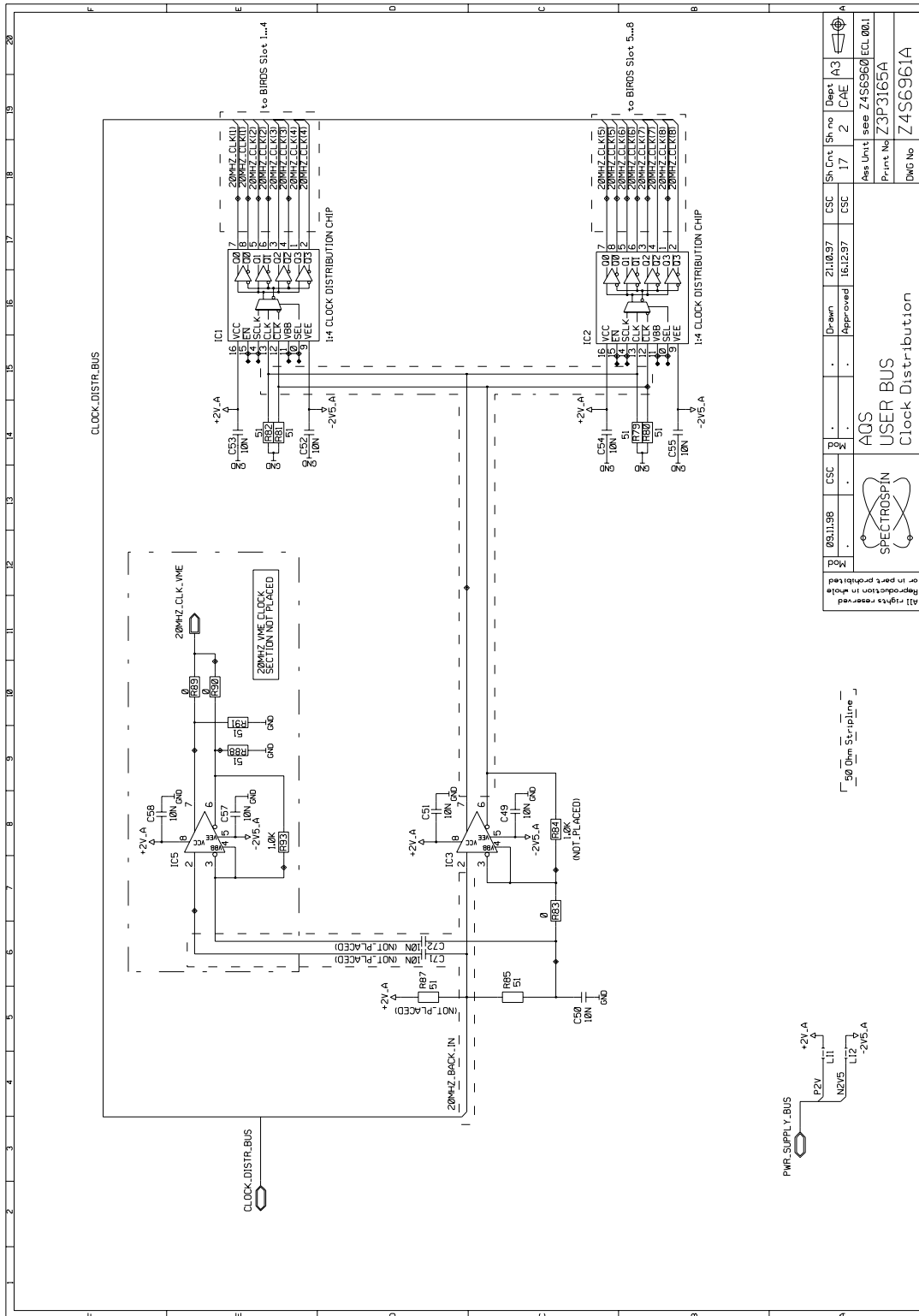


Figure 3.8. Clock Distribution



Mod	0811.98	CSC		Mod				
Drawn		21.03.97	CSC	Sh. no	17	Dept	CAE	A3
Approved		16.12.97	CSC	Ass. Unit	see Z456960	ECL	0001	
				USER BUS				
				Clock Distribution				
				Print No	Z3P3165A			
				DWG No	Z4S6961A			

Figure 3.9. User Bus Slot 1

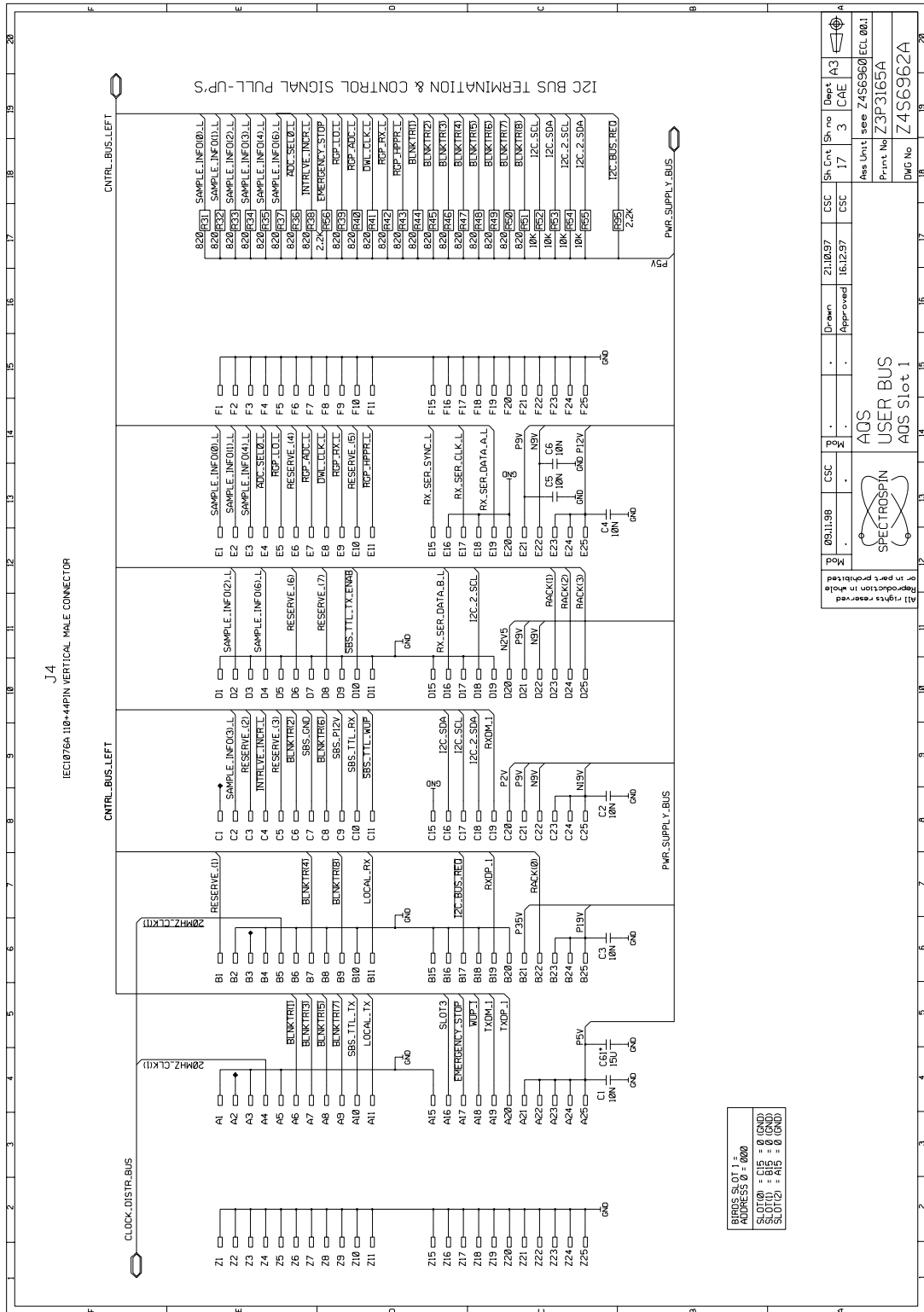


Figure 3.10. User Bus Slot 2

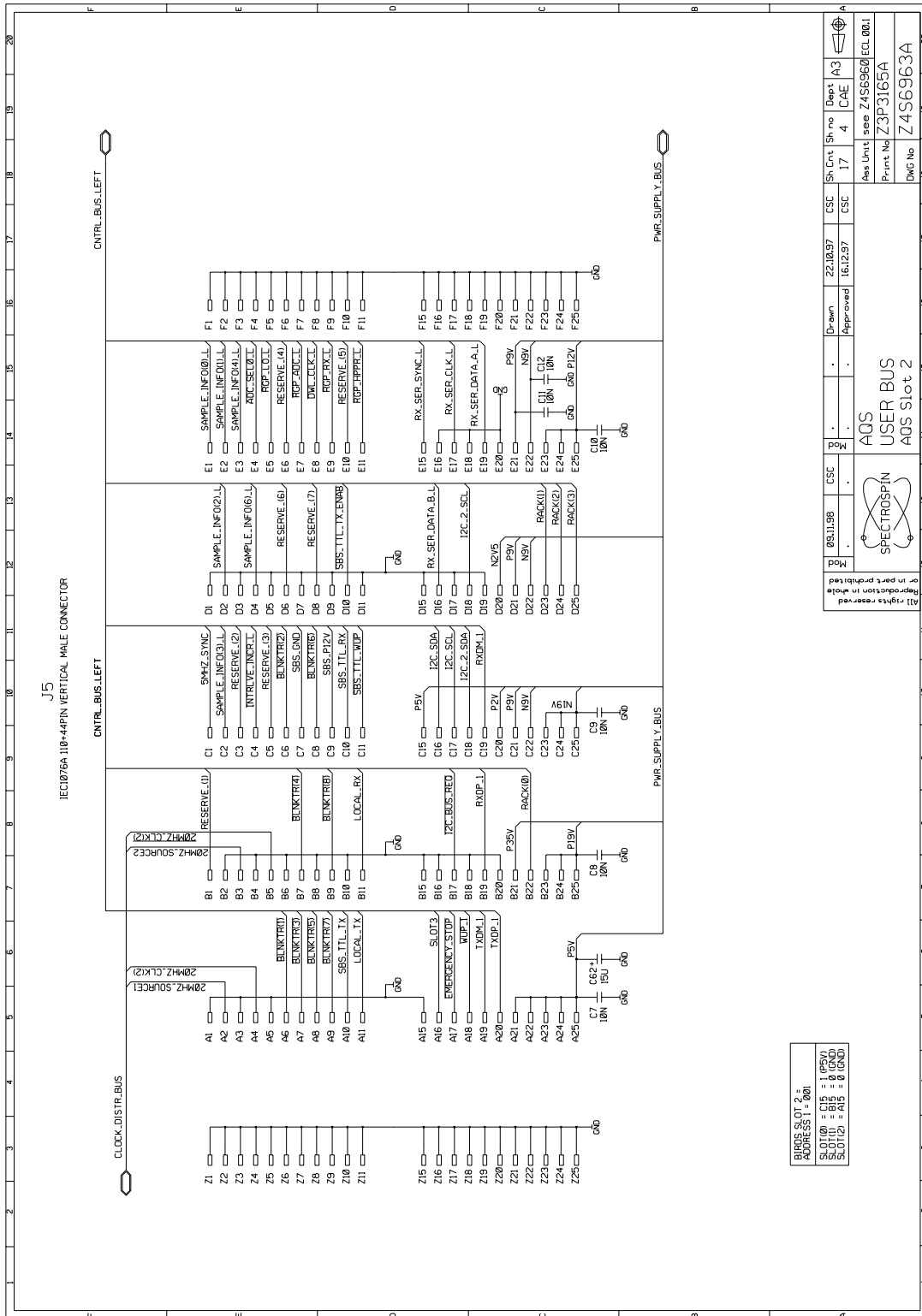


Figure 3.11. User Bus Slot 3

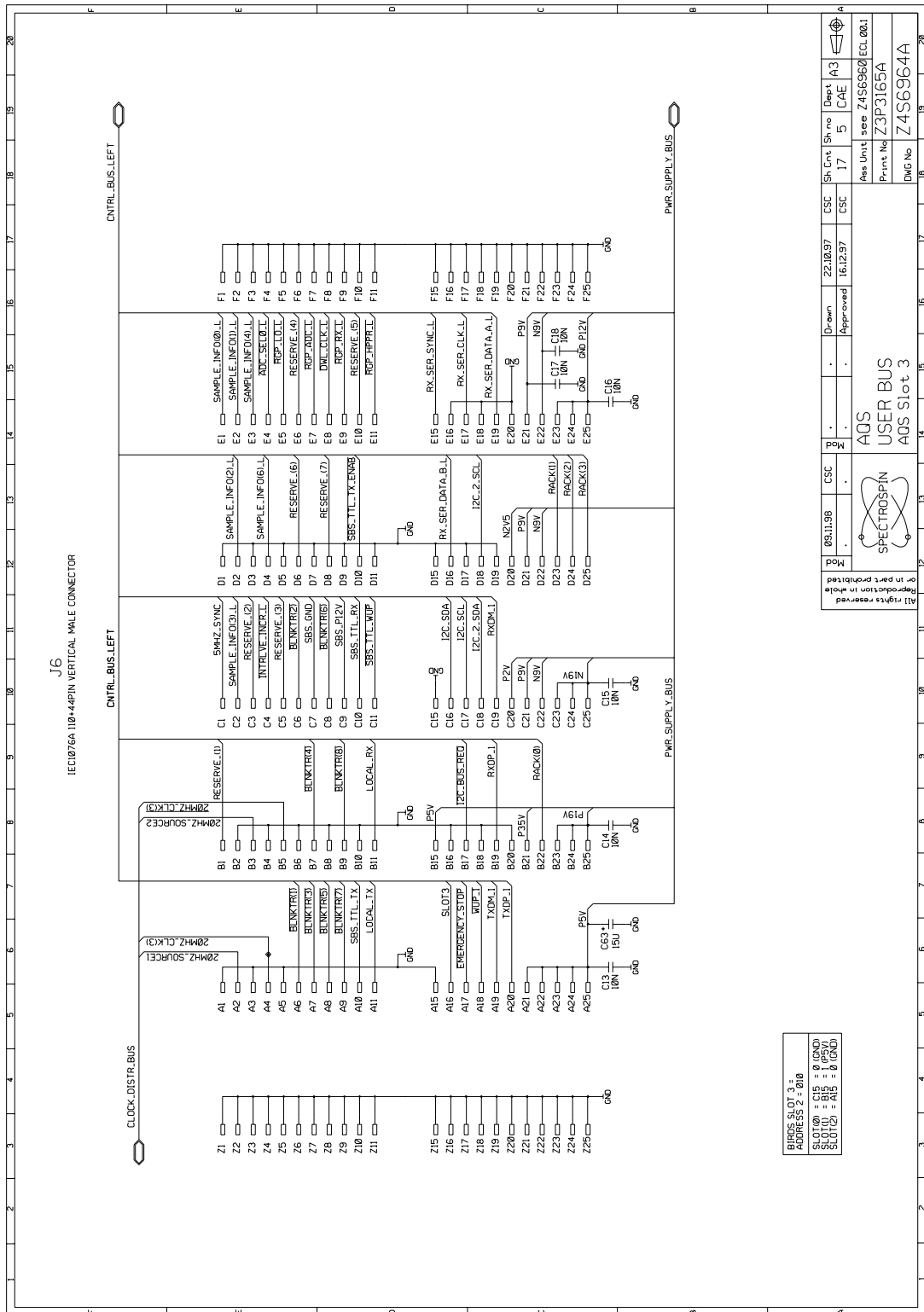


Figure 3.12. User Bus Slot 4

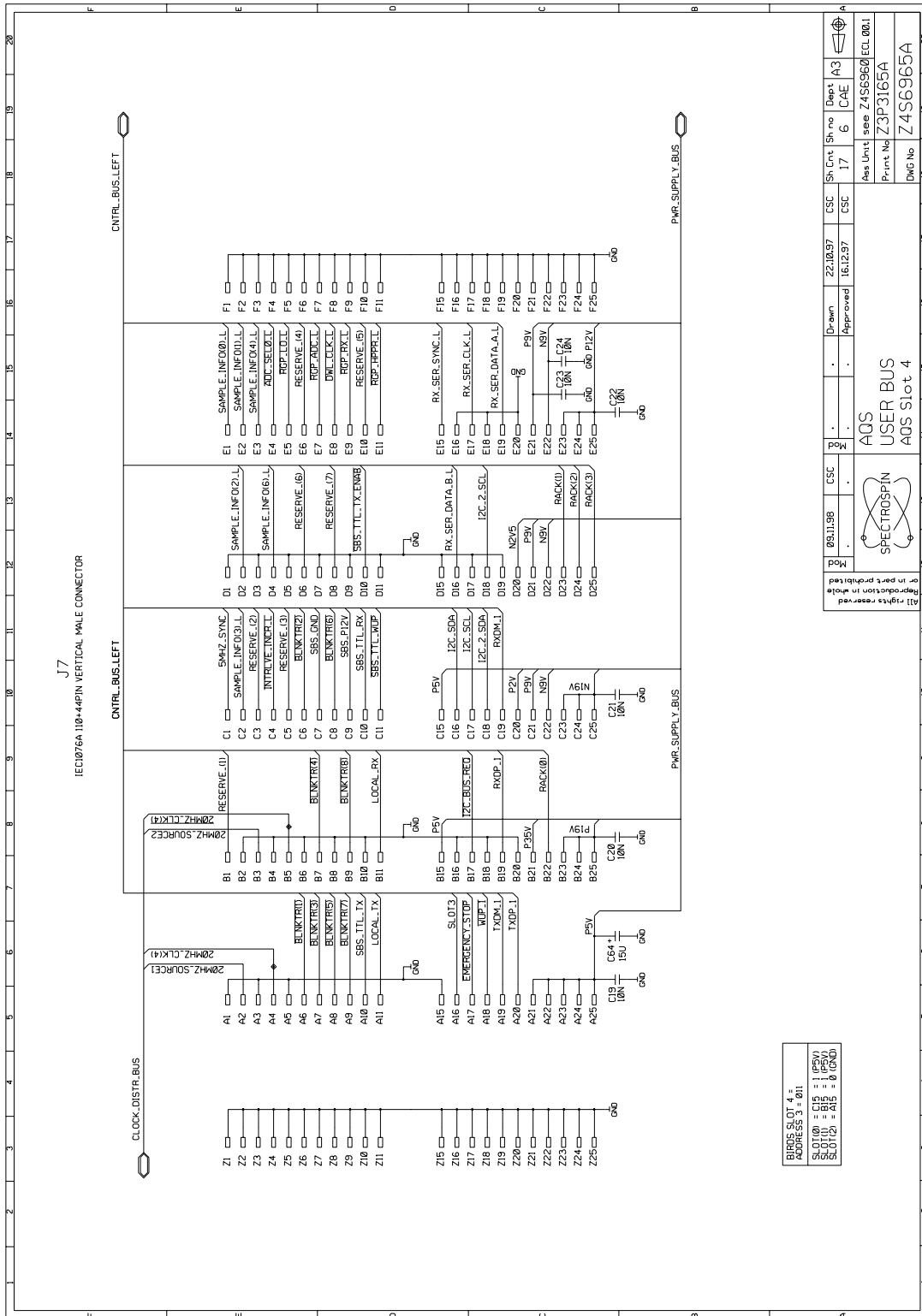


Figure 3.14. User Bus Slot 6

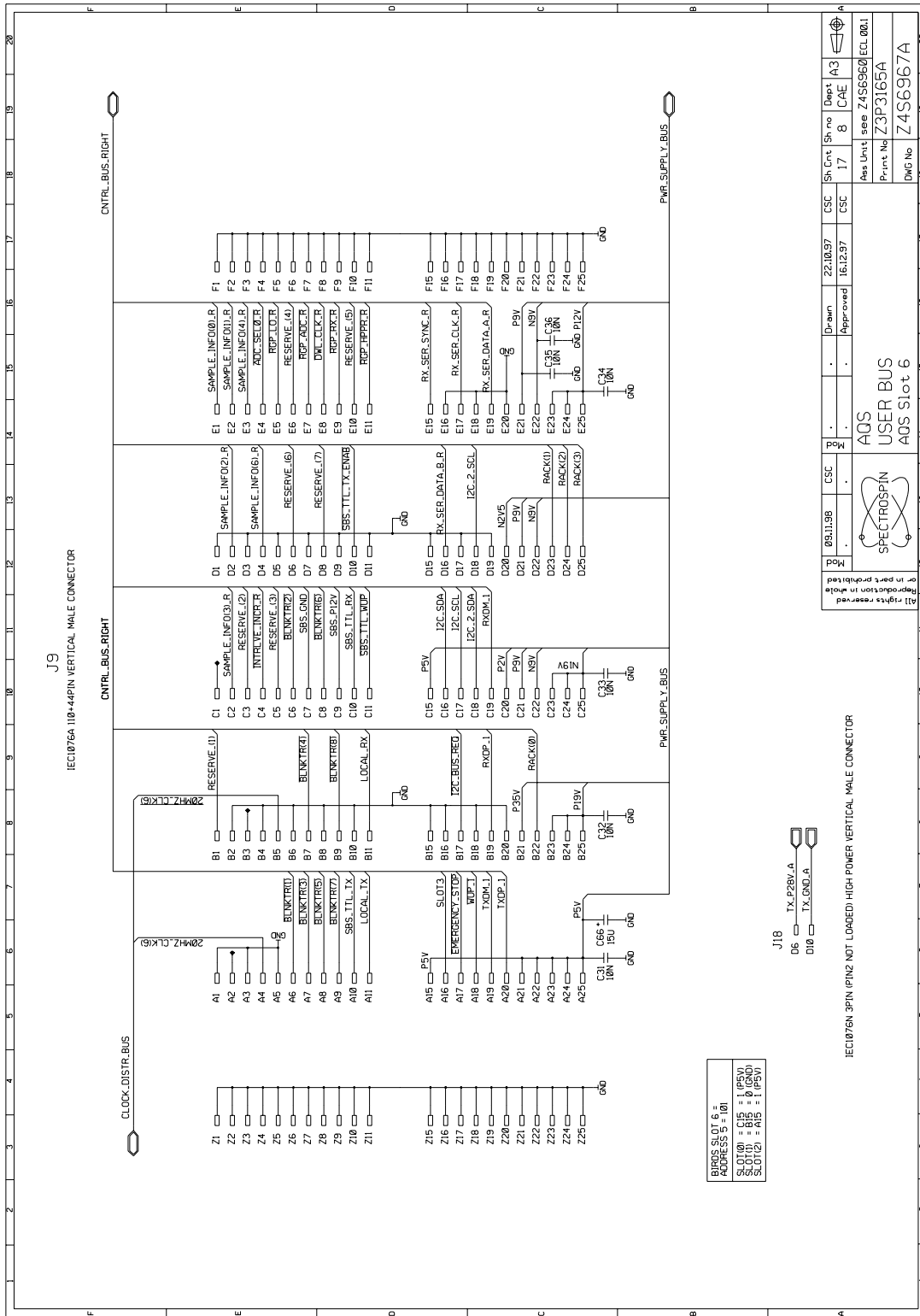


Figure 3.15. User Bus Slot 7

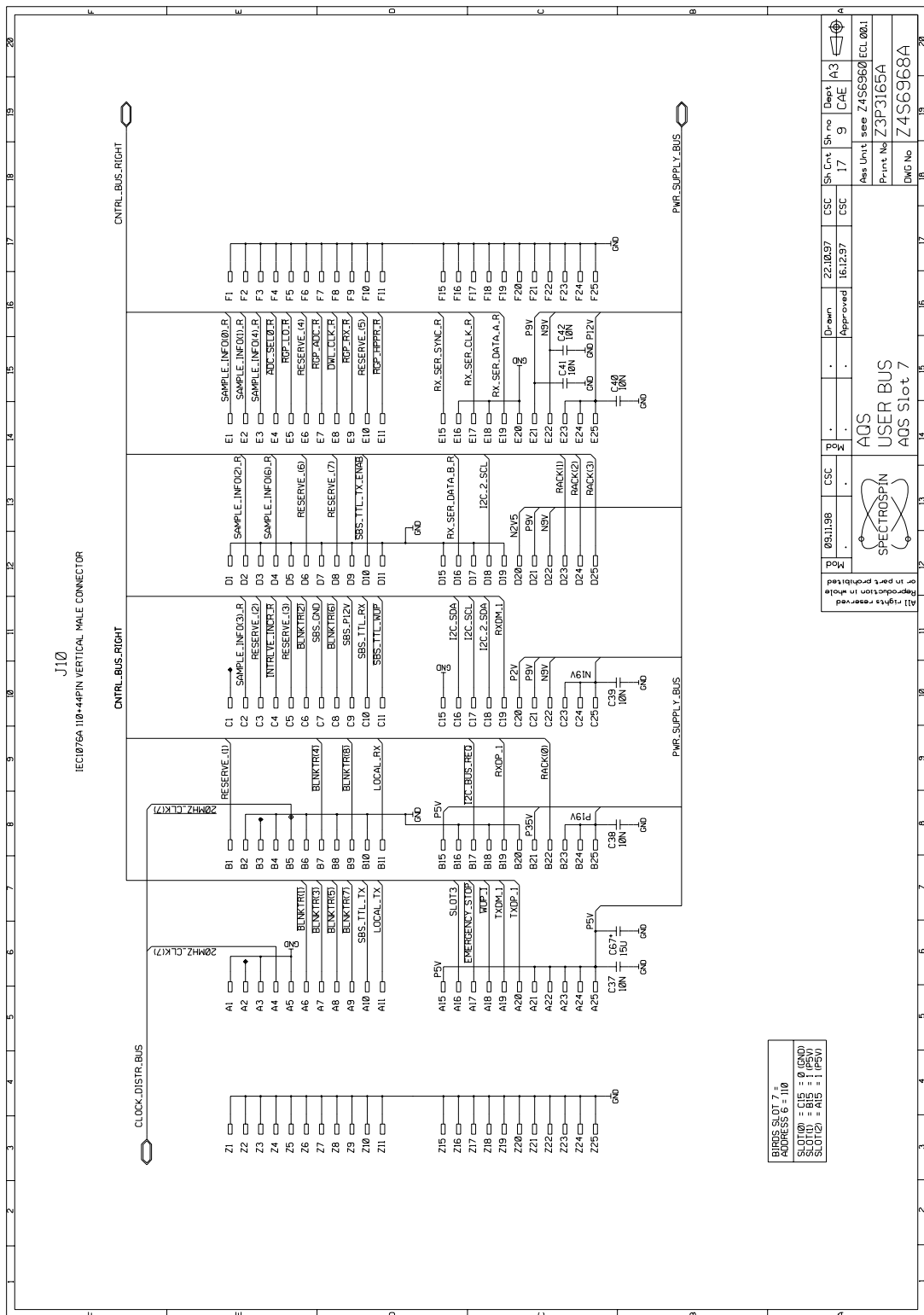


Figure 3.16. User Bus Slot 8

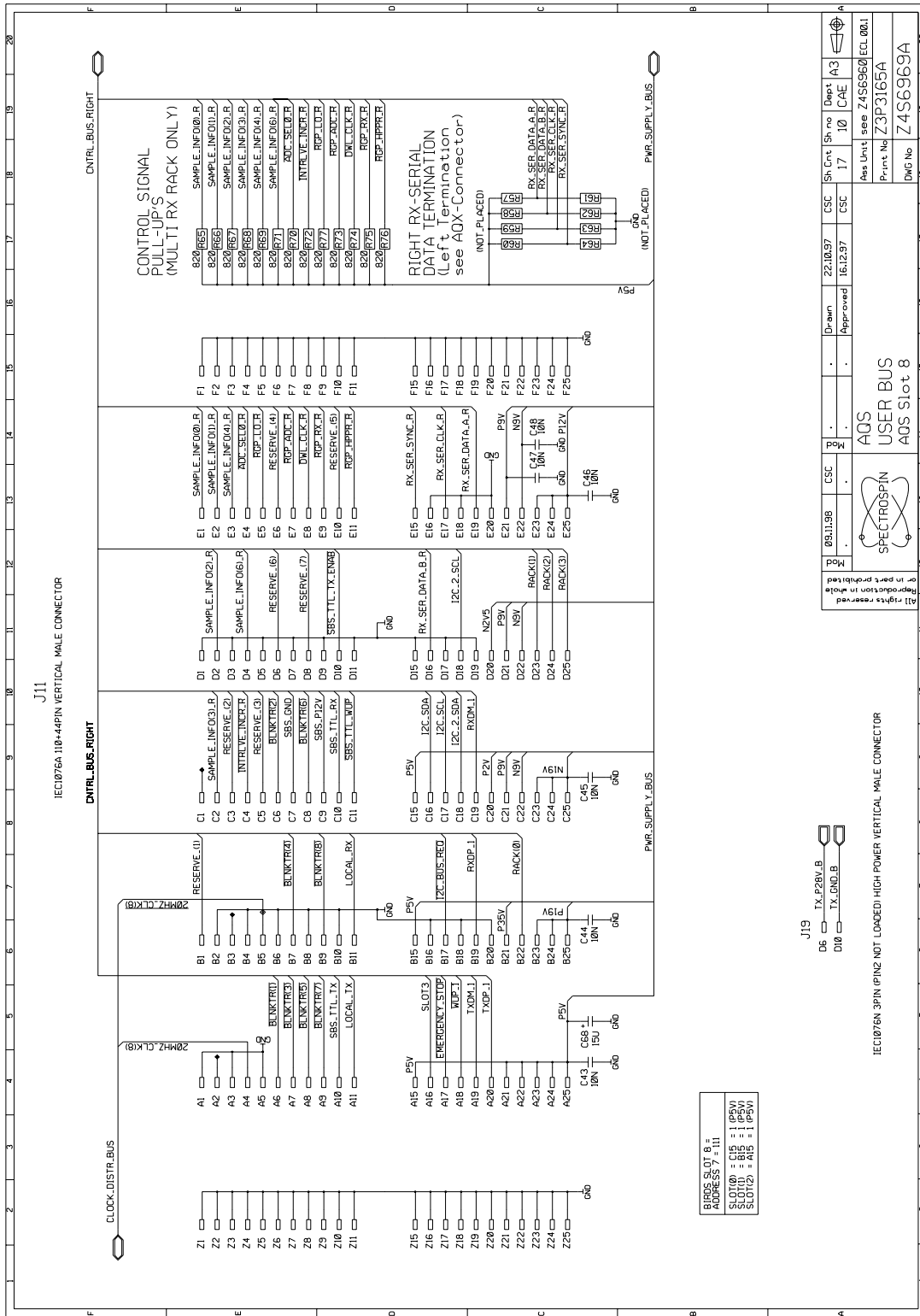


Figure 3.17. ACB Standard/ PSD Slot

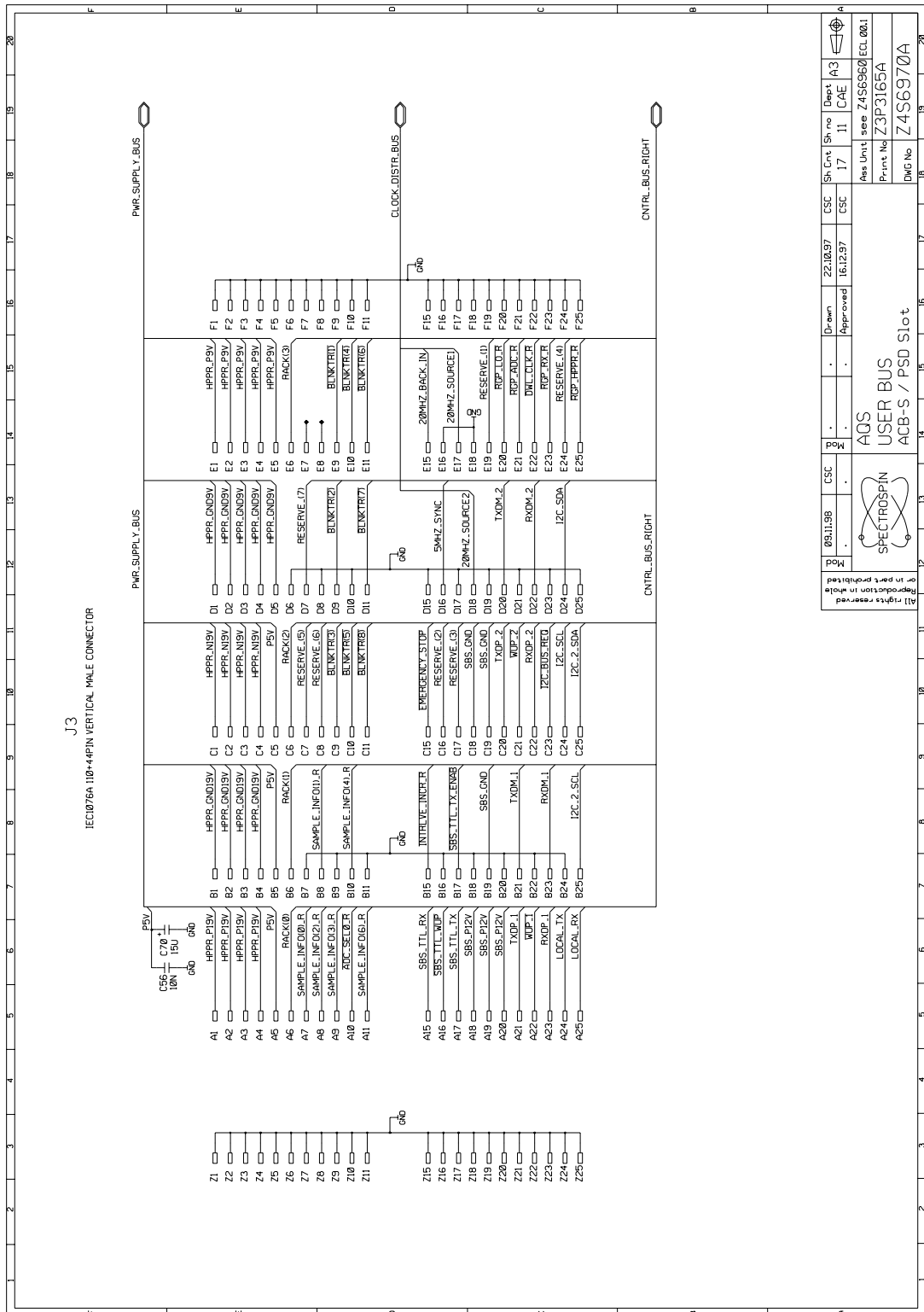


Figure 3.19. Power Supply Slot 2

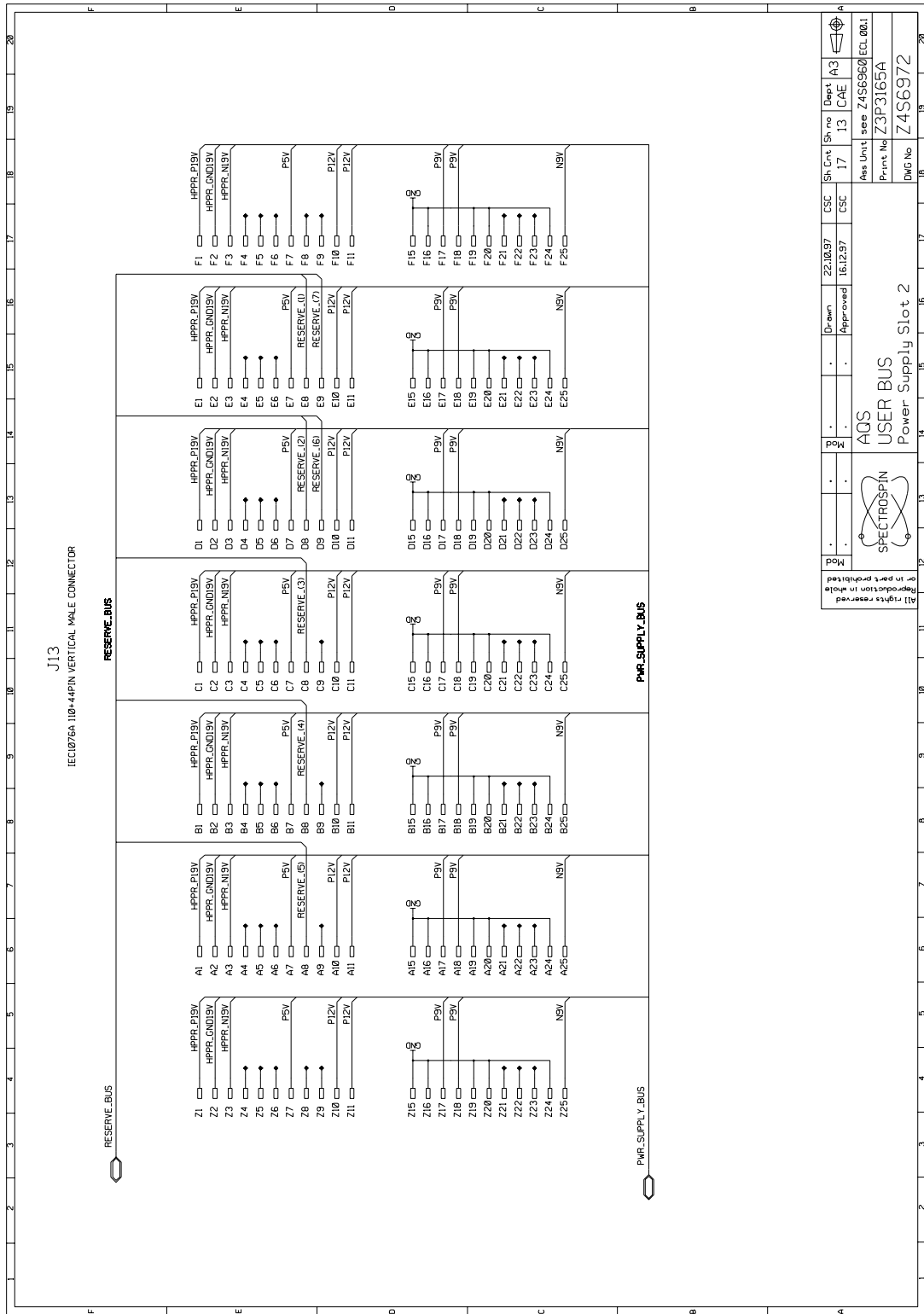
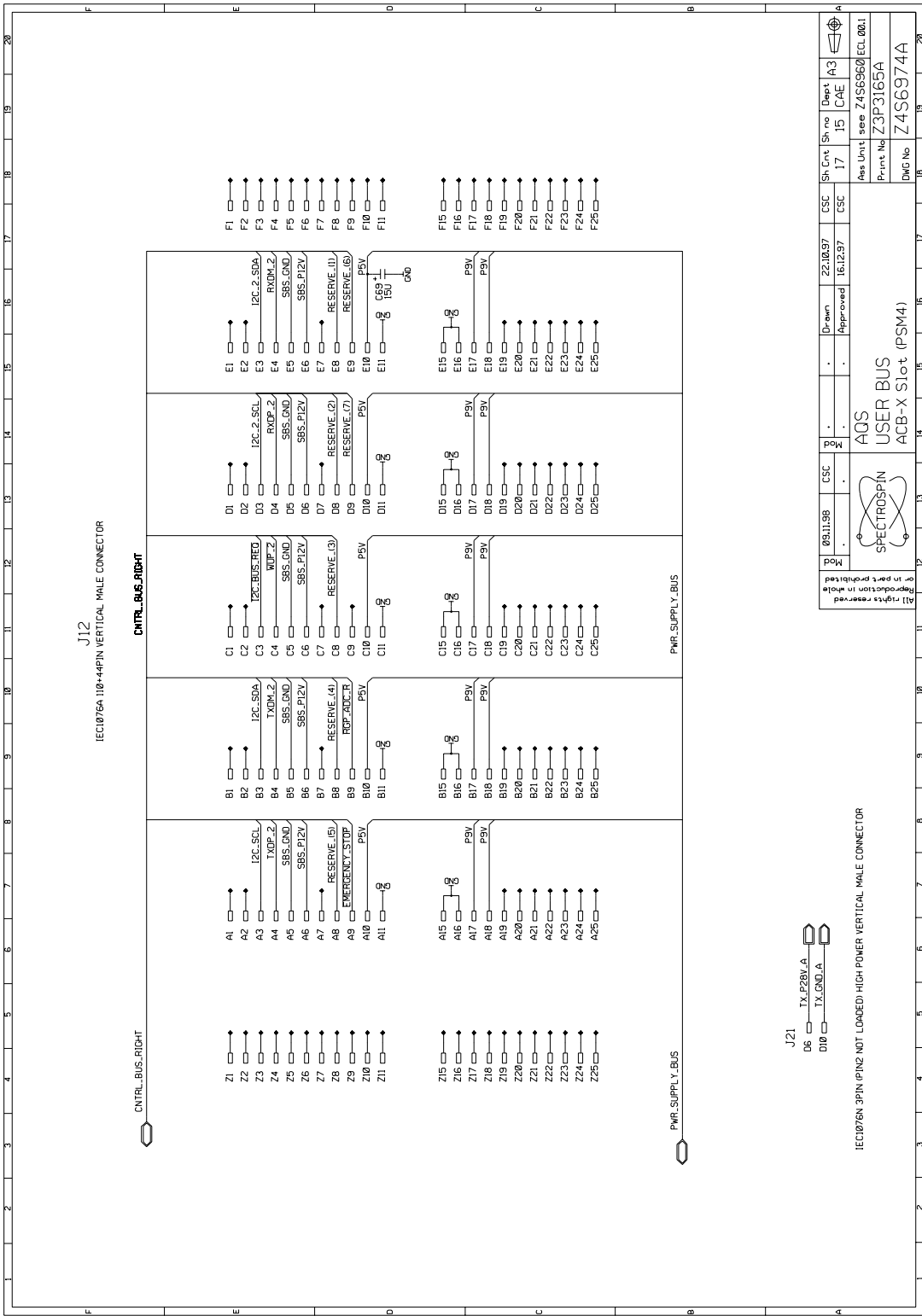
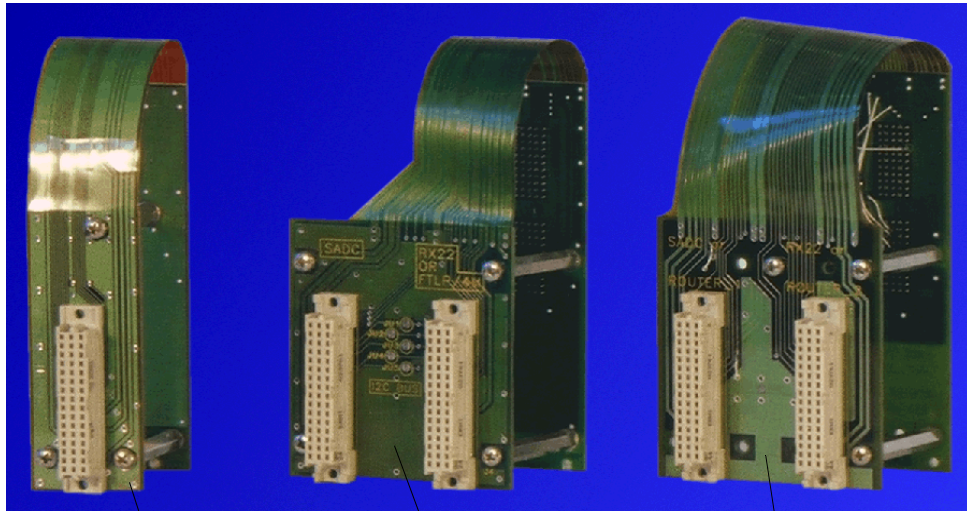


Figure 3.21. ACB Extended Slot



Adapters**3.9**

The adapters are necessary to install shorter AQR boards such as RX22, FTLP4M or modified boards (AQS HADC/2, AQS Router...) in the AQS.



Z003575 AQS ADAPTER ROUTER / RX22

Z003348 AQS ADAPTER ADC + RX22/FTLP-4M

Z003349 AQS ADAPTER ROUTER DUAL

Figure 3.23. Power Supply Module Schematic (page 1)

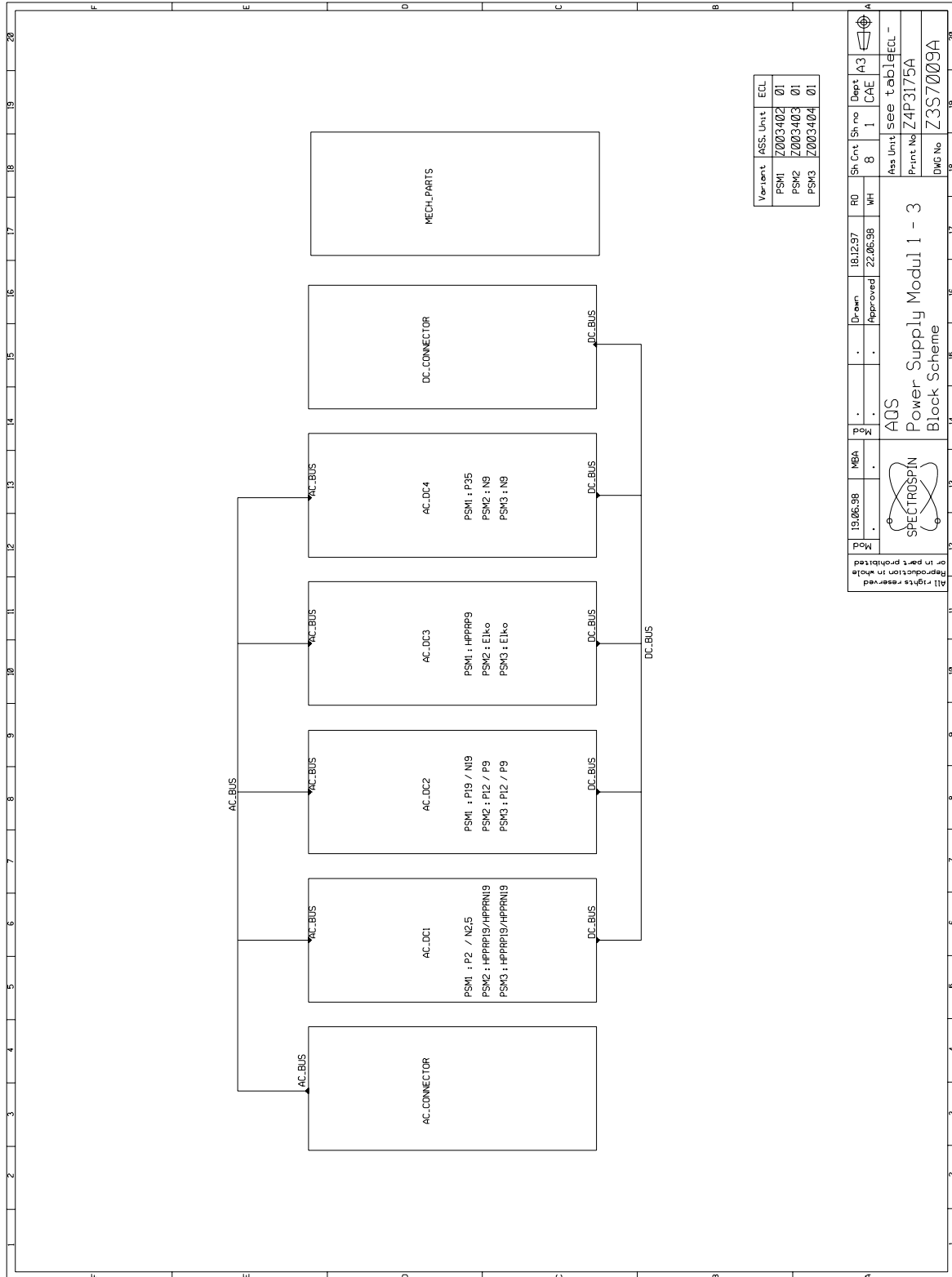
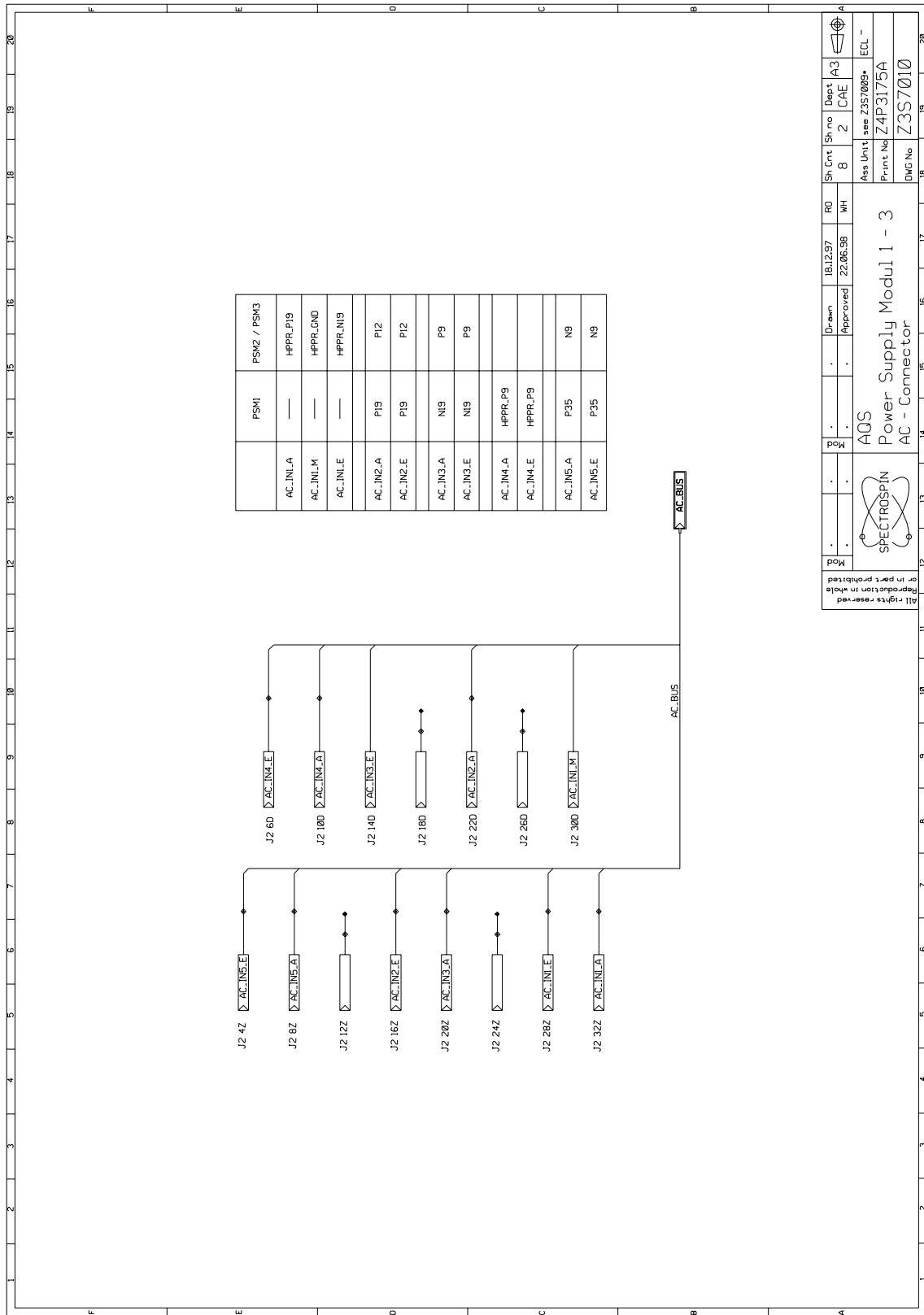
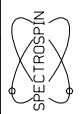


Figure 3.24. Power Supply Module Schematic (page 2)





 AGS

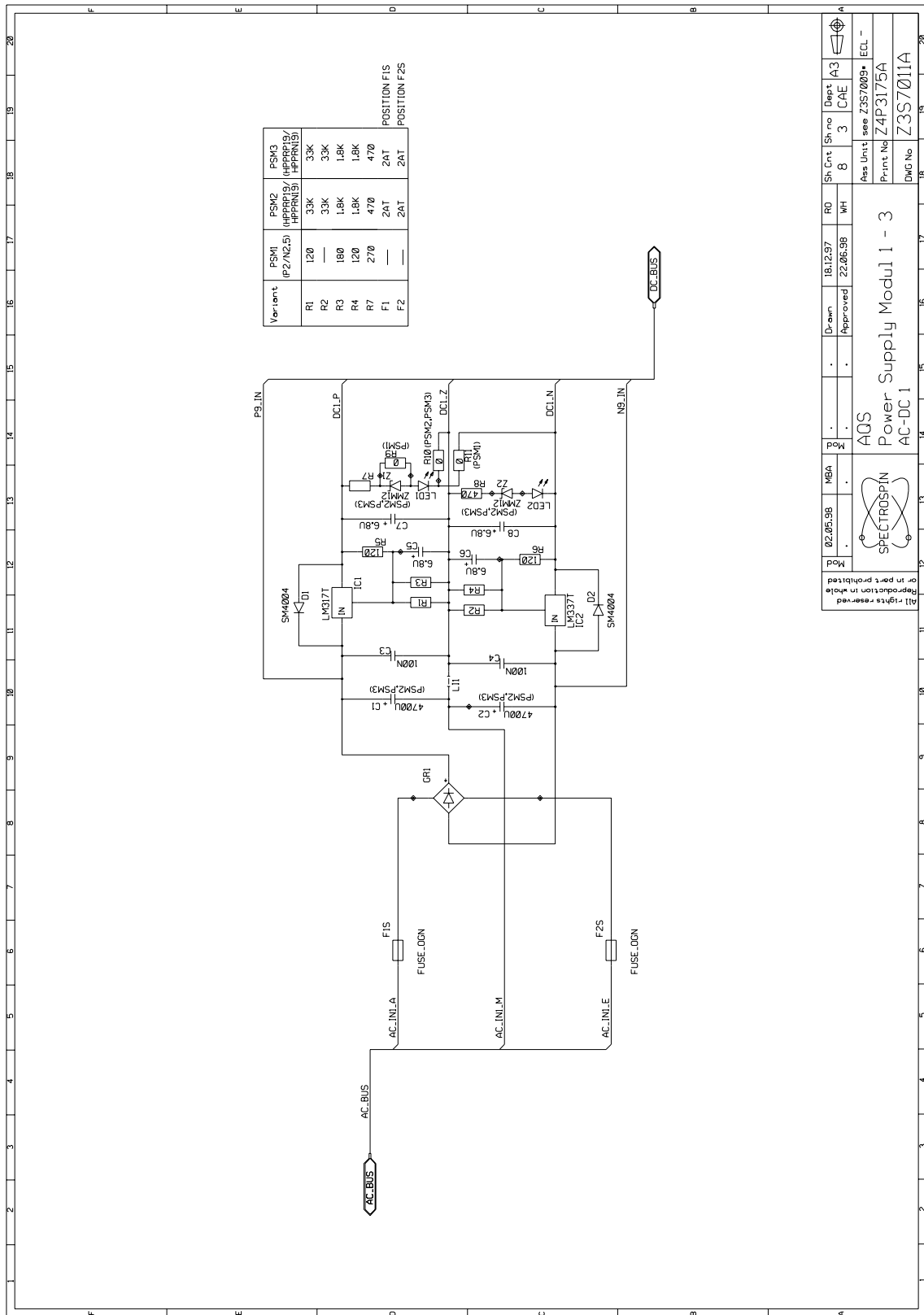
 Power Supply Modul 1 - 3

 AC - Connector

Sh Cnt	Sh no	Dept
8	2	CAE
RO	1812297	WH
	22.06.98	
	Approved	
Ass Unit	see Z3S7009	
Print No	Z4P3175A	
DWG No	Z3S7010	

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Figure 3.25. Power Supply Module Schematic (page 3)



AQS

 Power Supply Modul 1 - 3

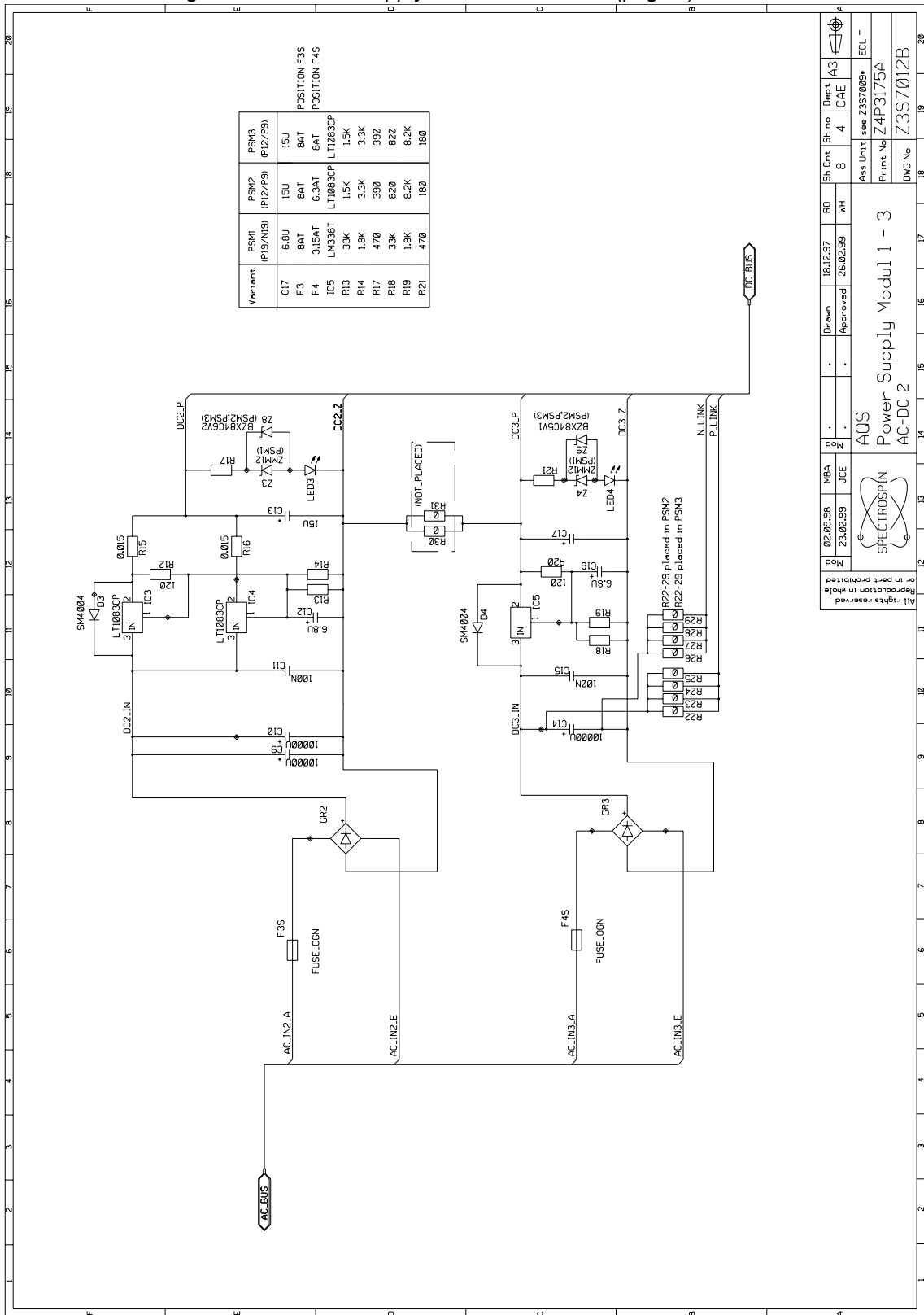
 AC-DC 1

Mod	82.05.98	MBA	.	Drawn	.	Sh. no	18.12.97	RD	WH
Mod	.	.	.	Approved	.	Sh. no	22.06.98	RD	WH

Sh. Cnt 8
 Sh. no 3
 Dept CAE
 Ass. Unit see Z3S7009
 Print. No Z4P3175A
 DWG. No Z3S7011A

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Figure 3.26. Power Supply Module Schematic (page 4)



Mod 02.05.596
 JCE 23.02.99
 M8A
 JCE

Drawn 18.12.97
 Approved 26.02.99
 RO WH

Sh Cnt 8
 Sh no 4
 Dept CAE
 A3

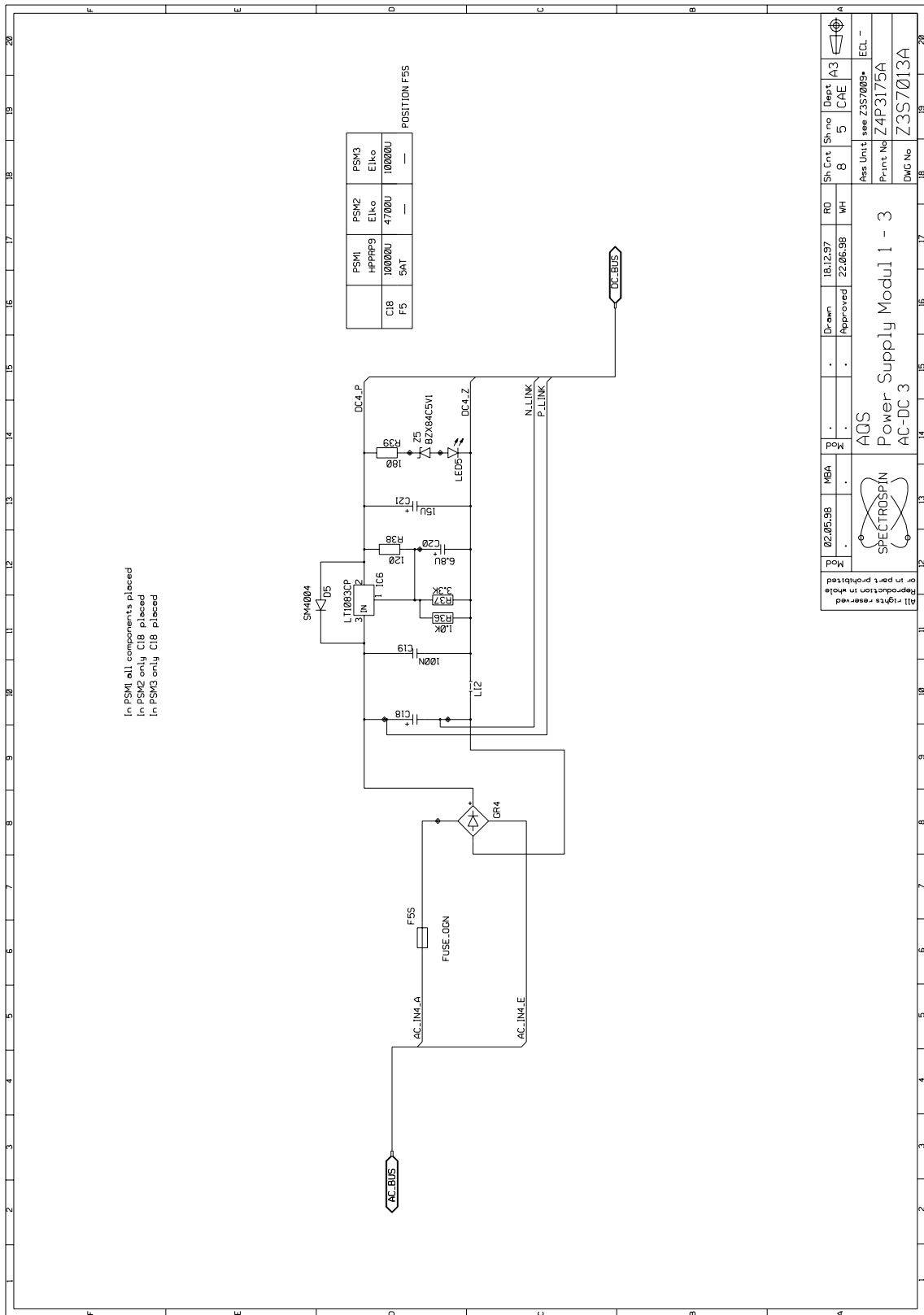
Ass Unit: see Z3S7009+
 Z4P3175A
 ECL -

Power Supply Modul 1 - 3
 AC-DC 2
 Z3S7012B

SPECTROSPIN
 AQS

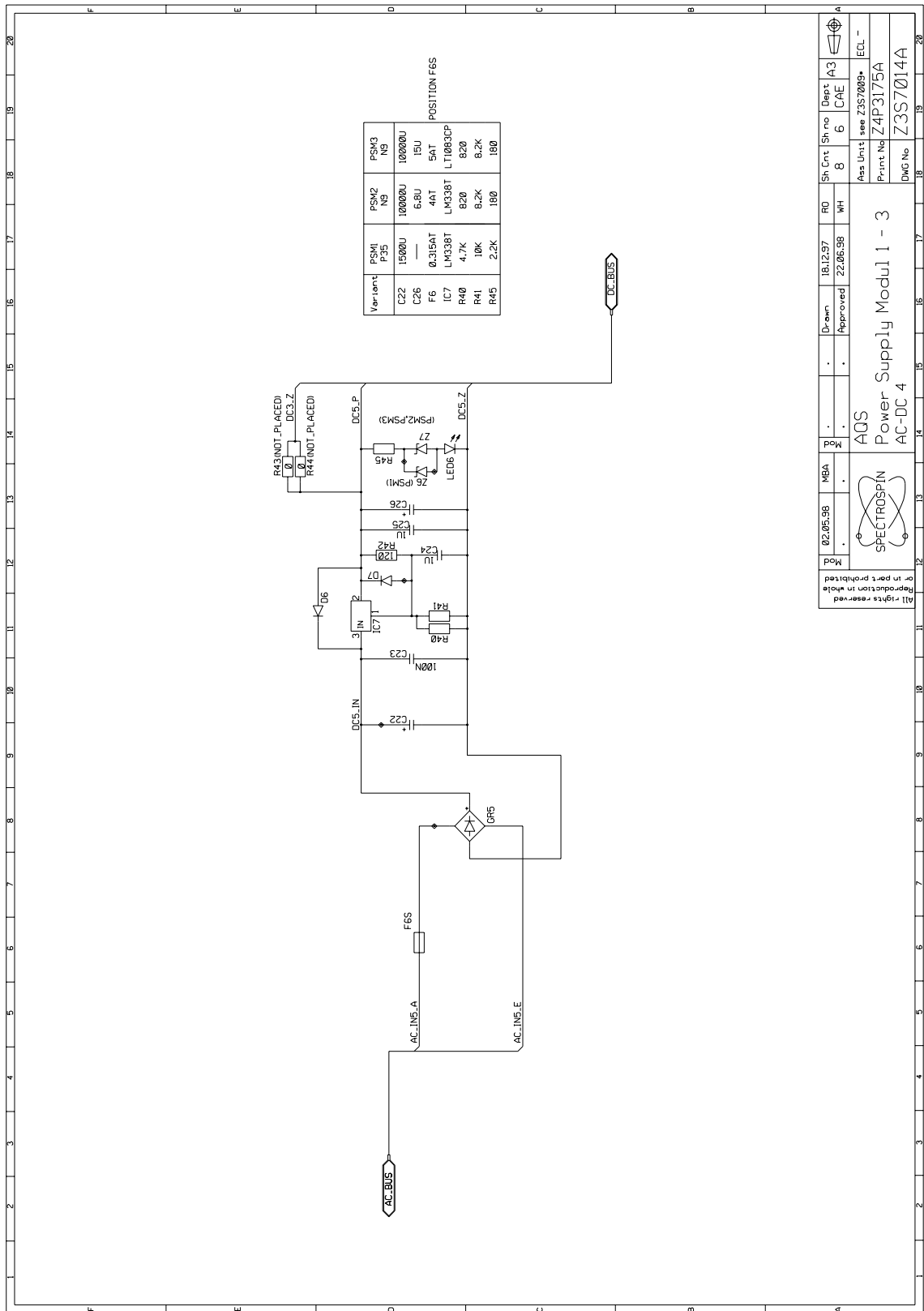
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Figure 3.27. Power Supply Module Schematic (page 5)



In PSM1 all components placed
 In PSM2 only C18 placed
 In PSM3 only C18 placed

Figure 3.28. Power Supply Module Schematic (page 6)



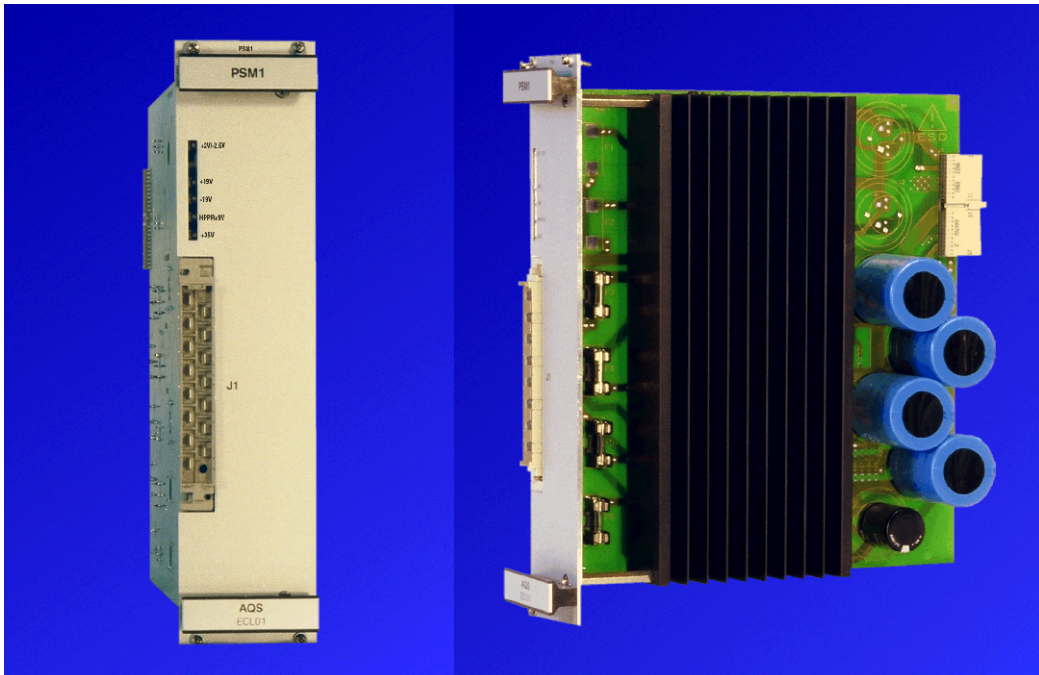
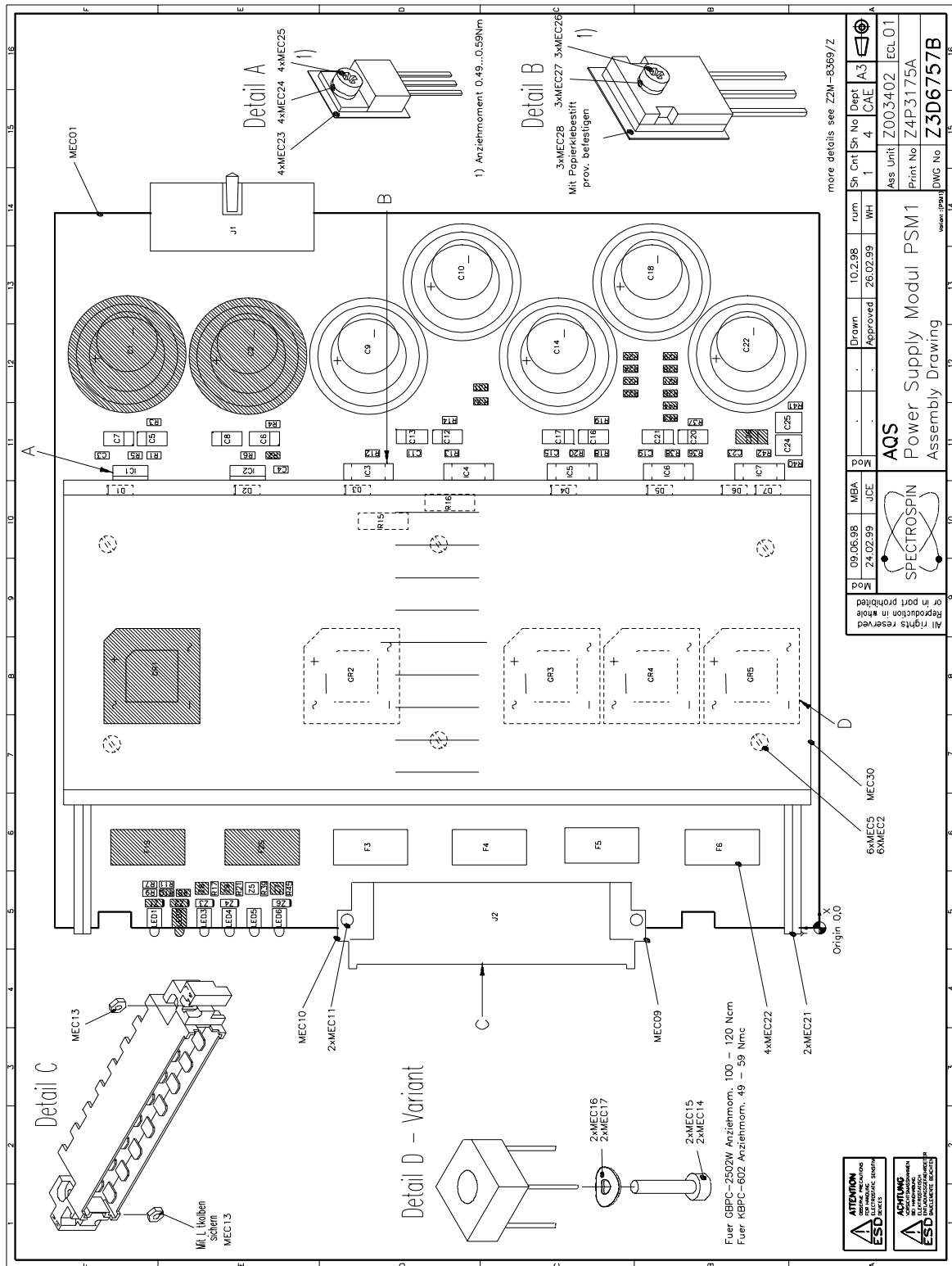


Table 3.1. Fuses PSM1

PHY LOC	CAT_NM	VALUE
F3	2259	8AT
F4	2256	3.15AT
F5	4907	5AT
F6	2248	0.5AT ¹

¹ prior fuse was 0.315AT

Figure 3.30. Power Supply Module 1 Assembly Drawing



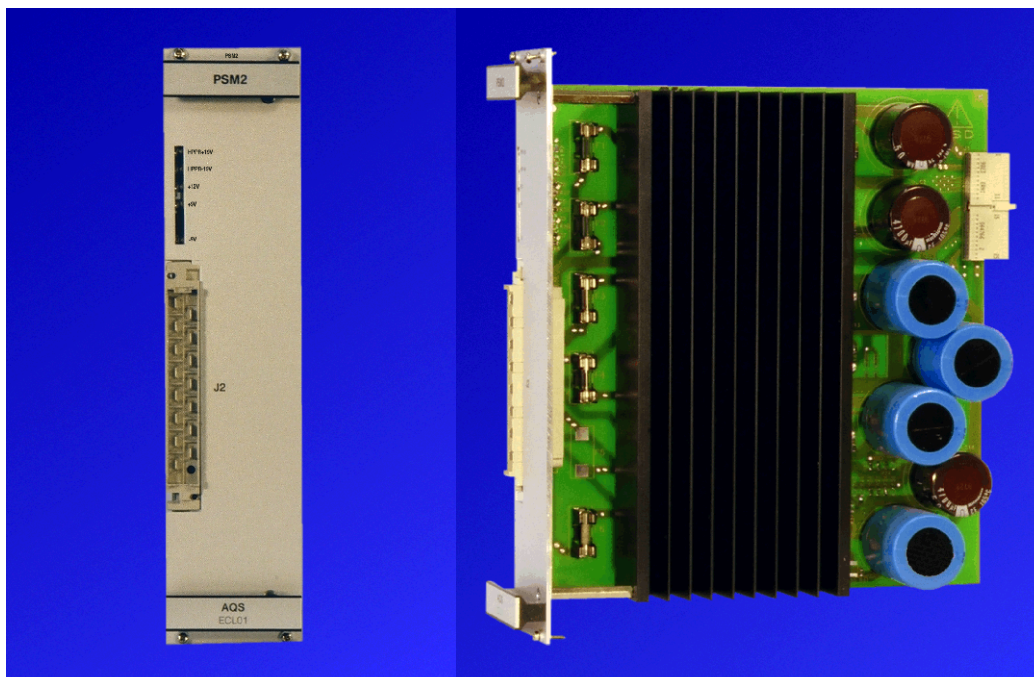
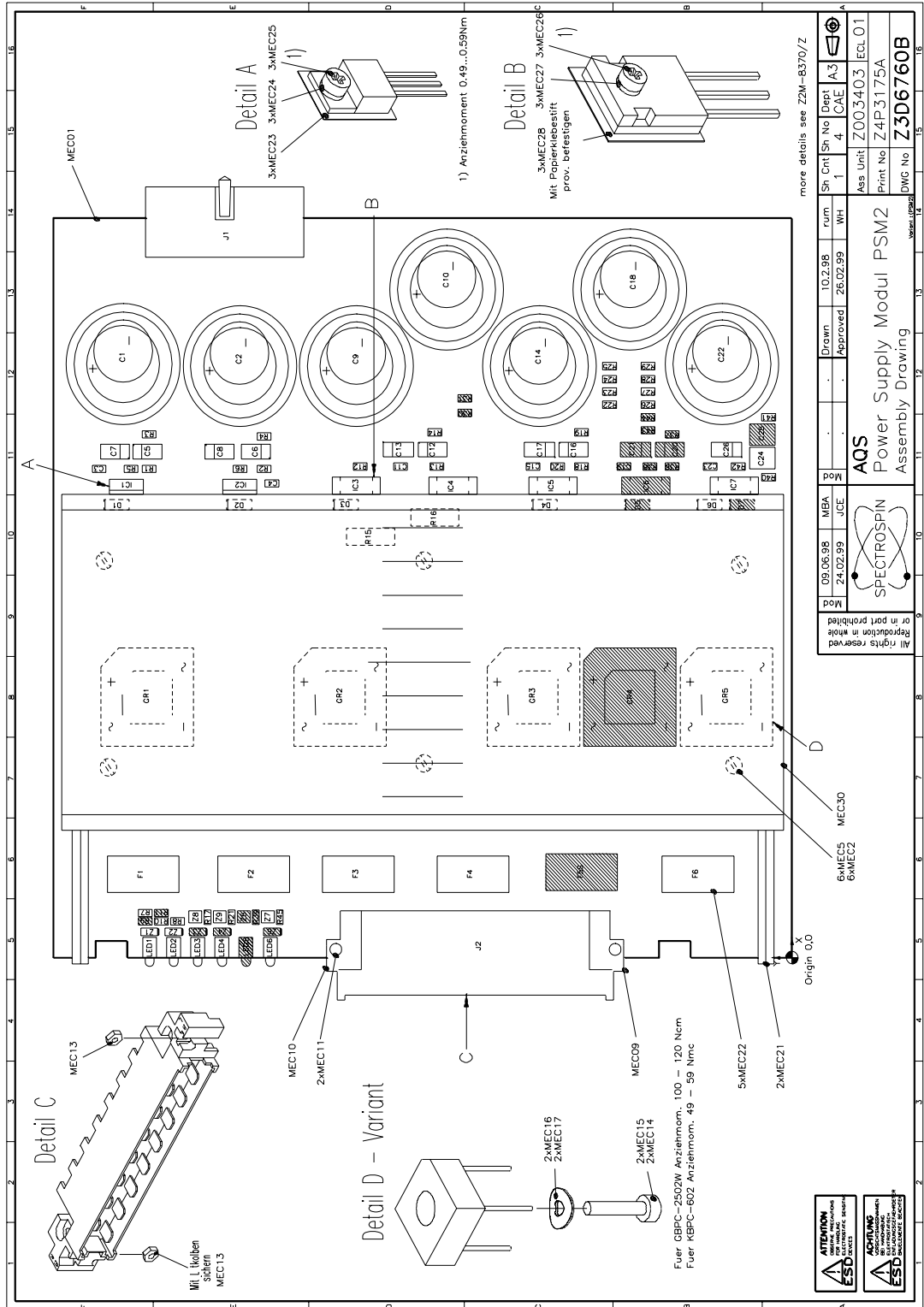


Table 3.2. Fuses PSM2

PHY LOC	CAT_NM	VALUE
F1	2254	2AT
F2	2254	2AT
F3	2259	8AT
F4	2258	6.3AT
F6	2257	4AT

Figure 3.31. Power Supply Module 2 Assembly Drawing



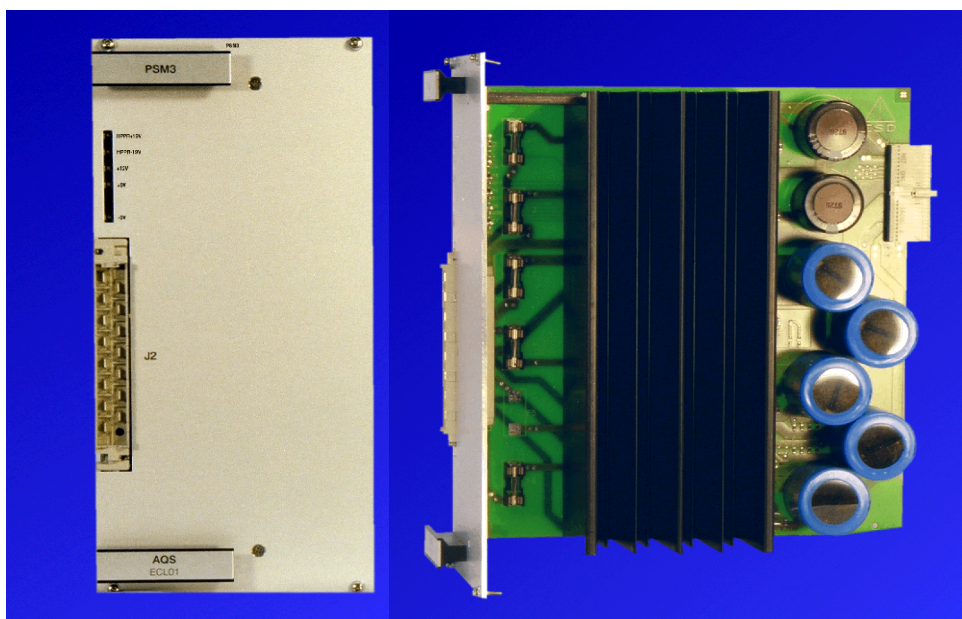


Table 3.3. Fuses PSM3

PHY LOC	CAT_NM	VALUE
F1	2254	2AT
F2	2254	2AT
F3	2260	10AT ¹
F4	2259	8AT
F6	4907	5AT

¹ prior fuse was 8AT

Figure 3.32. Power Supply Module 3 Assembly Drawing

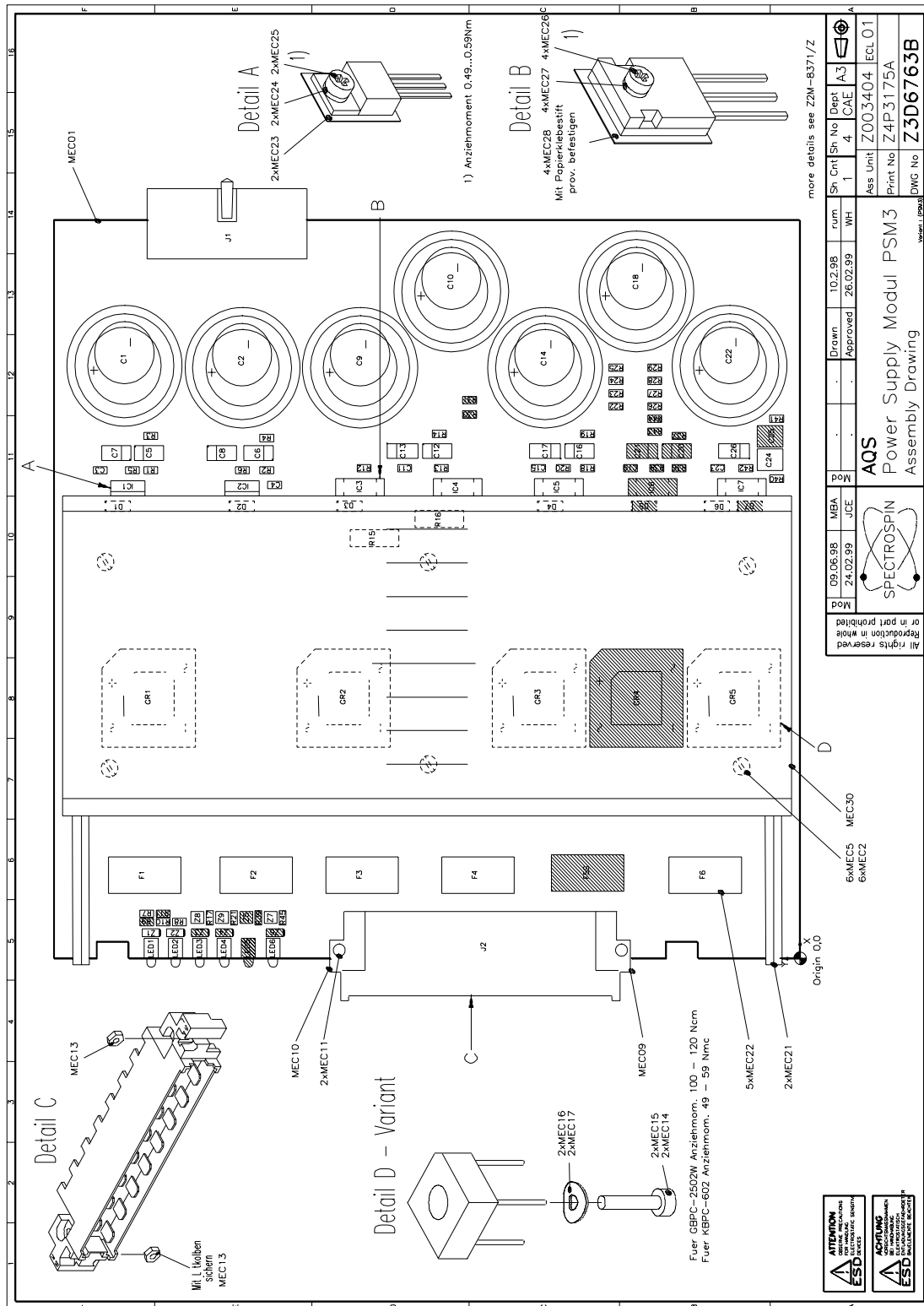
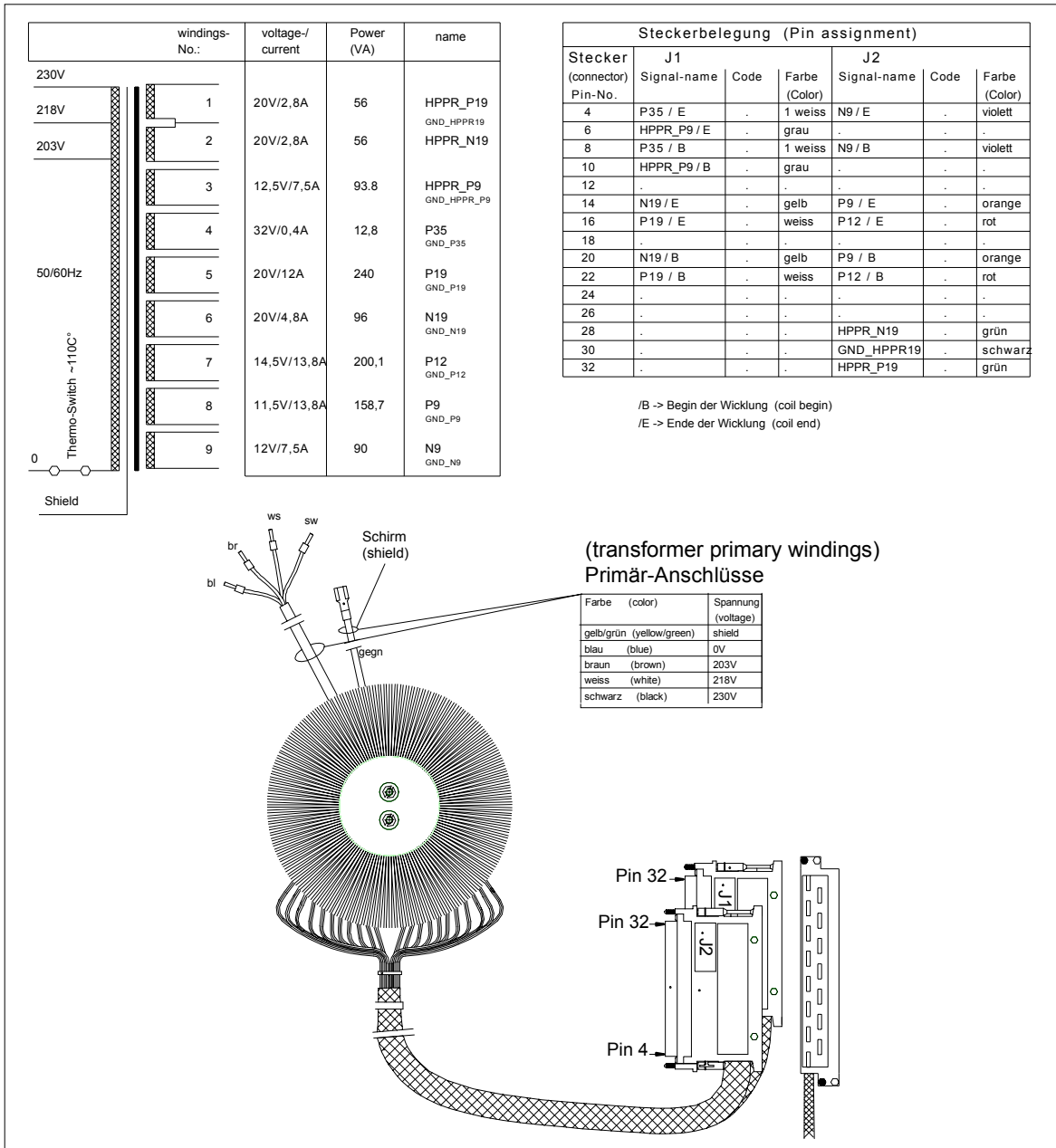


Figure 3.33. AQS Transformer



AQS Reference Board

4

Introduction

4.11

The AQS Reference Board is a new development in the AV series. As spectrometers become more sophisticated the importance of coherence and in particular phase coherence between the various channels as well as between the transmission and receiving paths is more and more important. The philosophy of the AV is to ensure that all RF signals as well as all clocks originate from one source. This source is a temperature controlled crystal oscillator at the heart of the AQS Reference Board. Apart from clock signal each AQS Reference Board will provide the necessary RF signals for up to 4 SGUs. This is to enable the SGU generate frequencies using a so called up converter. If more channels are required then a second AQS Reference Board will need to be installed. The location of the AQS Reference Board will depend on the configuration and electronically it can be placed in any user slot J4 to J8 (slot 1 to 5). Configurations to date for single rack systems have placed it in slot J5 immediately to the right of the RX/SADC combination. Two rack system place AQS Reference Board in rack 1 (REF1) in slot J7 and AQS Reference Board in rack 2 (REF2) in slot J5.

Functions/ Description

4.12

The REF is responsible for the synchronization through the generation of various frequencies. Specifically the generated signals are

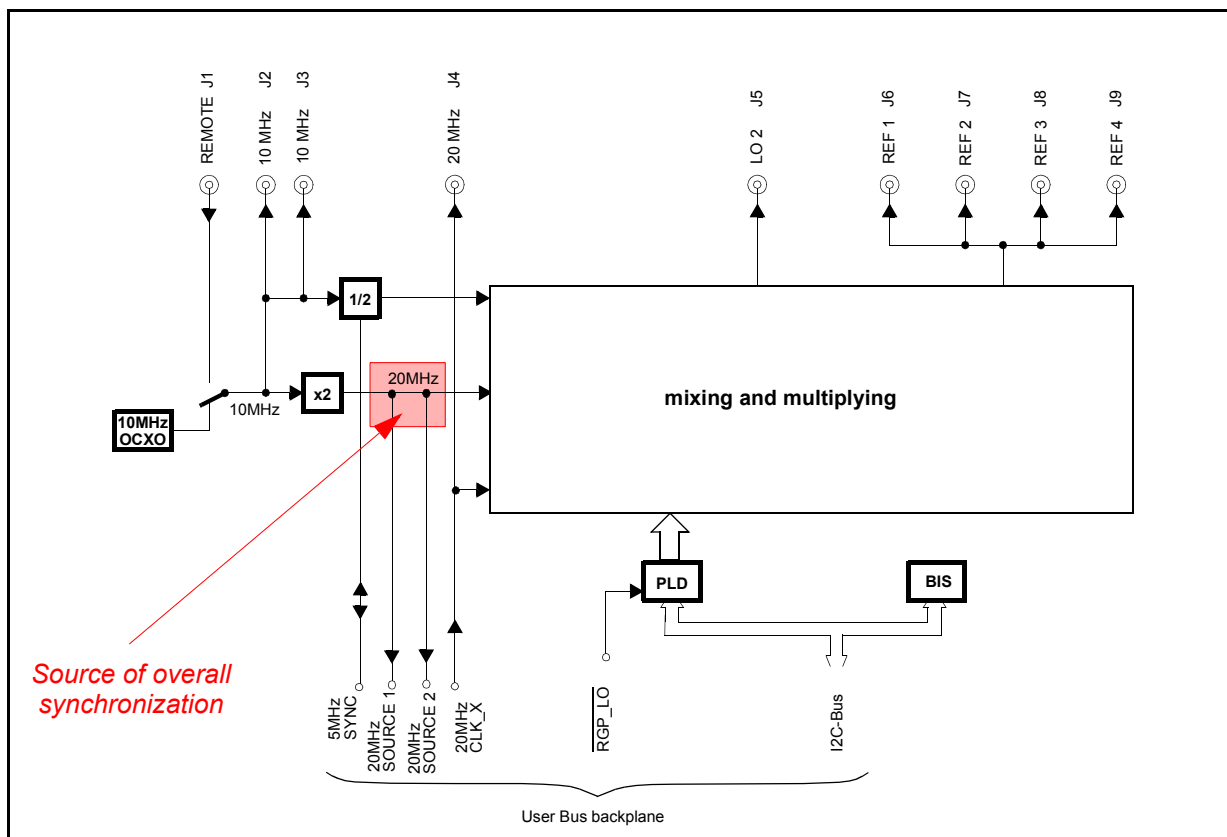
1. Detection reference frequency (LO2) for the receiver. There are three versions of the AQS Reference Board that supports RX22 (AQS REFERENCE RX22 400, AQS REFERENCE RX22 600, AQS REFERENCE RX22 1000) and three versions for AQS RX-BB (AQS REFERENCE 400, AQS REFERENCE 600, AQS REFERENCE 1000).
2. 20MHz synchronization clock for all SGUs, FCU, TCU user backplane
3. auxiliary signals (frequency mixture) for up to four SGUs
4. 10 MHz signal for the BSMS LTX

At the heart of the AQS Reference Board is a 10 MHz oven controlled oscillator (OCXO) see [Figure 4.34](#). The 10 MHz signal for the BSMS LTX is ported directly through connector J2. This signal is mixed and multiplied and afterwards ported to the four outputs REF1-4 (J6-J9).

The detection reference frequency (LO2) for the RX22 receiver is generated on-board by DDS which is clocked by a frequency that is derived also from the same frequency source. This ensures phase coherency with the receiving path. Specifically the DDS can set the phase to a precalculated value, controlled by the RGP LO signal. This ensures that the receiver phase is always coherent.

The detection reference frequency (LO2) for the AQS RX family of receivers is generated as mentioned above.

Figure 4.34. block diagram of AQS Reference Board

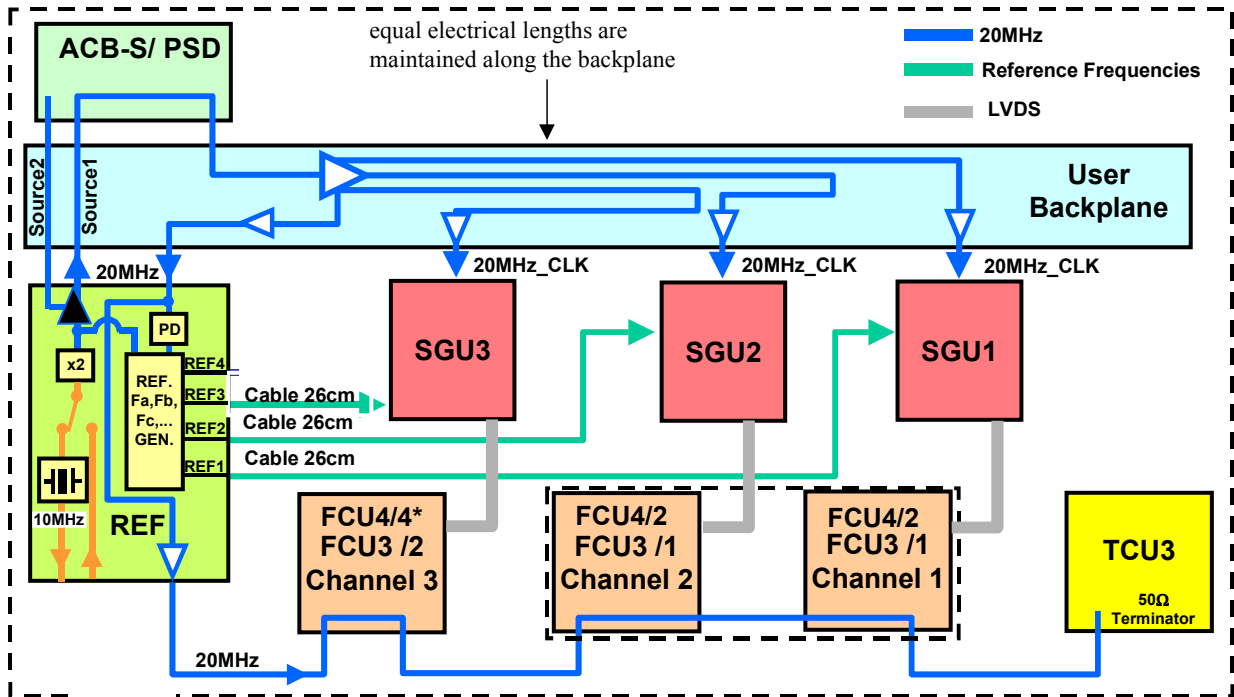


Overall synchronization

4.12.1

This is achieved using the 20MHz sinusoidal signal generated at the first frequency doubler which is transmitted to the backplane. This is then transformed into a differential clock signal (20MHzclk / 20MHzclk) used to clock all 8 slots of the user bus, which will of course include the SGUs. The same 20MHz clock is returned and is ported out via J4 and used to clock the TCU/FCU chain. In turn the TCU uses the same 20MHz to generate the 40 MHz signal for the RCU and GCU. Essentially all clocking frequencies in both the analog and digital sections of the AQS are synchronized with the 20MHz clock of the AQS Reference Board.

Figure 4.35. overall synchronization of spectrometer for single AQS rack

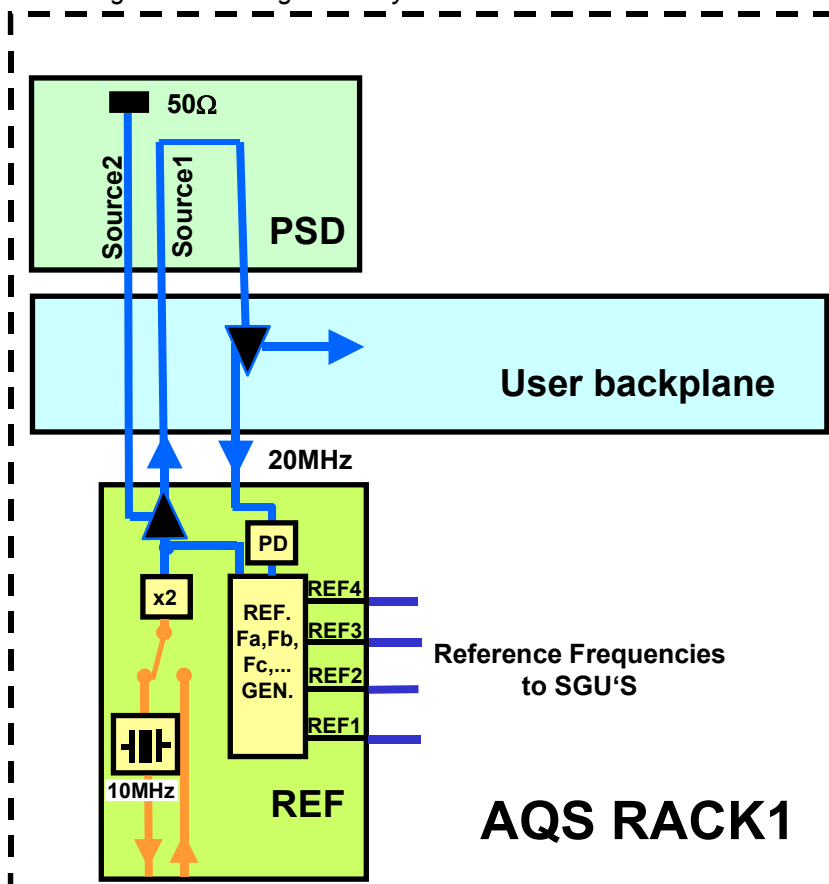


* in case of 3 channels, a single FCU4/4 is used for all channels

Synchronization between two AQS racks:

To ensure that two AQS racks can be synchronous two (identical) 20MHz signals (source1, source2) are used to generate the clock. In the case of a single AQS rack, Source 2 is not required and is terminated on the PSD or ACB-S, and Source 1 is used for the AQS user bus slots. The cable is extended to ensure that the total length is 895cm (earlier versions 155cm).

Figure 4.36. Single rack synchronization



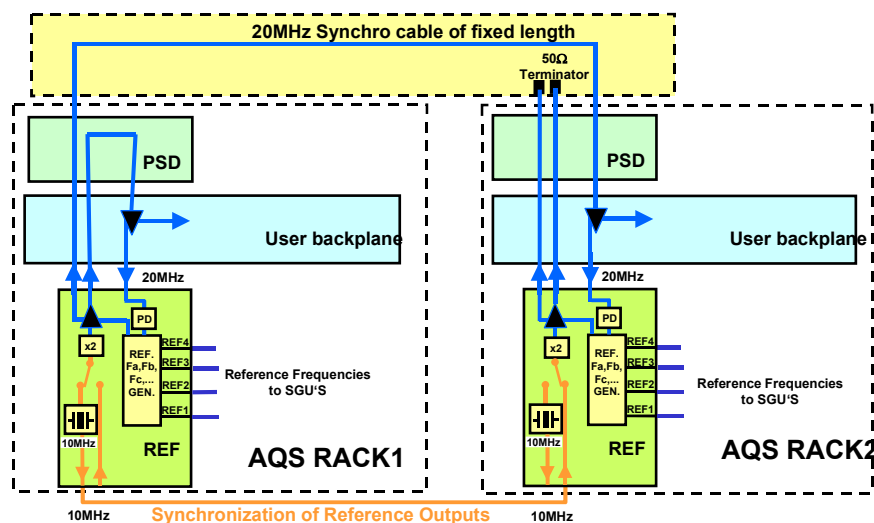
In the case of two AQS racks the two AQS Reference Boards must first be synchronized with each other. This will enable up to 8 SGUs to be synchronized. The 10 MHz out J3 of the AQS Reference Board in rack 1 (REF1) is connected to the Remote J1 of the AQS Reference Board in rack 2 (REF2). This signal will automatically replace the oscillator in REF2. Both units have then essentially the same oscillator. With two AQS Reference Boards there are potential 4 sources for the 20MHz clock. How they are used is explained in the table below.

Table 4.4. Synchronization with two AQS Reference Boards.

Signal	use
REF1 source1	used to clock AQS1
REF1 source2	used to clock AQS2
REF2 source1	not used. Terminated at PSD connection
REF2 source2	not used. Terminated at PSD connection

Essentially in a two rack system AQS Reference Board in rack 1 (REF1) is used to clock both racks. The second REF. unit is only required to provide the RF frequency mixtures for SGU 5/6/7/8.

Figure 4.37. double rack synchronization

**Cable lengths:**

4.12.2

To maintain this synchronization particularly with respect to phase all signals should pass through identical electronic circuitry as well as cables of equal length. The circuitry along the user backplane is designed to ensure equal electrical lengths regardless of the physical slot occupied by an SGU.

If cables are to be replaced then the same length cable should be used. For example the cables carrying the mixture of 6 frequencies to the SGUs are a standard length of 26cm. Similarly the cables carrying the 20MHz clock signal need to be the same length. To maintain this equal length it will be noticed that extra cable length is connected at the first PSD unit. This is to equalize the cable for PSD1 and PSD2.

Bus interfaces:

4.12.3

The AQS Reference Board is controlled by the I²C bus on the backplane. This bus is used to

1. read the BIS data (Bruker information system, successor to BBIS)
2. control of the LO/detection reference phase
3. allow the master SGU load settings which are stored in an FPGA (fully programmable gate array) on-board into DACs to control the REF signal output.

Unit Configuration / Version / Jumpers

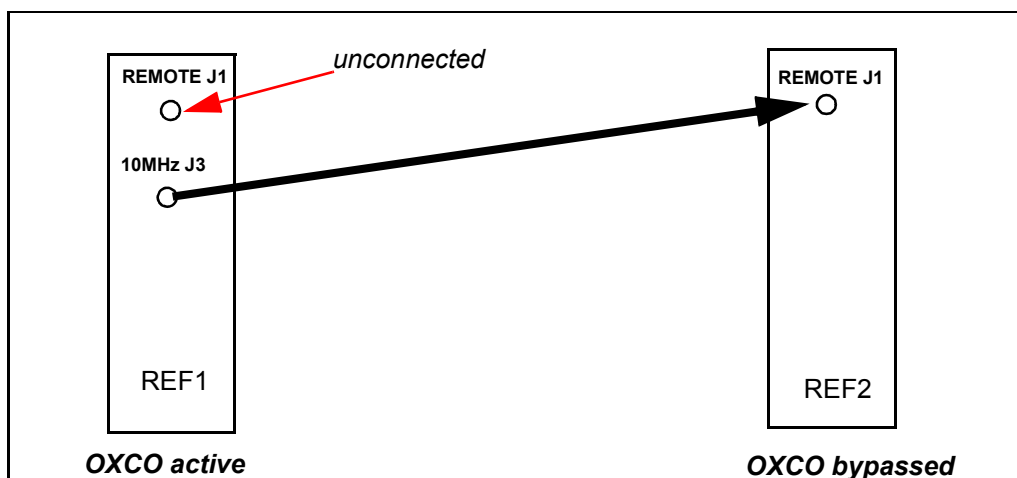
4.13

The unit is automatically configured through the 'cf' routine. No jumper settings are required. The distinction between AQS Reference Board in rack 1 (REF1) and

AQS Reference Board

AQS Reference Board in rack 2 (REF2) depends entirely on the presence of the J1 REMOTE IN signal. This signal is connected only for REF 2.

Figure 4.38. Synchronization of REF2 by REF1.

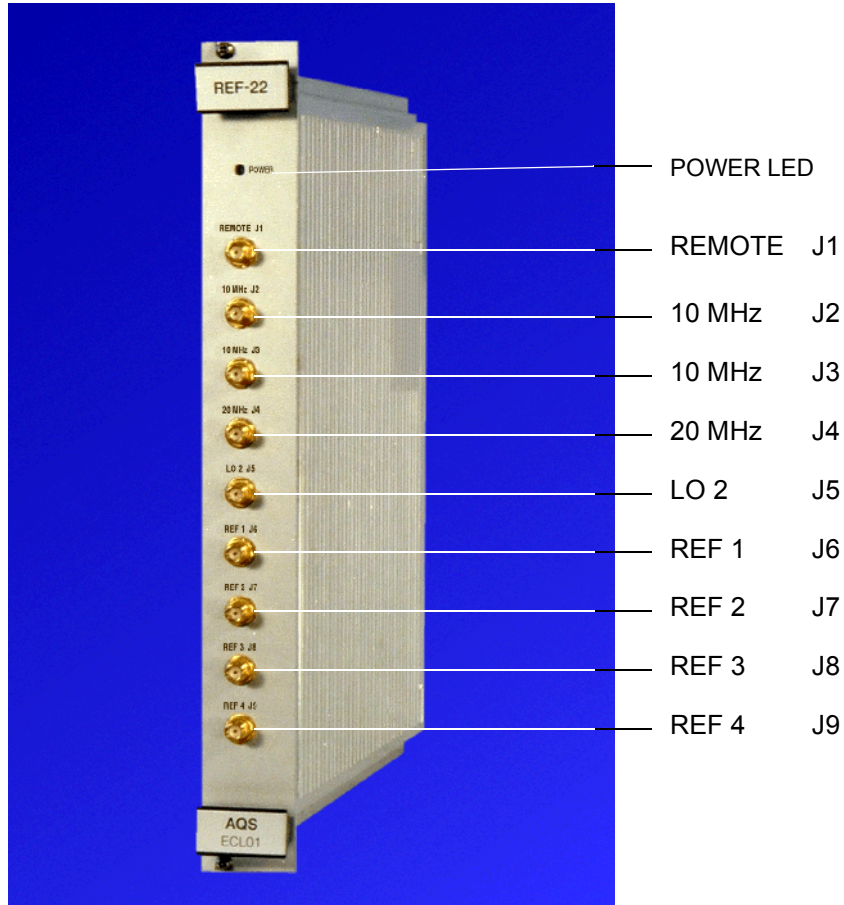


Differences from previous versions.

4.13.4

This is a totally new development for the AV series and the REF does not have a counterpart in the AVANCE series.

Figure 4.39. AQS Reference Board front panel



J1 REMOTE IN

Sinusoidal input for external 10 MHz clock and must have a value in the range 6...13dBm. The presence of this signal will automatically switch off the internal 10 MHz clock generated by the crystal oscillator. This is normally not connected except when a second AQS Reference Board is synchronized with the first.

J2 10 MHz OUT

Output to BSMS L-TX J2, used to clock BSMS Lock Transmitter board. Sinusoidal wave approx. 7dBm (1.0Vpp) @ 50Ω

J3 10 MHz OUT

Output for synchronization with second AQS Reference Board. Sinusoidal wave approx. 7dBm (1.0Vpp) @ 50Ω

J4 20MHz OUT

Clock signal to TCU/FCUs, ECL (emitter coupled logic) square wave approx. $\pm 1\text{Vpp}$ @ 50Ω This is the principal synchronization signal for the spectrometer.

J5 LO 2 OUT

Receiver detection reference to RX22 J3 resp. AQS RX J3, approx. 4dBm (1.0Vpp) @ 50Ω

J6 - J9 Ref 1-4 OUT

Frequency mixture to SGUs. 2.2Vpp @ 50Ω

Power LED:

4.14.5

See "***Power Supply / Fuses***" on page 117

The table below shows the pin assignment for the middle rear 90 pin connector. Note the presence of the source and clock signals.

Part Numbers and Cables

4.15

Six versions of AQS Reference Boards are available. They differ for the maximum NMR frequency up to 400, 600 or 1000 MHz and for the used receiver type.

- AQS REFERENCE BOARD RX22 400 P/N Z003351
- AQS REFERENCE BOARD RX22 600 P/N Z003938
- AQS REFERENCE BOARD RX22 1000 P/N Z003939
- AQS REFERENCE BOARD 400 P/N Z003265
- AQS REFERENCE BOARD 600 P/N Z003936
- AQS REFERENCE BOARD 1000 P/N Z0039371

Troubleshooting / Unit replacement / Tips 'n' Tricks

4.16

1. Terminate any unused outputs with 50Ω
2. If you suspect the OCXO is faulty switch to an external 10 MHz signal.
3. Ensure that any unused SGU outputs (J6-J9) are properly terminated with a 50 Ohm frequency connector

Diagnostic Tests

4.17

Not applicable.

Specifications**4.18**

The principal specification is that of the stability of the crystal oscillator which is specified to 1×10^{-9} /day.

Power Supply / Fuses**4.19**

The REF uses +5V, +12V, \pm 9V,+19V from the backplane see "**Backplane Connector Ref. unit**" on page 118. The power LED on the front panel indicates that all necessary voltages are present and at the correct level. If the voltage level drops then the LED will go out. Thus once the power LED lights then further investigation of the backplane to check the precise voltage is unnecessary.

Table 4.5. Backplane Connector Ref. unit

	z	a	b	c	d	e	f
1	GND	GND		5MHZ_SYNC	GND		GND
2	GND	20MHZ_SOURCE1	GND				GND
3	GND	GND	20MHZ_SOURCE2		GND		GND
4	GND	20MHZ_CLK_X	GND				GND
5	GND	GND	20MHz_CLK_X		GND	RGP_LO	GND
6	GND		GND				GND
7	GND				GND		GND
8	GND		GND				GND
9	GND				GND		GND
10	GND		GND				GND
11	GND				GND		GND
23x GND (21%)							
15	GND	SLOT2	SLOT1	SLOT0	GND		GND
16	GND		GND	I2C_SDA		GND	GND
17	GND			I2C_SCL	GND		GND
18	GND		GND			GND	GND
19	GND				GND		GND
20	GND		GND			GND	GND
21	GND	P5V		P9V	P9V	P9V	GND
22	GND	P5V		N9V	N9V	N9V	GND
23	GND	P5V	P19V	N19V	RACK1	P12V	GND
24	GND	P5V	P19V	N19V	RACK2	P12V	GND
25	GND	P5V	P19V	N19V	RACK3	P12V	GND

The AQS RX is an integrated high dynamic range receiver for NMR available also in a broad band version (RX-BB). The AQS RX is fully integrated in the AQS concept and runs in conjunction with the AQS SGU and AQS REF. The AQS RX is located in the analog section of the AQS rack. The board is physically as long as the other AQS units (REF/SGU) and attaches to the user bus directly.

As the name suggests the AQS RX receiver is concerned with the amplification of the signal 'received' from the sample and therefore uses a single intermediate frequency that is generated by the input signal and the local oscillator synthesizer signal.

The AQS RX enables a gain of 93dB to be set in 1dB steps. The correct setting of the RF gain will ensure that the receiver output is matched to the ADC range.

The entire receiver function is controlled by a microprocessor. This allows accurate gain setting, phase/amplitude and dc offset adjustment in the quadrature-module via a RS485-Interface which runs over the backplane. Calibration and production data (BIS, Bruker Board Information System) are stored in a flash EEPROM on the board.

A vital element of any RF receiver is the quality of the shielding to maximize the suppression of noise. In the design of this unit special attention has been paid to good clean signal transmission etc. The AQS RX is mounted in a 19" RF cassette type case, the quadrature module is separately temperature stabilized.

All communication with the AQS RX take place using the SBSB1 link along the backplane. This enables the application of the UniTool which is a software diagnostic tool and is also used for accessing other devices like SGU or HPPR/2.

In contrast to the RX22, the AQS RX is also initialized and supervised by the AQS master SGU using the separate internal RS485 bus on the AQS User Bus.

In multi receiver systems each channel is equipped with a separate AQS RX and its SGU for LO (local oscillator) signal generation.

The AQS RX has three main functions, which are to amplify the signal from the sample/HPPR, to downconvert it and to match the input range of the ADC. The vital elements of this are the linear amplification of all frequencies as well as to guarantee the precise phase relationship of all RF signals.

The RF input is amplified in several stages to increase the dynamic range. The current LO frequency for the first mixer stage is generated in the LO frequency synthesizer.

At the final section the IF signal is split into two channels with phase difference of 90 degrees, a standard method well known as quadrature detection. In order to ensure that the two channels provide identical amplification slight adjustment to the phase and gain of these channels may be necessary. This can be done via UniTool. The outputs (channel A and channel B) are connected directly to the ADC.

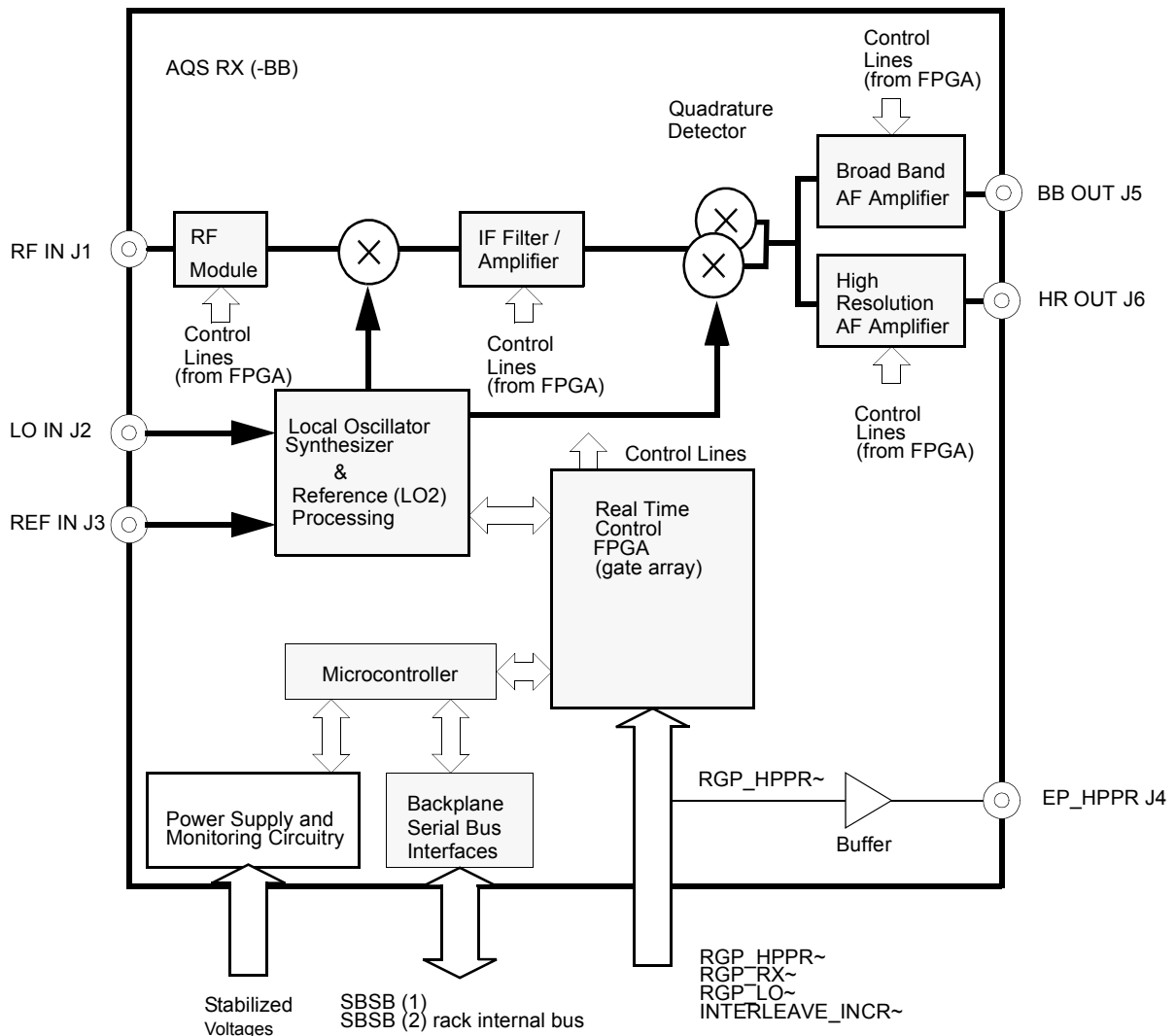
DC offset is pre-adjusted for proper control of the ADC input range and can be fine-adjusted using UniTool. The adjusted values can be saved in the on-board non-volatile memory.

During acquisition full control of the RX sections (gain, frequency, etc.) is maintained by a complex FPGA (field programmable gate array) that handles the real-time behavior. The FPGA real-time circuitry is controlled by external gating and pulse signals from the backplane (AQS User Bus). Control information is passed on from TCU, FCU and the actual Observe SGU in order to the channel concept.

The on-board microcontroller is used for initialization and RS485 communication.

For multi RX systems with several preamplifiers, the gating pulse for the HPPR (RGP_HPPR~) from the back plane is buffered and is fed separately to the front panel of the AQS RX.

Figure 5.1. RX (-BB) Blockdiagram



Power Supply and Monitoring

5.2.1

All voltages supplied from the backplane are filtered and stabilized on the RX. Operation of the *on-board* power stabilization is monitored and indicated by the green LED on the front labeled POWER. If one of the AQS power supply voltages used by the AQS RX fails the monitoring circuit will turn the LED off.

Reset

5.2.2

The AQS RX controller is normally in power down mode (reset state) to prevent disturbance and spikes in the spectra. The 20 MHz microprocessor clocking frequency is also switched off. The controller will be restarted each time a communication via the RS485 is opened (XWINNMR or UniTool).

The receiver will be active during acquisition only in the following cases:

- gs mode operation (which is typically used to adjust parameters dynamically) and
- at the beginning of wobble and receiver gain adjustment (rga)

This state is indicated by a **blinking** red LED labeled ERROR while the green LED labeled **READY remains on**.

The AQS RX is mainly controlled from the backplane by the following pulses

- RGP_LO~
- RGP_RX~
- INTERLEAVE_INCR~

RGP_LO~

The RGP_LO~ pulse indicates that the LO signal from the SGU is available and so the LO synthesizer of the AQS RX can synchronize. If there is a RGP_LO~ pulse and no appropriate LO signal (defective cable, not connected, wrong setting of SGU) an error message will appear.

RGP_RX~

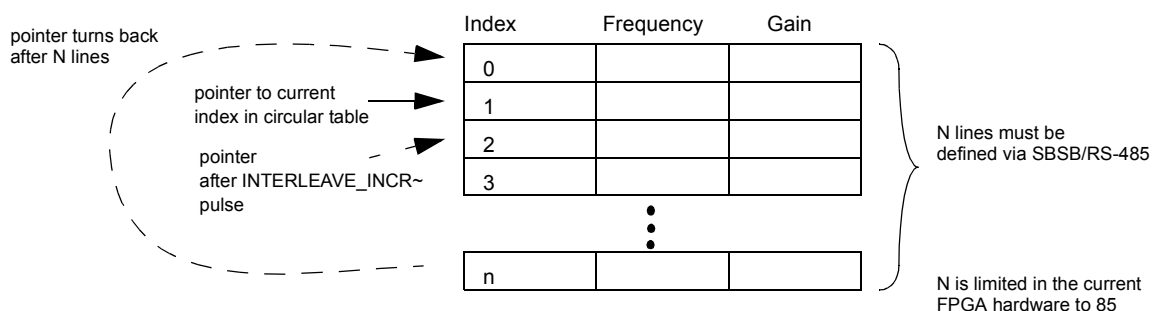
The RGP_RX~ pulse opens the receiver after excitation and prevents saturation of the input stage while transmitters are switched on. An RGP_RX~ pulse occurrence while the on-board microcontroller is running will also lead to an error message because microcontroller circuitry noise might affect the spectral purity of the RF signals.

INTERLEAVE_INCR~

The receiver is prepared for pre-loading a table of different frequency/gain pairs. An INTERLEAVE_INCR~ pulse selects the next line of the table.

This concept is used for wobble, interleaved acquisition experiments and fast receiver gain ('rg') switching.

Figure 5.2. Circular Table: Mode of operation



Effective Gain of the AQS RX

5.2.4

Table 5.1. Effective gain steps of the AQS RX

Receiver Gain 'rg'	AQS RX Gain [dB] $20 \cdot \log(V_{out}/V_{in})$	Receiver Gain 'rg'	AQS RX Gain [dB] $20 \cdot \log(V_{out}/V_{in})$	Receiver Gain 'rg'	AQS RX Gain [dB] $20 \cdot \log(V_{out}/V_{in})$
46300	105	1150	73	28.5	41
41200	104	1030	72	25.4	40
36800	103	912	71	22.6	39
32800	102	812	70	20.2	38
29100	101	724	69	18.0	37
26000	100	645	68	16.0	36
23100	99	575	67	14.2	35
20600	98	512	66	12.7	34
18400	97	456	65	11.3	33
16400	96	406	64	10.0	32
14600	95	362	63	9.00	31
13000	94	322	62	8.00	30
11500	93	287	61	7.12	29
10300	92	256	60	6.35	28
9200	91	228	59	5.60	27
8200	90	203	58	5.00	26
7290	89	181	57	4.50	25
6500	88	161	56	4.00	24
5790	87	144	55	3.56	23
5160	86	128	54	3.20	22
4600	85	114	53	2.80	21
4100	84	101	52	2.56	20
3640	83	90.5	51	2.25	19
3250	82	80.6	50	2.00	18
2890	81	71.8	49	1.78	17
2580	80	64.0	48	1.60	16
2300	79	57.0	47	1.40	15
2050	78	50.8	46	1.28	14
1820	77	45.2	45	1.12	13
1620	76	40.3	44	1.00	12
1440	75	36.0	43		
1290	74	32.0	42		

One version of RX is available:

- RX-BB Part-No. Z003689, input frequency range limited to 1072.5 MHz, includes broadband option.

Key specifications and digital control behavior remain the same for all versions.

Through the 'cf' routine the number and location of all installed RXs is determined. In multi RX systems each RX in the AQS User Bus has a unique address derived from its physical position and this is used to distinguish the various RXs from each other. There are no jumpers needed to be set.

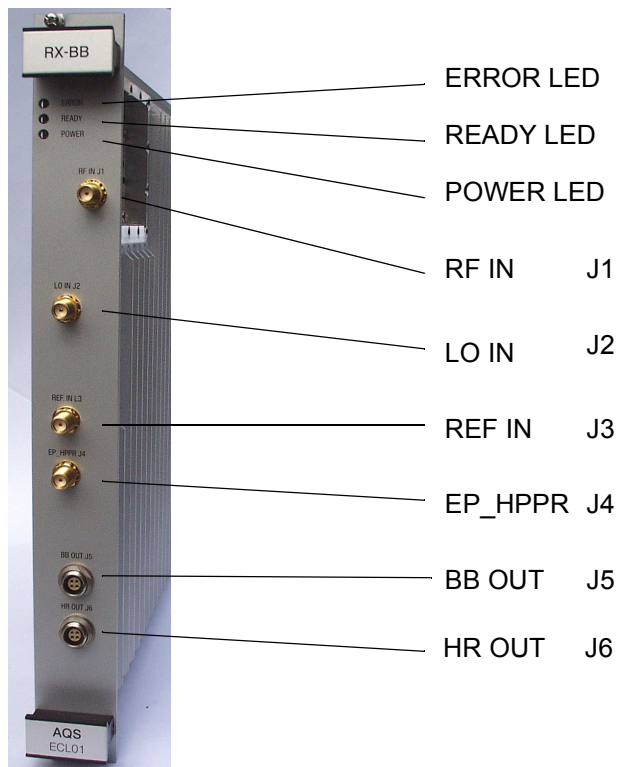
The AQS RX is different from the RX22 in many ways:

- very low dead-time to switch on receiving (RX-BB)
- different AQS Reference Unit necessary
- broad band suitability
- service access with UniTool instead of RX22 Tool

For solids experiments, the AQS RX-BB replaced the SE-451 system:

- now more than 3 channels available
- phase modulation with SGU
- integrated in AQS concept

Figure 5.3. AQS RX front panel



LED Display

5.4.1

The table below summarizes the states of the three front panel LEDs.

Table 5.2. LED States

ERROR	READY	POWER	Description
-	-	off	- power supply switched off or operating incorrectly
off	on	on	- Normal operating mode - ready for operation

Table 5.2. LED States

ERROR	READY	POWER	Description
off	short-time flickering	on	- Communication LED. The unit has received a command from the RS485 bus master. The READY LED switches off and as soon as the RX acknowledges the command the READY LED is switched on again.
blinking slowly (approx. 3 Hz)	on	on	Indicates warning and not error ('gs' mode). Caution: Sensitive NMR experiments are not possible in this mode due to disturbances of the controller system.

Power LED:

The power LED indicates that **all** necessary voltages are present and at the correct level. If any voltage level drops then the LED will go out. Thus once the power LED lights then further investigation of the backplane to check the precise voltage is unwarranted.

J1 RF IN

Input (receive signal) from HPPR. This is a RF signal which will only be present when the HPPR is in receive mode. The timing is controlled by the RGP_HPPR signal which is closely linked to the AQS RX gating signal (RGP_RX~).

J2 LO IN

RF CW signal with frequency of $SFO1 + f_{DQD}$ from SGU. This signal ($1V_{pp}$ at 50 Ohms) originates on the observing SGU (LO generating SGU) and is only present when the receiver is open.

The LO signal is routed in a chain and is fed from the most right SGU (connector LO OUT J4), see also wiring principle.

J3 REF

Detector reference frequency (local oscillator signal 2) from AQS Reference Board (REF) LO2 J5.

J4 EP_HPPR

Buffered gating pulse (RGP_HPPR~) from USER BUS, used for preamplifiers in multi receiver systems.

J5 BB OUT

Broadband signal output (Channel A and B) to FTLP/4M and FADC (RX-BB only)
Load impedance is 50 Ohm.

J5 HR OUT

High resolution signal output (Channel A and B) to SADC or HADC/2

Minimum load impedance is 1 kOhm (not 50 Ohm)!

Part Numbers and Cables**5.5**

- RX-BB (formerly hardware version called RX-E) Part-No. Z003689 (BB option, 1072.5MHz)

For the connection to the A/D-converters (SADC, HADC/2, FTLP4M/FADC) a separate cable Z15003 AQS KOAX CABLE RX is necessary.

Important notes:

- connect the high resolution output signal always to the SADC or HADC/2 directly even the system is equipped with a FTLP4M filter board.
- initially delivered RX-E (ECL 00) have swapped connections for CHA/CHB, the cable must be connected to the A/D converter in reverse order.

Troubleshooting / Unit replacement / Tips 'n' Tricks**5.6****General****5.6.1**

1. Do not open the AQS RX in the field.
2. Ensure the AQS Reference Board unit is not labeled with REF22-400, REF22-600 or REF22-1000. The AQS REF must be a REF400, REF600 or REF1000 type
3. To replace the unit simply switch off the AQS, replace the board and switch on. Having inserted a new AQS RX the spectrometer should be reconfigured and the entry in /u/conf/instr checked.
4. RF signals are all AC coupled and the overall output impedance is 50 Ω . (Please note: the SMA-connector nuts must not be tightened more than to a torque of 45Ncm.)

Description of possible error messages:

Table 5.3. AQS RX error messages

Error Nr.	Error Message	Description	Possible cause
Error Nr. 1	Serial RS485 timeout	slave device did not answer in expected time	slave device probably not initialized, check connections
Error Nr. 4	Serial RS485 command, checksum error	RS485 protocol violation	spectrometer control software failure
Error Nr. 10	RAM Error	RAM test failed	hardware failure
Error Nr. 11	Flash Error	no application firmware found	hardware failure or firmware download failed
Error Nr. 13	Power failed	indicate that a power up has occurred and the system is not initialized	ordinary power up or a power breakdown during an experiment
Error Nr. 15	Parameter exceeds valid range	value out of range	spectrometer control software failure or faulty input using Unitool
Error Nr. 16	Unknown board hardware version	this hardware version has never been delivered	firmware or hardware error on RX
Error Nr. 18	Unknown version index in configuration page	internal validation of calibration data failed	hardware error
Error Nr. 20	Syntax error	selected feature not supported by actual firmware, board does not understand command	spectrometer control software failure, wrong board selected, hardware feature not supported by actual version
Error Nr. 22	RTX create error	operating system error	firmware or hardware error on RX
Error Nr. 23	RTXmemory allocation error		
Error Nr. 24	RTX memory free error		
Error Nr. 25	RTX communication pool exhausted		
Error Nr. 26	RTX send signal error		
Error Nr. 27	RTX interrupt handling error		
Error Nr. 28	RTX semaphore waiting list full		
Error Nr. 29	RTX pool create error		

Table 5.3. AQS RX error messages

Error Nr.	Error Message	Description	Possible cause
Error Nr. 36	Flash Byte Program Error	failure during FLASH memory programming	hardware error
Error Nr. 37	Flash Erase Error		
Error Nr. 40	Flash Erase Timer expired		
Error Nr. 41	Error in Flash Command Sequence		
Error Nr. 42	Flash Page mismatch, storing terminated		
Error Nr. 43	calibration data not valid		
Error Nr. 50	RAM selftest error	RAM test failed	hardware failure
Error Nr. 51	no app firmware found (wrong FW checksum)	RAM test failed	hardware failure
Error Nr. 52	no app firmware found (wrong FW name)	RAM test failed	hardware failure
Error Nr. 53	no app firmware found (wrong FW id)	RAM test failed	hardware failure
Error Nr. 58	Corrupt BIS on board	BIS (Board Information System) test failed	hardware failure
Error Nr. 59	BIS checksum error	BIS (Board Information System) test failed	hardware failure
Error Nr. 62	BIS Group does not exist	BIS (Board Information System) missing Group entry	should never occur
Error Nr. 102	Missing valid configuration page	configuration data (calibration data) not available	hardware failure
Error Nr. 105	Flash table does not exist, using default table	configuration data (calibration data) not available	hardware failure
Error Nr. 128	input value out of range	entered input value out of range	spectrometer control software failure or faulty input using Unitool
Error Nr. 129	Error in LO generation (coarse tuning)	LO synthesizer was not able to set its frequency correctly	hardware failure
Error Nr. 130	Error in LO generation (VCO gradient fail)		
Error Nr. 131	Error in LO generation (PLL lock lost)	LO synthesizer was not able to set its frequency correctly	LO IN cable from SGU not connected REF IN cable from REF not connected spectrometer control software failure
Error Nr. 132	AF overflow (AF_OVERFLOW)	AF output signal too high, gain too high	wrong gain setting, spectrometer control software failure

Table 5.3. AQS RX error messages

Error Nr.	Error Message	Description	Possible cause
Error Nr. 133	Wrong RF-switch value	faulty input using Unitool	faulty input using Unitool
Error Nr. 134	Wrong IF-switch value		
Error Nr. 135	Wrong AF-switch value		
Error Nr. 136	Wrong PLL-gain-adjust value		
Error Nr. 137	Wrong PLL-level value		
Error Nr. 138	Enable/Disable expected		spectrometer control software failure or faulty input using Unitool
Error Nr. 139	No oscillator selected	faulty input using Unitool	faulty input using Unitool
Error Nr. 140	Power Diagnostic failed	on-board diagnostic detected faulty power supply voltages	check power LED on AQS RX and other AQS boards to determine if AQS RX hardware failed or fuses on the power supplies need to be exchanged
Error Nr. 141	RGP_RX-Error occurred	receiver has been gated while the on-board microcontroller was running spectra may show spikes	spectrometer control software failure
Error Nr. 142	Frequency invalid		spectrometer control software failure or faulty input using Unitool
Error Nr. 143	Gain invalid		
Error Nr. 144	Pgp table not found		hardware failure
Error Nr. 145	Gain table not found		
Error Nr. 146	PII table not found		
Error Nr. 147	VCO gradient too low		
Error Nr. 148	VCO gradient too high		
Error Nr. 149	I2C bus fail		
Error Nr. 150	wrong IF-gain-adjust value		
Error Nr. 151	wrong pgp-table-index		faulty input using Unitool
Error Nr. 152	invalid row number in loop-table		spectrometer control software failure or faulty input using Unitool
Error Nr. 153	invalid amount of rows in loop table		
Error Nr. 154	Wrong PLL-tune value		faulty input using Unitool
Error Nr. 155	On/Off expected		spectrometer control software failure or faulty input using Unitool
Error Nr. 156	Frequency too high for this type of RX		
Error Nr. 157	OfsTable full, offset setting is stored temporarily only		too many entries in the dc offset correction table
Error Nr. 158	OfsTable can't be deleted - delete OfsTable in RAM then save config		faulty input using Unitool

Testing the overall gain of the Receiver

5.6.3

Table "**Effective Gain of the AQS RX**" on page 123 shows the overall real gain of the AQS RX for a range of RG values. To check these values carry out the following procedure.

1. Measure the voltage of the 10 MHz output J3 of the REF unit ~7dBm (1.4Vpp) @ 50 Ohms by scope
2. Set SFO1 = 10.0001 MHz. AQ = 60 seconds
3. Set RG = 1
4. Connect the 10 MHz output via a variable attenuator to the receiver input. Set the attenuator to 80 dB.
5. Enter „zg“ and observe the voltage at the receiver output CHA or CHB. Adjust the variable attenuator until the voltage at the receiver output is equal to that measured at the 10 MHz output of the REF. unit. The attenuation required can be taken as a measure of the gain of the receiver.

Important: The maximum load of the HR out is 1 kOhm (not 50 Ohms) !

You can repeat using various values of RG, but be sure to increase the attenuation accordingly.

Diagnostic Tests

5.7

The AQS RX has no special written diagnostic program. The AQS RX can be accessed with the UniTool that is accessible from BRUKER Utilities:

With UniTool you can

1. read and write the AQS RX receiver gain
2. adjust the gain, phase and baseline for the quad module
3. adjust DC offset
4. measure the quad module temperature
5. read actual firmware version, ECL and hardware version
6. download new firmware

Be aware that the corruption of calibration data can lead to the incorrect operation of the unit and this menu point should be entered by service personnel only.

Quadrature and DC Offset Correction Table

5.8

The DC offset of the AQS RX can be adjusted by software and stored in the on-board FLASH non-volatile memory. The offset values are handled for each frequency/gain pair and will automatically be adjusted each time the receiver gain (rg) or the observe frequency is changed.

To fill a DC offset correction table you have to do a 'gs'- experiment with XWINNMR. Be sure XWINNMR has selected the nuclid/frequency you want to adjust the Offset Table for.

Choose the acquisition window in XWINNMR to see the time domain signal and select `Unsh` to see both channels.

Important: 'gs' must be started before UniTool because the UniTool occupies the serial port communication. At the end, before you try to change parameters in XWINNMR, UniTool must be left.

You can program the offset table with UniTool (Note: 'gs' must be started before UniTool!). When working with Windows NT start UniTool by opening Bruker Utilities, then Service Tools, then click on UniTool.cmd.

When working with UNIX or Linux open an shell and enter `xwinnmr -e UniTool` or start the UniTool from the directory `(/Bruker/<xwinnmr release>/conf/instr/servtool/UniTool`.

```
Enter device name ['?' for details] (aqs) >
```

```
--> hit <return>
```

```
Enter decimal SBSB address for board in AQS rack (36) >
```

```
--> enter address 16 for RX_1, address 17 for RX_2, ... and hit <return>
```

```
Bruker UniTool
  Version 1.xx
  Compilation date: <.....>
```

```
WARNING:
```

```
  This is a hardware level debug tool.
  Improper operation may damage your hardware.
```

```
Connecting SBSB address 16 (0x10)
```

```
>>> RX Main Menu <<<
```

```
=====
```

```
[0] RX Init
[1] RX Board Info
[2] RX Delete Error
[3] RX Query Request
[4] RX Auto Download
[5] RX Manual Download
```

```
-----
[G] RX Gain
[F] RX Offset Adjust (FADC selected)
[H] RX Offset Adjust (HADC/SADC selected)
[V] RX save configuration
[T] RX erase all OfsTableEntries of actual Frq
```

```
-----
[P] RX select Gain Distribution Scheme
[D] RX Diagnostic Functions
[X] eXit UniTool
    your choice:
```

The AQS rack must be powered on at least for 5 ... 10 mins to guarantee a stable temperature of the RX before adjusting any DC offset or quad image.

If necessary you can check the RX- temperature with [D] Diagnostic Functions and [T] RX Temperature :

Quadrature and DC Offset Correction Table

measurement range: 38...63 degree celsius
nominal value: 54 +/-2 degree celsius
AF Temperature: xx degree celsius
PLLTemperature: xx degree celsius

The temperature should be about 54 °C, except if you got an AQS RX-E ECL 00. AQS RX-E ECL 00 do not support temperature regulation.

To be sure the actual dc offset correction table in the read-only memory (RAM) is empty for this nuclid/frequency choose [T] RX erase all OfsTableEntries of actual Frequency in the main menu and <y> yes.

If you use a FADC choose [F] RX Offset Adjust (FADC selected). You need to know/enter

- the DigitalResolution (DR) from the acquisition parameters (see XWINNMR 'eda' or 'dr')
- and the 'FTLP-Gain' (see XWINNMR 'ftlpgn' --> type 0 for 0 dB - 1 for 14 dB).

You will get this menu:

```
>>> RX Offset Adjust Menu (FADC selected) <<<
=====
[G] RX Gain                               [N] next
[A] RX set AF offset channel A           [1] Inc [2] Dec
[B] RX set AF offset channel B           [3] Inc [4] Dec
[C] RX set Quadrature Amplitude DAC      [5] Inc [6] Dec
[D] RX set Quadrature Phase DAC          [7] Inc [8] Dec
[V] RX save Configuration
[Q] Quit Menu
     your choice:
```

If you use a HADC or a SADC choose [H] RX Offset Adjust (HADC/SADC selected). You need to know/enter

- the DigitalResolution (DR) from the acquisition parameters (see XWINNMR 'eda' or 'dr').

You will get this menu:

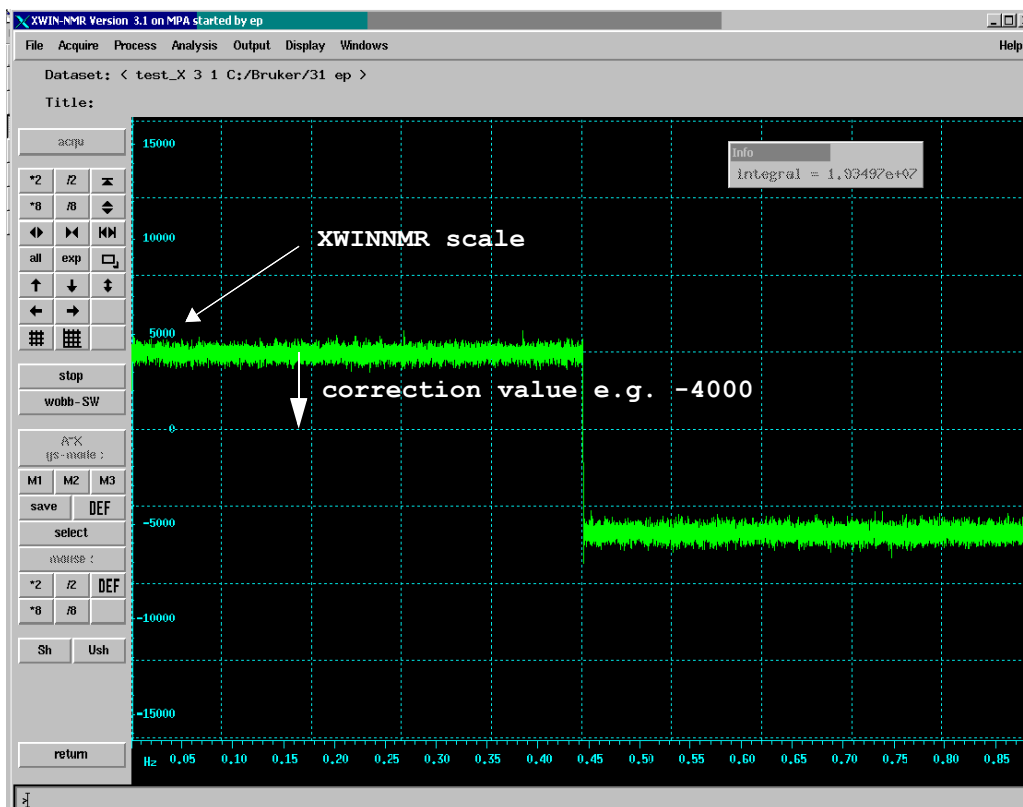
```
>>> RX Offset Adjust Menu (HADC/SADC selected) <<<
=====
[G] RX Gain                               [N] next
[A] RX set AF offset channel A           [1] Inc [2] Dec
[B] RX set AF offset channel B           [3] Inc [4] Dec
[C] RX set Quadrature Amplitude DAC      [5] Inc [6] Dec
[D] RX set Quadrature Phase DAC          [7] Inc [8] Dec
[V] RX save Configuration
[Q] Quit Menu
     your choice:
```

The offset table handles entries (max. 900 entries) which are stored according to selected nuclid/frequency (in steps of 2.5 MHz) and the selected gain (in steps of 1 dB).

To adjust the table for the actual nuclid/frequency you must start with the lowest gain. Choose [G] Gain and enter 1.

Choose [A] RX set AF offset channel A to adjust channel A.

Figure 5.4. Example figure 1



The graph's left half of the XWINNMR's y-axis shows you the offset correction of channel A. If the graph's y-value is negative you have to enter that value positively to converge to zero offset. If the graph's y-value is positive enter the value negatively.

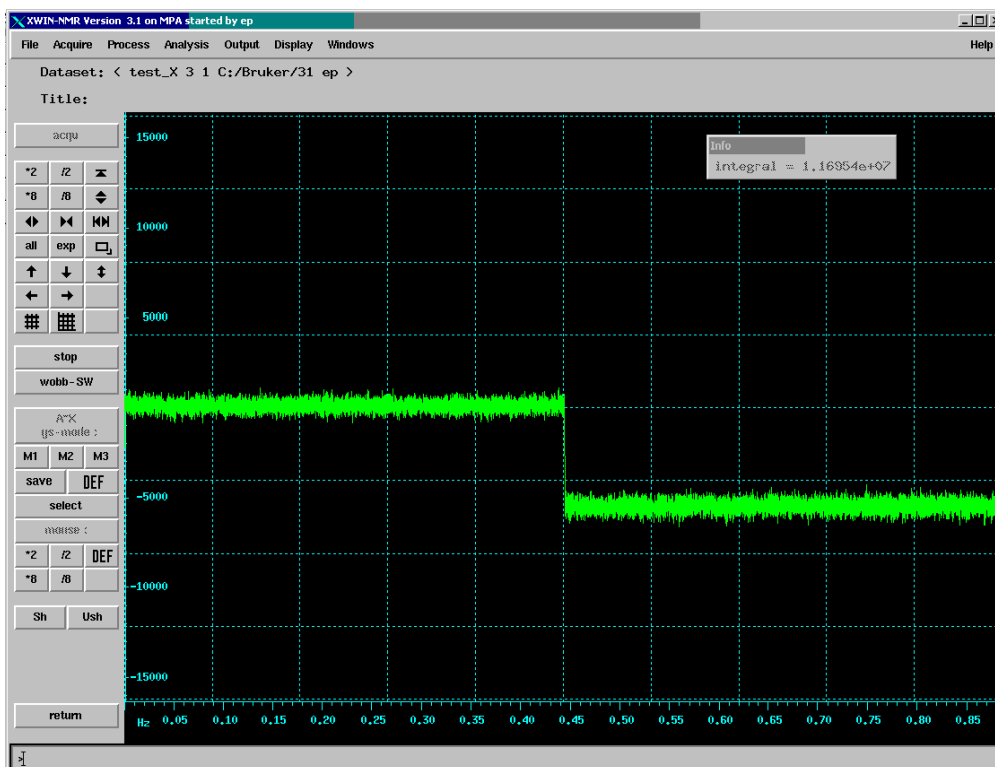
RX will calculate the internal RX values needed. Repeat this once or twice and you will be within one percent of the uncorrected offset. (If not you entered a wrong DR or you read the screen-value with too little precision)

a <correction value>, for channel A respectively b <correction value> for channel B

e.g. / for the above example:

a -4000

Figure 5.5. Example figure 2



When you have achieved small offset values you can adjust the offset by increasing or decreasing the lowest significant bit of the adjustment D/A-converter by typing

- [1] Inc or [2] Dec for Channel A respectively
- [3] Inc or [4] Dec for Channel B

The graph's right half of the XWINNMR's y-axis shows you the offset correction of channel B. --> the same as above for Channel B

Choose [B] RX set AF offset channel B to adjust channel B --> the same as above

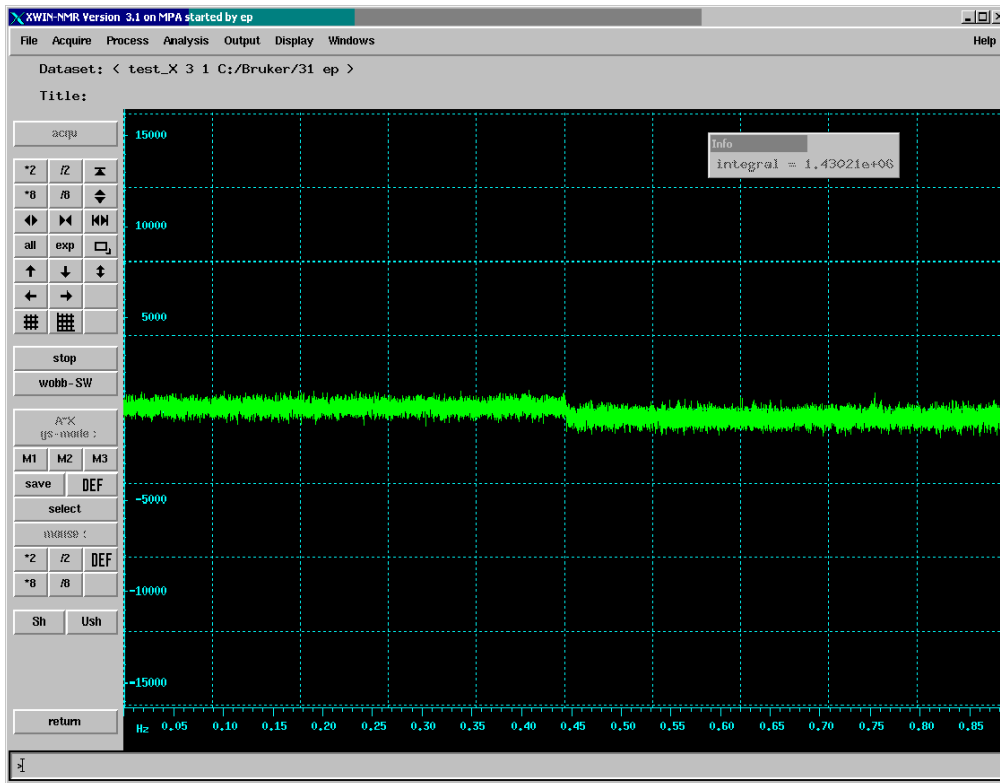
Instead of type [B] and afterwards enter the correction value you can also type:

b <correction value> for channel B

e.g. / for the above example:

b 5000

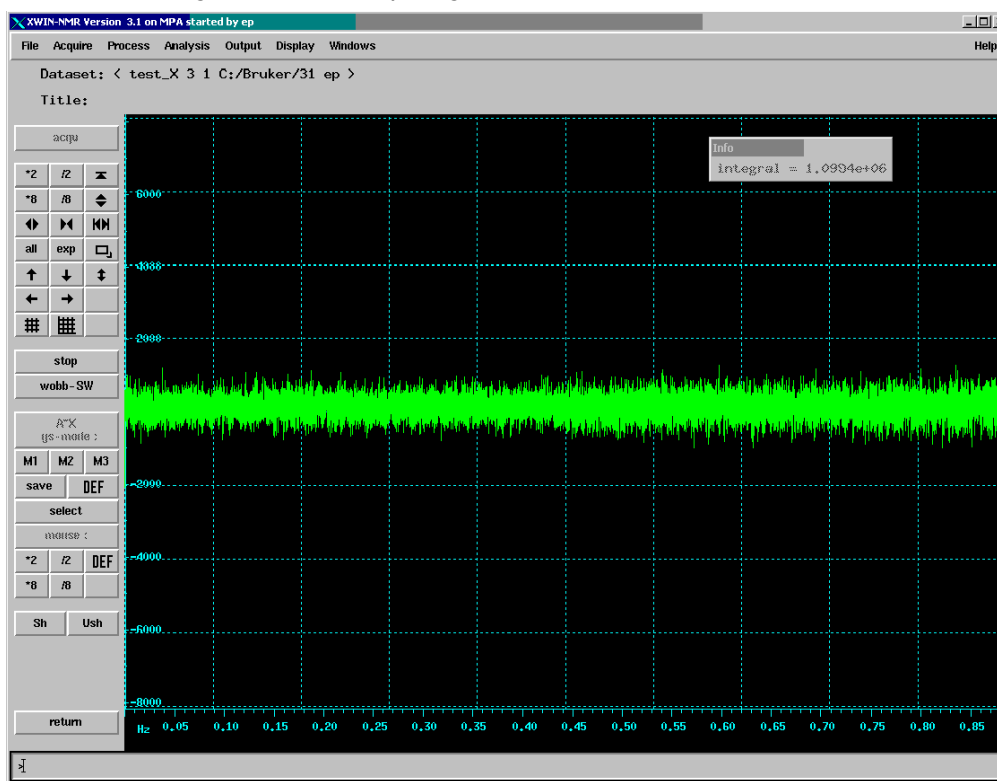
Figure 5.6. Example figure 3



When you have achieved small offset values you can adjust the offset by increasing or decreasing the lowest significant bit of the adjustment D/A-converter by typing

[3] Inc or [4] Dec for Channel B

Figure 5.7. Example figure 4



Repeat the whole procedure for the next gain by choosing [N] next Gain. Repeat 'Next Gain' until all gains are adjusted including the highest gain (= 46300).

If you don't want your table entries to be lost after a power down of the AQS-rack you need to save the RX configuration with [V] RX save configuration. This will take a few seconds.

Configuration has been saved

After saving the table initialize the receiver selecting [0] RX Init from the Main Menu.

Important: You must choose [Q] Quit Menu and [X] eXit UniTool to free/release the serial port of your work station before alter parameters in XWINNMR.

Stop the XWINNMR experiment, select the next nuclid/frequency you want to adjust and start another 'GS'- experiment. Adjust in the same way as above ...

For quadrature phase/gain adjustment the following pulse program is useful:

```
;zgcw.mod
;avance-version (02/07/08)
;1D sequence with CW decoupling
#include <Avance.incl>
"d11=30m"
```

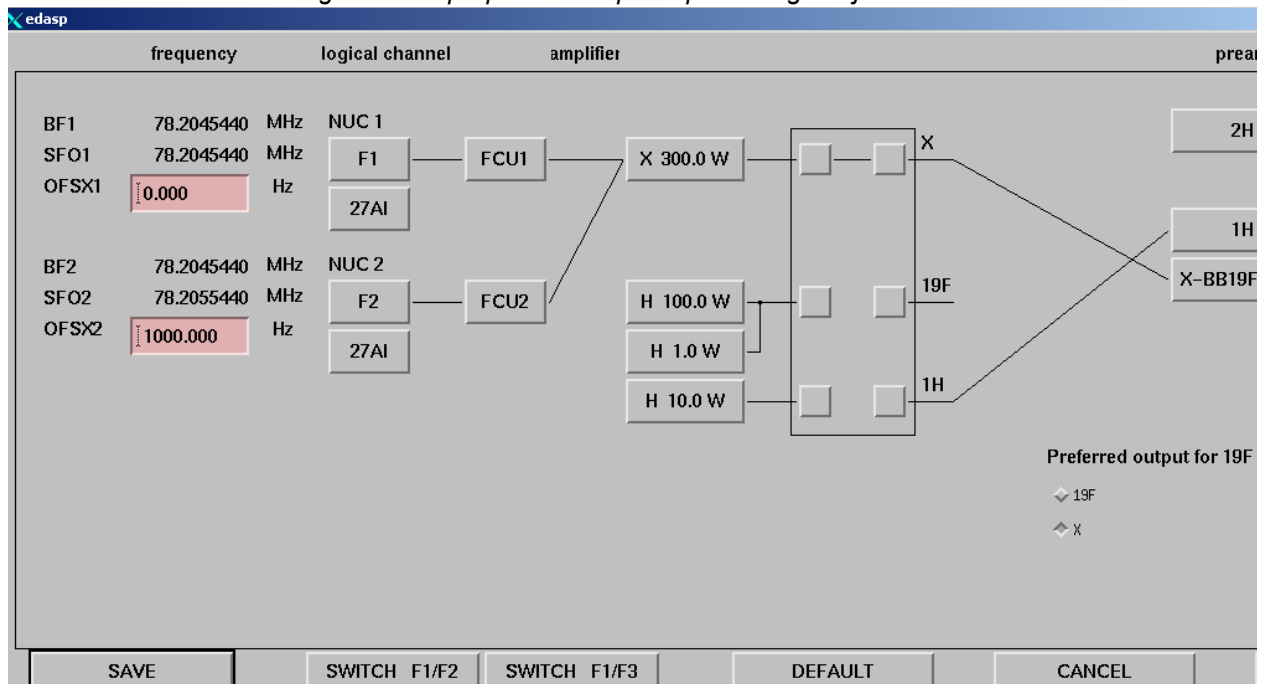
```

1 ze
2 d11 reset:f1 reset:f2
   d11 pl26:f2
   d11 cw:f2 ph30
   d1
   p1 ph1
   go=2 ph31
   wr #0
   d11 do:f2
exit
ph1=0 2 2 0 1 3 3 1
ph31=0 2 2 0 1 3 3 1
ph30=0
;pl1 : f1 channel - power level for pulse (default)
;p126: f2 channel - power level for cw decoupling
;p1 : f1 channel - high power pulse
;d1 : relaxation delay; 1-5 * T1
;d11: delay for disk I/O [30 msec]
;$Id: zgcw,v 1.7 2002/07/08 11:41:17 eng Exp $

```

In edasp select two identical nucleus for F1 and F2 and set the offset frequency OFSX2 of the second one to e.g. 1000.0Hz

Figure 5.8. proposed setup for quad image adjustment



Connect now the RF OUT of SGU2 with the RF IN of the RX directly and start acquisition in 'gs' mode.

Check the input signal level in the acquisition window. Check for appropriate load of the ADC and do not overload it.

Process the data by frequency domain phasing (magnitude) or enter `dspmc` and adjust the quadrature image signal with UniTool.

The adjustment procedure is similar to that one for dc offset correction.

For phase/amplitude adjustments select the following menu points:

```
[C] RX set Quadrature Amplitude DAC [5] Inc [6] Dec  
[D] RX set Quadrature Phase DAC [7] Inc [8] Dec
```

Frequency Range:

5.. 432.5 MHz (RX400)

5.. 647.5 MHz (RX600)

5..1072.5 MHz (RX-BB, RX1000)

Frequency Stability: This is governed by the stability of the crystal oscillator on the REF unit which is specified to 3×10^{-9} /day and 1×10^{-8} /year

Frequency Resolution: The local oscillator synthesizer in the AQS RX follows the SGU LO signal with its resolution of <0.005 Hz.

LO Phase Settling Time: 1.5 us max. (RX-BB)

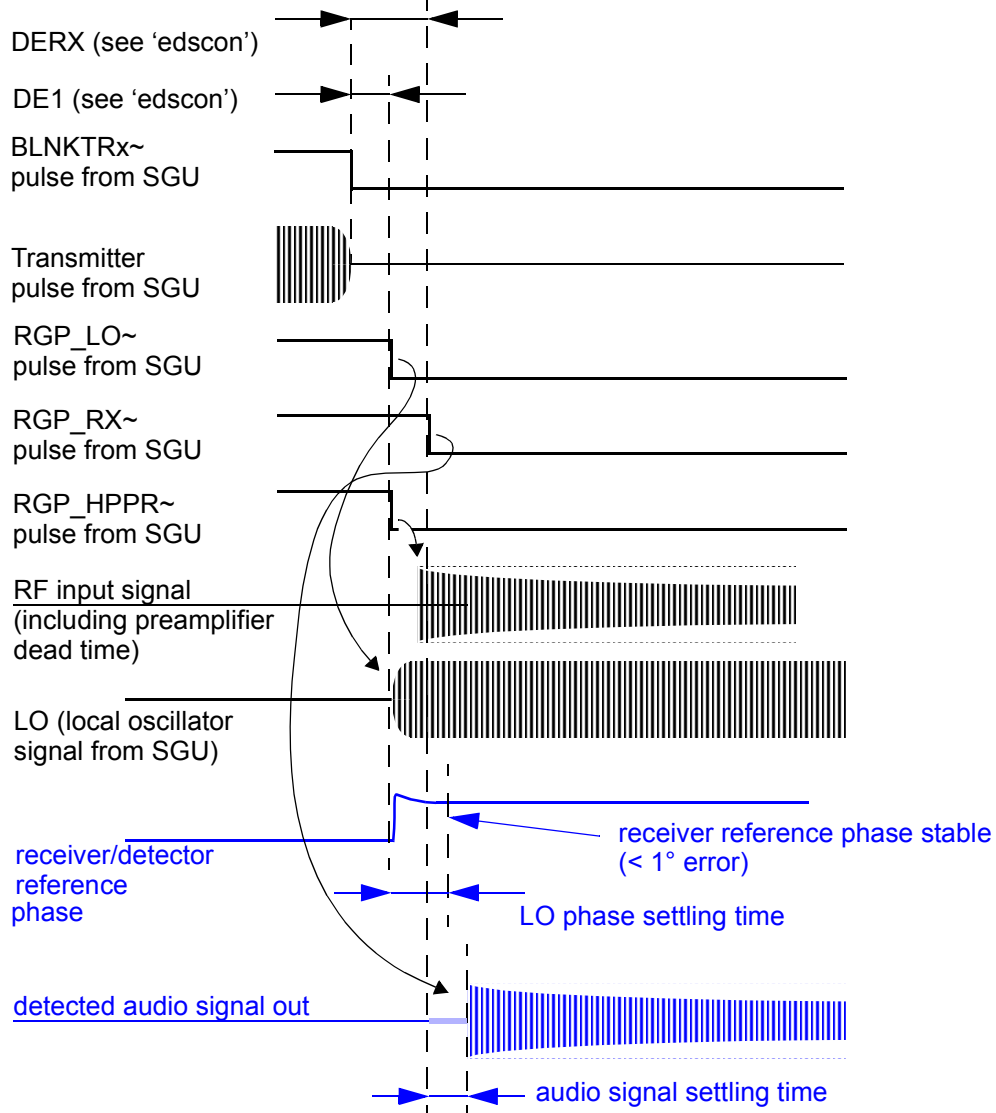
Audio Signal Settling Time: < 1us (RX-BB)

Gain:

Gain Range: 12..105dB, 93dB gain range in 1dB Steps

Turn on or settling time of the AQS RX-BB are defined as follows:

Figure 5.9. AQS RX-BB timing definitions



Power Supply / Fuses

5.11

See [5.4.1](#)

Backplane Connector

5.11.2

	z	a	b	c	d	e	f
1	GND	GND	RESERVE_1	NC	GND	SAMPLE_INFO0	GND
2	GND	NC	GND	SAMPLE_INFO3	SAMPLE_INFO2	SAMPLE_INFO1	GND
3	GND	GND	NC	RESERVE_2	GND	SAMPLE_INFO4	GND
4	GND	20MHZ_CLK_X	GND	INTERLEAVE_INCR~	ADC_SEL1	ADC_SEL0	GND
5	GND	GND	20MHZ_CLK_X~	RESERVE_3	GND	RGP_LO~	GND
6	GND	BLNKTR1~	GND	BLNKTR2	RESERVE_6	RESERVE_4	GND
7	GND	BLNKTR3~	BLNKTR4~	NC	GND	RGP_ADC	GND
8	GND	BLNKTR5~	GND	BLNKTR6~	RESERVE_7	DWL_CLK	GND
9	GND	BLNKTR7~	BLNKTR8~	NC	GND	RGP_RX~	GND
10	GND	SBS_TTL_TX	GND	SBS_TTL_RX	SBS_TTL_TX_ENAB~	RESERVE_5	GND
11	GND	LOCAL_TX	LOCAL_RX	SBS_TTL_WUP~	GND	RGP_HPPR~	GND

red = CCU-Bus galvanically isolated
blue = Intra Rack Bus

Key Area

15	GND	SLOT2	SLOT1	SLOT0	GND	RESERVE_ADC_1	GND
16	GND	SLOT3	GND	I2C_SDA	RESERVE_ADC_2	GND	GND
17	GND	EMERGENCY_STOP	I2C_BUS_REQ	I2C_SCL	GND	ADC_I2C_SDA	GND
18	GND	NC	GND	I2C_2_SDA	I2C_2_SCL	GND	GND
19	GND	NC	NC	NC	GND	ADC_I2C_SCL	GND
20	GND	NC	GND	P2V	N2.5V	GND	GND
21	GND	P5V	P35V	P9V	P9V	P9V	GND
22	GND	P5V	RACK0	N9V	N9V	N9V	GND
23	GND	P5V	P19V	N19V	RACK1	P12V	GND
24	GND	P5V	P19V	N19V	RACK2	P12V	GND
25	GND	P5V	P19V	N19V	RACK3	P12V	GND

SGU Signal Generation Unit

6

Introduction

6.12

The SGU is one of the most significant advances in the new AV series. It is the unit where the generation of all analog characteristics of the RF signal takes place. The SGUs are located in the analog section of the AQS rack between the REF unit and either the Router or internal amplifiers. Each RF channel has a dedicated SGU. If more than 4 channels are required the extra SGUs will be located in a second AQS rack.

On the transmission side the SGU generates the signal frequency, phase and regulates the amplitude (including shape control) as well as the blanking and gating pulses. The information is received from the TCU3 / FCU4 via the LVDS but implemented upon in the SGU. The output of the SGU will be a miniature version of the final transmitted signal. The only change that takes place to the signal after SGU generation is the power increase in the amplifiers. On the receive path the SGU generates the LO frequency as well as the receiver gating pulses and the dwell clock.

In hardware terms all SGUs are identical but one SGU will occupy the master slot in the AQS and is referred to as the 'rack master' or 'master SGU'. For single rack systems the master SGU will occupy slot 3 (J6) of the user bus. For a two rack system it is slot 5 (J8) of AQS1. This master SGU recognizes its position automatically and switches into master mode whereas all other SGUs are set to slave mode. The SGU master communicates with various analog units to reduce the needed communication to a minimum for the CCU10 and the subunits. see **"AQS signal path" on page 15.**

Note that while the master SGU has additional functionality it also performs all the tasks of a standard SGU. The various SGU boards are synchronized by means of a 20 MHz clock signal from the backplane. The clock signal originates on the AQS Reference Board. The synchronization is essential if the various RF channels are to be phase coherent etc.

Apart from the master SGU the only other distinction between the various SGUs is that one SGU is pre allocated as the observing SGU and generates the LO as well as the receiver timing. This can be any SGU depending upon which FCU in the edsp menu is chosen as the OBS.

Each SGU has a dedicated hardwired LVDS link to an FCU (either channel A or B). The high speed link transfers all NMR relevant real-time events in 50ns time slots to the corresponding SGU (e.g. pulses, shapes, phase jumps, frequency shifts etc.). Each rf channel is controlled by a separate high speed link. It is connected via a cable on the front panels of the two units (point to point connection).

NB: The SGU is really a DAC. It does nothing without FCU order. The FCU generates for example every dwell clock. It orders the SGU to go high/low/high/low and so the DWCLK is generated. The LVDS is really the bridge between the digital and analog side.

The SGU has access to the various buses along the AQS backplane.

A special feature of the SGU is the extra shielding. This is because of the importance of ensuring that the generated RF signals are free of distortion.

Functions / Description

6.13

The central role played by the SGU is evident from the extensive list of functions below. For further details on some of the specific details below see **"Important signals" on page 159**

All SGUs.

1. Generation of the precise final transmission frequency by means of an on-board frequency generator. The SGU implements all analog aspects of the signal including frequency, frequency shifts, phase shape etc. The information regarding the precise characteristic of the signal is received from the FCU via the LVDS.
2. Amplitude control both in terms of magnitude (mult) and shape (mod). Although the SGU delivers a max voltage of 1Vpp the linear nature of the amplifiers means that the SGU has exclusive control of the final amplitude.
3. Generation of blanking signals for use in the various amplifiers. The internal amps receive the blanking directly from the backplane, whereas the external amps receives the signals from the PSD which in turn receives the signals from the backplane.

observing SGU only.

4. Generation of gating pulses to be used in the HPPR, RX22, SADC
5. Generation of the dwell clock for the ADC and LO frequency for the RX22.

Master SGU only

6. Initializes various units after a power up or 'ii' command. A proper initialization of all RF units in the AQS mainframe is highly dependent on a correct power up process of the master SGU1.
7. Communication with the CCU10 via the SBSB1 and with other analog units via a I²C bus.
8. Router control via the backplane. This also includes control of the mini router in internal amplifiers. The information is transmitted via the I²C bus mentioned above.

SGU2 only

9. Generation of the 'wobb' signal

The LO will be generated on the observing SGU and daisy chained through all the succeeding SGUs to the RX22. This daisy chain is unidirectional in the direction of the RX22. If in a four channel system SGU2 is the OBS then SGU2 will generate the LO and this will be daisy chained through SGU3 and SGU4 to the RX22. see

Figure 6.10. LO daisychain for the case where SGU2 is the observing SGU

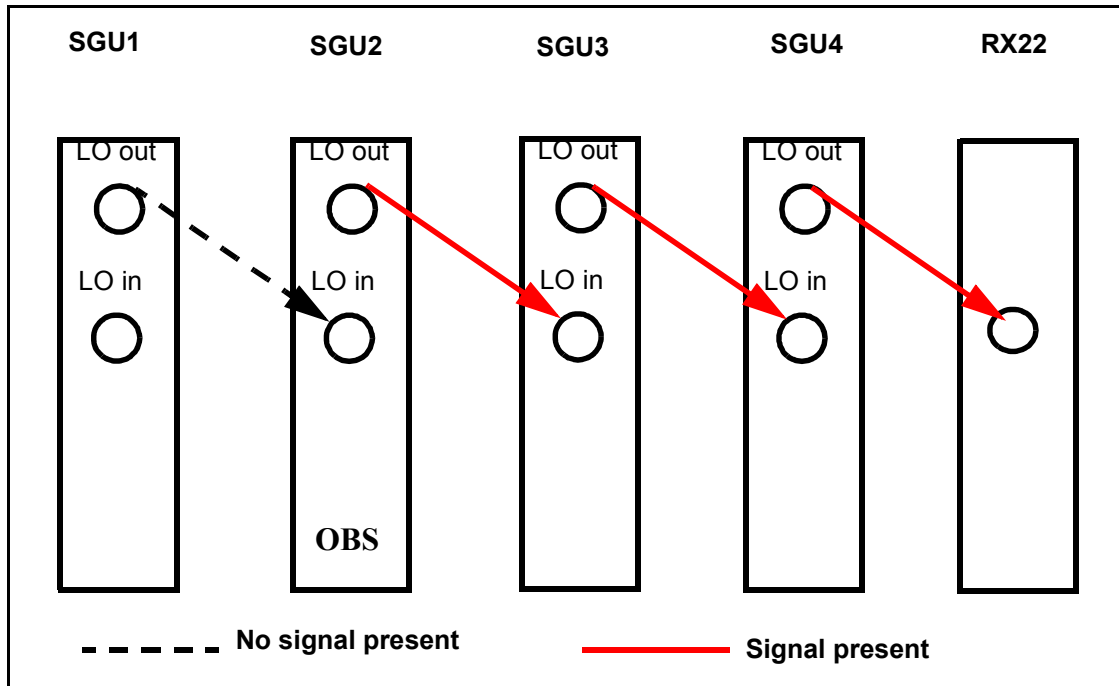
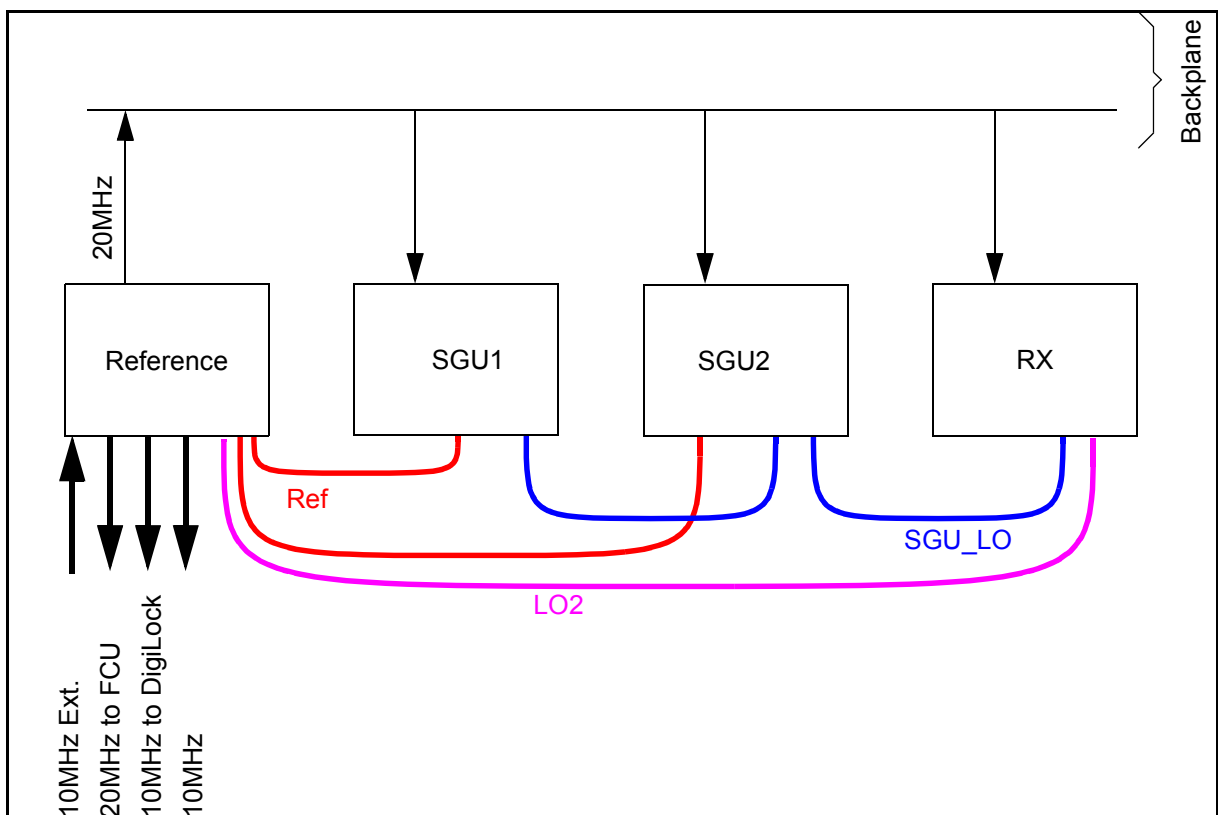
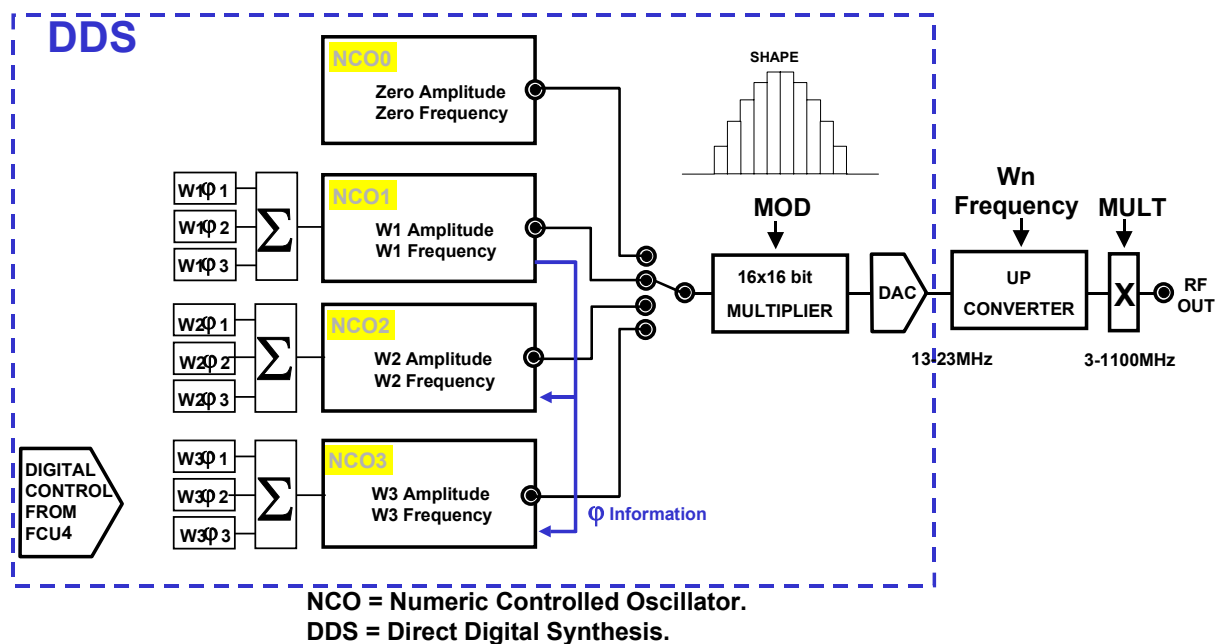


Figure 6.11. SGU RF paths



This is shown schematically in **Figure 6.13**. Note that the signal path switching is controlled via the LVDS.

Figure 6.12. signal generation on the SGU



Although from a service point of view the internal workings of the SGU are not relevant, this is such a new unit and plays such a central role in the spectrometer that it is perhaps worth making a short description of its main features.

At the heart of the SGU are three NCOs (Numerically Controlled oscillators) NCO1, NCO2, NCO3. A fourth NCO, NCO0 is actually a virtual oscillator in that it does not physically exist but is used to represent zero transmission, i.e. all three physical oscillators are switched off.

NCO0 is always used for zero transmission.

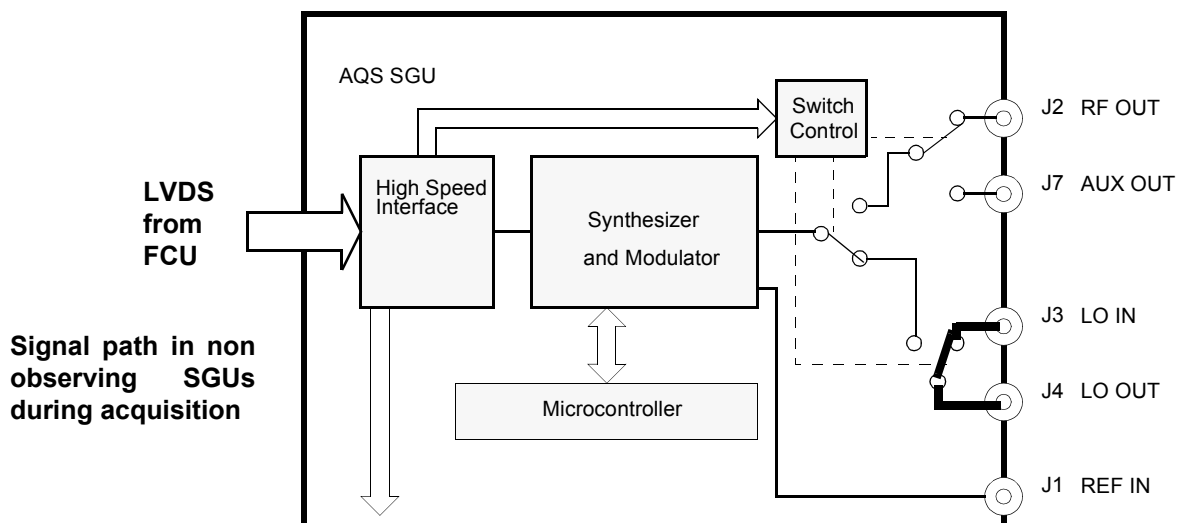
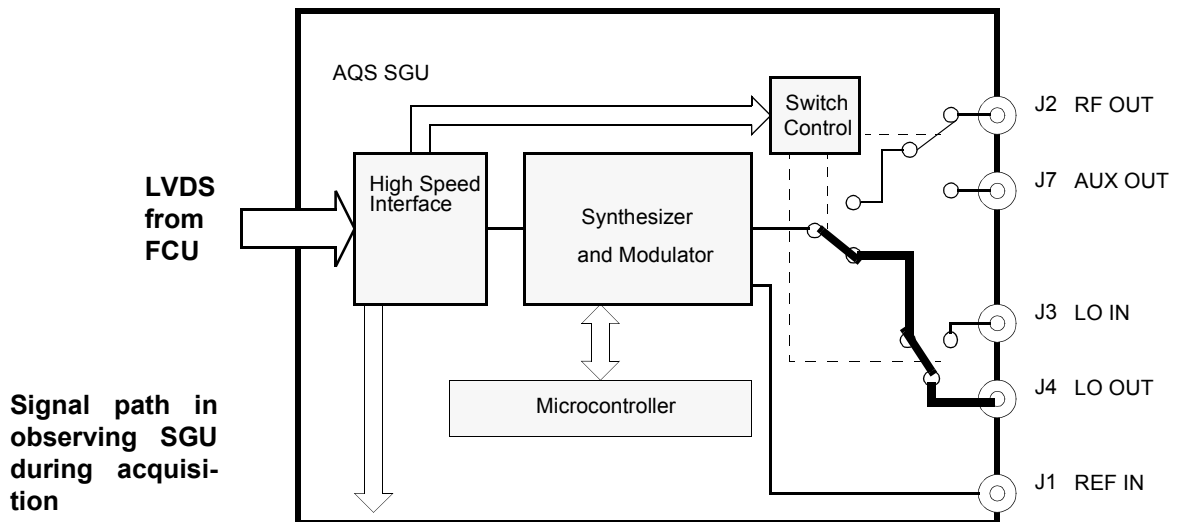
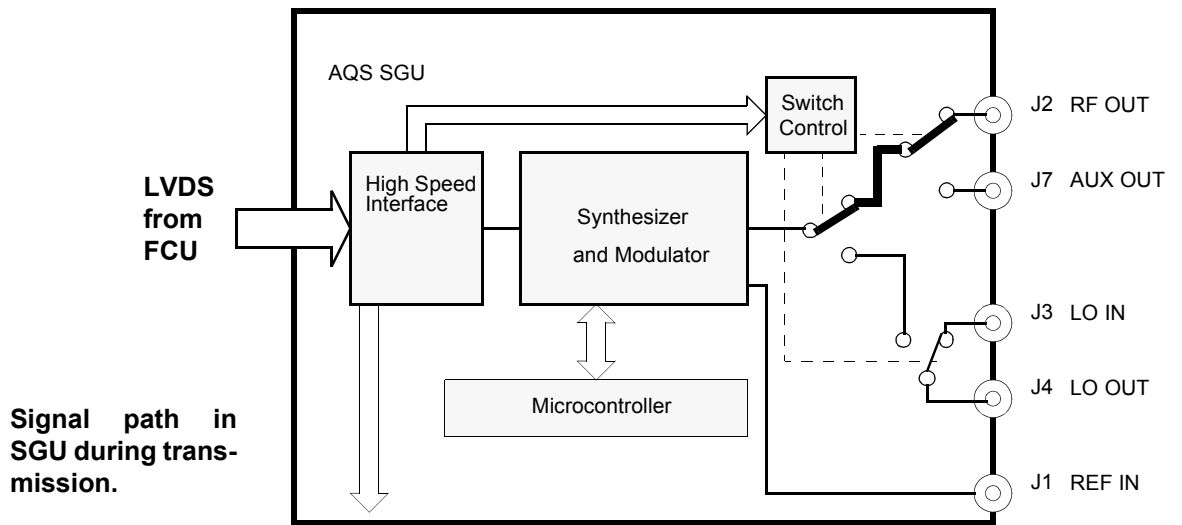
NCO1 is always used for the OBS frequency

Any shifts in frequency are implemented using NCO2.

NCO3 is always used for the LO frequency. This assignment of the various NCOs is illustrated in **"NCO allocation" on page 148**

The advantage of using multiple NCOs is that frequency, amplitude and phase information can be loaded simultaneously. This facilitates instantaneous switching from one phase or frequency to another etc.

Figure 6.13. Signal paths within the SGU

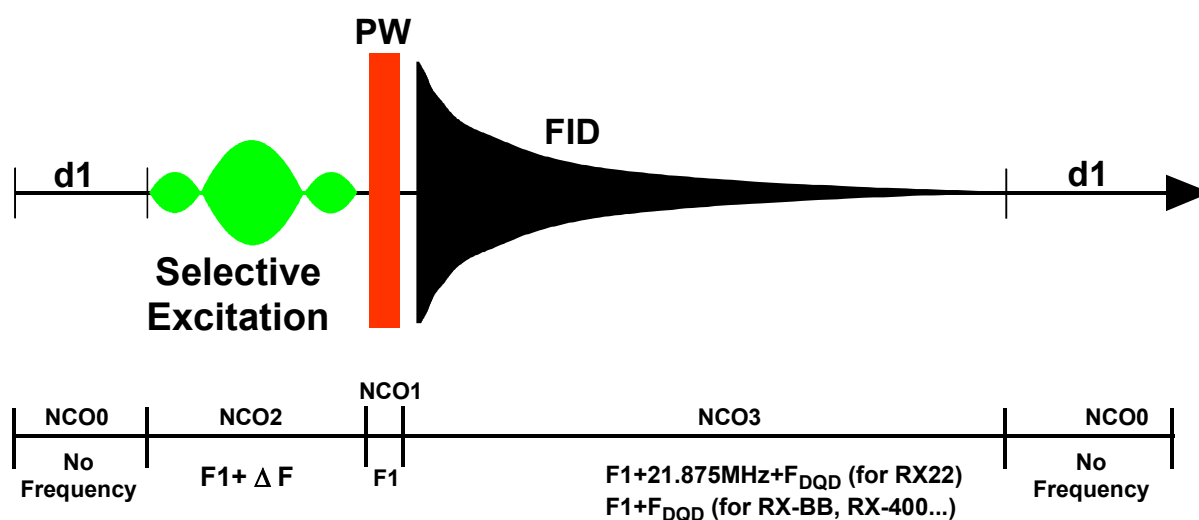


SGU Signal Generation Unit

The timing of the NCO output is controlled by a series of instructions delivered by the FCU via the LVDS with a 12.5ns timing resolution.

The output of the various NCOs is a digital representation of all characteristics of the required signal. This digital signal is then modulated using the 'MOD' input to implement the shape of the signal. The signal is still purely digital in nature but is then passed through a DAC to produce an analog output. The frequency at this stage is still not the final frequency, this only happens at the UP Converter which mixes the oscillator frequency with the appropriate frequency from the REF unit to produce the final transmission frequency. The last step is the application of the 'MULT' which sets the overall amplitude of the RF output.

Figure 6.14. NCO allocation



Unit Configuration / Version / Jumpers

6.14

Five versions of SGUs have been produced.

- SGU-C Part-No. Z003329, output frequency range limited to 325MHz
- SGU400 Part-No. Z003642, output frequency range limited to 430MHz
- SGU600 Part-No. Z003831, output frequency range limited to 643MHz
- SGU1000 Part-No. Z003330, output frequency range limited to 1072MHz
- SGU-FTMS Part-No. Z003643, output frequency range limited to 10MHz

Key specifications and digital control behavior remain the same for all versions

Through the 'cf' routine the number and location of all installed SGUs including the master SGU is determined. Each SGU in the user bus has a unique address by virtue of its physical position and this is used to distinguish the various SGUs from each other. There are no jumpers that need to be set.

Regardless of the system the units are lined up immediately to the left of the REF. unit.

A micro bay system will accommodate up to three SGUs.

A one bay system will accommodate up to four SGUs(three if internal amps are used)

A two bay system will accommodate up to 8 SGUs (4 attached to REF1 and 4 attached to REF2)

Any of the SGUs may be selected as the Observe SGU. In the 'edsp' menu the FCU number is equivalent to the SGU number and so this menu will easily tell the operator which SGU is the observing SGU.

Table 6.4. Assignment of SGUs

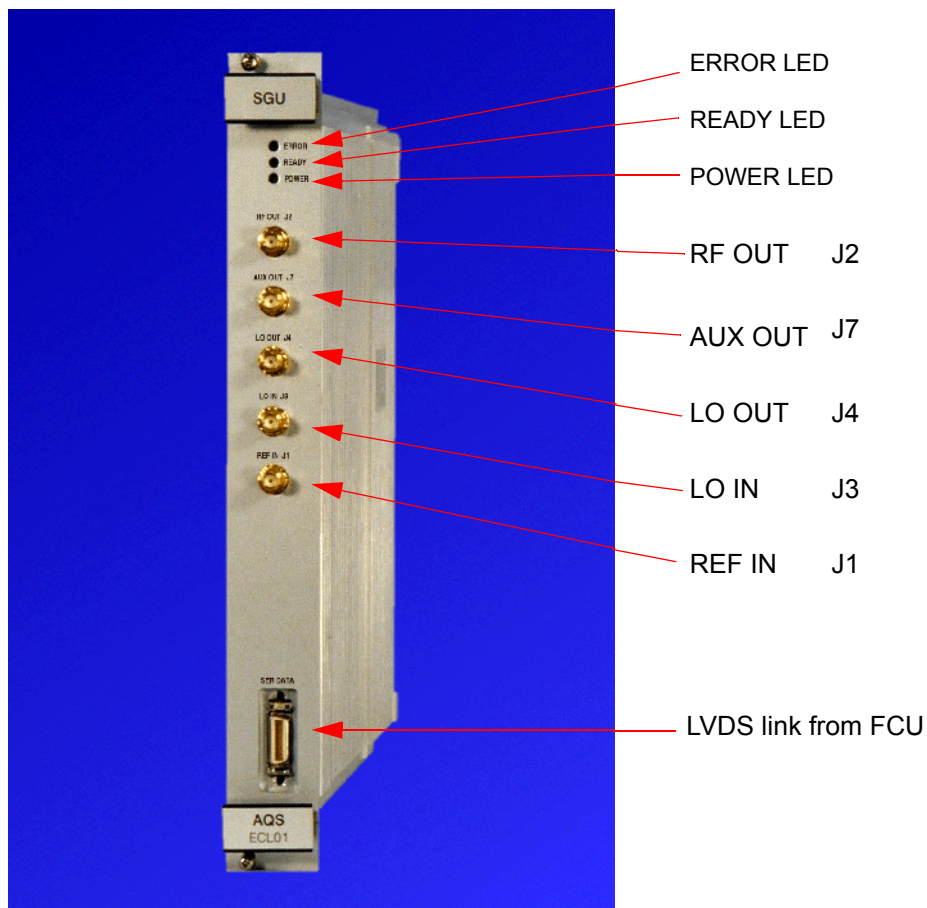
Physical SGU	Physical FCU	edsp display
1	FCU1 Channel A	FCU1
2	FCU1 Channel B	FCU2
3	FCU2 Channel A	FCU3
4	FCU2 Channel B	FCU4

Differences from previous versions.

6.14.2

This is a completely new development for the AV series and the SGU does not have a counterpart in the AVANCE series.

Figure 6.15. SGU front panel



RF OUT J2

This is the single rf output which will be connected either directly to an internal amplifier input or to the router on its way to an external amplifier. This signal will have a max amplitude of 1Vpp at a power setting of -6db. The signal will only be present during pulse transmission as the blanking takes place on the SGU itself.

AUX OUT J7

The wobb signal ALWAYS comes from the AUX out of SGU2 since this is hard-wired to the 'Tuning in' input of the HPPR cover display module. On all other SGUs this output is left unconnected except for the case of SGU1 where it can be connected to the 2HTX on an AQS with no router. The wobb signal will appear as a swept frequency whose variations in frequency will depend on the setting of 'wb-sw'. On the scope it appears typically as a pulsing frequency of maximal 1Vpp. (note that the wobble signal amplitude for HPPR/2 can be set by software, typical values are around 150mVpp)

The LO for the WOBB routine will come from the observing SGU LO OUT. This will also appear as a swept frequency except that this time the central frequency will be the wobble frequency + detection offset frequency (LO, DQD).

Since all SGU are physically identical the AUX OUT output would be capable of transmitting RF signal from any SGU but this would require explicit pulse programming.

LO OUT J4

RF signal for the receiver (1.0Vpp at 50 Ohm). The signal is generated on the observing SGU and then daisy chained through successive SGUs in the direction of the RX22. This signal will only be present during AQ (acquisition time) and if the SGU in question is the observing SGU or is located to the right (further along the daisy chain) of the observing SGU.

LO IN J3

This signal will only be present if the SGU in question is located to the right (further along the daisy chain) of the observing SGU (1.0Vpp at 50 Ohm).

REF in

Input RF signal from the REF. unit. This is a mixture of frequencies which are used to generate the final transmission frequencies.

Front Panel SGU-FTMS

The SGU FTMS has slightly different output connectors, because of the different receiver concept.

LO-I OUT J4

SYNT_0 signal for the ICR AQS FTMS HFU-RX A3147. This signal will only be present during AQ (acquisition time) and if the SGU in question is the observing SGU (-2dBm, 0.5Vpp at 50Ohm).

LO-Q OUT J3

SYNT_90 signal for the ICR AQS FTMS HFU-RX A3147. This signal will only be present during AQ (acquisition time) and if the SGU in question is the observing SGU (-2dBm, 0.5Vpp at 50Ohm).

LED Display:

6.15.3

Power LED:

The power LED indicates that **all** necessary voltages are present and at the correct level. If the voltage level drops then the LED will go out. Thus once the power LED lights then further investigation of the backplane to check the precise voltage is unwarranted.

The table below summarizes the states of the three front panel LEDs.

Table 6.5. LED States

ERROR	READY	POWER	Description
-	-	off	- power supply not on or operating incorrectly
off	on	on	- Normal operating mode - ready for operation
off	single, short-time flickering	on	- Communication LED. The unit has received a command from the RS485 bus master. The LED switches to off as soon as the SGU acknowledges the command.
blinking slowly (approx.3 Hz)	on	on	indicates warning and not error. The sleep mode during acquisition is disabled ('gs' mode). Caution: Sensitive NMR experiments are not possible in this mode due to disturbances of the controller system.

Part Numbers and Cables

6.16

- SGU-C Part-No. Z003329 (325MHz)
- SGU400 Part-No. Z003642 (430MHz)
- SGU600 Part-No. Z003831 (643MHz)
- SGU1000 Part-No. Z003330(1072MHz)
- SGU-FTMS Part-No. Z003643 (10MHz)

Troubleshooting / Unit replacement / Tips 'n' Tricks

6.17

General

6.17.4

1. All SGUs are identical and as such are fully interchangeable. If units are swapped it is advisable to reconfigure to ensure that there are no inconsistencies in unit recognition. Note that for best performance all the SGUs should be of the same type.
2. Ensure that all SGUs are using the same firmware (currently 'birdad.hex'). This can be done using UniTool.

3. Even upon rebooting after a power off, the error LED on the master SGU may light. It may be necessary to enter the command 'ii' (initialize interfaces) to clear this error.
4. Do not open the SGU in the field.
5. Ensure that the 20 pin cable to the FCU is connected before powering up the AQS. This will ensure the correct termination and also prevent the SGU from hanging.

Description of possible error messages:

Table 6.6. AQS SGU error messages

Error Nr.	Error Message	Description	Possible cause
Error Nr. 1	Serial RS485 timeout	slave device did not answer in expected time	slave device probably not initialized, check connections
Error Nr. 2	Checksum	wrong firmware checksum	internal hardware error or download failed
Error Nr. 3	Watchdog	hardware malfunction, on-chip diagnostic activated	hardware failure
Error Nr. 4	Serial RS485 command, checksum error	RS485 protocol violation	spectrometer control software failure
Error Nr. 10	RAM selftest error	RAM test failed	hardware failure
Error Nr. 11	no application firmware found	ROM test failed	hardware failure or firmware download failed
Error Nr. 13	Power failed	indicate that a power up has happened and the system is not initialized	ordinary power up or a power breakdown during an experiment
Error Nr. 15	Parameter exceeds valid range	value out of range	spectrometer control software failure or faulty input using Unitool
Error Nr. 17	Function not supported by board hardware version	selected feature not supported by actual hardware version	spectrometer control software failure, wrong command selected using UniTool
Error Nr. 18	Unknown version index in configuration page	internal validation of calibration data failed	hardware error
Error Nr. 20	Syntax error	selected feature not supported by actual firmware, board does not understand command	spectrometer control software failure, wrong board selected, hardware feature not supported by actual version
Error Nr. 22	RTX create error	operating system error	firmware or hardware error on SGU
Error Nr. 23	RTXmemory allocation error		
Error Nr. 24	RTX memory free error		
Error Nr. 25	RTX communication pool exhausted		
Error Nr. 26	RTX send signal error		
Error Nr. 27	RTX interrupt handling error		
Error Nr. 28	RTX semaphore waiting list full		
Error Nr. 29	RTX pool create error		

Table 6.6. AQS SGU error messages

Error Nr.	Error Message	Description	Possible cause
Error Nr. 36	Flash byte program error"	failure during FLASH memory programming	hardware failure
Error Nr. 37	Flash erase error		
Error Nr. 40	Flash erase timer expired		
Error Nr. 41	Error in flash command sequence		
Error Nr. 42	Flash page mismatch, storing terminated		
Error Nr. 43	No valid calibration data		
Error Nr. 50	RAM selftest error	RAM test failed	hardware failure
Error Nr. 51	No application firmware found (wrong firmware checksum)	ROM test failed	download error or wrong firmware downloaded
Error Nr. 52	No application firmware found (wrong firmware name)	ROM test failed	download error or wrong firmware downloaded
Error Nr. 53	No application firmware found (wrong firmware ID)	ROM test failed	download error or wrong firmware downloaded
Error Nr. 58	Corrupt BIS on board	BIS (Board Information System) test failed	hardware failure
Error Nr. 59	BIS checksum error	BIS(Board Information System) test failed	hardware failure
Error Nr. 60	Unknown rack code	Unknown rack code	invalid jumper setting on chassis user bus
Error Nr. 100	Serial DAC bus (SPI, 8420) error	on board serial DACs for calibration can not be set	hardware failure
Error Nr. 101	Serial ASIC bus (JTAG) error	SGU on board hardware bus can not be written to or devices on internal JTAG bus can not be initialized	Reference signals from AQS REF not connected, coaxial cable defect or ACB/PSD defect
Error Nr. 102	Missing valid configuration page	configuration data (calibration data) not available	hardware failure
Error Nr. 105	Flash table does not exist, using default table	configuration data (calibration data) not available	hardware failure
Error Nr. 107	Table address or identifier exhausts range	selected table not supported by actual hardware version	spectrometer control software failure, wrong command selected using UniTool
Error Nr. 108	SGU PLL lock lost or PLL unlocked error	diagnostic detected improper hardware state	hardware failure
Error Nr. 109	SGU frequency range exceeded	value out of range	spectrometer control software failure or wrong SGU type in chassis (e.g. SGU400 in a AV600 system)
Error Nr. 110	Emergency stop activated, SGU reseted	an emergency stop signal from backplane detected	emergency stop signal activated by any spectrometer unit or BSMS keyboard

SGU Signal Generation Unit

Table 6.6. AQS SGU error messages

Error Nr.	Error Message	Description	Possible cause
Error Nr. 111	FCU - SGU link checksum error, SGU reseted	indicate parity error, checksum of high speed data is not correct	illegal command from FCU, clock signal to FCU (High Speed Transmitter) not properly connected, high speed link cable not connected or frequency mixture from Reference Board not connected
Error Nr. 112	SBSB Wake-Up occurred during acquisition, SGU uP booted	SGU has been set to generate LO signal while the on-board microcontroller was running spectra may show spikes	spectrometer control software failure
Error Nr. 113	Function not allowed in present mode		spectrometer control software failure
Error Nr. 115	Board overheated, check AQS cooling and ventilation system !	on-board diagnostic detected board temperature of > 75°C	fans/ventilation broken down, power supply defect
Error Nr. 116	Power supply failure detected	on-board diagnostic detected drop of power supply voltages below specified range	power supply defect or on board voltage regulator failure
Error Nr. 200	Can not initialize board	Rackmaster cannot initialize slave board while power up chassis scan sequence	firmware version not compatible, hardware failure on master or slave backplane connection
Error Nr. 201	Can not read board information	Rackmaster cannot get board information from slave unit while power up chassis scan sequence	firmware version not compatible, hardware failure on master or slave backplane connection
Error Nr. 202	Can not read board firmware version	Rackmaster cannot read board firmware version from slave board while power up chassis scan sequence	firmware version not compatible, hardware failure on master or slave backplane connection
Error Nr. 203	Can not write board identifier to slave	Rackmaster cannot write board identifier to slave board while power up chassis scan sequence	firmware version not compatible, hardware failure on master or slave backplane connection
Error Nr. 204	Can not write SBSB address to slave	Rackmaster cannot write SBSB address to slave board while power up chassis scan sequence	firmware version not compatible, hardware failure on master or slave backplane connection
Error Nr. 210	Serial DAC bus (SPI, 8420) error	serial DACs for calibration on REFERENCE BOARD can not be set	hardware failure
Error Nr. 211	No I2c acknowledge received	Rackmaster can not access backplane I2C bus	one of the AQS units blocks up the backplane I2C bus or on board hardware failure
Error Nr. 212	I2c EEROM program timer expired	EEPROM for BIS entries can not be accessed	one of the AQS units blocks up the backplane I2C bus or on board hardware failure
Error Nr. 213	Serial ASIC bus (JTAG) error	REFERENCE BOARD on board hardware bus can not be written to or devices on internal JTAG bus can not be initialized	hardware failure
Error Nr. 215	Rack I2c bus not released error	Rackmaster can not access backplane I2C bus	one of the AQS units blocks up the backplane I2C bus or on board hardware failure

Table 6.6. AQS SGU error messages

Error Nr.	Error Message	Description	Possible cause
Error Nr. 216	Unknown board in rack	Rackmaster cannot identify board while power up chassis scan sequence	firmware version not compatible, incompatible board in chassis
Error Nr. 217	Rackconfiguration not allowed	improper combination of boards in chassis detected by rackmaster	some boards are not compatible to each other (e.g. REF22 and AQS RX-BB)
Error Nr. 218	Illegal slot occupation detected (I2C and SBSB device use same slot address)	I2C and SBSB device use same slot address	wrong AQS chassis code set in 2 chassis systems, hardware failure on backplane or according units
Error Nr. 220	Board timeout	slave board answered not within specified time	firmware version not compatible or hardware failure
Error Nr. 221	Rackmaster task interrupted by slave behaviour	slave board answered not in expected order	firmware version not compatible or hardware failure
Error Nr. 232	Different SGU firmware in AQS detected, download latest version on all SGU's	rackmaster detected different SGU firmware version that may cause improper operation	firmware version different, download latest version on all SGU's
Error Nr. 249	serious amplifier malfunction, error can not be deleted	hardware diagnostic on BLA2BB can not be reseted	hardware failure on BLA2BB or power supply
Error Nr. 250	no amplifier housing information in BIS, using default address	no amplifier housing information in BIS found while power up chassis scan sequence	no amplifier housing information in BIS
Error Nr. 251	multiple amplifier housing information in BIS, using default address	not valid amplifier housing information in BIS found while power up chassis scan sequence	not valid amplifier housing information in BIS found
Error Nr. 252	general fault detected	hardware diagnostic on BLA2BB detected	hardware failure on BLA2BB
Error Nr. 253	thermal fault detected	hardware diagnostic on BLA2BB detected	
Error Nr. 254	power supply fault detected	hardware diagnostic on BLA2BB detected	

Diagnostic Tests

6.18

Not applicable

Software / Useful Pulse Programs

6.19

Each SGU has 10 RTP outputs. They are set automatically with the go command in pulse programs. To set specific RTPs permanently, the syntax

setrtp<sgu1..8> | <bit0-8> ^ <bit0-8> is used.

Example:

```
setrtp1|0|1|2|8^7
```

SGU Signal Generation Unit

; set bits 0,1 , 2 and 8 and clear bit 7 on SGU 1

The RTP-bit-settings of different SGUs are combined at the backplane of the acquisition rack, so in fact it doesn't matter which SGU issues these pulses, but in order to avoid conflicts one should use the observe SGU for them.

Table 6.7. real time pulses

Bit #	Name	Meaning
Bit 0	RGP_ADC	ADC gating pulse
Bit 1	RGP_RX	Receiver gating pulse
Bit 2	RGP_HPPR	Preamplifier gating pulse
Bit 3-5	reserve	
Bit 6	INTERLEAVE_INCR	selector for gain switching in receiver
Bit 7	DWL_CLK	dwel time for receiver ADC
Bit 8	ADC_SEL0	selects HADC/2 or SADC+
Bit 9	ADC_SEL1	selects FADC

quisition rack, so in fact it doesn't matter which SGU issues these pulses, but in order to avoid conflicts one should use the observe SGU for them.

Fast Real Time Pulses (F RTP)

6.20

Each SGU has 4 F RTP outputs. They are set automatically with the pulse commands in pulse programs and CPD programs. To set specific F RTPs permanently, the command `setfrtp<sgu1..8>|<bit0-8>^<bit0-8>` is used.

Example:

```
setfrtp1|1
```

; set bit 1 on SGU 1 into F RTP register.

Bit1 is used for the amplifier blanking, Bits 0, 2 and 3 are reserve.

The amplifier blanking information is routed to the correct amplifier according to the router setting (edasp command and parameter RSEL, respectively).

Homodecoupling

6.20.6

The following SGU versions are equipped with an additional feature:

- SGU400 Part-No. Z003642 (430MHz) ECL 03 and higher
- SGU600 Part-No. Z003831 (643MHz) ECL 01 and higher
- SGU1000 Part-No. Z003330(1072MHz) ECL 04 and higher

These boards allow the usage of one F RTP pulse for gating another SGU synchronously. While one SGU controls the experiment by generating the LO signal and the real-time pulses for acquisition another SGU may be used as decoupling SGU. The observing SGU can now gate the decoupling SGU with a pulse in a way that the MOD and MULT are set to zero and the most conceivable suppression of the decoupling signal is achieved.

Important: When using this feature, all SGU involved in the experiment must have the same hardware version (minimal required ECL is given above).

All signals described below are active low and TTL except for the blanking signals which use an open drain configuration.

BLKTR (amplifier blanking pulses)

A SGU can control up to 8 power amplifiers with the corresponding BLKTR. The timing of the blanking pulses is controlled by the FCU via the LVDS which delivers real-time instructions in 50ns second bursts. All SGUs are capable of generating blanking pulses.

The internal amps receive the blanking directly from the backplane, whereas the external amps receives the signals from the PSD which in turn receives the signals from the backplane.

RGP_PA~ (Preampifier receiver gating pulse)

This pulse is generated by the observe SGU and is used to gate the OBS module on the HPPR and used to implemented the transmit/ receive switching. The timing of the pulse can be modified with the 'edscon' parameters .This signal is routed via the ACB-S standard (or PSD) to the observe module in the preamplifier HPPR or HPPR/2. All other non lock HPPR modules are left permanently in transmission mode. In contrast to AVANCE systems, the preamplifier RGP will not be connected to the AQR RX22. The EP-HPPR output of the RX22 is left unconnected.

RGP_LO~(Local oscillator gating pulse)

This pulse is generated by the observe SGU and initiates the frequency step to generate the LO frequency (SFO1+22MHz). The pulse is also used to control the LO output of the REF unit which will only be present when *RGP_LO* goes active low..

RGP_RX~ (Receiver gating pulse)

This pulse generated by the observing SGU controls the opening and closing of the RX22 and is transmitted directly over the backplane. The timing of the pulse can be modified with the 'edscon' parameters.

RGP_ADC~ (ADC gating pulse)

This pulse (also driven by the observe SGU) controls the ADC data. If the pulse is low and a dwell clock is applied, the ADC will perform a conversion. If the pulse is high and a dwell clock is applied, the ADC generates 'zero' data. The RGP_ADC is routed over backplane to the ADC via the RX22. This signal is specially used for digital homodecoupling with oversampling.

Dwell_Clk~ (ADC dwell clock)

The signal is driven by the observe SGU and is used to control the timing of the AD conversions. Every falling edge of the dwell clock executes an ADC conversion. Although the signal is generated on the SGU, the timing is controlled totally by the FCU via the LVDS. The pulse is routed over the backplane to the ADC via the RX22. Homodecoupling experiments are treated as typical pulse programs.

SEL_ADCx~ (Select A/D converter)

The signal is applied to select a required ADC in the case of configurations with more than one ADC. The signal is generated by the observe SGU and is wired directly via the backplane to the specified ADCs. see **"real time pulses" on page 158**

Timing

Minimum Pulse or delay duration: see specification of TCU/FCU

Timing Resolution: 12.5ns

The resolution is set by the internal 80MHz clocking frequency on-board the TCU3. Pulses or delays between pulses can thus be set to 50, 62.5, 75, 87.5ns, etc.

Frequency

Frequency Range SGU-C: 5-325 MHz

Frequency Range SGU400: 5-430MHz

Frequency Range SGU600: 5-643MHz

Frequency Range SGU1000: 5-1072MHz

Frequency Range SGU-FTMS: 0,003-10MHz

Frequency Stability: This is governed by the stability of the crystal oscillator on the REF. unit which is specified to 3×10^{-9} /day and 1×10^{-8} /year

Frequency Resolution: The DDS is clocked by 80MHz and the frequency setting is stored in a 34 bit register

$\Rightarrow 80 \text{ MHz}/2^{34} < 0.005 \text{ Hz.}$

Frequency Switching Time:

Instruction time for frequency steps: 100ns with resolution of 12.5ns

Further information on response time of analog hardware: see section **"Hardware response" on page 162**

Phase

Phase Resolution: A 16 bit register is used to store phase values.

$\Rightarrow 360^\circ/2^{16} < 0.006^\circ$

Phase Switching Time:

Instruction time for phase steps: 50ns with resolution of 12.5ns

Total response time for any phase step to a phase error with less than $1^\circ < 300\text{ns}$

Further information on phase settling time: see section **"Hardware response" on page 162**

Amplitude

Modulator Range: The Modulator values are stored in a 16 bit register which equates to a voltage dynamic range of 96dB. ($20 \log(2^{16}) = 96 \text{ dB}$).

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Power Level Range: The Power Level values are stored in a 15 bit register which equates to a voltage dynamic range of 90dB. ($20 \log(2^{15}) = 90 \text{ dB}$)

Power Level resolution: 0.1 dB

Amplitude switching time:

Instruction time for amplitude: 50ns

Response time of analog hardware: <100ns

Hardware response

6.22.7

The SGU frequency registers can be set within 25ns, the actual update rate is limited by the serial link and the event synchronization to 100ns. The SGU phase, shape (MOD) or amplitude (MULT) registers can be set within 12.5ns each, the actual update rate is limited by the serial link and the event synchronization to 50ns. There is a finite bandwidth within the analog sections of the SGU resulting in a response or settling time respectively.

The settling time is independently of change frequency or phase. A quite hard test is to change phase by 180° and measure the time elapsed to achieve a remaining error of $<1^\circ$.

Figure 6.16. Response 180° phase step

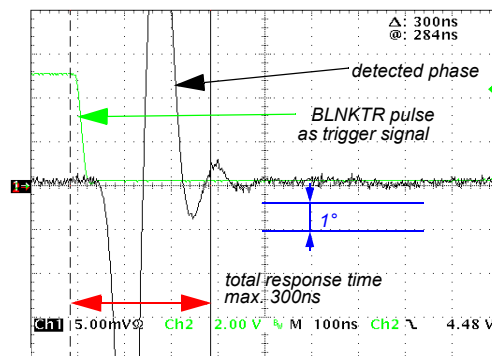
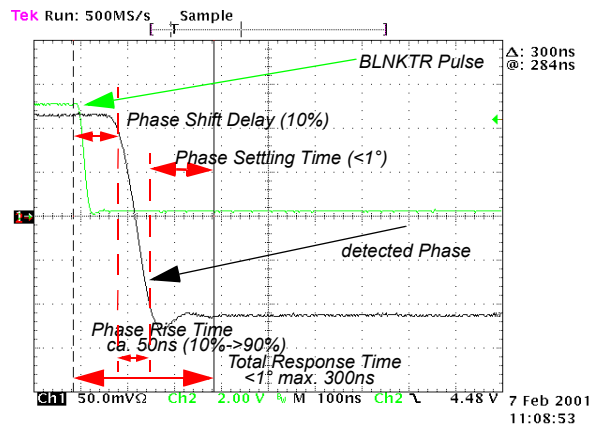


Figure 6.17. Response 90° step (45°/+135°)



See [6.15.3](#)

Table below is a list of the various signals transmitted to all user slots via the middle rear 110 pin connector J0.

Table 6.8. Backplane Connector

	z	a	b	c	d	e	f
1	GND	GND	RESERVE_1	NC	GND	SAMPLE_INFO0	GND
2	GND	NC	GND	SAMPLE_INFO3	SAMPLE_INFO2	SAMPLE_INFO1	GND
3	GND	GND	NC	(SGU-STOP)	GND	SAMPLE_INFO4	GND
4	GND	20MHZ_CLK_X ^a	GND	INTERLEAVE_INCR	ADC_SEL1	ADC_SEL0	GND
5	GND	GND	20MHZ_CLK_X	RESERVE_3	GND	RGP_LO	GND
6	GND	BLNKTR1	GND	BLNKTR2	RESERVE_6	RESERVE_4	GND
7	GND	BLNKTR3	BLNKTR4	NC	GND	RGP_ADC	GND
8	GND	BLNKTR5	GND	BLNKTR6	RESERVE_7	DWL_CLK	GND
9	GND	BLNKTR7	BLNKTR8	NC	GND	RGP_RX	GND
10	GND	SBS_TTL_TX	GND	SBS_TTL_RX	SBS_TTL_TX_ENAB	RESERVE_5	GND
11	GND	LOCAL_TX	LOCAL_RX	SBS_TTL_WUP	GND	RGP_HPPR	GND

Magenta = CCU-Bus galvanically isolated
Blue = Intra Rack Bus

Key Area

15	GND	SLOT2	SLOT1	SLOT0	GND	NC	GND
16	GND	SLOT3	GND	I2C_SDA	NC	GND	GND
17	GND	EMERGENCY_STOP	I2C_BUS_REQ	I2C_SCL	GND	NC	GND
18	GND	NC	GND	I2C_2_SDA	I2C_2_SCL	GND	GND
19	GND	NC	NC	NC	GND	NC	GND
20	GND	NC	GND	P2V	N2.5V	GND	GND
21	GND	P5V	P35V	P9V	P9V	P9V	GND
22	GND	P5V	RACK0	N9V	N9V	N9V	GND
23	GND	P5V	P19V	N19V	RACK1	P12V	GND
24	GND	P5V	P19V	N19V	RACK2	P12V	GND
25	GND	P5V	P19V	N19V	RACK3	P12V	GND

^a x = Slot-Nr. (20MHZ_CLK_1 bis 20MHZ_CLK_8)

AQS Service Tool (Unitool)

7

Introduction

7.1

For service purpose BRUKER has developed an universal service tool (named Unitool) that allows access to boards with Unitool support for diagnostic, check and firmware upgrade over the RS485 serial bus (SBSB, description can be found on [page 15](#)).

The Unitool acts as a browser, all menus are provided by the units themselves. Board specific Unitool access can be achieved by starting the Unitool with the matching SBSB address (for addresses see ["AQS address mapping" on page 166](#))

With firmware release 'AD' and newer (see later how to determine), the following devices support Unitool within the AQS Chassis:

- AQS Master (virtual, provided by one of the SGU)
- all SGU variants
- all AQS RX variants
- all AQS Amplifiers (reduced function)
- AQS FADC (reduced function)

FTLP4/M, HADC, SADC and Router can not be accessed by UniTool, but via the AQS rack master menu these boards are shown if available.

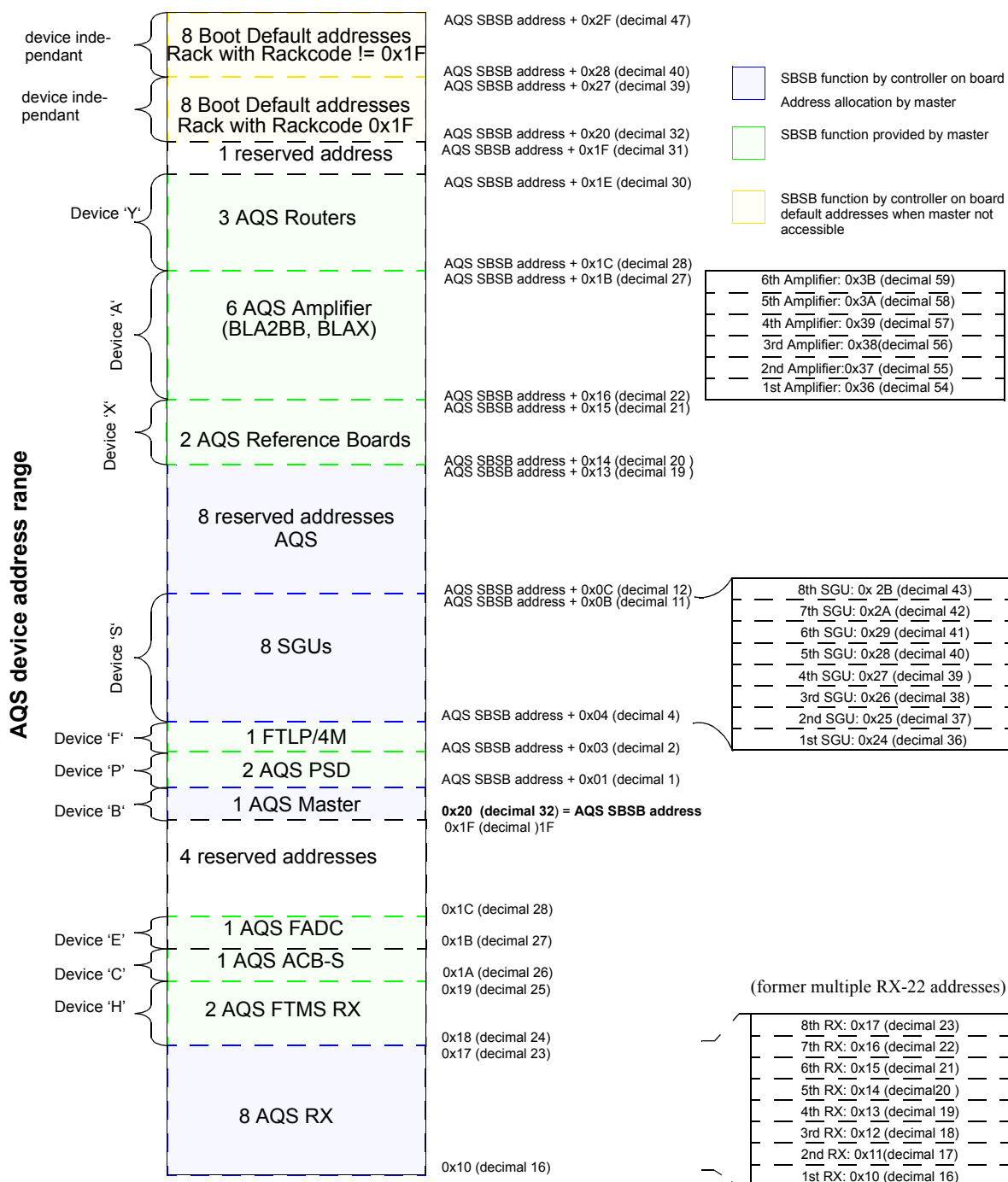
! *The master is a (virtual) device with its own SBSB address, although this function is provided physically on a SGU hardware. The master is a separate task within the SGU firmware.*

The AQS Master function can be accessed on the master address decimal 32 although the physical address of the SGU function is called on address 36.

! *Older firmware releases do not support the master Unitool function. Please follow the instructions to identify the actual firmware release first (see ["Identification of the firmware release" on page 167](#))*

Configuration and SBSB addresses can be found in
 the conf/instr/<instrument> directory in the file uxnmr.info
 or by **"Identify your chassis configuration" on page 167** using the Unitool.

Figure 7.1. SBSB Device addresses



Identification of the firmware release

7.3

1. Open a UNIX shell or the command prompt in the BRUKER Utilities folder when using Windows NT. Start
2. Start the UniTool: `xwinnmr -e UniTool`
3. `-> aqs`, confirm
4. `->` decimal address for e.g. SGU-1 is 36 or RX-1 is 16, confirm
5. Choose `-> 1`, confirm

You will be given the details of firmware and boot software version.

! ***Boards programmed in factory may show a different application firmware checksum compared to boards downloaded with UniTool***

```
----- Example how to start UniTool -----
45% xwinnmr -e UniTool
Enter device name ['?' for details] (aqs) >
Enter decimal SBSB address for board in AQS rack (36) > 36
device name taken from already existing configfile: /dev/tty10
B r u k e r   U n i T o o l
Version: 1.0
Compilation date: 000921
W A R N I N G:
This is a hardware level debug tool.
Improper operation may damage your hardware.
Connecting SBSB address 36 (0x24).
----- End Example -----
```

Identify your chassis configuration

7.4

! ***Older firmware releases do not support the master Unitool function. Please follow the instructions to identify the actual firmware release first (see "Identification of the firmware release" on page 167)***

1. Open a UNIX shell or the command prompt in the BRUKER Utilities folder when using Windows NT. Start
2. Start the UniTool: `xwinnmr -e UniTool`
3. `-> aqs`, confirm
4. `->` decimal address for the AQS Master is 32, confirm
5. Choose `-> [1]`, Configuration, confirm

With the rack master UniTool menu configuration information can be traced.

AQS Service Tool (Unitool)

```
----- Example -----
45% xwinmmr -e UniTool
Enter device name ['?' for details] (aqs) >
enter decimal SBSB address for board in AQS rack (36) > 32
device name taken from already existing configfile: /dev/tty10
B r u k e r U n i T o o l
  Version: 1.0
  Compilation date: 000921
W A R N I N G:
  This is a hardware level debug tool.
  Improper operation may damage your hardware.
Connecting SBSB address 32 (0x20).
```

```
>>> Rackmaster Menu <<<
=====
[0] Init Rack
[1] Rack Configuration
[2] Rack Delete Error
[3] Rack Query Request
[X] eXit UniTool
  your choice:1
Adr Id Type HWVersion Dev I2Cbus Slot ECL
-----
0x 0 - 0 0 ---- 0 0 -.-
0x34 X 3 1 REF1 1 2 1.3
0x24 S 16 2 SGU1 1 3 2.0
0x25 S 16 2 SGU2 1 4 2.0
0x 0 - 0 0 ---- 0 0 -.-
0x 0 - 0 0 ---- 0 0 -.-
0x 0 - 0 0 ---- 0 0 -.-
0x36 A 5 1 BLA1 1 8 1.9
0x1a C 9 0 ACB1 2 9 0.0
0x 0 - 0 0 ---- 0 0 -.-
0x 0 - 0 0 ---- 0 0 -.-
0x 0 - 0 0 ---- 0 0 -.-
0x 0 - 0 0 ---- 0 0 -.-
0x 0 - 0 0 ---- 0 0 -.-
0x 0 - 0 0 ---- 0 0 -.-
0x 0 - 0 0 ---- 0 0 -.-
0x 0 - 0 0 ---- 0 0 -.-
0x 0 - 0 0 ---- 0 0 -.-
0x20 B 7 0 AQS1 0 19 -.-
  Press <ENTER> !
```

```
>>> Rackmaster Menu <<<
=====
[0] Init Rack
[1] Rack Configuration
[2] Rack Delete Error
[3] Rack Query Request
[X] eXit UniTool
  your choice:
```

```
----- End Example -----
```


Board type codes are shown in the following table:

Table 7.1. AQS Board Type Identifier Codes

Board Type	Board Type	Board Description	BRUKER Number
0x00	0	SGU-C (frequency range 5..430MHz, print index C) SGU (regular frequency range 5..<643.45MHz, print index D)	Z003329 Z003642
0x01	1	board not inserted	
0x02	2	AQS Reference Board for AQS Receiver (REF400)	Z003265
0x03	3	AQS Reference Board with 22MHz IF output for RX22 (REF400-22)	Z003351
0x04	4	AQS Router Combiner	Z003624
0x05	5	AQS BLA2BB 150-60 dual amplifier 20-400MHz	W1345049
0x06	6	AQS BLAX300 single 300W X amplifier	W1345052
0x07	7	AQS rack master	
0x08	8	AQS FTLP/4M filterboard	Z002812
0x09	9	AQS ACB standard	H9488
0x0A	10	AQS PSD power supply distribution board	H9530
0x0B	11	AQS FTMS receiver connector board	A3145
0x0C	12	AQS FTMS PSD power supply distribution board	A3142
0x0D	13	AQS FADC	H9685
0x10	16	SGU400 (frequency range 5..430MHz)	Z003642 from ECL2.0
0x18	24	SGU600 (frequency range 5..<643.45MHz)	Z003831
0x28	40	SGU1000 (extended frequency range 5..1072.625MHz)	Z003330 from ECL2.0
0x30	48	SGU-FTMS (FTMS frequency range)	Z003643
0x40	64	AQS RX600 (standard frequency range 5..645MHz)	Z003925
0x50	80	AQS RX-1000 (extended frequency range 5..1077.5MHz)	Z003926
0x60	96	AQS RX-E (extended frequency range 5..1077.5MHz)	Z003689
0x61	97	AQS RX-BB (extended frequency range 5..1077.5MHz)	Z003689
0x70	112	AQS RX400 (base frequency range 5..430MHz, ...)	Z003688
0xC0	192	AQS Reference Board for AQS Receiver RX600 (REF600)	Z003936
0xC1	193	AQS Reference Board for AQS Receiver RX1000 (REF1000)	Z003937

AQS Service Tool (Unitool)

Table 7.1. AQS Board Type Identifier Codes

Board Type	Board Type	Board Description	BRUKER Number
0xC2	194	AQS Reference Board with 22MHz IF output for RX22 (REF600-22)	Z003938
0xC3	195	AQS Reference Board with 22MHz IF output for RX22 (REF1000-22)	Z003939
0xC4	196	AQS BLA2BB 150-60 dual amplifier 20-500MHz	W1345072

Download new SGU firmware**7.5**

Please refer to the BRUKER Service Information to check out if a download is necessary.

! *The download of the newest firmware is not always necessary or makes sense, please read instructions carefully*

! *If you download new firmware ensure that the master SGU has always the newest firmware. For proper operation all SGU with same ECL must have identical firmware versions.*

Further information about the demand of new firmware can also be found on the FTP server of BRUKER AG (B-CH):

<ftp://ftp.bruker.ch/pub/NMR/download/servtools/firmware/aqs/>

Previous SGU firmware release is BIRDAA**7.5.1**

! *If you identified a firmware release AC or later (AD, AE, ..), go to section "SGU firmware release is other than BIRDAA" on page 172*

The first master/SGU software release BIRDAA does support download in the master slot 3(8) J6 only. Release BIRDAD and newer (e.g.BIRDAF) will allow download in every slot. Follow these instructions:

1. Switch off the AQS chassis
2. Pull out all SGU's (not completely, only the connection to the backplane must be cut off) except the SGU in slot 3(8)
3. Switch on the AQS chassis and perform a spectrometer power up
4. Create a new directory in the path of the UniTool (/Bruker/<xwinnmr release>/conf/instr/servtool/UniTool/files/birds)
5. Copy new firmware into the directory /Bruker/<xwinnmr release>/conf/instr/servtool/UniTool/files/birds
6. Start the UniTool in a shell: `xwinnmr -e UniTool`
7. -> aqs, confirm
8. -> decimal address for the master is 32, confirm
9. When the UniTool Menu is loaded from the master SGU, enter <4> Check Download -> download is started (depending on time-out settings, one communication error may occur, but the download is not affected). The download takes about 30 min
10. When download is finished, switch off the AQS chassis
11. Insert all other SGU's and switch on the AQS chassis
12. Start the UniTool in a Shell: `xwinnmr -e UniTool`
13. -> aqs, confirm
14. -> decimal address for the master is 32, confirm
15. 0, Init Device

16. All SGU's with software release AA report errors because they do not understand new commands from the master while power up. Errors are:
17. Error No. 221 and Error No. 20, delete them (confirm, (n/y) -> y)
18. Select 1, Configuration-> a list is shown (see "**Identify your chassis configuration**" on page 167) with the SBSB addresses of the devices. Check address of next SGU for download (e.g. SGU2 Hex 0x25, decimal 37)
19. Exit master menu
20. Start the UniTool in a Shell: `xwinnmr -e UniTool`
21. -> aqs, confirm
22. -> decimal address of e.g. SGU2 is **37**, confirm
23. <4>, Check Download
Download all SGU's in this manner

SGU firmware release is other than BIRDAA

7.5.2

! *If you identified a firmware release AA with date 99-08-05, go to section "**Previous SGU firmware release is BIRDAA**" on page 171*

Follow these instructions:

1. Check if the directory (/Bruker/<xwinnmr release>/conf/instr/servtool/UniTool/files/birds) exists. Otherwise create it.
2. Copy the new firmware into the directory /Bruker/<xwinnmr release>/conf/instr/servtool/UniTool/files/birds
3. Start the UniTool in a shell: `xwinnmr -e UniTool`
4. -> aqs, confirm
5. -> decimal address for SGU-1 is **36**, confirm
6. When the UniTool Menu is loaded, enter <4> Check Download -> download is started. The download takes about 30 min
7. Start the UniTool in a Shell: `xwinnmr -e UniTool`
8. -> aqs, confirm
9. -> decimal address for SGU-2 is **37**, confirm
10. When the UniTool Menu is loaded, enter <4> Check Download -> download is started. The download takes about 30 min
Download all other SGU's in this manner

Error handling

7.5.3

In case of communication errors (network problems, host shut down) the download **can be restarted**. The SGU automatically starts in the **boot mode**, but UniTool operation is still provided on the same SBSB address, **unless** the power is switched off and switch on again (in this situation the master is not able to spread out the SBSB addresses while booting to the other slave SGU's in boot mode).

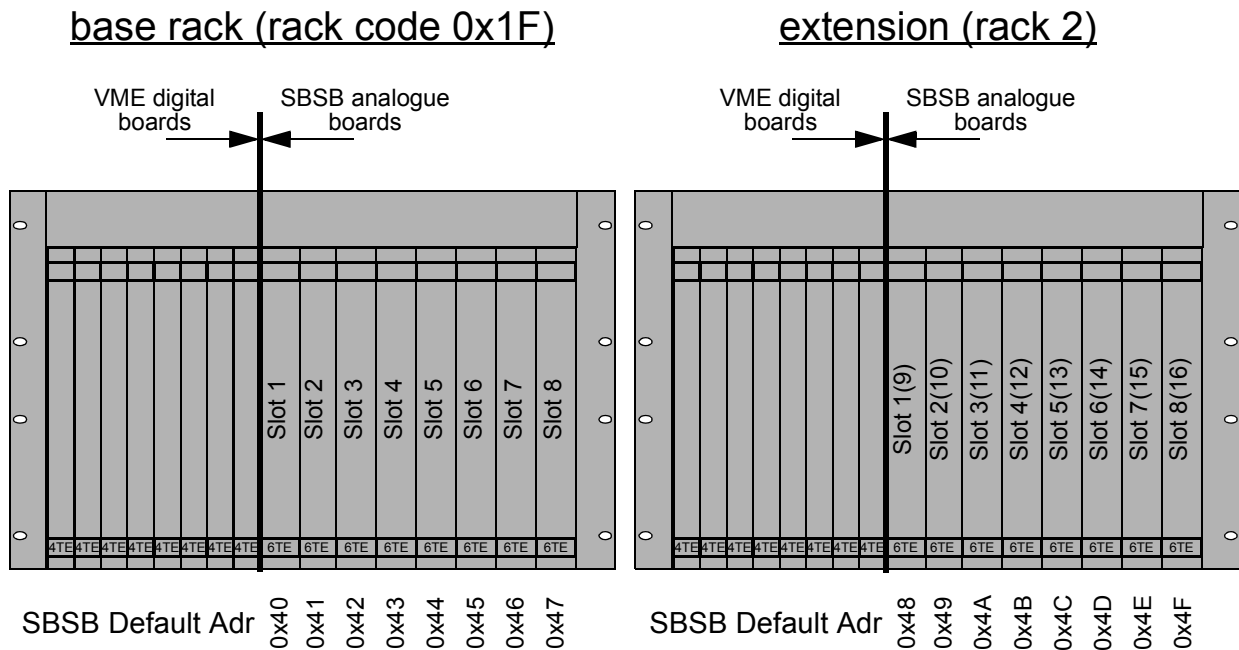
If a serious hardware malfunction occurs during download (e.g. power down), the download **can be restarted**. The SGU automatically starts in the **boot mode**, but Unitool operation is provided on special default addresses **only**. In this situation the master is not able to spread out the SBSB addresses to the other slave SGU's while booting. The SGU can be accessed by calling them on their default addresses (see **"AQS address mapping" on page 166**).

Example: SGU-2 in slot 5(8) can not be accessed on their address decimal 37. Then you can try to call it on the address determined by the following formula:

$$\begin{aligned} & \text{AQS SBSB address (decimal 32) + 0x20 (decimal 32) + SLOT number - 1} \\ & = 32 + 32 + 5 - 1 = 68 \end{aligned}$$

See also **Figure 7.2**.

Figure 7.2. SBSB default addresses



1. Check if the directory (/Bruker/<xwinnmr release>/conf/instr/servtool/UniTool/files/birds) exists. Otherwise create it.
2. Copy the new firmware e.g. **rxs_ak.hex** into the directory /Bruker/<xwinnmr release>/conf/instr/servtool/UniTool/files/birds
3. When download has finished, an error message like 'Communication error detected' may appear. This is an UniTool internal message and does not affect the download. Exit and restart UniTool. The board has to be accessible.
4. Start the UniTool in a shell: `xwinnmr -e UniTool`
5. -> aqs, confirm
6. -> decimal address for RX-1 is **16**, confirm
7. When the UniTool Menu is loaded, enter <4> Auto Download -> download is started. The download takes about 22 minutes
8. If you have more than one RX, do the same as above with address **17**, **18**, and so on.

New configuration of the AQS amplifiers**7.7**

! **Remember that the UniTool is a hardware level debug tool. Improper operation may damage your hardware. Please read the following lines carefully.**

According to the document "BIS Groups and Values" (Andreas Hünnebeck (AH), version 2.6 and higher), the amplifiers provide a housing information in its BIS that allows the software to determine an SBSB address.

Later versions of the amplifiers have this entry in their BIS. If an error message like

"no amplifier housing information in BIS, using default address " or

"multiple amplifier housing information in BIS, using default address "

is printed out you should read the following lines.

For future 3 channel configurations with internal AQS amplifiers, housing information must be programmed in the BIS

Default values**7.7.1**

Default values in the amplifier BIS should be:

BLA2BB: Housing, Hsg = 1 (amplifier 1)

BLAX300: Housing, Hsg = 2 (amplifier 2)

In a 2 channel AV with one BLA2BB without a housing entry, no error or warning messages are given (backward compatibility to most used configurations). BLA2BB is amplifier 1.

For a 3 channel AV with BLA2BB and BLAX300, where both amplifier do not have a housing entry, warning messages are given and default values are set. These values can be modified using the UniTool with the BLA SBSB address.

Default SBSB addresses, **when no housing** is originally programmed

1. 1 BLA2BB in Slot 8: 0x36

2. BLA2BB (Slot 8), BLAX300 (Slot 6, on the left side of BLA2BB):

BLA2BB: 0x36 (decimal 54)

BLAX300: 0x37 (decimal 55)

Check the addresses before changing any entry. This can be done by starting the UniTool at the master address:

1. Start the UniTool in a Shell: `xwinnmr -e UniTool`

2. `-> aqs`, confirm

3. `-> decimal address of the master is 32`, confirm

4. Select 1, Configuration-> a list is shown (see **"Identify your chassis configuration" on page 167**) with the SBSB addresses of the devices.

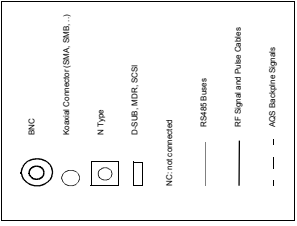
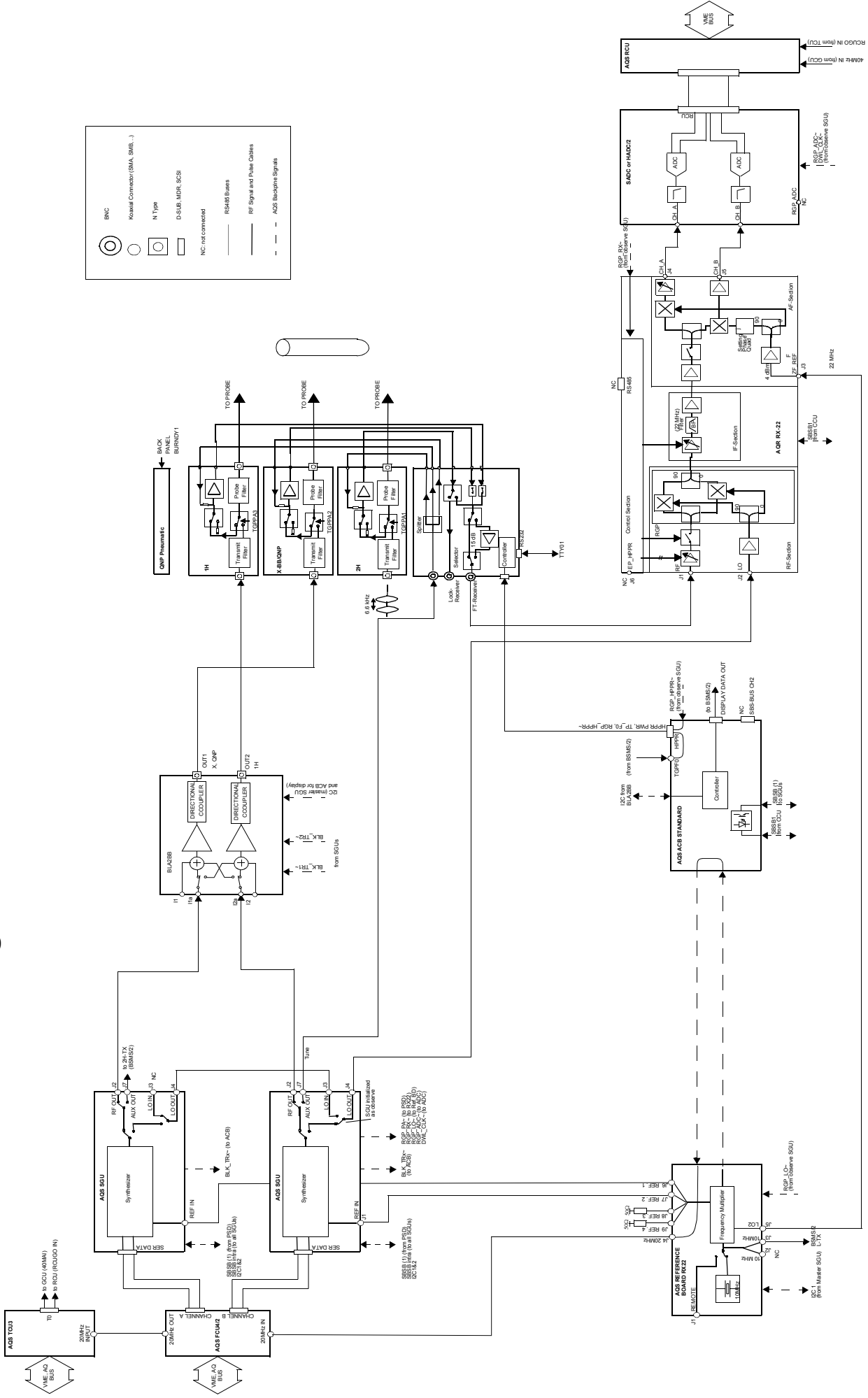
Follow these instructions to add the housing information to amplifiers with old BIS.

Conditions:

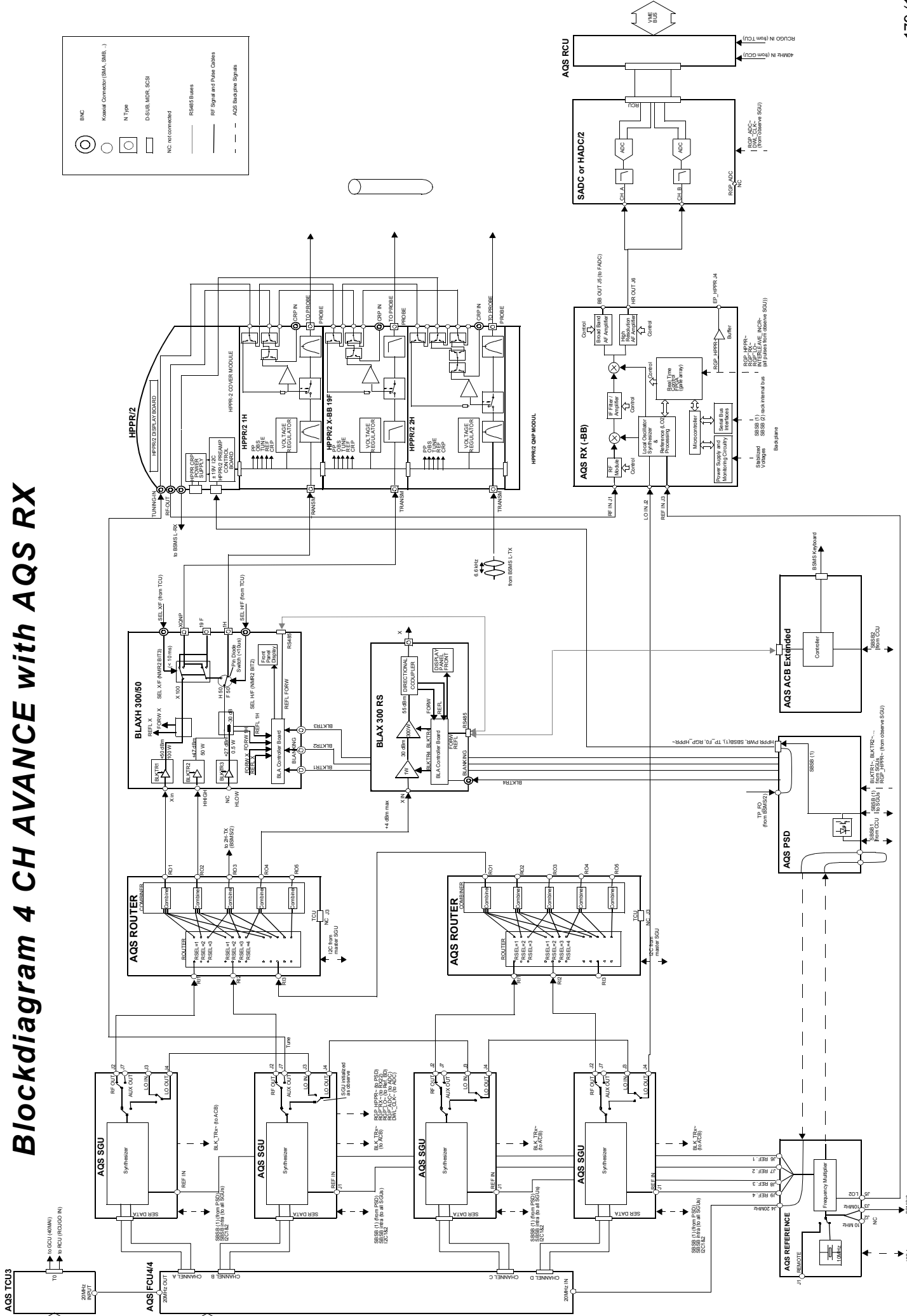
- BLA2BB in Slot 8
- BLAX300 in Slot 6

1. Power up the AQS Chassis
2. Start the UniTool in a Shell: `xwinnmr -e UniTool`
3. `-> aqs`, confirm
4. `-> SBSB` address of the amplifier BLA2BB is hex 0x36 resp. decimal **54**, confirm,
5. Change at menu Point 2 the housing information (1 for BLA2BB recommended). The setting is saved automatically. Exit UniTool.
6. Start the UniTool in a Shell: `xwinnmr -e UniTool`
7. `-> aqs`, confirm
8. `-> SBSB` address of the amplifier BLAX300 is hex 0x37 resp. decimal **55**, confirm,
9. Change at menu Point 1 the housing information (2 for BLAX300 recommended). The setting is saved automatically. Exit UniTool.
10. Perform an AQS power down
11. Power up the AQS chassis and initialize the spectrometer, a "cf" command should perform correct address mapping, no further errors according amplifier addresses should occur
12. SBSB addresses should be (e.g. check with UniTool on master address 32):
13. BLAX300 in Slot 6 with housing 2: 0x37, amplifier is AMP2
14. BLA2BB: in Slot 8 with housing 1: 0x36, amplifier is AMP1

Blockdiagram 2 CHANNEL AVANCE



Blockdiagram 4 CH AVANCE with AQS RX



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