BRUKER

AQR

RX22 Receiver
RX22 Service Manual

Version   003

BRUKER

The information in this manual may be altered without notice.

Contents

Index

Index

L

M

N

O

P

Q

R

Goto

General Description 1

Introduction 1.1

The RX22 Receiver applies for DRX- and DPX-Spectrometers.

The RX22 Receiver is a further development of the ARX-Receiver. The new receiver works with the same intermediate frequency of 22MHz.

The entire receiver function is controlled by a microprocessor. Therefore accurate gain setting, phase and gain adjustment in the quadrature-module and other parameters are controlled via a RS485-Interface.

To achieve optimal leakage and RF performance, the entire receiver is mounted in a 19" HF case.

Calibration and production datas, known as the BBIS are stored in a flash EPROM direct on the board.

Features 1.2

-Low noise

-High dynamic range

-93dB gain range

-1dB Gain Steps

-Mounted in 19" HF moulded case

-Temperature Controlled Quadrature Module

$-\mu$-metal shielded quadrature module and NF-amplifiers

-RS485 Interface

Operation 1.3

The most used parameter which is set by the operator is the receiver gain. The following description gives more information about the receiver gain.

Receiver Gain 1.3.1

The receiver gain (voltage gain) can be set within a range of 12 to 105 dB. The operator is used to setting the linear gain from the UXNMR. The following equation

describes the context of the 'UXNMR Gain' and the logarithmic voltage gain of the receiver (between input and output).

$$\text{Gain}_{\text{UXNMR}} \ = \ 10^{\left(\dfrac{\text{Gain}_{\text{RX}} - 12}{20}\right)}$$

$$\text{Gain}_{\text{RX}}[\text{dB}] \ = \ 20 \cdot \text{Log}(\text{Gain}_{\text{UXNMR}}) + 12\text{dB}$$

The gain steps in the RX-22 Receiver are realized in different sections. In the rf-section, the gain can be switched in 12dB steps within a range of 36dB. In the IF-Section, a range of 48dB with 12dB steps can be set. The fine adjustment (1dB steps) are done with a pin diode attenuator (PAS) in the IF-Section.

The operator doesn't have to worry about setting the right switches. Just write down the wanted gain via the RS485 Interface, and the receiver will handle the different switches and the PAS itself.

The following table describes the internal control of the switches and the PAS for various UXNMR Gains.

Table 1.1. *Gain Table for 3dB Steps (RX22 Prototype)*

	Gain	RF–Section	IF–Section										
UXNMR	DRX Receiver [dB]		G2	PAS	IF	Signal Names RXC: Burndy SE451:	DRG1 D	DRG2 E	DRG3 N	DRG4 P	DRG5 T	DRG0 A	
46341.0	105.3	24	20	0	32								
32768.0	102.3	24	20	−3	32		0	1	1	1	1	1	
23170.5	99.3	24	20	−6	32								
16384.0	96.3	24	20	−9	32		0	1	1	1	1	0	
11585.2	93.3	24	20	−0	20								
8192.0	90.3	24	20	−3	20		0	0	1	1	1	1	
5792.6	87.3	24	20	−6	20								
4096.0	84.2	24	20	−9	20		0	0	1	1	1	0	
2896.3	81.2	24	20	−0	8								
2048.0	78.2	24	20	−3	8		0	1	0	1	1	1	
1448.2	75.2	24	20	−6	8								
1024.0	72.2	24	20	−9	8		0	1	0	1	1	0	
724.1	69.2	24	8	−0	8								
512.0	66.2	24	8	−3	8		0	0	0	1	1	1	
362.0	63.2	24	8	−6	8								
256.0	60.2	24	8	−9	8		0	0	0	1	1	0	
181.0	57.2	12	8	−0	8								
128.0	54.1	12	8	−3	8		1	0	0	1	1	1	
90.5	51.1	12	8	−6	8								
64.0	48.1	12	8	−9	8		1	0	0	1	1	0	
45.3	45.1	12	8	−0	−4								
32.0	42.1	12	8	−3	−4		1	0	0	0	1	1	
22.6	39.1	12	8	−6	−4								
16.0	36.1	12	8	−9	−4		1	0	0	0	1	0	
11.3	33.1	0	8	−0	−4								
8.0	30.1	0	8	−3	−4		1	0	0	1	0	1	
5.7	27.1	0	8	−6	−4								
4.0	24.0	0	8	−9	−4		1	0	0	1	0	0	
2.8	21.0	−12	8	−0	−4								
2.0	18.0	−12	8	−3	−4		1	0	0	0	0	1	
1.4	15.0	−12	8	−6	−4								
1.0	12.0	−12	8	−9	−4		1	0	0	0	0	0	

Table 1.2.   Gain Table for 1dB Steps (RX22 ECL00 or later)

		Gain	RF–Section	IF–Section			Signal Names RXC:	DRG1	DRG2	DRG3	DRG4	DRG5	DRG0
UXNMR	DRX Receiver [dB]			G2	PAS	IF	Burndy SE451:	D	E	N	P	T	A
46341.0	105.3	24		20	0	32							
41285.1	104.3	24		20	−1	32							
36780.8	103.3	24		20	−2	32							
32768.0	102.3	24		20	−3	32		0	1	1	1	1	1
29193.0	101.3	24		20	−4	32							
26008.0	100.3	24		20	−5	32							
23170.5	99.3	24		20	−6	32							
20642.5	98.3	24		20	−7	32							
18390.4	97.3	24		20	−8	32							
16384.0	96.3	24		20	−9	32		0	1	1	1	1	0
14596.5	95.3	24		20	−10	32							
13004.0	94.3	24		20	−11	32							
11585.2	93.3	24		20	−0	20							
10321.3	92.3	24		20	−1	20							
9195.2	91.3	24		20	−2	20							
8192.0	90.3	24		20	−3	20		0	0	1	1	1	1
7298.2	89.3	24		20	−4	20							
6502.0	88.3	24		20	−5	20							
5792.6	87.3	24		20	−6	20							
5160.6	86.3	24		20	−7	20							
4597.6	85.3	24		20	−8	20							
4096.0	84.2	24		20	−9	20		0	0	1	1	1	0
3649.1	83.2	24		20	−10	20							
3251.0	82.2	24		20	−11	20							
2896.3	81.2	24		20	−0	8							
2580.3	80.2	24		20	−1	8							
2298.8	79.2	24		20	−2	8							
2048.0	78.2	24		20	−3	8		0	1	0	1	1	1
1824.6	77.2	24		20	−4	8							
1625.5	76.2	24		20	−5	8							
1448.2	75.2	24		20	−6	8							
1290.2	74.2	24		20	−7	8							
1149.4	73.2	24		20	−8	8							
1024.0	72.2	24		20	−9	8		0	1	0	1	1	0
912.3	71.2	24		20	−10	8							
812.7	70.2	24		20	−11	8							
724.1	69.2	24		8	−0	8							
645.1	68.2	24		8	−1	8							
574.7	67.2	24		8	−2	8							
512.0	66.2	24		8	−3	8		0	0	0	1	1	1
456.1	65.2	24		8	−4	8							
406.4	64.2	24		8	−5	8							
362.0	63.2	24		8	−6	8							
322.5	62.2	24		8	−7	8							
287.4	61.2	24		8	−8	8							
256.0	60.2	24		8	−9	8		0	0	0	1	1	0
228.1	59.2	24		8	−10	8							
203.2	58.2	24		8	−11	8							
181.0	57.2	12		8	−0	8							
161.3	56.2	12		8	−1	8							
143.7	55.1	12		8	−2	8							
128.0	54.1	12		8	−3	8		1	0	0	1	1	1
114.0	53.1	12		8	−4	8							
101.6	52.1	12		8	−5	8							
90.5	51.1	12		8	−6	8							
80.6	50.1	12		8	−7	8							
71.8	49.1	12		8	−8	8							
64.0	48.1	12		8	−9	8		1	0	0	1	1	0
57.0	47.1	12		8	−10	8							
50.8	46.1	12		8	−11	8							
45.3	45.1	12		8	−0	−4							
40.3	44.1	12		8	−1	−4							
35.9	43.1	12		8	−2	−4							
32.0	42.1	12		8	−3	−4		1	0	0	0	1	1
28.5	41.1	12		8	−4	−4							
25.4	40.1	12		8	−5	−4							
22.6	39.1	12		8	−6	−4							
20.2	38.1	12		8	−7	−4							
18.0	37.1	12		8	−8	−4							
16.0	36.1	12		8	−9	−4		1	0	0	0	1	0
14.3	35.1	12		8	−10	−4							
12.7	34.1	12		8	−11	−4							
11.3	33.1	0		8	−0	−4							
10.1	32.1	0		8	−1	−4							
9.0	31.1	0		8	−2	−4							
8.0	30.1	0		8	−3	−4		1	0	0	1	0	1
7.1	29.1	0		8	−4	−4							
6.3	28.1	0		8	−5	−4							
5.7	27.1	0		8	−6	−4							
5.0	26.0	0		8	−7	−4							
4.5	25.0	0		8	−8	−4							
4.0	24.0	0		8	−9	−4		1	0	0	1	0	0
3.6	23.0	0		8	−10	−4							
3.2	22.0	0		8	−11	−4							
2.8	21.0	−12		8	−0	−4							
2.5	20.0	−12		8	−1	−4							
2.2	19.0	−12		8	−2	−4							
2.0	18.0	−12		8	−3	−4		1	0	0	0	0	1
1.8	17.0	−12		8	−4	−4							
1.6	16.0	−12		8	−5	−4							
1.4	15.0	−12		8	−6	−4							
1.3	14.0	−12		8	−7	−4							
1.1	13.0	−12		8	−8	−4							
1.0	12.0	−12		8	−9	−4		1	0	0	0	0	0

Quadrature Imagine Adjustment 1.3.2

The quadrature imagine adjustment can be set via the RS485 Interface. Two different commands for gain adjust and phase adjust are implemented.

This two adjustments can be done with the RX22-Service-Tool. With the Gain Adjustment the gain difference between the in-phase and quad-phase channel is altered. With the Phase Adjustment, the phase difference between this two channels is set.

After optimizing this parameters the values can be stored on the board with the Save Config command. Even after a power up, the old stored values are activated. For proper operation of the RX22-Tool see chapter Submenu Quad Image Adjustment on page 29.
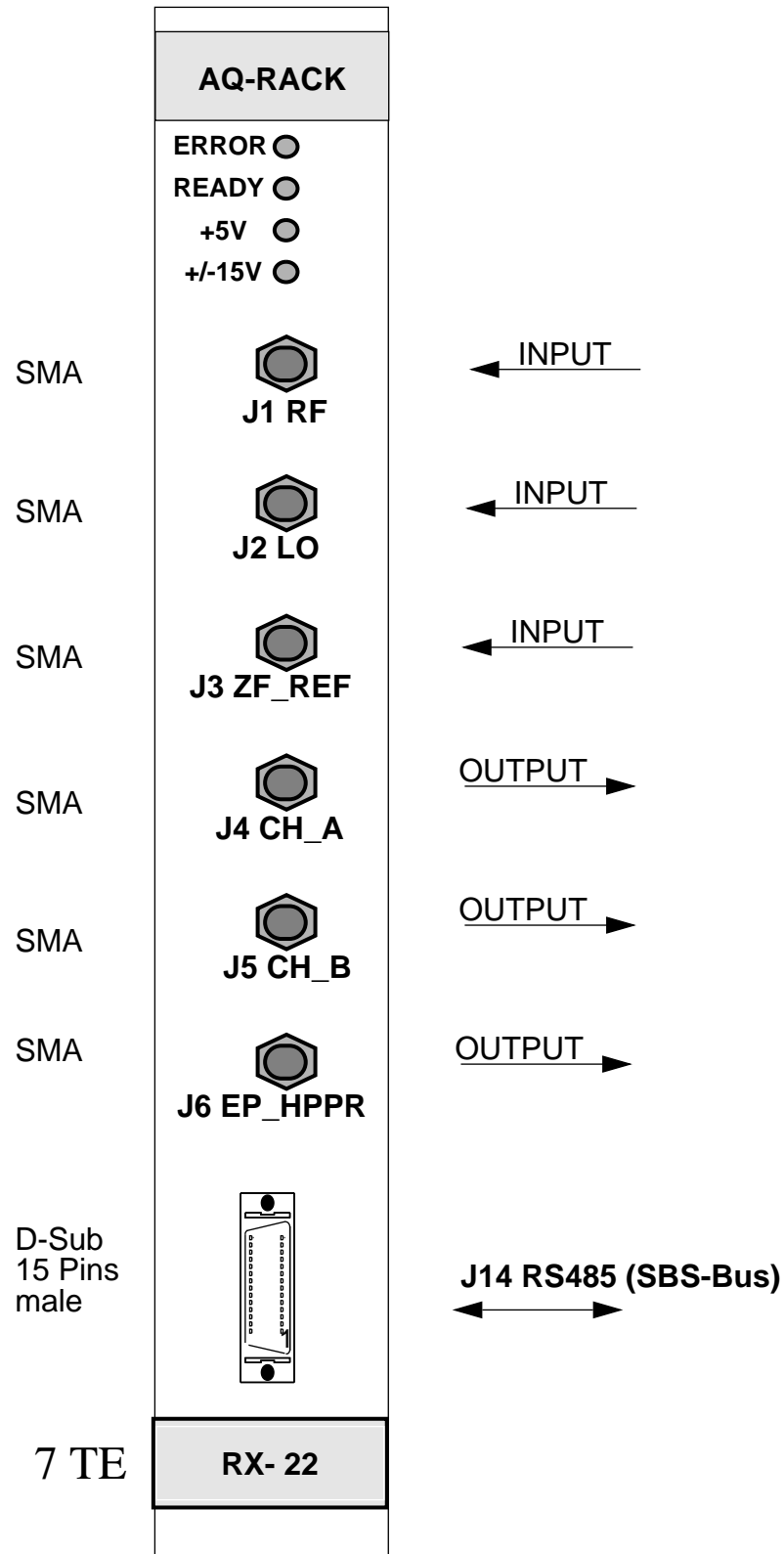
Baseline Correction (DC-Offset) 1.3.3

The acquired fid can be DC offset adjusted via the RS485 Interface. Two different commands for each channel are implemented.

The two offset adjustment can be done with the RX22- Service Tool. A DC-Offset voltage is added to the NF amplifier in the AF-Section. This adjustment can be done individually for each channel A and B.

After optimizing this parameters the values can be stored on the board with the Save Config command. Even after a power up, the old stored values are activated. For proper operation of the RX22-Tool see chapter Submenu Quad Image Adjustment on page 29.

Figure 1.1. *Installation RX-22*

SBS Bus (RS485) Connector Pin Assignment   1.5

Figure 1.2.   RS485 Connector Pin Assignment
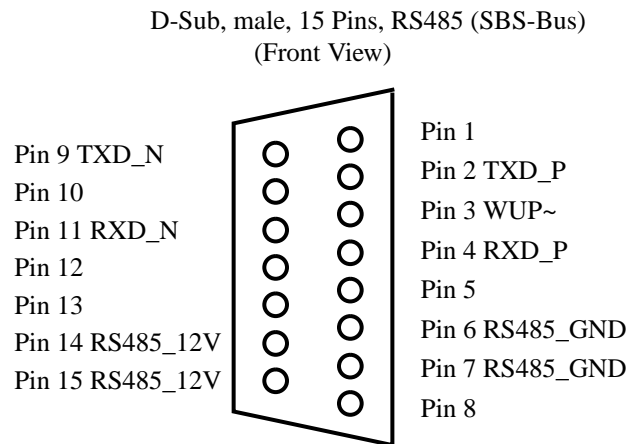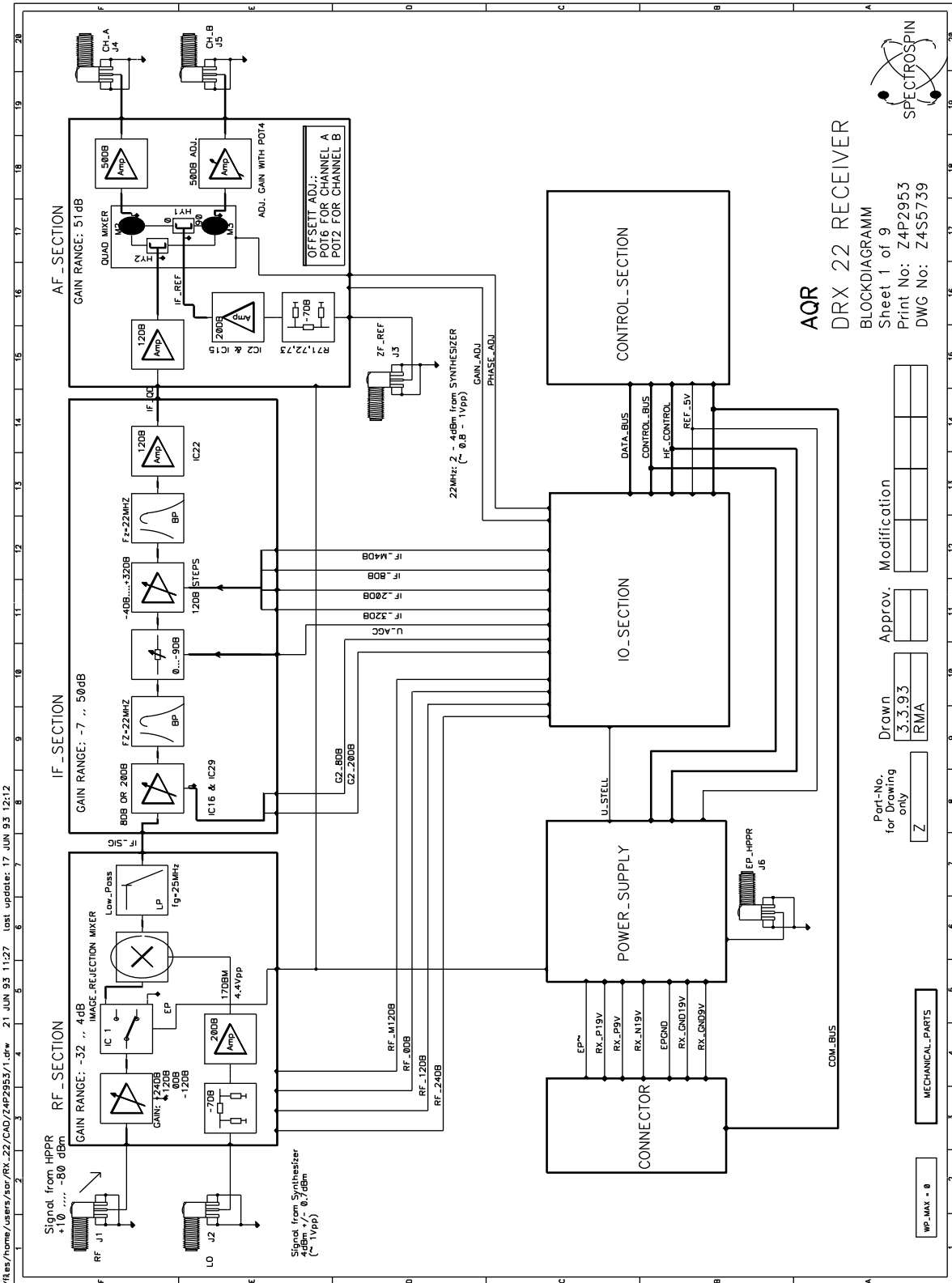
D-Sub, male, 15 Pins, RS485 (SBS-Bus)
(Front View)

Pin 9 TXD_N

Pin 10

Pin 11 RXD_N

Pin 12

Pin 13

Pin 14 RS485_12V

Pin 15 RS485_12V

Pin 1

Pin 2 TXD_P

Pin 3 WUP~

Pin 4 RXD_P

Pin 5

Pin 6 RS485_GND

Pin 7 RS485_GND

Pin 8

Figure 1.3.   Block Diagram

Jumper Settings (ECL00) *1.7*

Board Z4P2953:

- Ju15 and Ju16 switch different supply voltages to the RS interface. They must be in the same position.
If they are placed closer to the front panel (Position A) than the RS interface is supplied with an external RS485_12V supply voltage. This voltage is connected to the RS485 plug on pin14,15 positive 12V and pin 6,7 GND.
If they are placed closer to the back plane (Position B) then the internal digital +5V Voltage supplies the RS interface section. (Caution no galvanic isolation)

- Ju7 and Ju8 select the RS input channel. They must be in the same position.
If the position of both jumpers is closer to the front panel (Position A) than the RX22 serves a RS485 interface on the RS485 plug .
If the position of both jumpers is closer to the back plain (Position B) than the RX22 serves a RS232 interface on the RS232 pin plug.

Jumper Settings (ECL01 or later) *1.8*

Table 1.3.   *Jumper Settings:*

Jumper	Setting A	Setting B	Factory Configuration
J7	RS485 interface	RS232 interface (if IC36 is placed)	A
J8	RS485 interface	RS232 interface (if IC36 is placed)	A
J15	True galvanic isolation for RS485 interface (If external 12V for RS485 interface is available use setting A)	No galvanic isolation for RS485 interface (If external 12V for RS485 interface is not available use setting B)	B
J16	True galvanic isolation for RS485 interface (If external 12V for RS485 interface is available use setting A)	No galvanic isolation for RS485 interface (If external 12V for RS485 interface is not available use setting B)	B
J17	Not a valid setting. Set J17 to B	J17 must be always set to Position B	B
J18	Reserved for further options	Reseved for further options	B
J19	EPA_SE451 and EPB_SE451 low active	EPA_SE451 and EPB_SE451 high active	B
J20	EP_HPPR low active	EP_HPPR high active	B

Figur 1.4.   Jumper Locations

RS485 Connector

Jumpers

Technical Data

2

DC Specifications   *2.1*

Mean Supply Current (RX_P19V)	1210mA
Mean Supply Current (RX_N19V)	90mA
Mean Supply Current (RX_P9V)	250mA
Leakage (DC at CH_A and CH_B output)	max. +-100mV

AC Specifications (f_{RF}=400MHz)   *2.2*

Voltage Gain Range (Load=1kΩ)	12..105.3dB
Single Side Band Suppression	> 20dB
RF-Flatness (5..600MHz)	< 5dB
IF-Flatness (21.5..22.5MHz)	< 0.3dB
1dB Compression (at CH_A and CH_B output, Load=1kΩ)>32dBm	> 9Veff
Noise Figure (Gain 69..105dB)	max. 8dB
Noise Figure at minimum Gain (not measured)	max. 50dB
Dynamic Range at maximum Gain, BW=1Hz (P1dB+174-F-Gain)	92dB
Dynamic Range at minimum Gain, BW=1Hz	144dB

Soft- and Hardware Specifications digital uP Part   *2.3*

Software boottime from power up to uP ready	10sec
Hardware Reset from EP inactive to uP ready	0.4sec
Hardware Reset from WUP inactive to uP ready	0.4sec
RS-485 Baudrate	9600Baud
RS-485 Startbit	1
RS-485 Stopbit	1
RS-485 parity	none
uP Clock Frequency	12MHz

FunctionDescription 3

RF-Section *3.1*

The RF-Section is built as a low noise broadband input module with various gain steps. The gain can be set in 12dB steps from -12 to +24dB. The pin diode switches, which handle the various amplifiers, are controlled from the microprocessor.

The image rejection mixer converts the wanted signal down to the IF band. The carrier and one of the sidebands will be cancelled at the output port. Therefore the IMR mixer provides also a good SSB noise suppression.

The following 25MHz lowpass suppresses the unwanted LO leakage signal from the IF-Section and prevents saturation of the following amplifiers

The four RF amplifier control signals are filtered with smoothing capacitors since ECL04. This capacitors act like lowpasses.
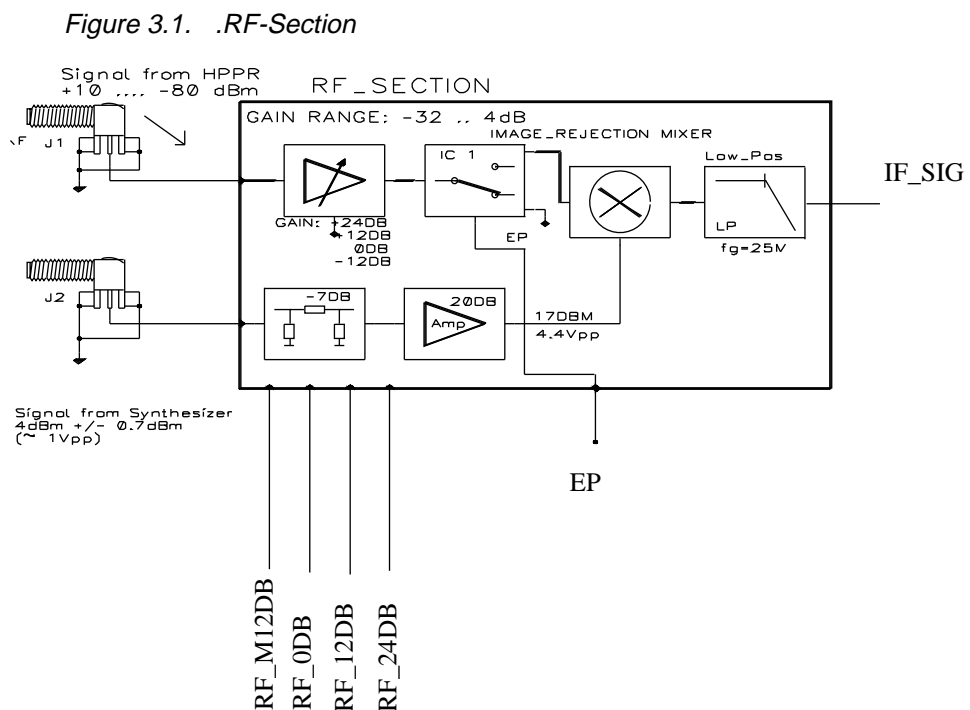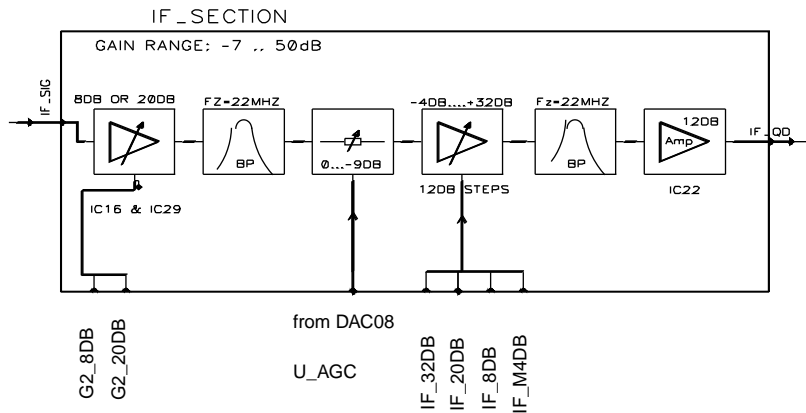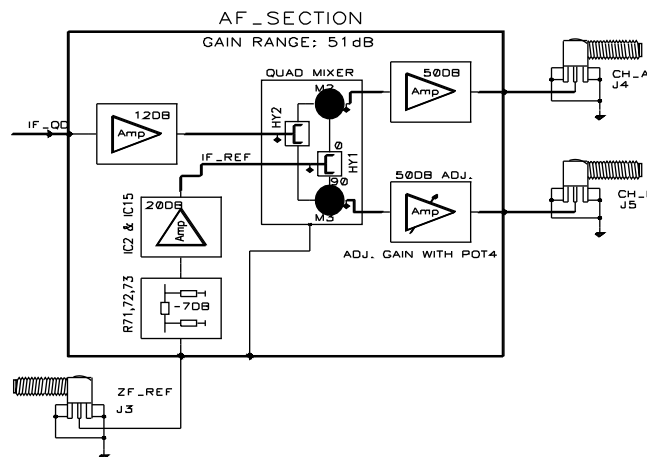
Figure 3.1. .RF-Section

IF-Section **3.2**

Figure 3.2. IF-Section

```
                    IF_SECTION
              GAIN RANGE: -7 .. 50dB

   8DB OR 20DB   FZ=22MHZ              -4DB....+32DB   Fz=22MHZ      12DB
                                                                    Amp          IF_QD

                            BP      0...-9DB               BP              IC22
   IC16 & IC29                              12DB STEPS

   G2_8DB  G2_20DB          from DAC08      IF_32DB  IF_20DB  IF_8DB  IF_M4DB
                            U_AGC
```

The IF-Section is built as a selective amplifier with different gain steps. In the first stage a 20dB or a 8dB amplifier can be activated.

A two stage bandpass filter with a 0.3dB bandwidth of 1MHz suppresses all unwanted signals.The pin diode attenuator (PAS) allows fine gain adjustment. The following stage consists of 4 switchable amplifiers for coarse gain steps from -4 to +32dB.

AF-Section **3.3**

Figure 3.3. AF-Section

```
                       AF_SECTION
                    GAIN RANGE: 51dB

                    QUAD MIXER    50DB
                        M2        Amp              CH_A
                  HY2                              J4

   IF_QD    12DB         HY1
            Amp     IF_REF
                            90°   50DB ADJ.
        IC2 & IC15             Amp              CH_B
              20DB                              J5
              Amp      M3
                            ADJ. GAIN WITH POT4
   R71,72,73
              -7DB

              ZF_REF
              J3
```

In the AF-Section the signal is converted down to the audio frequency band. The quadrature mixer produces in-phase and the quad-phase output signals. The optimal 90 degree local oscillator phase shift is controlled by software, therefore the quadrature imagine can be optimized from the computer and no hardware trimming is necessary. Also equal gain in both channels is adjustable by software.

The temperature of the quadrature module is measured and regulated to a constant value of about 65 degree celsius with boards till ECL01. The temperature in later designs is held stable to 55 degree celsius.

RX22 Controller Section   *3.4*

Microcontroller   *3.4.1*

The Microcontroller system consists of a 80C535 12MHz Microcontroller, a 32K * 8 Bit Static RAM, a 128K * 8 Bit paged FLASH EEROM and a 12MHz clock generator. The external bus interface of the 80C535 consists of an 8-bit data bus, a 16-bit address bus and five control lines. The address latch enable signal (ALE) is used to demultiplexing address and data of port 0. The program memory is accessed by the program store enable signal (PSEN~) twice a machine cycle. The read or write strobe (RD~, WR~) is used for accessing the external data memory.

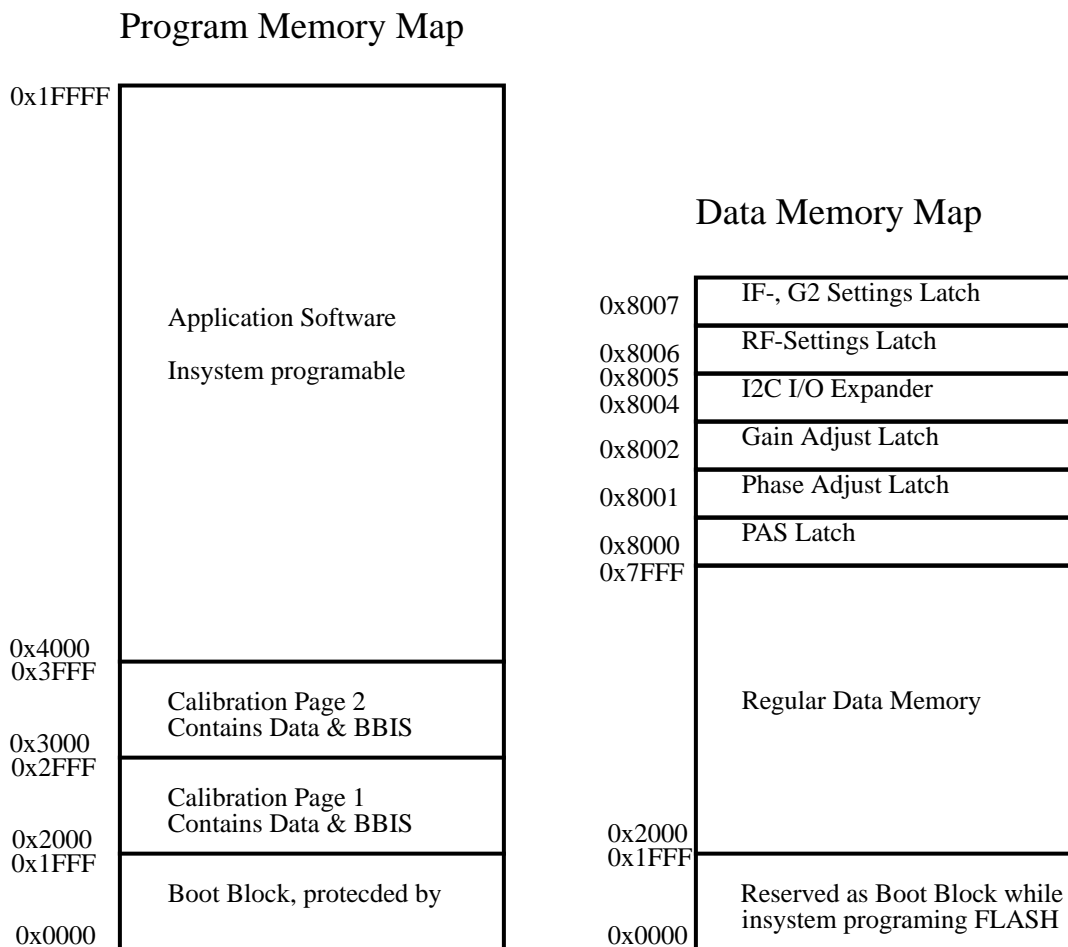### *Address Decoder*   *3.4.2*

The address decoder controls the microcontroller program and data memory accesses. It enables/disables depending on the address and control signals different devices. Normally, the uP boots from the lower page of the FLASH memory and runs its application software from the upper page. The PSEC~ control signal is asserted by the uP while the uP downloads new application software or stores new BBIS or configuration data. This mapes the FLASH memory into the data segment and the RAM into code segment. The uP accesses now the RAM as it were a nonvolatile code memory. Therefore, program instructions are copied from the boot partition of the FLASH memory to the RAM before starting the download procedure.

The uP may access several devices as data memory. Its own RAM(Address 0x2000..0x7FFF), the latch for the PAS D/AC(located at 0x8000), the latch for the phase adjustment D/AC(located at 0x8001), the latch for the gain adjustment D/AC(located at 0x8002), the latch for the RF control signal driver(located at 0x8006) and the latch for the IF and G2 control signal driver(located at 0x8007).

A special mode allows the download of the boot software into the lower page of the FLASH memory. The boot software is copied in the test department from an EPROM to the FLASH. The boot partiton is in normal operation mode protected from unwanted program and erase operations.

Figure 3.4.   Memory Map

Program Memory Map

Data Memory Map

0x1FFFF	
	Application Software Insystem programable
0x4000 0x3FFF	
	Calibration Page 2 Contains Data & BBIS
0x3000 0x2FFF	
	Calibration Page 1 Contains Data & BBIS
0x2000 0x1FFF	
	Boot Block, protecded by
0x0000	

Data Memory Map:

Address	Description
0x8007	IF-, G2 Settings Latch
0x8006	RF-Settings Latch
0x8005 0x8004	I2C I/O Expander
0x8002	Gain Adjust Latch
0x8001	Phase Adjust Latch
0x8000	PAS Latch
0x7FFF	
	Regular Data Memory
0x2000 0x1FFF	
0x0000	Reserved as Boot Block while insystem programing FLASH

Non volatile Code Memory   ***3.4.3***

The RX22 receiver uses a new FLASH technology, a 128K * 8 block wide erase/ programmable non volatile Memory. The address space is separated into four blocks, each block is insystem erase-, and programmable. Data in the boot block is protected from unwanted erase/program operations if jumper JU2 is not placed (normal operation).

Parameterblock 1 and 2 contain BBIS(Bruker Board Information System) data, calibration data for gain steps and values stored with the "save config" command. Only one parameterblock is valid at a time, the other is erased and will be written with the next save config or update BBIS data command.

The uP software manages which parameter block is actual valid.

The application or main block contains the application software. It is possible to make an insystem update of the receiver software version. The download software is stored in the boot block and copied to the low page of the RAM before a download starts. The uP will then disable PSEC (Program SECurity) and while PSEC is low access the RAM as code memory and the FLASH as data memory (address decoder).

Communication to the RX22 receiver is achieved via the RS485 interface. The RS485 is a full duplex differential interface which allows to connect several transceivers to the same wires. The interface is realized by seperate transmit and receive lines. A extra wakeup line may activate a hardware reset on the RX22. This line is driven from the RS485 master.

All signals in the RS interface are galvanic isolated with optocoupler circuits. The supply voltage for the galvanic isolation delivers the RS485 Master. A voltage regulator placed in the interface section generates +5V Vcc out of the 12V on the RS485 plug. Data collisions in a network with several slaves is avoided with the TX_EN signal. The uP switches its transmit outputs into tristate (high impedance mode) after the end of each data transmission.

The default baud rate is set to 9600 Baud. One startbitt, no parity, one stopbit

Figure 3.5.   RS485- Transmission
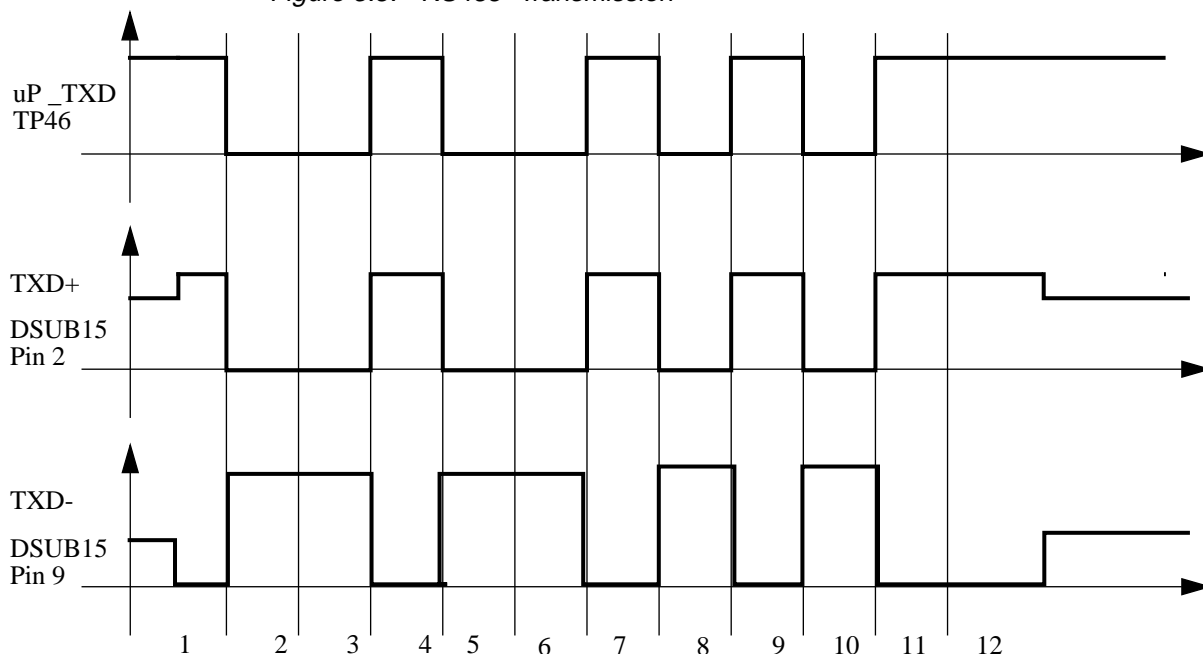
The RX22 I2c interface is not any longer connected to the I2c bus in the AQR rack. The hardware change is made to avoid I2c bus collisions in the AQR. This change is valid from RX22 with ECL02 .

All components for the I2c interface are not placed since ECL02, the RX22 does not support I2c bus functions anymore.

Function Description

A supply voltage controller monitors the digital supply voltage (+5V). If the supply voltage drops below 4.5V a hardware reset automatically takes place. When switching on the power supply, the voltage monitor releases the RESET~ signal after a time delay. This allows the quartz oscillator building-up the 12MHz system clock.

Different reset sources drive the RESET~ signal after the power up. The regular reset switch placed on the board for manual resets, the RS_WUP~ (RS485 Wake up) and a EP~. All those sources may initiate a hardware reset. The Controller is because of disturbance reasons held in a reset state during the whole acquisition of NMR data(EP~ active).

The uP system boots after each reset. While the uP boots, the RX22 does not serve the serial interface. Any data received on the serial RS485 interface is ignored.

The boot time must be considered by any application or testing software.

The boottime consists of two separates time delaies. The hardware delay caused by the Power monitor ~15msec and the boot time of the uP system software.

For exact boot time see Soft- and Hardware Specifications digital uP Part on page 17

The uP is driven from a 12MHz oscillator. Two possible circuits may be used. If R158 and R194 are placed on the board, the uP uses its internal timing circuits. The uP makes it possible to turn off the clock with a software instruction. Leaving this deep power down mode is achieved with a hardware reset.

If R101, R106 and R108 are placed on the board, the uP uses the external clock oscillator. This oscillator turns off while EP~ is active low. Leaving this mode is achieved with the positive state of the EP~ and a resulting hardware reset through EP~. A special software mode disables the EP~ reset and clock turning off. This mode is asserted with software instructions to allow phase, gain and baseline adjustment while the acquisition is on. It is also for tunning, matching and 'gs' procedures.

Figure 3.6.   uP Clock
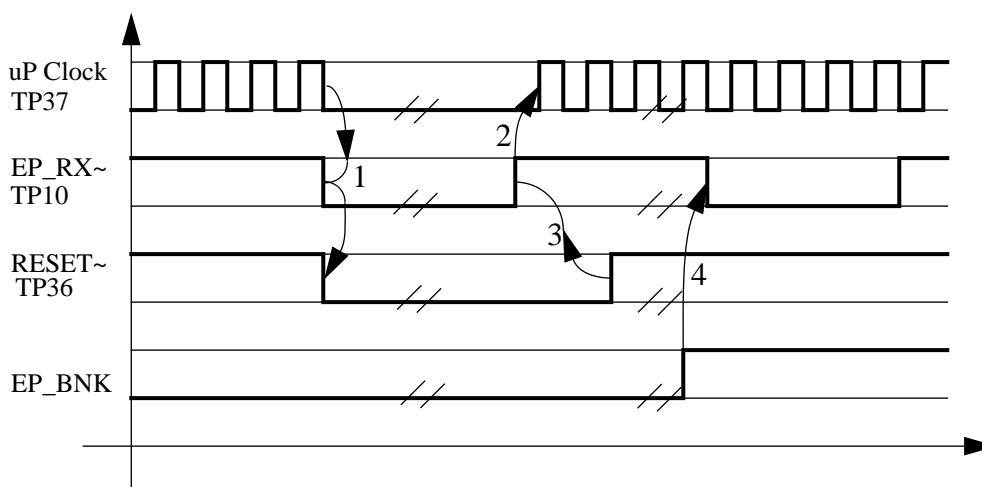
Explanation:
1. A Acquisition activates EP_RX~. EP_RX~ triggers a hardware reset in the reset logic and switches the clock oscillator off.
2. Disabling EP_RX~ releases the clock oscillator, the clock oscillator starts building up the 12MHz clock frequency.
3. Disabling EP_RX~ releases the reset logic input, the reset logic pulls RESET~ high after a certain time delay.
4. The uP switches EP_BNK(EP_BlaNK) on. An EP_RX~ does not result anything in the uP system. This mode is entered for phase- and gain adjustment only.

Gain settings   *3.4.8*

The receiver gain depends on the RF, IF, G2 and PAS settings. The uP switches on the MSA amplifiers in the HF-Section by executing a data memory write cycle to the proper address of the RF or IF and G2 latch. Two drivers supply the MSA amplifiers with the required currents.
The PAS setting makes a fine calibration of the receiver gain possible. The digital PAS value is latched and digital/analog converted with a DAC08. The analog voltage(U_AGC) is then brought to a voltage controlled attenuator PAS_1.

Phase and Gain Adjustment   *3.4.9*

Fine calibration of the phase and gain in the quad module is adjustable by software.
Both adjust signals result of a digital/analog conversion. The digital values are latched and then converted with two DAC08. The PHASE_ADJ(TP6) signal controls a capacitance diode(D5), the GAIN_ADJ(TP1) signal controls a field-effect transistor (T1) in the AF section.

The uP may measure the temperature in the quad module. This temperature is regulated to keep phase and gain drift caused by temperature drift in the quad module as low as possible. The temperature sensor Ref02 is placed in the quad modul, it converts temperature to voltage. A Operational amplifier(IC56) spreads the temperature voltage to the full scale (0..+5V) uP A/DC range(TP15). The uP can compress its internal reference voltage range (set automatically by software) to achieve a higher resolution(~10 bit => 0.01Kelvin, full range 0..5V on TP15 => 20Kelvin).

The effective temperature in the modul is then calculated by software using the conversion result and the reference value of the temperature regulator.

LEDs   *3.4.11*

Some LED's on the front panel of the board signal the state of the RX22. Two LED's display the uP status, two LED's monitor the supply voltage.

Possible combinations of the READY and ERROR LED are described in table LED Description on page 26.

The +5V LED monitors the digital +5V supply. The LED is on when the observed +5V voltage is correct.

The +-15V LED monitors the positive- and negative 15V supply for the analogue section. The LED is on when both, the +15V and the -15V voltage are correct.

Another LED is placed inside the RX22 HF-Cassette. This LED is not visible. To control the LED, the cover plate has to be removed. This LED monitors the positive- and negative 15V supply for the quad image module. The LED is on when both, the +15V and the -15V voltage are correct.

Table 3.1.   LED Description

Error LED red	Ready LED green	Status
off	off	- power supply not on
off	on	- Normal operating mode - ready for operation
off	single, short-time flickering	- Communication LED. The board has received a command from the RS485 bus master. The LED switches to off as soon as the RX22 acknowledges the command.
blinking	on	The uP disabled the EP reset logic. (tuning, matching and gs procedure) Caution: NMR experiments are not possible in this mode due to disturbances of the uP system.

Error LED red	Ready LED green	Status
on	off	Error state. The firmware triggered an error. The error must be acknowledged by the Master. The RX22 refuses further operation until the error is cleared.
on	on	- The board was powered up. - An active EP disables any uP operations, the uP system is always in a reset state. Check the polarity of the connected EP pulse

RX22 Service Tool 4

A service tool running under UNIX supports some RX22 functions. This tool can be started by typing rx22 under UNIX or by opening a shell(term) and typing rx22 under openwindows. This tool supports user, service and testing function.

Receiver Gain 4.1

This command reads and writes the RX22 receiver gain. The gain corresponds to the UXNMR gain(1.0..46341.0).

Submenu Quad Image Adjustment 4.2

Entering this menupoint will open a new menu where gain, phase and baseline adjustment for the quad module may be done. Before the new menu structure appears on the screen, the tool inhibts hardware resets and clock oscillator shoot downs caused by an active EP~(Acquisition) (see explanation Reset and Clock Oscillator).
Leaving this menu will again switch the EP~ logic on.

Initialize Default Values:

The RX22 receiver initializes itself with default values. New default values can be obtained by the Save Configuration command (see below). Executing an Initialize reloads all settings with default values. The receiver is in a defined state (power up) after the init command

Save Configuration:

The RX22 receiver stores the current settings as its default into a non volatile data memory. The RX22 receiver sets the default values after an "Initialize" command or a power up.

Quad image Gain Adjust:

This command reads and writes the gain adjust value in the quad module. The resolution is +-3.2 percent of the current gain.

Increment Quad Image Gain:

The quad image gain value is incremented with the smallest possible D/A converter resolution. Use this function for fine adjusting.

Decrement Quad Image Gain:

The quad image gain value is decremented with the smallest possible D/A converter resolution. Use this function for fine adjusting.

Quad image Phase Adjust:

This command reads and writes the phase adjust value in the quad module. The adjustable phase is +-5 degrees.

Increment Quad Image Phase:

The quad image phase value is incremented with the smallest possible D/A converter resolution. Use this function for fine adjusting.

Decrement Quad Image Phase:

The quad image phase value is decremented with the smallest possible D/A converter resolution. Use this function for fine adjusting.

Offset Channel A:

This command reads and writes the channel A offset adjustment. The channel A low frequency output of the quad module is DC offset adjustable. The valid range is from 0 to 255.

Increment Offset AF-Channel A:

The AF offset voltage for the channel A is incremented with the smallest possible D/A converter resolution. Use this function for fine adjusting.

Decrement Offset AF-Channel A:

The AF Offset voltage for the channel A is decremented with the smallest possible D/A converter resolution. Use this function for fine adjusting.

Offset Channel B:

This command reads and writes the channel B offset adjustment. The channel B low frequency output of the quad module is DC offset adjustable. The valid range is from 0 to 255.

Increment Offset AF-Channel B:

The AF offset voltage for the channel B is incremented with the smallest possible D/A converter resolution. Use this function for fine adjusting.

Decrement Offset AF-Channel B:

The AF Offset voltage for the channel B is decremented with the smallest possible D/A converter resolution. Use this function for fine adjusting.

Submenu I2C AQR Functions   4.3

The RX22 does not support any AQR I2c functions.

Autodownload *4.4*

The firmware software on the RX22 board is automatically checked and if necessary downloaded with the latest firmware version. Dependencies between firmware and hardware are controlled by the tool software. Do always execute an autodownload after receiving a new firmware tape.

Submenu Service *4.5*

This menu contains various functions like debug-, service- and test department function. Some function are reserved for authorized persons and can not be accessed by a regular user.

Initialize Default Values:

The RX22 receiver initializes itself with default values. New default values can be obtained by the Save Configuration command (see below). Executing an Initialize reloads all settings with default values. The receiver is in a defined state (power up) after the init command

Delete Error:

Some errors may occur during runtime of the RX22 receiver. All this errors announced by the Rx22 must be acknowledged. The RX22 receiver refuses operation as long as an error is not deleted. This functions deletes one error.

Download:

An update of the application software in the RX22 receiver, is insystem possible. This function starts the download procedure. Normally the application software is loaded in the test department and must not be updated.

Save Configuration:

The RX22 receiver stores the current settings as its default into a non volatile data memory. The RX22 receiver sets the default values after an "Initialize" command or a power up.

Version Config:

This command gets the RX22 receiver hard- and software configuration and displays it on the screen.

Measure Quad Module Temperature:

Selecting this menupoint triggers a temperature measurement in the quad module. The uP receives a analog voltage on his A/DC input pin which corresponds to the current temperature in the quad module. The reference value in the temperature regulating circuit is 2.5V equal to 65 or 55 degrees Celsius. (Depends on the hardware index, Z3P2953 and Z3P2953A 65 degrees, , Z3B2953B, Z3P2953C or newer 55 degrees celsius.)

This menupoint contains commands about board information and calibration data. Each board is individual adjusted and calibrated in the test department. Calibration data is then stored in the non-volatile data memory.
Selecting this menupoint opens a new menu with the following commands:

Read BBIS to Screen:

The receiver BBIS(Bruker Board Information System) data is displayed on the screen. BBIS contains production, testing, hard- and software versions data.

Read BBIS to File:

The receiver BBIS(Bruker Board Information System) data is written to a file and may be edited with a normal ASCII editor like vi or emacs. BBIS contains production, testing, hard- and software versions data.

Write BBIS from File:

The receiver non-volatile data memory is loaded with new BBIS data. Normally the test department writes valid data to the board after production or repair.

Caution: The BBIS data memory may contain non-valid data if a unauthorized user selects this menupoint. The old data will be irretrievable lost.
For use of authorized persons only!!!

Read Calibration Data to File:

The Receiver has a gain table stored in his data memory. This table includes RF, IF and G2 amplifier settings and PAS D/AC values for all Gain steps. The command creates a ASCII file containing the gain table.

Write Calibration Data from File:

The receiver non-volatile data memory is loaded with a new gain table. The table is determined individually for all receiver in the test department.

Caution: The gain table is essential for a correct operation of the RX22 receiver. A wrong table disables any normal operation, the board must then be adjusted again in the test department. Old calibration data is irretrievable lost after executing this command. For use of authorized persons only!!!

Entering into this point opens a new menu. This menu is made for debug and test functions. It also inhibits the EP~ hardware reset and shoot down of the clock oscillator while the EP~ pulse is active. Leaving this menu switches the EP~ logic on.
The ERROR LED on the front panel off the RX22 blinks while this submenu is active. This is a warning that the acquired spectra may be disturbed by the uP system.

Init:

The RX22 receiver initializes itself with default values. New default values can be obtained by the Save Configuration command (see below). Executing an Initialize command loads all settings with values from the non volatile EEPROM and sets the RX22 in a defined state. (Power up).

Delete Error:

Some errors may occur during runtime of the RX22 receiver. All this errors announced by the RX22 must be acknowledged. The RX22 receiver refuses operation as long as an error is not deleted. This functions deletes one error.

Save Configuration:

The same as described above. New adjustment values may be stored to the non-volatile datamemory. Those values will then be treated as new default values after a power up or hardware reset.

Receiver Gain:

This command reads and writes the RX22 receiver gain. The gain corresponds to the UXNMR gain(1.0..46341.0).

Debug RF, IF and G2 setting:

This command writes a bitpattern to the RF, IF and G2 UDN2982 driver. It is possible to switch on any amplifier combinations (resulting a unique gain) in the receiver.
The bitpattern has a 10 bit size, the input data is in hexadecimal code starting with 0x. The lower nibble(bit0..bit3) switches directly the RF_M12DB, RF_0DB, RF_12DB and RF_24DB amplifier on/off. The middle nibble (bit4..bit7) switches directly the IF_M4DB, IF_8DB, IF_20DB and IF_32DB amplifier on/off. The higher nibble switches directly the G2_8DB and G2_20DB amplifier on/off.
Example: 0x241(binaer 10'0100'0001) switches the RF_0DB, the IF_20DB and the G2_20DB amplifier in the HF section on. All other MSA are switched off.

AGC Voltage:

This command writes a new AGC Value(PAS) to the D/AC. Normally the PAS value is set with a regular Receiver Gain instruction. The PAS value for all gainsteps is individually saved for all receivers in a table.

Phase Adjust:

This command reads and writes the phase adjust value in the quad module. The adjustable phase is +-5 degrees.

Gain Adjust:

This command reads and writes the gain adjust value in the quad module. The resolution is +-3.2 percent of the current gain.

Offset Channel A:

This command reads and writes the channel A offset adjustment. The channel A low frequency output of the quad module is DC offset adjustable. The valid range is from 0 to 255.

Offset Channel B:

This command reads and writes the channel B offset adjustment. The channel B low frequency output of the quad module is DC offset adjustable. The valid range is from 0 to 255.

Submenu Gain functions   4.5.3

Some gain functions are implemented to make the tuning and matching procedure as easy as possible. Some of this functions will not set a new RX22 gain, they do just inform the tuning software about the gain table in the RX22. This menu is for debug reasons only.

Submenu Diagnostic: 4.5.4

This submenu contains debug functions for bug fixing. More functions will be implemented with a later firmware release.

Measure Quad Module Temperature

Selecting this menupoint triggers a temperature measurement in the quad module. The uP receives a analog voltage on his A/DC input pin which corresponds to the current temperature in the quad module. The reference value in the temperature regulating circuit is 2.5V equal to 65 or 55 degrees Celsius. (Depends on the hardware index, Z3P2953 and Z3P2953A 65 degrees, , Z3B2953B, Z3P2953C or newer 55 degrees celsius.)

ECL-Information

5

Table 5.1.   ECL information for RX22

ECL	Additional Features	Print Index	Software	Boot Software	Tool
Prototype		Z4P2953	rx22aa.hex rx22ab.hex rx22ac.hex rx22ad.hex	rxbootaa.hex	
ECL00	1dB Steps	Z4P2953	rx22aa.hex rx22ab.hex rx22ac.hex rx22ad.hex	rxbootaa.hex	
ECL01	-Full galvanic isolation of RS485 interface -u-metal shielded quadrature module -Polarity of signal EP_HPPR can be selected by jumper -CH_A and CH_B offset can be adjusted by software - The I2c interface is not placed any more. No I2c bus function possible.	Z4P2953A	rx22aa.hex rx22ab.hex rx22ac.hex rx22ad.hex	rxbootab.hex	
ECL02	-Redesign Gain-Adjust. - Temperature . Controller -Incircuit test points implemented for testing reasons	Z3P2953B	rx22aa.hex rx22ab.hex rx22ac.hex rx22ad.hex	rxbootab.hex	
ECL03	-With 10MHz Filters at the low frequency channel A and channel B output -AF gain 2dB increased - The quad image gain adjustment resolution is finer - Better amplifier in the HF section inserted	Z3P2953C	rx22aa.hex rx22ab.hex rx22ac.hex rx22ad.hex	rxbootab.hex	
ECL04	- The RF amplifier control signals are inserted with smoothing capacitors	Z3P2953C	rx22aa.hex rx22ab.hex rx22ac.hex rx22ad.hex	rxbootab.hex	

Table 5.2.   *Firmware Versions*

Release Tape Version	Firmware Version	Application Date	Application Checksum	Length
---	RX22AA	930826	$8106	79089
---	RX22AB	931203	$F67B	82735
---	RX22AC	940222	$B0F0	84021
940614	RX22AD	940531	$5974	90929

Please refer to the specific firmware release note to get full information about the features and bugs of each release.

RX22 Software Release Note

6

Fixed Bugs:

1. The AF offset adjust value was not correct reloaded after a power up. The software loaded the D/A converter with the hexadecimal complementary value. All adjust values will now be read correct and set properly on the hardware. Make sure that all settings of an adjusted RX22 are saved to the non volatile memory with the "save config" command in the rx22 tool.

New Facts:

1. New commands are implemented to make a fine quad image adjustment possible. The digital values for the D/A converters on the RX22 are incremented / decremented with the smallest possible resolution (1 LSB). The new features are located in the rx22 service tool version 940614, quad image adjustment menu.

2. In normal operation, the digital part of the receiver RX22 is shoot down during acquisitions. A special mode is implemented to achieve full operation also when an EP is active. This special mode was made for tuning and matching procedures. When the RX22 switchs to the "Disable EP Logic mode on", the ERROR LED on the front panel starts blinking. This is a warning for the user, it reminds him that the uP system is working and that the acquired spectra may be disturbed by the uP clock oscillator or other frequency products. The UXN-MR enters into the "Disable EP Logic mode" when a tuning or matching procedure or the gs mode is activated.

3. The temperature in the receiver RX22 quad image module is reduced to 55 degrees celsius for all RX22 with board index Z3P2953B and Z3P2953C. The monitored temperature adapts this fact to the new temperature calculation.

Test Equipement 7

HF-Case Test-Extension *7.1*

There is an extension board available if you have to make further hardware measurements. It allows you to check the board out of the Rack. This extension can also be used for all other boards in a HF case with a c/2-connector (48 pins). It's a standard one to one extension.

You may order this extension board at:

SPECTROSPIN AG

Industriestrasse 26

CH-8117 Fällanden

Tel 01/ 825'91'11

as HF-Case Test-Extension, Part Nr.: Z012746

RX22 Error Messages

8

Error are also announced with the two LED placed on the front panel. (see chapter LEDs on page 26

Table 8.1.   Error Messages

ERROR MESSAGE	ERROR DESCRIPTION	
RX22 ROM Error Error 11	The RX22 has no application software downloaded. Execute a download first. (Tool, Submenu Service, Download)	
RX22 Power failed Error 13	The RX22 was powered up and not initialized. No commands will be accepted before initiation. (Tool, Submenus, Initialize Default Values).	
RX22 Syntax Error Error 20	The RX22 received a undefined command. The syntax is not specified and can therefore not be served. You might have a inconsistent system. Establish consistency with the autodownload command.	
RX22 Error_Startchar Error 30	The RX22 receiver application software is a INTEL Hex file. If the starting character of any line in this file violates the format specifications downloading will stop immediately. Your downloaded file may be damaged, contact your local Bruker service agent for a correct RX22 receiver xx.HEX file. To restart the download, reset the RX22 (Powerdown on AQR rack or initiate an EP pulse) and clear the RX22 receiver Errormessage #11.	
RX22 Error_Datacount Error 31	The RX22 receiver application software is a INTEL Hex file. If the length of any line in this file violates the format specifications downloading will stop immediately. Your downloaded file may be damaged, contact your local Bruker service agent for a correct RX22 receiver xx.HEX file. To restart the download, reset the RX22 (Powerdown on AQR rack or initiate an EP pulse) and clear the RX22 receiver Errormessage #11.	

RX22 Error Messages

ERROR MESSAGE	ERROR DESCRIPTION	
RX22 Error_Address Error 32	The RX22 receiver application software is a INTEL Hex file. If any address in this file is bigger than the uController(80C535) serves with its addressbus(0xFFFF) downloading will stop immediately. Your download file may be damaged, contact your local Bruker service agent for a correct RX22 receiver xx.HEX file. To restart the download, reset the RX22 (Powerdown on AQR rack or initiate an EP pulse) and clear the RX22 receiver Errormessage #11.	
RX22 Error_Rec Type Error 33	The RX22 receiver application software is a INTEL Hex file. If any line record type specifier violates the format specifications downloading will stop immediately. Your download file may be damaged, contact your local Bruker service agent for a correct RX22 receiver rxx.HEX file. To restart the download, reset the RX22 (Powerdown on AQR rack or initiate an EP pulse) and clear the RX22 receiver Errormessage #11.	
RX22 Error_Checksum Error 34	The RX22 receiver application software is a INTEL Hex file. Every line in this file gets a checksum. The RX22 receiver calculates for each line its own checksum and compares them. If a checksum differs from the calculated checksum downloading will stop immediately. Your download file may be damaged, contact your local Bruker service agent for a correct RX22 receiver xx.HEX file. To restart the download, reset the RX22 (Powerdown on AQR rack or initiate an EP pulse) and clear the RX22 receiver Errormessage #11.	
RX22 Error_Prommer Error 36	Special algorithems allow an insystem programming of the Flash EPROM. If an erase or program cycle of a memorylocation fails, downloading will stop immediately. If this error happens twice, contact your local Bruker service agent or replace your RX22 board. To restart the download, reset the RX22 (Powerdown on AQR rack or initiate an EP pulse) and clear the RX22 receiver Errormessage #11.	
RX22 Error_Erase Error 37	Special algorithems allow an insystem programming of the Flash EPROM. If an erase cycle of a memorylocation fails, downloading will stop immediately. If this error happens twice, contact your next Bruker service agent or replace board your RX22 board.. To restart the download, reset the RX22 (Powerdown on AQR rack or initiate an EP pulse) and clear the RX22 receiver Errormessage #11.	

ERROR MESSAGE	ERROR DESCRIPTION	
RX22 Error_NoHexChar Error 38	The RX22 receiver application software is a INTEL Hex file. A stopline indicates the end of file. If this end of file line violates the file specification downloading will stop immediately. Your download file i may be damaged, call your local Bruker service agent for a correct RX22 receiver xx.HEX file. To restart the download, reset the RX22 (Powerdown on AQR rack or initiate an EP pulse) and clear the RX22 Errormessage #11.	
RX22 Error_ReCount Error 39	The RX22 receiver boots from a lower page of his Flash memory. The bootroutine stored in this page must correspond to the downloaded application software. The downloaded application software conflicts with the boot block. Restart the download with a correct rx22xx.hex file. To restart the download, reset the RX22 (Powerdown on AQR rack or initiate an EP pulse) and clear the RX22 receiver Errormessage #11.	
RX22 VDD12 +12V failed Error 40	The RX22 is insystem programmable. Performing this ability requires a positive 12 Volt Voltage. The RX22 observes this voltage during program/erase operations in the Flash memory.	
RX22 Error in Flash Command Sequence Error 41	The RX22 is insystem programmable. The erase/programable device (Flase EPROM 28F001) expects a defined command sequence for erase and program commands. This error reports a sequence mismatch.	
RX22 Page Mismatch, Storing terminated Error 42	Non volatile data in the Flash memory is protected with a software key from unwanted program/erase operations. This error appears if the valid data conflicts with the new program command. The software refuses further operations in the data segment as long as it can not guarantee data validity. Please reset the RX22 , sorry...	
RX22 No valid Calibration Data Error 43	Each RX22 receiver is individually adjusted in the test department. Correct calibration data guarantee true gain steps. The gain table (RF, IF, G2 and PAS) is protected from unauthorized accesses by a software Key.	
RX22 Device is SE451 interface, function is for RX22 receiver only Error 200	The SE-451 interface controller received a command which is not supported in this configuration. The digital part of the board may control either RX22 or RXC application. Configuration is done with a resistor network.	
RX22 Device is RX22 Receiver, function is for SE451 interface only Error 201	The RX22 receiver received a command which is not supported in this configuration. The digital part of the board may control either RX22 or RXC application. Configuration is done with a resistor network.	
RX22 No Acknowledge received on I2c Bus Error 204	The RX22 receiver Rdrives a serial I2c interface. Every data transfer on the serial I2c bus must be acknowledged. The slave is obligated to generate this acknowledge. This error appears if either the I2c bus address is wrong (no device in the I2c bus corresponds to this address) or a hardware problem inhibits a proper transfer on the serial bus (a wrecked I2c device).	

ERROR MESSAGE	ERROR DESCRIPTION	
RX22 I2c bus is busy, transmission not possible. Error 205	The RX22drives a serial I2c interface. The I2c specifications allow multi-master applications. Bus arbitration is done with the SCL(Serial CLock). This error appears if a other device initiated a bus request and did not signal the end of transmission or a device pulls either SDA or SCL of the I2c Bus permanent low.(broken device)	
RX22 I2c R/W~ bit protocol violation, Bit 2^0 of address must be 1 Error 206	The RX22drives a serial I2c interface. The I2c hardware protocol spezifications define bit 2^0 of the device address as Read/Write~ selector. A proper address byte for a read cycle is binary xxxx'xxx1. (eg Deviceaddress is 0x42, this address changes for a read cycle to 0x43)	
RX22 I2c R/W~ bit protocol violation, Bit 2^0 of address must be 0 Error 207	The RX22drives a serial I2c interface. The I2c hardware protocol spezifications define bit 2^0 of the device address as Read/Write~ selector. A proper address byte for a write cycle is binary xxxx'xxx0. (eg Deviceaddress is 0x42, the address for a write cycle is 0x42)	
RX22 Hardware on board does not support channel offset adjust functions Error 208	Boards with ECL00 (Z3P2953) do not support channel offset adjustment. The D/AC's for this feature are inserted on ECL01 boards(Z3P2953A or newer)	
RX22 Hardware of RX22 does not support Temperature Measurements Error 210	Prototyp boards do not support Quad Image temperature measurements.	

Figures

Figures

Tables

Tables