Bruker BioSpin

AQS BLA2BB150/60

Amplifier 20-400MHz
Operating & Service Manual

Version 002

think forward

NMR Spectroscopy

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© May 7, 2010: Bruker BioSpin

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P/N: Z31608
DWG-Nr: 1319.002

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GeneralInformation 1

Introduction 1.1

The AQS BLA2BB150/60 Amplifier 20-400MHz is a double broadband linear pulse power amplifier specifically designed for Nuclear Magnetic Resonance (NMR) application for 4.7 to 9.4 Teslas Systems. It is commercialized under the BRUKER BIOSPIN part number W1345049.

It is operated in AB linear class and provides 140W and more peak RF power over the frequency range 20-162MHz and 50W and more peak RF power over the frequency range 188-400MHz.

The AQS BLA2BB150/60 Amplifier is also equipped with a integrated input router, two way to two which premise to mix and or route each input to each amplifier channel.

The amplifier is equipped with **N-Channel RF LDMOSFETs** transistors. Each power output is protected with a integrated bi-directional coupler to protect user and amplifier of excessive reflected power.

Its built-in control circuitry has been designed to supervise output power and protect against:

- Excessive amplifier temperature.
- Excessive reflected power (more then 50%).

The amplifier is powered by an external switched power supply assembly that provides the +28VDC for the power amplifiers. All low level voltages for the system are provided by the AQS rack.

The external power supply is self protected for overcurrent and overvoltage.

The AQS BLA2BB150/60 amplifier is housed in a 12TE width, 6HE high, 290mm depth rack.

Safety

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The AQS BLA2BB150/60 Amplifier 20-400MHz is in accordance with the standard 61010-1 and with the UL 61010-1 / CSA C22.2 No.61010-1-04 Safety Requirements for Electrical Equipments.

Identification Labels 2.1

Labels are provided to alert operating and service personnel to conditions that may cause personal injury or damage to the equipment from misuse or abuse. Please read the labels and understand their meaning.

Identifying Plate 2.1.1

The AQS BLA2BB150/60 Amplifier 20-400MHz can be identified by an identifying plate at the front panel of the unit that contains the following information :

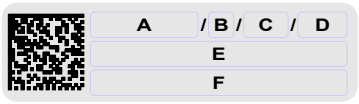

Figure 2.1. Identifying Plate

- **(A) Part Number**
  This field indicates the part number of the product.
- **(B) Variant**
  This field indicates the variant number that identifies the production category of the product. The variant is not used.
- **(C) Revision Level**
  This field indicates the revision number that identifies the product configuration. The initial revision level is 00.00.
- **(D) Serial Number**
  This field indicates the serial number of the product.
- **(E) Designation**
  This field contains the designation of the product.
- **(F) Information**
  This field contains additional information about the product.

Safety Labels and Symbols 2.2

Warning Signs 2.2.1

Risk of Danger

DANGER! Risk of electrical shocks

Throughout this manual, this symbol indicates the possibility of severe personal injury, loss of life or equipment damage if the instructions are not followed.

On the equipment, the symbol also implies a danger and alerts the user.

Operating Instruction

Operating personal should not remove RF output cable without turn off the power supply because the RF output can cause serious burns before the "Mismatch" protection is active.

Please disconnect the mains supply before opening to prevent potential hazard such as :

- Electrical shock from power supply
- Contact burns from the RF module and heatsink
- Finger scratch due to the fan assembly on the RF module.

Installation 3

The installation of the device must be done only by an authorized and qualified technician, in total accordance with the running standards.

BRUKER BIOSPIN assumes no liability for the customer’s failure to comply with these requirements and is therefore not responsible or liable for any injury or damage that occurs as a consequence of non-approved installation.

Initial Inspection 3.1

Mechanical Check 3.1.1

If damage of the shipping cardboard is evident, request the carrier's agent to be present when the instrument is unpacked. Check the equipment for damage and inspect the cabinet and panel surfaces for dents and scratches.

Claim for Damage 3.1.2

If the unit is mechanically damaged or fails to meet specifications upon receipt, notify BRUKER or our representative immediately. Retain the shipping cardboard and packing material for the carriers inspection as well as for subsequent use in returning the unit if necessary.

Reshipment and Repackaging Requirements 3.1.3

Whenever possible, the original cardboard and packing material should be used for reshipment. If the original packing material is not available, wrap the instrument in heavy paper or plastic. Use a strong shipping container. If cardboard is used, it should be at least 200 lbs. test material.

Use shock absorbing material around all sides of the instrument to provide a firm cushion and to prevent movement from inside the container wall on each side. Protect the front panel by means of cardboard spacers inserted between the front panel and the shipping cardboard. Make sure that the instrument cannot move in the container during shipping. Seal the cardboard box with a good grade of shipping tape and mark the container :

"FRAGILE ELECTRONIC INSTRUMENT"

Environment Requirements *3.1.4*

This amplifier is built for use in a AQS rack of a NMR spectrometer in association with his power supply.

Be care that air flow provide by the AQS rack is not obstructed.

It should, however, be in an environment which conforms to the 5°C - 45°C (41°F - 113°F) thermal specifications, a 80% maximum relative humidity of air and a contamination level of two (means a normal non-conductive contamination, temporary conductivity due to condensation is possible).

Installation Requirements *3.2*

The AQS BLA2BB150/60 Amplifier can only be installed in a specifically AQS system.

Power Requirements *3.3*

The AQS BLA2BB150/60 Amplifier is designed to be powered by an external switched power supply (P/N:W1345050)

The connection to this power supply is realized via the backplane connectors of the AQS rack.

It provides the +28V power necessary to the AQS BLA2BB150/60 to work.

The AQS BLA2BB150/60 Amplifier needs also low level voltages. This voltages are supplied by the AQS rack.

System Check *3.4*

Before applying power for the first time the following items should be checked:

- The AC input voltage 208-230 VAC ± 10% range must be compatible with the power supply.
- The AQS BLA2BB150/60 Amplifier 20-400MHz has a nominal input level of +4dBm. Ensure that the system drivers are operating at these levels.
- Output RF loads are connected.

Initial Turn on Procedure *3.5*

The following list describes how to turn on the AQS BLA2BB150/60 Amplifier and what should be seen as this occurs.

Before starting this procedure, make sure that you have properly followed the instructions in section ***"System Check" on page 10***.

1. Put the AQS BLA2BB150/60 unit in the AQS rack.
2. Put also the associated power supply in the AQS rack and connect it to the AC line.
3. Switch on the AQS rack and observe the front panel of the amplifier :
   - The +28V led will illuminates.
4. System is now fully operational.

Operation 4

Front Panel Description 4.1

The AQS BLA2BB150/60 Amplifier 20-400MHz front panel is provided with 4 indicators for status monitoring and 4 RF connectors.

Indicators 4.1.1

Normal operation is indicated when following LED's are ON.

Table 4.1. Indicators Assignment

+28V	Indicates that the +28V supply is applied.
PULSE 1	Indicates when RF power is present on the RF output OUT1 (XQNP) connector.
PULSE 2	Indicates when RF power is present on the RF output OUT2 (1H) connector.
ERROR	Indicates if an error occurs in the amplifier : • output mismatch • amplifier overheat • +28V supply missing.

Coaxial Connectors 4.1.2

Table 4.2. Coaxial Connectors Assignment

I 1A, I 2A	RF input of the embedded router, SMA type connector (female). Defaults routing is I 1A to the OUT1 (XQNP) and I 2A to the OUT2 (1H).
OUT1 (XQNP)	RF output, N type connector (female).
OUT2 (1H)	RF output, N type connector (female).

Device Front View 4.1.3

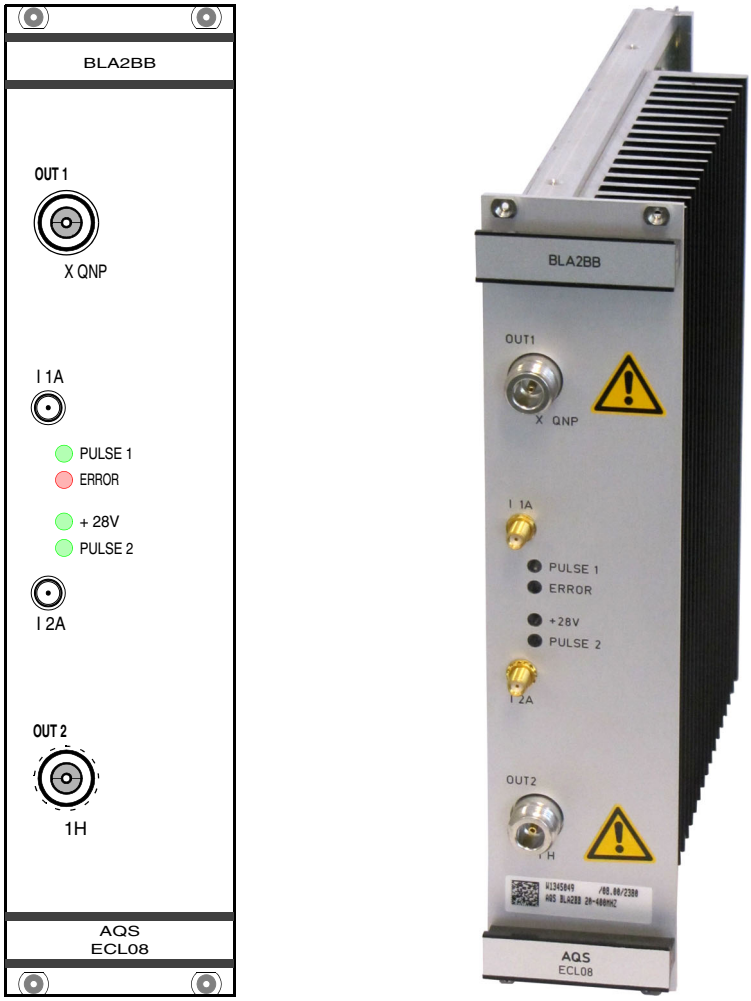

Figure 4.1. AQS BLA2BB150/60 Amplifier 20-400MHz Front Panel Designs

Rear Panel Description 4.2

The AQS BLA2BB150/60 Amplifier 20-400MHz rear panel is provided with a ERNI ERmet type A 110 pins female connector in association with a ERNI ERmet type N 3 pins female connector.

Supply Connector 4.2.1

Table 4.3. IEC 61076-ERmet Type N Pin Assignment

Pin 2	N/A
Pin 6	+28V (Power supply)
Pin 10	PGND (Power ground)

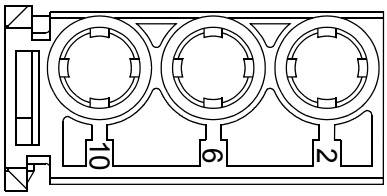

Figure 4.2. IEC 61076-ERmet Type N Connector Design

Interface Connector *4.2.2*

Table 4.4. IEC 61076-ERmet Type A Pin Assignment

Pin a7	BLNK3	**Pin e22**	-9V
Pin a15	I²C address A2	**Pin e23**	+12V
Pin a21	+5V	**Pin e24**	+12V
Pin b6	GND	**Pin e25**	+12V
Pin b8	GND	**Pin f1**	GND
Pin b15	I²C address A1	**Pin f3**	GND
Pin b16	GND	**Pin f5**	GND
Pin b18	GND	**Pin f7**	GND
Pin b20	GND	**Pin f9**	GND
Pin c3	I²C status int.	**Pin f11**	GND
Pin c15	I²C address A0	**Pin f13**	GND
Pin c16	I²C SDA	**Pin f15**	GND
Pin c17	I²C SCL	**Pin f17**	GND
Pin d15	GND	**Pin f19**	GND
Pin d17	GND	**Pin f21**	GND
Pin d19	GND	**Pin f23**	GND
Pin e20	GND	**Pin f25**	GND
Pin e21	+9V		

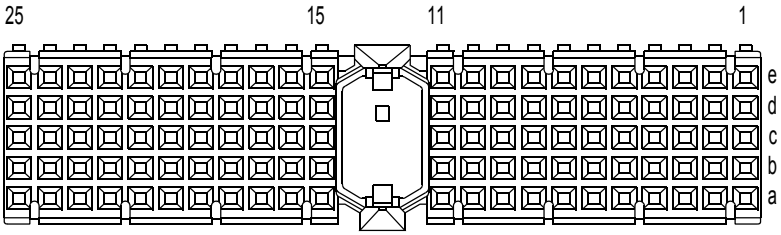

Figure 4.3. IEC 61076-ERmet Type A Connector Design

Router Combinations *4.3*

The truth table below shows the different combinations available for the router.

Table 4.5. Router Combinations

I²C	**OUT 1** (X QNP)	**OUT 2** (1H)
00	I 2A	I 1A
01	no output	I 1A + I 2A
02	I 1A + I 2A	no output
03	I 1A	I 2A

Technical Description

5

System Overview 5.1

The AQS BLA2BB150/60 Amplifier 20-400MHz contains two equivalent broadband amplifiers and each provides :

- RF outputs of 140W nominal power for the X frequency range 20 to 162MHz.
- RF outputs of 50W nominal power for the 1H frequency range 188 to 400MHz.

The RF section of the system consists of an embedded router on the front panel and a two linear amplifier paths monted around a single heatsink.

The embedded router has two RF inputs and two RF outputs each feeded to the amplifier section.

Each amplifier section is built on a linear class A / AB driver using switches and bias voltage gatings, delivers the RF input power to the power amplifier. The class AB power amplifier delivers the total output power.

Power amplifiers are equipped with a bi-directional coupler which gives an image of the forward and the reflected power.

The entire system is controlled by a self contained control system. This control unit provides :

- The BIS data information.
- A 256 kbit (32kbyte) memory to save linearization data.
- A sample and hold system for each output power level. This feature digitiles and sends the effective power value to the I²C bus.
- An output mismatch detection for each power output. This controls the reverse to forward power ratio and, if it is over 50%, the system stops the RF emission.
- A heatsink temperature supervisor stops all RF emission and cuts off the amplifier power supply if the heatsink temperature increases over +70°C.
- An LED monitoring that provides :

  Pulse 1 is lit if any RF power is present on OUT1 (XQNP).

  Pulse 2 is lit if any RF power is present on OUT2 (1H).

  Error is lit if any mismatch, overheat or +28V supply fault is detected. If this LED is lit, no RF emission is possible.

  +28V is lit if the power supply is present.

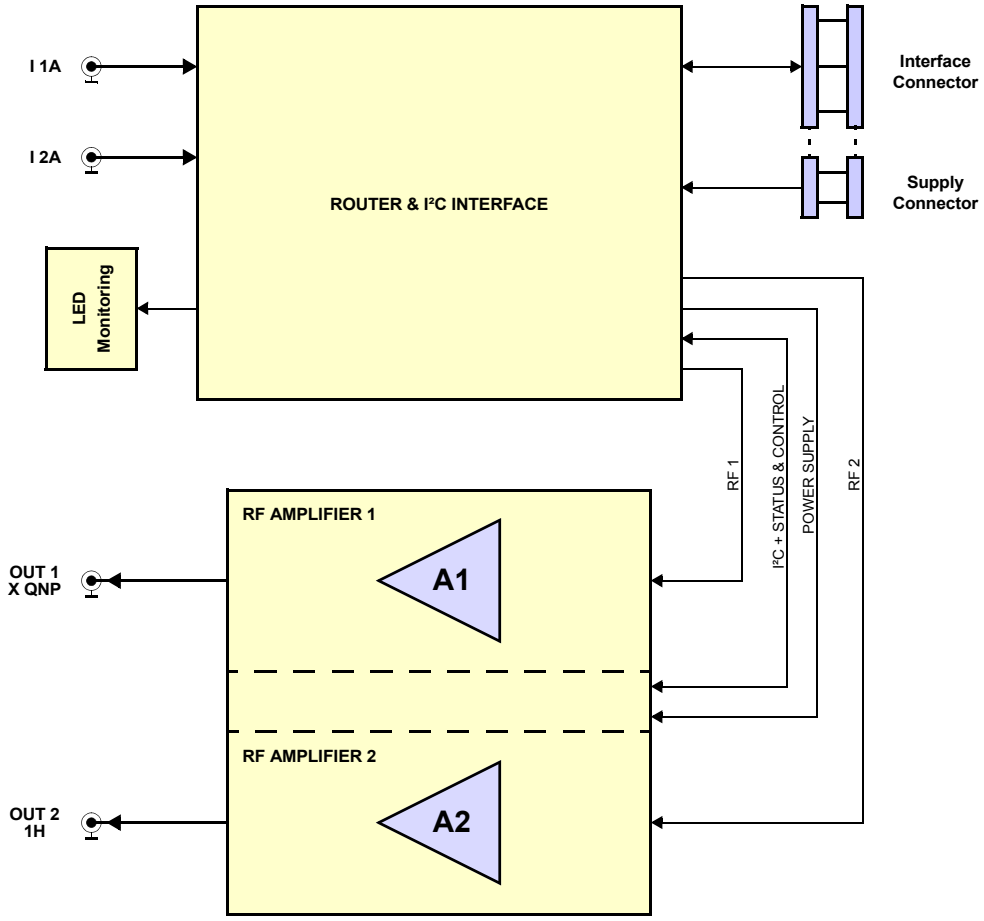

Figure 5.1. AQS BLA2BB150/60 Amplifier 20-400MHz System Block Diagram

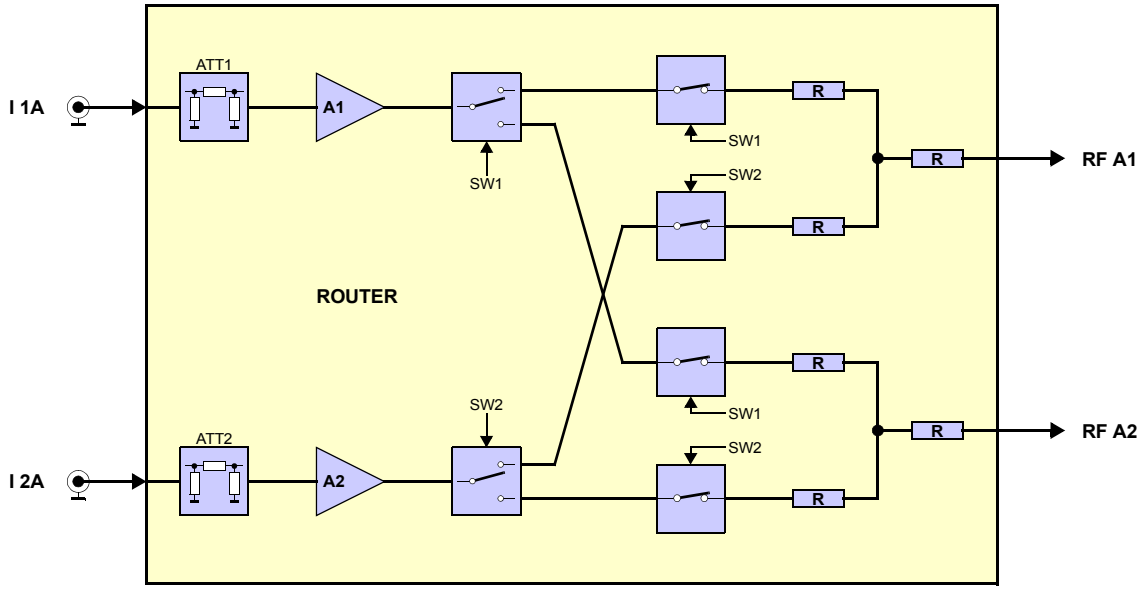

Figure 5.2. Embedded Input Router Block Diagram

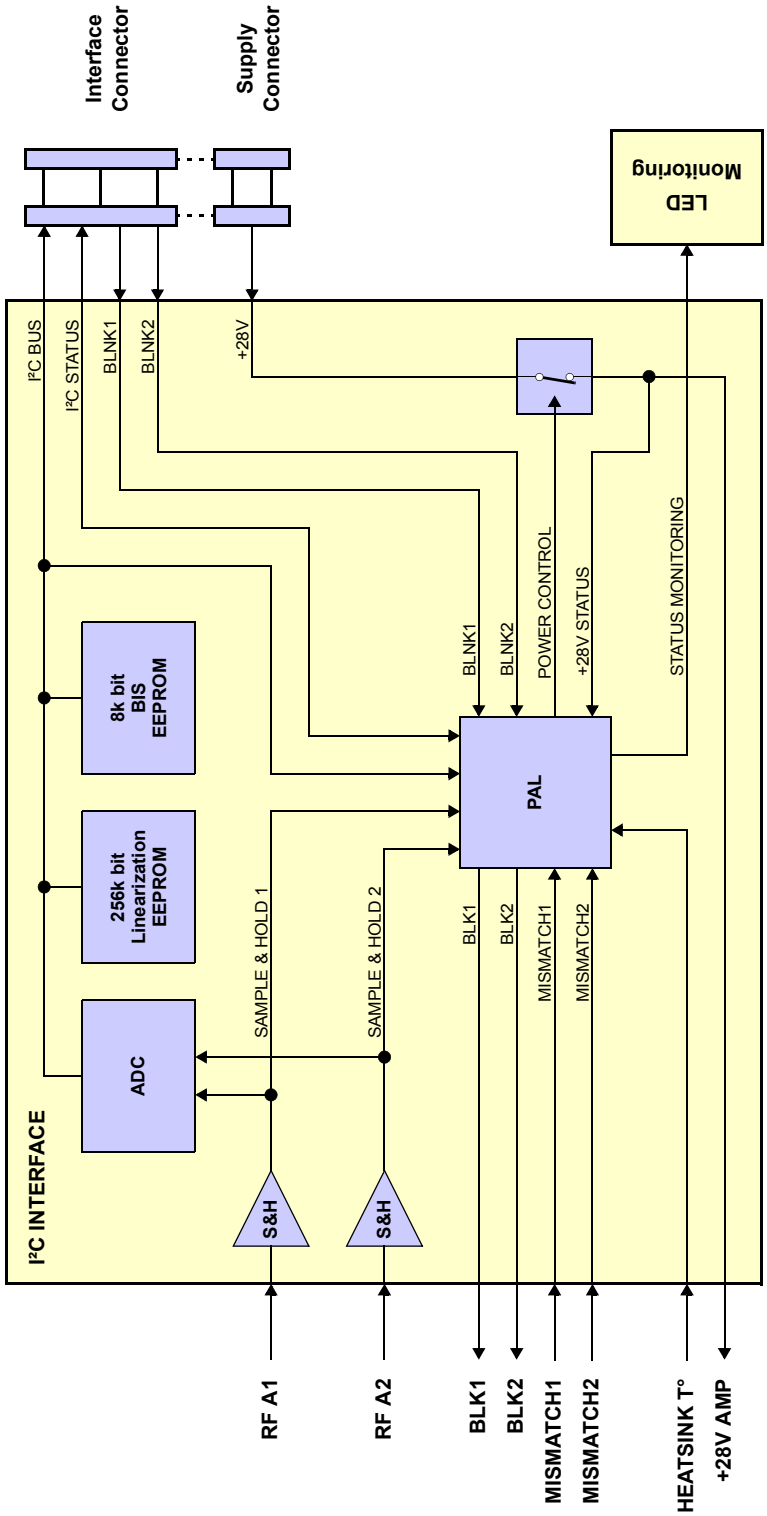

Figure 5.3. I²C Interface Block Diagram

Theory of Operation *5.2*

RF Path *5.2.1*

The AQS BLA2BB150/60 Amplifier 20-400MHz (P/N: W1345049) consists of a couple of broadband amplifier with a integrated input router and a self contained control system.

A nominal input power level of +4dBm produces a rated linear output power of :

- 150W peak power for X range (20MHz to 162MHz).
- 50W peak power for 1H range (188MHz to 400MHz).

The amplifiers are not controlled by pulse with and duty cycle. For normal operation, the pulse with value should not get over 10ms and the duty cycle not over 10% for a +4dBm input (full power). The rated continuous wave power is 5W. Work over this values will increase heatsink temperature and can stop RF emission if the 70°C limit is reached.

Embedded Input Router

The embedded router consists of a class A RF amplifier IC's and RF switches, manufactured on a Gallium Arsenide process.

The two RF inputs could be routed alone or combined each other to the RF output by selecting the wished RF path through the I²C bus. Each entire RF path has a nominal 10dB of gain.

RF Power Amplifiers

The input of the amplifier is made with a variable attenuator to adjust the total chain gain.

The RF is then authorized or blanked with GaAs switch commanded with the control unit.

The second section of the amplifier is made with a biased RF N channel MOSFET transistor followed by a blanked RF N channel power MOSFET transistor. The polarization of this transistors require a gating signal to control the bias voltage on the gate of the FETs.

The circuitry around the transistors consists of complementary input and output transformers and baluns and operates the device in Push-Pull.

The RF amplifier has a nominal 36 to 42dB gain and operates at +28VDC.

With the embedded router gain, the entire path has a nominal 45dB gain for the 1H range and 51dB gain for the X range.

RF Couplers

The bi-directional coupler provides an approximate coupling of 1V peak DC signal for 150W and also a peak DC signal for the reflected power.

Both signals, forward and reflected, are analyzed by the control unit for monitoring and protection setting on the RF outputs.

The Controller Unit has 4 main functions

1. Amplifier protection.

   Temperature control : amplifier stops if heat sink temperature exceeds 70°C (158°F).

   +28V supply voltage : amplifier stops if a problem occurs on the +28V external supply.

   Mismatch monitoring : amplifier is stopped if the reflected power is over 50% of forward power.

2. Setting blanking signals for amplifier gating, stop the amplifier if any default appears.

   Blanking signals are hard wired, BLNK1 drives amplifier 1, BLNK2 drives amplifier 2 and BLNK3 is not used. No crossing is possible.

3. Setting input router/combiner commands

4. I²C communication with the AQS rack

The Controller Unit can function in two different modes

1. Normal mode.

   In this mode, the controller stops RF emission if any fault like overheat, supply fault of the +28V or output mismatch of any output. Error register is set and a fault signal is available on the I²C bus.

2. Status interrupt mode.

   To run in this mode, status register must be set to the right value. In this mode, if a fault occurs, the RF emission stops, error register is set , a fault signal is available on the I²C bus and the status interrupt line is pulled down. The fault is maintained until a software clear is done by the AQS rack.

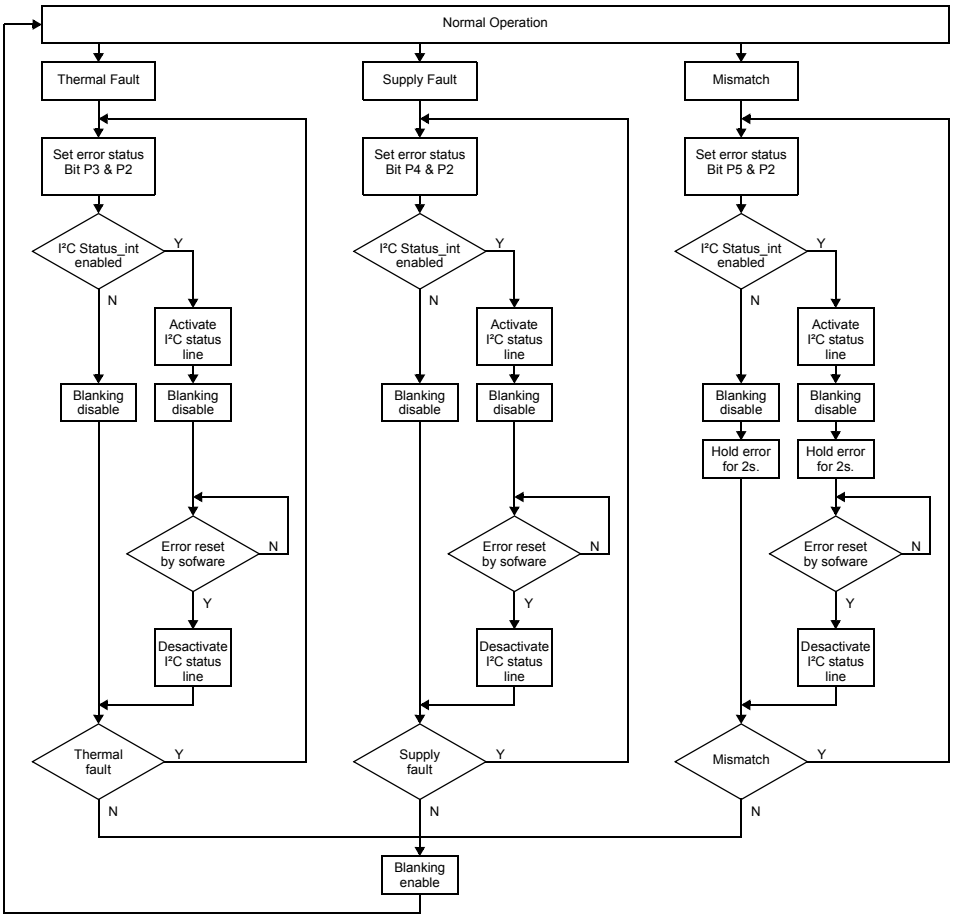

Figure 5.4. Flow Diagram

Status information register available on the I²C address

Table 5.1. Status Register Values

0	1	0	0	A2	A1	A0	R/W-

For more information see datasheet of PCF8574T Bruker P/N:22951.

Table 5.2. Status Register Description

P0	P1	P2	P3	P4	P5	P6	P7
P0+	P1+	Fault-	ThFault-	SpFault-	Mism-	I²C Status-int enable	Clear

- P0+ and P1+ : This two signals drives the input router of the amplifier.
- P2 : Fault-
  This bit is active if any fault (supply, thermal or mismatch) appears.
  Active = "0", inactive = "1".
- P3 : ThFault-
  This bit is active in a case of overheating of the thermal element.
  Active = "0", inactive = "1".
- P4 : SpFault-
  This bit appears in case of main supply (+28V) is missed.
  Active = "0", inactive = "1".
- P5 : Mism-
  This bit indicates if a load mismatch on one or both amplifier outputs is detected.
  Active = "0", inactive = "1".
- P6 : I²C Status_int enable
  This bit must be written to "0" to enable the I²C status_int line in case a error appears. If this bit is not written, nothing happens on the I²Cstatus_int line if an error occurs. Default is "1" = status_int is disabled.
- P7 : Clear
  This bit is an input signal and clears all fault bits : P2 to P5.

Table 5.3. Status Register Truth Table

P0+	P1+	I A1 to OUT 1	I A2 to OUT 2	I A1 to OUT 2	I A2 to OUT 1
1	1	ON	ON	ISOLATED	ISOLATED
1	0	ON	ISOLATED	ISOLATED	ON
0	1	ISOLATED	ON	ON	ISOLATED
0	0	ISOLATED	ISOLATED	ON	ON

Power information register available on I²C address

Table 5.4. Power Register Values

1	0	0	1	A2	A1	A0	R/W-

For more information see datasheet of PCF8591T Bruker P/N:75252.

Table 5.5. Power Register Description

P0	P1	P2	P3	P4	P5	P6	P7
Amplifier1 Fwd Power	Amplifier2 Fwd Power						

Amplifier1 Fwd Power and Amplifier2 Fwd Power are image values of forward power delivered on the amplifiers . This values are in Hexadecimal format. The full scale ("FF") is given for an output power of 170W.

Specifications 6

AQS BLA2BB150/60 Amplifier 20-400MHz Specifications 6.1

Table 6.1. RF Amplifier Specifications

	Range 1	Range 2
Frequency Range	188 to 400MHz	9 to 162MHz
Linear Gain	47dB ±1dB typical	51dB ±1dB typical
Gain Flatness	±2dB max.	±2dB max.
Minimum Pulsed Output Power (@ nominal Input +4dBm)	50W min. full range	90W for 9-20MHz 140W min. for 41-162MHz 170W for 15N (20-41MHz)
CW Output Power	5W max.	5W max.
Linear Output Power	30W typ. @ 1dB compression	100W typ. @ 1dB compression
Linearity	+1/-2dB to 50W typical	+1/-2dB to 140W typical
Amplifier Biasing	Class AB operation	Class AB operation
Blanking Delay Time	1µs min.	1µs min.
RF Rise Time	< 100ns	< 100ns
RF Fall Time	< 50ns	< 50ns
DC Ringing	±100mV typical (due to blanking signal)	±100mV typical (due to blanking signal)
Input Noise Figure	5dB typical	4dB typical
Output Noise Power (Unblanked)	-119dBm @ 1Hz	-116dBm @ 1Hz
Output Noise Power (Blanked)	Thermal Noise	Thermal Noise
Input/Output Impedance	50W	50W
Input V.S.W.R.	1.5 : 1 max.	1.6 : 1 max.
Isolation channel 1 / Channel 2	80dB typical	80dB typical
«GARP»[a] Specification	-90dBm max.	
Output Harmonics (2fc ; 3fc)	-20dB @ 2fc ; -30dB @ 3fc	-20dB @ 2fc ; -10dB @ 3fc
Pulse Width (Internal Limitation)	Up to 10ms @ 50W	Up to 10ms @ 140W
Duty Cycle (Internal Limitation)	Up to 10% @ 50W	Up to 10% @ 140W
Droop & Pulse Flatness	±2% for 1ms PW @ nom. power	±2% for 1ms PW @ nom. power
Amplitude Stability vs. Temperature	±0.1% / °C	±0.1% / °C

a. Output power mesured at 402.4MHz on the ^{1}H channel (off) with ^{13}C channel at 5W CW power.

Service Information and Maintenance 7

Every intervention on the device must be carried out by an authorized and qualified person. Any failure due to a non-respect of the following instructions will not be attributable to BRUKER BIOSPIN and will not be covered by the guarantee clauses.

Figures

Figures

Tables

Tables

End of Document

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