Bruker BioSpin

BLAH300

Amplifier 200-600 MHz
Operating & Service Manual

Version 002

think forward

NMR Spectroscopy

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This manual describes the units as they are at the date of printing. On request, the manufacturer shall supply circuit diagrams, lists of components, descriptions, calibrating instructions and any other information for use by qualified personnel of the user, in charge of repairing the parts of the unit which have been stated by the manufacturer to be "repairable". Such supply shall in no event constitute permission to modify or repair the units or approval of the same.

This unit is not designed for any type of use which is not specifically described in this manual. Such use may be hazardous.

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General information 1

Introduction 1.1

The BLAH300 Pulse Power Amplifier is a broadband linear pulse power amplifier specifically designed for Nuclear Magnetic Resonance and Magnetic Resonance Imaging (NMR/MRI) applications from 4,7 to 14 Tesla Systems. It is commercialized under the BRUKER part number W1345071.

The class AB linear amplifier provides 300W peak power and more over the frequency range 188-600 MHz on the H300 output and 50W peak power and more on the H50 output for the High Resolution applications.

The amplifier is realised by employing N-CHANNEL MOS BROADBAND RF POWER FETs of the latest generation. The unit can provide full power for any combination of pulse width and duty cycle up to 100ms and 20% (10% for the H300 output)

Its built-in protection circuitry will allow lower power pulses for longer pulse widths and duty-cycles, maintaining a 30W average power on the H300 output, and 10W average power on the H50 output.

The electronic protection circuitry has been designed to protect against :

- Excessive power output level (overdrive)
- Excessive pulse repetition rate (over duty-cycle protection)
- Excessive pulse duration (over pulse- width)
- More than 50% reflected RF power (mismatch $\geq$ 6)
- Overheat protection

The amplifier is powered by an internal switched power supply assembly providing +32VDC to the power amplifiers, in addition to all low level voltages used by the system.

The supply is self-protecting for overcurrent and overvoltage.

The entire unit is housed in a 19", 3U, 520mm rack cabinet.

Safety 2

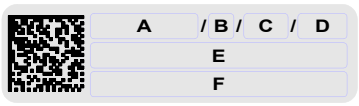
Labels 2.1

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 BLAH300 Amplifier 200-600MHz can be identified by an identifying plate at the front panel of the unit that has following information.

Figure 2.1. Identifying plate

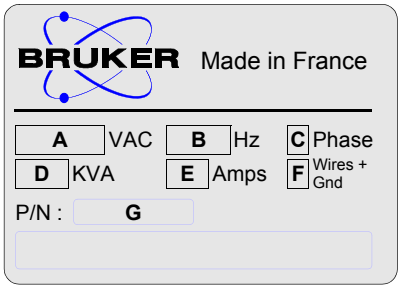


- **(A) Part Number**
  This field indicates the part number of the product.
- **(B) Variant**
  This field indicates the variant number that identifies the production category of the product. The default variant is 00.
- **(C) ECL**
  This field indicates the revision number that identifies the product configuration. The initial revision is 0.00.
- **(D) Serial Number**
  This field indicates the serial number of the product.
- **(E) Type**
  This field contains the designation of the product.
- **(F) Information**
  This field contains additional information about the product.

Manufacturer's nameplate 2.1.2

The BLAH300 Amplifier 200-600MHz can be identified by a manufacturer's nameplate at the back panel of the unit that has following information:

Figure 2.2. Manufacturer's nameplate



- **(A) Voltage**
  This field indicates the input mains voltage of the product.
- **(B) Frequency**
  This field indicates the input mains frequency of the product.
- **(C) Phases**
  This field indicates the number of phases of the mains.
- **(D) Power**
  This field indicates the absorbed power of the product.
- **(E) Current**
  This field indicates the absorbed current of the product.
- **(F) Wires**
  This field indicates number of wires with the ground in the mains cord.
- **(G) Part Number**
  This field indicates the assembly number that identifies the part number of the product.

Safety labels and symbols 2.2

Figure 2.3. General hazard symbol

Please disconnect line cord before opening or prevent potential hazards such as:

- Electric schock on power supply.
- Contact burn with the RF module and heatsink.
- Finger scratch due to the fan assembly on the RF module.

Installation 3

Initial inspection 3.1

Mechanical check 3.1.1

If damage of the shipping carton 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 carton 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 carton 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 a 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 from movements inside the container wall on each side. Protect the front panel by means of cardboard spacers inserted between the front panel and the shipping carton. Make sure that the instrument cannot move in the container during shipping. Seal the carton with a good grade of shipping tape and mark the container :

" FRAGILE ELECTRONIC INSTRUMENT."

Installation requirements 3.2

No special precautions are necessary. Mount the equipment in an area which is relatively free of vibration, and has sufficient room for cable connections.

Bench operation 3.2.1

The units can be placed onto a secure flat surface.

Cooling and ventilation 3.2.2

No specific cooling or ventilation is required. It should, however, be in an environment which conforms the 0°- 45°C (32°F - 113°F) specification, and in an area that does not obstruct the free flow into and out of the unit.

System check 3.3

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

- The AC input voltage 220 - 230 VAC ± 15%, 50-60Hz single phase range must be compatible with.
- An external blanking (gating) pulse must be applied to the amplifier in order for the unit to function. Ensure that this pulse has a proper level and logic polarity.
- The BLAH300 has a nominal input level of +4dBm. Ensure that the system drivers are operating at these levels.

Initial turn on procedure 3.4

The following list describes how to turn on the BLAH300 and what should be seen as this occurs.

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

1. Connect the amplifier to the AC line and turn the circuit breaker, to ON.
2. Observe the indicators on the front panel :
   - The +32V ON LED's will illuminate
   - The +15V, -15V and + 5V ON LED's will illuminate
3. System is now fully operational.

Operation 4

Front Panel 4.1

The BLAH300 front panel is provided with 12 indicators for status monitoring, 5 connectors and 2 interface connectors.

Indicators 4.1.1

Normal operation is indicated when following LED's are on :

Table 4.1. Indicators

+32V ON	Indicates that the +32V supply is applied.
+15V ON	Indicates that the +15V supply is applied.
-15V ON	Indicates that the -15V supply is applied.
+5V ON	Indicates that the +5V supply is applied.
Overdrive	Indicates when the power limit has been reached.
Duty Cycle (D.C.)	Indicates when the duty cycle limit has been reached.
Pulse Width (P.W.)	Indicates when the pulse width limit has been reached.
Mismatch	Indicates when the max. reflected power limit has been reached.
RF POW. FLT	Lights ON when one of the above limits has been reached.
Overheat	Indicates that the thermistor located on the RF heatsink has sensed excessive heatsink temperature. All gatings are removed from the amplifier until the unit cools. The function is self-resetting and no maintenance is needed. Indicates that a fan on the assembly stops turning. The gatings are cut off and fans must be changed for good working.
H300 ON	Lights ON when RF Power is present on the Solid output.
H50 ON	Lights ON when RF Power is present on the High Resolution output.

Connector *4.1.2*

Table 4.2. Connectors

H IN	RF IN SMA type connector (female). Nominal +4dBm drive to the BLAH300 to deliver full power.
H300	RF OUT H300 N type connector (female).
H50	RF OUT H50 (High Resolution) N type connector (female).
BLANKING	BNC type connector (female). TTL logic, 5V = blanking ON, 0 V = blanking OFF. When BLANKING signal is at TTL level high (+5V), no gating is applied to the amplifier stages, and no RF Power is possible. When BLANKING signal is at TTL level low (0V), the amplifier stages are gated and RF Power is possible.
Sel H50/H300	BNC type connector (female). When the Sel H50/H300 signal is at TTL level low (0V), the output H300 is selected. When the Sel H50/H300 signal is at TTL level high (5V), the High Resolution output H50 is selected.

Interface Connector RS485 *4.1.3*

The Control I/O interface connections are 15 pin, D shape sub-miniature type connectors mounted on the SBS BUS Controller.

SBS BUS = Serial Bruker Spectrospin Bus

The next table shows the pinout of the master and slave connectors

Table 4.3. RS485 pinout assignment

Pin 1	Shield	**Pin 9**	Transmit data line -
Pin 2	Transmit data line +	**Pin 10**	NC
Pin 3	Wake up line /WUP	**Pin 11**	Receive data line -
Pin 4	Receive data line +	**Pin 12**	NC
Pin 5	NC	**Pin 13**	VRS (+12V)
Pin 6	GND	**Pin 14**	VRS (+12V)
Pin 7	GND	**Pin 15**	VRS (+12V)
Pin 6	GND		

Figure 4.1. BLAH300 Front Panel Design

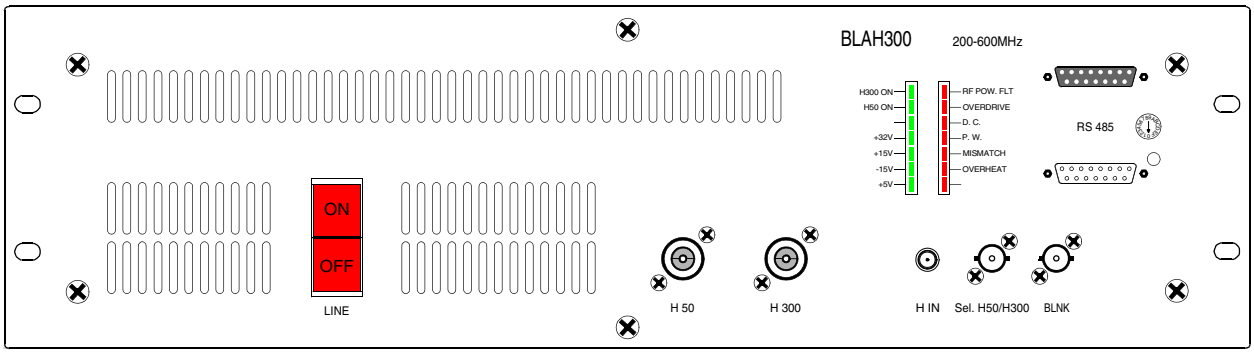
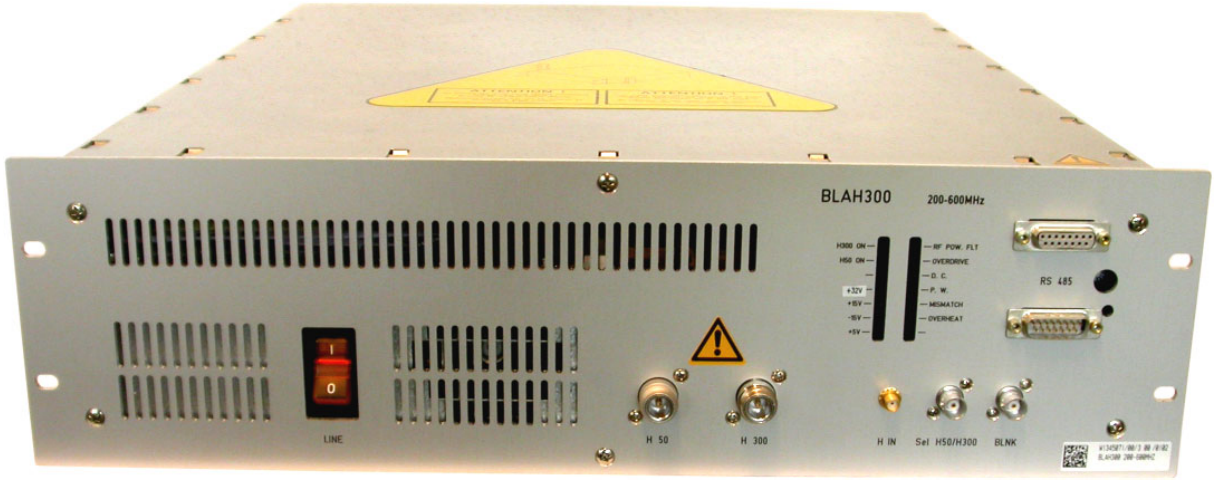


Figure 4.2. BLAH300 Front Panel View



Rear Panel *4.2*

The rear Panel of the BLAH300 Amplifier is free of elements in exception of the 3 poles (2P+E) line filter socket.

Technical description

5

System Overview 5.1

The BLAH300 amplifier provides :

- A RF Output of 300W and more on the Output H300, over the full frequency range 188 to 600MHz, when selected with Sel H50/H300 command controlled at TTL level low.
- A RF Output of 50W and more on the High Resolution Output H50 over the same full frequency range 188 to 600MHz when selected for High Resolution operation by Sel H50/H300 controlled at TTL level High.

The RF section of the system consists of a linear module BLMH300/H50 mounted around a single, self-contained Push fan assembly, heatsink.

A linear class A / AB driver, using switches and bias voltage gatings, delivers the RF input power to the Power Amplifier.

The driver is located on the bottom of the heatsink assembly.

The class AB power amplifier is located on the top of the heatsink.

The output of the power amplifier is connected to a bi-directional Coupler mounted on the front panel of the amplifier. This output consist in the H300 Output when the amplifier is controled for Solid applications.

When controlled for High Resolution applications, the output of the driver is switched to the front panel H50 output via a rf relay and a bi-directional Coupler.

The entire system is tied together by a Digital Signal Processing control board, processing information from the amplifier and blanking signal, providing protection from excessive peak power, duty cycle and pulse width for average power, maximum reflected power and heatsink over-temperature.

The DSL control board reads identification information of the amplifier (BBIS).

Monitoring of Fan Status, Supply Status & LED's Status is also performed by the control board.

Figure 5.1. BLAH300 System Block Diagram

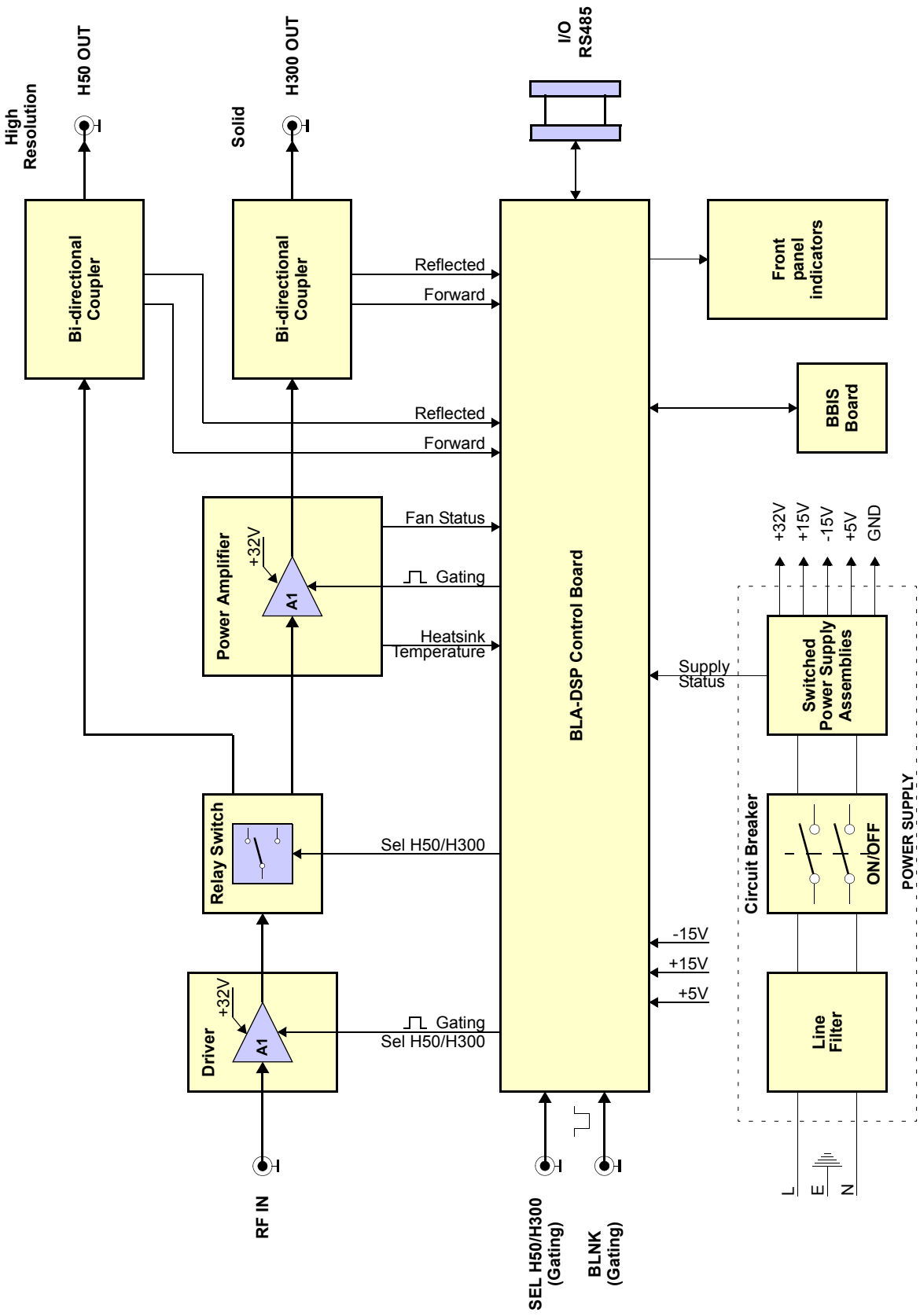
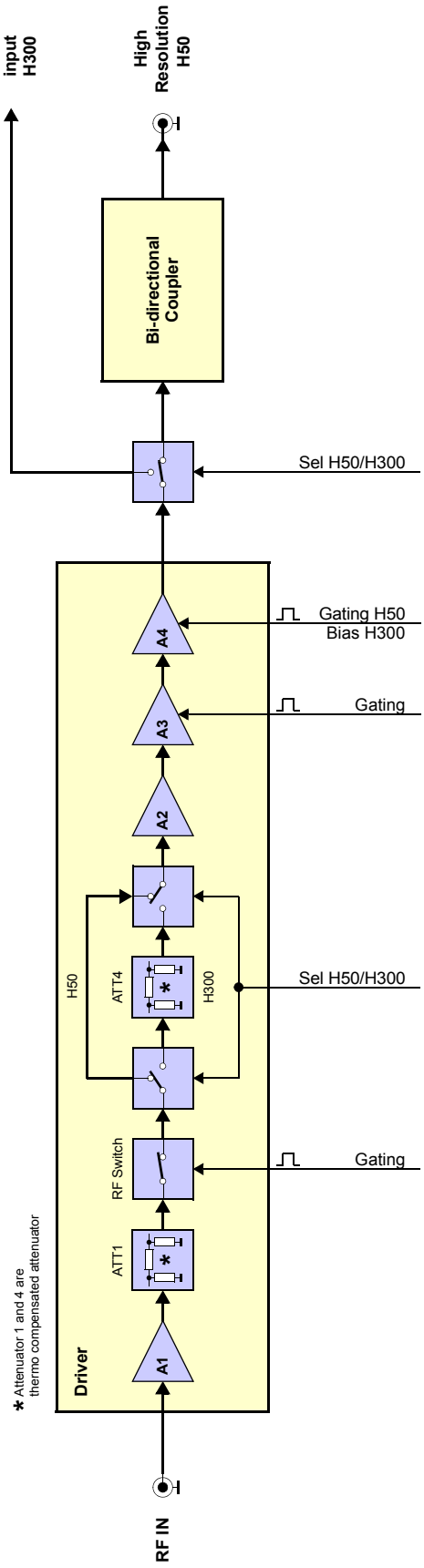


Figure 5.2. Driver Block Diagram



Theory of Operation 5.2

RF Path 5.2.1

The BLAH300 (P/N : W1345071) amplifier consists of a Class A / AB driver amplifier and a Class AB power amplifier.

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

- 50W peak for 20% duty cycle at 100ms pulse width maximum on the High Resolution output H50, when selected as High Resolution amplifier.
  In this case the 50W driver is directly switched to the front panel via a mechanical relay and a bi-directional coupler.
- 300W peak for 10% duty-cycle at 100ms pulse width maximum on the output H300, when selected as Solid amplifier.
  In this case the output of the 50W driver is switched to the input of the power amplifiers via the mechanical switch.

The unit is also capable of longer pulses for lower average power, up to 30W CW Power on the output H300 (10W CW on the High Resolution output H50).

RF Driver

In the first section of the driver, the RF input signal is fed through a hybrid amplifier to a thermo-compensated attenuator followed, via an AsGa RF Switch, by a commutable H50/H300 attenuator and a second hybrid amplifier.

The commutable H50/H300 attenuator minimizes the gain of this section of about 3dB by a thermo-compensated attenuator when the amplifier is operating on the Solid H300 Output.

In this section, only the AsGa RF Switch requires a control board conditioned gating signal to control the operation of the switching element.

The second section of the driver includes two stages of MOS FET Transistors.

The circuitry around the transistors consists of complementary input and output transformers and baluns and operates the devices in push-pull.

This section requires a control board conditioned gating signal to control the bias voltage on the gates of the FETs.

The entire RF driver has a nominal gain of 46dB, is capable to develop as much as 50W linear power, and operates at +32VDC.

RF Relay H50/H300

The coaxial RF relay switches the RF Power from the driver via a bi-directional coupler to the High Resolution output H50 on side of the front panel, when the SELH50/H300 signal is controlled to TTL level high.

When controlled by SELH50/H300 signal at TTL low, the relay switches the output of the driver to the Power Amplifiers, to build the output H300.

RF Coupler H50

The H50 bi-directional coupler provides an approximate 1V peak DC signal for full 50W on the High Resolution output H50.

The bi-directional coupler also provides peak DC signal for reflected power.

Both signals, forward and reflected, are analyzed by the BLA DSP control board for monitoring and protection setting on the H50 output.

RF Power Amplifier

The PA includes four FET transistors mounted on a single flange. The circuitry around each transistor consists of complementary input and output transformers and baluns and operates the devices in push-pull. The RF input signal is splitted to each transistor via a micro-strip line splitter. The RF output signal from each transistor is combined by a micro-strip line combiner. The PA requires a control board conditioned gating signal in order to control the bias gate voltage on the gates of the FETs.

The entire RF Power amplifier a 10dB nominal gain and operates at +32VDC.

RF Coupler H300

The H300 bi-directional coupler on the front panel provides an approximate 1V peak DC signal for full 300W on the output H300.

The bi-directional coupler also provides peak DC signal for reflected power.

Both signals, forward and reflected, are analyzed by the control board for monitoring and protection setting on the H300 output.

Control Board *5.2.2*

The BLA DSP Control Board consists of circuitry to monitor the output characteristics of the amplifier, as determined from the DC peak detections from the bi-directional couplers, and to condition the input blanking (gating) signal and deliver it to the above mentioned RF Paths.

The monitoring circuitry also serves to process the information from the detection and protect the amplifier from overstress in peak power, average power versus duty cycle and pulse width, so as reflected power.

The control board also monitors the RF Path heatsink temperature to protect against thermal overstress and reads identification information of the amplifier.

Information from supply and fans also being analyzed by the control board.

If one of the above overstresses, or faults on power supplies or fans, appears, the gating signal is disabled, and the status led board on the front panel displays the fault.

SBS Bus Controller *5.2.3*

The SBS Bus Controller, via the RS485 connector, could read all the information given by the control board as described before, read information about forward and reflected power, information of identifications of the amplifier (Bruker Board Identification System = BBIS).

The SBS Bus controller, via the RS485 connector, also could minimize absolute ratings for pulse width, duty cycle and peak power limitations.

Warning : the operating of the SBS Bus Controller needs the exploitation of a Spectrometer Management Software such as BRUKER XWIN - NMR in addition of the ACB (Amplifier Control Board)

Status Led Board *5.2.4*

The Status Led Board, on the front panel of the amplifier, displays overstress functions, supplies status, and so on, as described in ***"Front Panel" on page 11*** and ***"Control Board" on page 19***.

BBIS Board *5.2.5*

The Universal BBIS board is located on the bottom of the amplifier case and contains identifcation information of the amplifier.

Specifications 6

General specifications for Solid output 6.1

Table 6.1. BLAH300 Output H300 Specifications

Frequency range	180 to 600MHz
Linear Gain	55dB typical ± 2dB
Gain Flatness	± 2dB max.
Minimum Pulsed Output Power	300W min full range (@ nominal input +4dBm)
CW Output Power (internal limitation)	30W max.
Linear Output Power	250W typical @ 1dB compression
Linearity	± 1dB to 250W typical
Amplifier biasing	Class AB Operation
Blanking Delay Time	1µs min.
RF Rise Time	< 100ns
RF Fall Time	< 50ns
DC Ringing	± 200mV typical (due to blanking signal)
Input Noise Figure	7dB typical
Output Noise Power (Unblanked)	< -110dBm @ 1Hz
Output Noise Power (Blanked)	< 20dB over Thermal Noise
Input / Output Impedance	50 Ohms
Input V.S.W.R.	1,5 max.
Output Harmonics (2fc ; 3fc)	-40dBc ; -20dBc max. @ 300W
Pulse Width (internal limitation)	100ms @ 300W (up to CW @ 30W)
Duty Cycle (internal limitation)	10% @ 300W (up to 100% @ 30W)
Droop & Pulse Flatness	± 3% @ 300W for 100ms Pulse Width
Amplitude stability vs. Temperature	± 0,2% / °C max.

General specifications for High Resolution output 6.2

Table 6.2. BLAH300 High Resolution Output H50 Specifications

Frequency range	180 to 600MHz
Linear Gain	46dB typical ± 2dB
Gain Flatness	± 1,5dB max.
Minimum Pulsed Output Power	50W min full range (@ nominal input +4dBm)
CW Output Power (internal limitation)	10W max.
Linear Output Power	50W typical @ 1dB compression
Linearity	± 1dB to 50W typical
Amplifier biasing	Class AB Operation
Blanking Delay Time	1µs min.
RF Rise Time	< 100ns
RF Fall Time	< 50ns
DC Ringing	± 100mV typical (due to blanking signal)
Input Noise Figure	7dB typical
Output Noise Power (Unblanked)	< -119dBm @ 1Hz
Output Noise Power (Blanked)	Thermal Noise
Input / Output Impedance	50 Ohms
Input V.S.W.R.	1,5 max.
Output Harmonics (2fc ; 3fc)	-40dBc ; -20dBc max. @ 50W
Pulse Width (internal limitation)	100ms @ 50W (up to CW @ 10W)
Duty Cycle (internal limitation)	20% @ 50W (up to 100% @ 10W)
Droop & Pulse Flatness	± 1,5% @ 50W for 100ms Pulse Width
Amplitude stability vs. Temperature	± 0,2% / °C max.

Common Characteristics *6.3*

Table 6.3. BLAH300 Common Specifications

Constant Internal Protection	Supplies and fans faults & Overtemperature Forward Power : peak & CW power pulse width duty cycle Reflected Power : peak & CW power
Front Panel Indicators	Amplifier Status Led Board
Front Panel Interfaces	2 x I/O 15 pins subminiature type D connectors
Front Panel controls	1 x Sel H50/H300 control signal ; AC line ON / OFF
Front Panel connectors	1 x RF input, 2 x RF output, 1 x gating input
Rear Panel Interface	AC line socket
Cooling System	Forced-air cooling (from front to rear)
Size	19" rack cabinet x 3U height x 520mm depth
Weight	19kg
Power requirements	220-230VAC ± 15%

Specifications

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