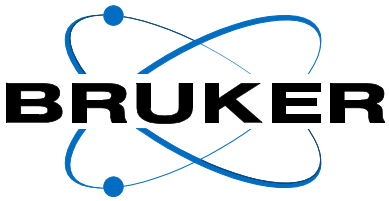

BLAH1000

Amplifier 200-600MHz
Operating & Service Manual

Version 001

The information in this manual may be altered without notice.

BRUKER accepts no responsibility for actions taken as a result of use of this manual. BRUKER accepts no liability for any mistakes contained in the manual, leading to coincidental damage, whether during installation or operation of the instrument. Unauthorised reproduction of manual contents, without written permission from the publishers, or translation into another language, either in full or in part, is forbidden.

This manual describes the units as they are at the time 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.

This manual was written by

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P/N: Z31653
DWG-Nr: 1359.001

Contents

Contents

General information 1

Introduction 1.1

The BLAH1000 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 Teslas Systems.

The class AB linear amplifier provides 1000W peak power and more over the frequency range 188-600 MHz on the H1000 output for the Solid applications and 100W peak power and more on the H100 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% (5% for the H1000 output)

Its built-in protection circuitry will allow lower power pulses for longer pulse widths and duty-cycles, maintaining a 50W average power on the H1000 output, and 20W average power on the H100 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 ≥ 6)
- Overheat protection

The amplifier is powered by an external switched power supply assembly, housed in a 19" rack cabinet.

Safety

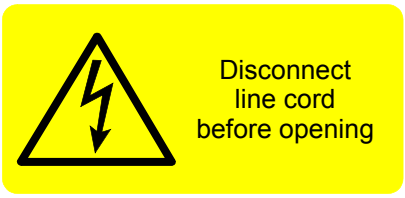
2

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.

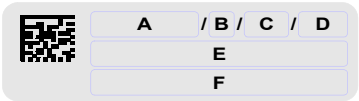
Dangerous area 2.1.1

WARNING ! High Voltage.



Name plate 2.1.2

The BLAH1000 Amplifier 200-600MHz can be identified by a name plate at the front panel of the unit which has following information:



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

- **(F) Information**
  This field contains information about the useful frequency range of the product.

Installation 3

Initial inspection 3.1

Mechanical check 3.1.1

If damage of the shipping carton is evident, request the carrier's agent 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 movement 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."

Auxiliary kit 3.1.4

The BLAH1000 is shipped with an accessories kit containing following items :

- Manual
- Line Cord
- Switched Power Supply in separate carton

The BLAH1000 (P/N:W1345073) with the POWER SUPPLY (P/N:W1303539) is commercialized under the BRUKER Part Number W1306277.

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.

Power requirements 3.3

The BLAH1000 is designed to be powered by means of an additional switched power supply (BRUKER Part Number P/N : W1303539).

The connection to this power supply is realized via a 500 mm cable fitted with a 15 pins DIN 41612-HERNI female connector, and coming out from the rear panel of the amplifier.

This switched power supply provides all the voltages necessary to the BLAH1000. (5 x +32V / +15V / -15V / +5V / GND)

System check 3.4

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

- The AC input voltage from the Power Supply must be compatible with 188 to 264VAC range.
- An external blanking (gating) pulse must be supplied to the amplifier in order for the unit to function. Ensure that this pulse is of proper level and logic polarity.
- The BLAH1000 has a nominal input level of +4dBm. Ensure that the system drivers are operating at these levels.

Initial turn on procedure *3.5*

The following list describes how to turn on the BLAH1000 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" on page 10***".

1. Connect the amplifier to the power supply and turn the circuit breaker, to ON.
2. Observe the indicators on the front panel of the power supply :
   - The five channels +28V (+32 V) ON LED's will illuminate
   - The +15V, -15V and + 5V ON LED's will illuminate
3. Observe the indicators on the front panel of the amplifier :
   - The +32V, +15V , -15V and +5V ON LED's will illuminate
4. System is now fully operational.

Operation 4

Front Panel 4.1

The BLAH1000 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 5 x +32V supplies are 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.
H1000 ON	Lights on when RF Power is present on the Solid output.
H100 ON	Lights on when RF Power is present on the High Resolution output.

Connectors *4.1.2*

Table 4.2. Connectors

H IN	RF in SMA type connector (female). Nominal +4dBm drive to the BLAH1000 to deliver full power.
H1000	RF OUT H1000 (Solid output) N type connector (female).
H100	RF OUT H100 (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 H1000.H100	BNC type connector (female). When the SELH1000.H100 signal is at TTL level low (0V), the Solid output H1000 is selected. When the SELH1000.H100 signal is at TTL level high (5V), the High Resolution output H100 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 2	Transmit data line +
Pin 3	Wake up line /WUP
Pin 4	Receive data line +
Pin 5	NC
Pin 6	GND
Pin 7	GND
Pin 8	GND
Pin 9	Transmit data line -
Pin 10	NC
Pin 11	Receive data line -
Pin 12	NC
Pin 13	VRS (+12V)
Pin 14	VRS (+12V)
Pin 15	VRS (+12V)

Figure 4.1. BLAH1000 Front Panel Design

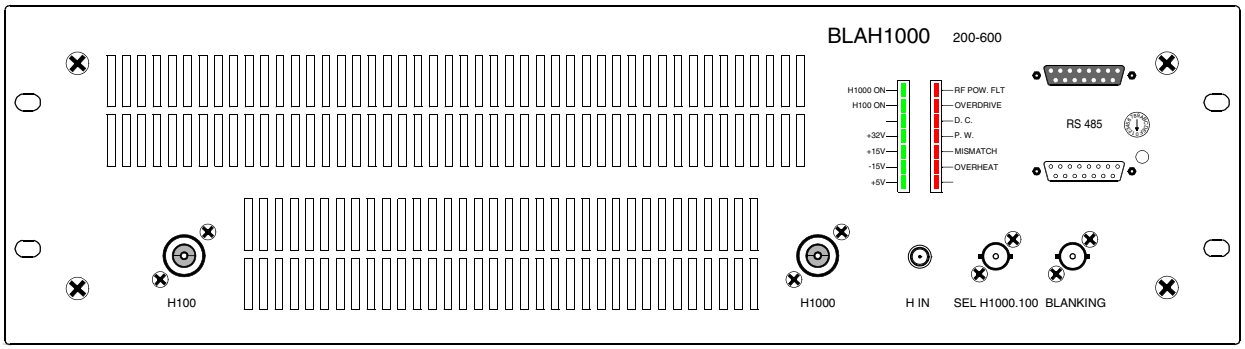


Figure 4.2. BLAH1000 Front Panel View

Rear Panel 4.2

The rear Panel of the BLAH1000 Amplifier is free of elements in exception of a 500mm cable fitted with a 15 pin DIN 41612-HERNI female connector, coming out from the rear panel of the amplifier.

Rear panel supply connector 4.2.1

Table 4.4. DIN 41612-HERNI Pin assignment

Pin z4	+5V
Pin z8	+15V
Pin z12	-15V
Pin z16	+32V
Pin z20	+32V
Pin z24	+32V
Pin z28	+32V
Pin z32	+32V
Pin d6	not connected
Pin d10	DGND
Pin d14	PGND
Pin d18	PGND
Pin d22	PGND
Pin d26	PGND
Pin d30	PGND

Note

DGND = Digital Ground for ±15V and +5V
PGND = Power Ground for 5 x +32V

Technical description

5

System Overview 5.1

The BLAH1000 amplifier requires the additional Bruker Power Supply P/N : W1303539, to provide :

- A RF Output of 1000W and more on the Solid Output H1000, over the full frequency range 188 to 600MHz, when selected for Solid operation with SELH1000.H100 command controlled at TTL level low.
- A RF Output of 100W and more on the High Resolution Output H100 over the same full frequency range 188 to 600MHz when selected for High Resolution operation by SELH1000.H100 controlled at TTL level High.

The RF section of the system consists of a linear module BLMH1000 mounted around a single, self-contained Push and Pull fan assemblies, heatsink.

A linear class A / AB driver using switches and bias voltage gatings, delivers the RF input power to the four Power Amplifiers, through a Power Splitter / Combiner acting as a 4 ways in-phase splitter.

The driver is located on the bottom of the heatsink assembly. The power splitter is located between the heatsink assembly and the lateral left side of the case.

Four class AB power amplifiers, located on the top and the bottom of the heatsink are combined by mean of a Power Splitter/combiner acting as a 4 ways in-phase. The power combiner is located between the heatsink assembly and the lateral right side of the case.

The output of the combiner is connected to a bi-directional Coupler mounted on the front panel of the amplifier. This output consist in the Solid H1000 Output when the amplifier is controlled for Solid applications.

When controlled for High Resolution applications, the output of the driver is switched to the front panel H100 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, providing protection from excessive peak power, duty cycle and pulse width for average power, maximum reflected power and heatsink over-temperature.

Circuits such, Fan Status board, Supply Status board and LED's Status board, completes the amplifier assembly.

Figure 5.1. BLAH1000 System Block Diagram

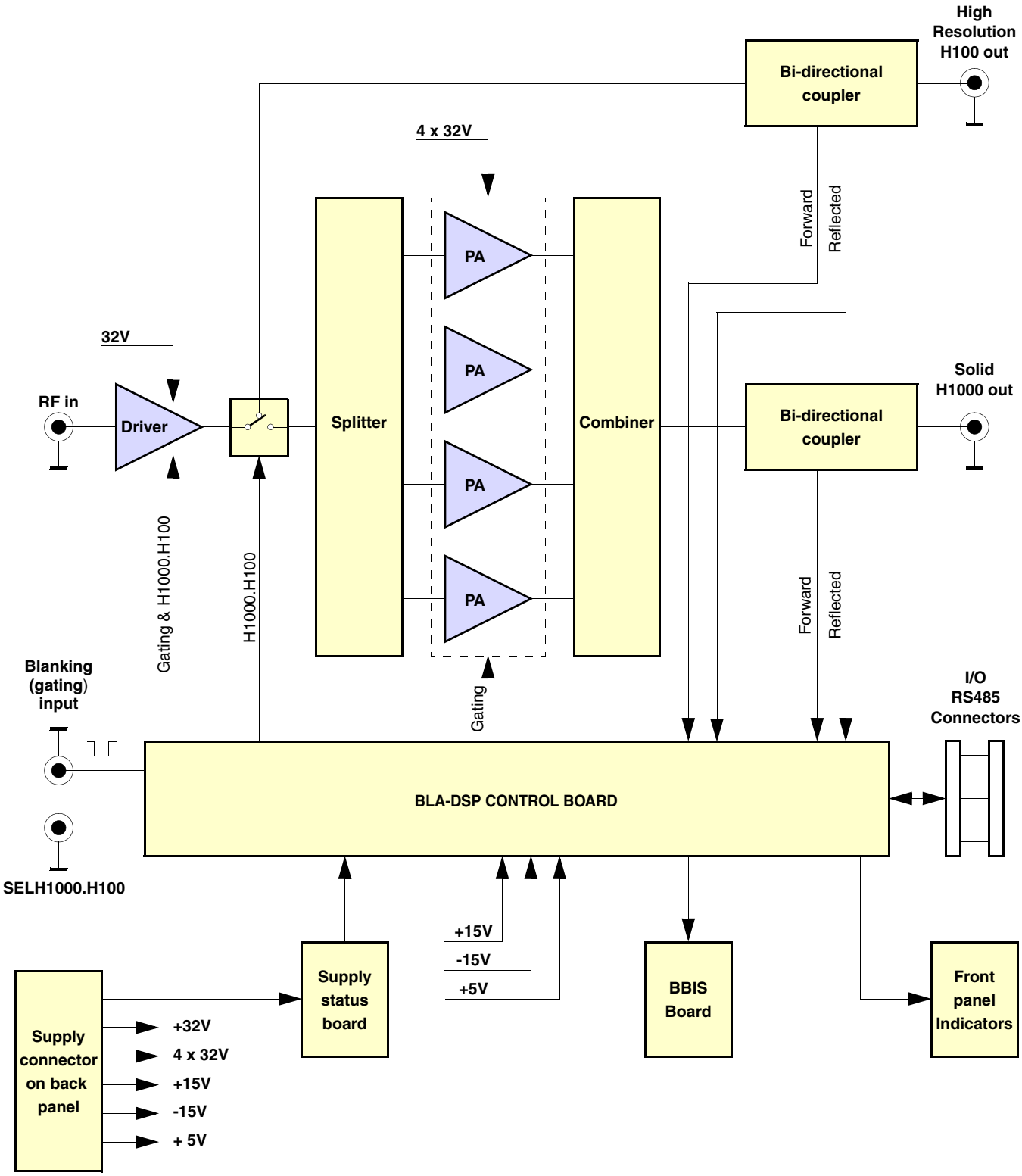
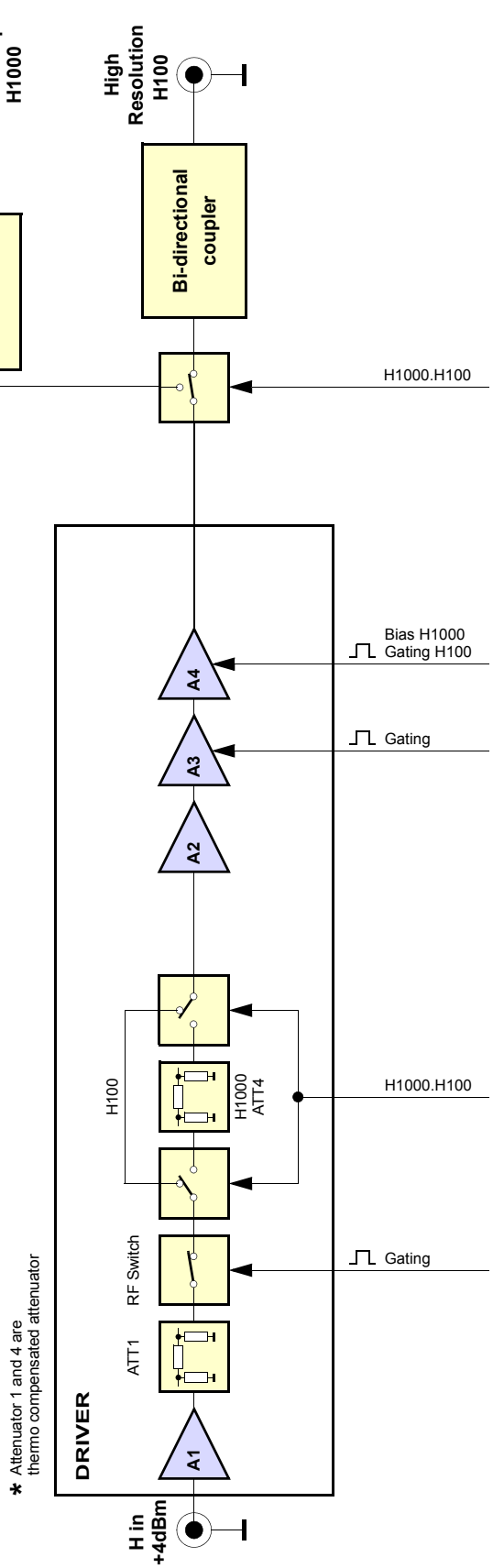


Figure 5.2. Driver Block Diagram



Theory of Operation 5.2

RF Path 5.2.1

The BLAH1000 (P/N : W1345073) 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 :

- 100W peak for 20% duty cycle at 100ms pulse width maximum on the High Resolution output H100, when selected as High Resolution amplifier.
  In this case the 100W driver is directly switched to the front panel via a mechanical relay and a bi-directional coupler.
- 1000W peak for 5% duty-cycle at 100ms pulse width maximum on the Solid output H1000, when selected as a Solid amplifier.
  In this case the output of the 100W driver is switched to the input of the four output power amplifiers via the mechanical switch and a 4 ways power splitter.

The unit is also capable of longer pulses for lower average power, up to 50W CW Power on the Solid output H1000 (20W CW on the High Resolution output H100).

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 H1000.H100 attenuator, a second hybrid amplifier.

The commutable H1000.H100 attenuator minimize the gain of this section of about 3 dB by a thermo-compensated attenuator when the amplifier is operating on the Solid H1000 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 50 dB of gain, and is capable of developing as much as 100 W linear power, and operates at + 32 VDC.

RF Relay H1000.H100

The coaxial RF relay switches the Rf Power from the driver via a bi-directional coupler to the High Resolution output H100 on side of the front panel, when the SELH1000.H100 signal is controlled to TTL level high.

When controlled by SELH1000.H100 signal at TTL low, the relay switches the output of the driver to the 4 Power Amplifiers via a 4 ways in-phase splitter, to built the Solid output H1000.

RF Coupler H100

The H100 bi-directional coupler provides an approximate 1 V peak DC signal for full 100 W on the High Resolution output H100.

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 H100 output.

RF Splitter

The RF Splitter acts as a 4 ways in-phase splitter between the output of the RF driver and the inputs of the 4 power amplifiers PA. All the wiring around this splitter are made with 50 Ω coaxial cables equipped with SMA connectors.

RF Power Amplifier

Each of the four 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 splitting to each transistor via a micro-ship line splitter. The RF output signal from each transistor is combining by a micro-strip line combiner. The four PA requires a control board conditioned gating signal in order to control the bias gate voltage on the gates of the FETs.

The four PA operates off + 32 VDC and are followed by an in-phase combiner.

RF Combiner

The RF Combiner acts as an 4 ways in-phase combiner between the outputs of the four PA and the input of the bi-directional coupler mounted on the front panel of the BLAH1000 amplifier. All wiring around this combiner are made with 50 Ω coaxial cables mounted on SMA and N connectors.

RF Coupler H1000

The H1000 bi-directional coupler on the front panel provides an approximate 1 V peak DC signal for full 1000W on the Solid output H1000.

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 H1000 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's 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.

Information from supplies and fan status board 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)***

Supply Status Board *5.2.4*

This board gives the information of the status of the power supply.
A defect on one or more of the supplies is read by the control board, and in case of, the gating signal is disabled while the defect is visualized on the front panel led display.

Fan Status Board *5.2.5*

The fan status board gives information of the status of the two push and pull fan assemblies. A defect on the fans is read by the control board, the gating signal is disabled, and the "overheat" led of the front panel Status led display lights ON.

Status Led Board *5.2.6*

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 13*** and ***"Control Board" on page 21***.

Specifications 6

General specifications Solid output H1000 6.1

Table 6.1. BLAH1000 Solid Output H1000 Specifications

Frequency range	180 to 600MHz
Linear Gain	59dB typical
Gain Flatness	±4dB max.
Peak Pulsed Power	1000W min.
CW Power (limited)	50W max.
Linear Output Power	800W @ 1dB Comp. typical
Amplifier biasing	Class AB Operation
Blanking Delay Time	< 1µs typ.
RF Rise Time	< 70ns, 10 - 90% peak power
RF Fall Time	< 50ns, 90 - 10% peak power
Input/output Impedance	50Ω
Output Noise Power	< -108dBm @ 1Hz unblanked Thermal Noise blanked
Pulse Width (limited)	100ms @ 1000W (up to CW @ 50W)
Duty Cycle (limited)	5% @ 1000W (up to 100% @ 50W)
Amplitude Droop	< 6% @ 1000W for 10ms pulse width
Amplitude stability v. temperature	± 0,2% / °C
Input V.S.W.R.	1.5 max.
Noise Figure	7dB typ.

General specifications High Resolution output H100 6.2

Table 6.2. BLAH1000 High Resolution Output H100 Specifications

Frequency range	180 to 600MHz
Linear Gain	50dB typical
Gain Flatness	±2dB max.
Peak Pulse Power	80W min. to 250MHz ; 100W to 600MHz
CW Power (limited)	20W max.
Linear Output Power	80W @ 1dB Comp. typical
Amplifier biasing	Class AB Operation
Input/output Impedance	50Ω
RF Rise Time	< 70ns, 10 - 90% peak power
RF Fall Time	< 50ns, 90 - 10% peak power
Blanking Delay Time	< 1µs typ.
Output Noise Power	< -117dBm @ 1Hz unblanked Thermal Noise blanked
Pulse Width (limited)	100ms @ 100W (up to CW at 20W)
Duty Cycle (limited)	20% @ 100W (up to 100% at 20W)
Amplitude Droop	< 4% @ 100W for 10ms pulse width
Amplitude stability v. temperature	± 0,2% / °C
Noise Figure	7dB typ.

BLAH1000 Common Characteristics *6.3*

Table 6.3. BLAH1000 Common Specifications

Constant Internal Protection	Supplies 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 SELH1000.H100 control signal
Front Panel connectors	1 x RF input, 2 x RF output, 1 x gating input
Rear Panel Interface	15 pins DIN 41612-H ERNI female connector (power supply connection)
Cooling System	Forced-air cooling (from front to rear)
Size	19" rack cabinet x 3U height x 580mm depth
Weight	26kg
Supply	Additional 188-264 VAC single phase switched power supply Bruker part number W1303539. A front panel circuit breaker turns the AC Line ON/OFF A status led board, on the front panel, indicates the power supplies condition. Size : 19" rack cabinet x 2U height x 520mm depth Weight : 14kg

Specifications

Figures

Figures

Tables

Tables