BLA2000 I

Amplifier 300MHz
Operating & Service Manual

Version 001

The information in this manual may be altered without notice.

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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 BLA2000 I Amplifier is a selectiv linear pulse power amplifier specifically designed for Nuclear Magnetic Resonance and Magnetic Resonance Imaging (NMR/MRI) at 300W.

The class AB linear amplifier provides 2000W peak power over the frequency range 280-320MHz.

The Amplifier is equipped with N-CHANNEL BROADBAND RF POWER MOS FETs of the latest generation. The unit can provide full power for any combination of pulse width and duty cycle up to 10ms and 5%.

Its built-in protecion circuitry will allow lower power pulses for longer pulse widths and duty-cycles up to 100W CW power.

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)
- Thermal protection (overheat)

The amplifier is powered by an internal switched power supply assembly and it is housed in a 19", 4U, 520mm deep rack cabinet.

The Amplifier is equiped with a CAN interface for the Siemens MAGNETOM electronic platform and can be used in combination with the Siemens *syngo* software. Internal monitiring provides detailed status information wich is transfered over the CAN bus to the *syngo* MR error logger.

Safety

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The BLA2000 I Amplifier 300MHz is in accordance with the standard 61010-1 safety Requirements for Electrical Equipments.

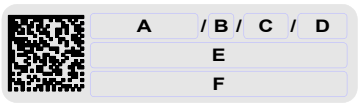
Labels 2.1

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 BLA2000 I Amplifier 300MHz can be identified by an identifying plate at the front panel of the unit that has following information.

Figure 2.1. Identifying plate

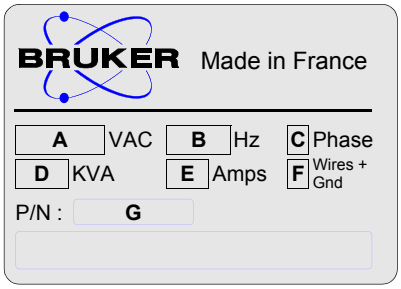


- **(A) Part Number**
  This field indicates the part number of the product.
- **(B) Variant**
  This field indicates the variant number that identifies the production category of the product. The default variant is 00.
- **(C) ECL**
  This field indicates the revision number that identifies the product 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 BLA2000 I 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

WARNING! *Risk of electrical shocks*

Figure 2.3. General hazard symbol

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

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

- Electric shock on power supply.
- Contact burn on the RF module 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. Every breakdown due to a non-respect of the following instructions will not be attributable to Bruker and will not be covered by the guarantee clauses.

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."

Environment requirements *3.1.4*

This amplifier is build for inside use only on a maximum high level of 2000m above sea level (6600 feet).
No specific cooling or ventilation is required.
Be sure that the amplifier has enough area around so that the free air flow into and out of the amplifier is not obstruct.
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 2 (means a normal only non conductive contamination, temporary conductivity due to condensation is possible).

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.
The amplifier is a class II of installation category.

Bench operation *3.2.1*

The unit can be placed onto a secure flat surface.

Power requirements *3.3*

The BLA2000 I is designed with a built-in switched power supply. The main line connector is a CEI 10A.

One Phase Line requirements :

AC input voltage :	220-230VAC	± 15%
Input current max :	7A	
Inrush current max :	30A	
Frequency :	50/60Hz	± 5Hz

System check *3.4*

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

- The AC input voltage 220-230VAC ± 15% range must be compatible with the power supply.
- An external blanking (gating) pulse must be supplied to the amplifier in order the unit to function. Ensure that this pulse has a proper level and logic polarity (1 = Blanking / 0 = RF).
- The BLA2000 I has a nominal input level of +0dBm. 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 BLA2000 I 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 12***.

1. Connect the AC line to the power supply and set the power switch to the ON position.
2. Observe the indicators on the front panel of the amplifier :
   - 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 BLA2000 I front panel is provided with 12 indicators for status monitoring, 5 RF connectors, 2 interface connectors and 6 optocoupled connectors.

Indicators 4.1.1

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

Table 4.1. Indicators assignment

+32V	Indicates that the +32V supplies are applied.
+15V	Indicates that the +15V supply is applied.
-15V	Indicates that the -15V supply is applied.
+5V	Indicates that the +3,3V supply is applied.
Overdrive	Indicates when the peak 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	Indicates when one of the above limits has been reached.
Overheat	Indicates that the thermistor located on the RF module heatsink has sensed excessive heatsink temperature. The amplifier is blanked until an accepable temperature is reached. The function is self-resetting and no maintenance is needed. Indicates also that a fan on the assembly stops turning. The amplifier is blanked until fans are changed.
2000W	Indicates when the RF Power is present on the 2000W output.

Coaxial Connectors *4.1.2*

Table 4.2. Coaxial Connectors assignment

RF IN	RF input, SMA type connector (female). Nominal input +0dBm.
2000W	RF output, N type connector (female). Pnominal 2000W (300MHz)
BLNK TEST	Blanking Test input, BNC type connector (female), for test only. TTL logic, 5V = blanking on, 0V = 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.
POWER FORWARD	Forward signal output, SMA type connector (female). Pnominal output -70dB.
POWER REFLECTED	Reflected signal output, SMA type connector (female). Pnominal output -90dB.

Interface Connector RS485 *4.1.3*

The 2 Control I/O interface connections are 15 pin, Male and Female 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 8	GND		

Interface connectors CAN Bus 4.1.4

Table 4.4. CAN Bus connectors assignment

U2	Optocoupled output TX1
U3	Optocoupled input RX1
U4	Optocoupled output TX2
U5	Optocoupled input RX2
ENABLE	Optocoupled enable input
UNBLANK	Optocoupled input blanking

Device design 4.1.5

Figure 4.1. BLA2000 I Front Panel Design

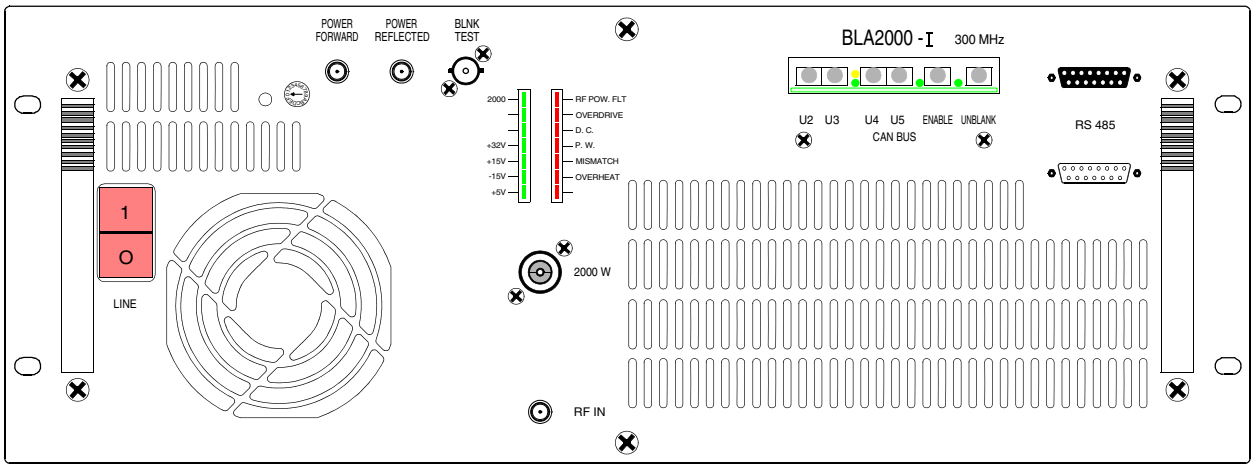


Figure 4.2. BLA2000 I Front Panel View

Rear Panel *4.2*

The rear Panel of the BLA2000 I Amplifier is free of elements in exception of the three pole (2P + E) line filter socket.

Figure 4.3. BLA2000 I Rear View

Technical description

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System Overview 5.1

The BLA2000 I amplifier provides :

- A RF Output of 2000W on the Output 2000W at 0dB input over the frequency range 280 to 320MHz.

The RF section of the system consists of a linear module BLM2000 mounted on to a single heatsink, self-contained Push and Pull fan assemblies.

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

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

Four class AB power amplifiers, located on the top of the heatsink are combined by mean of a 4 ways in-phase combiner.

The output of the combiner is connected to a bi-directional coupler mounted on the front panel of the amplifier.

The entire system is controlled 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 DSP Control Board reads indentification information of the amplifier (BIS).

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

CAN BUS Interface 5.1.1

In Siemens electronics based MR-systems, the optocoupled CAN Bus interface has control of the amplifier :

CAN 1 In (RX U3) / Out (TX U2)

The normal on/off switching of the amplifier as well as suppling status and error information to the Siemens electronics takes place over this serial communication bus. Via signal RFPA_OFF, the RFPA is switched off. It can be switched on afterward by a CAN-command only. Activity on the CAN bus is visualized by the LEDs.

CAN 2 In (RX U5) / Out (TX U4)

A feed-through to other components in the CAN chain.

Enable

The enable signal allows the Siemens electronics to shut the amplifier down independent from the CAN Bus controller. If the signal is missing (light out), the amplifier shuts down.

Unblank

To reduce noise and loss of the MR echo during reception, the amplifier is blanked during the receive cycle. This is accomplished with the fiber optic signal UNBLANK. When signal is active (light on), the amplifier is activated.

Figure 5.1. BLA2000 I System Block Diagram

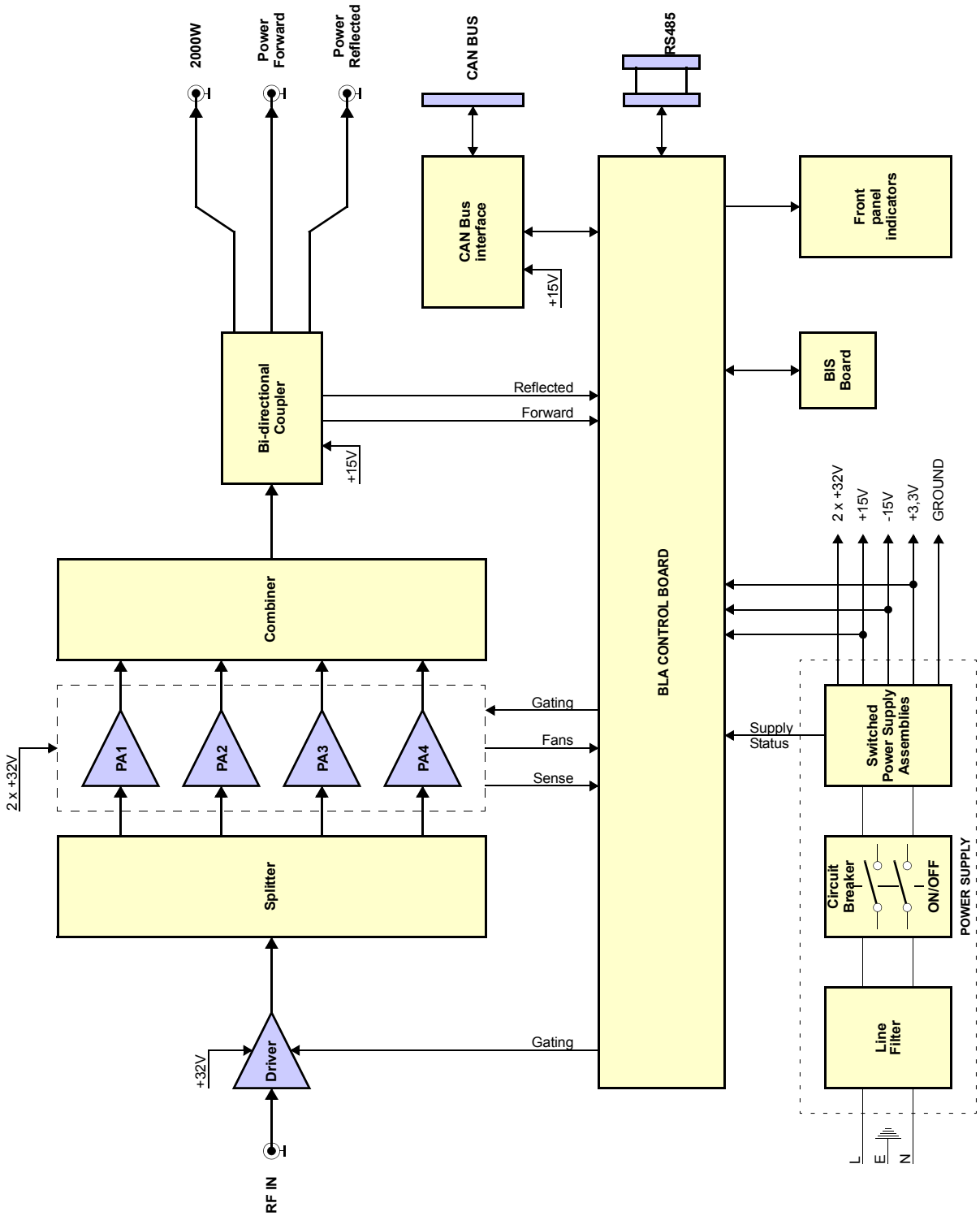
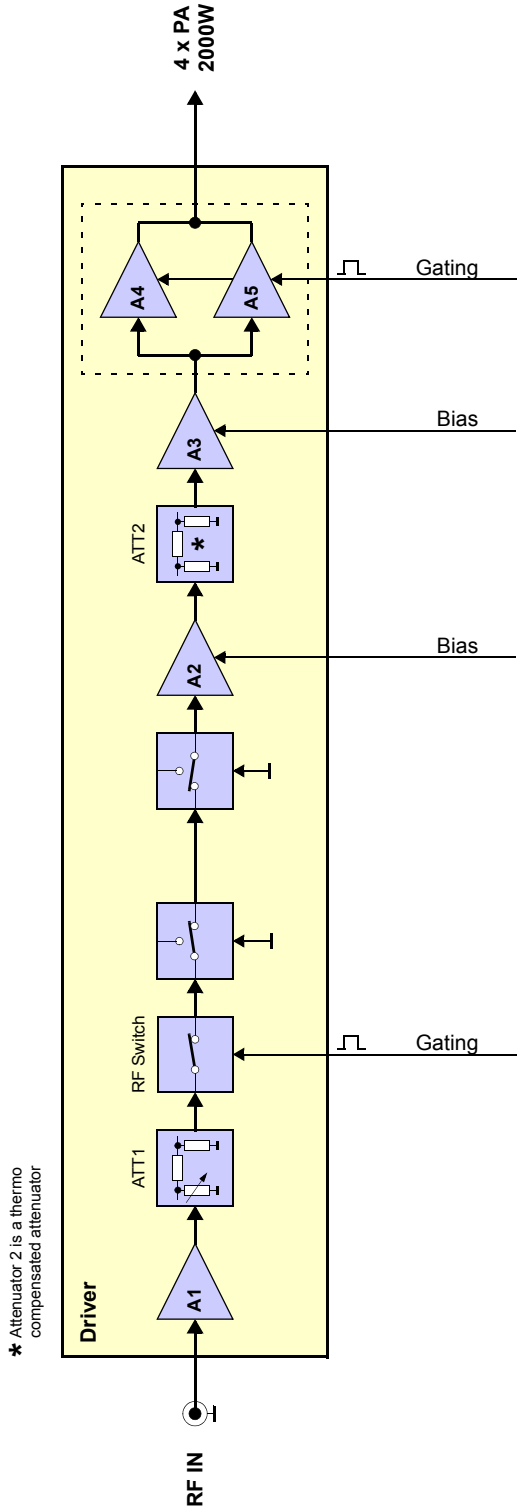


Figure 5.2. Driver Block Diagram



Theory of Operation 5.2

RF Path 5.2.1

The BLA2000 I (P/N : W1345078) amplifier consists of a class A/AB driver and a Class AB power amplifier.

A nominal input power level of +0dBm produces a rated linear output power of :

- 2000W peak for 5% duty-cycle at 10ms pulse width maximum on the output 2000W.
  The unit is also capable of longer pulses for lower average power, up to 100W CW Power on the output 2000W.

RF Driver

In the first section of the driver, the RF input signal is preamplified with a low noise stage and followed by a 2dB variable attenuator and a thermo-compensated attenuator for temperature compensation.

Then follows a gating switch.

Next is a two stage class A/AB amplifier to built a nominal 40dB gain block. The second section of the driver includes two power 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 input-output gain of this section is at nominal 13dB.

The entire RF driver has a nominal 53dB gain, able to develop more than 200W linear power and operates at +32V DC.

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.

RF Power Amplifier

Each of the four PA includes two 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 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 at +32V DC 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.

Control Board 5.2.2

The BLA Control Board consists of circuitry to monitor the output characteristics of the amplifiers, as determined from the DC peak detection's from the bi-directional couplers and to condition the input blanking (gating) signals and deliver them to the above mentioned RF Paths.

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

The control board also monitors the RF Path heatsink temperature to protect against thermal overstress.

Information from supplies and fan status board are also analyzed by the control board.

If one of the above overstresses, or faults on power supplies or fans appears, the gating signals are 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, reflected power 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)

Can Bus Interface 5.2.4

The CAN Bus interface control the pulse generation for gating the amplifier and the security of the system.

Status Led Board 5.2.5

The Status Led Board, on the front panel of the amplifier, displays overstress functions, supplies status, and so on, as described in ***"Indicators" on page 15***.

BBIS Board *5.2.6*

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

Technical help: please contact your local representative.

Specifications 6

General specifications Output 2000W 6.1

Table 6.1. BLA2000 I Output 2000W Specifications

Frequency range	280 to 320MHz
Linear Gain	68dB ± 1dB typical
Gain Flatness	± 1dB max.
Nominal Output Power	2000W @ 300MHz (at nominal input +0dBm)
CW Output Power (internal limitation)	100W max.
Linear Output Power	1500W @ 300MHz
Amplifier Biasing	Class AB Operation
Blanking Delay Time	< 1.5µs typical "ON" & "OFF"
RF Rise Time	< 100ns
RF Fall Time	< 70ns
DC Ringing	± 500mV typical (due to blanking signal)
Input Noise Figure	5dB max.
Output Noise Power (Unblanked)	-101dBm @ 1Hz
Output Noise Power (Blanked)	Thermal Noise
Input/output Impedance	50Ω
Input V.S.W.R.	1.3 max.
Output Harmonics 2nd order	-30dBc or better
Output Harmonics 3rd order	-20dBc @ 2000W
Pulse Width (internal limitation)	10ms @ 2000W (up to CW @ 100W)
Duty Cycle (internal limitation)	5% @ 2000W (up to 100% @ 100W)
Droop & Pulse Flatness	< 8% @ 2000W for 10ms
Amplitude Stability vs. Temperature	± 0,1% / °C max.

Common Characteristics 6.2

Table 6.2. BLA2000 I Common Characteristics

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, 1 x I/O optocoupled CAN Bus
Front Panel controls	1x Power Forward output, 1 x Power Reflected output, 1 x Blanking Test
Front Panel connectors	1 x RF input, 1 x RF output
Rear Panel connectors	1 x main line CEI 10A connector
Cooling System	Forced-air cooling (from front to rear)
Temperature Limits	5°C to 45°C (41°F to 113°F)
Size	19" rack cabinet x 4U height x 520mm depth
Weight	30kg

Inside Power Supply Characteristics 6.3

Table 6.3. BLA2000 I Power Supply Characteristics

Voltage	+32V
Current	50A DC
Pulsed current	200A pulse 100ms
Input voltage	230V ± 15% @ 50/60Hz ± 5Hz
Input current	Max @ 230V : 7A
Input power	Max @ 230V : 1600VA
In rush current	< 30A
Input Thermal protection	16A

Service information and maintenance 7

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

Preventive maintenance of the RF module on BLA-type Amplifiers 7.1

The RF module inside BLA's Amplifiers is equipped with a easily extractible PUSH and PULL FAN Assembly.

Fan's on assembly have a high reliability and manufacturer gives a expected live time of 70000 hours (8 years) at 25°C and 5 years at 60°C.

Replacement of the assemblies could be done in the field when a misfonction of fans is detected by lightning from the OVERHEAT Status Led.

To prevent such a misfonction, a preventive maintenance should be done every 4 years.

These assemblies can be ordered on the manufactory BBIO-FR by P/N:

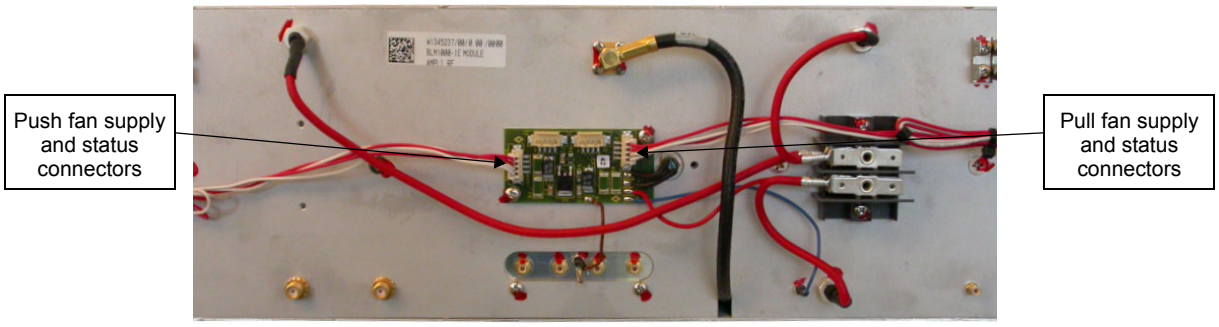
- **W1346530** «PUSH FAN ASSEMBLY H1000/300»,
- **W1346531** «PULL FAN ASSEMBLY H1000/300».

Operation 7.1.1

Read below or see SIH0292.

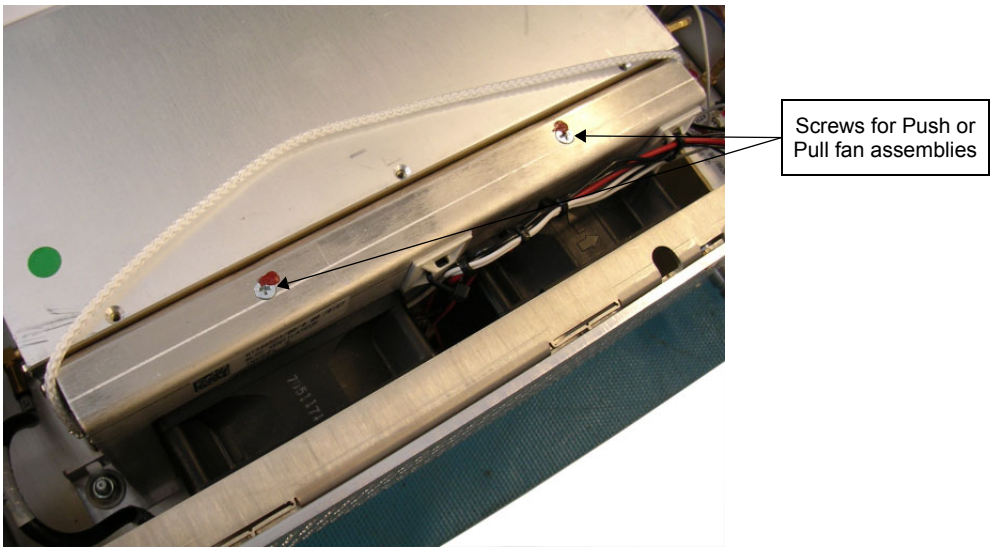
1. Disconnect all cables from the front panel and the supply connector on the rear panel. Remove the amplifier from the BIOSPEC / CLINSCAN console and place it on a secure flat surface.
2. Unscrew and remove the coverage plate from the amplifier.
3. Disconnect the 2 connectors J3 and J4 from the Status Connections Board on the RF Amplifier Module.

Figure 7.1. Fans supplies and status Connections



4. Unscrew only the 2 screws from the top of the Push and Pull fan assemblies on both side of the RF module.

Figure 7.2. Push and Pull Fan Assembly



5. Remove the Push and the Pull fan assembly.
6. Place correctly the 2 new fan assemblies in the holes on the bottom of the RF module and screw it on the top.
7. Connect the 2 connectors J3 and J4 from the fans to the Status Connections Board .
8. Connect the supply cable from BLA2000 I to the external power supply, turn on the amplifier. Note that the fans are turning and no OVERHEAT status led appears on front panel.
9. Put the coverage plate on the BLA2000 I amplifier and screw it.
10. Put the amplifier in the BIOSPEC / CLINSCAN console, connect all cables on the front panel and the supply connector on the rear panel.

Figures

Figures

Tables

Tables