
# BLA2X500, X500, X300

## Amplifier 6-365MHz
## Operating & Service Manual

**Version 002**

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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# Contents

# Contents

# General information 1

## Introduction 1.1

The BLAX serie amplifiers are linear broadband pulse power amplifiers specifically designed for Nuclear Magnetic Resonance (NMR) applications for 4,7 to 21 Teslas Systems.

The class AB linear amplifiers provides two 500W peak power outputs (X1 and X2) over the frequency range 6-365MHz on the dual channel amplifier BLA2X500, 500W peak power on the one channel amplifier BLAX500 and 300W peak power on the one channel amplifier BLAX300.

The amplifier is realized 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 100 msec and 10%. Its built-in protection circuitry will allow lower power pulses for longer pulse widths and duty cycles, maintaining a 30W average power on channel output.

An 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)
- Thermal overload (overheat)

The amplifier is powered by an internal Switched power supply assembly that provides the 32VDC for the power amplifiers, in addition to all low level voltages for 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

*BLA2X500, X500, X300 6-365MHz amplifiers are in accordance with the standard 61010-1 safety Requirements for Electrical Equipments.*

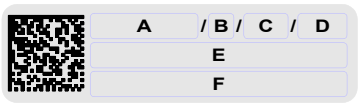
## Labels 2.1

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

BLA2X500, X500, X300 6-365MHz amplifiers can be identified by an identifying plate at the front panel of the unit that has following information.

*Figure 2.1. Identifying plate*

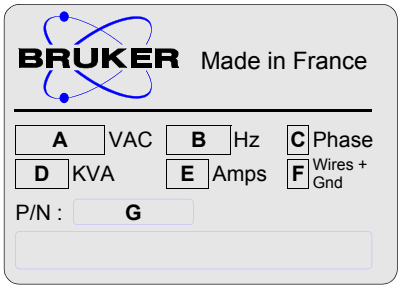



- **(A) Part Number**
  This field indicates the part number of the product.
- **(B) Variant**
  This field indicates the variant number that identifies the production category of the product. The default variant is 00.
- **(C) ECL**
  This field indicates the revision number that identifies the product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

BLA2X500, X500, X300 6-365MHz amplifiers 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.

## *Warning signs* *2.1.3*

*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 "**

### Auxiliary kit 3.1.4

The BLAX Amplifiers are shipped with an accessories kit containing following items:

- Manual
- Line Cord

The BLAX Amplifiers are commercialized under the BRUKER Part Number:

- BLA2X500 Amplifier 6-365MHz : W1345067
- BLAX500 Amplifier 6-365MHz : W1345070
- BLAX300 Amplifier 6-365MHz : W1345069

## 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% 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 BLAX Amplifiers have 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 BLAX Amplifiers 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'' above.

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 BLAX serie front panels are provided with 12 indicators for status monitoring (2 x 12 indicators for the BLA2X500), 3 connectors (6 connectors for the BLA2X500), 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.<br>All gatings are removed from the amplifier until the unit cools.<br>The function is self-resetting and no maintenance is needed.<br>Indicates that a fan on the assembly stops turning.<br>The gatings are cut off and fans must be changed for good working. |
| X500 ON or X300 ON | Lights ON when RF Power is present on this output. |

### *Connectors* *4.1.2*

*Table 4.2. Connectors*

| | |
|---|---|
| **X or X1 / X2 IN** | RF in SMA type connectors (female).<br>Nominal +4dBm drive to the BLAX Serie to deliver full power. |
| **X or X1 / X2 OUT** | RF OUT N type connectors (female). |
| **BLNK or BLNK1 / BLNK2** | Blanking signals BNC type connectors (female).<br>TTL logic, 5V = blanking ON, 0V = blanking OFF.<br>When BLANKING signal is at TTL level high (5V), no gating is applied to the amplifier stages, and no RF Power is possible.<br>When BLANKING signal is at TTL level low (0V), the amplifier stages are gated, and RF Power is possible. |

### *Interface connectors 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 th e pinout of the master and slave connectors.

*Table 4.3. RS485 pinout*

| | |
|---|---|
| **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) |

## *Amplifiers front panel design* *4.1.4*

*Figure 4.1. BLA2X500 front panel design*

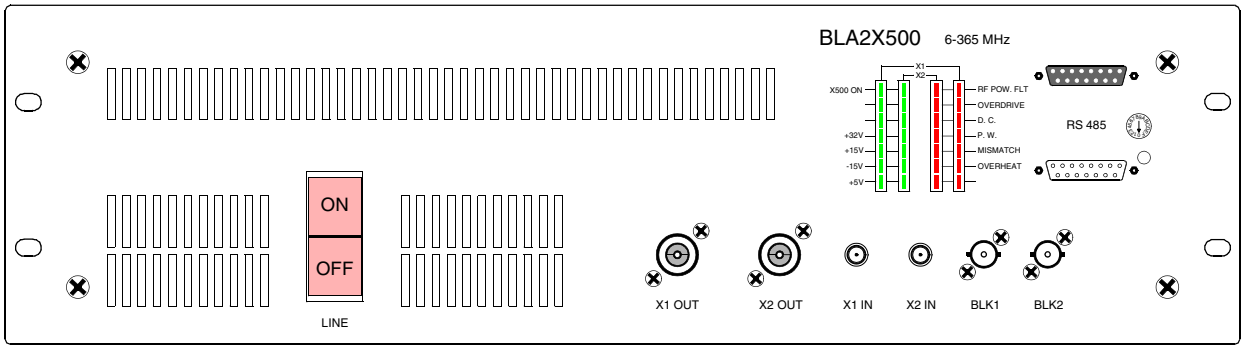



*Figure 4.2. BLAX500 front panel design*

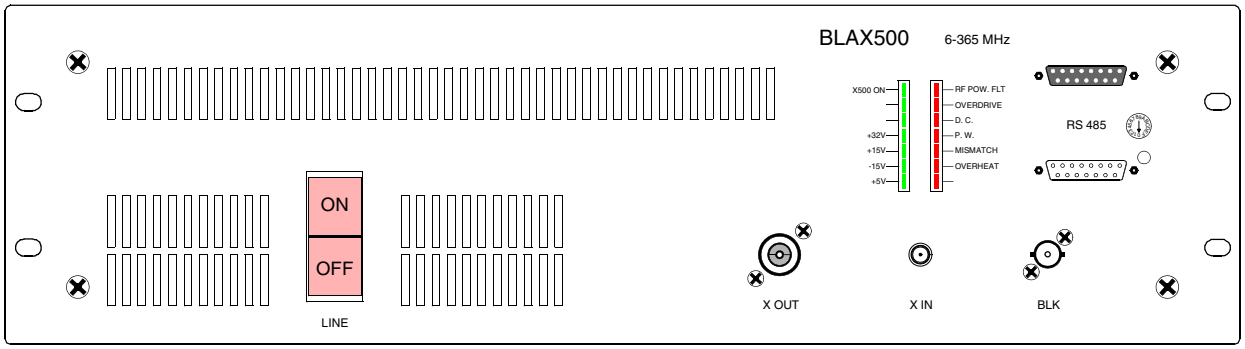
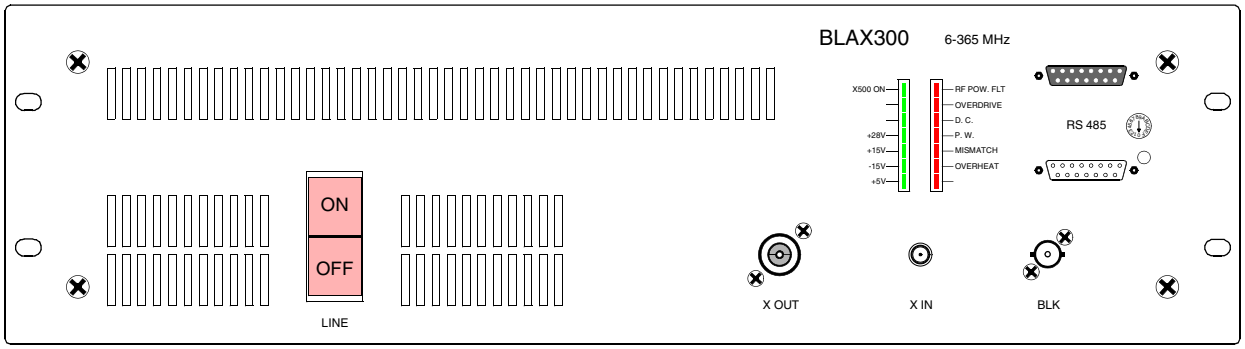



*Figure 4.3. BLAX300 front panel design*



### *Amplifiers view* *4.1.5*

*Figure 4.4. BLA2X500 view*


*Figure 4.5. BLAX500 View*

*Figure 4.6. BLAX300 Front Panel View*


## *Rear Panel* *4.2*

The rear Panel of the BLAX Serie Amplifiers is free of elements in exception of the three pole ( 2P + E ) line filter socket.

# Technical Description

# 5

## System Overview 5.1

The BLAX serie amplifiers provides one or two RF Outputs of 2 x 500W, 1 x 500W or 1 x 300W in the 6-365MHz frequency range.

The RF section of the system consists of a linear module BLMX500/500, BLMX500 or BLMX300, mounted around a single, self-contained Push fan assembly, heatsink.

The linear module BLMX500/500 includes two class AB power amplifiers.

The amplifier for the X1 channel is located on the top side of the module, and the one for the X2 channel on the bottom side.

Each channel is connected to the front panel of the amplifier via 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 overtemperature. The DSP control board reads identification information of the amplifier (BBIS). Monitoring of Fan status, Supply status and LED’s status is also performed by the control board.

Circuits such as BBIS board and LED's Status board, completes the amplifier assembly.

*Figure 5.1. BLA2X500 System Block Diagram*

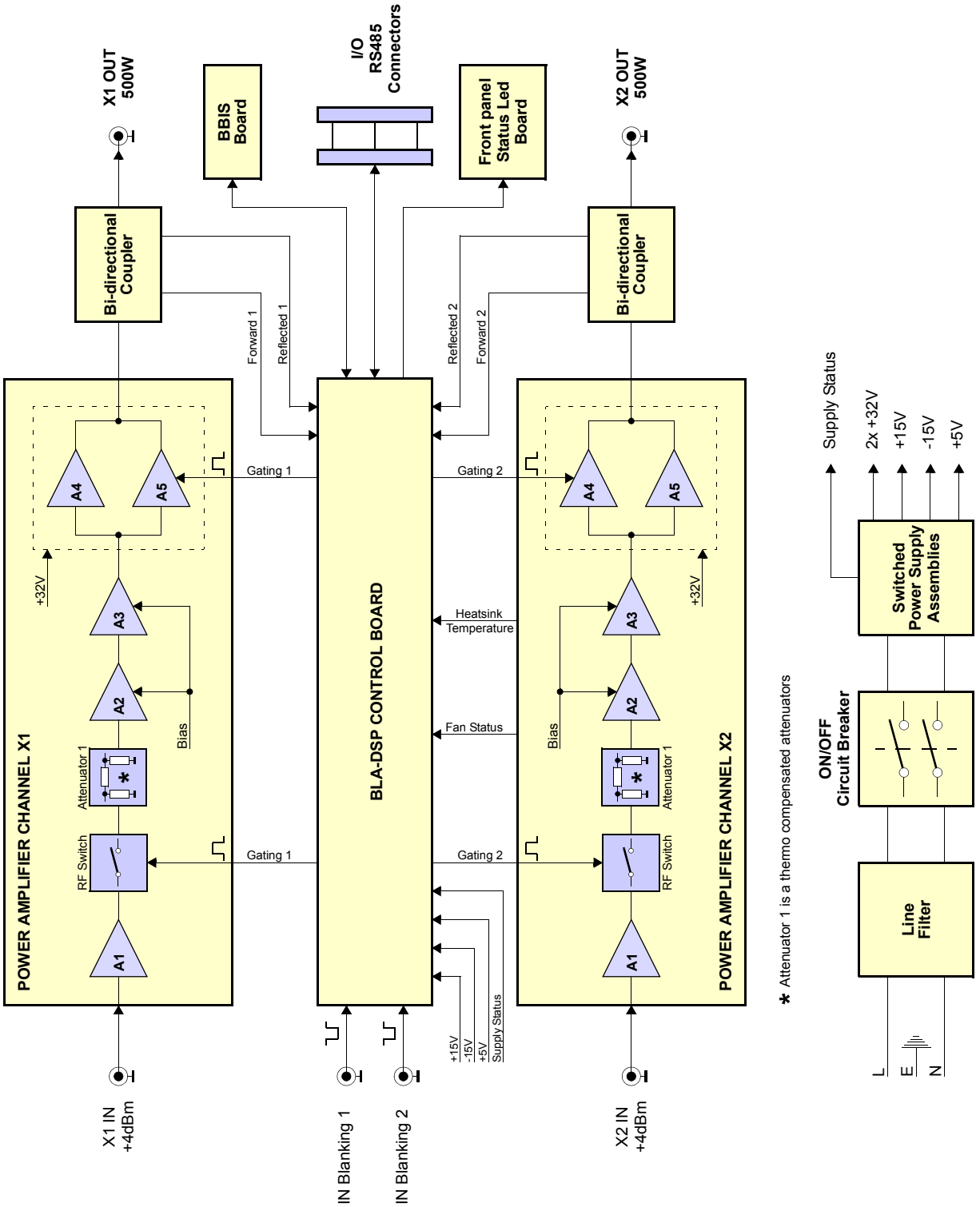


*Figure 5.2. BLAX500 System Block Diagram*

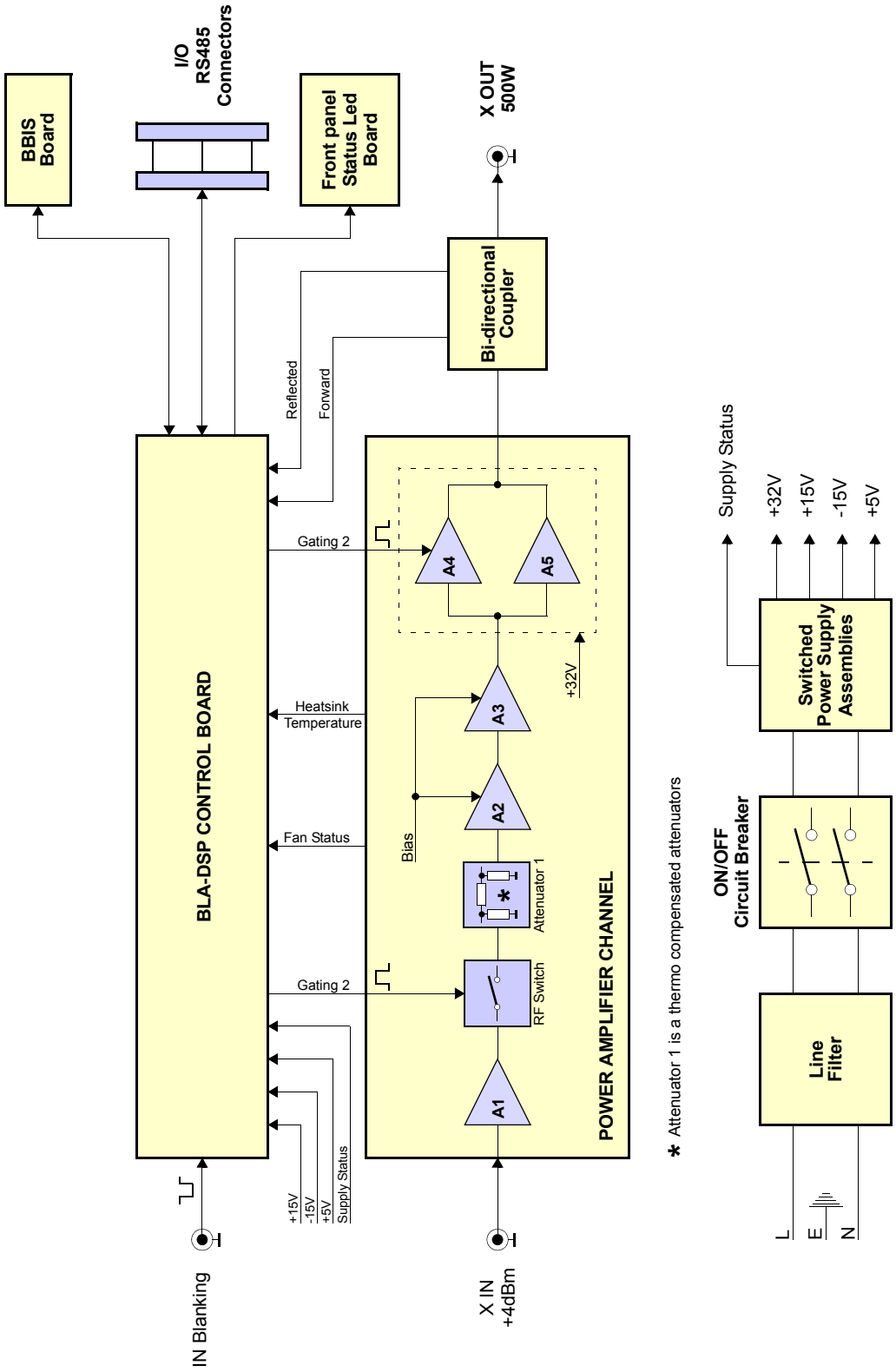
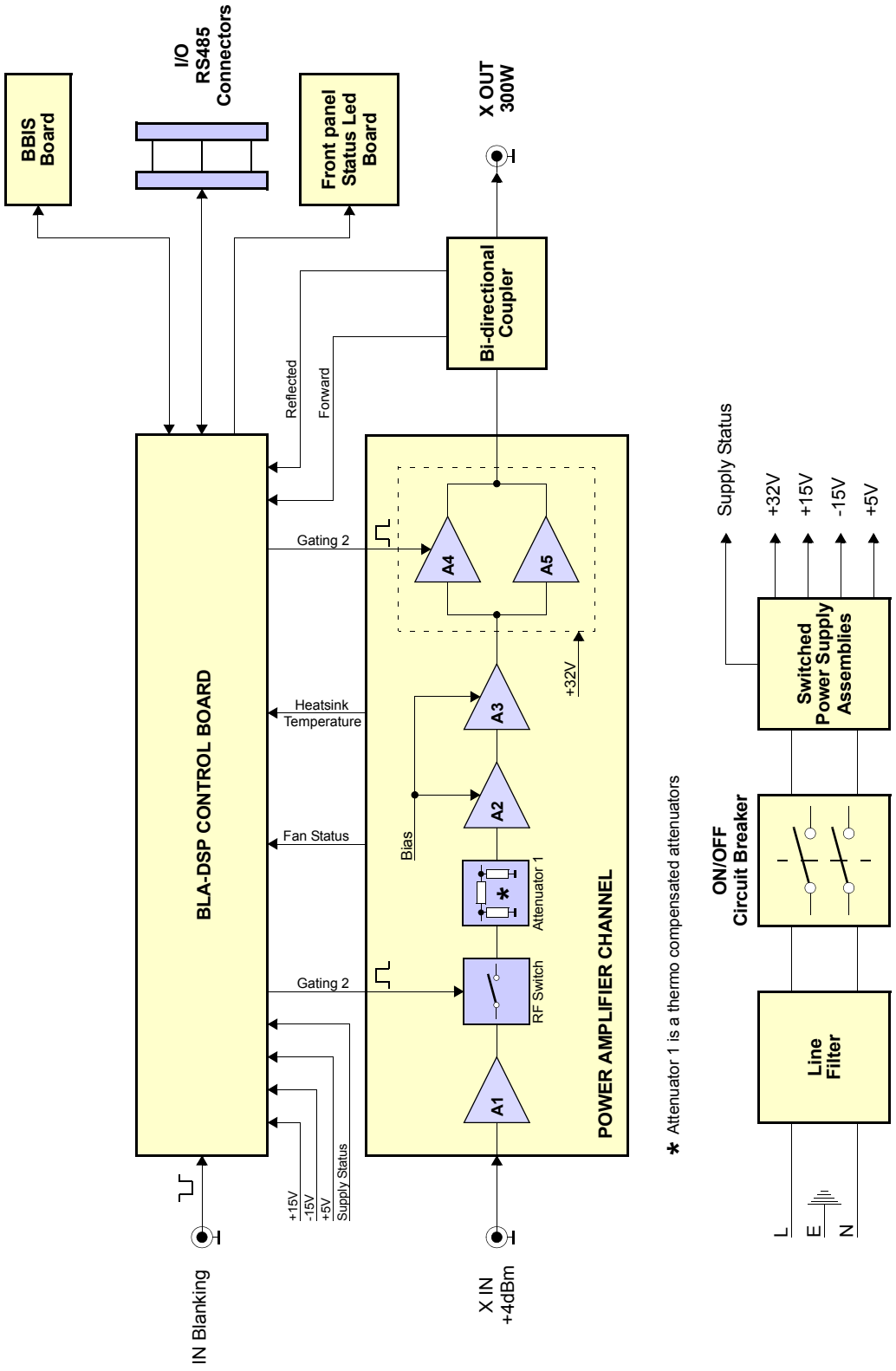


*Figure 5.3. BLAX300 System Block Diagram*



# Theory of Operation 5.2

## RF Path 5.2.1

The BLA2X500 amplifier (P/N : W1345067) consists of two Class AB power amplifiers. A nominal input power level of +4dBm produce a nominal output power of 500W peak for 6% duty cycle at 100ms pulse width maximum, on each of the both X1 and X2 channels.

The BLAX500 amplifier (P/N : W1345070) consists of only one Class AB power amplifier. A nominal input power level of +4dBm produce a nominal output power of 500W peak for 6% duty cycle at 100ms pulse width maximum, on the X out channel.

The BLAX300 amplifier (P/N : W1345069) consists of only one Class AB power amplifier. A nominal input power level of +4dBm produce a nominal output power of 300W peak for 10% duty cycle at 100ms pulse width maximum, on the Xout channel.

The units are also capable of longer pulses for lower average power, up to CW at 30W.

### RF Power Amplifiers

In the first section of the power amplifiers, the input RF signal is fed directly to a hybrid amplifier followed, via an AsGa RF Switch, by an attenuator and two class A drivers to build a nominal 40dB to 44dB gain block.
In this section, only the RF Switch requires a control board conditioned gating signal to control the operation of the switching element.

The second section of the PA includes two 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 in order to control the bias gate voltage on the gates of the FETs.
The input-output gain of this section is at nominal 13dB.

The entire RF power amplifiers have a nominal gain of 57dB and operates off +32VDC for the BLA2X500 and BLAX500, and only 53dB gain operating off +32VDC for the BLAX300.

### RF Coupler

The bi-directional couplers on the front panel provides an approximate 1V peak DC signal for full output power from the envelope.
The bi-directional couplers also provides peak DC signal for reflected power.
Both signals, forward and reflected, are analysed by the control board for monitoring and protection setting.

### 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 detections 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 also serves to process the information from the detections and protect the amplifiers 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 supplies and fan status are also being analysed 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 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 ***"Indicators" on page 11***.

### 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 6.1

*Table 6.1. BLA2X500 general specifications 2 channels*

| | |
|---|---|
| **Frequency range** | 6 to 365 MHz |
| **Linear Gain** | 57dB typical |
| **Gain Flatness** | ±1dB |
| **Peak Pulse Power** | 500W min. to 300 MHz (400W min. to 365MHz) |
| **CW Power** (limited) | 30W max. |
| **Linear Output Power** | 400W @ 1dB compression typical |
| **Linearity** | ±1dB to 400W |
| **Amplifier Biasing** | Class AB Operation |
| **Input/Output Impedance** | 50Ω |
| **Input V.S.W.R** | 1.3 max. |
| **RF Rise Time** | < 100ns, 10-90% peak power |
| **RF Fall Time** | < 50ns, 90-10% peak power |
| **Blanking Delay Time** | < 2µs typical. |
| **Output Noise Power** | < -110dBm/Hz unblanked,<br>< 25dB over Thermal Noise blanked |
| **Pulse Width** (limited) | 60ms @ 500W (up CW @ 30W) |
| **Duty Cycle** (limited) | 6% @ 500 W (up to 100% @ 30W) |
| **Amplitude Droop** | < 6% @ 300W for 20ms Pulse width<br>< 3% @ 500W for 1ms Pulse width |
| **Amplitude stability versus temperature** | ± 0,1%/C° |
| **Constant Internal Protection** | Supplies, fans faults & Overtemperature<br>Forward Power: peak & CW power<br>pulse width<br>duty cycle<br>Reflected Power: peak & CW power |
| **Front Panel Indicators** | Amplifier Status Led Board |
| **Front Panel Interfaces** | 2 x I/O 15-pin subminiature type D connectors |

# Specifications

| | |
|---|---|
| **Front Panel controls** | AC Line ON/OFF |
| **Front panel connectors** | 2 x RF input, 2 x RF output, 2 x gating input |
| **Rear Panel interface** | AC Line IN socket |
| **Cooling System** | Forced-air cooling (from front to rear) |
| **Size** | 7" H x 19" rack cabinet x 20,4" D (17,8 x 48,3 x 52cm) |
| **Weight** | 29kg |
| **Power requirements** | 220/230VAC ±15%, single phase 50/60Hz |

*Table 6.2. BLAX500 general specifications*

| | |
|---|---|
| **Frequency range** | 6 to 365 MHz |
| **Linear Gain** | 57dB typical |
| **Gain Flatness** | ±1dB |
| **Peak Pulse Power** | 500W min. to 300 MHz (400W min. to 365MHz) |
| **CW Power** (limited) | 30W max. |
| **Linear Output Power** | 400W @ 1dB compression typical |
| **Linearity** | ±1dB to 400W |
| **Amplifier Biasing** | Class AB Operation |
| **Input/Output Impedance** | 50Ω |
| **Input V.S.W.R** | 1.3 max. |
| **RF Rise Time** | < 100ns, 10-90% peak power |
| **RF Fall Time** | < 50ns, 90-10% peak power |
| **Blanking Delay Time** | < 2µs typical. |
| **Output Noise Power** | < -110dBm/Hz unblanked,<br>< 25dB over Thermal Noise blanked |
| **Pulse Width** (limited) | 60ms @ 500W (up CW @ 30W) |
| **Duty Cycle** (limited) | 6% @ 500 W (up to 100% @ 30W) |
| **Amplitude Droop** | < 6% @ 300W for 20ms Pulse width<br>< 3% @ 500W for 1ms Pulse width |
| **Amplitude stability versus temperature** | ± 0,1%/C° |
| **Constant Internal Protection** | Supplies, fans faults & Overtemperature<br>Forward Power: peak & CW power<br>pulse width<br>duty cycle<br>Reflected Power: peak & CW power |
| **Front Panel Indicators** | Amplifier Status Led Board |
| **Front Panel Interfaces** | 2 x I/O 15-pin subminiature type D connectors |
| **Front Panel controls** | AC Line ON/OFF |
| **Front panel connectors** | 2 x RF input, 2 x RF output, 2 x gating input |
| **Rear Panel interface** | AC Line IN socket |
| **Cooling System** | Forced-air cooling (from front to rear) |
| **Size** | 7" H x 19" rack cabinet x 20,4" D (17,8 x 48,3 x 52cm) |
| **Weight** | 29kg |
| **Power requirements** | 220/230VAC ±15%, single phase 50/60Hz |

*Table 6.3. BLAX300 general specifications*

| | |
|---|---|
| **Frequency range** | 6 to 365 MHz |
| **Linear Gain** | 53dB typical |
| **Gain Flatness** | ±1dB |
| **Peak Pulse Power** | 300W min. full range |
| **CW Power** (limited) | 30W max. |
| **Linear Output Power** | 300W @ 1dB compression typical |
| **Linearity** | ±1dB to 300W |
| **Amplifier Biasing** | Class AB Operation |
| **Input/Output Impedance** | 50Ω |
| **Input V.S.W.R** | 1.3 max. |
| **RF Rise Time** | < 100ns, 10-90% peak power |
| **RF Fall Time** | < 50ns, 90-10% peak power |
| **Blanking Delay Time** | < 2µs typical. |
| **Output Noise Power** | < - 114dBm/Hz unblanked,<br>< 25dB over Thermal Noise blanked |
| **Pulse Width** (limited) | 100ms @ 300W (up CW @ 30W) |
| **Duty Cycle** (limited) | 10% @ 300W (up to 100% @ 30W) |
| **Amplitude Droop** | < 6% @ 300W for 20ms Pulse width<br>< 3% @ 300W for 1ms Pulse width |
| **Amplitude stability versus temperature** | ± 0,1%/C° |
| **Constant Internal Protection** | Supplies, fans faults & Overtemperature<br>Forward Power: peak & CW power<br>pulse width<br>duty cycle<br>Reflected Power: peak & CW power |
| **Front Panel Indicators** | Amplifier Status Led Board |
| **Front Panel Interfaces** | 2 x I/O 15-pin subminiature type D connectors |
| **Front Panel controls** | AC Line ON/OFF |
| **Front panel connectors** | 1 x RF input, 1 x RF output, 1 x gating input |
| **Rear Panel interface** | AC Line IN socket |
| **Cooling System** | Forced-air cooling (from front to rear) |
| **Size** | 7" H x 19" rack cabinet x 20,4" D (17,8 x 48,3 x 52 cm) |
| **Weight** | 28kg |
| **Power requirements** | 220/230VAC ±15%, single phase 50/60Hz |

# Figures

# Figures

# Tables

# Tables