

**BLA2X500
BLAX500 & BLAX300**

**Amplifier 6-365MHz
User Manual**

Version 001

BRUKER

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Contents

	Contents	3
	Index	5
1	General Information.....	7
1.1	Introduction	7
1.2	System Check	7
1.3	Initial Turn On Procedure	8
2	Safety	9
2.1	Labels	9
	Dangerous Area	9
	Name Plate	9
3	BLAX Serie Amplifier Operation.....	11
3.1	Front Panel	11
	Indicators	11
	Connectors	12
	Interface Connectors RS485	12
3.2	Front Panel	13
3.3	Rear Panel	15
4	Technical Description.....	17
4.1	System Overview	17
4.2	Theory of Operation	21
	RF Path	21
	Control Board	22
	Supply Status Board	22
	Status Led Board	22
5	Specifications	23
5.1	General specifications	23
	Figures	27
	Tables	29

Index

A

AC input voltage..... 7

C

Connectors..... 12

I

Indicators..... 11

N

Nominal input level..... 7

R

Revision Number..... 9

S

Serial Number 9

Specifications 23

T

Type of the product 9

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 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 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.

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 ≥ 6)
- Thermal overload (overheat)

The amplifier is powered by an internal Switched power supply assembly that provides the 30VDC 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.

System Check

1.2

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

- The AC input voltage from the Amplifiers must be compatible with 176 to 264 VAC range.
- External blanking (gating) pulses must be supplied to the amplifier in order for the unit to function. Ensure that these pulses are of proper level and logic polarity.
- The BLAX serie amplifiers has a nominal input level of +4dBm. Ensure that the system drivers are operating at these levels.

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

Before starting this procedure, make sure that you have properly followed instructions in the "System Check" Section.

1. Connect the amplifier to the AC line and turn the circuit breaker on the front panel, to ON.
2. Observe the indicators on the front panel:
 - The +28V or +32V LEDES will illuminate
 - The +15V, -15V, and +5V LEDES will illuminate
3. System is now fully operational.

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

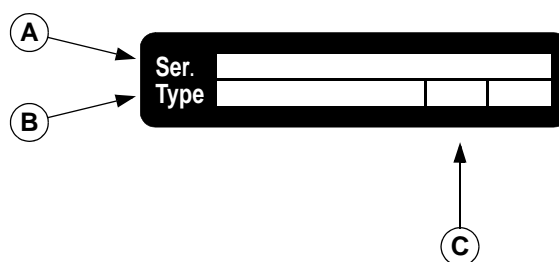
WARNING ! High Voltage.



Name Plate

2.1.2

Amplifiers BLAX serie can be identified by a name plate at the front panel of the unit which has information as follows :



- **(A) Ser.**
This line contains an assembly number which identifies the Part and the Serial number of the product.
- **(B) Type**
This line contains the designation of the product.
- **(C) Revision**
This cell indicates the revision number which identifies the product configuration. The initial revision is 00.

BLAX Serie Amplifier Operation

3

Front Panel

3.1

The BLAX Serie front panel is provided with 1 or 2 x 11 indicators for status monitoring, 3 or 6 connectors, and 2 interface connectors.

Indicators

3.1.1

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

Table 3.1. Indicators

+28V (+32V) ON	Indicates that the 28V or 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	Indicates when the duty cycle limit has been reached.
Pulse Width	Indicates when the pulse width limit has been reached.
Mismatch	Indicates when the max. reflected power limit has been reached.
RF Power FLT	Lights ON 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. All gatings are removed from the amplifier until the unit cools. The function is self-resetting and no maintenance is needed.
X or X1 / X2 ON	Lights on when RF Power is present.

Table 3.2. Connectors

X or X1 / X2 IN	RF in SMA type connectors (female). 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). 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.

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 3.3. 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)

Figure 3.1. BLA2X500 Front Panel Design

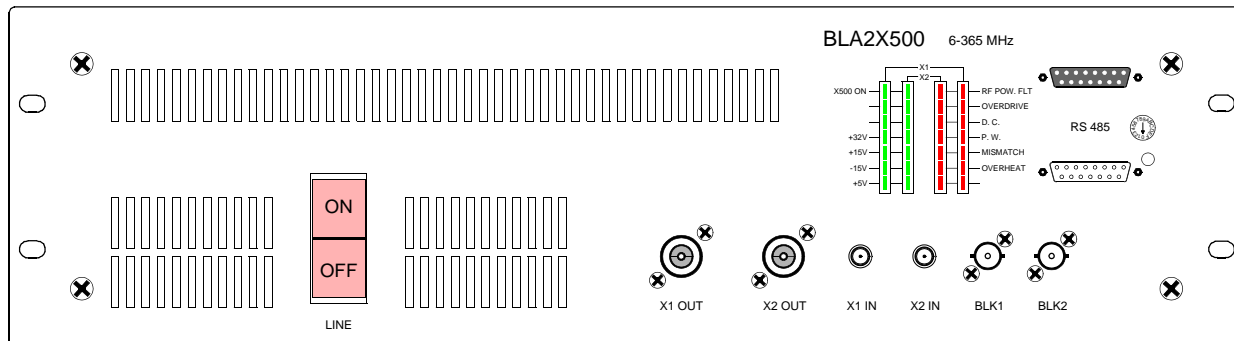


Figure 3.2. BLA2X500 Front Panel View



BLAX Serie Amplifier Operation

Figure 3.3. BLAX500 Front Panel Design

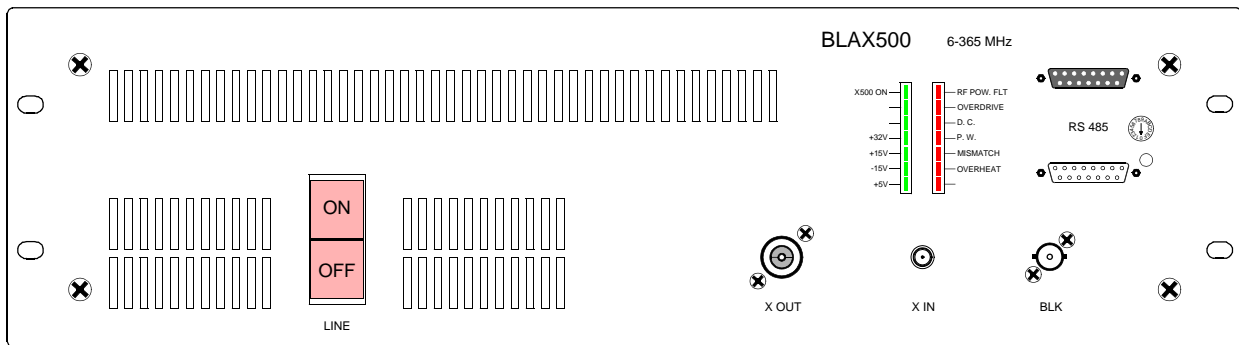


Figure 3.4. BLAX500 Front Panel View



Figure 3.5. BLAX300 Front Panel Design

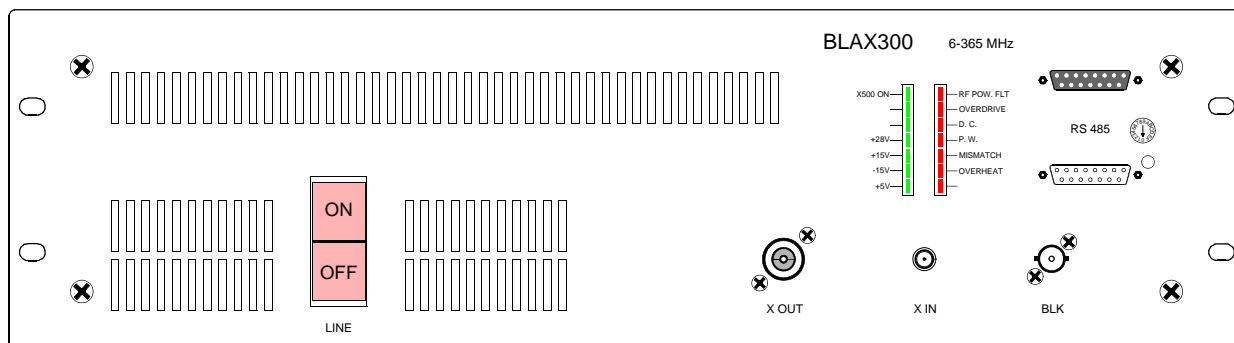


Figure 3.6. BLAX300 Front Panel View



Rear Panel

3.3

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

4

System Overview

4.1

The BLAX serie amplifiers provides one or two RF Outputs of 2 x 500W, 1 x 500W or 1 x 300W in the 6-365 MHz 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, providing protection from excessive peak power, duty cycle and pulse width for average power, maximum reflected power; and heatsink overtemperature.

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

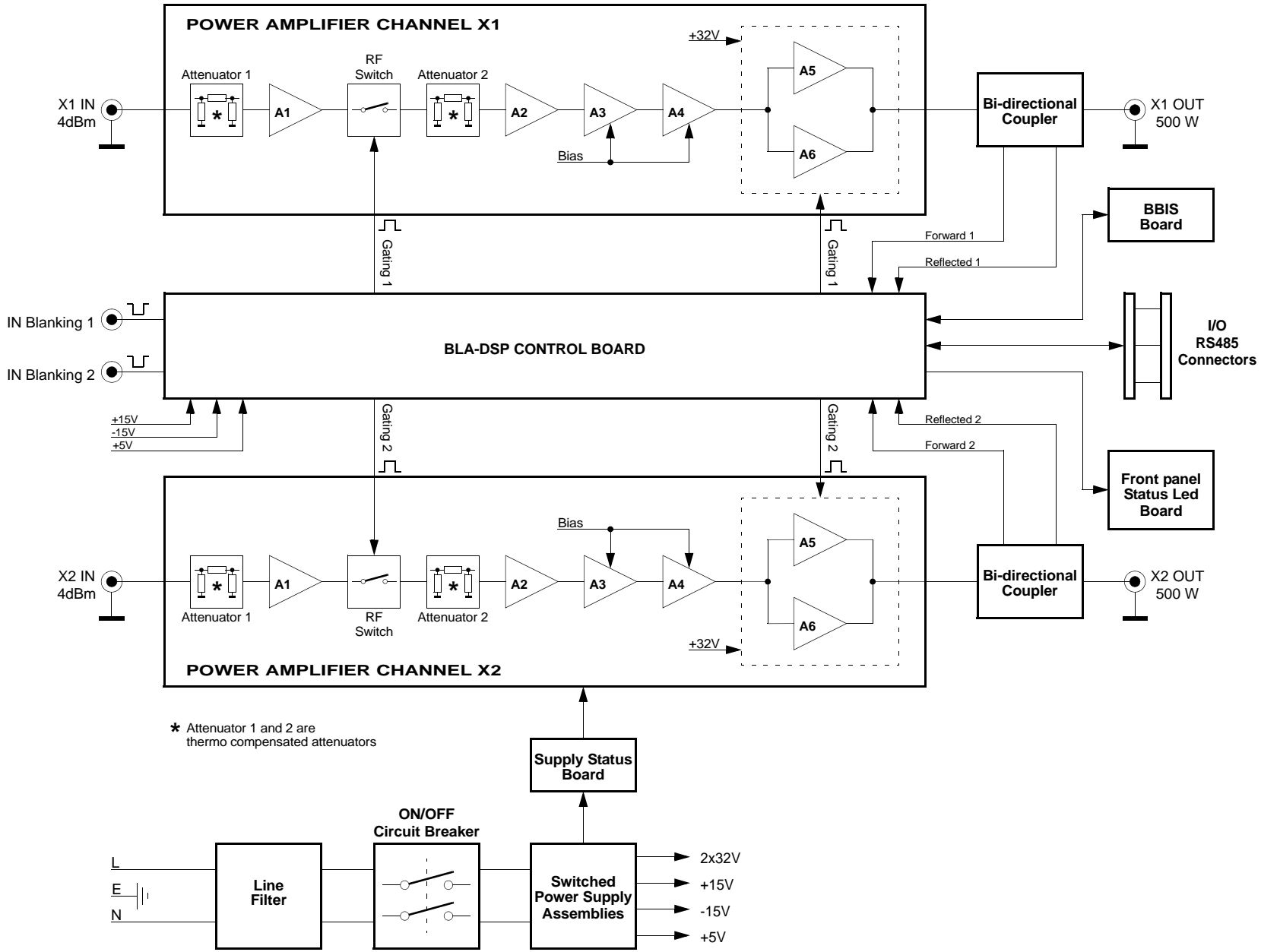


Figure 4.1. BLA2X500 System Block Diagram

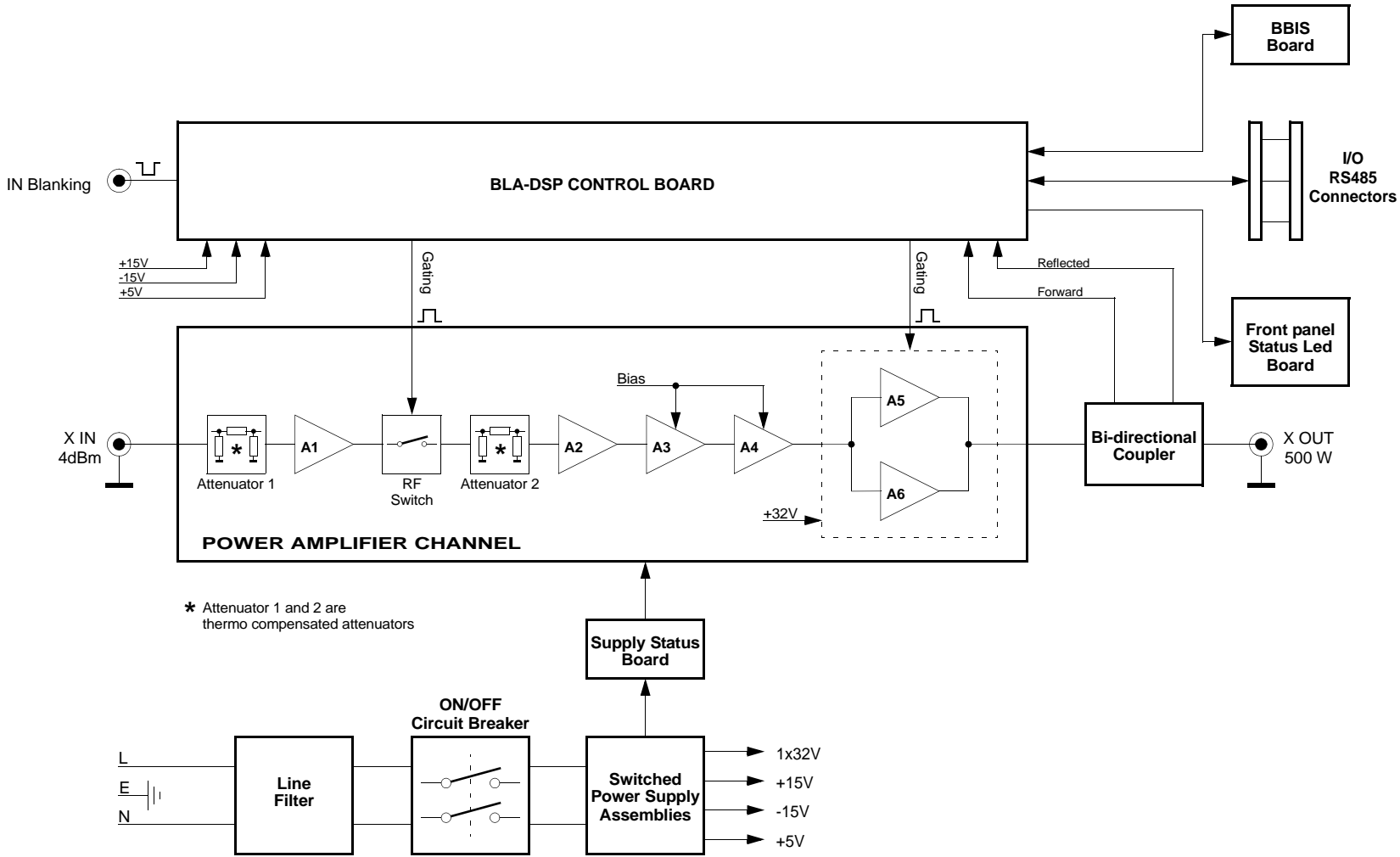


Figure 4.2. BLAX500 System Block Diagram

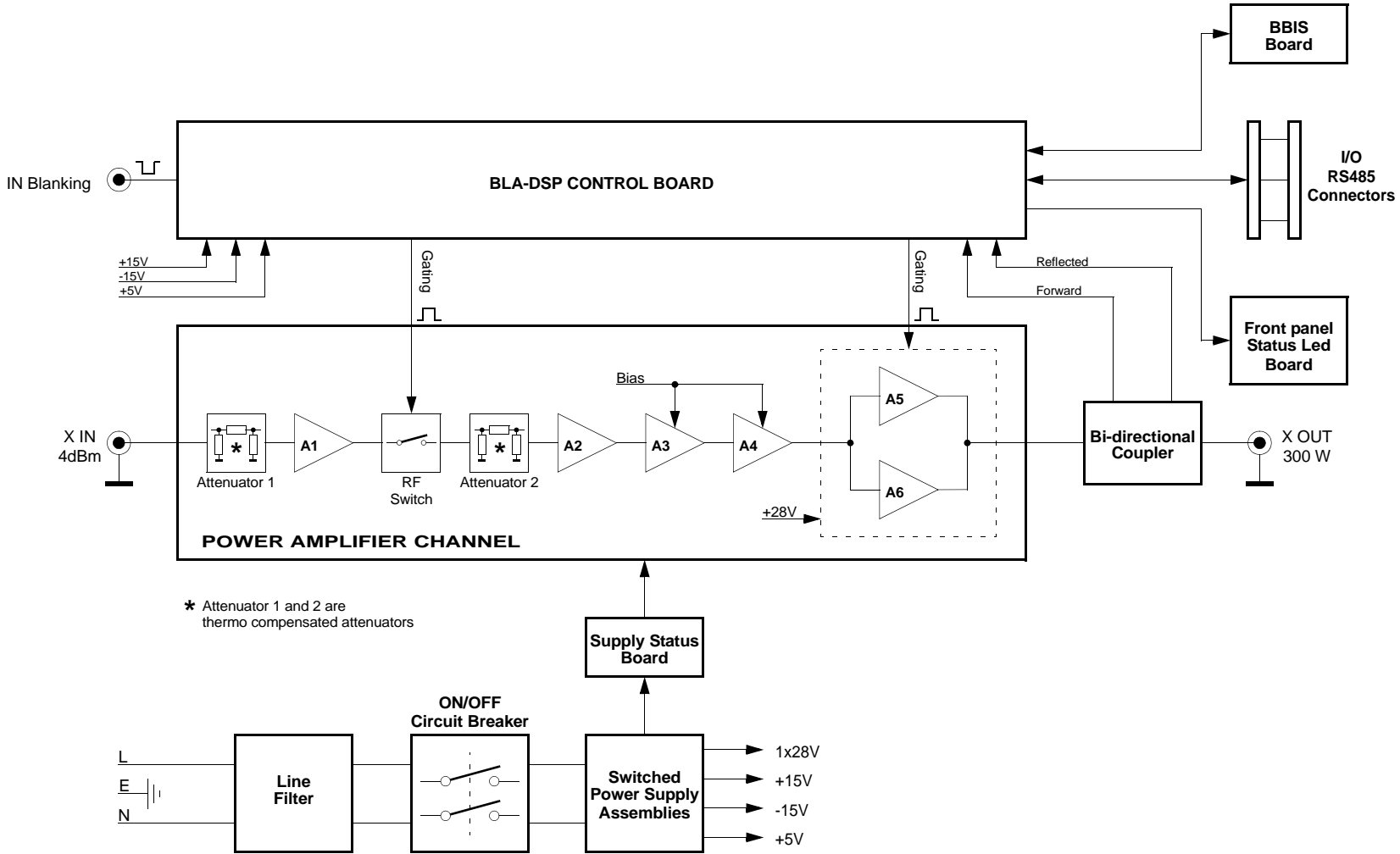


Figure 4.3. BLAX300 System Block Diagram

Theory of Operation**4.2**

RF Path**4.2.1**

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 through an attenuator to a hybrid amplifier followed, via an AsGa RF Switch, by a second attenuator and hybrid amplifier and two class A drivers to built 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 57dB of gain, and operates off +32VDC for the BLA2X500 and BLAX500, and only 53dB gain operating off +28VDC 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

4.2.2

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.

Information from supplies and fan status 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.

Supply Status Board

4.2.3

This board gives the information of the status of the power supplies.

A defect on one or more of the supplies is read by the control board, and in case of, the gating signals are disabled while the defect is visualized on the front panel led display.

Status Led Board

4.2.4

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

Specifications

5

General specifications

5.1

Table 5.1. BLA2X500 general specifications 2 channels

Frequency range	6 to 365 MHz
Linear Gain	57 dB typical
Gain Flatness	± 2 dB
Peak Pulse Power	500 W min. to 300 MHz (400 W min. to 365 MHz)
CW Power (limited)	30 W max.
Linear Output Power	400 W @ 1 dB compression typical
Linearity	± 1 dB to 400 W
Amplifier Biasing	Class AB Operation
Input/Output Impedance	50 Ω
RF Rise Time	< 100 ns, 10-90% peak power
RF Fall Time	< 50 ns, 90-10% peak power
Blanking Delay Time	< 1 μs typical.
Output Noise Power	< - 105 dBm/Hz unblanked, < - 140 dBm/Hz blanked
Pulse Width (limited)	60 ms @ 500 W (up CW @ 30 W)
Duty Cycle (limited)	6 % @ 500 W (up to 100 % @ 30 W)
Amplitude Droop	< 6 % @ 300 W for 20 ms Pulse width < 3 % @ 500 W for 1 ms Pulse width
Amplitude stability versus temperature	≥ ± 0,1% / C°
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-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

Specifications

Table 5.1. *BLA2X500 general specifications 2 channels*

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	29 kg
Power requirements	180 - 276 VAC, single phase 50 - 60 Hz

Table 5.2. BLAX500 general specifications

Frequency range	6 to 365 MHz
Linear Gain	57 dB typical
Gain Flatness	± 2 dB
Peak Pulse Power	500 W min. to 300 MHz (400 W min. to 365 MHz)
CW Power (limited)	30 W max.
Linear Output Power	400 W @ 1 dB compression typical
Linearity	± 1 dB to 400 W
Amplifier Biasing	Class AB Operation
Input/Output Impedance	50 Ω
RF Rise Time	< 100 ns, 10-90% peak power
RF Fall Time	< 50 ns, 90-10% peak power
Blanking Delay Time	< 1 μ s typical.
Output Noise Power	< - 105 dBm/Hz unblanked, < - 140 dBm/Hz blanked
Pulse Width (limited)	60 ms @ 500 W (up CW @ 30 W)
Duty Cycle (limited)	6 % @ 500 W (up to 100 % @ 30 W)
Amplitude Droop	< 6 % @ 300 W for 20 ms Pulse width < 3 % @ 500 W for 1 ms Pulse width
Amplitude stability versus temperature	$\geq \pm 0,1\% / C^\circ$
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-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	28 kg
Power requirements	180 - 276 VAC, single phase 50 - 60 Hz

Specifications

Table 5.3. BLAX300 general specifications

Frequency range	6 to 365 MHz
Linear Gain	53 dB typical
Gain Flatness	± 2 dB
Peak Pulse Power	300 W min. full range
CW Power (limited)	30 W max.
Linear Output Power	250 W @ 1 dB compression typical
Linearity	± 1 dB to 300 W
Amplifier Biasing	Class AB Operation
Input/Output Impedance	50 Ω
RF Rise Time	< 100 ns, 10-90% peak power
RF Fall Time	< 50 ns, 90-10% peak power
Blanking Delay Time	< 1 μs typical.
Output Noise Power	< - 109 dBm/Hz unblanked, < - 146 dBm/Hz blanked
Pulse Width (limited)	100 ms @ 300 W (up CW @ 30 W)
Duty Cycle (limited)	10 % @ 300 W (up to 100 % @ 30 W)
Amplitude Droop	< 6 % @ 300 W for 20 ms Pulse width
Amplitude stability versus temperature	≥ ± 0,1% / C°
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-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	28 kg
Power requirements	180 - 276 VAC, single phase 50 - 60 Hz

Figures

1	General Information	7
2	Safety	9
3	BLAX Serie Amplifier Operation	11
Figure 3.1.	BLA2X500 Front Panel Design	13
Figure 3.2.	BLA2X500 Front Panel View	13
Figure 3.3.	BLAX500 Front Panel Design	14
Figure 3.4.	BLAX500 Front Panel View	14
Figure 3.5.	BLAX300 Front Panel Design	15
Figure 3.6.	BLAX300 Front Panel View	15
4	Technical Description	17
Figure 4.1.	BLA2X500 System Block Diagram	18
Figure 4.2.	BLAX500 System Block Diagram	19
Figure 4.3.	BLAX300 System Block Diagram	20
5	Specifications	23

Tables

1	General Information	7
2	Safety	9
3	BLAX Serie Amplifier Operation	11
Table 3.1.	Indicators	11
Table 3.2.	Connectors	12
Table 3.3.	RS485 pinout	12
4	Technical Description	17
5	Specifications	23
Table 5.1.	BLA2X500 general specifications 2 channels	23
Table 5.2.	BLAX500 general specifications	25
Table 5.3.	BLAX300 general specifications	26

