



# SS1G-500

**Solid State  
Power Amplifier**

## *Operation Manual*



## RECORD OF REVISIONS

The EMC Shop is constantly improving its products and therefore the information in this document is subject to changes.

The EMC Shop makes no warranty of any kind with regard to this material, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. No responsibility for any errors or omissions that may pertain to the material herein is assumed.

Copying of this document, making it available to others and the use or communication of the contents thereof is forbidden without authorization by The EMC Shop. Offenders are liable to payment of damages. All rights reserved in the event of a patent or a registration of a utility model or design.

The EMC Shop assumes no responsibility for use of any circuitry other than the circuitry employed in the The EMC Shop equipment.

This operation manual is for the amplifier:

**SS1G-500**                      **S/N: 2214220A**

This unit is equipped with the following options:

**L      Ethernet remote control interface**

## TABLE OF CONTENTS

<b>1. DATASHEET</b> .....	IV
<b>2. PREPARATION FOR USE</b> .....	1
2.1. Setting up the amplifier .....	2
2.2. Rack mounting .....	2
2.3. Mains connection .....	2
2.4. RF connectors.....	2
2.5. Interlock safety loop .....	3
<b>3. OPERATION</b> .....	5
3.1. Front panel view.....	5
3.2. Rear panel view .....	7
3.3. Manual operation .....	8
3.4. Remote control .....	11
3.4.1. Commands on the remote control interfaces.....	13
3.4.2. Status messages of the amplifier on the remote control interfaces.....	16
3.4.3. TTL Remote control interface .....	19
3.4.4. Remote control via the IEC/IEEE-488.2 GPIB interface (Option C) .....	20
3.4.5. Remote control via the Ethernet interface (Option L) .....	23
3.4.6. Remote control via the RS232 or RS485 interface (Option R) .....	27
3.4.7. Remote control via the USB interface (Option U).....	28
3.5. Typical application.....	29
<b>4. FUNCTIONAL DESCRIPTION</b> .....	30
4.1. RF amplifier.....	30
4.2. Power supply.....	31
4.3. Monitor output (Option A).....	32
4.4. IEEE-488.2 GPIB remote control interface (Option C).....	32
4.5. Output power indication (Option E).....	32
4.6. Gain Adjustment (Option F).....	32
4.7. Ethernet remote control interface (Option L).....	33
4.8. RS232 or RS485 remote control interface (Option R).....	33
4.9. USB remote control interface (Option U) .....	33
4.10. Control.....	33
<b>5. MAINTENANCE AND TROUBLESHOOTING</b> .....	34
5.1. Maintenance.....	34
5.2. Troubleshooting.....	35
<b>6. TESTING THE RATED SPECIFICATIONS</b> .....	36
6.1. Measuring equipment and auxiliary means.....	36
6.2. Test sequence .....	37
6.2.1. RF Characteristics .....	37
6.2.2. Interlock function.....	41
6.2.3. Messages via the TTL remote control interface.....	41
6.2.4. Status messages on the remote control interfaces.....	42
6.3. Performance test report .....	45
<b>7. APPENDIX</b> .....	46

## LIST OF FIGURES AND TABLES

Fig. 2-1: Pin assignment of remote control and interlock connector

Fig. 2-2: Example of interlock safety loop

Table 3-1: ASCII/ISO and IEC character set

Table 3-2: Commands at the remote control interfaces

Table 3-3: Status messages at the remote control interfaces

Table 3-4: Signals at the remote control and interlock connector

Table 3-5: Pin configuration of the IEEE interface

Table 3-6: IEEE universal commands

Table 3-7: IEEE addressed commands

Table 3-8: Pin configuration of the Ethernet interface

Table 3-9: Configuration of the Ethernet interface

Table 3-10: Pin configuration of the RS232 or RS485 interface

Table 3-11: Configuration of the RS232 or RS485 interface

Table 3-12: Pin configuration of the USB interface

Table 3-13: Configuration of the USB interface

Fig. 3-1: Front panel view (in appendix)

Fig. 3-2: Rear panel view (in appendix)

Fig. 3-3: User menu

Fig. 3-4: Typical application (in appendix)

Fig. 4-1: Block diagram of complete amplifier (in appendix)

Fig. 4-2: Block diagram of RF amplifier module (in appendix)

Fig. 4-3: Block diagram of power supply (in appendix)

Table 6-1: Measuring equipment and auxiliary means

Table 6-2: Signals at the remote control and interlock connector

Table 6-3: Status messages at the remote control interfaces

Fig. 6-1: Test setup (in appendix)

## DATASHEET

### SPECIFICATIONS

Frequency Range	80 MHz to 1 GHz
Output Power P <sub>N</sub> min / typ W	500 / 600
Gain min / typ dB	57 / 59 ±2
Harmonics 2nd / 3rd dBc	20 / 20
Line Power VA	3300
Dimensions (H, D) 19"-System	4 HU, 24,8 in
Weight	92,5 lb

### STANDARD SPECIFICATIONS

Input Power	0 dBm (1 mW) max.
Overdrive Protection	up to +10 dBm for no damage
Input Impedance	50 Ohm nominal
Output Impedance	50 Ohm nominal
Input VSWR	<2:1 typ.
Load VSWR	infinite for no damage (100% mismatch tolerant) P <sub>N</sub> -0.5 dB min. at VSWR 2:1
Spurious (at P <sub>N</sub> )	-60 dBc typ. (excluding harmonics)
Class of Operation	A-linear or AB-linear

### GENERAL

RF Input	N-f, standard on rear panel
RF Output	N-f, standard on rear panel
Mains Supply	200 ... 240 V AC ±10%, 47 ... 63 Hz
Elapsed Time Meter	via status display
Ambient Temperature	0 ... +45 °C
Storage Temperature	-20 ... +85 °C
Relative Humidity	up to 95% (non-condensing)
Operating Altitude	up to 2000 m above sea level
Vibration and Shock	MIL-STD-810 G
Cooling	forced air with integral blower air intake from front, air exhaust at rear

### OPTIONS

- |  |                                     |   |
|--|-------------------------------------|---|
| <b>A</b> RF-Sample Ports                   | <b>F</b> Gain Adjustment            | <b>R</b> RS-232C/RS-485 Remote Control        |
| <b>B</b> External Dual Directional Coupler | <b>H</b> DC Supply                  | <b>U</b> USB Remote Control                   |
| <b>C</b> IEEE-488.2 GPIB Remote Control    | <b>I</b> 3x 208 V AC / 60 Hz        | <b>W</b> Liquid Cooling                       |
| <b>D</b> Front Panel RF Connectors         | <b>L</b> LAN Remote Control         | <b>X</b> External Control of other Amplifiers |
| <b>E</b> RF Power Indication (digital)     | <b>S</b> Internal RF Switching Unit |   |

## 2. PREPARATION FOR USE



### **Pay Attention to the Operating Instructions!**

*Always read the operation manual carefully and always comply to all instructions in the operation manual.*

*During operation there may be a hazard due to electromagnetic fields.  
(According to Part 2 of VDE 0848)!*



### **Dangerous Electric Voltages!**

*During open-circuit operation, the voltage at the center conductor of the output connector may exceed 50 V AC.*

*Dangerous electric voltages are used in the instrument. Operation with open covers is only allowed for service purposes and only by qualified service personnel.*

### **Caution!**

*This device generates RF power, which can be emitted unintentionally if the operating instructions and the general safety regulations are not observed!*

*This amplifier corresponds to rating class 1A according to VDE 0800. The AC voltage at the output is  $\leq 60$  Vrms.*

## 2.1. Setting up the amplifier

When setting up the amplifier, make sure that the cooling airflow is impeded neither at the air inlet at the front nor at the outlet at the rear. The permissible operating temperature ranges from +5°C to +45°C with an air humidity of max. 95%.

**Caution!** *The temperature of the inlet cooling air must not exceed +45 °C. The outlet air temperature should be maximum 20 °C higher than the inlet air temperature.*

## 2.2. Rack mounting

For rack installation the feet of the housing can be removed. The fixing screws are located under the rubber inserts at the bottom side of the feet.

To ensure sufficient ventilation, make sure to provide enough space between the casing and the air inlet at the front panel and the air outlet at the rear.

Make sure that there is sufficient air supply inside the rack (forced ventilation) and that no over-heating can occur due to other instruments placed under or over the amplifier.

**Caution!** *The temperature of the inlet cooling air must not exceed +45 °C.*

## 2.3. Mains connection

The amplifier is equipped with a power supply which can be operated at a voltage of 200 ... 240 V AC. The line fuses (2x 25 A T) are located in the mains connection unit of the instrument.

**Note:** *When connecting the amplifier to the AC mains network, make sure to provide a proper protective earth connection according to the regulations.*

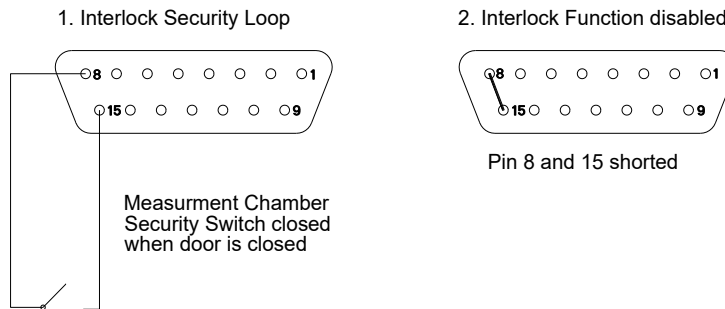
## 2.4. RF connectors

The amplifier is equipped with **N-series female** connectors at all RF connectors. The mating connectors must be tightened with the correct torque!

## 2.5. Interlock safety loop

This amplifier permits an interlock safety loop to be connected, which must be always closed for activating the amplifier. The interlock function protects the user against unintentional emission of RF power.

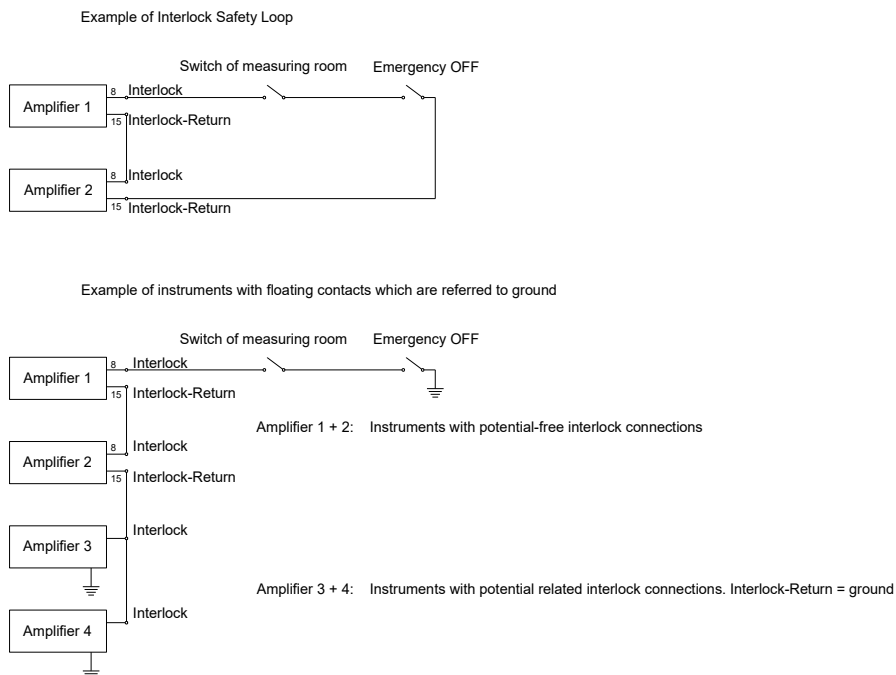
It is necessary to wire the attached mating connector for the Remote Control and Interlock connector at the rear panel of the instrument as shown below. Pin 8 and pin 15 should be connected to the safety loop of the measuring room.



**Fig 2-1: Pin assignment of remote control and interlock connector**

This ensures that the amplifier can only be switched on when the safety switch, and thus the door of the measuring room, is closed.

The EXTERNAL INTERLOCK and EXTERNAL INTERLOCK RETURN contacts are designed as floating ones. In this way more than one amplifier can be interconnected in an interlock system with a common switch or a common loop.



**Fig. 2-2: Example of interlock safety loop**



If this safety function is not used after thorough examination, the interlock contact can be bridged in the Remote Control and Interlock connector. This is done using a jumper from pin 8 EXTERNAL INTERLOCK to pin 15 EXTERNAL INTERLOCK RETURN.

**Note:** *If the interlock connection is missing, the amplifier cannot be operated!*

*Finally check that there is no message indicating an interlock error status on the display. Now the amplifier is ready for use and can be operated either manually via the front panel or via one of the remote control interfaces.*

### 3. OPERATION

#### 3.1. Front panel view

See Fig. 3-1: Front panel view (in appendix)

- |   |   |
|---|---|
| <p><b>1</b> STATUS</p>  | <p>LED LED is illuminated blue when the amplifier is active LED, is illuminated yellow during the turn on sequence LED, is illuminated red when a fault occurs.</p>   |
| <p><b>2</b> DISPLAY</p> <p>TYPE OF AMPLIFIER</p> <p>ELAPSED TIME METER</p> <p>IEEE-ADDRESS</p> <p>AMPLIFIER STATUS</p> <p>FAULT INDICATIONS</p> <p>POWER INDICATION</p>   | <p>Status Display</p> <p>Indication of Amplifier model number</p> <p>Indication of hours in operation</p> <p>Setting of the IEEE-address</p> <p>See chapter 3.3/3.4</p> <p>See chapter 5.2</p> <p>(only if Option E is installed)</p>   |
| <p><b>3</b> AMPLIFIER KEY</p> <p>Display: <b>AMP=ON</b></p> <p>Display: <b>AMP=OFF</b></p>  | <p>Key for switching the amplifier on/off</p> <p>Amplifier active (RF switched on)</p> <p>Amplifier in standby (RF switched off)</p>  |
| <p><b>4</b> BAND/GAIN KEY</p> <p>Display: <b>BAND=x</b></p><br><p>Display: <b>xx dB xx dB</b></p>   | <p>Key for switching the amplifier band (only if Option S is installed)</p> <p>Band x is selected</p> <p>Key for selecting the gain setting (only if Option F is installed)</p> <p>Attenuation is selected</p>  |
| <p><b>5</b> CONTROL KEY</p> <p>Display: <b>LOCAL</b></p> <p>Display: <b>TTL</b></p> <p>Display: <b>GPIB</b></p> <p>Display: <b>LAN</b></p> <p>Display: <b>USB</b></p> <p>Display: <b>RS232</b></p> <p>Display: <b>RS485</b></p> <p>Display: <b>EXTERN</b></p> | <p>Key for switching to local control mode</p> <p>Front Panel control enabled</p> <p>Standard remote control enabled</p> <p>IEEE 488.2 GPIB remote control enabled</p> <p>Ethernet remote control enabled</p> <p>USB remote control enabled</p> <p>RS232 remote control enabled</p> <p>RS485 remote control enabled</p> <p>Remote control by external amplifier enabled</p> |

- |                        |  |
|------------------------|--|
| <b>6</b> RF INPUT      | RF-input connector (only if Option D is installed)           |
| <b>7</b> RF OUTPUT     | RF-output connector (only if Option D is installed)          |
| <b>8</b> FORWARD       | Forward monitor output (only if Options A+D are installed)   |
| <b>9</b> REFLECTED     | Reflected monitor output (only if Options A+D are installed) |
| <b>10</b> MAINS SWITCH | Illuminated in green color if the instrument is switched on  |

### 3.2. Rear panel view

See Fig. 3-2: Rear panel view (in appendix)

<b>11</b>	MAINS RECEPTACLE	AC power connection unit with integrated fuses 10 A
<b>12</b>	REMOTE CONTROL AND INTERLOCK CONNECTOR	Connector for interlock loop and the TTL remote control interface
<b>13</b>	ETHERNET CONNECTOR	Ethernet remote control interface connector (only if Option L is installed)
<b>14</b>	IEEE CONNECTOR	IEEE 488.2 GPIB remote control interface (only if Option C is installed)
<b>15</b>	USB CONNECTOR	USB remote control interface connector (only if Option U is installed)
<b>16</b>	RF INPUT	RF input connector
<b>17</b>	RF OUTPUT	RF output connector
<b>18</b>	FORWARD	Forward monitor output (only if Option A is installed)
<b>19</b>	REFLECTED	Reflected monitor output (only if Option A is installed)
<b>20</b>	FANS	
<b>21</b>	EXTERNAL CONTROL	Connector for external system control (only if Option X is installed)
<b>22</b>	RS232/RS485 CONNECTOR	RS232/RS485 remote control interface connector (only if Option R is installed)
<b>23</b>	GND	External ground connection bolt
<b>24</b>	MAINS FUSE	Mains fuse 25 A

### 3.3. Manual operation

- Press the MAINS switch to turn on the amplifier.

The MAINS switch is illuminated. Only the main control board is supplied and the turn-on procedure of the instrument is executed.

- The model number will be shown in the power up screen on the display. (Screen P)
- After 2 seconds the amplifier will change the display to its main screen. (Screen M) The amplifier is now in standby and in the local control mode (Display: **LOCAL**).

In this state the amplifier offers a so called user menu, which allows viewing miscellaneous diagnostic parameters of the instrument and allows adjusting of the IEEE address.

The following description refers to the figure 3.3 user menu on the next page which gives an overview of the user menu pages: From the main screen, the user menu can be accessed by pushing the left and the right button below the display simultaneously for at least 0.5 seconds.

The 1<sup>st</sup> page of the user menu is the voltage and current page. (Screen V) It is primary intended for diagnostics (e.g. during checking or service) and shows the actual voltage and current values of all the internal power supply output channels of the instrument. By clicking the left or right button below the display, the previous or next supply channel can be monitored. In case, there is no diagnostic indication available (only outputs with voltage measurement are activated), "no indication avail" is shown in the display. The voltage and current page can be left by pushing the left and the right button below the display simultaneously for at least 0.5 seconds.

The 2<sup>nd</sup> page of the user menu is the amplifier identification screen. (Screen I) This screen shows the type and serial number of the amplifier (same as the remote control command "\*\*IDN?" will respond). The amplifier identification page can be left by pushing the left and the right button below the display simultaneously for at least 0.5 seconds.

The 3<sup>rd</sup> page of the user menu is the elapsed time meter screen. (Screen E) This screen shows the overall amount of time that the amplifier has been in operation mode (RF ON) and the amount of RF switch on cycles. The display format is "Total Hours:Minutes:Seconds (Cycles)". You can change between the elapsed time meter for "Mains on", the elapsed time meter for "RF on" and (if applicable) the elapsed time meters for "RF on in each frequency band" by pushing the right button or the left button (to step back) below the display. The elapsed time meter page can be left by pushing the left and the right button below the display simultaneously for at least 0.5 seconds.

The 4<sup>th</sup> screen of the user menu is the GPIB/IEEE address screen. (Screen G) This screen allows viewing and changing of the current GPIB/IEEE address of the amplifier. The address is changed via clicking the left or right button below the display. The address ranges from 01 to 31 and the default address is 07. The GPIB/IEEE address page can be left by pushing the left and the right button below the display simultaneously for at least 0.5 seconds.

After exiting the 4<sup>th</sup> user menu page the amplifier will show the main screen (Screen M) again.

User Menu

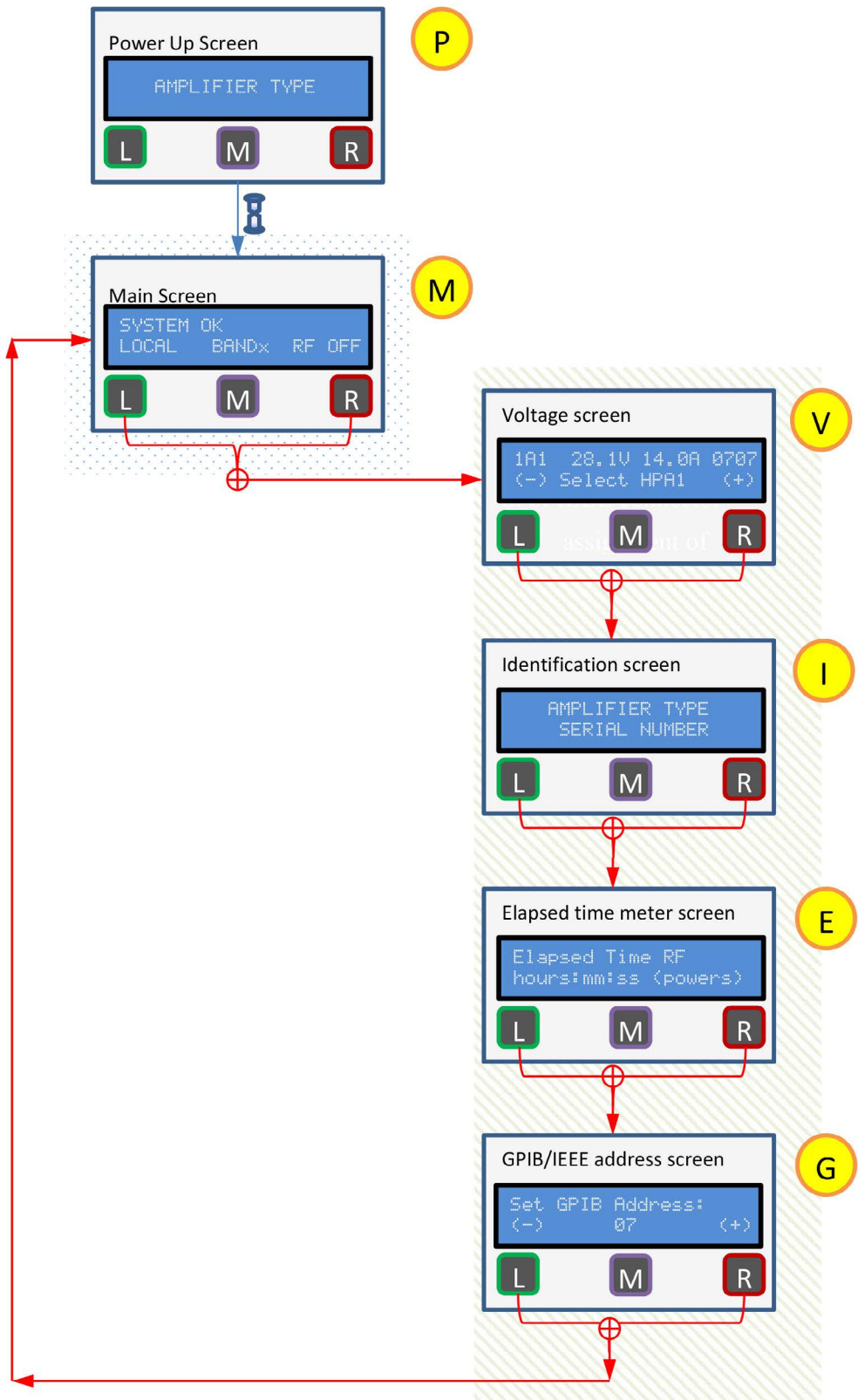


Fig. 3-3: User menu

For safety reasons, the amplifier includes an interlock function as standard. Any occurring error is indicated on the front panel in the display.

**Note:** The amplifier can be activated neither from the front panel nor via the remote control interfaces as long as an interlock error is signalled!

- Connect RF generator to the RF input connector and RF power load to the RF output connector using suitable RF cables. (tighten RF connectors with correct torque!).

**Caution!** The maximum permissible input power is +10 dBm (0.707 V)! The amplifier already provides the nominal output power at typically -5 dBm!!

- Press the **Band/Gain** key for at least 0.5s to enter the gain setting menu. (Only if option F is installed)
  - GAIN=xx.xdB** Shows the actual attenuation value xx.x dB in the display.
  - (-) EXIT (+)** Press the Control key to decrement the attenuation.  
Press the Amplifier key to increment the attenuation.  
Press the Band key (or wait 4s without pressing any key) to exit the gain setting menu.
- Press the **Amplifier** key.

The **AMP=OFF** text in the display changes to **AMP=ON**.

(only if Option X is installed) If the instrument is controlled from an external amplifier (External control connection cable is connected and the indication **EXTERN** is shown in the display), then all control commands are only available at the front panel of the external amplifier.

If the interlock loop is interrupted during operation, the amplifier is deactivated automatically. The error message **INTERLOCK EXT. FAIL** will be displayed. If the door and thus the safety switch are closed again, the amplifier is not activated again automatically but must be activated via the front panel or via one of the remote control interfaces.

After a measurement has been concluded, the amplifier can be deactivated by pressing the Amplifier key again. **AMP=OFF** will be shown at the display. For removal of the internal heat, the fan can be operating for about 2 more minutes.

Changing from **OFF to ON** and vice versa may take some time. During switchover **AMP=...** is displayed

**Caution!** If the amplifier is driven outside its frequency range, no damage is caused, however, only the signal component (e.g. harmonics of generator), which lies within the frequency range of the amplifier, is amplified! In this case, measuring the output power does not provide any information on the actual operation of the instrument!

### 3.4. Remote control

- Press the MAINS switch to turn on the amplifier.

The MAINS switch is illuminated. Only the main control board is supplied and the turn-on procedure of the instrument is executed.

- The model number will be shown in the power up screen on the display. (Screen P)
- After 2 seconds the amplifier will change the display to its main screen. (Screen M) The amplifier is now in standby and in the local control mode (Display: **LOCAL**).

If the command **REMOTE** is sent to the amplifier by a remote control interface, the amplifier changes the control mode from local to the active remote control interface and remains in this state even after termination of data transmission. This is indicated by the message **TTL, GPIB, LAN, RS232, RS485, USB** or **EXTERN** at the front panel display.

A device remains addressed to listen until it is unaddressed by the controller.

There are two methods to return to the local state:

- by sending the controller command **LOCAL**.
- by pressing the **Control** key on the front panel of the amplifier.

For safety reasons, the amplifier includes an interlock function as standard. Any occurring error is indicated on the front panel in the display.

**Note:** *The amplifier can be activated neither from the front panel nor via the remote control interfaces as long as an interlock error is signalled!*

- Connect RF generator to the RF input connector and RF power load to the RF output connector using suitable RF cables. (tighten RF connectors with correct torque!).

**Caution!** *The maximum permissible input power is +10 dBm (0.707 V)! The amplifier already provides the nominal output power at typically -5 dBm!!*

- Send the command **AMP=ON**.

The **AMP=OFF** text in the display changes to **AMP=ON**.

(only if Option X is installed) If the instrument is controlled from an external amplifier (External control connection cable is connected and the indication **EXTERN** is shown in the display), then all control commands are only available at the front panel of the external amplifier.



If the interlock loop is interrupted during operation, the amplifier is deactivated automatically. The error message **INTERLOCK EXT. FAIL** will be displayed. If the door and thus the safety switch are closed again, the amplifier is not activated again automatically but must be activated via the front panel or via one of the remote control interfaces.

After a measurement has been concluded, the amplifier can be deactivated by sending the **AMP=OFF** command. **AMP=OFF** will be shown at the display. For removal of the internal heat the fan can be operating for about 2 more minutes.

Changing from **OFF** to **ON** and vice versa may take some time. During switchover **AMP=...** is displayed

**Caution!** *If the amplifier is driven outside its frequency range, no damage is caused, however, only the signal component (e.g. harmonics of generator), which lies within the frequency range of the amplifier, is amplified! In this case, measuring the output power does not provide any information on the actual operation of the instrument!*

### 3.4.1. Commands on the remote control interfaces

All commands to the amplifier consist of a single character set followed by the "Line feed" character (hexadecimal: 0A; decimal: 10) as a terminator

All commands to the amplifier must be terminated by a terminator. The only permissible terminator is:  
<Line feed> (ASCII code 10 decimal)

A command line may require more than one line on the screen of the controller because it is only limited by the terminator. Most controllers automatically append a terminator to the transmitted data.

The ASCII code (ISO 7-bit code) is used.

Control Characters					Numbers and Characters					Upper-case letters				Lower-case letters			
0	Nul		16	DLE		32	SP	48	0	64	@	80	P	96	`	112	p
1	SOH		17	DC1		33	!	49	1	65	A	81	Q	97	a	113	q
2	STX		18	DC2		34	~	50	2	66	B	82	R	98	b	114	r
3	ETX		19	DC3		35	#	51	3	67	C	83	S	99	c	115	s
4	EOT	SDC	20	DC4	DCL	36	\$	52	4	68	D	84	T	100	d	116	t
5	ENQ		21	NAK		37	%	53	5	69	E	85	U	101	e	117	u
6	ACK		22	SYN		38	&	54	6	70	F	86	V	102	f	118	v
7	BEL		23	ETB		39	'	55	7	71	G	87	W	103	g	119	w
8	BS		24	CAN		40	(	56	8	72	H	88	X	104	h	120	x
9	HT		25	EM		41	)	57	9	73	I	89	Y	105	i	121	y
10	LF		26	SUB		42	*	58	:	74	J	90	Z	106	j	122	z
11	VT		27	ESC		43	+	59	;	75	K	91	[	107	k	123	{
12	FF		28	FS		44	,	60	<	76	L	92	\	108	l	124	
13	CR		29	GS		45	-	61	=	77	M	93	]	109	m	125	}
14	SO		30	RS		46	.	62	>	78	N	94	^	110	n	126	~
15	SI		31	US		47	/	63	?/ UNL	79	O	95	-	111	o	127	DEL
Addressed Commands			Universal Commands			Listener Address				Talker Address				Secondary Addresses and Commands			

Table 3-1: ASCII/ISO and IEC character set

The following command sequences result from this:

Function	Command	Remark
Go to remote	REMOTE	
Go to local	LOCAL	
Amplifier on	AMP=ON	
Amplifier off (Standby)	AMP=OFF	
Amplifier Reset (Clear fault indications)	*RST	
SRQ notifications on GPIB interface disabled	*SRE 0	
SRQ notifications on GPIB interface enabled	*SRE 1	
Select Band x	BAND=x	Option S only
Change power indication to Watt	P_UNIT=WATT	Option E only
Change power indication to dBm	P_UNIT=DBM	Option E only
Change power indication to %	P_UNIT=PNOM	Option E only
Change gain setting to step x	GAIN=x	Option F only
Increase gain setting by one step	GAIN=UP	Option F only
Decrease gain setting by one step	GAIN=DOWN	Option F only
Emergency off	STOP!	
Send a repeated command string of more than one command and up to 10 commands  The periodical answer string to the commands in the command string will then be:	PUSH_STR=<str> e.g.:PUSH_STR=STATUS? AMP?   PUSH:<str> e.g: PUSH:SYSTEM_OK;AMP=OFF;	The commands must be separated and terminated by „ “. An empty string will end the sequence.  The answers will be separated by semicolons.
Set the repetition rate in t=seconds for periodic command strings	PUSH_INTV=<t>	possible range from 1 to 500 s
Query of periodic command strings	PUSH_STR?	
Query of amplifier identification	*IDN?	
Query of firmware version	*VER?	
Query of installed features/options	FEATURES?	
Query of SRQ on GPIB interface enable status	*SRE?	
Query of amplifier on/off status	AMP?	
Query of instrument status	STATUS?	
Query of active control interface	CONTROL?	

Function	Command	Remark
Query of elapsed time meter mains on	ETM_MAINS?	
Query of elapsed time meter since last mains on	ETM_POWERUP?	
Query of elapsed time meter AMP=ON	ETM_RF?	
Query of elapsed time meter Band x active	ETM_BANDx?	
Query of active fault messages	NEXTALERT?	
Query of first item in fault log	FIRSTLOG?	
Query of next item in fault log	NEXTLOG?	
Query if command has been executed	EXECUTION_RESULT?	
Query if instrument is answering	PING?	
Query of diagnosis channel x	DIAG_x?	
Repeat query of same diagnosis channel	DIAG_GET?	
Query of first diagnosis channel	DIAG_FIRST?	
Query of last diagnosis channel	DIAG_LAST?	
Query of next diagnosis channel	DIAG_NEXT?	
Query of previous diagnosis channel	DIAG_PREV?	
Query of selected band	BAND?	Option S only
Query of gain setting	GAIN?	Option F only
Query of forward power	P_FWD?	Option E only
Query of reflected power	P_REF?	Option E only
Query of external control status	LATCH?	Option X only

**Table 3-2: Commands at the remote control interfaces**

Between each two commands there should be a delay time of min. 200 ms to avoid a command overflow situation.

All commands ending with the ? are status queries.

This type of commands and the command STOP! can be executed all the time, even when the amplifier will be controlled locally or from a different remote control interface.

All other commands can only be executed at the currently active remote control interface.

### 3.4.2. Status messages of the amplifier on the remote control interfaces

The amplifier will return a status information if it is requested to do so by a data poll command.

The status messages which are indicated on the front panel display can also be transmitted as status information via the remote control interfaces to the control computer.

The status messages are encoded in the status text according to the following table:

Query	Status message (String)	Meaning
*IDN?	<b>SS1G-500 2214220A</b>	Instrument identification: Manufacturer, Model number, Serial number
*VER?	VER: xxx	Firmware Version number and date
AMP?	AMP=ON	Amplifier is set to operate (active)
	AMP=...	Amplifier changes from the off state to the operate state or vice versa
	AMP=OFF	Amplifier is set to off (standby)
*SRE?	SRE +0	SRQ on GPIB interface disabled
	SRE +1	SRQ on GPIB interface enabled
STATUS?	SYSTEM_OK	Instrument works normally
	INTERLOCK EXT. FAIL	External Interlock fault
	INTERLOCK x FAIL	Cable x interlock fault
	TEMP x FAIL	Over temperature fault at sensor x
	PSx xxx FAIL	Power supply fault at output x
	SW-x xxx FAIL	Switch x faulty
	<b>DC- x xxx WARN/FAIL</b>	<b>DC Supply voltage warning or fail</b>
	<b>AC- x xxx WARN/FAIL</b>	<b>AC Supply voltage warning or fail</b>
	<b>POWCTL xxxWARN/FAIL</b>	<b>Warning that the threshold limit x of forward or reflected RF power has been exceeded</b>
	<b>VSWR WARNING</b>	<b>VSWR too high</b>
	BUS xxx TIMEOUT	No response from device x
	LATCH TIMEOUT	External control cable is not connected correctly (Option X only)

Query	Status message (String)	Meaning
ETM_MAINS?	hhhhh:mm:ss (pppp)	Elapsed time meter mains on (number of turn on cycles)
ETM_POWERUP?	hhhhh:mm:ss (pppp)	Elapsed time since last mains on (number of turn on cycles)
ETM_RF?	hhhhh:mm:ss (pppp)	Elapsed time meter AMP=ON (number of turn on cycles)
ETM_BANDx?	hhhhh:mm:ss (pppp)	Elapsed time meter Band x active (number of turn on cycles)
CONTROL?	CONTROL=LOCAL	Local control is active
	CONTROL=TTL	TTL remote control is active
	CONTROL=GPIB	GPIB remote control is active
	CONTROL=LAN	LAN remote control is active
	CONTROL=RS232	RS232 remote control is active
	CONTROL=RS485	RS485 remote control is active
	CONTROL=USB	USB remote control is active
	CONTROL=EXTERN	Instrument is controlled by external amplifier
FEATURES?	FEATURES= <Feature 1> <Feature 2> ...<Feature n>  Possible features:  TYP=< Series> BANDS=< n> FREQS=<B1Fmin><B1Fmax>,... <BnFmin><BnFmax> POW=<PowB1>,..<PowBn> GAIN= 0.0,30.0,dB  IND=FWD,REF	Returns the list of the installed amplifier features separated by „ “. Not installed features will remain empty.  Amplifier model series Number of frequency bands Lower and upper frequencies of each frequency band  Output power level of each frequency band Setting range (min./max.) of gain adjustment option (Option F only) Power indication (Option E only)
PUSH_STR?	[<Cmd1>;..< Cmdn>]	Shows all separate commands in the command string which is sent periodically
BAND?	BAND=x	Band x is selected
GAIN?	GAIN=x	Attenuation x dB is selected
P_FWD?	P_FWD=x	Forward power is x (Unit)
P_REF?	P_REF=x	Reflected power is x (Unit)
LATCH?	LATCH=STANDALONE	Instrument works independently
	LATCH=MASTER	Instrument controls external amplifier
	LATCH=SLAVE	Instrument is controlled by external amplifier

Query	Status message (String)	Meaning
NEXTALERT?	hhhhh:mm:ss xx	Time when fault xx occurred
FIRSTLOG?	hhhhh:mm:ss xx	Time when fault xx occurred
NEXTLOG?	hhhhh:mm:ss xx	Time when fault xx occurred
DIAG_x?	yy	Result yy of diagnosis channel x
DIAG_FIRST?	yy	Result yy of first diagnosis channel
DIAG_LAST?	yy	Result yy of last diagnosis channel
DIAG_NEXT?	yy	Result yy of next diagnosis channel
DIAG_PREV?	yy	Result yy of previous diagnosis channel
EXECUTION_RESULT?	OK	Command was executed successfully
	FAIL_UNKNOWN_CMD	Command unknown/Syntaxerror
	FAIL_NO_EFFECT	Command has no effect
	FAIL_ERRORS_PRESENT	Command ignored as a fault message is active or latched
	FAIL_WARNIS_PRESENT	Command ignored as awarning is active
	FAIL_BANDCHG_ON_RFON	Band switching is blocked during AMP=ON
	FAIL_FOCUSCHG_ON_RFON	Control change is blocked during AMP=ON
	FAIL_FOCUSCHG_ON_NOTLOCAL	Instrument is controlled by another interface
	FAIL_FOCUSCHG_ON_EXTERN	Instrument is controlled by external amplifier
	FAIL_NO_FOCUS	Instrument is controlled by another interface
	FAIL_RFINHIBIT	Operate inhibited e.g. after initial turn on
	FAIL_ILLEGAL_BAND	Invalid band selected
	FAIL_ILLEGAL_ATTN	Illegal gain step selected
	FAIL_UNSPEC_ERR	Unspecified error
PING?	PING: CNT=x	Query x was successful (x will be increased by 1 on each query)

**Table 3-3: Status messages at the remote control interfaces**

### 3.4.3. TTL Remote control interface

Pin	Signal	Function
1	MAINS ON (100 mA)	Status (CMOS, 12 V = Mains on)
2	AMP=ON	Status (CMOS, 12 V = RF on)
3	READY ( Tube amplifiers only)	Status (CMOS, 12 V = Amplifier ready)
4	HV ( Tube amplifiers only)	Status (CMOS, 12 V = HV =ON)
5	REMOTE	Status (CMOS, 12 V = Remote)
6	FAIL	Status (CMOS, 12 V = Fault)
7	GND	
8	EXTERNAL INTERLOCK	
9	AMP=ON	Command (negative slope triggered)
10	BAND	Command (negative slope triggered)
11	REMOTE	Command (negative slope triggered)
12	BAND	Command (negative slope triggered)
13	n.u.	
14	GND	
15	EXTERNAL INTERLOCK RETURN	

**Table 3-4: Signals at the remote control and interlock connector**

All commands and messages, which are available on the front panel, can also be found on the TTL remote control interface. The status messages for all faults are combined to a summary alarm on the interface.

The remote control interface commands are activated by negative slope triggering. (The pulse width should be 10 to 50 ms.) This is done in order not to activate the amplifier immediately on power-on by static remote control interface commands (REMOTE and AMP=ON). Triggering on the negative slope permits to control the interface by 12 V CMOS logic or 5 V open-collector TTL logic. The status output MAINS ON supplies a maximum current of 100 mA in order to be able to activate and feed other equipment, or, for example, an external interface and similar devices together with the amplifier.

The amplifier can be set to remote control mode by using the command REMOTE. At the status display the text will change from **LOCAL** to **TTL**. Now the amplifier can be activated using the command AMP=ON. The indicated message must then change accordingly from **AMP=OFF** to **AMP=ON**.



### 3.4.4. Remote control via the IEC/IEEE-488.2 GPIB interface (Option C)

The instrument is optionally (Option C) equipped with an IEC/IEEE 488.2 GPIB Bus connection. The connector according to is located at the rear panel of the instrument. This interface can be used to connect a controller for remote control purposes. The connection must be made using a shielded cable.

#### 3.4.4.1. Pin configuration of the IEC/IEEE 488.2 GPIB interface

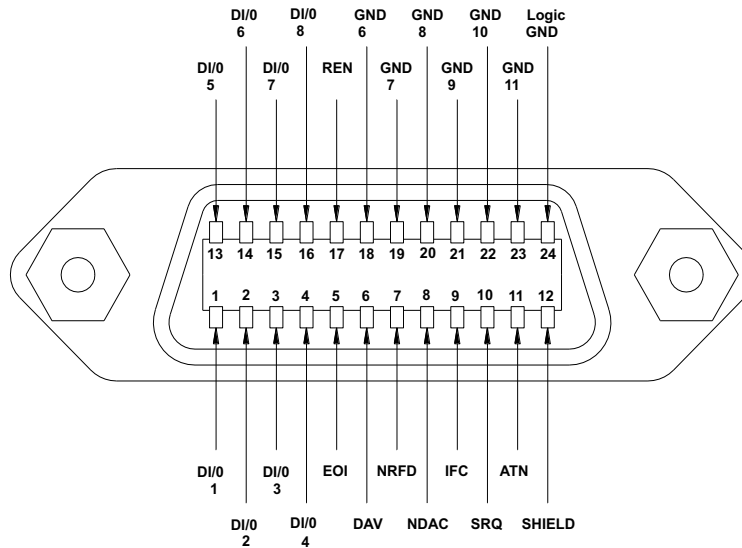


Fig. 3-5: Pin configuration of the IEEE interface

#### 3.4.4.2. Setting the IEEE instrument address

The IEEE bus address (GPIB address) of the amplifier will be shown and can be changed within the user menu. Please refer to section 3.3.1 for details.

The valid address range is from 01 to 31. Other settings are not permissible! The address set is immediately taken over after an alteration.

Upon delivery of the instrument, address 07 is set.

### 3.4.4.3. Interface messages

Interface messages are transferred by the controller to a device via eight data lines, the ATN line remaining active, i.e. low. Only an active controller is able to issue interface messages. A distinction is made between universal commands and addressed commands.

#### Universal Commands

Universal commands are effective for all the devices connected to the IEEE-488 GPIB-bus without previous addressing.

Command	Function
DCL (Device Clear)	Aborts processing of the currently received commands and resets the command processing software to a defined initial status. This command does not affect the device settings.

**Table 3-6: IEEE universal commands**

#### Addressed Commands

Addressed commands act only on devices that have been addressed as listeners by the controller before.

Command	Function
SDC (Selected Device Clear)	Aborts processing of the currently received commands and resets the command processing software to a defined initial status. This command does not affect the device settings.

**Table 3-7: IEEE addressed commands**

#### 3.4.4.4. Device messages

Device messages (to IEC 625-1) are transmitted on the data lines, in which case the ATN line is not active, i.e. high. The ASCII code (ISO 7-bit code) is used.

The amplifier transmits messages via the IEEE-488.2 GPIB-bus if it has been requested by a query command to provide data in its output buffer and has been addressed as talker.

Note that the command line with the data requests must be transmitted immediately before addressing as talker. The output buffer is cleared if another command line is entered in between.

- Alarms

If a fault status occurs, the amplifier indicates the specific fault message and sends a service request via the IEEE interface. The controller is able to recognize this alarm message without having to poll the status byte of the amplifier repeatedly.

To reset the fault message the command \*RST has to be sent to the amplifier.

The alarm message has to be acknowledged by way of the serial poll procedure specified in the IEEE-488.2 GPIB standard (see interface manual of the controller). The status byte issued by the amplifier corresponds to the above-mentioned status messages.

### 3.4.5. Remote control via the Ethernet interface (Option L)

#### 3.4.5.1. Configuration of the Ethernet Interface

The LAN remote control interface automatically detects the data rate of the transmission 10 or 100 MBit/s and full or half duplex mode.

RJ-45-Connector female (EIA/TIA 568A)		
1	TX+	Transmitted data high
2	TX-	Transmitted data low
3	RX+	Receive data high
4		(not used)
5		(not used)
6	RX-	Receive data low
7		(not used)
8		(not used)

**Table 3-8: Pin configuration of the Ethernet interface**

Setting	Value
Data rate	10 or 100 MBit/s
TCP port	2500

**Table 3-9: Configuration of the Ethernet interface**

## Administration by LAN

The default IP address of the Ethernet interface is 192.168.1.253, subnet mask 255.255.255.0

This IP address can be changed to any desired address according to your network configuration. To be able to perform such change of the IP address, a computer with matching IP settings has to be connected directly to the amplifier.

To do this the LAN adapter settings of the control computer must be temporarily changed.

## Control computer configuration

Configure the control computer with IP address 192.168.1.xxx where xxx is 001 or any number between 001 and 254, subnet mask 255.255.255.0

Check that the computer is connected to same Ethernet LAN than the Ethernet interface of the amplifier.

Then call the amplifier's settings page via the browser (see the following screen shots), and change the amplifier's IP settings to your desired network configuration.

After that, you can set your computer's LAN adapter settings back to the original settings.

## TCP/IP configuration

IP address of each Ethernet interface must be unique on the network. An individual address can be either assigned by

- a static address using administrative commands, or
- an existing DHCP server on the network, who can assign an available address.

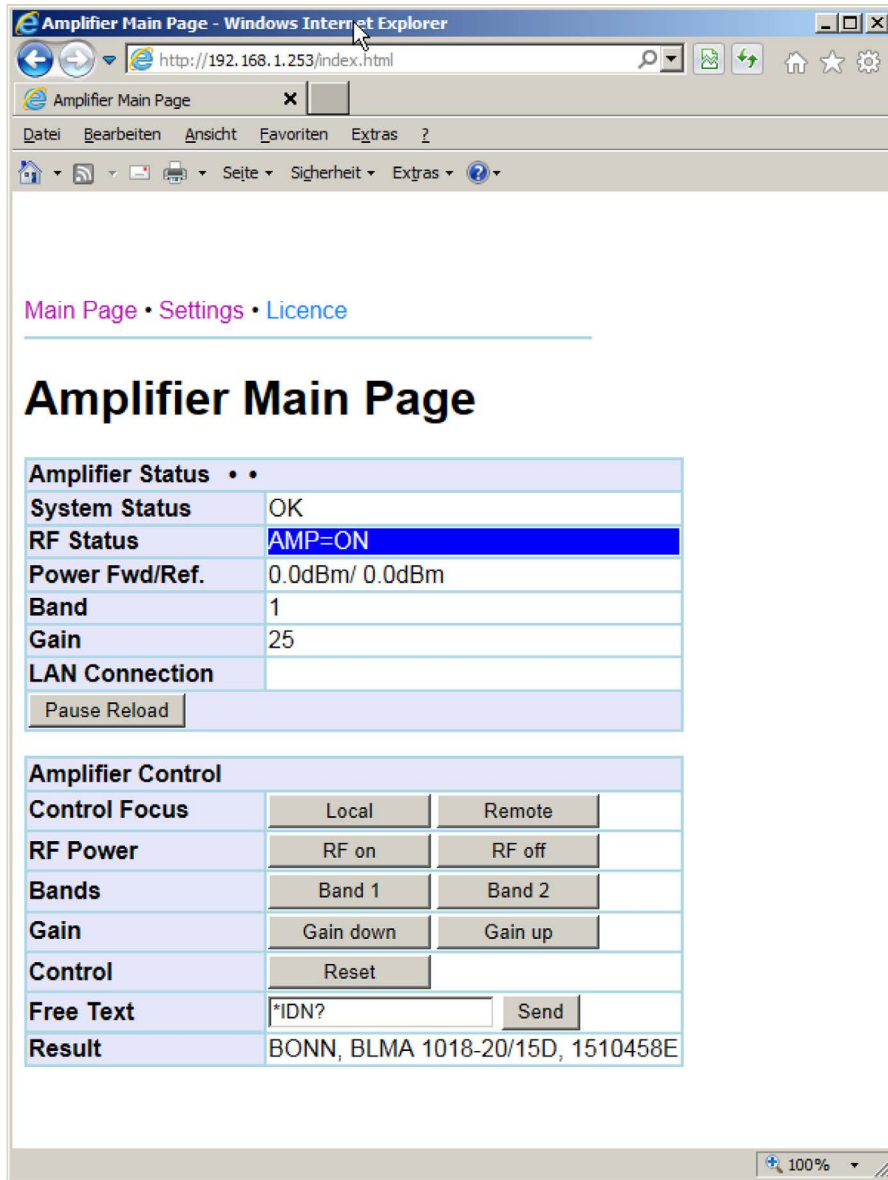
If both DHCP and static IP addresses are defined, DHCP configuration will override static IP.

Only one new Ethernet interface can be plugged on the LAN at a given time, until an individual IP address is assigned on each Ethernet interface. Otherwise conflicts will be caused.

## TCP/IP configuration setup

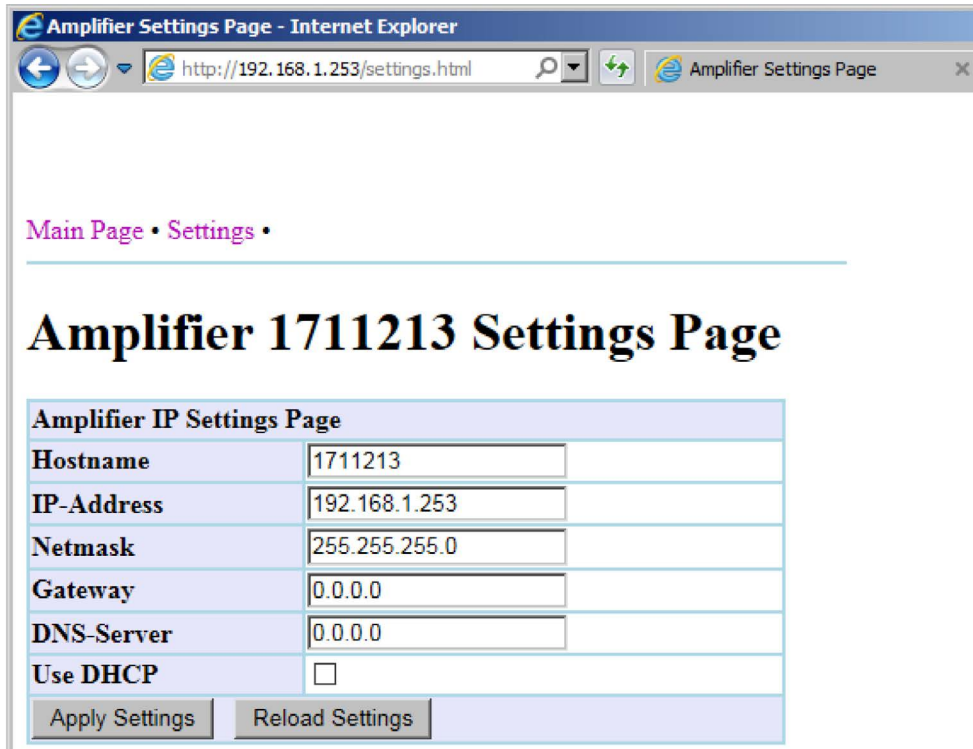
- Open the web browser.
- Enter the IP address of the Ethernet interface (e.g. <http://192.168.1.253>)

Then the following page will display:



(Depending on the installed options this page may actually look a bit different)

- Select "Settings" and then the following page will display:



- Set address, netmask and gateway or alternatively select DHCP and confirm settings by "Apply Settings". Before setting the amplifier's IP settings to DHCP, please make sure that you have a DHCP server running in your LAN, and you can find out the IP address, that the DHCP server assigned to your amplifier. If you are not sure, do not use DHCP.

Select "Main Page" to return to the previous page from where the instrument can be fully controlled.

### 3.4.6. Remote control via the RS232 or RS485 interface (Option R)

#### 3.4.6.1. Pin configuration of the RS232 or RS485 interface

DB9-Connector female		
Pin	RS232	RS485
1	Not used	Not used
2	TxD data transmitter	Z inverting data transmitter
3	RxD data receiver	A noninverting data receiver
4	Not used	Not used
5	Signal ground	Signal ground
6	Not used	Y noninverting data transmitter
7	Not used	B inverting data receiver
8	Not used	Not used
9	Not used	Not used

*Table 3-10: Pin configuration of the RS232 or RS485 interface*

#### 3.4.6.2. Configuration of the RS232 or RS485 interface

Setting	Value
Data rate	19200 Bit/s
Data bits	8
Stop bits	1
Parity	even
Handshake	none

*Table 3-11: Configuration of the RS232 or RS485 interface*



### 3.4.7. Remote control via the USB interface (Option U)

#### 3.4.7.1. Pin configuration of the USB connector

USB 2.0 connector, type A		
1	VBus	Power Supply
2	D-	Differential Data-Line
3	D+	Differential Data-Line
4	GND	Signal Ground
Shell	Shield	Ground

**Table 3-12: Pin configuration of the USB interface**

#### 3.4.7.2. Installation of the USB Driver

Plugging the Amplifier into the target PC should result in Windows launching the “Add New Hard-ware Wizard”. If it does not, then the drivers are probably already installed of the target PC.

When the Amplifier is first connected the system will detect new hardware. First the composite driver will be loaded. This is a native driver and should happen automatically.

When this happens the “Found new Hardware Wizard” will run.

Select “Install from al list or specific location (Advanced )” and click on next.

Use the Browse option to point the wizard to the CD which is delivered with the amplifier on the “USB-Driver” directory, click on OK, then next.

The bus driver will then install.

Select Finish.

Once the drivers are fully installed a dialog will be shown in the bottom right corner of the desktop.

#### 3.4.7.3. Configuration of the USB interface

Setting	Value
Data rate	19200 Bit/s
Data bits	8
Stop bits	1
Parity	even
Handshake	none

**Table 3-13: Configuration of the USB interface**

### 3.5. Typical application

An example of a typical application is given in Fig. 3-4 in the appendix, illustrating an EMS test setup with several amplifiers.

## 4. FUNCTIONAL DESCRIPTION

### 4.1. RF amplifier

See Fig. 4-1: Block diagram of complete amplifier (in appendix)

See Fig. 4-2: Block diagram of RF amplifier module (in appendix)

The power amplifier **SS1G-500** can deliver an output power of **500 W** over the frequency range of 80 MHz to 1000 MHz.

The four-stage solid-state amplifier is of modular design and integrated into two RF modules, both featuring a high linearity and a flat frequency response. The first two stages are implemented with MIC components (microwave integrated circuits). They ensure high overload immunity and a low VSWR at the input of the amplifier.

The input stage is decoupled from the input DC voltage via a coupling capacitor. Due to the high linearity over the wide frequency range of the MIC component used, a frequency-dependent negative feedback is not required. The following stages, on the other hand, all feature an individually adjusted negative feedback, resulting in a flat overall frequency response.

In the final stage module, the signal is split up between the two amplifier chains of the push-pull final stage via a broadband coupler. The third (driver) stage is also implemented using MIC technology; working in class-A mode, driving the push-pull final stage. The push-pull final stage is using FET technology and it works in class A mode to reduce distortion over the wide frequency range. In the final stage module the signal is recombined again from the two amplifier chains via a broadband coupler.

In order to achieve a stable output power, the bias of the FET stages are controlled by low-drift voltage regulators.

The maximum input power for achieving the nominal output power is 0 dBm corresponding to 1 mW or 0.224 V into 50  $\Omega$ . Due to its gain reserve, the amplifier usually achieves full output power with an input power of -5 dBm.

The final stage is separately protected against overload by current limitation. The amplifier is protected against open circuit and short circuit at the output. By using suitable transistors and a special circuit design in the final stage, even a total mismatch at the output will not cause any damage. For a VSWR  $\leq$  2:1 the maximum power can be obtained, all specifications being met.

The amplifier housing is designed to ensure minimum RF leakage and high RF immunity. The module is supplied with DC voltage via RF feed through filters.

In order to protect the amplifier against thermal overload in case the blower fails or the ambient temperature is too high, a temperature sensor is mounted on the heat sink in the vicinity of the final stage.

## 4.2. Power supply

See Fig. 4-3: Block diagram of power supply (in appendix)

The power supply consists of a main power supply module with line filtering and auxiliary power supply modules.

### Line filtering

Mains phase and neutral are routed to the line filter via mains fuse and mains switch.

Radiated emissions are avoided by shielding and a special design of the wire connections. Conducted emissions are suppressed by a two stage filtering in the main power supply and the line filter at the mains input.

The radio interference suppression of the complete power supply meets the requirements of class B according to VDE 0871.

### Power supply

The main power supply is designed such as to work from an operating voltage range of 200 to 240 V AC. The front-end module filters the distortions caused by the power factor correction and the switched-mode controller.

The power supply is designed as a switched mode DC\_DC converter using resonance converter technology and has an efficiency of >95%. In the front-end of the switched-mode power supply, the required correction of the power factor is integrated. The front-end module also limits the inrush current and provides a transient and over voltage protection.

After switching the instrument on with the mains switch the auxiliary power supply will be operating. It feeds the control circuitry of the amplifier and the power supply even if the outputs of the main power supply are disabled.

The communication between the main control board and the micro controllers on the power supply boards is made via the internal control bus system. All operating conditions or fault status messages are continuously polled and processed.

The power supply control is surveying the status of all DC-DC converter outputs in the power supply. An error status will be indicated by the respective fault message on the front panel display.

As voltage and current of all outputs are continuously monitored a detailed problem diagnosis can be issued.

All DC-DC converter outputs have their own voltage regulation (over voltage protection) as well as an own current limitation circuit. For optimum adaptation to the final stage transistors the current limitation for each individual transistor can be set directly by the micro controller.

Additionally there are auxiliary power supply outputs which work in the same way and are also monitored in the same way as the outputs of the main power supply.

Wherever possible and practicable power supply lines, control lines and RF modules are separated totally. This ensures a minimum of intersignal interference. Radiated emission is limited by the technique used for the RF modules.

### 4.3. Monitor output (Option A)

The option monitor output provides the possibility to decouple a part of both the forward as well as the reverse power for measurement purposes.

The monitor output is implemented with an internal dual directional broadband coupler for forward and reflected power at the connectors FORWARD and REFLECTED (as a standard at the rear panel).

At some Antennas (or other power transducers) the matching is very bad in certain frequency ranges and thus the level of reflected power is very high. With bad matching there is no more related ratio between output power and resulting field strength. A monitoring of the reflected power will be very helpful to prevent the amplifier from being overdriven at the input. It has to be taken into consideration that the coupling value of directional couplers will increasingly deviate from the nominal value with rising Load VSWR and thus the power reading on the output ports of the coupler will be wrong.

Without additional correction, the frequency response of a broadband coupler becomes the greater, the wider the bandwidth is. A correction of the frequency response over a bandwidth of several octaves is technically very difficult to achieve and sometimes impossible to implement at all. The actual coupling attenuation at the output of the coupler therefore deviates from the nominal value with a certain ripple. To derive the actual output power of the amplifier from the decoupled power, a calibration of the frequency response is necessary. (see section 6.2.1.4)

### 4.4. IEEE-488.2 GPIB remote control interface (Option C)

The IEEE-488.2 GPIB interface is integrated on the main control board.

### 4.5. Output power indication (Option E)

The output power indication is implemented in the front panel display. The information generated from an internal directional broadband coupler for forward and reflected RF power is converted to digital information which will be displayed at the front panel display if AMP=ON is selected. The displayed unit of the output power indication can be dBm or Watt or %.

### 4.6. Gain Adjustment (Option F)

The Gain adjustment attenuator can be operated manually via the pushbutton Band/Gain at the front panel or with the remote control interfaces. It has a setting range of 30 dB min.

#### 4.7. Ethernet remote control interface (Option L)

The Ethernet interface is integrated on a separate control board which directly communicates to the main control board.

#### 4.8. RS232 or RS485 remote control interface (Option R)

The RS232 or RS485 interface is integrated on a separate control board which directly communicates to the main control board.

#### 4.9. USB remote control interface (Option U)

The USB interface is integrated on a separate control board which directly communicates to the main control board.

#### 4.10. Control

The system control consists of a Bus-system with differential transmission. All boards of the system are connected to the control bus. The main control board will handle all status and fault messages and will control all other control and power supply boards.

## 5. MAINTENANCE AND TROUBLESHOOTING

### 5.1. Maintenance

In general, the amplifier does not require any maintenance due to its solid-state amplifier design and overrating of all components under thermal stress.

The fan has a lifetime  $\geq 40,000$  h; this results in a lifetime of 5 years even with permanent operation.

Cleaning and care of the RF connectors are to be performed according to the regulations valid for **N-series** connectors. All mechanical and electrical specifications are guaranteed for at least 500 plug-in cycles.

For cleaning the front panel, it is best to use a moist, soft cloth and, if necessary, a mild detergent. Solvents must not be used.

**Note:** *Improper maintenance of the instrument may void the warranty.*

**Warning:** *The person performing maintenance of this equipment must have training and knowledge of both the product and safety requirements and safety issues related to the equipment.*

**Warning:** *In some cases it may be required to work on the equipment with exposed live voltages exceeding 50 V. Access into the instrument and working circuitry with live voltages exceeding 50 V is restricted to authorized personnel skilled in RF amplifiers and high-voltage equipment. The person exposed to live voltages must be observed by at least one other person able to switch off the voltage without delay. Also, the observer should be trained to render first aid by means of cardiopulmonary resuscitation (CPR). The observer must have immediate access to the main circuit breaker "Emergency Off" button. Work safely!*

## 5.2. Troubleshooting

If the green control light inside the mains switch does not light green after turning mains on, please check the following.

- No response after switching the mains switch on:
  - Check the fuses at the line input at the rear panel of the amplifier.
  - Check the mains voltage at the mains connector.

If a fault message will be displayed, the following should be checked:

- Display: **INTERLOCK EXT. FAIL**
  - Check the connection to the external interlock switch or jumper in the interlock connector (see Fig. 2-1).
- Display: **TEMP x FAIL**
  - Check whether the airflow is obstructed.
  - Check if the internal blower works.
  - Check if the ambient temperature is more than 45 °C Allow the instrument to cool down and try to start again. Check if the Fault message persists.
- Display: **PS-xxx FAIL**
  - Fault of one or more output voltages of the indicated power supply output xxx.
  - Switch off the amplifier and try to start again.
  - Check if the Fault message persists.
- Display: **TTL or GPIB or LAN USB or RS232 or RS485**
  - The instrument is controlled remotely.
  - Press the **Control** key until the display indicates **LOCAL**.
  - The amplifier can now be activated locally.
- Display: **EXTERN**
  - Instrument can only be controlled by the external amplifier as long as the control connection cable is connected. (Only if option X is installed).

If a non-permanent error message is being displayed it has to be confirmed by pushing the **Amplifier** key at the front panel or by sending the \*RST command before the fault status will be unlatched.



## 6. TESTING THE RATED SPECIFICATIONS

### 6.1. Measuring equipment and auxiliary means

Item	Type of instrument	Required specifications	Use
1	Signal generator	80 to 1000 MHz Level: -30 to 0 dBm	6.2.1
2	Power meter	80 to 1000 MHz Level: - 30 to + 10 dBm	6.2.1
3	Power probe *)	80 to 1000 MHz Level: 0 to +10 dBm	6.2.1
4	Power coupler	80 to 1000 MHz Coupling attenuation: 40 dB	6.2.1
5	High power Load	80 to 1000 MHz Power: 200 W / 50 Ω	6.2.1
6	Terminations 2 pieces	80 to 1000 MHz Power: 1 W/ 50 Ω	6.2.1
7	RF power cables 2 pieces	Power: 700 W / 50Ω Attenuation: <0.1 dB/m	6.2.1
8	Digital multimeter	4 1/2-digit	6.2.3
9	Spectrum analyzer	80 to 3000 MHz Sensitivity: -100 dBm	6.2.1.3

**Table 6-1: Measuring equipment and auxiliary means**

\*) If the amplifier is fitted with an internal coupler (Option A monitor output), a second power probe is required so that the coupling curve can be recorded in addition to the output power.

## 6.2. Test sequence

### 6.2.1. RF Characteristics

See Fig. 6-1: Test setup (in appendix)

Before checking the RF characteristics, a warm-up time of at least 5 minutes has to be allowed for.

All measurements can be performed e.g. for the frequencies of the performance test report. (See section 6.3)

#### 6.2.1.1. Output power (rated power)

- Set the first test frequency on the generator.
- Apply the input level starting at -30 dBm (7 mV).
- Increase the input level until the nominal output power (rated power) of **500 W** is obtained at the output of the amplifier.

Minimum value of the output power: **500 W (+57 dBm)**

**Caution!** Note that the coupling attenuation from the calibration curve of the coupler has to be added to the measured value!  
The maximum permissible input power is +10 dBm (0.707 V)!

- Reduce the input level of the amplifier to -30 dBm.

### 6.2.1.2. Gain and ripple of frequency response

- Set the first test frequency on the generator.
- Apply the input level starting at -30 dBm (7 mV).
- Increase the input level until the nominal output power (rated power) of 500 W is obtained at the output of the amplifier.

**Caution!** Note that the coupling attenuation from the calibration curve of the coupler has to be added to the measured value!  
The maximum permissible input power is +10 dBm (0.707 V)!

- The resulting gain is calculated from the output power of 500 W (equivalent to +57 dBm) minus the measured input power level.

Minimum value of the gain: 57 dB

- The ripple of the frequency response results from the maximum gain value minus the minimum gain value.
- Reduce the input level of the amplifier to -30 dBm.

### 6.2.1.3. Harmonics and spurious

- Unscrew the termination at the output of the power head and connect the spectrum analyzer.
- Set the first test frequency on the generator.
- Apply the input level starting at -30 dBm (7 mV).
- Increase the input level until the nominal output power (rated power) of 500 W is obtained at the output of the amplifier.

**Caution!** Note that the coupling attenuation from the calibration curve of the coupler has to be added to the measured value!  
The maximum permissible input power is +10 dBm (0.707 V)!

- Use the spectrum analyzer to determine the suppression of the second and third harmonic with respect to the signal level of the test frequency.

Nominal value of second harmonic: < -20 dBc

Nominal value of third harmonic: < -20 dBc

- To determine the spurious suppression, the levels of all non-harmonic signals are measured with respect to the output level of the test frequency.

The measurement is performed over the entire frequency range with nominal output power. The ratio between test signal and spurious signal is measured with the spectrum analyzer.

Nominal value of spurious: < -60 dBc

- Reduce the input level of the amplifier to -30 dBm.

#### 6.2.1.4. Monitor output (Option A)

The option monitor output provides the possibility to decouple a part of both the forward as well as the reverse power for measurement purposes.

Without additional correction, the frequency response of a broadband coupler becomes the greater, the wider the bandwidth is. A correction of the frequency response over a bandwidth of several octaves is technically very difficult to achieve and sometimes impossible to implement at all. The actual coupling attenuation at the output of the coupler therefore deviates from the nominal value with a certain ripple. To derive the actual output power of the amplifier from the decoupled power, a calibration of the frequency response is necessary.

For this purpose, it is recommended to use two power measuring heads. This considerably facilitates the measurement procedure because the power head does not have to be changed at each test frequency from the coupled output of the external test coupler to the coupled output of the internal coupler and vice versa.

A coupler is a passive and linear element. Therefore, it is not necessary to perform the calibration at rated output power, because the coupling should not vary with power. However, all RF characteristics of the amplifier can to be tested at a time, so it is recommended to determine also the coupling at nominal output power.

The calibration of the coupling for the reflected power should not be done in the case of mismatch (short or open circuit) and at full output power. The amplifier would not be damaged, but the final stages would be put under considerable thermal stress for no reason.

For the calibration, the coupling attenuation has to be measured at several test frequencies. The ripple of the frequency response results from the maximum value of the coupled power minus the minimum value, taking into account the calibration curve of the external test coupler.

Nominal value **-50** dB ( $\pm 2$  dB)

### 6.2.2. Interlock function

- Switch on the amplifier.
- Remove the remote control and interlock connector.

The error message INTERLOCK EXT. should be displayed at the front panel display.

### 6.2.3. Messages via the TTL remote control interface

The status messages of the amplifier indicated via the status display on the front panel are also available at the remote control interface at the rear panel of the instrument.

The signals at the remote control interface are shown in the following table:

Pin	Signal	Function
1	MAINS ON (100 mA)	Status (CMOS, 12 V = Mains on)
2	AMP=ON	Status (CMOS, 12 V = RF on)
3	READY ( Tube amplifiers only)	Status (CMOS, 12 V = Amplifier ready)
4	HV ( Tube amplifiers only)	Status (CMOS, 12 V = HV =ON)
5	REMOTE	Status (CMOS, 12 V = Remote)
6	FAIL	Status (CMOS, 12 V = Fault)
7	GND	
8	EXTERNAL INTERLOCK	
9	AMP=ON	Command (negative slope triggered)
10	BAND	Command (negative slope triggered)
11	REMOTE	Command (negative slope triggered)
12	BAND	Command (negative slopetriggered)
13	n.u.	
14	GND	
15	EXTERNAL INTERLOCK RETURN	

**Table 6-2: Signals at the remote control and interlock connector**

It is recommended to check the status messages by comparison with the status messages on the front panel.

### 6.2.4. Status messages on the remote control interfaces

The status messages of the amplifier indicated via the display on the front panel are transferred as status messages via one of the different integrated remote control interfaces to the controller. For this purpose, the status text must be polled.

The possible status messages are encoded in the status text according to the following table:

It is recommended to check the status text by comparison with the status messages on the front panel.

Query	Status message (String)	Meaning
*IDN?	SS1G-500 2214371A	Instrument identification: Manufacturer, Model number, Serial number
*VER?	VER: xxx	Firmware-Version number and date
AMP?	AMP=ON	Amplifier is set to operate (active)
	AMP=...	Amplifier changes from the off state to the operate state or vice versa
	AMP=OFF	Amplifier is set to off (standby)
*SRE?	SRE +0	SRQ on GPIB interface disabled
	SRE +1	SRQ on GPIB interface enabled
STATUS?	SYSTEM_OK	Instrument works normally
	INTERLOCK EXT. FAIL	External Interlock fault
	INTERLOCK x FAIL	Cable x interlock fault
	TEMP x FAIL	Over temperature fault at sensor x
	PS-x xxx FAIL	Power supply fault at output x
	SW-x xxx FAIL	Switch x faulty
	DC- x xxx WARN/FAIL	DC Supply voltage warning or fail
	AC- x xxx WARN/FAIL	AC Supply voltage warning or fail
	POWCTL xxx WARN/FAIL	Warning that the threshold limit x of forward or reflected RF power has been exceeded
	VSWR WARNING	VSWR too high
	BUS xxx TIMEOUT	No response from device x
	LATCH TIMEOUT	External control cable is not connected correctly (Option X only)

Query	Status message (String)	Meaning
ETM_MAINS?	hhhhh:mm:ss (pppp)	Elapsed time meter mains on (number of turn on cycles)
ETM_POWERUP?	hhhhh:mm:ss (pppp)	Elapsed time since last mains on (number of turn on cycles)
ETM_RF?	hhhhh:mm:ss (pppp)	Elapsed time meter AMP=ON (number of turn on cycles)
ETM_BANDx?	hhhhh:mm:ss (pppp)	Elapsed time meter Band x active (number of turn on cycles)
CONTROL?	CONTROL=LOCAL	Local control is active
	CONTROL=TTL	TTL remote control is active
	CONTROL=GPIB	GPIB remote control is active
	CONTROL=LAN	LAN remote control is active
	CONTROL=RS232	RS232 remote control is active
	CONTROL=RS485	RS485 remote control is active
	CONTROL=USB	USB remote control is active
	CONTROL=EXTERN	Instrument is controlled by external amplifier
FEATURES?	FEATURES= <Feature 1> <Feature 2> ...<Feature n>   Possible features:  TYP=< Series> BANDS=< n> FREQS=<B1 Fmin> <B1 Fmax>,... <Bn Fmin> <Bn Fmax> POW=<PowB1>,...<PowBn> GAIN= 0.0,30.0,dB  IND=FWD,REF	Returns the list of the installed amplifier features separated by „ “. Not installed features will remain empty.  Amplifier model series Number of frequency bands Lower and upper frequencies of each frequency band  Output power level of each frequency band Setting range (min./max.) of gain adjustment option (Option F only) Power indication (Option E only)
PUSH_STR?	[<Cmd1>;...< Cmdn>]	Shows all separate commands in the command string which is sent periodically
BAND?	BAND=x	Band x is selected
GAIN?	GAIN=x	Attenuation x dB is selected
P_FWD?	P_FWD=x	Forward power is x (Unit)
P_REF?	P_REF=x	Reflected power is x (Unit)
LATCH?	LATCH=STANDALONE	Instrument works independently
	LATCH=MASTER	Instrument controls external amplifier
	LATCH=SLAVE	Instrument is controlled by external amplifier



Query	Status message (String)	Meaning
NEXTALERT?	hhhhhh:mm:ss xx	Time when fault xx occurred
FIRSTLOG?	hhhhhh:mm:ss xx	Time when fault xx occurred
NEXTLOG?	hhhhhh:mm:ss xx	Time when fault xx occurred
DIAG_x?	yy	Result yy of diagnosis channel x
DIAG_FIRST?	yy	Result yy of first diagnosis channel
DIAG_LAST?	yy	Result yy of last diagnosis channel
DIAG_NEXT?	yy	Result yy of next diagnosis channel
DIAG_PREV?	yy	Result yy of previous diagnosis channel
EXECUTION_RESULT?	OK	Command was executed successfully
	FAIL_UNKNOWN_CMD	Command unknown/Syntaxerror
	FAIL_NO_EFFECT	Command has no effect
	FAIL_ERRORS_PRESENT	Command ignored as a fault message is active or latched
	FAIL_WARNINGS_PRESENT	Command ignored as a warning is active
	FAIL_BANDCHG_ON_RFON	Band switching is blocked during AMP=ON
	FAIL_FOCUSCHG_ON_RFON	Control change is blocked during AMP=ON
	FAIL_FOCUSCHG_ON_NOTLOCAL	Instrument is controlled by another interface
	FAIL_FOCUSCHG_ON_EXTERN	Instrument is controlled by external amplifier
	FAIL_NO_FOCUS	Instrument is controlled by another interface
	FAIL_RFINHIBIT	Operate inhibited e.g. after initial turn on
	FAIL_ILLEGAL_BAND	Invalid band selected
	FAIL_ILLEGAL_ATTEN	Illegal gain step selected
	FAIL_UNSPEC_ERR	Unspecified error
PING?	PING: CNT=x	Query x was successful (x will be increased by 1 on each query)

**Table 6-3: Status messages at the remote control interfaces**

### 6.3. Performance test report

Model: **SS1G-500**

**Test Conditions:**

Network: V Hz

Temperature: °C

Input-VSWR < 2:1

Instrument safety

Input Overload +10 dBm max.

TTL remote control interface:

IEEE remote control interface:

Ethernet remote control interface:

RS232 or RS485 rem. control interface:

USB remote control interface:

Power indication:

Gain adjustment:

Frequency MHz	P <sub>in</sub> dBm	P <sub>out</sub> nom. dBm	Harmonics		Spurious dBc	Gain dB	Option -50 dB Monitor Output	
			2 <sup>nd</sup> dBc	3 <sup>rd</sup> dBc			Forw. dB	Refl. dB
80		57						
100		57						
150		57						
200		57						
300		57						
400		57						
500		57						
600		57						
700		57						
800		57						
900		57						
1000		57						
Spec. max.	0		-20	-20	-60 typ.		-52	-52
min.		57				57	-48	-48

Tested by:

Date:

Approved by:

Date:

Quality Management  
(QM-stamp)

Release:

Date:

APPENDIX

Fig. 3-1 Front Panel View

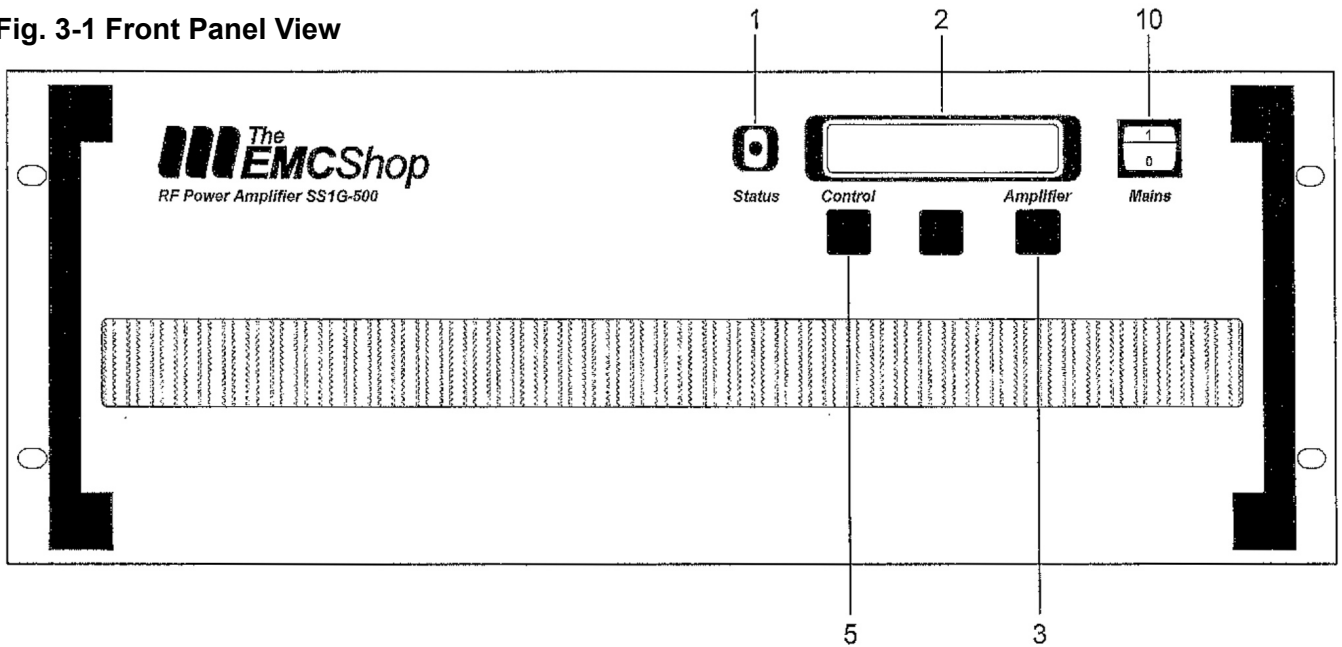


Fig. 3-2 Rear Panel View

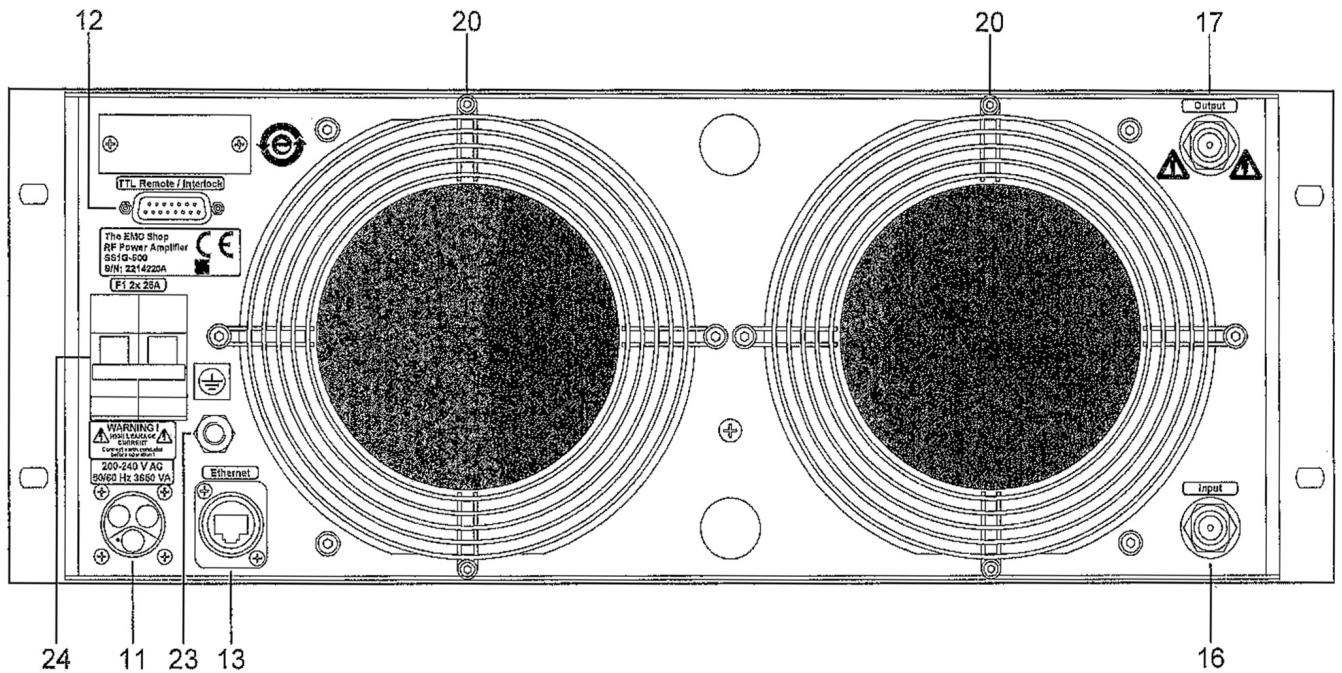


Fig. 3-4 Typical Application

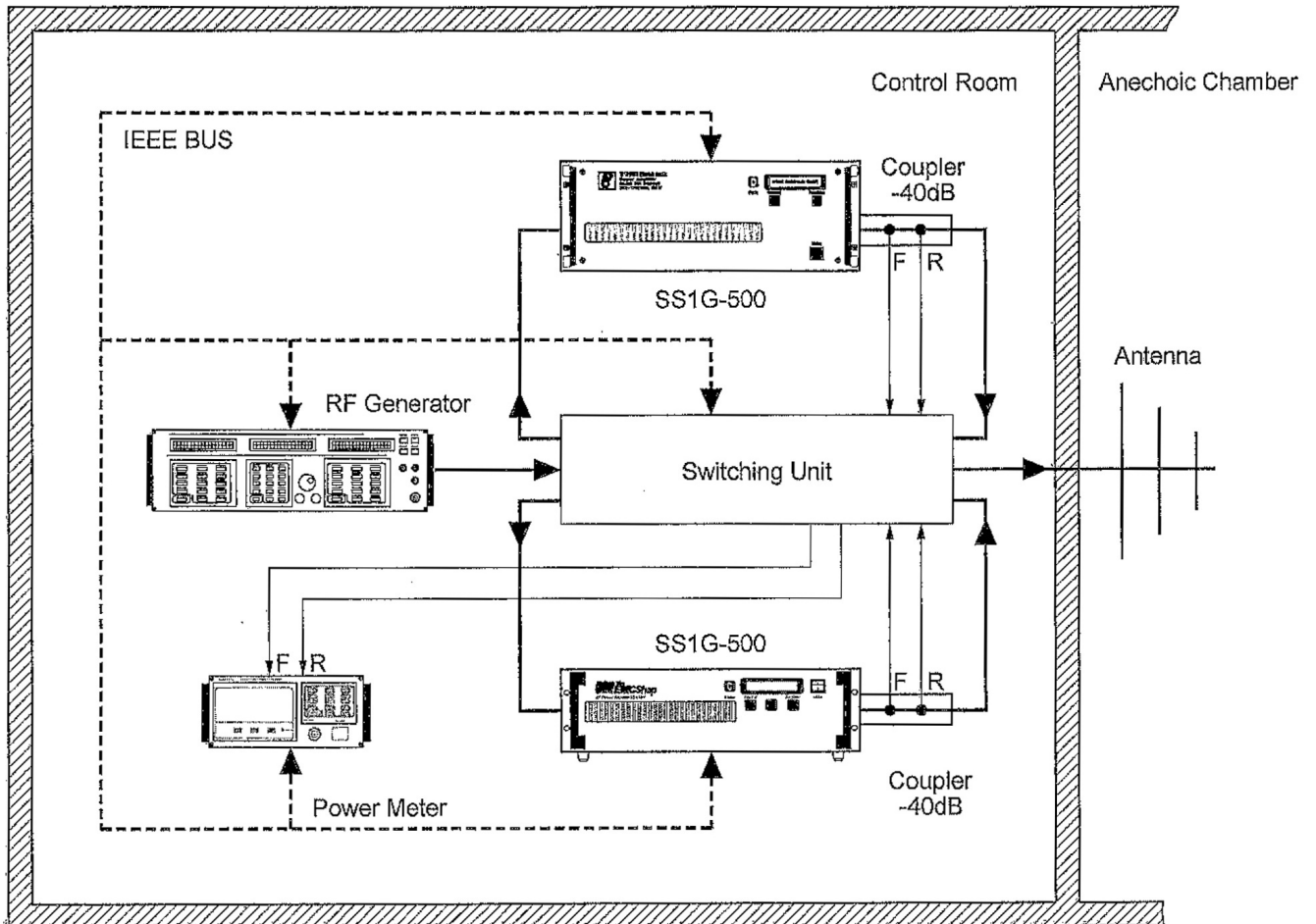


Fig. 4-1 Block Diagram of Complete Amplifier

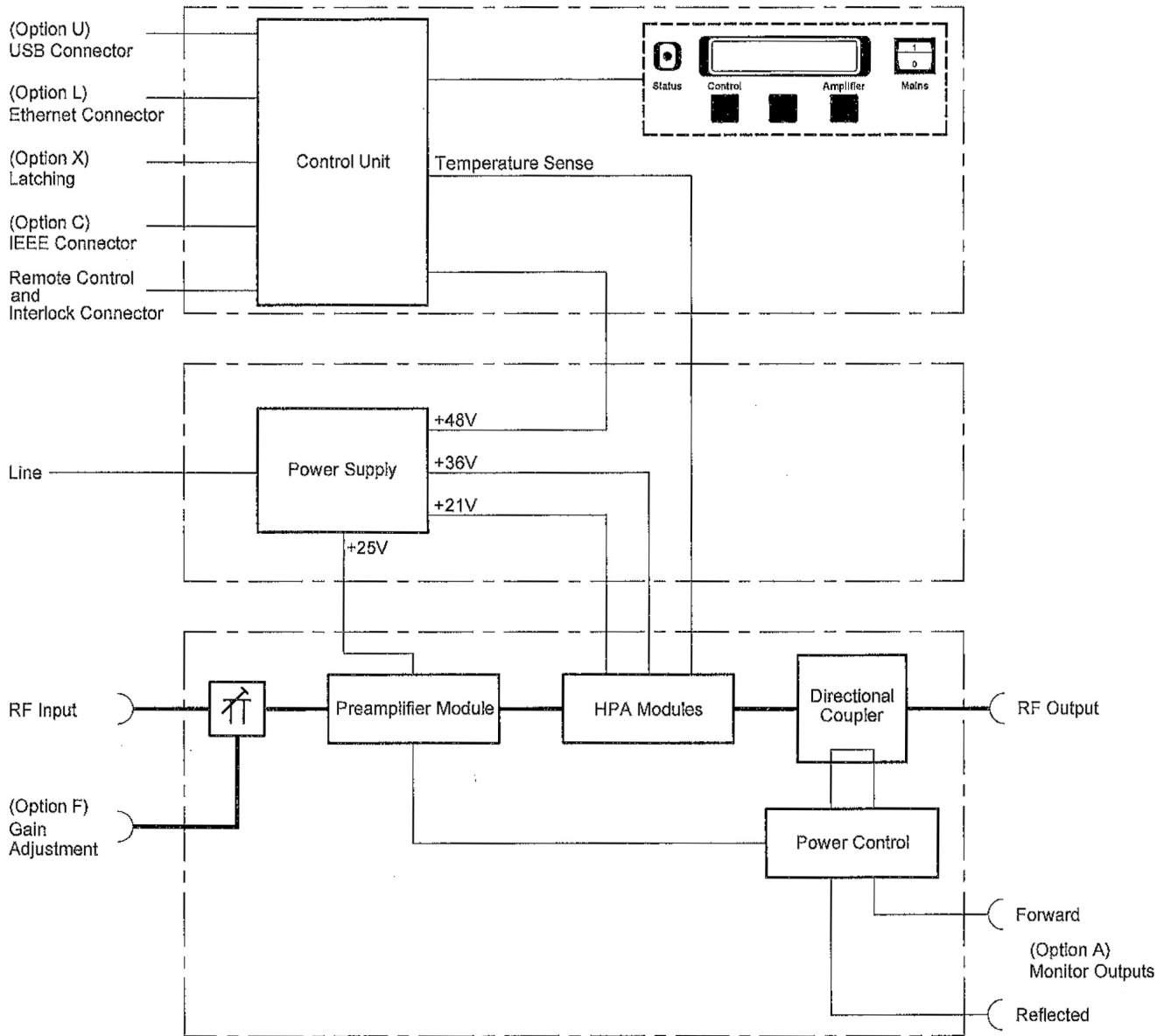


Fig. 4-2 Block Diagram of Amplifier Module

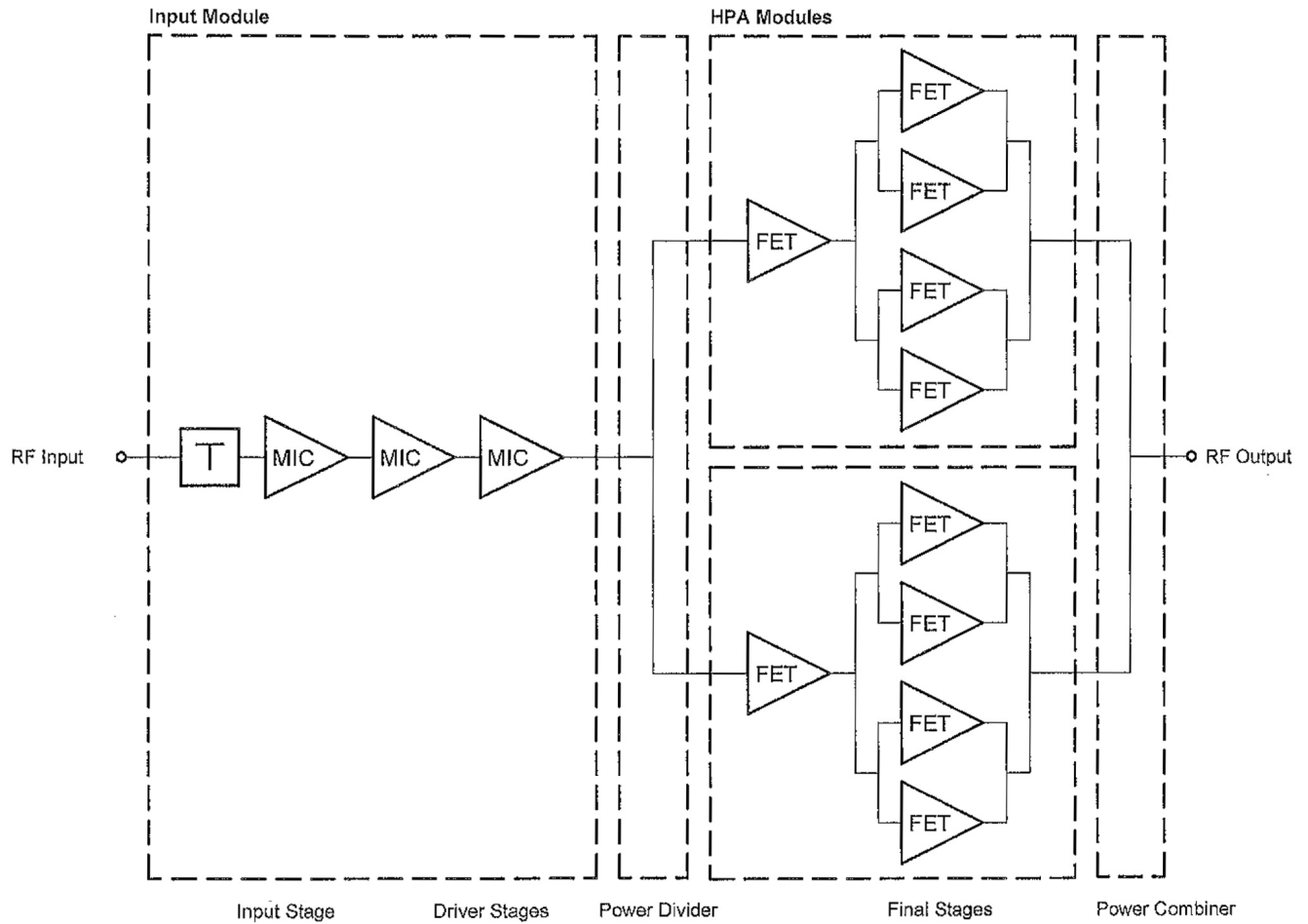


Fig. 4-3 Block Diagram of Power Supply

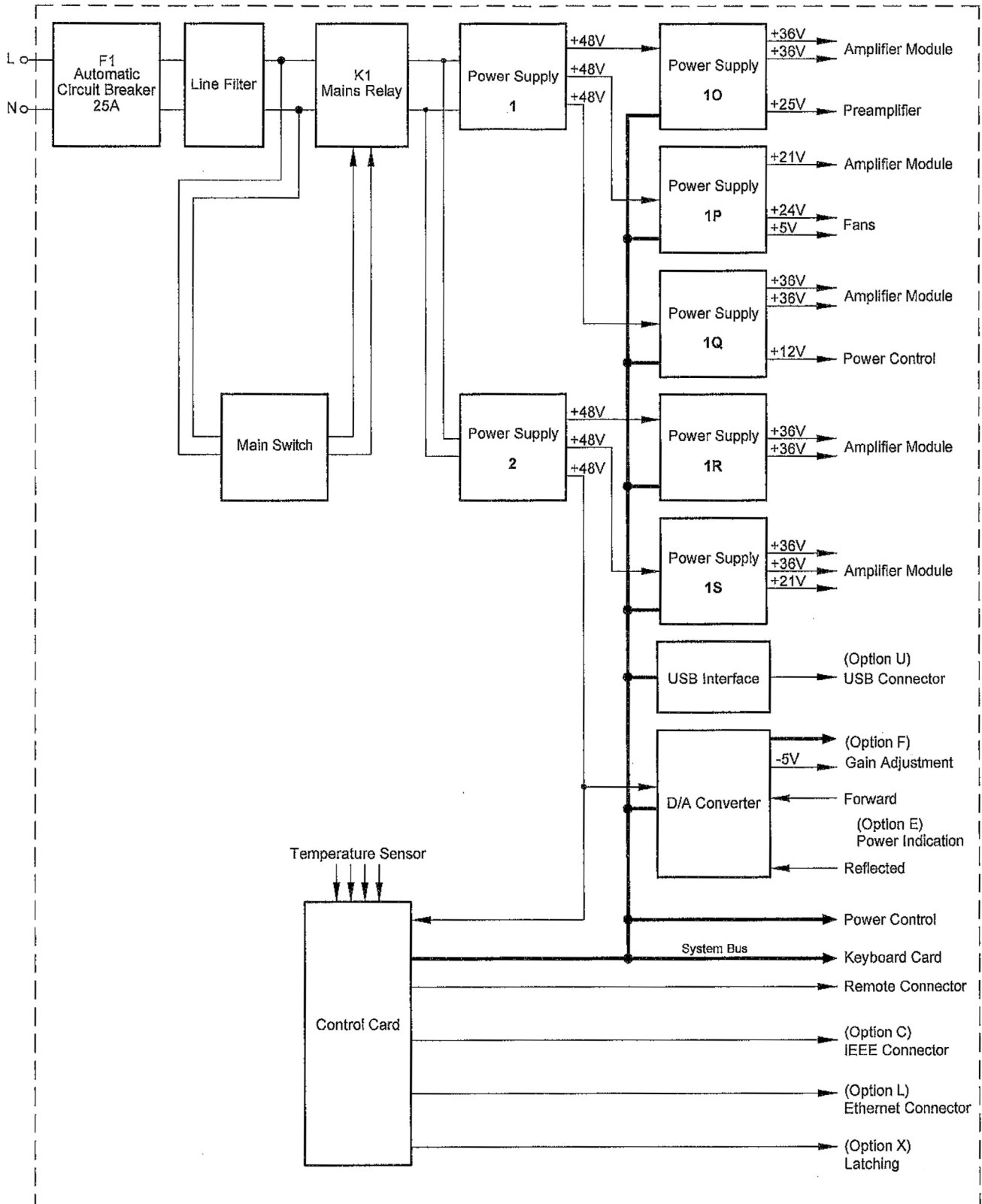




Fig. 6-1 Test setup

