AE-Amp

User Manual

Table of contents

1 Overview

The AE-Amp is design for amplifying signals generated from various types of different Acoustic Emission (AE) sensors. The amplifier inputs are AC coupled with a high pass frequency of 25 kHz. The Bandwidth depends on the selected gain from 1 to 3 MHz. The amplifier can be used with passive or active sensors due the integrated sensor power supply. The amplifier path can be passed-through for applying high voltage pulses when using the sensors also as ultra-sonic actuator.

1.1 Key Capabilities

- Two independent channels per module
- Gain 0 dB, 20 dB, 40 dB, 60 dB
- Bandwidth up to 3 MHz (Gain 0 dB)
- High Voltage Pulse Through up to 500 V
- USB or RS485 interface for configuring all settings

1.2 Versions

There are two versions available:

1.2.1   Boxed Version

- 2-Channel Modules AE-Amp-Box
- USB interface (emulated COM port)
- External power supply

1.2.2   Rack Version

- 2-Channel Rack-Modules AE-Amp-P
- Two different Base Unit chassis available:
    - Amp-BU-20-AE (for up to 10 modules / 20 channels)
    - AE-HV-MUX (for up to 8 modules / 16 channels)
- USB interface (emulated COM port) for accessing all installed amplifiers (Internally over RS485)

The Base unit is available in two different variants. The Amp-BU-20-AE is the standard system where the AE-Amp has a DIN connector and is intended for use inside the base unit only. In the AE-HV-MUX variant, the amplifiers are equipped with a round header connector which allows to operate the amplifier also outside of the chassis. This could be useful if the amplifier must be placed close to the sensor as possible.

Two base unit can be combined for having up to 16 or 20 amplifiers connected to one multiplexer.
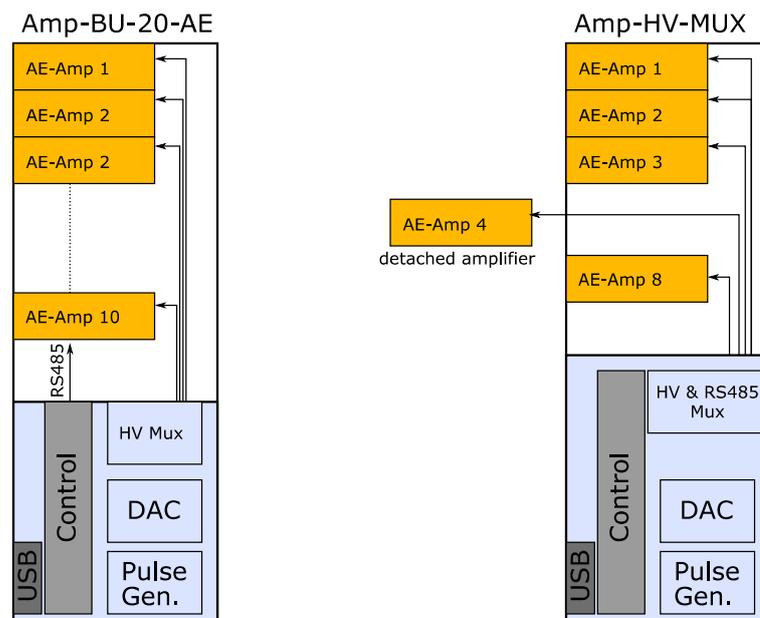
Figure 1 Base Unit Variants

2 Schematics
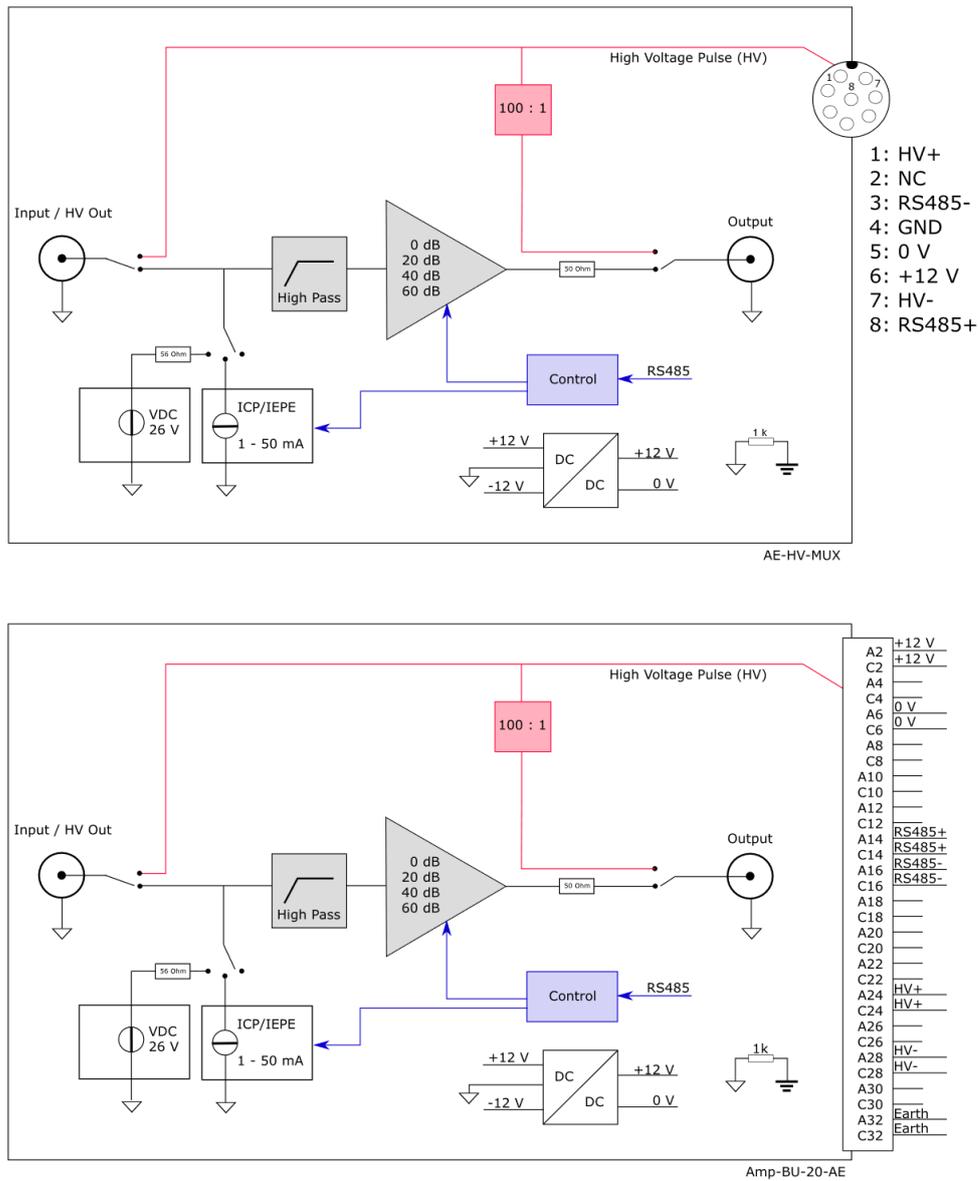
Figure 2 Schematics

2.1 Pin Assignment

Pin (AE-HV-MUX)	Amp-BU-20-AE	Description
1	A24 / C24	High Voltage Pulse In
2	-	Not connected
3	A16 / C16	RS485-
4	A32 / C32	Chassis Ground
5	A6 / C6	Power Supply GND
6	A2 / C2	Power Supply +12 V
7	A28 / C28	High Voltage Pulse In GND
8	A14 / C14	RS485+

3 Configuration and Settings

3.1   Hardware Settings

The Board Address (rotary switch) has to be selected ones for a board. In the boxed version, this Address is per default set to 0. In a Rack version with multiple boards, each device needs a unique address.
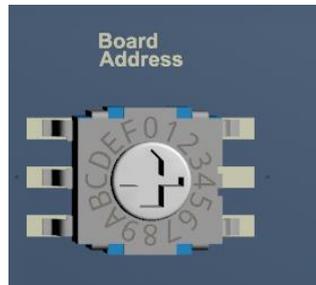

Figure 3: Configuration settings

3.2   Front LEDs

There is an LED for each channel with three colors (red, orange and green).

Color LED	Description
Off	Amplifier is off
Green	Normal operation
Orange	Normal operation with sensor power on
Red	High Voltage Pass Through is active

4 Mode of Operation

4.1 Amplifier with Passive Sensor

By default, the amplifier works with the gain set by the hardware switch on the frontside of the amplifier. Both channels have the same gain. The available gains are 20, 40 and 60 dB.

Different gains per channel are only possible by setting the gain over the software interface. See the Software Programming guide. **If the gain is set by software, the hardware switch on the frontside is no longer active until a reset command is send or the amplifier is powered off.**

4.2 Amplifier with Active Sensors

The AE-Amp has an internal current source which can deliver 1 to 50 mA which is compatible to all ICP/IEPE or JFET active sensors. The power source can be configured and activated over the Software interface.

If the power source is active, the gain set over the hardware switch is 0, 20, 40 dB as noted in orange on the front. Other gains can be set over the Software interface.

4.2.1   Constant Voltage

For operating the amplifier with a constant voltage instead of a current source, a hardware switch on the amplifier must set to VDC. For accessing this switch:
- Unmount the amplifier from the Rack
- Open the Amplifier
- Remove the shielding case from the PCB
- Change the switch position to VDC

For activate the voltage source, set a ICP current > 0. The value of the current has no influence of the voltage. Vdc is always 26 V (no load).

4.3 High Voltage Pulse Through

If the sensors should also work as actuator, for example for tomography application, the amplifier stage can be passed through and the sensor input is acting as output. The front LED is red when the pass-through mode is activated. Activation is done over software.

The applied voltage to the sensor is also passed to the amplifier output attenuated by 100.

Attention: Do not use the High Voltage Pulse Through Mode width active sensor like ICP/IEPE or JFET sensors as this will damage the internal electronic of the sensor!

5 Multiplexer and Pulse Generator

(Only available in the Rack Version together with an Amp-BU-20-AE or AE-HV-MUX)

The Amp-BU-20-AE or AE-HV-MUX (Base unit, BU) provides a TTL Pulse Output for triggering any external high voltage pulse generators. The high voltage signal coming from the external pulse generator can be feed back to the BU and is then multiplexed to one of the installed amplifier channels. If the Amplifier is set to the High Voltage Pulse Through Mode, the pulse is applied to the attached sensor.
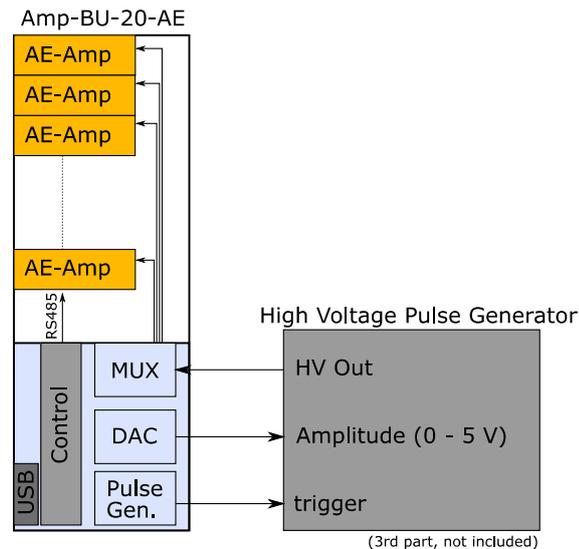
Figure 4 Amp-BU-20-AE System Overview

The TTL pulse generator and the multiplexer sequence control can be programmed by software. After a start command is received, the sequence is run once.
If the external high voltage generator provides an analog control input for the high voltage amplitude, the DAC output of the BU can used for this purpose.

5.1 Pulse Generator Control Parameter

The following parameters can be set by software:

Parameter	Description	Software CMD
Interval [s]	Repetition period between a pulsing session. This interval is controlled by the user application	-
Voltage [V]	Amplitude of high voltage pulse. (Only available with analog amplitude control, assuming 1 V → 100 V	SETHVVAL, GETHVVAL
No. Pulses	Number of consecutives pulses generated on the same channel	SETHVPULSE, GETHVPULSE

Pulsewidth min/max [us]	Pulse width of each pulse. If min/max are not equal, the generator starts with the smallest value and gets longer on each consecutive pulse on each channel. (see Sequence Diagram)	SETHVLENFROM, SETHVLENTO, GETHVLENFROM, GETHVLENTO
Pulse Interval [ms]	Time period between each pulse on the same channel	SETHVINR, GETHVINR
Chn. Delay	Delay between the last pulse on one channel until a new pulse on a second channel is applied	SETHVLSTDL, GETHVLSTDL

W : Pulse Width min and max
I : Pulse Interval
C : Channel Switch Delay

Figure 5 Sequence Diagram

Figure 6 HV-Pulse Configuration with the AE-Amp Tool
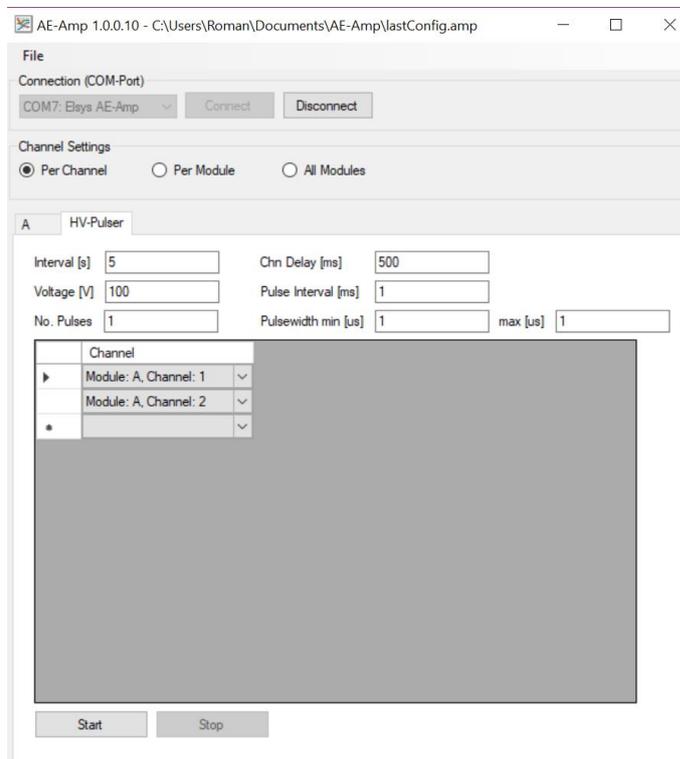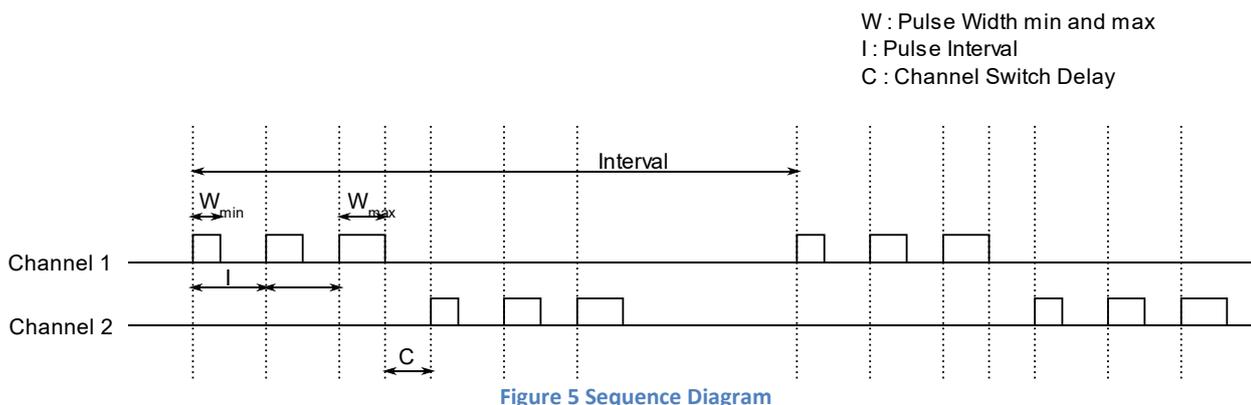
6 Software Interface

All AE-Amp modules have a RS485 interface. For the boxed version, each box comes with an USB to RS485 converter module. RS485 interface is used as a unidirectional interface.

The Rack version uses a so called Base Unit with a built in USB to RS485 converter module. The USB module uses a standard FTDI chip and its FTDI drivers. After installation of the drivers the module will be listed in the windows device manager as a USB Serial Port.
The number of the Serial Port, in this example COM9 depends on the configuration and already used ports on the final system. There is no need to do change any settings in the device manager, this should be done with software or configuration tool itself.

Please contact Elsys AG to get a free version of the software tool "AE-Amp".

6.1 Serial Port Settings

Please use the following settings to communicate with the modules:

Settings	Value
Baud	19'200
Data bits	8
Stop bits	1
Parity	None

6.2 Driver downloads

Download the drivers for the USB to RS485 converter chip directly from the FTDI web-site: http://www.ftdichip.com/Drivers/VCP.htm

6.3 Recommended tools

Also, a very useful tool for testing is HTerm, this can be downloaded here:
http://www.der-hammer.info/terminal/
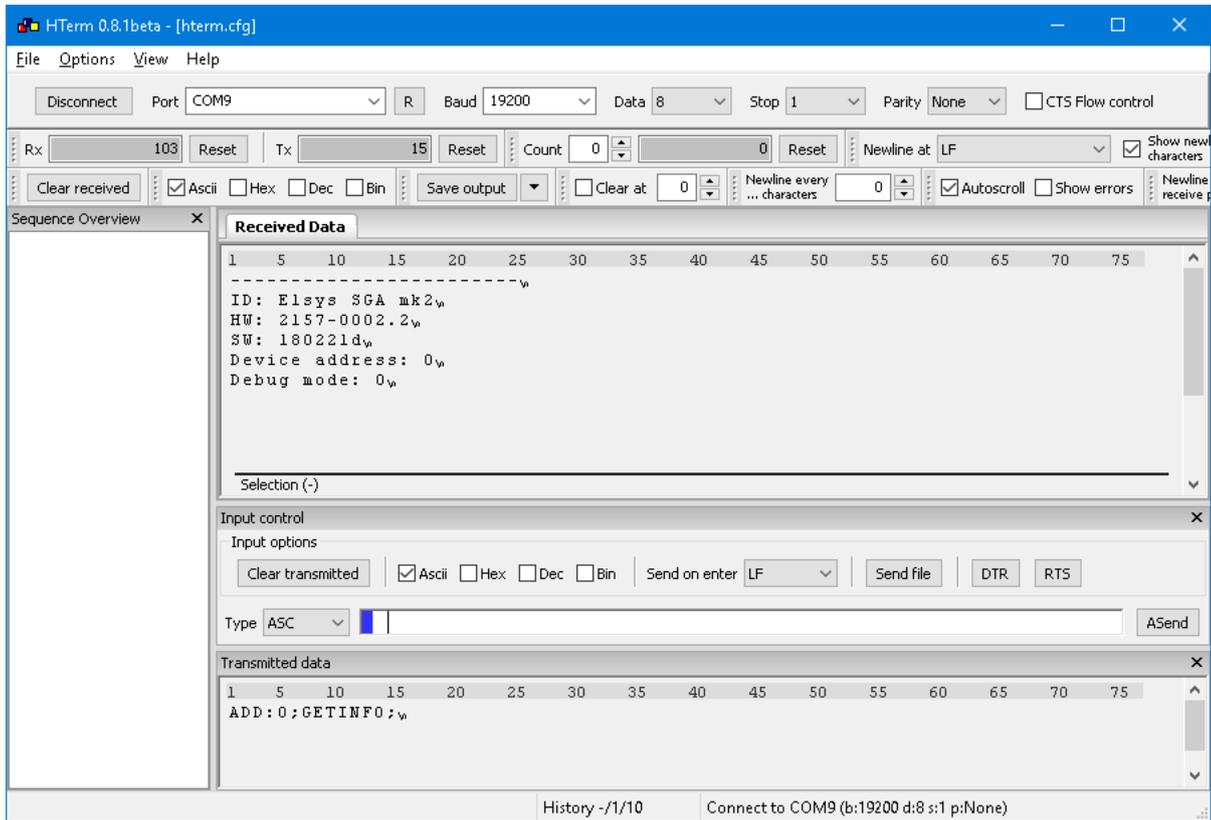
6.4 Serial protocol

The used protocol is based on simple string commands and parameters, which makes it easy to understand and to use. The syntax is always: **COMMAND:VALUE;\n**
Several commands can be combined in one string. The end of a command is set by sending a New Line (\n) character.

Command (String)	Value (String)	Return (String)	Broadcast	All Chn	Description
Addressing:					
ADD	0 … 15	no return value	n.a.	n.a.	Address of the device
CHN	1, 2, n	no return value	n.a.	n.a.	Channel, Ch 1, 2 or both
Info					
GETINFO		multiple lines	no	n.a.	returs ID, HW SW, ADD, DEBUG status
GETID		Elsys AE-AMP	no	n.a.	Description
GETHW		2192-2000.1	no	n.a.	HW Revision
GETSW		yymmddRev	no	n.a.	SW Revision, e.g: 180105a
GETADD		0 … 15	yes	n.a.	Address, Rotray switch position
GETMODE		0, 1	no	no	0=HW settings, 1=SW stettings
ECHO		0 … 15	no	n.a.	Returns Address, if alive
SETDEBUG	0, 1, n	0	no	n.a.	1 more detailed output, any other value than 1 will be equal to SETDEBUG:0; 0 after restart of the device
System:					
RESET		0, -1	yes	yes	Reset to HW settings
Write settings:					
SETGAIN	0, 20, 40, 60	0, -1	yes	yes	Set SW gain 0, 20, 40, 60dB
SETCHARGE	0, 1	0, -1	yes	yes	ChargeImput, disable=0(default), enable=1
SETICP	0….50	0, -1	yes	yes	Set ICP output current, disable=0(default)
SETHV	0, 1	0, -1	no	no	Enable HV Out and ATT, disable=0(default), enable=1
Read settings:					
GETGAIN		0, 20, 40, 60	no	no	Read current Gain settings
GETICP		0…50	no	no	Get ICP output current, 0 = disabled
GETHV		0, 1	no	no	Read HV Output status

Figure 7 Serial Protocol AE-Amp

Parameter (String)	Value (String)	Return (String)	Broadcast	All Chn	Description
Addressing					
MUX	0 … 15	no return value	n.a.	n.a.	Address of the device
Info					
GETINFO			no	n.a.	
GETID		Elsys AE-HV-MUX	no	n.a.	Description
GETHW		2192-2000.1	no	n.a.	HW Revision
GETSW		180329a	no	n.a.	SW Revision
ECHO		0 … 15	no	n.a.	Returns Address, if alive
SETDEBUG	0, 1, n	0	no	n.a.	1: More detailed output, any value than 1 will be equal to SETDEBUG:0;
System					
RESET		0, -1	no	n.a.	Reset all
PULSESTART	666, 777	0, 1, -1	no	n.a.	Start HV pulser: 666 actual channel 777 handels the channel list
PULSESTOP		0, 1	no	n.a.	Stops HV pulser sequence. In case of running PULSESTART, return value will be sent ones for both commands, In non running sequenze return value will be 0, else 1
SETCHNLST	011, …. 162,	0, -1	no	n.a.	Define a list with 32 values, first two digits are the module number, last digit the channel. In Combination with PULSESTART:777; HV pulses will be generated on the defined channel list.
Write settings					
SETMOD	1 … 16	0, -1	no	n.a.	select a module for RS485 communication
SETHVMOD	1 … 16	0, -1	no	n.a.	Select HV Relais for a module
SETHVVAL	0 … 500	0, -1	no	n.a.	HV level in Volt
SETHVPULSE	0 … 1000	0, -1	no	n.a.	Number of pulses
SETHVLENFROM	0 … 1000	0, -1	no	n.a.	Length of the HV pulses in us
SETHVLENTO	0 … 1000	0, -1	no	n.a.	Length of the HV pulses in us
SETHVINR	0 … 1000	0, -1	no	n.a.	Interval between pulses in ms
SETHVLSTDL	0 … 1000	0, -1	no	n.a.	Delay between channel list in ms
Read settings					
GETMOD		1 … 16	no	n.a.	active AE-AMP module, communication
GETHVMOD		1 … 16	no	n.a.	active AE-AMP module, HV pulser
GETHVVAL		0 … 500	no	n.a.	HV level in Volt
GETHVPULSE		0 … 1000	no	n.a.	Number of pulses
GETHVLENFROM		0 … 1000	no	n.a.	Length of the HV pulses in us
GETHVLENTO		0 … 1000	no	n.a.	Length of the HV pulses in us
GETHVINR		0 … 1000	no	n.a.	Interval between pulses in ms
GETHVLSTDL		0 … 1000	no	n.a.	Delay between channel list in ms

Figure 8 Serial Protocol AE-HV-MUX & Amp-Bu-20-AE

6.5 Addressing

For selection of a specific device, channel or MUX-Channel the parameters **ADD:n; CHN:n** or **MUX:n;** can be used. Some Parameters are broadcast messages, which can be used for either all available channel or one specific channel. The addressing is active till the end of the command, set by a new line character. For a new command, the addressing must be set again.

Remark: If an AE-HV-MUX is in use, the address (ADD) is always 0 and the corresponding MUX channel and SETMOD command must be activated for communicate with a single amplifier.

6.6 Info

Some functions and commands are meant to get information from the device.
ADD:0;GETINFO; returns multiple lines with information about Hard and software.
GETADD; is a Broadcast command and returns the Address of all connected SGA mk2 boards. Between each reply will be a delay form approx. 100ms.

ADD:0;SETDEBUG:1; enables the debug output which will give much more detailed feed-back regarding settings etc..

6.7 System

The command **RESET;** is used to return from the software configuration back to the hardware configuration.

6.8 Write Settings

Commands like **SETGAIN**, **SETICP** and **SETHV**, will be used for the software configuration of the amplifier settings.

6.9 Read Settings

Commands like **GETGAIN**, **GETICP** and **GETHV** will be used to get the actual used configuration.

6.10 Examples

Amp-BU-20-AE:

Set Gain to 40 dB for Amplifier 3, channel 2:
```
ADD:2;CHN2;SETGAIN:40;\n
```

Enable ICP, 4 mA on all channels of Amplifier 3
```
ADD:3;SETICP:4;\n
```

AE-HV-MUX:

Set Gain to 40 dB for Amplifier 3, channel 2:
```
MUX:0;SETMOD:2;ADD:0;CHN2;SETGAIN:40;\n
```

Enable ICP, 4 mA on all channels of Amplifier 3
```
MUX:0;SETMOD:2;ADD:0;SETICP:4;\n
```

Configure Pulse Generation:
Configure 6 Pulses, 250 V, 20ms Interval, 10 to 100 us
```
MUX:0;SETHVVAL:250;\n
MUX:0;SETHVPULSE:6;\n
MUX:0;SETHVINR:20;\n
MUX:0;SETHVLSTDL:100;\n
MUX:0;SETHVLENFROM:10;\n
MUX:0;SETHVLENTO:100;\n
```

Generate Pulses and route them from the HV input to Amplifier 3, Channel 1
```
MUX:0;SETHVMOD:2;ADD:0;CHN:1:SETHV:1\n
MUX:0;PULSESTART:666;
```

Use a channel list for switching automatically from one channel to the other and generate pulses:

```
MUX:0;SETCHNLST:011,021,031,041,051,012,022,032,042,052;\n
MUX:PULSESTART:777;
```

7 Safety Information

(Base Unit Amp-BU-20-AE or AE-HV-MUX only)

- This instrument is intended for indoor use and should be operated in a clean, dry environment.
- **It must not be operated in explosive, dusty, or wet/damp atmosphere.**
- Make sure this product's operating environment is kept within the following parameters prior to use:
  - o Temperature: 0 to 45 °C, Note: Direct sunlight, radiators and other heat sources should be taken in account when assessing the ambient temperature.
  - o Humidity: Maximum relative humidity 80% for temperatures up to 31 °C decreasing linearly to 50% relative humidity at 45 °C
  - o Altitude: Up to 2'000m

- The design of the instrument has been verified to conform to the EN 61010-1 safety standard per the following limits:
  - Installation (Overvoltage)
    Category II (Main Supply Connector) and
    Category I (Measuring Terminals)
  - Pollution Degree 2
  - Protection Class I

Warning
Lethal voltages exist inside the instrument. **Only qualified technicians of supplier staff are authorized to open the case of the Base Unit.** Otherwise warranty will be lost! **Always ensure that power cord is removed before opening the case.**

8 Base Unit Specifications

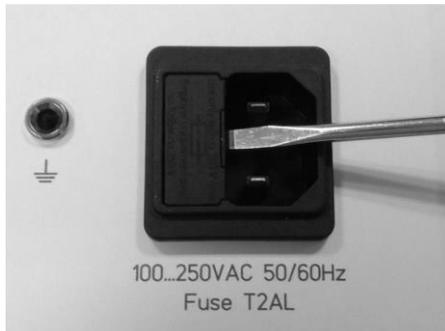| Case:	Amp-BU-20-AE AE-HV-MUX	19"-Rack Case ca. 480x290x140 mm
Plug-In Capacity:	Amp-BU-20AE AE-HV-MUX	up to 20 channels, 10 modules up to 16 channels, 8 modules

Main Power Voltage:	100 to 250 VAC, 50/60 Hz
Power consumption:	max. 75 W
Inlet Protection Fuse:	Type 5x20 mm, only T2AL fuses must be used. There are two fuses installed.

Weight:	max. 7.5 kg (incl. 10 Plug-In Modules)

9 Specifications of the AE-Amp-Box

| Case:	Aluminum case, approx. 110x45x185 mm (WxHxT)
Number of channels per Box:	2
Power Supply: By a Mains Adapter:	12 VDC, max. 500mA 100 to 240 VAC, 50/60Hz
Weight:	0.65 kg (incl. Mains Adapter)

10 Amplifier Specifications

Case: Module with 2 channels
Gain: x1, x10, x100
Indication of adjusted Bridge: Front-LED
Input stage: AC-Coupled Voltage Input
Gain Error: < +/- 1 % (@ 100 kHz)

Gain	Output Noise	Bandwidth (- 3 dB)
0 dB	TBD	> 5 MHz
20 dB	TBD	3 MHz
40 dB	TBD	2 MHz
60 dB	TBD	700 kHz
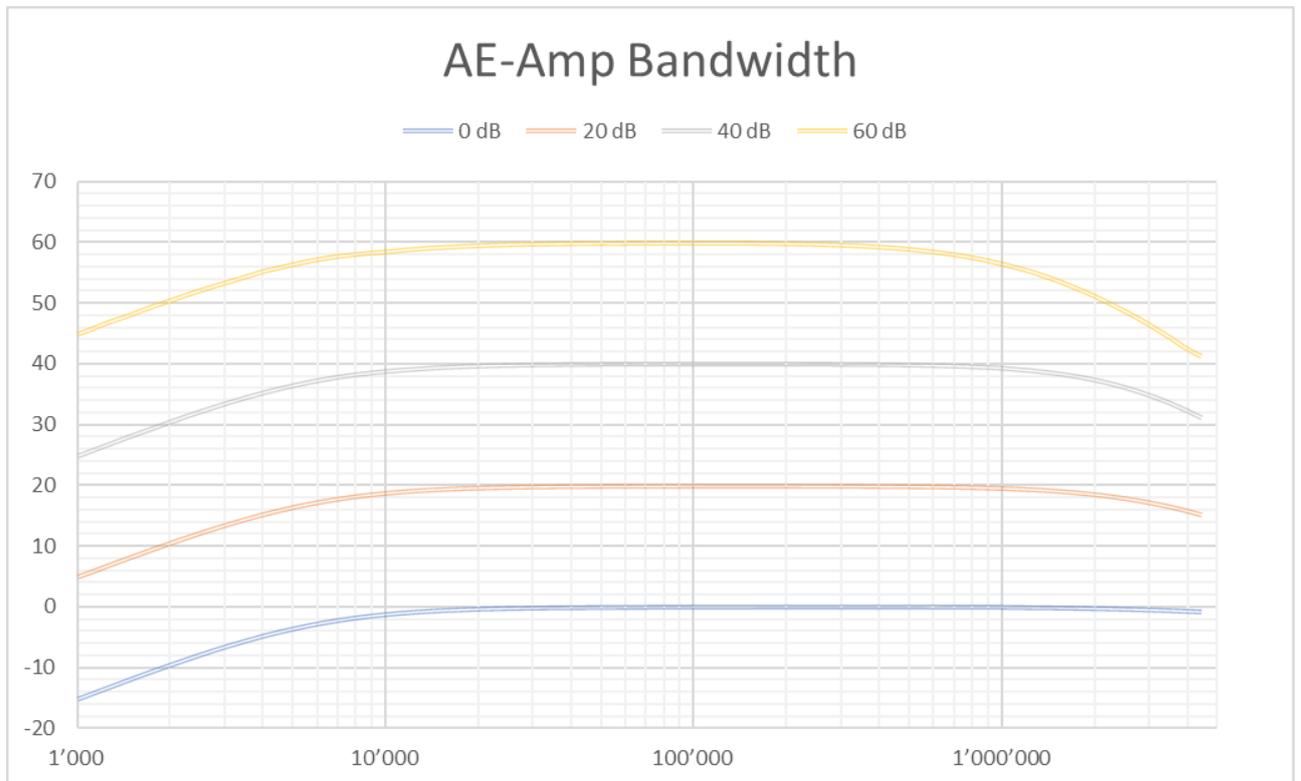
Sensor Power: 1 – 50 mA Current Source, 26 VDC max.
Output Impedance: 50 Ω +/-1%
Max. Output Voltage Swing: +/-9 V (no Load)
                                                 +/-4.5 V (Load = 50 Ω)
Max. High Voltage Pulse: 500 VDC
Power Supply: 12 Vdc +/-10%, max. 6 W per 2 Ch
Operating Temperature: 0 to 45 °C
Storage Temperature: -20 to 60 °C
Rel. Humidity: < 80 % (up to 31 °C)
                                                 decreasing to < 50% at 31 to 45°C
Max. Operating Elevation: 2'000 m
Weight (Plug-In Module):   0.25 kg
Connector Type Output: BNC
Connector Type Input: BNC

Document information

Filename: AE-Amp Manual EN.docx
Status: Released

Last modification

Date: 21.11.2018
Author: R. Bertschi