VERSION 1.0 APRIL 2020

PHYSICAL INSTRUMENTS

SMART MATERIAL

HVA-ST300
User Manual

Version 1.0

CONTENTS

1. SAFETY INSTRUCTIONS
READ FIRST

The high voltage amplifier **HVA-ST300** generates voltages up to 200V. These voltages are present inside the unit and at the rear-panel output connectors that can could result in injury or loss of life.

THE INFORMATION, CAUTIONS, AND WARNINGS IN THIS MANUAL MUST BE HEEDED.

SAFETY PRECAUTIONS:

- **USE THE POWER CORDS PROVIDED:** To avoid fire hazard, use only the power cord provided with this instrument. Before switching on the high voltage amplifier, make sure that all cables are connected to the corresponding sockets.
- **AVOID ELECTRIC OVERLOAD:** To avoid electric shock or fire hazard, do not apply a voltage to a terminal that falls outside the range specified for that terminal.
- **AVOID ELECTRIC SHOCK:** To avoid electric shock, do not touch the high voltage output connector or the load circuit while the instrument is on.
- **GROUND THE PRODUCT:** This product is electrically grounded through the ground conductor of the power cord. To avoid electric shock, the ground conductor must be connected to earth ground. Before making connections to the input and output terminals of the product, first ensure that the product is properly grounded.
- **DO NOT OPERATE WITHOUT COVERS:** To avoid electric shock or fire hazard, do not operate this instrument with the covers removed.
- **USE PROPER FUSES:** To avoid fire hazard, use only the fuse type and rating specified for this instrument.
- **INDOOR USE ONLY:** This instrument is intended for indoor use only.
- **DO NOT OPERATE IN WET OR DAMP CONDITIONS:** To avoid electric shock, do not operate this instrument in wet or damp conditions.
- **DO NOT OPERATE IN AN EXPLOSIVE ENVIRONMENT:** To avoid injury or fire hazard, do not operate this instrument in an explosive environment.
- **NEVER OPERATE THE HIGH VOLTAGE AMPLIFIER** if any housing part of the unit is defective or removed.
- **BEFORE REMOVING THE CABLES FROM THE LOAD,** switch off the amplifier and wait at least 10 minutes until the load capacitors are discharged.

WARNING!

HAZARDOUS VOLTAGES UP TO 200V ARE PRESENT AT THE OUTPUTS OF THE HIGH VOLTAGE AMPLIFIER.
TAKE APPROPRIATE PRECAUTIONS DURING MEASUREMENT PROCEDURES.
BEFORE TURNING ON THE AMPLIFIER, REMOVE HANDS AND ALL TEST EQUIPMENT FROM THE HVA-ST300 AND CONNECTED CABLES!!

2. INSPECTION AND INSTALLATION

This section provides information for incoming inspection, damage claims, shipping, and installation of the HVA-ST300.

2.1 WHAT IS INCLUDED WITH THE HVA-ST300

The high voltage amplifier package consists of the following items:

- High voltage amplifier unit HVA-ST300
- Line voltage cord
- High voltage cable with SHV plug
- 3-pin interlock connector
- User Manual

2.2 INCOMING INSPECTION

The high voltage amplifier unit should be inspected for damage, scratches, dents, or other defects. Also the cushioning materials should be checked additionally for signs of severe stress.

The electrical performance of the amplifier unit should be verified upon receipt. Make sure that no cable is electrically and mechanically defective.

If the unit is damaged in transit, or fails to meet the specifications upon receipt, notify the carrier and Smart Material's sales office immediately. Retain the shipping carton and padding material for the carrier's inspection. Our sales office will arrange for replacement or repair of your unit.

2.3 INSTALLATION

The AC power supplied to the amplifier unit should be 90 to 264 VAC, 47 to 63Hz, single phase. Two slow-blow fuses of 3.15A are used.

For safety reasons, the power supply must be grounded through the AC power cord. When operating from ungrounded power sources, a secondary grounding method is mandatory.

Before operation, make sure that the output cable of the amplifier unit is connected to the load.

The power supply uses a forced-air cooling. Please ensure that the unit is located in an area with adequate air circulation.

2.4 EU DECLARATION OF CONFORMITY

The high voltage amplifier HV-ST300 has the CE marking. The EU Declaration of Conformity ensures that the device meets the requirements of the European Standard given by the regulation of the Council of the European Union for assimilation of the legal regulations of the members of the European Union concerning the Electromagnetic Compatibility (89/336/EEC). Conformity is shown by the compliance with the concerning standards EN 50081-1; EN 50082 or EN50081-2; EN 50082-2 respectively.

This symbol refers to the compliance of the equipment to the European Council (EC) standards.

3. OVERVIEW

The high voltage amplifier HVA-ST300 was designed for high capacitive loads as typically exhibited by piezo ceramic actuators, especially multilayer stack actuators.
The HVA-ST300 is capable of delivering an output voltage in the range of 0V to +200V and an output current of up to 2A DC. The amplifier provides a large signal bandwidth of DC to 1kHz, depending on the load capacitance. The HVA-ST300 has a gain of 20 V/V, input voltage to ouput voltage.

Two independent signal inputs are provided — a wave generator input and an audio signal input — both of which are selected by a rotary switches. The wave generator input accepts signals in the range of 0V to +10V at a frequency of 0 Hz to 1 kHz. The audio signal input accepts audio signals in the range of 0 to 10 V at a frequency of 0 Hz to 1 kHz. Two potentiometers are also provided to adjust the gain and the offset of the audio signal.

The monitoring circuitry allows for output voltage and output current monitoring. Both monitoring signals are low output voltages, i.e. at no hazardous voltages.

Furthermore, two LEDs are used to indicate the states of the output voltage/current. The amplifier features signaling LEDs for HV On (amplifier on/off status) and for Limit (signaling an overload condition).
The interlock circuitry allows switching the high voltage on or off by an external signal.

4. SPECIFICATIONS

The HVA-ST300 is designed to be operated as a high voltage power supply for driving piezo ceramic multilayer stack actuators and similar, high capacitive piezo ceramic devices.

4.1 GENERAL SPECIFICATIONS

Input line voltage	90-264 VAC, 47-63 Hz, 300 VA
Operating Conditions	Ambient temperature 0°C to 30°C
	Relative humidity up to 85%, non condensing
Mechanical	255 mm width x 100 mm height x 400 mm depth
	Weight 8kg (18 lbs)

4.2 OUTPUT VOLTAGE, MAXIMUM CURRENT

Output Voltage Range	0V to +200 V
Output Current Range	0V to +2 A DC
Connector	SHV Connector

4.3 OUTPUT PERFORMANCE

DC Voltage Gain	20 V/V for signal generator input, non-inverting
DC Voltage Gain Accuracy	Better than 0.5% of full scale
Offset Voltage	Less than 1 V
Large Signal Bandwidth	DC to 1 kHz
Capacitance Driving Performance	*see chapter 6, page 14*

4.4 SIGNAL GENERATOR INPUT

Input Voltage Range	0 V to +10 V corresponds to 0 V to +200 V output
Input Resistance	20 kΩ
Signal Frequency Range	0 Hz to 1 kHz
Connector	BNC coaxial connector

4.5 AUDIO SIGNAL INPUT

Input Voltage Range	0 V to +10 V
Input Resistance	20 kΩ
Gain Control Range	0 to 10, by using a 10-turn potentiometer
Offset Control Range	0 V to +200 V, by using a 10-turn potentiometer
Signal Frequency Range	0Hz to 1kHz
Connector	BNC coaxial connector

4.6 OUTPUT VOLTAGE MONITORING

Conversion Factor	1/20th of the output voltage
Output Impedance	1 kΩ
Connector	BNC coaxial connector

4.7 OUTPUT CURRENT MONITORING

Conversion Factor	5 V/A of the output current
Output Impedance	1 kΩ
Connector	BNC coaxial connector

4.8 INDICATORS

HV On 	A red LED illuminates indicating that the high voltage is on
Limit 	A red LED illuminates if the output voltage or current exceeds the limits

4.9 INTERLOCK

Function	The output voltage is turned on only if the interlock signal is closed, i.e. pin 1 and pin 2 of the interlock connector are connected together
Interlock Connector Signals	A 3-pole socket on the rear panel. • Pin 1: output signal, +5 V • Pin 2: input signal, i.e. interlock signal

5. OPERATIONS

This section outlines a general procedure for operating the high voltage amplifier and the load, typically multilayer stack actuators.

5.1 FRONT PANEL CONTROLS

POWER	Toggle Switch	Turns the power supply on and off.
IN/OUT CONTROL	WG Audio Switch	This rotary switch enables the wave generator input or the audio signal input.
	Off On Switch	This rotary switch turns the output voltage on or off.
WG INPUT	Input Signal, BNC Connector	The wave generator input accepts signals in the range of 0 V to +10 V, frequencies of 0 Hz to 1 kHz which corresponds to an output voltage of 0 V to +200 V.
AUDIO SIGNAL INPUT	Input Signal, BNC Connector	The audio signal input accepts signals in the range of 0 V to +10 V, frequencies of 0 Hz to 1 kHz.
	Gain Potentiometer	This potentiometer adjusts the gain in the range of 0 to 10.
	Offset Potentiometer	This potentiometer adjusts the offset of the output voltage in the range of 0 V to +200 V.
MONITORING	LED Indicator HV On	This indicator lights up if the output voltage is turned on both by the rotary switch in the In/Out Control section and by the external interlock signal.
	LED Indicator Limit	This indicator lights up if the output voltage and/or current exceeds the limits.
	Voltage Monitor, BNC Connector	This output signal monitors the high voltage at the output. The conversion factor is 1V / 20V. The output signal is low voltage.
	Current Monitor, BNC Connector	This output signal monitors the output current. The conversion factor is 10V / 2A. This output signal islow voltage.

5.2 REAR PANEL CONTROLS

LINE VOLTAGE INPUT	Connector	International standard three-wire connector
	Line Voltage	90-264 VAC
	Power	300 VA
	Fuse	Two 3.15 A slow-blow fuses
GROUND SCREW	Function	Allows grounding of the unit
HIGH VOLTAGE OUTPUT	Connector, SHV Connector	High voltage output 
	Voltage Range	0 V to +200 V
INTERLOCK INPUT	Connector	3-pole socket on the rear panel
	Pin Assignment	Pin1: 5 V output Pin2: interlock signal input Pin3: not used Amplifier output voltage is turned on if pin1 is connected to pin2; otherwise, the output voltage is set to 0 V

5.3 OPERATING REQUIREMENTS

Before making any connections, make sure that the amplifier unit is turned off.

- Plug the amplifier unit into the main outlet.
- Connect the load with the high voltage output connector of the amplifier using the included high voltage cable with the SHV plug.
- Connect the interlock cable to the interlock connector of the amplifier unit.
- Connect a ground cable from the load to the GND screw on the rear panel of the amplifier unit if necessary.

5.4 OPERATING INSTRUCTIONS

Before switching the amplifier unit to **ON**, preset the controls on the front panel. Set the output control switch to **OFF**.

Prior to normal operation, the amplifier should be warmed up for 5 minutes in order to achieve the nominal stability of the amplifier.
To do so:

- Set the output control switch to **OFF**.
- Select the required input to **WG Input** or **Audio Signal Input**.
- Make sure the interlock signal is activated at the rear panel socket **Interlock**.
- Apply a signal to the input selected.
- Turn on the output voltage by setting the output control switch to **ON**. The indicator **HV on** will turn on. If not, check the interlock signal **Interlock** at the rear panel socket.
- Check if output voltage is present at the output by monitoring the monitor signal **Voltage** or **Current** outputs, using an oscilloscope.
- Should the indicator **Limit** turn on, lower the input signal amplitude or signal frequency. In case of an input audio signal, the gain or offset potentiometer can also be used.
- To turn the unit off, turn the **Power** switch off.

6. CAPACITIVE DRIVING PERFORMANCE

The table below gives an overview of the maximum achievable sine wave frequency at some listed MFC capacitances and output voltage swings. For the calculation of the maximum achievable frequency, the following formula may be used:

$$C_{max} = 700\,000 / U_{pp} \times f$$

f = Sine wave frequency in Hz.
U_{pp} = peak-to-peak voltage across the piezoceramic device.
C = the piezo ceramic device capacitance in µF.

f_{max} @ U_{pp} = 200V	**C_{max}**
10 Hz	350 µF
100 Hz	35 µF
200 Hz	18 µF
500 Hz	7 µF
1000 Hz	3.5 µF

7. FURTHER RESOURCES

We feature our popular in-depth tutorials on on our YouTube channel SmartMaterialCorp.

Keep up to date with our latest events and see some great tips and resources on our Facebook page: www.facebook.com/SmartMaterialUSA