

PICOSCALE Vibrometer Stage Controller PV-STG-V1.0



The **PICOSCALE Vibrometer** contains two controllers, the system controller and the stage controller: The system controller hosts all the necessary optical components and electronics to generate the IR laser beam and to detect the interference signal. Furthermore, it contains the circuitry to convert the measured interferometric data into a position signal and to extract its amplitude and frequency. The stage controller contains the electronics to operate the XYZ positioning stage in closed-loop. In addition, it provides access to internal system signals and contains a power amplifier to drive the shaker stage. This document contains the specifications of the stage controller.

1. XYZ STAGE CONTROL

The electronics to operate the XYZ positioning stage are based on SmarAct GmbH's modular control system **MCS2**. This allows to achieve the maximum performance of the used stick-slip positioners. Basically, the controller decodes the signal from the position sensors that are integrated in each of the positioners. These position signals, which have nm resolution, are used to generate the appropriate drive signals to move the XYZ positioning stage to the desired position. The system always operates in closed-loop. Table 1 contains the basic specifications of the stage controller.

2. ANALOGUE SIGNAL INPUT

Through the 'Sensor' BNC connector of the stage controller, analogue signals can be read in and recorded via the control software. This can be used to monitor electrical excitation signals. The specifications of the analogue to digital converter are provided in Table 2.

Table 1. Specifications and operating conditions of the stage controller.

Property	Value
XYZ stage controller type ¹	MCS2
AC Power Supply [V]	100 - 240
AC Power Supply [Hz]	50- 60
Input current (at 230 V) [A]	< 0.5
Fuse (slow blow) [A]	2.5
Environmental temperature [°C]	15 - 30
Environmental humidity [%]	5 - 80
Storage temperature [°C]	0 - 50
Altitude [m]	< 2000
Dimensions W x L x H [cm]	33 x 27 x 7.3
Weight [kg]	4

¹See **MCS2** specification sheet, available at SmarAct GmbH, for further information.

Table 2. Specifications of the high-speed analogue input.

Property	Value
Resolution [bit]	16
Sample rate [MHz]	10
Range ¹ [V]	±10
Bandwidth ² [MHz]	> 2.5
Impedance [kΩ]	7.5
Connector	BNC

¹The input is not calibrated. For an exact mapping of voltage to ADC values, a calibration can be performed by measuring 2 known voltages.

²Bandwidth at -3 dB.

3. ANALOGUE SIGNAL OUTPUT

The signals on the 'GPIO 1' and 'GPIO 2' BNC connectors of the stage controller depend on the operating mode of the device. When the excitation signal is internally generated by the PICOSCALE Vibrometer, the 'GPIO 1' connector outputs the excitation signal. This signal, mostly a sine of a fixed or variable frequency, can be used as excitation signal for a sample. The specifications of the digital to analogue converter are provided in Table 3. The analogue output can drive currents of up to 30 mA. To be able to drive larger loads an additional amplifier will be required, either the built-in shaker stage amplifier or an external amplifier.

4. SHAKER STAGE AMPLIFIER

The stage controller includes a high-bandwidth power amplifier to drive the shaker stage. This amplifier is internally connected to the analogue signal output and is designed to drive the shaker stage at MHz frequencies. As compared to the analogue signal output, the amplifier can generate much higher currents which is essential to drive high capacitive load such as the shaker stage. By default, the amplified signal carries a DC offset, so that the shaker stage is always operating at a positive voltage. Table 4 contains the specifications of the shaker stage amplifier output.

An adapter cable (Figure 1) is available as accessory to connect other loads to the amplifier output via BNC connectors. In this case, the signal can be used to drive capacitive loads such as piezo actuators. Even capacitances of multiple μF can be connected although the bandwidth will be reduced. The adapter cable also offers an AC-coupled signal to drive inductive loads like voice coils and loudspeakers. The actual bandwidth will depend on the electrical resonance of the electronic circuit which in turn will strongly depend on the connected device.



Figure 1. Adapter cable to make the shaker stage signal available through 2 BNC connectors, as DC-coupled and as AC coupled signal.

Table 3. Specifications of the high-speed analogue output (without load).

Property	Value
Resolution [bit]	12
Sample rate [MHz]	10
Range [V]	± 10
Bandwidth ¹ MHz	1.0
Impedance [Ω]	47
Connector	BNC

¹Bandwidth at -3 dB, at 2.5 MHz the attenuation is -12 dB.

Table 4. Specifications of the shaker stage amplifier (without load).

Property	Value
Range [V]	± 2.5
Signal offset [V_{DC}]	7.5
Bandwidth ¹ [MHz]	1.3
Impedance [Ω]	1
Connector	2 pin Lemo

¹Bandwidth at -3 dB, at 2.5 MHz the attenuation is -9 dB. With a load of 0.1 μF the bandwidth at -3 dB remains identical but at 2.5 MHz the attenuation has increased to -16 dB.

5. DIGITAL SIGNAL OUTPUT

When the PICOSCALE *Vibrometer* is set up for operation with externally generated excitation signals, the 'GPIO 1' and 'GPIO 2' connectors output digital signals that can be used to control an external function generator.

The 'GPIO 1' will give out a clock signal when a recording of displacement data takes place, this can be used to synchronize an external function generator. The frequency of the clock signal can be adjusted up to 10 MHz through the control software. Due to the rise time, the clock signal will look increasingly distorted above 2 MHz.

The 'GPIO 2' output will be high during the recording of displacement data, thus the rising flank of this signal can be used to trigger an external function generator. The latency of this flank with respect to the recorded data packages is $\approx 8 \mu\text{s}$ with a jitter of $< 40 \text{ ns}$ (standard deviation from latency distribution).

Table 5 contains the specifications of the digital output. The best signal quality is achieved with short cable lengths and in a 50Ω environment.

Table 5. Specifications of the digital output.

Property	Value
Output [V]	0/5
Rise time ¹ [ns]	50
Connector	BNC

¹From 10 to 90 %.

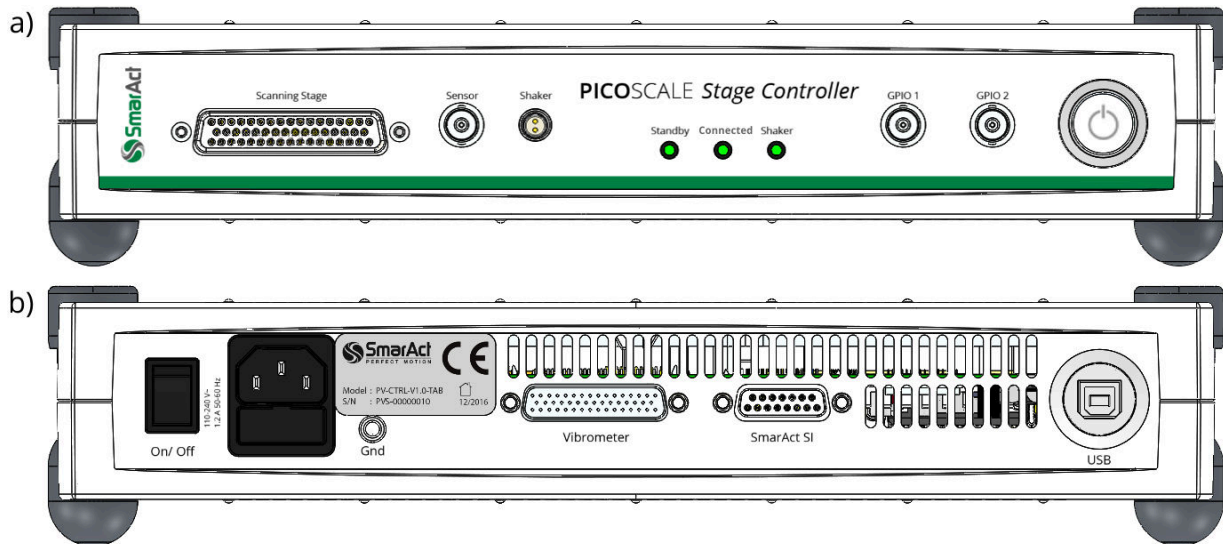


Figure 2. a) Front and b) rear panel of the stage controller.

6. CONNECTORS

The stage controller contains multiple connectors to connect it to the other components of the **PICOSCALE Vibrometer** and to provide access to system signals. The front panel, shown in Figure 2a, contains, from left to right:

- D-Sub 50 connector '*Scanning Stage*', female, to connect the XYZ positioning stage.
- BNC connector '*Sensor*', to read in analogue signals (ADC1).
- LEMO 2 pin connector '*Shaker*', female, to connect the standard shaker stage (matching male connector: LEMO FGG.0B.302.CLAD).
- LED '*Standby*', indicates when the device is in standby mode.
- LED '*Connected*', indicates an active connection between stage controller and system controller.
- LED '*Shaker*', indicates when the shaker amplifier is switched on.
- BNC connector '*GPIO 1*', to output analogue or digital signals.
- BNC connector '*GPIO 2*', to output analogue or digital signals.
- Power button to switch the stage controller on or off (standby).

The stage controller rear panel, shown in Figure 2b, contains, from left to right:

- Main power switch '*On/Off*', to power up the device.
- Power supply socket, including a fuse.
- Ground connector '*Gnd*', which can be used to ground external devices.
- D-Sub 44 connector '*Vibrometer*', male, to connect with the system controller.
- D-Sub 15 connector '*SmarAct SI*', female (reserved for future use).
- USB Type B connector '*USB*', to connect with the PC.

7. ORDER CODES

The order codes of the stage controller and its accessories are given in Table 6.

Table 6. Order codes of the stage controller and accessories.

Order code	Description
PV-STG-V1.0-TAB	PICOSCALE <i>Vibrometer</i> stage controller
PV-ACC-OUT-01	Adaptor cable for shaker signal, 2 BNC outputs, AC- and DC-coupled

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