

Components for Surface Analysis

Nanonis HVA4 High Voltage Amplifier

Lowest Noise for Demanding SPM Applications

Key Features

- Lowest Noise and Drift
- Six High Voltage Channels
- Differential Inputs
- Stable with Capacitive Loads
- Separate High Voltage Ground
- Output Relays
- Short-circuit Proof
- Safe Operation

Applications

- Scanning Probe Microscopy
- Piezo-driven Nano-Positioning

NanonisTM



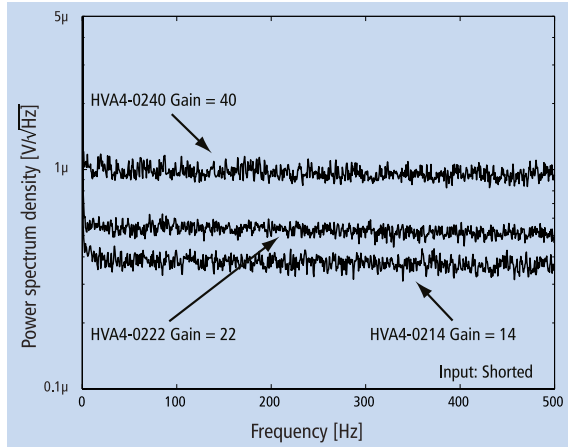
HVA4 – High Voltage Amplifier

Designed for SPM: Ultra low noise and high reliability make the HVA4 the ideal choice for the most demanding applications such as high resolution Scanning Probe Microscopy

The HVA4 family is a set of high voltage amplifiers designed for nano-positioning applications using piezo elements. Three different models with maximum output voltages of ± 140 V, ± 220 V or ± 400 V let the user choose an optimal setup for his application. The HVA4 is a six-channel high voltage amplifier featuring four inputs (X,Y,Z, and AUX) divided into three groups (X&Y, Z, AUX). Each group has its individual gain selector with 4 settings. Z and AUX inputs additionally have switchable polarities.

Lowest noise and drift

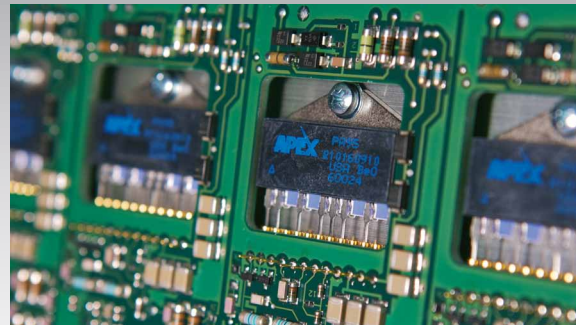
With a noise spectrum density below $1 \mu\text{V}/\sqrt{\text{Hz}}$ at 300Hz and noise levels below $65 \mu\text{V rms}$ or $510 \mu\text{V p-p}$ (BW 10 Hz – 300 kHz) at gain 40 (input shorted), the HVA4 sets the standard for low-noise HV applications.



The SNR of the HVA4 is greater than 130dB which, in SPM relevant terms, means that with a $10 \mu\text{m}$ Z-range piezo tube, the noise level in Z corresponds to less than 2pm (RMS). Therefore, even when using large scan area piezo tubes, the intrinsic noise of the HVA4 is far below the corrugation of the sample.

External power supply

To further eliminate noise, the HVA4 is powered by the external high voltage linear power supply HVS4. The sensitive amplifier circuits of the HVA4 are therefore isolated from potential sources of hum and noise. As an additional benefit, up to two HVA4s can be powered from one power supply.



Differential inputs

The HVA4's differential inputs guarantee that the excellent noise figures of the amplifier are not degraded when used in a typical experimental setup. This is of utmost importance since the performance can be kept optimized without sacrificing flexibility in wiring and ground concept.

Stable with capacitive loads

The output of the HVA4 remains absolutely stable even when driving large capacitive loads. At a gain of 40, the HVA can drive a load of 5 nF at its full voltage swing of 800 V and at frequencies up to 2 kHz .

Output power

The peak output power of the HVA4 is greater than 60 W , meaning that there are enough reserves for driving dynamic signals into large capacitive loads. Each output can deliver a current of up to 27 mA (actively limited).

Thermal management

An aluminum plate of more than 1 kg , as well as the 1.9 kg of the aluminum enclosure act as a thermal mass for enhanced thermal stability, ensuring very low drift. The heat generated by high power peaks can easily be absorbed, allowing for a quiet fanless design without any moving parts.

Output protection

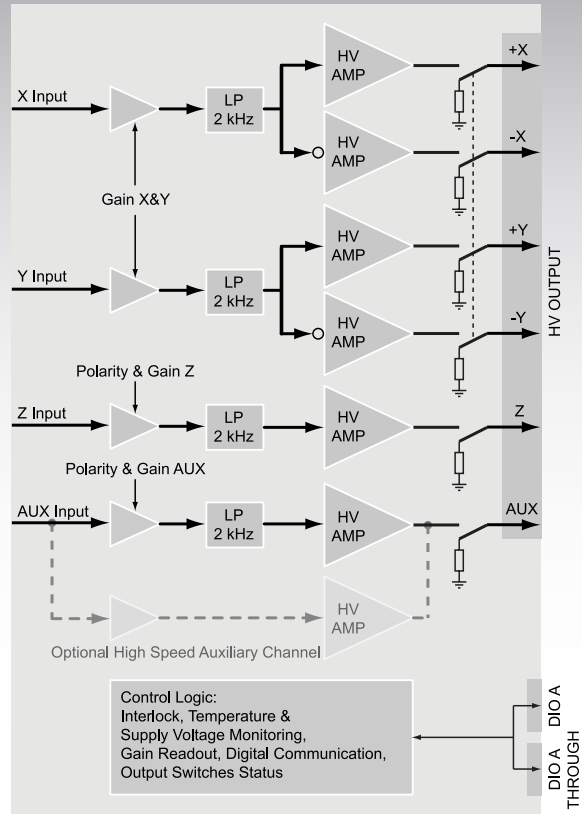
In order to protect piezos connected to the amplifier the output of the HVA4 is tied to ground with mechanical relays when the amplifier is switched off, or the output is disabled by the user. This effectively protects the amplifier, but also keeps the load connected to ground, when the amplifier is not in use. Piezos are therefore well protected against electrostatic discharge. Further electronic safety measures ensure that the output stage of the HVA4 cannot be damaged by voltage spikes induced by the piezos.

Safety

The HVA4 is short-circuit proof and its temperature and supply voltages are continuously monitored. A thermal shutdown prevents the instrument from exceeding its maximum operating temperature. The high voltage output is protected by an interlock mechanism, which disables all output signals should the output connector be disconnected. Inputs and outputs are all ESD-proof.

Digital interface

The gain settings of the HVA4 and all status information indicated by LEDs on the front panel can be read out over a digital port. The Nanonis software will react accordingly by adjusting calibration values, or by disabling scanning or approach in the event that piezos become disconnected or incorrect settings are applied.



Optional high speed channel for piezo motors

The auxiliary channel can be optionally fitted with a fast amplifier stage (1.2 MHz bandwidth) capable of delivering a peak current of up to 90 mA. Together with the waveform generator of the Nanonis base package, this will turn the HVA4 into a high performance and cost saving fine and coarse positioning solution in a compact package.

Separated high voltage ground

A well thought-out ground concept is of fundamental importance for reducing noise and hum in an experimental setup. Therefore high voltage ground and protection earth are separately available, with no compromise in safety. The scientist can thus adapt the device to his laboratory's setup and optimize performance.



Specifications

| Generel | |
|-------------------------------------|---|
| Mounting | Stackable benchtop casing, rack mount kit available |
| Dimensions | 32.5 x 28 x 7 cm |
| Weight | 5.5 kg |
| Power supply | Powered by Nanonis HVS4 |
| Power consumption (quiescent power) | 27 W |
| Outputs | 6 (+X, -X, +Y, -Y, Z, AUX) |
| Inputs | 4 (X, Y, Z, AUX) |
| Gain selector | For X/Y, Z, and AUX, manual selector, digital read back |
| Gain | Depending on model, 4 selectable values |
| Operating temperature | +5°C to +35°C |

| Analog Inputs | |
|---------------------------|--|
| Connectors | BNC |
| Coupling | DC, differential |
| Diff. input voltage range | ±10 V |
| Diff. input resistance | 1 MΩ @ DC, 100 kΩ @ 2 kHz |
| Analog bandwidth | 2 kHz, 10 kHz optional, 1.2 MHz for fast AUX channel |

| High Voltage Outputs | |
|----------------------|-----------------------------|
| Connector | Souriau TRIM TRIO UTG01619S |
| Coupling | DC, referenced to HVGND |
| Voltage range | Up to ±400 V for gain 40 |
| Maximum current | 27 mA (90 mA for fast AUX) |
| Output impedance | 200 Ω (100 Ω for fast AUX) |

| Noise (HVA4-0240N, gain 40, input shorted) | |
|--|---------------------------|
| BW 0.1 Hz - 10 Hz | < 5 μV RMS, < 30 μV p-p |
| BW 10 Hz - 300 kHz | < 65 μV RMS, < 510 μV p-p |
| Noise density @ 300 Hz | < 1 μV/√Hz |

| Noise (HVA4-0222N, gain 22, input shorted) | |
|--|---------------------------|
| BW 0.1 Hz - 10 Hz | < 2.5 μV RMS, < 15 μV p-p |
| BW 10 Hz - 300 kHz | < 40 μV RMS, < 320 μV p-p |
| Noise density @ 300 Hz | < 550 nV/√Hz |

| Noise (HVA4-0214N, gain 14, input shorted) | |
|--|---------------------------|
| BW 0.1 Hz - 10 Hz | < 1.5 μV RMS, < 8 μV p-p |
| BW 10 Hz - 300 kHz | < 35 μV RMS, < 290 μV p-p |
| Noise density @ 300 Hz | < 420 nV/√Hz |

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