SOLUTIONS FOR HIGH-DYNAMICS 24/7 OPERATION

High Power Switching Amplifiers, Energy Recovery

Piezo actuators are often used for an especially precise materials processing, for example in mechanical engineering for fine positioning in milling and turning machines. These require high forces as well as dynamics. The piezo actuators are correspondingly dimensioned for high forces; i.e. piezo actuators with a high capacitance are used here. Particularly high currents are required to charge and discharge them with the necessary dynamics. The control of valves also requires similar properties.

Energy Recovery Minimizes the Energy Consumption in Continuous Operation

Since these applications frequently run around the clock, seven days a week, the energy consumption of the amplifier is particularly important. For this purpose, PI offers switching amplifier electronics with which the pulse width of the control signal is modulated (PWM) and the piezo voltage is thereby controlled. This results in an especially high efficiency. In addition, a patented circuitry for energy recovery is integrated: this stores part of the returning energy in a capacitive store when a piezo is discharged and makes the energy available again for the next charging operation. This permits energy savings of up to 80% to be realized. Furthermore, the amplifier does not heat up so much and thus influences the actual application less.

Unlike conventional class D switching amplifiers, PI switching amplifiers for piezo elements are current- and voltage-controlled. Product examples are the E-617 for PICMA® actuators and E-481 for the PICA actuator series.

Protection of the Piezo Actuator through Overturempature Protection

In continuous operation, the heat development in the piezo actuator is not negligible. Corresponding electronics can therefore evaluate the signals of a temperature sensor on the piezo. This protects the ceramic from overheating and depolarization.

Valid patents

German patent no. 19825210C2
International patent no. 1080502B1
US patent no. 6617754B1

Thanks to their patented energy recovery system, PI amplifiers only consume approx. 20% of the power required by a corresponding linear amplifier with the same output power.

Power consumption of a piezo amplifier with linear and switching amplifier at the piezo output, capacitive load 1 µF. The measured values clearly show that the pulse width modulated amplifier allows significantly higher dynamics than the classic linear amplifier. The linear amplifier reaches the upper limit of its power consumption at frequencies of up to approx. 700 Hz, the switching amplifier does not reach the limit until far beyond 2 kHz.
E-481 PICA™ Piezo High-Power Driver / Controller
2000 W and Energy Recovery for High Efficiency

The E-481 high-power piezo amplifier/controller is specifically designed for dynamic operation of high-capacitance PICA™ PZT actuators.

The E-481 is based on a novel design combining pulse width modulation and energy recovery. Instead of dissipating the reactive power in heat sinks, this energy is temporarily stored in inductive elements. Only the active power used by the piezo actuator has to be delivered. The energy not used by the actuator is returned to the amplifier and reused as supply voltage via a step-up transforming process. A peak sink and source current of up to 2000 mA is possible.

Open-Loop and Closed-Loop Operation
E-481 amplifiers can be used to drive open- and closed-loop piezo positioning systems.

For open-loop piezo operation the amplifier output voltage is determined by the analog signal at the Control Input combined with the DC-offset potentiometer setting. Open-loop operation is ideal for applications where the fastest response and the highest bandwidth are essential. Here, commanding and reading the target position in absolute values is either not important or carried out by an external feedback loop. The Control In signal can be adjusted by various settings.

Thermal Piezo Protection Circuit
The E-481 features a temperature sensor input and control circuit to shut down the amplifier if the connected piezo ceramic exceeds a maximum temperature threshold.

Selecteable Output Range
The output range can be set to positive, negative or bipolar, and provides a voltage swing of 1100 V in open-loop operation.

Optional Servo Controller Upgrade
The E-481.00 allows easy installation of an optional E-509

(see p. 2-152) sensor- / servo-controller module for closed-loop piezo position control. In this mode the amplifier is slaved to the E-509 servo controller. Depending on the attached piezo mechanics and feedback sensor, positioning accuracy and repeatability in the nanometer range and below are feasible.

Computer Control
The E-517 computer interface/display module can also be installed in the E-481.

Optionally digital control via a D/A converter is possible. For several D/A boards from National Instruments PI offers a corresponding LabVIEW™ driver set which is compatible with the PI General Command Set (GCS), the command set used by all PI controllers. A further option includes the patented Hyperbit™ technology providing enhanced system resolution.

Ordering Information
E-481.00
HVPZT Piezo Amplifier / Controller, Energy Recovery, 1100 V, 2000 W, 19''

Note
Requires Piezo Actuators with Option P-177.50, Temperature Sensor and Protective Air

Upgrades
Sensor / Servo-Control Modules
E-509.C1A
Sensor / Servo-Controller Module, Capacitive Sensor
E-509.S1
Sensor / Servo-Controller Module, SGS-Sensor

Interface / Display Modules
E-517.I1
Interface-/Display Module, 24 Bit D/A Ethernet, USB, RS-232, 1 Channel
E-515.01
Display Module for PZT Voltage and Position
E-500.ACD
LabView with Driver Set for Analog Controllers
E-500.HCD
Hyperbit™ Functionality for Enhanced System Resolution
Supports Certain D/A Boards.

Extension cables, adapters & connectors: see in “Accessories” in the “Piezo Drivers / Servo Controllers” section, (p. 2-168 ff).

Ask about custom designs!
Technical Data

**Model**
- **E-481.00**

**Function**
- Power amplifier for PICA™ high-voltage PZTs

**Amplifier**
- **Output voltage**
  - 0 to 1100 V (default)
  - Selectable
  - -260 to +780 V
  - -550 to +550 V
  - +260 to -780 V
  - 0 to -1100 V
- **Amplifier channels**
  - 1
- **Average output power**
  - Equivalent to 630 VA reactive power
- **Peak output power <5 ms**
  - 2000 VA
- **Average current**
  - >600 mA
- **Peak current <5 ms**
  - 2000 mA
- **Amplifier bandwidth, small signal**
  - 5 kHz (660 nF), 1 Hz (3.4 µF)
- **Amplifier bandwidth, large signal**
  - 1.4 kHz (660 nF), 350 Hz (3.4 µF)
- **Ripple, noise**
  - 0 to 100 kHz: 150 mV RMS
  - 2000 mV peak-peak (100 nF)
- **Current limitation**
  - Short-circuit-proof
- **Voltage gain**
  - +100
- **Control input voltage**
  - Servo off: ±1/100 of selected output range
  - Servo on: 0 to 10 V
- **Input impedance**
  - 100 kΩ

**Interface and operation**
- **PZT voltage output socket**
  - LEMO EGG.0B.701.CJL1173
- **Control input socket**
  - BNC
- **PZT temperature sensor**
  - Max 85 °C, high voltage output is automatically deactivated if PZT temperature out of range
- **DC Offset**
  - 10-turn pot., adds 0 to +10 V to Control IN

**Miscellaneous**
- **Operating voltage**
  - 100–120 or 220–240 VAC, 50–60 Hz (fuse change required)
- **Operating temperature range**
  - +5 to +50 °C (over 40 °C, max. av. power derated 10%)
- **Weight**
  - 8.6 kg
- **Dimensions**
  - 288 x 450 x 158 mm

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E-481: operating limits with various PZT loads, capacitance is measured in nF
PICA High-Performance Piezo Amplifier / Servo Controller

High Energy Efficiency due to Energy Recovery

PICA high-performance piezo amplifier
19-inch benchtop device for dynamic continuous operation of PICA piezo actuators with high electrical capacitance. Analog control. Output voltage to 1050 V, bipolar can be set. 6 A peak current, 2 A continuous current.

Energy saving of up to 80% due to switched amplifier principle
Switching amplifier with pulse width modulation (PWM) of the piezo output voltage. When the piezo actuator is discharged, a patented circuitry for energy recovery stores part of the returning energy in a capacitor and makes it reusable for the next charging cycle. The amplifier runs cooler and provides better stability.

Fields of application

E-482
- Peak current 6 A
- Output voltage to 1050 V
- Integrated energy recovery
- Temperature sensor protects piezo actuator from overheating
- Position control (optional)
- Computer interface and display modules
# Specifications

<table>
<thead>
<tr>
<th><strong>Function</strong></th>
<th>E-482.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power amplifier with energy recovery for PICA high-voltage piezo actuators</td>
<td></td>
</tr>
</tbody>
</table>

## Amplifier

<table>
<thead>
<tr>
<th><strong>Output voltage</strong></th>
<th>Default: 0 to 1050 V &lt;br&gt;Can be set: -260 to +780 V, -525 to +525 V</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Amplifier channels</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Average output current (reactive current)</strong></td>
<td>2 A</td>
</tr>
<tr>
<td><strong>Peak current, &lt;5 ms</strong></td>
<td>6 A</td>
</tr>
<tr>
<td><strong>Current limitation</strong></td>
<td>Short-circuit proof</td>
</tr>
<tr>
<td><strong>Voltage gain</strong></td>
<td>100</td>
</tr>
<tr>
<td><strong>Amplifier bandwidth, small signal</strong></td>
<td>2 kHz (1 µF)</td>
</tr>
<tr>
<td><strong>Amplifier bandwidth, large signal</strong></td>
<td>400 Hz (5 µF)</td>
</tr>
<tr>
<td><strong>Residual ripple, noise, 0 to 10 kHz, 1 µF</strong></td>
<td>300 mV&lt;sub&gt;rms&lt;/sub&gt;</td>
</tr>
<tr>
<td><strong>Suggested capacitive load</strong></td>
<td>1 µF (min.), 17 µF (max.)</td>
</tr>
<tr>
<td><strong>Input impedance</strong></td>
<td>100 kΩ</td>
</tr>
<tr>
<td><strong>Input voltage range</strong></td>
<td>Without servo: ±1/100 of selected output voltage range&lt;br&gt;With servo: 0 to 10 V</td>
</tr>
</tbody>
</table>

## Interfaces and operation

<table>
<thead>
<tr>
<th><strong>Piezo connection</strong></th>
<th>LEMO EGG.08.701.CJL.1173</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Analog input</strong></td>
<td>BNC socket</td>
</tr>
<tr>
<td><strong>Temperature sensor (piezo actuator)</strong></td>
<td>LEMO socket; automatic deactivation of high voltage at 120 °C</td>
</tr>
<tr>
<td><strong>DC offset setting</strong></td>
<td>10-turn potentiometer, adds 0 to ±10 V to the input voltage</td>
</tr>
</tbody>
</table>

## Miscellaneous

<table>
<thead>
<tr>
<th><strong>Operating voltage</strong></th>
<th>100 to 120 / 220 to 240 VAC, 50 to 60 Hz (fuse change required)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating temperature range</strong></td>
<td>5 to 40 °C</td>
</tr>
<tr>
<td><strong>Mass</strong></td>
<td>10.4 kg</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td>288 mm × 450 mm × 158 mm + handles</td>
</tr>
</tbody>
</table>
Drawings / Images

E-482.00: Operating limits (open loop) with various capacitive loads, capacitance values in nF

Ordering Information

E-482.00
PICA high-performance piezo amplifier / controller with energy recovery, 1050 V, 6 A, 19"
High-Power Amplifier for Piezo Actuators
Modular System for Continuous Dynamic Applications

E-619
- Peak power up to 1200 W
- High currents to 10 A
- Low power consumption due to integrated energy recovery
- Bandwidth to 20 kHz for high dynamics applications
- Overheat protection for piezo actuators with temperature sensor
- Optional upgrade for control and digital interfaces

High-power amplifier for piezo actuators
High peak current, >5 A continuous current. High bandwidth for high dynamics. Suitable for PICMA® piezo actuators with special electrodes. Output voltage -30 to 130 V. Analog control. Evaluation of temperature sensor protects the piezo actuator against overheating

High degree of efficiency
Class-D switched amplifier with capacitor for energy recovery. Low influence of the application thanks to reduced heat dissipation

Optional servo controller upgrade
Optional control module for nanopositioning systems with integrated position sensors (SGS, capacitive). Optional interface module with wave generator, data recorder, digital interfaces (TCP/IP, USB, RS-232, SPI). Optional driver set for use with D/A converter boards from National Instruments and NI LabVIEW software

Application fields
Mechanical engineering: High dynamics placement, vibration absorber, noncircular grinding, valve control, materials testing, test equipment
High dynamics tip/tilt mirror applications
## Specifications

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function</strong></td>
<td>High-power amplifier module for PICMA® piezo actuators with special electrodes</td>
<td>Offset voltage source for tip/tilt platforms with PICMA® piezo actuators and special electrodes</td>
<td>Housing for E-619 amplifier modules</td>
</tr>
<tr>
<td><strong>Channels</strong></td>
<td>1</td>
<td>1</td>
<td>1 / 3</td>
</tr>
</tbody>
</table>

### Amplifier

<table>
<thead>
<tr>
<th></th>
<th>E-619.H / E-619.00</th>
<th>E-619.S</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input voltage range</strong></td>
<td>-2 to 12 V</td>
<td>-</td>
</tr>
<tr>
<td><strong>Output voltage</strong></td>
<td>-30 to 130 V</td>
<td>100 V</td>
</tr>
<tr>
<td><strong>Peak output power (&lt;5 ms)</strong></td>
<td>1200 W</td>
<td>1200 W</td>
</tr>
<tr>
<td><strong>Average output power (&gt;5 ms)</strong></td>
<td>Equivalent to 800 VA reactive power</td>
<td>Equivalent to 800 VA reactive power</td>
</tr>
<tr>
<td><strong>Peak current (&lt;5 ms)</strong></td>
<td>10 A</td>
<td>10 A</td>
</tr>
<tr>
<td><strong>Average output current (&gt;5 ms)</strong></td>
<td>&gt;5 A</td>
<td>&gt;5 A</td>
</tr>
<tr>
<td><strong>Current limitation</strong></td>
<td>Short-circuit proof</td>
<td>Short-circuit proof</td>
</tr>
<tr>
<td><strong>Voltage gain</strong></td>
<td>10 ± 0.1</td>
<td>-</td>
</tr>
<tr>
<td><strong>Amplifier bandwidth, small signal</strong></td>
<td>20 kHz / 3 kHz</td>
<td>-</td>
</tr>
<tr>
<td><strong>Ripple, noise, 0 to 10 kHz</strong></td>
<td>&lt;2 mV&lt;sub&gt;rms&lt;/sub&gt;</td>
<td>&lt;2 mV&lt;sub&gt;rms&lt;/sub&gt;</td>
</tr>
<tr>
<td><strong>Capacitive base load (internal)</strong></td>
<td>2 µF / 1 µF</td>
<td>2 µF</td>
</tr>
<tr>
<td><strong>Recommended piezo load</strong></td>
<td>&gt;1 µF</td>
<td>&gt;1 µF</td>
</tr>
<tr>
<td><strong>Output impedance</strong></td>
<td>0.1 Ω; 53 µH; 2 µF / 0.1 Ω; 1 mH; 1 µF</td>
<td>0.1 Ω; 53 µH; 2 µF</td>
</tr>
<tr>
<td><strong>Amplifier resolution</strong></td>
<td>&lt;2 mV</td>
<td>&lt;2 mV</td>
</tr>
<tr>
<td><strong>Amplifier classification</strong></td>
<td>Class D, switched 400 kHz / 100 kHz</td>
<td>Class D, switched 400 kHz</td>
</tr>
<tr>
<td><strong>Input impedance</strong></td>
<td>100 kΩ</td>
<td>-</td>
</tr>
</tbody>
</table>

### Interfaces and operation

<table>
<thead>
<tr>
<th></th>
<th>E-619.H, E-619.00</th>
<th>E-619.S</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Piezo connection</strong></td>
<td>LEMO EGG.1B.302.CLL, with safety cover</td>
<td>LEMO EGG.1B.302.CLL, with safety cover</td>
</tr>
<tr>
<td><strong>Analog input</strong></td>
<td>SMB</td>
<td>-</td>
</tr>
<tr>
<td><strong>Temperature sensor (piezo actuator)</strong></td>
<td>PT 1000; LEMO FFA.05.303.CLAC32 Max. 150 °C, deactivation of the voltage output</td>
<td>-</td>
</tr>
<tr>
<td><strong>Display and indicators</strong></td>
<td>LEDs for Power, Temp Overflow</td>
<td>Power LED</td>
</tr>
<tr>
<td><strong>DC offset setting</strong></td>
<td>10-turn potentiometer, adds 0 to 10 V to the input voltage</td>
<td>-</td>
</tr>
</tbody>
</table>

### Miscellaneous

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating voltage</strong></td>
<td>Supply via E-619 housing</td>
<td>100 - 240 V~, 50 - 60 Hz</td>
</tr>
<tr>
<td><strong>Max. power consumption, full load</strong></td>
<td>&lt;150 W</td>
<td>150 VA / 360 VA</td>
</tr>
<tr>
<td><strong>Max. power consumption without load</strong></td>
<td>20 W</td>
<td>30 VA / 80 VA</td>
</tr>
<tr>
<td><strong>Operating temperature range</strong></td>
<td>5 to 40 °C</td>
<td>5 to 40 °C</td>
</tr>
<tr>
<td><strong>Mass</strong></td>
<td>3.5 kg</td>
<td>10 kg / 18 kg</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td>21 HP/3 U</td>
<td>236 x 132 x 296 mm (without handles) / 450 x 132 x 296 mm (without handles)</td>
</tr>
</tbody>
</table>

Ask about customized versions.
Drawings / Images

E-619.R1: dimensions in mm

E-619.R3: dimensions in mm
E-619.H: Operating limits (open loop) with various piezo loads, capacitance values in µF

E-619.00: Operating limits (open loop) with various piezo loads, capacitance values in µF
Ordering Information

E-619.H
High-power piezo amplifier module, 1 channel, 20 kHz bandwidth, 1200 W peak output power, -30 to 130 V

E-619.00
High-power piezo amplifier module, 1 channel, 3 kHz bandwidth, 1200 W peak output power, -30 to 130 V

E-619.S
Offset voltage source for tip/tilt platforms, 1 channel, 1200 W peak output power, 100 V fixed voltage

E-619.R1
9.5" housing for E-619 high-power piezo amplifier module, 1 channel

E-619.R3
19" housing for E-619 high-power piezo amplifier module, 3 channels

Optional upgrades

E-509.C1A
Sensor / servo controller module, capacitive sensor, 1 channel

E-509.C2A
Sensor / servo controller module, capacitive sensors, 2 channels

E-509.C3A
Sensor / servo controller module, capacitive sensors, 3 channels

E-509.E03
PISeca modular evaluation electronics for single-electrode capacitive sensors, 3 channels

E-509.E3
PISeca Sensor / servo controller module for capacitive single-electrode sensors, 3 channels

E-509.S1
Sensor / servo controller module, strain gauge sensor, 1 channel

E-509.S3
Sensor / servo controller module, strain gauge sensors, 3 channels

E-515.01
Display module for piezo voltage and displacement, 1 channel

E-515.03
Display module for piezo voltage and displacement, 3 channels

E-518.I3
Interface module, 3 channels, TCP/IP, USB, and RS-232 interfaces

E-500.ACD
Driver set for use with NI LabVIEW software, for analog controllers
The E-617 is an exceptionally efficient, high-power, piezo amplifier for low-voltage piezo actuators. Providing peak power of up to 280 W and average power of 100 W, it can output and sink a peak current of 2000 mA. This allows driving high-capacitance piezo actuators at frequencies in the kilohertz range.

Energy Recovery Operating Principle
The working principle of the E-617 series is ideally suited for high-dynamics scanning and switching applications.

Two models are available: The E-617.001 version is equipped for top-hat rail mounting which makes it ideal for automation and industry applications. The E-617.00F version is a compact module for chassis mounting.

High Performance with High Capacitive Loads
The E-617 amplifiers provide precision control of piezo actuators and positioning systems in open-loop operation with an analog control voltage amplified by the factor 10. Such analog operation is ideal for applications where fast response and very high resolution with maximum bandwidth are essential, but where commanding and reading the target position absolutely is either not important or carried out by external position sensors.

Power Supply / Contents of Delivery
Only one unipolar stabilized voltage in the range of 23 to 26 V is required to operate the E-617.

All connections of the E-617.001 top-hat rail module are conveniently provided on the front of the device. All inputs and outputs of the E-617.00F OEM module are via a 32-pin rear connector. Mating connectors are included.

Remote Control via Computer Interface
Optionally, digital control via an external D/A converter is possible. For several D/A boards from National Instruments, PI offers a corresponding LabVIEW driver set which is compatible with the PI General Command Set (GCS), the command set used by all PI controllers. A further option includes the patented Hyperbit™ technology providing enhanced system resolution.

The same functionality and specifications are available in the E-504 amplifier module. see p. 2-148.

The E-617.001 high-power piezo amplifier is intended for top-hat-rail mounting in switching cabinets.

Peak Power to 280 W
High Currents to 2000 mA
Energy Recovery for Low Power Consumption
OEM Module and Top-Hat-Rail Versions

Energy not consumed is fed through the energy recovery circuitry for reuse in the next charging cycle.

E-617: operating limits with various PZT loads (open-loop), capacitance is measured in μF
### Technical Data

<table>
<thead>
<tr>
<th>Model</th>
<th>E-617.001</th>
<th>E-617.00F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function</strong></td>
<td>High-Power-Piezo Amplifier with Energy Recovery, 1 Channel, -30 to 130 V, for Top-Hat Rail mounting</td>
<td>High-Power-Piezo Amplifier with Energy Recovery, OEM-Module, 1 Channel, -30 to 130 V</td>
</tr>
<tr>
<td><strong>Amplifier</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input voltage</td>
<td>-2 to +12 V</td>
<td>-2 to +12 V</td>
</tr>
<tr>
<td>Output voltage</td>
<td>-30 to +130 V</td>
<td>-30 to +130 V</td>
</tr>
<tr>
<td>Peak output power</td>
<td>&lt;5 ms, 280 VA</td>
<td>≥5 ms, 280 VA</td>
</tr>
<tr>
<td>Average output power</td>
<td>≥5 ms, Equivalent to 100 W reactive power</td>
<td>≥5 ms, Equivalent to 100 W reactive power</td>
</tr>
<tr>
<td>Peak current, &lt;5 ms</td>
<td>2000 mA</td>
<td>2000 mA</td>
</tr>
<tr>
<td>Average current, &gt;5 ms</td>
<td>1000 mA</td>
<td>1000 mA</td>
</tr>
<tr>
<td>Voltage gain</td>
<td>10 ±0.1</td>
<td>10 ±0.1</td>
</tr>
<tr>
<td>Amplifier bandwidth, small signal</td>
<td>3.5 kHz</td>
<td>3.5 kHz</td>
</tr>
<tr>
<td>Ripple, noise, 0 to 100 kHz</td>
<td>&lt;30 mV&lt;sub&gt;rms&lt;/sub&gt;, &lt;100 mV&lt;sub&gt;pp&lt;/sub&gt;</td>
<td>&lt;30 mV&lt;sub&gt;rms&lt;/sub&gt;, &lt;100 mV&lt;sub&gt;pp&lt;/sub&gt;</td>
</tr>
<tr>
<td>Capacitive base load (internal)</td>
<td>2.5 μF</td>
<td>2.5 μF</td>
</tr>
<tr>
<td>Suggested capacitive load</td>
<td>&gt;3 μF</td>
<td>&gt;3 μF</td>
</tr>
<tr>
<td>Output impedance</td>
<td>0.5 Ω</td>
<td>0.5 Ω</td>
</tr>
<tr>
<td>Amplifier resolution</td>
<td>1 mV</td>
<td>1 mV</td>
</tr>
<tr>
<td>Amplifier classification</td>
<td>class D (switching amp), 100 kHz</td>
<td>class D (switching amp), 100 kHz</td>
</tr>
<tr>
<td>Input impedance</td>
<td>100 kΩ</td>
<td>100 kΩ</td>
</tr>
<tr>
<td>Interfaces and operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piezo connector</td>
<td>Phoenix-plug connector MINI-COMBICON 3-pin MC1.5/3-ST-3.81</td>
<td>LEMO ERA.00.250.CTL (front); DIN 41612 32-pin (rear)</td>
</tr>
<tr>
<td>Analog input</td>
<td>Phoenix-plug connector MINI-COMBICON 6-pin IMC1.5/6-ST-3.81</td>
<td>SMB</td>
</tr>
<tr>
<td>DC-Offset</td>
<td>External potentiometer (not included), adds 0 to +10 V to Control In</td>
<td>External potentiometer (not included), adds 0 to +10 V to Control In</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>+5 to +50 °C (10% derated over 40 °C)</td>
<td>+5 to +50 °C (10% derated over 40 °C)</td>
</tr>
<tr>
<td>Dimensions</td>
<td>205 x 105 x 60 mm</td>
<td>7 HP/3U</td>
</tr>
<tr>
<td>Mass</td>
<td>1 kg</td>
<td>0.35 kg</td>
</tr>
<tr>
<td>Operating voltage</td>
<td>23 to 26 VDC, stabilized, on Phoenix plug MINI-COMBICON 3-pin IMC1.5/3-ST-3.81</td>
<td>23 to 26 VDC, stabilized, on 32-pin rear connector</td>
</tr>
<tr>
<td>Max. power consumption</td>
<td>&lt;30 W</td>
<td>&lt;30 W</td>
</tr>
</tbody>
</table>