PI Piezo Controller Calibration Information

Custom Tuning for Optimum Perfomance

To achieve optimum performance each piezo servo-controller is precision-tuned for displacement range, frequency response, settling time and optimum match with the position sensor. This calibration is done at the PI factory and is included in the price of the controller (see p. 2-8, p. 3-7).

To optimize calibration, additional information about the application of the piezo is needed (see details below).

The position servo-control portion of all analog PI piezo servo-controllers is identical, employing a proportional integral (P-I) algorithm specially optimized for piezo actuators. A differential term would not improve piezo performance but only increase noise. A notch filter is used and greatly improves dynamics and increases bandwidth. See the block diagram on page 6-52 for further information on amplifier/servo-controller functions.

In addition, PI offers a number of processing features for digital and analog controllers, which in many applications can bring dramatic improvements to linearity, bandwidth and settling behavior (see p. 4-33 *ff.* in the "Tutorial" section).

To optimize closed-loop calibration for your individual application, please provide us with the desired operating bandwidth, the mass to be moved by the piezo and the spring constant of any preload or of the material the piezo pushes against. **Without this information we will optimize your system for low-dynamics operation!**

External Sensors

For a more detailed explanation, please refer to the "Tutorial: Piezoelectrics in Positioning" section.

When PI servo-controllers are ordered together with external sensors (E-115 LVDT sensors or D-015 to D-100 capacitive sensors), PI offers a special precalibration service free of charge. The controller will be prepared for the required travel range and the dynamic control circuit will be pre-adjusted for the expected resonant frequency of the system.

When ordering external sensors, please provide the following information:

- Estimated first mechanical resonant frequency of the system
- Sensor direction: will the sensor be "compressed" or will it "expand" when the piezo actuator expands (see Fig. A)
- Required measuring range

Notes

For more information on position servo-control, please see p. 4-31 *ff.* in the "Tutorial: Piezoelectrics in Positioning" section.

Rules of Thumb:

- Reducing the mass increases the resonant frequency and thus the bandwidth.
- Reducing sensor and controller bandwidth can make higher resolution possible (reduced noise) and vice versa.
- Open-loop operation is faster and lower in noise than closed-loop operation.

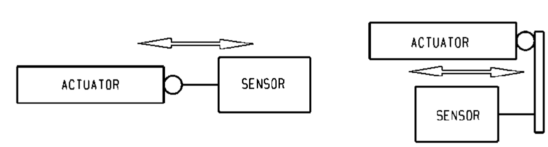

Fig. A. Actuator/Sensor Configurations

*** Calibration Information for Closed-Loop Piezo Positioning Systems**

Desired operating bandwidth:
☐ 0-10 Hz ☐ 0-50 Hz ☐ 0-100 Hz ☐ 0-250 Hz ☐ other: (______) Hz

Maximum acceptable settling time (for step operation, to 1% accuracy):
☐ 100 ms ☐ 50 ms ☐ 10 ms ☐ 5 ms ☐ other: (______) ms

Mass to be moved by the piezo:
☐ 10 g ☐ 50 g ☐ 100 g ☐ 500 g ☐ 1 kg ☐ 5 kg
☐ 10 kg ☐ 50 kg ☐ 100 kg ☐ 500 kg ☐ 1000 kg ☐ other: (______) kg

Cable between piezo and control electronics:
☐ 1 m ☐ 2 m ☐ 3 m ☐ 5 m ☐ 10 m ☐ other: (______) m

Spring constant:
(Force generation applications in which the piezo pushes against an elastic load, e.g. a spring):
☐ 0.1 N/µm ☐ 1 N/µm ☐ 10 N/µm ☐ 100 N/µm ☐ 1000 N/µm ☐ other: (______) N/µm

* See p. 2-8 and p. 3-7 for PI calibration procedures and equipment.