User's Manual – MXPZT-300

Greetings. Siskiyou has teamed up with PI to develop a high-speed solution switcher. Our mechanicals and their PZT control electronics provide the fastest possible PZT translation of solution exchange pipettes. Included:

MX1640 Siskiyou manipulator with integral PZT mount
Power supply / signal conditioning box
Power cable
BNC signal cable
PZT power cable
Grounding wire

Theory of Operation
Rapid sweeps of the theta-glass pipette are desirable for quick switching of solutions. Piezoelectric actuators are ideal for this since they are capable of extremely high acceleration and deceleration. Simplistic actuation of a motion mechanism can present many problematic issues: in particular, the rapid actuation drives resonances in the pipette, PZT mechanism and the supporting coarse-positioning structure. This can greatly shorten PZT life, and the vibrations often manifest themselves as unwanted rapid "switching" as the bores repetitively sweep back and forth due to the vibrations.

The MXPZT-300 controller incorporates a powerful PZT amplifier and a patented Input Shaping® circuit based on a digital signal processor. This Input Shaping® coprocessor is factory-configured to nullify the structural vibrations caused by rapid PZT actuation. The nullification targets the specific resonant frequencies characteristic of your MX1640 configuration. This allows especially rapid switching without driving lingering vibrations of the structure and pipette, and it protects the PZT mechanism from amplifier saturation and excessive slew rates. Any motion profile may be safely commanded.

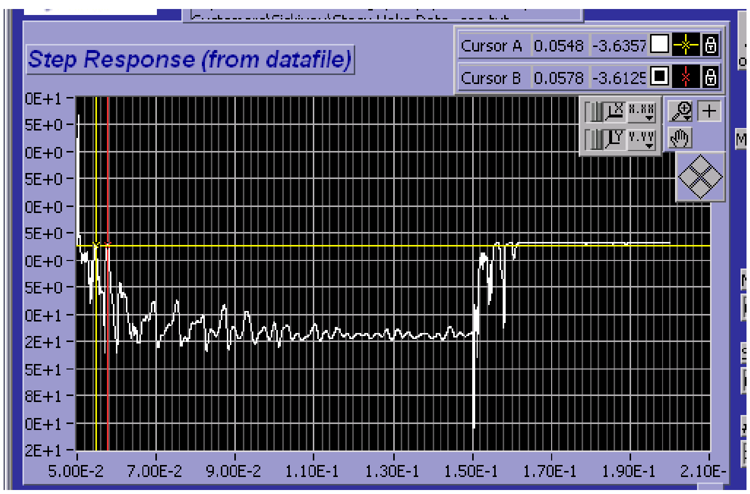

Figure 1. HEKA data showing repetitive switching of theta-glass pipette in rapid back-and-forth actuation. Vertical axis is proportional to HEKA picocurrent signal; horizontal axis is time.

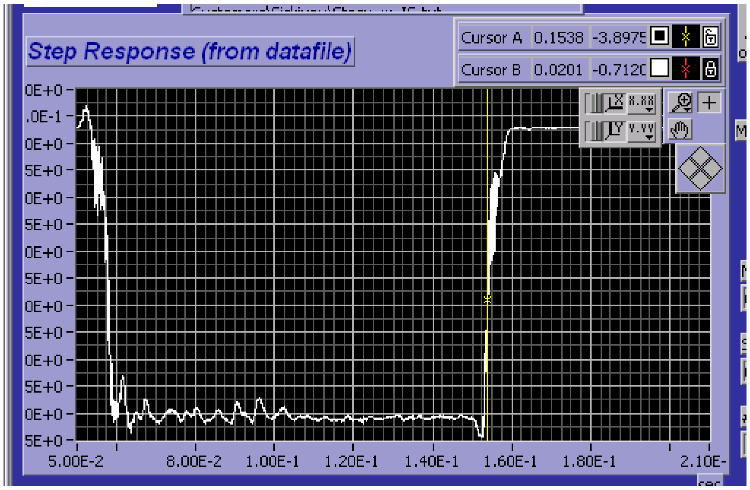

Figure 2. HEKA data of theta-glass pipette in rapid back-and-forth switching, similar to Figure 1 but using the Input Shaping® technology built into the Siskiyou MX-PZT controller. The undesirable switching is eliminated.

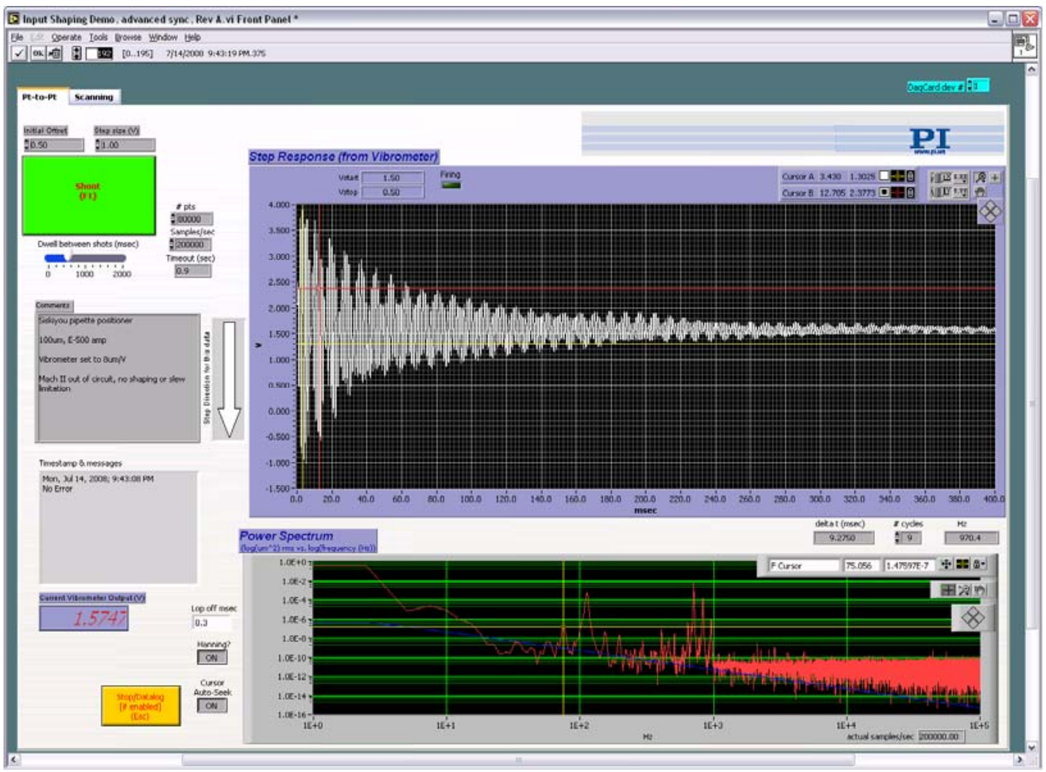

Figure 3. Interferometric position metrology of pipette motion using a laser Doppler vibrometer operating in the position domain. Top graph shows vibrometer position out put in Volts (8V/µm) vs. time after a sharp step *without* Input Shaping®. Motion-driven vibrations in the structure and pipette constitute ringing which can manifest as unwanted repetitive switching of the theta glass solutions.

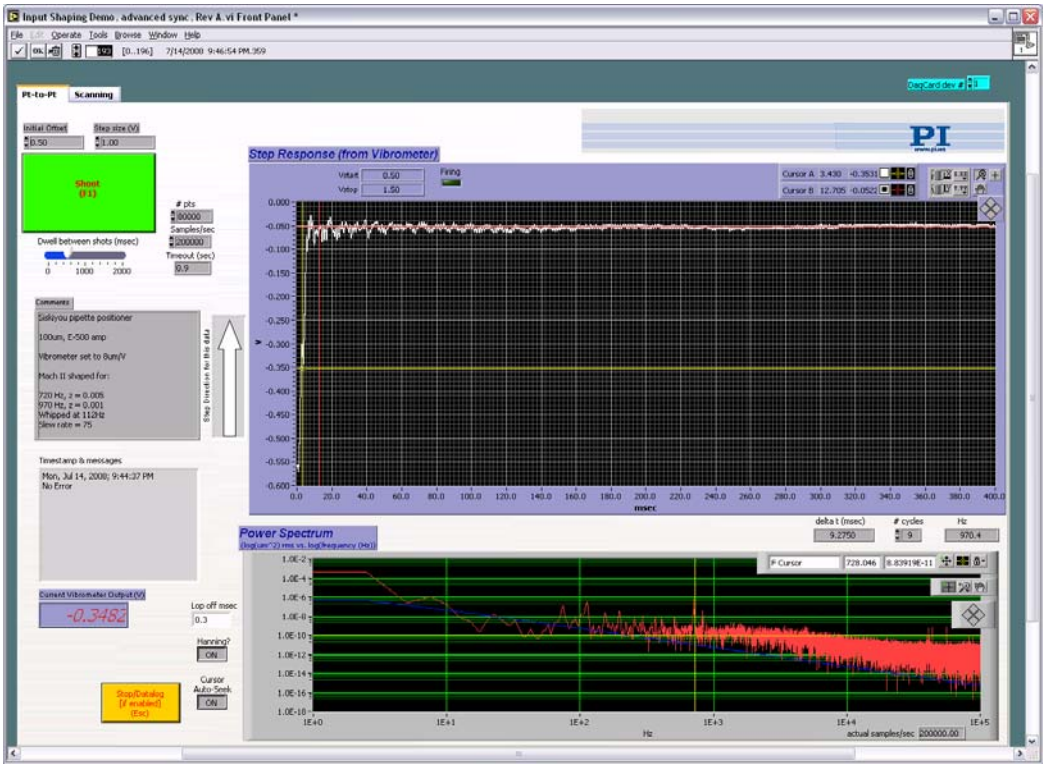

Figure 4. Same as Figure 3 but using Input Shaping®. The rapid actuation of the PZT no longer excites resonances in the structure and pipette. The cleaner step means repetitive switching is eliminated.

Setup and operation are very simple. Rigidly mount the manipulator to a sturdy platform to minimize any additional resonances such that the pipette is easily visible in the microscope optics, and position it where desired. The configuration assumes that the solution switcher will be located on the left side of the microscope, and the direction of travel of the pipette is back-to-front.

Different mechanical configurations of the coarse manipulator / PZT mount will have different resonant frequencies than the factory setting. You will see vibrations in your setup once mechanical configuration changes have been made, but these changes are often necessary to get the optimum Theta tube angle. To deal with this, the system is field reprogrammable. First, send us a graph of your data that shows the vibrations, preferably with the distance between as many peaks as possible labeled with a cursor. From that, we'll calculate the frequency we need to attenuate, and email you a new vibration-dampening algorithm. Now, connect your computer with the control box via the RS-232 port on the back of the box, select the new configuration file, then select " download ". It might take an iteration or two of this process to knock the vibration down as far as we can get it, but we will be able to attenuate the vibrations to allow the fastest possible switching of a specific mechanical setup.

Locate the power supply box such that the BNC cable can easily reach from your voltage source to the power supply box, and the PZT drive cable reaches the PZT. Attach those cables, as well as the power cord for the box. Attach the ground wire from the socket head cap screw on the front of the PZT mount to a suitable grounding location.

That's it – you're ready to go. The power supply box is configured to accept inputs from –10V to +10 V. The Input Shaping coprocessor takes care of vibrations associated with square wave inputs, so there's no need to specify " softer " waveforms.