

## APPLICATIONS

### Piezoelectric Positioning Enables Vibration Assisted Machining

A precision piezoelectric positioning system with high-bandwidth and high-power enables a new class of precision machining called Vibration Assisted Machining. The actuator and drive electronics optimize stroke, stiffness and dynamic response of the diamond tool.

A pair of triangle-shaped stacks achieves a tool resonant frequency of 5000 Hz. Each actuator has a 30 mm base, 13 mm height and 22 mm length. The piezoelectric ceramic layers are 0.5 mm thick and formed from PZWT-100, a high D33 ceramic composition from KCI. Each stack has a modest capacitance of 0.2 uF and, at peak power, the thermal loss approach 100 watts, which requires active fluid cooling. The triangle shape maximizes heat transfer and provides the best dynamic performance. The stack materials and design operate reliably at the estimated interior temperature of 120 °C. Maximum elliptical tool movement is 7 µm in the minor axis and 33 µm in the major axis with drive voltages of 0 to 1000 volts. The actuator shape and specifications were developed by researchers at the Precision Engineering Center (PEC) at NCSU in Raleigh, NC.

Ultra-fast elliptical oscillations require a two-channel high-bandwidth and high-power amplifier that can rapidly charge and discharge the piezoelectric stacks. This is achieved using a Class AB-1 linear amplifier, which produces 1500 watts and 6.3 Amps peak at 1000 volts with a bandwidth of 15,000 Hz. The external bias voltage adjustment enables input drive signal to be centered at zero volts while keeping the output drive voltage always positive.

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