7th ECCOMAS Thematic Conference on Smart Structures and Materials
SMART 2015
A.L. Araújo, C.A. Mota Soares, et al. (Editors)

Abstract ID-067

EXTREME PERFORMANCES OF PIEZO SYSTEM: HIGH STROKE, HIGH FREQUENCY, HIGH TEMPERATURE

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Keywords: Piezoelectric, Actuators, Switching Amplifier, High Power.

Summary: Although the advantages of piezoelectric actuators are well know the number applications that these smart materials can be used for is still limited. The main drawbacks derive from stroke and frequency limitations, overheating of the ceramics, maximum operational temperature, power electronics, etc. [...]
Up till now the piezo-actuators with the highest stroke that could be found on the market were limited to 1mm. To meet the needs of more demanding applications it was required to expand this boundary. [...] Performed studies allowed designing an APA® that reaches 2mm of stroke with blocked-free resonant frequency close to 90Hz allowed a fast response time. New actuator with an amplification ratio of 1:15 provides sufficient amount of force within a compact size. This actuator has also been mounted with new high temperature ceramics from Noliac allowing for operation up to 180°C.
One limitation is ceramics self heating when using the actuators at high frequency for long time. This limits to minutes or even seconds depending on the driven frequency the time for constant use. Designed encapsulation with cooling systems overcome overheating limitation. Preliminary tests showed that encapsulated actuator constantly driven at 700Hz at full strain keeps the ceramics temperature below 90°C. Without the cooling system the standard actuator would have reach the Curie temperature in less than one minute at same frequency.
Power consumption of piezoelectric actuators increases proportionally to the driven frequency. Due to this correlation it is required to provide a high power supply that allows driving the actuators at high frequency. [...] Designed amplifiers, with the series SA75, allows driving [...] piezoelectric actuators with maximum current of 20A up to 1kHz. At the same time the required power consumption is less than 50W, thanks to an energy recovery function. Additionally the switching topology allows to obtain a compact dimensions of 1dm³ with total mass of 850g for the driver part. Presented specifications make this amplifier one of the most powerful currently available on the market while keeping small volume.
This paper presents results of designing and testing new piezoelectric actuators that overcome usual limits in terms stroke, frequency and temperature.