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Design and Development of Power Sources for Plasma Actuators to Control Flow Separation

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Abstract : Plasma actuators are essential for aerodynamic flow separation control due to their lack of mechanical parts, lightweight, and high response frequency, which have numerous applications in hypersonic or supersonic aircraft. The working of these actuators is based on the formation of a low-temperature plasma between a pair of parallel electrodes by the application of a high-voltage AC signal across the electrodes, after which air molecules from the air surrounding the electrodes are ionized and accelerated through the electric field. The high-frequency operation is required in dielectric discharge barriers to ensure plasma stability. To carry out flow separation control in a hypersonic flow, the optimal design and construction of a power supply to generate dielectric barrier discharges is carried out in this paper. In this paper, it is aspired to construct a simplified circuit topology to emulate the dielectric barrier discharge and study its various frequency responses. The power supply can generate high voltage pulses up to 20kV at the repetitive frequency range of 20-50kHz with an input power of 500W. The power supply has been designed to be short circuit proof and can endure variable plasma load conditions. Its general outline is to charge a capacitor through a half-bridge converter and then later discharge it through a step-up transformer at a high frequency in order to generate high voltage pulses. After simulating the circuit, the PCB design and, eventually, lab tests are carried out to study its effectiveness in controlling flow separation.

Keywords : aircraft propulsion, dielectric barrier discharge, flow separation control, power source
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