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Frequency-Selective Power Amplifier for Greener Fertilizer Production and More

Researchers at Stanford have developed a frequency-selective MHz power amplifier for generating dielectric barrier discharge (DBD) plasma. Commercial applications include plasma-assisted nitrogen fixation for fertilizer production. An alternative to the conventional Haber-Bosch process for generating ammonia, plasma-assisted nitrogen fixation using DBD is able to achieve much cleaner and decentralized fertilizer production at atmospheric pressure without generating greenhouse gases. The Stanford team's newly designed, frequency-selected Class E power amplifier is able to drive such DBD plasma loads at 10s of MHz frequencies. Due to the thermal limitations of the DBD electrodes, delivering power to one of the loads at an alternating manner allows better utilization of the power amplifier. Other advantages include greater efficiency and a more compact design compared to most commercial power amplifiers currently used in the plasma generation industry.

Stage of Development
The designed power amplifier is able to output 600 W at frequencies of 12.4 MHz and 15.5 MHz with a peak efficiency of 91.5%. Testing with the designed DBD electrodes demonstrates its ability to directly drive the plasma loads.

Applications

- Plasma-assisted nitrogen fixation for fertilizer production
- Wireless power transfer
- Biomedical (e.g., dielectrophoresis – widely applied towards the selective transport, separation and characterization of biosystems)

Advantages

- More efficient and compact than most commercial power amplifiers used in the plasma generation industries
- Supports smaller system size and more environmentally friendly fertilizer production than Haber-Bosch process
- Plasma-assisted nitrogen fixation works under atmospheric conditions without emission of greenhouse gases
- Localized production due to the reduced system size also eliminates potential cost and hazards during transportation
- Allows efficient power delivery to the selected loads at multiple switching frequencies

Patents

- Published Application: 20230283249
- Issued: 12,573,987 (USA)

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