Quasi Three-Phase Traveling Wave Generation for an Electrodynamic Screen Via Snake Electrode Pattern with No High-Voltage Crossover Connections

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***Abstract*—The electrodynamic screen (EDS) has shown promise as a means to remove dust from solar collectors, such as concentrating solar mirrors and photovoltaic panels. These collectors are found in large-scale solar power plants in geographic regions where water is scarce but high daily solar irradiance is virtually guaranteed. Dust removal is crucial to the long-term economic efficacy of such solar installations, because even the smallest amount of dust can reduce energy-conversion efficiency below the profit margin of the solar plant.**

Current methods for cleaning dust rely on washing or mechanical robots. The EDS is a water-free alternative that has no moving parts. It removes dust by creating a lateral, electrostatic traveling wave that sweeps particles from the surface. The most efficient traveling wave is produced by a set of three-phase, interdigitated electrodes printed on a transparent dielectric film. These electrodes are activated by square-wave voltages at 1 to 2 kV, with the voltage phases all shifted by 120o relative to each other.

Producing the required three-phase interdigitated electrodes presents a problem. It is topologically impossible to connect to all three electrode sets without crossover wires to one of the phases. The crossover points become regions of high electric and mechanical stress, leading to electric breakdown and physical deterioration. These drawbacks compromise the long-term electrical and environmental stability of the EDS which also must withstand prolonged exposure to the sun. Electrode sets with crossovers are also much more expensive and difficult to manufacture.

One solution is to start with a two-electrode pattern, and then "snake" a third electrode in between the fingers of the other two phases. This pattern has no crossovers, hence it ensures that the electrodes can be printed easily and inexpensively as a two-dimensional structure on dielectric films for retrofitting on to existing solar collectors. A quasi three-phase electrostatic wave can still be produced by energizing the parallel electrodes in a precisely programmed

way. This talk will explain how the "snake" electrode system works and will compare its EDS performance to that of conventional three-phase electrode systems with crossovers. Experimental data on the performance of the EDS with conventional and "snake" electrodes will be presented, and a new, inexpensive approach to the three-phase HV supply will also be discussed.