Skysong Innovations
Advancing the Arizona State University Knowledge Enterprise

1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

Case ID:M20-051P
Published: 8/11/2020

Inventors

Tyler Smith
John Patterson
Clinton Ewell

Contact

Shen Yan
shen.yan@skysonginnovations.com

Capacitive Coupler for Efficient High Voltage Step-Down

Capacitive dropper circuits are employed when a low DC voltage, typically at a low current, must be obtained inexpensively and reliably from a high AC voltage. Capacitive dropper circuits are notable for their low consumption of active power relative to the current that they are able to supply, and are notable for their ability to supply reactive power to AC power systems, which in certain cases may be used to aid in local power-factor correction. Additionally, in some cases capacitors may be lighter and potentially less expensive, per unit power transfer, than magnetic transformers. For very high input voltages, capacitors may in general be preferable to magnetic transformers for converting small amounts of power to a lower voltage, as is seen in capacitive-coupled voltage transformers.

Traditional capacitive dropper circuits typically utilize a passive shunt element to perform voltage regulation at the DC output. This element carries the full dropper capacitor current at all times, and as a result, dissipates power when no or little load is applied to the circuit. This wastes energy during light-load periods of operation, and additionally limits the power capacity of larger dropper circuits to that which is reasonably able to be dissipated by a passive regulator element such as a pass transistor or Zener diode.

Researchers at Arizona State University have developed a new capacitive coupler that creates usable voltage for small electronics by efficiently harvesting and converting energy from high-voltage power lines.

The active capacitive coupler utilizes an actively-controlled current-steering circuit in series with a current-limiting capacitor in order to transform a higher and potentially variable AC voltage to a lower regulated DC voltage. The topology intrinsically limits the maximum voltage across all switching elements and diodes to that of the DC output voltage, and as such may be used to transform very high AC voltages (limited by the dropper capacitor rating only) to low DC voltage.

Potential Applications:

- Telecommunication power lines
- Electrical line maintenance

- Charging stations for electric vehicles and drones
- Consumer electronics

Benefits and Advantages:

- Employs a switched-mode regulator that dissipates minimal power in the regulating element
- Allows operation at greater efficiency than an equivalent passive shunt-regulated capacitive coupler over most (especially lighter) load ranges
- Versatile design can accommodate various types of electronics
- Compact, minimalist form simplifies field implementation