Technologies Related to Variable-Load Voltage Converters and Their Control Schemes

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ABSTRACT

Researchers at the University of California, Davis have developed voltage converters systems – with associated control schemes – that span a broad spectrum of potential applications.

FULL DESCRIPTION

Switched-capacitor power converters are non-linear circuits that can transition quickly to another circuit configuration under certain conditions. For overall system efficiency reasons, switched-capacity power converters have not been used historically as part of high-density power solutions. More recently, switched-capacitor-inductor (LC) converters have demonstrated improved performance at high conversion ratios and found some appropriate applications in this space. Split-phase Dickson converters have been introduced in the literature which are efficient under heavy loads but which suffer increased component voltage stress with increasing conversion ratio [1],[2]. Additionally, like most conventional DC-DC converters, split-phase converters suffer reduced efficiency at light load due to maximized switch utilization.

Researchers at the University of California, Davis have developed a converter which leverages three key innovations to yield an improved solution:

First, this technology applies split-phase switching to a Cockcroft-Walton ladder variant; dramatically reducing voltage stress and allowing for a significantly smaller solution size.

Second, a new highly efficient clocking scheme, termed "N-Phase" switching, was developed for the exact same hardware and which offers improved light-load efficiency relative to split-phase switching due to its reduced switch utilization [3].

Lastly, this technology allows for optimal merging of switching between N-phase and split-phase control yielding the advantages of both. The control system automatically selects the most appropriate switching scheme based on the operating point and associated power load.

Since both N-phase and split-phase converters employ identical hardware, a control method that selects the optimal conversion technique for any operational environment provides the highest energy efficiency across a wide and variable load range. This technology thus has applications in mobile devices, aviation, biomedical markets and power distribution.

APPLICATIONS

- Efficient and high-energy voltage conversion/control across diverse power requirement ranges

FEATURES/BENEFITS

- Voltage stress is reduced on most converter components
- Allows for physically smaller capacitors that exhibit the same effective capacitance
- Higher efficiency across entire load range

CONTACT

Michael M. Mueller
mmmueller@ucdavis.edu
tel: .

INVENTORS

- Ellis, Nathan

OTHER INFORMATION

KEYWORDS

Voltage conversion, N-phase converters, Split-phase converters, Multi-phase switching, L/C converters

CATEGORIZED AS

- **Energy**
  - Other
- **Engineering**
  - Engineering
  - Other

RELATED CASES

2019-583-0

- Suitable for large conversion ratios

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,979,089	05/07/2024	2019-583

Additional Patent Pending

RELATED MATERIALS

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University of California, Davis
Technology Transfer Office
1 Shields Avenue, Mrak Hall 4th Floor,
Davis,CA 95616

Tel:
530.754.8649
techtransfer@ucdavis.edu
https://research.ucdavis.edu/technology-transfer/
Fax:
530.754.7620