

ICRERA 2025

**14th INTERNATIONAL CONFERENCE ON RENEWABLE
ENERGY RESEARCH AND APPLICATIONS**

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Abstract

Title: Tristate converters

In a tristate converter the basic circuit topology of a DC/DC converter is extended by an additional electronic switch and an additional diode. Three modes follow each other within one switching period. During the first mode M1, both electronic switches are on and both diodes are off. In the second mode M2, only the second switch is on and the first diode is conducting, and in mode M3, only the second diode is conducting. The voltage transformation ratio is a function of the two duty cycles of the electronic switches. In a typical tristate converter, the current flows through the second switch during the first two modes. In the converters especially treated here, the current is flowing through the second switch only during the second mode, so the losses are reduced compared to the normal tristate converter. This is shown for the Buck, the Buck-Boost, the Boost, the Zeta, the Cuk, the Super Boost, the quadratic Buck, and a reduced-duty cycle converter. The voltage transformation ratios are depicted in diagrams. As an example the reduced loss tristate Buck is used to demonstrate the derivation of the large and the small signal models. The transfer functions are also calculated and Bode plots are shown for an operating point. A very interesting feature of tristate converters with step-up possibility is that with a special control the small signal behavior is that of a phase-minimum system. The voltage and the current stress of the converters are analyzed and the results are summarized in tables. The considerations are proved by simulations with the help of LTSpice.