POWER

DESIGN FAQs

Frequently Asked Questions:

DUAL-OUTPUT, NON-ISOLATED DC-DC CONVERTER ICs

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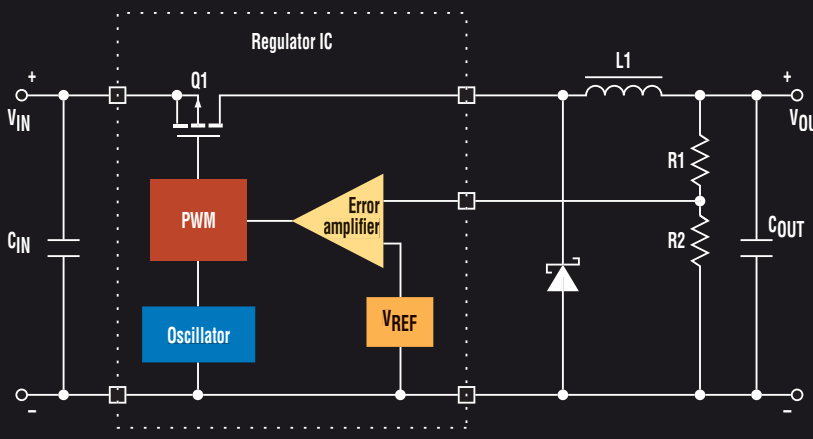
What are the available dual-output converter topologies?

Dual-output, non-isolated dc-dc converter ICs include switch-mode, low-dropout (LDO), LDO plus switch-mode, and charge pump types. These ICs are non-isolated converters because there is no dc voltage isolation between the input and output. In contrast, isolated converters employ a transformer to provide I/O isolation.



1. Buck converter IC employs pulse-width modulation to control the switching of a power MOSFET, whose output is then rectified to provide a lower dc output voltage than the input.

What types of dual switch-mode converter ICs are available?

In a single package, these switch-mode converter ICs come with one buck and one boost, two buck converters, and two boost converters. Dual switch-mode converter ICs offer higher efficiencies than the other converter topologies.

What are the typical applications for dual switch-mode dc-dc converters?

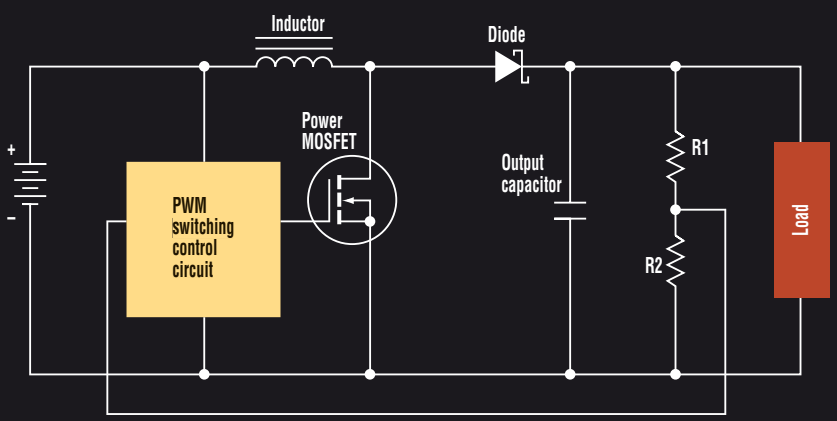
These converters are space-efficient, so their primary applications include battery-based handheld devices.

What is a buck converter?

In the simplified buck or step-down regulator shown in Figure 1, the regulator IC accepts a dc input. It then converts it to a pulse-width modulator (PWM) switching frequency that controls the output of the power MOSFET (Q1). An external Schottky rectifier, inductor, and output capacitors produce the regulated dc output. This regulator IC compares a portion of the rectified dc output with a voltage reference (V_{REF}) and varies the PWM duty cycle to maintain a constant dc output voltage. If the output voltage tends to increase, the PWM reduces its duty cycle, reducing the output and maintaining the required regulated output voltage. Conversely, if the output voltage tends to go down, the feedback causes the PWM duty cycle to increase and maintain the proper output.

How does a boost converter work?

A MOSFET switch controls the circuit in the simplified boost IC circuit *(Fig. 2)*. Turning the switch on causes current to build up through the inductor. Turning the switch off forces current through the diode to the output. Multiple cycles of this result in the output capacitor voltage building due to charge it stores from the inductor current. That means a higher output voltage than its input. A PWM control circuit drives the MOSFET. Without feedback, the PWM duty cycle determines the out-



2. Boost converter IC uses on-off power MOSFET switching to build up current through an inductor, which adds charge to the output capacitor and results in a higher output voltage than the input.

put voltage, which is twice the input for a 50% duty cycle. Stepping up the voltage by a factor of two creates an input current of twice the output current. In a real current with losses, the input current will be slightly higher. The ratio of the resistor divider across the output sets the output voltage.

What are the selection criteria for the input capacitor?

The input capacitor should be a low-ESR (equivalent series resistance) aluminum, tantalum, or ceramic type connected between the input pin and power ground. This capacitor prevents large voltage transients from appearing at the input, so its value depends on the circuit's RMS current and voltage requirements.

What determines output capacitor selection for the buck or boost converter?

Output capacitor selection depends on the maximum allowable output voltage ripple. Usually, the capacitor's ESR also plays a role in determining the output voltage ripple. Most circuits require a low-ESR aluminum electrolytic or tantalum capacitor. Electrolytic capacitors aren't recommended for temperatures below –25°C because their ESR rises dramatically at cold temperatures. A tantalum capacitor has a much better ESR specification in cold temperatures and is preferred for low-temperature applications.

What are the inductor selection considerations?

The critical parameters for the inductor are its inductance, peak current, and dc resistance. The inductance value affects the peak-to-peak inductor ripple current and the input and output voltages. A high ripple current reduces inductance but increases the conductance loss, core loss, and current stress for the inductor and associated switch devices. It also needs a bigger output capacitor for the same output voltage ripple requirement. A reasonable value is setting the ripple current to 30% of the dc output current. Because ripple current increases with the input voltage, the maximum input voltage affects the choice of inductance value. ED Online 10329