

Design Idea DI-1

TOPSwitch®

Buck Converter



Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Industrial Bias	TOP222P	3.0 W	38 - 375 VDC	15 V	Buck

Design Highlights

- Lowest cost **non-isolated** switch mode converter
- Minimum parts count
- DC/DC or AC/DC markets
- 48V telecoms or wide input range AC input applications
- No transformer required

Operation

The TOPSwitch buck converter generates a single non-isolated output voltage from either a DC input or a rectified AC input. Further output voltages can be generated from the main output using linear regulators.

In the example shown, C1 smooths the input rectified AC providing a DC voltage bus at the TOPSwitch DRAIN pin. If the input is a DC source, C1 is not required. C2 is charged up to 5.7V by the TOPSwitch internal current source during start-up to initiate operation. During the ON time of each TOPSwitch switching cycle the current in L1 ramps up linearly.

When TOPSwitch turns off at the end of each cycle, free-wheeling diode D1 maintains the current in L1. The SOURCE pin of TOPSwitch is therefore clamped by D1 to a voltage

which is the output ground rail minus the forward voltage drop of D1. During this period, D2 rectifies the voltage across L1 and provides feedback to the TOPSwitch control pin via R1 and VR1. Since the forward voltage drop across D2 compensates the forward voltage drop of D1, the voltage across C3 is equal to the output voltage. The output voltage is therefore determined by the choice of VR1 and the fixed shunt regulator voltage at the CONTROL pin. R1 limits current into the CONTROL pin within specified levels. A small resistor (2Ω to 15Ω) may be introduced in series to C2 to compensate control loop (for detailed information please see AN-14, Item 12, Control Loop).

The inductance should be chosen sufficiently large to ensure continuous mode of operation over the desired range of load current. Otherwise duty cycle has to be adjusted dependent on load current as well to prevent output voltage runaway, which could lead to lose of regulation due to finite ON times of TOPSwitch. Hence the inductor current ripple has to be limited to twice the minimum output current. A minimum output current of 25mA for instance, would require an inductance of 3mH for continuous mode.

For best results, the component values shown in the circuit schematic should be employed for the specified input and output conditions. Alternative diodes for components D1

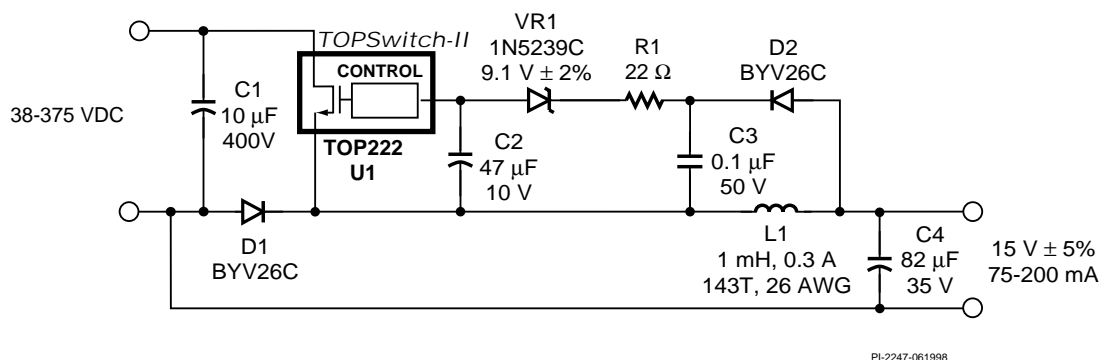


Figure 1. TOPSwitch Buck Converter.

and D2 can be used but they should be of an ultra fast recovery type with reverse recovery times $t_{RR} < 50$ ns, in order to keep additional *TOPSwitch* losses at a minimum during continuous mode of operation. Both D1 and D2 should be rated for the maximum DC rail voltage and at least a 20% margin be provided. Free-wheeling diode D1 has to have a minimum DC current rating of the peak inductor current. A good practical choice is a rated DC current of three times the output current.

For example, in the case shown, the maximum DC input voltage generated from 265 VAC is 375 VDC. D1 and D2 should therefore both be chosen with at least a 500 V peak inverse voltage rating (PIV rating). The BYV26C devices shown are rated for 600 V and 1.0 A with 50 ns reverse recovery time and therefore ideal for this application.

Inductor Parameters	
Core Material	Micrometals T68 - 52 A or equiv. $A_L = 54 \text{ nH/T}^2$
Inductance	1.0 mH \pm 10%
Winding	143 turns, 26 AWG

Key Design Points

- Choose correct *TOPSwitch* device based on respective *Initial Current Limit* I_{INIT} provided in *TOPSwitch-II* data sheet
- $V_{OUT(MIN)} = V_{IN(MAX)} \times DC_{MIN}$
- $V_{OUT(MAX)} = V_{IN(MIN)} \times DC_{MAX}$
- D1 & D2 should be of an ultrafast reverse recovery type (< 50 nsecs) and rated for $1.2 \times V_{IN(MAX)}$ and $3 \times I_O$
- Size inductor for continuous mode over output load range
- User powdered iron or gapped ferrite cores to prevent core saturation at respective *TOPSwitch* maximum current limit

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