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
- 48 V 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 5.7 V 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 (2 Ω to 15 Ω) may be introduced in series with C2 to compensate the 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, the minimum duty cycle of *TOPSwitch* may allow the output voltage to go too high at light loads. Hence, the inductor current ripple has to be limited to twice the minimum output current. A minimum output current of 25 mA instead of 75 mA for instance, would require an inductance of 3 mH for continuous mode.

For best results, the component values shown in the circuit schematic should be employed for the specified input and

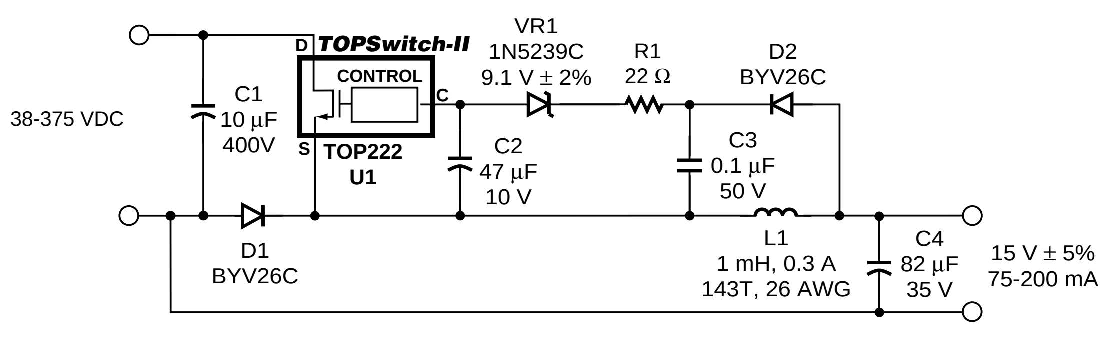

Figure 1. TOPSwitch Buck Converter.

output conditions. Alternative diodes for components D1 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 should 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 I_O.

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 nH/T[2]
Inductance	1.0 mH ± 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
- $V_{OUT(MIN)} = V_{IN(MAX)} \times D_{MIN}$
- $V_{OUT(MAX)} = V_{IN(MIN)} \times D_{MAX}$
- D1 & D2 should be of an ultrafast reverse recovery type (< 50 ns) and rated for $1.2 \times V_{IN(MAX)}$ and $3 \times I_O$
- Size inductor for continuous mode over output load range
- Use powdered iron or gapped ferrite cores to prevent core saturation at respective *TOPSwitch* maximum current limit

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