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DT0036
Design tip

Improving voltage regulation of a buck converter using the VIPerPLUS

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Main components	
Viper06L	Fixed frequency VIPer™ plus family
Viper16	Fixed frequency VIPer™ plus family
Viper26	Fixed frequency VIPer™ plus family
STTH1R06A	TURBO 2 Ultrafast High Voltage Rectifier

Purpose and benefits

The Viperx6 buck converter, part of the VIPerPLUS family of high voltage offline SMPS converters that includes the Viper06, Viper16, and Viper26, has been designed to start at very low input voltages and can operate with up to 700V input.

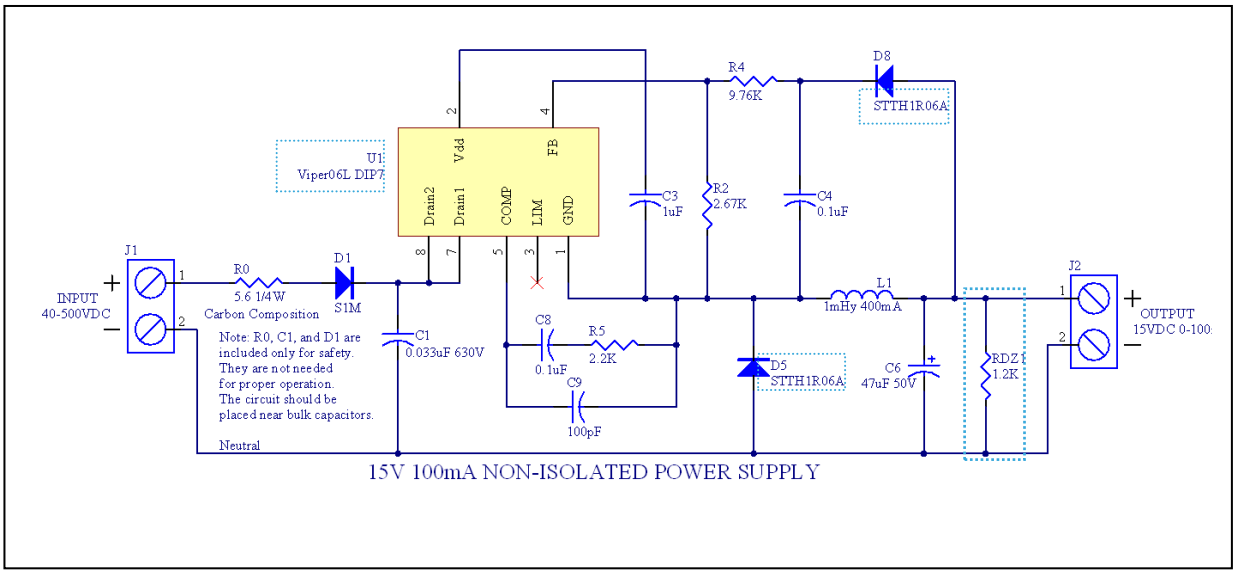
During shutdown of the Viperx6 and at very low input voltages below 40 volts, however, it can lose regulation if the load is very light. In this Design Tip, different options are presented to address this issue.

Description

The solution for improving the voltage regulation is to add a few simple components to limit the output voltage. Three options are presented that work well, taking into account the trade-offs between power and cost.

To illustrate the solution, a power converter design with a target range of 45V to 450V, with some margin, has been implemented by modifying ST's standard demo board, STEVAL-ISA130V1. Figure 1 shows the schematic for a 15V 100mA non-isolated power supply using the Viper06.

Figure 1. Circuit diagram of power converter with target range of 46V to 450V



Design Specifications

Input 46V to 450Vdc
Output: 15Vdc +/-10%

Performance Outside of Specified Input Range

The converter was tested to determine if there were any concerns regarding whether the input range was being exceeded on either end.

For high input voltages, there were no issues as the unit operated correctly to over 530Vdc input.

For low input voltages, it is assumed that the unit will run from large capacitors used to filter the power electronics and these will slowly discharge below the specified range. As the input voltage is reduced, the unit loses regulation with very light loads and the output voltage rises. Therefore, for a low input voltage, a light load or a voltage clamp is required.

This can easily be addressed in one of three ways. As it takes about 14mA of load current to hold the output voltage in the specified range, the solution is to add a simple component to limit the output voltage as shown in Figure 1 for RDZ1.

Three possible solutions for RDZ1 including cost-power dissipation trade-offs are described:

1. Add a single preload resistor of 1.2KΩ that dissipates about 0.23 Watts. This solution is the simplest and least expensive one but dissipates the most power.
2. Increase the preload resistor to 3.3KΩ, assuming the other side has a minimum load of 10mA, for 0.07 Watt dissipation. The benefit is

better power dissipation than the third option, but it relies on minimum load.

3. Install an 18V Zener diode which dissipates about 0.25 watts minus light load power worst case during shutdown. The benefit is very low power dissipation during normal operating mode with normal input voltage range.

After adding the component for RDZ1 as described in #1 above, typical results for the regulation test data are shown below.

Figure 2. Regulation test data

Input V	No Load	10mA	30mA	100mA
45	16.04	15.81	15.55	15.33
100	15.7	15.47	15.27	15.17
200	15.49	15.36	15.22	15.15
300	15.7	15.37	15.27	15.17
400	16.11	15.69	15.32	15.15
500	16.39	15.96	15.49	15.13

Final note: please use ultrafast diode STTH1R06 in this application. Using a slow diode will cause severe ringing and malfunction of VIPerX6 device.

Support material

List any related support material such as evaluation boards, Gerber files etc. and any documents which might be useful to the customer, for example the datasheets, the evaluation board user manual etc.

Related design support material
Product Evaluation board – STEVAL-ISA130V1 12V, 140mA 30 kHz non-isolated buck topology regulator based on VIPer06XN http://www.st.com/web/en/catalog/tools/PF258332#
Gerber files – STEVAL-ISA130V1 http://www.st.com/st-web-ui/static/active/en/resource/technical/layouts_and_diagrams/board_manufacturing_specification/steval-isa130v1_gerber.zip
bill of materials – STEVAL-ISA130V1 http://www.st.com/st-web-ui/static/active/en/resource/technical/document/bill_of_materials/steval-isa130v1_bom.pdf
schematics files – STEVAL-ISA130V1 http://www.st.com/st-web-ui/static/active/en/resource/technical/layouts_and_diagrams/schematic_pack/steval-isa130v1_schematic.pdf
Documentation
Datasheet VIPER06, VIPER16, and VIPER26, Fixed-frequency VIPer™ plus family

Revision history

Date	Version	Changes
17-June-2014	1	Initial release

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