

# — APPLICATION NOTE

## DESIGN CONSIDERATIONS FOR MINIATURE PROPORTIONAL HIGH VOLTAGE CONVERTERS

The A and Q Series are UL approved, proportional type, DC to high voltage DC converters in an ultra-miniature package. Models are available covering the range of 0 to +/-100 volts through +/-10,000 volts.

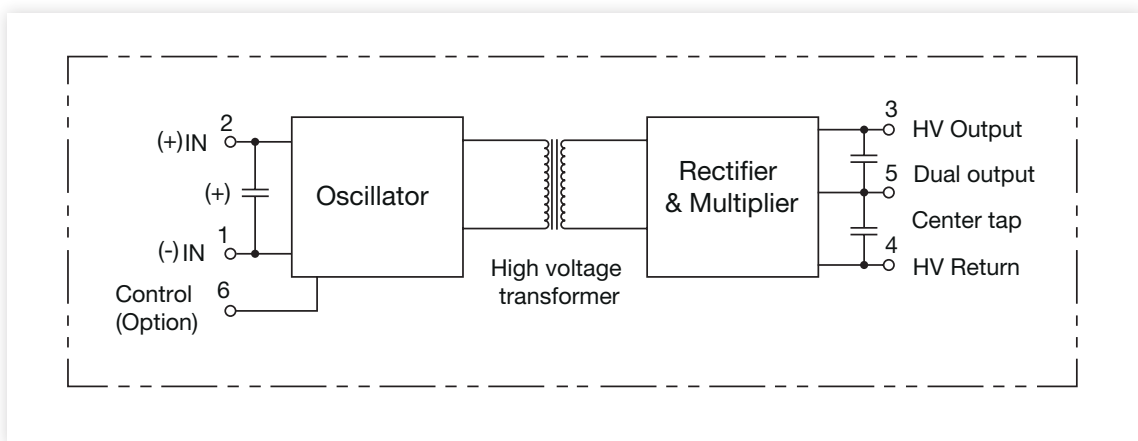


Figure 1: Block diagram

**Safety Warning**

High voltage power supplies present a serious risk of personal injury if not used in accordance with design and/or use specifications, if used in applications on products for which they are not intended or designed, or if they are used by untrained or unqualified personnel.

For more information, please refer to the XP Power Safety Warning and Disclaimer at the end of this document.

**Proportional Output:**

The output is proportional to the input voltage and is relatively linear from about 15% to 100% output. The unit turns on at approximately 0.7 volts input at which point the output jumps up to about 15% (Figure 2). From 0.7 volts upwards, the output is proportional to the input voltage. The slope is steeper with lighter loads.

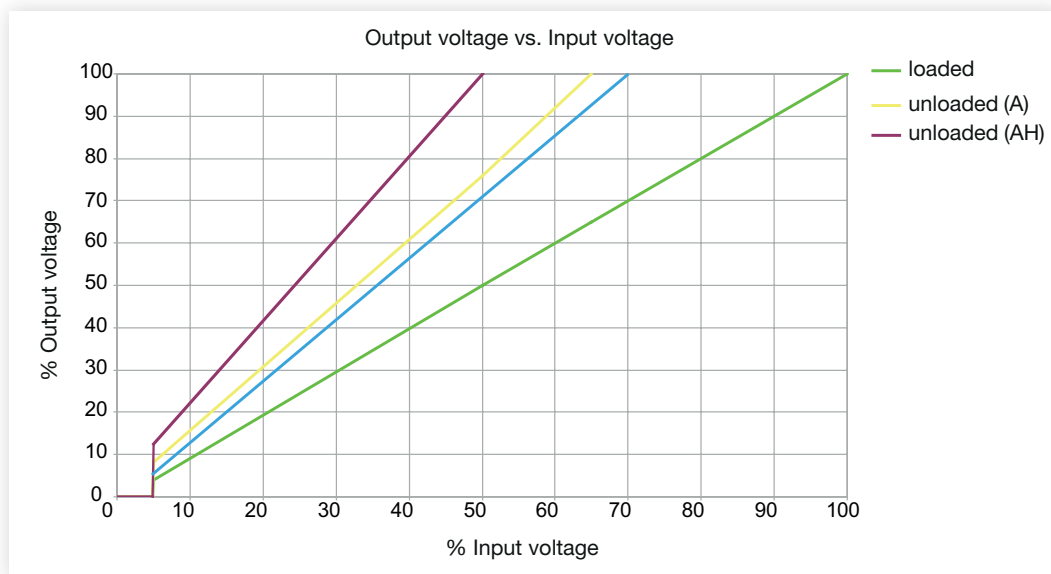


Figure 2

**Short Circuit and Overload Conditions:**

Load current that exceeds the rate maximum will cause reduced output voltage (Figure 3). At loads approaching a short circuit, primary circuit quenching cause both the output voltage and output current to approach zero. Extended operation under conditions requiring the unit to source significantly more than its rated current may result in thermal damage to the unit. Results vary from model to model.

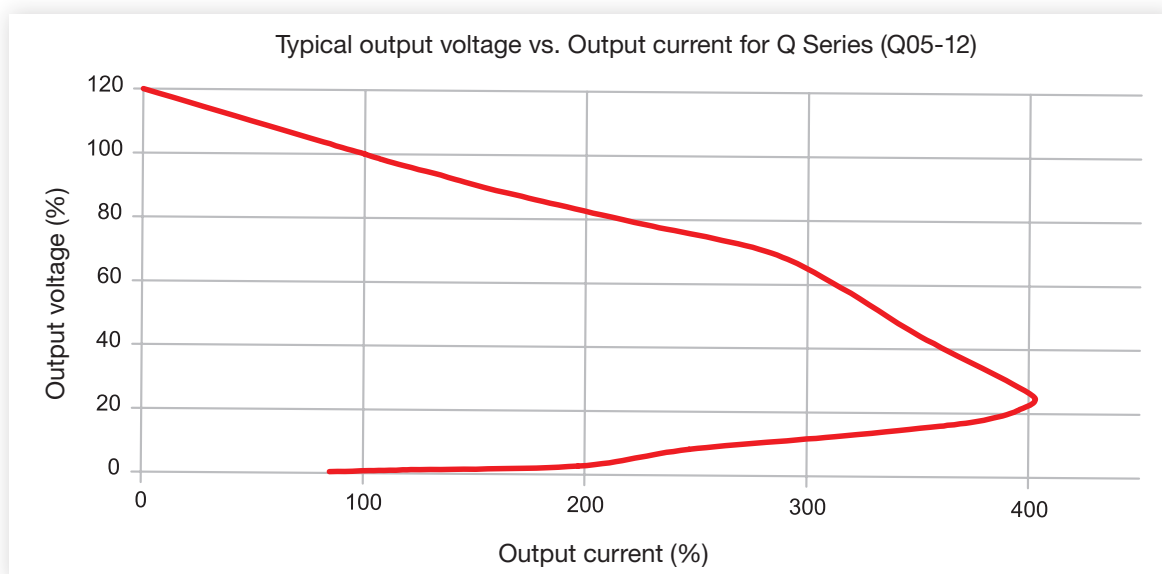


Figure 3

**Regulation:**

If your design requires a regulated output, the type of regulation circuit you need depends upon the degree of regulation required. If the output needs to be very stable over time, temperature, load and line variations, then the high voltage output should be sampled, fed back to an error amplifier and the input to the converter should be varied by a series pass device (Figures 4A and 4B). If the output voltage regulation is not critical, simply providing a steady, fixed input voltage may be all that is required. XP Power also offers precision regulated high voltage converters.

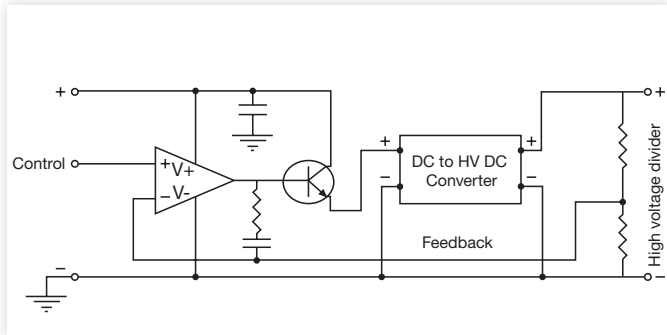


Figure 4A: Without control pin

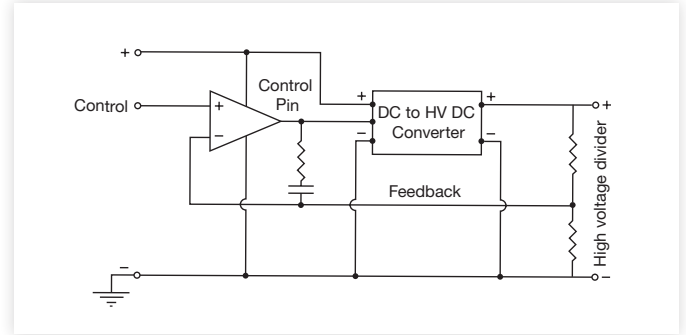


Figure 4B: With control pin

**Input Power Requirements:**

The input current for these converters is proportional to the input voltage [with a fixed load]. See Figure 5. For special applications requiring lower input current with very little output power required, a higher voltage model can be used at a lower input voltage which will consume much less input power. For example, the input power required for an output voltage of 1000V at 50mW can be reduced by 60% by using a Q20-5 with a reduced input voltage instead of a Q10-5 at maximum output voltage.

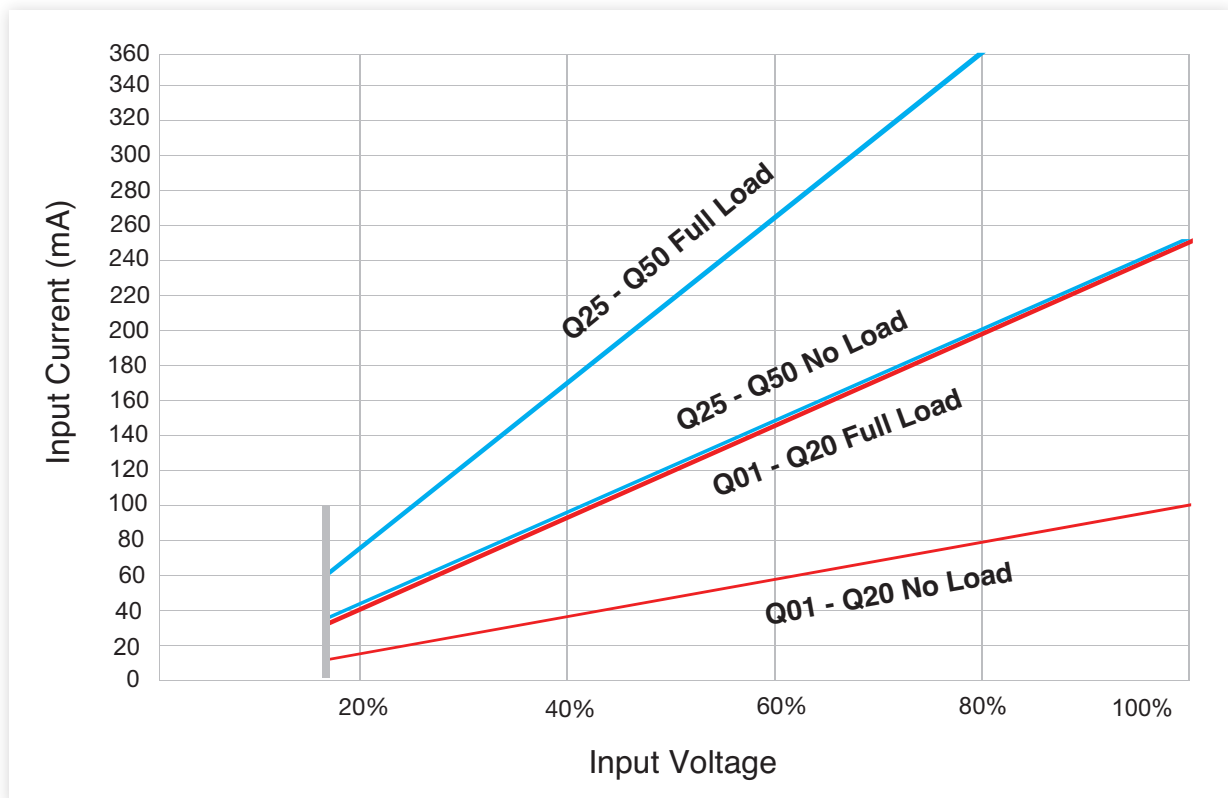


Figure 5

**Protection and Filtering:**

Because of its very small size, several filtering and protection components normally included in our other lines of DC to HV DC converters have not been included in the A and Q Series. These added features, described below, can easily be included in the user’s design as desired.

**Reverse Polarity Protection:**

This is easily achieved by placing a diode in series with the input to the converter (Figure 6). A Schottky diode is preferred because it will introduce less of a voltage drop than a silicon diode. The voltage rating of the diode should be higher than the highest reverse voltage the circuit might see. Although the Q Series only consumes about 250 mA under full load, the diode should be rated for 500mA to allow for inrush current, converter output short circuit or overload, and adequate derating.

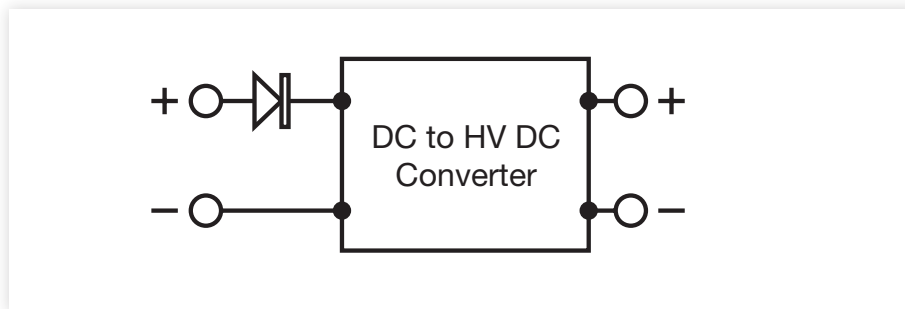


Figure 6

**Input Bypassing Capacitor:**

Internal to these converters is a small input capacitor. We recommend adding a low impedance electrolytic capacitor close to the input leads of the converter (Figure 7). This will reduce reflected ripple on the input supply lines and will decrease the amount of work being done by the small capacitor inside the converter, thus increasing reliability. A slight increase in efficiency and decrease in output ripple

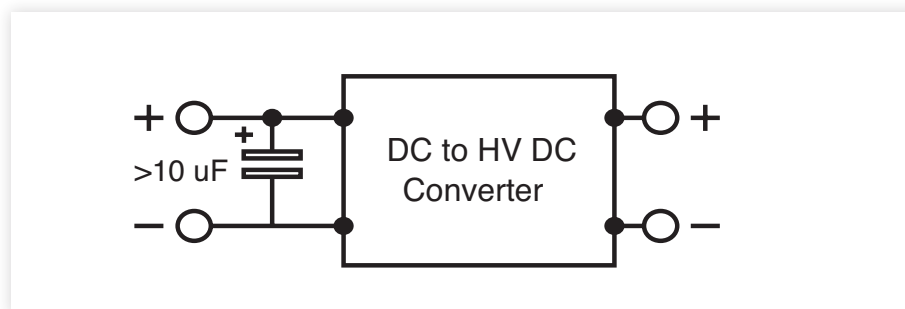


Figure 7

**Bleeder Resistor:**

Also not included in the Q Series is an internal high voltage bleeder resistor. It is always a good idea to discharge the high voltage capacitors after the circuit is turned off. Test equipment and assembly people do not enjoy getting zapped by a circuit that is turned off. A high value resistor placed across the output pins will bleed off the high voltage charge on the output capacitors after the circuit is turned off.

A common mistake made is selecting a resistor value that is too small. The current through the bleeder resistor combined with the load current should not exceed the output current rating of the converter. Unless required for faster fall time, select bleeder current of less than 10% of the converter’s rated output current. Be sure the resistor is rated for the amount of voltage across it. Several resistors can be placed in series if required.

**Arc Protection:**

A small series resistor on the output is recommended in cases where high voltage arcing may occur. This will limit the peak current associated with an arc and thus limit the stress on the high voltage capacitors internal to the converter. Load regulation requirements help dictate the value of the resistor. If your load resistance changes very little, pick a tolerable voltage drop across the resistor and your load current to get the resistor value ( $R=E/I$ ). This resistor should be a carbon composition type or similar in order to survive repetitive arcing.

**Ripple Reduction Filter:**

A simple RC output filter will reduce the ripple on the high voltage. Use your load current to select the series resistor value and a 0.001 to 0.01 uF ceramic disc high voltage capacitor (Figure 8). Several stages can be cascaded to reduce the ripple to very low levels.

**EMI and RFI Shielding:**

The high voltage transformer is constructed using a ferrite pot core which encloses the windings and greatly attenuates external magnetic fields. Additionally, the quasi-sinewave oscillator does not produce high switching spikes associated with square-wave oscillators and switching power supplies.

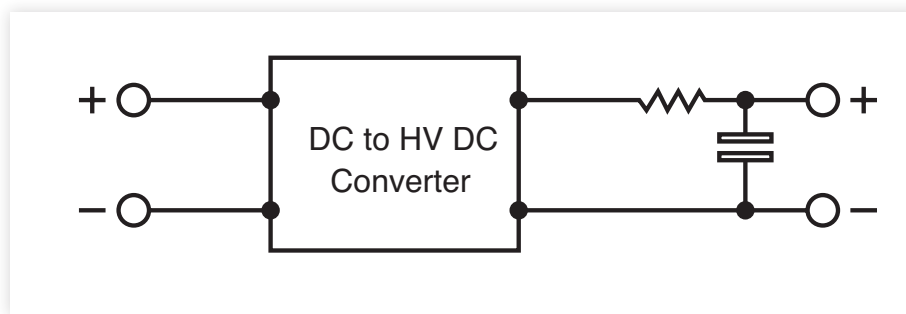


Figure 8

**Safety Information**

High voltage power supplies present a serious risk of personal injury if not used in accordance with design and/or use specifications, if used in applications on products for which they are not intended or designed, or if they are used by untrained or unqualified personnel. Before testing, incorporating or using XP Power's products, read, understand and thereafter adhere to all instructions, protocol, cautions and safety procedures applicable not only to XP Power's products but to each product and/or application into which XP Power's products are incorporated or assembled, as well as industry standard safe practices and rules and regulations regarding the use of high voltage.