Design Considerations for the Q Series

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 EMCO Safety Warning and Disclaimer located at:
http://www.xppower.com/High-Voltage/Safety-Warning-Concern-HV.pdf

1. Description:

The Q Series is a UL approved line of step-up 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. See figure 1 for the block diagram of the design.

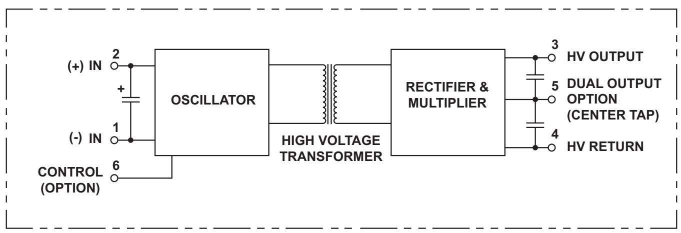

Figure 1.

2. Controlling the Output:

The output of the Q Series 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 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. 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.

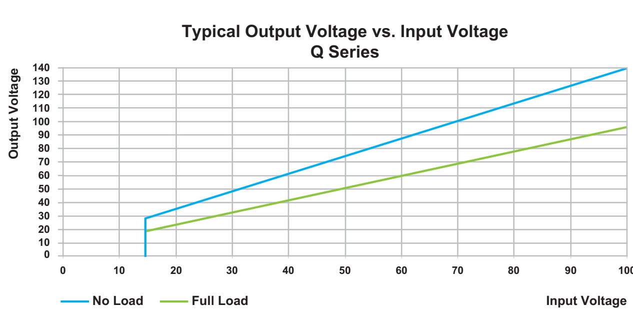

Figure 2.

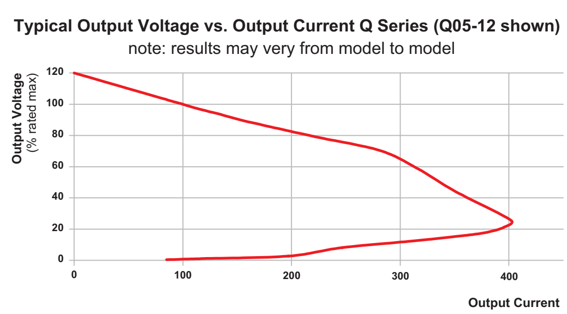

Figure 3.

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 (Figure 4A). For Control pin option see figure 4B. If the output voltage stability is not critical, simply providing a steady, fixed input voltage may be all that is required. We also offer a line of precision regulated and programmable miniature converters; see the C and CA Series.

Sample regulation circuits

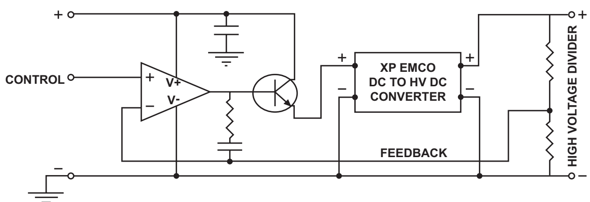

Figure 4A.

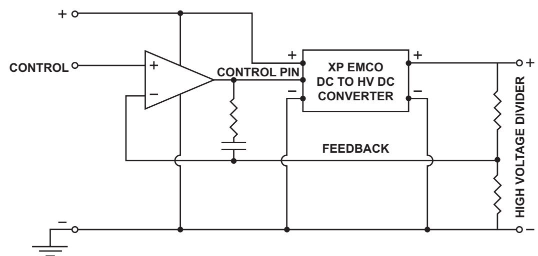

Figure 4B.

3. Selecting Output Polarity:

Since the Q Series is built with internal transformer isolation, either output pin may be connected to ground to produce either a positive or negative high voltage output on the other pin. These potentials should not exceed 500 volts maximum to prevent internal breakdown and failure. However, due to physical limitations inside the converter, models with output voltages of 1000 volts or greater are required to be ordered with either positive or negative output. For example, order a Q20 for +2000 volts out, order a Q20N for -2000 volts out. Models Q01-Q08 may be connected in either positive or negative output configuration. All models have galvanic input to output isolation.

4. Input Power Requirements:

Input power requirements depend upon load current and input voltage, as shown in the graph below (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 quiescent input power. For example, if a 1,000 volt output is required, a Q20 can be biased at 2.5 volts input to get 1,000 volts out. The input power is 50 mW, as opposed to 175 mW for a Q10 at 5 volts in.

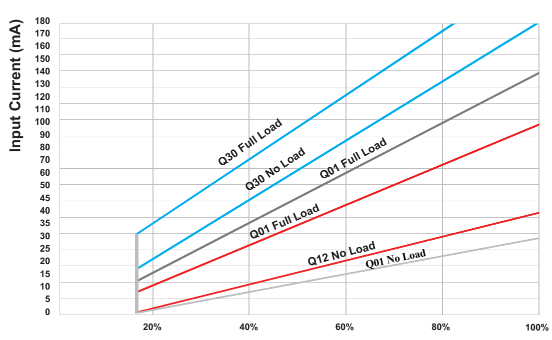

Figure 5.

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 Q Series. These added features, described below, can easily be included in the user's design as desired.

5.1 Reverse Polarity Protection:

Reverse polarity protection is not included inside the Q Series. This is easily achieved by placing a diode in series with the input to the converter (Figure 6). A Shottkey 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.

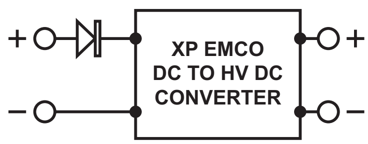

Figure 6.

5.2 Input Bypassing Capacitor:

Internal to the Q Series is a small input capacitor. We recommend placing a low impedance electrolytic capacitor (such as United Chemicon's LXV Series) 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 might also be observed.

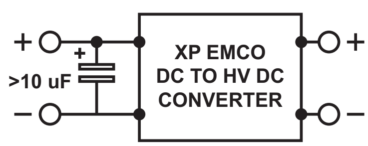

Figure 7.

5.3 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.

5.4 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.

5.5 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.

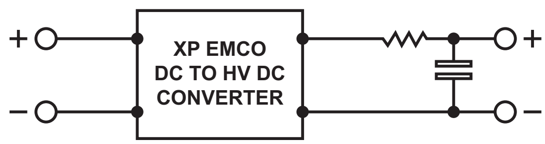

Figure 8.

5.6 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.

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