

# ULTRAVOLT AEQ SERIES

## APPLICATION NOTE - 01



This application document, in conjunction with the product specification sheet is intended to provide technical information on the operation of the AEQ series of ultra-miniature DC to DC power converters, this includes pin assignments, input requirements, and output characteristics.

The AEQ family of ultra-miniature UL approved, isolated single or dual output DC to DC converters, supplying up to 600 VDC at 0.5 Watts of output power from an input voltage of +5 VDC, the converters are packaged in a housing measuring 1/2" [0.5" x 0.5" x 0.5"] cube.

### Note:

- All specifications are after a 30-minute warm-up at full load at 25°C unless otherwise noted.
- Maximum output load is available at the maximum rated output voltage, the load derates linearly as control pin voltage is decreased.
- The AEQ output voltage is load dependent, under light load conditions it may be necessary to adjust the control pin, so the maximum rated output voltage is not exceeded.
- Good thermal management techniques must be used to maintain the maximum case temperature when operating the AEQ at maximum load.

## SAFETY WARNING

High voltage power converters present a serious risk of personal injuries if not used by qualified personal and/or used in designs or applications the converters were not designed for.



## FUNCTIONAL DIAGRAM

Simplified functional diagram of a dual output

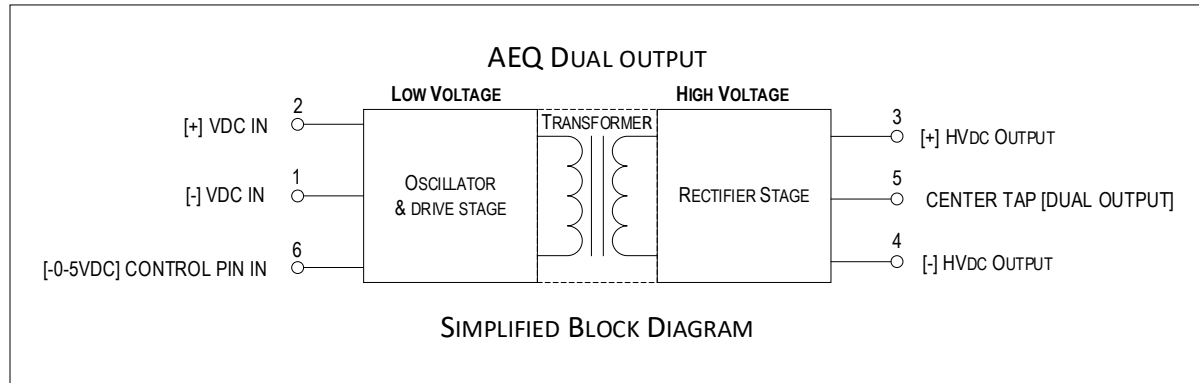


Figure 1

Simplified functional diagram of a single output

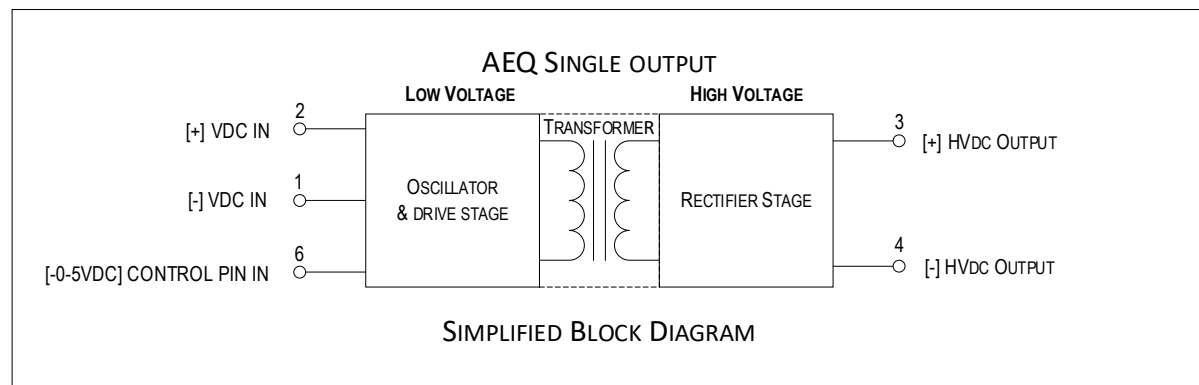


Figure 2

## PIN FUNCTION OVERVIEW

Please refer to the above functional diagrams for reference.

### Pin 1 - INPUT POWER RETURN (-IN)

Pin 1 is located on the low voltage side of the AEQ module, this pin is the ground return to the DC input source powering the AEQ module. This pin is also used as the return path for the voltage control programming signal.

Please Note: The input voltage is isolated from the output voltage; this pin is not the same as the high voltage return path.

### Pin 2 - INPUT POWER (+IN)

Pin 2 is located on the low voltage side of the AEQ module. The pin is the power input to the AEQ module and is supplied by the DC source powering the AEQ. The DC source must be capable of providing the full input voltage and the maximum input current necessary for the correct operation of the AEQ module. These input requirements vary by module/series and can be found on the product data/specification sheet.

### Pin 3 - HIGH VOLTAGE OUTPUT (+)

Pin 3 is located on the high voltage side of the AEQ module. This pin provides the high voltage positive output of the module and provides a voltage of up to 600 VDC at a maximum power output power of 0.5 Watts. The output is adjustable via the control pin. Refer to the datasheet/product specification sheet for the specific model maximum ratings.

### Pin 4 - HIGH VOLTAGE RETURN (-)

Pin 4 is located on the high voltage side of the AEQ module. It provides the AEQ modules high voltage return path. Please note, the high voltage return path is not internally connected to the input power return path (Pin 1). The high voltage output (Pin 3) is referenced to Pin 4.

### Pin 5 - CENTER TAP (BP0 CONFIGURATION ONLY)

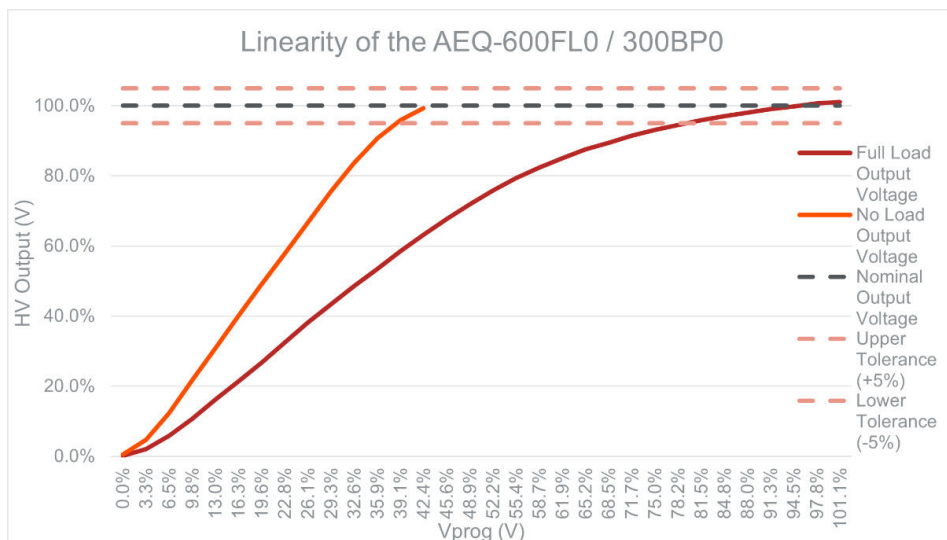
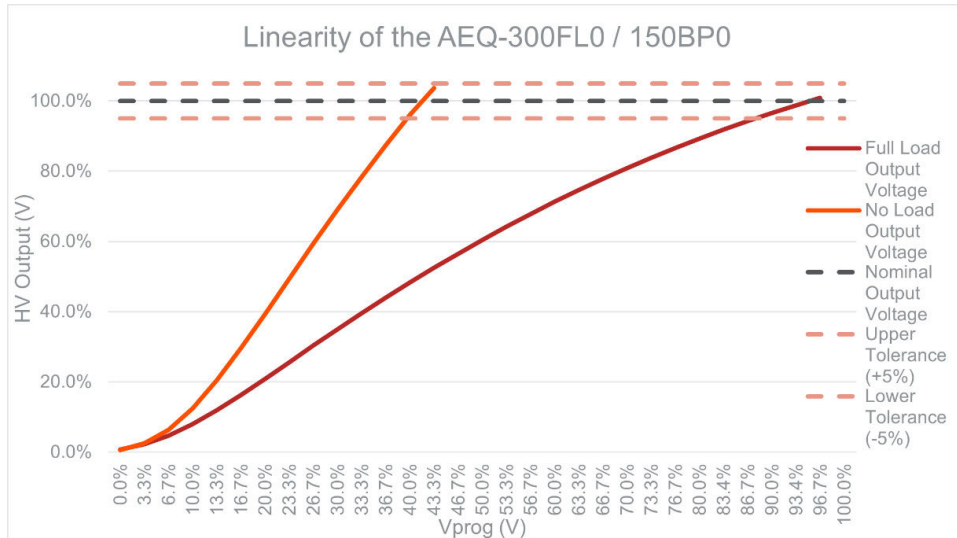
Pin 5 is located on the high voltage side of the AEQ module. This optional pin provides center tap allowing for a  $\pm$ dual high voltage output configuration when referenced to this pin.

### Pin 6 - CONTROL PIN

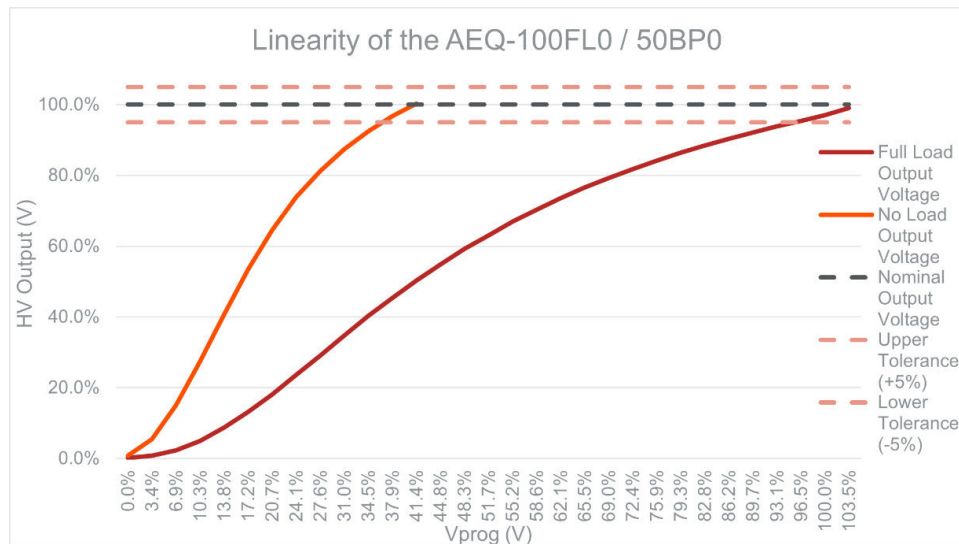
Pin 6 is located on the low voltage side of the AEQ module. The pin is used to control the high voltage output of the module. Applying a low voltage analog signal of 0 VDC to +5 VDC to the pin will control the high voltage output from 0% to 100% of the maximum rated output as described in the product specification sheet. The input is high impedance. A wide variety a programming signal sources to be utilized. Any signal source used must have a common ground return to Pin 1 of the AEQ module. This is also true if digital to analog converters are used, operational amplifiers, microprocessors, potentiometers etc.

## OUTPUT VOLTAGE

The AEQ output voltage is proportional to the > 0.1 VDC to +5 VDC applied to the control pin and is independent of the power converter supply voltage. With the +5 VDC power converter voltage present on Pin 2, the output turns on when approximately 0.1 VDC is applied to the control pin (Pin6). As the voltage increases on the control pin so does the output high voltage, likewise as the control pin voltage decreases so does the high voltage output. At light or no-load conditions, the control pin must be compensated to allow the high voltage output to remain in the maximum rated output. See specification sheet for individual modules.



## OUTPUT VOLTAGE



## DESIGN CONSIDERATIONS

### PCB Layout (Always use best practices when designing PCB boards)

The AEQ family of miniature high voltage converters are designed to be PCB mounted. It is highly recommended that the low voltage input side of the AEQ module and the high voltage output side traces be separated and all recommended creepage and clearances must be observed (IPC-2221 standard for reference).

Ground planes and power planes are recommended where possible but must follow the same rules as above. Do not rout traces directly under the module, care should be taken when routing critical traces to avoid noise pickup.

### Module Cleaning

Prior to soldering, the module should be checked for contamination. If contaminants are present on the module housing or module pins, it must be cleaned.

### Soldering

The AEQ series of modules are rated for hand soldering only. Module damage may occur in convection or wave soldering processes. The PCB soldering temperature should not exceed 600°F (315.5°C) for more than 4 seconds. Post soldering all solder connections should be inspected in compliance to industry standards.

## CUSTOMIZATION

The AEQ family can be manufactured with modifications if necessary. Contact Advanced Energy for information.

## PROTECTION

Due to the extremely small nature of the AEQ series of modules, components found in larger converters have not been included in the AEQ family.

### Reverse Polarity Protection

Reverse polarity is achieved by placing a series diode with the input to the converter (Figure 3). A schottky diode is preferred because it will introduce less of a voltage drop than a silicon diode (DC input source maybe adjusted to compensate for the voltage drop). The voltage rating of the diode should be higher than the highest reverse voltage the circuit might see. The AEQ Series only consumes about 250 mA under full load conditions, the diode should be rated for 400 mA to allow for inrush current, converter output short circuit or overload, and derating.

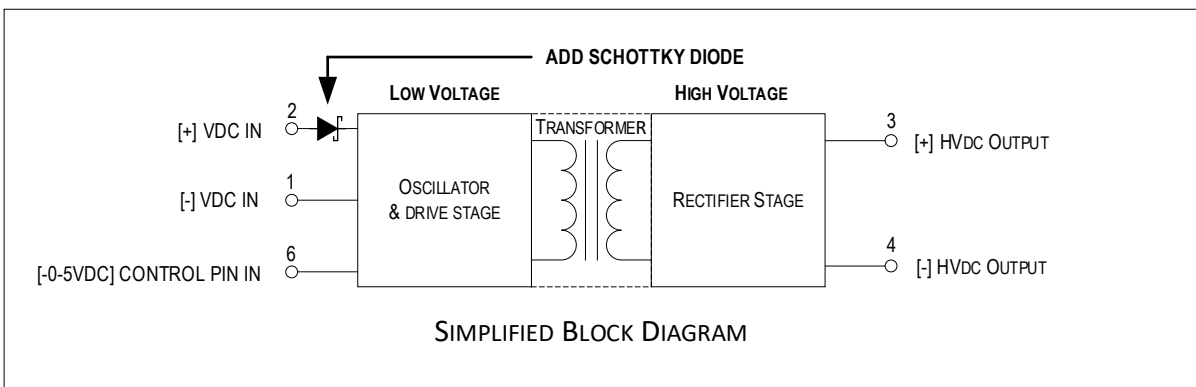


Figure 3

### Arc Protection

If the application is prone to arcing a small series resistor placed on the high voltage output is recommended, the addition of a resistor will limit the peak current associated with an arc incident and will limit the stress on the high voltage capacitors internal to the converter. Load regulation requirements help dictate the maximum value of the protection resistor. If your load resistance is reasonable constant, pick a tolerable voltage drop across the resistor and your load current. To calculate the resistor value, use this Ohms law formula ( $R=V/I$ ). It is important to use the correct style of resistor, a carbon composition or similar type is recommended to survive repetitive arcs.

## APPLICATION NOTE

### Input Bypass Capacitor

Internal to the AEQ series of converters there is a small input capacitor. We recommend adding a good quality low impedance electrolytic capacitor as close to the input pins of the converter as possible (Figure 4). This capacitor will work in parallel with the internal capacitor and will reduce reflected ripple on the input supply lines.

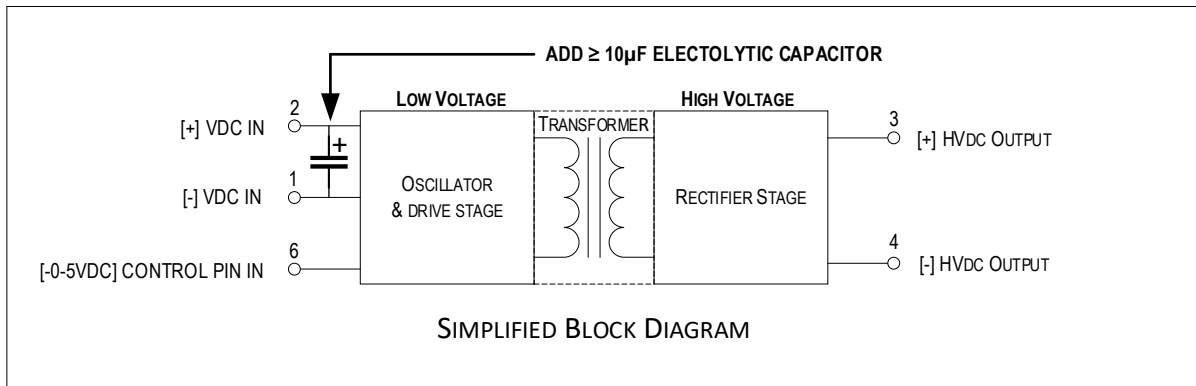


Figure 4

### Output Ripple Reduction Filter

The AEQ has an output ripple of  $\leq 1\%$  (see specification sheet), if a further reduction of ripple is required on the high voltage output, a simple 1 stage (or several cascaded stages) RC filter network can be implemented (Figure 5). Using the load current to calculate the resistor and using high voltage ceramic capacitors in the value range of 0.001 to 0.01  $\mu\text{F}$ , very low levels of ripple can be achieved.

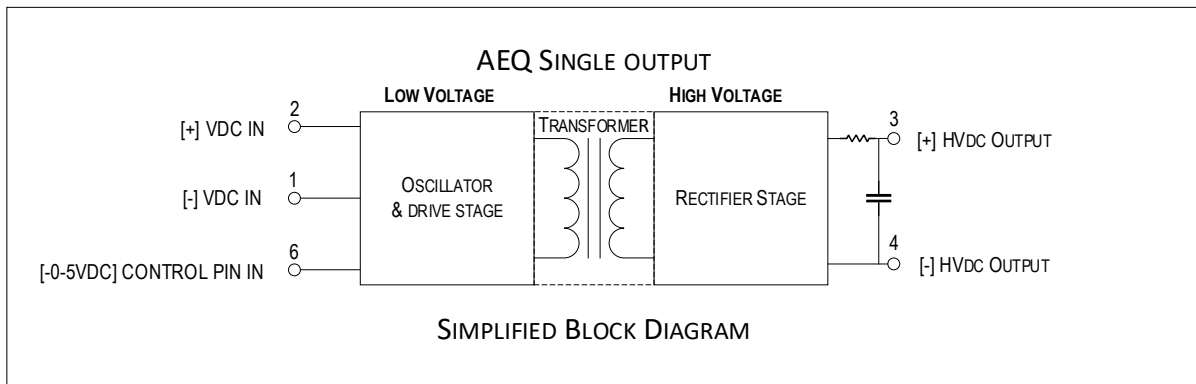


Figure 5

## Pin Assignment



PIN ASSIGNMENT	
PIN 1	INPUT POWER RETURN (-IN)
PIN 2	INPUT POWER (+IN)
PIN 3	HIGH VOLTAGE OUTPUT (+)
PIN 4	HIGH VOLTAGE (-)
PIN 5	CENTER TAP (BP0 CONFIGURATION ONLY)
PIN 6	CONTROL PIN

Recommended printed circuit board footprint.

