

**Problem:**

Large capacitors require large amounts of energy and long periods of time to charge to their full voltage. If the charge time is greater than half a second ( $>500\text{ms}$ ), the charging supply will shut down the output current and indicate a load fault condition. The supply will automatically reset itself after half a second in the off state, and continue the charge sequence (unless the LP latching overload protection option is installed). Figure 1 below illustrates the resulting charge waveform.

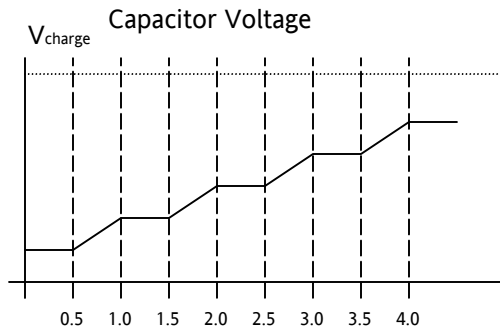


Figure 1. Charging with a load fault condition

**Cause**

When a capacitor charging power supply is used to charge a capacitor it acts as a constant current source until the programmed voltage is reached, where the supply goes into voltage regulation mode. A capacitor charging power supply can deliver approximately twice the output current compared to a similarly rated DC power supply. If the supply is allowed to deliver this current for an extended period of time, damage to the internal components is possible, so the supply is designed to limit the average output current to prevent damage.

**Charging in load fault mode**

All ALE capacitor charging power supplies feature a load fault (sometimes referred to as overload) protection circuit. When large capacitors are charged the load voltage waveform will look like that shown in figure 1. In some applications this 'stair case' waveform is undesirable, and can easily be eliminated using an external inhibit signal.

**Using an external inhibit**

The inhibit function is featured on all Lambda EMIs ALE series capacitor charging power supplies. It offers the user on/off control of the unit output current, by application of a suitable inhibit signal via the remote control interface. A 50% duty cycle square waveform with a frequency between 20 and 100Hz can be applied to the inhibit input of the remote control interface. This will turn on and off the output current at a high rate, resulting in a smooth load charge waveform, while still limiting the output power to prevent damage to the unit.

**Safety Precautions**

When a capacitor charging power supply is used to charge a load circuit that contains greater than 1kilojoule of stored energy, it is wise to add an external isolation network between the power supply and the load. The isolation circuit will prevent the load capacitor from discharging into the power supply in the event of a catastrophic failure in the output section. The power supply warranty may be voided if an isolation network is not installed. Figure 2 (below) shows the recommended isolation network.

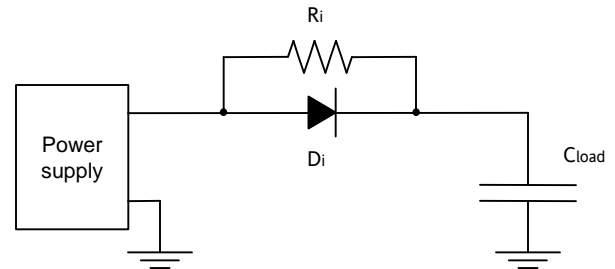


Figure 2 Recommended isolation network for loads with stored energy greater than 1kJ.

Diode  $D_i$  isolates the power supply from the load and in the event of a catastrophic failure in the power supply output section will prevent rapid discharge of the energy in  $C_{load}$  through the supply, which could present a safety hazard.  $D_i$  should have a reverse voltage rating at least 1.5 times the rating of the power supply, and a forward current rating at least 2 times the power supply capability.

Resistor  $R_i$  is designed to dissipate the energy stored in  $C_{load}$  in the event of a power supply output failure. The value of  $R_i$  should be approximately  $100\Omega$  with an energy rating sufficient to dissipate all of the stored energy in  $C_{load}$ .

For additional isolation it is recommended that the power supply is disconnected from the load circuit using a high voltage relay or disconnect switch prior to load discharge.

**HV diode manufacturers;**

CKE - P.O. Box 211, Lucernemines, PA. 15754 USA.  
Tel. 724-479-3533. Web: [www.cke.com](http://www.cke.com)

VMI - 8711 W. Roosevelt Ave, Visalia, CA. 93291. Tel. 209-651-1402.  
Web: [www.voltagemultipliers.com](http://www.voltagemultipliers.com)

**High energy resistor manufacturers;**

Kanthal Globar - Niagara Falls, NY 14302-0339  
Tel. 877-GLOBAR-2. Web: [www.globar.com](http://www.globar.com)

HVR Advanced Power Components - Tonawanda, NY 14150  
Tel. 716-693-4700. Web: [www.hvrapc.com](http://www.hvrapc.com)

**HV relay manufacturers;**

Northstar Research Corporation - Albuquerque, NM, 87109  
Tel. 505-888-4908. Web: [www.northstar-research.com](http://www.northstar-research.com)

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