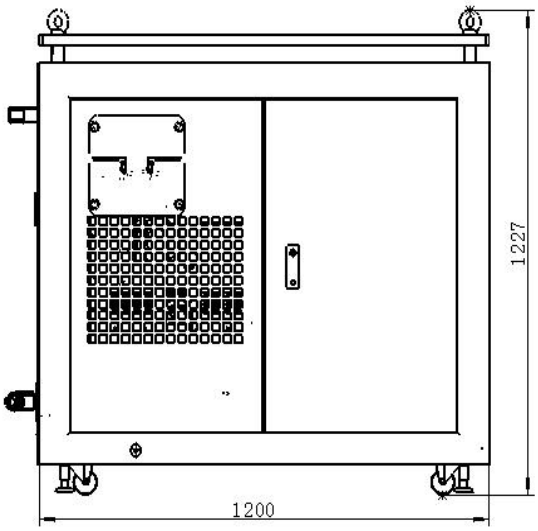
CCH MODULES

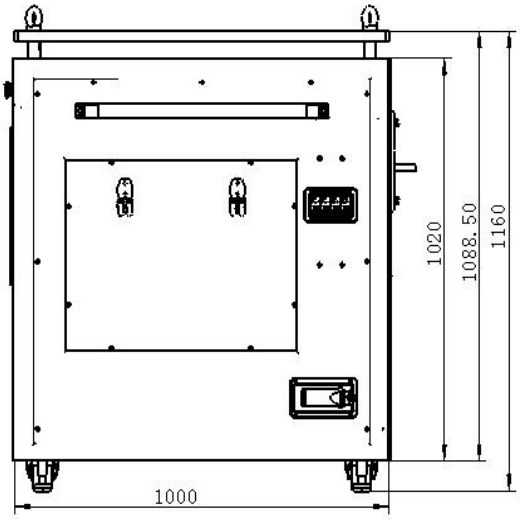
High voltage supply

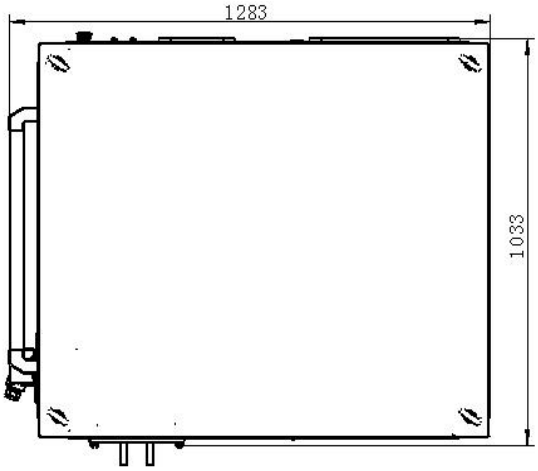
CCH高功率电容充电电源机柜

产品尺寸重量

长*宽*高：1283mm*1033mm*1227mm，重约420kg







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英国真维特(Genvolt)高压设备有限公司
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使用说明

机柜由高压电源和冷水机组成，机柜内部的冷却水路和供电回路已连接好。用户仅需接上主电，合上断路器即可。

一、主电电缆插头接线说明：

如下图所示，图1中红色圈出部分标有数字1、2、3、4，即对应图2中孔位。接线时1、2、3分别接三个相线（不分相序），4接零线。

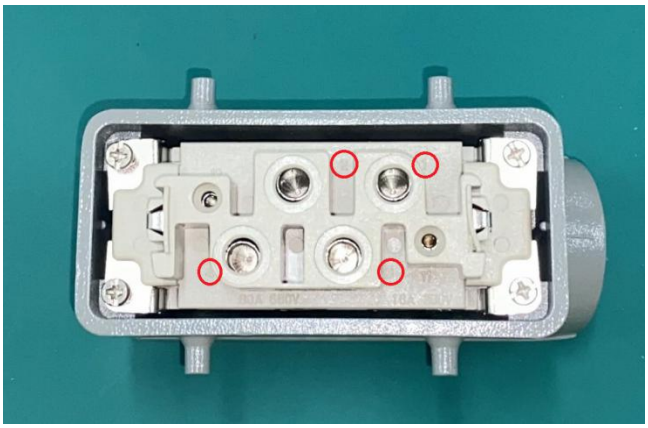

图1

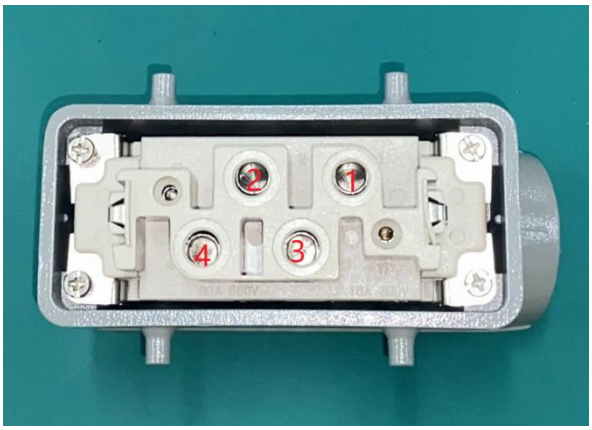

图2

二、断路器分合位置说明：

如下图所示，向上为合，向下为分。

注：出厂时已将内部的冷水机和电源开关打开。合上空开后，冷水机和电源开始工作。

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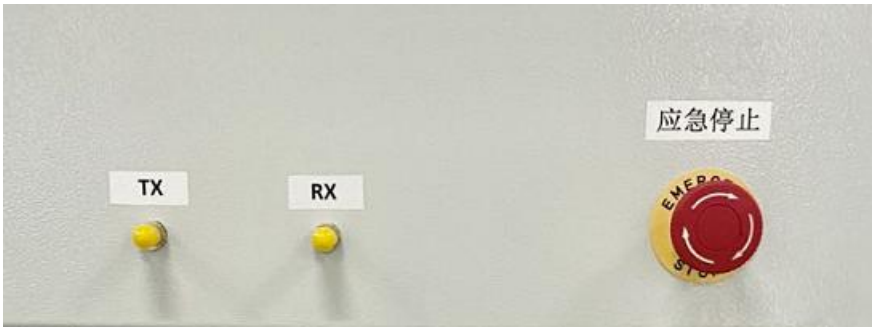
三、光纤通讯接口和应急停止按钮

前面板有光纤通讯接口，用户按软件使用说明连接好光纤，即TX连至模块的TX，RX连至模块的RX。

通常情况下，应急停止按钮为松开状态，当按下应急停止按钮时，高压逆变器停止工作。



四、冷水机

整套机柜出厂时，已将冷水机调为最佳使用模式（智能模式，冷水机会根据室温和水温自行调节，即满足冷却要求又不会产生冷凝水）。无特殊情况不需要客户再进行设置。

冷水机的使用参见冷水机使用说明。

五、高压电源

详见“CCH高功率电容充电电源”使用说明。出厂时电源默认为远程上位机控制模式。

六、高压输出端和接地端

高压输出端和接地端位于机柜后侧，使用前确保接线正确可靠。

七、其他

机柜上方布置工作台，侧面设有线缆挂钩供用户使用。

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CCH高功率电容充电电源

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产品简介

CCH系列电源是由英国Genvolt公司设计，由Genvolt独资的宿迁波尔高压电源公司生产的高功率高压充电电源系列。功率范围从5KW到80KW，电压输出从1KV到60KV。该系列电源全部采用高频逆变和智能控制技术，包含有多项专利，技术先进，冗余度大，可靠性高。

CCH系列电源所用的大功率逆变器采用Genvolt独到设计的谐振逆变器， 输入整流、滤波、逆变全部集成在一块散热器上，采用风冷结构。高压变压器也采用了含有专利技术的低储能高频高压整流变压器。CCH系列电源有完整的保护，包括过压、过流、过热、放电检测等。这些特点确保CCH系列电源能过长期稳定的工作。

注：由于电流过大，本电源内部没有集成限流电阻和其他的保护电路，在实际使用的时候需要加上保护电路，提高电源的可靠性!!（推荐保护电路见附录）

产品特点

- 集成高压电源
- 全部采用15kHz以上高频逆变技术
- 所有输出都能从0到100%可调
- 本地和远程控制
- 输出高压0-3kV
- 最大输出电流20A，功率最大60kW
- 高压输出方式灵活，可由用户定制
- 放电保护 短路保护 超温保护

应用领域

电容充电

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技术参数

1 输入/输出电压：输入交流三相380V带中性线，电压允许波动10%
输出最大3kV
2 输出电流：最大电流20A
输出电流稳定度：<1% 额定值
3 输出功率：峰值充电功率60kW
4 功率因数：满功率大于0.9
5 整机效率：满功率大于0.92
6 冷却方式：水冷
7 工作环境温度：-10到40℃
8 工作环境湿度：小于90%并不结露
9 电源外形尺寸：约810mm * 宽485mm * 高540mm
10 重量：约160kG

控制方式

本地控制：在电源前面板先设置好充电电压和充电电流，通过前面板的高压开关控制充电的开启和关闭。

远程控制：1）REMOTE模式下，将开关切至RS232，可通过上位机控制。

2）REMOTE模式下，将开关切至PLC，可通过DB25控制。（此功能未用）

注：本地控制给电容充电时，当电压充到设定值时，高压开关会保持开的状态，需要手动关闭高压开关。
远程控制时，当电压充到设定值时，高压开关会自动关闭！！

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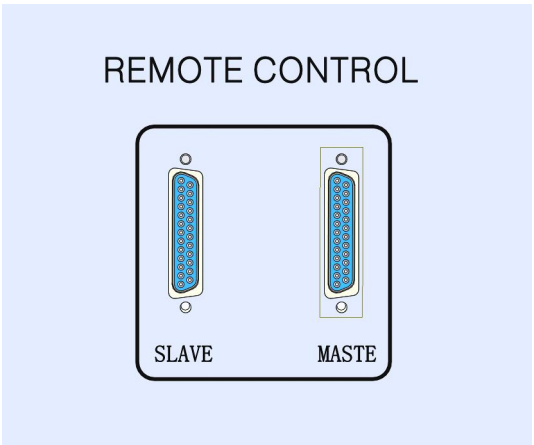
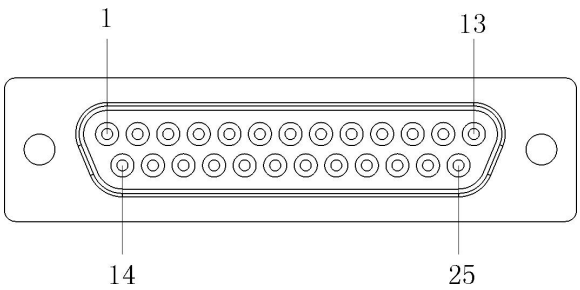
针号	信号名称	输入/输出	说明
1	+15V	OUTPUT	15V输出电源，提供最大125mA 电流
2	EMERGENCY STOP LED	OUTPUT	OC输出。表明紧急制动开关动作
3	INHIBIT LED	OUTPUT	OC输出。表明电源接收到一个禁止信号
4	EOC LED	OUTPUT	OC输出。表明电源充电结束，即充电电压已经达到设定值
5	IGBT FAULT LED	OUTPUT	OC输出。IGBT故障
6	INVERTER OVER CURRENT LED	OUTPUT	OC输出。逆变器电流超过设定保护阈值
7	CONSTANT CURRENT LED	OUTPUT	OC输出。表明电源正以恒定电流模式充电
8	INVERTER OVER TEMPEARTURE	OUTPUT	OC输出。表明逆变器散热器上温度>60C
9	ISOLATING SWITCH STATE	INPUT	不选择，悬空
10	ENABLE/RESET	INPUT	15V = 启动电源高压输出，接地或开路 = 禁止电源高压输出
11	$V_{PROGRAM}$	INPUT	0-10V = 0-最大
12	I_{ANALOG}	OUTPUT	10V 对应最大输出电流
13	V_{ANALOG}	OUTPUT	10V 对应最大输出电压
14	INTERLOCK LED	OUTPUT	OC输出。表明连锁环节没有闭合
15	VBUS LOW LED	OUTPUT	OC输出。表明内部母线电压太低（低于550V）
16	SINGLE/MULTI PULSE STATE	INPUT	不选择，悬空
17	CHARG ENABLED	OUTPUT	OC输出。表明电源已经启动高压输出
18	Iprogram	INPUT	0-10V = 0-最大
19	OIL OVER TEMPERATURE LED	OUTPUT	OC输出。表明油箱温度 >70C
20	CONSTANT VOLTAGE LED	OUTPUT	OC输出。表明输出电压和设定电压相等
21	DIGITAL GND		数字地
22	INHIBIT	INPUT	>5V 禁止高压输出，0V允许高压输出（与10脚配合使用）
23	ANALOG GND		模拟地
24	+11V DC	OUTPUT	+11V参考信号供外部使用
25	VOLT METER	OUTPUT	+10V 对应最大输出电压



■ MASTER和SLAVE的DB25接口



■ DB25控制针说明

电源面板上端口为母头，使用时需配备公头进行连接，从而实现远程控制功能。

注： 控制针功能详细说明见左侧

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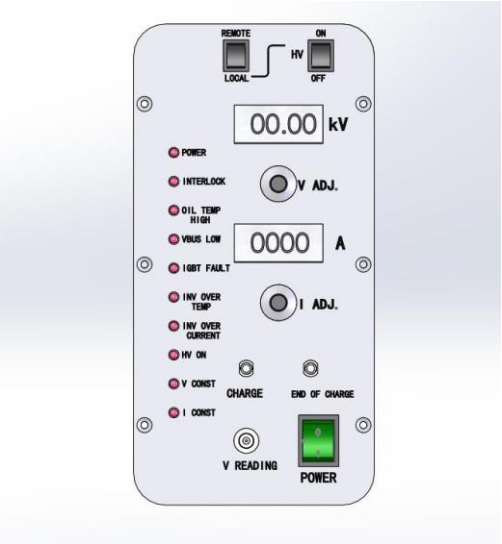
前面板说明

左侧红色小灯

针号	名称	说明
1	POWER	电源开关
2	INTERLOCK	连锁
3	OIL TEMP HIGH	油箱过温
4	VBUS LOW	母线电压过低
5	IGBT FAULT	IGBT报错
6	INV OVER TEMP	逆变器过温
7	INV OVER CURRENT	逆变器过流
8	HV ON	高压开关
9	V CONST	恒压输出
10	I CONST	恒流输出



中间黑色旋钮

针号	名称	说明
1	V ADJ	电压调节
2	I ADJ	电流调节

- 1．所有旋钮均为顺时针方向旋代表增大，反之减小。
  2．绿色的POWER开关为电源总开关，0为关闭，I为打开。

部分英文释义

针号	名称	说明
1	REMOTE	远程
2	LOCAL	本地
3	ON	打开
4	OFF	关闭
5	SALVE	“从”模式
6	MASTER	“主”模式
7	PLC	远程DB25控制
8	RS232	远程上位机控制

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通讯光纤接口

按软件使用说明连接好光纤，即TX连至控制模块的TX，RX连至控制模块的RX。

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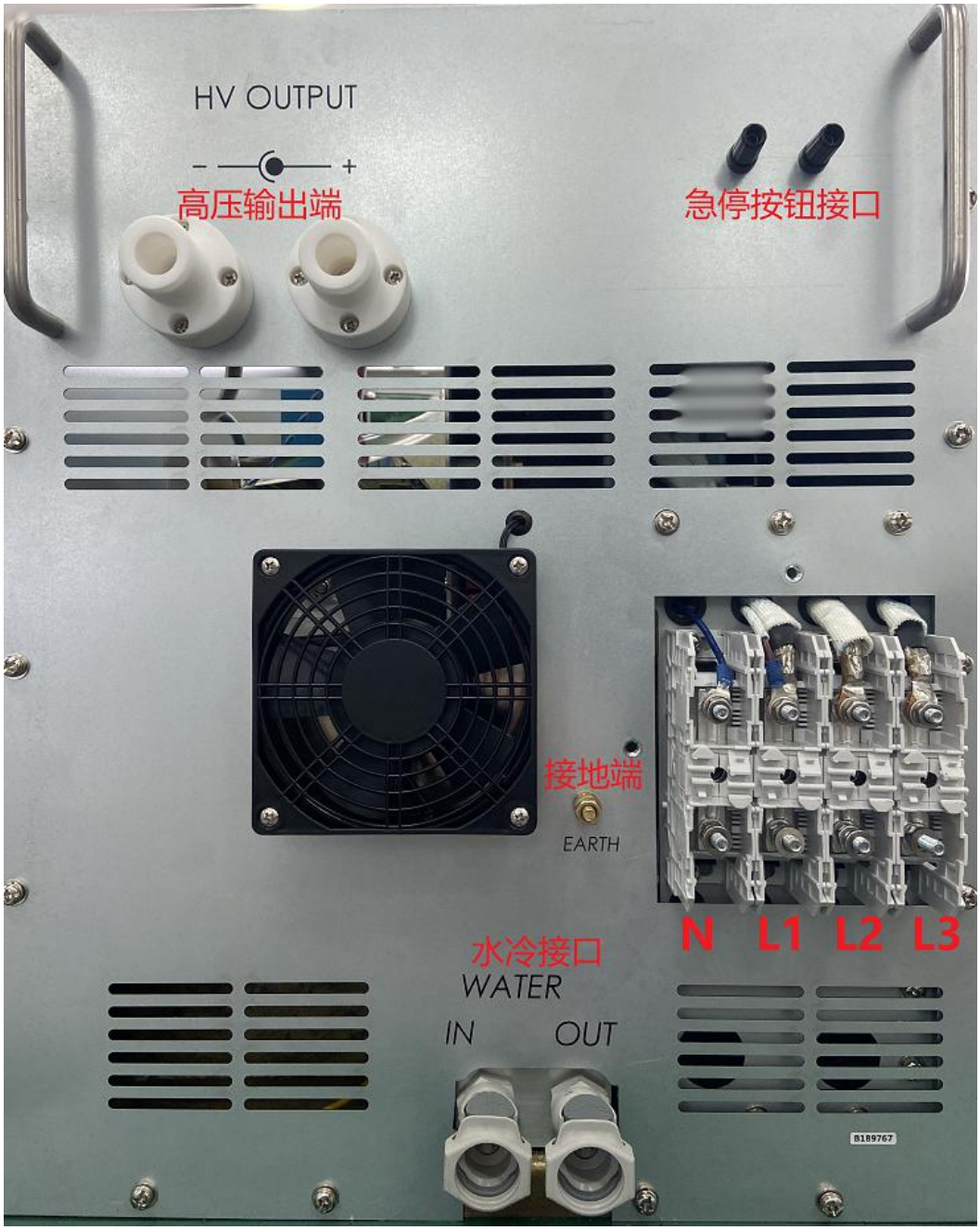
后面板说明



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安全和注意事项：

本电源为高压、大功率电源，请在专业人员的指导下谨慎操作，否则会给您的人身带来危险。

在开启电源之前请做如下检查：

1. 电源及所处环境清洁、干燥。
2. 在高压输出接口或高压负载附近无任何不相关的物品。
3. 请确认电源接地螺栓良好的接地。

如您在使用过程中有任何疑问，请致电：0527-88068878

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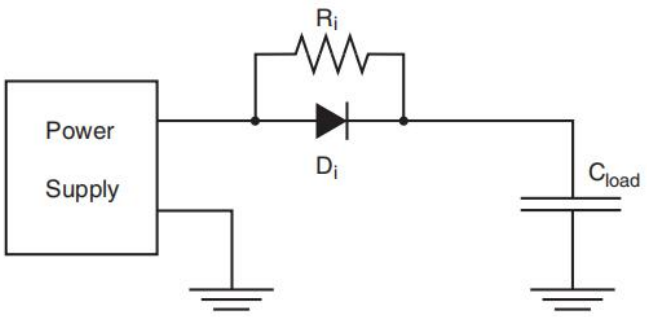
附录：保护电路

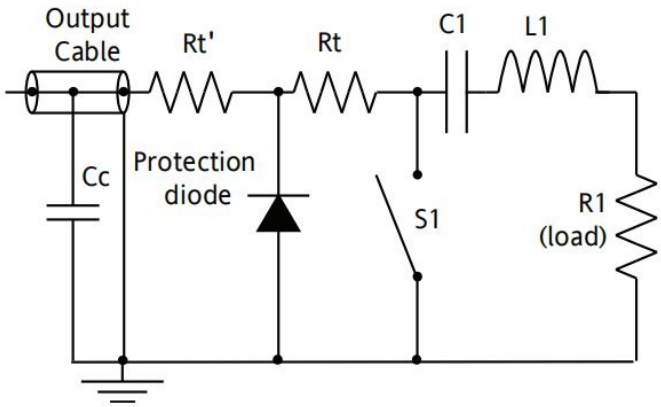
保护一：

1、防止电源损坏时，负载电容倒灌保护



Ri可不选，Di选择耐压大于1.5倍的输出电压，电流大于2倍的输出电流

2、反压续流保护



Rt’和Rt可以先假定，此案例中，可以假定Rt为2.5欧姆，Rt’为2.5欧姆，功率各为1000W；

保护二极管选择如下：脉冲电流为 $Ipk = \frac{Vr}{Rt}$ ，极限值为3000/2.5=1200A。选择保护电压为≥3000V的TVS管。

宿迁波尔高压电源有限公司(英国独资)
公司地址:宿迁市宿豫区雁荡山路79号
联系电话:0527-88068878 传真:0527-88068828
网址:www.boherhv.com
北京办事处地址:北京市朝阳区汤立路216号东方郁金香A单元716
联系电话:010-59919200 传真:010-59919200

英国真维特(Genvolt)高压设备有限公司
总部地址:New Road,Highley,BridgnorthShropshire,
United kingdom WN166NN
电话：+441746862555 传真：+441746862666
网址：www.genvolt.co.uk 邮箱:sales@genvolt.co.uk

保护二：

1、可以选择加装高压开关，充完电后，断开开关，但是仍要加防止倒灌二极管。

以上保护措施具体原理见附件。

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网址：www.genvolt.co.uk 邮箱:sales@genvolt.co.uk

3kV60kW 高压电源

软件使用说明书

波尔高压电源（宿迁）有限公司
生产基地：江苏省宿迁市宿豫经济开发区雁荡山路 79 号
电话：0527-88068878　　传真：0527-88068028
网址：www.boherhv.com　　邮箱：sales@boherhv.com
技术服务：北京市朝阳区汤立路 216 号东方郁金香 A 单元 716
电话：010-59919200　　传真：010-59919200

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（研发中心） Shropshire, United Kingdom WV166NN
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网址：www.genvolt.co.uk 邮箱：sales@genvolt.co.uk

目录

一、通信接线说明

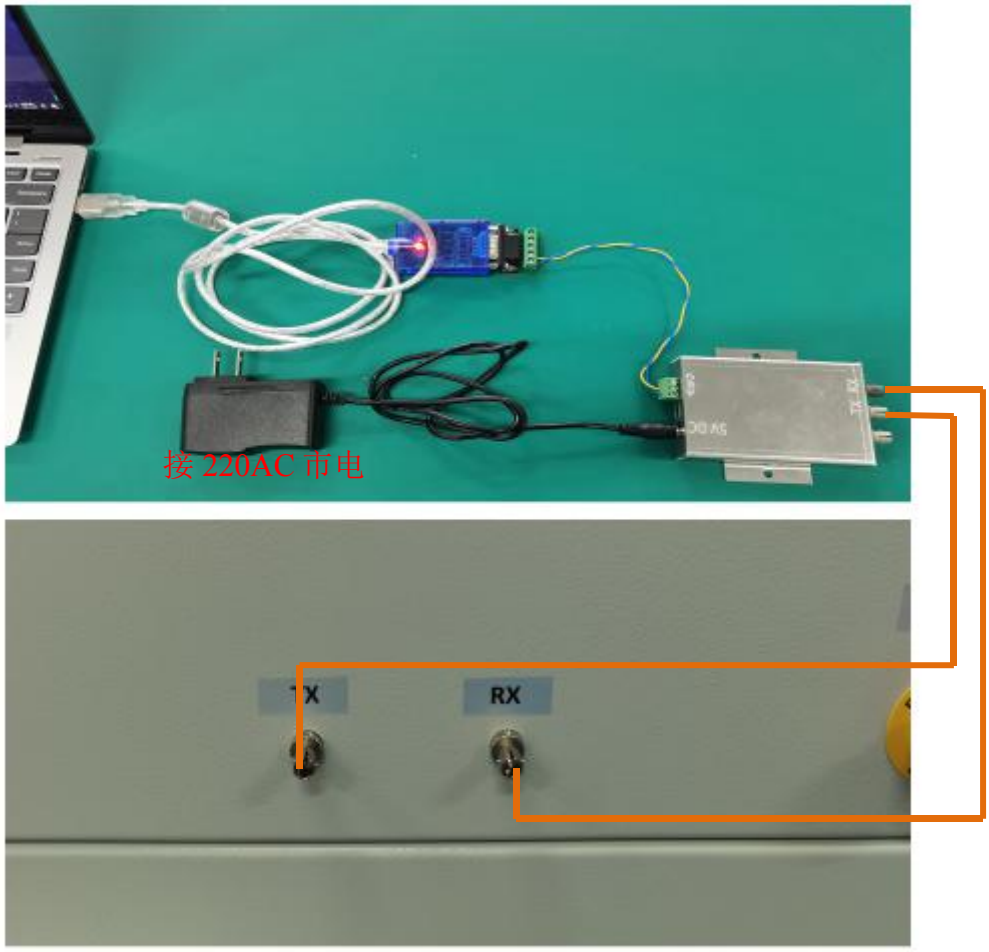

图 1 软件通信接线

二、设备配置

1、硬件配置

计算机 1 台。

USB 转 485 通讯线，接口驱动。

2、软件配置

操作系统为：Windows XP 32 位操作系统。

波尔高压电源（宿迁）有限公司
生产基地：江苏省宿迁市宿豫经济开发区雁荡山路 79 号
电话：0527-88068878 传真：0527-88068028
网址：www.boherhv.com 邮箱：sales@boherhv.com
技术服务：北京市朝阳区汤立路 216 号东方郁金香 A 单元 716
电话：010-59919200 传真：010-59919200

英国真维特（Genvolt）高压设备有限公司
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（研发中心） Shropshire, United Kingdom WV166NN
电话：+441746862555 传真：+441746862666
网址：www.genvolt.co.uk 邮箱：sales@genvolt.co.uk

三、使用方法说明

1、软件安装

打开安装包文件夹，双击 setup.exe 安装控制软件，并安装 USB 转 485 通信线的驱动。详见资料包。

2、软件协议

1）通信协议：RS485

2） 波特率：38400

3、软件使用方法

软件操作界面如下图所示：

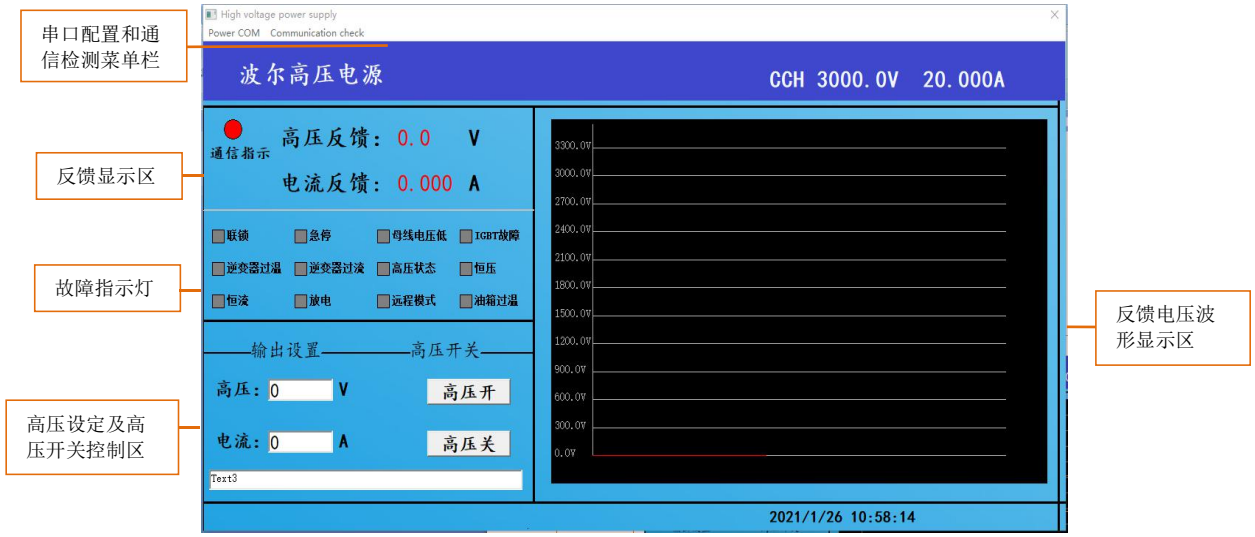

图 2. 软件操作界面

1).配置 COM 口。

单击菜单栏的 Power COM 按钮弹出串口配置界面。插好 USB 转 485 通讯线，在串口配置界面根据电脑设备管理器中的串口号选择串口，点击 load 按钮后充电机串口界面中的 load 灯为红色，完成 COM 口的配置。

完成 COM 口的配置后，给系统供电，点击菜单栏的Communication check按钮发送指令，此时主界面左上角圆形指示灯由红灯变绿灯表示串口连接成功。

若配置失败，给系统断电，重新插拔电脑主机上的 USB 线，重复以上方法设置。

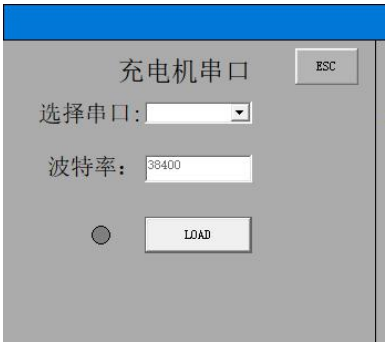

图 3.串口参数设置

2）高压设定

在电压设定文本框内输入电压值，可输入的电压范围为 0~3000v。在电流文本框输入电流值，可输入的电流范围为 0~20A。

点击“高压开”按钮开启高压，电源按设定的电压电流值工作；点击“HV_OFF”关闭高压输出，此时电源设定自动归零。

在反馈显示区查看电源的实际输出高压值和电流值，通过Communication check发送指令，查看通信指示灯是否变化，来监查软件通信是否正常。

在反馈电压波形显示区，查看电源高压输出波形，了解高压输出实际过程。

App Note 517 - Voltage Reversal Protection

Simple Resistive Protection

When a high voltage is transmitted via a coaxial cable -such as the cable supplied with TDK-Lambda ALE HV Capacitor Charging Supplies- it should ideally be terminated in a resistance equal to or greater than the cable characteristic impedance. The resistor limits potential reflected energy from the shorted cable from reaching supply output stages. This reverse voltage can cause erratic operation, and potentially actual damage to the output section of the power supply. The sketch in figure 1 below shows a typical HV capacitor charging supply load connection.

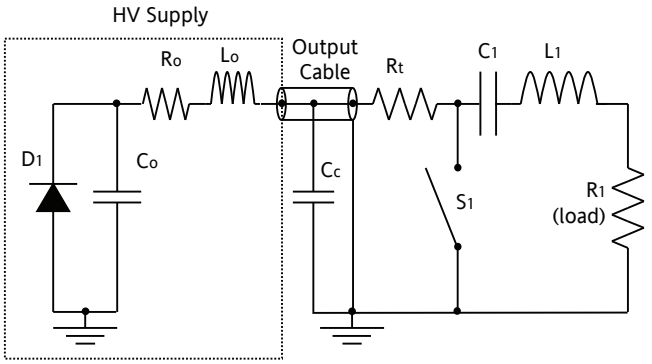

Figure 1. Generalized HV Supply Load Connection

If R_t is not in the circuit, when the switch S_1 closes the supply output cable (which is a short PFN) is discharged through S_1 along with the energy from C_1. The pulse produced by discharging the output cable is inverted and reflected at the shorted switch S_1 and propagates back into the HV Supply output stages. The addition of R_t to the circuit presents a matched load to the supply output cable impedance, and hence the pulse produced when S_1 is closed is dissipated in R_t.

The value of Rt is typically 50 to 500Ω with a power rating of 200W. This rating ensures enough physical size to provide sufficient voltage holdoff capability during the discharge period. For example, the power rating of the terminating resistor for a series 303 supply @ 40kV can be calculated as follows:

$$I_{out} = 1.88A,\ R_t = 50W$$
$$\text{Average power is} = 1.88^2 \times 50 = 177\ \text{Watts}$$

There are two additional sources of current that can cause the dissipated power to increase by several orders of magnitude. The first source is the distributed energy stored in the supply output cable capacitance C_c. With reference to figure 1, the internal capacitance of the supply C_o along with C_c is discharged through R_t and R_o (R_o represents the supply output resistance which is typically a few ohms or less) every time S_1 closes.

A typical value for C_o can be 200pF, and C_c is related to the length of output cable (~30pF/ft) which could be 300pF for a standard 10ft cable.

Assuming a circuit charge voltage of 40kV the stored energy in C_o and C_c can simply be calculated using the following equation;

$$E = \tfrac{1}{2}CV^2 = \tfrac{1}{2} \times (500pF) \times (40kV)^2 = 0.4\ \text{Joules}$$

If the discharge circuit is operating at a repetition rate (rep. rate) of 1kHz, then the mean power dissipated in Rt and Ro is 0.4 Joules x 1000 or 400W.

Additional power dissipation in R_t may be caused by voltage reversal across due to an underdamped discharge. For example in a positive output power supply, if the discharge circuit is underdamped when switch S_1 closes the voltage on the HV cable will undershoot and a transient negative voltage is applied to the supply output stage. When this occurs current will flow out of the power supply through the now forward biased output rectifiers and Rt to ground. This is illustrated in Figure 2 below.

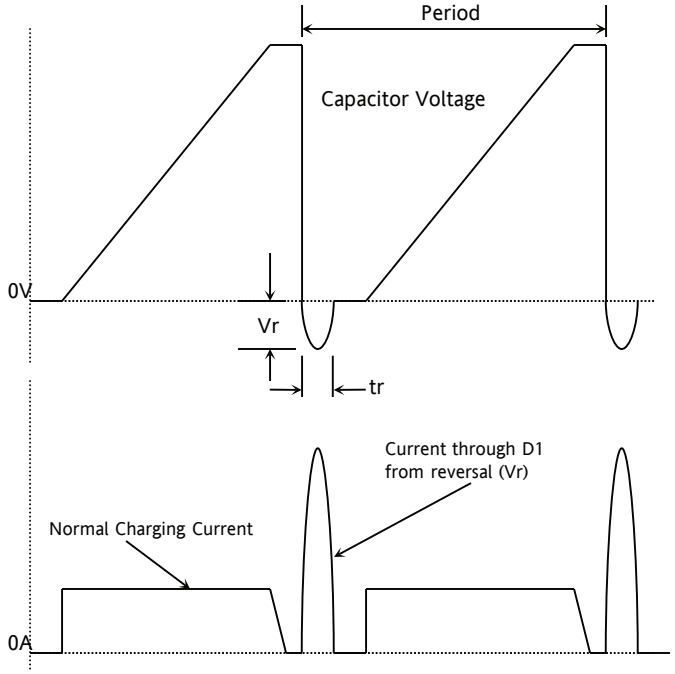

Figure 2. HV Supply output diode current under voltage reversal conditions.

If the peak current associated with load voltage reversal is large enough, damage to the output rectifiers may occur. The damage threshold for voltage reversal is difficult to quantify but if a reversal causes the output current to be greater than the supply rated output current then a protection diode should be added to the load circuit.

The following formula can be used as a guide when deciding whether or not to include a reverse protection diode.

$$\text{Diode required if;}\quad \frac{V_r}{R_t} >= I_{rated}$$

Where; V_r is the voltage reversal in volts,
I_{rated} is rated output current of the HV supply
R_t is series resistance shown in Figure 1

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App Note 517 - Voltage Reversal Protection *(continued)*

Diode Resistor Protection

A typical load circuit with an additional protection diode is shown in Figure 3 below.

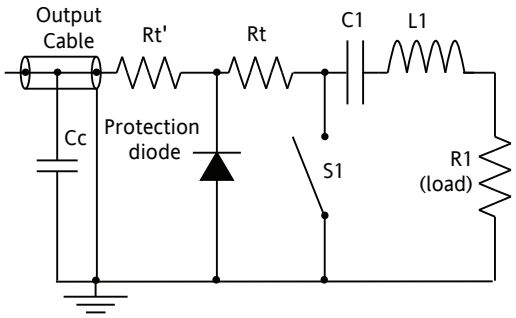

Figure 3. Voltage Reversal Protection Circuit

The choice of protection diode is very important to achieve reliable and effective reversal protection. The user must ensure that the following three diode ratings are sufficient for the application.

- *The **diode reverse voltage** rating must be greater than the circuit operating voltage, and the supply operating voltage.*
- *The **RMS. current** through the diode is less than the manufacturers rated figure.*
- *The **forward voltage drop** across the diode during conduction should be less than the voltage drop across the diodes in the supply if Rt' is not used.*

For safety sake the user should factor the diode rated voltage by approx. 1.5 to give a margin in case any overvoltage transients are present in the load circuit. In the case of a 20kV supply the reverse protection diode should be rated at approximately 30kV.

The protection diode RMS. current rating must be greater than the current due to load voltage reversals. The RMS. rating can be determined using the following steps.

Peak current through the protection diode during voltage reversal is determined from;

$$Ipk = \frac{Vr}{Rt}$$

Where Rt is the resistor shown in the circuit of figure 3. For pulse reversal the RMS. current during a single cycle is;

$$Irms\ (pulse) = \frac{Ipk}{\sqrt{2}}$$

With repetitive load operation the overall RMS. current in the protection diode can be determined from RMS. current for a single cycle and the duty cycle of the reversal event, as below;

$$Irms = Irms\ (pulse) \times \sqrt{duty\ cycle}$$

Vr can be measured on a scope using an HV probe, or for the worst case assume Vr = Vcharge. To measure Vr, start with the power supply set to a low output voltage without a bypass diode for the first measurements and calculate the percent reversal. Use this as a guide as what to expect at full voltage, thus avoiding operation at full voltage without a bypass diode.

Knowing the forward voltage drop across the protection diode is critical in achieving effective supply protection. The circuit in figure 4 shows the equivalent supply output circuit with a voltage reversal.

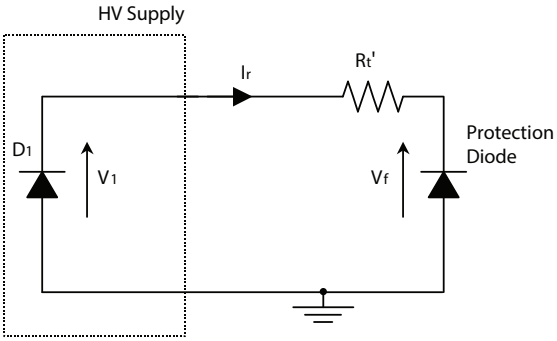

Figure 4. Supply equivalent output circuit with reverse protection diode shown.

The reverse current Ir is given from;

$$Ir = \frac{V_f - V_1}{Rt'}$$

The resistance of Rt' should be selected to maintain Ir at a figure less than or equal to the supply rated output current. The key figure in selecting the protection diode is to ensure that Vf is as low as possible. If Vf<V1, then Rt' may not be necessary.

The critical parameters which should be considered when selecting the reverse protection diode are;

Reverse Voltage Rating - Should be greater that supply operating voltage.

RMS. Current Rating - should be greater than Irms due to load voltage reversal.

Forward Voltage Drop - as small as possible.

Note: The recovery time of the voltage reversal protection diode does not have to be fast.

High Voltage Diode manufacturers

Semtech - Newbury Park, CA. 91320. Tel. 800-298-2111.
Web: www.semtech.com

Dean Technology, Inc. - Dallas, TX. Tel. 972-248-7691
Web: www.deantechnology.com

VMI - Visalia, CA. Tel. 209-651-1402.
Web: www.voltagemultipliers.com

If you have any questions or comments regarding this or any of our Application Notes or products, please contact Andy Tydeman at the factory, we are here to help.

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93008517. Rev B.

App Note 507 - Charging Large Load Capacitors

Introduction

TDK-Lambda's ALE series Capacitor Charging Power Supplies, are specifically designed to rapidly and efficiently charge capacitors in pulsed discharge loads such as lasers and modulators. These supplies operate as constant current sources which makes them ideal for operating with the variable load impedance of a charging capacitor. This application note aims to highlight the advantages of the ALE series supplies, and some useful precautions when charging large high energy storage capacitors.

Load Fault Condition

ALE power supplies are rated to run in repetitive circuits that often operate with tens or hundreds of charge/discharge cycles per second. In this case capacitor charge times are short and the power supply reaches the programmed output voltage typically within a few milliseconds or tens of milliseconds.

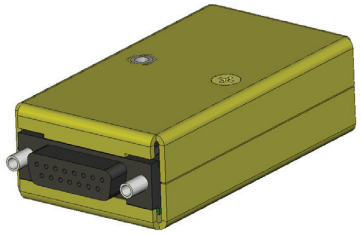
When supplies are used to charge large loads over a few seconds or longer, the power supply will indicate a Load Fault or Overload condition. Load Fault is a simple timer circuit within the supply designed to protect it and the load, in the event of an external short or latching condition. The supply output shuts down ('off' state) and indicates a Load Fault if the output voltage does not reach the programmed voltage after charging for 500ms. Following 500ms in the 'off' state, the load fault indication clears and the supply automatically begins recharging the load(1). This 500ms on, 500ms off cycle continues until the programmed output voltage is reached, leading to a staircase like charge voltage waveform.

Operating the power supply in this mode will not cause any damage to the unit, but it is not the fastest way to charge the load since the supply is only operating at 50% duty cycle.

Long Charge Adapter

To realize the fastest charge time from any ALE supply charging large energy storage capacitors, a programming module is available that optimizes the output current profile of the supply. Using this module results in significantly improved charge times compared with conventional HVDC power supplies with identical power ratings, or capacitor charging supplies operated in the Load Fault mode.

The ALE Long Charge Adapter (or LCA) is a simple module that plugs into the power supply remote control interface and modifies its output current to automatically minimize charge time for large loads. A sketch of the LCA is shown below.



With the LCA installed the Load Fault circuit is effectively defeated, allowing the supply to continuously deliver its full rated charge current while the output voltage is less than 50% of rated, and linearly reduces output current to half its rated value at 100% of rated voltage.

The LCA module requires no modification to the normal control circuits and operates in both remote and local mode.

Calculating load charge time with an LCA equipped power supply involves a charge simulation spreadsheet that can be obtained from our web site, or by contacting the factory. The simulation requires the load circuit information to be defined (Capacitance, Charge Voltage, Supply Rated Voltage), and allows the user to try different power supply combinations for optimum circuit operation.

Example

The following example demonstrates a standard 30kW, 26kV HVDC power supply, and a capacitor charging supply with and without the LCA, charging a 7000µF load capacitor to 24kV.

Conventional HVDC supply

A conventional HVDC power supply with a 30kW, 26kV rating has an output current rating of 1.15A (30kW/26kV). The time to charge 7000µF to 24kV is given by;

$$T_c = C \times V / I = 7000 \times 10^{-6} \times 24 \times 10^{3} / 1.15 = 146 \text{seconds}$$

Capacitor Charging Supply without LCA

The ALE model 303 is a 30kW rated capacitor charging supply with a peak output current of 2.88A at 26kV. The average charging current is half this value (1.44A) when the supply operates in load fault mode. The charge time is given by;

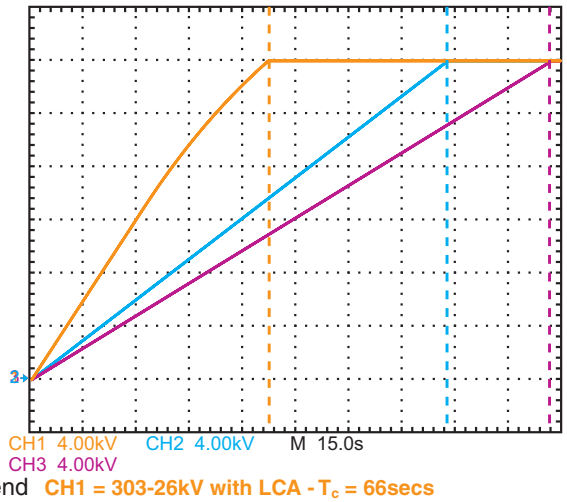
$$T_c = C \times V / I = 7000 \times 10^{-6} \times 24 \times 10^{3} / 1.44 = 117 \text{seconds}$$

Capacitor Charging Supply with LCA

Using the same model ALE 303 supply, and the Long Charge Adapter, the time to charge the load to 24kV is;

$$T_c = 66 \text{seconds (using simulation spreadsheet)}$$

The graph below shows the charge waveforms for each case of the example above.



Legend **CH1 = 303-26kV with LCA - T_c = 66secs**
CH2 = 303-26kV w/o LCA - T_c = 117secs
CH3 = Conventional 30kW 26kV HVDC supply - T_c = 146secs.

The graph and data clearly shows that the ALE 303 supply equipped with the LCA, and with the same rating as a conventional 30kW DC supply, charges the 7000µF load to 24kV in less than half the time.

Note 1. If LP option is enabled, supply requires HV ON/OFF cycle to clear Load Fault.

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App Note 507 - Charging Large Load Capacitors *(continued)*

The faster charge time significantly reduces voltage stress on the load capacitor resulting in a longer operating life.

There are three different LCAs available, each for use with one of three product families. All LCAs function in an identical manner, but have different connector pin arrangements depending on the power supply family control interface.

Part 26922100 for models 500A, 102A, 152A, and 202A

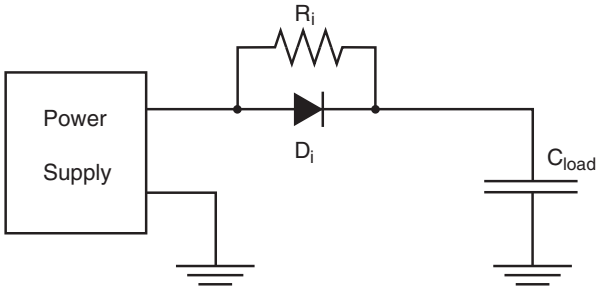
Part 26922200 for models 402, 802, XR802, and LC1202

Part 26922300 for models 203 and 303

The LCA can be purchased with the supply at the time of ordering, or as a spare part through our repair depot, contact the factory for current pricing.

Safety Precautions

When a capacitor charging power supply is used to charge a load circuit that contains greater that 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 of the supply. The power supply warranty may be voided if an isolation network is not installed. The sketch below shows the recommended isolation network.



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 100Ω 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.

For suggested protection circuit component manufacturers, see opposite.

High Voltage Diode manufacturers

Dean Technology, Inc.
Dallas, TX, Tel. 972-248-7691
Web: www.deantechnology.com, Email: info@hvca.com

Voltage Multipliers Inc
Visalia, CA.
Tel. 559-651-1402.
Web: www.voltagemultipliers.com

High Energy Resistors manufacturers

Kanthal Globar
Amherst, NY, Tel. 716-691-4010
Web: www.globar.com

HVR Advanced Power Components
Tonawanda, NY, Tel. 716-693-4700
Web: www.hvrapc.com

High Voltage Relay manufacturers

Ross Engineering Corporation
Campbell, CA, Tel. 800-654-3205
Web: www.rossengineeringcorp.com/hv_relays.htm

Tyco Electronics (Kilovac)
Tel. 800-253-4560
Web: relays.tycoelectronics.com/kilovac/

If you have any questions or comments regarding this or any of our Application Notes or products, please contact Andy Tydeman at the factory, we are here to help.

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93008507. Rev E.