AMERICAN HIGH VOLTAGE

G Series
High Power High Voltage DC / DC Converter

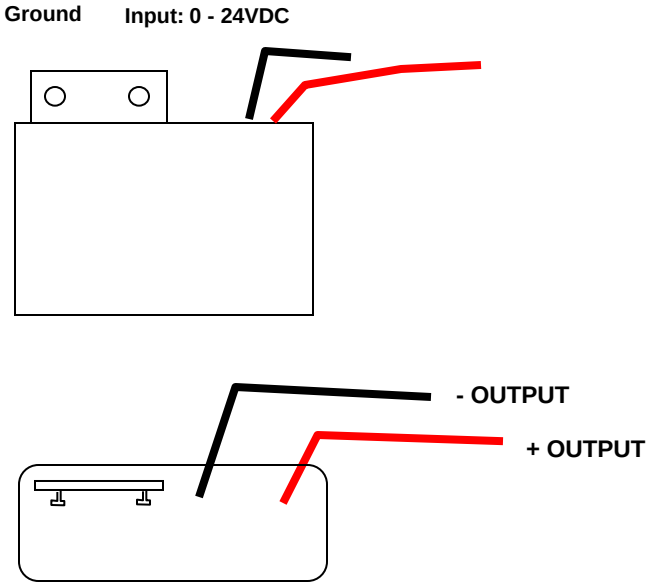
General Description

The G Series high voltage power supplies are designed to provide floating high output voltages. Their outputs are isolated to up to 50 kV with power levels to 20 Watts depending on model selected. The output voltage of the G power supply is directly proportional to the input voltage (0 – 24 VDC). The output ripple is typically less than 1% at full power load. The two output leads are fully isolated from the input power leads. This permits either positive or negative polarity operation. All models are encapsulated in an RTV elastomer for high reliability. The G series are reverse input voltage and short circuit protected.

Features

- Output proportional to Input
- Encapsulated
- 5,000 VDC to 50,000 VDC available
- 20 Watts power (models under 30kV)
- Metal case for low ripple: 1% Vpp

Connection Diagram



AMERICAN HIGH VOLTAGE

Electrical Characteristics

(at 25 degrees C unless otherwise specified)

Parameter	Conditions		Value			Units
			Min	Typical	Max	
Supply Voltage:	(all models)		2 VDC	24 VDC	28 VDC	VDC
Input Current:	No Load (at Vin =24VDC):		175	185	195	mA
	Full Load (20W models):		1.05	1.15	1.25	A
Output Ripple:	No Load (all models): Full Load (all models):		0.5 % 0.8 %	0.6 % 0.9 %	0.7 % 1 %	Vpp Vpp
Load Regulation:	No Load to Full Load Half Load to Full Load		20% 15%	25% 20%	30% 25%	V_{NL}/V_L VNL/VL
Output Linearity	No Load			1%		$\frac{\Delta V_{OUT}}{\Delta V_{OUT\ (ideal)}}$
Output Linearity	Full Load (all models):			1%		$\frac{\Delta V_{OUT}}{\Delta V_{OUT\ (ideal)}}$
Short Circuit Current:				300	350	mA
Power Efficiency:	Full Load		65%	70%	75%	$\frac{P_{OUT}}{P_{IN}}$
Reverse Input Polarity	Protected to 50 VDC					
Temperature Drift:	No Load Full Load				1,000 1,000	ppm/DegC ppm/Deg C
Thermal Rise:	No Load (case) Full Load (case)				15 25	degrees C degrees C
Slew Rate (10% - 90%)	No Load Full Load				150 220	mS mS
Slew Rate (90% - 10%)	No Load Full Load				350 100	mS mS
Drain Out Time	No Load (5 TC)				450	mS

AMERICAN HIGH VOLTAGE

Physical Characteristics

(at 25 degrees C unless otherwise specified)

Parameter	Conditions	Value	Units
Dimensions	MKS	127L x 44.5W x 95.3H	mm
	English	5.0L x 1.75W x 3.75H	inches
Volume:	MKS	538.6	cm^3
	English	32.8	$inch^3$
Mass:	MKS	675	grams
	English	24	oz
Packaging:	RTV Elastomeric		
Finish	Black anodized aluminum		
Terminations: Input:	Electro Plated Brass terminals		
Output:	Flying HV leads #22 AWG		

Environmental Characteristics

(at 25 degrees C unless otherwise specified)

Parameter	Conditions	Value	Units
Temperature Range	case temperature	-40 degrees to + 71 degrees	Celsius
	case temperature	-40 degrees to + 160 degrees	Fahrenheit
Shock:	MIL-STD-810 Method 516	40 g's	Proc IV
Altitude:	pins sealed against corona	-350 to + 16,700	meters
	pins sealed against corona	-1,000 to +55,000	feet
Vibrations:	MIL-STD-810 Method 514	20 g's	Curve E
Thermal Shock	MIL-STD-810 Method 504	-40 deg C to + 71 deg C	Class 2

AMERICAN HIGH VOLTAGE

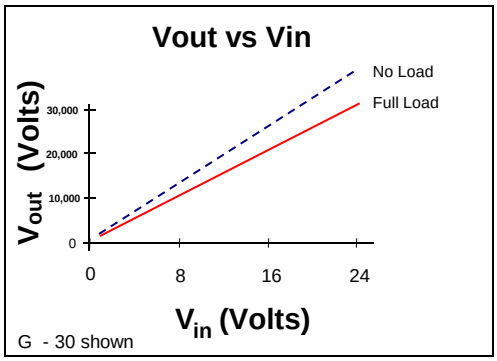
Models Available (as of July 2019):

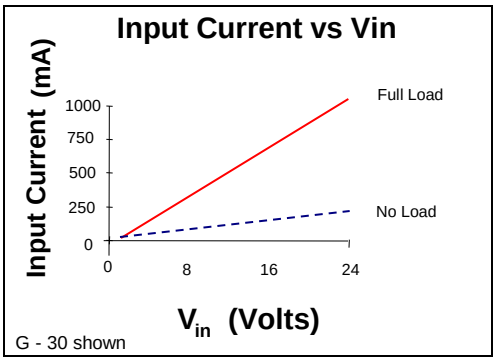
(Vin = 0 – 24 VDC)

Model	Input Voltage Range	Output Voltage Range	Power
G-5	0 – 24 VDC	0 - 5,000 VDC	20 Watts
G-10	0 – 24VDC	0 – 10,000 VDC	20 Watts
G-20	0 – 24 VDC	0 – 20,000 VDC	20 Watts
G-30	0 – 24 VDC	0 – 30,000 VDC	20 Watts
G-40	0 - 24 VDC	0 – 40,000 VDC	20 Watts
G–50	0 – 24 VDC	0 – 50,000 VDC	20 Watts

AMERICAN HIGH VOLTAGE

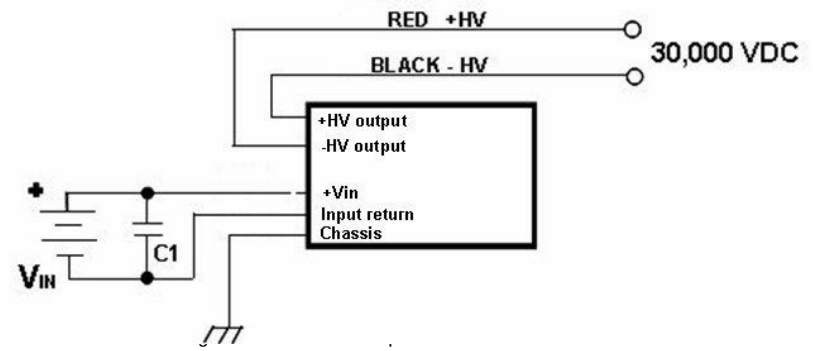
G Series Performance Charts





G Series Application Notes

The G Series high voltage power supplies are driven by an input voltage of between 2 and 24 VDC The output voltage is directly proportional to the input voltage as shown in the above figure. The input current is a function of load and this is also show above. There are NO internal connections between the input and output pins. As can be seen from the chart the output voltage is linear with respect to input voltage. As shown in Figure 1 below, the simple connection of a G unit to a DC source of voltage will provide a high voltage stepped-up output. The input AC bypass capacitor C1 is optional and is utilized to prevent switching spikes from riding back on the input power lines. Values of 0.1 uF to 10 uF are commonly used.



The output voltage of the G unit may be regulated by incorporating a simple op-amp circuit and linear control device such as an NPN transistor. Here, the output voltage is sensed and compared against an external reference or control voltage. For single supply operation, the circuit of Figure 2 may be used for positive output regulation. A high voltage divider is made up of R5 and R6 to divide down the output to a value comparable with the control voltage. The resistor R5 is value is determined by power considerations. A good rule of thumb is to use a value 10% of the full output load. Too high a value may lead to output drift problems due to operational amplifier input bias current drift and too low a value leads to unnecessary power dissipation. The resistor R5 must be rated for the voltage that will be across it. Simple high value carbon film resistors are usually avoided because their maximum voltage is limited to 300 VDC or less. Precision metal film resistors are more stable but also have limiting maximum voltages. It is possible to series several metal film resistors to build up the voltage rating of R5. Capacitor C4 likewise must be rated for the proper voltage. It serves to lower output ripple and provide a feed-forward pole in the feedback loop for stability. Capacitor C5, the ground mirror capacitor serves as a lower end of the AC divider formed with C4 and prevents excessive voltage from being fed to the operational amplifier in the case of a suddenly shorted output.

AMERICAN HIGH VOLTAGE

G Series Application Notes (continued)

R6 is selected by calculating the resistance divider ration with R5, providing a 5 volt feedback at full output voltage. The input reference bypass capacitor C1 is used to remove any noise feeding to the non-inverting signal pin of the operational amplifier. For maximum temperature stability, R1 should be identical in value to R6.

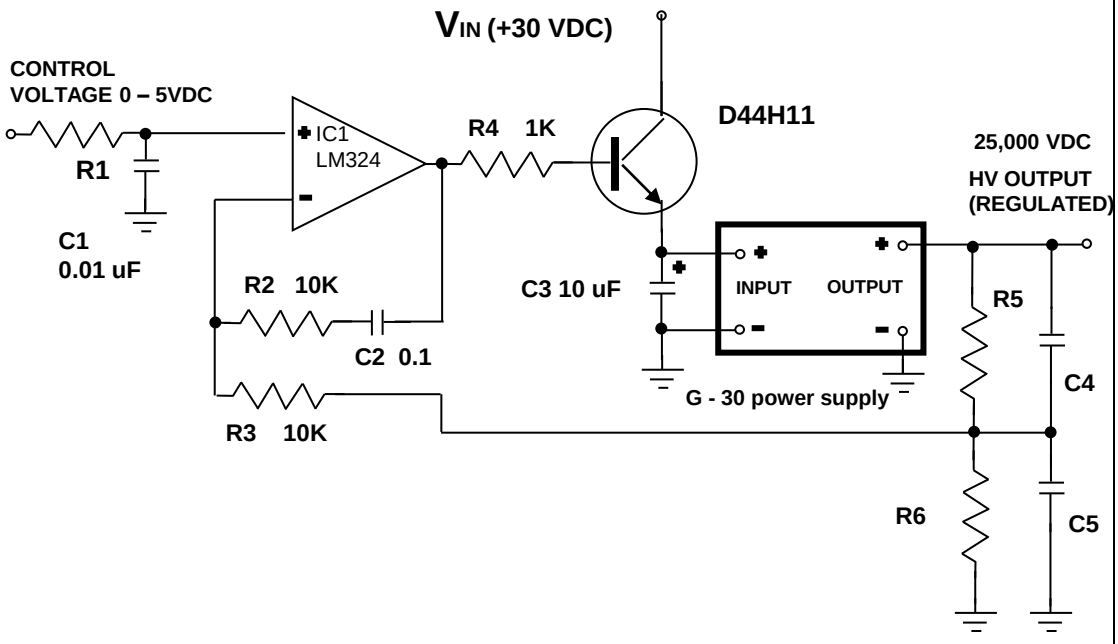


Figure 2: Positive 25,000 Volt Regulator

Resistor R2 and capacitor C2 provide frequency compensation for the amplifier IC1 a common bipolar amplifier is used since its outputs and signal inputs can reach almost to ground. R3 provides protection to the signal inverting input of the opamp in case of a short circuit or arcing condition exists on the HV output. R4 protects the output of the opamp in case of a shorted NPN transistor. Typical values for a 1,000 volt PMT supply are as follows:

G:	G - 30
R1:	100K Ohm
R5:	500 Megohms (Slimox 104 – Ohmite two 250 M in series)
R6:	100K Ohm
C4:	1,000 pF 30kV disc
C5:	0.1 uF 100 V ceramic
IC1:	LM324
Q1:	Power NPN such as D44H11 or 2N3055

Typical voltages seen during operation are as follows:

Voltage at junction of R5 and R6:	5V
Voltage at opamp output:	20.2 V
Voltage into + supply G:	19 V (depends somewhat on output load)
Voltage of base of Q1:	20.9 V

The power supply feeding the opamp is not shown however it may be connected to the +30 V supply and ground. This allows an output from the power NPN transistor to be approximately 20 volts maximum. This is sufficient head room to allow 25,000 VDC from the G-30 power supply. It is always a good idea to bypass the input power pins of the opamp with a 0.1 uF capacitor to reduce line noise. ……..

AMERICAN HIGH VOLTAGE

G Series Application Notes (continued)

By varying the control voltage from 1 to 5V, the high voltage output of the G power supply may be regulated. Line and load regulation as good as 0.01% are achievable depending upon physical layout and quality of feedback resistor. To lower the output ripple further, an resistor (carbon composition type) of a high value may be inserted in series with the HV output of the G power supply before it continues on in the circuit. A value of 200K Ohm will drop the output ripple to less than 0.1% Here the 200 K Ohm resistor works as a filter in conjunction with C4. Higher ripple reduction is achievable with a capacitor added directly between the output pin and ground.

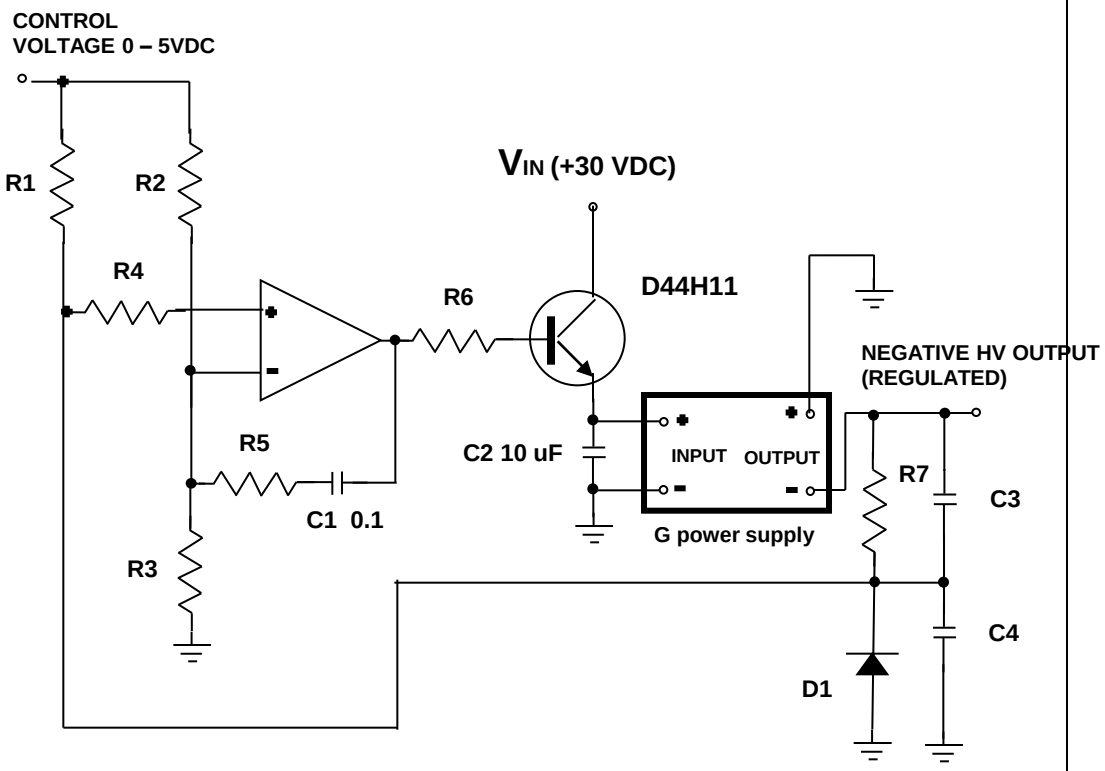


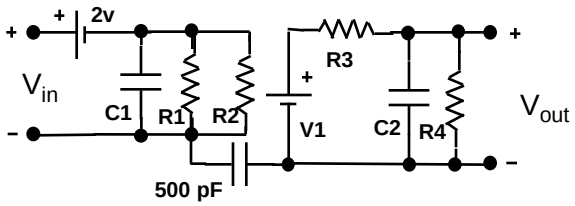
Figure 3: Negative 15,000 Volt Regulator

A regulated negative High Voltage output is easily obtained using the floating output feature of the G unit. Figure 3 utilizes much of the same topology as the positive regulator except that a summing junction is made for operational amplifier IC1. Again, the values of R7 and C3 are selected with respect to the proper HV output parameters. Both R7 and C3 must be rated for high voltage operation. Diode D1 provides a return path in case of a sudden output short. Resistors R2 and R3 form a simple divider, their values should be equal. The voltage drop in R1 should be such that at full output voltage the signal at the non-inverting input of IC1 should be exactly half the control voltage. R4 is a simple 10K Ohm limiter. The values of R2 and R3 should be twice that of R1 for good thermal stability. Typical values for a negative 15,000 volts negative output electrostatic precipitator power supply are as follows:

G:	G - 20	R5:	10K
R1:	33.3 K Ohm	C3:	1,000 pF 20kV disc
R7:	200 Megohms (Slimox 104 – Ohmite)	C4:	0.1 uF 100 V ceramic
R2:	66.6K Ohm	IC1:	LM324
R3:	66.6K Ohm	Q1:	Power NPN such as D44H11

AMERICAN HIGH VOLTAGE

Equivalent G Circuit Model



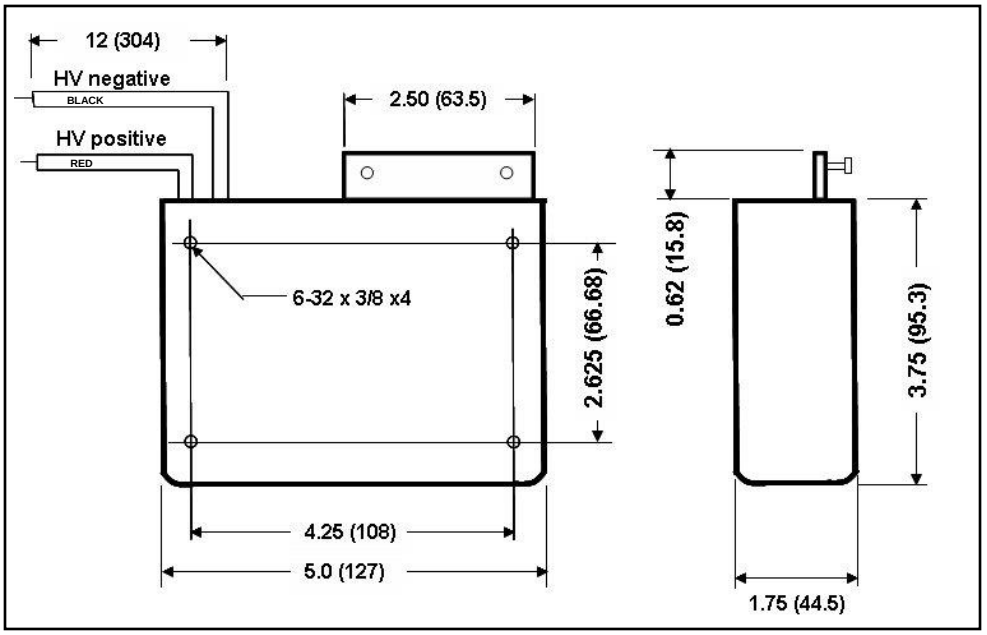
Equivalent G HVPS Circuit Model

R1 = (137) *Ohms*
R2 = (520 / Pout) *Ohms*
R3 = (0.2 x Vout $_{max}$ / Iout $_{max}$) *Ohms*
R4 = (1 x Vout $_{max}^{2}$) *Ohms*
C1 = (10 x 10^{-6}) *Farads*
C2 = (0.01 x $Iout_{max}$ / $Vout_{max}$) *Farads*
V1 = (V_{R2} x $Vout_{max}$ / 24) *Volts*

For example, for an G - 20

Vout**max** = 20,000 V
Pout**max** = 20 W
Iout**max** = 0.001 A
R1 = 137 Ohms
R2 = 26 Ohms
R3 = 4 Megohms
R4 = 200 Megohm
C1 = 10 uF
C2 = 500 pF

Outline Drawing: (inches (millimeters))



Ordering Information:

G – XX

Example:

G - 30: Maximum output = 30,000 V
G - 20: Maximum output = 20,000 V

XX = Output voltage
5 = 5,000
10 = 10,000
20 = 20,000
30 = 30,000
40 = 40,000
50 = 50,000