

Parallel Operation of UltraVolt HV Power Supplies

Introduction:

It is possible to operate UltraVolt high voltage power supplies in parallel. The method for paralleling two voltage sources depends on the requirements of the application. In this Application Note, we will consider two distinct cases.

In the first case - a capacitor charging system - the power supplies operate as current sources during the charge cycle and switch to voltage regulation only when the capacitor voltage reaches its maximum level. At that time, the power supply sources nearly no current and maintains the capacitor voltage until the next charge cycle begins.

In the second case, we want to operate the power supplies in parallel continuously to achieve twice the power capability of a single power supply. Here, the two power supplies should behave as a single power supply at nearly twice the current capacity. There are two ways we can accomplish this: one way is with standard UltraVolt power supplies; the second is using the I5 or I10 option. Fig. 2 shows a technique using standard units while Fig. 3 shows how to parallel two (or more) units using the enhanced interface.

Capacitor Charging:

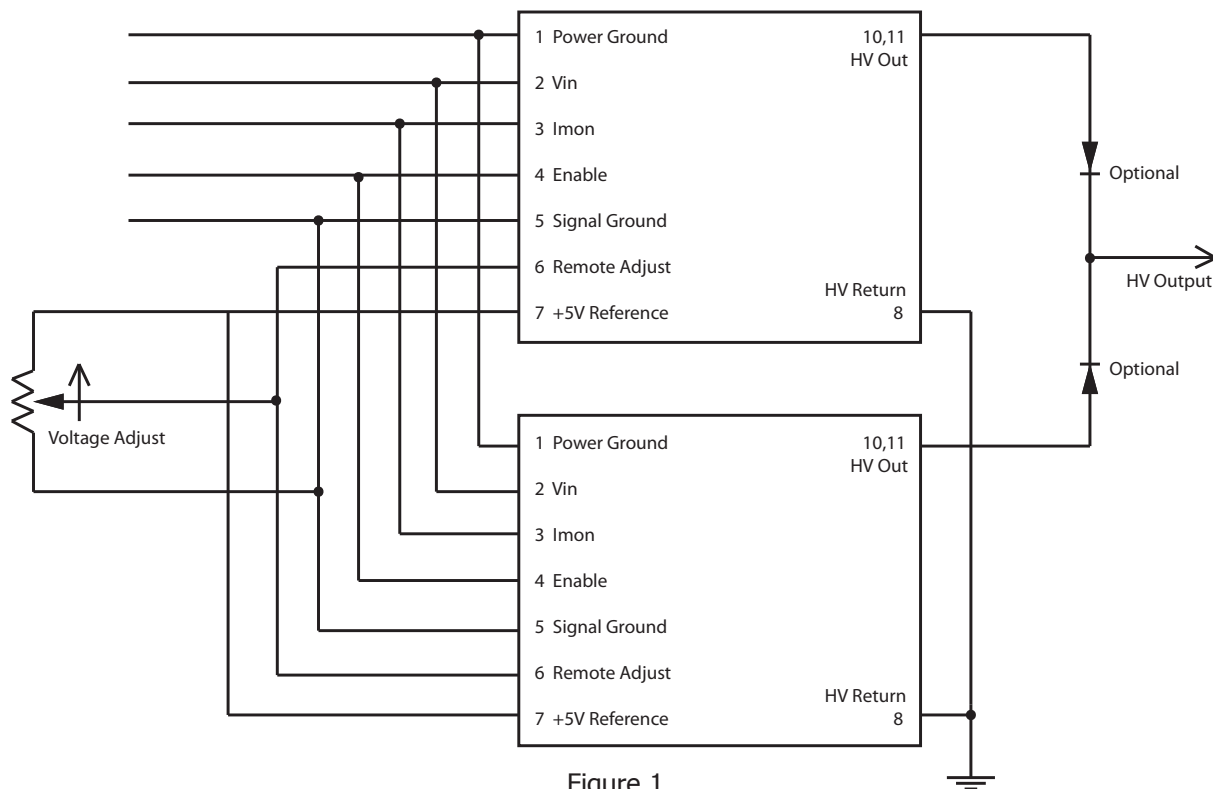


Figure 1

In Fig. 1, the two UltraVolt high-voltage power supplies (HVPSs) have the control pins tied together, providing a single control interface. While charging the capacitor, the HVPSs will be in current limit, allowing the power supplies to operate in parallel well. The power supplies will remain in current limit until the voltage set point is reached, at which time the voltage control loop will take over and maintain the capacitor voltage and the power delivered will drop to zero. The isolation diodes on the output are optional, but will provide some protection in the case of redundant systems.

Parallel Operation Method 1:

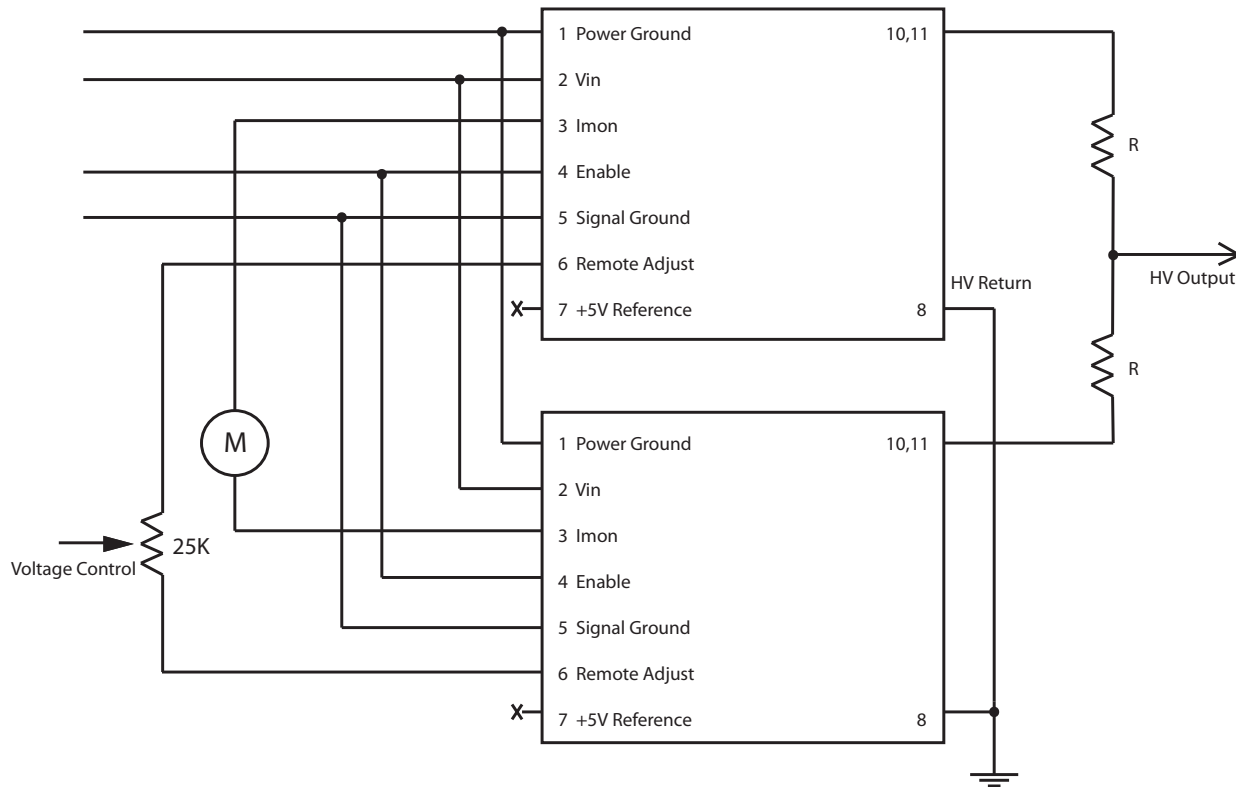


Figure 2

In this configuration (Fig. 2), we want the two power supplies to run continuously in voltage control as a single power supply. The sharing resistors used to sum the outputs help to this end. The closer the two output voltages are to each other the better the sharing will be. This technique works best with two identical power supplies; using dissimilar power supplies is not recommended. Sharing can be improved with the addition of the potentiometer on the voltage control signal and a simple setup procedure.

The 25k Ω potentiometer works against the input impedance of 1.1Meg Ω on the remote adjust pin, forming a voltage divider. This gives an adjustment range of about $\pm 2.2\%$ between the two units. A simple setup procedure should be done with the output of the system loaded. The potentiometer is turned until the meter between the two current monitor pins reads zero; this indicates the two power supplies are sourcing equal currents and the system is balanced. This setup procedure should be done with the system at full load and at output voltages closer to maximum to achieve the best results.

Selection of the output resistors depends on a number of competing factors. As the resistor value is increased, the load sharing improves and the voltage balance becomes less critical – but these benefits come at the expense of higher power loss. For example, if we use two 10A24-P30 power supplies with a maximum output current of 3mA each with 2W balancing resistors running at half their power rating, we have 111k Ω . Rounding the resistance to a standard value of 100k Ω ; we lose 300 volts across the resistor and approximately 1 watt at full load current. If this is an unacceptably large voltage regulation error, then smaller resistors can be used and more care should be applied to the balancing setup.

Parallel Operation Method 2:

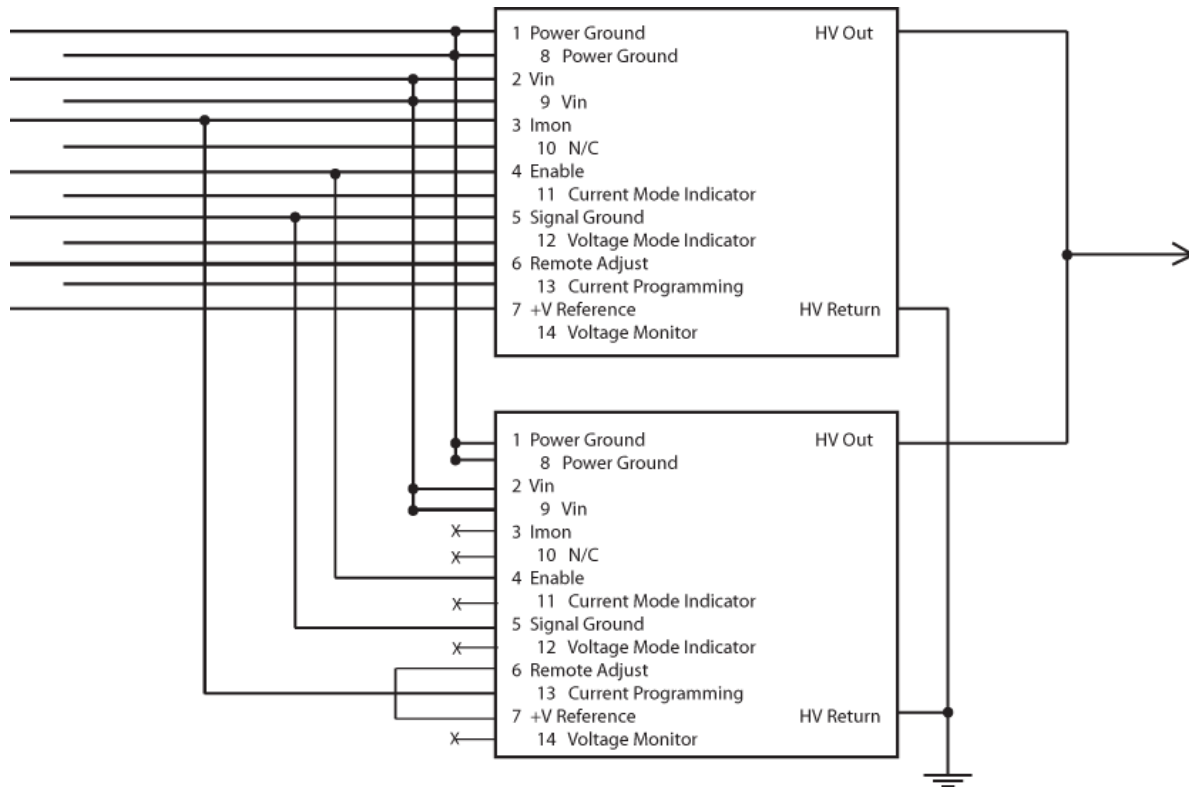


Figure 3

This configuration (Fig. 3) depends on some of the features in the I5 and I10 interface. The first power supply in Figure 3 is the 'Master'; the second and any additional supplies are slave supplies. The interface for the entire system is still an I5 or I10 interface. The Master supply will operate in either voltage control or current control, depending on operating conditions, just as a single supply would work. The slave supply will always operate in current regulation. Load sharing is forced by using the current monitor of the Master to drive the current programming on the slave supply, thereby ensuring both units will source equal current. The voltage programming of the slave supply should be tied to the voltage reference and not left floating.

Since the two outputs are brought together and out to the load, both units will be operating at the same output voltage by definition. By joining the enable, power, and grounds together the rest of the interface is configured. The system will operate as a single power supply with a power rating of twice a single supply. The voltage monitor of the master represents the output voltage of the system. The current monitor of the master will represent twice the current of a single supply, which is the output current of the system.