Electrical Termination & Mounting Configurations of UltraVolt HVPSs

As with any precision electronic device, proper mounting and electrical termination is necessary for trouble-free and reliable operation of an UltraVolt high-voltage power supply (HVPS). Improper electrical termination of UltraVolt HVPSs can cause damage to the electrical connectors of the power supply, resulting in the power supply's failure. Improper mounting of the UltraVolt HVPS can create stresses (both thermal and mechanical) within the HVPS, possibly shortening the operation life of the device. For more information on mounting as it relates to thermal considerations, please see Application Note #6, "Thermal Management of UltraVolt HVPSs."

Electrical Termination Methods of UltraVolt HVPSs

An UltraVolt HVPS is usually electrically terminated via a printed circuit board (PCB), a wiring harness, or a combination of the two (a sub-assembly PCB) depending on the mechanical mounting method used. Mechanical mounting methods and design considerations are discussed below.

PCB Termination

When an UltraVolt HVPS is electrically terminated to a PCB, there are essentially two methods of actual termination: 1) soldering the UV HVPS directly to the PCB and, 2) using a single or dual socket (depending on the model of HVPS utilized). Each method has its advantages and disadvantages; however, using a socket for termination may be preferred for a field-repairable system.

The UV HVPS can easily be soldered directly to a PCB, since the pin spacing is compatible with the 0.100"/0.200" industry-standard header spacing. This method offers ease of manual mounting; however, it may suffer from service-related and automated-assembly drawbacks. As discussed below, soldering the UltraVolt high-voltage power supply directly to the PCB does not replace the mechanical mounting requirement of the HVPS. In all cases, the UltraVolt high-voltage power supply must be mounted mechanically via one of the methods outlined below.

Sockets are the preferred connection method to UV HVPSs for several reasons. Socket termination greatly improves your ability to troubleshoot your product, allowing for the simplified testing of the UltraVolt high-voltage power supply and associated interface circuitry. Socketed connections also make your product more field repairable, allowing the failed interface circuit board or the failed HVPS to be replaced individually (permitting component level repairs). Socketed connections are also more easily wave soldered or infrared re-flowed, since the relatively large mass of the HVPS need not be present during either of these delicate operations.

There are essentially two options for the PCB termination of UV HVPSs: in-line machined sockets, or press-in sockets. An example of an in-line machined socket is the 7-pin, single-row Samtec SS-113-T-13 (see the "UltraVolt HVPS Industry-Standard Mating Connectors" guide for more information on UltraVolt high-voltage power supply connector compatibility with different suppliers' products). In-line machined sockets can be handled and placed like standard electrical components, a definite advantage over other methods of electrical termination. Press-in sockets usually come in the form of single-pin sockets that are pressed into, then soldered directly to the PCB. Although these sockets require nonstandard-size PCB holes and special assembly procedures, this method requires only one type of socket (with certain HVPSs), whereas at least two different types of in-line machined sockets would be required for a design using the more specific in-line machined sockets.

Should a UV HVPS be mounted onto a PCB (as opposed to being mounted onto a chassis), various thermal considerations will arise. For a full discussion of the thermal considerations in the various mounting methods of the UV HVPS, please see Application Note #6: “Thermal Management of UltraVolt HVPSs.”

Wiring Harness Electrical Termination

The use of a wiring harness has the obvious advantage of enabling you to mount the UltraVolt HVPS anywhere within your chassis, allowing for both optimal positioning of the UV HVPS for thermal considerations and minimization of overall chassis size. Again, there are two choices for the electrical termination of the HVPS: directly soldering the wiring harness to the UV HVPS or utilizing sockets that match the plugs on the UV HVPS.

As noted previously, sockets are preferred over direct soldering for troubleshooting, field reparability, and relative ease of assembly. However, when soldering leads directly to the UV HVPS, remember to use a reliable method of soldering (such as ‘j’ hooking the leads around the HVPS pins). Also keep in mind, the pins of the UV HVPS are high-quality, gold-plated, bronze-phosphor material. Due to this material’s nature, the pins cannot sustain large lateral forces without damage or fatigue and eventual failure. Therefore, it is recommended that the wiring harness be strain-relieved before connecting to the HVPS. In fact, all wiring harnesses should be strain-relieved before reaching the HVPS pins. The types of wiring harness sockets which can be used are summarized in the “UltraVolt HVPS Industry-Standard Mating Connectors” guide (listed under Type as ‘wire applied’).

General Rules of Thumb for Electrical Terminations to UltraVolt HVPSs

Although not yet discussed, the gauge of the wire (or the cross-sectional area of the copper track on a PCB) feeding the UltraVolt HVPS is very important. A power supply wire of too thin a gauge can not only cause wiring failures, but also degrade the load regulation and linearity of the UltraVolt HVPS. How thin is too thin? As seen in Table 1 below, certain UltraVolt high-voltage power supplies can draw up to 13 amps through the input-power pins. Table 2 can be used as a rough guide to determine the required input-supply wire gauge, based on the UV HVPS current.

UV Power Supply Rating	Maximum Current
4W (for 12V unit)	0.5A
15W / 20W (24V unit)	1A
60W	3A
125W	6A
250W	13A

Table 1: A partial list of HVPSs and maximum currents
(See product-specific data sheets for more information.)

Maximum Continuous Current (Amps)	Suggested Wire Gauge (Gauge (AWG))
20	10
15	11
12	12
8	14
5	16
3	18
2	20
0.8	24
0.5	26
0.3	28
0.2	30

Table 2: A list of HVPS currents and recommended input-supply wire gauges.

Not surprisingly, choosing a PCB track size is slightly more complex than choosing a specific wire gauge, given a particular current. In PCB applications, the maximum allowable temperature rise of the track becomes an important design consideration. Table 3 is a general guide for the current-carrying capacity of different external, plated-PCB track sizes.

	Current-Carrying Capacity			
PCB track size	**0.5A**	**1A**	**1.5A**	**2A**
1oz. copper (1.4 mils high)	20 mils width (10°C temp rise)	50 mils (10°C temp rise)	100 mils (10°C temp rise)	50 mils (45°C temp rise)
2oz. copper (2.8 mils)	10 mils (10°C temp rise)	25 mils (10°C temp rise)	50 mils (10°C temp rise)	25 mils (45°C temp rise)
3oz. copper (4.2 mils)	7.5 mils (10°C temp rise)	19 mils (10°C temp rise)	38 mils (10°C temp rise)	19 mils (45°C temp rise)

Table 3: Plated-PCB track sizes and currents with temperature rise

As Table 3 illustrates, PCBs cannot handle large currents unless proper track width and copper weight are used. (For example, PCB-mounting a 125W unit is only recommended when specific care is taken — such as a 3oz. copper PCB with two 75-mil tracks to the two power pins.) Please note, a 10°C temperature rise is quite acceptable; however, a 45°C temperature rise is not recommended for continuous use. Track width should be increased to carry the current and to reduce self-heating.

Another important point concerns the presence of multiple pins for the same apparent function. A perfect example is the paired *Input Power Ground Return* pins (#1 and #8) on the 125W “C”

Series. This supply will draw up to 6 amps from the input voltage supply; however, the connector pins are rated for a maximum of 5.9 amps. For this reason, on the 125W "C" Series, UltraVolt paired the supply pins, increasing the rating to a total of 11.8 amps, leaving a larger margin for safety. In order to eliminate possible damage to the HVPS's pins, each pin of the same function should be externally wired in parallel to spread the current over the required number of pins.

As an aside, the 250W "C" Series will draw up to 13 amps; therefore, the units utilize an AMP mate-and-lock connector, which is rated for 10 amps per contact and 20 amps total for the parallel connection. This connector can easily handle the relatively large currents most likely to be supplied by an off-line switching power supply elsewhere within the chassis. If you intend to mount a PCB on the top of a chassis-mouted 250W unit, please contact UltraVolt Customer Service for the appropriate part-number suffix to specify the PCB power connector with .045" square pins. Also keep in mind, although the HVPS pins labeled *Input Power Ground Return*, *Signal Ground Return*, and *HV Ground Return* imply a similar function, they are not interchangeable and each should be used only for its own purpose (see Application Notes #1 and #16 for more information).

Mounting Configurations of UltraVolt HVPSs

Different mounting configurations are required for different models of UltraVolt high-voltage power supplies. In all cases, supplementary mounting procedures are required. Under no circumstances should the UV HVPS be restrained by its pins alone (the pins cannot withstand lateral shock and will shear if the system is dropped or subjected to long-term vibration).

There are essentially two mounting configurations for low-power UV HVPSs: chassis mounting and PCB mounting. However, certain case configurations lend themselves more to one mounting method than to the other. High-power units (such as the 125W "C" Series) and lower power units with the -C option have aluminum cases incorporating mounting ears or studs, making them ideal for chassis mounting. Lower power, Mu-metal-shielded, or plastic-enclosed units (i.e. a 4W "A" Series HVPS) have the option of being PCB mounted or chassis mounted (using an optional mounting bracket or -E plate).

Mounting Units With Built-In Mounting Ears or Studs

As mentioned above, metal-enclosed units with built-in mounting ears or studs should normally be chassis mounted. As many of these aluminum-enclosed units are of relatively high wattage, chassis-mounting makes sense because it allows the produced thermal energy to dissipate easily. For further discussion on thermal considerations, see Application Note #6 on thermal management.

When mounting units incorporating mounting ears (such as the "A" Series units with the -C or -E option), it is good policy to use all 4 mounting holes. This ensures a lower thermal resistance, as well as adequately restraining the relatively large mass of the metal-encapsulated UV HVPS.

Units with mounting studs (such as the High Power "C" Series) should be mounted to ensure each stud can be utilized. Each stud should be held to the chassis using a lock washer and a #8 nut tightened to approximately 8 ftolbs of torque. The nuts should be alternately tightened in an X-pattern to prevent possible harmful mechanical stress to the HVPS case.

In tight mounting locations where you would like to chassis-mount a -E UltraVolt, you might consider putting a louver or tab in the chassis to lock in the inaccessible end of the HVPS, while still bolting the opposite end to the chassis (see below).

Mounting Units without Mounting Ears or Studs

Units without mounting ears or studs can be PCB mounted or chassis mounted, whichever is preferred.

Should the UltraVolt HVPS be PCB mounted, the HVPS should be held in place using #2 screws threaded into the HVPS's two molded-in thermal standoffs. These screws should brace the HVPS to the PCB, ensuring both a solid electrical connection to all pins and a firm mechanical connection between the PCB and the UV HVPS. If these screw holes are not used, the HVPS's electrical pins may shear when the unit is placed under severe mechanical stress.

As noted above, these units may also be chassis-mounted using an optional bracket (for 4W to 30W units). Depending upon the height of the HVPS used (check product data sheets), either the 0.8"-high BR-001 bracket or the 0.9"-high BR-002 can be used to fasten the UV HVPS to the chassis wall. The bracket is fastened to the chassis using screws. The UltraVolt high-voltage power supply is fastened to the bracket by two #2 screws threaded into the blind screw holes in the connector side of the HVPS. Mounting the HVPS this way allows for a good thermal interface between the power supply and the chassis wall (thus allowing the chassis to become an alternative to a separate heat sink). This also secures the HVPS mechanically. Should the chassis be used as a means to cool the HVPS, a thermal-resistance-reducing interface (such as a thermal elastomer or thermal grease) should be used between the HVPS and the chassis wall. As mentioned previously, thermal management considerations are outlined in Application Note #6.

In lower power, chassis-mount applications an alternative to mounting brackets and plates is available. Since thermal interfacing is less critical, the HVPS can be mounted using a double-sided foam tape with an acrylic adhesive. These tapes are rugged enough to be used in harsh applications such as aircraft manufacture. 3M Scotch® brand VHB4929 tape has undergone extensive testing and has been found to be a low-cost, low-labor assembly solution. It is essential this mounting system not be used in applications where high thermal resistance would allow an HVPS to overheat. For this reason, the tape mounting system should only be used with 4 watt units.

While thermally conductive acrylic tapes are available, they are not generally used as the only mounting method for devices that weigh more than 1 or 2 ounces and are, therefore, not appropriate for use as the only method of mounting an UltraVolt HVPS.