

Assembly and Installation Notes for the Slot 13 Power Distribution Assembly

Important:

The power distribution assembly carries up to ~100 Amps per supply. All electrical connections must have minimum resistance for two reasons:

1. Power dissipation at each connection must be low enough to prevent overheating. $P = I^2R$. E.g., a connection with $R = 100$ microohms will dissipate $100A * 100A * 100 * 10^{-6}$ ohms = 1 Watt.
2. To prevent overloading of backplane connector pins, the CRB and the VME supply voltages must be at nearly identical voltages. For example, if the VME 5V supply voltage is a few mV higher than the CRB 5V supply voltage, then current will flow from the VME backplane, through the modules (e.g., the ROD), and into the CRB backplane. The excess current carried through the VME connector pins en route to the CRB can exceed the rating of the connectors.

The most critical connections are:

connection	qty per crate	Notes
supply bars to VME backplane power bus	4	These are connections via short heavy cables (8AWG minimum). Each supply bar has two holes for cable connections. One hole is for the cable to the power supply. The other hole is for the cable to the VME backplane power bus. The cables should be no longer than reasonably necessary. Lugs should be crimped to the cable and then soldered at the crimps. The 5V connection is the most critical. These connections should *not* be lubricated. See the prototype crate at UCI for an appropriate fastener stack.
supply bars to power supply	4	These connections carry high currents. The connection should be made with the largest bolt compatible with the supply bars and supply cable lugs. These connections should *not* be lubricated. See the prototype crate at UCI for an appropriate fastener stack.
ground blocks to CRB	2	These are direct connections. They should be lightly lubricated with conductive grease.
CRB to ground bus bars. Only the three central connections (per bar) are critical).	6	These connections are via nickel-plated brass spacers. The three central connections (only) should be lightly lubricated with conductive grease at the spacer faces.
power tabs to power bus bars	4	These are direct connections. The screw should be carefully torqued. Careful use of thread locker, e.g., applied to the nut threads with a toothpick, may be advisable. The 5V connections are the most critical. These connections should *not* be lubricated.
power tabs to power supply bars	4	These are direct connections. Given the multiple heavy bolts per connection, these connections should not present any special problems. These connections should *not* be lubricated.

Avoid touching all electrical contact areas.

Wearing clean vinyl gloves is recommended.

Clean critical connections with alcohol before assembly.

Conductive grease should be used lightly and only on those connections specified above.

Files related to the Power Distribution Assembly are posted here:

http://positron.ps.uci.edu/~pier/csc/sup/pwr_dist/

Terms:

Front	Toward the front (ROD side) of the CSC ROD crate.
Rear	Toward the rear (CTM side) of the CSC ROD crate.
CRB	CSC ROD Backplane. A 3U backplane that resides below the 6U VME backplane in the CSC ROD crate.
Shield PCB	The two-layer printed circuit boards that sandwich the supply bars. The right shield PCB is adjacent to the support PCB and is inaccessible once the supply bar assembly is assembled. The left shield PCB is exposed after final assembly.
Support PCB	A single layer of FR4 to which are mounted the shield PCB's, the supply bars, the injector/ejector handles and the rear panel. Its top edge fits in the slot 13 upper card guide. Its bottom edge resides slightly above the slot 13 lower card guide.
Supply bar	One of the heavy copper bars sandwiched between the two shield PCB's. They are called supply bars because one end of each is connected by cable to the remote power supply. For details, see the drawings in SupplyBars_xxx.doc.
CRB bus bar	One of the square copper bars mounted on the CRB. The 5V and 3.3V bus bars span approximately half the width of the CRB and are mounted to the power taps on the rear side of the CRB. The GND bus bars span nearly the entire width of the CRB and are mounted directly to the power sites on the front side of the CRB. For details, see the drawings in CRB_BusBars_xx.doc.
CRB ground block	The custom milled, drilled, and threaded brass blocks that connect the GND supply bars directly to the rear side of the slot 13 GND power sites. For details, see CRB_GroundBlocks_xx.doc.
Power site	The footprint on the CRB to which power connections are made. 5V and 3.3V connections are via power taps pressed into the rear side of the power site. GND connections are via spacers (front side) or ground blocks (rear side) bolted to the site.
Power tap	An off-the-shelf power connector with a screw terminal that is pressed into the CRB at each 5V and 3.3V power site. Example: ERNI part number 114192.
Power tab	A custom cut, drilled, and bent sheet copper part that connects 5V/3.3V supply bars to the 5V/3.3V bus bars. For details see PowerTabs_xx.xls.
Rear panel	The aluminum extrusion attached to the support PCB and the injector/ejector handles. The panel is off-the-shelf except for two custom drilled and countersunk holes. The Elma part number is 66-514-29.
CRB assembly	The assembly that includes the CRB, the CRB bus bars, the CRB ground blocks, and associated hardware (including ground spacers).
Supply bar assembly	The assembly that includes the support PCB, the supply bars, the shield PCB's, the rear panel, and the injector/ejector handles.

Plating Summary:

Component	Plating
Shield PCB copper	silver
All other copper components	tin over nickel
ground blocks (brass)	gold over nickel

Assembly Notes:

Assemble the following at UCI, outside of the crate:

1. The CRB assembly. Protect this assembly, especially the ground blocks, during shipping.
2. The supply bar assembly. Ship this assembly with bolts moderately tightened (to prevent abrasion of PCB plating during shipping).

CRB Assembly Notes:

The fastener stack for 5V and 3.3V bus bars is 8-32:

- philip head screw
- lockwasher
- flat washer
- bus bar (through hole)
- power tap (with integral nut)

Exception: the fastener stack at the power tabs is:

- philip head screw (extra length)
- lockwasher
- flat washer
- power tab
- bus bar (through hole)
- power tap (with integral nut)

Ground bus bars should be insulated on the sides that will be adjacent to crate struts once the CRB is installed in the crate. This can be done with shrink tubing (used for prototype) or kapton tape. The insulation need not be perfect, because the struts and ROD connector shields (once ROD's are installed) are at ground potential. The insulation prevents ground loops, which would not be likely to affect the system.

The fastener stack for ground bus bars is M3:

- socket-head screw
- wave washer
- bus bar (through hole)
- nickel-plated brass spacer
- CRB (through hole)
- wave washer
- nut

Exception: the fastener stack at the ground blocks is M3:

- socket-head screw (extra long)
- wave washer
- bus bar (through hole)
- nickel-plated brass spacer
- CRB (through hole)
- ground block (with integral thread)

Be sure to install both ground blocks with the correct orientation. See the prototype crate at UCI.

Supply Bar Assembly Notes:

Three supply bars require soldering to form L-shaped bars. This requires a propane torch or similar heat source. Heating takes several minutes. Before soldering, the surfaces to be soldered must be thoroughly cleaned, e.g., with sandpaper and/or wire brush. Plumbing flux (e.g., NoCorrode) applied to the joint area before heating and lead-free plumbing solder are recommended. The pieces should be held coplanar during soldering (e.g., with woodworking pipe clamps). Solder flow should be complete (e.g., until solder drips from the joint), and excess solder should be removed while molten (e.g., by wiping with a paper towel). The joint should be allowed to cool naturally. Any flux remaining after soldering must be removed. The bars should be plated after soldering.

Latex spacers should be placed in (only) the following holes in the supply bars:

- the end holes
- the corner holes (L-shaped bars only)

The spacers may be cut from latex tubing. The spacers provide rough mechanical alignment. They are not intended to guarantee electrical isolation of the screws. The screws in the supply bar assembly are typically live.

Avoid touching the supply bars and the exposed conductor on the shield PCB's.

Gaps between supply bars may be plugged with foam rubber to prevent foreign objects from falling into the assembly. E.g., the foam may be placed near the edges of the PCB.

Six nylon spacers should be fitted between the six pairs of holes at the top of the assembly (between 5V and 5V RET). The spacers may be held in place by string or dental floss. The spacers prevent deformation of the shield PCB's when, during final assembly, nylon cable ties are routed through the holes (and spacers) and tightened. These cable ties secure the assembly to the crate. See the prototype crate at UCI for a reasonable tying arrangement.

The fastener stack for the supply bar assembly is M3:

- philip-head screw
- left shield PCB
- supply bar (through hole)
- right shield PCB
- support PCB
- wave washer
- nut

The rear panel is mounted to the support PCB. Two custom mounting holes must be drilled/countersunk in the off-the-shelf Elma panel. See the prototype at UCI. Panel Injector/Ejectors, small metal mounting blocks, and screws are also from Elma.

Torque Note:

Some screws compress the CRB PCB. Overcompression could damage the PCB. Screws with wave washers should be tightened until the wave washer fully compresses, but no more.

Avoid overtightening screws in the supply bar assembly. The screws should not be so tight that the PCB deforms significantly. Check that the screw does not protrude far beyond the nut. See the prototype crate at UCI.

Screws with lockwashers may be tightened beyond the compression point of the lockwasher.

Final Assembly Notes:

The final assembly sequence is:

1	Power down the crate. Remove any installed boards. Disconnect the power supply from the line voltage.
2	Install the CRB assembly loosely in crate.
3	Align the CRB assembly by carefully installing a TIM, one or more ROD's, and/or one or more CTM's. During alignment, support the CRB vertically if necessary.
4	Tighten the CRB assembly mounting screws to their final torques.
5	Remove all boards installed in step 3.
6	Loosen fasteners in the supply bar assembly (except rear panel fasteners). This allows adjustment of supply bar position.
7	Coarsely install the supply bar assembly in the crate. Be careful not to damage connectors, apply force to ground blocks, etc. Also be careful to avoid touching any contact areas. Initially, insert the supply bar assembly diagonally. Insert until the alignment posts in the injector/ejectors are within about .25 inch of the crate. While rotating the assembly toward the final vertical orientation, insert the top ends of the three rearmost supply bars (5V RET, 3.3V, 3.3V RET) into the gap in the guide rails above slot 13. The support PCB rides in the upper guide rail, but slightly above (not in) the lower guide rail. Once the assembly is vertical and the support PCB is in the upper guide rail, gently continue insertion of the assembly until the injector/ejectors lock in place. Be careful at this point to avoid contact with the ground blocks—adjust the position of ground bars if necessary to avoid contact.
8	Bolt the rear panel to the crate with M2.5 screws.
9	Loosen then slightly tighten the top screws (ground supply bars only, one per bar) in the supply bar assembly. Loosen all other screws, including all of those for 5V and 3.3V supply bars, until supply bar position can be adjusted. Keep force on ground blocks to a minimum. Align ground blocks with ground supply bars. Apply minimum force to the ground blocks. Loosely install fasteners between ground supply bars and ground blocks. The fastener stack is M3: socket-head screw, wave washer, supply bar, ground block. Slowly tighten fasteners between ground supply bars and ground blocks, supporting/shifting the ground supply bar as necessary to align the merging faces and to avoid force on the ground blocks. Tighten the fasteners between ground supply bars and ground blocks until the wave washer is fully compressed, then tighten some more, e.g., until the hex wrench flexes moderately. Tighten the top screws (ground supply bars only, one per bar) to further support the ground supply bars.
10	Loosely install the power tabs. See the prototype crate at UCI for suitable fastener stacks. Tighten the various fasteners gradually and in turn, adjusting the power supply bars as necessary. Before fully tightening the power-tab-to-bus-bar screws, adjust the position of the power tab to avoid contact with CTM connector shields (once CTM's are installed), e.g., align the power tab edge with the bus bar edge. The power tab may be trimmed slightly if necessary.
11	Tighten the supply bar assembly fasteners. See Torque Note, above.
12	Strap the supply bar assembly to the crate with nylon cable ties at the tying holes between the 5V and 5V RET supply bars. See the prototype crate at UCI for a reasonable tying arrangement, which uses three ties through the upper three tying holes. The lower three tying holes are not used.
13	Check that no supplies are shorted together.
14	Connect the eight power cables: 4 short cables between the supply bars and the VME backplane power bus 4 long cables between the supply bars and the remote power supply.
15	Power up the crate and check for reasonable voltages (check these at the backplanes) and currents.