CLAS - NOTE 95-021

LOW VOLTAGE DISTRIBUTION SYSTEM FOR THE DRIFT CHAMBERS OF CLAS

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Introduction:

The eighteen drift chambers of CLAS (CEBAF Large Acceptance Spectrometer) instrument the six sectors defined by the toroidal magnet. In the radial direction, three regions are defined by the location of the chambers with respect to the target and magnet. Region 1 drift chambers are the closest to the target. Region 2 chambers are in the magnetic field, between the cryostats. Region 3 chambers are located just beyond the outer coil of the toroidal magnet.

Since each CLAS drift chamber is to be powered with its own dc power supply, a voltage distribution system is needed to provide power to the pre-amplifiers located on the signal translator boards of a given drift chamber. The LV distribution system is designed to provide a minimum of 6V at the STB so that the voltage regulators can maintain a constant 5V potential for the pre-amplifiers. Since the voltage range of the power supply is limited to a maximum of 8V, it is important that the voltage drop across the distribution system be less than 2V.

Each region 3 drift chamber has 24 stereo and 24 axial signal translator boards (STBs); a total of 48 STBs. Each board is provided with a low voltage (LV) connector. However, the LV connectors of a pair of boards; stereo and the corresponding axial board are jumpered together. Hence there are only 24 low voltage cables per region 3 drift chamber. Each axial and each stereo board has 48 single inline package (SIP) amplifiers (a total of 96 SIPs per STB pair). Each SIP requires 13.75mA (a total of 1.32A per STB pair). Therefore, 24 low voltage power cables each capable of carrying 1.32A are required for every region 3 drift chamber.

Region 2 drift chambers have 13 STBs. These STBs span both the stereo and axial super layers . The number of SIPs per STB varies from 24 to 192. Hence, current requirement varies from 330mA to 2.64A. With the exception of the first board # 0 (which has one LV connector) all other STBs have two LV connectors each. Therefore, 25 low voltage power cables, each capable of carrying 1.32A, are required per region 2 drift chamber.

Region 1 drift chambers have 10 STBs. These STBs also span both the stereo and axial super layers . The number of SIPs per STB varies from 64 to 160. Hence, current requirement varies from 880mA to a maximum of 2.2A. Therefore, 10 low voltage power cables capable of carrying 2.2A, are required per region 1 drift chamber.

1.0 Low Voltage Power Cable

The low voltage power cable consists of a pair of conductors insulated in PVC, shielded with a copper braid and the whole assembly is encased in a PVC jacket. One conductor is red, for positive voltage, the other black, for negative voltage. Both conductors connect to the STB's LV connector. To minimize voltage drop, each conductor is selected to be16 AWG stranded copper wire consisting of 19 strands of 30 AWG copper wires. Voltage drop across 200 feet of 16 AWG copper wire at 1.92A is 1.55V. Note, the average low voltage cable length is 70 feet, (which is equal to 140 feet of conductor) and the maximum allowable voltage drop of the entire assembly is 2V. Further, 16 AWG is the largest recommended wire size (by the manufacturer) for the Molex Mini-Fit Jr. connector, (Part No.5024-1047). Due to limited cable-tray space, the maximum outer diameter of the cable can not to exceed 0.250 inches. The copper braided shielding over conductors is required to have 90% or more coverage to prevent voltage fluctuation due to induced noise.

Safety Aspects

Each conductor is required to have a continuous current rating of at least 6.5 A (although the maximum expected current is only 2.2A). CEBAF's safety standards require LV cables to pass one of the following ratings from Article 725 of the NEC, CL2P, CL2R, or CL2.

2.0 Bus Bar Assemblies

Bus bar assemblies consist of a positive, negative and ground bus bars (see figure 1). All bus bars are 6 x 6 mm solid copper bus bar rail with an insulating base. The large cross-section is required to minimize voltage drop. Each positive and negative bus bar assembly requires a 35 mm distribution terminal to accommodate a 2 AWG wire from the respective positive or negative terminal of the LV power supply. The ground bus bar assembly also requires a 35 mm distribution terminal to accommodate a 2 AWG ground wire. Twenty-five, 4 mm distribution terminals are required to connect the ground bus bar assembly to the braided shielding of the twenty-five power cables. Each positive and negative bus bar requires a set of twenty-five, 4 mm distribution terminal, and twenty-five 10 AWG wire segments. The twenty-five, 4 mm distribution terminals are required to connect the twenty-five 10 AWG wire segments to their respective bus bar rail. In turn, the twenty-five 10 AWG wire segments are designed to connect between their respective bus bar rail and their respective twenty-five fuse block modules. The largest wire size the selected fuse block will accommodate is 10 AWG.

Safety Aspects:

Because of the potential current output of the selected power supply (50A), the bus bar rail, and distribution terminals, are required to have a continuous current rating of at least 65A. CEBAF's safety standards require 10 AWG wire segments pass one of the following ratings from Article 725 of the NEC, CL2P, CL2R, or CL2.

3.0 Fuse Block Assemblies

A segment of DIN rail is required to properly secure each positive and negative fuse block module assembly to an enclosure. End clamps are needed for securing the fuse block bases to the DIN rail segment (see figure 1). Twenty five fuse block bases are required for each positive and negative DIN rail assembly, in order to connect the wire segments from their respective bus bar rails to the appropriate wire of each power cables. Twenty five fuse holders are required to mount the appropriate fuse to the fuse block base in an efficient manner. To prevent the premature failure of SIPs due to over current damage, an in-line fuse is designed for every STB cable.

Safety Aspects:

Fuse block bases and fuse holders should be UL rated to at least **10**A to safely accommodate the expected 2.2A demand of STBs.

4.0 Assembly Enclosure

To minimize installation time, every LV enclosure is designed to be directly mountable to the rear side of a 19 inch rack. In order to have proper clearance between equipment within the 19 inch rack, the enclosure depth is designed to be less than 8 inches (outside dimension). In order to have six LV distribution system in one rack, the enclosure is designed to be less than 13 inches high (outside dimension). To minimize maintenance time when changing fuses or other repairs, the enclosure is designed to have a hinged door (see figure 1).

Safety Aspects:

Enclosure is require to be UL approved with a NEMA 1 rating so to prevent damage due to debris. Enclosure is designed to be double interlocked to the HP dc power supply to prevent accidental shock due to contact with bus bar rails during routine maintenance.

5.0 Low Voltage DC Power Supply

The Hewlett Packard 6651A power supply has a maximum output of 8 volts, 50 A and mounts directly to the front of a standard 19 inch rack. It has remote sense compensation and is able to compensate for up to 1 V total line drop per load lead.

Safety Aspects:

The HP power supply has over-current, over-voltage and thermal protection. Trip levels for the over-current and over-voltage conditions are adjustable to at least 120% of nominal output levels. If a trip condition is detected for current, voltage or temperature, the power supply automatically shuts down and remains off until manually reset. The HP 6651A is approved by the IEC, VDE, UL, and CSA.

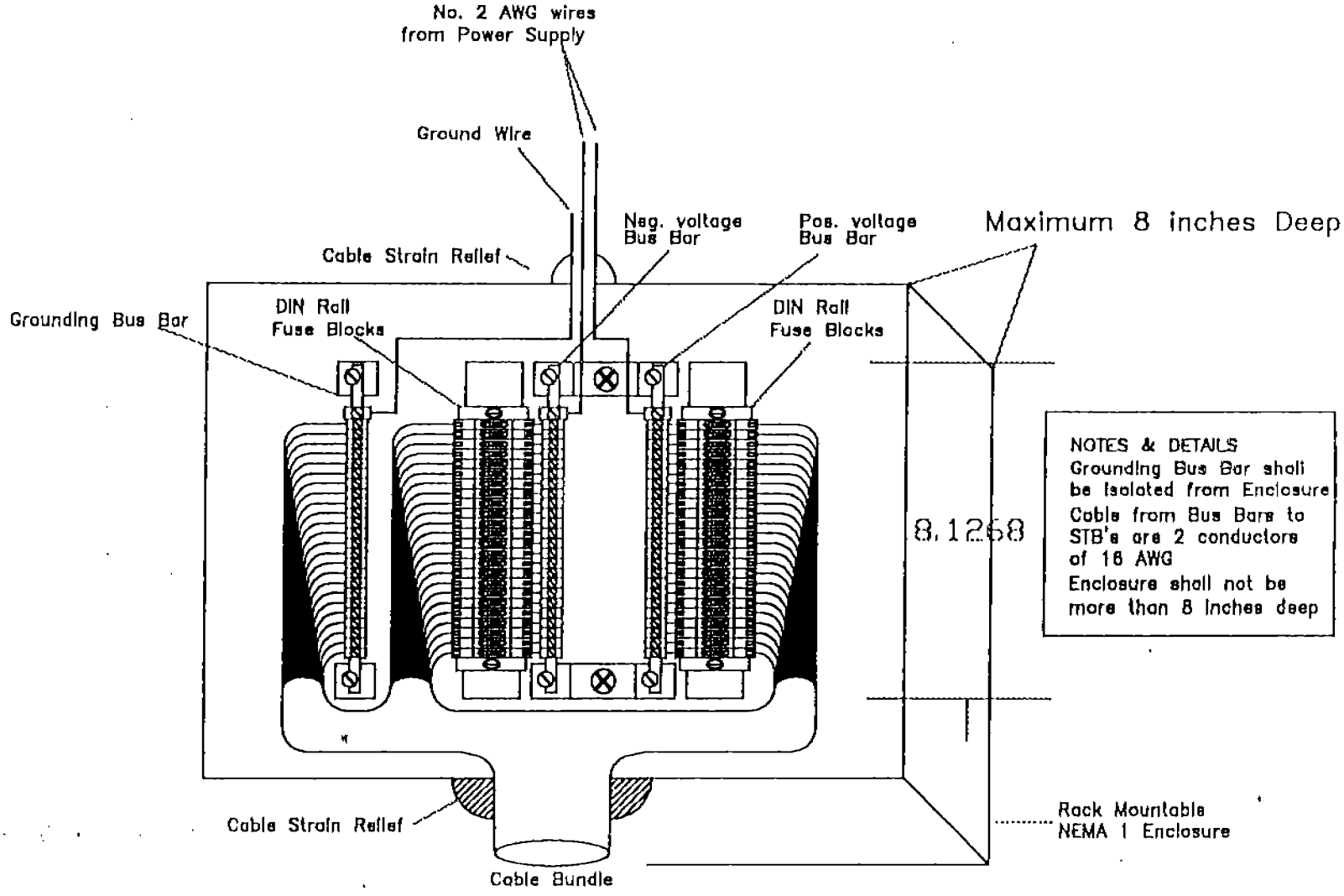

Figure 1. Low Voltage Distribution System