Installation of 9U VME (VIPA) Crates and Power Supplies for the CDF Upgrade

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1. Introduction – description of system

Most of the CDF Upgrade electronics systems reside in 126 VME crates. These are used for the Front-end, Trigger and Data acquisition systems. We describe how the power distribution for these systems including the fusing on printed circuit boards, design of the crate backplane, power supplies, and DC power distribution cables. Finally, there is a brief description of the environment in which the crates and power supplies are mounted.

2. VME Cards

The CDF electronics systems include over 2000 9Ux400mm main modules comprising about 60 different types and over 1000 9Ux120mm transition modules of about 30 types All of these 9U boards are custom designed by Fermilab engineers or collaborating institutions on CDF. All designs were reviewed by a Printed Circuit Board Review Panel chaired by Bob DeMaat. The designs were reviewed after a prototype was produced but before production board were fabricated. The panel reviewed electronic issues such as how VME protocols were implemented. A major function of the reviews was to verify implementation of CDF standards requiring fusing and over voltage transient protection on all custom designed electronics. These standards were followed by all designs.

In addition to custom boards, there are some commercial 6U modules such as crate processors used in the 9U crates. The commercial boards typically are not fused. However, to insert the 6U boards in to a 9U crate a custom adapter card has been designed which provides fusing on all power lines.

3. VME crates

All of the 9U crates for CDF were constructed by the Rittal Corporation to the VITA 23-1998 specifications laid out by the VMEbus International Physics Association (VIPA). These crates (or Subracks in VIPA parlence) are commonly known as "VIPA Crates"). The design of the power distribution in these crates was reviewed by a Fermilab committee chaired by xxxx in 1996(?).

A particular feature of the VIPA crate design of interest for power distribution is that separate remote sense connections are available at the rear bulkhead of the crate. These remote sense connections have over-current protection built into the backplane. The overcurrent protection is accomplished with resettable fuses on both the voltage and return leads of each remote sense pair. These fuses have a trip current of 1A. All sense lead cables use 26 AWG wire.

4. Power Supplies

There are three types of power supplies used for all of the VIPA crates: a switching power supply design used for 88 of the crates, a very low noise linear design used for 36 crates and a low noise switching supply design is used for 2 crates. All of the power supplies share certain common features:

- One multiple output chassis for each crate mounted in a 3U high relay rack mount chassis
- All supply outputs are isolated from each other and chassis ground
- Overvoltage protection
- Overcurrent protection at 105-110% of supply rating
- Overtemperature protection
- Remote monitoring via standardized RS485 interface

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Power specifications were determined by a detailed accounting of the power needs for each subsystems crates. This accounting is kept up-to-date in a spreadsheet describing the power requirements of each card type in CDF and which cards will be used each crate. A summary is attached. The *minimum* current needs for each crate were then determined using an escalation factor of 1.4-1.5 providing headroom for additional modules and longer life.

4.1 Switching power supplies

The switching power supplies are based on a commercial multiple output switching supply. These are ASTEC VS8 series chassis which have a total chassis output of up to 2.5kW. Outputs are configured by installing different output modules into a standard 4 slot chassis. The ASTEC supply is mounted in a customized 3U chassis along with voltage monitoring circuitry. To cover the different voltage needed by different systems, five models of switching supplies have been specified each using one VS8 chassis. These supplies are rated for operation using 208V 3phase AC input anywhere from 50-400Hz. For additional details see the specification CDF/SO-040798 “Power Supply Assemblies”. These supplies are often referred to as “Alacrity Supplies” for the integrator that does the chassis assembly work. The five models are referred to as Models 1-5.

4.2 Linear Power Supplies

The linear power supplies are a custom design made by Power Engineering Industries. There are 5 outputs with a total of 1kW output in a single 3U rack mount chassis. There is currently a single model although a second higher power (~1.5kW) model is expected. These supplies must be operated using 208V 3 phase 400Hz power. A unique 5 contact AC plug specified for 400Hz use is used. Details of the design are specified CDF/SO-21 Nov 98/Rev 1-6 Jan 99 “1 kW 5 Output Linear Power Supply”.

4.3 Low noise switchers

For two crates in the counting rooms where lower noise is required but 400Hz AC input is not available a low noise switching power supply made by Vicor will be used. These will be packaged in chassis similar to the ones used for the other switching power supplies. The packaging will be carried out at Fermilab. They will comply with the electrical specifications of the linear power supplies with the exception of having 60Hz AC input and a slightly different balance of output current requirements.

5. DC Power Cabling

Power cabling between the power supplies and crates are described in a specification "DC Power Cable Assemblies for CDF VIPA (VME) Crates" and 15 accompanying drawings. The specification lists wire gauges, lug types and cable lengths for each needed connection. The drawings describe what connections need to be made for each crate in the system. Wire gauge choices are made based on NEC requirements for the given power supply rating.

6. Rack Environment

All crates covered by this description are mounted in racks with rack protection system. The rack protection and water cooling systems have been previously reviewed. All crates are cooled by air forced through air-water heat exchangers. In the counting rooms, the crates, power supplies and connecting cables are all contained a closed cooled system with recirculated air. On the detector, the crates are cooled with a single pass system and the power cables and power supplies are in free air with no forced circulation other than that contained in the power supply chassis.

The AC power distribution to the relay racks follows NEC requirements with safety ground connected to the relay racks per article 250.

The rack protection system has sensors for correct cooling fan operation, air temperature, cooling water leaks and smoke detection (counting rooms only). This system controls water valves to stop water flow and undervoltage releases or contactors to shut off power.

7. Summary

We conclude that the VIPA crate power distribution systems are sufficient for safe operation.