Procurement Specifications for low voltage DC power supplies for Belle-II iTOP readout electronics

RFP No. 297176

Overview

The Belle II iTOP detector system requires low voltage power supplies with remote sense capability to power the readout electronics assemblies (REA). There will be a total of 64 REAs in the complete system. The subject contract action is for a preproduction system representing ¼ of the full system capability that will be required, i.e. sufficient to provide low voltage power to 16 REAs.

Load requirements

1. Each REA has three input DC supply voltage requirements as follows:
    a. 2.20 to 2.50 V (set point working range) at maximum of 15 A load
    b. 3.40 to 3.70 V (set point working range) at maximum of 15 A load
    c. 4.40 to 4.70 V (set point working range) at maximum of 5.5 A load.
2. The REA is connected to the power supply through a combined cable of length 32.5 m (in some cases it may be up to 10 m less). The cable has the following electrical characteristics:
    a. A pair of 10 AWG wires (not twisted) for each of the loads 1.a, 1.b detailed above
    b. A pair of 14 AWG wires (not twisted) for the load 1.c detailed above
    c. A twisted pair 24 AWG for remote sense for each of the loads
    d. An overall aluminum foil shield enclosing a, b, c.
3. *Note that the resulting voltage drop in the cables (round trip on both wires) is up to 3.5 V.*
4. Transient current steps of various magnitudes will be taken by the loads under various conditions, particularly on initial start-up (FPGA & processor boot, and subsequent enabling of clocks and analog function blocks). Maximum positive steps may be up to 5 A on the loads 1.a, 1.b, and up to 1.5 A on the load 1.c. The power supply must show a stable response.
5. Maximum allowable negative deviation of regulated load voltage (measured at the point of connection of the remote sense lines) is 0.5 V for a +2 A load step starting from any load current >1.5 A on the loads 1.a, 1.b. Similarly, maximum allowable negative deviation of regulated load voltage is 0.5 V for a +1 A load step starting from any load current >0.5 A on the load 1.c.
    a. A capacitance at the load is anticipated to be necessary to meet this requirement. We can allow up to 1 mF per load, with an ESR requirement of 0.015 Ω·mF or higher, e.g.. for a 100 µF capacitor we can allow an ESR requirement of 0.15 Ω or higher.
6. All power supply output channels should be independently floating with minimum 500 V test voltage to ground. In application, actual voltage to ground will be <15 V, apart from possible

power line / ground voltage surge effects. REA are grounded to earth ground connecting on the negative side of each DC supply input at the REA.

7. Ripple and noise voltage shall be <3 mV p-p over 0 to 20 MHz, at full load per item 1 (above). This shall be measured at the load with cable according to item 2 (above), appropriate high frequency bypass capacitors, and a clean earth ground connection at the load.

Control and monitoring requirements

8. The power supplies shall support all normal operating control and monitoring functions including adjusting regulation and protection set points, reading voltage and current monitors, and switching on/off over an Ethernet TCP/IP interface capable of interacting with non-proprietary software running on a Linux host computer. Other interfaces e.g. USB are welcome but will not be the primary method for control and monitoring in the installed system.
9. It shall be possible to configure the power supply to trip on overvoltage at power supply terminals, overcurrent, and over- and under-voltage on the sense terminals, all with programmable set points.
10. The three DC supply channels feeding to each REA must be able to be turned on and off together as a group with a single software action, and must trip together as a group in case of any trip condition (see item 9) on any of the three channels.
11. Load currents shall be monitored with minimum 10 bit resolution over the indicated ranges.
12. Regulation set points and trip voltage set points shall be controllable with minimum 10 mV resolution. Trip current set points shall be controllable with minimum 10 mA resolution.
13. No local front-panel controls are needed other than a means to force all output power off for servicing the loads. (This could be AC line off but any hardware switch is ok.)
14. When internal fans are used for cooling the power supply, means shall be provided to monitor temperatures or fan health via the remote software interface.

Other requirements

15. Physical partitioning: The 16 × 3 power supply channels may be organized in one or more independent rack-mount chassis, ideally a single chassis, but no more than 4 such chassis.
16. Each power supply chassis shall be rack-mountable in a standard 19 inch equipment rack of depth 67 cm. Cables shall connect on the rear side of the chassis, and chassis depth shall not exceed the rack depth *minus a reasonable allowance to permit the load cable connections to be contained within the rack*. We do not give a fixed value here since it depends on the type of mating connectors for the power supply.
17. If the chassis is not self-supporting but requires rails, the cost of the rails must be included in the bid.
18. The total rack space available is 18 U. The power supplies must fit within this rack space *allowing for any necessary vertical spacing for air cooling*. Assume no top or bottom airflow out of the 18 U boundary, because of the presence of rack floor or closed rack top. There will be no other heat-generating equipment in the same rack.
19. AC line input:
    a. Primary installation is at KEK laboratory, Tsukuba, Japan. Line voltage is 200 VAC, 50 Hz.

   b. The power supplies should also be operable with at least one of the options 208 VAC or 120 VAC, 60 Hz. This is necessary for system tests in the USA.
   c. Minimum power factor 0.95, sinusoidal input current.

20. Overall average efficiency of the power supplies alone (excluding losses in the load cables of item 2) shall be 70% or greater, at maximum loads of item 1 and AC line condition item 19.a.
21. Interlock input: A hardware permit input, e.g., optocoupler LED drive, is required on each chassis. DC output power from the supplies must be disabled if the permit signal is de-asserted. The permit input shall be floating, not ground referenced.
22. Cooling shall be by air alone. Forced air as may be required shall be provided with internal fans. Various airflow directions are allowable, including bottom entry, top exit, front entry or exit, rear entry or exit, and one side entry or exit. Side to side airflow is not allowable. Rated ambient air temperature range for operation shall include 20 to 40 °C.