Operation of the DØ Layer Zero Isolated Low Voltage Power Supply System and Module in the DØ Counting House and Collision Hall

RunIIb Layer Zero Silicon Group

Abstract

This document describes the planned operation of the Layer Zero Isolated Low Voltage Power Supply System and associated Module electronics in the DZero movable counting house and collision hall. Safety features related to its design are presented. The purpose of this document is to provide technical information required to obtain Partial Operational Readiness Clearance for unattended operation of the Layer Zero Prototype System.

Introduction

The DØ RunIIb upgrade project includes a new Layer Zero Silicon detector. We have installed several prototype channels of the new detector including a low voltage isolated power supply system. This system provides power to the newly designed active Adapter Card and subsequently the SVX4 readout chip. The Module consists of a silicon sensor, analog cable, SVX4 hybrid, digital jumper cable, Junction Card, and twisted pair/power cable bundle. We seek partial operational readiness clearance for unattended operation of the Layer Zero Prototype System.

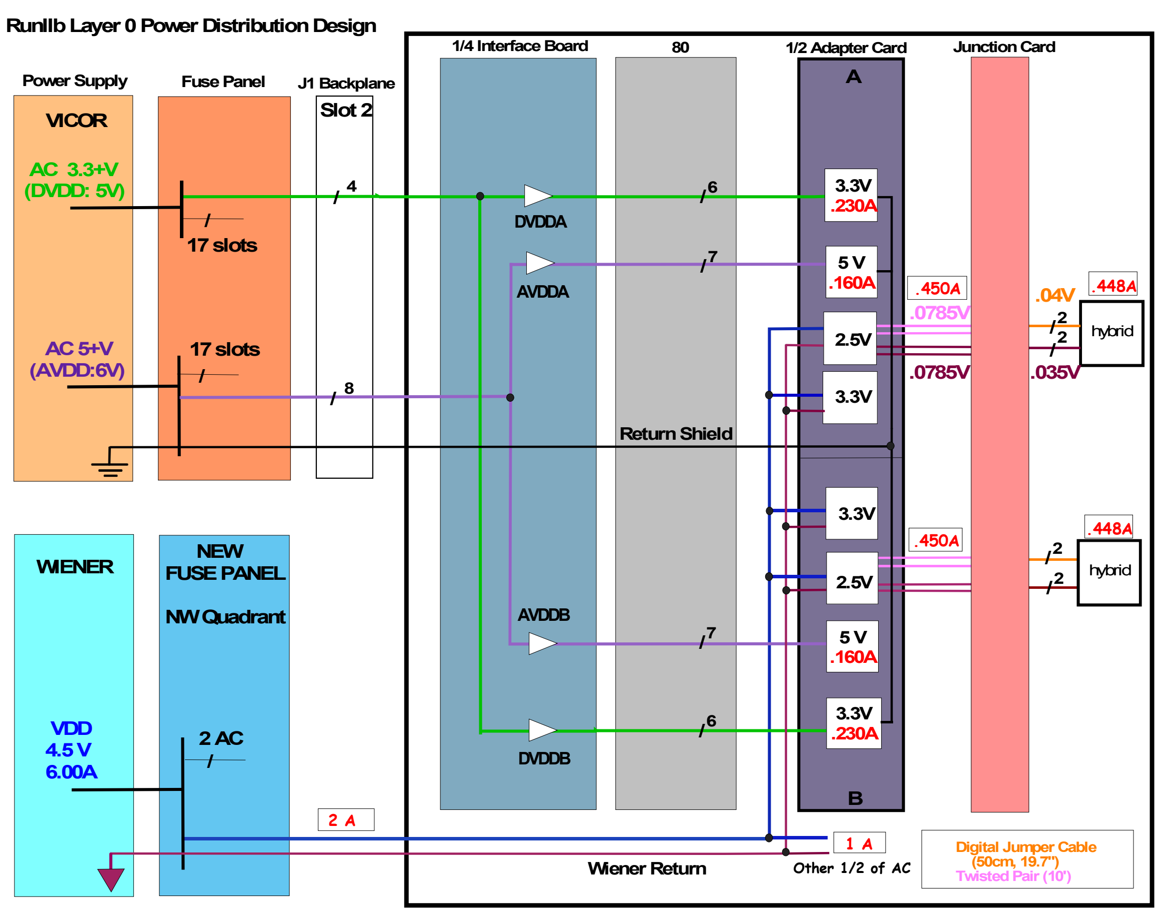
Low Voltage Power Supply System

The Layer Zero Low Voltage Power Supply System is composed of a commercial Wiener power supply, an Interlock chassis, and a fuse panel. The purpose of the system is to provide power to the SVX4 readout chip on a temporarily installed prototype version of a few channels of the Layer Zero detector.

Block Diagram

Figure 1 shows a block diagram of the isolated Low Voltage Power Supply System and its relationship to pre-existing hardware that provides power to the RunIIa Silicon Detector electronics. The SVX4 readout chip power is electrically isolated from the RunIIa SVX2 readout chips. This is accomplished with isolation signal drivers and an isolated voltage source for the SVX4 located on the Adapter Card. The low voltage power supply system provides a bulk voltage to two regulators on the Adapter Card. The 3.3 volt regulator is used to power the 'hybrid' side of the signal driver chip while the 2.5 volt regulator provides a 2.5V operating voltage to the SVX4.

Figure 1: Low Voltage Power Supply System Block Diagram



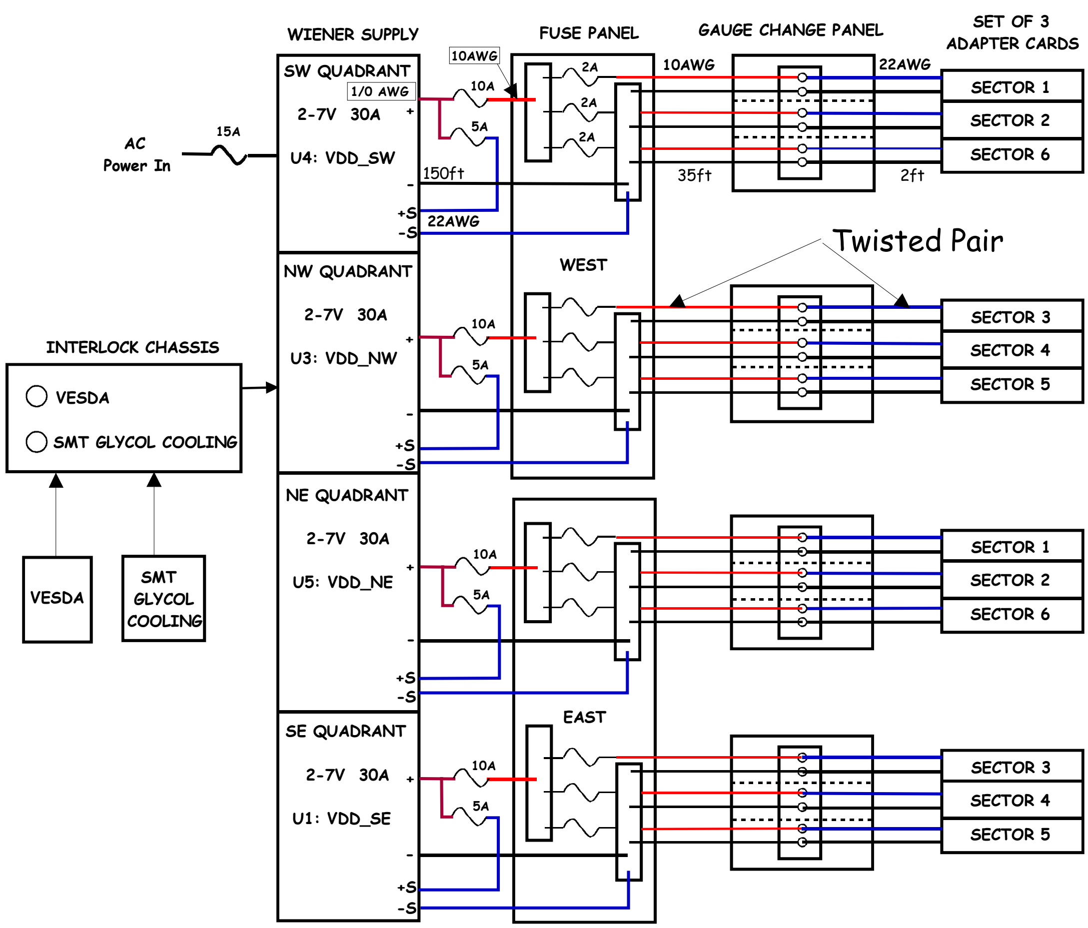
Bulk Distribution

The Wiener PL500 unit is specifically designed to provide power over long distances. In order to facilitate easy access, the power supplies are housed in the movable counting house while the fuse panels, gauge change panels, and Adapter Cards are mounted on the face of the calorimeter central cryostat in the collision hall. Figure 2 shows the bulk distribution for the modules within the Wiener mainframe housing.

Four modules provide power to each quadrant consisting of three Adapter Cards. Each Adapter Card requires 2A of current for a total of 6A per power supply module. 150 feet of 1/0 cable is used from the power supply, located on the second floor of the movable counting house, to the fuse panel located in the cathedral area of the collision hall. This cable is fused with a 10A fuse. A gauge change takes place on the load side of this fuse to 10AWG accommodated by the 2A fuse holding structure. Another gauge change takes place after ~30 feet of 10 AWG cable to accommodate the 22 AWG Adapter Card power connector. The 2A fuse protects this cable as well as the Adapter Card. The 22 AWG sense line is fused with a 5A fuse.

The Wiener power supply AC input has a 15A fuse mounted on the mainframe housing. The return of each module is considered floating. 5MΩ of resistance was measured between the mainframe chassis and the return of each module.

Figure 2: Wiener Bulk Distribution



Equipment Location

The power supply system is installed in three locations. The Wiener mainframe and Interlock chassis are located in rack M209 on the second floor of the movable counting house. The fuse panel is located in the cathedral area of the collision hall. The gauge change panel and load, the Adapter Card, are located on the horseshoe that is mounted on the face of the Calorimeter Central Cryostat.

Movable Counting House

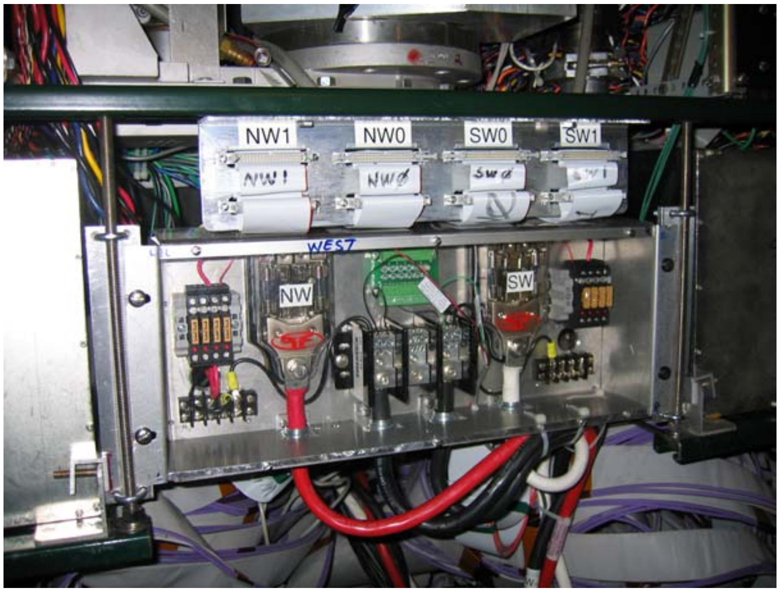
Figure 3 is the rack layout of the Wiener power supply and Interlock chassis in rack M209 located on the second floor of the movable counting house. Air space is provided above and below the power supply for cooling.

Figure 3: M209 Equipment Layout

Cathedral Area

The fuse panels are located on the west and east side of the cathedral area inside the Dzero collision Hall. A clear Lexan cover prevents foreign objects from falling inside the unit.

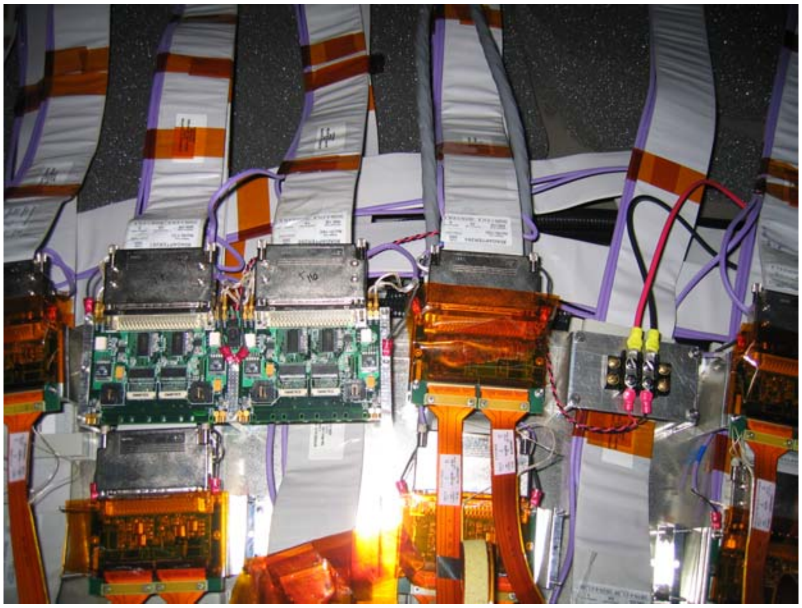
Figure 4: West Cathedral Fuse Panel



Horseshoe Area

The Adapter Card is mounted between the Calorimeter Central Cryostat (CC) and the North Calorimeter End Cap (EC). The gauge change panel is mounted in an open position to the right of the Adapter Card.

Figure 5: Adapter Card and Gauge Change Panel located on the horseshoe.



Equipment Specifications

Wiener Power Supply

The Wiener PL500 power supply provides separate floating voltages for each of the four quadrants (SE:SouthEast, NW:NorthWest, SW:SouthWest, NE:NorthEast). A spare module (U6) is provided for quick recovery in the event of module failure. Only one quadrant (NW) will be powered for the prototype hybrid installation. All four supply modules will be used when the Layer Zero detector is installed next year.

Table 1 shows the power supply module capacity and operating parameters. Two trip levels are associated each module's output current. The first trip level is called I Max, and the second level of protection is the I Limit trip. Since only one Adapter Card with two hybrids attached will be powered at this time, the levels are set for an expected current draw of 1A. There are three voltage trip parameters for each module. An upper (Over V) and lower (Under V) window is set around the target voltage (Output V). The third voltage trip level is the Over Voltage Protection (OVP) value.

The Wiener supply is operated via the mainframe front panel, RS232, or CAN bus interfaces at this time. Incorporating the system into the experiment's EPICS system is currently being developed. U0, U2, and U7 will not be used in the final system.

The module mainframe is fused on the 120VAC input with a 15 Amp fuse. A solid state relay is used to control application of AC power to all modules housed in the mainframe. This relay is used as part of the interlock system described in the next section.

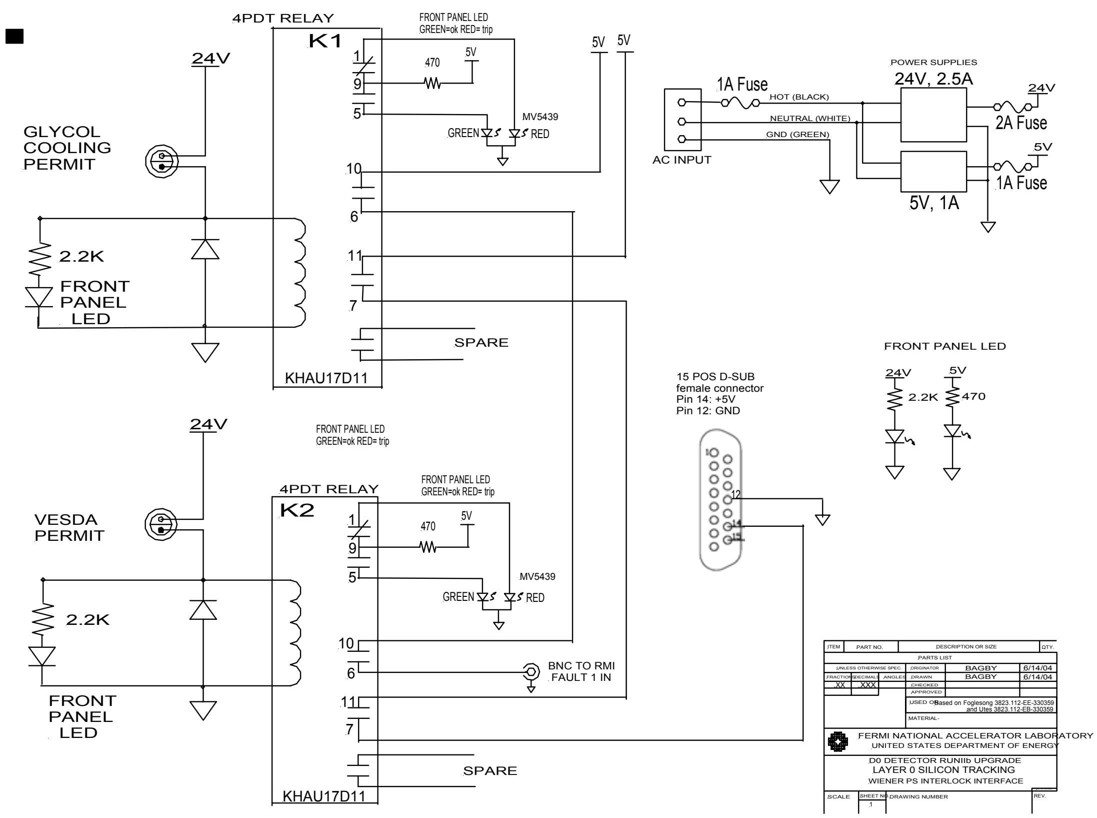
Table 1: Wiener Module Specifications

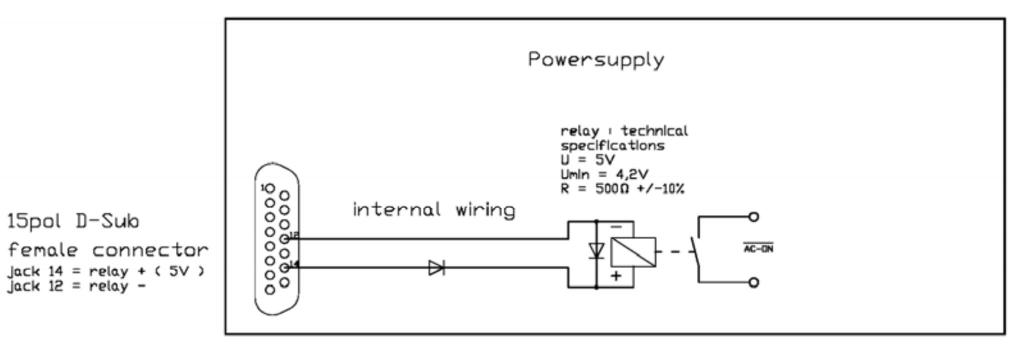
Power Supply	Module Specification	Output V (V)	I Limit (A)	Under V(V)	Over V (V)	I Max (A)	OVP(V)
U0: VDD	2-7V, 115A, 550W	0	5	0	3	4	6
U1: VDD_SE	2-7V, 30A, 210W	4.5	1.75	4	5	1.5	5.5
U2: 15V	12-30V, 11.5A, 280W	0	5	0	15	4	6
U3: VDD_NW	2-7V, 30A, 210W	4.5	1.75	4	5	1.5	5.5
U4: VDD_SW	2-7V, 30A, 210W	4.5	1.75	4	5	1.5	5.5
U5: VDD_NE	2-7V, 30A, 210W	4.5	1.75	4	5	1.5	5.5
U6: SPARE	2-7V, 30A, 210W	0	1.75	0	5	1.5	5.5
U7: VCC	5-10V, 80A, 600W	0	5	0	5.5	4	6

Interlock Chassis

The Interlock chassis provides a means of disabling the Wiener mainframe, thus all power supply modules, in the event of a detector cooling fault (GLYCOL) or a fire (VESDA) in the west and east cathedral area. Figure 6 is the schematic drawing of the interlock chassis. A set of dry contacts, from the Glycol cooling system and the VESDA fire system, enables power to relays K1 and K2 thus closing a solid state relay on the AC line of the Wiener power supply . In addition, a fault out indication is sent to the RMI thus disabling the AC power via the Pulizzzi box. Permit, chassis power, and fault condition status are indicated on the front panel of the chassis by LEDs as well as through the 1553 RM .

Figure 6: Interlock Chassis Schematic Diagram

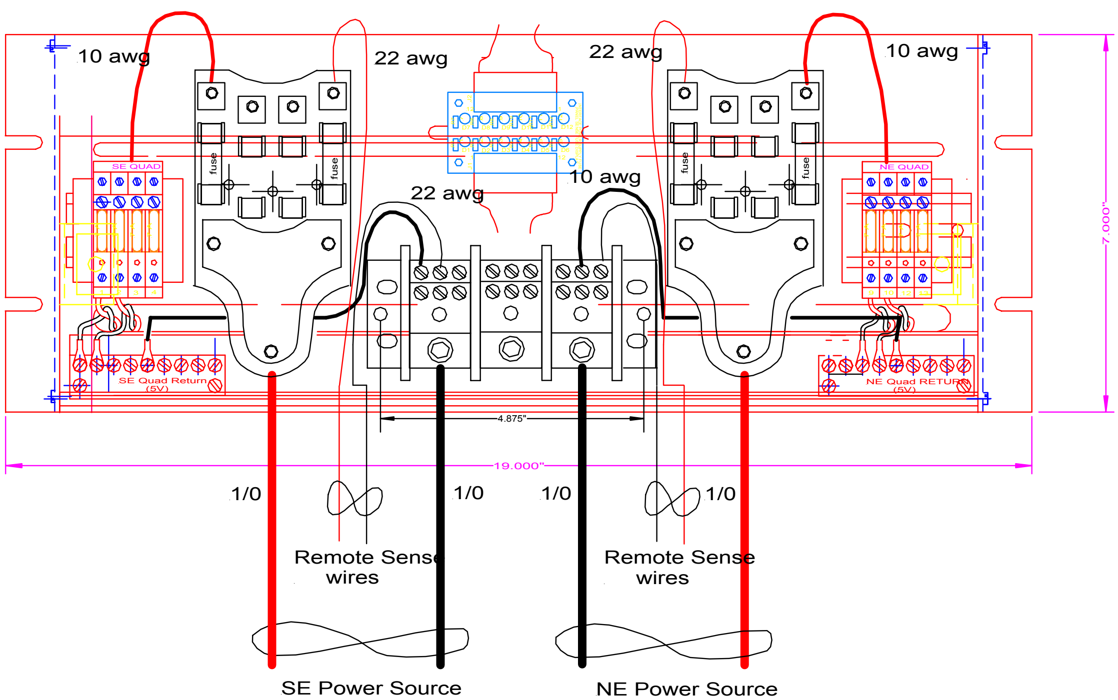




Fuse Panel

The bulk power is distributed via the Fuse Panel, Figure 7. The power is brought via 1/0 AWG cable from the power supply to the distribution structure on the Fuse Panel. This wiring and the hardware of the distribution structure can accommodate the maximum current that a single power module can produce (worst case is 6A for three modules in each quadrant. Fuses after the distribution structure (2A) limit the maximum current that can be delivered to an individual Adapter Card and protect all circuitry beyond that point. The LED board, located in the middle of the panel, provides power on indication for each Adapter Card.

Figure 7: Layer Zero LV Fuse Panel

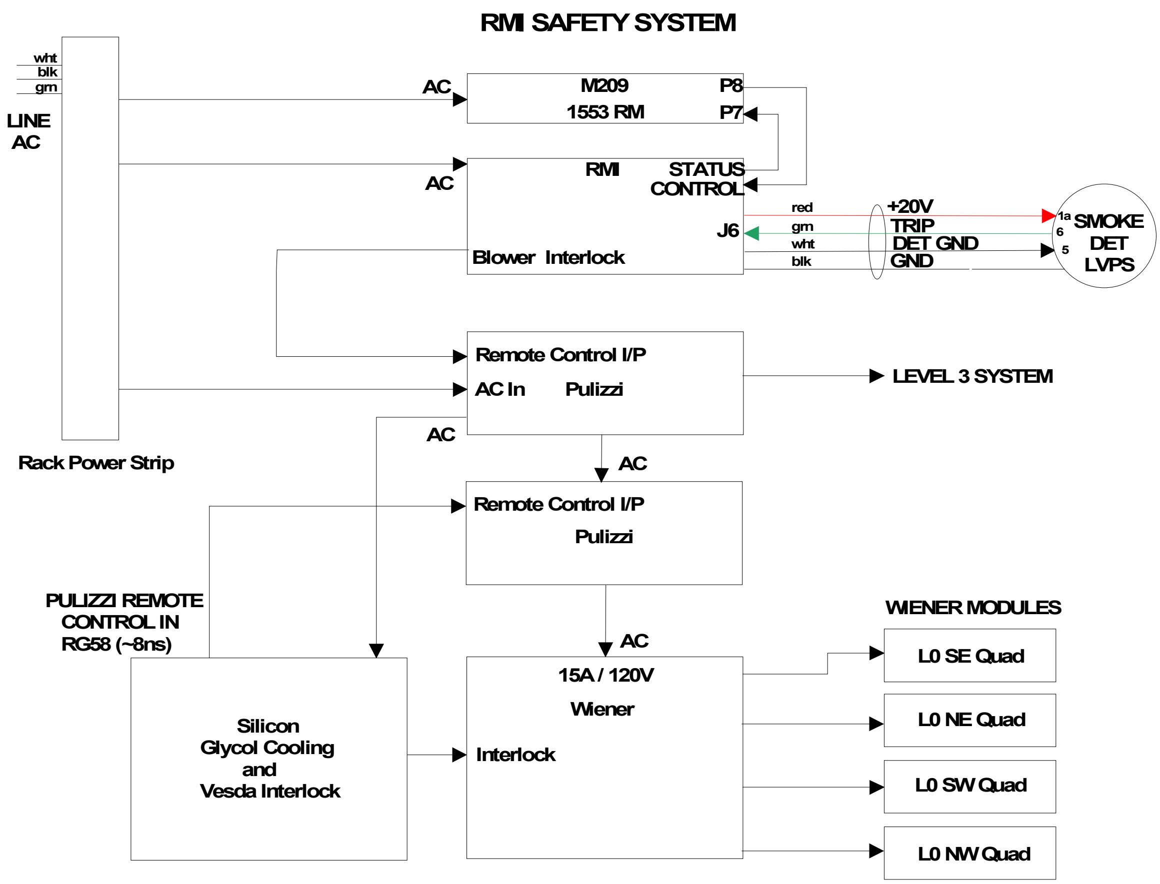


Safety System

Movable Counting House Rack Safety

Figure 8 illustrates the block diagram of the safety system in rack M209. This is a standard installation for all Dzero racks in the counting house. The configuration shown will disrupt AC power to the Wiener and Interlock Chassis in the event there is a fire in relay rack M209. In addition, if the Interlock chassis detects an external interlock, the Wiener power will be interrupted by two mechanisms. The first mechanism is a direct interlock into the Wiener while the second is via the Pulizzi.

Figure 8: Counting House Safety System



Electronics Safety

Isolated Power Supply System

The Layer Zero prototypes are protected against all possible fault situations with the Wiener Power Supply and the Interlock chassis as well as features on other system electronics such as the Interface Board and the Adapter Card. There are 4 levels of protection for the prototype system within the low voltage power supply system.

1. Fuse in AC power line in the Wiener power supply.
2. Solid state relay in the Wiener 120 VAC power line.
3. Fuses in SVX4 power lines on the Fuse Panel.
4. Two current and three voltage trip levels in the Wiener Power supply.

1. The 15A AC line fuse, providing main power to the Wiener, protects the system from faults on the mainframe side of the system.

2. The solid state relay on the AC main of the Wiener provides an external trip mechanism for shutting down the system in case of GLYCOL cooling or VESDA trips. The philosophy behind the cooling system interlock is that the silicon sensors should not be allowed to get too hot (and burn up) or too cold (humidity condensation). GLYCOL cooling is associated with the RunIIa detector at this time. The Layer Zero cooling will be incorporated in this system when the detector is installed in the summer of 2005. VESDA provides a shutdown trip in the case of fire in the cathedral area of the collision hall.

3. A series of fuses in the power lines up to the adapter card protect the cabling and the Adapter Card. The fusing will be above the normal operating levels and should not open under a normal fault condition.

4. Internal Wiener trip levels provide a two level current trip (Imax, I Limit) and a three level voltage trip (Under Voltage, Over Voltage, and OVP).

Adapter Card and Junction Card

The D0 L0 adapter card and junction card benefits from many safety features built into the readout system. There are three power sources to the adapter card, one routes through a fuse panel directly to the adapter card board from power supplies and two sources routed through the interface board. Presently, all source voltages from the interface board are current limited to .8 Amps, easily protecting traces on the adapter card and junction card. Once on the adapter card, these voltages are regulated to appropriate levels

The third source voltage, SVX Signal Voltage, routes through a fuse panel. This adapter card voltage drives a pair of regulators on each of four channels that have internal current limiting at 4 amps and 450 milliamps, respectively. The minimum trace width on each channel is effectively .024”, four traces of .006” each. This requires the fuse panel to be fused at 2.5 amps maximum.

In addition to the basic circuit protection outlined above, the adapter card has on board logic to insure the voltages reaching the SVX IV at turn on are non-damaging. Although power to the SVX Signal Voltage may be constantly on, photovoltaic relays do not allow the voltage to reach the regulators until one of the unregulated voltage sources from the interface board is received. This essentially allows the regulator applying voltage to the SVX IV to be controlled from the sequencer. Further circuitry prevents voltage from reaching the digital signal drivers communicating with the SVX IV until the SVX IV supply voltage is active.

The junction card is passive, having only connectors and capacitors. SVX IV power is routed to the Molex 50 pin connector through five pins with two traces from each pin to the copper area supplying the power for a total minimum trace width of .06". This trace width would easily handle the current up to the 2.5 amps of the fused value.

Overall, fusing, interface board current monitoring, and voltage regulation on the adapter card work together to keep voltage and current levels in a safe range for the adapter card and junction card.