Operational Readiness Clearance Documentation

DØ Layer Zero

RunIIb Layer Zero Silicon Group

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System Contact
Linda Bagby
DAB X3100
bagby@fnal.gov

Introduction

The DØ RunIIb upgrade project includes a new Layer Zero Silicon detector. In November of 2004 we obtained Partial Operational Readiness Clearance on the prototype version of the system. The production version is now installed and ready for review. The difference between the prototype system and the production version is the addition of a low voltage filter network and a high voltage system described in this document. We seek operational readiness clearance for unattended operation of the Layer Zero electronics system.

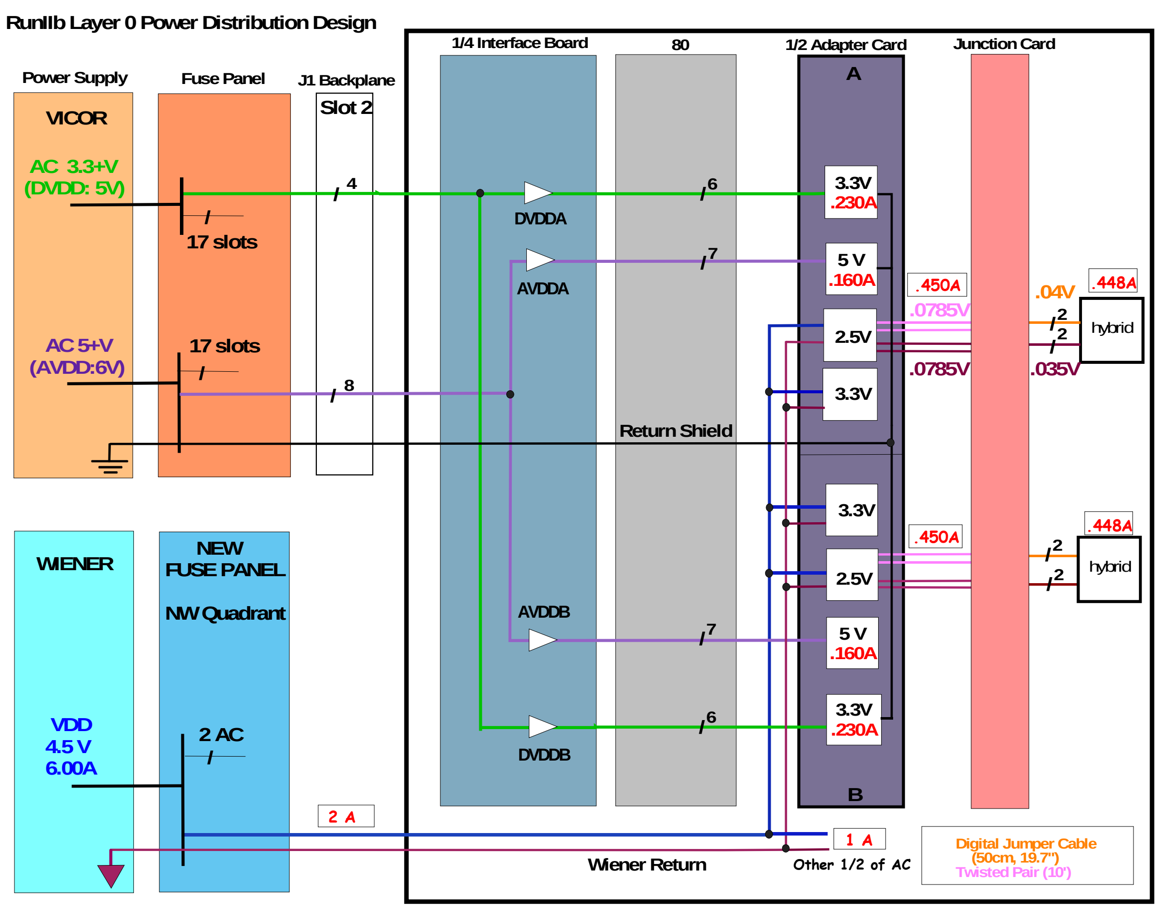
Low Voltage Power Supply System

The Layer Zero Low Voltage Power Supply System is composed of a commercial Wiener power supply, an external filter network, an Interlock chassis, and a fuse panel. The purpose of the system is to provide power to the SVX4 readout and signal driver chips mounted on ceramic hybrids affixed to the Layer Zero detector support structure.

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 3.3V 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.

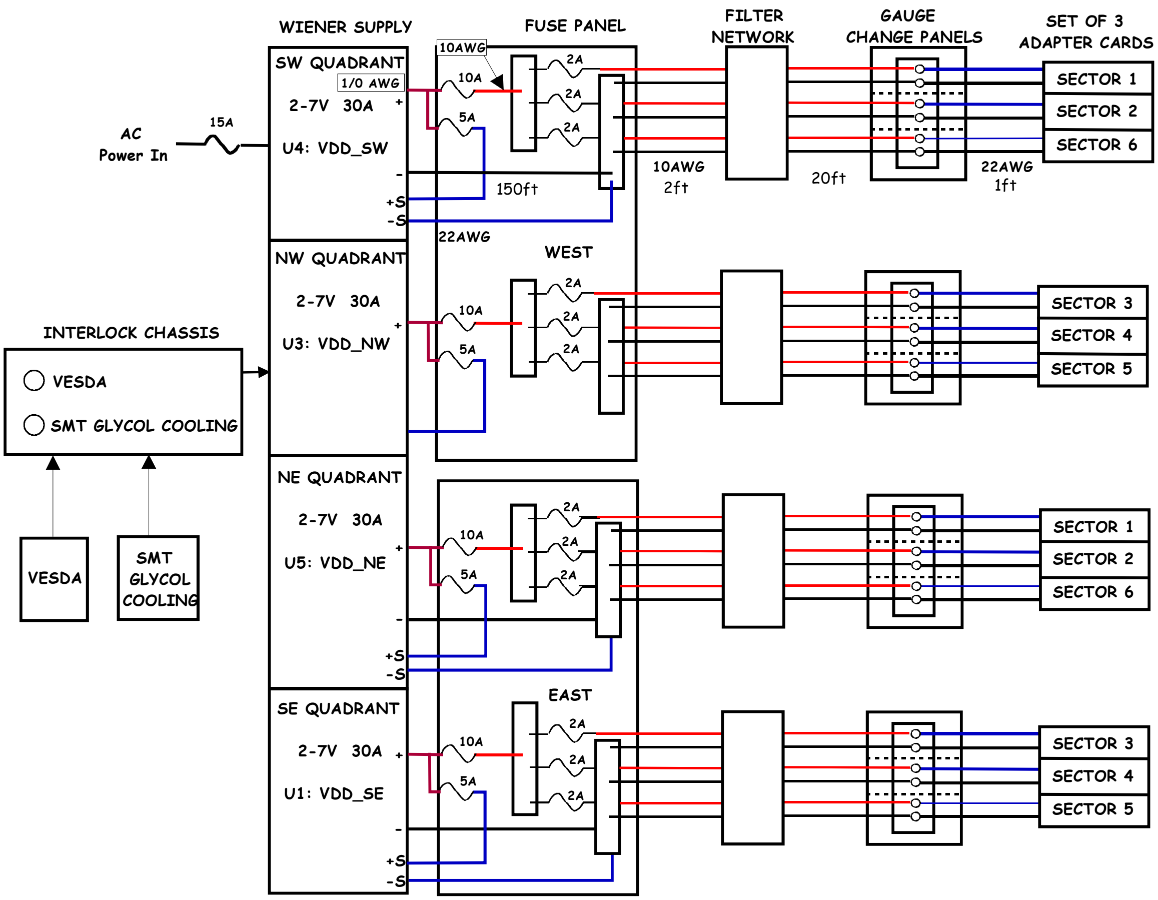
Figure 1: Low Voltage Power Supply System Block Diagram



Bulk Distribution

The Wiener PL500 unit is specifically designed to provide power over long distances. In order to facilitate easy access, the power supply and interlock chassis are located in the movable counting house. The fuse panels and filter networks are mounted in the Cathedral area of the collision hall. The gauge change panels and Adapter Cards are mounted on the face of the calorimeter central cryostat. Figure 2 shows the system block diagram.

Figure 2: Wiener Bulk Distribution



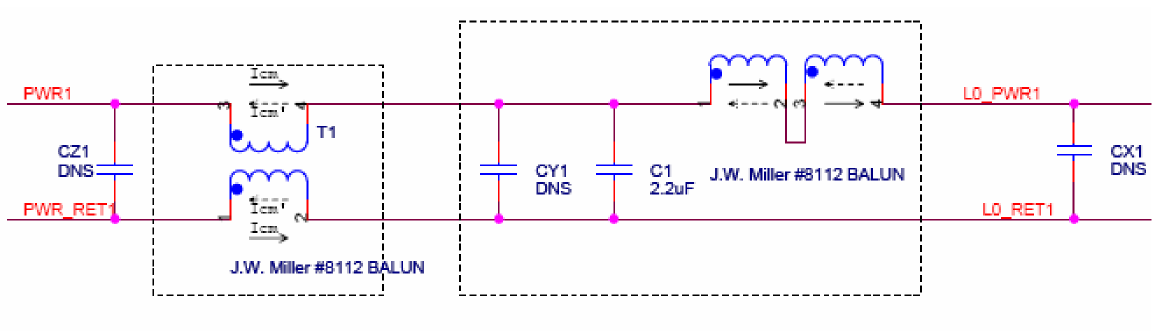
Four modules provide power to each quadrant consisting of three Adapter Cards. Each Adapter Card requires 2A of current for a total of 6A per power supply module. 150 feet of 1/0 cable is used from the power supply to the fuse panel to minimize the voltage drop. 1/0 cable is capable of handling the 30A maximum current available from the supply. 10AWG cable is used to connect the 2A fuse to the filter circuit described in the next section and from the filter to the gauge change panel. The gauge change takes place on the load side of the filter circuit from 10AWG to 22 AWG. The 2A fuse protects the 22 AWG cable and 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.

Filter Network

The filter network was design to minimize noise pickup in the readout system. The filter consists of two baluns and a 2.2uF capacitor shown below in Figure 3. The first balun provides common-mode rejection while the second is used in band-reject mode. Each supply line to the Adapter Card is connected to a separate filter network. The #8112 balun is rated for a maximum current of 5.6 Amps which causes a 35C temperature rise. Due to the 2 Amp fuse upstream of each filter, the baluns will not experience more than 2 Amps of current. A complete description of the filter design is available at http://d0server1.fnal.gov/users/bagby/www/LV_PS/a1050923.pdf .

Figure 3: Power Supply Filter Network



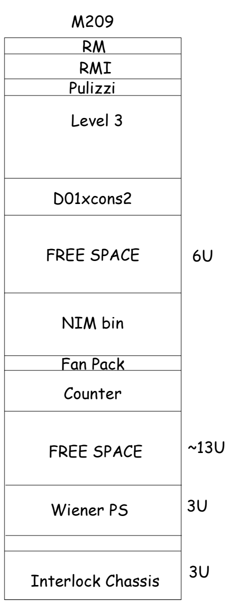
Equipment Location

The following sections describe the location of the Low Voltage Power Supply system, High Voltage Power Supply system, and readout electronics.

Movable Counting House

Figure 4 is the rack layout of the Wiener Low Voltage 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 4: M209 Equipment Layout

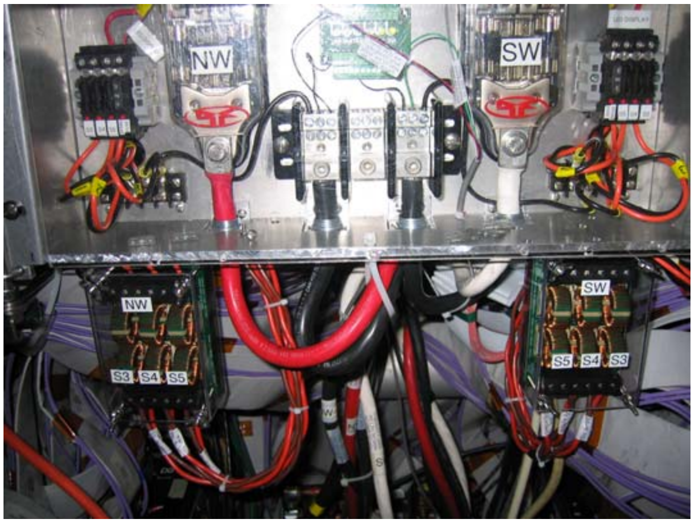


The High Voltage Power Supply system uses commercially available BiRa crates and power supplies. The equipment is located in MCH222. One crate powers the south end of the Layer 0 detector while the other powers the north end. Type 12, 2kV/3mA, BiRa High Voltage pods are used for Layer 0. Type 12 pods are modified versions of the typical T4 pods used by the RUNIIa SMT detector. The modification involved changing a resistor value to provide higher resolution current readings. A full description of the modification is available at http://d0server1.fnal.gov/users/bagby/www/LV_PS/A1050803.pdf .

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. The filter networks are mounted under the fuse panel and are also covered with a Lexan shield. Figure 5 is a photograph of the installation.

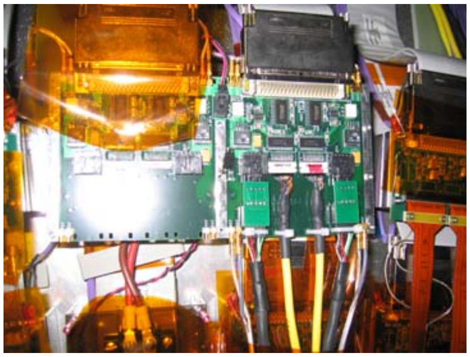
Figure 5: West Cathedral Fuse Panel and Filter Networks



Central Calorimeter Cryostat Face

The Adapter Card is mounted between the Calorimeter Central Cryostat (CC) and the North Calorimeter End Cap (EC). The gauge change panels are mounted in an open position next to the Adapter Cards as shown in Figure 6.

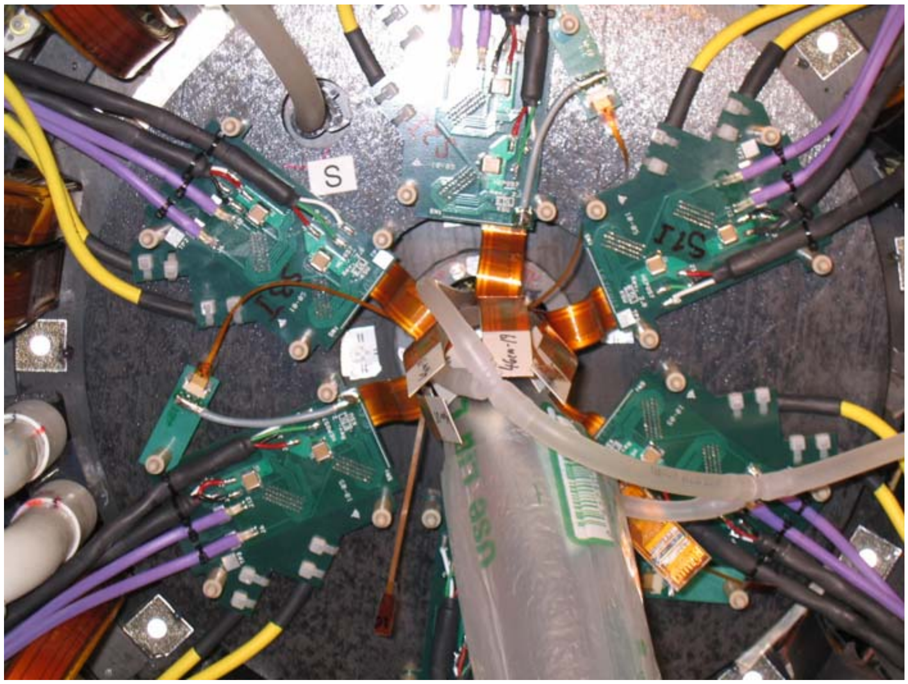
Figure 6: Adapter Card and Gauge Change Panel located on the horseshoe.



Calorimeter Bore

The Junction cards are mounted inside the bore of the Calorimeter Central Cryostat (CC). Figure 7 illustrates the inner junction card ring mounting configuration. There are two such Junction Card mounting rings on each end the of CC. Six cards are mounted on each ring for a total of 12 per end.

Figure 7: Junction Cards mounted in bore of CC.



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.

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. 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 a CAN bus interface. The system has been integrated into the experiment's EPICS system and is monitored with a software application. U0, U2, and U7 will not be used in the 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.

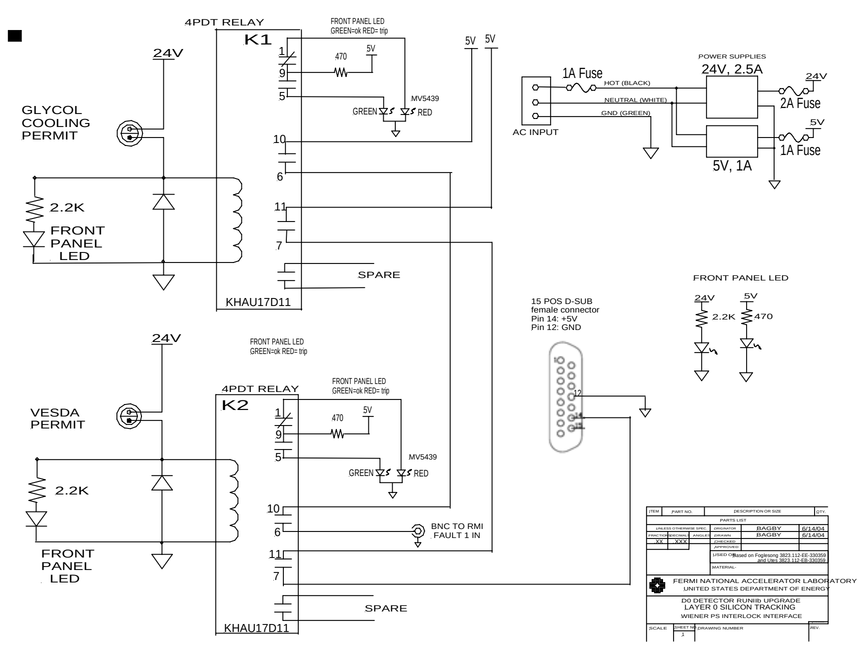
Table 1: Wiener Module Specifications

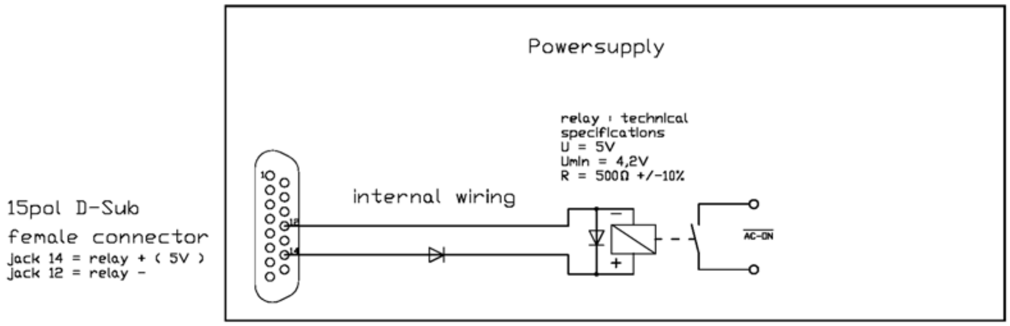
Power Supply	Module Specification	Output V (V)	I Limit (A)	Under V(V)	Over V (V)	I Max (A)	OVP(V)
U0: VDD	2-7V, 115A, 550W	0	5	0	3	4	6
U1: VDD_SE	2-7V, 30A, 210W	4.5	2.2	4	5	2.1	5.5
U2: 15V	12-30V, 11.5A, 280W	0	5	0	15	4	6
U3: VDD_NW	2-7V, 30A, 210W	4.5	2.2	4	5	2.1	5.5
U4: VDD_SW	2-7V, 30A, 210W	4.5	2.2	4	5	2.1	5.5
U5: VDD_NE	2-7V, 30A, 210W	4.5	2.2	4	5	2.1	5.5
U6: SPARE	2-7V, 30A, 210W	0	2.2	0	5	2.1	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 8 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 8: Interlock Chassis Schematic Diagram

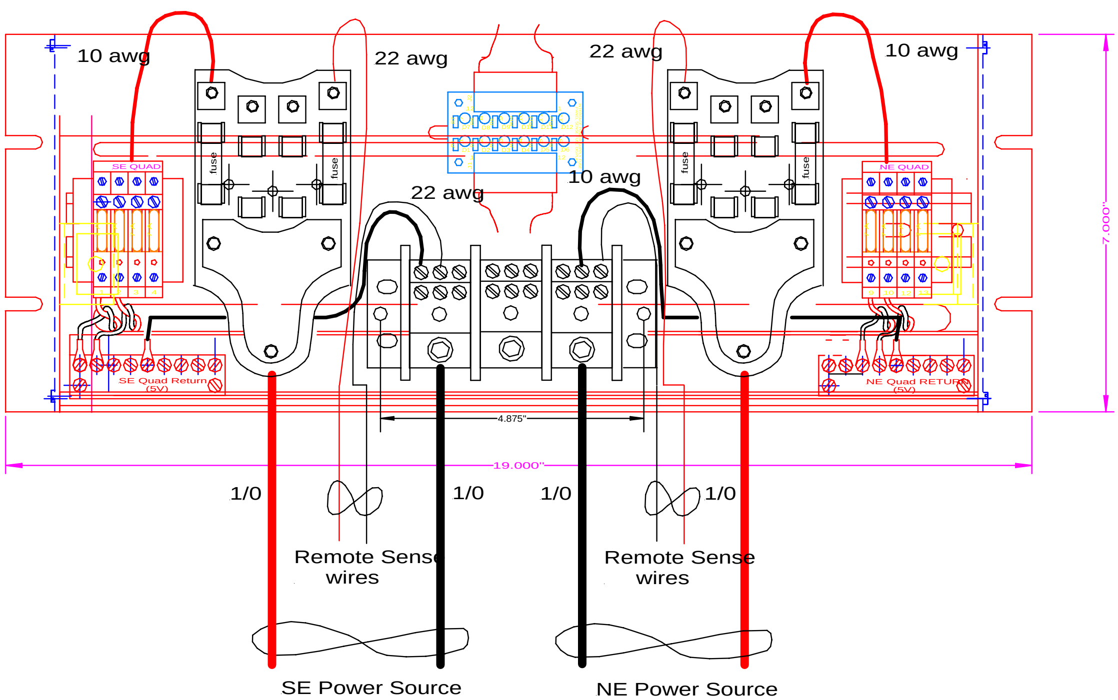




Fuse Panel

The bulk power is distributed via the Fuse Panel, Figure 9. 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 quadrant.

Figure 9: Layer Zero LV Fuse Panel

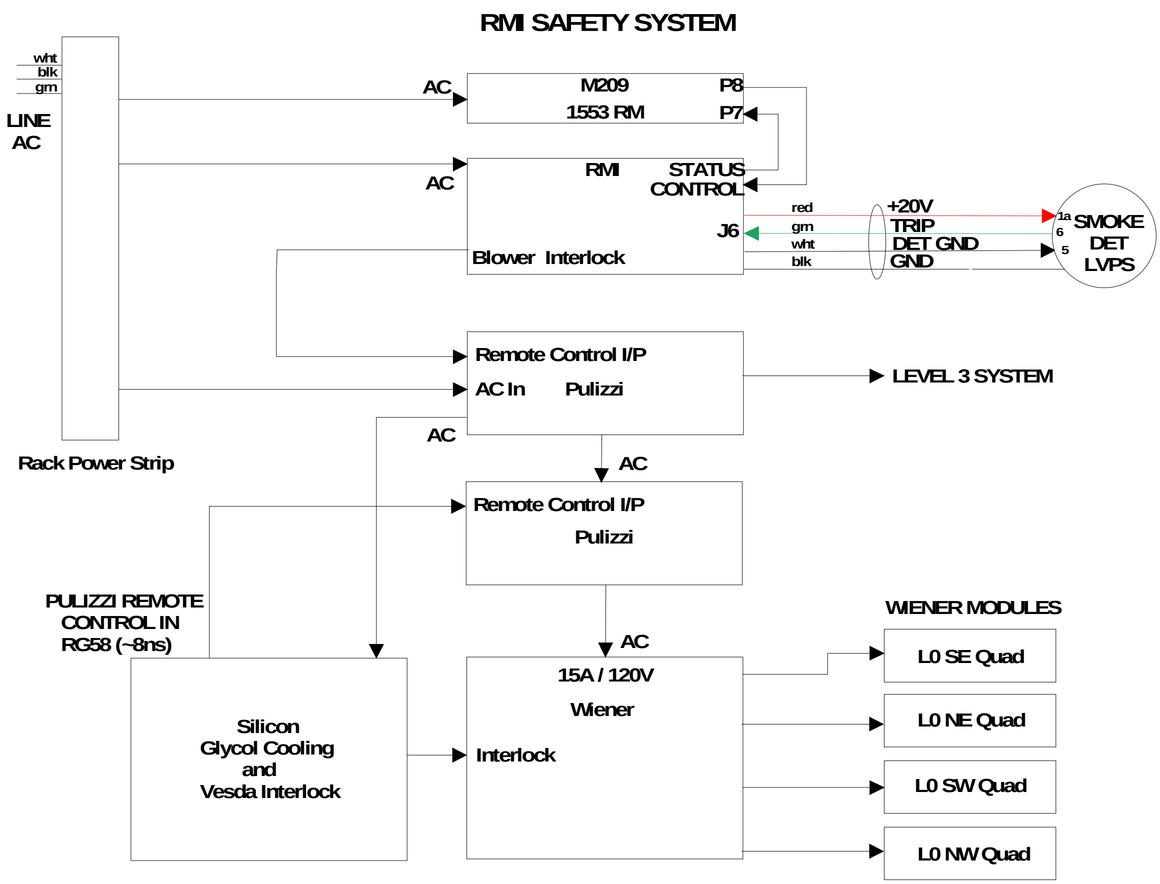


Safety System

Movable Counting House Rack Safety

Figure 10 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 10: Counting House Safety System



Electronics Safety

Low Voltage 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 removing power from 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. 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.

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 the fuse panel directly to the Adapter Card from power supplies and two sources routed through the interface board. 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 SVX4 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 4 to be controlled from the Sequencer. Further circuitry prevents voltage from reaching the digital signal drivers communicating with the SVX4 until the SVX4 supply voltage is active.

The junction card is passive, having only connectors and capacitors. SVX4 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.