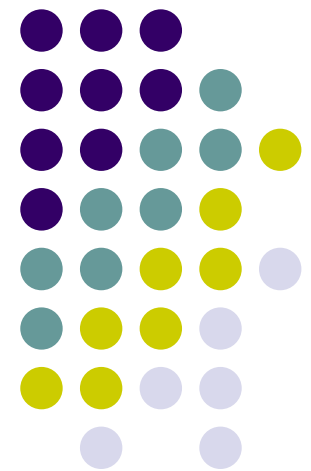


TOF Low Voltage System Review



TOF Low Voltage Power System.



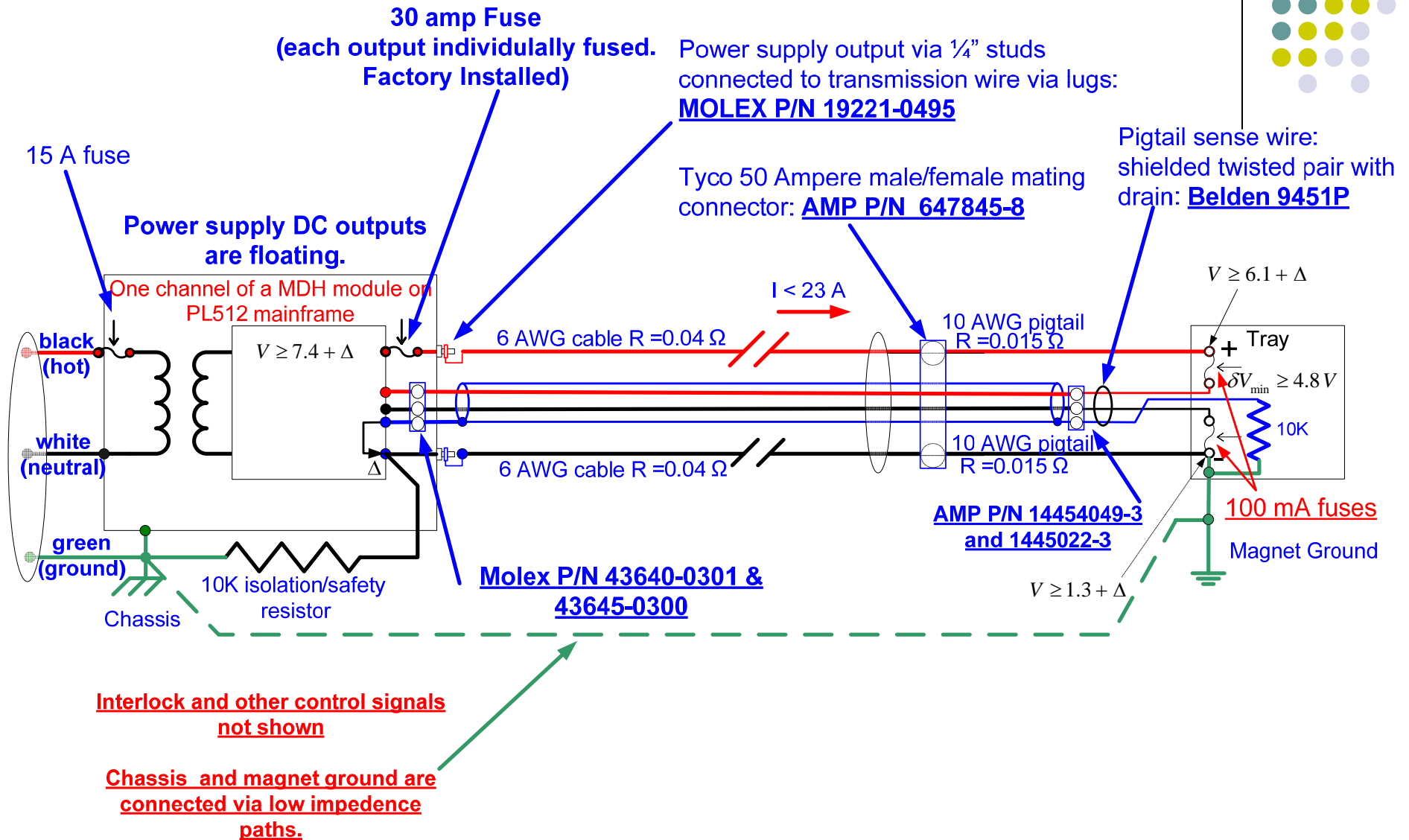
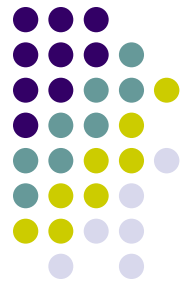
- The TOF low voltage system is based on the Wiener PL512 low noise, high efficiency switching power supply mainframe. These units are the upgraded version of PL500 and PL508 systems which are currently in use by the EMC PMT high voltage system and the TOF system (in Run 5).
[a PL508 was purchased and used in data taking run of 2005 to test its possible noise contribution to TOF FEEs. No difference was observed between data taken with the Linear Power supplies used in the earlier year runs (and also in 2005 data) and the PL508 data within the statistical significance of the dark current data- see the plot of the dark current data on slide].
- The DC power will be transmitted via DC transmission lines (one pair of 6 AWG cables) to the 120 trays, 4 THUBs and 2 TPMDs. The maximum current per transmission line shall not exceed 25 amperes @ 8 volts [this is the maximum output of each channel]. In addition the DC voltage at the load will be sensed via sense wires and transmitted to the PL512s via a pair of 22 AWG twisted pair shielded cables.
These cables will be installed and cut to appropriate lengths depending on position of each tray. This is intended to minimize the cable slack in the trays and in the electronic racks. All connectors will be installed after the cables are routed.
- The PL512s will need 208 VAC @ 16 Amperes (maximum)
- There are 6 MDH modules used by PL512. Each MDH module has two independent DC outputs which are **floating** and may be remotely set and monitored via PL512's Ethernet interface. Each floating output of the MDH module has a 30 Ampere fuse in series. In addition each output channel has over voltage and current limiting functions built into the circuitry.
- A total of twelve PL512's are used in TOF LV system:
 - ⚡ 10 of these units supply 23 amperes @ 4.5 volts (at the load) to the TOF trays,
 - ⚡ 11th unit supplies 4.5 volts @ 25 amperes to THUBs (8 outputs are used to supply power to 4 THUBs).
 - ⚡ Two additional channels supply DC to TOF start detector front end electronics [one per each side]
 - ⚡ The 12th PL512 (i.e., 12 DC outputs) will be used as spare
- Interlock function on the LV system is implemented via rack power control box.
- Slow control of the LV system is implemented in SNMP/Ethernet protocol via STAR standard EPICS. [voltage and current settings/monitoring, ramp up rate, temperature readings are all implemented].
- The return of each DC transmission line is Grounded at the tray to STAR magnet ground.

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LV Electrical Connection Details

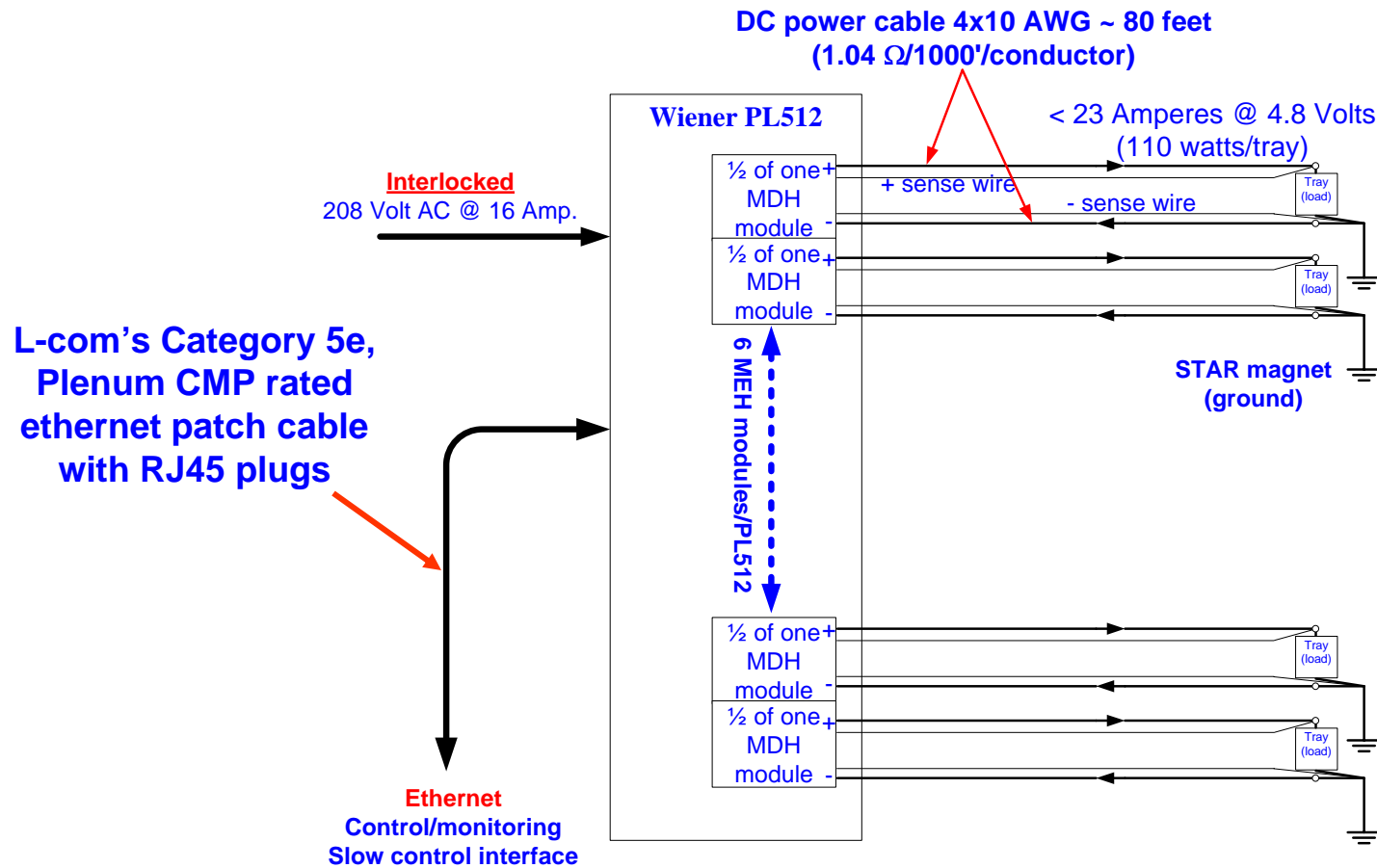


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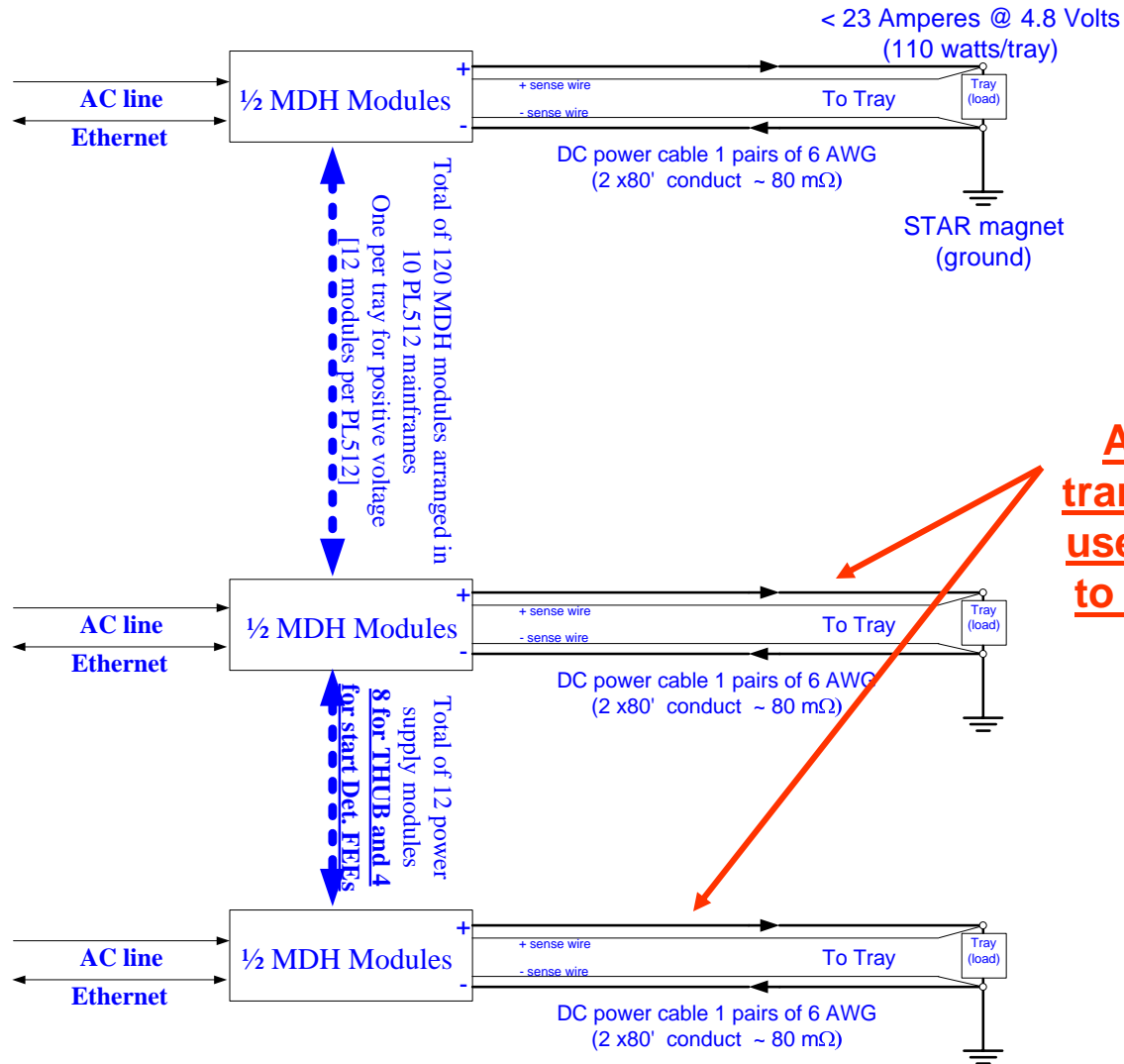


Tray Low Voltage System Configuration



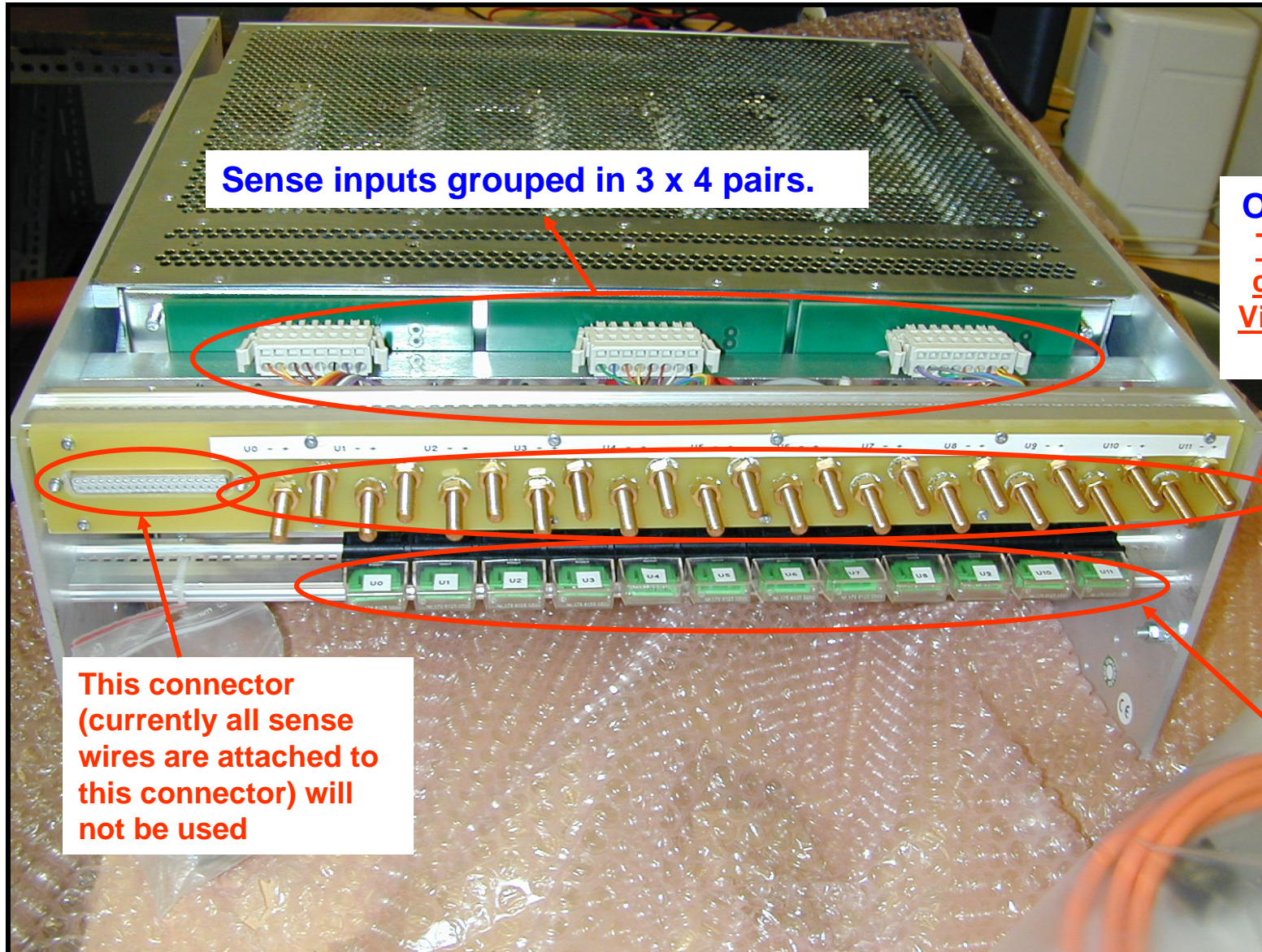
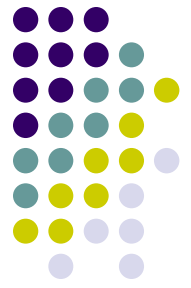
Wiener PL512 based low voltage power supply system for TINO based TOF FEE.
(only one out of 11 units shown)

Tray Low Voltage Power System.



A total number of 130 transmission lines will be used to supply DC power to the TOF trays, THUBs and TPMDs

Rear View of PL512 mainframe LV power supply



Sense inputs grouped in 3 x 4 pairs.

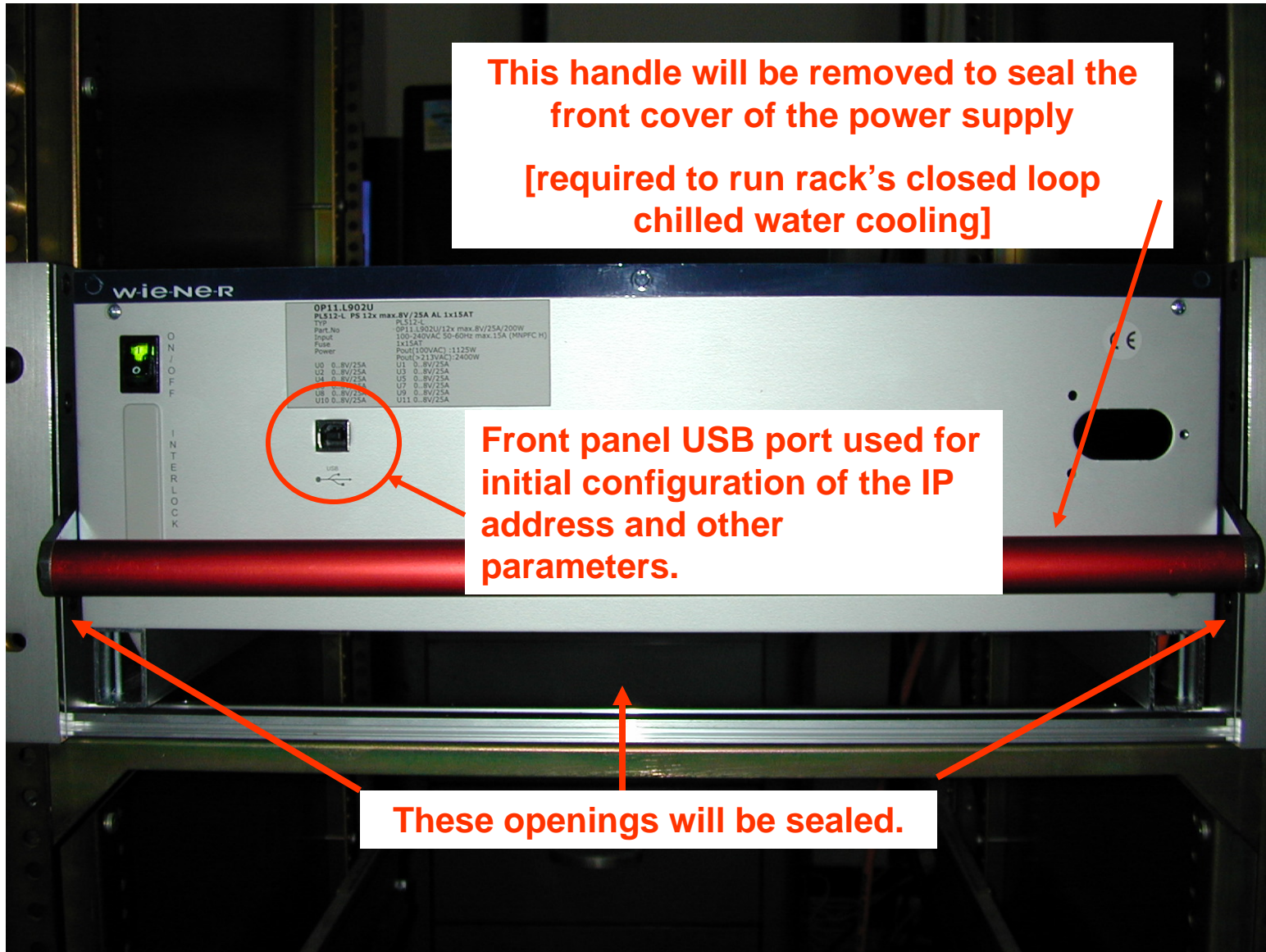
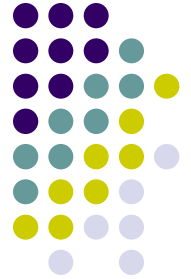
Output studs
These will be capped using Vinyl insulating caps.

This connector (currently all sense wires are attached to this connector) will not be used

30 Amp fuses on every DC output



Front View of PL512 Low Voltage Mainframe



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LV power Supply Arrangement in the Full size Racks

- Total power dissipated by each tray ~ 110 Watts
- Total Power dissipated outside power supply [45 Watts dissipated in each transmission cable] (trays + cables) ~ 155 Watts
- Total heat dissipation per MDH module (assuming 83% efficiency) ~ 63.5 Watts
- Total Heat Dissipation per power supply mainframe ~ 381 Watts
- Total heat dissipation per full rack ~ 2.3 KW
- Available cooling power/rack (2 heat exchangers) ~ 2.4 KW

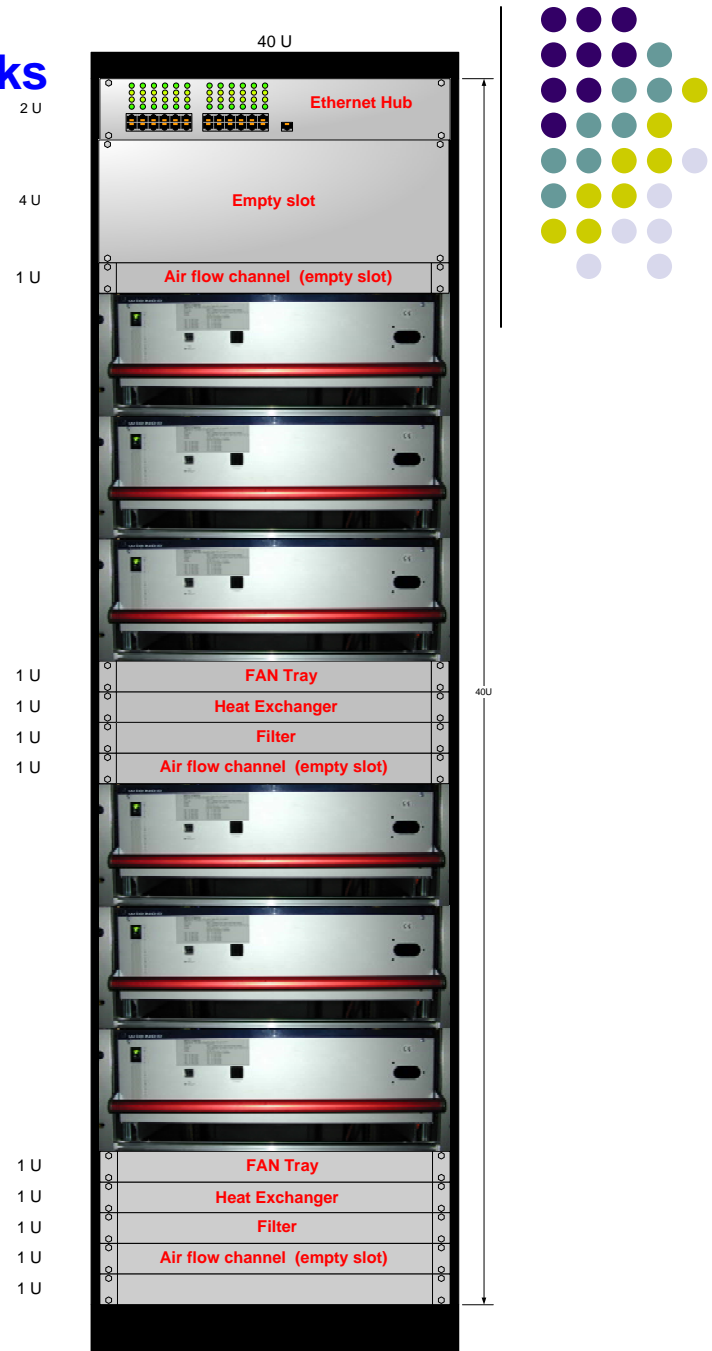
Max. output power per mainframe chassis: 3 KW

(power factor 0.96; $V_{\max} = 208 \text{ V}$; $I_{\max} = 15 \text{ A}$)

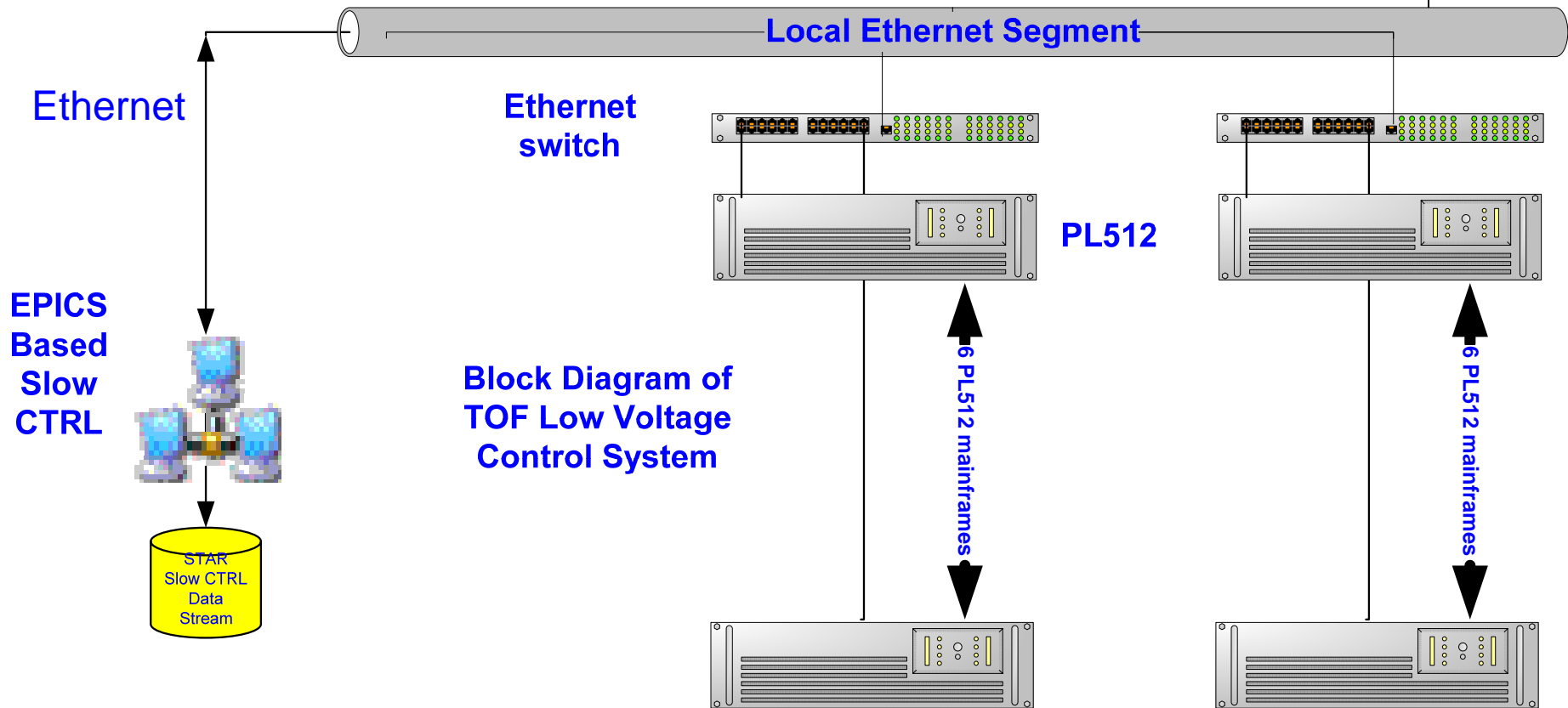
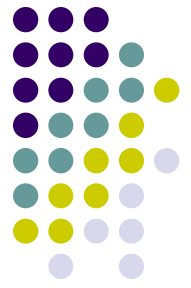
<http://www.wiener-d.com/products/20/73.html>

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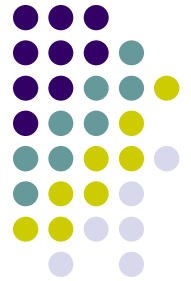
Slow Control for the TOF Low Voltage System



This figure shows the slow control interface to the TOF LV power supplies.

LabView Based Control Program for PL512

[this software is only used to test functionality of the PL512]



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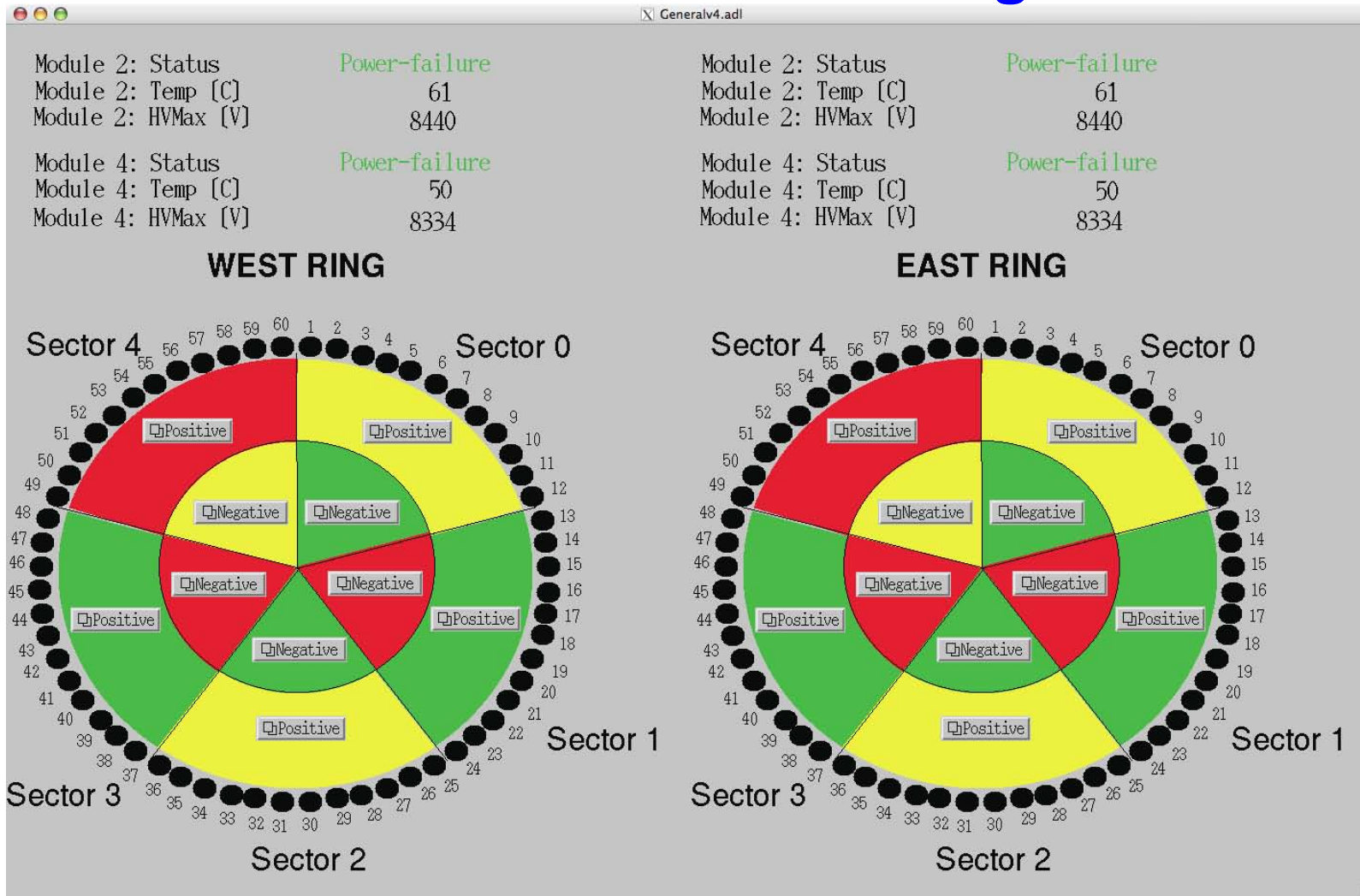




Slow Control System for LV and HV systems.

- An EPICS based slow control system is under development. EPICS/Scientific Linux is the STAR standard slow control environment. This allows archiving of process variables, and allows integration of the TOF LV and HV systems into the “experiment control”.
- The slow control system for the LV and HV are integrated (i.e.. both LV and HV systems are accessible through the same general MEDM screen), and is Ethernet based .
- The control system is multilayered (i.e.. Three different screens are used to give access to the “General” user, “detector operator” and “expert” users).
- A UCLA graduate student (B. Biritz) has the responsibility for developing the slow control software. He has completed the development and testing of the HV control system using a loaner SY2527 from CAEN.

MEDM Screen for the TOF HV and LV Control and Monitoring



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MEDM Screen for "Operator" User.



Operator.adl

Negative HV, West, Sector 1

Expert Settings

| | |
|----------------------|--------------------------------|
| Ramp up rate [V/s] | 300 |
| Ramp down rate [V/s] | 300 |
| Max. Current [uA] | 31 |
| Sw HV Max [V] | 8000 |
| Trip [s] | 10 (1000s == Constant Current) |

Channel Status

V0 Set [V]
0 to 8000

Present Voltage [V]
7941.5

Present Current [uA]
0.00

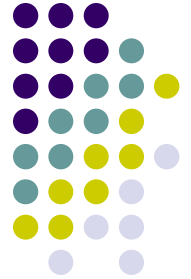
The screen displays two empty plots for Present Voltage and Present Current over time. The x-axis for both plots is 'Time (sec)' ranging from -60.0 to 0.0. The y-axis for both plots ranges from 0.0 to 1.0.

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MEDM Panel for “Expert” User.



Expert.adl

Negative HV, West, Sector 1

Ramp up rate [V/s]
0 to 500

Ramp down rate [V/s]
0 to 500

Max. Current [uA]
0 to 200

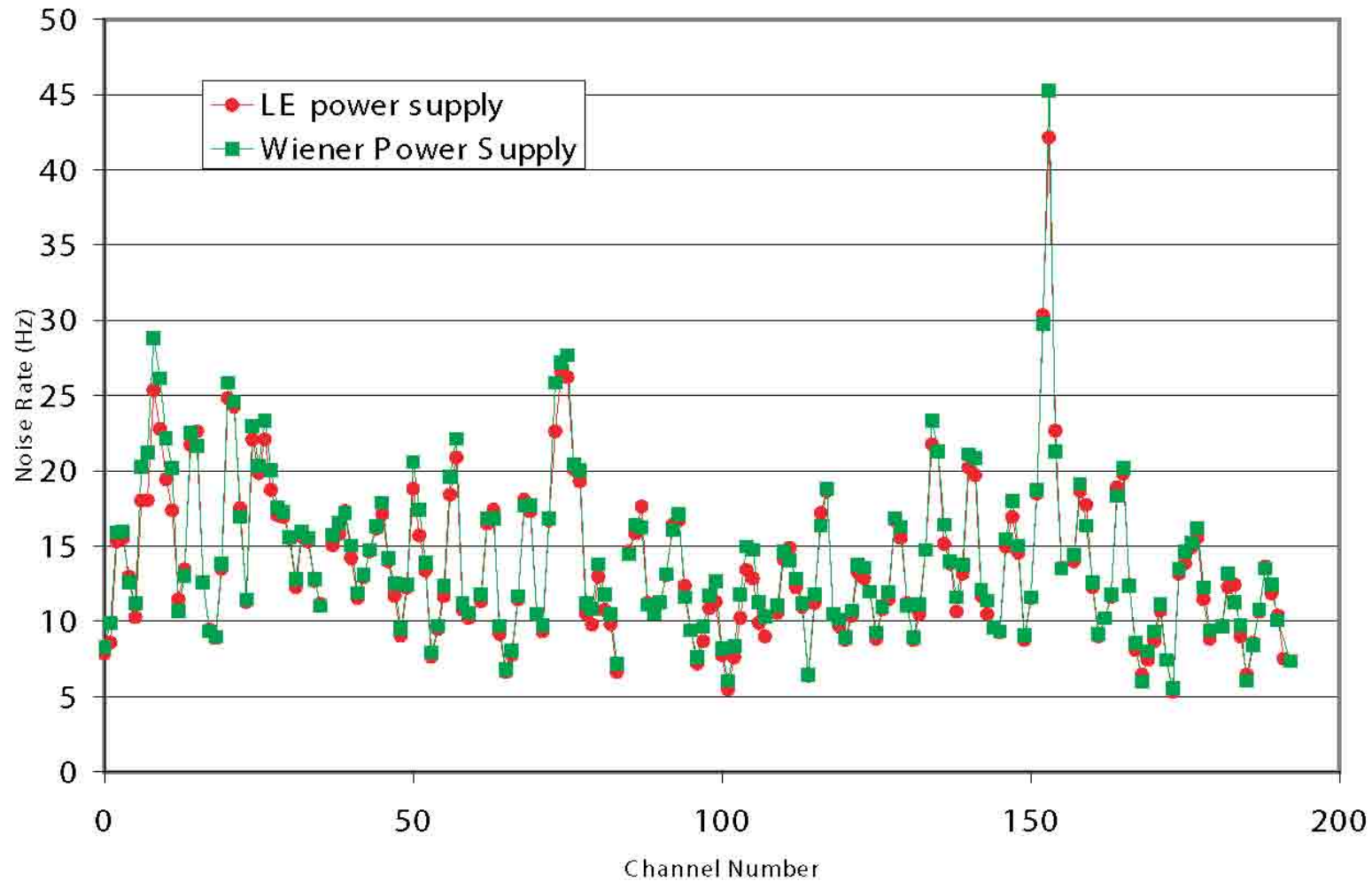
Trip [s]
0 to 1000 == Constant Current

Power Up Mode:

Power Down Mode:



Comparison of TOF tray noise data taken with Linear regulated supplies vs. PL508

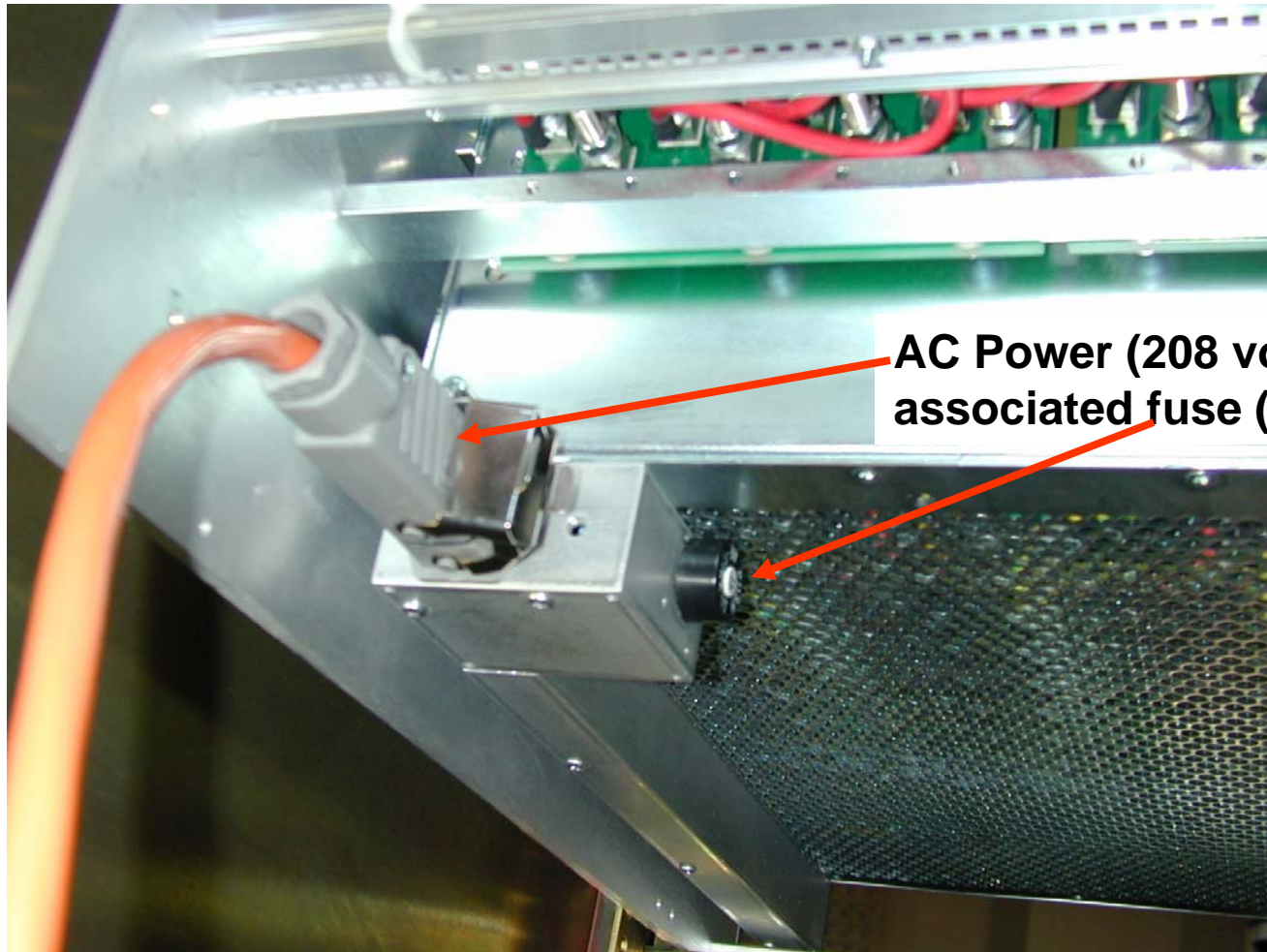
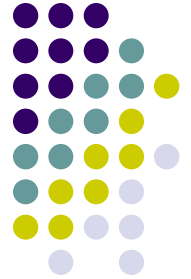


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Photograph of the Bottom-Rear view of PL512 showing AC connection and the AC power Fuse

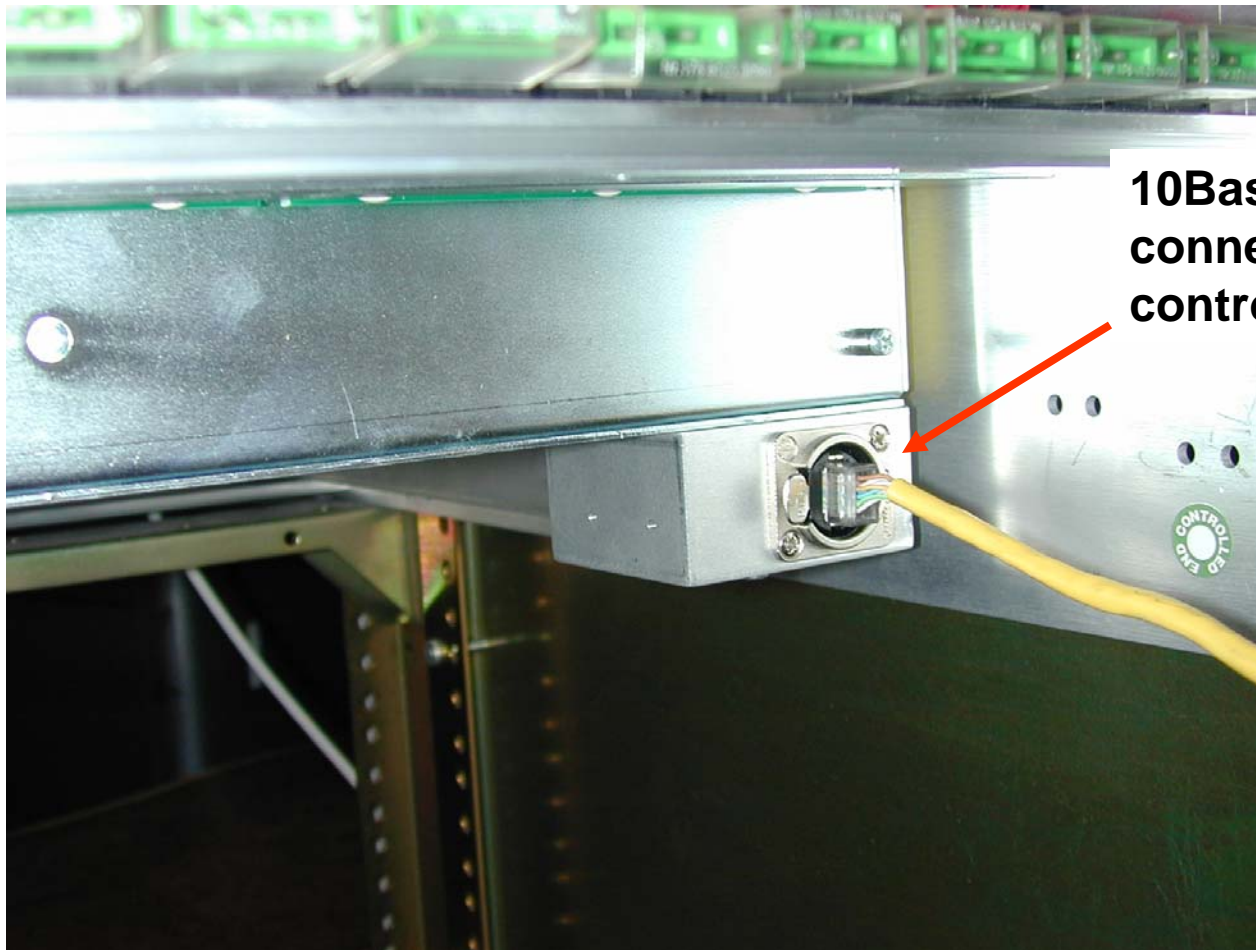


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Photograph of the Bottom-Rear view of PL512 showing 1—Base T Ethernet connection



10Base-T Ethernet connection used for slow control interface to PL512



List of Connectors and Cables Used in the TOF Low Voltage System.

➤ Connectors:

↙ DC power connectors:

- 6 AWG cable connection to power supply stud: lug for 6 AWG wire: **Molex P/N 19221-0495**
- cable connection between 6 AWG cable and 10 AWG “pigtail” cable at the tray: **AMP P/N 647845-8**

↙ Sense wire connection to the power supply:

- 22 AWG sense wire connection to power supply “pigtail” via **MOLEX P/N 43640-0301 & 43645-0300 male/female** connectors. The pigtail directly connects to the power supply’s PC mount connector.
- Sense wire connection to the tray pigtail also uses the above connectors.

↙ Ethernet category 5e patch cable connection to PL512 and to the Ethernet hub is via RJ45 connector: **L-Com Cat. 5E EIA568 Plenum Patch Cable, RJ45 / RJ45, 15.0 ft (CMP rated)**



List of Connectors and Cables Used in the TOF Low Voltage System. (continued)

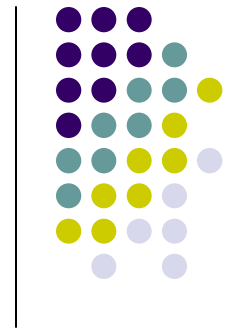
➤ Cables:

↙ DC power cable:

- One pair of 6 AWG cable: this cable is custom made by KC Electronics with PVC jacketed, 600 volt, 105° C, VW-1 and CM rated. [see slide 20 for details]
- One pair of 22 AWG twisted and shielded cable with drain wire used for remote voltage sensing. This cable has its own jacket and is also assembled into a single cable by a further external PVC jacket. All ratings (except current) are the same as the 6 AWG cable. [see slide 20 for details]
- Pigtail 10 AWG (twisted together) 2'-3' connecting above wires to the trays. **SPC P/N 2902** (UL 1015 approval UL and CSA).
- Pigtail 22 AWG (shielded and twisted pair with inside drain wire) connecting the sense wires of the main transmission line to the TCPU (inside tray) **Belden P/N 9451P** (CMP rated plenum, tray wire)

↙ Ethernet category 5e patch cable connection to PL512 and to the Ethernet hub is via RJ45 connector: **L-Com Cat. 5E EIA568 Plenum Patch Cable, RJ45 / RJ45, 15.0 ft (CMP rated)**

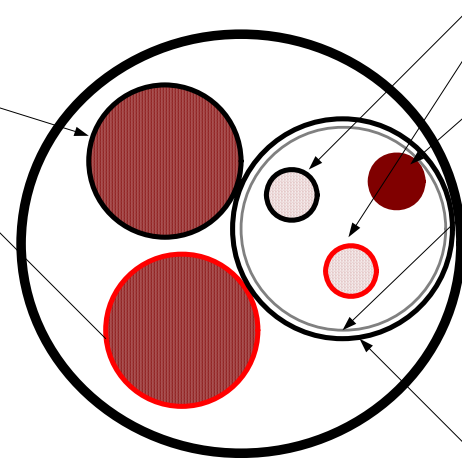
Properties of DC Transmission Custom Cable.



- 6 AWG wire is per UL1283.
- Flame rating on this wire is FT-1 and VW-1.
- 22awg wire is per UL1015. Flame rating on this wire is FT-1.
- Both of these wires are rated 600v per UL.
- The overall Black PVC jacket will have VW-1 flame rating.
- The outer jacket thickness is approx 50 mil.

6 AWG, stranded twisted pair conductors (jacketed Red and Black)

22 AWG, stranded twisted pair conductors (jacketed Red and Black)



Stranded drain wire

Foil shield

Black jacket

Specifications supplied by the vendor:
KC Electronics, Long Island, NY

Safety features of the Electronics Boards



The features presented on this page are outside the scope of the LV system, and are presented for completeness. These features will be presented in more detail in the safety reviews of the TOF electronics.

- Start detector FEE: TPMD boards are equipped with Raychem SMD075-2 self resetting $\frac{3}{4}$ A fuses, and Diode Inc. SMCJ type 1500 W voltage over voltage protection devices on the power input sections.
- Tray Boards:
 - ↪ TDIG boards use Raychem SMD25-2 self resetting 2.5 A 15 V max fuses and same over voltage protection as TPMD.
 - ↪ TCPU protection will be similar to TDIG's