Fermilab

DØ CRYOGENIC SYSTEM SUPERCONDUCTING SOLENOID PLATFORM I/O

ENGINEERING NOTE
3823.111-EN-474

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October 9,1997

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I Introduction

The Dzero detector is scheduled for a major upgrade between 1996 and 1999. This note describes the specifications and configuration of the physical Input/Output devices and instrumentation of the 2 Tesla Superconducting Solenoid.

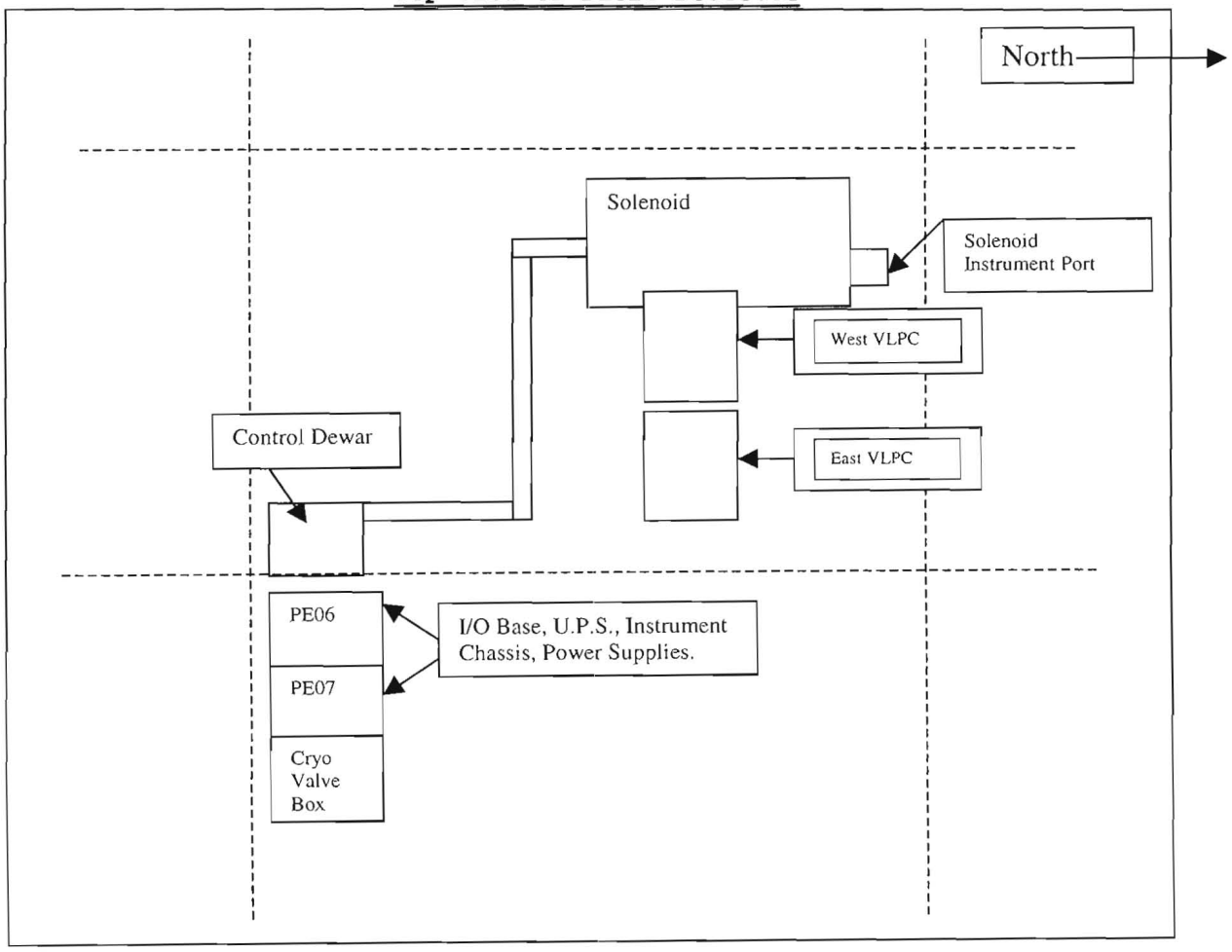
The Solenoid and the VLPC cryostats both reside on the detector platform and are cooled by the Dzero Helium Refrigerator. The cryogenic process controls for these two components will be an extension of the TI565 programmable logic controller system used for other Dzero cryogenic controls.

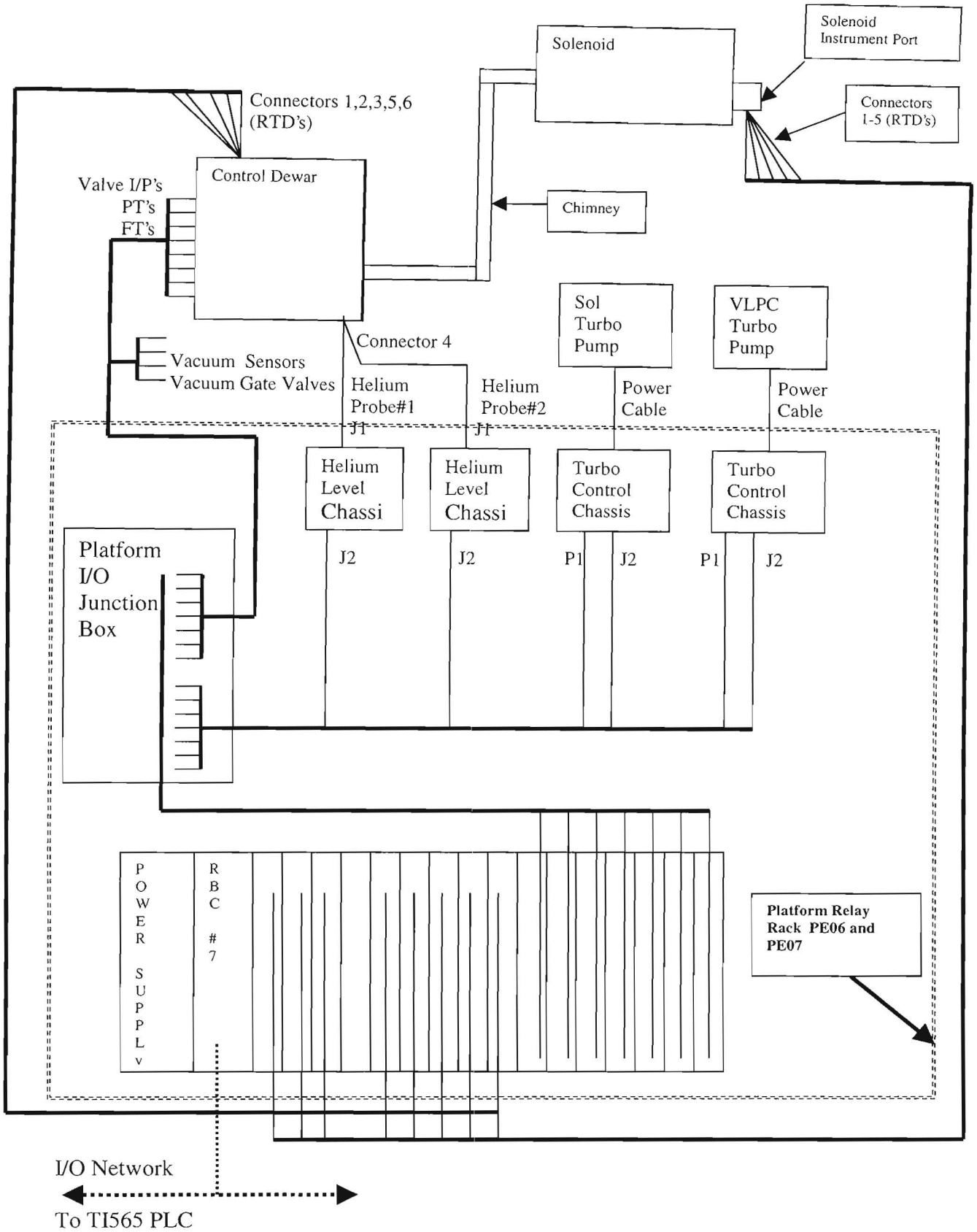
Two Input/Output Bases will be installed on the Dzero detector platform near the cryo corner. These I/O bases will handle all the sensor input and process control output devices from the Solenoid and VLPC cryostats. Having the I/O bases installed on the detector platform makes the connecting cabling to the platform much easier. All the instruments are wired directly to the I/O base. The bases have only one communications network cable that must be routed off the platform to the South side of the Dzero building.

II. Equipment Layout and Cable Routing

A. Platform Cryogenic Control equipment location

Top View of Dzero Detector





Dzero Superconducting Solenoid Cryogenic Controls Interconection and Cabling Block Diagram

The cables from the Solenoid North end instrument port will follow the North face of the CC vacuum vessel down to the cable tray below the CC. This tray runs out the lower South end of the center iron. They will then drop down to the lower platform and over to PE06 and PE07.

The Control Dewar cables will run straight down the East leg of the cryo beam and across to PE06 and PE07.

B. Equipment Installed in Relay Racks PE06 and PE07

1. TI565 Input Output Base #7.
2. TI565 Input Output Base #8.
3. 2 American Magnetics Helium Level Chassis.
4. 24 Vdc Power Supply.
5. 15 Vdc Power Supply.
6. Input/Output Network Termination Box.
7. 120 VAC U.P.S. and Battery Pack.
8. 2 Turbomolecular pump controller chassis.
9. DC Power distribution and protection terminals.
10. Input/Output base signal distribution terminals.

III. I/O Base Layout and I/O Map

The TI565 Programmable Logic Controller will have Input/Output bases #7 and #8 installed on the platform in Relay Racks PE06 and PE07.

A. I/O Base #7

The base will be addressed as Base #7 on PLC channel #3. The base slots will have the following modules installed:

Slot#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
POWER SUPPLY	RBC															

Slot 1-CTI 16 Channel RTD Module. 2557 SPQ334
Slot 2-CTI 16 Channel RTD Module. 2557 SPQ334
Slot 3-CTI 16 Channel RTD Module. 2557 SPQ334
Slot 4-Unused
Slot 5-Siemens 8 Channel Platinum RTD Module. 505-7038
Slot 6-Siemens 8 Channel Platinum RTD Module. 505-7038
Slot 7-Siemens 8 Channel Platinum RTD Module. 505-7038

Slot 8-Siemens 8 Channel Platinum RTD Module. 505-7038
Slot 9-Siemens 8 Channel Platinum RTD Module. 505-7038
Slot 10-Siemens 16 Channel Analog Input Module. 505-2555
Slot 11-Siemens 16 Channel Analog Input Module. 505-2555
Slot 12-Siemens 8 Channel Analog Output Module. 505-6208A
Slot 13-Siemens 8 Channel Relay Output Module. 505-4908
Slot 14-1/2 Siemens 16 Channel DC Output Module. 505-4716
Slot 15-1/2 Siemens 16 Channel DC Output Module. 505-4716
Slot 16-Siemens 16 Channel DC Input Module. 505-4316A

B. I/O Base #8

	Slot#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
POWER SUPPLy	RBC																

Slot 1-CTI 16 Channel RTD Module. 2557 SPQ334
Slot 2-Unused
Slot 3-Unused
Slot 4-Unused
Slot 5-Unused
Slot 6-Unused
Slot 7-Unused
Slot 8-Unused
Slot 9-Unused
Slot 10-Unused
Slot 11-Unused
Slot 12-Unused
Slot 13-Unused
Slot 14-Unused
Slot 15-Unused
Slot 16-Unused

C. Platform I/O Map and Assignments

I/O Ch	Base	SLOT/PT	I/O Type	Address	DMACS Tagname	Description	Range
3	7	01/01	CGR RTD	WX2537	TR-3301	Sol, South axial support #1	SER#C16795
3	7	01/02	CGR RTD	WX2538	TR-3302	Sol, South axial support #2	SER#C16796
3	7	01/03	CGR RTD	WX2539	TR-3303	Sol, South axial support #3	SER#C16797
3	7	01/04	CGR RTD	WX2540	TR-3304	Sol, North axial support #4	SER#C16810
3	7	01/05	CGR RTD	WX2541	TR-3305	Sol, North axial support #5	SER#C16811
3	7	01/06	CGR RTD	WX2542	TR-3306	Sol, North axial support #6	SER#C16812
3	7	01/07	CGR RTD	WX2543	TR-3317	Sol, North radial support #7	SER#C16813

3	7	01/08	CGR RTD	WX2544	TR-3318	Sol, North radial support #8	SER#C16814
3	7	01/09	CGR RTD	WX2545	TR-3319	Sol, North radial support #9	SER#C16815
3	7	01/10	CGR RTD	WX2546	TR-3320	Sol, North radial support #10	SER#C16816
3	7	01/11	CGR RTD	WX2547	TR-3321	Sol, North radial support #11	SER#C16817
3	7	01/12	CGR RTD	WX2548	TR-3322	Sol, North radial support #12	SER#C16818
3	7	01/13	CGR RTD	WX2549	TR-3330	Sol, outer support cylinder (South 90 degrees)	SER#C16819
3	7	01/14	CGR RTD	WX2550	TR-3331	Sol, outer support cylinder (Center 90 Degrees)	SER#C16820
3	7	01/15	CGR RTD	WX2551	TR-3332	Sol, outer support cylinder (North 90 Degrees)	SER#C16821
3	7	01/16	CGR RTD	WX2552	TR-3333	Sol, outer support cylinder (South 270 Degrees)	SER#C16830
3	7	02/01	CGR RTD	WX2553	TR-3334	Sol, outer support cylinder (Center 270 degrees)	SER#C16823
3	7	02/02	CGR RTD	WX2554	TR-3335	Sol, outer support cylinder (North 270 degrees)	SER#C16824
3	7	02/03	CGR RTD	WX2555	TR-3343-H	Sol, magnet coil (South 270 Degrees)	SER#C16825
3	7	02/04	CGR RTD	WX2556	TR-3344-H	Sol, magnet coil(Center 270 Degrees)	SER#C16826
3	7	02/05	CGR RTD	WX2557	TR-3345-H	Sol,outer support cylinder (North 270 degrees)	SER#C16827
3	7	02/06	CGR RTD	WX2558	TR-3360-H	Sol, outer support cylinder,helium supply	SER#C16828
3	7	02/07	CGR RTD	WX2559	TR-3370-H	Sol, outer support cylinder, helium return	SER#C16829
3	7	02/08	CGR RTD	WX2560			
3	7	02/09	CGR RTD	WX2561	TR-3268-H	Control dewar, East Vapor Cooled Leads, Bottom	SER#C16478
3	7	02/10	CGR RTD	WX2562	TR-3278-H	Control dewar, West Vapor Cooled Leads, Bottom	SER#C16553
3	7	02/11	CGR RTD	WX2563	TR-SCOUT-H	Solenoid Subcooler Helium Out	SER#C16822
3	7	02/12	CGR RTD	WX2564	TR-3212-H	Cooldown/quench Helium return	SER#C17105
3	7	02/13	CGR RTD	WX2565	TR-3103-H	Solenoid GHe ruturn	SER#x03618
3	7	02/14	CGR RTD	WX2566			
3	7	02/15	CGR RTD	WX2567			
3	7	02/16	CGR RTD	WX2568			
3	7	03/01	CGR RTD	WX2569			
3	7	03/02	CGR RTD	WX2570			
3	7	03/03	CGR RTD	WX2571			
3	7	03/04	CGR RTD	WX2572			
3	7	03/05	CGR RTD	WX2573			
3	7	03/06	CGR RTD	WX2574			
3	7	03/07	CGR RTD	WX2575			
3	7	03/08	CGR RTD	WX2576			
3	7	03/09	CGR RTD	WX2577			
3	7	03/10	CGR RTD	WX2578			
3	7	03/11	CGR RTD	WX2579			
3	7	03/12	CGR RTD	WX2580			

3	7	03/13	CGR RTD	WX2581		
3	7	03/14	CGR RTD	WX2582		
3	7	03/15	CGR RTD	WX2583		
3	7	03/16	CGR RTD	WX2584		
3	7	05/01	RTD	WX2601	TP-3301	Sol, South axial support #1
3	7	05/02	RTD	WX2602	TP-3302	Sol, South axial support #2
3	7	05/03	RTD	WX2603	TP-3303	Sol, South axial support #3
3	7	05/04	RTD	WX2604	TP-3304	Sol, North axial support #4
3	7	05/05	RTD	WX2605	TP-3305	Sol, North axial support #5
3	7	05/06	RTD	WX2606	TP-3306	Sol, North axial support #6
3	7	05/07	RTD	WX2607	TP-3311	Sol, support cylinder (North 30 degrees)
3	7	05/08	RTD	WX2608	TP-3312	Sol, support cylinder (North 150 degrees)
3	7	06/01	RTD	WX2609	TP-3313	Sol, outer support cylinder (North 270 Degrees)
3	7	06/02	RTD	WX2610	TP-3314	Sol, support cylinder (South 30 degrees)
3	7	06/03	RTD	WX2611	TP-3315	Sol, support cylinder (South 150 degrees)
3	7	06/04	RTD	WX2612	TP-3316	Sol, outer support cylinder (South 270 Degrees)
3	7	06/05	RTD	WX2613	TP-3317	Sol, North radial support #7
3	7	06/06	RTD	WX2614	TP-3318	Sol, North radial support #8
3	7	06/07	RTD	WX2615	TP-3319	Sol, North radial support #9
3	7	06/08	RTD	WX2616	TP-3320	Sol, North radial support #10
3	7	07/01	RTD	WX2617	TP-3321	Sol, North radial support #11
3	7	07/02	RTD	WX2618	TP-3322	Sol, North radial support #12
3	7	07/03	RTD	WX2619	TP-3346	Sol, outer vacuum vessel (90 degrees)
3	7	07/04	RTD	WX2620	TP-3347	Sol, inner vacuum vessel, 270 degrees
3	7	07/05	RTD	WX2621	TP-3348	Vacuum vessel bulkhead, North, 270 degrees
3	7	07/06	RTD	WX2622	TP-3350-N	Sol, outer LN2 shield
3	7	07/07	RTD	WX2623	TP-3351-N	Sol, outer shield, Center, 270 degrees
3	7	07/08	RTD	WX2624	TP-3352-N	Sol, inner LN2 shield, Center, 90 degrees
3	7	08/01	RTD	WX2625	TP-3353-N	Sol, inner LN2 shield, Center, 270 degrees
3	7	08/02	RTD	WX2626	TP-3354-N	Sol, inner LN2 shield, South, 90 degrees
3	7	08/03	RTD	WX2627	TP-3355-N	Sol, North end LN2 shield
3	7	08/04	RTD	WX2628	TP-3269-H	Control dewar, East Vapor Cooled Lead, Top
3	7	08/05	RTD	WX2629	TP-3279-H	Control dewar, West Vapor Cooled Lead, Top
3	7	08/06	RTD	WX2630	TP-3208-H	Sol, subcooler JT Inlet
3	7	08/07	RTD	WX2631	TP-3207-H	Sol subcooler helium return
3	7	08/08	RTD	WX2632	TP-3206-N	Sol, LN2 supply

3	7	09/01		RTD	WX2633	TP-3225-N	Sol, LN2 return	
3	7	09/02		RTD	WX2634			
3	7	09/03		RTD	WX2635			
3	7	09/04		RTD	WX2636			
3	7	09/05		RTD	WX2637			
3	7	09/06		RTD	WX2638			
3	7	09/07		RTD	WX2639			
3	7	09/08		RTD	WX2640			
3	7	10/01	AI	4-20mA	WX2641	PT-3264-H	Control dewar pressure	0-20 psig
3	7	10/02	AI	4-20mA	WX2642	PT-3258-H	cooldown/quench He return pressure	0-150 psig
3	7	10/03	AI	4-20mA	WX2643	PT-3222-N	LN2 supply to solenoid	0-110 psig
3	7	10/04	AI	4-20mA	WX2644	PT-3218-H	Solenoid, helium supply	0-20 psig
3	7	10/05	AI	4-20mA	WX2645	FT-3253-H	Solenoid He Magnet Flow	0-150 "H2O
3	7	10/06	AI	4-20mA	WX2646	PT-2973-V	Solenoid turbo vacuum Exhaust to Mechanical Pumps	1mTorr-1000Torr
3	7	10/07	AI	4-20mA	WX2647	PT-2921-V	VLPC turbo to D0 vacuum headers	1mTorr-1000Torr
3	7	10/08	AI	4-20mA	WX2648	PT-3242-H	Supply helium pressure at control dewar	0-20 psig
3	7	10/09	AI	4-20mA	WX2649	LL-3250A-H	Control dewar liquid level	45 cm
3	7	10/10	AI	4-20mA	WX2650	LL-3250B-H	Control dewar liquid helium level	45 cm
3	7	10/11	AI	4-20mA	WX2651			
3	7	10/12	AI	4-20mA	WX2652			
3	7	10/13	AI	4-20mA	WX2653			
3	7	10/14	AI	4-20mA	WX2654			
3	7	10/15	AI	4-20mA	WX2655			
3	7	10/16	AI	4-20mA	WX2656			
3	7	11/01	AI	VOLTS	WX2657	PT-2975-V	Solenoid turbo Inlet vacuum	3.8E-9-750 Torr
3	7	11/02	AI	VOLTS	WX2658	PT-2970-V	Sol & VLPC Turbo Common Header	3.8E-9-750 Torr
3	7	11/03	AI	VOLTS	WX2659	PT-3259-V	Control dewar vacumm	3.8E-9-750 Torr
3	7	11/04	AI	VOLTS	WX2660	PT-2925-V	VLPC turbo pump	3.8E-9-750 Torr
3	7	11/05	AI	VOLTS	WX2661	PT-2934-V	VLPC turbo pump	3.8E-9-750 Torr
3	7	11/06	AI	VOLTS	WX2662	PT-4251-V	VLPC vacuum jacket /turbo pump	3.8E-9-750 Torr
3	7	11/07	AI	VOLTS	WX2663			
3	7	11/08	AI	VOLTS	WX2664			
3	7	11/09	AI	VOLTS	WX2665	?PT-4252-V	VLPC vacuum jacket /turbo pump	
3	7	11/10	AI	VOLTS	WX2666	?PT-3229-V	Control dewar vacuum	
3	7	11/11	AI	VOLTS	WX2667			
3	7	11/12	AI	VOLTS	WX2668			
3	7	11/13	AI	VOLTS	WX2669		Solenoid Turbo Pump Current	
3	7	11/14	AI	VOLTS	WX2670		VLPC Turbo Pump Current	

3	7	11/15	AI VOLTS	WX2671	?FT-4278-H	VLPC stagnant helium volumes	
3	7	11/16	AI VOLTS	WX2672			
3	7	12/01	AO	WY2673	D0EVMF	Solenoid helium supply control valve Equal%	0-100%
3	7	12/02	AO	WY2674	PV-3201-H	Solenoid Cooldown Return Control Valve	0-100%
3	7	12/03	AO	WY2675	PV-3209-H	He Return To Control Dewar Subcooler From Solenoid	0-100%
3	7	12/04	AO	WY2676	PV-4300-H	Isolate East VLPC helium return	0-100%
3	7	12/05	AO	WY2677	PV-4400-H	Isolate West VLPC helium return	0-100%
3	7	12/06	AO	WY2678	PV-4305-N	Isolate east LN2 supply	0-100%
3	7	12/07	AO	WY2679	PV-4405-N	Isolate VLPC west LN2 supply	0-100%
3	7	12/08	AO	WY2680			
3	7	13/01	Relay Output	Y2681	SOL_START	Sol Turbo "Start"	
3	7	13/02	Relay Output	Y2682	SOL_LOWSPD	Sol Turbo "Low Speed"	
3	7	13/03	Relay Output	Y2683	SOL_STOP	Sol Turbo "Emergency Stop"	
3	7	13/04	Relay Output	Y2684			
3	7	13/05	Relay Output	Y2685	VLPC_START	VLPC Turbo "Start"	
3	7	13/06	Relay Output	Y2686	VLPC_LOWSPD	VLPC Turbo "Low Speed"	
3	7	13/07	Relay Output	Y2687	VLPC_STOP	VLPC Turbo "Emergency Stop"	
3	7	13/08	Relay Output	Y2688			
3	7	14/01	Discrete Output	Y2689	PV-2915-V	Isolates UV header from VLPC,solenoid vacuums	
3	7	14/02	Discrete Output	Y2690	PV-2920-V	Isolates IV header from VLPC, Solenoid vacuums	
3	7	14/03	Discrete Output	Y2691	PV-2972-V	Isolate solenoid turbo from cntrl dwr, VLPC turbo	
3	7	14/04	Discrete Output	Y2692	PV-3231-V	Isolates control dewar from vacuums	
3	7	14/05	Discrete Output	Y2693	PV-2930-V	Vacuum selctor between VLPC and solenoid	
3	7	14/06	Discrete Output	Y2694	PV-2925-V	VLPC turbo pump isolation from vacuum header	
3	7	14/07	Discrete Output	Y2695	PV-4250-V	VLPC vacuum isolation	
3	7	14/08	Discrete Output	Y2696			
3	7	14/09	Discrete Output	Y2697			
3	7	14/10	Discrete Output	Y2698			
3	7	14/11	Discrete Output	Y2699			
3	7	14/12	Discrete Output	Y2700			
3	7	14/13	Discrete Output	Y2701			
3	7	14/14	Discrete Output	Y2702			

3	7	14/15	Discrete Output	Y2703		
3	7	14/16	Discrete Output	Y2704		
3	7	16/01	Discrete Input	X2705	PV-3231CL	Isolates control dewar from vacuums(Closed Switch)
3	7	16/02	Discrete Input	X2706	PV-3231OP	Isolates control dewar from vacuums(Open Switch)
3	7	16/03	Discrete Input	X2707	PV-4250CL	VLPC vacuum isolation(Closed Switch)
3	7	16/04	Discrete Input	X2708	PV-4250OP	VLPC vacuum isolation(Open Switch)
3	7	16/05	Discrete Input	X2709		
3	7	16/06	Discrete Input	X2710		
3	7	16/07	Discrete Input	X2711		
3	7	16/08	Discrete Input	X2712		
3	7	16/09	Discrete Input	X2713	SOL_FAULT	Sol Turbo "Fault"
3	7	16/10	Discrete Input	X2714	SOL_THRESHOLD	Sol Turbo "R1 Speed Threshold"
3	7	16/11	Discrete Input	X2715	SOL_START_STATUS	Sol Turbo "Start"
3	7	16/12	Discrete Input	X2716	SOL_LOWSPD_MODE	Sol Turbo "Low Speed Mode"
3	7	16/13	Discrete Input	X2717	VLPC_FAULT	VLPC Turbo "Fault"
3	7	16/14	Discrete Input	X2718	VLPC_THRESHOLD	VLPC Turbo "R1 Speed Threshold"
3	7	16/15	Discrete Input	X2719	VLPC_START_STATUS	VLPC "Start"
3	7	16/16	Discrete Input	X2720	VLPC_LOWSPD_MODE	VLPC "Low Speed Mode"
3	8	01/01	CGR RTD	WX2721		
3	8	01/02	CGR RTD	WX2722		
3	8	01/03	CGR RTD	WX2723		
3	8	01/04	CGR RTD	WX2724		
3	8	01/05	CGR RTD	WX2725		
3	8	01/06	CGR RTD	WX2726		
3	8	01/07	CGR RTD	WX2727		
3	8	01/08	CGR RTD	WX2728		
3	8	01/09	CGR RTD	WX2729		
3	8	01/10	CGR RTD	WX2730		
3	8	01/11	CGR RTD	WX2731		
3	8	01/12	CGR RTD	WX2732		
3	8	01/13	CGR RTD	WX2733		
3	8	01/14	CGR RTD	WX2734		
3	8	01/15	CGR RTD	WX2735		
3	8	01/16	CGR RTD	WX2736		

IV. Vacuum System Components

The Vacuum system for the Solenoid and VLPC system must monitor and maintain a vacuum below 10-4 Torr. This system employs 2 Turbo-Molecular pumps, Vacuum transducers and Vacuum slide valves.

The Vacuum system uses three transducers to convert vacuum into a voltage measurement that the control system can read. The three transducers are Granville-Phillips model 275 thermocouple gage, Granville-Phillips model 343 Ion gage, and a Balzer combination thermocouple-Cold cathode gage.

A. Thermocouple

The Thermocouple has a useful range of 760 Torr down to 10-3 Torr. The model 275 has the signal conditioning electronics built into the unit, this allows for a direct voltage input into the control system. The curve fit is broken into 3 segments.

Granville-Phillips Model 275 Tags:

1. PT2973V Solenoid Turbo Foreline Pressure.
2. PT2921V VLPC Turbo Foreline Pressure.

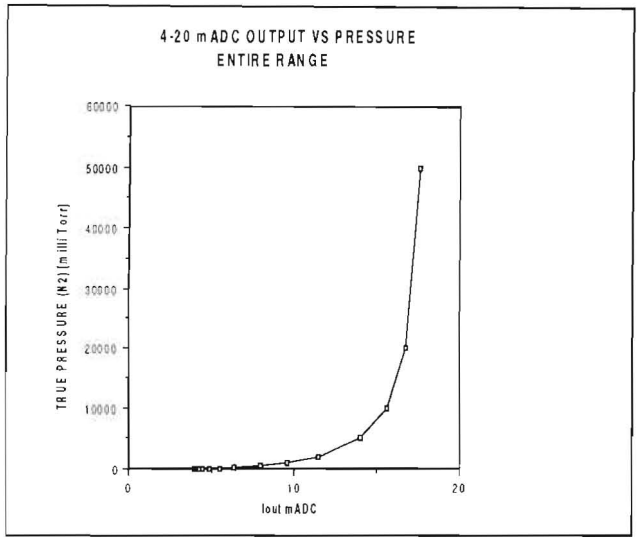
The following equations are used to curve fit the voltage output into the vacuum units:

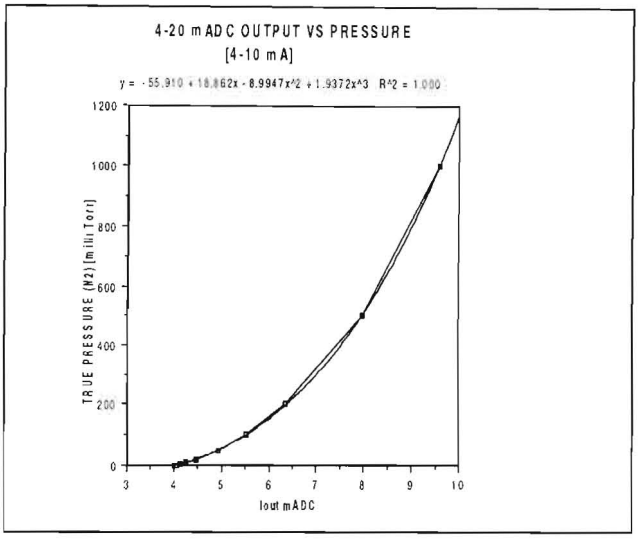
GRANVILLE-PHILLIPS SERIES 275 THERMOCOUPLE

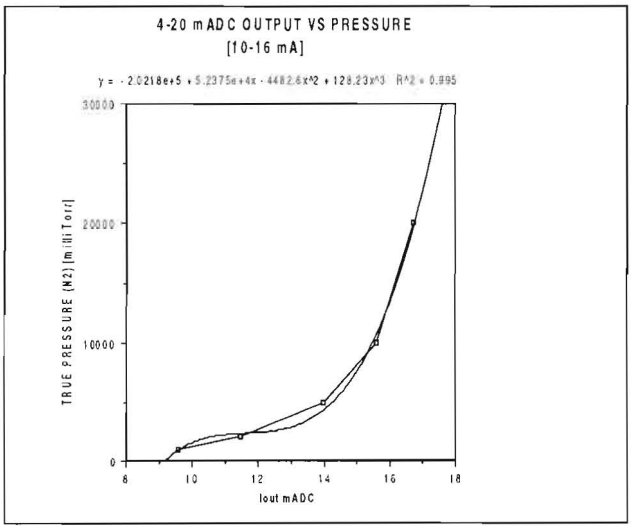
TRUE PRESSURE (N2) [milli Torr]	Iout mADC
0.00	4.000
1.00	4.027
2.00	4.051
5.00	4.127
10.00	4.245
20.00	4.459
50.00	4.928
100.00	5.522
200.00	6.360
500.00	7.958
1000.00	9.573
2000.00	11.465
5000.00	13.985
10000.00	15.592
20000.00	16.715
50000.00	17.529
100000.00	17.829
200000.00	18.052
300000.00	18.331
400000.00	18.673
500000.00	18.991
600000.00	19.263
700000.00	19.493
760000.00	19.611
800000.00	19.684

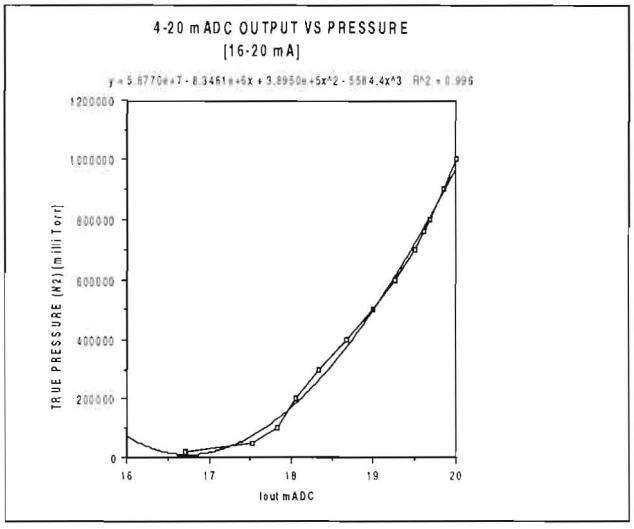
900000.00	19.853
1000000.00	20.000

Granville-Phillips model 275 Thermocouple









Thermocouple 275 Connector Wiring

Pin#	Function
3	+ Power 11-16VDC
4	- Power
5	+ Signal
8	- Signal

B. Ion Gage

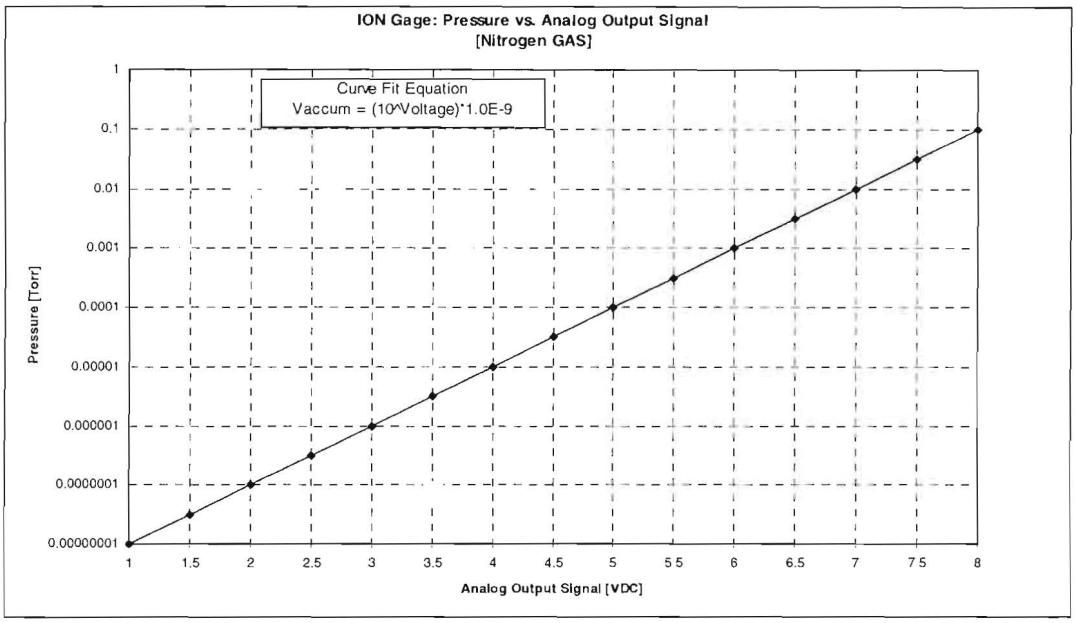
The Ion gage has a useful range of 10-3 Torr down to 10-8 Torr. It is highly accurate and has good repeatability. It does need turn-off protection for when the vacuum is above 10-3 Torr. It also need some control logic to turn them back on when the vacuum goes below 10-3 Torr. The Ion gage will be used on each vacuum vessel in conjunction with the Balzer combination transducer.

Granville-Phillips Model 343 Mini-Ion Tags:

1. PT3229V Solenoid Vacuum Vessel.
2. PT4252V VLPC Vacuum Vessel.

Ion Gage:(Nitrogen Gas) Pressure vs. Analog Output Signal

Analog Ouput Signal [Volts DC]	*Pressure [Torr]*
1	0.00000001
1.5	3.16228E-08
2	0.0000001
2.5	3.16228E-07
3	0.000001
3.5	3.16228E-06
4	0.00001
4.5	3.16228E-05
5	0.0001
5.5	0.000316228
6	0.001
6.5	0.003162278
7	0.01
7.5	0.031622777
8	0.1



Ion Gage 343 Connector Wiring

Pin#	Function
1	Gage On/Off
2	- Power
3	+ Signal
4	+ Power 24VDC
5	Degas Status
6	Degas On/Off
7	- Signal
8	Emission Current
9	Gage Status

C. Balzer Combination Cold Cathode-Thermocouple

The Balzer combination transducer is a combination cold cathode and thermocouple in one housing with one signal output. It has a useful range from 760 Torr down to 10-9 Torr. It is not as accurate or repeatable as a Ion gage below 10-3 Torr, however the Balzer needs no range protection. The Balzer will be used throughout the pumping circuit as well as in conjunction with the Ion gage on the Vacuum vessels.

Balzer PKR250 Tags:

1. PT3259V Solenoid Vacuum Shell.
2. PT4251V VLPC Vacuum Shell.
3. PT2970V Solenoid Turbo Crossover.
4. PT2975V Solenoid Turbo Inlet.
5. PT2934V VLPC Turbo Crossover.
6. PT2925V VLPC Turbo Inlet.

Pressure vs. Signal for BALZERS

Signal [volts]	*Pressure [Torr]*
< 0.5	ERROR
0.5 ..... 1.82	UNDERRANGE
1.82	3.80E-09
2	7.50E-09
2.6	7.50E-08
3.2	7.50E-07
3.8	7.50E-06
4.4	7.50E-05
5	7.50E-04
5.6	7.50E-03
6.2	7.50E-02
6.8	7.50E-01
7.4	7.5
8	75
8.6	750
8.6 ..... 9.5	OVERRANGE

Balzer Connector Wiring

Pin#	Function
2	+ Signal
3	- Signal
1	
4	+ Power 15-30VDC
5	- Power
6	Shield (Earth Ground)

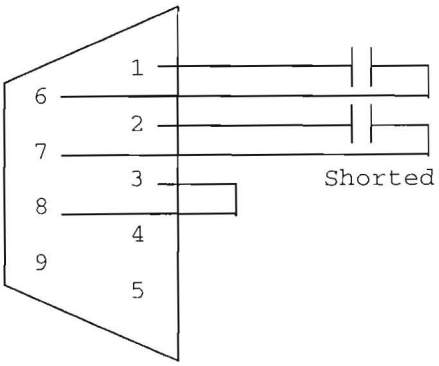
D. TurboMoloecular Pump Controller

The Platform vacuum system has 2 TurboMolecular pumps, one dedicated to the solenoid vacuum vessel and one dedicated to the VLPC vacuum vessel. The pumping manifold configuration also contains a crossover piping configuration.

The Turbo Molecular pumps are powered by a manufacturer's control unit. This control unit will be relay rack mounted on the detector platform. The control unit has remote control connections which will be wired to the platform I/O base. This will allow a DMACS picture to be the control interface to the turbo pumps.

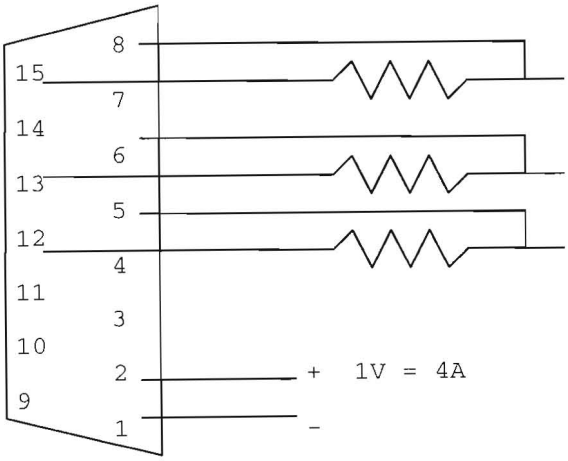
The following connection diagrams show this wiring interface:

Connector P1 "PIN" Interconnection



	Solenoid	VLPC
Start/Stop	Y2681	Y2685
Low/High Speed	Y2682	Y2686

Connector J2 "Socket" Interconnection
Resistors are 10k



	Solenoid	VLPC
24V = Fault 0V = No Fault	X2713	X2717
24V = Starting 0V = Normal	X2715	X2719
24V = Low Speed 0V = High Speed	X2716	X2720
	WX2669	WX2670

E. Gate Valve

The Dzero Detector Platform Vacuum system uses slide gate valves for isolating piping sections. The gate valves are pneumatically driven. The pneumatics are directed by a 24VDC solenoid that is purchased with the valve and is mounted to it. The pneumatic solenoid is wired to the PLC I/O Base #7.

V. Instrumentation

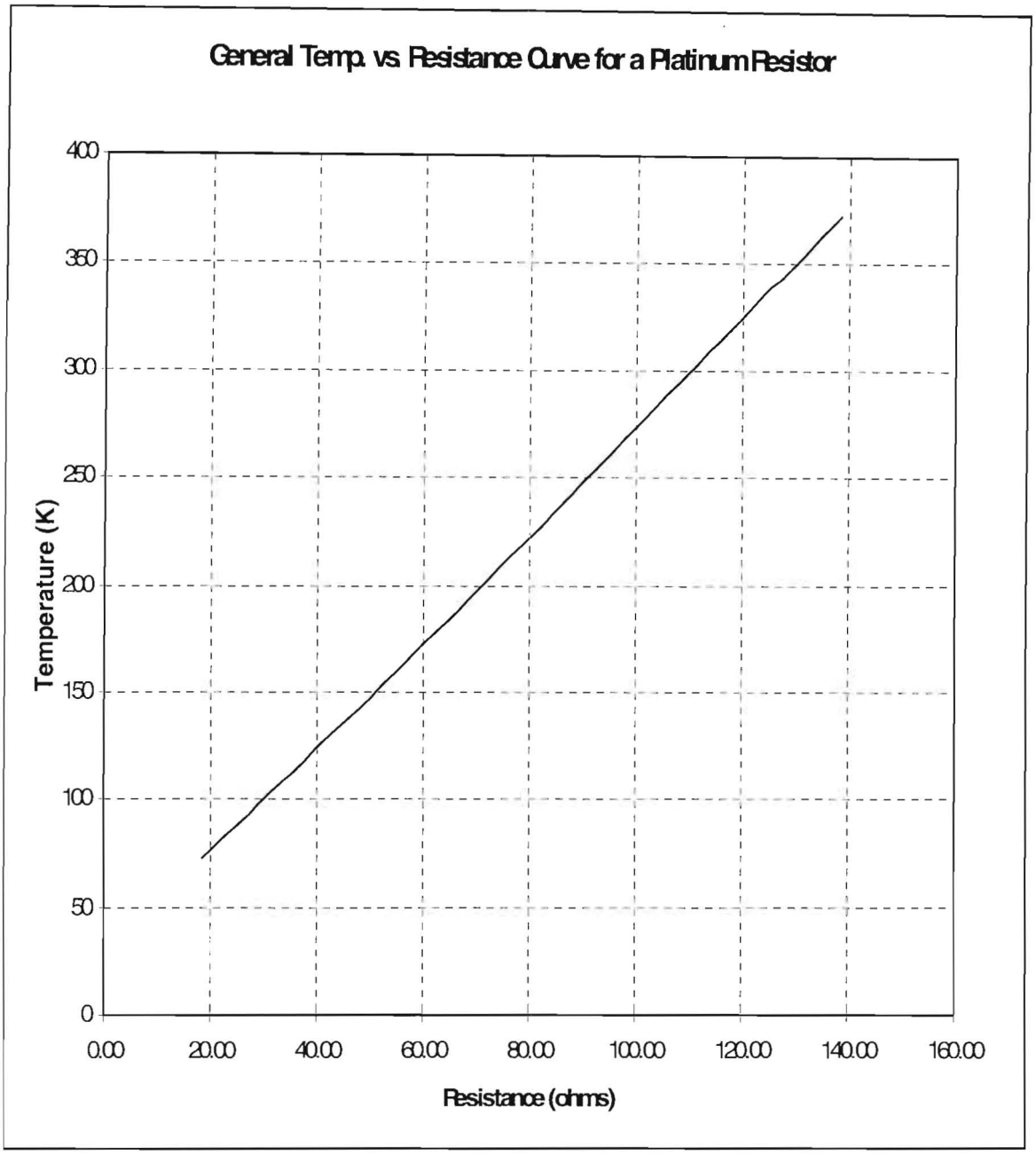
Temperature is measured by three types of sensors throughout the Solenoid, Solenoid control dewar, and VLPC cryostats. The three sensors are platinum RTD's, Carbon Glass RTD's, and Cernox RTD's. Each RTD's resistance is measured by the control system I/O base on the platform. The control system then curve fits the resistance into temperature using the following curve fit equations. All platform RTD's are four wire devices.

A. Platinum RTD

Platinum RTD's are useful between room temp to 70 degrees kelvin. They are typically used on nitrogen shield related devices and cryogenic transitions to room temperature, such as vent piping.

PLATINUM RESISTOR

Temp.(Celsius)	Temp.[K]	Resist.[ohms]	Temp.(Celsius)	Temp.[K]	Resist.[ohms]
-200	73	18.49	-40	233	84.27
-190	83	22.80	-30	243	88.22
-180	93	27.08	-20	253	92.16
-170	103	31.32	-10	263	96.09
-160	113	35.53	0	273	100.00
-150	123	39.71	10	283	103.90
-140	133	43.87	20	293	107.79
-130	143	48.00	30	303	111.67
-120	153	52.11	40	313	115.54
-110	163	56.19	50	323	119.40
-100	173	60.25	60	333	123.24
-90	183	64.30	70	343	127.07
-80	193	68.33	80	353	130.89
-70	203	72.33	90	363	134.70
-60	213	76.33	100	373	138.50
-50	223	80.31			

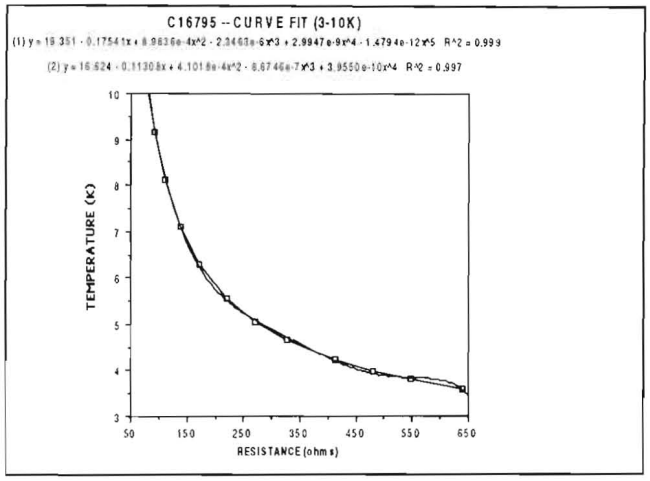

General Temp. vs. Resistance Curve for a Platinum Resistor
Temperature (K)
400
350
300
250
200
150
100
50
0
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
Resistance (ohms)

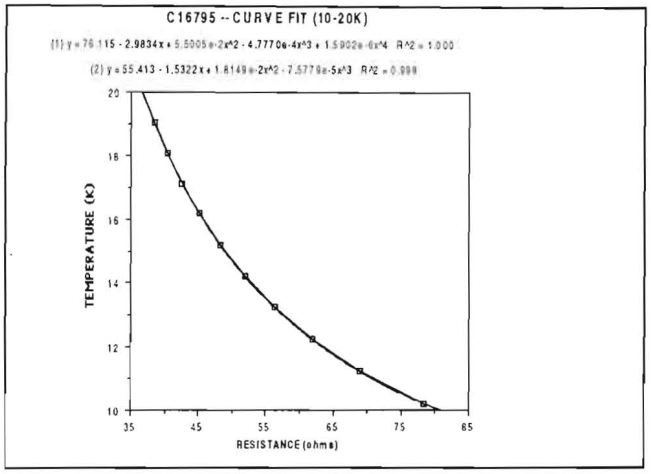
B. Carbon Glass RTD

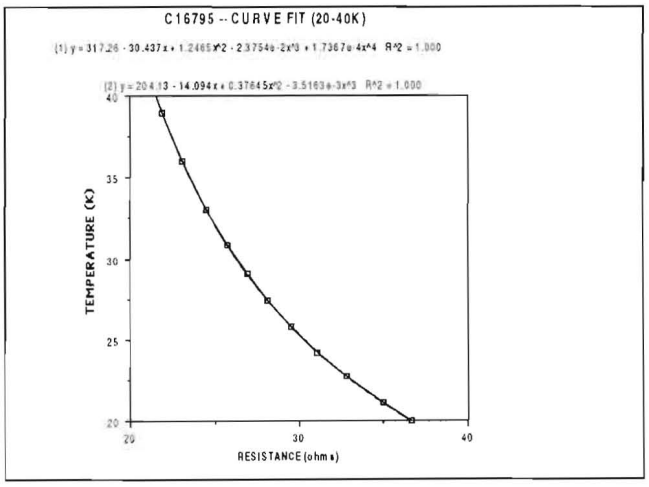
The Carbon Glass RTD's have a useful temperature range of between 1 and 50 Degrees Kelvin. They are particularly sensitive below 10 degrees Kelvin. They are used throughout the solenolid coil and internal Helium piping. Special Control Technology Inc. PLC modules were ordered to measure these sensors. The modules have a stimulation current of 10 microAmps, and can read a resistance range of 0 to 1060 ohms.

These RTD's are individually curve fit to match their resistance with the temperature. The following plots and curve fit equations are for a carbon glass RTD with the serial #C16795.

TR3301 C16795





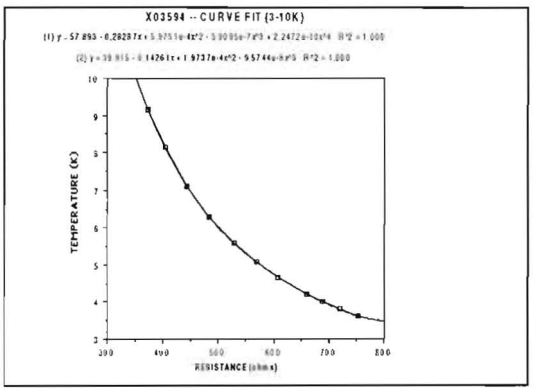


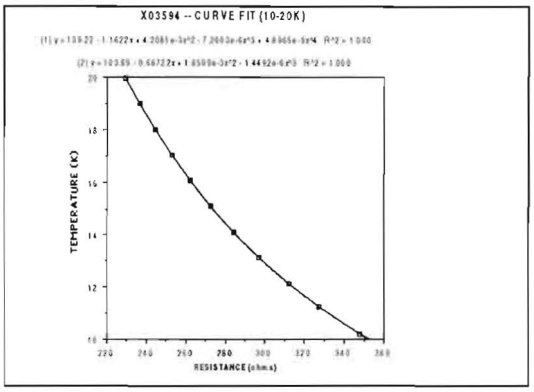
C. Cernox RTD

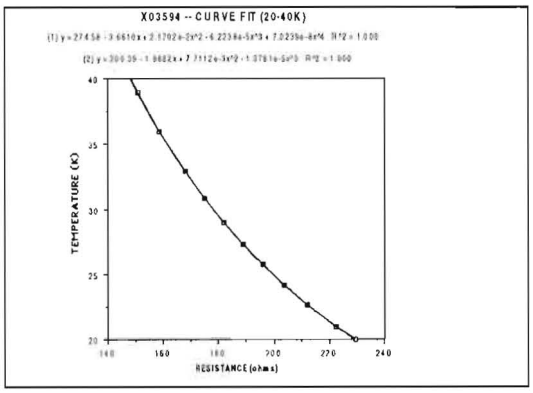
The Cernox RTD's have a useful temperature range of between 1 and 50 Degree Kelvin. They're sensitivity is more linear than Carbon Glass RTD's. This type of sensitivity is used in places where the normal operating temperature may be between 6 and 20 degrees Kelvin. Special Control Technology Inc. PLC modules were ordered to measure these sensors. The modules have a stimulation current of 10 microAmps, and can read a resistance range of 0 to 1060 ohms.

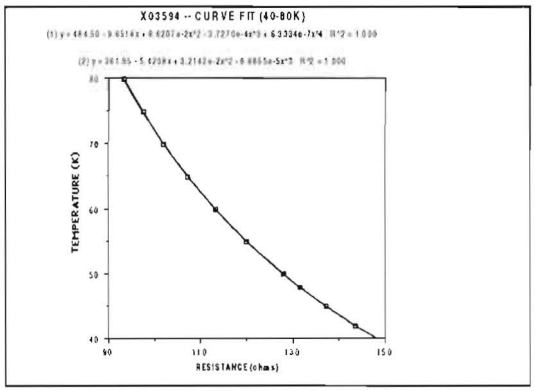
These RTD's are individually curve fit to match their resistance with the temperature. The following plots and curve fit equations are for a carbon glass RTD with the serial #X30594.

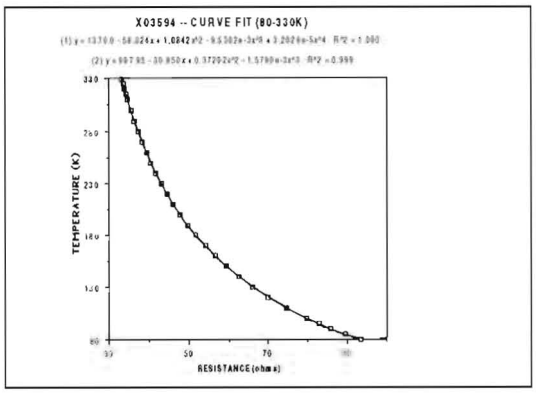
X30594









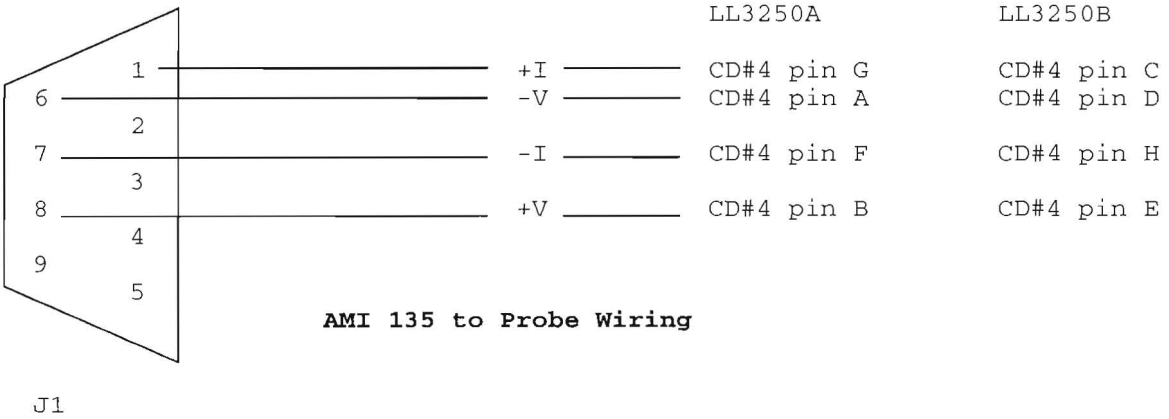


D. Helium Level Probe

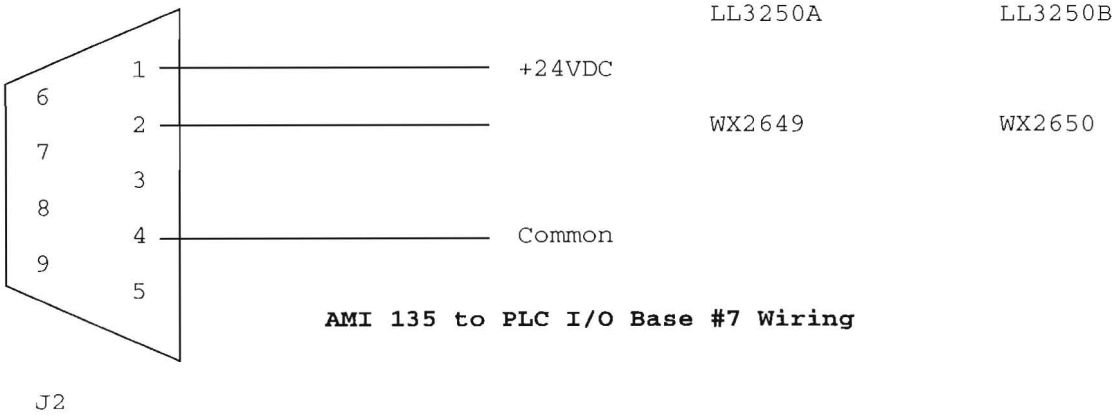
There are two 45 cm American Magnetic level probes installed in the Control Dewar. Each level probe has a signal conditioning chassis installed in PE06 and PE07. These 2 chassis can be installed side by side with the relay rack mount kit that was purhased.

The signal conditioning chassis is an American Magnetics model #135 Liquid Helium Level Monitor. Each chassis has a J1 probe connection and a J2 output connector.

The Output is a 4-20mA signal which is linear to the Helium level on the probe.



AMI 135 to Probe Wiring



AMI 135 to PLC I/O Base #7 Wiring

E. Pressure Transmitter

The Solenoid Control Dewar Pressure transmitters are all Rosemount model 1151's. They all have 4-20mA outputs, which require 24 VDC applied to the + Terminal. The - terminal is connected to the proper analog input of the PLC base #7. Refer to the I/O map for the transmitter to I/O assignments.

F. Control Valve

The control valves for the Solenoid are all pneumatically driven and positioned by a Badger 1/2", type 766 air to open Actuator. This actuator has the positioner built into it, and requires a 3-15 psi air signal for to set its current position. Each actuator has a Fairchild model #T600 I/P connected to it's air signal input port. The Fairchild I/P converts a 4-20 mA signal from the PLC I/O base into a 3-15 PSI air signal.

Each I/P has an analog output I/O assignment in the PLC I/O map for base #7. The assigned output should be tied to the red wire on the I/P. The black wire on each I/P should be tied to common. Refer to the I/O map for the I/P to I/O assignments.

VII Solenoid Interconection Tables

There are two Solenoid instrumentation feedthrough ports. These feedthroughs contain instrumentation for Coil voltage taps, Carbon Glass RTD's, Platinum RTD's, Strain Gages, Thermocouple's, and Helium Level probe's. They are the Solenoid North end and the Control Dewar. The Voltage Tap feedthroughs will be connected to the DC Power control system in room 511. The rest of the instrumentation will be connected to the Cryogenic control system with the exception of the chimney Thermocouple's.

A. North End Hermetic Feedthrough Port

The Solenoid North end box contains 6 Burndy hermetically sealed feedthrough's, 5 48 pin feedthroughs and 1 8 pin feedthrough. The connector numbers are clearly stamped on the feed through box.

1.Connector #1 48 socket Burndy Cable End Connector Assignments

Connector #1 48 socket Burndy Cable End Connector Assignments:

Tag	Description	Socket		I/O Assignment
TR3301	South Axial Support #1	A	V+	WX2573
	Serial # C16795	U	V-	Slot #1/PT #1
		T	I+	
		S	I-	
TR3302	South Axial Support #2	R	V+	WX2538
	Serial # C16796	P	V-	Slot #1/PT #2
		N	I+	
		M	I-	

TR3303	South Axial Support #3 Serial # C16797	L K J H	V+ V- I+ I-	WX2539 Slot #1/PT #3
TR3304	North Axial Support #4 Serial # C16810	G F E D	V+ V- I+ I-	WX2540 Slot #1/PT #4
TR3305	North Axial Support #5 Serial # C16811	C B V k	V+ V- I+ I-	WX2541 Slot #1/PT #5
TR3306	North Axial Support #6 Serial # C16812	j i h g	V+ V- I+ I-	WX2542 Slot #1/PT #6
TR3317	North Radial Support #7 Serial # C16813	f e d c	V+ V- I+ I-	WX2543 Slot #1/PT #7
TR3318	North Radial Support #8 Serial # C16814	b a Z Y	V+ V- I+ I-	WX2544 Slot #1/PT #8
TR3319	North Radial Support #9 Serial # C16815	X W m w	V+ V- I+ I-	WX2545 Slot #1/PT #9
TR3320	North Radial Support#10 Serial # C16816	v u t s	V+ V- I+ I-	WX2546 Slot #1/PT #10
TR3321	North Radial Support#11 Serial # C16817	r q p n	V+ V- I+ I-	WX2547 Slot #1/PT #11
TR3322	North Radial Support#12 Serial # C16818	x aa z y	V+ V- I+ I-	WX2548 Slot #1/PT #12

2.Connector #2 48 socket Burndy Cable End Connector Assignments

Connector #2 48 socket Burndy Cable End Connector Assignments:

Tag	Description	Socket		I/O Assignment
TR3330	Outer Cylinder Support	A	V+	WX2549
	(South 90 Degrees)	U	V-	Slot #1/PT #13
	Serial # C16819	T	I+	
		S	I-	
TR3331	Outer Cylinder Support	R	V+	WX2550
	(Center 90 Degrees)	P	V-	Slot #1/PT #14
	Serial # C16820	N	I+	
		M	I-	
TR3332	Outer Cylinder Support	L	V+	WX2551
	(North 90 Degrees)	K	V-	Slot #1/PT #15
	Serial # C16821	J	I+	
		H	I-	
TR3333	Outer Cylinder Support	G	V+	WX2552
	(South 270 Degrees)	F	V-	Slot #1/PT #16
	Serial # C16830	E	I+	
		D	I-	
TR3334	Outer Cylinder Support	C	V+	WX2553
	(Center 270 Degrees)	B	V-	Slot #2/PT #1
	Serial # C16823	V	I+	
		k	I-	
TR3335	Outer Cylinder Support	j	V+	WX2554
	(North 270 Degrees)	i	V-	Slot #2/PT #2
	Serial # C16824	h	I+	
		g	I-	
TR3343	Magnet Coil	f	V+	WX2555
	(South 270 Degrees)	e	V-	Slot #2/PT #3
	Serial # C16825	d	I+	
		c	I-	
TR3344	Magnet Coil	b	V+	WX2556
	(Center 270 Degrees)	a	V-	Slot #2/PT #4
	Serial # C16826	Z	I+	
		Y	I-	
TR3345	Magnet Coil	X	V+	WX2557
	(North 270 Degrees)	W	V-	Slot #2/PT #5
	Serial # C16827	m	I+	
		w	I-	
TR3360	Outer Support Cylinder	v	V+	WX2558
	(Helium Supply)	u	V-	Slot #2/PT #6
	Serial # C16828	t	I+	
		s	I-	
TR3370	Outer Support Cylinder	r	V+	WX2559
	(Helium Return)	q	V-	Slot #2/PT #7
	Serial # C16829	p	I+	
		n	I-	

3.Connector #3 48 socket Burndy Cable End Connector Assignments

Connector #3 48 socket Burndy Cable End Connector Assignments:

Tag	Description	Socket		I/O Assignment
TP3301	South Axial Intercept#1	A	V+	WX2601
	Serial # P1151	U	V-	Slot #5/PT #1
		T	I+	
		S	I-	
TP3302	South Axial Intercept#2	R	V+	WX2602
	Serial # P1152	P	V-	Slot #5/PT #2
		N	I+	
		M	I-	
TP3303	South Axial Intercept#3	L	V+	WX2603
	Serial # P1153	K	V-	Slot #5/PT #3
		J	I+	
		H	I-	
TP3304	North Axial Intercept#4	G	V+	WX2604
	Serial # P1154	F	V-	Slot #5/PT #4
		E	I+	
		D	I-	
TP3305	North Axial Intercept#5	C	V+	WX2605
	Serial # P1155	B	V-	Slot #5/PT #5
		V	I+	
		k	I-	
TP3306	North Axial Intercept#6	j	V+	WX2606
	Serial # P1156	i	V-	Slot #5/PT #6
		h	I+	
		g	I-	
TP3311	Support Cylinder	f	V+	WX2607
	(North 30 Degrees)	e	V-	Slot #5/PT #7
	Serial # P1157	d	I+	
		c	I-	
TP3312	Support Cylinder	b	V+	WX2608
	(North 150 Degrees)	a	V-	Slot #5/PT #8
	Serial # P1158	Z	I+	
		Y	I-	
TP3313	Support Cylinder	X	V+	WX2609
	(North 270 Degrees)	W	V-	Slot #6/PT #1
	Serial # P1159	m	I+	
		w	I-	
TP3314	Support Cylinder	v	V+	WX2610
	(South 30 Degrees)	u	V-	Slot #6/PT #2
	Serial # P1160	t	I+	
		s	I-	
TP3315	Support Cylinder	r	V+	WX2611
	(South 150 Degrees)	q	V-	Slot #6/PT #3
	Serial # P1163	p	I+	
		n	I-	

TP3316	Support Cylinder	x	V+	WX2612
	(South 270 Degrees)	aa	V-	Slot #6/PT #4
	Serial # P1162	z	I+	
		y	I-	

4.Connector #4 48 socket Burndy Cable End Connector Assignments

Connector #4 48 socket Burndy Cable End Connector Assignments:

Tag	Description	Socket		I/O Assignment
TP3317	North Radial Intrcpt#7	A	V+	WX2613
	Serial # P1164	U	V-	Slot #6/PT #5
		T	I+	
		S	I-	
TP3318	North Radial Intrcpt#8	R	V+	WX2614
	Serial # P1165	P	V-	Slot #6/PT #6
		N	I+	
		M	I-	
TP3319	North Radial Intrcpt#9	L	V+	WX2615
	Serial # P1166	K	V-	Slot #6/PT #7
		J	I+	
		H	I-	
TP3320	North Radial Intrcpt#10	G	V+	WX2616
	Serial # P1167	F	V-	Slot #6/PT #8
		E	I+	
		D	I-	
TP3321	North Radial Intrcpt#11	C	V+	WX2617
	Serial # P1168	B	V-	Slot #7/PT #1
		V	I+	
		k	I-	
TP3322	North Radial Intrcpt#12	j	V+	WX2618
	Serial # P1169	i	V-	Slot #7/PT #2
		h	I+	
		g	I-	
TP3346	Outer Vacuum Vessel	f	V+	WX2619
	(270 Deg)	e	V-	Slot #7/PT #3
	Serial # P1170	d	I+	
		c	I-	
TP3347	Inner Vacuum Vessel	b	V+	WX2620
	(90 Degrees)	a	V-	Slot #7/PT #4
	Serial # P1171	Z	I+	
		Y	I-	
TP3348	Vacuum Vessel Bulkhead	X	V+	WX2621
	(North 300 Degrees)	W	V-	Slot #7/PT #5
	Serial # P1172	m	I+	
		w	I-	
TP3350	Outer Shield Center	v	V+	WX2622
	(90 Degrees)	u	V-	Slot #7/PT #6
	Serial # P1173	t	I+	
		s	I-	
TP3351	Outer Shield Center	r	V+	WX2623

	(270 Degrees)	q	V-	Slot #7/PT #7
	Serial # P1174	p	I+	
		n	I-	
TP3352	Inner Shield Center	x	V+	WX2624
	(90 Degrees)	aa	V-	Slot #7/PT #8
	Serial # P1237	z	I+	
		y	I-	

5.Connector #5 48 socket Burndy Cable End Connector Assignments

Connector #5 48 socket Burndy Cable End Connector Assignments:

Tag	Description	Socket		I/O Assignment
TP3353	Inner Shield Center	A	V+	WX2625
	(270 Degrees)	U	V-	Slot #8/PT #1
	Serial # P1226	T	I+	
		S	I-	
TP3354	South End Shield	R	V+	WX2626
	(90 Degrees)	P	V-	Slot #8/PT #2
	Serial # P1227	N	I+	
		M	I-	
TP3355	North End Shield	L	V+	WX2627
	(90 Degrees)	K	V-	Slot #8/PT #3
	Serial # P1228	J	I+	
		H	I-	

The rest of the sockets on this connector are connected to 6 internal strain gages. There is no intended use for these strain gages at this time

6.Connector #6 8 socket Burndy Cable End Connector Assignments

This connector is allocated for magnet coil voltage taps. These taps are used by the DC circuit control system. They will not be connected to the cryogenic control system.

Tap Point	Description	Socket
T4	Coil Beginning	B
T5	Center of 1st layer	A
T6	Transition Point before 90 Deg	G
T7	Transition Point	F
T8	Coil End	E
T3'	Power Lead Bottom Point (beginning)	D
T9'	S. Power Lead Bottom Point (end)	C

B. Control Dewar Hermetic Feedthrough Ports

1.Connector #1 48 socket Burndy Cable End Connector Assignments

Tag	Description	Socket		I/O Assignment
TRSCOUT	Solenoid Helium	A	V+	WX2563
	Subcooler Return	U	V-	Slot #2/PT #11
	Serial # C	T	I+	
		S	I-	
TR3212	Cooldown/Quench	R	V+	WX2564

	Helium Return	P	V-	Slot #2/PT #12
	Serial # C	N	I+	
		M	I-	
TP3208	Subcooler JT Inlet	L	V+	WX2630
		K	V-	Slot #8/PT #6
	Serial #	J	I+	
		H	I-	
TP3207	Subcooler Helium	G	V+	WX2631
	Return	F	V-	Slot #8/PT #7
	Serial #	E	I+	
		D	I-	
TP3206	Ln2 Supply	C	V+	WX2632
		B	V-	Slot #8/PT #8
	Serial #	V	I+	
		k	I-	
TP3225	LN2 Return	j	V+	WX2633
		i	V-	Slot #9/PT #1
	Serial #	h	I+	
		g	I-	

2.Connector #2 8 socket Burndy Cable End Connector Assignments

Tag	Description	Socket		I/O Assignment
TR3268	C.D. East Vapor Cooled	B	V+	WX2561
	Leads (Bottom)	A	V-	Slot #2/PT #9
	Serial # C16478	G	I+	
		F	I-	
T2	C.D. East Vapor Cooled	H		DC Controls
	Leads (Bottom)			
	Voltage Tap			

3.Connector #3 8 socket Burndy Cable End Connector Assignments

Tag	Description	Socket		I/O Assignment
TR3278	C.D. West Vapor Cooled	B	V+	WX2562
	Leads (Bottom)	A	V-	Slot #2/PT #10
	Serial #	G	I+	
		F	I-	
T10	C.D. West Vapor Cooled	H		DC Controls
	Leads (Bottom)			
	Voltage Tap			

4.Connector #4 8 socket Burndy Cable End Connector Assignments

Tag	Description	Socket		I/O Assignment
LL3250A	Lhe Level Probe	B	V+	To Helium Level Chassis
		A	V-	#1
		G	I+	
		F	I-	

LL3250B	Lhe Level Probe	E	V+	To Helium Level Chassis
		D	V-	#2
		C	I+	
		H	I-	

5.Connector #5 8 socket Burndy Cable End Connector Assignments

Tag	Description	Socket		I/O Assignment
TP3269	C.D. East Vapor Cooled	B	V+	WX2628
	Leads (Top)	A	V-	Slot #8/PT #4
	Serial #	G	I+	
		F	I-	
T1	C.D. East Vapor Cooled	H		DC Controls
	Leads (Top)			
	Voltage Tap			

6.Connector #6 8 socket Burndy Cable End Connector Assignments

Tag	Description	Socket		I/O Assignment
TP3279	C.D. West Vapor Cooled	B	V+	WX2629
	Leads (Top)	A	V-	Slot #8/PT #5
	Serial #	G	I+	
		F	I-	
T11	C.D. West Vapor Cooled	H		DC Controls
	Leads (Top)			
	Voltage Tap			

7.Connector #7 22 socket Burndy Cable End Connector Assignments

Tag	Description	Socket	I/O Assignment
T3	East Power Lead Bottom	P	DC Controls
T9	West Power Lead Bottom	G	DC Controls

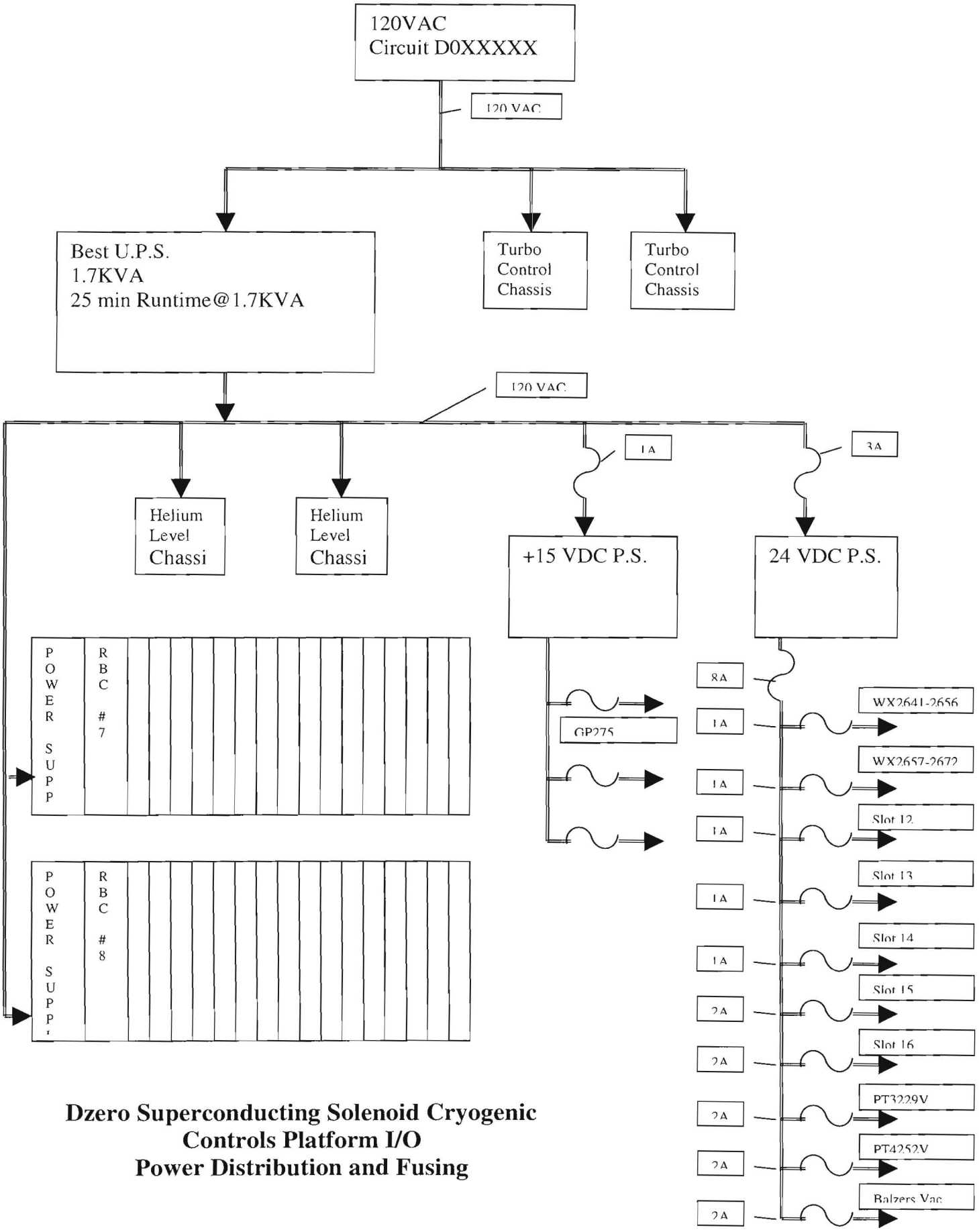
VII. Instrumentation Power

The Dzero Detector platform is insolated from earth ground. AC power used on the Detector Platform is transformer isolated from the AC Building distribution grid. This precludes us from running a typical U.P.S. cryo controls power circuit onto the platform. Instead, a small U.P.S. will be installed in Relay racks PE06 and PE07. This U.P.S is a Best model LI1.7KFX with 1 external Battery Pack.

U.P.S. Specs:
Output = 1.7KVA
Full Load Runtime = 25 minutes
1/2 Load runtime = 60 minutes

Platform U.P.S. AC loads:
1. AMI 135 Helium Level Chassis; 2@120VA
2. I/O Base #7; 1@360VA
3. I/O Base #8; 1@360VA
4. 24 VDC P.S.; 1@360VA
5. +15 VDC P.S.: 1@120VA

Platform Non-U.P.S. Loads:
1. V550 Turbo Pump controller; 2@600VA MAX



Dzero Superconducting Solenoid Cryogenic Controls Platform I/O Power Distribution and Fusing