**DZERO CRYOGENIC SYSTEM
VLPC & SOLENOID VACUUM SYSTEM
INSTRUMENTATION, CONTROL, AND LOGIC**

**ENGINEERING NOTE
3823.111-EN-482**

**Dan Markley
Fermi Accelerator Lab
January 16, 1998**

Table of Contents

- I. Introduction
- II. User Interface Pictures
 - A. Overview
 - B. VLPC and Solenoid Turbo Pump Control
- III. Picture Command Script
 - A. DZERO Helium Vacuum System Overview Picture
 - B. DZERO Solenoid Turbo Pump Picture
 - C. DZERO VLPC Turbo Pump Picture
- IV. Input/Output List
- V. Control Logic
- VI. Ladder Logic
- VII. Special Functions
 - A. SFPGM 424
 - B. SFPGM 425
 - C. SFPGM 426
 - D. SFPGM 427
 - E. SFPGM 428
- VIII. Vacuum Instrumentation and Vacuum Valves
 - A. Thermocouple
 - B. Ion Gage
 - C. Balzer Combination Cold Cathode-Thermocouple

I. Introduction

The DZERO VLPC Cryostat and the Superconducting Solenoid both require an insulating Vacuum of 10⁻⁵ Torr or less. There is a vacuum system on the Detector Platform consisting of 2 Turbomolecular vacuum pumps and their associated piping, valves, instrumentation that are dedicated to this task.

This vacuum equipment requires an operator interface and control logic in order to function properly. The operator interface allows an operator to monitor, control and configure the proper pumping setup required at any given time. The control logic is needed to protect the Vacuum vessels and Vacuum equipment from catastrophic events that may harm them. This is typically done with interlock chains or strings.

II. User Interface Pictures

A. Overview

B. VLPC and Solenoid Turbo Pump Control

III. Picture Command Script

A. DZERO HE VACUUM PICTURE

```
PV-4520 (Open)
    closeDIG D0_CCRS2:pv-4250-v-open.F_CV [CR431]
PV-4520 (close)
    OPENDIG D0_CCRS2:pv-4250-v-open.F_CV [CR431]
PV-3231 (open)
    CLOSEDIG D0_CCRS2:pv-3231-v-open.F_CV [CR423]
PV-3231 (close)
    OPENDIG D0_CCRS2:pv-3231-v-open.F_CV [CR423]
PT-4252 (DEGAS)
    CLOSEDIG D0_CCRS2:PT4252DEGAS.F_CV [Y2688]
    PAUSE 5
    OPENDIG D0_CCRS2:PT4252DEGAS.F_CV [Y2688]
PT-3229 (DEGAS)
    CLOSEDIG D0_CCRS2:PT3229DEGAS.F_CV [Y2684]
    PAUSE 5
    OPENDIG D0_CCRS2:PT3229DEGAS.F_CV [Y2684]
```

B. DZERO SOLENOID TURBO PUMP PICTURE

```
START
    CLOSEDIG D0_CCRS2:sol_START.F_CV [CR419]
STOP
    OPENDIG D0_CCRS2:sol_START.F_CV [CR419]
LOW SPEED ON
    OPENDIG D0_CCRS2:sol_LOWSPD.F_CV [Y2682]
```

LOW SPEED OFF
closeDIG D0_CCRS2:sol_LOWSPD.F_CV [Y2682]

C. DZERO VLPC TURBO PUMP PICTURE

START
CLOSEDIG D0_CCRS2:VLPC_START.F_CV [CR427]
STOP
OPENDIG D0_CCRS2:VLPC_START.F_CV [CR427]
LOW SPEED ON
OPENDIG D0_CCRS2:VLPC_LOWSPD.F_CV [Y2686]
LOW SPEED OFF
closeDIG D0_CCRS2:VLPC_LOWSPD.F_CV [Y2686]

IV. Input/Output List

Tagname	Description	Sex	Address
PT-2973-V	Solenoid turbo vacuum Exhaust to IV Header	4-20mA	WX2646
PT-2921-V	VLPC turbo vacuum Exhaust to IV Header	4-20mA	WX2647
PT-2975-V	Solenoid turbo Inlet vacuum	1.5V-8.5V	WX2657
PT-2970-V	Sol & VLPC Turbo Common Header	1.5V-8.5V	WX2658
PT-3259-V	Control dewar vacuum	1.5V-8.5V	WX2659
PT-2925-V	VLPC turbo pump	1.5V-8.5V	WX2660
PT-2934-V	VLPC turbo pump	1.5V-8.5V	WX2661
PT-4251-V	VLPC vacuum jacket /turbo pump	1.5V-8.5V	WX2662
?PT-4252-V	VLPC vacuum jacket /turbo pump		WX2665
?PT-3229-V	Control dewar vacuum		WX2666
	Solenoid Turbo Pump Current	2VDC=1A	WX2669
	VLPC Turbo Pump Current	2VDC=1A	WX2670
SOL_START	Sol Turbo "Start"	On=on	Y2681
SOL_LOWSPD	Sol Turbo "Low Speed"	On=Low	Y2682
PT3229CON	Solenoid Ion Gage ON/OFF Control		Y2683
PT3229DEGAS	Solenoid Ion Gage Degas Gage ON/OFF Control		Y2684
VLPC_START	VLPC Turbo "Start"	On=on	Y2685
VLPC_LOWSPD	VLPC Turbo "Low Speed"	On=Low	Y2686
PT4252CON	VLPC Ion Gage ON/OFF Control		Y2687
PT4252DEGAS	VLPC Ion Gage Degas Gage ON/OFF Control		Y2688
PV-2915-V	Isolates UV header from VLPC,solenoid vacuums	On=Open	Y2689
PV-2920-V	Isolates IV header from VLPC, Solenoid vacuums	On=Open	Y2690
PV-2972-V	Isolate solenoid turbo from cntrl dwr, VLPC turbo	On=Open	Y2691
PV-3231-V	Isolates control dewar from vacuums	On=Open	Y2692
PV-2930-V	Vacuum selector between VLPC and solenoid	On=Open	Y2693
PV-2925-V	VLPC turbo pump isolation from vacuum header	On=Open	Y2694
PV-4250-V	VLPC vacuum isolation	On=Open	Y2695
PV-3231CL	Isolates control dewar from vac(Closed Switch)	On=Closed	X2705
PV-3231OP	Isolates control dewar from vac (Open Switch)	On=Open	X2706
PV-4250CL	VLPC vacuum isolation(Closed Switch)	On=Closed	X2707
PV-4250OP	VLPC vacuum isolation(Open Switch)	On=Open	X2708
PT3229STAT	Solenoid ION Gage Status		X2709
PT3229DEGS	Solenoid ION Gage Degas Status		X2710
PT4252STAT	VLPC ION Gage Status		X2711

Tagname	Description	Sex	Address
PT4252DEGS	VLPC ION Gage Degas Status		X2712
SOL_FAULT	Sol Turbo "Fault"	On=Fault	X2713
SOL_THRESHOLD	Sol Turbo "R1 Speed Threshold"		X2714
SOL_START_STATUS	Sol Turbo "Start"	On=Starting	X2715
SOL_LOWSPD_MODE	Sol Turbo "Low Speed Mode"	On=Low	X2716
VLPC_FAULT	VLPC Turbo "Fault"	On=Fault	X2717
VLPC_THRESHOLD	VLPC Turbo "R1 Speed Threshold"		X2718
VLPC_START_STATUS	VLPC "Start"	On=Starting	X2719
VLPC_LOWSPD_MODE	VLPC "Low Speed Mode"	On=Low	X2720

V. Control Logic

PV-4250-V VLPC VACUUM SHELL ISOLATION VALVE OPEN

```

IF      Operator Command to open
      and
      [PT2934V < 10 microns and NOT DISABLED] or DISABLED
      and
      [PT2934V < PT4251V and NOT DISABLED] or DISABLED

```

PV-3231-V SOLENOID VACUUM SHELL ISOLATION VALVE OPEN

```

IF      Operator Command to open
      and
      [PT2970V < 10 microns and NOT DISABLED] or DISABLED
      and
      [PT2970V < PT3259V and NOT DISABLED] or DISABLED

```

SOLENOID TURBO PUMP is Running

```

IF      Operator Command to Run
      And
      [PT2973V < 1000 microns and NOT DISABLED] or DISABLED
      and
      Control Turbo Chassis has no Faults

```

VLPC TURBO PUMP is Running

```

IF      Operator Command to Run
      And
      [PT2921V < 1000 microns and NOT DISABLED] or DISABLED
      and
      Control Turbo Chassis has no Faults

```

VI. Ladder Logic

LAD1Network 356

LAD1Network 357

LAD1Network 358

VII. Special Functions

A. SF PROGRAM 424

TITLE: PT-2973V

CONTINUE ON ERROR (Y,N): YES
ERROR STATUS ADDR (Y,C,WY,V):
PROGRAM TYPE (N,P,C,R): NORMAL
CYCLE TIME (SEC): 0.0

```
-----
00001 *   THIS SPECIAL FUNCTION DETERMINES THE VACUUM PRESSURE GIVEN
          A CURRENT INPUT OF 4-20 MILLI AMPS.
          [GRANVILLE-PHILLIPS THERMOCOUPLE]
00002 *   ---VARIABLES---
          WX2646 = UNSCALED BINARY INPUT OF CURRENT
          V784.  = SCALED [4-20 MILLI AMPS] CURRENT
          V808.  = REAL CALCULATED PRESSURE IN MILLI TORR
          V789   = UNSCALED V808. TO INTEGER
00003 *   **STEP #1**
          SCALE THE BINARY INPUT (WX3103) INTO A REAL VALUE (V775.)
00004 SCALE  BINARY INPUT.: WX2646      SCALED RESULT.: V784.
          LOW LIMIT.....: 4.0          HIGH LIMIT.....: 20.0
          20% OFFSET.....: YES          BIPOLAR.....: NO
00005 IF    WX2646 <= 6400
00006 MATH   V784. := 4.0
00007 ENDIF
00008 *   **STEP #2**
          DETERMINE THE RANGE THAT THE CURRENT (V775.) IS IN AND THEN
          CALCULATE THE CORRESPONDING VACUUM PRESSURE (V800.) IN MILLI TORR
00009 *   -----RANGE: 4-10 MILLI AMPS
00010 IF    V784. >= 4.0 AND V784. < 10.0
00011 MATH   V808. := -55.91 + 18.862 * V784. - 8.9947 * V784. ** 2.0 + 1.9372
          * V784. ** 3.0
00012 ELSE
00013 *   -----RANGE: 10-16 MILLI AMPS
00014 IF    V784. >= 10.0 AND V784. < 16.0
00015 MATH   V808. := -2.0218E5 + 5.2375E4 * V784. - 4482.6 * V784. ** 2.0 +
          128.23 * V784. ** 3.0
00016 ELSE
00017 *   -----RANGE: 16-20 MILLI AMPS
00018 IF    V784. >= 16.0 AND V784. <= 20.0
00019 MATH   V808. := 5.677E7 - 8.3461E6 * V784. + 3.895E5 * V784. ** 2.0 -
          5584.4 * V784. ** 3.0
00020 ENDIF
00021 ENDIF
00022 ENDIF
00023 IF    V808. <= 0.0
00024 MATH   V808. := 0.0
00025 ENDIF
00026 UNSCALE SCALED INPUT.: V808.      BINARY RESULT.: V789
          LOW LIMIT.....: 0.0          HIGH LIMIT.....: 1.0E6
          20% OFFSET.....: NO          BIPOLAR.....: NO
**** END ****
```

B. SF PROGRAM 425

TITLE: PT-2921V

CONTINUE ON ERROR (Y,N): YES

ERROR STATUS ADDR (Y,C,WY,V):

PROGRAM TYPE (N,P,C,R): NORMAL

CYCLE TIME (SEC): 0.0

```
-----
00001 *   THIS SPECIAL FUNCTION DETERMINES THE VACUUM PRESSURE GIVEN
          A CURRENT INPUT OF 4-20 MILLI AMPS.
          [GRANVILLE-PHILLIPS THERMOCOUPLE]
00002 *   ----VARIABLES---
          WX2647 = UNSCALED BINARY INPUT OF CURRENT
          V786.  = SCALED [4-20 MILLI AMPS] CURRENT
          V810.  = REAL CALCULATED PRESSURE IN MILLI TORR
          V788   = UNSCALED V810. TO INTEGER
00003 *   **STEP #1**
          SCALE THE BINARY INPUT (WX3103) INTO A REAL VALUE (V775.)
00004 SCALE  BINARY INPUT.: WX2647      SCALED RESULT.: V786.
          LOW LIMIT.....: 4.0          HIGH LIMIT.....: 20.0
          20% OFFSET.....: YES          BIPOLAR.....: NO
00005 IF    WX2647 <= 6400
00006 MATH   V786. := 4.0
00007 ENDIF
00008 *   **STEP #2**
          DETERMINE THE RANGE THAT THE CURRENT (V775.) IS IN AND THEN
          CALCULATE THE CORRESPONDING VACUUM PRESSURE (V800.) IN MILLI TORR
00009 *   ----RANGE: 4-10 MILLI AMPS
00010 IF    V786. >= 4.0 AND V786. < 10.0
00011 MATH   V810. := -55.91 + 18.862 * V786. - 8.9947 * V786. ** 2.0 + 1.9372
          * V786. ** 3.0
00012 ELSE
00013 *   ----RANGE: 10-16 MILLI AMPS
00014 IF    V786. >= 10.0 AND V786. < 16.0
00015 MATH   V810. := -2.0218E5 + 5.2375E4 * V786. - 4482.6 * V786. ** 2.0 +
          128.23 * V786. ** 3.0
00016 ELSE
00017 *   ----RANGE: 16-20 MILLI AMPS
00018 IF    V786. >= 16.0 AND V786. <= 20.0
00019 MATH   V810. := 5.677E7 - 8.3461E6 * V786. + 3.895E5 * V786. ** 2.0 -
          5584.4 * V786. ** 3.0
00020 ENDIF
00021 ENDIF
00022 ENDIF
00023 IF    V810. <= 0.0
00024 MATH   V810. := 0.0
00025 ENDIF
00026 UNSCALE SCALED INPUT.: V810.      BINARY RESULT.: V788
          LOW LIMIT.....: 0.0          HIGH LIMIT.....: 1.0E6
          20% OFFSET.....: NO          BIPOLAR.....: NO
**** END ****
```

C. SF PROGRAM 426

TITLE: BALZERS1

CONTINUE ON ERROR (Y,N): YES
ERROR STATUS ADDR (Y,C,WY,V):
PROGRAM TYPE (N,P,C,R): NORMAL
CYCLE TIME (SEC): 0.0

```
-----
00001 *   THIS SPECIAL FUNCTION IS USED FOR THE BALZERS PRESSURE
          TRANSMITTERS. THE INPUT VOLTAGE [0-10 VOLTS] CONVERTS TO
          [3.8E-9 - 750 TORR]
00002 *   --STEP 1--
          THE (WX----) IS CONVERTED TO A REAL NUMBER [0-10 VOLTS]
          REPRESENTED BY V1136. - V1146.
00003 *   --STEP 2--
          NEXT, THE PRESSURE IS CALCULATED USING THE EQUATION
           $P = 10^{(1.667 * (U - D))}$ 
          WHERE P = PRESSURE V812. - V822.
          U = VOLTAGE [0-10 VOLTS]
          D = 11.46 [CORRESPONDS TO OUTPUT IN TORR]
00004 *   (PT-2975-V)
00005 MATH  V1136. := WX2657 / 32000 * 10.0
00006 MATH  V812. := 10.0 ** ( 1.667 * V1136. - 11.46 )
00007 *
00008 *   (PT-2970-V)
00009 MATH  V1138. := WX2658 / 32000 * 10.0
00010 MATH  V814. := 10.0 ** ( 1.667 * V1138. - 11.46 )
00011 *
00012 *   (PT-3259-V)
00013 MATH  V1140. := WX2659 / 32000 * 10.0
00014 MATH  V816. := 10.0 ** ( 1.667 * V1140. - 11.46 )
00015 *
00016 *   (PT-2925-V)
00017 MATH  V1142. := WX2660 / 32000 * 10.0
00018 MATH  V818. := 10.0 ** ( 1.667 * V1142. - 11.46 )
00019 *
00020 *   (PT-2934-V)
00021 MATH  V1144. := WX2661 / 32000 * 10.0
00022 MATH  V820. := 10.0 ** ( 1.667 * V1144. - 11.46 )
00023 *
00024 *   (PT-4251-V)
00025 MATH  V1146. := WX2662 / 32000 * 10.0
00026 MATH  V822. := 10.0 ** ( 1.667 * V1146. - 11.46 )
**** END ****
```

D. SF PROGRAM 427

TITLE: SOL_VLPC

CONTINUE ON ERROR (Y,N): YES

ERROR STATUS ADDR (Y,C,WY,V):

PROGRAM TYPE (N,P,C,R): NORMAL

CYCLE TIME (SEC): 0.0

```
-----
00001 *   THIS SPECIAL FUNCTION IS USED TO PERFORM COMPARISONS FOR THE
          INTERLOCK ON VALVES PV-3231-V AND PV-4250-V
00002 *   SOLENOID VALVE - PV-3231-V
00003 *   ---COMPARISON #1: PT-2970-V < 10 MILLITORR
00004 *   -----TURN COIL 421 ( ON OR OFF )
00005 IF    V814. <= 0.01
00006 MATH  C421 := 1
00007 ELSE
00008 MATH  C421 := 0
00009 ENDIF
00010 *   ---COMPARISON #2: PT-2970-V < PT-3259-V
00011 *   -----TURN COIL 422 ( ON OR OFF )
00012 IF    V814. <= V816.
00013 MATH  C422 := 1
00014 ELSE
00015 MATH  C422 := 0
00016 ENDIF
00017 *
00018 *   VLPC VALVE - PV-4250-V
00019 *   ---COMPARISON #1: PT-2934-V < 10 MILLITORR
00020 *   -----TURN COIL 429 ( ON OR OFF )
00021 IF    V820. <= 0.01
00022 MATH  C429 := 1
00023 ELSE
00024 MATH  C429 := 0
00025 ENDIF
00026 *   ---COMPARISON #2: PT-2934-V < PT-4251-V
00027 *   -----TURN COIL 430 ( ON OR OFF )
00028 IF    V820. <= V822.
00029 MATH  C430 := 1
00030 ELSE
00031 MATH  C430 := 0
00032 ENDIF
**** END ****
```

E. SF PROGRAM 428

TITLE: ION_GAGE

CONTINUE ON ERROR (Y,N): YES

ERROR STATUS ADDR (Y,C,WY,V):

PROGRAM TYPE (N,P,C,R): NORMAL

CYCLE TIME (SEC): 0.0

```
-----
00001 *   THIS SPECIAL FUNCTION IS USED TO CALCULATE THE VACUUM VIA ION
          GAGES AS WELL AS CONTROL THESE GAGES.
          NOTE: THIS IS FOR A ((NITROGEN)) GAS ION GAGE
00002 *   SOLENOID ION GAGE - PT-3229-V
00003 *   ---VARIABLES---
          WX2666 = INTEGER VOLTAGE SIGNAL
          V790.  = REAL VOLTAGE (0-8 VOLTS)
          V824.  = CALCULATED VACUUM PRESSURE [TORR]
          Y2683  = ION GAGE STATUS (1=ON) (0=OFF)
          X2709  = GAGE OUTPUT
00004 SCALE  BINARY INPUT.: WX2666      SCALED RESULT.: V790.
          LOW LIMIT.....: 0.0          HIGH LIMIT.....: 8.0
          20% OFFSET.....: NO           BIPOLAR.....: NO
00005 MATH   V824. := 10.0 ** V790. * 1.0E-9
00006 *   IF (ION STATUS IS OFF AND VACCUM < 1.0E-3) THEN ( TURN ON GAGE)
00007 IF     Y2683 = 0 AND V816. <= 1.0E-3
00008 IMATH  Y2683 := 1
00009 ELSE
00010 *   IF (GAGE STATUS IS OFF) THEN (TURN OFF GAGE)
00011 IF     Y2709 = 0
00012 IMATH  Y2683 := 0
00013 ENDIF
00014 ENDIF
00015 *
00016 *   VLPC ION GAGE - PT-4252-V
00017 *   ---COMPARISON #1: PT-2934-V < 10 MILLITORR
00018 *   ---VARIABLES---
          WX2662 = INTEGER VOLTAGE SIGNAL
          V792.  = REAL VOLTAGE (0-8 VOLTS)
          V826.  = CALCULATED VACUUM PRESSURE [TORR]
          Y2687  = ION GAGE STATUS (1=ON) (0=OFF)
          X2711  = GAGE OUTPUT
00019 SCALE  BINARY INPUT.: WX2662      SCALED RESULT.: V792.
          LOW LIMIT.....: 0.0          HIGH LIMIT.....: 8.0
          20% OFFSET.....: NO           BIPOLAR.....: NO
00020 MATH   V826. := 10.0 ** V792. * 1.0E-9
00021 *   IF (ION STATUS IS OFF AND VACUUM IS < 1.0E-3) THEN (TURN ON GAGE)
00022 IF     Y2687 = 0 AND V822. < 1.0E-3
00023 IMATH  Y2687 := 1
00024 ELSE
00025 *   IF (GAGE STATUS IS ON) THEN (TURN OFF GAGE)
00026 IF     X2711 = 0
00027 IMATH  Y2687 := 0
00028 ENDIF
00029 ENDIF
**** END ****
```

VIII. Vacuum Instrumentation and Vacuum Valves

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	PT2973V	PT2921V
3	+ Power 11-16VDC		
4	- Power		
5	+ Signal	WX2646	WX2647
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 Resistors are 1kOhms

Pin#	Function	PT3229V	PT4252V
1	Gage On/Off	Y2683	Y2687
2	- Power		
3	+ Signal	WX2666	WX2665
4	+ Power 24VDC		
5	+24VDC Degas Status	X2710	X2712
6	Degas On/Off	Y2684	Y2688
7	- Signal		
8	Emission Current		
9	+24VDC Gage Status	X2709	X2711

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

<i>Signal [volts]</i>	<i>Pressure [Torr]</i>
< 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	PT3259V	PT4251V	PT2970V	PT2975V	PT2934V	PT2925V
2	+ Signal	WX2659	WX2662	WX2658	WX2657	WX2661	WX2660
3	- Signal						
1							
4	+ Power 15-30VDC						
5	- Power						
6	Shield (Earth Ground)						

D. 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.