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TURBO PUMP *(TPS-Mini, Agilent Technologies)*

The TPS-mini is an integrated system with a turbo-molecular pump for high and ultra-high vacuum applications associated with its relevant controller and its primary pump. The system can pump any type of gas or gas compound. It is not suitable for pumping liquids or solid particles. The pumping action is obtained through a high-speed turbine driven by a high-performance 3-phase electric motor. The TPS-mini is free of contaminating agents and, therefore, is suitable for applications requiring a "clean" vacuum. The TPS-mini is equipped with auxiliary connectors to control the vent valve, to be controlled from a remote site by means of an host computer connected through a serial line.

Storage and Caution:

1. Turbomolecular pump must be always soft-started[1] when received and operated for the first time by the customer.
2. The shelf life of a turbomolecular pump is 12 months from the shipping date. After which the pump has to be returned to the factory.
3. To prevent outgassing problems, do not use bare hands to handle components which will be exposed to vacuum. Always use gloves or other appropriate protection.
4. Try to prevent any form of pollution by dust. Do not install or use the pump in an environment exposed to atmospheric agents (rain, snow, ice), dust, aggressive gases, or in explosive environments or those with a high fire risk.
5. Do not remove the adhesive and protective cap before connecting the turbopump to the system.
6. Maintain the following during operation:
    - Pressure: Must be less than 3.01325 bar (or 2.97385 atm)
    - Temperature:
    - Relative Humidity:
7. In the presence of magnetic fields, the pump must be protected using a ferromagnetic shield

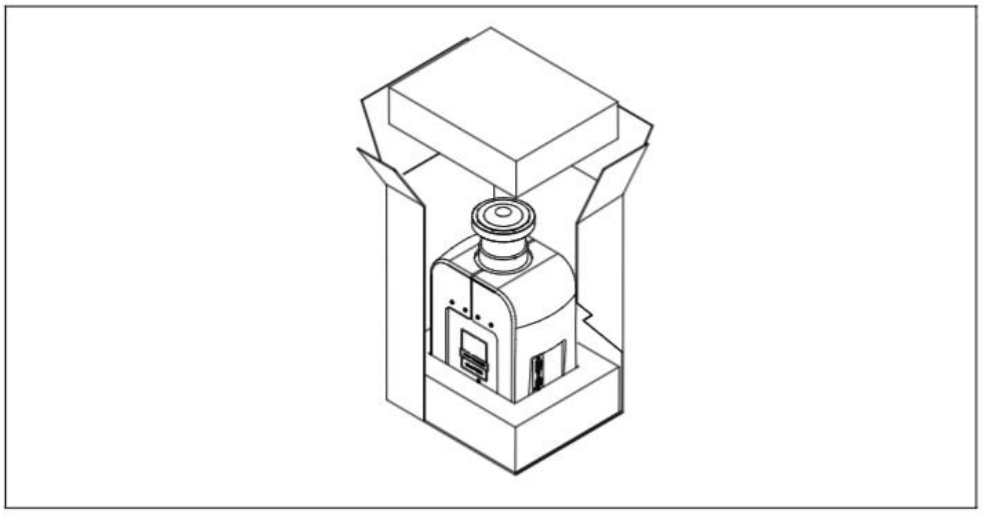


Figure 1: Turbo Pump sketch

[1] In details later on

Installation and Running:

Note:

1. TPS-Mini can be installed in any position.
2. Arrange the system such that one can easily interrupt the line voltage.
3. For free and good air circulation keep a buffer zone of 20 cms around the system.
4. To immediately stop the TPS-mini in an emergency condition it is necessary to remove the supply cable from the mains plug or moving the external switch to OFF position.

Procedure to install:

Connect the turbopump's ISO inlet flange with the vacuum chamber with the help of clamps or claws: For each fixing device, the necessary number of clamps or claws and the relevant fixing torque is shown in Table below connecting with appropriate Agilent Hardware. *The power supply cord is a three wire (Ph+N+Earth) cable with atleast 0.75 mm^2 wire section.*

Tab. 1

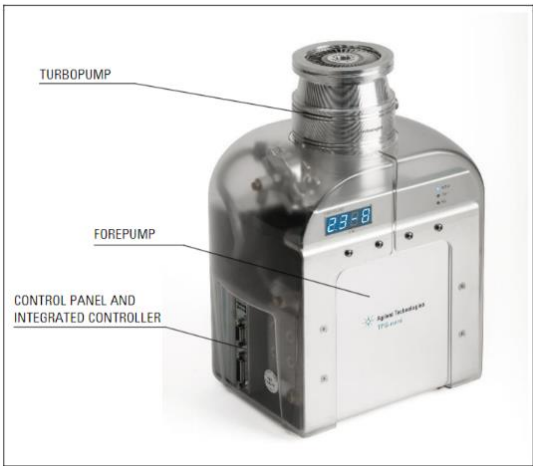
FLANGE	FIXING DEVICE	N.	FIXING TORQUE
ISO 63	M10 clamps	4	22 Nm
	M8 claws	4	11 Nm

Startup:

1. To switch on the TPS-mini it is sufficient to **supply the mains and then move the external switch to ON position** (red light on). The integrated controller automatically recognizes the mains presence and start up the pump. At the first start-up it is recommended to use the "Soft Start" mode by enabling it on the controller. For the following start-ups it is recommended to disable the "Soft Start" mode.

The **Blue LED "STATUS"** located on the TPS-mini base front panel indicates with its flashing frequency the system operating conditions:

- **With no flashing**: the pump is *normally rotating*.
- **Slowly flashing**: System is in ramp, or in braking, or in Stop, or in "Waiting for interlock" status.
- **Fast flashing**: Error condition.



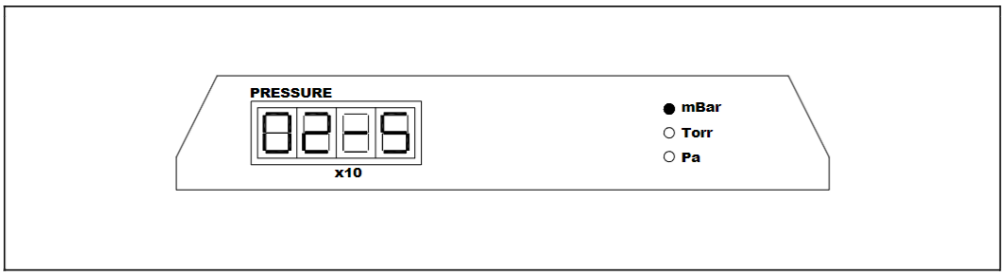
Switching off:

To switch off the TPS-mini it is sufficient to move the external switch to OFF position (red light off). The integrated controller immediately stops the pump.

Cleaning:

The exterior surfaces of the TPS-Mini may be cleaned with mild detergents only.

Control Panel and Communication



Communication Format

- 8 data bit
- no parity
- 1 stop bit
- baud rate: 600/1200/2400/4800/9600 programmable

Commands:

PIN N.	SIGNAL NAME	INPUT/OUTPUT
1	START/STOP (+)	IN
2	START/STOP (-)	IN
3	INTERLOCK (+)	IN
4	INTERLOCK (-)	IN
5	SPEED SETTING (+)	IN
6	SPEED SETTING (-)	IN
7	SOFT START (+)	IN
8	SOFT START (-)	IN
9	+24 Vdc I_{max} = 30 mA	OUT
10	NORMAL OUTPUT (relay) V_{max} = 125V I_{max} = 200 mA	OUT
11	PROGRAMMABLE SET POINT	OUT
12	NORMAL OUTPUT	OUT
13	FAULT OUTPUT	OUT
14	PROGRAMMABLE ANALOG SIGNAL (+)	OUT
15	• GROUND • PROGRAMMABLE ANALOG SIGNAL (-)	OUT

Cryocooler *(Cryotel-MT, Sunpower) with Active Vibration Cancellation*

Some imp Parts:

1. NW50 Vacuum Flange: Used to keep the thermal load in vacuum

Figure 1-12. Removable NW50 Vacuum Flange (Optional)

2. Air Fins: For removing the heat from heat rejector.

In order to use the air fins option, the design must include a shroud around the fins to direct the air flow through the fins and ideally also over the back end of the cryocooler. It is recommended to install a layer of malleable foam between the shroud and the outer diameter of the fins to seal the gap in order to ensure that the air will go through the fins instead of through the gap. The minimum airflow required to maintain proper cooling is 100 cfm (2.83 m3/min), so an appropriately-sized fan should be used.

Figure 1-19. Air Fins (Optional)

Cryocooler Operating instructions: Ubuntu

On Ubuntu serial communication with minicom is an option. Install minicom using:

sudo apt-get install minicom

Minicom settings manual : https://developer.nvidia.com/docs/drive/drive-os/archives/6.0.4/linux/sdk/common/topics/util_setup/ToconfigureMinicom47.html

Attached below: The Cryotel-MT manual (overall operating instructions etc.) and AVC manual (we have controller version 1.1.5)

Next few steps for first time operation only to save settings for the Cryotel MT in the computer

For checking the USB port being used:

1. dmesg| grep tty

For checking the minicom and setting it up

1. sudo minicom –s
2. In the settings save the following using the instructions (such as pressing the correct alphabet in the command line as prompted

    a) Serial port setup: /dev/ttyUSB0; thus if ttyUSB0 was displayed in the dmesg grep command
    b) Hardware flow control: No
    c) Bps/par/bits: 9600 8N1

3. This has been saved in MSR's office laptop as the default configuration (.dfl) as well as a file called CryotelMT_AVC_comm

Follow instructions of "Verify proper communications between the PC & the controller" in the CryotelMT manual (page 58, 3-22) as pasted below.

1. Open minicom and ensure the settings are as above
2. **Cycle power to the controller either by disconnecting and reconnecting the controller's power cable or the power supply's power cable, or by using the on/off power switch on the power supply – this is the first time set up only.**
3. Type a command such as TC (the "Display Cold-Tip Temperature" command) into the terminal emulator's window and press the Enter key to make sure the serial communications are working.

Next few steps are once the Cooler has been configured as above and we are running the cooler

1. Open minicom (settings above)
2. Type tc – this will return the cold tip temperature – make sure this is displayed and is a reasonable value
3. Status – displays status of various cooler settings
4. Sensor – displays the type of thermometer connected (such as PT100 in our case)
5. Cooler = on – starts the cooler
6. Monitor Tc using the Tc command
7. Cooler = off – stops the cooler

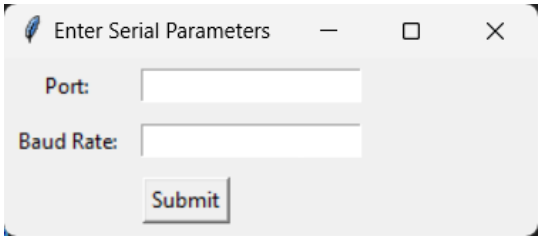
To exit minicom – Ctrl + A X

Cryocooler Operating instructions: Windows

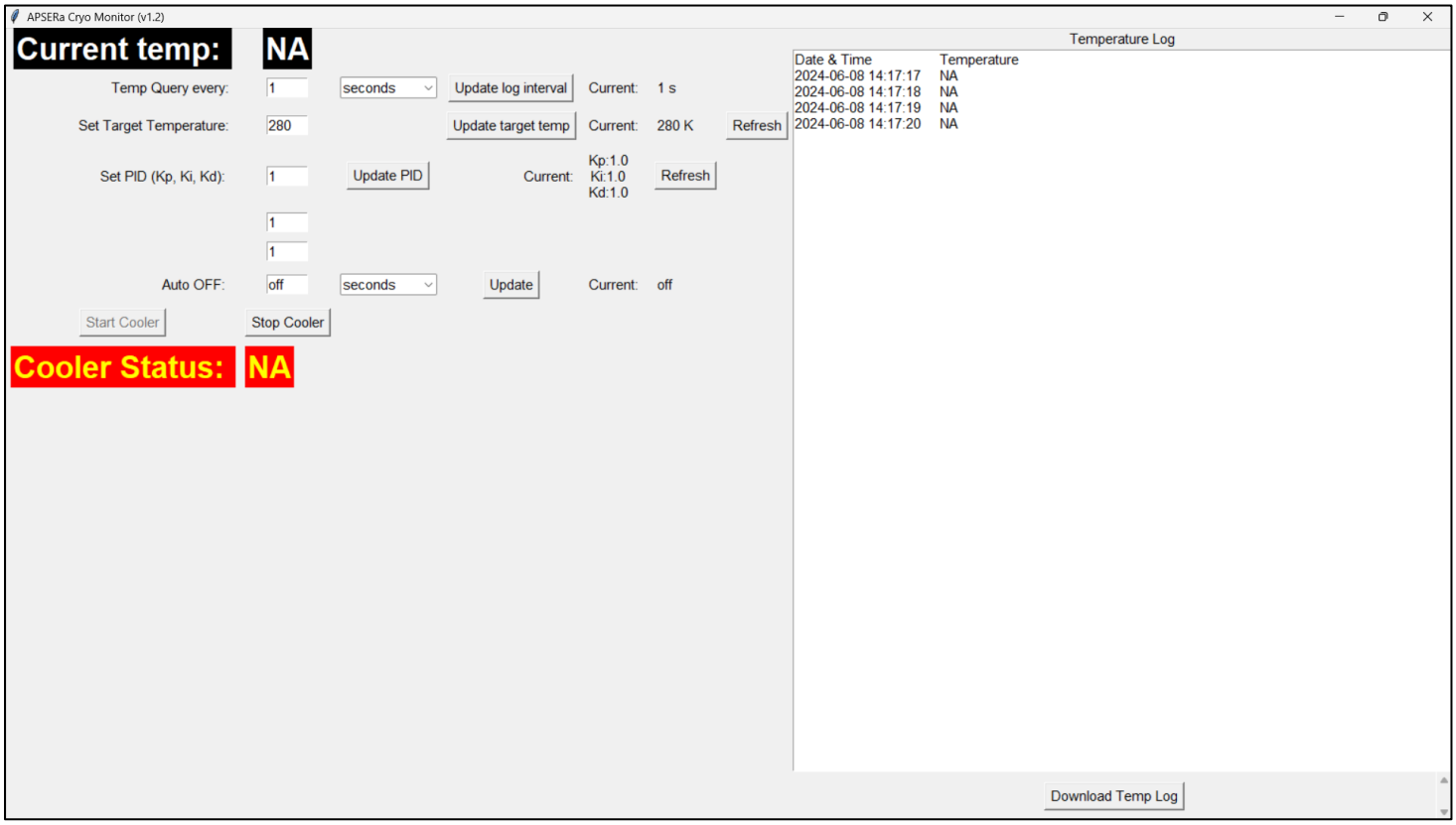
Description of Terminal

How to Run: The code (Cryotel_controller_GUI.py) is available here. We need to download the code and the requirements.txt, for an error free operation. Install the dependencies in a venv. Open terminal in the code directory and then run the py file.

This shall open up this dialog box, where you need to type the port name and baud rate values. And you need to **PRESS SUBMIT** to enter into the GUI.



We will see the GUI like this:



Explanation of the fields:

Current Temperature: Displays the current temperature of the cryocooler feeding the input from the RTD based thermometer PT-100 put on the copper plate. The temperature is refreshed every 5 seconds. Which can be changed only from code.

Temp query every: We can choose the interval with which the Temperature logger in the right pane logs. On setting the required time interval, by choosing the unit from the drop-down menu, click on **'Update Log Interval'** button to save changes. The current value of Query interval is shown next to the button. No default value.

Set Target Temperature: User can type in the target temperature in Kelvin in the white box and click on **'Update Target Temp'** button to save changes. On pressing the button, the current target temp string also is changed to the present value. We can also at any point of time click **Refresh** button at the end of the row, to update the string to the current Target Temperature by querying. The default value is obtained by querying the controller and is not changed until you set.

Set PID (Kp, Ki, Kd): We can also set the Kp, Ki, Kd in the white box and click on **'Update PID'** button to save changes. On pressing the button, the PID string also is changed to the presently set value. We can also at any point of time click **Refresh** button at the end of the row, to update the string to the current PID values set, by querying. The default value is obtained from querying the controller and is not changed until you set it.

Auto off: We can automatically turn off the cooler after a certain amount of time. We can set the time in the white box and then select the units from the drop-down menu. Press the **Update** button next to it for saving changes. Then we press start cooler button in the next row. The cooler automatically performs the cooling and shuts down. If you wish to turn off this feature just type in **'off'.** The default value is 'off' which is loaded at launch.

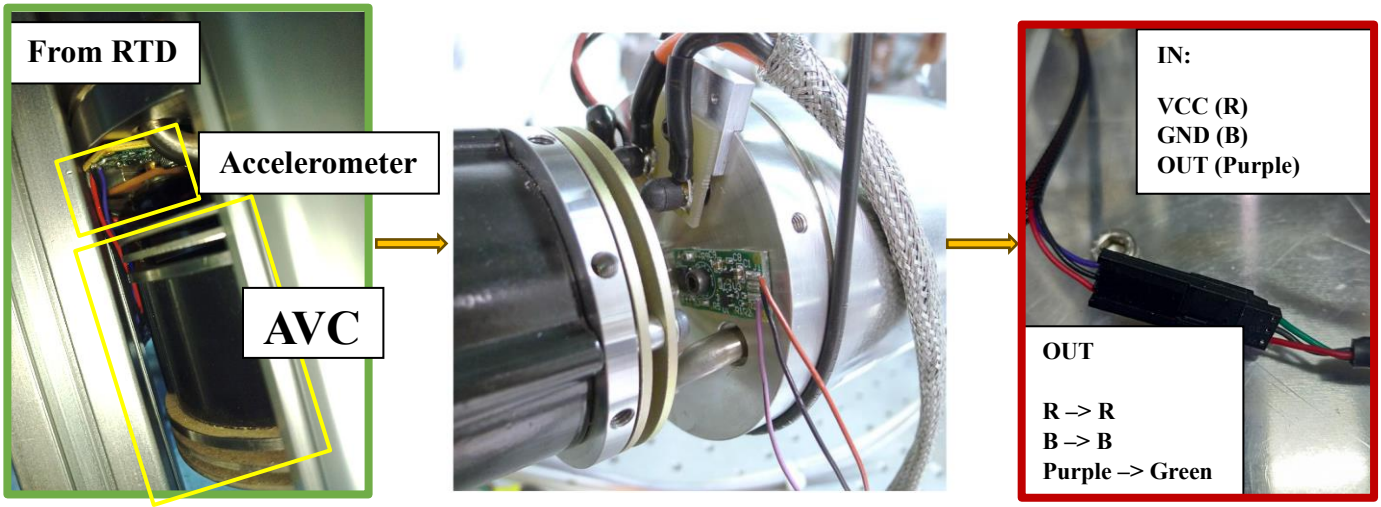
Start Cooler and Stop Cooler: Press the **Start Cooler** button to start the cooler (Keep in mind of the preset value of the auto off choice above, which will be off as default).

The **Stop cooler** button is initially disabled and is only enabled, when the Start Cooler button is pressed. If the user did not set the auto off timer or wants to stop the experiment urgently, press the Stop Cooler button. When the experiment is in progress the Start Cooler button is disabled and is enabled when the experiment ends or the Stop Cooler button is pressed.

Downloading the data: On completion of experiment i.e. via auto off or manual shutdown, there will be one header file and another log file saved in the directory of the code. The auto save is called when one automatically finishes the experiment with the help of auto off timer option or presses the Stop Cooler button. At any point in time while the experiment is in progress, user can also download the Log by pressing the **Download Temp Log** button.

Connections:

Accelerometer:



RTD:

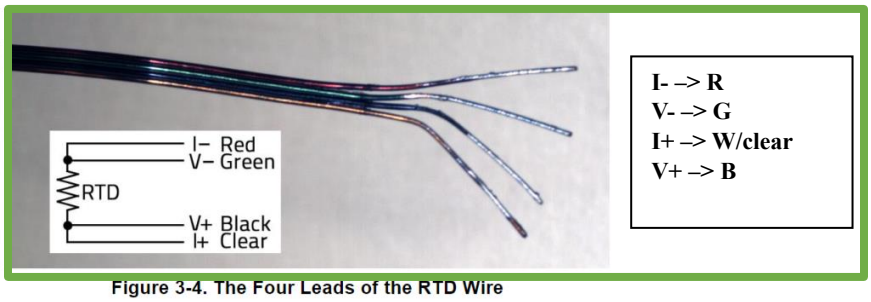
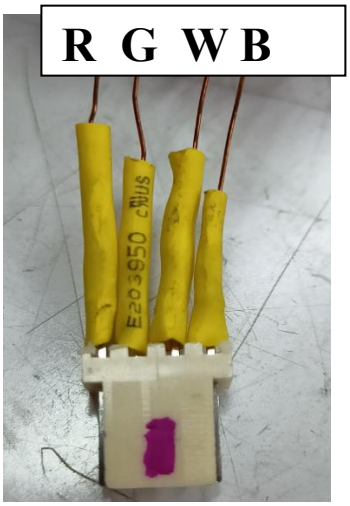
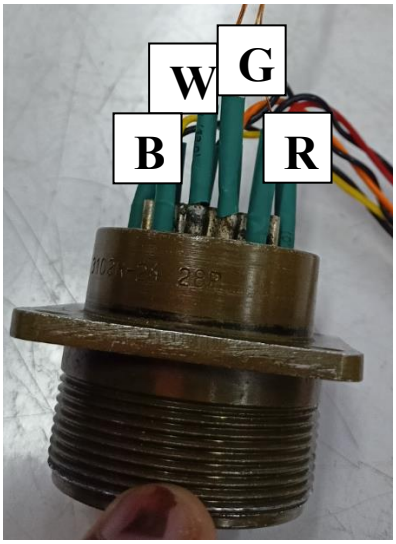
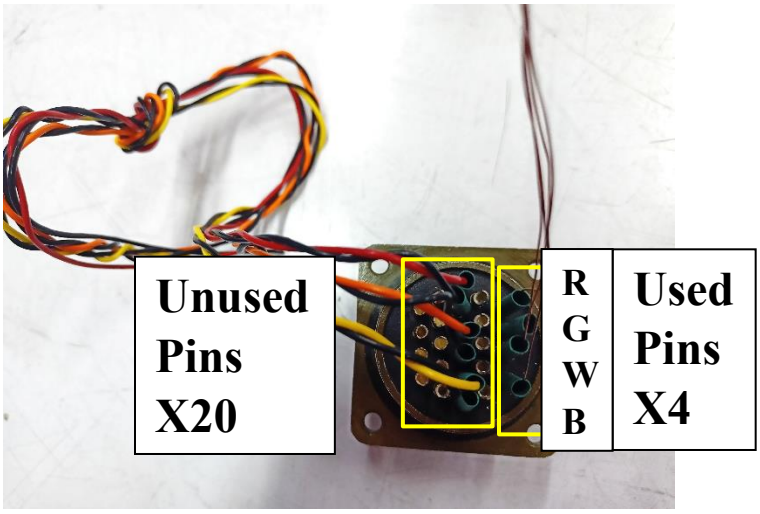


Figure 3-4. The Four Leads of the RTD Wire

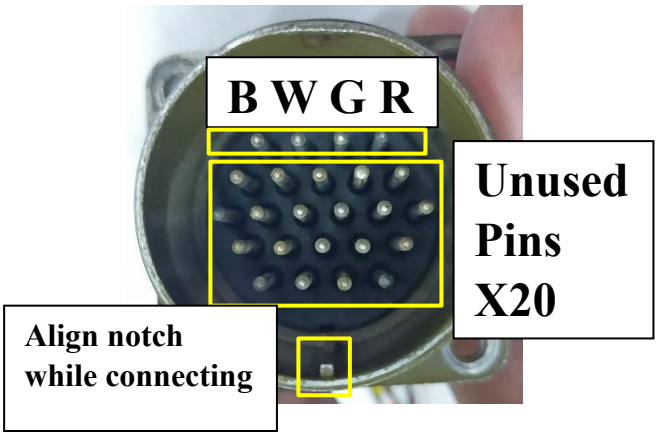
Circular Connector – 24 Pins for Connecting RTD's (usually 4 pins/2 pins)



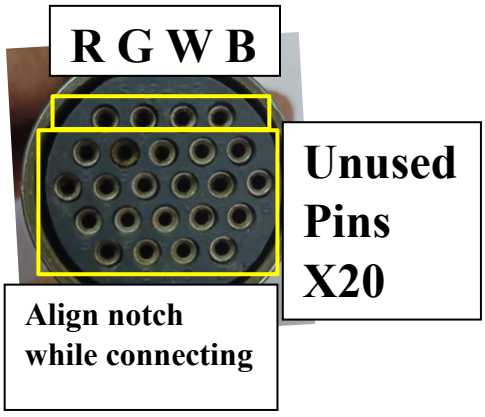




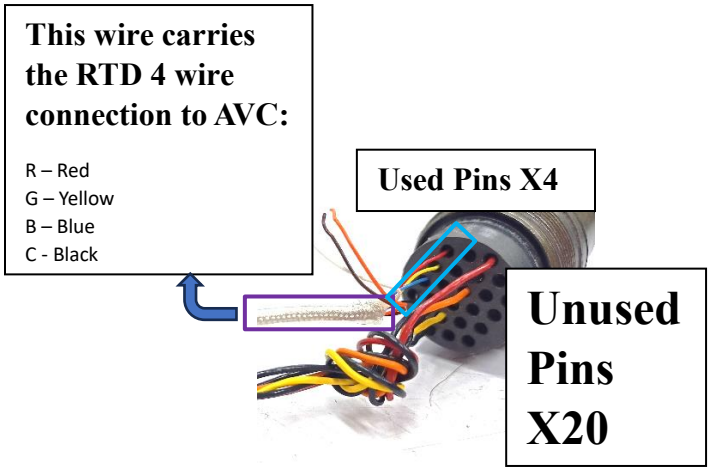
Dewar In Circular (M)



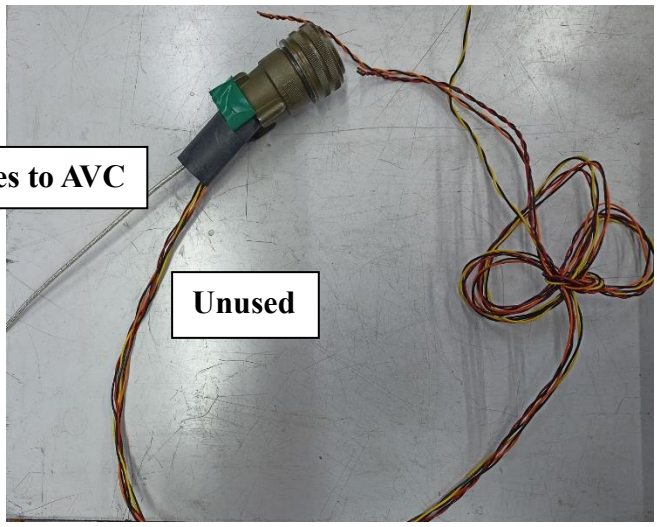
Dewar Out Circular (F)

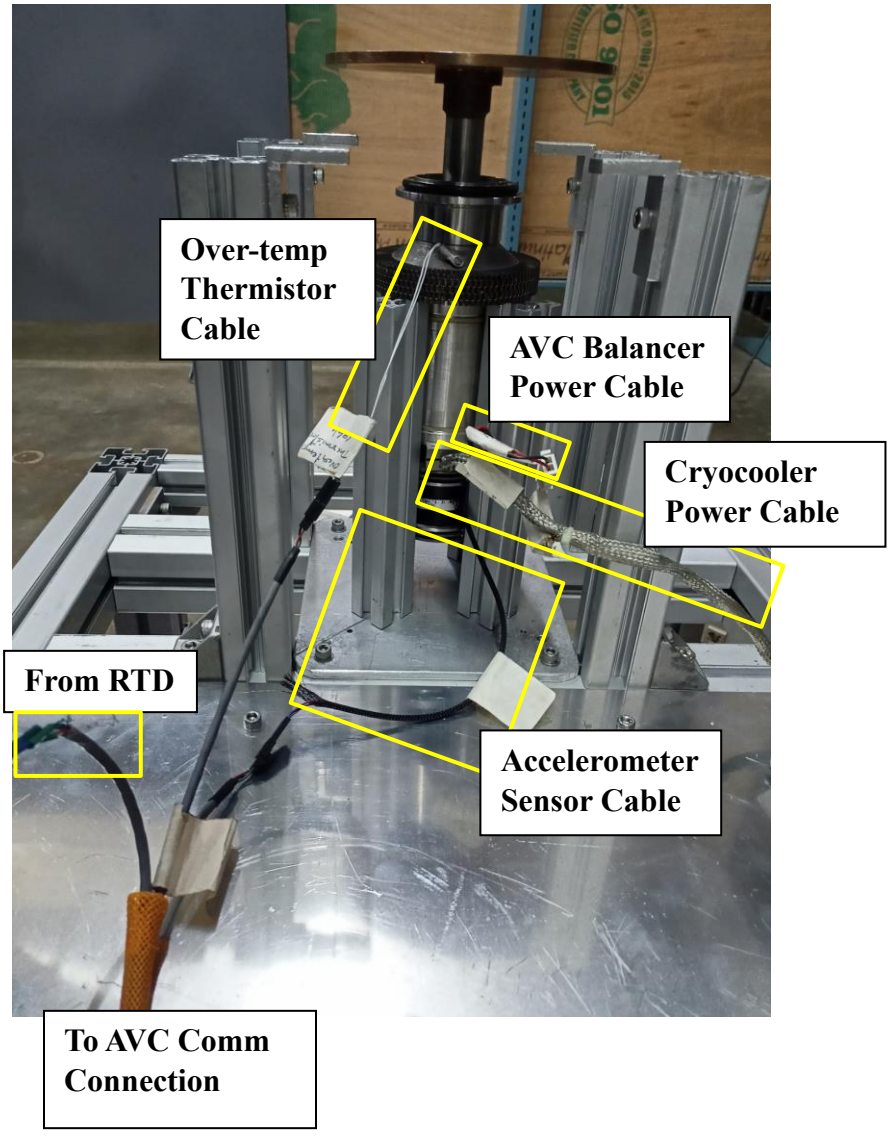


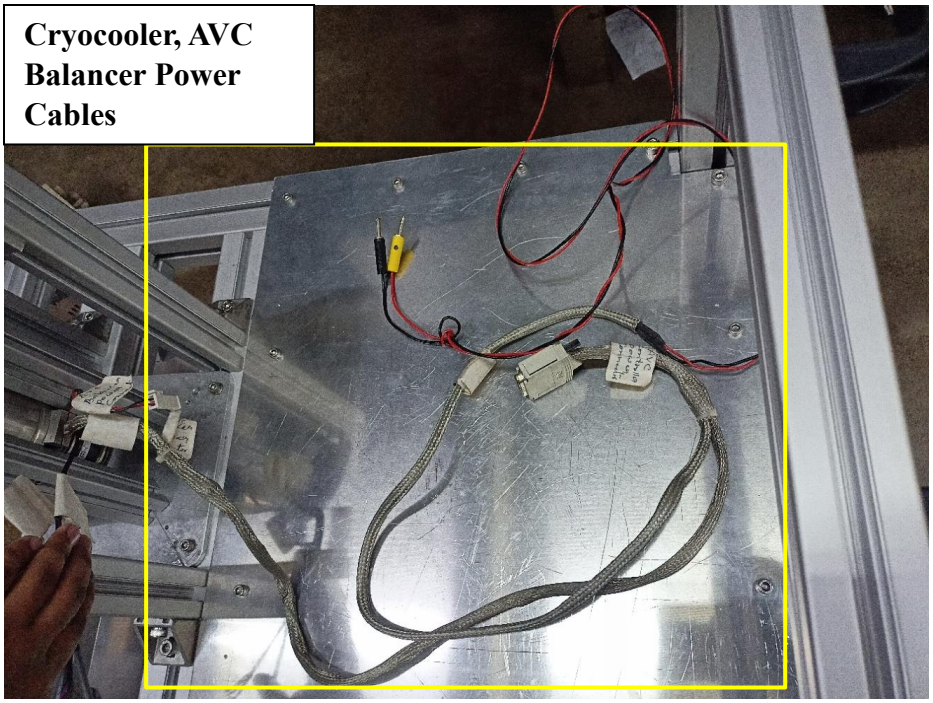
Mid Circular Dewar Connecter

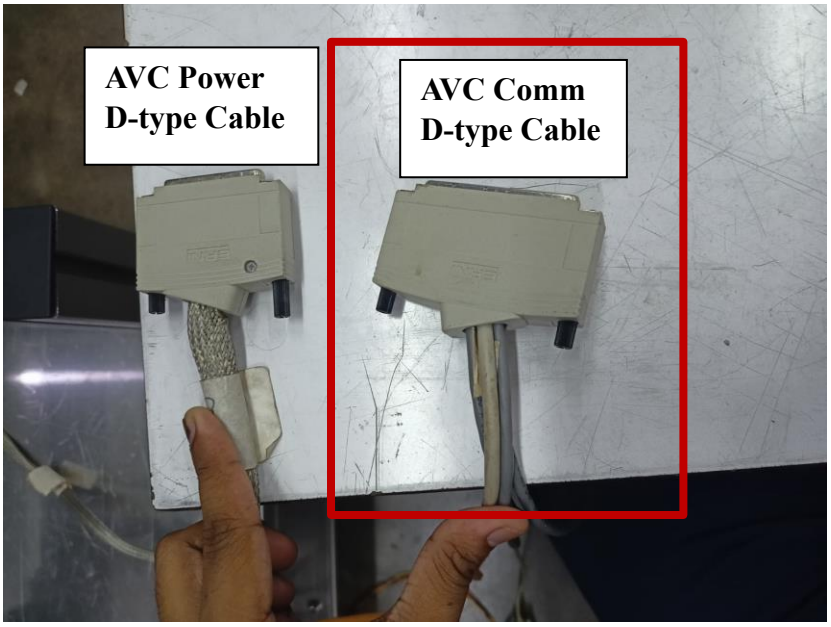


Mid Circular AVC Connecter

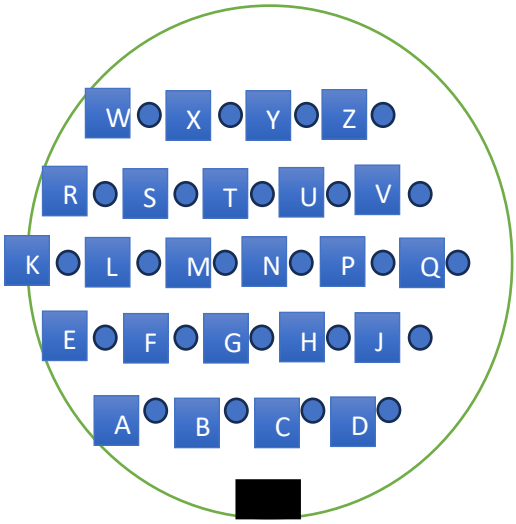

Goes to AVC
Unused


Over-temp Thermistor Cable
AVC Balancer Power Cable
Cryocooler Power Cable
From RTD
Accelerometer Sensor Cable
To AVC Comm Connection


Cryocooler, AVC Balancer Power Cables


AVC Power D-type Cable
AVC Comm D-type Cable

Continuity test from cooler till cryo-controller



Mid Circular Dewar

Current continuity links

Sensor	In-Cooler	Dewar Circular Out	At AVC comm
PT-111	I^- (R)	W	20
	V^- (G)	X	2
	I^+ (W, C)	Y	21
	V^+ (B)	Z	1