Ideal® vacuum

OUR PRODUCTS DEVELOP TOMORROW'S TECHNOLOGIES™

Liquid Nitrogen Cooling Option

For EXPLORAVAC™ Systems

USER MANUAL

LNCO-11082023 - V 1.0.2

WARRANTY

Ideal Vacuum warrants to the original purchaser this product to be free from defects in workmanship and materials for a period of 1 year from the original delivery date. The liability of Ideal Vacuum under this warranty is limited to servicing, adjusting, repairing or replacing any unit or component part which, at Ideal Vacuum's sole discretion, is determined to have failed during normal, intended use. This warranty does not cover improper installation, process related damage, product use in any way other than defined in this manual, or any misuse, abuse, negligence, accident, or customer modification to the product.

Prior to returning any product, we require that you contact us by phone or email to determine if the issue can be resolved quickly. A technical support representative will work with you to resolve the problem. If the issue cannot be resolved in that manner, we will issue an RMA number and provide product return instructions.

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CUSTOMER SERVICE AND SUPPORT

If you have any questions concerning the installation or operation of this equipment, or if you need warranty or repair service, please contact us. Customer Service and Technical Support is available weekdays, from 8am-5pm, Mountain Time.

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LIQUID NITROGEN SAFETY

Thank you for purchasing this equipment from Ideal Vacuum Products. We want you to operate it safely.

The Ideal Vacuum liquid nitrogen cryogenic option may only be installed, operated, maintained and serviced by trained, qualified personnel who have received and been certified in an approved cryogenics safety training course.

Read this manual, the ExploraVAC manual, and the AutoExplor manuals before installing or operating this equipment. Obey all safety warnings. Keep all manuals in a safe location for future reference. Follow all codes that regulate the installation and operation of the equipment.

DANGER

Explosion Hazard. Never add, remove, or circumvent any valve, relief valve, or burst disc attached to the ExploraVac or an LN_2 tank. Pressure in excess of system or tank ratings can occur.

WARNING

Asphyxiation Hazard. Do not use in a closed or unventilated room. Plumb the exhaust out of the facility. Large amounts of inert nitrogen gas are generated during operation.

CAUTION

Frostbite Hazard. Do not touch valves or nitrogen lines during operation. They can be extremely cold and may not show condensation.

CAUTION

Burn Hazard. Do not touch valves or nitrogen lines during operation. When cooling hot items, outlet lines and connectors can reach up to 200°C.

CAUTION

Wear Hearing Protection. The system generates a loud, high pitched sound out of the exhaust. Plumb the exhuast line outside of the facility.

CAUTION

Wear Personal Protective Equipment when working with liquid nitrogen. This includes a face shield, insulated gloves, a long-sleeved shirt, full-length pants, and closed footwear.

1. SYSTEM INFORMATION

The Ideal Vacuum liquid nitrogen cooling option is available for cooling the platen of an ExploraVAC thermal vacuum test instrument. The liquid nitrogen cooling option is only available in combination with platen heating. This cryogenic cooling system is capable of producing platen temperatures and cooling attached test items to ≤ -170°C. Liquid nitrogen (LN_2) is used as it provides the fastest cooling rates available for temperatures below -5°C.

The LN_2 cooling option connects the owner's bulk liquid nitrogen supply tank (the house system) through a vacuum jacketed supply hose to a pneumatically controlled cryogenic valve. The valve is then connected by another vacuum jacketed hose to one end of the thermal fluid tube embedded in the ExploraVac platen. Liquid and gaseous nitrogen exit the platen through the other end of the platen thermal fluid tube (Figure 1, p. 6). Exhaust and must be either recaptured or expelled through the facility's exhaust line to prevent asphyxiation.

An ExploraVac with the LN_2 cooling option allows even hot objects affixed to the ExploraVAC platen to be rapidly cooled to cryogenic temperatures at a maximum cooling rate of approximately 10ºC/min. Constant low temperatures to within ± 0.3ºC can also be maintained. Often used for space simulation and stress testing of aerospace parts, the LN_2 cooling option makes it possible for the platen temperature to change sufficiently fast to simulate an orbiting object moving from light into shadow. Other possible uses for the LN_2 cooling option include freeze drying, biological sample freezing, reaction quenching, and cryopreservation.

LN_2 transfer is PID controlled by the ExploraVac. The ExploraVac's onboard temperature controller operates a pneumatic solenoid valve which opens and closes the cryogenic valve, efficiently delivering LN_2 to the platen (see the ExploraVac and AutoExplor User Manuals).

The cryogenic valve must be mounted to a wall or strong support structure. The length of vacuum jacketed liquid nitrogen hoses between the supply and cryogenic valve, and the valve and ExploraVac instrument will vary depending on the customer's layout. The design, fabrication, and location of a suitable mount and the purchase of suitably long transfer hoses is left to the user.

User safety is paramount. All safety warnings and procedures must be followed for safe handling and transfer of cryogenic liquid. All LN_2 cooling option plumbing components are rated for cryogenic use at 150 psig maximum.

If LN_2 is shut off upstream, it is possible for the transfer line pressure to exceed the tank pressure as the trapped liquid becomes gas. A 100 psig relief valve, a 200 psi burst disc, and necessary fittings are included with the system and installed on the supply side of the cryogenic valve for supply tank pressures up to 100 psig. If the bulk supply tank is operated at 150 psig, a 150 psig relief valve must be substituted. These safety components must not be eliminated or bypassed.

Depending on frequency of use, the cryogenic valve should operate for 1-2 years before any maintanence is needed. A valve rebuild kit, part number P1013404 is available.

A diagram of the cryogenic valve and connections are provided on page 8.

2. CONNECTION

Connections to and from the cryogenic valve and the ExploraVac instrument are male 1/2” JIC 45º flare fittings.

The LN_2 supply must be ≤ 150 psig and the supply line must be vacuum jacketed and have a female JIC 45º flare fitting to connect to the valve. The transfer hose between the ExploraVac and cryogenic valve must also be vacuum jacketed and both ends require female JIC 45º flare fittings.

The platen supply and exhaust lines, located at the back of the ExploraVac, have 1/2” Swagelok® compression fitting nuts and ferrules attached.

The platen exhaust line must be able to withstand temperatures up to 200ºC and be insulated to protect personnel from burns since cooling a very hot platen produces hot exhaust gas.

The cryogenic valve requires a compressed air supply to operate the pneumatic actuator (maximum 35 psig). The ExploraVac’s onboard compressor supplies air through a push-to-connect port located below the platen tubes at the back of the ExploraVac. 1/4” OD tubing is included to connect to the cryogenic valve. A regulator attached to the valve and factory preset to 30 psig has a push-to-connect fitting to which the air line is attached.

See Figure 3, page 8, for plumbing connections.

1. Mount the cryogenic valve to a wall or strong support structure.
2. Connect the included 1/2” Swagelok-to-female NPT adapters onto the ExploraVac platen tube ends. Use a 1-1/16” and 7/8” wrench.
3. Connect the 45° flare-to-Male NPT brass adapters to the ExploraVac platen tube ends.
4. Connect the vacuum jacketed LN2 supply hose to either of the platen tube ends.
5. Connect the other end of the vacuum jacketed LN_2 supply hose to the cryogenic valve.
6. Connect the other platen tube to the facility exhaust system (supplied by the user).
7. Connect included 1/4” OD air line tubing between the Exploravac and cryogenic valve regulator.
8. Energize the ExploraVac system.
9. Open the main facility LN2 supply valve.
10. Use the ExploraVac’s setpoint controller or the PLATEN TEMP controller in AutoExplor to cool the platen.

Figure 1 - Connect LN_2 hoses to platen tubes

3. DISCONNECTION

1. Turn off the LN_2 bulk tank supply to the cryo valve.
2. On the Exploravac temperature controller, set the platen temperature to 10ºC above its current temperature for 2 minutes at MAX ramp.
3. Turn on the temperature controller. This boils off the LN_2 between the cryo valve and the platen exhaust.
4. Set the platen temperature to 10ºC below its current platen temperature for 2 minutes at MAX ramp rate.
5. Turn on the temperature controller. This opens and depressurizes the cryo valve and allows LN_2 in the supply line to pass through the platen and out the exhaust.
6. If the supply line fittings are iced up, wait for them to de-ice. **CAUTION**: If any part of the LN_2 lines physically droop below the valve or platen connections, some LN_2 may remain in the line.
7. It is now safe to disconnect the LN_2 lines from the cryogenic valve or ExploraVac.

   At the ExploraVac, disconnect the lines at the Swagelok nut closest to the feedthrough, leaving the brass fittings and Swagelok adapters attached to the LN_2 hoses.

Figure 2 - Disconnect LN_2 hoses from platen tube at Swagelok nut

4. VALVE AND CONNECTIONS DIAGRAM

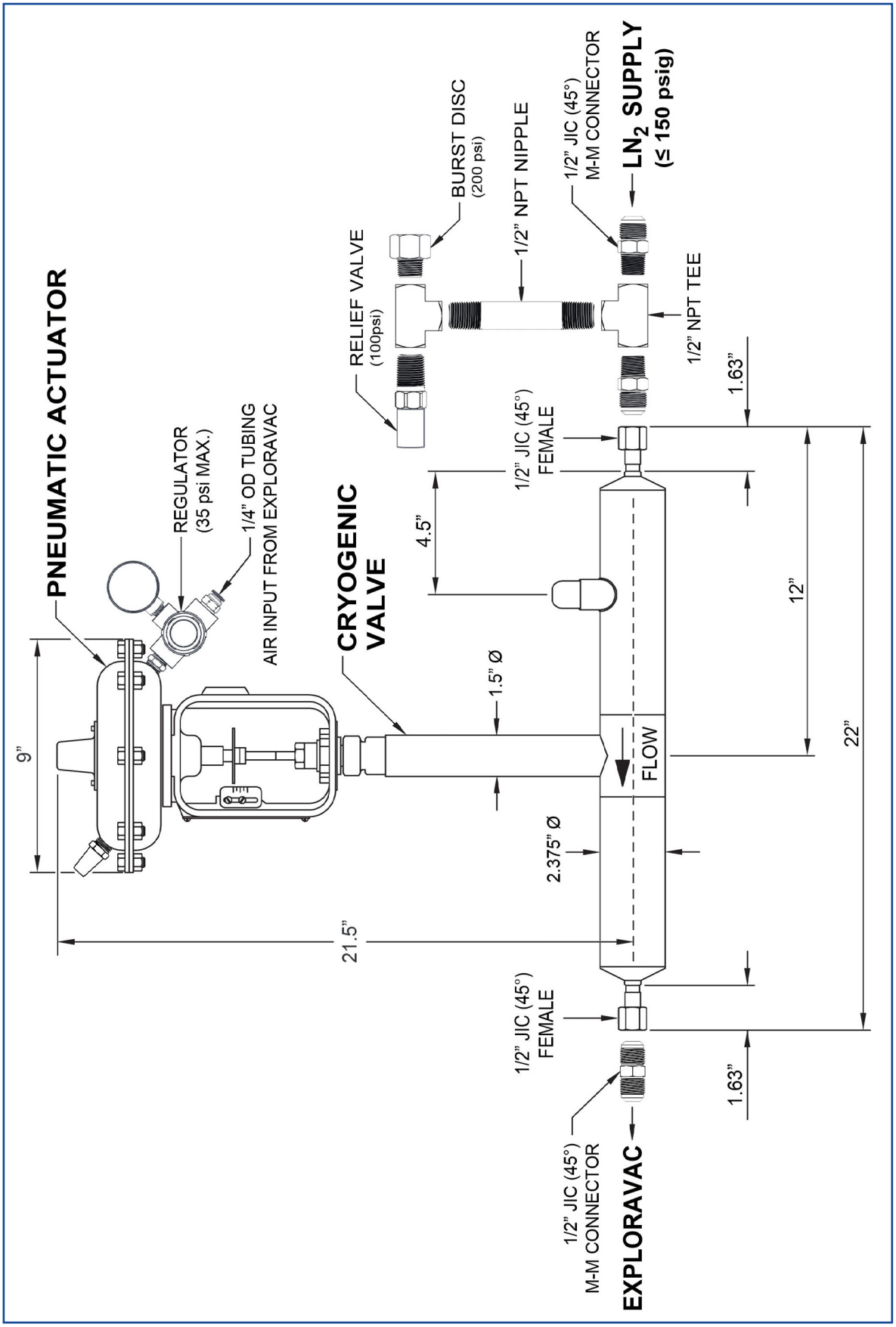

Figure 3 - Cryogenic valve and connections

5. PERFORMANCE GRAPH

The performance curves below show the cooling rates of an ExploraVAC system with a 20” or 24” stainless steel chamber and a heated and liquid nitrogen cooled platen.

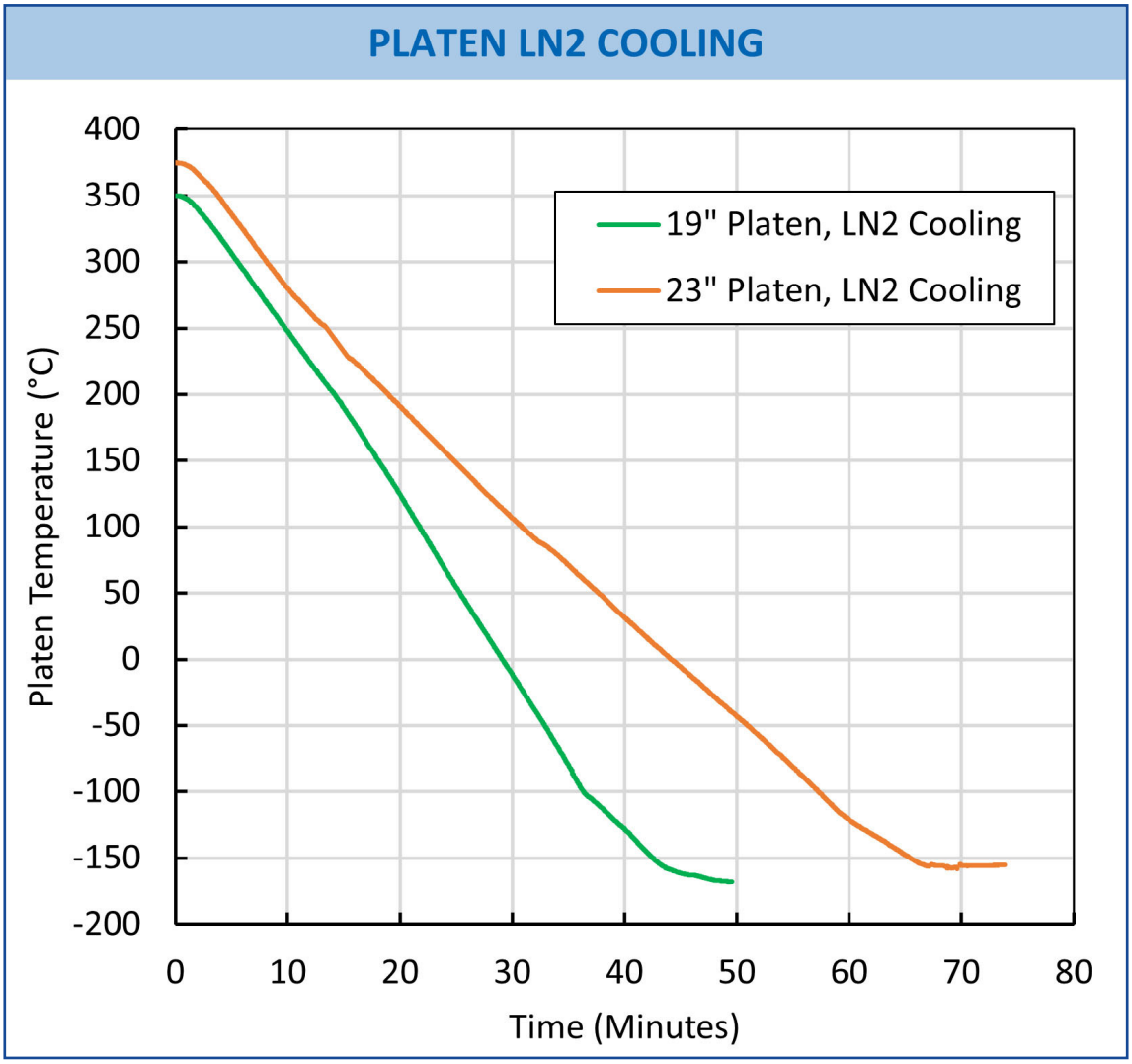

Figure 4 - Platen cooling performance graph

6. USING SETPOINT CONTROLLERS

In order to run the LN_2 cooling option, a temperature setpoint, ramp rate, and soak time must be input into either the ExploraVAC XGC-820 setpoint controller on standard ExploraVac instruments, or into the PLATEN TEMP controller on ExploraVacs running AutoExplor software. The platen or sample thermocouple measures the temperature. Once setpoint parameters are entered into the controller, liquid nitrogen flow is initiated by pressing the HEAL/COOL PLATEN switch on the ExploraVAC's console, or by pressing the PLATEN TEMP icon in AutoExplor.

6.1 XGC-820 TEMPERATURE SETPOINT CONTROLLER

The onboard XGC-820 setpoint controller on an ExploraVAC manually operated system, is used to input setpoint parameters.

Setpoint temperature is the temperature for the system to maintain.

Ramp rate is the speed with which the platen heats or cools from its initial state to the setpoint temperature. The maximum cooling ramp rate is approximately 10°C/min. The ramp rate can also be set to MAX, which forces the platen to get to temperature as quickly as possible. Compared to a numerical ramp rate which is a linear function, the MAX rate is non-linear.

Soak is the amount of time, after the setpoint temperature is reached that the platen temperature is maintained. When the soak time has elapsed, liquid nitrogen flow and/or platen heaters will turn off. Platen or test item temperature will naturally heat or cool to ambient temperature.

The XGC-820 temperature setpoint controller's home screen show's the current platen temperature, the setpoint temperature, the ramp rate or soak time, and the platen mode. See the ExploraVac User Manual about the temperature setpoint controller and platen modes.

Figure 5, below, shows the XGC-820's home page. Figure 6, page 11, shows its menu flowchart.

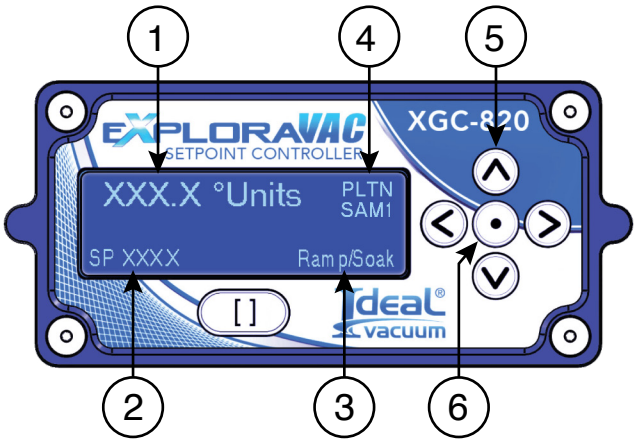

Figure 5 - XGC-820 controller home page

Item	Description
1	Platen Temperature (user selected units, resolution 0.1 degree
2	Setpoint Temperature (in same units as platen temperature)
3	Ramp Rate or Soak Time (if a soak time is saved, ramp rate changes to soak time when setpoint temperature is reached.
4	Platen Mode (indicates the thermocouple the controller is using. SAM1-SAM4 are the feedthrough thermocouples attached to a test object)
5	Arrow Buttons (used to negotiate through the menus)
6	Select/Enter Button (used to make a selection or save a parameter value)

Table 1 - XGC-820 controller display items

To negotiate the menu heirarchy:

- Press the center SELECT/ENTER button to go down (right) one tier.
- Press the LEFT ARROW button to go to the left (up) one tier.
- Press the UP or DOWN ARROW button to move vertically in the same tier.
- Press the UP or DOWN ARROW to increase or decrease a value.
- Press the SELECT/ENTER button to save a value.
- Arrows on the flowchart boxes below indicate which arrow buttons are active for that menu item.

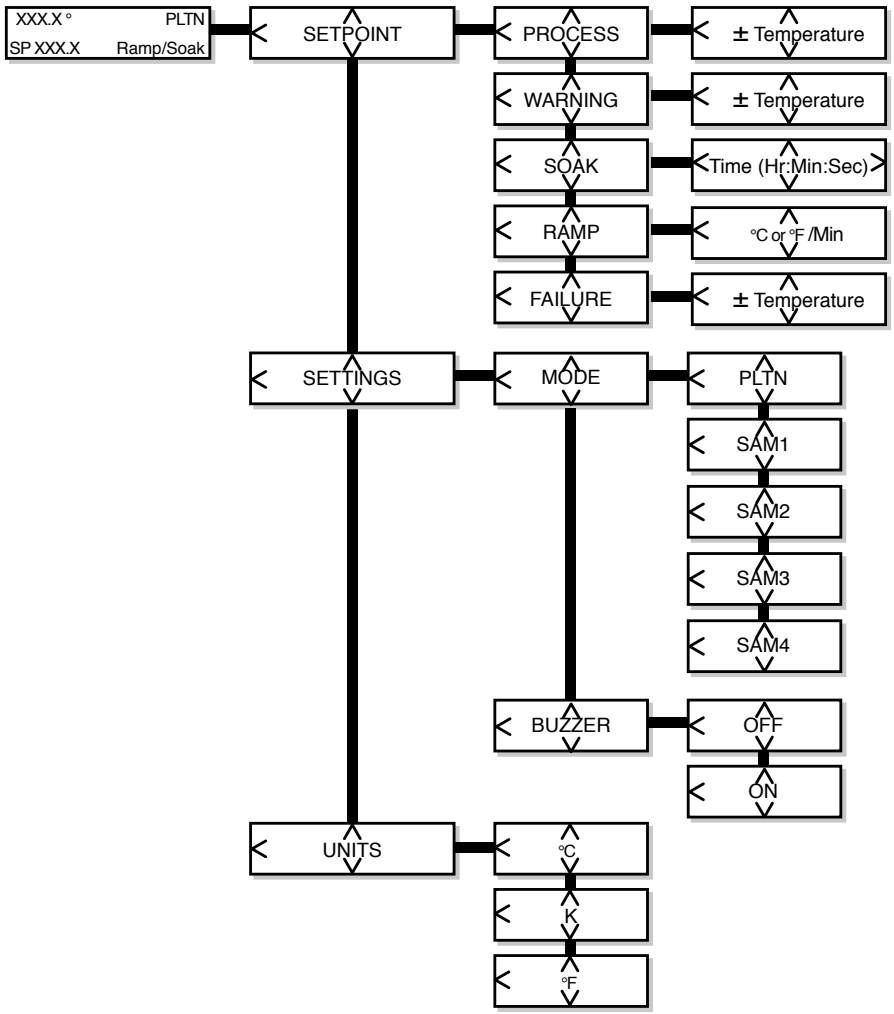

Figure 6 - Temperature controller menu flowchart

- PROCESS is the temperature for the system to maintain (the setpoint).
- WARNING is the temperature above the setpoint that the HEAT/COOL PLATEN switch will begin to blink green/yellow to indicate a potential problem. The platen will continue to operate.
- SOAK is the amount of time after reaching the setpoint that the temperature will be maintained.
- RAMP is the rate at which the temperature increases or decreases towards the setpoint (process).
- FAILURE is the temperature above the setpoint when the system will automatically shut off and alarm. This setting ensures that your sample or the system will not be damaged.
- MODE is the thermocouple that the setpoint controller uses.

6.2 AUTOEXPLOR PLATEN TEMP CONTROLLER

When used on an ExploraVAC system running AutoExplor software, the LN_2 cooling option is automatically recognized. The software adds the LN2 SYSTEM tile into the devices section of the home page. When selected, the LN2 SYSTEM data card is displayed. PWM is a measure of the amount of time (in percent) that the valve is open based on the setpoint temperature. The Valve parameter indicates if the valve is open (1), or closed (0).

Figure 7 - LN2 device tile and data card

Setpoint parameters are entered from the AutoExplor home page in the PLATEN TEMP controller box. Any of the control parameters can be adjusted at any time. Select the PLATEN TEMP icon on the left side to turn on the controller and start heating or cooling.

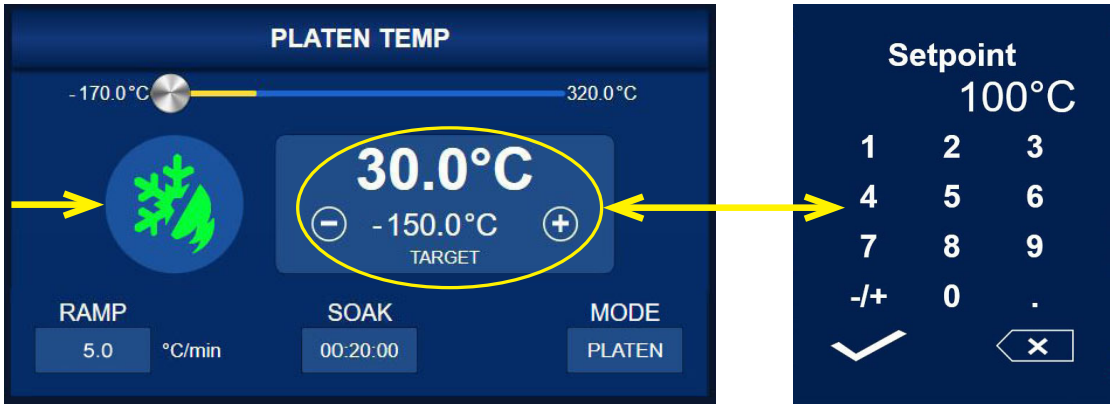

Figure 8 - Platen Temp. controller - input setpoint value

The largest white text displays the current temperature. In Figure 7, above, the current temperature is 30°C. Select the current temperature to open a window that allows the measurement units to be changed.

Changing the Setpoint Value:

The setpoint (target) temperature is shown just below the current temperature. In Figure 8, the setpoint target temperature is -150°C. Select it to open a window where a numerical value is entered. Select the (+) or (-) button to change the setpoint temperature incrementally. If a temperature input is outside the system limit, the pressure reverts to the closest allowable value.

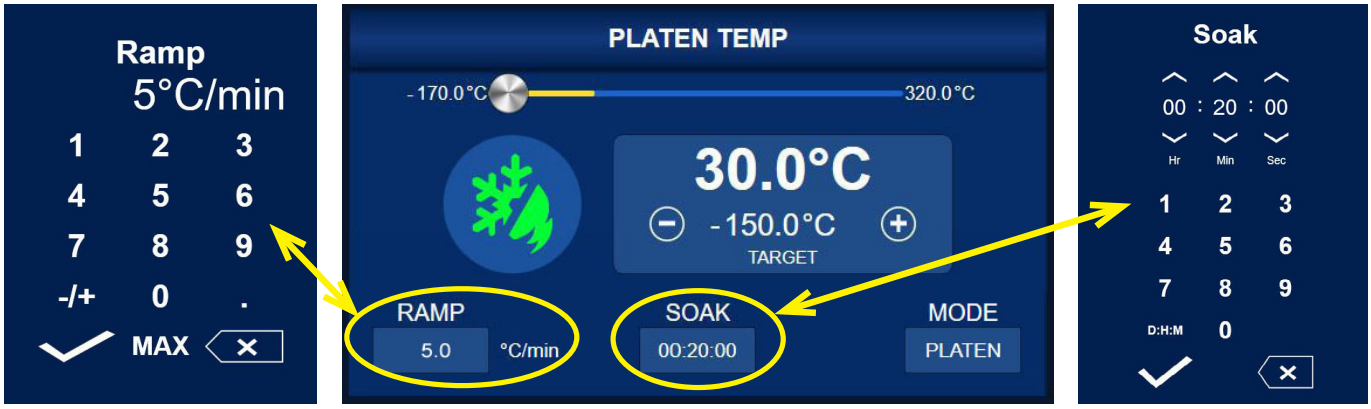

Figure 9 - Platen Temp. controller - input ramp rate and soak time

Changing the Ramp Rate:

Ramp rate is the speed at which the platen goes from its current temperature to the target (setpoint) temperature. The rate is dependent on the speed with which the heating elements and/or liquid nitrogen can tranfer heat to or from the platen, as well as the chamber pressure. When the chamber is under vacuum, the platen heats and cools faster than when at ambient atmosphere. Under vacuum, the ramp rate limit for cooling is approximately 10°C/min.

To change the ramp rate, select the RAMP tile at the bottom left of the controller (above). A window appears where a value can be entered. The ramp rate is expressed in the current temperature units per minute. Above, a ramp rate of 5°C/min. is entered. The ramp rate can also be set to MAX, which forces the system to get to the setpoint temperature as quickly as possible. Compared to a numerical ramp rate which is a linear function, the MAX rate is non-linear.

Changing the Soak Duration:

Soak is the amount of time after the setpoint temperature is reached that the platen temperature is maintained. When the soak time has elapsed, heating and/or cooling is discontinued and the platen will naturally heat or cool towards ambient temperature.

Select the SOAK tile at the bottom right of the controller to enter a soak time. Select the time in hours, minutes, and seconds, or select D:H:M to change to days, hours, and minutes. The maximum soak duration is 99 days. If no soak time is specified, the system continues at the setpoint until it is turned off manually.

Changing the Platen Mode:

Please see the AutoExplor Manual, Sec. 3.3.2, Platen Temperature Controller.

7. MORE INFORMATION AND ASSISTANCE

For more information about using AutoExplor and the ExploraVAC system, please see the user manuals provided with the system or download them here:

AutoExplor Software: idealvac.com/files/manuals/AutoExplor_Software_User_Manual.pdf

ExploraVAC Manual: idealvac.com/files/manuals/ExploraVAC_System_User_Manual.pdf

ExploraVAC MAX Manual: idealvac.com/files/manuals/ExploraVAC_MAX_System_User_Manual.pdf

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