CUSTOM BIOGENIC SYSTEMS
2301 LN2 STORAGE UNIT
USER MANUAL



Custom BioGenic Systems

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Leading the World with Innovative Cryopreservation Technology Solutions

European Authorized Representative
EC REP
EMERGO GROUP
Molenstraat 15
2513 BH, The Hague
The Netherlands

Custom Biogenic Systems liquid nitrogen freezers equipped with 2301 controllers are CE marked to the Medical Device Directive. The Medical Device Directive is a European Union directive regulating medical device construction and operation.

CE 0086

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Custom Biogenic Systems maintains ISO 13485:2003 Quality Management System

This manual covers the use of Custom Biogenic Systems Liquid Nitrogen Freezers equipped with 2301 controllers. This equipment is intended for use by trained personnel only. READ THE MANUAL BEFORE USING THIS EQUIPMENT.

Custom Biogenic Systems Liquid Nitrogen Freezers covered in this manual are non-hazardous, open mouth vacuum insulated dewars specifically designed for use with liquid nitrogen. They are not subject to any pressure vessel codes as they are open to atmospheric pressure. They are shipped empty without liquid nitrogen or any hazardous material from our factory in Michigan

Custom Biogenic Systems liquid nitrogen freezers, cryogenic equipment and accessories are designed and intended for use with various applications where extremely low temperature storage is desired, such as veterinarian, horticultural, pharmaceutical, industrial, scientific and research laboratories. They are not intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment or prevention of disease, and as such have no medical purpose. They are designed for, but not limited to, use in the laboratory environment.

Thank you for choosing Custom BioGenic Systems

Custom BioGenic Systems can supply you with everything you need to effectively and safely store your samples.

Our 2101 controlled rate freezer will freeze your samples down at a controlled rate prior to long term liquid nitrogen storage.

We have an extensive selection of freezer racks, bag storage solutions, boxes and dividers for liquid nitrogen freezers, mechanical freezers as well as custom configurations.

For long term storage we offer our patented Isothermal dry storage liquid nitrogen freezers, carousel freezers, standard liquid nitrogen freezers, cryosystems and dewars in many popular sizes.

VersAlert will monitor your temperature critical products and send alerts via text message or email if specified parameters are exceeded.

For more information please contact Custom BioGenic Systems at 1.800.523.0072, www.custombiogenics.com or email sales@custombiogenics.com.



IMPORTANT INFORMATION

We at Custom BioGenic Systems are proud of our work, and appreciate your purchase of this product. With proper care, this equipment will be trouble-free for many years to come. Before setting up and using your new cryogenic storage unit, first check to see that all parts are accounted for and that no damage has occurred during shipping. Also, read this manual completely before proceeding to set-up. If at any time you are unsure of the procedures for set-up and use of this product, please contact CBS or your CBS sales representative.

NOTE: If equipment is used in a manner not specified by Custom BioGenic Systems, the protection provided by the equipment will be impaired.

PRODUCT WARRANTY

Custom BioGenic Systems warrants all manufactured cryogenic equipment to be free from defects in workmanship or materials for a period of five year vacuum warranty and a 2 year warranty on electronics and parts.

Custom BioGenic Systems' liabilities under the warranty shall be limited to correcting or replacing defective workmanship or materials. A claimant under the warranty must notify Custom BioGenic Systems within (10) days after the discovery of the defect. Custom BioGenic Systems reserves the right, at their discretion, to correct the defect(s) in the field without return shipment to the factory.

This warranty does not cover defects on cryogenic equipment resulting from abusive handling and subsequent structural failure.

To register you Custom BioGenic Systems product(s) please go to www.custombiogenics.com/registration.html

Controller Serial Number:_____ Model:_____

Freezer Serial Number:_____ Model:_____

For Technical Assistance Call: 1.800.523.0072 (U.S. Only)
Phone: 586.331.2600 Fax: 586.331.2588
www.custombiogenics.com

TABLE OF CONTENTS

Q&A ____ Page 1
Safety ____ 2-3
V Series and S Series Vessel Descriptions ____ 4
Initial Set-Up ____ 5
Operation ____ 5
Front Panel Controls (ALL) ____ 6
2301 Back Panel ____ 7
Series 5000 Back Panel ____ 8
V Series Manual Fill Instructions ____ 9
Feature Details ____ 10-11
Remote Alarm Wiring ____ 12
Storage Unit Parameters ____ 12
LCD Display Functions ____ 13
- Standard Operating Mode ____ 14
- Programming Mode ____ 16

Verification & Calibration
- High & Low Alarm Set Point Verification ____ 26
- Temperature Display Verification ____ 26
- 2301 Temperature Calibration ____ 27
- V Series Level Display Verification & Calibration ____ 28

Trouble Shooting ____ 29-33
Plumbing Wiring Diagram Part ID ____ 34
Plumbing Assembly Diagram ____ 35
2301 Controller Wiring Diagram ____ 36
2301 Controller Diagram Part ID ____ 37
5000 2301 Controller Diagram Part ID ____ 38
Series 2301 Controller Back Panel Part ID ____ 39
Series 5000 2301 Controller Back Panel Part ID ____ 40
90 Series Tank Diagram Part ID ____ 41
S-1500 Series Tank Diagram Part ID ____ 42
V-1500 Tank Diagram Part ID ____ 43
3000 Tank Diagram Part ID ____ 44
5000 & 5000EH Tank Diagram Part ID ____ 45
Console and Rear Service Cover Assembly ____ 46
Probe Assembly Diagram Part ID ____ 47
Cleaning and Maintenance ____ 48
EMC Test Report ____ 49
Notes ____ 50

RECOMMENDED BEST PRACTICES

Recommended Best Practices in the industry for safe sample storage

Secondary or backup alarm

It is strongly recommended to have, at a minimum, an ***Independent Temperature Alarm*** for each LN2 freezer.

Remote alarm connection

It is strongly recommended to have, at a minimum, a ***Remote Auto Dialer*** connected to your Delta Room, Facility Monitoring Station or Remote Auto Dialer for each LN2 freezer.

Split Samples

Separate samples in to two different freezers.

Keep a daily log

Track temperature levels daily.
Record fill intervals and amount of LN2 filled into vessel (manual or pour-fill freezer or dewar).
This information should be documented daily and reviewed monthly to foresee and prevent future problems such as temperature fluctuations and varying liquid levels.

Prepare a contact list

Have at least 3 people on your contact list with Home, Cell and Pager Number. Review the list regularly for accuracy and changes.

Contingency plan

What to do if no one returns a call from your call list.
What to do if we run out of LN2 and it is a weekend or holiday.
What to do if you have a High Temp Alarm.
What to do if you have a Low Level Alarm.
What to do if you have a High Level Alarm.
What to do if you lose power.
What to do if you get a Source Alarm.

QUESTIONS and ANSWERS

Keep your most important samples safe.

You can plan for the future, you can't change the past.

Back-up or secondary Alarm

Q: Why do I need a Secondary or Back-Up Alarm?

A: Your freezer could malfunction. By having a secondary or back-up alarm you can minimize the possibility of a loss due to a malfunction.

Remote Alarm Connection to your Delta Room, Facility Monitoring Station or Remote Auto Dialer

Q: Why should I use my remote alarm feature or connection?

A: If an alarm occurs after hours, on a weekend or holiday the remote alarm connection will alert you to a problem and let you address it quickly.

Q: I am not sure how to connect the alarm or what to connect the alarm to.

A: First, contact your lab manager, supervisor or in house biotech representative. If no one is sure what to do, contact CBS customer service for help and direction.

Q: What is an Auto Dialer and why would I use one?

A: An Auto Dialer is used when a central connection is not available for the remote alarm. When connected to a telephone land line the Auto Dialer will dial up to 8 different contacts.

If you have any question, comments or concerns please contact:

Custom BioGenic Systems Customer Service
Phone 586.331.2600
Toll free (US only) 800.523.0072
Email sales@custombiogenics.com

SAFETY

IMPORTANT: The following section on SAFETY should be read carefully and followed completely. Warnings regarding the handling of liquid nitrogen are by no means a complete volume on the safe use of cryogenic liquids. All personnel should have complete knowledge of the correct procedures, as well as the hazards of working with liquid nitrogen. Failure to do so could result in serious injury or death. Be sure to read and understand the Liquid Nitrogen Safety Data Sheet provided by your Liquid Nitrogen Supplier.

WARNING

To avoid risk of electric shock, this equipment must only be connected to a supply mains with protective earth.

The lid could present a crush hazard. Open the lid entirely and carefully to prevent the lid from improperly engaging and falling. Use both hands while lowering lid into the closed position.

To prevent a rolling hazard, ensure the casters are locked.

HAZARDS ASSOCIATED WITH LIQUID NITROGEN:

Asphyxiation

When liquid is released into a confined space it displaces oxygen from the air. This results in an oxygen-deficient atmosphere, particularly if vented into a closed space, and asphyxia can result. Entering an oxygen deficient room can cause unconsciousness without warning. Always check air quality upon entering a room where cryogenic liquids are being used, and if possible, have an air respirator available.

Cold Burns

Due to its extremely low temperature, the cold vapor and gas that are produced when liquid nitrogen boils can give rise to cold burns or frostbite upon contact with unprotected skin. Exposure may also produce discomfort in breathing and can provoke an asthma attack in susceptible individuals. Never allow direct skin contact with liquid nitrogen or serious frostbite will result. Personal Protective Equipment (PPE) must be used, based on the principle that it should prevent liquid nitrogen from touching the skin and eyes. Appropriate PPE includes:

- Cryo-gloves (elbow length and loose fitting).
- Safety goggles/full face shield.
- Long sleeve lab coat.
- Cryo-apron.
- Long pants that come over the top of shoes.
- Fully enclosed footwear.

Go to custombiogenics.com/technicalguides.html
for more information.

Boiling, Splashing and Spurting

Introducing equipment which is at room temperature into liquid nitrogen is always somewhat hazardous. Beware of splashing and "boiling" which may occur. Never dip a hollow tube into liquid nitrogen; it may spurt liquid nitrogen.

Compatibility

Liquid nitrogen should ony be handled and transported in approved containers. Liquid nitrogen may alter the physical characteristics of many materials, make them brittle and fail. Liquid nitrogen should never be used in combination with other substances or materials without knowing what the result will be. When in doubt, contact a competent authority.

Fire in Oxygen-Enriched Atmostphere

Liquid Nitrogen can condense oxygen from the atmosphere. Liquid oxygen creates potentially flammable or explosive conditions by greatly increasing the combustibility of many materials (e.g. solvents, hydrocarbons).

FIRST AID

In the event a person has frostbite from liquid nitrogen, the following first aid treatment should be given while awaiting the arrival of medics or a doctor.

1. If the material has contaced skin or eyes, flood those areas with large quantities of unheated water and protect frozen areas with loose, bulky, dry, and sterile dressings.
2. If the skin is blistered or there is a chance that the eyes have been affected, seek medical help immediatley.

SPECIFIC FIRST AID PROCEDURES: PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVEREXPOSURE TO NITROGEN. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS.

INHALATION: Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an uncontaminated area, given mouth-to-mouth resuscitation and supplemental oxygen. Further treatment should be symptomatic and supportive.

SKIN OR EYE CONTACT: Flush affected areas with lukewarm water. DO NOT USE HOT WATER. A physician should see the patient promtly, especially if the cryogenic "burn" has resulted in blistering

V SERIES AND S SERIES DESCRIPTIONS

Throughout this manual references are made to the "S Series" and "V Series" storage unit vessels. In order to give a complete understanding of the difference between these two models, the diagrams at right are being provided. They show clearly the difference between the two, and the characteristics of each. Although the two are quite different physically, they operate in essentially the same way, and the electronic controls are identical for them both. Whenever there is a different procedure or operation for one, we've clearly stated the different instructions for each model. When not stated as different, the procedure or operation is the same for both.

What makes these two designs so different is this basic fact:

With the S Series models, the liquid nitrogen is contained within the storage vessel, and the stored samples are, or are *potentially*, in contact with the liquid.

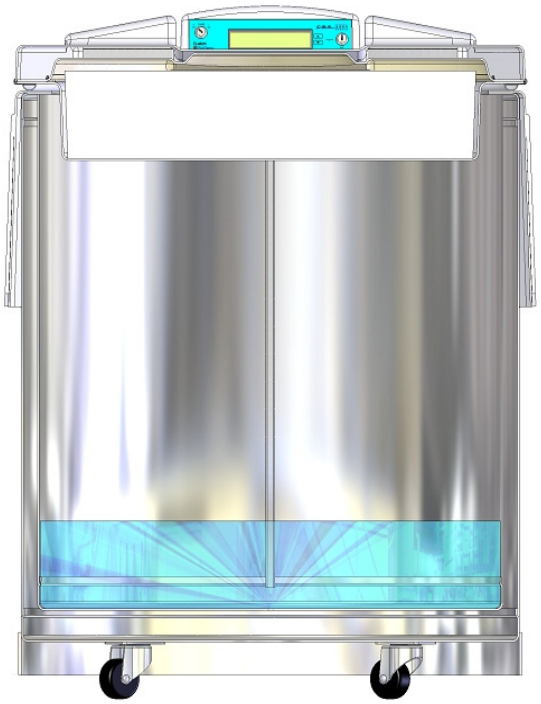
With the V Series or Isothermal models, the liquid nitrogen is contained inside the vessel walls, and the stored samples never come into contact with the liquid nitrogen except in the case of an accidental overfill.

To understand the way the system operates, see the OPERATION section on the next page for a basic explanation of the mechanics of the system. Also, be sure to read this manual completely before attempting to use this equipment. If you are still not sure how to use this equipment properly, contact a competent authority, rather than risking your safety or the safety of the stored samples.

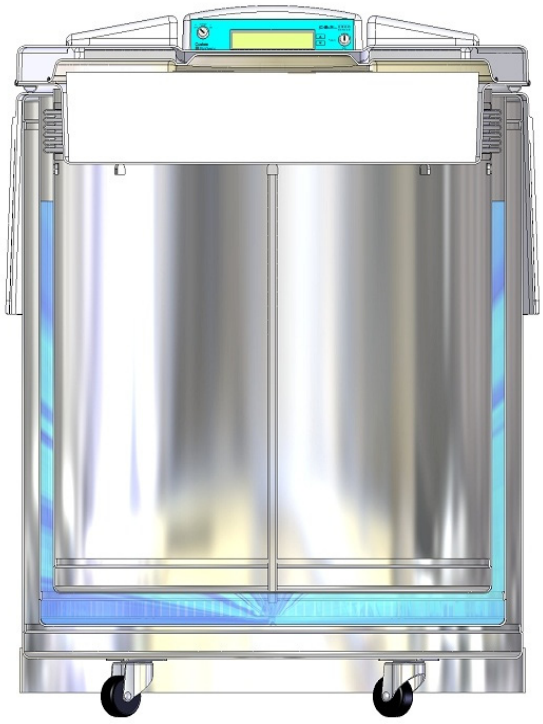
When the unit is placed into service, check daily to ensure proper operation and safety of the stored samples. For the V Series units, it is essential to lift the lid each day and check for vapor and signs of proper freezing.

Go to custombiogenics.com/technicalguides.html for more information.

S SERIES (STANDARD) VESSEL
LIQUID NITROGEN IS CONTAINED WITHIN THE VESSEL, AND IS DIRECT CONTACT WITH THE INVENTORY SYSTEM.



V SERIES (ISOTHERMAL) VESSEL
LIQUID NITROGEN IS CONTAINED INSIDE THE VESSEL WALLS, AND DOES NOT CONTACT THE INVENTORY SYSTEM.



INITIAL SET-UP

This equipment is designed to operate in the following environmental conditions:

Temperature: 5°C (41°F) to 40°C (104°F)
Humidity: 80% at ≤ 31°C, decreasing linearly to 50% at 40°C
Altitude: ≤ 2,000 meters (6,650 feet)

Whenever working with Liquid Nitrogen in an enclosed space, the use of personal O_2 detection equipment is recommended.

As a first step in the set-up procedure, be sure to read this manual completely to become more familiar with this equipment. Next, remove all packing materials and wipe unit with a clean cloth inside and out to remove any debris left from shipping. Once the unit is wiped down, complete the following Steps: **(Note: The Temp A/Temp B alarm is set at +30°C from the factory. Thus, it will not alarm during the first fill and must be set by the user once the freezer cools.(-150°C)**

1. (Connect the LN^2 stainless steel flexible hose from the supply tank to the storage freezer), but do not open the manual supply valve until instructed to do so.
2. Connect Remote Alarm or Auto Dialer if desired.
3. Plug unit into an appropriate power source.
4. Turn the power key switch to the "ON" position and the program/lock to program.
5. Adjust the Liquid Level Set points. See display #4 on page 16 for instructions.**(press LIQ'D level)**
6. Adjust the High Temperature Alarm Set point after filling is complete. See display #5 on page 16 for instructions. **(press "TEMP")**
7. Open the manual valve on the supply tank. Check for leaks at the connection points, then proceed to normal operation.

Go to custombiogenics.com/technicalguides.html for more information.

Lid must be open for first fill cycle

OPERATION

Storage units should not be disconnected from their supply while attempting to fill.

The ***S Series*** Storage Units are designed to maintain liquid nitrogen levels within specified parameters inside a cryogenic storage vessel. The ***V Series*** Storage Units are designed to maintain liquid nitrogen levels within specified parameters *inside the walls* of a cryogenic storage vessel. This is achieved by measuring gravitational weight of the liquid nitrogen with a pressure sensing unit in the controller. The controller activates the **FILL** solenoid valve when the liquid level goes below the **LOW** level set point, and deactivates the solenoid valve, stopping the fill, when the level reaches the **HIGH** set point.

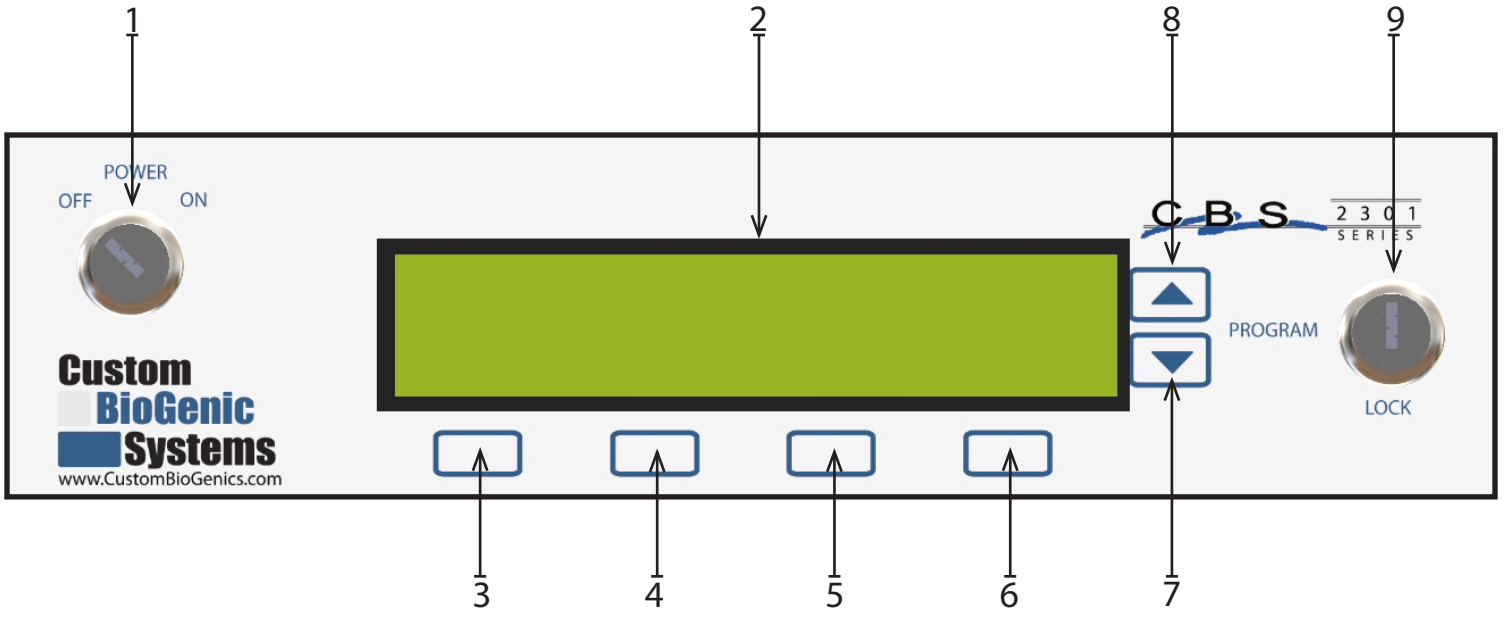
The Bypass Function has an additional solenoid valve to vent vapor from the transfer lines before the **FILL** solenoid is activated. In the description below, the part of the sequence which is unique to the Bypass Function is in *[brackets]*. All other information refers to units with or without the Bypass Function.

During regular operation, the sequence of events is as follows: When the liquid level in the vessel falls below the low level set point, a signal is sent to the controller. At this time the **FILL** solenoid valve is activated, allowing the flow of liquid into the vessel. *[The Bypass Function will activate the* **VENT** *solenoid first to release gas or vapor from the transfer lines. The venting will continue until the line temperature reaches approximately -150° to -160°C. This can be adjusted, consult the factory for more information. When the line reaches this temperature the vessel will begin to fill.]* When the liquid level reaches the high level set point a signal is sent to the controller which deactivates the solenoid valve and stops the flow of liquid into the vessel. As long as the unit is powered up, this fill sequence repeats as necessary, maintaining the desired liquid level.

Check unit daily to ensure proper operation and safety of the stored samples. For the V Series units, it is essential to lift the lid each day and check for vapor and signs of proper freezing.

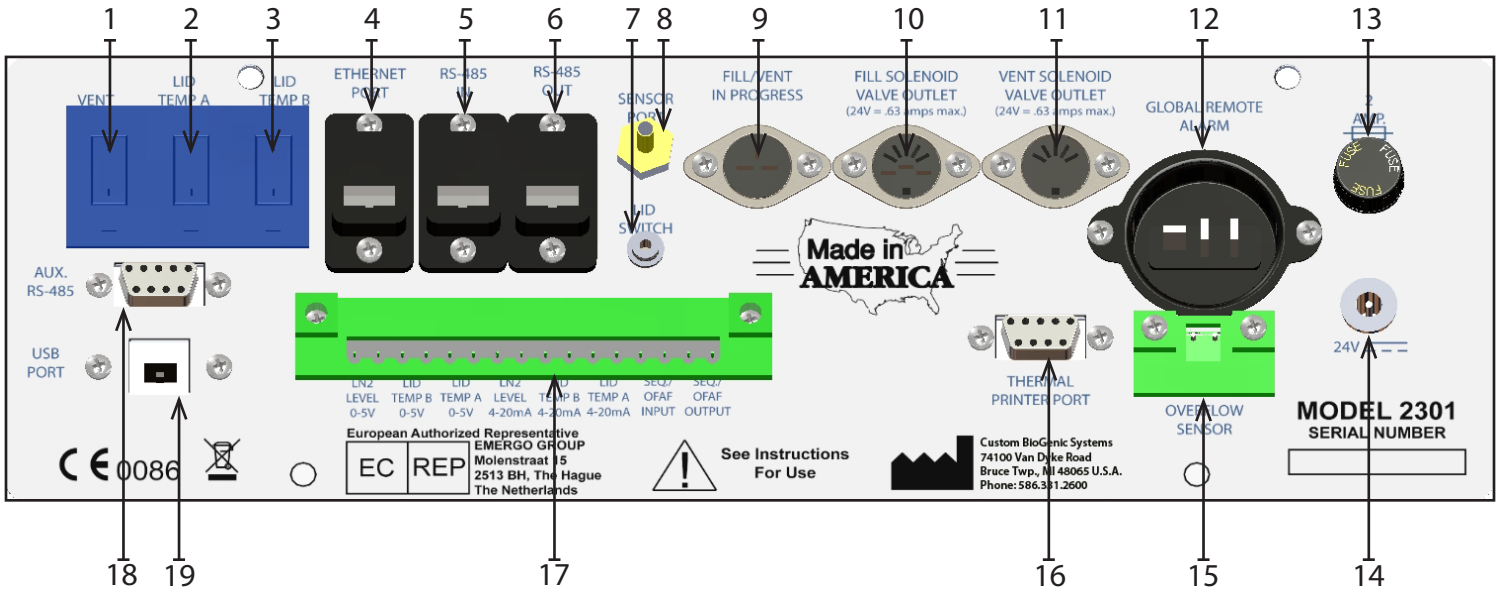
FRONT PANEL CONTROLS

Warning: Depressing buttons with pointed objects (Pen, Pencil, etc.) will damage buttons



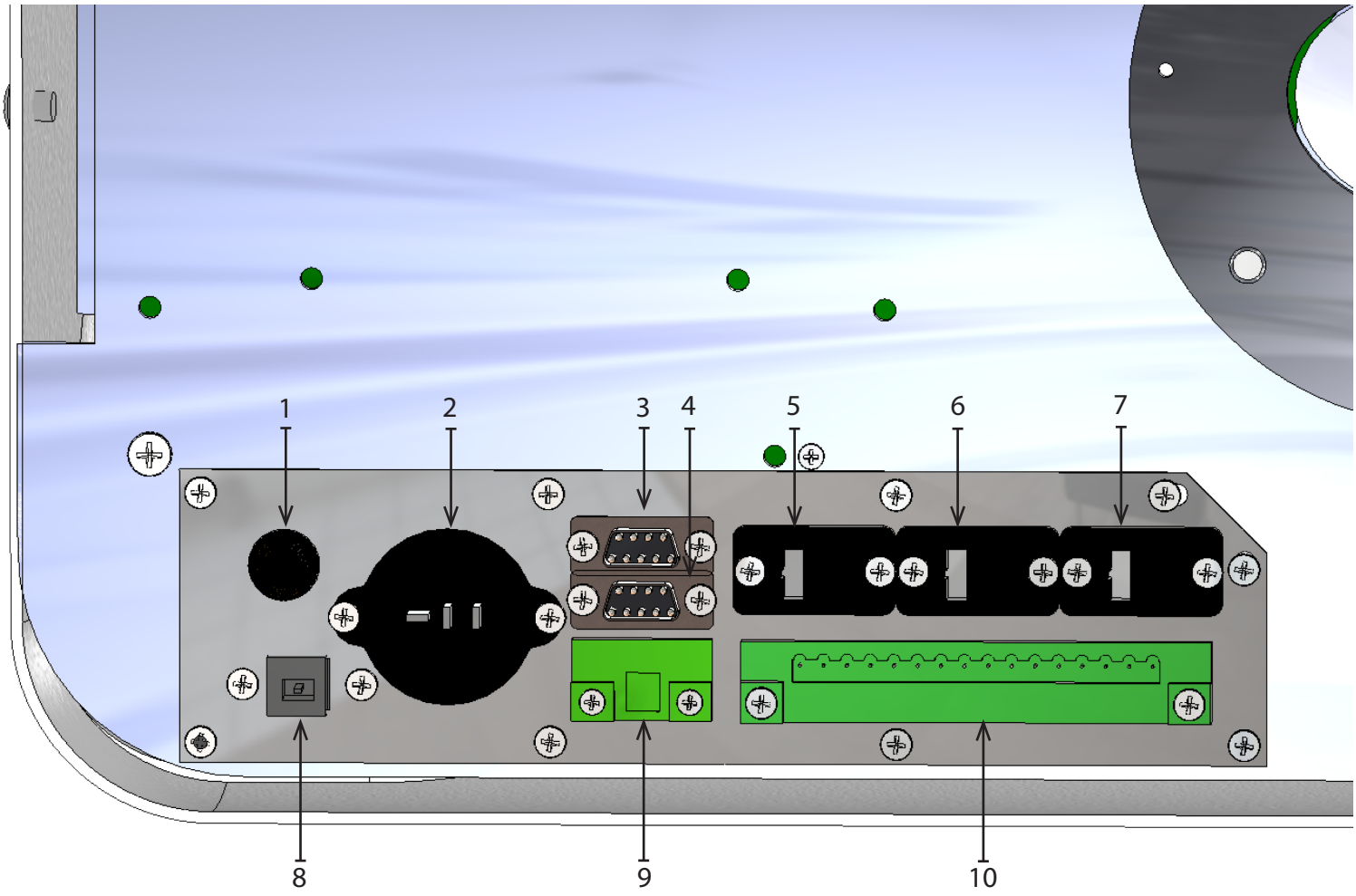
1. Key - Switch Power Control - Main power control for the unit.
2. LCD Display Window - Text interface for the storage unit electronic settings. See page 13 for complete listing of all display menus and functions.
3. First Menu Select Button - This is used to select various control menus and to make changes in programming as shown by the text which appears above the button.
4. Second Menu Select Button - This is used to select various control menus and to make changes in programming as shown by the text which appears above the button.
5. Third Menu Select Button - This is used to select various control menus and to make changes in programming as shown by the text which appears above the button.
6. Fourth Menu Select Button - This is used to select various control menus and to make changes in programming as shown by the text which appears above the button.
7. Scroll "Down" Button - Scrolls to lower numbers when programming electronics.
8. Scroll "Up" Button - Scrolls to higher numbers when programming electronics.
9. "Program / Lock" Key Switch - Switches the controller between the Standard Operating Mode and the Program Mode. Also protects electronic programming from being changed by unauthorized personnel.

SERIES 2301 CONTROLLER BACK PANEL



1. **Vent Thermocouple-** The Vent Thermocouple Plugs in here.
2. **Lid Temp. A Thermocouple-** The Lid Temp A Thermocouple Plugs in here. (see page 11)
3. **Lid Temp B Thermocouple-** The Lid Temp B Thermocouple Plugs in here. (see page 11)
4. **Ethernet Port-** The Ethernet Cord for future expansion.
5. **RS-485 IN-** Used for RS-485 Cryomonitor communication between controllers.
6. **RS-485 OUT -** Used for RS-485 Cryomonitor communication between controllers.
7. **Lid Switch -** Used to indicate "Lid Open" condition.
8. **Sensor Port -** Used to sense level in vessel.
9. **Fill/Vent In Progress -** Outputs 24V DC whenever filling or venting. (see page 11)
10. **Fill Solenoid Valve Outlet -** The fill solenoid valve plugs in here. (Specifications: Rating: 100VAC 2A, Insulation Resistance: 300Ω minimum @500VDC, Dielectric Strength: 1,000VAC for 1 minute, Contact Resistance: 20mΩ maximum, Withstand Voltage: 1,000VAC for 1 minute, Insertion Force: 4Kg max, Withdrawal Force: 1-3.5Kg).
11. **Vent Solenoid Valve Outlet -** The vent solenoid valve plugs in here. (see specifications in #10)
12. **Global Remote Alarm -** Dry contact that switches status when any alarm occurs. (see page 12) All Global Alarm connections are contact relays with max output of 250VAC at 5A
13. **2 Amp Fuse -** VAC 2 amp buss fuse; 220 volts slow-blow. (T2A-250V)
14. **24 V Power Supply -** This is the main power supply cord to the unit, be sure to check for proper voltage - See voltage requirements on the controller.
15. **Overflow Sensor (*Optional*)-** If installed, used to sense an overflow condition in the storage space of a vessel. (see page 11)
16. **Thermal Printer Port -** Used for printing alarms & data.
17. **16 Port Connector -** *Operational range: Temperature is +50° C to -200°C Level: 0"-33"*
    - **0-5VDC Outputs -** For Temp. A, Temp B. and Level. (see page 11)
    - **4-20mA Outputs -** For Temp A. , Temp B. and Level**.** (see page 11)
    - **SEQ/OFAF Input and Output Connection -** For communication between controllers. (see page 10)
18. **AUX RS 485 -** RS-485 communications port for future expansion.
19. **USB Port -** Used for Cryomonitor communications with PC.

SERIES 5000 BACK PANEL



1. **2 Amp Fuse -** VAC 2 amp buss fuse; 220 volts slow-blow. (T2A-250V)
2. **Global Remote Alarm -** Dry contact that switches status when any alarm occurs. All Global Alarm connections are dry contact relays with a max output of 250VAC at 5A(see page 12)
3. **Thermal Printer Port -** Used for printing alarms & data.
4. **AUX RS 485 -** RS-485 communications port for future expansion.
5. **Ethernet Port-** The Ethernet Cord for future expansion.
6. **RS-485 IN-** Used for RS-485 Cryomonitor communication between controllers.
7. **RS-485 OUT -** Used for RS-485 Cryomonitor communication between controllers.
8. **USB Port -** Used for Cryomonitor communications with PC.
9. **Overflow Sensor (*Optional*)-** If installed, used to sense an overflow condition in the storage space of a vessel. (see page 11)
10. **16 Port Connector -** *Operational range: Temperature is +50° C to -200°C Level: 0"-33"*
    - **0-5VDC Outputs -** For Temp. A, Temp B. and Level. (see page 11)
    - **4-20mA Outputs -** For Temp A. , Temp B. and Level**.** (see page 11)

V SERIES MANUAL FILL INSTRUCTIONS

The unique design of the new Isothermal Storage Unit is such that it is no longer necessary to fill the storage chamber with liquid nitrogen. Instead, the inner walls of the storage vessel are filled with liquid nitrogen and the storage chamber holds no liquid at all. Because of this unique design, the manual filling of this equipment is very different from storage units of the past. Use the following instructions to manually fill the Isothermal Storage unit in the event of a power outage or if the auto-fill is not working properly.

IMPORTANT: It is not recommended to attempt to manually fill the Isothermal Storage Unit by opening the lid and placing a fill line over the edge into the vessel. This is an incorrect fill method and will cause liquid nitrogen to come in contact with the stored samples.

For the correct manual filling of the Isothermal unit perform the following steps:

1. Turn off the liquid nitrogen supply valve at the supply tank.

2. Disconnect the supply line from the Isothermal Unit at the port on the back of the unit.



AUTO-FILL
CONNECTION

3. Remove the cap from the manual fill port, also on the back of the unit.

MANUAL-FILL
CONNECTION



4. Place the cap on the auto-fill port where the supply line was connected, and tighten down.

5. Connect the liquid nitrogen supply line to the manual fill port, and tighten down.

CAUTION: Before opening the supply valve to fill the Isothermal Unit, read the following text to learn how to gauge the liquid level, so the Storage Unit does not overfill and create hazardous conditions.

Without power there will be no digital display to give the liquid level, and the liquid cannot be seen visually since it is contained inside the walls of the Isothermal Unit. Thus the lid must remain open during the manual fill process. With this in mind, the best way to gauge the fill level is when the tank is nearing maximum fill, liquid nitrogen will begin to "spray" from the vents located near the top edge of the inner walls of the vessel. When this is seen, the supply valve should be shut off immediately before excessive amounts of liquid nitrogen begin to spill into the storage space.

FEATURE DETAILS

SEQ/OFAF system: (See page 16 screen # 7)

SEQUENTIAL MODE (recommended):
- Connect all 2301 controllers to your LN2 supply source.
- Select "Sequential" mode to maintain optimum fill pressure and significantly reduce LN2 transfer loss.
- Once the first controller reaches its High Level Set Point, it will activate the next controller. This process will continue until all linked controllers have reached their High Level Set Point sequentially.

SIMULTANEOUS MODE:
- Connect all 2301 controllers to your LN2 supply source.
- Select "Simultaneous" mode.
- All freezers will begin to fill at the same time until all linked controllers have reached their High Level Set Point simultaneously.

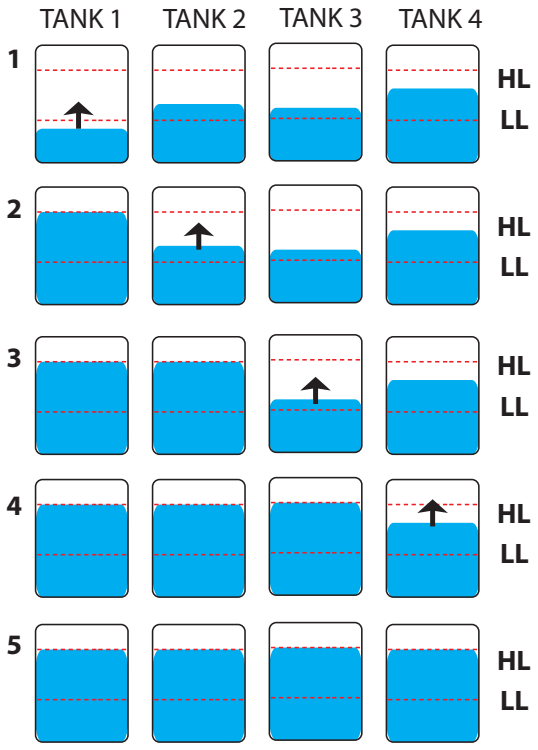
Connection:

Connect all 2301 controllers you want linked using a two conductor wire going from one 2301 controllers SEQ/OFAF output to the next 2301 SEQ/OFAF input. Continue making these connections until all the desired 2301 controllers are connected in a complete loop. To set the system each controller must be powered off and back on to reset.

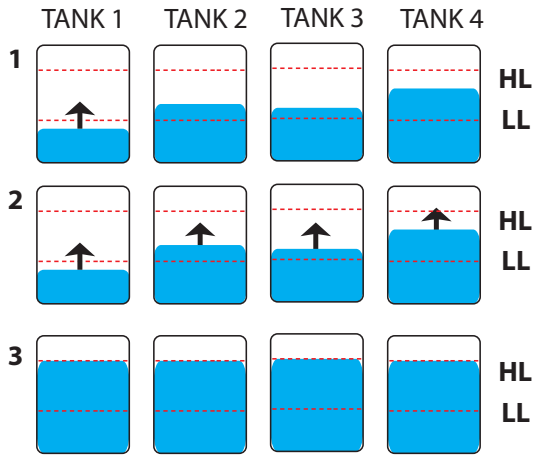
Custom BioGenic Systems recommends selecting "Sequential". This mode allows freezers to fill one at a time with a primed and cold supply system making it easier to maintain proper filling pressure and reducing LN2 transfer loss. This is more efficient than a keep cold system.

For best results with large pipeline LN2 supply systems, adjustment to the source alarm timer may be required. Please contact Custom BioGenic Systems with any questions regarding the function and setup of the SEQ/OFAF feature. In the event of an alarm status that stops the freezer from reaching the High Level Set Point, the 2301 controller will not trigger the next freezer in line to fill. However the auto fill function always takes priority over the SEQ/OFAF settings. The next freezer to fill will trigger the SEQ/OFAF system. Custom BioGenic Systems has programmable timers factory set to stop the system from going into a continuous loop. Given this feature is connected using a simple two conductor wire relay closures, an infinite number of 2301 controllers can be connected to this system.

SEQUENTIAL FILL



SIMULTANEOUS FILL



Go to custombiogenics.com/technicalguides.html for more information.

FEATURE DETAILS

Fill Timer: (See page 16 screen #6)
Enables setting the timer to fill the freezer at 24, 48 or 72 hour intervals at the time selected. Note that the Auto Fill setting will always override the Fill Timer setting.

Lid Temperature Display:
- Lid Temperature A Thermocouple is located approximately 11" from the top of the tank.
- Lid Temperature B Thermocouple is located approximately 20" from the top of the tank.

0-5Vdc & 4-20mA Outputs:
Easy screw terminal output connections for existing alarm and monitoring systems. This feature is available through the Tank ID menu (See page 16 screen # 4). Select either:
- 0-5Vdc with connections to Temp-A, Temp-B and Level
- 4-20mA with connections to Temp-A, Temp-B and Level

Operational range: Temperature is +50° C to -200°C Level: 0"-33"

Fill/Vent In Progress:
Can be used as a signal to activate the Custom BioGenic Systems TS-1B LN2 supply tank switcher or an additional 24Vdc valve to control the LN2 supply.
- Outputs 24VDC whenever filling or venting.

Report Log Feature: (See page 15 screen #99)
- Alarms – Records Sequence of events such as POWER ON, LID OPEN, etc…
- Data –The LOG function is enabled for use with either Cryomonitor or Reporting. This will Date/Time stamp Temp-A, Temp-B and Level at the programmable rate of 1-90 hours on the hour. This information is selected by date range to either be displayed or printed for easy review.

Optional Features

Overflow Sensor: (Not included as standard equipment, can be purchased separately)
This feature uses a thermistor set at the bottom of the storage space along the probe holder tube. If an overflow occurs it will cause the LN2 to make contact with the thermistor. An audible and visual alarm will occur and "SYSTEM STATUS: ALARM ** LN2 OVERFLOW **" will appear on the display and power to all solenoid valves will be disabled.

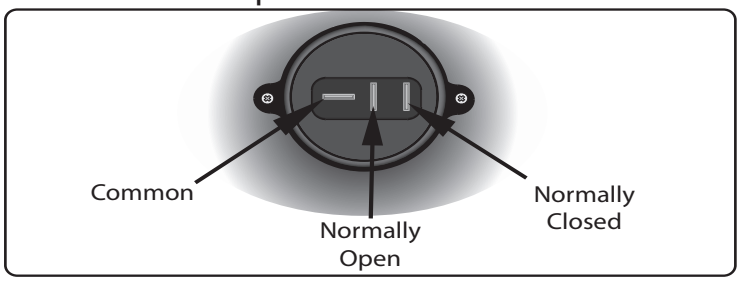
NOTE: Turbulence from liquid nitrogen supply may trip alarm if operated at higher levels than factory set points (Low: 10" High: 17").


Go to custombiogenics.com/technicalguides.html
for more information.

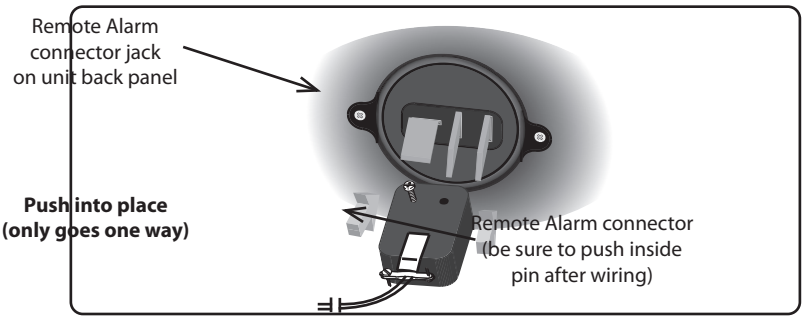
REMOTE ALARM WIRING

Locate the Remote Alarm Connector on the controller (#12 on page 7; #2 on page 8). This is where the remote alarm or auto dialer will plug into the control unit. All Global Alarm connections are dry contact relays with a max output of 250VAC at 5A

The Remote Alarm Connector is a Dry Contact.
The Diagram shows connections for wiring arrangement.



First, wires from the remote alarm or auto dialer must be connected to the plug-end which plugs into the Remote Alarm Connector. Use the diagram to connect wires from the remote unit.



When unit goes into an alarm condition or loses power, the contacts will switch their "Open" or "Closed" state to be the opposite of when there was not an alarm condition, thereby sending a signal to the remote alarm or auto dialer. Wiring it to common and normally open will trigger the remote contact if a power failure occurs

STORAGE UNIT PARAMETERS

Cooling medium: **Liquid nitrogen only** (supplied by a pressurized cryogenic transport vessel)
Operating Pressure: **22 p.s.i.**
This Unit has been tested and complies with the EN60601-1 Standards.

IMPORTANT: Normal operating pressure is 25 p.s.i. max/ 20 p.s.i. min (22 p.s.i. recommended) if the pressure is greater or less than, the efficiency of your liquid nitrogen storage unit could be affected. This could be noticeable in ways such as increased liquid use, level and source alarms.

Power Supply Voltage: **120 Volts AC 60 Hz standard - 220 Volts AC 60/50 Hz optional**
Amperage: **2 amp max**
Fuse: **VAC 2 amp Buss fuse; 220 volts slow-blow. (T2A 250V)** (automotive glass tube type fuse)

Specification:	V1500AB	V3000AB	V5000AB	V5000ABEH
LN2 Capacity (Liters)	30	70	93	140
Static Evaporation Rate (Liters/Day)	5	9	11	11
Static Holding Time (Days)	6	8	8	12
External Dimensions				
Width (in/mm)	26 / 660	37 / 939	47 / 1219	47 / 1219
Depth (in/mm)	37 / 939	48 / 1219	54 / 1371	54 / 1371
Height (in/mm)	45 / 1143	47.5 / 1206	52 / 1320	58 / 1473
Usable Interior Height (in/mm)	29 / 736	29 / 736	29 / 736	34 / 864
Usable Interior Diameter(in/mm)	21 / 534	31 / 787	40 / 1016	40 / 1016
Weight Empty (lbs/kg)	327/148	600/272	936/425	997/453
Weight Full (lbs/kg)	383/174	720/327	1100/500	1247/566

Operating levels for LN^2: **Extra High Series**: **1 to 31 inches** (higher fill heights may be used, call CBS for more info)
V Series Models: **1 to 23 inches**

LCD DISPLAY FUNCTIONS

This section shows each display window and gives important information necessary for understanding and operating the LCD text functions of the 2301 Controller.

To start, the index below shows where in this section to find each and every function of the controller. This will enable the user to correctly program all functions of the storage unit to meet their individual needs.

The overall operation consists of two basic modes: the Standard Operating Mode, and the Program Mode. The unit is in the Standard Operating Mode when the Program/Lock key switch on the front panel (Page 6, number 9) is turned to **Lock**. To enter the Program Mode, the key must be inserted and the switch turned to **Program**.

In the Standard Operating Mode, there are 6 different displays possible. They are as follows:

Standard Display - Display number 1 - page 14
Standard Display While Unit is Filling - Display number 2 - page 14
Standard Display With Lid Open - Display number 3 - page 15
Alarm Condition Display - Display number 90 - page 15
Alarm Condition Display With Audible Alarm Muted - Display number 91 - page 15
Printing Report - Display number 99 - page 15

The Alarm Condition display will give the specific cause of each alarm condition that may be occurring. The following is a list of the possible alarm conditions:

Low Alarm
High Alarm
Source Alarm
Temp. A High
Temp. B High
Thermistor Open
Open Fill
Open Bypass
Temp. A Probe
Temp. B Probe
Open BP Probe
LN2 Overflow *"Optional" Additional Equipment Required*

In the Program Mode, there are various displays possible. The following is a list of programming functions and the corresponding display windows. For each of these programming functions, there may be sub-menus that follow the primary display window. The sub-menus are not listed here, but are shown and explained following the primary windows. The primary programming functions are as follows:

Main Menu - Display number 4 - page 16 Provides access to:
- **Date/Time Settings -** Display number 8 - page 17
- **Tank ID Settings -** Display number 13 - page 18
- **Liquid Level Settings -** Display number 15 - page 18
- **Main Menu 2 -** Display number 5 - page 16 Provides access to:
  - **Temp Settings -** Display number 19 - page 18
  - **Printer Functions -** Display number 22 - page 19
  - **Bypass Settings -** Display number 24 - page 19
  - **Main Menu 3 -** Display number 6 - page 16 Provides access to:
    - **Control Validation -** Display number 40 - page 20
    - **Fill Timer Settings -** Display number 7A - page 17
    - **Revision level-** Display number 42 - page 23
    - **Main Menu 4** - Display number 7 - Page 16 Provides access to:
      - **One Fill All Fill** - Display #44 on page 24
      - **Log** - Display #45 on Page 23
      - **Return to Main Menu** - Display #4 on page 16

LCD DISPLAY FUNCTIONS

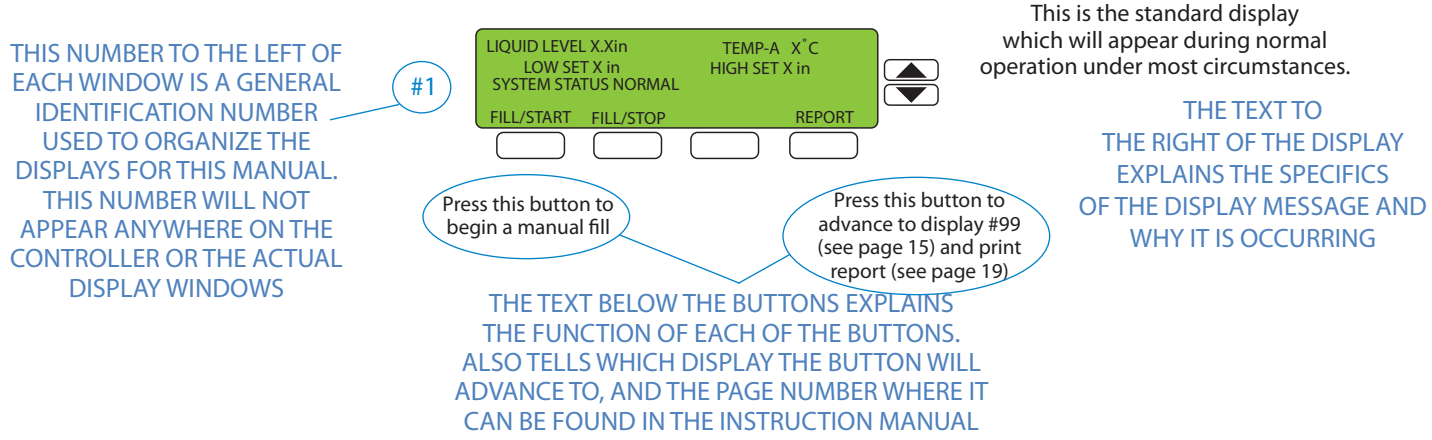
Using The Diagrams to Understand the Display Functions

WARNING: NEVER USE AN OBJECT OTHER THAN YOUR FINGER TO PRESS THESE BUTTONS. DOING SO WILL RESULT IN PERMANENT DAMAGE TO THE CONTROLLER OVERLAY.

Below is a sample display window as they're shown in the following section. Use the diagram to become familiar with the way this section is organized, and how the information is presented in reference to each display window and it's functions. (NOTE: Tolerance on Liquid Level Display is +/- 1" (2.54cm) and the tolerance on the temperature display is +/- 1°C)

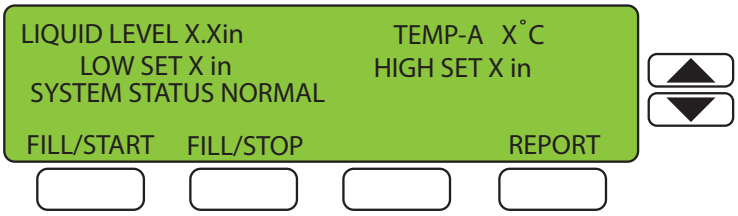
SAMPLE DISPLAY WINDOW

X's ARE USED IN PLACE OF NUMBERS IN THE DISPLAY WINDOW, SINCE THE ACTUAL NUMBERS WILL VARY.



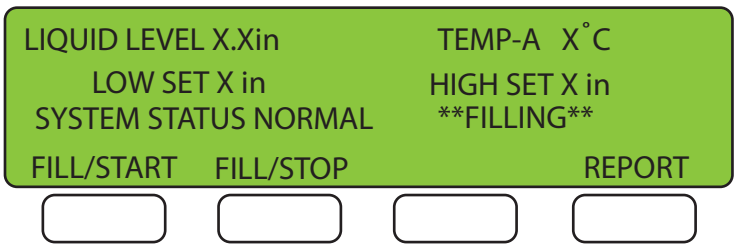
Standard Operating Mode Display Windows

#1



This is the standard display which will appear during normal operation under most circumstances.
NOTE: Use Up/Down arrows to toggle display between Temp. A and Temp. B

#2

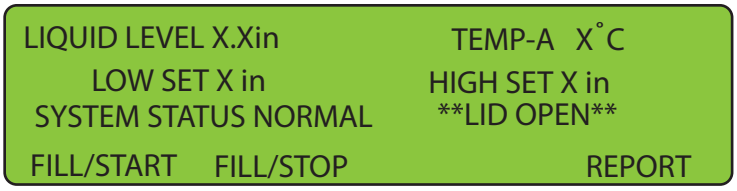


This display will appear during normal operation when either a manual or automatic fill is occurring.

LCD DISPLAY FUNCTIONS

Standard Operating Mode Display Windows

#3

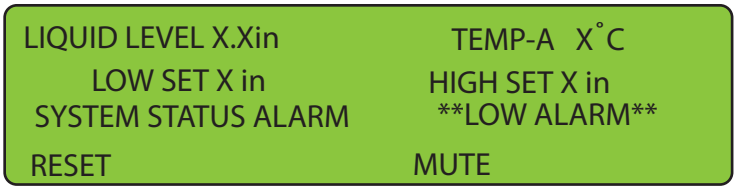


Press this button to begin a manual fill.

Press this button to stop filling.

This display will appear during normal operation when the lid is opened.

#90



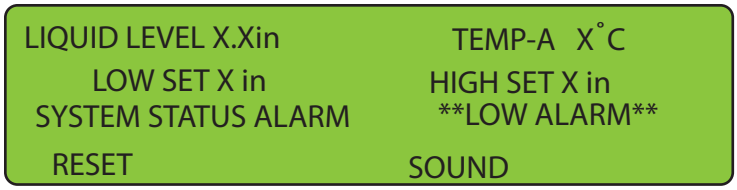
Press this button to reset alarm. If it re-occurs, repeat until all alarms are corrected.

Press this button to mute audible alarm and advance to display #91 (see below).

This display will appear when an alarm condition is occurring. The specific nature of the alarm will be shown in line 3 of the display text. The **ALARM** will flash on and off in one second intervals.

("LOW ALARM" is shown only as an example of the alarm display window. See page 13 for a complete list of alarms.)

#91



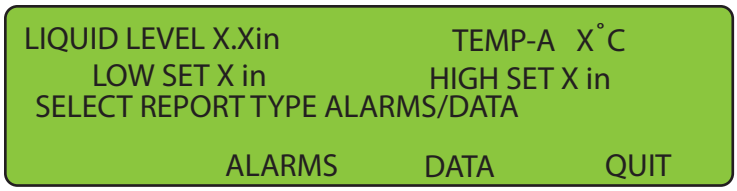
Press this button to reset alarm. If it re-occurs, repeat until all alarms are corrected.

Press this button to enable audible alarm and return to display #90 (see above).

This display will appear when an alarm condition is occurring AND the audible alarm is muted.

("LOW ALARM" is shown only as an example of the alarm display window. See page 13 for a complete list of alarms.)

#99



Press this button to view alarms and advance to display #99A (page 24)

Press this button to view data and advance to display #99A (page 24)

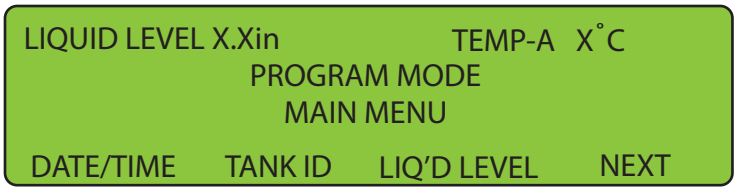
Press this button and the display will go back to whatever screen was showing when the report was requested.

This display will appear during normal operation when "REPORT" is selected from displays 1, 2, or 3.

LCD DISPLAY FUNCTIONS

Program Mode Display Windows

#4



Press this button to advance to display #8: DATE/TIME settings. (see page 17)

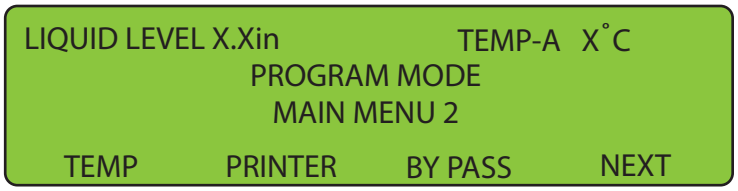
Press this button to advance to display #13 TANK ID settings. (see page 17)

Press this button to advance to display #15: LIQUID LEVEL settings. (see page 18)

Press this button to advance to display #5: MAIN MENU 2. (see below)

This display will appear when the PROGRAM/LOCK switch is turned to PROGRAM.

#5



Press this button to advance to display #19: LID TEMP settings. (see page 18)

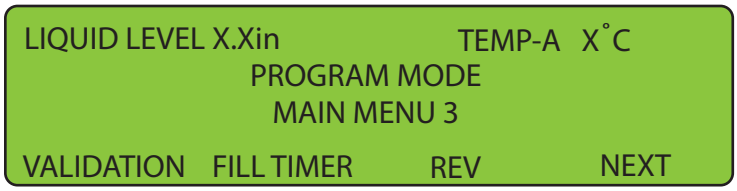
Press this button to advance to display #22: REPORT settings. (see page 19)

Press this button to advance to display #24: BYPASS settings. (see page 19)

Press this button to advance to display #6: MAIN MENU 3. (see below)

This display will appear when "NEXT" is selected on display #4.

#6



Press this button to advance to display #40: VALIDATION settings. (see page 19)

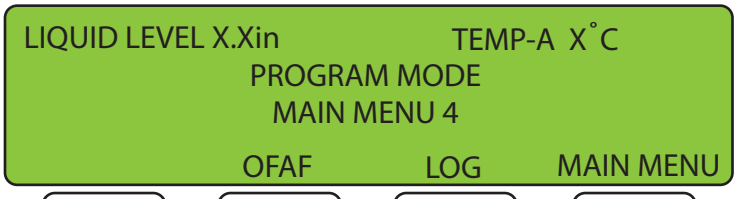
Press this button to advance to display #7A: FILL TIMER settings. (see below)

Press this button to advance to display #42:REVISION parameters. (see page 22)

Press this button to return to display #4: MAIN MENU. (see above)

This display will appear when "NEXT" is selected on display #5.

#7



Press this button to advance to Display #44 (see page 24)

Press this button to advance to screen #45 (see page 25)

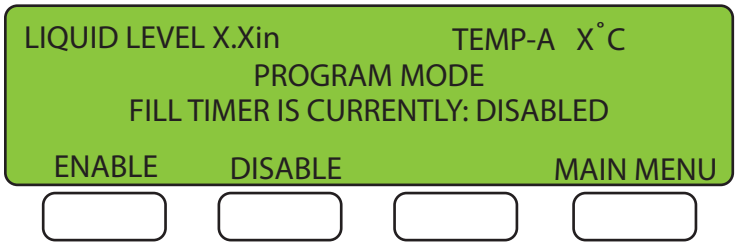
Press this button to end operation and return to display #4: MAIN MENU (see above)

This display will appear when "NEXT" is selected on display #6.

LCD DISPLAY FUNCTIONS

Program Mode Display Windows

#7A

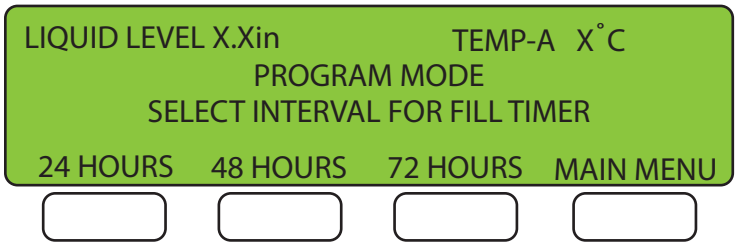


Press this button to ENABLE Fill Timer this will advance you to display #7B (below)

Press this button to DISABLE Fill Timer this will return you to display #6 Main Menu 3 (see page 16)

This display will appear when "FILL TIMER" is selected on display #6. This is a prompt to ENABLE or DISABLE the Automatic Fill Timer. The Fill Timer gives the option of an automatic fill every 24, 48, or 72 hours at a specified time of day. These settings are programmed in the 2 menus that follow.

#7B



Press this button to select a 24 hour time interval and advance to display #7C. (below)

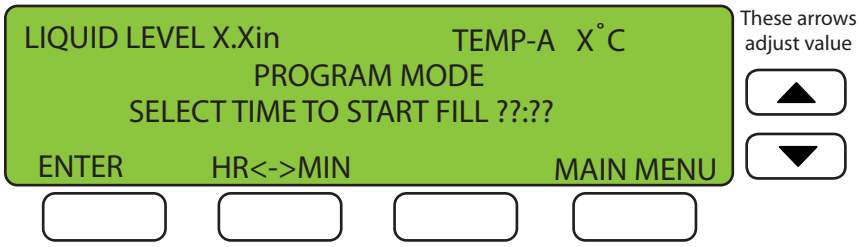
Press this button to select a 48 hour time interval and advance to display #7C. (below)

Press this button to select a 72 hour time interval and advance to display #7C. (below)

Press this button to discard changes and return to display #6: MAIN MENU 3 (see page 16)

This display will appear when "ENABLE" is selected on display #7A. Use this menu to set the time interval that the automatic fill will occur.

#7C



These arrows adjust value

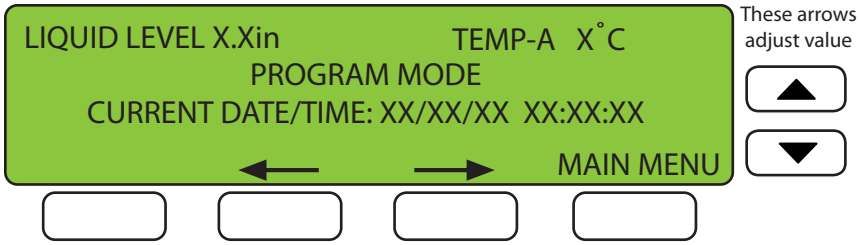
Press this button to advance to display #16: Main Menu 3 (see page 16)

Press this button to move the curser between Hours and Minutes

Press this button to advance to display #6: MAIN MENU 3. (see page 16)

This display will appear when any time interval is selected on display #7B. Use this menu to set the time of day that the automatic fill will occur.

#8



These arrows adjust value

Press this button to move cursor left.

Press this button to move cursor right.

Press this button to return to display #4: MAIN MENU (see page 16)

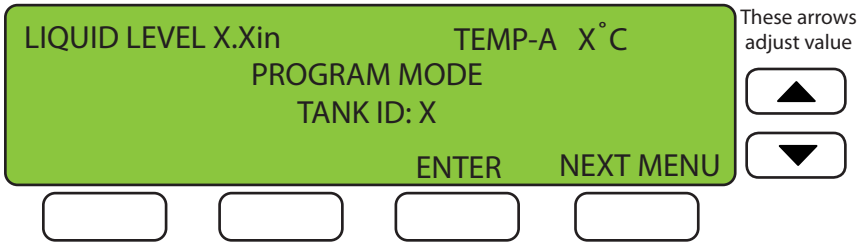
This display will appear when "DATE/TIME" is selected on display #4. Use this menu to change the date and time settings.

NOTE:
DAY/MONTH/YEAR

LCD DISPLAY FUNCTIONS

Program Mode Display Windows

#13



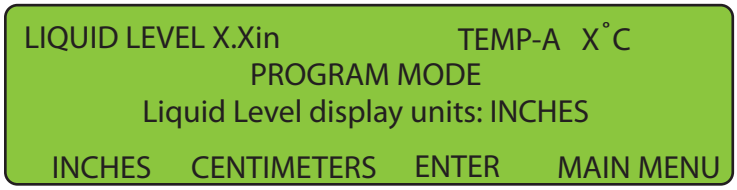
These arrows adjust value

Press this button to save the setting and return to display #13A: MASTER/SLAVE (see page 23)

Press this button to discard changes and return to display #13A: Master/Slave (see page 23)

This display will appear when "TANK ID" is selected on display #4. The Tank ID is necessary when using the CryoMonitor computer interface software.

#15



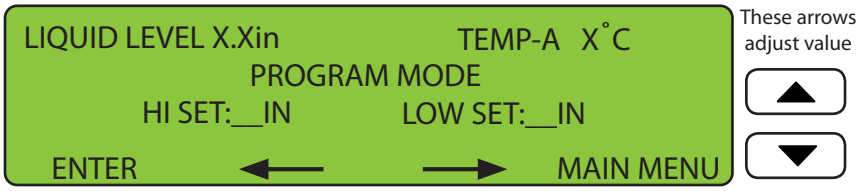
Press this button to select INCHES and advance to display #16. (below)

Press this button to select CENTIMETERS and advance to display #16. (below)

Press this button to discard changes and return to display #4: MAIN MENU (see page 16)

This display will appear when "LIQ'D LEVEL" is selected on display #4. Use this menu to select measurement preferences for the liquid level settings, i.e. inches or cm.

#16



These arrows adjust value

Press this button to save settings and return to display #4: MAIN MENU (see page 16)

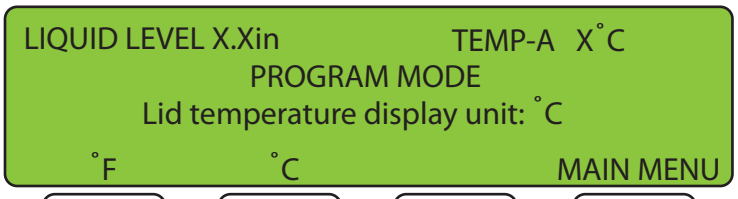
Press this button to move cursor to HI SET

Press this button to move cursor to LOW SET

Press this button to discard changes and return to display #4: MAIN MENU (see page 16)

This display will appear when "INCHES" or "CENTIMETERS" is selected on display #15. Use this menu to select HI and LOW liquid level settings.

#19



Press this button to select degrees Fahrenheit and advance to display #20 (see page 19)

Press this button to select degrees Celsius and advance to display #20 (see page 19)

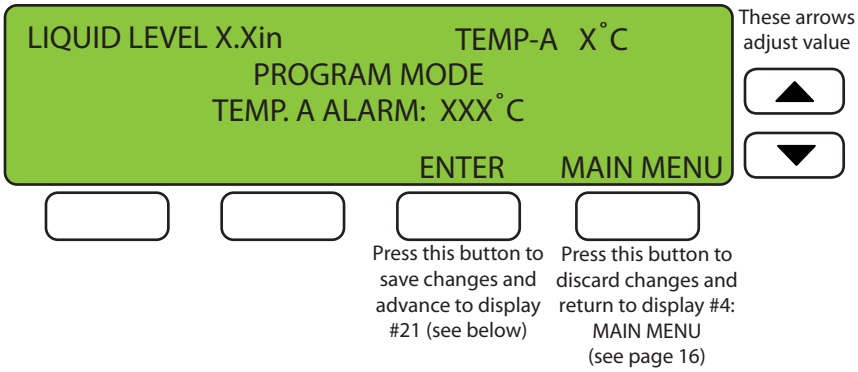
Press this button to discard changes and return to display #4: MAIN MENU (see page 16)

This display will appear when "TEMP" is selected on display #5. Use this menu to select temperature preferences, i.e. °F or °C.

LCD DISPLAY FUNCTIONS

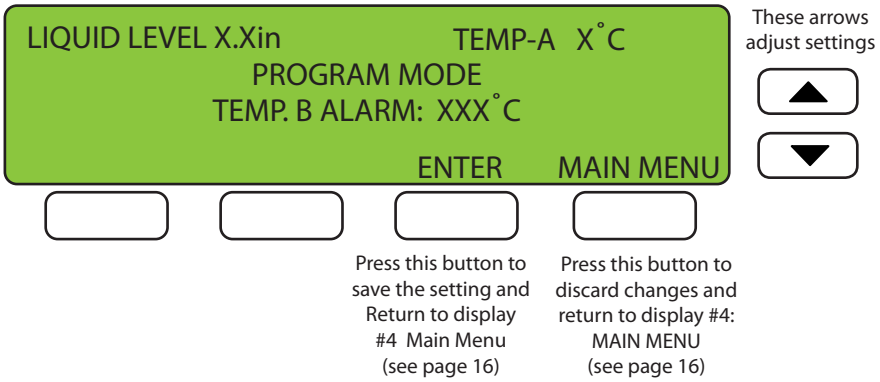
Program Mode Display Windows

#20



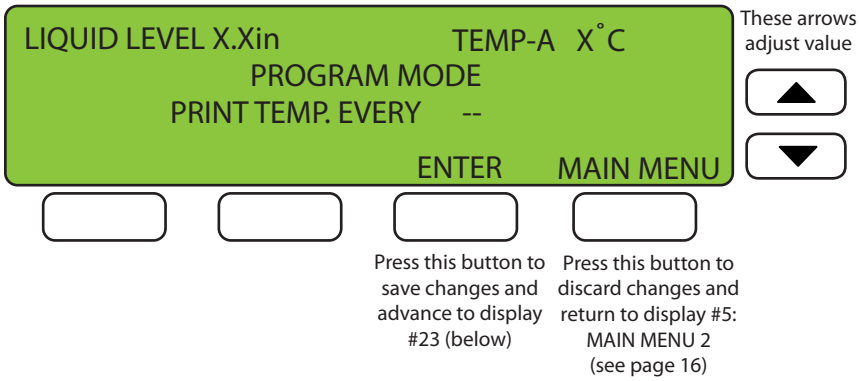
This display will appear when "°F" or "°C" is selected on display #19. Use this menu to select a temperature for the Temp. A. Alarm to be activated.

#21



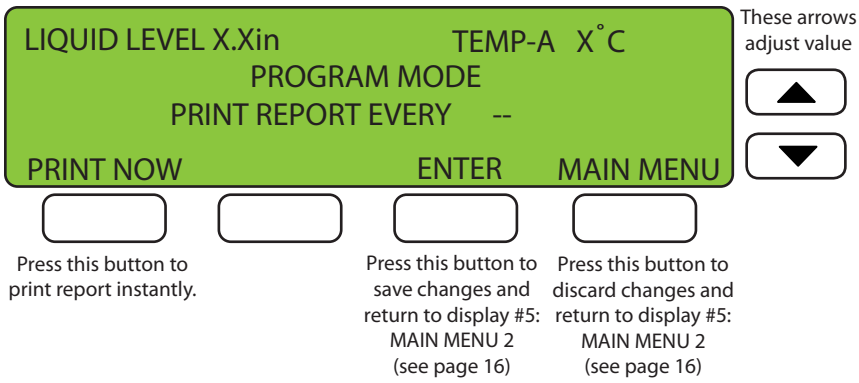
This display will appear when "°F" or "°C" is selected on display #19. Use this menu to select a temperature for the Temp. B. Alarm to be activated.

#22



This display will appear when "REPORT" is selected on display #5. Use this menu to select the time interval between temperature reports. **NOTE:** A value of "--" means temp. report printing is disabled. For use with thermal printer only.

#23

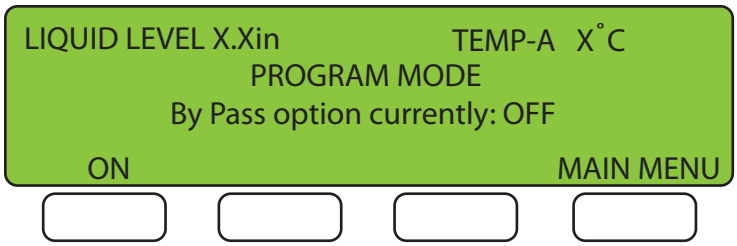


This display will appear when "ENTER" is selected on display #22. Use this menu to select number of days between temperature reports. **NOTE:** A value of "--" means temp. report printing is disabled. For use with thermal printer only.

LCD DISPLAY FUNCTIONS

Program Mode Display Windows

#24

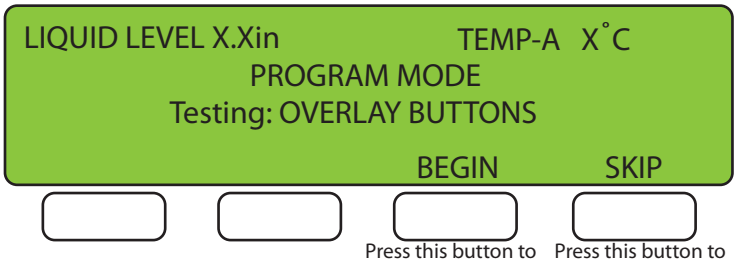


Press this button to change current setting and return to display #4: MAIN MENU (see page 16)

Press this button to maintain current setting and return to display #4: MAIN MENU (see page 16)

This display will appear when "BYPASS" is selected on display #5.
This menu is a prompt to enable or disable the Bypass Option.

#40

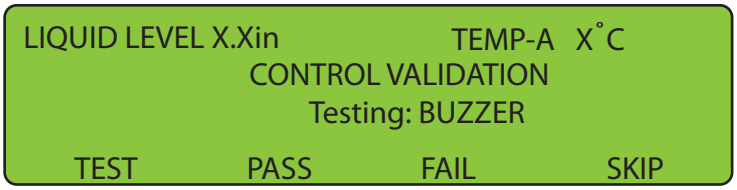


Press this button to begin testing the overlay buttons, and advance to display #41, and begin the final test. (see below)

Press this button to skip test and advance to display #41 (see below)

This display will appear when "VALIDATION" is selected on display #6. This menu begins the testing of the overlay buttons. Select "BEGIN" to proceed or "SKIP" to advance to the next window of the validation process.

#41



Press this button to test audible alarm. Buzzer should sound.

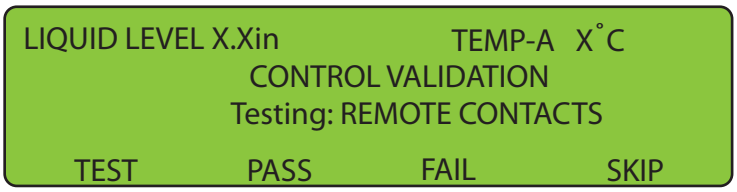
Press this button if test passes, to advance to display #41A, and next test. (below)

Press this button if test fails, to advance to display #41A, and next test. (below)

Press this button to skip test, advance to display #41A, and next test. (below)

This display will appear when "SKIP" is selected on display #40 or upon completion of testing the overlay buttons. This menu tests the audible alarm. This is the first in a series of test menus which will appear in sequence when "PASS", "FAIL", or "SKIP" is selected for each function being tested.

#41A



Press this button to toggle remote alarm contacts.

Press this button if test passes, to advance to display #41B, and next test. (see page 21)

Press this button if test passes, to advance to display #41B, and next test. (see page 21)

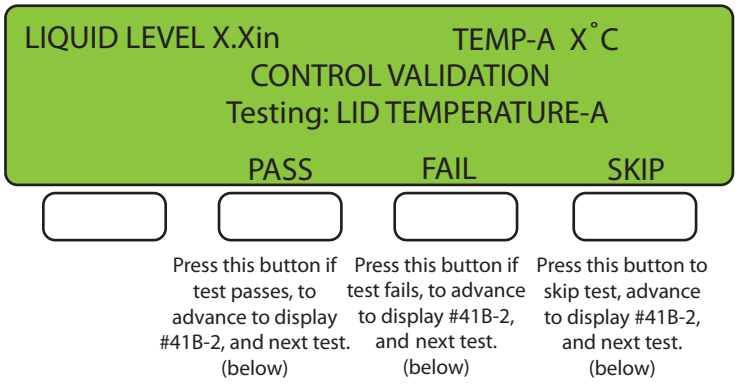
Press this button to skip test, advance to display #41B, and next test. (see page 21)

This display will appear when "PASS", "FAIL", or "SKIP" is selected on display #40. This menu tests remote alarm contacts. Controller advances to next test when "PASS", "FAIL", or "SKIP" is selected.

LCD DISPLAY FUNCTIONS

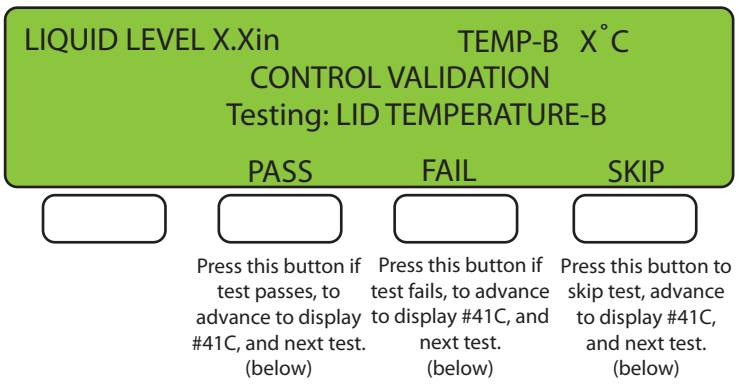
Program Mode Display Windows

#41B



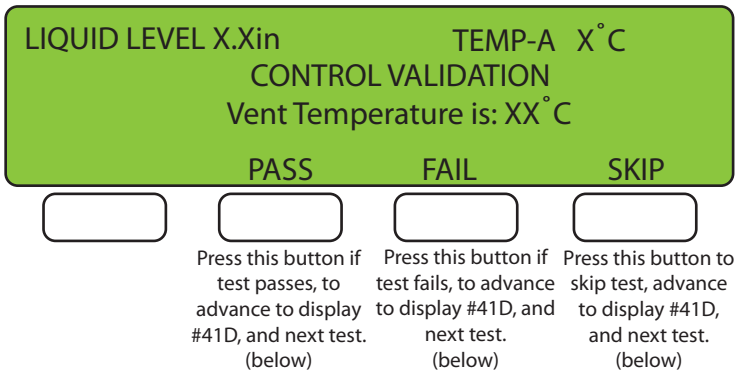
This display will appear when "PASS", "FAIL", or "SKIP" is selected on display #41A. This menu is for testing the lid temperature. Controller advances to next test when "PASS", "FAIL", or "SKIP" is selected.

#41B-2



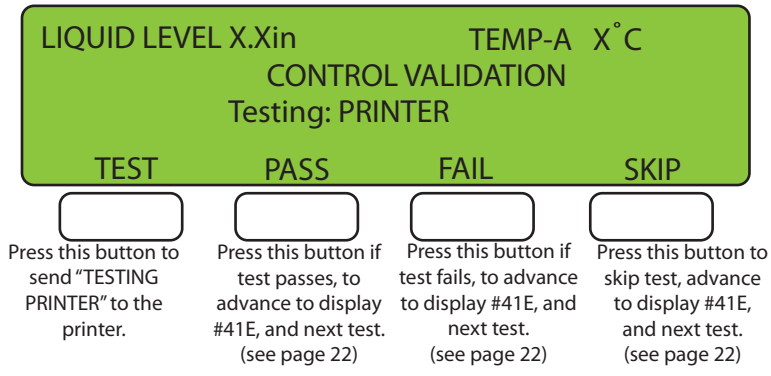
This display will appear when "PASS", "FAIL", or "SKIP" is selected on display #41B. This menu is for testing the lid temperature. Controller advances to next test when "PASS", "FAIL", or "SKIP" is selected.

#41C



This display will appear when "PASS", "FAIL", or "SKIP" is selected on display #41B-2. This menu displays current vent temperature. Controller advances to next test when "PASS", "FAIL", or "SKIP" is selected.

#41D

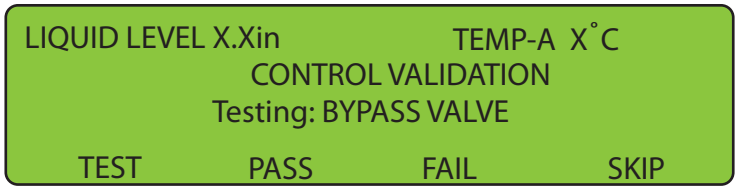


This display will appear when "PASS", "FAIL", or "SKIP" is selected on display #41C. This menu tests printer. Controller advances to next test when "PASS", "FAIL", or "SKIP" is selected.

LCD DISPLAY FUNCTIONS

Program Mode Display Windows

#41E



Press this button to activate the Bypass Valve for as long as the button is held.

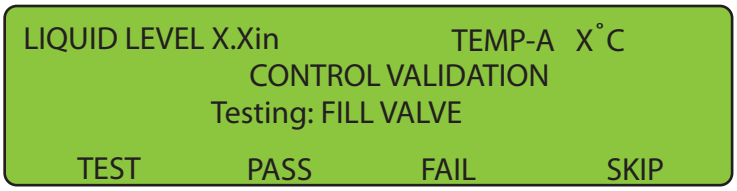
Press this button if test passes, to advance to display #41F, and next test. (below)

Press this button if test fails, to advance to display #41F, and next test. (below)

Press this button to skip test, advance to display #41F, and next test. (below)

This display will appear when "PASS", "FAIL", or "SKIP" is selected on display #41D. This menu tests the fill valve. Controller advances to next test when "PASS", "FAIL", or "SKIP" is selected.

#41F



Press this button to activate Fill Valve for as long as the button is held.

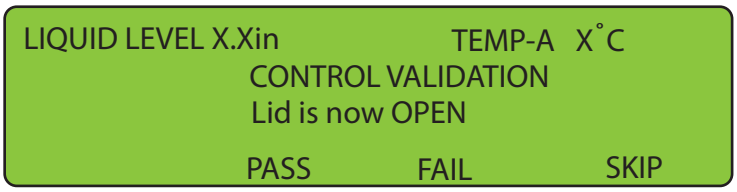
Press this button if test passes, to advance to display #41G, and next test. (below)

Press this button if test fails, to advance to display #41G, and next test. (below)

Press this button to skip test, advance to display #41G, and next test. (below)

This display will appear when "PASS", "FAIL", or "SKIP" is selected on display #41E. This menu tests the fill valve. Controller advances to next test when "PASS", "FAIL", or "SKIP" is selected.

#41G



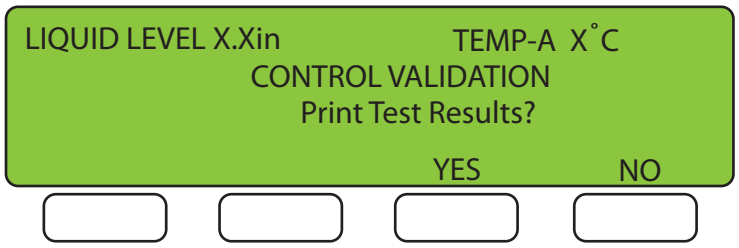
Press this button if test passes, to advance to display #41H, and next test. (below)

Press this button if test fails, to advance to display #41H, and next test. (below)

Press this button to skip test, advance to display #41H, and next test. (below)

This display will appear when "PASS", "FAIL", or "SKIP" is selected on display #41F. This menu tests the lid switch. With the lid closed, the display should read "LID IS NOW CLOSED", with the lid open, it should read "LID IS NOW OPEN". Controller advances to next test when "PASS", "FAIL", or "SKIP" is selected.

#41H



Press this button to print test results and return to display #6: MAIN MENU 3. (see page 16)

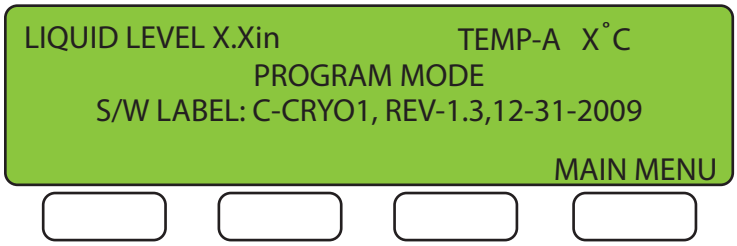
Press this button to return to display #6: MAIN MENU 3. (see page 16)

This display will appear when the final test button is selected on display #41G, and when all tests have been completed or skipped. Use this menu to print test results if desired.

LCD DISPLAY FUNCTIONS

Program Mode Display Windows

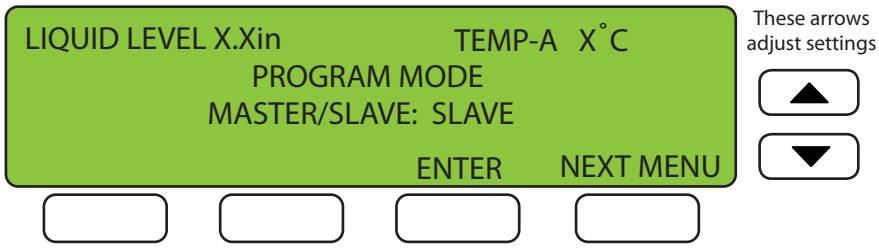
#42



Press this button to maintain current setting and return to display #4: MAIN MENU (see page 16)

This display will appear when you hit the REV button on display #6, on PAGE 16. Use this menu to view your revision number and date.

#13A



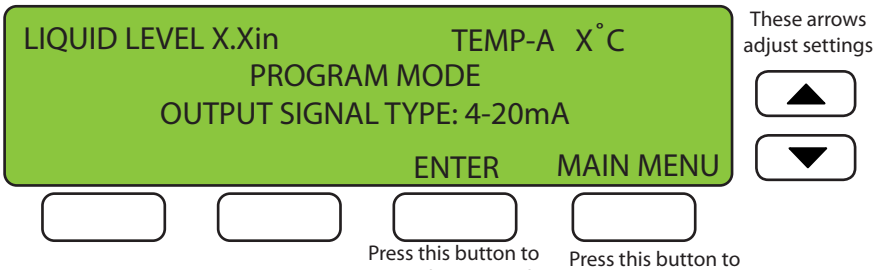
These arrows adjust settings

Press this button to save the setting and go to display #13C: OUTPUT SIGNAL TYPE (see below)

Press this button to discard changes and return to display #13B: Output Signal Type (see below)

This display will appear after a selection is made on screen #13 (see page 18).
NOTE: If this controller is connected to the PC it is to be set to master, if it is in the chain leading to the master it is to be set to slave.

#13B



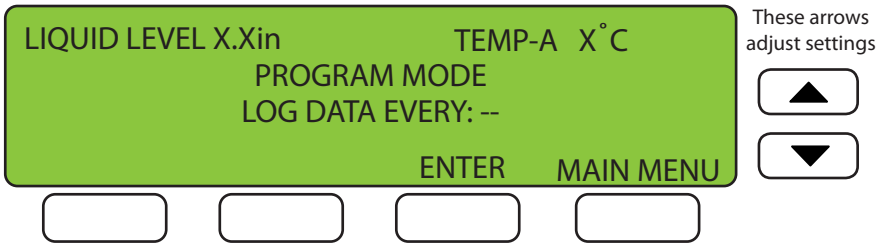
These arrows adjust settings

Press this button to save changes and return to display #4: MAIN MENU (see page 16)

Press this button to discard changes and return to display #4: MAIN MENU (see page 16)

This display will appear after a selection is made on screen #13A (see above). Use this menu to activate either the 4-20mA outputs or the 0-5V outputs.
NOTE: Outputs are for use with an external monitoring system through the 16 port connector.

#45



These arrows adjust settings

Press this button to save the setting and Return to display #5 Main Menu 2 (see page 16)

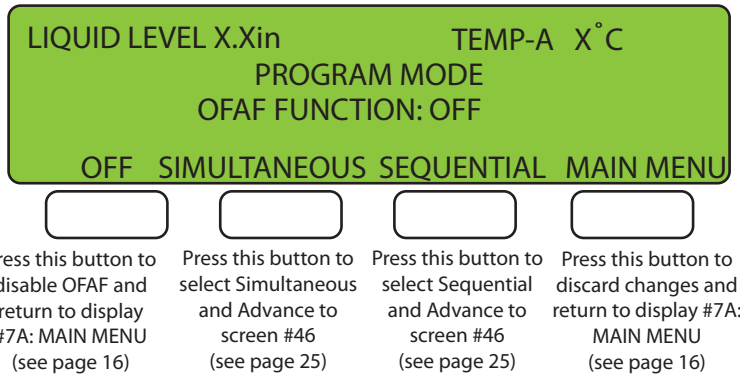
Press this button to discard changes and return to display #5: MAIN MENU 2 (see page 16)

This display will appear when "LOG" is selected on display #7 (see page 16). This menu is used to choose how often you wish the data(Temp. A., Temp. B. and Level) to be recorded. The recorded info can be displayed/printed when the report function is selected from screens 1, 2, or 3.

LCD DISPLAY FUNCTIONS

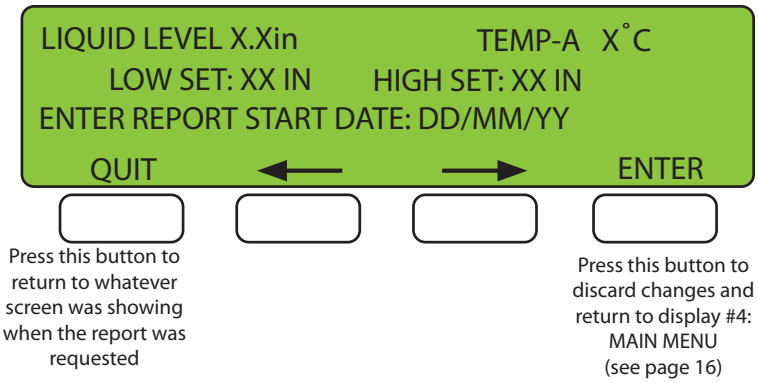
Program Mode Display Windows

#44



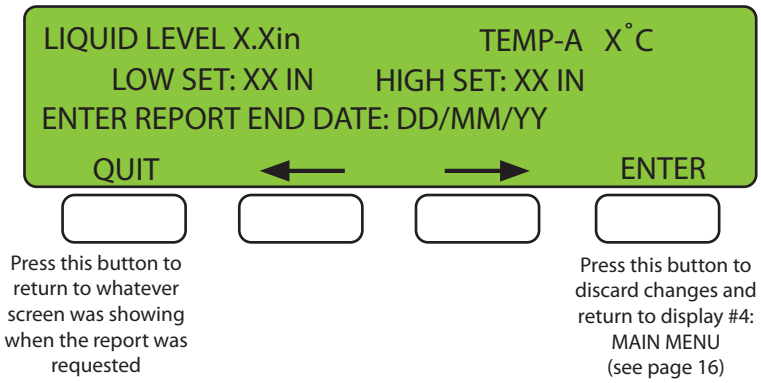
This display will appear when OFAF is selected on display #7 (see page 16).

#99A



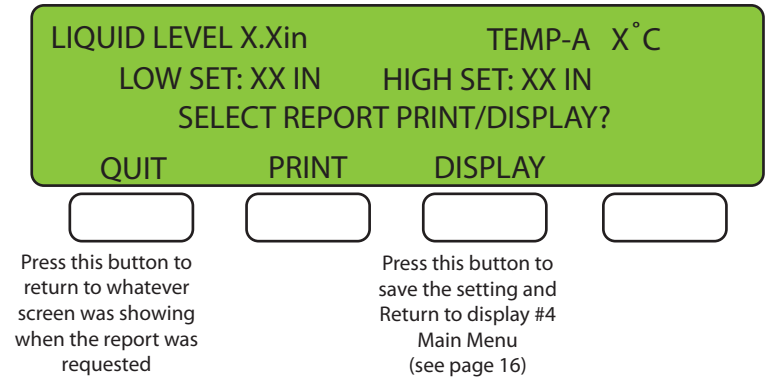
This display will appear when either alarms or data is selected on display #99 (see page 15). Use this menu to select the start date that you want the alarm/data to begin on the report display or printout.

#99B



This display will appear when enter is selected on display #99A (see above). Use this menu to select the end date that you want the alarm/data to end on the report display or printout.

#99C

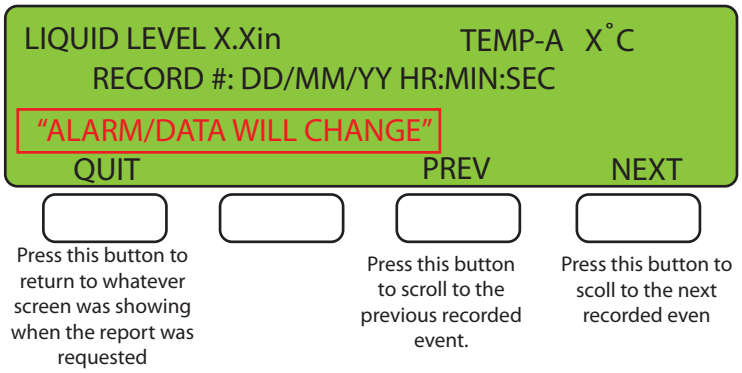


This display will appear when enter is selected on display #99B (see above). Use this menu to choose weatehr you want the report to be printed or displayed on the screen.

LCD DISPLAY FUNCTIONS

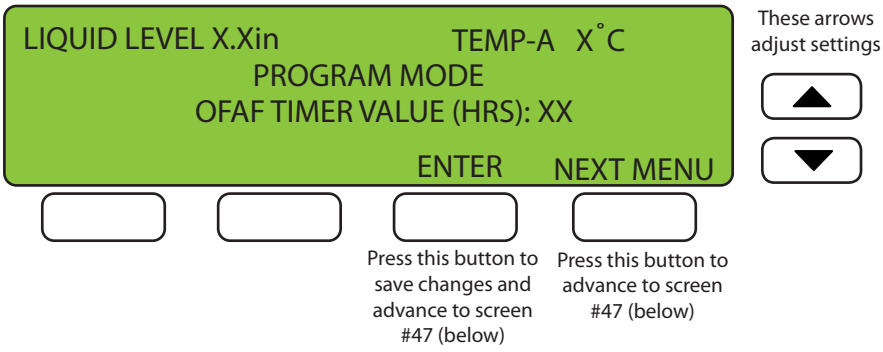
Program Mode Display Windows

#99D



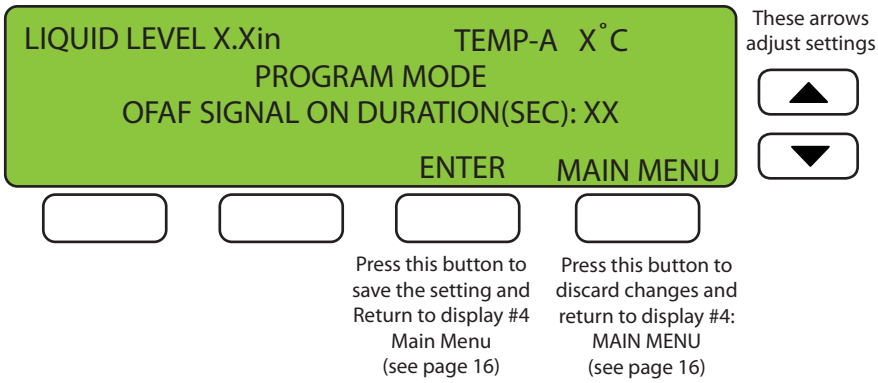
This display will appear when "DISPLAY" is selected on display #99C (see page 24). Use this menu to view either the "ALARMS" or "DATA" that was selected on screen #99 (see page15).

#46



This display will appear when OFAF function is set to SIMULTANEOUS or SEQUENTIAL (see page 24 display #44) and the "ENTER" button was pressed.
Note: Factory settings should be kept, any questions please contact Custom BioGenic Systems.

#47



This display will appear after screen #46 (see above).
Note: Factory settings should be kept, any questions please contact Custom BioGenic Systems.

HIGH & LOW LEVEL ALARM AND TEMPERATURE DISPLAY VERIFICATION

The following section includes verification procedures for the High and Low Level Alarms, and the Temperature Display on the Standard and Isothermal Liquid Nitrogen Storage Units.

Low Level Alarm Verification

1. Using the manual valve on the liquid nitrogen supply tank, turn off the liquid supply.
2. Create a low level alarm condition. This is done by adjusting the level set-points above the actual liquid level. If necessary, refer to page 18, display #15, and #16.
   Example: The liquid level is 6 inches. Adjust the high level set-point to 10, and the low level set-point to 8. This will cause the controller to go into an auto fill.
   In 7 to 10 minutes, a low alarm should occur. This will be indicated by the **LOW ALARM** text flashing and the audible alarm sounding. The remote alarm output will activate also.
3. Return set-points to the desired settings.
4. Open manual valve on supply tank to resume normal operation.

High Level Alarm Verification

1. Create a high level alarm condition. This is done by adjusting the level set-points at lease one inch below the actual liquid level. If necessary, refer to page 18, display #15, and #16.
   Example: The liquid level is 6 inches. Adjust the low set-point to 2 and the high set-point to 4.
   In 3 to 5 minutes, a high alarm should occur. This will be indicated by the **HIGH ALARM** text flashing and the audible alarm sounding. The remote alarm output will activate also.
2. Return set-points to the desired settings. Unit is now ready for normal operation.

If the alarm functions aren't occurring as described above, repeat the verification procedure. If one or both of the alarms are still not functioning properly, refer to the troubleshooting guide on page 29 for further instruction.

Temperature Display Verification

1. Open storage unit lid and locate temperature sensing probes.
2. Carefully remove probe from protective sleeve.
3. Submerge the sensor probe into liquid nitrogen. The digital temperature display should read -196° degrees celsius (+/- 1°C).
4. Remove probe from liquid nitrogen and place tip of probe in an ice bath (mixture of ice and water), and wait 30 seconds. While the probe is submerged, the digital display should read 0° (+/-1°C) degrees celsius.
5. Check probe end for cracks or damage, return probe into its protective sleeve at the desired depth.
6. Close the storage unit lid and resume normal operation.

If the temperature display doesn't operate as described, there may be a problem with the probe, or the probe connections. See the Troubleshooting Guide on page 29 for further information if a problem is detected.

2301 TEMPERATURE CALIBRATION

IMPORTANT: When calibrating you should always calibrate Zero "ice bath" first. Then make sure the probe end is dry before calibrating Span "Liquid Nitrogen" to avoid ice formation on the probe end during calibration.

TEMP PROBE A

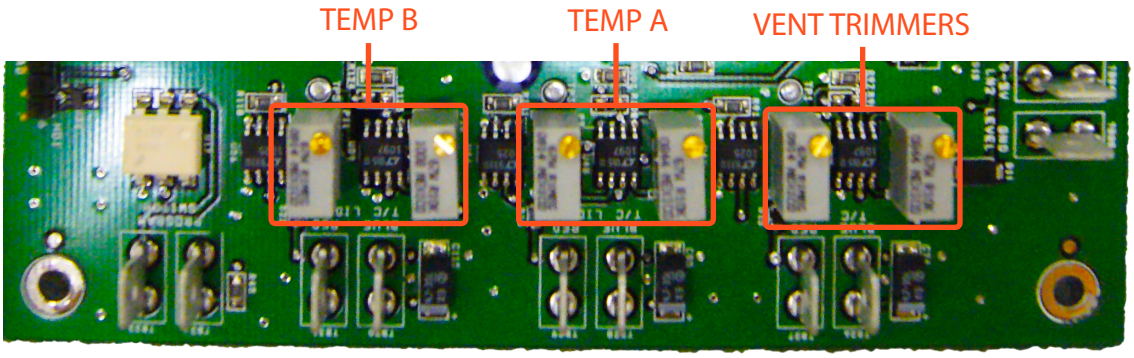
1. Satisfy alarm conditions so that the controller is in its normal operating state. Examples: Connect valves and thermocouples, set up low, high set points, and temperature alarm set point.
2. Place Temp A thermocouple probe in an Ice Bath and adjust trimmer P8 until display reads 0 deg. C. Clock wise adjusts temp. display down, Counter clockwise adjusts temp. display up.
3. Place Temp A thermocouple probe in Liquid Nitrogen and adjust trimmer P9 until display reads –196 deg. C. Clockwise adjusts temp. display down, Counter clockwise adjusts temp. display up.
4. Continue adjusting back and forth between steps 2 and 3 until temperature is correct on both ends, Zero and Span, without further adjustment. (Calibrate to +/- 1 degree)

TEMP PROBE B

1. Satisfy alarm conditions so that the controller is in its normal operating state. Examples: Connect valves and thermocouples, set up low, high set points, and temperature alarm set point.
2. Place Temp B thermocouple probe in an Ice Bath and adjust trimmer P10 until display reads 0 deg. C. Clock wise adjusts temp. display down, Counter clockwise adjusts temp. display up.
3. Place Temp B thermocouple probe in Liquid Nitrogen and adjust trimmer P11 until display reads –196 deg. C. Clockwise adjusts temp. display down, Counter clockwise adjusts temp. display up.
4. Continue adjusting back and forth between steps 2 and 3 until temperature is correct on both ends, Zero and Span, without further adjustment. (Calibrate to +/- 1 degree)

BYPASS TEMP

1. Satisfy alarm conditions so that the controller is in its normal operating state. Examples: Connect valves and thermocouples, set up low, high set points, and temperature alarm set point.
2. Place BYPASS thermocouple probe in an Ice Bath and adjust trimmer P6 until display reads 0 deg. C. Clock wise adjusts temp. display down, Counter clockwise adjusts temp. display up.
3. Place BYPASS thermocouple probe in Liquid Nitrogen and adjust trimmer P7 until display reads –196 deg. C. Clockwise adjusts temp. display down, Counter clockwise adjusts temp. display up.
4. Continue adjusting back and forth between steps 2 and 3 until temperature is correct on both ends, Zero and Span, without further adjustment. (Calibrate to +/- 1 degree)



Go to custombiogenics.com/technicalguides.html for more information.

V SERIES LIQUID LEVEL DISPLAY VERIFICATION & CALIBRATION

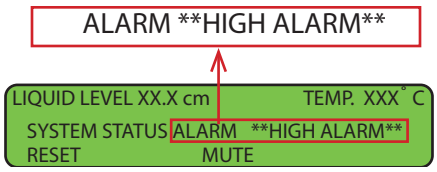
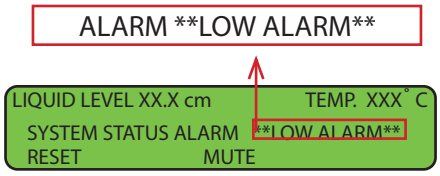
Since the V Series storage units hold LN2 in a jacketed space between the vacuum insulated space and storage chamber it cannot be calibrated the same as S Series storage units. Customers have multiple options to choose from in how they want to go about calibrating their Isothermal storage unit.

For all options below please call for pricing and further details:

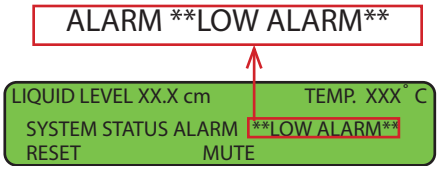
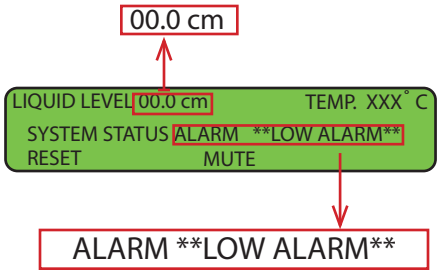
N.I.S.T. traceable options:

1. **Purchase Calibration Equipment**
2. **Rent Calibration Equipment**
3. **Have a qualified technician sent to your facility to perform the calibration**
4. **Return the controller to Custom BioGenic Systems to be calibrated**

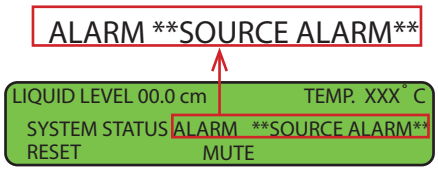
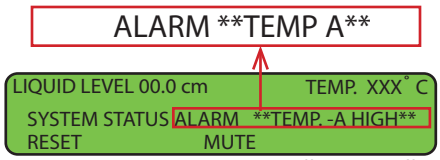
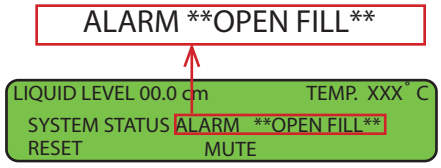
TROUBLESHOOTING GUIDE: ALARMS

CONDITIONS	CAUSES	SOLUTIONS
HIGH ALARM text is flashing and audible alarm is present.  *Liquid level in the vessel has risen above the HIGH level set-point.	◆ Check to see if unit is filling: -If unit is filling: -If unit is not filling:	◆ Push the STOP button, if fill continues, the solenoid valve may be frozen open; push the FILL and STOP buttons 15 to 20 times to un-stick the valve. If the fill continues, turn off the manual valve on the liquid nitrogen supply tank and let the solenoid valve warm to room temperature, then re-open the manual valve to see if proper operation returns. If not, the solenoid valve may need to be disassembled for service (see page 39 - *Cleaning and Maintenance)* ◆ There may be an obstruction in the solenoid valve. Remove solenoid valve and disassemble for service. (see page 39- *Cleaning and Maintenance)*
LOW ALARM text is flashing and audible alarm is present.  *Liquid level in the vessel has fallen below the LOW level set-point.	◆ Supply tank is empty ◆ Supply tank is shut off ◆ Supply tank pressure is too low ◆ 3 or more storage units are filling at one time from a single supply line	◆ Replace supply tank ◆ Open manual valve on the supply tank ◆ Check pressure in supply tank - 25 p.s.i. maximum, 20 p.s.i. minimum **(22 p.s.i. recommended)** ◆ Storage vessels will fill very slowly and alarm will correct itself. Continued on next page

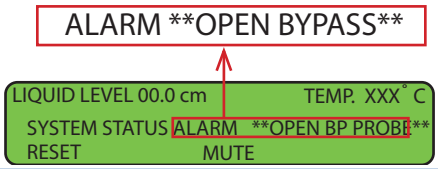
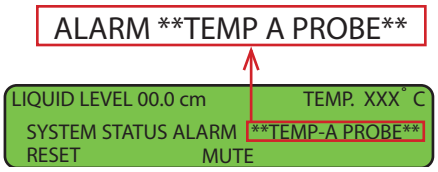
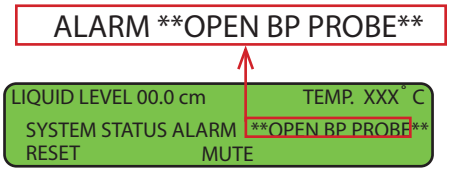
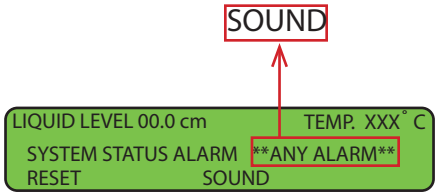
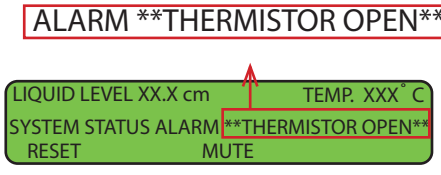
TROUBLESHOOTING GUIDE: ALARMS

CONDITIONS	CAUSES	SOLUTIONS
LOW ALARM text is flashing and audible alarm is present. 	◆ Solenoid valve operating erratically	◆ Push STOP button briefly and listen for the fill solenoid valve to "click". This sound is the valve operating. If the "click" is heard and the supply tank still has liquid and pressure in it, there may be an obstruction in the valve or in the line. If no "click" is heard, check to see that the valve is plugged in, and/or that there is power to the outlet which the valve is plugged into. If power is present at the valve, but the vessel is still not filling with liquid nitrogen, the valve may be defective.
LOW ALARM text is flashing, audible alarm is present, and level display reads "00.0 cm" (or "00.0 in") 	◆ The LN^2 level in the vessel has fallen below the pressure sensing port.	◆ An automatic fill will begin, and when the liquid level rises above the LOW level set-point and the pressure port, the alarm will subside. ◆ Check pressure hose at all connection points; a white clamp should be in place at each end of the hose inside the controller, and at the hose connection on the back of the controller. If hose appears loose, disconnect it, remove an inch off the end by cutting it with scissors, and reconnect it. (If the vessel is holding liquid, it may take some time to read the corrected level.)

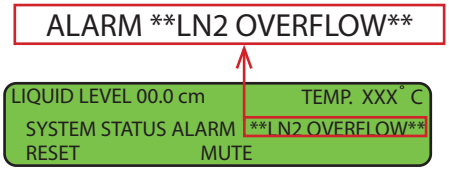
TROUBLESHOOTING GUIDE: ALARMS

CONDITIONS	CAUSES	SOLUTIONS
SOURCE text is flashing and audible alarm is present.  *This indicates a weak or empty liquid supply. Liquid level is above the LOW level set-point, but isn't rising fast enough to satisfy the system.	◆ Supply tank is empty ◆ Supply tank is shut off ◆ Supply tank pressure is too low or to high ◆ 3 or more storage units are filling at one time from a single supply line	◆ Replace supply tank ◆ Open manual valve on supply tank if closed ◆ Check pressure in supply tank - 25 p.s.i. maximum, 20 p.s.i. minimum **(22 p.s.i. recommended)** ◆ Source alarms are not self correcting.
TEMP A text is flashing and audible alarm is present.)  **NOTE: Text may display "Temp B"**	◆ Temperature has risen above set-point. ◆ Probe has been inadvertently moved.	◆ Lid has been open too long. ◆ Low liquid nitrogen level. ◆ Move probe to original location.
OPEN FILL text is flashing and audible alarm is present 	◆ Fill valve disconnected from power source. ◆ Fill valve defective.	◆ Connect fill valve power cord correctly using diagram on page 7. ◆ Replace fill valve.

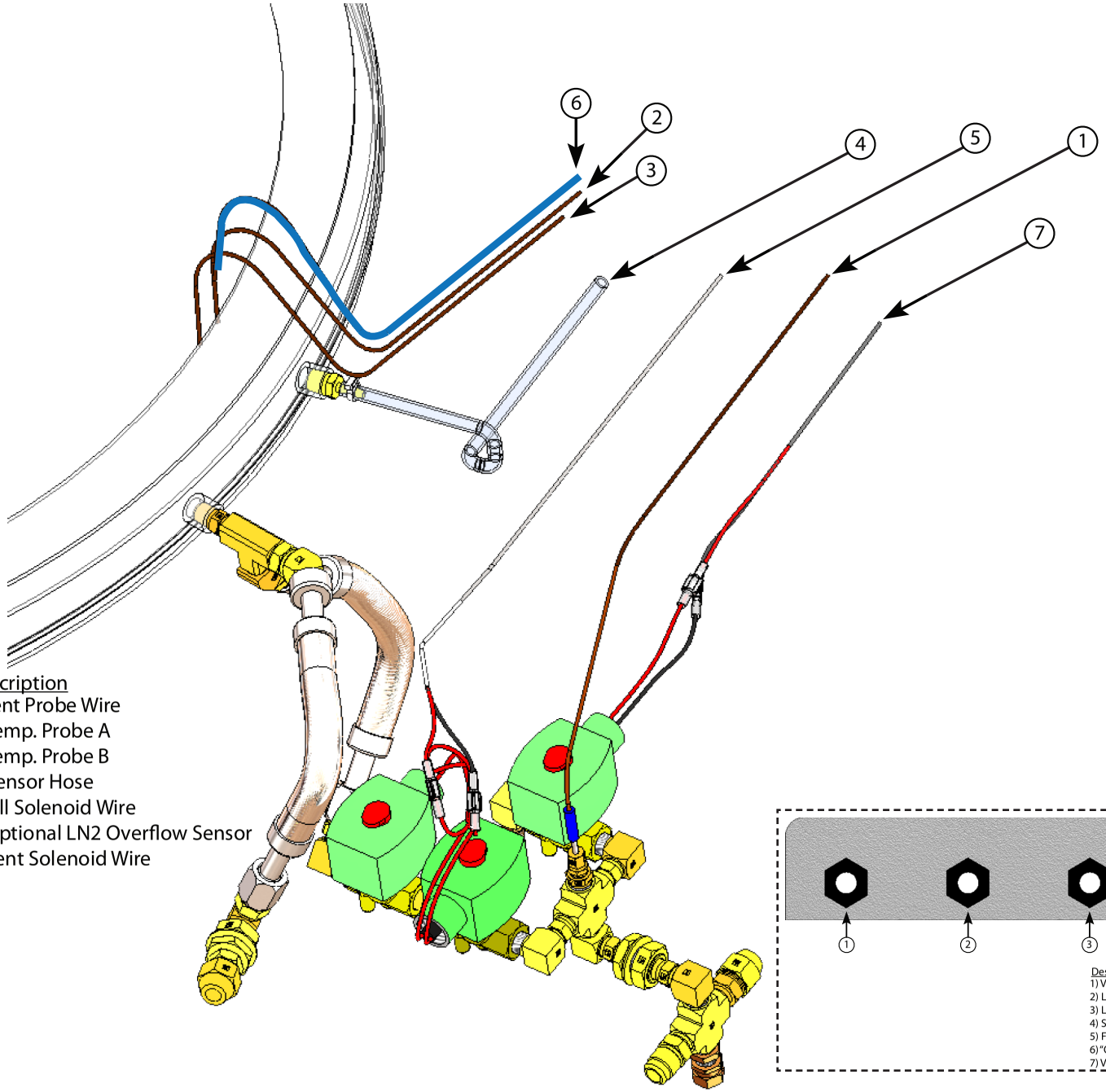
TROUBLESHOOTING GUIDE: ALARMS

CONDITIONS	CAUSES	SOLUTIONS
OPEN BYPASS text is flashing and audible alarm is present. 	◆ Bypass valve disconnected from power source. ◆ Bypass valve defective.	◆ Connect bypass valve power cord correctly using diagram on page 7. ◆ Replace bypass valve.
TEMP-A PROBE text is flashing and audible alarm is present.  **NOTE: Text may display "Temp B"**	◆ Thermocouple probe plug is disconnected. ◆ Thermocouple probe is damaged.	◆ Connect probe plug properly using diagram on page 7. ◆ Replace damaged probe.
OPEN VENT PROBE text is flashing and audible alarm is present. 	◆ Thermocouple probe plug is disconnected. ◆ Thermocouple probe is damaged.	◆ Connect probe plug properly using diagram on page 7. ◆ Replace damaged probe.
Any **ALARM** text is flashing and an audible alarm is **NOT** present. 	◆ There is an alarm condition of some kind and the alarm MUTE is activated.	◆ Correct the alarm condition and then push the SOUND switch, so the audible alarm will be activated at the next alarm occurrence.
THERMISTOR OPEN text is flashing and audible alarm is present. 	◆ Thermistor plug is disconnected. ◆ Thermistor is damaged.	◆ Connect Thermistor properly using diagram on page 7. ◆ Replace damaged Thermistor.

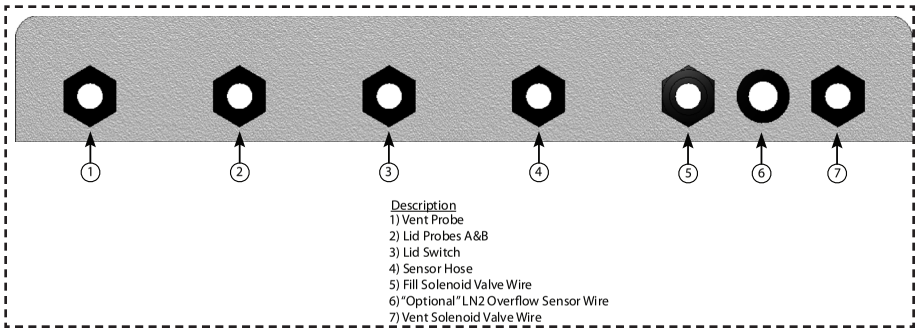
TROUBLESHOOTING GUIDE: ALARMS

CONDITIONS	CAUSES	SOLUTIONS
LN2 OVERFLOW test is flashing and audible alarm is present. **NOTE: This is an optional function, additional equipment is required. If overflow alarm is activated power to the solenoid valve is disabled.** 	◆ Liquid level has become too high inside the vessel walls because of stuck solenoid, user error, etc. ◆ Disconnected sensor tube (see #7 on page 7) ◆ EH settings are enable on a non EH unit. ◆ High pressure supply	◆ Shut off manual valve on liquid supply, wait for the liquid to settle and do one of the following: - Carefully bail liquid out of vessel using approved cryogenic container and proper personal safety equipment, or - Wait for liquid to evaporate from vessel on it's own.
Liquid Nitrogen has flooded vessel through internal vents. (V Series units only)	◆ Liquid level has become too high inside the vessel walls because of stuck solenoid, user error, etc. ◆ Disconnected sensor tube (see #7 on page 7) ◆ EH settings are enable on a non EH unit. ◆ High pressure supply	◆ Shut off manual valve on liquid supply, wait for the liquid to settle and do one of the following: - Carefully bail liquid out of vessel using approved cryogenic container and proper personal safety equipment, or - Wait for liquid to evaporate from vessel on it's own.
No lights	◆ Blown fuse ◆ No power at wall outlet. ◆ AC power cord not plugged in. ◆ ON/OFF switch in OFF position	◆ Replace with two amp fuse. ◆ Use live power source. ◆ Plug the AC power cord into a wall socket. ◆ Move power key-switch into the ON position.
Liquid level display showing incorrect reading.	◆ Obstructed pressure port. ◆ Loose sensor hose. ◆ Unit out of calibration.	◆ Clear blockage from pressure port in bottom of vessel. ◆ Check sensor hose connection. ◆ Calibrate unit using the calibration guide on page 29, 30.
Remote alarm working improperly or not at all.	◆ Remote alarm wires connected to the wrong terminals.	◆ Reconnect wiring using the guide on page 12: *Remote Alarm Wiring*

Plumbing Wiring Diagram Part I.D.

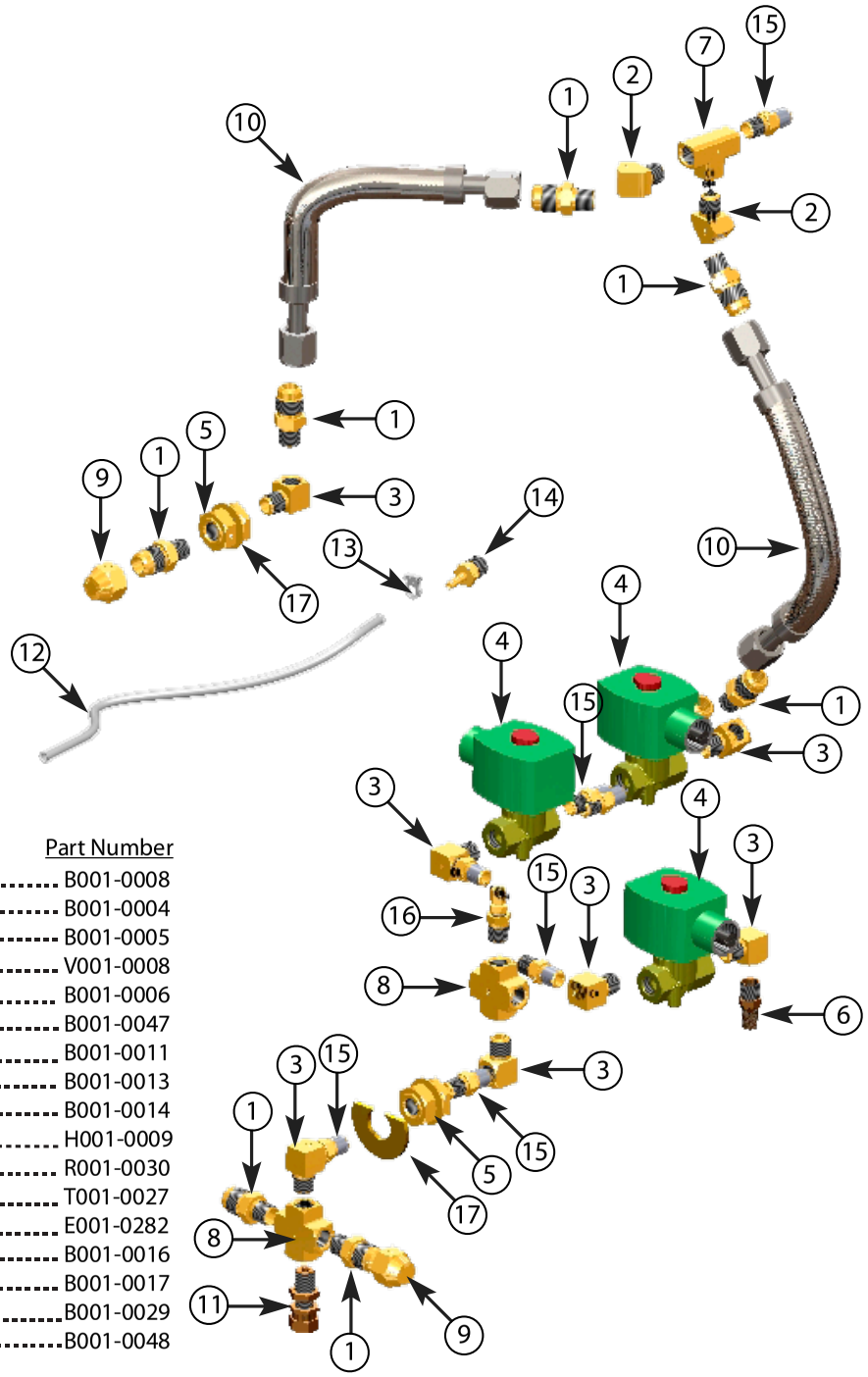


Description
1)Vent Probe Wire
2) Temp. Probe A
3) Temp. Probe B
4) Sensor Hose
5) Fill Solenoid Wire
6) Optional LN2 Overflow Sensor
7) Vent Solenoid Wire



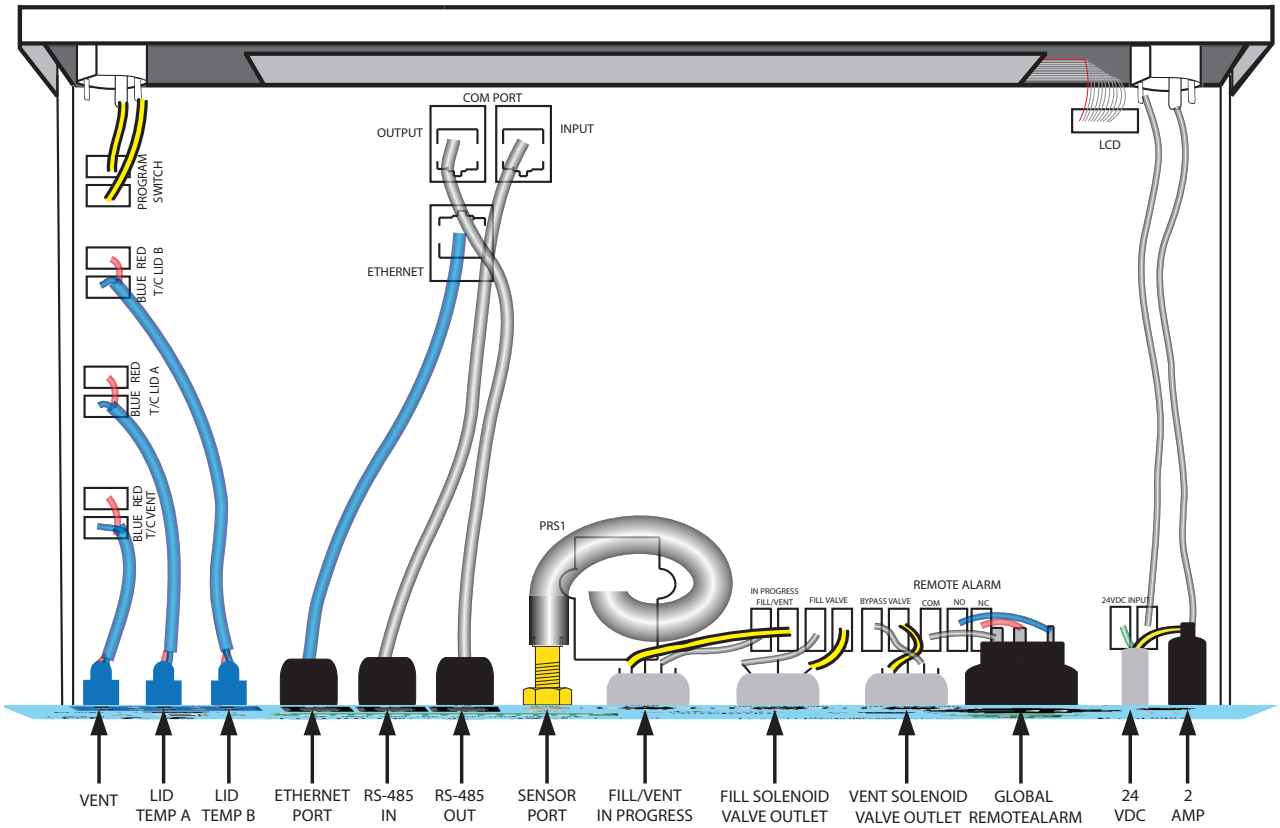
Description
1) Vent Probe
2) Lid Probes A&B
3) Lid Switch
4) Sensor Hose
5) Fill Solenoid Valve Wire
6) "Optional" LN2 Overflow Sensor Wire
7) Vent Solenoid Valve Wire

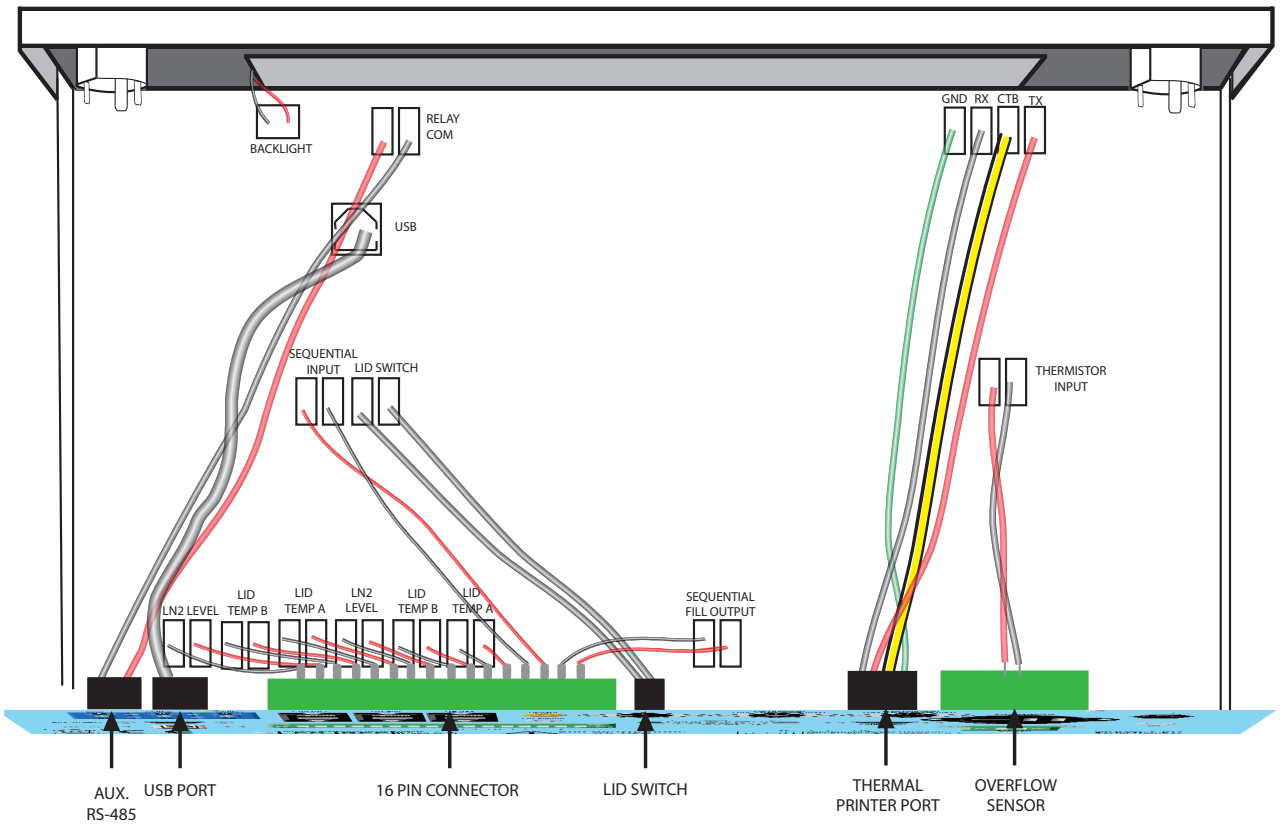
Plumbing Assembly Diagram Part I.D.



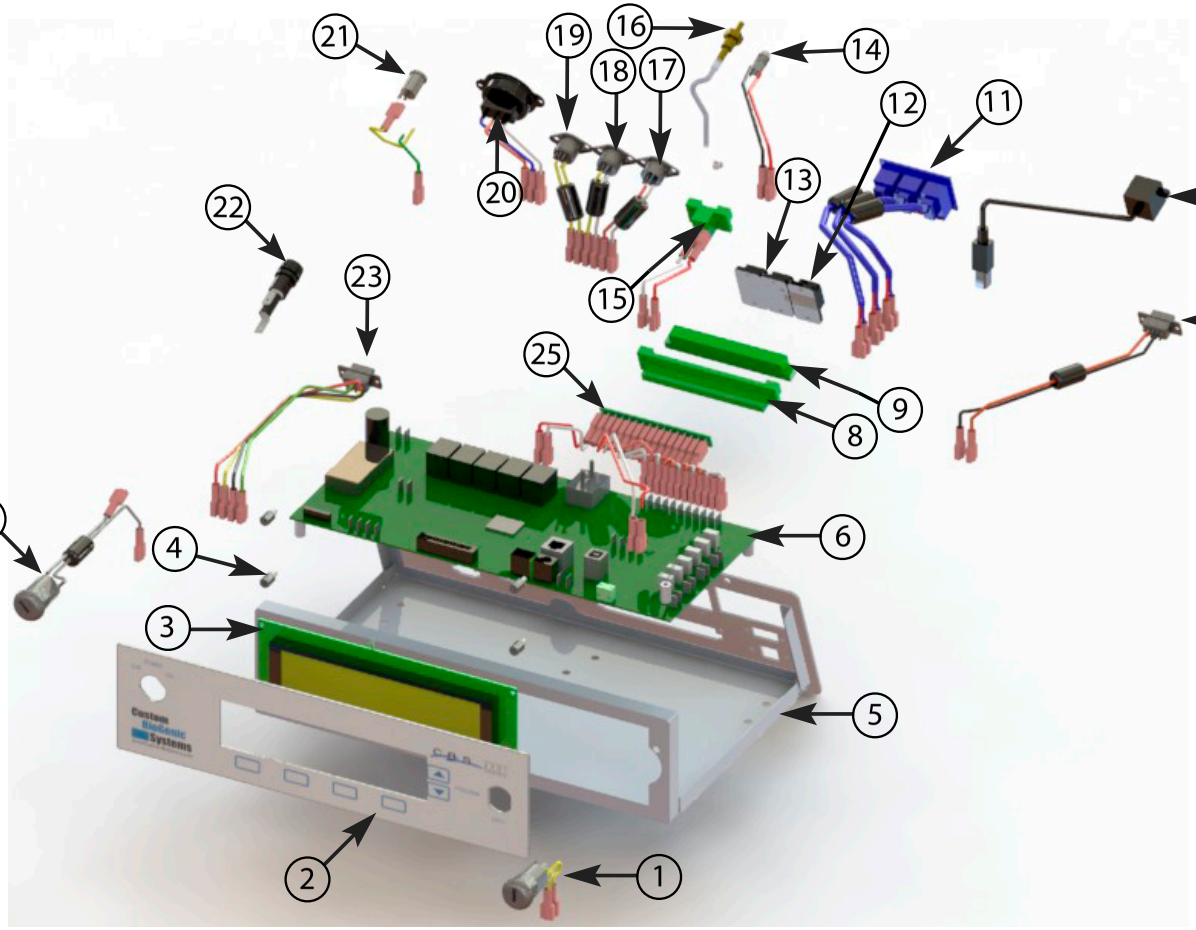
Description	Part Number
1) Male Connector	B001-0008
2) 45 Degree Street Elbow	B001-0004
3) 90 Degree Street Elbow	B001-0005
4) Solenoid Valve 24V DC	V001-0008
5) Short Anchor Coupling	B001-0006
6) Arrow Muffler	B001-0047
7) 1/2" 3-Way	B001-0011
8) Cross	B001-0013
9) Flare Cap Nut	B001-0014
10) S.S. 9.5" Braided Hose	H001-0009
11) Relief Valve CE MArked 60 P.S.I.	R001-0030
12) Sensor Hose	T001-0027
13) Plastic Clip	E001-0282
14) 1/8" Hose Barb	B001-0016
15) Hex Nipple	B001-0017
16) Bypass Probe Compression Fitting	B001-0029
17) Brass Flatwasher	B001-0048

2301 Controller Wiring Diagram





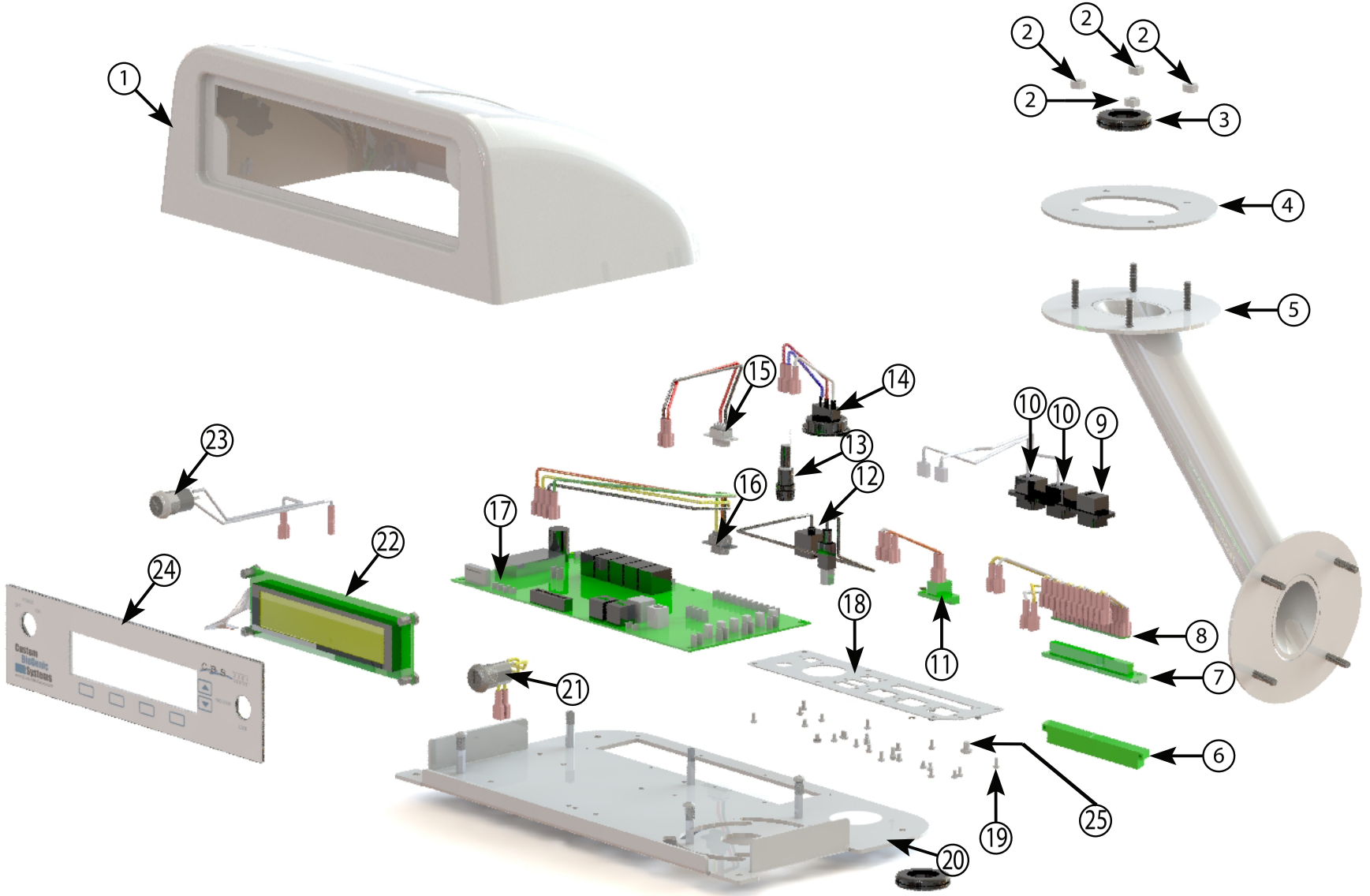
2301 Controller Diagram Part I.D.



Description	Part Number
1) Program PC Key Switch Assembly	5670-E601
2) Front Panel Assembly	5668-E601
3) LCD Display	E001-0413
4) M/F 0.375" Stnadoffs	E001-0050
5) 2301 Tray Assembly	5301-E601
6) 2301 Circut Board	E001-0381
7) Aux. RS-485 Assembly	5648-E601
8) 16-Pin Female Connector	E001-0399
9) 16-Pin Male Connector	E001-0400
10) USB Assembly	5601-E068
11) Female Temp. Probe Assembly	5638-E601
12) Ethernet Connector and Cable	5639-E601
13) RS-485 Connector and Cable	5640-E601

Description	Part Number
14) Lid Switch Female Connector Assembly	5642-E601
15) Overflow Sensor Male/Female Connector	5601-E070
16) Brass Sensor Port Barb Connection	5641-E601
17) Female 3-Pin Assembly	5643-E601
18) Female 6-Pin Assembly	5644-E601
19) Female 5-Pin Assembly	5645-E601
20) Global Remote Alarm Assembly with Female Connector	5646-E601
21) 24V DC Female Connector Assembly	5650-E601
22) 2-Amp Fuse with Housing Assembly	5647-E601
23) Thermal Printer Port Assembly	5649-E601
24) Power PC Key Switch Assembly	5671-E601
25) 16-Pin Capacitor Filter Board	5672-E601

5000 2301 Controller Diagram Part I.D.

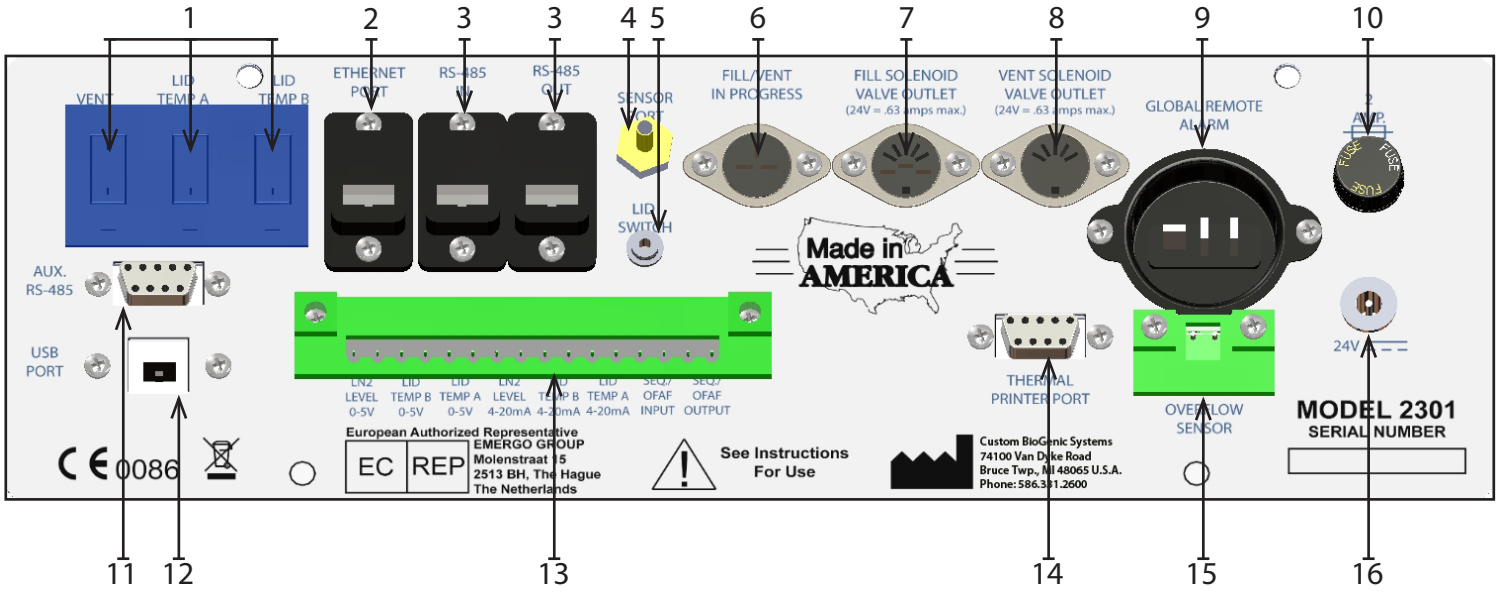


Description	Part Number
1) 5000 Controller Housing	5601-E001
2) 1/4" - 20 Stainless Steel Nylon Nut	N001-0018
3) CG Gromet	E001-0299
4) 5000 Nylon Controller Arm Spacer	E001-0201
5) 5000 Controller Arm Assembly	1107-V601
6) 16-Pin Male Connector	E001-0400
7) 16-Pin Female Connector	E001-0399
8) 16-Pin Capacitor Filter Board	5672-E601

Description	Part Number
9) RS-485 Connector and Cable	5640-E601
10) Ethernet Connector and Cable	5639-E601
11) Overflow Sensor Male/Female Connector	5601-E070
12) USB Assembly	5601-E068
13) 2-AMP Fuse With Housing Assembly	5647-E601
14) Global Remote Alarm Assembly With Fremale Connector	5646-E601
15) AUX RS-485 Assembly	5648-E601
16) Thermal Printer Port Assembly	5649-E601

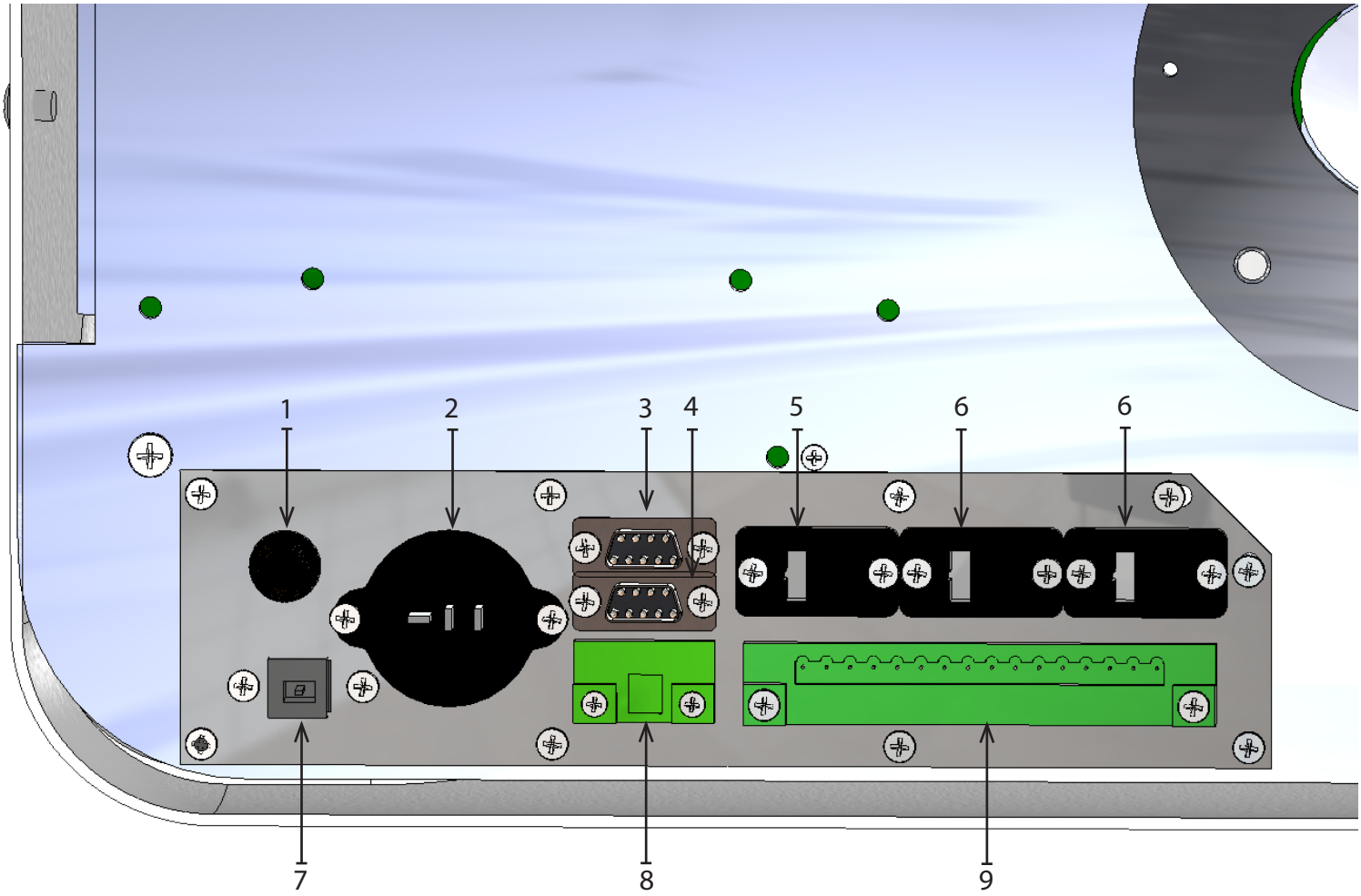
Description	Part Number
17) 2301 Circuit Board	E001-0381
18) 2301 Component Back Panel	5601-E078
19) 6/32" x 1/4" Stainless Steel Panhead Screw	S001-0047
20) 5000 Controller Base Plate	5601-E014
21) Program Key Switch Assembly	5670-E601
22) LCD Display	E001-0413
23) Power PC Key Switch Assembly	5671-E601
24) Front Panel Assembly	5668-E601
25) 8-32 Rivnut	R001-0050

Series 2301 Controller Back Panel Part I.D.



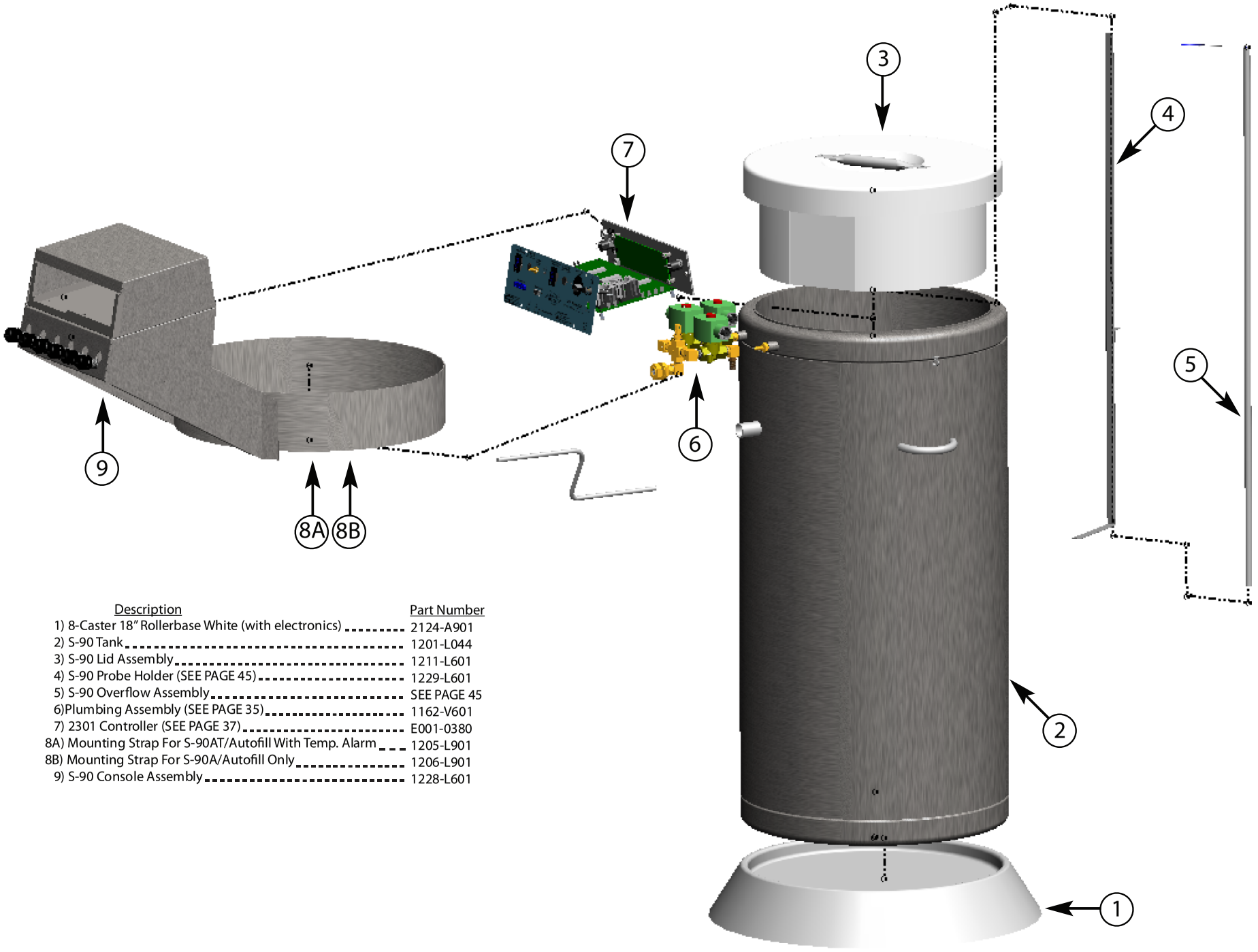
Description	Part Number
1. Female Temperature Probe Assembly	5638-E601
2. Ethernet Connector and Cable	5639-E601
3. RS-485 Connector and Cable	5640-E601
4. Brass Sensor-port Barb Connection	5641-E601
5. Lid Switch Female Connector Assembly	5642-E601
6. Female 3 Pin Assembly	5643-E601
7. Female 6 Pin Assembly	5644-E601
8. Female 5 Pin Assembly	5645-E601
9. Global Remote Alarm Assembly With Female Connector	5646-E601
10. 2-AMP Fuse With Housing Assembly	5647-E601
11. AUX. RS-485 Assembly	5648-E601
12. USB Port Connector	5601-E068
13. 16 Port Connectors Male and Female	5601-E069
14. Thermal Printer Port Assembly	5649-E601
15. Overflow Sensor Male and Female Connectors	5601-E070
16. 24 V DC Female Connector Assembly	5650-E601

Series 5000 Back Panel Part I.D.



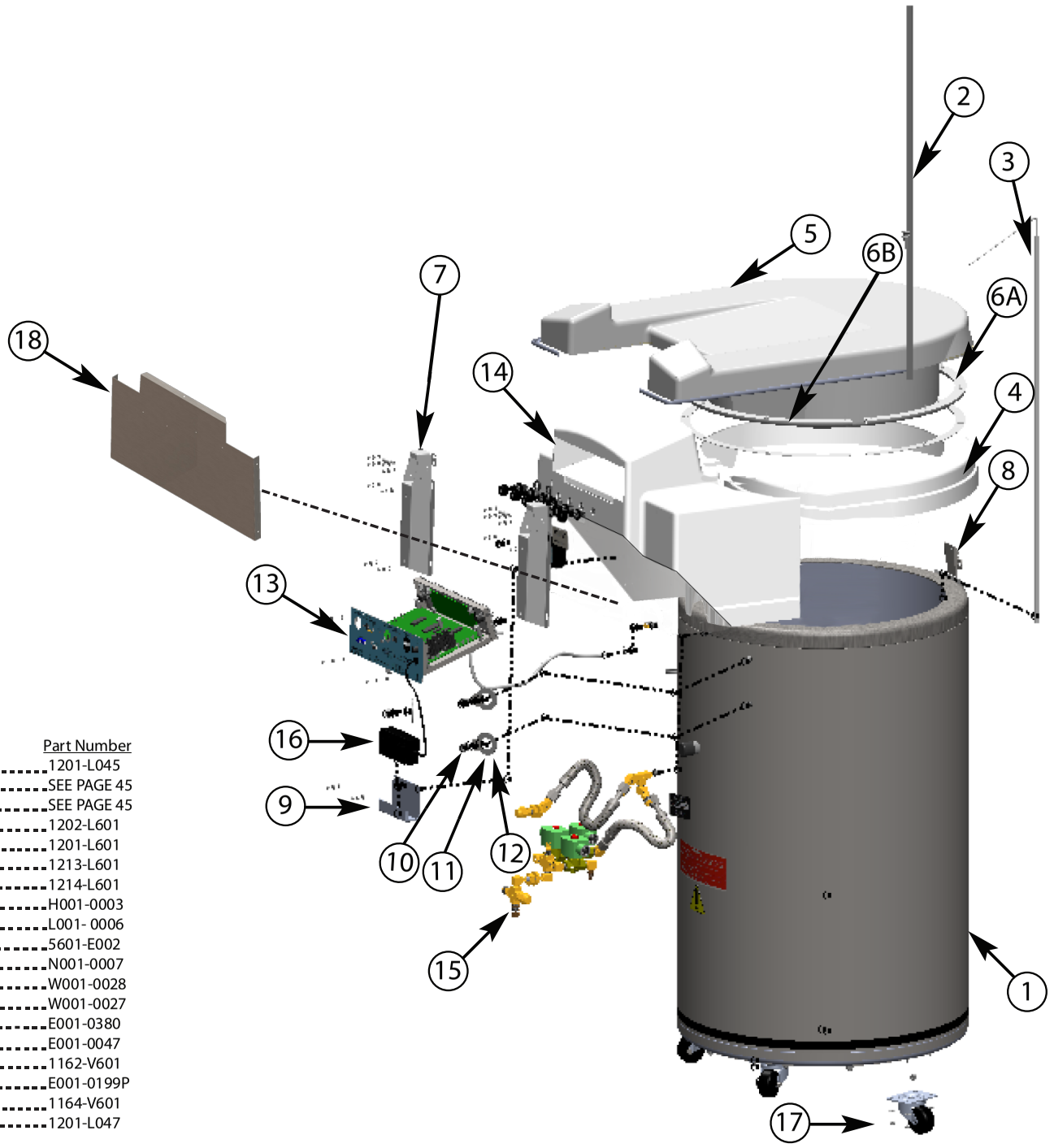
Description	Part Number
1. 2-AMP Fuse With Housing Assembly	5647-E601
2. Global Remote Alarm Assembly With Female Connector	5646-E601
3. Thermal Printer Port Assembly	5649-E601
4. AUX. RS-485 Assembly	5648-E601
5. Ethernet Connector and Cable	5639-E601
6. RS-485 Connector and Cable	5640-E601
7. USB Port Connector	5601-E068
8. Overflow Sensor Male and Female Connectors	5601-E070
9. 16 Port Connectors Male and Female	5601-E069

90 Series Tank Diagram Part I.D.



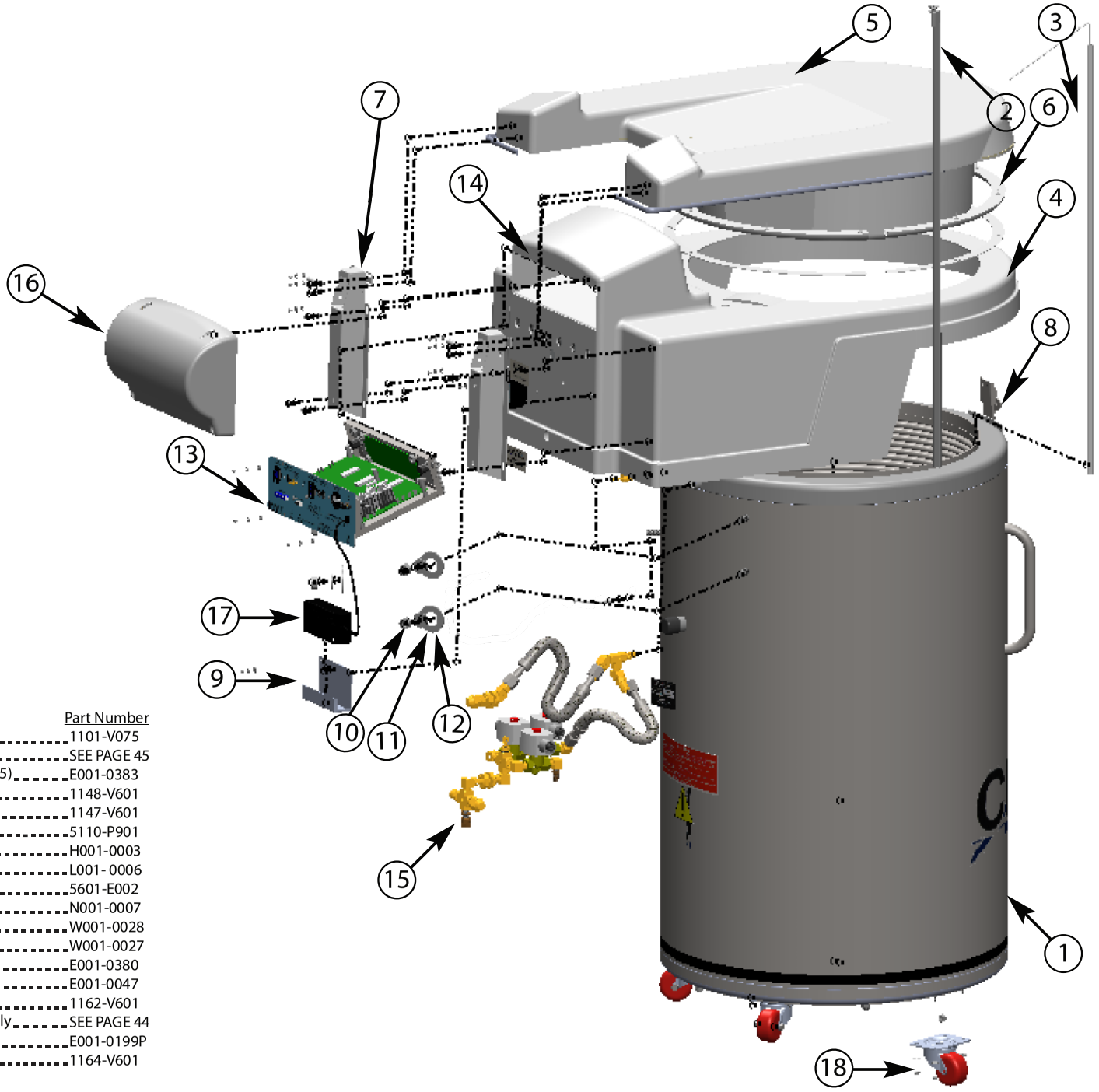
Description	Part Number
1) 8-Caster 18" Rollerbase White (with electronics)	2124-A901
2) S-90 Tank	1201-L044
3) S-90 Lid Assembly	1211-L601
4) S-90 Probe Holder (SEE PAGE 45)	1229-L601
5) S-90 Overflow Assembly	SEE PAGE 45
6)Plumbing Assembly (SEE PAGE 35)	1162-V601
7) 2301 Controller (SEE PAGE 37)	E001-0380
8A) Mounting Strap For S-90AT/Autofill With Temp. Alarm	1205-L901
8B) Mounting Strap For S-90A/Autofill Only	1206-L901
9) S-90 Console Assembly	1228-L601

S-1500 Series Tank Diagram Part I.D.



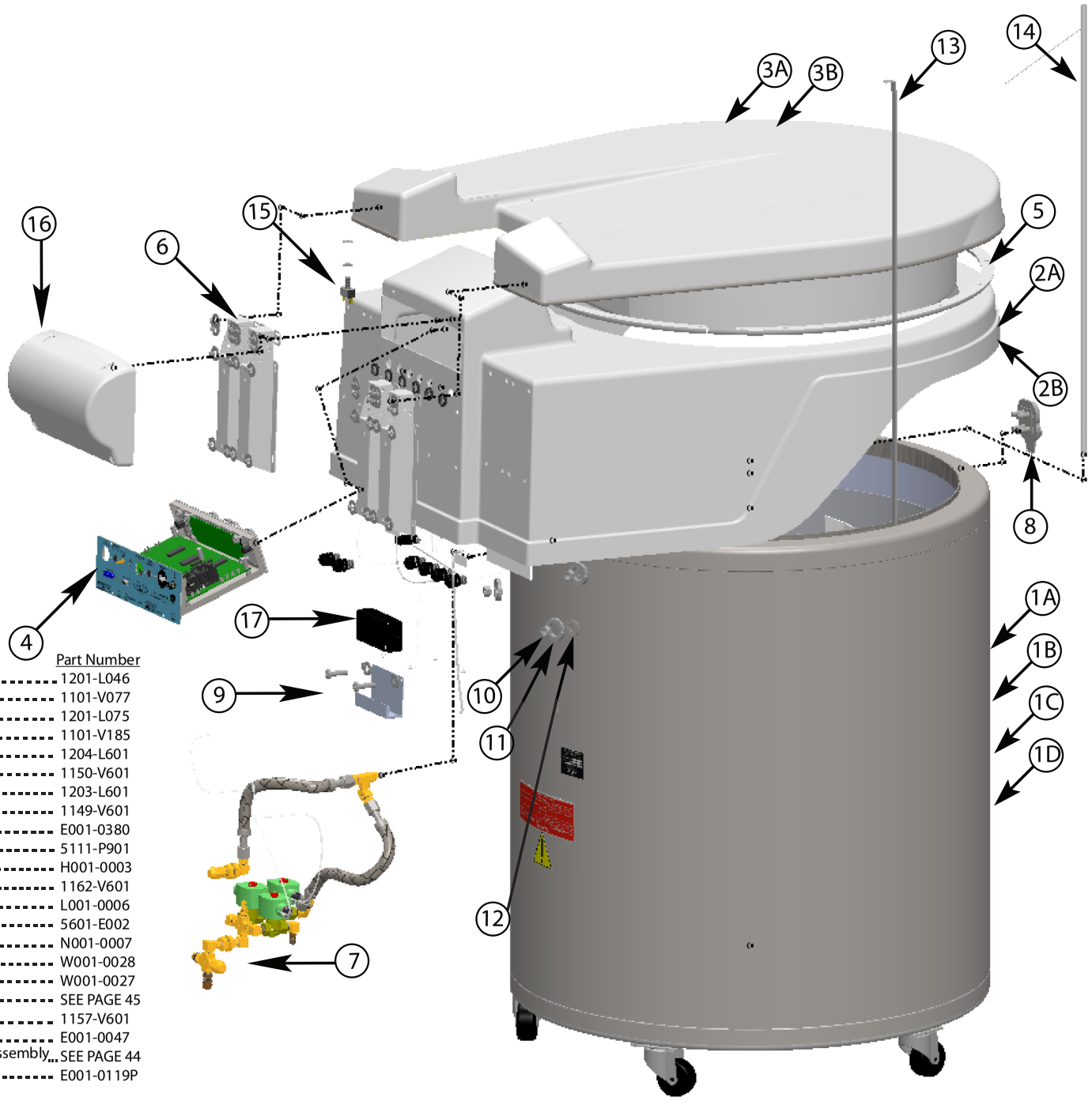
Description	Part Number
1) S-1500AB	1201-L045
2) Probe Holder Assembly	SEE PAGE 45
3) Overflow Tube Assembly	SEE PAGE 45
4) S-1500 Console Assembly	1202-L601
5) S-1500 Lid Assembly	1201-L601
6A) S-1500 Gasket Assembly Front	1213-L601
6B) S-1500 Gasket Assembly Rear	1214-L601
7) S-1500 Hinge Assembly	H001-0003
8) Lid Latch Assembly	L001- 0006
9) Power Supply Bracket Assembly	5601-E002
10) 1/2" SS Nut	N001-0007
11) 1/2" SS Fender Washer	W001-0028
12) 1/2" S.S. Flat Washer	W001-0027
13) 2301 Controller (SEE PAGE 37)	E001-0380
14) Lid Limit Switch Assembly	E001-0047
15) S-1500 Plumbing Assembly (SEE PAGE 35)	1162-V601
16) 24V Power Supply	E001-0199P
17) 2 1/2" Red Poly Swivel Caster Assembly	1164-V601
18) Metal Back Plate	1201-L047

V-1500 Tank Diagram Part I.D.



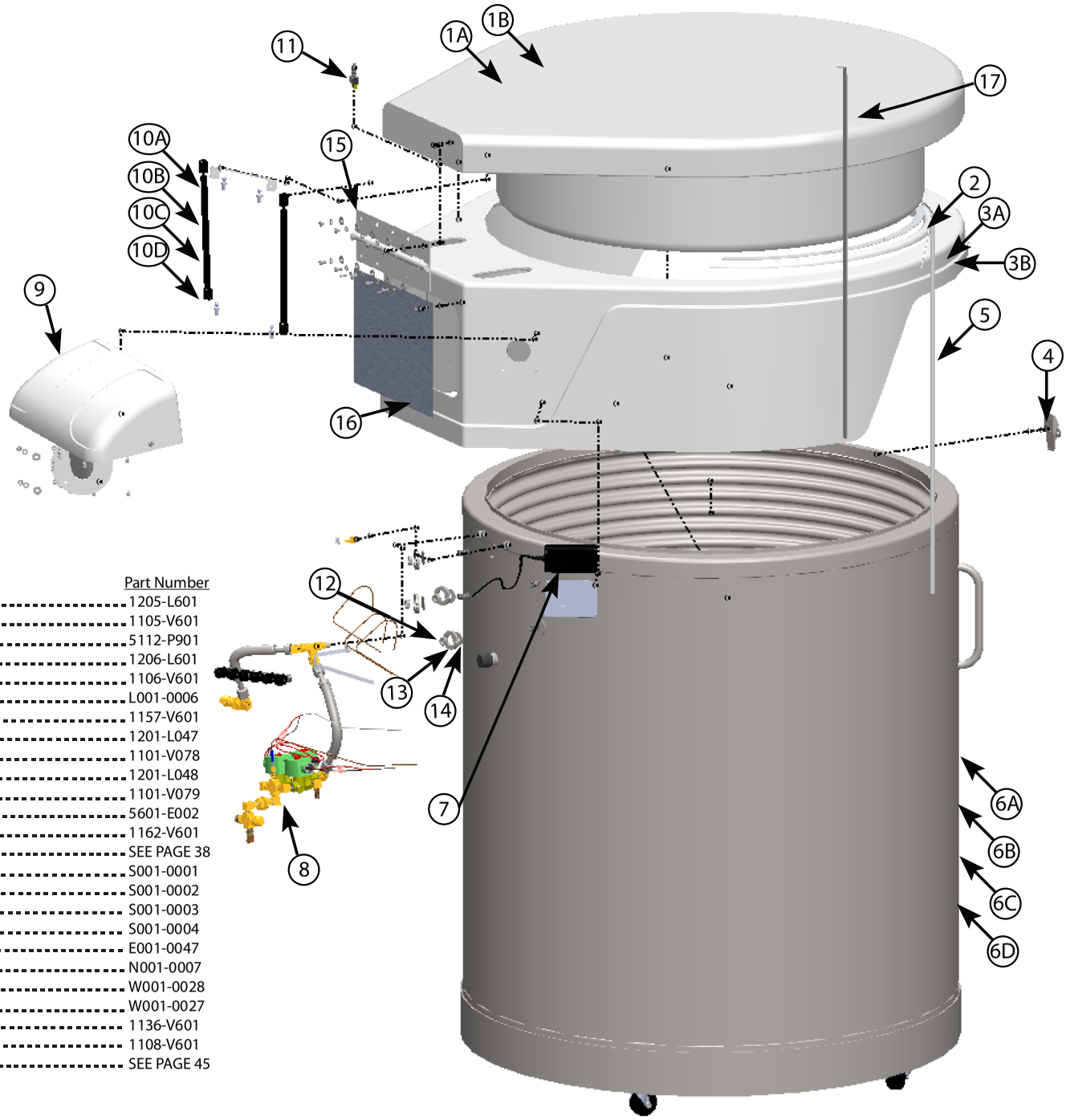
Description	Part Number
1) V-1500AB	1101-V075
2) Probe Holder Assembly	SEE PAGE 45
3) Optional LN2 Overflow Sensor (SEE PAGE 45)	E001-0383
4) V-1500 RTM Console Assembly	1148-V601
5) V-1500 RTM Lid Assembly	1147-V601
6) V-1500 Gasket Assembly	5110-P901
7) Hinge Assembly (SEE PAGE 44)	H001-0003
8) Lid Latch Assembly	L001- 0006
9) Power Supply Bracket Assembly	5601-E002
10) 1/2" SS Nut	N001-0007
11) 1/2" SS Fender Washer	W001-0028
12) 1/2" S.S. Flat Washer	W001-0027
13) 2301 Controller (SEE PAGE 37)	E001-0380
14) Lid Limit Switch Assembly	E001-0047
15) Plumbing Assembly (SEE PAGE 35)	1162-V601
16) Rear Controller Service Cover RTM Assembly	SEE PAGE 44
17) 24V Power Supply	E001-0199P
18) 2 1/2" Red Poly Swivel Caster Assembly	1164-V601

3000 Tank Diagram Part I.D.



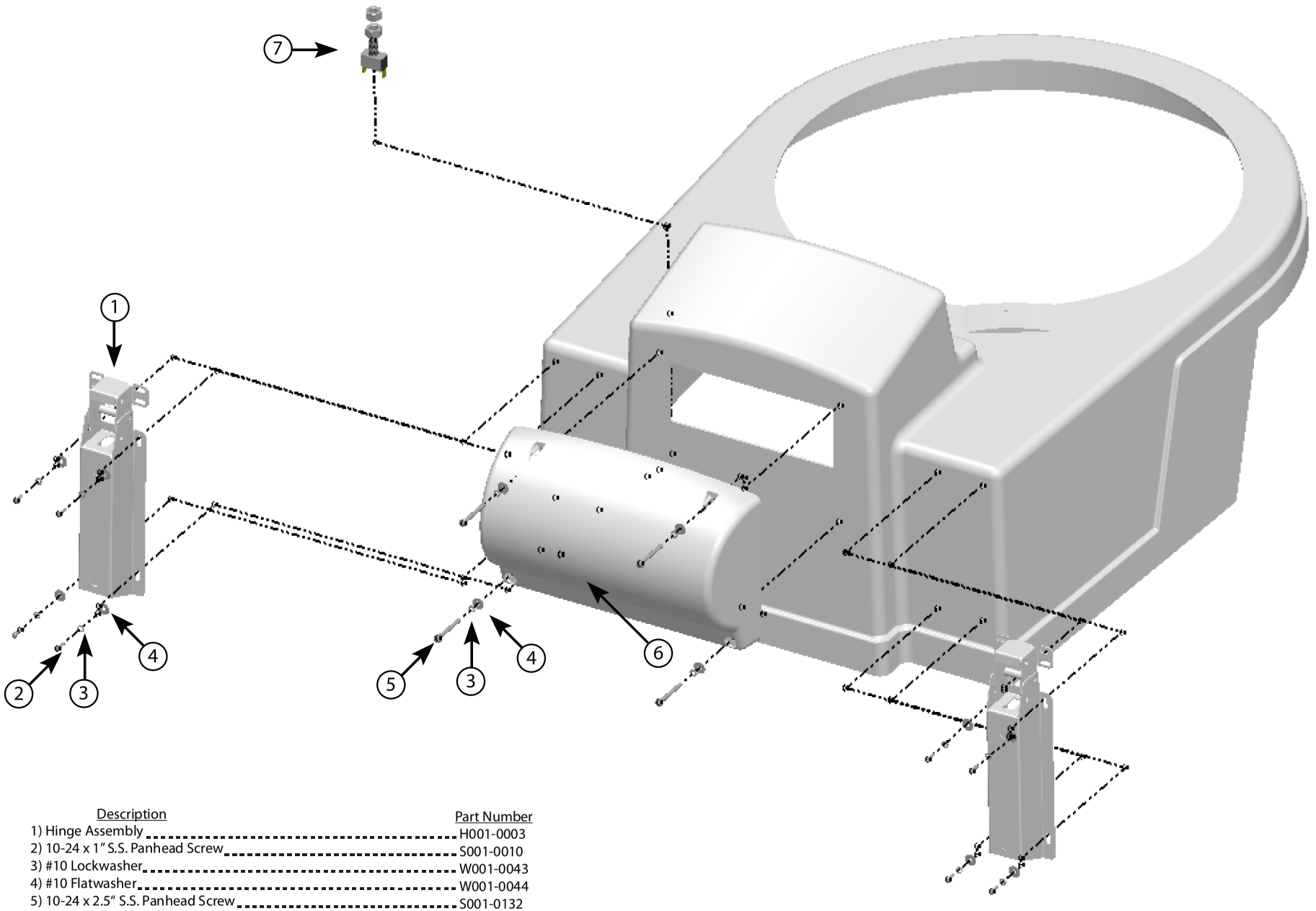
Description	Part Number
1A) S-3000 Tank	1201-L046
1B) V-3000 Tank	1101-V077
1C) S-3000EH Tank	1201-L075
1D) V-3000EH Tank	1101-V185
2A) S-3000 RTM Console Assembly	1204-L601
2B) V-3000 RTM Console Assembly	1150-V601
3A) S-3000 RTM Lid Assembly	1203-L601
3B) V-3000 RTM Lid Assembly	1149-V601
4) 2301 Controller (SEE PAGE 37)	E001-0380
5) 3000 Gasket Assembly	5111-P901
6) 3000 Hinge Assembly (SEE PAGE 44)	H001-0003
7) 3000 Plumbing Assembly (SEE PAGE 35)	1162-V601
8) Lid Latch Assembly	L001-0006
9) Power Supply Bracket Assembly	5601-E002
10) 1/2" S.S. Nut	N001-0007
11) 1/2" S.S. Lock Washer	W001-0028
12) 1/2" S.S. Fender Washer	W001-0027
13) Probe Holder Assembly	SEE PAGE 45
14) Optional LN2 Overflow Sensor (SEE PAGE 45)	1157-V601
15) Lid Limit Switch Assembly	E001-0047
16) V-Series Rear Controller Service Cover RTM Assembly	SEE PAGE 44
17) 24V Power Supply	E001-0119P

5000 & 5000EH Tank Diagram Part I.D.



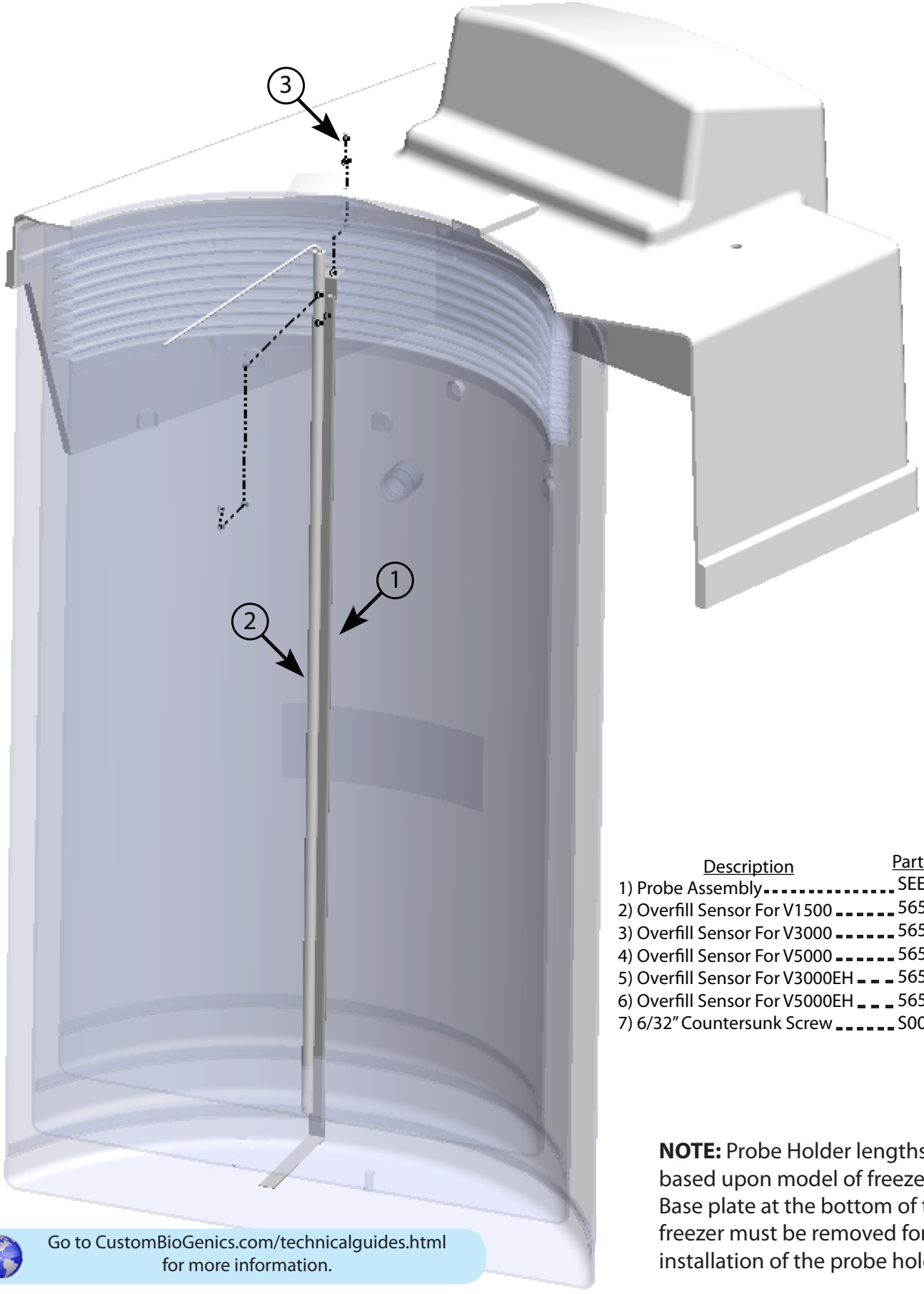
Description	Part Number
1A) S-5000 Lid Assembly	1205-L601
1B) V-5000 Lid Assembly	1105-V601
2) 5000 Gasket Assembly	5112-P901
3A) S-5000 Console	1206-L601
3B) V-5000 Console	1106-V601
4) Lid Latch Assembly	L001-0006
5) Optional LN2 Overflow Sensor (SEE PAGE 45)	1157-V601
6A) S-5000 Tank	1201-L047
6B) V-5000 Tank	1101-V078
6C) S-5000EH Tank	1201-L048
6D) V-5000EH Tank	1101-V079
7) Power Supply Bracket Assembly	5601-E002
8) Plumbing Assembly (SEE PAGE 35)	1162-V601
9) 5000 2301 Controller Assembly	SEE PAGE 38
10A) 50 LB Piston Support	S001-0001
10B) 60 LB Piston Support	S001-0002
10C) 80 LB Piston Support	S001-0003
10D) 90 LB Piston Support	S001-0004
11) Lid Limit Switch Assembly	E001-0047
12) 1/2" Nut	N001-0007
13) 1-2" Lock Washer	W001-0028
14) 1/2" Fender Washer	W001-0027
15) V-5000 Hinge	1136-V601
16) V-5000/S-5000 Back Panel	1108-V601
17) Probe Assembly	SEE PAGE 45

Console and Rear Service Cover Assembly



Description	Part Number
1) Hinge Assembly	H001-0003
2) 10-24 x 1" S.S. Panhead Screw	S001-0010
3) #10 Lockwasher	W001-0043
4) #10 Flatwasher	W001-0044
5) 10-24 x 2.5" S.S. Panhead Screw	S001-0132
6) Rear Controller Service Cover RTM Assembly	1151-V601
7) Lid Limit Switch Assembly	E001-0047

Probe Assembly Diagram Part I.D.



Description	Part Number
1) Probe Assembly	SEE NOTE
2) Overfill Sensor For V1500	5651-E601
3) Overfill Sensor For V3000	5652-E601
4) Overfill Sensor For V5000	5654-E601
5) Overfill Sensor For V3000EH	5653-E601
6) Overfill Sensor For V5000EH	5655-E601
7) 6/32" Countersunk Screw	S001-0113

NOTE: Probe Holder lengths vary based upon model of freezer. Base plate at the bottom of the freezer must be removed for installation of the probe holder.

Go to CustomBioGenics.com/technicalguides.html for more information.

CLEANING & MAINTENANCE

Cleaning Exterior:

To clean the exterior use a mild, non-abrasive household type cleaner mixed with warm water. Apply by using a damp cloth that you soaked in the cleaning solution and wrung out. Do not expose LCD Display to liquids as this may cause damage.

Sanitizing and Decontamination of Interior:

When sanitizing the interior, a mixture of 30% chlorine bleach with 70% water solution is considered the best method for decontamination. However, any household detergent or mild soap solution is suitable and can be used. This includes bleach, detergents, and mild soaps. Other cleaners and disinfectants that can be safely used include hydrogen peroxide, and denatured alcohol. NOTE: DO NOT USE ANY PETROLEUM BASED CLEANING SOLUTIONS.

To perform this sanitizing procedure, cover all inner surfaces with the solution, let stand for 30 minutes and remove. Spraying the solution into the inner vessel is preferred, although agitation of the solution inside the inner will suffice. Rinse the decontaminated surfaces with clean water and make sure all cleaner residues have been removed. Allow the tank to dry completely before putting back into service.

If you have any questions concerning decontamination process please contact Custom BioGenic Systems Technical Support 1-800-523-0072.

System Check

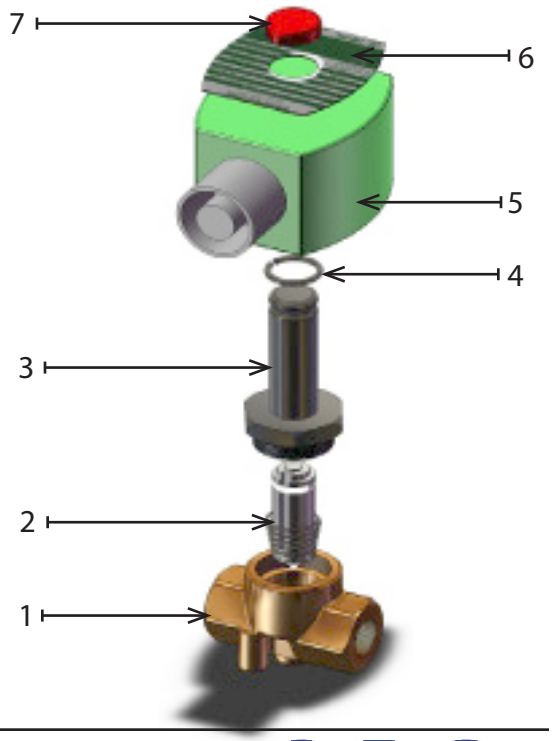
1. Test all alarm functions for proper operation.
2. Check any connected Remote Alarms or Automatic Dialing Systems to ensure proper operation. See page 26 for detailed instructions on how to manually cause a HIGH ALARM or LOW ALARM to test the remote alarm contacts.
3. Check for leaks at all connection points of the liquid nitrogen lines.
4. Be sure that all electrical wires are free of damage and plugs are firmly in place.

SOLENOID VALVE MAINTENANCE

IMPORTANT: This should be done ***only as required,*** and is not a necessary part of maintenance.
Solenoid valve(s) may be opened to inspect for cleanliness and to check seals for wear.
Wipe seals with a clean, lint-free cloth. Distilled ammonia may be used to wipe seals if needed.

The solenoid valves may be opened and cleaned if they are not working smoothly. If this is done, use the diagram below to re-assemble the valves properly. (NOTE: If the valve is found to be defective, the entire valve must be replaced, individual parts are not available).

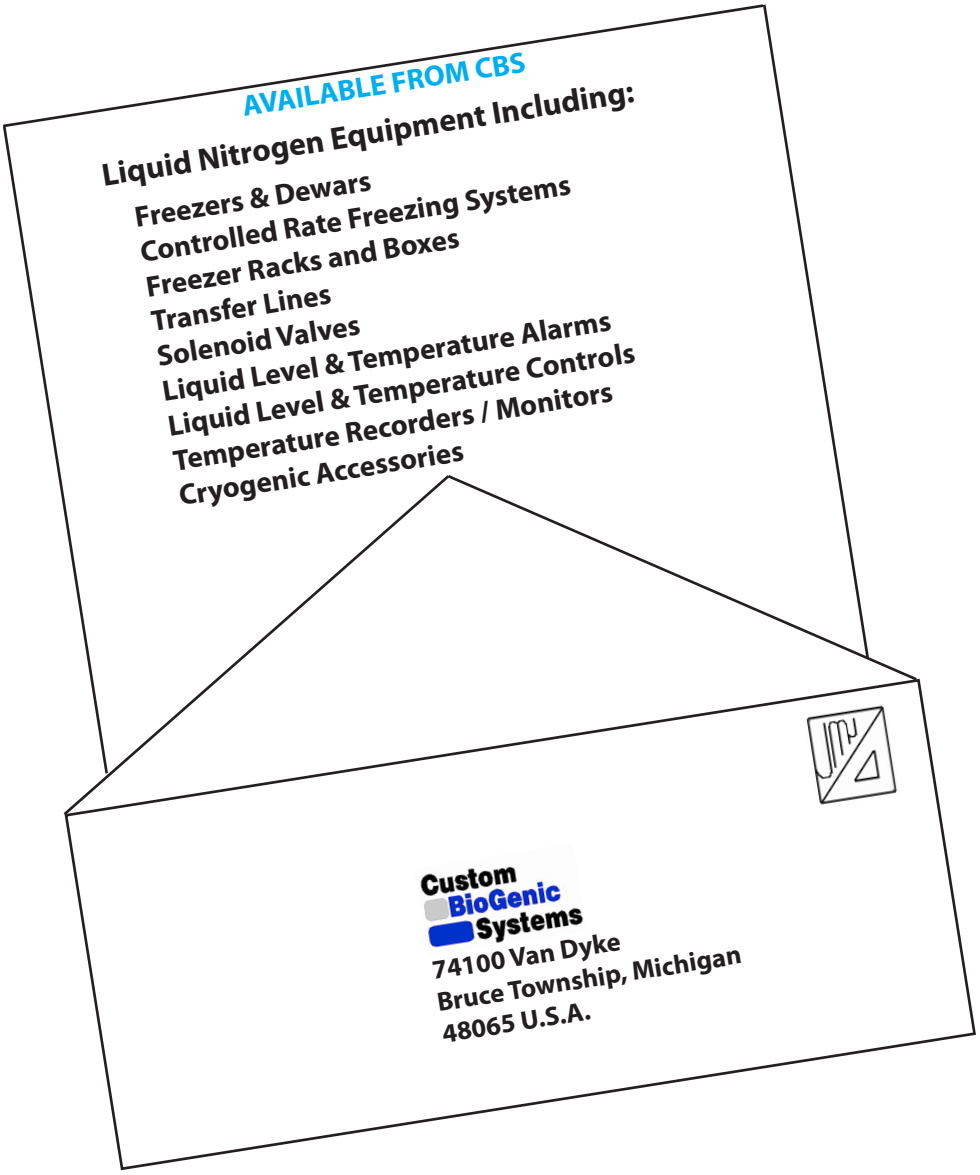
1. Valve Body
2. Plunger
3. Flange
4. Valve Coil Locknut
5. Coil
6. Spec. Plate
7. Valve Cap



Guidance and manufacturer's declaration – electromagnetic immunity			
The CBS family of large LN2 freezers including the V1500-AB, S1500-AB, V3000-AB, V3000EH-AB, V3000-AB/C, V3000EH-AB/C, S3000-AB, V5000-AB, V5000-AB, V5000-EH-AB, S5000-AB, S5000EH-AB, V5000-AB/C, V5000EH-AB/C are intended for use in the electromagnetic environment specified below. The customer and user of these products should assure that they are used in such an environment.			
Immunity test	**IEC60601 test level**	**Compliance level**	**Electromagnetic environment – guidance**
Electrostatic discharge (ESD) IEC 61000-4-2	±6kV Contact ±8kV Air	Complies	Floors should be wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%
Radiated RF IEC 61000-4-3	3 V/m 80MHz to 2.5GHz	Complies	Field strengths outside the shielded location from fixed RF transmitters, as determined by an electromagnetic sit survey, should be less than 3 V/m. Interference may occur in the vicinity of equipment marked with the following symbol: 
Conducted RF IEC 61000-4-6	3Vrms 150kHz to 80MHz		
Electrical fast transient IEC 61000-4-4	±2kV power line ±1kV I/O lines		Main power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±1kV differential ±2kV common		
Power frequency magnetic field IEC 61000-4-8			Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
Voltage dips, short interrupts and voltage variations on power supply input lines IEC 61000-4-11	>95% dip 0.5 cycle 60% dip 5 cycles 70% dip 25 cycles 95% dip 5 sec.		Main power quality should be that of a typical commercial or hospital environment. If the user of the Cryo Freezer requires continued operation during power mains interruptions, it is recommended that the Cryo Freezer be powered from an uninterruptible power supply or battery.

Guidance and manufacturer's declaration – electromagnetic emissions		
The CBS family of large LN2 freezers including the V1500-AB, S1500-AB, V3000-AB, V3000EH-AB, V3000-AB/C, V3000EH-AB/C, S3000-AB, V5000-AB, V5000-AB, V5000-EH-AB, S5000-AB, S5000EH-AB, V5000-AB/C, V5000EH-AB/C are intended for use in the electromagnetic environment specified below. The customer and user of these products should assure that they are used in such an environment.		
Emissions Test	**Compliance**	**Electromagnetic environment – guidance**
RF Emissions CISPR 11	Group 1	The Cryo freezer uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF Emissions CISPR 11	Class A	The Cryo freezer is suitable for use in all establishments other than domestic, and may be used in domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes, provided the following warning is heeded: **Warning:** This equipment/system is intended for use by healthcare professionals only. This equipment/ system may cause radio interference or may disrupt the operation of nearby equipment. It may be necessary to take mitigation measures, such as re-orienting or relocating the Cryo freezer or shielding the location.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations / flicker emissions	Complies	

NOTES



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