

HX-540 Recirculating Chiller

Thermo NESLAB P/N U00292
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Instruction and Operation Manual



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WARRANTY

HX-540 Quick Reference Operating Procedures

Installation

Position the unit in a clean environment with easy access to facility cooling water and a drain. The facility water requirements must meet those specified in the instruction manual or unit performance will be derated. Inadequate water supply could cause the compressor to overheat and turn the unit off.

Ensure the voltage of the power source meets the specified voltage, $\pm 10\%$.

The plumbing connections are located on the rear of the unit and are labelled FACILITY WATER INLET and OUTLET, and RECIRCULATING FLUID INLET and OUTLET. Remove the plastic protective plugs from all the plumbing connections. Connect the FACILITY WATER INLET fitting to the facility cooling water and the FACILITY WATER OUTLET fitting to a drain. Connect the RECIRCULATING FLUID INLET fitting to the outlet of your application and the RECIRCULATING FLUID OUTLET fitting to the inlet of your application.

A non-freezing fluid is required for operation at any recirculating or ambient temperatures. The selected fluid must have a viscosity of 50 centistokes or less at the lowest operating temperature.

To fill the reservoir open the access panel on the left rear corner of the case top and remove the reservoir cover by unscrewing the thumbscrews. Fill the reservoir to within two inches of the top when the unit is at the desired operating temperature. If the fluid capacity of your application and recirculation lines are significant, have extra fluid on hand.

Operation

Before starting the unit, ensure the compressor mounting nuts have been loosened and that the facility water is on and properly connected to the unit. Double check all electrical and plumbing connections. Make sure the circulating system has been filled with cooling fluid.

Verify/configure the control transformer position in the power enclosure. Switch on all the enclosure's circuit breakers. Close and latch the enclosure's door.

The unit must be connected to the power source for at least 12 hours to allow the oil to be heated and separated from the refrigerant.

Switch on the main circuit breaker (1CB), press the START button, and then press the ON button located on the controller.

The LEDs on the controller indicate the status of the refrigeration system. Cool is on when the unit is removing heat from the cooling fluid. As the operating temperature approaches the setpoint, the Cool LEDs cycles.

To display the temperature setpoint, while in the Operator's Loop press and NEXT key. To adjust the temperature setpoint use the YES/NO keys as described in this manual.

Flow Control

The RECIRCULATING FLOW CONTROL handle controls the flow rate to your application. In the "+" position you receive full flow, the "-" position is no flow.

Periodic Maintenance

Periodically inspect the reservoir fluid. If cleaning is necessary, flush the reservoir with a cleaning fluid compatible with the circulating system and the cooling fluid.

The cooling fluid should be replaced periodically. When operating at low temperatures, the concentration of water in the cooling fluid will increase over time, leading to a loss of cooling capacity.

The unit has a pump strainer. If debris is in the system, the strainer will prevent the material from being drawn into the pump and damaging the pump vanes.

After initial installation, the strainer may become clogged. The strainer must be cleaned after the first week of installation. After this first cleaning, a monthly visual inspection is recommended. After several months, the frequency of cleaning will be established.

Before cleaning the strainer, disconnect the power cord from the power source and drain the reservoir.

Preface

Compliance Products tested and found to be in compliance with the requirements defined in the EMC standards defined by 89/336/EEC as well as Low Voltage Directive (LVD) 73/23/EEC can be identified by the CE label on the rear of the unit. The testing has demonstrated compliance with the following directives:

LVD, 73/23/EEC	Complies with UL 3101-1:93
EMC, 89/336/EEC	EN 55011, Class A Verification
	EN 50082-1:1992
	IEC 1000-4-2:1995
	IEC 1000-4-3:1994
	IEC 1000-4-4:1995

For any additional information refer to the Letter of Compliance that shipped with the unit (Declaration of Conformity).

Unpacking Retain all cartons and packing material until the unit is operated and found to be in good condition. If the unit shows external or internal damage, or does not operate properly, contact the transportation company and file a damage claim. Under ICC regulations, this is your responsibility.

Warranty Units have a warranty against defective parts and workmanship for one full year from date of shipment. See back page for more details.

NES-care Extended Warranty Contract

- Extend parts and labor coverage for an additional year.
- Worry-free operation.
- Control service costs.
- Eliminate the need to generate repair orders.
- No unexpected repair costs.

Other contract options are available. Please contact Thermo NESLAB for more information.

After-sale Support

Thermo NESLAB is committed to customer service both during and after the sale. If you have questions concerning the operation of your unit or the information in this manual, contact our Sales Department. If your unit fails to operate properly or if you have questions concerning spare parts or Service Contracts, contact our Service Department.

Before calling, *please* refer to the serial number label on the rear of the case top to obtain the following information:

- *BOM number* _____

- *Serial number* _____

- *Software version (see page 46)* _____

Section I Safety

Warnings

Make sure you read and understand all the instructions and safety precautions listed in this manual before installing or operating your unit. If you have any questions concerning the operation of your unit or the information in this manual, contact our Sales Department (see Preface, After-sale Support).

Performance of installation, operation, or maintenance procedures other than those described in this manual may result in a hazardous situation and may void the manufacturer's warranty.

Transport the unit with care. Sudden jolts or drops can damage the refrigeration lines.

Observe all warning labels.

Never remove warning labels.

Never operate damaged or leaking equipment.

Always disconnect the line cord from the power source before performing any maintenance procedures, or before moving the unit.

Never operate equipment with damaged line cords.

Refer service and repairs to a qualified Thermo NESLAB technician.



In addition to the safety warnings listed above, warnings are posted throughout the manual. These warnings are designated by an exclamation mark inside an equilateral triangle with text highlighted in bold print. Read and follow these important instruction. Failure to observe these instruction can result in permanent damage to the unit, significant property damage, or personal injury or death.

Section II General Information

Description

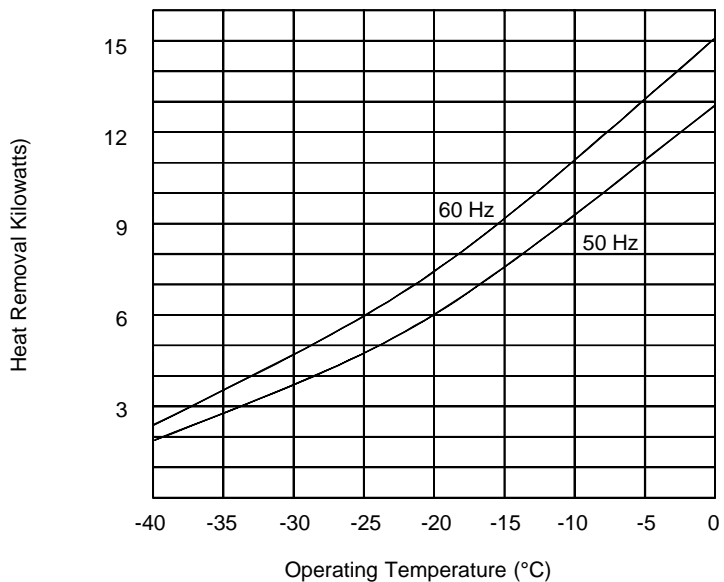
The HX-540 Recirculating Chiller is designed to provide a continuous flow of cooling fluid at a constant temperature and pressure.

The unit consists of a water-cooled refrigeration system, stainless steel reservoir, recirculating pump, and a microprocessor controller.

An important characteristic of the unit is its ability to track a set temperature virtually independent of changing heat loads. Once the desired operating temperature is set, the operating temperature will not shift more than a few tenths of a degree.

Specifications

Cooling Capacity¹



Temperature Range

-40°C to +25°C

Temperature Stability

± 0.5°C

Fluid Capacity²

Gallons

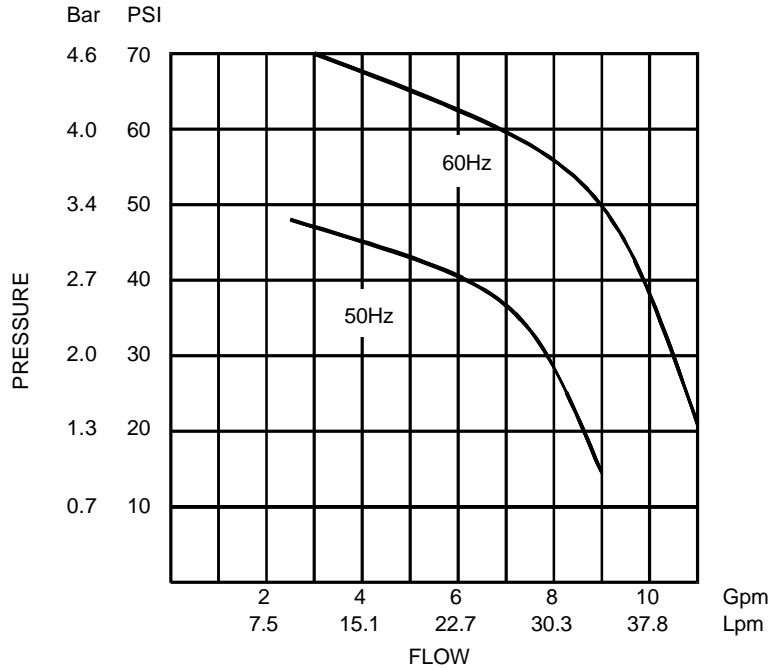
5

Liters

19

1. Specific heat of cooling fluid is 0.6 BTU/lb°F.
2. Total fluid volume of the reservoir, exchanger, and all internal plumbing lines.

Pump Capacity³



Dimension⁴

(H x W x D)

Inches

Centimeters

44 x 34 x 25.5
111.8 x 86.3 x 64.7

Weight

Pounds

Kilograms

915

415

3. Specific gravity is 0.5.

4. Add 9 inches (22.9 cm) to depth for electrical enclosure.

Section III Installation

Site

The unit is designed for indoor operation in a laboratory or clean industrial environment. Ambient temperatures should be in the range of +50°F to +100°F (+10°C to +38°C).

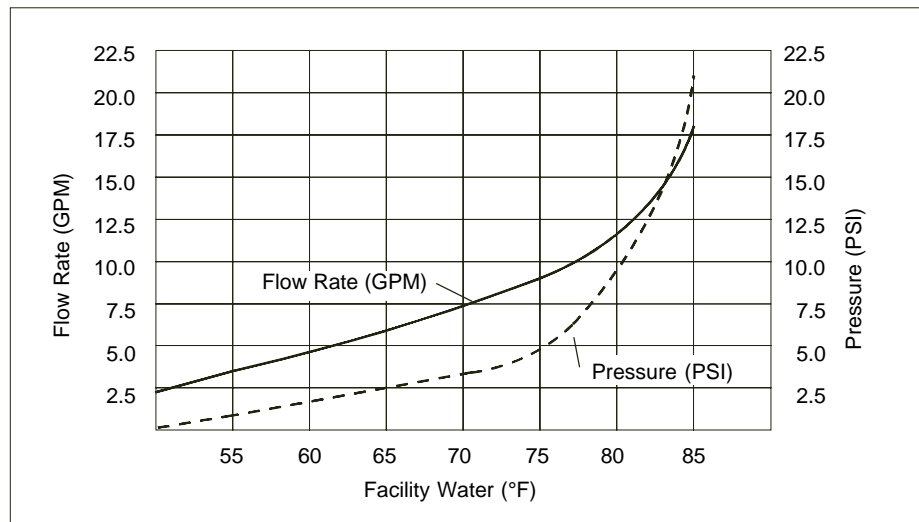


Never install the unit in a location where excessive heat, moisture, or corrosive materials are present.

The unit has a water-cooled refrigeration system. It should be placed in a location with easy access to a facility water source and a drain.

Facility Water Requirements

The facility water must meet or exceed the following requirements for the unit to retain its full rated capacity. If the facility water does not meet these standards, the cooling capacity will be reduced.



The unit has a water regulating valve located in the FACILITY WATER INLET line. The valve regulates the flow rate of the facility water that passes through the heat exchanger based on the heat load. Flow through the heat exchanger is stopped when the unit turned off. If the facility water temperature or pressure do not meet the specified requirements, contact our Service Department for assistance.

Electrical Requirements

Refer to the serial number label on the rear of the unit to identify the specific electrical requirements of your unit.

Ensure the voltage of the power source meets the specified voltage, $\pm 10\%$.



All power connections should be made by a qualified electrician.

The facility power source connection is the main 20A circuit breaker (1CB) plus a ground connection. It will operate on a Delta or Wye system, a neutral connection is not required. Ensure an adequate ground connection is provided. Use the ground bar located in the power enclosure as a facility power source ground.

The facility power source connection may be made by removing the panel located on the lower right power enclosure. Use a knockout and the appropriate size conduit fitting for your facility power source requirements.

The unit has an automatic compressor crankcase heater. The crankcase heater warms the oil in the compressor and prevents refrigerant and oil from mixing. Before initial start up, or after storage, the unit should be connected to the power source for at least 12 hours before turning the unit on. This will allow time for the crankcase oil to be heated and the refrigerant to separate from the oil.

Ensure the main 20A circuit breaker (1CB) and the crank case heater (4CB) are on during this 12-hour period. Refer to the unit's wiring diagram for complete details.

NOTE: Some units are equipped with a disconnect power receptacle, IEC 309 plug, and a line cord. Use the appropriate facility power source interface where applicable.

The HX-540 Recirculating Chiller is a three phase unit. The unit is equipped with a phase rotation interlock. This interlock prevents the unit from starting if the phase rotation is wrong. If the unit will not start, see Section VI, Troubleshooting. If the options in the checklist are not applicable, the problem may be phase rotation.



For personal safety and equipment reliability, the following procedure should only be performed by a qualified technician.



For phase reversal, disconnect the unit from the power source. Shut off the main 20A circuit breaker (1CB) and open the power enclosure. Reverse any two line cord leads on the line side of 1CB.



Never remove the green ground wire.

If the unit will not start, contact our Customer Service Department.

Facility Power Source Configuration

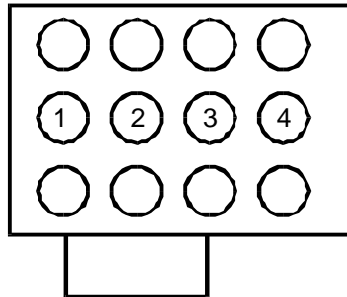
Control transformer (1T) must be configured for the appropriate facility power source. Refer to the drawing below and the label located in the power enclosure for details.

For 50/60 Hertz units the jumper wire will be installed between 1TB-1 and 1TB-2. The unit is shipped in this configuration.



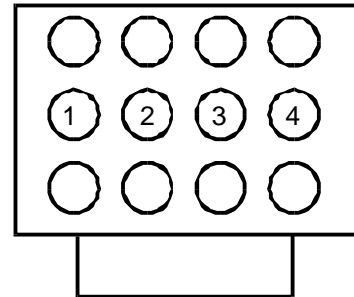
When installing the unit the jumper wire should be installed for the appropriate facility power source.

1TB



FACILITY MAIN VOLTAGE
RANGE: 420V - 480V
CONNECT 1TB-1 TO 1TB-3

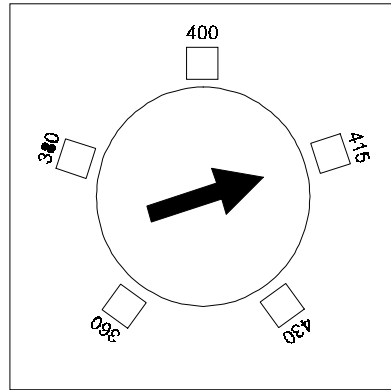
1TB



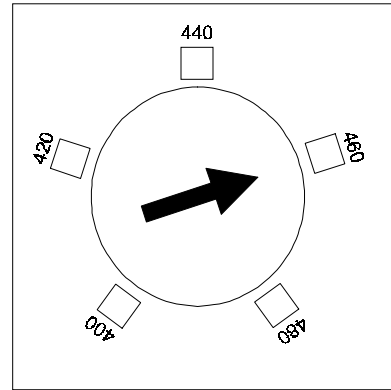
FACILITY MAIN VOLTAGE
RANGE: 360V - 415V
CONNECT 1TB-1 TO 1TB-4

3 Phase Monitor

Check the unit's power requirements on the serial tag located in the power enclosure. For 50 Hertz units the voltage range is 360 - 430 volts. For 60 Hertz the range is 400 - 480 volts. For 50/60 Hertz units there are no voltage adjustment requirements. Set the phase monitor's voltage arrow to the closest nominal facility input voltage. See illustration on next page.



50 Hertz Units



60 Hertz Units

Plumbing Requirements

The plumbing connections are located at the rear of the unit.

The facility water connections are labelled FACILITY WATER INLET and OUTLET. These connections are 1 inch FPT.

The cooling fluid connections are labelled RECIRCULATING FLUID INLET and OUTLET. These connections are $\frac{3}{4}$ inch FPT.

Connect the FACILITY WATER INLET to the facility water source.

Connect the FACILITY WATER OUTLET to the drain.

Connect the RECIRCULATING FLUID INLET to the outlet of the instrument being cooled.

Connect the RECIRCULATING FLUID OUTLET to the inlet of the instrument being cooled.

All tubing should be rated to withstand 100 psi. Make sure all tubing connections are securely clamped. Avoid running lines near radiators, hot water pipes, etc. If substantial lengths of tubing are necessary, insulation may be required to prevent loss of cooling capacity. Tubing and insulation are available from Thermo NESLAB. Contact our Sales Department for information.

Before installing the unit to a instrument that previously used tap water as a cooling fluid, flush the instrument several times to remove any rust or scale that has built up. The manufacturer of the instrument should be able to recommend a cleaning fluid to clean their equipment.

It is important to keep the distance between the unit and the instrument being cooled as short as possible, and to use the largest diameter tubing

practical. Tubing should be straight, without bends or kinks. If reductions must be made, they should be made at the inlet and outlet of the instrument being cooled, not at the HX.

An externally mounted flow meter and temperature readout are required with this unit. These monitors will indicate whether the facility water requirements are being met (see Section III, Facility Water Requirements). It is the users responsibility to provide adequate facility water to the unit.

Both devices should be installed in the FACILITY WATER INLET line.

Fluids



A non-freezing fluid is required for operation at any recirculating or ambient temperature. Use a fluid capable of operating at -60°C without freezing.



Due to the physical nature of a plate heat exchanger, and its response to temperature changes, 100% water must not be used as a circulating fluid. Using 100% water may cause the plate heat exchanger to rupture.



Do not use automotive anti-freeze. Commercial anti-freeze contains silicates that can damage pump seals.



Never use flammable or corrosive fluids with this unit.



Highly distilled and deionized water may be aggressive and cause material corrosion. Please contact Thermo NESLAB before subjecting this unit to prolonged exposure to highly distilled or deionized water.

The selected fluid must have a viscosity of 50 centistokes or less at the lowest operating temperature.

Filling Requirements

The fluid capacity of the connecting tubes and your application may be appreciable. Have extra cooling fluid on hand until the entire system is filled.

Thermal expansion and contraction of the cooling fluid must be taken into account when filling the unit. Lift the hinged access panel on the unit's cover. Loosen the two thumbscrews and remove the reservoir cover.

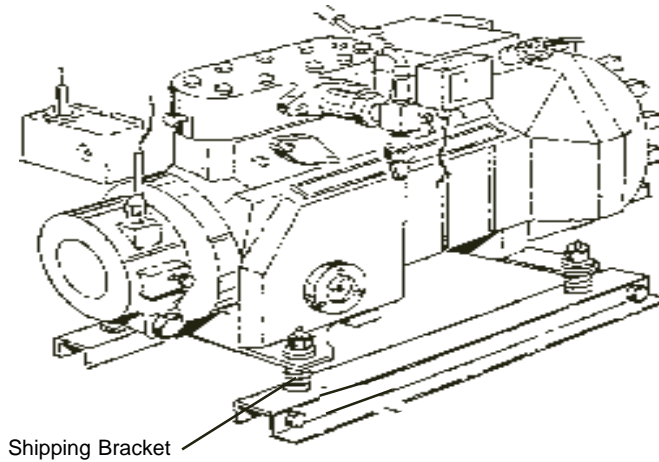
Fill the reservoir with cooling fluid so that the fluid level will be within 2 inches of the top when the unit is at the desired operating temperature.

Replace the reservoir cover. Tighten the thumbscrews. Close the panel.

Pre-Start Up

Remove the two side access panels and the rear access panel (opposite end from the electrical enclosure) to access the compressor area.

Loosen the four compressor mounting nuts. There should be approximately 1/8" clearance between each compression mounting foot and shipping bracket to allow the compressor to "float" on the mounting springs.



Disconnect facility power to the unit. Shut off the main circuit breaker, 1CB, using the handle located on the right side of the power enclosure.

Open the power enclosure, use a flat blade screw driver on the 1/4" fasteners.

Verify and/or configure the unit's control transformer and 3 phase monitor according to the instructions located on the enclosure door or on page 10 of this manual.

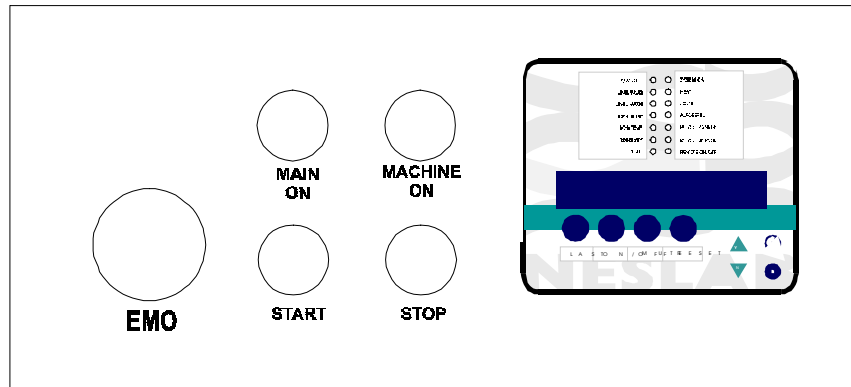
Switch on all circuit breakers located in the power enclosure.

Close the power enclosure door and secure the fasteners.

Provide facility power to the unit and switch on 1CB.

Section IV Operation

Panel Controls



MAIN ON

Indicates facility power is supplied to the unit. Also, the main circuit breaker (1CB) is on, the control circuit breaker (3CB) is on, and the machine on/off circuit breaker (7CB) is on.

MACHINE ON

Indicates the machine control circuit is on.

START

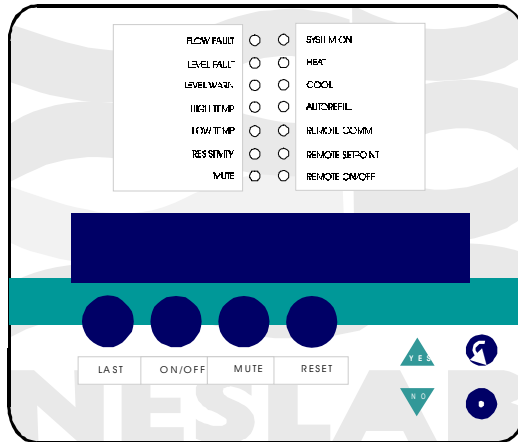
Push to power the machine control circuit. The MACHINE ON indicator will illuminate and the controller will go through a self test. After the self test, the controller will enter a stand-by mode.

STOP

Push to remove power from the machine control circuit. The MACHINE ON indicator will extinguish.

EMERGENCY OFF Button

When pressed, the unit will shut off immediately, bypassing the unit's HG shutdown cycle, see page 22. This button is intended for emergencies only. Do not use it as a normal shut down procedure. The button must be pulled out following an emergency shut down in order to perform the normal start up procedure.



Controller Keypad

The front panel mounted unit/temperature controller allows the operator to start, control and monitor many features of the unit.

LAST

Scrolls backward through the menus and for optional remote operation.

ON/OFF

Energizes/De-energizes process control, pump, compressor, and temperature display.

MUTE

Toggles audible alarm silence function for the current alarm. When alarm is silenced, the MUTE LED lights.

RESET

Clears alarm indications after fault condition has been corrected. Alarm LEDs will remain lit after problem is eliminated to provide indication of problem cause for operator. RESET clears these indicators.

YES, ▲

Answers Yes to Y/N questions, increments numerical values upward for setting numeric values.

NO, ▼

Answers NO to Y/N questions, increments numerical values downward for setting numeric values.

NEXT

Scrolls forward through the menus.

ENTER

Confirms entry of numeric values.

NOTE: If NEXT is pressed while the value still flashes, the new value will not be accepted. The display will stop flashing and the original value will be displayed. In this case the NEXT key can be used to abort data entry. The display will not sequence unless the NEXT key is depressed again.

For large values, the displayed can be changed by manipulating the individual digits. Press YES and NO at the same time, the most significant digit will start to flash. The YES key increments and the NO key decrements the digit. Press the ENTER key to accept the digit and to move to the next most significant digit. Repeat until all digits are entered. Pressing the NEXT key before all digits are entered will abort the procedure and return the display to the original value.

The controller will not allow you to enter a value above the maximum or below the minimum value, or any illegal value. If you try to enter an illegal value the display will revert to its original value when the last digit was entered.

Status Indicators

Units can be configured in one of two ways. Units are designed to either shut down in the case of a fault, Cutout Option (fault condition), or, for those customers willing to take the risk of damage to their unit in order to continue providing all available cooling to their application, a Switches Option (warning condition). Contact our Service Department for more information.

If the Switch Option is chosen, FLOW FAULT, HIGH TEMP, and LOW TEMP **do not** shut down the unit but, they are serious conditions and require immediate attention. Once the cause of the fault is identified and corrected, push the controller's RESET button to clear the flashing indication.

NOTE: LEVEL FAULT shuts the unit down immediately. This fault is independent of the switches/cutout option.

Status indicators are provided to show the state of the various functions.

FLOW FAULT indicates the unit flow is too low. The default is 2 gpm. The unit will shut down in the Cutout mode, but will continue to operate in the Switch mode.

LEVEL FAULT indicates the reservoir level is too low for safe operation. The unit will shut down.

LEVEL WARN indicates the reservoir level is below the float switch mounted in the reservoir. The unit will continue to run. **NOTE:** This indication is operable only on units with autorefill.

HIGH TEMP indicates that the reservoir temperature is above the high temperature limit setpoint. The default is 30°C.

For safety reasons, if the unit is configured for the Cutout Option and the HIGH TEMP is set for a value less than the fluid temperature, **the unit will not start**. If required, set the limit after the unit is started.

Should the reservoir go above the high limit setpoint the unit continues to run in the Switch Option, but shuts down in the Cutout Option.

LOW TEMP indicates that the reservoir temperature is below the low temperature limit setpoint. The default is -45°C.

For safety reasons, if the unit is configured for the Cutout Option and the LOW TEMP is set for a value higher than the fluid temperature, **the unit will not start**. If required, set the limit after the unit is started.

Should the reservoir temperature subsequently go below the low limit setpoint the unit continues to run in the Switch Option, but shuts down in the Cutout Option.

RESISTIVITY (Optional) displays measurement value on the controller and a 0-10VDC signal to the analog interface connector on the rear of the unit.

The controller is designed to measure and/or control resistivity. Should the resistivity go above the specific level set in the Setup Loop (see page 20), a warning will be declared.

MUTE indicates the buzzer has been turned off.

SYSTEM ON indicates unit is running.

HEAT (optional) indicates heat capacity is being added to the reservoir system to maintain constant temperature.

COOL indicates the refrigeration system is removing heat from the reservoir system to maintain constant temperature.

As the fluid temperature approaches the temperature setpoint, the COOL indicator cycles on and off to indicate the duty cycle of the system. The unit can be in COOL or HEAT mode, but never both at the same time. A balance between COOL and HEAT controls the temperature.

AUTOREFILL (optional) depends upon configuration of unit to automatically refill the reservoir.

REMOTE COMM (optional) indicates the unit is configured to receive communication via an optional interface located on the side of the electrical enclosure.

REMOTE SETPT indicates the temperature setpoint is being remotely controlled via the J100 INTERFACE on the side of the electrical enclosure.

REMOTE ON/OFF indicates the unit is configured to receive a remote on/off input signal via the J100 INTERFACE on the side of the electrical enclosure.

Changing a Value

The **YES** key increments the value. The **NO** key decrements the value.

The display will flash as soon as either key is depressed, and will continue to flash until the **ENTER** key is pressed to accept the new value. The new value will not be used by the controller until the **ENTER** key is depressed and the display stops flashing.

If the **NEXT** key is pressed while the value is flashing, the new value will not be accepted. The display will stop flashing and the original value will be displayed. In this case the **NEXT** key can be used to abort data entry. The display will not sequence unless the **NEXT** key is depressed again.

For large values the display can be changed by manipulating the individual digits. Press the **YES** key and the **NO** key at the same time. The most significant digit will start to flash. The **YES** key increments or the **NO** key decrements the digit. Press the **ENTER** key to accept the digit and to move to the next most significant digit. Repeat until all digits are entered. Pressing the **NEXT** key before all digits are entered will abort the procedure and return the display to the original value.

The controller will not allow you to enter a value below the minimum or above the maximum. If you try to enter an illegal value outside the operating range, the display will revert to its original value.

Controller Displays

An alphanumeric display presents numeric readings of various operating conditions within the chiller. Display function is selected by pressing the appropriate keys to move through a menu of available information.

An Operator's Loop and a Setup Loop allow you to display and/or alter different parameters of the controller. The Setup Loop can be accessed from the temperature display by pressing and holding the key combinations shown on Figure 1 on the next page.

When the controller is first powered up it goes through a short self test and then enters the Operator's Loop, displaying the reservoir fluid temperature.

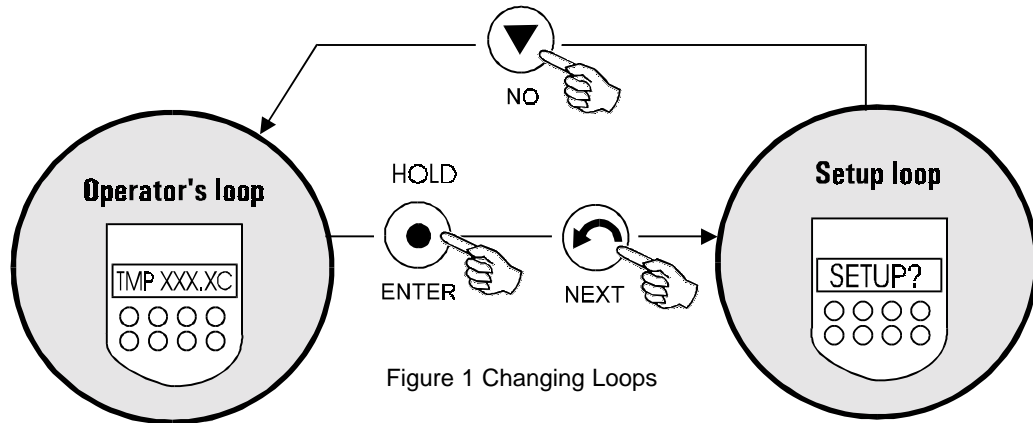


Figure 1 Changing Loops

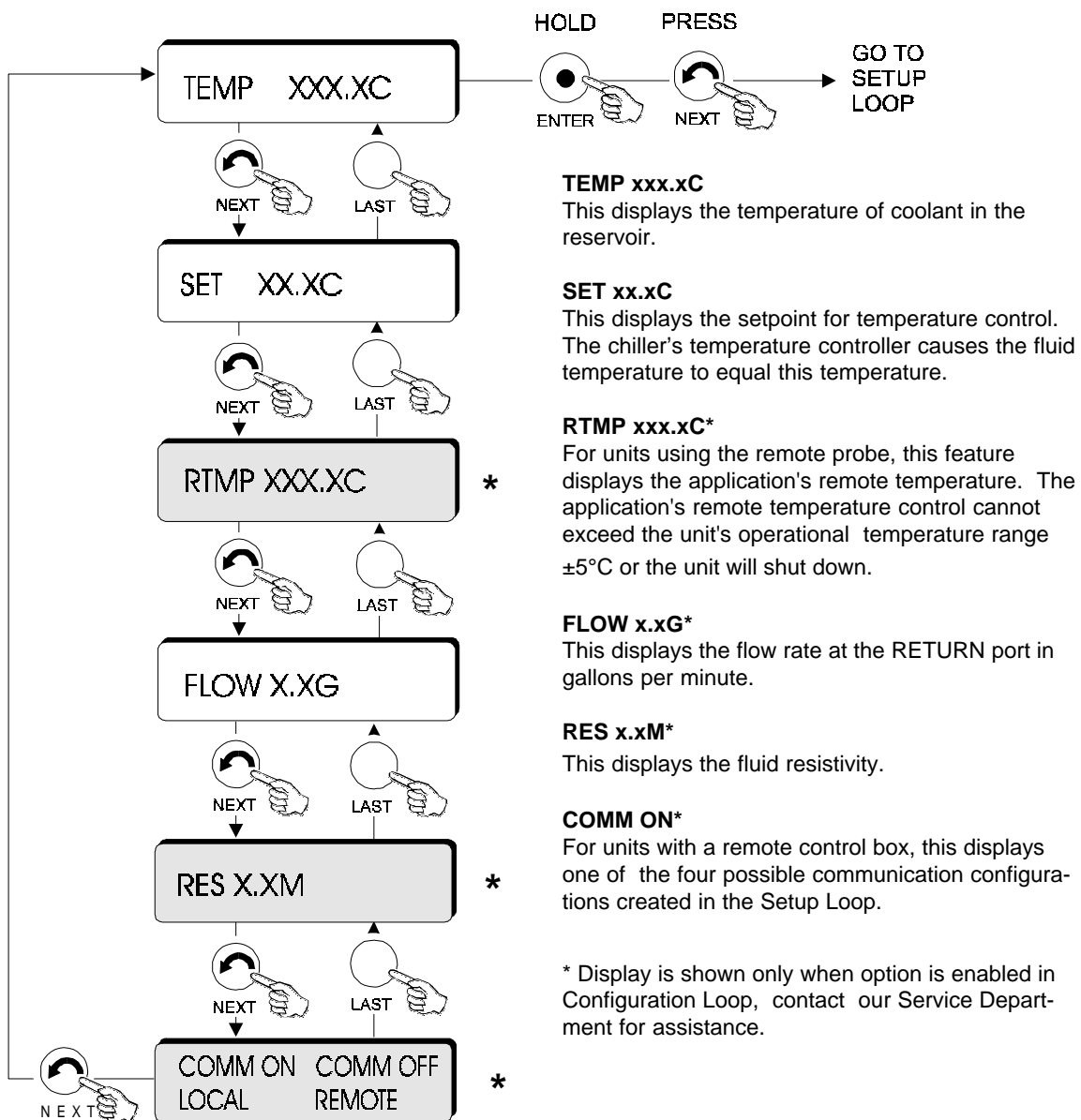


Figure 2 Operator's Loop

Setup Loop

The setup loop allows the operator to change temperature and flow limits, change resistivity limit (optional), to change the temperature controller's tuning constants, and, for units with a remote control box, to change the communication operations.

NOTE: If the unit is configured for the remote operation option, the temperature limits are for the remote probe. For safety reasons, if the unit's fluid reservoir temperature exceeds 5°C of either end of the unit's temperature range, **the unit will shut down.**

To enter this loop you must be in the Operator's Loop and displaying temperature, see Figure 2. Depress and hold the **ENTER** key then press **NEXT**. Adjust values with the **YES** and **NO** keys. Press **ENTER** for the controller to accept each new entry.

NOTE: Changes are not initiated until they are saved at the end of the loop.

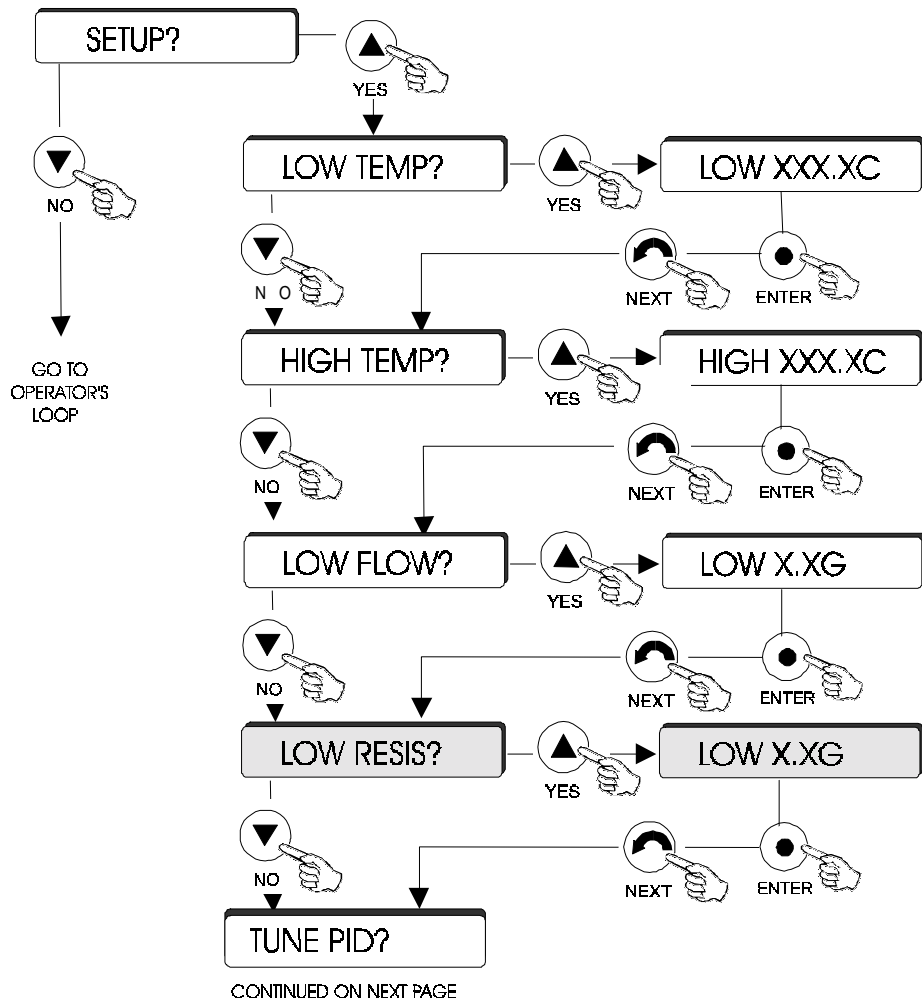


Figure 3 Setup Loop (1 of 2)

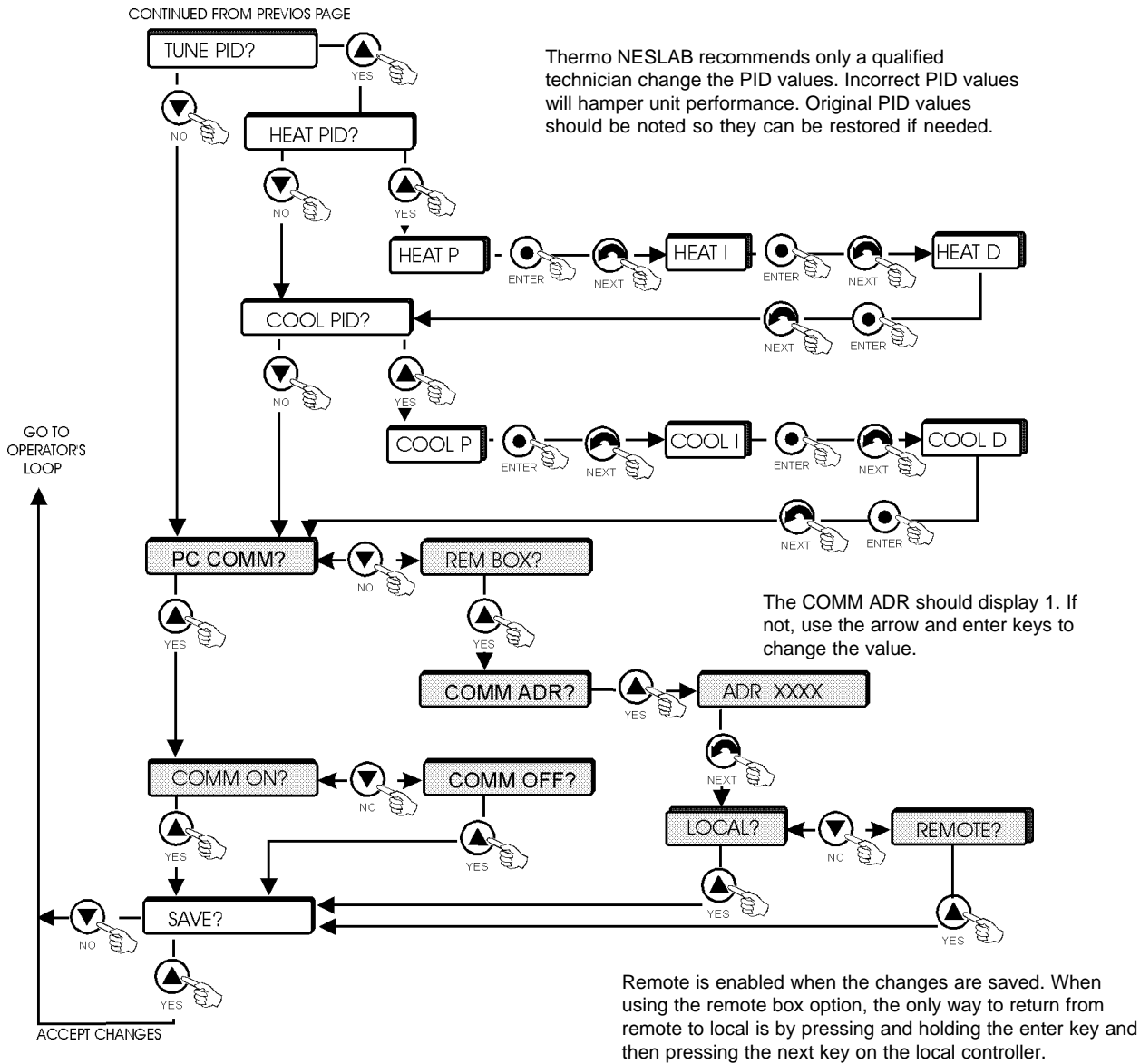


Figure 3 Setup Loop (2 of 2)

NOTE: Should you desire to return to the temperature display and abort *all* changes, keep pressing next until the display reads **SAVE?** Press **NO**.

Start Up



Ensure the facility water is on and make sure the cooling water supply is connected to the TAP WATER connection, not the DRAIN connection.

LOCAL Start Up

Place the LOCAL REMOTE switch to the LOCAL position. Press the ON/OFF key on the temperature controller. The unit will start and the SYSTEM ON indicator will illuminate. The controller will indicate the temperature of the reservoir fluid.

To stop the unit depress the ON/OFF key on the temperature controller.

REMOTE Start Up

Place the LOCAL REMOTE switch to the REMOTE position. This enables the J100 INTERFACE connector located on the side of the electrical enclosure. See Appendix A for details. On the INTERFACE connect pin 1 to pin 14. The unit will start and the SYSTEM ON indicator will illuminate. The controller will indicate the temperature of the reservoir fluid.

To stop the unit disconnect pin 1 from pin 14.

When the unit is shut off, wait approximately five minutes before restarting. This allows time for the refrigeration pressures to equalize. If the pressures are not allowed to equalize, the compressor will short-cycle (clicking sound) and no cooling will occur.

Hot Gas Shut Down Cycle

The Hot Gas (HG) shut down cycle is designed to extend the compressor's life. A shut down cycle allows the compressor and hot gas solenoid valve to continue to run for approximately 30 seconds before the unit shuts down. This additional running time allows the refrigerant in the compressor to be removed and stored.

The following conditions will initiate an HG shut down:

System off from the controller's keypad. **NOTE:** A MACHINE OFF from the panel controls or shutting the unit off using a device (circuit breaker machine off) on the line side of the controller defeats the purpose of the HG cycle and is not recommended. Refer to the unit's wiring diagram.

System off from remote box or serial communications, if applicable.

Refrigeration Shut Down Cycle

The ReFrigeration (RF) shutdown cycle is designed to prevent plate exchanger failure due to ice formation. A shut down cycle allows the compressor and hot gas solenoid valve to continue to run for approximately 30 seconds before the unit shuts down. This additional running time allows the refrigerant to heat the plate exchanger and pump to remove any collected ice.

The following conditions will initiate an RF shut down: Activation of the differential pressure switch.

Flow Control

The flow control handle is located on the right side of the unit. The handle is connected to a valve that controls the flow of fluid to your application. When the handle is in the vertical "+" position, the valve is open and all fluid is supplied to your application. When the handle is in the horizontal "-" position, the valve is closed and no fluid is supplied to your application. When the handle is between these two positions, the flow rate of the fluid is between full flow and no flow. Use a flow meter on the RECIRCULATING FLUID OUTLET to adjust the desired flow rate.

Ensure the flow control handle is in a slightly open position before starting the unit. Once the unit is running, slowly adjust the handle to the desired flow rate. Never start the unit with the handle in the full closed "-" position and never rapidly turn the valve wide open from the closed or slightly open position.

The pressure gauge next to the flow control valve (labelled RECIRCULATING PRESSURE) indicates the operating pressure of the system.

Flow Transducer

A magnetically coupled flow transducer is located in the return line, underneath the unit's top. The flow rate can be displayed on the controller.

High and Low Pressure Switch Cutout

The switches are located in the right, rear of the unit. Remove the rear panel to access the switches.

The high pressure switch monitors the refrigeration pressure on the discharge side of the compressor. In the event of a high pressure fault the compressor will shut down. The compressor will automatically restart once the pressure returns to an acceptable level.

The low pressure switch monitors the refrigeration pressure on the suction side of the compressor. In the event of a low pressure fault the compressor will shut down. The compressor will automatically restart once the pressure returns to an acceptable level.

Differential Pressure Switch Cutout

The switch is located under the top of the unit, below the flow transducer.

The differential pressure switch monitors the pressure differential across the plate exchanger. In the event of an obstruction is present (i.e. ice formation), a fault signal will generate RF shutdown. See Operation for details.

Compressor Oil Pressure Sensing System (Senstronic)

The compressor is equipped with an electronic oil pressure sensing system that monitors the differential pressure between the compressor crankcase and the compressor oil pump. In the event of a fault the compressor will shut down. Once the pressure returns to an acceptable level reset the Senstronic.

Remove the right-lower panel to access the reset.

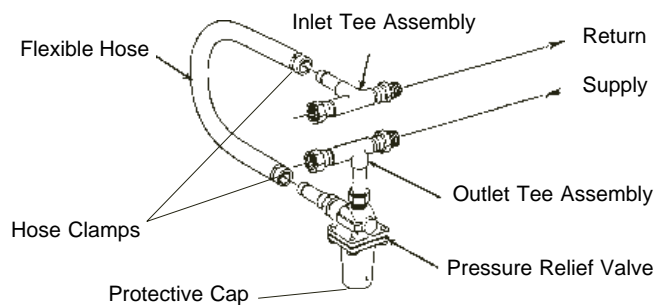
Pump Motor Overload Protector

An overload protector prevents the pump motor from exposure to excessively high current. If an overload condition occurs, due, for example, to a heavy work load, the overload protector shuts the pump and compressor down. The overload protector automatically resets after approximately two minutes. The source of the overload must be identified and corrected before the pump and compressor will restart.

External Pressure Regulator (Optional)

For applications requiring a maximum pressure less than 55 psi, an External Pressure Reducer (EPR) is available. An EPR allows an adjustable operating pressure of 10 to 50 psi. If the pressure of the fluid leaving the unit exceeds the valve setting the relief valve will bypass the fluid back into the unit to relieve the pressure. The pressure of the system is determined by the back pressure of the connected equipment and the flow rate of the recirculating fluid to your application.

Connect the EPR assembly as shown below. Tighten the hose clamps tight enough to prevent leakage. Do not over-tighten or the clamps will “bite” into the flexible tubing and can cause excessive wear.



Connect the outlet tee assembly to the inlet of your application. Connect the inlet tee assembly to the outlet of your application.

Adjustment

When adjusting the relief valve some leaking may occur, place a container under the valve during adjustment.

Remove the protective cap and locate a threaded fitting with a slot for a large screwdriver. Hold the threaded fitting in place and loosen the lock nut on the valve body until it is almost flush with the threaded fitting. Unscrew the threaded fitting three to four turns. (If the threaded fitting unscrews completely from the valve housing, screw it back in two to three turns.)

To simulate blockage, close (or pinch off) the hose between the EPR outlet tee assembly and your application. Monitor the operating pressure of the HX unit. Turn the threaded fitting until the desired relief pressure is set (the EPR valve cannot be set lower than the total back pressure of your instrument, or flow will not be received).

Tighten the locknut to secure the position of the threaded fitting. Open the hose between the EPR outlet tee assembly and your application.

Section V Maintenance

Service Contracts

Thermo NESLAB offers on-site Service Contracts that are designed to provide extended life and minimal downtime for your unit. For more information, contact our Service Department. Phone numbers and addresses for all our Sales and Service Centers are located in the front of this manual (see Preface, After-sale Support) and on the back cover of this manual.

Cleaning

Periodically inspect the reservoir. If cleaning is necessary, flush the reservoir with a cleaning fluid compatible with the circulating system and the cooling fluid.

The cooling fluid should be replaced periodically when operating at low temperatures. The concentration of water in the cooling fluid will increase over time, leading to a reduction in the cooling capacity.

Before changing the cooling fluid, raise the operating temperature of the unit to de-ice the reservoir. Refer to Section III, Filling Requirements for instructions on replacing the cooling fluid.

Pump Strainer

A wire mesh pump strainer is located in the reservoir on the pump suction line. If debris is drawn into the reservoir, the strainer will prevent the material from being drawn into the pump and damaging the pump vanes.

Inspect the strainer whenever the reservoir is checked for cleanliness. If the strainer is visibly clogged, cleaning is required.

Disconnect the line cord from the power source and drain the reservoir before cleaning the strainer.


Cover the strainer with a baggie to catch any debris which may become free. Unscrew the strainer and rinse it with water. Replace the strainer. Refer to III, Filling Requirements for instructions on replacing cooling fluid.



Strainer

Section VI Troubleshooting

Displaying Software Version

To display the software version ensure the controller is in the Operator's Loop and displaying the reservoir fluid temperature. Depress and hold the enter key . Press the YES NO YES keys and the display will indicate CALIBRATE? While continuing to hold the enter key press the YES NO YES keys again. The display will now indicate the software version, for example 000550.63a. Press NO to return to the temperature display.

Checklist

Unit will not start or cycles on and off

For CE Mark units, check the circuit breaker setting on the rear of the bonnet.

Check the position of the EMO button.

Check for a fault condition.

Check the position of the LOCAL REMOTE switch. In REMOTE, check the INTERFACE connection.

Check power source for correct voltage output. Refer to the serial number label on the rear of the unit for the specific electrical requirements of your unit. Power source must be specified voltage, $\pm 10\%$.

Check house circuit breaker.

On three phase units with three phase pump motors, the phase rotation may be reversed (see Section III, Electrical Requirements).

Ensure the facility water is on and make sure the cooling water supply is connected to the TAP WATER connection, not the DRAIN connection. Check the High Pressure Cutout, it may need to be reset (see Section IV, High and Low Pressure Switch Cutout).

Unit will not circulate.

Check for obstructions or kinks in the tubing between the unit and the instrument being cooled.

Check pressure gauge reading. If reading is "0" with flow, the gauge may be faulty. Verify by placing a second gauge in the RECIRCULATING WATER OUTLET line.

Check pump strainer (see Section V, Pump Strainer).

Check for a pump motor overload.

Inadequate temperature control.

Check installation of unit for compliance with conditions in Section III.

Make sure instrument being cooled has not overcome the cooling capacity of the unit (see Section II, Specifications).

Service Assistance

If, after these troubleshooting steps, your unit fails to operate properly, contact our Service Department.

Our Service Department can provide you with a complete list of spare parts for your HX-540 Recirculating Chiller. Phone numbers and addresses for all our Sales and Service Centers are printed on the back cover of this manual. Before calling, *please* obtain the following information:

BOM number

Serial number

Voltage of unit

Voltage of power source

Temperature of facility water

Appendix A Interface Definitions

J-100 INTERFACE

The LOCAL/REMOTE switch is used to enable the INTERFACE connector located on the side of the electrical enclosure. With the interface enabled the unit can be controlled and monitored with various electronic accessories.

NOTE: Placing the switch to REMOTE without the interface connected will shut down the unit.

PIN	NAME	NOTES	DEFINITION
1	12VDC COMMON		Common for digital inputs (pins 13 and 14)
2	RESISTIVITY OUT		0-10VDC Analog Voltage Output: Reference to pin 6 This voltage output is proportional to the resistivity of the reservoir fluid: 0.5VDC / M-cm. (Ex 9.0V = 18Mohm-cm) (Max Load @ 10V = 5mA)
3	LOW LEVEL	Note 1	<u>Dry Relay Contact:</u> Reference to pin 11. Closes if either level switch is in the "low" position for more than 1 second.
4	TEMP/SENSOR	Note 1	<u>Dry Relay Contact:</u> Reference to pin 11. Closes immediately when any of the following occur: 1. High Temp Fault, 2. High Temp Warn, 3. Low Temp Fault, 4. Low Temp Warn, 5. RTD1 Fault/Warn, 6. RTD2 Fault/Warn, or 7. Resistivity Warn.
5	PUMP ON	Note 1	<u>Dry Relay Contact:</u> Reference to pin 11. Closes immediately when pump is turned on. Opens immediately when pump is turned off.
6	ANALOG GROUND		Common for analog signals (pins 2, 7 and 15)
7	RESERVOIR TEMP OUT		0-10VDC Analog Voltage Output: Reference to pin 6 This voltage output is proportional to the reservoir fluid temperature: Scale = 10mV / °C. (Ex 200mV = 20°C) (Max Load @ 10V = 5mA) * Optional Range = 0 – 10V (where: 0V = Low Temp Span, 10V = Hi Temp Span) Contact Factory for details
8	LOW FLOW	Note 1	<u>Dry Relay Contact:</u> Reference to pin 11. Closes immediately when a low flow occurs while the pump is on. Note: To allow the pump to get up to speed at startup, the pump is allowed to run for 3 seconds before the low flow sensor is read.
9	FAULT NO	Note 1	<u>Dry Relay Contact:</u> Reference to pin 11. Closes immediately when any of the following faults occur: 1. Low Flow, 2. Low Level, 3. Temp/Sensor, 4. High Pressure Fault, or 5. Heater High Temp Cutout.
10	FAULT NC	Note 1	<u>Dry Relay Contact:</u> Reference to pin 11. Compliment of pin 9 (Open when pin 9 is closed)
11	RELAY COMMON		Common for all relay contacts (pins 3, 4, 5, 8, 9, 10)
12	(Not used)		
13	REMOTE SETPOINT ENABLE		Digital Input: Reference to pin 1. Connect to pin 1 to allow the setpoint to be changed remotely through pin 15 "Remote Setpoint In".
14	REMOTE ON/OFF		Digital Input: Reference to pin 1. Connect to pin 1 to turn unit on. Disconnect to turn unit off. <u>Note:</u> The front panel LOCAL/REMOTE switch, must be in the REMOTE position to allow operation from this pin.
15	REMOTE SETPOINT IN		Analog Voltage Input: Reference to pin 6 Apply a DC voltage to this pin to adjust the unit's setpoint: Range = 10mV / °C. (Ex 200mV = 20°C) (Max Input Voltage = 10VDC, Input Impedance > 600K) * Optional Range = 0 – 10V (where: 0V = Low Temp Span, 10V = Hi Temp Span) Contact Factory for details

Note 1:

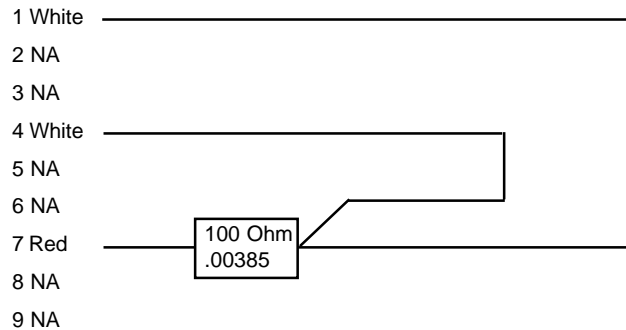
All relay contacts (except for Pin 10) are normally OPEN when power is off. Pin 10 contacts are normally CLOSED when power is off. All relay contacts are rated: 250V/3A, <= .08 Ohm.

SENSOR (Optional)

The unit can be configured to have its temperature controlled from a remote location. Temperature is read on the controller's RTMP display. In the Operator's Loop, RTMP is your application's temperature, TEMP indicates the HX's tank temperature.

The remote probe is connected by a 9-pin male "D-sub" located on the rear of the unit. Ensure your remote application does not cause the HX to exceed its temperature range. For safety reasons the HX will shut down if either limit is exceeded by 7°C.

This is a 3-wire RTD probe. It must be calibrated before initial use, see Appendix B.



COMM (Optional)

J105 is a 9-pin female "D-sub" located on the side of the electrical enclosure used for remote operation. The unit can be configured to operate from a PC comm or remote box option. For remote box operation/configuration see pages 20-21. For serial communications protocol, see Appendix C. For NEScom software information, see Appendix D.

When using the remote box option, the quickest way to return from remote to local is by pressing and holding the enter key and then pressing the next key on the local controller.

Going from local to remote is not available at the remote box.

The pin out information for either configuration is:

RS-232 (NC com)	RS-485 (Remote Box)
1 Not used	1 Ground
2 TX	2 -7 Not used
3 RX	8 T+
4 Not used	9 T-
5 Ground	
6-9 Not used	

Appendix B Remote Probe Calibration

Before using the optional remote probe it must be calibrated. This is done by running the unit to its temperature extremes and using the controller's Calibration Loop.

Install the remote probe into the SENSOR 9-pin "D-sub" located on the rear of the unit.

Use the Operator's Loop to run the unit to its high-end temperature limit. When the setpoint is reached press and hold the ENTER key and then press YES-NO-YES to display CALIBRATE? Press YES.

Press NEXT until RMT RTD? is displayed. Press YES to display HI CAL? HI xxx.xC will be displayed, use the YES/NO keys to reach the desired temperature and the press ENTER. Press the NEXT key until SAVE? is displayed, press YES to return to the Operator's Loop.

Use the Operator's Loop to run the unit to its low-end temperature limit. When the setpoint is reached press and hold the ENTER key and then press YES-NO-YES to display CALIBRATE? Press YES.

Press NEXT until RMT RTD? is displayed. Press YES to display HI CAL? Press NO and LOW CAL? is displayed. Press YES and LOWxxx.xC will be displayed, use the YES/NO keys to reach the desired temperature and the press ENTER. Press the NEXT key until SAVE? is displayed, press YES to return to the Operator's Loop.

The probe is now calibrated. Re-calibrate as necessary or if the probe is replaced.

Appendix C Serial Communications Protocol

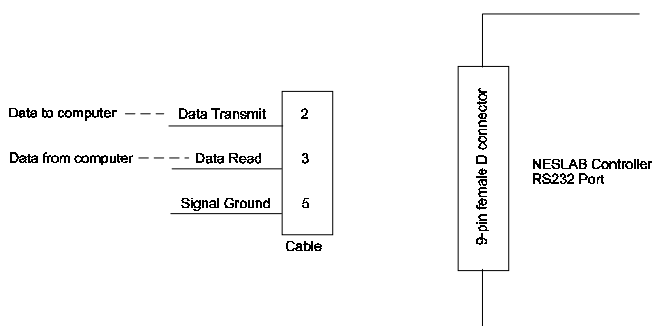
NOTE: This appendix assumes you have a basic understanding of communications protocols.

All data is sent and received in binary form, do not use ASCII. In the following pages the binary data is represented in hexadecimal (hex) format.

The Thermo NESLAB Serial Communications Protocol, NC, is based on a master-slave model. The master is a host computer, while the slave is the chiller's controller. Only the master can initiate a communications transaction (half-duplex). The slave ends the transaction by responding to the master's query. The protocol uses an RS-232 serial interface with the parameters: 9600 baud, 8 data bits, 1 stop bit and no parity.

NOTE: Before the unit will communicate, RS232 must be turned on in the controller's Setup Loop.

The unit can be controlled through your computer's serial port by using the unit's standard 9-pin RS-232 connection. Data read of the serial port connects to the data transmit (pin 2) of the unit. Data transmit of the serial port connects to data read (pin 3) of the unit.



Communication cables are available from Thermo NESLAB. Contact our sales department for additional information.

All commands must be entered in the exact format shown in the tables on the following pages. The tables on the last two page of this Appendix show all commands available, their format and responses. Controller responses are either the requested data or an error message. The controller response *must* be received before the host sends the next command.

The host sends a command embedded in a single communications packet, then waits for the controller's response. If the command is not understood or the checksums do not agree, the controller responds with an error command. Otherwise, the controller responds with the requested data. If the controller fails to respond within 1 second, the host should resend the command.

NC Serial Communications Protocol

NOTE: All byte values are shown in hex, represents the binary values that must be sent to the chiller. **Do not use ASCII.**

The framing of the communications packet in both directions is:

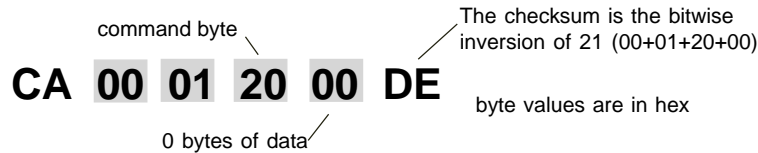
Checksum region								
Lead char	Addr-MSB	Addr-LSB	Command	n d-bytes	d-byte 1	...	d-byte n	Checksum
CA	00	01						

<i>Lead char</i>	CA (hex).
	Device address is 1
<i>Addr-msb</i>	Most significant byte of device address is 00 hex.
<i>Addr-lsb</i>	Least significant byte of device address is 01 hex.
<i>Command</i>	Command byte (see Table 1).
<i>n d-bytes</i>	Number of data bytes to follow (00 to 03 hex).
<i>d-byte 1</i>	1 st data byte (the qualifier byte is considered a data byte).
...	...
<i>d-byte n</i>	n th data byte.
<i>Checksum</i>	Bitwise inversion of the 1 byte sum of bytes beginning with the most significant address byte and ending with the byte preceding the checksum. (To perform a bitwise inversion, "exclusive OR" the one byte sum with FF hex.)

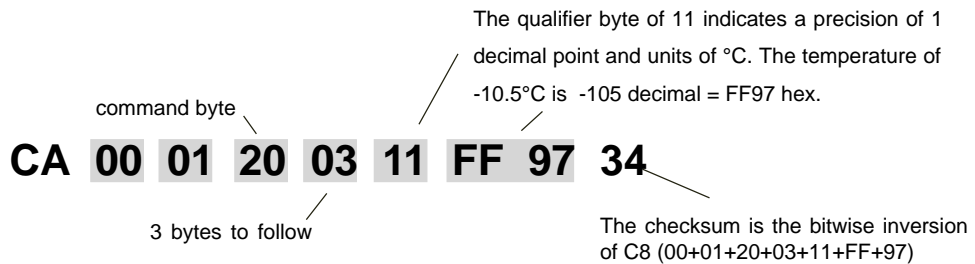
The master requests information by sending one of the Read Functions as shown in Table 1. Since no data is sent to the chiller during a read request, the master uses 00 for the number of data bytes following the command byte.

The chiller will respond to a Read Function by echoing the lead character, address, and command byte, followed by the requested data and checksum. When the chiller sends data, a qualifier byte is sent first, followed by a two byte signed integer (16 bit, MSB sent first). The qualifier byte indicates the precision and units of measure for the requested data as detailed in Table 2.

As an example, the master requests to read internal temperature by sending:

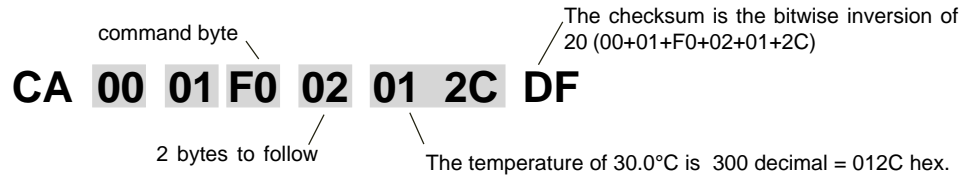


If the temperature is -10.5°C, the slave would reply:



The master sets parameters in the chiller by sending one of the Set Functions as shown in Table 1. The master does not send a qualifier byte in the data field. The master should be preprogrammed to send the correct precision and units (it could also read the parameter of interest first to decode the correct precision and units needed).

For example, if the master wants to set the setpoint to 30°C, it would send :



The slave responds:

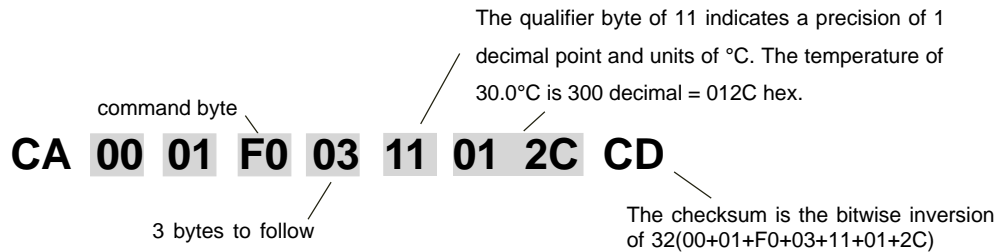


Table 1 Commands (All bytes are in hex)

FUNCTION	MASTER SENDS	UNIT RESPONDS
<u>READ</u>		
Read Internal Temperature	CA 00 01 20 00 DE	CA 00 01 20 03 qb d1 d2 cs
Read External Sensor	CA 00 01 21 00 DD	CA 00 01 21 03 qb d1 d2 cs
Read Setpoint (control point)	CA 00 01 70 00 8E	CA 00 01 70 03 qb d1 d2 cs
Read Low Temperature Limit	CA 00 01 40 00 BE	CA 00 01 40 03 qb d1 d2 cs
Read High Temperature Limit	CA 00 01 60 00 9E	CA 00 01 60 03 qb d1 d2 cs
Read Heat Proportional Band (P)	CA 00 01 71 00 8D	CA 00 01 71 03 qb d1 d2 cs
Read Heat Integral (I)	CA 00 01 72 00 8C	CA 00 01 72 03 qb d1 d2 cs
Read Heat Derivative (D)	CA 00 01 73 00 8B	CA 00 01 73 03 qb d1 d2 cs
Read Cool Proportional Band (P)	CA 00 01 74 00 8A	CA 00 01 74 03 qb d1 d2 cs
Read Cool Integral (I)	CA 00 01 75 00 89	CA 00 01 75 03 qb d1 d2 cs
Read Cool Derivative (D)	CA 00 01 76 00 88	CA 00 01 76 03 qb d1 d2 cs
Read Resistivity Value	CA 00 01 2C 00 D2	CA 00 01 2C 03 qb d1 d2 cs
Read Flow Value	CA 00 01 10 00 CE	CA 00 01 10 03 qb d1 d2 cs
Read Resistivity Setpoint	CA 00 01 4C 00 B8	CA 00 01 4C 03 qb d1 d2 cs
Read Low Flow Setpoint	CA 00 01 30 00 CE	CA 00 01 30 03 qb d1 d2 cs

command bytes shown in **bold**
 qb = qualifier byte
 d1,d2 = 16 bit signed integer of the value being sent or received
 cs = the checksum of the string (see text)

ed = echo back of the command byte as received
 v1,v2 = protocol version
 * = limited to the range of the chiller
 xx = no valid data, include in checksum

Continued on next page.

Table 1 Commands (All bytes are in hex)

FUNCTION	MASTER SENDS	UNIT RESPONDS
SET		
Set Setpoint (control point)*	CA 00 01 F0 02 d1 d2 cs	CA 00 01 F0 03 qb d1 d2 cs
Set Heat Low Temperature Limit*	CA 00 01 C0 02 d1 d2 cs	CA 00 01 C0 03 qb d1 d2 cs
Set Heat High Temperature Limit*	CA 00 01 E0 02 d1 d2 cs	CA 00 01 E0 03 qb d1 d2 cs
Set Low Flow Setpoint	CA 00 01 B0 02 d1 d2 cs	CA 00 01 B0 03 qb d1 d2 cs
Set Resistivity Setpoint	CA 00 01 CC 02 d1 d2 cs	CA 00 01 CC 03 qb d1 d2 cs
Set Heat Proportional Band (P=1-99.9)	CA 00 01 F1 02 d1 d2 cs	CA 00 01 F1 03 qb d1 d2 cs
Set Heat Integral (I = 0-9.99)	CA 00 01 F2 02 d1 d2 cs	CA 00 01 F2 03 qb d1 d2 cs
Set Heat Derivative (D= 0-5.0)	CA 00 01 F3 02 d1 d2 cs	CA 00 01 F3 03 qb d1 d2 cs
Set Cool Proportional Band (P=1-99.9)	CA 00 01 F4 02 d1 d2 cs	CA 00 01 F4 03 qb d1 d2 cs
Set Cool Integral (I = 0-9.99)	CA 00 01 F5 02 d1 d2 cs	CA 00 01 F5 03 qb d1 d2 cs
Set Cool Derivative (D= 0-5.0)	CA 00 01 F6 02 d1 d2 cs	CA 00 01 F6 03 qb d1 d2 cs
UNIT ERROR RESPONSES		
Bad Command	N/A	CA 00 01 0F 02 01 ed xx cs
Bad Checksum	N/A	CA 00 01 0F 02 03 ed xx cs
Bad Data	N/A	CA 00 01 0F 02 02 ed xx cs
MISCELLANEOUS		
Request Acknowledge	CA 00 01 00 00 FE	CA 00 01 00 02 v1 v2 cs

command bytes shown in **bold**

qb = qualifier byte

d1,d2 = 16 bit signed integer of the value being sent or received

cs = the checksum of the string (see text)

ed = echo back of the command byte as received

v1,v2 = protocol version

* = limited to the range of the chiller

xx = no valid data, include in checksum

Table 2

QUALIFIER BYTE

00 hex	0 precision, no units of measure
01 hex	0 precision, °C
02 hex	0 precision, °F
10 hex	0.1 precision, no units of measure
11 hex	0.1 precision, °C units
12 hex	0.1 precision, °F units
13 hex	0.1 precision, LPM
14 hex	0.1 precision, GPM
08 hex	0 precision, MOhm-cm
18 hex	0.1 precision, MOhm-cm
20 hex	0.01 precision, no units of measure

Example: The temperature of 45.6°C would be represented by the qualifier 11 hex, followed by the 2 bytes 01 C8 hex (456 decimal).

Appendix D Programming Software

The Thermo NESLAB Communications Software is a user friendly software that allows you to automate your temperature control process. The software includes a 3½" disk, comprehensive operator's manual and a toll-free number to a trained technical staff.

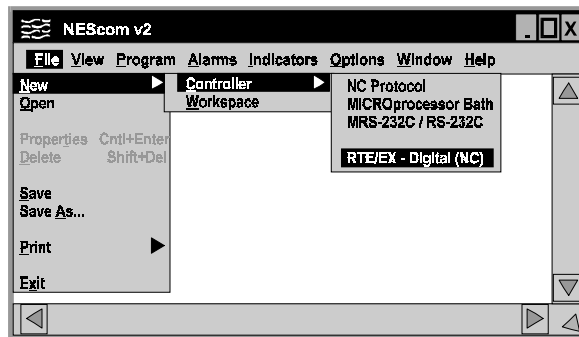
NEScom Software allows you to write custom temperature programs for our Digital or Microprocessor based temperature control apparatus. Choose upper or lower temperature limits and monitor system status with an alarm. NEScom can also record your results on a user selectable graph. NEScom must be used with an IBM or 100% compatible computer.

Select from easy to use product icons.

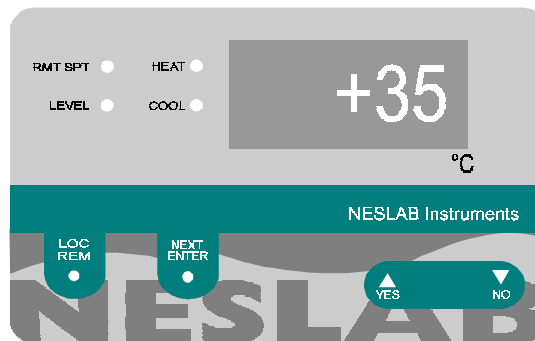
Create graphs and charts.

Easily configure ramping functions which set the setpoint over time.

View pop-up alarm windows which display if an alarm condition occurred.



Select software functions from the easy to use pulldown menus.



View a virtual controller screen which allows remote monitoring and operation of product control panel.

WARRANTY

Thermo NESLAB Instruments, Inc. warrants for 12 months from date of shipment any Thermo NESLAB unit according to the following terms.

Any part of the unit manufactured or supplied by Thermo NESLAB and found in the reasonable judgment of Thermo NESLAB to be defective in material or workmanship will be repaired at an authorized Thermo NESLAB Repair Depot without charge for parts or labor. The unit, including any defective part must be returned to an authorized Thermo NESLAB Repair Depot within the warranty period. The expense of returning the unit to the authorized Thermo NESLAB Repair Depot for warranty service will be paid for by the buyer. Thermo NESLAB's responsibility in respect to warranty claims is limited to performing the required repairs or replacements, and no claim of breach of warranty shall be cause for cancellation or rescission of the contract of sales of any unit. With respect to units that qualify for field service repairs, Thermo NESLAB's responsibility is limited to the component parts necessary for the repair and the labor that is required on site to perform the repair. Any travel labor or mileage charges are the financial responsibility of the buyer.

The buyer shall be responsible for any evaluation or warranty service call (including labor charges) if no defects are found with the Thermo NESLAB product.

This warranty does not cover any unit that has been subject to misuse, neglect, or accident. This warranty does not apply to any damage to the unit that is the result of improper installation or maintenance, or to any unit that has been operated or maintained in any way contrary to the operating or maintenance instructions specified in Thermo NESLAB's Instruction and Operation Manual. This warranty does not cover any unit that has been altered or modified so as to change its intended use.

In addition, this warranty does not extend to repairs made by the use of parts, accessories, or fluids which are either incompatible with the unit or adversely affect its operation, performance, or durability.

Thermo NESLAB reserves the right to change or improve the design of any unit without assuming any obligation to modify any unit previously manufactured.

THE FOREGOING EXPRESS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO WARRANTIES OR MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Thermo NESLAB'S OBLIGATION UNDER THIS WARRANTY IS STRICTLY AND EXCLUSIVELY LIMITED TO THE REPAIR OR REPLACEMENT OF DEFECTIVE COMPONENT PARTS AND Thermo NESLAB DOES NOT ASSUME OR AUTHORIZE ANYONE TO ASSUME FOR IT ANY OTHER OBLIGATION.

Thermo NESLAB ASSUMES NO RESPONSIBILITY FOR INCIDENTAL, CONSEQUENTIAL, OR OTHER DAMAGES INCLUDING, BUT NOT LIMITED TO LOSS OR DAMAGE TO PROPERTY, LOSS OF PROFITS OR REVENUE, LOSS OF THE UNIT, LOSS OF TIME, OR INCONVENIENCE.

This warranty applies to units sold in the United States. Any units sold elsewhere are warranted by the affiliated marketing company of Thermo NESLAB Instruments, Inc. This warranty and all matters arising pursuant to it shall be governed by the law of the State of New Hampshire, United States. All legal actions brought in relation hereto shall be filed in the appropriate state or federal courts in New Hampshire, unless waived by Thermo NESLAB.