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NESLAB

AG Associates RTE-134M Refrigerated Bath/Circulator Instruction Manual

NESLAB Manual P/N 000013
Rev. 02/17/95

ISO 9001 REGISTERED

NESLAB

Constant Temperature Bath/Circulators
Immersion Coolers
Recirculating Chillers

AG Associates RTE-134M Bath/Circulator Instruction and Operation Manual

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Preface

Unpacking

Retain all cartons and packing material until the unit is operated and found to be in good condition. The unit control box for microprocessor units is packed in a separate carton. Be sure to locate this separate carton; do not dispose of it by mistake.

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

All NESLAB units are shipped with a warranty card. The top portion of the card remains with the unit. The bottom portion must be filled out and returned to NESLAB.

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

After-sale Support

NESLAB is committed to customer service both during and after the sale. If you have questions concerning the operation of your unit, contact our Sales Department. If your unit fails to operate properly, or if you have questions concerning spare parts or Service Contracts, contact our Customer Service Department. Before calling, please obtain the following information from the unit's serial number label:

- *part number* _____

- *serial number* _____

Section I Safety

Warnings

Make sure you read and understand all 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.

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.

Observe all warning labels.

Never remove warning labels.

Never operate damaged or leaking equipment.

Never operate the unit without bath fluid in the bath.

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

Always empty the bath before moving the unit.

Never operate equipment with damaged line cords.

Refer service and repairs to a qualified 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 instructions. Failure to observe these instructions can result in permanent damage to the unit, significant property damage, personal injury or death.

Section II General Information

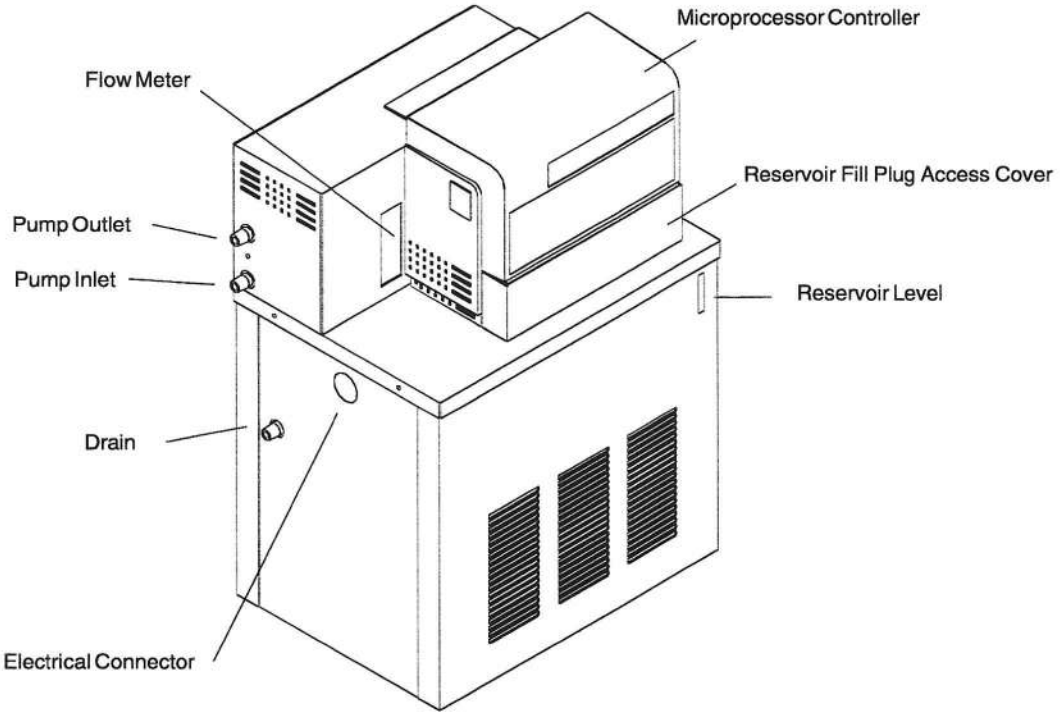
Description

The AG RTE-134M Bath/Circulator is designed to provide temperature control for applications requiring pumping to an external system.

Units consists of a non-CFC air-cooled refrigeration system, circulation pump, sealed reservoir, flow meter, 9-pin accessory connector and a microprocessor temperature controller. The unit is built to UL specifications.

Specifications

Temperature Range	+5°C to +35°C
Temperature Stability	±0.1°C
Pump Capacity	15 lpm at 0' (0 M) 0 lpm at 16' (4.9 M)
Heater	800 Watts
Case Dimensions *(H x W x D)* *Inches* *Centimeters*	 22 1/4 x 11 x 15 56.5 x 27.9 x 38.1
Power Requirements	115 V, 60 Hz, 11 Amps



Pumping

The pump is designed to deliver a flow of 15 liters/minute (4 gallons minute) at 0 feet head. To prevent external circulation, the PUMP INLET and PUMP OUTLET lines on the side of the unit are capped. The caps must be removed when external circulation is required.

To properly secure external hose connections to the unit, wrap Teflon® tape around the pipe line threads before installation. Once the hose connections are made, the hoses must be properly plumbed to an external system. *It is important the bath is not in operation until all plumbing is complete.*

If the bath is not used for external circulation, make sure the stainless steel caps are in place prior to operating the bath.

Drain



Ensure the temperature of the bath fluid is safe before draining the unit.

The unit is equipped with a drain located at the side of the unit. The drain has ¼ inch male pipe threads and is capped with a stainless steel plug. To drain the reservoir simply remove the cap.

To assure proper fit when replacing the cap, be sure to line the threads with Teflon® tape.

Fluids

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



Never use flammable or corrosive fluids with this unit.

Tap water is the recommended fluid for operation to +35°C.

Filling Requirements

Remove the front reservoir access panel to expose the reservoir fill plug. Remove the plug. The reservoir fill hole is 3/8 inch female pipe thread. The unit has a high and low level marker to guide filling. ***Slowly*** fill the unit to the top marker.



The heating and cooling coils will be exposed and may become damaged if the correct fluid level is not provided.

When pumping to an external system, keep extra fluid on hand to maintain the proper level in both the circulating lines and the external system.



Never run the unit when the reservoir is empty.

High Temperature/ Low Liquid Level Safety

To protect your application, the adjustable High Temperature/Low Liquid Level Safety (HIGH TEMP/LOW LEVEL) ensures the heater will not exceed temperatures which can cause serious damage to your unit. A single temperature sensor, located on the heater coils in the bath, monitors both conditions. A High Temperature/Low Liquid Level fault occurs when the temperature of the sensor exceeds the set temperature limit.

In the event of a fault, the unit will shut down. The cause of the fault must be identified and corrected before the unit can be restarted.

The safety is not pre-set and must be adjusted during initial installation.

To set the safety, locate the HIGH TEMP/LOW LEVEL SAFETY adjustment dial on the right side of the pump box. Turn the dial fully clockwise and press the red RESET switch.

Start the unit. Adjust the setpoint for a few degrees higher than the highest desired fluid temperature and allow the bath to stabilize at the temperature setpoint. Turn the HIGH TEMP/LOW LEVEL SAFETY dial counter-clockwise until you hear a click and the unit shuts down. The red FAULT LED on the temperature controller will light to indicate a fault has occurred.

Cool the bath and then, without moving the adjustment dial, press the red RESET switch.

NOTE: The minimum high temperature safety setting is 50°C.

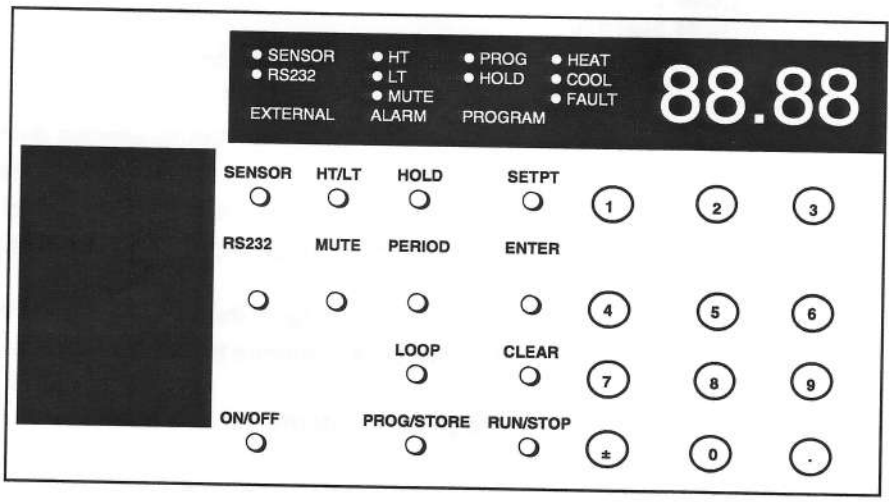
Section IV Microprocessor Controller

Microprocessor Controller

Description

The microprocessor controller is designed as a separate component from the unit. The controller can be mounted directly on the pump box, or remotely from the bath. The controller provides proportional with integral and derivative (PID) control.

The controller has two sections. The upper section contains the LED indicators and the Main display which provide feedback to you about the controller and bath. The ten individual LED indicators provide output on selected parameters while the Main display will provide information on various unit conditions. The lower section contains the keypad you use to input data to the controller.



Microprocessor Temperature Controller (Front View)

Controller Mounting

The controller can be removed from the bath and placed in a remote location. Extension cables are available from NESLAB.

Controller Connection

Microprocessor controllers are supplied with a cable needed to connect the controller to the pump box. Connect the cable to the 25-pin male connector on the control box and the female connector on the pump box. Once the connection is made, the unit is ready for operation.

NOTE: The MAIN POWER should be OFF before connecting/disconnecting cables from the control box.

LED Indicators

The following table explains the controller LED indicators. The LEDs can be on, off or flashing.

LED	STATUS	INDICATION
SENSOR	OFF	All controller functions are operating from the unit's internal probe.
	ON	All controller functions are operating from remote sensor input.
	FLASHING	The Main display indicates the remote sensor temperature. The controller, however, uses the internal probe to control the temperature.
RS232	OFF	Communication port disabled.
	ON	Communication port enabled.
	FLASHING	Awaiting next key press
LT	OFF	No alarm.
	ON	Main display indicates low limit setpoint.
	FLASHING	Low limit alarm condition.
HT	OFF	No alarm.
	ON	Main display indicates high limit setpoint.
	FLASHING	High limit alarm condition.
HOLD	OFF	Programming hold feature disabled.
	ON	Programming hold feature enabled.
PROG	OFF	No program running.
	ON	The program is suspended[1].
	FLASHING	The program is running.
COOL	OFF	Refrigeration is off[2].
	ON	Refrigeration is on.
HEAT	OFF	The heater is off.
	ON	The heater is on.
	FLASHING	The heater duty cycle.
MUTE	OFF	The alarm is enabled.
	ON	The alarm horn is disabled.
	FLASHING	The alarm horn has been disabled for any current condition. The alarm horn will automatically reset when the condition is cleared.
FAULT	OFF	No fault condition.
	ON	The high temperature/low level safety has activated.

1. The bath fluid will maintain the setpoint achieved at the time the program is suspended, except when the bath is in a rapid cool segment. No operator inputs are available to the controller while in a suspended condition.
2. Below 50°C the refrigeration is on unless the setpoint is more than 2°C above the bath temperature. This allows rapid heat up. Above 50°C refrigeration is off unless the setpoint is more than 2°C below the bath temperature. This allows rapid cool down.

Start Up

Before starting the unit, check all electrical and plumbing connections and make sure the work area has been properly filled with bath fluid.

To power the controller, toggle the MAIN POWER switch on the side of the unit to the ON position.

The pump will start and the Main display will indicate the temperature of the fluid in the bath. The controller will respond to the current setpoint.

Pressing the keypad ON/OFF button will disable control of the bath and shut down the pump. The Main display will indicate OFF. (When the controller is in the RS232 mode of operation the ON/OFF button is deactivated. Control of the bath can only be disabled via an RS232 input. RS232 mode of operation is discussed in Appendix A.)

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.

Temperature Adjustment

To display the temperature setpoint, press SETPT. The Main display will flash the current setpoint. Press ENTER to return the display to the bath's fluid temperature. To adjust the setpoint press SETPT and then press CLEAR, the display will go blank. Use the keypad to input the desired value. If the value is correct press ENTER. If the value is incorrect press CLEAR, the display will go blank. Use the keypad to correct the value and press ENTER.

Low and High Temperature Limits

To display the temperature limits, press HT/LT. Either the HT or LT LED will illuminate and the Main display will flash the corresponding temperature limit. Press ENTER and then press HT/LT again to observe the other temperature limit. The corresponding LED on the controller will illuminate. Should either limit be exceeded an alarm will sound (if not muted) and the corresponding LED will flash.

To adjust either limit, press HT/LT and then press CLEAR, the display will go blank. Use the keypad to input the desired value. If the value is correct press ENTER. If the value is incorrect press CLEAR, the display will go blank. Use the keypad to correct the value and press ENTER. Use the LT or HT LED indicators to verify which temperature limit you are changing.

Alarm/External Functions

Mute Alarm

To suspend the alarm's audio press MUTE on the temperature controller. The MUTE LED flashes to indicate a muted alarm. The MUTE button acts as a toggle switch to activate/deactivate the alarm horn. The appropriate HT or LT LED will continue to flash during the alarm condition. If the alarm is muted for an existing condition it will automatically reset once the temperature limit problem is corrected. The alarm resounds if a limit is exceeded unless MUTE is pressed again.

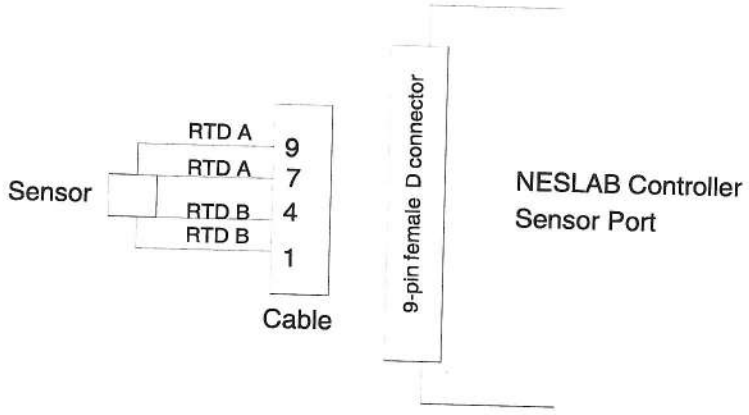
To permanetly silent the alarm audio press MUTE, and then immediately pressing HOLD. The MUTE LED will now stay lit. To restore the audio, press MUTE and then immediately press CLEAR. The MUTE LED will extinguish.

Sensor

The controller can enable and/or monitor a remote bath's temperature sensor. Pressing SENSOR, with a remote sensor properly connected to the 9-pin SENSOR connector, displays the remote sensor's temperature on the Main display. The SENSOR LED will flash. *The controller and alarm, however, will continue to respond to the signals from the unit's internal probe.*

To transfer all display, control and alarm functions to the remote sensor, press SENSOR and then press ENTER. The SENSOR LED will stay lit. The controller will not respond to the signal from the unit's internal probe.

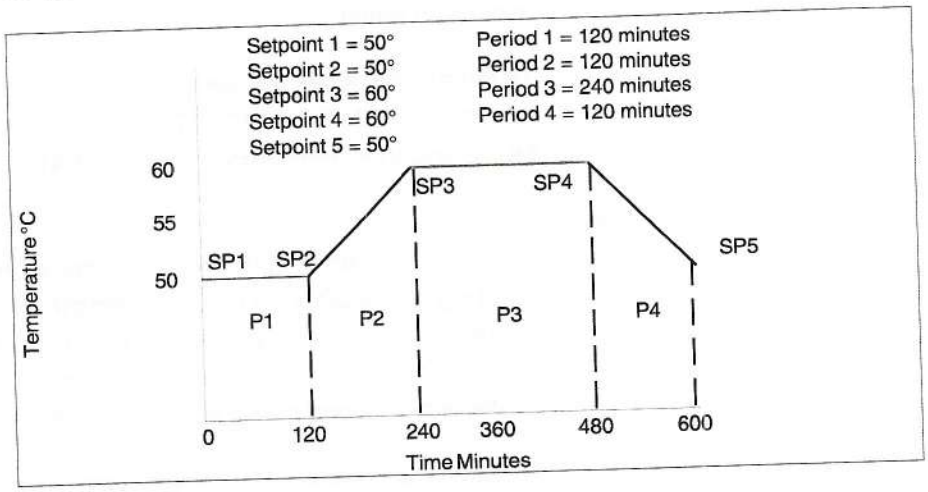
To disable the remote sensor press SENSOR and then press CLEAR. The SENSOR LED will extinguish. All display and alarm functions will again respond to the signal from the unit's internal probe.



Program Functions

Programming

The microprocessor controller can store up to 8 temperature programs, each one having up to 15 program steps (16 setpoints). You can select, enter or run one program at a time. The procedure for selecting a program is discusssed in Program Control on page 14. The programs can cover the unit's full temperature operating range in 0.01°C increments. Step times can vary from 0 to 6,500 minutes in 0.1 minute increments. Each program can be set up to run as many as 9999 repetitions (LOOPS).



Typical Program

The controller can store all programs in its nonvolatile memory, see Program Control on page 14.

The programming process begins with program definition. Define your program as a series of setpoints with a known period of time interval between each of them. Each interval is one step of the program. Give careful attention to the first part of your program. What conditions must exist at the beginning of your process? For example, you may wish to program an initial period of constant temperature at the starting setpoint to allow for thermal stabilization.

NOTE: When a program is started, it begins immediately at the initial programmed setpoint.

Consider the unit's limitations when designing programs. Temperature or time parameters which exceed the performance capabilities of the bath will result in unsatisfactory operation. It is possible to create a program calling for very rapid changes in temperature. Although the equipment may not be capable of producing such changes, it may be practical to program such steps as a way to cause the fastest *possible* temperature change.

Loops

This option allows for automatic repetition(s) of a program. For example, set the number of loops to three. Once the program reaches the last setpoint, it will loop back to the first setpoint and run the program again. In this instance the program will loop back three times. The entire program will run a total of four times. The maximum number of loops is 9999.

Hold

This option determines what will happen at the end of a program. In the hold mode of operation the setpoint will remain at the final temperature when the program is completed. Without hold the setpoint will return to the starting setpoint when the program is completed. The setpoint may change abruptly, but the fluid temperature will respond as quickly as the systems heating and cooling capacity allows.

The procedures for placing the controller in the hold mode is discussed in Program Control on page 14.

Current Values

While a program is running, the program selected, current period, current setpoint, time remaining for the current step, or the current loop, may be viewed on the Main display. Momentarily depress the appropriate key listed below to view the desired parameter. After several seconds, the Main display will again indicate the temperature of the bath fluid.

SETPT	View Current Setpoint
LOOP	View Current Loop
PERIOD	Time Remaining in Current Period
PERIOD PERIOD	Current Period Number
+/- followed immediately by **PROG/STORE**	Selected Program Number

Assured Soak

This option is used when you need the bath temperature to reach the next setpoint (regardless of time) before moving onto the next period.

This option is controlled by a DIP switch on the rear of the controller. Turn DIP switch number seven (7) to the ON position to enable this feature.

Rapid Cool Down

This option is used to enable maximum cooling operation. This option is available with or without a program running. **NOTE:** The unit is normally in a maximum cooling mode when the bath temperature is below 28°C.

When not running a program, if you enter a setpoint greater than 2°C colder than the current bath temperature, maximum cooling will be enabled until the setpoint is reached.

For programming, determine which program period(s) will require maximum cooling. Then instead of entering a time for those periods, press the " - + " button on the keypad. The Main display will indicate FASt verifying a rapid cool down period has been entered. When the appropriate program period is executed, maximum cooling will be enabled until the setpoint is reached.

Period Adjust

This option is used to skip the current period of a runing program. See Table 13 on page 16 for the appropriate procedure. **NOTE:** If Assured Soak is activated, the bath must reach the setpoint before the program will continue.

Program Control

The following tables show how to use the keypad and Main display to program the controller.

Use Table 1 to select one of the eight programs to be the current program for either entering or running.

TABLE 1 Keypad input	Main Display	Comments
+/-	Current bath temperature	
-PROG/STORE[1]	**Pro** followed by the program number	Enter desired program number.
-ENTER	Current bath temperature	

1. PROG/STORE must be depressed immediately (within one second) after +/-.

Once Table 1 is complete, use Table 2 for entering and storing a two-setpoint program. You would follow this procedure for programming any number of setpoints (up to the 16 setpoint maximum).

TABLE 2 Keypad input	Main Display	Comments
-PROG/STORE	- - - - - -	If YES appears you should clear the current program (see Table 10).
-SETPT	**SP-1**	Input setpoint.
-ENTER	Desired setpoint	
-PERIOD	**P-1**	Input time in minutes.
-ENTER	Desired time	
-SETPT	**SP-2**	Input setpoint.
-ENTER	Desired setpoint	
-LOOPS	**LOOPS**	Input number of loops
-ENTER	Desired number of loops	
-PROG/STORE	**FILE?**	
-ENTER	Current bath temperature	

Use Table 3 to abort programming at any time.

TABLE 3 Keypad input	Main Display	Comments
-ENTER	- - - - -	
-PROG/STORE	**FILE?**	
-CLEAR	Current bath temperature	

Use Table 4 to scroll through a two-setpoint stored program. You would use this procedure for scrolling any number of setpoints (up to the 16 setpoint maximum).

TABLE 4

Keypad input	Main Display	Comments
-PROG/STORE	**YES**	
-ENTER	**SP-1** followed by actual value	
-ENTER	**SP-2** followed by actual value	
-ENTER	**P-1** followed by actual value	
-ENTER	**LOOPS** followed by actual value	
-ENTER	Current bath temperature	

Use Table 5 to abort scrolling through a program at any time.

TABLE 5

Keypad input	Main Display	Comments
-PROG/STORE	**FILE?**	
-ENTER	Current bath temperature	

Once Tables 1 and 2 are complete, use Table 6 to run a stored program.

TABLE 6

Keypad input	Main Display	Comments
-RUN/STOP	Current bath temperature	**PROG LED** will flash.

Use Table 7 to stop a running program.

TABLE 7

Keypad input	Main Display	Comments
-RUN/STOP	Current bath temperature	**PROG LED** will stay on steady.
-CLEAR	Current bath temperature	**PROG LED** extinguishes.

Use Table 8 to temporarily suspend a running program.

TABLE 8

Keypad input	Main Display	Comments
-RUN/STOP	Current bath temperature	**PROG LED** stays on steady.

Use Table 9 to resume a suspended program.

TABLE 9 Keypad input	Main Display	Comments
-RUN/STOP	Current bath temperature	**PROG LED** flashes.

Use Table 10 to clear a stored program.

TABLE 10 Keypad input	Main Display	Comments
-PROG/STORE	**YES**	
-PROG/STORE	**FILE?**	
-CLEAR	Current bath temperature	

Use Table 11 to add HOLD operation. (Hold must be established before running a program. The hold function is not part of the stored program.)

TABLE 11 Keypad input	Main Display	Comments
-PROG/STORE	**YES**	
-HOLD	**YES**	**HOLD** LED stays on steady.
-PROG/STORE	**FILE?**	
-ENTER	Current bath temperature	

Use Table 12 to clear hold operation.

TABLE 12 Keypad input	Main Display	Comments
-PROG/STORE	**YES**	
-HOLD	**YES**	**HOLD** LED extinguishes.
-PROG/STORE	**FILE?**	
-ENTER	Current bath temperature	

Use Table 13 to force a running program to skip ahead to the next period.

TABLE 13 Keypad input	Main Display	Comments
+/-	Current bath temperature	
-PERIOD[1]	**P-Adj**	(Period adjust)

1. PERIOD must be depressed immediately (within one second) after +/-.

Error Messages

The Main Display will indicate an error message for eight different conditions.

Error1 - Program incomplete or illogical. Re-enter the program.

Error2 - Period entered exceeds 6,500 minutes. Reenter a period.

Error3 - Entered value exceeds allowable limits. Reenter proper value.

Error4 - Loops entered greater than 9,999. Reenter loops

Error5 - Attempted to run a program without a program in memory. Build a program.

Error6 - No period entered for a program. Enter a period.

Error7 - With alarm - SENSOR depressed without a sensor properly connected to controller. Properly connect a sensor. (If sensor is properly connected the sensor may have failed.) Without alarm - Internal probe failure, unit will shut off.

Error8 - Internal nonvolatile memory has failed. Press ENTER for the controller to reinitialize nonvolatile memory to factory preset parameters. **NOTE:** This will erase any program and setpoints in nonvolatile memory. The unit will have to be recalibrated.

Miscellaneous

Additional Parameters

Two parameters can also be set while the controller is deactivated (Main display shows OFF). You can adjust the light intensity of the Main display and set the controller pushbuttons to "beep" or not when depressed.

To adjust the Main display intensity first press the "±" key on the controller keyboard. Repeatedly depress the "1" key to decrease intensity or the "3" key to increase. Each press changes the intensity an incremental amount. Once the desired intensity is displayed press ENTER.

To silence the "beep" first press the "." key. Press "0" to turn the beep off or press "1" to turn it on. Next, press ENTER.

DIP Switches

Three DIP switches on the rear of the controller are operational. Switch #1 controls the temperature scale. OFF displays the temperature in °C, ON displays the temperature in °F.

Switch #6 sets the display update rate the controller uses to display temperature. This will determine how sensitive the display will be to temperature fluctuations. OFF sets a fast rate, ON sets a slow rate. (OFF causes more fluctuations than ON.)

Switch #7 controls the assured soak option for programs. ON enables assured soak.

The remaining switches (#2, #3, #4, #5) are inactive.

PID Control

PID controllers are best suited for systems that may experience changing heat loads. Proportional control is combined with Integral and Derivative adjustments which allow the controller to automatically compensate for any changes from the setpoint. You may have to experiment with the PID settings to find out which are most suitable to your application.

To change or view any of the PID settings the controller must be operating.

To change or view the proportional band, press "1" and immediately, within one second, press ENTER. The "percent of span" value will flash on the Main display. Press ENTER to accept the value. To change the value press CLEAR and then enter the desired value. Press ENTER to exit this mode.

To change or view the Integral, press "2" and immediately, within one second, press ENTER. The "repeats per minute" value will flash on the Main display. Press ENTER to accept the value. To change the value press CLEAR and then enter the desired value. Press ENTER to exit this mode.

To change or view the Derivative, press "3" and immediately, within one second, press ENTER. The "minutes" value will flash on the screen. Press ENTER to accept the value. To change the value press CLEAR and then enter the desired value. Press ENTER to exit this mode.

Restoring Factory Preset Values

To restore the factory preset values hold the "0" button on the keypad and turn the Main Power switch on the side of the unit to the ON position. Release the "0" button and the Main display will indicate OFF. The following preset values will be installed:

P =0.6%
I =0.25 repeats per minute
D =0.05 minutes

In addition, the following values will be preset

BAUD Rate	=9600
Stop bits	=1
Data Bits	=8
Parity	=none

MIN Power Mode

If desired, you can trade off bath cooling speed for increased temperature stability. Do this by placing the refrigeration system in a minimum power mode.

To place the unit in this mode press "5" followed immediately (within one second) by ENTER. The decimal point to the right of the Main display's °C or °F will flash. To exit and resume normal operation, press "5" followed immediately (within one second) by CLEAR.

Calibration

The microprocessor controller has three different modes of calibration: Self-Cal, Two-point, and One-point. The controller is shipped from the factory with a Two-point calibration so no additional controller calibration may be required. Both the internal probe and the remote sensor input must be independently calibrated. Different calibration modes for each probe can be used if desired. The remote sensor input has been Self-Calibrated at the factory.

Self-Cal is used to initialize the analog-to-digital (A/D) converter input channel before performing the other types of calibrations. This mode removes all previous calibrations and brings the measurement error to less than 2°C. If this is the required accuracy, then no additional calibration is needed.

Two-point calibration is used to negate A/D and probe errors over the full span of the controller. This type of calibration is performed when high accuracy is desired.

One-point calibration (offset) is used to make the controller very accurate at one specific operating temperature.

One-point Calibration can be performed after a Two-point calibration as many times as desired. Each One-point calibration adds a different offset to the original Two-point calibration data (if one was already performed).

Calibration Procedures

Note: The controller should be powered at least 15 minutes before calibration to assure the electronic circuits are at operating temperature. To perform One and Two-point calibrations on the remote sensor input the unit must be in the remote sensor mode. Messages will end with CAL 1 for internal probe calibrations and CAL 2 for remote sensor calibrations.

Self-Cal: The controller must be deactivated (displaying OFF) to access this mode. Press SETPT followed by ENTER to Self-Cal the internal probe input. The message "S-CAL 1" will be followed by "done". To Self-CAL the sensor input press SENSOR followed by ENTER. The message "S-CAL 2" followed by "done" will be displayed.

Two-point: For high accuracy measurements the controller input can be calibrated at two points. These two points (one high, one low) should be as far apart as practical for good performance.



Do not pick points that are outside the safe operating limits of the fluid in your application. For example with a water bath, 5°C and 35°C would be typical calibration points.

Before a Two-point cal, Self-cal must be performed on the desired sensor input.

With the controller on and measuring from the internal or remote probe, depending on which sensor is being calibrated, set the controller setpoint to the desired high cal temperature. When the bath reaches the setpoint and stabilizes, measure the actual bath temperature with an external calibrated thermometer. Press in quick succession "2" "." "ENTER". The message H-CAL # will appear followed by the flashing setpoint. Now enter in the actual bath temperature as measured by the calibrated thermometer and press ENTER. The Main display will indicate the temperature of the bath fluid (the calibrated temperature will not appear until the next step is complete).

Next set the controller setpoint to the desired low cal temperature. When the bath reaches this setpoint and stabilizes, measure the actual bath temperature with an external calibrated thermometer. Press in quick succession "2" "." "ENTER". The message L-CAL # will appear followed by the flashing setpoint. Now enter in the actual bath temperature as measured by the calibrated thermometer and press ENTER. The Main display will now indicate the calibrated temperature of the fluid in the bath.

One-point: Before a One-point cal, Self-cal or Two-point cal must be performed on the desired sensor.

With the controller on, and measuring from the internal or remote probe, depending on which sensor is being calibrated, set the controller setpoint to the desired temperature. When the bath reaches this setpoint and stabilizes, measure the actual bath temperature with an external calibrated thermometer. Press in quick succession "1" "." "ENTER". The message 1-CAL # will appear followed by the flashing setpoint. Now enter in the actual bath temperature as measured by the calibrated thermometer and press ENTER. The display will now show the calibrated temperature and all temperatures will have this offset added to them.

Calibration clear: At any point the calibration data from a One or Two-point cal can be erased by quickly pressing "2" "." "CLEAR". This procedure clears the calibration data only for the selected probe.

9-pin Auxillary Connector

The unit has a 9-pin female D connector located on the rear of the control box. Connect the supplied ten foot cable to access the connector's outputs.

The pin out information for the single wires at the other end of the cable is:

Pin 1 -Analog Signal Return
Pin 2 +Analog Signal Output
Pin 3 Fault In
Pin 4 Fault Out

The analog signal specifications are:



Ensure a minimum load impedance of 5Kohm.

Output signal range 0°C to 30°C
Absolute reference 0mV = 0°C
12 bit digital to analog converter output signal 1mV = 1°C
Output signal accuracy ±0.1mV
Output signal when temperature is less than 0°C is ~ 0mV
Output signal when temperature is greater than 30°C is ~ 30mV

A fault condition occurs under *any* of the following conditions:

Temperature of the bath is below the low temperature alarm setpoint
Temperature of the bath is above the high temperature alarm setpoint
Fluid flow is less than 0.5 gallons per minute

Should a fault occur the fault contact will open. The contact rating is 24VDC @ 0.5Amps, resistive load only.

To calibrate the analog output:

Verify the unit has had a 2-point calibration. If not, one needs to be accomplished before proceeding.
Connect a voltmeter to the analog output (pin 2) referenced to pin 1
Enter a 30°C setpoint on the microprocessor controller and then allow the bath to stabilize
On the microprocessor keypad quickly press **"3"** **"."** **"ENTER"**
The display will indicate "**d-cal**"
Use the keypad to adjust the analog output voltage to 30.00 ± 0.03mV. The "**0**" key lowers the voltage, the "**1**" key raises it. To fine tune the voltage use the "**+ -**" key.
Press "**ENTER**" to accept the new calibration or "**CLEAR**" to cancel it.
After ENTER is pressed the display will indicate "**dOnE**"

The analog output calibration is now complete. Bath temperatures between 0°C and 30°C will be transmitted as a corresponding voltage signal between 0.0mV and 30.0mV.

Section V Maintenance

Service Contracts

NESLAB offers on-site Service Contracts that are designed to provide extended life and minimal down-time for your unit. For more information, contact our Service Department (see Preface, After-sale Support).

Algae

To restrict the growth of algae in the bath, we recommend the bath cover be kept in place and that all circulation lines be opaque. This will eliminate the entrance of light required for the growth of most common algae.

If algae becomes a problem, contact our Service Department for a recommendation (see Preface, After-sale Support).

Section VI Troubleshooting

Checklist

Unit will not start

Make sure the voltage of the power source meets the specified voltage, ±10%. Refer to the serial number label on the rear of the unit to identify the specific electrical requirements of your unit.

Check the High Temperature/Low Liquid Level Safety. If the FAULT light is on, make sure the fluid level in the bath is between the marks in the baffle and the HIGH TEMP/LOW LEVEL SAFETY setting is greater than the fluid temperature. Push the RESET switch and attempt to restart.

Loss of cooling capacity

Be sure the cooling capacity of the unit has not been exceeded if circulating to an external system.

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.

Proper ventilation is required for heat removal. Make sure ventilation through the front and rear panels is not impeded and the panels are free of dust and debris.

Ice build up on the cooling coils can act as insulation and lower the cooling capacity. Raise the temperature of the bath to de-ice the cooling coil and increase the concentration of non-freezing fluid.

No external circulation

Make sure the stainless steel plugs on the PUMP INLET and PUMP OUTLET have been removed.

Check for obstructions, kinks, or leaks in the circulation tubing.

Circulation will cease when the pump head has been exceeded.

No communication between bath's microprocessor and your computer
Ensure the bath's microprocessor parameters (baud rate, parity etc.) match your computer requirements.

Ensure the RS-232 light is on steady. See Appendix A for details. **NOTE:** You cannot input data from the keypad when the RS-232 mode is enabled.

Check the cable. The microprocessor reads data on pin 2 and transmit data on pin 3. Ensure the cable is correctly connected. Computer 25-pin and 9-pin communication ports usually have different conventions.

Ensure the only pins connected to the microprocessor are 2, 3 and 5. All other pins must *not* be connected.

Service Assistance and Technical Support

If, after following these troubleshooting steps, your unit fails to operate properly, contact our Customer Service Department for assistance (see Preface, After-sale Support). Before calling, please obtain the following information:

Part number
Serial number
Voltage of unit
Voltage of power source

In addition to arranging warranty service, our Service Department can provide you with a wiring diagram and a complete list of spare parts for your unit. Before calling, please obtain the following information:

Part number
Serial number

Warranty

NESLAB Instruments, Inc. warrants for one (1) year from date of shipment any NESLAB unit according to the following terms.

Any part of the unit manufactured or supplied by NESLAB and found in the reasonable judgement of NESLAB to be defective in material or workmanship will be repaired by an authorized NESLAB Service Center without charge for parts or labor. The unit including any defective part must be returned to an authorized NESLAB Service Center within the warranty period. The expense of returning the unit to the authorized NESLAB Service Center for warranty service will be paid for by the buyer. NESLAB's responsibility in respect to warranty claims is limited to making the required repairs or replacements, and no claim of breach of warranty shall be cause for cancellation or rescission of the contract of sale of any unit.

This warranty does not cover any unit that has been subject to misuse, neglect, or accident. The 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 as specified in 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, the warranty does not extend to repairs made by the use of parts, accessories, or fluids which are either incompatible with the unit or adversely effect its operation, performance or durability.

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

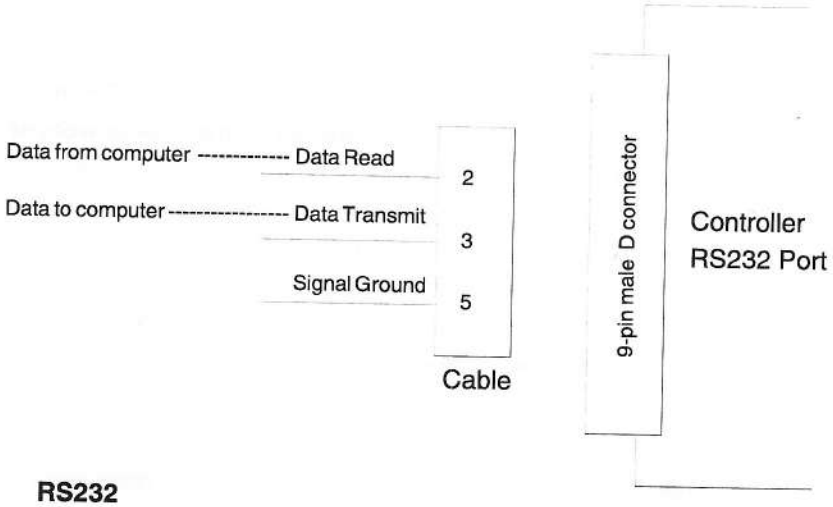
The foregoing express warranty is in lieu of all other warranties, expressed or implied, including warranties or merchantability and fitness for a particular purpose.

NESLAB's obligation under this warranty is strictly and exclusively limited to the repair or replacement of defective parts, and NESLAB does not assume or authorize anyone to assume for them any other obligation.

NESLAB assumes no responsibility for incidental, consequential, or other damages including, but not limited to loss or damage to property, loss of revenue, loss of use of the unit, loss of time, or convenience.

This warranty applies to units sold in the United States. Any units sold elsewhere are warranted by the affiliated marketing company of NESLAB Instruments, Inc. This warranty and all matters arising pursuant of it shall be governed by law of the State of New Hampshire, United States.

Appendix A RS232 Mode of Operation



RS232

The unit can be controlled through your computer's serial port by using a standard 9-pin RS232 connection on the rear of the temperature controller. Data transmit of the serial port connects to data read (pin 2) of the bath. Data read of the serial port connects to the data transmit (pin 3) of the bath.

NOTE: Do not use a cable that connects to the unused pins on the bath communications port. This may cause a communication fault.

With a cable properly connected to the controller press RS232, the RS232 LED will start to flash. Press ENTER while the LED is flashing and the RS232 LED will come on steady indicating your computer's serial port can control the unit's operation.

In this mode of operation you cannot manually input data with the keypad. You can, however, observe the setpoint and/or alarm temperature limits by pressing the appropriate button on the controller. Your computer can be used to operate all modes of operation.

Communication Commands

All commands must be entered in the exact format shown in the following four tables. Do not send a [LF] (line feed) after the [CR]. Ensure the specified letter case is used. The tables on the next few pages show all commands available, their format and responses. Controller responses are either the requested data, an exclamation point (!) if the command was properly executed, or a question mark (?) if the controller could not execute the command. A question mark response indicates either an improper command format or an attempt to enter settings that are outside the allowable range.

The controller response *must* be received before sending the next command.

NOTE: All responses by the bath are terminated by a single [CR] only.

TABLE 1 GENERAL COMMANDS	
Command Echo	SEi[CR]
Echo: i = 1, No echo: i = 0 (control returns commands)	
Set Setpoint	SSxxx.xx[CR]
-30.00 to +150.00°C or -22.00 to +300.00°F	
Read Setpoint	RS[CR]
Read Main Probe Temperature	RT[CR]
Read Remote Probe Temperature	RR[CR]
Turn Control On or Off	SOi[CR]
On: i = 1, Off: i = 0	
Set Power Status Flag	SWi[CR]
Set: i = 1, Reset i = 0 (reset when controller power is lost)	
Read Power Status Flag	RW[CR]
Read F or C Units	RU[CR]
TABLE 2 ALARM COMMANDS	
Set High Alarm Limit	SHxxx.xx[CR]
Same range as setpoint	
Read High Alarm Limit	RH[CR]
Set Low Alarm Limit	SLxxx.xx[CR]
Same range as setpoint	
Read Low Alarm Limit	RL[CR]
Read Alarm Status	RF[CR]
Returns: 0 = no alarm, 1 = alarm	
TABLE 3 CONTROL COMMANDS	
Set Proportional Bandwidth	SPxx.xx[CR]
0.10 to 10.00 % of full scale	
Read Proportional Bandwidth	RP[CR]
Set Integral Compensation	SIxx.xx[CR]
0.00 to 10.00 repeats/minute	
Read Integral Compensation	RI[CR]
Set Derivative Compensation	SDx.xx[CR]
0.00 to 1.00 minutes	
Read Derivative Compensation	Rd[CR]
Main/Remote Probe Selection	Sri[CR]
Main: i = 0, Remote: i = 1	
Compressor Inhibit	SCi[CR]
Inhibit: i = 0, Enable: i = 1	
Boost Heater Inhibit	SBi[CR]
Inhibit: i = 0, Enable: i = 1	
Max Mode Inhibit	SMi[CR]
Inhibit: i = 0, Enable: i = 1	

TABLE 3 CONTROL COMMANDS (Continued)	
Disable Auto Cool[1] Auto Cool: = 0, Manual Cool: = 1	STi[CR]
Auxillary Cooling Valve Open: 1 Closed: 0	SAi[CR]
Main Cooling Valve[2] Open: 1 Closed: 0	SFi[CR]

TABLE 4 PROGRAMMING COMMANDS	
Set Step Setpoint	SYn,xxx.xx[CR]
n = step number	
Read Step Setpoint	RYn[CR]
Set Step Period	SXn,xxx.xx[CR]
n = step number	
Read Step Period	RXn[CR]
Read Number of Steps	Rs[CR]
Set Number of Loops	SKxxxx[CR]
0 to 9999 additional loops after first program execution	
Read Number of Loops	RK[CR]
Set Hold Status	SZi[CR]
Hold: i = 1, No hold: i = 0	
Pause/Resume Program	SGi[CR]
Resume: i = 1, Pause: i = 0	
End Program	SR[CR]
Read Elapsed Step Time	RE[CR]
Select Program Number	SVx[CR]
Read Selected Program Number	RV[CR]
Read Current Period	RC[CR]
Skip Ahead One Period	SJ[CR]

1. Disables automatic cooling logic before manual control on the cooling valves is initiated.
2. Main cooling valve can be open only if the auxillary cooling valve is open.

To set the communications data format the controller must be deactivated (Main display indicates OFF). Press the RS232 button. The word "Baud" will momentarily appear followed by the current baud rate (9600, 4800, 1200, 600 or 300). Use the keypad to enter the desired change, if any. Press ENTER and "db" will momentarily appear followed by the current number of data bits setting. Again, use the keypad to enter any desired change (7 or 8) and then press ENTER. "Sb" will momentarily appear followed by the current number of stop bits (1 or 2). Change, if needed, and press ENTER and "PAr" will momentarily appear followed by the current parity control setting (0 = none, 1 = odd, 2 = even). Change, if needed, and press ENTER.

To manually exit this mode of operation press RS232. The RS232 LED will start to flash. Press the CLEAR button and the RS232 LED will extinguish.

Sample Program

Enter step setpoints using the SYn command, time periods using the SXn command, number of loops using the SKxxxx command and number of periods in the program using the Ssn command. Start the program using SG1 and suspend the program using SG0. When the program is finished it will stop automatically. If needed, SR will end the program at any time. Here is a four setpoint, two loop example:

SV1[CR]	Select program number one
SY1,25.00[CR]	First setpoint = 25.00 degrees
SX1,20.0[CR]	First period = 20.0 minutes
SY2,40.00[CR]	Second setpoint = 40.00 degrees
SX2,60.0[CR]	Second period = 60.0 minutes
SY3,40.00[CR]	Third setpoint = 40.00 degrees
SX3,45.0[CR]	Third period = 45.0 minutes
SY4,25.00[CR]	Fourth setpoint = 25.00 degrees
Ss3[CR]	Program has three periods
SK2[CR]	Execute the program three times total
SG1[CR]	Begin executing program
SG0[CR]	Temporarily suspend the program
SR[CR]	Stop the program before it is finished

Communication Command Protocol

The following table lists the communication command protocol for programming the controller via a computer. Use the Ctrl - C key combination to clear the controller receiving buffer if an erroneous character is detected.

FUNCTION	SYNTAX[1]	RETURN MESSAGE[2]
SET SETPOINT	SSxxx.xx[CR]	![CR]
SET LOW LIMIT	SLxxx.xx[CR]	![CR]
SET HIGH LIMIT	SHxxx.xx[CR]	![CR]
SET PROPORTIONAL BAND[3]	SPxx.xx[CR]	![CR]
SET INTEGRAL[4]	SIxx.xx[CR]	![CR]
SET DERIVATIVE[5]	SDx.xx or Sdx.xx[CR]	![CR]
COMPRESSOR IHHIBIT	SCi[CR]	![CR]
BOOST HEATER IHHIBIT	SBi[CR]	![CR]
MAX MODE IHHIBIT	SMi[CR]	![CR]
SET POWER STATUS FLAG	SWi[CR]	![CR]
SET ON/OFF	SOi[CR]	![CR]
SELECT PROGRAM NUMBER	SVx[CR]	![CR]
SET STEP SETPOINT	SYn,xxx.xx[CR]	![CR]
SET STEP PERIOD	SXn,xxx.x[CR]	![CR]
SET NUMBER OF PERIODS	Ssn[CR]	![CR]
SET NUMBER OF LOOPS	SKxxxx[CR]	![CR]
SET HOLD STATUS	SZi[CR]	![CR]
SET DISABLE AUTO COOL[6]	STi[CR]	![CR]
SET MAIN COOLING	SFi[CR]	![CR]
SET SECONDARY COOLING	SAi[CR]	![CR]
END PROGRAM	SR[CR]	![CR]
ECHO CONTROL[7]	SEi[CR]	![CR]
REMOTE SENSOR CONTROL	Sri[CR]	![CR]
SUSPEND/RESUME PROGRAM	SGi[CR]	![CR]
SKIP AHEAD ONE PERIOD	SJ[CR]	![CR]
READ SETPOINT	RS[CR]	xxx.xx[CR]
READ TEMPERATURE	RT[CR]	xxx.xx[CR]
READ ALARM STATUS	RF[CR]	![CR]
READ REMOTE TEMPERATURE	RR[CR]	xxx.xx[CR]
READ UNITS	RU[CR]	C[CR] or F[CR]
READ CURRENT PERIOD	RC[CR]	xx[CR]
READ ELAPSED TIME	RE[CR]	xxx.x[CR]
READ LOW LIMIT	RL[CR]	xxx.xx[CR]
READ HIGH LIMIT	RH[CR]	xxx.xx[CR]
READ PROPORTIONAL BAND	RP[CR]	xx.xx[CR]
READ INTEGRAL	RI[CR]	xx.xx[CR]
READ DERIVATIVE	Rd[CR]	x.xx[CR]
READ PROGRAM NUMBER	RV[CR]	x[CR]
READ STEP SETPOINT	RYn[CR]	xxx.xx[CR]
READ STEP PERIOD	RXn[CR]	xxx.x[CR]
READ NUMBER OF STEPS	Rs[CR]	x[CR]
READ NUMBER OF LOOPS	RK[CR]	xxxx[CR]
READ POWER STATUS	RW[CR]	x[CR]

1. x = ASCI digit, i = 0 (OFF or STOP) i = 1 (ON or GO), n = step number.
2. Ensure the return message is correct. If not, resend or troubleshoot communication lines.
3. Factory preset at 0.6%.
4. Factory preset at 0.25 repeats per minute.
5. Factory preset at 0.05 minutes.
6. Disable internal automatic cool logic before using the 'SF' and 'SA' commands to manually control the cooling values.
7. Allows computer to compare send signal to receive signal.

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