At Dimplex Thermal Solutions we are aware that our success depends on your satisfaction. We thank you for the confidence you have displayed in our company through your recent purchase of a Dimplex Thermal Solutions chiller.

The unit is designed with your specific needs in mind to provide years of service and ongoing satisfaction. It has been thoroughly tested in our plant prior to shipping and stands ready to exceed expectations.

Please thoroughly review the enclosed materials before installation or operation. These pages contain detail regarding suggested fluids, start-up/maintenance operation and controls applications. They will guide you through the important steps of making this purchase part of your process.

As always, we stand by our product and should you require clarification or service please call us at:
1-800-YOU-KOOL (968-5665)
or 269-349-6800
# AIR COOLED CHILLER INSTALLATION and OPERATION MANUAL

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GENERAL INFORMATION REGARDING DESIGN TEMPERATURE

Our custom chiller systems are designed to maintain the temperature of cooling fluids within a selected temperature range. Each of our units is tested through monitored operation within design parameters. This enables our experienced technicians to calibrate all instrumentation precisely to the customers needs and verify that each individual unit will function as specified. Supporting test data is enclosed either in digital format or in print.

The units are designed to operate efficiently within given parameters. Due to varying heat exchange rates outside of design temperature, it is highly recommended that the machine operate only at temperatures within 10°F of the specified temperature. **Consult the factory if a process requires changes in excess of 10°F in either direction of design temperature.**

INSTALLATION:

1. Read and follow all information included with the chiller manual.
2. Read and understand all warning labels and tags on the chiller before installation.
3. Ensure the unit is placed on a flat, level, hard surface. Unless the chiller has been built for outdoor operation, it must be placed indoors. Space above and around the unit must be capable of dissipating the heat rejected by the chiller and allow room for servicing. Keep the unit at least 3ft away from walls or other objects and allow full access to all openings and electrical enclosures. At a minimum, 8ft of clearance is required above the unit for proper air circulation around the chiller as shown in Fig 1.
4. Chillers with solid feet should be secured using the provided mounting holes if possible. Units that have caster wheels should be locked to ensure the chiller does not move around.

5. Connect fluid lines to the proper fittings from the process to the chiller marked “FLUID INLET TO CHILLER” and “FLUID OUTLET FROM CHILLER”. Make sure that the flow of fluid to and from the unit can not be shut off or blocked while the chiller is in operation. Piping size should be large enough to match the fluid flow conditions, generally the size of the fittings on the chiller.

6. Fill the process plumbing and, if applicable, the chiller reservoir with the proper type and amount of fluid. **Check with the manufacturer of the process equipment for specific fluid requirements. Refer to the “Process Fluid Recommendations” section of the manual for information on using water in the chiller.**

7. Purge any air out of the fluid system to ensure that the pump suction is flooded. If possible, bleed any air trapped in the pump by opening the vent plug at the top of the pump until no more air comes out and fluid is present in the pump cavity.

**DO NOT ALLOW THE FLUID PUMP TO RUN DRY. THIS WILL DAMAGE THE PUMP SEALS AND WILL NOT BE COVERED UNDER WARRANTY.**

8. Connect any communication wiring between the chiller and process equipment including remote controls and interlocks. All communication and remote wiring is to be provided by the customer. Refer to the chiller’s electrical prints for information on wiring locations.
9. Run power wiring to the chiller’s main disconnect. Conductor size should match the chiller’s disconnect size and power requirements in accordance with local codes. Ensure the power supplied matches the chiller data plate requirement for voltage, frequency, and amperage.

10. All inclusive units are shipped with the proper refrigerant charge in place. No adjustments should be necessary to the refrigeration system before startup. Refrigeration service valves are shipped in the open (back-seated) position.

11. Chillers with a remote condenser are shipped with a nitrogen charge from the factory. Refer to the included refrigeration drawing or contact Dimplex Thermal Solutions (DTS) for instructions on installing remote condenser units.

BASIC COMPONENTS:
Refer to Figure 2 for identification of the main parts on a standard DTS chiller. Please note that this is only a general representation of components and the model of your chiller may differ from the design shown. Contact Dimplex Thermal Solutions for specific component information regarding your chiller.

Figure 2. Basic Air-Cooled Chiller Components
**PRE-STARTUP PROCEDURE:**

1. Complete all steps of the *installation* process before applying power to the chiller.

2. If the unit is equipped, ensure the system switch is in the OFF position, then turn on the main power disconnect. The temperature controller will turn on and automatically go into a self-test. When the self-test is complete, the controller will begin to monitor the process fluid.

3. For units that run on three-phase power, **motor rotation must be checked and corrected to avoid damaging the chiller and voiding the warranty.** If the chiller is equipped with a phase protector, the unit will not start up and may display a fault if phase rotation is not correct. Correcting phase rotation should make this fault go away.

   Single phase units will not be affected by any certain phase rotation and should continue on with step 4 of the *pre-startup procedure*.

   If the unit is equipped with a process fluid pump, phase rotation can be checked by briefly turning on the system and allowing the pump to energize. Watch the rotation of the cooling fan on the pump to see that it is turning in the direction indicated by the rotation arrow on the pump motor. Do not use condenser fans to judge phase rotation as many three phase units have single phase fans and will run correctly from DTS even with incorrect power phasing.

   If the unit does not have a pump or any other visual method of checking rotation, a phase checking device can be used to check power at the disconnect. All components of the chiller are wired to operate with a “right-hand” phase rotation. If you do not have a phase checking device, a certified refrigeration technician should be utilized to monitor refrigerant pressures as the chiller compressor comes online.

   **All motors within the chiller are synchronized at the factory for proper rotation.** If one motor is turning in the wrong direction, all other motors will as well. **DO NOT** change the orientation of any motor leads within the chiller. If phase rotation is incorrect, shut off the power feed and change any two incoming power leads **BEFORE** the main disconnect.

4. Chillers two tons or larger are equipped with a compressor crankcase heater. These units must have power supplied to the unit with only the disconnect switch on for 8 hours prior to starting the chiller. This will raise the temperature of the compressor oil enough to vaporize any refrigerant that may be in the crankcase oil. **Failure to allow this warm-up can result in compressor damage.**

5. Ensure all process fluid lines and shutoff valves are open and the system is able to flow freely. Re-check the fluid level in the system before continuing with the startup.

**INITIAL STARTUP & OPERATING PROCEDURE:**

1. Complete all steps of the *pre-startup procedure* before starting the chiller process.

2. Before turning on the chiller system, become familiar with the operation of the temperature controller on the chiller. Refer to the *temperature controller guide* in this manual for instructions.

3. Turn on the chiller process by moving the selector switch to either **ON** or **LOCAL**. If the unit is wired to start remotely, turn the selector switch to **REMOTE** and start the chiller from the other location.

   Chillers that do not have a process selector switch or remote control should begin the chilling process as soon as the disconnect switch is turned on.

4. If the unit is equipped with a process pump, it will energize and produce flow as soon as the chiller is turned on. Monitor any system
pressure gauges and make note of initial pressures. The pump may need to run for several minutes to allow any air to be worked out of the system before regular flow is established. Any fluid bypass valves in the system should be factory set according to customer specifications but may need slight adjustment in the field. Consult the factory before making any adjustments to the system.

5. Check the entire fluid system for leaks and ensure there is flow throughout the system.

6. After the pump turns on, the temperature controller will then analyze the process fluid temperature and determine whether or not cooling is needed. If the fluid temperature is above setpoint, the refrigerant compressor will commence and begin cooling the fluid.

7. Monitor the chiller to ensure it is performing as designed. The chiller should be able to maintain the desired fluid setpoint under a full load from the process. Slight adjustments may be necessary according to your specific process. Please consult a technician at Dimplex Thermal Solutions before making any changes to the unit.

8. To turn off the chiller process, move the selector switch to the OFF position. With the selector OFF, the temperature controller display will be on to monitor the process, but indicate the system is off. Keep the chiller’s main power-disconnect ON even when the chiller is not in use, unless it is used to turn the chiller process off and on. This keeps the power to the crankcase heater and prevents compressor damage when starting again.

If the unit is equipped with a fluid maintenance heater, the heater will operate if the fluid falls below the factory setpoint and will operate with the selector switch off.

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**MAINTENANCE:**

**Proper maintenance is the key to extending the life of your chiller.** Routine checks and a watchful eye will minimize costly repairs and down time. Establish a regular schedule of maintenance depending on the amount the chiller is used and the environment in which it is used. Environments that are very dirty or dusty will require more attention than ones that maintain a cleaner atmosphere.

This list of maintenance items will help to ensure an operational chiller:

1. **Inspect and clean condenser / air filters**
   Excessive buildup of dirt, oil, and other debris on the condenser coil will cause refrigerant pressures to increase and not allow the unit to perform to its full capacity. Ensure the fins of the condenser are clean and not damaged to keep airflow at a maximum. Use compressed air at no more than 30PSI to blow out the condenser in the opposite direction of air flow. If the unit is equipped with air filters, clean them with compressed air or wash them out with water and allow drying before reinstallation.

2. **Check water quality/glycol mixture**
   The process fluid should be clean and free of contaminants. If the chiller has a reservoir, check for debris or contaminants which could reduce the efficiency of your chiller. Check for normal inlet and outlet fluid pressures through the chiller. A large pressure differential could indicate a plugged heat exchanger or dirty tank. Test the process fluid to ensure proper freeze and corrosion protection in accordance with original design specifications. Do not test the process fluid from the sight glass due to the lower turnover at that location.

3. **Inspect fluid filters**
   Fluid filters should be clean enough to allow for proper flow and pressure in the system. An increased fluid pressure on the system may indicate a dirty filter. Replacement of fluid filters should be done at regular intervals to keep the fluid system clean and free flowing. Inspect fluid filters shortly after initial start-up of the chiller and establish a basis for how frequently they may need to be changed in the future.

4. **Inspect fluid system**
Visually check for fluid leaks throughout system. Physically check for loose pipe fittings or hoses. Ensure that no plumbing parts are wearing, cracking, or chafing.

5. Check voltage & amp draws
Check for proper incoming voltage and current draws on all motors and heaters. Refer to the chiller's electrical schematics or the motor nameplate for proper voltage and amperage ratings. Readings should be within +/- 10% of the nameplate and have a maximum difference of +/- 2% between each phase.

6. Inspect mechanical components
Check mechanical components of the chiller for signs of wear or over-heating. Metallic sounds or other excessive noise could indicate a problem with the chiller. Discolored paint or metal could be a sign of a motor under excessive load and over-drawing current. Keep all components with lubrication fittings properly filled according to the nameplate data or information tag.

7. Check all wiring
Ensure the chiller’s main power disconnect is OFF. Check the electrical box and all junction boxes for any loose or damaged wiring. Replace any wiring that could cause problems with shorting or unintentional grounds.

8. Inspect/test refrigeration system
Check the inside of the chiller for evidence of refrigerant leaks. Spots of oil inside of the chiller or refrigeration lines covered in oil could indicate a possible leak. Have a certified refrigeration technician check the refrigeration system for proper operation. The technician should leak check the unit, monitor operating pressures, and adjust as needed.

9. Pump seals
All pump seals are designed to have some leakage to promote long seal life. The two parallel parts of the pump seal are separated by a thin film of the fluid being pumped. If pump seals did not leak at all, the two halves of the pump seal would contact each other and quickly be destroyed. With this said, with water or water/glycol most of the leaking fluid evaporates before ever dripping below the pump. With a water/glycol mixture some evidence of glycol staining or a drop or two below the pump is considered normal. With pumps used with oil, one should expect some evidence of oil near the pump considering that the oil cannot evaporate. A small amount of leakage is considered normal and desirable for long seal life.

- For more information, contact the DTS Service Department 24 hours a day at 1-800-YOU-KOOL. Be sure to have model and serial number ready when calling.
- To purchase spare parts and regular maintenance items for your chiller, contact our Parts department at 1-800-YOU-KOOL.

PROCESS FLUID RECOMMENDATIONS:
For recommendations on the correct process fluid to use in your chilling system, refer to the manufacturer of the equipment served by the chiller. Most manufacturers have a specified type of fluid for correct system operation. This document should serve as a guide only when using a glycol and water mixture for the heat transfer fluid.

USING WATER FOR CHILLER PROCESS:
Dimplex Thermal Solutions recommends the use of an industrial inhibited glycol and water mixture in its water chiller systems. The main job of glycol is to prevent freezing of the process fluid and ensure consistent flow at the operating temperature. Inhibited glycols will also prevent formation of scale and corrosion while protecting metals such as brass, copper, steel, cast iron, and aluminum. Water systems treated with inhibited glycol will also be protected from algae and bacteria that can grow and degrade the fluid system performance. Ethylene and Propylene are the two standard types of inhibited glycols that can be used in DTS chillers.

- Do not mix different types or brand names of glycol as this can result in some inhibitors precipitating out of the solution.
- Do not use automotive grade anti-freeze in the chiller process. These types of glycols are not designed for industrial applications and may cause problems with heat transfer or fluid flow.
Many automotive glycols contain silicate-based inhibitors that can coat heat-exchangers, attack pump seals, or form a flow restricting gel.

Check state and local codes when selecting the process fluid. Certain areas may have environmental regulations concerning the use and disposal of glycol or other additives.

**ETHYLENE GLYCOL:**
Ethylene glycol is the standard heat-transfer fluid for most industrial applications. This type of glycol can be used in any application where a low-toxicity content is not required. Ethylene glycol has moderately acute oral toxicity and should not be used in processes where the fluid could come in contact with potable water, food, or beverage products.

**PROPYLENE GLYCOL:**
Propylene glycol maintains generally the same freeze protection, corrosion and algae prevention as ethylene glycol, but has a lower level of toxicity. This type of glycol is more readily disposable than ethylene and safer to handle. Propylene glycol is commonly used in the food industry and in applications where the user may come in frequent contact with the fluid.

**Dimplex Thermal Solutions recommends the use of K-Kool Glycols in its units.**

**WATER:**
When selecting the water to mix with the glycol, use a good quality, filtered source that meets the requirements of the process machine manufacturer. Dimplex Thermal Solutions recommends the use of **distilled** or **reverse-osmosis** water for the water / glycol mixture.

**De-ionized** water can be used to fill the chiller process initially, but should not be maintained to a de-ionized state thereafter. Unless the chiller has been ordered and designed for the use of water that is continually de-ionized, the fluid will actually attack certain metals within the chiller and cause damage to some components. Damage caused by the use of maintained de-ionized water in a chiller not designed for it will not be covered under warranty. Consult DTS before continuously using de-ionized water to check for compatibility.

The use of regular tap water is not recommended. Water from the “city” or “ground” contains deposits and additives which can decrease component life and increase maintenance time.

**GLYCOL / WATER MIXTURES:**
The location of the chiller and environmental concerns must be taken into account when selecting the proper mixture of glycol and water for the chiller process. A process which is located completely indoors and has no chance of freezing will require less glycol than a system located outdoors where low temperatures can cause the fluid to freeze and piping to burst. Applications that have a low operating temperature (below 30°F) should use a glycol mixture equivalent to an outdoor system.

After selecting the proper glycol and water types, use the following chart to determine the recommended mixture depending on application and location of the process. The glycol percentage figures in the chart below will apply to any brand of ethylene or propylene glycol.

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>GLYCOL %</th>
<th>WATER %</th>
<th>FREEZE PROTECTION*</th>
<th>BURST PROTECTION*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor chiller and process</td>
<td>30</td>
<td>70</td>
<td>5°F / -15°C</td>
<td>-20°F / -29°C</td>
</tr>
<tr>
<td>Outdoor chiller / Low fluid temperature system (&lt;30°F)</td>
<td>50</td>
<td>50</td>
<td>-35°F / -37°C</td>
<td>-60°F / -60°C</td>
</tr>
</tbody>
</table>

* Figures based on performance of DTS “K-Kool-E” brand of Ethylene Glycol.
FLUID MAINTENANCE / FILTRATION:
Maintaining clean process water and the proper glycol content will extend the life of the system and reduce costly down-time. If the chiller was not equipped with a fluid filter from the factory, it is highly recommended to install some sort of filtering system to remove unwanted dirt and debris. Refer to the Chiller Maintenance section of the manual for water and filter maintenance information.
**TROUBLESHOOTING GUIDE:**
- This guide should serve as a general outline for troubleshooting issues with all Dimplex Thermal Solutions chillers. Due to the various models of DTS chillers, the items listed in possible causes may not apply to every DTS chiller. Contact the DTS customer service department for assistance at 1-800-YOU-KOOL.
- Refer to the Warranty Procedures section of this manual before having any work performed on units that are under warranty.

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>POSSIBLE CAUSE</th>
<th>CORRECTIVE ACTION</th>
</tr>
</thead>
</table>
| Chiller will not turn on. (No display on temperature controller) | • No power to chiller.  
• Main disconnect turned off.  
• Blown fuses.  
• Tripped starter overloads. | • Check power feed to chiller.  
• Turn on main disconnect.  
• Check for and replace blown fuses.  
• Reset any tripped overloads. |
| Chiller turns on but nothing happens. (Display is on but no pump or cooling cycle) | • Selector switch not turned on.  
• Remote signal not active.  
• Fault present within chiller.  
• Fluid pump not operating.  
• Blown fuses.  
• Phase rotation incorrect. | • Turn selector switch to ON or LOCAL.  
• Check remote connection for signal.  
• Determine fault and clear if possible.  
• Check pump overload and power to contactor.  
• Check and replace fuses.  
• Correct phase rotation at main disconnect. |
| Fluid pump is on but does not create required pressure or flow. (Flow fault) | • No fluid present at pump suction.  
• Pump discharge closed or blocked.  
• Fluid is dirty / dirty filters.  
• Fluid line size too small.  
• Pump / fluid system is air-bound.  
• Phase rotation incorrect. | • Check fluid level and ensure there is fluid at the pump’s suction.  
• Ensure all fluid lines are open to flow.  
• Clean fluid and change filters.  
• Up-size fluid lines outside of chiller.  
• Vent pump cavity to flood the suction.  
• Correct phase rotation at main disconnect. |
| Fluid pump is operational but the refrigerant compressor will not run. | • Fluid temp is below setpoint.  
• Inadequate fluid flow.  
• Low refrigerant pressure.  
• High refrigerant pressure.  
• Compressor overload tripped.  
• Compressor lube protector tripped (If equipped).  
• Blown fuses to compressor.  
• Faulty temp controller output.  
• Bad compressor. | • Allow fluid system to increase in temperature.  
• Correct fluid system to establish flow.  
• SEE "Low refrigerant fault" section.  
• SEE "High refrigerant fault" section.  
• SEE "Compressor overload" section.  
• Reset lube protector.  
• Check and replace blown fuses.  
• Consult DTS customer service department.  
• Consult DTS customer service department. |
| Chiller is running but does not maintain the desired fluid temp. | • Fault present within chiller.  
• Phase rotation incorrect.  
• Fluid or heat exchanger is dirty.  
• Loss of flow or fluid level.  
• Low refrigerant pressure.  
• Ambient temperature too high.  
• Heat load exceeds chiller’s capacity. | • Determine fault and clear if possible.  
• Correct phase rotation at incoming power.  
• Replace fluid and clean fluid system.  
• Check fluid system for free flow and ensure chiller has adequate fluid level.  
• Restart chiller or clear fault on controller.  
• SEE “low refrigerant fault” section.  
• Ensure chiller is operating within its designed ambient temperature specification.  
• Reduce heat load to chiller if possible.  
• Check the factory specifications to ensure the chiller is not being operated more than +/- 10°F of the original temperature setpoint or fluid flow. |
| Low refrigerant pressure fault - *(Automatically reset when satisfied with pressure)* | • Low ambient air temperature.  
• Loss of fluid flow through evaporator.  
• Loss of refrigerant.  
• Refrigerant solenoid not functional.  
• Faulty pressure switch.  
• Compressor crankcase not warm or faulty crankcase heater. | • Ensure chiller is operating within its designed ambient temperature specification.  
• Check fluid flow and ensure evaporator is clean.  
• Have a refrigeration technician leak check unit and charge with the appropriate refrigerant.  
• Check wiring to solenoid or replace valve.  
• Replace pressure switch.  
• Ensure main power disconnect has been on for at least 8 hours prior to use. Replace crankcase heater if faulty. |
| High refrigerant pressure fault - *(Manually reset inside of chiller)* | AIR COOLED CHILLERS:  
• Air filters dirty.  
• Condenser dirty.  
• Incoming air too hot.  
• Inoperative fans.  
• Back panel out of chiller.  
• Phase rotation incorrect.  
• Refrigerant system overcharged.  
WATER COOLED CHILLERS:  
• Low water flow to condenser.  
• Condenser dirty.  
• Regulating valve operating incorrectly.  
• Refrigerant system overcharged. | • Clean filters (See maintenance section).  
• Clean condenser (See maintenance section).  
• Ensure the chiller is properly ventilated with fresh air not exceeding 90°F, unless designed for high-ambient temperature operation.  
• Check for blown fan fuses.  
• Ensure all covers and panels are in chiller.  
• Correct phase rotation at incoming power.  
• Have a refrigeration technician ensure the system is properly charged.  
• Check condenser water supply and pressure.  
• Clean condenser.  
• Have a refrigeration technician adjust the valve to the proper pressure setting and check operation.  
• Have a refrigeration technician ensure the system is properly charged. |
| Compressor overload - *(May be manually or automatically reset, depending on compressor)* | • Compressor running too hot.  
• Temperature setpoint too high.  
• Refrigerant pressures too high or low.  
• Faulty overload module.  
• Low voltage to chiller.  
• Defective compressor. | • Allow compressor to cool, then restart unit.  
• Move temperature setpoint to +/- 10°F of factory setting.  
• Have a refrigeration technician monitor pressures and determine cause.  
• If compressor will run, check amp draw on compressor leads to verify compressor is ok.  
• Correct incoming voltage.  
• Replace compressor. |
GENERAL WARRANTY PROCEDURES:

WARRANTY WORK:
Before doing any work on a chiller covered under warranty, call Dimplex Thermal Solutions (DTS) and explain the problem to one of our service technicians who can then determine the best course of action. DTS will not be obligated to pay for warranty service performed without our prior approval.

Please Note: It is the service contractor’s responsibility to enclose a service report/work order with each invoice. Unless pre-authorized for special circumstances, DTS will not honor invoices for work done by two or more people at a time, or for overtime labor charges. If the customer requests work that falls into either of these categories, the customer is responsible for the extra charges incurred.

WARRANTY PARTS:
All replacement parts under warranty must come from Dimplex Thermal Solutions. When it is necessary for DTS to replace parts which are under warranty, we will issue a Returned Goods Authorization (RGA) for all parts we wish to have shipped back to our factory, freight prepaid. RGA’s are valid for a period of thirty (30) days. If DTS has not received the requested parts by the expiration date, the customer will be invoiced for the replacement cost at that time.

Please Note: While DTS is willing to pay freight charges one way for replacement parts, special freight charges such as next day service, Saturday delivery, etc, are not included. If the customer requests one of these special services, they are responsible for the charges incurred.

____________________________________
DIMPLEX THERMAL SOLUTIONS

2625 Emerald Drive
Kalamazoo, MI 49001

1-800-YOU-KOOL
(1-800-968-5665)
1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: R-22
DISTRIBUTOR: National Refrigerants, Inc.
661 Kenyon Avenue
Bridgeton, New Jersey 08302

FOR MORE INFORMATION CALL: (Monday-Friday, 8:00am-5:00pm)
1-800-262-0012

IN CASE OF EMERGENCY CALL:
CHEMTREC: 1-800-424-9300

2. COMPOSITION / INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>INGREDIENT NAME</th>
<th>CAS NUMBER</th>
<th>WEIGHT %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorodifluoromethane</td>
<td>75-45-6</td>
<td>100</td>
</tr>
</tbody>
</table>

Trace impurities and additional material names not listed above may also appear in Section 15 toward the end of the MSDS. These materials may be listed for local “Right-To-Know” compliance and for other reasons.

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: Colorless, volatile liquid with ethereal and faint sweetish odor. Non-flammable material. Overexposure may cause dizziness and loss of concentration. At higher levels, CNS depression and cardiac arrhythmia may result from exposure. Vapors displace air and can cause asphyxiation in confined spaces. At higher temperatures, (>250°C), decomposition products may include Hydrochloric Acid (HCl), Hydrofluoric Acid (HF) and carbonyl halides.

POTENTIAL HEALTH HAZARDS

SKIN: Irritation would result from a defatting action on tissue. Liquid contact could cause frostbite.

EYES: Liquid contact can cause severe irritation and frostbite. Mist may irritate.

INHALATION: R-22 is low in acute toxicity in animals. When oxygen levels in air are reduced to 12-14% by displacement, symptoms of asphyxiation, loss of coordination, increased pulse rate and deeper respiration will occur. At high levels, cardiac arrhythmia may occur.

INGESTION: Ingestion is unlikely because of the low boiling point of the material. Should it occur, discomfort in the gastrointestinal tract from rapid evaporation of the material and consequent evolution of gas would result. Some effects of inhalation and skin exposure would be expected.

DELAYED EFFECTS: None Known
Ingredients found on one of the OSHA designated carcinogen lists are listed below.

<table>
<thead>
<tr>
<th>INGREDIENT NAME</th>
<th>NTP STATUS</th>
<th>IARC STATUS</th>
<th>OSHA LIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>No ingredients listed in this section</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. FIRST AID MEASURES

SKIN: Promptly flush skin with water until all chemical is removed. If there is evidence of frostbite, bathe (do not rub) with lukewarm (not hot) water. If water is not available, cover with a clean, soft cloth or similar covering. Get medical attention if symptoms persist.

EYES: Immediately flush eyes with large amounts of water for at least 15 minutes (in case of frostbite, water should be lukewarm, not hot) lifting eyelids occasionally to facilitate irrigation. Get medical attention if symptoms persist.

INHALATION: Immediately remove to fresh air. If breathing has stopped, give artificial respiration. Use oxygen as required, provided a qualified operator is available. Get medical attention immediately. DO NOT give epinephrine (adrenaline).

INGESTION: Ingestion is unlikely because of the physical properties and is not expected to be hazardous. DO NOT induce vomiting unless instructed to do so by a physician.

ADVICE TO PHYSICIAN: Because of the possible disturbances of cardiac rhythm, catecholamine drugs, such as epinephrine, should be used with special caution and only in situations of emergency life support. Treatment of overexposure should be directed at the control of symptoms and the clinical conditions.

5. FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES

<table>
<thead>
<tr>
<th>FLASH POINT:</th>
<th>Gas, not applicable per DOT regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLASH POINT METHOD:</td>
<td>Not applicable</td>
</tr>
<tr>
<td>AUTOIGNITION TEMPERATURE:</td>
<td>Unknown</td>
</tr>
<tr>
<td>UPPER FLAME LIMIT (volume % in air):</td>
<td>None*</td>
</tr>
<tr>
<td>LOWER FLAME LIMIT (volume % in air):</td>
<td>None*</td>
</tr>
<tr>
<td>FLAME PROPAGATION RATE (solids):</td>
<td>Not applicable</td>
</tr>
<tr>
<td>OSHA FLAMMABILITY CLASS:</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

EXTINGUISHING MEDIA:

Use any standard agent – choose the one most appropriate for type of surrounding fire (material itself is not flammable).

UNUSUAL FIRE AND EXPLOSION HAZARDS:

R-22 is not flammable at ambient temperatures and atmospheric pressure. However, this material will become combustible when mixed with air under pressure and exposed to strong ignition sources. Contact with certain reactive metals may result in formation of explosive or exothermic reactions under specific conditions (e.g. very high temperatures and/or appropriate pressures).
SPECIAL FIRE FIGHTING PRECAUTIONS/INSTRUCTIONS:
Firefighters should wear self-contained, NIOSH-approved breathing apparatus for protection against possible toxic decomposition products. Proper eye and skin protection should be provided. Use water spray to keep fire-exposed containers cool.

6. ACCIDENTAL RELEASE MEASURES

IN CASE OF SPILL OR OTHER RELEASE:  (Always wear recommended personal protective equipment.)
Evacuate unprotected personnel. Protected personnel should remove ignition sources and shut off leak, if without risk, and provide ventilation. Unprotected personnel should not return until air has been tested and determined safe, including low-lying areas.

Spills and releases may have to be reported to Federal and/or local authorities. See Section 15 regarding reporting requirements.

7. HANDLING AND STORAGE

NORMAL HANDLING:  (Always wear recommended personal protective equipment.)
Avoid breathing vapors and liquid contact with eyes, skin or clothing. Do not puncture or drop cylinders, expose them to open flame or excessive heat. Use authorized cylinders only. Follow standard safety precautions for handling and use of compressed gas cylinders.

R-22 should not be mixed with air above atmospheric pressure for leak testing or any other purpose. See Section 5: Unusual Fire and Explosion Hazards

STORAGE RECOMMENDATIONS:
Store in a cool, well-ventilated area of low fire risk and out of direct sunlight. Protect cylinder and its fittings from physical damage. Storage in subsurface locations should be avoided. Close valve tightly after use and when empty.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

ENGINEERING CONTROLS:
Provide local ventilation at filling zones and areas where leakage is probable. Mechanical (general) ventilation may be adequate for other operating and storage areas.

PERSONAL PROTECTIVE EQUIPMENT

SKIN PROTECTION:
Skin contact with refrigerant may cause frostbite. General work clothing and gloves (leather) should provide adequate protection. If prolonged contact with liquid or gas is anticipated, insulated gloves constructed of PVA, neoprene or butyl rubber should be used. Any contaminated clothing should be promptly removed and washed before reuse.

EYE PROTECTION:
For normal conditions, wear safety glasses. Where there is reasonable probability of liquid contact, wear chemical safety goggles.
RESPIRATORY PROTECTION:
None generally required for adequately ventilated work situations. For accidental release or non-ventilated situations, or release into confined space, where the concentration may be above the PEL of 1,000 ppm, use a self-contained, NIOSH approved breathing apparatus or supplied air respirator. For escape: use the former or a NIOSH approved gas mask with organic vapor canister.

ADDITIONAL RECOMMENDATIONS:
Where contact with liquid is likely, such as in a spill or leak, impervious boots and clothing should be worn. High dose-level warning signs are recommended for areas of principle exposure. Provide eyewash stations and quick-drench shower facilities at convenient locations. For tank cleaning operations, see OSHA regulations, 29 CFR 1910.132 and 29 CFR 1910.133.

EXPOSURE GUIDELINES

<table>
<thead>
<tr>
<th>INGREDIENT NAME</th>
<th>ACGIH TLV</th>
<th>OSHA PEL</th>
<th>OTHER LIMIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorodifluoromethane</td>
<td>1000 ppm  TWA (8hr)</td>
<td>1000 ppm TWA (8hr)</td>
<td>None</td>
</tr>
</tbody>
</table>

OTHER EXPOSURE LIMITS FOR POTENTIAL DECOMPOSITION PRODUCTS:
Hydrogen Fluoride: ACGIH TLV = 3ppm ceiling

9. PHYSICAL AND CHEMICAL PROPERTIES

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPEARANCE</td>
<td>Clear, colorless liquid and vapor</td>
</tr>
<tr>
<td>PHYSICAL STATE</td>
<td>Gas at ambient temperatures</td>
</tr>
<tr>
<td>MOLECULAR WEIGHT</td>
<td>86.45</td>
</tr>
<tr>
<td>CHEMICAL FORMULA</td>
<td>CHClF₂</td>
</tr>
<tr>
<td>ODOR</td>
<td>Faint ethereal odor</td>
</tr>
<tr>
<td>SPECIFIC GRAVITY (water = 1.0)</td>
<td>1.21 @ 21.1°C (70°F)</td>
</tr>
<tr>
<td>SOLUBILITY IN WATER (weight %)</td>
<td>0.3 wt% @ 25°C and 1 atmosphere</td>
</tr>
<tr>
<td>pH</td>
<td>Neutral</td>
</tr>
<tr>
<td>BOILING POINT</td>
<td>-40.8°C (-41.40°F)</td>
</tr>
<tr>
<td>FREEZING POINT</td>
<td>-160°C (-256°F)</td>
</tr>
<tr>
<td>VAPOR PRESSURE</td>
<td>136.1 psia @ 70°F</td>
</tr>
<tr>
<td></td>
<td>311.4 psia @ 130°F</td>
</tr>
<tr>
<td>VAPOR DENSITY (air = 1.0)</td>
<td>3.0</td>
</tr>
<tr>
<td>EVAPORATION RATE</td>
<td>&gt;1</td>
</tr>
<tr>
<td>% VOLATILES</td>
<td>100</td>
</tr>
<tr>
<td>FLASH POINT</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

(Flash point method and additional flammability data are found in Section 5.)
10. STABILITY AND REACTIVITY

NORMALLY STABLE? (CONDITIONS TO AVOID):
   The product is stable.
   Do not mix with oxygen or air above atmospheric pressure. Any source of high temperatures, such as lighted cigarettes, flames, hot spots or welding may yield toxic and/or corrosive decomposition products.

INCOMPATIBILITIES:
   (Under specific conditions: e.g. very high temperatures and/or appropriate pressures) – Freshly abraded aluminum surfaces (may cause strong exothermic reaction). Chemically reactive metals: potassium, calcium, powdered aluminum, magnesium, and zinc.

HAZARDOUS DECOMPOSITION PRODUCTS:
   Halogens, halogen acids and possibly carbonyl halides.

HAZARDOUS POLYMERIZATION:
   Will not occur.

11. TOXICOLOGICAL INFORMATION

IMMEDIATE (ACUTE) EFFECTS:
   LC₅₀ : 4 hr. (rat) - ≥ 300,000 ppm / Cardiac Sensitization threshold (dog) - 50,000 ppm

DELAYED (SUBCHRONIC AND CHRONIC) EFFECTS:
   Subchronic inhalation (rat) NOEL – 10,000 ppm
   Not mutagenic in in-vitro or in-vivo tests
   Not teratogenic

OTHER DATA:
   Lifetime exposure of male rats was associated with a small increase in salivary gland fibrosarcomas.

12. ECOLOGICAL INFORMATION

Degradability (BOD): R-22 is a gas at room temperature; therefore, it is unlikely to remain in water.
Octanol Water Partition Coefficient: Unknown

13. DISPOSAL CONSIDERATIONS

RCRA
   Is the unused product a RCRA hazardous waste if discarded? Not a hazardous waste
   If yes, the RCRA ID number is: Not applicable
OTHER DISPOSAL CONSIDERATIONS:
Disposal must comply with federal, state, and local disposal or discharge laws. R-22 is subject to U.S. Environmental Protection Agency Clean Air Act Regulations Section 608 in 40 CFR Part 82 regarding refrigerant recycling.

The information offered here is for the product as shipped. Use and/or alterations to the product such as mixing with other materials may significantly change the characteristics of the material and alter the RCRA classification and the proper disposal method.

14. TRANSPORT INFORMATION

US DOT PROPER SHIPPING NAME: Chlorodifluoromethane
US DOT HAZARD CLASS: 2.2
US DOT PACKING GROUP: Not applicable
US DOT ID NUMBER: UN1018

For additional information on shipping regulations affecting this material, contact the information number found in Section 1.

15. REGULATORY INFORMATION

TOXIC SUBSTANCES CONTROL ACT (TSCA)
TSCA INVENTORY STATUS: Listed on the TSCA inventory
OTHER TSCA ISSUES: None

SARA TITLE III / CERCLA
“Reportable Quantities” (RQs) and/or “Threshold Planning Quantities” (TPQs) exist for the following ingredients.

<table>
<thead>
<tr>
<th>INGREDIENT NAME</th>
<th>SARA / CERCLA RQ (lb.)</th>
<th>SARA EHS TPQ (lb.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorodifluoromethane (HCFC-22)</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

Spills or releases resulting in the loss of any ingredient at or above its RQ requires immediate notification to the National Response Center [(800) 424-8802] and to your Local Emergency Planning Committee.

SECTION 311 HAZARD CLASS: IMMEDIATE PRESSURE

SARA 313 TOXIC CHEMICALS:
The following ingredients are SARA 313 “Toxic Chemicals”. CAS numbers and weight percents are found in Section 2.

<table>
<thead>
<tr>
<th>INGREDIENT NAME</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorodifluoromethane (HCFC-22)</td>
<td>None</td>
</tr>
</tbody>
</table>

STATE RIGHT-TO-KNOW

In addition to the ingredients found in Section 2, the following are listed for state right-to-know purposes.

<table>
<thead>
<tr>
<th>INGREDIENT NAME</th>
<th>WEIGHT %</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>No ingredients listed in this section</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ADDITIONAL REGULATORY INFORMATION:
R-22 is subject to U.S. Environmental Protection Agency Clean Air Act Regulations at 40 CFR Part 82.

WARNING: DO NOT vent to the atmosphere. To comply with provisions of the U.S. Clean Air Act, any residual must be recovered. Contains Chlorodifluoromethane, an HCFC substance which harms public health and the environment by destroying ozone in the upper atmosphere. Destruction of the ozone layer can lead to increased ultraviolet radiation which, with excess exposure to sunlight, can lead to an increase in skin cancer and eye cataracts.

WHMIS CLASSIFICATION (CANADA):
This product has been evaluated in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR.

FOREIGN INVENTORY STATUS:
Canada – Listed on DSL
EU - EINECS # 2008719

16. OTHER INFORMATION

CURRENT ISSUE DATE: December, 2008
PREVIOUS ISSUE DATE: August, 2007

OTHER INFORMATION:
HMIS Classification: Health – 1, Flammability – 1, Reactivity – 0
NFPA Classification: Health – 2, Flammability – 1, Reactivity – 0
ANSI/ASHRAE 34 Safety Group – A1
UL Classified

Regulatory Standards:
2. DOT classification per 49 CFR 172.101
3. Clean Air Act Class II Substance

17. DISCLAIMER

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Program Setup ....................................................................... 12
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Theory of Operation ............................................................. 15
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GETTING STARTED

1. Install the control as described on page 4.

2. Wire your control following the instructions on page 5. If you are using a two-wire transmitter as an input, see the drawing and instructions on page 6. Option wiring instructions are on Page 7. Option descriptions and specific instructions start on page 16.

3. Most controls do not need many (if any) program changes to work on your process. For best results when changing the programming, make all the necessary changes in the Secure Menu (page 26) before making changes to the Secondary Menu (page 19). If error messages occur, check the Error Messages on page 34-36 for help.

Take the example of a Model 16A3010 that comes from the factory programmed for type J thermocouples. Suppose for this example you wish to change the input to a 100 ohm Platinum RTD and limit the set point range between 0° and 300° C.

First, enter the Secure menu by pressing and holding the ✈️ UP ARROW &
ENTER keys for 5 Seconds (see Page 28.) Press the INDEX key until the display shows $p$ and press the DOWN ARROW until the display shows $P365$. Don’t forget to press the ENTER key to retain your setting.

Next, press the INDEX key to display $\Delta n \ & \ \varepsilon$. Press the DOWN ARROW until the display shows $\varepsilon$. Press ENTER.

Next, press the INDEX key until $F$ or $I$ is displayed (pass the $a\pi$ and $h\pi$ selections). Press the UP ARROW until the display shows $\varepsilon$. Press ENTER.

Finally, press the INDEX key to display $F$ or $I$. Press the DOWN ARROW until the display shows 300. Press ENTER.

The necessary program changes are now complete. After 30 seconds the display will switch back to the temperature reading. If you want to return faster, press the UP ARROW and ENTER keys (at the same time) and then press the DOWN ARROW and INDEX keys (again at the same time). This will back out of the menu and immediately display the temperature reading.

If you want to use Self Tune®, Auto/Manual, or the Ramp/Soak Programmer features, see the special sections on these items. Page numbers for these are in the Contents section on the previous page.

MODEL IDENTIFICATION

<table>
<thead>
<tr>
<th>Features</th>
<th>Alarm</th>
<th>Output A</th>
<th>Output B</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 = Standard</td>
<td>0 = No</td>
<td>1 = SSR</td>
<td>0 = None</td>
</tr>
<tr>
<td>3 = Enhanced</td>
<td>1 = Yes</td>
<td>2 = 15 VDC</td>
<td>1 = SSR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 = Relay, NO</td>
<td>2 = 15 VDC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 = Relay, NC</td>
<td>3 = Relay, NO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 = Current</td>
<td>4 = Relay, NC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 = DC SSR</td>
<td>5 = Current</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 = DC SSR</td>
</tr>
</tbody>
</table>

Option Description
924* Analog Remote Set Point, 0 to 10 VDC, scalable.
926* Analog Remote Set Point, 0 to 20 mA DC, scalable (may be programmed for 1 to 5 mA, 4 to 20 mA, etc.).
928* Analog Remote Set Point, 0 to 10,000 ohms, scalable.
934* Analog Retransmission of Process Variable or Set Variable, 0 to 20 mA DC, scalable (may be programmed for 1 to 5 mA, 4 to 20 mA, etc.).
936* Analog Retransmission of Process Variable or Set Variable, 0 to 10 VDC, scalable.
948 4-Stage Set Point. One of four pre-set setpoint values can be implemented via contact closure.
992 RS-485 Serial Communications, Lovelink™ protocol.
993 RS-232 Serial Communications, Lovelink™ protocol.
995 RS-232 Serial Communications, Modbus™ protocol.
996 RS-485 Serial Communications, Modbus™ protocol.
9502 12-24 Vdc/Vac 50-400Hz power supply (control operates on low voltage equipment).

* These options may not be combined with each other. Option 948 may be combined with only one of options 934 or 936. Option 9502 may be combined with any other options.
INSTALLATION

Mount the instrument in a location that will not be subject to excessive temperature, shock, or vibration. All models are designed for mounting in an enclosed panel.

Select the position desired for the instrument on the panel. If more than one instrument is required, maintain the minimum of spacing requirements as shown on the drawing below. Closer spacing will structurally weaken the panel, and invalidate the IP66, UL type 4X rating of the panel.

Prepare the panel by cutting and deburring the required opening.

![Cut Out Diagram]

All Tolerances are -0.00 +0.60mm (-0.000 +0.020 in.)

From the front of the panel, slide the housing through the cut out. The housing gasket should be against the housing flange before installing.

From the rear of the panel slide the mounting collar over the housing. Hold the housing with one hand and using the other hand, push the collar evenly against the panel until the spring loops are slightly compressed. The ratchets will hold the mounting collar and housing in place.

**CAUTION:** It is not necessary to remove the instrument chassis from the housing for installation. If the instrument chassis is removed from the housing, you must follow industry standard practice for control and protection against Electro-Static Discharge (ESD). Failure to exercise good ESD practices may cause damage to the instrument.
WIRING

Do not run RTD, thermocouple, or other class 2 wiring in the same conduit as power leads. Use only the type of thermocouple or RTD probe for which the control has been programmed. Maintain separation between wiring of sensor, optional inputs and outputs and other wiring. See the “Secure Menu” for input selection.

For thermocouple input always use extension leads of the same type designated for your thermocouple.

For supply connections use No. 16 AWG or larger wires rated for at least 75°C. Use copper conductors only. All line voltage output circuits must have a common disconnect and be connected to the same pole of the disconnect.

Input wiring for thermocouple, current, and RTD; and output wiring for current and 15 VDC is rated CLASS 2.

Control wiring is as shown (view is from rear of instrument showing wiring terminals).

* For 2-wire 1000 Ω RTD use terminals 1 & 3.
  For 2-wire 100 Ω RTD use terminals 1 & 3, and place a jumper wire between terminals 3 & 4.
OUTPUTS
(Rear View showing center block of wiring terminals.)

For AC SSR or relay type outputs (Output Codes 1 or 3), 15 & 16, and 17 & 18 are Normally Open. For relay (Output Code 4) outputs are Normally Closed. See Rating Label for details.

For Pulsed DC, Current, or DC SSR outputs (Output Codes 2, 4, or 8), 15 & 17 are positive, 16 & 18 are negative.

Output A
Output B

Note: Factory default assigns Output A to Set Point 1 and Output B to Set Point 2. If necessary, these relationships may be reversed. See 59 80 in the Secure Menu.

Wiring for 4 to 20mA Transmitter Inputs

Wire power and outputs as shown above. Two-wire transmitters wire as shown below. View is of instrument as seen from the rear to show wiring terminals.
For three- or four-wire transmitters follow the wiring instructions provided with your transmitter.

CAUTION: DO NOT WIRE THE 24 VOLT POWER SUPPLY ACROSS THE INPUT OF THE CONTROL. DAMAGE TO THE CONTROL INPUT CIRCUITRY WILL RESULT.

Wiring for Optional Inputs and Outputs

Options are described on Page 3. Detailed option programming and operation starts on Page 16. Wire power and outputs as shown on pages 5 and 6. Wiring for options is shown opposite. All wiring shown below is Class 2. Shielded twisted pair is required for Options 992 and 996. Shielded cable is required for Options 993 and 995. Options 924, 926, and 928 share a common ground with input.

CAUTION: DO NOT RUN SIGNAL WIRING IN THE SAME CONDUIT OR CHASE AS THE POWER WIRING. ERRATIC OPERATION OR DAMAGE TO THE CONTROL CIRCUITRY WILL RESULT.

SWITCH CONTACTS FOR OPTION 948 MUST BE ISOLATED AND CAN NOT SHARE WIRING WITH OTHER CONTROLS.
### Option / Terminals

<table>
<thead>
<tr>
<th>Option</th>
<th>Terminals</th>
<th>11</th>
<th>12</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>934</td>
<td>PV/SV Retransmission, Current (e.g. 4 to 20 mA)</td>
<td>+</td>
<td>-</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>936</td>
<td>PV/SV Retransmission, Voltage (e.g. 0 to 10 V)</td>
<td>+</td>
<td>-</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>924</td>
<td>Remote Set Point, Voltage (e.g. 0 to 10 V)</td>
<td>+</td>
<td>-</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>926</td>
<td>Remote Set Point, Current (e.g. 4 to 20 mA)</td>
<td>+</td>
<td>-</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>928</td>
<td>Remote Set Point, Resistance (e.g. 0 to 10,000Ω)</td>
<td>CCW</td>
<td>Wiper</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>948</td>
<td>4-Stage Set Point Selection</td>
<td>na</td>
<td>na</td>
<td>Signal Ground</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>992, 996</td>
<td>RS-485 Serial Communications</td>
<td>B</td>
<td>A</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>993, 995</td>
<td>RS-232 Serial Communications</td>
<td>Data In</td>
<td>Data Out</td>
<td>Signal Ground</td>
<td>na</td>
<td>na</td>
</tr>
</tbody>
</table>

### 948 Truth Table

<table>
<thead>
<tr>
<th></th>
<th>A to Gnd</th>
<th>B to Gnd</th>
<th>SP</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPEN</td>
<td>OPEN</td>
<td>1SP1</td>
<td></td>
</tr>
<tr>
<td>CLOSED</td>
<td>OPEN</td>
<td>2SP1</td>
<td></td>
</tr>
<tr>
<td>OPEN</td>
<td>CLOSED</td>
<td>3SP1</td>
<td></td>
</tr>
<tr>
<td>CLOSED</td>
<td>CLOSED</td>
<td>4SP1</td>
<td></td>
</tr>
</tbody>
</table>

View of rear of instrument showing wiring terminals.

### Option 948

Wiring for Relay control  
(Coil wiring not shown)

Alternates wiring for Transistor control.
Use NPN open collector transistors.  
(Drive circuit not shown)

### RS-485 Daisy Chain Wiring Example

120 ohm terminator resistor

Shielded Twisted Pair Wire

**Note:** Industry standard designation for RS-485 lines is A and B. Some equipment manufacturers use a non-standard designation of plus and minus. The association of A to minus and B to plus is based on a sample of devices marked as plus and minus and is not intended to represent ALL such labeled devices. Final responsibility for correct identification of leads and terminals rests with the user/installer and the manufacturer of the other device(s) installed in the system.

### RS-232 DB-25 Wiring (Viewed from Wire Side)

<table>
<thead>
<tr>
<th>Pin Desc</th>
<th>Pin Desc</th>
<th>Pin Desc</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SHIELD</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>TRANSMIT</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>RECEIVE</td>
<td>6</td>
</tr>
</tbody>
</table>

### RS-232 DB-9 Wiring (Viewed from Wire Side)

<table>
<thead>
<tr>
<th>Pin Description</th>
<th>Pin Description</th>
<th>Pin Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DCD</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>RECEIVE</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>TRANSMIT</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>DTR</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>GROUND</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>DSR</td>
<td>9</td>
</tr>
<tr>
<td>7</td>
<td>RTS</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>CTS</td>
<td></td>
</tr>
</tbody>
</table>

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Page 7 of 44  
949-1265-4
FRONT PANEL KEY FUNCTIONS

The decimal point flashes when Self Tune is operating. Keys are illuminated when pressed. Key functions are as follows:

INDEX: Menu Navigation. Pressing the INDEX key advances the display to the next menu item. May also be used in conjunction with other keys as noted below.

UP ARROW: Increments a value, changes a menu item, or selects the item to ON. The maximum value obtainable is 9999 regardless of decimal point placement.

DOWN ARROW: Decrements a value, changes a menu item, or selects the item to OFF. The minimum value obtainable is -1999 regardless of decimal point placement.

ENTER: Pressing ENTER stores the value or the item changed. If not pressed, the previously stored value or item will be retained. The display will flash once when ENTER is pressed.

AUTO/MANUAL (16A3): This key toggles the control output between Automatic mode and Manual mode. Press and hold key for three seconds to activate. See section on AUTO/MANUAL operation on Page 14.

RUN/HOLD (16A3): This key toggles the Ramp/Soak program functions between Run mode (program runs as set up), and Hold mode (program functions are suspended). Press and hold key for three seconds to activate. See section on Ramp/Soak (Page 11) for further details.

UP ARROW & ENTER: Menu Access. Pressing these keys simultaneously brings up the secondary menu starting at the alarm, tune, or cycle item (depending on programming). Pressing these keys for 5 seconds will bring up the secure menu.

INDEX & DOWN ARROW: Menu navigation. Pressing these keys simultaneously will allow backing up one menu item, or if at the first menu item they will cause the display to return to the primary menu.

INDEX & DOWN ARROW: Alarm Reset. If an alarm condition has occurred, press and hold these keys for three seconds to reset the alarm. Note that the alarm condition will not reset if the alarm condition still exists.

INDEX & ENTER: ‘Global Reset’. Pressing these keys simultaneously and holding them for 5 seconds forces a ‘warm boot’, restart-
ing the control (similar to turning power off and on). 'Global Reset' will allow recovery from errors and reset the following menu items:

\( RL \) inP: Alarm inhibit
\( CPEn \) inP: Input error message
\( bRd \) inP: Input error message
\( CHeC eRL \): Check calibration error

Correct the problems associated with the above conditions before using these reset keys. More than one error could be present. Caution is advised since several items are reset at one time.

While in the **Primary** or **Secondary Menu**, if no key is pressed for a period of 30 seconds, the display will return to the HOME position displaying the temperature value. While in the **Secure Menu**, if no key is pressed for a period of 60 seconds, the display will return to the HOME position displaying the temperature value. Outputs are disabled (turned off) when the **Secure Menu** is active.

**NOTE:** To move to the **Primary Menu** quickly from any other menu, press the \( \text{UP ARROW} \) & \( \text{ENTER} \) keys followed by pressing the \( \text{INDEX} \) & \( \text{DOWN ARROW} \) keys.

**SECURITY LEVEL SELECTION**

Four levels of security are provided. The display shows the current security level. To change security levels change the password value using the \( \text{UP ARROW} \) and \( \text{DOWN ARROW} \) keys and press the \( \text{ENTER} \) key. Refer to the password table (following) for the correct value to enter for the security level desired. The \( \text{SEC} \) menu item security level may be viewed or changed at any time regardless of the present security level.

To set the access level to, for example, \( 2 \), at the \( \text{SEC} \) menu item press the \( \text{UP ARROW} \) key until the upper display shows the password for level \( 2 \) access, \( 1 \ 0 \ 1 \). Press the \( \text{ENTER} \) key. The display will blink and return with the level value, \( 2 \), in the upper display.

The password values shown in the table cannot be altered, so retain a copy of these pages for future reference. This is the only reference made to password values in this instruction book.
### PASSWORD TABLE

<table>
<thead>
<tr>
<th>Security Level Menu</th>
<th>Status</th>
<th>Displayed Value When Viewed</th>
<th>Password Value To Enter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Secure</td>
<td>Locked</td>
<td>1</td>
<td>1110</td>
</tr>
<tr>
<td>Secondary Secure</td>
<td>Locked</td>
<td>2</td>
<td>1101</td>
</tr>
<tr>
<td>Secure</td>
<td>Locked</td>
<td>3</td>
<td>1011</td>
</tr>
<tr>
<td>Primary Secure</td>
<td>Unlocked</td>
<td>4</td>
<td>111</td>
</tr>
<tr>
<td>Secondary Secure</td>
<td>Unlocked</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secure</td>
<td>Unlocked</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### NOTATION CONVENTIONS FOR THE MENUS

Because of the number of features available in this control, information is included that may not apply to your specific control. All usable features are included in this book, but may not be used in your process. To increase clarity the following conventions are used:

1. Certain features, menu items, and functions shown in this book may or may not appear on your control, depending on other menu item selections. At various places in the menus there are notes identifying menu items that “control” or “direct” other menu items. If you are looking for a particular menu item and can't find it, check the menu item that is its “control” for proper setting.

2. The “#” symbol is used in two ways. It is used inside a group of characters to indicate which set point function (SP1 or SP2) is being affected. It is also used before a group of characters of a menu item to indicate that there may be more than one selection or value for that menu item. This is used for certain repeated items such as in the Ramp/Soak Program section.

3. **Features that apply only to Options will be printed in Italic.** Features that apply only to the 16A3 Series will be notated in Roman serif type.
THE HOME DISPLAY

The home display is the normal display while the control is operating. If no errors or functions are active, the HOME display will indicate the Process Variable (the temperature, pressure, flow, RH, etc., that is being measured) on the top display and the Set Variable (Set Point 1) on the bottom.

Items that can change the HOME display are the Auto/Manual function, the Run/Hold function, the P-93 function, the PctD function, and any error message. Description of these special displays follows.

If the Auto/Manual key is pressed, the Manual indicator lights, and the home display is changed. The upper display continues to show the Process Variable (PV), but the lower display changes to show the percentage of output in tenths of a percent to 99.9% (0.0 to 99.9), or 100 if 100%. The display digit to the right of the number shows a flashing letter \( \sigma \) to indicate that the value displayed is no longer the SV, but percent output. The SP\( \sigma \) percent output is indicated by the use of an underline on the letter \( \sigma \). Access to the SP\( \sigma \) value is made by the INDEX key. See Auto/Manual Operation on Page 14 for further information.

If P-93 is turned \( \sigma \), the HOME display changes the SV display from \( SP \) to the Present Set Variable as calculated by the Ramp/Soak Programmer function. See Programming and Operation for Ramp/Soak Feature below for more information.

If PctD (Secondary Menu) is turned \( \sigma \), the lower display changes to show the active percentage of output as required to maintain \( SP \). The display is similar to the Auto/Manual display above, except that the percent indicators (\( \alpha, \sigma \)) do not flash, and the output is displayed in whole percentages of output, not in tenths of a percent. If the control has both \( SP \) and SP\( \sigma \), the lower display will alternate between the \( SP \) percent output and the SP\( \sigma \) percent output.

Error messages are listed on Pages 37-39.

**Programming and Operation for Ramp / Soak Feature**

(16A3 only)

The ramp / soak feature offers a great deal of flexibility by allowing changes in the set point to be made over a predetermined period of time. Dwell times can be programmed, and the alarm output relay can be programmed to open or close during any of the segments.
Theory of Operation

The 16A3 Series controls offer a very simple approach to programming a ramp. Rather than requiring the operator to calculate an approach rate (usually in degrees per minute), the 16A3 does the calculation internally. Thus, the operator only needs to program the target set point and the time desired to reach that point. When the ramp segment is executed by the control, it calculates the ramp required to move the process from the starting value (current PV) to the desired value (programmed SP) in the time allowed.

Soaks (or dwells) are ramp segments where the target set point is the same as the beginning process value. This allows for multistage ramps without wasting intermediate soak steps. Care must be taken, however, that the process does actually reach the soak value before the soak time starts. If not, the next segment will calculate a slope from the starting PV to the target SP. Depending on your process requirements, this difference may be important. Make sure to test any program for desired results before running production material.

Do not operate Self Tune while a ramp function is operating. The ramp function will prevent the Self Tune from operating properly. Make sure that all tuning is set up before operating Ramp / Soak.

Program Setup

All of the programming for the Ramp / Soak function is done in the Secondary Menu. You may wish to work out your program on paper before going into the programmer menu sequence.

In the Secondary Menu INDEX to PRoG and make sure that PRoG is set to OFF.

INDEX to PSEt and turn on. Press ENTER.

Skip the SIRt setting (this is discussed later) and press INDEX to tRAS.

The time base menu item, tRAS, allows selection of the amount of time that is counted per time unit. Setting tRAS to 1 makes all time settings use a time base of one second. A tRAS setting of 60 makes all time settings use a time base of 60 seconds, or one minute. Make the appropriate selection and then press ENTER and INDEX to tE r.

The following items repeat in the following order: tE r, tSP, tR (if AL t in the Secure Menu is programmed set to EUnEt), tR r, tSP, tAl, . . ., t6Et r, t6SP, t6Al r. To avoid repetition each item will only be described once.
Set \( t \) to the amount of time you want for the first ramp. This value is in time units (determined by the \( \text{t}b\text{RS} \) menu item) from 0 to 9999. Press \( \text{R} \) ENTER.

Set \( \text{SP} \) to the target value desired for the first ramp. This value is in actual units just like \( \text{SP} \) \( t \). If the control is programmed for temperature, then the SP displays are in temperature. If the control is programmed for some other engineering unit, the SP is set in that unit.

Press \( \text{INDEX} \) to continue. If Alarm 1 is programmed as an event (\( \text{Ar} \) \( t \) \( = \) \( \text{E} \text{nt} \)), then \( \text{Ar} \) \( t \) will appear. If you wish the Alarm 1 contact to function for this segment, set \( \text{Ar} \) \( t \) for \( \text{On} \). If not, set for \( \text{OFF} \). Press \( \text{R} \) ENTER. When \( \text{Ar} \) \( t \) is set to \( \text{On} \), the Alarm 1 function will be active for the entire period set in \( t \), above.

Complete setting the segment times (\( t \) \( t \) ... \( t \) \( t \) \( t \) \( t \)), segment set points (\( \text{SP} \) \( \text{SP} \) \( \text{SP} \)), and event alarms (\( \text{Ar} \) \( \text{Ar} \) \( \text{Ar} \) \( \text{Ar} \)) to \( \text{On} \) or \( \text{OFF} \).

For unneeded or unused segments set the segment times (\( t \) \( t \) ... \( t \) \( t \) \( t \) \( t \)) to \( \text{On} \), and set the segment set points (\( \text{SP} \) \( \text{SP} \) \( \text{SP} \)) to the same value as the last active set point. A segment alarm may be set to indicate "end of run" at the segment number you select.

The last menu item for the ramp / soak function is \( \text{PEnd} \). \( \text{PEnd} \) determines what the control does when the program has ended. You may choose to have the program repeat (\( \text{Rep} \)), \( \text{Hold} \) the last set point (\( \text{SP} \) \( \text{SP} \)), revert to the local \( \text{SP} \) \( t \), or turn the outputs off (\( \text{Off} \)).

It is important to remember that if you want the program to repeat, you must allow the process to return to the same condition that existed when the program first started. Remember that the ramp function calculates the slope by drawing a line from the beginning PV to the ramp target set point. If the PV at the end of the program is different than the PV at the initial start, the ramp will calculate differently.

**Ramp / Soak Operation**

When you wish to start the program, enter the Secondary Menu and set the \( \text{Pr} \) \( \text{RS} \) menu item to \( \text{On} \). Return to the HOME position by waiting for the display to time out or by pressing the \( \text{UP} \) ARROW & ENTER keys and then the \( \text{DOWN} \) ARROW & INDEX keys.

The home display will read as it normally does. The HOLD indicator by the RUN / HOLD key will be lit. To start the program press the \( \text{RUN} \) \( \text{HOLD} \) key for three seconds. The HOLD indicator will go out, and the program will start.

To suspend the program at any time, press the \( \text{RUN} \) \( \text{HOLD} \) key. Press the key again to resume.
Pressing the AUTO / MANUAL key will also suspend the program operation. The difference is that AUTO / MANUAL also puts the control into manual mode. See Auto / Manual Operation on page 14.

The function of the Primary Menu will change depending on the setting of the $\text{StR} \text{E}$ menu item in the Secondary Menu. If $\text{StR} \text{E}$ is OFF then the Primary Menu is not changed.

If the $\text{StR} \text{E}$ menu item is set to ON, then the Primary Menu has three additional information items added before $SP$ appears. The first INDEX item displays the time remaining in the current segment in the top display (####), and the message $\text{t s}$, in the lower display. The next INDEX item displays the total time for the active segment in the upper display (####) and the message $\# \# \text{t}$, (t s ... t s), in the lower display. The third INDEX item displays the segment set value (####) in the top display, and the message $\# \# \# \# \# \text{t}$ (SP ... SP) in the lower display. The next INDEX press resumes the normal Primary Menu.

**AUTO / MANUAL OPERATION (16A3 ONLY)**

The AUTO / MANUAL function allows you to manually adjust the output of the control. This is normally used during process setup or start up. It can also be used for troubleshooting. To switch from AUTO to MANUAL, press the AUTO / MANUAL key and hold for three seconds. The MANual indicator will light and the lower display will change from normal to showing the actual output in percent. The value will be the actual percentage of output that was active when the key was pressed. This is usually known as "bumpless transfer".

If you wish to change the output while in manual, press the UP ARROW or DOWN ARROW keys to change the value, and press ENTER to retain it. It is important to remember that the value of the display can be read as 0 to 100% of the full control output, or 0 to 100% of the range between $S \text{tOL}$ and $S \text{tOH}$ or $S2 \text{OL}$ and $S2 \text{OH}$. If $\text{PC}\text{t}$ is set for $\text{ERL}$, a reading of 50% in MANUAL represents 10 mA (Assuming a current output regardless of the $S \text{tOL}$ or $S \text{tOH}$ settings.) If $\text{PC}\text{t}$ is set for $\text{Adj}$, then 50% in MANUAL will represent the midpoint in output between $S \text{tOL}$ and $S \text{tOH}$. (Assuming a current output, 4 to 20 mA, with $S \text{tOL}$ set to 20 and $S \text{tOH}$ set to 00, 50% will represent 12 mA.)

To return to AUTOMatic control, press the AUTO / MANUAL key again. The MANual indicator will go out, and the set point will take over. However, if you want bumpless transfer back to AUTO, slowly change the percentage of output until the process variable matches (or at least is close) to the set point. The further away the PV is from the set point, the greater the "bump" or upset there will be in the output.
Operation of Self Tune Function

Self Tune allows automatic selection of the necessary parameters to achieve best control operation from your 16A2 & 16A3 Series control. If you are using the control output as a simple on-off function (Output set for QnQF), none of the following will apply.

Theory of Operation

The Self Tune function calculates the Pb i, rES, and rEE parameters under the P d tuning selection, and the Fbd and FEE parameters, as shown in the Secondary Menu. These values are determined by measuring the response of the process connected to the control. When Self Tune is started, the control temporarily acts as an on-off control. While in this mode the control measures the overshoot and undershoot of the process, and the period of the process (the time from peak value to the next peak value). These measurements are collected over a period that lasts three periods of overshoot and undershoot. The data collected over this time is then compared and calculated into final PID and Fuzzy Logic values. The effect of Fuzzy Logic on the process is still controlled by the Fnt (fuzzy intensity) setting. If Fnt is 0, the Fbd and FEE will be calculated, but will have no effect. The calculations for the PID values are the same as used in the standard Ziegler-Nichols equations that have been recognized as standard for decades.

The only modification to the application of the Ziegler-Nichols equations is controlled by the dFRC menu item. This menu item controls the amount of rate (derivative) that is applied. A dFRC setting of 3 (factory default) or less allows for less damping. A dFRC setting of 4 allows for critical damping as set forth in Ziegler-Nichols. A dFRC setting of 5 or more allows over damping of the process.

Program Setup and Operation

Do not cool the process or add heat while the tuning is occurring. In the secondary menu set tHE to SELF. Skip LErr and check to make sure that dFRC is set to the desired value. Back up to LErr and set to YES. The control will begin the Self Tune function. While the Self Tune function is active, the right hand decimal point on the lower display will blink. When Self Tune is complete, the blinking will stop.

After Self Tune is complete, the tHE setting automatically switches to P d. This allows examination and/or modification of the values calculated. We recommend that you do not change the calculated values unless you have a firm understanding of the parameters involved and their function.
OPERATION AND PROGRAMMING OF OPTIONS

Options 924, 926, 928, Analog Remote Set Point
The analog remote set point allows the control set point to be determined by an outside analog signal. The signal may be 0 to 10 VDC (Option 924), 0 (or 4) to 20 mA ADC (Option 926), or 0 to 10,000 Ohms (Option 928).

Wire the input as shown on page 7.

To set up the analog remote set point, first determine the scale range that the analog signal will represent. The maximum span is 11,998 degrees or counts. In the Secure Menu set $rSCl$ for the scale value that will be represented by the low end of the analog signal (0 Volts, 0 mA, 0 Ohms). Set $rSCh$ for the scale value that will be represented by the high end of the analog signal (10 Volts, 20 mA, 10,000 Ohms).

If you require a suppressed scale or input, use the following equations to determine the proper settings for $rSCL$ and $rSCH$.

$$K = (\text{Highest desired scale reading} - \text{Lowest desired scale reading}) / \text{(Maximum desired analog signal} - \text{Minimum desired analog signal})$$

$$rSCH = ((\text{Maximum possible analog signal} - \text{Maximum desired analog signal}) * K) + \text{Highest desired analog reading}$$

$$rSCL = \text{Lowest desired scale reading} - ((\text{Minimum desired analog signal}) * K)$$

Operation is simple. Make sure that a valid analog signal is available to the control. In the Secondary Menu set the $SPt$ to ON. The REM indicator on the front of the control will turn on. When the control returns to the HOME position, the displayed SV will be the value supplied from the analog remote signal. If the analog remote signal fails or goes out of range of the $SPt$ or $SPH$ settings, the control will revert to the internal $SP$ (or $#SP$ t), and flash the error message $CHEC rSPt$. If $SPt$ or $SPH$ are set outside of $rSCL$ or $rSCH$ then the error will be suppressed, and the control will attempt to work with the remote value.

To clear the error message, change $SPt$ to OFF.

Option 934, 936, Isolated Analog Retransmission.

The analog retransmission option allows the Process Variable or the Set Variable to be sent as an analog signal to an external device. The signal may be either 0 to 10 VDC (Option 936) or 0 (or 4) to 20 mA ADC (Option 934). The output may be changed in the field from one to the other by the toggle switch located on the top printed circuit board.

Wire the output as shown on page 7.
To set up the analog retransmission, first determine the scale range that the analog signal will represent. The maximum scale is 9999°F, 5530°C, or 9999 counts. In the Secondary Menu set $P_{OL}$ for the scale value that will be represented by the low end of the analog signal (0 Volts or 0 mA). Set $P_{OH}$ for the scale value that will be represented by the high end of the analog signal (10 Volts or 20 mA).

If you require a suppressed scale or output, use the following equations to determine the proper settings for $P_{OL}$ and $P_{OH}$.

$$K = \frac{(\text{Highest desired scale reading} - \text{Lowest desired scale reading})}{(\text{Maximum desired analog signal} - \text{Minimum desired analog signal})}$$

$$P_{OH} = (\text{Maximum possible analog output} - \text{Maximum desired analog signal}) \times K + \text{Highest desired analog reading}$$

$$P_{OL} = \text{Lowest desired scale reading} - (\text{Minimum desired analog output}) \times K$$

Next select whether you want the retransmission signal to follow the Process Variable or the Set Variable. Usually the Process Variable is sent to recorders or other data acquisition devices. Usually the Set Variable is sent to other controls to be used as an analog remote set point. If you want the analog retransmission signal to follow the PV, in the Secondary Menu set $P_{OS}$ to $\times P$. If you want the analog retransmission signal to follow the SV, set $P_{OS}$ to $\times E$.

Operation is automatic. There are no further programming steps required.

Option 948, 4-Stage Set Point.

The 4-stage set point option allows four different values to be used for $SP$ and all of the values associated with the $E_{\text{SP}}$ menu items. The control will switch to a given stage when an external contact or contacts are made or opened across the appropriate terminals at the rear of the control ($SP_{SR}$, Set Point Switch Action, set for remote, $\times E$), or when the stage is selected from the Secondary Menu, $SP$ (when $SP_{SR}$ is set for $x_{E}$). When the state of a contact changes (or the stage number is changed in the Secondary Menu), the values in use are stored and the previously stored values for the new stage are used.

Wire the input as shown on page 7.

Usually the control is configured for external switching of the stages. In this case, the operation is usually automatic, selected by the external switches driven by the machine logic. If it is necessary to program the stages in advance, you may select the stage to modify with the $SP$ menu item. When $SP$ is changed while the $SP_{SR}$ is set for $\times E$, the selected stage is displayed for modification, but only used when the appropriate contact is made.
Option 992, 993, 995, 996 Serial Communication.

The serial communications options allow the control to be written to and read from a remote computer or other similar digital device. Communication is allowed either through a RS-485 (Option 992, 996) port, or a RS-232 (Option 993, 995) port.

Wire the communication lines as shown on Page 7. Wiring for the RS-485 is run from control to control in a daisy chain fashion with a termination resistor (120 ohms) across the transmit and receive terminals of the last control in the chain.

Select the control address and communication baud rate with the Addr and Baud menu items in the Secure Menu.

NOTE: THE BAUD RATE AND ADDRESS MENU ITEM SETTINGS WILL TAKE EFFECT ON THE NEXT POWER UP OF THE CONTROL. BE SURE TO TURN THE POWER TO THE CONTROL OFF AND ON BEFORE USING THE NEW BAUD RATE AND ADDRESS VALUES.

In operation, you have the option of preventing a write command from the host computer. To prevent the host from writing to the control change the LG-E menu item in the Secondary Menu to LOC. To allow the host to write commands to the control set LG-E to rE. (The host does have the ability to change the LG-E state, but it is not automatic.)

If your system depends on constant reading or writing to and from the host, you may wish to set the No Activity Timer (nRT) to monitor the addressing of the control. When the LG-E is set to rE and the nRT is set to any value other than OFF, the control will expect to be addressed on a regular basis. If the control is not addressed in the time set by the value of nRT, then the control will display the error message CHECK LG-E. To clear the message set LG-E to LOC.

Serial Communications Options and Nonvolatile Memory

There are many different types of memory used in computer driven devices. The terms RAM (random access memory) and ROM (read only memory) are a couple with which you may be familiar.

RAM is used in computers to run programs and hold data for a short period of time. This is the memory that is used primarily in PCs. RAM is very fast and can be read and written to over and over again. Its major weakness is that it is erased when the power is turned off.

ROM is used in computers to hold the 'permanent' programming that allows a PC to start. This memory is 'burned in' to the chip itself and can not be changed. Unlike RAM, however, this memory is permanent. While it can not be changed, it can not lose its programming when power is turned off. This is the type of memory that is used to store the permanent programming for the control.
There is a third type of memory that is now currently used to combine the characteristics of both RAM and ROM. This is known as EEPROM (electrically erasable programmable read only memory). While the name may be long and somewhat cryptic, the EEPROM can be erased and re-written many times, and yet hold the programmed data even over long periods when the power is off. This is the type of memory that Love Controls uses to save the settings you program in your control. The reliability and longevity of the data retention is what allows us to guarantee a 10 year data retention without power.

In normal operation, the control uses RAM, just as any other computerized device. Whenever you make a change to one of the parameters in the control, the set point for example, the new value is written into the EEPROM. This way, if power goes off for whatever reason, when power resumes, the latest settings are preserved. When power is turned on, the data is copied from the EEPROM to the RAM to restore operation.

You might ask, “If EEPROM is such a wonderful thing, why bother with RAM?” One reason is that is that RAM is much faster than EEPROM. Faster speed gives you better performance in critical control functions.

Perhaps the most important reason is that RAM allows an unlimited number of writes, while EEPROM has a limit to the number of times that it can be erased and re-written. Current technology now sets that limit at about one million erase / write cycles. In a dynamic control situation, it may be necessary to update RAM every few milliseconds. EEPROM can not keep up to that pace, and, even if it could, it would be ‘used up’ in a matter of days.

If you think about how long it would take to make a million changes to the control programming through the front key pad, you will see that it would take a very long time to get to use up the life of the EEPROM.

Adding one of the computer communications options (e.g. 992, 993, 995, 996) changes the picture. The speed of computer communications is such that hundreds of instructions can be made in less than a minute. In such a situation, the million erase / write cycles could be used up in a couple of months causing the chip (and the control) to fail.

Usually in such a situation, the control is under close observation by the host computer. It may not be necessary, then, to have the data written to the EEPROM, as it is ‘transitory’ in nature (changing set points for a ramp/soak sequence for example).

Controls equipped with a Serial communications option have a menu item in the Secure menu ($\text{Cor}$) that allows the serial communications to write to RAM ($\text{Cor} = \text{no}$).

The factory default is ‘write to EEPROM’ ($\text{Cor} = \text{yes}$).
If your computer system will be making frequent changes to the control, we strongly recommend that you select the 'write to RAM' parameter (S\texttt{Cor} = \texttt{n}). If you are primarily reading from the control, there is no need to change the setting.

For further information on protocols and technical information regarding computer programming for the Serial Communications options, see our web site at http://www.love-controls.com/protocol/.

**MENU SELECTIONS**

**PRIMARY MENU**

Press \(\text{INDEX}\) to advance to the next menu item. Press \(\text{UP ARROW}\) or \(\text{DOWN ARROW}\) to change the value in the display. Press \(\text{ENTER}\) to retain the value. If \(\text{S\texttt{Rt}}\), (Secondary Menu [16A3]), is \(\text{on}\), the three program status menu items shown on Page 14 will precede the following.

- \#SP 1 (Option 948, 4-Stage Set Point) or
- \#SP 1 Set Point 1 Adjust, Control Point 1.
- \#SP 2 Set Point 2 Adjust (if equipped), Control Point 2.

**SECONDARY MENU**

Hold \(\text{UP ARROW} \& \text{ENTER}\). Press \(\text{INDEX}\) to advance to the next menu item. Press \(\text{UP ARROW}\) or \(\text{DOWN ARROW}\) to change the value in the display. Press \(\text{ENTER}\) to retain the value.

- \(\text{AL 1L}\) Alarm 1 Low: The Low Alarm point is usually set below the Set Point. May not appear depending on \(\text{AL 1} \) setting in Secure Menu.
- \(\text{AL 1H}\) Alarm 1 High: The High Alarm Point is usually set above the Set Point. May not appear depending on \(\text{AL 1} \) setting in Secure Menu.
Output selection: Select OnOF, #tP, #PUL, or P&P.

OnOF
A setting of OnOF allows the control to operate in simple on/off mode. This setting forces the control to turn off at set point, and on at the set point plus the differential (SP ID). When selected, the Out 1 OnOF menu item is followed by #### SP ID, and the EonC, Pb, rES, DF5, and rE selections in the Secondary menu and the S IDL and S IDH selections in the Secure menu are suppressed.

SP ID
Set Point On-Off Differential (hysteresis). Set for the amount of difference between the turn off point and the turn on point. Select + to 9999 (direct acting), or - to -9999 (reverse acting). This value will be negative for reverse acting set points, and positive for direct acting outputs. The following drawing shows output behavior for reverse and direct action. For reverse action note how the output decreases as the input process variable increases, e.g. heat power goes to zero as the temperature increases to set point.

Time Proportioning Cycle Time. Select #tP to B0tP.

#tP
A setting of #tP is recommended for solid state outputs (SSR or 15VDC).

2tP to B0tP Time Proportioning Control is adjustable in 1 second steps. Recommended for mechanical outputs (relays, solenoids, etc.). For best contact life, a time should be selected as long as possible without causing the process to wander.

#PUL Pulsed Time Proportioning Output: Select #PUL to #PUL. #PUL = Linear and #PUL = most non-linear. Changes output linearity for use in cooling applications or for extremely fast response processes. At the center of the proportional band, a pulse value of 1 provides an output
of one second on and one second off (50% output). A pulse value of 2 provides an output of one second on and two seconds off (33% output). Output at center of band equals one second on, $2^{\text{pulse value}-1}$ seconds off.

$\rho_{op}$ For Current (Code 5) outputs only.

The following menu items apply only if your control is equipped with a second set point (last digit of model number is not zero). If your control does not have a second set point, jump to the tune menu on the next page.

$\phi t_{2}$ Output selection: Select $onOff$, $\# tP$, $\# p_{ul}$, or $\rho_{op}$.

$onOff$ A setting of $onOff$ allows the control to operate in simple on/off mode. This setting forces the control to turn off at set point, and on at the set point plus the differential ($SPd$). When selected, the $\phi t_{2}/onOff$ menu item is followed by $SPd$, and the $Pb_{2}$ selection in the Secondary menu and the $S20L$ and $S20H$ selections in the Secure menu are suppressed.

$SPd$ Set Point On-Off Differential (hysteresis). Select $t$ to 9999 (direct acting), or $-t$ to -9999 (reverse acting). See $SPId$ on the previous page.

$\# \# tP$ Time Proportioning Cycle Time. Select $tP$ to 80$tP$.

$tP$ A setting of $tP$ is recommended for solid state outputs (SSR or 15VDC).

$2tP$ to 80$tP$ Time Proportioning Control is adjustable in 1 second steps. Recommended for mechanical outputs (relays, solenoids, etc.). For best contact life, a time should be selected as long as possible without causing the process to wander.

$\# p_{ul}$ Pulsed Time Proportioning Output: Select $p_{ul}$ to $\gamma p_{ul}$. $p_{ul}$ = Linear and $\gamma p_{ul}$ = most non-linear. Changes output linearity for use in cooling applications or for extremely fast response processes. At the center of the proportional band, a pulse value of 1 provides an output of one second on and one second off (50% output). A pulse value of 2 provides an output of one second on and two seconds off (33% output). Output at center of band equals one second on, $2^{\text{pulse value}-1}$ seconds off.

$\rho_{op}$ For Current (Code 5) outputs only.
(Option 948, 4-Stage Set Point) Active Set Point Stage. Select 1SP 1, 2SP 1, 3SP 1, 4SP 1. (See Page 17 for more detail.)

1SP 1 Set Menu Items to display Stage 1 for view and change access. If 5PSR is set for Int, 1SP 1 is made active.

2SP 1 Set Menu Items to display Stage 2 for view and change access. If 5PSR is set for Int, 2SP 1 is made active.

3SP 1 Set Menu Items to display Stage 3 for view and change access. If 5PSR is set for Int, 3SP 1 is made active.

4SP 1 Set Menu Items to display Stage 4 for view and change access. If 5PSR is set for Int, 4SP 1 is made active.

#SP 1 (Option 948, 4-Stage Set Point) Adjust Control Point 1 for Stage selected above.

Note: The menu items for ᵇunE (below) are modified when Option 948 is active. Then, the menu items are shortened or shifted right, and preceded with the stage number selected in 5P above. Each stage has its own set of ᵇunE parameters as indicated by #ᵦun.

#ᵦun (Option 948, 4-Stage Set Point) or ᵇunE Tuning Choice: Select SELF, P id, SL0, nor, or FAS.E.

 SELF The Controller will evaluate the Process and select the PID values to maintain good control. Active for SP1 only.

 LErr Select YES or no

 YES Start Learning the Process. After the process has been learned the menu item will revert to no.

 no Learning will stay in present mode.

 dFAC Damping factor, Select OFF, 1 to 7. Sets the ratio of Rate to Reset for the SELF ᵇunE mode. 7 = most Rate. Factory set to 3. For a fast response process the value should be lowered (less Rate). For a slower process the value should be increased (more Rate).

 P id Manually adjust the PID values. PID control consists of three basic parameters, Proportional Band (Gain), Reset Time (Integral), and Rate Time (Derivative).

 #Pb 1 (Option 948, 4-Stage Set Point) or Pb 1 Proportional Band (Bandwidth). Select 1 to 9999 °F, °C, or counts.

 Pb1 Proportional Band (Bandwidth). Select 1 to 9999 °F, °C, or counts. Appears only if control
is equipped with second set point and  is NOT selected as OFF.

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#:E5</td>
<td>Automatic Reset Time. Select OFF, 0.0 to 99.9 minutes. Select OFF to switch to E5.</td>
</tr>
<tr>
<td>#:D5</td>
<td>Manual Offset Correction Select OFF, 0.0 to 99.9 percent. Select OFF to switch to #:E5.</td>
</tr>
<tr>
<td>#:tE</td>
<td>Rate Time. Select OFF, 0.0 to 99.99 minutes, Derivative.</td>
</tr>
</tbody>
</table>

PID values are preset for a slow response process.
PID values are preset for a normal response process.
PID values are preset for a fast response process.

**P d2** Linkage of PID parameters between SP1 and SP2: Select ON or OFF.
- ON Applies SP1 #:E5, #:tE, Fbnd, and #:tE terms to SP2 for heat/cool applications.
- OFF SP2 functions without #:E5, #:tE, Fbnd and #:tE.

**Ar-Up** Anti-Reset Windup Feature: Select ON or OFF.
- ON When Ar-Up is ON the accumulated Reset Offset value will be cleared to 0% when the process input is not within the Proportional Band.
- OFF When Ar-Up is OFF, the accumulated Reset Offset Value is retained in memory when the process input is not within the Proportional Band.

**Ar-tE** Approach Rate Time: Select OFF, 0.0 to 99.99 minutes. The function defines the amount of Rate applied when the input is outside of the Proportional Band. The Ar-tE time and the #:tE time are independent and have no effect on each other. To increase damping effect and reduce overshoot set the approach rate time for a value greater than the natural rise time of the process (natural rise time = process value time to set point).

**F int** Fuzzy Logic Intensity: Select 0 to 100%. 0% is OFF (disables Fuzzy Logic). The function defines the amount of impact Fuzzy Logic will have on the output.

**Fbnd** Fuzzy Logic Error Band: Select 0 to 4000 °F, °C, or counts. Sets the bandwidth of the Fuzzy Logic. Set Fbnd equal to PID proportional band (Pb t) for best results.
FrtE  Fuzzy Logic Rate of Change: Select 0.00 to 99.99 counts/second. For best initial setting, find the counts/second change of process value near Set Point 1 with output ON 100%. Multiply this value by 3. Set FrtE to this calculated value.

PEA  The Peak feature stores the highest input the control has measured since the last reset or Power On. At Power On PEA is reset to the present input. To manually reset the value PEA must be in the lower display. Press the ENTER key to reset. PEA will be reset and display the present input value.

URL  The Valley feature stores the lowest input the Instrument has measured since the last reset or Power On. At Power On URL is reset to the present input. To manually reset the value URL must be in the lower display. Press the ENTER key. URL will be reset and display the present input value.

PctO  Percent Output Feature: Select On or Off.

On  When selected On, the HOME lower display will indicate the output of the controller in percent. An "o" will appear in the right hand side of the lower display to indicate percent output for SP1. An "o" will appear on the right hand corner of the lower display to represent percent output for SP2, if the control is so equipped. The display will alternate between these values.

Off  Percent Output display is disabled.

ProG  Ramp/Soak Feature (16A3): Select On or Off

On  Allows Programmed Ramp/Soak function to be started by the Run/Hold key on the control front panel.

Off  Turns Ramp/Soak function Off and resets program to beginning.

PSEt  Programmer function set (16A3). Select On or Off.

Off  Skip Ramp/Soak Programming. Go to next Secondary Menu Item, InPC on the next page.

On  Enable Ramp/Soak Programming.

Stat  Programmer Status Display in the Primary Menu when Prog (above) is On (16A3): Select On or Off.

Off  The Primary Menu operates as normal.

On  The Primary Menu is altered to have the following items inserted before the SP1 menu item:

# # # #  t , time remaining in active segment
### $\Delta t$, total time in active segment
### $\Delta SP$, segment target set point

$tbAS$  
Ramp/Soak Time Base (16A3). Select $\_5$ or $60.5$.  

- $\_5$  
Ramp/Soak time base is in 1 second increments. Program time $\Delta t$, is measured in seconds.  

- $60.5$  
Ramp/Soak time base is in 60 second increments (minutes). Program time $\Delta t$, is measured in minutes.

The following items repeat in the following order: $\Delta t$, $\Delta SP$, $\Delta A$ (if $\Delta A$ is programmed as $E_{ult}$), $\Delta t$, $\Delta SP$, $\Delta A$, $\Delta t$, $\Delta SP$, $\Delta A$.  

To avoid repetition each item will only be described once.

$\Delta t$,  
Segment Time (16A3): Select 0 to 9999 units (minutes if $tbAS$ is set to $60.5$, seconds if $tbAS$ is set to $\_5$).

$\Delta SP$,  
Segment Set Point (16A3): Set to target value desired.

$\Delta A$,  
Segment Alarm 1 Event (16A3): Select $on$ or $OFF$.  

- $on$  
Alarm 1 is active during segment 1 time ($\Delta t$).  

- $OFF$  
Alarm 1 is inactive during segment 1 time ($\Delta t$).

$PEnd$,  
Program End action (16A3): Select $Hold$ or $OFF$.  

- $Hold$  
Stay at the Present Set Point ($\Delta SP$).  

- $OFF$  
Turn Off SP1 and SP2 Outputs at the end of the program.

$Loop$,  
Repeat program starting at $\Delta t$.

$SP \_1$,  
Revert to $SP \_1$ value.

$InPC$,  
Input Correction: Select $-500$ to 0 to 500 °F, °C, or counts. This feature allows the input value to be changed to agree with an external reference or to compensate for sensor error. **Note:** $InPC$ is reset to zero when the input type is changed, or when decimal position is changed. Factory default is 0.

$F \_Lt$,  
Digital Filter: Select $OFF$, 1 to 99. In some cases the time constant of the sensor, or noise, could cause the display to jump enough to be unreadable. A setting of 2 is usually sufficient filtering (2 represents approximately a 1 second time constant). When the 0.1 degree resolution is selected this should be increased to 4. If this value is set too high, controllability will suffer.
Loop Break Protection: Select OFF, 1 to 9999 seconds. If, during operation, the output is minimum (0%) or maximum (100%), and the input moves less than 5°F (3°C) or 5 counts over the time set for \( t_{LPR} \), the \( t_{LPR} \) bAd message will appear. This condition can also be routed to an Alarm Condition if alarms are present and turned On (see \( R_{LPR} \) in the Secure Menu). The loop break error can be reset by pressing the ENTER key when at the \( t_{LPR} \) menu item. The INDEX & ENTER keys may also be used.

\( P_{OL} \) (Option 934, 936, Analog Retransmission Output) Process Output Low: Select -450°F, -260°C, or -1999 counts to any value less than \( P_{OH} \).

\( P_{OH} \) (Option 934, 936, Analog Retransmission Output) Process Output High: Select from any value greater than \( P_{OL} \) to +9999°F, +5530°C, or 9999 counts.

\( P_{OS} \) (Option 934, 936, Analog Retransmission Output) Process Output Source: Select \( I_{NP} \) or \( S_{Pt} \).
\( I_{NP} \): Output follows the Process Variable (input).
\( S_{Pt} \): Output follows the Set Variable.

\( r_{SP} \) (Option 924, 926, 928, Analog Remote Set Point) Remote Set Point: Select ON or OFF.
OFF: The control uses the value set for \( SP \).
ON: The control uses the value set by the analog remote set point signal as established by the Secure Menu items \( r_{SC} \) and \( r_{SH} \). If the analog signal fails, the control will display the error message CHEC \( r_{SP} \) and revert to the \( SP \) local value.

\( L_{C-E} \) (Option 992, 993, 995, 996, Serial Communications) Local / Remote Status: Select \( L_{C} \) or \( E \). Does not affect other instruments on daisy chain.
\( L_{C} \): The host computer is advised that remote write commands will be rejected. Any write commands sent to this control will be rejected. All read commands are accepted.
\( E \): The host computer is allowed to send write commands. If the control is not addressed within the time set in \( n_{RT} \) (No Activity Timer in the Secure Menu) the CHEC \( L_{C-E} \) error message will be displayed.
(Option 992, 993, 995, 996, Serial Communications) Control Address: Set from 1 to 3FF (Options 992 and 993) or set from 1 to FF (Options 995 and 996). This number (hexadecimal, base 16) must match the address number used by the host computer. Not settable in this menu. To change this parameter, see Addr in the Secure Menu.

SECURE MENU

Hold \(\text{UP ARROW} & \text{ENTER}\) for 5 Seconds. Press \(\text{INDEX}\) to advance to the next menu item. Press \(\text{UP ARROW}\) or \(\text{DOWN ARROW}\) to change the value in the display. Press \(\text{ENTER}\) to retain the value.

OUTPUTS ARE DISABLED (TURNED OFF) WHILE CONTROL IS IN SECURE MENU.

Secs Security Code: See the Security Level Selection and the Password Table in this manual, in order to enter the correct password.

Input Type: Select one of the following. Refer to the Wiring section for the proper wiring.

- \(J-E\) Type "J" Thermocouple
- \(E-R\) Type "K" Thermocouple
- \(E-E\) Type "E" Thermocouple
- \(E-T\) Type "T" Thermocouple
- \(E-L\) Type "L" Thermocouple
- \(E-N\) Type "N" Thermocouple
- \(E-M\) Type "R" Thermocouple
- \(S-S\) Type "S" Thermocouple
- \(B-R\) Type "B" Thermocouple
- \(C-C\) Type "C" Thermocouple

- \(P392\) 100 ohm Platinum (NIST 0.00392 \(\Omega/\Omega^\circ \text{C}\))
- \(n 20\) 120 ohm Nickel
- \(P385\) 100 ohm Platinum (IEC/DIN 0.00385 \(\Omega/\Omega^\circ \text{C}\))
- \(P38\) 1000 ohm Platinum (IEC/DIN 0.00385 \(\Omega/\Omega^\circ \text{C}\))
- \(\text{Curr}\) DC Current Input 0.0 to 20.0 or 4.0 to 20.0 mA.
- \(\text{Vol}\) DC Voltage Input 0.0 to 10.0 or 1.0 to 10.0 volts.
- \(d FF\) DC Voltage Input -10 to +10 mV.
- \(d FF\) Reserved

\(\text{Sup}\) Zero Suppression: Select \(\text{On}\) or \(\text{OFF}\). Only with Current and Voltage input types.

\(\text{OFF}\) The input range will start at 0 (zero) Input.

\(\text{On}\) The input range will start at 4.00 mA or 1.00 V.
In it  \( F, \zeta \) or \( \text{non}E \).

\( F \)  
°F descriptor is On and temperature inputs will be displayed in actual degrees Fahrenheit.

\( \zeta \)  
°C descriptor is On and temperature inputs will be displayed in actual degrees Celsius.

\( \text{non}E \)  
°F and °C descriptors will be Off. This is only available with Current and Voltage Inputs.

\( dPt \)  
Decimal Point Positioning: Select 0, 0.0, 0.00, 0.000, or .0000. On temperature type inputs a change here will alter the Process Value, SP1, SP2, ALLo, ALHi, and InPC. For Current and Voltage Inputs all Menu Items related to the Input will be affected.

0  
No decimal Point is selected. This is available for all Input Types.

0.0  
One decimal place is available for Type J, K, E, T, L, RTD's, Current and Voltage Inputs.

0.00  
Two decimal places is only available for Current and Voltage Inputs.

0.000  
Three decimal places is only available for Current and Voltage Inputs.

0.0000  
Four decimal places is only available for Current and Voltage Inputs.

\( inPt \)  
Input Fault Timer: Select OFF, 0, 1 to 540.0 minutes. Whenever an Input is out of range (UF or DF displayed), shorted, or open, the timer will start. When the time has elapsed, the controller will revert to the output condition selected by \( inPb \) below. If OFF is selected, the Input Fault Timer will not be recognized (time = infinite).

\( inPb \)  
Input Fail Action (16A3): Select FA il, RU E, or Pr E. When the Input is out of range (UF or DF displayed) and the Input timer (\( inPt \)) time has elapsed, the controller will revert to the selected condition.

FA il  
Outputs are disabled (go to 0% output).

RU E  
The outputs will hold at the last known average percentage of output.

Pr E  
The outputs will maintain preprogrammed percentages of output as specified in \( Pr E_1 \) and \( Pr E_2 \).

Pr E 1  
Preset output for Set Point 1. Select 0 to 100%.

Pr E 2  
Preset output for Set Point 2. Select 0 to 100%.
**APCt**  Manual and PctO display adjustment (16A3). Select rEAL or Adj.
  rEAL  Manual display will display output 0 to 100% relative to actual range of the output.
  Adj  Manual display will display output 0 to 100% relative to the $\#OL$ and $\#OH$ settings.

**SEnC**  Sensor Rate of Change: Select OFF, 1 to 4000 °F, °C, or counts per 1 second period. This value is usually set to be slightly greater than the fastest process response expected during a 1 second period, but measured for at least 2 seconds. If the process is faster than this setting, the SEnC bAd error message will appear. The outputs will then be turned off. This function can be used to detect a runaway condition, or speed up detection of an open thermocouple. Use the \(\text{INDEX} \& \text{ENTER}\) keys to reset.

**SCAL**  Scale Low: Select 100 to 11998 counts below SCAH. The total span between SCAL and SCAH must be within 11998 counts. Maximum setting range is -1999 to +9999 counts. For Current and Voltage inputs, this will set the low range end. Value not adjustable for Thermocouple and RTD ranges.

**SCAH**  Scale High: Select 100 to 11998 counts above SCAL. The total span between SCAL and SCAH must be within 11998 counts. Maximum setting range is -1999 to +9999 counts. For Current and Voltage inputs, this will set the high range end. Value not adjustable for Thermocouple and RTD ranges.

**SPL**  Set Point Low: Select from the lowest input range value to $SPH$ value. This will set the minimum SP1 or SP2 value that can be entered. The values for SP1 or SP2 will stop moving when this value is reached.

**SPH**  Set Point High: Select from the highest input range value to $SPL$ value. This will set the maximum SP1 or SP2 value that can be entered. The values for SP1 or SP2 will stop moving when this value is reached.

**SP 1D**  Set Point 1 Output Select: Select $OutA$ or $OutB$.
  $OutA$  Set Point 1 is routed through Output A, Set Point 2 (if equipped) is routed through Output B.
  $OutB$  Set Point 1 is routed through Output B, Set Point 2 (if equipped) is routed through Output A.
Set Point 1 State: Select \( d \) or \( rE \).

\( d \) = Direct Action. As the input increases the output will increase. Most commonly used in cooling processes.

\( rE \) = Reverse Action. As the input increases the output will decrease. Most commonly used in heating processes.

If \( \text{Out} \) is set for \( \#\#P \), \( \#PUL \), or \( PrP \), then \( 5 iOL \) and \( 5 iOH \) appear. If \( \text{Out} \) is set for \( 0nOF \), then skip to \( 5 i-E \).

\( 5 iOL \) = Set Point Output Low Limit: Select \( 0 \) to \( 100\% \) but not greater than \( 5 iOH \). This item limits the lowest output value. This is useful for adding a bias to the process when needed. Factory set to \( 0 \) for output codes 1, 2, 3, 4, and 8. Factory set to \( 20 \) for output code 5 (20\% output equals 4 mA output).

\( 5 iOH \) = Set Point 1 Output High Limit: Select \( 0 \) to \( 100\% \) but not less than \( 5 iOL \) for output codes 1, 2, 3, 4, or 8. Select \( 0 \) to \( 102\% \) but not less than \( 5 iOL \) for output code 5. This item allows setting the maximum output limit. This is useful with processes that are over powered. Adjustment to 102\% allows setting current output to force a full on condition for output devices which do not have bias adjustments. Factory set to \( 100 \) for all output codes.

If \( \text{Out} \) is set for \( \#\#P \), \( \#PUL \), or \( PrP \), then skip to \( 5 i-P \) below.

If \( \text{Out} \) is set to \( 0nOF \) (in the Secondary Menu), then the next three menu items can make the \( SP 1 \) and \( SP \) \( iD \) settings act like a high or low alarm set point. See the information on alarm settings and the cautions and warnings that apply to them on Pages 33-34.

Note that when Set Point 1 Power Interrupt, \( 5 iP \), is \( 0n \), and Set Point 1 Reset, \( 5 i-E \), is programmed to \( HoLD \), the SP1 output will automatically reset upon a power failure and subsequent restoration, if the process is below \( SP 1 \).

\( 5 i-E \) = Set Point 1 Reset. Select \( 0nOF \) or \( HoLD \).

\( 0nOF \) = Output will automatically reset when process passes back through \( SP iD \).

\( HoLD \) = Manual Reset. Reset (acknowledge) by simultaneously pressing the \( \text{INDEX} \) & \( \text{DOWN ARROW} \) keys for 3 seconds.
5 SP - Set Point 1 Power Interrupt. Select On or Off.

On - Alarm Power Interrupt is On. Output will automatically reset on power-up if no alarm condition exists.

Off - Alarm Power Interrupt is Off. Output will be in the alarm condition on power-up regardless of condition of process.

5 IH - Set Point 1 Inhibit: Select On or Off.

On - Alarm Inhibit is On. Alarm action is suspended until the process value first enters a non-alarm condition.

Off - Alarm Inhibit is Off.

5 LP - Set Point Lamp: Select On or Off.

On - Lamp ON when Output is ON.

Off - Lamp OFF when Output is ON.

If your control is not equipped with Set Point 2, then proceed to the alarm section (next page).

52t - Set Point 2 type: Select AbS or dE.

AbS - Absolute SP2. SP2 is independent of SP1, and may be set anywhere between the limits of SP L and SP H.

dE - Deviation SP2. SP2 is set as a deviation from SP1, and allows SP2 to retain its relationship with SP1 when SP1 is changed (SP2 tracks SP1).

52St - Set Point 2 State: Select d or rE.

d - Direct Action. As the input increases the output will increase. Most commonly used in cooling processes.

rE - Reverse Action. As the input increases the output will decrease. Most commonly used in heating processes.

If Out2 is set for #P, #Pul, or ProP, then 520L and 520H appear. If Out2 is set for OnOff, then skip 520L and 520H.

520L - Set Point Output Low Limit: Select 0 to 100% but not greater than 520H. This item limits the lowest output value. This is useful for adding a bias to the process when needed. Factory set to 0 for output codes 1,2, 3,4, and 8. Factory set to 20 for output code 5 (20% output equals 4 mA output).

520H - Set Point 2 Output High Limit: Select 0 to 100% but not less than 520L for output codes 1, 2, 3,4, or 8. Select 0 to 102% but not less than 520L for output code 5. This item allows setting the maximum output limit. This is useful with processes that are over powered. Adjustment to 102% allows setting current output to
force a full on condition for output devices which do not have bias adjustments. Factory set to **OFF** for all output codes.

If $O_{\text{UT}}$ is set to $O_{\text{ON}}$ (in the Secondary Menu), then the next three menu items can make the $S_{\text{P2}}$ and $S_{\text{P2d}}$ settings act like a high or low alarm set point. See the information on alarm settings and the cautions and warnings that apply to them on the next pages.

Note that when Set Point 2 Power Interrupt, $S_{\text{P2}}$, is $O_{\text{ON}}$, and Set Point 2 Reset, $S_{\text{R-E}}$, is programmed to $H_{\text{OLD}}$, the SP2 output will automatically reset upon a power failure and subsequent restoration, if the process is below $S_{\text{P2}}$.

$S_{\text{R-E}}$ Set Point 2 Reset. Select $O_{\text{ON}}$ or $H_{\text{OLD}}$.
- **ON** Output will automatically reset when process passes back through $S_{\text{P2d}}$.
- **HOLD** Manual Reset. Reset (acknowledge) by simultaneously pressing the **INDEX & DOWN ARROW** keys for 3 seconds.

$S_{\text{P2}}$, Set Point 2 Power Interrupt. Select $O_{\text{ON}}$ or $O_{\text{OFF}}$.
- **ON** Alarm Power Interrupt is $O_{\text{ON}}$. Output will automatically reset on power-up if no alarm condition exists.
- **OFF** Alarm Power Interrupt is $O_{\text{OFF}}$. Output will be in the alarm condition on power-up regardless of condition of process.

$S_{\text{H}}$, Set Point 2 Inhibit: Select $O_{\text{ON}}$ or $O_{\text{OFF}}$.
- **ON** Alarm Inhibit is $O_{\text{ON}}$. Alarm action is suspended until the process value first enters a non-alarm condition.
- **OFF** Alarm Inhibit is $O_{\text{OFF}}$.

$S_{\text{LP}}$, Set Point 2 Lamp: Select $O_{\text{ON}}$ or $O_{\text{OFF}}$.
- **ON** Lamp ON when Output is ON.
- **OFF** Lamp OFF when Output is ON.

**ALARM TYPE AND ACTION** (if alarm function is present)

- **Caution**: In any critical application where failure could cause expensive product loss or endanger personal safety, a redundant limit controller is required.

When setting an alarm value for an absolute alarm (\(R_{E} = R_{bS}\)), simply set the value at which the alarm is to occur.

When setting the alarm value for a deviation alarm (\(R_{E} = dE\)), set the difference in value from the Set Point desired. For example if a low alarm is
required to be 5 degrees below the Set Point, then set \( R_{LH} \) to \(-5\). If a high alarm is required 20 degrees above the Set Point, then set \( R_{HH} \) to \(+20\). If the Set Point is changed, the alarm will continue to hold the same relationship as originally set.

The diagram below shows the action and reset functions for both absolute and deviation alarms.

\[ D = 1 \text{ degree } F; 1 \text{ degree } C, \text{ or 1 count} \]

**Absolute Alarms**

- **High Alarm**
  - ON/Off
  - \( LH \)

- **Low Alarm**
  - ON/Off
  - \( LH \)

- **High and Low Alarm**
  - ON/Off
  - \( LH \)
  - \( LH \)

**Deviation Alarms**

- **High Alarm**
  - ON/Off
  - \( LH \)

- **Low Alarm**
  - ON/Off
  - \( LH \)

Note that when Alarm Power Interrupt, \( R_{IP} \), is programmed \( ON \) and Alarm Reset, \( R_{IE} \), is programmed for \( HOLOD \), the alarm will automatically reset upon a power failure and subsequent restoration if no alarm condition is present.

If Alarm Inhibit, \( R_{IH} \), is selected \( ON \), an alarm condition is suspended upon power up until the process value passes through the alarm set point once. Alarm inhibit can be restored as if a power up took place by pressing both the \( \text{ Index } \) and \( \text{ Enter } \) keys for 3 seconds.

**Warning:** If inhibit is on and a power failure occurs during a high alarm, restoration of power will not cause the alarm to occur if the process value does not first drop below the high alarm setting. Do not use the Alarm Inhibit feature if a hazard is created by this action. Be sure to test all combinations of high and low alarm inhibit actions before placing control into operation.
The following menu items apply only to the alarm.

**RL 1**

Alarm 1 function: Select **OFF, Lo, H, H Lo,** or **EUnk**.

**OFF**
Alarm 1 is disabled. No Alarm 1 menu items appear in the Secondary or Secure menus.

**Lo**
Low Alarm Only. **RL Lo** appears in the Secondary Menu.

**H**
High Alarm Only. **RL H** appears in the Secondary Menu.

**H Lo**
High and Low Alarms. Both **RL Lo** and **RL H**, appear in the Secondary Menu, and share the same Alarm 1 Relay output.

**EUnk**
Alarm 1 is controlled by the Ramp/Soak program function. (16A3). See pages 11-14 and 26 (#A 1) for further information.

If **RL 1** is set to **OFF** and the control is not equipped with options, the Secure Menu ends here. If **RL 1** is set to **OFF** and the control is equipped with options, proceed to **SP, Adr,** or **SC** below.

If **RL 1** is set to **EUnk**, go to **RLSt** below.

**A Lt**
Alarm 1 Type: Select **A bS** or **dE**

**A bS**
Absolute Alarm that may be set anywhere within the values of **S CR L** and **S CR H** and is independent of **SP 1**.

**dE**
Deviation Alarm that may be set as an offset from **SP 1**. As **SP 1** is changed the Alarm Point will track with **SP 1**. A Deviation alarm will also track any active ramp or soak set point.

**A r-E**
Alarm 1 Reset: Select **OnQF** or **HoLd**.

**OnQF**
Automatic Reset.

**HoLd**
Manual Reset. Reset (acknowledge) by simultaneously pressing the **INDEX & DOWN ARROW** keys for 3 seconds.

**A iP**
Alarm 1 Power Interrupt: Select **On** or **OFF**.

**On**
Alarm Power Interrupt is **On**.

**OFF**
Alarm Power Interrupt is **OFF**.

**A iH**
Alarm 1 Inhibit: Select **On** or **OFF**.

**On**
Alarm Inhibit is **On**. Alarm action is suspended until the process value first enters a non-alarm condition.

**OFF**
Alarm Inhibit is **OFF**.

**A iSt**
Alarm 1 Output State: Select **CLOS** or **OPEN**.

**CLOS**
Closes Contacts at Alarm Set Point.

**OPEN**
Opens Contacts at Alarm Set Point.
Alarm 1 Lamp: Select on or off.
- on: Alarm Lamp is ON when alarm contact is closed.
- off: Alarm Lamp is OFF when alarm contact is closed.

Alarm 1 Loop Break. Select on or off.
- on: Loop Break Condition will cause an Alarm Condition.
- off: Loop Break will not affect the Alarm Condition.

SPSR (Option 948, 4-Stage Set Point) Switch Action: Select sE or sE.
- sE: Set Point Stage selected by external contact closures.
- sE: Set Point Stage selected by internal menu selection.
  See SP menu item in Secondary Menu.

Addr (Option 992, 993, 995, 996, Serial Communications) Control Address:
Set from 1 to FF for Options 992 and 993. Set from 1 to FF for Options 995 and 996. This number (hexadecimal, base 16) must match the address number used by the host computer. Power to instrument must be turned off and on before change takes effect (see Page 18).

bAud (Option 992, 993, 995, 996, Serial Communications) Communication Baud Rate:
Select 300, 1200, 2400, 4800, 9600 (baud), 19.2, 28.8, or 57.6 (kbaud) for Options 992 and 993. Select 300, 1200, 2400, 4800, 9600 (baud), or 19.2 (kbaud) for Options 995 and 996. This number must match the baud rate used by the host computer. Power to instrument must be turned off and on before change takes effect (see Page 18).

nAtc (Option 992, 993, 995, 996, Serial Communications) No Activity Timer:
Select off or 1 to 99 minutes.
- 1 - 99: Maximum time between host computer accesses. If timer counts to 0, [HEC] Lor-E will be displayed.
- off: No Activity Timer function is disabled.

Stor (Option 992, 993, 995, 996, Serial Communications) Store to EEPROM:
Select yes or no. (See additional information on page 18).
- yes: Menu Item changes made through the Serial Communications are stored directly to the EEPROM.
- no: Menu Item changes made through the Serial Communications are stored in RAM.

rSCL (Option 924, 926, 928, Analog Remote Set Point) Remote Scale Low:
Select 100 to 11998 counts below rSCL. The total span between rSCL and rSCH must be within 11998 counts. Maximum setting range is -1999 to +9999 counts.
(Option 924, 926, 928, Analog Remote Set Point) Remote Scale High: Select 100 to 11998 counts above r-SCL. The total span between r-SCL and r-SCH must be within 11998 counts. Maximum setting range is -1999 to +9999 counts.

NOTES

ERROR MESSAGES
Any error message may be cleared by using the 'Global Reset' by pressing and holding the INDEX & ENTER keys for five seconds.

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>MEANING</th>
<th>SP OUTPUTS</th>
<th>ACTION REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>r-ER (Alternates with PV)</td>
<td>This message appears if the ambient temperature of the control approaches the ends of tolerance.</td>
<td>Set point outputs active Alarm active</td>
<td>Correct the ambient temperature conditions. Ventilate the area of the cabinet or check for clogged filters. If internal temperature sensor (RJC located in terminal 2) is broken, return to factory for service.</td>
</tr>
<tr>
<td>r-ER</td>
<td>This message appears if the ambient temperature of the control is out of range or RJC sensor is broken.</td>
<td>Set point outputs active Alarms active</td>
<td>Correct the ambient temperature conditions. Ventilate the area of the cabinet or check for clogged filters. If internal temperature sensor is broken, return to factory for service.</td>
</tr>
</tbody>
</table>
### ERROR MESSAGES

Any error message may be cleared by using the ‘Global Reset’ by pressing and holding the INDEX & ENTER keys for five seconds.

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>MEANING</th>
<th>SP OUTPUTS</th>
<th>ACTION REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UFL</strong> or <strong>OFL</strong></td>
<td>Underflow or Overflow: Process value has exceeded input range ends.</td>
<td>Set point outputs active. Alarm active</td>
<td>May be normal if input signals go above or below range ends. If not the case, check sensor, input wiring and correct.</td>
</tr>
<tr>
<td><strong>bad inP</strong></td>
<td>For RTD inputs RTD is open or shorted.</td>
<td>Set point outputs inactive. Alarm active</td>
<td>When ( \text{inp} ) (input fault timer) has been set for a time, the outputs will be turned off after the set time. Setting the time to ( \text{OFF} ) causes the outputs to remain active, however <strong>UFL</strong> or <strong>OFL</strong> will still be displayed. Correct or replace sensor.</td>
</tr>
<tr>
<td><strong>OPEN inP</strong></td>
<td>For THERMOCOUPLE inputs thermocouple is open.</td>
<td></td>
<td>Correct or replace sensor.</td>
</tr>
<tr>
<td><strong>LOOP bad</strong></td>
<td>The sensor may be defective, heater fuse open, heater open, or the final power output device is bad.</td>
<td>Set point outputs inactive. Alarm active.</td>
<td>Correct or replace sensor, or any element in the control loop that may have failed. Correct the problem.</td>
</tr>
<tr>
<td><strong>5enC bad</strong></td>
<td>Sensor Rate of Change exceeded the programmed limits set for <strong>5enC</strong>.</td>
<td>Set point outputs inactive. Alarm active</td>
<td>Check for the cause of the error. The value setting may be too slow for the process, or the sensor is intermittent. Correct the problem. Clear with ‘Global Reset’.</td>
</tr>
<tr>
<td><strong>HECK ORE</strong></td>
<td>Check calibration appears as an alternating message if the instrument calibration nears tolerance edges.</td>
<td>Set point outputs active. Alarm active</td>
<td>Remove the instrument for service and / or recalibration.</td>
</tr>
<tr>
<td><strong>CHECK ORE</strong></td>
<td>Check calibration appears as a flashing message if the instrument calibration exceeds specification.</td>
<td>Set point outputs inactive. Alarm active</td>
<td>Remove the instrument for service and / or recalibration.</td>
</tr>
</tbody>
</table>
**ERROR MESSAGES**

Any error message may be cleared by using the ‘Global Reset’ by pressing and holding the INDEX & ENTER keys for five seconds.

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>MEANING</th>
<th>SP OUTPUTS</th>
<th>ACTION REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>No display lighted</td>
<td>Display is blank. Instrument is not getting power, or the supply voltage is too low.</td>
<td>Set point outputs inactive Alarm inactive</td>
<td>Check that the power supply is on, measure supply voltage, check that the external fuses are good.</td>
</tr>
<tr>
<td>FA l TEST</td>
<td>Fail test appears upon power up if the internal diagnostics detect a failure. This message may occur during operation if a failure is detected. Displays flash. Fail test may also occur due to an EEPROM failure.</td>
<td>Set point outputs inactive Alarm inactive</td>
<td>The display alternates between FA l TEST and one of the following messages: FACT dFL: Memory may be corrupted. Press the DOWN ARROW and ENTER keys to return control to the factory default settings. Recheck controller programming. rEt FACT: Unrecoverable error, return to factory for service.</td>
</tr>
<tr>
<td>CHEC SP 1, CHEC SP 2, CHEC 16SP, CHEC 1SP, ..., CHEC #5SP</td>
<td>This message will appear upon power up if SP 1, SP 2, #SP 1, or #SP is set outside of the SPL or SPH values.</td>
<td>Set point outputs inactive Alarm active</td>
<td>Correct the SP 1, etc. or adjust the SPL or SPH values by programming new values.</td>
</tr>
<tr>
<td>CHEC SPL or CHEC SPH</td>
<td>This message appears at power up if SPL or SPH values are programmed outside the input range ends.</td>
<td>Set point outputs inactive Alarm active</td>
<td>Correct the SPL or SPH values by programming new values.</td>
</tr>
<tr>
<td>CHEC rSP</td>
<td>This message appears if the analog remote set point signal is out of range.</td>
<td>Set point outputs active Alarm active</td>
<td>The control will revert to SP 1. Correction of the analog signal or turning OFF the rSP clears the error message.</td>
</tr>
<tr>
<td>CHEC Lor</td>
<td>This message appears if the Serial Communications has timed out.</td>
<td>Set point outputs active Alarm active</td>
<td>Change the LorE to LOC. Restore the communications line and switch LorE back to rE.</td>
</tr>
</tbody>
</table>
SPECIFICATIONS

Selectable Inputs: Thermocouple, RTD, DC Voltage, or DC Current selectable.

Input Impedance:
   Thermocouple = 3 megohms minimum.   RTD current = 200 µA.
   Current = 10 ohms.                   Voltage = 5000 ohms.

Sensor Break Protection: De-energizes control output to protect system after customer set time. (See Menu in Secure Menu.)

Set Point Range: Selectable (See Input Ranges Page 43).
Display: Two 4 digit, 7 segment 0.3" high LEDs.
Control Action: Reverse (usually heating), Direct (usually cooling) selectable.

Proportional Band: 1 to 9999 °F, °C, or counts.
Reset Time (Integral): Off or 0.1 to 99.9 minutes.
Rate Time (Derivative): Off or 0.01 to 99.99 minutes.
Cycle Rate: 1 to 80 seconds.
On - Off Differential: Adjustable 1° F, 1° C, or 1 count to full scale in 1° F, 1° C, or 1 count steps.

Alarm On - Off Differential: 1° F, 1° C, or 1 count.
Fuzzy Percent: 0 to 100%.
Fuzzy Rate: Off or 0.01 to 99.99 counts per second.
Fuzzy Band: Off or 1 to 4000 °F, °C, or counts.
Accuracy: ±0.25% of span, ±1 least significant digit.
Resolution: 1 degree or 0.1 degree, selectable.

Line Voltage Stability: ±0.05% over the supply voltage range.

Temperature Stability: 4µV/°C (2.3 µV/°F) typical, 8 µV/°C (4.5 µV/°F) maximum (100 ppm / °C typical, 200 ppm / °C maximum).

Common Mode Rejection: 140 db minimum at 60 Hz.
Normal Mode Rejection: 65 db typical, 60 db at 60 Hz.

Isolation:
   Relay and SSR outputs: 1500 Vac to all other inputs and outputs.
   SP1 and SP2 Current outputs: 500 Vac to all other inputs and outputs, but not isolated from each other.
   SP1 and SP2 Switched Voltage outputs: 500 Vac to all other inputs and outputs, but not isolated from each other.
   Process Output (934, 936): 500 VAC to all other inputs and outputs.
Supply Voltage: 100 to 240 Vac, nominal, +10 -15%, 50 to 400 Hz. single phase; 132 to 240 Vdc, nominal, +10 -20%.
Supply Voltage (Option 9502): 12 to 24 Vdc, Vac 40-400 Hz, ±20%.
Power Consumption: 5VA maximum.
Operating Temperature: -10 to +55 °C (+14 to 131 °F).
Storage Temperature: -40 to +80 °C (-40 to 176 °F).
Humidity Conditions: 0 to 90% up to 40 °C non-condensing, 10 to 50% at 55 °C non-condensing.

Memory Backup: Nonvolatile memory. No batteries required.

Control Output Ratings:

SSR: 2.0 A combined outputs A & B @ 240 Vac at 25 °C (77°F). Derates to 1.0 A @ 55°C (130°F).

Relay: SPST, 3 A @ 240 Vac resistive; 1.5A @240 Vac inductive; Pilot duty rating 240 VA, 2 A @ 120 Vac or 1 A 240 Vac.

Alarm Relay: SPST, 3 A @ 240 Vac resistive; 1/10 HP@ 120 Vac.

Current (Isolated): 0 to 20 mA across 600 ohms maximum.

Switched Voltage (Isolated): 15 Vdc @ 20 mA.

DC SSR: 1.75 A @ 32 Vdc maximum.

Panel Cutout: 45 mm x 45 mm (1.775” x 1.775”).

Depth Behind Mounting Surface: 121.6 mm (4.79”) maximum.

Weight: 220 g (8 oz).

Agency Approvals: UL, C-UL E83725; CE.

Front Panel Rating: IP66, (UL Type 4X).

OPTIONS

-924 Analog Remote Set Point

Input: 0 to 10 VDC

Input Impedance: 1 Meg Ohms

Isolation: Shares common ground with PV input.

Scale: Programmable from 100 to 11998 counts, depending on PV range selected.

-926 Analog Remote Set Point

Input: 0 to 20 mADC.

Input Impedance: 10 Ohms

Isolation: Shares common ground with PV input.

Scale: Programmable from 100 to 11998 counts, depending on PV range selected.

-928 Analog Remote Set Point

Input: 0 to 10,000 ohms, two wire.

Search Current: 4 μA.

Isolation: Shares common ground with PV input.

-934 Analog Retransmission of PV/SV (programmable)

Output: 0 to 20 mADC into 600 Ohms, maximum.

Isolation: 500 VAC

Scale: Programmable from 100 to 11998 counts, depending on PV range selected.

-936 Analog Retransmission of PV/SV (programmable)

Output: 0 to 10 VDC @ 20 mA maximum.

Isolation: 500 VAC

Scale: Programmable from 100 to 11998 counts, depending on PV range selected.
-948 Four Stage Set Point
  Input:  Dry contact or NPN Open Collector Transistors.
  Current:  1 mA DC.
  Isolation:  Shares common ground with PV input.

-992 RS-485 Series Communications
  Port Compliance:  EIA-485
  Isolation:  500 VAC
  Protocol:  Lovelink™ II
  Address Range:  001H to 3FFH
  Baud Rates:  300, 1200, 2400, 4800, 9600, 19.2k, 28.8k, 57.6k.
  Mode:  Half duplex
  Character:  8 bits, 1 start, 1 stop, no parity.
  Number of units on line/port*:  32.
  Cable Length*:  6,000 ft (1,828 m).
  Termination:  120 Ohms, balanced.

-993 RS-232 Serial Communications
  Port Compliance:  RS-232C
  Isolation:  500 VAC
  Protocol:  Lovelink™ II
  Address Range:  001H to 3FFH
  Baud Rates:  300, 1200, 2400, 4800, 9600, 19.2k, 28.8k, 57.6k.
  Mode:  Half duplex
  Character:  8 bits, 1 start, 1 stop, no parity.
  Number of units on line/port:  1.
  Cable Length:  25 ft (7.6 m).

-995 RS-232 Serial Communications
  Port Compliance:  RS-232C
  Isolation:  500 VAC
  Protocol:  MODBUS® RTU
  Address Range:  001H to 0FFH
  Baud Rates:  300, 1200, 2400, 4800, 9600, 19.2k.
  Mode:  Half duplex
  Character:  8 bits, 1 start, 1 stop, no parity.
  Number of units on line:  1.
  Cable Length:  25 ft (7.6 m).

-996 RS-485 Serial Communications
  Port Compliance:  EIA-485
  Isolation:  500 VAC
  Protocol:  MODBUS® RTU
  Address Range:  001H to 0FFH
  Baud Rates:  300, 1200, 2400, 4800, 9600, 19.2k.
  Mode:  Half duplex
  Character:  8 bits, 1 start, 1 stop, no parity.
  Number of units on line*:  32
  Cable Length*:  6,000 ft (1,828 m).
**Termination:** 120 Ohms, balanced.

Number can be increased through use of a repeater such as the Mother Node™. Consult factory for details.

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### INPUT RANGES

<table>
<thead>
<tr>
<th>INPUT TYPE</th>
<th>RANGE °F</th>
<th>RANGE °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type J or L¹ Thermocouple</td>
<td>-100 to +1607</td>
<td>-73 to +871</td>
</tr>
<tr>
<td>Type K¹ Thermocouple</td>
<td>-200 to +2500</td>
<td>-129 to +1371</td>
</tr>
<tr>
<td>Type T¹ Thermocouple</td>
<td>-350 to +750</td>
<td>-212 to +398</td>
</tr>
<tr>
<td>Type E¹ Thermocouple</td>
<td>-100 to +1800</td>
<td>-73 to +982</td>
</tr>
<tr>
<td>Type R Thermocouple</td>
<td>0 to 3200</td>
<td>-17 to +1760</td>
</tr>
<tr>
<td>Type S Thermocouple</td>
<td>0 to 3200</td>
<td>-17 to +1760</td>
</tr>
<tr>
<td>Type B Thermocouple</td>
<td>+75 to +3308</td>
<td>+24 to +1820</td>
</tr>
<tr>
<td>Type C Thermocouple</td>
<td>0 to 4208</td>
<td>-17 to +2320</td>
</tr>
<tr>
<td>Type N¹ Thermocouple</td>
<td>-100 to +2372</td>
<td>-73 to +1300</td>
</tr>
<tr>
<td>100 Ω Pt1 0.00385 DIN¹ RTD</td>
<td>-328 to 1607</td>
<td>-200 to +875</td>
</tr>
<tr>
<td>100 Ω Pt1 0.00392 NIST¹ RTD</td>
<td>-328 to 1607</td>
<td>-200 to +875</td>
</tr>
<tr>
<td>120 Ω Nickel 0.00628 US¹ RTD</td>
<td>-112 to +608</td>
<td>-80 to +320</td>
</tr>
<tr>
<td>1000 Ω Pt1 0.00385 DIN¹ RTD</td>
<td>-328 to +1607</td>
<td>-200 to +875</td>
</tr>
<tr>
<td>Current/Voltage/Δ Voltage²</td>
<td>Scalable Units from -1999 to +9999</td>
<td></td>
</tr>
</tbody>
</table>

¹ These Input Types can be set for 0.1° display. If temperature goes above 999.9° or less than -199.9° the display will return to whole degree resolution.

² The 0 to 20 mA DC, 4 to 20 mA DC, 0 to 10 VDC, 2 to 10 VDC, and -10 to +10 mVDC inputs are fully scalable from a minimum of 100 counts span placed anywhere within the within the range of -1999 to +9999. Decimal point position is adjustable from the zero place (9999), tenths (999.9), hundredths (99.99), thousandths (9.999), or ten thousandths (.9999).