Instructions for the 16A2 & 16A3 Series
Microprocessor Based
Temperature / Process Control
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 13.

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 28) before making changes to the Secondary Menu (page 20). If error messages occur, check the Error Messages on page 37-39 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 \( I^{n}P \) and press the DOWN ARROW until the display shows \( P385 \). Don’t forget to press the ENTER key to retain your setting.

Next, press the INDEX key to display \( U^{n} \). Press the DOWN ARROW until the display shows \( C \). Press ENTER.

Next, press the INDEX key until \( S^{P}L \) is displayed (pass the \( d^{P} \) and \( I^{n}P \) selections). Press the UP ARROW until the display shows \( O \). Press ENTER.

Finally, press INDEX key to display \( S^{P}H \). 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 OWN 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 or Auto/Manual 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>Model</th>
<th>Features</th>
<th>Alarm</th>
<th>Output A</th>
<th>Output B</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>16A</td>
<td>2 = Standard</td>
<td>0 = No</td>
<td>1 = SSR</td>
<td>0 = None</td>
<td>(blank if none)</td>
</tr>
</tbody>
</table>

#### Option Description

- **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 50-400 Hz power supply (control operates on low voltage equipment).

* These options may not be combined with each other. 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.

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 inputs 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 connect.

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 the rear of instrument showing wiring terminals).
OUTPUTS
(Rear View showing center block of wiring terminals.)

Output A
For AC SSR or relay type outputs (Output Codes 1 or 3), 15 & 16, and 17 & 18 are normally open. See Rating Label for details.

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

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 SP 10 in the Secure Menu.

Wiring for 4 to 20mA Transmitter Inputs
Wiring 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 OCCUR.

Wiring for Optional Inputs and Outputs
Options are described on Page 3. Detailed option programming and operation starts on Page 13. Wire power and outputs as shown on Pages 5 and 6. Wiring for options is shown opposite. All wiring shown above is CLASS 2. Shielded twisted pair is required for Options 992 and 994. Shielded cable is required for Options 993 and 995.

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 OCCUR.
## OPTION/TERMINALS

<table>
<thead>
<tr>
<th>PV1 PV/SV Retransmission, Current (e.g. 4-20 mA)</th>
<th>11</th>
<th>12</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PV2 PV/SV Retransmission, Voltage (e.g. 0-10V)</th>
<th>11</th>
<th>12</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
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<tr>
<td>+</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>992, 996 RS-485 Serial Communications</th>
<th>11</th>
<th>12</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>993, 995 RS-232 Serial Communications</th>
<th>11</th>
<th>12</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data In</td>
<td>Data Out</td>
<td>Signal Ground</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
</tbody>
</table>

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**View of rear of instrument showing wiring terminals.**

### RS-485 Daisy Chain Wiring Example

120 ohm terminator resistor

Ground

Line B

Line A

*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 labelled 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</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SHIELD</td>
</tr>
<tr>
<td>2</td>
<td>TRANSMIT</td>
</tr>
<tr>
<td>3</td>
<td>RECEIVE</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>7</td>
</tr>
</tbody>
</table>

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

**PIN DESCRIPTION**

1. DCD
2. RECEIVE
3. TRANSMIT
4. DTR
5. GROUND
6. DSR
7. RTS
8. CTS
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 Ramp/Soak (Page 11) for further details.

- **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 Auto/Maunal Operation on page 14.

- **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 iH: Alarm inhibit
- OPEN inp: Input error
- bR inp: Input error
- CHEC CAL: Check calibration

Correct the problems associated with the above conditions before using the reset keys. More than one error could 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 HOME position displaying the temperature value. Outputs are disabled (turned off) when the Secure Menu is active.

NOTE: To move the Primary Menu quickly from any other menu, press the \( \uparrow \rightarrow \) UP ARROW & ENTER keys followed by pressing the \( \downarrow \rightarrow \) INDEX & 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 \( \uparrow \) UP ARROW and \( \downarrow \) DOWN ARROW keys and press the \( \rightarrow \) ENTER key. Refer to the password table for the correct value to enter for the security level desired. The SEC menu item security level may be viewed or changed at any time regardless of the present security level.

Example: To set security access level to 2, at the SEC menu item, press the \( \uparrow \) UP ARROW key until the upper display shows the password for level 2 access, 1101. Press the \( \rightarrow \) 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 reference. This is the only reference made to password values in this instruction book.
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 function 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 it’s “control” for proper setting.

2. The “#” symbol is used in two ways. It is used inside 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 Italics. Features that apply only to the 16A3 Series will be notated in the Roman serif type.

Password Table

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

Error 1026: The feature you tried to use is not supported in this application. This may be caused by the following conditions:
- The feature you tried to use is not supported in this application.
- The control you are using is not compatible with the feature you are trying to use.
- The settings you are using are not compatible with the feature you are trying to use.
- The feature you are trying to use is not supported by the software you are using.
- The software you are using is not compatible with the feature you are trying to use.

The error message will appear on the display screen and in the event log. The message will also be recorded in the event log for future reference.

The error message can be cleared by turning the power off and on again. If the error message persists, please contact your local distributor for further assistance.
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 Pro9 function, the Pct0 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 o to indicate that the value displayed is no longer the SV, but percent output. The $SP2$ percent output is indicated by the use of an overline on the o. Access to the $SP2$ value is made by the $INDEX$ key. See Auto/Manual Operation on Page 14 for further information.

If $Pro9$ is turned on, the HOME display changes the SV display from SP1 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 $Pct0$ (Secondary Menu) is turned on, the lower display changes to show the active percentage of output as required to maintain $SP1$. The display is similar to the Auto/Manual display above, except that the percent indicators ($o, \overline{0}$) do not flash, and the output is displayed in whole percentages of output, not in tenths of a percent. If the control has both $SP1$ and $SP2$, the lower display will alternate between the $SP1$ percent output and the $SP2$ 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 StAt setting (this is discussed later) and press INDEX to tbAS.

The time base menu item, tbAS, allows selection of the amount of time that is counted per time unit. Setting tbAS to 1 makes all time settings use a time base of one second. A tbAS 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 1ti.

The following items repeat in the following order: 1ti, 1SP, 1A1 (if AL1 in the Secure Menu is programmed set to EUnt), 2ti, 2SP, 2A1, . . . , 16ti, 16SP, 16A1. To avoid repetition each item will only be described once.

Set 1ti to the amount of time you want for the first ramp. This value is in time units (determined by the tbAS menu item) from 0 to 9999. Press ENTER.
Set \( IS^P \) to the target value desired for the first ramp. This value is in actual units just like \( SP^1 \). 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 (\( A_1^i = E(Unt) \)), then \( A_1^i \) will appear. If you wish the Alarm 1 contact to function for this segment, set \( A_1^i \) is set to \( On \). If not, set for \( Off \). Press \( \text{ENTER} \). When \( A_1^i \) is set \( On \), the Alarm 1 function will be active for entire period set above.

Complete setting the segment times (\( 2t_j \cdots 16t_j \)), segment set point (\( 2SP \cdots 16SP \)), and event alarms (\( 2A_1 \cdots 16A_1 \)) to \( On \) or \( Off \).

For unneeded or unused segments set the segment times (\( 2t_j \cdots 16t_j \)) to 0, and set the segment set point (\( 2SP \cdots 16SP \)) 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 \( P\text{End} \). \( P\text{End} \) determines what the control does when the program has ended. You may choose to have the program repeat (\( Loop \)), \( Hold \) the last set point (\( 16SP \)), revert to the local \( SP^1 \), or turn the outputs off (\( Off \)).

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 \( Prog \) menu item on \( On \). Return to the HOME position by waiting for the display to time out or by pressing the \( \uparrow \downarrow \text{UP ARROW \& ENTER} \) keys and then the \( \downarrow \uparrow \text{DOWN ARROW \& INDEX} \) 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 \( \text{RUN / HOLD} \) key for three seconds. The HOLD indicator will go out, and the program will start.

To suspend the program at any time, press the \( \text{RUN / HOLD} \) 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 StAt menu item in the Secondary Menu. If StAt is OFF then the Primary Menu is not changed.

If the StAt menu item is set ON, then the Primary Menu has three additional information items added before SP 1 appears. The first INDEX item displays the time remaining in the current segment in the top display (#####), and the message ti, in the lower display. The next INDEX item displays the total time for the active segment in the upper display (#####) and the message #ti, ( 1ti . . . 16ti), in the lower display. The third INDEX item displays the segment set value (#####) in the top display, and the message #SP ( 1SP . . . 16SP) 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 S10L and S10H or S20L and S20H. If APCt is set for RERL, a reading of 50% in MANUAL represents 10 mA (Assuming a current output regardless of the S10L and S10H settings.) If APCt is set for R assuming a current output, 4 to 20 mA, with S10L set to 20 and S10H set to 100, 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.
Operating 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 (set for \( \text{O}n\text{F} \)), none of the following will apply.

Theory of Operation

The Self Tune function calculates the \( P_b \), \( rE_S \), and \( r\text{tE} \) parameters under the \( P \)-\text{tunE} selection, and the \( F\text{bnd} \) and \( F\text{rtE} \) parameters, as shown in the Secondary Menu. These values are determined by measuring the response of the process connection to the 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 effect of Fuzzy Logic on the process is still controlled by the \( F\text{nt} \) (fuzzy intensity) setting. If \( F\text{nt} \) is 0, the \( F\text{bnd} \) and \( F\text{rtE} \) 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 \( d\text{FAC} \) menu item. This menu item controls the amount of rate (derivative) that is applied. A \( d\text{FAC} \) setting of 3 (factory default) or less allows for less damping. A \( d\text{FAC} \) setting of 4 allows for critical damping as set forth in Ziegler - Nichols. A \( d\text{FAC} \) 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 \( \text{tunE} \) to \( \text{SELF} \). Skip \( \text{LErn} \) and check to make sure that \( d\text{FAC} \) is set to the desired value. Back up to \( \text{LErn} \) and set to \( \text{YES} \). 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 \( \text{tunE} \) setting automatic switches to \( P \)-\text{tunE}. This allows examination and/or modification of the values calculated. We recommended 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**

**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 **L0rE** menu item in the Secondary Menu to **L0C**. To allow the host to write commands to the control set **L0rE** to **rE**. (The host does have the ability to change the **L0rE** 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 **L0rE** 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 **CHEC L0rE**. To clear the message set **L0rE** to **L0C**.
Serial Communications
Options and Non-volatile 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.

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.

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 of time when the power is off. This is the type of memory that all Love Controls uses to save the settings your 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 begin operation.

If EEPROM is such a wonderful thing, you might ask, why bother with RAM? One reason 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 EEPROM has a limit to the number of times 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 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) 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 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 the data written to the EEPROM, as it is 'transitory' in nature (changing set points for a ramp/soak sequence for example).

All 16A Series controls with communications options made before April 2001 are only able to write to the EEPROM. Controls manufactured after this date have a menu item in the Secure menu (_Stor_) that allows the serial communications to write to RAM (_Stor_ = no) with a special write command that allows to EEPROM to be updated or written directly to EEPROM (protocol command 0442).

The factory default is ‘write to EEPROM’ (_Stor_ = YES).

If your computer system will be making frequent changes to the control we strongly recommend that you select the ‘write to RAM’ parameters (_Stor_ = no). If you are primarily reading from the control, there is no need to change the setting.

Any instruments equipped with any Serial Communications are limited to one million WRITE cycles to the EEPROM through the Serial Communications Port. Exceeding this limit will generate a **FAIL TEST** error. There is no limit to the number of times you can READ from this instrument EEPROM.

Make sure that the software you use does not write too often to the instrument.

If you have any questions regarding how your software works with the instrument(s), contact your System Administrator, Programmer, or Software Supplier.
MENU SELECTIONS

PRIMARY MENU
Press INDEX to advance to the next menu item. Press UP ARROW or DOWN ARROW to change the value in the display. Press ENTER to retain the value. If StAt, (Secondary Menu [16A3]), is 0, the three program status menu items shown on Page 14 will precede the following.

SP 1 Set Point 1 Adjust, Control Point 1.

SP 2 Set Point 2 Adjust (if equipped), Control Point 2.

SECONDARY MENU
Hold UP ARROW & ENTER. Press INDEX to advance to the next menu item. Press UP ARROW or DOWN ARROW to change the value in the display. Press ENTER to retain the value.

R L Alarm 1 Low: The Low Alarm point is usually set below the Set Point. May not appear depending on R L setting in Secure Menu.

R H Alarm 1 High: The High Alarm Point is usually set above the Set Point. May not appear depending on R L setting in Secure Menu.
Output selection: Select OnOF, #tP, #PuL, or ProP.

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 ≤d). When selected, the Out1 OnOF menu items is followed by #### SP ≤d, and the tune, Pb, rES, S10L and S10H selections in the Secure menu are suppressed.

SP ≤d  Set Point On-Off Differential (hysteresis). Set for the amount of difference between the turn off point and the turn on point. Select 1 to 9999 (direct acting), or -1 to -9999 (reverse acting). This value will be negative for reverse acting set points, and positive for direct acting outputs. The following drawings 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.

#tP  Time Proportioning Cycle Time. Select 1tP to 80tP.

1tP  A setting of 1tP is recommended for solid state outputs (SSR or 15VDC).

2tP to 80tP  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 1PuL to 7PuL. 1PuL = Linear and 7PuL = most nonlinear. 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(pulse value -1) seconds off.

ProP  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.

**Out2**  
Output selection: Select **OnOF**, **#tP**, **#PuL**, or **ProP**.

**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 (**SP2d**). When selected, the **Out2/OnOF** menu item is followed by #### **SP2d**, and the **Pb2** selection in the Secondary menu and the **S2OL** and **S2OHi** selections in the Secure menu are suppressed.

**SP2d**  
Set Point On-Off Differential (hysteresis). Select 1 to 9999 (direct acting), or -1 to -9999 (reverse acting). See **SP1d** on the previous page.

**#tP**  
Time Proportioning Cycle Time. Select 1**tP** to 80**tP**.

1**tP**  
A setting of 1**tP** is recommended for solid state outputs (SSR or 15VDC).

2**tP** 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.

**#PuL**  
Pulsed Time Proportioning Output: Select 1**PuL** to 7**PuL**.

1**PuL** = Linear and 7**PuL** = most nonlinear. 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(pulse value -1) seconds off.

**ProP**  
For Current (Code 5) outputs only.
The Controller will evaluate the Process and select the PID values to maintain good control. Active for SP1 only.

**SELF**

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 Rate for the **SELFtune** 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).

**Pd** Manually adjust the PID values. PID control consists of three basic parameters, Proportional Band (Gain), Reset Time (Integral), and Rate Time (Derivative).
- **Pb1** Proportional Band (Bandwidth). Select 1 to 9999°F, °C, or counts.
- **Pb2** Proportional Band (Bandwidth). Select 1 to 9999°F, °C, or counts. Appears only if control is equipped with second set point and **OUT2** is NOT selected as **OF**.
Automatic Reset Time. Select OFF, 0.1 to 99.9 minutes.
Select OFF to switch to OFS.
Manual Offset correction Select. Select OFF, 0.1 to 99.9 percent. Select OFF to switch to rES.
Rate Time. Select OFF, 0.1 to 99.9 minutes. Derivative.
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.
Linkage of PID parameters between SP1 and SP2: Select On or OFF.
On Applies SP1 rES, rFrE, Fbnd, and rFrE terms to SP2 for heat/cool applications
OFF SP2 functions without rES, rFrE, Fbnd, and rFrE.
Anti-Reset Windup Feature: Select On or OFF.
On When rFrE is On the accumulated Reset Offset value will be cleared to 0% when the process input is not within the Proportional Band.
OFF When rFrE is OFF, the accumulated Reset Offset value is retained in memory when the process input is not within the Proportional Band.
Approach Rate Time: Select OFF, 0.01 to 99.99 minutes. The function defines the amount of Rate applied when the input is outside of the Proportional Band. The rFrE time and the rFrE 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).
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.
Fuzzy Logic Error Band: Select 0 to 4000 °F, °C, or counts. Sets the band width of the Fuzzy Logic. Set Fbnd equal to PID proportional band (Pb) 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.

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

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

Pct0 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.

Pro9 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, inPE on the next page.
On Enable Ramp/Soak Programming.

Start 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
   #### ##t, total time in active segment
   #### ##SP segment target set point
Ramp/Soak Time Base (16A3): Select 1.5 or 60.5.

1.5 Ramp/Soak time base is in 1 second increments. Program time 1t1, ... 1t16 is measured in seconds.

60.5 Ramp/Soak time base is in 60 second increments (minutes). Program time 1t1, ... 1t16 is measured in minutes.

The following items repeat in the following order: 1t1, 1SP, 1A1 (if AL1 is programmed as EUnt), 2t1, 2SP, 2A1, ... 16t1, 16SP, 16A1. To avoid repetition each item will only be described once.

Segment Time (16A3): Select 0 to 9999 units (minutes if 2bAS is set to 60.5, seconds if 2bAS is set to 1.5).

Segment Set Point (16A3): Set to target value desired.

Segment Alarm 1 Event (16A3): Select On or Off.

On Alarm 1 is active during segment 1 time (1t1).

Off Alarm 1 is inactive during segment 1 time (1t1).

Program End Action (16A3): Select Hold or Off.

Hold Stay at the Present Set Point (16SP).

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

Repeat program starting at 1t1.

Revert to SP1 value.

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 the decimal position is changed. Factory default is 0.

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.
LPbr  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 LPbr, the LOOP brd message will appear. This condition can also be routed to an Alarm Condition if alarms are present and turned On (see ALbr in the Secure Menu). The loop break error can be reset by pressing the ENTER key when at the LPbr menu item. The INDEX & ENTER keys may also be used.

L0rE  (Option 992, 993, 995, 996, Serial Communications) Local / Remote Status: Select LOC or rE. Does not affect other instruments on daisy chain.  
LOC  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.  
rE  The host computer is allowed to send write commands. If the control is not addressed within the time set in nAt (No Activity Timer in the Secure Menu) the CHECL orE error message will be displayed.

P0L  (Option 934, 936, Analog Retransmission Output) Process Output Low: Select -450°F, -260°C, or -1999 counts to any value less than P0H.

P0H  (Option 934, 936, Analog Retransmission Output) Process Output High: Select from any value greater than P0L to +9999°F, +5530°C, or 9999 counts.

P0Sr  (Option 934, 936, Analog Retransmission Output) Process Output Source: Select inP or SPt.  
inP  Process output follows the Process Variable (input).  
SPt  Process output follows the Set Variable (SP1).
Addr (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 ▲ ▼ UP ARROW & ENTER for 5 Seconds. Press ▼ INDEX to advance to the next menu item. Press ▲ ▼ UP ARROW or DOWN ARROW to change the value in the display. Press ▼ ENTER to retain the value.

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

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

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

- J-1C Type “J” Thermocouple
- CA Type “K” Thermocouple
- E- Type “E” Thermocouple
- t- Type “T” Thermocouple
- L- Type “L” Thermocouple
- n- Type “N” Thermocouple
- r-13 Type “R” Thermocouple
- S-10 Type “S” Thermocouple
- b- Type “B” Thermocouple
- C- Type “C” Thermocouple
- P392 100 ohm Platinum (NIST 0.00392 Ω/°C)
- n120 120 ohm Nickel
- P385 100 ohm Platinum (IEC/DIN 0.00385 Ω/°C)
- iP38 1000 ohm Platinum (IEC/DIN 0.00385 Ω/°C)
- Curr DC Current Input 0.0 to 20.0 or 4.0 to 20.0 mA.
- Volt DC Voltage Input 0.0 to 10.0 or 1.0 to 10.0 volts.
- dFF DC Voltage Input -10 to +10 mV.
- - - - - Reserved

0SUP Zero Suppression: Select On or OFF. Only with Current and Voltage input types.

- OFF The input range will start at 0 (zero) Input.
- On The input range will start at 4.00 mA or 1.00 V.
Unit F, C or none.

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

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

none °F and °C descriptors will be Off. This is only available with Current and Voltage Inputs.

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.

.0000 Four decimal places is only available for Current and Voltage inputs.

Input Fault Timer: Select OFF, 0.1 to 540.0 minutes. Whenever an Input is out of range (UFL or OFL displayed), shorted, or open, the timer will start. When the time has elapsed, the controller will revert to the output condition selected by Input Fail Action (InPb) below. If OFF is selected, the Input Fault Timer will not be recognized (time = infinite).

Input Fail Action (16A3): Select FAIL, AUE, or PRE. When the Input is out of range (UFL or OFL displayed) and the Input timer (InPt) time has elapsed, the controller will revert to the selected condition.

FAIL Outputs are disabled (go to 0% output).

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

PRE The outputs will maintain preprogrammed percentages of output as specified in PRE1 and PRE2.

PRE1 Preset output for Set Point 1. Select 0 to 100%.

PRE2 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 \$#\$L and \$#\$H settings.

**SEnC** Sensor Rate of Change: Select **OFF**, \(t\) 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 ** INDEX & ENTER** keys to reset.

**SCRL** Scale Low: Select 100 to 11998 counts below **SCAH**. The total span between **SCRL** 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 **SCRL**. The total span between **SCRL** 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.

**SP1O** 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 r.

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

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

If Out1 (Page 21) is set for ##tP, #PUL, or Prop, then S1OL and S1OH appear. If Out1 is set for OnOff, then skip S1rE.

S1OL Set Point Output Low Limit. Select 0 to 100% but not greater than S1OH. This item limits the lowest output value. This is useful for adding a bias to the process when needed. Factory set to 0 for outputs codes 1, 2, 3, 4, and 8. Factory set to 20 for output code 5 (20% output equals 4 mA output).

S1OH Set Point 1 Output High Limit. Select 0 to 100% but not less than S1OL for output codes 1, 2, 3, 4, or 8. Select 0 to 102% but not less than S1OL 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 Out1 is set for ##tP, #PUL, or Prop, then skip to S1LP below.

If Out1 is set to OnOff (in Secondary Menu), then the next three menu items can make the SP1 and SP1d 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 30-31.

Note that when Set Point 1 Power Interrupt, S1IP, is On, and Set Point 1 Reset, S1rE, is programmed to Hold, the SP1 output will automatically reset upon a power failure and subsequent restoration, if the process is below SP1.

S1rE Set Point 1 Reset. Select OnOff or Hold.

OnOff Output will automatically reset when process passes back through SP1d.

Hold Manual Reset. Reset by simultaneously pressing the INDEX & DOWN ARROW keys for 3 seconds.
**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.

**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**.

**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).

**Set Point 2 type**: Select **Ab** or **dE**.

- **Ab**: Absolute. **SP2** is independent of **SP1**, and may be set anywhere between the limits of **SPH** and **SPL**.
- **dE**: Deviation. **SP2** is set as a deviation from **SP1**, and allows **SP2** to retain its relationship with **SP1** when **SP1** is changed (**SP2** tracks **SP1**).

**Set Point 2 State**: Select **dir** or **rE**.

- **dir**: 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 **##EP**, **PUL**, or **Prop**, then **S2OL** and **S2OH** appear. If **Out2** is set for **On0FF**, then skip **S2OL** and **S2OH**.

**Set Point Output Low Limit**: Select 0 to 100% but not greater than **S2OL**. 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).

**Set Point Output High Limit**: Select 0 to 100% but not less than **S2OL** for output codes 1, 2, 3, 4, or 8. Select 0 to 102% but not less than **S2OL** 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

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force a full on condition for output devices which do not have bias adjustments. Factory set to 100 for all output codes.

If Out2 is set to OnOff (in the Secondary Menu), then the next three menu items can make the SP2 and SP2d 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, S2Pi, is On, and Set Point 2 Reset, S2rE, is programmed to Hold, the SP2 output will automatically reset upon a power failure and subsequent restoration, if the process is below SP2.

S2rE Set Point 2 Reset. Select OnOff or Hold.
  OnOff Output will automatically reset when process passes back through SP2d.
  Hold Manual Reset. Reset (acknowledge) by simultaneously pressing the INDEX & DOWN ARROW keys for 3 seconds.

S2Pi Set Point 2 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.

S2iH Set Point 2 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.

S2LP Set Point 2 Lamp: Select On or 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 (A1t = AABS), simply set the value at which the alarm is to occur. When setting the alarm value for a deviation alarm (A1t = 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 A1Lo to -5. If a high alarm is required 20 degrees above the Set Point, then set A1Hi 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.

![Diagram of absolute and deviation alarms]

Note that when Alarm Power Interrupt, A1Pi, is programmed ON and Alarm Reset, A1rE, is programmed for Hold, the alarm will automatically reset upon a power failure and subsequent restoration if no alarm condition is present.

If Alarm Inhibit, A1iH, 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 INDEX and 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**, **Hi**, **HiLo**, or **EUnt**.
- **OFF**  
  Alarm 1 is disabled. No Alarm 1 menu items appear in the Secondary or Secure menus.
- **Lo**  
  Low Alarm Only. **R Lo** appears in the Secondary Menu.
- **Hi**  
  High Alarm Only. **R Hi** appears in the Secondary Menu.
- **HiLo**  
  High and Low Alarms. Both **R Lo** and **R Hi** appear in the Secondary Menu, and share the same Alarm 1 Relay output.
- **EUnt**  
  Alarm 1 is controlled by the Ramp/Soak program function. (16A3). See Pages 11-14 and 26 (#A1) 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 **SPSr**, **Addr**, or **rScl** below.

If **RL 1** is set to **EUnt**, go to **A1St** below.

**RL 1**  
Alarm 1 Type: Select **AbS** or **dE**
- **AbS**  
  Absolute Alarm that may be set anywhere within the values of **SCAL** and **SCAH** 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**.

**RL 1**  
Alarm 1 Reset: Select **OnOF** or **Hold**.
- **OnOF**  
  Automatic Reset.
- **Hold**  
  Manual Reset. Reset (acknowledge) by simultaneously pressing the INDEX & DOWN ARROW keys for 3 seconds.

**RL 1**  
Alarm 1 Power Interrupt: Select **On** or **OFF**.
- **On**  
  Alarm Power Interrupt is **On**.
- **OFF**  
  Alarm Power Interrupt is **OFF**.

**RL 1**  
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**.

**RL 1**  
Alarm 1 Output State: Select **ClO5** or **OPEn**.
- **ClO5**  
  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.

**(Option 992, 993, 995, 996, Serial Communications) Control Address:** Set from 1 to 3FF for Options 992 and 993. Set from 1 to FF for options 993 and 995. 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 14).

**(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 14).

**(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, **CHECK Lo—E** will be displayed.
- **OFF**: No Activity Timer function is disabled.

**(Option 992, 993, 995, 996 Serial Communications) Store to EEPROM:** Select **YES** or **NO**. (See additional information on page 18).
- **YES**: Menu Items changes made through the Serial Communications are stored directly to the EEPROM.
- **NO**: Menu items changes made through the Serial Communications are stored directly in RAM.
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>RrERA</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 is broken (RJC located in terminal 2), return to service.</td>
</tr>
<tr>
<td>(Alternates with PV)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RrEA</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. Alarm 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 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>
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<th>ACTION REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>UFL or OFL</td>
<td>Underflow or Overflow: Process value has exceeded input range ends. UFL or OFL will sequence to display one of these messages if the InPt is set for a time value. For RTD inputs RTD is open or shorted. For THERMOCOUPLE inputs thermocouple is open.</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. When InPt (input fault timer) has been set for a time, the outputs will be turned off after the set time. Setting the time to OFF causes the outputs to remain active, however UFL or OFL will still be displayed. Correct or replace sensor. Clear with ‘Global Reset’.</td>
</tr>
<tr>
<td>bAd InP</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>OPEN InP</td>
<td>Sensor Rate of Change exceeded the programmed limits set for SEnC.</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.</td>
</tr>
<tr>
<td>LOOP bAd</td>
<td>Check calibration appears as an alternating message if the instrument calibration nears tolerance edges. 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. 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><strong>FAIL TEST</strong></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 error.</td>
<td>Set point outputs inactive. Alarm inactive</td>
<td>The display alternates between FAIL TEST and one of the following messages: FACT dFLt: Memory may be corrupted. Restore to the factory default settings. Recheck controller programming. rEt FACT: Unrecoverable error. Return to service.</td>
</tr>
<tr>
<td>CHEC SP1, CHEC SP2, CHEC 1SP, ..., CHEC 16SP</td>
<td>This message will appear upon power up if SP1, SP2, #SP1, or ##SP is set outside of the SPL or SPH values.</td>
<td>Set point outputs inactive. Alarm active</td>
<td>Correct the SP1, 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 rSPt</td>
<td>This message appears if the analog remote set point signal is out of range.</td>
<td>Set point outputs inactive. Alarm active</td>
<td>The control will revert to SP1. Correction of the analog signal or turning off the rSPt clears the error message.</td>
</tr>
<tr>
<td>CHEC LorE</td>
<td>This message appears if the Serial Communications has timed out.</td>
<td>Set point outputs inactive. 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 InPt 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 output: 500 Vac to all other inputs and outputs but not isolated from each other.

SP1 and SP2 Switched Voltage output: 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).
RS-485 Series Communications
Port Compliance: EIA-485.
Isolation: 500 VAC.
Protocol: Lovelinks™ II.
Address Range: 001H or 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/ports: 32.
Cable Lengths: 6,000 ft (1,828 m).
Termination: 120 Ohms, balanced.

RS-232 Series Communications
Port Compliance: RS-232C.
Isolation: 500 VAC.
Protocol: Lovelinks™ II.
Address Range: 001H or 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/ports: 1.
Cable Lengths: 25 ft (7.6 m).

RS-232 Series Communications
Port Compliance: RS-232C.
Isolation: 500 VAC.
Protocol: MODBUS® RTU.
Address Range: 001H or 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 Lengths: 25 ft (7.6 m).

RS-485 Series Communications
Port Compliance: EIA-485.
Isolation: 500 VAC.
Protocol: MODBUS® RTU.
Address Range: 001H or 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/ports: 32.
Cable Lengths: 6,000 ft (1,828 m).
**Termination:** 120 Ohms, balanced.

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

---

### 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 Plt. 0.00385 DIN¹ RTD</td>
<td>-328 to 1607</td>
<td>-200 to +875</td>
</tr>
<tr>
<td>100 Ω Plt. 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 Plt. 0.00385 DIN¹ RTD</td>
<td>-328 to +1607</td>
<td>-200 to +875</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 mADC, 4 to 20 mADC, 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 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).