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CN8600 SERIES PROCESS CONTROLLER

Operator's Manual

OMEGA ENGINEERING, INC.
An OMEGA Technologies Company

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SECTION 1 INTRODUCTION

1.1 GENERAL DESCRIPTION

The OMEGA® CN8600 Series of ¼ DIN controllers is a complete line of microcomputer based, single loop, setpoint programmable process controllers capable of measuring, displaying, and controlling a process variable from a variety of inputs. Applications include temperature, pressure, level, flow, and others.

Control functions, alarm settings and other parameters are easily entered via the front keypad. All user data can be protected from unauthorized changes by the Enable mode security system, and is protected against loss from AC power failure by battery back-up.

The process input options are user configurable to directly connect to either thermocouple, RTD, volt/mV/mA inputs. Changes to input types are easily accomplished in the field. Thermocouple and RTD linearization, as well as thermocouple cold junction compensation, is performed automatically. The unit's process input is isolated from the rest of the instrument.

Output options are either a 5A resistive load rated electromechanical relay, a solid state relay driver or a 4-20 mA control output signal on Output 1 and the optional Output 2. The optional alarm output (Output 3) is also available with a 5A electromechanical relay or a solid state relay driver. Alarm options are programmable for either Process Alarm, Deviation Alarm or Deviation Band Alarm.

The unit can be ordered to operate on either 115 VAC or 230 VAC power (optional) at 50/60 Hz.

The instrument is housed in an extruded aluminum enclosure suitable for panel mounting.

The CN8600 Series incorporates Proportional, Integral (Automatic Reset) and Derivate (Rate) actions. Changing tuning parameters for proportional control is a front panel operation accomplished via the 4 key membrane keypad. Other parameter changes, such as output positioning, proportional band widths, cycle times, and alarm values are also changeable via the keypad.

The CN8600 also can incorporate up to three event outputs that can be programmed to be on or off during a given ramp or soak period. The availability of event outputs is dependent on the number of on-off outputs supplied via the hardware configuration. See Figure 1-1 for a photo of CN8600 Controller.

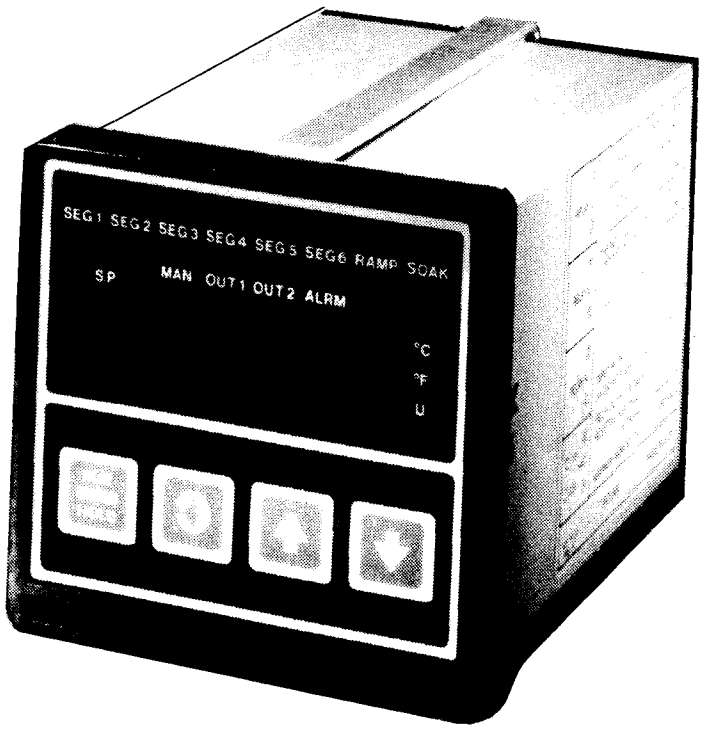


Figure 1-1. CN8600 Controller

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The different types of ramp and soak controllers that are available are shown in Table 1-1.

TABLE 1-1
TYPES OF CONTROLLERS

STYLE	TYPE	OMEGA MODEL NUMBER	*HARDWARE CODE CORRESPONDING TO OMEGA NUMBER
SINGLE RELAY OUTPUT	Thermocouple	CN8610TC	6110001
	RTD	CN8610P1	6310001
	Voltage Input	CN8610V5	6210001
DUAL RELAY OUTPUTS, 1 ALARM RELAY	Thermocouple	CN8611TC-A	6111101
	RTD	CN8611P1-A	6311101
	Voltage Input	CN8611V5-A	6211101
DUAL DC SSR DRIVER OUTPUTS, 1 ALARM RELAY	Thermocouple	CN8622TC-A	6122101
	RTD	CN8622P1-A	6322101
	Voltage Input	CN8622V5-A	6222101
SINGLE 4-20 mA OUTPUT, 1 RELAY OUTPUT, 1 EVENT RELAY	Thermocouple	CN8631TC	6131001
	RTD	CN8631P1	6331001
	Voltage Input	CN8631V5	6231001
SINGLE 4-20 mA OUTPUT, SINGLE RELAY OUTPUT, 1 ALARM RELAY, 1 EVENT RELAY	Thermocouple	CN8631TC-A	6131101
	RTD	CN8631P1-A	6331101
	Voltage Input	CN8631V5-A	6231101
DUAL 4-20 mA OUTPUTS, 1 ALARM RELAY, 2 EVENT RELAYS	Thermocouple	CN8633TC-A	6134101
	RTD	CN8633P1-A	6334101
	Voltage Input	CN8633V5-A	6234101

* "6XXX" (6XXX representing the first four digits of the Hardware code).
"XXX—" (XXX— representing the last three digits of the Hardware code). For more detail, see Section 3.1.

OPTIONAL ITEMS
— 230 V—230 VAC Power
— NI—Additional noise immunity for high noise environment
— RRH—Remote Run/Hold for CN8600 units

1.2 DISPLAYS

Each unit is provided with a digital display and status indicators. The digital display is programmable to display the process value only, process and setpoint, deviation from setpoint only, deviation and setpoint, or setpoint continuously.

Status indication is provided for Alarm, Output 1, Output 2, degree C, degree F, engineering units, manual operation, Segment 1 through 6, Ramp and Soak, as applicable.

Display resolution is programmable for 0.1 or 1 degree for thermocouple and RTD inputs, and 0.001, 0.01, 0.1 or 1 unit for other input types.

1.3 CONTROL

Instruments can be programmed for on-off, time proportioning, or current proportioning control implementations. Selectable direct or reverse control action is also provided. Proportional control implementations are provided with fully programmable PID parameters.

Automatic manual switching is easily accomplished via the Standby mode. Switching is bumpless, and while in manual, manipulation of proportional outputs is possible.

Other standard control features include control output limits, setpoint limits, anti-reset windup control and a unique Automatic Transfer function, which, if configured, allows manual control of the process until setpoint is reached, at which time the unit will automatically transfer from manual to automatic control.

Remote Run-Hold capability can be obtained if ordered as an option.

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1.4 PROGRAMMABLE SETPOINT PROFILES

The CN8600 is a setpoint profile controller. The setpoint can be varied according to prescribed profiles that are programmed in the controller. Up to eight profiles can be programmed on any of these Profile controllers. Each of the eight profiles can contain up to six segments. Each segment contains a ramp and a soak operation. Profiles can be programmed to run continuously or any number of times up to 9999. A combination of profiles may be linked together to form larger profiles.

Assured soak is provided with the use of two programmable parameters that will activate an Auto/Hold feature. This feature will place a running profile in the Hold condition and prohibit a Soak operation from starting or completing if an acceptable process value is not reached and then maintained.

Events outputs may also be provided. Up to three events may be assigned and can be turned on or off at the beginning of each ramp and soak.

1.5 ALARMS

Alarm settings are fully programmable. Alarm type may be set as Process direct or reverse (High or Low), Deviation direct or reverse (above or below setpoint), or Deviation Band type (closed or open within band).

Alarm outputs can be provided by assigning any specified relays (SPST or SSR driver) to the respective alarm.

1.6 HARDWARE OPTIONS

The hardware options are not field changeable, but the software options are, as long as the appropriate hardware option exists. Refer to the Program Mode Section for information on how to select the desired functions.

1.7 SOFTWARE OPTIONS (CONFIGURED IN PROGRAM MODE)

Software options are configured by you, the user. Refer to the Program Mode Section 4.1. The options define the input type and how the outputs are programmed, i.e., on-off, reverse or direct action, the type of alarm and its operation, and what information will be displayed.

After setting up the input and output parameters, it is suggested that the Program Mode be disabled so it can not be inadvertently altered. This is performed by using the Enable Mode. Refer to the Enable Mode Section 4.4. Or the user can read about how to enable (or disable) the mode by referring to the individual mode section.

NOTE

If the controller is not set up properly, you may see error messages. Refer to the Error Code Section 7.

1.8 CONTROL CAPABILITY

1.8.1 General

The unit provides a variety of user programmable control features and capabilities including:

1. On-off Control
2. Time Proportioning Control
3. Current Proportioning Control
4. Dual Output Control
5. Automatic Transfer
6. Setpoint Adjustment

The capabilities available in a specific unit are dependent on the hardware options specified and provided. As an example, On-Off Control cannot be implemented if no relays or SSR drivers have been specified.

1.8.2 Control Responses

Each instrument can be configured to provide proportional control. This type of control is provided with Proportional (P), Integral (I), and Derivative (D) control responses. The PID parameters are defined as follows:

P	(Proportional)	Proportional Band
I	(Integral)	Automatic Reset
D	(Derivative)	Rate

Manual Reset is provided for use in lieu of, or in conjunction with, Automatic Reset, and a Cycle Time parameter is provided for use in Time Proportioning control applications.

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1.8.2.1 Proportional Band

The Proportional Band adjustment is made in terms of degrees or engineering units. This parameter defines the band over which the control output will function. Other instrumentation may define this in %.

This control response defines the controller Gain. The Gain is defined as the amount of change in output for a given change in input. The higher the controller gain, the larger the control output will be. The Proportional Band in % is the mathematical inverse of the Gain, i.e. Gain = 1/Proportional Band %. The larger the Proportional Band is, the smaller the Gain. The smaller the Proportional Band, the larger the Gain. For proper control of the process, the controller gain must be set to match the gain of the process, i.e. High Process Gain requires Low Controller Gain (Wide Proportional Band), and Low Process Gain requires High Controller Gain (Narrow Proportional Band).

1.8.2.2 Automatic Reset

Automatic Reset or Integral action response adjustments are made in terms of repeats per minute. This can be defined as the number of times a change in the control output, due to the proportional action, will be repeated in one minute.

1.8.2.3 Manual Reset

The Manual Reset parameter is adjusted in terms of degrees/engineering units. This adjustment will shift the proportional band by + or − the Manual Reset value. This allows for compensation of offset between the process value and setpoint, after the process has settled out. Manual Reset should be used only where single setpoints and consistent process loads are used.

1.8.2.4 Rate

Rate or Derivative action is adjusted in terms of minutes. The Rate time is defined as the time the output from a PD (proportional band + derivative) controller will lead the output from a P (proportional band) only controller when both experience the same input change. Rate action is applied to the process input, not the setpoint. This prohibits the Rate action from occurring when the setpoint is changed. Rate is a dynamic parameter and is adjusted to the time constants and lags in the process. It should affect the control output only when the process itself changes.

1.8.2.5 Cycle Time

Controllers used in time proportioning applications require a Cycle Time adjustment in addition to the PID responses. Cycle Time can be defined as the time duration or period of oscillation of the relay or SSR driver output.

1.8.2.6 Direct/Reverse Control Action

Each control output is programmable for direct or reverse action. Direct acting control provides an increasing output as the process value increases. Reverse acting control provides a decreasing output as the process value increases. In On-Off control, Reverse action turns the output "ON" when the process goes below setpoint. Direct action turns the output "OFF" when the process goes below setpoint.

1.8.3 On-Off Control

On-Off control can only be implemented on controllers provided with SPST relay or SSR driver output capability. On-Off operation can be assigned to either or both output 1 and 2. Hysteresis adjustment is provided for On-Off outputs. This adjustment is in terms of degrees or engineering units and defines the width of the hysteresis band. Relay chatter can be reduced by proper adjustment of this parameter.

When operating in On-Off control, the control algorithm will turn the output on or off depending upon the setpoint, the relative position of the process value, and the hysteresis adjustment. The controller setpoint may be adjusted via the front keypad, or a Profile. Indication of an **"ON"** output can be seen in the display. The respective **"OUT 1"** or **"OUT 2"** indicator will illuminate.

1.8.4 Time Proportioning Control

Time Proportioning Control can be implemented on controllers provided with a SPST relay or SSR driver. This can be programmed for either output 1 or 2. Time Proportioning control is accomplished by continuously cycling the output on and off during a prescribed period of time. The "on" time is a percentage of the Cycle Time.
Example: Calculated output % = 40%; cycle time adjustment = 20 sec.

Output "on" time = 0.4 x 20 = 8 seconds
Output "off" time = 0.6 x 20 = 12 seconds.

When the controller is operating in automatic, the control algorithm determines the output % required to correct for any difference between the process value and the setpoint. The output calculation is also dependent upon the tuning parameter adjustments. Refer to Section 4.3.3 for controller tuning. If the controller is switched to manual control, the output relay or SSR driver will continue to cycle as a function of the output % which is entered using the Up and Down keys. The output % upon entry into manual will be the last value calculated by the control algorithm (which will be implemented with a bumpless transfer). Output adjustment while in manual is typically from 0 to 100%.

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1.8.5 Current Proportioning Control

Current Proportioning control can be implemented on controllers provided with 4 to 20 mA DC outputs. This output type can be assigned to either or both output 1 or 2.

Current Proportioning control provides a proportional current output, typically from 4 to 20 mA DC, in response to process and setpoint deviation.

As with Time Proportioning, the calculated output % for Current Proportioning control is also a function of the tuning parameter adjustments. However, a Cycle Time adjustment is not required.

If the controller is switched to manual control, the current output continues as a function of the output % which is entered using the Up and Down keys. The output % upon entry into manual will be the last value calculated by the control algorithm (which will be implemented with a bumpless transfer). Output adjustment while in manual is typically from 0 to 100%.

1.8.6 Dual Output Control

Each unit is provided with Dual Output Control capability. This requires that the necessary outputs be specified and that they be appropriately assigned during instrument configuration as described in Section 4.

Dual Output control can be performed with a combination of any two outputs. Each output may be programmed for either On-Off, Time Proportioning, or Current Proportioning, as applicable, and for direct or reverse control action.

Operation of a Dual Output controller is similar to the other control forms, in that the process value, setpoint, and tuning parameters are used by the control algorithm to determine the output value required.

Each output functions as described in 1.8.3, 1.8.4, or 1.8.5 depending upon the type of control programmed for each.

The output action is dependent upon the adjustment of two additional parameters, First Output Position, and Spread (Second Output Position). These parameters are adjusted in terms of engineering units from control setpoint, and define the point at which the respective output will begin functioning. Figure 1-2 shows the output action of a dual output controller based upon First Output Position and Spread. The first output is programmed as a reverse acting proportional output, and the second as a direct acting proportional output. Refer to Section 13 for definitions of terms and illustrations of use.

If the controller is switched to manual control, the outputs continue as a function of the output % for each proportional output which is entered using the Up and Down keys. The output values upon entry into manual will be the last values calculated by the control algorithm (bumpless transfer). Proportional output adjustment while in manual is typically from 0 to 100%. On-Off outputs are not manually adjustable.

Dual Proportioning outputs are provided with a Proportional Band adjustment for each output.

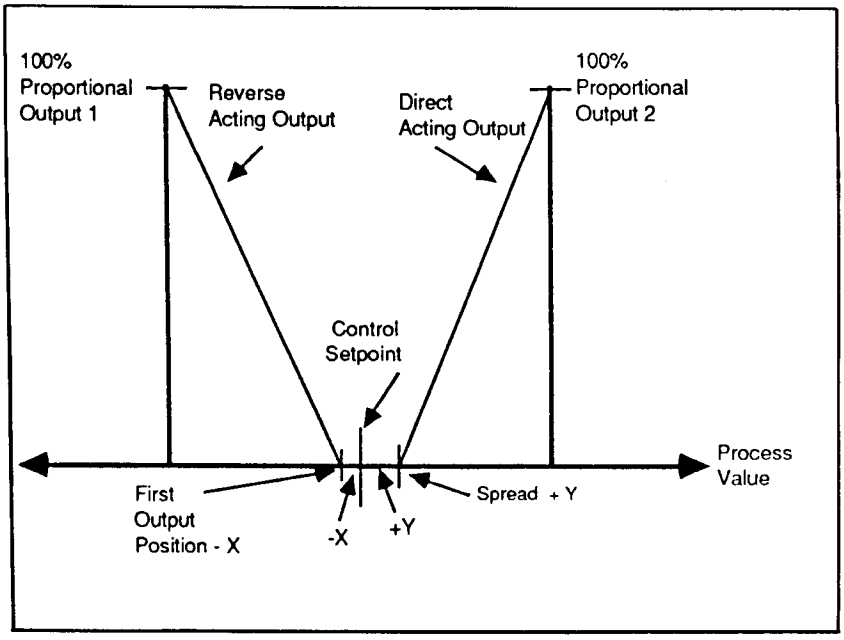


Figure 1-2. Dual Output Control Action

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1.8.7 Automatic Transfer Function

Automatic Transfer allows start-up or operation in manual and automatically transfers the controller from manual to automatic control when the process reaches the setpoint.

1.8.8 Setpoint Sources

The control setpoint may be provided locally or from profile operation.

Local adjustment of setpoint is accomplished by manipulation of the Up and Down keys on the front keypad.

The setpoint may be programmed for Ramp and Soak operation in up to eight independent setpoint profiles. When a profile is executed, the setpoint used by the control algorithm will change as a function of time. Configuration and operating of this capability is discussed in Sections 4 and 5. Figure 1-3 shows a typical programmed setpoint profile.

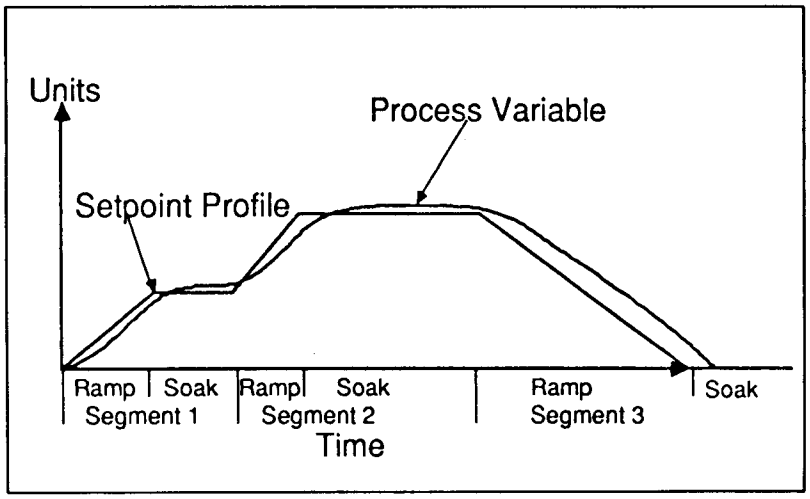


Figure 1-3. Typical Programmed Setpoint Profile

SECTION 2 INSTALLATION

2.1 UNPACKING

Remove the Packing List and verify that all equipment has been received. If there are any questions about the shipment, please call the OMEGA Customer Service Department at (203) 359-1660.

Upon receipt of shipment, inspect the container and equipment for any signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material and carton in the event reshipment is necessary.

2.2. LOCATION OF EQUIPMENT

Locate the instrument away from excessive moisture, oil, dust, and vibration. Do not subject the instrument to temperatures outside of 0° to 55°C or rated accuracies will not apply.

2.3 MOUNTING

The instrument mainframe can be removed from its housing for installation, if so desired. To remove, loosen the locking screw centered on the bottom face of the instrument. The controller pulls straight out. When reinstalling, be sure that the vertically mounted circuit boards are inserted in the correct grooves in the top and bottom of the housing. Also make sure the screw lock is sufficiently tight. When installing multiple instruments, be sure to reinsert the proper instrument into its correct enclosure by matching the serial number with the number inside the housing. This will insure that the accuracy of the controller will be within the published specifications. The ambient compensator on the rear of the enclosure is calibrated to the instrument at the factory.

Cut panel hole to dimensions shown in Figure 2-1. Remove the mounting bracket by removing the two screws at the back of the instrument. Insert the controller housing in the panel cutout and reinstall the mounting bracket. Replace the mounting screws on the back of the housing and tighten until the instrument is rigidly mounted. Do not overtighten.

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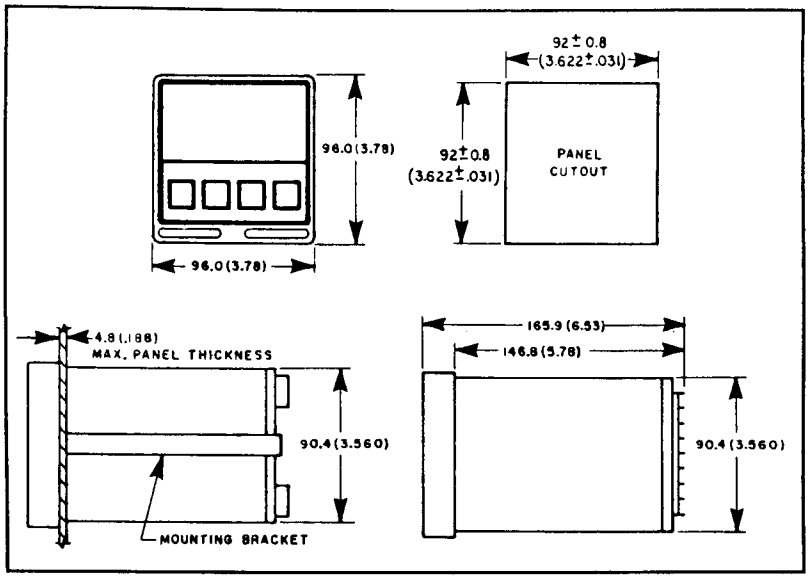


Figure 2-1. Dimensions of Panel Cutout and Controller

2.4 SENSOR PLACEMENT

Thermocouple lead resistance should not exceed 300 ohms; instrument accuracy could be affected.

Two wire RTD's should be used for only lead lengths less than 10 feet.

If the probe is to be subjected to corrosive or abrasive conditions, it should be protected by the appropriate thermowell.

The probe should be positioned to reflect true process temperature; in liquid media, the most agitated area; in air, the best circulated.

2.5 WIRING, GENERAL

Please note that all wiring should conform to the local and national codes, where applicable. Refer to sections 2.6 through 2.8.9 for specific wiring information. Refer to Noise Section (Section 9.4) for detailed information about electrical noise.

2.6 PREPARATION FOR WIRING

Consult the model code number (located at the bottom of the unit) and wiring label for the appropriate line voltage for the unit. Wire the AC to terminals A and B per Figure 2-2. Insure that a proper earth ground is connected to the green ground screw just under the power input terminals.

NOTE

Sensor leads should not run in the same conduit or wire trough as the power or load wiring. Shielded cable is recommended for the input signal wiring. The shield should be grounded at one point only, preferably at the sensor. Thermocouple extension wire must correspond with the type thermocouple installed. Thermocouples should never be wired to the instrument with common wire.

2.6.1 AC Wiring

Earth Ground

Earth ground must be attached to the instrument chassis. To verify that it is a good earth ground being attached, make a resistance check from instrument chassis to the nearest metal water pipe or proven earth ground. This reading should not exceed 1000 ohms.

Neutral (for 115 VAC)

It is good practice to assure that the AC neutral is at or near ground potential. To verify this, a voltmeter check between neutral and ground should be done. On the AC range, the reading should not be more than 50 millivolts. If it is greater than this amount, the secondary of the AC transformer supplying the instrument should be checked by an electrician. A proper neutral will help ensure maximum performance from the instrument.

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2.6.2 Wire Isolation

Four voltage levels of input and output wiring may be used with the unit:

- Analog input or output (i.e. thermocouple, RTD, VDC, mV DC, or mA DC)
- SPST Relays
- SSR driver outputs
- AC power

The only wires that should be run together are those of the same category. If they need to be run parallel with any of the other lines, maintain a minimum 6 inch space between the wires. If wires must cross each other, do so at 90 degrees. This will minimize the contact with each other and reduce "cross talk" . "Cross talk" is due to the EMF (Electro Magnetic Flux) emitted by a wire as current passes through it. This EMF can be picked up by other wires running in the same bundle or conduit.

2.6.3 Use of Shielded Cable

Shielded cable helps eliminate pickup of RF and EMI noise the wire may be exposed to. Shielded cable is a single or multi-pair insulated wires with each wire or pair of wires surrounded by a wire mesh or conductive foil and then covered with plastic insulation.

It is recommended that all analog signals be run with shielded cable. Connection lead length should be kept as short as possible, thus keeping wires protected by the shielding. The shield should be grounded at one end only. The preferred grounding location is at the sensor. **GROUNDED SENSORS ESPECIALLY SHOULD HAVE THE SHIELD GROUNDED AT THE SENSOR.**

2.6.4 Sensor Placement (Thermocouple or RTD)

Thermocouple lead resistance should not exceed 300 ohms. If this is exceeded, instrument accuracy could be affected.

Two wire RTD's should be used only for lead lengths less than 10 feet.

If the temperature probe is to be subjected to corrosive or abrasive conditions, it should be protected by the appropriate thermowell. The probe should be positioned to reflect true process temperature:

in liquid media—the most agitated area.
in air—the best circulated area.

2.7 INPUT WIRING

2.7.1 Thermocouple Wiring

Attach the thermocouple according to Figure 2-3.

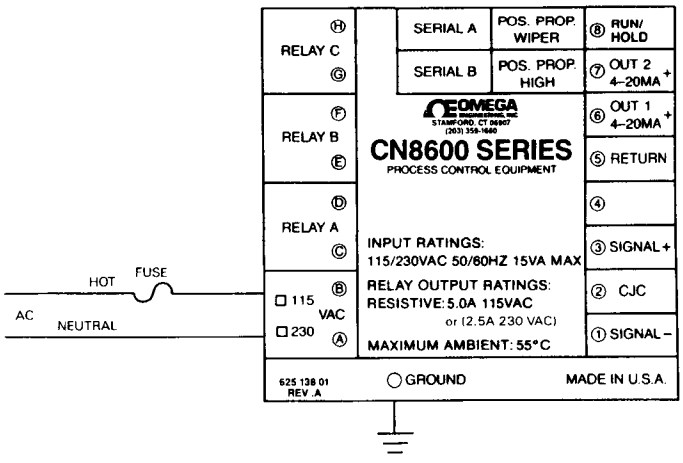


Figure 2-2. Power hookup for the Controller

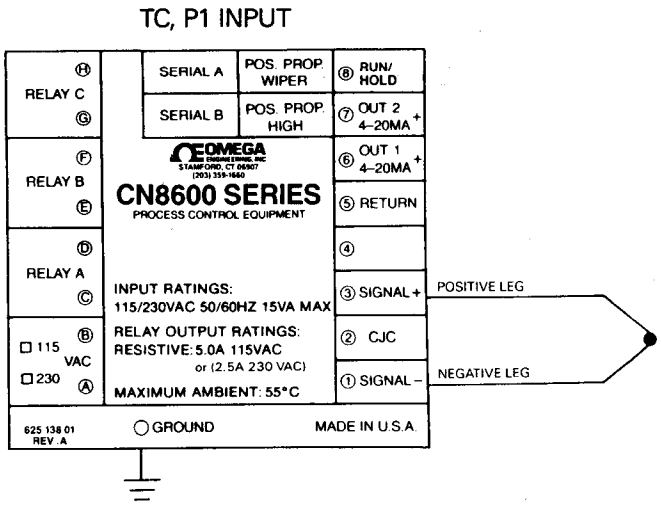


Figure 2-3. Thermocouple Wiring

For 230 VAC powered units relay is rated at 230 VAC 2.5A resistive

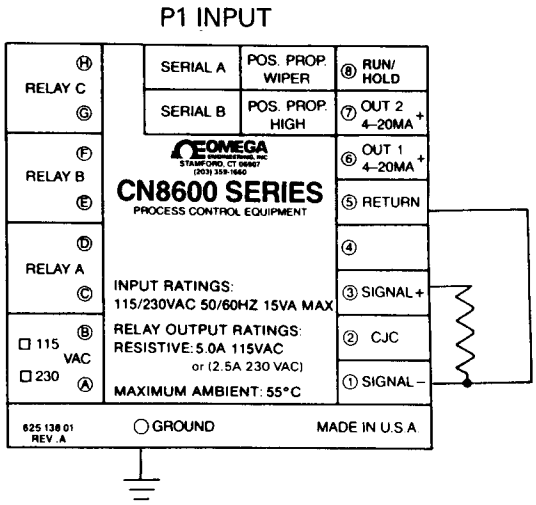
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2.7.2 RTD Wiring

Attach the RTD sensor as shown in Figure 2-4. If a 2-wire RTD is used, install a jumper between terminals 1 and 5. If the RTD is a 3-wire device, install the two common wires of the RTD to terminals 1 and 5.

2.7.3 Volts/Millivolts Wiring

Attach the wires as shown in Figure 2-5.



* If a 2-wire RTD is used install a jumper between terminals 1 and 5.

Figure 2-4. RTD Wiring

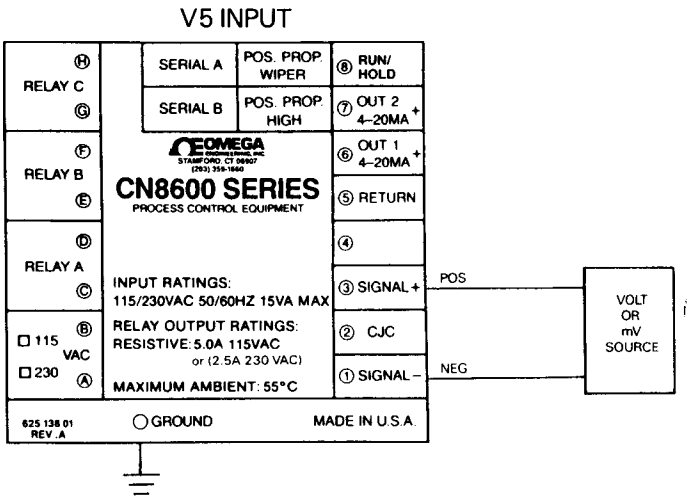


Figure 2-5. Volts/Millivolts Wiring

For 230 VAC powered units relay is rated at 230 VAC 2.5A resistive

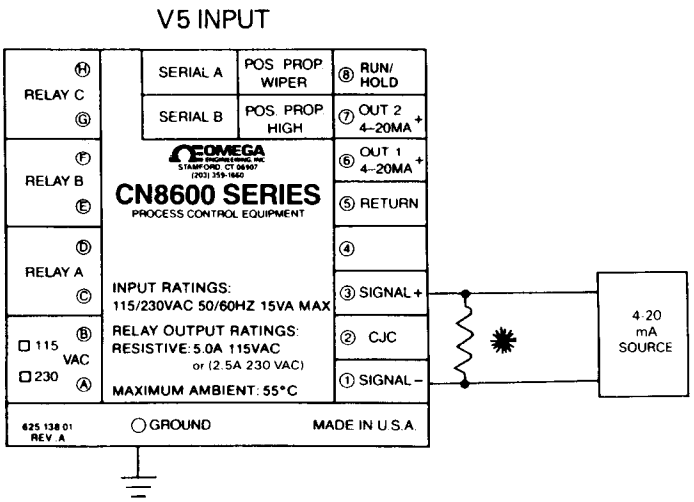
2.7.4 Milliamp Wiring

Attach the wires as shown in Figure 2-6. Insure that the proper shunt resistor is installed across terminals 1 and 3.

2.8 OUTPUT WIRING

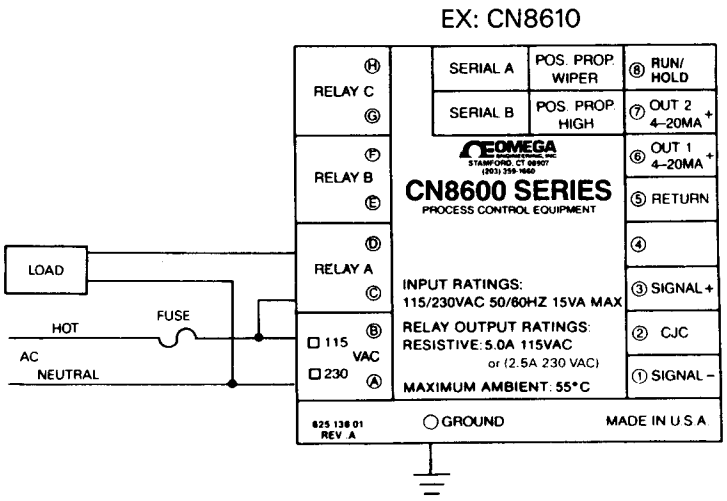
2.8.1 Output 1, Relay Wiring

Attach the load as shown in Figure 2-7. Connections are made across terminals C and D.



* Shunt resistor required.
2.5 ohms for 10-50 mV input 250 ohms for 1-5 VDC input

Figure 2-6. Milliamp Wiring



** RELAY A IS FACTORY ASSIGNED TO OUTPUT 1

Figure 2-7. Output 1, Relay Wiring

For 230 VAC powered units relay is rated at 230 VAC 2.5A resistive

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2.8.2 Output 1, SSR Driver Wiring

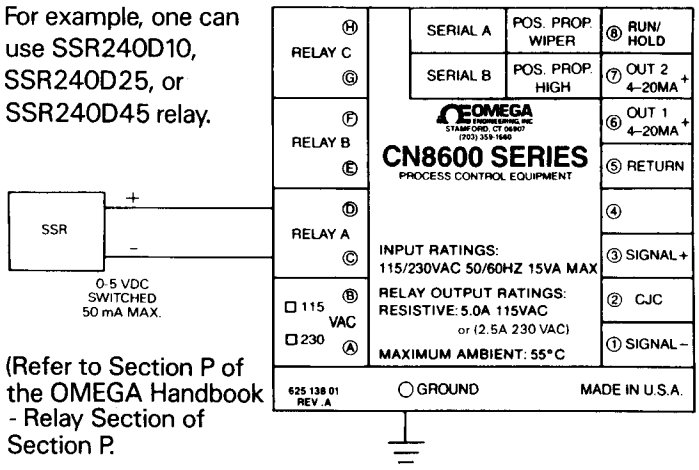
Attach the load as shown in Figure 2-8. Connections are made across terminals C and D.

2.8.3 Output 1, 4-20 mA Wiring

Attach the load as shown in Figure 2-9. The load should not exceed 650 ohms. Connections are made across terminals 6 and 5.

EX: CN8622-A

For example, one can use SSR240D10, SSR240D25, or SSR240D45 relay.



(Refer to Section P of the OMEGA Handbook - Relay Section of Section P.

** RELAY A IS FACTORY ASSIGNED TO OUTPUT 1

Figure 2-8. Output 1, SSR Driver Wiring

EX: CN8631-A

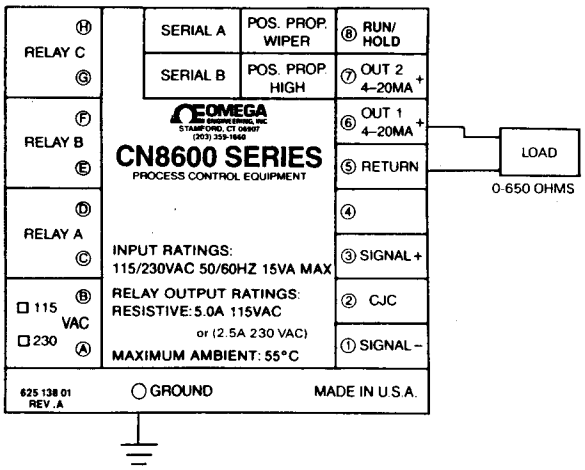


Figure 2-9. Output 1, 4-20 mA Wiring

For 230 VAC powered units relay is rated at 230 VAC 2.5A resistive

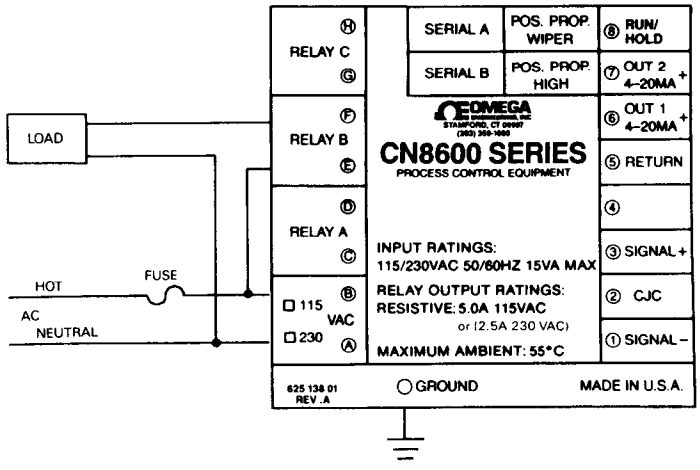
2.8.4 Output 2, Relay Wiring

Attach the load as shown in Figure 2-10. Connections are made across terminals E and F.

2.8.5 Output 2, SSR Driver Wiring

Attach the load as shown in Figure 2-11. Connections are made across terminals E and F.

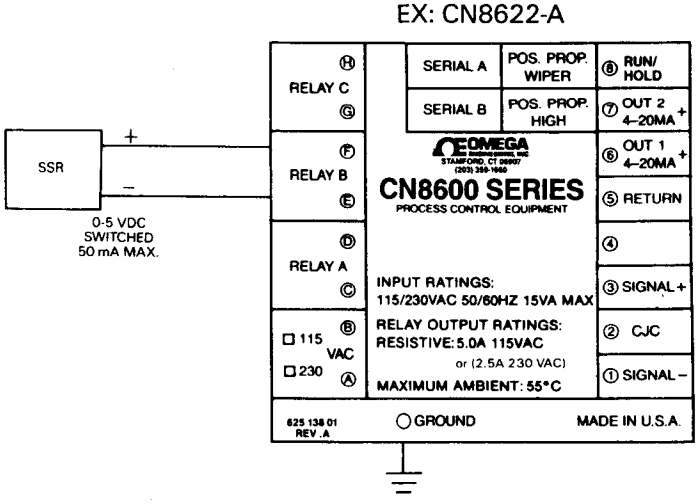
EX: CN8611-A



* RELAY B IS FACTORY ASSIGNED TO OUTPUT 2

Figure 2-10. Output 2, Relay Wiring

EX: CN8622-A



* RELAY B IS FACTORY ASSIGNED TO OUTPUT 2

Figure 2-11. Output 2, SSR Driver Wiring

For 230 VAC powered units relay is rated at 230 VAC 2.5A resistive

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2.8.6 Output 2, 4-20 mA Wiring

Attach the load as shown in Figure 2-12. The load should not exceed 650 ohms. Connections are made across terminals 7 and 5.

2.8.7 Alarm Output, Relay Wiring

Attach the load as shown in Figure 2-13. Connections are made across terminals G and H.

EX: CN8633-A

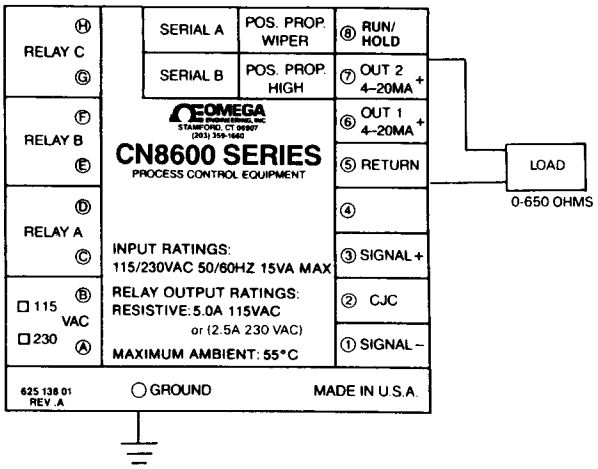
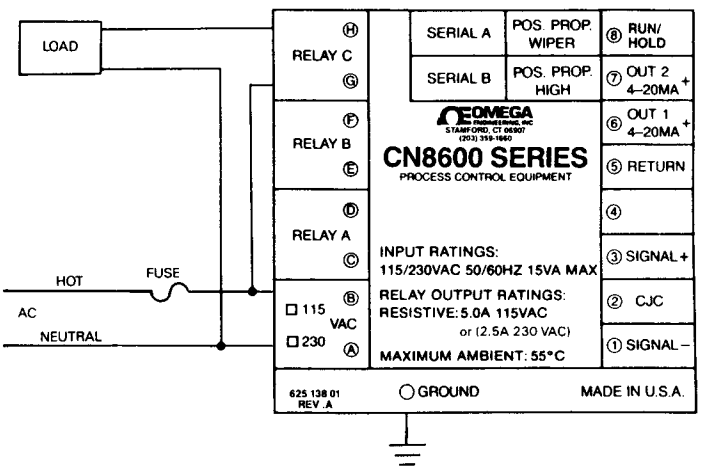


Figure 2-12. Output 2, 4-20 mA Wiring

EX: CN8611-A



* RELAY C IS FACTORY ASSIGNED TO OUTPUT 3 (ALARM)

Figure 2-13. Alarm Output, Relay Wiring

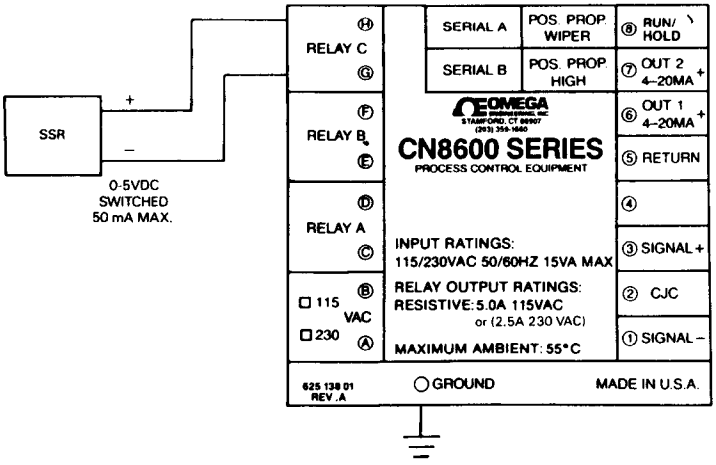
For 230 VAC powered units relay is rated at 230 VAC 2.5A resistive

2.8.8 Alarm Output, SSR Driver Wiring

Attach the load as shown in Figure 2-14. Connections are made across terminals G and H.

2.8.9 Remote Run/Hold Input Wiring (optional)

If remote run/hold capability is specified (ordered), attach the wires to terminal 8 and 5. Refer to Figure 2-15. Shielded cable is recommended between the remote contact and the controller. Do not run the cable in the same conduit as the power and load wiring.



* RELAY C IS FACTORY ASSIGNED TO OUTPUT 3 (ALARM)

Figure 2-14. Alarm Output, SSR Driver Wiring

OPTIONAL RRH OPTION

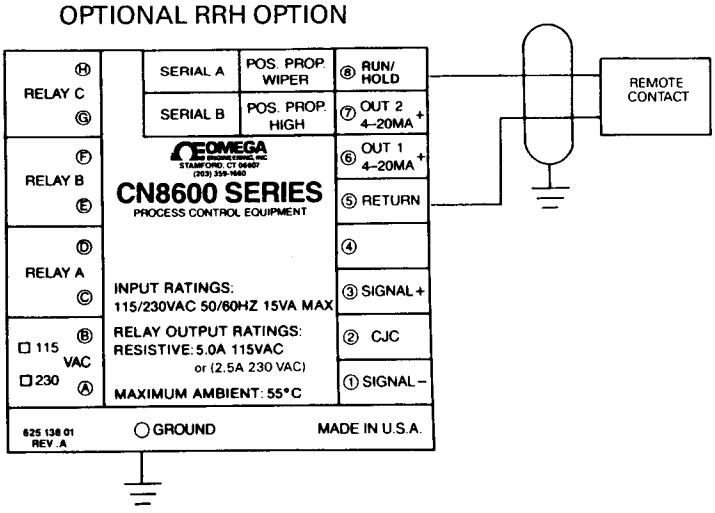


Figure 2-15. Remote Run/Hold Input Wiring

For 230 VAC powered units relay is rated at 230 VAC 2.5A resistive

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2.9 JUMPER POSITIONING

NOTE

THIS SECTION IS TO BE FOLLOWED BY THOSE WHO NEED TO CHANGE THE STYLE OF THE CONTROLLER (FOR EXAMPLE: CHANGING FROM THERMOCOUPLE TO RTD)

If the unit is to become an RTD unit—JU3 must be in the RTD position on the Options Board. JU1 on the Analog/Processor Board must be in ALL OTHER INPUTS position.

If the unit is to become a Thermocouple unit—JU3 must be in the NON-RTD position on the Options Board. JU1 on the Analog/Processor Board must be in ALL OTHER INPUTS position.

If the unit is to become an Voltage Input unit—JU3 must be in the NON-RTD position on the Options Board. JU1 on the Analog/Processor Board must be in VOLTS INPUT position.

Table 2-1 shows in table format how to set up the jumpers.

TABLE 2-1
SETTING UP JUMPER POSITIONS

JUMPER NUMBER & BOARD NAME	THERMOCOUPLE TYPE	RTD TYPE	VOLTAGE INPUT TYPE
JU2 on Options Bd	NON-RTD	RTD	NON-RTD
JU1 on Analog/Processor Bd	ALL OTHER INPUTS	ALL OTHER INPUTS	VOLT INPUTS

Analog/Processor Board Assembly

There are two jumpers (JU1 and JU2) on the Analog/Processor Board (see Analog/Processor Assembly Drawing in the Appendix) which can be changed by the user. JU1 is discussed here. JU2 is discussed in Section 4.4.1.

JU1 allows a Thermocouple Input unit to be changed to a voltage input (0—5 VDC or 1—5 VDC) or vice versa. The unit is shipped with this jumper in the correct position for the type of input ordered.

Options Board Assembly

When an RTD version of the controller is ordered, the options board is installed with jumpers JU2 and JU3 in the RTD position (see Options Board Assembly Drawing in the Appendix). With jumpers in this position, the unit can be programmed and used for thermocouple inputs. However, if the RTD unit is to be used for THERMOCOUPLES or VOLTAGE INPUTS, it is recommended that jumpers JU2 and JU3 be changed to the non-RTD position which allows for better common mode voltage noise rejection on the input.

Refer to Section 12 if used with external solid state relay.

SECTION 3 OPERATION

3.1 POWER UP PROCEDURE

Verify that all connections have been properly made before applying power to the instrument. Upon verification, power may be applied. Upon power-up, the following displays are shown:

1. "6XXX" (6XXX representing the first four digits of the Hardware code).
2. "XXX—" (XXX— representing the last three digits of the Hardware code).
3. "rN.NN" (rN.NN representing the software revision level).
4. "tSt1", "tSt2" and "tSt3" for tests 1 through 3 executed automatically.
5. Upon successful completion of the test, an alpha code is displayed for about 3 seconds. During this time the operator can select another mode prior to the unit automatically going into the indicated mode. If any error messages are displayed, refer to the list of "Error Codes" (see Section 7).

The code that is displayed and the mode the unit will go into, depends on what mode the unit was in on power-down and how it had been programmed.

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Hardware Code

First part of factory programmed number based on model type purchased

6 X X X

6 for Model 8600 Unit

X for Input
- 1 - T/C or mV
- 2 - Volts or mA
- 3 - RTD

X for Output Group 1 - Control Output 1 and/or Event
- 1 - Relay
- 2 - SSR Driver
- 3 - 4-20 mA and Relay

X for Output Group 2 - Control Output 2 and/or Event
- 0 - None
- 1 - Relay
- 2 - SSR Driver
- 4 - 4-20 mA and Relay

Second part of factory programmed number based on model type purchased

X X X –

X for Output Group 3 - Alarm or Event
- 0 - None
- 1 - Relay

X for Remote
- 0 - None
- 2 - Remote run/hold (optional)

X for Voltage
- 1 - 115 VAC
- 2 - 230 VAC (optional)

3.2 FRONT PANEL

The front panel consists of four 7-segment LEDs to provide alpha codes and numeric values, and eight rectangular LEDs to indicate the status of the unit. The status of the unit can mean:

1. being in manual mode of operation,
2. the state of outputs 1, 2 and the alarm,
3. that the setpoint is being displayed,
4. the units, either °C or °F or engineering units.

Eight additional rectangular LEDs indicate the setpoint profile segments and whether the unit is ramping or soaking. Refer to Table 3-1 for a listing of LEDs on the Front Panel of the controller.

TABLE 3-1
LEDS ON FRONT PANEL

LED	COLOR	FUNCTION
OUT 1	Red	Lights when Output 1 is energized.
OUT 2	Yellow	Lights when Output 2 is energized.
MAN	Yellow	Lights when the controller is in Manual control of the process.
ALRM	Red	Lights when the alarm is energized or active.
SEG 1 through SEG 6	Red	Lights to indicate segment number when appropriate.
RAMP	Red	Lights during the Ramp part of any profile segment.
SOAK	Red	Lights during the Soak part of any profile segment.
S.P.	Green	Lights to indicate that the setpoint value is being displayed.
C	Red	Lights to indicate that the process value is in terms of degrees C.
F	Red	Lights to indicate that the process value is in terms of degrees F.
U	Red	Lights to indicate that the process value is in terms of engineering units.
–	Red	Lights to indicate a negative displayed value.

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An integral part of the front panel is the four key membrane keypad, which has tactile feedback. The four keys, from left to right, are referred to as the RUN/HOLD key, SCROLL key, UP key, and DOWN key.

Uses of the RUN/HOLD Key:

1. To initiate a profile, while the profile code is displayed, press the RUN/HOLD key. Execute a profile.
2. While in a profile "run" condition, repeated depression of the RUN/HOLD key will cause the instrument to alternate between the "run" condition and the "hold" condition.

Uses of the SCROLL Key:

1. If unit is in Off Mode or Control Mode, repeated depression of the SCROLL key will cause the unit to display the code corresponding to each mode which is enabled and each profile which has been entered.
2. Step between parameter display and entry in a given mode.
3. If the unit is running a profile and in the run condition, repeated depression of the SCROLL key will alternate between the Profile and Tune Modes codes, provided the Tune Mode is enabled. (Step between modes). Only the Tune Mode can be entered if the unit is running a profile.
4. If in the "hold" condition, rather than the run condition, repeated depression of the SCROLL key will sequence through the codes for the enabled modes and entered profiles. To insure that a running profile is not inadvertently aborted, the unit will only allow entry into the Tune and Standby Modes, and upon exiting, will resume the profile. If the Off or Control Modes are entered, the profile is aborted. Attempting to enter any other selected mode will cause the unit to return to the profile in the hold condition. Therefore, to access any of the non-control modes, a profile must first be aborted.

Uses of the UP Key:

1. Display the setpoint.
2. Exit a mode while a parameter code within a mode is displayed.
3. Turn a parameter function "ON".
4. Increase a numerical value. The rate at which a given value will change is dependent upon the length of time the key is held depressed, initially slow then increasingly faster (example: to change setpoint).
5. Works with other keys for other functions.

Uses of the DOWN Key:

1. Display the setpoint.
2. To enter a mode, while its code is displayed, press the DOWN key.
3. To initiate a profile, while the profile code is displayed, press the DOWN key. Execute a profile.
4. Turn a parameter function "OFF".
5. Decrease a numerical value. The rate at which a given value will change is dependent upon the length of time the key is held depressed, initially slow then increasingly faster.
6. Works with other keys for other functions.

3.3 HOW TO GET STARTED—CN8600

1. After mounting and wiring the controller, program the controller for the Input Type and Output configuration (software configuration). See Program Mode in Section 4.1.

   If software configuration will not be changed after initial programming, then disable Program Modes using Enable Mode.
2. Set setpoint in Control Mode if Profile Operation is not required,

   OR

   Set up Profiles. See Profile Entry Mode (up to eight (8) profiles can be programmed).
3. Tune the Controller to the process and set second setpoint and alarm points (if required). See Tune Mode in Section 4.3.
4. If other modes are to be disabled (to keep the operator from altering characteristics) follow instructions in Enable Mode or at beginning of each mode section.

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3.4 MODES

The CN8600 is a controller with eleven distinct modes. Each mode is explained in its corresponding section of this manual. Many of the modes can be "disabled" to eliminate access to them.

The CN8600 is shipped from the factory with the Test, Calibration, and Profile Continue Modes disabled and no profiles entered. Refer to the section on the Enable Mode for details. The following briefly describes each mode and identifies the code that will be displayed as each is being selected. The modes of operation are as follows:

1. SETUP
   a. PROGRAM—"Prog" (See Section 4.1)
      Provides a means of modifying controller operation and instrument configuration.
   b. PROFILE ENTRY—"PEnt" (See Section 4.2)
      Provides a means of entry, review, or alteration of any one of the eight available setpoint profiles.
   c. TUNE—"tunE" (See Section 4.3)
      Provides a means of modifying process tuning and other related parameters.
   d. ENABLE—"EnAb" (See Section 4.4)
      Provides a means of enabling/disabling setpoint changes and each of the non-control modes.
2. OPERATING
   a. OFF MODE—"oFF"
      Provides an operating mode with all control outputs off or at 0% output.
   b. CONTROL—"CtrL" (See Section 5.1)
      Normal non-profile control operation.
   c. STANDBY—"Stby" (See Section 5.2)
      Provides a means of setting proportional output values and maintaining manual control of the process.
   d. RUN PROFILE—"P1" through "P8" (See Section 5.4)
      Provides a simple way of initiating a profile. For each profile which has been entered, a "P" and the corresponding profile number will appear in the display.
   e. PROFILE CONTINUE—"PCon" (See Section 5.5)
      Provides a means of initiating or continuing a profile from any point in the profile.
3. SERVICE
   a. TEST—"tESt" (See Section 6)
      Provides a series of automatic and selected user tests.
   b. ERROR CODES—(See Section 7)
   c. CALIBRATION—"CAL" (See Section 8)
      Provides initialization, test and calibration routines.

3.5 HOW TO SELECT A MODE

Mode selection is accomplished in the following manner:

* If the unit is in the Off Mode or Control Mode, repeated depression of the SCROLL key will cause the unit to display the code corresponding to each mode which is enabled and each profile which has been entered.
* To enter a mode, while its code is displayed, depress the DOWN key.
* To initiate a profile, while the profile code is displayed, depress the DOWN key or RUN/HOLD key.
* If the unit is running a profile and in the run condition, repeated depression of the SCROLL key will alternate between the Profile and Tune Mode codes, provided the Tune Mode is enabled. Only the Tune Mode can be entered if the unit is running a profile.
* If in the hold condition, rather than the run condition, repeated depression of the SCROLL key will sequence through the codes for the enabled modes and entered profiles. To insure that a running profile is not inadvertently aborted, the unit will only allow entry into the Tune and Standby Modes, and upon exiting, will resume the profile.
* If the Off or Control Modes are entered, the profile is aborted. Attempting to enter any other selected mode will cause the unit to return to the profile in the hold condition. Therefore, to access any of the non-control modes, a profile must first be aborted. Figure 3-1 shows in flowchart form how to access different modes.

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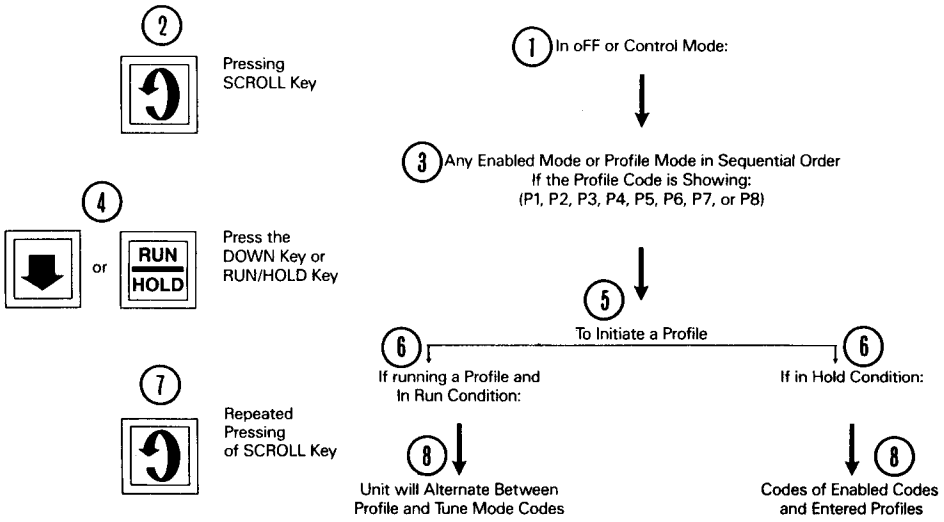


Figure 3-1.
Flowchart of How to Access Different Modes

(Steps 1-8)

3.6 HOW TO USE THE MODES (HOW TO GET IN AND OUT OF DIFFERENT MODES)

Table 3-2 shows the user how to get in and out of different modes.

TABLE 3-2
HOW TO GET IN AND OUT OF DIFFERENT MODES

MODES	HOW TO GET IN	HOW TO GET OUT
Program Mode	Press SCROLL key until ''Prog'' is displayed, then press the DOWN key to get the codes.	While the parameter code, not the value, is displayed, press the UP key.
Test Mode	To enter test, press the DOWN and SCROLL keys at the same time.	To exit, press the UP key while a Test Mode code is displayed.
Tune Mode	Press SCROLL key until ''tunE'' is displayed, then press the DOWN key to get the codes.	While the parameter code, not the value, is displayed, press the UP key.
Standby Mode	Press SCROLL key until ''Stby'' is displayed, then press the DOWN key to get the codes.	While the parameter code, not the value, is displayed, press the UP key.
Enable Mode	Press UP AND DOWN keys simultaneously while in the Control Mode.	Press UP key after displaying ''EtSt''.
Profile Continue Mode	Press SCROLL key until ''Pcon'' is displayed, then press the DOWN key to get the codes.	While the parameter code, not the value, is displayed, press the UP key.
Profile Entry Mode	Press SCROLL key until ''PEnt'' is displayed, then press the DOWN key to get the codes.	While the parameter code, not the value, is displayed, press the UP key.
P1 through P8	Press SCROLL key until a ''P'' code is displayed, then press the DOWN key to get the codes.	1. Press RUN/HOLD key to put profile in ''hold''. 2. Scroll until you get to ''oFF'' or ''CtrL'' mode. 3. Enter oFF Mode by pressing the DOWN key when OFF Mode is displayed or enter the Control Mode by pressing DOWN key when ''CtrL'' is displayed.
OFF Mode	Press SCROLL key to get the controller to display ''oFF'', then press the DOWN key.	Press SCROLL key until desired parameter is displayed, then press the DOWN key.
CAL	Press SCROLL key until ''CAL'' is displayed, then press the DOWN key to get the codes.	While the parameter code, not the value, is displayed, press the UP key.

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SECTION 4 SETUP MODES

4.1 PROGRAM MODE

In the Program Mode, controller operation can be reconfigured or reprogrammed within the limits of the hardware options included. If a hardware option is not included in the unit, the corresponding parameter codes will not be displayed.

TO ACCESS THE PROGRAM MODE, while the controller is in "oFF" or "CtrL" Mode, depress the SCROLL key until "Prog" is displayed and then depress the DOWN key.

Each time the DOWN key is depressed, another parameter code is displayed. When the appropriate parameter to be changed has been located, depress the SCROLL key to display the value of the selected parameter. Now with the value displayed, it can be changed by using the UP or DOWN keys as required. Once the desired value has been obtained, depress the SCROLL key to move on to the next parameter code.

TO REVIEW THE PARAMETER VALUES, depress the SCROLL key. Each time the SCROLL key is depressed, the display will alternate between the parameter codes and the parameter values.

TO EXIT THE PROGRAM MODE, depress the UP key while a parameter code, not a parameter value, is displayed. This will return to where "Prog" is displayed.

NOTE
If "Prog" does not appear, the mode is disabled.

4.1.1 How to Enable the Program Mode

1. While in Control Mode, press and hold for about 10 seconds the UP AND DOWN keys (at the same time) until you see "EnAb", then "EtSt" (when you release keys).
2. Press SCROLL key until you see "Epro".
3. Press SCROLL key again until you see "oFF" associated with the "Epro".
4. Change the condition to "on" (by pressing the UP key).
5. After the desired condition is displayed, press the SCROLL key to move to the next parameter code.
6. To exit, press the UP key.

4.1.2 How to Disable the Program Mode

Go through the steps to step 4 above and change the condition to "oFF" (by pressing the DOWN key). Then continue through step 6.

Figure 4-1 shows a flowchart of how to access and exit the Program Mode.

The Program Mode parameters are in Table 4-1 in order of appearance.

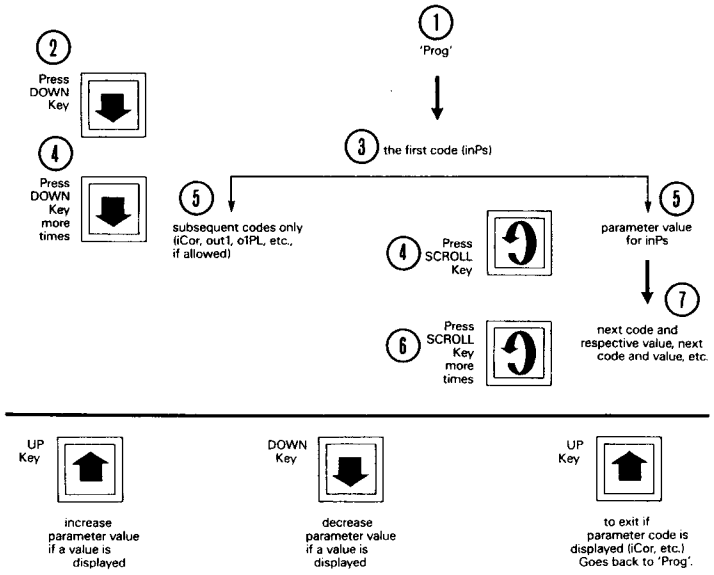


Figure 4-1.
Flowchart of Program Mode
(Steps 1-7)

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TABLE 4-1
PROGRAM MODE PARAMETERS

CODE	DEFAULT VALUE	DESCRIPTION
		NOTE All available relays or SSR Drivers not assigned as control outputs are available for event outputs.
inPs	1	Input Select (00-33) 00 J T/C C 01 J T/C F 02 K T/C C 03 K T/C F 04 T T/C C 05 T T/C F 06 R T/C C 07 R T/C F 08 S T/C C 09 S T/C F 10 E T/C C 11 E T/C F Input selected (00-11) must match thermocouple 20 RTD C 21 RTD F 100 ohm Pt, α = 0.00385 ohm/ohm/°C 30 0-5 VDC 31 1-5 VDC ** 32 0-50 MV 33 10-50 MV *** ** 4-20 mA with shunt resistor 250 ohm *** 4-20 mA with shunt resistor 2.5 ohm
iCor	0	Input Correction, compensates for sensor error + or − 100
out1	2	Output 1 Select (1-7) 1 = On/off—Direct (cooling) 2 = On/off—Reverse (heating) 3 = Time proportional—Direct (cooling) 4 = Time proportional—Reverse (heating) 5 = 4-20 mA—Direct (cooling) 6 = 4-20 mA—Reverse (heating) 7 = Position Proportional—CW Rotation (future use)
o1PL	100	Output 1 Proportional Percent Limit, 0-100%. These parameters specify the maximum percentage desired for each proportional value. For example, if you wanted a gas valve, controlled by Output 1, to never open more than 30%, this would be done by setting "o1PL" to 30.
out2	0	Output 2 Select 0 = NONE 1 = On/off—direct (cooling) 2 = On/off—reverse (heating) 3 = Time Proportional—direct (cooling) 4 = Time Proportional—reverse (heating) 5 = 4-20 mA—direct (cooling) 6 = 4-20 mA—reverse (heating) 7 = Position Proportional—CCW rotation (future use)
o2PL	100	Output 2 Proportional Percent Limit, 0-100%
out3	0	Output 3, Alarm Select 0 = NONE 1 = Process—Direct (closed above alarm point (low)) 2 = Process—Reverse (closed below alarm point) 3 = Deviation—Direct (closed above deviation from setpoint) 4 = Deviation—Reverse (closed below deviation from setpoint) 5 = Deviation Band Alarm—Open within band 6 = Deviation Band Alarm—Closed within band

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TABLE 4-1 (Cont'd)
PROGRAM MODE PARAMETERS

CODE	DEFAULT VALUE	DESCRIPTION
rLyA	1	Relay A Assignment 0 = Not Assigned 1 = Assigned to Output 1 2 = Assigned to Output 2 3 = Assigned to Output 3 4 = Assigned to Event 1 5 = Assigned to Event 2 6 = Assigned to Event 3 **NOTE** This feature provides the capability to assign one or more of the relays to any output. This might be used to separately actuate a high voltage and a low voltage circuit with one out put without additional external hardware. Relay Assignments—The relays are not directly associated with the outputs and can be assigned as needed. For example, if it is required to have two relays controlled by Output 1, one for a 24 Vac circuit and one for a 115 Vac circuit, this can be done by setting ''rLyA'' and ''rLyb'' both to 1. Or if you have a single 4-20mA unit and need an alarm output, you can use Relay A as the alarm relay by setting ''rLyA'' to 3.
rLyb	2	Relay B Assignment, same as above **NOTE** Refer to NOTE in rLyA section.
rLyc	3	Relay C Assignment, same as above **NOTE** Refer to NOTE in rLyA section.
diSP	1	Display Select 1 = Process value only (Standard) 2 = Process value & Setpoint 3 = Process Deviation 4 = Process Deviation & Setpoint 5 = Setpoint only
dPoS *	0	Decimal Position for V/mV/mA Inputs only 0-3 **NOTE** RTD and Thermocouple inputs are limited to either 0 (Standard) or 1 decimal place (for 0.1 degree resolution). Whenever ''inPS'' is changed, ''dPoS'' will set to a default value: 1 for Volt/Millivolt/Milliamp inputs.
Euu	100.0	Engineering Units Upper Value, V/mV Inputs Only −9999 to 9999
EuL	0.0	Engineering Units Lower Value V/mV Inputs Only −9999 to 9999
HySt	3	Hysteresis (Deadband)—for on-off outputs 0-300 degrees/units (width of hysteresis band)
SPL	1400	Setpoint Limit, specifies maximum value for setpoint
AtFr	0	Automatic Transfer from Standby Mode 0 = No Transfer (Standard) 1 = Transfer when the process value goes below setpoint 2 = Transfer when the process value goes above setpoint **NOTE** The Automatic Transfer feature provides the capability to automatically transfer from Manual Mode to Control Mode when the process value reaches setpoint.

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TABLE 4-1 (Cont'd.)
PROGRAM MODE PARAMETERS

CODE	DEFAULT VALUE	DESCRIPTION
PtB	3	Profile Time Base 1 = HHH.T - Hours and Tenths 2 = HH.MM - Hours and Minutes 3 = MM.SS - Minutes and Seconds
PiA **	1	Profile Interrupt Action - Power Interrupt 0 = Go to Off Mode 1 = Continue Profile 2 = Go into hold Condition 3 = Restart at Beginning of Profile
dFF	1	Display Filter Factor—Allowable settings 1 to 20. Unit scans input one time per second. This function specifies the number of scans to be averaged together before the display is updated. Used for noisy input signal if the display is constantly changing. Normally left at 1 for temperature inputs. 1 = Display is updated every second 20 = Display is updated every 20 seconds (averaged over 20 seconds)
PFF	1	Process Filter Factor—Allowable settings 1 to 20. Unit scans input one time per second. This function specifies the number of scans to be averaged together before the process input is updated for use in the control algorithm. Used for noisy input signal. Normally left at 1 for temperature inputs. 1 = Process value is updated every second 20 = Process value is updated every 20 seconds (averaged over 20 seconds)
rrh	0	Remote Run/Hold (optional) 0 = Not selected 1 = Selected. Remote Run/Hold will override keystroke from controller front face when placed in hold from remote source. Switch Open = Run Switch Closed = Hold 2 = Selected. Remote Run/Hold will NOT override keystroke from controller front face. Switch Open = Run Switch Closed = Hold Uses Auxiliary Input to sense a contact closure. The "DEFAULT" values are the values to which CAL 1 initializes the Program parameter.

* Decimal Position effect on parameter resolution:
Selecting a decimal position other than 0 will provide decimal positioning for all engineering unit based parameters. Example: "dPos" = 1 will cause engineering unit based parameters such as Proportional Band "Pb1" to reflect this decimal position as well. If the Proportional Band setting was 100 and "dPos" is changed from 0 to 1, "Pb1" will change from 100.0 to 10.0.

When changing the "dPos" parameter during instrument operation, please note that the CN8600 will simply shift the decimal position. It will not change the whole number from 100 to 100.0. In this case the parameter value will change from 100 to 10.0.

** "Profile Interrupt Action" Parameter
If Profile Interrupt Action parameter is set to "3" (restart at beginning of profile) and Profile End Control (PEnd) is set to link two or more profiles together, upon return of AC power the instrument will restart at the BEGINNING OF THE PROFILE IT WAS IN. EXAMPLE: If Profile 1 and 2 are to be executed back to back (in that order) and AC power fails while in Profile 2, upon return of AC power the instrument will restart the Profile at the beginning of Profile 2 not Profile 1.

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4.2 PROFILE ENTRY MODE

This mode allows the entry, review or altering of any one of the eight available setpoint profiles (used for ramp and soak control).

TO ACCESS THE PROFILE ENTRY MODE, while the controller is in "oFF" or "CtrL" Mode, repeatedly depress the SCROLL key until "PEnt" is displayed and then depress the DOWN key. If "PEnt" is not displayed (disabled), see below.

To move down through the Profile Entry Mode parameter codes, depress the DOWN key. Each time the DOWN key is depressed, another parameter code is displayed.

TO EXAMINE THE SELECTED PARAMETER VALUE, depress the SCROLL key. Now with the value displayed, it can be changed by using the UP or DOWN keys as required. Once the desired value has been obtained, depress the SCROLL key to move to the next parameter code.

TO REVIEW THE PARAMETER VALUES, depress the SCROLL key. Each time the SCROLL key is depressed, the display will alternate between the parameter codes and parameter values.

TO EXIT FROM THE PROFILE ENTRY MODE, make sure a parameter code is displayed, then depress the UP key. This will return to where "PEnt' is displayed.

NOTE

If "PEnt" does not appear, the mode is disabled.

4.2.1 How to Enable the Profile Entry Mode

1. While in Control Mode, press and hold for about 10 seconds the UP AND DOWN keys (at the same time) until you see "EnAb", then "EtSt" (when you release keys).
2. Press SCROLL key until you see "EPE".
3. Press SCROLL key again until you see "oFF" associated with the "EPE".
4. Change the condition to "on" (by pressing the UP key).
5. After the desired condition is displayed, press the SCROLL key to move to the next parameter code.
6. To exit, press the UP key.

4.2.2 How to Disable the Profile Entry Mode

Go through the steps to step 4 above and change the condition to "oFF" (by pressing the DOWN key). Then continue through step 6.

Figure 4-2 shows a flowchart of how to access and exit the Profile Entry Mode.

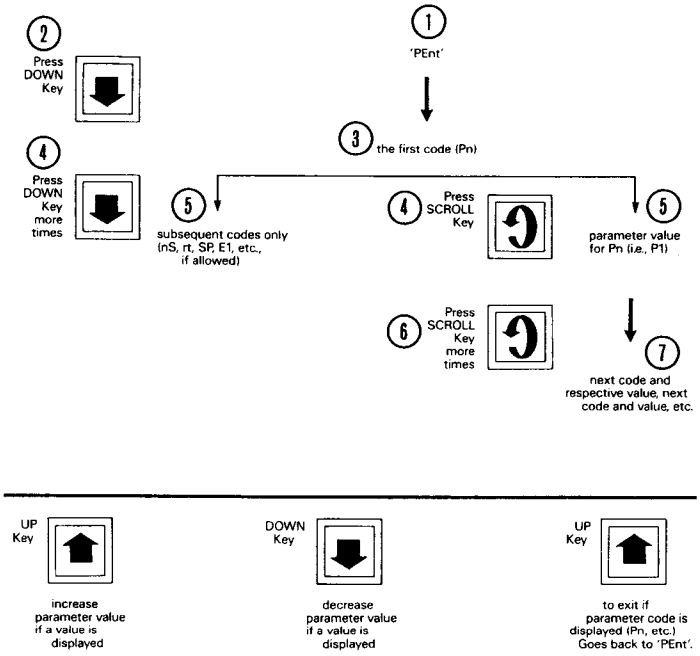


Figure 4-2.
Flowchart of Profile Entry Mode
(Steps 1-7)

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The Profile Entry Mode parameters are listed in Table 4-2 in the order of appearance. If a software option (example: Event Output) is not programmed in the Program Mode, the corresponding parameter codes will not be displayed.

TABLE 4-2
PROFILE ENTRY MODE PARAMETERS

CODE	PARAMETER	DESCRIPTION/FUNCTION
Pn	Profile Number	Specifies the profile to be entered or reviewed. 1 to 8—up to 8 profiles
nS	Number of Segments	Specifies the number of segments in the profile. 0 to 6—up to 6 segments are allowed. 0 segments turns the selected profile off. Each segment contains two parts: a ramp and a soak period. The following nine parameters apply to each segment. Each event output will be displayed only if a relay has been assigned to it per the "rLyA", "rLyb", and "rLyC" parameters in the Program Mode. The appropriate segment indicator "SEG1" through "SEG6" will be lit while the codes and values are displayed. The "RAMP" or "SOAK" indicator will also be lit, as appropriate. Only the number of segments specified in the "nS" parameter value will be accessible.
rt	Ramp Time	Time to move from last setpoint to next setpoint. Controller automatically adjusts setpoint linearly over time. Adjustable from 0 to 9999 where the units and decimal point are as specified by the "Ptb" (Profile Time Base) parameter in the Program Mode. The minimum of 0 means—no ramp part of this segment The maximum of 9999 means—total time in Profile Time Base units for the unit to ramp from last setpoint to next setpoint. Initial ramp is contructed based from the process values at the time the profile is executed, to the new setpoint over the specified time period.
SP	Setpoint	Specifies what the setpoint value will be at the end of the ramp time. Units correspond with the input type selected: DEG C, DEG F, or ENGR units.
E1	Event Output 1	Turns Event Output 1 on or off during the ramp. UP key to turn on, DOWN key to turn off.
E2	Event Output 2	Turns Event Output 2 on or off during the ramp. UP key to turn on, DOWN key to turn off.
E3	Event Output 3	Turns Event Output 3 on or off during the ramp. UP key to turn on, DOWN key to turn off.
St	Soak Time	Time to hold temperature (or process variable) at a selected setpoint. Adjustable from 0 to 9999 where the units and decimal point are as specified by the "Ptb" (Profile Time Base) parameter in the Program Mode. The minimum of 0 means—no soak part of this segment. The maximum of 9999 means—Total time in Profile Time Base units for the unit to ramp from last setpoint to next setpoint. (Ex: PtB=1 up to 9999 hour soak time).
E1	Event Output 1	Turns Event Output 1 on or off during the soak. UP key to turn on, DOWN key to turn off.
E2	Event Output 2	Turns Event Output 2 on or off during the soak. UP key to turn on, DOWN key to turn off.
E3	Event Output 3	Turns Event Output 3 on or off during the soak. UP key to turn on, DOWN key to turn off. Reference Event Outputs:

NOTE

If event output(s) have been programmed for a given profile—any event output will go OFF when the profile is aborted or ended by proceeding to the Off Mode. Any event will be maintained at its last state when the profile is aborted or ended by proceeding into the Control Mode.

PLCt	Profile Loop Count	Specifies how many times the profile will be performed before ending. Ajustable from 0 to 9999. If set to zero, the profile runs continuously. The minimum of 1 means—profile will run loop one time. The maximum of 9999 means—profile will run loop 9999 times.
dhru	Deviation Hold After Ramp Up (Assured Soak)	Specifies that the controller implements an automatic hold after a Ramp Up when the process value is less than the ramp setpoint by the specified amount. Adjustable from 0 to 3000. If set to zero, this feature is disabled. Zero means—soak time starts when ramp time is completed even if system has not reached required value. The minimum of 1 means—the temperature (or process variable) must be less than one degree (or unit) below setpoint for ramp to be completed and soak time started. The maximum of 3000 means—the process variable must be less than 3000 units below the setpoint for ramp to be completed and soak time started.

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TABLE 4-2 (Cont'd)
PROFILE ENTRY MODE PARAMETERS

CODE	PARAMETER	DESCRIPTION/FUNCTION
dhrd	Deviation Hold After Ramp Down (Assured Soak)	Specifies that the controller implements an automatic hold after a ramp down when the process value is greater than the ramp setpoint by the specified amount. Adjustable from 0 to 3000. If set to zero, this feature is disabled. Zero means—soak time starts when ramp time is completed even if system has not reached required value. The minimum of 1 means—the temperature (or process variable) must be less than one degree above setpoint for ramp to be completed and soak time started. The maximum of 3000 means—the process variable must be less than 3000 units above setpoint for ramp to be completed and soak time started.
PEnd	Profile End Control	Specifies operation after the profile has been completed. Adjustable from 1 to 8. −1 = Hold at last setpoint 0 = Abort (all outputs off or at 0% output and all events off) 1 = Run Profile 1 2 = Run Profile 2 3 = Run Profile 3 4 = Run Profile 4 5 = Run Profile 5 6 = Run Profile 6 7 = Run Profile 7 8 = Run Profile 8

"Assured Soak" Operation
The CN8600 provides "assured soak" by the inclusion of two parameters called "Deviation Hold After Ramp Up" and "Deviation Hold After Ramp Down". Refer to the Profile Entry Mode section for additional information. If this capability is activated, by selection of the appropriate values in the Profile Entry Mode, the following applies:

When a profile is in the run condition, if the unit goes into an automatic hold after a Ramp Up or Ramp Down because the process value is not within the specified limits from setpoint, the unit will display "Auto", "Hold", "SP", the setpoint, "Proc", and then the process value in a cyclic display and will continue until the process value is within the specified amount from setpoint. This only applies while the unit is in the soak phase, and soak time is not decremented while the unit is holding.

4.3 TUNE MODE

TO ACCESS THE TUNE MODE, while the controller is in "oFF" or "CtrL" Mode, repeatedly depress the SCROLL key until "tunE" is displayed, and then press the DOWN key.

TO MOVE DOWN THROUGH THE TUNE MODE PARAMETER CODES, depress the DOWN key. Each time the DOWN key is depressed another parameter code is displayed. When the appropriate parameter is to be changed has been located, depress the SCROLL key to display the value of the selected parameter. Now with the value displayed it can be changed by using the UP or DOWN keys as required. Once the desired value has been obtained depress the SCROLL key to move on to the next parameter code.

TO REVIEW THE PARAMETER VALUES, depress the SCROLL key. Each time the SCROLL key is depressed, the display will alternate between the parameter codes and the parameter values.

TO EXIT FROM THE TUNE MODE, make sure a parameter code is displayed, then depress the UP key. This will return to where "tunE" is displayed.

NOTE
If "tunE" does not appear, the mode is disabled.

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4.3.1 How to Enable the Tune Mode

1. While in Control Mode, press and hold for about 10 seconds the UP AND DOWN keys (at the same time) until you see "EnAb", then "EtSt" (when you release keys).
2. Press SCROLL key until you see "Etun".
3. Press SCROLL key again until you see "oFF" associated with the "Etun".
4. Change the condition to "on" (by pressing the UP key).
5. After the desired condition is displayed, press the SCROLL key to move to the next parameter code.
6. To exit, press the UP key.

4.3.2 How to Disable the Tune Mode

Go through the steps to step 4 above and change the condition to "oFF" (by pressing the DOWN key). Then continue through step 6.

Figure 4-3 shows a flowchart of how to access and exit the Tune Mode.

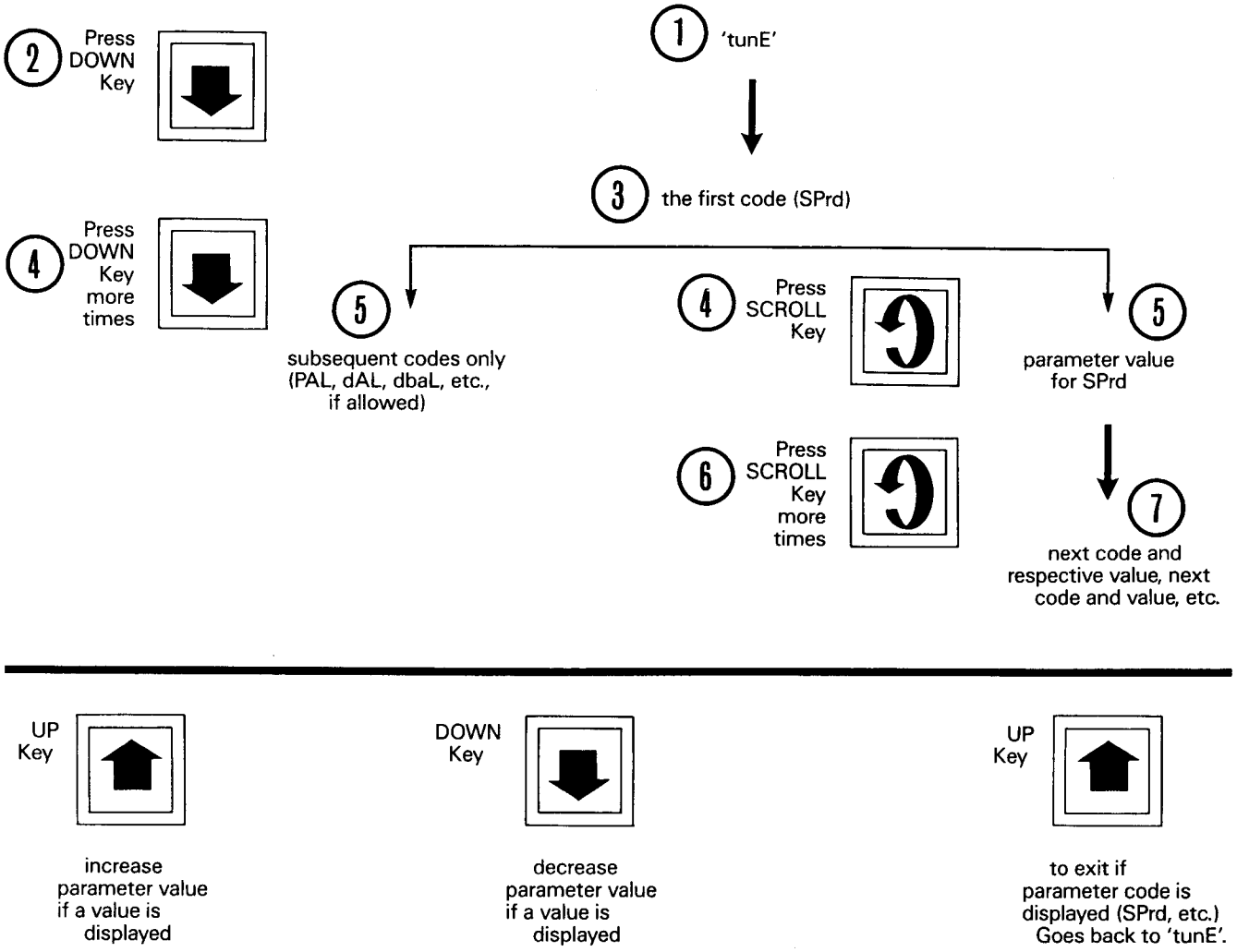


Figure 4-3.
Flowchart of Tune Mode
(Steps 1-7)

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The Tune Mode parameters are listed in Table 4-3 in order of appearance.

NOTE

Parameters will not be displayed if not applicable to how the instrument was programmed. For example, if no second output is present, the code and parameter value for spread (second output position) will not be displayed.

TABLE 4-3
TUNE MODE PARAMETERS AND DEFINITIONS

CODE	PARAMETER	MIN	MAX	DEFAULT	UNITS
SPrd	Spread	−1000	1000	0	*
PAL**	Process alarm	Limits of Span	Limits of Span	0	*
dAL**	Deviation Alarm	−3000	3000	0	*
dbAL**	Deviation Band Alarm	1	3000	1	*
Pb1	1st Out Band Width	1	3000	100	*
Pb2	2nd Out Band Width	1	3000	100	*
rSEt	Manual Reset	−1500	1500	0	*
ArSt	Auto Reset	0.0	100.0	0.0	Repeats/Min
rAtE	Rate	0.0	10.0	0.0	Min
Ct1***	1st Out Cycle Time	1	240	30	Sec
Ct2	2nd Out Cycle Time	1	240	30	Sec
FoP	1st Out Position	−1000	1000	0	*

* Units are C Deg., F Deg. or Engineering Units, depending on input type.
** The type of alarm is determined by the Alarm Select parameter in Program Mode.
*** Ct1 is the duration of the on/off cycle for time proportioning, and the valve actuation time, from full closed to full open, for position proportioning.

The Deviation Band Alarm value specifies the width of the band that straddles the setpoint.

SPREAD "OUT 2" in Program Mode must be selected. Difference in units between first and second setpoint. Second setpoint tracks first −1000 to 1000 units.
The minimum of −1000 means—1000 units below main setpoint.
The maximum of 1000 means—1000 units above main setpoint.

PROCESS ALARM "OUT 3" in Program Mode must be 1 or 2. Used for high or low alarm which can be set at any point within limits of span.

DEVIATION ALARM "OUT 3" in Program Mode must be 3 or 4. High or low deviation alarm which tracks main setpoint.

The minimum of −3000 means—3000 units below main setpoint.
The maximum of 3000 means—3000 units above main setpoint.

DEVIATION BAND ALARM "OUT 3" in Program Mode must be 5 or 6. Sets band in units around setpoint which for out of limits type alarm if process is above or below setpoint.

The minimum of 1 means—½ unit above or ½ unit below setpoint.
The maximum of 3000 means—1500 units above or 1500 units below setpoint.

1ST OUT BANDWIDTH (PROPORTIONAL BAND) "OUT1" must be 3, 4, 5, or 6 for proportional control.
Proportional band is set in units representing total width of area of proportional action. For units with one control output (heating only) proportional band is symmetrical around the setpoint (assuming no rate or reset action has moved the proportional band). For units with two control outputs (heating and cooling) proportional band is below setpoint fro heating and above setpoint for cooling.

The minimum of 1 means—a proportional band of 1 unit.
The maximum of 3000 means—a proportional band of 3000 units.

2ND OUT BANDWIDTH "OUT 2" must be 3, 4, 5, or 6 for proportional control (see 1ST OUT BANDWIDTH).

MANUAL RESET This adjustment will shift the proportional band by + or − the Manual Reset value in engineering units. This allows for compensation of offset between process variable and setpoint after the process has settled out. Manual reset should only be used where single setpoints and consistent process load are used. Not used when Automatic Reset is used.

The minimum of −1500 means—the proportional band is offset by 1500 units below setpoint.
The maximum of 1500 means—the proportional band is offset by 1500 units above setpoint.

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AUTO RESET Also known as integral action given in units of repeats per minute. This can be defined as the number of times a change in the control output is due to the proportional action. Works on both outputs if two proportional outputs are used (heating and cooling).

0.0 means—automatic reset is off.
The minimum of 0.1 means—0.1 repeats per minutes.
The maximum of 100.0 means—100 repeats per minute.

RATE Rate, or Derivative action, is adjusted in terms of minutes. The Rate time is defined as the time the output from a PD (proportional band + derivative) controller will lead the output from a P (proportional band) only controller when both experience the same input change. Rate action is applied to the process input, not the setpoint. This prohibits the Rate action from occurring when the setpoint is changed. Rate is a dynamic parameter and is adjusted to the time constants and lags in the process. It should affect the control output only when the process itself changes. Rate works on both outputs if two proportional outputs are used.

0.0 means—Turns off rate
The minimum of 0.0 means—0 minutes
The maximum of 10.0 means—10.0 minutes.

1ST OUT CYCLE TIME "OUT 1" in Program Mode must be 3 or 4. Required for time proportioning control. Cycle time is the time duration or period of oscillation of the relay or SSR driver output. Adjustable from one second to 240 seconds. Mechanical relays are not recommended for use with cycle times of less than 10 seconds.

The minimum of 1 means—1 second
The maximum of 240 means—240 seconds (4 hours)

2ND OUT CYCLE TIME "OUT 2" in Program Mode must be 3 or 4. Cycle time for second control output. See 1ST OUT CYCLE TIME.

1ST OUT POSITION Allows the actual position first output to be adjusted above or below the setpoint independent of the second setpoint.

The minimum of −1000 means—1000 units below setpoint
The maximum of 1000 means—1000 units above setpoint.

4.3.3 How to Tune

NOTE

IF YOU ARE TUNING THE CONTROLLER, YOU MUST SET THE VALUES BY TRIAL AND ERROR FOR YOUR PARTICULAR SYSTEM. IF PROFILES ARE USED, THE CONTROLLER SHOULD BE TUNED AT AN AVERAGE TEMPERATURE OR AT THE MOST CRITICAL TEMPERATURE.

4.3.3.1 Tuning Criteria

The effects of process variable deviations and oscillations should be evaluated as to their effects on the process being controlled to determine what tuning criteria should be used.

The tuning methods described in the tuning methods and guidelines sections are for a basic 1/4 amplitude decay ratio response. If an overdamped response is desirable, changes to the PID values should be made appropriately.

4.3.3.2 Process Control Stability

It should be noted that once a controller has been tuned to a specific set of conditions, control instability can be introduced by significant changes to process conditions. As an example, in a situation in which stable recovery is achieved from a slowly applied load change, excessive cycling can occur if the same load change is applied rapidly. Also, if a large load change occurs over a long time duration, severe cycling can be caused with Integral action (Auto Reset) as a tuning parameter.

4.3.3.3 Non-Linearity of Control Loop Components

Most discussions concerning control loop tuning assume their linearity. This is a convenient simplification which is not necessarily representative of actual conditions. Because of the non-linearities that do exist in actual processes, control tuning adjustments that produce acceptable control at one setpoint or load change rate may produce severe cycling at other setpoints or load change rates. Where this occurs, a compromise in control adjustments is necessary so that acceptable cyclic recovery can be achieved under the most unstable load and setpoint conditions.

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4.3.3.4 Tuning Guidelines

There are some guidelines that should be considered before tuning:

1. Before tuning a controller to your process, make sure there is a good understanding of the dynamics involved in your process, i.e. Where is the measuring element located?, Is the final control element sized properly, etc.?
2. Decide on the criteria for evaluating the tuning of the controller, Minimal Area, Disturbance, Amplitude, Startup conditions, No Overshoot, etc. The process requirements determine which criteria is the most important.
3. Changes in turning parameters should be made one at a time.
4. After making any changes in tuning parameters, a disturbance should be introduced into the process so that the process reaction may be observed. This process reaction, or recovery, will tell whether the tuning parameters provide the desired control. It is usually easiest to make a step change in setpoint to introduce this disturbance.
5. The change in setpoint, or disturbance, referenced in 4. above, should be large enough to cause an observable deviation of process from setpoint. However, this change should not be so large that it will cause the controller output to proceed to either extreme limit.
6. Controller tuning for optimal control is not "hard and fast". **Be patient.** The process will take a certain amount of time to react to the setpoint changes during tuning. The amount of time depends upon the specific process, however, a period of 8 to 12 minutes should be allowed between changes. The important point to remember is to allow the process to react **completely.** Don't rush through tuning of the controller. If the complete process reaction is not observed, optimum control may never be achieved.
7. Start with the Proportional Band adjustment. All other tuning parameters (Manual Reset, Auto Reset, Rate, First Output Position, Spread, etc.) should be set to 0 or off. Obtain the best possible process reaction, without losing control. The setting that achieves this should be left in the controller programming.
8. If there are to be no setpoint or load changes in the process, the Proportional Band adjustment may be all that is necessary for proper control. If an "offset" still exists (the process does not settle out at setpoint with the best possible proportional band adjustment) Manual Reset may be added to eliminate this offset.
9. Auto Reset may be added to eliminate offsets and improve response to setpoint and load changes. Increase Auto Reset from 0 in 0.2 increments. Start with a small amount. Increase this increment if there is no apparent reaction. Remember to allow the process 8 to 12 minutes to any changes.
10. If necessary, Rate may be added. Rate is a dynamic tuning parameter; it should be added only when absolutely required. Rate may be required to compensate for process lags or to help inhibit reset windup when a large amount of Auto Reset (4 or 5 repeats per minute) is being used. If being used to compensate for large Auto Reset settings, a rule of thumb to follow is 10:1 (Auto Reset:Rate). If Auto Reset is 5 repeats per minute, set Rate at 0.5 minutes. If the Auto Reset value is not large, a 5:1 ratio is more conservative.
11. Controller tuning is not "hard and fast". It may be necessary to fine tune tuning parameters to obtain optimal control of the process.

The following section will describe how to tune the controller when a proportional output is required. If only on-off control is used, no tuning adjustments are required.

When using the CN8600 as a proportional control, observe the following characteristics of the process:

SETTING TIME — The time it takes to reach a normal steady state operation.

OVERSHOOT — The extent to which the process exceeds setpoint on the first cycle.

OFFSET (LOAD ERROR) — The settling out of the process at a level other than setpoint because of load variations.

OSCILLATION — Continuing temperature fluctuation above and below setpoint.

PROPORTIONAL BANDWIDTH ADJUSTMENT — This adjustment is made in actual degrees or units, not in the customary % of span or gain. The value used will be the actual bandwidth or throttling range. This value is factory set at 100 degrees/units. The proportional band is adjustable from 1 to 3000 degrees/units. To widen or narrow the band simply press the UP or DOWN key as required. The instrument will continue to control throughout this time. If the settling out time of the system is too slow, the overshoot too high, or if oscillation persists, a proportional bandwidth adjustment is necessary.

Condition 1—Slow response,
Solution—Decrease bandwidth.

Condition 2—High overshoot,
Solution—Increase bandwidth.

Condition 3—Oscillations,
Solution—Increase bandwidth.

Proportional band adjustment does not correct offset. Offset correction is accomplished by adjusting either the manual reset or automatic reset (integral).

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MANUAL RESET ADJUSTMENT The manual reset adjustment counteracts offset (load error) inherent in all proportional controlled processes. Adjust reset to correct offset in accordance with the two conditions listed below. With manual reset, adjustment is necessary with every significant load change. The manual reset adjustment of the CN8600 is in degrees/units. In other words, if the process is 10 degrees lower than a manual reset, adjustment of 10 degrees/units upwards will cause the process to line out at setpoint. Manual reset should only be used where single setpoints and consistent process load are used. Not used when Automatic Reset is used.

Condition 1—Control point above setpoint,
Solution—Adjust manual reset value downward by the amount of error in degrees/units.

Condition 2—Control point below setpoint,
Solution—Adjust manual reset value upward by the amount of error in degrees/units.

AUTO RESET (INTEGRAL) ADJUSTMENT Integral action, or automatic reset, corrects for offset (load error) for all load variations. After initial adjustment, further adjustments are not normally necessary, no matter what the load change. Reset wind-up inhibition prevents integral action outside the proportional band. To optimize integral response, the proportional bandwidth must be adjusted per the Proportional Bandwidth Adjustment section. If offset is noticed above or below setpoint, increase the auto reset value and observe the process response to a change in setpoint when process response shows continuing oscillation or instability, decrease reset to achieve stability.

Condition 1—Slow response,
Solution—Increase automatic reset.

Condition 2—Instability or oscillations,
Solution—Decrease automatic reset.

RATE (DERIVATIVE) ADJUSTMENT Derivative action is adjusted to match the response time of the process. Correct adjustment provides power output compensation for process load variation, minimizes overshoot and cycling at start up or in large process upsets. After the proportional band adjustment has been made, adjust the rate in accordance with the three conditions listed below, then move setpoint to another temperature and observe response to the change.

Condition 1—High overshoot,
Solution—Increase rate.

Condition 2—Continuing oscillations,
Solution—Decrease rate.

Condition 3—Slow response,
Solution—Decrease rate.

CYCLE TIME ADJUSTMENT The cycle time adjustment applies to time proportioning controllers. Cycle time should be adjusted only if necessary to achieve tighter control, decrease overshoot, or increase the life of cycling components. Optimum control is realized with minimum cycle time, but since rapid cycle time shortens the life of electromechanical relays and other cycling components, acceptable control is always a compromise between cycle rate and undue equipment wear.

4.3.3.5 Tuning Method

This tuning procedure assumes some familiarity with process control tuning and requires measurement of time periods to calculate some of the tuning parameters.

This procedure is applicable to P, PI, PD, or PID controllers. It assumes that it has been determined which combinations of control responses (PID) will provide for optimum control.

Determine Ultimate Proportional Band and Ultimate Time Period:

1. Tune out all the reset and derivative action from the controller, leaving only the proportional mode.
2. Maintain the controller on automatic, i.e., leave the loop closed.
3. With the Proportional Band (PB) of the proportional mode of the controller at some arbitrary value, disturb the equilibrium of the process and observe the response. One easy method for disturbing the equilibrium is to move the setpoint for a few seconds and then return it to its original value.
4. If the response curve from step 3 does not damp out, as in curve A in Figure 4-4, the PB is too low. The PB should be increased and step 3 repeated.
5. If the response in step 3 damps out, the PB is too high. The PB should be decreased and step 3 repeated.
6. When a response curve similar to the sustained oscillation (curve C) is achieved, this is the Ultimate Proportional Band (UPB) and Ultimate Time Period (UTP).

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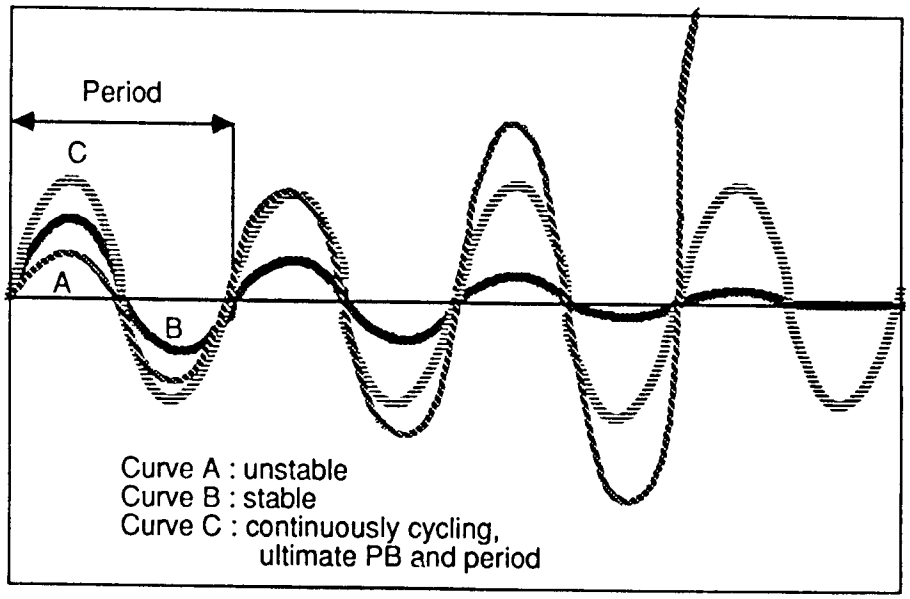


Figure 4-4. Tuning Curves

These values obtained for Ultimate Proportional Band (UPB) and Ultimate Time Period (UTP) are used to calculate optimal P, PI, PD, and PID tuning parameters using the following Ziegler-Nichols equations:

Proportional only control (P):

P (''Pb1'' or ''Pb2'') = 0.5 x UPB (degrees or units)

Proportional plus automatic reset (PI):

P (''Pb1'' or ''Pb2'') = 0.45 x UPB (degrees or units)
I (''ArSt'') = 1.2/UTP (repeats per minute)

Proportional-plus-derivative (or rate) (PD):

P (''Pb1'' or ''Pb2'') = 0.6 x UPB (degrees or units)
D (''rAtE'') = UTP/8 (minutes)

Proportional-plus automatic reset-plus derivative (PID):

P (''Pb1'' or ''Pb2'') = 0.6 x UPB (degrees or units)
I (''ArSt'') = 2/UTP (repeats per minute)
D (''rAtE'') = UTP/8 (minutes)

4.3.3.6 Time Proportioning Tuning

In addition to the PID tuning parameters, Time Proportioning control requires adjustment to the Cycle Time. The Cycle Time should be set based upon process and final control element characteristics.

It should be noted that the tuning parameters (PID) are sensitive to Cycle Time adjustments. Tuning parameter settings at one Cycle Time settings may not be appropriate at a different Cycle Time setting. Typically the longer the Cycle Time, the more conservative the tuning parameters should be, i.e. a wider Proportional Band, less Auto Reset, etc..

4.3.3.7 Dual Output Control Tuning

The preceeding procedures on control tuning are designed for single output control. They may be used for dual output tuning by tuning one output at a time, i.e. tune the Heating output, then tune the Cooling.

Dual output controllers are provided with a Proportional Band and Cycle Time adjustment for each output which must be tuned separately. The Auto Reset and Rate parameters are common to both outputs.

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4.4 ENABLE MODE

The CN8600 has the capability to limit operator access to the various modes and setpoint changes. This is accomplished by accessing the ''Enable Mode''. When the Enable Mode has been accessed, Table 4-4 shows which codes are enabled or disabled by the factory and what the codes become when enabled when previously disabled.

TABLE 4-4
ENABLED OR DISABLED MODES (FACTORY SET)

MODE	FACTORY SET	CODE	ENABLED CODE
Test Mode	Disabled	OFF	EtSt
CAL Mode	Disabled	OFF	ECAL
Program Mode	Enabled	ON	EPro
Tune Mode	Enabled	ON	Etun
Standby Mode	Enabled	ON	ESby
Profile Continue Mode	Disabled	OFF	EPC
Profile Entry Mode	Enabled	ON	EPE
Setpoint Changes	Enabled	ON	ESPC

The Test, Calibration, and Profile Continue Modes are factory set to ''oFF'' or not immediately accessible to the user. The Program, Tune, Standby, Profile Entry and Setpoint Modes are set to ''ON''. User access to any of the above modes can be turned on or off.

Table 4-5 shows step-by-step (following the number in parentheses) how to enable or disable each parameter mode. Each ''X'' denotes the key pressed if required. In step (1), the user must press UP AND DOWN keys at the same time. Then press SCROLL key (step 2). In step (3), the user can press either UP or DOWN key to enable (turn on) or disable (turn off) the test mode. Continue on in the chart.

TABLE 4-5
GENERAL FLOWCHART - ENABLE MODE

Press UP key (on)	Press DOWN key (off)	SCROLL	DISPLAY
when in Control Mode, X (Hold simultaneously for 10 seconds)	(1) X		you see ''EnAb'' then ''EtSt''
		(2) X (to show condition of Test Mode)	
(3) X or (3) X if you see the condition you wanted (on or off), merely press scroll to move on.			
		(4) X	''ECAL''
		(5) X (to show condition of calibration Mode)	
	(6) X should remain OFF		
		(7) X	''EPro''
		(8) X (to show condition of Program Mode) *	

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TABLE 4-5 (Cont'd)
GENERAL FLOWCHART - ENABLE MODE

Press UP key (on)	Press DOWN key (off)	SCROLL	DISPLAY IF ENABLED
(9) X or (9) X if you see the condition you wanted (on or off), merely press SCROLL key to move on.			
		(10) X	"Etun"
		(11) X (to show condition of Tune Mode) *	
(12) X or (12) X if you see the condition you wanted (on or off), merely press SCROLL key to move on.			
		(13) X	"ESby"
		(14) X (to show condition of Standby Mode) *	
(15) X or (15) X if you see the condition you wanted (on or off), merely press SCROLL key to move on.			
		(16) X	"EPC"
		(17) X (to show condition of Profile Continue Mode)	
(18) X or (18) X if you see the condition you wanted (on or off), merely press SCROLL key to move on.			
		(19) X	"EPE"
		(20) X (to show condition of Profile Entry Mode) *	
(21) X or (21) X if you see the condition you wanted (on or off), merely press SCROLL key to move on.			

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TABLE 4-5 (Cont'd)
GENERAL FLOWCHART - ENABLE MODE

Press UP key (on)	Press DOWN key (off)	SCROLL	DISPLAY
		(22) X	"ESPC"
		(23) X (to show condition * of Setpoint Changes) **	
(24) X or	(24) X if you see the condition you wanted (on or off), merely press SCROLL key to move on.		
		(25) X	"EtSt"
(26) X if all finished ***			

* This mode is enabled from the factory. After the process is established and no operator interaction is desired, this mode can be disabled or turned "oFF".

** This mode should not be turned off until the proper setpoint has been established in the Control Mode.

*** If all selections have been made, depress the UP key to leave the Enable Mode. The controller will revert to the Control Mode. If no keys are depressed for 10 seconds, the unit will automatically leave the Enable Mode.

4.4.1 Enable Mode Lockout Using Jumper JU2

NOTE

The instrument is shipped from the factory with the Enable Mode accessible from the keypad (the jumper is installed with the two pins toward the front of the unit).

If no access to the Enable Mode via the front keypad is desired, a second level of security is provided. Loosen the screw on the front of the controller and remove the unit from its housing. On the top of the Analog/Processor Board, locate the jumper, PU2 on JU2, along the board edge near the flat cable. Refer to Analog/Processor Board Assembly drawing in the Appendix. If no access to the Enable Mode is desired, install the jumper with the two pins towards the rear of the unit (see details on Analog/Processor Board Assembly drawing in the Appendix). The Enable Mode is now locked from any front panel access and any inadvertent changes can not happen. Reinstall the instrument in its enclosure and tighten the screw to hold the instrument in place.

SECTION 5 OPERATING MODES

5.1 CONTROL MODE

In the Control Mode, the process value will normally be displayed, unless otherwise specified by the display select parameter in the Program Mode. While in the Control Mode, the CN8600 controller will be in automatic control of the process, and will control to the current setpoint.

SETPOINT REVIEW/CHANGE Setpoint can be reviewed by depressing either the UP or DOWN key momentarily. If the UP or DOWN key is depressed for longer than 2 seconds, the setpoint will increase or decrease respectively, provided setpoint changes have not been disabled. The longer the key is depressed, the faster the setpoint value will change.

NOTE

If UP or DOWN key is pressed for more than 2 seconds and the setpoint is not changed automatically, the Setpoint Mode is disabled.

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5.1.1 How to Enable the Setpoint

1. While in Control Mode, press and hold for about 10 seconds the UP AND DOWN keys (at the same time) until you see "EnAb", then "EtSt" (when you release keys).
2. Press SCROLL key until you see "ESPC".
3. Press SCROLL key again until you see "oFF" associated with the "ESPC".
4. Change the condition to "on" (by pressing the UP key).
5. After the desired condition is displayed, press the SCROLL key to move to the next parameter code.
6. To exit, press the UP key.

5.1.2 How to Disable the Setpoint

Go through the steps to step 4 above and change the condition to "oFF" (by pressing the DOWN key). Then continue through step 6.

LAMP TEST All displays and status indicators can be tested by depressing the UP and DOWN keys at the same time.

MODE CHANGE Depressing the SCROLL key will cause the controller to move sequentially to all enabled operating modes, and finally back to the Control (CtrL) Mode.

PERCENT OUTPUT OF PROPORTIONAL OUTPUTS While in Control Mode, holding in the UP key and depressing the SCROLL key will cause the display to sequence through a series of display codes and values.

1. First "Po1" for percent output 1,
2. The percentage value,
3. "Po2" for percent output 2,
4. The percentage value,
5. "Proc" for process
6. The process value.

Each code and percentage value will be displayed only if the corresponding proportional output is present. Each code or value will be displayed for 1 second and this sequence will continue until any key is depressed which will return the display to the normal mode.

MODE CHANGE Refer to "How to Select a Mode" (Section 3.5).

5.2 STANDBY MODE (AUTO/MANUAL)

(Proportional Controls Only) Auto to manual bumpless transfer is achieved by entering the Standby Mode. Depress the SCROLL key until "Stby" is displayed.

Pressing the DOWN key begins manual control and maintains the proportional outputs at the last value when in automatic. If the first output is proportional, then "Po1" will be displayed. Then you see the information shown in Table 5-1 after pressing the appropriate keys.

TABLE 5-1
STANDBY MODE SEQUENCE

KEY TO PRESS	DISPLAY
SCROLL	first output percentage ("Po1")
UP OR DOWN	increases or decreases the output
SCROLL	"Po2" if the second output is proportional
SCROLL	second output percentage
UP OR DOWN	increases or decreases the output
SCROLL	displays initial proportional output code

While in manual control, the yellow LED labeled "MAN" will be lit and if no key is depressed for 5 seconds, the display will sequence as follows:
"Po1" (if applicable)
Out 1% (if applicable)
"Po2" (if applicable)
Out 2% (if applicable)
"Proc" Process Value

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NOTE

The Manual Mode of operation opens the automatic control loop and allows for manual operation of the final control element. No automatic control takes place. A HIGH LIMIT SAFETY DEVICE IS RECOMMENDED.

TO EXIT FROM THE STANDBY MODE (MANUAL OPERATION), press the UP key twice.The controller will be in automatic control with ''Stby'' displayed.

NOTE

If ''Stby'' does not appear, the mode is disabled.

5.2.1 How to Enable the Standby Mode

1. While in Control Mode, press and hold for about 10 seconds the UP AND DOWN keys (at the same time) until you see ''EnAb'', then ''EtSt'' (when you release keys).
2. Press SCROLL key until you see ''Esby''.
3. Press SCROLL key again until you see ''oFF'' associated with the ''Esby''.
4. Change the condition to ''on'' (by pressing the UP key).
5. After the desired condition is displayed, press the SCROLL key to move to the next parameter code.
6. To exit, press the UP key.

5.2.2 How to Disable the Standby Mode

Go through the steps to step 4 above and change the condition to ''oFF'' (by pressing the DOWN key). Then continue through step 6.

5.3 AUTO TRANSFER AT SETPOINT

This feature automatically transfers the control from the Manual Mode back to automatic when setpoint is reached. The CN8600 is shipped from the factory with the auto transfer value at ''0'' or disabled. If the auto transfer is required refer to the Program Mode to access the ''AtFr'' parameter. You can see either 0, 1, or 2. See below.

A value of zero disables auto transfer.

A value of 1 will transfer to automatic when process goes below setpoint; for cooling applications.

A value of 2 will transfer to automatic when process goes above setpoint; for heating applications.

5.4 PROFILE EXECUTION/OPERATION

As mentioned in the Mode Selection Section, if the unit is not already running a profile, repeated depression of the SCROLL key will cause the unit to display the code corresponding to each mode which is enabled, and each profile which has been entered. To initiate a profile, while a profile code, ''P1'' through ''P8'', is displayed, depress the DOWN key or the RUN/HOLD key. The unit will display ''run''momentarily and then begin the profile. The initial setpoint ramp will begin at the current process value.

While in the Profile ''run'' condition, repeated depression of the RUN/HOLD key will cause the unit to alternate between the run condition and the hold condition. When the unit is running a profile, the information displayed will be per the ''diSP'' parameter in the Program Mode. While the unit is in the hold condition, the display will alternate between the process value and ''hold''.

If the unit is running a profile and in the run condition (rather than the hold condition), repeated depression of the SCROLL key will alternate between the Profile and the Tune Mode codes, provided the Tune Mode is enabled. Only the Tune Mode can be entered if the profile is in the run condition.

If the unit is in the hold condition, repeated depression of the SCROLL key will sequence through the codes for the enabled modes and entered profiles. To abort a profile, the following may be done:

1. Enter the Off Mode by depressing the DOWN key when the Off Mode code is displayed or
2. Enter the Control Mode by depressing the DOWN key when the Control Mode code is displayed.

If while running a profile, you see an error message, first look at the Error Codes (see Section 7) to determine the problem. To get back to the operating modes (Off, Control, Program, etc.) press:

1. RUN/HOLD key
2. SCROLL key

Then go into applicable operating mode and change the code (parameter) that was incorrectly entered.

To insure that a profile is not inadvertently aborted, the unit will react as follows:

If the Tune or Standby Mode is entered, they will perform their normal functions and, upon exiting, the profile will be in the hold condition. Attempting to enter any other selected mode will cause the unit to return to the profile in the hold condition. Therefore, to access any of the other modes, the profile must first be aborted.

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If a profile is aborted by going into the Control Mode, the unit will control at the last setpoint determined by the profile. If the profile is aborted by entering the Off Mode, proportional outputs will go to 0% output.

During profile execution, the current segment and ramp or soak condition will be identified by the status indicators. Holding in the DOWN key and depressing the SCROLL key will cause the display to sequence through a series of display codes and values. You see the following:

1. ''Pn''
2. the Profile number
3. ''tr''
4. the time remaining in the current ramp or soak phase
5. ''E1''
6. the ''on'' or ''oFF'' status of event 1
7. similarly the status of the other events
8. ''SP''
9. the setpoint
10. ''Proc''
11. the Process value
12. ''PLCt''
13. the loop counts remaining

Each event code and status will be displayed for one second and this sequence will continue until any key is depressed, which will return the display to the normal mode.

5.5 PROFILE CONTINUE MODE

This mode allows the execution of a profile from any point in the profile. It is primarily intended to be used to resume a profile after it has been aborted, but can be used to start in the middle of one. The parameter values displayed correspond to the state of the last profile executed.

TO ACCESS THE PROFILE CONTINUE MODE, repeatedly depress the SCROLL key until the ''PCon'' is displayed, and then depress the DOWN key. If ''PCon'' is not displayed (disabled), see below. To move down through the Profile Continue Mode parameter codes, depress the DOWN key. Each time the DOWN key is depressed, another parameter code is displayed.

TO EXAMINE THE SELECTED PARAMETER CODE, depress the SCROLL key. Now with the value displayed, it can be changed simply by using the UP or DOWN keys as required. Once the desired value has been obtained, depress the SCROLL key to move onto the next parameter code.

TO EXIT FROM OR ABORT THE PROFILE CONTINUE MODE, make sure a parameter code is displayed, then depress the UP key. This returns the control to where ''PCon'' is displayed.

NOTE

If ''PCon'' does not appear, the mode is disabled.

5.5.1 How to Enable the Profile Continue Mode

1. While in Control Mode, press and hold for about 10 seconds the UP AND DOWN keys (at the same time) until you see ''EnAb'', then ''EtSt'' (when you release keys).
2. Press SCROLL key until you see ''EPC''.
3. Press SCROLL key again until you see ''oFF'' associated with the ''EPC''.
4. Change the condition to ''on'' (by pressing the UP key).
5. After the desired condition is displayed, press the SCROLL key to move to the next parameter code.
6. To exit, press the UP key.

5.5.2 How to Disable the Profile Continue Mode

Go through the steps to step 4 above and change the condition to ''oFF'' (by pressing the DOWN key). Then continue through step 6.

Figure 5-1 shows a flowchart of how to access and exit the Profile Continue Mode.

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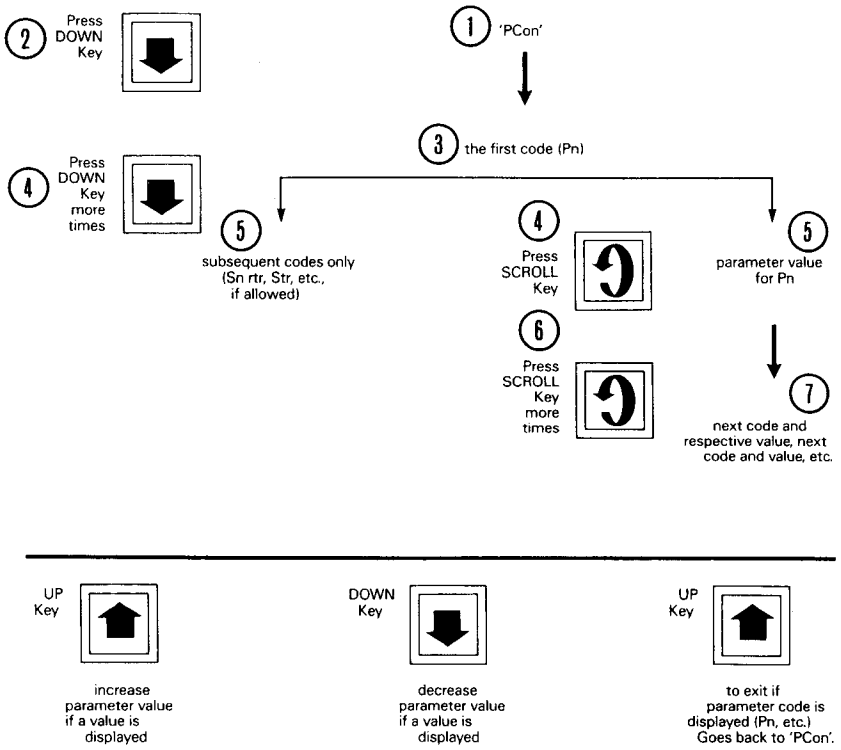


Figure 5-1.
Flowchart of Profile Continue Mode

(Steps 1-7)

The Profile Continue Mode parameters are listed in Table 5-1 in the order of appearance.

TABLE 5-1
PROFILE CONTINUE MODE PARAMETERS

CODE	PARAMETER	RANGE	DESCRIPTION/FUNCTION
Pn	Profile Number	1—8	Specifies the Profile
Sn	Segment Number	0—6	Specifies where execution is to begin
rtr	Ramp Time Remaining	0—9999	Specifies the time remaining in ramp period
Str	Soak Time Remaining	0—9999	Specifies the time remaining in soak period
PLCt	Profile Loop Count Remaining	0—9999	Specifies the remaining loop count

When the RUN/HOLD key is depressed, the controller will begin running the profile at the specified point.

The Segment Number Parameter, displayed in the Profile Continue Mode, is limited to the number of segments in the specified profile. Any profile number can be specified, however, if the profile has no segments, per the Profile Entry Mode, an "Er19" will be displayed if Profile Continue is initiated.

If the Ramp Time Remaining Parameter is not set equal to 0, the Soak Time Remaining Parameter will not be displayed. Conversely, if the ramp time remaining is set to 0, the Soak Time Remaining Parameter will be displayed and a value can be specified for it. Therefore, this prescribes that you can continue in the ramp phase or the soak phase, respectively.

If Profile Continue is executed to continue in the ramp phase of a segment, and NO parameter values are changed, the instrument will begin ramping the setpoint from the current setpoint to the setpoint value specified for that ramp in the Profile Entry Mode, within the ramp time remaining as specified in the Profile Continue Mode.

If Profile Continue is executed to continue in the ramp phase of a segment, and any parameter value(s) are changed, the instrument will begin ramping the setpoint from the current process value.

Note that "tr" time remaining displayed in Profile Continue Mode, or in the cyclic display, is rounded down to the nearest digit, i.e., a "tr" actual time remaining of "000.05" tenths will be shown as "000.0".

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SECTION 6 TEST MODE

The Test Mode provides user test routines. In addition to accessibility in the Test Mode, some of the test routines are also executed on power-up and every fifteen minutes during normal operation in the Control Mode.

Upon power-up, "6XXX" will be displayed, then "XXX—" will be displayed, identifying the seven digit hardware order matrix number, then the revision level will be displayed in the format "rN.NN", then Test 1 through 3 will be executed automatically, with "tSt1", "tSt2", and "tSt3" displayed. Upon successful completion of the tests, "Ctrl" will be displayed for about three seconds. During this time, the operator can select another mode prior to the unit automatically going into the Control Mode.

THE TEST MODE IS SELECTED, WHEN ENABLED, by pressing the SCROLL key until "tESt" is displayed, and then pressing the DOWN key. Pressing the SCROLL key will sequentially select the Test routines, indicated by "tSt" and the number appearing in the display. Tests 1 through 3 are executed automatically as a group, so the selection will jump from "tSt1" to "tSt4". After the last routine is selected, pressing the SCROLL key will return control back to the beginning of the Test Mode, with "tSt1" appearing in the display.

TO ENTER A TEST, while pressing the DOWN key, press the SCROLL key.

TO EXIT THE TEST MODE, press the UP key.

Should an error occur during a test routine, an error message will be displayed. There are two error categories: hardware errors and software errors. A hardware error indicates that a device has failed, and the software will not allow recovery, since reliable operation of the controller is questionable. A software error is not related to defective hardware and can be cleared or recovered from by taking the appropriate action to correct the problem.

A hardware error can only be recovered from by depowering the unit. If the problem remains, the error message will be displayed again when encountered.

NOTE

If "teSt" does not appear, the mode is disabled.

How to Enable the Test Mode

1. While in Control Mode, press and hold for about 10 seconds the UP AND DOWN keys (at the same time) until you see "EnAb", then "EtSt".
2. Press SCROLL key once until you see "oFF" associated with the "EtSt".
3. Change the condition to "on" (by pressing the UP key).
4. After the desired condition is displayed, press the SCROLL key to move to the next parameter code.
5. To exit, press the UP key.

How to Disable the Test Mode

Go through the steps to step 3 above and change the condition to "oFF" (by pressing the DOWN key). Then continue through step 5.

The following list summarizes the Tests available.

TEST 1 Microcomputer Internal RAM Test
TEST 2 External RAM Test
TEST 3 Program PROM Checksum Test
TEST 4 NVRAM Checksum Tests
TEST 5 Keypad/Display Test
TEST 6 Relay Outputs Test
TEST 7 4-20 mA Output Test—First Output
TEST 8 4-20 mA Output Test—Second Output
TEST 9 Auxiliary Input Test

Test 1 through Test 3 are executed on power-up and periodically during the Control Mode. Test 4 is executed upon entry into the Control Mode, and periodically during the Control Mode.

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6.1 LINE FREQUENCY DETERMINATION

Description: Upon power-up, the unit counts the number of zero-crossings that occur during one second and limit checks the result. If the count is between 45 and 55, it assumes a line frequency of 50 Hertz. If the count is between 55 and 65, it assumes a line frequency of 60 Hertz. If the count falls outside these limits, it displays an error message.

Operation: This routine is executed only on power-up with no separate message displayed.

Errors: Er 5—Hardware Error—No Zero Crossings Being Detected
Er 6—Hardware Error—Line Frequency Less than 45 Hertz
Er 7—Hardware Error—Line Frequency Higher than 65 Hertz

6.2 TEST 1—MICROCOMPUTER INTERNAL RAM TEST

Description: This is a non-destructive memory test storing and checking two alternating bit patterns which verifies that all bit cells can store a "1" or "0". When complete, the memory is restored with its initial contents.

Operation: With "tSt1" displayed, while pressing the DOWN key, press the SCROLL key. "tSt" will be displayed momentarily while the test is in progress. Upon successful completion of the test, the controller will proceed to Test 2.

This test is also executed as part of the power-up self-test, and periodically during the Control Mode, without the message displayed.

Errors: Er1—Hardware Error—Internal RAM test failure.

6.3 TEST 2—EXTERNAL RAM TEST

Description: This is a non-destructive memory test storing and checking two alternating bit patterns which verifies that all bit cells can store a "1" or "0". When complete the memory is restored with its initial contents.

Operation: After the completion of Test 1, "tSt2" will be displayed momentarily while the test is in progress. Upon successful completion of the test, the controller will proceed to Test 3.

This test is also executed as part of the power-up self-test, and periodically during the Control Mode, without the test message displayed.

Errors: Er 2—Hardware Error—External RAM test failure.

6.4 TEST 3—PROGRAM PROM CHECKSUM TEST

Description: This is a checksum test to verify data integrity of the stored program code.

Operation: After completion of Test 2, "tSt3" will be displayed momentarily while the test is in progress. Upon successful completion of the test, the controller will proceed back to Test 1.

This test is also executed as part of the power-up self-test, and periodically during the Control Mode, without the message displayed.

Errors: Er 3—Hardware Error—Program PROM checksum test failure.

6.5 TEST 4—NVRAM CHECKSUM TESTS

Description: These are checksum tests to verify the integrity of the data stored in NVRAM. Checksums are used for the calibration values and program/tuning parameter, and the profiles.

Operation: With "tSt4" displayed, while pressing the DOWN key, press the SCROLL key. The display will blank momentarily, then may display three numbers, and then "tSt4" will be displayed. Test 4 can now be initiated again, or another routine selected. The three numbers represent the number of times the instrument has automatically recovered from error 16, 17, and 18 respectively. Three numbers will not always be displayed. If no numbers were, then no checksum errors have occurred.

This test is also executed when the controller enters the Control Mode and periodically during the Control Mode. If an error occurs, the appropriate error message is displayed. The unit will not control if a checksum error is detected.

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NOTE

Whenever calibration, program, tuning values, or the setpoint is changed, the unit calculates the appropriate checksum and stores it.

Errors: Er16—Software Error—Program Tuning Parameters Checksum Error
Er17—Software Error—Calibration Values Checksum Error
Er18—Software Error—Profiles Data Checksum Error

Error Recovery: If during the Test Mode: Press the DOWN key to execute the test again, or the SCROLL key to return to "tSt4".

If during the Control Mode: Press the SCROLL key to exit the Control Mode.

The unit will display this error upon return to the Control Mode, unless the condition has been corrected.

For Er16, review and correct the program and setup parameters.
For Er17, the appropriate calibration must be done.
For Er18, review and correct the profile data.

6.6 TEST 5—KEYPAD/DISPLAY TEST

Description: This test allows the operator to verify that the keypad works and that all display elements can be lit.

Operation: With "tSt5" displayed, while pressing the DOWN key, press the SCROLL key. The following will be displayed while the corresponding key is depressed, otherwise the display will be blank.

Table 6-1 lists the keys on the Front Panel and their associated display when pressed.

TABLE 6-1
KEYS AND ASSOCIATED DISPLAY

KEY	DISPLAY
RUN/HOLD	run
UP KEY	uAro
DOWN KEY	dAro
SCROLL KEY	SCrL
UP AND DOWN KEY	(All LEDs and Segments lit)
SCROLL KEY AND UP KEY	(exit)

To exit from the test, press SCROLL and UP keys simultaneously. Upon exiting, "tSt5" will be displayed. Test 5 can now be initiated again, or another routine selected.

Errors: Simultaneous depression of more than one key, except as stated above to exit, will have no effect. The only errors are those observable by the operator.

6.7 TEST 6—RELAY OUTPUTS TEST

Description: This test allows the operator to verify that the output relays are working.

Operation: With "tSt6" displayed, while pressing the DOWN key, press the SCROLL key. "oFF" will be displayed. Each time the DOWN key is pressed, the controller will advance through the following sequence:

DISPLAY	RELAY ON
rLyA	A only
rLyb	B only
rLyC	C only
oFF	None

The above sequence is repeated as the DOWN key is pressed. The operator must verify proper operation of the relays by an appropriate method.

To exit the test, press the SCROLL key. Upon exiting, "tSt6" will be displayed. Test 6 can now be initiated again, or another routine selected.

The existence of the relays is dependent on the hardware configuration.

Errors: Those observable by the operator.

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6.8 TEST 7—4-20 mA OUTPUT TEST—FIRST OUTPUT

Description: This test allows the operator to verify that the first 4-20 mA output is functioning properly or will allow the selection of an output value for testing of associated equipment.

Operation: With "tSt7" displayed, while pressing the DOWN key, press the SCROLL key. The display will indicate the milliamp output value during this test, initially "4" milliamps. While the UP or DOWN key is depressed, the unit will increase or decrease the output in one milliamps steps. The output is limited within the 4-20 milliamp range. The operator must verify the corresponding output with appropriate equipment. The output current should be ±0.3 mA at any output value with a load of 0-600 ohms.

To exit the test, press the SCROLL key. Upon exiting, "tSt7" will be displayed. Test 7 can now be initiated again, or another routine selected.

The existence of the first 4-20 mA output is dependent on the hardware configuration.

Errors: The only error is improper operation of the output as measured by the operator.

6.9 TEST 8—4-20 mA OUTPUT TEST—SECOND OUTPUT

Description: This test allows the operator to verify that the second 4-20 mA output is functioning properly or will allow the selection of an output value for testing of associated equipment.

Operation: With "tSt8" displayed, while pressing the DOWN key, press the SCROLL key. The display will indicate the milliamp output value during this test, initially "4" milliamps. While the UP or DOWN key is depressed, the unit will increase or decrease the output in one milliamps steps. The output is limited within the 4-20 milliamp range. The operator must verify the corresponding output with appropriate equipment. The output current should be ± 0.3 mA at any output value with a load of 0-600 ohms.

To exit the test, press the SCROLL key. Upon exiting, "tSt8" will be displayed. Test 8 can now be initiated again, or another routine selected.

The existence of the second 4-20 mA output is dependent on the hardware configuration.

Errors: The only error is improper operation of the output as measured by the operator.

6.10 TEST 9—AUXILIARY INPUT TEST

Description: This test allows the operator to verify that the auxiliary input, used for motor modulation feedback or remote run/hold input is functioning properly.

Operation: With "tSt9" displayed, while pressing the DOWN key, press the SCROLL key. The auxiliary input voltage will be displayed to the nearest hundredth of a volt. The operator must connect a voltage source to terminals 8 and 4 to verify the proper value is displayed, ± 0.1 volts.

To exit the test, press the SCROLL key for one second. Upon exiting, "tSt9" will be displayed. Test 9 can now be initiated again or another routine selected.

The existence of the auxiliary input is dependent on the hardware configuration.

Errors: rSEr—Software Error—Remote Setpoint Error—Voltage over/under range.

Error Recovery: rSEr error recovery is automatic, provided the condition causing the error is corrected.

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SECTION 7 ERROR CODES

Table 7-1 summarizes the possible error conditions that can exist.

TABLE 7-1
ERROR CODE DEFINITIONS AND TYPE (HARDWARE/SOFTWARE ERROR)

CODE	DEFINITIONS	REFERENCE	CORRECTION
Er 1	Microcomputer Internal RAM Test Failure - HARDWARE	Test 1	Call factory, for return.
Er 2	External RAM Test Failure - HARDWARE	Test 2	Call factory, for return.
Er 3	Program PROM Checksum Test Failure - HARDWARE	Test 3	Call factory, for return.
Er 4	RTD Input Mismatch Error - SOFTWARE	Cal 5	1. Check connections. 2. Redo Cal 5. 3. Call factory, for return.
Er 5	No Zero Crossings Being Detected - HARDWARE	Power-up	1. Check incoming AC. 2. Call factory, for return.
Er 6	Line Frequency Less than 45 Hertz - HARDWARE	Power-up	1. Check incoming AC. 2. Call factory, for return.
Er 7	Line Frequency Higher than 65 Hertz - HARDWARE	Power-up	1. Check incoming AC. 2. Call factory, for return.
Er 8	Main Calibration Input Voltage Error - SOFTWARE	Cal 2	1. Check input voltage. 2. Redo calibration.
Er 9	Analog Ground ADC Error - SOFTWARE	Control/Cal	1. Ground loop on 4-20 mA input. 2. Check wiring. 3. Redo Cal 2. 4. Possible hardware problem.
Er10	Reference Voltage ADC Error - SOFTWARE	Control/Cal	1. Check input element. 2. Check input voltage. 3. Simulate input. 4. Do/redo Cal 2. 5. Hardware problem.
Er11	CJC Sensor ADC Error - SOFTWARE	Control/Cal	1. Redo Cal 3. 2. Broken cold junction resistor.
Er12	Calibration Voltage Mismatch Error - SOFTWARE	Cal 2	1. Check input for 50.00 mV ±5%. 2. Redo calibration.
Er13	RTD Input Magnitude Error - SOFTWARE	Cal 5	Check input resistance.
Er14	CJC Sensor Input Validity Error - SOFTWARE	Control/Cal	1. Check CJC. 2. Check thermocouple. 3. Do/redo Cal 3.
Er15	Ground Counts Tolerance Error - SOFTWARE	Cal 2	1. Check to see if input is shorted. 2. Redo Cal 2.
Er16	Program/Tuning Parameters Checksum Error - SOFTWARE	Control/Test	Check "TST 4" to see how many times error has occurred.
Er17	Calibration Values Checksum Error - SOFTWARE	Control/Test	Check "TST 4" to see how many times error has occurred.
Er18	Profile Data Checksum Error - SOFTWARE	Control/Test	1. Do Cal 8. 2. See Er16.
Er19	Attempted to run a Profile with No Segments - SOFTWARE	Profiling	1. Enter segments to profile. 2. Choose correct profile. 3. Do Cal 8 and re-enter.
Er20	Setpoint Value Validation Error - SOFTWARE	Control	Do Cal 8.
Er36	Unit Configured for Communications Option. Proper hardware is not installed - HARDWARE	Power-up	Call factory.

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TABLE 7-1 (Cont'd)
ERROR CODE DEFINITIONS AND TYPE (HARDWARE/SOFTWARE ERROR)

CODE	DEFINITIONS	REFERENCE	CORRECTION
Er37	Unit Configured for Communications Option. Proper hardware is not installed - HARDWARE	Power-up	Call factory.
SnSr	Input Over/Under Range or Sensor Break - SOFTWARE	Control/Cal	Check sensor.
Hi	Input More than 10% Higher than Span (TC/RTD) - SOFTWARE	Control/Cal	1. Check to see that sensor type matches the input type selected in Program Mode. 2. Do Cal needed for sensor.
Lo	Input More than 10% Lower than Span (TC/RTD) - SOFTWARE	Control/Cal	Do Cal needed for sensor.
rSEr	Remote Setpoint Over/Under Range or Break - SOFTWARE	Control/Cal	Check Remote Setpoint input.
FbEr *	Modulation Motor Feedback Sensor Break - SOFTWARE	Control	1. Check motor and wiring. 2. Do Test 9. 3. Possible hardware problem.

* Position Proportion output only

SECTION 8 CALIBRATION - GENERAL DESCRIPTION

The Calibration Mode provides initialization routines, calibration routines and other utilities.

NOTE

If an error condition occurs while a profile is running the profile, the profile must be put in hold and aborted before the error can be cleared.

THIS MODE SHOULD REMAIN IN THE OFF CONDITION AND IS NOT REQUIRED DURING NORMAL OPERATION. CALIBRATION SHOULD ONLY BE ATTEMPTED BY A QUALIFIED TECHNICIAN. DO NOT ATTEMPT ANY OF THESE CALIBRATION TESTS WITHOUT THE PROPER TEST EQUIPMENT WITH SPECIFICATIONS AT OR GREATER THAN THOSE LISTED.

THE CALIBRATION MODE IS SELECTED, if enabled, by pressing the SCROLL key until "CAL" is displayed, and pressing the DOWN key. Pressing the SCROLL key will sequentially select the Calibration Routines, indicated by "CAL" and the number appearing in the display. After the last routine is selected, pressing the SCROLL key will return control back to the beginning of the Calibration Mode, with "CAL 1" appearing in the display.

TO ENTER A CALIBRATION ROUTINE, while pressing the DOWN key, press the SCROLL key.

TO EXIT THE CALIBRATION MODE, press the UP key.

Should an error occur during a test or calibration routine, an error message will be displayed. There are two error categories: hardware errors and software errors. A hardware error indicates that a device has failed, and the software will not allow recovery, since reliable operation of the controller is questionable. A software error is not related to defective hardware and can be cleared or recovered from by taking the appropriate action to correct the problem.

NOTE

If "ECAL" does not appear, the mode is disabled.

HOW TO ENABLE THE CALIBRATION MODE:

1. While in Control Mode, press and hold for about 10 seconds the UP AND DOWN keys (at the same time) until you see "EnAb", then "EtSt".
2. Press SCROLL key until you see "ECAL".
3. Press SCROLL key again until you see "oFF" associated with the "ECAL".
4. Change the condition to "on" (by pressing the UP key).
5. After the desired condition is displayed, press the SCROLL key to move to the next parameter code.
6. To exit, press the UP key.

TO DISABLE THE CALIBRATION MODE:

Go through the steps to step 4 above and change the condition to "oFF" (by pressing the DOWN key). Then continue through step 6.

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Table 8-1 lists the calibration modes that can be performed in the controller.

TABLE 8-1
CALIBRATION MODES

CALIBRATION NUMBER	DESCRIPTION
CAL 1	Parameter Initialization—Program and Tuning Parameters Only
CAL 2	Main Calibration
CAL 3	Cold Junction Compensation Calibration
CAL 4	Cold Junction Temperature Utility
CAL 5	RTD Input Calibration
CAL 6	Special Operating Modes
CAL 7	Troubleshooting Modes
CAL 8	Profiles Initialization—Profile Data Only

8.1 CAL 1—PARAMETER INITIALIZATION

Description: This routine is used to clear all programmed information put in during Program and Tune Mode set.

NOTE

Before proceeding with this procedure make sure that the Program and Tune Mode parameters are written down so that they can be re-entered after Calibration 1 is completed.

Test Equipment: None

Operation: With "CAL 1" displayed, while pressing the DOWN key, press the SCROLL key. The display will momentarily blank while the initialization is in progress. Upon completion of the routine, "CAL 1" will be displayed. The routine can be executed again, or another routine selected.

Errors: None.

8.2 CAL 2—MAIN CALIBRATION

Description: This routine determines and saves calibration values which correct for component variations relating to the basic measuring functions of the instrument. During the self calibration, the unit also checks the raw values from the ADC (Analog to Digital Converter) and compares the relative values of the 50 mV input signal and the reference voltage signal to ensure that the ADC and reference are functioning properly.

This is the only calibration required for proper operation of the Volt and Millivolt inputs. Other calibration steps are required for the other input types.

Operation:

1. With "CAL 2"displayed, while pressing the DOWN key, press the SCROLL key.
2. The controller will display "hld1".
3. Short the input terminals, or connect a 0.00 ±0.01 mV source.
4. Press the DOWN key.
5. "dELy"will be displayed for 10 seconds, allowing the input to settle.
6. "SCAn"will be displayed for 10 seconds.
7. While the input is being sampled, a number will be displayed. The number is the difference between raw ground counts, and the raw counts for the shorted input, which is the offset seen after amplification. This must not be greater than the maximum allowed.
8. Connect a 50.00 ±0.01 mV source to the input terminals.
9. Press the DOWN key.
10. "dEly"will be displayed for 10 seconds, allowing the input to settle.
11. "SCAn"will be displayed for 10 seconds, while the input is being sampled and test and calibration are done.
12. "CAL 2"will be displayed. CAL 2 can now be initiated again, or another routine selected.

Errors: Er 9—Software Error—Analog Ground ADC Error: Ground Counts extremely high/low. Possible ADC problem.

SnSr—Software Error—Input Over/Under Range or Sensor Break: Input counts extremely high/low. Input may not be connected or is not 50 mV.

Er10—Software Error—Reference Voltage ADC Error: Input counts extremely high/low. Possible ADC or reference problem.

Er15—Software Error—Ground Counts Tolerance Error: Raw counts for ground are not ±15% of expected value. Possible ADC ramp problem.

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Counts Max. (Operator determined)—Input Offset Error: (Raw counts for the shorted input are not within MAX.) counts of the raw counts for ground. Possible input circuit or reed relay problem.

Er 8—Software Error—Main Calibration Input Voltage Error: Delta counts for input voltage are not ±15% of expected value. Input may not be 50 mV.

Er12—Software Error—Calibration Voltage Mismatch Error: Divided reference voltage is not 59.2 mV ±5% or input voltage is not 50.0 mV ±5%.

Error Recovery: Be sure that the millivolt source is connected and functioning properly.

Press the DOWN key to bring the controller back to the "dELy" condition and proceed to retry the test and calibration.

Press the SCROLL key to exit, and "CAL 2" will be displayed.

NOTE

With "hld1" or counts displayed, pressing the SCROLL key will exit, and "CAL 2" will be displayed.

8.3 CAL 3—COLD JUNCTION COMPENSATION CALIBRATION

Description: This routine determines and saves calibration values which correct for component variations relating to the Cold Junction Compensation. This routine indirectly calibrates the CJC as follows:

1. It computes the temperature of a J Type thermocouple based on its current CJC calibration values.
2. It allows the operator to correct the display to the actual temperature at the thermocouple.
3. It calculates the actual CJC based on the temperature it had computed and the operator change,
4. It calculates and stores the new calibration values based on the actual temperature.

This procedure requires that a J Type thermocouple input of known characteristics and known temperature be connected directly to the input terminals.

This calibration must be preceeded by CAL 2, Main Calibration, to properly calibrate the instrument. These two calibrations are all that are required for proper operation of all thermocouple inputs. Other calibration steps are required for other input types.

Test Equipment: 1 - type J thermocouple
1 - mercury thermometer ±0.25 degrees °F or equivalent.

Operation:

1. With "CAL 3" displayed, while pressing the DOWN key, press the SCROLL key.
2. The controller will display "hold".
3. Connect a J Type thermocouple to the input terminals.
4. Press the DOWN key.
5. "dEly" will be displayed for 10 seconds, allowing the input to settle.
6. "SCAn" will be displayed for 10 seconds, while the input is being sampled.
7. The unit computes the temperature, based on the average of ten samples and displays the result to a tenth of a degree C.

Correct the display value, as required, using the UP key or DOWN key to increment or decrement the value. Press the SCROLL key to complete the calibration, then "CAL3" will be displayed. CAL 3 can now be initiated again, or another routine selected.

If the unit has never been previously calibrated, the displayed value may be drastically in error. To establish a reasonable starting point:

1. Press the SCROLL key to exit and "CAL3" will be displayed.
2. With "CAL3" displayed, while pressing the DOWN key, press the SCROLL key. The controller will display "hold".
3. With "hold" displayed, press the UP key. This will store a default calibration value and proceed to the "dELy" condition described above.

Errors:
SnSr—Software Error—Input Over/Under Range or Sensor Break: Possibly the thermocouple has not been properly connected.

Er11—Software Error—CJC Sensor ADC Error: Possible the CJC assembly is not connected or not working.

Er14—Software Error—CJC Sensor Input Validity Error: The divided CJC compensator voltage is not within specification.

Error Recovery: Press the DOWN key to bring the controller back to the "dELy" condition and proceed to retry the test and calibration.

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Press the UP key to store a default calibration value and proceed to the "dELy" condition described above.

Press the SCROLL key to exit, and "CAL3" will be displayed.

NOTE

With "hold" displayed, pressing the SCROLL key will exit, and "CAL3" will be displayed.

8.4 CAL 4—COLD JUNCTION TEMPERATURE UTILITY

Description: This utility displays the temperature that the cold junction compensator is reading.

Test Equipment: None

Operation:

1. With "CAL4" displayed, while pressing the DOWN key, press the SCROLL key.
2. "SCAn" will be displayed for 10 seconds while the unit samples the input and computes the CJC assembly temperature.
3. The result will be displayed to a tenth of a degree C. The input terminals must be shorted or have a reasonable input connected.

If the unit has not been previously calibrated, the displayed value may be drastically in error. CAL 3 must be performed for proper operation of this utility.

To exit this routine, press the SCROLL key. Upon exiting, "CAL4" will be displayed. CAL 4 can now be initiated again, or another routine selected.

NOTE

The displayed temperature is not the ambient temperature. It is the temperature of the cold junction compensator or thermocouple terminals.

Errors: SnSr—Software Error—Input Over/Under Range or Sensor Break: Possibly the TC has not been properly connected.

Er11—Software Error—CJC Sensor ADC Error: Possibly the CJC assembly is not connected or not working.

Er14—Software Error—CJC Sensor Input Error: The divided CJC compensator voltage is not within specification.

Error Recovery: Press the DOWN key to bring the controller back to the "SCAn" condition.

Press the SCROLL key to exit, and "CAL4" will be displayed.

8.5 CAL 5—RTD INPUT CALIBRATION

Description: This routine determines and saves calibration values which corrects for component variations relating to RTD inputs. During the self-calibration, the unit indirectly checks the current source operation by limit checking the voltage developed across an external resistor simulating an RTD.

This calibration must be preceeded by CAL 2, Main Calibration, to properly calibrate the instrument. These two calibrations are all that is required for proper operation of all RTD inputs. Other calibration steps are required for other input types.

Operation:

1. With "CAL5" displayed, while pressing the DOWN key, press the SCROLL key. The controller will display "hld1".
2. Connect a 100 ohm, 0.01% resistor to terminals 1/4 and 3.
3. Press the DOWN key.
4. "dELy" will be displayed for 10 seconds allowing the input to settle.
5. "SCAn" will be displayed for 10 seconds, while the input is being sampled and the test and calibration are done.
6. "hld2" will then be displayed.
7. Connect a 277 ohm, 0.01% resistor to terminals 1/4 and 3.
8. Press the DOWN key.
9. "dEly" will be displayed for 10 seconds, allowing the input to settle.
10. "SCAn" will be displayed for 10 seconds, while the input is being sampled and test and calibration are done.
11. "CAL5" will be displayed. CAL 5 can now be initiated again, or another routine selected.

Errors: Er 4—Software Error—RTD Input Mismatch Error: With a 100 ohm input, the voltage at the signal multiplexer is not 0 ±2.0 mV. The current sources are not matched or the input and internal resistors are not 100 ohms.

Er13—Software Error—RTD Input Magnitude Error: With a 277 ohm input, the voltage at the signal multiplexer is not 58.4 mV ±15%. The current sources are not 330 μA ±15%.

SnSr—Software Error—Input Over/Under Range or Sensor Break: Possibly one of the current sources is much different than 330 μA.

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Error Recovery: Ensure that the proper resistor value is properly connected to terminal 1 and 3, and a jumper installed between 1 and 4.

Press the DOWN key to bring the controller back to the "dELy" condition and proceed to retry the test and calibration.

Press the SCROLL key to exit, and "CAL5" will be displayed.

NOTE

With "hld1" or "hld2" displayed, pressing the SCROLL key will exit, and "CAL5" will be displayed.

8.6 CAL 6—SPECIAL OPERATING MODES

Description: This routine provides selection of special operating modes or displays to aid in evaluating and/or troubleshooting controller performance/problems.

Operation:

1. With "CAL6" displayed, while pressing the DOWN key, press the SCROLL key.
2. The controller will display "C6" and the number of the mode in effect.
3. Pressing the UP or DOWN key will change the mode selection, with the display indicating the mode number to the right of the "C6".
4. Pressing the SCROLL key will exit with the last displayed mode in effect.
5. "CAL6" will be displayed.
6. Cal 6 can now be initiated again, or another routine selected.

The selected mode will remain in effect if power is interrupted. To return the controller to normal operation, CAL 6 must be executed, with mode zero selected, or CAL 1 must be executed to initialize all parameters. Table 8-2 shows two types of special operating modes.

TABLE 8-2
SPECIAL OPERATING MODES

MODE	DESCRIPTION
0	Normal operating mode
1	Cold Junction Compensation temperature will be internally fixed at 0°C by the software to facilitate linearization testing, requiring only an uncompensated millivolt source to simulate the thermocouple voltage per the tables. The Process Value will also be displayed to a tenth of a degree to provide higher display resolution for engineering evaluations.

NOTE

If the Process Value exceeds 999.9, the leftmost digit will be the letter "o" with a bar over it. The other digits will be valid.

Errors: None.

NOTE

If the mode value can only be set to 0 or 1, only the normal and CJC Temp = 0 are available. This change applies to newer software which includes normal operation to a tenth of a degree.

8.7 CAL 7—TROUBLESHOOTING MODES

Description: This routine provides modes to facilitate troubleshooting.

Operation:

1. With "CAL7" displayed, while pressing the DOWN key, press the SCROLL key. The controller will display "C7 1".
2. Pressing the UP key or DOWN key will change the mode number, the display indicating the mode number to the right of "C7".
3. Press the SCROLL key to enter the mode. The controller will perform the ADC cycle on the selected signal many times per second, per the descriptions below.
4. Once each second the raw counts will be displayed in hexadecimal format.
5. Press the SCROLL key to return to the mode selection.
6. Press the UP key to exit.
7. Upon exiting, "CAL7" will be displayed. Cal 7 can now be initiated again, or another routine selected.

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For C7 1 through C7 5, the MUX will continually select the prescribed signal, as defined below, and the ADC will continuously repeat the conversion cycle, with the ramp terminating when the ramp voltage matches the amplified selected signal voltage or the microcontroller's timer times-out. There will be a 2 millisecond delay between delay between ADC cycles. Table 8-3 shows Troubleshooting Modes.

TABLE 8-3
TROUBLESHOOTING MODES

MODE	SIGNAL	MUX	ADRS	
1	GND	S5	100	100 ohms to Ground
2	GND	S1	000	Intermediate Ground
3	DREF	S7	110	
4	DCJC	S6	101	
5	DRSP	S8	111	
6	VIN	*	*	RTD Current Sources Off
7	VIN	*	*	RTD Current Sources On

* For C7 6 and C7 7, the controller must "sample" the input via the "flying capacitor" by repeating the following sequence shown in Table 8-4.

TABLE 8-4
SAMPLING THE INPUT VALUES

RELAY K1	RELAY K2	SIGNAL MUXED	MUX SWITCH	$\overline{K1}$	MUX ADRS	$\overline{SADC}$	DELAY
CLOSED	OPEN	GND	S5	LO	100	HI	10 ms
OPEN	OPEN	GND	S5	HI	100	HI	5 ms
OPEN	CLOSED	GND	S1	HI	000	HI	2 ms
OPEN	CLOSED	VIN	S3	HI	010	LO	
		Adc ramps until $\overline{EOC}$ goes LO or the timer times-out. This time period is dependent on input voltage level.					
OPEN	OPEN	GND	S5	HI	100	HI	5 ms
CLOSED	OPEN	GND	S5	LO	100	HI	
		(now back at conditions on first step)					

ERRORS: None

8.8 CAL 8—PROFILES PARAMETER INITIALIZATION

Description: This routine clears all programmed information put in during Profile Entry Mode setup.

NOTE

Before proceeding with this procedure make sure that all profile parameters have been written DOWN so that they can be re-entered after calibration is performed.

Test Equipment: None

Operation:

1. With "CAL8" displayed, while pressing the DOWN key, press the SCROLL key. This display will momentarily blank while the initialization is in progress.
2. Upon completion of the routine, "CAL 8" will be displayed.
3. The routine can be executed again, or another routine selected.

Errors: None.

NOTE

All values are initialized to zero and all event outputs are initialized to off, with the exception of the first profile.

The first profile has the number of segments initialized to zero, to turn the profile off, but the profile has values stored in it for demonstration purposes. By setting the number of segments to two, the profile can be review and/or executed. Event will not be shown unless event relays were default in the Program Mode.

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HOW TO USE CAL 8 AND DEMONSTRATION VALUES:

1. Get into Cal 8 and run through test.
2. Press the UP key to get out of Cal 8—you see the display blank out and then display CAL.
3. Use the SCROLL key to scroll to PEnt Mode.
4. Press DOWN key to get to "Pn".
5. Press SCROLL key to get "1". You established one profile.
6. Continue to press SCROLL key to get to "nS"—it comes up as "0".
7. Press the UP key to get to "2". You established two segments.
8. Use SCROLL key to continue. You see the following values shown in Table 8-5.

TABLE 8-5
DEMONSTRATION VALUES

Profile 1—Values for Demonstration Purposes

CODE	VALUE	DESCRIPTION
SEGMENT 1		
rt	.10	Ramp Time
SP	100	Setpoint
E1	on	Event 1 on
E2	oFF	Event 2 off
E3	oFF	Event 3 off
St	.10	Soak Time
E1	oFF	Event 1 off
E2	on	Event 2 on
E3	oFF	Event 3 off
SEGMENT 2		
rt	.10	Ramp Time
SP	0	Setpoint
E1	oFF	Event 1 off
E2	oFF	Event 2 off
E3	on	Event 3 on
St	.10	Soak Time
E1	oFF	Event 1 off
E2	oFF	Event 2 off
E3	oFF	Event 3 off
PLct	2	Profile Loop Count
dhru	0	Deviation Hold after Ramp Up—none
dhrd	0	Deviation Hold after Ramp Down—none
PEnd	0	Profile End Control—abort—"oFF" Mode

NOTE

The Event Output Parameters will only be displayed and in effect if the relays have been assigned as event outputs.

SECTION 9 ELECTRICAL NOISE IN THE INDUSTRIAL ENVIRONMENT

9.1 NOISE

A. What is noise? Electrical noise is a variation in frequency or voltage beyond the normal expected range. It exists in the industrial environment in the form RF (radio frequency) noise or a short duration transient voltage spike. Noise can be carried by or modified by AC or DC voltages. Thus any wire to a microprocessor-based instrument can potentially carry noise. The immunity to noise is controlled by the environment a unit operates in, and the amount of noise suppression that is done. It should be remembered that no matter how many noise suppression components are added; an instrument can not overcome noise unless its environment (i.e. location, wiring and power) meets some minimum installation guidelines.

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9.2 INSTALLATION

A. Several considerations should be made before installing and wiring a microprocessor-based instrument. First, consider the microprocessor-based unit; it is for all intents and purposes a small specified computer. Ideally these units should be installed like computers, in a clean control room, free of dust, heat and noise. In an industrial environment the best that can be hoped for is a location isolated from sources of noise.

B. Listed below are some of the common sources of severe noise:
- Ignition transformers
- Arc welders
- Mechanical contact relays
- Solenoids
- Motors

C. Before using microprocessor-based instruments with devices listed in 9.2-B, the following guidelines should be followed:

1) If the instrument is to be mounted in the same panel as any of the devices listed in 9.2-B, separate them by the largest distance possible. Ideally the microprocessor-based instrument should be mounted in a separate panel.

2) Wherever possible, eliminate mechanical contact relays and replace them with solid state relays. If the mechanical relay being powered by the instrument cannot be replaced, try using a Solid State relay to isolate the instrument from this source of noise.

3) A separate isolation transformer which feeds only instrumentation might be considered. If available, it isolates many noise problems, but may be cost prohibitive for less than eight to ten instruments in the same panel.

4) If the microprocessor-based instrument is a retrofit to replace existing non-microprocessor-based equipment, a complete review of the existing wiring should be done, and changes made, in accordance with the guidelines in Section 9.3.

9.3 WIRING

A. AC Power

1) Earth Ground
Earth ground must be attached to the unit's chassis. To verify that it is earth ground make an ohm check from unit chassis to the nearest metal water pipe or proven Earth Ground. This reading should not exceed 1000 ohms. The chassis will be used to tie all suppression components to ground. This makes it essential that it be noise free.

2) Neutral
Next, it is necessary to assure that neutral is at, or near, ground potential. To check this, a voltmeter check between neutral and ground should be done. On the AC range it should not be more than 50 millivolts. If it is greater than this amount, the secondary of the AC transformer supplying the instrument should be checked by an electrician.

B. Isolation of Wires

1) All wires coming into or out of the microprocessor-based instrument can be classified into three different categories:
- Analog (i.e., 4-20 mA, T/C, RTD, V or mVDC).
- Relay or SSR outputs.
- AC

Each of these must be isolated from each other and from any wires coming from devices listed in 9.2-B. If they need to be run parallel with any of the other lines, then maintain a minimum 6 inch space between the wires. Remember that the only wires that can be run together in a bundle are those of the same category. If the wires must cross each other, do so at 90°. This minimizes the contact with other wires and reduces cross talk. Cross talk is the EMF (Electro Magnetic Flux) emitted by a wire as current passes through it. This EMF can be picked up by other wires running in the same bundle.

2) Shielded Cabling

a) Shielded cable is single or multipairs of insulated wires with each pair wrapped with an un-insulated wire (the shield), wrapped with foil, and all inside a cover of plastic insulation.

b) It is recommended that all Analog signals be run with shielded cable. Terminal lead length should be as short as possible, thus keeping them protected by the shielding. The shielding should be grounded at one end only. The preferred grounding location is the microprocessor-based unit since its chassis should be at ground potential. The shielding helps eliminate RF and EMF noise the wires may be exposed to.

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9.4 DETERMINING THE SOURCE OF NOISE

A. If the microprocessor-based instrument continues to be affected by noise it is necessary to determine the source of the electrical noise before it can be suppressed.

1) If the occurrence is intermittent, try to determine if it occurs at a certain time or event. More than likely it is noise on the AC power line. Refer to section 9.5-A-1 regarding noise suppression on the AC line.

2) If the noise is constant, the source may be determined by isolation of the instrument from all its wiring except AC. If the AC is the source of continuous noise, it will be necessary to find a clean source, or use an isolation transformer to remove the noise. Then, reinstall wires one at a time until the noise condition occurs again. This will help isolate the source of the noise. With the source(s) isolated, proceed to Section 9.5 for specific noise suppression.

3) Where available, an oscilloscope should be used to determine the source of the noise. It can determine if more than one source of noise is at fault and whether the noise suppression component is eliminating the problem.

9.5 NOISE SUPPRESSION

A. In conjunction with the above sections, on installation and wiring practices, additional suppression can be installed to lessen or eliminate the effect of noise upon microprocessor-based instrumentation.

1) MOV's (Metal Oxide Varistors) are very useful in removing high voltage transient noise from AC lines. It is recommended that two MOV's be installed on AC power to the instrument. One from hot to ground and the other from neutral to ground.

2) The filtering of Analog input or output lines can be done with 0.01 μf capacitors between each of the two leads and ground.

3) For microprocessed-based process instrumentation installed with any of the noise generating devices listed in Section 9.2-B, it is recommended that the optional noise immunity enhancement be bought. This package provides additional noise suppression on all input and output lines.

B. Noise suppression can be installed at the final control device to eliminate more noise. Listed below are the components and the form of suppression needed.

1) Relay contacts—if the AC power feeding the microprocessor-based unit also feeds power through external relay contacts, using a resistor (47 ohms) and a (0.1 μf) capacitor across the external contacts will help eliminate spikes as the contacts open and close.

C. If the output of a microprocessor-based unit is controlling any of the following devices, the form of suppression noted with each will help prevent noise feeding back to the instrument.

1) DC RELAY COIL - Use a 1N914 (or equivalent) diode, mounted across coil with cathode to + DC side. This will shunt negative going spikes and prevent chattering of DC relays.

2) AC RELAY COIL - A MOV can be used across the coil to suppress spikes and relay chatter. Also a resistor-capacitor network like the one used in Section 9.5-B-1) can be used here if the noise is low frequency and low voltage.

3) SOLENOIDS - Use 0.1 μf capacitors tied across device or to ground will help solve problems with these devices.

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SECTION 10 SPECIFICATIONS

INPUTS	RANGES
J T/C	0 to 760°C 0 to 1400°F
K T/C	0 to 1370°C 0 to 2500°F
T T/C	−200 to 400°C −330 to 750°F
R T/C	200 to 1650°C 400 to 3000°F
S T/C	200 to 1650°C 400 to 3000°F
E T/C	0 to 750°C 0 to 1400°F
RTD 100 ohm (.00385 ohms/ohm/C)	−140 to 400°C −220 to 750°F
Volts 0—5 VDC ** 1—5 VDC **	Scaleable
Millivolts 0—50 mV ** 10—50 mV **	Scaleable
Milliamps * 4-20 mA **	Scaleable

* 4-20 mA input is accommodated via the 10—50 mV or 1 to 5 V inputs with the addition of an appropriate external shunt resistor across the input terminals.

** Display scaling provides a displayed process value of −9999 to 9999 with zero to three decimal places.

CONTROL OUTPUTS 1 AND 2

SPST ELECTROMECHANICAL RELAY: 5 A resistive, 3 A inductive at 115 VAC, 2.5 A resistive at 230 VAC.

OPEN COLLECTOR OUTPUT SOLID STATE RELAY DRIVER: Short circuit protected at 100 mA maximum. Provides 4 VDC at 20 mA or 3 VDC at 40 mA.

4-20 MILLIAMP CONTROL OUTPUT: Capable of driving a 0—650 ohms grounded or ungrounded load.

ALARM OUTPUT

SPST ELECTROMECHANICAL RELAY: 5 A resistive, 3 A inductive at 115 VAC, 2.5 A resistive at 230 VAC.

OPEN COLLECTOR OUTPUT SOLID STATE RELAY DRIVER: Short circuit protected at 100 mA maximum. Provides 4 VDC at 20 mA or 3 VDC at 40 mA.

DISPLAY: Four .56" high-efficiency LED 7 segment displays. Individual LED status indicators for Setpoint, Out 1, Out 2, Man, Alarm, C, F, and U. Display programmable for process only, process/setpoint alternately, deviation, deviation/setpoint alternately or setpoint.

KEYPAD: Four key, tactile feedback membrane keypad for accessing all programming, tuning, setpoint and auto/manual parameters.

CONTROL ADJUSTMENTS

ON-OFF HYSTERESIS: 0 to 300 Units

PROPORTIONAL BANDWIDTHS: 1 to 3000 units

MANUAL RESET: −1500 to 1500 units

AUTO RESET (INTEGRAL): 0.0 to 100. Rpt/Min.

RATE DERIVATIVE: 0.0 to 10.0 Min

CYCLE TIME: 1 to 240 Sec.

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SPECIFICATIONS (Cont'd)

SPREAD (SECOND OUTPUT FROM FIRST OUTPUT):	−1000 to 1000 units
OUTPUT 1 POSITIONING:	−1000 to 1000 units

ALARM

PROCESS ALARM:	Limits of span selected
DEVIATION ALARM:	−3000 to 3000 units
DEVIATION BAND ALARM:	1 to 3000 units
INPUT CORRECTION:	−100 to 100 units

NOTE

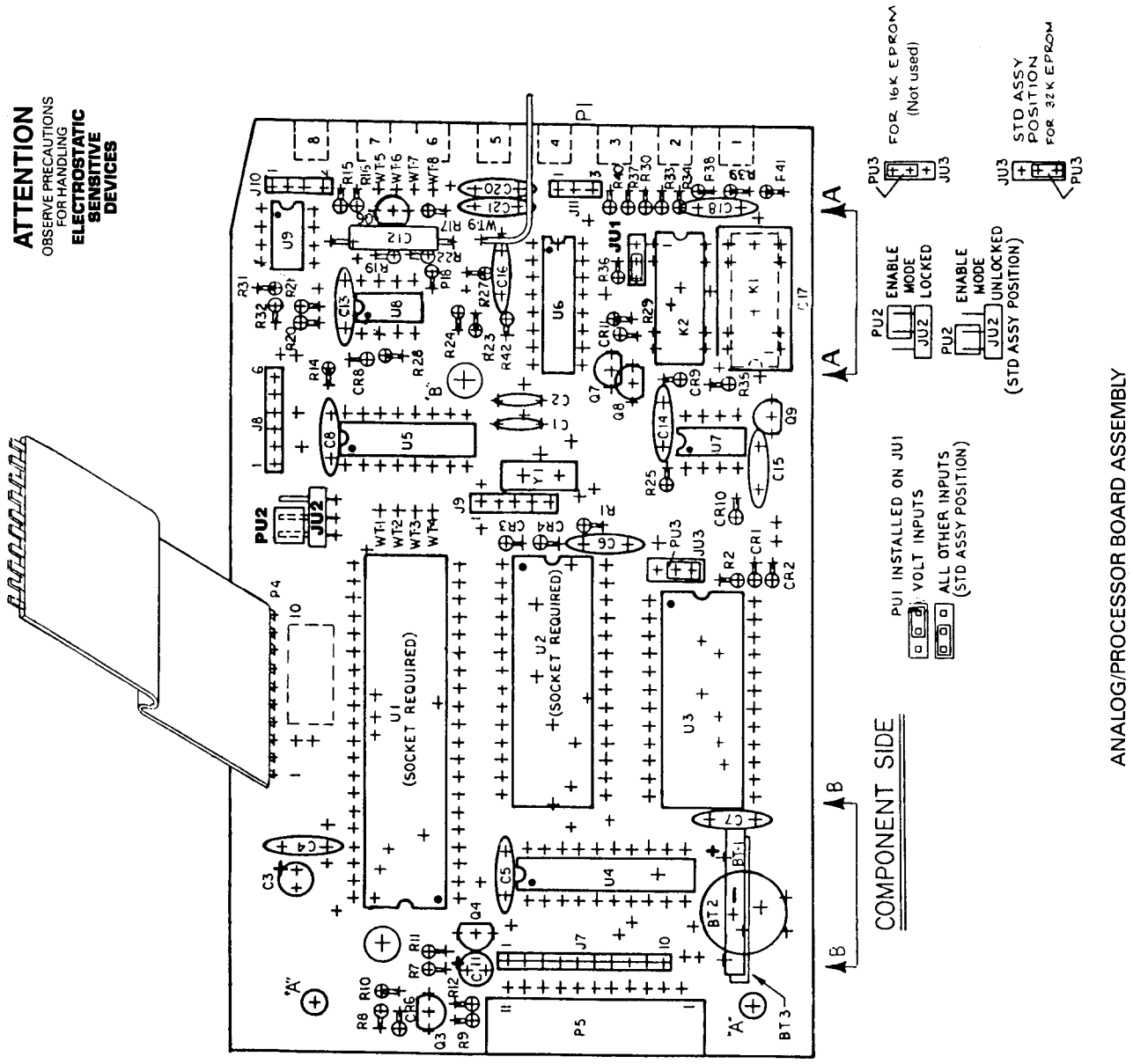
Units are defined as degrees C, degrees F or Engineering Units depending on the input range and type selected.

AUTO/MANUAL:	0 to 100% bumpless transfer with selectable auto transfer.

PERFORMANCE

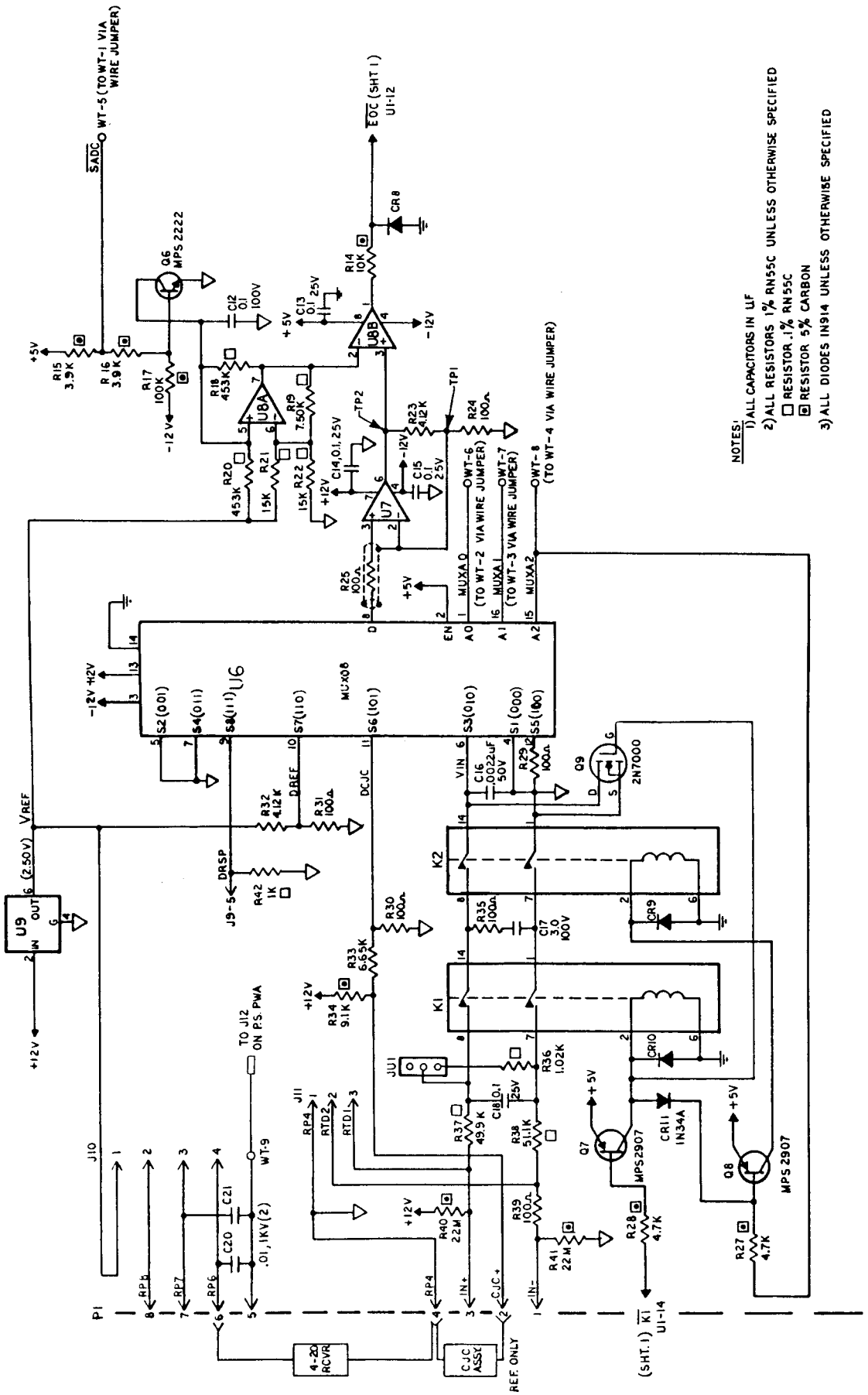
ACCURACY:	Thermocouple & RTD: ±0.25% of reading plus 1 whole digit over advertised span at 25°C Volt & Millivolt: ±0.25% of scaled span plus 1 Least Significant digit at 25°C.
AMBIENT TEMPERATURE ERROR:	0.01% of span per °C deviation from 25°C
RESOLUTION:	1 degree/unit
CALIBRATION DRIFT:	Self compensation for ambient temperature. All calibration values are stored in memory.
NOISE REJECTION:	Normal mode, 85 dB minimum at 60 Hz or greater. Common mode, 90 dB minimum ±8 VDC maximum peak for RTD input, 115 VAC maximum for other inputs.
LINE VOLTAGE:	115 ±10% 50/60 Hz 230 ±10% 50/60 Hz
POWER CONSUMPTION:	15 VA maximum
AMBIENT TEMPERATURE:	0 to 55°C
STORAGE TEMPERATURE:	−40 to 65°C
HUMIDITY:	0 to 90% RH
DIMENSIONS:	¼ DIN front panel (96 mm x 96 mm) and panel opening
DEPTH:	5.8 inches maximum
WEIGHT:	3 pounds maximum
VIBRATION:	0.5 to 100 Hz at 0.5 g

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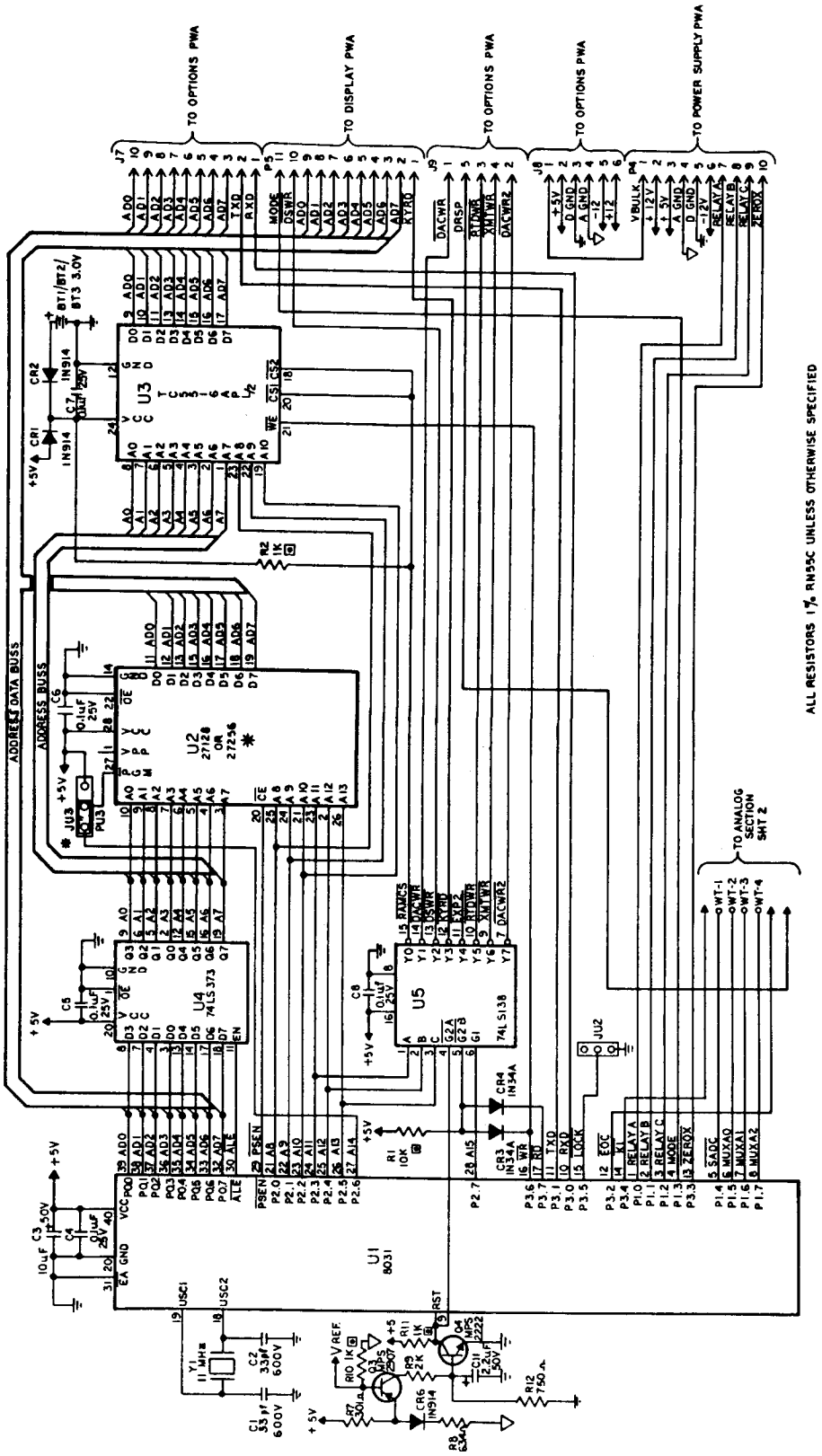


ANALOG/PROCESSOR BOARD ASSEMBLY

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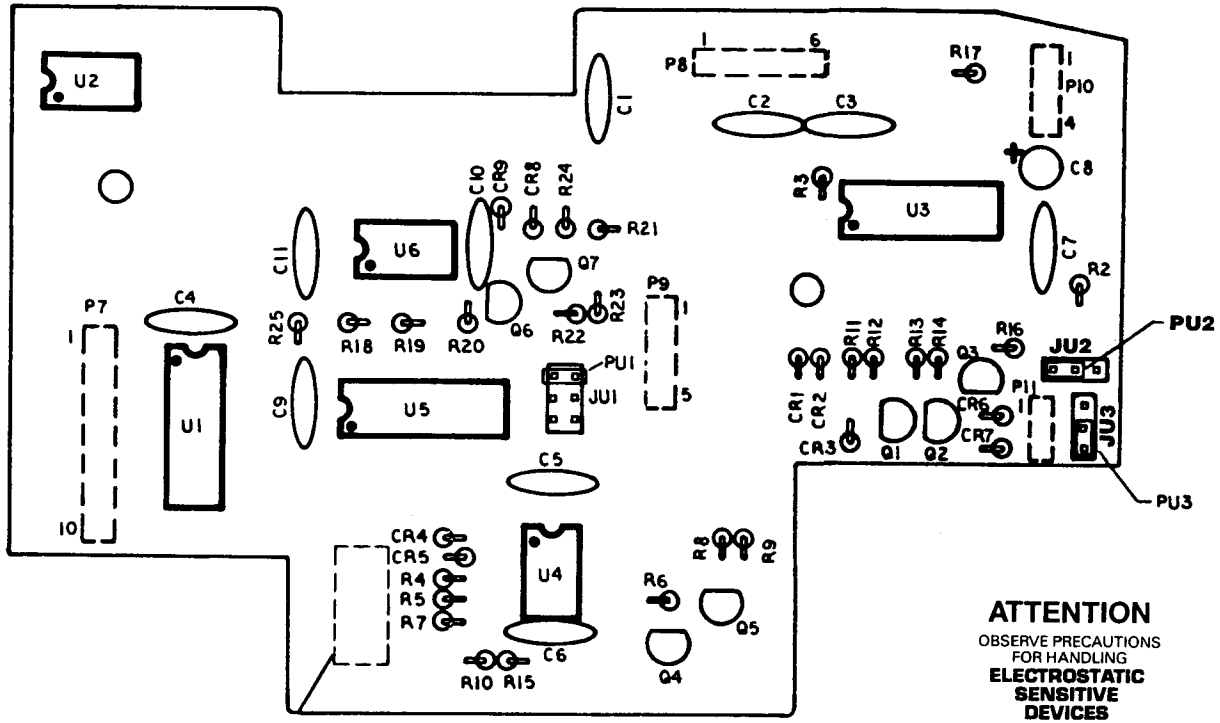


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ANALOG/PROCESSOR BOARD SCHEMATIC

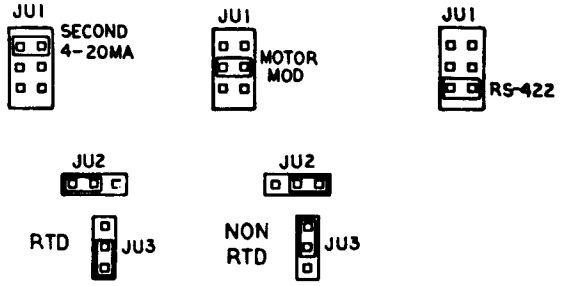
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ATTENTION

OBSERVE PRECAUTIONS FOR HANDLING **ELECTROSTATIC SENSITIVE DEVICES**

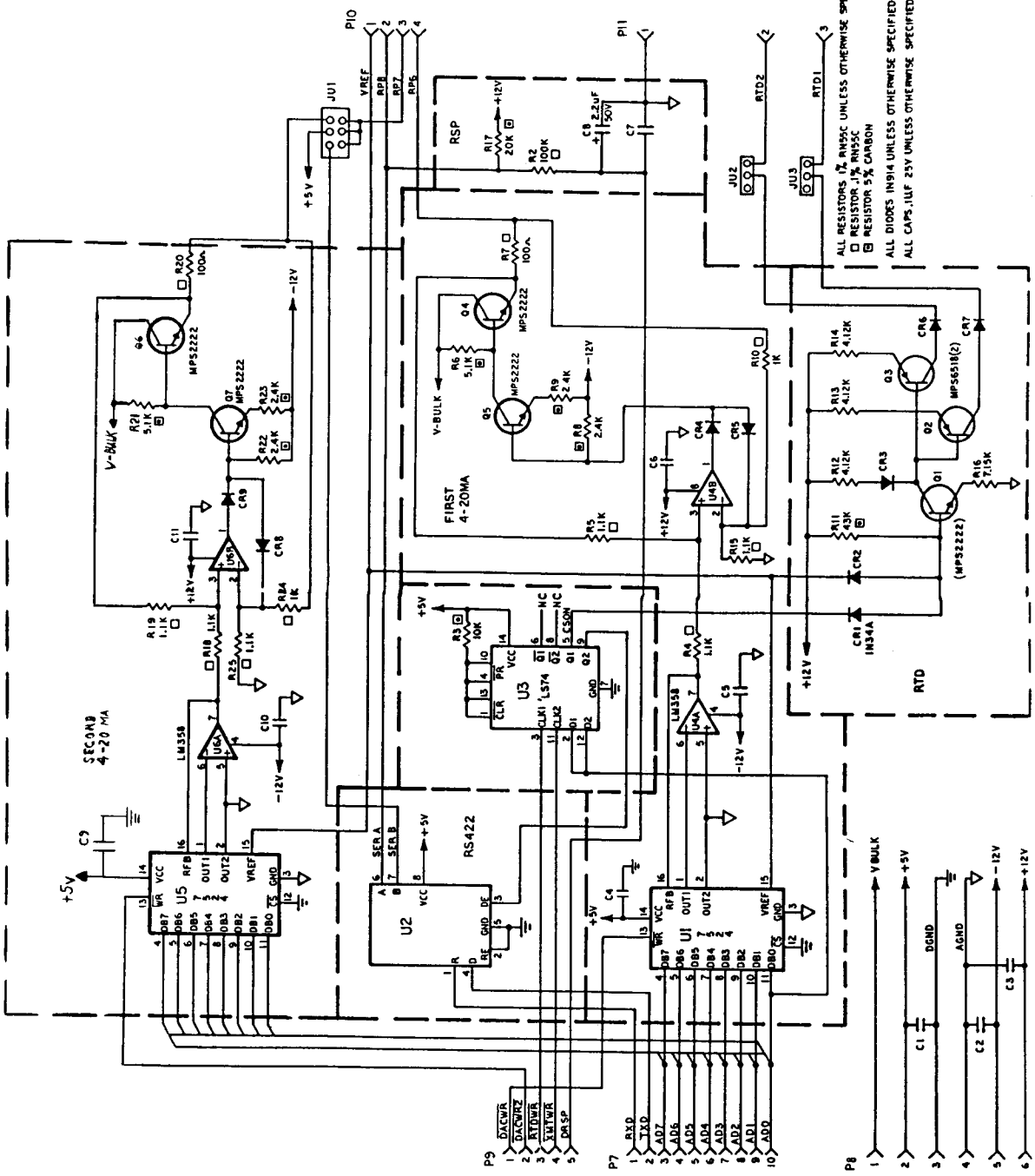
COMPONENT SIDE



JUMPERS PU2 & PU3 CAN BE INSTALLED IN THE RTD POSITION FOR NON-RTD INPUTS, BUT THIS ELIMINATES THE HIGH COMMON MODE VOLTAGE CAPABILITY ON THE INPUT.

OPTIONS BOARD ASSEMBLY

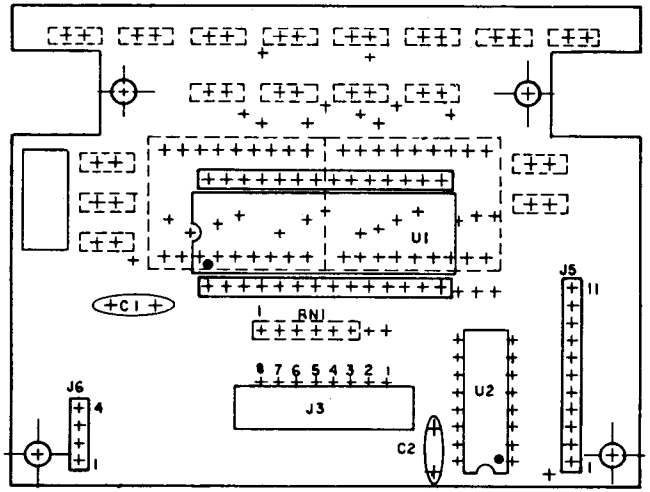
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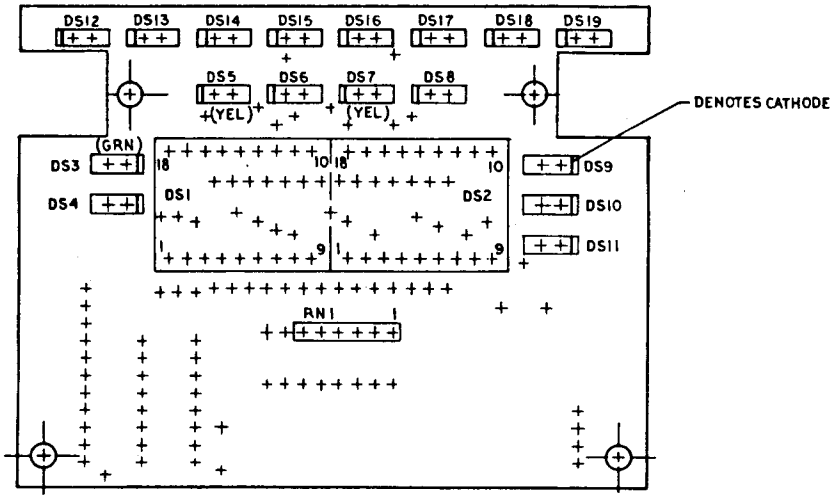
OPTIONS BOARD SCHEMATIC

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COMPONENT SIDE
(BACK VIEW)

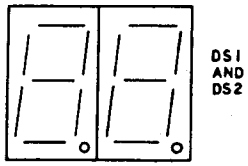


SOLDER SIDE
(FRONT VIEW)

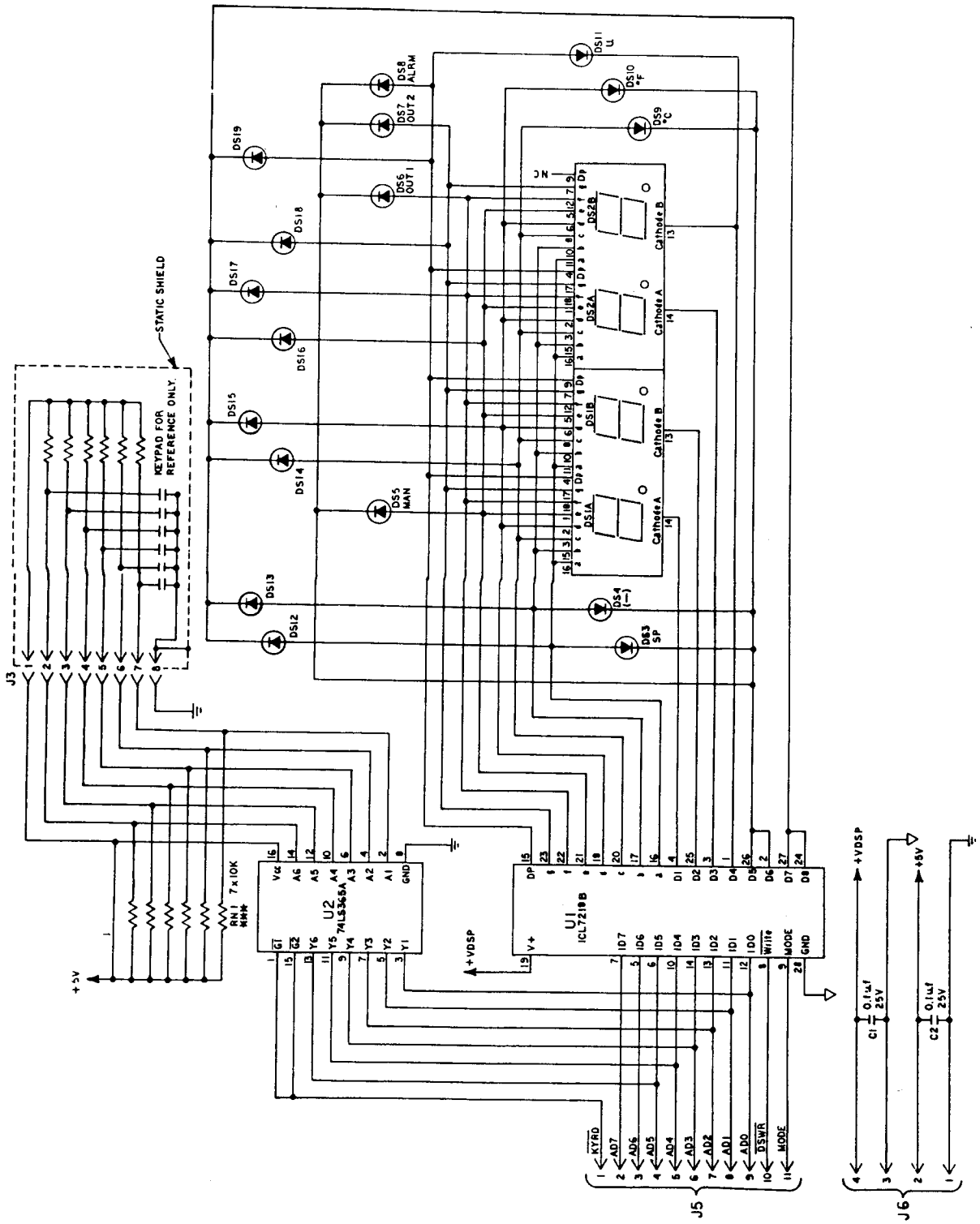
ATTENTION

OBSERVE PRECAUTIONS
FOR HANDLING
ELECTROSTATIC SENSITIVE DEVICES

DETAIL 'B'

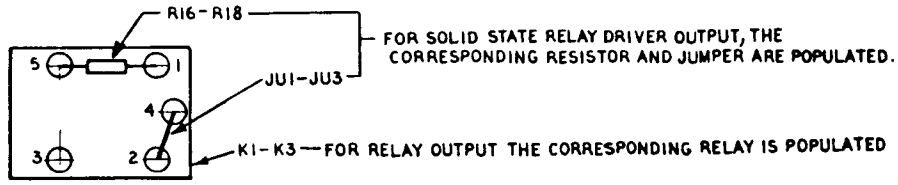


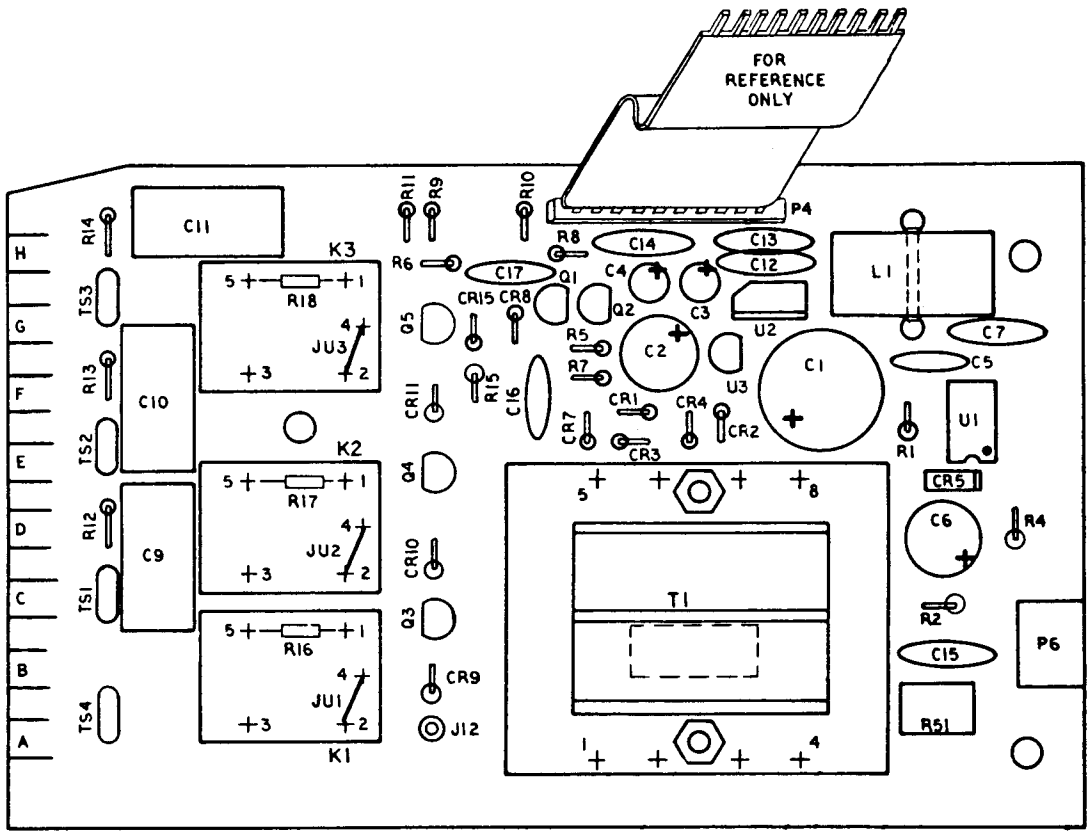
DISPLAY BOARD ASSEMBLY



DISPLAY BOARD SCHEMATIC

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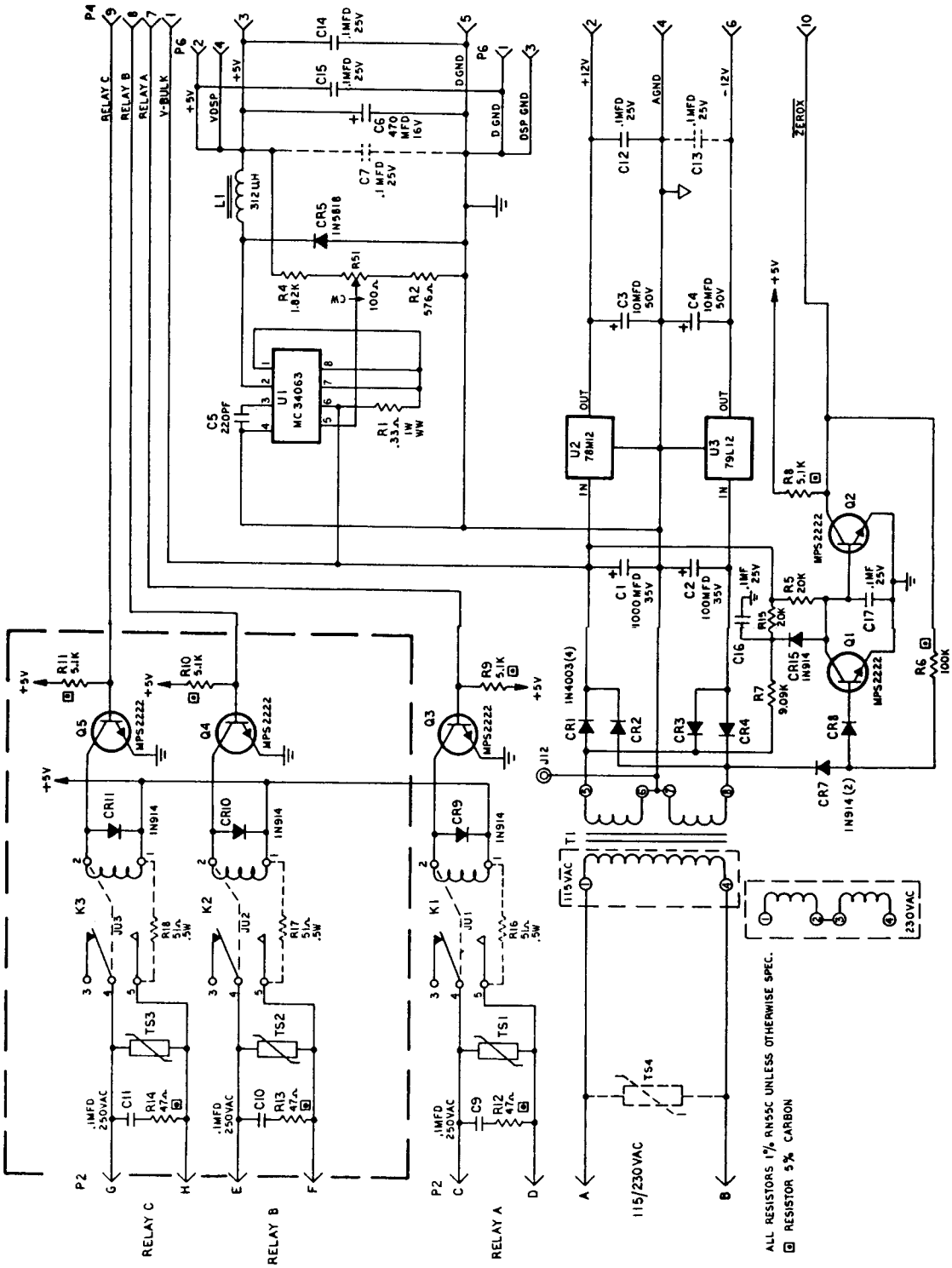


COMPONENT SIDE

ATTENTION
OBSERVE PRECAUTIONS FOR HANDLING **ELECTROSTATIC SENSITIVE DEVICES**

POWER SUPPLY BOARD ASSEMBLY

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POWER SUPPLY BOARD SCHEMATIC

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SECTION 12 RELAY OUTPUT SNUBBER NETWORK

If the unit is used with a high impedance AC device, the snubber network used to protect the relay contacts may cause the output to be activated with the relay off. This problem can occur if the mechanical relay in the controller is wired to an external Solid State Relay.

To cure the problem, cut the snubber resistor for the output that is being affected.

RESISTOR	RELAY
R12	Relay A
R13	Relay B
R14	Relay C

An alternative method to correct this problem would be to add a load across the input to the external solid state relay. A 2kΩ (2000 ohm) 8 watt power resistor could be used. Refer to Figure 12-1.

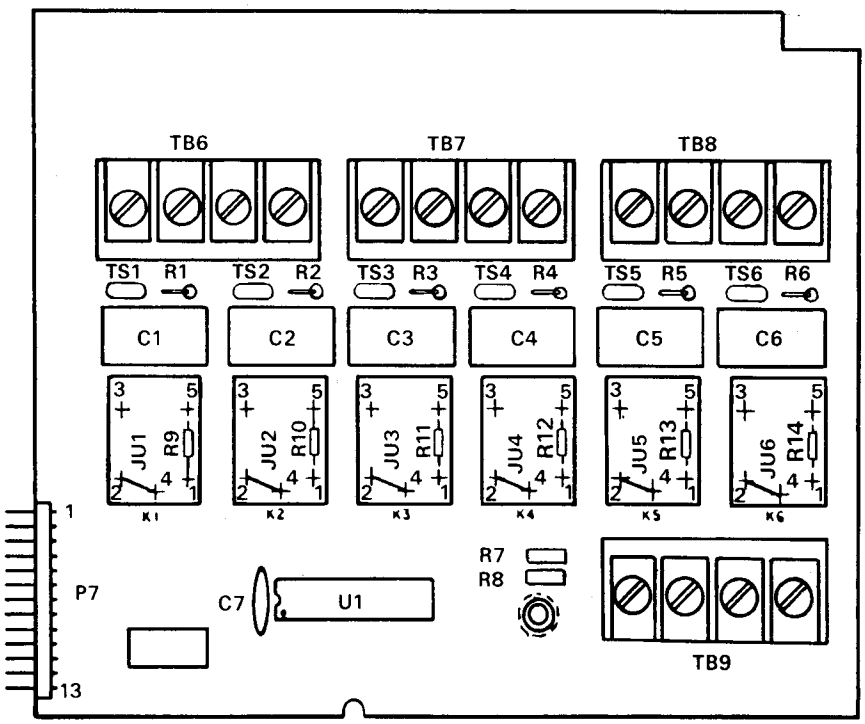


Figure 12-1. Resistor Locations

SECTION 13 GLOSSARY

AUTOMATIC RESET (INTEGRAL)

This parameter is adjustable from 0.0 to 100.0 repeats per minute and is designed to compensate for process variable deviations from setpoint that occur when proportional only control is used. Instructions for determining the automatic reset settings are given in Section 4.3.3. Factory default is 0.0. Display Code is **"ArSt"**.

AUTOMATIC TRANSFER

This feature, if configured, allows manual control of the process until setpoint is reached, at which point the controller automatically transfers from manual to automatic control. Factory default is 0 = no auto transfer. Display code is **"AtFr"**.

BUMPLESS TRANSFER

This feature prevents step changes in proportional outputs when changing between automatic and manual control.

DISPLAY FILTER FACTOR

This parameter is adjustable from 1 to 20 which represents the number of scans of the process variable that are averaged together before updating the displayed and recorded value. The factory default value is 1 = no filtering. Display code is **"dFF"**.

FIRST OUTPUT POSITION

The parameter is adjustable from −1000 to 1000 units and represents a shift or offset of the on-off actuation points or proportional band for the first output relative to the normal position. For example, a negative value could be used to offset an expected overshoot. First Output Position also shifts the proportional band with respect to the process value range outside of which integral action is inhibited. Factory default is 0. Display code is **"FoP"**. Refer to Figures 13-1 through 13-8.

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GLOSSARY (Cont'd)

HYSTERESIS

This parameter is adjustable from 0 to 300 units (°C, °F, or engineering units) representing the width of the band (half above and half below setpoint). Used with ON/OFF outputs to reduce cycling. For instance, with a value of 4 and a setpoint of 70, the output will turn ON when the process variable drops to 68 and stay ON until 72 is reached, then turn OFF the output. Factory default = 3. Display code is **"HySt"** for control and alarm outputs. Refer to Figures 13-5 and 13-6.

INPUT CORRECTION

This parameter is adjustable from −300 to 300 units (°C, °F, or engineering units) and is used as a method to compensate for a linear sensor error. Factory default is 0 = no correction. Display code is **"iCor"**.

MANUAL RESET (INTEGRAL)

This parameter is adjustable from −1500 to 1500 units (°C, °F, or engineering units) representing a manual shift of on-off actuation points or proportional band of one or both outputs relative to the normal position. Manual reset is intended to be used when automatic reset is not used to allow compensation for deviations from setpoint which remain after the process has stabilized. Factory default is 0. Increasing the value increases the process variable, i.e. if the process variable stabilizes too low, increase the manual reset. Integral action, and conversely reset-windup inhibit apply over the same process value range regardless of the manual reset value. Display code is **"rSEt"**.

PROCESS FILTER FACTOR

This parameter is adjustable from 1 to 20 which represents the number of scans of the process variable that are averaged together before updating the process value used for control purposes. The factory default value is 1 = no filtering. Display code is **"PFF"**.

PROCESS OUTPUT UPPER AND LOWER VALUES (USED IN CONJUNCTION WITH PROCESS OUTPUT)

These parameters specify the process value range over which the assigned current output will decrease linearly from 100% to 0%. If the process value is greater than **"Pou"**, the output will be 100%. If the process value is less than **"PoL"**, the output will be 0%. Factory default values are 2000 for the upper value and 0 for the lower value. Display codes are **"Pou"** (upper) and **"PoL"** (lower).

PROPORTIONAL BAND

This parameter is adjustable from 1 to 3000 units (°C, °F, or engineering units) (**not** Percent of Span) and represents the process value range where the proportional output is at a percentage of the full output. Instructions for determining Pb are given in Section 4.3.3. Factory default is 100 units. Display code is **"Pb1"** for output 1 and **"Pb2"** for output 2.

RATE (DERIVATIVE)

This parameter is adjustable from 0.0 to 10.0 minutes and specifies how the control action responds to the rate of change in the process variable. Instructions for determining rate are given in Section 4.3.3. Factory default is 0.0. Display code is **"rAtE"**.

SPREAD (SECOND OUTPUT POSITION)

This parameter is adjustable from −1000 to 1000 units (°C, °F, or engineering units) and represents a shift or offset of the on-off actuation points or proportional band for the second output relative to the normal position. A positive value creates a gap where no control outputs are on, a negative value creates an overlap of control outputs (if the first output position is at the normal position). Spread (Second Output Position) also shifts the proportional band with respect to the process value range outside of which integral action is highlighted (reset-windup inhibit). Factory default is 0. Display code is **"Sprd"**. Refer to Figures 13-6 and 13-8.

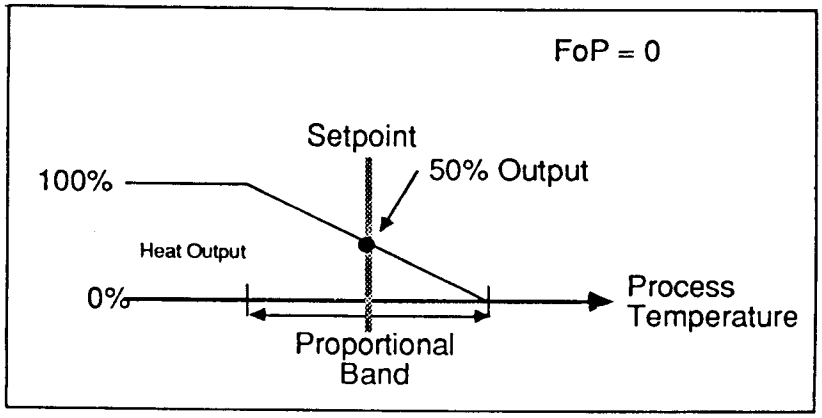


Figure 13-1. Single PID Output Normal Position

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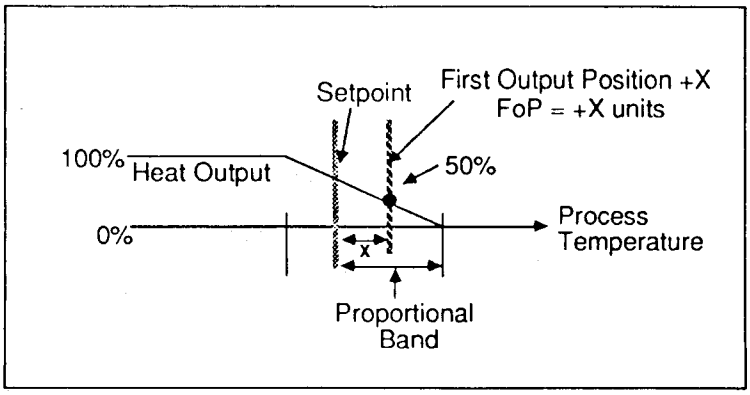


Figure 13-2. Single PID Output with First Output Position

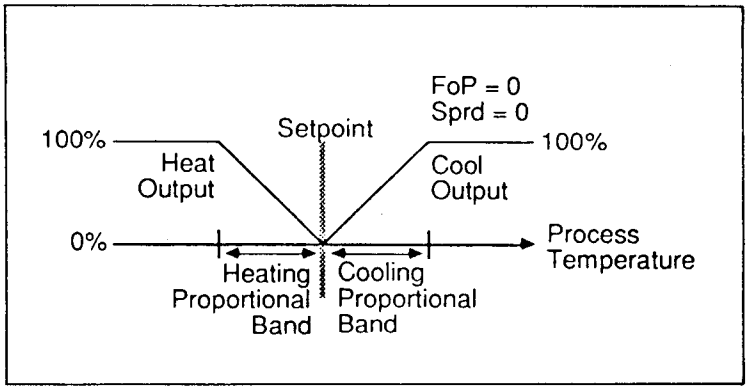


Figure 13-3. Dual PID Output Normal Position

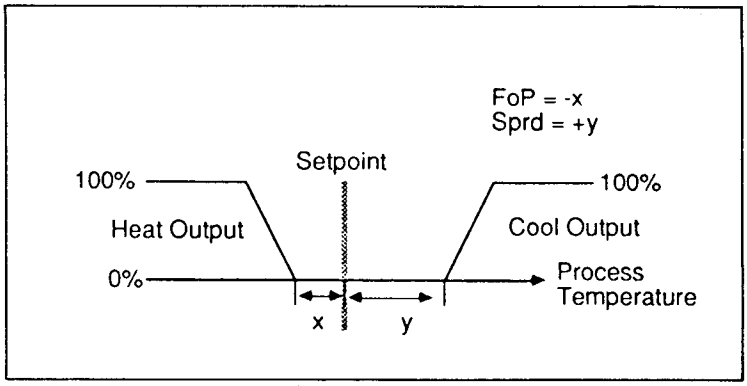


Figure 13-4. Dual PID Output with First Output Position and Spread

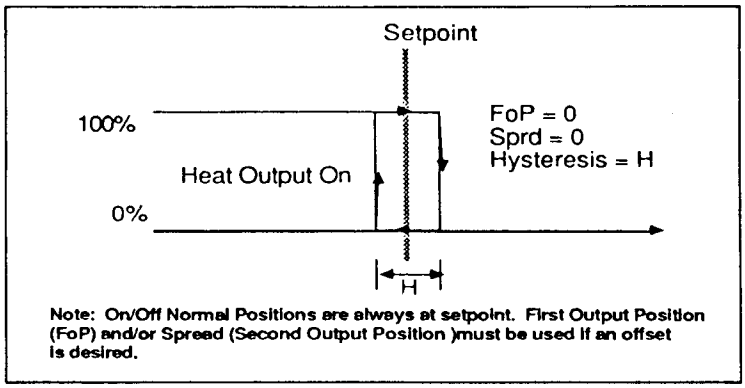


Figure 13-5. On/Off Control Normal Position

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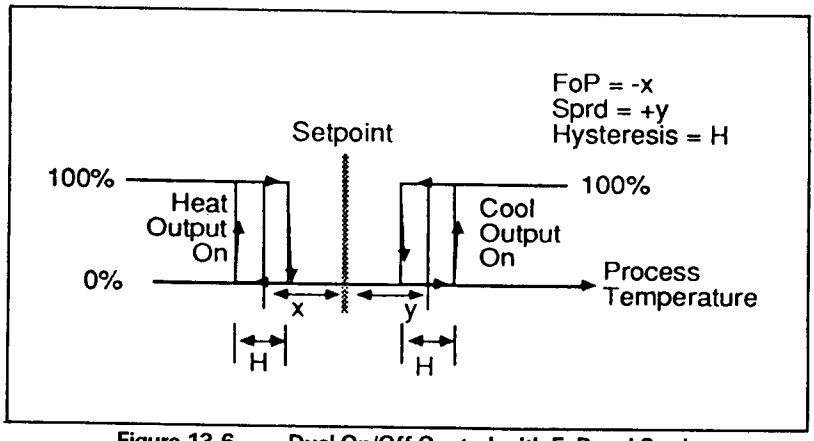


Figure 13-6. Dual On/Off Control with FoP and Sprd

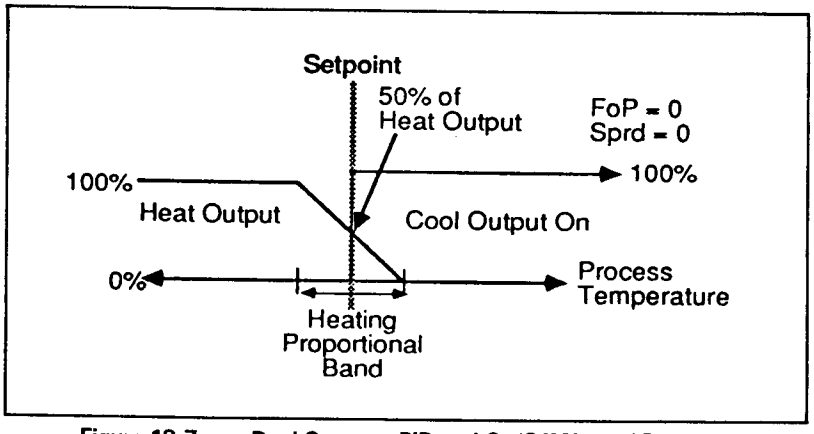


Figure 13-7. Dual Output—PID and On/Off Normal Position

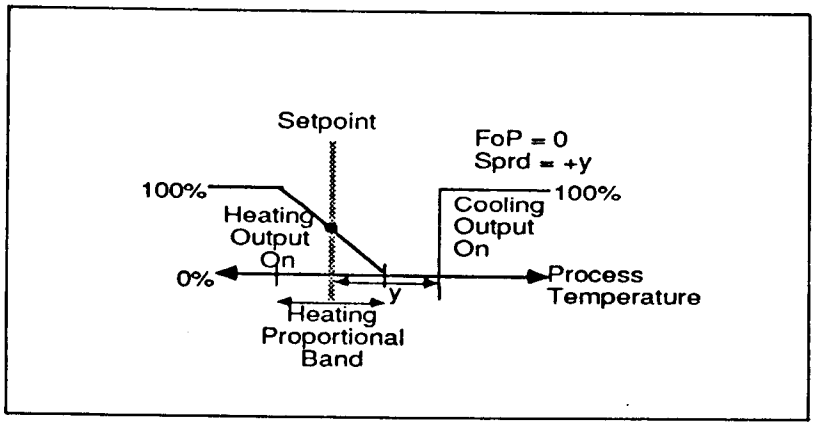


Figure 13-8. Dual Output—PID and On/Off with Spread (Second Output Position)

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- ☐ Transducers & Strain Gauges
- ☐ Load Cells & Pressure Gauges
- ☐ Instrumentation

FLOW

- ☐ Rotameters & Flowmeter Systems
- ☐ Air Velocity Indicators
- ☐ Turbine/Paddlewheel Systems
- ☐ Vortex Meters and Flow Computers

pH

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- ☐ Benchtop/Laboratory Meters
- ☐ Controllers, Calibrators & Simulators

DATA ACQUISITION

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- ☐ Communications-Based Acquisition Systems
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- ☐ Recorders, Printers & Plotters

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- ☐ Strip Heaters
- ☐ Cartridge Heaters
- ☐ Immersion Heaters
- ☐ Tubular & Band Heaters

OMEGA ENGINEERING, INC.

An OMEGA Technologies Company

One Omega Drive, Box 4047
Stamford, CT 06907-0047
(203) 359-1660 Telex: 996404 Cable: OMEGA FAX: (203) 359-7700

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WARRANTY

OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of 13 months from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal one (1) year product warranty to cover handling and shipping time. This ensures that our customers receive maximum coverage on each product. If the unit should malfunction, it must be returned to the factory for evaluation. Our Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. However, this WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear or which are damaged by misuse are not warranted. These include contact points, fuses, and triacs.

THESE UNITS ARE INHERENTLY DANGEROUS AND ARE INTENDED TO BE INSTALLED AND USED ONLY BY QUALIFIED PERSONNEL. NO WARRANTY EXTENDED HEREIN WILL APPLY IF SUCH UNIT IS INSTALLED OR USED BY UNQUALIFIED PERSONNEL. THERE ARE NO WARRANTIES EXCEPT AS STATED HEREIN. THERE ARE NO OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR A PARTICULAR PURPOSE. OMEGA ENGINEERING, INC. IS NOT RESPONSIBLE FOR ANY DAMAGES OR LOSSES CAUSED TO OTHER EQUIPMENT, WHETHER DIRECT, INDIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL, WHICH THE PURCHASER MAY EXPERIENCE AS A RESULT OF THE INSTALLATION OR USE OF THE PRODUCT. THE BUYER'S SOLE REMEDY FOR ANY BREACH OF THIS AGREEMENT BY OMEGA ENGINEERING, INC. OR ANY BREACH OF ANY WARRANTY BY OMEGA ENGINEERING, INC. SHALL NOT EXCEED THE PURCHASE PRICE PAID BY THE PURCHASER TO OMEGA ENGINEERING, INC. FOR THE UNIT OR UNITS OR EQUIPMENT DIRECTLY AFFECTED BY SUCH BREACH.

EVERY PRECAUTION FOR ACCURACY HAS BEEN TAKEN IN THE PREPARATION OF THIS MANUAL, HOWEVER, OMEGA ENGINEERING, INC. NEITHER ASSUMES RESPONSIBILITY FOR ANY OMISSIONS OR ERRORS THAT MAY APPEAR NOR ASSUMES LIABILITY FOR ANY DAMAGES THAT RESULT FROM THE USE OF THE PRODUCTS IN ACCORDANCE WITH THE INFORMATION CONTAINED IN THE MANUAL.

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An OMEGA Technologies Company
One Omega Drive, Box 4047
Stamford, Connecticut 06907-0047

Call OMEGA Toll Free*

Sales: 1-800-82-66342 / 1-800-TC-OMEGA

Customer Service: 1-800-622-2378 / 1-800-622-BEST

Engineering Assistance: 1-800-872-9436 / 1-800-USA-WHEN

*In CT: (203) 359-1660 CABLE: OMEGA EASYLINK: 62968934
And International TELEX: 996404 FAX: (203) 359-7700

Return Requests/Inquiries

Direct all warranty and repair requests/inquiries to OMEGA Customer Service Department, telephone number (203) 359-1660. BEFORE RETURNING ANY INSTRUMENT, PLEASE CONTACT THE OMEGA CUSTOMER SERVICE DEPARTMENT TO OBTAIN AN AUTHORIZED RETURN (AR) NUMBER. The designated AR number should then be marked on the outside of the return package.

To avoid processing delays, also please be sure to include:

1. **Returnee's name, address, and phone number.**
2. **Model and Serial numbers.**
3. **Repair instructions.**

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. That way our customers get the latest in technology and engineering.

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