M958 4/91

# MODEL CN1200 SERIES CONTROLLER

## CN1201, CN1204, CN1211

# Operator's Manual

OMEGA ENGINEERING, INC.
An OMEGA Technologies Company

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# UDC 2000

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# OVERVIEW

# SECTION 1

The OMEGA CN1200 monitors and controls temperatures and other variables in applications such as environmental chambers, plastic processing machines, furnaces and ovens, and packaging machinery.

The CN1200 can be used to control variables such as temperature, pressure, flow, level, and rotation.

The controller has a dedicated configuration display which provides plain English prompts providing unmatched operating simplicity. Programmed sequences of displays assure quick and accurate entry of all configurable parameters. Simple keystrokes let you change the operating parameters to meet your process control needs.

## Features/Benefits

***Easy to Configure*** -- A bright dedicated configuration display provides straightforward English prompts that allow easy set-up with minimum time and effort.

***Universal Inputs*** -- Accepts 10 thermocouple types, RTDs, Radiamatic, MA, MV or voltage inputs through simple configuration.

***Thermocouple Failsafe*** -- Configurable upscale or downscale burnout and failsafe output level.

***High Noise Immunity*** -- The CN1200 is designed to provide reliable performance in industrial environments that often affect highly noise-sensitive digital equipment.

***Dual Setpoints*** -- Simple pushbutton selection allows quick switchover from primary to alternate set point with minimal operator confusion.

***Decimal Point Location*** -- Configurable for none, one, or two places.

***Diagnostic/Failsafe Outputs*** -- Continuous diagnostic routines detect failure modes, trigger a failsafe output value and identify the failure to minimize troubleshooting time.

***Highly Secure*** -- Non-volatile memory assures data integrity during loss of power. Keyboard security inhibits accidental or unauthorized changes to the process.

***Default Display Configuration*** -- Can be configured to indicate Process Variable (PV) or Set Point (SP) being displayed instead of blank display during normal operation.

***Control Algorithms*** -- The controller can be configured for: On/Off, PID-A, PD + MR, or Three Position Step Control algorithm.

## Optional Features

***Remote Set Point*** -- 4 to 20 mA or 1 to 5 Volt input available for remote set point signal.

***Programmable Choice of Terminals*** -- To be used for: Process Variable (PV) Output or Remote Closure Contacts to select remote/local set point, local set point #1/#2, stop/run autotuning function. Process Variable output can be scaled from 0 to 5 Vdc or 1 to 5 Vdc for 0 to 100% for range desired.

***Alarm Selection*** -- None, one, or two SPST relays to activate external equipment when preset high/low set points are reached. There is an indicator for each alarm on the operator interface. For Duplex operation, only one alarm is available. There is a fixed alarm hysteresis of 0.5% of (PV) input span.

***Two Solid State Relay Output Kits*** -- Output rated at either 1 Amp at 120/240V or 10 Amps at 120/240V. Minimum load 0.1 Amp.

***Autotune*** -- When enabled, this feature will automatically calculate and enter into memory the optimum tuning parameters required for your process. A "Short Tune" feature lets you obtain approximate tuning constants.

***Set Point Ramp/Program*** -- Enables you to run a single set point ramp or program and store 6 ramp and 6 soak segments for set point programming. Run or Hold of program is keyboard or remote switch selectable.

## Inputs

***Field Selectable Inputs*** -- Include thermocouples (J, K, E, T, R, S, B, C, N), RTDs, milliamps (4 to 20), millivolts (0 to 10, 0 to 100), volts (0 to 1, 0 to 5, 0 to 10, 1 to 5).

## Outputs

The CN1200 is available with the output types listed below.

***Time Proportional*** -- provides On-Off or Time Proportional output. Relay output is standard, solid state output is provided with optional kit.

***Current Proportional*** -- supplies proportional current output for final control elements that require a 4-20 mA signal.

***Time Proportional Duplex*** (Heat/Cool) -- depending on which control algorithm you select, this duplex output type can provide on-off duplex, or time proportional duplex control.

The time proportional duplex output provides independent PID tuning constants and two time proportional outputs: one for heat zone above the 50% output display, and one for cool zone from 0% to 50% of the output display.

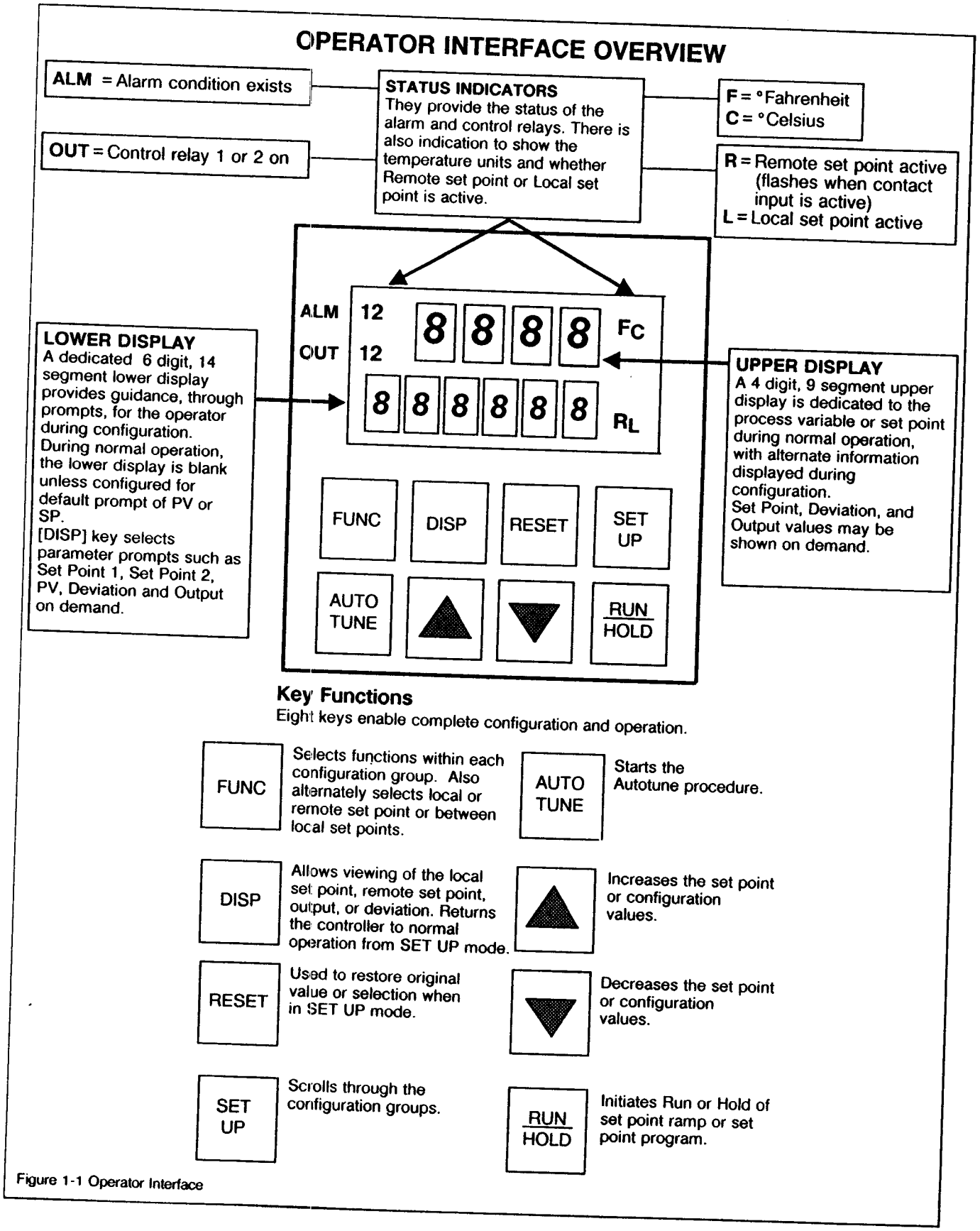



Figure 1-1 Operator Interface

# MODEL NUMBER INTERPRETATION

| *MODEL SELECTION* | | | *AVAILABILITY* | | | |
|---|---|---|---|---|---|---|
| **Output Type** | Current Proportional | CN1204 | ↓ | | | |
| | Time Proportional and On/Off | CN1201 | | ↓ | | |
| | Two Time Proportional Outputs/3 Position Step | CN1211 | | | ↓ | |
| | Hi Limit + | CN1208 | | | | ↓ |
| | Lo Limit + | CN1209 | | | | ↓ |
| **Alarms** | None | | ● | ● | | ● |
| (See Table 2-2) | 1 Alarm Relay | -A1 | | | ● | ● |
| | 2 Alarm Relays | -A2 | ● | ● | | |
| **Options** | Programmable PV Output or Input Contact Closure | -PR | ● | ● | ● | ● |
| | Remote Set Point Input | -RSP | ● | ● | ● | |
| | Autotune | -AT | ● | ● | ● | |
| | Ramp and Soak or Autotune | -RAMP | ● | ● | ● | |
| | 1 Amp S.S. Relay for #1 Output Terminal (Kit) | CN1201-T1 KIT | | ● | ● | ● |
| | 10 Amp S.S. Relay for #1 Output Terminal (Kit) | CN1201-T10 KIT | | ● | ● | ● |

**+ Available with temperature ranges only**

# CONDENSED SPECIFICATIONS

**Operating Conditions**

| | *Reference Conditions* | *Rated Conditions* | *Operative Limits* | *Transportation and Storage* |
|---|---|---|---|---|
| **Ambient Temperature** | 22 ±3°C<br>72 ±5°F | 15 to 55°C<br>58 to 131°F | 0 to 55°C<br>32 to 131°F | -40 to 66°C<br>-40 to 151°F |
| **Vibration** | | | | |
| Frequency (Hz) | 0 | 0 to 70 | 0 to 200 | 0 to 200 |
| Acceleration (g) | 0 | 0.1 | 0.5 | 0.5 |
| **Mechanical Shock** | | | | |
| Acceleration (g) | 0 | 1 | 5 | 20 |
| Duration (ms) | 0 | 30 | 30 | 30 |
| **Voltage (Vac) --** | 120 ±1 | 102 to 132 | 102 to 132 | -- |
| **Jumper Switchable 120/240** | 240 ±2 | 204 to 264 | 204 to 264 | -- |
| **Frequency (Hz)** | 50 ±0.2 | 49 to 51 | 48 to 52 | -- |
| | 60 ±0.2 | 59 to 61 | 58 to 62 | -- |

# CONDENSED SPECIFICATIONS (CONTINUED)

## Field Selectable Input Actuations

| PV Input | Range °F | Range °C |
|---|---|---|
| **Thermocouples** | | |
| B | 150 to 3300 | 66 to 1815 |
| E | -100 to 1832 | -73 to 1000 |
| E(Low Span) | -100 to 1100 | -73 to 593 |
| J | 0 to 1600 | -18 to 871 |
| J(Low Span) | 0 to 900 | -18 to 482 |
| K | 0 to 2400 | -18 to 1316 |
| K(Low Span) | -20 to 1000 | -29 to 538 |
| NiNiMoly (N)* | 32 to 2500 | 0 to 1371 |
| R | 0 to 3100 | -18 to 1704 |
| S | 0 to 3100 | -18 to 1704 |
| T | -300 to 700 | -184 to 371 |
| T (Low Span) | -80 to 500 | -63 to 260 |
| W5W26 | 0 to 4200 | - 18 to 2316 |
| NIC (Nicrosil Nisil) | 0 to 2372 | -17.8 to 1300 |
| **RTD (α = .00385)** | | |
| 100 Ohm Pt. | -300 to 900 | -184 to 482 |
| 100 Ohm Pt. (Low Span) | 0 to 300 | -18 to 149 |
| **Radiamatic (RH)** | 1400 to 3400 | 760 to 1871 |
| **Linear** | | |
| Milliamps | 4 to 20 | |
| Millivolts | 0 to 10 | |
| | 0 to 100 | |
| Volts | 0 to 1 | |
| | 0 to 5 | |
| | 0 to 10 | |
| | 1 to 5 | |

*NOTE: This thermocouple is not the same as Nicrosil-Nisil, sometimes referred to as Type N.

### Accuracy

±0.50% of span typical
(±1 digit for display)

### Tuning Parametrers

*Gain* or *PB* 0.1 to 1000
*Rate* 0.08 to 10.00 minutes
*Reset* 0.02 to 50.00 minutes per repeat or repeats per minute, chosen in setup

### Power Requirements

120/240 Volts, 50 or 60 Hz, jumper switchable

# INSTALLATION

# SECTION 2

## Inspect for Shipping Damage and Check for Accessories

If the CN1200 has not been removed from its shipping carton, inspect the carton for damage, and remove the controller. Inspect the CN1200 for any obvious shipping damage and report any damage due to transit to the carrier. Check that a bag containing mounting hardware is included in the carton with the controller.

## Model Number Identification

Make sure the model number shown on the nameplate on the outside of the case agrees with what you have ordered. The model number interpretation is on page 1-3.

## Preliminary Checks

Before you install the controller make the following preliminary checks. The procedure is shown on page 2-4.

### ALL MODELS

***CHECK OPERATING VOLTAGE SELECTION***

Check the Operating Voltage Jumper position. The CN1200 is shipped configured for use with 120 Vac. If you want to use 240 Vac, you will have to position the J1 connector on the main printed wiring board to the 240 Volt position, as shown in Figure 2-2.

***CAUTION: Operating a 120 Volt controller at 240 Volts will damage the unit.***

***CHECK THE INPUT TYPE SELECTION***

You must check an internal DIP switch to make sure the switches are set for the correct input type. The switches are located at position J8 on the main printed wiring board. Set the switches for the input desired. See Figure 2-2.

***CHECK THE RELAY OUTPUT JUMPER***

*Without Solid State Relay*

Make sure pin #1 on the jumper at J7 on the main printed wiring board is plugged into pin #1 on connector J7 as shown in Figure 2-2.

*With Solid State Relay*

Remove the relay output jumper on connector J7 and position the jumper supplied with the solid state relay kit as shown in Figure 2-2. Wire the relays as shown in Figure 2-5.

## Preliminary Checks (Continued)

### RELAY OR SSR OUTPUT MODELS

***CHECK CONTROL RELAY ACTION***

Position the jumper at J6 on the main printed wiring board for **(NO)** Normally Open or **(NC)** Normally Closed contacts on the ***CONTROL*** relay.
For Duplex/3 Position Step operation, also position jumper J4 on the option board for N.O. normally open or N.C. normally closed contacts on the control relay.
See Table 2-1 for contact information and Figure 2-2 for jumper placement.
The controller has been shipped with CONTROL relays configured for **normally open** contacts.

See Control Relay Caution Note -- Page 2-3.

### ALARM RELAY MODELS

***CHECK ALARM RELAY ACTION***

Position the jumpers at J4 and J5 on the option Printed wiring board for **(NO)** Normally Open or **(NC)** Normally Closed contacts on the relays.
J5 is the ALARM contact selector.
J4 is the contact selector for the second relay which is the CONTROL relay for model CN12 11-A1 and an ALARM relay for all others.
See Table 2-2 for alarm contact information and Figure 2-1 for jumper placement.
The controller has been shipped with ALARM relays configured for **normally closed** contacts.

See Alarm Relay Caution Note -- Page 2-3.

### PROCESS VARIABLE OUTPUT MODELS (PR OPTION)

***CHECK OPTIONAL PV OUTPUT OR CONTACT INPUT SELECTION***

Position a jumper at J6 on the option printed wiring board to select **PR IN** (Contact Input) or **PR OUT** (PV Output). See Figure 2-2 for jumper placement.
The controller has been configured for **PV OUTPUT (PR OUT)**

### SECOND INPUT MODELS

***CHECK INPUT 2 (RSP) SELECTION***

Position a jumper at J8 on the option printed wiring board to select 1 to 5Vdc or 4 to 20 mAdc as the Remote Set Point Signal. See Figure 2-2 for jumper placement. The controller has been configured for 1-5 Vdc input signal.

**Table 2-1 Control Relay Contact Information Chart**

| UNIT POWER | CONTROL RELAY JUMPER | CONTROL RELAY CONTACT | #1 OR #2 OUTPUT INDICATOR STATUS |
|---|---|---|---|
| Off | N.O. | Open | Off |
| | N.C. | Closed | |
| On | N.O. | Open<br>Closed | Off<br>On |
| | N.C. | Closed<br>Open | Off<br>On |

**NOTE:** *Control relays operate in the standard control mode. i.e. Energized when output state is on.*

**Table 2-2 Alarm Relay Contact Information Chart**

| UNIT POWER | ALARM RELAY JUMPER | *VARIABLE NOT IN ALARM* | | *VARIABLE IN ALARM STATE* | |
|---|---|---|---|---|---|
| | | RELAY CONTACT | INDICATORS | RELAY CONTACT | INDICATORS |
| Off | N.O. | Open | Off | Open | Off |
| | N.C. | Closed | | Closed | |
| On | N.O. | Closed | Off | Open | On |
| | N.C. | Open | | Closed | |

**NOTE:** *Alarm relays are designed to operate in a failsafe mode. i.e. De-energized during alarm state. This results in alarm actuation when power is OFF or when initially applied, until the unit completes self diagnostics. If power is lost to the unit, the alarms will function.*

## ALARM AND CONTROL RELAY *CAUTION* NOTE

*The alarm and control relay output suppression (snubber) circuitry can be extremely critical when controlling processes and maintaining plant safety. The Universal Digital Controller is shipped with a board-mounted R-C suppression circuit. Its purpose is to protect the relay contacts from arcing due to high energy spikes. These spikes could occur when driving highly inductive loads and fast cycle-time processes. However, in certain AC powered, external solid state relays with very high input impedance, an undesirable leakage current can flow in the R-C suppression circuit and cause a voltage across the external load. This prevents deactivation of your external device (such as a Solid State relay) even though our display and internal relay are functioning correctly.*

*The fix, as shown in the figure below, is to open the correct R-C circuit by cutting one of the capacitor leads. This is acceptable because if the above problem occurred, the suppression circuit was not needed. Opening the circuit eliminates any leakage current flow and allows the external relay to function normally.*

1. To remove the chassis, loosen the screw on the front, and pull the chassis out of the case.
2. Open the desired circuit by cutting the capacitor lead.
3. Return the chassis to the case. Make sure it slides under the guide clip in the bottom of the case.

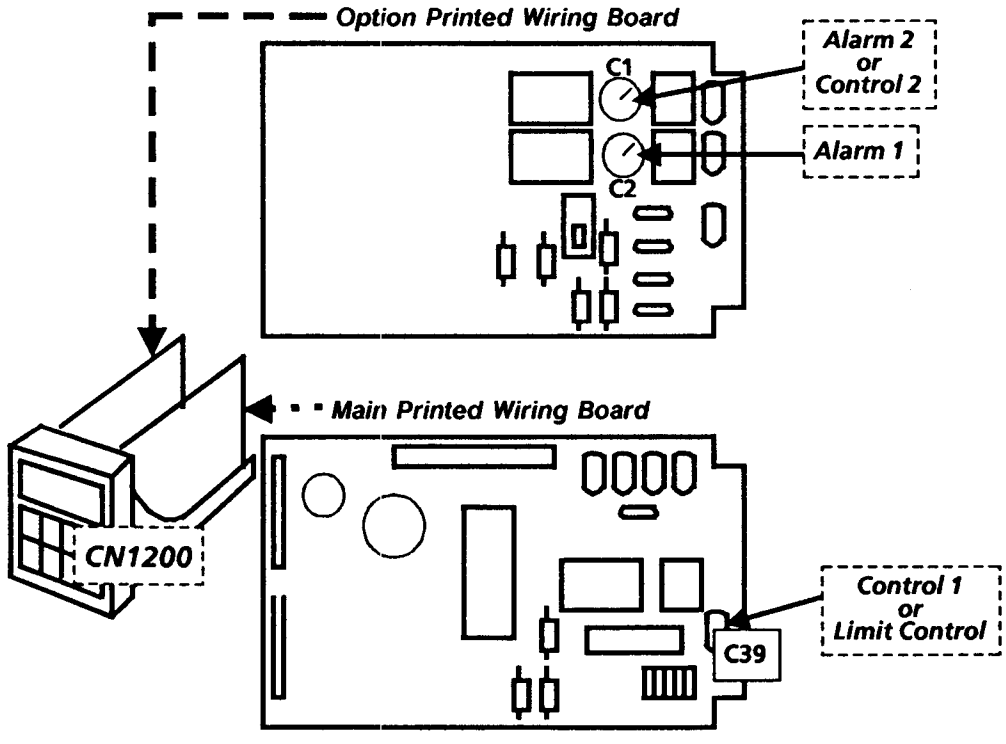



Figure 2-1 RC Circuit Capacitors

**PROCEDURES**

Before you install the controller, loosen the screw on the front of the controller, pull the chassis out and make any preliminary checks necessary. When you return the chassis to the case, make sure it slides under the guide clip in the case. The figure below shows all the checks listed on page 2-1.

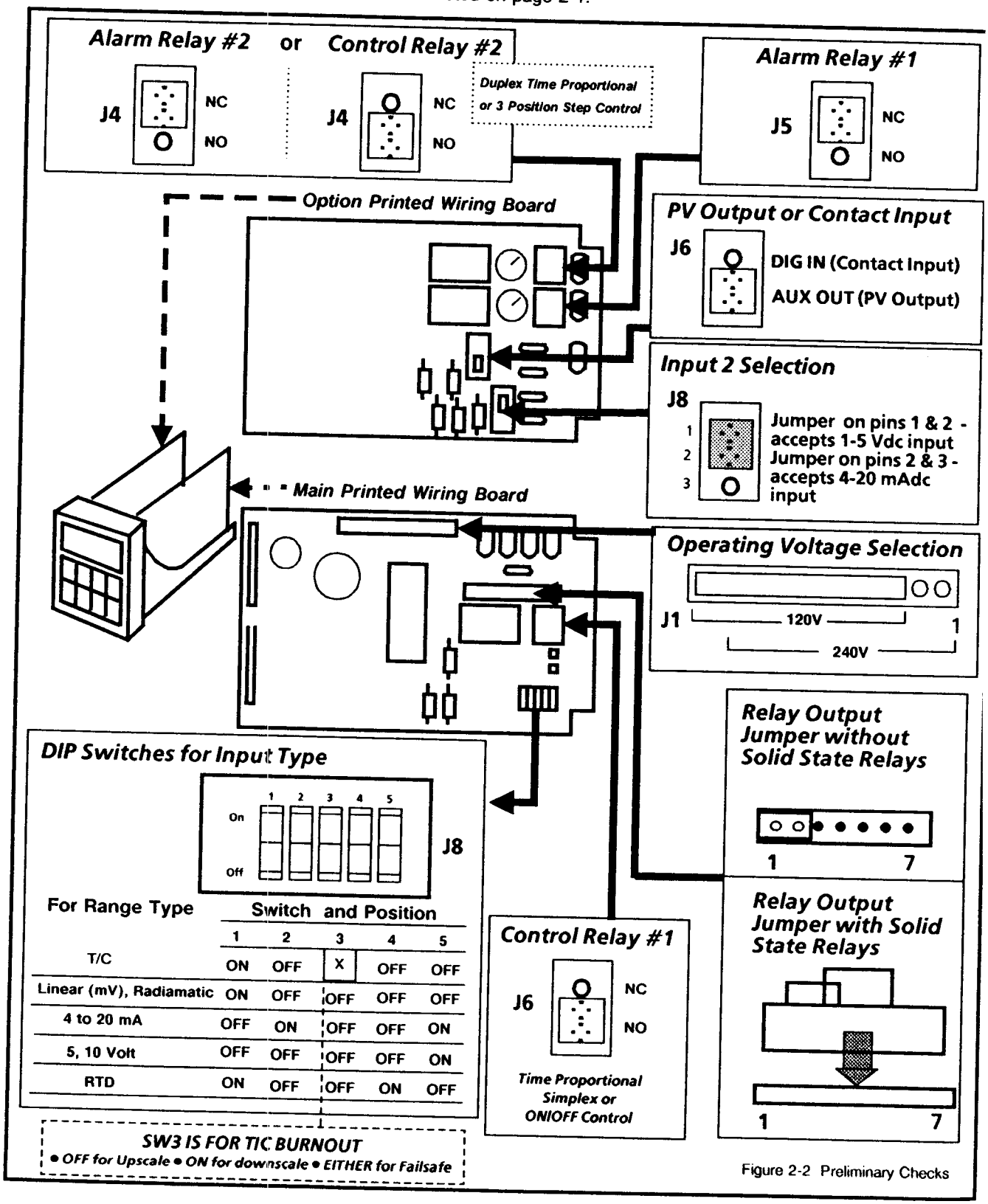



Figure 2-2 Preliminary Checks

## Mounting

### Physical Considerations

The CN1200 controller can be mounted on either a vertical or tilted panel using the mounting kit supplied with the controller. Adequate access space must be available at the back of the panel for installation and servicing activities. The overall dimensions and panel cutout requirements for mounting the controller are shown on the dimension data drawing in Figure 2-3. The enclosure into which the CN1200 is mounted must be grounded as a matter of good practice (see, e.g., CSA standard C22.2 No. 0.4 or Factory Mutual Class No. 3820 paragraph 6.1.5).

### Mounting

Before mounting the controller, refer to the nameplate on the outside of the case and make a note of the model number. It will help later when selecting the proper wiring diagram.

1. Mark and cut out the controller mounting hole in the panel according to the dimensions specified on the dimension drawing below.
2. Loosen the screw on the front of the controller and pull the chassis from the case.
3. Orient the case properly and slide it through the panel hole from the front.
4. Remove the mounting kit from the shipping container and install the kit as follows:
   a. Install the screws into the threaded holes of the clips.
   b. Insert the prongs of the clips into the two holes in the top and bottom of the case.
   c. Tighten both screws to secure the case against the panel.
   d. Carefully slide the chassis assembly under the guide clip and into the case, press to close and tighten the screw.

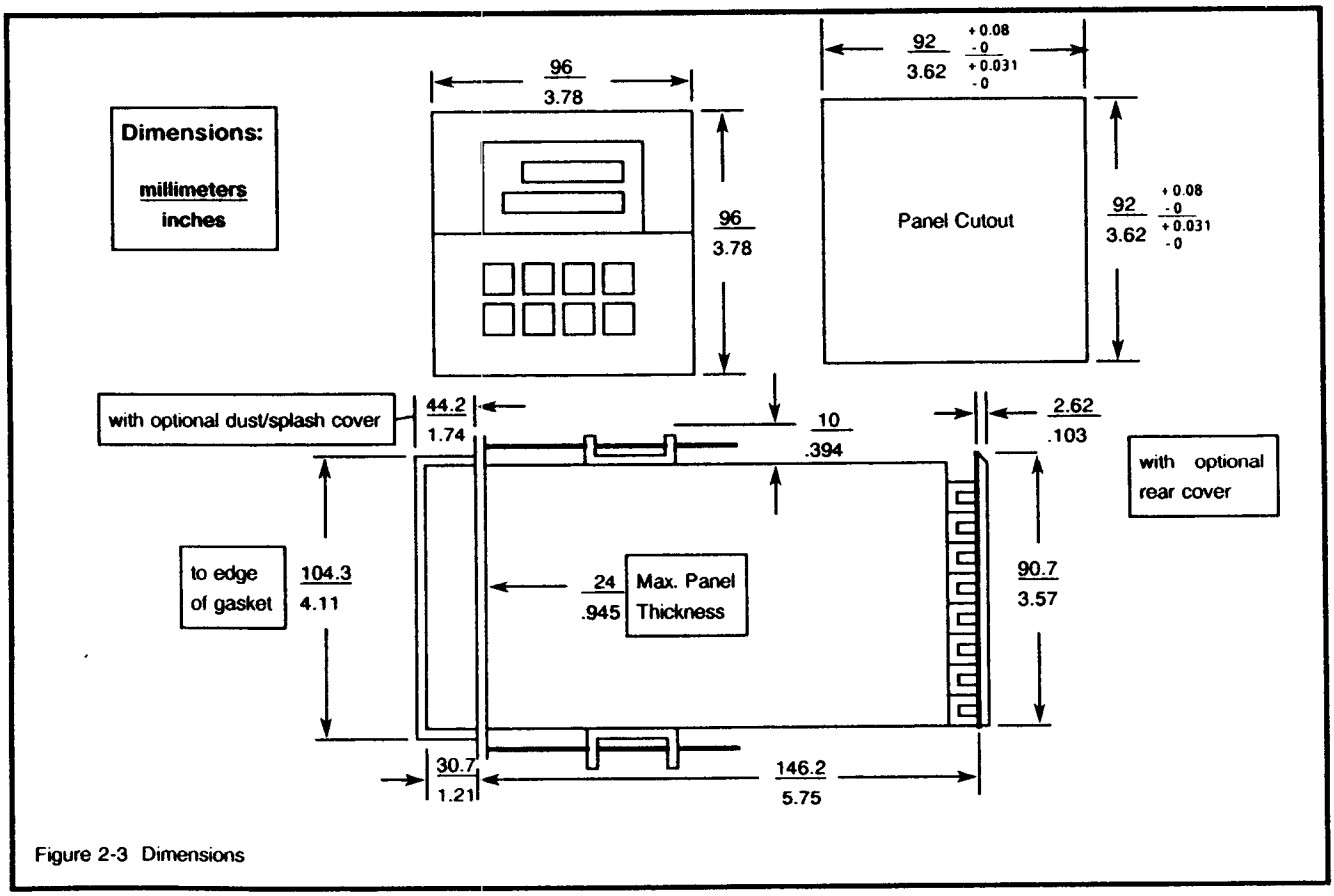



Figure 2-3 Dimensions

## Mounting (continued)

### Mounting Accessories

In addition to the panel cutout described above, other aids for mounting the CN1200 controller include the following supplemental accessories and kits:

- A rear terminal cover kit, part no. 30756091-001
- A splash cover, part no. 24400107-001

## WIRING

### Identify your Model Number

To determine the appropriate diagrams for wiring your controller:

- Refer to the model number interpretation shown on page 1-3. The model number of the controller contains selection codes that identify the Output type, Input type, number of Alarms, and optional selections. The model number of your controller can be found on the outside of the case.

## Taking Electrical Noise Precautions

Electrical noise is unabated electrical signals which produce undesirable effects in measurement and control circuits. Digital equipment is especially sensit to the effects of electrical noise. Your CN1200 controller has built-in circuits to reduce the effects o electrical noise from various sources. To further red these effects:

- Separate External Wiring - separate connecting wires into bundles (see table 2-3), and route the individual bundles through separate conduits or metal trays;
- Use Suppression Devices - for additional noise protection, you may want to add suppression devices at the external source. Appropriate suppression devices are available.

### Table 2-3
### PERMISSIBLE WIRE BUNDLING

| *Bundle No.* | *Wire Functions* |
|---|---|
| 1 | a. Line power wiring<br>b. Earth ground wiring<br>c. Control relay output wiring<br>d. Line voltage alarm wiring |
| 2 | Analog signal wire, such as<br>a. Input signal wire(T/C, 4-20mA,e<br>b. 4-20mA output signal wiring<br>c. Digital input signals |
| 3 | a. Low voltage alarm relay output wiring<br>b. Low voltage wiring to solid stat type control circuits |

### Wiring the Controller

- Using the information contained in the model number, select the appropriate wiring diagrams f the connection diagrams in Figures 2-4 through and wire the controller accordingly.

RELAY OUTPUT
***Models CN1201, CN1211*** FIGURE 2-

SOLID STATE RELAY OUTPUT
***Models CN1201, CN1211 with SSR Kits*** FIGURE 2

CURRENT OUTPUT
***Model CN1204*** FIGURE 2

EXTERNAL INTERFACE OPTIONS
***PR Option*** FIGURE 2

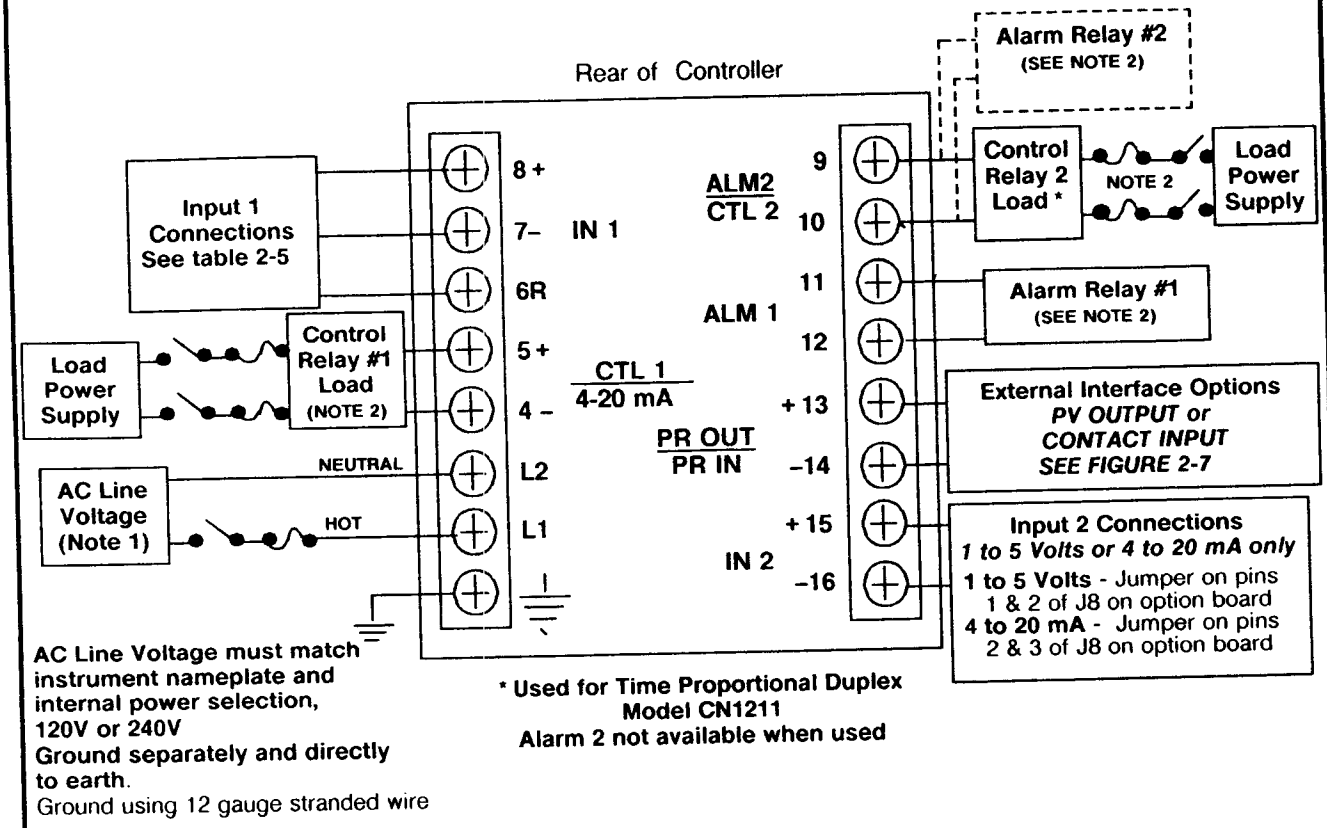
3 POSITION STEP CONTROL
***Model CN1211*** FIGURE 2

**TABLE 2-4 1/4 DIN Adaptor Plates**

| DIMENSIONS | | | | MAXIMUM CUTOUT | | | | PART NUMBER |
|---|---|---|---|---|---|---|---|---|
| INCHES | | CENTIMETERS | | INCHES | | CENTIMETERS | | |
| WIDTH | HEIGHT | WIDTH | HEIGHT | WIDTH | HEIGHT | WIDTH | HEIGHT | |
| 5.25 | 8.875 | 13.3 | 22.5 | 4.5 | 8.125 | 11.4 | 20.6 | 24400104-001 |
| 8.25 | 7.25 | 21.0 | 18.4 | 7.5 | 6.5 | 19.0 | 16.5 | 24400104-003 |
| 8.375 | 8.875 | 21.3 | 22.2 | 7.625 | 8.125 | 19.3 | 20.6 | 25500104-004 |
| 9.875 | 10.875 | 25.1 | 27.6 | 9.125 | 10.125 | 23.1 | 25.6 | 24400104-005 |

# RELAY OUTPUT WIRING - For Models CN1201, CN1211*

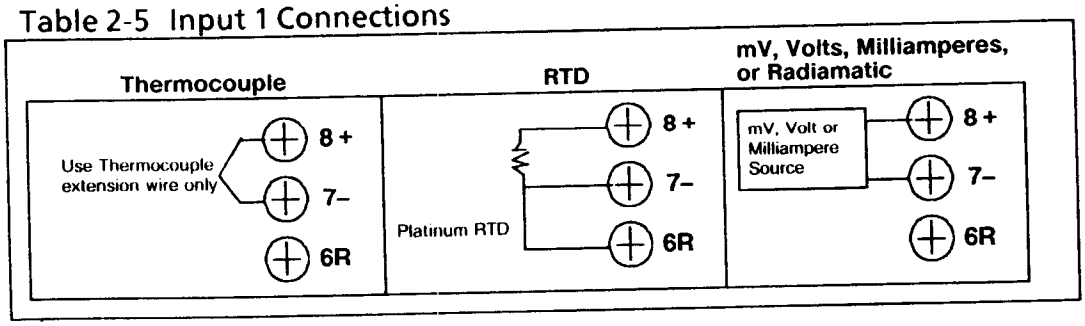
***For 3 Position Step Control, See Figure 2-8**




**AC Line Voltage must match instrument nameplate and internal power selection, 120V or 240V**
**Ground separately and directly to earth.**
Ground using 12 gauge stranded wire

*** Used for Time Proportional Duplex Model CN1211**
**Alarm 2 not available when used**

## Table 2-5 Input 1 Connections




**NOTE 1.** Before powering the unit, see "Preliminary Checks" in this section of the product manual. Set DIP switches for input type. Set jumpers for operating voltage and relay contacts.

**NOTE 2.** Control relays 1 and 2 are shipped having N.O. contacts configured. Alarm relays 1 and 2 are shipped with N.C. contacts configured. N.O. or N.C. contacts are selectable by means of a jumper on the main and option printed wiring boards. See "Preliminary Checks" in this section of the product manual for details. Each alarm is a SPST relay, rated at 5 amps at 120V, and 2.5 amps at 240 Vac. For solid state relay outputs, see Figure 2-5.

Figure 2-4 Relay Output Wiring

## SOLID STATE RELAY OUTPUT WIRING -- For Models CN1201, CN1211

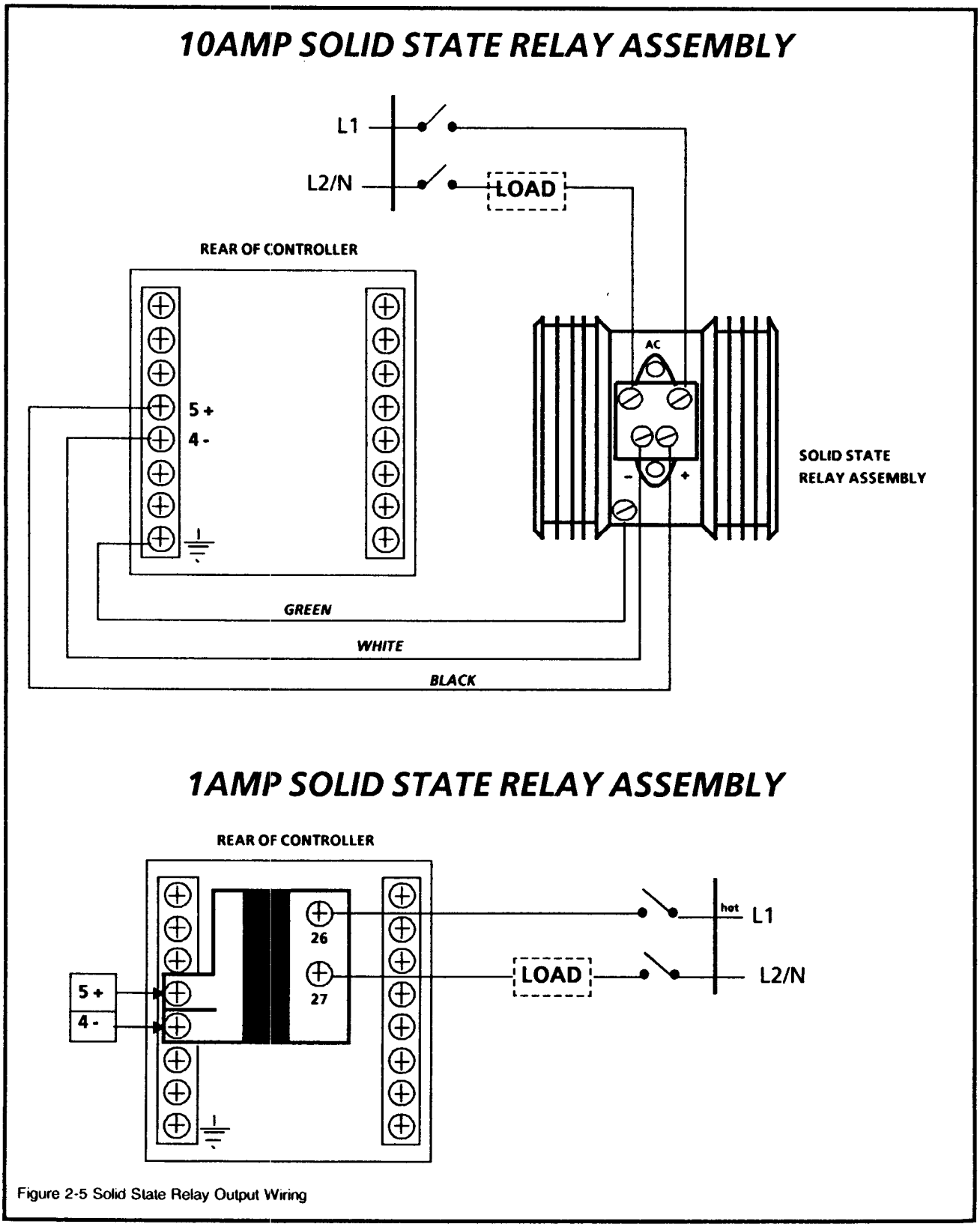
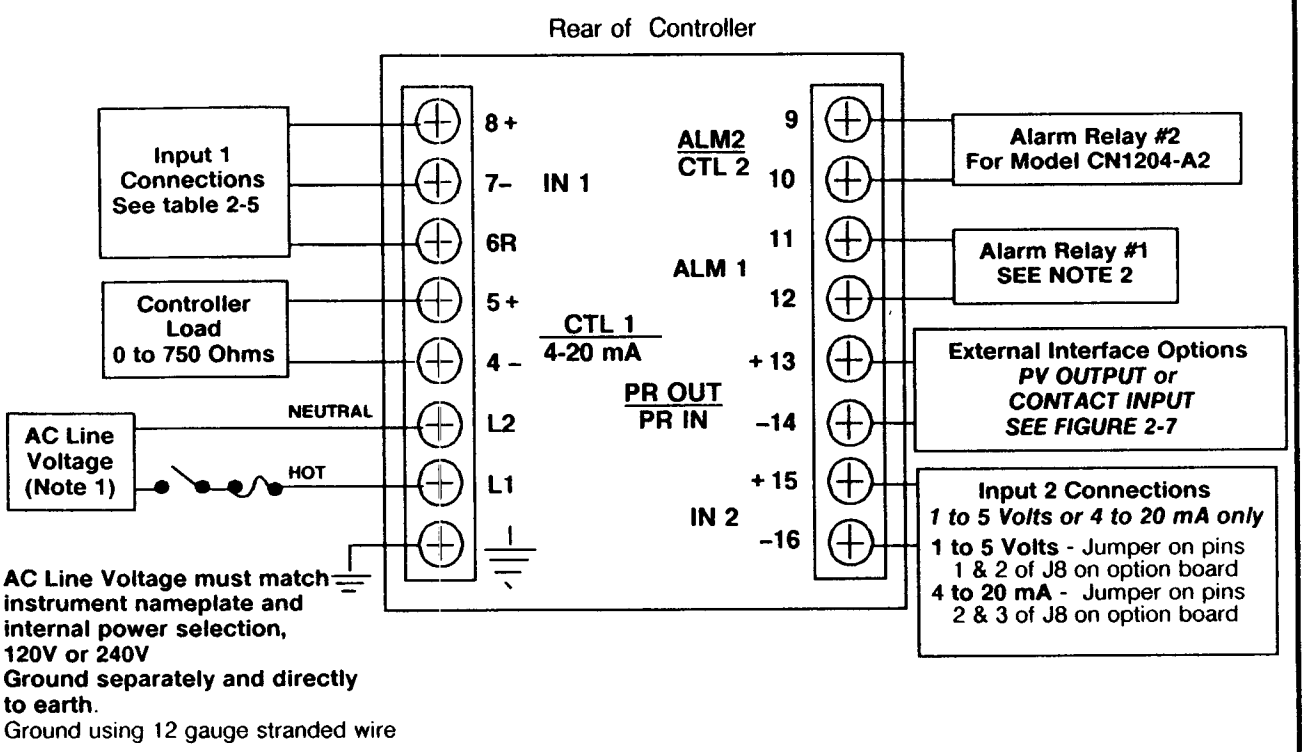


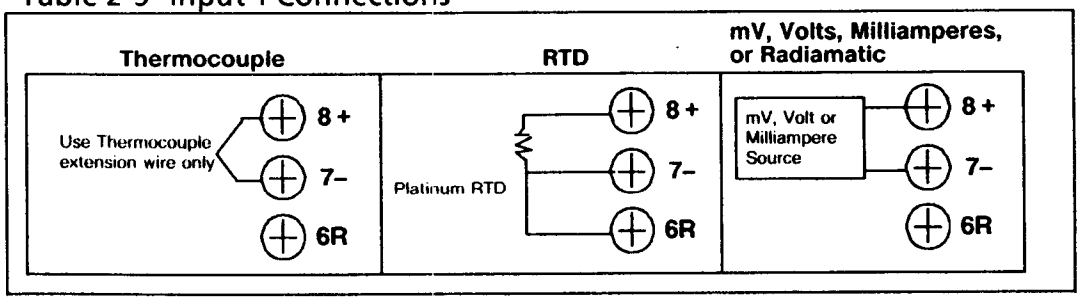

Figure 2-5 Solid State Relay Output Wiring

# CURRENT OUTPUT WIRING -- For Model CN1204




**AC Line Voltage must match instrument nameplate and internal power selection, 120V or 240V**
**Ground separately and directly to earth.**
Ground using 12 gauge stranded wire

## Table 2-5 Input 1 Connections

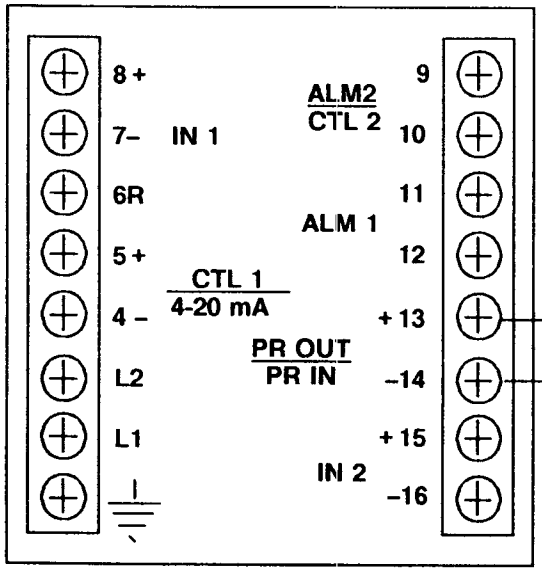


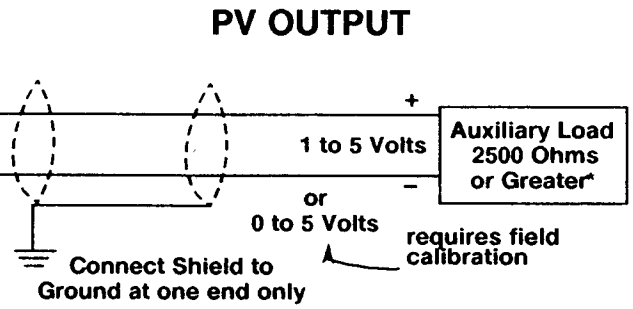

**NOTE 1.** Before powering the unit, see "Preliminary Checks" in this section of the product manual. Set DIP switches for input type. Set jumpers for operating voltage and relay contacts.

**NOTE 2.** Relay 2 is shipped as an alarm relay. It and alarm relay 1 are shipped with N.C. contacts configured. N.O or N.C. contact is selectable by means of a jumper on the option printed wiring board. See "Preliminary Checks" in this section of the product manual for details. Each alarm is a SPST relay, rated at 5 amps at 120V, and 2.5 amps at 240 Vac.

Figure 2-6 Current Output Wiring

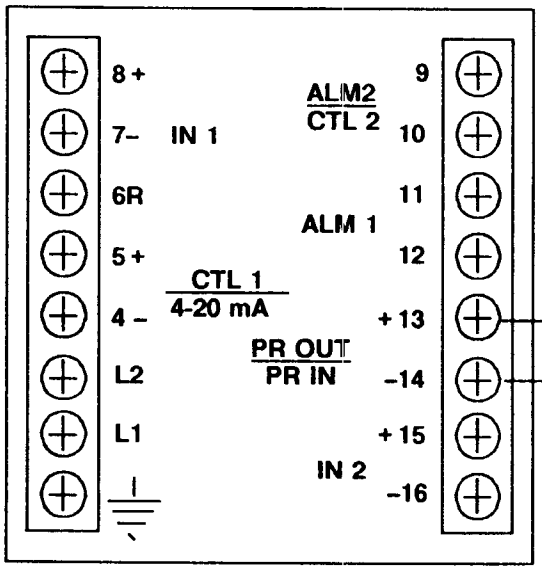
## EXTERNAL INTERFACE OPTION WIRING - For Process Variable (-PR) Models

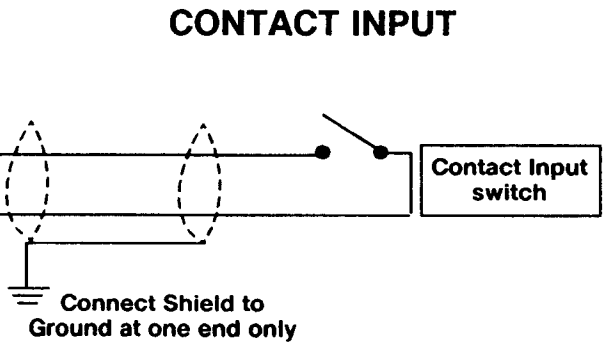



**NOTE:** The PV output will not be isolated from other inputs and outputs.

*PV output is factory calibrated at 2500 ohm load. Accuracy can be maintained at other loads by performing a field calibration.

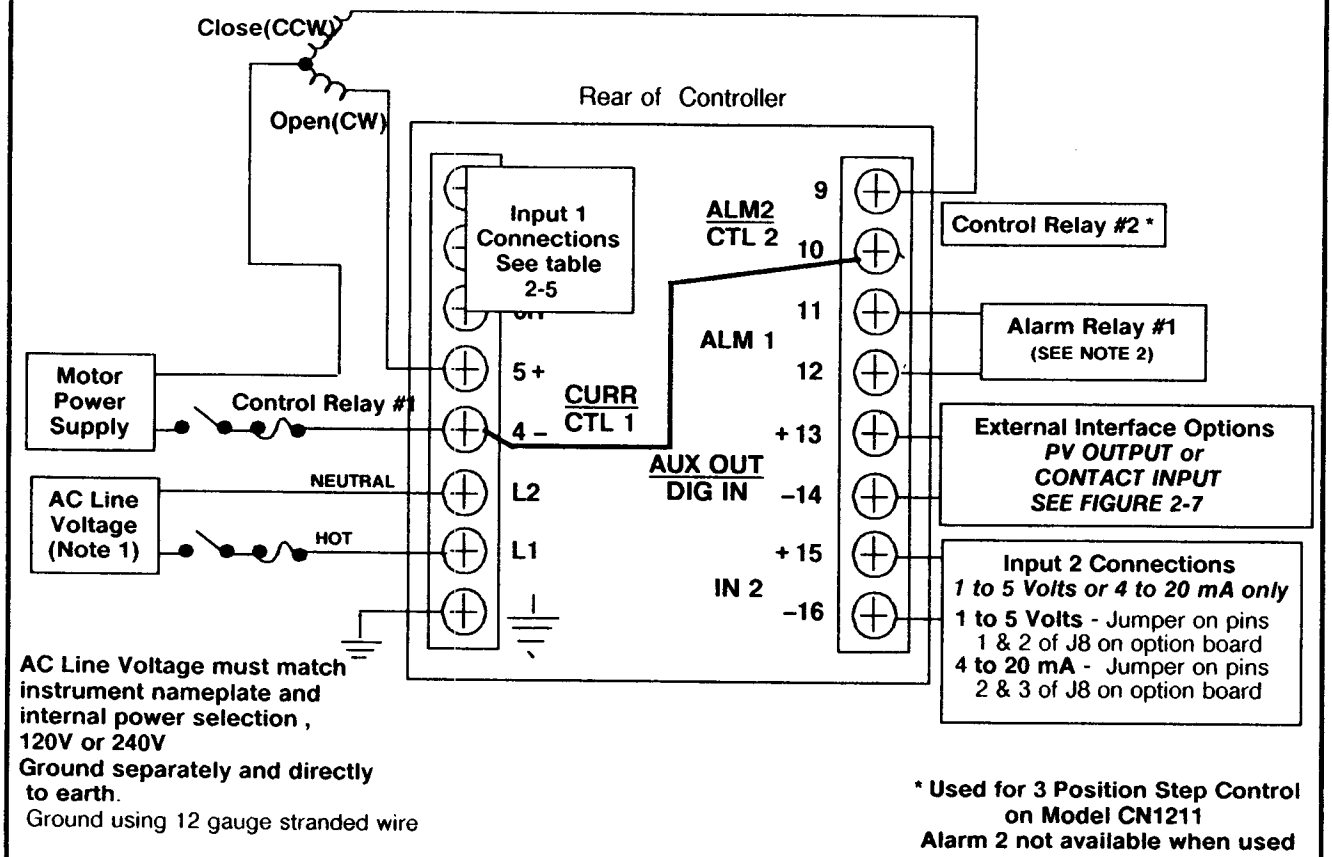


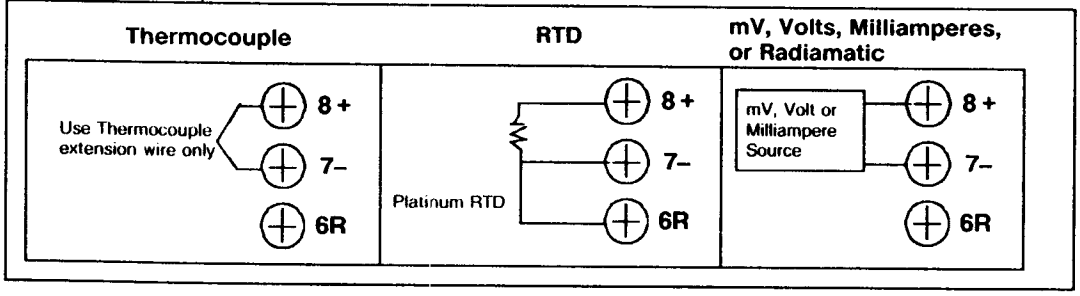

**NOTE:** Contact Input and PV Output are mutually exclusive. Selection is determined by jumper J6 on the Option Printed Wiring Board. (See Figure 2-2.)

Figure 2-7 External Interface Wiring

# 3 POSITION STEP CONTROL WIRING - For Model CN1211




## Table 2-5 Input 1 Connections




**NOTE 1.** Before powering the unit, see "Preliminary Checks" in this section of the product manual. Set DIP switches for input type. Set jumpers for operating voltage and relay contacts.

**NOTE 2.** Control relays 1 and 2 are shipped having N.O. contacts configured. Alarm relay 1 is shipped with N.C. contacts configured. N.O. or N.C. contacts are selectable by means of a jumper on the main and option printed wiring boards. See "Preliminary Checks" in this section of the product manual for details. Each alarm is a SPST relay, rated at 5 amps at 120V, and 2.5 amps at 240 Vac. For solid state relay outputs, see Figure 2-5.

Figure 2-8 Three Position Step Control Wiring

# CONFIGURATION

# SECTION 3

## *SOFTWARE CONFIGURATION*

### Introduction

Software configuration is a dedicated operation where you use straightforward keystroke sequences to select and establish (configure) pertinent controller data best suited for your specific application.

### Prompts

To assist you in this process, there are prompts which appear in the upper and lower displays (see Figure 3-1). These prompts let you know what group of configuration data you are working with and also, the specific parameters associated with each group. Figure 3-2 gives you an overview of these prompts. As you can see, the configuration data is divided into 9 main Set-Up groups plus *Calibration* and *Read*.

TUNING
ALGORITHM
SP RAMP/PROGRAM
AUTOTUNE
INPUT 1
INPUT 2
CONTROL
OPTIONS
ALARMS

Within each of these groups are function prompts of associated parameters.

***NOTE: This manual explains all the prompts that can appear in the CN1200 controller. Some of the prompts won't apply to your specific controller and therefore will not appear.***

### Key Error

When a key is pressed and the prompt **"KEY ERROR"** appears in the lower display, it will be for either of the following reasons:

- Parameter not available
- Not in Set-Up mode, press **[SET UP]** first

### How to Get Started

- Read the procedure (page 3-3) for accessing the groups and the function parameters within each group to become familiar with the key sequences.
- Read the "Configuration Tips" on page 3-3, then start to configure the controller for your application. The groups and parameters are all listed on page 3-4, along with the selections and range of setting available for each.
- If you need a detailed explanation of any Set-Up or Function prompt listed in this section, go to Section 8 - Appendix A.
- Record your selections on the configuration record sheet (page 3-16) so you'll have a record of how you've configured the controller.

Figure 3-1 is a view of the operator Interface with which you'll be working.

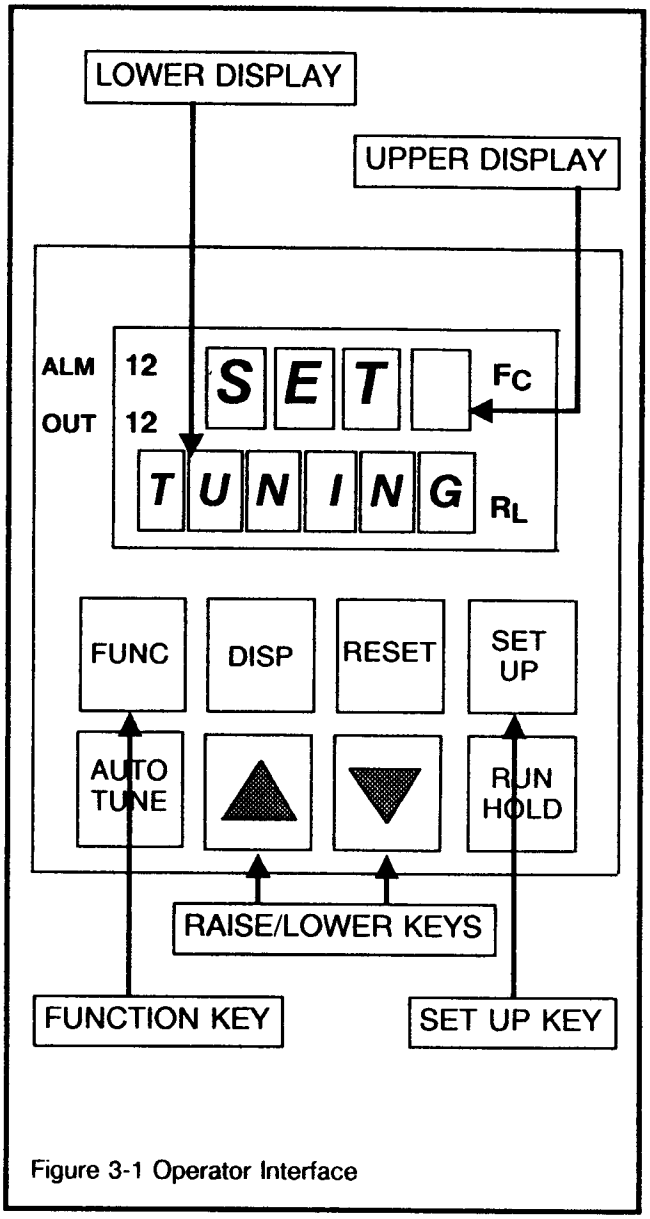



Figure 3-1 Operator Interface

## PROMPT HIERARCHY

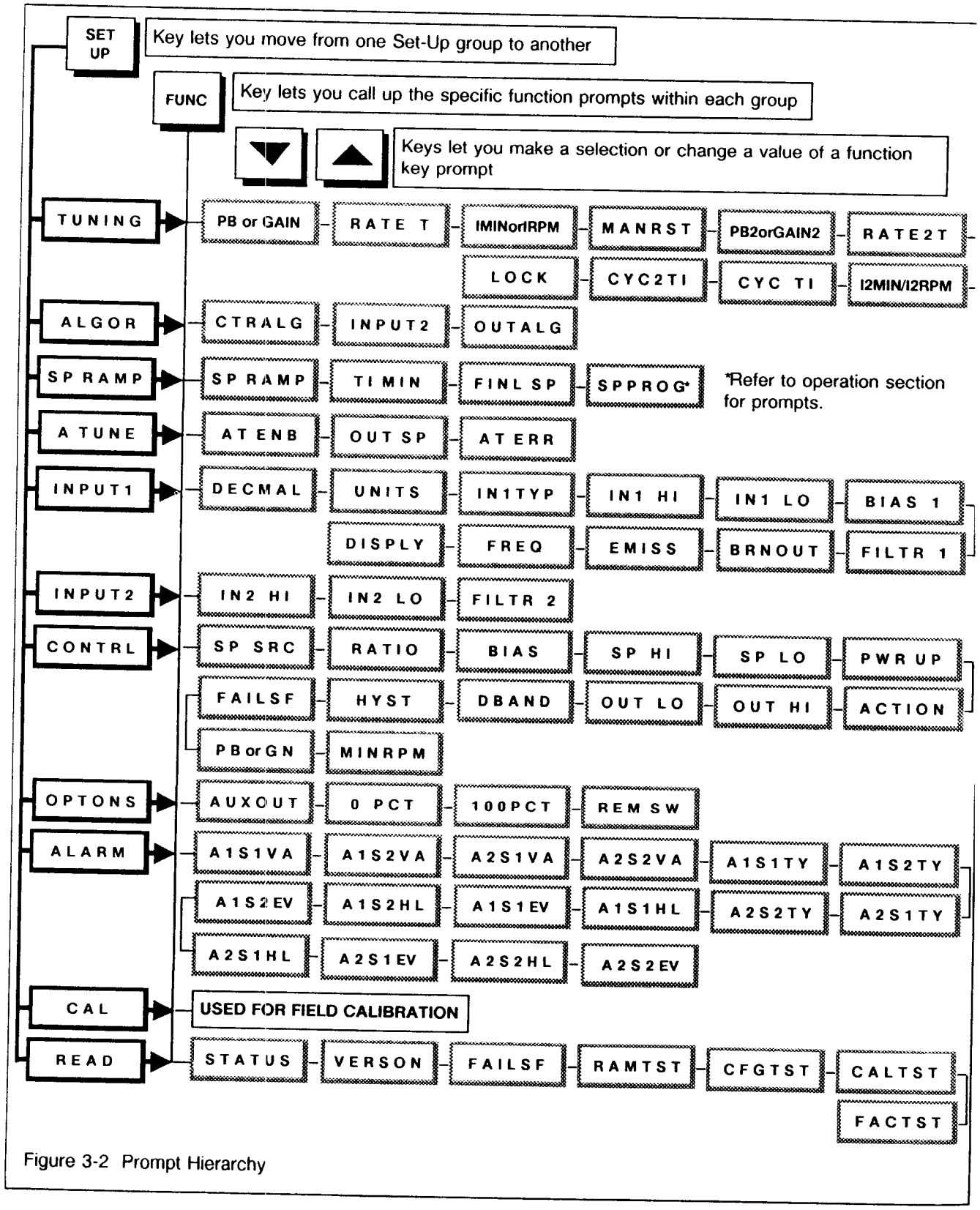



Figure 3-2 Prompt Hierarchy

## *SOFTWARE CONFIGURATION (continued)*

### How to Call Up and Change a Configuration Parameter

A list of how the controller was configured at the factory "Factory Settings"appears on page 3-16. If you want to change any of these selections or values, follow the procedure listed below. This procedure tells you what keys to press so you can effectively use the prompts to start configuring your controller.

***How to Select a Set-Up Group***

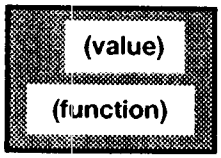
Press the **[SET UP]** key. You will see **SET** in the upper display to let you know you are in the Set-Up mode and a SET-UP group title is being displayed in the lower display. **TUNING** is first.


Successive presses of the **[SET-UP]** key will sequentially display the other Set-Up groups as shown in the prompt hierarchy (page 3-2).

***Note 1:*** Stop at the group you want to configure then go to "***How to Select a Function***" for the parameters within that group.

***How to Select a Function***

As shown in the prompt hierarchy, each of the groups listed contain specific prompts which deal with functions that are pertinent to that particular group. Press the **[FUNC]** key, you will see the individual function prompts for each group and the current value or selection. Successive presses of the **[FUNC]** key will sequencially display all the functions and their values or selections for that group.




NOTE 2: Stop at the function you want to configure, then go to "How to change a value or selection".

***How to Change Value or Selection***

Press the **[RAISE/LOWER]** key to change the value or selection in the upper display.
If the display blinks, you are trying to select an unacceptable entry or the LOCKOUT is preventing changes.

***How to Restore the Original Value or Selection***

When you change the value or selection of a parameter while in SET UP mode and decide not to enter it, press the **[RESET]** key once. The original value or selection will be recalled.

***How to Enter a Value or Selection***

Press the **[FUNC]**, **[SET UP]**, or **[DISP]** key. The value or selection will be entered into memory.

***How to Exit Configuration***

Press the **[DISP]** key to exit from configuration and return to normal operation.

### Configuration Tips

Listed below are a few procedures that will help you to easily and quickly accomplish the tasks at which you'll be working when you configure the controller.

***Scrolling***

To get to a SET-UP group or FUNCTION parameter quickly, hold **[SET UP]** or **[FUNC]** key in. The display will scroll through the parameters.

***Changing Values Quickly***

When you press the **[RAISE/LOWER]** keys to change a number, the least significant digit increments and decrements. However, if you momentarily press the opposite key while holding one of these two keys, the next significant digit begins to increment and decrement and each additional tap of the "opposite Key" will move the scrolling digit one more step to the left.
Remember - you must hold in one key while the other is pressed.

***How to Restore the Original Value or Selection***

When you change the value or selection of a parameter while in SET UP mode and decide not to enter it, press the **[RESET]** key once. The original value or selection will be recalled.

***Timing Out from SET-UP***

If you are in **SET-UP** mode and don't press any keys for ***one minute***, the controller will time out and revert to the mode and display that was being used prior to entry into SET-UP mode.

**Refer to Appendix A for additional data about any prompt you're not sure how to configure.**

## TUNING PARAMETERS GROUP (For definitions, see page 8-2)

| PRESS | DISPLAYS | ▲▼ SETTING | REMARKS |
|---|---|---|---|
| SET UP | SET<br>TUNING | | *In configuration mode,* **"Tuning"** *group displayed.* |
| FUNC | PB or GAIN | **Range: 0.1 to 1000** | *Select* ***PB*** *or* ***GAIN*** *at* **"CONTRL"** group prompt **"PB or GN"** *Also defined as "HEAT" PB or GAI on Duplex models for Heat/Cool applications.* |
| FUNC | RATE T | **Range: 0.00 to 10.00 minutes<br>0.00 to 0.08 is off** | ***RATE*** *-Also defined as "HEAT" Rat on duplex models for Heat/Cool applications.* |
| FUNC | IMINorIRPM | **Range: 0.02 to 50.00 minutes per repeat or repeats per minute** | ***INTEGRAL TIME or RESET RATE*** *- Used with control algorithm PID-A Select* ***MIN*** *or* ***RPM*** *at* **"Contrl"** *prompt* ***"MINorRPM"*** *"HEAT" Rate on duplex models fo Heat/Cool applications.* |
| FUNC | MANRST | **Range: –100 to + 100<br>(% Output)** | ***MANUAL RESET*** *- Used with contrc algorithm PD + MR..* |
| FUNC | PB2orGAIN2 | **Range: 0.1 to 1000** | *Select* ***PB2*** *or* ***GAIN2*** *at* **"Control"** group prompt **"PB or GN"** *Also defined as "COOL" PB or GA on Duplex models for Heat/Cool applications.* |
| FUNC | RATE2T | **Range: 0.00 to 10.00 minutes<br>0.00 to 0.08 is off** | ***RATE2T*** *- Also defined as "COOL Rate on duplex models for Heat/Cc applications.* |
| FUNC | I2MIN/I2RPM | **Range: 0.02 to 50.00 minutes per repeat or repeats per minute** | ***INTEGRAL TIME2 or RESET RATE2*** *Used with control algorithm PID-A Select* ***MIN*** *or* ***RPM*** *at* **"CONTRL"** *prompt* ***"MINRPM"*** *"COOL" Reset Time on duplex models for Heat/Cool applications.* |
| FUNC | CYC T1 | **Range: 1 to 120 Seconds** | ***CYCLE TIME*** *-Also defined as "HEAT" Cycle Time on duplex mode for Heat/Cool applications.* |

***Continued Next Page***

## TUNING PARAMETERS GROUP (Continued)

| PRESS | DISPLAYS | ▲▼ SETTING | REMARKS |
|---|---|---|---|
| FUNC | CYC2TI | Range: 1 to 120 Seconds | ***CYCLE TIME*** *-Also defined as "COOL" Cycle Time on duplex models for Heat/Cool applications.* |
| FUNC | LOCK | Selections:NONE<br>CAL<br>CONF | ***NO*** *lockout*<br>***CAL****ibration locked out*<br>***CONF****uration parameters are READ only* |
| SET UP then FUNC or DISP | | | ***SET UP*** *puts you in next set-up group*<br>***FUNC*** *selects the first parameter in the next group*<br>***DISP*** *exits set-up mode* |

## ALGORITHM PARAMETERS GROUP (For definitions, see page 8-3)

| PRESS | DISPLAYS | ▲▼ SETTING | REMARKS |
|---|---|---|---|
| SET UP | SET ALGOR | | *In configuration mode,* ***"ALGORITHM "*** *group displayed.* |
| FUNC | CTRALG | Selections:ONOF<br>PIDA<br>PDMR<br>TPSC | ***ON-OFF*** *control (Relay Output only)*<br>***PID-A*** *used for three mode control*<br>***PD + MR*** *PD with Manual Reset*<br>*Three* ***P****osition* ***S****tep* ***C****ontrol (Note 1)*<br>*- Model CN1211* |
| FUNC | INPUT2 | Selections:ENAb<br>DIS | ***ENAb****le Input 2*<br>***DIS****able Input 2* |
| FUNC | OUTALG | Selections:RLY<br>CUR<br>RLYD | ***RLY*** *Relay Simplex (one relay)*<br>***CUR*** *Current Simplex*<br>***RLYD*** *Relay Duplex (Two relays)**<br>**Model CN1211 only* |
| SET UP then FUNC or DISP | | *Note 1: Set Motor Travel Time at Set Up prompt "CAL," "TPSC."* | ***SET UP*** *puts you in next set-up group*<br>***FUNC*** *selects the first parameter in the next group*<br>***DISP*** *exits set-up mode* |

## SET POINT RAMP/PROGRAM GROUP (For definitions, see pages 4-6 thru 4-14)

| PRESS | DISPLAYS | ▲▼ SETTING | REMARKS |
|---|---|---|---|
| SET UP | SET<br>SPRAMP | | *In Set Up mode,* ***"SP RAMP/PROGRAM"*** *group displayed.* |
| FUNC | SPRAMP | Selections:DIS<br>ENAB | ***SINGLE SET POINT RAMP***<br>***Enable****--SP Ramp*<br>***Disabl****--Must select DISABL to use SP Program* |
| FUNC | TIMIN | Range: 0 to 255 Minutes | ***SINGLE SET POINT RAMP TIME***<br>*The time it takes to go from start to final set point on Single SP Ramp. Entering 0 will imply an immediate change in set point to the final set point.* |
| FUNC | FINLSP | Range: Within the set point limits | ***SINGLE SET POINT RAMP FINAL SET POINT***<br>*The controller will operate at the set point set here at the end of the Single Set Point Ramp.* |
| FUNC | SPPROG | Selections:DIS<br>ENAB | ***SET POINT RAMP/SOAK PROGRAM***<br>*Only available when SP RAMP is disabled.*<br>*See OPERATION section for prompts.*<br>*RUN key initiates the program.* |
| SET UP then FUNC or DISP | | | ***SET UP*** *puts you in next set-up group*<br>***FUNC*** *selects the first parameter in the next group*<br>***DISP*** *exits set-up mode* |

## AUTOTUNE PARAMETERS GROUP (For definitions, see pages 4-15 thru 4-20)

| PRESS | DISPLAYS | ▲▼ SETTING | REMARKS |
|---|---|---|---|
| SET UP | SET<br>ATUNE | | *In Set Up mode,* ***"AUTOTUNE"*** *group displayed.* |
| FUNC | AT ENB | **Selections: DIS**<br>**ASTP**<br>**MSTP** | ***AUTOTUNE FUNCTION***<br>***DIsable***<br>***A Step****--Auto Step Change*<br>***M Step****--Manual Step Change*<br>*Select output step size below.* |
| FUNC | OUT SP | **Range: –100 to + 100% of output in 1% increments**<br>*NOTE: Process can be tuned using an upscale or downscale step change.* | ***OUTPUT STEP SIZE***<br>*Appears if MSTP is chosen above. Must be large enough to result in a PV change of at least 2.5% of span.* |
| FUNC | AT ERR | **READ ONLY** | ***AUTOTUNE STATUS ERROR MESSAGES***<br>*See the OPERATION section.* |
| SET UP then FUNC or DISP | | | ***SET UP*** *puts you in next set-up group*<br>***FUNC*** *selects the first parameter in the next group*<br>***DISP*** *exits set-up mode* |

## INPUT 1 PARAMETERS GROUP (For definitions, see page 8-6)

| PRESS | DISPLAYS | ▲▼ SETTING | REMARKS |
|---|---|---|---|
| SET UP | SET<br>INPUT1 | | *In configuration mode,* ***"INPUT 1"*** *group displayed.* |
| FUNC | DECMAL | **Selections:8888**<br>**888.8**<br>**88.88** | ***No*** *Decimal place*<br>***One*** *Decimal place*<br>***Two*** *Decimal places**<br>**Can be used only with Linear Inputs.*<br>NOTE: Increasing resolution does not increase accuracy. |
| FUNC | UNITS | **Selections:F**<br>**C**<br>**NONE** | *Degrees* ***FAHRENHEIT***<br>*Degrees* ***CELSIUS***<br>***No*** *Selection* |
| FUNC | IN1TYP | **Selections: b R 10 M**<br>**E H S 100M**<br>**E L T H 0-1**<br>**J H T L 1-5**<br>**J L W 0-5**<br>**K H 100H 0-10**<br>**K L 100L RADI**<br>**NNM 4-20 NIC** | *Select which* ***ACTUATION TYPE*** *you are going to use for Input one. See* ***"Installation"*** *to set DIP switches for Input type.*<br>NOTE: Thermocouple choice "W" refers to the Tungsten-Rhenium sensor often called type C. |
| FUNC | IN1 HI | **Range: -99.9 to 99.99**<br>**or**<br>**-999 to 9999** | ***INPUT 1 HIGH RANGE VALUE***<br>*Can be changed for Linear Inputs only.* |
| FUNC | IN1 LO | **Range: -99.9 to 99.99**<br>**or**<br>**-999 to 9999** | ***INPUT 1 LOW RANGE VALUE***<br>*Can be changed for Linear Inputs only.* |
| FUNC | BIAS 1 | **Range: -999 to 9999**<br>**with**<br>**-99.9 to 999.9** | ***INPUT 1 BIAS*** *Value*<br>*A numerical value that can offset the process variable.*<br>*PV = Input 1 + Bias* |
| FUNC | FILTR1 | **Range: 0 to 120 Seconds** | ***INPUT 1 FILTER*** *- A Digital software filter to smooth the Input signal.*<br>*0 = No Filter* |
| FUNC | BRNOUT | **Selections:UP**<br>**DOWN**<br>**NONE** | ***SENSOR BREAK PROTECTION (BURNOUT) (T/C only)***<br>***UP****scale*<br>***DOWN****scale*<br>***NO*** *burnout-Failsafe output applied for failed input (T/C only)* |

***Continued Next Page***

## INPUT 1 PARAMETERS (Continued)

| PRESS | DISPLAYS | ▲▼ SETTING | REMARKS |
|---|---|---|---|
| FUNC | EMISS | Range: 0.01 to 1.0 | ***EMISSIVITY*** *Will appear only if "RADI" (Radiamatic) is selected as Input 1 Type. See page 8-6 for definition.* |
| FUNC | FREQ | Selections: 60<br>50 | ***POWER FREQUENCY*** ***60*** *Hertz* ***50*** *Hertz* *See* ***"Installation"*** *to select jumper position for Operating Voltage.* |
| FUNC | DISPLY | Selections: SP<br>PR_N<br>PR_Y | ***DEFAULT DISPLAY SELECTION*** ***SP*** *SP shows in lower display. SP Value in upper display.* ***PR-N*** *Lower display blank. Upper display shows PV.* ***PR-Y*** *PV shows in lower display. Process Variable value in upper display.* |
| SET UP then FUNC or DISP | | | ***SET UP*** *puts you in next set-up group* ***FUNC*** *selects the first parameter in the next group* ***DISP*** *exits set-up mode* |

## INPUT 2 PARAMETERS GROUP (For definitions, see page 8-7)

| PRESS | DISPLAYS | SETTING | REMARKS |
|---|---|---|---|
| SET UP | SET<br>INPUT2 | | *In configuration mode,* ***"INPUT 2"*** *group displayed. Input 2 must be ENABLED at "Algorithm" group prompt "Input 2."* |
| FUNC | IN2 HI | Range: -99.9 to 99.99<br>or<br>-999 to 9999 | ***INPUT 2 HIGH RANGE VALUE*** *This is what 20 mA or 5 Volts is to represent.* |
| FUNC | IN2 LO | Range: -99.9 to 99.99<br>or<br>-999 to 9999 | ***INPUT 2 LOW RANGE VALUE*** *This is what 4 mA or 1 Volt is to represent.* |
| FUNC | FILTR2 | Range: 0 to 120 Seconds | ***INPUT 2 FILTER*** *- A Digital software filter to smooth the Input signal.* *0 = No Filter* |
| SET UP then FUNC or DISP | | | ***SET UP*** *puts you in next set-up group* ***FUNC*** *selects the first parameter in the next group* ***DISP*** *exits set-up mode* |

## CONTROL PARAMETERS GROUP (For definitions, see pages 8-8, 8-9)

| PRESS | DISPLAYS | ▲▼ SETTING | REMARKS |
|---|---|---|---|
| SET UP | SET / CONTRL | | *In configuration mode,* **"CONTRL"** *group displayed.* |
| FUNC | SP SRC | **Selections:1LOC 2LOC REM** | ***SET POINT SOURCE*** *1* **LOC***al Set Point 1 only* *2* **LOC***al set points - Set Point 1/Set Point 2 toggled via* **[FUNC]** *key* ***REM****ote Set Point* |
| FUNC | RATIO | **Range: –20.00 to 20.00** | ***RATIO*** *- used when Input 2 is used as a Remote Set Point.* |
| FUNC | BIAS | **Range: –999 to 9999 Engr. Units with –99.9 to 999.9** | ***BIAS*** *- used when Input 2 is used as a Remote Set Point.* |
| FUNC | SP HI | **Range: 0 to 100% of input 1 in Engineering Units** | ***HIGH SET POINT LIMIT*** *The local set point will automatically adjust itself to be within this limit. The highest Value to which you want an operator set the control value.* |
| FUNC | SP LO | **Range: 0 to 100% of input 1 in Engineering Units** | ***LOW SET POINT LIMIT*** *The local set point will automatically adjust itself to be within this limit. The lowest value to which you want an operator to set the control value.* |
| FUNC | PWR UP | **Selections:ALSP ARSP** | ***SET POINT AT POWER UP*** ***ALSP*** *- Local set point* ***ARSP*** *- Remote set point* |
| FUNC | ACTION | **Selections:DIR REV** | ***CONTROL OUTPUT DIRECTION*** ***DIR****ect action - the controller's output increases as the PV increases.* ***REV****erse action - the controller's output decreases as the PV increases* |
| FUNC | OUT HI | **Range: –5 to 105% of Output** | ***HIGH OUTPUT LIMIT*** *Use 0 to 100% for Relay output* *Use -5 to 105% for Current output* |

***Continued Next Page***

## CONTROL PARAMETERS GROUP (Continued)(For definitions, see page 8-8, 8-9)

| PRESS | DISPLAYS | ▲▼ SETTING | REMARKS |
|---|---|---|---|
| FUNC | OUT LO | Range: –5 to 105% of Output | ***LOW OUTPUT LIMIT***<br>*Use 0 to 100% for Relay output*<br>*Use -5 to 105% for Current output* |
| FUNC | DBAND | Range: –5.0 to 25.0%<br>0.5 to 5.0% (TPSC) | ***DEADBAND*** *- an adjustable gap between the operating ranges of control relay one and control relay two.*<br>*Duplex/3 Position Step only*<br>*Model CN1211* |
| FUNC | HYST | Range: 0.0 to 5.0% | ***HYSTERESIS (Output Relay Only)*** *- An adjustable gap of the ON/OFF states of each relay.*<br>*On/Off control only* |
| FUNC | FAILSF | Range: Within the range of the output limits(%) | ***FAILSAFE OUTPUT VALUE*** *- controller will go to the value set here on controller failure.* |
| FUNC | PB or GN | Selections:Pb<br>GN | ***PROPORTIONAL BAND UNITS*** *-*<br>***Pb*** *- units of percent proportional band for the P term of the PID algorithm.*<br>***GN****-unitless term of Gain for the P term of the PID algorithm* |
| FUNC | MINRPM | Selections:MIN<br>RPM | ***RESET UNITS***<br>***MIN*** *- Minutes per Repeat. The time betwen each repeat of the proportional action by reset*<br>***RPM*** *- Repeats per Minute. The number of times per minute that the proportional action is repeated by reset.* |
| SET UP then FUNC or DISP | | | ***SET UP*** *puts you in next set-up group*<br>***FUNC*** *selects the first parameter in the next group*<br>***DISP*** *exits set-up mode* |

## OPTION PARAMETERS GROUP (For definitions, see page 8-10)

| PRESS | DISPLAYS | ▲▼ SETTING | REMARKS |
|---|---|---|---|
| SET UP | SET<br>OPTONS | | *In configuration mode,* **"OPTIONS"** *group displayed.* |
| FUNC | AUXOUT | Selections: NONE<br>PROC | ***AUXILIARY OUTPUT OPTION***<br>***NO*** *selection*<br>***PROC****ess Variable* |
| FUNC | 0 PCT | Range: WITHIN THE RANGE LIMITS OF INPUT 1 | ***LOW SCALING FACTOR***<br>*use a value in engineering units* |
| FUNC | 100PCT | Range: WITHIN THE RANGE LIMITS OF INPUT 1 | ***HIGH SCALING FACTOR***<br>*use a value in engineering units* |
| FUNC | REM SW | Selections: NONE<br>LSP<br>SP2<br>HOLD | ***REMOTE SWITCHING*** *Contact closure*<br>***NO*** *selection*<br>***LSP*** *- puts controller in local set point if in remote*<br>***SP2*** *- selects set point 2 if in set point 1*<br>***Hold*** *-- Holds Set Point Ramp/Program* |
| SET UP then FUNC or DISP | | | ***SET UP*** *puts you in next set-up group*<br>***FUNC*** *selects the first parameter in the next group*<br>***DISP*** *exits set-up mode* |

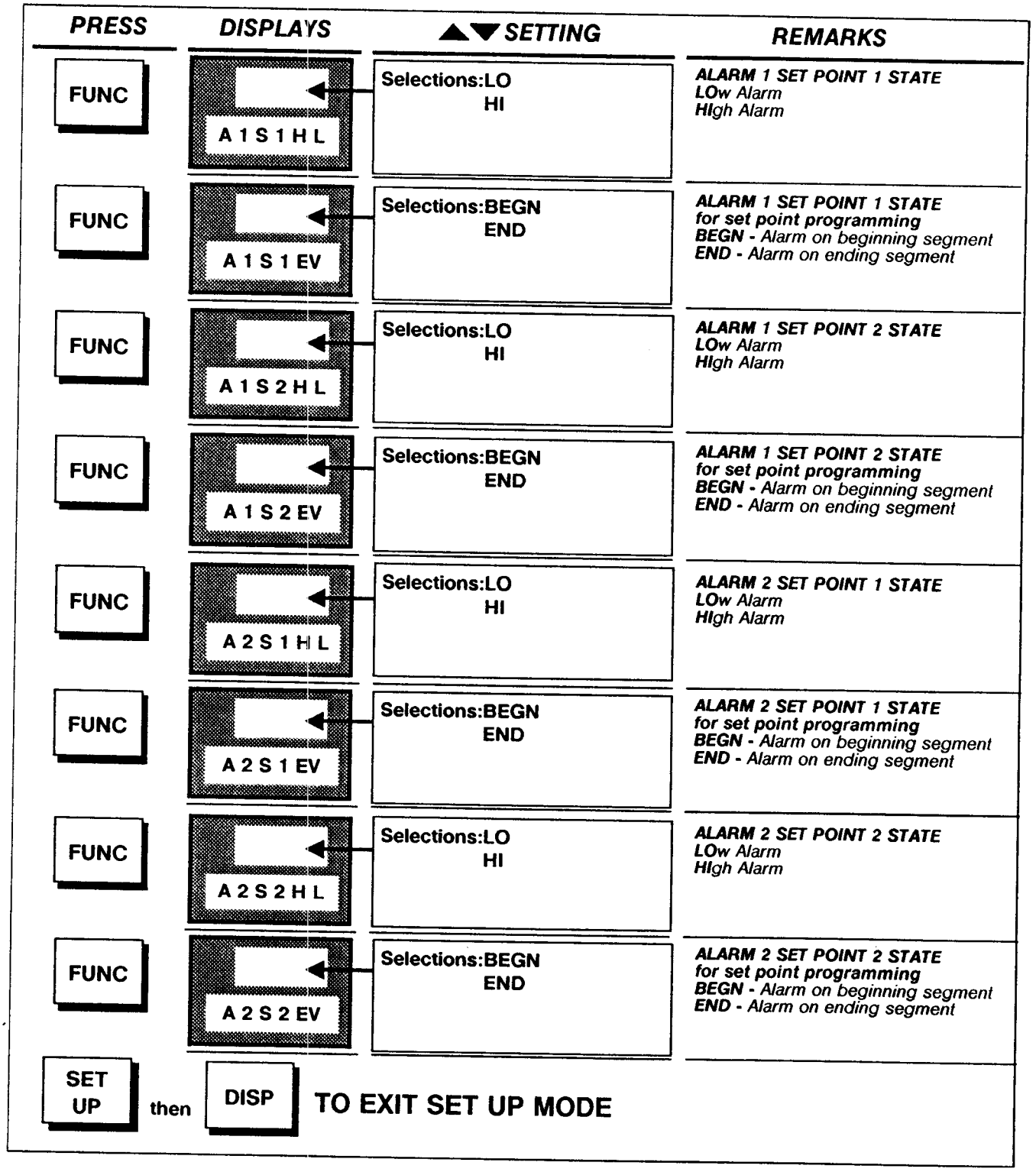
## ALARM PARAMETERS GROUP (For definitions, see page 8-11)

| PRESS | DISPLAYS | ▲▼ SETTING | REMARKS |
|---|---|---|---|
| SET UP | SET ALARM | | *In configuration mode,* **"ALARMS"** *group displayed.* |
| FUNC | A1S1VA | Range: Within Input 1 range for PROC type<br>Within Input 1 span for DEV type<br>Segment #1 to 12 for On/Off eventt | ***ALARM 1 SET POINT 1 VALUE***<br>*Will not appear unless selection* ***PROC*** *or* ***DE*** *is made at* ***"A1S1TY"***<br>*Enter value in engineering units*<br>*When* ***EVON*** *or* ***EVOF*** *is selected at* ***"A1S1TY"****, select alarm segment here* |
| FUNC | A1S2VA | Range: Within Input 1 range for PROC type<br>Within Input 1 span for DEV type<br>Segment #1 to 12 for On/Off eventt | ***ALARM 1 SET POINT 2 VALUE***<br>*Will not appear unless selection* ***PROC*** *or* ***DE*** *is made at* ***"A1S2TY"***<br>*Enter value in engineering units*<br>*When* ***EVON*** *or* ***EVOF*** *is selected at* ***"A1S2TY"****, select alarm segment here* |
| FUNC | A2S1VA | Range: Within Input 1 range for PROC type<br>Within Input 1 span for DEV type<br>Segment #1 to 12 for On/Off eventt | ***ALARM 2 SET POINT 1 VALUE***<br>*Will not appear unless selection* ***PROC*** *or* ***DE*** *is made at* ***"A2S1TY"***<br>*Enter value in engineering units*<br>*When* ***EVON*** *or* ***EVOF*** *is selected at* ***"A2S1TY"****, select alarm segment here* |
| FUNC | A2S2VA | Range: Within Input 1 range for PROC type<br>Within Input 1 span for DEV type<br>Segment #1 to 12 for On/Off eventt | ***ALARM 2 SET POINT 2 VALUE***<br>*Will not appear unless selection* ***PROC*** *or* ***DE*** *is made at* ***"A2S2TY"***<br>*Enter value in engineering units*<br>*When* ***EVON*** *or* ***EVOF*** *is selected at* ***"A2S2TY"****, select alarm segment here* |
| FUNC | A1S1TY | Selections: NONE<br>PROC<br>DE<br>EVON<br>EVOF | ***ALARM 1 SET POINT 1 TYPE***<br>***NO*** *selection*<br>***PROC****ess variable*<br>***DE****viation*<br>***EVent*** *-* ***ON*** *(SP Programming)*<br>***EVent*** *-* ***OFF*** *(SP Programming)* |
| FUNC | A1S2TY | Selections: NONE<br>PROC<br>DE<br>EVON<br>EVOF | ***ALARM 1 SET POINT 2 TYPE***<br>***NO*** *selection*<br>***PROC****ess variable*<br>***DE****viation*<br>***EVent*** *-* ***ON*** *(SP Programming)*<br>***EVent*** *-* ***OFF*** *(SP Programming)* |
| FUNC | A2S1TY | Selections: NONE<br>PROC<br>DE<br>EVON<br>EVOF | ***ALARM 2 SET POINT 1 TYPE***<br>***NO*** *selection*<br>***PROC****ess variable*<br>***DE****viation*<br>***EVent*** *-* ***ON*** *(SP Programming)*<br>***EVent*** *-* ***OFF*** *(SP Programming)* |
| FUNC | A2S2TY | Selections: NONE<br>PROC<br>DE<br>EVON<br>EVOF | ***ALARM 2 SET POINT 2 TYPE***<br>***NO*** *selection*<br>***PROC****ess variable*<br>***DE****viation*<br>***EVent*** *-* ***ON*** *(SP Programming)*<br>***EVent*** *-* ***OFF*** *(SP Programming)* |

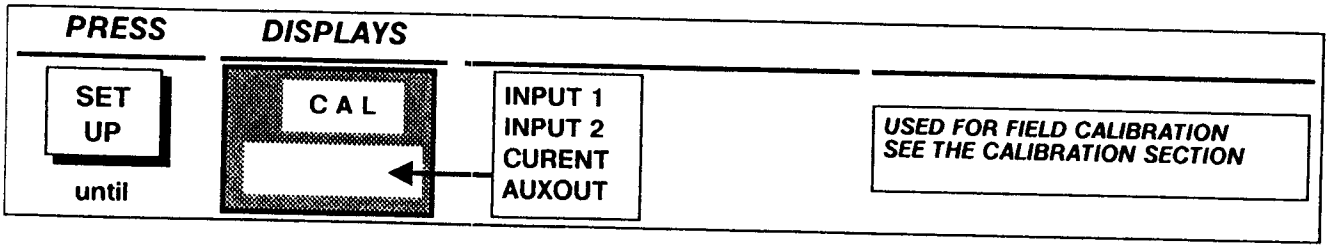
***Note: When Alarm type is reconfigured, the value of the current Alarm set pointdoes not automatically change to be consistent with the range of the new alarmtype until it is viewed on the display.***

***Continued Next Page***

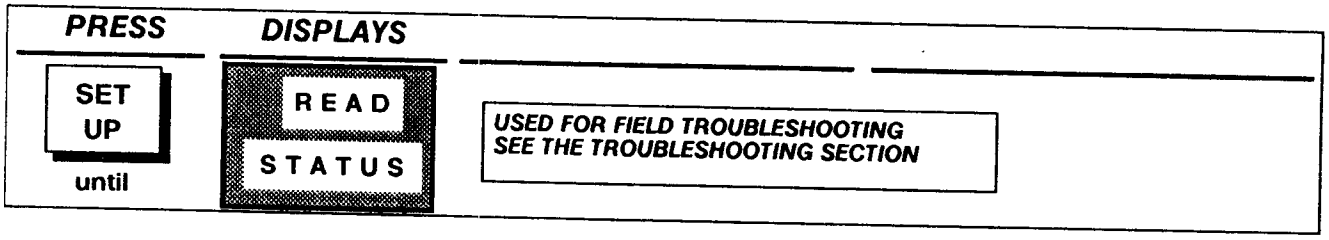
## ALARM PARAMETERS GROUP (Continued)



## CALIBRATION PARAMETERS GROUP




## STATUS GROUP



## CN1200 CONFIGURATION RECORD SHEET

| GROUP DESCRIPTION | FUNCTION DESCRIPTION | VALUE OR SELECTION | FACTORY SETTING |
|---|---|---|---|
| **TUNING** | GAIN | | 1.0 |
| | PB | | |
| | RATE T | | 0.00 |
| | I MIN | | 1.0 |
| | I RPM | | |
| | MANRST | | 0 |
| | GAIN 2 | | 5.0 |
| | PB 2 | | |
| | RATE2T | | 0.0 |
| | I2 MIN | | 0.2 |
| | I2 RPM | | |
| | CYC TI | | 20 |
| | CYC2TI | | 20 |
| | LOCK | | CAL |
| **ALGORITHM** | CTRALG | | PIDA |
| | INPUT 2 | | ENAB* |
| | OUTALG | | ** |
| **SP RAMP** | SPRAMP | | DISABL |
| | TI MIN | | 0 |
| | FINLSP | | 0 |
| | SP PROG | | DISABL |
| **A TUNE** | AT ENB | | DISABL |
| | OUTSTP | | 20 |
| | AT ERR | | NONE |
| **INPUT 1** | DECMAL | | 8888 |
| | UNITS | | NONE |
| | IN1TYP | | 10M |
| | IN1 HI | | 1000 |
| | IN1 LO | | 0 |
| | BIAS 1 | | 0 |
| | FILTR1 | | 0 |
| | BRNOUT | | NONE |
| | EMISS | | 1.0 |
| | FREQ | | 60 |
| | DISPLY | | PR N |
| **INPUT 2** | IN2 HI | | 1000 |
| | IN2 LO | | 0 |
| | FILTR2 | | 0 |

| GROUP DESCRIPTION | FUNCTION DESCRIPTION | VALUE OR SELECTION | FACTORY SETTING |
|---|---|---|---|
| **CONTROL** | SP SRC | | 1LOC |
| | RATIO | | 1.0 |
| | BIAS | | 0.0 |
| | PWR UP | | ALSP |
| | SP HI | | 1000 |
| | SP LO | | 0 |
| | ACTION | | REV |
| | OUT HI | | 100 |
| | OUT LO | | 0 |
| | DBAND | | 2.0 |
| | HYST | | 0.5 |
| | FAILSF | | 0 |
| | PB or GN | | GAIN |
| | MIN RPM | | MIN |
| **OPTIONS** | AUXOUT | | NONE* |
| | 0 PCT | | 0 |
| | 100 PCT | | 1000 |
| | REM SW | | NONE* |
| **ALARMS** | A1S1VA | | 90 |
| | A1S2VA | | 10 |
| | A2S1VA | | 95 |
| | A2S2VA | | 5 |
| | A1S1TY | | NONE |
| | A1S2TY | | NONE |
| | A2S1TY | | NONE |
| | A2S2TY | | NONE |
| | A1S1HL | | HI |
| | A1S1EV | | BEGN |
| | A1S2HL | | LO |
| | A1S2EV | | END |
| | A2S1HL | | HI |
| | A2S1EV | | BEGN |
| | A2S2HL | | LO |
| | A2S2EV | | END |
| | Note: | Fixed Alarm Hysteresis of 0.5% of (PV) Input Span | |

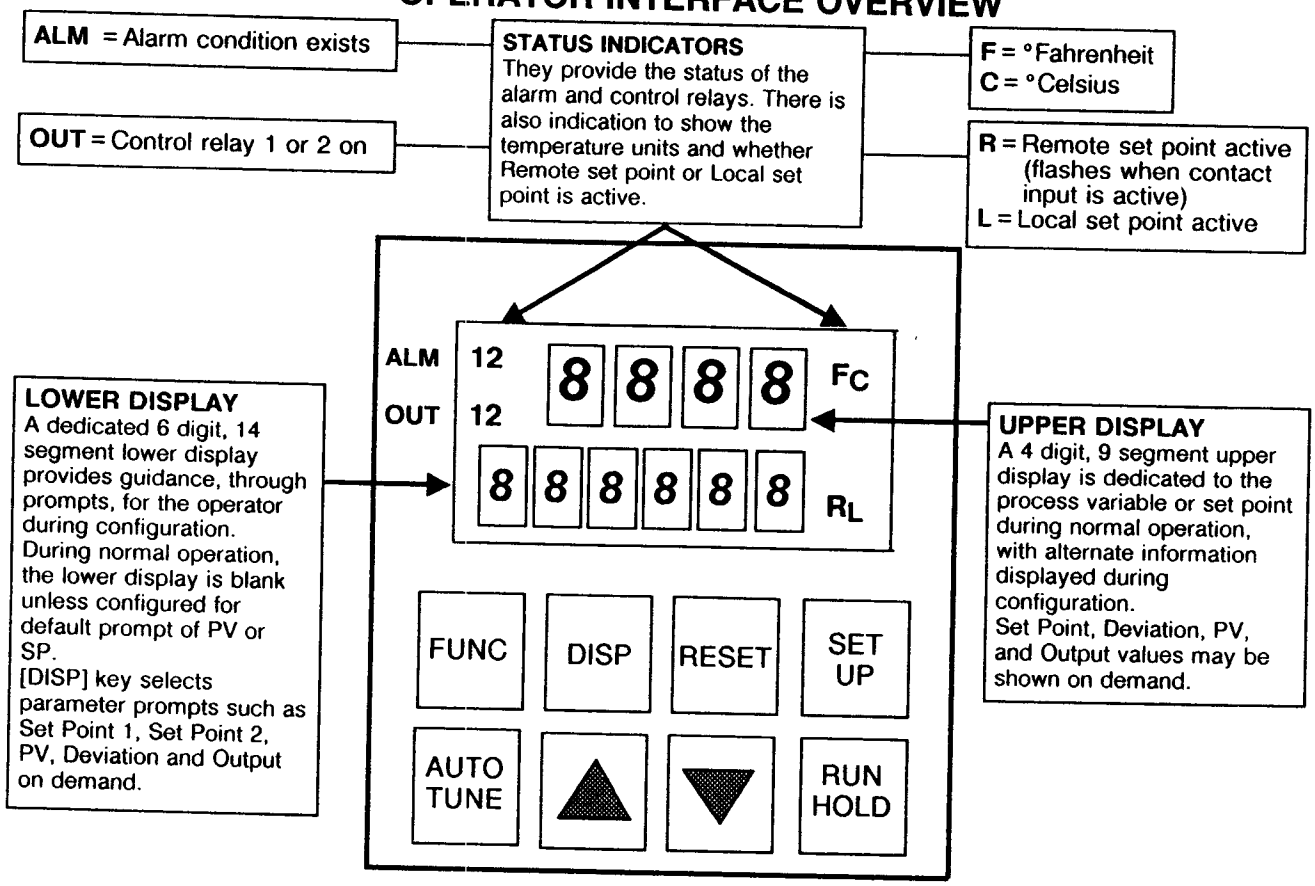
*Appears only if model number allows

**Selected according to model number

# OPERATION

# SECTION 4

## OPERATOR INTERFACE OVERVIEW




### Key Functions

Eight keys enable complete configuration and operation.

| | | | |
|---|---|---|---|
| FUNC | Selects functions within each configuration group. Also alternately selects local or remote set point or between local set points. | AUTO TUNE | Starts Autotune procedure. |
| DISP | Allows viewing of the local set point, remote set point, PV, output, or deviation. Returns the controller to normal operation from SET UP mode. | ▲ | Increases the set point, output, or configuration values. |
| RESET | Used to restore original value or selection when in SET UP mode. | ▼ | Decreases the set point, output, or configuration values. |
| SET UP | Scrolls through the configuration groups. | RUN HOLD | Initiates Run or Hold of set point ramp or set point program. |

Figure 4-1 Operator Interface

## POWERING THE CONTROLLER

### Apply Power

The CN1200 runs four on-going background tests to determine the status of the controller:

- *RAM TEST* - checks internal memory
- *CONFIGURATION TEST* - checks the controller's software configuration for inconsistencies
- *CALIBRATION* - check calibration of the controller's configured analog inputs (Input 1/Input 2) and outputs (Control Current/PV Output Voltage)
- *FACTORY CALIBRATION CHECKSUM* - check factory set input constants

If all these Background tests pass, the controller will function in a normal manner without any diagnostic message.

However, if one or more of these tests fail, the controller will go to FAILSAFE (**"FAILSF"** blinking in the lower display). Refer to the "Troubleshooting" section in this manual to identify and correct the problem.

## MONITORING THE CONTROLLER

### The Displays and Indicators

The displays and indicators on the operator interface as shown in figure 4-1 let you see what is happening to your process and how the controller is responding.

#### Displays

The CN1200 is a single display device except when in the SET-UP mode or **[DISP]** key is pressed.

The ***UPPER*** display area has 4 digits dedicated to the value of the process variable or set point during normal operation with alternate information displayed on demand during configuration. Set Point, Output, PV, and Deviation values can also be shown on demand using **[DISP]** key.

The ***LOWER*** display area has 6 digits which are normally blank unless configured to show SP or PV. It indicates Set Point, Output, PV, and Deviation prompts upon request. It also provides alphanumeric prompts during configuration as well as diagnostic and error messages when appropriate.

#### Indicators

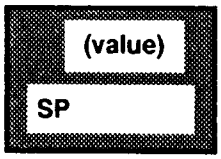
The annunciator displays, as shown in figure 4-1, give the following indications:

**ALM 1 2** = Alarm Relay ON/OFF status
**OUT 1 2** = Output (Control) Relay status
**F or C** = Temperature Units (°F or °C)
**R or L** = Active Set Point (LSP1 vs LSP2 or RSP)

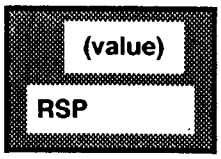
## MONITORING THE CONTROLLER (cont.)

### The [DISP] key

Press the **[DISP]** to scroll through the following operating parameters in the lower display:
NOTE - *The display will show only those that apply to your specific model and the way it was configured.*

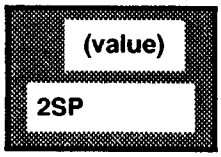



**Local Set Point 1**

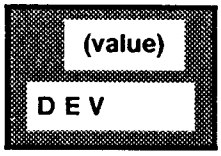



**Remote Set Point (when available)**

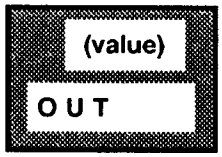
or



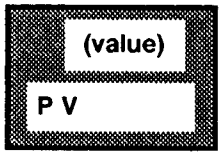

**Local Set Point 2 (when remote set point does not apply)**




**PV Deviation from Set Point**




**Output (for 3 Position Step Control, see Note 1)**




**Process Variable**

Press the **[RAISE/LOWER]** keys to change the value of set point 1 or set point 2 shown in the lower display.
*You cannot change Remote Set Point, Deviation or Output.*

### Timing out from Lower Display

The normal Process Variable display will automatically return in the upper display if the **[DISP]** key is not pressed for 60 seconds.

The **[DISP]** key is also used to return to normal control from SET-UP mode.

Note 1: When using 3 Position Step Control algorithm, the OUT display will indicate an ***estimated*** motor position of from 0 to 100%. The "Motor Time," the time it takes the motor to travel from 0 to 100%, is set under Set Up Prompt "CAL," "TPSC."

## MONITORING THE CONTROLLER (cont.)

### The [RAISE/LOWER] key

When you press the **[RAISE/LOWER]** keys to change a number, the least significant digit increments or decrements. However, if you momentarily press the opposite key while holding one of these two keys, the next significant digit begins to increment or decrement and each additional tap of the "opposite Key" will move the scrolling digit one more step to the left.
*Remember - you must hold in one key while the other is pressed.*

### Key Error

When a key is pressed and the prompt "KEY ERR" appears in the lower display. it will be for one of the following reasons:

- Parameter not available
- Not in SET-UP mode. Press **[SET UP]** key first.

### Diagnostic Error Messages

The CN1200 performs additional background tests to verify data and memory integrity. If there is a malfunction, an error message will be displayed. In the case of more than one, the one with the highest priority will appear on the lower display.

| *LOWER DISPLAY PROMPT* | *CONDITION* |
|---|---|
| **E FAIL** | Unable to write to non-volatile memory |
| **FAILSF** | Failsafe |
| **IN1FL** | Two consecutive failures of Input 1 integration |
| **IN2FL** | Two consecutive failures of Input 2 integration |
| **IN1 RNG** | Input 1 out-of-range |
| **IN2 RNG** | Input 2 out-of-range |
| **RV LIM** | Remote variable out-of-range NOTE: RV = (input 2 X ratio) + Bias |

IF ANY OF THESE ERROR MESSAGES OCCUR, REFER TO THE TROUBLESHOOTING SECTION IN THIS MANUAL.

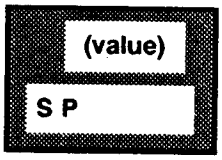
## START UP

### Tune the Controller

Make sure the controller has been configured properly and all the values and selections have been recorded on the Configuration Record Sheet.
Refer to the "TUNING" set-up group to ensure desired selections for "PB" or "GAIN", "RATE T", and "I MIN" or "I RPM" have been entered.
Tune your controller using the procedure found in Appendix B - Manual Tuning.

### Enter a Local Set Point

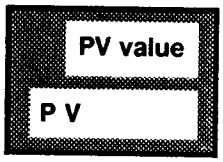
If SP is not normally displayed, press the **[DISP]** key until you see




Press the **[RAISE/LOWER]** keys to adjust the Local Set Point to the value at which you want the process variable maintained.

### Return to PV Display

If normal display is PV, press the **[RESET]** key after changing the set point. You will see




The controller will automatically adjust the output to maintain the process variable at the set point, if the controller is properly configured and tuned.

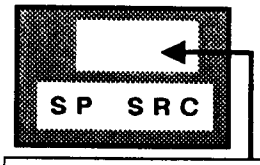
## OPERATING THE CONTROLLER

### Selecting the Set Point Source

You can select what you want your set point(s) to be:
*A Single Local Set Point*
*A Local Set Point and Remote Set Point*
*Two Local Set Points*

Press **[SET UP]** key until you see


Press the **[FUNC]** key until you see



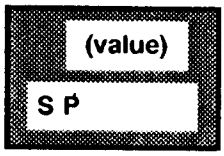

**Selections:1LOC** *1 Local Set Point Only*
**REM** *Remote Set Point*
**2LOC** *2 Local Set Points - Set Point 1/Set Point 2 key toggled via [FUNC] key*

Press the **[RAISE/LOWER]** keys to change selection.

Press the **[DISP]** key to return to normal control.

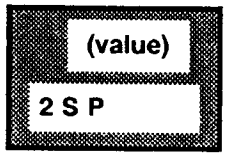
### Changing the Set Point(s)

Press the **[DISP]** key until you see




**Local Set Point 1**

or




**Local Set Point 2 (when configured)**

Press the **[RAISE/LOWER]** keys to change the Local Set Point value in the upper display. The display "blinks" if you attempt to enter Set point values beyond the high and low set point limits.

Press the **[RESET]** to return to PV display.
***YOU CANNOT CHANGE THE* REMOTE SET POINT *VALUE***

## OPERATING THE CONTROLLER (CONT.)

### Switching Between Local and Remote Set Points or Between 2 Local Set Points (when configured)

The current Set Point is indicated in the lower display (right side)

**R** = Remote Set Point (if configured) or Local Set Point 2 shown

Press the **[DISP]** key to show set point in the lower display.
Press the **[FUNC]** key to alternately select LOCAL or REMOTE set point or switch between 2 LOCAL set points (when configured).
NOTE: "KEY ERR" will appear in the lower display if the remote or 2nd local set point is not configured as a set point source.

REFER TO THE CONFIGURATION SECTION OF THIS MANUAL TO DISPLAY OR CHANGE THESE ASSOCIATED PARAMETERS

| *SET UP GROUP PROMPT* | *FUNCTION PROMPT* | *PARAMETER* |
|---|---|---|
| **CONTRL** | **SP HI** or **SP LO** | Set Point high and low limits |
| | **RATIO** | Used when remote set point selected |
| | **BIAS** | Used when remote set point selected |
| | **PWR UP** | Set Point at Power up - Local or Remote |

## OPERATING THE CONTROLLER (CONT.)

### Changing the Alarm Set Points

The Alarm Set Point Values can be changed for each of the four alarm set points.

Press the **[SET UP]** key until you see


Press the **[FUNC]** key until you see


**Range: Within Input 1 range for PROC type**
**Within Input 1 span for DEV type**

This is the Alarm 1 Set Point 1 Value.
Press the **[RAISE/LOWER]** keys to change the value in the upper display.

Press the **[FUNC]** key 3 more times and repeat the procedure after each press to set the other three alarm set point values.

**A 1 S 2 V A**
**A 2 S 1 V A**
**A 2 S 2 V A**

REFER TO THE CONFIGURATION SECTION OF THIS MANUAL TO DISPLAY OR CHANGE THESE ASSOCIATED ALARM PARAMETERS

| *SET UP GROUP PROMPT* | *FUNCTION PROMPT* | *PARAMETER* |
|---|---|---|
| **ALARMS** | **A1S1TY**<br>**A1S2TY**<br>**A2S1TY**<br>**A2S2TY** | Alarm Set Point type |
| | **A1S1HL**<br>**A1S2HL**<br>**A2S1HL**<br>**A2S2HL** | Alarm High or Low event |

A jumper selection configures the relay contacts for Normally Open (open with power off) or Normally Closed. Refer to the Installation Section under "Preliminary Checks" for Alarm relay contact information chart and jumper placement.

Press the **[DISP]** key to return to normal control.

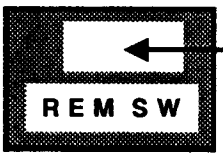
## OPERATING THE CONTROLLER (CONT.)

### Using Contact Input Option (Remote Switching)

The Contact Input Option detects the state of external contacts. On contact closure, the controller will respond according to how the controller is configured for Contact Input. Make the Contact Closure Selection as follows:

Press the **[SET UP]** key until you see


Press the **[FUNC]** key until you see




Press the **[RAISE/LOWER]** keys to make your selection in the upper display. See below.

| *SELECTION* | *ACTION ON CLOSURE* | *DISPLAY* |
|---|---|---|
| NONE | NONE | NONE |
| **LSP** | If you are currently using the remote SP, it switches out of remote SP and selects the local set point. | Flashing **R** Indicator |
| **SP2** | If you are currently using local SP, it switches out of first local set point and selects the 2nd local set point. | Flashing **R** Indicator |

Press the **[DISP]** key to return to normal control.

## OPERATING A SINGLE SET POINT RAMP

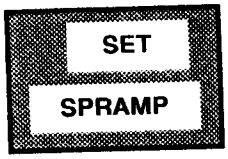
### Configuring a Single Set Point Ramp

You can configure a single set point ramp to occur between the current local set point and a final local set point over a time interval of from 1 to 255 minutes. You can RUN or HOLD the ramp at any time after starting the Ramp/Soak via the front panel.

### Procedure

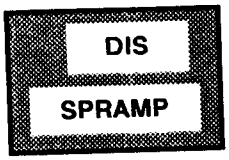
***Select SP RAMP Group***

Press the **[SET UP]** key until you see

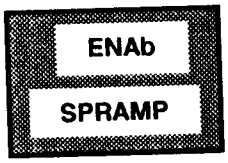



***Enable SP RAMP Function***

Press the **[FUNC]** key, you will see

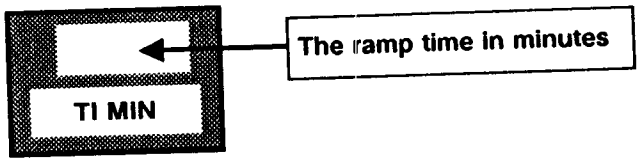



Press the **[RAISE]** key to enable the set point ramp function. You will see




***Set Ramp Time***

Press the **[FUNC]** key, you will see



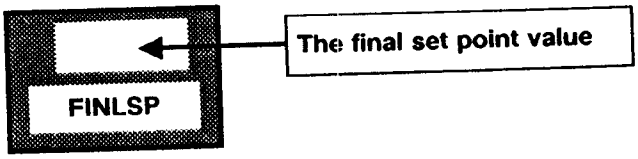

Press the **[RAISE/LOWER]** keys to change the upper display value to the number of minutes in which you want the final set point to be reached.

Setting Range = 0 to 255 minutes

NOTE: Entering 0 will imply an immediate step change in set point to the final set point.

***Set FINAL SP Value***

Press the **[FUNC]**, you will see




### Procedure (continued)

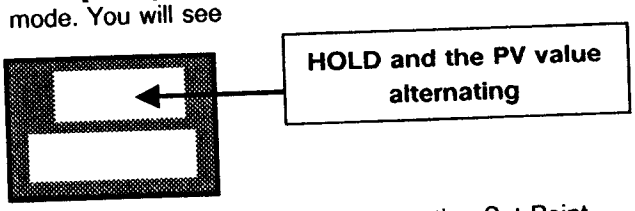
Press the **[RAISE/LOWER]** keys to change the upper display value to the desired final set point for the ramp.

Setting Range = within the set point limits.

### Running a Single Set Point Ramp

### Procedure

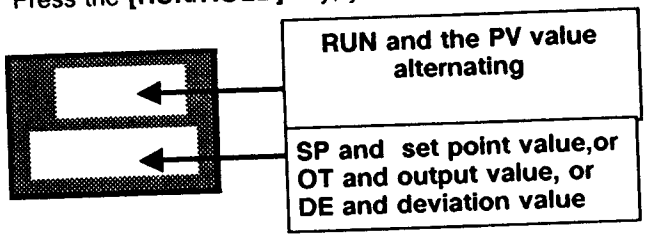
Press **[DISP]** key to exit Configuration (SET-UP) mode. You will see




Note: Press **[DISP]** key to verify starting Set Point.

***Start Ramp***

Press the **[RUN/HOLD]** key, you will see




The value in the lower display will be increasing or decreasing as the controller moves toward the final set point value.

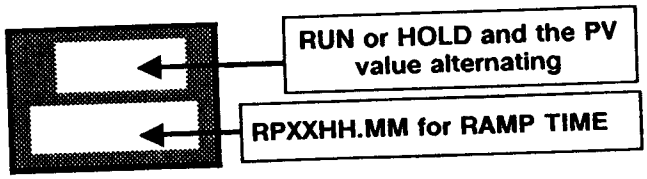
**NOTE: You cannot change the current local set point if the set point ramp is running, you can change it in "HOLD".**

Press the **[RUN/HOLD]** key to hold the ramp at the current set point value. Press again to continue run.

A "KEY ERR" prompt will appear if **[RUN/HOLD]** key is pressed while "SPRAMP" is disabled.

***View the Remaining Time for the Ramp or Soak***

Press the **[DISP]** key until you see




***End Ramp***

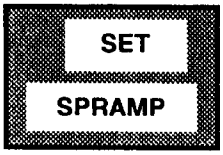
When the final set point value is reached, the "RUN" changes to "HOLD" in the upper display and the controller operates at the new final set point.

## Running a Single Set Point Ramp (continued)

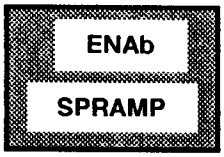
### Procedure (continued)

***Disable SP RAMP Function***

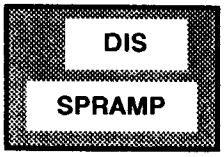
Press the **[SET UP]** key until you see




Press the **[FUNC]** key, you will see




Press the **[RAISE]** key to disable the set point ramp function. You will see




Press the **[DISP]** to return to normal display.

**NOTE:** Set point RAMP can be disabled while in RUN or HOLD.

# SET POINT RAMP / SOAK PROGRAMMING

## Introduction

The term "Programming" is being used here to identify the process for selecting and entering the individual ramp and soak segment data needed to generate the required Set Point vs Time profile (also called a program).

A segment is a ramp or soak function which together make up a set point program. Set Point Ramp / Soak Programming lets you configure 6 ramp and 6 soak segments to be stored for use as one program or several small programs. You designate the beginning and end segments to determine where the program is to start and stop.

Each ramp segment can be configured to be run in hours and minutes or degrees per minute.

All soak segments can have a guaranteed soak deviation which guarantees the value for each soak. This means that the timer will not start until the process variable (PV) is within the deviation limit (±) and then if the PV subsequently exceeds the deviation range, the timer holds until the PV enters the range.

All segments, Ramps or Soaks, have a minimum setting of one minute.

## Configuration

*What you will configure*

Basically, you will configure all the data that is relevant to each ramp and soak segment for a given set point versus time profile. The controller will prompt you through the sequence of segments and associated functions. These will include:

RAMP **TIME** or **RATE**

A ramp segment is the time it will take to change the set point to the next set point value in the program.

RAMPS are odd number segments. Segment #1 will be the initial ramp time.

Ramp time is determined in either

**TIME*** (Hours:Minutes)
Range 0-99 hrs : 59 min.
Enter value XX.YY where
XX = hours (0-99)
YY = minutes (1-59)
Minimum setting = 1 minute


or

**RATE*** (Degrees per Minute)
Range 0 to 999
Enter value XXX where
XXX = degrees/minute


*** This selection of time or rate is made at prompt "RP UNIT", the last prompt in the group.**

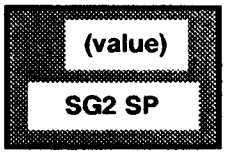
## Configuration (continued)

SOAK SET POINT RANGE **VALUES** AND DURATION **TIME**

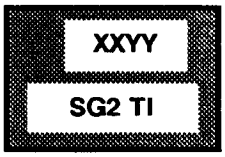
A soak segment is a combination of soak set point **(value)** and a soak duration **(time)**.

Soaks are even number segments.
Segment 2 will be the initial soak value and soak time.

The soak **SET POINT VALUE** must be within the set point high and low range limits in engineering units.




**SOAK TIME** is the duration of the soak and is determined in
**TIME** (Hours:Minutes)
Range 0-99 hrs : 59 min.
Enter value XX.YY where
XX = hours (0-99)
YY = minutes (1-59)
Minimum setting = 1 minute




**START SEGMENT NUMBER**
This designates the number of the first segment.

The selection is 1 to 11

**END SEGMENT NUMBER**
This designates the number of the last segment. It must be a soak segment (even number).

The selection is 2 to 12 (even only)

**RECYCLE NUMBER**
This number allows the program to recycle a specific number of times from beginning to end.

The range is 0 to 99

**GUARANTEED SOAK DEVIATION IN ENGINEERING UNITS**

Guaranteed soaks can be enabled or disabled via the configuration prompts. When enabled, all soak segments will have a positive or negative deviation value of 0 to 99 which guarantees the value for each segment.

Guaranteed soak segment values guarantee that the segments process variable is within the deviation for the configured soak time. There are no guaranteed soaks whenever the positive and negative deviation value is configured to 0, i.e., soak segments start timing soak duration as soon as the soak set point is first reached, regardless of where the process variable remains relative to the soak segment.

The value is the number in engineering units, above or below the set point, outside of which the timer halts.

The decimal location corresponds to input 1 decimal selection.

## SET POINT RAMP / SOAK PROGRAMMING (continued)

### Configuration (continued)

**PROGRAM TERMINATION STATE**
This function determines the status of the controller upon completion of the program.
LAST = controls to last set point.
LSP2 = Control using Local Set Point 2
***Will only appear if "2 Local Set Points" is selected under "Control" group.***

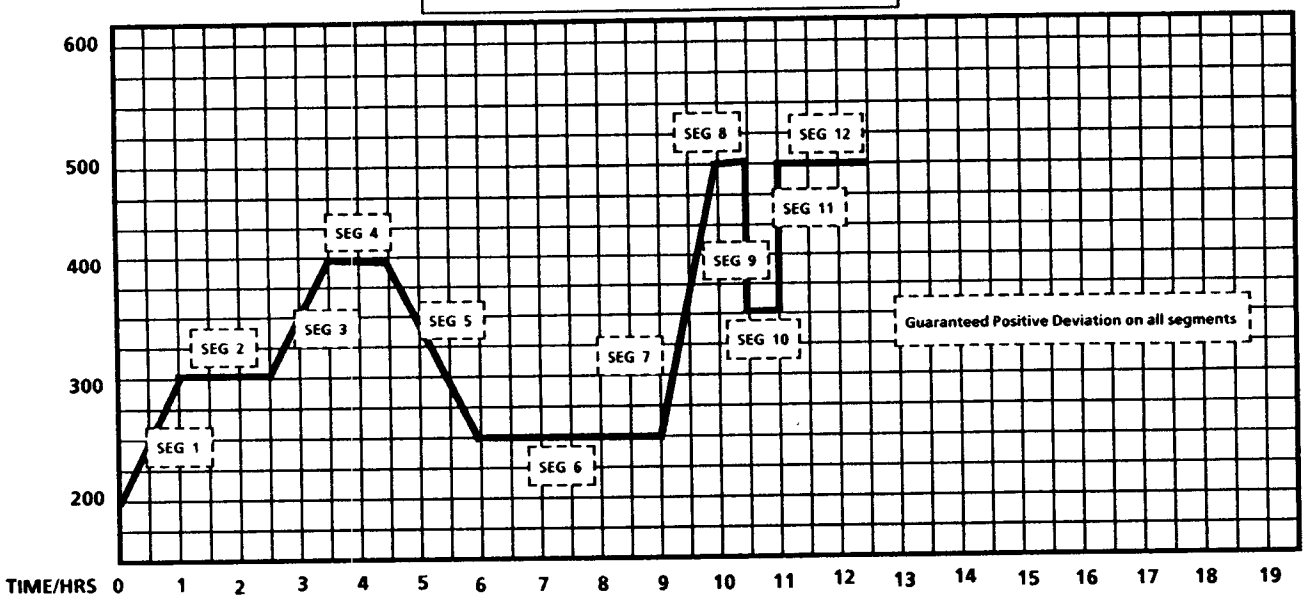
**PROGRAM STATE**
This selection determines the program state after completion of the program
DIS = Program is disabled
HOLD = Program on Hold

**RAMP UNIT**
This determines the engineering units for the ramp segments.
TIME = Hours : Minutes
RATE = Degrees / Minute

**DRAWING A RAMP / SOAK PROFILE**
Before you do the actual configuration, we recommend that you draw a Ramp/Soak profile in the space provided on the program record sheet (page 11) and fill in the associated information.

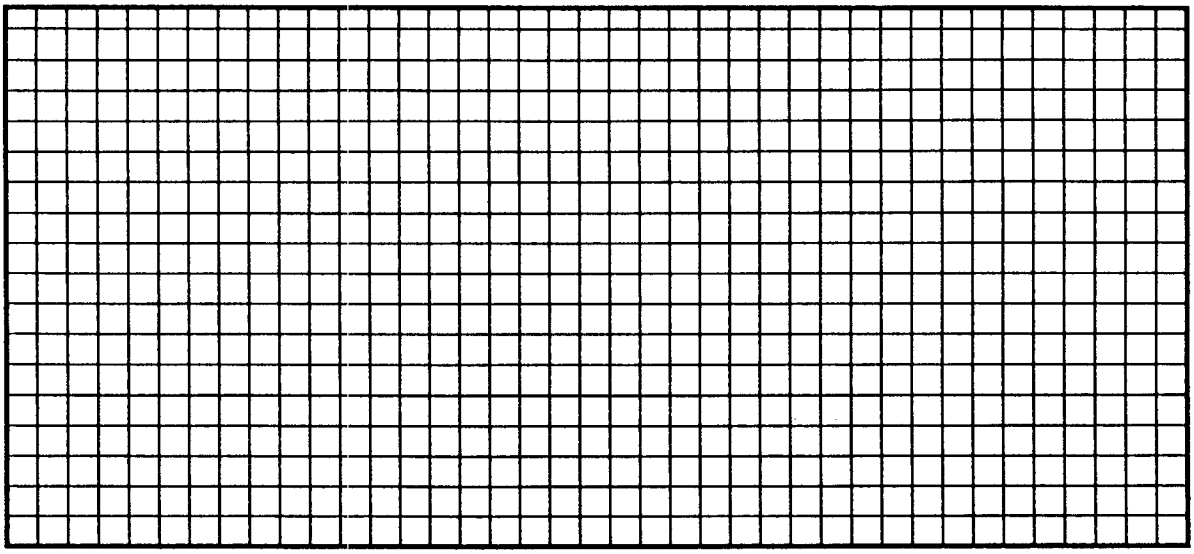
AN EXAMPLE OF A RAMP / SOAK PROFILE IS SHOWN ON THE NEXT PAGE.

## *RAMP / SOAK PROFILE EXAMPLE*




| PROMPT | FUNCTION | SEGMENT | VALUE | PROMPT | FUNCTION | SEGMENT | VALUE |
|---|---|---|---|---|---|---|---|
| STRSEG | Start Segment | | 1 | SG7 RP | Ramp Time | 7 | 1:00 |
| ENDSEG | End Segment | | 12 | SG8 SP | Soak Set Point | 8 | 500 |
| RECYCL | Number of recycles | | 1 | SG8 T1 | Soak Time | 8 | 0:30 |
| SOKDEV | Guaranteed Soak Deviation | | + 5 | SG9 RP | Ramp Time | 9 | 0 |
| SG1 RP | Ramp Time | 1 | 1:00 | SG10SP | Soak Set Point | 10 | 350 |
| SG2 SP | Soak Set Point | 2 | 300 | SG10TI | Soak Time | 10 | 0:30 |
| SG2 TI | Soak Time | 2 | 1:30 | SG11RP | Ramp Time | 11 | 0 |
| SG3 RP | Ramp Time | 3 | 1:00 | SG12SP | Soak Set Point | 12 | 500 |
| SG4 SP | Soak Set Point | 4 | 400 | SG12TI | Soak Time | 12 | 1:30 |
| SG4 TI | Soak Time | 4 | 1:00 | PG END | Controller Status | | Last SP |
| SG5 RP | Ramp Time | 5 | 1:30 | STATE | Program State | | Hold |
| SG6 SP | Soak Set Point | 6 | 250 | RPUNIT | Engr unit for Ramp | | Time |
| SG6 TI | Soak Time | 6 | 3:00 | | | | |

## *RAMP / SOAK PROFILE WORKSHEET*



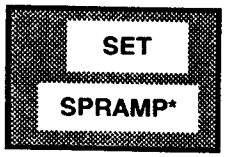
| PROMPT | FUNCTION | SEGMENT | VALUE | PROMPT | FUNCTION | SEGMENT | VALUE |
|---|---|---|---|---|---|---|---|
| STRSEG | Start Segment | | | SG7 RP | Ramp Time | 7 | |
| ENDSEG | End Segment | | | SG8 SP | Soak Set Point | 8 | |
| RECYCL | Number of recycles | | | SG8 T1 | Soak Time | 8 | |
| SOKDEV | Guaranteed Soak Deviation | | | SG9 RP | Ramp Time | 9 | |
| SG1 RP | Ramp Time | 1 | | SG10SP | Soak Set Point | 10 | |
| SG2 SP | Soak Set Point | 2 | | SG10TI | Soak Time | 10 | |
| SG2 TI | Soak Time | 2 | | SG11RP | Ramp Time | 11 | |
| SG3 RP | Ramp Time | 3 | | SG12SP | Soak Set Point | 12 | |
| SG4 SP | Soak Set Point | 4 | | SG12TI | Soak Time | 12 | |
| SG4 TI | Soak Time | 4 | | PG END | Controller Status | | |
| SG5 RP | Ramp Time | 5 | | STATE | Program State | | |
| SG6 SP | Soak Set Point | 6 | | RPUNIT | Engr unit for Ramp | | |
| SG6 TI | Soak Time | 6 | | | | | |

## SET POINT RAMP / SOAK PROGRAMMING (continued)

### Entering the Set Point Program Data

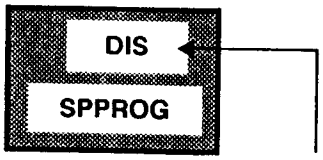
This procedure tells you what keys to press and what prompts you will see when entering the Set Point Program data.

Press **[SET UP]** key until you see

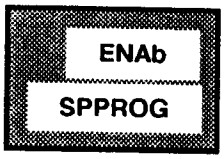



***Set SP RAMP to disable first**

Press the **[FUNC]** key, until you see




Press the **[RAISE]** key to **ENABLE** the Set Point Program function. You will see




Successive presses of the **[FUNC]** key will sequencially display all the functions and their value and selections as shown below.

### Entering the Set Point Program Data (continued)

***Changing Values or Selections***

Press **[RAISE/LOWER]** keys to change the value or selection in the upper display. If the display blinks, you are trying to make an unacceptable selection.

***Entering a Value or Selection***

Press the **[FUNC]** or **[SET UP]** key or any other key. The value or selection will be entered into memory. *Time Out* will also enter value or selection into memory.

***Exiting SET-UP mode***

Press the **[DISP]** key. This returns the display to the same state it was in immediately preceding entry into the SET-UP mode and stores any change you made.

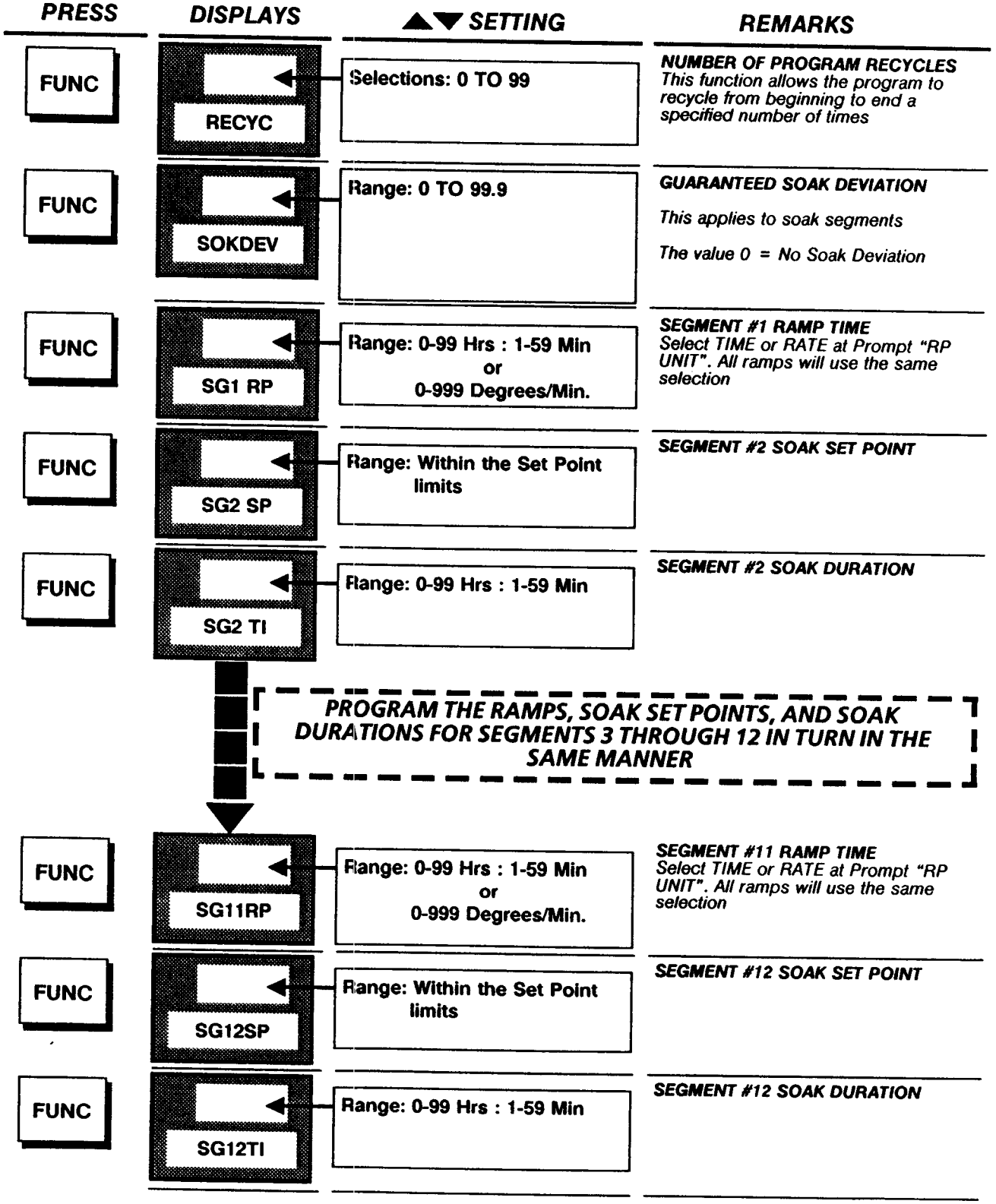
***Alarming on the Set Point Program***

You can configure an event to go ON or OFF at the beginning or end of any segment. Refer to the Configuration Section under "ALARMS" for details.

**NOTES:** ***All parameters can be changed while the program is disabled or in Hold mode. Any changes occurring to the present segment are ignored.***

***Set Point Programming cannot be enabled while an Auto Tune process is in operation.***

| *PRESS* | *DISPLAYS* | *▲▼ SETTING* | *REMARKS* |
|---|---|---|---|
| **SET UP** UNTIL | **SET** / **SPRAMP** | | *In Set Up mode,* **"SP RAMP "** *group displayed.* |
| **FUNC** UNTIL | **SP PROG** | **Selections:DIS ENAB** | ***SINGLE SET POINT RAMP*** ***Dis*** *- Disabled* ***Enab-*** *Must select ENABLED to use Set Point Program* ***Set Point RAMP must be disabled*** |
| **FUNC** | **STRSEG** | **Selections: 1 TO 11** | ***START SEGMENT NUMBER*** *This designates the number of the beginning segment* |
| **FUNC** | **ENDSEG** | **Selections:SK XX XX = 2 to 12** | ***END SEGMENT NUMBER*** *The program always ends in a Soak Segment (2,4,6,.....12)* |


PRESS
DISPLAYS
▲▼ SETTING
REMARKS
FUNC
RECYC
Selections: 0 TO 99
NUMBER OF PROGRAM RECYCLES
This function allows the program to recycle from beginning to end a specified number of times
FUNC
SOKDEV
Range: 0 TO 99.9
GUARANTEED SOAK DEVIATION
This applies to soak segments
The value 0 = No Soak Deviation
FUNC
SG1 RP
Range: 0-99 Hrs : 1-59 Min
or
0-999 Degrees/Min.
SEGMENT #1 RAMP TIME
Select TIME or RATE at Prompt "RP UNIT". All ramps will use the same selection
FUNC
SG2 SP
Range: Within the Set Point limits
SEGMENT #2 SOAK SET POINT
FUNC
SG2 TI
Range: 0-99 Hrs : 1-59 Min
SEGMENT #2 SOAK DURATION
PROGRAM THE RAMPS, SOAK SET POINTS, AND SOAK DURATIONS FOR SEGMENTS 3 THROUGH 12 IN TURN IN THE SAME MANNER
FUNC
SG11RP
Range: 0-99 Hrs : 1-59 Min
or
0-999 Degrees/Min.
SEGMENT #11 RAMP TIME
Select TIME or RATE at Prompt "RP UNIT". All ramps will use the same selection
FUNC
SG12SP
Range: Within the Set Point limits
SEGMENT #12 SOAK SET POINT
FUNC
SG12TI
Range: 0-99 Hrs : 1-59 Min
SEGMENT #12 SOAK DURATION

| PRESS | DISPLAYS | ▲▼ SETTING | REMARKS |
|---|---|---|---|
| FUNC | PG END | Selections: LAST<br>LSP2 | ***CONTROLLER STATUS AT PROGRAM END***<br>*LAST = Control at last set point in program*<br>*LSP2 = Control using Local Set Point 2*<br>*Will only appear if "2 local set points" is selected under "control" group* |
| FUNC | STATE | Selections: DIS<br>HOLD | ***PROGRAM CONTROLLER STATE AT END OF PROGRAM***<br>*Dis = terminates sp program*<br>*Hold = RUN key restarts set point program* |
| FUNC | RPUNIT | Selections: TIME<br>RATE | ***ENGINEERING UNITS FOR RAMP SEGMENTS***<br>*Time = Hours : Minutes*<br>*Rate = Degrees / Minute* |

## Running the Set Point Ramp / Soak Program

Make sure all the **SET POINT PROGRAM** function prompts have been configured with the required data.

An **"HOLD"** will appear in the upper display indicating the program is in HOLD state.

***RUN STATE***

Press **[RUN/HOLD]** key to initiate the Set Point Program.

An **"RUN"** will appear in the upper display indicating the program is running.

***HOLD STATE***

Press **[RUN/HOLD]** key to hold the Set Point Program.

An **"HOLD"** will appear in the upper display indicating the program is in the hold state. The set point holds at the current set point.

***EXTERNAL HOLD***

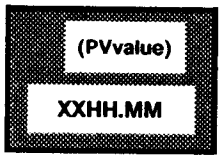
If Remote Switching Option is present on your controller, contact closure places the controller in the HOLD state if the Set Point Program is running.

**"HOLD"** will appear in the upper display indicating that the program has been placed in the HOLD state by the remote contact closure.

NOTE: The keyboard takes priority over the external switch for the RUN/HOLD function

***VIEWING PRESENT SEGMENT NUMBER AND TIME***

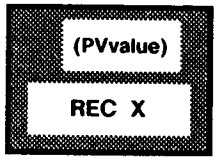
Press **[DISP]** key until you see




Time remaining in the SEGMENT in hours and minutes
XX = 1 to 12

***VIEWING NUMBER OF CYCLES LEFT IN PROGRAM***

Press **[DISP]** key until you see




**RECYCLES REMAINING**
Number of cycles remaining in the set point program
X = 1 to 99
You cannot change this number
***Will not appear if 0 is selected***

***END PROGRAM***

When the final segment is completed, the "RUN" in the upper display either changes to "HOLD" if configured for HOLD state, or disappears if configured for disable of Set Point Programming. The controller operates at the last set point in the program or will control using Local Set Point 2.

## AUTOTUNE

### Introduction

Autotune automatically calculates Gain (PROP BD), Rate (Derivative), and Reset (Integral) Time tuning constants on demand. These tuning constants are calculated at the end of the Autotune procedure based on the output step introduced onto the process. An output step causing an approximately 4.0% change in PV will be automatically generated when autotune is performed using the Auto step approach. If you select the manual step approach, you must select a specific output step size in % that will be large enough to result in at least a 2.5% PV change. These constants, once calculated, are automatically entered into the controller memory in their normal locations.

Autotune provides the theoretical PID constants which results in little or no overshoot. This usually provides a conservative Gain value which results in a slower response to insure no overshoot. If faster response is desired and some overshoot can be tolerated, the calculated Gain value can be increased by a factor of 2 or perhaps more or PB decreased by 2. Of course, the process loop must be checked for stability.

Alarm 1 is available to protect the process during Autotune. If alarm set point is exceeded during the sampling period Autotune will abort. This eliminates the need to continually monitor the Autotune sequence.

There is a SHORT TUNE feature that lets you obtain approximate tuning constants by prematurely implementing the Autotune calculation before the PV has fully lined out during the Autotune process.

Autotune is most effective when implemented in the region of PV where you plan to operate. Don't Autotune at 900°F if you plan to operate at 1300°F. The process dynamics may be different at different energy levels. Always try to start Autotune 2.5% below your operating set point.

In summary, Autotune and Short Tune can be used as a flexible tool to quickly identify Gain, Rate, and Reset time constants. Further tuning can then be done using these values as a starting point.

**IMPORTANT:** Autotune will function only when the controller is in a closed loop system. Attempts to Autotune open loop will result in "ABORT" error message.

**NOTE: *Set Point Ramp* and *Set Point Programming* cannot be enabled while Autotune is in operation.**

### Configuring for Autotune

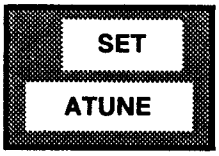
Before starting Autotune, you must

- enable the Autotune feature,
- select whether you want the controller to generate an output step automatically (ASTP) or whether you want to enter an output step size manually (MSTP).
- set alarm 1 Set Point 1 to proper type and value to protect process if desired -- otherwise set to *NONE* to avoid accidental abort.
- Select the set point you want to line out at after Autotune.

### Procedure

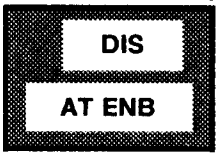
***Enter Configuration Mode***

Press **[SET UP]** key until you see

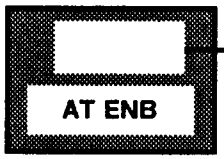



***Enable Autotune and Select Output Step Type***

Press **[FUNC]** key, you will see




Press **[RAISE/LOWER]** keys to select "**ASTP**" OR "**MSTP**" in upper display. Press again to select step type.

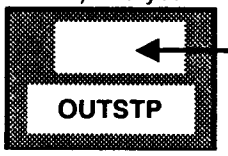



**ASTP** **(Will generate the output step automatically) or**

**MSTP** **(Requires you to manually enter a step size value under prompt "OUT STP")**

***Select Output Step Size for MSTP***

Press the **[FUNC]** key (***only if selection MSTP is made***) and you will see




**the value of the controller output step size in %**

Press **[RAISE/LOWER]** keys to choose an output step in percent that will be applied to the output of the controller when Autotune is initiated.

This step must be large enough to result in a PV change of at least 2.5% of span. Use as large a step as possible.

Range of Setting = −100 to + 100% of output.

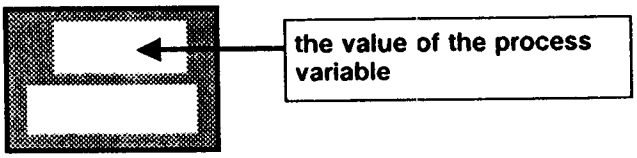
NOTE: The process can be tuned using either an upscale or downscale step change.

## Configuring for Autotune (continued)

## Procedure (continued)

### *Exit Configuration Mode*

Press **[DISP]** key once to exit configuration mode and you will see




## Starting Autotune

### *ASTP (Automatic Step Change)*

In order to start Autotune using Auto step, simply let the ***controller PV line out (PV = SP)*** and press **[AUTOTUNE]** key. (See "***Start Autotune***") The controller automatically calculates an output step which is intended to provide a PV transient of 4%.

### *MSTP (Manual Step Change)*

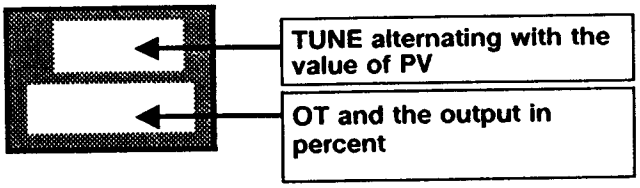
In order to start Autotune in manual step approach,

- make sure you have selected an output step value that will result in a PV change of at least 2.5%
  ***(see "OUTSTP" on previous page)***
- let the **controller PV line out (PV = SP)** and press **[AUTOTUNE]** key. (See "***Start Autotune***")
  This will cause the controller to go into a quasi-manual mode and generate the step change in output as selected at prompt "OUTSTP".

### *Start Autotune*

Press the **[AUTOTUNE]** key. The Autotune algorithm automatically introduces the output step change (manual or automatic) to the process.

"**TUNE**" appears in the upper display to indicate that Autotune is in progress. You will see



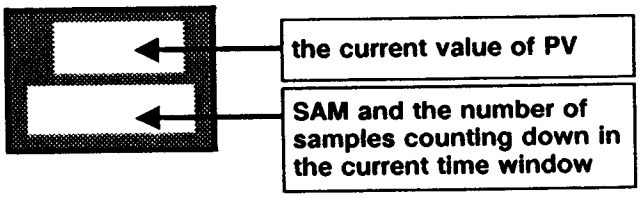

The algorithm samples the step response of the process until that response has lined out. The line out time depends on the process reaction time. Autotune will abort if no line-out has occurred after 6.07 hours of sampling.

In "Auto Step" if the resultant PV step is less than 2.5% the Autotune will abort.

### *Viewing the Remaining Samples*

You can view the remaining number of samples left in the most recently initiated time window. (See next page.)

Press the **[DISP]** key until you see




**NOTE:** ***The output value upon which the output step is based is not the instantaneous displayed output value, but an internal averaged value of the output.***

## STEP RESPONSE SAMPLING

### Introduction

When Autotune is initiated, the controller output is step changed. The algorithm samples the step response of the process until the response has lined out (PV stabilized). The line-out time depends on the process reaction time.

### Time Window

A time window is the time it takes for the algorithm to sample the step response of the process for line-out. The first time window takes 256 PV samples at a rate of one every 1/3 second. The lower display counts down from 256 until it reaches 0 (total time elapsed = 85-1/3 seconds) at which time the algorithm checks for line-out. If line-out has not occurred, another time window takes 128 samples at a rate of one every 2/3 second. The lower display counts down from 128 until it reaches 0 (total time elapsed for two windows = 170-2/3 seconds) and again checks for line-out. If there is no line-out, a third window of 128 samples, at 1-1/3 seconds each, is initiated. As long as there is no line-out, this time windowing will continue 6 more times, each time sampling at a lower rate. See Table 4-1 to determine what time window the controller is displaying. By determining how long one sample takes (column C in table), you can find out what time window the controller is displaying (column A) and how long the time window will last (column D).

For Example: If one sample takes 42-2/3 seconds then the Autotune algorithm is in the #8 time window and will take 91 minutes to complete. At the end of window #8 the total time elapsed for all windows is 3.03 hours. If line-out has not occurred after the 9th window (6.07 hours) the Autotune will abort.

**TABLE 4-1 -- Time Windows**

| A | B | C | D | E |
|---|---|---|---|---|
| **Window Number** | **Total Samples*** | **Sampling Time** | **Time for This Window** | **Total Time Window** |
| 1 | 256 | 1/3 sec | 85-1/3 sec | 85-1/3 sec |
| 2 | 128 | 2/3 sec | 85-1/3 sec | 170-2/3 sec |
| 3 | 128 | 1-1/3 sec | 170-2/3 sec | 341-1/3 sec |
| 4 | 128 | 2-2/3 sec | 341-2/3 sec | 11-1/4 min |
| 5 | 128 | 5-1/3 sec | 11-1/4 min | 22.7 min |
| 6 | 128 | 10-1/3 sec | 22.7 min | 45.5 min |
| 7 | 128 | 21-1/3 sec | 45.5 min | 91.0 min |
| 8 | 128 | 42-2/3 sec | 91.0 min | 3.03 hrs |
| 9 | 128 | 85-1/3 sec | 3.03 hrs | 6.07 hrs |

*The lower display indicates the number of samples remaining in the present window number.

## "SHORT TUNE" FEATURE

### Introduction

This feature lets you obtain approximate tuning constants by prematurely implementing the Autotune calculation before the PV has fully lined-out during the Autotune process. This typically results in a different Gain value; however, Rate and Reset time will be relatively close to the optimum calculated value. You can then increase gain by a factor of 2 to 4 until an acceptable stable closed loop response is achieved. -- all in a short time -- without prior process knowledge or trial and error guesswork.

### Implementing Short Tune

After implementing the Autotune process, press **[AUTOTUNE]** key while the controller is sampling the process response. "**tunE**" in the upper display will change to "tunE acknowledging the short tune procedure.

At the end of the time window (when lower display SAM = 0), the Autotune algorithm will calculate constants based on the PV response up to that time if the PV has changed by at least 2.5% of span.

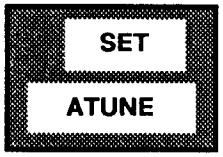
## AUTOTUNE ERROR CODES

When an error is detected in the Autotune process, the message "**ABORT**" will appear in the lower display. Access function prompt "**ATERR**" to determine what is causing the error.

Refer to Table 4-2 for the definition of the error code and what action to take to correct it.

### *Access "AT ERR"*

To examine the autotune error code, press the **[SET UP]** key until you see




Press the **[FUNC]** key until you see

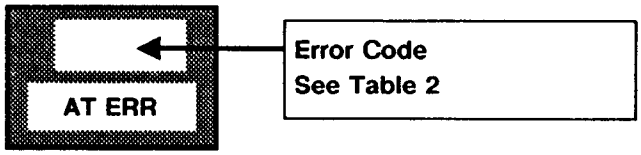



**TABLE 4-2 -- Error Codes**

| Error Code (Upper Display) | Definition | Action to Take |
|---|---|---|
| **OTLM** | OUTPUT GREATER THAN HIGH OUTPUT LIMIT OR LESS THAN LOW OUTPUT LIMIT | • Check the output limits under "CONTRL" function prompts "OUTHI" and "OUTLO." See Configuration Section.<br>• If you are using a manual step change, reconfigure "OUTSTP" prompt under ATUNE group.<br>• Restart Autotune procedure. |
| **DPLM** | OUTPUT GREATER OR LESS THAN THE HEAT/COOL LIMITS<br>The step entered cool zone when tuning heat or the step entered heat zone when tuning cool. | • Reconfigure the step size to fall only within heat or cool zone. Autotune function prompt "OUTSTP."<br>• Restart Autotune procedure. |
| **ALM 1** | ALARM 1 LIMIT EXCEEDED<br>Alarm 1 error code will show if you have configured alarm 1 to activate at a value of a parameter and it is exceeded. | • Check alarm type and limit under "ALARM" function prompts "A1S1VA" and "A1S1TY."<br>• Reconfigure smaller step size.<br>• Restart Autotune procedure. |
| **LOWP** | PV CHANGE NOT GREATER THAN 2.5%<br>The algorithm has sampled the process step response for a period of time (6.07 hours max) and the PV has lined out with less than a 2.5% change. | • Reconfigure to MSTP and use a larger step size "ATUNE" function prompt "OUTSTP."<br>• Restart Autotune procedure. |

***TABLE CONTINUED ON NEXT PAGE***

**TABLE 4-2 -- Error Codes (continued)**

| Error Code (Upper Display) | Definition | Action to Take |
|---|---|---|
| **IDFL** | PROCESS IDENTIFICATION FAILURE<br>Autotune has aborted due to either excessive noise or a step response interruption, or because the process cannot be tuned. | • Excessive noise<br>– reconfigure larger step size "AUTOTUNE" function prompt "OUT STP."<br>• Step response interruption<br>– make sure interruption is not repeated.<br>– restart Autotune procedure.<br>• Untunable process -- contact local application engineer. |
| **ILIM** | RESET LIMITS EXCEEDED<br>The reset value has exceeded high or low limits. The unit will control at high or low limits<br>Low = 0.02 minutes<br>High = 50.00 minutes | • Increase or decrease PB or Gain to bring reset within the defined limits.<br>• Check the final control element for proper application.<br>• Untunable process -- contact local application engineer. |
| **PLIM** | GAIN LIMITS EXCEEDED<br>The Gain value has exceeded high or low limits. The unit will control at high or low limits.<br>Low = 0.1<br>High = 999.9 | • Increase or decrease Reset to bring Gain or PB to within defined limits.<br>• Check the final control element for proper application.<br>• Untunable process -- contact local application engineer. |
| **AbRT** | MANUAL ABORT<br>Autotune has been manually aborted. | • Autotune will abort if the [RESET] key is pressed during Autotune. |
| **INP1** | INPUT ERROR<br>Any input is outside of its 0 to 100% range, or any input failed. | • Make sure the range and actuation are configured properly.<br>• Check the input source(s). |
| **RAMP** | AUTOTUNE ILLEGAL DURING RAMP OR SET POINT PROGRAM | • Wait until Ramp is complete and restart Autotune. |
| **RMSW** | AUTOTUNE IS ABORTED WHEN EXTERNAL SWITCH IS DETECTED | • Restart Autotune -- Do not interrupt with digital input (Remote Switching) contact closure. |

## ABORTING AUTOTUNE

To abort Autotune and return to the last previous operation (SP or output level), press **[RESET]** key to abort the Autotune process.

Autotune will abort automatically if alarm 1 set point is exceeded or if the Autotune procedure requires more than 9 windows.

## COMPLETING AUTOTUNE

When Autotune is complete,

- The calculated tuning parameters are stored in their proper memory location in the controller.
- The controller will control at the local set point using the newly calculated tuning constants.

## RESTARTING AFTER A POWER LOSS

If the power to the controller fails and power is reapplied, the controller goes through the power-up tests then goes to a user configured ***FAILSAFE OUTPUT VALUE.***

### Set The Failsafe Output Value

Press the**[SET UP]** key until you see


Press the **[FUNC]** key until you see


**Range: Within the range of the output**
**0 to 100 for Relay**
**-5 to 105 for Current**

Press the **[RAISE/LOWER]** keys to select a Failsafe Output Value.

Press the **[DISP]** key to return to normal control.
At Power up, the Output will be at the value set here.

# CALIBRATION

# SECTION 5

This section basically has two parts, **Input Calibration** and **Output Calibration.**

Each part has the following sub-headings:

- ***Introduction*** - when calibration is required.
- ***Preliminary Procedures*** - disconnecting the field wiring, setting internal DIP switches, etc.
- ***Equipment Needed*** - what you need to do the calibration.
- ***Set Up*** - how to set-up the controller for the calibration procedure, i.e. terminal connections, etc.
- ***Calibration Procedures*** - how to do the calibration.

Also included in this section is a procedure for setting Motor Travel Time when you are using 3 Position Step Control.

***INPUT CALIBRATION*** - describes the field calibration procedures for Input 1 and Input 2.

- ***Input 1*** - can be calibrated for a variety of thermocouples, RTDs, Radiamatic, mA, mV, and Volt ranges.
  You select which type of input you will be calibrating by SETTING A DIP SWITCH inside the chassis on the Main Printed Wiring board, then connect a calibrating device as described in SET UP and following the PROCEDURE for Input 1.

- ***Input 2*** - can be calibrated for two ranges: 1 to 5 Volts or 4 to 20 mA., by connecting a calibrating device as described in SET UP and following the PROCEDURE for Input 2.

***OUTPUT CALIBRATION*** - describes the field calibration procedures for Current Proportional Output and PV (Auxiliary) Output.

- ***Current Proportional Output*** - can be calibrated for a range of 4 to 20 milliamperes by connecting a calibrating device as described in SET UP and following the PROCEDURE.

- ***PV (Auxiliary) Output*** - can be calibrated for a range of 0 to 5 Volts or 1 to 5 Volts by connecting a calibrating device as described in SET UP and following the PROCEDURE.

## INPUT CALIBRATION

### Introduction

This part describes the field calibration procedures for input 1 and input 2. However, this procedure should only be implemented if the factory calibration of the desired input range is not within specifications. Note that every CN1200 controller contains all input ranges fully factory calibrated and ready for configuration to the range by the user. It should not be necessary to recalibrate the controller.

**Note also, that the field calibration will be lost if a change in input type configuration is implemented at a later time. The input will revert to whatever is stored in memory.**

### Minimum and Maximum Range Values

Calibrate the CN1200 controller to the minimum (0%) and maximum (100%) range values for your particular sensor. If you have a two input controller, calibrate each input separately.

Select the voltage or resistance equivalent for 0% and 100% range values from Table 5-1 on page 5-2. Use these values when calibrating the inputs.

**TABLE 5-1 -- Voltage and Resistance Equivalents for 0% and 100% Range Values**

| Sensor Type | PV Input Range | | Range Value | |
|---|---|---|---|---|
| | °F | °C | 0% | 100% |
| B T/C | 150 to 3300 | 66 to 1815 | 0.009 mV | 13.763 mV |
| E T/C | –100 to 1832 | –73 to 1000 | –3.976 mV | 76.358 mV |
| E (low) T/C | –100 to 1100 | –73 to 593 | –3.976 mV | 44.547 mV |
| J (T/C) | 0 to 1600 | –18 to 871 | –0.885 mV | 50.059 mV |
| J (low) T/C | 0 to 900 | –18 to 482 | –0.885 mV | 26.396 mV |
| K T/C | 0 to 2400 | –18 to 1316 | –0.692 mV | 52.939 mV |
| K (low) T/C | –20 to 1000 | –29 to 538 | –1.114 mV | 22.251 mV |
| N (NiNiMoly) T/C* | 32 to 2500 | 0 to 1371 | –0.001 mV | 71.330 mV |
| R T/C | 0 to 3100 | –18 to 1704 | –0.089 mV | 20.275 mV |
| S T/C | 0 to 3100 | –18 to 1704 | –0.092 mV | 17.993 mV |
| T T/C | –300 to 700 | –184 to 371 | –5.341 mV | 19.095 mV |
| T (low) T/C | –80 to 500 | –63 to 260 | –2.225 mV | 12.572 mV |
| C ($W_5W_{26}$) T/C | 0 to 4200 | –18 to 2316 | –0.234 mV | 37.066 mV |
| NIC Nicrosil Nisil T/C | 0 to 2372 | –17.8 to 1300 | –0.461 mV | 47.502 mV |
| **RTD IEC alpha = 0.00385** 100 ohms (3 wire type) | –300 to 900 | –184 to 482 | 25.18 ohms | 274.96 ohms |
| | 0 to 300 | –18 to 149 | 93.03 ohms | 156.90 ohms |
| **Radiamatic** | 1400 to 3400 | 760 to 1871 | 0.99 mV | 57.12 mV |
| **Linear** Milliamps | 4 to 20 mA | | 4 mA | 20 mA |
| Millivolts | 0 to 10 mV | | 0 mV | 10 mV |
| | 0 to 100 mV | | 0 mV | 100 mV |
| Volts | 0 to 1 Volt | | 0V | 1V |
| | 0 to 5 Volts | | 0V | 5V |
| | 0 to 10 Volts | | 0V | 10V |
| | 1 to 5 Volts | | 1V | 5V |

*Note: This is not for the Nicrosil-Nisil thermocouple type which is sometimes referred to as Type N.

# INPUT CALIBRATION (continued)

## *Preliminary Procedures*

**Disconnect Field Wiring**
Depending on which input (#1 or #2) you are going to calibrate, tag and disconnect any field wiring connected to the input terminals on the rear of the controller. (See Figure 5-1.)

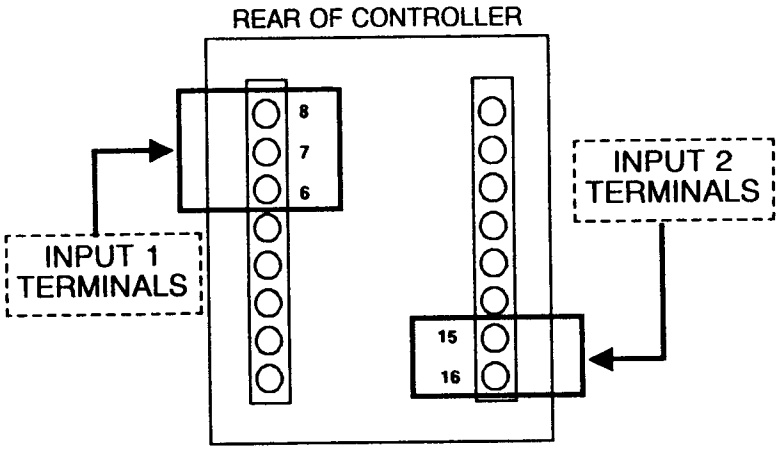


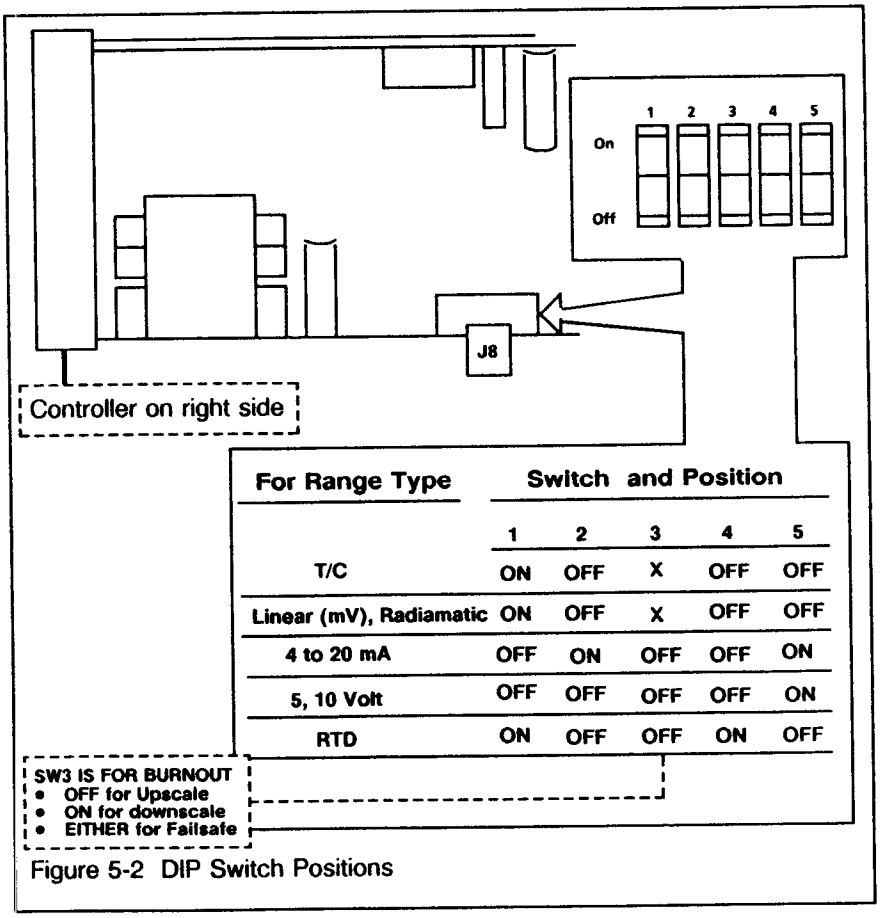

Figure 5-1 Input Connections

**Set the DIP Switches for Input 1**
Before you calibrate Input 1, you must check an internal DIP switch to make sure the switches are set for the correct Input type;

*Thermocouples,*
*Millivolts,*
*Radiamatic,*
*RTD,*
*Milliamp, or*
*Voltage*

*Procedure*

1. Loosen the screw on the front of the controller and pull the chassis out of the case. Lay the chassis on the right side.
2. The switches are located at position J8 on the main assembly board. (See Figure 5-2.)
3. Set the switches for the range type desired according to the table in Figure 5-2.




| For Range Type | Switch and Position | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| T/C | ON | OFF | X | OFF | OFF |
| Linear (mV), Radiamatic | ON | OFF | X | OFF | OFF |
| 4 to 20 mA | OFF | ON | OFF | OFF | ON |
| 5, 10 Volt | OFF | OFF | OFF | OFF | ON |
| RTD | ON | OFF | OFF | ON | OFF |

SW3 IS FOR BURNOUT
- OFF for Upscale
- ON for downscale
- EITHER for Failsafe

Figure 5-2 DIP Switch Positions

# INPUT CALIBRATION (continued)

## *Equipment Needed*

- Screwdriver

**THERMOCOUPLE INPUTS**

- A calibrating device with ±0.02% accuracy for use as a signal source.
- Thermocouple extension wire that corresponds with the type of thermocouple that will be used with the controller input.

*If you are using an Ice Bath*

- Two insulated copper leads for connecting the thermocouple extension wire from the ice baths to the mV source.
- Two containers of crushed ice.

**RTD (Resistance Thermometer Device)**

- A Decade Box, with ±0.02% accuracy, capable of providing stepped resolution of .01 ohm.
- Three insulated copper leads for connecting the Decade Box to the controller.

**MILLIVOLTS, VOLTS, MILLIAMPERES, or RADIAMATIC**

- A calibrating device with ±0.02% accuracy for use as a signal source.
- Two insulated copper leads for connecting the calibrator to the controller.

## *Set-Up (SEE FIGURE 5-3)*

**THERMOCOUPLE INPUTS (Ice Bath)**

- Connect the copper leads to the calibrator.
- Connect a length of thermocouple wire to the end of each copper wire and insert each junction point into an ice bath.
- Connect the thermocouple extension wire to the terminals for input 1.

**THERMOCOUPLE INPUTS (T/C Source)**

- Connect the thermocouple extension wire to the terminals for input 1.

**RTD, MILLIVOLT, VOLTS, MILLIAMPERES, or RADIAMATIC**

- Connect the copper leads from the calibrator to the input 1 terminals as shown in Figure 5-3.
- Place current source at zero before switching on.
- Do not switch current sources on/off while connected to the CN1200 input.

***NOTE: For Radiamatic Inputs only set Emissivity value to 1.0. See Set Up Prompt "INPUT 1" Function Prompt "EMISS."***

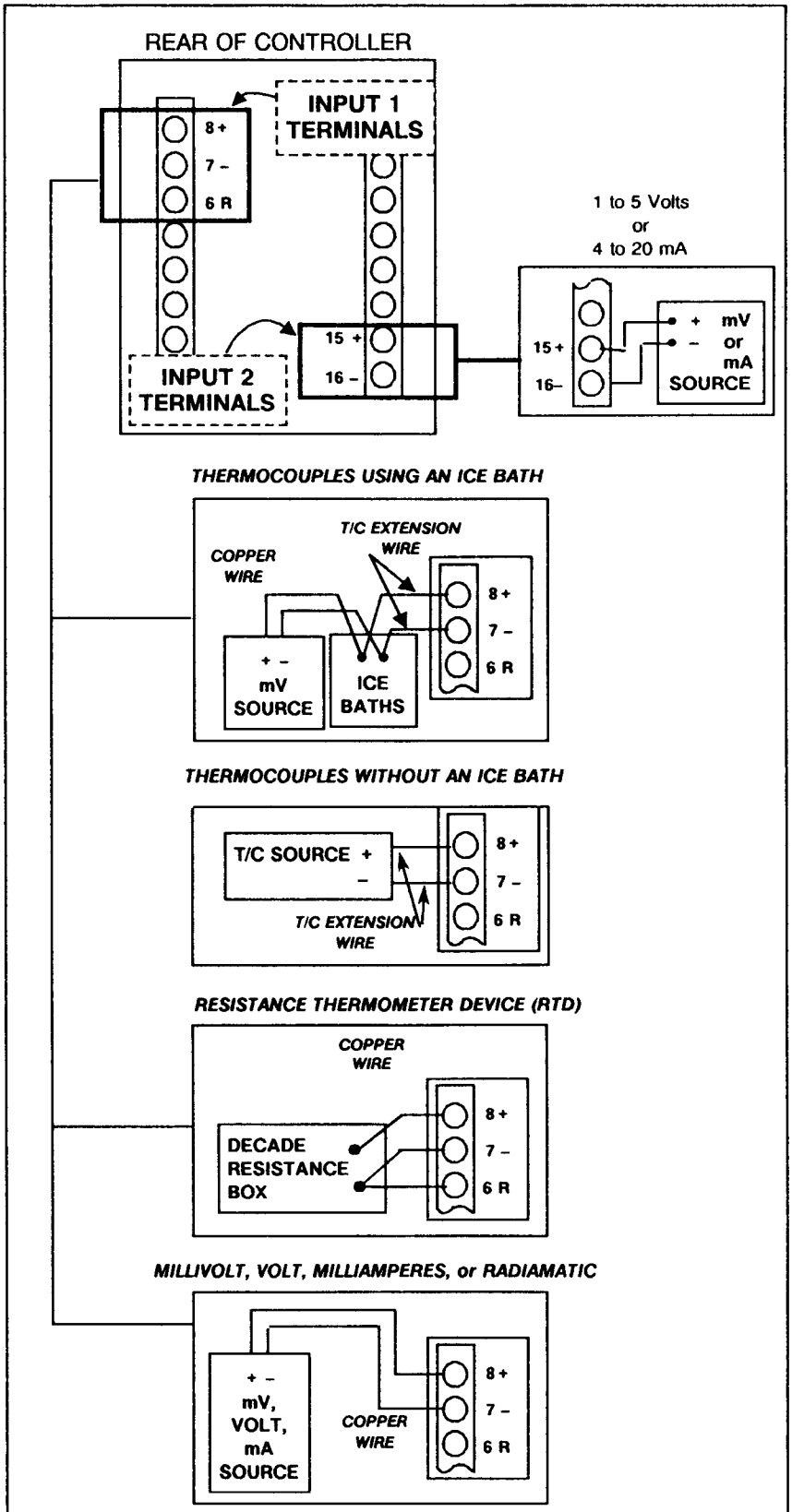



Figure 5-3 Calibration Equipment Connections

# INPUT CALIBRATION (continued)

## *INPUT 1 CALIBRATION PROCEDURE*

Apply power and let the controller warm up for 15 minutes before you calibrate.

**NOTE:** Set "LOCK" in tuning section to "NONE."

**CAUTION: For Linear inputs, avoid step changes in inputs. Vary smoothly from initial value to the final 100% value.**

Please read **"SET UP"** on previous page before beginning the procedure.

See Table 5-1 on page 5-2 for Voltage vs Resistance equivalent.

| *PROCEDURE* | *PRESS* | *DISPLAYS* | *ACTION* |
|---|---|---|---|
| Enter Calibration Mode | SET UP | CAL / INPUT1 | Go to next key press. |
| | FUNC | DIS / CALIN1 | Go to next key press to enable INPUT 1 calibration.<br>*Note: After completion of the calibration sequence, the controller automatically reverts to disable.* |
| | ▲ | BEGN / CALIN1 | This begins the calibration procedure, Go to next step. |
| Calibrate 0% | FUNC | APLY / IN1ZRO | Adjust your calibrating device to an output signal equal to the 0% range value for your particular input sensor. (table 5-1) Wait 30 seconds, then go to next step. |
| Calibrate 100% | FUNC | APLY / IN1SPN | Adjust your calibrating device to an output signal equal to the 100% range value for your particular input sensor. Wait 30 seconds, then go to next step if the input is configured for thermocouple; otherwise, go to *"Exit Calibration Mode"*. |
| Check the Cold Junction Temperature | FUNC | (value) / CJTEMP | The value in the upper display is in tenths of a degree. It is the current reading of the temperature as measured at the thermocouple terminals and recognized by the controller. You can change this value, if it is in error, using ▲▼ keys. |
| Exit Calibration Mode | FUNC *then* DISP | pv value | This stores the calibration constants and exits the calibration mode. |

## INPUT CALIBRATION (continued)

### *INPUT 2 CALIBRATION PROCEDURE* (Ranges 4 to 20 mA or 1 to 5 Volts only)

Apply power and let the controller warm up for 15 minutes before you calibrate.

**NOTE:** Set "LOCK" in tuning group to "NONE."

**CAUTION: For these inputs, avoid step changes in inputs. Vary smoothly from initial value to the final 100% value.**

Please read **"SET UP"** before beginning the procedure.

NOTE: For Current Input, do not remove the signal resistor from the terminals.

| *PROCEDURE* | *PRESS* | *DISPLAYS* | *ACTION* |
|---|---|---|---|
| Enter Calibration Mode | SET UP | CAL / INPUT2 | Go to next key press. |
| | FUNC | DIS / CALIN2 | Go to next key press to enable INPUT 2 calibration. *Note: After completion of the calibration sequence, the controller automatically reverts to disable.* |
| | ▲ | BEGN / CALIN2 | This begins the calibration procedure, Go to next step. |
| Calibrate 0% | FUNC | APLY / IN2ZRO | Adjust your calibrating device to an output signal equal to the 0% range value for your particular input (table 5-1). Wait 30 seconds, then go to next step. |
| Calibrate 100% | FUNC | APLY / IN2SPN | Adjust your calibrating device to an output signal equal to the 100% range value for your particular input . Wait 30 seconds, then go to next step . |
| Exit Calibration Mode | FUNC *then* DISP | pv value | This stores the calibration constants and exits the calibration mode. |

# OUTPUT CALIBRATION

## *CURRENT PROPORTIONAL OUTPUT*

### *Introduction*

Calibrate the controller so that the output provides the proper amount of current over the desired range. The controller can provide an output current range of 2 to 21 milliamperes and can be calibrated at 4 mA for 0% of output and 20 mA for 100% of output or any other values between 2 and 21 mA.

### *Preliminary Procedures*

- Tag and disconnect the field wiring at the rear of the controller from terminals 4 and 5 (see Figure 5-4).

### *Equipment needed*

- A standard shop type milliammeter with whatever accuracy is required, capable of measuring 0 to 20 milliamps.

### *Set-Up*

- Connect a milliammeter across terminals 4 and 5 (see Figure 5-4).
- Apply the power and allow the controller to warm up for 15 minutes before you calibrate.
- **Set "LOCK" in tuning group to "NONE."**

***Follow the procedure on the next page.***

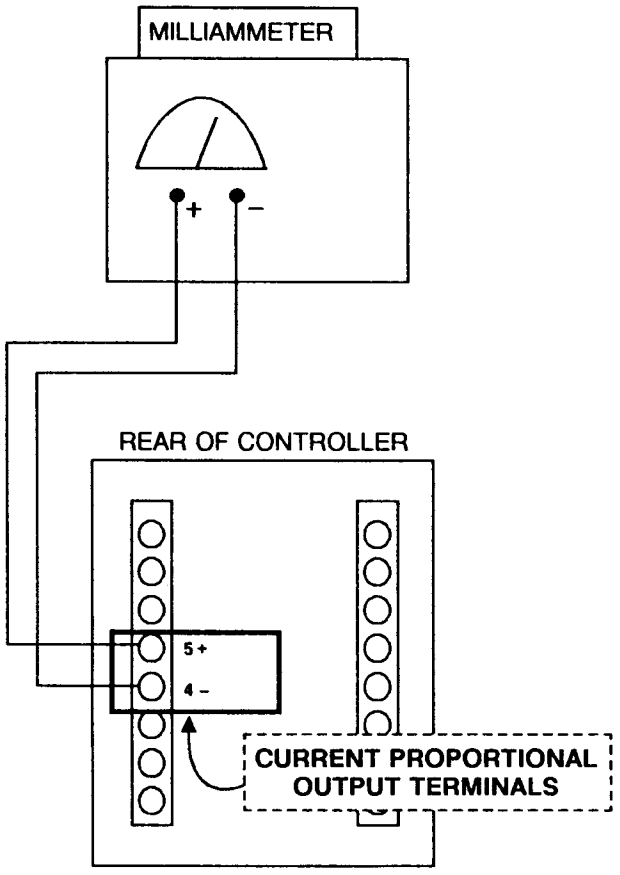



Figure 5-4 Calibration Equipment Connections

## OUTPUT CALIBRATION (continued)

### *CURRENT PROPORTIONAL OUTPUT CALIBRATION PROCEDURE*

| *PROCEDURE* | *PRESS* | *DISPLAYS* | *ACTION* |
|---|---|---|---|
| Enter Calibration Mode | SET UP | CAL / CURENT | Go to next step. |
| Calibrate 0% | FUNC | (value) / ZROVAL | Go to next step. |
| | ▲ or ▼ *until* | | the desired 0% output is read on the milliammeter. Use table 1 to find the correct value. |
| Calibrate 100% | FUNC | (value) / SPNVAL | This stores the minimum value and gives you the display shown. Go to the next key press. |
| | ▲ or ▼ *until* | | the desired 100% (span) output is read on the milliammeter. Use table 1 to find the correct value. |
| Exit Calibration Mode | FUNC *then* DISP | (pv value) | This stores the span value and exits the calibration mode. |

**TABLE 1**

| *Reading* | *4-20 mA Direct* | *4-20 mA Reverse* |
|---|---|---|
| 0% | 4 mA | 20 mA |
| 100% | 20 mA | 4 mA |

# OUTPUT CALIBRATION (CONTINUED)

## *AUXILIARY OUTPUT CALIBRATION*

### *Introduction*

Calibrate the controller so that the output provides the proper amount of voltage over the desired range. The controller can provide a Voltage output range of from 0 to 5 Volts and can be calibrated at 0 Volt for 0% of output and 5 Volts for 100% of output or any other values between 0 and 5 Volts.

### *Preliminary Procedures*

- Tag and disconnect the field wiring at the rear of the controller from terminals 13 and 14. (See Figure 5-5.)

### *Equipment needed*

- A calibrating device with whatever accuracy is necessary, capable of measuring 0 to 5 Volts.

### *Set-Up*

- Connect a calibrating device across terminals 13 and 14 (see Figure 5-5).
- Apply the power and allow the controller to warm up for 15 minutes before you calibrate.
- **Set "LOCK" in tuning group to "NONE."**

***Follow the procedure on the next page.***

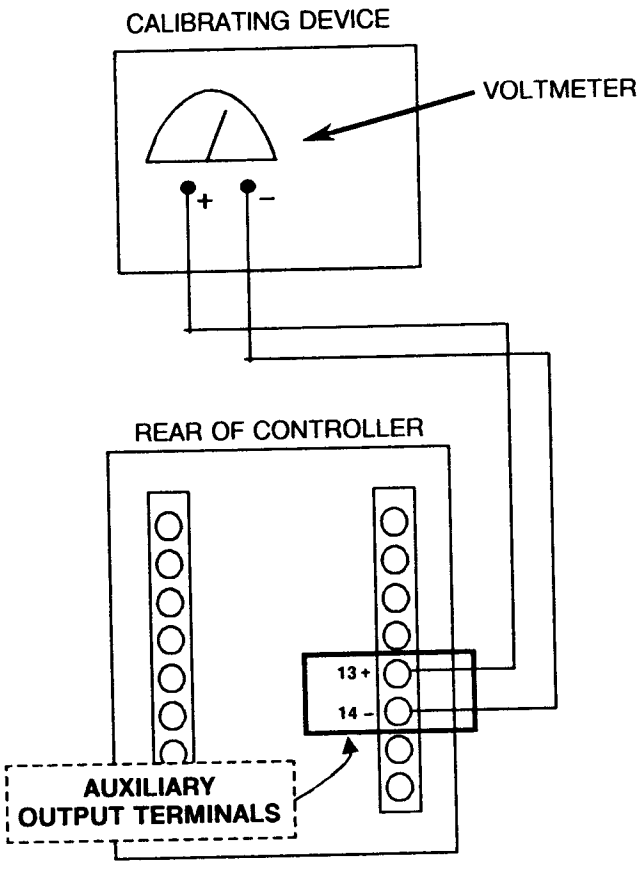



Figure 5-5 Calibration Equipment Connections

## OUTPUT CALIBRATION (continued)

### *AUXILIARY OUTPUT CALIBRATION PROCEDURE*

| *PROCEDURE* | *PRESS* | *DISPLAYS* | *ACTION* |
|---|---|---|---|
| Enter Calibration Mode | SET UP | CAL / AUXOUT | Go to next step. |
| Calibrate 0% | FUNC | (value) / ZROVAL | Go to next step. |
| | ▲ or ▼ *until* | | the desired 0% output is read on the voltmeter. |
| Calibrate 100% | FUNC | (value) / SPNVAL | This stores the minimum value and gives you the display shown. Go to the next key press. |
| | ▲ or ▼ *until* | | the desired 100% (span) output is read on the voltmeter. |
| Exit Calibration Mode | FUNC *then* DISP | (pv value) | This stores the span value and exits the calibration mode. |

## *THREE POSITION STEP CONTROL ALGORITHM, MOTOR TRAVEL TIME SETTING*

***Introduction***

Three Position Step Control lets you control a valve or other actuator with an electric motor driven by the output relays. These relays actuate two sets of coils, one to move clockwise and the other counterclockwise without a feedback slidewire linked to the motor shaft.

There is internal feedback of the state of the relays.

A TPSC controller provides an estimated position of the motor since the motor is not using any feedback from a slidewire. The "OUT" display will indicate this estimated motor position.

The only calibration required is setting the Motor Travel Time (the time it takes for the motor to travel from 0% to 100%).

***Set Up***

Set "LOCK" in tuning group to "NONE."

***Procedure***

| PROCEDURE | PRESS | DISPLAYS | ACTION |
|---|---|---|---|
| Enter Calibration Mode | SET UP Until you see | CAL / TPSC | Go to next step. |
| Select Motor Time Prompt | FUNC | (value) / MTR TI | The value in the upper display represents the time it takes the motor to travel from 0 to 100%. |
| Change the Value | ▲ or ▼ until | | the desired Motor Travel Time is reached. See the Motor Specifications or measure the time from 0 to 100%. Range of setting = 15 to 240 seconds |

# TROUBLESHOOTING SECTION 6

## INTRODUCTION

Instrument performance can be adversely affected by installation and application problems as well as hardware problems. We recommend that you investigate the problems in the following order:

- **Installation Related Problems** - Read the Installation Section in this manual to make sure the CN1200 has been properly installed. The Installation section provides information on protection against electrical noise, connecting external equipment to the controller, and shielding and routing external wiring.
  IMPORTANT: System noise induced into the controller will result in diagnostic error messages recurring. If the diagnostic error message can be cleared, it indicates a "soft" failure and is probably noise related.
  If system noise is suspected, completely isolate the controller from all field wiring. Use calibration sources to simulate PV and check all controller functions i.e. Gain, Rate Reset, Output, Alarms, etc.
- **Application Related Problems** - Review the application of the controller; then, if necessary, direct your questions to the local sales office.
- **Hardware and Software Related Problems** Use the troubleshooting error message prompts and controller failure symptoms to identify typical failures which may occur in the controller. Follow the troubleshooting procedures to correct them.

## CONTROLLER FAILURE INDICATIONS

### Error Messages

The CN1200 runs background tests during normal operation. If a problem with the Background tests occurs, an error message will be displayed on the operator interface. Table 6-1 shows you the error message, what the failure is, and how to correct the problem.

### Other Failure Symptoms

Other failure symptoms may occur that deal with the Power, Output, or Alarms. Refer to the controller failure symptoms in Table 6-3 to determine what is wrong and the troubleshooting procedure to use to correct the problem.

### Check Installation

If a set of symptoms still persists, refer to the Installation section of this manual and ensure proper installation and proper use of the controller in the system.

## CUSTOMER SUPPORT

If you cannot solve the problem using the trouble-shooting procedures listed in this section, get model and serial number and

***Call Applications Engineering Support***
***Phone Number***
**203-359-1660**

If it is determined that a hardware problem exists and the controller is within the warranty period, a replacement controller will be shipped with instructions for returning the defective unit.

## ERROR MESSAGES

The CN1200 performs on-going background tests to verify data and memory integrity. If there is a malfunction, an error message will be displayed (blinking) in the lower display.

In the case of more than one simultaneous malfunction, only the one with the highest priority will appear in the lower display.

Table 6-1 below shows these error messages, the reason for the failure, and how to correct the problem.

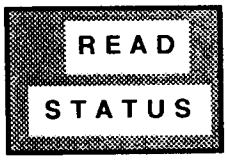
### TABLE 6-1 BACKGROUND TESTS ERROR PROMPTS

| Lower Display Prompt | Reason For Failure | How to Correct the Problem |
|---|---|---|
| **E FAIL** | Unable to write to non-volatile memory. Anytime you change a parameter and it is not accepted, you will see **E FAIL**. | 1. Check the accuracy of the parameter and re-enter. |
| **FAILSF** | This error message shows whenever the controller goes into failsafe mode of operation. This will happen if:<br>• RAM Test failed<br>• Configuration Test Failed<br>• Calibration Test Failed<br>• Factory Calibration Checksum Failed | 1. Run through **STATUS** check to determine the reason for the failure:<br>Press [SET UP] until **READ** appears in the lower display.<br>Press [FUNC] to see which tests Pass or Fail.<br>**RAMTST CFGTST CALTST FACTST**<br>2. Correct according to the recommendations given for a particular failure in Table 6-2. |
| **IN1FAIL** | Two consecutive failures of input one integration, i.e. cannot make analog to digital conversion | 1. Make sure the actuation is configured correctly. See Configuration Section 3.<br>2. Make sure the input is correct.<br>3. Check for gross overranging. |
| **IN2FAIL** | Two consecutive failures of input two integration, i.e. cannot make analog to digital conversion | 1. Make sure the actuation is configured correctly. See Configuration Section 3.<br>2. Make sure the input is correct.<br>3. Make sure the position of the jumper at J8 on the option board is correct for the given input 2 signal.<br>4. Check for gross overranging. |
| **IN1RNG** | Input 1 - out of range. The process is outside the range limits.<br>NOTE: If the range goes outside the Range Limits, the controller will go to the failsafe output value. | 1. Make sure the range and actuation are configured properly.<br>2. Check the input source.<br>3. Go to the Configuration Section and change the input type to a different type. Enter it, loop through STATUS test prompts then return input to original.<br>4. Check the Input type switch placement. Refer to "Preliminary Checks" in Installation Section 2.<br>5. Field calibrate - See Calibration section 5. |
| **IN2RNG** | Input 2 - out of range<br>The remote input is outside the range criteria listed under input 1 above. | Same as INPUT 1 |
| **RV LIM** | The result of the formula shown below is beyond the range of the remote variable.<br>RV = (INP2 x RATIO) + BIAS | 1. Make sure the input signal is correct.<br>2. Make sure the Ratio and Bias settings are correct.<br>3. To recheck calibration, use Ratio 1.0 and Bias 0.0 |

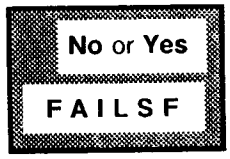
## STATUS TESTS

When required, the results of these STATUS tests can be checked to determine the reason the controller has gone to failsafe.

Press the **[SET UP ]** key until you see




Press **[FUNC]** key until you see




### TABLE 6-2 STATUS TESTS

| Lower Display Prompt | Definition | Upper Display Prompt | Reason for Failure | How to Correct the Problem |
|---|---|---|---|---|
| **FAILSF** | Failsafe Fault | NO<br>YES | No Failure<br>Burnout configured for none and input fails<br>RAMTST failed<br>CFGTST failed<br>CALTST failed<br>FACTST failed | 1. Step through the rest of the STATUS check to identify the particular failure. Press **[FUNC]** key. |
| **RAMTST** | RAM Test | PASS<br>FAIL | No Failure<br>RAM Failure | 1. Power cycle to see if the error clears. |
| **CFGTST** | Configuration Checksum | PASS<br>FAIL | No Failure<br>Configuration data in the controller in error. | 1. Step through the STATUS tests, the controller will calculate the checksum.<br>2. Check all the configuration prompts for accuracy. See Configuration Section 3. |
| **CALTST** | Working Calibration Checksum | PASS<br>FAIL | No Failure<br>Working calibration constants in the controller in error. | 1. If the controller has not been field calibrated, see the configuration section and change the input type to a different type. Enter it, loop through all the STATUS tests then return input type to the original.<br>2. If the controller has been field calibrated, recalibrate the controller. |
| **FACTST** | Factory Calibration Cyclic Redundancy Check | PASS<br>FAIL | No Failure<br>Factory set input constants in the controller are in error. | 1. Cycle through STATUS to clear the error.<br>2. Check the calibration - make sure 0 and 100% are the correct values. See Calibration Section 5.<br>3. Recalibrate. If step 1 is unsatisfactory, always do step 3 - See Calibration Section 5. |

## CONTROLLER FAILURE SYMPTOMS

In addition to the error message prompts there are failure symptoms that can be identified by noting how the controllers displays, indicators, and controller functions are reacting.
Compare your symptoms with those shown in Table 6-3 and refer to the troubleshooting procedure indicated to correct the problem.

If a set of symptoms or prompts other than the one you started with appears while troubleshooting, re-evaluate the symptoms. This may lead to a different troubleshooting procedure.
If the symptoms still persist, refer to the Installation Section in this manual to ensure proper installation and proper use of the controller in your system.

## EQUIPMENT NEEDED TO FOLLOW TROUBLESHOOTING PROCEDURES

- DC Milliammeter XX.XX mAdc
- Calibration Sources - T/C, mV, Volt, etc.
- Voltmeter

The troubleshooting procedures begin on the next page.

### TABLE 6-3 CONTROLLER FAILURE SYMPTOMS

| Upper Display | Lower Display | Indicators | Controller Output | Probable Cause | Troubleshooting Procedure |
|---|---|---|---|---|---|
| Blank | Blank | Off | None | Power Failure | 1 |
| OK | Displayed Output Disagrees with Controller Output | OK | Controller Output Disagrees with Displayed Output | Current Proportional Output | 2 |
| | | | | Time (Relay) Proportional Output | 3 |
| OK | OK | OK | External Alarm Function Does Not Operate Properly | Malfunction in Alarm Output | 4 |

## CONTROLLER FAILURE SYMPTOMS TROUBLESHOOTING PROCEDURES

### *PROCEDURE 1: TROUBLESHOOTING POWER FAILURE*

| What to Do | How to do it or where to find the Data |
|---|---|
| 1. Check the AC line Voltage. | 1. Use a Voltmeter to measure the AC Voltage across terminals L1 and L2 on the rear terminal panel of the controller. |
| 2. Make sure the chassis plugs into the rear of the case properly. | 2. Withdraw the chassis from the case and visually inspect the main printed wiring board for damage. |
| 3. Check the Voltage selection. | 3. See if the J1 connector on the main printed wiring board is in the proper position for the voltage being used. See "Preliminary Checks" in the Installation Section. |
| 4. Check the system for brown-outs, heavy load switching, etc.; and conformance to installation instructions. | 4. Refer to the Installation Section. |

### *PROCEDURE 2: TROUBLESHOOTING CURRENT PROPORTIONAL OUTPUT*

| What to Do | How to do it or where to find the Data |
|---|---|
| 1. Make sure the controller is configured for current output. | 1. Make [SET UP] group "ALGOR" , [FUNC] prompt "OUTALG" = selection "CUR". See the Configuration Section. |
| 2. Check the field wiring. | 2. Load must be less than or equal to 750 Ohms. |
| 3. Make sure all the configurable constants, limits and configuration data stored in the controller are correct. Reconfigure if necessary. | 3. See the configuration section in this manual to check constants, limits and configuration data and to reconfigure. |
| 4. Check the Output. | 4. Press the [DISP] key until you see **OUT** in the lower display. Use a DC milliammeter at the rear of the terminals to verify the output. 4 to 20 mA output corresponds to an output of 0 to 100%. |
| 5. Recalibrate the Current Proportional output. | 5. See the Calibration Section. |

## CONTROLLER FAILURE SYMPTOMS TROUBLESHOOTING PROCEDURES (continued)

### *PROCEDURE 3: TROUBLESHOOTING SINGLE RELAY OR DUAL RELAY OUTPUT FAILURE*

| What to Do | How to do it or where to find the Data |
|---|---|
| 1. Make sure the controller has at least one relay for relay simplex operation or an option board with an additional 2 relays for Duplex operation. | 1. Make [SET UP] group "ALGOR" , [FUNC] prompt "OUTALG" = selection "RLY" or "RLYD". See the Configuration Section. |
| 2. Make sure all the configurable constants, limits and configuration data stored in the controller are correct. Reconfigure if necessary.. | 2. See the configuration section in this manual to check constants, limits and configuration data and to reconfigure. |
| 3. Check that the applicable output relay actuates properly. If it doesn't go to step 5. If it does, go to step 4. | 3. Vary the set point around the PV. Listen for the click of the relay as the Set Point moves in either direction. Observe OUT 1 or 2 light on the operator interface. |
| 4. Check the Output (control) relay jumper position. | 4. See the Installation Section for relay jumper placement and relay contact information. |
| 5. Check the field wiring | 5. See the Installation Section for wiring diagrams. |

### *PROCEDURE 4: TROUBLESHOOTING ALARM RELAY OUTPUT FAILURE*

| What to Do | How to do it or where to find the Data |
|---|---|
| 1. Check the alarm configuration data. If it is correct, check the field wiring. Reconfigure if necessary. | 1. See the Configuration Section. |
| 2. Check the alarm relay jumper position. | 2. See the Installation Section for jumper placement and contact information. |
| 3. Check that the applicable alarm relay actuates properly depending on what you have set at "ALARMS" group prompt "AxSxTY". If it does, check the field wiring. | 3. If the alarm type is set for PROC (process variable), press **[DISP]** to display SP. Vary the set point around the alarm set point creating a deviation value and listen for a click from the relay as the PV moves in either direction and note that the proper ALM 1 or 2 is lit.<br>If the alarm is set for DEV (deviation), raise or lower the set point above or below the PV to get the deviation you have set as the alarm set point. |

# PARTS LIST SECTION 7

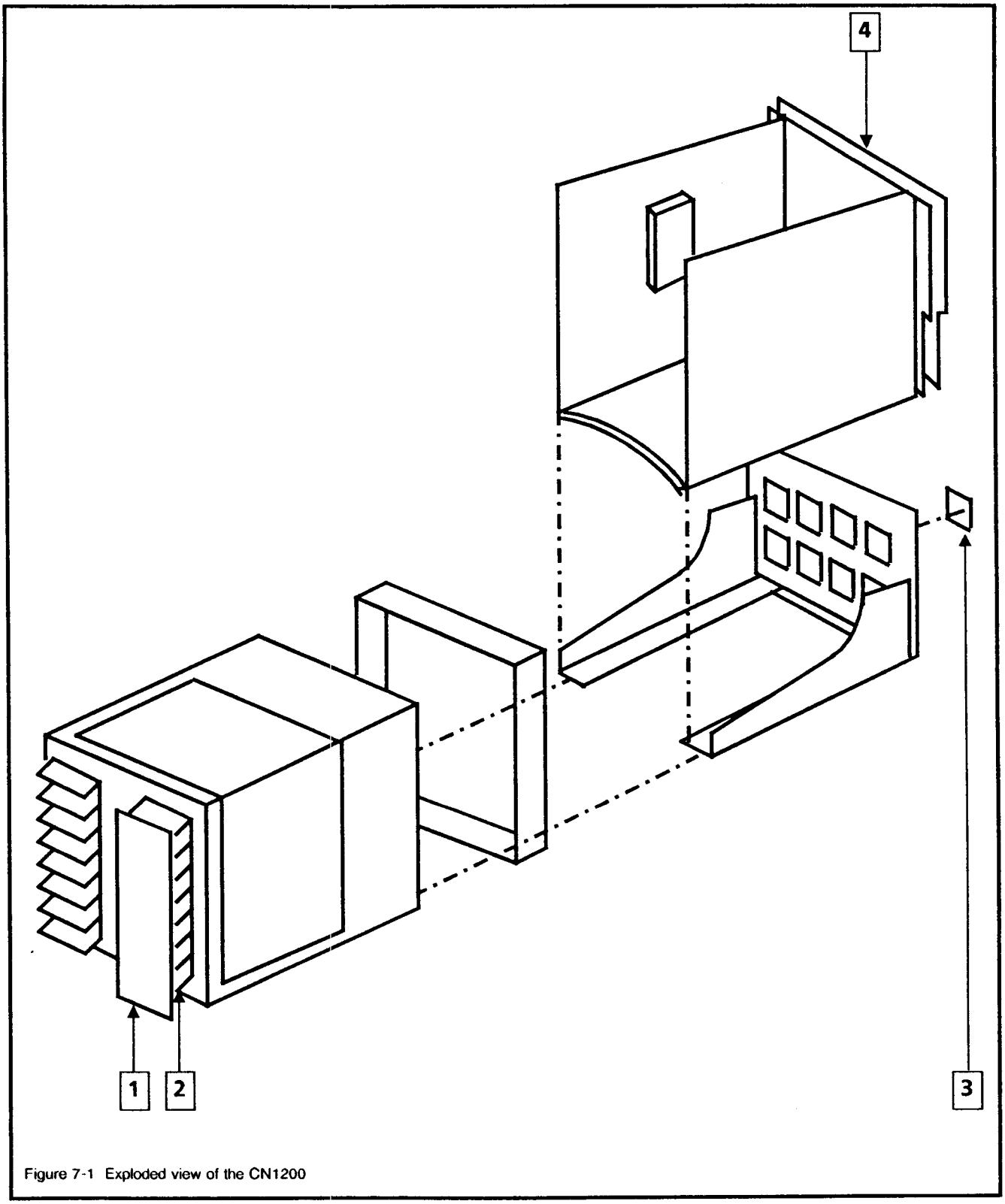



Figure 7-1 Exploded view of the CN1200

## CN1200 Parts List

| KEY NO. | PART NUMBER | DESCRIPTION | QUANTITY |
|---|---|---|---|
| 1 | 30756091-001 | Rear Terminal Cover Kit | 1 |
| 2 | 30754142-003 | Terminal Strip | 1 |
| 3 | 30755754-001 | Plug Button Kit (10 Buttons) | 1 |
| 4 | 30755751-501 | Keyboard | 1 |

## PARTS KITS NOT SHOWN

- A mounting kit, part no. 30755050-001
- A splash cover, part no. 24400107-001

# APPENDIX A

# SECTION 8

## *INTRODUCTION*

This Appendix provides information for all the user configurable parameters listed in the configuration section. If you aren't familiar with these parameters, this appendix gives you a definition of how each parameter setting affects controller performance. It will also refer you to any other prompts that might be affected by your selection.

## *PARAMETER GROUPS AND PROMPTS*

As shown in the Table of Contents, the information is divided into 9 configuration groups which are accessed by pressing the **[SET UP]** key.

Each of these groups contain prompts, viewed in the lower display, which deal with functions that are pertinent to that particular group. These are accessed by pressing the **[FUNC]** key.

The selections or values are listed in the upper display. Refer to the Configuration section for step by step instructions.

## *TABLE OF CONTENTS*

## *TUNING*

Tuning consists of establishing the appropriate values for the tuning constants you are using so that your controller responds correctly to changes in process variable and set point. You can start with pre-determined values but you will have to watch the system to see how to modify them.

### PB

PROPORTIONAL BAND is the percent of the range of the measured variable for which a proportional controller will produce a 100% change in its output.

### GAIN

GAIN is the ratio of output change (%) over the measured variable change (%) that caused it.

$$G = \frac{100\%}{PB\%}$$ where PB is the proportional band (in %)

If the PB is 20%, then the Gain is 5. Likewise, a 3% change in the error signal (SP-PV) will result in a 15% change in the controller's output due to proportional action. If the gain is 2 then the PB is 50%. Defined as "HEAT" Gain on Duplex models for variations of Heat/Cool applications. The selection of Prop. Band or Gain is made in the control parameter group under Prompt "PBorGN."

### RATE T

RATE TIME affects the controller's output whenever the deviation is changing; and affects it more when the deviation is changing faster. Defined as "HEAT" Rate on Duplex models for variations of Heat/Cool applications.

### IMIN or IRPM

RESET RATE or INTEGRAL TIME adjusts the controller's output in accordance with both the size of the deviation (SP-PV) and the time it lasts. The amount of the corrective action depends on the value of Gain. The Reset adjustment is measured as how many times proportional action is repeated/minute.

Defined as "HEAT" Reset on Duplex models for variations of Heat/Cool applications. The selection of minutes per repeat or repeats per minute is made in the control parameters group under Prompt "MIN/RPM."

$$I_{MIN} = \frac{1}{IRPM}$$

### MANRST

MANUAL RESET Only applicable if you have control algorithm PD WITH MANUAL RESET. Because a proportional controller will not necessarily line out at set point, there will be a deviation (offset) from set point. This eliminates the offset and lets the PV line out at set point.

### GAIN2, PB2, RATE2T, I2MIN, I2RPM

PROPORTIONAL BAND 2 or GAIN 2, RATE 2, and RESET RATE 2 or INTEGRAL TIME 2 are the same as previously described except that they refer to the cool zone tuning constants on duplex models.

### CYC T1

CYCLE TIME (HEAT) determines the length of one time proportional output relay cycle. Defined as "HEAT" cycle time for Heat/Cool applications.

### CYC T2

CYCLE TIME 2 (COOL) is the same as above except it applies to Duplex models as the cycle time in the "COOL" zone of Heat/Cool applications.

### LOCKOUT

LOCKOUT applies to one of the functional groups: Configuration or Calibration. DO NOT CONFIGURE LOCKOUT UNTIL ALL OTHER CONFIGURATION IS COMPLETE.

#### NONE

No Lockout -- all groups read/write.

#### CAL

Calibration is deleted from the SETUP list.

#### CONF

Tuning is read/write. All other groups are read only.

## *ALGOR*

This data deals with various algorithms in the controller: Control algorithm, Enabling the second input, or the Output algorithm.

## CTRALG

The CONTROL ALGORITHM lets you select the type of control that is best for your process.

### ONOF

ON/OFF is the simplest control type. The output can be either ON (100%) or OFF (0%). The Process Variable (PV) is compared with the set point (SP) to determine the sign of the error (ERROR = PV-SP). The ON/OFF algorithm operates on the sign of the error signal.

In Direct Acting Control, when the error signal is positive, the output is 100%; and when the error signal is negative the output is 0%. If the control action is reverse, the opposite is true. An adjustable overlap (Hysteresis Band) is provided between the on and off states.

DUPLEX ON/OFF is an extension of this algorithm when the output is configured for Relay Duplex. It allows the operation of a second ON/OFF output. There is a deadband between the switching points of the relays and a hysteresis band for the on and off states of each relay. Both Deadband and Hysteresis are separately adjustable. With no relay action the controller will read 50%.

### PIDA

PID A is normally used for three-mode control. This means that the output can be adjusted somewhere between 100% and 0%. It applies all three control actions -- Proportional (P), Integral (I), and Derivative (D) -- to the error signal.

Proportional (Gain) -- regulates the controller's output in proportion to the error signal (the difference between Process Variable and Set Point).

Integral (Reset) -- regulates the controller's output proportional to the size of the error and the time the error has existed (the amount of corrective action depends on the value of proportional Gain).

Derivative (Rate) -- regulates the controller's output in proportion to the rate of change of the error (the amount of corrective action depends on the value of proportional Gain).

### PD+MR

PD WITH MANUAL RESET is used whenever integral action is not wanted for automatic control. The equation is computed with no integral contribution. The MANUAL RESET, which is operator adjustable, is then added to the present output to form the controller output.
If you select PD with Manual Reset you can also configure the following variations

- PD (Two Mode) control,
- P (Single Mode) control.

Set Rate to 0.
*Other prompts affected: "MANRST"*

## CTRALG (continued)

### TPSC

Three Position Step Control is an extension of the On/Off Duplex control. It lets you control a valve or other actuator with an electric motor driven by the output relays. These relays actuate two sets of coils, one to move clockwise and the other counter-clockwise without a feedback slidewire linked to the motor shaft.
There is internal feedback of the state of the relays. The effect of the control action is that the On/Off times of the output relay change in proportion to the error signal and the Gain and Reset time settings. A TPSC controller provides an estimated position of the motor since the motor is not using any feedback from a slidewire.
The Deadband is adjustable in the same manner as the Duplex Output algorithm.

## INPUT2

INPUT 2 algorithm allows you to enable or disable the second input.

### ENAB

Enable Input 2

### DIS

Disable Input 2

## OUTALG

The OUTPUT ALGORITHM lets you select the type of output you want.

### RLY

RELAY SIMPLEX -- Type of output using one SPDT relay. Its normally open (NO) or normally closed (NC) contacts are selected by positioning an internal jumper. (See "Preliminary Checks" in the Installation section.)

*Other prompts affected: "OUTHYST"*

### CUR

CURRENT SIMPLEX -- Type of output using one 4 to 20 mA signal that can be fed into a positive or negative grounded load of 0 to 750 ohms. The signal can be recalibrated for any desired range from 4 to 20 mA for 0 to 100% output.

### RLYD

RELAY DUPLEX -- Type of output using two SPDT relays. Its normally open (NO) or normally closed (NC) contacts are selected by positioning an internal jumper for each relay. (See "Preliminary Checks" in the Installation section.)

*Other prompts affected: "DEADBAND" and "OUT HYST"*

## *SP RAMP / SP PROGRAM*

This data deals with enabling Single Set Point Ramp function and enabling Set Point Ramp/Soak Programming. You can start and stop the ramp or program using the Run/Hold key.

### SP RAMP

Make selection to enable or disable the set point ramp function. Make sure you configure a ramp time and a final set point value.

#### ENAB

Allows the single set point ramp prompts to be shown.

#### DIS

Must select disable to use the Set Point Ramp/Soak Programming option.

### TI MIN

The Single Set Point Ramp Time is the time it takes to go from start to the final set point on a single set point ramp. 0 will imply an immediate change in set point to the final set point.

Enter the number of minutes desired to reach the final set point.

### FINLSP

The controller will operate at the set point set here at the completion of the single set point ramp. Enter the desired value.

### SPPROG

#### DIS

Must select disable to use the SP Ramp option.

#### ENAB

Allows the prompts for Set Point Ramp/Soak Programming.

***See the Operation Section for definitions and prompt hierarchy.***

## *AUTOTUNE*

Autotune automatically calculates Gain, Rate, and Reset Time (PID) tuning constants for your control loop. When initiated on demand, the Autotune algorithm measures a process step response and automatically generates the PID tuning constants needed for no overshoot on your process.

## AT ENB

### DIS

Disables the Autotune function.

### ASTP

Automatic steps let you perform an Autotune with a step size automatically generated.

### MSTP

Manual step lets you choose an output step size in percent, that will be large enough to result in a PV change. The value of the output step size is selected under function prompt "OUT STP."

## OUTSTP

Choose an output step size, in percent, that will be applied to the output of the controller when Autotune is initiated. This step must be large enough to result in a process variable (PV) change of at least 2.5% of span. This step can be predetermined by stroking the process in manual mode.

The process can be tuned using either an upscale or downscale step change.

## AT ERR

See the Operating section for a list of error prompts.

## *INPUT1*

These are the parameters required for input 1; temperature units, decimal location, actuation, high and low range values in engineering units, bias, filter, burnout, emissivity, frequency, and display default.

### DECMAL

DECIMAL POINT LOCATION -- This selection determines where the decimal point appears in the display.

None
One Place
Two Places

### UNITS

TEMPERATURE UNITS -- This selection will affect the indicator. What display of temperature do you want.

F = Degrees Fahrenheit
C = Degrees Celsius
None = None

### IN1TYP

INPUT 1 ACTUATION TYPE -- This selection determines what actuation you are going to use for input one.

| | |
|---|---|
| **b** | B thermocouple |
| **E H** | E thermocouple high |
| **E L** | E thermocouple low |
| **J H** | J thermocouple high |
| **J L** | J thermocouple low |
| **K H** | K thermocouple high |
| **K L** | K thermocouple low |
| **N*** | N thermocouple |
| **R** | R thermocouple |
| **S** | S thermocouple |
| **T H** | T thermocouple high |
| **T L** | T thermocouple low |
| **W** | W thermocouple |
| **100H** | 100 ohm RTD high |
| **100L** | 100 ohm RTD low |
| **4-20** | 4 to 20 milliamps |
| **10 M** | 0 to 10 millivolts |
| **100M** | 0 to 100 millivolts |
| **0-1** | 0 to 1 volt |
| **0-5** | 0 to 5 volts |
| **0-10** | 0 to 10 volts |
| **1-5** | 1to 5 volts |
| **NIC** | Nicrosil Nisil thermocouple |
| **RADI** | Radiamatic RH |

*For NiNiMoly thermocouples; not for Nicrosil-Nisil thermocouples.

### IN1 HI

INPUT 1 HIGH RANGE VALUE in engineering units. Scale the #1 input signal to the display value you want for 100%.

*Example:*

Actuation (Input) = 4 to 20 mA
Process Variable = Flow
Range of Flow = 0 to 250 Gal/Min
High Range display value = 250
Then 20 mA = 250 Gal/Min

The control set point will be limited by the range of units selected here.

### IN1 LO

INPUT 1 LOW RANGE VALUE in engineering units. Scale the #1 input signal to the display value you want for 0%. The control set point for Input 1 will be limited by the range of units selected here.

### BIAS 1

BIAS ON INPUT 1 -- Select the bias value you want on input one.

### FILTR1

FILTER FOR INPUT ONE -- A software digital filter is provided for input 1 to smooth the input signal. You can configure the first order lag time constant from 0 to 120 seconds. If you don't want filtering, enter 0.

### BRNOUT

BURNOUT PROTECTION (SENSOR BREAK) provides thermocouple types with upscale or downscale protection if the input fails.

**NONE**
NO BURNOUT -- Failsafe output applied for failed input.

**UP**
UPSCALE BURNOUT will make the indicated PV signal increase when a sensor fails, and flash the upper display.

**DOWN**
DOWNSCALE BURNOUT will make the indicated PV signal decrease when a sensor fails, and flash the upper display.

### EMISSIVITY

EMISSIVITY FOR RADIAMATIC (RH) INPUTS
A radiamatic pyrometer converts radiant energy emitted by a target into electrical energy. Emissivity is a correction factor applied to the radiamatic input signal that is the ratio of the actual energy emitted from the target to the energy which would be emitted if the target were a perfect radiator.
Range: 0.01 to 1.0

### FREQ

POWER LINE FREQUENCY -- Select whether your controller is operating at 60 Hz or 50 Hz.

60 Hertz
50 Hertz

### DISPLY

DEFAULT DISPLAY CONFIGURATION -- Select what the default display will be during normal operation:

| | |
|---|---|
| PR_N | Upper display - PV value<br>Lower display - blank |
| PR_Y | Upper display - PV value<br>Lower display - **PV** |
| SP | Upper display - Set Point value<br>Lower display - **PV** |

## *INPUT2*

These are the parameters required for input 2; high and low range values in engineering units, filter.

### IN2 HI

INPUT 2 HIGH RANGE VALUE in engineering units, for linear actuations only. Scale the #2 input signal to the display value you want for 100%.

*Example:* Same as input one.

### IN2 LO

INPUT 2 LOW RANGE VALUE in engineering units, for linear actuations only. Scale the #2 input signal to the display value you want for 0%.

*Example:* Same as input one.

### FILTR2

FILTER FOR INPUT TWO -- A software digital filter is provided for input 2 to smooth the input signal. You can configure the first order lag time constant from 0 to 120 seconds. If you don't want filtering, enter 0.

## *CONTRL*

The functions listed in this group deal with how the Mini-Pro will control the process including: Set point source, Ratio, Bias, Set point limits, Output direction and limits, Deadband, Hysteresis and Failsafe.

### SP SRC

SET POINT SOURCE -- This selection determines what your set point source will be; One local, Remote, or Two local-Key toggled.

#### 1LOC

LOCAL SET POINT -- The set point entered from the keyboard.

#### REM

REMOTE SET POINT -- A signal is brought in through the input 2 terminals and used as the control set point. Ratio and Bias can be applied to the remote set point.

#### 2LOC

TWO LOCAL SET POINTS -- This selection lets you switch between two local set points.

### RATIO

RATIO -- Used when input 2 operates as a remote set point, prompt "RSP." This ratio value can be applied to the remote set point. It establishes the correct relationship between the remote set point and the input 2 signal applied according to the formula below...

### BIAS

BIAS -- Used when input 2 operates as a remote set point prompt "RSP." Bias, together with ratio, establishes the correct relationship between the remote set point and the input 2 signal applied according to the formula:

(RATIO × INPUT 2) + BIAS = REMOTE SET POINT

### SP HI

SET POINT HIGH LIMIT* -- This selection prevents the local and remote set points from going above the value selected here. The setting must be equal or less than the upper range of input 1 and input 2. Input 2, when configured for remote set point, will be restricted to this upper limit.

### SP LO

SET POINT LOW LIMIT* -- This selection prevents the local and remote set points from going below the value selected here. The setting must be equal or greater than the lower range of input 1 and input 2. Input 2, when configured for remote set point, will be restricted to this lower limit.

### PWR UP

SET POINT AT POWER UP -- This selection determines which set point the controller will use when the controller restarts after a power loss

#### ALSP

LOCAL SET POINT -- The set point entered from the keyboard

#### ARSP

REMOTE SET POINT -- A signal brought in through the input 2 terminals and used as the control set point.

### ACTION

CONTROL OUTPUT DIRECTION -- Which direction do you want the controller output to go when the process variable increases.

#### DIR

DIRECT ACTING CONTROL -- The controller's output *increases* as the process variable increases.

#### REV

REVERSE ACTING CONTROL -- The controller's output *decreases* as the process variable increases.

### OUT HI

HIGH OUTPUT LIMIT -- This is the highest value of output beyond which you do not want the controller automatic output to exceed. Use 0 to 100% for time proportional output type.

### OUT LO

LOW OUTPUT LIMIT -- This is the lowest value of output below which you do not want the controller automatic output to exceed. Use 0 to 100% for time proportional output type.

*The Local Set Point will automatically adjust itself to be within the set point limit range. For example, if SP = 1500 and the SP HI LIM is changed to 1200, the new Local Set Point will be 1200.

***CONTRL (continued)***

## DBAND

DEADBAND is an adjustable gap between the operating ranges of output 1 and output 2. It is the difference between the nominal trip points of relay 1 and relay 2.

## HYST

HYSTERESIS (OUTPUT RELAY ONLY) is an adjustable overlap of the ON/OFF states of each control relay. This is the difference between the value of the process variable at which the control relay(s) energize and the value at which they de-energize. Only applicable for ON-OFF control.

## FAILSF

FAILSAFE OUTPUT VALUE -- Select the value you want the output to be when power is returned after a power-down. The value used here will also be the output level when input 1 fails, for all inputs except T/C. Similarly, the value used here will be the output level when no burnout is configured and input 1 fails for T/C inputs.

## PB or GN

PROPORTIONAL BAND UNITS -- Select one of the following:

### PB

PROPORTIONAL BAND selects units of percent proportional band for the P term of the PID algorithm.

### GN

GAIN selects the unitless term of gain for the P term of the PID algorithm.

## MINRPM

RESET UNITS -- Selects units of minutes or repeat per minutes for the I term of the PID algorithm. 20 Repeats per Minute = 0.05 Minutes per Repeat.

### RPM

REPEATS PER MINUTE -- The number of times per minute that the proportional action is repeated by reset.

### MIN

MINUTES PER REPEAT -- The time between each repeat of the proportional action by reset.

***OPTONS***

Contact Input (Remote Mode Switching) and PV (Auxiliary) Output options are mutually exclusive. Configure the contact input to a specific contact closure response, or configure the PV Output to be a specific selection with desired scaling.

## REM SW

REMOTE SWITCHING (DIGITAL INPUT) enables remote selection of set point source (SP1/SP2).

### NONE

No remote switching

### LSP

TO LOCAL SET POINT -- Contact closure puts the controller into local set point if in Remote.

### SP2

TO LOCAL SET POINT TWO -- Contact closure selects set point 2 if in Set Point 1.

### HOLD

HOLD SET POINT RAMP/PROGRAM -- Contact closure holds set point ramp or program.

## AUXOUT

AUXILIARY OUTPUT SELECTION provides a voltage output representing they process variable. The display for auxiliary output viewing will be in engineering units.

*Other prompts affected by this selection: "0PCT" and "100PCT."*

### NONE

No auxiliary output

### PROC

PROCESS VARIABLE -- Represents the value of the Process Variable.

## 0 PCT

PV (AUXILIARY) OUTPUT LOW SCALING FACTOR -- Use a value in engineering units for Process Variable.

## 100 PCT

PV (AUXILIARY) OUTPUT HIGH SCALING FACTOR -- Use a value in engineering units for Process Variable.

## *ALARMS*

An alarm is an indication that an event that you have configured (for example--Process Variable) has exceeded one or more alarm limits. There are two alarms available. Each alarm has two set points. You can configure each of these two set points to alarm on the process variable or deviation. There are two alarm output selections, High and Low. You can configure each set point to alarm either on High or Low. These are called single alarms. You can also configure the two set points to alarm on the same event and to alarm both high and low. There is a Fixed Alarm Hysteresis of 0.5% of (PV) Input Span. You can also configure an alarm to go on or off in a segment of Set Point Programming.

### A1S1VA

ALARM 1 SET POINT 1 VALUE -- This is the value at which you want the alarm type chosen in Prompt "A1S1TY' to actuate. The value depends on what the alarm set point has been configured to represent. Also, segment number for EVON/EVOF.

### A1S2VA

ALARM 1 SET POINT 2 VALUE -- This is the value at which you want the alarm type chosen in Prompt "A1S2TY" to actuate. The value depends on what the alarm set point has been configured to represent. Also, segment number for EVON/EVOF.

### A2S1VA

ALARM 2 SET POINT 1 VALUE -- This is the value at which you want the alarm type chosen in Prompt "A2S1TY" to actuate. The value depends on what the alarm set point has been configured to represent. Also, segment number for EVON/EVOF.

### A2S2VA

ALARM 2 SET POINT 2 VALUE -- This is the value at which you want the alarm type chosen in Prompt "A2S2TY" to actuate. The value depends on what the alarm set point has been configured to represent. Also, segment number for EVON/EVOF.

### A1S1TY

ALARM 1 SET POINT 1 TYPE -- Select what you want set point 1 of alarm 1 to represent. It can represent the process variable or deviation.

**NONE** No alarm
**PROC** Process Variable
**DE** Deviation
**EVON** Event ON (SP Programming)
**EVOF** Event OFF (SP Programming)

### A1S2TY

ALARM 1 SET POINT 2 TYPE -- Select what you want set point 2 of alarm 1 to represent. The selections are the same as A1S1TY.

### A2S1TY

ALARM 2 SET POINT 1 TYPE -- Select what you want set point 1 of alarm 2 to represent. The selections are the same as A1S1TY.

NOTE: Not applicable with relay duplex output.

### A2S2TY

ALARM 2 SET POINT 2 TYPE -- Select what you want set point 2 of alarm 2 to represent. The selections are the same as A1S1TY.

NOTE: Not applicable with relay duplex output.

### A1S1HL

ALARM 1 SET POINT 1 STATE -- Select whether you want the alarm type chosen in Prompt "A1S1TY" to alarm HIGH or LOW.

If SP Programming is configured do you want alarm on begin or end event.

**HI** High alarm
**LO** Low alarm
**BEGN** Beginning Event
**END** End Event

### A1S2HL

ALARM 1 SET POINT 2 STATE -- Select whether you want the alarm type chosen in Prompt "A1S2TY" to alarm HIGH or LOW.

If SP Programming is configured do you want alarm on begin or end event.

**HI** High alarm
**LO** Low alarm
**BEGN** Beginning Event
**END** End Event

### A2S1HL

ALARM 2 SET POINT 1 STATE -- Select whether you want the alarm type chosen in Prompt "A2S1TY" to alarm HIGH or LOW.

If SP Programming is configured do you want alarm on begin or end event.

**HI** High alarm
**LO** Low alarm
**BEGN** Beginning Event
**END** End Event

### A2S2HL

ALARM 2 SET POINT 2 STATE -- Select whether you want the alarm type chosen in Prompt "A2S2TY" to alarm HIGH or LOW.

If SP Programming is configured do you want alarm on begin or end event.

**HI** High alarm
**LO** Low alarm
**BEGN** Beginning Event
**END** End Event

### *CAL*

The prompts used here are for field calibration purposes. Refer to the Calibration section in this manual for complete information.

### *READ*

The prompts used here are for determining the reason for a controller failure. Refer to the Troubleshooting section in this manual for complete information.

# APPENDIX B
# MANUAL TUNING

# SECTION 9

## *INTRODUCTION*

When you tune a controller, there are some things to consider:

- Process Characteristics -- Gain (PB), Time, Constants, etc.
- Desired Response -- Minimal overshoot

Basically, controller tuning consists of determining the appropriate values for the Gain (PB), Rate (Derivative), and Reset (Integral) Time tuning parameters (control constants) that will give the control you want. Depending on the characteristics of the deviation of the process variable from the set point, the tuning parameters interact to alter the controller's output and produce changes in the value of the process variable. Since each parameter responds to a specific characteristic of the deviation, you may not need a combination of all three. It depends on the process characteristics and the desired control response.

You can estimate a starting point and the tuning parameters required to give the desired controller response and with some experience become proficient with this method.

An alternate approach is to rely on a tuning technique. In practice, tuning techniques usually do not give exactly the type of response desired; thus, some final adjustments to the tuning parameters must be made. However, you should at least obtain a reasonable starting point from which the desired response characteristics can be obtained.

The tuning method presented here requires finding the Gain (PB) of a proportional-only controller that will cause the loop to cycle indefinitely with a constant amplitude. This Gain (PB) is called the ultimate (measured) Gain (PB).

- Tune out all rate and reset (integral) time action.
- Introduce an upset into the loop, and adjust the Gain (PB) until the loop cycles continuously.
- Record the value of Gain or PB and the period of time for one oscillation of the process variable (measured time).
- Determine the setting from the table of formulas given in the procedure.

## *CONTROLLER TUNING PROCEDURES*

There are two procedures for tuning the controller:

- Time or Current Proportional control,
- Duplex Time Proportional control,

The suggested procedures describe how to establish and store values of Gain (PB), Rate, and Reset (integral) time constants for your process. You must know the type of control and algorithm your controller has.

A graphic recorder connected to the process variable will make it easier to determine when the oscillations are constant and the time for one oscillation. If a recorder is not available, you can use a stop watch to time the oscillation of the process variable displayed on the controller.

## *TIME OR CURRENT PROPORTIONAL CONTROL*

### Procedure

**STEP 1**

Adjust the output to bring the PV (Process Variable) near the desired value. When obtaining HEAT tuning parameters, the output must remain above 50% (to obtain COOL tuning parameters see the procedure for Duplex Time Proportional Control).

**STEP 2**

Set Rate Time (RATE T) to 0 minutes and set Reset Time (IMIN) to maximum value to minimize Reset action.

If applicable, set CYCLE TIME (CYC TI) to 2 seconds and DEADBAND (DBAND) to 0.5 if applicable.

**STEP 3**

Increase GAIN (decrease PB) significantly. Try a factor of 10 (PB = 10).

**STEP 4**

Adjust the local set point to equal PV.

**STEP 5**

Increase the set point by 5 or 10% and observe the process variable response.

**STEP 6**

If the PV oscillates, continue to the next step. If it doesn't oscillate, return to the original set point and increase GAIN (decrease PB) again by a factor of 2, and repeat step 5.

**STEP 7**

Compare the oscillations with Figure 9-1 shown on next page.

- If the oscillation matches pattern A, go to STEP 8.
- If the oscillation matches pattern B, increase GAIN (decrease PB) by a factor of 2 and repeat steps 4 to 6.

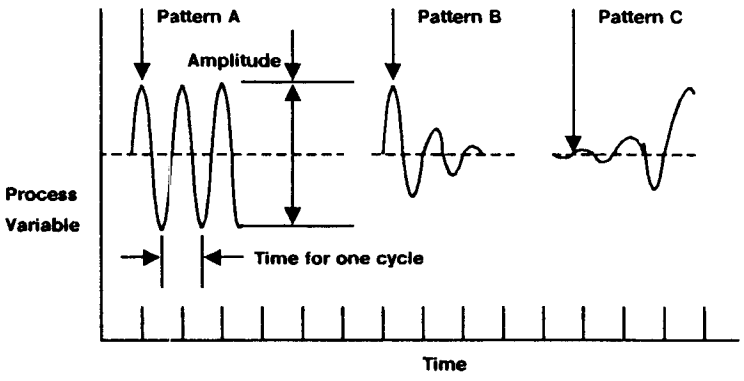



Figure 9-1

- If the oscillation matches pattern C, decrease GAIN (increase PB) by a factor of 0.5 and repeat steps 4 to 6.

  The amplitude of the cycle is immaterial, but all of the elements of the loop must be within the operating range (i.e., the valve must not go full open or full closed).

**STEP 8**

Record the current value of GAIN (or PB) and measure and record the value of time for one complete oscillation of PV (in minutes).

**STEP 9**

Select the proper set of formulas from the Table 9-1. Use the values of GAIN (or PB) and time (in minutes) in the formulas to arrive at the controller's tuning parameters settings.

**STEP 10**

Enter the values of GAIN (or PB), RATE, and RESET in Minutes (or Repeats per minute) into the Mini-Pro and verify that the PV response is adequate. Make additional trimming adjustment if necessary to fine tune the controller per the guide lines shown below:

*To Reduce Overshoot*

Less Gain (More PB)
Perhaps longer Rate Time

*To Increase Overshoot or Increase Speed or Response*

More Gain (Less PB), perhaps shorter Rate Time

## *DUPLEX TIME PROPORTIONAL CONTROL*

For HEAT/COOL applications, tune the controller with the output above 50% for HEAT and below 50% for COOL.

The "TUNING" function prompts for HEAT/COOL are:

| HEAT | COOL |
|---|---|
| PB or GAIN | GAIN2 |
| IRATE T | RATE2T |
| MIN or IRPM | I2MIN or I2RPM RESET2 |
| CYC TI | CYC2 TI |

**TABLE 9-1– Formulas**

| | Units | |
|---|---|---|
| | **GAIN and RESET TIME in $\frac{\text{Minutes}}{\text{Repeat}}$** | **% PROPORTIONAL BAND and RESET ACTION in $\frac{\text{Repeats}}{\text{Minute}}$** |
| **Proportional, (P) only** | GAIN = Measured Gain ×0.5<br>RESET TIME = 50.00 (minimum reset)<br>RATE = 0 | % PB = Measured PB × 2<br>RESET ACTION = 0.02 (repeats/minute)<br>RATE = 0 |
| **Proportional + Reset, (PI) (No Rate)** | GAIN = Measured Gain ×0.45<br>RESET TIME (M/R) = $\frac{\text{Measured Time}}{1.2}$<br>RATE = 0 | % PB = Measured PB × 2.2<br>RESET ACTION (R/M) = $\frac{1.2}{\text{Measured Time}}$<br>RATE = 0 |
| **Proportional + Reset + Rate (PID)** | GAIN = Measured Gain ×0.6<br>RATE = $\frac{\text{Measured Time}}{8}$<br>RESET = $\frac{\text{Measured Time}}{2}$ | % PB = Measured PB × 1.7<br>RESET ACTION = $\frac{2}{\text{Measured Time}}$<br>RATE = $\frac{\text{Measured Time}}{8}$ |

# APPENDIX C
# NOISE ENVIRONMENTS

# SECTION 10

## *HOW TO APPLY DIGITAL INSTRUMENTATION IN SEVERE ELECTRICAL NOISE ENVIRONMENTS*

### Introduction

Products which incorporate digital technology provide recognized performance advantages over conventional analog instrumentation used for process control. These advantages can result in better product uniformity and greater overall efficiency when used correctly.

There are, however, certain guidelines regarding installation and wiring which must be carefully followed in order to achieve this performance. In addition to the traditional precaution of the separation of signal and power wiring in separate conduits, other measures must be taken to minimize the effects of electromagnetic interference (EMI) and radio frequency interference (RFI) on the operation of the equipment. Otherwise, if high level, short duration, noise spikes are permitted to enter the digital equipment, the noise can be transferred into the system's logic networks and can be misinterpreted as signal data, resulting in erroneous system operation and other unpredictable responses.

### Potential Noise Sources

Noise can enter electronic equipment via three methods of coupling, namely:

- capacitive (or electrostatic)
- inductive (or magnetic)
- impedance

Capacitive and inductive coupling have the same essential effect -- they couple current or voltage, without any actual connection of the two circuits. Impedance coupling requires a connection between the two circuits.

Typical noise-generating sources that could affect electronic equipment through capacitive and inductive coupling include:

- Relay coils
- Solenoids
- AC power wires -- particularly at or above 100 Vac
- Current carrying cables
- Thyristor field exciters
- Radio frequency transmissions

Impedance couple noise may enter by way of the lines used to power the digital equipment or by way of improper grounding. Most power lines, at typical industrial locations, are far from noise-free. The noise on them can be generated in many ways, but are nearly always associated with switching circuits of some nature.

These include:

- large relays
- contactors
- motor starters
- business and industrial machines
- power tools
- HID (High Intensity Discharge) lights
- Silicon Controlled Rectifiers (SCRs) that are phase angled fired.

These are three ways to prevent electrical noise from interfering with the operation of the electronic digital equipment. One is to suppress the noise at its source. This is the most effective but also the most difficult because it is not easy to identify all of the potential noise sources in a typical industrial installation. Therefore, "suppression" is usually a last resort for those extreme situations where the other methods are insufficient by themselves.

The second method is to prevent noise from getting on the signal and power lines that are connected to the equipment. This is achieved by proper separation and shielding of those lines. In some cases separate power lines or special power line regulation or filtering may be required for satisfactory electronic digital equipment operation. It is the responsibility of the installer to follow good wiring practices.

The third method is to design the digital equipment with a high degree of noise rejection built-in. This includes housing the equipment in a case that will provide shielding, liberal use of noise rejection filters and opto-isolators, and the use of noise suppressors on potential noise sources within the equipment itself. This, of course, is the responsibility of the manufacturer who usually performs extensive laboratory and field testing of newly designed digital equipment to insure the adequacy of its immunity to noise. As a minimum requirement, the equipment should be able to pass the tests outlined in the IEEE Standard 472-1974 (Surge Withstand Capacity Tests).

#### *Recommended Wiring Practices*

- All wiring must conform to local codes and practices.
- Wires carrying similar types of signals (Table 10-1) may be bundled together, but bundles with different types of signals must be kept separated to prevent inductive or capacitive coupling.
- For distances over five (5) feet, and when shielding is recommended, use a separate metal tray or conduit for each bundle. Where conduits or trays are not practical, use twisted wires with a metal

overbraid and provide physical separation of at least one foot.

- Tray covers must be in continuous contact with the side rails of the trays.
- When unlike signal levels must cross, either in trays or conduits, they should cross at a 90-degree angle and at a maximum spacing. Where it is not possible to provide spacing, a grounded steel barrier or grid should be placed between the unlike levels at the crossover points.
- Trays containing low level wiring should have solid bottoms and sides. Tray covers must be used for complete shielding. Tray cover contact with side rails must be positive and continuous to avoid high reluctance air gaps, which impair shielding. Trays for low level cables should be metal and solidly grounded.
- Wires containing low level signals should not be routed near any of the following:
  - contactors
  - motors
  - generators
  - radio transmitters
  - wires carrying high current that is being switched on and off
- Use a 12-gage (or heavier) insulated stranded wire for the ground connection. Attach it firmly to a proven good earth ground such as a metal stake driven into the ground.
- All shields should be grounded at one end only -- preferably the instrument end.

***Power Source***

The AC power for the digital electronic equipment must be within the voltage and frequency limits specified for that equipment. Attempts to operate outside the specified limits will result in no performance. For those installations where the supply voltage will not stay within the specified limits; a ferro-resonant transformer, for voltage resolution, should be used.

For protection against noise, the AC source for the digital electronic equipment should be independent of all other loads especially when switching loads are involved. For example, it should not provide power for air-conditioning, convenience outlets, lighting, motors, or similar noise generating devices. To obtain electrical isolation (Figure 10-1) a separate transformer is required to supply power to the digital equipment. For additional noise and transient rejection, shielded primary and secondary windings may be required. And if necessary, power line filters may be added to attenuate noise signals that have a higher frequency than the power line frequency.

**TABLE 10-1 -- External Wiring**

| Wire Function | | Bundle No. | Are Shielded Twisted Wires Recommended? |
|---|---|---|---|
| **No.** | **Type** | | |
| | HIGH VOLTAGE | 1 | NO |
| 1 | Line Power | | |
| 2 | Earth Ground | | |
| 3 | Line Voltage | | |
| | Digital I/O | | |
| | ANALOG I/O | 2 | YES |
| 4 | Process Variable | | |
| | RTD | | |
| | Thermocouple | | |
| | dc Millivolts | | |
| 5 | Low Level (< 100V) | | |
| | 4-20 mA dc | | |
| | 1-5 Vdc | | |
| | DIGITAL I/O | 3 | YES |
| 6 | Low Voltage (< 100V) | | |
| 7 | Computer Interface | | |

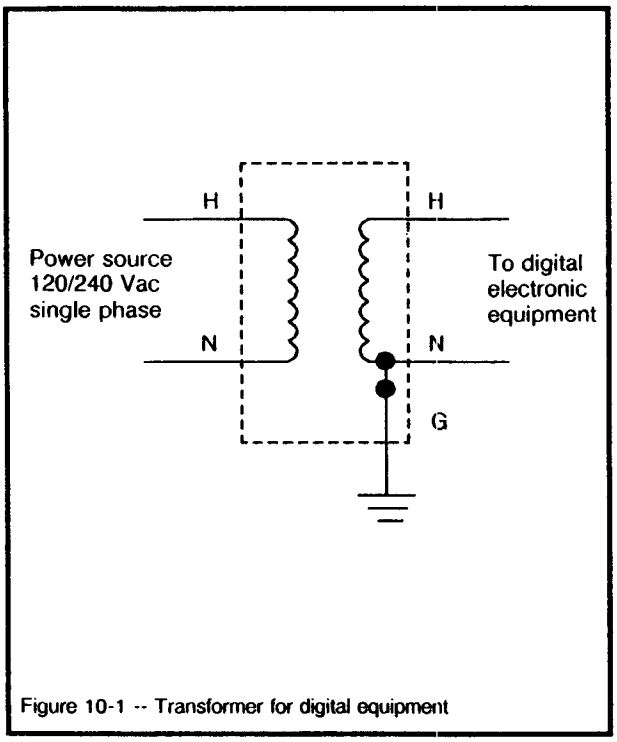



Figure 10-1 -- Transformer for digital equipment

### *Noise Suppression at the Source*

Generally speaking, when good wiring practices are used with well designed digital electronic equipment, no further noise protection is necessary. However, in some severe electrical environments, the magnitude of the electrical noise is so great that it must be suppressed at the source. In most control cabinets, the main sources of noise are motor starters, contactors, relays, and switch gear. For this reason, many manufacturers of these devices supply "surge suppressors" which mount directly on the noise source, for example, on the coil of a control relay or motor starter.

For those devices that do not have accessory "surge suppressors," resistance-capacitance (RC) circuits and/or voltage limiters such as metal varistors may be added when and where needed. This can be broken down into two categories, namely inductive loads(e.g., a relay switch in series with a relay coil) and contacts.

- Inductive Coils: Metal Oxide Varistors (MOVs) are recommended for transient suppression in inductive coils. An MOV is connected in parallel with the coil and is as close as physically possible to the coil (Figure 10-2). MOV devices (Table 10-2) are recommended for general purpose applications.

**TABLE 10-2 -- MOV Devices**

| Spare Part Number | 30732481-001 | 30732481-002 |
|---|---|---|
| Maximum AC | 130V | 275V |
| Energy Pulse Rating | 10 Joules | 15 Joules |
| Supplier (General Electric) | V130LA10A | V275LA15A |

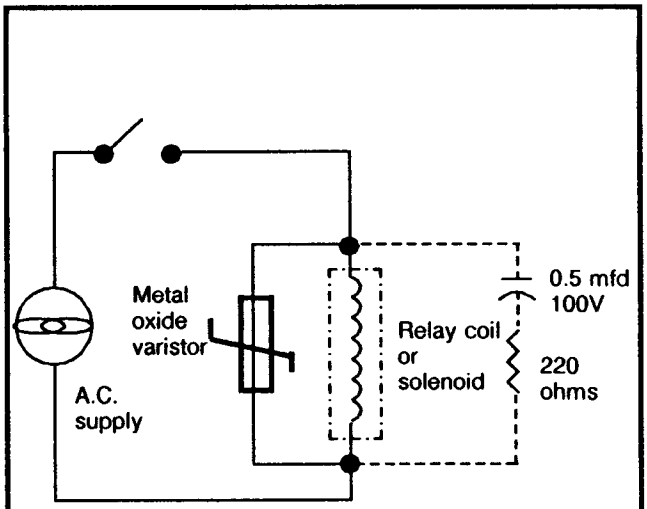



Figure 10-2 -- Transient suppression in inductive coils

***Noise Suppression at the Source (continued)***

Additional protection may be provided by adding an RC circuit in parallel with the MOV. This consists of a 220 ohm resistor in series with a 0.5 microfarad, 1000V capacitor. The power rating of the resistor will depend on the voltage rating of the coil (Table 10-3).

**TABLE 10-3 --**
**Coil Voltage vs Resistor Voltage Rating**

| Coil Voltage | Resistor Voltage Rating |
|---|---|
| 115V | 1/4 Watt |
| 230V | 1 Watt |
| 460V | 3 Watt |
| 550V | 5 Watt |

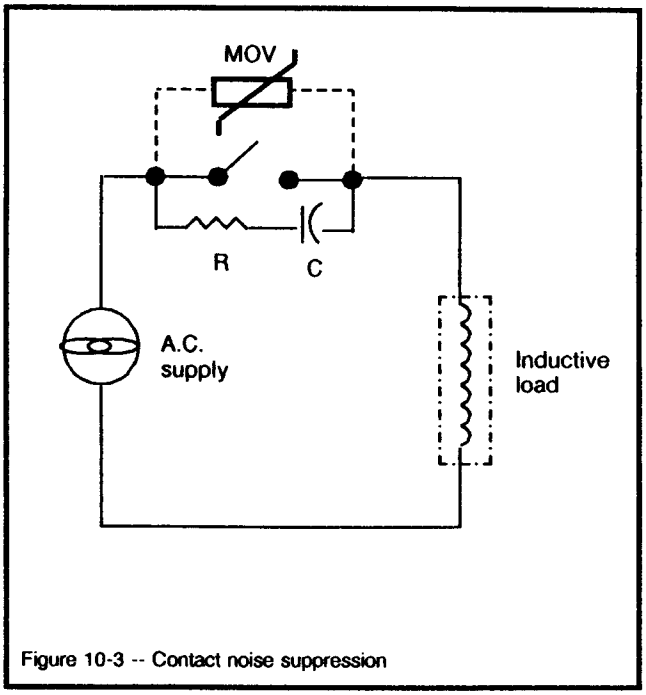



Figure 10-3 -- Contact noise suppression

- *Contacts:* When a contact interrupts an inductive load, a certain amount of energy is stored in the load. An MOV or RC circuit in parallel with the load provides a place where this energy may be dissipated. However, if there is no MOV or RC circuit, the energy may create a visible electrical arc across the open contacts. And this, in turn, results in electrical noise as well as damage to the contacts.

  One way to eliminate this arc is to connect a resistor and capacitor across the contacts (Figure 10-3). A combination of 47 ohms and 0.1 microfarads (1000 Vdc) is recommended for circuits up to 3 amps and 300 Vac. And for voltage above 2000 Vac, an MOV across the contact may be added for extra protection.

  For large load currents, a rule-of-thumb is to size the capacitor so that the number of microfarads equals the number of amperes in the load current, and the resistor is the same value as the load. The objective is to eliminate the visible arc.

  Either discreet resistors and capacitors or packaged RC networks may be used. An RC network (47 ohms and 0.1 microfarad) is available as part number 30371852-001. Similar RC networks are available from Electrocube Inc. (part number RG1782-3) and from Industrial Condensor Corporation.

  In DC circuits, the power dissipation under steady-state condition can be eliminated by placing a diode (in series with a resistor) in parallel with the load (Figure 10-4). The value of R should be less than or equal to the DC resistance of the inductive load.

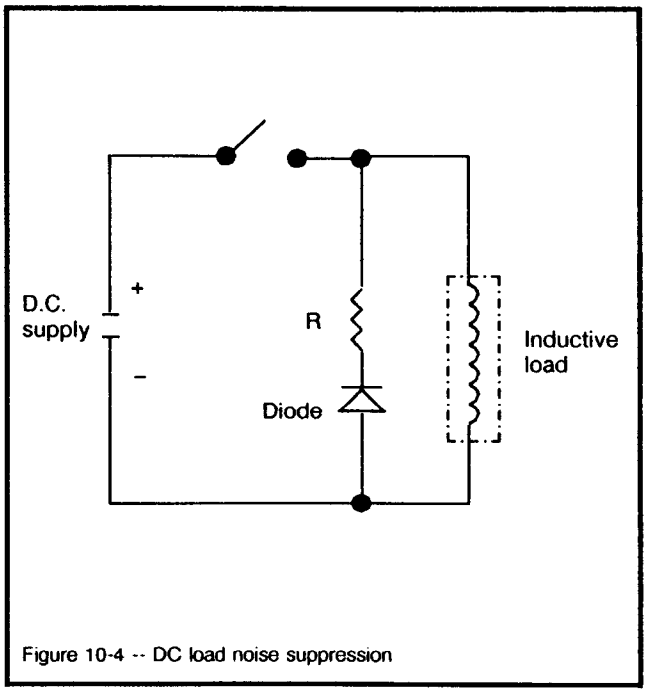



Figure 10-4 -- DC load noise suppression

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## TEMPERATURE

- ☐ Thermocouple, RTD & Thermistor Probes & Assemblies
- ☐ Connector Systems and Panels
- ☐ Wire: Thermocouple, RTD and Thermistor
- ☐ Calibrators and Ice Point References
- ☐ Recorders, Controllers and Process Monitors
- ☐ Data Acquisition Modules and Data Loggers
- ☐ Computer Sensor Interface

## PRESSURE/STRAIN

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

## FLOW

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

## pH

- ☐ Electrodes
- ☐ Benchtop/Laboratory Meters
- ☐ Controllers
- ☐ Calibrators/Simulators
- ☐ Transmitters


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