Technical manual for

JC Systems Stand-Alone Temperature Controllers

Model 210 Single-Channel Controller (Vertical Mount)
Model 270 Single-Channel Controller (Horizontal Mount)
Model 310 Single-Channel Controller (Remote Mount)
Model 280 Dual-Channel Controller (Horizontal Mount
Model 300 Three-Channel Controller (Horizontal Mount)

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Chapter 1. Introduction.

1.1. HOW TO USE THIS MANUAL.

This manual describes how to use the various configurations of JC Systems' stand-alone digital controller. Unless specified otherwise, all procedures apply to all models. Where differences do exist, these are fully explained in the text. Unless otherwise noted, illustrations in the manual show the Model 210 Digital Process Controller or the Model A1970 Temperature Controller PCB.

1.1.1. How to Find Information.

Table of Contents

This reference aid lists major topics in the order they appear. It's an outline of the manual that also shows the page on which the discussion of each topic starts. All the figures and tables are listed separately at the end of the table of contents.

Index

The index is on the very last pages of the manual. It indexes each paragraph and subparagraph of the manual in alphabetical order.

Reference Drawings

Electrical schematics and assembly drawings of the controller's principal components are grouped together in Appendix C at the back of the manual, in the last pages immediately before the index.

Appendixes

Appendix A provides detailed instructions for fine-tuning PID parameters. Appendix B explains how to use the controller's computer interface port (J1). As previously noted, Appendix C contains copies of schematics and assembly drawings for the various controller configurations, options, and related components.

1.1.2 Conventions Used in This Manual.

1. Names of pushbutton switches and displays are shown in ALL CAPITAL LETTERS. If the name appears on the equipment, spelling is exactly as shown there.

   Example: SET POINT

2. If an item is shown on a figure, the figure callout (item number) appears in parentheses after the item name is mentioned for the first time in each paragraph or step.

   Example: Set digiswitch (Figure 2-5, Item 1) to....

   If the figure number does not appear with the item number, the item is on the last figure number referenced.

   Example: Refer to Figure 2-5 and proceed as follows.
   1. Set digiswitch (1) to....

3. Standard abbreviations are not defined. However, the first time a non- standard abbreviation or acronym is used, its meaning is spelled out in parentheses.

   Example: PCB (printed circuit board).

1.2 SYSTEM DESCRIPTION.

The models documented in this manual all use the same basic controller board with minor modifications to either circuitry, packaging, or both to accomodate a variety of applications and installation sites. All models have dual PID parameters. During diagnostic testing, both the heat (INCREASE) and cool (DECREASE) parameters are displayed. Table 1-1 lists the features and capabilities of the basic temperature controller configuration. Table 1-2 provides a listing of available models with a description of each, including the way each differs from the basic model.

The temperature range and sensor type are specified using a dash number after the basic model number as shown in Table 1-3. For multiple controllers (Model 280 or 300), a separate dash number must be supplied for each channel; if only one dash number is shown, all channels will be set to those specifications. The suffix P must be used at the end of each dash number to indicate that both power proportioning and time proportioning output are desired on that channel. The other suffixes used are as follows:

RTD - Resistance temperature detector

RH - Linear (%humidity)

Para. 1.2 (Cont.)

Here are some examples of the order numbers and their meanings:

Order No.	*Description*
Model 210-315CT	Model 210 dual parameter board with Type T Thermocouple, range -99.9 to +315.0°C, time proportioning only
Model 210-315CTP	Same as above, but with both time- and power-proportioning output
Model 210-RTD	Model 210 with 100-ohm platinum RTD, range -99.9 to +320.0°C
Model 210-RTD-P	Same as above, but with power proportioning output
Model 280-315CT/RHP	Model 280 Dual-Channel Controller with a range of -99.9 to +315.0°C on one channel and linear % humidity with power proportioning output on the other

TABLE 1-1: FEATURES AND SPECIFICATIONS.

Characteristic	*Description*
Temp Display Resolution	0.1° (1.0° for hi-temp units)
Setpoint Resolution	0.1° (1.0° for hi-temp units)
Repeatability	±0.1° (1.0° for hi-temp units)
Cold Junction Compensation	±0.01° per degree over 15° to 35°C ambient
Control Mode	Digital - Three Mode, Dual-Parameter PID (Proportional, Integral & Derivative) with digitally selected Reset Windup Inhibit
Display Update Rate	7.5 readings per second
Calibration	Ambient and full-scale
Proportional Gain	Switch-selectable from 1 to 255
Automatic Reset (Integral Action)	Switch-selectable from 0.00 to 2.55 resets per minute
Rate (Derivative Action)	Switch-selectable from 0.0 to 0.7 minutes
Reset Windup Inhibit	Switch-selectable from 1 to 100% of proportional bandwidth
Time Proportioning Outputs	Heat & cool outputs: logic outputs, max. load 40Vdc, max. sink 50mA (suitable for driving photo-isolated solid-state relays) Cycle Time - switch-selectable from 1 to 255 seconds
Power Proportioning Output (Optional)	Jumper-selectable 4-20 or 0-16 mA; switch-selectable 4-12/12-20, or 0-8/8-16 mA current loop. 12 bit (3.91 microamp) resolution. Max. loop resistance 1000 ohms.
Dimensions and Weight	See Table 1-2

TABLE 1-2: CONTROLLER CONFIGURATIONS.

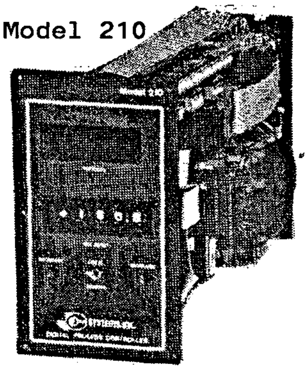
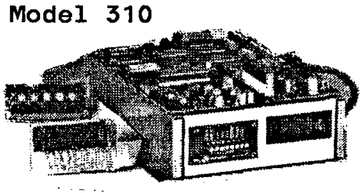
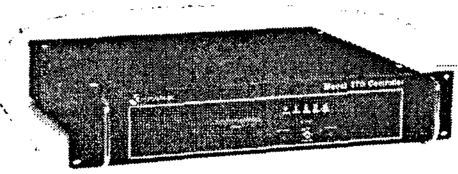
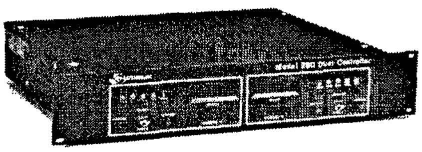
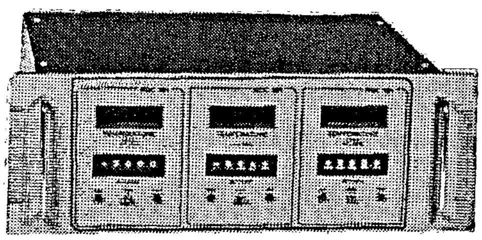
Model No.	*Description*
Model 210 	Basic single-channel controller as described in Table 1-1. Vertical 1/2 DIN panel mount, front panel approx. 7-1/2 x 4 in. (19 x 10 cm), enclosure 7-1/8 x 3-1/2 x 13-1/2 in. (18.1 x 8.9 x 34.3 cm); 5 lbs. (2.3 kg)
Model 310 	Remote-mount version of Model 210 includes ribbon cables for digi-switch and display. 4 x 8-1/2 x 9-1/2 in. (10.2 x 21.6 x 24 cm); 6 lbs. (2.7 kg)
Model 270 	Horizontal version of Model 210. Ready for 19-in. rack mount (or attach rubber feet for bench use). 3-1/2 in. vertical clearance required. 3-1/2 x 19 x 16 in. (8.9 x 48.3 x 40.6 cm), 10 lbs. (4.5 kg)
Model 280 	Dual-channel version of Model 270. Same size; weight 10.5 lbs. (4.8 kg)
Model 300 	Three-channel version of Model 210. 19-in. rack mount requires 3-1/2 in. vertical clearance. (Rubber feet provided for bench mount.) 7 x 19 x 15 in. (17.8 x 48.3 x 38.1 cm), 22 lbs. (10 kg)

TABLE 1-3: ORDERING INFORMATION.

Basic P/N	Dash No.	Sensor	Range
Model No.	315CJ*	Type J T/C	-99.0° to 600.0°F (-73.0 to 315.0°C)
(from	600CJ*	Type J T/C	-32.2° to 799.8°F (0.0 to 600.0°C)
Table 1-2)	315CT*	Type T T/C	-99.9° to 600.0°F (-99.9 to 315.0°C)
	200CT*	Type T T/C	-299.0° to 393.0°F (-184.0 to 200.0°C)
	180CT*	Type T T/C	-99.9° to 356.0°F (-99.9°to 180.0°C)
	RTD*	100-ohm platinum RTD	-99.0° to 600.0°F (-73.0 to 315.0°C) (European curve, Alpha = 0.00385)
	RH	Linear	0-100% relative humidity

*Include the suffix letter P here to specify optional power proportioning output in addition to time proportioning output

1.3 SYSTEM APPLICATIONS.

The controller is designed to perform direct digital control of temperature and related process values, such as pressure or humidity. The controller comes equipped with a BCD parallel interface port that can be used to communicate directly with a computer or via optional IEEE-488 or RS-232C/RS-422A communica tion interfaces.

Accessories available include the Model A2192 Chamber Enhancer, a full-range, bumpless staging sequencer. The Model A2192 provides a way to achieve the higher heating/cooling requirements dictated by fast rate-of-change specifications without the higher energy consumption other approaches need to meet those specifications. It enables you to use refrigeration systems that are not balanced or performing at less than peak efficiency due to age.

With the chamber enhancer accessory, you can use the full range of staged system heating and cooling combinations. The enhancer's microprocessor uses a sophisticated algorithm to translate the controller's time-proportioning outputs into signals that accurately regulate the full range of LOW and HIGH heating or cooling capabilities. As a result, you can achieve the desired chamber temperature quickly, yet with the lowest possible energy consumption.

With the chamber enhancer, the LOW capacity is always fully utilized before HIGH capacity is enabled, so even a system with marginal LOW capacity can be used effectively in a staged application.

Chamber enhancer features include:

- Full-range staging — simultaneous but independent control of LOW and HIGH outputs derived from the controller's time-proportioning outputs.
- Adjustable debang in increments of cycle time for all modes.
- Staged Cool bypass output.
- Adjustable compressor time on. Can be used for both Cool and Dehumidify Compressor Control, or for Cool only with a separate output for Dehumidify Compressor Control using an external solid-state relay.
- Eight socketed locations that accept plug-in type solid-state relays for control and staging outputs.

1.4. PRINCIPAL COMPONENTS.

Principal components of the system are:

- the front panel, which contains the thumbwheel switch (digi-switch) used to select the setpoint and the display which shows the current process variable;
- the rear panel, where electrical connections are made, and
- the printed circuit boards (PCB) within the cabinet.

Bench-mount configurations are enclosed in a case, and the Model 310 configuration includes cabling to remotely mount its digi-switch and display. Procedures for making electrical connections and setting switches are given in Chapter 2.

Chapter 2. Installation and Operation.

2.1. INFORMATION PROVIDED.

This chapter describes installing and operating the controller. It includes unpacking and mounting the system, connecting electrical power, thermocouples, and controller outputs. It also describes the controls and displays used for controller operation, as well as the DIP switch settings required for correct controller operation.

2.2. UNPACKING.

Remove all protective packing and tiedowns from the controller and remove the controller from its shipping container.

2.3. MOUNTING.

2.3.1. Panel Mounting (Model 210).

The Model 210 is designed to be mounted by its front panel directly into a 1/2 DIN opening in the controlled equipment. Dimensions of the unit are shown in Figure 2-1. Be sure that the installation permits access to the back panel (for thermocouple and accessory cable connections.)

2.3.2. Remote Mounting (Model 310).

The Model 310 can be mounted in any remote location -- for example, inside the chamber's electronic cabinet. Ribbon cables are provided to bring out the process variable display and thumbwheel switch.

2.3.3. Rack Mounting (Model 270, 280, or 300).

Mount the controller in a standard 19-in. electronic rack, allowing enough vertical clearance to accommodate its height (3-1/2 in. for Model 270 or 280, 8-3/4 in. for Model 300). Rack slides are available for these controllers; just add -S to the order number (Table 1-2).

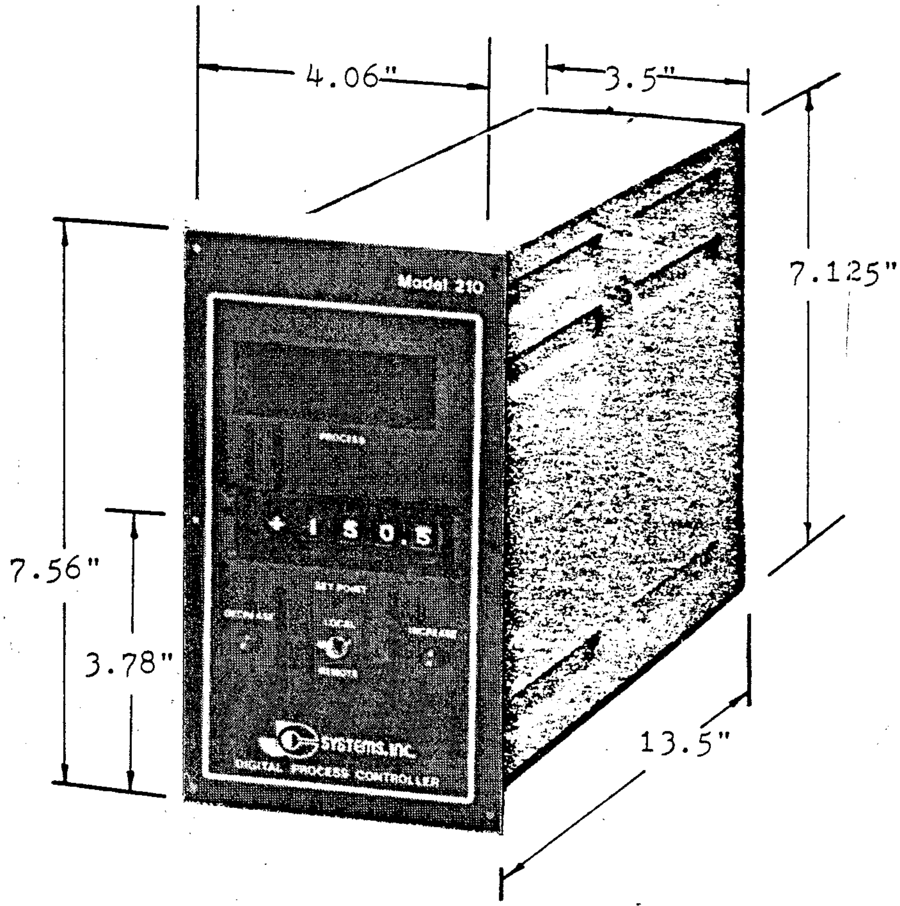


Figure 2-1: Model 210 Mounting Dimensions.

2.3.4 Bench Mounting.

For bench use of the Model 270, 280, or 300, be sure to install rubber feet (available at no charge from JC Systems) on the bottom of the controller to prevent damage to the benchtop. (The Model 210 and 310 are not suitable for bench mounting.)

2.4 CONNECT ELECTRICAL POWER.

Plug in power cable from rear panel to 117V, 50/60 Hz grounded socket.

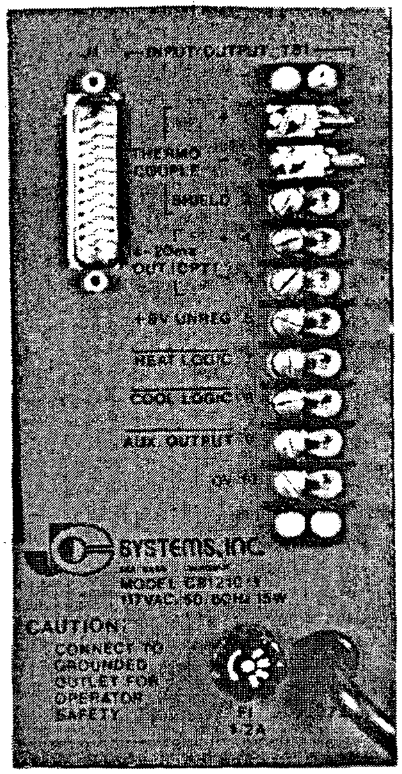


Figure 2-2: Typical Rear Panel Layout (Model 210 Shown).

2.5. CONNECT TEMPERATURE INPUTS.

Connect thermocouple or RTD (resistance temperature detector) leads at terminal board TB1 on the rear panel. A label on the rear panel specifies the temperature input configuration of your unit. Use terminals 1 and 2 for thermocouples.

On units with multiple controller channels, additional terminal boards with corrresponding reference designations (TB-2, for example) are provided for each channel.

When using two-wire RTD sensors, connect one sensor wire each to the second and third terminals (TB1-2 and -3). Then connect the first and second terminals (1 and 2 in our example) with a short jumper wire.

When using three-wire RTD sensors, connect the two same-colored wires to the first and second terminals. Connect the remaining wire to the third terminal; if a shield is present, connect that to terminal 10.

2.6. CONNECT TIME-PROPORTIONING OUTPUTS.

NOTE

> If your controller is equipped with the power proportioning (current loop) option and you want to use power proportioning instead of time proportioning, skip this paragraph and proceed to the next one, which describes current loop output connections.

Connect controller time-proportioning outputs (located on TB1 on the rear panel) to the heat and cool SSR (solid-state relays) as shown in Figure 2-3. Make the connections at terminals 6 thru 8. Figure 2-3 shows connections for typical applications.

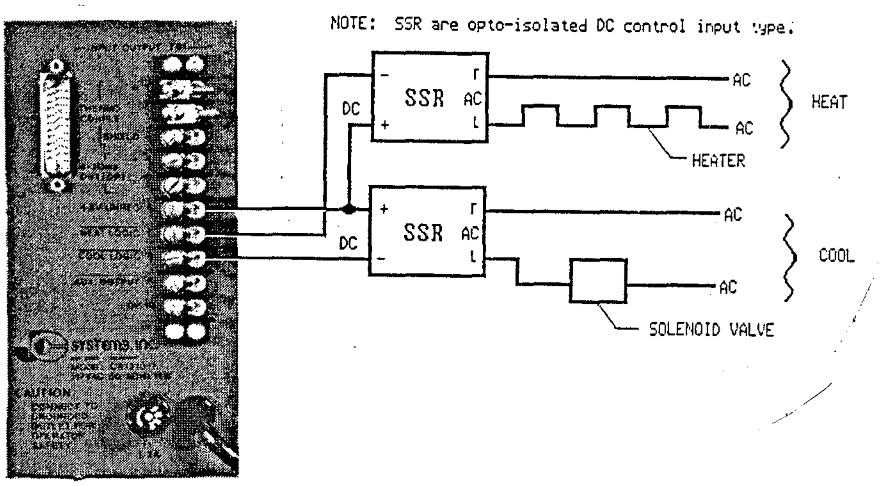


Figure 2-3: Connecting Time-Proportioning Outputs (Typical Applications)

2.7. CONNECT POWER PROPORTIONING (CURRENT LOOP) OUTPUT OPTION.

NOTE

This type of output is available only on units equipped with the Model 1034 current loop option.

2.7.1. Connect Power Proportioning Outputs.

Connect the 4-20 mA proportional current loop to terminals 4 (+) and 5 (-) of the applicable terminal board on the rear panel. (TB1 for a single-channel controller or for Channel 1 of dual-channel controller, TB2 for Channel 2, TB3 for Channel 3).

NOTE

Heat and cool time proportioning outputs with two-second cycle time are also available when the current loop output is installed.

2.7.2. Set Cycle Time Switch.

When the power proportioning feature is used (ribbon cable connected between A1034 current loop and A1970 controller PCB), the controller cycle time DIP switch (S1) must be set to 255 (all bits up). (If you have a multi-channel controller with power proportioning on one or more channels, you will need to set the switch on each controller board.) This switch is located on the controller PCB (Figure 2-4, Item 1).

To gain access to the switch in rack-mounted controllers (Models 270, 280 and 300), loosen the four camlock fasteners securing the top cover and remove it.

The setting of 255 defaults the time proportioning output period to 1 second as long as the power proportioning output is installed. If power proportioning is removed, the time proportioning period reverts to 255 seconds (the switch setting), and *must* be reset for correct time proportioning operation.

If S1 is set to any value other than 255 when power proportioning output is installed, the process value display will read "LOOP". To remove the LOOP display, set S1 to 255 (all bits up).

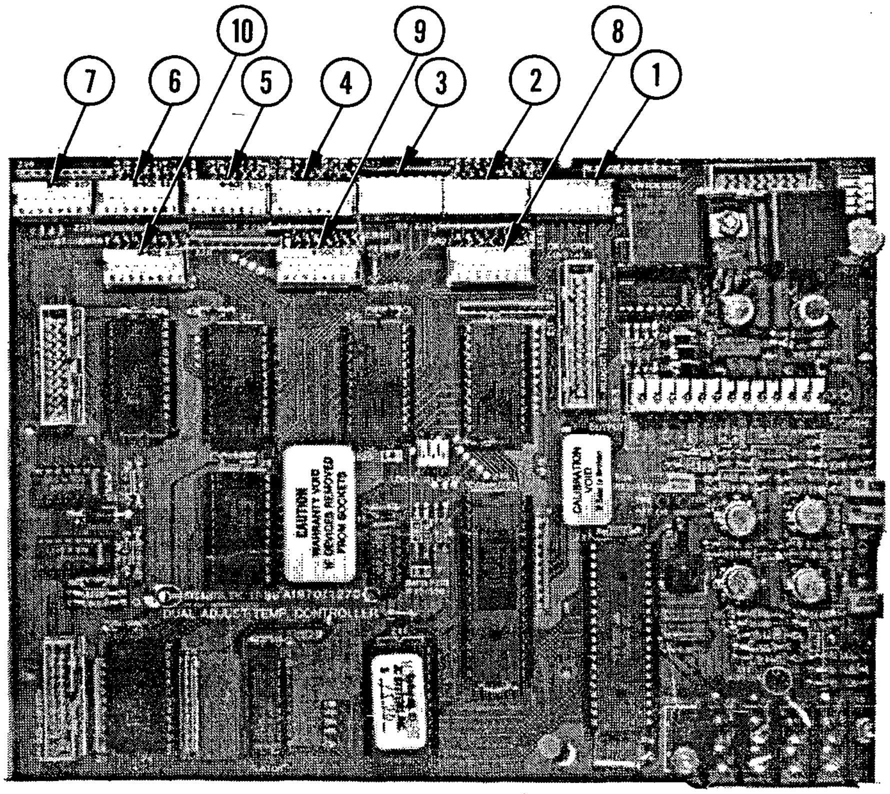


Figure 2-4: Controller Board DIP Switch Locations

2.7.3. Select Power Proportioning Operating Modes.

Select operating modes for the power proportioning output by setting DIP switch S7 on the controller board (Figure 2-4, Item 7) as specified below. The "normal" setting is the factory setting in all cases. If you have a controller with power proportioning output on both channels, you will need to set the switches on both controller boards.

2.7.3.1. Select Single-Current or Split-Range Output (S7-1).

1. Set S7-1 HI (up position) to select single-current (normal) operation. In this position, 4 mA is null output. Current output from 4mA to 20mA corresponds linearly to required output action from 0 to 100%.
2. Set S7-1 LO (down position) to select split-range operation. In this position, current output is 12-20 mA for 0-100% heat requirement (reverse action) and 12-4 mA for 0-100% cooling requirement (direct action). The null output current value is 12 mA.
3. Table 2-1 shows what effect the position of Switch S7-1 has on current loop output.

TABLE 2-1: ERROR VALUE AND CORRESPONDING CURRENT OUTPUT FOR REVERSE ACTION

SETPOINT SETTING	OUTPUT CURRENT, mA	PERCENT POWER
OUTPUTS IN SINGLE-CURRENT OPERATION (S7-1 HI)		
+100.0	20.0	100
+50.0	12.0	50
0.0	4.0	0
-50.0	4.0	0
-100.0	4.0	0
OUTPUTS IN SPLIT-CURRENT OPERATION (S7-1 LO)		
+100.0	20.0	100 HEAT
+50.0	16.0	50 HEAT
0.0	12.0	0
-50.0	8.0	50 COOL
-100.0	4.0	100 COOL

2.7.3.2. Select Reverse or Direct Action (S7-3).

1. Set S7-3 HI (up position) to select reverse (heating) action. In this position, the controller decreases the output as the process value approaches the setpoint from a temperature *below* the setpoint.
2. Set S7-3 LO (down position) to select direct (cooling) action. In this position, the controller decreases the output as the process value approaches the setpoint from a temperature *above* the setpoint.

2.7.3.3. Select Automatic or Manual Current Loop and Time Proportioning Function (S7-2).

1. Set S7-2 HI (up position) to select automatic (normal) current loop and time proportioning functions. This is the normal operating position for the controller.
2. Set S7-2 LO (down position) to select manual current loop and time proportioning functions. In this position, the operator can manually select the amplitude of current output and the duty cycle of time proportioning outputs by changing the controller setpoint setting to the desired value (see Table 2-1). When this function is selected, the controller does not operate as a closed-loop system. In other words, it does not take feedback from the process and correct for deviations.

2.8 SELECT TEMPERATURE OR LINEAR INPUT MODE (S7).

Controller DIP Switch S7 (Figure 2-4, Item 7) positions 1-3 select power pro portioning output modes as previously described in Para. 2.7.4. On controllers configured for temperature applications, S7 bit 4 sets control circuitry to function in either C when up or F when down.

On controllers configured for linear input applications, S7-4 is preset to the required value at the factory. S7-4 is set LO for 4-20 mA input current loop operations. Note that an external resistor (25.5 Ohms, 1%, 1/2 W) must be used with the 4-20 mA input. S7-4 is set HI for 0-500 mV input.

S7 bits 5 thru 8 are not used.

2.9 FACTORY SWITCH SETTINGS.

2.9.1 Controller DIP Switches.

Each controller leaves the factory with controller DIP switch settings that are correct for the configuration ordered. Typical settings for a 260° span temperature controller with and without the Model A2192 Chamber Enhancer are shown in Table 3-1. If you need to change these settings, refer to Appendix A. You can use the diagnostics feature to determine the switch settings as explained in Para. 2.9.2 below.

TABLE 3-1: TYPICAL SETTINGS FOR A 260° SPAN TEMPERATURE CONTROLLER.

SWITCH NUMBER	DESCRIPTION	TYPICAL SETTING
S1	Inc/Dec Cycle Time	4 seconds (Bit 3 up)
S2	Inc Automatic Reset	.32 x 10^{-2} (Bit 6 up)
S3	Inc/Dec ID Band	0.5° (Bits 1 and 3 up)
S4	Inc Reset Windup Inhibit	With A2192 – 40% (Bits 4 and 6 up) Without A2192 – 20% (Bits 3 and 5 up)
S5	Inc/Dec Rate (Derivative) (Bits 1-3 Inc, 4-6 Dec)	Off (0 — Bits 1-6 down)
S6	Inc Proportional Gain	Set to obtain a proportional bandwidth (See Appendix A) of: 10° with A2192 5° without A2192
S7	Miscellaneous Functions	On (All bits up — see Para. 2.10)
S8	Dec Automatic Reset	.32 x 10^{-2} (Bit 6 up)
S9	Dec Reset Windup Inhibit	With A2192 – 40% (Bits 4 and 6 up) Without A2192 – 20% (Bits 3 and 5 up)
S10	Dec Proportional Gain	Set to obtain a proportional bandwidth (See Appendix A) of: 10° with A2192 5° without A2192

2.9.2 Read Switch Settings Using Diagnostics.

To determine current switch settings, use the diagnostic mode to examine and record the values used as follows.

NOTE

Switch S5 bit 7 must be in the UP position for the diagnostics to work.

1. Set Switch S5 bit 7 UP. (Wait until the display test is over before proceeding, or enter .9 to exit the display test.)
2. Change the digi-switch setting to the diagnostic test code (-590.4, for example) you want displayed.
3. Perform Step 3 for each of the diagnostic codes in Table 2-2 to determine the corresponding switch setting. Record the setting in the space provided (or any convenient place).
4. To exit diagnostics, Set Switch S5 bit 7 down (DN). The controller will resume automatic operation.

NOTE

The decimal must be entered when any code is used; for example, -590.4.

TABLE 2-3: DIP SWITCH SETTINGS.

SWITCH NUMBER	FUNCTION	DIAGNOSTIC CODE	SETTING
S6	Inc Proportional Band	-591.6	______________
S10	Dec Proportional Band	-581.6	______________
S1	Inc/Dec Cycle Time	-590.4	______________
S2	Inc Automatic Reset	-590.5	______________
S8	Dec Automatic Reset	-580.5	______________
S3	Inc/Dec ID Band	-590.6	______________
S4	Inc Reset Windup Inhibit	-590.7	______________
S9	Dec Reset Windup Inhibit	-580.7	______________
S5	Bits 1-3 Inc Rate	-590.8	______________
S5	Bits 4-6 Dec Rate	-580.8	______________

2.10 2.10. CONTROLLER OPERATION.

To run the system as a manual controller, refer to Figure 2-5 and proceed as specified below. Numbers in parentheses refer to item numbers shown on Figure 2- 5.

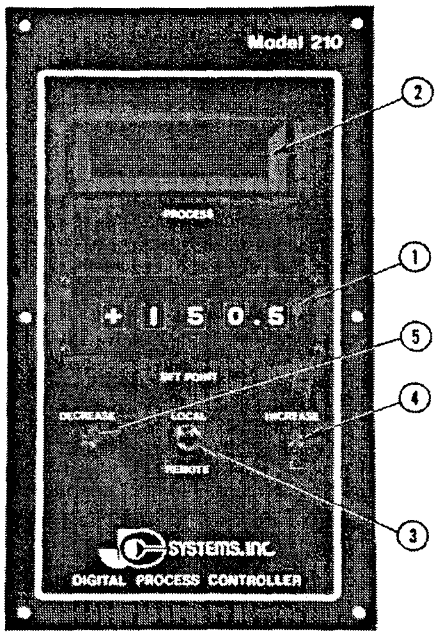


Figure 2-5: Front Panel Displays and Switches.

2.10.1. Select Setpoint.

Set digi-switch (1) to desired setpoint. If the selected setpoint is outside the controller's range, a row of dashes (----) appears in the PROCESS display (2). (For linear controllers, the range is 0.0 to 100.0.)

2.10.2. Select Local Operation.

Turn the LOCAL/REMOTE switch (3) to LOCAL. The controller will control the process based on the setpoint entered via the digi-switch per Para. 2.10.1. (The REMOTE mode sets the controller to accept its setpoint from a remote device.)

2.10.3. Power Up.

Turn on the controller or the unit it controls. The PROCESS display will show the current process variable.

2.10.4. Operation.

Once switch settings and the setpoint have been selected, operation itself is automatic. During operation, the INCREASE and DECREASE LED's (4 & 5) will light as their corresponding outputs are activated. Each LED is on when its corresponding output is active and off when its output is inactive.

2.10.5 How to Detect a Failure.

2.10.5.1 Probe Open.

If a thermocouple or RTD probe is open, or if a linear input signal is out of range, a probe open condition results and causes the following to occur:

1. The CODE "P.OP." appears in the controller's PROCESS display (2).
2. Heat and Cool outputs automatically turn off.

2.10.5.2 Invalid Setpoint.

If the setpoint entered by the operator is outside the operating range of the controller(s), the following actions occur. (Diagnostics can be used to determine the controller's operating range — refer to Chapter 3.)

1. A series of dashes (– – – . –) appears in the controller's PROCESS display (2).
2. The Heat and Cool outputs automatically turn off.

Chapter 3. Maintenance and Calibration.

3.1. PREVENTIVE MAINTENANCE.

3.1.1. Cleaning.

Regularly dust outside surfaces and keep the controller's interior free of dust and debris, especially pieces of wire that could cause shorts.

3.1.2. Other Preventive Maintenance.

Perform the calibration procedures described in this chapter at least once a year.

3.2. PERFORM CORRECTIVE MAINTENANCE.

The controller is designed to be trouble-free, offering reliable service without extensive maintenance. The only corrective maintenance recommended consists of troubleshooting to the board level using procedures provided in this chapter, followed by removal and replacement of defective components if required.

3.3. RUN DIAGNOSTICS.

The controller's diagnostic capability allows quick, simple troubleshooting and verification of hardware operation. The tests described below can be used to check hardware functions. Each test operates a particular I/O device and the displays or switches associated with that device. Settings on various switches also may be displayed.

3.3.1. Using Diagnostics.

NOTE

Switch S5 bit 7 must be in the UP position for the diagnostics to work.

1. Set Switch S5 bit 7 UP. (Wait until the display test is over before proceeding, or enter .9 to exit the display test.)
2. Change the digi-switch setting to the diagnostic test code (-590.4, for example) you want displayed.
3. Perform Step 2 for each of the diagnostic codes in Table 2-2 to determine the corresponding switch setting. Record the setting in the space provided (or any convenient place).
4. To exit diagnostics, Set Switch S5 bit 7 DN. The controller will resume automatic operation.

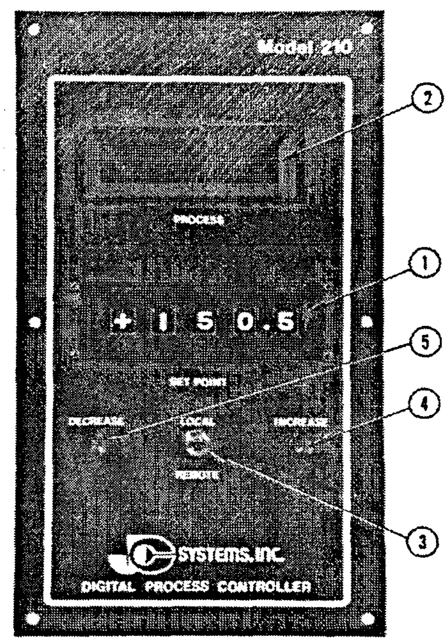


Figure 3-1: Front Panel Displays and Indicators.

3.3.2 Dual Parameters Display.

The DP (dual parameter) controllers display both heating and cooling parameters during diagnostics. To access cooling parameters, use the -58XX series of diagnostic test codes (use the same last two digits for the -58XX code as you would use for the corresponding -59XX test).

3.3.3 List of Diagnostic Tests.

Table 3-1 lists the diagnostic test codes and short titles and provides a brief description of each test. The tests are grouped by their intended use. Where more detailed descriptions of a test are provided in the text, the table references the applicable paragraph number.

NOTE

For ease of reference, decades of displays are identified as positions 1 thru 4, with position 1 equal to the least significant digit (at the extreme right of display) and 4 as the most significant digit (at the extreme left of the display). Decimal positions are not counted.

TABLE 3-1. SUMMARY OF DIAGNOSTIC TESTS.

Test No.	Item Tested	Description	See Para.
-500.0 (also -594.0)	Display	Starts automatically when diagnostics invoked; cycles all characters and indicators. Can quit or expedite.	3.3.4
		Tests to Read Actual Switch Settings	
—	Enter Setpoint	Echoes back a changed setpoint value (or current output when current loop installed).	3.3.5.1
-590.0	A/D Data Valid	Shows that the A/D converter is generating "data valid" strobe. High and low levels produced by the A/D converter show as alternating letters H and L on the display.	
-590.1	A/D Data Display	A/D converter data output displayed in decimal form.	

Test No.	Item Tested	Description	See Para.
-590.2	Computer Handshake and Current Loop Select	Displays the logic level of two computer handshake lines as either an H or L in display position 1 and 2, respectively; position 3 shows current loop present (L) or absent (H).	3.3.5.2
-590.3	Mode Select Switch	An H or L shows the settings of individual bits on Switch 7. Status and bit positions correspond — i.e., display position 1 is DIP switch S7-1.	
		Tests to Verify (Read) Parameter Settings	
-590.4	Cycle Time Switch (Increase/Decrease) (S1)	Displays the decimal value selected on DIP Switch S1.	
-590.5 (Inc) -580.5 (Dec)	Automatic Reset Switch (Increase S2, Decrease S8)	Displays the decimal equivalent of the binary value selected on switch S2 or S8 as determined by the settings on the switch. The values can range from 0 (all bits LO) to 255 (all bits HI).	
-590.6	ID Band (No Proportional Action) Switch (S3)	Displays the ID band in degrees (or units) expressed as the decimal equivalent of the binary value selected on switch S3. This value can range from 0.0 to 6.3, as only 6 bit positions of the switch are used.	
-590.7 (Inc) -580.7 (Dec)	Reset Windup Inhibit Switch (Increase S4, Decrease S9)	Displays the reset windup inhibit expressed as the decimal equivalent of the binary value selected on switch S4 or S9. The value, represented in units of percent of proportional band, can be set from 0 to 127 (7 bit positions used). However, values of 0, 100, or >100 disable RWI.	
-590.8 (Inc) -580.8 (Dec)	Rate Switch (S5) bits 1-3 Increase, bits 4-6 Decrease	Displays the decimal equivalent of the value selected on the rate switch (S5). The value can range from 0 to 7 (3 bit positions used; Bits 1-3 for heat parameters and Bits 4-6 for cool parameters). (Bit 7 enables the controller diagnostics. It is factory sealed and must not be changed.)	

Test No.	Item Tested	Description	See Para.
-590.9 (Inc) -580.9 (Dec)	Proportional Gain Switch (Increase S6, Decrease S10)	Displays the decimal equivalent of the binary value selected on switch S6 or S10. The value can range from 0, which is the on/off mode of operation, to 255, which is the maximum proportional gain setting for the controller.	
-591.5	Span	Displays the span of the controller, expressed in degrees and tenths of a degree. (The span is the algebraic sum of the difference between the maximum and minimum setpoint.)	
-591.6 (Inc) -581.6 (Dec)	Proportional Band	Displays the proportional band (span divided by proportional gain) in degrees and tenths.	
-591.7 (Inc) -581.7 (Dec)	Reset Windup Inhibit Bandwidth	Displays the Reset Windup Inhibit (RWI) bandwidth in tenths of a degree.	
-591.8	Lower Setpoint Limit	Displays the lowest setpoint accepted by the controller. A lower setpoint causes dashes (– – – . –) to appear in the display and disables both the "heat" and "cool" outputs of the controller.	
-591.9	Upper Setpoint Limit	Displays the highest setpoint accepted by the controller. The same error message as described for the Lower Limit Setpoint will appear if this limit is exceeded.	

Tests of System Operation.

Test No.	Item Tested	Description	See Para.
-592.0	Watchdog Timer Circuit Check	Verifies that the watchdog timer circuit timed out and reset the controller to its start condition.	3.3.6
-594.0	Exercise Display and Outputs	Initiates display test; cycles all characters and indicators.	3.3.4

3.3.4 Display Test.

This test verifies that each digit of the setpoint and process temperature displays for the applicable controller cycle through the entire character set (0-9,-,E,H,L,P).

EXCEPTION: The most significant digit will not display the numeral "0".

After cycling the displays, the diagnostic program will momentarily and in sequence turn on decimal point 1 (xxx.x); decimal points 3 (x.xxx) and 0 (xxxx.), followed by the HEAT, COOL and AUX outputs. HEAT and COOL output will be indicated by the corresponding INCREASE or DECREASE LED momentarily turning on and off; there is no indication for AUX output.

To expedite the display test, enter .1 in the least significant bit (LSB) position. To exit the test, enter .9 in the LSB position.

3.3.5 Tests to Read Actual Switch Settings.

3.3.5.1 Enter Setpoint Test.

Enter a setpoint other than -59x.x. Observe that the corresponding PROCESS display echoes back the setpoint value (except for the numbers -59x.x, as that number series is used exclusively for diagnostic tests).

If the 4-20 mA current loop option is connected, test output by entering any number from 0000 (which outputs the minimum current) to 4095 (which outputs the maximum current). 50% current output would occur with a setpoint setting of 2047.

3.3.5.2 -590.2 Computer Handshake and Current Loop Select Test.

This test indicates the status of the computer interface handshake command inputs and the optional 4-20mA output. The two handshake lines involved are the READ TEMP Command (PIN 22) and the SETPT VALID Command (PIN 24) on the remote interface connector (J1). The display shows the logic level of each as an "H" or "L" (see Figure 3-2). The READ TEMP (PIN 22) status appears in position 1 of the display, while the SETPT VALID (PIN 24) status appears in position 2.

Current loop select bit status is low when the current loop is plugged into connector J1 on the controller PCB; status is indicated by an H or L in Position 3.

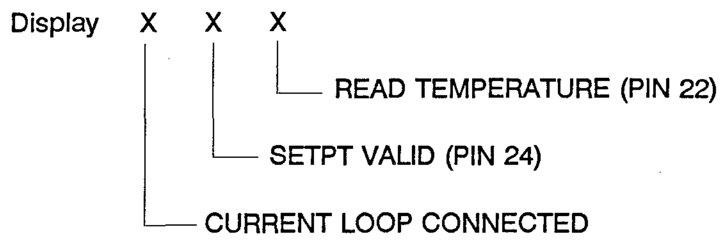


Figure 3-2: Display Positions for -590.2 Diagnostics Test.

3.3.6 -592.0 Watchdog Timer Circuit Check

The system's watchdog timer ensures that the controller will reset and restart upon sensing a brownout or transient on the power lines sufficient to disrupt the operation of the microcomputer. This function keeps the microcomputer from getting lost. Approximately 4 seconds after test -592.0 is selected, the controller will reset and the display will cycle through the digits. This activity verifies that the watchdog timer circuit timed out and reset the controller to its start condition.

3.4 CALIBRATE CONTROLLER.

The controller is calibrated before shipping from JC Systems. Calibration parameters used by JC Systems are shown on the Calibration Parameters Sheet included with this manual. Perform any subsequent calibration as specified below, using the values provided on the Calibration Parameters Sheet.

3.4.1 Procedure for Thermocouple Input.

3.4.1.1 Equipment Required.

1. Thermocouple calibration standard (calibrator) such as Wahl Instruments Model C-65 or Biddle Model 720350.
2. Thermocouple extension wire of the required type for the unit being calibrated.
3. Temperature sensor to measure ambient temperature.

3.4.1.2. Ambient Calibration.

1. Disconnect thermocouples.
2. Using the thermocouple extension wire, connect the calibrator to the temperature controller input.
3. Measure and record ambient temperature.
4. Turn on controller using rocker switch on rear panel and set calibrator output to the ambient temperature as measured in Step 2.
5. Adjust ambient potentiometer R24 (Figure 3-3, Item 1) until the PROCESS display reading matches that of the calibrator.

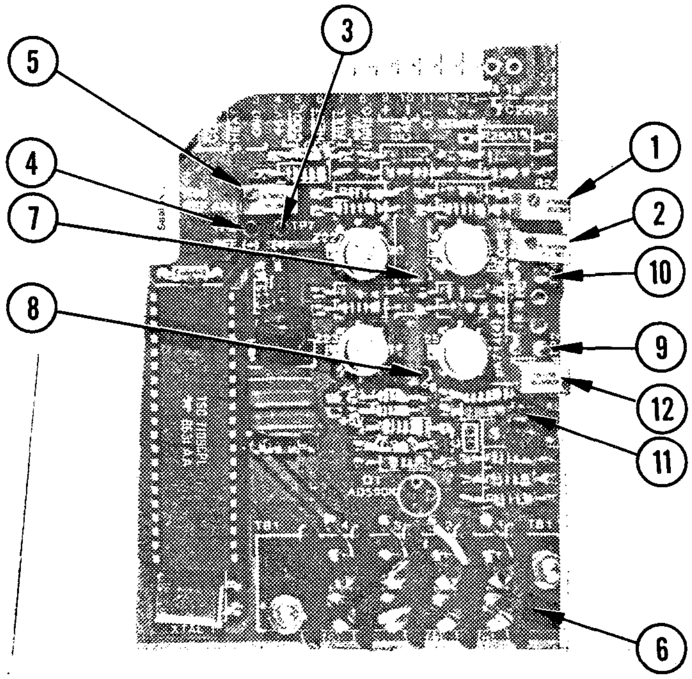


Figure 3-3: Controller Calibration Points.

3.4.1.3. Full-Scale Calibration.

1. Set the calibrator to the calibration temperature specified on the Calibration Parameters Sheet for the type of controller being calibrated.
2. Adjust slope potentiometer R9 (Item 2) until the PROCESS display reading matches that of the calibrator.

3.4.1.4. Final Calibration and Verification.

To verify calibration, set calibrator to various temperatures throughout the controller's range. Ensure that the temperature in the PROCESS display matches the calibrator setting to within ±0.5°C, which is the accuracy specification for the controller. If accuracy is not within ±0.5°C, repeat calibration.

3.4.2. Procedure for Linear Input Controller.

3.4.2.1. Equipment Required.

Millivolt or milliamp source (depending on linear input type).

3.4.2.2. Ambient Calibration.

1. Using standard copper wire, connect the current source to the temperature controller input.
2. Turn on controller using rocker switch on rear panel and set current to the value specified on the Calibration Parameters Sheet.
3. Adjust ambient potentiometer R24 (Figure 3-3, Item 1) until the PROCESS display reading matches that of the current source.

3.4.2.3. Full-Scale Calibration.

1. Set the current source to the value specified on the Calibration Parameters Sheet.
2. Adjust slope potentiometer R9 (2) until the PROCESS display reading matches that of the current source.

3.4.2.4. Final Calibration and Verification.

Repeat ambient and full-scale calibration until there is no interaction between the ambient and slope potentiometers.

To verify calibration, set current source to various values throughout the controller's range. Ensure that the reading in the PROCESS display matches the current source setting.

3.4.3. Procedure for RTD Input Controller.

3.4.3.1. Equipment Required.

Precision resistance decade box or 1% resistors with values as specified on the Calibration Parameters Sheet.

3.4.3.2. Ambient Calibration.

1. Connect the decade box or resistor across TB1 pins -2 and -3, of the temperature controller input. Short pins TB1-1 & -2.
2. Power up controller and set resistance to the value specified on the Calibration Parameters Sheet.
3. Adjust ambient potentiometer R24 (Figure 3-3, Item 1) until the PROCESS display reading matches that specified on the Calibration Parameters Sheet.

3.4.3.3. Full-Scale Calibration.

1. Set the resistance to the value specified on the Calibration Parameters Sheet.
2. Adjust slope potentiometer R9 (2) until the PROCESS display reading corresponds to the value specified on the Calibration Parameters Sheet.

3.4.3.4. Final Calibration and Verification.

Repeat ambient and full-scale calibration until there is no interaction between the ambient and slope potentiometers.

To verify calibration, set resistance to correspond to various values throughout the controller's range. Ensure that the reading in the PROCESS display matches the selected resistance.

3.5. ADJUST CONTROLLER REFERENCE VOLTAGE AND BALANCE.

The following adjustments are made at the factory and the associated potentiometers are then sealed. Please be aware that JC Systems cannot be responsible for any unit that does not conform to calibration standards if the described adjustments have been changed without authorization from JC Systems.

3.5.1. Equipment Required.

Digital voltmeter capable of reading 0.001 V.

3.5.2. Gain Access to Internal Components.

The exact procedure for gaining access will vary with the controller model. The following steps are provided as a guide.

1. Disconnect the power source to avoid electrical shock.
2. Remove covers or enclosures as required to gain access to the controller PCB.
3. When calibration is complete, reverse these procedures to restore the controller to operational status.

3.5.3. Adjust Reference Voltage.

The following procedure is valid regardless of the input type (thermocouple, RTD, or linear).

1. Connect the voltmeter to TP7 (positive) and TP8 (negative) on the controller PCB (Figure 3-3, Items 3 & 4).
2. Turn on controller power (rocker switch on rear panel) to energize controller.
3. Adjust potentiometer R36 (Item 5) until the reference voltage matches that listed on the controller specification sheet.
4. Turn controller power off and remove meter.

3.5.4. Adjust Balance of Thermocouple or Linear Input Controllers.

This procedure is *not valid* for RTD input controllers. Refer to Para. 3.5.5 below for procedures to adjust balance of RTD controllers.

1. Short the thermocouple input by placing a jumper across either TB1 (Figure 3-3 Item 6) pins 2 and 3 or TP5 and TP6 (Items 7 and 8) on the controller board.
2. Connect the voltmeter to TP2 (negative) and TP4 (positive) (Items 9 and 10).
3. Connect a 33k-ohm resistor across R22 (Item 11) (Z8 pin 3 and minus 5V).

CAUTION

Take care at these connection points to prevent shorting out the -5V or device input.

NOTE

One of the connections must be removed and replaced during the adjustment procedure.

4. Turn on controller at rocker switch on rear panel to energize the controller.
5. Note the meter reading, then remove one side of the 33k-ohm resistor and note the meter reading again.
6. Adjust balance potentiometer R11 (Item 12) to correct for the difference in the two readings.
7. Replace the 33k-ohm resistor in the circuit.
8. Repeat Steps 5 thru 7 until there is no voltage difference between the two readings.
9. Turn off controller power.
10. Remove the 33k-ohm resistor and the jumper on TB-1, then remove the meter.

3.5.5. Adjust Balance of RTD Input Controllers.

This procedure is valid *only* for RTD input controllers. Refer to Para. 3.5.4 above for procedures to adjust balance of thermocouple and linear input controllers.

1. Short the input by placing a jumper across TP5 and TP6 (Items 7 and 8) on the controller board.
2. Connect the voltmeter to TP2 (negative) and TP4 (positive) (Items 9 and 10).
3. Connect a 100k-ohm resistor across R22 (Item 11) (Z25 pin 3 and minus 5V).

CAUTION

Take care at these connection points to prevent shorting out the -5V or device input.

NOTE

One of the connections must be removed and replaced during the adjustment procedure.

4. Power up the controller.
5. Note the meter reading, then remove one side of the 100k-ohm resistor and note the meter reading again.
6. Adjust balance potentiometer R11 (Item 12) to correct for the difference in the two readings.
7. Replace the 100k-ohm resistor in the circuit.
8. Repeat Steps 5 thru 7 until the maximum voltage difference between the two readings is ±0.020V.
9. Power down the controller.
10. Remove the 100k-ohm resistor and the jumper on TB-1, then remove the meter.

Appendix A.
PID Parameters and Their Adjustment

A.1. INTRODUCTION.

All JC Systems controllers are three-mode controllers offering proportional, integral and differential control actions. These three control actions are independently derived, then summed to act upon the controller output. The following information provides a basic description of the three control actions and how they interact, followed by specific instructions for using controller DIP switches to adjust PID parameters.

A.2. DEFINITIONS.

The following definitions will be more fully explained in the accompanying text. Some of these terms are also illustrated in Figure A-1.

Process Variable -- The variable (temperature, humidity, pressure), being directly controlled; its value is sensed to originate the feedback signal.

Process Value -- the instantaneous (real-time) measured value of the process variable.

Setpoint -- An inputted variable that specifies the desired value of the controlled variable.

Deviation -- The difference between the setpoint and the process value, also referred to as "error" or "droop".

Internal Setpoint -- A setpoint derived by a controller using reset action. The internal setpoint is the controller's automatic internal equivalent to a manual setpoint.

Proportional Bandwidth -- The bandwidth from zero deviation to the deviation from setpoint (in degrees) that will produce 100% output. Bandwidth is determined by the ratio of the span (in degrees) to the selected proportional gain. Bandwidth is selected by setting the proportional gain switch S6.

Span -- The range of possible setpoints for the controller: the algebraic difference between the lowest and highest possible setpoints. For example, if the lowest setpoint value is -100.0 and the highest is +315, the span is 415.0 [+315 - (-100) = +415].

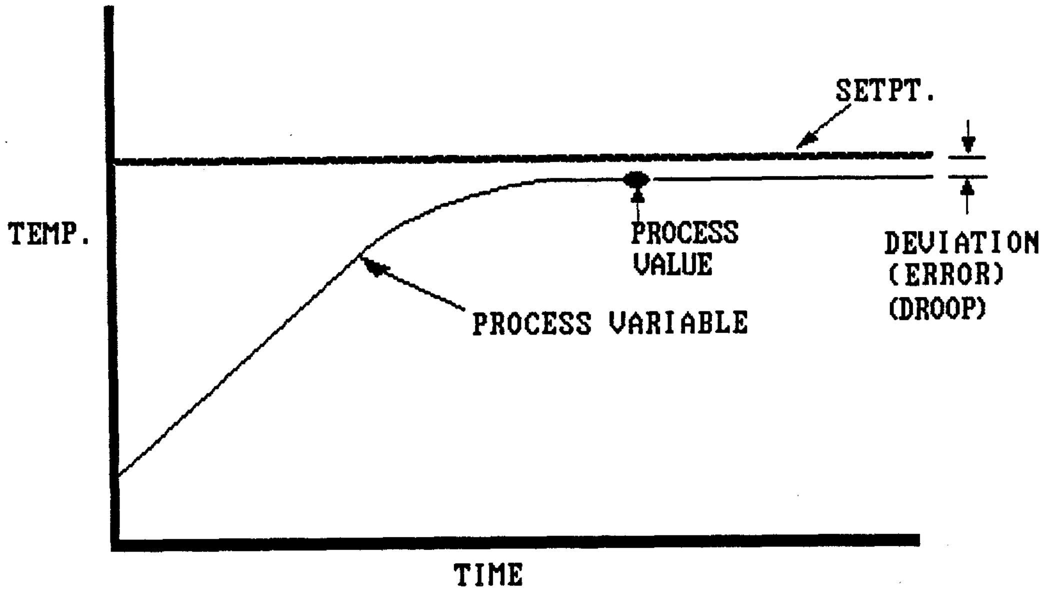


Figure A-1: Terms Used in Profile Charts.

A.3. DESCRIPTION OF CONTROL ELEMENTS.

A.3.1. Proportional Control.

A.3.1.1. Theory of Operation.

The first element, or control action, of a PID controller is P - the proportional factor. The action of the controller is proportional if the controller produces an output that is proportional to the deviation (setpoint - process value). In other words, the controller output (in percent) changes linearly as a function of the deviation.

As shown in Figure A-2, the digital process value PV is received from the monitoring equipment (thermometer in this case) and compared with the digital setpoint SP. The difference is the deviation DEV, which is the error between the desired setpoint and the actual process value. Because no other control actions are in effect, this deviation is used to calculate output power.

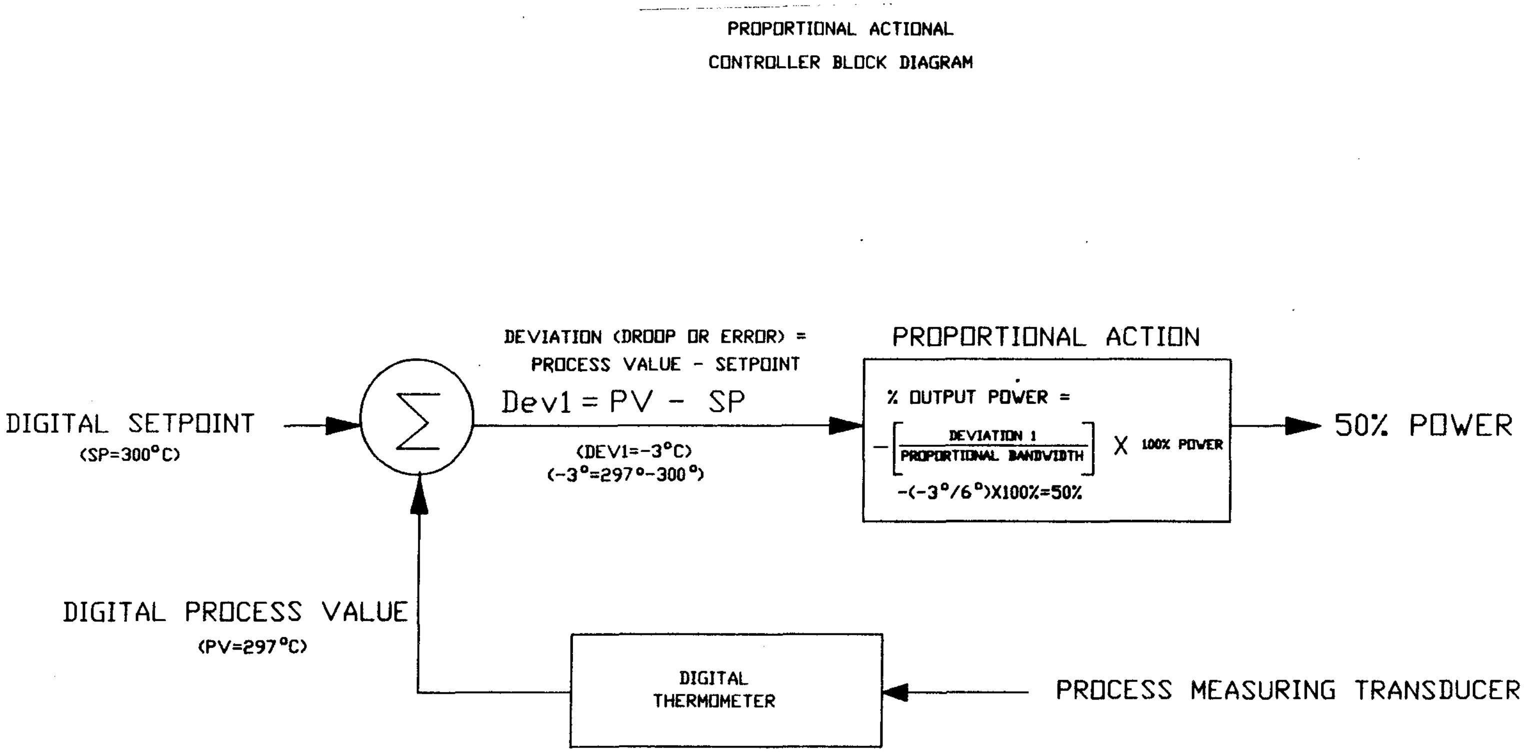


Figure A-2: Proportional Control Action Diagram.

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Para. 3.1.1. (Cont.)

The proportional bandwidth is expressed in degrees. Zero degrees (0°) corresponds to no deviation from setpoint and therefore no output. The total bandwidth in degrees corresponds to the deviation from setpoint that will produce 100% output. For example, a proportional bandwidth of 6° will result in 50% output when the deviation is 3° and 100% output when the deviation is 6°. As shown in Figures A-2 and A-3, a temperature chamber controller operating with proportional action only and a proportional bandwidth of 6° will apply 50% power to the heaters if the setpoint is 300° and the system temperature is 297° (deviation = 3°).

The proportional output value will always be a percentage of the total possible output. This is true whether using 4-20 mA power proportioning output or ON-OFF time proportioning output. For example, power proportioning output for a +50% error would be 12 mA in a 4-20 mA application. In time proportioning output for the same error, output would be ON 50% of the cycle time and OFF 50% of the cycle time.

Note that JC System controllers provide dual outputs to control both heating and cooling, so the proportional band would extend both above and below the chosen setpoint. For clarity, the cooling band has been omitted from the figures.

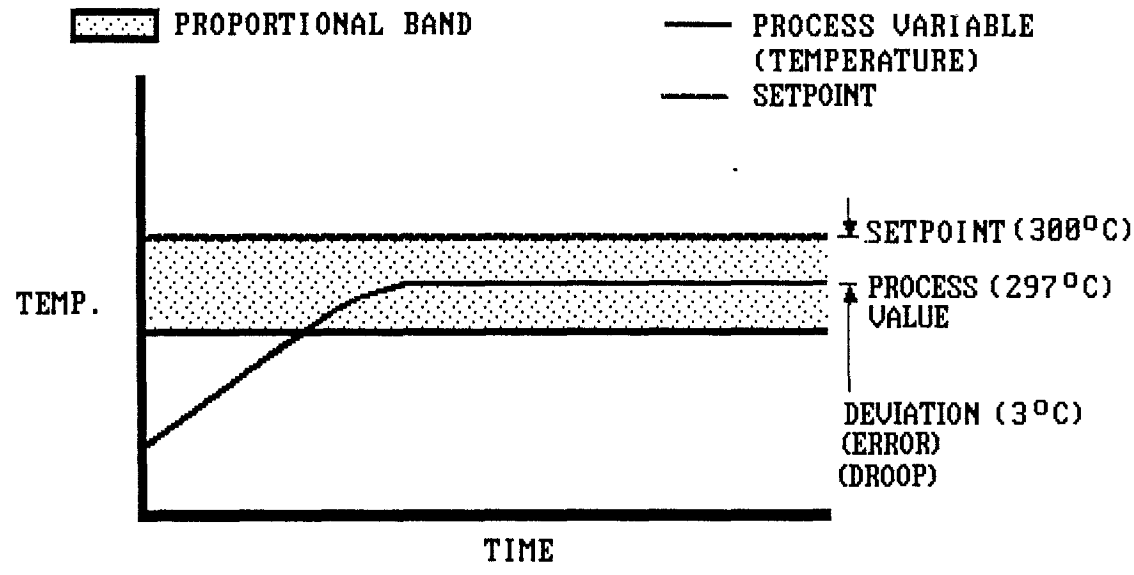


Figure A-3: Proportional Control Profile Chart.

A.3.1.2. Droop.

A condition known as droop (see Figure A-4) always occurs in a system that has a controller with only proportional action. This is because there must be some offset from the setpoint before proportional action can apply power to make up for system heat loss. In this sense, "droop" is a *specific* type of deviation or error, but the word is also sometimes used to refer to any error condition.

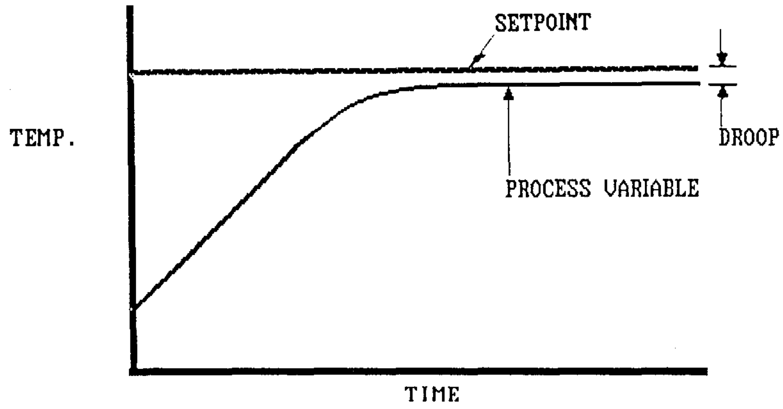


Figure A-4: Droop.

For example, suppose our temperature chamber has a maximum heater capacity of 1500 watts and its thermal characteristics require a power input of 750 watts to maintain 297 °C with a constant ambient temperature of 25 °C. With a typical proportional bandwidth of 6 ° and a setpoint of 300 °, the system temperature would stabilize at 297 °. Why? Because the 3 ° deviation from setpoint requires 50% proportional output, which is the same amount of power we already established as being required to maintain the system at 297 °.

The two methods used to counteract this condition, manual and automatic reset, are described below.

A.3.1.3. Manual Reset.

Given the error described in A.3.1.2, you could manually reset the setpoint switch to 303 °C. The higher temperature setting would demand the extra power required to increase the process value by 3 °.

Many simple controllers with proportional action incorporate provisions for manually compensating the offset (in this case three degrees) for a fixed temperature. Obviously, this approach is inefficient when changes in the setpoint are desired. Also, any given offset can only work for a particular setpoint and constant heat load with no changes in ambient temperature. A more effective system utilizes integral control action as described in the following section.

A.3.2. Automatic Reset (Integral Control).

A.3.2.1. Theory of Operation.

The second control action of a PID controller is I - the integral factor, also commonly referred to as *reset*. This control action generates a correction factor by integrating (as a function of time) the deviation (error) between the setpoint and the process value. Integral action automatically and internally performs the same function as the manual reset. The setpoint is internally corrected (reset) to a value that will completely offset the deviation as shown in Figure A-5.

In other words, the integral action I correction factor is exactly the opposite of the deviation (error or droop). As shown in Figure A-6, this correction factor is added to the original setpoint to create a new, *internal* setpoint. The internal setpoint in turn is used to calculate an adjusted error derived by summing the correction factor and the setpoint, minus the process value. This adjusted error is used to calculated the output power that must be supplied to the system.

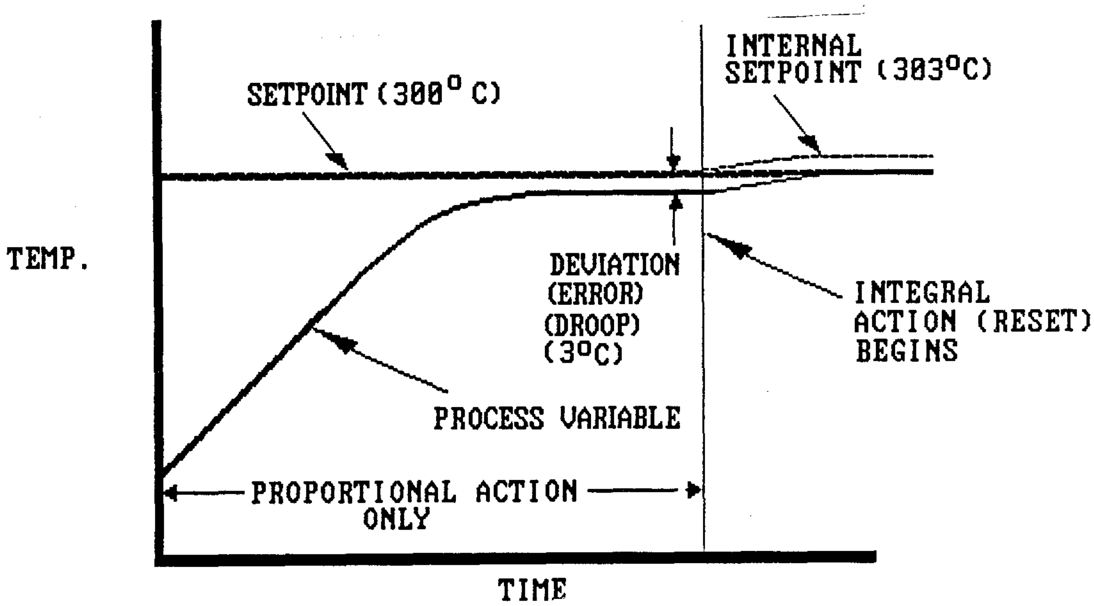


Figure A-5: Reset Used to Correct Droop.

Para. A.3.2.1 (Cont.)

For example, as previously shown (in Figure A-4) a setpoint of 300° and a process value of 297° results in a droop (error or deviation) of -3°. The correction factor (value required to offset the droop) is therefore +3°. As shown in Figure A-6, the new internal setpoint is therefore the setpoint (300°) plus the correction factor (3°), and the adjusted error is 300° minus 303° (the process value), or -3°. With a proportional bandwidth of 6°, this will result in 50% output power (3° : 6° = 0.5 x 100% = 50%).

Automatic reset action repeats the correction factor X times per minute, causing a recalculation of the internal setpoint for each repeat. The value of X depends on the setting of DIP switch S2 (as described later). The switch allows you to select how fast the controller corrects for the deviation in terms of repeats per minute.

For example, if the switch were set for one repeat per minute *and the error remained constant,* the correction factor would be repeated once per minute, causing the internal setpoint to linearly ramp up. In other words, with a theoretical constant error of 3°, the internal setpoint would increase 15° in 5 minutes (5 minutes times 1 reset/minute = 5, or 5 resets times 3° = 15°). Of course, the error would not remain constant in an actual process, so this effect could not normally occur.

A.3.2.2. Reset Windup.

Reset windup is a problem that can result with most other PI controllers that don't offer features included in the JC Systems controllers. Most controllers with integral action will make a correction proportional to the magnitude of the deviation whenever a deviation exists. As shown in Figure A-7, when a process starts with an extremely large deviation, this large error will be integrated and the setpoint will be internally corrected on this basis. Reset action will continue as long as the error exists. This effectively "winds up" the internal setpoint.

By the time the process value finally reaches the original setpoint, the internally reset setpoint is much higher and a deviation still exists. The controller's proportional action (P factor) uses this deviation to regulate output, thereby causing an overshoot. As the process value approaches the internal setpoint, the controller detects that a *negative* deviation now exists between the internal setpoint and the original one. Integrating this error drives the internal setpoint, and therefore the process value, back down. Rather than providing a realistic reset factor, the integral action is now driving the process value up and down around the setpoint. This oscillation will continue for some time (depending on system response, integration value, and other factors) until the system finally stabilizes.

PROPORTIONAL + INTEGRAL CONTROL ACTION
CONTROLLER BLOCK DIAGRAM

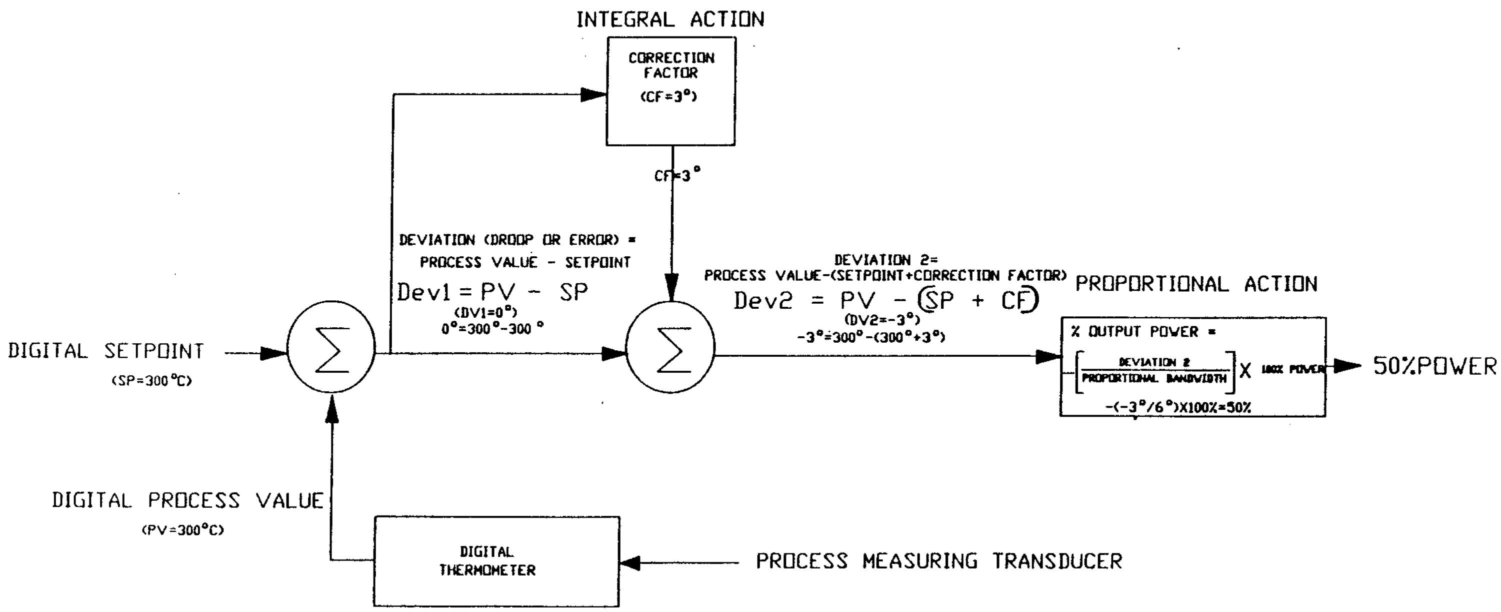


Figure A-6: Diagram of Proportional Control with Integral Action.

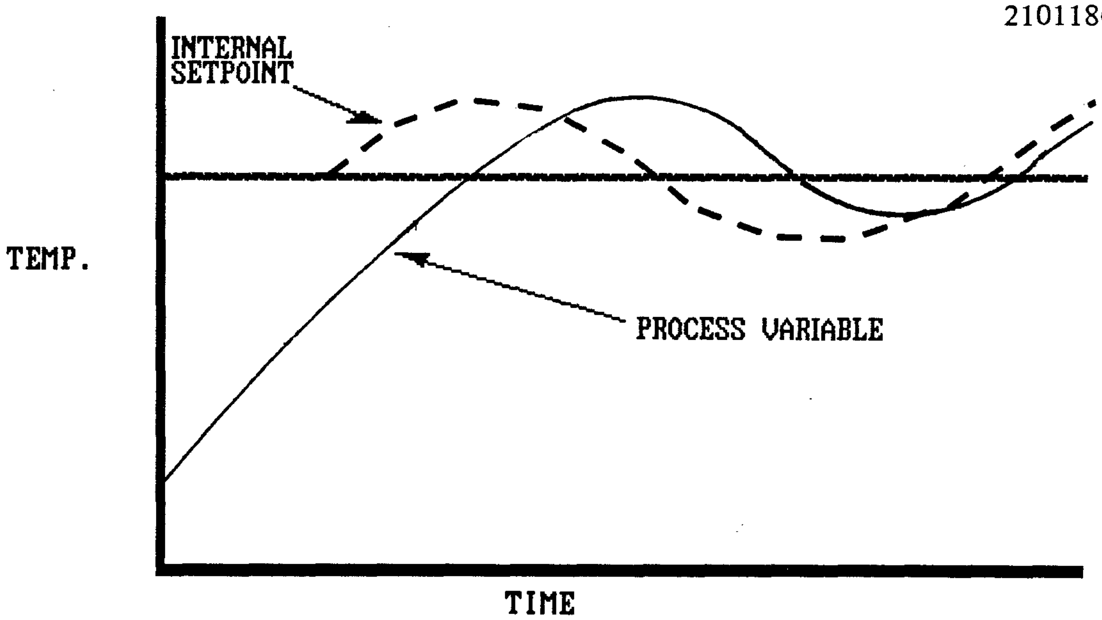


Figure A-7: Oscillations Due to Reset Windup.

A.3.2.3. Reset Windup Inhibit.

JC Systems controllers counteract reset windup in two ways. First, integral action does not correct for a deviation unless the process value is within the proportional bandwidth. In other words, with a bandwidth of 6°, integral action would occur only with a deviation of 6° or less.

Second, your JCS controller has a separate, switch-selectable parameter called Reset Windup Inhibit (RWI). This allows you to specify (as a percentage of the proportional bandwidth) the maximum error in degrees that the controller will integrate as a function of time to adjust the internal setpoint.

For example, with a bandwidth of 10° and an RWI setting of 10%, a deviation of any magnitude between 1 and 10 ° will be treated as a deviation of only 1° (10% of the 10° proportional bandwidth). Only when the actual error is less than 1° will the actual error be integrated. This allows much higher integration values without causing over-integration instability (oscillation).

A.3.3. Derivative Control.

The final control action of a PID controller is D - the derivative factor, sometimes called "rate action" or "pre-act" (because it anticipates changes). In most controllers, derivative control initiates corrective action whenever the deviation changes. (If there is no change, there is no derivative action.) The amplitude of the response (correction) is proportional to how fast the deviation (input) is changing. This approach can result in excess correction when the setpoint is changed -- the new setpoint represents a very fast change in deviation, and derivative action therefore dictates a large correction factor.

Para. A.3.3 (Cont.)

JCS controllers avoid such overreacting by using the rate of change of the *actual process value* as the basis (input) for calculating the correction. Changing the setpoint doesn't cause a derivative action response until the process variable begins to change. The net effect of this approach is a dynamic braking action -- the controller's derivative action opposes a change in the actual process value. In this way, overly rapid responses can be slowed and a delayed system can be kept from overshooting the setpoint.

The typical application of derivative control is for a system with lengthy thermal delay. By the time the controller can respond to the actual process value, too much heat energy is stored in the system. The process value will overshoot the setpoint, then oscillate around the setpoint before stabilizing. Figure A-8 shows how derivative action tends to dampen process value changes. Note that the amplitude of the derivative correction remains constant as long as the process value is changing at a constant rate. Also note that the amplitude of the derivative correction corresponds to the process value change rate.

Figure A-9 shows how the three factors — proportional, integral, and derivative — are independently derived, then summed to act upon controller output.

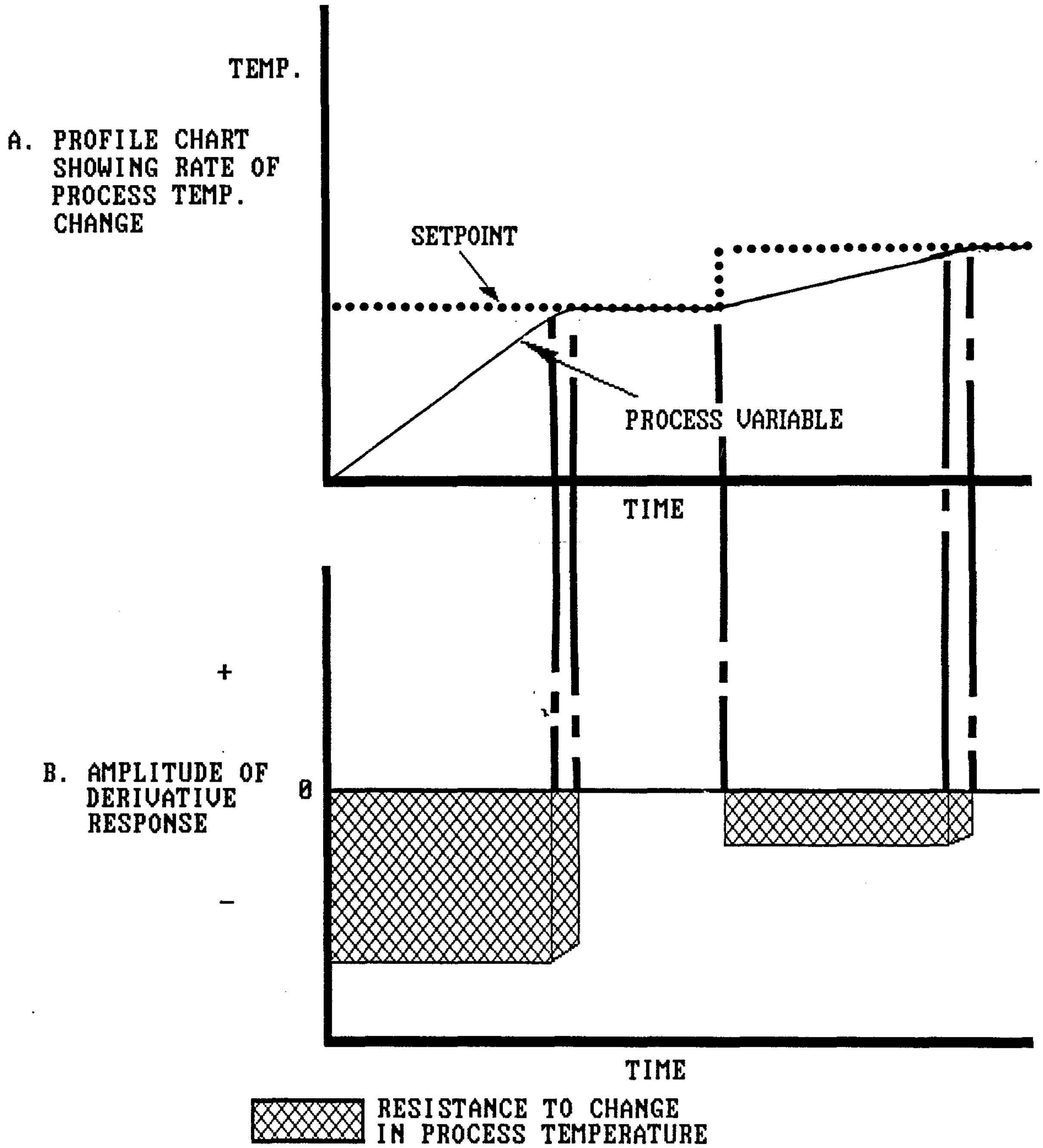


Figure A-8: Relation of Differential Action to Process Value Change.

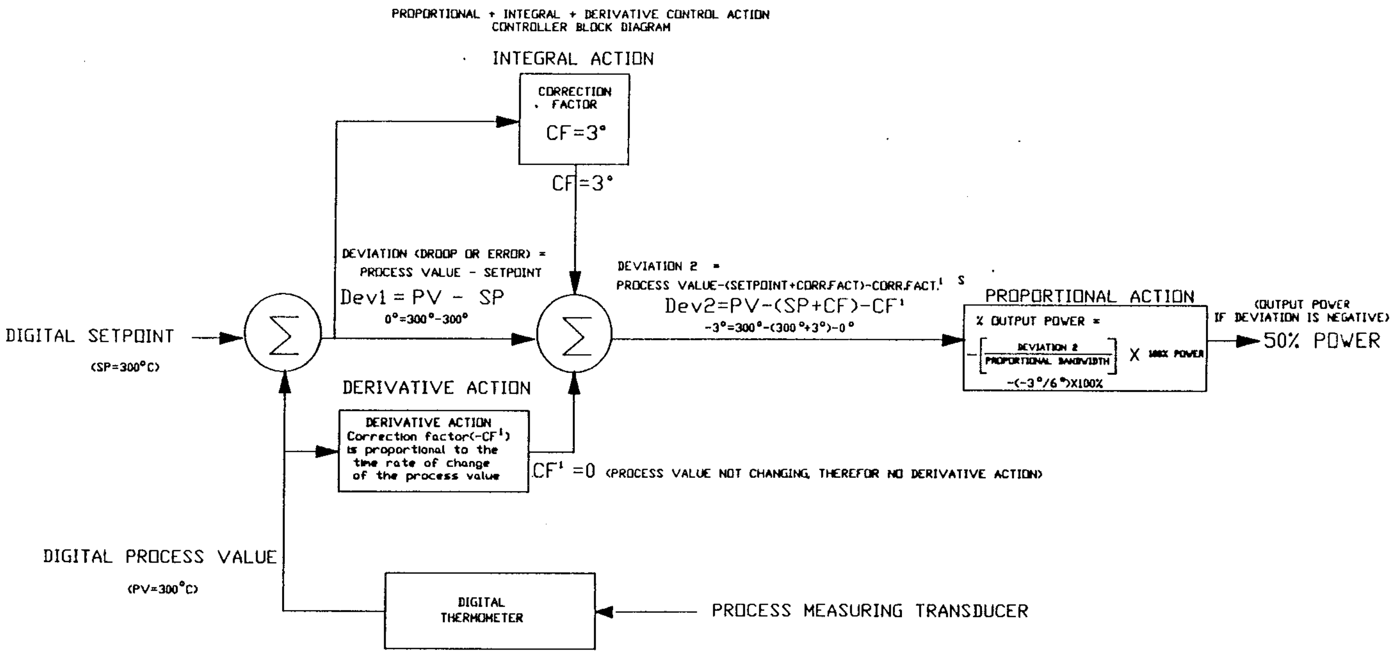


Figure A-9: Interaction of PID Parameters.

A.4 RESETTING CONTROLLER SWITCHES.

A.4.1 Switch and Display Locations.

The DIP switches involved are all located on the upper edge of the controller printed circuit board (PCB) as shown in Figure A-10. Figure A-11 shows the controller display areas you will need to monitor while setting those switches. If you have a dual-channel controller, you will need to set the switches on both controller boards.

On a dual-parameter (dual adjust) board, you will need to set the PID parameters and reset windup inhibit for both heat and cool modes. When heat parameters are active, a red LED near DIP switch S1 lights; when cool parameters are active, the LED goes out.

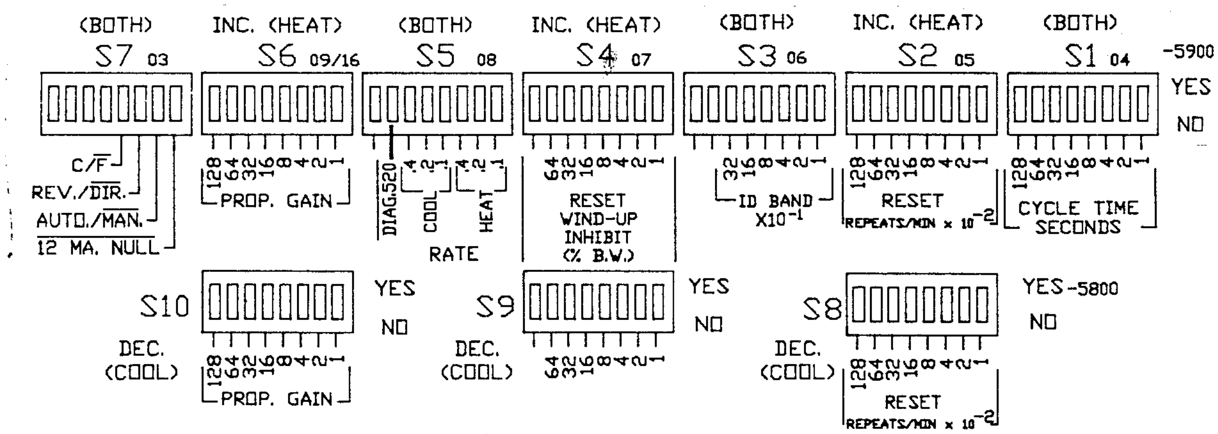


Figure A-10: Controller PCB DIP Switch Locations.

A.4.2 How to Set a DIP Switch.

Each DIP switch has eight slide elements (bits). Slide up towards the top (OPEN) to select a bit, or slide down towards the bottom (CLOSED) to zero it. Figure A- 12 shows bit positions for a typical DIP switch set to a value of 18.

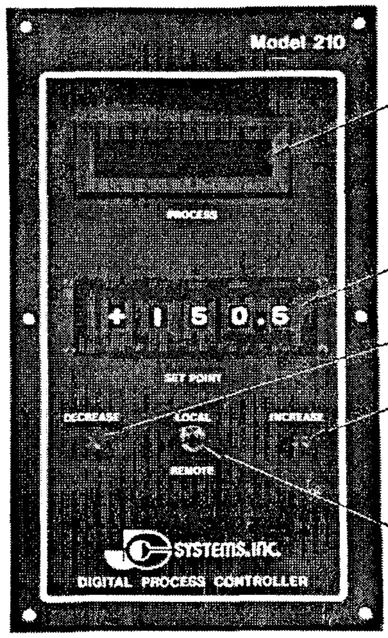


Figure A-11: Front Panel Displays and Switches.

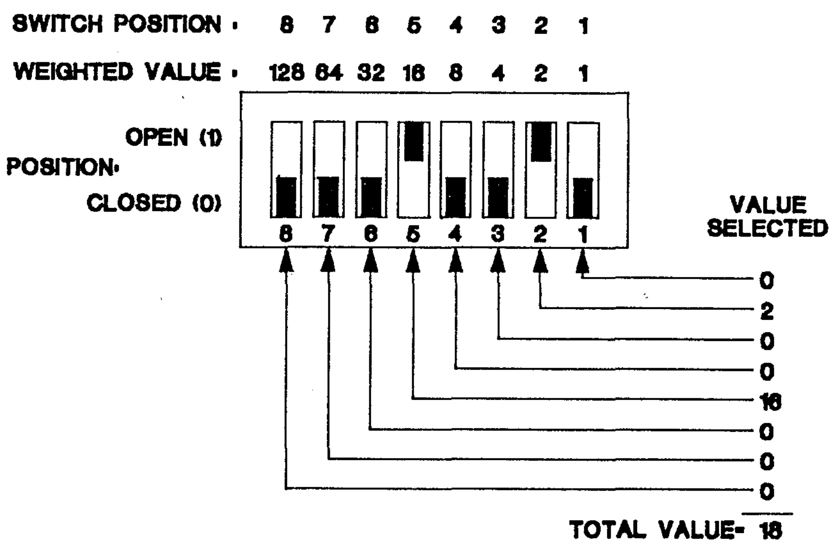


Figure A-12: Setting a Typical Dip Switch.

A.4.3 Set Proportional Bandwidth(S6, -591.6; S10, -581.6).

A.4.3.1 Determine the Minimum Setting.

The setting of DIP switch S6 (S10 for cool) selects the proportional gain (sensitivity) and thereby determines the proportional bandwidth. The higher the proportional gain, the tighter the proportional bandwidth. Use the following formula to determine the proportional gain setting for your system's controller(s).

Proportional Gain Setting =

Controller Span (degrees) divided by Bandwidth (degrees)

Restating the equation to calculate bandwidth:

Proportional Bandwidth =

Controller Span (degrees) divided by Proportional Gain Setting

For example, if the controller's span (see definitions) is 415°; to achieve a bandwidth of 6°(the factory setting) for this system, you must set S6 to 69. Expressed algebraically:

X = 415 divided by 6; X = 69

A.4.3.2 Considerations for Selecting Proportional Bandwidth.

The proportional bandwidth should be as small as possible without causing oscillation. With a bandwidth of 0, the proportional and integral actions of the controller are disabled. The control action with 0 bandwidth is similar to the on/off control action of a bimetallic thermostat.

A.4.3.3 Setting the Switch.

To set proportional gain (Switch S6 for heat, S10 for cool) for the desired proportional bandwidth (see A.4.3.1 to calculate bandwidth if necessary), proceed as follows.

1. Enter diagnostics per Para. 3.3 and select -591.6 for heat or -581.6 for cool. The selected proportional bandwidth will appear in the controller display.
2. Set all bits off (down) on switch S6 for heat or S10 for cool.
3. Switch on the left-most (most significant) bit (bit 8).
4. Observe the display. If the bandwidth displayed is less than the desired value, switch the bit off; otherwise, leave it on.
5. Switch on the next most significant bit (to the right) and repeat Step 4.
6. Repeat Step 5 for each bit in descending order until the desired value is displayed, or until the last bit has been checked and the value is within ±0.3 units of that desired.

A.4.4 Set Integral Control (S2, -590.5; S8, -580.5).

The Reset (repeats/min) switch (S2 for heat, S8 for cool) regulates the I (integral) portion of PID control. The setting of S2 (or S8) determines the factor the controller uses to correct for deviation. If the reset value is too high, the derived (internal) setpoint overcorrects for the deviation and causes the process value to oscillate around the setpoint; if the reset value is too low, it will take too long for the process temperature to reach the setpoint. (See the discussion in Para. A.3.2.)

If the process value (temperature or relative humidity) exceeds the setpoint by the selected factor, the integral action (reset) overshoot is clipped so that the system can rapidly settle to the final setpoint value. This does not directly affect PID parameters.

When using Figure A-12 as a guide to reset S2, substitute the values below for the bit positions. (Values for this switch are multiplied by 10^{-2}. The standard S2 factory setting is .32 resets per minute — position 6 is up.)

Position Number:	8	7	6	5	4	3	2	1
Value (Repeats/Min):	1.28	.64	.32	.16	.08	.04	.02	.01

A.4.5 Set Reset Windup Inhibit (S4, -590.7; S9, -580.7).

This switch (S4 for heat, S9 for cool) works with the Reset switch (S2 or S8) to limit the maximum error integrated and reduce instability around the setpoint. Use S4 or S9 to select a reset windup inhibit (RWI) percentage (of bandwidth) from 1 to 100%. (Settings of 0 or over 100 default to 100%.) This setting determines the maximum error in degrees that the controller will integrate as a function of time.

A.4.6 Set Derivative Control (S5, -590.8, -580.8).

Set S5 to regulate the amplitude of the controller's derivative action response to changes in process temperature. Bits 1-3 set the rate for heat and 4-6 set the rate for cool. (Bit 7 is the factory-sealed diagnostics select.)

When using Figure A-12 as a guide to reset S5, substitute the values below for the bit positions. The standard S5 factory setting is 0 — all positions are down.

Position Number:	8	7	6	5	4	3	2	1
Value (Minutes):	Not Used	Fact. Seal	.4	.2	.1	.4	.2	.1
			[C	O O	L]	[H	E A	T]

A.4.7 Set Cycle Time (S1, -590.4).

A.4.7.1 For Time Proportioning Output.

The controller regulates average power to heaters by turning the heaters on and off. Cycle time may be set from 1 to 255 seconds. The longest possible cycle time that produces a stable, controlled output should be used. Long cycle times extend the life of electromechanical devices such as relays and solenoids.

The cycle time includes both time off and on, and is regulated by proportional control (see Para. A.3.1). For example, with a deviation of 3°, a bandwidth of 6°, and a cycle time of 2 seconds (the factory setting), the output will be on for 50% of the time, or 1 second, and off for the remaining 50% of the time (1 second).

A.4.7.2 For Power Proportioning Output.

Set controller switch S1 to 255 whenever the power proportioning output (current loop option) is connected. Setting any other value will cause the process variable display (Figure A-11 Item 2) to display the word "LOOP" until the S1 setting is corrected or the current loop board is disconnected.

A.4.8 Set ID Band (No Proportional Action Band, S3, -590.6).

The adjustable ID (Integral-Derivative) band disables proportional action between the selected Heat and Cool proportional bands. The ID band creates a zone between Heat and Cool proportioning where the proportional action is disabled. The Integral and Derivative actions continue to function in the ID band. The value selected on switch S3 — 0.0 to 6.3 degrees or units — offsets the Heat proportional band *down* from the setpoint. It offsets the Cool proportional band *up* from the setpoint.

A small amount of ID band can be very helpful in adjusting operating parameters for a chamber system. A value of 0.5 (S3 Bits 1 and 3 both up) is suggested.

A.4.9 Determining and Selecting a Proportional Gain Setting.

The procedure below may be used if you wish to empirically develop a proportional gain setting for heat parameters. Begin by setting controller switches to the positions shown in Table A-1 (reset if necessary) before setting proportional gain as described below. If you have a dual-channel controller, you will need to set the switches on both controller boards.

To determine proportional gain setting for COOL parameters, change the parameters switch to COOL position and modify the procedure below by selecting the appropriate switches and displays.

TABLE A-1: CONTROLLER SWITCH POSITIONS FOR PROPORTIONAL GAIN SELECTION. (heat parameters and switches shown)

SWITCH NUMBER	DESCRIPTION	SETTING
S1	Cycle Time	4 seconds (Bit 3 up)
S2	Automatic Reset	Off (0 — all bits down)
S3	ID Band	Don't care
S4	Reset Windup Inhibit	Off (0 — all bits down)
S5	Rate (Derivative)	Off (0 — all bits down)
S7	Miscellaneous Functions	On (1 — see Para. 2.9)

A.4.9.1 Determine Thermal Overshoot.

Perform the following test to determine the amount of thermal overshoot when the system goes from 100% power to 0% power.

1. Select a setpoint temperature 10° higher that the point at which you want to determine thermal overshoot. For example, if you want to determine overshoot at 100°C, then the initial setpoint will be 110°C. The selected test temperature should to be high enough to allow heaters to store as much heat as they can (worse case).
2. When the temperature reaches the selected test temperature (100°), change the setpoint to a new value at least 20° lower. (This turns off all power to the heaters, allowing the system temperature to rise due to stored heat energy.)
3. Carefully monitor the PROCESS temperature display (Figure A-11 Item 2), which shows the actual temperature the sensor is recording, to determine the temperature at which overshoot peaks.
4. Multiply the overshoot (the difference between the peak temperature observed in Step 3 and the test temperature) by 2. If the result is more than 5, use that figure in degrees for the bandwidth. If the result is less than 5, use a bandwidth of 5°.
5. Adjust the proportional gain setting (S6) as described in Para. A.4.3.3 to achieve the desired bandwidth.

Para. A.4.8.4 (Cont.)

6. After resetting S6, select a new setpoint about 100° above ambient (or any other setpoint typical for your process) and monitor the PROCESS display. Look for steady-state action (oscillation) around the setpoint; don't be overly concerned with overshoot at this time.
7. If Step 6 shows continued oscillation or slow reaction (sluggish system), increase the RATE switch (S5) value one unit (0.1 minute) (see Para. A.4.6 for procedure) and repeat Step 6. If oscillation persists, add the next bit (position 2, value 0.2), increasing the value to 0.3.
8. If the rate adjustments of Step 7 don't stop the oscillations, the proportional bandwidth is too narrow. Reset the RATE switch (S5) to zero and repeat Steps 1 thru 7, except increase the Step 4 overshoot multiplier by 1 each time you repeat the test until the steady-state oscillations disappear.

A.4.8.5. Reset Related Switches.

After the proportional bandwidth is correctly adjusted, reset related switches RWI (S4) and RESET (S2) as follows.

1. Set S2 at 1.28 and S4 at 10 (same as initial settings of Table A-1).
2. Using the same setpoint as in Para. A.4.8.4 Step 6 above, try the system in operation. Observe action of the system as it settles into operation and the process temperature approaches the setpoint.
3. If action is sluggish, note the amount of time required outside the RWI band (RWI setting times bandwidth -- in our example, 10% times 6° = 0.6°).
4. If most of the delay is at temperatures outside the RWI band (0.6° in the example), increase the RWI switch setting (try doubling it to 20, bits 3 and 5 up) and retest.
5. If most of the delay is at temperatures within the RWI band, increase the AUTOMATIC RESET rate (S2) (try increasing by increments of 10) and retest.

Appendix B. Using the Controller's Computer Interface Port J1

B.1. INFORMATION PROVIDED.

This appendix provides detailed information on J1 pinouts, functions, and signals required to communicate with JCS controllers using a computer connected to the parallel port J1. Using this information, the customer can then develop software and an interface cable to directly communicate with the controller using his computer.

B.2. J1 PINOUTS AND FUNCTIONS.

Table B-1 provides the pinouts and functions for the remote computer interface port J1 on the controller back panel. This is a subminiature 25-pin D-type connector that mates with an external, customer-fabricated ribbon cable. Note that the pinouts of this connector do not correspond with those of the board-mounted receptacle J5 on the controller because the mass terminations do not follow the ribbon cable lines.

TABLE B-1: CONNECTOR J1 PINOUTS AND FUNCTIONS.

Pinout	*Function or Description*	*Pinout*	*Function or Description*
1	0.1 BCD tenths component	8	400 BCD hundreds component
14	0.2 " " " "	21	Negative temperature
2	0.4 " " " "	9,10,22,	
15	0.8 " " " "	23	Logic common
3	1.0 " units " "	11,13	*Do not use*
16	2.0 " " " "	24	READ TEMPERATURE command
4	4.0 " " " "		(Low-going input signal)
17	8.0 " " " "	12	REMOTE command (low-going
5	10 " tens " "		signal sets controller to
18	20 " " " "		accept remote commands)
6	40 " " " "	25	SETPOINT VALID command
19	80 " " " "		(high-going signal
7	100 " hundreds component		verifies validity)
20	200 " " " " "		

NOTES:
1. Pinouts on the board-mounted receptacle J5 do not correspond to those listed in Table B-1. See Para. B-2 for discussion.
2. On pins containing BCD data (the setpoint), outputs are from an Intel 8243 I/O device with 22K pull-up resistors to +5 Vdc. Logic high is true on BCD information lines.
3. Command input lines (12, 24 and 25) are connected to NMOS inputs with 10K or 22K pull-up resistors to +5Vdc.
4. Input interface from the computer must be 5Vdc logic levels with 0 volts connected to controller logic common line (9, 10, 22, or 23).

B.3. FUNCTIONAL DESCRIPTION.

B.3.1. Remote Control and Setpoint.

The REMOTE CONTROL INPUT signal at J1-12 selects one of the two separate setpoint I/O devices on the controller and reads the four decades of BCD information on that port. The microcomputer thus determines the system setpoint as information present at the inputs to the 8243 I/O chip.

If the REMOTE signal is low (enabled), the computer reads the setpoint at Z15, which is connected directly to the remote temperature socket J5. If the REMOTE signal is high, the computer reads the setpoint internally from Z4, which is connected to the panel-mounted digi-switch.

When using the controller in an environment where all setpoint input is via the remote interface, maintain pin 12 low with the setpoint latched on the I/O BCD lines. Then, the current setpoint will always be the four-decade BCD information from the remote interface connector (as read from Z15).

B.3.2. Setpoint Valid

The SETPOINT VALID input on J1-25 pertains to the validity of BCD information at the 8243 I/O chip inputs. If the signal is high (logic true), the information is valid and is not changing. If the signal drops, this tells the processor that the information will remain valid for at least 80 microseconds, causing the processor to store the setpoint information in internal RAM memory until the SETPOINT VALID line goes high again.

B.4. WRITING A SETPOINT VIA J1.

1. Drive line 12 LO and keep it LO to use I/O device Z15.
2. Latch the BCD setpoint information onto the data lines (1-8 & 14-20) of J1. (HI = logic true.)

B.5. READING THE PROCESS VARIABLE VIA J1.

This may be accomplished using of two methods, each requiring five steps, as follows.

B.5.1. Method 1.

1. Take the SETPOINT VALID line (Pin 25) LO and keep the data on the BCD lines latched for another 120 microseconds, allowing the controller microprocessor to store the setpoint in its internal memory.
2. Tri-state the BCD data lines, which notifies the user's computer to prepare to read data the controller will output on those lines.

Para.B.5.1 (Cont.)

3. Take the READ TEMPERATURE line (Pin 24) LO and look for a BCD character as the most significant digit (MSD), which indicates that information is present at the output. Until the information is ready to be read, the MSD (Pins 21, 8, 20 & 7) will contain all logic highs (hex F).
4. Take the READ TEMPERATURE line HI to latch the process variable data on the output of the temperature controller. This data can now be read without changing in the middle of the computer read.
5. After reading the data, take the SETPOINT VALID line HI and latch the setpoint BCD data on the data lines.

B.5.2. Method 2.

1. Take the SETPOINT VALID line (Pin 25) LO and keep the data on the BCD lines latched for another 120 microseconds, allowing the controller microprocessor to store the setpoint in its internal memory.
2. Tri-state the BCD data lines, which notifies the user's computer to prepare to read data the controller will output on those lines.
3. Take the READ TEMPERATURE line (Pin 24) LO for 330 milliseconds, then take it back to HI.
4. Wait for 60 microseconds, then read the process variable on the BCD data lines. (The delay ensures that the latched data remained stable.)
5. After reading the data, take the SETPOINT VALID line HI and latch the setpoint BCD data on the data lines..

Appendix C. Reference Drawings.

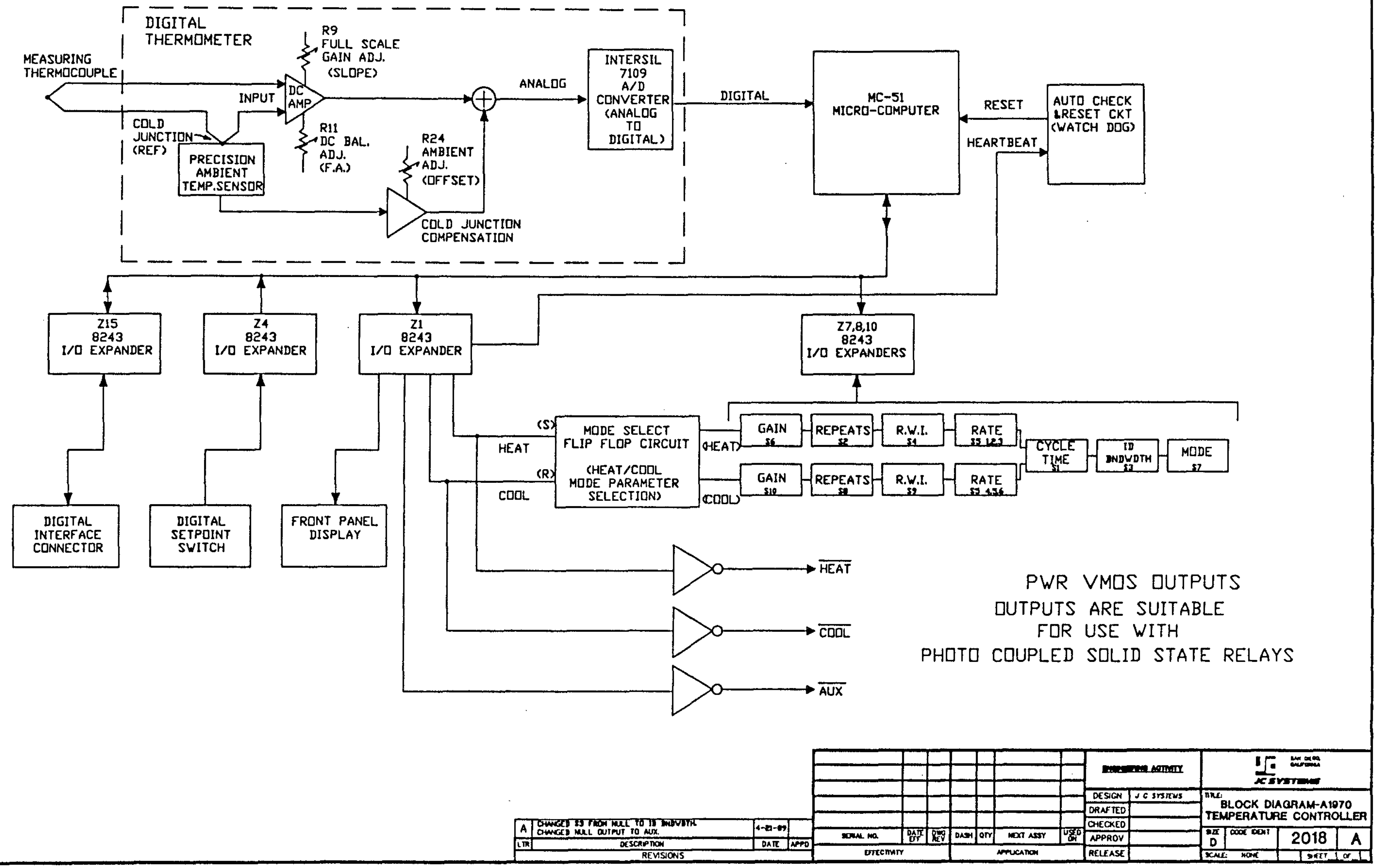
The following drawings are provided for reference, and appear in the sequence shown.

TABLE C-1. LIST OF CONTROLLER REFERENCE DRAWINGS.

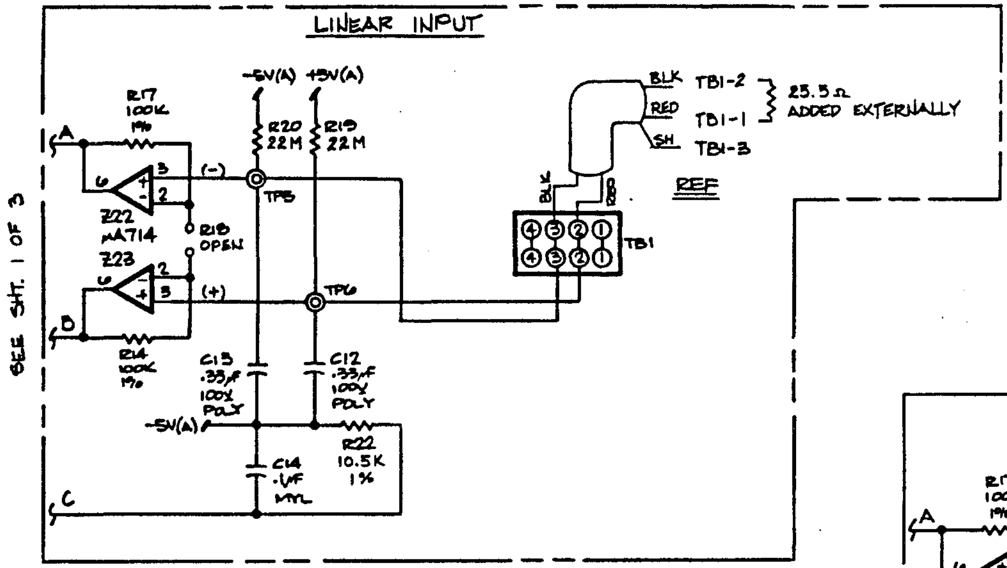
TABLE C-2. NUMERICAL INDEX OF CONTROLLER REFERENCE DRAWINGS.

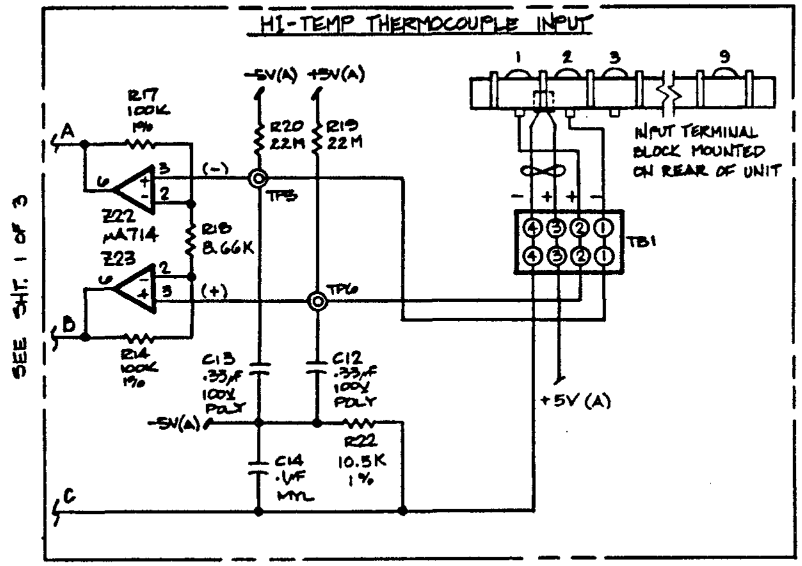
DWG NO.	DESCRIPTION	PAGE NO.
958	PCB Schematic, Temperature Digi-Switch Model A959	C-8
959	PCB Assembly, Temperature Digi-Switch Model A959	C-9
1002	PCB Schematic, Numeric Display II Model A1003	C-10
1003	PCB Assembly, Numeric Display II Model A1003	C-11
1033	PCB Schematic, 4-20 mA Output Interface Model A1034	C-12
1034	PCB Assembly, 4-20 mA Output Interface Model A1034	C-13
1317	Wiring Diagram, Temperature Controller II Model C81210	C-18
1537/1037	PCB Schematic, IEEE-488 4 Decade BCD Interface, Model A1538/1038	C-16
1538/1038	PCB Assembly, IEEE-488 4 Decade BCD Interface, Model A1538/1038	C-17
1616	Model 280 Dual Controller Board Wiring Diagram	C-22
1666	Model 270 Single Controller Wiring Diagram	C-19
1666-1	Model 270 W/IEEE-488 Single Controller Wiring Diagram	C-20
1794	TC LED SW-BD Schematic	C-14
1795	TC LED SW-BD Assembly	C-15
1868	JCS Model 300 w/Multiplexer Wiring Diagram	C-23
1868-1	Model 300 Wiring Diagram	C-24
1938	Model 270 W/RS422A Wiring Diagram	C-21
1969/1269, Sheet 1	PCB Schematic, Dual Adjust Temp. Controller Model A1970/1270	C-4
1969/1269, Sheet 2	PCB Schematic, Dual Adjust Temp. Controller Model A1970/1270	C-5
1969/1269, Sheet 3	PCB Schematic, Dual Adjust Temp. Controller Model A1970/1270	C-6
1970/1270	PCB Assembly, Dual Adjust Temp. Controller Model A1970/1270	C-7
2018	Block Diagram - A1970 Temperature Controller	C-3
2024	JCS Model 300 Input Sensor Wiring Detail	C-27
2039	JCS Models 210/270/280 Input Sensor Wiring Detail	C-26
2041	JCS Model 310 Wiring Diagram	C-25

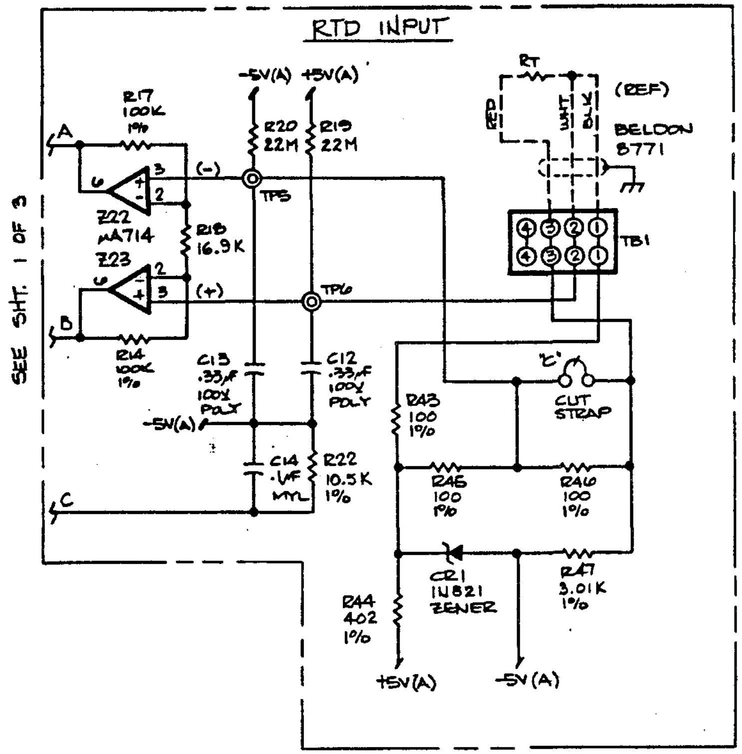
"A1970" JC SYSTEMS CONTROLLER BLOCK DIAGRAM



REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPD
		SEE SHT. 2 OF 3		







DASH	QTY	NEXT ASSY	USED ON	SERIAL NO.	DATE EFF	DWG REV
APPLICATION				EFFECTIVITY		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
DECIMALS .XX ±.03 .XXX ±.010 ANGLES 0°30'

MATERIAL △

FINISH △

ENGINEERING ACTIVITY	
DESIGN	C.H. HOLDAWAY
DRAFTED	CHL 10-18-88
CHECKED	
APPROV	
RELEASE	
DO NOT SCALE DWG	

SYSTEMS, INC.

TITLE: PRINTED CIRCUIT BD. SCH.— DUAL ADJUST TEMP. CONTROLLER MODEL A1970/1270

SIZE	CODE IDENT		
C		1969/1269	A4
SCALE N.A.			SHEET 3 OF 3

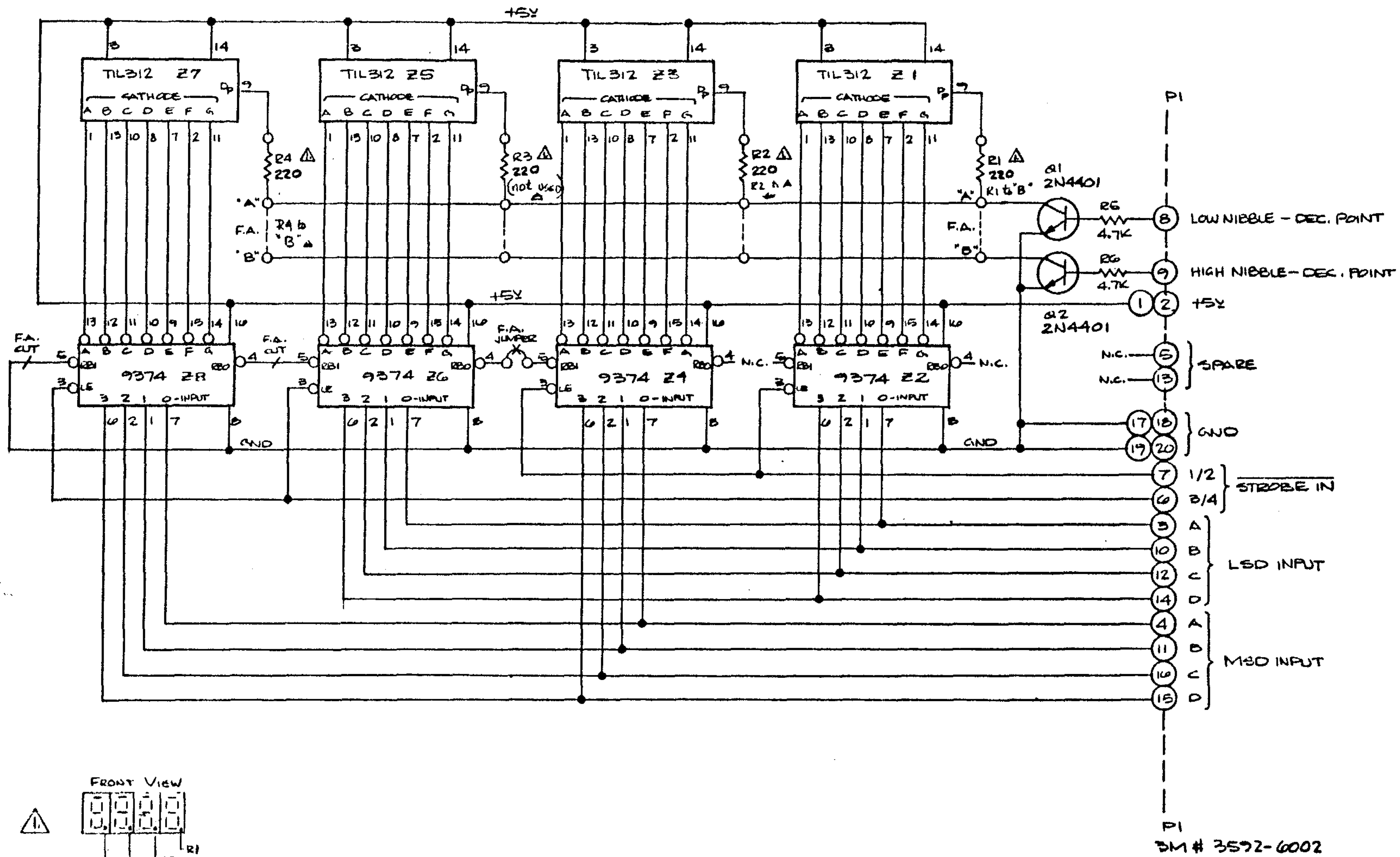
△ FINISH (IF APPLICABLE)

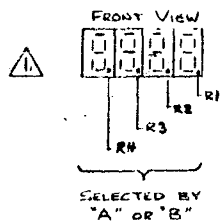
△ MATL (IF APPLICABLE)

NOTES: UNLESS OTHERWISE SPECIFIED

2100589

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPD
		SEE ASSY 1003		





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2100589

Page C-10

	1	A1003		1 & ON		N/C
DASH	QTY	NEXT ASSY	USED ON	SERIAL NO.	DATE EFF	DWG REV
APPLICATION				EFFECTIVITY		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
DECIMALS .XX ±.03 .XXX ±.010 — ANGLES ±0°30'

HOLE TOLERANCE

MATERIAL △ — FINISH △

ENGINEERING ACTIVITY

DESIGN	JC SYSTEMS INC.
DRAFTED	" 29 JUNE 1979
CHECKED	
APPROV	
RELEASE	

DO NOT SCALE DWG

JC ENTERPRISES

TITLE: PRINTED CIRCUIT BD SCH— NUMERIC DISPLAY II MODEL A1003

SIZE	CODE IDENT		
C		1002	A

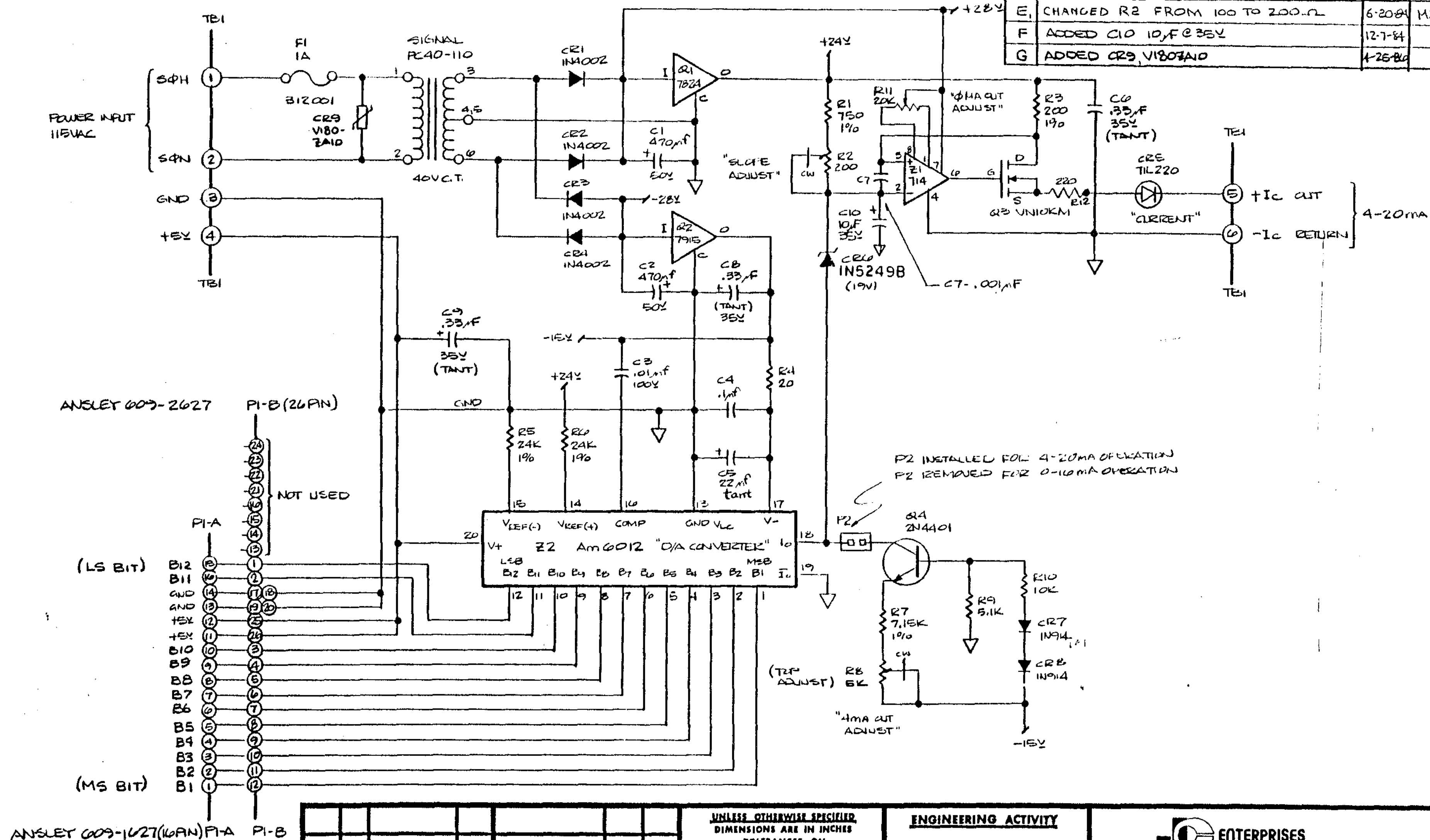
SCALE N.A. — SHEET 1 OF 1

△ FINISH (IF APPLICABLE)
MATL (IF APPLICABLE)
NOTES: UNLESS OTHERWISE SPECIFIED

LTR	DESCRIPTION	DATE	APPD
H	CHANGED CR6 FROM 1N4768 TO 1N5249B	8-25-86	T.J.C.

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPD
	A	Z1 WAS 741; Q4 WAS VN10KM; R7 WAS 5.49K 1%; ADDED: C7 .001 CAP; Z2-19 TO GND; R11 20K POT; CR7 & CR8 WAS OPTIONAL; ADDED HEADER JUMPER (2 PIN)	1-31-80	
	B	C6 WAS .1µF; ADDED C8 & C9 .33µF @ 35V TANT; C7 IS NO LONGER OPTIONAL	7-1-81	
	D	ADDED P1-A (16 PIN HDR CONN) & P1-B (26 PIN)	9-13-82	
	E	CHANGED Q1 - LEAD SPACING	12-16-82	
	E	CHANGED R2 FROM 100 TO 200 Ω	6-20-84	MJC
	F	ADDED C10 10µF @ 35V	12-7-84	
	G	ADDED CR9, V180ZA10	4-26-86	



▲ FINISH (IF APPLICABLE)

▲ MATL (IF APPLICABLE)

NOTES: UNLESS OTHERWISE SPECIFIED

DASH	QTY	NEXT ASSY	USED ON	SERIAL NO.	DATE EFF	DWG REV
	1	A1034		1 & ON		H/C
APPLICATION				EFFECTIVITY		

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .XX ± .03 .XXX ± .010
ANGLES 0°30'

HOLE TOLERANCES
.013 THRU .125 +.004 -.001
.126 THRU .250 +.005 -.001
.251 THRU .500 +.006 -.001
.501 THRU .750 +.008 -.001

MATERIAL ▲
FINISH ▲

ENGINEERING ACTIVITY

DESIGN	JC SYSTEMS INC.
DRAFTED	" 04 OCT 1979
CHECKED	
APPROV	
RELEASE	

DO NOT SCALE DWG

JC ENTERPRISES

TITLE: PRINTED CIRCUIT BD SCH - 4-20mA OUTPUT INTERFACE MODEL A1034

SIZE	CODE IDENT	DWG NO.	REV
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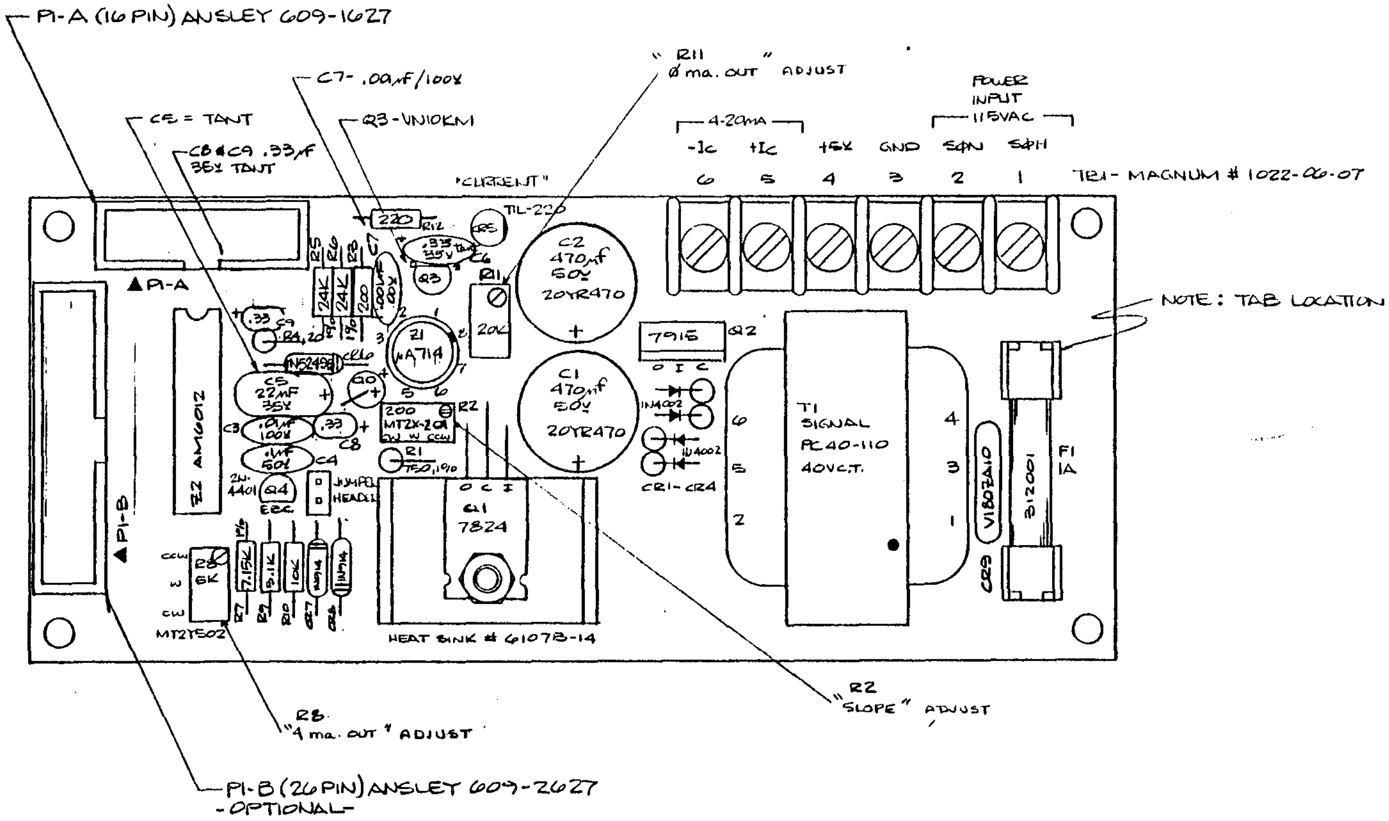
SCALE N.A. SHEET 1 OF 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPD
		SEE SCH C1033		



	1	END ITEM		1 & ON		N/C
DASH	QTY	NEXT ASSY	USED ON	SERIAL NO.	DATE EFF	DWG REV
APPLICATION				EFFECTIVITY		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .XX ± .03 .XXX ± .010 — ANGLES 0°30'

HOLE TOLERANCES
.013 THRU .125 +.004 -.001 — .251 THRU .500 +.006 -.001
.126 THRU .250 +.005 -.001 — .501 THRU .750 +.008 -.001

MATERIAL ⚠1
FINISH ⚠2

ENGINEERING ACTIVITY	
DESIGN	JC SYSTEMS INC.
DRAFTED	04 OCT 1979
CHECKED	
APPROV	
RELEASE	
DO NOT SCALE DWG	

JC ENTERPRISES SAN DIEGO, CALIFORNIA

TITLE: PRINTED CIRCUIT BD ASSY 4-20mA OUTPUT INTERFACE MODEL A1034

SIZE	CODE IDENT		
C		1034	H
SCALE 2:1			SHEET 1 OF 1

⚠2 FINISH (IF APPLICABLE)

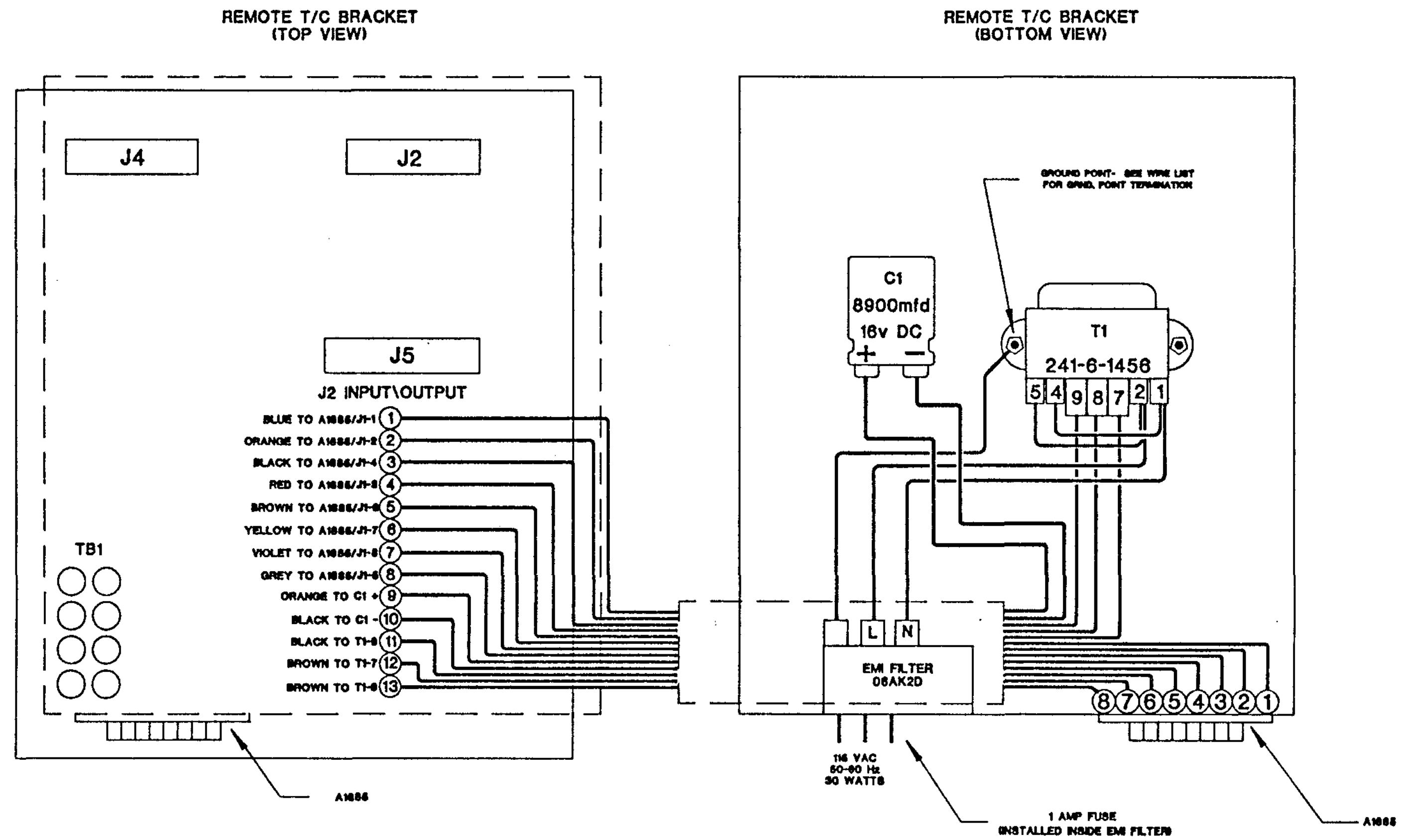
⚠1 MATL (IF APPLICABLE)

NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPD
	B	CHANGED DWG2041 PICTORAL OF T1	3/3/87	

JCS MODEL 310

(REMOTE MOUNT TEMPERATURE CONTROLLER)



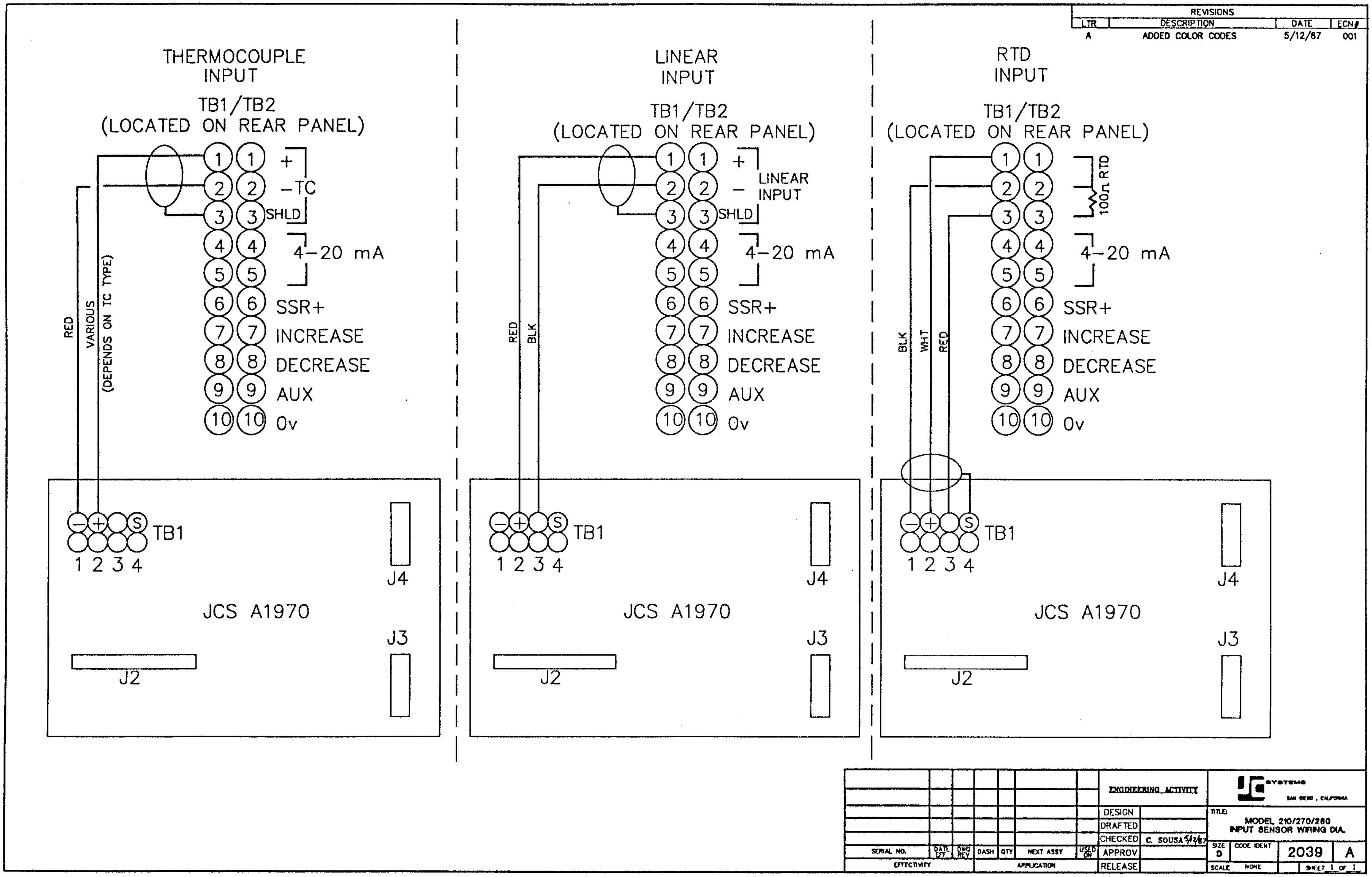
△ FINISH (IF APPLICABLE)

△ MATL (IF APPLICABLE)

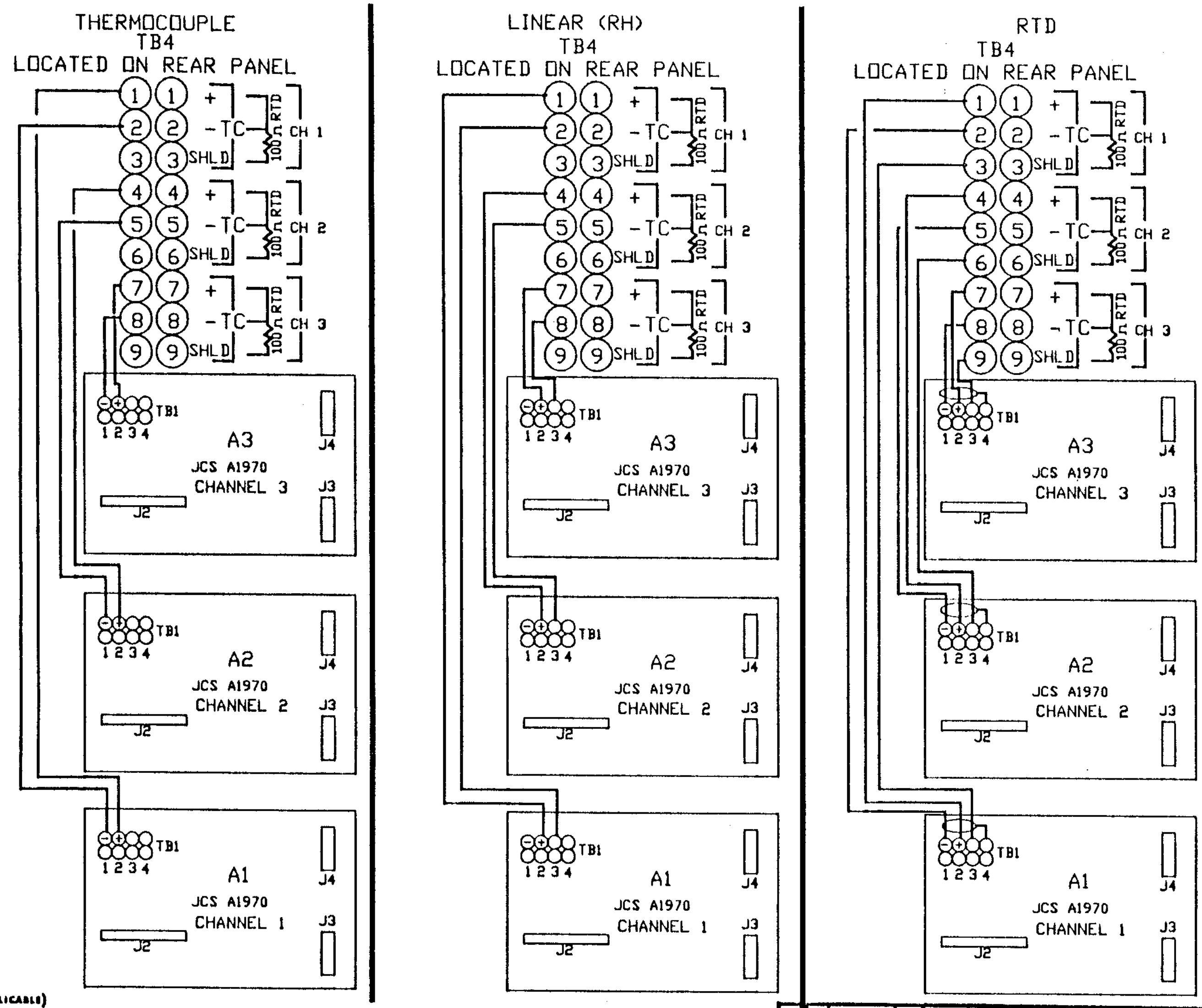
NOTES: UNLESS OTHERWISE SPECIFIED

DASH / QTY / NEXT ASSY / USED ON (APPLICATION)	SERIAL NO. / DATE EFF / DWG REV (EFFECTIVITY)	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	ENGINEERING ACTIVITY	SYSTEMS, INC.
		MATERIAL △	DESIGN / DRAFTED / CHECKED / APPROV / RELEASE	TITLE: JCS MODEL 310 WIRING DIAGRAM
		FINISH △	DO NOT SCALE DWG	SIZE D · CODE IDENT · 2041 · B
				SCALE · SHEET 1 OF 1

2100589



REVISIONS
LTR | DESCRIPTION | DATE | ECN#
A | ADDED COLOR CODES | 5/12/87 | 001
THERMOCOUPLE INPUT
TB1/TB2 (LOCATED ON REAR PANEL)
+
–TC
SHLD
4–20 mA
SSR+
INCREASE
DECREASE
AUX
0v
RED
VARIOUS (DEPENDS ON TC TYPE)
TB1
1 2 3 4
J4
JCS A1970
J3
J2
LINEAR INPUT
TB1/TB2 (LOCATED ON REAR PANEL)
LINEAR INPUT
RED
BLK
RTD INPUT
TB1/TB2 (LOCATED ON REAR PANEL)
100Ω RTD
BLK
WHT
RED
ENGINEERING ACTIVITY
SYSTEMS SAN DIEGO, CALIFORNIA
DESIGN
DRAFTED
CHECKED C. SOUSA 5/12/87
APPROV
RELEASE
SERIAL NO.
DATE EFF
DWG REV
DASH
QTY
NEXT ASSY
USED ON
EFFECTIVITY
APPLICATION
TITLE: MODEL 210/270/280 INPUT SENSOR WIRING DIA.
SIZE D
CODE IDENT
2039
A
SCALE NONE
SHEET 1 OF 1



REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPD

⚠ FINISH (IF APPLICABLE)

⚠ MATL (IF APPLICABLE)

NOTES: UNLESS OTHERWISE SPECIFIED

JC SYSTEMS, INC.

TITLE: JCS MODEL 800

SENSOR INPUT WIRING DETAIL

SIZE D | CODE IDENT | 2024

SCALE | SHEET __ OF __

DESIGN / DRAFTED / CHECKED / APPROV / RELEASE

ENGINEERING ACTIVITY

DO NOT SCALE DWG

MATERIAL ⚠ / FINISH ⚠

DASH / QTY / NEXT ASSY / USED ON — APPLICATION

SERIAL NO. / DATE EFF / DWG REV — EFFECTIVITY

INDEX

INDEX (Cont.)