JC SYSTEMS

by TMC Services Inc.

USER MANUAL

Model 510 Single-Channel Programmer/Controller

Model 520 Dual-Channel Programmer/Controller

TABLE OF CONTENTS

CHAPTER 1. INTRODUCTION.

CHAPTER 2. MANUAL CONTROLLER OPERATION

CHAPTER 3. PROGRAMMED CONTROLLER OPERATION

CHAPTER 4. USING THE PROMSAVE ACCESSORY

CHAPTER 5. REMOTE PROGRAMMING AND OPERATION

CHAPTER 6. MAINTENANCE AND CALIBRATION

APPENDIXES AND ADDENDUMS

LIST OF FIGURES

LIST OF TABLES

Chapter 1. Introduction.

1.1. HOW TO USE THIS MANUAL.

This manual describes how to use the JC Systems Model 510 Single-Channel Programmer/Controller and the Model 520 Dual-Channel Programmer/Controller.

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 programmer/controller's principal components are grouped together 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 contains a sample program worksheet. You can make as many copies of this as you need for your own use. Appendix C contains copies of schematics and assembly drawings for the Model 510/520 and related components.

1.1.2. How the Manual Is Organized.

The first chapter summarizes the applications, components and features of the Model 510 or 520 Programmer/Controller systems, usually referred to simply as "the Model 520". (Where material applies only to one configuration, this will be stipulated; for example, "Model 520 only".)

Chapters 2 through 5 each describe a different application, beginning with manual controller operation and progressing to remote computer operation. Each chapter builds on the information in the preceding chapter. The last chapter of the manual describes maintenance and calibration of the system.

1.1.3. 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: SELECT SETPNT

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: Press SELECT SETPNT button (Figure 2-5, Item 8).

   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. Press SELECT SETPNT button (8).

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 Programmer/Controller (Figure 1-1) is available in two models. The Model 510 consists of a single-channel programmer and a single-channel setpoint controller. The Model 520 consists of a dual-channel programmer and dual-channel setpoint controller. Except for the fact that the Model 510 has only one channel, all programming and operating procedures apply to both. Where differences do arise, these are mentioned in the text. Unless otherwise noted, illustrations show the Model 520.

Para. 1.2 (Cont.)

This JCS product includes many features that result in easier use and more effective applications. These include random access to any step within the programmer's memory; internal nested looping capability in addition to repeating the complete program, soft start to prevent thermal stress to devices under test; switch-selectable deviation limits; a split-range current loop for reverse/direct output; long-life battery backup for program memory, and many other features. (See the product data sheet provided at the beginning of this manual for more information on features.)

1.3. SYSTEM APPLICATIONS.

The Model 520 is designed to program and perform direct digital control of temperature and related process values, such as pressure or humidity. The Model 520 comes equipped with a RS-232C interface. IEEE-488 or RS-232C/RS-422A communication interfaces are available as options. Typical applications of the Model 520, some of which depend on the options and accessories available, are briefly described in the following paragraphs. The chapter describing each application in full is referenced in the paragraph heading.

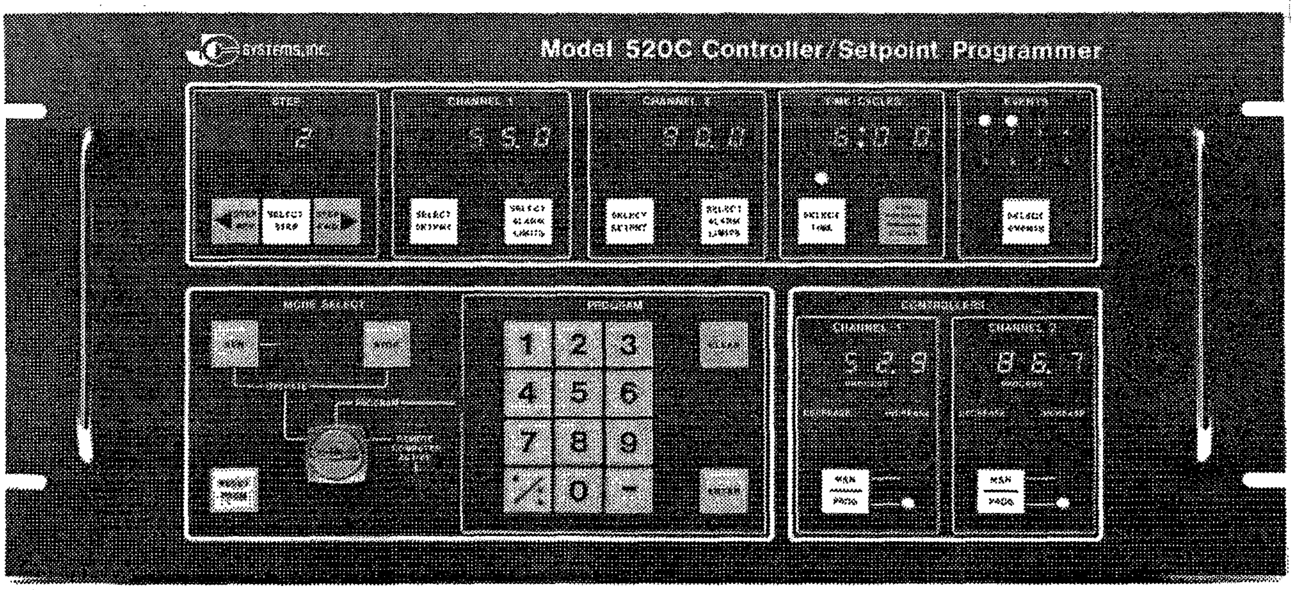


Figure 1-1: Model 520 Programmer/Controller Front Panel.

1.3.1. Manual Controller Operation - Chapter 2.

The controller portion of the Model 520 is used by itself as a pair of single-loop controllers. Constant-temperature setpoints can be entered, along with deviation alarm limits. The setpoints and process values are always displayed.

1.3.2. Programmed Controller Operation - Chapter 3.

The front panel keyboard is used to enter a program into the Model 520 program memory. The controller channel(s) then exercises direct digital control of the process value. All features can be used in programmed operation. The entered program remains in the Model 520 memory until revised. A helpful feature: any parameter of any program can be changed at any time -- you don't have to reenter the whole program to change one parameter.

1.3.3. Program Storage with PromSave™ - Chapter 4.

One or more programs stored in Model 520 memory can be stored in and retrieved from the PromSave™. This JC Systems accessory uses removable, reusable EEPROM (electrically erasable, programmable, read-only memory) cartridges that hold the entire content of a Model 240, 510, or 520 programmer's memory.

1.3.4. Remote (Computer) Operation - Chapter 5.

A remote computer interfaces with the Model 520. Using the 520's standard RS-232C serial interface or either of the interface options (RS-422A or IEEE-488), the remote computer exercises complete control of the Model 520 programming and operating functions.

1.4. PRINCIPAL COMPONENTS.

Principal components of the system are its front panel, which contains the operating controls; the rear panel, where electrical connections are made, and the printed circuit boards (PCB) within the cabinet. Some switches, which must be set before beginning operation, are mounted on these PCB. Procedures for making the electrical connections and setting switches are given in the applicable chapter noted above.

Chapter 2. Manual Controller Operation.

2.1. INFORMATION PROVIDED.

This chapter describes using the Model 520 as a manual setpoint controller with a deviation alarm. It includes unpacking and mounting the system, connecting electrical power, thermocouples, and controller outputs. It also describes the controls and displays used for manual 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 Model 520 and remove the programmer/controller from its shipping container.

2.3. MOUNTING.

2.3.1. Rack Mounting.

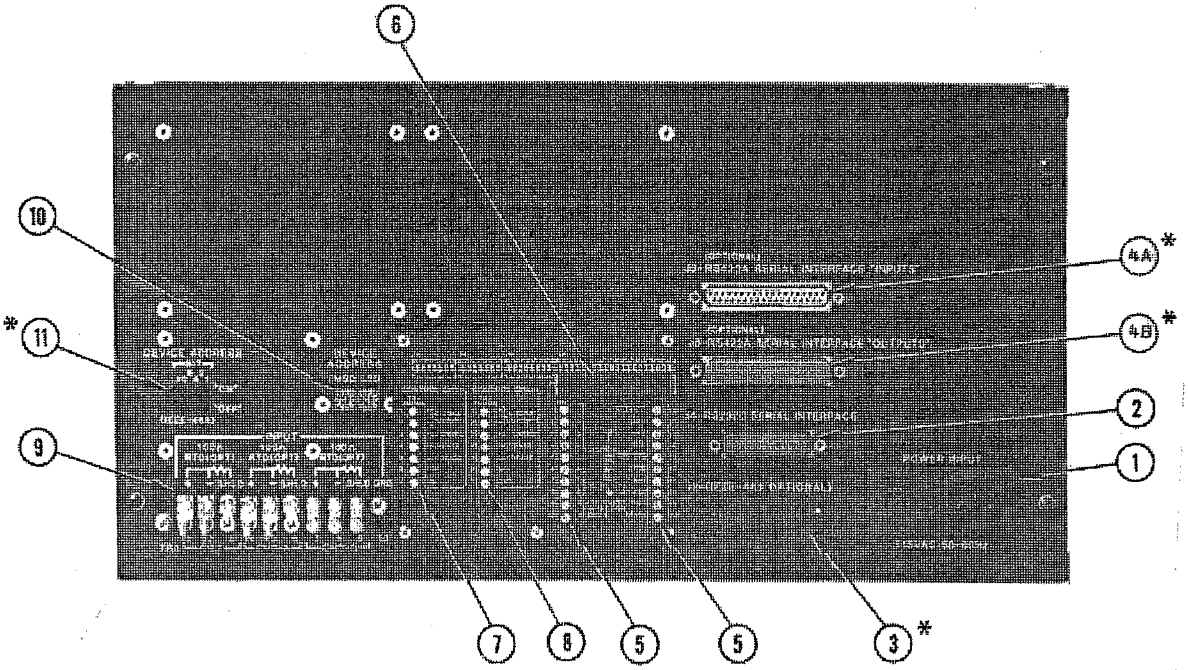
Mount the Model 520 in a standard 19-in. electronic rack, allowing at least 8-3/4 in. rack space to accommodate its height.

2.3.2. Bench Mounting.

For bench use, be sure to install rubber feet (available at no charge from JC Systems) on bottom of the Model 520 to prevent damage to the benchtop.

2.4. CONNECT ELECTRICAL POWER.

Plug in power cable to 117V, 50/60 Hz grounded socket (Figure 2-1, Item 1).



* OPTIONAL COMPONENTS - BLANK PANEL IF NOT INSTALLED

Figure 2-1: Rear Panel Layout -- Standard Configuration

2.5. CONNECT TEMPERATURE INPUTS.

Connect thermocouple or RTD (resistance temperature detector) leads at temperature input terminal board TB4 (Item 9) on the rear panel. A label on the rear panel specifies the temperature input configuration of your unit.

2.5.1. Thermocouples.

Use terminals 1 and 2 for single-channel Model 510 or Channel 1 of dual-channel Model 520, and terminals 4 and 5 (also marked CH2-A) for Channel 2. Terminals 7-10 (marked CH2-B) are not used in either the Model 510 or 520 configuration.

2.5.2. RTD Sensors.

Use the same terminals as described for thermocouples. When using two-wire RTD sensors, connect one sensor wire each to the first and third terminals (for example, 1 and 3 of TB4). Then connect the first and second terminals (1 and 2 in our example) with a short jumper wire.

Para. 2.5.2 (Cont.)

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 Model 520 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 channel time-proportioning outputs (located on terminal boards on the rear panel) to the heat and cool SSR (solid-state relays) as shown in Figure 2-2. Make the connections at terminals 3 thru 5 of the applicable controller terminal board. Use TB1 for single-channel Model 510 or for Channel 1 of dual-channel Model 520, and TB2 for Channel 2. Figure 2-2 shows connections for typical applications.

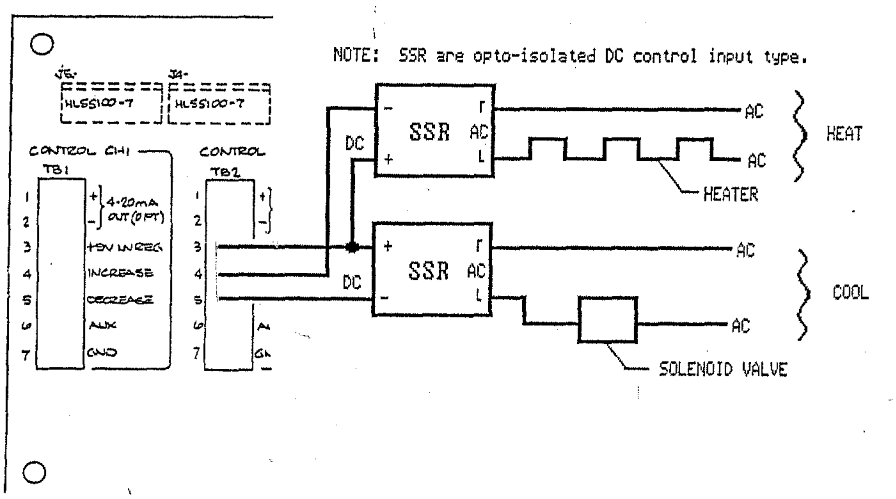


Figure 2-2: Connecting Time Proportioning Outputs (Typical Applications)

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 1 and 2 of the applicable controller terminal board on the rear panel. (Use TB1 for single-channel Model 510 or for Channel 1 of dual-channel Model 520, and TB2 for Channel 2).

NOTE

Heat and cool time proportioning outputs with one-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 Model 520 with power proportioning on both channels, you will need to set the switch on both controller boards.) This switch is located on the controller PCB (Figure 2-3, Item 1). To gain access to the switch, 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.

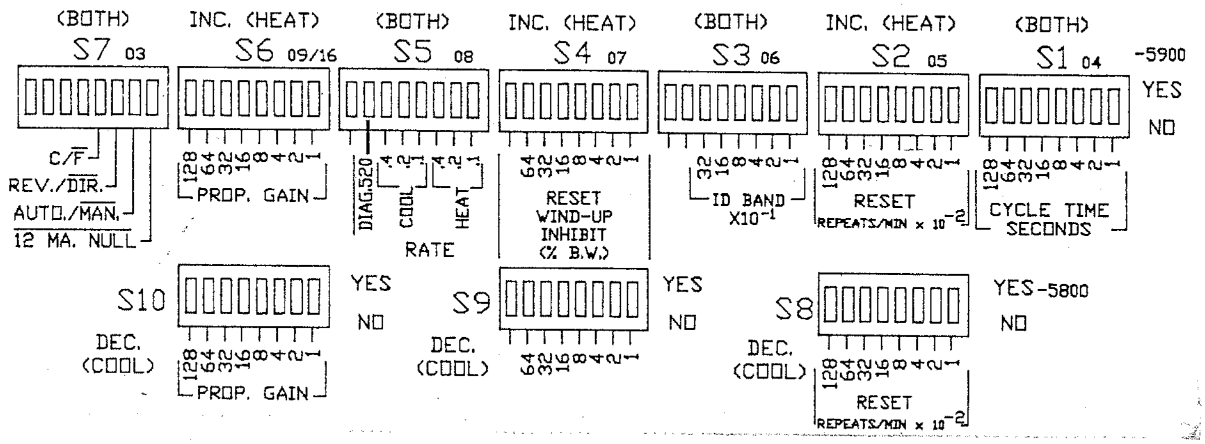


Figure 2-3: Controller Board DIP Switch Locations

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 (see Figure 2-3) as specified below. The "normal" setting is the factory setting in all cases. If you have a Model 520 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 and 12-4 mA for 0-100% cooling requirement. 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

ERROR (% BANDWIDTH)	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

2.7.4.3. 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.

2.7.4.4. 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 by changing the Model 520 setpoint setting from -100 to +100%. 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 CONNECT ALARM OUTPUTS TO PHOTO-ISOLATED SSR.

Connect alarms to appropriate terminals of TB3 (Figure 2-1, Item 5) as shown in Table 2-1. (If you're using the JCS A1748 Event Relay Board Accessory, you can connect the cable supplied with that accessory directly to panduit J1 on the Model 520 rear panel (2); the pin assignments correspond with the terminals).

All outputs are open collector logic type limited to 50 mA and 50 Vdc maximum. TB3-12, the internal +9V source, should be used as the positive source for photo-isolated solid-state relays (SSR) on the alarm output drives.

Make connections to TB3 terminals 10 thru 12 only at this time. (Remaining programmer outputs are used elsewhere, and will be explained later.) Terminal No. 10 is alarm #2 output; No. 11 is alarm #1 output, and No. 12 is the +9 Vdc unregulated internal voltage (100 mA max) used as source voltage for SSR.

2.9 SELECT TEMPERATURE OR LINEAR INPUT MODE (S7).

Controller DIP Switch S7 (see Figure 2-3) positions 1-3 select power proportioning output modes as previously described in Para. 2.7.4. On Model 520's configured for temperature applications, S7 Bit 4 sets control circuitry to function in either °C when up or ° F when down.

On Model 520's 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.

2.10 SELECT EVENTS PRESET FOR MANUAL OPERATION.

The setting of the Control Logic Board DIP switch S1 positions 2 and 3 (Figure 2-4, Item 1) determines the status of events during manual operation. Bit 3 determines if all events will be ON or OFF. If Bit 2 is set to PRESET EVENTS, then the status of events upon entering manual operation will be as selected by Bit 3. If Bit 2 is set to HOLD EVENTS, event status will not change upon entering manual operation regardless of the Bit 3 setting.

2.11 RUN SYSTEM AS A MANUAL CONTROLLER.

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. If you are using a dual-channel system, you can operate one controller in the manual mode while the other is in the program mode. If you have a single-channel system, the references in the following paragraphs to the "appropriate" or "desired" channel do not apply.

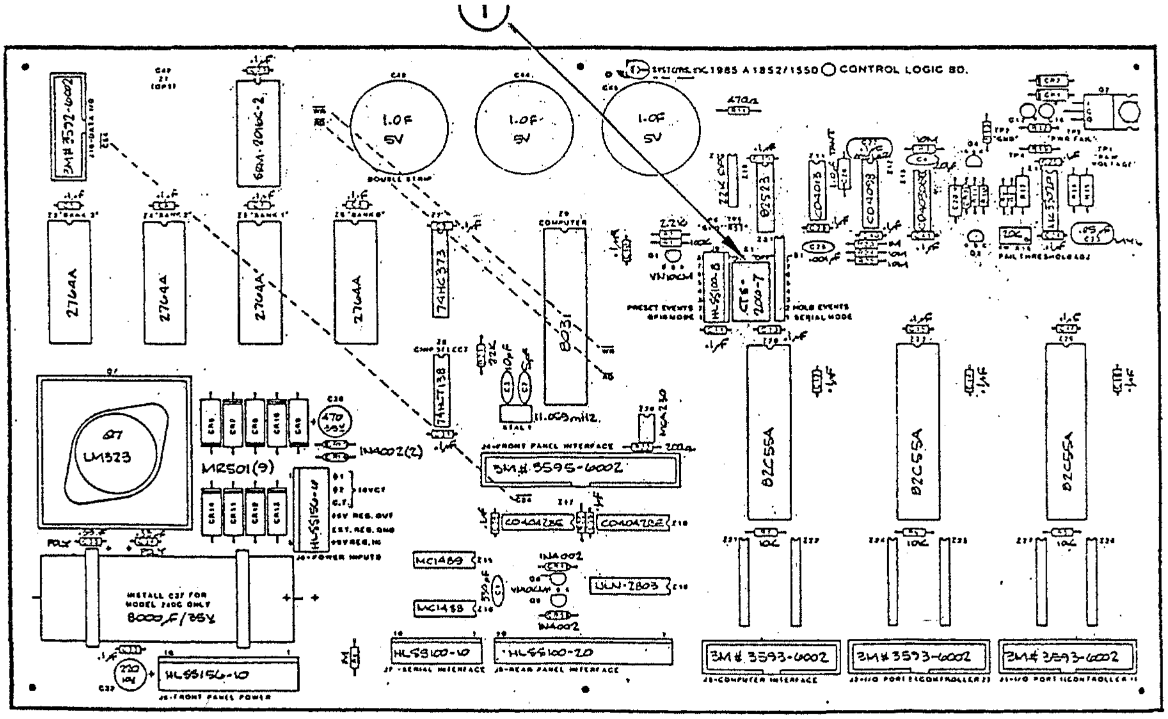


Figure 2-4: Control Logic Board DIP Switch S1.

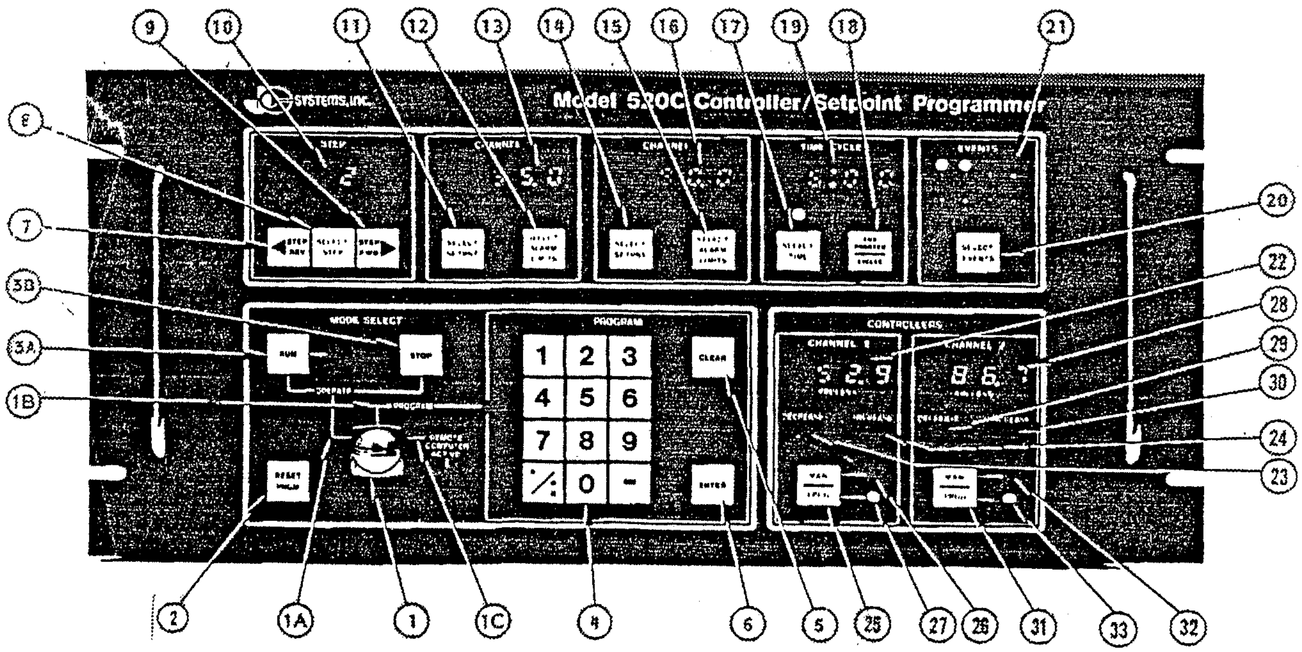


Figure 2-5: Front Panel Displays and Switches.

2.11.1. Turn on the System.

1. Turn on power at rocker switch on rear panel.
2. Place MODE SELECT keyswitch (1) in either the OPERATE or PROGRAM position.

2.11.2. How to Detect a Failure.

2.11.2.1. Alarm Conditions.

The following conditions result in an alarm while operating in manual mode.

1. *Alarm Limits Exceeded.* The process variable is outside the range allowed by the selected alarm limits.
2. *Probe Open (P.OP.).* A temperature controller's probe is disconnected, open, or defective.
3. *Setpoint Fail (---.-).* The setpoint is outside of the controller's range.

2.11.2.2. Alarm Actions.

When an alarm condition is present, the following actions occur.

1. The applicable channel's SELECT ALARM LIMITS LED flashes for alarm condition 1 (limits exceeded). The SELECT SETPNT LED flashes for alarm conditions 2 (probe open) and 3 (out-of-range).
2. The applicable channel's alarm output on TB3-10 or -11 goes low.

2.11.2.3. Probe Open.

If a probe is open, the following actions occur.

1. The CODE "P. OP." appears in the controller's PROCESS display (22 or 28) and the applicable channel's SELECT SETPNT LED flashes.
2. Heat and Cool outputs automatically turn off.

2.11.2.4. Invalid Setpoint.

If the setpoint entered by the operator is outside the operating range of the Model 520 controller(s), the following actions occur. (Diagnostics can be used to determine the Model 520's operating range -- refer to Chapter 6.)

1. The applicable channel's SELECT SETPNT LED flashes.
2. A series of dashes (---.-) appears in the controller's PROCESS display (22 or 28).
3. The Heat and Cool outputs automatically turn off.

2.11.3. Select Manual Mode.

If the controller manual mode LED (26 or 32) for the desired controller channel is not lighted to indicate that the controller is in manual mode, select manual operation as follows.

1. If the keyswitch is in OPERATE position and the Model 520 is running (RUN LED lighted), press STOP button (3B).
2. Press the MAN/PROG button (25 or 31) to change to manual operation. MAN LED (26 or 32) will light.

NOTE

> You can operate manually with the MODE SELECT keyswitch in the PROGRAM position. However, if you try to operate manually with the keyswitch and controller mode both set to PROGRAM, you will overwrite the setpoint information for that channel stored in the Model 520.

2.11.4. Enter a Setpoint.

1. Press SELECT SETPNT button (11) for appropriate controller channel. SELECT SETPNT LED will light.
2. Use keyboard (4) to input the desired setpoint value, which will be displayed in the window (13) above the SELECT SETPNT button. If the setpoint is out of range, the controller's process display will show a series of dashes (----). (See Para. 2.11.2.3).
3. If the displayed setpoint is incorrect or out of range, press clear to erase the value and reenter the desired value.
4. Once the displayed setpoint is correct, press ENTER button (6) to record the setpoint in memory and start controller operation.

2.11.5. Enter Deviation Alarm Limit.

Press SELECT ALARM LIMITS button (12 or 15). Pointer LED will light. Use the keyboard to input the deviation alarm limit in the same fashion as you entered the setpoint.

In manual operation, the Model 520 deviation alarm function is enabled whenever the process temperature is outside the deviation limits.

2.11.6. Shut Down Controller.

To shut down a controller operating in manual mode, proceed as follows.

1. Press SELECT SETPNT button (11 or 13) for appropriate controller channel. Pointer will light.
2. Press CLEAR button (5). Display will show a row of dashes (---.-).
3. Press ENTER button (6). Controller will shut down.

Chapter 3. Programmed Controller Operation.

3.1 INFORMATION PROVIDED.

This chapter describes how to plan and record a simple program using the program worksheet, how to enter the program, and how to operate the controller using that program. Before the program can be entered, events must be connected and the setting of certain switches must be selected, so these procedures are described first.

3.2 SWITCH SETTINGS.

3.2.1 Controller Dip Switches.

Each Model 520 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. 3.2.3 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

3.2.2 Programmer Logic Control Board A1852/1550 Switch S1.

Bit positions for this switch should be set for the intended application as specified in Para. 3.4.2. Factory settings are shown in Table 3-2.

TABLE 3-2: FACTORY SETTINGS FOR CONTROL LOGIC BOARD DIP SWITCH S1.

BIT	SETTING	DESCRIPTION (ON/OFF SETTING)
1	ON	Serial/GPIB select (RS-232C & RS-422A/IEEE-488)
2	OFF	Preset/Hold Events (Preset defined by Bit 3 setting)
3	OFF	All Events On/All Events Off
4	OFF	Single Step On/Off — (programmed stop) enables automatic stop after any step that has event 6 on
5	OFF	Not used
6	OFF	Remote Mode Front Panel Run Enable On/Off — enables front panel RUN control when the Model 520 is in Remote Computer Active mode
7	OFF	Multi-Sync On/Off — enables synchronization of multiple programmers

3.2.3 Read Switch Settings Using Diagnostics.

To determine current controller switch settings, use the Model 520 diagnostic mode to examine and record the values used as follows.

3.2.3.1 Enter and Select Diagnostic Test.

NOTE

Controller switch S5 Bit 7 must be in the up position for the diagnostics to work. (This switch is factory sealed in place and should not be changed.)

1. Set keyswitch (Figure 3-1, Item 1) to PROGRAM.
2. Hold down the RESET PRGM button (2) while pressing the STOP button (3B). This automatically places you in turbo diagnostics at test code -591.6, the current HEAT proportional band setting, with the value displayed for each channel.

NOTE

The display test that occurs first in standard diagnostics is bypassed in turbo mode. If you want to conduct this test (code -594.0), select it using the standard method (see Step 6 below).

3. To switch from HEAT to COOL parameters, press the STEP button (8).
4. To select another test, simply press and hold down the applicable step slew button — STEP REV (7) or STEP FWD (9) — until that test number appears in the applicable channel setpoint display. When you release the slew button, the number in the process display (22 or 28) will change to the current HEAT parameter for the selected test.
5. The first value displayed will always be the HEAT parameter for the selected test. To check the COOL parameter, press the STEP button (8).

6. At any time during turbo diagnostics, you can also use the standard method to select a test. Press SELECT SETPNT button (11 or 14) and input the diagnostic test code (-500.0, for example) using the keyboard (4), then press ENTER button (6) to start the selected test.

NOTE

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

TABLE 3-3: CONTROLLER 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	

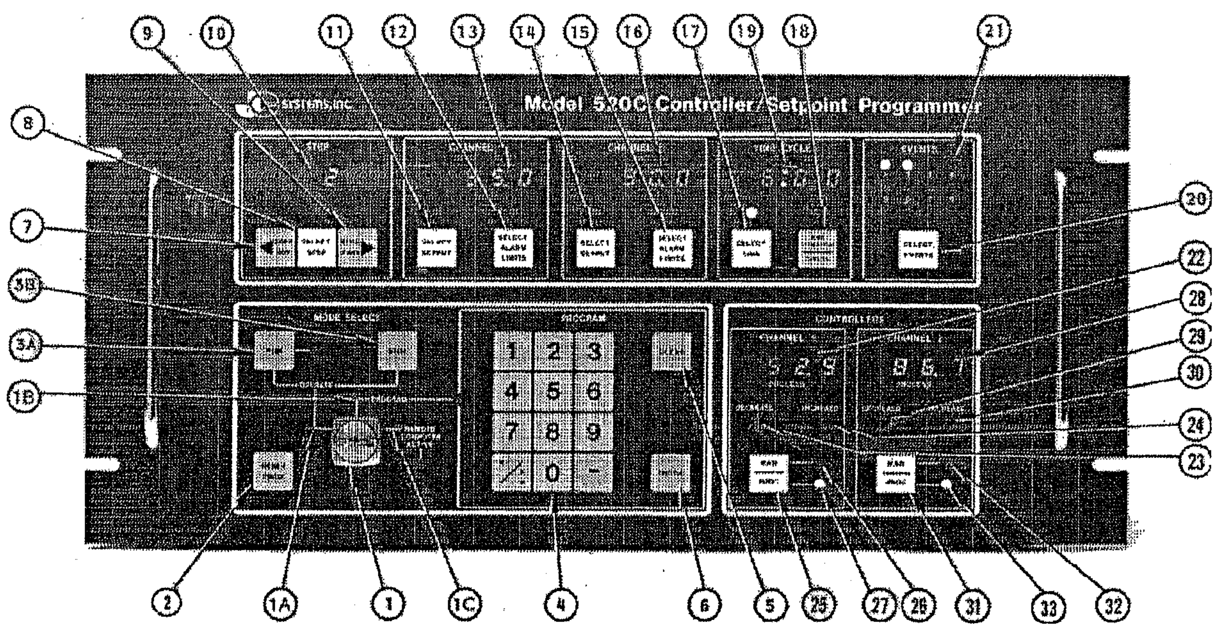


Figure 3-1: Front Panel Buttons, Displays and Indicators.

3.2.3.2 Exit Diagnostics.

To exit diagnostics, turn keyswitch (1) to either OPERATE or REMOTE COMPUTER ACTIVE mode. The Model 520 will exit diagnostics and the controller PROCESS display will show an error message (— — —.—). The error message will be replaced when a valid setpoint is sent to the controller. This may be done either from a program (with controller in Program mode), or by front-panel setpoint entry (with controller in manual mode).

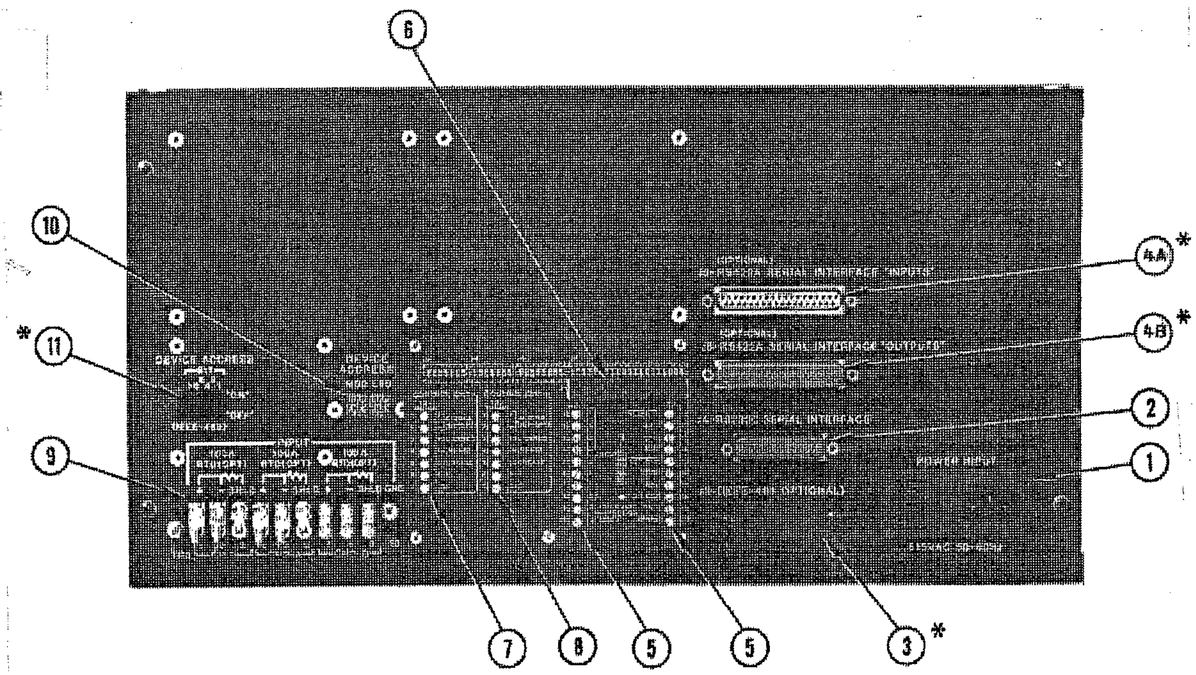
3.3 CONNECT EVENTS INTERFACE.

Connect events solid-state relays to appropriate terminals of TB3 (Figure 3-2, Item 5) as shown in Table 3-4. (If you're using the JCS Model A1748 Event Relay Board, you can connect the cable supplied with that accessory directly to panduit J1 on the Model 520 rear panel (6); the pin assignments correspond to the terminal assignments listed in Table 3-4.) The terminals identified as 14 through 19 are used for external control signals; their use will be explained later.

All outputs are open collector logic type limited to 50 mA and 50 Vdc maximum. TB3-12, the internal +9V source, can be used as the positive source for photo-isolated solid-state relays (SSR) on event output drives.

NOTE

Alarms (Pins 10 and 11) were connected earlier.



* OPTIONAL COMPONENTS — BLANK PANEL IF NOT INSTALLED

Figure 3-2: Rear Panel Connectors and Terminals.

TABLE 3-4: TERMINAL ASSIGNMENTS FOR EVENTS CONNECTIONS TO SSR.

TERM. NO.	FUNCTION	TERM. NO.	FUNCTION
1	Event 1	8	Event 8
2	Event 2		
3	Event 3		
4	Event 4		
5	Event 5	12	+ 9 V DC unregulated internal source (100 mA max) (SSR source voltage)
6	Event 6		
7	Event 7		

3.4 SET DIP SWITCHES.

3.4.1 Set Front Panel Dip Switch Z33.

Certain operating characteristics of the Model 520 programmer can be selected by changing the bit positions of DIP switch Z33 (Figure 3-3) on the inside of front panel display board A1840 as specified below. Note that the paragraph headings do not correspond to the actual legends on the PCB. Also, Channel 2 functions are inoperable on single-channel Model 510.

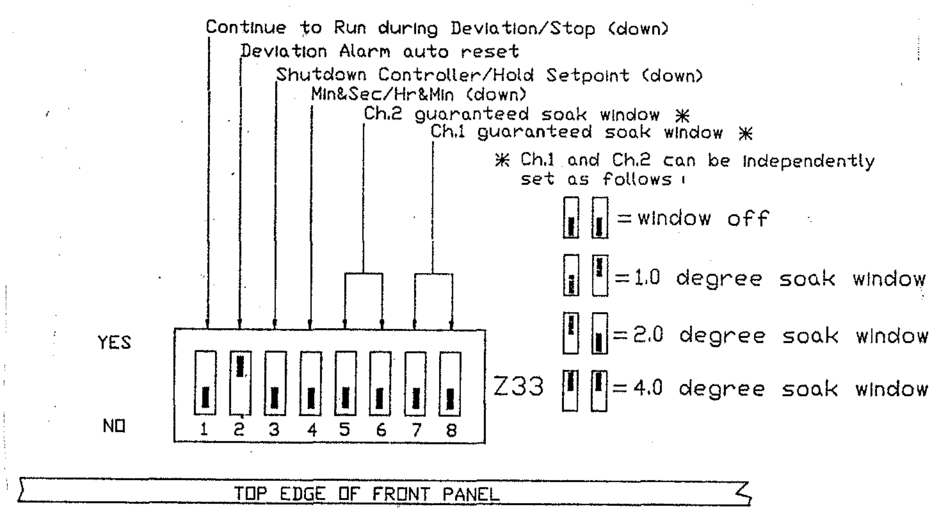


Figure 3-3: Z33 DIP Switch Settings (for Standard Model 520).

3.4.1.1 Channel 1 Guaranteed Soak Window.

Bit positions 7 and 8 of Switch Z33 can be set to select how long Channel 1 of the Model 520 controller will wait (even though step duration has elapsed) until process variable No. 1 is within its setpoint ° the selected soak window. Figure 3-3 shows how to set the switch to turn the soak window off or select soak windows of 1, 2, or 4 degrees. During this guaranteed soak window, the Model 520 will hold operation (colon in TIME/CYCLES display will stop flashing) until process variable No. 1 is within the selected limit.

3.4.1.2 Channel 2 Guaranteed Soak Window.

Bit positions 5 and 6 of Switch Z33 can be set to select the guaranteed soak window for Channel 2 of the Model 520 controller in the same manner as positions 7 and 8 are used for Channel 1 (see preceding paragraph and Figure 3-3).

3.4.1.3 Set Time Base.

With the MIN&SEC/HR&MIN, Bit 4, set to YES (MIN&SEC), time can be measured in minutes and seconds from 0 seconds to 99 minutes, 59 seconds. In the NO (HR&MIN) position, time can be measured in hours and minutes from 0 minutes to 99 hours and 59 minutes.

3.4.1.4 Controller Shutdown/Setpoint Hold.

When the CONTROLLER SHUTDOWN/SETPOINT HOLD, Bit 3, is set toYES (CONTROLLER SHUTDOWN) position, the programmer automatically shuts down both controllers at the end of the program. When the switch is set to NO (SETPOINT HOLD) position, the setpoint specified at the end of the program (in program memory) will be used as the final setpoint.

3.4.1.5 Alarm Auto Reset.

Placing the DEVIATION ALARM AUTO RESET, Bit 2, to OFF (no AUTO RESET) causes the following: whenever alarm limits are exceeded, the Model 520 stops (TIME/CYCLES colon stops flashing), the alarm limit energizes, and the applicable SELECT ALARM LIMIT LED flashes. These conditions continue until parameters returns within limits and the RUN button is actuated (by manual or remote computer operation).

When the switch is set to YES (AUTO RESET), the Model 520 will automatically resume operation as soon as an out-of-limits condition has ended. At the same time, the alarm outputs are reset.

3.4.1.6 Run During Deviation.

When the CONTINUE TO RUN DURING DEVIATION, Bit 1, is set to ON, the Model 520 will continue running even though alarm limits have been exceeded. The alarm outputs will either latch (continue) or automatically reset (turn off), depending on ALARM AUTO RESET Bit 2 position.

3.4.2 Programmer Control Logic Board Switch S1.

This switch is used to select event output status in manual mode and single-step operation as explained below. It is also used to select serial or IEEE-488 interface mode, and to enable front panel RUN while the unit is in Remote Computer Active mode. The application of these features is discussed in Chapter 5.

3.4.2.1 Events Status.

The setting of the Control Logic Board DIP switch S1 positions 2 and 3 (Figure 3-4, Item 1) determines the status of event outputs when both controllers are switched from programmed to manual operation. Bit 3 determines if all events will be ON or OFF when Bit 2 is set to PRESET EVENTS. If Bit 2 is set to HOLD EVENTS, programmed events will not change when the controllers are switched from programmed to manual operation. (For the Model 520, both controllers must be set to manual before this feature is enabled.)

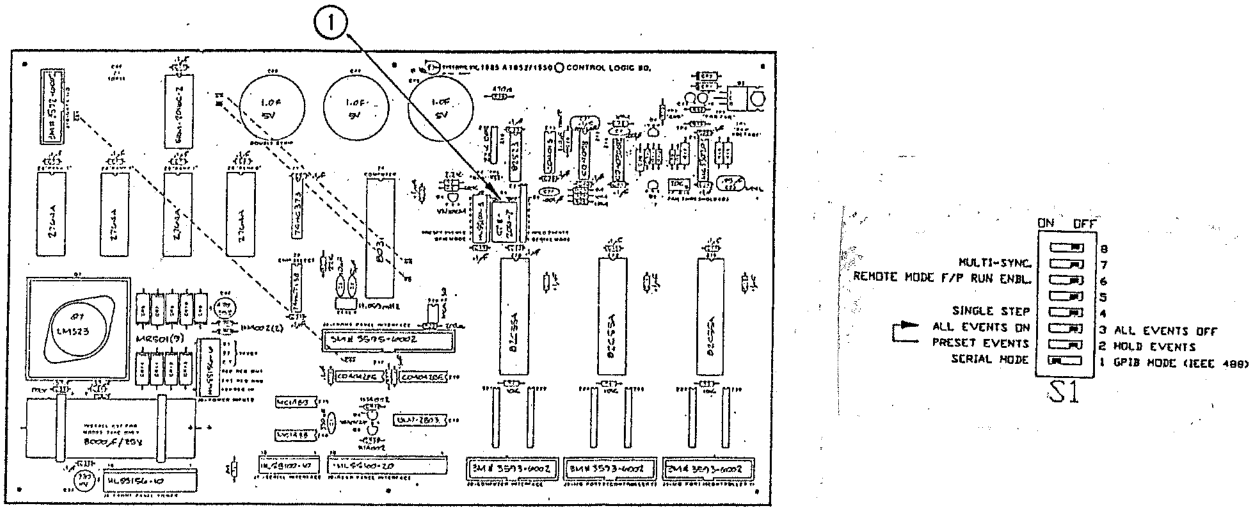


Figure 3-4: Control Logic Board DIP Switch S1.

3.4.2.2 Multiple-Programmer Synchronization.

The Model A2014 Multi-Programmer Synchronizer is an optional board that is enabled by setting Switch S1 Bit 7 to ON. Connect synchro-equipped programmers pin-to-pin via the Synchronizer's I/O terminal block, TB1-1 thru -6. Up to 10 daisy-chained units can be synchronized so that all units start a new step together. If any one synchronized unit stops for any reason, all units will stop and wait until all units are ready to run again. All units must be on and in the RUN state before any/all will run. If no cable is connected to the Synchronizer I/O block of a programmer equipped with the option board, or if S1-7 is in the OFF position, the programmer functions as a normal standalone type.

3.4.2.3 Single-Step (Programmed Stop) Operation.

Single-step programmed stop operation allows you to automatically stop a program at the end of a selected step. When Switch S1 Bit 4 is ON (set to Single Step) and Event 6 of a program step is enabled, program execution will halt at the beginning of the next step. The STEP display will show the next step number. The time/cycle display will show the time for the next step, and the clock will stop. The last setpoint output will be displayed, latched, and maintained from the step where Event 6 was enabled. The event outputs will also remain in the configuration selected for the step in which Event 6 was turned on.

Para. 3.4.2.3 (Cont.)

For example, assume that Step 2 of your program is a 2-hour soak at 100° with Event 6 enabled and Switch S1-4 ON to invoke the program stop (single-step) feature. Step 3 is a 1-hour ramp to -55° . At the end of the 2-hour soak in Step 2, the programmer will halt program execution. The setpoint will be displayed, latched and maintained at 100°. The step display will show 3, the time display will show 1 hour, and the event display will show Event 6 on.

To restart program execution, either press the RUN button on the front panel, activate the remote RUN switch (if installed), or use the remote computer RUN command.

3.5 ENTER A PROGRAM.

3.5.1 Use the Worksheet to Plan a Program.

Figure 3-5 shows a typical profile that demonstrates the basic features of the Model 520 programmer. The program assumes that the Model 520 is set for operation in °C with a time base in minutes and seconds.

You will find it much easier to enter a program in the Model 520 if you first use a program worksheet to write down the program. This way, you can spot potential problems and correct them without backtracking through the Model 520 displays. Figure 3-6 shows the profile from Figure 3-5 entered on a sample worksheet.

When using synchronized programmers (Model A2014 Synchronizer installed, logic board switch S1-7 ON, and multiple programmers daisy-chained together), enter programs with the same time base and step duration for all units to be operated synchronously. If one programmer gets to the end of its step before the others, it will wait for the other programmers, and then all units will resynchronize before starting the next step. No unit will start until all units are ready.

In Paragraph 3.7, we will revise the program to introduce more advanced features. But for now, let's go through the program on Figures 3-5 and 3-6 step by step.

Step 1. Ramp from ambient to -50° in 15 minutes, 10° alarm deviation limit set. The Model 520's soft start feature permits starting the program immediately from ambient. If a guaranteed ramp is desired, add a preliminary step to achieve the desired starting temperature.

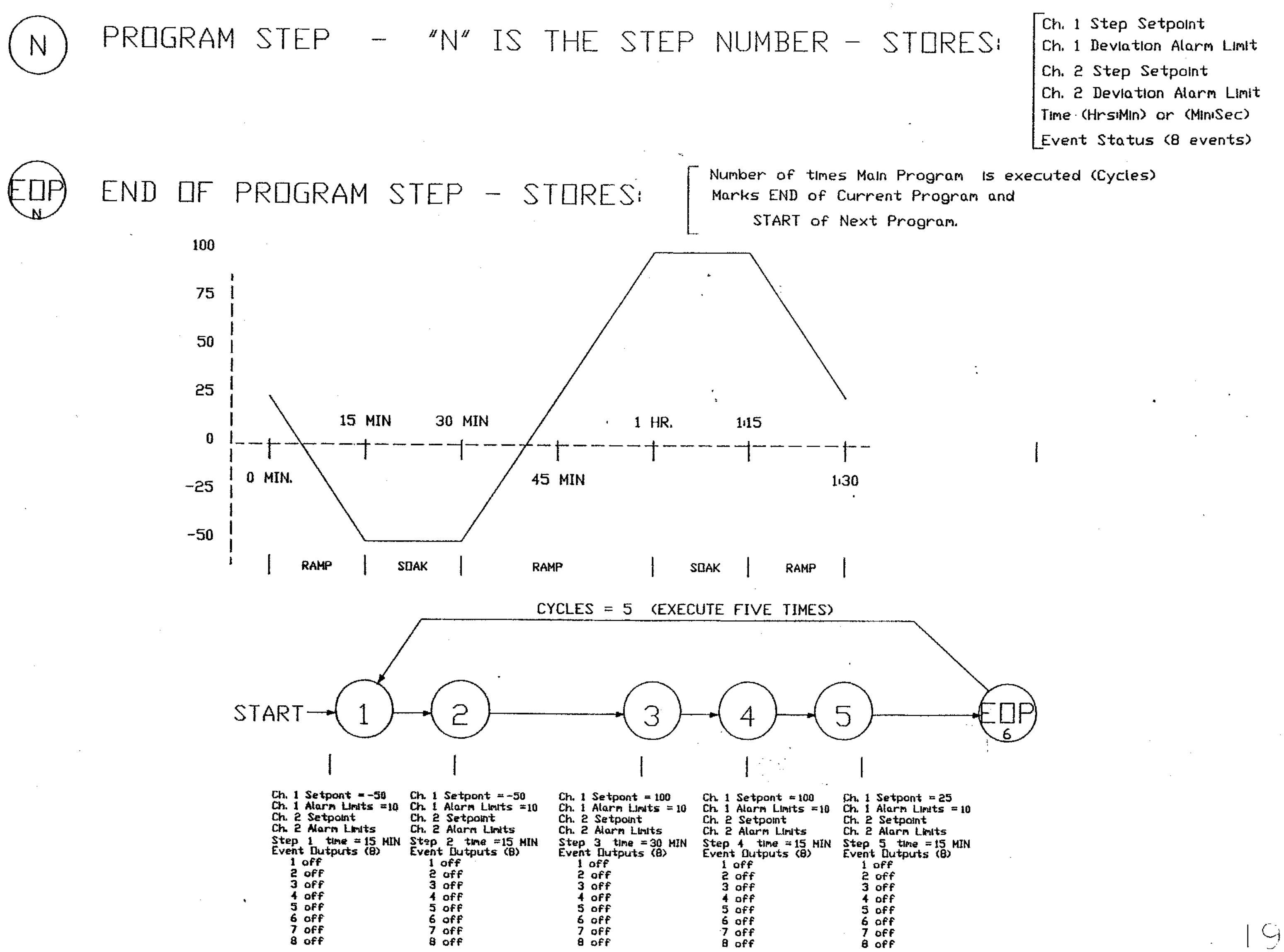
Step 2. Soak at -50° for 15 minutes; alarm limits unchanged, no events turned on.

Step 3. Ramp to 100° in 30 minutes; alarm limits unchanged, no events on.

Step 4. Soak at 100° for 15 minutes; alarm limits unchanged, no events on.

Step 5. Ramp to 25° (ambient) in 15 minutes. Alarm limits unchanged, no events on.

Step 6. Execute Program 5 Times and End Program. Note the 5 in the time column. This is my reminder that I entered a 5 at the END PRGM/CYCLES step, so that the entire program would execute 5 times. (More about that when we actually enter the program.)



1945

LOOPS_2 4/1/86

NOTE: Encircled numbers correspond to step numbers shown on sample program worksheet.

Figure 3-5: Profile for Program Listed on Sample Worksheet (Figure 3-6).

PROGRAM WORKSHEET

JC SYSTEMS INC.   PROGRAM NO. Sample #1 (for Fig. 3-5)   DATE: ______________

STEP	CHANNEL 1		CHANNEL 2		TIME/	EVENTS							
NO.	SETPNT	ALM LMT	SETPNT	ALM LMT	CYCLES	1	2	3	4	5	6	7	8
1	-5Ø	1Ø	--	--	15								
2	-5Ø	1Ø	--	--	15								
3	1ØØ	1Ø	--	--	3Ø								
4	1ØØ	1Ø	--	--	15								
5	25	1Ø	--	--	15								
6	EOP				5								
7													
8													
9													
1Ø													
11													
12													
13													
14													
15													
16													
17													
18													
19													
2Ø													
21													
22													
23													
24													
25													
26													
27													
28													
29													
3Ø													

NOTES:

1. Each separate program must be terminated with an END OF PROGRAM (EOP) step to separate it from the ones before and after.
2. Multiple programs can be stored and individually executed -- select first step of desired program

Figure 3-6: Program Worksheet with Program Entered.

3.5.2. Watch Program Length.

3.5.2.1. Program Length and Model 520 Program Storage Capacity.

One complete program consists of all steps containing parameters and the EOP step. A program with nine steps is actually ten steps long (counting the EOP). Since the Model 520 can store a maximum of 91 steps, it has room for nine programs each containing ten steps total (9 steps plus the EOP step).

3.5.2.2. Importance of End-of-Program Step.

The EOP has the following functions:

1. It marks the end of one program and the beginning of another.
2. It specifies the number of times the program will be executed.

The first step of a program must be immediately preceded by an EOP step, unless the program starts at Step 1. If a program does not start after an EOP, the programmer will skip over channels and will not accept your input.

Hint: it's not necessary, and may even be inconvenient, to start the next program on the next available step after an EOP. Leave a few steps blank in case you want to revise and expand the program later. (Be sure to terminate the blank steps with an EOP step.) This technique is especially useful if you have a way to store Model 520 programs elsewhere (on the JC Systems PromSave™ or a remote computer disk), which we'll explain later.

3.6. ENTER THE PROGRAM AT MODEL 520 FRONT PANEL.

Now that we've planned the program, let's enter it in the Model 520. For this first program, we will be using Channel 1 only. If you compare Figure 3-6 to the front display panel (Figure 3-1), you will see that the worksheet provides a place to enter each of the values you will program into the Model 520. The order of the values is the same order as the Model 520 pointer (the LED that lights above the SELECT buttons) will progress across the top row of the Model 520.

3.6.1. General Instructions.

1. The controller(s) being programmed must be in program mode (PROG indicator LED on), or the values will not entered in memory.
2. Remember that the CLEAR button (5) can be used at any time to remove incorrect input, and the ENTER button (6) must be used to store input in memory. If the value already in memory is correct, simply press the ENTER button to keep that value.

3. As you progress through programming, the LED above the top row of buttons serve as a pointer to tell you where you are in a program. For example, the pointer above the SELECT SETPNT button will light as soon as you select a program starting step. The SELECT SETPNT pointer will go out as soon as you have entered the setpoint, and the pointer above the SELECT ALARM LIMITS button will light.
4. The sample program lists the applicable value from Figures 3-5 and 3-6 in brackets []. You could enter any similar program simply by substituting your own values.

3.6.2. Finding Switches and Displays.

Figure 3-1 shows the location of and identifies front panel displays and buttons you will use to enter the program.

3.6.3. Select Starting Step.

1. Insert key in keyswitch (1) and turn to PROGRAM mode (1B). PROGRAM LED lights and keypad becomes active.
2. Be sure that both controllers are in program mode (PROG LED on). If not, press controller mode selection buttons (25 and 31) to change to program mode.
3. If a program has been entered, there are two convenient ways to access the first available step.

   a. If you are currently on any step of the program you wish to run, press the RESET PRGM BUTTON (2).
   b. If you know the first step number of the program you want to run, use the random access feature to select the starting step as follows:
      1) Press SELECT STEP button (8). The SELECT STEP LED will light.
      2) Use the keypad (4) to input the desired step number, then press the ENTER button (6). SELECT STEP pointer will go out and SELECT SETPNT pointer will light. (You are ready to start programming.)

NOTE

The easiest way to keep track of available steps and programs is by using a program worksheet like Figure 3-6 as a log. (A blank worksheet form is provided in Appendix B that you may copy for your own use.)

3.6.4. Enter Step 1.

3.6.4.1. Enter Channel 1 Setpoint.

The Model 520 will only run with a setpoint within the operating range of your system's controllers (as listed on the rear panel and the Calibration Parameters Sheet included at the front of this manual). To enter the setpoint, proceed as follows.

1. Using keypad (4), input desired value [-50°]. CHANNEL 1 display (13) will show inputted value.
2. Press ENTER button (6) to record value in program memory and advance program pointer to next parameter.

3.6.4.2. Enter Channel 1 Alarm Limits.

Enter a deviation limit of 10° for Step 1 as follows.

1. Using keypad (4), input desired deviation limit value (10°). CHANNEL 1 display (13) will show inputted value.
2. Press ENTER button (6) to record value in program memory and advance program pointer to next parameter.

3.6.4.3. Enter Channel 2 Setpoint.

Channel 2 is not used for this program, so when the Channel 2 SELECT SETPNT pointer lights, press CLEAR (5) and then ENTER (6) buttons to advance pointer to Channel 2 SELECT ALARM LIMITS. This will clear Channel 2 setpoint for all remaining steps.

If Channel 2 *were* used, the procedure would be the same as that for Channel 1 (except that the values might be different.)

3.6.4.4. Enter Channel 2 Alarm Limits.

Channel 2 is not be used for this program, so when the Channel 2 ALARM LIMITS pointer lights, press CLEAR (5) and then ENTER (6) buttons to advance pointer to SELECT TIME button (17). Since the Channel 2 setpoint was already cleared, this will clear Channel 2 and the program pointer will skip Channel 2 for all remaining steps.

If Channel 2 *were* used, the procedure would be the same as that for Channel 1 (except that the values might be different.)

3.6.4.5. Enter Time (Step Duration).

1. Using keypad (4), input desired value [15 minutes]. (The Model 520 will accept values from 0 minutes thru 99 hours, 59 minutes, or from 0 seconds thru 99 minutes, 59 seconds, depending on the setting of switch Z-33 bit 4 (time base setting.) A colon must be entered to select seconds (or minutes, if the hour/minute mode has been selected). TIME/CYCLES display (19) will show inputted value.
2. Press ENTER button (6) to record value in program memory and advance program pointer to next parameter.

3.6.4.6. Select Events.

There are no events for this step (or for any step of this program; programming of events will be explained later). Press CLEAR (5) and ENTER (2) buttons; STEP display (10) will advance to next step (Step 2) and pointer will advance to channel 1 SELECT SETPNT.

3.6.5. Enter Additional Intermediate Steps.

For each additional intermediate step in the program (up to the final end-of-program step), the procedure is the same as it was for Step 1. Only the parameters change as shown in Figure 3-5 and repeated here for reference.

Step 2. Soak at -50 ±10° for 15 minutes.
Step 3. Ramp to 100 ±10° in 30 minutes.
Step 4. Soak at 100 ±10° for 15 minutes.
Step 5. Ramp to 25 ±10° in 15 minutes.

3.6.6. Enter End-of-Program (EOP) Step.

After all parameters for all steps of the program have been stored in memory, Step 6 will be displayed and the program pointer LED will be on over the Channel 1 SELECT SETPNT button (11). Enter the End of Program (EOP) step as specified below.

3.6.6.1. Program Cycles.

The CYCLES selection contained in the EOP step makes it possible to repeat the entire program as many times as desired. (One cycle equals one complete program execution.) Our sample program executes the complete program's heat/cool cycle five times. You can program as many as 9999 cycles with the EOP step. The cycle will execute the entire program as many times as necessary without using up valuable program memory.

1. To enter an EOP step with multiple executions (cycles), press END PRGM/CYCLES button (18). Program pointer LED over button will light and display will show current setting.
2. Using keypad (4), input desired number of program executions [5 for our sample.] TIME/CYCLES display (19) will show inputted value.
3. Press ENTER button (6) to record value in program memory. Program pointer automatically moves to first step of program just entered (Step 1), ready to begin operation.

3.6.6.2. End Program After One Execution.

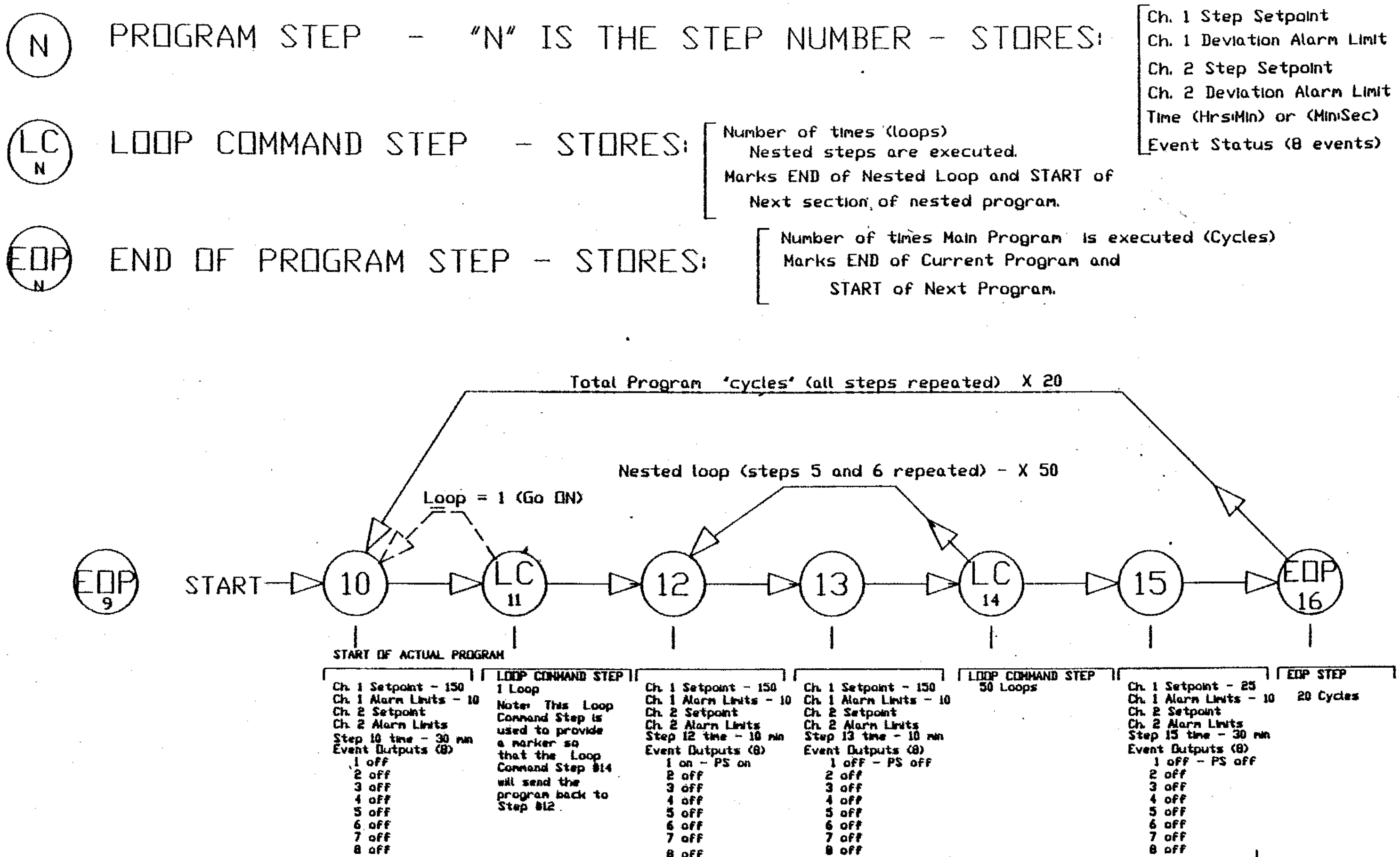
1. To enter an EOP step for a program you only want to execute once, press END PRGM/CYCLES button (18). Program pointer LED over button will light and display will show current setting.
2. Using keypad (4), input desired number of program executions [1 if only one cycle is desired].
3. Press ENTER (6) button to record value in program memory. Program pointer automatically moves to first step of program just entered, ready to begin operation.

3.7. ENTER A PROGRAM WITH NESTED LOOPS.

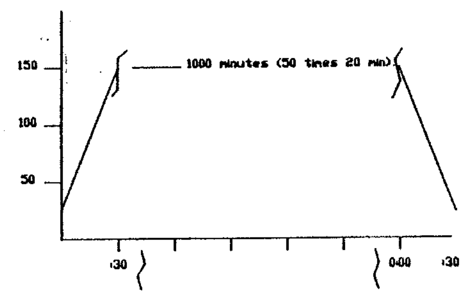
3.7.1. Using the Nested Loop Capability.

With the first sample program above, you saw how you could use the EOP step to cycle the entire program several times. The nested loop capability enables you to do the same thing with selected portions of the program.

In our second sample program, starting at Step 10, we've added such a loop. Now we're going to turn the power supply on and off 50 times within a program using a nested loop, *and* we're going to repeat the entire program 20 times. That means we're actually going to repeat Steps 12 and 13 a total of 1,000 times. Figure 3-7 graphically presents the program and its profile; Figure 3-8 is the worksheet for the program shown in 3-7.



Note: This example is to demonstrate the power of the nested loop. The power supplies have to be turned on for 10 min. and off for 10 min. 50 times.



Channel 2 is ignored in this example

LOOPS_1

Figure 3-7: Nested Loop Flow Chart and Profile.

PROGRAM WORKSHEET

JC SYSTEMS INC. PROGRAM NO. Sample #2 (for Fig. 3-7) DATE: ____________

STEP	CHANNEL 1		CHANNEL 2		TIME/	EVENTS							
NO.	SETPNT	ALM LMT	SETPNT	ALM LMT	CYCLES	1	2	3	4	5	6	7	8
1													
2													
3													
4													
5													
6													
7													
8													
9													
1Ø	15Ø	1Ø	--	--	3Ø								
11	LOOP				1								
12	15Ø	1Ø	--	--	1Ø	ON							
13	15Ø	1Ø	--	--	1Ø								
14	LOOP				5Ø								
15	25	1Ø	--	--	3Ø								
16	EOP				2Ø								
17													
18													
19													
2Ø													
21													
22													
23													
24													
25													
26													
27													
28													
29													
3Ø													

NOTES:
1. Each separate program must be terminated with an END OF PROGRAM (EOP) step to separate it from the ones before and after.
2. Multiple programs can be stored and individually executed -- select first step of desired program

Figure 3-8: Worksheet for Program Sample with Nested Loop.

3.7.2. Programming a Nested Loop.

The sample program shown in Figures 3-7 and 3-8 incorporates two more Model 520 features: the nested loop and events programming. The following paragraphs explain these procedures.

3.7.2.1. Loop Location.

The programmer will not start on any loop command step. If the RUN button (3a) is pressed while in such a step, the RUN LED will flash and the Model 520 will return to the STOP mode.

3.7.2.2. Loop Execution.

A nested loop must contain its program steps in sequence. The beginning of the nested loop is marked either by an EOP step or by a loop command step. The loop will return to first step after that beginning marker and execute the program steps within the nested loop until it executes the number of loops specified in the end loop command step. Then the program exits the loop and proceeds to the step immediately following the end loop command. At no time can the program exit the nested loop and jump to other parts of the program.

3.7.2.3. Loop Storage.

Each loop command uses one program step, just like the EOP command. Up to the 91-step capacity of the program, a 520 program can contain as many *sequential* nested loops as required. (Nested loops may not be nested *within* nested loops.)

3.7.2.4. Loop Format.

The nested loop consists of:

1. A marker at the beginning of the loop. This can be either a loop command with a cycle number of 1, or the first step after an EOP. No marker is required for Step 1.
2. The program steps to be performed during the nested loop.
3. A LOOP command step to mark the end of the loop and specify the number of times it will be executed.

When the Model 520 encounters a loop command step, it decrements the loop counter (number of cycles selected for the loop) by 1 and checks the count. If the count is not 0, the Model 520 moves backward linearly through the steps until it encounters either a previous loop command or an EOP command, then resumes program execution. If the count is 0, the Model 520 advances to the next programmed step.

Para. 3.7.2.4 (Cont.)

To enter a nested loop that begins with the Step 1 of the program, you do not need a loop command step as a beginning marker. The beginning marker is needed only when the nested loop does not include the first step of the program, as is the case for our second sample.

3.7.2.5. Programming Procedure for a Nested Loop.

For the example, we are entering the nested loop shown in Figures 3-7 and 3-8. The steps of this program are numbered 10 thru 16 to distinguish them from the first sample program.

1. Make sure there's an EOP step immediately before the first step of your program. The easiest way to do this is to enter an EOP step.
2. Start the program in the usual way, by entering desired program parameters for Step 10, the first step [Channel 1 setpoint 150°, alarm limits ±10, time 30 minutes, no events]. Advance to the next step.
3. For Step 11, mark the beginning of the nested loop by pressing the END PRGM/CYCLES button (18). A number between 0 and 9999 will appear in the TIME/CYCLES display (19). This is the value (if any) previously entered for that step.
4. Use the keypad (4) to input 1 (the beginning loop step is only executed once). Then press the END PRGM/CYCLES button to mark the beginning of the loop. **DO NOT PRESS THE ENTER KEY**, since the Model 520 would then interpret the entry as an EOP command instead of a loop marker.
5. Enter the steps you want executed in the nested loop (No. 12 and 13 of our sample program). The setpoint and alarm limits for both are the same as program Step 10, but the time changes to 10 minutes. We also want to turn on an event [#1, which energizes the power supply of the device under test] during Step 12, then turn it off during Step 13. To program these steps, proceed as follows.
   a. Enter the setpoint, alarm limit, and time for Step 12 using the same procedures previously described. The program pointer advances to SELECT EVENTS.
   b. Enable Event #1 for Step 12 using the procedure described in Para. 3.7.2.6 below.
   c. Repeat procedural Step 3.a above for program Step 13, then disable Event #1 using the procedure described in Para. 3.7.2.6.
6. At Step 14 of the sample program, press the END PRGM/CYCLES button (18). A number between 0 and 9999 will appear in the TIME/CYCLES display (19). This is the value (if any) previously entered for that step.
7. Use the keypad (4) to input the number of times you want the loop to execute [50 for our sample]. Then press the END PRGM/CYCLES button to record the loop command. **DO NOT PRESS THE ENTER KEY**, since the Model 520 would then interpret the entry as an EOP command instead of a LOOP command.

8. Enter any additional operational steps (Step 15 in our sample).
9. Enter the EOP step. The nested loop program has an EOP step with 20 repeat cycles instead of the first sample program's 5 cycles, but the procedure for step entry is the same.

3.7.2.6. Select EVENTS Status.

The buttons used to clear or select events are as follows.

1. The first time after events are selected for a step, pressing the keypad (4) button corresponding to the event number toggles the selected event on and toggles off any previously selected events. (The corresponding event status LED (22) will toggle on and off as applicable.)
2. At any other time, pressing the keypad (4) button corresponding to the event number toggles the selected event on and off as indicated by the corresponding event status LED (22).
3. Pressing the CLEAR button (5) turns off all events.
4. Pressing the ENTER button (6) enters the current events status in program memory.
5. Once events status has been selected and the ENTER button pressed, STEP display (10) will advance to next step and program pointer will light over Channel 1 SELECT SETPNT button (11).

3.8. STORE THE PROGRAM.

No special procedure is required to store the program in the Model 520's internal memory. The program will remain in the Model 520's memory until you either revise it or write over it. (The battery backup's minimum five-year life will protect the program almost indefinitely, even with repeated shutdowns or power outages.)

You can also save the program to a remote storage device and retrieve it later. See Chapter 4 for instructions on using the JC Systems PromSave™ accessory, or Chapter 5 for saving programs to a remote computer.

3.9. REVISE THE PROGRAM.

You can revise any step of a program without having to redo the entire program. You also can change one or more values within the step without affecting values you don't want to change. However, if you add steps to a program, you must re-enter any subsequent steps. The procedures for accessing and revising the step are given below. Numbers in parentheses refer to Figure 3-1.

3.9.1. Access a Step in Program Mode.

You can access the step(s) you want to revise by either random access or sequential selection.

3.9.1.1. Random Access.

This feature enables you to select and revise any step of a program with the following simple procedure.

1. If program is running (RUN LED on), press STOP button (3B).
2. Press SELECT STEP button (8). Pointer LED will light.
3. Input desired step number on keypad (4). The selected step number will appear in the STEP display (10).
4. Press desired parameter SELECT button.

3.9.1.2. Sequential Access.

In sequential access, you simply use the STEP REV (7) or STEP FWD (9) button to move the program pointer to the step you want to change. Pressing the button momentarily moves the pointer one parameter; holding the button down causes the pointer to slew rapidly thru parameters and steps.

3.9.2. Access a Step During Manual Controller Operation.

A step can be accessed for review or programming even when the Model 520's manual controller operation mode is selected. To do so, simply reset the controller to program mode by pressing the controller MAN/PROG button (25 or 31) while program execution is stopped. The controller will continue to regulate process temperature at the previously entered manual setpoint while the corresponding programmer display will show the program parameter being entered or reviewed. To restore the manual setpoint display, press the MAN/PROG button again.

3.9.3. Make the Change.

1. Turn the MODE SELECT keyswitch (1) to PROGRAM position (1B).
2. Use STEP REV (7) or STEP FWD (9) button to select the parameter you want to change.
3. The present value will appear on the display for the selected parameter. Input the desired change on the keypad (4), then press ENTER button (6). The change is now recorded.
4. Repeat Steps 2 and 3 as required for each change you wish to make.

3.10. RUN THE PROGRAM

This section describes operations where all commands originate from a program in the Model 520's memory evoked from the front panel by the operator. No computer or external control signals are used, and the MODE SELECT keyswitch (1) is in the OPERATE position (1A).

3.10.1. Access a Step in Operate Mode.

You can access step(s) from the operate mode by either random access or sequential selection. If the Model 520 is in OPERATE-RUN mode, press STOP button (3B) to freeze operation before accessing the new step. The RUN LED will go off.

3.10.1.1. Random Access.

This feature enables you to select and start at any step of a program with the following simple procedure.

1. Press SELECT STEP button (8). Pointer will light.
2. Input desired step number on keypad (4). The selected step number will appear in the STEP display (10).
3. Push the RUN button (3A) to start operation.

IMPORTANT

> Reviewing a running program using random access will reset the time/cycles clock. Returning to any step and restarting the program will invoke the entire time programmed for that step (program will not resume at the point where it was stopped).

3.10.1.2. Sequential Access.

With the programmer in STOP mode, sequential access allows you to use the STEP REV (7) or STEP FWD (9) button to move the program pointer to the step you want to review. Pressing these buttons momentarily will cause the pointer to advance one parameter; holding them down will cause the pointer to move rapidly through the parameters and steps.

IMPORTANT

> When using sequential access, pressing the RUN button will return the program to the step where it was stopped, and the program will resume with the time remaining for that step. DO NOT use the SELECT STEP switch if you're only reviewing parameters; if you do, you can't return to the original step.

3.10.2. Start Operation.

To start programmed controller operation, proceed as follows.

1. Set MODE SELECT keyswitch (1) to OPERATE position.
2. Select starting step using either of the methods explained in Para. 3.10.1.
3. Press RUN button. Colon (:) in TIME/CYCLES display (19) will start flashing. The Model 520 will execute programmed controller operations without any further operator intervention. If sequential access was used in 3.10.1, execution will resume from the point where the program was stopped. If random access was used, execution will begin at the currently displayed step.
4. If an alarm sounds, respond as specified in Para. 3.10.4 or 3.10.5.

3.10.3. Monitor Displays.

3.10.3.1. Active Displays.

With the keyswitch in OPERATE position and the RUN button pressed (RUN LED is on), the Model 520 displays current STEP number, realtime current set-points, actual time remaining, EVENTS status (programmed events have a lighted LED), and the current process temperature (or value) for each operating controller channel. The INCREASE and DECREASE LED for each controller channel will also light whenever heating or cooling (respectively) is in process.

3.10.3.2. Reviewing Programmed Values for Current Step.

Setpoint -- To view programmed setpoints in the corresponding CHANNEL display (13 or 16), press and hold down the corresponding SELECT SETPNT button (11 or 14).

Alarm Limits -- To view programmed alarm limits in the corresponding CHANNEL display (13 or 16), press and hold down the corresponding SELECT ALARM LIMITS button (12 or 15).

Duration -- To view programmed step duration (total time) on the TIME/ CYCLES display (19), press and hold down the SELECT TIME button (17).

Cycles or Loops -- To view cycles remaining on the TIME/CYCLES display (19), press and hold down the END PRGM/CYCLES button (18) during any step that is not in a loop. To view the number of loops remaining, press and hold down the END PRGM/CYCLES button during any step that is in a loop. If you hold down the button while the programmer is in RUN, the display will show the number of cycles (or loops) left until completion. If you hold down the button while the programmer is in STOP, the display will show the number of cycles (or loops) originally programmed. In either case, if the number of *cycles* is displayed, the CYCLES LED will light; if the number of *loops* is displayed, the LED will not light.

3.10.4. Respond to Deviation Alarm.

When the process variable is outside the range allowed by the selected alarm limits, the following actions occur.

1. The SELECT ALARM LIMITS LED flashes.
2. The applicable channel's alarm output to TB3-10 or -11 goes low.
3. If the program was running and the CONTINUE TO RUN DURING DEV switch is off, the colon (:) in the TIME/CYCLES display stops flashing to indicate that the program has stopped.

3.10.4.3. Run During Deviation.

If the CONTINUE TO RUN DURING DEVIATION/STOP switch (Z33-1) is set to ON, the Model 520 will continue running even though alarm limits have been exceeded. The alarm outputs will either latch on (continue) or automatically reset (turn off), depending on ALARM AUTO RESET switch position (next paragraph).

3.10.4.4. Reset.

If the DEVIATION ALARM AUTO RESET switch (Z33-2) is set ON to enable automatic reset, the Model 520 will automatically resume operation and the alarm outputs will be automatically reset as soon as the out-of-limits condition has ended. If the switch is set OFF to disable the automatic reset, alarm actions continue until parameters return within limits and the RUN button is actuated (either manually or by remote computer).

3.10.5. Respond to Probe Open Indication.

If a probe is defective, disconnected, or has an open junction, the following actions occur.

1. The CODE "P. OP." appears in the controller's PROCESS display (22 or 28) and the SELECT SETPNT LED flashes.
2. Heat and Cool outputs automatically turn off.
3. The alarm output is activated.
4. Program execution stops.

Press the STOP button, correct the error condition, and press RUN to resume program operation.

3.10.6. Respond to Invalid Setpoint Indication.

If the realtime setpoint goes outside the operating range for the Model 520's controllers, the following actions occur.

1. The SELECT SETPNT LED flashes.
2. A series of dashes (---.-) appears in the controller's PROCESS display (22 or 28).
3. The Heat and Cool outputs are disabled.
4. The alarm output is activated.
5. Program execution stops.

NOTE

Diagnostics can be used to determine the Model 520's operating range -- refer to Chapter 6.

Stop the program and revise the setpoint to one within Model 520 limits, then restart.

3.11. STOP THE PROGRAM FOR REVIEW.

In programmed operation, the program will stop automatically when completed. To stop the program during operation for review, simply press the STOP button (3B). RUN button LED will go out and the colon on the TIME/CYCLES display (19) will stop flashing to show that program was interrupted. The clock stops; the program freezes at present conditions and holds there until the RUN button (3A) is pressed to resume Model 520 operation.

Program parameters can then be reviewed as follows.

1. Use STEP REV or STEP FWD buttons (7 or 9) to move program pointer to desired parameter as indicated by lighted LED above corresponding SELECT button.
2. Value will appear in the display window above the selected parameter: SETPNT, Channel 1 or 2 (11 or 14); ALARM LIMITS, Channel 1 or 2 (12 or 15); and TIME (17). Programmed events are always displayed (their corresponding EVENTS LEDs are on).
3. To review settings at other steps, use random or sequential access (Para. 3.10.1) to select the desired step.

NOTE

Use sequential access if you want to resume the program from the step and time at which it was stopped. Using random access or changing the keyswitch position resets the time/cycles clock.

3.12. RESTART PROGRAM.

3.12.1. Soft Start.

This feature can be used to abort and restart a program without thermal stress to the device under test. For the soft start to work, the step selected for restart must be one with a nonzero time (time other than 0:00). (The soft start feature calculates a ramp from the process temperature to the programmed temperature based on time allotted for a step.)

When the Model 520 is started from any program step with a nonzero time, the soft start is invoked as follows.

1. The Model 520 reads the actual *process* temperature and uses that temperature as the starting setpoint for that step.
2. The Model 520 then takes the process temperature to the programmed value at a linear rate over the time programmed for the ramp.
3. If the program is stopped for any reason, the timer stops and the present process temperature is latched and maintained.

3.12.2. Restarting at Ramp or Soak Step (XX:XX STEP TIME).

The setpoint starts at the actual process value and is linearly incremented or decremented to arrive at the final programmed setpoint value at the end of the programmed time.

3.12.3. Restarting Without Ramp or Soak (00:00 STEP TIME).

The Model 520 will supply the controller(s) with the setpoint stored for the restart step. The system will go to the programmed temperature at the maximum possible rate.

3.12.4. Select Restarting Step.

3.12.4.1. Restart at First Step of Present Program.

To restart at the current program's first step (start the program over), press STOP (3B) to stop program operation, then press RESET PRGM button (2) to reset to step 1 of the current program, and finally press the RUN button (3A) to restart.

3.12.4.2. Restart at Any Other Step.

To restart at any other step of the same program *OR* a different program, use random access to select the starting step as described in Para. 3.10.1.1, then press the RUN button (3A).

Chapter 4. Using the PROMSAVE™ Accessory.

4.1. INFORMATION PROVIDED.

This chapter describes how to connect and use the JC Systems Model 285 PromSave™ (Figure 4-1). This device is an optional accessory that permits fast, easy storage and retrieval of programs developed on the JCS Model 240A, 510 or 520. Such programs can be stored on the PromSave™'s cartridge and retrieved for reuse at any time.

4.2. HOW THE PROMSAVE™ WORKS.

The PromSave™ uses an EEPROM cartridge that stores programs developed for the user's JC Systems programmer applications. Programs in a RS-232C serial-capable JC Systems programmer such as the Model 240A, 510, or 520 can be readily saved to the Model 285's cartridge EEPROM, stored indefinitely, then loaded back into the programmer when next required. The 285 does an auto-compare and verification between the programmer memory and the cartridge with every memory transfer.

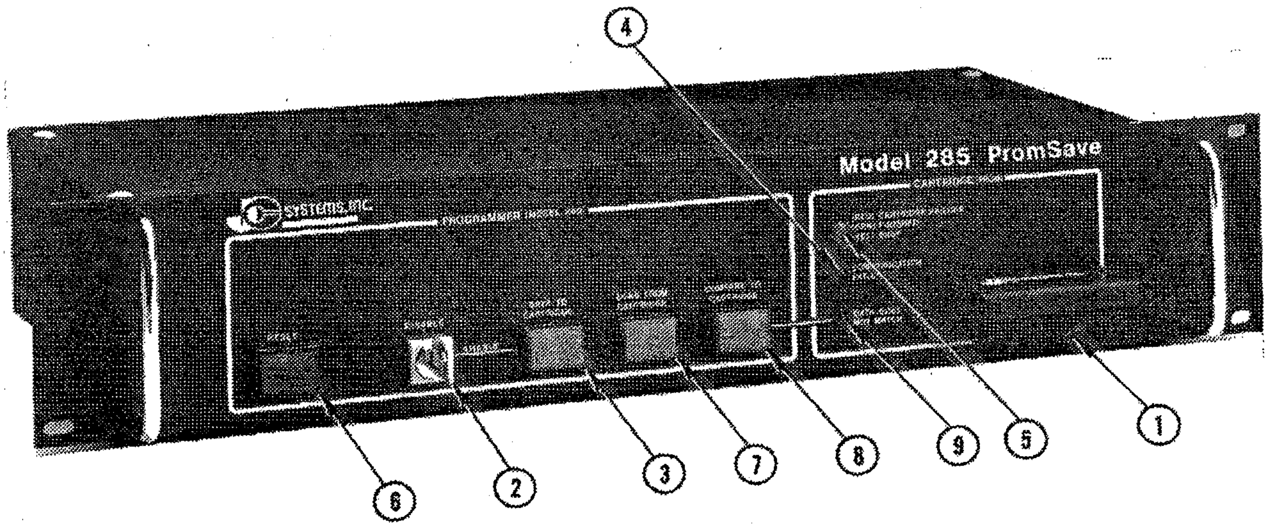


Figure 4-1: Model 285 PromSave™ Controls and Indicators.

4.3. CONNECT PROMSAVE™ POWER.

The Model 285 requires 115 Vac electrical power at 50-60 Hz.

4.4. ESTABLISH COMMUNICATIONS INTERFACE.

4.4.1. Connect PromSave™ to 520.

Disconnect RS-232C interface from the Model 520 to any other system at Model 520 rear panel connector J4. Use the cable supplied with the PromSave™ to connect the Model 520 to the PromSave™ RS-232C interface on the rear panel at J1, a 25-pin Type D subminiature connector.

4.4.2. Configure 520 for Communication.

4.4.2.1. RS232C Configuration.

The 520 standard configuration is RS-232C compatible, so it is ready for use with the PromSave™.

4.4.2.2. RS422A Configuration.

If the optional RS-422A Programmer Interface Board A1566 is installed, set switch S3 on that board to the RS-232C position.

4.4.2.3. IEEE488 Configuration.

If the optional IEEE488 Interface is installed, be sure the Serial Mode Select Jumper is installed on the 2-pin terminal strip on the rear panel.

4.4.3. Set Model 520 to Remote.

Turn MODE SELECT keyswitch on Model 520 front panel to REMOTE COMPUTER ACTIVE position.

4.5. TURN ON PROMSAVE™ POWER.

Press rocker switch on the PromSave™ rear panel to turn on power.

4.6. SAVE MODEL 520 PROGRAM TO CARTRIDGE.

To save a program stored in the Model 520 memory to the PromSave™ EEPROM cartridge, proceed as follows.

1. Insert EEPROM cartridge (Figure 4-1 Item 1) into its receptacle on PromSave™ front panel.
2. Turn PromSave™ keyswitch (2) to ENABLE position.
3. Press SAVE TO CARTRIDGE button (3). Program transfer will begin. During memory transfer, the PromSave™ will automatically perform a comparison and verification between the Model 520 memory and the cartridge. One of the three LEDs on the PromSave™ front panel will light as appropriate to indicate cartridge or transfer status as follows.

   a. Top LED (5) will be:
      Yellow if PromSave™ is BUSY (transfer in progress).
      Red if the cartridge is defective. (Replace cartridge and try again.)
      Green when the transfer is successfully completed.

   b. Center LED (4), which is red, will light if there is a communications failure between the Model 520 and the PromSave™. Check Model 520 front panel keyswitch and control board switch S1 mode selections (see Para. 4.4) and RS-232C interface cable connections.

   c. Bottom LED (9), which is also red, will light if the Model 520 memory and the PromSave™ cartridge memory do not contain the same information.

4. If a red LED lights during transfer, correct the indicated problem and press the RESET button (6) to try again.
5. After transfer has been successfully completed, turn the PromSave™ keyswitch (2) to DISABLE position.

4.7. LOAD PROGRAM INTO MODEL 520 FROM CARTRIDGE.

To load a program from the PromSave™ EEPROM cartridge to the Model 520 memory, proceed as follows.

1. Insert EEPROM cartridge and turn PromSave™ keyswitch (2) to DISABLE position.
3. Press LOAD FROM CARTRIDGE button (7). Program transfer will take place in the same manner and with the same indications as described for the SAVE TO CARTRIDGE procedure.

4.8. COMPARE CARTRIDGE AND MODEL 520 MEMORY CONTENTS.

To compare the contents of the two memory storage areas (EEPROM cartridge and Model 520 program memory), set keyswitch to DISABLE and press COMPARE TO CARTRIDGE button (8). If the two are not exactly alike, the DATA DOES NOT MATCH red LED (9) will light.

NOTE

Data comparison occurs automatically when data is transferred from one storage area to another.

4.9. INTERRUPT PROMSAVE™ (RESET).

To abort memory transfer, press the RESET button (6). Transfer will stop and the PromSave™ will be returned to its initial state.

To clear a red LED indication, press the RESET button (6).

Chapter 5. Remote Programming and Operation.

5.1. INFORMATION PROVIDED.

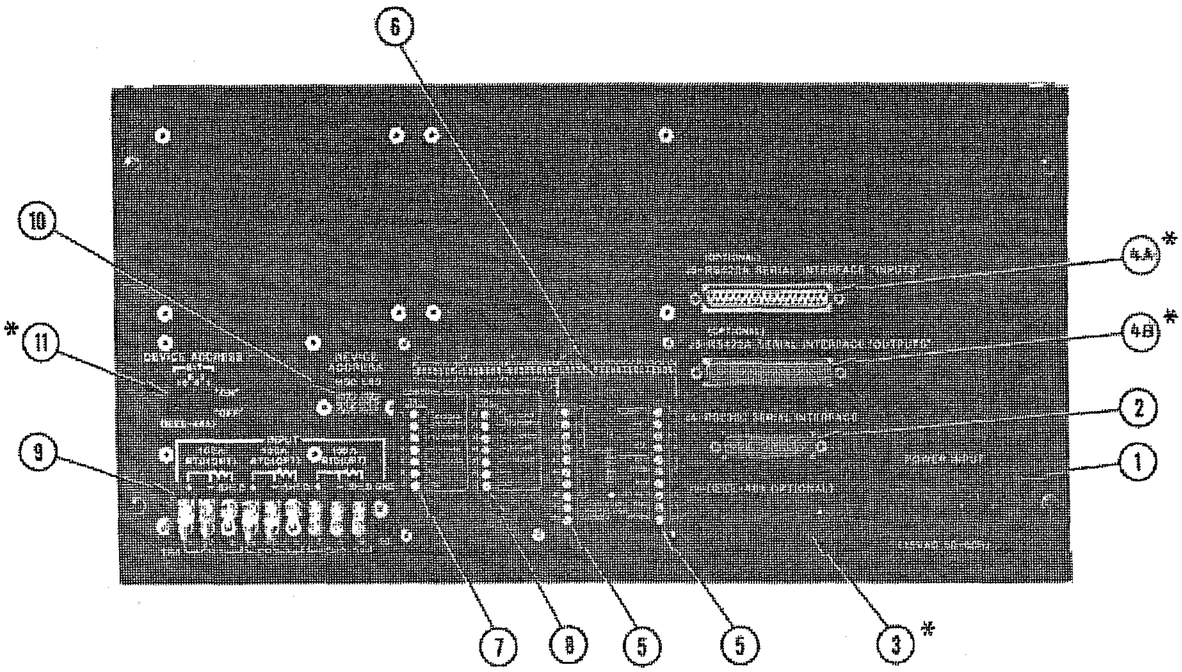
This chapter describes how to interface a remote computer to the Model 520 and then enter, run, and monitor programs. The Model 520 understands and responds to commands from a remote computer in the same manner as though you were entering the command directly into the Model 520 front panel. (You may want to review Chapter 3 before using the information in this chapter for the first time.) You must develop your own software using the command set provided in this chapter to communicate with software resident in the Model 520.

Note that the RS-232C serial interface capability is standard on any Model 510/520, while either the RS-422A interface or the IEEE-488 (GPIB) interface is available as an option. To quickly determine which interface capabilities your unit has, check the connectors installed on the back panel (see Figure 5-1). Active interfaces have a connector mounted in the labeled port. A blank panel means your unit doesn't have that interface capability.

5.2. OPERATING WITH EXTERNAL CONTROL INPUTS.

With the mode keyswitch set to OPERATE position, the Model 520 accepts externally generated inputs for program RUN, STOP, and RESET. Connect control inputs as follows.

Connect external RUN, STOP and RESET control signals at appropriate terminals of TB3 events/alarms interface on the Model 520 rear panel (Figure 5-1). (See Table 5-1 for terminal assignments.) Note that these are photo-coupled input lines, and the source voltage (TB3-18) must be connected to a +5V power supply. You may either use an external power supply to provide 5V to the photo-isolators, or use the Model 520's internal 5V, 50 mA supply (TB3-17).



* OPTIONAL COMPONENTS — BLANK PANEL IF NOT INSTALLED

Figure 5-1: Rear Panel Terminals and Connectors.

Para. 5.2 (Cont.)

If the internal power supply is used, jumper TB3-17 to TB3-18 and connect TB3-14, -15, or -16 to TB3-13 momentarily to actuate the RUN, RESET, or STOP functions, respectively. There is no external isolation in this case.

If an external 5V power supply is used, connect its positive (+) output to TB3-18. The RUN, RESET, or STOP function is actuated by momentarily connecting TB3-14, -15, or -16 to the negative (-) output of the external power supply. No connection should be made to TB3-13 if external isolation is desired.

TABLE 5-1: EXTERNAL CONTROL SIGNAL CONNECTIONS.

NO.	FUNCTION
13	0 V DC (circuit common)
14	RUN
15	RESET to start of program
16	STOP
17	+ 5 V DC regulated internal logic power supply (50 mA max)
18	+ Isolated source voltage input

5.3 REMOTE COMPUTER INTERFACE VIA RS-232C SERIAL CONNECTION.

5.3.1 Configure Model 520 for RS-232C Communication.

1. If the IEEE-488 Interface Board is installed, install the Serial Mode Select Jumper on the 2-pin terminal board on the rear panel.
2. Connect a suitable cable from the remote computer to Model 520 RS-232C port J4, a 25-pin D subminiature connector. The fixed baud rate for this serial interface is 2400. Parity is not required, but odd parity is transmitted. The frame width is 7 bits plus parity plus 1 start bit and 1 stop bit. RS-232C voltage connections from the Model 520 are via J4 as follows:

Transmit - Pin 2	Sends output from the Model 520 to the computer
Receive Data - Pin 3	Receives input from the computer to the Model 520
Common - Pin 7	

NOTE

When using the RS-232 interface directly from a computer, a null modem hookup must be used instead of pin-to-pin connections. (In a null modem cable, pins 2 and 3 are crossed so that the transmit pin at one end connects to the receive pin at the other end.)

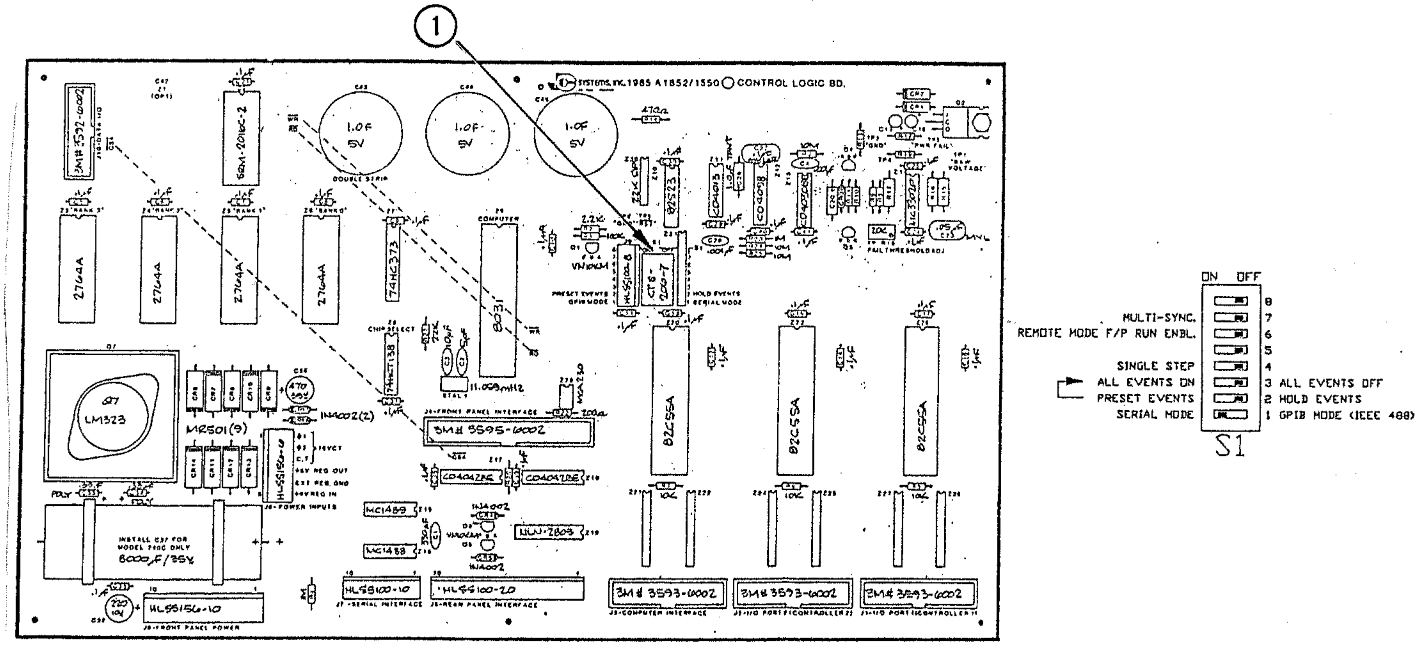


Figure 5-2: Control Logic Board A1852/1550.

5.3.2 Monitoring Model 520 Status via RS-232C Interface.

With the Model 520 MODE SELECT keyswitch in the OPERATE position and either the RUN or STOP mode selected, you can use the remote computer's RS-232C serial interface to monitor the current status of a program. (If you want to take complete control of the Model 520 from the remote computer, refer to Para. 5.3.3.)

Para. 5.3.2 (Cont.)

To monitor current status, send an ASCII string command code selected from those shown in Table 5-2. For example, to read the current setpoint on Channel 1, send the ASCII string SP1. To then read the time remaining in the current step, send the ASCII string TIM. The 520 will transmit the requested data immediately upon receipt of the command code. The computer must read (input) the data into a string variable.

5.3.2.1 Parameter Response.

A parameter response shows the current setting in numeric form; for example, 75.0 for current setpoint. When a parameter has been cleared (for example, a setpoint for Channel 2 when that controller is not in use), the display will read "– – – . –". Parameter responses include the setpoints for Channels 1 and 2, as well as alarm limits.

5.3.2.2 Mode Response.

A mode response shows a 3-letter abbreviation for the mode; for example, RUN for running, STP for stopped, EOP for end of program, or DGN for diagnostics.

5.3.2.3 DIP Switch Position Response.

A DIP switch response shows the settings of switch positions (bits), reading from left to right as 1 through 8. If the bit is not selected, a 0 is shown; if it is selected, the bit position is shown. For example, a response of 02000000 shows that Bit 2 is on and all others are off.

5.3.2.4 Alarm Condition Response.

The alarm condition response is an eight-character ASCII string as listed in Table 5-2.

5.3.3 Full Remote Computer Control via RS-232C Interface.

5.3.3.1 How It Works.

With the Model 520 SELECT MODE keyswitch in the OPERATE position, the remote computer can only monitor the Model 520. With the SELECT MODE keyswitch in the REMOTE COMPUTER ACTIVE position, all Model 520 operations are controlled by commands from the interfaced computer. When the Model 520 is stopped in this mode, its front panel shows all displays and values in the appropriate position.

The front panel RUN switch can be enabled in this mode by setting control logic board switch S1 Bit 6 to ON.

TABLE 5-2: COMMAND SET FOR OPERATE OR REMOTE MODE KEYSWITCH POSITION.

SP1	Read Channel 1 current setpoint value
SP2	Read Channel 2 current setpoint value
PR1	Read current actual Channel 1 process variable (such as temperature)
PR2	Read current actual Channel 2 process variable
TIM	Read time to go in current step
STN	Read current step number
CTG	Read number of cycles to go in current program (including current cycle)
LTG	Read number of loops to go in current nested loop
DIP	Read internal DIP switch 1 setting (Z33 on front panel)
SW1	Read internal DIP switch 1 (Z33)
SW2	Read internal DIP switch 2 (S1 on control logic board)
LCK	Read keyswitch position - returns operate (OPR), program (PRG), or remote (RMT)
ALM	Read alarm status. Response is "S1L1S2L2" if all alarms are active; "--" replaces code for inactive alarms L1 = Channel 1 limit exceeded L2 = Channel 2 limit exceeded S1 = Controller 1 failure S2 = Controller 2 Failure
CTL	Read controller modes as 6-character ASCII string (for Mod. 520). First 3 characters indicate status of Controller #1, second 3 indicate status of Controller #2. For example:

```
MN1PG2
 |  |__ Controller #2 in PROGRAM mode
 |_____ Controller #1 in MANUAL mode
```

SST	Select Step Mode
SCY	Select Cycles/End of Program
SLP	Select Loops
SS1	Select Setpoint #1
SS2	Select Setpoint #2
SL1	Select Limit #1
SL2	Select Limit #2
STM	Select Time
SE1	Select stored events. Use EV1 command (below) to enter or change selected events.
EV1	Initiates events mode so that event outputs can be read or changed. Standard events line format is used.
RQN	Service request enable (IEEE-488 only)
RQD	Service request disable (IEEE-488 only)
MOD	Read Operating mode - returns run (RUN), stop (STP), end of program (EOP) or diagnostics (DGN)
?	Used during programming to read program parameters and advance program pointer. Reading the last step returns EOP. Also used to read event outputs after EV1 command.
!	Enter step number and advance pointer
ULD	Upload command - sends out total program data as stored in 520 programmer memory (2050 characters compressed in binary code) via computer interface with an ASCII Code ":" as the start-of-file character and a "/" as the end-of-file character.

CAUTION

Model 520 must be in STOP mode, and both controllers channels set to PROGRAM (PROGRAM LED on) whenever ULD or DLD commands are used, or data may be lost.

PRR	Reset command - resets current program to first step in program being reviewed

In addition to the mode commands for any switch position listed in Table 5-2, the operational commands listed in Table 5-3 are accepted by the Model 520 only in REMOTE COMPUTER ACTIVE mode. All commands in Table 5-3 except "!" require the keyswitch to be in the REMOTE COMPUTER ACTIVE position. "!" can be used to enter a step number under any circumstances. Other "!" entries require that 520 be stopped and in REMOTE COMPUTER ACTIVE.

TABLE 5-3: COMMAND SET FOR REMOTE COMPUTER ACTIVE KEYSWITCH POSITION.

RUN	Starts operation - same as pressing RUN button
STP	Stops operation - same as pressing STOP button
PRR	Reset to first step in present program - same as pressing RESET PRGM button
!	Enter command - enters data and advances pointer to next parameter -- same as pressing ENTER button
CLR	Clear command - clears data for parameter identified by program pointer -- same as pressing CLEAR button
MN1	Place Controller #1 into MANUAL mode
MN2	Place Controller #2 into MANUAL mode
PG1	Place Controller #1 into PROGRAM mode
PG2	Place Controller #2 into PROGRAM mode
DLD	Download command - accepts data in the same format that was produced as a result of the ULD (upload) command and loads 520 programmer memory with all information previously uploaded to the computer. Accepts 2050 characters; spaces ( ) and carriage returns <↵> are not counted in total.

CAUTION

Model 520 must be in STOP mode, and both controllers channels set to PROGRAM (PROGRAM LED on) whenever ULD or DLD commands are used, or data may be lost.

5.3.3.2. Select/Read Controller Modes.

The commands beginning with MN and PG and followed by the controller number make it possible to place the specified controller in manual or program mode, respectively. The 520 mode keyswitch also must be in the PROGRAM position whenever the unit is to be programmed.

The CTL command reads the controller modes, returning data in ASCII characters that indicates the controller status. These responses also begin with either MN or PG for manual or program mode, followed by the controller number.

For the single-controller Model 510, 3 characters are returned to indicate controller status. For the dual-controller Model 520, 6 characters are returned: the first 3 indicate Controller #1 status; the second 3 indicate Controller #2 status.

5.3.3.3. Select a Step.

There are three ways to access a desired step.

1. If you are currently on any step of a program, you can return to the first step of that program by sending the reset command, PRR.
2. If you know the step number you want, use the random access feature to select that step as follows:
   a. Send the Select Step command SST.
   b. Send the desired step number, followed by an exclamation mark (!). This is the same as pressing the ENTER button in direct manual operation.

5.3.3.4. Select a Parameter.

The command set used with full remote computer control of the Model 520 permits random access to a specific parameter (or the events) within a step. These commands -- SCY, SLP, SS1, SS2, SL1, SL2,STM, and SE1/EV1 -- are listed and defined in Table 5-2. For example, to change the time for a given step, proceed as follows.

1. Place both controllers in program mode (PROGRAM LED on).
2. Access the desired step per 5.3.3.3.
3. Send the Select Time command string STM.
4. Send the new time as explained in 5.3.3.5.

5.3.3.4. Enter a Parameter.

To enter a new or changed parameter from a remote computer, note that you must send the new entry, then press the exclamation mark (!). This transmits the data from the remote computer to the Model 520 programmer. You can send two or more parameters for a step as a single string as follows.

1. Send the first parameter to be programmed or changed followed by the !, which is the remote computer ENTER command.
2. Send the second and subsequent parameters *in the order they appear* (on the front panel display or the program worksheet), separating each by an !.

5.4. REMOTE COMPUTER INTERFACE VIA RS-422A SERIAL NETWORK OPTION.

5.4.1. Configuring Model 520 for RS-422A Communication.

A single master computer can communicate with up to 50 Model 520's that are equipped with the RS-422A option. However, care must be taken to correctly connect the Model 520's and the master computer. Several switch positions also must be selected based on system configuration. These requirements are detailed in the following paragraphs.

5.4.1.1. Voltage Connections.

Unless your computer is equipped with an RS-422A port, you will need to install an RS-232C/RS-422A level shifter (JC Systems Model A1740 or equivalent) between the RS-232C port of the master computer and the first Model 520 in the network.

RS-422A voltage-level connections from the computer to the first Model 520 on the party line are via RS-422A Port J6, a 37-pin "D" type miniature connector, as shown in Figure 5-3. (Pin assignments are given in Table 5-4.) Connector J5 on the first Model 520 then connects to J6 on the second Model 520. Subsequent Model 520's in the network connect in the same manner as the first pair.

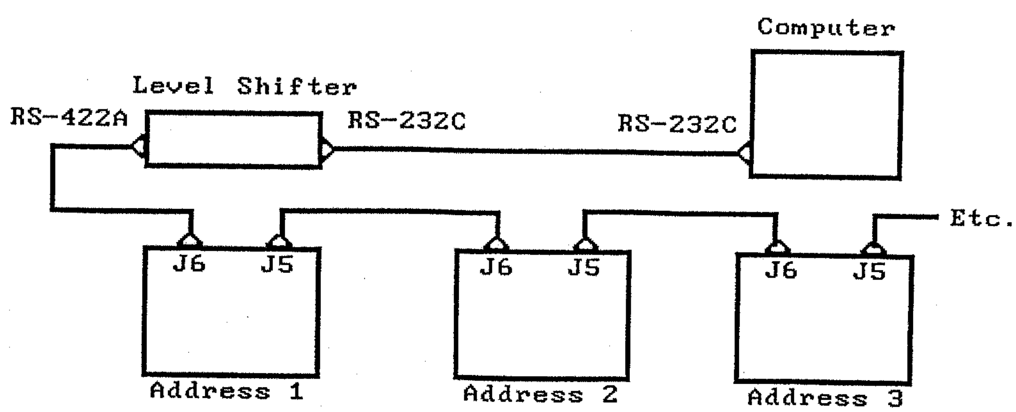


Figure 5-3: RS-422A Serial Communication Connections.

TABLE 5-4: RS-422A PORT PIN ASSIGNMENTS.

FUNCTION	SIGNAL	COMPUTER VIA LVL SHFTR TO UNIT #1 J6 PIN NO.	UNIT #1 TO UNIT #2 J5 PIN NO.	UNIT #2 TO UNIT #3 J6 PIN NO.
Send Data (to Master	SD (A)	4	4	4
Computer)	SD (B)	22	22	22
Receive Data (from	RD (A')	6	6	6
Master Computer)	RD (B')	24	24	24
Signal Ground	SG	19	19	19
Shield 6	Shield	1	NC	1

NOTE

Shielded cable is required for the RS-422 connection. Shield should be grounded at pin 1. Only connect one end of shield to ground.

5.4.1.2 RS-422A Interface Switch Settings.

The following switches must be set as specified to ensure correct party-line serial operation. To gain access to internal switches, loosen camloc fasteners securing the top cover and remove the cover.

1. *Address Switch* on Model 520 rear panel — this direct-reading rotary switch (Figure 5-1, Item 10) must be set to a different number (address) for each Model 520 connected to the system. When two or more Model 520's are used, the usable addresses are 1-99 inclusive.

NOTE

The user will need assigned addresses to communicate command and status information from the master computer to party-line Model 520's. Therefore, a hard-copy address chart posted near the computer showing the address and physical location of each Model 520 on the network might prove useful in some applications.

2. *RS-232C/RS-422A Select Switch S3* on photo-isolated A1566 Interface Board (Figure 5-4 Item 1) — set to RS-422A (up) position for serial communications between a single computer and several programmers on a RS-422A network.

NOTE

An RS-232C/RS-422A Level Shifter (JC Systems Model A1740 or equivalent) must be used to convert RS-232C output from the computer for RS-422A network use.

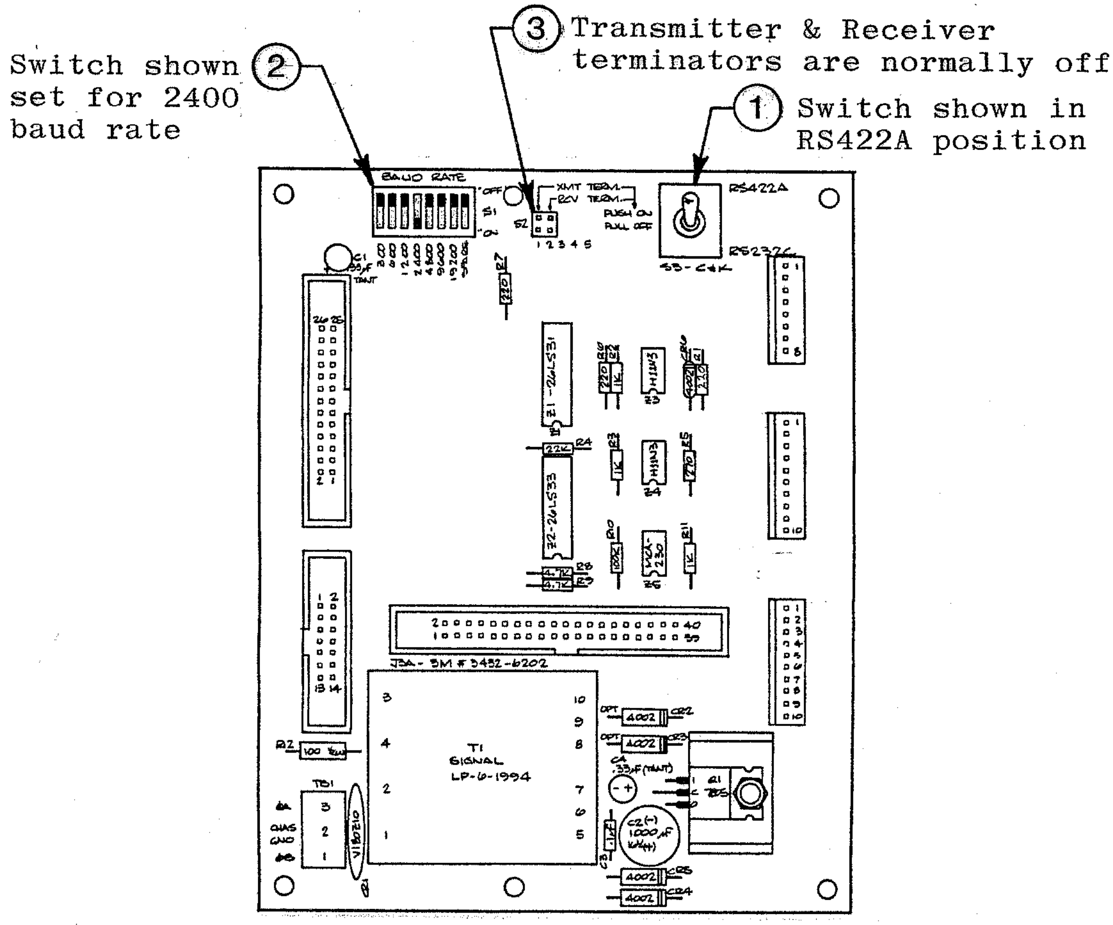


Figure 5-4: RS422A Programmer Interface Board A1566.

Para. 5.4.1.2 (Cont.)

3. *Baud Rate Dip Switch S1* on A1566 (Item 2) -- Select a baud rate of 300, 600, 1200, 2400, 4800, or 9600 by placing that switch in the ON (down) position. (9600 is the maximum baud rate for Model 520 communications.) All other baud switches must be in the OFF (up) position, and all Model 520's sharing party-line serial communications must be set to the same rate.

4. *Terminate Network A1566 Jumper* -- If only one Model 520 is connected to the computer, jumper pins 1 and 2 of the termination header (Figure 5-4, Item 3). If more than one Model 520 is connected, terminate the last unit only; leave the jumper off all other Model 520 termination headers.

5.4.2. Monitoring Model 520 Status via RS-422A Interface.

With the Model 520 MODE SELECT keyswitch in the OPERATE position, you can use a remote computer's serial interface to monitor the current status of a program. To monitor current status, send an ASCII string command code selected from those shown in Table 5-2. For example, to read the current setpoint on Channel 1, send the ASCII string SP1. To then read the time remaining in the current step, send the ASCII string TIM. The 520 will transmit the requested data immediately upon receipt of the command code. The computer must read (input) the data into a string variable.

5.4.3. Full Remote Computer Control via RS-422A Interface.

With Model 520 SELECT MODE keyswitch in the OPERATE position, the remote computer is used to read values already programmed into the Model 520. To transfer full control of the Model 520, set the SELECT MODE keyswitch in the REMOTE COMPUTER ACTIVE position. In this mode, the Model 520 front panel controls are inactive; all Model 520 operations are controlled by commands from the interfaced computer.

5.4.4. Format for Entering RS-422A Computer Commands.

You must send the address of the specific Model 520 you want to query before you send the command code string. To enter the address, send the disconnect command, a number symbol (#), followed by the address number assigned to the Model 520 (1-99). There must be a blank space between the address number and the command (see Figure 5-5).

The disconnect command (#) disconnects all addresses, clearing the network. The Model 520 address number connects the computer to the selected address *only*, and the computer remains connected to that address until another disconnect command is received. Therefore, you only need to transmit the address once, immediately after the disconnect command. The computer will continue to address the same Model 520 from that time until the next disconnect command is sent.

```
EXAMPLE:  #3 SP1
          ||| |
          ||| |__ Command (from Table 5-2 or 5-3)
          |||____ Blank space
          ||_____ Model 520 address number
          |______ Number symbol (disconnect command)
```

Figure 5-5: Format for Remote Computer Commands (more than one Model 520 on line).

5.5. REMOTE COMPUTER INTERFACE VIA IEEE-488 (GPIB) OPTION.

This optional interface provides a remote IEEE-488 controller or computer with the same command and communications capabilities as the RS-232C interface described in Para. 5.3. In addition, the IEEE-488 option includes the capability to generate service requests upon user-selected events.

5.5.1. Configure Model 520 for IEEE-488 Interface.

If the IEEE-488 computer interface option is installed, connect IEEE-488 system at Connector J3 on the rear panel (Figure 5-1 Item 3), make sure the Serial Mode Select Jumper is not installed on the two-pin terminal board on the rear panel, and set service request function and address switches as specified below.

5.5.1.1. Set Service Request DIP Switch.

The IEEE-488 option includes a service request feature which, when enabled, causes the Model 520 to generate a service request when a deviation alarm condition begins and/or ends. The user can also set switches on the SRQ board, which is mounted on the inside of the 520 rear panel, to generate a service request at selected events.

Service request DIP switch S1 positions on the SRQ and device address interface board A1848 (Figure 5-6) are marked YES/NO. You can select what conditions will (or will not) cause a service request by the switch positions. Selecting the YES position causes a service request to be generated when the specified condition exists; the NO position prevents the service request. Selecting the YES position for both the Event ON and Event OFF will generate a service request both when the event turns ON and when it turns OFF.

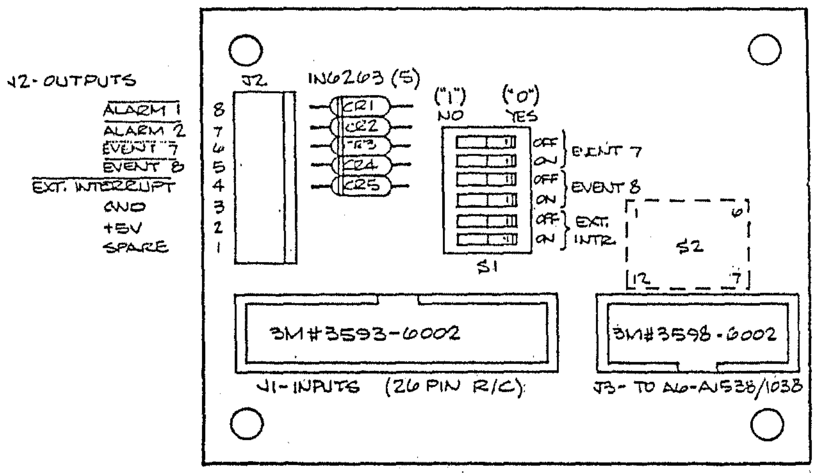


Figure 5-6: IEEE-488 SRQ and Device Address Board A1848.

Para. 5.5.1.1 (Cont.)

Service request DIP switch positions and corresponding events are identified below.

1. Positions 1 and 2 control service requests when Event 7 turns OFF and ON, respectively.
2. Positions 3 and 4 control service requests when Event 8 turns OFF and ON, respectively.

NOTE

> Event 8 and the External Interrupt (bit positions 5 and 6 on the DIP switch) share common access to the IEEE-488 interface, so do not select both at the same time.

3. Positions 5 and 6 allow the External Interrupt Input access to the IEEE-488 interface. Connecting TB3 Pin 19 (remote interrupt) to Pin 13 (ground) with an isolated set of contacts generates a service request if SRQ board switch S1 positions 5 and 6 are both set to YES.

5.5.1.2. Read Service Request (Serial Poll) Data.

All 520's on the buss are polled by the computer to identify the one that generated the service request and to determine what condition(s) caused the service request to be generated.

The serial poll response from the Model 520's is an 8-bit word in ASCII characters that gives the computer this information. The list below explains the significance of each bit setting. Note that Bits 0 and 1, for example, work together to show not only if a Channel 1 alarm is on or off (bit 0), but also if the alarm status has changed (bit 1) since the last service request. The other bits provide similar information. After a serial poll, all bits are automatically reset.

```
Bit 0 set -- Channel 1 Alarm is ON
Bit 1 set -- Channel 1 Alarm status change
Bit 2 set -- Channel 2 Alarm is ON
Bit 3 set -- Channel 2 Alarm status change
Bit 4 set -- Event 7 ON
Bit 5 set -- Event 8 ON
Bit 6 set -- When any condition causes a Service Request
Bit 7 set -- Programmer failure caused a Service Request
```

5.5.1.3. Set Device Address.

The IEEE-488 device address switch (S2 on the A1848 PCB, which is accessible on the Model 520 rear panel -- see Figure 5-1, Item 11) must be set to a different number (address) for each Model 520 connected to the network. The highest possible address is 31 (all bits set to ON); however, address 31 is normally reserved for UNTALK and UNLISTEN commands.

5.5.2. Remote Computer Operations via the IEEE-488 Interface.

5.5.2.1. Commands and Format.

Commands and command format for the IEEE-488 interface are the same as those previously described for the RS-422A interface (see Para. 5.4), except as follows:

1. The service request functions have been added as described below.
2. "#" (address) is not part of the transmitted command string as it is with the RS-422A.

5.5.2.2. Service Request Enable/Disable.

To enable the service request function, an RQN command must be transmitted by the computer. An RQD command disables the service request.

*RQN	Service Request Enable
*RQD	Service Request Disable

* Active only with IEEE-488 option. When installed as described in Para. 5.5.1, the service request capability can generate an interrupt whenever the alarm status for either channel changes. These commands turn that capability on and off.

NOTE

There is no memory of service request conditions that occur while the service request is disabled. Therefore, when the service request is enabled, a service request will not be generated for a condition that occurred while the service request was disabled.

6. Maintenance and Calibration.

6.1 PREVENTIVE MAINTENANCE.

6.1.1 Cleaning.

Regularly dust outside surfaces and keep the Model 520's interior free of dust and debris, especially pieces of wire that could cause shorts.

6.1.2 Other Preventive Maintenance.

1. Perform the calibration procedures described in this chapter at least once a year.
2. Replace the lithium battery every five years.

6.2 PERFORM CORRECTIVE MAINTENANCE.

The Model 520 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.

6.3 RUN TURBO DIAGNOSTICS.

The Model 520's turbo-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.

6.3.1 Using Diagnostics.

NOTE

Controller switch S5 bit 7 must be in the up position for the diagnostics to work. (This switch is factory sealed in place and should not be changed.)

1. Set keyswitch (Figure 6-1, Item 1) to PROGRAM.
2. Hold down the RESET PRGM button (2) while pressing the STOP button (3B). This automatically places you in turbo diagnostics at test code -591.6, the current HEAT proportional band setting, with the value displayed for each channel. If the diagnostic mode does not come up on test -591.6, the programmer is not equipped with turbo diagnostics. Proceed to Step 6.

NOTE

The display test is bypassed in turbo mode. If you want to conduct this test (code -594.0), select it using the individual entry method (see Step 6 below).

3. To switch from HEAT to COOL parameters, press the SELECT STEP button (8).
4. To select another test, simply press and hold down the applicable step slew button — STEP REV (7) or STEP FWD (9) — until that test number appears in the applicable channel setpoint display. When you release the slew button, the number in the process display (22 or 28) will change to the current HEAT parameter for the selected test.
5. The first value displayed will always be the HEAT parameter for the selected test. To check the COOL parameter, press the SELECT STEP button (8).
6. At any time during diagnostics, you can individually select a specific test as follows:

   Press SELECT SETPNT button (11 or 14) and input the diagnostic test code (-594.0, for example) using the keyboard (4), then press ENTER button (6) to start the selected test.

NOTE

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

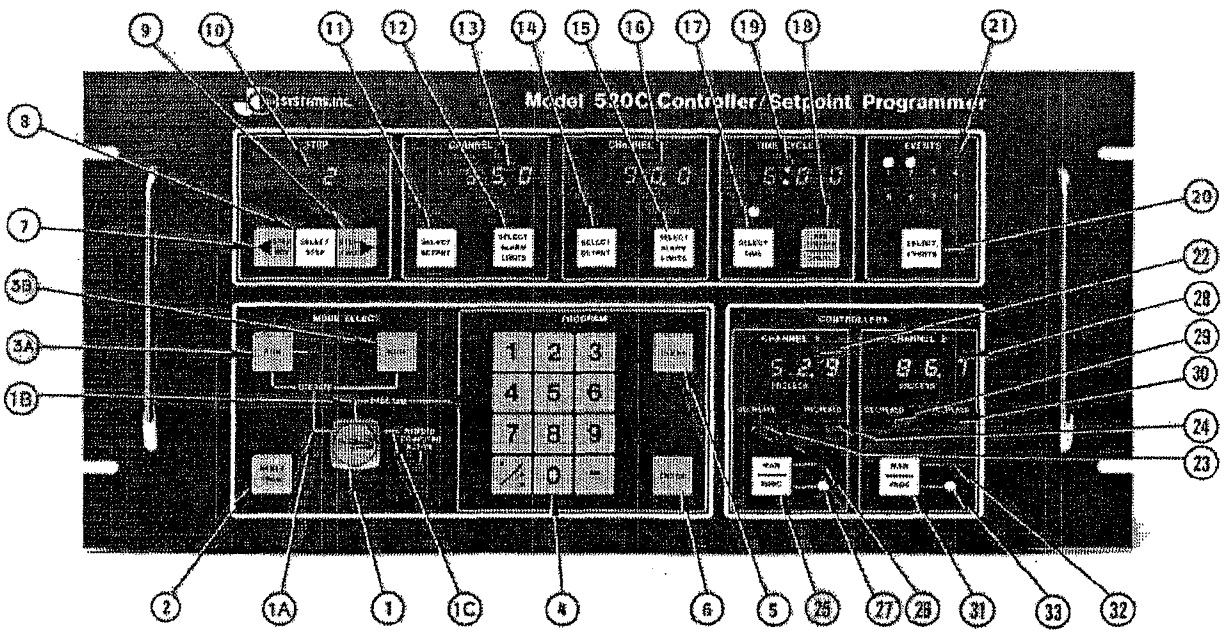


Figure 6-1. Front Panel Displays and Indicators.

7. To exit diagnostics, turn keyswitch (1) to either OPERATE or REMOTE COMPUTER ACTIVE mode. The programmer/controller will exit diagnostics and the controller PROCESS display will show an error message (—-.-). The error message will be replaced when a valid setpoint is sent to the controller. This may be done either from a program (with controller in Program mode), or by front-panel setpoint entry (with controller in Manual mode).

6.3.2 Dual Parameters Display.

The Model 520DP permits display of both heating and cooling parameters during diagnostics. Codes for diagnostic test of cooling parameters are assigned 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).

6.3.3 List of Diagnostic Tests.

Table 6-1 lists the heating parameter diagnostic test codes and their short titles with 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.

NOTES

1. 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.

2. Unless otherwise specified, displays appear on the corresponding process controller display(s).

TABLE 6-1. SUMMARY OF DIAGNOSTIC TESTS.

Test No.	Item Tested	Description	See Para.
		Tests to Read Actual Switch Settings	
—	Address Switch (RS-422A Only)	Model 520 STEP display shows RS-422A party-line address. No STEP display for RS-232C or IEEE-488 mode.	
—	Baud Rate (RS-422A Only)	Pressing SELECT STEP button displays setting of RS-422A interface board baud rate switch in EVENTS display.	
—	Programmer Switch Z33	Pressing SELECT TIME button turns on EVENTS LEDs corresponding to switch positions that are on (up) — i.e., event 1 LED is on if switch Z33 Bit 1 is up	

Test No.	Item Tested	Description	See Para.
—	Control Logic Board Switch S1	Pressing the END PROGRAM/ CYCLES button displays S1 settings in the same manner as described for Z33 — if EVENTS LED 1 is on, switch S1 Bit 1 is on (to the left)	
—	Events	Pressing the SELECT EVENTS button turns on LEDs for event outputs that are currently on. The outputs can be manipulated and latched while in diagnostics by entering the event number(s) on the keypad and pressing the ENTER button; the SELECT EVENTS LED will turn off and event outputs will be latched.	
—	Enter Setpoint	Echoes back a changed setpoint value (or current output when current loop installed).	6.3.5.1
-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.	
-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).	6.3.5.2
-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.	

-Test No.	Item Tested	Description	See Para.
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 4-7 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.)	
-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.	

Test No.	Item Tested	Description	See Para.
-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.	
-592.0	Watchdog Timer Circuit Check	Verifies that the watchdog timer circuit timed out and reset the controller to its start condition.	6.3.6
-594.0	Exercise Display and Outputs	Initiates display test; cycles all characters and indicators.	6.3.4

6.3.4 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 NULL outputs. HEAT and COOL output will be indicated by the corresponding LED momentarily turning on and off; there is no indication for NULL output.

To expedite the display test, press the SELECT SETPNT button (8), then enter .1 in the least significant bit (LSB) position. To exit the test, press the SELECT SETPNT button (8), then enter .9 in the least significant bit (LSB) position.

6.3.5 Tests to Read Actual Switch Settings.

6.3.5.1 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.

6.3.5.2 -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 PROGRAM connector (J5). The display shows the logic level of each as an "H" or "L" as shown in Figure 6-2. 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.

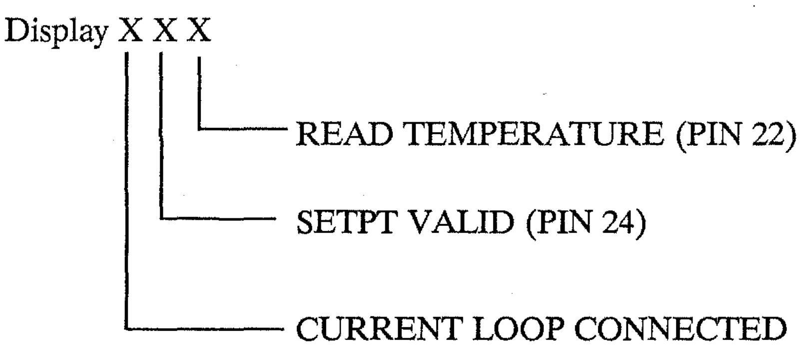


Figure 6-2. Display Positions for -590.2 Test.

6.3.6 -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.

6.4 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 as the first page of this manual. Perform any subsequent calibration as specified below, using the values provided on the Calibration Parameters Sheet.

6.4.1 Calibrate for Thermocouple Input.

6.4.1.1 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.

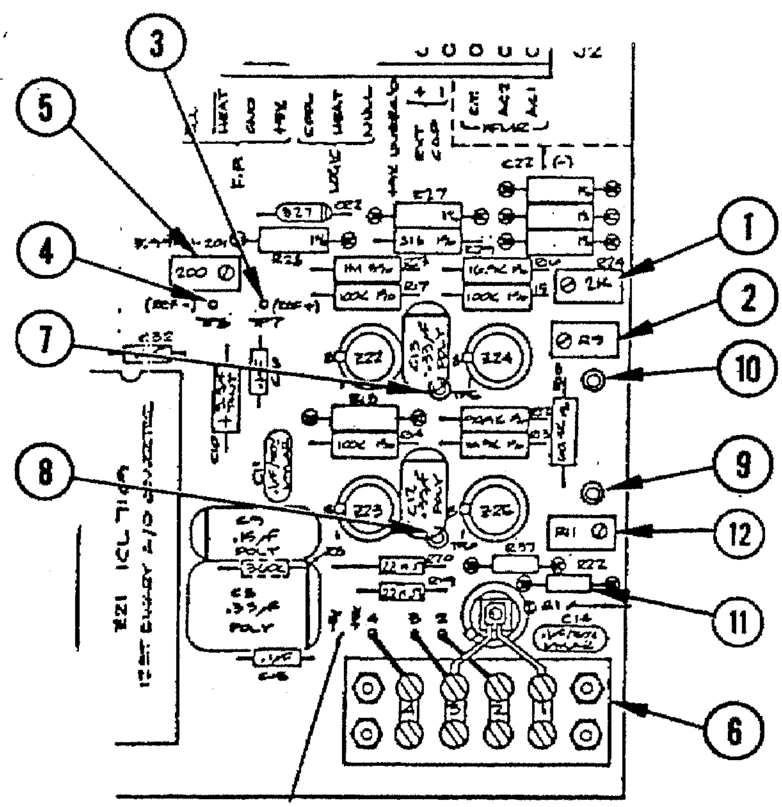


Figure 6-3. Controller Calibration Points.

6.4.1.2 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 Model 520 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 6-3, Item 1) until the PROCESS display reading matches that of the calibrator.

6.4.1.3 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 3) until the PROCESS display reading matches that of the calibrator.

6.4.1.4 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 ±.5°C, which is the accuracy specification for the controller. If accuracy is not within ±.5°C, repeat calibration.

6.4.2 Procedure for Linear Input Controller.

6.4.2.1 Equipment Required.

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

6.4.2.2 Ambient Calibration.

1. Using standard copper wire, connect the current source to the temperature controller input.
2. Turn on Model 520 using rocker switch on rear panel and set current to the value specified on the Calibration Parameters Sheet.
3. Adjust ambient potentiometer R24 (Figure 6-3, Item 1) until the PROCESS display reading matches that of the current source.

6.4.2.3 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.

6.4.2.4 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.

6.5 ADJUST CONTROLLER REFERENCE VOLTAGE AND BALANCE.

The following adjustments are made at the factory and the associated poten tiometers 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.

6.5.1 Equipment Required.

Digital voltmeter capable of reading 0.001 V.

6.5.2 Gain Access to Internal Components.

1. Disconnect the power source to avoid electrical shock.
2. Remove both the bottom and top covers.
3. Note the positions of service loops in the ribbon cables, then remove and retain the bands securing excess cable length.
4. Remove the four screws securing the vertical PCB board bracket and raise the bracket so that its bottom holes align with the top holes in the side plate.
5. Install the four screws removed in Step 4 in the bottom of the vertical bracket to hold controllers in an accessible position.
6. When calibration is complete, reverse these procedures to restore the Model 520 to operational status.

6.5.3 Adjust Reference Voltage.

1. Connect the voltmeter to TP7 (positive) and TP8 (negative) on the controller PCB (Figure 6-3, Items 3 & 4).
2. Turn on Model 520 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 Model 520 power off and remove meter.

6.5.4 Adjust Balance.

1. Short the thermocouple input by placing a jumper across either TB1 (Figure 6-3 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 Model 520 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.

Para. 6.5.4 (Cont.)

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 Model 520 power.

6.6 FRONT PANEL SWITCH AND DISPLAY TESTS.

NOTE

Perform these tests after exiting diagnostic mode.

1. Set keyswitch to program mode and press SELECT STEP button (Figure 6-1, Item 8). SELECT STEP LED should light. If STEP display (10) doesn't show the number 1, press 1 on keypad (4), then ENTER button (6); STEP display should now show 1.
2. Press and hold down STEP FWD button (9). STEP display should slew (move rapidly) from 2 to 91. Verify that all step numbers light with uniform brightness.
3. Press and hold down STEP REV button (7). STEP display should slew from 91 back to 1. Press SELECT STEP button (8), then 1 on keypad (4), and finally ENTER button (6); program pointer LED should light above Channel 1 SELECT SETPNT button (11).
4. Press Channel 1 SELECT SETPNT button, then press numbers on keypad (1,2,3, etc.). Numbers on display should shift left from the decimal point. Press decimal point and numbers again; numbers should shift right from decimal point.
5. Press keypad #1 and hold for 1/2 second; key should not auto-repeat.
6. Repeat Steps 4 and 5 with each parameter button and display.
7. Press MAN/PROG button for controller Channels 1 and 2 several times. LED should indicate corresponding changes in mode.

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 Model 520 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].

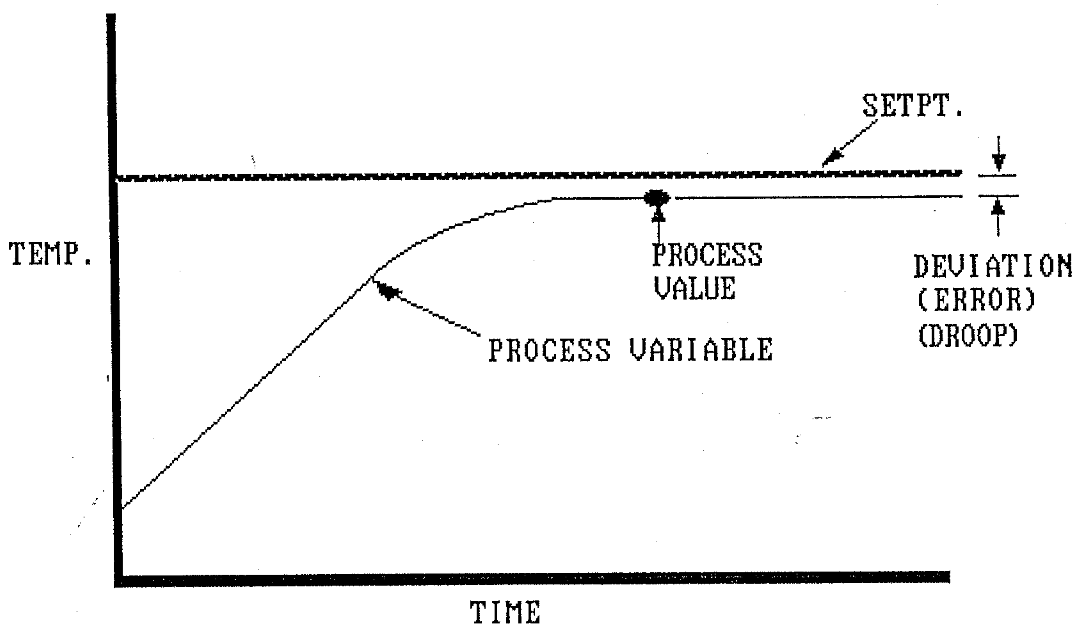


Figure A-1: Terms Used in Profile Charts.

A.3. DESCRIPTION OF CONTROL ELEMENTS.

A.3.1. Proportional Control.

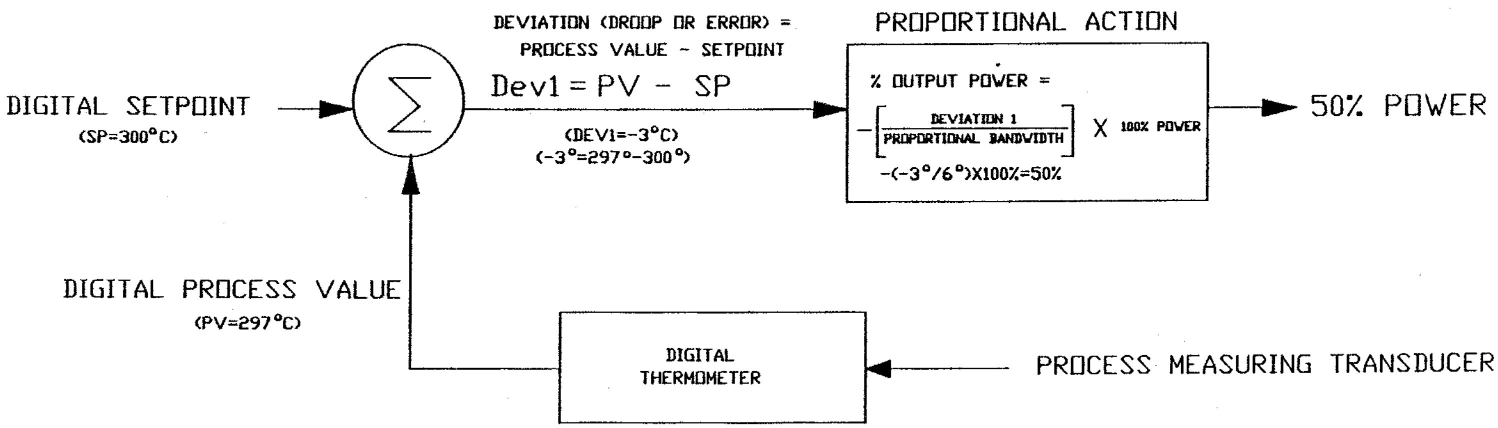
A.3.1.1. Theory of Operation.

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.

PROPORTIONAL ACTIONAL

CONTROLLER BLOCK DIAGRAM



FINISH (IF APPLICABLE)

MATL (IF APPLICABLE)

NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS	ZONE / LTR / DESCRIPTION / DATE / APPD
APPLICATION	DASH / QTY / NEXT ASSY / USED ON
EFFECTIVITY	SERIAL NO. / DATE EFF / DWG REV
MATERIAL	
FINISH	
ENGINEERING ACTIVITY	DESIGN / DRAFTED / CHECKED
JC SYSTEMS, INC.	TITLE: TEMP CONTROLLER BLOCK DIAGRAM "P" ONLY

Figure A-2: Proportional Control Action Diagram.

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.

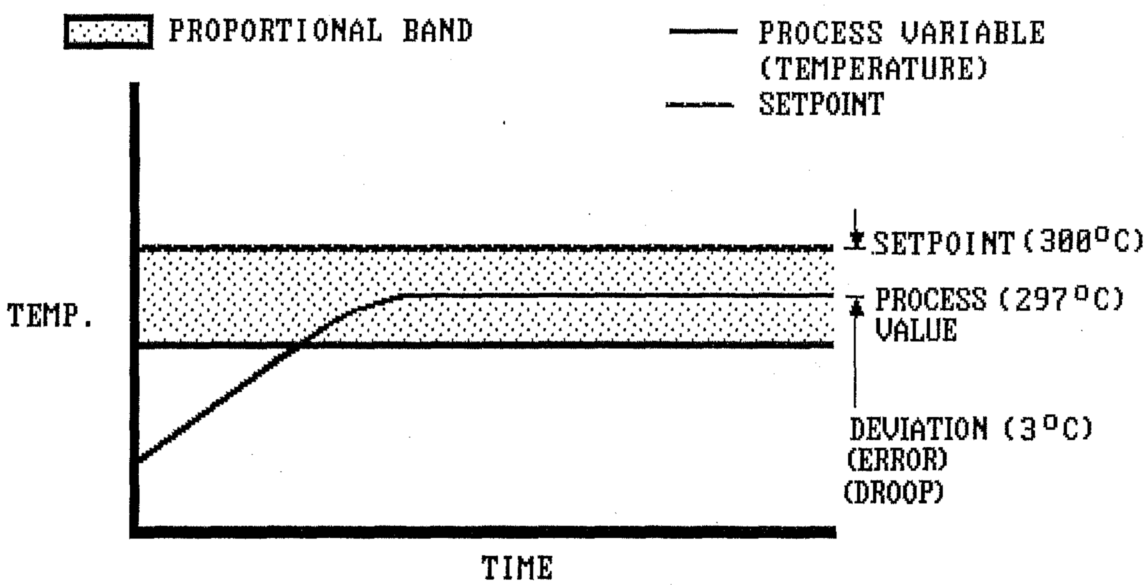


Figure A-3: Proportional Control Profile Chart.

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.

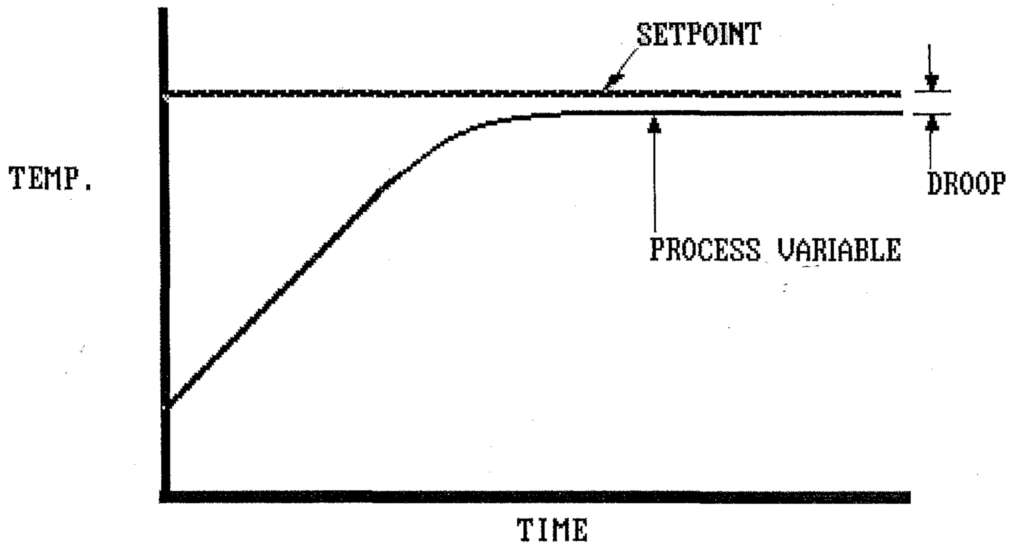


Figure A-4: Droop.

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.

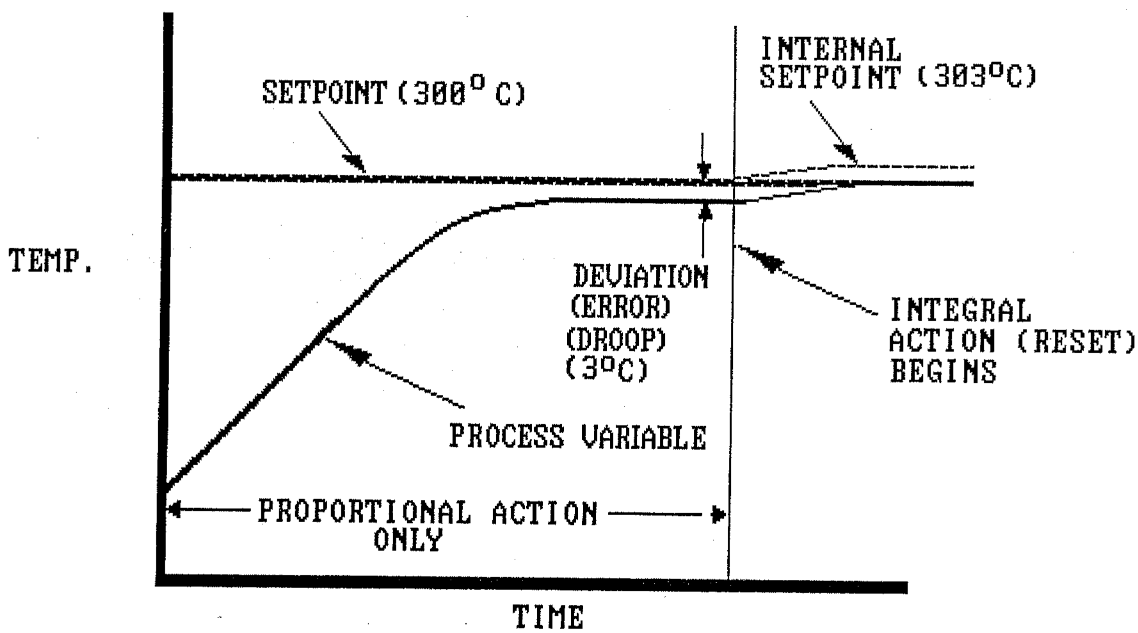


Figure A-5: Reset Used to Correct Droop.

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%).

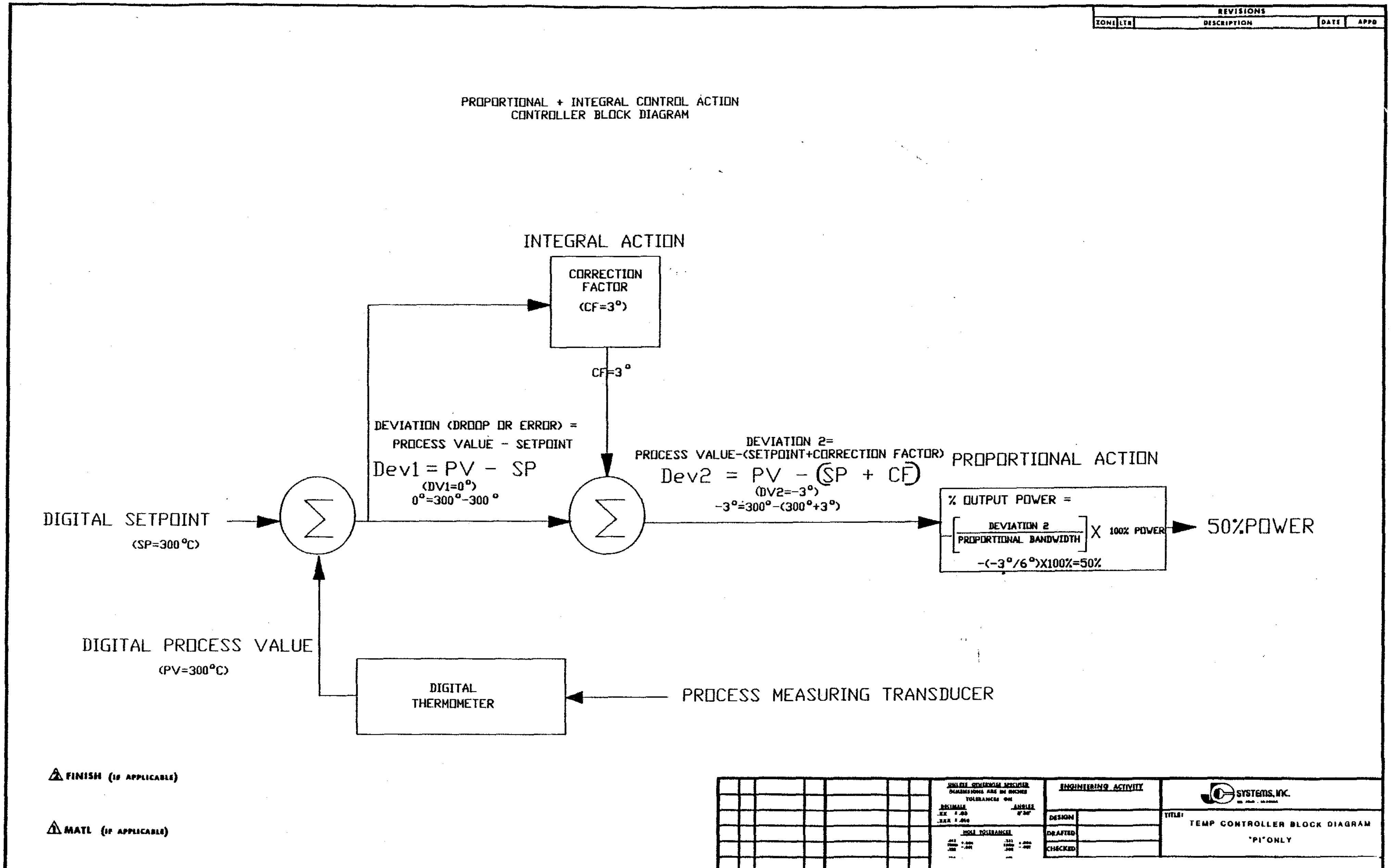
Automatic reset action repeats the correction factor X times per minute, causing a recalculation of the internal setpoint for each repeat. The value of X depends on the setting of DIP switch S2 (as described later). The switch allows you to select how fast the controller corrects for the deviation in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



NOTES: UNLESS OTHERWISE SPECIFIED

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

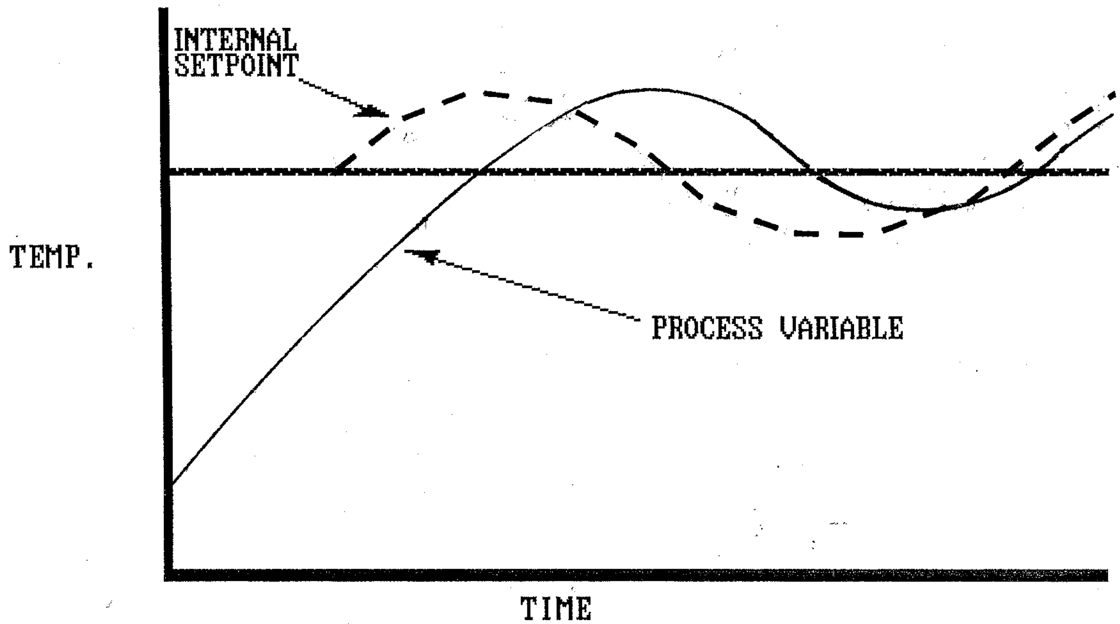


Figure A-7: Oscillations Due to Reset Windup.

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.

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.

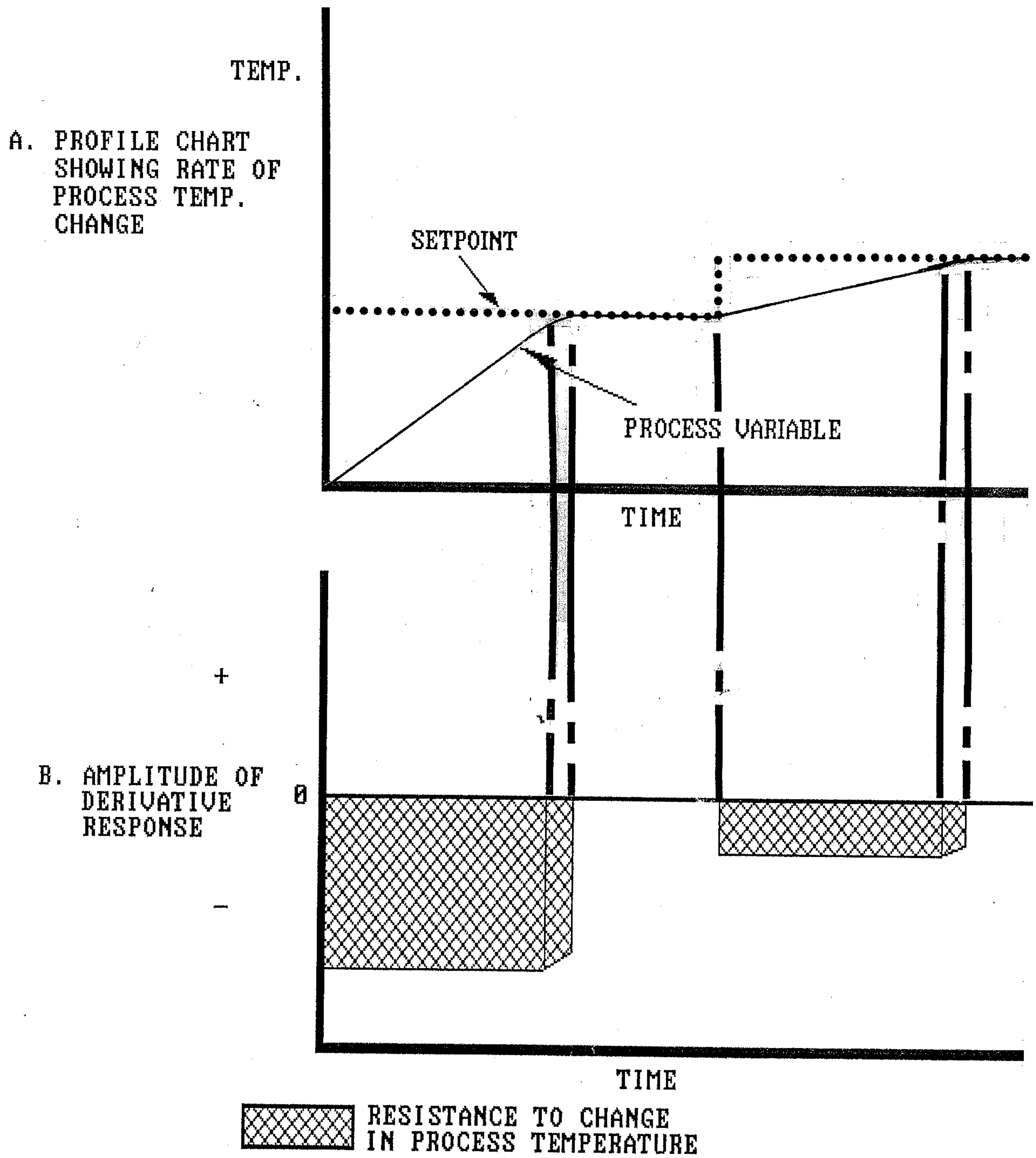


Figure A-8: Relation of Differential Action to Process Value Change.

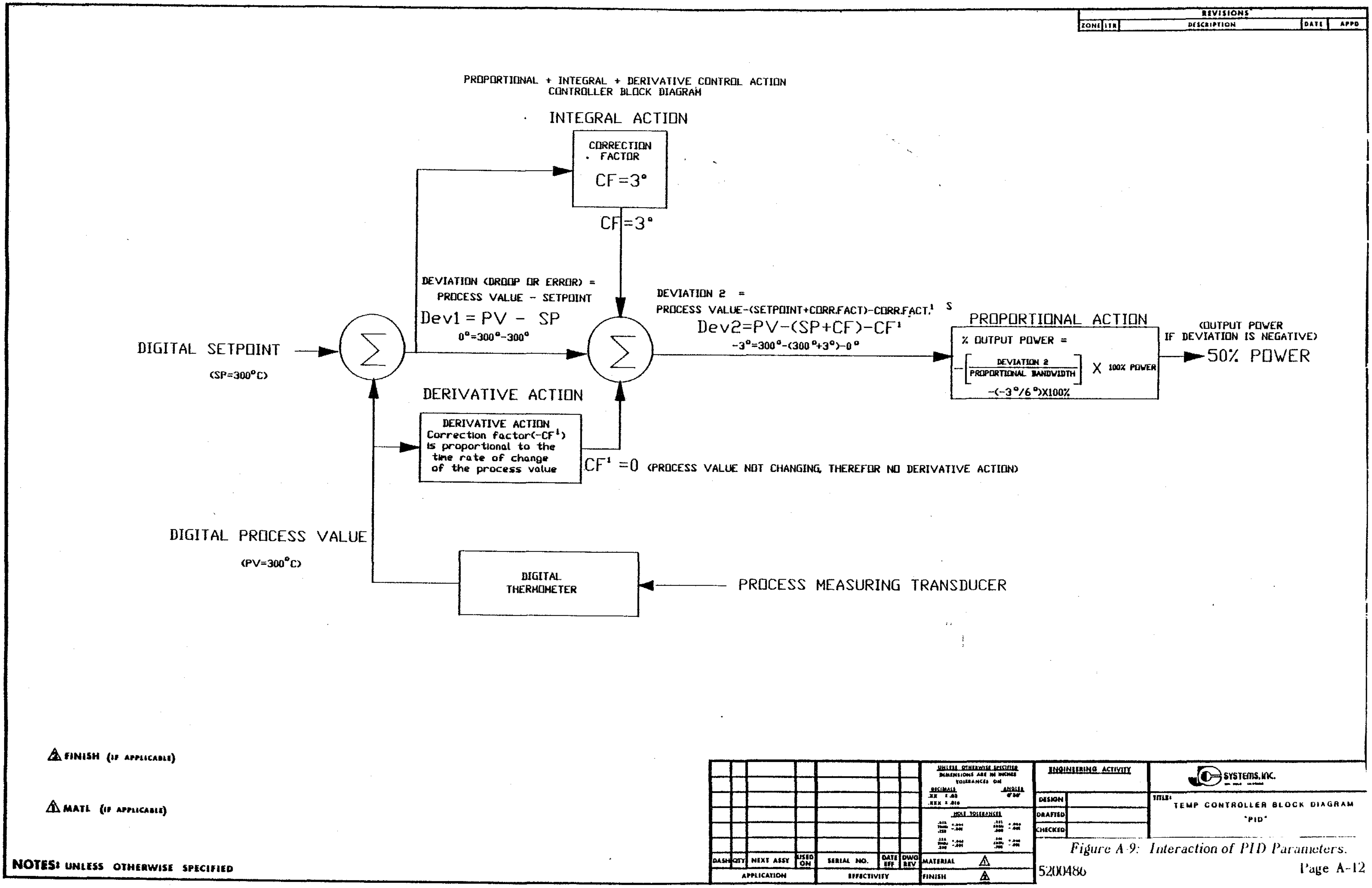


Figure A-9: Interaction of PID Parameters.

5200486

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 Model 520 display areas you will need to monitor while setting those switches. If you have a dual-channel Model 520, you will need to set the switches on both controller boards.

Since the Model 520 provides 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.

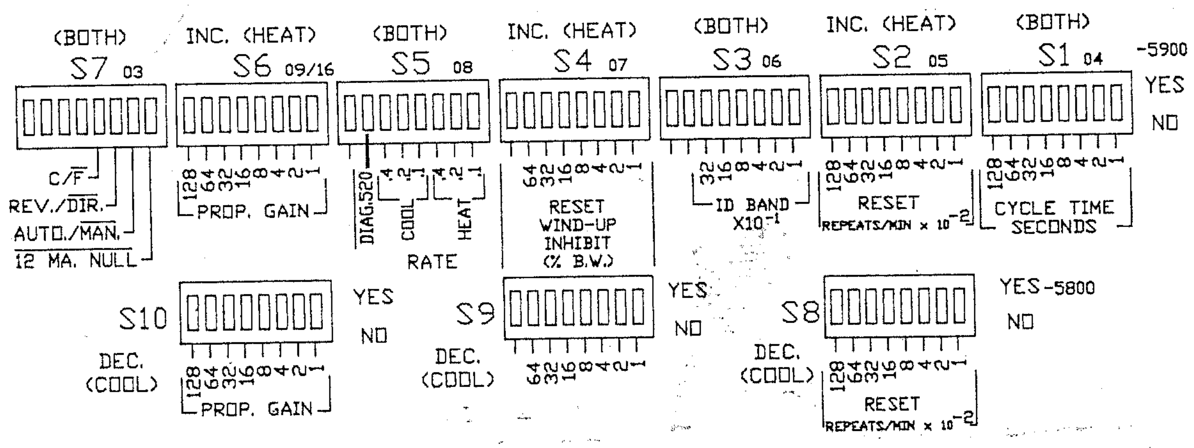


Figure A-10: Controller PCB DIP Switch Locations.

A.4.2 How to Set a DIP Switch.

The simplest way to set a DIP switch is as follows:

1. Enter diagnostics per Chapter 6.
2. Select the diagnostic test that will display the current setting for the switch you are adjusting. The test number is provided in parentheses following the paragraph heading for each setting. HEAT (-590.X) numbers are displayed first, followed by COOL (-580.X) numbers when appropriate.
3. Monitor the diagnostics display as you reset the 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.

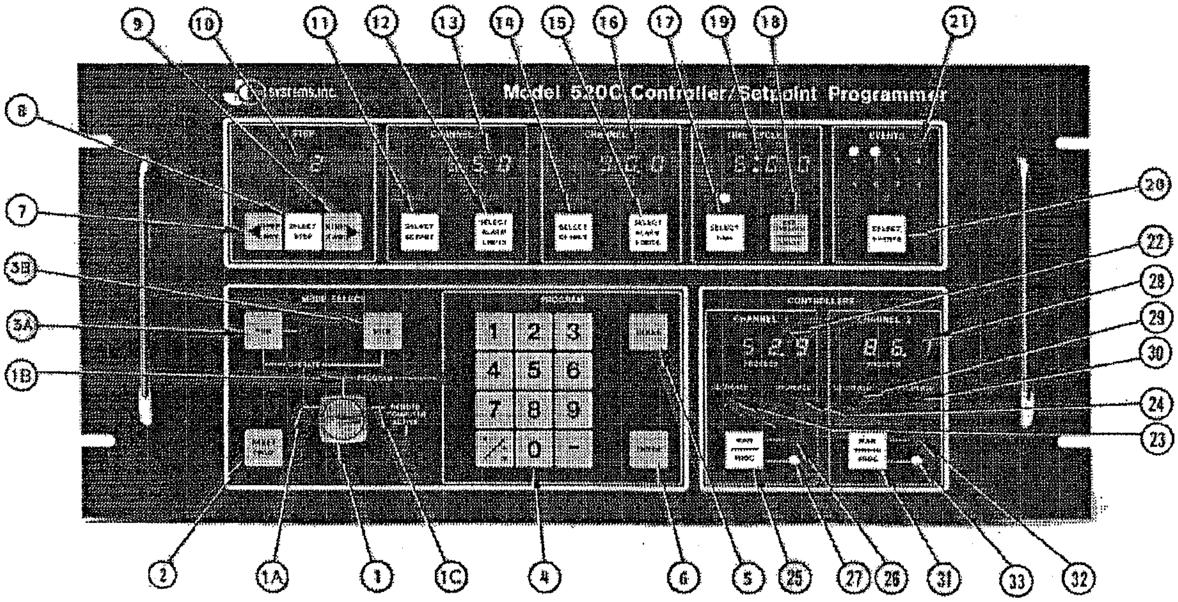


Figure A-11: Front Panel Displays and Switches.

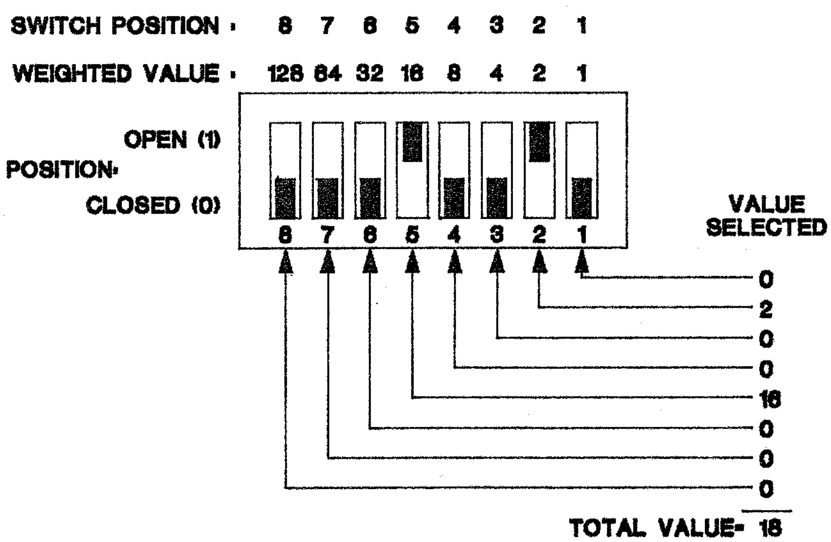


Figure A-12: Setting a Typical Dip Switch

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 Model 520 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:

$$X = 415 \text{ divided by } 6;\ X = 69$$

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 Model 520 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. Set all bits off (down) on switch S6 for heat or S10 for cool.
2. Switch on the left-most (most significant) bit (Bit 8).
3. Observe the display. If the bandwidth displayed is less than the desired value, switch the bit off; otherwise, leave it on.
4. Switch on the next most significant bit (to the right) and repeat Step 3.
5. Repeat Step 4 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 defaults 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 Model 520 regulates average power to heaters by turning the heaters on and off. Cycle time may be set from 1 to 255 seconds, but a minimum settting of 2 seconds is recommended for most applications and required for operation with the Model A2192 Chamber Enhancer. 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-9 Item 22 or 28) 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 Model 520, 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.

Refer to Chapter 2 for manual operating procedures and 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-9, Item 22 or 28), 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 as described in Para. A.4.3.3 to achieve the desired bandwidth.

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 (22 or 28). 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.4.9.2 Reset Related Switches.

After the proportional bandwidth is correctly adjusted, reset related switches RATE (S5), 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 6d = 0.6d).
4. If most of the delay is at temperatures outside the RWI band (0.6d 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 (try increasing by increments of 10) and retest.

APPENDIX B. PROGRAM WORKSHEET

JC SYSTEMS INC. PROGRAM NO. __________ DATE: ______________

STEP	CHANNEL 1		CHANNEL 2		TIME/	EVENTS							
NO.	SETPNT	ALM LMT	SETPNT	ALM LMT	CYCLES	1	2	3	4	5	6	7	8
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													

NOTES:

1. Each separate program must be terminated with an END OF PROGRAM (EOP) step to separate it from the ones before and after.
2. Multiple programs can be stored and individually executed -- select first step of desired program

JC SYSTEMS INC. PROGRAM NO. __________ DATE: ______________

STEP NO.	CHANNEL 1 SETPNT	CHANNEL 1 ALM LMT	CHANNEL 2 SETPNT	CHANNEL 2 ALM LMT	TIME/ CYCLES	EVENTS 1	2	3	4	5	6	7	8
31													
32													
33													
34													
35													
36													
37													
38													
39													
40													
41													
42													
43													
44													
45													
46													
47													
48													
49													
50													
51													
52													
53													
54													
55													
56													
57													
58													
59													
60													

NOTES:
1. Each separate program must be terminated with an END OF PROGRAM (EOP) step to separate it from the ones before and after.
2. Multiple programs can be stored and individually executed -- select first step of desired program

JC SYSTEMS INC. PROGRAM NO. __________ DATE: ______________

STEP	CHANNEL 1		CHANNEL 2		TIME/	EVENTS							
NO.	SETPNT	ALM LMT	SETPNT	ALM LMT	CYCLES	1	2	3	4	5	6	7	8
61													
62													
63													
64													
65													
66													
67													
68													
69													
70													
71													
72													
73													
74													
75													
76													
77													
78													
79													
80													
81													
82													
83													
84													
85													
86													
87													
88													
89													
90													
91													

NOTES:
1. Each separate program must be terminated with an END OF PROGRAM (EOP) step to separate it from the ones before and after.
2. Multiple programs can be stored and individually executed -- select first step of desired program

JC SYSTEMS

Addendum B

Using *FastTRAC*™ Controllers

JC Systems, Inc.

Using FastTRAC™ Controllers

B1. DESCRIPTION.

The JC Systems FastTRAC™ (Thermal Response Accelerating Control) System is a specially configured version of the Model 520 Dual Channel Setpoint Programmer/Controller. The system uses cascade-control strategy and proprietary JCS firmware to maximize the performance of any environmental chamber test program.

FastTRAC™ systems can decrease by 50% or more the thermal response time of a device under test (DUT). They completely eliminate the need for complicated, time-consuming thermal response characterizations because the actual device temperature is the focal point for chamber temperature control.

FastTRAC™ includes a ThermoBoost™ capability that permits precisely controlling the maximum and minimum temperatures within user-defined limits. Since heating and cooling are based on real-time measurements of the DUT's actual temperature, ramp or step temperature changes are achieved with almost no temperature overshoot.

Figure B-1 shows the response of a device under test when a FastTRAC™ controller is used as compared with the response using a standard controller.

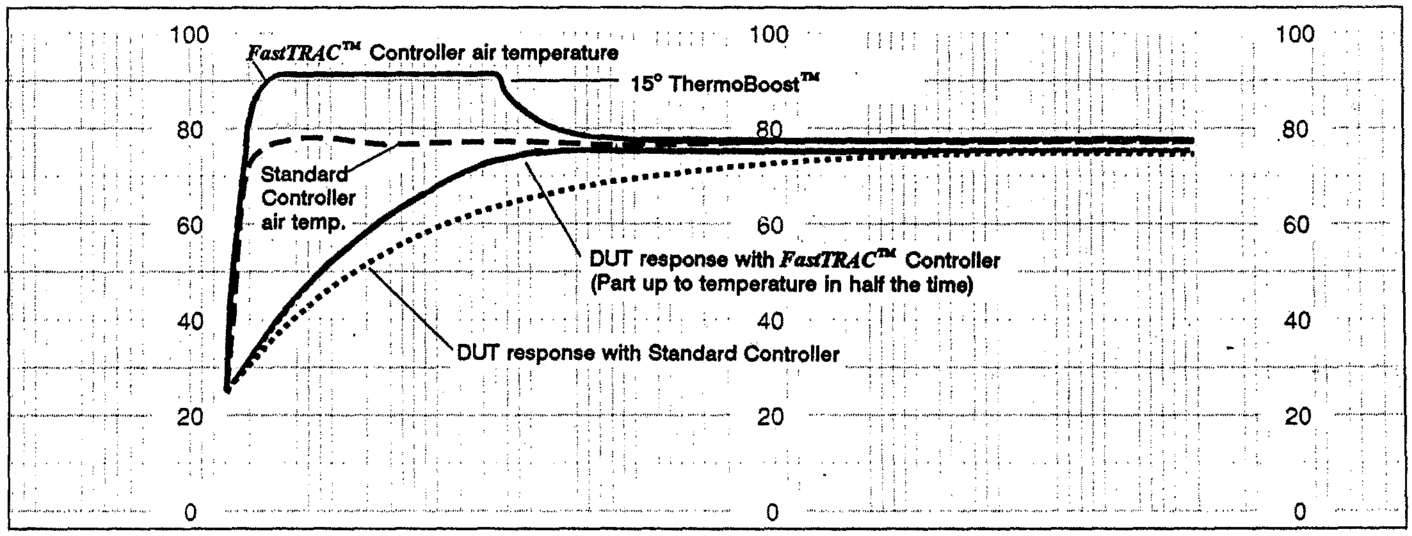


Figure B-1.Comparison of DUT Response with FastTRAC™ and Standard Controllers.

B2. THEORY OF OPERATION.

B2.1 Temperature Control.

FastTRAC™ uses two channels to control chamber operation. The primary loop, Channel 1 (Figure 2, Item 1), is a modified PID direct digital controller that controls part temperature. It reads the actual part temperature directly from an attached thermocouple or resistance temperature detector (RTD), compares this input with the desired setpoint, and generates a desired chamber air temperature setpoint for the secondary loop, Channel 2 (Item 2), through the programmer.

A switch-selectable ***ThermoBoost***™ value for the primary controller specifies the maximum allowable difference between the part temperature setpoint and the air temperature setpoint called for by primary controller output. This feature makes it possible to accelerate DUT temperature changes while insuring that the device is not damaged by extreme temperatures.

The secondary loop (Channel 2), is a PID direct digital controller which uses the air temperature setpoint generated by the primary controller to control chamber air heating and cooling.

B2.2 Controller Operation and Adjustments.

B2.2.1 Part Temperature Controller (Primary Loop).

Operation and adjustment of the primary controller varies in several important respects from the standard controller. These differences are summarized here and detailed in Para. 5, FastTRAC™ Setup.

B2.2.2 Displays and Indicators.

Table B-I lists the functions of the displays and indicators shown in Figure 2.

TABLE B-I. FastTRAC™ DISPLAYS AND INDICATORS

Fig. 2 Item No.	Label	Function
3	PRIMARY LOOP SETPOINT	Displays the programmed part temperature setpoint
4	SECONDARY LOOP SETPOINT	Displays the air temperature setpoint being generated by the primary loop
5	PRIMARY LOOP PROCESS VALUE	Displays the real-time part temperature
6	SECONDARY LOOP PROCESS VALUE	Displays the air temperature in the chamber
7	SP2<SP1	Lights to indicate when the part temperature setpoint generated by the primary loop controller is less than the programmed part temperature setpoint
8	SP2>SP1	Lights to indicate when the part temperature setpoint generated by the primary loop controller is greater than the programmed part temperature setpoint

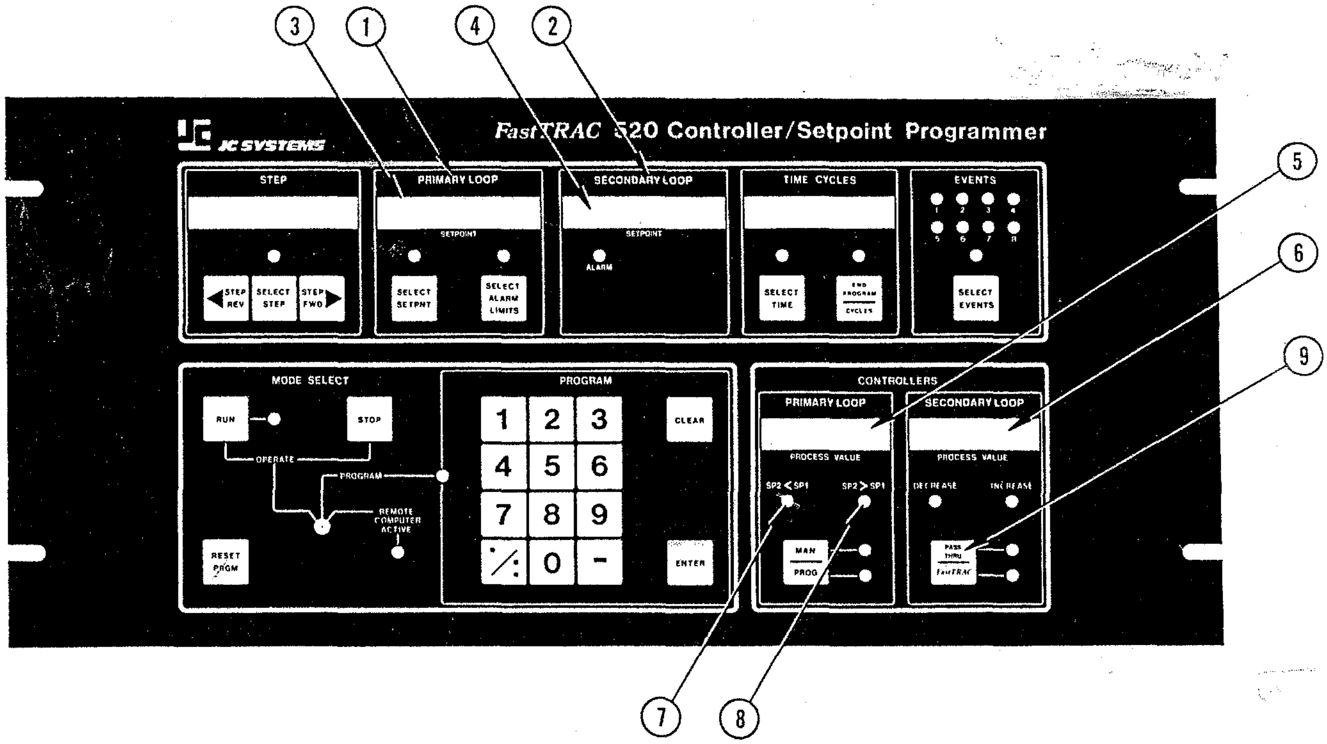


Figure B-2. FastTRAC™ Displays and Indicators.

B2.2.3 Pass-Thru Operating Mode.

CAUTION

When the system is used in the pass-thru mode, soft-start and alarm deviations are triggered by the primary loop process value. Therefore, the air and part temperature sensors must be tied together in the airflow location to insure they are looking at the same temperature.

Bit 1 and 2 of DIP Switch S7 on the primary controller are factory set in the up position to enable the FastTRAC™ system. A pushbutton switch (Figure B-2, Item 9) at the lower right-hand corner of the front panel permits selecting the pass-thru or FastTRAC™ operating mode. In pass-thru mode, the primary loop controller setpoint is not modified by firmware and is passed directly to the secondary loop. In this case, the unit functions as a single-channel, standard air temperature control system.

Switch S7 Bit 2 of the primary controller can be set in the down position to lock out the front panel pushbutton switch. This forces the system into the pass-thru mode and prevents inadvertent selection of FastTRAC™ mode.

B2.2.4 ThermoBoost™.

ThermoBoost™ values for heat and cool are set on the primary controller's switches S4 and S9, respectively. (These are the heat and cool reset windup inhibit switches on standard controllers.)

B2.2.5 PID Adjustments.

As in the standard controller, separate adjustments are provided for the heat and cool control actions of the proportional (P), reset or integral (I), and derivative (D) functions of the primary controller. However, the cycle time, derivative action, and reset windup inhibit (RWI) are not used for this controller, since the primary controller output is a digital setpoint for the secondary controller. The switches for cycle time (S1) and rate (S5) should be set to off.

B2.3 Air Temperature Controller (Secondary Loop).

The secondary loop of the FastTRAC™ system is a standard JCS Model A1970 direct digital controller. Its operation and adjustment are essentially as described in the basic manual, except that the setpoint is derived from the primary controller and received via the unit's programmer.

B2.4 Remote Communications.

FastTRAC™ system controllers respond to the appropriate commands from a remote computer.

B3. CONNECTING THE CONTROLLERS.

Figure B-3 shows the general arrangement of a typical FastTRAC™ system. Temperature inputs are connected as described in the basic manual. Note that there are no external outputs from Channel 1 to any device.

B4. GENERATING A SETPOINT.

A Model 520 with the FastTRAC™ option will accept a setpoints from its programmer to the primary controller only. Note that only the primary loop can be programmed.

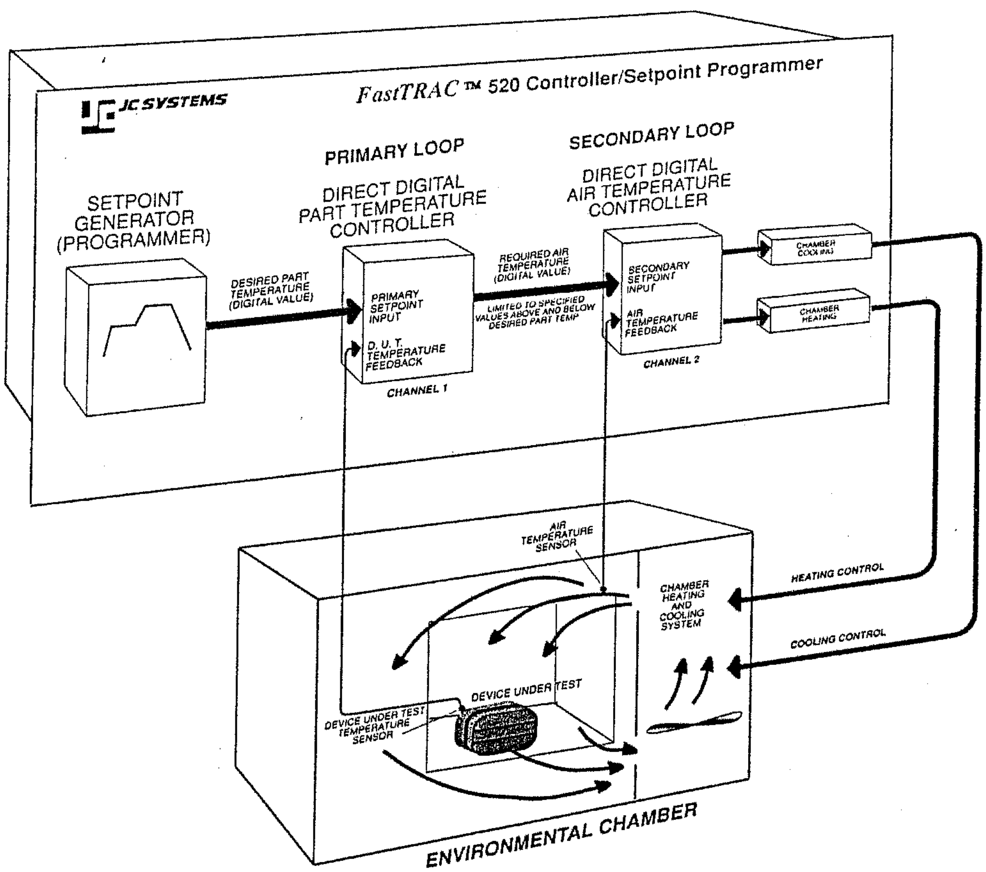


Figure B-3. FastTRAC™ General Arrangement.

B5. FastTRAC™ SETUP.

B5.1 Channel 1 Switch Settings.

To select FastTRAC™ mode and operating parameters, set Channel 1 switches as shown in Table I. From that point, use the guidelines provided in Appendix A of the basic manual to fine-tune integral and proportional actions.

TABLE B-II. CHANNEL 1 TYPICAL SWITCH SETTINGS FOR FastTRAC™ OPERATION.

Switch No.	Function	Setting
Switch S1	Not used	All bits down (off).
Switch S2	Heat Integral Action	Start with 1.28 (most significant bit up)
Switch S3	Not used	All bits down (off).
Switch S4	Heat ThermoBoost™	Set desired maximum ThermoBoost™ for increased heating — range 0 to 127.
Switch S5	Rate select	Bits 1 thru 6 down (off); bits 7 & 8 up.
Switch S6	Heat Proportional Action	Set heat gain to 6.4 (bit 7 up) for massive DUT, or to 0.7 (bits 1 thru 3 up) for very light part or air temperature measurement.
Switch S7	Misc. select	Bits 1 and 2 normally up (on). Bit 3 up (no effect). Bit 4 up for°C readout, down for°F readout.
Switch S8	Cool Integral Action	Start with 1.28 (most significant bit up)
Switch S9	Cool ThermoBoost™	Set desired maximum ThermoBoost™ for increased cooling — range 0 to 127.
Switch S10	Cool Proportional Action	Set cool gain to 6.4 (bit 7 up) for massive DUT, or to 0.7 (bits 1 thru 3 up) for very light part, or for air temperature measurement

B5.2 Channel 2 Switch Settings.

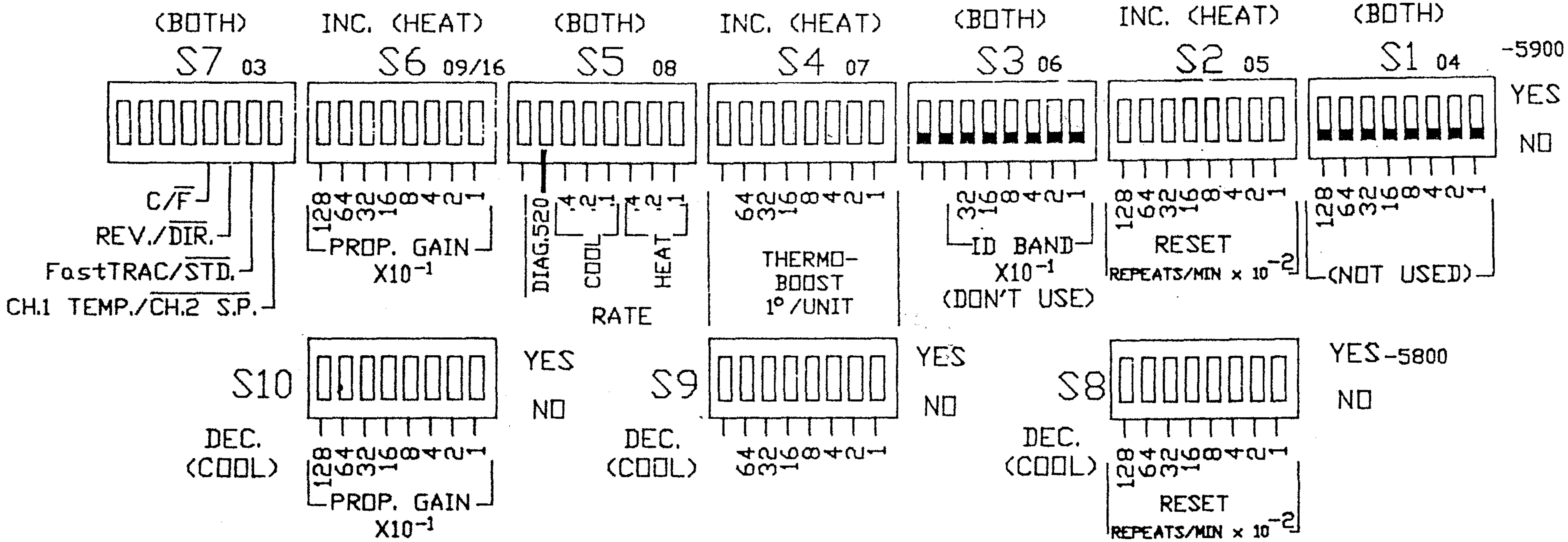
Use the guidelines provided in Appendix A of the basic manual to initially set and then fine-tune Channel 2 operation.

B6. End-of-Program Action.

When the programmer reaches the end of a program (EOP), it automatically returns to the first step of the program. However, the secondary controller setpoint latches at the programmed setpoint for the last step of the program just completed. Therefore, the primary controller display (Figure 2, Item 3) shows the setpoint for the *first* step of the program, while the secondary controller display (4) shows the setpoint for the *last* step, and controls at that setpoint.

As an example, assume the first step of a program calls for a setpoint of 25°C and the last step calls for a soak at 50°C. The primary loop display will show 25.0, the secondary loop display will show 50.0, and the secondary controller will be maintaining the air temperature at 50°C.

A1970 PRIMARY CONTROLLER DIP SWITCH SETTINGS (CH. 1)



A1970 SECONDARY CONTROLLER DIP SWITCH SETTINGS (CH. 2)