5 3 5 PROFILER

5 3 5 P R O F I L E R

1/4 DIN PROFILE CONTROLLER
USER'S MANUAL

MOORE INDUSTRIES

M535-PROF V7, © OCTOBER 2023

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About This Manual:
Throughout this User's Manual information appears along the margins (**NOTE**: **CAUTION!** and **WARNING!**). Please heed these safety and good practice notices for the protection of you and your equipment.

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CHAPTER 1

INTRODUCTION

Thank you for selecting the 535 Profile Controller — the most sophisticated instrument in its class. It will provide you with years of reliable, trouble-free performance.

From its surge-resistant power supply to its rugged construction, the 535 Profile Controller is designed to ensure the integrity of your process with maximum reliability — hour after hour, day after day. The isolated inputs and outputs guard against the dangers of electrical interference, the front face meets NEMA 4X standards for watertight operation and exposure to corrosive environments, and the solid metal housing and sturdy rubber keys enhance durability and ESD protection.

The 535 Profile Controller has been engineered to be the industry's most user–friendly process controller. With three digital display areas — two offering up to 9 characters of true alphanumerics — the controller effectively eliminates the cryptic messages that could confuse even the most experienced operator. The bright, crisp display is vacuum fluorescent, and offers much better readability than any other display technology. Additional operator–friendly features include: custom programmable alarm messages, illuminated keys, and an easy–to–use menu system.

The 535 Profile Controller is the most accurate instrument in its class. With a sampling rate of ten times per second, it is ideal for demanding pressure and flow applications. The controller also offers a universal process input and modular, field interchangeable outputs that allow more flexibility than ever before. The RS-485 serial communications interface allows the controller to utilize sophisticated software routines and high speed hardware to provide exceptionally fast and accurate transmission of data. The 535 Profile Controller also offers sophisticated control algorithms, including **exclusive Adaptive Tune** which constantly analyzes your process and makes modifications to the tuning parameters to ensure you're always under control.

535 PROFILE CONTROLLER MODES

There are four operating modes for the 535 profile controller:

OPERATION, the default mode of the controller. When the 535-PROF is operating, you can run recipes, change setpoints, select manual control and change output level, acknowledge alarms and monitor conditions.

SET UP, also referred to as configuration. Here the basic functions of the instrument are configured, such as input and output assignments, alarm types and special functions.

TUNING, where control function parameters for Proportional, Integral and Derivation (PID) are configured. Use this mode periodically to optimize the control performance of the instrument.

RECIPE SET UP, where the ramps, dwells and events for each recipe are configured.

ORDER CODE, PACKAGING INFORMATION

Compare the product number to the ordering code on page 3 to determine the outputs and options installed on the controller. The product number is printed on the label on the top of the controller case.

Included with this 535 Profile Controller are:

- a 535 Profile Controller User's Manual
- mounting hardware
- 1 sheet of Engineering unit adhesive labels

WHERE TO GO NEXT

- To become familiar with the controller interface, continue to Chapter 2.
- For important hardware installation guidelines, see Chapters 3 and 4.
- For a detailed description of all the software menus and parameters, follow through Chapters 5 and 6. Appendix 1 can be used as a basic guideline to these parameters.

TEXT FORMATTING IN THIS MANUAL

Feature	Format	
KEYS	**RUN**	**DISPLAY**
	or	
	[RUN]	[DISPLAY]
ICONS	**OUT, ALM**	
MENUS	**CONFIG., TUNING,**	
PARAMETERS	**CYCLE TM:1, MIN.OUT2**	
PARAMETER VALUES	OFF, SETPOINT, LAST OUT.	
DISPLAY MESSAGES	TOO HOT, OUT%	

535 – □ □ □ □ □ □ □ □ 0 0

Output 1: Control	Order Code
None	**0**
Mechanical Relay (5 amp)	**1**
Analog (milliamp)	**2**
Solid State Relay (triac) (1 amp)	**3**
DC Logic (SSR drive)	**4**

Output 2: Control, Alarm, or Retransmission	
None	**0**
Mechanical Relay (5 amp)	**1**
Analog (milliamp)	**2**
Solid State Relay (triac) (1 amp)	**3**
DC Logic (SSR drive)	**4**

Output 3: Control, Alarm, Retransmission, or Loop Power	
None	**0**
Mechanical Relay (5 amp)	**1**
Analog (milliamp)	**2**
Solid State Relay (triac) (1 amp)	**3**
DC Logic (SSR drive)	**4**
Loop Power	**5**

Output 4: Alarm, Retransmission, or Loop Power	
None	**0**
Mechanical Relay (0.5 amp, 24 V)	**1**
Analog (milliamp)	**2**
Solid State Relay (triac) (0.5 amp, 24 V)	**3**
DC Logic (SSR drive)	**4**
Loop Power	**5**

Options

Enter "0" if not desired

Slidewire Feedback for Position Proportioning Output	**A**
24 VAC/24 VDC Operation	**F**
Slidewire and 24 VAC/24 VDC	**G**

Remote Setpoint	**B**
Profile Controller Option	**C**
Remote Setpoint and Profile	**E**

Set of Five Digital Inputs	**D**
CE Certification	**H**
Five Digital Inputs and CE Certification	**J**

Serial Communications

Enter "0" if not desired

RS-485 Serial Communications	**S**

Note 1: Capability for position proportioning output is specified by ordering 535-11xxAxxx00, 535-33xxAxxx00, or 535-44xxAxxx00. **Note 2:** Capability for velocity proportioning output is specified by ordering 535-11xxxxxx00, 535-33xxxxxx00, or 535-44xxxxxx00. **Note 3:** Up to two outputs may be used for alarms. **Note 4:** All outputs are interchangeable modules. **Note 5:** The mechanical relay and solid state relay modules are derated to 0.5 amp at 24 Vac when used as the fourth output.

CHAPTER 2
BASIC INTERFACE

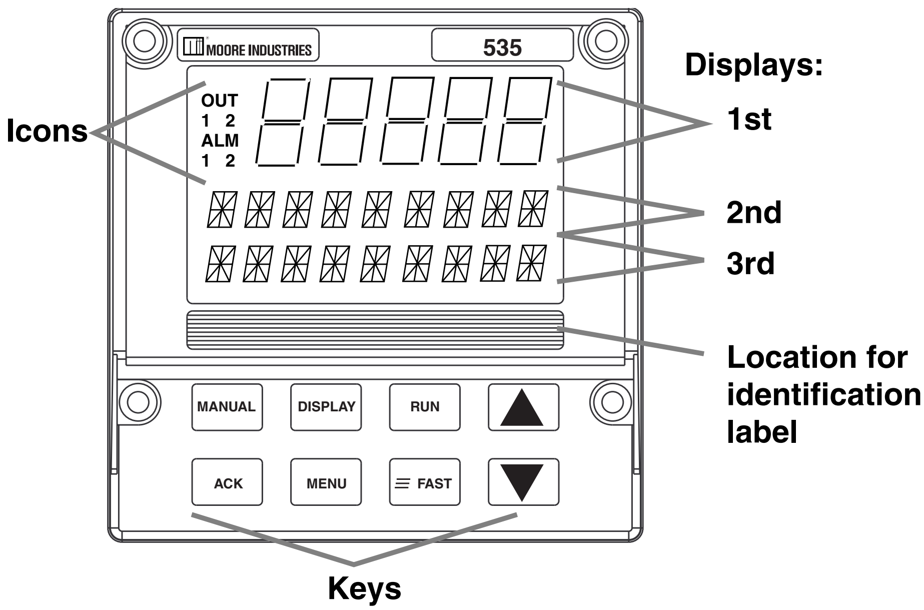


Figure 2.1
Operator Interface

DISPLAYS

The display strategy of the 535 Profile Controller is the same for all modes.

1st Display (five 7-segment digits)

- For the process variable value.

2nd Display (nine 14-segment digits)

- For the setpoint, deviation, output level or valve position (if available)
- In **RECIPE SET UP, TUNING** or **SET UP** mode, for the parameter name.
- Upon power up, indicates the current setpoint.
- In **OPERATION** Mode, displays program operating values:
  a. The target soak setpoint value for this segment, for example:
     SP 1425 means “the final [soak] setpoint during this segment is 1425”
  b. The current setpoint value, for example:
     RAMP 300 means “the current ramping setpoint value is 300”
     SOAK 1425 means “the current soak segment setpoint value is 1425”

3rd Display (nine 14-segment digits)

- For alarm messages, loop name, errors, etc.
- In **RECIPE SET UP, TUNING** or **SET UP** mode, the value or choice of parameter shown in the 2nd display.
- In **OPERATION** Mode, displays recipe status values and messages. It will alternate every two seconds between the selected recipe status value and the next message (if any messages are active).
  a. The ramp or soak segment number being run or held, for example:
     RAMP 10/11 means “using ramp segment 10 of 11 segments in this recipe”
     SOAK 3/4 means “using soak segment 3 of 4 segments in this recipe”

b. The amount of time left in the current ramp or soak segment or the amount of time the soak segment has been waiting to run or continue due to guaranteed soak, for example:
 15:03 LEFT means "15:03 is remaining in this segment's current cycle"
 WAIT 12:37 means "the soak segment has been waiting for 12:37"

c. The status of events will be displayed. Active events will be indicated by a '1' and inactive events by a '0', for example:
 EVENT 000 means "events 1, 2, and 3 are inactive"
 EVENT 100 means "event 1 is active and events 2 and 3 are inactive"
 EVENT 111 means "events 1, 2, and 3 are active"

d. The current cycle number and the total number of cycles will be displayed, for example:
 CYCLE 1/1 means "the first and only cycle is currently active"
 CYCLE 13/99 means "the thirteenth of 99 cycles is currently active"
 CYCLE 246 means "the 246th cycle [in continual cycling] is currently active"

e. The current recipe number will be displayed, for example:
 RECIPE 6 means "the sixth recipe is currently active"

ICONS (LIT)

OUT Indicates either the relay output is energized, or the analog output is greater than 0%.

ALM1 Indicates the respective alarm (one) is active.

ALM2 Indicates the respective alarm (two) is active.

ALM Indicates an alarm wihtout an assigned output is active.

KEYS

FAST

FAST

No independent function. Press to modify the function of another key.

MANUAL

MANUAL

Press to toggle between manual and automatic control.

When lit, indicates the unit is under manual control.

Press to abort a running or held recipe and return controller to manual control.

RUN

RUN (For Profile Control)

Press to Run, Hold or Abort a recipe.

When a recipe is active, press to prompt a display message for selecting the recipe nuumber (1 through 20).

When lit, indicates a recipe is running.

When blinking, indicates a recipe is on hold.

FAST + RUN

FAST+RUN

When a recipe is running or held, press to advance to next segment.

DISPLAY
Press to toggle through values in the 2nd display for setpoint, ramping setpoint (if available), deviation, PV1 (If PV source is not PV1), PV2 (if PV Source is not PV1), output and valve position (if available).

In **RECIPE SET UP, TUNING, SET UP** mode, press to return controller to **OPERATION** mode (display will show current setpoint).

DISPLAY

FAST+DISPLAY
When a recipe is running or held, press to select recipe status.

When no recipe is running or held, press to display EVENT 000 message.

FAST + DISPLAY

▲
Press to increase the value or selection of displayed parameter.

▲

FAST+▲
Press to scroll through values at a faster rate.

FAST + ▲

▼
Press to decrease the value or selection of displayed parameter.

▼

FAST+▼
Press to scroll through values at a faster rate.

FAST + ▼

ACK
Press to acknowledge (an) alarm(s).

Press to acknowledge Run, Abort and next segment commands.

When lit, indicates there is an acknowledgeable alarm or an event is being held at the end of a recipe.

ACK

FAST+ACK
For events held at the end of a recipe, press to acknowledge and disable the events.

FAST + ACK

MENU
In **OPERATION** mode, press to access the **TUNING** mode/menu.

In **RECIPE SET UP, SET UP** or **TUNING** mode, press to advance through a menu's parameters. (Use **FAST+MENU** to advance to to the next menu.)

MENU

FAST+MENU
In Automatic control, press to enter **RECIPE SET UP** mode. In Manual control, press to enter the **SET UP** mode.

In **SET UP** mode, press to advance through menus. (Use **MENU** by itself to access the parameters of a particular menu.)

FAST + MENU

BASIC PROFILE CONTROLLER OPERATING PROCEDURES

Use the following as a quick guide to key operating functions of the 535-PROF.

To Enter the RECIPE SET UP Mode

1. To enter the **RECIPE** SET UP mode from any other mode, hold down **FAST** and press **MENU**. The **MENU** key will illuminate. The 2nd display line will indicate RECIPE #, where # represents the recipe number.
2. Use the ▲ or ▼ key to select the recipe number.
3. Press **MENU** by itself. The first parameter of this menu for this recipe will appear in the 2nd display, replacing RECIPE # , while the choices or selections appear in the 3rd display.
4. Pressing **DISPLAY** at any time exits the **RECIPE** SET UP mode and returns you to **OPERATION** mode.

To Enter the SET UP Mode

1. If you are not in **MANUAL** control, press **MANUAL**. The **MANUAL** key will illuminate.
2. Hold down **FAST** and press **MENU**. The **MENU** key will illuminate. RECIPE # will appear alone in the 2nd display. Entering the **SET UP** mode first gives you access to the **RECIPE** SET UP mode.
3. Hold down **FAST** and press **MENU**. CONFIG appears alone in the 2nd display. You are now in the **SET UP** mode. See Chapter 5 for a list of all Set Up parameters, and Chapter 7 for applications.

To run a recipe:

1. Pressing the **RUN** key prompts the choice of recipe number.
2. Use the ▲ or ▼ key to select the proper recipe.
3. Press the **ACK** key to start the recipe.

To hold a recipe:

1. While a recipe is running (indicated when the **RUN** key is lit red), briefly press the **RUN** key. The key will blink on and off and the 3rd display will indicate HOLDING.
2. Press the **RUN** key again to resume the recipe.

To abort a recipe and place the controller in MANUAL mode:

1. While a recipe is running (indicated when the **RUN** key is lit red), press the MANUAL key. The 2nd display line will show REC. ABORT and the 3rd display will show PRESS **ACK**.
2. Press the **ACK** key within 5 seconds to abort the recipe and place the controller in MANUAL mode. The manual output value will be the last output at the point the recipe was aborted. The raise and lower keys may be used to modify the output.

To abort a recipe and control to the IDLE setpoint:

1. While a recipe is running (indicated when the **RUN** key is lit red), press the **RUN** key and hold until the 2nd display line shows REC. ABORT and the 3rd display will show PRESS ACK.
2. Press the **ACK** key within 5 seconds to abort the recipe and the controller

will control to the IDLE setpoint. The raise and lower keys may be used to adjust the setpoint.

To display the setpoint (SP), ramping setpoint (RAMP), deviation (DEV) or output % (OUT %) while a recipe is running:

1. Toggle the **DISPLAY** key until the appropriate selection appears on the 2nd display line.

To display the recipe number, the current ramp or soak segment, the time left in the segment, the event status or the number of recipe cycles completed:

1. Press the **FAST** key and toggle the **DISPLAY** key until the appropriate selection appears on the 3rd display line.

BASIC PROCESS CONTROLLER OPERATING PROCEDURES

This is a guide to controller operation when not using the profile options.

To select /change a setpoint

1. Press the **MENU** key twice to display **SP SELECT** in the **TUNING** mode.
2. Use the ▲ or ▼ key to toggle the active setpoint.

   Before the newly selected setpoint is made active, there is two-second delay to prevent any disruptive bumps.If the setpoint displayed is ramping, RAMPING will show the 3rd display.
3. To change the setpoint value, press ▲ or ▼ while the setpoint is shown in the 2nd display.

To change from auto to manual control (bumpless transfer)

1. When in automatic control, press the MANUAL key at any time, except while in the **TUNING** mode.
2. The MANUAL key will light in red, and the 2nd display will immediately change to indicate current output level.

To change from manual to auto

1. When in manual control, press **MANUAL** at any time except while in the **SET UP** mode.
2. The 2nd display will not change, and the **MANUAL** key will no longer be lit once control changes.

To change manual output values

1. Make sure the controller is under manual control.
2. Use the **DISPLAY** key to toggle 2nd display to output level.
3. Use the ▲ or ▼ key to change the value.

To override security

If a locked operation is attmpted, SECURITY appears in the 2nd display for two seconds).

1. Use the ▲ and ▼ keys to quickly enter the security code, which will show in the 3rd display. The starting value is 0.

   Note: Two seconds of key inactivity will clear the display.

2. If the code is correct, CORRECT appears in the 3rd display. The display will clear after two seconds, allowing full access.
4. If code is incorrect, INCORRECT appears in the 3rd display. This will disappear after two seconds, and a new security code can then be entered.
5. The controller will revert back to full security lock after one minute of key inactivity.

To display control output value

1. Toggle **DISPLAY** key until the 2nd display shows OUT followed by the output percentage. This value is the PID output.
   - In duplex applications, this value does not directly refer to the output signal (refer to the Chapter 7 section on Duplex Control for details.)
   - For on/off outputs, the output value shown is either ON or OFF.
   - For duplex applications with two on/off outputs, the OUT tag is not shown. In this case, the status of both outputs is shown in the following manner: 1:ON 2:OFF (1 and 2 are the respective outputs).

To display the active PID set

1. Press **MENU** to reach Tuning Mode.
2. In **TUNING** Mode, press **MENU** to reach the correct Menu parameter.
3. The active PID set will have an asterisk (*) on both sides of the value.

ALARM OPERATION

Alarms may be used in systems to provide warnings of unsafe conditions. All 535 operators must know how the alarms are configured, the consequences of acknowledging an alarm and how to react to alarm conditions.

Alarm Indication

- lit icons **ALM 1** and/or **ALM 2**
- lit **ACK** key
- displayed alarm message

Acknowledgable alarms meet the first two of these conditions.

Non-acknowledgable alarms only meet the first condition (only icon is lit).

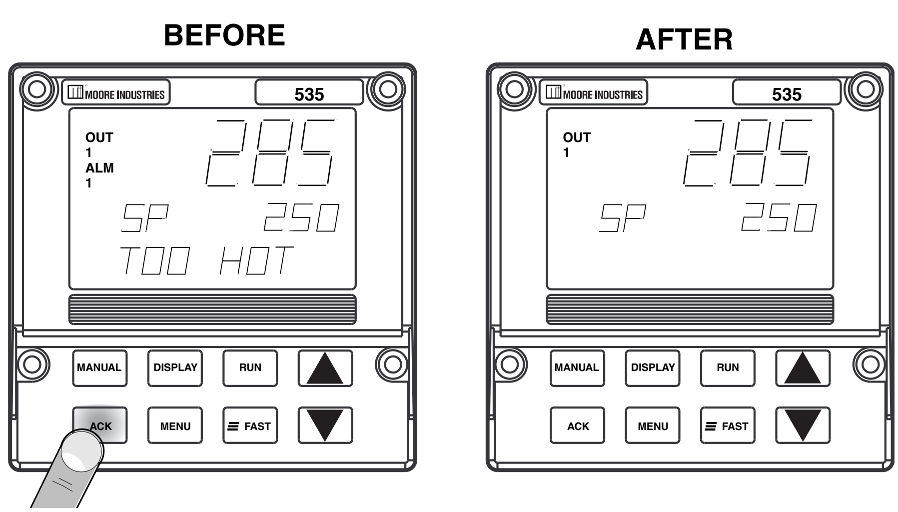


Figure 2.2
Before and After Acknowledging an Alarm

To acknowledge an alarm(s):

1. To acknowledge Alarm 1, press **ACK** once.
2. To acknowledge Alarm 2, press **ACK** twice.
3. If both alarms are activated, press **ACK** once to acknowledge Alarm 1, then again to acknowledge Alarm 2.
4. The message and alarm icon dissappear. Refer to *Figure 2.2*.

Latching Alarms

If an alarm is set up to be latching (for details, see Chapter 5) then, in general, it must be acknowledged in order to clear the alarm and release the relay (if applicable). A non-latching alarm will clear itself as soon as the process leaves the alarm condition.

Limit Sequence

An alarm can be configured to be both latching and non-acknowledgeable. In this case, the alarm is acknowledgeable only after the process has left the alarm condition. This is similar to the function of a limit controller.

More on Alarms

For more details on how to set up alarms and for examples of various ways alarms can be set up, refer to the section on Alarms in Chapter 7.

NOTE:
All alarms are software alarms unless tied to an output relay in the **SET UP** mode. See Chapters 5 and 7 for details on alarms.

NOTE:
Powering down the 535 acknowledges/clears all latched alarms. When powering up, all alarms will be reinitialized.

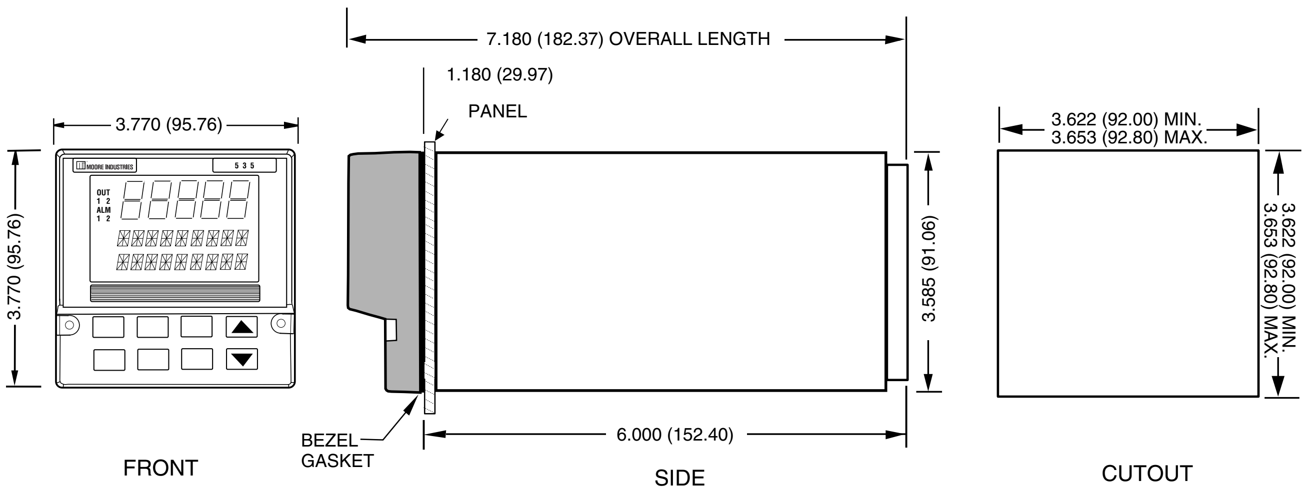
CHAPTER 3
INSTALLATION

MOUNTING THE CONTROLLER

The 535-PROF front face is **NEMA 4X rated** (waterproof). To obtain a waterproof seal between the controller and the panel, follow these directions:

1. The 535-PROF fits in a standard 1/4 DIN cutout. Mount the 535-PROF in any panel with a thickness from .06 in. to .275 in. (1.5 mm to 7.0 mm).
2. *Figure 3.1* shows the controller and panel dimensions. The panel cutout must be precise, and the edges free from burrs and waves.

Figure 3.1
Instrument Panel & Cutout Dimensions



3. Place bezel gasket around the controller case (starting at the back of controller). Then, slide the gasket against the back of the bezel.
4. With the bezel gasket in place, insert the 535-PROF into the panel cutout from the front of the panel.
5. Slide the mounting collar over the back of the case, as shown in *Figure 3.2.* The collar clip edges will lock with matching edges on the controller case.
6. Insert the four mounting collar screws from the rear of the collar. Gradually

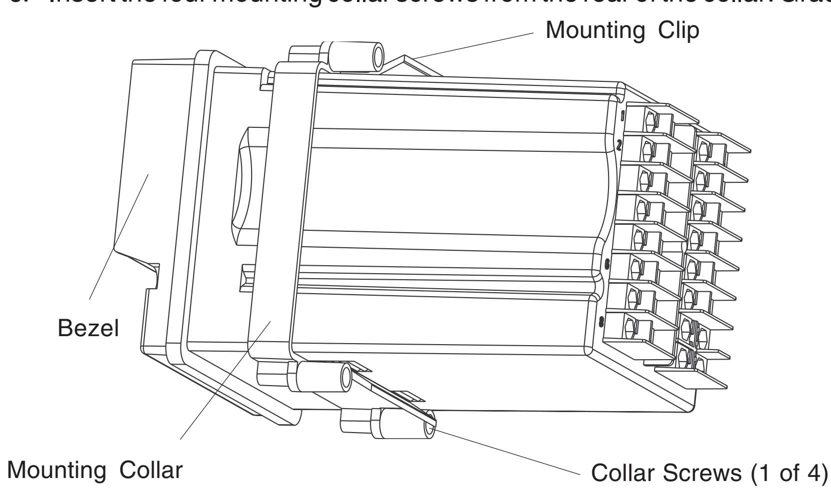


Figure 3.2
Attaching mounting collar

tighten the screws (using a Phillips #2 screwdriver) to secure the controller against the panel.

7. If there is difficulty with any of the mounting requirements, apply a bead of caulk or silicone sealant behind the panel around the perimeter of the case

CAUTION!
The enclosure into which the 535-PROF Controller is mounted must be grounded.

WIRING

535-PROF controllers are thoroughly tested, calibrated and "burned in" at the factory, so the controller is ready to install. Before beginning, read this chapter thoroughly and take great care in planning a system. A properly designed system can help prevent problems such as electrical noise disturbances and dangerous extreme conditions.

WARNING!
Avoid electrical shock. Do not connect AC power wiring at the source distribution panel until all wiring connections are complete.

1. For improved electrical noise immunity, install the 535-PROF as far away as possible from motors, relays and other similar noise generators.
2. Do not run low power (sensor input) lines in the same bundle as AC power lines. Grouping these lines in the same bundle can create electrical noise interference.
3. All wiring and fusing should conform to the National Electric Code and to any locally applicable codes.
4. An excellent resource about good wiring practices is the IEEE Standard No. 518-1982 and is available from IEEE, Inc., 345 East 47th Street, New York, NY 10017, (212) 705-7900.

Diagrams on the next three pages serve as guides for wiring different types of process inputs. The shaded areas on the diagrams show which rear terminals are used for that type of wiring.

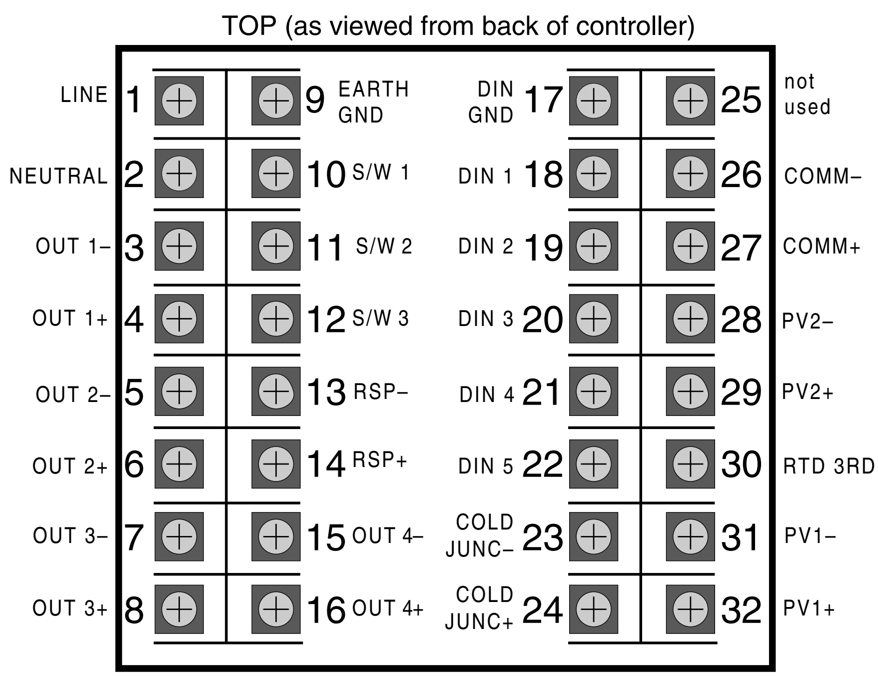


Figure 3.3
All 535-PROF Terminal Assignments
Actual 535-PROF device only has top and bottom numbers of each column of terminals marked.

WARNING!
ELECTRIC SHOCK HAZARD!
Terminals 1 and 2 carry live power. DO NOT touch these terminals when power is on.

WARNING!
Terminal 9 must be grounded to avoid potential shock hazard, and improved noise immunity to your system.

AC Power Input

Terminals 1 and 2 are for **power**. Terminal 9 is the **earth ground**.
Use a 0.5 Amp, 250 V, fast-acting fuse in line with your AC power connection.

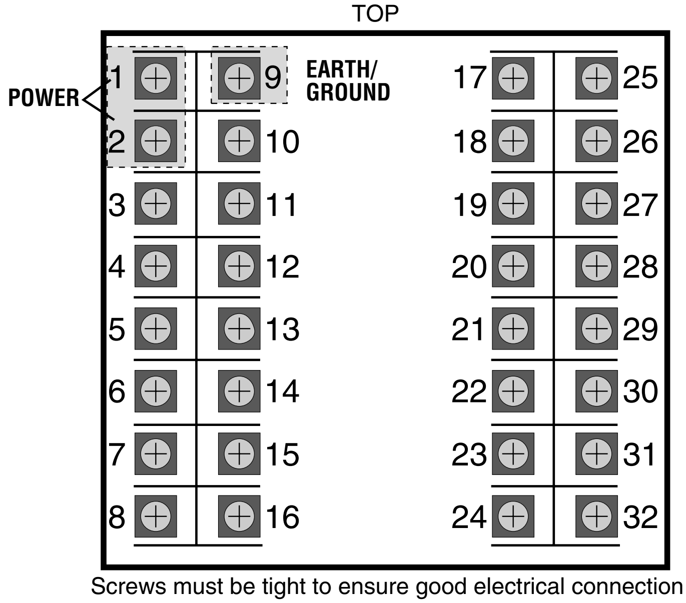


Figure 3.4
AC Power Input Terminals

CAUTION!
Do not run low power (sensor input) lines in the same bundle as AC power lines. Grouping these lines in the same bundle can create electrical noise interference.

Process Variable Input

The 535-PROF accommodates the following types of process variable inputs:

- Thermocouple Input
- RTD Input
- Voltage Input
- Milliamp Input with External Power Supply
- Milliamp Input with Internal Power Supply

Each type of input can be wired for PV1 (terminals 31 and 32) or for PV2 (terminals 28 and 29).

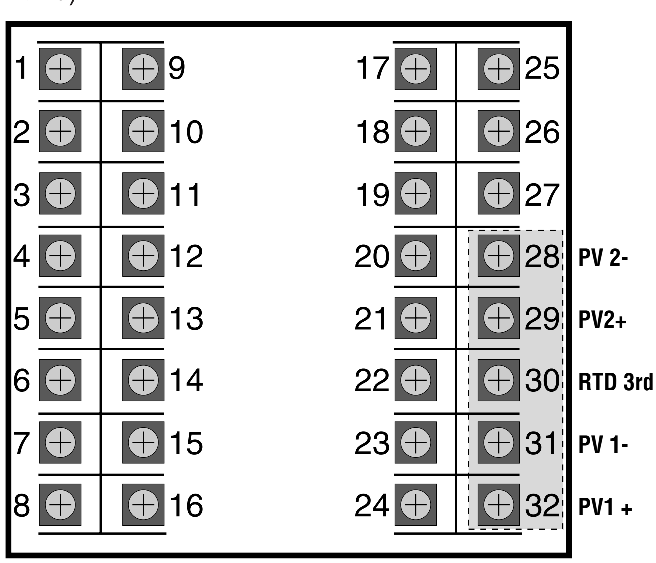
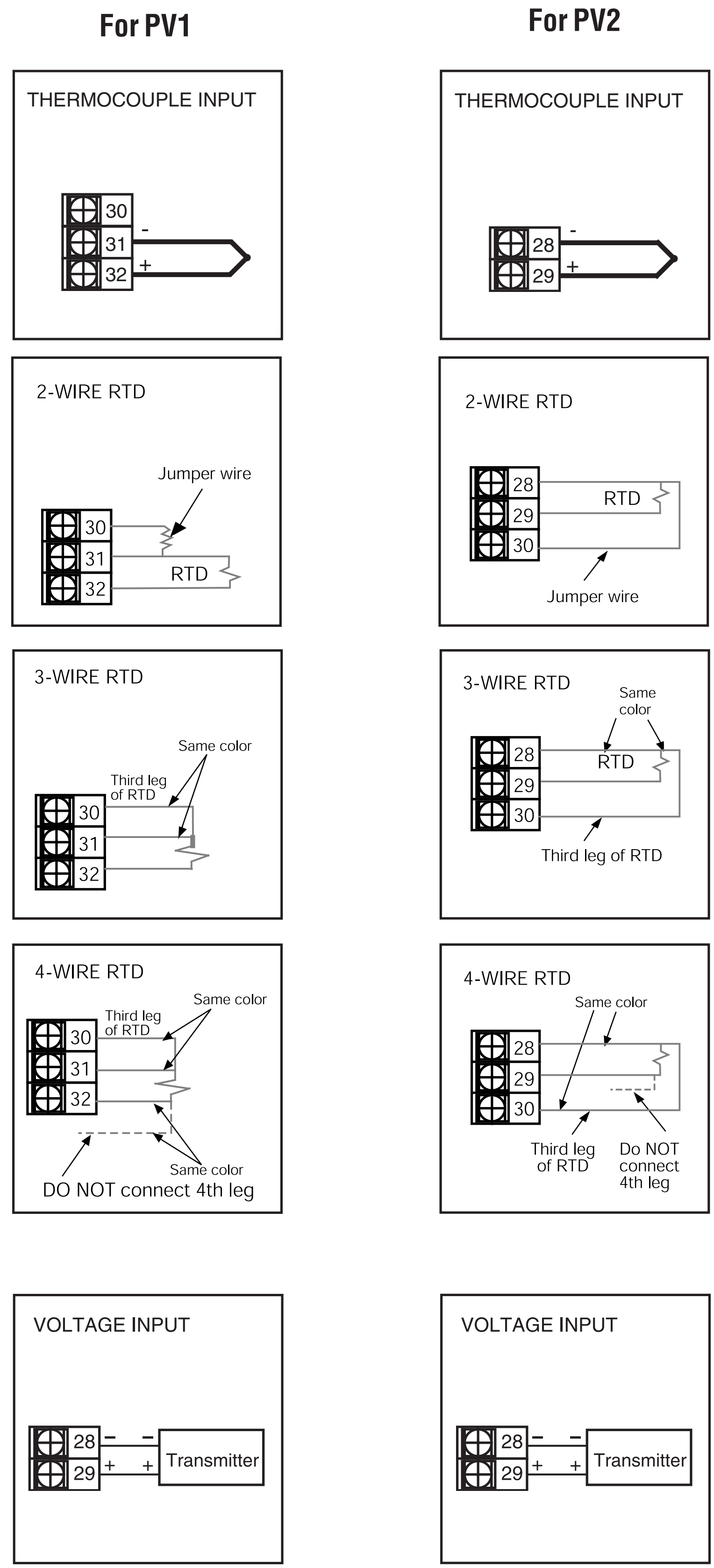


Figure 3.5
Process Variable Terminals

NOTE:
Typically, in the U.S., negative leads are red.

Figure 3.6
PV1 and PV2 Wiring for Milliamp, RTD and Voltage Inputs.



For PV1 **For PV2**

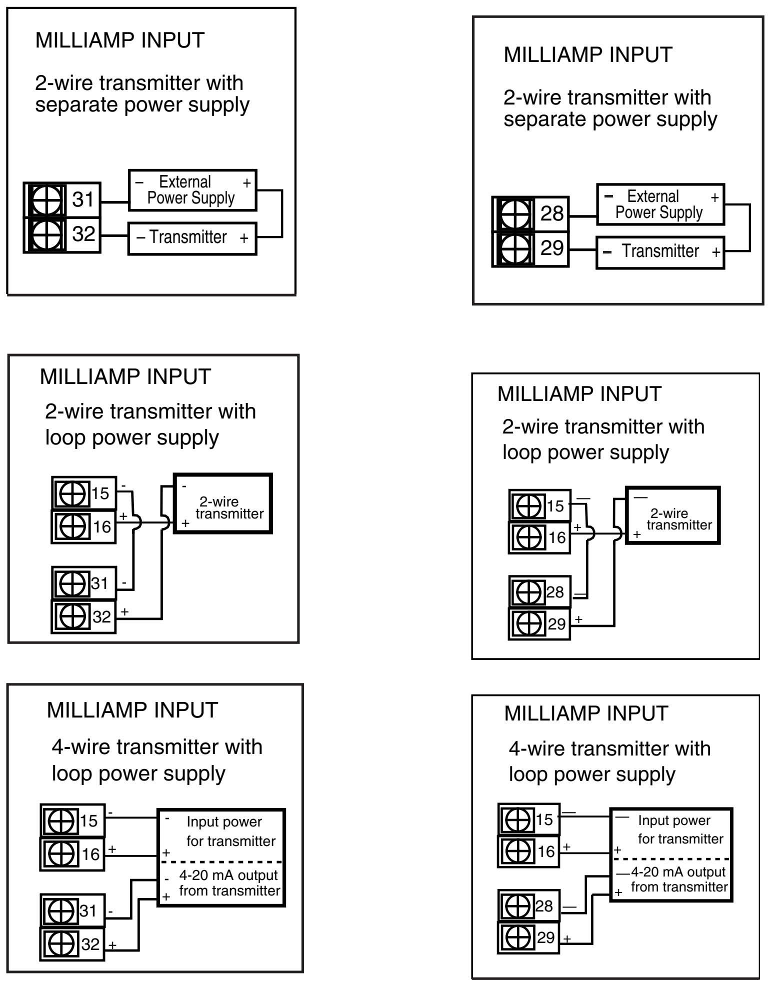


Figure 3.7
PV1 and PV2 Wiring for Milliamp Inputs with Internal and External Power Supply

NOTE:
To use loop power, there must be a loop power module is installed in the 3rd or 4th output socket. Compare the controller product number with the order code in Chapter 1 to determine if the 535-PROF has a loop power module installed. To install a loop power module, refer to Chapter 4.

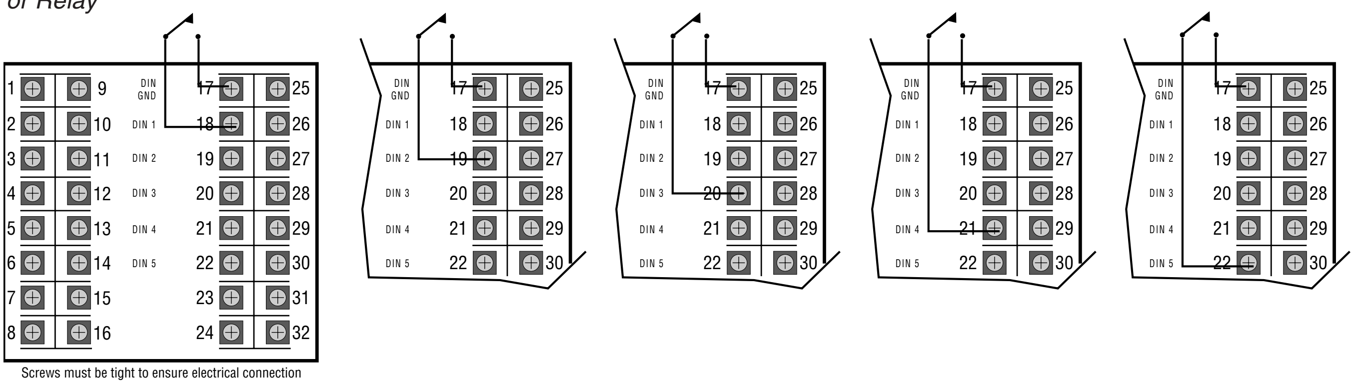
Digital Input(s)

Digital inputs can be activated in three ways: a switch (signal type), closure of a relay, or an open collector transistor. Digital inputs are only functional when that option is installed (via hardware) The controller detects the hardware and supplies the appropriate software menu.

1. Digital Inputs with a switch or relay

Wire the switch/relay between terminal 17 and the specific digital input terminal (*Figure 3.8*).

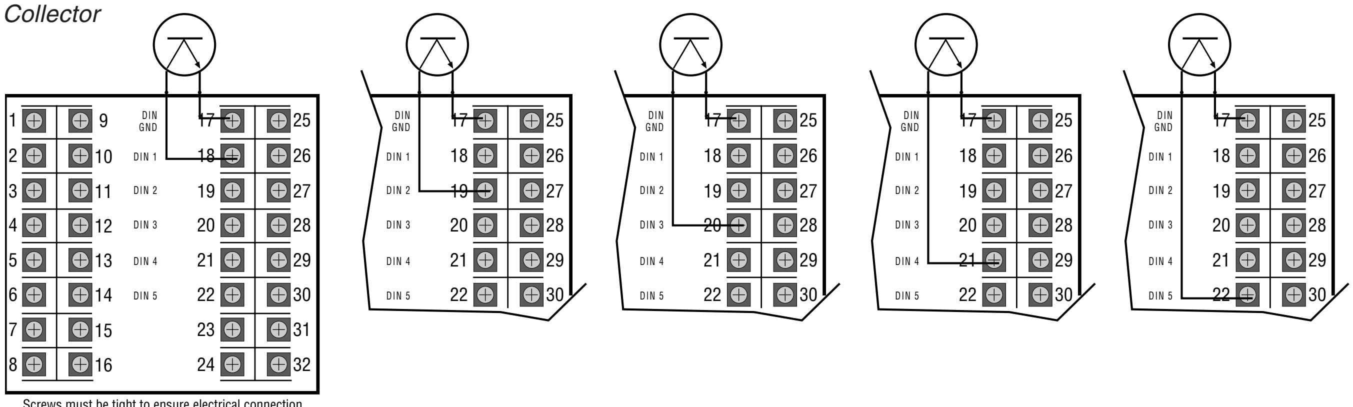
Figure 3.8
Digital inputs Wiring with a Switch or Relay



2. Digital Inputs with an Open Collector

An open collector is also called a transistor. Wire the transistor between terminal 17 and the specified digital input terminal (*Figure 3.9*)

Figure 3.9
Digital Input Wiring with an Open Collector



Remote Setpoint Option

Use terminals 13 and 14 to connect the remote setpoint signal (see *Figure 3.10*).

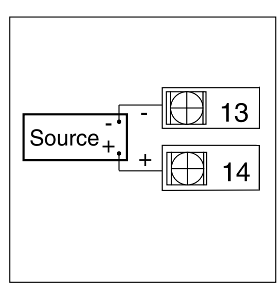


Figure 3.10
Remote Setpoint Terminals

OUTPUT MODULES

The 535-PROF output modules are used for control, alarms and retransmission. The four output module types are: **Mechanical** Relay, **Solid State** Relay (Triac), **DC Logic** (SSR Drive) and **Analog** (Milliamp)

To install these modules, plug them into any of the four output sockets on the printed circuit boards (refer to Chapter 4). The wiring is the same whether the modules are used for control, alarm or retransmission.

The diagrams on the next two pages are a guide for properly connecting the various outputs. To find out which module(s) have been installed in the controller, compare the product number on the controller label with the section Order Code in Chapter 1. This section also includes a diagram of how to wire a position proportioning output, a special application using two mechanical or two solid state relays.

NOTE:
Refer to *Figure 4.2* for location of the corresponding jumpers.
Second input jumper connector on the option board must be in either *mA* (milliamp) or *V* (voltage) position.

1. Mechanical Relay Output

- Output 1 is always Control 1.
- Outputs 1, 2 and 3 are jumper selectable for normally open and normally closed on the power supply circuit board.
- Output 4 is always configured for normally open and has reduced voltage and current ratings (see Specifications).

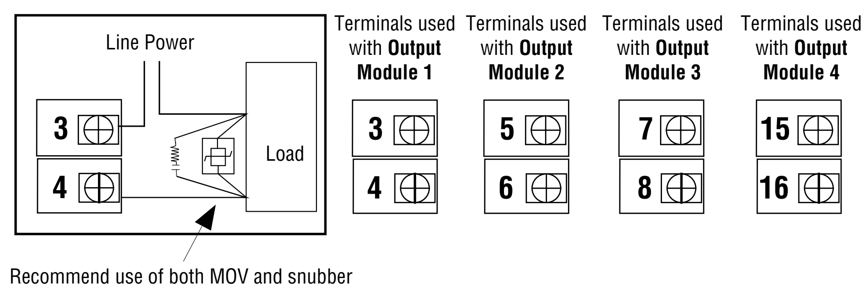


Figure 3.11
Mechanical Relay Output wiring

2. Solid State Relay (Triac) Output

- Output 1 is always Control 1.
- Respective jumper J1, J2 or J3 must be set to normally open for SSR (Triac) output.
- Output 4 is always configured for normally open and has reduced voltage and current ratings (see Specifications).

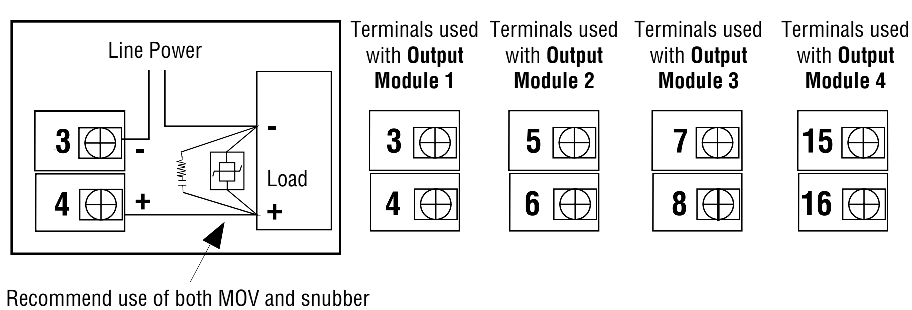


Figure 3.12
SSR Relay Output Wiring

3. DC Logic (SSR Drive) Output

- Output 1 is always Control 1.
- Respective jumper J1, J2 or J3 must be set to normally open for DC Logic output.
- Output 4 is always configured for normally open.

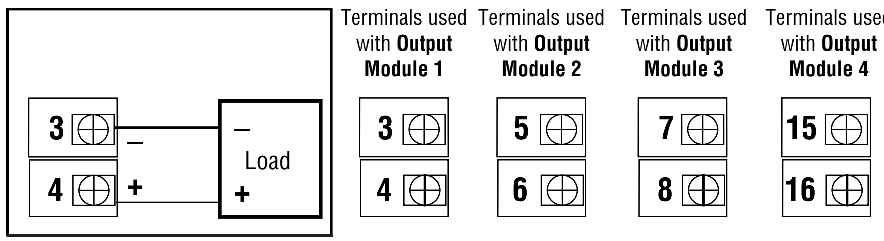


Figure 3.13
DC Logic Output Wiring

4. Milliamp Output

- Output 1 is always Control 1.
- Respective jumper J1, J2 or J3 must be set to normally open for Milliamp output.

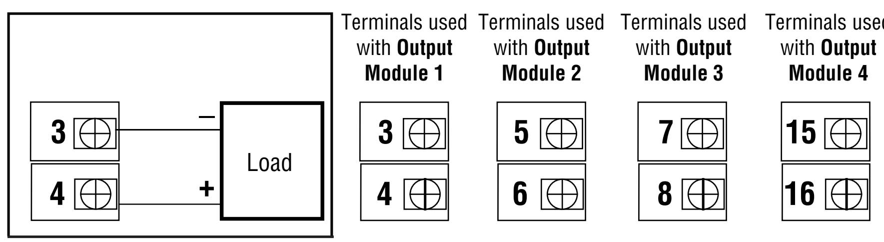


Figure 3.14
Milliamp Output Wiring

5. Position Proportioning Output (with or without Slidewire Feedback)

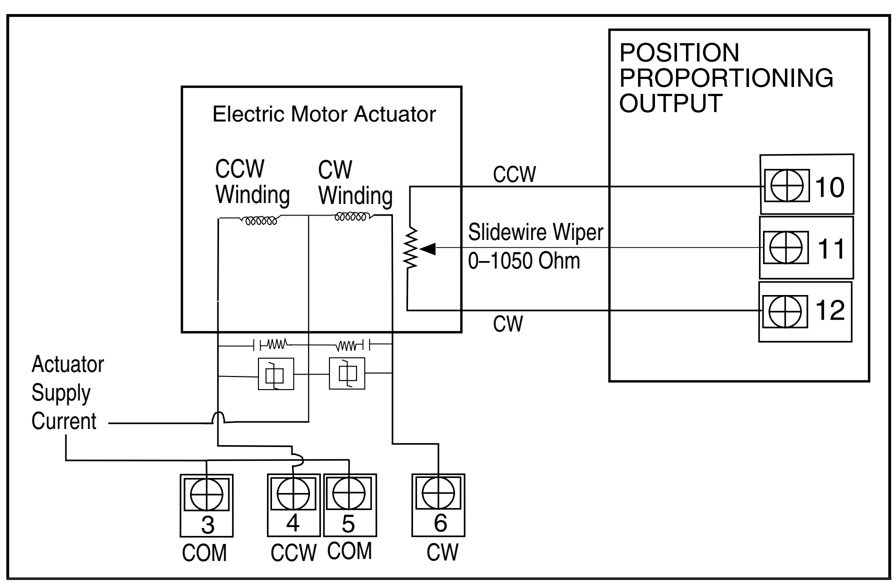


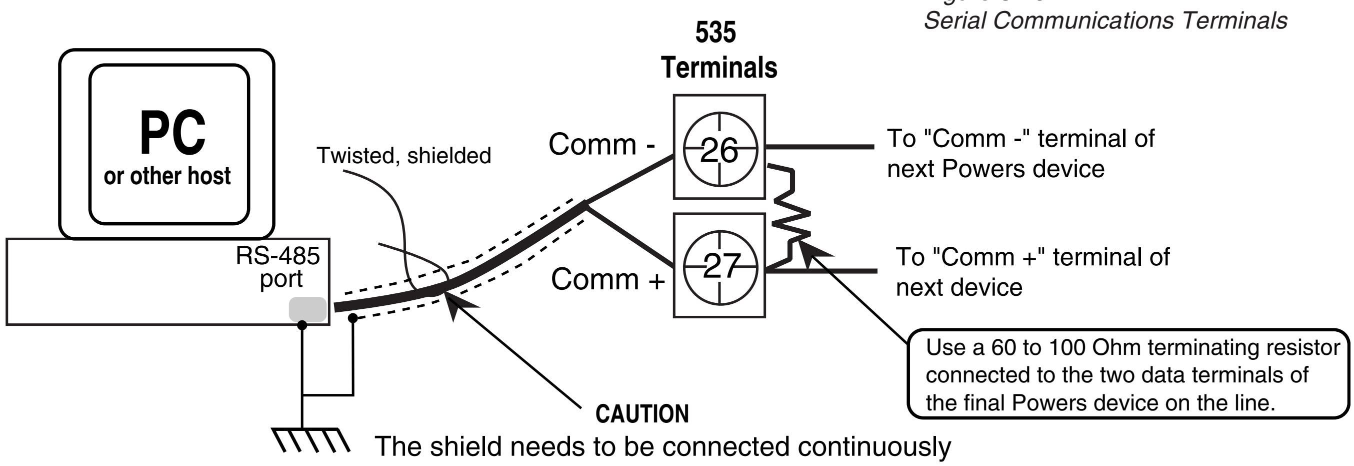
Figure 3.15
Position Proportioning Output Wiring

- Mechanical relay or solid state relay modules must be installed in output sockets 1 and 2.
- When using velocity control (no slidewire feedback), there are no connections at terminals 10, 11 and 12.
- Use of the slidewire feedback is optional

Serial Communications

A twisted shielded pair of wires should be used to interconnect the host and field units. Belden #9414 foil shield or #8441 braid shield 22-gauge wire are acceptable for most applications. The foil shielded wire has superior noise rejection characteristics. The braid shielded wire has more flexibility. The maximum recommended length of the RS 485 line is 4000 feet. Termination resistors are required at the host and the last device on the line. Some RS 485 cards/converters already have a terminating resistor. We recommend using RS-232/RS-485 converter (Product #500-485). The communication protocol is asynchronous bidirectional half-duplex, hence the leads are labelled *Comm +* and *Comm –*.

Figure 3.16
Serial Communications Terminals

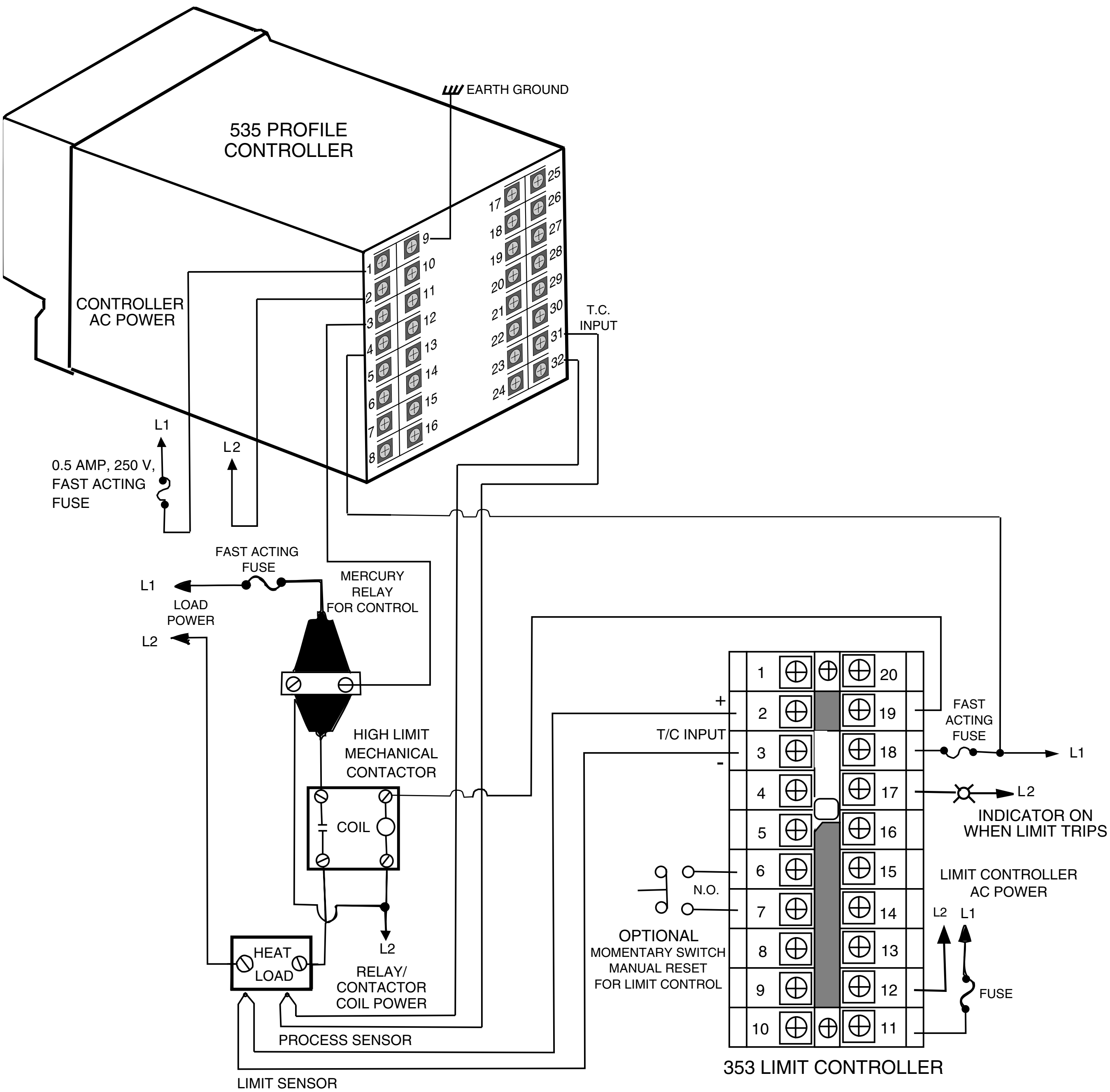


The shield needs to be connected continuously but only tied to one ground at the host. Failure to follow these proper wiring practices could result in transmission errors and other communications problems.

Limit Control

Temperature applications where abnormally high or low temperature conditions pose potential hazards for damage to equipment, product and operator. For such applications, we recommend the use of an **FM-approved temperature limit device** in conjunction with the process controller. This wiring example illustrates a typical application using the 535-PROF Process Controller with a 353 Limit Controller.

Figure 3.17
535-PROF Wiring with Limit Control



CHAPTER 4
HARDWARE SET UP

Hardware configuration determines the available outputs as well as the type of input signal. The 535-PROF controller comes factory set with the following:

- All specified module and options installed (for details, refer to the Order Code in Chapter 1).
- Process variable and remote setpoint set to accept a milliamp input
- Relay outputs set to normally open.

Alter the factory configuration of the 535-PROF, requires accessing the circuit boards, and locating the jumpers and output modules (see *Figure 4.1*).

1. With the power off, loosen the four front screws, and remove them.
2. Slide chassis out of the case by pulling firmly on the bezel.

NOTE: Hardware configuration of the controller is available at the factory; Consult an application engineer for details.

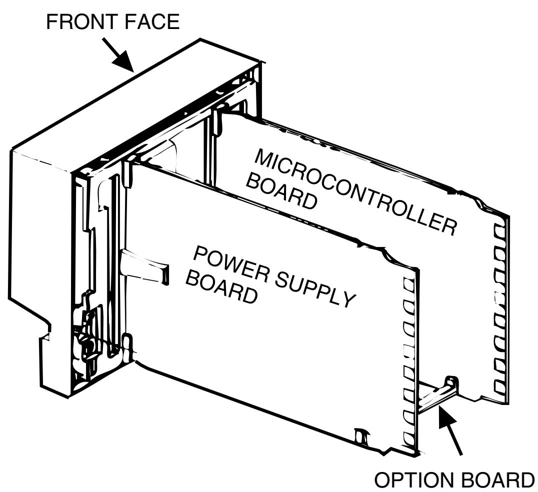


Figure 4.1
Location of Printed Circuit Boards for Hardware Configuration

A detailed view of the circuit boards appears in *Figure 4.2*.

After configuring the hardware, or if no changes are necessary, continued setting up the process as needed.

HARDWARE INPUT TYPES

The Process Variable

The 535-PROF accepts several different types of process variable signals. Set a jumper location to specify the type of input signal. Set the signal range in the software (see Chapter 5 for software menus, or Chapter 7 for applications).

The jumpers for the process variable are located on the Microcontroller Circuit Board (see *Figure 4.2*). The factory default is Milliamp. Locations are marked as follows:

V	Voltage
MA	Milliamp
TC▼	Thermocouple with downscale burnout
TC▲	Thermocouple with upscale burnout
RTD	RTD

NOTE: Thermocouple downscale and upscale burnout offers a choice in which direction the controller would react in the event of thermocouple failure. For example, in heat applications, typically, it is desirable to fail upscale (TC▲) so that the system does not apply more heat.

NOTE:
Changing the jumpers means moving the jumper connector. The jumper connector slips over the pins, straddling two rows of pins. The printed circuit boards are labeled next to the jumpers.

The Remote Setpoint

Figure 4.2 shows the location of the remote setpoint jumper. **The factory default is milliamp**. Choose from the following settings:

V Remote setpoint with voltage signal (jumper removed)
MA Remote setpoint with milliamp signal (jumper installed)

Mechanical Relays

There are three output module sockets on the Power Supply Circuit Board, and one output module on the Option Board (see *Figure 4.2*). The mechanical relay on the Power Supply Board may be configured for either normally open (NO) or normally closed (NC). A jumper located next to each socket determines this configuration. All relay output are factory set to NO (normally open).

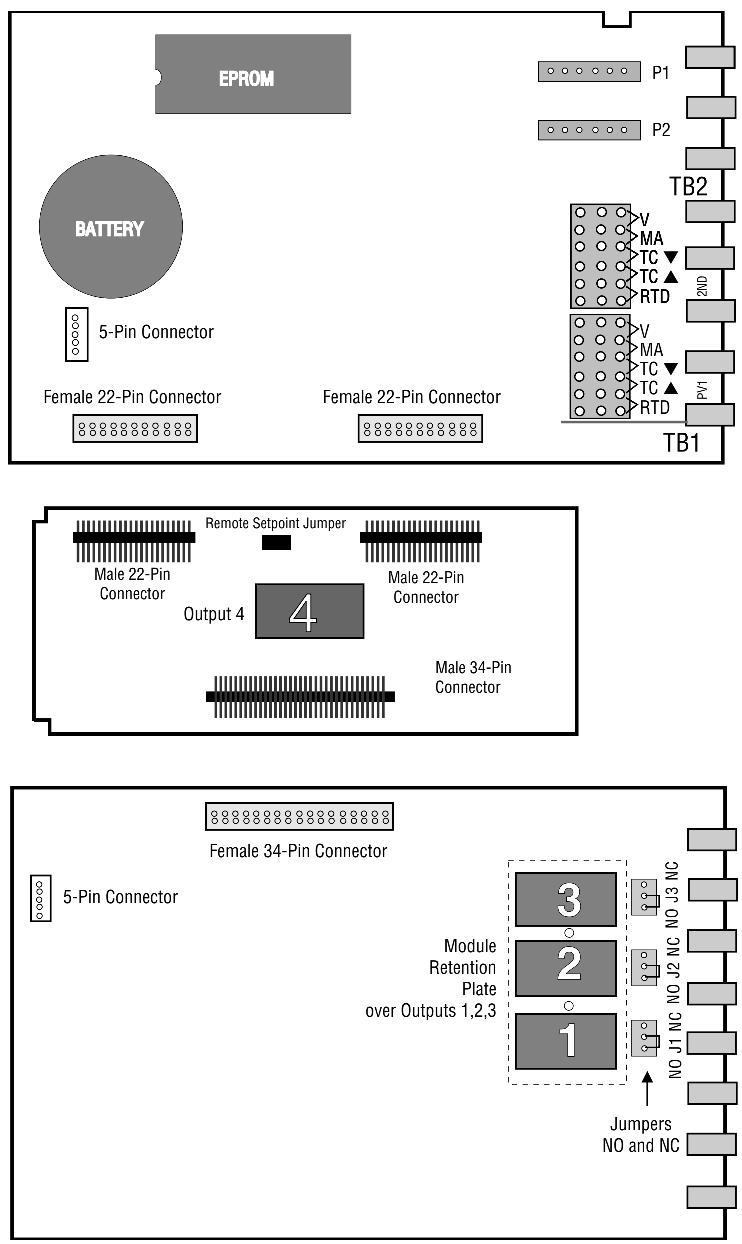


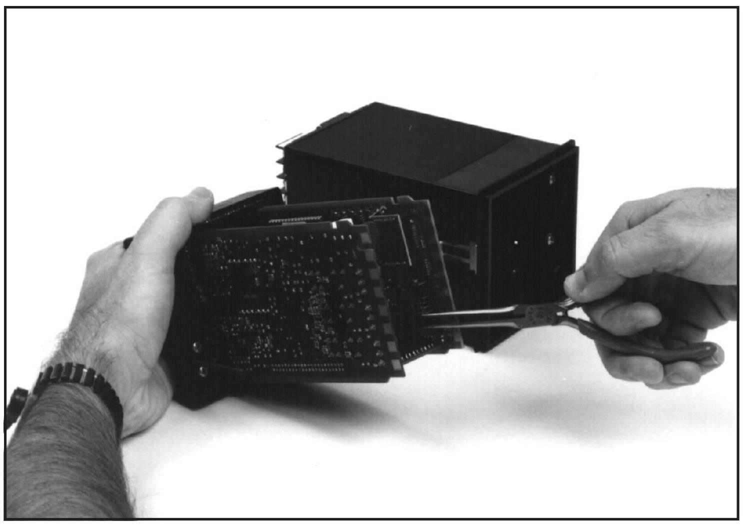
Figure 4.2
(from the top) The Microcontroller Circuit Board, the Option Board, and the Power Supply Board

ACCESSING AND CHANGING JUMPERS

Follow these instruction to change jumpers for the Process Variable, Remote Setpoint and Digital Inputs:

Equipment needed: Needle-nose pliers (optional)
Phillips screwdriver (#2)
Wrist grounding strap

1. With power off, loosen the four front screws, and remove them.
2. Side the chassis out of the case by pulling firmly on the bezel.
3. Use *Figure 4.2* to locate the jumper connector to change.
4. Using the needle nose pliers (or fingers), pull straight up on the connector and remove it from its pins, as shown in *Photo 2*. Be careful not to bend the pins.



2. Remove Jumpers

5. Find the new location of the jumper connector (again, refer to *Figure 3.2*). Carefully place it over the pins, then press connector straight down. Make sure it is seated firmly on the pins.
6. Make any other jumper changes as needed. **To alter output modules, please refer to the next section, starting with Step #3.**
7. To reassemble the controller, properly orient the chassis with board opening on top. Align the circuit boards into the grooves on the top and bottom of the case. Press firmly on the front face assembly until the chassis is all the way into the case.

   If it is difficult to slide the chassis in all the way, make sure the screws have been removed (they can block proper alignment), and that the chassis is properly oriented.
8. Carefully insert and align screws. Tighten them until the bezel is seated firmly against the gasket. **Do not overtighten.**

CAUTION!!
Static discharge can cause damage to equipment. Always use a wrist grounding strap when handling electronics to prevent static discharge.

ADDING AND CHANGING OUTPUT MODULES

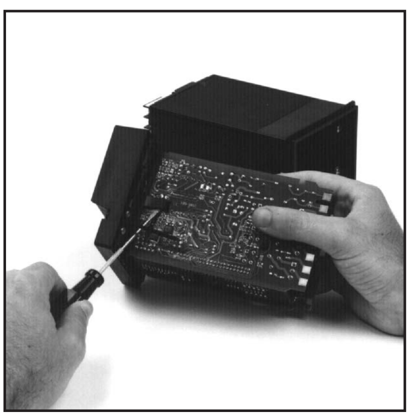
The 535-PROF has provisions for four output modules. A controller ordered with output module options already has the modules properly installed. Follow these instruction to add modules, change module type(s) or change module location(s).

Equipment needed: Wrist grounding strap
Phillips screwdriver (#2)
Small flat blade screwdriver
Wire cutters

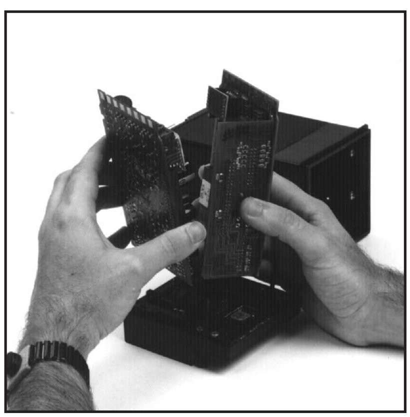
1. With power off, loosen the four front screws, and remove them.
2. Side the chassis out of the case by pulling firmly on the bezel.
3. Use a flat screwdriver to carefully pry apart the clips that hold the front face assembly to the chassis, as in Photo 3. Separate the printed circuit board assembly from the front face assembly. Use care not to break the clips or scratch the circuit boards.
4. As shown in *Photo 4*, carefully pry apart, using hands or a small flat screwdriver, the smaller Option board and the Power Supply board (the one with 3 modules).
5. **To change modules 1, 2 or 3:**

   Output modules 1, 2, and 3 are firmly held in place by a retention plate and tie wrap. Carefully snip the tie wrap with a wire cutter. To prevent damage to the surface mount components, ALWAYS snip the tie wrap on TOP of the Retention Plate, as shown in *Photo 5*.

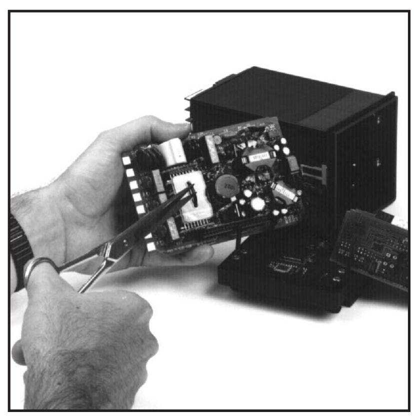
   Remove the retention plate.



3. Pry Clips



4. Separate Boards



5. Remove Retention Plate

6. **To change module 4:**
   Output Module 4 (on the Option board) is also held in place by a tie wrap. Snip tie wrap to remove module as shown in *Photo 6*.
7. *Figure 4.3* shows a representation of an output module. Inspect the module(s) to make sure that the pins are straight.
8. To install any module, align its pins with the holes in the circuit board, and carefully insert the module in the socket. Press down on the module until it is firmly seated; refer to *Photo 7*.

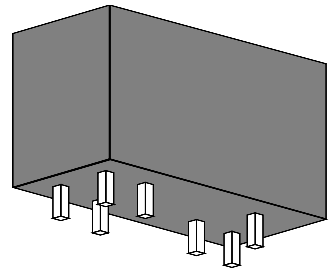
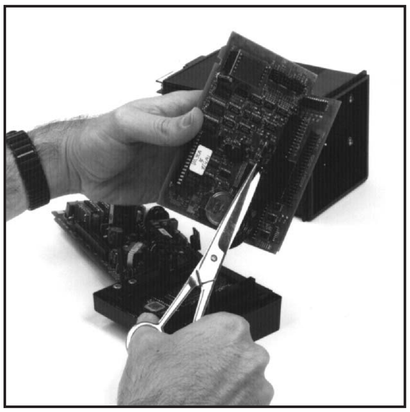
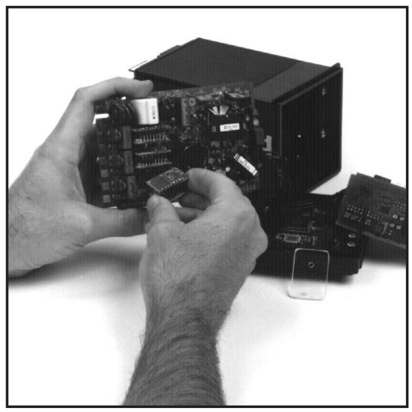


Figure 4.3
Representation of Module



6. Snip Tie Wrap



7. Add/Change Module

9. Replace tie wraps for all the modules (the Retention Plate and Output Module 4) with new ones before reassembling the controller.
   Failure to use the tie wraps may result in loosening of the module and eventual failure. All separately ordered modules should come with a tie wrap. Extra sets of tie wraps are available by ordering Part #535-PROF-665.
   NOTE: For greatest accuracy, calibrate all milliamp modules added for retransmission as per the instructions in Appendix 2.
10. Rejoin the circuit boards by aligning the pins of their connectors, then squeezing the board(s) together. Make sure that all three printed circuit boards are properly seated against one another; check along side edges for gaps. Make sure the cable assemblies are not pinched.
11. To reattach the board assembly to the front face assembly, align the boards (with the open area on top) into the slots of the font face assembly. The clips should snap into place.
12. To reassemble the controller, properly orient the chassis with board opening on top. Align the circuit boards into the grooves on the top and bottom of the case. Press firmly on the front face assembly until the chassis is all the way into the case.
    If it is difficult to slide the chassis in all the way, make sure the screws have been removed (they can block proper alignment), and that the chassis is properly oriented.
13. Carefully insert and align screws. Tighten them until the bezel is seated firmly against the gasket. **Do not overtighten.**

SPECIAL COMMUNICATIONS MODULE

A special communications module is available for the 535-PROF; see order code in Chapter 1 for details.

Equipment needed: Wrist grounding strap
Phillips screwdriver (#2)
Small flat blade screwdriver

1. Before installing the communications module, set up the hardware wiring for the application. See Chapter 4 for details.
2. With power off, loosen the four front screws, and remove them.
3. Side the chassis out of the case by pulling firmly on the bezel. Do not detach the board assembly form the front face of the controller.
4. Orient the Communications Module as shown, and attach it to Connectors P1 and P2 as shown in *Figure 4.4*.

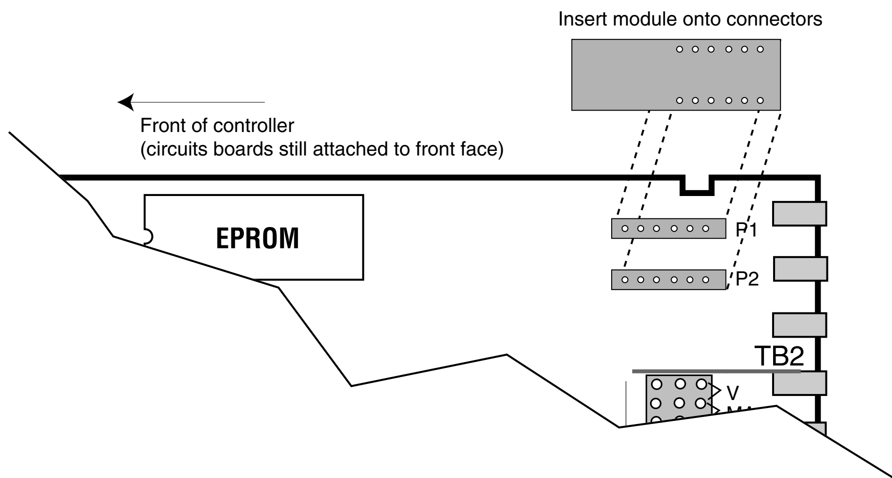


Figure 4.4
Install Communications Module onto Microcontroller Board

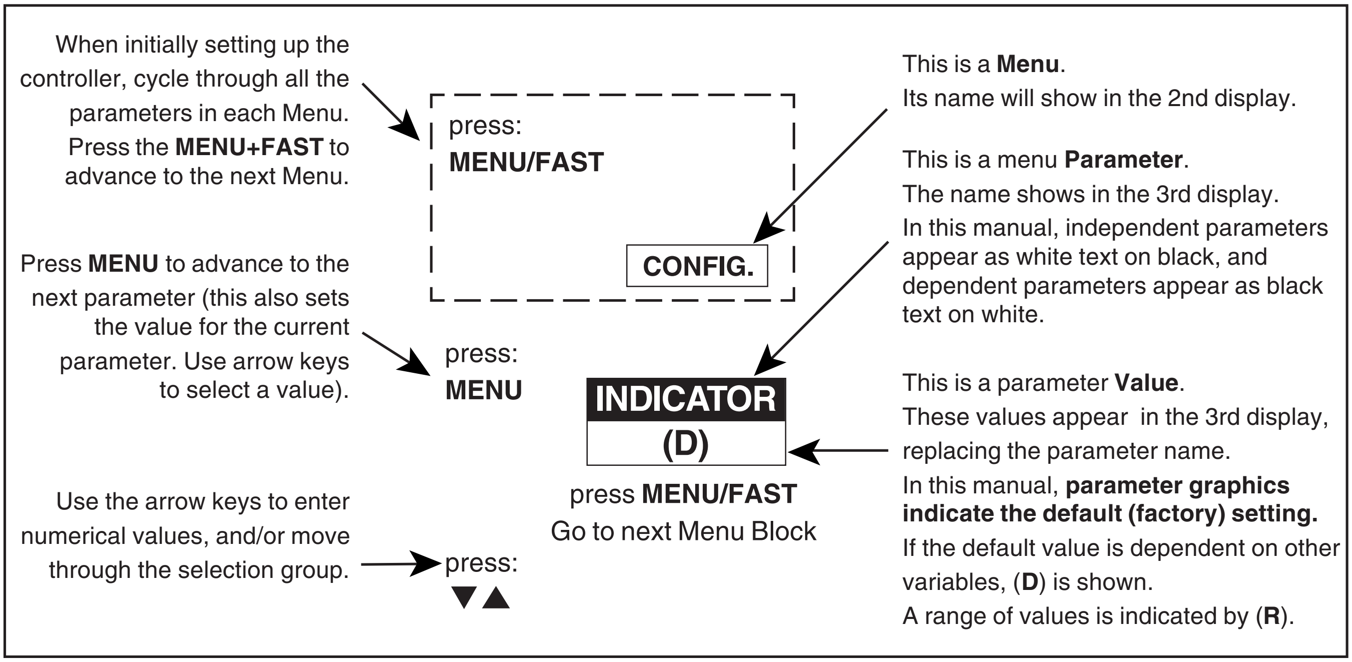
5. To reassemble the controller, properly orient the chassis with board opening on top. Align the circuit boards into the grooves on the top and bottom of the case. Press firmly on the front face assembly until the chassis is all the way into the case.

   If it is difficult to slide the chassis in all the way, make sure the screws have been removed (they can block proper alignment), and that the chassis is properly oriented.
6. Carefully insert and align screws. Tighten them until the bezel is seated firmly against the gasket. **Do not overtighten.**

CHAPTER 5
SOFTWARE CONFIGURATION

The software configuration menus of the 535-PROF contain user-selected variables that define the action of the controller. Read through this section before making any parameter adjustments to the controller.

Figure 5.1
Menu Flowchart for Set Up



MENUS

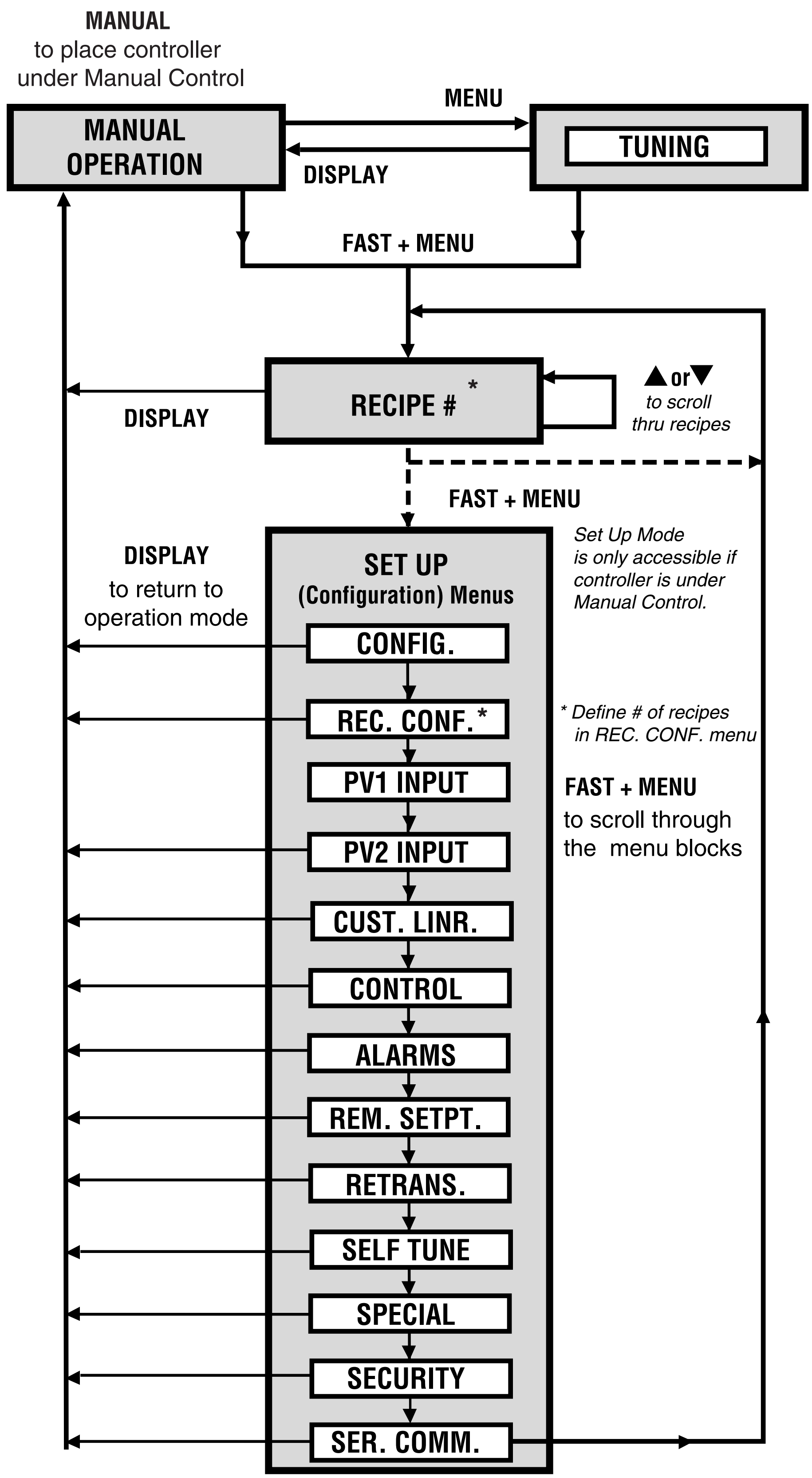
In Set Up mode, there are 13 sets of options that control different aspects of 535-PROF operation; in Tuning mode, there is one. Each set of options is a menu. When traversing the two modes, the menu names appear in the 2nd display.

CONFIG	Mode selection and input/output hardware assignments
REC. CONF.	General recipe options
PV1 INPUT	1st process variable input options
PV2 INPUT	2nd process variable input options
CUST. LINR.	Linearization curve options for PV1 input.
CONTROL	Control algorithm options
ALARMS	Alarm options
REM. SETPT.	Controller remote setpoint options
RETRANS.	Retransmission output options
SELF TUNE	Self tune algorithm options
SPECIAL	Special feature options
SECURITY	Security functions
SER.COMM.	Serial Communications options (requires comm. board)
RECIPE #	Individual recipe configuration
TUNING	Tuning parameters configuration (see Chapter 6)

CAUTION!
All software changes occur in real time; always perform set up functions under manual operation.

NOTE: For information about the Tuning menu/mode, refer to Chapter 6. For more information about set up parameters and 535-PROF applications, refer to Chapter 7.

Figure 5.2
Configuration Flowchart



PARAMETERS

TUNE PT.	CONTACT 1
AUTOMATIC	MANUAL

Figure 5.3
Independent vs. Dependent Parameters

Within each menu are **parameters** for particular control functions. Select values for each parameter depending on the specific application. Use the **MENU** key to access parameters for a particular menu; the parameter name will replace the menu name in the 2nd display, and the parameter value will show in the 3rd display.

This chapter outlines **all** the available parameters for the 535-PROF. Some parameters are **independent** of any special configuration, and others are **dependent** on the individual configuration. This manual displays these two types of parameters differently; refer to *Figure 5.3*. A special feature of the 535-PROF, called **Smart Menus**, determines the correct parameters to display for the specific configuration, so not all the listed parameters will appear.

CONFIGURATION AND OPERATION

Figure 5.3 shows the relationships among the different modes of the 535-PROF and the configuration menus:

- **SET UP** menus can only be accessed from manual control. To transfer the 535-PROF from automatic to manual control, press **MANUAL**.
- To access the **SET UP** menus, hold down **FAST** and press **MENU** until CONFIG appears in the 2nd display. The **MENU** key will also illuminate.
- To access the parameters for a particular menu, press **MENU**.
- To select a parameter value, use ▲ and ▼. Press **MENU** to advance to the next parameter, or **FAST+MENU** to advance to the next menu.
- To advance to the next menu, press **FAST+MENU**.
- **TUNING** mode (and the **TUNING** menu) can be accessed from either automatic or manual control. To access the tuning menu, press **MENU** .
- **RECIPE SET UP** mode (and the **RECIPE #** menu) can be accessed from either automatic or manual control.
- To access the **RECIPE #** menu, press **FAST+MENU**.
- To return controller to manual control, press **DISPLAY** or **SET PT**.

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

A key to these functions (as shown below) appears at the bottom of every page in the menu section of this chapter.

WHERE TO GO NEXT

- For information about all the software menus and parameters, continue reading this chapter. Refer to Appendix D for a quick-reference flowchart of all menus and parameters.
- For information about the installed options on the 535-PROF, compare the product label on top of the controller to the order code in Chapter 1.
- To mount the controller and configure the wiring of the 535-PROF for inputs and outputs, see Chapter 3.
- To alter the output module and jumper configuration of the controller, see Chapter 4.

- For information about applications for the 535-PROF, see Chapter 7.
- For more information about the Tuning function of the 535-PROF, see Chapter 6.

SOFTWARE MENUS AND PARAMETERS

CONFIG.

CONFIG.

1. CTRL. TYPE

Defines the type of control output(s).

D	STANDARD	Standard control output, no special algorithms
•	POS. PROP.	Position proportioning control output
•	STAGED	Staged outputs
•	DUPLEX	Duplex outputs

CTRL. TYPE
STANDARD

2. LINE FREQ

Defines the power source frequency.

- • 50 HZ
- D 60 HZ

LINE FREQ
60 Hz

3. PV SOURCE

Defines how the PV input is derived from PV1 and PV2.

D	PV1	Use PV1
•	1/2:SWITCH	Use PV1 until contact/com selects PV2
•	1/2:BACKUP	Use PV2 if PV1 is broken
•	PV1–PV2	Use PV1–PV2
•	PV1+PV2	Use PV1+PV2
•	AVG. PV	Use the average of PV1 and PV2
•	HI SELECT	Use PV1 or PV2 (whichever is greater)
•	LO SELECT	Use PV1 or PV2 (whichever is less)

PV SOURCE
PV1

NOTE:
PV1 and PV2 can be of different types and different range.

4. REM. SETPT.

Selects function of the remote setpoint.

- D DISABLED
- • ENABLED

REM. SETPT.
DISABLED

5. OUTPUT 2

Defines the function of the second output.

•	ALM/EV:ON	For an alarm or event output
•	ALM/EV:OFF	For an alarm or event output
•	RETRANS.	Retransmission
•	COMM. ONLY	Output addressable only through communication
D	OFF	Completely deactivates the output

OUTPUT 2
OFF

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

OUTPUT 3
OFF

6. **OUTPUT 3**

Defines the function of the third output.

•	ALM/EV:ON	For an alarm or event output
•	ALM/EV:OFF	For an alarm or event output
•	RETRANS.	Retransmission
•	COMM. ONLY	Output addressable only through communications
D	OFF	Completely deactivates the output

OUTPUT 4
OFF

7. **OUTPUT 4**

Defines the function of the fourth output.

•	ALM/EV:ON	For an alarm or event output
•	ALM/EV:OFF	For an alarm or event output
•	RETRANS.	Retransmission
•	COMM. ONLY	Output addressable only through communications
D	OFF	Completely deactivates the output

ANLG.RNG.:1
4-20 mA

8. **ANLG. RNG.:1**

Defines the output signal for the first output.

D 4–20 mA
• 0–20 mA
• 20–4 mA
• 20–0 mA

ANLG.RNG.:2
4-20mA

9. **ANLG. RNG.:2**

Defines the output signal for the second output.

D 4–20 mA
• 0–20 mA
• 20–4 mA
• 20–0 mA

ANLG.RNG.:3
4-20mA

10. **ANLG. RNG.:3**

Defines the output signal for the third output.

D 4–20 mA
• 0–20 mA
• 20–4 mA
• 20–0 mA

ANLG.RNG.:4
4-20mA

11. **ANLG. RNG.:4**

Defines the output signal for the fourth output.

D 4–20 mA
• 0–20 mA
• 20–4 mA
• 20–0 mA

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

12. CONTACT 1

Defines the operation of the first digital input.

CONTACT 1
MANUAL

•	RECIPE. 1–7	Chooses the recipe number (uses Binary contact 1-3)
•	SETPT. 1–8	Chooses Local setpoint 1–8 (uses BCD contacts 1–4)
•	REM. SETPT.	Makes the remote setpoint active
D	MANUAL	Trips the controller to manual control
•	2ND. SETPT.	Makes the second setpoint active
•	2ND. PID	Makes the second set of PID values active
•	ALARM ACK.	Acknowledges alarms
•	RST. INHBT.	Deactivates the reset term
•	D.A./R.A.	Switches the control action
•	STOP A/T	Suspends the adaptive tune function
•	LOCK. MAN.	Locks controller in manual control
•	UP KEY	Remote ▲ function
•	DOWN KEY	Remote ▼ function
•	MENU KEY	Remote **MENU** key function
•	FAST KEY	Remote **FAST** key function
•	DISP KEY	Toggle between SP DEV or OUT%
•	COMM. ONLY	Status readable only through communications
•	START REC.	Runs the most recently selected recipe (default is RECIPE 1). Aborts recipe when deactivated.
•	HOLD REC.	Holds running recipe at current position. Resumes running of recipe when deactivated.
•	RESET REC.	Resets a running or held recipe to the beginning. For linked recipes, resets to the beginning of the first linked recipe. No action when deactivated.
•	ABORT REC.	Aborts running or held recipe. No action when deactivated.
•	NEXT SEG.	Advances running or held recipe to the end of the current ramp or soak segment. No action when deactivated
•	PV2.SWITCH	Switches between PV1 and PV2

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

CONTACT 2
REM. SETPT.

13. CONTACT 2

Defines the operation of the second digital input.

D REM. SETPT.
- MANUAL
- 2ND. SETPT.
- 2ND. PID
- ALARM ACK.
- RST. INHBT.
- D.A./R.A.
- STOP A/T
- LOCK. MAN.
- UP KEY
- DOWN KEY
- MENU KEY
- FAST KEY
- DISP KEY
- COMM. ONLY
- START REC.
- HOLD REC.
- RESET REC.
- ABORT REC.
- NEXT SEG.
- PV2.SWITCH

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

14. CONTACT 3

Defines the operation of the third digital input.

CONTACT 3
2ND. SETPT.

- REM. SETPT.
- MANUAL
- D 2ND. SETPT.
- 2ND. PID
- ALARM ACK.
- RST. INHBT.
- D.A./R.A.
- STOP A/T
- LOCK. MAN.
- UP KEY
- DOWN KEY
- MENU KEY
- FAST KEY
- DISP KEY
- COMM. ONLY
- START REC.
- HOLD REC.
- RESET REC.
- ABORT REC.
- NEXT SEG.
- PV2.SWITCH

CONTACT 4
2ND. PID

15. CONTACT 4

Defines the operation of the fourth digital input.

- REM. SETPT.
- MANUAL
- 2ND. SETPT.
- D 2ND. PID
- ALARM ACK.
- RST. INHBT.
- D.A./R.A.
- STOP A/T
- LOCK. MAN.
- UP KEY
- DOWN KEY
- MENU KEY
- FAST KEY
- DISP KEY
- COMM. ONLY
- START REC.
- HOLD REC.
- RESET REC.
- ABORT REC.
- NEXT SEG.
- PV2.SWITCH

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

16. CONTACT 5

This defines the operation of the fifth digital input.

CONTACT 5
ALARM ACK.

- • REM. SETPT.
- • MANUAL
- • 2ND. SETPT.
- • 2ND. PID
- **D** ALARM ACK.
- • RST. INHBT.
- • D.A./R.A.
- • STOP A/T
- • LOCK. MAN.
- • UP KEY
- • DOWN KEY
- • MENU KEY
- • FAST KEY
- • DISP KEY
- • COMM. ONLY
- • START REC.
- • HOLD REC.
- • RESET REC.
- • ABORT REC.
- • NEXT SEG.
- • PV2.SWITCH

17. LOOP NAME

A 9-character message associated with the loop. The first character of the 3rd display will be flashing. To enter message, press ▲ and ▼ keys to scroll through character set. Press **FAST** key to enter the selection and move to next digit. Press **MENU** key to advance to next parameter.

D LOOP ONE

LOOP NAME
LOOP ONE

REC. CONF.

REC. CONF.

1. RECIPES

Defines the number of recipes available in the 535.

- • NONE
- **R** 1 to 20
- **D** 1

RECIPES
1

2. TIME BASE

Defines time base units for recipes.

- **D** HOURS:MIN.
- • MIN:SEC.

TIME BASE
HOUR:MIN.

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

RAMP UNIT
TIME

3. **RAMP UNIT**

Defines ramp segment terms.

- D TIME
- • RATE

SP START
PV

4. **SP START**

Defines initial value for the first ramp segment's setpoint.

• IDLE SP	the IDLE SP is the first value
D PV	The starting value will be adjusted to account for the initialPV value

GUAR.SOAK
OFF

5. **GUAR. SOAK**

Selects whether guaranteed soak is used during each soak segment.

D OFF	guaranteed soak will not occur
• START SEG.	guaranteed soak can occur only at the start of a soak segment
• WHOLE SEG.	guaranteed soak can occur at the start of or at anytime during a soak segment

EVT.:1 OUT.
NONE

6. **EVT.:1 OUT.**

Selects which output is assigned to event 1. To assign a numerical value (non-default), the corresponding output needs to be set to ALM/EV:ON or ALM/EV:OFF.

- D NONE
- • 2
- • 3
- • 4

EVT.:2 OUT.
NONE

7. **EVT.:2 OUT.**

Selects which output is assigned to event 2. To assign a numerical value (non-default), the corresponding output needs to be set to ALM/EV:ON or ALM/EV:OFF.

- D NONE
- • 2
- • 3
- • 4

EVT.:3 OUT.
NONE

8. **EVT.:3 OUT.**

Selects which output is assigned to event 3. In order to assign a numerical value (non-default), the corresponding output needs to be configured as ALM/EV:ON or ALM/EV:OFF.

- D NONE
- • 2
- • 3
- • 4

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

9. HOLD EVT.

Selects whether or not the last segment's event(s) will be held active after the recipe has been successfully completed.

- **D** DISABLED
- • ENABLED

HOLD EVT.
DISABLED

PV1 INPUT

PV1 INPUT

1. PV1 TYPE

Specifies the particular sensor range or input range for PV1.

T/C	RTD	VOLTAGE	CURRENT (mA)
D J T/C	**D** DIN RTD	**D** 1-5 V	**D** 4-20mA
• E T/C	• JIS RTD	• 0-5 V	• 0-20mA
• K T/C	• SAMA RTD	• 0-10 mV	
• B T/C		• 0-30 mV	
• N T/C		• 0-60 mV	
• R T/C		• 0-100 mV	
• S T/C		• +/– 25 mV	
• T T/C			
• W T/C			
• W5 T/C			
• PLAT.II T/C			

PV1 TYPE
J T/C

2. DEG. F/C/K

Selects the PV1 temperature units if using a thermocouple or RTD.

- **D** FAHR.
- • CELSIUS
- • KELVIN

DEG. F/C/K
FAHR

3. DECIMAL

Specifies the PV1 decimal point position.

- **D** XXXXX
- • XXXX.X
- • XXX.XX
- • XX.XXX
- • X.XXXX

DECIMAL
XXXXX

4. LINEARIZE

Specifies if the PV1 input is to be linearized. NOTE: T/C's and RTD's are automatically linearized.

- **D** NONE
- • SQR. ROOT — Square root linearization is activated.
- • CUSTOM — 15-point custom linearization curve is activated.

LINEARIZE
NONE

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

LOW RANGE
(D)

5. LOW RANGE

Specifies the engineering unit value corresponding to the lowest PV1 input value, e.g. 4 mA.

R –9999 to 99999 Max. is **HI RANGE**
D Dependent on the input selection

HI RANGE
(D)

6. HI RANGE

Specifies the engineering unit value corresponding to the highest PV1 input value, e.g., 20mA.

R -9999 to 99999 Min. is LOW RANGE
D Dependent on the input selection

SP LO LIM.
(D)

7. SP LO LIM.

Defines the lowest setpoint value that can be entered from the front panel only.

R –9999 to 99999 Max. is SP HI LIM. Min. is LOW RANGE
D Dependent on the **LOW RANGE** value.

SP HI LIM.
(D)

8. SP HI LIM.

Defines the highest setpoint value that can be entered from the front panel only.

R –9999 to 99999 Min. is SP LO. LIM. Maximum is HI RANGE
D Dependent on **HI RANGE**

CAUTION!
Set parameter values in the presented order—dependent parameters are dynamically related and changing values of one can alter the value of another.

For example, if **SP LO LIM**. is set to 0, and then thermocouple type is changed to **B T/C**, the **SP LO LIM**. value will change to 104° (the low limit of a type B thermocouple).

SP RAMP
OFF

9. SP RAMP

Defines the rate of change for setpoint changes.

D OFF Deactivates this function
R 1 to 99999 units per hour

FILTER
0

10. FILTER

Setting for the low pass PV1 input filter.

R 0 to 120 seconds
D 0 seconds

OFFSET
0

11. OFFSET

Defines the offset to PV1 in engineering units.

R –9999 to 99999
D 0

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

12. GAIN

Defines the gain to PV1.

R 0.100 to 10.000
D 1.000

GAIN
1.000

13. RESTORE

Defines the control mode when a broken PV1 signal is restored.

D LAST MODE
- MANUAL
- AUTOMATIC
- START REC.
- RESUME.REC.
- HOLD REC.

RESTORE
LAST MODE

PV2 INPUT

PV2 INPUT

1. PV2 SETUP

Defines function of PV2

D	SAME.AS.PV1	All PV2 parameters are set to the same values as PV1 (no further parameters will appear)
•	NOT PV1	Enables user to enter different values for the following PV2 parameters

PV2 SETUP
SAME.AS.PV1

2. PV2 TYPE

Selects the particular sensor or input range for PV2

T/C	RTD	VOLTAGE	CURRENT (mA)
D J T/C	**D** DIN RTD	**D** 1-5 V	**D** 4-20mA
• E T/C	• JIS RTD	• 0-5 V	• 0-20mA
• K T/C	• SAMA RTD	• 0-10 mV	
• B T/C		• 0-30 mV	
• N T/C		• 0-60 mV	
• R T/C		• 0-100 mV	
• S T/C		• +/– 25 mV	
• T T/C			
• W T/C			
• W5 T/C			
• PLAT.II T/C			

PV2TYPE
J T/C

3. DECIMAL

Specifies the PV2 decimal point position.

D XXXXX
- XXXX.X
- XXX.XX
- XX.XXX
- X.XXXX

DECIMAL
XXXXX

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

LINEARIZE
NONE

4. LINEARIZE

Specifies if the PV2 input is to be linearized. Thermocouples and RTD's are automatically linearized.

D NONE
- SQR. ROOT — Square root linearization is activated.

LOW RANGE
(D)

5. LOW RANGE

Specifies the engineering unit value corresponding to the lowest PV2 input value, e.g. 4 mA.

R –9999 to 99999 — Max. is **HI RANGE**
D Dependent on the input selection

HI RANGE
(D)

6. HI RANGE

Specifies the engineering unit value corresponding to the highest PV2 input value, e.g. 20 mA.

R -9999 to 99999 — Min. is **LOW RANGE**
D Dependent on the input selection

FILTER
0

7. FILTER

Setting for the low pass PV2 input filter.

R 0 to 120 seconds
D 0 seconds

OFFSET
0

8. OFFSET

Defines the offset to PV2 in engineering units.

R –9999 to 99999
D 0

GAIN
1.000

9. GAIN

Defines the gain for PV2.

R 0.100 to 10.000
D 1.000

RESTORE
LAST MODE

10. RESTORE

Defines the control mode when a broken PV2 signal is restored.

D LAST MODE
- MANUAL
- AUTOMATIC
- START REC.
- RESUME.REC.
- HOLD REC.

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

CUST. LINR.

CUST. LINR.

Defines a custom linearization curve for PV1, if selected. Points 1 and 15 are fixed to the low and high end of the input range and require only setting a corresponding PV value. Points 2 through 14 (the Xth points) require setting both the input and PV values.

It is not necessary to use all 15 points. Whenever the **XTH INPUT** becomes the high end of the range, that will be the last point in the linearization table.

1. **1ST. INPUT**
   Specifies the input signal corresponding to the first point.
   D The low end of the appropriate input range (e.g. 4.00 mA)

   1ST. INPUT
   (D)

2. **1ST. PV**
   Specifies the engineering unit value corresponding to the first point.
   R –9999 to 99999
   D 0

   1ST. PV
   0

3. **XTH. INPUT**
   Specifies the input signal corresponding to the XTH point (X is 2 to 14).
   R Any value greater than the first input
   D The low end of the appropriate input range (e.g. 4.00 mA)

   XTH INPUT
   (D)

4. **XTH. PV**
   Specifies the unit value corresponding to the XTH point (X is 2 to 14).
   R –9999 to 99999
   D 0

   XTH PV
   0

5. **15TH. INPT.**
   Specifies the input signal corresponding to the 15th point.
   R –9999 to 99999 Minimum is **[XTH-1] INPUT**
   D The high end of the appropriate input range (e.g. 20.00 mA)

   15TH INPT.
   (D)

6. **15TH. PV**
   Specifies the engineering unit value corresponding to the 15th point.
   R –9999 to 99999
   D 0

   15TH PV
   0

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

CONTROL

CONTROL

For configuring the choices for the control algorithm.

ALGORITHM
PID

1. ALGORITHM

Defines the type of control algorithm.

- **D** PID
- • PI
- • PD
- • P
- • ON/OFF
- • PID:ON/OFF — For Duplex applications using PID for the first output and on/off for the second output

D. SOURCE
PV

2. D. SOURCE

Selects the variable for the derivative action.

- **D** PV — Derivative term will not react when setpoint changes
- • DEVIATION — Derivative term will react when setpoint changes

ACTION:1
REVERSE

3. ACTION:1

Defines the action of the first control output.

- • DIRECT
- **D** REVERSE

PV BREAK
(D)

4. PV BREAK

Defines the manual output level if the process variable input is lost. Choose values based on the process type.

Standard Control	On/Off Control	Velocity Prop Control
• –5 to 105%	• ON	• CW
D 0	**D** OFF	• CCW
		D OUTS. OFF

LOW OUT
0

5. LOW OUT.

Defines the lowest output value that can be achieved in automatic control.

- **R** 0 – 100% — Max is HIGH OUT
- **D** 0%

HIGH OUT.
100

6. HIGH OUT.

Defines the highest output value that can be achieved in automatic control.

- **R** 0 – 100% — Min is LOW OUT
- **D** 100%

ACTION:2
DIRECT

7. ACTION:2

Defines the action of the second control output.

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

D DIRECT
• REVERSE

8. P.P. TYPE

Defines the type of position proportioning algorithm. Choose values based on the process.

Feedback option installed	Feedback option not installed
D SLIDEWIRE	• SLIDEWIRE
• VELOCITY	**D** VELOCITY

P.P. TYPE
(D)

9. CCW TIME

Defines the time it takes a motor to fully stroke counter clockwise.

R 1 to 200 seconds
D 60 seconds

CCW TIME
60

10. CW TIME

Defines the time it takes a motor to fully stroke clockwise .

R 1 to 200 seconds
D 60 seconds

CW TIME
60

11. MIN. TIME

Defines the minimum amount of time the controller must specify for the motor to be on before it takes action.

R 0.1 to 10.0 seconds
D 0.1 seconds

MIN. TIME
0.1

12. S/W RANGE

Specifies the full range resistance of the slide (e.g., 100 ohms)

R 0–1050 Ohms
D 100 Ohms

S/W RANGE
100

13. OPEN F/B

Defines the feedback ohm value corresponding to full open (100% output).

R 0 to **S/W RANGE**
D Dependent on **S/W RANGE** value

OPEN F/B
(D)

14. CLOSE F/B

Defines the feedback ohm value corresponding to full close (0% output).

R 0 to **S/W RANGE**
D 100 Ohms

CLOSE F/B
100

15. OUT1 STOP

This defines the stopping point for control output 1 when staging outputs.

R 1 to 100%
D 50%

OUT1 STOP
50

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

OUT2 STRT.
50

16. **OUT2 STRT.**

Defines the starting point for control output 2 when staging outputs.

R 0 to 99%
D 50%

ALARMS

ALARMS

ALM. TYPE:1
OFF

1. **ALM. TYPE:1**

Defines the type of alarm for alarm 1.

•	HIGH ALRM.	
•	LOW ALARM	
•	HIGH/LOW	Separate High & Low alarm setpoints in one alarm
•	BAND	
•	DEVIATION	
•	MANUAL	Causes an alarm when in manual control
•	REMOTE SP	Causes an alarm when in Remote Setpoint
•	RATE	Selects a rate-of-change alarm
D	OFF	Deactivates the first alarm

ALM. SRC:1
PV

2. **ALM. SRC:1**

Selects the source of the value being monitored by HIGH, LOW or HIGH/LOW alarm 1.

D PV
- SP
- RAMP SP
- DEVIATION
- OUTPUT
- PV2

ALARM SP:1
0.0%

3. **ALARM SP:1**

Specifies the alarm set point for alarm 1 (except HIGH/LOW)

For **HIGH** or **LOW** alarms:

If **ALM.SRC.:1** = OUTPUT	If **ALM.SRC.:1** = any other type
R 0.0% to 100.0%	**R** **LOW RANGE to HI RANGE**
D 0.0%	**D** 0

For **BAND** alarms:

R 1 to 99999
D 0

For **DEVIATION** or **RATE** alarms:

R -9999 to 99999
D 0

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

4A. HIGH SP:1

Specifies the high alarm set point for alarm 1 of type HIGH/LOW.

If **ALM.SRC.:1** = OUTPUT	If **ALM.SRC.:1** = any other type
R 0.0% to 100.0%	**R** **LOW RANGE** to **HI RANGE**
D 0.0%	**D** 0

HIGH SP:1
0.0%

4B. LOW SP:1

Specifies the low alarm set point for alarm 1 of type HIGH/LOW.

If **ALM.SRC.:1** = OUTPUT	If **ALM.SRC.:1** = any other type
R 0.0% to 100.0%	**R** **LOW RANGE** to **HI RANGE**
D 0.0%	**D** 0

LOW SP:1
0.0%

5. DEADBAND:1

Defines the deadband for alarm 1.

If **ALM.SRC.:1** = OUTPUT	If **ALM.SRC.:1** = any other type
R 0.1% to 100.0%	**R** 1 to 99999
D 2	**D** 2

DEADBAND:1
2

6. ALM.:1 OUT.

Selects the output number for alarm 1.

D NONE
- 2
- 3
- 4

ALM.:1 OUT
NONE

7. LATCHING:1

Defines the latching sequence of alarm 1.

D LATCH
- NO LATCH

LATCHING:1
NONE

8. ACK.:1

Defines whether alarm 1 may be acknowledged.

D ENABLED	Allows the alarm to be acknowledged
• DISABLED	Prevents the alarm from being acknowledged while in alarm condition

ACK.:1
ENABLED

9. POWER UP:1

Defines how alarm 1 will be treated on power up.

D NORMAL	Alarm depends on process variable
• ALARM	Always power up in alarm regardless of PV
• DELAYED	Must leave alarm condition and reenter before activating the alarm

POWER UP:1
NORMAL

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

MESSAGE:1
ALARM 1

10. MESSAGE:1

A 9-character message associated with alarm 1. To enter message: The first character of third display will be flashing. Press the ▲ and ▼ keys to scroll through the character set. Press **FAST** key to advance to subsequent characters. Press the **MENU** to advance to next parameter.

D ALARM 1.

ALM. TYPE:2
OFF

11. ALM. TYPE:2

Defines the type of alarm for alarm 2.

•	HIGH ALRM.	
•	LOW ALARM	
•	HIGH/LOW	Separate High & Low alarm setpoints in one alarm
•	BAND	
•	DEVIATION	
•	MANUAL	Causes an alarm when in manual control
•	REMOTE SP	Causes an alarm when in Remote Setpoint
•	RATE	Selects a rate-of-change alarm
D	OFF	Deactivates the first alarm

ALM.SRC.:2
PV

12. ALM. SRC:2

Selects the source of the value being monitored by **HIGH**, **LOW** or **HIGH/LOW** alarm 2.

D PV
- SP
- RAMP SP
- DEVIATION
- OUTPUT
- PV2

ALARM SP:2
(D)

13. ALARM SP:2

Specifies the alarm set point for alarm 2 (except HIGH/LOW)

For **HIGH** or **LOW alarms:**

If **ALM.SRC.:2** = OUTPUT	If **ALM.SRC.:2** = any other type
R 0.0% to 100.0%	**R** **LOW RANGE** to **HI RANGE**
D 0.0%	**D** 0

For **BAND** alarms:

R 1 to 99999

D 0

For **DEVIATION** or **RATE** alarms:

R -9999 to 99999

D 0

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

14A. HIGH SP:2

Specifies the high alarm set point for alarm 2 of type HIGH/LOW.

If **ALM.SRC.:2** = OUTPUT	If **ALM.SRC.:2** = any other type
R 0.0% to 100.0%	**R** **LOW RANGE** to **HI RANGE**
D 0.0%	**D** 0

HIGH SP:2
0.0%

14B. LOW SP:2

Specifies the low alarm set point for alarm 2 of type HIGH/LOW.

If **ALM.SRC.:2** = OUTPUT	If **ALM.SRC.:2** = any other type
R 0.0% to 100.0%	**R** **LOW RANGE** to **HI RANGE**
D 0.0%	**D** 0

LOW SP:2
0.0%

15. DEADBAND:2

Defines the deadband for alarm 2.

If **ALM.SRC.:2** = OUTPUT	If **ALM.SRC.:2** = any other type
R 0.1% to 100.0%	**R** 1 to 99999
D 2	**D** 2

DEADBAND:2
2

16. ALM.:2 OUT.

Selects the output number for alarm 2.

D NONE
- 2
- 3
- 4

ALM.:2 OUT.
NONE

17. LATCHING:2

Defines the latching sequence of alarm 2.

D LATCH
- NO LATCH

LATCHING:2
LATCH

18. ACK.:2

Defines whether alarm 2 may be acknowledged.

D ENABLED	Allows the alarm to be acknowledged
• DISABLED	Prevents the alarm from being acknowledged while in alarm condition

ACK.:2
ENABLED

19. POWER UP:2

Defines how alarm 2 will be treated on power up.

D NORMAL	Alarm depends on process variable
• ALARM	Always power up in alarm regardless of process variable
• DELAYED	Must leave alarm condition and reenter before activating the alarm

POWER UP:2
NORMAL

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

MESSAGE:2
ALARM 2

20. MESSAGE:2

A 9-character message associated with alarm 2. To enter message: The first character of third display will be flashing. Press the ▲ and ▼ keys to scroll through the character set. Press **FAST** key to advance to subsequent characters. Press **MENU** to advance to next parameter.

D ALARM 2.

FAULT
OFF

21. FAULT

Defines whether either of the alarm relays will trip if a fault condition (lost process variable) is detected. Only appears if at least one alarm relay is installed.

D OFF
- ALARM 1
- ALARM 2

OUTPUT
NO ACTION

22. OUTPUT

Defines whether a rate-of-change alarm is interpreted as a lost or broken process variable (causing a trip to manual output).

- P.V. BREAK

D NO ACTION

RATE TIME
5

23. RATE TIME

Defines the time period over which a rate-of-change alarm condition is determined.

R 1 to 3600 seconds
D 5 seconds

REM. SETPT.

REM. SETPT.

This menu appears only if parameter **REM. SETPT** (of the **CONFIG.** menu) = **ENABLED**.

RSP. TYPE
1-5 4-20

1. TYPE V/mA

Specifies the type of input signal that will be used for remote setpoint.

D	1-5 4-20	1–5 volt or 4–20 mA remote setpoint
•	0-5 0-20	0–5 volt or 0–20 mA remote setpoint

RSP:LO RNG.
0

2. RSP:LO RNG.

Specifies the engineering unit value corresponding to the lowest remote setpoint input value, e.g. 4 mA.

R -9999 to 99999
D 0

RSP:HI RNG.
1000

3. RSP:HI RNG.

Specifies the engineering unit value corresponding to the highest remote setpoint input value, e.g. 20 mA.

R –9999 to 99999

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

D 1000

4. RSP: LOW

Defines the lowest setpoint value to be accepted from the remote setpoint source.

R –9999 to 99999.

D Dependent on **RSP:LO.RNG.** value.

RSP:LOW
(D)

5. RSP: HIGH

Defines the highest setpoint value from a remote setpoint source.

R –9999 to 99999

D Dependent on **RSP:HI.RNG.** value

RSP:HIGH
(D)

6. TRACKING

Defines whether the local setpoints 1 to 8 will track the remote setpoint.

D NO

• YES

TRACKING
NO

7. BIAS LOW

Defines the lowest bias value that may be entered.

R –9999 to 99999. Maximum value is **BIAS HIGH.**

D –1000

BIAS LOW
-1000

8. BIAS HIGH

Defines the highest bias value that may be entered.

R –9999 to 99999. Minimum value is **BIAS LOW.**

D 1000

BIAS HIGH
1000

9. RSP FIXED

Defines what happens if remote setpoint is lost while it is active and then is restored.

• REMOTE SP	Returns to remote setpoint when it is restored
D LOCAL	Local setpoint remains active when RSP is restored

RSP: FIXED
LOCAL

RETRANS.

RETRANS.

1. TYPE:2

Defines what is to be retransmitted for output 2

D PV	This refers to the linearized process variable
• SETPOINT	This is the target setpoint
• RAMP SP	This is the ramping, or actual setpoint, when the setpoint is ramping
• CTRL. OUT	This is the control output value

TYPE:2
PV

2. LOW RANGE:2

Defines the low end of the range for output 2 in engineering units. Does not appear for

LO RANGE:2
(D)

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

type **CTRL.OUT**.

R –9999 to 99999

D Dependent on the process variable range

HI RANGE:2
(D)

3. HI RANGE:2

Defines the high end of the range for output 2 in engineering units. Does not appear for type **CTRL.OUT**.

R –9999 to 99999

D Dependent on the process variable range

TYPE:3
PV

4. TYPE:3

Defines what is to be retransmitted for output 3

D	PV	This refers to the linearized process variable
•	SETPOINT	This is the target setpoint
•	RAMP SP	This is the ramping, or actual setpoint, when the setpoint is ramping
•	CTRL. OUT	This is the control output value

LO RANGE:3
(D)

5. LOW RANGE:3

Defines the low end of the range for output 3 in engineering units. Does not appear for type **CTRL.OUT**.

R –9999 to 99999

D Dependent on the process variable range

HI RANGE:3
(D)

6. HI RANGE:3

Defines the high end of the range for output 3 in engineering units. Does not appear for type **CTRL.OUT**.

R –9999 to 99999

D Dependent on the process variable range

TYPE:4
PV

7. TYPE:4

Defines what is to be retransmitted for output 4

D	PV	This refers to the linearized process variable
•	SETPOINT	This is the target setpoint
•	RAMP SP	This is the ramping, or actual setpoint, when the setpoint is ramping
•	CTRL. OUT	This is the control output value

LO RANGE:4
(D)

8. LOW RANGE:4

Defines the low end of the range for output 4 in engineering units. Does not appear for type **CTRL.OUT**.

R –9999 to 99999

D Dependent on the process variable range

9. **HI RANGE:4**

   Defines the high end of the range for output 4 in engineering units. Does not appear for type **CTRL.OUT**.

   R –9999 to 99999

   D Dependent on the process variable range

HI RANGE:4
(D)

SELF TUNE

SELF TUNE

1. **TYPE**

   This defines the type of self tuning algorithm that is available.

•	PRETUNE	Allows the operator to initiate Pretune only
•	ADAPTIVE	Allows the operator to initiate Adaptive Tune only
•	BOTH	Allows the operator to initiate both Pretune and Adaptive Tune
D	DISABLED	Both Pretune and Adaptive Tune are disabled

TYPE
DISABLED

2. **PRETUNE**

   Defines the type of pretune algorithm that is available.

D	TYPE 1	Normally used with slower thermal processes
•	TYPE 2	Normally used with faster fluid or pressure processes
•	TYPE 3	Normally used with level control applications

PRETUNE
TYPE 1

3. **TUNE PT.**

   Defines the PV value at which the output will switch off during a **TYPE 1** pretune. Helps prevent overshoot.

   R Any value in PV input range

   D AUTOMATIC (Controller defines this point)

TUNE PT.
AUTOMATIC

4. **OUT. STEP**

   Defines the output step size in absolute percent during a **TYPE 2** or **TYPE 3** pretune.

   R –50% to 50.0%

   D 10.0%

OUT.STEP
10.0

5. **LOW LIMIT**

   Defines the lower most limit the process variable can reach during pretune before aborting.

   R Any value in the process variable range

   D Dependent on the process variable range

LOW LIMIT
(D)

6. **HI LIMIT**

   Defines the upper most limit the process variable can reach during pretune before aborting.

HI LIMIT
(D)

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

R Any value in the process variable range
D Dependent on the process variable range

TIMEOUT
1500

7. TIMEOUT

This defines the execution time limit for pretune before aborting.

R 8 to 1500 minutes
D 1500 minutes

MODE
AUTOMATIC

8. MODE

Defines the control mode after pretune is completed or aborted.

•	MANUAL	Go to Manual mode after pretune has completed
D	AUTOMATIC	Go to Automatic mode after pretune has completed
R	RECIPE 1 to 20	Run the designated recipe after pretune has completed

NOISE BND.
0.2

9. NOISE BND.

Defines the noise band to be used by the adaptive tuning algorithm.

R 0.1% to 10% of the process variable range
D 0.2%

RESP. TIME
60

10. RESP. TIME

Defines response time to be used by the adaptive tuning algorithm.

R 10 to 32000 seconds
D 7200 seconds

DEAD TIME
0.1

11. DEAD TIME

Defines the amount of time required for process to begin to respond to an output change (used by POWERBACK algorithm).

R 0.1 seconds to 7200.0 seconds
D 0.1 seconds

SPECIAL

SPECIAL

AUTO. TRIP
OFF

1. AUTO. TRIP

This defines the condition under which the 535-PROF will automatically trip to automatic control from manual control upon start up.

D	OFF	Deactivates this function
•	RISING PV	Will trip when a rising process variable is within the specified deviation from the setpoint
•	FALLNG. PV	Will trip when a falling process variable is within the specified deviation from the setpoint

2. TRIP DEV.

This defines the deviation from setpoint at which the controller will trip to automatic.

For **AUTO. TRIP** = RISING PV	For **AUTO. TRIP** = FALLING PV
R -99999 to 0	**R** 0 to 99999
D 0	**D** 0

TRIP DEV.
(D)

3. DES. OUTPT.

If a digital input is defined to trip the controller to manual mode, this designates the output value after the trip. **LAST OUT** means that the output value will be equal to the last output value while in automatic. Choose values based on the process.

Standard Control	On/Off Control	Velocity Prop Control
• –5 to 105%	• ON	• CW
D LAST OUT	**D** OFF	• CCW
		D OUTS. OFF

DES. OUTPT.
(D)

4. POWER UP

This defines the control mode upon power up.

- • MANUAL
- • AUTOMATIC
- **D** LAST MODE — Will power up in the same mode prior to power down
- • PRETUNE — Will Pretune on every power up. (Recommended for TYPE 1 pretune only.)
- • RECIPE

POWER UP
LAST MODE

5. PWR. UP:REC.

Selects the recipe to use after power up. Appears only if **POWER UP = RECIPE**.

- **D** LAST REC. — Last recipe used
- **R** RECIPE 1 to 20 — Select recipe number

PWR.UP:REC.
LAST. REC.

6. PWR. UP:RUN

Specified how to use the selected recipe after power up. Appears only if **POWER UP = RECIPE**.

- • START REC. — Start from the beginning of the recipe
- **D** RESUME REC. — Resume recipe from where it left off before power down
- • HOLD REC. — Hold recipe from where it left off before power down

PWR.UP:RUN
RESUME REC.

7. PWR. UP: OUT.

Defines the output of the controller if powering up in manual mode. LAST OUT means the output value will be equal to the last output value while in automatic. Choose values based on your process.

PWR.UP:OUT.
(D)

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

Standard Control	On/Off Control	Velocity Prop Control
• –5 to 105%	• ON	• CW
D LAST OUT	D OFF	• CCW
		D OUTS. OFF

PWR. UP:SP
LAST SP

8. **PWR. UP:SP**
Defines the setpoint upon power up.

D LAST SP	Powers up with the same setpoint (local or remote) that was active prior to power down
• LOCAL	Powers up using the primary local setpoint
• REMOTE	Powers up using the remote setpoint, if available

NO. OF SP
1

9. **NO. OF SP**
Defines the number of local setpoints (up to 8) to be stored for selection by BCD (binary coded decimal), digital inputs, or front **SET PT** key. Only applicable when a recipe is not running or held.
R 1 through 8
D 1

SECURITY

SECURITY

For configuring the security function.

SEC. CODE
0

1. **SEC. CODE**
Defines the security code temporarily unlocking the instrument.
R –9999 to 99999
D 0

SP ADJUST
UNLOCKED

2. **SP ADJUST**
Defines lockout status setpoint changes.
D UNLOCKED
• LOCKED

AUTO./MAN.
UNLOCKED

3. **AUTO./MAN.**
Defines lockout status of the **MANUAL** key.
D UNLOCKED
• LOCKED

SP SELECT
UNLOCKED

4. **SP SELECT**
Defines lockout status of the **SP SELECT** parameter in the **TUNING** menu.
D UNLOCKED
• LOCKED

5. **RUN KEY**

RUN KEY | UNLOCKED

Defines lockout status of the **RUN** key.

D UNLOCKED
- LOCKED

6. **ALARM ACK.**

ALARM ACK | UNLOCKED

Defines lockout status of the **ACK** key.

D UNLOCKED
- LOCKED

7. **TUNING**

TUNING | UNLOCKED

Defines lockout status of the tuning parameters.

D UNLOCKED
- LOCKED

8. **RECIPES**

RECIPES | UNLOCKED

Defines lockout status of the **RECIPE #** menu.

D UNLOCKED
- LOCKED

9. **CONFIGURE**

CONFIGURE | UNLOCKED

Defines lockout status of the configuration parameters.

D UNLOCKED
- LOCKED

SER. COMM.

SER. COMM.

1. **STATION**

STATION | 1

Defines the unit's station address.

R 1 to 99
- OFF — **Disables the communications function**

D 1

2. **BAUD RATE**

BAUD RATE | 9600

Defines the baud rate.

- 1200 BPS
- 2400 BPS
- 4800 BPS

D 9600 BPS
- 19200 BPS

3. **CRC**

CRC | YES

Defines whether CRC (cyclic redundancy check) is being calculated.

D YES
- NO

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

SHED TIME
OFF

4. SHED TIME

Defines the time interval between communications activity before the controller determines that communications is lost ("sheds").

R 1 to 512 seconds
D OFF

SHED MODE
LAST MODE

5. SHED MODE

Defines the state of the controller if communications is lost ("sheds").

D	LAST MODE	Remain in automatic or manual control (last mode before losing communications)
•	MANUAL	Trip to manual control
•	AUTOMATIC	Trip to automatic control

SHED OUT.
(D)

6. SHED OUT.

Defines the output if the unit sheds and trips to manual control. Choose values based on the process.

Standard Control	On/Off Control	Velocity Prop Control
• –5 to 105%	• ON	• CW
D LAST OUT	**D** OFF	• CCW
		D OUTS. OFF

SHED SP
LAST SP

7. SHED SP

This defines the setpoint status if communications is lost.

D	LAST SP	Continues to use setpoint that was active prior to losing communications
•	DESIG. SP	Goes to a designated setpoint value if communications is lost.

DESIG. SP
(D)

8. DESIG. SP

Defines the value of the designated setpoint if communications is lost.

R Any value in the process variable range
D Dependent on the process variable range

RECIPE #

RECIPE

(# = 1 to 20) For each recipe number (as determined by the **RECIPES** parameter in the **REC. CONF.** menu), you will set values for the following parameters:

CYCLES
CONTINUAL

1. CYCLES

Defines the number of times the recipe will run before ending or going to the next linked recipe.

• CONTINUAL
R 1 to 99
D 1

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

2. **NEXT LINK**

   NEXT LINK
   OFF

   Defines which (if any) recipe will run after the current recipe has ended. Also can place the output in manual at a specified percentage.

   D NONE
   R 1 to # of configured recipes
   • NO OUTPUT

3. **IDLE SP**

   IDLE SP
   LAST SP

   Selects the setpoint to be used when the recipe starts or after it has completed.

D	LAST SP	use the previous setpoint
•	REMOTE SP	use the remote setpoint (if option is installed and enabled)
R	-9999 to 99999	(decimal point defined by **DECIMAL** parameter)

4. **SOAK HYST.**

   SOAK HYST.
   OFF

   Defines the absolute value of the maximum allowable deviation from setpoint either when a soak segment starts (if GUAR.SOAK = START SEG.) or anytime during a soak segment (if GUAR.SOAK = WHOLE SEG.). If the deviation exceeds this value, guaranteed soak will occur.

D	OFF	
R	1 to 99999	(decimal point defined by DECIMAL parameter)

5. **RAMP RT:##**

   RAMP RT:##
   OFF

   For RAMP UNIT = RATE, defines the rate of rise or fall of the setpoint during ramp segment ##, while approaching soak setpoint ##.

If **TIME BASE** = HOURS:MIN	If **TIME BASE** = MIN:SEC
D OFF	**D** OFF
R 1 to 99999/MIN	**R** 1 to 99999/SEC

   The decimal point is defined by the DECIMAL parameter.

NOTE:
To end programming, set **RAMP RT:###** or **RAMP TIM:##** to OFF.

6. **RAMP TM:##**

   RAMP TM:##
   OFF

   For RAMP UNIT = TIME, defines the time for ramp segment ## to reach soak setpoint ##.

If **TIME BASE** = HOURS:MIN	If **TIME BASE** = MIN:SEC
D OFF	**D** OFF
R 00:01 to 99:59 HR:MN	**R** 00:01 to 99:59 MN:SC

7. **RAMP EV:##**

   RAMP EV:##
   NONE

   Defines which events will be activated during ramp segment ##.

   D NONE
   • EVENT 1
   • EVENT 2
   • EVENT 12

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

- EVENT 3
- EVENT 13
- EVENT 23
- EVENT 123

SOAK SP:##
0

8. SOAK SP:##

Defines the setpoint after ramp segment ## has completed.

D 0

R -9999 to 99999 decimal point defined by **DECIMAL** parameter

SOAK TM:##
OFF

9. SOAK TM:##

Defines the length of soak segment ## (units defined by **TIME BASE** parameter in **REC. CONF.** menu).

If **TIME BASE** = HOURS:MIN	If **TIME BASE** = MIN:SEC
D OFF	**D** OFF
R 00:01 to 99:59 HR:MN	**R** 00:01 to 99:59 MN:SC

SOAK EV:##
NONE

10. SOAK EV:##

Defines which events will be activated during soak segment ##.

D NONE

- EVENT 1
- EVENT 2
- EVENT 12
- EVENT 3
- EVENT 13
- EVENT 23
- EVENT 123

PID SET:##
LAST SET

11. PID SET:##

If NO. OF **PID = SEG.SELECT**, defines which PID set to use during ramp and soak segments ##.

D LAST SET

R 1 to 8

After **PID SET:##**, you will return to the **RAMP RT:##** or **RAMP TM:##** parameter.

To continue programming within this recipe, set a value for this segment, and you will scroll through the subsequent parameters of this menu.

To end programming, set **RAMP RT:##** or **RAMP TM:##** to OFF.

PARAMETER VALUE CHARTS

This section of value charts is provided for logging in the actual parameter values and selections for the process. It is recommended that these pages be photocopied so there will always be a master.

CONFIG

Parameter	Description	Values
1. CTRL. TYPE	Type of control output(s)	
2. LINE FREQ	Power source frequency	
3. PV SOURCE	PV input derivation	
4. REM. SETPT.	Remote setpoint function	
5. OUTPUT 2	Second output function	
6. OUTPUT 3	Third output function	
7. OUTPUT 4	Fourth output function	
8. ANLG. RNG.:1	First output signal	
9. ANLG. RNG.:2	Second output signal	
10. ANLG. RNG.:3	Third output signal	
11. ANLG. RNG.:4	Fourth output signal	
12. CONTACT 1	First digital input operation	
13. CONTACT 2	Second digital input operation	
14. CONTACT 3	Third digital input operation	
15. CONTACT 4	Fourth digital input operation	
16. CONTACT 5	Fifth digital input operation	
17. LOOP NAME	Message associated with the loop	

REC. CONF

Parameter	Description	Values
1. RECIPES	the number of recipes available in the 535	
2. TIME BASE	Time base units for recipes	
3. RAMP UNIT	Ramp segment definition (time or rate)	
4. SP START	Initial value for the first ramp segment's setpoint	
5. GUAR.SOAK	Selects whether guaranteed soak is used	
6. EVT.:1 OUT.	Output assigned to event 1	
7. EVT.:2 OUT.	Output assigned to event 2	
8. EVT.:3 OUT.	Output assigned to event 3	
9. HOLD EVT.	Hold status last segment's event(s)	

PV1 INPUT

Parameter	Description	Values
1. PV1 TYPE	Sensor/input range for PV1	
2. DEG. F/C/K	PV1 temperature units	
3. DECIMAL	PV1 decimal point position	
4. LINEARIZE	PV1 input linearization	
5. LOW RANGE	Engineering unit value for lowest PV1 input	
6. HI RANGE	Engineering unit value for highest PV1 input	
7. SP LO LIM.	Lowest setpoint value for front panel entry	
8. SP HI LIM.	Highest setpoint value for front panel entry	
9. SP RAMP	Rate of change for setpoint changes	
10. FILTER	Low pass PV1 input filter setting	
11. OFFSET	PV1 offset in engineering units	
12. GAIN	PV1 gain	
13. RESTORE	Control mode when a broken PV1 signal is restored	

PV2 INPUT

Parameter	Description	Values
1. PV2 SETUP	PV2 function	
2. PV2 TYPE	Sensor/input range for PV2	
3. DECIMAL	PV2 decimal point position	
4. LINEARIZE	PV2 input linearization	
5. LOW RANGE	Engineering unit value for lowest PV2 input	
6. HI RANGE	Engineering unit value for highest PV2 input	
7. FILTER	Low pass PV2 input filter setting	
8. OFFSET	PV2 offset in engineering units	
9. GAIN	PV2 gain	
10. RESTORE	Control mode when a broken PV2 signal is restored	

CUST. LINR

Parameter	Description	Values
1. 1ST. INPUT	1st point input signal	
2. 1ST. PV	1st point engineering unit value	
3. XTH. INPUT	XTH point input signal (X is 2 to 14)	
4. XTH. PV	XTH point engineering unit value	
5. 2ND. INPUT	2nd point input signal	
6. 2ND. PV	2nd point engineering unit value	
7. 3RD. INPUT	3rd point input signal	
8. 3RD. PV	3rd point engineering unit value	
9. 4TH. INPUT	4th point input signal	
10. 4TH. PV	4th point engineering unit value	
11. 5TH. INPUT	5th point input signal	
12. 5TH. PV	5th point engineering unit value	
13. 6TH. INPUT	6th point input signal	
14. 6TH. PV	6th point engineering unit value	
15. 7TH. INPUT	7th point input signal	
16. 7TH. PV	7th point engineering unit value	
17. 8TH. INPUT	8th point input signal	
18. 8TH. PV	8th point engineering unit value	
19. 9TH. INPUT	9th point input signal	
20. 9TH. PV	9th point engineering unit value	
21. 10TH. INPUT	10th point input signal	
22. 10TH. PV	10th point engineering unit value	
23. 11TH. INPUT	11th point input signal	
24. 11TH. PV	11th point engineering unit value	
25. 12TH. INPUT	12th point input signal	
26. 12TH. PV	12th point engineering unit value	
27. 13TH. INPUT	13th point input signal	
28. 13TH. PV	13th point engineering unit value	
29. 14TH. INPUT	14th point input signal	
30. 14TH PV	14th point engineering unit value	
31. 15TH. INPT.	15th point input signal	
32. 15TH. PV	15th point engineering unit value	

CONTROL

Parameter	Description	Values
1. ALGORITHM	Control algorithm Type	
2. D. SOURCE	Derivative action variable	
3. ACTION:1	First control output action	
4. PV BREAK	Manual output level upon PV input loss	
5. LOW OUT.	Lowest output value in automatic control	
6. HIGH OUT.	Highest output value in automatic control	
7. ACTION:2	Second control output action	
8. P.P. TYPE	Position proportioning algorithm	
9. CCW TIME	Counter clockwise motor stroke time	
10. CW TIME	Clockwise motor stroke time	
11. MIN. TIME	Motor "on" time (minimum value)	
12. S/W RANGE	Full range resistance of the slidewire	
13. OPEN F/B	Feedback ohm value for full open	
14. CLOSE F/B	Feedback ohm value for full close	
15. OUT1 STOP	Control output 1 stop point for staging outputs	
16. OUT2 STRT.	Control output 2 start point for staging outputs	

ALARMS

Parameter	Description	Values
1. ALM. TYPE:1	Alarm 1 type	
2. ALM. SRC:1	Value monitored by alarm 1	
3. ALARM SP:1	Set point for alarm 1 (except HIGH/LOW)	
4A.HIGH SP:1	High alarm set point for alarm 1 of type HIGH/LOW	
4B.LOW SP:1	Low alarm set point for alarm 1 of type HIGH/LOW	
5. DEADBAND:1	Deadband for alarm 1	
6. ALM.:1 OUT.	Output number for alarm 1	
7. LATCHING:1	the latching sequence of alarm 1	
8. ACK.:1	Acknowledge status of alarm 1	
9. POWER UP:1	Alarm 1 power up status	
10. MESSAGE:1	9-character message for with alarm 1	
11. ALM. TYPE:2	Alarm 2 type	
12. ALM. SRC:2	Value monitored by alarm 2	
13. ALARM SP:2	Alarm set point for alarm 2 (except HIGH/LOW)	
14A. HIGH SP:2	High alarm set point for alarm 2 of type HIGH/LOW	
14B. LOW SP:2	Low alarm set point for alarm 2 of type HIGH/LOW	
15. DEADBAND:2	Deadband for alarm 2	
16. ALM.:2 OUT.	Output number for alarm 2	
17. LATCHING:2	Latching sequence of alarm 2	
18 ACK.:2	Acknoledge status of alarm 2	
19. POWER UP:2	Alarm 2 power up status	
20. MESSAGE:2	9-character message for with alarm 2	
21. FAULT	Alarm status for fault condition (lost PV)	
22. OUTPUT	Rate-of-change alarm effect on trip to manual output)	
23. RATE TIME	Time period over for a rate-of-change alarm condition	

REM. SETPT

Parameter	Description	Values
1. TYPE V/mA	Remote setpoint input signal type	
2. RSP:LO RNG.	Lowest remote setpoint input value egineering unit value	
3. RSP:HI RNG.	Highest remote setpoint input value engineering unit value	
4. RSP: LOW	Lowest setpoint value from remote setpoint source	
5. RSP: HIGH	Highest setpoint value from a remote setpoint source	
6. TRACKING	Local setpoint track status of remote setpoint	
7. BIAS LOW	Lowest bias value that may be entered	
8. BIAS HIGH	Highest bias value that may be entered	
9. RSP FIXED	Remote setpoint restoration status	

RETRANS

Parameter	Description	Values
1. TYPE:2	Output 2 transmission type	
2. LOW RANGE:2	Low end of the range for output 2 in engineering units	
3. HI RANGE:2	High end of the range for output 2 in engineering units	
4. TYPE:3	Output 3 transmission type	
5. LOW RANGE:3	Low end of the range for output 3 in engineering units	
6. HI RANGE:3	High end of the range for output 3 in engineering units	
7. TYPE:4	Output 4 transmission type	
8. LOW RANGE:4	Low end of the range for output 4 in engineering units	
9. HI RANGE:4	High end of the range for output 4 in engineering units	

SELF TUNE

Parameter	Description	Values
1. TYPE	Self tuning algorithm type	
2. PRETUNE	Pretune algorithm type	
3. TUNE PT.	PV value at which output switches off (TYPE 1)	
4. OUT. STEP	Output step size in absolute percent (TYPE 2 or 3)	
5. LOW LIMIT	Lower limit for PV during pretune (before aborting)	
6. HI LIMIT	Upper limit for PV during pretune (before aborting)	
7. TIMEOUT	Execution time limit for pretune (before aborting)	
8. MODE	Control mode after pretune is completed or aborted	
9. NOISE BND.	Noise band for adaptive tuning algorithm	
10. RESP. TIME	Response time for the adaptive tuning algorithm	
11. DEAD TIME	Wait time for process initiation (POWERBACK)	

SPECIAL

Parameter	Description	Values
1. AUTO. TRIP	Trip to automatic control from manual control upon start up	
2. TRIP DEV	Deviation from setpoint for a trip to automatic	
3. DES. OUTPT.	Output value after the trip	
4. POWER UP	Control mode upon power up	
5. PWR. UP:REC.	Recipe to use after power up.	
6. PWR. UP:RUN	Selected recipe status after power up	
7. PWR. UP: OUT.	Output of the controller if powering up in manual mode	
8. PWR. UP:SP	Setpoint upon power up	
9. NO. OF SP	Number of local setpoints (up to 8) to be stored for selection	

SECURITY

Parameter	Description	Values
1. SEC. CODE	Security code for temporarily unlocking the instrument.	
2. SP ADJUST	Lockout status for setpoint changes	
3. AUTO./MAN.	Lockout status of the MANUAL key	
4. SP SELECT	Lockout status of the SET PT key	
5. RUN KEY	Lockout status of the RUN key	
6. ALARM ACK.	Lockout status of the ACK key	
7. TUNING	Lockout status of the tuning parameters	
8. RECIPES	Lockout status of the RECIPE # menu	
9. CONFIGURE	Lockout status of the configuration parameters	

SER. COMM

Parameter	Description	Values
1. STATION	Unit's station address	
2. BAUD RATE	Baud rate	
3. CRC	Cyclic redundancy check	
4. SHED TIME	Time interpreted as communications loss (shed)	
5. SHED MODE	State of the controller if communications is lost ("sheds")	
6. SHED OUT.	Output if the unit sheds and trips to manual control.	

RECIPE

Parameter	Description	Values
1. CYCLES	Number of recipe cycles	
2. NEXT LINK	Next recipe to run	
3. IDLE SP	Initial or ending setpoint for recipe	
4. SOAK HYST.	Absolute value of the max. deviation from setpoint for soak	
5. RAMP RT:##	Rate of rise or fall of setpoint during ramp segment ##	
6. RAMP TM:##	Time for ramp segment ## to reach soak setpoint ##	
7. RAMP EV:##	Events activated during ramp segment ##	
8. SOAK SP:##	Setpoint after ramp segment ## has completed	
9. SOAK TM:##	Length of soak segment ##	
10. SOAK EV:##	Events activated during soak segment ##.	
11. PID SET:##	PID set for ramp and soak segments ##.	

CHAPTER 6
TUNING

OVERVIEW

The self tune function of the 535 consists of two distinct components — Pretune and Adaptive Tune. In addition, you may choose from three type of Pretune:

- **TYPE 1 -** for slow thermal processes.
- **TYPE 2 -** for fast fluid or pressure processes.
- **TYPE 3 -** for level control applications.

You choose the type of Pretune in the **SELF TUNE** menu.

The Pretune and Adaptive Tune components may be used separately or together.

On the following pages is the step by step guide to the **TUNING** menu paramters.

NOTE:
For more information about Pretune and Adaptive Tune, refer to section on Tuning applications in Chapter 7.

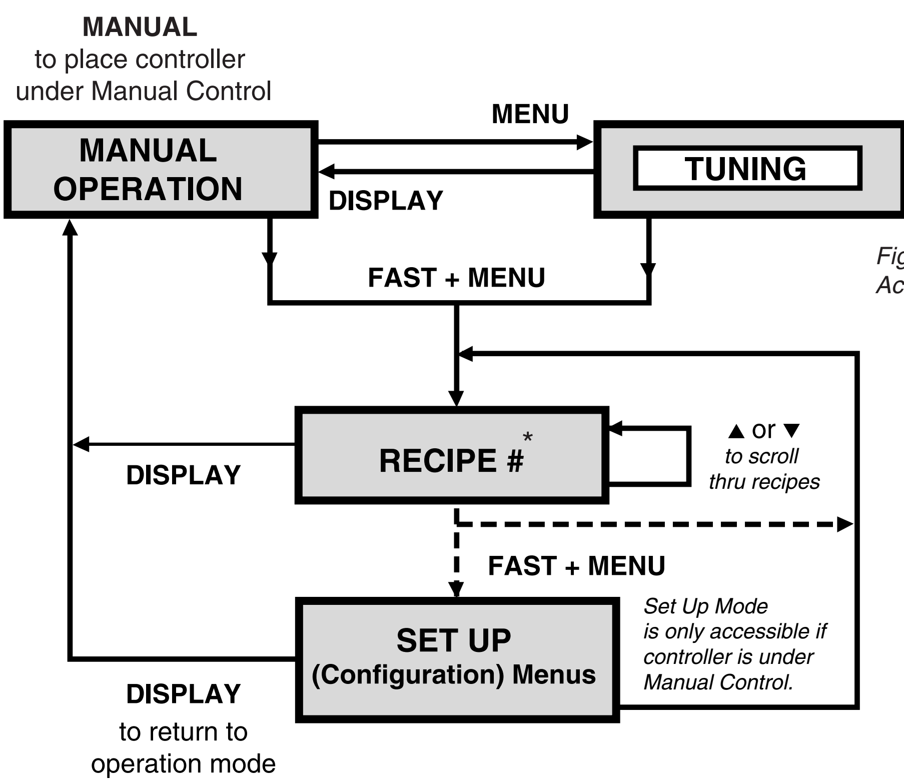


Figure 6.1
Access the Tuning Menu Block

TUNING

TUNING

1. SP SELECT

SP SELECT
REMOTE SP

Replaces function of the SET PT key. Selects the setpoint used when a recipe is not running or held.

D	REMOTE SP	Only if RSP option is installed
•	LOCAL SP	
•	LOCAL SP2	NO. OF SP has to be 2
•	LOCAL SP3	NO. OF SP has to be 3
•	LOCAL SP4	NO. OF SP has to be 4
•	LOCAL SP5	NO. OF SP has to be 5
•	LOCAL SP6	NO. OF SP has to be 6
•	LOCAL SP7	NO. OF SP has to be 7
•	LOCAL SP8	NO. OF SP has to be 8

2. ADAPTIVE

ADAPTIVE
DISABLED

Activates the self tune algorithm (upon transfer to automatic control). Only allowed to operate during soak segments.

D DISABLED
• ENABLED

3. PRETUNE

PRETUNE
NO

Activates the pretune algorithm (if unit is under manual control). Not selectable if a recipe is running or holding

To initiate the Pretune cycle, press the ▲ or ▼ . Confirm by pressing ACK within two seconds.

D NO

4. POWR. BACK

POWR. BACK
DISABLED

Reduces setpoint overshoot at power up or after setpoint changes.

D DISABLED
• ENABLED

5. PROP. BND.:1

PROP. BND.:1
50.0

Defines the proportional band for PID set 1.

R 0.1 to 999.0%
D 50.0%

6. RESET:1

RESET:1
20

Defines the integral time for PID set 1.

R 1 to 9999 seconds
D 20 seconds

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

7. RATE:1

Defines the derivative time for PID set 1.

R 0 to 600 seconds
D 1 second

RATE:1
1

8. MAN. RST.:1 (or LOADLINE:1)

Defines the manual reset for PID set 1. If using automatic reset, then this specifies the load line out value.

R 0 to 100%
D 0%

MAN. RST.:1
0

9. CYCLE TM.:1

Defines the cycle time for control output 1 when using a time proportioning output.

R 0.3 to 120.0 seconds
D 15.0 seconds

CYCLE TM.:1
15.0

10. DEADBAND:1

Defines the dead band for control output 1 when using on/off control.

R 1 to 99999 in engineering units
D 2

DEADBAND:1
2

11. P. PROP. D.B.

Defines the dead band setting for a slidewire position proportioning output.

R 0.5 to 10.0%
D 2.0%

P.PROP.D.B.
2.0

12A. PID OFST.:1

For duplex applications, defines the offset for the first output.

R –50.0% to 50.0%
D 0.0%

PID OFST.:1
0

12B. ON OFST.:1

For On/Off applications, defines the offset for the first output.

R -9999 to 99999 in engineering units
D 0

ON/OFST.:1
0

13A. PID OFST.:2

For duplex applications, defines the offset for the second output.

R –50.0% to 50.0%
D 0.0%

PID OFST.:2
0

13B. ON OFST.:2

For On/Off applications, defines the offset for the second output.

R -9999 to 99999 in engineering units
D 0

ON/OFST.:2
0

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

REL. GAIN:2
1.0

14. REL. GAIN:2

Defines the adjustment factor for the second output's proportional band. It is multiplied by the effective gain of output 1 to obtain the second output's proportional band.

R 0.1 to 10.0
D 1.0

CYCLE TM.:2
15.0

15. CYCLE TM.:2

Defines the cycle time for control output 2 when using a time proportioning output.

R 0.3 to 120.0 seconds.
D 15.0 seconds

DEADBAND:2
2

16. DEADBAND:2

Defines the dead band for control output 2 when using on/off control.

R 1 to 99999 in engineering units
D 2

RSP RATIO
1.00

17. RSP RATIO

Defines the multiplier applied to the remote set point.

R -99.99 to 99.99
D 1.00

RSP BIAS
(D)

18. RSP BIAS

Defines the bias (additive term) applied to the remote set point.

R Any value in engineering units (minimum is **BIAS LOW**; maximum is **BIAS HIGH**)
D Dependent on the **BIAS LOW** and **BIAS HIGH** values

NO. OF PID
1

19. NO. OF PID

Defines the number of PID sets that will be stored and available for use.

R 1 to 8 — For numbers>1, **PID TRIP** defines tripping between the PID sets

D 1

- SP NUMBER — PID Set = current local setpoint (specified in NO. OF SP). Each PID set has a respective SP NUMBER.
- REC.NUMBER — PID Set = current recipe #. If no recipe is running or held, previous PID set is used.
- SEG.SELECT — PID Set = set assigned to the current recipe segment. If no recipe is running or held, previous PID set is used.
- PV NUMBER — PID Set = process variable (PV1 or PV2) used when PV SOURCE = 1/2: SWITCH or PV SOURCE = 1/2:BACKUP

D 1

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

20. PID TRIP

For **NO. OF PID > 1**, defines the variable used to select the various PID sets. Not applicable for SP NUMBER, REC. NUMBER or SEG. SELECT.

•	PV VALUE	PID set selection based on process variable
D	SP VALUE	PID set selection based on setpoint
•	DEV. VALUE	PID set selection based on deviation from setpoint

PID TRIP
SP VALUE

21. TRIP:1

Defines the value that triggers a change to the primary set (#1) of PID values.

R The process variable range
D Dependent on the process variable range

TRIP:1
(D)

For each set of PID 2 through 8 (or equals SP NUMBER, REC.NUMBER or SEG.SELECT) set up the following group of parameters (X represents the PID set number), as they appear for each set of PID. The controller designates the values for the active PID parameter in the third display with this symbol—*—on either side.

22. PROP. BND.:X

Defines the proportional band for PID set X.

R 0.1 to 999.0%
D 50.0%

PROP.BND.:X
(D)

23. RESET:X

Defines the integral time for PID set X.

R 1 to 9999 seconds (increments of 1)
D 20 seconds

RESET:X
(D)

24. RATE:X

Defines the derivative time for PID set X.

R 0 to 600 seconds
D 1 seconds

RATE:X
1

25. MAN. RST.:X (or LOADLINE:X)

Defines the manual reset (or load line) for PID set X.

R 0 to 100%
D 0%

MAN.RST.:X
0

26. TRIP:X

This defines the value that triggers a change to the Xth set of PID values.

R The process variable range
D Dependent on the process variable range

TRIP:X
(D)

Access Set Up	Return to Operation	Next menu	Next parameter	Next value	Access Tuning	Return to Operation
FAST + MENU	DISPLAY	FAST + MENU	MENU	▲ ▼	MENU	DISPLAY

TUNING

Parameter	Definition	Values
1. SP SELECT	Selects the setpoint used when a recipe is not running or held	
2. ADAPTIVE	Activates the self tune algorithm	
3. PRETUNE	Activates the pretune algorithm	
4. POWR. BACK	Reduces setpoint overshoot at power up or after setpoint changes	
5. PROP. BND.:1	Proportional band for PID set 1	
6. RESET:1	Integral time for PID set 1	
7. RATE:1	Derivative time for PID set 1	
8. MAN. RST.:1	Manual reset for PID set 1.	
9. CYCLE TM.:1	Cycle time for control output 1 for time proportioning output	
10. DEADBAND:1	Dead band for control output 1 for on/off control	
11. P. PROP. D.B.	Dead band setting for slidewire position proportioning output	
12A. PID OFST.:1	Offset for the first output for duplex applications	
12B. ON OFST.:1	Offset for first output for on/off applications	
13A. PID OFST.:2	Offset for the second output for duplex applications	
13B. ON OFST.:2	Offset for second output for on/off applications	
14. REL. GAIN:2	Adjustment factor for the second output's proportional band	
15. CYCLE TM.:2	Cycle time for control output 2 for time proportioning output	
16. DEADBAND:2	Dead band for control output 2 for on/off control	
17. RSP RATIO	Multiplier for remote set point	
18. RSP BIAS	Bias for remote set point	
19. NO. OF PID	Number of PID sets	
20. PID TRIP	For NO. OF PID > 1, variable used to select the various PID sets	
21. TRIP:1	Value that triggers a change to the primary set (#1) of PID values	
22. PROP. BND.:2	Proportional band for PID set 2	
23. RESET:2	Integral time for PID set 2	
24. RATE:2	Derivative time for PID set 2	
25. MAN. RST.:2	Manual reset (or load line) for PID set 2	
26. TRIP:2	Value that triggers a change to the 2nd set of PID values	
27. PROP. BND.:3	Proportional band for PID set 3	

28. RESET:3	Integral time for PID set 3	
29. RATE:3	Derivative time for PID set 3	
30. MAN. RST.:3	Manual reset (or load line) for PID set 3	
31. TRIP:3	Value that triggers a change to the 3rdset of PID values	
32. PROP. BND.:4	Proportional band for PID set 4	
33. RESET:4	Integral time for PID set 4	
34. RATE:4	Derivative time for PID set 4	
35. MAN. RST.:4	Manual reset (or load line) for PID set 4	
36. TRIP:4	Value that triggers a change to the 4th set of PID values	
37. PROP. BND.:5	Proportional band for PID set 5	
38. RESET:5	Integral time for PID set 5	
39. RATE:5	Derivative time for PID set 5	
40. MAN. RST.:5	Manual reset (or load line) for PID set 5	
41. TRIP:5	Value that triggers a change to the 5th set of PID values	
42. PROP. BND.:6	Proportional band for PID set 6	
43. RESET:6	Integral time for PID set 6	
44. RATE:6	Derivative time for PID set 6	
45. MAN. RST.:6	Manual reset (or load line) for PID set 6	
46. TRIP:6	Value that triggers a change to the 6th set of PID values	
47. PROP. BND.:7	Proportional band for PID set 7	
48. RESET:7	Integral time for PID set 7	
49. RATE:7	Derivative time for PID set 7	
50. MAN. RST.:7	Manual reset (or load line) for PID set 7	
51. TRIP:7	Value that triggers a change to the 7th set of PID values	
52. PROP. BND.:8	Proportional band for PID set 8	
53. RESET:8	Integral time for PID set 8	
54. RATE:8	Derivative time for PID set 8	
55. MAN. RST.:8	Manual reset (or load line) for PID set 8	
56. TRIP:8	Value that triggers a change to the 8th set of PID values	

SELF TUNE MESSAGES AND TROUBLESHOOTING

Refer to Chapter 7 for more information on the Self Tune function of the 535 controller.

When the Pretune function terminates, one of the following messages will appear:

Message	Pretune Type	Conclusion/Problem	Corrective Action
COMPLETED	1	PRETUNE has generated initial PID and the Dead Time values	
	2,3	PRETUNE had generated initial PID, Response Time, Band Noise and the Dead Time values	
ABORTED	1,2,3	User has aborted PRETUNE before completion	
LIMIT ERR.	1	The Process variable went beyond the HI LIMIT or LOW LIMIT	Change the HI LIMIT and LOW LIMIT, or the HIGH OUT and LOW OUT, and run Pretune again
	2,3	The Process variable went beyond the HI LIMIT or LOW LIMIT	Change the HI LIMIT and LOW LIMIT, or the OUT.STEP size and run Pretune again
	1,2,3	The inital process variable was near or beyond the HI LIMIT or LOW LIMIT	Change the manual output percentage, or the HI LIMIT and LOW LIMIT, and run Pretune again
TIMEOUT	1,2,3	TIMEOUT limit was reached before Pretune completed	Set a longer TIMEOUT period and/or increase the OUT.STEP size, and run Pretune again.
NOISE ERR.	1,2,3	Too much PV noise was detected	Eliminate the noise source (if possible) or increase the OUT.STEP and run Pretune again
INPUT ERR.	1,2,3	PV or Cold Junction break detected during Pretune	Check the described conditions and make corrections or repairs
	1,2,3	PV HIGH or PV LOW detected during Pretune	
	1,2,3	SLIDEWIRE break detected during Pretune	
	1,2,3	Remote SP Break detected during Pretune	
OUT. ERROR	1,2,3	The initial control output is outside the high and low limits defined in the Control menu	Change the manual output percent and run Pretune again
DATA ERR.	2,3	The PV moved too quickly to be analyzed	Decrease the OUT.STEP size and run Pretune again
ZERO ERR.	2,3	One or more model parameters are calculated to be zero	Increase the OUT.STEP size and run Pretune again
DEV. ERROR	1	The initial PV is too close to the TUNE PT.	Move TUNE PT. (or the Setpoint if TUNE PT. is Automatic) farther from the process variable and run Pretune again
RETRY	1,2,3	The Process variable went beyond the HI LIMIT or LOW LIMIT	Check if any PID values were generated and if they are acceptable. If not, eliminate noise sources (if possible) and run Pretune again

If Pretune and Adaptive Tune do not generate optimal PID values for control, check the following menu entries:

Message	Potential Problem	Corrective Action
RESPONSE TIME	Adaptive Tune cannot run if RESPONSE TIME is inaccurate	Run TYPE 2 or TYPE 3 Pretune to obtain the correct value, or enter it manually
NOISE BAND	Adaptive Tune cannot compensate for PV oscillation due to hysteresis of output device (e.g., a sticky valve)	Set NOISE BAND large enought to prevent Adaptive Tune from acting on the oscillation. If oscillation is not acceptable, consider replacing valve
PRETUNE	Pretune does not develop optimum PID Parameters	Wrong pretune TYPE selected. Refer to Chapter 7, the section on Self Tune

CHAPTER 7 APPLICATIONS

NOTE: Controller capabilities depend upon the specified hardware option.

The 535 controller provides a variety of user-programmable control features and capabilities. The following topics are included in this chapter:

A. PROFILE CONTROL

The 535-PROF controller is capable of storing 20 separate recipes. Each recipe can consist of up to 12 ramps and 12 dwells. Individual recipes may be continuously run or be repeated up to 99 times. Recipes may be linked together to form longer, more complex recipes. Some profile control terms are:

NOTE:
Self Tune and Adaptive Tune may be used to optimize PID settings at varous PV/LOAD points, but should NOT be used while running a recipe. Consult factory for further details.

Ramp

A rise or fall of the setpoint in a given segment. Ramps may be defined by the time it will take for the setpoint to be achieved or the rate of rise or fall necessary for the target (soak) setpoint to be achieved.

Dwell or Soak

The designated period of time in which the setpoint does not change after the ramp has been completed.

Guaranteed Soak

Guaranteed soak insures that the soak setpoint has been achieved before the soak segment starts.

Example: Ramp 1 is programmed for 2 hours. The Soak setpoint is 400° and the soak time is set for 4 hours. If 400° can not be achieved in the 2 hour ramp time, the timing of the soak will not start until the setpoint has been reached.

To use this feature,two parameters must be defined. The first one, **GUAR.SOAK**, defines whether guaranteed soak is used and how it is used. It is located in the **REC.CONF.** menu. The second parameter, **SOAK HYST.**, is located in the **RECIPE #** menu. It defines the absolute value of the maximum allowable deviation from setpoint when a soak segment starts. If the deviation exceeds this value, guaranteed soak will stop the clock until the deviation is less than the soak hysteresis. Then the soak segment will begin. In addition, if the deviation exceeds the soak hysteresis value during the soak segment, the soak timing will stop until the deviation is less than the soak hysteresis value.

Cycles

Recipes may be repeated up to 99 times before completion or being linked to a different recipe. Recipes may also be set up to run continuously.

Linking

Recipes may be linked together to form longer, more complicated programs. Through the selective use of **CYCLES** and **LINKING**, complex recipes with subroutines can be created.

Events

For each ramp and dwell, 1, 2 or 3 available relays may be opened or closed. These may be used for a variety of purposes to include starting and stopping other process equipment. Upon recipe completion, events may be held until released by the operator (using **FAST + ACK**).

Programming recipes requires the user to make selections in the **REC. CONF.** menu of the **SET UP** mode before programming the actual recipes.

Software Configuration

The controller must be configured for the profile option before accepting recipes:

1. Enter the **SET UP** mode. Select the **REC. CONF.** menu.
2. The first parameter is **RECIPES**. This parameter defines the number of recipes available in the 535. Choices are:

D 1

R 1 through 20

3. The next parameter is **TIME BASE**. It defines whether recipes are timed in hours and minutes or in minutes and seconds. Choices are:

D HOURS:MIN

- MIN:SEC.

4. The next parameter is **RAMP UNIT**. It defines the times unit for ramp segments (hours:min or min:sec) or rate of change required to reach setpoint. If **TIME BASE**=HOURS:MIN, the ramp unit will be in PV units per minute. If **TIME BASE**=MIN:SEC the ramp unit will be in PV units per second. Choices are:

D TIME

- RATE

5. The next parameter is **SP START**. It selects whether the first ramp segment's setpoint must start at the IDLE setpoint or if it can be adjusted to account for the initial PV value (thus allowing the ramp segment to be shortened). Choices are:

- IDLE SP — the IDLE SP will be the starting setpoint of the first ramp segment
- PV — the first ramp's starting setpoint can be adjusted

6. The next parameter is **GUAR.SOAK**. It selects whether the guaranteed soak feature will be used. Its choices are:

D OFF — guaranteed soak will not occur

- START SEG. — guaranteed soak can occur only at the start of a soak segment
- WHOLE SEG. — guaranteed soak can occur at the start of or at anytime during soak segment

7. The next 3 parameters are **EVT.:1 OUT, EVT.:2 OUT** and **EVT.:3 OUT**. These select which outputs are assigned to each events. Choices are:

D NONE

- 2
- 3

• 4

The numerical choices only appear if the corresponding output is configured as **ALM.EVT:ON** or **ALM.EVT:OFF** in the **CONFIG.** menu.

8. The next parameter is **HOLD EVT**. It determines whether the last segment's event(s) will be held active after the recipe has successfully completed. Choices are:

D DISABLE

• ENABLE

Now the recipes can be programmed:

1. Enter the **RECIPE SET UP** mode. The display will indicate **RECIPE #** (# =recipe number) in the 2nd line.

Use ▲ and ▼ to select the recipe to be programmed.

Use **MENU** to advance through the parameters.

2. The first parameter is **CYCLES.** It selects the number of times the recipe will run before ending or going to the next linked recipe. Choices are:

• CONTINUAL

D 1

R 1 - 99

3. The next parameter is **NEXT LINK**. It defines which recipe will run next after the current recipe has completed. Choices are:

D NONE

R 1 to # of configured recipes

• NO OUTPUT

4. The next parameter is **IDLE SP**. It defines the setpoint to be used when the recipe starts or after it has completed. Choices are:

D LAST SP use the previous setpoint [default]

R -9999 to 99999

• REMOTE SP use the remote setpoint (only if option installed an enabled)

The decimal point is defined by the **DECIMAL** parameter.

5. The next parameter is **SOAK HYST**. It defines the absolute value of the maximum allowable deviation from the setpoint when a soak segment starts. If the deviation exceeds this value, Guaranteed Soak will occur.
This parameter appears only if GUAR.SOAK is not OFF. Choices are:

D OFF

R 1 to 99999

The decimal point is defined by the **DECIMAL** parameter in the **PV1 INPUT** menu

6. The next parameter is **RAMP RT:**## (## = 1 to 12). It defines the rate of rise or fall of the setpoint during ramp segment ## while approaching soak setpoint ##. This parameter will only appear if **RAMP UNIT = RATE**. Choices are:

D OFF ends recipe progrmming

R 1 to 99999/MIN if TIME BASE = HOURS:MIN

R 1 to 99999/SEC. if TIME BASE = MIN:SEC

The decimal point is defined by the **DECIMAL** parameter.

7. The next parameter is **RAMP TM:##** (## = 1 to 12). It defines the time for the current ramp segment (##) to reach the current soak setpoint (##). This parameter will only appear if **RAMP UNIT =** TIME. Choices are:

D OFF ends recipe programming

R 00:01 to 99:59 HR:MN if TIME BASE = HOURS:MIN

R 00:01 to 99:59 MN:SC if TIME BASE = MIN:SEC

IMPORTANT: For each **RAMP** segment, you will scroll through and set values for the next six parameters. However, choosing OFF for either **RAMP RT.##** or **RAMP TM##** will conclude the programming.

8. The next parameter is **RAMP EV:##** (## = 1 to 12). It selects which events will be activated during the current ramp segment. Choices are:

D NONE

- EVENT 1 event output 1 is selected
- EVENT 2 event output 2 is selected
- EVENT 12 event outputs 1 and 2 are selected
- EVENT 3 event output 3 is selected
- EVENT 13 event outputs 1 and 3 are selected
- EVENT 23 event outputs 2 and 3 are selected
- EVENT 123 event outputs 1, 2 and 3 are selected

9. The next parameter is **SOAK SP:##** (## = 1 to 12). It defines the setpoint after the current ramp segment (##) has completed. Choices are:

- -9999 to 99999

R Dependent upon process variable range

The decimal point defined by the **DECIMAL** parameter

10. The next parameter is **SOAK TM:##** (## = 1 to 12). It defines the length of the current soak segment. Time units are defined by the **TIME BASE** parameter in the **REC. CONF.** menu. Choices are:

D OFF Selecting off eliminates the SOAK and makes possible 2 or more ramps to different setpoints.

R 00:01 to 99:59 HR:MN if TIME BASE = HOURS:MIN

R 00:01 to 99:59 MN:SC if TIME BASE = MIN:SEC

11. The next parameter is **SOAK EV:##** (## =1 to 12). It defines which events will be activated during this soak segment. This parameter will only appear if **SOAK TM:##** is not OFF. Choices are:

D NONE

- EVENT 1 event output 1 is selected
- EVENT 2 event output 2 is selected
- EVENT 12 event outputs 1 and 2 are selected
- EVENT 3 event output 3 is selected
- EVENT 13 event outputs 1 and 3 are selected
- EVENT 23 event outputs 2 and 3 are selected
- EVENT 123 event outputs 1, 2 and 3 are selected

12. The last parameter is **PID SET:##** (## =1 to 12). It selects which PID set to use during the current ramp and soak segments. This parameter only appears if **NO. OF PID** = SEG SELECT (in the **TUNING** menu). Choices are:

D LAST SET

PROFILE CONTROLLER SET-UP WORKSHEET

RECIPE #:

Start From
Idle Setpoint: Process Variable

Time Base
HRS/MIN: MIN/SEC:

TIME →

PROCESS ↑

Ramp 1	Soak 1	Ramp 2	Soak 2	Ramp 3	Soak 3	Ramp 4	Soak 4	Ramp 5	Soak 5	Ramp 6	Soak 6	Ramp 7	Soak 7	Ramp 8	Soak 8	Ramp 9	Soak 9	Ramp 10	Soak 10	Ramp 11	Soak 11	Ramp 12	Soak 12

Use this chart to set up your recipe(s).

END SETPOINT																								
RATE																								
RAMP TIME																								
SOAK TIME																								
SOAK HYS.																								
EVENT 1																								
EVENT 2																								
EVENT 3																								
PID SET																								

Figure 7.1
Contacts for Recipe Selection

Recipe Number	Contact 1	Contact 2	Contact 3
None	O	O	O
1	●	O	O
2	O	●	O
3	●	●	O
4	O	O	●
5	●	O	●
6	O	●	●
7	●	●	●

O = Open

● = Closed

NOTE:
The 535 Profile Controller can store 20 recipes, but only recipes 1 through 7 may be selected remotely. This will use three of the five input contacts. The two remaining can be used to start or abort a recipe (START REC.) or hold the recipe (HOLD REC.). See **Section I** for other input options.

R 1 to 8

13. After parameter **PID SET**, the controller will cycle to the **RAMP RT:##** or **RAMP TM:##** parameter.

To end programming:

- Set either **RAMP RT:##** = OFF or **RAMP TM:##** = OFF.

To continue programming:

- Set a value for for **RAMP RT:##** or **RAMP TM:##**, and scroll through subsequent parameters.

Digital Inputs

Special digital input capabilities are available for 535 as a Profile Controller (see **Section I** in this chapter for information on standard Digital Input options). Profile Control digital input options are:

- RECIPE. 1-7

  Selects recipe number (1through 7 using binary contacts 1, 2 and 3) for the next time a recipe is run. The recipe number selected must be be tween 1 and the number of recipes selected in the REC. CONF. menu. Note that a binary value of “0” (zero) is inactive, and values of 1 to 7 select recipes 1 to 7 respectively.
- START REC. (Active = Start Recipe; Inactive = Abort Recipe)

  When activated, the most recently selected recipe will start running.

  When deactivated, a running or held recipe will be aborted. This action will take place if a recipe is not running or held at the time of the contact closure.
- HOLD REC. (Active = Hold Recipe; Inactive = Resume Recipe)

  When activated, a running recipe will be held at its current position. When deactivated, a held recipe will resume running from its current position.
- RESET REC.

  When activated, a running or held recipe is reset to the beginning. If the recipe is linked to other recipes, the beginning of the first linked recipe will be used. When deactivated, no action will be taken.
- ABORT REC.

  When activated, a running or held recipe will be aborted. When deacti vated, no action will be taken.
- NEXT SEG.

  When activated, a running or held recipe will advance to the end of the current segment. When deactivated, no action will be taken.
- PV2. SWITCH

  (only applicable if **PV SOURCE** = 1/2:SWITCH). When activated, causes the controller to use PV2 as the PV input (instead of PV1).

Master/Slave Operation

The 535 Controller with profile option Is capable of operating as a master setpoint generator controlling up to 4 standard (slave) 535 controllers. The 535 with profile option can retransmit the recipe setpoints to the remote setpoint inputs of up to 4 standard 535 controllers. Configured as such, a common recipe may be applied to 5 different control loops or heating/cooling zones.

Hardware Configuration

- The 535 controller with profile option must be configured with an analog milliamp module in the first available output.
- See **Section H** in this chapter for instructions on configuring the retransmission feature.
- Up to four model 535 controllers can be used, each must be specified with the remote setpoint option.
- See **Section J** in this chapter for instructions on configuring the optional remote setpoint feature.

B. CONTROL TYPE

NOTE: Controller capabilities depend upon the specified hardware option.

Software Configuration

1. Go to the **CONTROL** menu.
2. For the parameter **ALGORITHM**, select the type of 535 control:

- **ON-OFF**

  "Crude" control similar to a household thermostat. Used primarily on slow, stable processes where moderate deviation (cycling) around setpoint is tolerable. Only available with SSR, SSR Drive, and relay outputs.
- **P**

  Proportional only control. Provides much better control than on/off. Used on processes that are less stable or require tighter control, but have few load variations and do not require a wide range of setpoints.
- **PI**

  Proportional plus integral control. In addition to proportional control, it compensates for control errors due to wide range of setpoints or load requirements. The integral term works to eliminate offsets.
- **PD**

  Proportional plus derivative control. In addition to proportional control, it compensates for control errors due to fast load variations.
- **PID**

  Proportional plus integral plus derivative control. In addition to proportional control, it compensates for changes in setpoint, load requirements and process variations.
- **PID/ON-OFF**

  Only available with Duplex control. First output uses the PID algorithm, while second output uses on/off control.

3. For algorithms using the derivative function (D), choose the conditions for the derivative term:

   Scroll to parameter **D. SOURCE**
   - For derivative action based on error, or deviation from setpoint, choose DEVIATION
   - For derivative action based on changes in the process variable, choose PV.

NOTE: Specifying a variable other than the setpoint (SP) to **HIGH ALARM** and **LOW ALARM** allows for greater flexibility in creating alarm and control strategies.

C. ALARMS

The 535 controller has two extremely flexible and powerful software alarms. The number of available outputs limits how alarms are linked to relays. A Global Alarm feature allows all alarms to be assigned to the same relay.

The 535 indicates an alarm condition by:

- Lighting up the alarm icon(s)
- Displaying a custom message in the 3rd display
- Illuminating the **ACK** key (if the alarm is acknowledgeable)

Software Configuration

1. Access the **ALARM** menu.
2. Set values for the following parameters. All possible values are shown.

ALM.TYPE:1 and ALM. TYPE:2

Specifies the type of alarm to implement. Selection includes:

- **HIGH ALARM**

  High process variable alarm. Occurs when the process variable exceeds the alarm setpoint.

- **LOW ALARM**

  Low process variable alarm. Occurs when the process variable goes below the alarm setpoint.

- **HIGH/LOW**

  Combination of high and low alarms. Occurs when the process variable exceeds the individually set high or low setpoint.

- **BAND**

  Creates a band centered around the control setpoint, that is twice the alarm setpoint. Alarm occurs when the process variable travels outside of this band. The alarm is dependent on the control setpoint. As the control setpoint changes, the band adjusts accordingly.

  For example, if the control setpoint is 500 and the alarm setpoint is 25, then the band extends from 475 to 525.

- **DEVIATION**

  Similar to the band alarm but creates a band only on one side of the control setpoint. Alarm occurs when the process variable deviates from the control setpoint by an amount greater than the alarm setpoint. This alarm is dependent on the control setpoint; as the control setpoint changes, the alarm point changes.

  For example, if the control setpoint is 500 and the alarm setpoint is +50, then an alarm occurs when the process variable exceeds 550. In order for an alarm to occur when the process variable drops below 450, select an alarm setpoint of –50.

- **MANUAL**

  Alarm occurs when the controller is put into manual mode of operation. This may be useful for security purposes or to alert the operator that 535 is no longer under automatic control.

- **RATE**

  Alarm occurs when the process variable changes at a rate greater than what is specified by the alarm setpoint and time base. This alarm helps to anticipate problems before the process variable can reach an undesirable level.

  For example, if the alarm setpoint is 10 with a time base of 5 seconds, an alarm occurs whenever a change in process variable greater than 10 occurs in 5 seconds.

ALM.SRC.:1 and ALM.SRC.:2

For HIGH , LOW or HIGH/LOW alarms, specifies the variable (source) upon which a selected alarm is based. Selection includes:

- PV
- PV2
- SP
- RAMP SP
- DEVIATION
- OUTPUT

ALARM SP:1 and ALARM SP:2

Defines the point at which an alarm occurs. For a RATE (rate of change) alarm, it specifies the amount of change (per RATE TIME period) that must occur before the alarm activates. A negative value specifies a negative rate-of-change. Does not apply to HIGH/LOW alarms.

HIGH SP:1 and HIGH SP:2

For a HIGH/LOW alarm, defines the high setpoint at which an alarm occurs.

LOW SP:1 and LOW SP:2

For a HIGH/LOW alarm, defines the low setpoint at which an alarm occurs.

DEADBAND:1 and DEADBAND:2

Specifies the range through which the process variable must travel before leaving an alarm condition (see alarm examples at the end of this section). Prevents frequent alarm oscillation or “chattering” if the process variable has stabilized around the alarm point.

ALM.1 OUT and ALM.2 OUT

For any enabled alarm, selects the output number to which the selected alarm will be assigned. It is possible to assign both alarms to the same output relay, thus creating a “global” alarm .

LATCHING:1 and LATCHING:2

A latching (YES) alarm will remain active after leaving the alarm condition unless it is acknowledged. A non-latching (NO) alarm will return to the non-alarm state when leaving the alarm condition without being acknowledged.

Alarm Parameters Reference

For Alarm 1

Parameter	Description
ALM. TYPE:1	Type
ALM. SRC.:1	Source
ALARMSP:1	Setpoint
HIGHSP:1	High setpoint
LOWSP:1	Low setpoint
DEADBAND:1	Deadband
ALM.:1 OUT.	Output number
LATCHING:1	Latching sequence
ACK.:1	Acknowledging
POWERUP:1	Status on power up
MESSAGE:1	Message

For Alarm 2

Parameter	Description
ALM. TYPE:2	Type
ALM. SRC.:2	Source
ALARMSP:2	Setpoint
HIGHSP:2	High setpoint
LOWSP:2	Low setpoint
DEADBAND:2	Deadband
ALM.:2 OUT.	Output number
LATCHING:2	Latching sequence
ACK.:2	Acknowledging
POWERUP:2	Status on power up
MESSAGE:2	Message

For either alarm
(depending on choices)

Parameter	Description
FAULT	Fault assignment
OUTPUT	Output action for rate
RATETIME	Time base for rate

ACK.:1 and ACK.:2

For any enabled alarm, enables or disables operator use of the **ACK** key to acknowledge an alarm at any time, even if the control process is still in the alarm condition.

A latching alarm can always be acknowledged when it is out of the alarm condition. When either alarm is available to be acknowledged, the **ACK** key will be illuminated. If both alarms are acknowledgeable, pressing **ACK** will first acknowledge alarm #1. Pressing **ACK** a second time will acknowledge alarm #2.

POWER UP:1 and POWER UP:2

For any enabled alarm, selects the alarm condition upon power up. Choices are:

- NORMAL

  Controller will power up in alarm only if it is in alarm condition.

- ALARM:

  Controller always powers up in alarm regardless of system's alarm condition. This is an excellent way to activate an alarm if there has been a power failure.

- DELAYED

  Controller will never power up in alarm, regardless of system's alarm condition. The system must leave and reenter the alarm condition before the alarm will activate. This is typically used to avoid alarms during start up.

MESSAGE:1 and MESSAGE:2

Allows user to specify a nine-character message to be displayed when the respective alarm is active. If both alarms are active or any other diagnostic message is present, the messages will alternate.

FAULT

Activates an alarm if the process variable signal is lost. Assign this function to either Alarm 1 or Alarm 2 (not both). This action is in addition the selected alarm type (additive alarm function).

OUTPUT

For a RATE alarm, selects the output action. Use to obtain early indication of a possible break in the process variable signal. Select PV BREAK to have rate-of-change alarm take the same action as a detection of a break in the process variable signal (where it trips to manual control at a predetermined output).

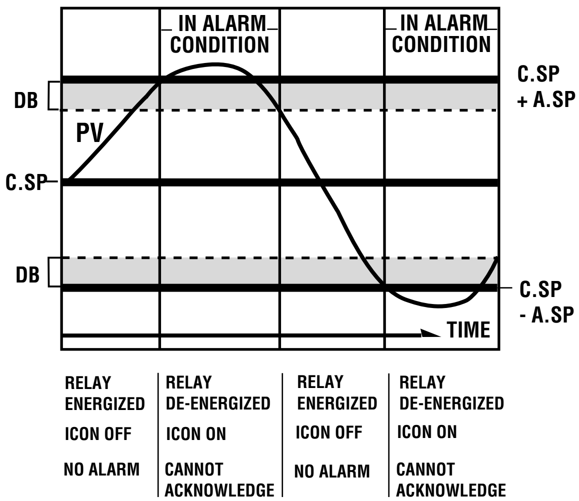
RATE TIME

For RATE alarms, defines the time period over which a discrete change in process variable must occur for the rate alarm to be activated. The amount of change is defined by the alarm setpoint. The rate-of-change is defined as the amount of change divided by the time period.

Example

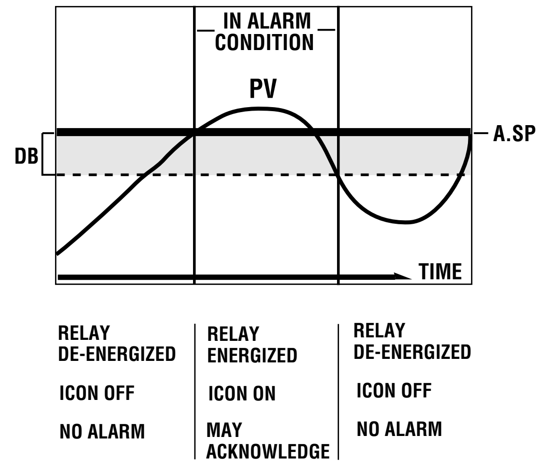
A. If the alarm setpoint is set to 10 and the time base is set to 1 second, the rate of change is 10 units per second.

BAND ALARM



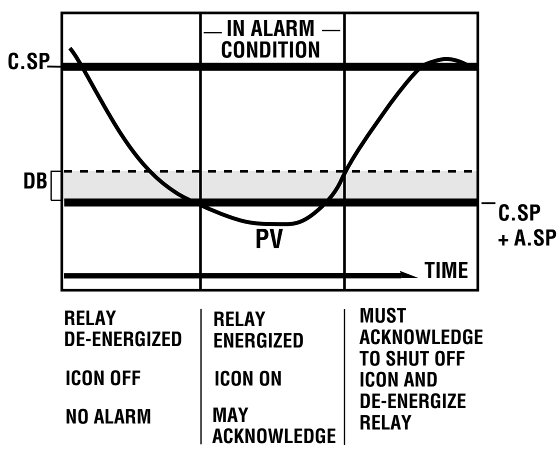
PARAMETER SETTINGS:
OUTPUT N = ALM.RLY:OFF (N = 2 to 4)
ALM. TYPE:1 = BAND
ALM.:1 OUT. = N (N= 2 to 4)
LATCHING = NO LATCH
ACK.:1 = DISABLED

HIGH PROCESS VARIABLE ALARM



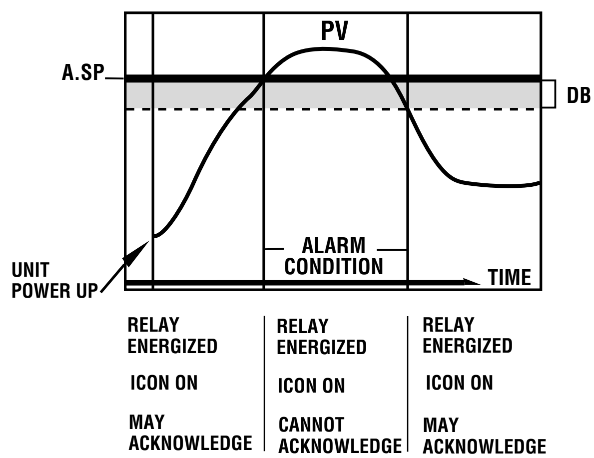
PARAMETER SETTINGS:
OUTPUT N = ALM.RLY:ON (N = 2 to 4)
ALM. TYPE:1 = HIGH ALRM.
ALM.:1 OUT. = N (N = 2 to 4)
LATCHING = NO LATCH
ACK.:1 = ENABLED

DEVIATION ALARM



PARAMETER SETTINGS:
OUTPUT N = ALM.RLY:ON (N = 2 to 4)
ALM. TYPE:1 = DEVIATION
ALM.:1 OUT. = N (N = 2 to 4)
LATCHING = LATCH
ACK.:1 = ENABLED
ALARM SP:1 = (<0)

POWER UP ALARM



PARAMETER SETTINGS:
OUTPUT N = ALM.RLY:ON (N = 2 to 4)
ALM. TYPE:1 = HIGH ALM.
ALM.:1 OUT. = N (N = 2 to 4)
LATCHING:1 = LATCH
ACK.:1 = DISABLED
POWER UP:1 = ALARM

Figure 7.2 Alarm Examples

NOTE: The duplex output states vary depending upon:
1. Control Type (PID, On/Off, etc.)
2. Control Action (DA, RA)
3. Output Limits
4. Output Gap or Overlay, and
5. Ouput 2 Relative Gain and PID% Output.

Please refer to the output state examples in this section to confirm that the configuration is appropriate for the process.

NOTE: Set manual reset/load line parameters to 50% when using Duplex control (**MAN. RST.:X** parameter is in the **TUNING** menu.)

B. If the alarm setpoint is set to 100 and the time base set to 10, the rate of change is also 10 units per second.

In example A, the process variable would only have to experience a ten unit change over a short period of time, while in Example B, it would require a 100 unit change over a ten second period. Example A is much more sensitive than Example B. In general, for a given rate-of-change, the shorter the time period, the more sensitive the rate alarm.

D. DUPLEX CONTROL

The Duplex control algorithm enables two discrete control outputs for the control loop. Duplex control is commonly used for applications that require both heating and cooling or when 2 control elements are needed to achieve the desired result.

Hardware Configuration

- The controller must have two output modules assigned to the loop (any combination of output modules).

Software Configuration

1. Go to the **CONFIG**. menu.
   Set **CTRL.TYPE** to DUPLEX.
2. To use different algorithms for each output (PID for the first, and On/Off for the second):
   Go to the **CONTROL** menu.
   Set **ALGORITHM** to PID:ON/OFF.
3. To make the control action for each output independent of the other:
   Go to the **CONTROL** menu.
   Set **ACTION:1** or **ACTION:2** to either DIRECT or REVERSE action based on the diagrams in the output examples section (*Figures 7.2 through 7.8*).
4. Go to the **TUNING** menu.
   Set values for **PID OFST:1** (or **ON OFST:1**) and **PID OFST:2** (or **ON OFST:2**). These parameters allow the user to independently offset the point at which output 1 and output 2 become active. **PID OFSET** units are in percent (%) of control output; **ON OFST** is in engineering units. The settings can be used to make sure there is a dead band, i.e., no controller output around setpoint. They can also be used to overlap output 1 and output 2 so that both are "on" in a small band around setpoint.
5. Set **MAN. RESET** (manual reset) term to 50%. This causes the PID output to be 50% when there is zero error. This term is still active as a "load line" setting when using automatic reset (integral), so set it to 50% whether using automatic reset or not.
6. **REL. GAIN** (relative gain) changes the gain of Output 2 relative to Output 1. Note that the relative gain can limit the maximum output available for Output 2 when using PID control.
7. Go to the **CONTROL** menu.
   Set **LOW OUT.** and **HIGH OUT.** to limit the maximum or minimum outputs from Output 1 and Output 2. The actual limitation on the outputs is dependent on the offset settings, the relative gain setting and the control action.

Duplex Output State Examples

The following Duplex examples represent a variety of ways this function can be set up. PID control examples show the PID output percentage on the horizontal axis, and On/Off control examples show the process variable on the horizontal axis. The vertical axes are the output of each physical output. Most of these examples use the first output as heating and the second output as cooling.

When using PID control, the 535 controller actually displays the PID output. To relate this output to the actual physical output, locate the PID output on the horizontal axis. Draw a vertical line at that point. At the intersection of this vertical line and the respective output line, draw a horizontal line. The physical output is the value where this horizontal line intersects the respective axis.

The illustrations assumes a manual reset/load line term of 50%. Therefore, at zero error (process variable equals setpoint) the PID output is 50%.

Duplex with reverse and direct acting outputs

A reverse acting output 1 and a direct acting output 2 with: no offset, no restrictive outputs limits, and a neutral relative gain with PID control.

PARAMETER SETTINGS
ACTION:1 = REVERSE
ACTION:2 = DIRECT
PID OFST.:1 = 0
PID OFST.:2 = 0
LOW OUT = 0
HIGH OUT = 100
REL. GAIN = 1.0

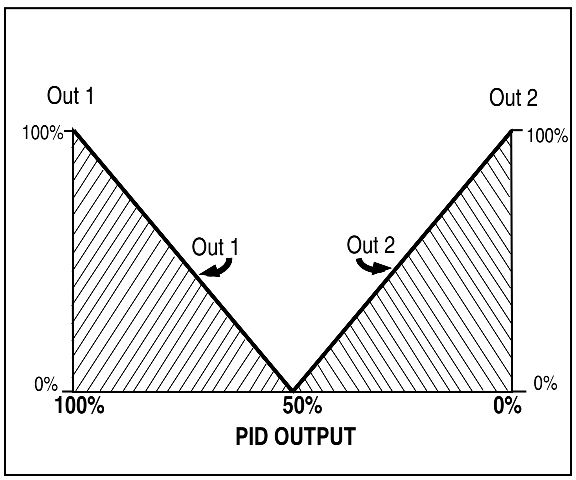


Figure 7.3
Duplex with reverse and direct acting outputs

Duplex with direct and reverse acting outputs

A reverse acting output 1 and a direct acting output 2 with: no offset, no restrictive output limits, and a neutral relative gain with PID control.

PARAMETER SETTINGS
ACTION:1 = DIRECT
ACTION:2 = REVERSE
PID OFST.:1 = 0
PID OFST.:2 = 0
LOW OUT = 0
HIGH OUT = 100
REL. GAIN = 1.0

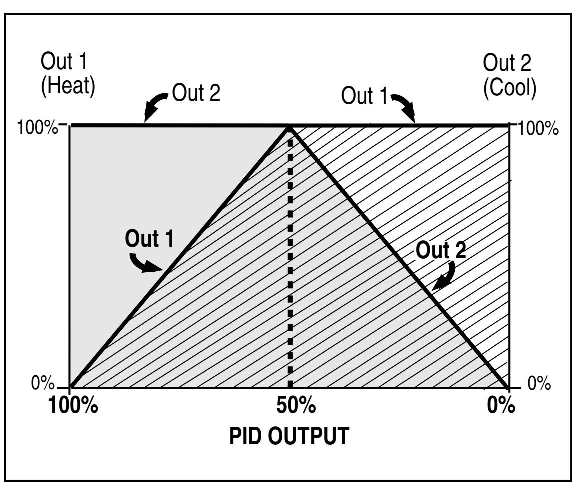


Figure 7.4
Duplex with direct and reverse acting outputs

Duplex with 2 reverse acting outputs

Two reverse acting outputs with: no offset, no restrictive output limits, and a neutral relative gain with PID control.

PARAMETER SETTINGS
ACTION:1 = REVERSE
ACTION:2 = REVERSE
PID OFST.:1 = 0
PID OFST.:2 = 0
LOW OUT = 0
HIGH OUT = 100
REL. GAIN = 1.0

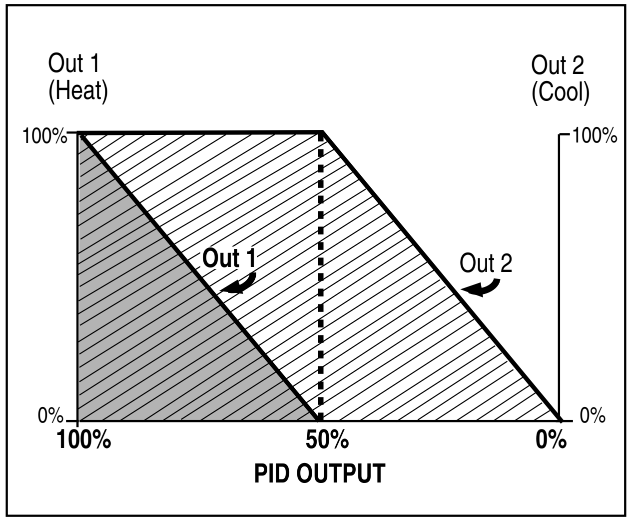


Figure 7.5
Duplex with two reverse acting outputs

Duplex with a gap between outputs

A reverse acting output 1 and a direct acting output 2 react with: a positive offset for output 1 and a negative offset for output 2 (assume no restrictive output limits and a neutral relative gain with PID control).

On the graph, a positive offset refers to an offset to the left of 50%; a negative offset is to the right of 50%.

PARAMETER SETTINGS
ACTION:1 = REVERSE
ACTION:2 = DIRECT
PID OFST.:1 = + VALUE
PID OFST.:2 = – VALUE
LOW OUT = 0
HIGH OUT = 100
REL. GAIN = 1.0

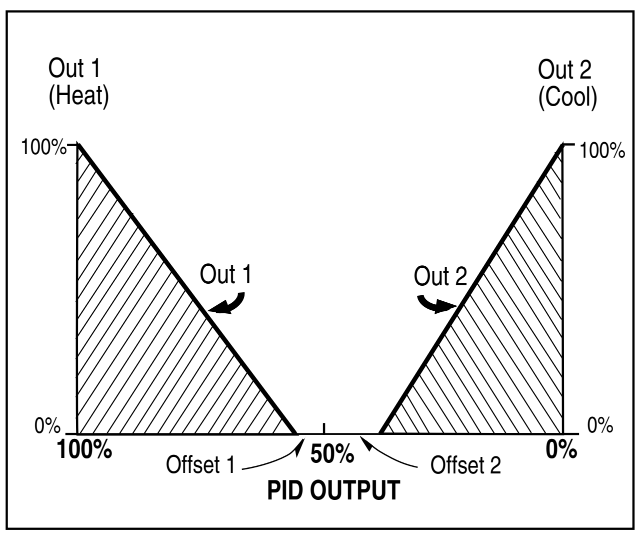


Figure 7.6
Duplex with a gap between outputs

Duplex with overlapping outputs and output limits

A reverse acting output 1 and a direct acting output 2 with: a negative offset for output 1, a positive offset for output 2, and restrictive high and low output limits with PID control.

This combination of offsets results in an overlap where both outputs are active simultaneously when the PID output is around 50%.

The output limits are applied directly to the PID output. This in turn limits the actual output values. In this example, the high output maximum limits the maximum value for output 1, while the low output minimum limits the maximum value for output 2. The value the actual outputs are limited to depends on offset settings, control action and relative gain setting with PID control.

PARAMETER SETTINGS
ACTION:1 = REVERSE
ACTION:2 = DIRECT
PID OFST.:1 = – VALUE
PID OFST.:2 = + VALUE
LOW OUT = 10%
HIGH OUT = 85%
REL. GAIN = 1.0

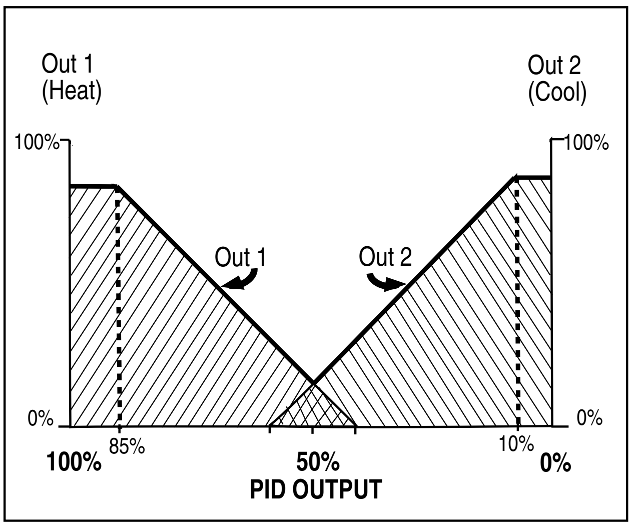


Figure 7.7
Duplex with overlapping outputs and output limits

Duplex with various relative gain settings

A reverse acting output 1 and a direct acting output 2 with: various relative gain settings (assume no offset or restrictive outputs) with PID control.

PARAMETER SETTINGS
ACTION:1 = REVERSE
ACTION:2 = DIRECT
PID OFST.:1 = 0
PID OFST.:2 = 0
LOW OUT = 0
HIGH OUT = 100
REL. GAIN ❶ = 2.0
REL. GAIN ❷ = 1.0
REL. GAIN ❸ = 0.5

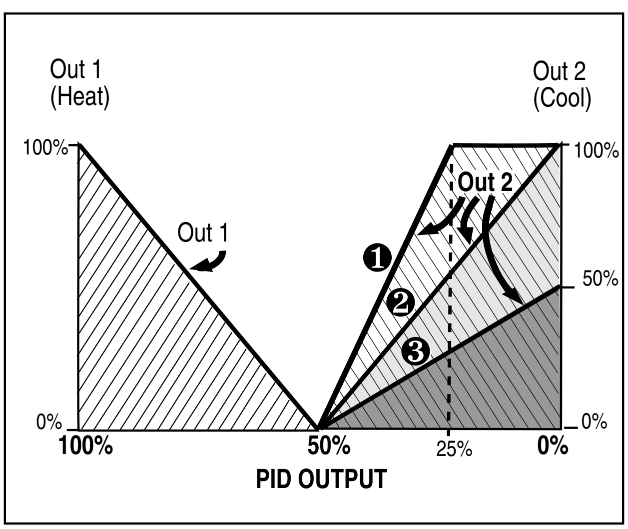


Figure 7.8
Duplex with various relative gain settings

Notice that the relative gain setting does not affect output 1. In this example, a relative gain setting of 2.0 (curve 1) results in output 2 reaching its maximum value at a PID output of 25%. A relative gain setting of 1.0 results in output 2 reaching its maximum value at a PID output of 0%. A relative gain setting of 0.5 results in output 2 reaching a maximum of 50% at a PID output of 0%.

Duplex with one ON/OFF output

A reverse acting output 1 and a direct acting, on/off output 2 with a positive offset.

Relative gain does not apply when using duplex with an on/off output. The deadband setting for output 2 works the same as the deadband in single on/off control (the deadband effect for output 2 is not illustrated here).

PARAMETER SETTINGS
ACTION:1 = REVERSE
ACTION:2 = DIRECT
PID OFST.:1 = 0
ON OFST.:2 = + VALUE
LOW OUT = 0
HIGH OUT = 100

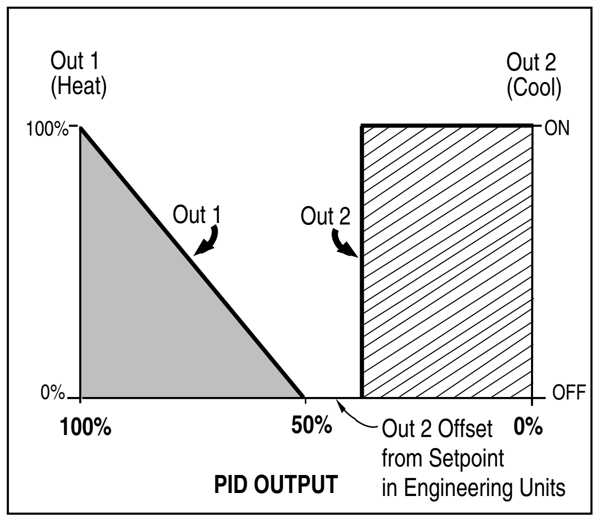


Figure 7.9
Duplex with one ON/OFF output

Duplex with two ON/OFF outputs

A reverse acting on/off output 1 and a direct acting on/off output 2 with a negative offset for output 1 and a positive offset for output 2.

Note that here the horizontal axis is expressed in terms of process variable rather than PID output.

PARAMETER SETTINGS
ACTION:1 = REVERSE
ACTION:2 = DIRECT
ON OFST.:1 = − VALUE
ON OFST.:2 = + VALUE

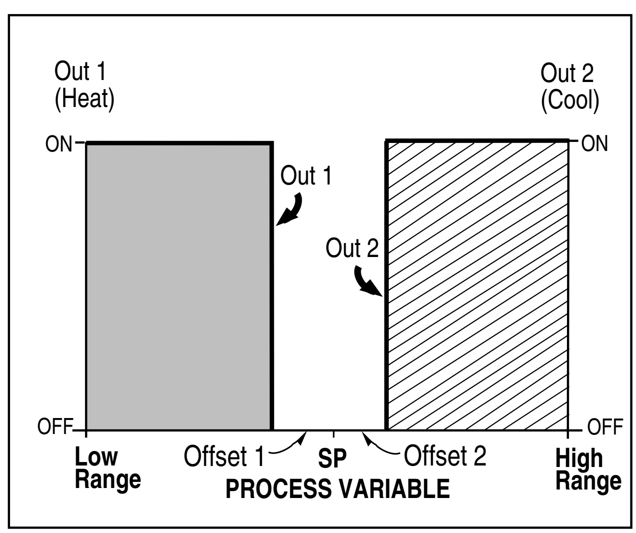


Figure 7.10
Duplex with two ON/OFF outputs

E. SLIDEWIRE POSITION PROPORTIONING CONTROL

Slidewire position proportioning utilizes a slidewire feedback signal to determine the actual position of the actuator being controlled.

Hardware Configuration

- The controller **must** have the Slidewire Feedback option installed. Refer to the order code in Chapter 1 for more information.
- The controller must have mechanical relays, solid state relays or DC logic modules installed in the first two output sockets.
- The Slidewire does NOT have to be wired to the controller in order to set up position proportioning.

CAUTION!

The relay in socket 1 drives the motor counterclockwise and the relay in output socket 2 drives the motor clockwise.

This is important for:

- Wiring the outputs
- Selecting the control **ACTION:1** parameter, or
- Determining the normally open or normally closed relays,

The configuration choices influence the way the position proportioning algorithm works.

Software Configuration

1. To configure the controller before wiring the slidewire feedback signal to the controller, complete these steps:
   a. Go to the **CONTROL** menu.
   b. Set a value for **PV BREAK**
   c. Go to the **SPECIAL** menu.
   d. Set a value for **DES. OUTPT.**
   e. Set a value for **PWR.UP:OUT.**
   f. Go to **SER. COMM.** menu.
   g. Set a value for **SHED OUT.**
2. Place the controller under manual control.
3. Go to the **CONFIG.** menu.
4. Set **CTRL. TYPE** to POS. PROP (position proportioning).
5. Set **P.P. TYPE** to SLIDEWIRE.
6. Go to the **CONTROL** menu.
7. For **S/W RANGE**, specify the full range resistance of the slidewire from end-to-end. With a 100 ohm slidewire, this parameter should be set to 100.
8. Scroll to **OPEN F/B** (Open feedback). Enter the ohm value when the actuator is fully open (0 to 1050 ohms).
9. Scroll to **CLOSE F/B** (Closed feedback). Enter the ohm value when the actuator is fully closed (0 to 1050 ohms).
10. Measure the actual slidewire value at the terminals (10 and 11).

    As an alternative, set up these two parameters dynamically. Before entering Set Up set the manual output at 100%. Enter Set Up and change the **OPEN F/B** value until the actuator just reaches its full open position.

    Exit Set Up and set the manual output to 0%. Enter configuration and change the **CLOSE F/B** value until the actuator just reaches its full closed position.

NOTE: OPEN F/B and **CLOSE F/B** values are always reference to the CCW end of the Slidewire.

11. Set the parameter **P. PROP. D.B.**, which is used to eliminate cycling of the motor. A low deadband setting may result in motor overspin or cycling. A high deadband will result in reduction of sensitivity. To set:
    a. Go to the **TUNING** menu.
    b. Set **P. PROP. D.B.** to .5%.
    c. Place controller under Manual control.

NOTE: **P.PROP.D.B.** can only be configured if the Slidewire Feedback is wired to the controller.

d. Change the output percentage and observe if the valve stabilizes at the new value.
e. If the valve oscillates, increase the **P.PROP.D.B.** value by 0.5%; repeat until oscillation stops.

12. Set the parameter **S/W BREAK** to define the output value for when the slidewire breaks.

NOTE: Adaptive tuning is not available with velocity position proportioning control.

F. VELOCITY POSITION PROPORTIONING CONTROL

Velocity position proportioning does not utilize direct feedback. It estimates the position of the actuator, based on time and the speed of the actuator.

In automatic control mode, the controller will display “CW” to refer to energizing of the clockwise relay, and “CCW” to refer to energizing of the counterclockwise relay. A blank display means that both relays are de-energized.

In manual control mode, the display is blank unless an output change is being made. Use the ▲and ▼ keys to change the output; the relay is only energized while the keys are being pressed. The display indicates the percentage change in valve position in real time. The rate of change is dependent on the values entered for **CCW TIME** and **CW TIME**.

The controller will transfer to manual control due to a lost process variable (**PV. BREAK**), a digital input closure (**DES.OUTPT.**), a power-up sequence (**PWR.UP:OUT.**), or lost communications (**SHED OUT**). In these cases, the output can be set to: remain at its last value with both relays de-energized (OUTS OFF); rotate fully counterclockwise (CCW); or rotate fully clockwise (CW). CCW and CW will energize the respective relay for a period two times that of the **CCW TIME** or **CW TIME**.

Hardware Configuration

- The controller must have mechanical relay, solid state relay or DC logic modules installed in the first two output sockets.

Refer to the section on Chapter 1 for more information.

Software Configuration

1. Go to **CONFIG.** menu.
   Set **CTRL. TYPE** to POS. PROP.
2. Go to the **CONTROL** menu.
   Set **P.P. TYPE** to VELOCITY.
3. Set **CCW TIME** to the amount of time (in seconds) it takes for the actuator to fully rotate in the counterclockwise direction.
   Set **CW TIME** to the amount of time (in seconds) it takes for the actuator to fully rotate in the clockwise direction.
   Loads on the valve may affect the time required, therefore, it is best to measure these values when the valve is in service. As an alternative, enter the values specified by the actuator manufacturer and then make adjustments later.
4. Set **MIN. TIME** to the minimum amount of time the controller must specify for the motor to be on before it takes any action.
5. Set values for **PV. BREAK, DES. OUTPT., PWR.UP:OUT.** and **SHED OUT.**

G. STAGED OUTPUTS

With staged outputs, one analog output can vary its signal (e.g., 4-20 mA) over a portion of the PID output range. The second analog output then varies its signal over another portion of the PID output range. This is an excellent method to stage two control valves or two pumps using standard control signal ranges.

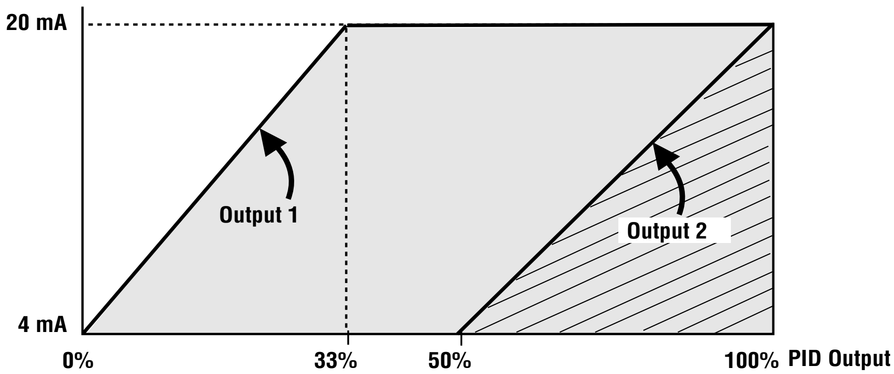


Figure 7.11
Staged Outputs Example
OUT1 STOP *was set to 33% and*
OUT2 STRT. *was set to 50%.*

Hardware Configuration

- The controller must have analog output modules installed in the first two output sockets.

Software Configuration

1. Go to the **CONFIG.** menu.
   Set **CTRL. TYPE** to STAGED.
2. Go to the **CONTROL** menu.
3. For **OUT1 STOP**, specify where the first output reaches 100%.
4. For **OUT2 START**, specify where the second output begins.

H. RETRANSMISSION

The retransmission feature may be used to transmit a milliamp signal corresponding to the process variable, target setpoint, control output, or actual setpoint to another device. A common application is to use it to record one of these variables with a recorder.

Hardware Configuration

- There must be an analog module installed in output socket 2, 3 or 4.

NOTE: For an analog output module for retransmission that was not factory-installed, calibrate the output for maximum accuracy. Refer to Appendix 4 for details on calibration.

Software Configuration

Up to two outputs can be configured for retransmission. The menu will scroll through the configuration parameters for specified value "X" (2, 3 or 4).

1. Go to the **CONFIG.** menu.
2. For **OUTPUT:2, OUTPUT:3** and **OUTPUT:4** parameters, set one or two of them to RETRANS.
3. Go to the **RETRANS.** menu.
4. Set the corresponding parameter, **TYPE:X**, for the first retransmission

output to define what is being transmitted: the process variable, setpoint, ramping setpoint or output.

5. Set parameters **LOW RANGE:X** and **HIGH RANGE:X** for the first retransmission output, to define the range of the transmitted signal in engineering units. This can be useful in matching the input range of the receiving device.
6. For any other retransmission output, continue to scroll through the this menu and set the **TYPE:X, LOW RANGE:X** and **HIGH RANGE:X** for the second retransmission output.

I. DIGITAL INPUTS

Digital inputs can be activated in three ways: A switch (signal type)—the recommended type, a relay, or and open collector transistor

Digital inputs are only functional when that option is installed (via hardware). The controller detects the hardware type, and supplies the appropriate software menus (see the section on parameters in Chatper 5). There are 14 contact types for the up to 5 digital inputs. See **Section A** for digital input options when using Profile Control.

Hardware Configuration

- This optional features is only available if ordered originally from the factory, Product #535xxxxxxDx00. The (up to) five digital inputs share a common ground.

NOTE: To take advantage of multiple setpoints, make sure that the **SP NUMBER** parameter in the **SPECIAL** menu is set to a value greater than 1.

Software Configuration

1. Go to the **CONFIG.** menu.
2. Set parameters **CONTACT:1** through **CONTACT:5** (only those available will shown) by assigning the desired function to each output. Choices are:
   - SETPT 1-8

     (For **CONTACT:1** only) Allows the controller to use the first four digital inputs to select a setpoint (see Figure 7.12). If the inputs' states remain constant, the controller will continue to use the selected setpoint unless overridden. Override the set of digital inputs by selecting a different setpoint (via the **SP SELECT** parameter in the **TUNING** menu, or through communications), or by using the fifth digital

Setpoints	DIN 1	DIN 2	DIN 3	DIN 4
SP	X	0	0	0
SP2	0	X	0	0
SP3	X	X	0	0
SP4	0	0	X	0
SP5	X	0	X	0
SP6	0	X	X	0
SP7	X	X	X	0
SP8	0	0	0	X

Figure 7.12
Combinations of Closed Digital Inputs for Each Setpoint (based on BCD logic)
X=closed contact
0=open contact

     input to select the remote or 2nd setpoint. To "rearm" this set of digital inputs, the DIN combination must change.

   - REM. SETPT.

Closing input changes active setpoint to remote setpoint. Opening reverts controller to previous setpoint. Override by selecting a different setpoint via the **SP SELECT** parameter (in the **TUNING** menu), a communications command, or other digital inputs.

- MANUAL

  Closing input trips the controller to manual. Opening input reverts controller to automatic. Override by using **MANUAL** key, a communications command, or "trip to automatic" function.

- 2ND. SETPT.

  Closing input changes active setpoint to the 2nd local setpoint. Opening input reverts controller to previous setpoint digital input. Override by selecting a different setpoint via the **SP SELECT** parameter (in the **TUNING** menu), a communications command, or other digital inputs.

- 2ND. PID

  Closing input changes active set of PID values to 2nd set. Opening input bases active set of PID on rules defined in **PID TRIP** and **TRIP:1** to **TRIP:8**. Override input only by directly linking PID set to the active setpoint and changing the active setpoint.

- ALARM ACK.

  Closing input acknowledges all active alarms. Opening input "rearms" the controller. If the digital input remains closed, it *does not* continue to immediately acknowledge alarms as they become active.

- RST. INHBT.

  Reset Inhibition. Closing input deactivates "I" (integral) term, regardless of the PID values being used. Opening input activates "I" term (if applicable).

- D.A./R.A.

  Direct Acting/Reverse Acting. Closing input reverses action of the first control output (from direct to reverse, or reverse to direct). Opening reinstates original action.

- STOP A/T

  Closing input temporarily disables Adaptive Tuning. Opening input enables it.

- LOCK. MAN.

  Closing contact places the controller in manual control at the designated output percentage. All locked manual contacts must be opened in order to return controller to automatic control.

- UP KEY / DOWN KEY

  Closing the contact mimics the designated ▲ or ▼ key. Useful if controller is mounted behind a window; contact push-buttons can be used to change setpoint values.

- DISP. KEY

  Closing contact mimics the **DISPLAY** key; scroll through display of the Setpoint, Deviation % and Output%.

- FAST KEY

  Closing contact mimics the **FAST** key . Use in conjunction with **▲, ▼, DISPLAY** and **MENU** keys.

NOTE: The second display does not change when tripping to manual from a closed digital input.

NOTE: Only alarms configured to be acknowledged are affected by this digital input.

NOTE: There is a one-second delay before a closed digital input takes action.

- MENU KEY

  Closing contact mimics the **MENU** key. In **OPERATION** Mode, provides entry to **TUNING** menu. In **SET UP** or **TUNING** Mode, advances through the menus.
- COMM. ONLY

  Makes input status readable through communications (but has no effect on the controller itself).
- PV2.SWITCH

  (only applicable for **PV SOURCE** = 1/2:SWITCH). Closing contact causes the 535 to use PV2 as the PV input (instead of PV1).

Basic Operating Procedures

1. If more than one digital input closes and their actions conflict, the last digital input that closed has priority.

   For example, if one digital input closes and selects 2nd setpoint, and then another digital input closes and selects a remote setpoint, the remote setpoint takes precedence.
2. Any digital input can be overridden by: another digital input, a keyboard operation, or an automatic function. If a closed digital input is overridden, then it must be opened in order to be rearmed.

   For example, if one digital input closes and selects the 2nd setpoint, and then a different setpoint is selected through the keyboard, the keyboard selection takes precedence.

J. REMOTE SETPOINT

Remote setpoint limits are the same as setpoint limits.

Hardware Configuration

- The optional feature is available only if ordered originally from the factory, Product #535-xxxxxBxx00 or #535-xxxxxExx00). Refer to the order code in Chapter 1.
- Before configuring the software, make sure the corresponding jumper is set properly. Refer to Chapter 4 to check or change jumper positions.

Software Configuration

1. Go to the **CONFIG.** menu.
2. Set **REM. SET PT.** to ENABLED.
3. Go to the **REM. SETPT.** menu.
4. **TYPE V/MA** defines the input signal range (e.g. 1-5/4-20 mA).
5. **RSP:LO. RNG.** and **RSP: HI RNG.** define the range of the remote setpoint in engineering units. The correct range will be dependent on the remote setpoint signal source.
6. **RSP:LOW** and **RSP:HIGH** set limits on the remote setpoint value in engineering units.
7. **TRACKING** determines whether or not the controller will revert to a local setpoint if the remote setpoint signal is lost. This prevents a process upset due to a sudden change in setpoint.
8. **BIAS LOW** and **BIAS HIGH** set limits on an operator entered bias value.

9. **RSP FIXED** determines the signal to which the controller will revert when a lost RSP is restored (fixed). Options are to stay in local or automatically return to remote setpoint.
10. To bias or ratio the remote setpoint value:
    a. Go to the **TUNING** menu.
    b. Set **RSP BIAS** and **RSP RATIO** values.

Basic Operating Procedures

After configuring the hardware and software, the remote setpoint can be selected by either of two methods:

- Go to **TUNING** menu, **REMOTE SP** parameter, and set it to REMOTE SP.
- Use a digital input

K. MULTIPLE SETPOINTS

The 535 can to store up to eight local setpoints and use a remote setpoint. One application of this feature is configuring the controller to restrict operators to discrete setpoint choices. The 535 can also store multiple sets of PID parameters (see next section).

Software Configuration

1. Go to the **SPECIAL** menu.
2. Set **NO. OF SP** to the number of local setpoints desired.
3. Go to the **TUNING** menu. Access the **SP SELECT** parameter. Use ▲ and ▼ to select the desired local setpoint.
4. To link the PID sets to the corresponding local setpoint:
   Set **NO. OF PID** to SP NUMBER.
   For details on multiple sets of PID, refer to the next section in this chapter.

Basic Operating Procedures

To select a set point, go to the **TUNING** menu, access the **SP SELECT** parameters, and scroll through the setpoints. The displayed setpoint becomes active after two second of key inactivity.

The digital inputs can also be used to select the active setpoints. A single digital input may be used for selecting the second setpoint, SP2. A set of four digital inputs may be used, to select up to 8 setpoints (see the section in this Chapter in Digital Inputs).

L. MULTIPLE SETS OF PID VALUES

The 535 has the ability to store up to eight sets of PID values. This can be a valuable feature for operating the controller under conditions which require different tuning parameters for optimal control. There are various methods of selecting which set should be active. These methods are explained in this section.

Software Configuration

1. Go to the **TUNING** menu.
2. **NO.OF PID** is the desired number of PID sets to be stored. SP VALUE automatically sets this value equal to the number of stored local setpoints

(each PID set will be active when its respective local setpoint is active).

3. **PID TRIP** determines which variable selects the various PID sets: process variable, setpoint or deviation from setpoint.
4. **TRIP:X** defines the point (in the PV range) at which that set of PID values become active.

Basic Operating Procedures

A PID set can be selected in one of six ways.

- For **NO. OF PID** = PV NUMBER, the PID set (1 or 2) is selected when PV1 or PV2 is used.
- For **NO. OF PID** = SP NUMBER, the active set of PID values is the same as the active setpoint. For example, if SP3 is active, then PID set #3 will be active.
- For **NO. OF PID** = REC. NUMBER, the PID set (1-8) is the same as the current recipe number which is running (or on hold).
- For **NO. OF PID** = SEG SELECT, the PID set (1-8) is assigned to the current recipe segment as defined by the **PID SET:##** parameter in the **RECIPE #** menu.
- When **NO. OF PID** = a number (2-8), a PID set becomes active when the variable exceeds its trip point.

  For example, if **PID TRIP** = SETPOINT, and **TRIP:2** = 500, the second set of PID values becomes active when the setpoint exceeds 500, and remains active until the setpoint drops below 500 or exceeds the next highest trip point. The PID set with the lowest trip point is also active when the trip variable is less than the trip value. (The user can set the lowest trip point = the low end of the process variable range, but this is not required.)
- A digital input can be set to trip to the second set of PID upon closure, which overrides a selection based on trip points.

Using with Adaptive and Pretune

The 535 can be programmed to automatically set the PID values using the Pretune and Adaptive Tuning functions.For both functions, the tuned set of PID is that which is active upon initiation of the tuning function.

The controller cannot trip to other PID sets (based on trip point or the digital input contact) until Adaptive Tuning is disabled. However, if the PID set is tied to the corresponding local setpoint, the active PID set values will change with the local setpoint.

Each PID set has 5 parameters that control its function—proportional band, reset, rate, manual reset (or loadline), and trip point. For each set (2 thru 8), these values have to be manually set.

1. Press **MENU** to access the **TUNING** menu.
2. Set values for parameters 1 thru 20 (these include the first PID set)
3. Press **MENU** to access these parameters for each additional PID set (2 through 8): **PROP. BND, RESET, RATE, MAN. RST.** and **TRIP**.

M. POWERBACK

POWERBACK is a proprietary algorithm which, when invoked by the user, reduces or eliminates setpoint overshoot at power up or after setpoint changes. Powerback monitors the process variable to make predictive adjustments to control parameters, which in turn helps to eliminate overshoot of the Setpoint.

Software Configuration

1. Go to the **TUNING** menu.
2. Set **POWR.BACK** parameter to ENABLED.
3. Go to the **SELF TUNE** menu.
4. For **DEAD TIME**, set the value (time) that the controller should wait before invoking an output change. This value is typically the dead time of the process. Or, let Pretune calculate the dead time, then complete just steps 1 and 2 above.

N. SELF TUNE—POWERTUNE®

The Self Tune function of the 535 consists of two distinct components, Pretune and Adaptive Tune. These components may be used independently or in conjunction with one another. For best results, we recommend using them together.

Pretune

This algorithm has three versions. Choose the type that most closely matches the process to optimize the calculation of the PID parameters. The three Pretune types are:

- TYPE 1 Normally used for slow thermal processes
- TYPE 2 Normally used for fast fluid or pressure processes
- TYPE 3 Normally used for level control applications

Pretune is an on-demand function. Upon initiation, there is a five second period during which the controller monitors the activity of the process variable. Then the control output is manipulated and the response of the process variable is monitored. From this information, the initial Proportional Band, Reset and Rate (P, I and D values) and dead time are calculated. When using TYPE 2 or TYPE 3 Pretune, the Noise Band (**NOISE BND.**) and Response Time (**RESP. TIME**) will also be calculated.

In order to run this algorithm, the process must fulfill these requirements:

- The process must be stable with the output in the manual mode;
- For tuning a non-integrating process, the process must be able to reach a stabilization point after a manual step change; and
- The process should not be subject to load changes while Pretune operates.

If these conditions are not fulfilled, set the Adaptive Tune to run by itself.

Adaptive Tune

Adaptive Tune continuously monitors the process and natural disturbances and makes adjustments in the tuning parameters to compensate for these changes. In order to make accurate calculations, Adaptive Tune needs noise band and response time values. Pretune TYPE 2 and TYPE 3 automatically calculate these values. These values may also be entered or changed manually in the **Self Tune** menu. For Pretune TYPE 1, Noise Band and Response Time parameters must be entered manually.

Figure 7.13 illustrates the relationship between Pretune and Adaptive Tune.

CAUTION!

Disable Adative Tuning before altering process conditions (e.g., for shutdown, tank draining, etc.). Otherwise, the 535 will attempt to adapt the Tuning parameters to the temporary process conditions.

Adaptive Tune can be disabled via digital input (if applicable—see Digital Inputs in this chapter), or via menus:

1. Go to the **TUNING** menu.
2. Go to parameter **ADAPTIVE.** Change the value to DISABLED.

Software Configurations

Pretune by Itself

1. Go to the **SELF TUNE** menu (press **MENU+FAST**)
2. Set the **TYPE** parameter to PRETUNE.
3. Set the **PRETUNE** type to the one that best matches the process (see above section).
4. The next parameter, **TUNE PT.**, appears only for TYPE 1 pretune. This parameter sets the PV point at which the output will switch off. In thermal processes, this will help prevent overshoot. The default is AUTOMATIC.
5. If using TYPE 2 or TYPE 3 pretune, Set the value for **OUT STEP**. This parameter defines the size of bump to be used. The resulting disturbance must change the process variable by an amount that significantly exceeds the peak-to-peak process noise, but does not travel beyond the “normal” process variable range.
6. The next two parameters, **LOW LIMIT** and **HI LIMIT**, set the process variable boundaries. If these boundaries are exceeded during the Pretune, the pretune cycle will abort and return to manual control at the output level prior to the initiation of pretune.
7. The next parameter, **TIMEOUT**, defines the maximum time in minutes within which pretune must complete its calculations before it is aborted.

   The first time a pretune is performed, set **TIMEOUT** to its maximum value. Make note of the length of the pretune cycle. Then, adjust **TIMEOUT** to a value about twice the pretune time.

   The purpose of this parameter is to prevent a Pretune cycle from continuing for an excessive time if a problem develops. The value has no impact on the PID values being calculated.
8. Next is **MODE**. This defines what mode the controller will enter when pretune is completed. Select MANUAL if there will be a need to review PID parameters before attempting to control with them; the default is AUTOMATIC.
9. Place the controller under manual control.
10. Access the **TUNING** menu (press **MENU**).
11. Access the parameter **PRETUNE** (press **MENU**).
12. Press ▲**and then ACK** to begin Pretuning.

    The 3rd display will show the message EXECUTING.
13. When Pretune is complete, the 3rd display will show COMPLETED for two seconds and then return to the current menu display.

Pretune TYPE 1 & Adaptive Tune

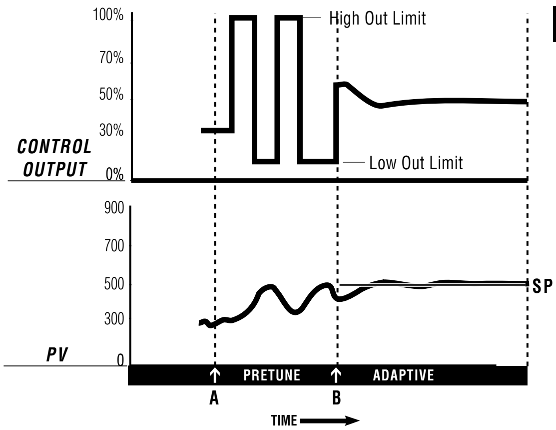
1. Go to the **SELF TUNE** menu.
2. Set **TYPE** to BOTH.
3. Set **PRETUNE** to TYPE 1.
4. Set a value for **TUNE PT**.

   NOTE: TUNE PT.= AUTOMATIC will work correctly only if the controller’s setpiont is set up properly beforehand.
5. Set **NOISE BND** parameter.
6. Set the **RESP. TIME** parameter.
7. Make sure that the process is reasonably stable and place the controller

under manual control.

8. Press **MENU** to access the **TUNING** menu.
   Set **ADAPTIVE** to ENABLED. The Adaptive Tuning cycle does not begin until the controller is under automatic control.
9. Activate the next parameter, **PRETUNE**.
10. Press ▲ **and then ACK** to begin Pretuning.
    The 3rd display will show the message EXECUTING.

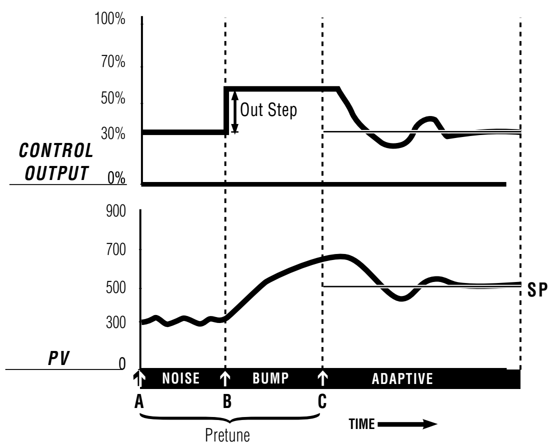
Figure 7.13
Pretune TYPE 1, TYPE 2 and TYPE 3 with Adaptive Tune



TYPE 1 Pretune/Adaptive Control

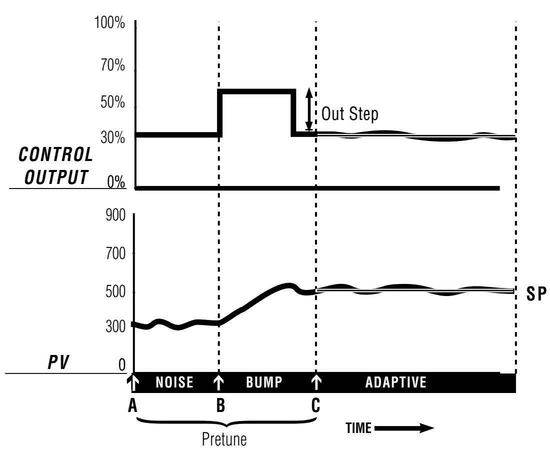
- A to B is ON/OFF control to determine initial PID values.
- B is Pretune completed, so Adaptive PID control beings if ENABLED.

Note: Noise Band and Resp. Time must be entered before enabling Adaptive TUne)



TYPE 2 Pretune/Adaptive Control

- A to B is a 5 second noise band measurement.
- B to C is an open loop bump test to determine initial PID values and response time.
- C is Pretune completed, so Adaptive PID control begins if ENABLED.



TYPE 3 Pretune/Adaptive Control

- A to B is a 5 second noise band measurement.
- B to C is an impulse to determine initial PID values and response time.
- C is Pretune completed, so Adaptive PID control begins if ENABLED.

11. When Pretune is complete, the 3rd display will show COMPLETED for two seconds and then return to the current menu display.

The controller will automatically transfer to automatic control upon completion of Pretune if set to do so, or upon manual transfer.

Figure 7.13 illustrates the operation of Pretune TYPE 1 with Adaptive Tune.

Pretune TYPE 2 or 3 & Adaptive Tune

1. Go to the **SELF TUNE** menu.
2. Set the **TYPE** parameter to BOTH.
3. Set the **PRETUNE** parameter to TYPE 2 or TYPE 3.
4. Enter a value for parameter **OUT. STEP**.
5. **DO NOT** Enter values for **NOISE BND** and **RESP TIME**. The Pretune algorithm will calculate these values.
6. Make sure that the process is reasonably stable and place the controller under manual control.
7. Press **MENU** to access the **TUNING** menu.
8. Set parameter **ADAPTIVE** to ENABLED. The Adaptive Tuning cycle does not begin the controller is under automatic control.
9. Activate the next parameter, **PRETUNE**.
10. Press ▲ **and then ACK** to begin Pretuning.
    The 3rd display will show the message EXECUTING.
11. When Pretune is complete, the 3rd display will show COMPLETED for two seconds and then return to the current menu display.

NOTE: Adaptive tuning is **not** available for velocity position proportional control.

The controller will automatically transfer to automatic control upon completion of Pretune if set to do so, or upon manual transfer.

Figure 7.13 illustrates the operation of Pretunes TYPE 2 and TYPE 3 with Adaptive Tune.

Adaptive Tune by Itself

1. Go to the **SELF TUNE** menu.
2. Set the **TYPE** parameter to ADAPTIVE.
3. Press **MENU** to access the **TUNING** menu.
3. Enter values for **NOISE BND** and **RESP. TIME** (as described below).
4. Set the **ADAPTIVE** parameter to ENABLED. The Adaptive Tuning cycle does not begin the controller is under automatic control.

CAUTION!

If the process conditions are temporarily changed, (e.g., during process shutdown, draining of a tank, etc.) **disable adaptive tuning.**

Otherwise, the controller will attempt to adapt its tuning parameters to the temporary process conditions.

Disable adaptive tuning by:

1. In the **TUNING** menu, change **ADAPTIVE** to DISABLED through the keypad; or
2. Closing the appropriate digital input (see Digital Input section in this chapter).

If Pretune results are poor or process conditions do not allow Pretune to run:

Adaptive Tune parameters can be manually configured. Proper setting of the noise band and response time parameters will yield excellent adaptive control without running the Pretune function.

1. Go to the **SELF TUNE** menu.
2. Set **NOISE BND**.
   The noise band is chosen to distinguish between disturbances which affect the process and process variable "noise." The controller functions to

compensate for disturbances (i.e., load changes), but it cannot compensate for process noise. Attempting to do this will result in degraded controller performance. The Noise Band is the distance the process deviates from the setpoint due to noise in percentage of full scale.

Figure 7.14 shows a typical process variable response in a steady-state situation. In this example, the process noise is within a band of about 0.5% of full scale.

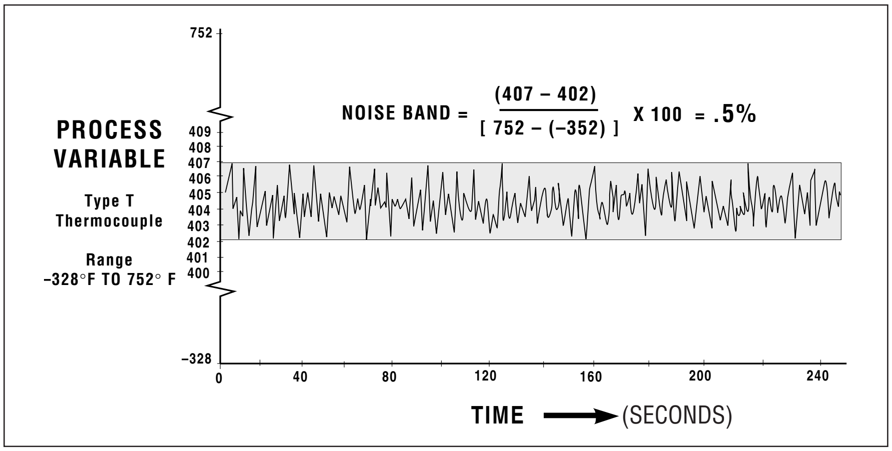


Figure 7.14
Noise Band Calculation Example

A noise band that is too small will result in tuning parameter values based on noise rather than the effects of load (and setpoint) changes. If the noise band is set too small, then Adaptive Tune will attempt to retune the controller too often. This may result in the controller tuning cycling between desirable system tuning and overly sluggish tuning. While the result may be better than that achieved with a non-adaptive controller, this frequent retuning is not desirable.

If the noise band is set too large, the process variable will remain within the noise band, and the controller will not retune itself. With too large a noise band, important disturbances will be ignored, and the controller will be indifferent to sluggish and oscillatory behavior.

Noise band settings are generally between 0.1% and 1.0%, with most common settings of 0.2% or 0.3%. *Figure 7.15* shows the conversion of peak-to-peak noise to an appropriate noise band for each T/C type & RTD.

	INPUT TYPE										
Peak to Peak Noise °F	B	E	J	K	N	R/S	T	W/WS	PLATINEL	RTD	0.1°RTD
0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2
3	0.1	0.2	0.2	0.1	0.1	0.1	0.3	0.1	0.2	0.2	0.3
4	0.1	0.2	0.2	0.1	0.1	0.1	0.4	0.1	0.2	0.2	0.5
5	0.2	0.2	0.2	0.2	0.2	0.2	0.5	0.1	0.2	0.3	0.6
6	0.2	0.3	0.3	0.2	0.2	0.2	0.6	0.1	0.3	0.3	0.7
7	0.2	0.3	0.3	0.2	0.3	0.2	0.6	0.2	0.3	0.4	0.8
8	0.2	0.4	0.4	0.3	0.3	0.3	0.7	0.2	0.4	0.4	0.9
9	0.2	0.4	0.4	0.3	0.3	0.3	0.8	0.2	0.4	0.5	1.0
10	0.2	0.4	0.4	0.3	0.4	0.3	0.9	0.2	0.4	0.5	1.1

Figure 7.15
Noise Band Values for Temperature Inputs

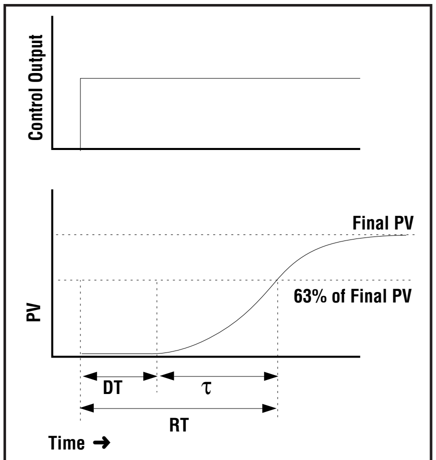


Figure 7.16
Deadtime and Time Constant

3. Set **RESP. TIME.**

   The response time is the most critical value in Adaptive Tuning. Response time represents the time lag from a change in valve position (controller output) to a specific amount of change in process variable. Specifically, Response Time is equal to the Deadtime of the process plus one Time Constant. The Deadtime is the time between initiation of an input change and the start of an observable response in the process variable. The Time Constant is the interval of time between the start of that observable response and the point where the process variable reaches 63% of its final value. (See *Figure 7.16*).

   Example

   After a stimulus (e.g., valve movement), if it takes 300 seconds for a process to reach 63% of its new (expected) value, the response time is 300 seconds. If the response time is set too short, the process will be unstable and cycle around the setpoint. If the Response Time is set too long, response to an off-setpoint condition will be sluggish. It is generally better to use too long a response time than too short.

Self Tuning with Multiple Sets of PID

For both Pretune and Adaptive Tune, the tuned set of PID is that which is active upon initiation of the tuning function.

The controller cannot trip to other PID sets (based on trip point or the digital input contact) until Adaptive Tuning is disabled. However, if the PID set is tied to the corresponding local setpoint, the active PID set values will change with the local setpoint.

Each PID set has 5 parameters that control its function—proportional band, reset, rate, manual reset (or loadline), and trip point. For each set (2 thru 8), these values have to be manually set.

1. Press **MENU** to access the **TUNING** menu.
2. Set values for parameters 1 thru 20 (these include the first PID set).
3. Press **MENU** to access these parameters for each additional PID set (2 through 8): **PROP. BND, RESET, RATE, MAN. RST.** and **TRIP**.

Self Tune with Time Proportioning Outputs

When using either the Pretune or the Adaptive Tune with a time proportioning output, use as short of a cycle time as possible within the constraint of maintaining a reasonable life on relays, contacts or heating elements.

Self Tune with Control Valves

In many systems utilizing a control valve, the point at which the control valve begins to stroke does not coincide with 0% output, and the point at which it completes its stroke doesn't coincide with 100%. The parameters **LOW OUT** and **HIGH OUT** in the **CONTROL** menu specify the limits on the output. Set these limits to correspond with the starting and stopping point of the valve's stroke. This prevents a form of "windup" and thus provides the adaptive control algorithm with the most accurate information.

For example, in manual the control output was slowly increased and it was noted that the control valve started to stroke at 18% and at 91% it completed its stroke. In this case **LOW OUT** should be set at 18% and **HIGH OUT** at 91%.

Note that when output limits are used, the full output range from -5 to 105% is available in manual control.

O. RAMP-TO-SETPOINT

The 535 contains a ramp-to-setpoint function that may be used at the user's discretion. This function is especially useful in processes where the rate-of-change of the setpoint must be limited.

When the ramping function is activated, the controller internally establishes a series of setpoints between the original setpoint and the new **target** setpoint. These interim setpoints are referred to as the **actual** setpoint . Either setpoint may be viewed by the user. When the setpoint is ramping, RAMPING will be shown in the 3rd display when the actual (ramping) setpoint is displayed.

When the target setpoint is being shown, RAMPING will **not** appear. Pressing the **DISPLAY** key will scroll the 2nd display as follows:

- From the target setpoint to the actual (ramping) setpoint;
- To the deviation from setpoint;
- To the output level; and
- Back to the target setpoint.

Note that when ramping, the deviation indication is with respect to the target setpoint.

The ramp-to-setpoint function is triggered by one of three conditions:

1. Upon power up, if the 535 powers up in automatic control, then the setpoint will ramp from the process variable value to the setpoint value at the specified rate.
2. On a transfer from manual to automatic control the setpoint will ramp from the process variable value to the setpoint value at the specified rate.
3. On any setpoint change, the setpoint will ramp from the current setpoint to the new target setpoint. When triggered, the display will automatically change to indicate the ramping setpoint.

Software Configuration

1. Go to the **PV1 INPUT** menu.
2. Set the **SP RAMP** parameter to the desired rate of change.

P. INPUT LINEARIZATION

Thermocouple and RTD Linearization

For a thermocouple or RTD input, the incoming signal is automatically linearized. The 535 has lookup tables that it uses to provide an accurate reading of the temperature being sensed.

Square Root Linearization

Many flow transmitters generate a nonlinear signal corresponding to the flow being measured. To linearize this signal for use by the 535, the square root of the signal must be calculated. The 535 has the capability to perform this square root linearization.

For the first 1% of the input span, the input is treated in a linear fashion. Then it is a calculated value, using the formula in *Figure 7.17*.

Figure 7.17
Square Root Linearization Formula

$$PV = \text{Low Range} + \left[(\text{Hi Range} - \text{Low Range}) \sqrt{(V_{input} - V_{low} / (V_{high} - V_{low})} \right]$$

Hi Range is the high end of the process variable.
Low Range is the low end of the process variable.
V_{input} is the actual voltage or current value of the input.
V_{high} is the high end of the input signal range (e.g. 5 volts or 20 mA).
V_{low} is the low end of the input signal range (e.g. 1 volt or 4 mA).

Example:
PV range is 0 – 1000.
Input signal range is 1–5 volts.
Input signal is 3 volts.
Therefore $PV = 0 + \left[(1000 - 0) \sqrt{(3-1) / (5-1)} \right] = 1000 \sqrt{.5} = \mathbf{707}$

Hardware Configuration

- A voltage or milliamp input must be installed on the controller.

Software Configuration

1. Go to the **PV1 INPUT** menu.
2. Set **LINEARIZE** to SQR. ROOT.

Custom Linearization

Custom linearization allows virtually any nonlinear signal to be linearized using a 15-point straight line approximation curve (see Figure 7.18). Typical applications are linearizing signals from nonlinear transducers, or controlling volume based on level readings for irregularly-shaped vessels. To define the function, enter data point pairs—the engineering units corresponding to a particular voltage or current input.

Software Configuration

1. Go to the **PV1 INPUT** menu.
2. Set the parameter **LINEARIZE** to CUSTOM.
3. Go to the **CUST. LINR.** menu.
4. Enter values for the **1ST INPUT** and **1ST PV** data points. All the input

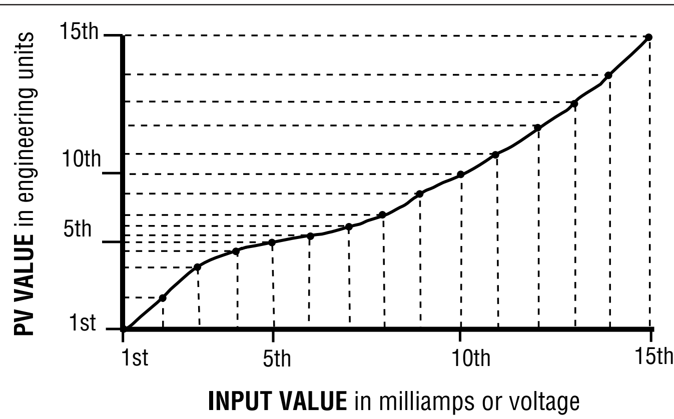


Figure 7.18
15-point Linearization Curve

parameters define the actual milliamp or voltage input. All the PV parameters define the corresponding process variable value in engineering units.

It is not necessary to use all 15 points. Whenever the **XTH INPUT** becomes the high end of the input range, that will be the last point in the table.

Once the various points are defined, the values between the points are interpolated using a straight line relationship between the points. The only limitation is that the resulting linearization curve must be either ever-increasing or ever-decreasing.

Q. LOAD LINE

Load line is a manual reset superimposed on the automatic reset action. Adjusting the **MAN. RST.** tuning constant shifts the controller proportional band with respect to the setpoint.

When used with a proportional only or proportional/derivative control algorithm, the **MAN. RST.** parameter (located in the **TUNING** menu) is in effect "manual reset".

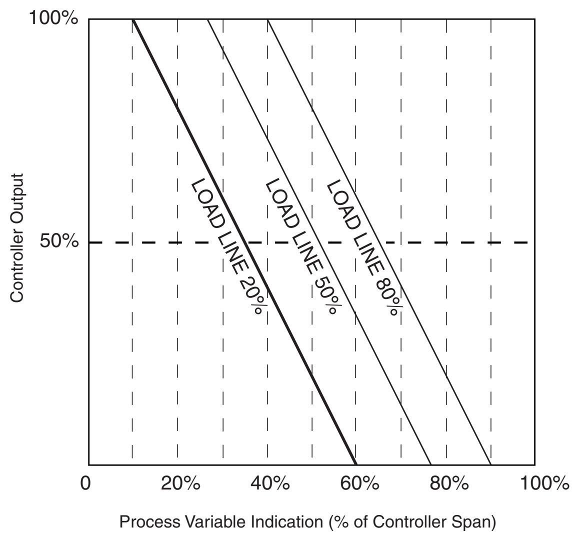


Figure 7.19
Load Line Example

However, when the automatic reset term is present, the reset action gradually shifts the proportional band to eliminate offset between the setpoint and the process. In this case, load line provides an initial shift at which the reset action begins. Load line is adjusted by observing the percent output required to control the process and then adjusting the load line to that value. This minimizes the effect of momentary power outages and transients. Load line may also be adjusted to give the best response when bringing the load to the desired level from a "cold" start.

R. SECURITY

The 535 security system is easily customized to fit a system's needs.

NOTE: SEC CODE does not appear unless all functions are unlocked.

Software Configuration

1. Go to the **SECURITY** menu.
2. **SEC. CODE** defines the security password (range from -9999 to 99999). The rest of the security parameters can be selectively locked out.
3. **SP ADJUST** prevents the operator from using the ▲ and ▼ keys to change

the setpoint value. It does not prevent the operator from changing setpoints via the **SP SELECT** (in the **TUNING** menu).

4. **AUTO./MAN**. locks out the **MANUAL** key preventing the operator from transferring between automatic control and manual control.
5. **SP SELECT** locks out the **SP SELECT** parameter in the **TUNING** menu. This prevents the operator from changing among the various local setpoints or changing to remote setpoint. It does not prevent the operator from changing the setpoint value via the ▲ and ▼ keys.
6. **RUN KEY** locks out the **RUN key**. This prevents an operator from starting, holding or aborting a recipe.
7. **ALARM ACK.** locks out the **ACK** key, preventing an operator from acknowledging any alarms.
8. **TUNING** locks out modification to the parameters in the **TUNING** menu, preventing unauthorized changes to the tuning parameters or the activation/ deactivation of the self tuning algorithm.
9. **RECIPES** locks out modification to the parameters in the **RECIPE #** menu.
10. **CONFIGURE** allows access to the configuration menus, but prevents any unauthorized changes to the configuration parameters. If locked out, the security code is not accessible.

NOTE: Lock out **CONFIGURE** for full security. If left unlocked, the operator will have access to the security code.

Basic Operating Procedures

NOTE: The security function is compromised if the security code is left at zero (0).

The security feature can be overridden. When a locked function is attempted, the operator will have the opportunity to enter the security code. **If the correct security code is entered, the operator has full access. The security feature is reactivated after one minute of keypad inactivity.** If the security code is forgtton, the security feature can still be overridden.

NOTE: Security does not prevent the operation from the digital inputs or serial communications.

- The security override code is **62647** .

  Store this number in a secure place and blacken out the code in this manual to limit access.

S. RESET INHIBITION

Reset Inhibition is useful in some systems either at the start-up of a process or when a sustained offset of process variable from setpoint exists. In conditions like these, the continuous error signal may cause the process temperature to greatly overshoot setpoint. Any of the digital inputs may be set up so that the contact closure disables the reset action (sets it to zero).

Software Configuration

1. Go to the **CONFIG.** menu.
2. Set corresponding parameter(s) **CONTACT:1** to **CONTACT:5** to RST. INHBT.

T. PROCESS VARIABLE READING CORRECTION

Conditions extraneous to the controller—and aging thermocouple, out of calibration transmitter, lead wire resistance, etc.—can cause the display to indicate a value other than the actual process value. The **OFFSET** and **GAIN** parameters can be used to compensate for these extraneous conditions. NOTE: This feature is provided as a convenience only. Correcting the cause of the erroneous reading is recommended.

1. Go to the **PV1 INPUT** menu.

2. Set **OFFSET**. This parameter either adds or subtracts a set value from the process variable reading in engineering units. For example, if the thermocouple was always reading 3° too high, the parameter could be set to "–3" to compensate.
3. Set **GAIN**. This multiplies the deviation from the low end of the process variable range by the gain factor and then adds it to the value of the low end of the range to arrive at the adjusted process variable value.

   For example, if the process variable range is 50 to 650 and the process variable reading is 472, a **GAIN** of 0.995 would yield an adjusted process variable equal to [(472 – 50) x .995] + 50 = 470.

NOTE: PV1 GAIN is only available if using a linear voltage or current input.

With a combination of both offset and gain factors, just about any inaccuracy in the sensor or transmitter can be compensated.

U. SERIAL COMMUNICATIONS

The serial communications option enables the 535 to communicate with a supervisory device, such as a personal computer or programmable logic controller.

The communications standard utilized is RS-485 which provides a multi-drop system that communicates at a high rate over long distances. Typical limitations are 32 instruments per pair of wires over a distance up to 4000 feet.

The 535 uses a proprietary protocol which provides an extremely fast and accurate response to any command. Cyclic redundancy checking (CRC) virtually ensures the integrity of any data read by the 535. Through communications, there is access to every Set up, Tuning and Operating parameter. For details on the 535 protocol, contact a application engineer.

Hardware Configuration

- This optional features is only available if ordered originally from the factory. The circuitry for communications is contained on a modular circuit board that plugs into the Microcontroller Circuit Board, Refer to the order code in Chapter 1 for details.

Software Configuration

1. Access the **SER. COMM.** menu.
2. **STATION** specifies the unit's station address. It is the only way one 535 can be distinguished from another. Each 535 on the same RS-485 interface must have a unique station address.
3. Choose a **BAUD RATE** from 1200 to 19,200. In general, select the highest value. However, every instrument on the RS-485 interface must be set to the same baud rate.
4. **CRC** indicates the cyclic redundancy checking feature. If the host supports it, activating this option is recommended.
5. When the 535 senses that communications is lost, it can go to a predetermined state (called "shedding"). The **SHED TIME** parameter sets the length of time that communications can be interrupted before the controller sheds. Since the 535 is a stand-alone controller, it does not depend on communications to operate. Therefore, if the "shed" feature is not needed, set it to OFF.
6. **SHED MODE** designates the mode to which the controller goes after it shes. Setting this to MANUAL brings up the following parameters.

7. Use **SHED OUT** to specify an output level if the unit sheds and trips to manual control.
8. To specify a control setpoint (in case the host is supervising the setpoint) if the 535 sheds.; Set **SHED SP** to DESIG. SP and then, set the parameter **DESIG. SP** to the desired setpoint.

V. CASCADE CONTROL

While a single 535 Controller is effective in maintaining many control systems, others require more sophisticated control schemes. *Figure 7.19*, shows a sample control set up with a 535 controller. Cascade control is often used to control a process more precisely. In cascade control, a second variable is monitored in addition to the primary controlled variable. This second variable is one that more quickly reflects any changes in the process environment.

Cascade control involves installing one feedback loop within another, as in *Figure 7.20*. This second loop, based on steam pressure, is called the inner or secondary feedback loop. The outer or primary feedback loop is based on the temperature of the liquid in the heat exchanger. However, instead of directly positioning the steam valve, the output of the primary 535 controller is now used to adjust the setpoint of the secondary 535 controller, which then positions the valve.

Cascade Control is typically used for the following:

- A slow responding process with a significant lag time
- A process requiring more advanced or tighter control
- A process where two PID control loops need to interact to achieve optimum control. Cascade control is commonly implemented in temperature control applications where the main control variable is affected by another variable, i.e., pressure.

Example

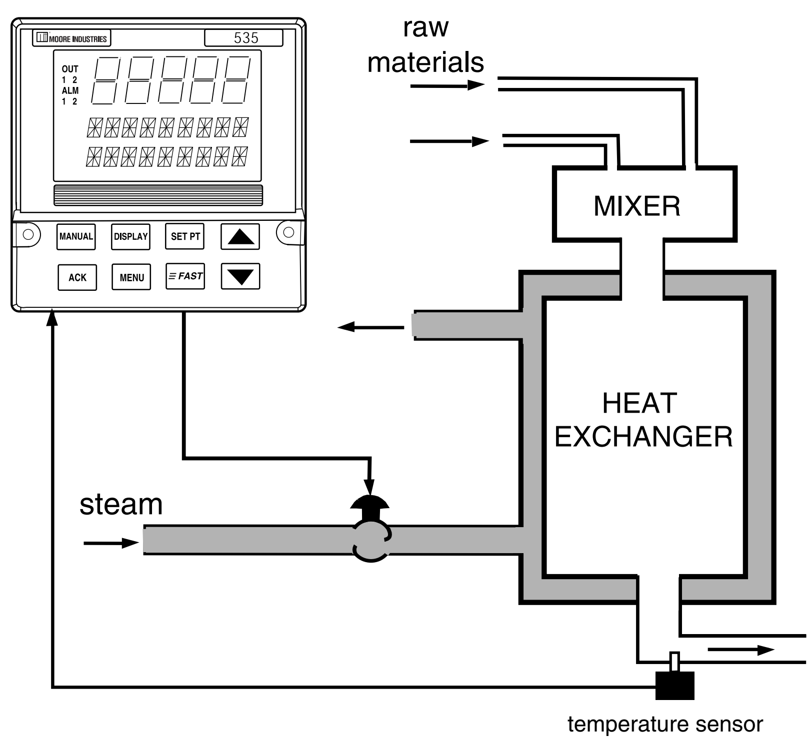


Figure 7.20
Heat Exchanger Control Loop for Steam Supply

In *Figure 7.20* we have a 535 set up to control a heat exchanger. In a PID-equipped heat exchanger, pressure in the steam shell more quickly reflects fluctuations in the steam supply than does the process liquid's temperature.

Why? In this example, with PID control, the average temperature of the liquid in the heat exchanger of 80°, but can vary by as much as five degrees because the steam supply itself is not constant. Fluctuations in the pressure of the steam supply cause fluctuations in the temperature of the steam within the heat exchanger. So, the process liquid's temperature begins to rise, but it takes several minutes for the increased heat from the steam to travel through the process liquid to reach the temperature sensor. By the time the sensor registers the higher value and calls for a decrease in steam, the process liquid near the walls is already at an even higher temperature. Although the steam supply is reduced, the process liquid's temperature continues to rise for a period of time. This delay in the transfer of heat prevents the 535 controller from controlling the temperature more precisely.

The solution to the problem is *Figure 7.21*. Have the PID controller position the steam valve, but add a sensor by means of another 535 controller that will monitor the steam pressure. The pressure control system now creates a second feedback control loop, which "cascades" from the first.

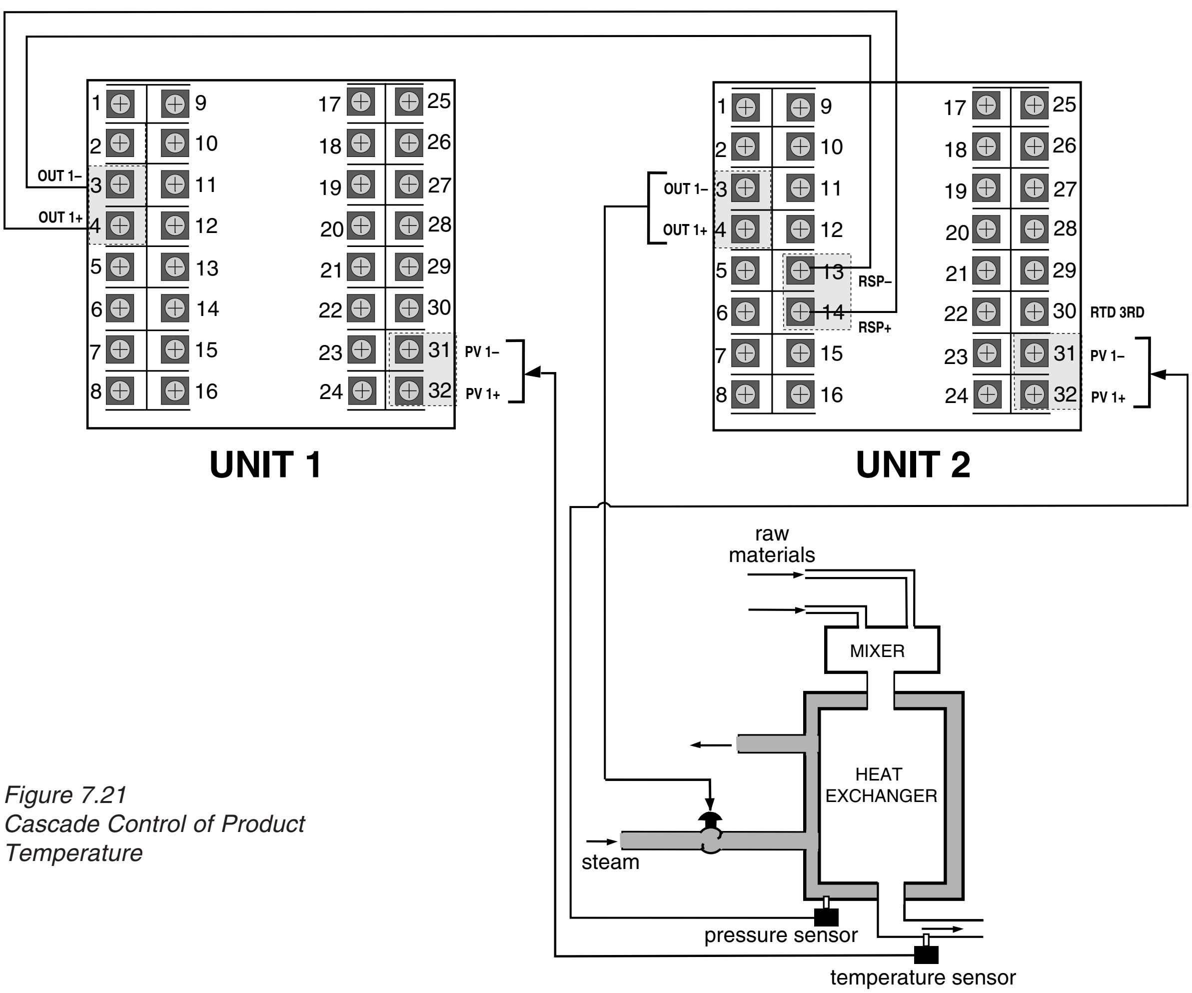


Figure 7.21
Cascade Control of Product Temperature

Hardware Configuration

- Configure Unit 1 for a 4-20mA output (analog module for control).
- Configure Unit 2 for the optional Remote Setpoint (see Chapter 4).

Software Configuration

1. For Unit #1
   a. In **CONFIG.** menu, set **CTRL. TYPE** to STANDARD.
   b. In **PV1 INPUT** menu, set the **PV1 TYPE** parameter.
   If type is V/mA, set **LOW RANG**E and **HI RANGE** parameters to match the transmitter range.
2. For Unit #2
   a. Set the RSP input jumper in the **mA** position on the Microcontroller Circuit Board (see Chapter 4).
   b. Go to the **REM. SETPT** menu.
   c. Set **RSP:LO. RNG.** to 0. Set **RSP:HI.RNG.** to 100. This will set the range of the remote setpoint to 0 TO 100 (to correspond to the 0% to 100% output range of Unit #1).
   d. Wire the control output of Unit #1 to the remote setpoint input of Unit #2 as shown in *Figure 7.21*.
   e. When in operation, Unit #2 must be under remote setpoint control.

Tuning Cascade Control

1. The secondary loop is controlled by Unit #2, which does most of the work in controlling the process. Put the secondary loop/Unit #2 under Manual control, and perform a Pretune on it. Once that Pretune is completed, put the Unit #2 under Automatic control.
2. The primary loop is controlled by Unit #1, which controls disturbances or load changes in the process. Now place the primary loop/Unit #1 into Manual and perform a Pretune on this loop. Once this Pretune is complete, the Cascade Control Loop is completely tuned. Place Unit #1 into Automatic control to allow the system to control to the desired Setpoint of the Primary loop.

W. RATIO CONTROL

Ratio Control is employed in mixing applications that require the materials to be mixed to a desired ratio.

For example: A given process requires Material A to be blended with Material B in a 2:1 ratio. Material B is uncontrolled or wild. Flow sensors/transmitters are used to measure the flow rate of each stream. The flow signal for Material A is wired to the process variable input, and the flow signal for Material B is wired to the remote setpoint input of the 535.

For this example, as shown in *Figure 7.22*, we would set **RSP RATIO** to 2.0. If the flow of Material B is measured at 50 gallons/minute, the effective remote setpoint value would be 2 times 50, or 100. The 535 controller would try to maintain the flow of Material A at 100. As the flow of Material B changes, the setpoint would change accordingly, always in a 2:1 ratio.

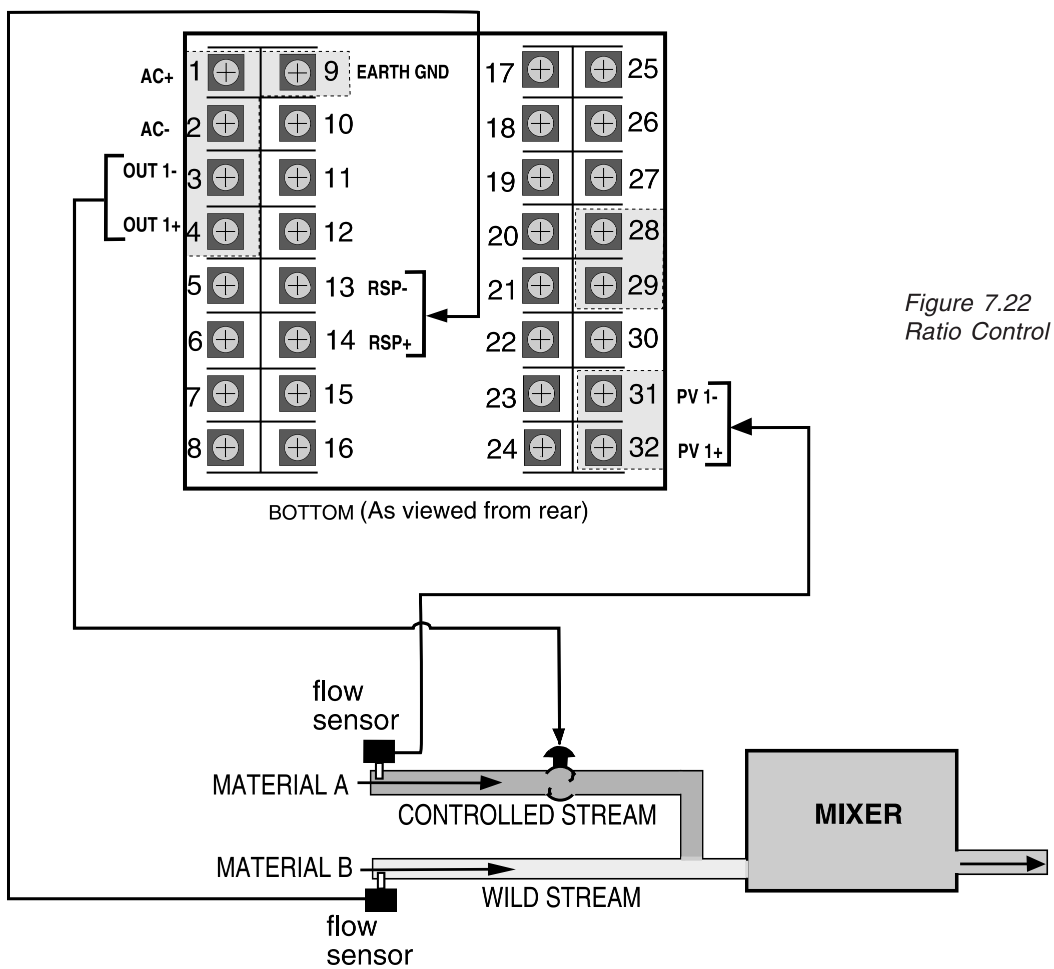


Figure 7.22
Ratio Control in Mixing Applicatoin

Hardware Configuration

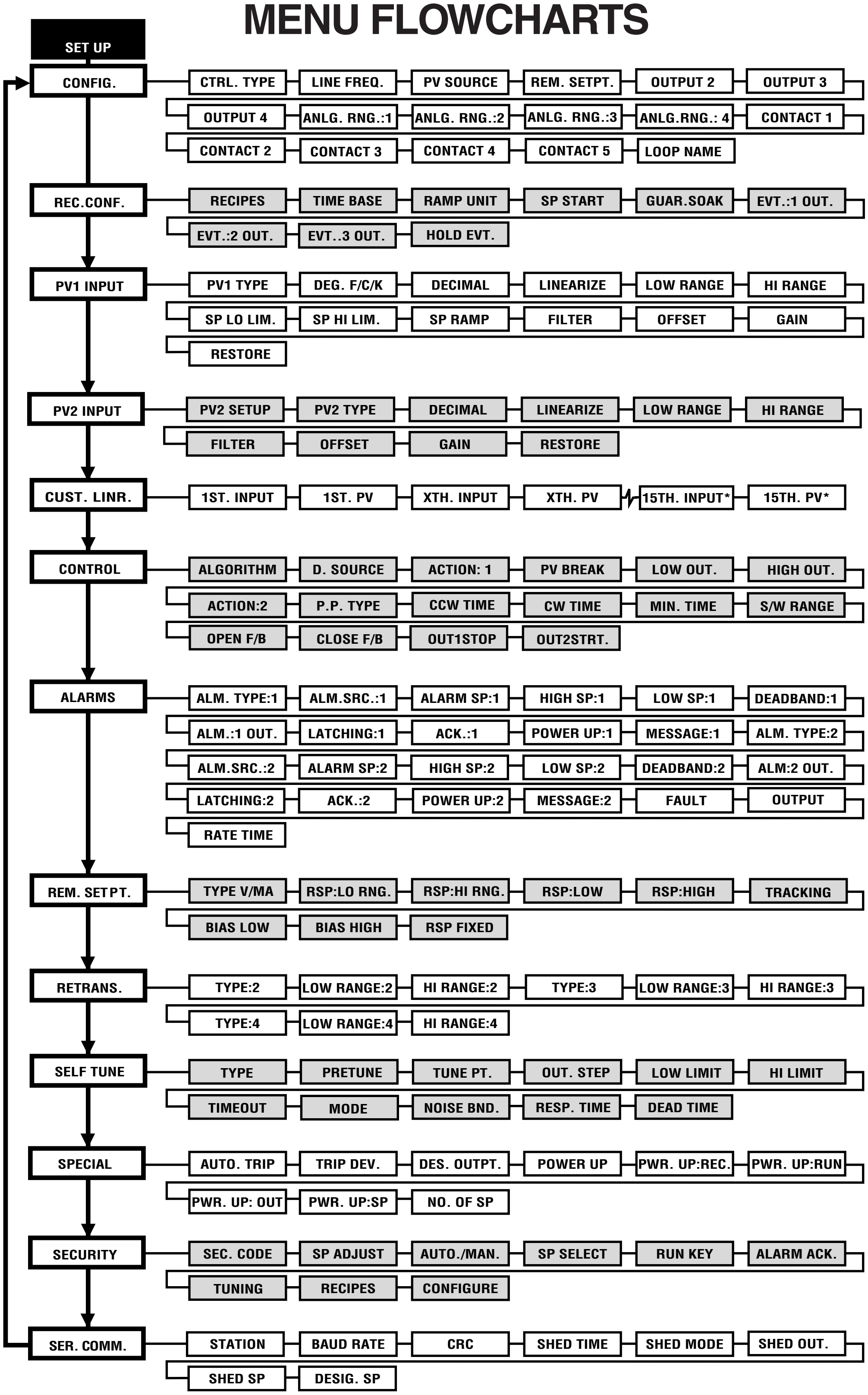
1. Set the process variable jumper and remote setpoint jumper to mA. Make sure that both inputs are set up to accept the corresponding signal from the flow transmitters.
2. Wire as in Figure *7.21*.

Software Configuration

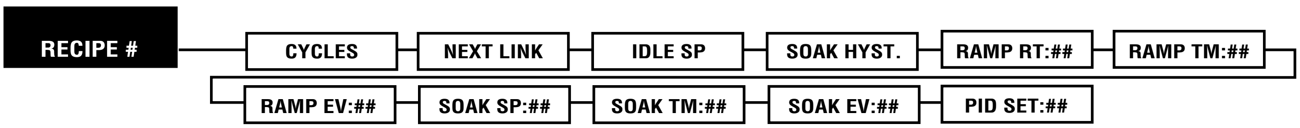
1. Make sure that the range of both inputs matches the range of the corresponding transmitter:
   a. Go to the **PV1 INPUT** menu.
   b. Set the **HI. RANGE** and **LOW RANGE** parameters.
   c. Go to the **REM. SETPT.** menu.
   d. Set the **RSP:HI RNG.** and **RSP:LO RNG.** parameters.
2. Adjust the ratio between the two streams:
   a. Go to the **TUNING** menu.
   b. Set the **RSP RATIO** parameter. The value of this parameter will be multiplied by the remote setpoint signal to yield the effective remote setpoint.

APPENDIX 1

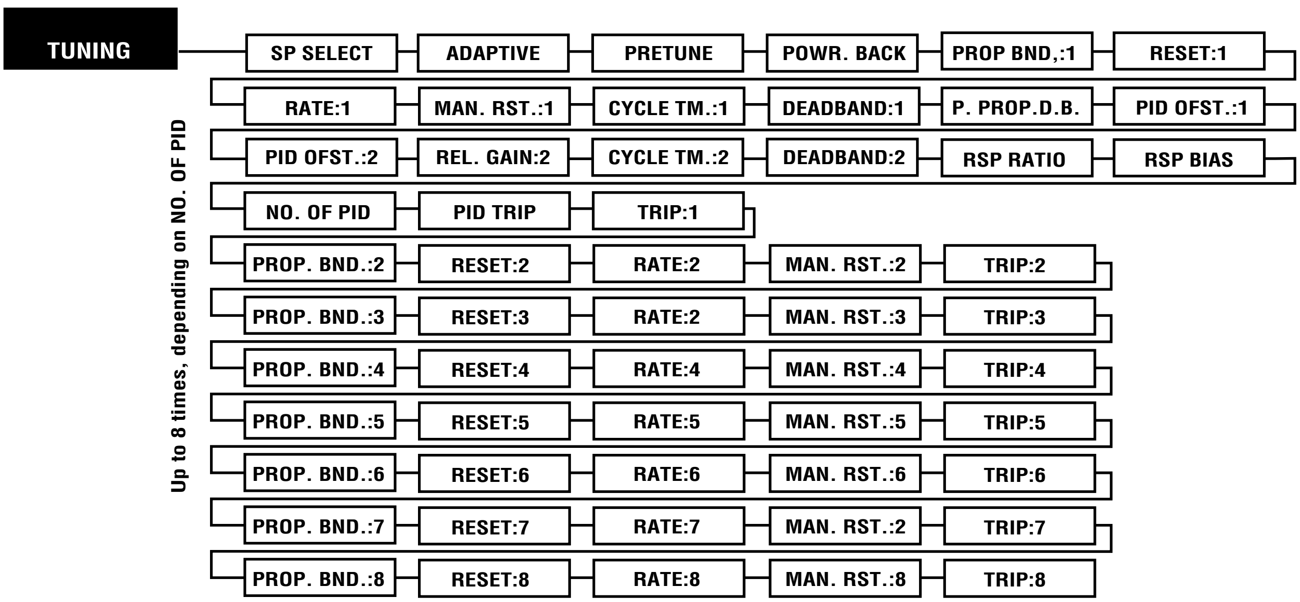
MENU FLOWCHARTS



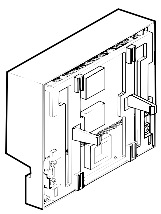
Menu Flowcharts



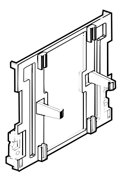
Configure these parameters for each recipe, up to 20. Each recipe has up to 12 ramp and 12 soak segments.



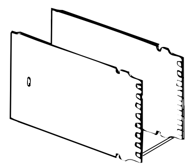
APPENDIX 2
PARTS LIST



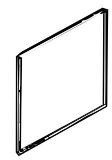
OPERATOR INTERFACE ASSEMBLY shown with bezel insert in place



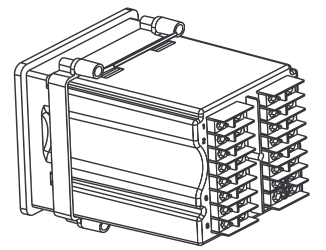
CIRCUIT BOARD SUPPORT (BEZEL INSERT)



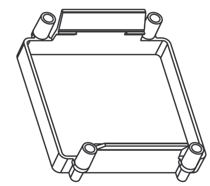
CIRCUIT BOARDS



BEZEL GASKET



CONTROLLER BODY shown with mounting collar in place



MOUNTING COLLAR

ITEM	PART #
Output Modules	
Mechanical Relay Module	535 600
Analog (milliamp Module)	535 601
Solid State Relay Module	535 602
DC Logic (SSR Drive) Module	535 603
Loop Power Module	535 604
RS-485 Communications Module	535 705
Repair/Replacement Parts	
Operator Interface Assembly	535 632
Power Supply Circuit Board	535 730
Microcontroller Circuit Board	535 731
Option Circuit Board w/no Options	535 720
Option Circuit Board w/Set of 5 Digital Contacts	535 721
Option Circuit Board w/Slidewire Feedback	535 722
Option Circuit Board w/set of 5 Digital Contacts & Slidewire Feedback	535 723
EPROM without Remote Setpoint Option	535 740
EPROM with Remote Setpoint Option	535 741
Lithium Battery	093 128
Jumper Kit: Set of All Jumper Connectors	535 660
Gasket Kit: 1 Panel Gasket & 1 Bezel Gasket	535 662
Mounting Kit: Mounting Collar & 4 screws	535 761
Bezel Retention Screw Kit	535 663
Module Retention Kit for Outputs 1-3 (Includes Retention Plate)	535 664
Module Retention Kit for Output 4: Set of 5 Tie Wraps	535 665
Circuit Board Support (Bezel Insert)	535 075
Engineering unit labels (1 sheet)	535 106

APPENDIX 3
TROUBLESHOOTING

SYMPTOM	PROBLEM	SOLUTION
Display will not light up	Defective power source	Check power source and wiring
	Improper wiring	Correct wiring
	Blown in-line fuse	Check wiring, replace fuse
	Unit not inserted in case properly; or, screws have not been tightened	Remove unit from case (and remove bezel screws), then reinsert unit and properly tighten screws.
Improper/Lost PV reading • Voltage/current	Input jumper selection improperly set	Move jumper to proper location
	Input range improperly selected in software	Select proper range
	Reverse polarity	Check and correct sensor wiring
	If controller powered, improperly wired	Check and correct wiring
	Loop power module not installed	Install module
	Defective transmitter	Replace transmitter
	Transmitter signal out of range	Select proper range in software
Improper/Lost PV reading • Thermocouple	Defective thermocouple	Replace thermocouple
	Input jumper selection improperly set	Select Proper input
	Wrong TC type selected in software	Select proper thermocouple type in software
	Improper wiring	Wire properly
Improper/Lost PV reading • RTD	Defective RTD	Replace RTD
	Input jumper selection improperly set	Move jumper connector to proper location
	Improper wiring	Wire properly
No control output	Output wiring and module location do not match	Check and correct wiring or module location
	If SSR, SSR Drive of Milliamp output, jumpers J1, J2 and J3 are not set properly	Set jumper connector to proper location
	Software configuration does not match hardware	Reconfigure software to match hardware
	PID values not set properly	Set PID values properly
Can't switch to auto control	Input sensor signal is not connected or valid	See PV LOST message
Erratic display	Resetting action due to electrical noise on powerline	Filter power line
	PID values not set properly	Retune controller

Message	When does it occur?	What to do:
DEFAULTS	Whenever the memory is cleared and all parameters revert to factory default settings. This may be done by purposely clearing the memory or when the unit is powered up for the first time or if the software version is changed.	Entering the Set Up mode and changing a parameter will clear the message. If due to something other than the user purposely clearing the memory, call factory for assistance.
LOST CAL. or **ERROR: BAD CAL. DATA**	Indicates that the calibration data has been lost. Occurs if all the memory has been erased.	Problem should never happen. Must correct the situation and recalibrate. Call factory for assistance.
PV1 UNDER or **PV1 OVER or** **PV2 UNDER or** **PV2 OVER or**	When the process variable value travels slightly outside the boundaries of the instrument span. Does not apply to thermocouple or RTD inputs.	May not need to do anything. May want to check the transmitter accuracy and check to see if range of transmitter matches the range of the controller.
LOST PV1 or **LOST PV2**	When the controller senses a lost process variable signal or the input signal travels well beyond the instrument span.	Check wiring and sensor/transmitter.
LOST RSP	When the remote setpoint is in use and the controller senses that the signal has been lost or has travelled well outside the range.	Check wiring and remote setpoint source.
COMM SHED	When the communications is lost for longer than the communications shed time.	Check communications wiring, etc. To clear message, must make an auto/manual change.
ERROR: ROM CHECKSUM	On power up a problem with the EPROM is detected. Controller locks up until fixed.	This is a fatal error and requires an EPROM change. Call factory for assistance.
OUT1 CONF or **OUT2 CONF**	Upon power up, controller senses that the modules needed for control as determined by software configuration are not present.	Must power down and install correct module combination or must reconfigure the controller to match the current module combination.
LOST F/B	The slidewire feedback is sensed as lost.	Check the slidewire wiring.
LOST CJC	The cold junction is sensed as lost.	Call factory for assistance.
ERROR: BAD EEPROM	During power up an EEPROM failure is detected. Controller locks up until fixed.	This is a fatal error and requires an EEPROM change. Call factory for assistance.
NEEDS CAL.	When the controller is powered up with default calibration data (input and output accuracy specifications may not be met).	Enter calibration menu and recalibrate the controller. Call factory for assistance.
ERROR: BAD MODEL NUM.	During power up, a discrepancy was found between the EEPROM's and controller's model numbers. Controller locks up until fixed.	This is a fatal error and requires an EPROM or EEPROM change. Call factory for assistance.
CAL.ERROR **SEE.MANUAL**	During cold junction calibration, a discrepancy was found between the controller type and the case type.	Install the 535 chassis into the actual case with which it was shipped, then run calibration again. If further problems, call factory for assistance.

APPENDIX 4
CALIBRATION

- To maintain optimum performance, once a year calibrate the analog input, the cold junction and milliamp output (when used). To achieve published accuracy specifications, follow directions carefully and use calibrated instruments of like quality to those suggested.
- If the controller is moved into an alternate case, or the hardware configuration is changed, and the thermocouple input is needed, recalibrate the cold junction for maximum accuracy. Failure to do so may result in small junction temperature (0.6°C/1.1°F).

Access the parts of the calibration menu as shown in *Figure A4.2*.

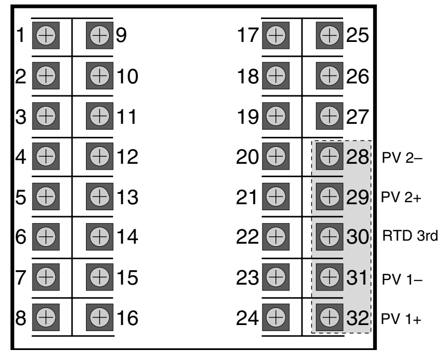


Figure A4.1
535 Rear Terminals for Calibration

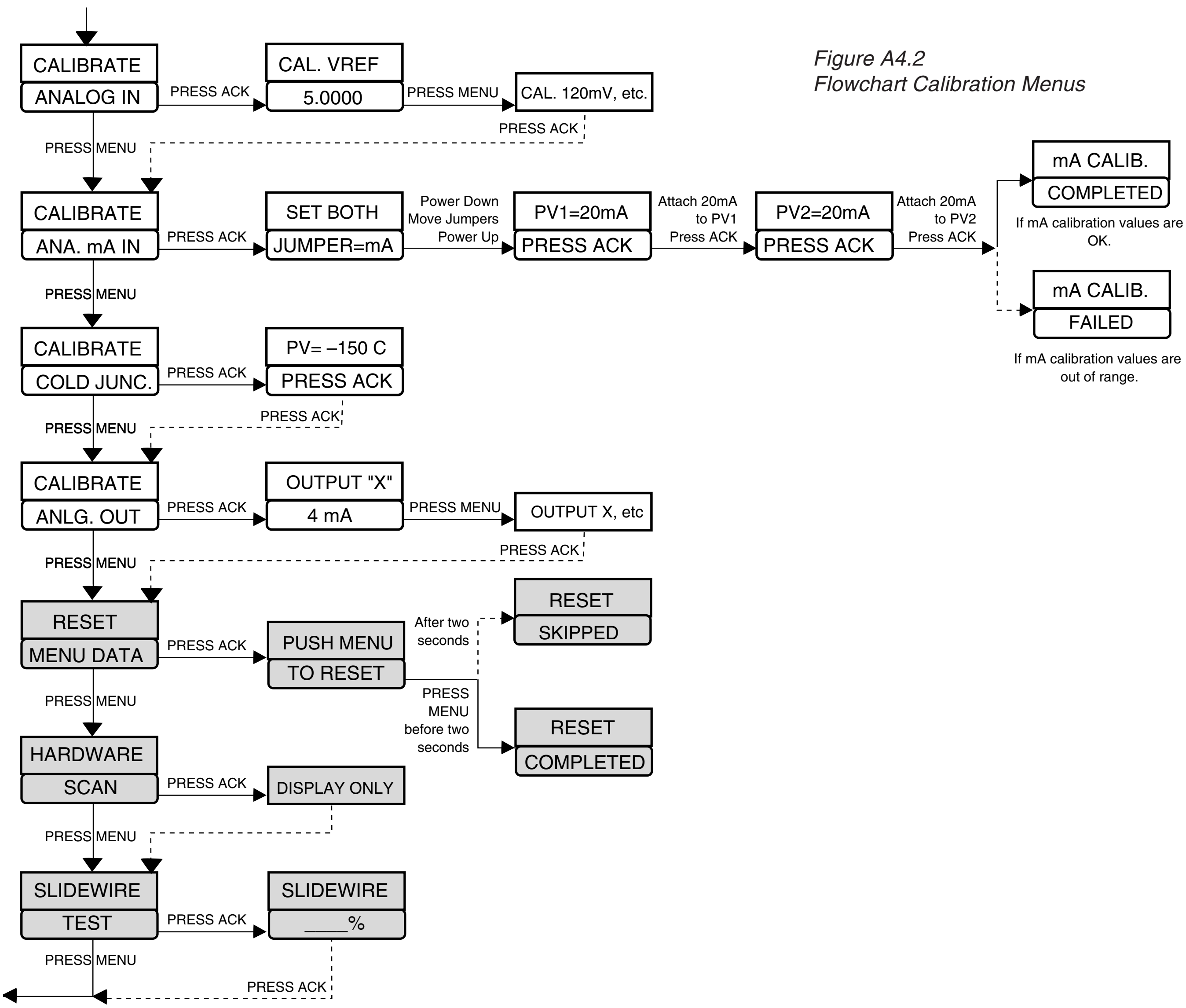
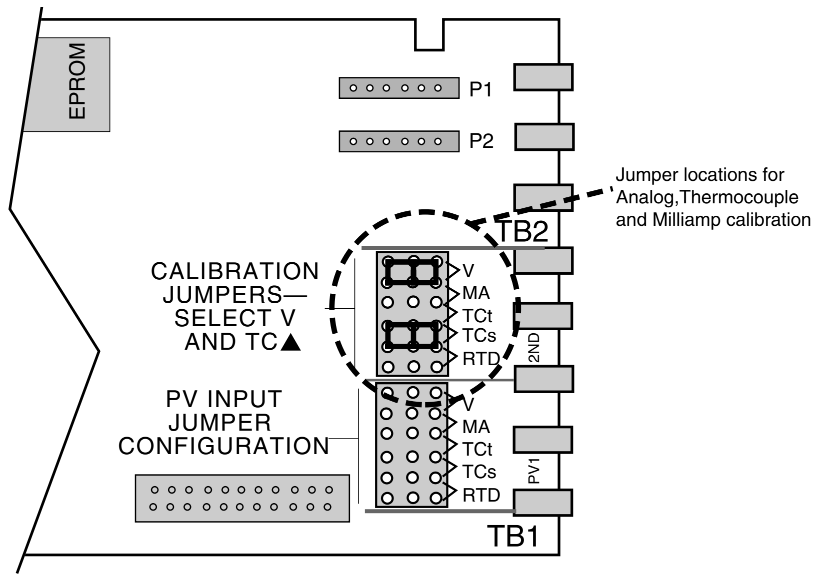


Figure A4.2
Flowchart Calibration Menus

Figure A4.3
Jumper Locations on the Microcontroller Circuit Board

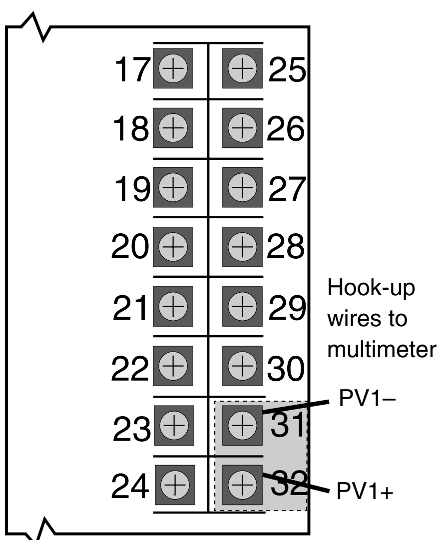


PREPARATION for ALL INPUT CALIBRATIONS

Equipment for analog input calibration:

- Precision 5-1/2 or 6-1/2 digit multimeter, e.g., Fluke 8842® or HP3478A® (a 4-1/2 digit meter will sacrifice accuracy)
- Four small pieces of wire
- Test leads with clips
- #2 Phillips screwdriver

Figure A4.4
Input Calibration Wiring



WARNING!
ELECTRIC SHOCK HAZARD!
Terminals 1 and 2 carry live power. DO NOT touch these terminals when power is on.

Additional equipment for thermocouple input:

- Precision thermocouple calibrator, e.g., Micromite II® by Thermo Electric Instruments
- Special limits grade, Type T thermocouple wire

1. Disconnect power to the instrument.
2. Remove chassis from case.
3. On the Microcontroller Circuit Board, locate jumpers locations marked PV1 and 2nd near the edge connector. Reposition both jumper connectors in the 2nd location onto pins for V and TC▲ as shown in *Figure A4.3.*
4. Connect hookup wires between terminals 31 and 32 and the multimeter as shown in *Figure A4.4,*
   Set the meter for **DC volts**.
5. Reinsert chassis into the case and apply power.
   The 2nd and 3rd display should read CALIBRATE ANALOG IN.
6. Allow the controller to warm up for at least 30 minutes.
7. Press the **ACK** key to get to the first step/parameter.
   The 2nd display should show CAL. VREF; the 3rd display should show a value close to 5.0000.
8. The multimeter should read a value in the range 4.9750 - 5.0250.
   Use the ▲ and ▼ (and **FAST**) keys on the controller until the display on the controller matches the meter reading.

9. Press **MENU** key.

   The 2nd display should show CAL. 120mV. The 3rd display should show a value close to 120.000. Match controller display to multimeter value using ▲ and ▼ keys.
10. Press **MENU** four more times. Each time, match the displays of the controller and the multimeter. Press **ACK** when done.

    The 2nd display should show CALIBRATE; the 3rd display should show ANA. mA IN.
11. Turn off power to the unit.
12. For **thermocouple input**, proceed to the Thermocouple Cold Junction Calibration.
13. For **milliamp input** , proceed to Analog Milliamp Input Calibration.
14. For **milliamp output calibration**, let the controller warm up for 10 minutes, then skip to step 5 of Milliamp Output Calibration.
15. If **calibration is complete**, place all the jumpers back in their original positions (as specified in Chapter 3).

THERMOCOUPLE COLD JUNCTION CALIBRATION

1. Connect the two pairs of T/C wire to terminals 28, 29, 31 and 32 as shown in *Figure A4.5.* Make sure the T/C wires are floating (disconnect from the multimeter also), and are not touching each other.
2. Turn on power to the unit and let controller warm up for 30 minutes in the normal horizontal position: while the unit is warming up, the rear face of the controller should be vertical, not horizontal.
3. Press the **MENU** key until the display indicates CALIBRATE COLD JUNC.
4. Press the **ACK** key. The display should show PV = -150 C PRESS ACK.
5. Connect both pairs of T/C wires in parallel—do not daisy chain—to a Type T thermocouple calibrator. (Both pairs must be connected or the calibration will not be accurate.)
6. Set the thermocouple calibrator to an output value of -150° C for a Type T thermocouple and allow the calibrator to stabilize for a few minutes.
7. Press **ACK** to initiate calibration of the cold junction.
8. For **milliamp output calibration**, proceed to Milliamp Output Calibration. Let the controller warm up for 10 minutes, then skip to step 5.
9. If **calibration is complete**, power down, then place all the jumpers in their original positions (as specified in Chapter 3).

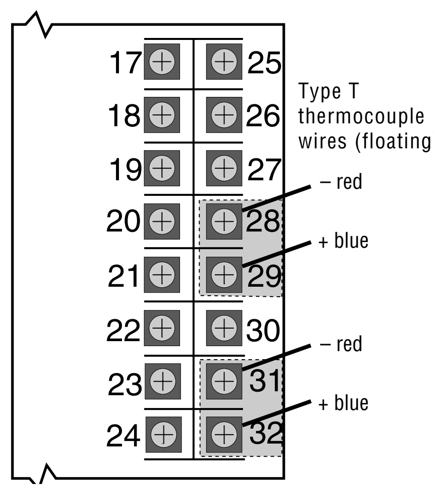


Figure A4.5
Thermocouple/Cold Junction Calibration Wiring

ANALOG MILLIAMP INPUT CALIBRATION

1. Remove the thermocouple wires (if present) from terminals 28, 29, 31 and 32. Replace them with pieces of wire that will be connected to a 20 milliamp input current (see *Figure A4.6*). Make sure terminal screws are securely tightened, but do not connect the wires yet (leave inputs floating).
2. Turn on power to the unit.
3. Press **MENU** until the display indicates CALIBRATE ANA. mA IN, then press **ACK**.

   If the display shows PV1=20mA PRESS ACK, move ahead to step #8.
4. The controller will display SET BOTH JUMPER=mA.
5. Power down the controller and remove chassis from the case.

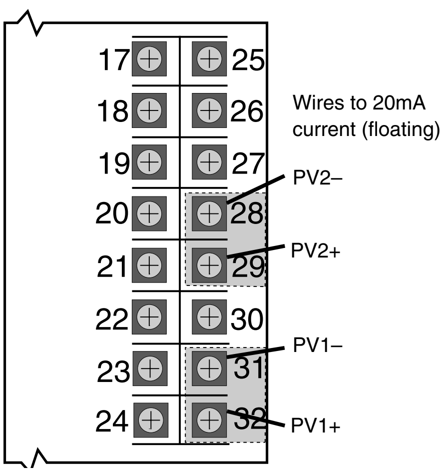


Figure A4.6
Analog mA Input Calibration Wiring

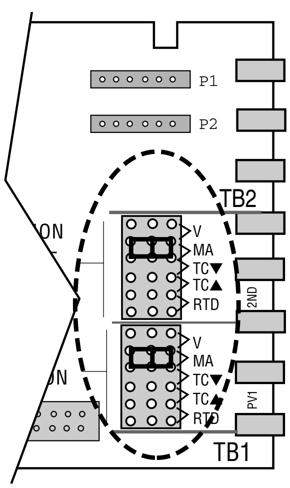


Figure A4.7
Analog mA Input Jumper Positions

6. Remove both input jumper connectors from the pins in the 2nd position. Place one of the jumpers on the PV1 position **mA** pins, and place the other jumper on the 2nd position **mA** pins, as shown in *Figure A4.7*.
7. Reinsert the chassis into the case and apply power. The controller should display PV1=20mA PRESS ACK to indicate it is ready to calibrate the PV1 milliamp input.
8. Connect a precision 20mA input to the PV1 terminals (31 is PV1-, 32 is PV1+). Make sure the terminal connections are fastened tightly and that a 20mA current is flowing through PV1. **Do not** connect the 20mA current to PV2 yet.
9. Let the controller warm up for at least 10 minutes (keep in normal horizontal position). Make sure the current is flowing, then press **ACK** to calibrate the PV1 input.
10. If the controller briefly displays PV2=20mA INPUT, PV1 calibration was successful. Move on to step 12.
11. If the controller briefly displays mA CALIB. FAILED, PV1 calibration was not successful.

    Check the 20mA connections, and return to step #3 to recalibrate the PV1 input.
12. Remove the 20mA input from the PV1 terminals, and attach it to the PV2 terminals (see *Figure A4.6)*.

    Make sure the terminal connections are fastened tightly and that a 20mA current is flowing through PV2.
13. Let the controller warm up for an additional 5 minutes (keep in the normal horizontal position). Make sure the current is flowing, then press **ACK** to calibrate the PV2 input.
14. If the controller briefle displays mA CALIB. COMPLETED, PV2 calibration was successful and the analog milliamp calibration procedure has been completed. If calibration is complete, power down. Place the jumpers into their original positions (see Chapter 4).
15. If the controller briefly displays mA CALIB. FAILED, PV2 calibration was not successful. Check the 20mA connections, and return to step #3 to recalibrate the PV1 and PV2 inputs.

MILLIAMP OUTPUT CALIBRATION

If the controller uses milliamp outputs, it is usually not necessary to calibrate them. If the milliamp output are being used for accurate retransmission of data, it is recommended that each output with an analog module be calibrated annually to maintain optimal performance.

Equipment needed:

- Precision 5-1/2 digit multimeter, e.g., Fluke 8842® or HP3478A® (4-1/2 digit meters sacrifice accuracy)
- Two small pieces of wire for every milliamp output
- Test leads with banana clips
- #2 Phillips screwdriver

1. Disconnect power to the instrument.
2. Remove chassis from case.

3. On the Microcontroller Circuit Board locate jumper locations marked PV1 and 2nd near the edge connector. Reposition both jumper connectors in the 2nd location onto pins for V and TC▲, as shown in *Figure A4.3.*
4. Reinsert chassis into the case and apply power.
5. Allow controller to warm up for at least 30 minutes.
   The 2nd and 3rd displays should read CALIBRATE ANALOG. IN. (**CALIBRATE** Menu, **ANALOG. IN** section).
   Press **MENU** three times to reach the **CALIBRATE ANLG. OUT** Menu.
6. Connect hook up wires to the terminals for the corresponding milliamp output modules.
   Output 1 uses terminals 3 and 4.
   Output 2 uses terminals 5 and 6
   Output 3 uses terminals 7 and 8 (shown in *Figure A4.8*)
   Output 4 uses terminals 15 and 16.
   Attach the test leads from the multimeter to the wires, and then plug the test leads into the meter. Set the meter for DC milliamp.
7. Press **ACK**. The 2nd display will read OUTPUT1, OUTPUT2, OUTPUT3 or OUTPUT4 (depending on the module installation).
8. Press **MENU** to scroll to the output to be calibrated (see *Figure A4.9)*. The 3rd display should read 4 mA.
   The multimeter should read a value close to 4.00.
9. Wait one minute. Use ▲ and ▼ (and **FAST**) on the controller to change the meter's display to exactly 4.00 mA.
10. Press **MENU**. The 3rd display should read 20 mA.
11. Let this setting stabilize for 5 minutes. Use ▲and ▼ (and FAST) on the controller to change the meter's display to exactly 20mA.
12. **To calibrate another analog output**:
   Move the wires and test leads to the new output terminals.
   Press **MENU** until the 3rd display shows 4mA for the corresponding output in the 2nd display. Repeat step 9-11.
13. To complete calibration, press **ACK** key, disconnect the power and place the jumper connectors back into their original position.

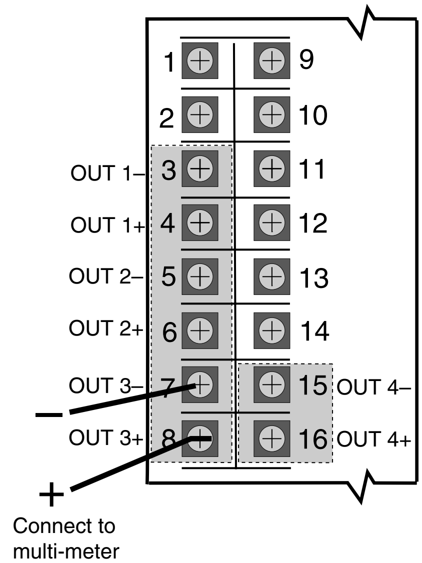


Figure A4.8
Milliamp Output Calibration Wiring

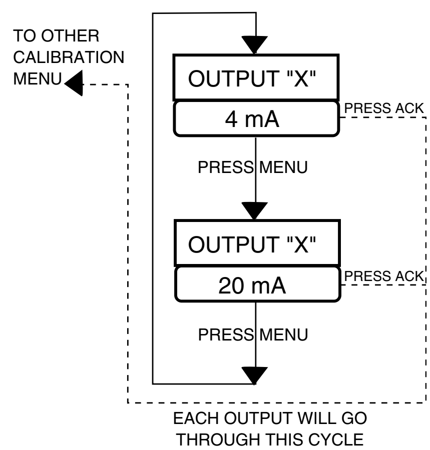


Figure A4.9
Output Module Menu Cycle

RESET MENU DATA

Resets all parameter values back to their factory default values (except for calibration information). Refer to the flowchart in *Figure A4.2.*

1. Disconnect power to the instrument.
2. Remove chassis from case.
3. On the Microcontroller Circuit Board, set jumpers at the 2nd PV location to **V** and **TC▲**.
4. Press **MENU** key until the display shows RESET MENU DATA.
5. Press the **ACK** key.
6. Press **MENU** key within two seconds to reset the menu data.
   If successful, RESET COMPLETED will appear in the display.
   If failed, RESET SKIPPED will appear instead.
7. To try again, press **ACK** key, and then press **MENU** key within two seconds.
8. When complete, return jumpers to their original positions.

HARDWARE SCAN

Use this read-only feature to identify the output hardware and installed options of the controller.

1. Set the jumpers to **V** and **TC▲**(see Figure *A4.3*).
2. Power up the controller
3. Press **MENU** until HARDWARE SCAN is displayed.
4. Press **ACK** to initiate the hardware display.
5. When complete, return jumpers to their original positions.

SLIDEWIRE TEST

If the slidewire option is installed, use the following to test its function:

1. Press **MENU** to scroll to the **SLIDEWIRE TEST** menu (refer to *Figure A4.2*)
2. Attach a 100ý to 1000ý potentiometer to terminals 10, 11 and 12 as shown in *Figure A4.10.*
3. Moving the potentiometer from one end to the other should display from "0%" to "100%" on the controller.
4. If the error message OPEN appears, check the connectors and try again.
5. Press **ACK** to exit.

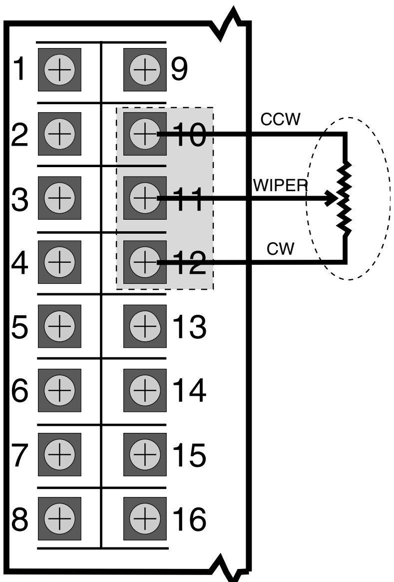


Figure A4.10
Slidewire Test Wiring

QUICK CALIBRATION PROCEDURE

This procedure may benefit users that have ISO or other standards requiring periodic calibration verification. It enables verification and modification of the PV input without entering the "Factory Configuration" mode.

1. Power down the 545 controller and place the input jumpers in the desired position (refer to Figure A4.2 and Figure A4.7).
2. Replace the process variable (PV1 or PV2) input signal with a suitable milliamp calibration device.
3. Apply power and allow controller to warm up for 30 minutes.
4. Place controller in manual mode. Then press **MENU** and **FAST** together to reach the **PV1 INPUT** or **PV2 INPUT** menu.
5. Press **MENU** until the **OFFSET** parameter appears inthe 2nd display.
6. Adjust the calibration device to an output signal equal to the 0% range value for the particular input sensor (for example, 4mA for a 4-20 mA input).
7. Verify value indicated in the 1st display is equal to the 0% range value for the particular input sensor. If incorrect use the ▲ and ▼ keys to scroll to the correct value.
8. For linear voltage or mA input: Press **MENU** until the **PV GAIN** parameter appears in the 2nd display.

   For thermocouple or RTD input: go to step 9.
9. Adjust the calibration device to an output signal equal to the 100% range value for the particular sensor.
10. Verify that the value shown in the 1st display is equal to 100% of the range value for the particular input sensor. If the value is not correct, use the ▲and ▼ keys to scroll to the correct value.
11. Repeat steps 4 through 10 to verify all values.
12. Press **DISPLAY** to return to the Operation mode.

APPENDIX 5
SPECIFICATIONS

ACCURACY

		TYPICAL	MAXIMUM
LINEAR	(Voltage)	± 0.025% of full scale	± 0.100% of full scale
	(Current)	± 0.050% of full scale	± 0.150% of full scale
RTD	1°	± 0.050% of span	± 0.150% of span
	0.1°	± 0.095% of span	± 0.225% of span
THERMOCOUPLE			
J, K, N, E (> 0°C)		± 0.060% of span	± 0.150% of span
J, K, N, E (< 0°C)		± 0.150% of span	± 0.375% of span
T (> 0°C)		± 0.100% of span	± 0.250% of span
T (< 0°C)		± 0.250% of span	± 0.625% of span
R, S (> 500°C)		± 0.150% of span	± 0.375% of span
R, S (< 500°C)		± 0.375% of span	± 0.925% of span
B (> 500°C)		± 0.150% of span	± 0.375% of span
B (< 500°C)		± 0.500% of span	± 1.000% of span
W, W5 & Platinel II		± 0.125% of span	± 0.325% of span

Display accuracy is ± 1 digit. These accuracy specifications are at reference conditions (25°C) and only apply for NIST ranges. Detailed accuracy information is available upon request.

CONTROL ALGORITHM

PID, P with manual reset, PI, PD with manual reset, and On-Off are selectable from the front panel. Duplex outputs each use the same algorithm, except On-Off may be used with PID. The PID algorithm used is non-interacting.

TUNING PARAMETERS

Proportional Band: 0.1 to 999% of input range

Integral: 1 to 9999 seconds/repeat

Derivative: 0 to 600 seconds

Manual Reset/Load Line: 0 to 100% output

Cycle Time: 0.3 to 120 seconds

On-Off Deadband: up to 15% of input range (in eng. units)

Up to eight sets of PID values may be stored in memory and selected automatically, based on setpoint value, process variable value, or the corresponding local setpoint (SP1–SP8).

SELF TUNING OF PID VALUES

POWERTUNE® On-demand "pretune": This is an open loop algorithm that may be used on its own to calculate PID variables, or it can be used to provide preliminary PID values, as well as process identification information to be used by the adaptive tune.

Three pretune types are available: TYPE 1 for slow thermal processes; TYPE 2 for fast fluid or pressure applications; and TYPE 3 for level control applications.

Adaptive tune: Our exclusive POWERTUNE® adaptive tuning algorithm automatically adjusts the PID values whenever a process upset occurs. Preliminary information may be input manually or automatically calculated by our pretune algorithm.

OVERSHOOT PROTECTION

POWERBACK is a proprietary, user-invoked, setpoint overshoot protection algorithm. When invoked, POWERBACK reduces or eliminates setpoint overshoot at power up or after setpoint changes. POWERBACK monitors the process variable to make predictive adjustments to the control parameters, a feature that helps eliminate overshoot of setpoint.

ISOLATION

Inputs and outputs are grouped into the following blocks:

Block 1: process variable

Block 2: outputs 1, 2, 3 and 4

Block 3: communications, set of five digital inputs

Block 4: remote setpoint

Each block is electrically isolated from the other blocks to withstand a HIPOT potential of 500 Vac for 1 minute or 600 Vac for 1 second, with the exception of blocks 1 and 4, which are not isolated, but is capable to withstand a potential of 50 volts peak for 1 minute between each other. Inputs and outputs are not isolated from other inputs and outputs within the same block.

CONTROLLER ARCHITECTURE

The 535 Controller hardware can be configured as follows:

Inputs: One univeral process variable input is standard. Available options include: remote setpoint, slidewire feedback and 5 digital inputs.

Outputs: Four outputs are available. See Ordering Information.

RS-485 Communications: Available as option with any configuration.

PROCESS VARIABLE INPUTS - 2 PROCESS VARIABLES AVAILABLE

Universal input type. Any input type may be selected in the field. Selection of input type (thermocouple, RTD, voltage or current) via jumper. Selection of particular sensor or range is via front panel.

THERMOCOUPLES	RANGE °F	RANGE °C
B	104 to 3301	40 to 1816
E	–454 to 1832	–270 to 1000
J	–346 to 1832	–210 to 1000
K	–418 to 2500	–250 to 1371
N	–328 to 2372	–200 to 1300
R	32 to 3182	0 to 1750
S	32 to 3182	0 to 1750
T	–328 to 752	–200 to 400
W	32 to 4172	0 to 2300
W5	32 to 4172	0 to 2300
Platinel II	–148 to 2550	–100 to 1399

RTDs	RANGE °F	RANGE °C
100ohm Pt. (DIN)	–328 to 1562	–200 to 850
	–328.0 to 545.0	–200.0 to 285.0
100ohm Pt. (JIS)	–328 to 1202	–200 to 650
	–328.0 to 545.0	–200.0 to 285.0
100ohm Pt. (SAMA)	–328 to 1202	–200 to 650
	–328.0 to 545.0	–200.0 to 285.0

TRANSMITTER SIGNALS	INPUT RANGE
Milliamps DC	4 to 20
	0 to 20
Voltage DC	1 to 5
	0 to 5
Millivolts DC	0 to 10
	0 to 30
	0 to 60
	0 to 100
	–25 to 25

LINEARIZATION

Thermocouple and RTD inputs are automatically linearized. Transmitter inputs may be linearized with a square root function or user-defineable 15-point straight line linearization function.

INPUT IMPEDANCE

Current Input: 250 ohms **Thermocouples:** 10 Mohms

Voltage Input: 1 Mohms **RTDs:** 10 Mohms

UPDATE RATE

Input is sampled and output updated 10 times per second. Display is updated five times per second.

TRANSMITTER LOOP POWER

Isolated 24 Vdc (nominal) loop power supply is available if a loop power module is installed in an output socket not used for control. Capacity is 25 mA.

INPUT SIGNAL FAILURE PROTECTION

When input is lost, output is commanded to a predetermined output (–5 to 105%). Thermocouple burnout is selectable for upscale or downscale.

INPUT FILTER

Single pole lowpass digital filter with selectable time constant from 0 to 120 seconds.

CALIBRATION

Comes fully calibrated from the factory and continuously calibrates itself for component aging due to temperature and time, except for the reference voltage. Field calibration can be easily performed in the field with a precision multimeter and thermocouple simulator. Process variable offset and gain factors are provided to correct for sensor errors.

OUTPUT MODULES

The controller can have a total of four control outputs, alarm outputs and/or loop power modules installed. There are five types of output modules which can be configured to suit your particular application. The modules may be ordered factory-installed, or they may be installed in the field.

Analog module: Either 0–20 mA or 4–20 mA (front panel selectable) into a load up to 1000ohms. Accuracy ± 5µA @ 25°C.

Mechanical relay module: SPDT electromechanical relay. Resistive load rated at 5 amps at 120/240 VAC. Normally open or normally closed selection is made by jumper. Output 4 is rated at 0.5 amps at 24 VAC and is always normally open.

Solid state relay (triac) module: Resistive load rated at 1 amp at 120/240 VAC. Output 4 is rated at 0.5 amps at 24 VAC. These outputs are normally open.

DC logic (SSR drive) module: "ON" voltage is 17 Vdc (nominal). "OFF" voltage is less than 0.5 Vdc. (Current limited to 40mA.)

Loop power supply module: Current is limited to 25 mA @ 24V (nominally loading).

CONTROL OUTPUTS

Up to two output modules may be designated for control. Any combination of output modules, with the exception of the loop power supply module, may be used.

Duplex control is available if output modules are installed in the first and second output sockets.

Position proportioning control with feedback is available if mechanical or solid state relay modules are installed in the first two output sockets, and the slidewire feedback option is installed. Slidewire feedback range is 0 to 1050ohms.

"Velocity" position proportioning control is available by installing mechanical or solid state relay modules in the first two output sockets. A special algorithm controls an electric actuator without the slidewire feedback signal.

Staged (split range) outputs are available if analog modules are installed in the first and second output sockets. This algorithm will allow the output range to be split between the two outputs.

RETRANSMISSION OUTPUT

Based on available outputs (any socket not used for control), up to two different variables can be simultaneously programmed for retransmission. Each precise, 16-bit resolution output may be scaled for any range. Variable selection includes: PV, SP, RAMP SP, and OUTPUT.

ALARMS

The 535 controller has two software alarms. High and low alarms may be sourced to the PV, SP, RAMP SP, DEVIATION and OUTPUT. If an alarm is tripped, the alarm message will show, the ACK key will illuminate (if acknowledgeable) and the ALM icon will light. If the alarm is tied to the first available non-control output, the "1" below the ALM icon will light. Similarly, if the alarm is tied to the second non-control output, the "2" below the ALM will light. The availability of outputs determines how many alarms can be tied to relays.

Up to two alarm outputs are available if an associated mechanical, solid state relay or DC logic module is installed in any output socket not used for control.

Global Alarm feature allows one or more of the internal software alarms to be tied to the same single, physical output. The acknowledge key is active for alarms associated with either loop.

DIGITAL INPUTS

A set of five external dry contacts or open collector transistor driven inputs are available. Each can be configured to perform one of the following functions:

- Select remote setpoint
- Select either direct or reverse control action
- Select manual control
- Select second local setpoint
- Disable adaptive tuning
- Select a second set of PID values
- Addressable through serial communications only
- Acknowledge alarms
- Inhibit the reset term
- Simulate ▲ and ▼ keys
- Lock controller in manual mode
- Simulate DISPLAY, FAST and MENU keys
- Select PV1 or PV2
- Operate recipes

In addition, if the set of five digital inputs is installed, four may be designated to select one of eight local setpoints (and associated PID set, if desired) via a binary coded decimal (BCD) input.

SETPOINT SELECTION

A remote setpoint input is available. Signal is 0–20/4–20 mADC or 0–5/1–5 VDC (jumper selectable). Signal may be ratioed and biased. Eight local setpoints may be stored in memory.

Setpoint selection is made via menu selection or digital contact(s).

FAULT OUTPUT

One of the alarm outputs may be designated to also energize if the input signal is lost.

SERIAL COMMUNICATIONS

Isolated serial communications is available using an RS-485 interface. Baud rates of up to 19,600 are selectable. The protocol supports CRC data checking. If communications is lost, a time-out feature will command the controller to a particular control mode and specific setpoint or output if desired. Outputs 2–4 and digital inputs can act as "host-controlled" I/O independent of the controller's function. The PV may be sourced via this interface. May be installed in the field.

DIGITAL DISPLAYS

Upper display: Five-digit, seven-segment. Used exclusively for displaying the process variable value. Height is 15 mm (0.6 in.).

2nd display: nine-character, 14-segment alphanumeric. Used for displaying setpoint, deviation, output value, slidewire position (actual valve position) and configuration information. Height is 6 mm (0.25 in.).

3rd display: nine-character, 14-segment alphanumeric. Used for indicating which loop is displayed and for displaying alarm messages and configuration information. Height is 6 mm (0.25 in.).

All displays are vacuum fluorescent. Color is blue-green.

STATUS INDICATORS

There are two types of indicators: icons and illuminated keys.

ALM 1 and ALM 2 icons: alarm 1 and alarm 2 status.

OUT 1 and OUT 2 icons: control output 1 and control output 2 status.

MAN key illuminated: controller is in manual control mode.

ACK key illuminated: alarm may be acknowledged.

RUN key illuminated: a recipe is active.

MENU key illuminated: controller is in configuration mode.

DIMENSIONS

Meets 1/4 DIN designation as specified in DIN standard number 43 700.
See diagram for details.

MOUNTING

Panel-mounted.

WIRING CONNECTIONS

29 screw terminals in the rear of the instrument.

POWER CONSUMPTION

15 VA at 120 VAC, 60 Hz (typical).

WEIGHT

Approximately 1 kg (2.2 lbs.).

AMBIENT TEMPERATURE

Operative Limits: 0 to 50°C (32 to 122°F).

Storage Limits: –40 to 70°C (–40 to 158°F).

RELATIVE HUMIDITY

10 to 90% non-condensing.

VOLTAGE AND FREQUENCY

Universal power supply: 90 to 250 VAC, 48 to 62 Hz.

NOISE IMMUNITY

Common mode rejection (process input): >120 dB.

Normal mode rejection (process input): >80 dB.

AC line is double filtered and transient protected. Snubbers are provided for each relay output.

CONSTRUCTION

Case: black plastic ABS.

Bezel: black plastic ABS.

Chassis assembly: plug-in type.

Keys: silicone rubber with diffusion printed graphics.

NEMA rating: front panel conforms to NEMA 4X when instrument is properly installed.

AGENCY APPROVALS

UL LISTED Process Control Equipment 4N66 CE (Heavy Industrial)
(Available as an option)

MEMORY RETENTION

Lithium battery maintains all programming for approximately ten years.

EEPROM maintains calibration data indefinitely.

SECURITY

There are two levels of access: restricted and full. A configurable code is used to enter the full access level. Functions not available in the restricted level are configurable.

PROFILE CONTROLLER OPTION

When a 535 is specified as a profile controller, the **SET PT** (setpoint) key is replaced at the factory with a **RUN** key to facilitate operation. Setpoint access is available through use of the **DISPLAY** key. All functions are described in the manual. The 535 with profile option provides full ramp and soak capability with the following features:

20 RECIPES/PROGRAMS

Up to twenty (20) recipes/programs may be stored in memory and recalled by number through the front panel keys, digital inputs or RS-485 communications.

24 SEGMENT PER RECIPE

Twelve (12) ramps and twelve (12) dwells may be programmed for each recipe. Programming a dwell time of OFF effectively skips the dwell allowing two (2) consecutive ramps of different rates. Recipes may be link if more than twelve (12) segments are necessary.

GUARANTEED SOAK WITH ADJUSTABLE HYSTERESIS

When activated, dwell time doesn't start until the ramp setpoint has been achieved within the specified hysteresis (a positive or negative deviation from the dwell setpoint).

3 EVENT OUTPUT CAPABILITY

Up to three (3) event outputs, programmable per segment, may be selected depending on the availability of controller outputs. The 535 has four (4) outputs; if one is used for control, three are available for events. Likewise, if one is used for control and one is used for alarm, two are available for events. These outputs are available for turning on fans, starting other processes, or performing other functions.

RAMPS PROGRAM IN TIME OR RATE

A ramp can be programmed to take place over a specific amount of time or be based on the rate of change of the PV per time unit. If time based, the time to reach setpoint must be between 0:01 and 99:59 (minutes:seconds or hours:minutes). If rate based, the setpoint must be reached at a rate between –9999 and 99999 engineering units per second or per minute.

DUAL TIME RATE

Two modes are available—Hour:Minutes or Minutes: Seconds.

MULTIPLE CYCLES, 1—99 PER RECIPE

Recipes may be programmed to automatically repeat up to 99 times or continually.

RECIPE LINKING

All twenty (20) recipes may be linked to form a new longer version. For example, select recipe 4 to automatically follow recipe 2.

REMOTE FUNCTIONS VIA DIGITAL INPUT

Using the optional digital inputs, the following functions may be remotely activated: Start, Hold, Reset, Abort and Segment advance.

MODIFY RECIPES WHILE RUNNING

Individual recipes may be modified by the operator while running.

REMOTE RECIPE CHOICE VIA DIGITAL INPUT

Using the optional digital inputs, recipes 1 through 7 may be selected remotely,.

POWER RESTORATION MODES

Four different power restoration modes are available. Upon Power failure and subsequent return, the controller can either 1) resume a recipe where it left off; 2) return to the last output of the recipe and hold it; 2) Abort the recipe; 4) Start a new recipe automatically

TIE PID SETS TO RECIPES OR SEGMENTS

Any one of eight PID sets may be tied to each recipe or segment to optimize control.

MASTER/SLAVE CAPABILITY

The 535 with profile controller option can retransmit the ramping setpoint to up to four 535s with remote setpoint creating a master/slave relationship.

With this capability, five (5) loops, each running the same recipe, can be controlled.

SEGMENT ADVANCE

The operator may advance thought the program segments while a recipe is running.

APPENDIX 6 GLOSSARY

adaptive control: Control in which automatic means are used to change the type or influence (or both) of control parameters in such a way as to improve the performance of the control system.

adaptive tune: A component of the 535 self tune function which continuously monitors the process and natural disturbances and makes adjustments in the tuning parameters to compensate for or improve the performance of the control system.

alarm: A condition, generated by a controller, indicating that the process has exceeded or fallen below the set or limit point.

alarm, band: A type of alarm set up where a band is created around the control setpoint.

alarm, deviation: An alarm similar to a band alarm except it only creates a band on one side of the alarm setpoint.

alarm, fault: An indication that becomes active upon loss of process variable. Fault alarm operates in addition to other alarm assignments.

alarm, global: The single physical output to which one or more internal software alarms are tied.

alarm, high process variable: A type of alarm that is set up to occur when the process variable goes above the alarm setpoint.

alarm, low process variable: A type of alarm that is set up to occur when the process variable goes below the alarm setpoint.

alarm, manual: A type of alarm set up to occur when the controller is put into manual mode of operation.

alarm, power up: A type of alarm that determines alarm condition on power up of the controller.

alarm, rate-of-change: A type of alarm set up to occur when there is an excessive change in the process variable (PV) value.

baud rate: Any of the standard transmission rates for sending or receiving binary coded data.

bezel: The flat portion surrounding the face of the controller, which holds the keys and display.

bump: A sudden increase in the output power initiated by the controller in order to determine the system response during a self tune procedure.

binary coded decimal (BCD): A notation in which the individual decimal digits are represented by a group of binary bits, e.g., in the 8-4-2-1 coded decimal notation each decimal digit is represented by four binary bits.

calibration: The act of adjustment or verification of the controller unit by comparison of the unit's reading and standards of known accuracy and stability.

cascade control: Control in which the output of one controller is the setpoint for another controller.

closed loop: Control system that has a sensing device for process variable feedback.

cold junction: Point of connection between thermocouple metals and the electronic instrument.

configuration: Also called "set up," selection of hardware devices and software routines that function together.

cold junction compensation: Electronic means used to compensate for the effect of temperature at the cold junction.

contact: In hardware, a set of conductors that can be brought into contact by electromechanical action and thereby produce switching. In software, a symbolic set of points whose open or closed condition depends on the logic status assigned to them by internal or external conditions.

control action: The slope of the output of the instrument in reference to the input, e.g., direct output increases on rise of input. Typical cooling response or reverse output decreases on rise of input (typical heating response).

control action, derivative (rate) (D): The part of the control algorithm that reacts to rate of change of the process variable.

control action, integral (reset) (I): The part of the control algorithm that reacts to offset between setpoint and process variable.

control action, proportional (P): Control action in which there is a continuous linear relation between the output and the input.

control action, proportional plus derivative (PD): A control algorithm that provides proportional control with the addition of derivative action to compensate for rapid changes in process variable.

control action, proportional plus integral (PI): A control algorithm that provides proportional control with the addition of integral action to compensate for offsets between setpoint and process variable.

control action, proportional plus integral plus derivative (PID): A control algorithm that provides proportional control with both integral and derivative action.

control, adaptive: (see adaptive control)

control algorithm: A mathematical representation of the control action to be performed.

control, cascade: (see cascade control)

Glossary

control output: The end product which is at some desired value that is the result of having been processed or manipulated.

control mode, automatic: A user selected method of operation where the controller determines the control output.

control mode, manual: A user selected method of operation where the operator determines the control output.

control parameters: User defined values that specify how the process is to be controlled.

controlled variable: A process variable which is to be controlled at some desired value by means of manipulating another process variable.

CRC (cyclic redundancy check): An error checking technique in which a checking number is generated by taking the remainder after dividing all the bits in a block (in serial form) by a predetermined binary number.

cycle time: The time necessary to complete a full ON-through-OFF period in a time proportioning control system.

damping: The decrease in amplitude of an oscillation due to the dissipation of energy.

damped, 1/4 amplitude: The loss of one-quarter of the amount of amplitude with every oscillation.

dead band: A temperature band between heating and cooling functions; the range through which an input can be varied without initiating observable change in output.

dead time: The interval of time between initiation of an input change or stimulus and the start of the resulting observable response.

default settings: Parameters selections that have been made at the factory.

derivative: Anticipatory action that senses the rate of change of temperature, and compensates to minimize overshoot and undershoot. Also “rate.”

derivative action: (See control action, derivative)

deviation: The difference between the value of the controlled variable and the value at which it is being controlled.

digital input: Used in this manual to indicate the status of a dry contact; also called “gate”.

DIN: Deutsche Industrial Norms, a German agency that sets standard for engineering units and dimensions.

display, 1st: The top, largest display of controller face that is used to display the process variable value.

display, 2nd: The middle display of the controller face used to indicate: OPERATION Mode—- the setpoint, deviation or output; in TUNING or SET UP Mode — the parameter or parameter menu.

display, 3rd: The bottom display of the controller face that is used to indicate: Operation Mode — alarm or error message; Tuning of Set up Mode — the value or choice of the parameter.

disturbance: An undesired change that takes place in a process that tends to affect adversely the value of a controlled variable.

duty cycle: Percentage of “load ON time” relative to total cycle time.

dwell: Also called "soak." The designated period of time in which the setpoint does not change after the ramp has been completed.

earth ground: A terminal used on the 535 to ensure, by means of a special connection, the grounding (earthing) of part of the controller.

engineering unit: Terms of data measurement such as degrees Celsius, pounds, grams, etc.

feedback: Process signal used in control as a measure of response to control action; the part of a closed-loop system which automatically brings back information about the condition under control.

FM: Factory Mutual Research Corporation; an organization which sets safety standards.

gain: The ratio of the change in output to the change in input which caused it.

heat/cool control: Control method where the temperature of the end product is maintained by controlling two final elements using two of the 535 outputs.

hysteresis: In ON/OFF control, the temperature change necessary to change the output from full ON to full OFF.

hunting: Oscillation or fluctuation of process temperature between setpoint and process variable.

icons: Indicators on the face of the controller.

input: Process variable information being supplied to the instrument.

integral: Control action that automatically eliminates offset, or “droop”, between setpoint and actual process temperature. Also “reset.”

internal voltage reference: A precision voltage source within the 535 controller, used to establish internal calibration.

isolation: Electrical separation of sensor from high voltage circuitry. Allows for application of grounded or ungrounded sensing element.

JIS: Japanese Industrial Standards. Also Japanese Industrial Standards Committee (JISC). Establishes standards on equipment and components.

jumper: A wire that connects or bypasses a portion of a circuit on the printed circuit board.

jumper connectors: The connecting device that straddles a jumper to connect or bypass a portion of a circuit on a printed circuit board.

linearization: A function the 535 uses to automatically linearize a non-linear signal, either from thermocouple or RTD temperature sensors, through the use of look up tables. The relationship that exists between two variables when the ratio of the value of one variable to the corresponding value of the other is constant over an entire range of possibilities.

linearization, custom: User-definable linearization.

linearization, square root: A function the 535 uses to linearize a non-linear signal corresponding to the flow being measured by flow transmitters.

load line out: A start up output value which is to bring initial output closer to actual steady state output.

loop power: An internal 24-volt current limited power supply used to power 2 or 4 wire transmitter on the input of the controller.

load: The demand for input to a process.

low pass input filter: A method to block fast acting signals (typically noise), while allowing slow acting signals (actual process variable) to pass.

manipulated variable: A quantity or condition which is varied so as to change the value of the controlled variable. (see also control output)

mechanical relay: (see relay)

menu: (see menu block)

menu block: Groups of parameters arranged in the software.

microcontroller: A large scale integrated circuit that has all the functions of a computer, including memory and input/output systems.

NEMA 4X: A National Electrical Manufacturers Association standard for specifying a product's resistance to water and corrosion.

normally open: A switched output (i.e, relay, etc.) whose unpowered state has no connection.

normally closed: A switched output (i.e., relay) whose unpowered state provides connection.

noise: An unwanted component of a signal or variable.

noise band: A measurement of the amount of random process "noise" affecting the measurement of the process variable.

offset: The difference in temperature between the setpoint and the actual process temperature. Also, the adjustment to actual input temperature and to the temperature values the controller uses tor display and control.

ON/OFF control: Control of temperature about a setpoint by turning the output full ON below setpoint and full OFF above setpoint in the heat mode.

open loop: Control system with no sensory feedback.

optimization: The act of controlling a process at its maximum possible level of performance, usually as expressed in economic terms.

output modules: Plug in devices that provide power handling to enable process control. These modules are either binary (on/off) such as a relay, or analog (continuously variable) for current loop control.

output: Action in response to difference between setpoint and process variable.

overshoot: Condition where temperature exceeds setpoint due to initial power up or process changes.

P control: Proportioning control.

parameter(s): A user-defined variable that specifies how a particular function in the 535 will operate.

PD control: Proportioning control with rate action.

PI control: Proportioning control with auto-reset.

PID control: Proportioning control with auto-reset and rate.

position proportioning: A type of control output that utilizes two relays to control an electric motorized actuator.

POWERBACK®: Our proprietary algorithm which monitors the PV to make predictive judgements to control parameters in order to reduce or eliminate overshoot at powerup or after setpoint changes.

POWERTUNE®: Our exclusive special self-tuning function. Consists of an on-demand pretune that calculates PID values or provide preliminary PID values and process information for the second tuning function. Second tuning function is an adaptive tuning algorithm that automatically adjusts PID values whenever a process upset or setpoint change occurs.

pretune algorithm: A method by which the 535 controller initiates an output value change, monitors the manner of the corresponding process variable change, and then determines the appropriate PID control parameters.

primary loop: The outer loop in a cascade system.

process variable: In the treatment of material, any characteristic or measurable attribute whose value changes with changes in prevailing conditions. Common variables are level, pressure and temperature.

Glossary

proportional band: The change in input required to produce a full range change in output due to proportional control action.

ramp: A rise or fall of the setpoint in a given segment. Ramps may be defined by the time it will take for the setpoint to be achieved or the rate of rise or fall necessary for the target (soak) setpoint to be achieved.

rate: Anticipatory action that senses the rate of change of temperature and compensates to minimize overshoot. Also “derivative.”

rate action: The derivative function of a controller.

rate time: The time interval over which the system temperature is sampled for the derivative function.

regulate: The act of maintaining a controlled variable at or near its setpoint in the face of load disturbances.

relay (mechanical): An electromechanical device that completes or interrupts a circuit by physically moving electrical contacts into contact with each other.

relay (solid state): A solid state switching device which completes or interrupts a circuit electrically with no moving parts.

reset: Control action that automatically eliminates offset, or “droop,” between setpoint and actual process temperature. Also “integral.”

reset term: (see reset)

RTD: Resistance Temperature Detector. Resistive sensing device displaying resistance versus temperature characteristics. Displays positive temperature coefficient.

relative gain: An open-loop gain determined with all other manipulated variables constant, divided by the same gain determined with all other controlled variables constant.

retransmission: a feature on the 535 which allows the transmission of a milliamp signal corresponding to the process variable, target setpoint or actual setpoint to another devices, typically a chart recorder.

sample interval: The time interval between measurements or observations of a variable.

secondary loop: The inner loop of a cascade system.

self tune: A method of automatically calculating and inserting optimum PID parameters by testing system response and timing.

serial communications: The sending or receiving of binary coded data to a supervisory device such as a personal computer of programmable logic controller.

setpoint: An input variable which sets the desired value of a controlled variable.

setpoint, actual: The desired value of a controlled variable that the controller is currently acting upon.

setpoint, deviation from: The number of units difference between the current process variable and the setpoint.

setpoint, ramping: A setpoint which is determined by the ramp function of the controller where over time the controller variable reaches a desired value.

setpoint, target: The end point of the ramp function.

set up: Also called configuration, selection of hardware devices and software routines that function together.

sheds: In serial communications, when the signal is lost.

slidewire position proportioning: An output algorithm that utilizes a slidewire feedback signal to determine the actual position of the actuator being controller.

soak: Also called "dwell.: The designated period of time in which the setpoint does not change after the ramp has been completed.

soak, guaranteed: Guaranteed soak insures that the soak setpoint has been achieved before the soak segment starts.solid state relay: (see relay, solid state)

SSR drive: A D.C. on/off signal output for controlling a solid state relay.

staged outputs: The set up of two analog outputs, where one analog output varies its signal over a portion of the PID output range, and the second analog output then varies its signal over the remainder of the PID output range.

static discharge: Undesirable current resulting from the discharge of electrostatic energy.

station address: The unique identifier assigned to a device for communications.

thermocouple: Temperature sensing device that is constructed of two dissimilar metals wherein a measurable, predictable voltage is generated corresponding to temperature.

thermocouple break protection: Fail-safe operation that assures desired output upon an open thermocouple condition.

thermocouple upscale burnout (▲): Jumper position that determines whether, when a thermocouple fails, its output is replaced by a millivoltage which will match the thermocouple’s maximum value. The jumper connector should be placed in the TC s position.

thermocouple downscale burnout (▼): Jumper position that determines whether, when a thermocouple fails, its output is replaced be a millivoltage which will match the thermocouple’s minimum value. The jumper connector should be placed in the TC t position.

three mode control: (See control action PID)

time proportioning control: A control algorithm that expresses output power (0–100%) as a function of percent ON versus percent OFF within a preset cycle time.

time proportioning output: A controller output assigned by software to facilitate time proportional control (typically a relay, SSR, or SSR Drive output).

tracking: A function that defines whether the local setpoint will track the remote setpoint. When the controller is transferred to a local setpoint, that local setpoint value will match the remote process value when the transfer occurs.

transmitter (2-wire): A device used to transmit data via a two wire current loop. A two-wire transmitter is loop powered.

transmitter (4-wire): A device used to transmit data via a current loop or a DC voltage. A 4-wire transmitter uses 2 wires for data and 2 wires for power.

triac: Solid state switching device used to switch alternating current signals on and off. Triac circuits are sometimes referred to as solid state relays (SSR).

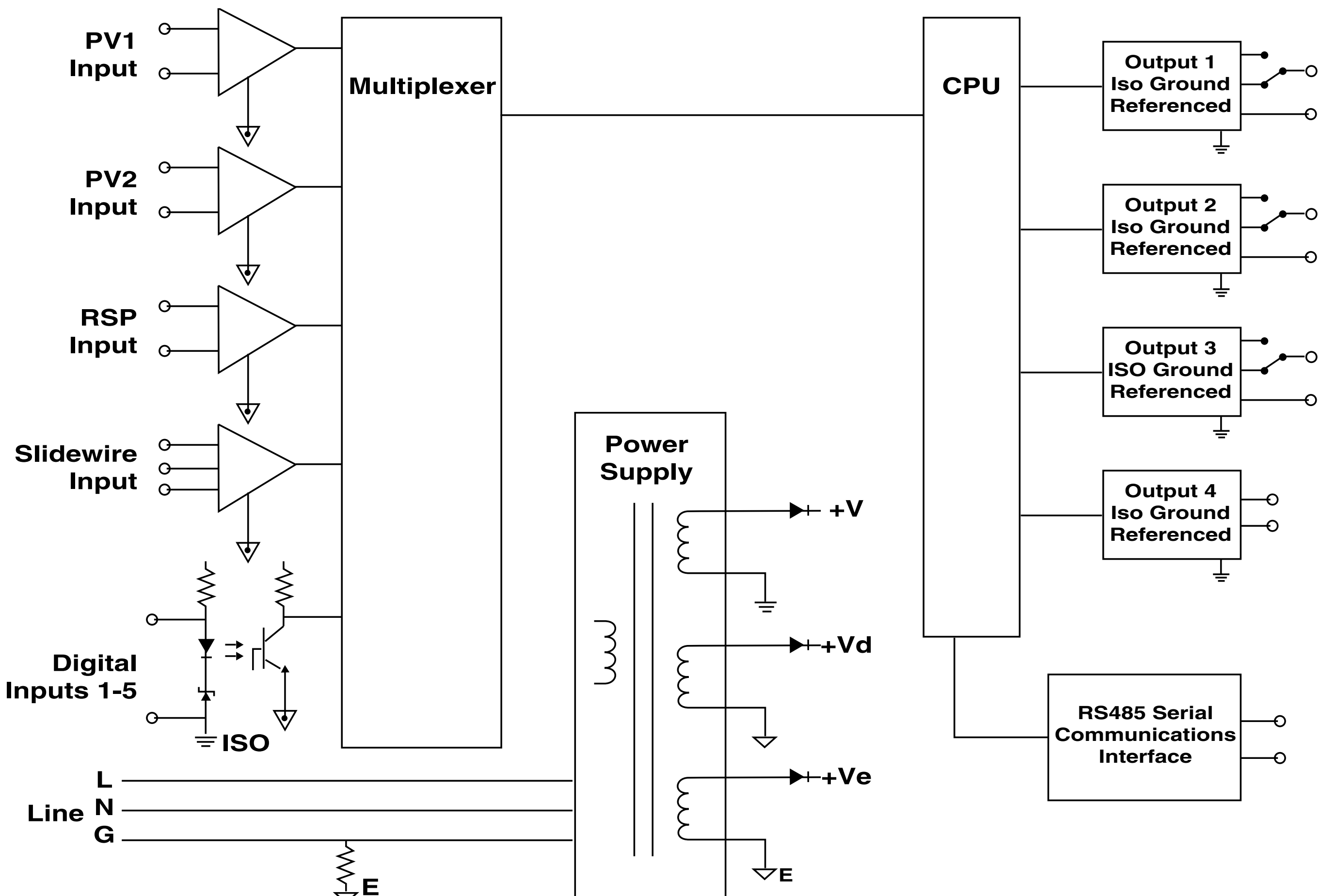
trip point: Value which determines when that set of PID values becomes active.

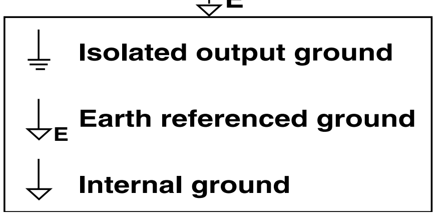
velocity position proportioning: This is a control technique where valve position is determined by calculating the amount of time it takes to open/close a valve by moving the valve for a portion of that time.

windup: Saturation of the integral mode of a controller developing during times when control cannot be achieved, which causes the controlled variable to overshoot its setpoint when the obstacle to control is removed.

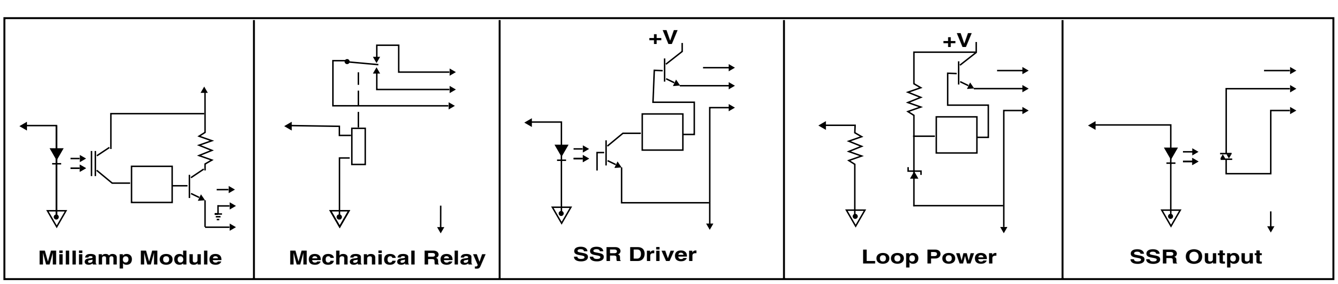
wild stream: In mixing applications that require materials to be mixed to a desired ratio, this is the one part of the material that is uncontrolled.

APPENDIX 7
ISOLATION BLOCK DIAGRAM





1. Each of the three ground circuits are isolated from each other to withstand a potential of 500 volts for 1 minute, or 600 volts for 1 second.
2. RSP, Slidewire and the PV inputs are not isolated but is capable to withstand 50 volts peak between each other for 1 minute.
3. Milliamp, Loop Power and SSR Drive modules in output positions 1, 2, 3 and 4 are not isolated from each other.



RETURN PROCEDURES

To return equipment to Moore Industries for repair, follow these four steps:

1. Call Moore Industries and request a Returned Material Authorization (RMA) number.

Warranty Repair –

If you are unsure if your unit is still under warranty, we can use the unit's serial number to verify the warranty status for you over the phone. Be sure to include the RMA number on all documentation.

Non-Warranty Repair –

If your unit is out of warranty, be prepared to give us a Purchase Order number when you call. In most cases, we will be able to quote you the repair costs at that time. The repair price you are quoted will be a "Not To Exceed" price, which means that the actual repair costs may be less than the quote. Be sure to include the RMA number on all documentation.

2. Provide us with the following documentation:
   a) A note listing the symptoms that indicate the unit needs repair
   b) Complete shipping information for return of the equipment after repair
   c) The name and phone number of the person to contact if questions arise at the factory

3. Use sufficient packing material and carefully pack the equipment in a sturdy shipping container.

4. Ship the equipment to the Moore Industries location nearest you.

The returned equipment will be inspected and tested at the factory. A Moore Industries representative will contact the person designated on your documentation if more information is needed. The repaired equipment, or its replacement, will be returned to you in accordance with the shipping instructions furnished in your documentation.

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ANY CAUSE OF ACTION FOR BREACH OF ANY WARRANTY BY THE COMPANY SHALL BE BARRED UNLESS THE COMPANY RECEIVES FROM THE BUYER A WRITTEN NOTICE OF THE ALLEGED DEFECT OR BREACH WITHIN TEN DAYS FROM THE EARLIEST DATE ON WHICH THE BUYER COULD REASONABLY HAVE DISCOVERED THE ALLEGED DEFECT OR BREACH, AND NO ACTION FOR THE BREACH OF ANY WARRANTY SHALL BE COMMENCED BY THE BUYER ANY LATER THAN TWELVE MONTHS FROM THE EARLIEST DATE ON WHICH THE BUYER COULD REASONABLY HAVE DISCOVERED THE ALLEGED DEFECT OR BREACH.

RETURN POLICY

For a period of thirty-six (36) months from the date of shipment, and under normal conditions of use and service, Moore Industries ("The Company") will at its option replace, repair or refund the purchase price for any of its manufactured products found, upon return to the Company (transportation charges prepaid and otherwise in accordance with the return procedures established by The Company), to be defective in material or workmanship. This policy extends to the original Buyer only and not to Buyer's customers or the users of Buyer's products, unless Buyer is an engineering contractor in which case the policy shall extend to Buyer's immediate customer only. This policy shall not apply if the product has been subject to alteration, misuse, accident, neglect or improper application, installation, or operation. THE COMPANY SHALL IN NO EVENT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

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