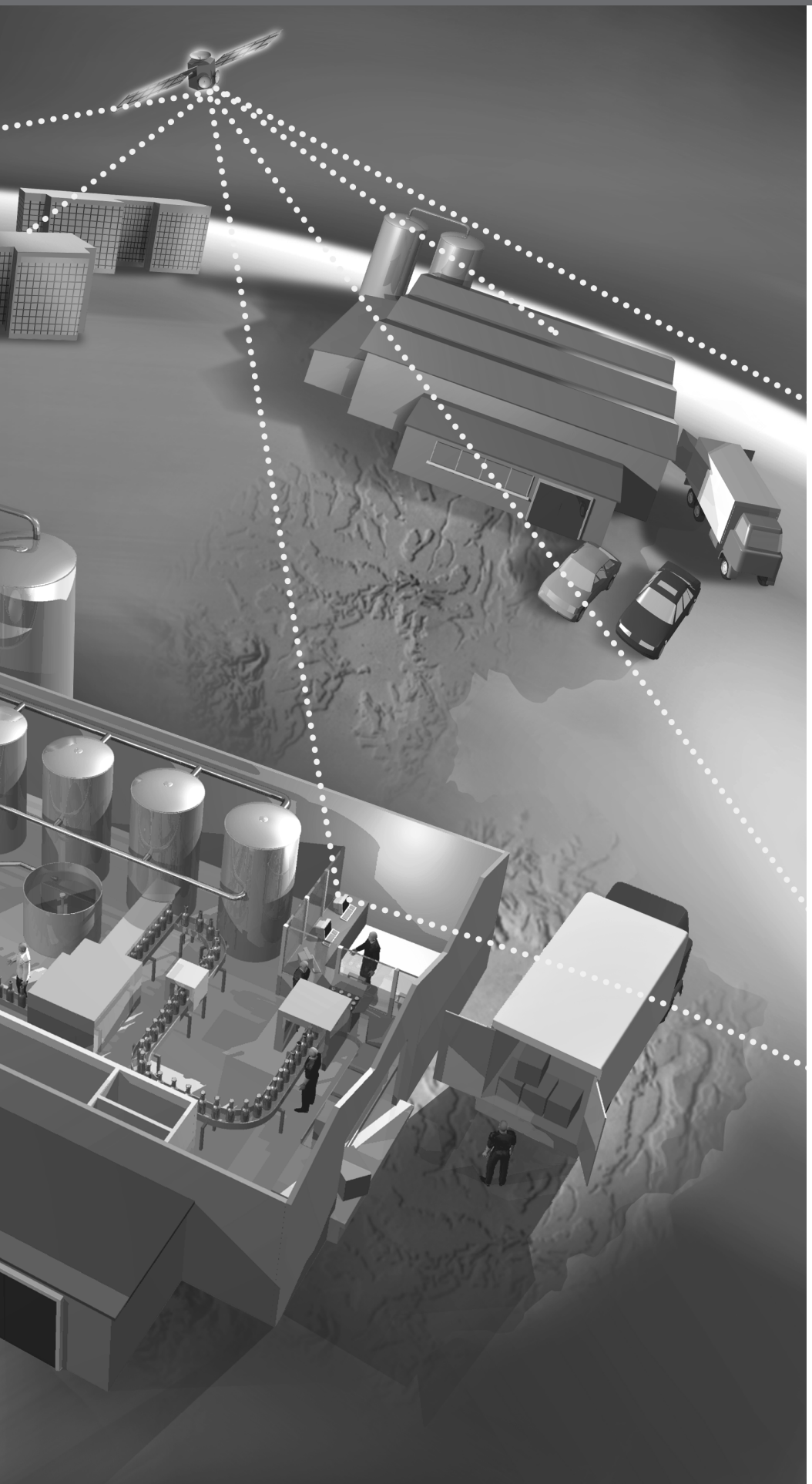


Allen-Bradley

On/Off Heater Control

A Complete Automation Workshop

Student Lab Manual

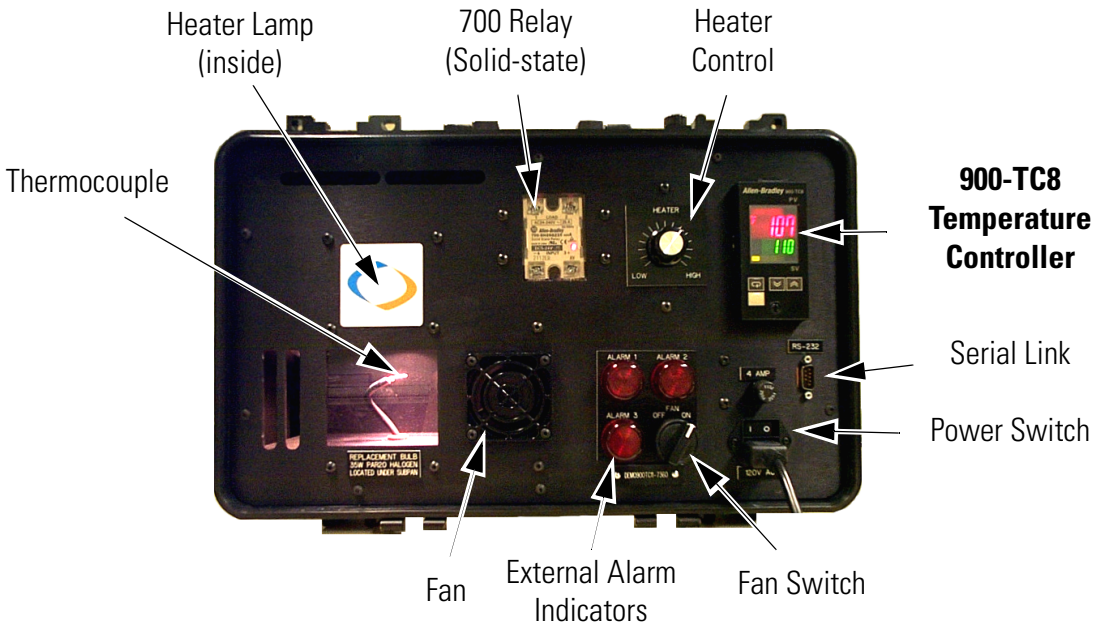
Rockwell Automation

Lab 7

Temperature Controller Reset to Default/ Factory Settings

Appendix A

The components shown below are contained in the **Bulletin No. 900-TC8 Temperature Controller** and **700 Solid-state Relay** demo case. Please take a moment to read through the table below to obtain a brief understanding of each component's function.



Component	**Purpose** (in the demo unit)
900-TC8 Temperature Controller	To monitor the input (in this case, from the Thermocouple) and provide outputs based on parameter settings entered by the user into the controller.
Input Connection	
• Thermocouple	Used to sense the temperature applied by the Heater Lamp
Output Connections	
• 700 Solid-state Relay (SSR)	To provide the means for the **Bulletin 900 Temperature Controller** to switch increased power to the load (in this case, the heater lamp). The 700 Solid-state Relay is turned off and on by the **Bulletin 900 Temperature Controller**.
- Heater Control	Used to vary voltage to the Heater Lamp (which is seen as a change in intensity, e.g. a dimmer). Power for the Heater Control is turned off and on by the 700 Solid-state Relay.
- Heater Lamp	Bulb used to control the temperature applied to the Thermocouple (by varying the lamp's voltage with the Heater Control and indirectly, by switching the lamp's voltage off and on via the 700 SSR).
• External Alarm Indicators	Used to simulate **Bulletin 900 Temperature Controller** external alarm indicators which may be located remotely. These indicators are tied to the alarm 1, 2, and 3 outputs of the controller.
Other	
• Fan	Used to change the heating environment of the Thermocouple (for experimentation)
• Fan Switch	Turns the heating environment Fan off and on
• Serial Link (RS232)	**Bulletin 900 Temperature Controller** serial link to external configuration software (often loaded on a personal computer). This allows the controller to be configured from a remote location via software.
• Power Switch	Demo Unit Power
Note: An interconnection chart is located at the end of this Introductory Lab section (see Figure 2, page xi)	

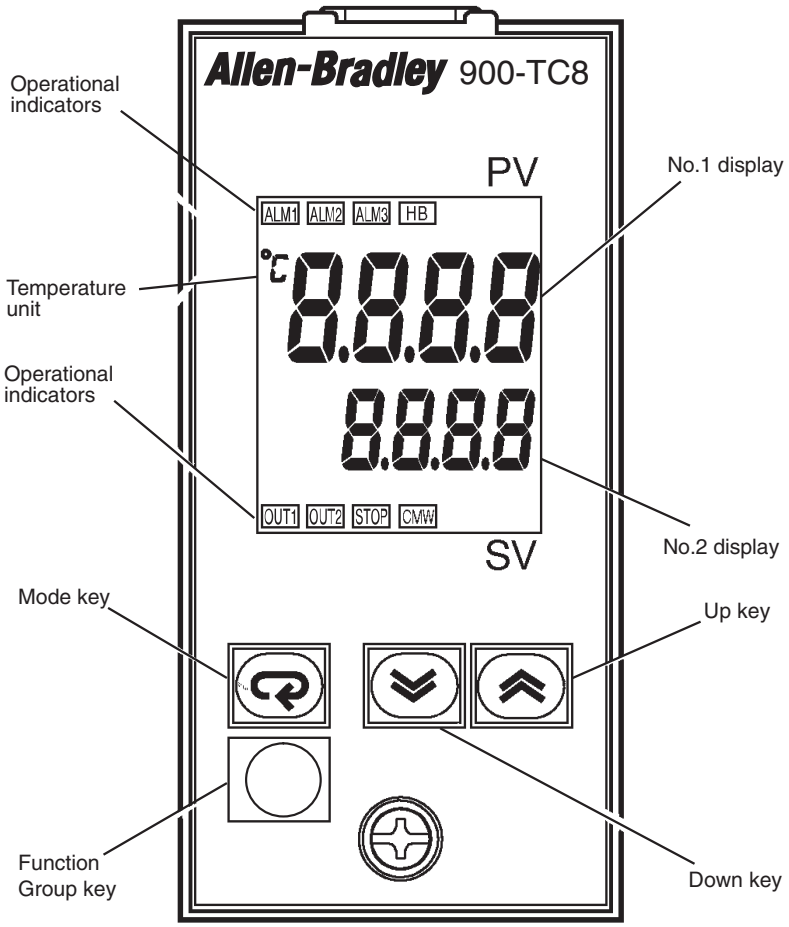
Basics of Operation

The Bulletin 900 Temperature Controller (TC) is the "heart" of the demo unit. The 900-TC8 senses temperature via the thermocouple, then, based on how its parameters have been configured by the user, provides a variety of outputs.

Below is a picture of the 900-TC8 Front Panel and Display. The primary keys and display sections used in the labs are:

- No. 1 Display
- No. 2 Display
- Mode Key
- Function Group Key
- Up/Down Keys

By using a combination of the above keys and displays, the labs will demonstrate how to configure the 900-TC8 for a variety of situations.



Display Meanings

- **No. 1 Display (upper) —** Displays the Process Value or parameter type. Lights for approximately one second during startup.
- **No. 2 Display (lower) —** Displays the Set Point, parameter operation read value, manipulated variable, or set value (setup) of the parameter.

Basic Keypad Functions

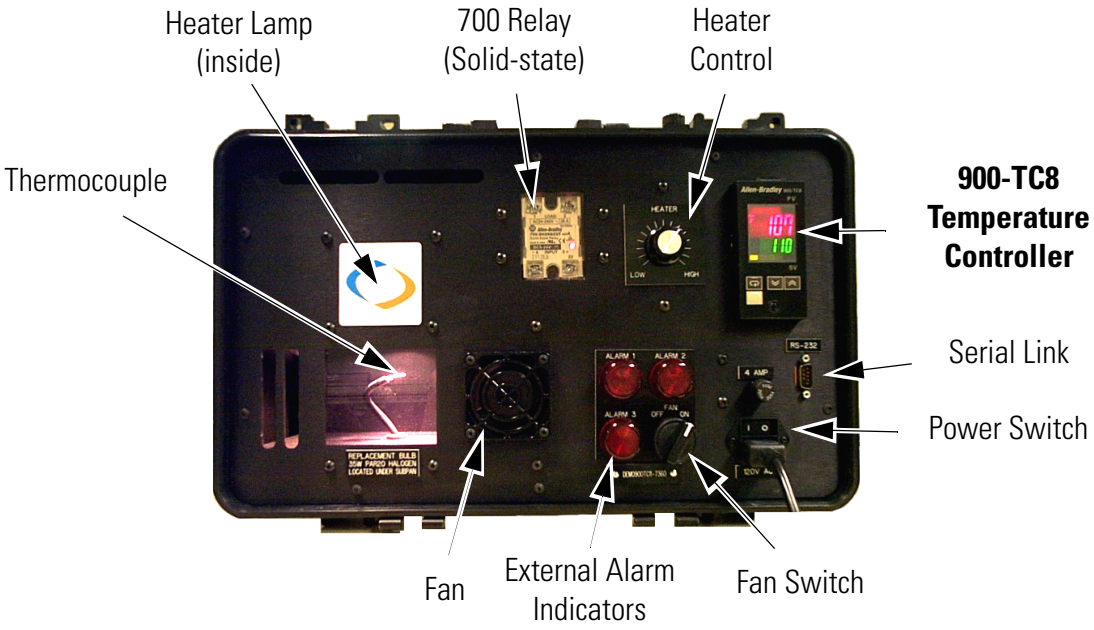
The following describes the basic functions of the front panel keys:

- ○ Function group select key — Use this key to move to the desired function group (Operation, Adjustment, Initial Setting, Communications Setting, Protect or Advanced Setting).

Important: The function group key operates differently depending on how long it is pressed. For instance, to change from the "**Operation** function group" to the "**Adjustment** function group", the ○ key is pressed for less than one second. The same key, when pressed for a minimum of three seconds, changes the user from the "**Operation** function group" to the "**Initial setting** function group".

- ⏎ Mode select key — Press this key to select the various parameters within each function group.
- ⌃ ⌄ Up and Down keys — Each press of these keys increases or decreases the value displayed on the No. 2 (SV) lower display. Holding down either of these keys quickens the change.

Lab Procedure



Please refer to the picture above and the demo unit to familiarize yourself with the controls, indicators, and sensor while performing the lab.

1. Begin the lab now by turning the Power Switch **ON**.

Prior to this demonstration the demo unit has been reset. Therefore, when the unit is first powered up, it is in its "default settings" mode of operation. On the **900-TC8 display**:

- ALM1, ALM2, and ALM3 should all be lit (indicating that all three alarms have been tripped)

Note: The demo unit's ALARM 1, ALARM 2, and ALARM 3 lights will also be lit. These are external indicators for ALM1, ALM2, and ALM3.

- On the upper left of the **900-TC8 display** the °**C** indicator should be shown, indicating that the Celsius scale is being displayed (vs. Fahrenheit).
- To the right of the °**C** symbol should be the current temperature being sensed via the thermocouple (approximately 20...25).
- Below the temperature value should be the current selection type setting of the thermocouple (0 for type K).

2. Try the **Mode** select key (⏎) by doing the following:

- Press it a number of times to see (in the upper display) the parameters associated with the **Operation** function group (which you should presently be in). Eventually, you should see the same parameters repeat. This is because the **Mode** select key returns to the beginning value once it reaches the end of the parameter list.

900-TC8 configurable parameters are divided into control categories, each called a **function group**. Each of the items/values that can be configured in these function groups is called a **parameter**.

3. Try the **Function Group** select key (◯) by doing the following:

•Press ◯ for less than one second.

This changes function groups from **Operation** to **Adjustment**.

•Press ◯ again for less than one second to change from **Adjustment** back to the **Operation** function group.

•Press ◯ for a minimum of three seconds.

This changes function groups from **Operation** to **Initial setting**. **Initial setting** has a variety of parameters which can be cycled through using the ↵ key. Also, you may have noticed that the alarm lamps turned off. This is because normal operation is suspended while in the **Initial setting** function group.

Do not change any parameters at this time.

•Press ◯ again for a minimum of one second to change from **Initial setting** back to the **Operation** function group.

From this point on, when it is necessary to press any of the select keys, the corresponding key graphic will be shown (e.g. ↵, ◯, ⩓, or ⩔).

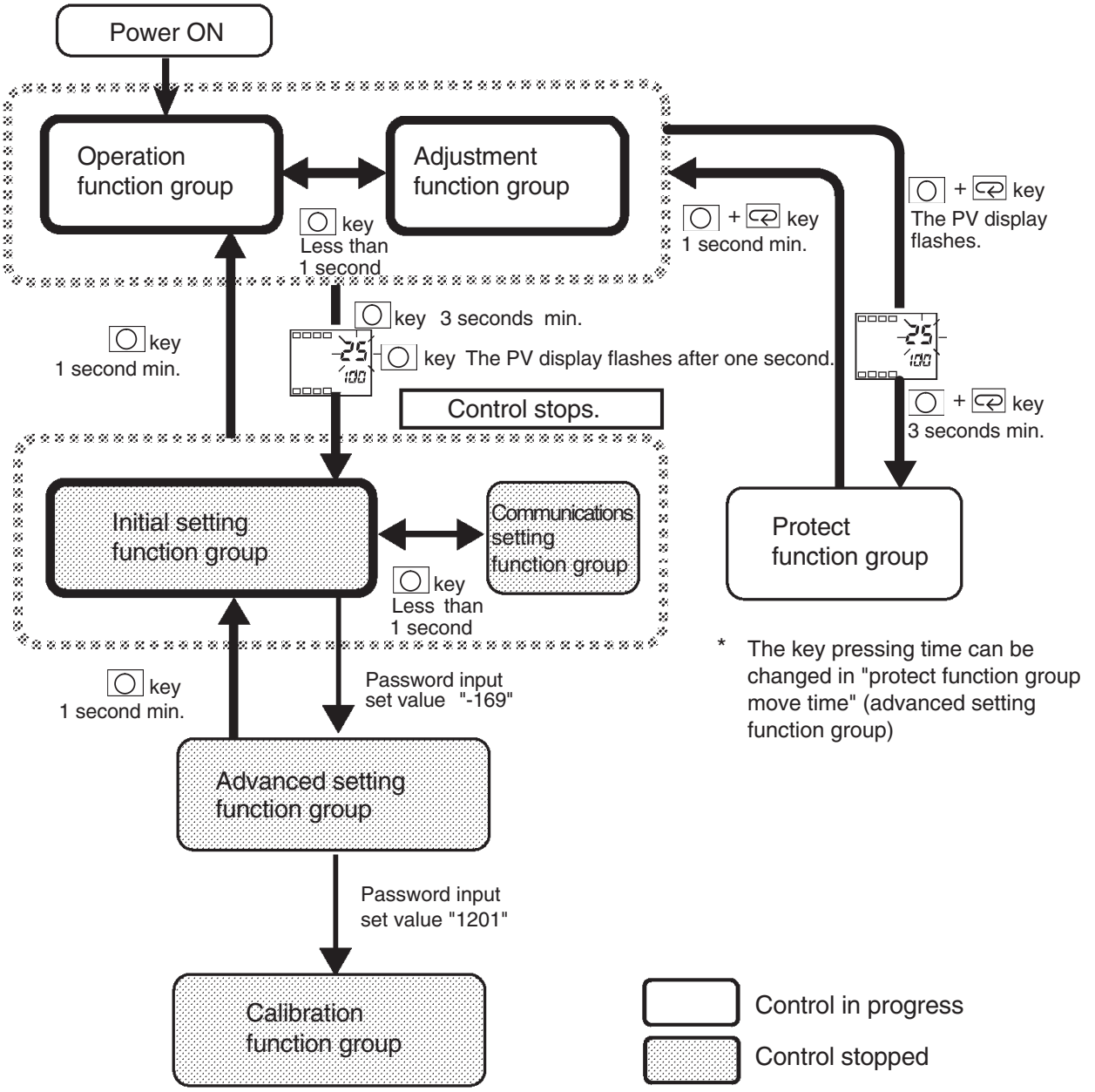
4. Try the ⩓ and ⩔ arrow keys. Notice that the temperature setpoint (in the lower display) changes. The purpose of the ⩓ and ⩔ arrow keys is to allow adjustment of the **set value** (in the lower display) for the parameter shown in the upper display.

See Figure 1 on page x for a diagram that summarizes how to navigate between function groups on the 900-TC8.

To move from one function group to another, there is a the brief instruction shown next to the arrow connecting the function groups. For example, the chart indicates to move between **Operation** and **Adjustment,** ◯ must be pressed for less than one second. Also, since the arrow is bidirectional, to get back from the **Adjustment** group to the **Operation** group, ◯ must again be pressed for less than one second.

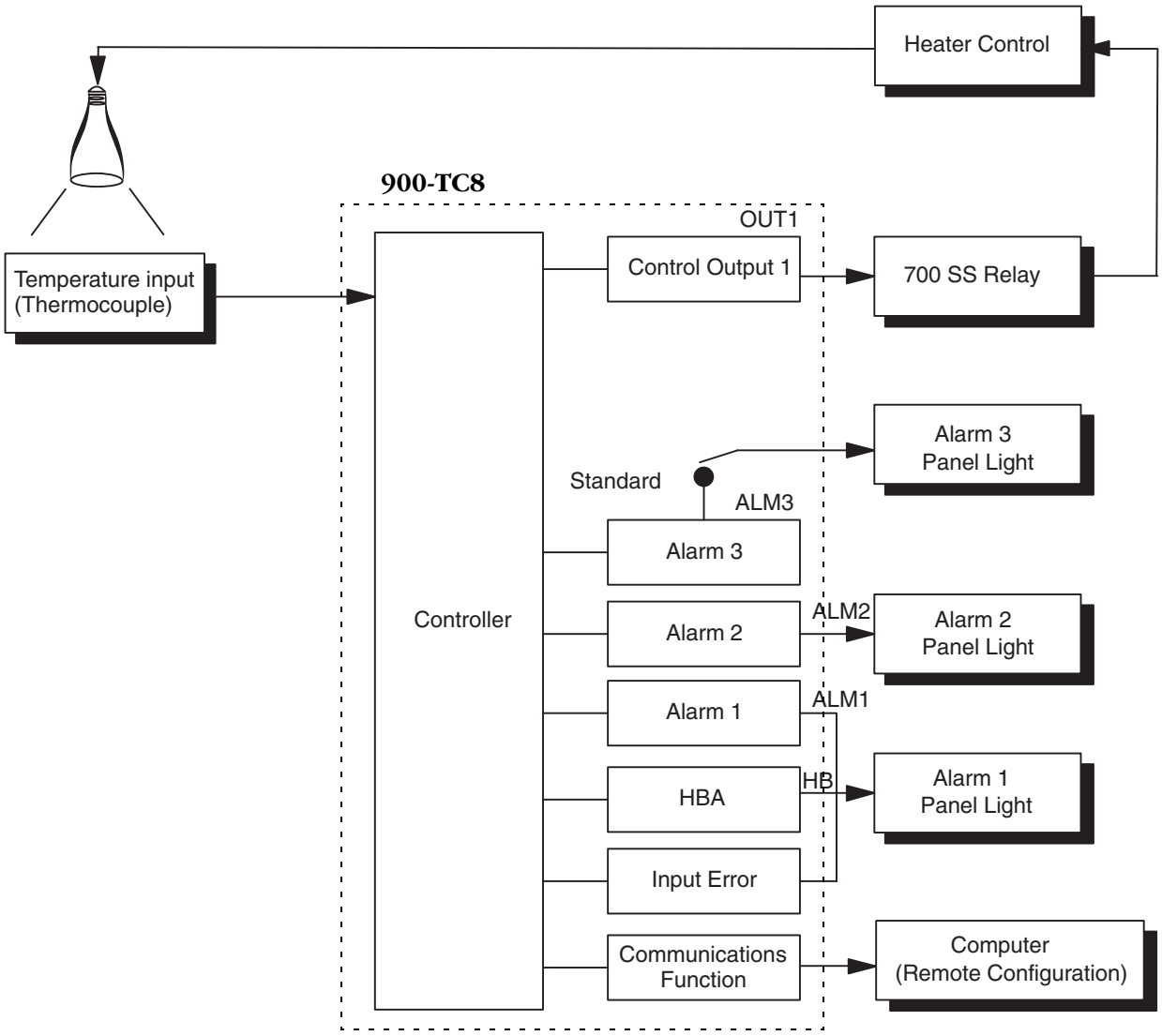
5. To complete this introduction, turn the demo unit power switch off. When the unit is powered back up for the next lab it will come back up in **Operation** mode.

Figure 1 Function Group Navigation Chart



Note: a detailed navigation chart that shows all the function groups and parameters contained in the Bulletin 900-TC8 has been included in Appendix A.

Figure 2 Demo Unit Interconnection Diagram



Notes

Configure the Controller Parameters to a Known Set of Values

Introduction

The purpose of this lab is to demonstrate how to modify the controller default parameters while providing a way to learn some of the principles of navigating from one functional group/level to another.

In this lab you will configure the temperature controller:
- Input and output types,
- Alarm types and limits, and
- Set point limits.

Before we begin the temperature controller configuration, let's consider that, for an actual site installation, it would first be necessary to:

- Determine which 900-TC **parameters** need to be configured (by reviewing the user guide for the controller)
- Determine what **set values** must be entered into the temperature controller for each parameter (again, by consulting the user guide)

For an overview table of the parameters configurable on the Bulletin 900-TC series Temperature Controllers, please take a moment to look at Appendix A. In it you will find a **Parameter Operations List** that lists all of the parameters, the symbol that will be displayed on the controller's front panel when the parameter is selected, values that can be set for the parameter, default settings, etc.

The Appendix A table and the detailed descriptions of each parameter included in the user guide are the tools that are used to lay the groundwork for configuring the temperature controller.

Once the **parameters** and **set values** are known, a table like the one on the following page can be constructed to simplify the process of configuring the 900-TC controller.

Once you have completed the above, you are ready to:

- Select the **parameters** via the 900-TC menus and enter the **set values**

The selection of parameters and the entering of set values may be done either via the front panel of the controller or via the serial link if you have the 900-TC configuration software installed on a personal computer (see Lab 5).

Example

In the table below, the parameters and set values have been determined and will be entered into the Buletin 900-TC8 for our simulated installation.

Table 1.A

Parameter	Set Value	Description
Input Type	0	Determined by the type of thermocouple that will be attached to the controller
Units	F	F or C
SET Point High Limit	175	—
SET Point Low Limit	110	—
On/Off Control	onoF	—
Standard Control	stnd	—
Reverse Operation	r	—
Alarm Type for Alarm 1	5	This configures alarm operation for Upper and Lower Limit Deviation from the Set Point.
Alarm Type for Alarm 2	6	This selection provides the Upper-limit w/Standby sequence (alarm disabled on startup) alarm configuration.
Alarm Type for Alarm 3	7	This selection provides the Lower-limit w/Standby sequence (alarm disabled on startup) alarm configuration.
Set Point	130	—
Alarm 1 high limit	2	This configures the Alarm 1 band to 2 degrees above the set point.
Alarm 1 low limit	3	This configures the Alarm 1 band to 3 degrees below set point.
Alarm 2 limit	4	This configures a second high level or (High-High) alarm limit as Alarm 2, with a value of 4 degrees above the set point.
Alarm 3 limit	5	This configures a second low level or (Low-Low) alarm limit as Alarm 3, with a value of 5 degrees below the set point.

Lab Procedure

Power Up

1. Begin this portion of the lab by turning the 900-TC8/700 SSR demo unit **ON**. (If the unit was already on, turn it off and back on.)

Enter the **Initial Setting** Function group/level

2. Press and hold the ⊙ (Function group/level) key for a minimum of three seconds to enter the **Initial Setting** group/level from the **Operation** group/level.

The upper (number 1) display should flash during this step, and the controller STOPS its control function.

Configure the **Input** Type to **0** (type K)

3. When the display stops flashing in the step above, the Input Type parameter **in-t** will be displayed, indicating the **Initial Setting** function group.

Ensure that the lower (number 2) display indicates the number zero (0) which specifies a Type-K thermocouple selection. If it doesn't indicate 0 use the ⩛ (Down Arrow) key to configure it to **0**.

> ***Note:*** *If you press ⊙ instead of ↵ by mistake, you will move to the Communications Setting function group. To return to the Initial Setting function group, momentarily depress ⊙.*

Configure the **Units** type to degrees **F**

4. Depress ↵ once.

The upper display will indicate the degrees-Units selection parameter **d-U**.
If **°F** are displayed (in the lower display), go to the next step.
If **°F** is not configured depress ⩚ to configure **°F** for temperature units.

Note the default setting, then configure the **SET Point High Limit** to **175**

5. Depress ↵ once.

The upper display will indicate the Set Point High limit parameter **SL-H**.

- Use ⩚ ⩛ to configure the value in the lower display to **175**.

Note: Hold the arrow key down to accelerate the rate of change.

Note the default setting, then configure the **SET Point Low Limit** to **110**

6. Depress ↵ once.

The upper display will indicate **SL-L** (Set Point Low limit) parameter.

- Use ⩚ ⩛ to configure the value in the lower display to **110**.

Configure for **On/Off Control** to onoF

7. Depress ↵ once.

The upper display will indicate the CONTROL mode – PID/On/Off parameter CntL.
The lower display will indicate On/Off or PID (onoF or PId).

•Use ⩓ ⩔ to select onoF.

Configure for **Standard Control** Stnd

8. Depress ↵ once.

The upper display will indicate **S-HC** (Standard/Heating and Cooling) parameter.
The lower display will indicate Stnd (Standard Control) or H-C (Heating and Cooling control).

•Use ⩓ ⩔ to select Stnd Standard Control.

Configure for **Reverse Operation** or-r

9. Depress ↵ once.

The upper display will indicate orEu, Direct or Reverse Operation parameter.
The lower display should indicate or-r (reverse) or or-d (direct) operation.

•Use ⩓ ⩔ to select reverse operation or-r.

Select the **Alarm Type for Alarm 1 = 5**

10. Depress ↵ once.

The upper display will indicate AL t 1 Alarm Type for Alarm 1 parameter.
The lower display will indicate a value between 0 and 11.

•Use ⩓ ⩔ to configure the value to **5**.

This configures alarm operation for Upper and Lower Limit Deviation from the Set point (we will set the deviation value in another step). It also **disables** the alarm on startup (Standby Sequence).

Select the **Alarm Type for Alarm 2 = 6**

11. Depress ↵ once.

The upper display will indicate AL t 2 Alarm Type for Alarm 2 parameter.
The lower display will indicate a value between 0 and 11.

•Use ⩓ ⩔ to configure the value to **6**.

This selection provides the Upper-limit w/Standby sequence (alarm disabled on startup) alarm configuration.

Select the **Alarm Type for Alarm 3 = 7**

12. Depress ↵ once.

The upper display should indicate **AL t 3**, Alarm Type for Alarm 3 parameter.
The lower display will indicate a value between 0 and 11.

•Use ▲ ▼ to configure the value to **7**.

This selection provides the Lower-limit w/Standby sequence (alarm disabled on startup) alarm configuration.

Place the controller in **Operation** mode

13. With the **Heater Control** in the **three o'clock position**, press and hold ○ for more than one second to enter the **Operation** group/level from the **Initial Setting** group/level.

Adjusting Alarms while in "Run" mode

The upper display will flash during this step, and the controller will begin operation in the On/Off control mode with your parameters entered in the above steps.

Adjust the **set point** to **130** °F

14. Use ▲ to configure the set point (on the lower display) to **130** °F.

Important: Allow the controller to reach 130 °F (the set point) before continuing to the next step.

While in the **Operation** function group/level you may notice that your alarm lights are **On** quite often. In the steps below, we'll change the alarm values, then view the response.

Configure **Alarm 1 high limit** to **2** degrees

15. From the **Operation** function group/level (controller operating) depress ↵ several times until the **A 1H** (Alarm 1 High Limit) parameter is showing in the upper display.

•Use ▲ to configure this parameter to **2°**.

Configure **Alarm 1 low limit** to **3** degrees

16. Depress ↵ once and the **AL 1L** (Alarm 1 Low Limit) parameter will appear in the upper display.

•Use ▲ to configure this parameter to **3°**.

These last two steps configure the Alarm 1 band to 2° above the set point and 3° below set point (refer to step 9 above).

Configure **Alarm 2 limit** to **4** degrees

17. Depress ↵ once and the **AL - 2** (Alarm 2 Limit) parameter will appear in the upper display.

•Use ▲ to configure this parameter to **4°**.

This configures a second high level or (High-High) alarm limit as Alarm 2, with a value of 4° above the set point (refer to Step 10 above).

Configure **Alarm 3 limit** to **5** degrees

18. Depress ↵ once and the **AL - 3** (Alarm 3 Limit) parameter will appear in the upper display.

•Use ⇈ to configure this parameter to **5°**.

This configures a second low level or (Low-Low) alarm limit as Alarm 3, with a value of 5° below the set point. Refer to Step 11 above.

View the PV & SV operation

19. Depress ↵ once so the measured temperature and the temperature setpoint are actively displayed (parameters PV and SV).

What is the status of the Alarm lights with the new Alarm values applied? _____ NONE

Note: Many applications require this type of alarm configuration, in which there are different alarm bands or levels based on how far the process value varies from the set point.

20. Turn the FAN switch on for approximately **5...15 seconds**.

Does the Alarm 1 and/or Alarm 3 light come on to indicate a low alarm or low-low alarm condition? _____ YES
If so, which Alarm(s) come on? _____ 1 & 3

Experiment/Observations

The controller is now operating in the On/Off mode along with the other parameters you configured in the **Initial Setting** function group/level.

21. Observe how closely the process temperature is controlled relative to (above & below) the 130 °F set point.
Are there any alarms with the Heater output potentiometer adjusted to the 12 o'clock position? _____ NO

22. Adjust the Heater output potentiometer to the High (max heat/light) position. Observe the process temperature with this selection.
Is there greater or less set point overshoot? _____ GREATER
Are there any alarms? _____ NO

This is an important point to understand for future demonstrations and real world applications where the heat output of the final control element (heater) is typically constant.

23. Return the Heater potentiometer to the three o'clock position.

In the above three steps (21...23) you noticed that the Process Value (PV) drifted several degrees from the Set Point. This is partially due to the On/Off control mode and the current value of the controller's **On/Off Hysteresis** parameter.

The **Hysteresis** parameter is used to give stability to the output around the set point in On/Off control. It provides a margin, or differential, for switching the control output ON when the controlled temperature moves away from the set point by the configured hysteresis value. Hysteresis has the same units (e.g. °F) as the set point, and allows the customer to effectively limit the amount that the output cycles in the On/Off mode. This feature can be important if the electromechanical relay output is used to control the process.

Adjust the ON/OFF Control Mode Hysteresis Parameter

Introduction

The purpose of this lab is to observe how a change in the hysteresis parameter impacts the operation of the controller in the On/Off operational mode.

Lab Procedure

Move to the Adjustment function group/level

1. Momentarily press and release the ⊙ to enter the **Adjustment** function group/level from the **Operation** group.

The upper display will indicate the Communication Writing parameter COMM
The lower display may indicate OFF.

Note: the controller is still operating while in this function group/level.

Select the Hysteresis parameter

2. Depress ↵ (approximately 4 times) until the HYS (Hysteresis) parameter is indicated in the upper display (if you miss it, depress ↵ several more times until it comes around again).

The lower display should indicate **1.0** (default value).

Adjust the Hysteresis parameter

3. Depress ⌃ until the lower display indicates **3.0**.

Return to the Operation function group/level

4. Depress ⊙ once to leave the **Adjustment** function group/level and enter the **Operation** group.

The upper display will indicate the **PV** value and the lower display will indicate the **SV** value.

Observe the controller operation

5. With the **HYS** (hysteresis) parameter configured to 3.0 is the control better or worse _____? WORSE

Looking at either the OUT1 indicator on the temperature controller or the 700 SSR LED, at what value does the controller output energize with the hysteresis set at 3.0 _____? 127°F
Does any alarm energize _____? ALARM 1

Change the Hysteresis parameter value

Observe the controller operation

6. Depress ⊙ once to reenter the **Adjustment** function group. Refer to the preceding steps (if necessary) and change the **HYS** value to **5.0**.
7. At what value does the controller output energize with the hysteresis set at 5.0 _____? 127°F

Does any alarm energize _____? ALARMS 1 & 3

Important: When the controller operation is setup for the ON/OFF mode, the Hysteresis parameter is the only adjustment available to change the system response/operation. When using a mechanical relay output, it also allows the customer to lengthen or reduce the life of the relay by adjusting the cycle rate (default is 1.0).

PID Mode with Auto-tune ON/OFF Operation

Introduction

The purpose of this lab is:

1/ To show you how to change the configuration of the controller from the On/Off control mode to the PID with Auto-tune, and

2/ To observe the operational differences between PID and On/Off control and the effect of Auto-tuning on the PID settings.

Note: PID control is typically used when a controller has an analog output, but it also improves control when using On/Off (e.g. relay) outputs in conjunction with the Control Period parameter.

Lab Procedure

Enter the Initial Setting function group/level

1. From the **Operation** group/level, press and hold ⊙ for a minimum of three seconds to enter the **Initial Setting** group/level.

The upper display will flash during this step, and the controller stops its control function.

When the display stops flashing, the Input Type parameter **inPt** will be displayed.

Select the PID/ON/OFF parameter

2. Depress ↵ (approximately 4 times) until the upper display shows the PID/ON/OFF parameter **Ctrl**.

The lower display will indicate On/Off (**onoF**).

Change to PID control

3. Depress ⌃ to change to the **PID** control mode.

The lower display should indicate **PID**.

Ensure Self-tune is OFF

4. Depress ↵ until **St** is showing in the upper display.

Ensure the lower display shows **oFF** . If it does not, use ⌄ so the parameter is configured as **oFF** .

Move to the Operation function group/level

5. Press and hold ⊙ for one second minimum to enter the **Operation** function group/level.

The controller is now controlling temperature using **default** PID parameters.

•Allow the controller Process Value (PV) to reach the 130° configured set point (SV).

Important: If after approximately 60 seconds the set point is not reached, skip to step 6.

Observe the controller operation

6. Is control better or worse with default controller PID parameters selected _____? WORSE

Do any alarms come on _____? NO

Start an Auto-tune cycle

7. Momentarily depress ⊙ to move from the **Operation** function group to the **Adjustment** function group to implement Auto-tune.

The AT Auto-tune parameter will be present in the upper display.

•Use ⌃ to select **oN** for Auto-tune.

The upper display will **begin to flash**, indicating the Auto-tune cycle has begun.

•Momentarily press and release ⊙.

The **PV** and **SV** operational parameters will be displayed with the **SV** (lower) display flashing. When the **SV stops flashing** the Auto-tune cycle is complete.

•Allow the SV display to stop flashing before going to the next step.

Investigate the current controller Auto-tune configured PID parameters

8. Perform the following steps:

•Momentarily press and release ⊙.

The AT Auto-tune parameter will be present in the upper display.

•Press ↵ several (approximately 5) times until the **proportional** parameter P is present in the upper display.

Make a note of its value (lower display)_____. 17.9

•Press ↵ once.

The **Integral** parameter _i_ will be present in the upper display. Make a note of its value in the lower display _____. 9

•Press ↵ once.

The **derivative** parameter _d_ will be present in the upper display. Make a note of its value in the lower display _____. 2

•Momentarily press and release ○ to return to the **Operation** function group.

Observe the controller operation

9. With the PID Auto-tune functionality operational is control better or worse than On/OFF control _____? WORSE

Notice that the PV drifts several degrees from the set point. To reduce the error it is necessary to adjust the CONTROL PERIOD **CP** parameter.

Stop Control to adjust the Control Period (CP)

10. To adjust the Control Period, it is necessary to enter the **Initial Setting** function group.

•From the **Operation** function group/level, press and hold ○ for a minimum of three seconds.

The upper display will flash during this step, and the controller stops its control function.

Adjust the Control Period

11. Press ↵ several times until the Control Period parameter **CP** appears in the upper display.

CP = minimum amount of time between ON cycles.

The lower display will show a value (default is 20, units are seconds).

•Use ▼ to configure the value to **10**.

Enter the Operation function group

12. Press and hold ○ for a minimum of one second to enter the **Operation** group/level from the **Initial Setting** group/level.

The upper display will flash during this process and stop flashing when it is complete. The **PV** and **SV** displays will show the operational values.

Important: Allow the controller to reach the 130° set point before going to the next step.

Observe controller operation

13. Observe operation with the **CP** parameter set to 10.

Is the control operation better or worse than when it was set to 20 _____? B
Is the PV maintained closer to the set point (SV) _____? YES
Do any alarms energize _____? ALARM 1

Initiate an Auto-tune cycle

14. Perform the following steps:

•Momentarily press and release ⊙.

The Auto-tune parameter **AT** will be present in the upper display, and **oFF** will be in the lower display.

•Use ⌃ to change the **oFF** to **_on_**.

The upper display will begin flashing indicating that an Auto-tune cycle has started.

•Momentarily press and release ⊙ to display the active SV and PV parameters.

The SV display will flash as long as the Auto-tune cycle is in progress, and stop when it is complete.

Investigate the new controller configured PID parameters

15. Compare the values found now (for the parameters below) to those noted in Step 8.

•The **proportional** parameter **P** value is: _____. 6.8

•The **Integral** parameter **I** value is: _____. 5

•The **derivative** parameter **d** value is: _____. 1

To finish:

16. In the **Operation** function group, configure the set point to **120**° and note how the alarms adjust to trip around the new set point.

PID Self-Tune Operation

Introduction

The purpose of this lab is to allow you to configure the controller for Self-tuning PID[1] using the On/Off control mode, and observe its operation. In this mode the controller automatically adapts to process changes. For example, if the set point changes by more than the range you've configured, the controller automatically adjusts the PID parameters. You do not need to manually initiate an Auto-tune cycle.

To initiate Self-tuning perform the following:

Lab Procedure

Move to the Initial Setting function group

1. From the **Operation** group/level, press and hold ⊙ for a minimum of three seconds to enter the **Initial Setting** group/level.

The upper display will flash during this step, and the controller stops its control function.

Select the Self-tuning parameter

2. Depress ⊂ until the Self-tuning parameter **St** is showing in the upper display.

The lower display will show **oFF**.

- Depress ∧ to change the Self-tuning operation to **on**.
- Depress ⊂ once and check the value of the Control Period **CP** parameter. It should be **10**. If it isn't use ∧ ∨ to adjust the parameter.

Move to the Operation function group

3. Press and hold ⊙ for a minimum of one second to enter the **Operation** function group from the **Initial Setting** group.

Both displays will flash momentarily, then the **SV** and **PV** displays will show actual values.

Note: the **°F** symbol will flash to indicate a Self-tune cycle is in progress. When it stops flashing the cycle is complete.

- Allow the °**F** symbol to stop flashing before going to the next step.

[1] Proportional, Integral, Derivative

Investigate the controller Auto-tune configured PID parameters

4. Perform the following steps:

•Momentarily depress and release ⊙.

The AT Auto-tune parameter will be present in the upper display.

•Press ↵ several (approximately 5) times until the proportional parameter P is present in the upper display.

Make a note of its value in the lower display_____. 6.8

•Press ↵ once.

The **Integral** parameter I will be present in the upper display. Make a note of its value in the lower display _____. 5

•Press ↵ once.

The Derivative parameter d will be displayed. Make a note of its value in the lower display _____. 1

•Momentarily depress and release ⊙ to return to the **Operation** function group.

Change the set point

5. Hold down ⩓ to ramp the set point to **150°** F.

Note: The °F symbol may flash to indicate a Self-tune cycle is in progress.

Investigate the current controller P,I, & D parameters with the PV at the set point of 150.

6. Record the parameters listed below once again (refer to step 4 above for the procedure if necessary):

P = _____ 6.8

I = _____ 5

D = _____ 1

•Observe how well the controller maintains the set point with the current configuration.

Stop Control to adjust the Control Period

7. To adjust the Control Period, it is necessary to enter the **Initial Setting** function group. From the **Operation** function group/level, press and hold ⊙ for a minimum of three seconds.

The upper display will flash during this step, and the controller stops its control function.

Adjust the Control Period

8. Press ⊂ several times until the Control Period parameter **CP** appears in the upper display.

The lower display will show its current value for the Control Period.

•Use ⊻ to configure the value to **5** .

Enter the Operation function group

9. Press and hold the ⊙ for a minimum of one second to enter the **Operation** group/level from the **Initial Setting** group/level.

The upper display will flash during this process and stop flashing when it is complete. The **PV** and **SV** displays will show the operational values.

Observe controller operation

10. Allow the controller to stabilize for several (2...3) minutes.

•Observe operation with the **CP** parameter set to 5.

Is the control operation better or worse than when it was set to 10 _____? B
Is the PV maintained closer to the set point (SV) _____? YES
Do any alarms energize _____? NO

Notes:

Controller Configuration Using 900Builder™ Software

Introduction

The purpose of this lab is to allow you to become familiar with some of the features of 900Builder software. 900Builder is optional configuration, monitoring and trending software for the Bulletin 900 temperature controllers. The software is self-documenting with HELP pages for general software operation in addition to information regarding all controller parameters, modes of operation and Bulletin 900 temperature controller information.

In this lab you will go online with the temperature controller to:

1/ View/monitor settings

2/ Make adjustments

3/ Save the configuration

Basic Setup for Using 900Builder Software

1. Turn the demo unit power off using the switch above the power cord connection.
2. Connect the 9-pin (female) RS-232 cable into the 9-pin (male) RS-232 socket on the demo case and your PC's COM port.
3. Turn the demo case power switch ON. The controller comes up performing its control function (**Operation** mode).

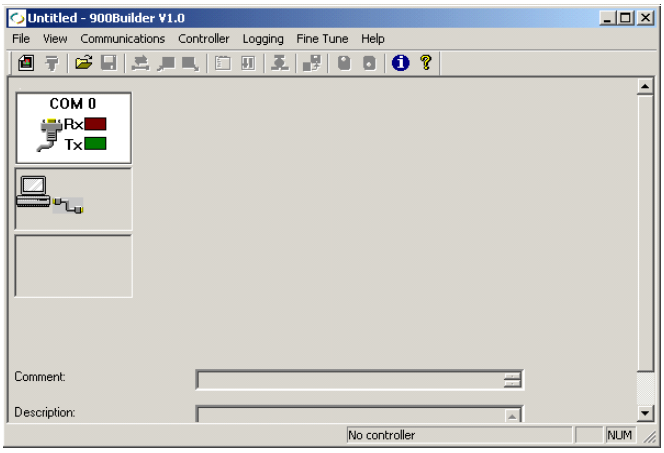
Lab Procedure

Running the 900Builder Software

Initiate Software Operation

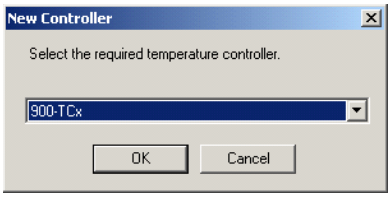
1. Open 900Builder software from the Windows Start Menu or the Desktop shortcut (if available).

The following screen will appear:

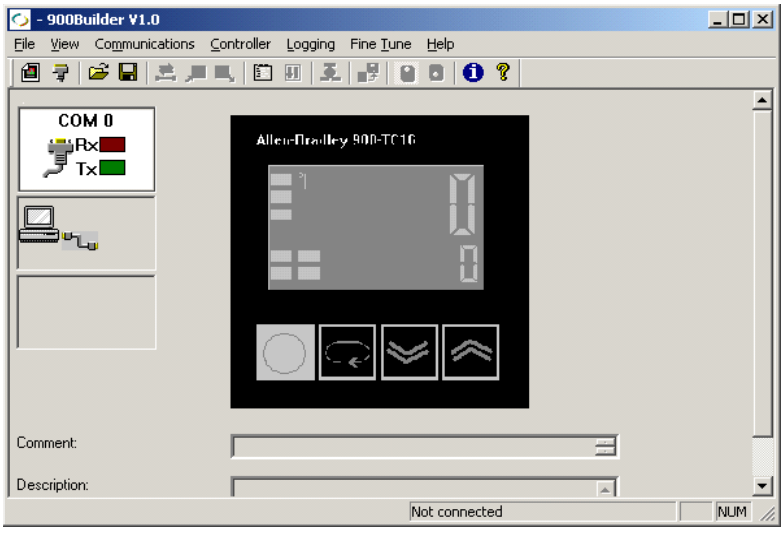


Begin a New Application

2. Click on the **File** pull-down and select **New** to begin a new parameter file (e.g. new job or application). The following screen will appear:



3. Select **OK** (Note: the 900-TCx is generic to all three Bulletin 900 controllers) and the following screen will appear:



Note: The preceding screen is the default controller template screen. The form of the template will change based on the controller you are using.

Important: Parameters can be configured off-line (without a controller connected) or on-line (with a controller connected).

On-Line Configuration — Initiate Communication Between the Controller and PC

Check/Verify Communications Settings

1. Next, click on the **Communications** pull-down menu and select **Settings**. Ensure the following settings are configured:

BAUD Rate: 9600

DATA Length: 7 bit

STOP Length: 2

Parity: EVEN

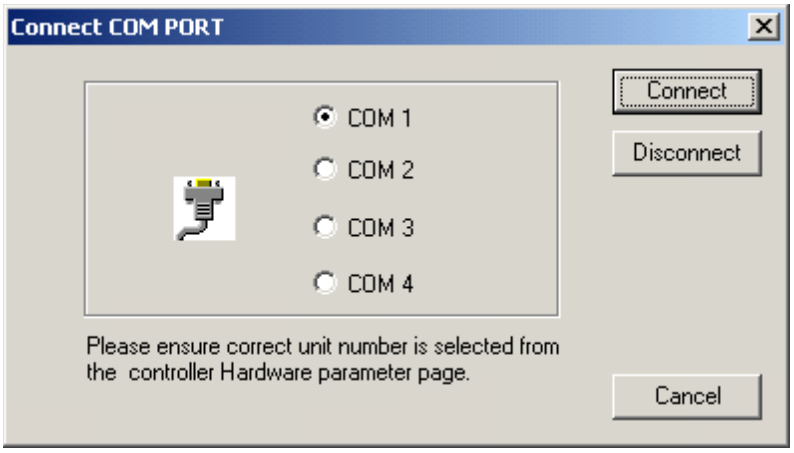
- After verifying the above settings, click **Ok**.

Initiate Communications

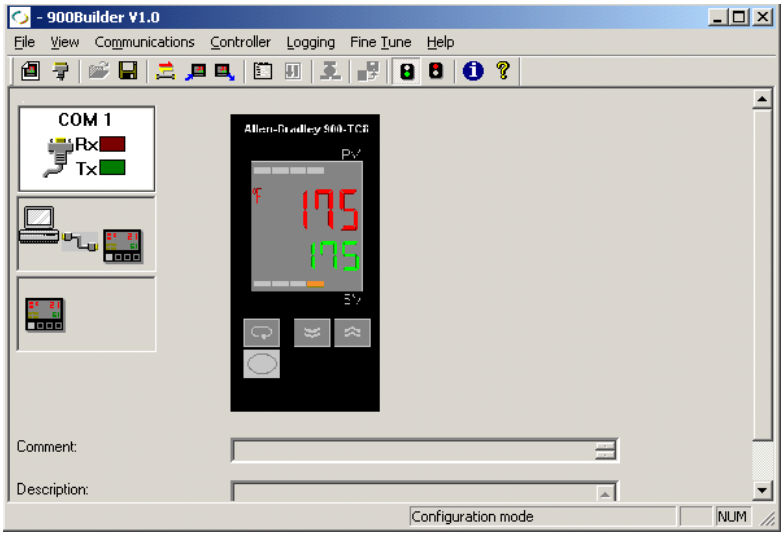
2. Next, return to the **Communications** pull-down menu and select **Connection**.

The selection box shown below will appear.

- Select the proper COM port for your PC (COM 1 typically), then select **Connect** to initiate communications



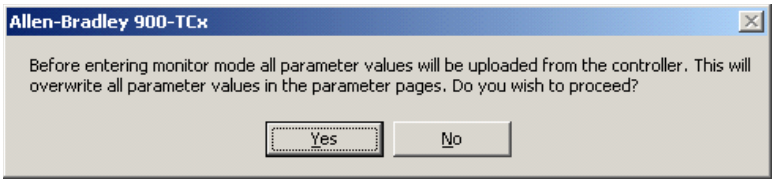
3. If communications are successful the following screen will appear:



Monitor Controller Operation

4. Next, use the **Controller** pull-down menu and select **Monitor Mode**.

The following screen will appear:



Note: Since you are starting a "New Application" there is nothing to overwrite in your PC file.

- Select **Yes**.

You are now actively monitoring the controller (after uploading), indicated by the flashing red/yellow arrows in the controller/PC sub-window on the left of the display.

Notice that the PC display and the 900-TC display show the same values and output indicators.

Change the Set Point from the PC

5. There are two ways to change the Set Point using the 900Builder software:

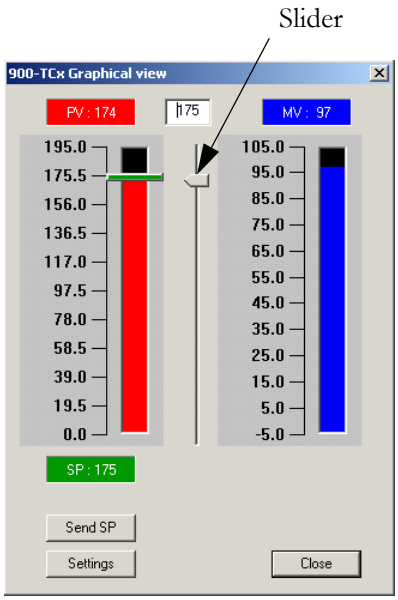
Using the Controller/Graphical View page and

Using the Parameter/Set Point page.

Controller/Graphical View

•Select the **Controller** pull-down, then **Graphical view**.

The following "Graphical view" screen will appear:



•Use the Set Point Adjustment **Slider**, then the **Send SP** button to change the set point to **110° F**.

What happens? _____ CONTROLLER CHANGES TO NEW VALUE

Note: You can also adjust the set point from this screen by clicking your cursor in the "desired set point" (white box) and typing the value. You must still use the "Send SP" button to make the adjustment valid to the controller.

•Adjust the set point to **120** by typing the value into the white box.

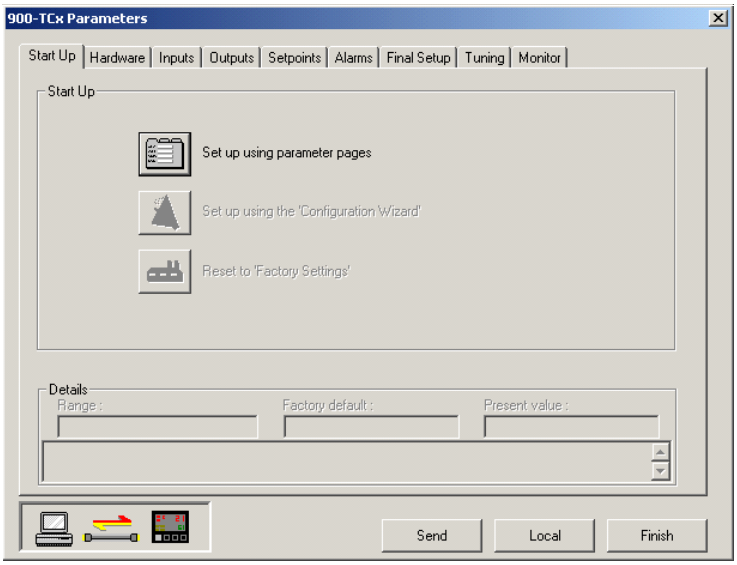
Observe/monitor the operation from the PC screen and controller faceplate. NOTE: CMW INDICATOR WILL MOMENTARILY ILLUMINATE

Exit Graphical View

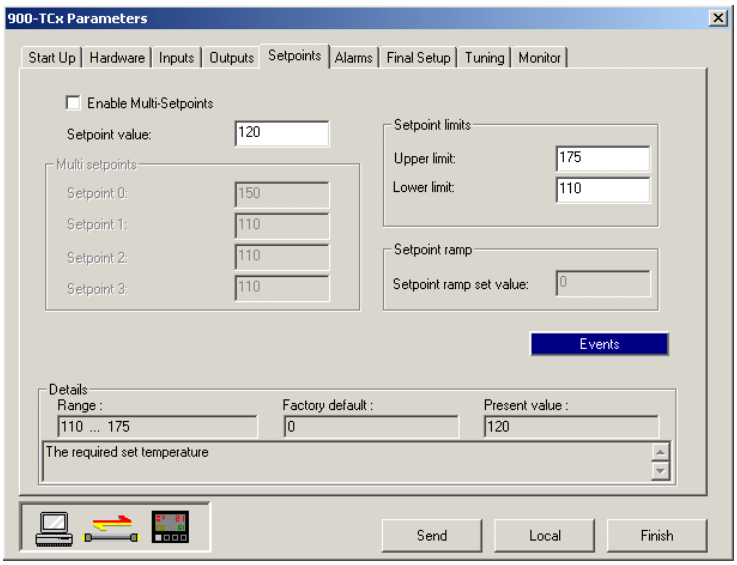
6. From the graphical view box, click on the **Close** button.

Controller/Parameter Pages

7. From the **Controller** pull-down, select **Parameter pages**. The following screen will appear:



•From the above screen select the **Setpoints** tab, and the following screen will appear: (Note: areas in white can be modified or are writable).



Adjust the Set Point

•In the above screen, click your cursor in the **Setpoint value** box and type in **140**. Use the **Send** button at the bottom of the screen to change the value in the controller (select **Yes**, then **OK**).

What happens on the PC Screen? CONTROLLER RESET DIALOG BOX

What happens on the controller? STILL RUNS / CMW INDICATOR "ON"

Note: Observe the information present in the "Details" section (lower part of screen) when you place the cursor in a writable area.

•Select **Finish** to close the Parameter pages screen when done.

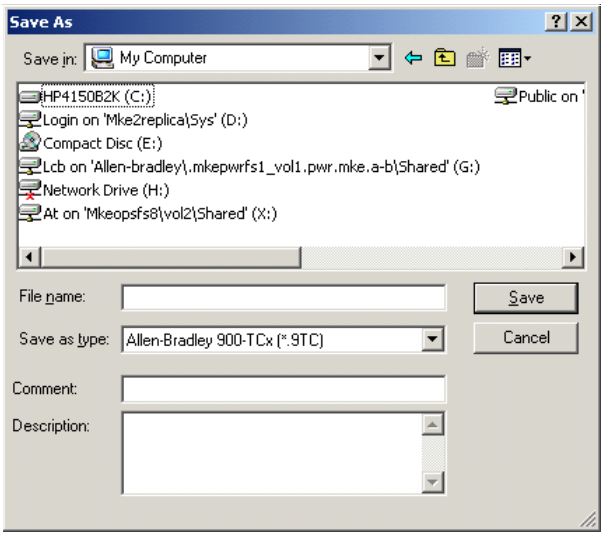
Save the Current Parameter Configuration to PC Disk Memory

Exit the Monitor mode

1. From the **Controller** pull-down, highlight and click on **Monitor mode** to deselect its operation. Note: to save the current parameters in PC memory to disk, monitor cannot be active.

Save Parameters to Disk

2. From the **File** pull-down select **Save...**. The following screen will appear:



- Select the disk and file location where you want to store the parameters
- Provide a unique name for the file
- Select **Save** and the file will be saved to the selected location.

3. To finish, exit the configuration software (File/Exit, "No" to not save), turn off power on the demo unit, then remove and store the serial cable.

Notes:

Keypad Protection

Introduction

The purpose of this lab is to show you how changing the operation of the key protection feature changes what can be done by the operator.

The controller has three levels of keypad protection in the **Operation/ Adjustment** groups to allow the customer to configure protection to meet their needs.

Lab Procedure

Enter the Protect function group/ level

1. With power ON, from the **Operation** group, press and hold both ⊙ and ↵ for a minimum of three seconds.

You are in the **Protect** function group when the Operation/Adjustment Protection parameter oAPt is present on the upper display.

Note: the controller is performing its control function while in the Protect function group.

Setup/change the level of protection

2. Press ↵ until the Configuration Change protection parameter CPt should is present on the upper display.

The lower display will indicate oFF.

•Press ⩓ so that on is displayed.

This selection will prevent the change of any parameter (including the set point) from the keypad.

Return to the Operation function

3. Press and hold both ⊙ and ↵ for a minimum of one second, until the PV and SV active display is present (you are back in the **Operation** group).

Attempt to change the set point

4. Use ⩓ ⩔ to attempt to change the set point.

Attempt to change other parameters

5. Depress ↵. Try to adjust/change other parameters with ⩓ ⩔.

Return to the Protect function group

6. Refer to step 1, and return the protection parameters to their default values:

oAPt = 0, LCPt=1 and UtPt = oFF.

Note: Configuring the LCPt parameter to zero would allow you to enter the Advanced Setting function group at a later point.

Return to the Operation function group

7. Press and hold both ⊙ and ↵ for a minimum of one second, until the PV and SV active display is present.

8. Turn off power to the demo unit to complete the lab.

Bonus Lab:

1. Refer to step 1, and change the protection parameters to the following values:

oAPt = 3, LCPt=2 and UtPt = oFF

2. Exit the **Protect** group.

3. What happens when any of the keys are depressed? NOTHING

4. Next, return the protection parameters to their default values:

oAPt = 0, LCPt=1 and UtPt = oFF.

Return to the Operation function group

5. Press and hold both ⊙ and ↵ for a minimum of one second, until the PV and SV active display is present.

6. Turn off power to the demo unit to complete the Bonus lab.

Temperature Controller Reset to Default/ Factory Settings

Introduction

The purpose of this lab is to show you how to reset the temperature controller back to its default/factory settings.

Lab Procedure

1. Cycle power to the unit.
2. Depress and hold ⊙ and ↵ for a minimum of three (3) seconds.

The PV value will start to flash. This will bring up the display:

3. Depress ↵ once.

The following screen appears:

4. Adjust the value to zero (0) with ⌄.
5. Depress and hold ⊙ and ↵ for a minimum of one (1) second so that the display returns to the **Operation** function group.
6. Depress and hold ⊙ for a minimum of three (3) seconds.

The PV value will start to flash, the controller will turn off, and the following screen will be displayed:

7. Depress ↵ (10 times) until  is displayed.

8. Enter the value of **-169** by using ⩔ (hold the arrow key to count quicker).

9. Wait for a couple of seconds and the controller display will now show:

10. Adjust the value to "ON" using ⩓.

11. Wait a couple of seconds and the screen will return to "OFF":

12. Depress and hold ○ for a minimum of one (1) second so that the screen returns to:

13. Depress and hold ○ until the unit resets (minimum of one second).

The unit has reset when all LEDs of the temperature controller face illuminate at the same time and the controller resumes operation.

What indications do you see that the controller has been reset to its default values?

_____

ALARM1, ALARM2, AND ALARM3 are ON again, C temperature scale vs. F (same as when first lab was begun)

14. To complete the lab, shut down power to the demo unit.

Parameter Operations List

Table A.1 Operation Function Group

Parameter Name	Symbol	Setting (Monitor) Value	Display	Default	Unit	Set Value
PV		Sensor input indication range				EU
PV/SP		SP lower limit to SP upper limit			0	EU
Multi-SP	ā-SP	0…3			0	None
Set Point during SP Ramp	SP-ā	SP lower limit to SP upper limit				EU
Heater Current Value Monitor	Ct	0.0…55.0				A
RUN/STOP	r-S	RUN/STOP	rUn, StoP	RUN	None	
Alarm Value 1	AL-1	–1999…+9999			0	EU
Upper-Limit Alarm Value 1	AL1H	–1999…+9999			0	EU
Lower-Limit Alarm Value 1	AL1L	–1999…+9999			0	EU
Alarm Value 3	AL-3	–1999…+9999			0	EU
Upper-Limit Alarm Value 3	AL3H	–1999…+9999			0	EU
Lower-Limit Alarm Value 3	AL3L	–1999…+9999			0	EU
MV Monitor (OUT1)	o	–5.0…+105.0 (standard)				%
		0.0…105.0 (heating and cooling)				%
MV Monitor (OUT2)	C-o	0.0…105.0				%

Table A.2 Adjustment Function Group

Parameter Name	Symbol	Setting (Monitor) Value	Display	Default	Unit	Set Value
AT Execute/Cancel	At	ON, OFF	on, oFF	oFF	None	
Communications Writing	CoMt	ON, OFF	on, oFF	oFF	None	
Heater Current Value Monitor	Ct	0.0…55.0			A	
Heater Burnout Detection	Hb	0.0…50.0		0	A	
Set Point 0	SP-0	SP lower limit to upper limit		0	EU	
Set Point 1	SP-1	SP lower limit to upper limit		0	EU	
Set Point 2	SP-2	SP lower limit to upper limit		0	EU	
Set Point 3	SP-3	SP lower limit to upper limit		0	EU	
Temperature Input Shift	InS	–199.9…+999.9		0.0	°C or °F	
Upper-Limit Temperature Input Shift Value	InSH	–199.9…+999.9		0.0	°C or °F	
Lower-Limit Temperature Input Shift Value	InSL	–199.9…+999.9		0.0	°C or °F	
Proportional Band	P	0.1…999.9		8.0	EU	

Table A.2 Adjustment Function Group (Continued)

Parameter Name	Symbol	Setting (Monitor) Value	Display	Default	Unit	Set Value
Integral Time	I	0…3999		233	Second	
Derivative Time	d	0…3999		40	Second	
Cooling Coefficient	C-SC	0.01…99.99		1.00	None	
Dead Band	C-db	–199.9…999.9		0.0	EU	
Manual Reset Value	oF-r	0.0…100.0		50.0	%	
Hysteresis (OUT1)	HYS	0.1…999.9		1.0	EU	
Hysteresis (OUT2)	CHYS	0.1…999.9		1.0	EU	

Table A.3 Initial Setting Function Group

Parameter Name	Symbol	Setting (Monitor) Value			Display	Default	Unit	Set Value
Input Type	In-t	Platinum resistance thermometer	0: Pt100 1: Pt100 2: Pt100	3: JPt100 4: JPt100			None	
		Thermocouple	0: K 1: K 2: J 3: J 4: T 17: T 5: E	6: L 7: U 8: N 18: T 9: R 10: S 11: B			None	
		Non-contact temperature sensor	12: K10…70° C 13: K60…120° C	14: K115…165° C 15: K160…260° C				
		Analog input	16: 0…50 mA					
Scaling Upper Limit	In-H	Scaling lower limit +1…9999					None	
Scaling Lower Limit	In-L	–1999 to scaling upper limit –1					None	
Decimal Point	dP	0,1					None	
Temperature Unit	d-U	° C, ° F			C, F	None		
Set Point Upper Limit	SL-H	SP lower limit +1 to input range lower value (temperature)					EU	
		SP lower limit +1 to scaling upper limit (analog)					EU	
Set Point Lower Limit	SL-L	Input range lower limit to SP upper limit –1 (temperature)					EU	
		Scaling lower limit to SP upper limit –1 (analog)					EU	
PID/ON/OFF	CntL	2-PID, ON/OFF			PId, onoF	ON/OFF		
Standard/Heating and Cooling	S-HC	Standard, heating and cooling			Stnd, H-C	Standard		
ST	St	ON, OFF			on, oFF	ON		

Table A.3 Initial Setting Function Group (Continued)

Parameter Name	Symbol	Setting (Monitor) Value	Display	Default	Unit	Set Value
Control Period (OUT1)	CP	1…99			Second	
Control Period (OUT2)	C-CP	1…99			Second	
Direct/Reverse Operation	orEu	Direct operation, reverse operation	or-d, or-r	Reverse operation		
Alarm 1 Type	ALt1	0: Alarm function OFF 1: Upper- and lower-limit (deviation range) 2: Upper-limit (deviation) 3: Lower-limit (deviation) 4: Upper- and lower-limit range (deviation range) 5: Upper- and lower-limit alarm with standby sequence (deviation range) 6: Upper-limit alarm with standby sequence (deviation) 7: Lower-limit alarm with standby sequence (deviation) 8: Upper-limit (absolute-value) 9: Lower-limit (absolute-value) 10: Upper-limit with standby sequence (absolute-value) 11: Lower-limit with standby sequence (absolute-value)			None	
Alarm 2 Type	ALt2	Same as alarm 1 type			None	
Alarm 3 Type	ALt3	Same as alarm 1 type		2	None	
Move to Advanced Setting Function Group	Amov	–1999…+9999			None	

Table A.4 Advanced Function Setting Function Group

Parameter Name	Symbol	Setting (Monitor) Value	Display	Default	Unit	Set Value
Parameter Initialize	InIt	ON, OFF	on, oFF	OFF	None	
Number of Multi-SP Uses	Eu-M	0…2		1	None	
Event Input Assignment 1	Eu-1	None, RUN/STOP	nonE, StoP	None	None	
Event Input Assignment 2	Eu-2	None, RUN/STOP	nonE, StoP	RUN/STOP	None	
Multi-SP Uses	MSPU	ON, OFF	on, oFF	OFF	None	
SP Ramp Set Value	SPrt	OFF, 1…9999	oFF, 1 to 9999	OFF	EU	
Standby Sequence Reset Method	rESt	Condition A, Condition B	A, b	Condition A	None	
Alarm 1 Open in Alarm	AL 1n	Open in alarm/Close in alarm	n-o, n-C	Close in alarm	None	
Alarm 1 Hysteresis	ALH1	0.1…999.9		0.2	EU	
Alarm 2 Open in Alarm	AL2n	Open in alarm/Close in alarm	n-o, n-C	Close in alarm	None	
Alarm 2 Hysteresis	ALH2	0.1…999.9		0.2	EU	
Alarm 3 Open in Alarm	AL3n	Open in alarm/Close in alarm	n-o, n-C	Close in alarm	None	

Table A.4 Advanced Function Setting Function Group (Continued)

Parameter Name	Symbol	Setting (Monitor) Value	Display	Default	Unit	Set Value
Alarm 3 Hysteresis	AL H3	0.1…999.9		0.2	EU	
HBA Used	HbU	ON, OFF	on, oFF	ON	None	
Heater Burnout Latch	HbL	ON, OFF	on, oFF	OFF	None	
Heater Burnout Hysteresis	HbH	0.1…50.0		0.1	A	
ST Stable Range	St-b	0.1…999.9		15.0	° C or ° F	
α(Alpha)	ALFA	0.00…1.00		0.65	None	
MV Upper Limit	oL-H	MV lower limit +0.1…105.0 (standard)		105.0	%	
		0.0…105.0 (heating and cooling)		105.0	%	
MV Lower Limit	oL-L	–5.0 to MV upper limit –0.1 (standard)		–5.0	%	
		–105.0…0.0 (heating and cooling)		–105.0	%	
Input Digital Filter	inF	0.1…999.9		0.0	Second	
Additional PV Display	PVAd	ON, OFF	on, oFF	OFF	None	
Manipulated Variable Display	o-dP	ON, OFF	on, oFF	OFF	None	
Automatic Return of Display Mode	rEt	OFF, 1…9999	oFF, 1 to 9999	OFF	Second	
Alarm 1 Latch	AILt	ON, OFF	on, oFF	OFF	None	
Alarm 2 Latch	A2Lt	ON, OFF	on, oFF	OFF	None	
Alarm 3 Latch	A3Lt	ON, OFF	on, oFF	OFF	None	
Protect Function Group Move Time	PrLt	1…30		3	Second	
Output Input Error	SErO	ON, OFF	on, oFF	OFF	None	
Cold Junction Compensation Method	CJC	ON, OFF	on, oFF	ON	None	
MB Command Logic Switching	rLrw	ON, OFF	on, oFF	OFF	None	
Move to Calibration Function Group	CnOu	–1999…+9999		0	None	

Table A.5 Protect Function Group

Parameter Name	Symbol	Setting (Monitor) Value	Display	Default	Unit	Set Value
Operation/Adjustment Protection	oAPt	0…3			0	None
Initial Setting/Communications Protection	iCPt	0…2			1	None
Setup Change Protection	wtPt	ON, OFF	on, oFF	OFF	None	

Table A.6 Communications Setting Function Group

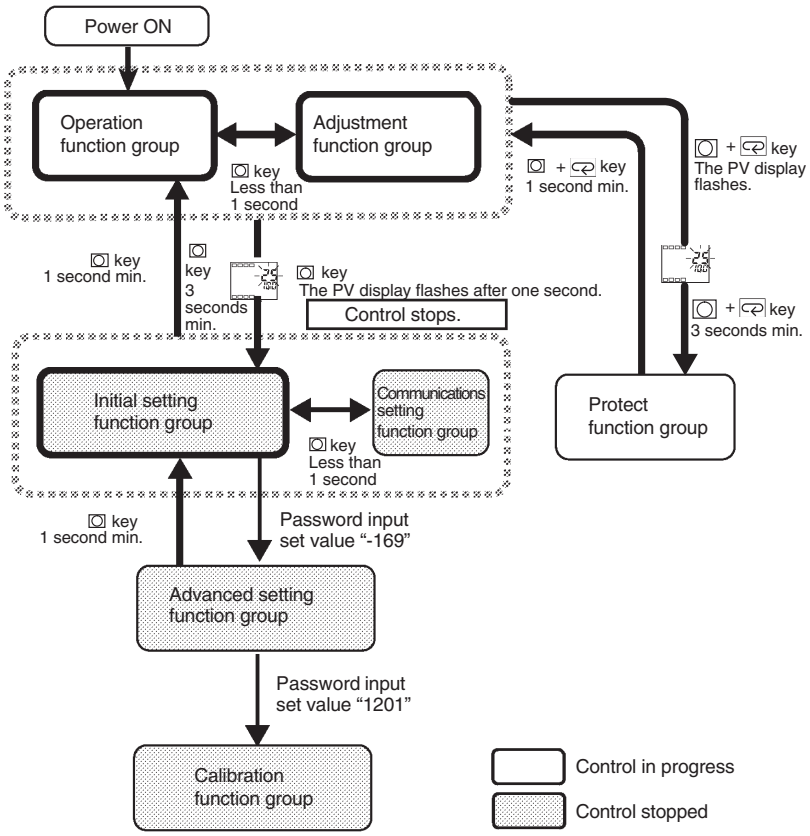
Parameter Name	Symbol	Setting (Monitor) Value	Display	Default	Unit	Set Value
Communication Unit No.	U-no	0…99		1	None	
Baud Rate	bPS	1.2, 2.4, 4.8, 9.6, 19.2	1.2, 2.4, 4.8, 9.6, 19.2	9.6	kbps	
Data Bit	LEn	7, 8		7	bit	
Stop Bit	Sbit	1, 2		2	bit	
Parity	Prty	None, Even, Odd	nonE, EuEn, odd	Even	None	

Setup Function Groups Diagram

The following diagram shows an overview of the setup function groups on the Bulletin 900-TC8. To move to the Advanced Setting function group and Calibration function group, you must enter passwords. Some parameters are not displayed depending on the Protect function group setting and the conditions of use.

Control stops when you move from the Operation function group to the Initial Setting function group.

Figure A.1



Parameter Flow

If you press the mode key at the last parameter in each function group, you return to the top parameter in that function group.

Figure A.2

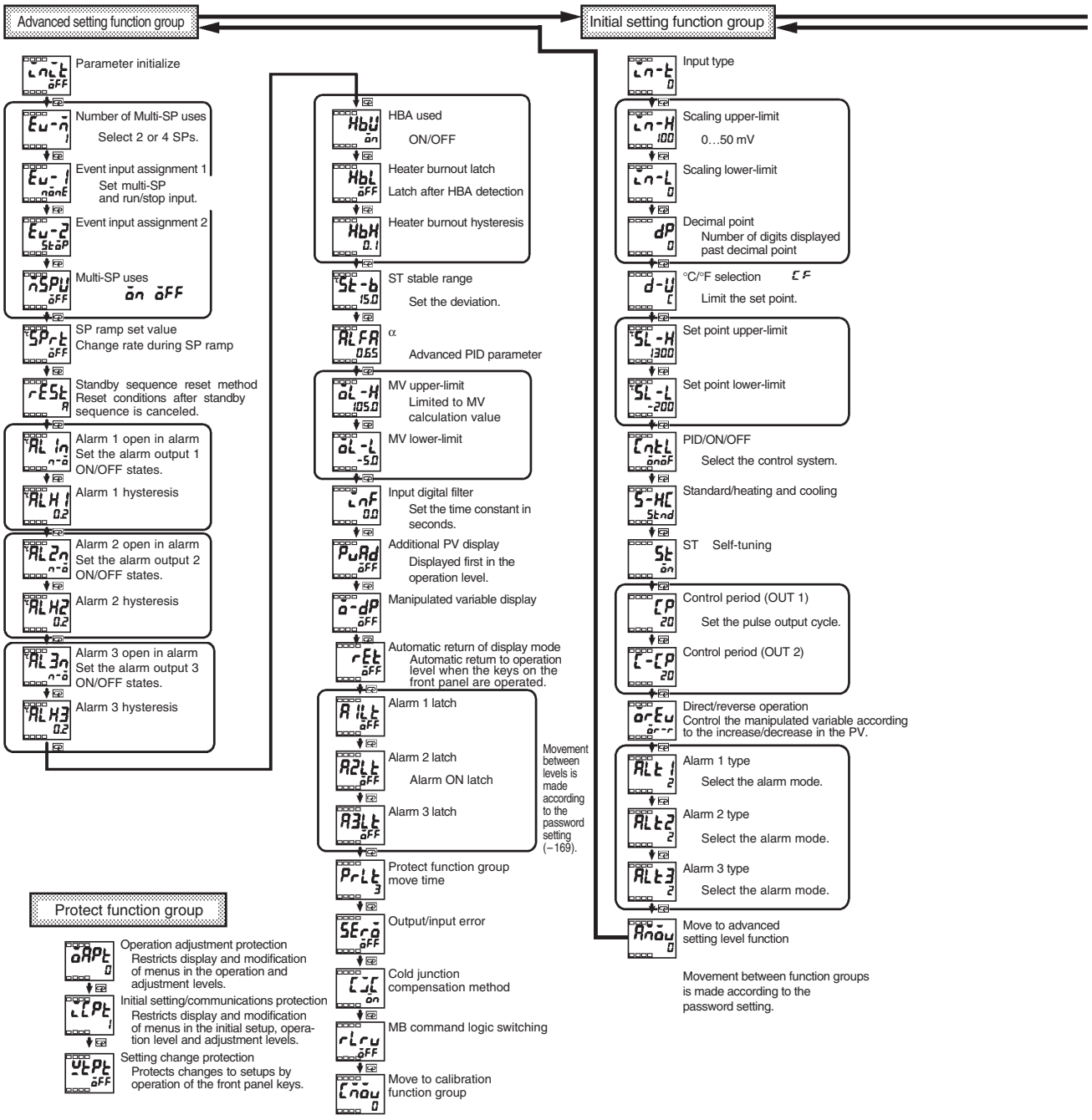
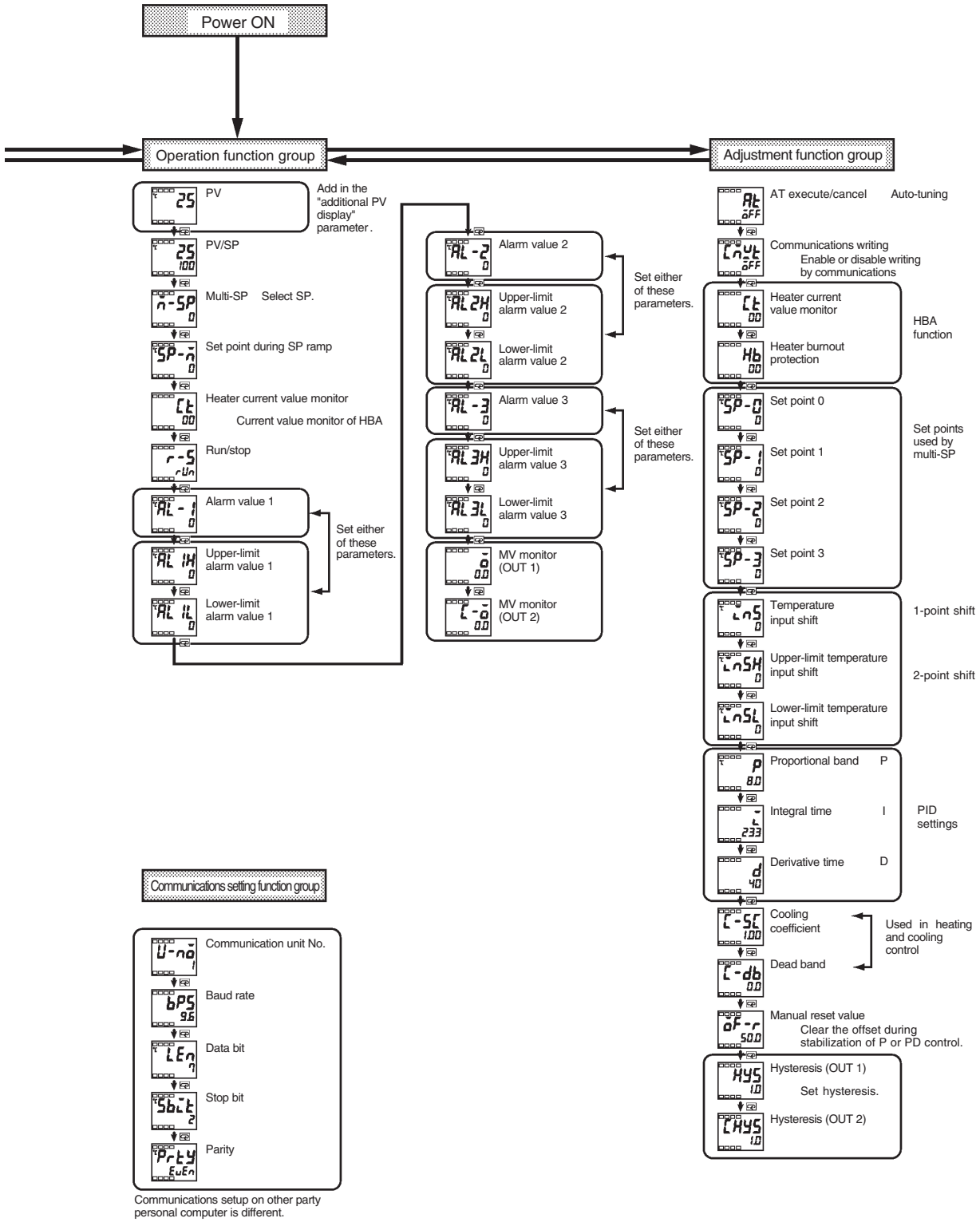


Figure A.2 (Continued)



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