P-Series Profile Communications Quick Guide

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Notes on Profile Entry

The P-Series controller can store 9 different profiles in its memory. These profiles are divided into three different lengths, i.e., the maximum number of segments (steps) that can be programmed for each profile. The profile steps are programmed beginning at segment 0 up to the maximum allowed:

Profiles *1* thru *4* =   16 steps maximum (segments 0 – 15)
Profiles *5* thru *7* =   32 steps maximum (segments 0 – 31)
Profiles *8* and *9* =   64 steps maximum (segments 0 – 63)

Prior to programming your profile in the P-Series controller, determine the length of the required profile in steps and make sure to choose a profile number in the controller that is capable of supporting the total number of steps your profile requires.

Profile Structure

Regardless of profile length, each profile programmed in the P-Series control has the same data structure, and is programmed in the same format. Each profile has five values that are common to the profile and are set once, prior to programming the individual steps. These are:

Register Address	Description	Range
86	Profile #	1-9
87	Holdback band	1-555°C (999°F)
88	Start setpoint value	SP low to SP high range
89	Units for ramp steps	0-3
90	Units for dwell (soak) steps	0-1

Once these values have been written (starting with the profile number to specify which profile you wish to program), you can then program each step of the profile, one at a time, by setting the segment (step) number in register 91, and then setting the step values to registers 92-100. You would then increment the step number to the next step, and then download the next step's data, and so on.

Register Address	Description	Range
91	Step number	0-63 (based on profile number)
92	Step type	0-3
93	Target setpoint for ramp step	SP low to SP high range
94	Time or ramp rate for ramp step	0-9999
95	PID and event selection for step	(4-bit binary number)
96	Holdback type	0-3
97	Time for soak step	0-9999
98	Jump step number	0-63
99	Number of cycles	1-9999
100	Final setpoint for end step	SP low to SP high range

The following step-by-step instructions discuss this process in detail, along with providing information on what each setting is for, and how it affects profile operation.

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Downloading a Profile

Step 1

To download a profile to the P-Series control, begin by setting register 86 to the desired profile number. The valid range is from 1 to 9. Once this value is set in the P-Series control, all current information for this profile stored in the controller's memory will be available in the profile programming registers. The profile number specified in register 86 also instructs the controller that any information you set to the profile programming registers is for the specified profile.

Step 2

Set the desired holdback band value in register 87. The holdback band is also known as a guaranteed soak value. If holdback is enabled on a profile step, this value will be used as the maximum allowed deviation from setpoint. If the temperature were to deviate from setpoint by more than this value, the profile would hold until the temperature falls back within the band from setpoint. The default value is 1 for one degree. If you intend to use guaranteed soak in your profile, set this to the desired value; otherwise, this step can be skipped.

Step 3

Set the desired profile starting setpoint to register 88. This is the setpoint that the controller will be set to immediately upon profile start. It eliminates the need for an initialization step in the profile.

Example: If the first step of the profile is to be a ramp from ambient to -40°C, segment 0 of the profile (step 1) can be programmed as a ramp step to -40°C. By setting the start set point to 25°C, the controller set point will go to 25°C immediately when the profile is started, and begin ramping down to -40°C .

Likewise, if the first step is to be a soak at ambient. Programming segment 0 (step 1) as a soak step with a starting setpoint of 25°C will cause the controller setpoint to go immediately to 25°C when the profile is started, and soak for the time period set in the first step of the profile.

NOTE: In order for the profile to use the starting setpoint of the profile, the P-Series must be configured to do so. This is done by setting register 80 to a value of 2, which sets the controller to use the profile starting setpoint. The controller can be set to use the current PV value as the starting setpoint (register 80 set to 0) or to use the current setpoint of the control when the profile is started (register 80 set to 1).

This is not something that is set with the profile. It is a controller configuration value that determines what setpoint the P-Series is to use when you start a profile. Once it is set for the desired action, it does not have to be set or changed again, and the controller will use the selected setpoint for each profile when it is started.

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Step 4

Set the desired units of time that you wish to use in the profile for ramp steps to register 89. The units of time can be set for hours and minutes or minutes and seconds. The units can also be set for ramp rate rather than time, i.e, ramp in degrees per hour or degrees per minute.

0 = hours and minutes
1 = minutes and seconds
2 = degrees per minute
3 = degrees per hour

Note that the setting here will be used for each ramp step of the profile. If hours and minutes are selected (maximum of 99 hours 59 minutes), all ramp step time entries will be in hours and minutes. If minutes and seconds are selected (maximum of 99 minutes 59 seconds), all ramp step time entries will be in minutes and seconds. If a ramp rate setting is selected, all ramp steps will have the ramp step entry made in either degrees per hour or degrees per minute.

Step 5

Set the desired units of time that you wish to use in the profile for dwell steps to register 90. The units of time can be set for hours and minutes or minutes and seconds.

0 = hours and minutes
1 = minutes and seconds

Note that the setting here will be used for each soak step of the profile. If hours and minutes are selected (maximum of 99 hours 59 minutes), all soak step time entries will be in hours and minutes. If minutes and seconds are selected (maximum of 99 minutes 59 seconds), all time entries will be in minutes and seconds for soak steps.

Step 6

Now that the base profile information for the profile has been set, you can begin downloading each step, one at a time by sequentially incrementing the segment number register (91) and then writing the step data registers (92-100) with the data for each step. Steps can be written using a single "write registers" command that sets all 9 registers at once. They can be set individually by using the "write register" command for each value separately, but it will take much longer to download a large profile.

Note that not all registers are used in each step because their use is based on the step type. However, regardless of the software platform you are using, the profile step data can be stored in a 2-dimensional array (9 columns by X rows where 'X' is the number of steps in the profile). By indexing through each row of the array, the same logic can be used to take the 9 data values for each step and write them to the profile step registers regardless of the length of the profile as follows:

  A. Begin by writing the segment number register (91) to 0 to begin at the first step of the profile.
  B. Write step 1 data to registers 92-100.
  C. Write the segment number register (91) to 1 for step 2.
  D. Write step 2 data to registers 92-100.

     ↳ Write step 'X' data to registers 92-100

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Once all steps have been written, the profile download is complete. The following definitions describe the settings for each of the 9 profile step elements.

Step Type (register 92) – this defines the type of step. It can be a ramp, soak, jump or end step. Note that the profile must have an end step. Therefore, the last step of you profile must be programmed as an end step.

0 = ramp step
1 = soak step
2 = jump step
3 = end step

Target Setpoint (register 93) – this is the setpoint that the profile will go to by the end of the step if the step type is a ramp. If it is not a ramp step type, the value of this register does not matter.

Ramp Time/Rate (register 94) – this defines the length of the ramp step or the rate at which the setpoint is to change based on the setting in register 89. If hours and minutes were the selected time, the first two digits would be the time in hours and the second two digits are the time in minutes. Thus, if the step was to be 2.5 hours long, you would set a value of 230 (2 hours, 30 minutes) to this register. If ramp rate units were selected, minutes for example, you would enter the rate of change for the setpoint. If you wanted the setpoint to ramp at a rate of 3 degrees per minute, you would set this for a value of 3. If the step is not a ramp step, than the value of this register does not matter.

PID/Event selection (register 95) - the value entered here is based on the configuration of the controller. Consult the documentation provided by your OEM regarding any events configured in your P-Series controller. This register allows you to turn event outputs (if equipped) on and off for each step, as well as select another set of PID parameters that may be fine tuned based on a particular operating condition.

This is a four bit binary number. That means that the decimal equivalent that is written to the controller is based on the value of each bit.

Bit0 = event 1
Bit1 = event 2
Bit2 = event 3
Bit3 = PID 2

Holdback type (register 96) – this sets the type of guaranteed soak. If enabled, this will put the profile in hold and stop the step timer until the temperature falls back within the band value as set in register 87.

0 = off
1 = deviation low (profile will pause only when the temperature drops below the setpoint band)
2 = deviation high (profile will pause only when the temperature rises above the setpoint band)
3 = band (profile will pause when the temperature rises above or falls below the setpoint band)

Soak Time (register 97) – this defines the length of a soak step based on the setting in register 90. If minutes and seconds were the selected time, the first two digits would be the time in minutes and the second two digits are the time in seconds. Thus, if the step was to be 10.5 minutes long, you would set a value of 1030 (10 minutes, 30 seconds) to this register. Note that there is no setpoint entry for a soak step. The setpoint remains at the current setpoint. If the step is not a soak step, then the value of this register does not matter.

Jump Step Number (register 98) – this is the step number that the profile will jump to if the step type is a jump step. When the jump step is executed, the profile will jump to this step of the profile and continue operation from there.

Note that the "End" step type can also perform a jump. This allows you to repeat the profile without having to enter a jump step. Thus, jump steps are only required if you need to repeat sections of the profile. If you want to repeat an entire profile, just set the jump step number and number of cycles in the end step.

Number of cycles (register 99) - this is the number of jump cycles to perform. Note that this is set for both the "jump" and "end" step types. The number of cycles can be set from 1 to 9999. The value can also be set to 10000 for an infinite number of cycles. If set on the "end" step of a profile for example, this would cause the profile to run and repeat indefinitely until stopped by the user. Note that a setting of 1 means that no jump is made. The first cycle is completed upon reaching the jump or end step. Thus, a setting of 1 means do the profile once, so if you want the profile to perform 10 cycles, you would set this value to 10.

Final Setpoint (register 100) – this sets the setpoint for the end of the profile. The value of this register needs to be set only for the "end" step. The value of the register does not matter for any other step type. Once the profile is completed, this value is set to the controller setpoint. It does not remain at the last setpoint set by a profile step. Thus, if you want the controller to remain operating at the last profile setpoint, this register must be set to match the last setpoint set by the profile.
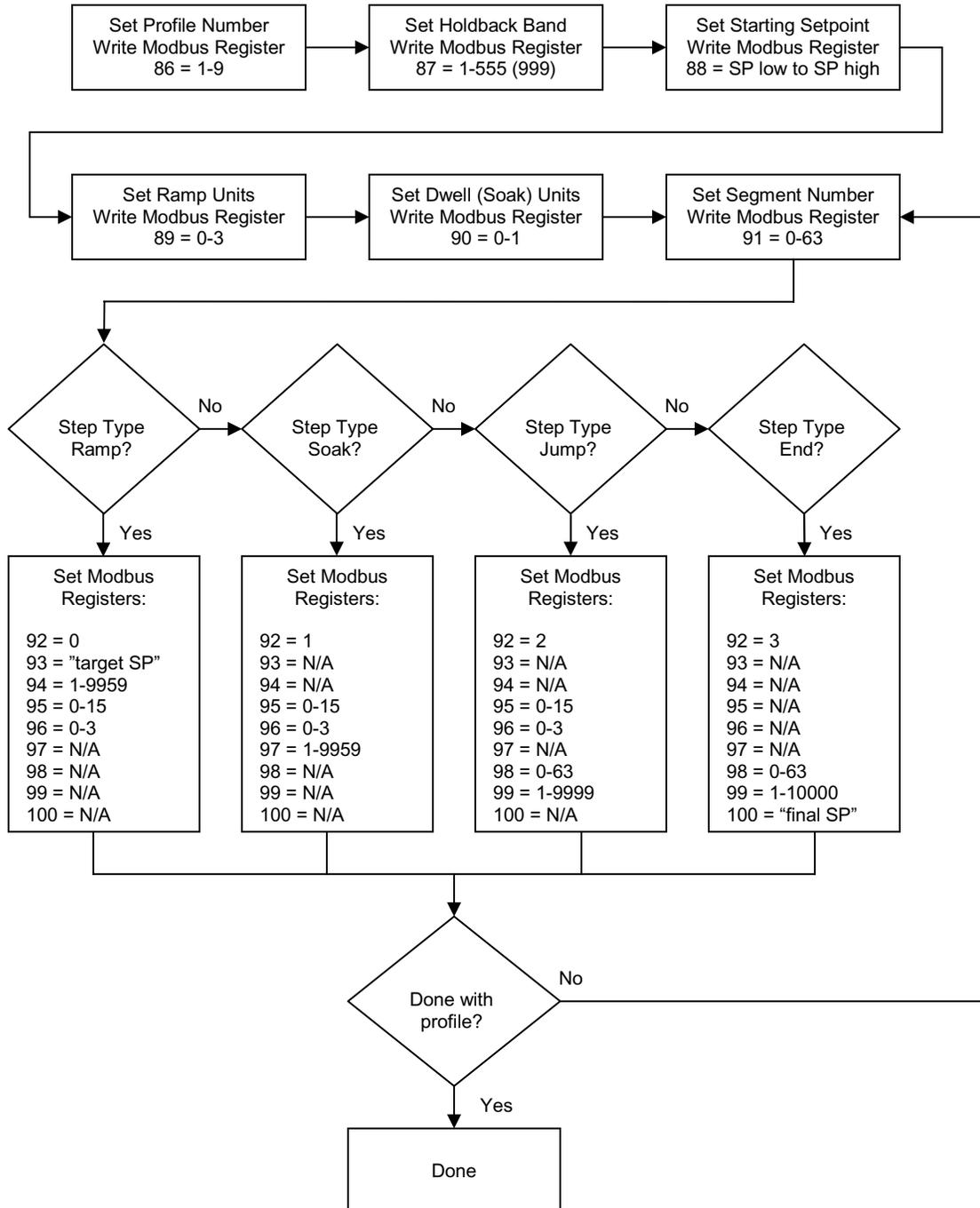
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Profile Programming Diagram

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┌─────────────────────┐   ┌─────────────────────┐   ┌─────────────────────┐
│ Set Profile Number  │→  │ Set Holdback Band   │→  │ Set Starting Setpoint│
│ Write Modbus Register│  │ Write Modbus Register│  │ Write Modbus Register│
│ 86 = 1-9            │   │ 87 = 1-555 (999)    │   │ 88 = SP low to SP high│
└─────────────────────┘   └─────────────────────┘   └─────────────────────┘

┌─────────────────────┐   ┌─────────────────────┐   ┌─────────────────────┐
│ Set Ramp Units      │→  │ Set Dwell (Soak) Units│→ │ Set Segment Number  │
│ Write Modbus Register│  │ Write Modbus Register│  │ Write Modbus Register│
│ 89 = 0-3           │   │ 90 = 0-1            │   │ 91 = 0-63          │
└─────────────────────┘   └─────────────────────┘   └─────────────────────┘
```

Step Type Ramp? — No → Step Type Soak? — No → Step Type Jump? — No → Step Type End?

Step Type Ramp? (Yes)	Step Type Soak? (Yes)	Step Type Jump? (Yes)	Step Type End? (Yes)
Set Modbus Registers:	**Set Modbus Registers:**	**Set Modbus Registers:**	**Set Modbus Registers:**
92 = 0	92 = 1	92 = 2	92 = 3
93 = "target SP"	93 = N/A	93 = N/A	93 = N/A
94 = 1-9959	94 = N/A	94 = N/A	94 = N/A
95 = 0-15	95 = 0-15	95 = 0-15	95 = N/A
96 = 0-3	96 = 0-3	96 = 0-3	96 = N/A
97 = N/A	97 = 1-9959	97 = N/A	97 = N/A
98 = N/A	98 = N/A	98 = 0-63	98 = 0-63
99 = N/A	99 = N/A	99 = 1-9999	99 = 1-10000
100 = N/A	100 = N/A	100 = N/A	100 = "final SP"

Done with profile? — No (loops back to Set Segment Number)

Yes →

Done

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Running a Profile

To start a profile, you must first tell the P-Series which profile you wish to start, and what step it is to start on. This is done by setting the profile number and start segment to register 1. This is a three digit decimal number where first digit of the number is the profile number, and the second two digits are the start segment.

Range low = 100   (profile 1, start segment 0)
Range high = 963   (profile 9, start segment 63)

Once the profile number and start segment have been set, you must set the P-Series controller into "profile run" mode. This is done by setting register 11 to 0.

0 = profile run mode (puts current profile in run)
1 = profile hold mode (puts current profile in hold)
2 = static mode (single setpoint operation mode)
3 = autotune PID set 1
4 = autotune PID set 2
5 = manual mode (no PID control, outputs set to fixed output)
6= off mode (no control action, all control outputs off)

Example: You want to start profile 2 at step 2 (segment 1). To start the profile, begin by writing a value of 201 to register 1. This specifies profile 2, start segment 1. Once complete, write a value of 0 to register 11. This tells the P-Series to begin running the specified profile.

To place the profile in hold, write a value of 1 to register 11. This will pause the profile at its current step. Writing a value of 0 to register 11 will then resume the profile.

To stop the profile, write a value of 2 to register 11. This places the controller back into static operation. Static operation is the normal, single setpoint mode of operation where the P-Series will control to the manually entered setpoint. You can also set a value of 6 to register 11 if desired; however, this will turn off all outputs on the P-Series controller and no control action will take place.

Consult your OEM regarding the configuration of your equipment and whether or not the "off mode" is acceptable for use. If the equipment does not power off when the control outputs turn off, damage to equipment and/or a run away condition may occur.