SIEMENS

APPLICATION DATA

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Procidia Control Solutions
Program Sequencer and Recipe Management

Batch process control systems require extensive logic and sequence capabilities, in addition to continuous functions for the control of flows, temperatures, levels, etc. The Siemens 353 controller includes a PRogram SEQuencer (PRSEQ) function block to sequence the events in a batch application. In addition, the Siemens i|ware PC™ HMI[1] software includes a Recipe Manager that is used by an operator to load user-defined recipes into the 353 from the i|ware™ Program Sequencer detail screen. Figure 1 shows a typical batch control application.

This publication provides an overview of recipe creation and management. The steps performed to create the recipe and download it to a 353 are listed below. Each step is discussed in this and referenced publications.

1. Create a batch strategy for the PRSEQ function block in the 353 controller. Identify each piece of involved process hardware (e.g. heaters, motors, pumps, stirrers, valves) and then determine the status (e.g. on/off state) of each item for each step in the batch process. Identify critical analog

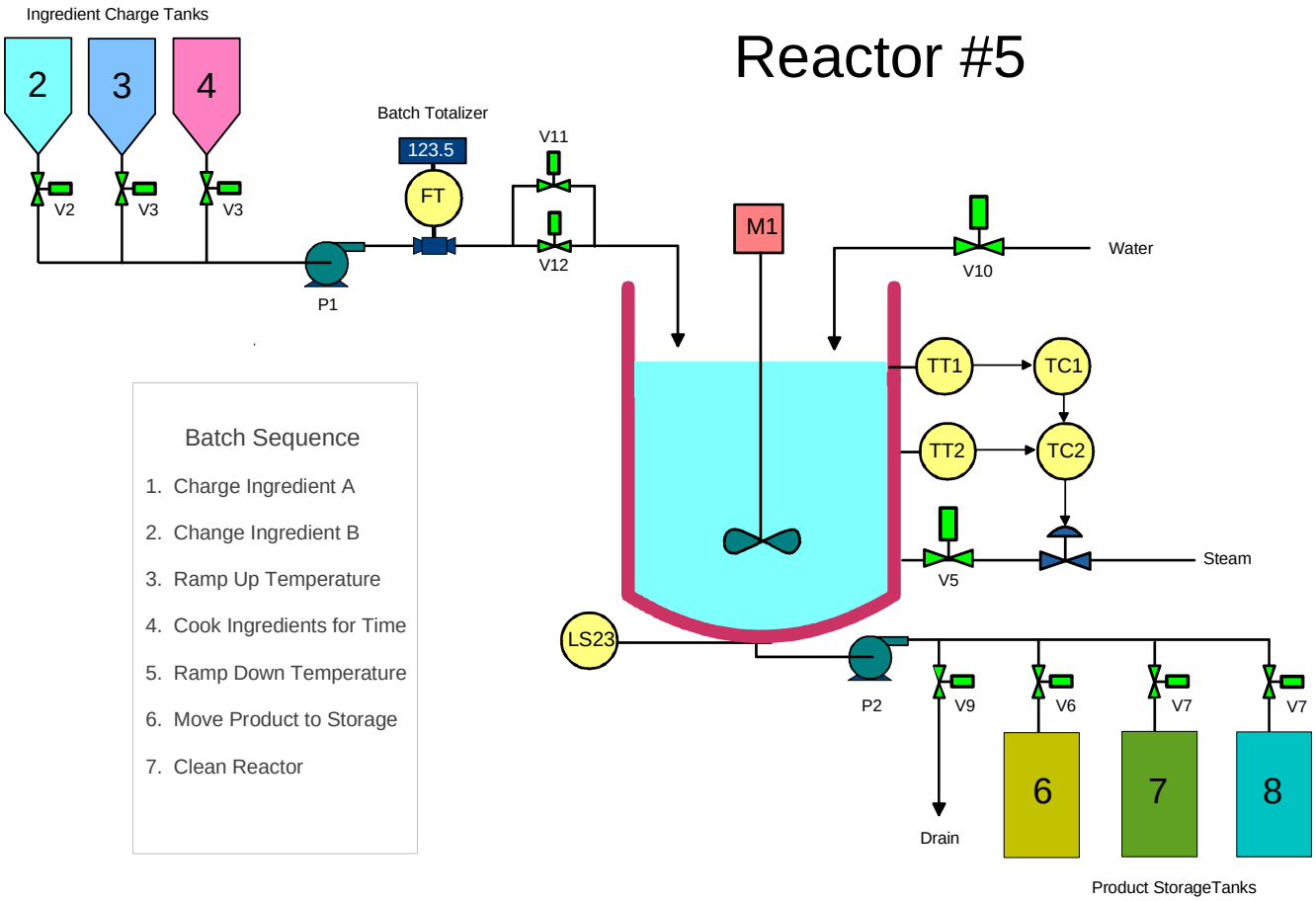


Figure 1 Batch Process Example

[1] HMI – Human Machine Interface

signal end points where a state transition must occur. Also, identify process steps that are time critical. Record this information on the worksheet supplied on the i|ware product CD.
2. Using the Siemens i|config™ configuration software, create a batch configuration for the 353 controller that includes the PRSEQ function block. Enter data from the worksheet in step1 into the PRSEQ function block. Download the configuration to the 353.
3. In Windows® Notepad, create a text file of parameters that change with each recipe and save the file to the i|ware folder.
4. When needed, download the recipe from i|ware to the 353.

The process shown in Figure 1 will be used to demonstrate the steps needed to create recipes to be used by the Recipe Manager in i|ware. The detailed functions of the PRSEQ function block are defined in the 353 User Manual, UM353-1. Read this function block information before continuing, so as to have an understanding of function block parameters and operation.

BATCH SEQUENCE DESIGN

For a given recipe, document the batch strategy using the supplied "Prseq.xls" worksheet. The data from the completed worksheet is later used to configure the Program Sequencer (PRSEQ) function block. Using the completed worksheet as a template, additional worksheets can be created to document additional recipes.

The "Prseq.xls" worksheet is a custom Microsoft Excel® spreadsheet found on the i|ware product CD. This worksheet can also be downloaded from the Siemens website; see Application Support for a link. The worksheet includes the full range of Steps and Groups available in the PRSEQ function block. However, in most applications only a small portion will be needed. Figure 2 shows a portion of the worksheet created for the application in Figure 1. This worksheet was saved as 'Recipe1' and was used to create the base configuration of the PRESQ function block.

Thirty Steps and two Groups (only Group 0 is shown in Figure 2) will be configured for this application. Each group has 16 inputs and 16 outputs associated with it. The description of each step is entered along the top in each column and the description of an input or output is entered to the left in each row. Although our application requires only 16 steps, 30 steps were selected to provide room in case additions are needed.

Input masks are used to define the discrete logic that will move the sequencer to the next step. When all discrete inputs that match the input mask are True (1)[2], the sequencer will advance to the next step. OR logic conditions can be created by inserting an OR function block before the input. In this example, the sequencer will move from step 1 to step 2 when the 'Start Sequence' pushbutton (PB1) is pressed. It will move to step 3 when 'Batch Preset – Full Charge (P1)' is reached.

Output masks are used to define which outputs are turned on during each step. In this example, 'Charge Tank #2' valve (V2) and 'Full Charge Valve (V11)' will open and 'Charge Pump (P1)' will turn on in Step 2.

The PRSEQ block will move to a new step when inputs match the configured mask or when a configured time has expired. On timed only steps, an unused input should be configured to require a logic "1" so that the step will move based only on the time. In this example steps 4, 7-10, 12, 14, and 16 are timed steps.

The worksheet will calculate the hexadecimal mask required for entry in the PRSEQ configuration for each step within a Group. This requires that the Excel Analysis ToolPak has been installed as part of the Add-Ins from the Tools menu. Refer to Excel Help for details on installing the ToolPak. All cells in the worksheet that have been marked with a yellow background are parameter settings that will vary with each recipe for this application. In Figure 2, the Time and Analog End Point values in steps 8 and 9 and the Group 0 output masks for steps 11 and 12 will change with each recipe. Figure 2 illustrates Recipe 1 data. Recipe 2 may have different settings for these parameters.

When the worksheet is completed, save it as new name (e.g. Recipe1). If needed, the Recipe 1 worksheet can now be saved as a new name (e.g. Recipe2) and used as a template for a second recipe.

CONTROLLER CONFIGURATION

Refer to the 353 User Manual and create a batch configuration that includes the PRSEQ function block. Include other batch related blocks, such as the Batch Totalizer, as needed. Also include all needed function blocks for continuous functions.

[2] A mask value of "0" is a 'don't care' condition.

I/O <reference>	Sequence of Events	Reset Position	Ingredient A - Full Charge	Ingredient A - Dribble Charge	Reset Batch - BATOT	Ingredient B - Full Charge	Ingredient B - Dribble Charge	Reset Batch - BATOT	Ramp Up Reactor Temp.	Cook Reaction	Ramp Down Reactor Temp.	Pump Out Product	Pump Out Finish	Fill Reactor for Washing	Clean Reactor	Drain Reactor	Finish Drain Sequence	Hold for Reset of Sequence	Hold for Reset of Sequence	Hold for Reset of Sequence	Hold for Reset of Sequence	Hold for Reset of Sequence	Hold for Reset of Sequence	Hold for Reset of Sequence	Hold for Reset of Sequence	Hold for Reset of Sequence	Hold for Reset of Sequence	Hold for Reset of Sequence	Hold for Reset of Sequence	Hold for Reset of Sequence	Hold for Reset of Sequence
Step Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Analog End Point		100	100	100	100	100	100	100	200	200	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Time Period (min)					0.01			0.01	0.4	1.4	0.2		0.03		0.2		0.03															
Start Sequence (PB1)	00	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Batch Preset - Full Charge (P1)	01	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Batch Preset - Dribble Charge (P2)	02	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reactor High Level (LS23)	03	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Empty Reactor (LS23)	04	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Timed Step - Lockout Discrete Action	0F	0	0	0	1	0	0	1	1	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Group 0 Input Masks		0001	0002	0004	8000	0002	0004	8000	8000	8000	8000	0010	8000	0008	8000	0010	8000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
Charge Tank #2 (V2)	00	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Charge Tank #3 (V3)	01	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Charge Tank #4 (V4)	02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Product Tank #6 (V6)	03	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Product Tank #7 (V7)	04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Product Tank #8 (V8)	05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drain Valve (V9)	06	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temperature Shutoff Valve (V5)	07	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clean Fill Valve (V10)	08	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Full Charge Valve (V11)	09	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dribble Charge Valve (V12)	0A	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agitator Motor (M1)	0B	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Charge Pump (P1)	0C	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Discharge Pump (P2)	0D	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0E	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Group 0 Output Masks		0000	1201	1401	1000	1202	1402	0000	0060	0860	0860	2008	2008	4100	4800	2040	2040	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000

Figure 2 PRSEQ Batch Sequence Steps (Worksheet)

PRSEQ CONFIGURATION

With the 353 batch configuration created, the PRSEQ function block can be configured.

Configuring the PRSEQ function block in the newly developed configuration involves transferring the data from the completed worksheet to the PRSEQ function block. Figure 3 shows the function block as described in the 353 User Manual. The first fifteen parameters, from Recipes to ESN, are fixed while the parameters from INPUT nn to the end are variable based on the settings of the STEPS and GROUPS parameters. The RECIPES parameter should be set to 1; this parameter is used only for small recipes that will be entered by the operator from the 353 faceplate and is discussed in more detail in the user manual.

Enter the number of STEPS and GROUPS in the PRSEQ function block. See Figure 4 for the i|config Item Attributes dialog box.

As the STEPS and GROUPS entries are made, the configuration dialog box will automatically update to include parameters for all inputs, steps, and groups. For this example, input parameters can be configured to connect to the discrete inputs that have been defined. For example, INPUT 01 will be connected to the T1 (Preset 1 trip point) output of the batch totalizer (BATOT) function block. Output parameters will now be available for other block inter-connections. For example, the input to the discrete output block that will operate the Product Tank #6 valve (V6) is connected to the PRSEQ.03 output.

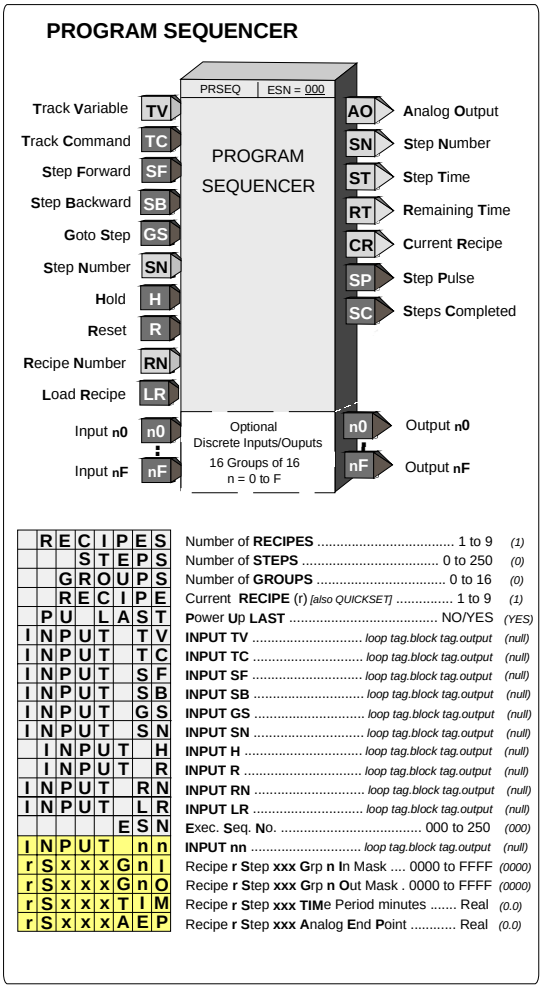


Figure 3 PRSEQ Function Block

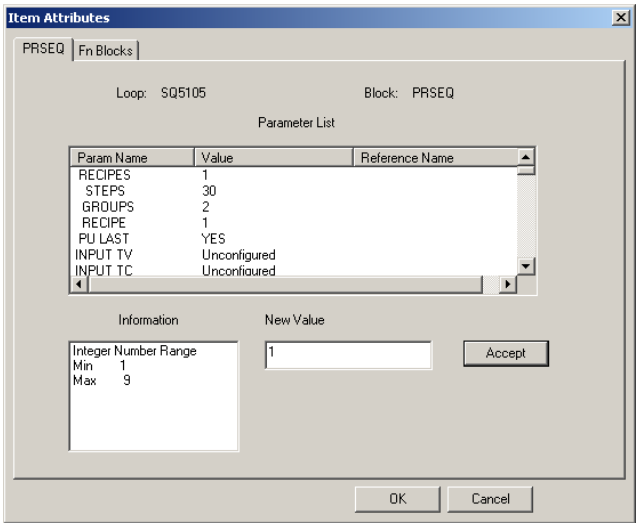


Figure 4 PRSEQ Configuration Entries, Steps & Groups (i|config)

Step times and analog end point values are entered using the available parameters discussed in the next section. For example, the step 8 analog end point of 200 is entered in parameter 1S008AEP and a step 8 time of 0.4 minutes is entered in parameter 1S008TIM. The time settings of steps that are not timed should be entered as 0 (default); this indicates that the step is not timed.

Group masks are configured using hexadecimal values from the worksheet. For example, the Group 0 Output Mask of 1202 for step 5 is entered in parameter 1S005G0O.

The application demo described in this document is also provided on the i|ware product CD in the ProcidiaDemo file folder.

RECIPE FILES

Certain Program Sequencer parameters, identified later in this section, can be changed by writing to Modbus memory locations in the 353 controller. The i|ware Recipe Manager uses this ability to change configuration (i.e. recipe) parameters within the Program Sequencer. To change the parameters in a recipe, a “recipe file” must be created.

Recipe files are created using Notepad.[3] Remember that the cells that were marked with a yellow background vary with each recipe. A recipe file for a basic configuration that will be called Recipe 1 is shown in Figure 5. Each new recipe can be made using Recipe 1.txt as a template. A recipe parameter consists of three lines. The first is a message that will be displayed in the Recipe Manager (e.g. Set COOK Time). The second line is the value to be downloaded (e.g. 1.40). The third line is the parameter ID (e.g. S009TIM).

Recipes files are stored in subfolders in the Recipe folder of i|ware using the Station Tag name and the Loop Tag name of the loop that contains the PRSEQ function block as the folder names. See Figure 6 for an example of the folder structure.

A list of the parameters that can be changed using recipe files and the Recipe Manager is provided at the back of this publication under “Configuration Data Sequencer Loop.” These parameters are also listed in the “Configuration” folder of the OPC server.

[3] A document editor (e.g. Microsoft Word) may not be used since the file will not be compatible with the Recipe Manager.

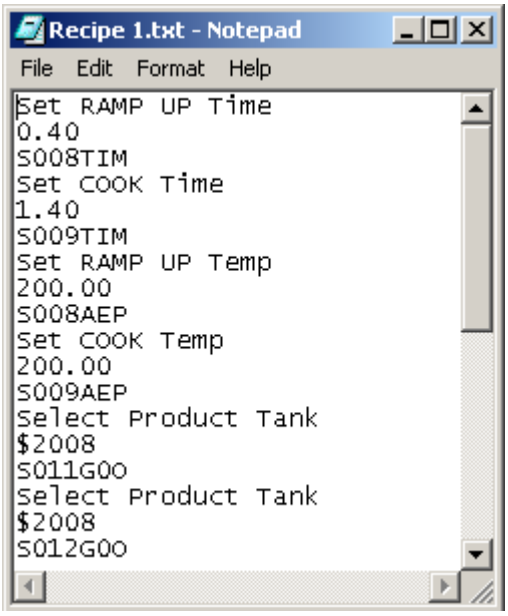


Figure 5 Recipe File

DOWNLOADING A RECIPE

A recipe is downloaded to the 353 from the i|ware Program Sequencer detail screen. Figure 7 shows the detail screen with the Procidia Recipe Manger. When a recipe button is pressed on the detail screen, the Recipe Manager will pop up, listing the recipe selected. Pressing the Download Recipe button on the Recipe Manger will download the parameter values to the controller. Pressing the Verify Download will upload the same parameters from the controller and verify that they agree with the recipe file.

APPLICATION SUPPORT

User manuals for controllers and transmitters, addresses of Siemens sales representatives, and more application data sheets can be found at www.usa.siemens.com/ia. To reach the process controller page, click **Process Instrumentation** and then **Process Controllers and Recorders**. To select the type of assistance desired, click **Support** (in the right-hand column). See AD353-138 for a list of Application Data sheets.

The batch concepts in this publication can be created in any of the following controllers:

- Model 353 Process Automation Controller
- Model 353R Rack Mount Process Automation Controller*
- i|pac™ Internet Control System*
- Model 352*Plus*™ Single-Loop Digital Controller*

* Discontinued model

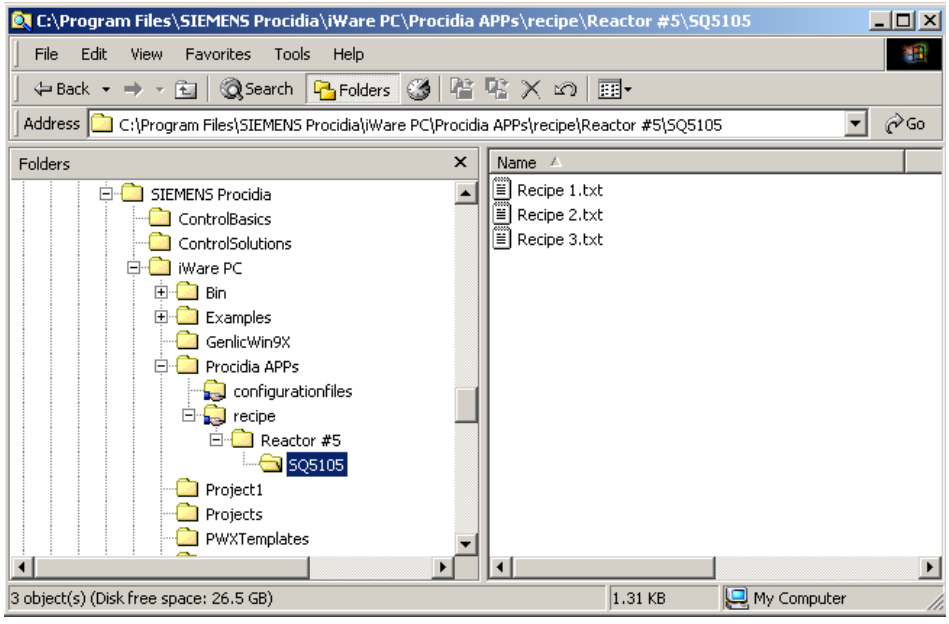


Figure 6 Recipe Folder Structure and File Location (Windows Explorer)

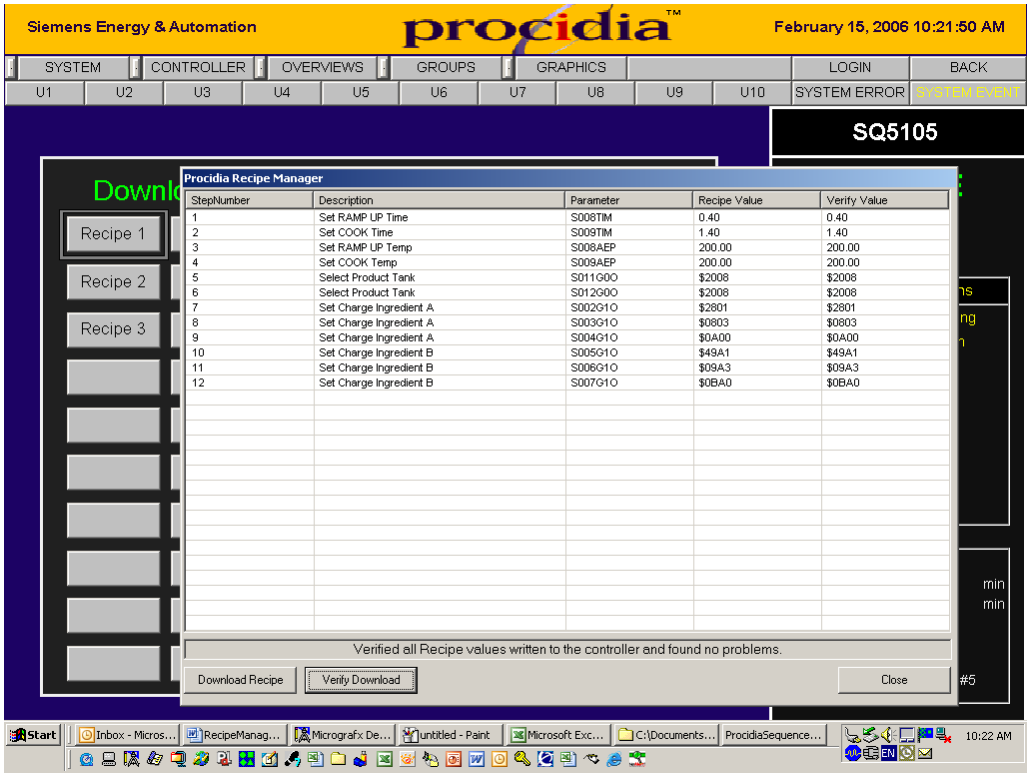


Figure 7 Download a Recipe (i|ware)

Configuration Data Sequencer Loop

Sequencer (MASK Configurations)

Code	R/W	Description	Range	Register (MB)	C/P (LIL)
S001G0I	R/W	Step 1 Group 0 Input Mask	$0000-$FFFF	410001	1/154
S001G0O	R/W	Step 1 Group 0 Output Mask	$0000-$FFFF	410002	1/170
S001G1I	R/W	Step 1 Group 1 Input Mask	$0000-$FFFF	410003	1/155
S001G1O	R/W	Step 1 Group 1 Output Mask	$0000-$FFFF	410004	1/171
S001G2I	R/W	Step 1 Group 2 Input Mask	$0000-$FFFF	410005	1/156
S001G2O	R/W	Step 1 Group 2 Output Mask	$0000-$FFFF	410006	1/172
S001G3I	R/W	Step 1 Group 3 Input Mask	$0000-$FFFF	410007	1/157
S001G3O	R/W	Step 1 Group 3 Output Mask	$0000-$FFFF	410008	1/173
.....					
S250GEI	R/W	Step 250 Group E Input Mask	$0000-$FFFF	417997	250/168
S250GEO	R/W	Step 250 Group E Output Mask	$0000-$FFFF	417998	250/184
S250GFI	R/W	Step 250 Group F Input Mask	$0000-$FFFF	417999	250/169
S250GFO	R/W	Step 250 Group F Output Mask	$0000-$FFFF	418000	250/185

Sequencer Time & Analog Configurations

Code	R/W	Description	Range	Register (MB)	C/P (LIL)
S001TIM	R/W	Step 1 Time Period (min)	Real	420001	1/150-151
S001AEP	R/W	Step 1 Analog End Point	Real	420003	2/150-151
S002AEP	R/W	Step 2 Analog End Point	Real	420007	2/152-153
S003TIM	R/W	Step 3 Time Period (min)	Real	420009	3/150-151
S003AEP	R/W	Step 3 Analog End Point	Real	420011	3/152-153
S004TIM	R/W	Step 4 Time Period (min)	Real	420013	4/150-151
S004AEP	R/W	Step 4 Analog End Point	Real	420015	4/152-153
.....					
S246TIM	R/W	Step 246 Time Period (min)	Real	420981	246/150-151
S246AEP	R/W	Step 246 Analog End Point	Real	420983	246/152-153
S247TIM	R/W	Step 247 Time Period (min)	Real	420985	247/150-151
S247AEP	R/W	Step 247 Analog End Point	Real	420987	247/152-153
S248TIM	R/W	Step 248 Time Period (min)	Real	420989	248/150-151
S2488AEP	R/W	Step24 8 Analog End Point	Real	420991	248/152-153
S249TIM	R/W	Step 249 Time Period (min)	Real	420993	249/150-151
S249AEP	R/W	Step 249 Analog End Point	Real	420995	249/152-153
S250TIM	R/W	Step 250 Time Period (min)	Real	420997	250/150-151
S250AEP	R/W	Step 250 Analog End Point	Real	420999	250/152-153

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