S7-200 EM 253 INTEGRATION WHITE PAPER

BY

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1. Introduction

The purpose of this document is to help in the integration of an EM 253 Position module in the S7-200 platform with a Stepper Motor Drive or Servo Drive. This position module generates the pulse signals utilized for open loop control of the position and speed for stepper motors or servo motors. This document will cover hardware required, required software, wiring, software configuration of the EM 253 and some software programming for the EM 253.

2. Required Software

Step 7 Micro/Win Version 3.2 or higher is required to integrate the EM 253 module with a drive. The latest version of the Step 7 Micro/Win is Version 4.0 Service Pack 6 as of October 31, 2008.

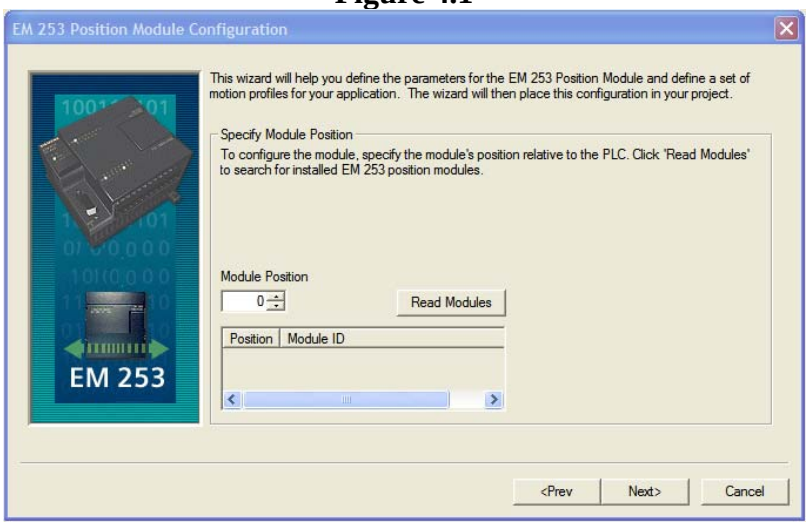
3. Installation

When wiring and installing the EM 253, please refer to the S7-200 Programmable Controller System Manual. For supply power to the EM 253 Position module, connect 24VDC to the L+ terminal of the EM 253 and Common to the M terminal of the EM 253. The power can be taken from the S7-200 CPU or from a separate 24VDC power supply. When wiring your drive to the EM 253 Position Module, please refer to the drive manufacturer's manual or guide.

4. Step 7 Micro/Win EM253 Wizard

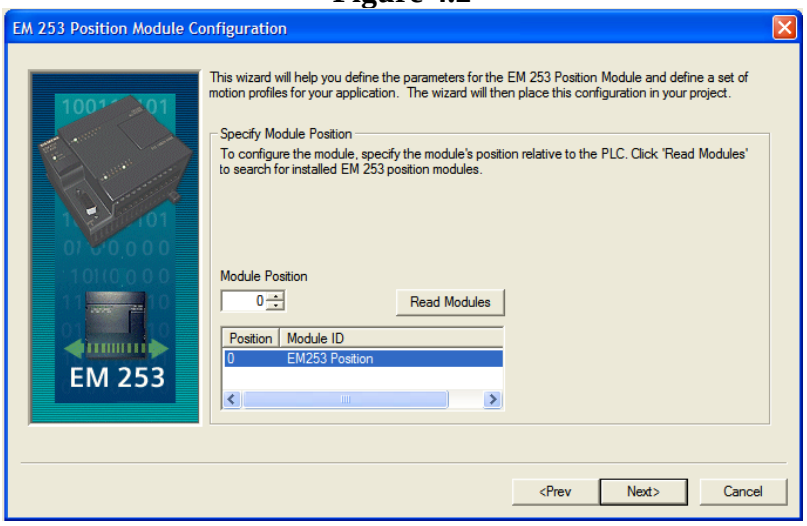
If you have not already, create a new project in the Step 7 Micro/Win Software with the CPU you intend on using. Next expand the Wizards folder in the project hierarchy and double left mouse click EM 253 Position to open the EM 253 Position module configuration Wizard shown in Figure 4.1.

Figure 4.1



Click on “Read Modules” to automatically detect which EM 253 Position module is connected to your S7-200 CPU. In order to read the modules, you have to be connected to the CPU via a programming cable and the module must be connected to the CPU. This may take several seconds to locate the EM 253 Position module. Under the table with Position and Module ID will populate with the EM 253 Position module information as shown in Figure 4.2. Now select the EM 253 Position module and click the “Next” button to continue.

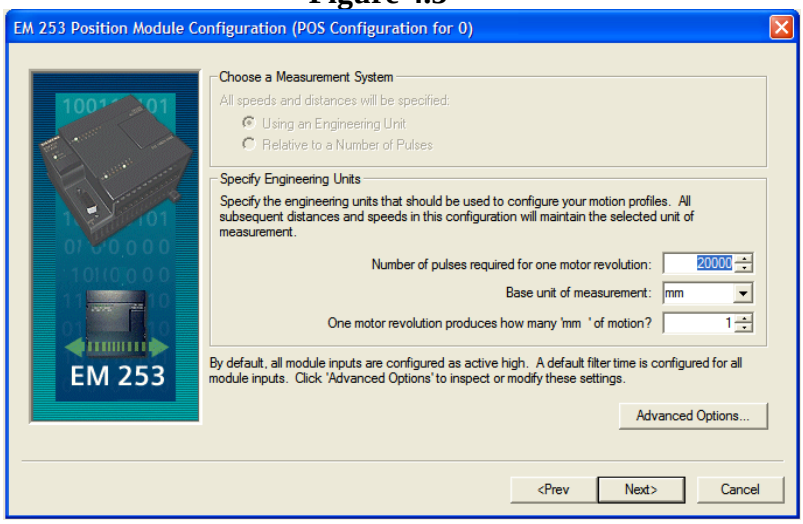
Figure 4.2



The next window to appear is shown in Figure 4.3. On this window the Measurement System and Engineering Units have to be specified. It is not necessary to click on the Advanced Options button. You will want to the set the measurement system to either engineering units or relative number of pulses.

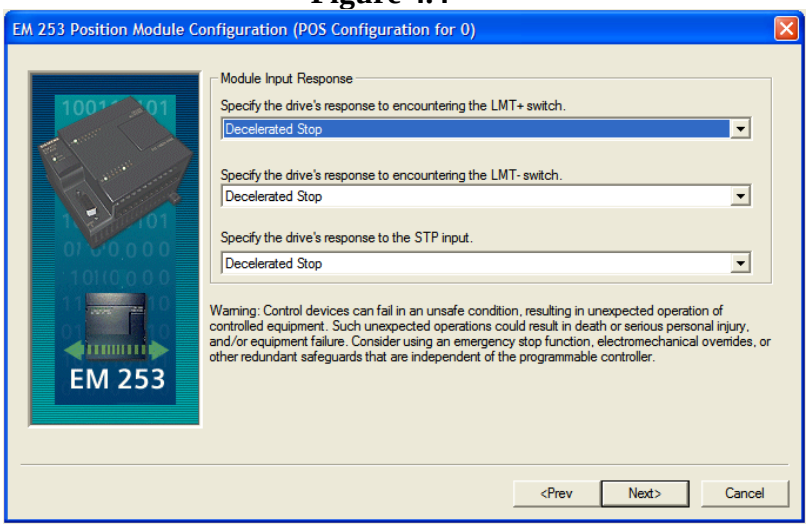
Select which one suits your application best. For our application “Engineering Units” was chosen. Then set the number of pulses required for one motor revolution to the desired value. In our application we had set the value to 20,000 because the drive used in our lab was set for micro stepping. Next, choose a base unit of measurement by clicking on the down arrow and selecting one. Finally set the “One motor revolution produces how many mm of motion?” field to the value that best fits your application. Once you have made your selections, click the Next button to proceed to the next module configuration window.

Figure 4.3



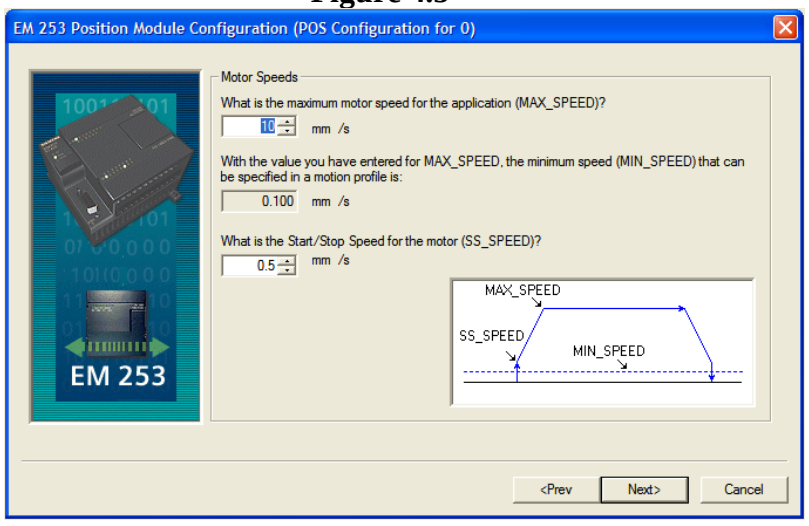
Next you will have to specify the module’s input response shown in Figure 4.4. As you can see Decelerated Stop was chosen for all the selections. The other options you can choose are “Immediate Stop” and “No action, Ignore input conditions.” Make your selections then to continue press the Next button.

Figure 4.4



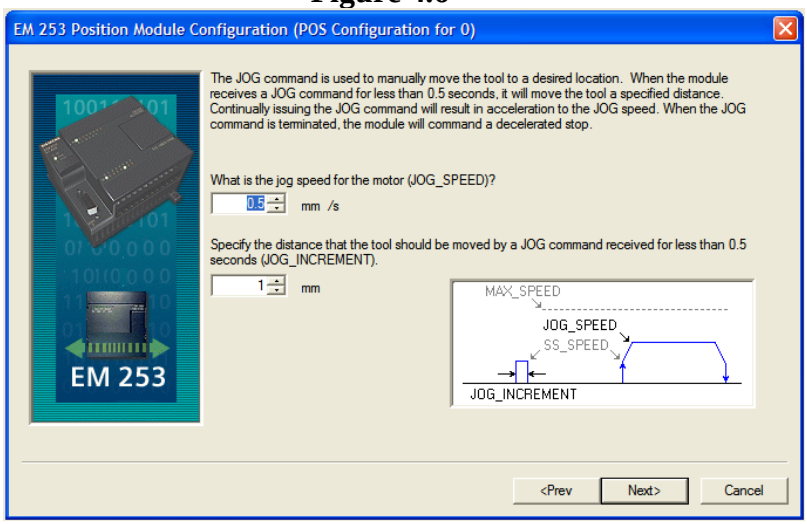
The next screen to appear is the Motor Speeds configuration window, as seen in Figure 4.5. The three parameters are shown but only two of the parameters can be configured, which are the Maximum Motor Speed and Start/Stop Speed. Also, the value for the Maximum Motor Speed must be higher than the value for the Start/Stop Motor Speed. If the Start/Stop Motor Speed value is too high, the motor may lose pulses on start up, and the load may overdrive the motor when attempting to stop. Typically, a useful Start/Stop Motor Speed value is 5% to 15% of the Maximum Motor Speed value. The Minimum Motor Speed is automatically adjusted according to the Maximum Motor Speed value. Enter in the values required for your application and click next.

Figure 4.5



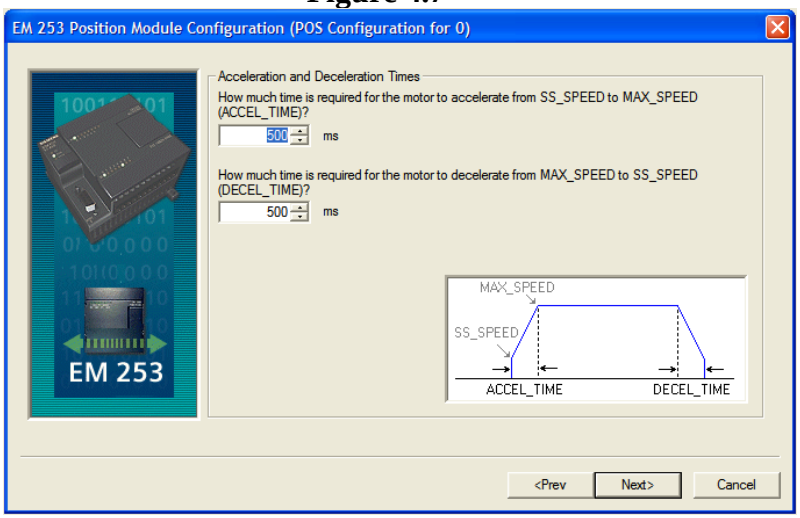
In the next configuration window, the Jog Speed and Jog Increment can be specified. The Jog Speed will not exceed the maximum motor speed specified on the previous configuration screen. This window is shown in Figure 4.6. Enter in the desired parameters and click next to proceed.

Figure 4.6



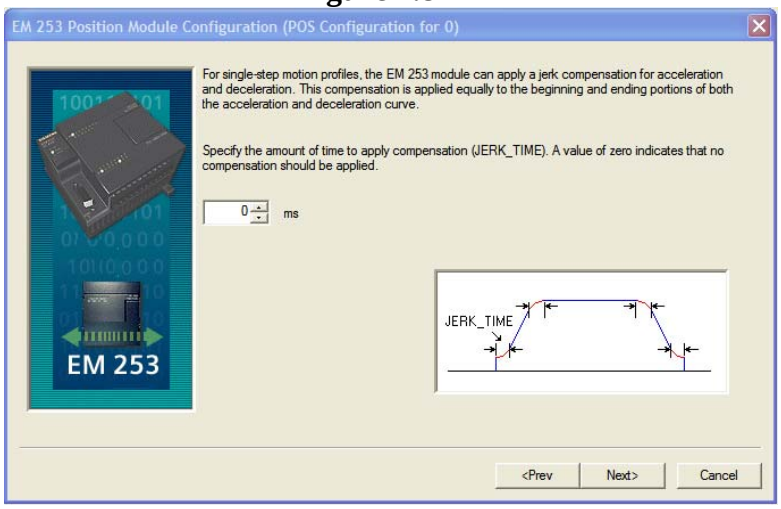
The next window to appear is for configuring the Accel and Decel times shown in Figure 4.7. The minimum value that can be entered for the Accel and Decel time is 20ms. A maximum value of 32,000 can be entered in for the Accel and Decel time. Once you have entered in the desired values, click on the "Next" button to go to the next position module configuration window.

Figure 4.7



After setting the parameter values for the Accel and Decel Time the next screen will allow you to set the Jerk time. The maximum value that can be entered for the Jerk time is 32,000 ms and the minimum is 0 ms. After selecting the desired Jerk time, click the Next button to continue in the EM 253 Position module configuration wizard. Refer to Figure 4.8 if necessary.

Figure 4.8



4.1 EM253 Wizard – No Reference Point

In the next window after setting the Jerk time it will ask whether you want to configure a Reference Point or not. A reference point is necessary if your application will specify absolute movements. If your application will specify relative movements, then setting a reference point may not be not required. For relative movements select "No", unless your application requires you otherwise and press the "Next button". Refer to Section 4.2 for configuring a reference point.

Figure 4.11

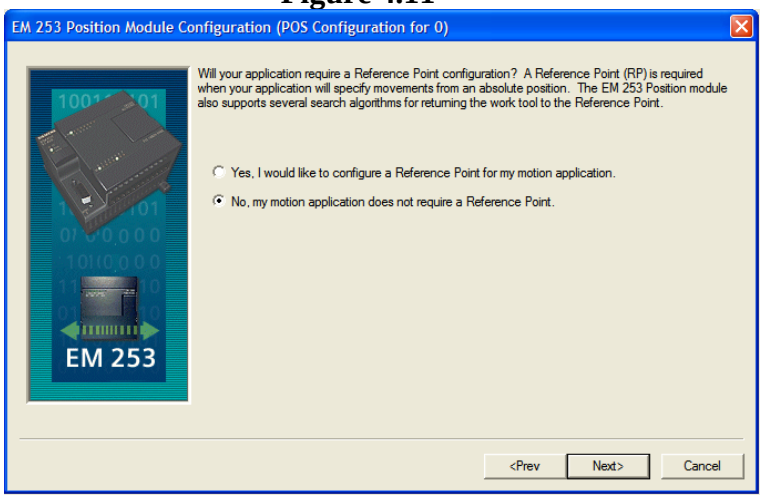
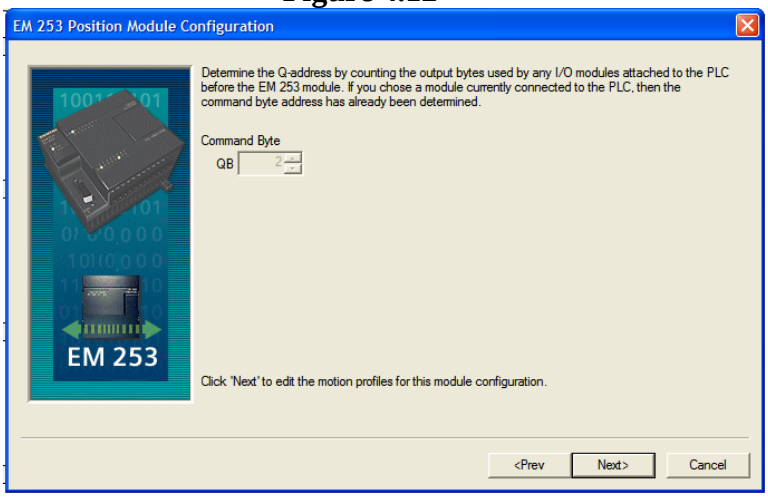


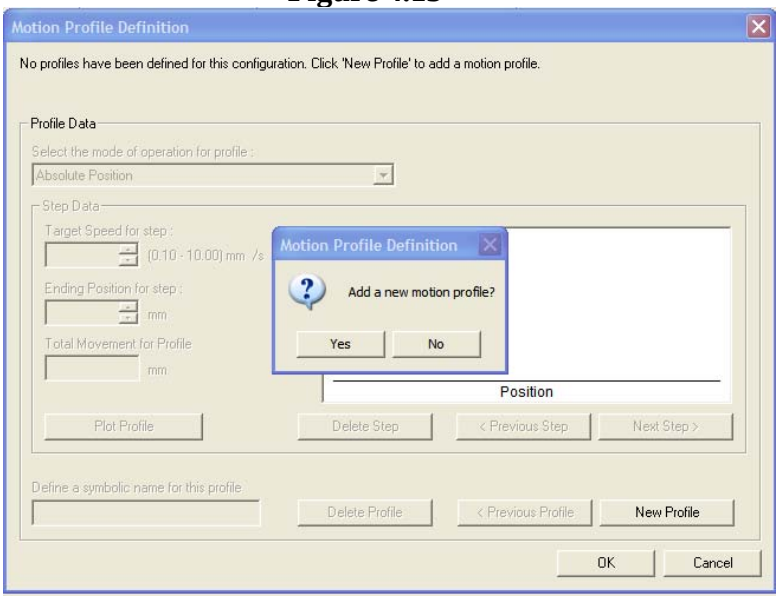
Figure 4.12 is the last EM 253 Module Configuration window. The Q byte address for the Command Byte will automatically be filled in and grayed out. Now click the "Next" button to continue on to setting up the Motion Profiles.

Figure 4.12



A new screen will appear that is the "Motion Profile Definition" screen. Click on the "New Profile" button to setup a new motion profile. You then be prompted with a dialog box asking whether you really want to create a motion profile or not shown in Figure 4.13. To continue setting up a motion profile select Yes.

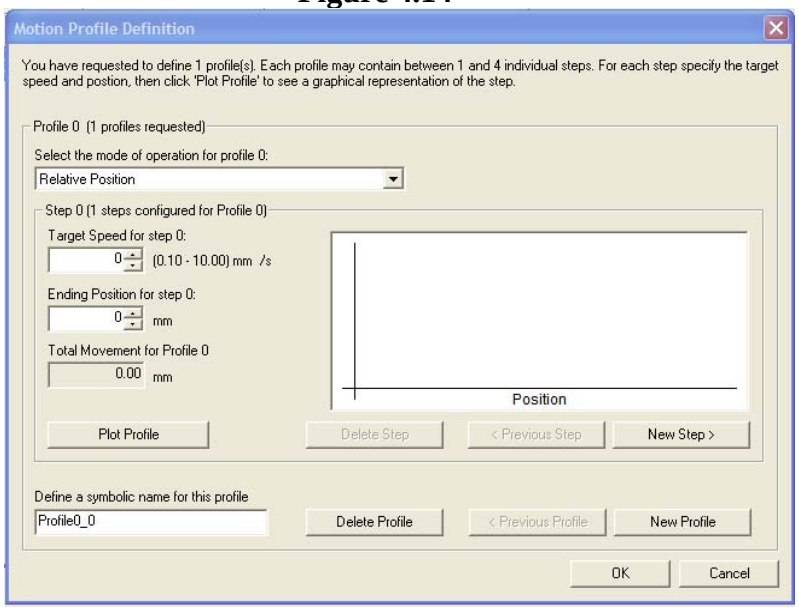
Figure 4.13



Once you have created a new motion profile, more parameters then have to be setup. An example of what you will see is displayed in Figure 4.14. You are allowed to setup up to 25 motion profiles and up to 4 steps per profile. For your profile enter values into the Target Speed and Ending Position. The Total Movement field cannot be edited because it is automatically filled in for you.

You are able to make your motion profile a clockwise motion profile or a counterclockwise motion profile by entering in a positive or negative value into the Ending Position field. Press the Plot Profile button to see a graphical representation of your profile. Click on the New Step button to create a new step within your motion profile. When creating a new step you will have to enter values in for the Target Speed and Ending Position. To create another profile click on the New Profile button and repeat the same process from before. Once you are done creating the Motion Profiles and Steps you need click the OK button to continue.

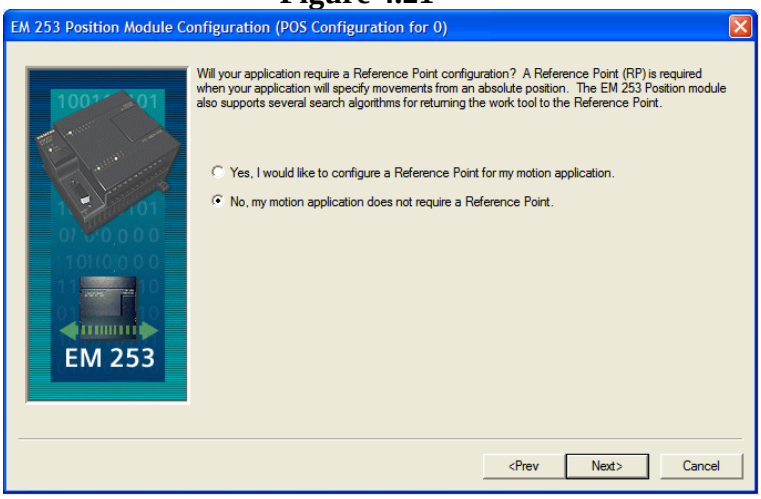
Figure 4.14



4.2 EM253 Wizard – Reference Point

In the next window after setting the Jerk time it will ask whether you want to configure a Reference Point or not. A reference point is necessary if your application will specify absolute movements. If your application will specify relative movements, then setting a reference point may not be not required. To select Reference Point select "Yes" in the window shown in Figure 4.21 and press the "Next" button.

Figure 4.21



After selecting yes in the previous window, then a window will appear for configuring the Reference Point Seek Speeds shown in Figure 4.22. The first configurable field is for the fast Reference Point Seek Speed (RP_FAST). You cannot enter a value that exceeds the maximum speed you set in an earlier configuration window. The minimum speed you can set for the RP_FAST field is 0.5mm/s. RP_FAST is the initial speed that the module uses when receiving a Reference Point Seek Command. Next, enter in a value in the Reference Point slow speed (RP_SLOW) field. The maximum value that can be entered is 0.5mm/s and the minimum is 0.1mm/s. RP_SLOW is the speed of the final approach to the reference point.

Next the direction needs to be selected for the RP_SEEK_DIR and RP_APPR_DIR. You can either select Positive or Negative for each field in the Direction of Reference Point Seek section. The RP_SEEK_DIR specifies the initial direction the module uses upon receiving a RP Seek Command. The RP_APPR_DIR specifies the final approach of the RP. You can also select to the "Advanced RP Options" and configure the RP Offset shown in Figure 4.23, however this is not necessary. To continue with the Reference Point configuration press the "Next" button shown in Figure 4.22.

Figure 4.22

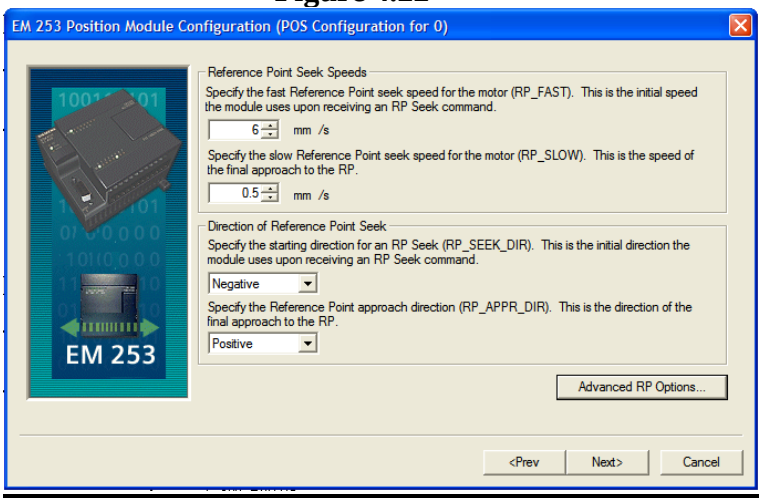
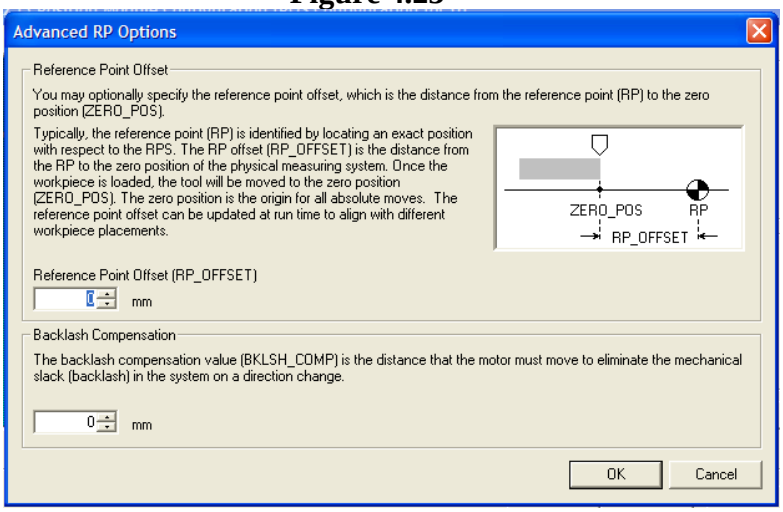


Figure 4.23



The next Reference Point window to appear will be the Reference Point Search Sequence configuration window shown in Figure 4.24. There are five options you can select for the Reference Point Search Sequence. You can select 0 through 4 in the field on this window. Selecting a value of zero with not have you define a Reference Point search sequence. If you select 1, then the Reference Point is where the RPS input goes active on the approach from the work zone side. Selecting a value of 2 will make the Reference Point centered within the active region of the RPS point. When the value 3 is selected, then the Reference Point is outside the active region of the RPS input.

If you select a value of three an optional field appears. This field is so you can enter the number of pulse counts are to be received after the RPS input becomes inactive. The value for the Reference Point Search Sequence is 4. Selecting this value will make the Reference Point generally within the active region of the RPS input. For this selection you must also specify the number of pulse counts that are to be received after the RPS is active. After you have made you selections click the “Next” button to proceed to the next configuration window shown in Figure 4.26.

Figure 4.24

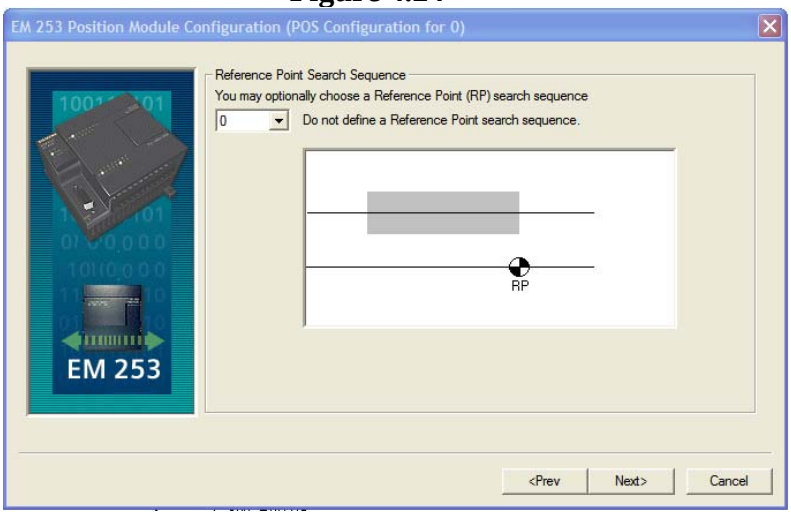
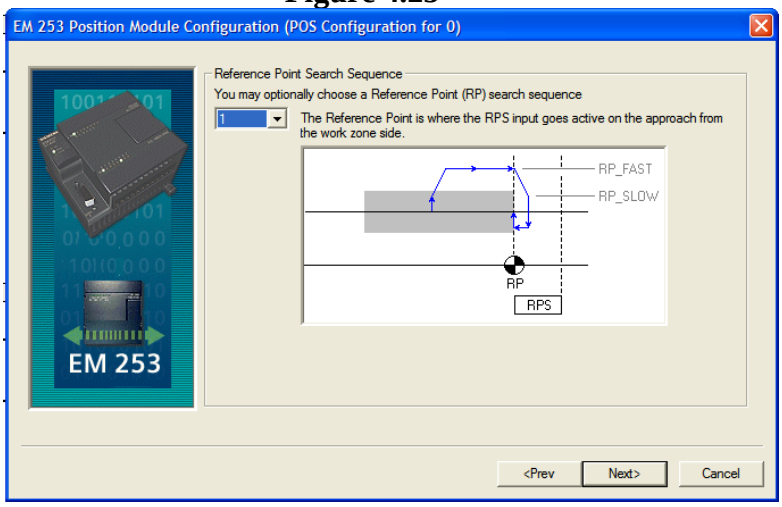
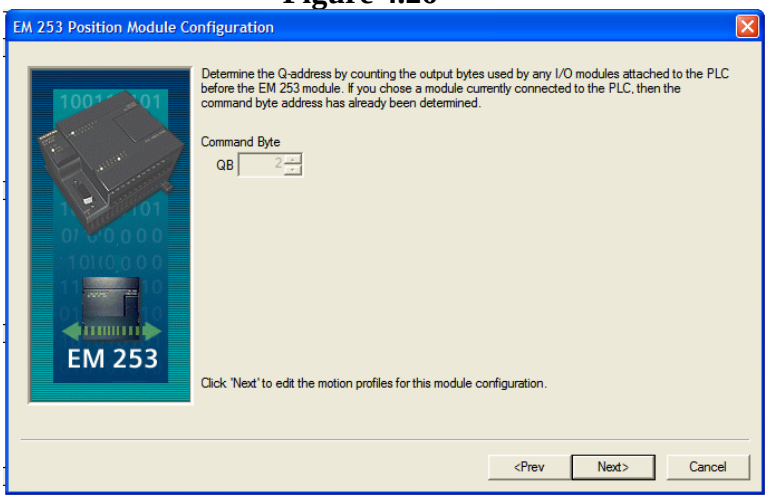


Figure 4.25



After configuring the Reference Point Search Sequence, now you will need to determine the Q address for the EM 253 Position Module shown in Figure 4.26. The Q byte address for the Command Byte will automatically be filled in and grayed out. Now click the "Next" button to continue on to setting up the Motion Profiles.

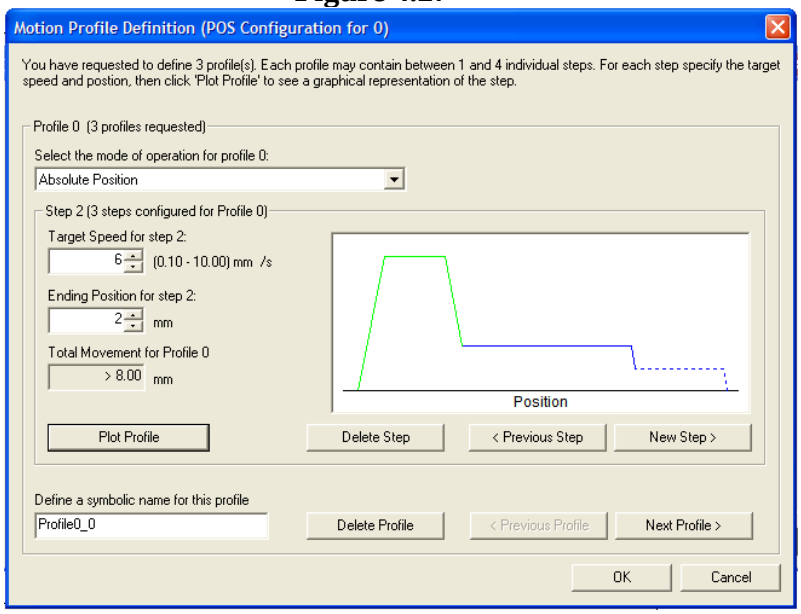
Figure 4.26



After determining the Q address, then motion profiles have to be setup shown in Figure 4.27. This is very similar to setting up motion profiles if you don't have a Reference Point. The only difference is that if you have a Reference Point then the mode is set to Absolute Position, whereas if you did not have a Reference Point the mode would be set for Relative Position. You are allowed to setup up to 25 motion profiles and up to 4 steps per profile. For your profile enter values into the Target Speed and Ending Position. The Total Movement field cannot be edited because it is automatically filled in for you.

You are able to make your motion profile a clockwise motion profile or a counterclockwise motion profile by entering in a positive or negative value into the Ending Position field. Press the Plot Profile button to see a graphical representation of your profile. Click on the New Step button to create a new step within your motion profile. When creating a new step you will have to enter values in for the Target Speed and Ending Position. To create another profile click on the New Profile button and repeat the same process from before. Once you are done creating the Motion Profiles and Steps you need click the OK button to continue.

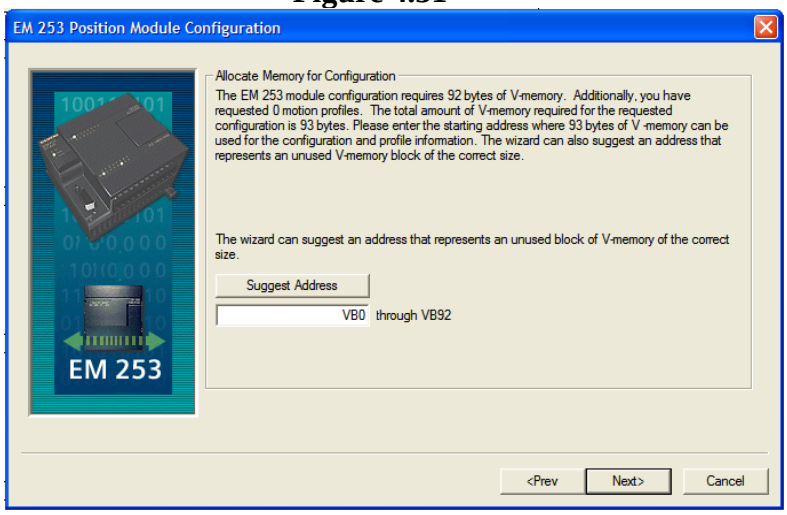
Figure 4.27



4.3 EM253 Wizard – Finishing Up

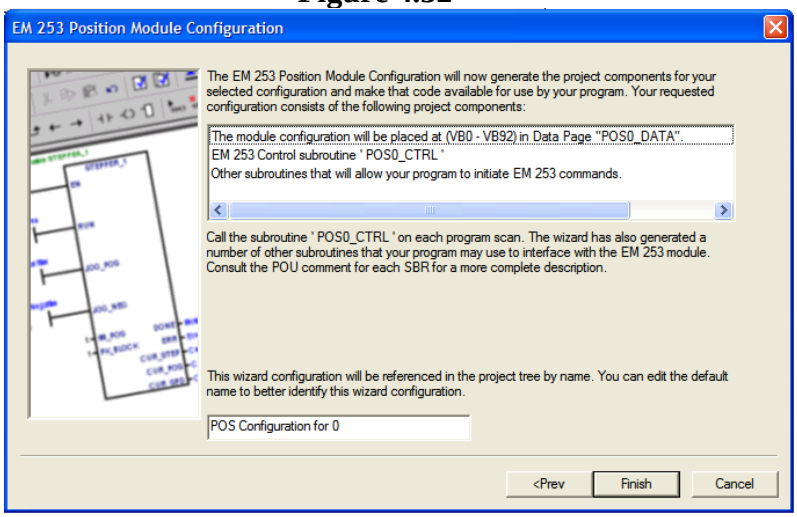
After clicking the OK button the screen shown in Figure 4.31 will appear. This screen is for allocating V Memory for the EM 253 Position Module Configuration. The configuration memory requires 92 bytes of V Memory from your CPU. You can leave it at the default V Memory range, have it suggest the V Memory range or manually type in the beginning address you want for the memory range. It is recommended that you press the "Suggest Address" button and then click "Next" to continue.

Figure 4.31



The window displayed is the last configuration screen in the EM 253 Position Module Configuration Wizard. This screen tells you that it will create the programming components that are needed to control a drive via the EM 253 Position Module. Press the "Finish" button to complete the EM 253 Position Module Configuration Wizard. You will be prompted with a window asking if you really want to finish and select "Yes". At anytime you can go back to the EM 253 configuration components to change parameters if needed. If you want to edit the configuration expand the Wizards folder in the project hierarchy, then expand the EM 253 Position folder, expand the POS Configuration for (whichever position the module is in) and then double click on the component of the configuration you wish to edit.

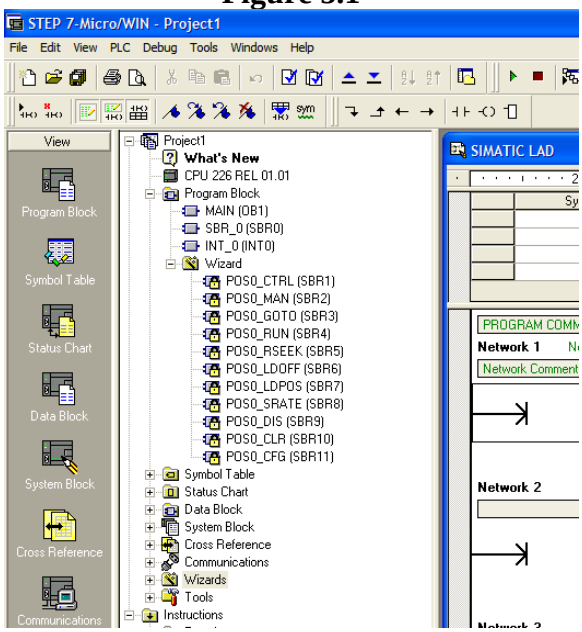
Figure 4.32



5. Step 7 Micro/Win EM253 Function Blocks

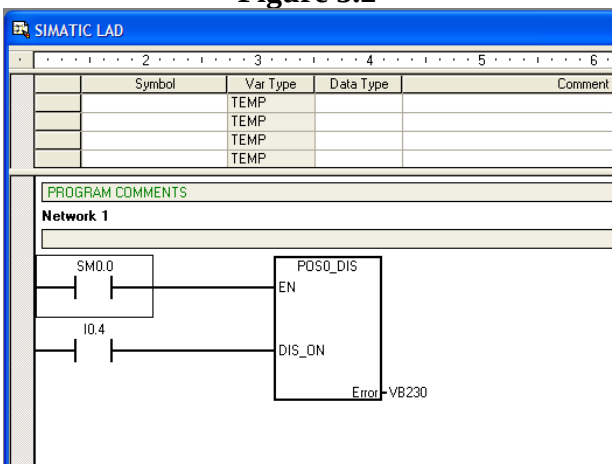
After completing the EM 253 Position Module Configuration Wizard, subroutines will be created in your project under Program Block → Wizards in the project hierarchy, refer to Figure 5.1. The letter x after POS indicates which position the module is in. For example, when configuring the position module through the wizard and it detects a position module in position 2 then the subroutines will read POS2_(routine name). You can also use Help in Micro Win and search for the subroutine you want to know more about and the data types that each parameter of the subroutine is expecting.

Figure 5.1



Now open the Main or Subroutine Ladder editor to start putting in logic for the position module. The first subroutine that should be entered in your logic is the POSx_DIS routine. The POSX_DIS routine is used to enable and disable the drive shown in Figure 5.2. Connect a normally open contact to the Enable parameter of the POSx_DIS routine. For the address of the normally open contact at the Enable parameter it can be SM0.0 or a Variable Memory (V Memory) bit address, input bit address or output bit address. SM0.0 is a special memory bit that is read only memory. SM0.0 is always on or active. For the DIS_ON parameter put in a contact with the address of you're choosing. When the Enable parameter is active and DIS_ON (Disable) is not active then your output will be low. When the Disable parameter is active then the Enable output will be high regardless of the status of the Enable parameter.

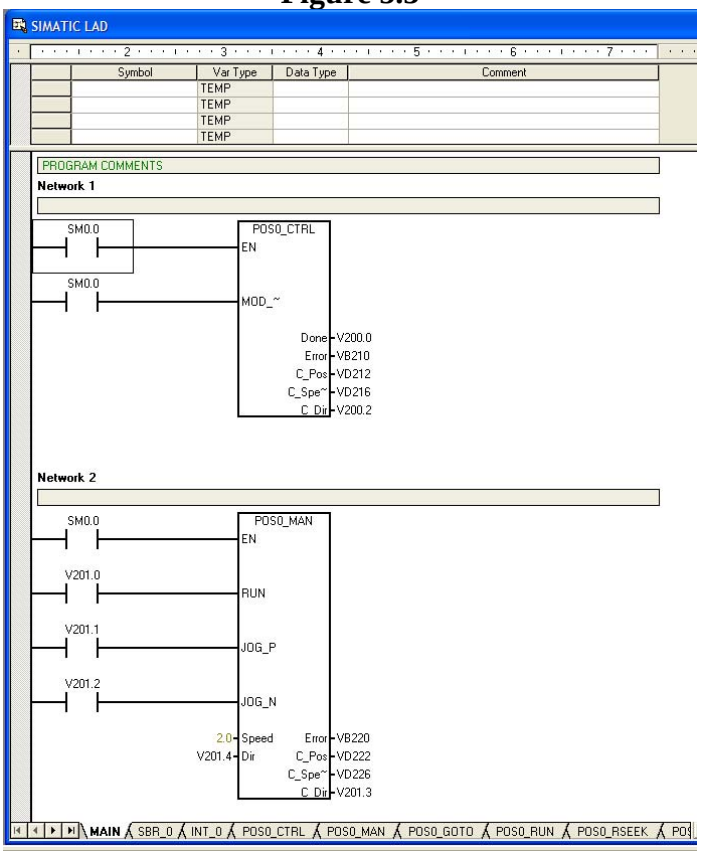
Figure 5.2



The POSx_CTRL subroutine has to be used in the ladder logic because this routine initializes the position module. Without this routine the position module will not work. The input parameters for the POSx_CTRL which are Enable and Module Enable must be on. Connect normally open contacts to the inputs and set the address of the two contacts to SM0.0. Refer to Figure 5.3 as needed when setting up the parameters of the POSx_CTRL subroutine. Then set the addresses of the output parameters to the desired available Variable Memory (V Memory) addresses. The Done and C_Dir parameters have to be assigned bit addresses. A byte address has to be assigned to the Error parameter. The C_Pos and C_Speed parameters are to have an address with the data types DINT or REAL assigned to them. Make sure these addresses are not used anywhere else in your program.

Now we can add the POSx_MAN subroutine to put the position module into manual mode. We can utilize this subroutine to test and debug our wiring from the EM 253 module to the drive. This subroutine allows us to run the drive at different speeds, directions or jog in a positive and negative direction. The Enable parameter of the POSx_MAN subroutine must be on to utilize this subroutine. Add a normally open contact to the ladder at the Enable of the routine and give the contact the SM0.0 (Always On) address. Next put in all the other addresses and contacts for the parameters of the POSx_MAN subroutine. The RUN, JOG_P and JOG_N parameters must be tied to a contact with a bit address. The Speed parameter has to be a REAL or DINT data type. The data types for the addresses for the output parameters for the POSx_MAN are the same as the POSx-CTRL subroutine. Download your program to your S7-200 and use the manual control to test and debug the wiring of your system.

Figure 5.3



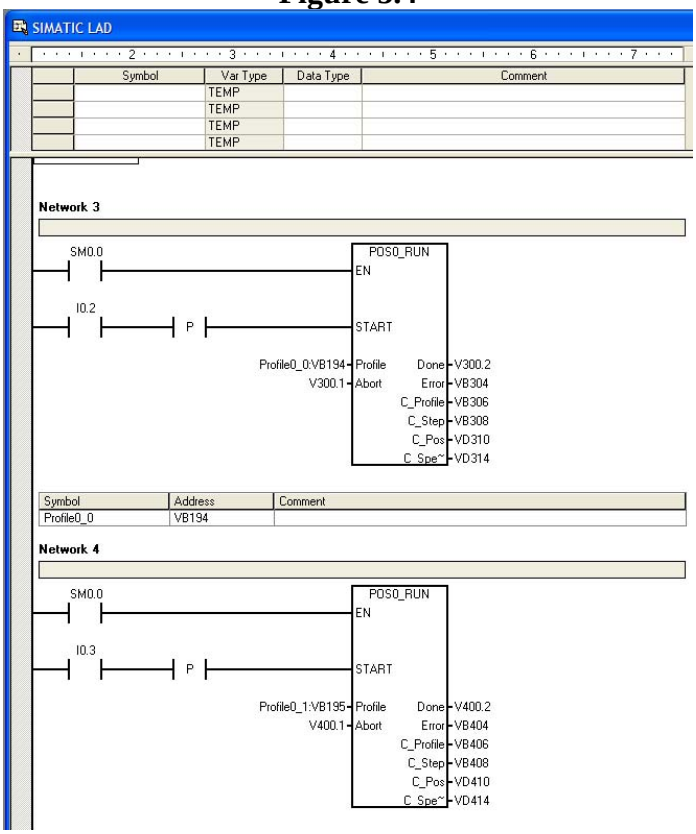
After you have debugged the wiring and can control the drive and motor with the manual subroutine, we can move onto setting up the run profile routine. The run profile routine (POSx_RUN) will run a profile of your choosing that was created in the profile wizard. Refer to Figure 5.4 as needed when adding and setting the parameters for the POSx_RUN subroutine. As with the other routine, in order to enable the POSx_RUN routine tie a normally open contact to the Enable parameter with the address of the always on special memory bit, SM0.0.

For the START parameter of the run profile routine has to have a positive transition bit after any other contact that you put in to trigger the start of the run profile routine. For the Profile parameter, the VB address of the profile needs to be entered there. You can locate and see all the VB addresses for all the profiles that were created by looking at the Symbol Table for the position module in the project hierarchy. To accomplish this expand the Symbol table folder in the project hierarchy, then expand the Wizard folder and then double click on the position module symbol table. Next, go back to your program editor to enter in the VB address of the profile you want to run in the Profile parameter of the POSx_RUN subroutine.

Now enter in the address with a bit data type for the Abort parameter. When the Abort parameter becomes activated or turned on, then the command is sent to

stop running the profile and decelerate the motor until it stops. Next, enter in all the output parameters for the POSx_RUN subroutine. The Done parameter requires a bit data type address to be entered. For the Error, C_Profile and C_Step output parameters these need to be addresses with the byte data type. Then for the C_Pos and C_Speed output parameters the need to be an address with the double word data type. For the output parameters it is recommended to you the V Memory addresses, but make sure that the addresses are not used anywhere else.

Figure 5.4

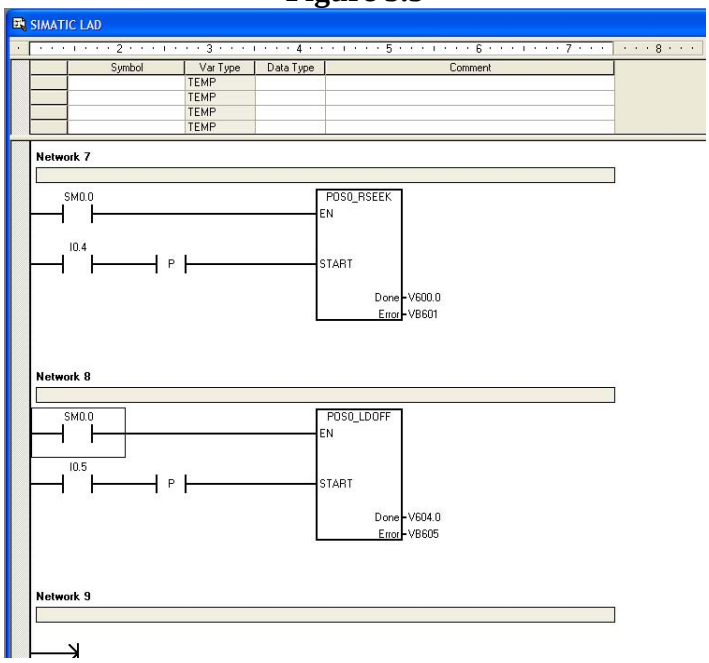


Refer to Figure 5.5 for example shown of the POSx_RSEEK (Seek Reference Point Position) subroutine and the POSx_LDOFF (Load Reference Point Offset) subroutine. These subroutines are used if you have setup a Reference Point. The POSx_RSEEK subroutine initializes a reference point seek operation, using the search method you selected in the configuration. As soon as the Position module finds the reference point and movement has stopped, the Position module loads the RP_OFFSET parameter value into the current position. The POSx_LDOFF subroutine establishes a new zero position that is at a different location from the reference point position.

Just like the other subroutines, in order to enable the POSx_RSEEK routine tie a normally open contact to the Enable parameter with the address of the always on special memory bit, SM0.0. For the START parameter of the POSx_RSEEK subroutine has to have a positive transition bit after any other contact that you put in to trigger the start of this routine. Next set the output parameters of the POSx_RSEEK subroutine to the desired memory addresses. A memory address with the bit data type is to be placed in for the Done parameter. For the Error parameter it expects a memory address with a data type of byte.

For the POSx_LDOFF subroutine the input and output parameters need to be setup just like the POSx_RSEEK subroutine. However, make sure that you use different memory addresses so it does not cause a conflict in your program. Once you are done with the programming, reload your program and test it out to make sure the drive and motor act accordingly. There are also more subroutines for the position module that can be utilized that are not covered in this document that you may choose to use for your application.

Figure 5.5



6. Technical Support

For technical support please call C&E Sales at 1-800-228-2790. Or you can send your technical questions via email to automation@cesales.com