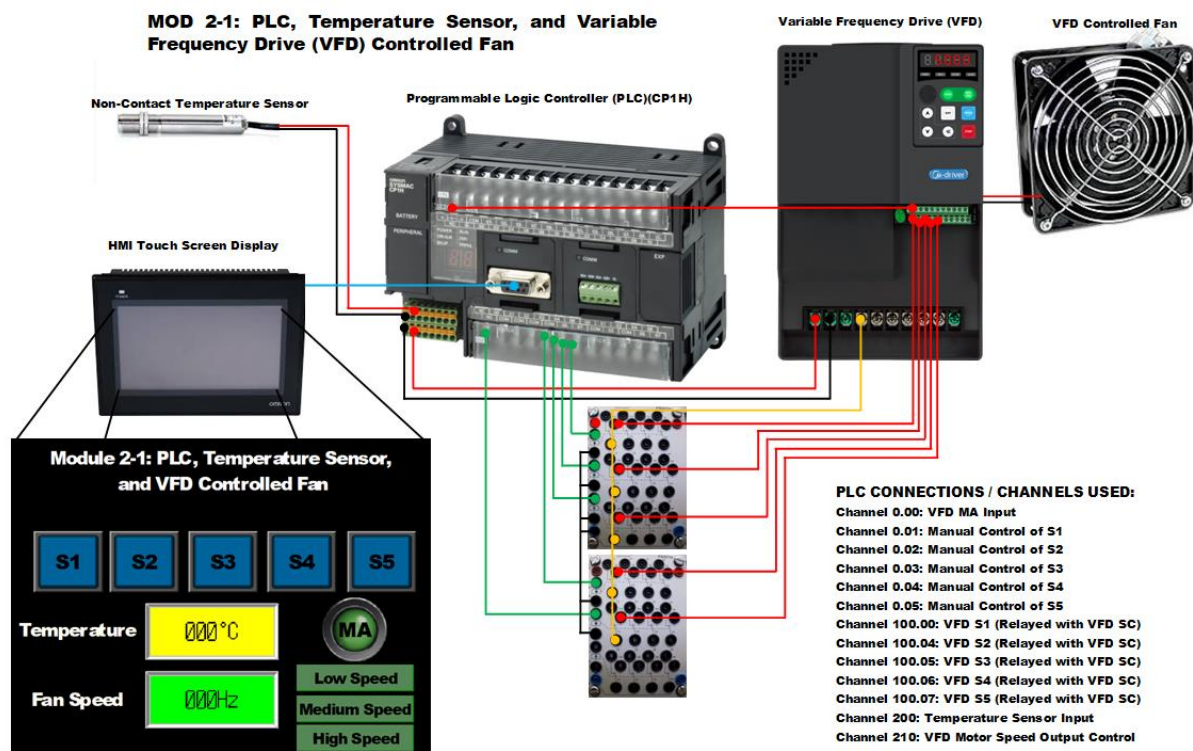# PLC, Temperature Sensor, and VFD Controlled Fan

1. Task Assignment

For this assessment, the task is to provide a detailed wirings and the complete PLC program that would have an input from the temperature sensor that ranges 0-1.5V which monitors 0 to 150°C. The output will be the VFD controlled fan that varies its speed into three categories: low speed with 30Hz, medium speed with 60Hz, and high speed with 90Hz motor rotation.

2. Wiring Diagram

The wiring diagram includes the following components: Programmable Logic Controller (PLC), Human-Machine-Interface (HMI) Touch Screen Display (NS5-SQ0-V2), Temperature Sensor (Non-Contact), Variable Frequency Drive (VFD), Fan, Relay, and connecting wires. The following ports and channels used in the diagram are listed which will be strictly followed as each channels have a corresponding use in the PLC program.

Channel 200 is used as the input analog voltage while channel 210 for the output analog voltage. Channel 0.00 is for the MA indicator input while other channels 0 are for the manual control of VFD S1 to S5 switches. Channels 100 are used as the digital output control to S1 and S5 which is also programmed so that it can be controlled in the HMI.

3. **HMI Design**
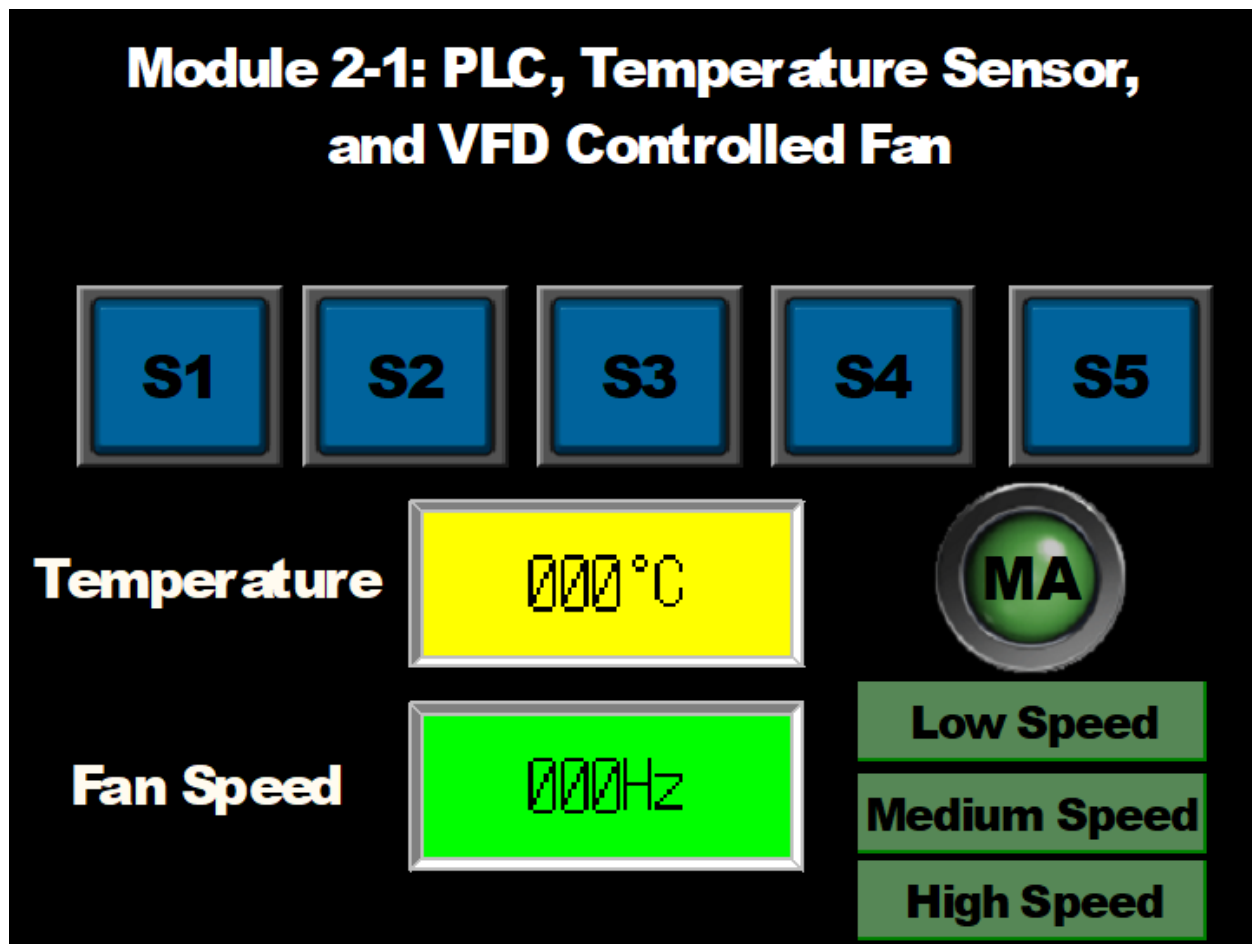
For the HMI, the S1-S5 buttons are for the control of the VFD multi-function switches. Only S2 and S3 are latching or non-momentary switches. Temperature and Fan Speed are digital displays only but shows the equivalent BCD value of the input temperature reading and output for the motor speed. MA is just an indicator which can be programmed on the VFD for how it will be used. Additionally, the "Low Speed", "Medium Speed", and "High Speed" components or symbol in the HMI are also indicator together with the fan speed in Hz.

4. PLC Program

| Name	Data Type	Address / Value	Rack Locati...	Usage	Comment
` VFD_MA	BOOL	0.00	Main Rack :...	In	0.00 - VFD_MA
` PB_VFD_S1	BOOL	0.01	Main Rack :...	In	0.01 - PB_VFD_S1
` PB_VFD_S2	BOOL	0.02	Main Rack :...	In	0.02 - PB_VFD_S2
` PB_VFD_S3	BOOL	0.03	Main Rack :...	In	0.03 - PB_VFD_S3
` PB_VFD_S4	BOOL	0.04	Main Rack :...	In	0.04 - PB_VFD_S4
` PB_VFD_S5	BOOL	0.05	Main Rack :...	In	0.05 - PB_VFD_S5
` HMI_VFD_MA	BOOL	10.00		Work	10.00 - HMI_VFD_MA
` HMI_VFD_S1	BOOL	10.01		Work	10.01 - HMI_VFD_S1
` HMI_VFD_S2	BOOL	10.02		Work	10.02 - HMI_VFD_S2
` HMI_VFD_S3	BOOL	10.03		Work	10.03 - HMI_VFD_S3
` HMI_VFD_S4	BOOL	10.04		Work	10.04 - HMI_VFD_S4
` HMI_VFD_S5	BOOL	10.05		Work	10.05 - HMI_VFD_S5
` LOW	BOOL	30.00		Work	30.00 - LOW
` MEDIUM	BOOL	31.00		Work	31.00 - MEDIUM
` HIGH	BOOL	32.00		Work	32.00 - HIGH
` VFD_S1	BOOL	100.00	Main Rack :...	Out	100.00 - VFD_S1
` VFD_S2	BOOL	100.04	Main Rack :...	Out	100.04 - VFD_S2
` VFD_S3	BOOL	100.05	Main Rack :...	Out	100.05 - VFD_S3
` VFD_S4	BOOL	100.06	Main Rack :...	Out	100.06 - VFD_S4
` VFD_S5	BOOL	100.07	Main Rack :...	Out	100.07 - VFD_S5

Every address used in the PLC program are also used in the wiring connection, HMI design, or internal program procedures. As explained in the wiring diagram section, channels 0 are also used as direct control to VFD S1 to S5 aside from VFD MA input. A separate address is used for the HMI components to avoid any possible error in using real input or output addresses.
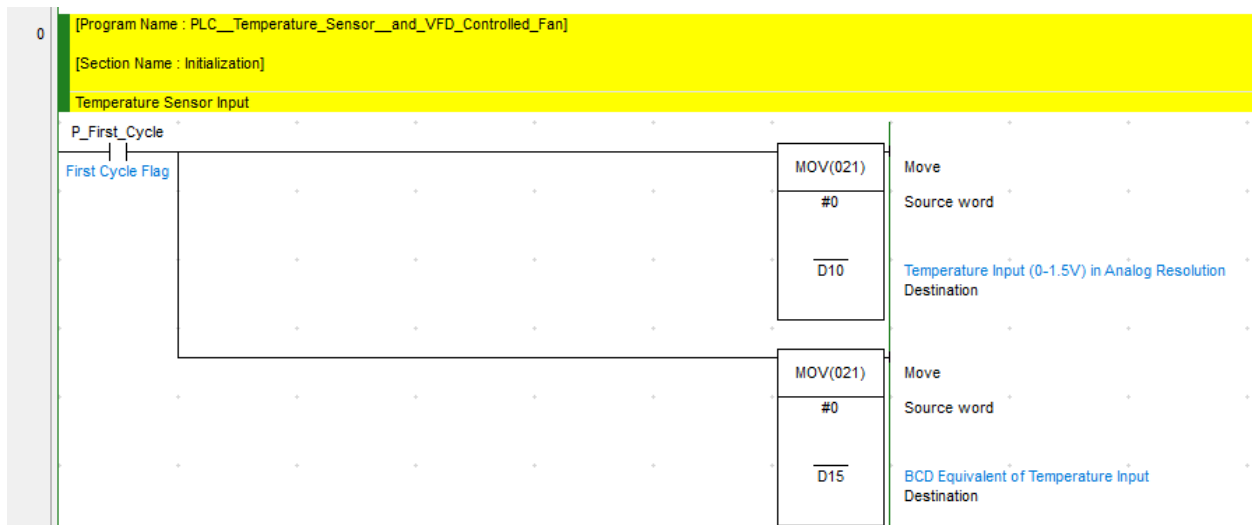

For the initial part of the program, it is important to initialize all the data memory that will be used to avoid error for the past stored data. The binary data of temperature sensor input is stored in D10 while its BCD equivalent will be stored in D15.
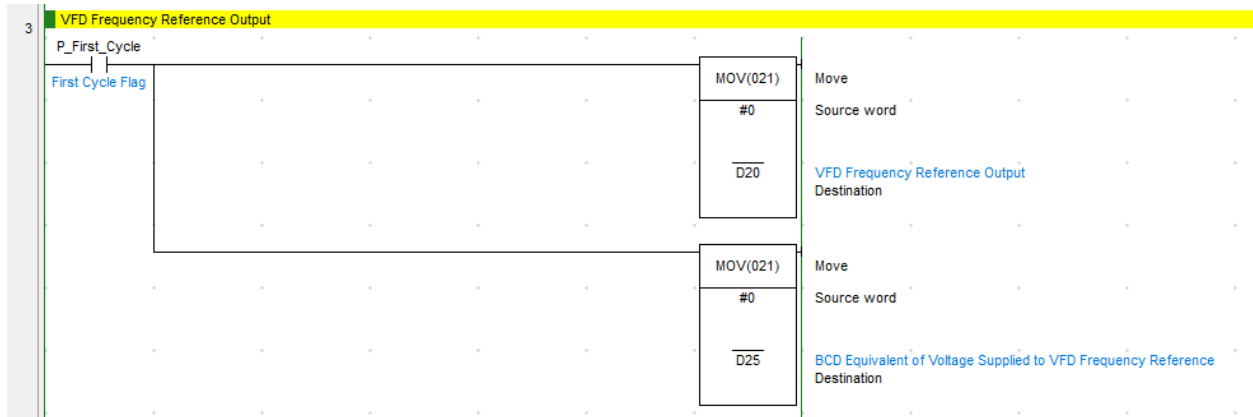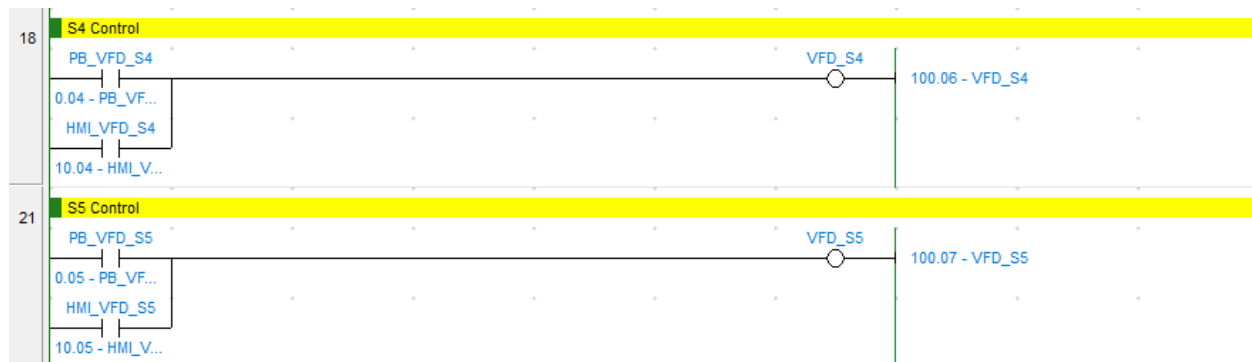
Aside from the input, the output for the VFD frequency reference is obtained from D20 while D25 has its BCD equivalent for HMI display.
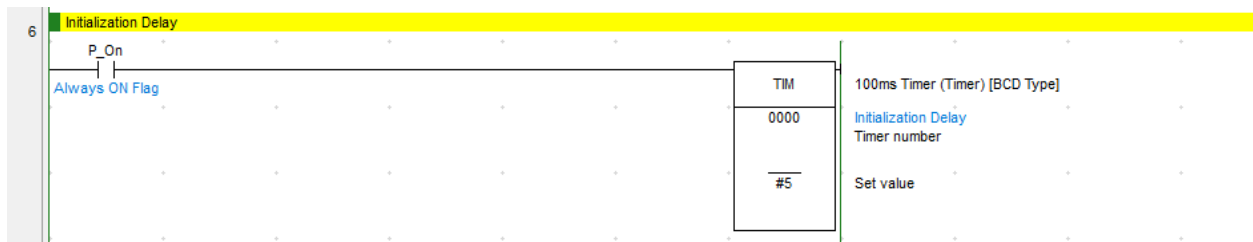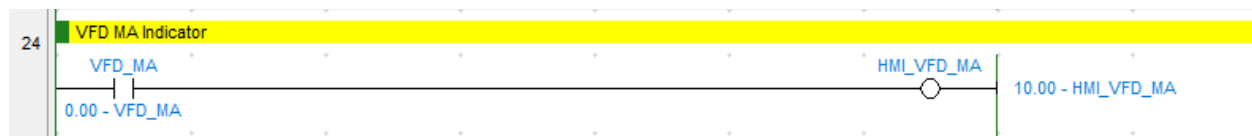

To let the program complete its initialization, a short delay of 0.5 seconds is used before any other command or instruction is used.
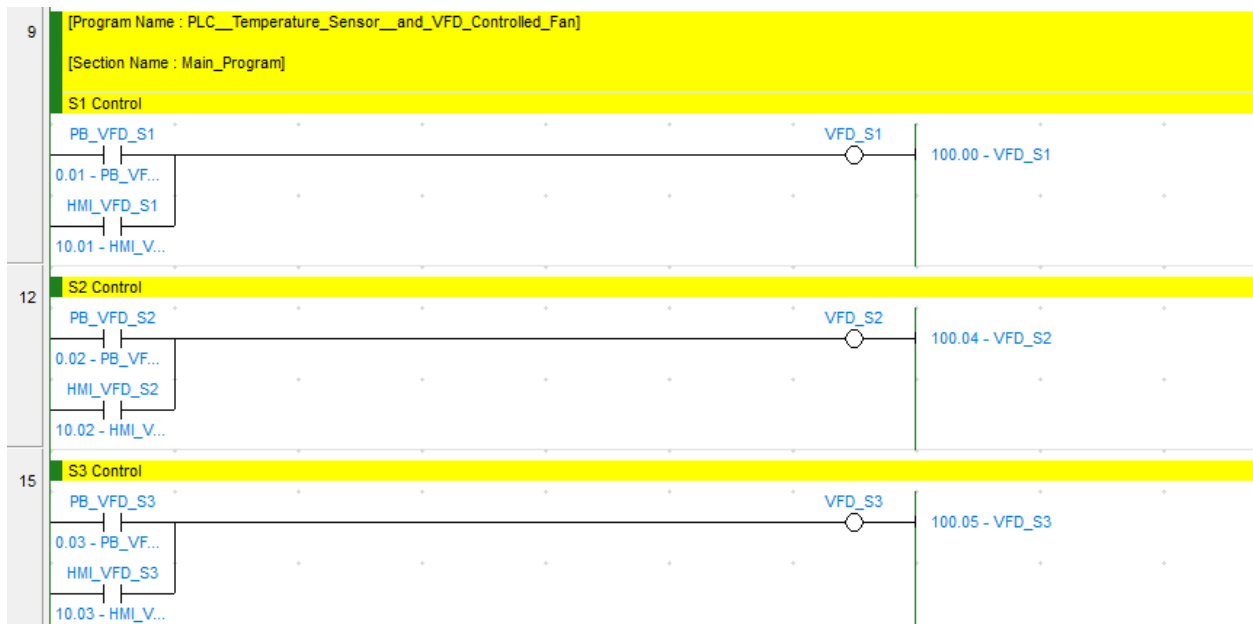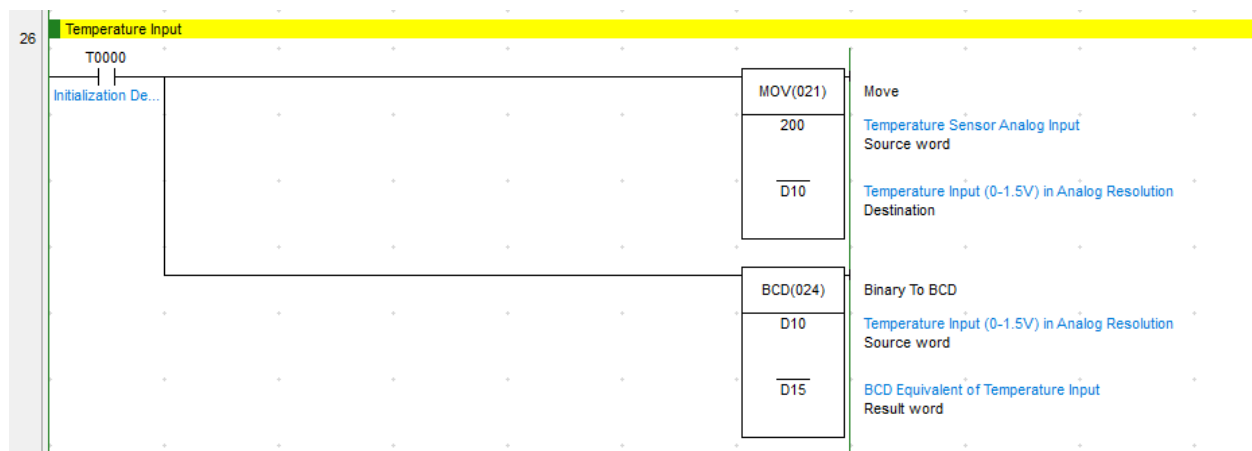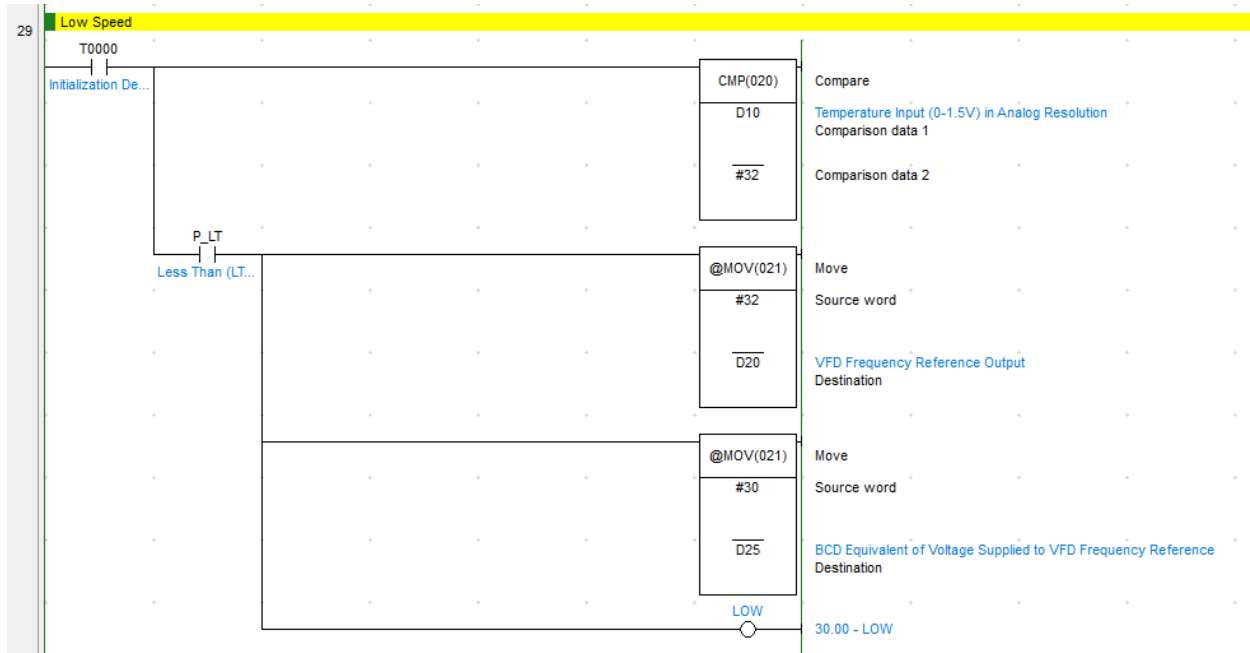
The control of VFD S1 to S5 switches can be controlled from the actual input port or from the HMI display.


The VFD MA is also displayed in the HMI for indication depending on the configured setting or application in the VFD.

The temperature sensor output that is connected to the voltage input analog channel 200 will be stored to D10.

For the first fan speed category, low speed, the program compares the temperature reading whether it is less than 50°C to enable the "LOW" indicator and use the corresponding data that will be sent to channel 210 for the VFD frequency reference.
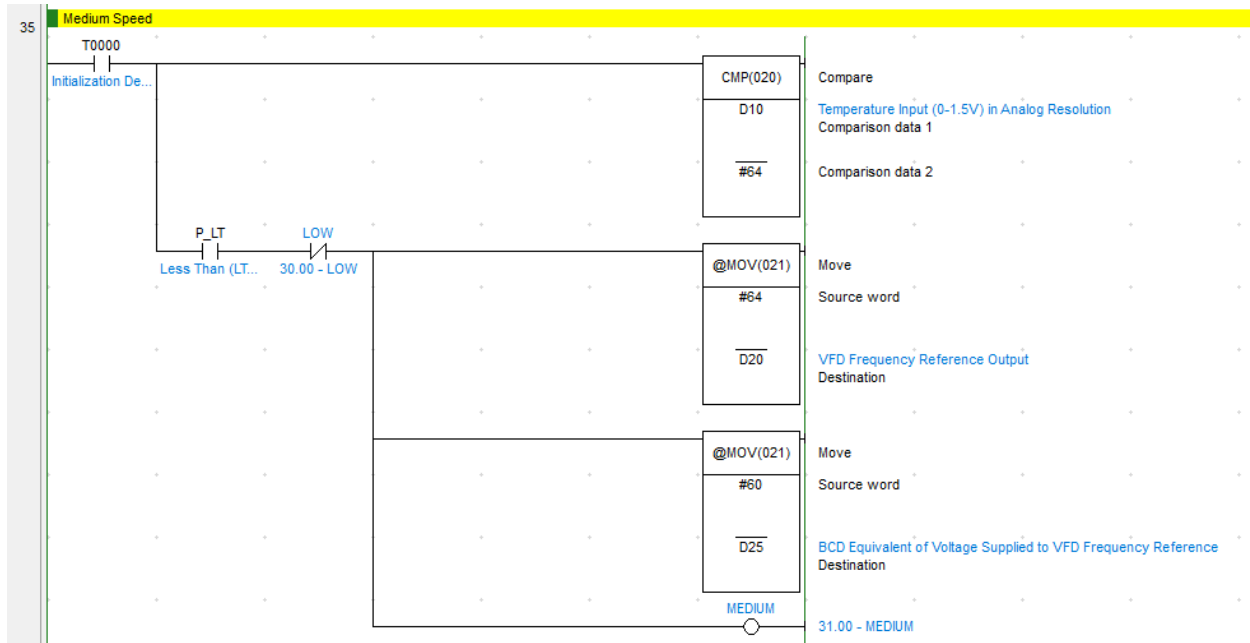

The second fan speed category is similar to the first however, it includes a condition that low speed must not be on which means the temperature reading is greater

than or equal to 50°C but must be less than 100°C to control the VFD at 60Hz indicating that it is now medium speed.
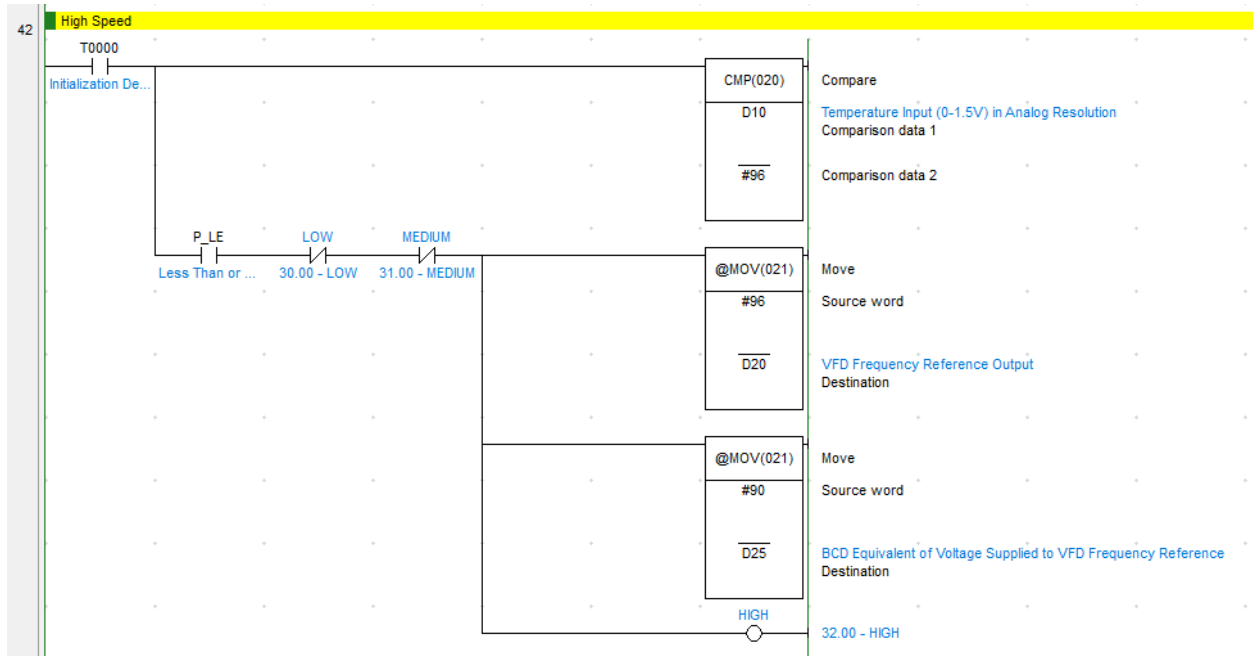
Similar with the second category, the third and last fan speed category is the same but now include the condition that the temperature must be greater than or equal to 100°C but less than or equal to 150°C. In this case, the VFD control the speed at 90Hz.
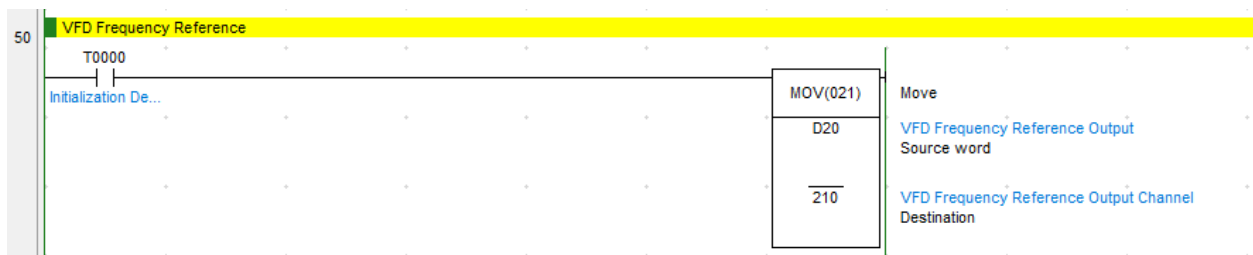
To actually change the VFD frequency reference, the PLC outputs the corresponding data from channel 210 enabled to output 0-10V.
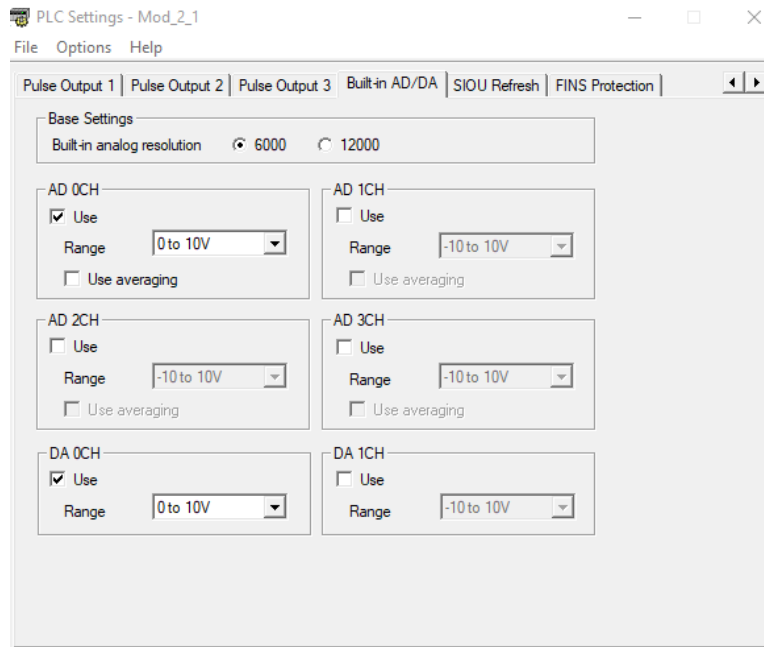
Both channel 200 and 210 are configured and used for the analog voltages 0-10V.

5. VFD Configuration

A. n01: Setting the Parameter Write-Prohibit Selection/Parameter Initialization

➢ PRGM >> n01 >> 8 : To enable 2-wire sequence.

➢ PRGM >> n01 >> 9 : To enable 3-wire sequence.

B. n02: Selecting the Operation Mode

➢ PRGM >> n02 >> 0 : To enable RUN and STOP/RESET key of the digital operator.

➢ **PRGM >> n02 >> 1 : To enable multi-function inputs in 2- or 3-wire sequence.**

➢ PRGM >> n02 >> 2 : To enable operation commands via RS-422A/485.

C. n03: Selecting the Frequency Reference in Remote Mode

➢ PRGM >> n03 >> 0 : To enable FREQ adjuster of the digital operator.

➢ PRGM >> n03 >> 1 : To enable Frequency Reference 1.

➢ **PRGM >> n03 >> 2 : To enable FR control terminal for 0-10V input.**

➢ PRGM >> n03 >> 3 : To enable FR control terminal for 4-20mA input.

➢ PRGM >> n03 >> 4 : To enable FR control terminal for 0-20mA input.

➢ PRGM >> n03 >> 6 : To enable FR via RS-422A/485.

Additional configurations include adjusting the VFD to enable remote access or control to the multi-function switches as well as remote analog input to frequency reference ports.