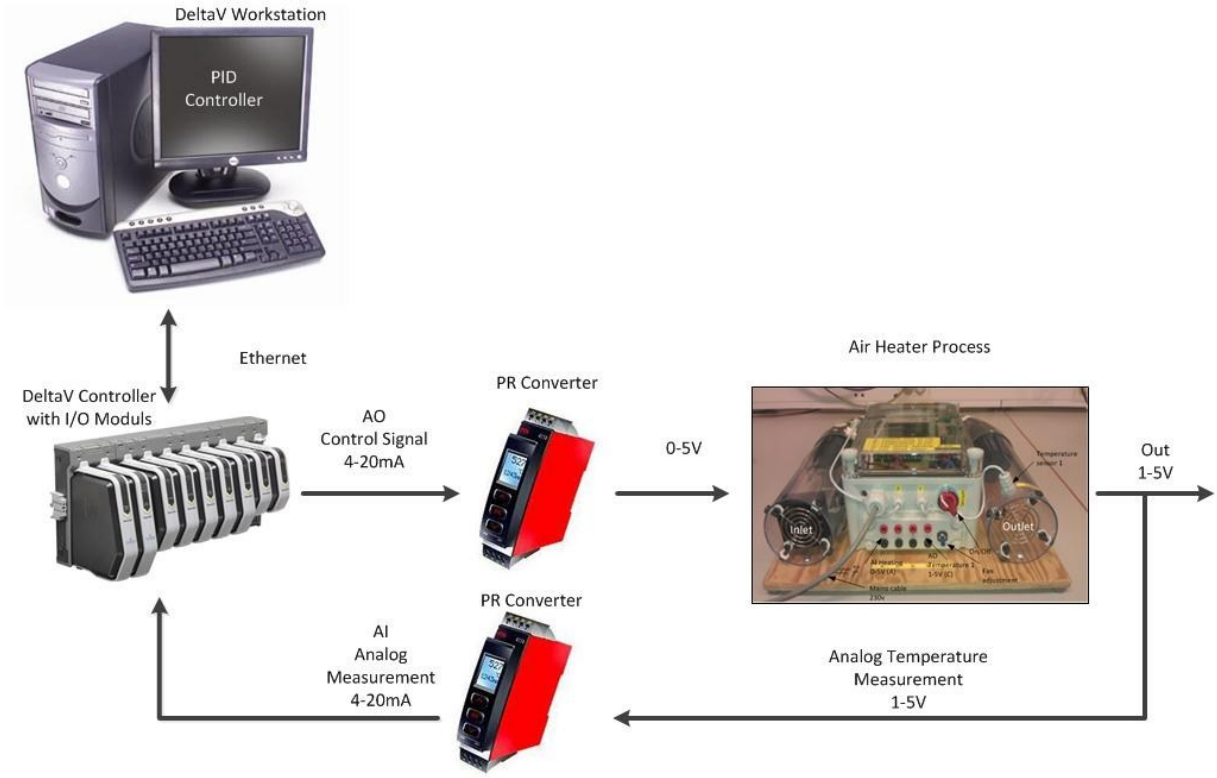
Høgskolen i Telemark
Fakultet for teknologiske fag
Bachelor i ingeniørfag

Temperature Control of Air Heater with DeltaV



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1 INTRODUCTION

In this task you will learn how to create a program and a HMI to regulate the temperature of the Air Heater system and using PID in DeltaV. Figure 1-1 shows the Air Heater and describes the different components.

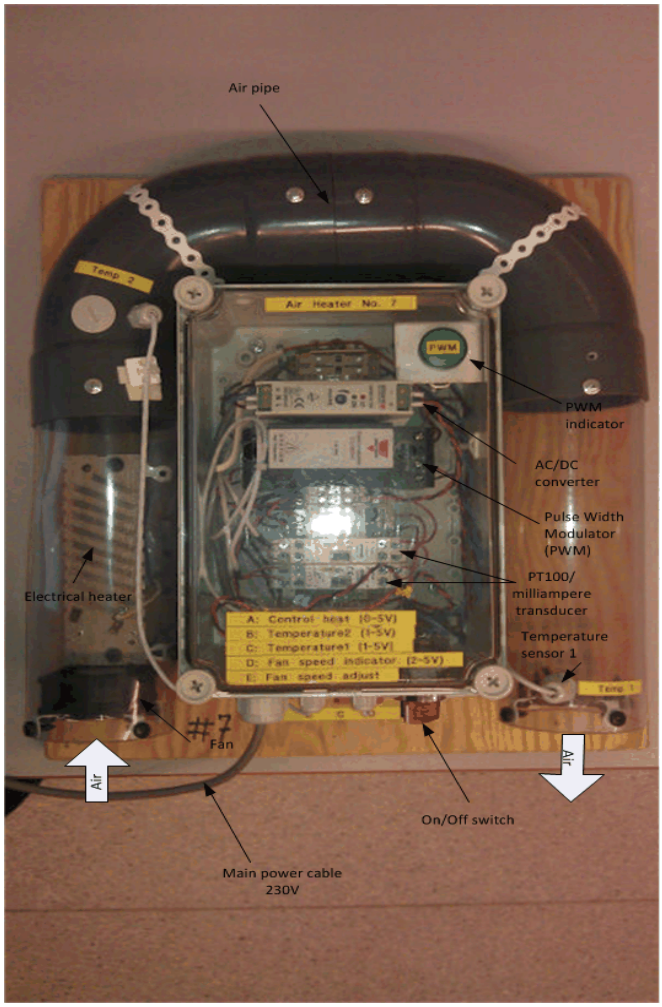

Figure 1-1 Air Heater system

Equation (1-1) is the mathematical model to the Air Heater system.

$$\dot{T_{out}} = \frac{1}{\theta_t}\{-T_{out} + [K_h u(t-\theta_d) + T_{env}]\} \quad (1\text{-}1)$$

Where:

- T_{out} is the air temperature at the tube outlet
- $\mathbf{u}$[V] is the control signal to the heater
- $\boldsymbol{\theta_t}$[s] is the time-constant
- $\boldsymbol{K_h}$[deg C/V] is the heater gain
- $\boldsymbol{\theta_d}$[s] is the time-delay representing air transportation and sluggishness in the heater
- $\boldsymbol{T_{env}}$ is the environmental(room) temperature

2 PROGRAM

In this chapter we will learn how to create the program used to control the temperature in the air heater model.

Before we start to program in DeltaV we would like to start on an empty program where no in or outs are used. This is easily done with the use of database. To avoid adding all the hardware configurations each time, we have premade a database that is empty, but contains the hardware configurations we need.

The First thing you need to do is log on to the DeltaV station with username: **Administrator** and password: **deltav**. When this is done choose DeltaV Desktop. Click on the start-menu and Database Administration. Double click on the icon Copy Database, choose Student1 and write your name in the Copy to field. Figure 2-1 is showing you how it should look like.

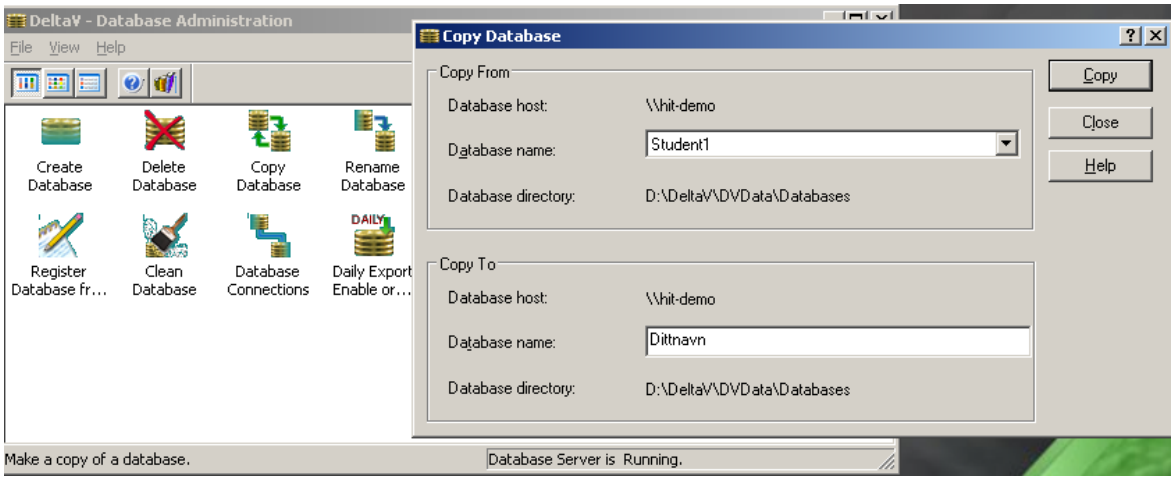

Figure 2-1 How to set up your database

Now set the database you just made active, with the Set Active Database button, this button is found in the Database Administration window. Select the database you just made and press ok.

Your database is now created and active. Go back to the start menu and run DeltaV Explorer.

Right click on “Control Strategies” and select “New Area”. Name your new Area Air heater.

We now have a new area called Air heater. Now we just need to configure a control module. Grab a PID module from library, see Figure 2-2. Choose Library→Module Templates→ Analog Control, Select the PID_LOOP and drag and drop it down to your Area called Air heater.

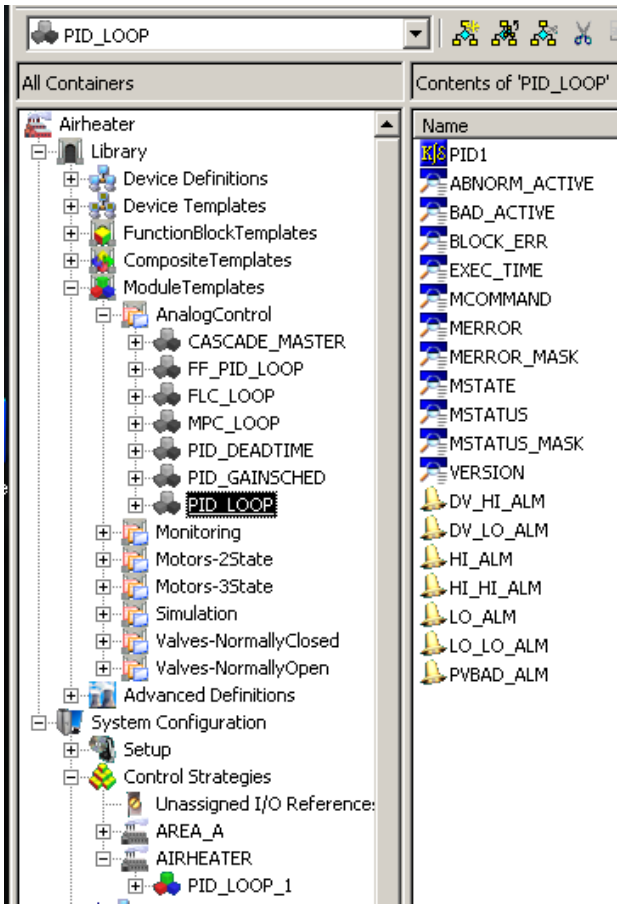

Figure 2-2 PID_LOOP

You will find the PID loop you just added in your Air heater area. Right click the PID_LOOP and choose open with Control Studio see Figure 2-3.

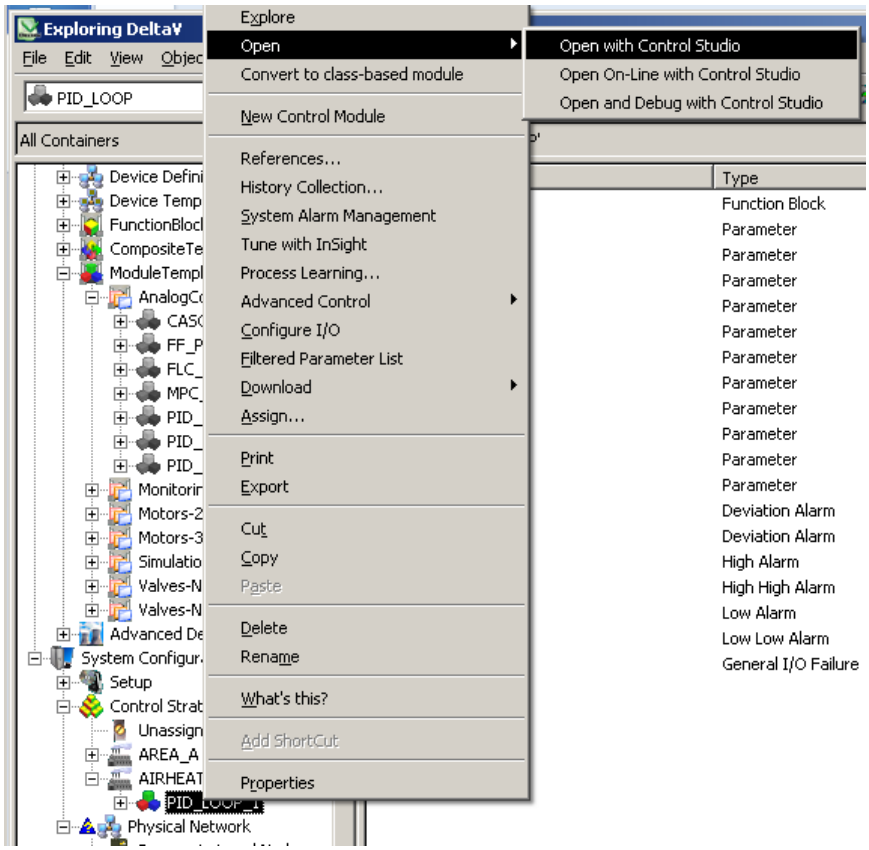

Figure 2-3 Open with Control Studio

We can now see that we have a PID block. The air heater model only needs one Analog inn and one analog out. We need to connect these to the block. Right click the PID block and choose Assign I/O-To Signal Tag see Figure 2-4.

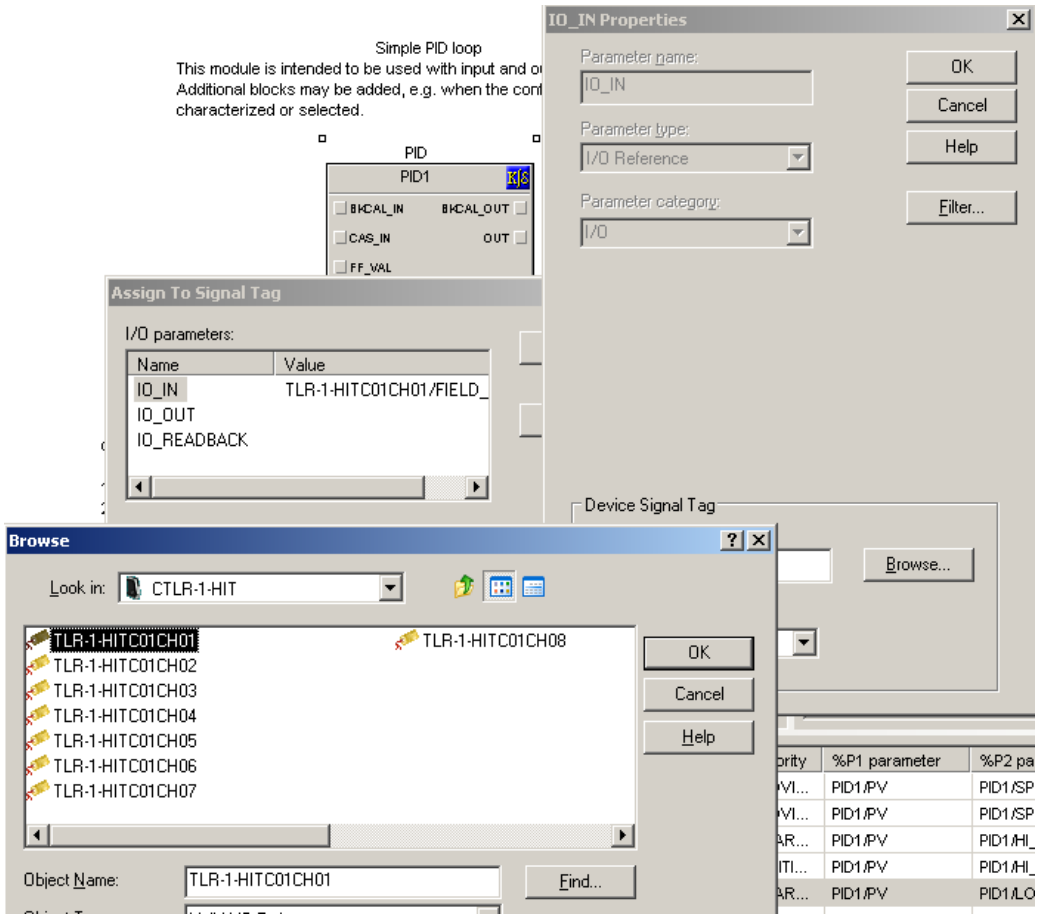

Figure 2-4 Assign I/O to Signal Tag

First choose IO_IN and press modify.

Browse Device Tag, Double click on CTLR and choose TLR-1-HITC01CH01.This is the first AI on the module (CH01)

Press ok until you are back to where you can choose IO_OUT. Browse Device Tag, double click on CTLR and choose TLR-1-HITC02CH02. This is the second OUT on the analog out module (CH02). Press OK and then close. We have now connected the I/O to the PID controller.

Now we need to activate the I/O. This is done in Exploring DeltaV. Choose applications → I/O configuration see Figure 2-5.

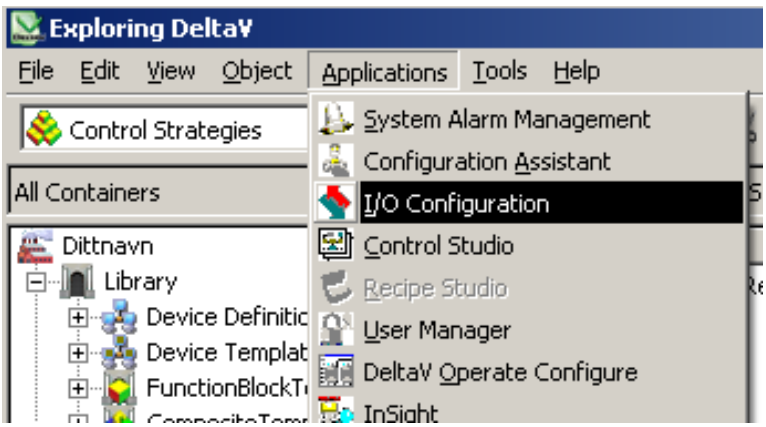

Figure 2-5 Exploring DeltaV

Here we can see all the modules that are connected to the station see Figure 2-6. Choose C01 and right click the CH01 and enable it. Do the same with C02→CH01.
CH01 under C01 and C02 should now be activated.

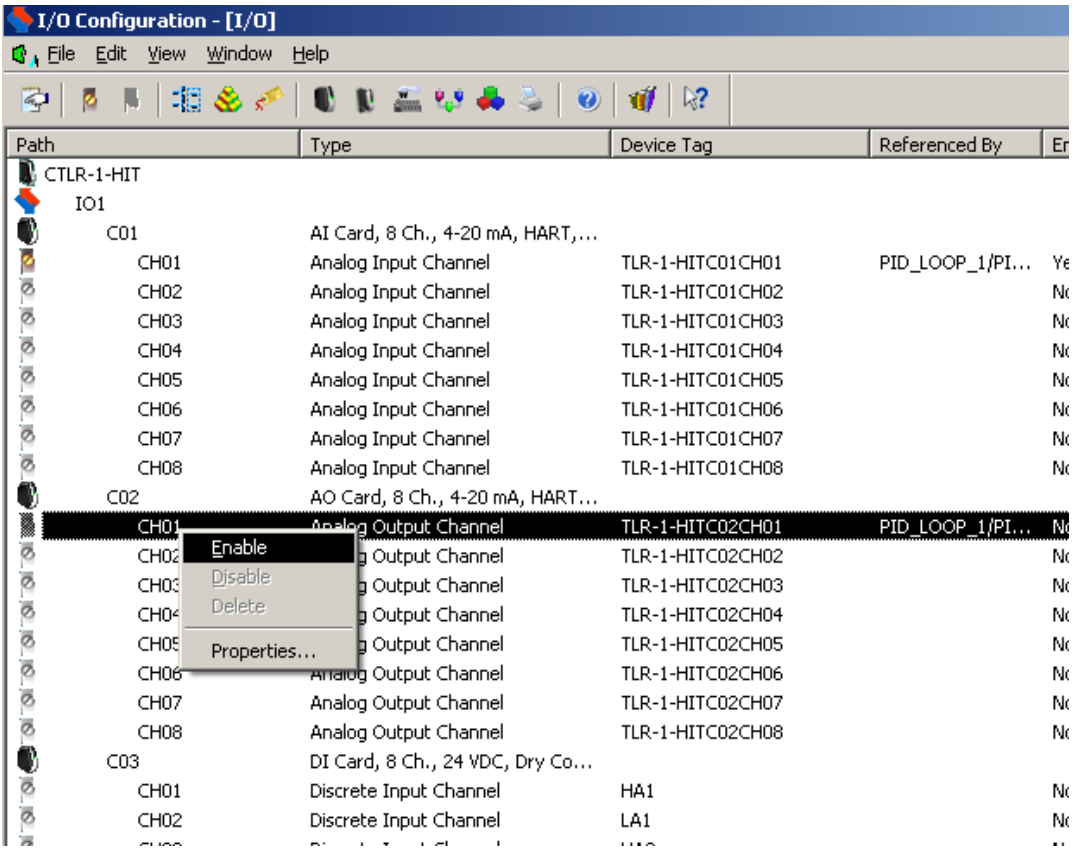

Figure 2-6 Configuration – I/O

Now we need to return to Control Studio and download our program. This is done by pressing the big arrow called Download, see Figure 2-7. You will then get a question box that asks if you want to assign the module. Press yes, Choose CTLR-1-HIT, press Ok, and yes on the Control Studio box. After that, press ok and yes on everything until you have downloaded. If you get any error messages just press Ok and proceed.

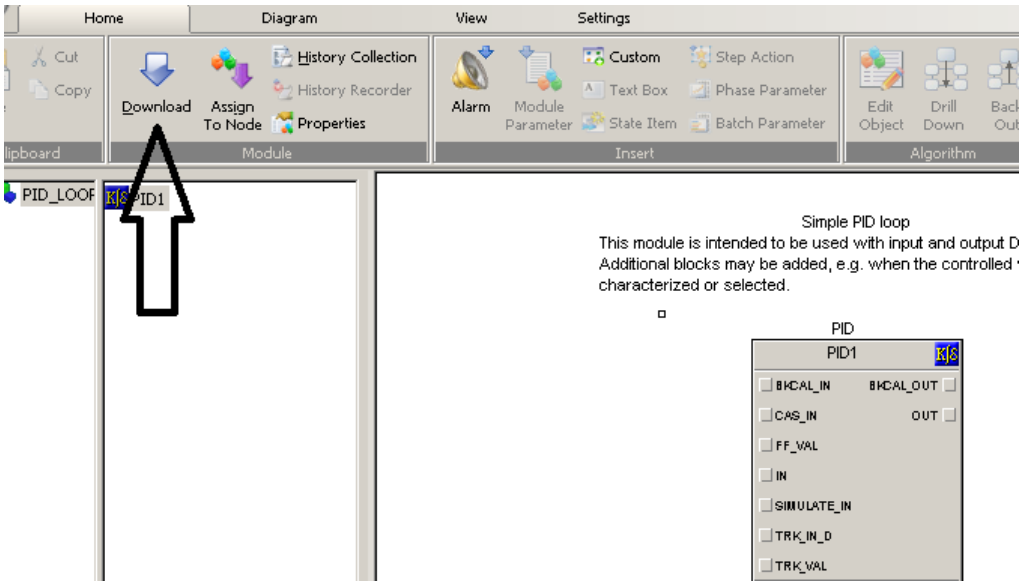

Figure 2-7 Download

The control module and I/O is now connected to the hardware module. For alarms and events to work we need to connect this to the history module that's premade in DeltaV

Then we return to Exploring DeltaV, choose Air heater and drag and drop it down to Alarms And Events see Figure 2-8.

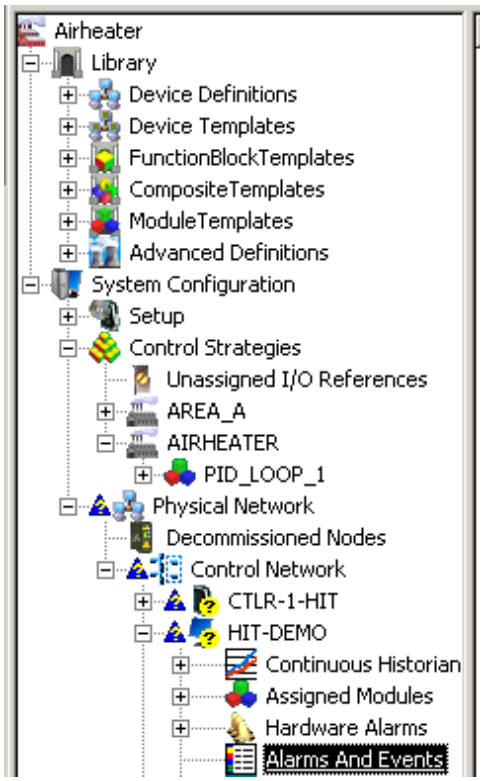

Figure 2-8 Alarms and Events

The last thing that needs to be done before we start making the user interface is to make sure everything is downloaded. Right click on Physical network and choose Download physical

network. Right click again and download setup data. Right click on Control Network, choose download control network. Right click again and download Setup Data, see Figure 2-9.

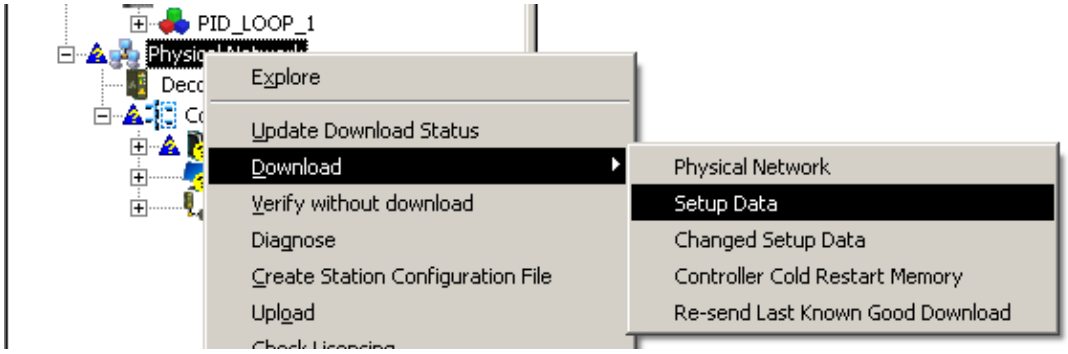

Figure 2-9 Download Setup Data

Enter CTLR-1-HIT, right click I/O and press download.

Before we make our interface we need to download the program in Control Studio once more. Every time you make a change to the program we need to download it again, see Figure 2-10.

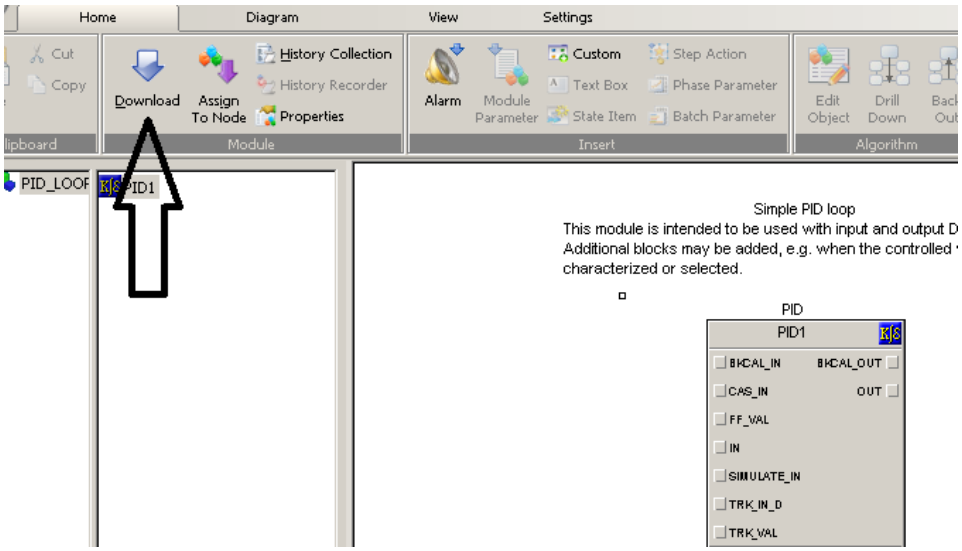

Figure 2-10 Download again

The program should now be ready. We just need to make the HMI

3 HMI

To be able to read and write values and simulate a process we need to create an HMI.

When you are in Exploring Deltav. Choose Applications and press: DeltaV operate Configure see Figure 3-1.

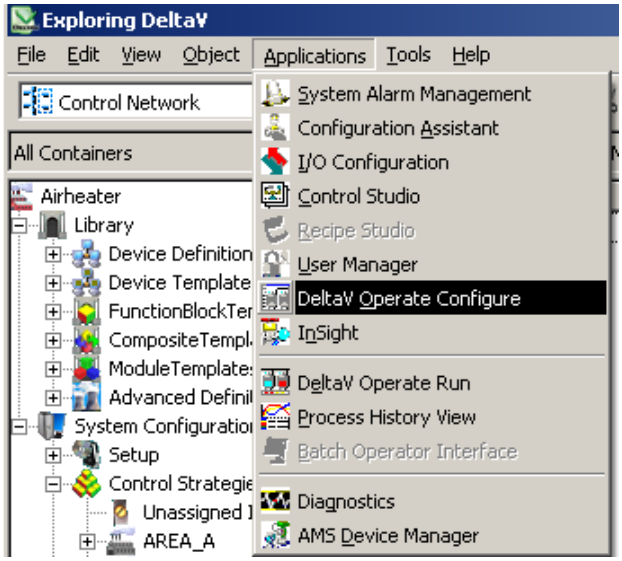

Figure 3-1 Exploring DeltaV

Press the +sign on the folder Pictures, then templates and double click on main. You will then get a standard picture. See Figure 3-2.

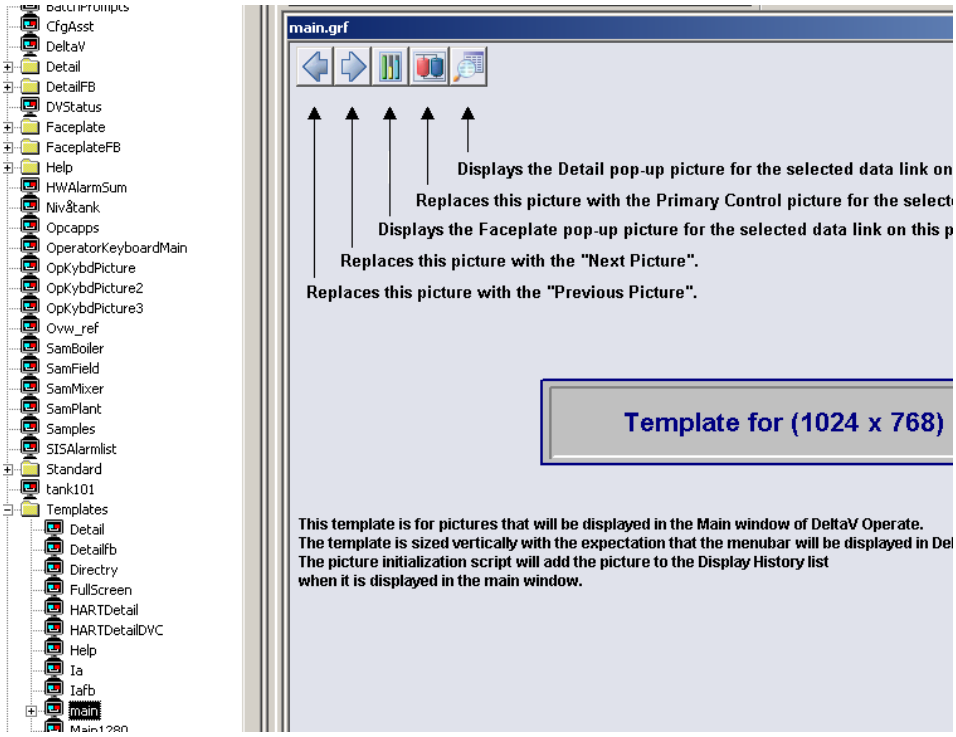

Figure 3-2 Main Picture

Delete all the text on the picture so you get a black picture like the one below see Figure 3-3.

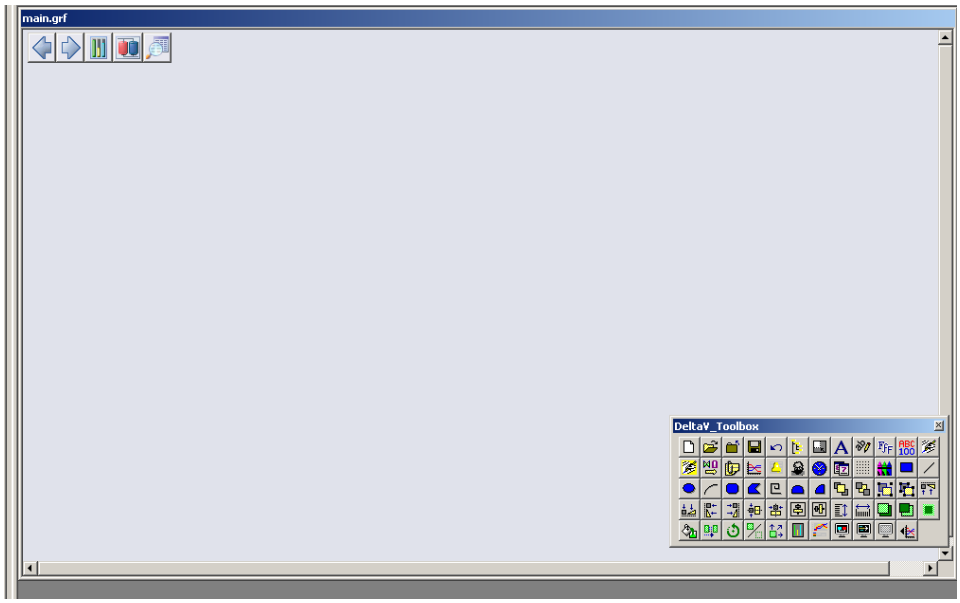

Figure 3-3 Blank Picture

Now we can begin creating our interface. In the left column you can find many premade components. We need a tube, a fan, a temperature measure and a heating element. Choose Dynamo sets and Blowers. Drag and drop a suitable fan onto the drawing board, see Figure 3-4.

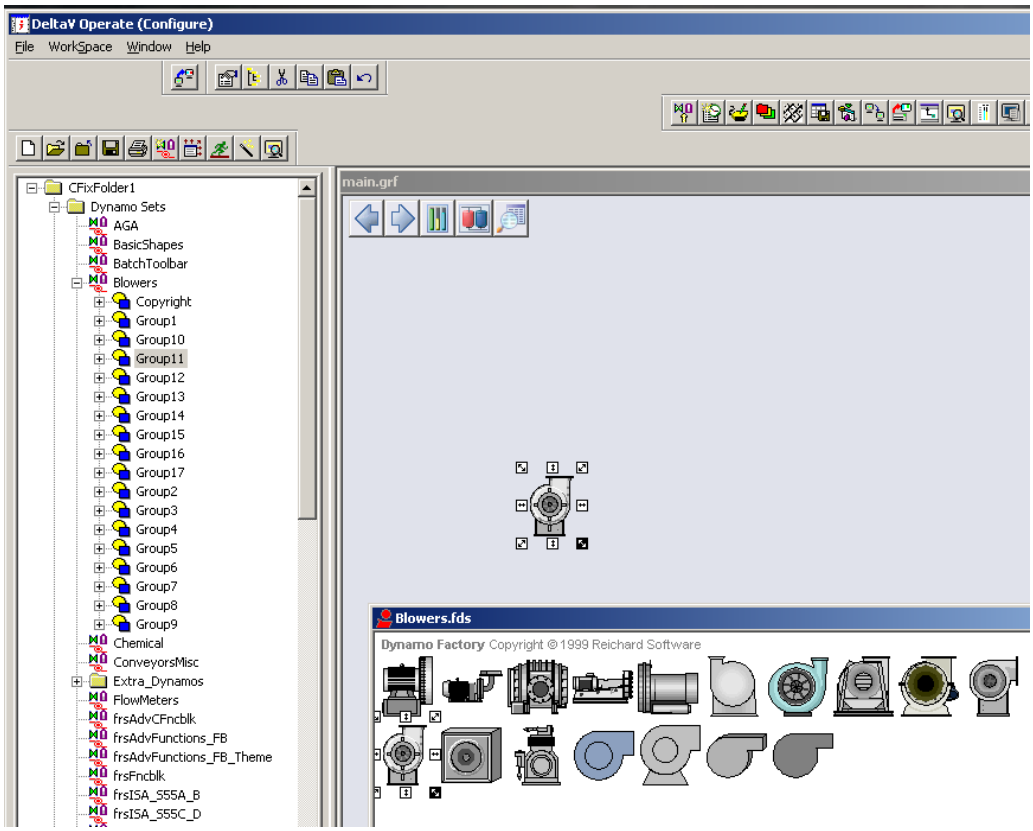

Figure 3-4 Fan

Then we choose “Pipes_DF”. Drag and drop Pipes and adjust them so you get something that looks similar to the Air heater model see Figure 3-5.

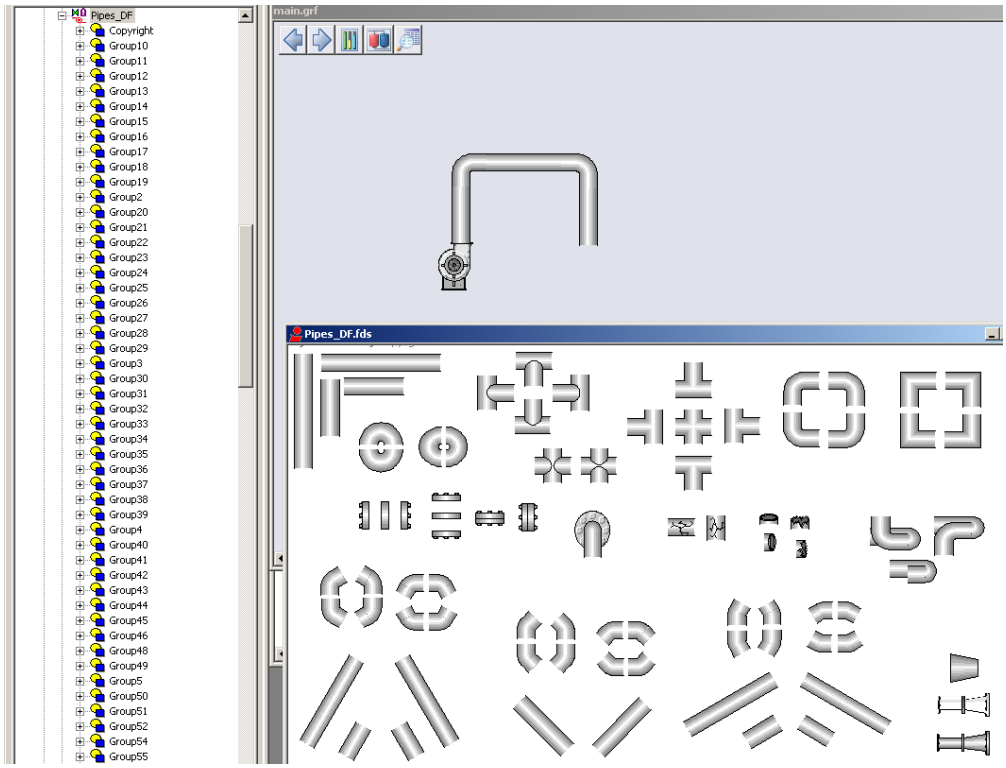

Figure 3-5 Pipes

Also drag a sensor to show where the temperature measurement is located. This you will find under Sensor. Also find a heating element from “GeneralMfg” see Figure 3-6.

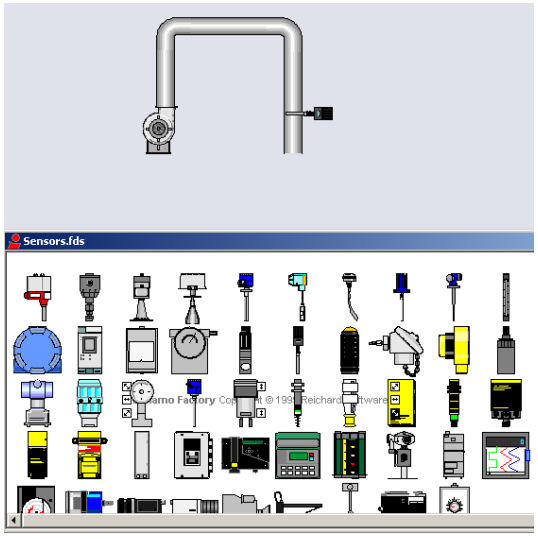

Figure 3-6 Temperature Measurement

Find a symbol that can replicate a heating element see Figure 3-7.

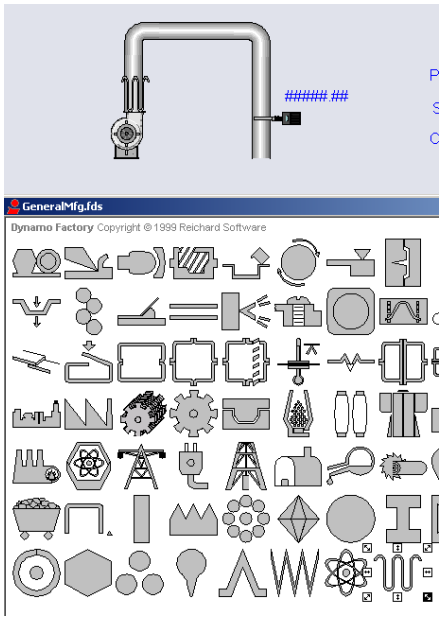

Figure 3-7 Heating element

Now we need some variables. Let's make one for PV, SP and OUT (so we can run the system manually)

Here we use "DeltaV_Toolbox". Press the big A and write the different variables we need. These need to be connected to our regulator. Let's start with PV. See Figure 3-8. Press "ABC100" that you can find in "DeltaV_toolbox". Then press the  button.
Browse DeltaV control parameters, air heater, pid_loop_1, pid1 and double click PV, then CV. Press ok until the Datalink box is left. Here we will swap Type to Numeric and press ok. Place the variable next to PV see Figure 3-9.

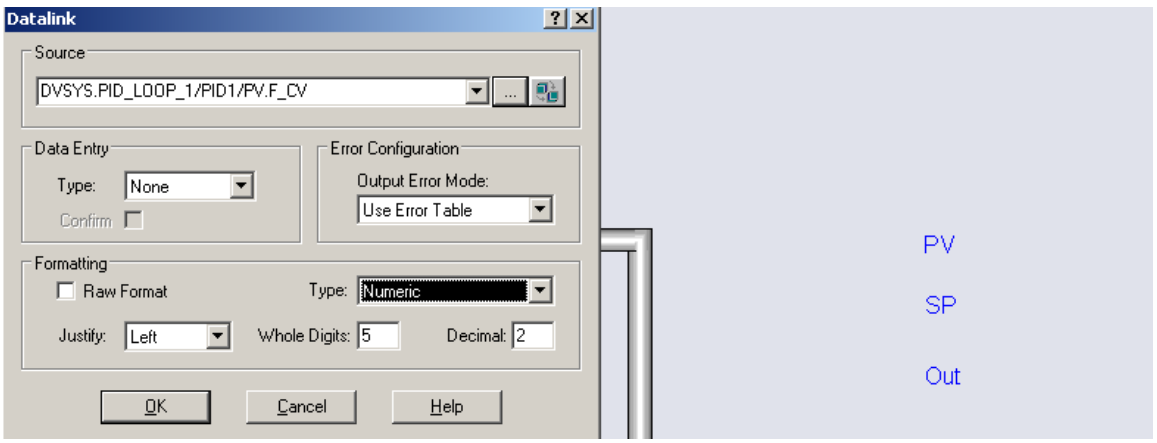

Figure 3-8 Datalink

Do exactly the same for SP, but choose SP, and in datalink box we need to choose in-place on the data entry to be allowed to change the variables. Place it next to SP.

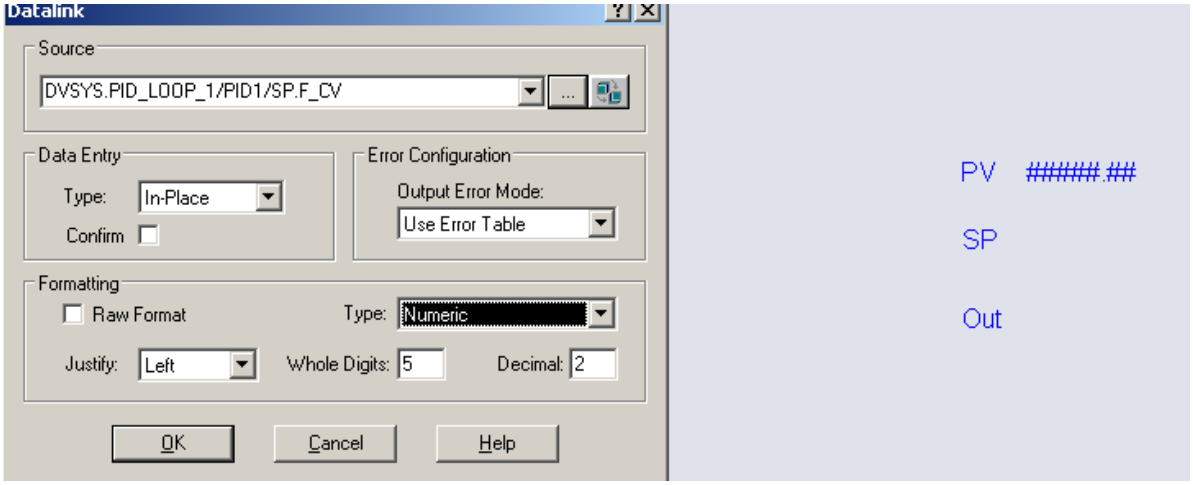

Figure 3-9 PV variable

The only one left is OUT. Exactly the same procedure as when we did with PV, except that we choose OUT. Place the variable next to Out.

You have now made the program and interface that can be used to regulate the temperature in the tube see Figure 3-10.

Press ctrl+w to set the program in run mode.

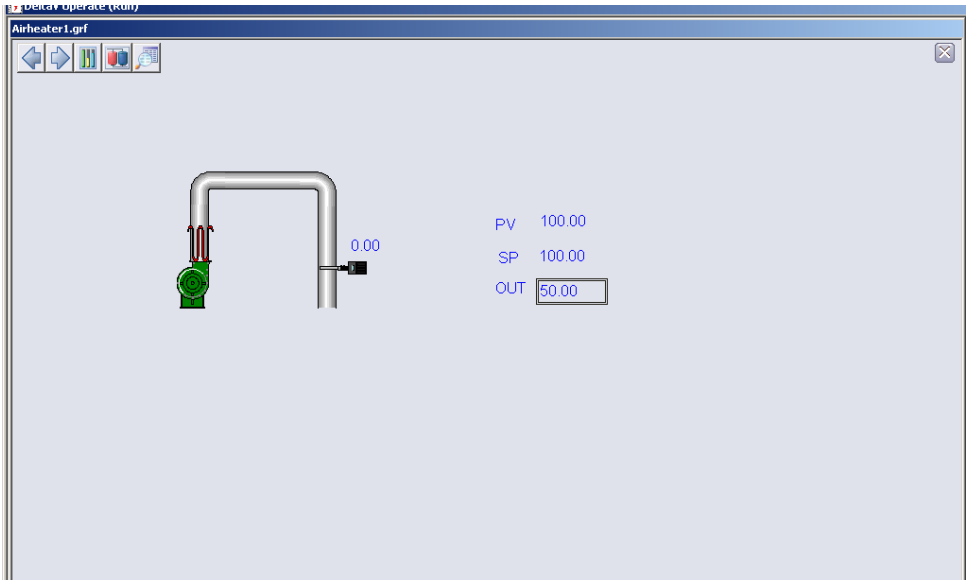

Figure 3-10 Model Completed

4 OPERATE

To operate the model we need to physical connect it to DeltaV. Figure 4-1 shows a sketch of how the model is planned to be wired

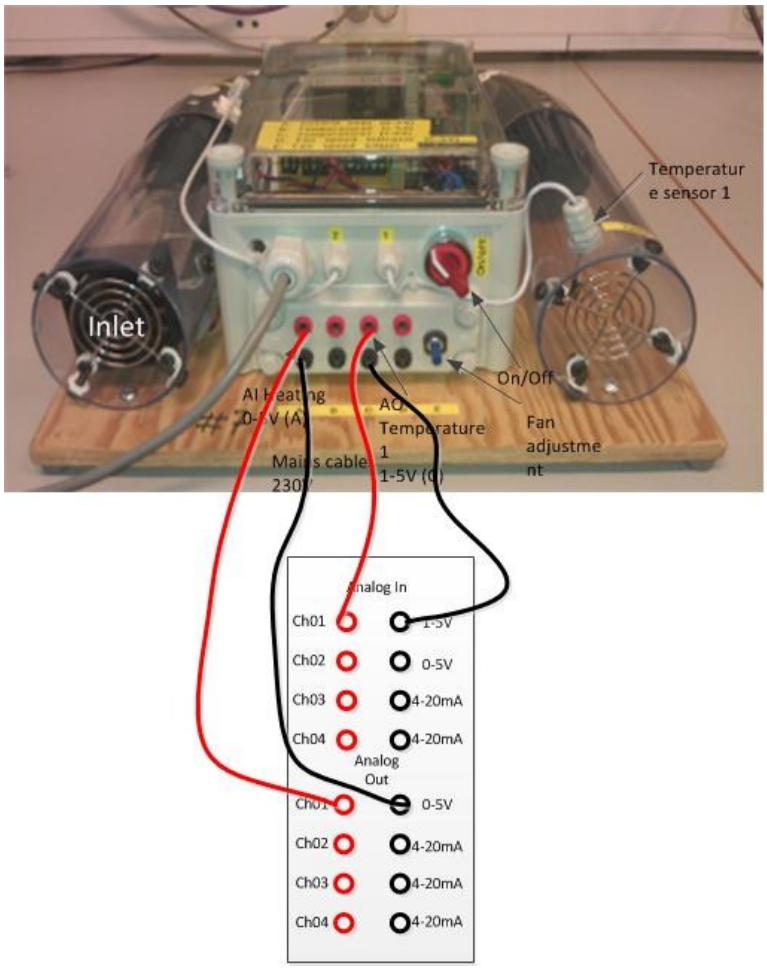

Figure 4-1 Connection of the model

When the model is connected you can press Ctrl+w to enable run mode, the model is now ready to be controlled.

To get the faceplate up you need to mark either SP or OUT. You then press the faceplate button in upper left corner. If you press the button with the magnifying glass on, the detail point will appear. This is where you change the PID parameters. Under “tuning”, Gain is the P-value, Reset is the I-value and Rate is the D-value. We choose P=2 and I=10 as start values. But feel free to experiment and find better values. See Figure 4-2

On the faceplate you have options to control the process manually or set it to auto. You can trend the regulator by pressing the button that looks like a trend. You will then see SP, OP and PV.

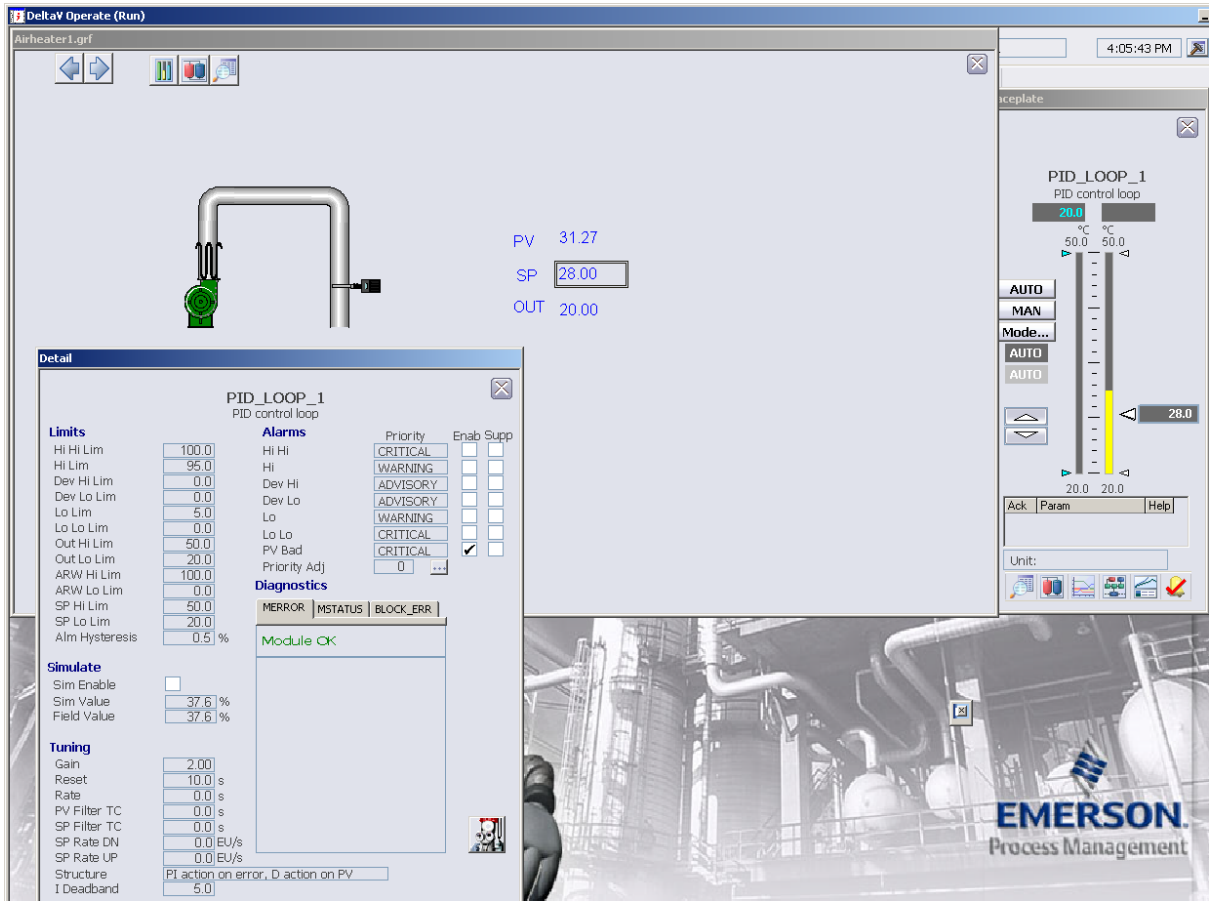

Figure 4-2 Operate Run