Skills for Life!

Jubail Technical Institute
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Department of Electrical and Electronics Skills

STUDENT HANDBOOK

Instrumentation Skills Practice 2

INCT 2433

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Prepared by
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Instrumentation Skills Practice 2
INCT 2433

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Unit 1: Plant Safety

1.1. Personal Protective Equipment (PPE)

Where engineering controls and safe systems of work have been applied, some hazards still remain for you in the workplace. You should therefore protect yourself using 'PPE' which must be available at the workplace.

Personal Protection:
The most vulnerable parts of the body and PPE available are as follows:

Eyes	Hazards include:	Chemical or metal splash, dust, gas,vapor and radiation	
	Options include:	Spectacles, goggles, face creams, helmets	

Head & Neck	Hazards include:	Impact from falling or flying objects, risk of head bumping, hair entanglement, chemical drips or splashes, climate/ temperature	
	Options include:	Helmets, bump caps, hair nets, cape hoods, scarves (for welding)	

Ears	Hazards include:	Impact noise, high intensities (even for short duration), pitch	
	Options include:	Ear plugs or muffs	

Hands & Arms	Hazards include:	Temperature extremes, cuts punctures, impact, chemicals, electric shock, skin irritation	
	Options include:	Gloves, mitts, wrist cuffs, armlets	
	Hazards	Wet, electrostatic build-	

Feet & Legs	include:	up,slipping, cuts, punctures, falling objects, heavy loads, metal or chemical splash, moving vehicles	
	Options include:	Safety boots and shoes with steel toe caps and steel mid sole, and knee pads	

1.2 Fixed Equipment & Machinery Safety

Hazards:

Many serious accidents at work involve machinery. Hair or clothing can become entangled in rotating parts; shearing can occur between 2 parts; crushing can occur between 2 parts moving towards one another, etc.

People can be struck by moving parts of machinery; cutting of severing can occur by sharp edges; material can be ejected from machinery causing injury.

Parts of the body can be drawn in or trapped between parts of rollers, belts and pulley drives; stabbing or puncture of the skin can occur by sharply pointed parts; and friction or abrasion is possible from contact with rough surface parts.

Extremes of temperature causing burns, and problems with electricity can also cause accidents.

Safety Guards:

Fixed guards enclosing the dangerous parts must be used; if practical, and must be fixed in place, eg with screws, or nuts and bolts.

Where fixed guards are not practical, (you may have to go near dangerous parts on a regular basis), other methods must be used, eg interlock the removable guard so that the machined cannot be restarted.

Operator's Checklist (Machinery):

1. Do you know how to stop the machine before starting-up?
2. Are all protective guards in position?
3. Is the area around the machine clean, tidy and free from obstructions?
4. Are you wearing the correct PPE?
5. Informed your supervisor if you feel anything is wrong with the machine or accessories?

Operator's Checklist (at Instrument Workbench)

Is the workbench clean and tidy?

Are all the tools and equipment to be used in good condition? Test instruments calibrated?

Are all Planning and Work Instructions readily available and up-to-date?

Are all components required correctly identified in accordance with work instructions?

Are all safety procedures in place (Danger warning signs, rubber matting, etc.)?

Don't:

Commence work until all tools, work instructions and components are readily available.

1.3 Hand Tools

1. Hand tools must be properly maintained and stored safely away on completion of task.

2. Hammers: avoid split, broken or loose shafts, worn or chipped hands. Head should be properly secured to the shaft.

3. Files: Never use without having a proper handle fitted. Never use a file as a lever. They are very brittle and will break quite easily.

4. Screwdrivers: Must never be used as chisels and hammers should never be used on them.

5. Chisels: The cutting edge should be sharpened to correct angle. Don’t allow the head to spread to a mushroom shape. Grind off the sides regularly.

6. Spanners: Avoid splayed jaws. Scrap any spanner that shows signs of slipping. Make sure you use spanners of the correct size. Don't improvise by using pipes, tubes, etc as extension handles.

Note: Split or damage handles on any hand-tools is dangerous, also can lead to accidents.
Report any damaged tools immediately to your safety officer or supervisor.

- **Electrical Power Tools:**

We should be aware of the three main hazards where electricity is concerned:

1. Contact with live parts 2. Fire 3. Explosion

It is essential therefore that we take necessary steps to ensure portable tools are used in a safe and proper manner.

1. Portable tools can be run at 110 V from an insulating transformer. In addition power tools should be double insulated.

2. Provide enough socket outlets. Avoid misuse of multi-plug adapters.

3. Fit correctly rated circuit-breaker, fuses, etc for the circuit they protect.

4. Fit a switch or isolator near any machine to cut off power in an emergency and mains switches must be readily accessible and clearly identified.

5. Flexible cables must always be connected to a suitable plug with the flex securely clamped to prevent the wires being pulled from their connections. Don't carry a portable electric tool by its cable.

6. Ensure plugs, sockets and fittings are sufficiently robust and adequately protected for the working environment.

7. Use special protection where electrical equipment is used in flammable or dusty environments.

8. Suspect faulty equipment must be taken out of use and clearly labeled.

9. Ensure equipment is switched off before plugging or unplugging.

10. Ensure appliances are unplugged before cleaning or making adjustments

Hand tools must be properly maintained and stored safely away on completion of a task.

Avoid split, broken or loose shafts, worn or chipped heads. Heads should be properly secured to the shafts.

1.4 Electrical Portable Tools

We should be aware of the 3 main hazards where electricity is concerned:

1. Contact with live parts
2. Fire
3. Explosion

It is essential therefore that we take necessary steps to ensure portable tools are used in a safe and proper manner. The following should be considered:

1. Portable tools can be run at 110 volts from an isolating transformer. In addition power tools should be double insulated.
2. Provide enough socket outlets. Avoid misuse of multi-plug adapters.
3. Fit correctly rated circuit-breakers, fuses, etc for the circuit they protect.
4. Fit a switch or isolator near any machine to cut off power in an emergency and mains switches must be readily accessible and clearly identified.
5. Flexible cables must always be connected to a suitable plug with the flex securely clamped to prevent the wires being pulled from their connections. Do not carry a portable electric tool by its cable.
6. Ensure plugs, sockets and fittings are sufficiently robust and adequately protected for the working environment.
7. Use special protection where electrical equipment is used in flammable or dusty environments. (See specialist advice).
8. Suspect or faulty equipment must be taken out of use and clearly labeled. Company's Safety representative must be informed.
9. Ensure equipment is switched off before plugging or unplugging portable equipment.
10. Ensure appliances are unplugged before cleaning or making adjustments.

1.5 Compressed Air

Many workshops are equipped with high pressure air lines. Compressed air can be very dangerous if used carelessly and can cause explosions.

Never

1. Misuse an airline or point it at another person.
2. When in use, pipes or hoses must be laid clear of traffic.
3. All gauges, valves and connections should be regularly checked as a matter of routine.
4. Always Visually Check Air Hoses Before use and Report any Defects

1.6 Safety Signs

As you go about your work, you will see a variety of signs, posters and notices. Some of these will be familiar to you – a 'No Smoking' sign for example; others you may not have seen before. Take notice of them. They give warning of possible danger and must not be ignored.

Safety signs fall into 4 separate categories:

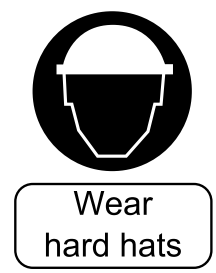
These can be recognized by their shape and color. Sometimes they may be just a symbol; other signs may include letters of figures and provide extra information such as the clearance height of an obstacle or the safe working load of a crane

1. **Prohibition Signs**

Shape	Circular
Color	Red border and cross bar Black symbol on white background
Meaning	shows what must not be done
Example	'No Smoking'

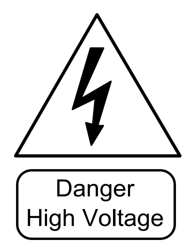
2. **Mandatory Signs**

Shape	Circular
Color	White symbol on blue background
Meaning	Shows what must be done
Example	'Wear hand protection'



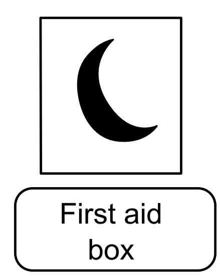
3. **Warning Signs**

Shape	Triangular
Color	Yellow background with black border
Meaning	Warns of hazard or danger
Example	'Caution', 'Risk of Electric Shock'



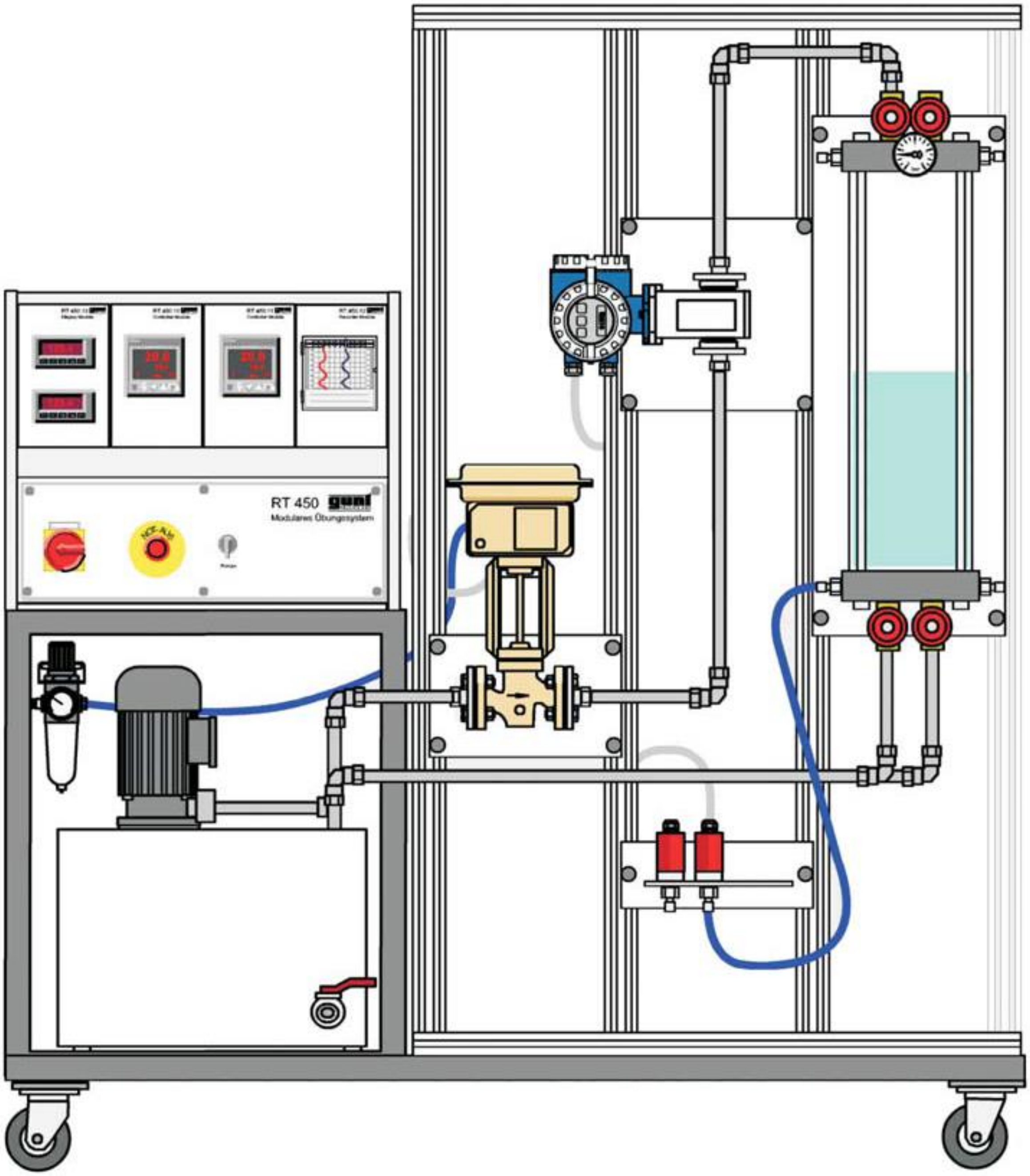
4. **Information Signs**

Shape	Square or oblong
Color	Red symbols on White background
Meaning	Gives information of safety provision
Example	'First Aid Point'



2. (GUNT RT-450) Modular Training System

RT450 Modular Training System



2.4 Introduction

The basic concept of the RT450 Modular Training System is to enable students to flexibly realize their own ideas for process, automation and control engineering.

A comprehensive range of accessories with different control system modules, numerous sensors and actuators, PLCs, different controllers and recorders can be used to investigate a wide variety of individual problems from these areas.

The following options are available to the student:

- Designing a complete process engineering system
- Planning the process engineering, measuring and electrical design in detail
- Setting up the system mechanically and electrically
- Testing the system
- In particular, studying the control engineering behavior

The components are prepared on module boards. Only the required pipework has to be set up using the easy to operate clamp fittings. The majority of the electrical components are fitted with connectors, which means that the electrical wiring is also easy to carry out.

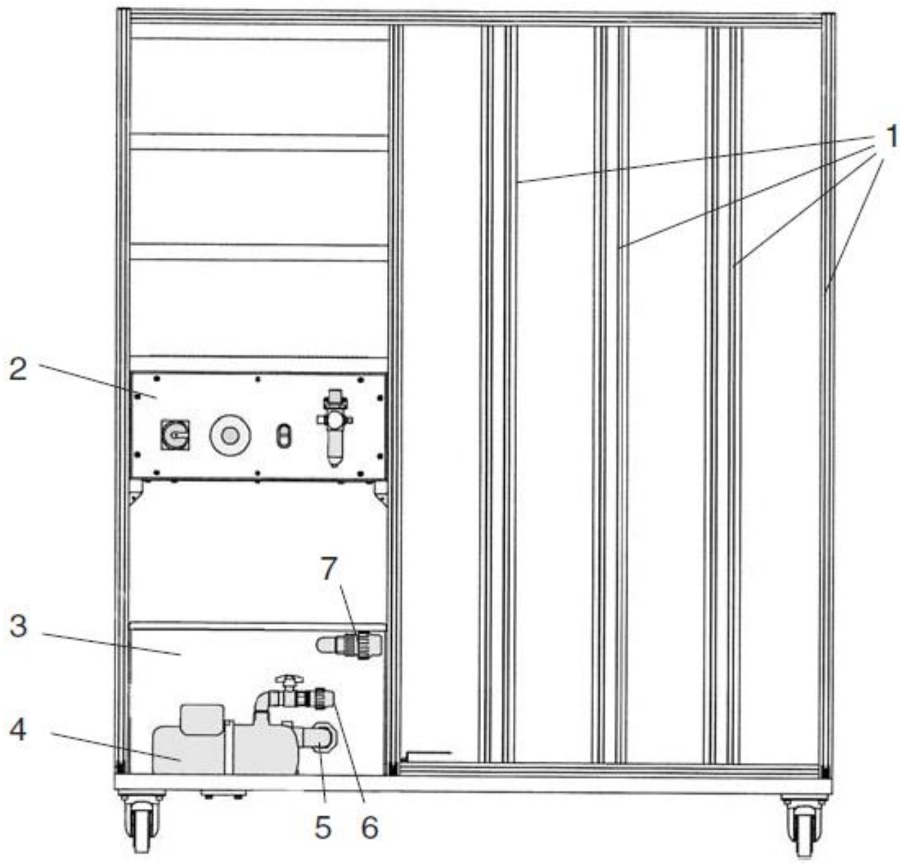
The system is designed for training and to illustrate the handling and methods used for industrial applications. However, it is not suitable for actual industrial production.

2.5 Basic Module Description

Basic Module

The **RT450** Training System Basic Module is used to:

- Set up and perform all experiments
- Supply all experiments with power and media.



1 Rails
2 Control cabinet
3 Water tank
4 Pump
5 Pump outlet
6 Pump inlet
7 System water return

The support frame is made up of rails, which contain grooves for attaching the individual components for an experiment.

Mains connection

The mains cable for the basic module's main electrical connection is located on the left-hand side of the control cabinet

Compressed air connection

Next to the mains connection is a threaded nozzle for the connection of the compressed air supply using a rapid action hose coupling

Power supply sockets

On the right-hand side of the control cabinet are three sockets that can be used to supply the auxiliary electrical equipment with mains voltage. These sockets are linked to the master switch and carry voltage as soon as the switch is turned on.

Contact terminals

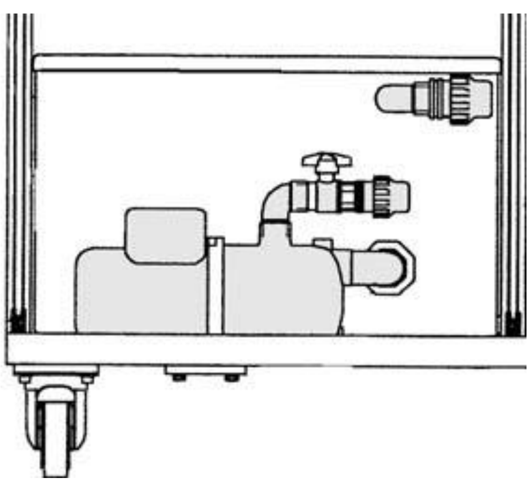
On the top of the control cabinet is a mounting rail with contact terminals and an electrical cut-out. These are used for wiring experiments.

Sockets X40 - X43

These are used to connect units with PROFIBUS modules to one another.
NOTE! To prevent malfunctions caused by open cable ends, sockets X40 and X43 must always be used first. X41 and X42 should then be used if required.

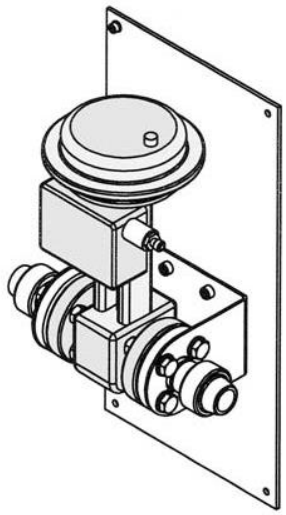
Sockets X30 - X34

These are used to supply units with a supply voltage of 24V DC.

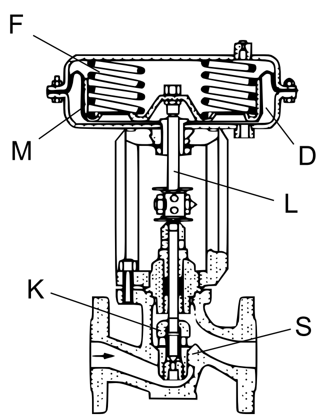


The tank is filled with water for filling level and flow rate experiments. A pump can be used to pump the water through the pipe system for one of these types of experiment. The pump is not regulated, it only has the statuses ON (0) or OFF (I).

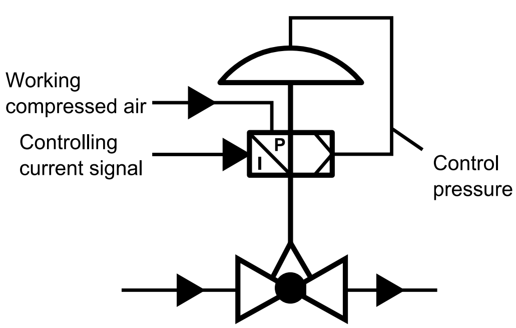
2.6 Control System Modules Description



Single-seated gate valves with pneumatic drives and integrated electro pneumatic i/p positioners are used as actuators for the system. On the control valve, the flow quantity is changed by the valve stroke. With the valve closed, the valve cone (**K**) is located in the valve seat (**S**). When the valve cone is lifted by the valve rod (**L**), a gap opens up between the valve cone and the valve seat, through which a certain quantity of material can flow. This gap is enlarged or reduced as required. The RT450.20 - RT450.22 valves differ in terms of their flow resistance (kvs value)

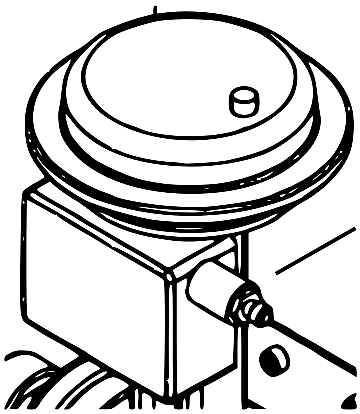


The valve rod is driven by compressed air, which acts on a diaphragm (**M**) in the head of the valve. This is connected to a mechanical spring (**F**), which is compressed by the resulting compression force. This results in a defined stroke for every pressure value in the pressure chamber (**D**).



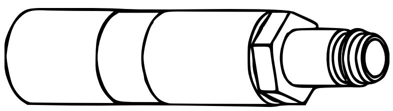
The i/p positioner used in combination with the valve has the task of enabling the pneumatically operated valve to be used with electrical input signals. (It represents a separate, subordinate control system.) The controlling electrical current signal is converted into a control pressure, which acts on the diaphragm.
The standard control signals are:

- 0...20mA or
- 4...20mA (live zero)

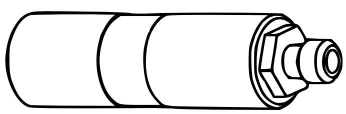


In order to function, the valve must be supplied with working compressed air. This is done using the compressed air connection on the basic module, which supplies working air to pneumatic valves (see Fig. 2.2, 12). The working pressure is **2.5 bar**. (For connection, see section 5.2.2)

The valves are connected to the pipe system with PP-H plastic pipes and clamp fittings (see section 5.5.1).



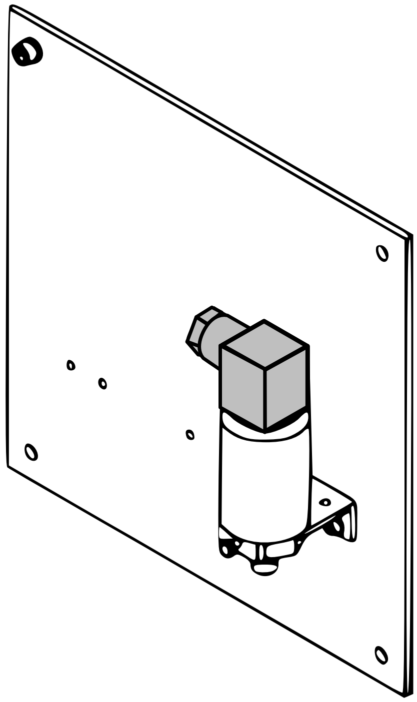
For experiments in which hoses are to be used instead of pipes (e.g. temperature control), the connection on the relevant valve can be changed into a connection with rapid action coupling for the cooling water hose using an adapter (see section 5.5.1 and 5.5.2).



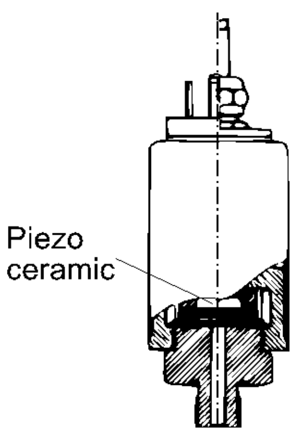
For experiments using compressed air, the connection on the relevant valve can be changed into a connection with rapid action pneumatic coupling using an adapter (see section 5.5.1 and 5.5.2).

NOTE! To ensure a secure connection, the adapters have a groove around the circumference of the pipe (see section 5.2.1).

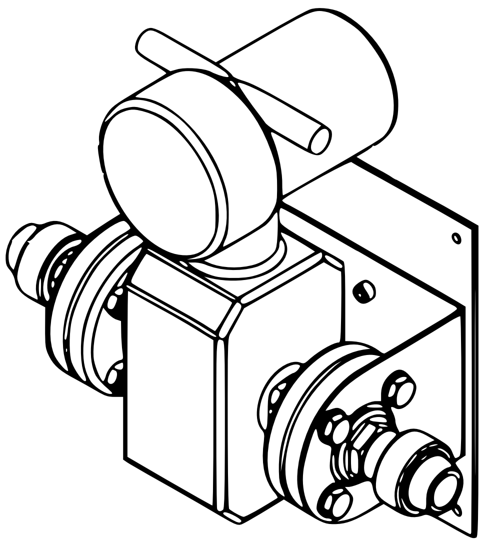
2.6.1 RT450.30 – RT450.32 Pressure Sensors

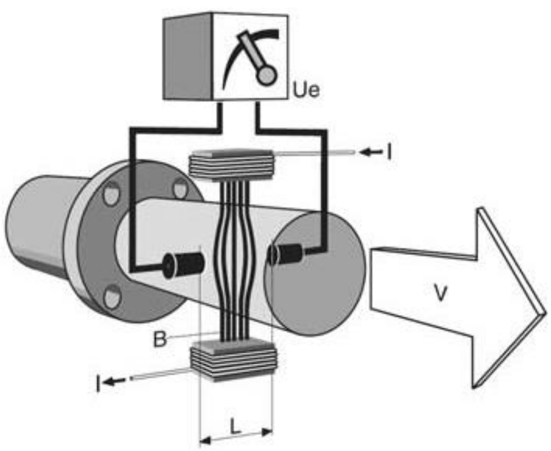


The training system includes piezo ceramic pressure transmitters as sensors for pressures.
This kind of sensor consists of ceramic material, which uses piezo-electric effects to measure.
One advantage of this technology is the favorable dynamic behavior of the sensors. Because of their very short response times, they are equally well suited for static and dynamic pressure measurements.
The sensor material has almost no temperature-dependent drift and does not age. This makes recalibration practically unnecessary. The sensors measure the relative pressure, i.e. the pressure difference from the environment.
The sensor contains an integrated p/i converter with two-wire technology. This means that a standardized current signal of 4...20 mA that is proportional to the pressure to be measured is available at the output.
One of the sensors is connected to the pipe system by a pneumatic rapid action coupling (see section 5.5.2).



2.6.2 RT450.34 Flow Rate Sensor





The training system has an electronic sensor for flow rate measurements. It is suitable for measuring the flow rate of liquids in enclosed pipework. The measured variable is the flow speed. Typical measuring ranges are v = 0.01 ... 10 m/s.

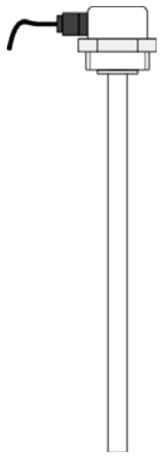
The measuring principle is magnetic-inductive based on Faraday's law. A voltage is induced in a conductor that moves in a magnetic field. The substance to be measured flows through the flow rate sensor and thus corresponds to the moving conductor. Therefore, for this type of measurement the flowing medium must have a minimum conductivity. The magnetic field is generated by a direct current. The induced voltage acts proportional to the flow speed and is measured by two measuring electrodes. The value and the known pipe cross-section are used to calculate the flow rate. After rearrangement, a standardized current signal of 4...20 mA that is proportional to the flow rate is available at the output.

This sensor has the advantage that there are no pressure losses due to flow resistance. This is because no moving mechanical elements are involved and the pipe cross-section in the system remains unchanged.

The flow rate sensor is connected to the pipe system with PP-H plastic pipes and clamp fittings (see section 5.5.1).

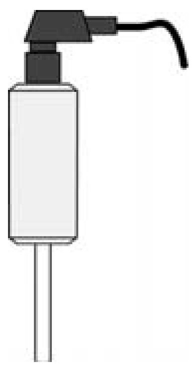
Alternatively, the hose adapter familiar from the pneumatic valves (RT450.20-22) can be used to connect hoses.

2.6.3 RT450.35 Level Sensor, capacitive



The RT450.35 Level Sensor is a capacitive sensor. The measuring rod immersed in the water represents an electric condenser. As the dielectric constants of water and air differ considerably, the capacity of the condenser changes measurably depending on the water level.
The sensor has a two-wire design and is fitted with a transducer. A standard 4 ... 20mA signal proportional to the level is output.

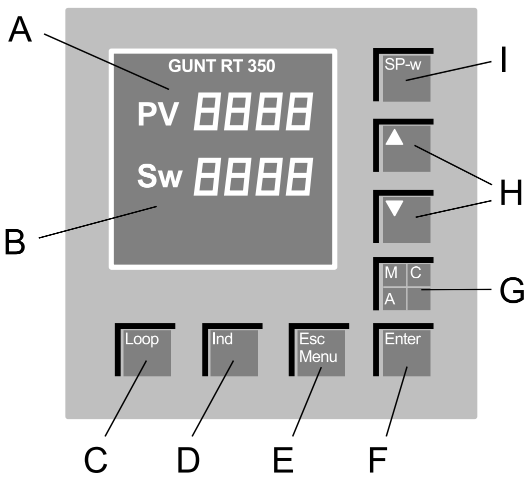
2.6.4 RT450.36 Temperature Sensor PT100



The RT450.36 Temperature Sensor is a Pt100 sensor. The measuring principle is based on temperature- dependent electrical resistance.
The sensor has a two-wire design and is fitted with a transducer, which outputs a standard 4 ... 20mA signal proportional to the temperature.

2.7 Controller, displays and recorder

2.7.1 Continuous controller



The RT450.10 Continuous Controller Module is a universal digital controller based on a microprocessor. The controller therefore has universal configuration and parameter definition.
All measured data is digitally processed and converted back to analogue variables prior to output.
Operation is also based on digital inputs. It has the
following features:

- Menu-based
- Input using push buttons
- Display using multifunction display

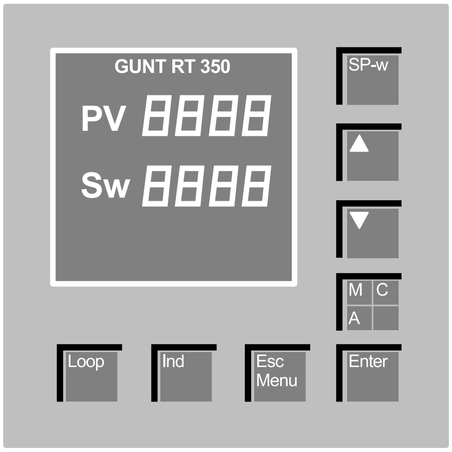
A	Control variable X display
B	Reference variable W display (in automatic mode), control value Y display (in manual mode)
C	“Loop” changeover
D	Display changeover switch
E	Menu selection key
F	Confirmation key for inputs, acknowledgement of alarms
G	Mode changeover switch A = Automatic, M = Manual, C = Cascade
H	Selection key, up / down
I	Reference variable changeover switch

The module has two separate analogue signal inputs and two analogue control outputs for control tasks.

<table>
<tr><td colspan="4">RT450.10 Continuous Controller</td></tr>
<tr><td colspan="4">Digital connector X2</td></tr>
<tr><td>X2.1</td><td>DI 01</td><td>Input</td><td>24 V</td></tr>
<tr><td>X2.2</td><td>DI 02</td><td>Input</td><td>24 V</td></tr>
<tr><td>X2.3</td><td>GND</td><td>Earth</td><td></td></tr>
<tr><td>X2.4</td><td>DO 03</td><td>Contact 1 output</td><td></td></tr>
<tr><td>X2.5</td><td>DO 03</td><td>Contact 1 output</td><td></td></tr>
<tr><td>X2.6</td><td>DO 04</td><td>Contact 2 output</td><td></td></tr>
<tr><td>X2.7</td><td>DO 04</td><td>Contact 2 output</td><td></td></tr>
<tr><td colspan="4">Analogue connector X3</td></tr>
<tr><td>X3.1</td><td>AI 01</td><td>+ Input</td><td rowspan="2">4 – 20 mA</td></tr>
<tr><td>X3.2</td><td>AI 01</td><td>- Input</td></tr>
<tr><td>X3.3</td><td>AI 02</td><td>+ Input</td><td rowspan="2">4 – 20 mA</td></tr>
<tr><td>X3.4</td><td>AI 02</td><td>- Input</td></tr>
<tr><td>X3.5</td><td>AO 01</td><td>+ Output</td><td rowspan="2">4 – 20 mA</td></tr>
<tr><td>X3.6</td><td>AO 01</td><td>- Output</td></tr>
<tr><td>X3.7</td><td>AO 31</td><td>+ Output</td><td rowspan="2">4 – 20 mA</td></tr>
<tr><td>X3.8</td><td>AO 31</td><td>- Output</td></tr>
</table>

The controller has several configuration levels. For details of setting and operation, refer to section 5 or the controller manual.

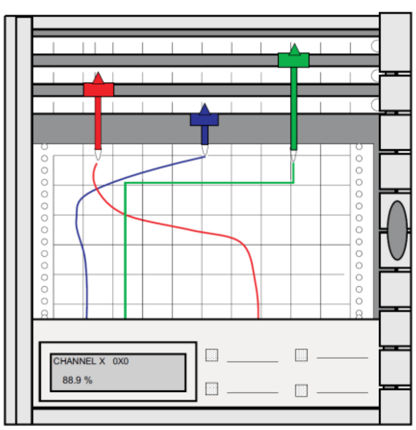
2.7.2 Switching controller



The RT450.11 “Switching Controller Module” is comparable with the RT450.10 “Continuous Controller Module” in terms of its structure and operation.
However, unlike the continuous controller module, it only has one analogue signal input and two switching outputs. There are no analogue outputs.

RT450.11 Switching Controller Module			
Signal connector X2			
X2.1	AI 01	+ Input	4 – 20 mA
X2.2	AI 01	- Input	
X2.3	DO 03	Contact 1 output	
X2.4	DO 03	Contact 1 output	
X2.5	DO 04	Contact 2 output	
X2.6	DO 04	Contact 2 output	

2.7.3 Line recorder



The RT450.12 “Chart Recorder Module” is used to plot three independent analogue electrical standard signals. The signals are continuously plotted on paper strips in three different colors.
The speed of the paper feed is adjustable.

RT450.12 Chart Recorder Module			
Signal connector X2			
X2.1	AI 01	+ Input channel 1	4 – 20 mA
X2.2	AI 01	- Input channel 1	
X2.3	AI 02	+ Input channel 2	4 – 20 mA
X2.4	AI 02	- Input channel 2	
X2.5	AI 03	+ Input channel 3	4 – 20 mA
X2.6	AI 03	- Input channel 3	

3. Project Planning

The RT450 Modular Training System is designed to be used to introduce students to all the practical aspects of control engineering. This includes process and automation engineering and also the technical aspects. This training system therefore allows these topics to be dealt with exhaustively without the need to follow a specific control engineering objective.
Nevertheless, the guiding principle of the training system is to define a control engineering task and then to solve it, with the associated planning and implementation stages.

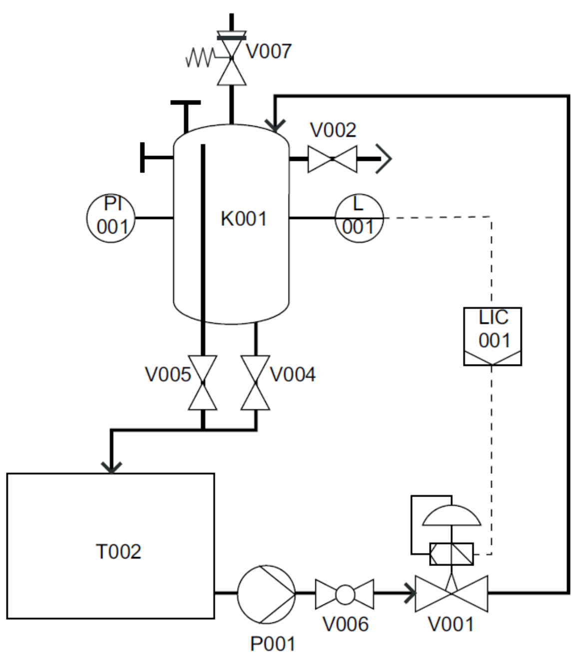
Before a project can be implemented and set up, its objective must first be clearly defined. It can (and must) then be planned.
The basis for all considerations is initially a **process flow diagram**. This process flow diagram can include additional information about the measuring, control and regulation tasks. It then contains all of the information necessary to identify the process engineering procedure, such as the position and number of measuring points, the arrangement and design of the valves and pumps, the size of the tanks, the flow rates, the type of materials etc.
More important for the layout of a system is the **PI flow diagram** (pipework and instrumentation flow diagram). This includes the designation of all components. In addition, the nominal diameter and pressure of the pipes and valves are specified here. It also includes the measuring, control and regulation tasks.

The PI flow diagram is then used to develop more detailed **pipework** and **electrical circuit diagrams**. To realize the system, the **layout** and **wiring diagrams** then need to be produced.

4. Process & Electrical Diagrams

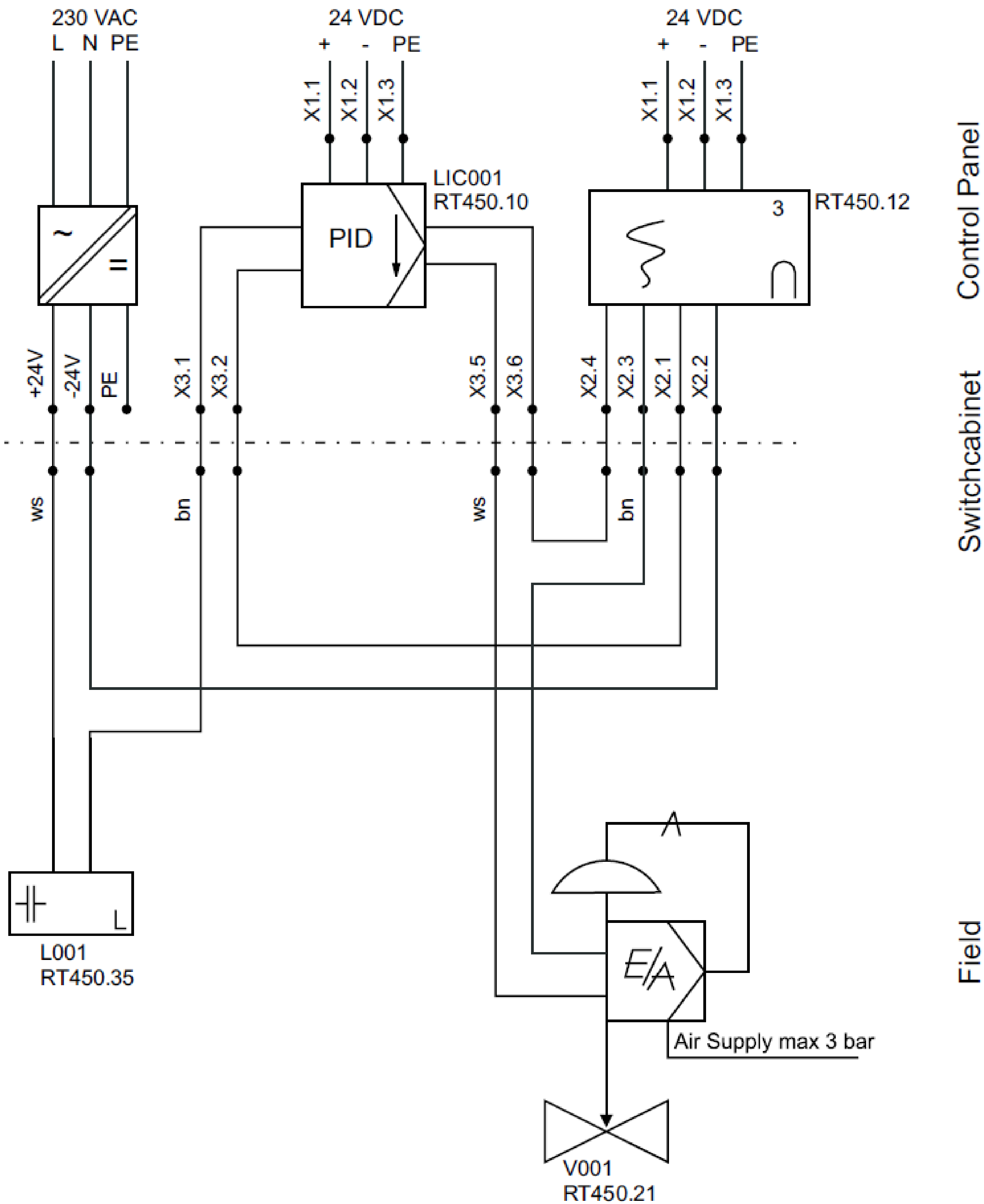
4.4 Liquid level

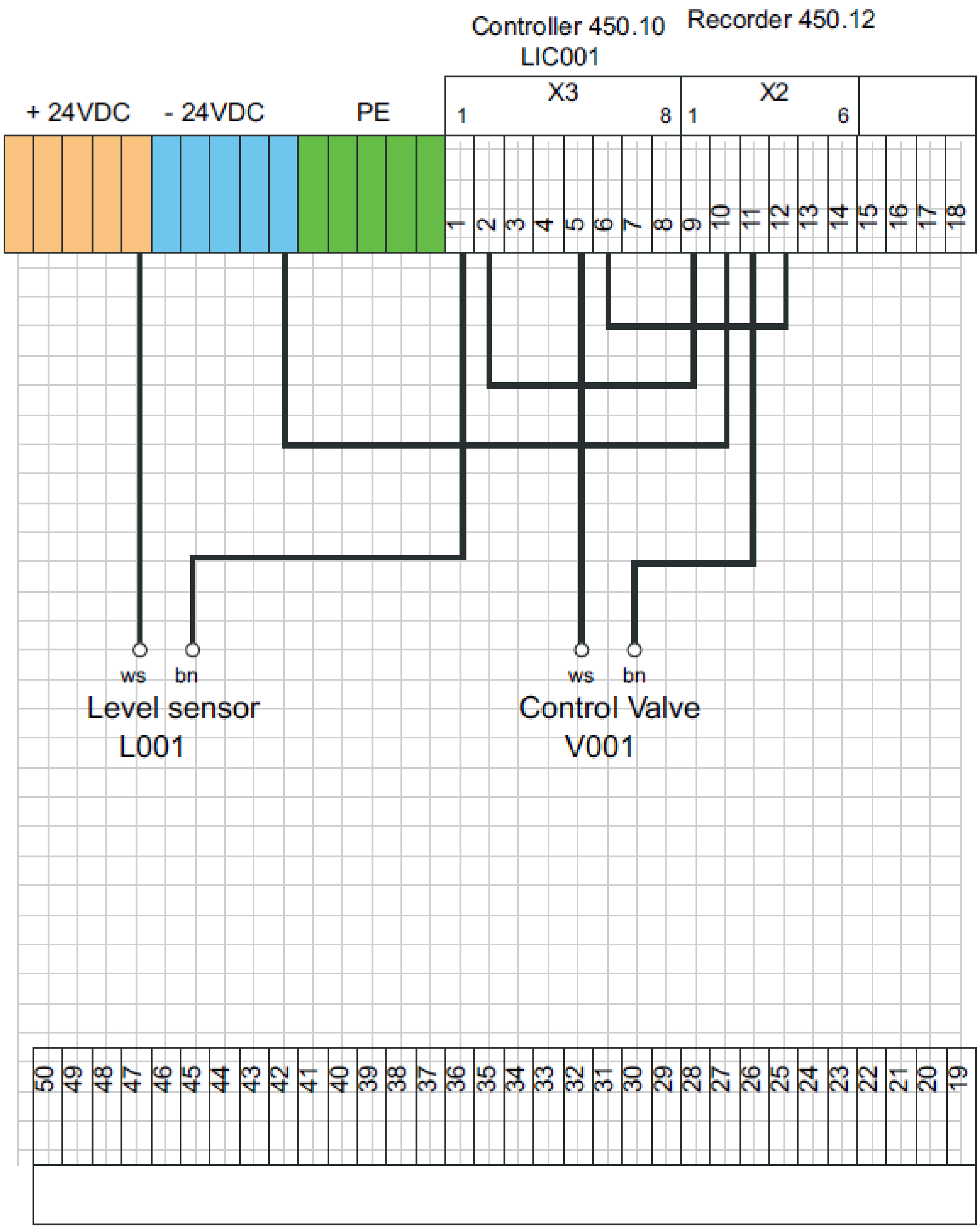
Component bill of materials: Level control system				
Cons. no.	MSR number	Designation	Measuring range, variable	RT450 component
1	K001	Level tank, transparent	6.9 dm^3	RT 450.01
2	T002	Supply tank	75 dm^3	RT 450 Basic Module
3	P001	Pump	Hmax=20m, Qmax=4m^3/h	RT 450 Basic Module
4	L001	Level sensor, capacitive	0 – 47 cm	RT 450.35
5	PI001	Pressure gauge	0 – 2.5 bar	RT 450.01
6	LIC001	Continuous controller	Digitric 500	RT 450.10
7	V001	Control valve, pneumatically operated, I/P positioner	Kv = 1.0	RT450.21
8	V002	Ventilation valve	1/4”	RT450.01
10	V004	Overflow shutoff valve	1/2”	RT450.01
11	V005	Drain valve	1/8”, 2 bar	RT450.01
12	V006	Pump delivery side stop valve	1”	RT 450 Basic Module
13	V007	Safety Valve	1”	RT 450



Process Flow Diagram (Level)

Electrical diagram (Liquid level process)

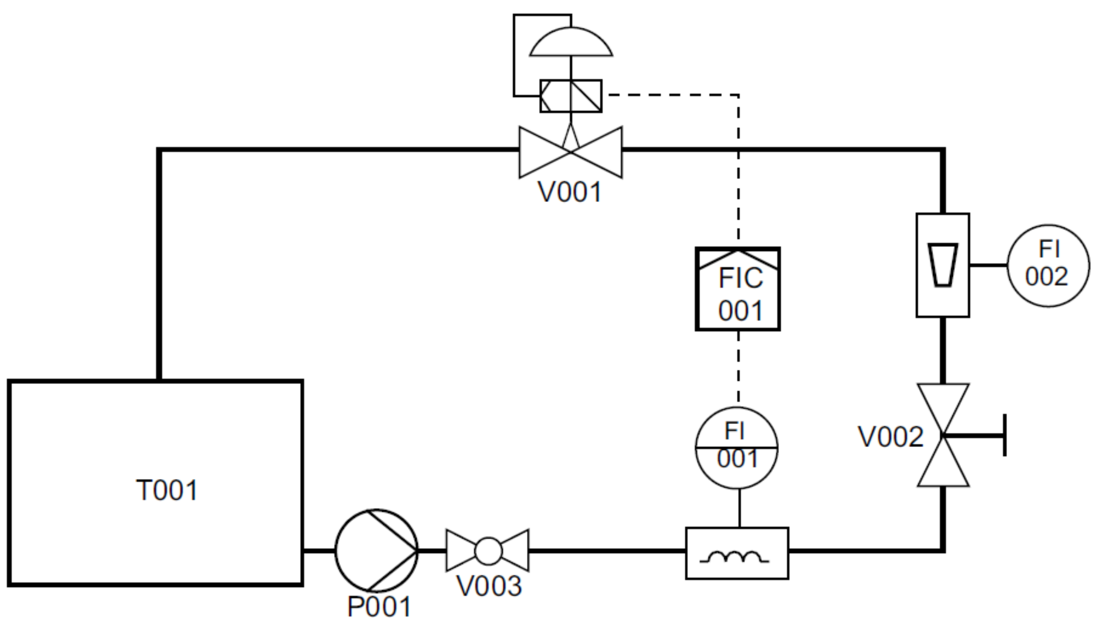




RT 450 Terminal assignment	Projekt Level Control 1	Name: Dorn Date: 10.08.05

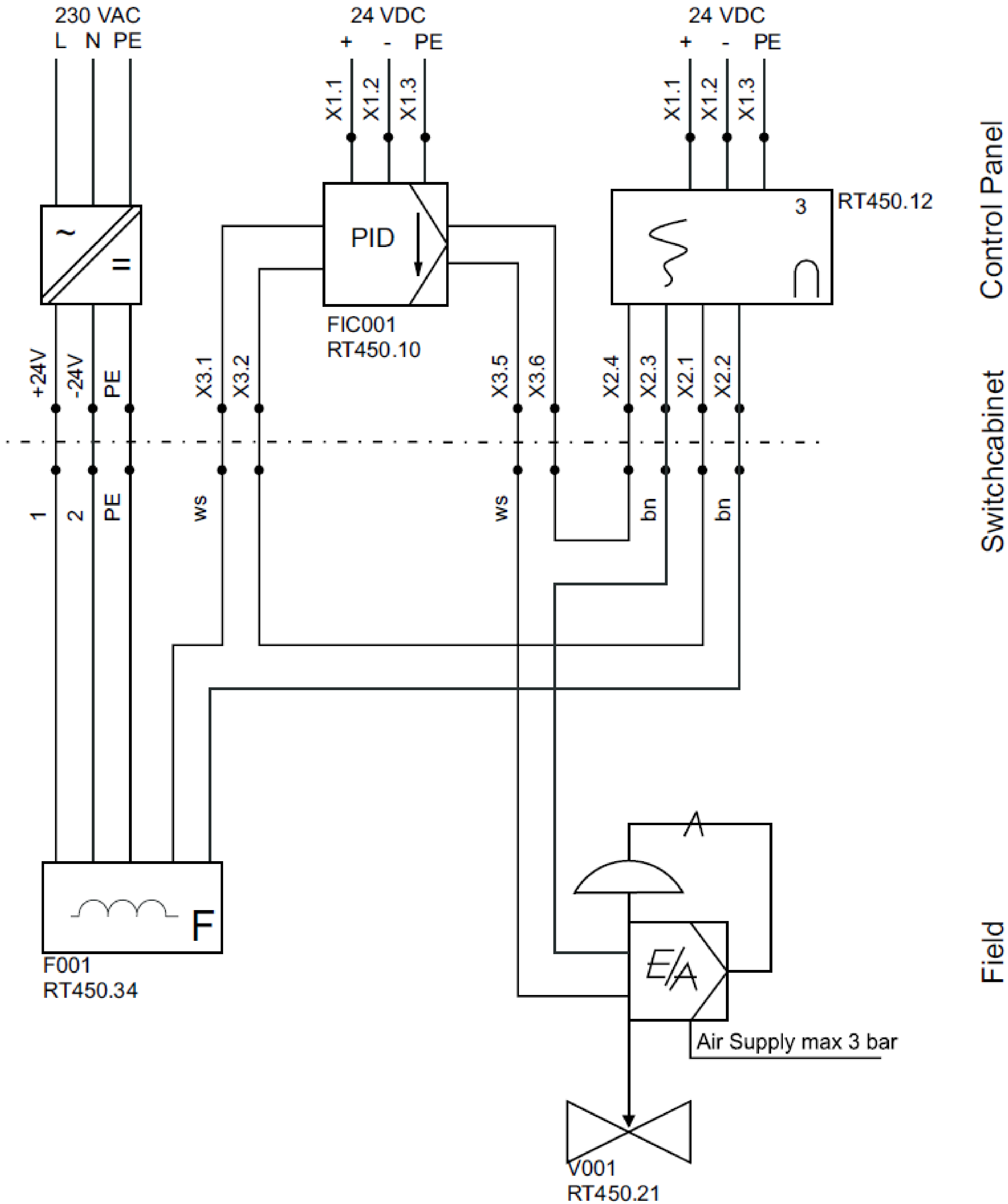
4.5 Flow rate

Component bill of materials: Flow rate control system				
Cons. no.	MSR number	Designation	Measuring range, variable	RT450 component
1	FI002	Flow meter with float	0.4 – 4.2 m^3/h	RT 450.02
2	T001	Supply tank	75 dm^3	RT 450 Basic Module
3	P001	Pump	Hmax=20m, Qmax=4m^3/h	RT 450 Basic Module
4	FI001	Magnetic-inductive flow meter	0 – 5 m^3/h	RT 450.34
5	FIC001	Continuous controller	Digitric 500	RT 450.10
6	V001	Control valve, pneumatically operated, I/P positioner	kv = 1.0	RT450.21
7	V002	Hand valve, sluice valve	1”	RT 450.02
8	V003	Pump delivery side stop valve	1”	RT 450 Basic Module

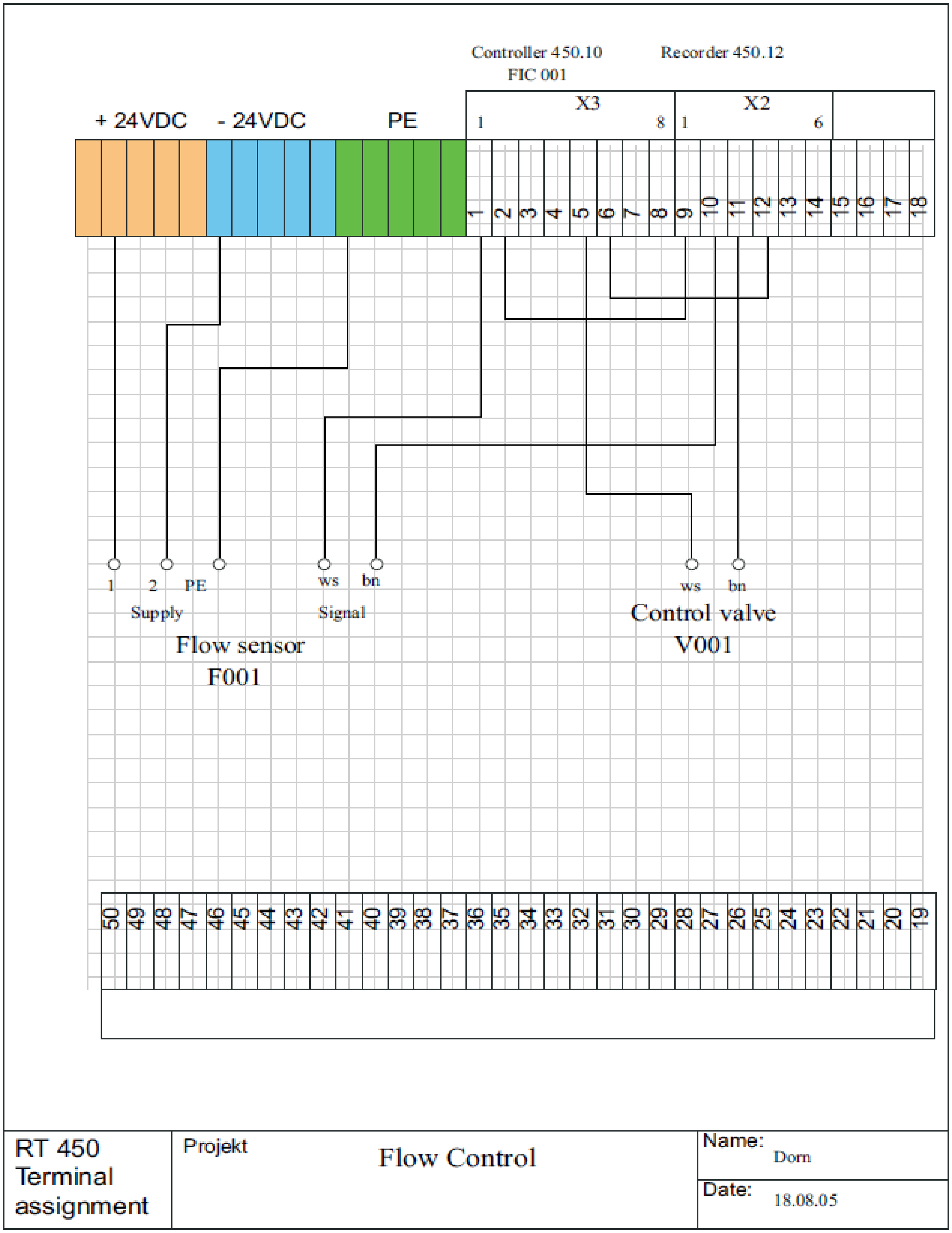


Process Flow Diagram (Flow)

Electrical diagram (Flow rate process)



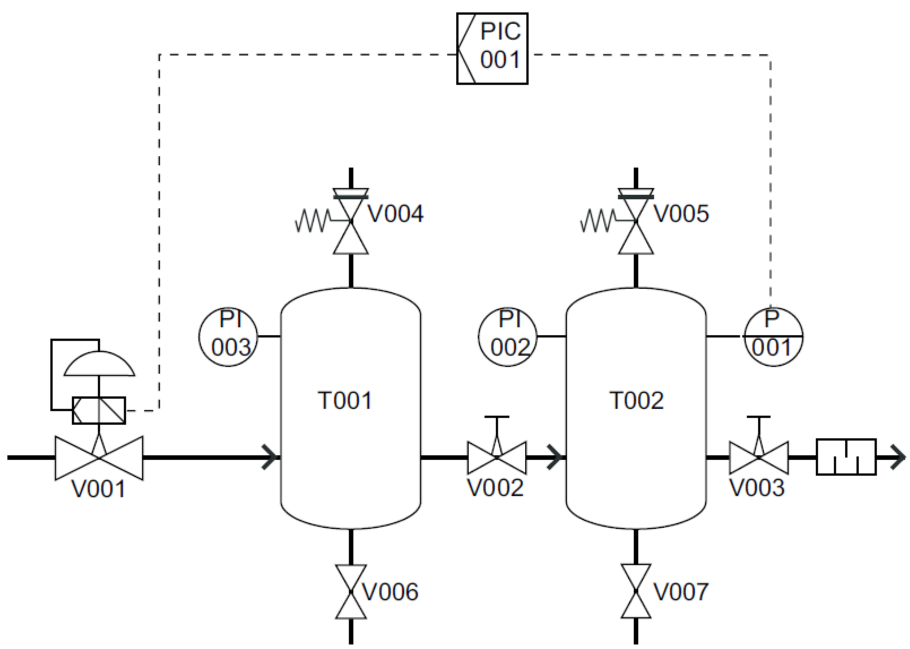
Example EMSR location diagram for flow control system



Example terminal diagram for flow control system

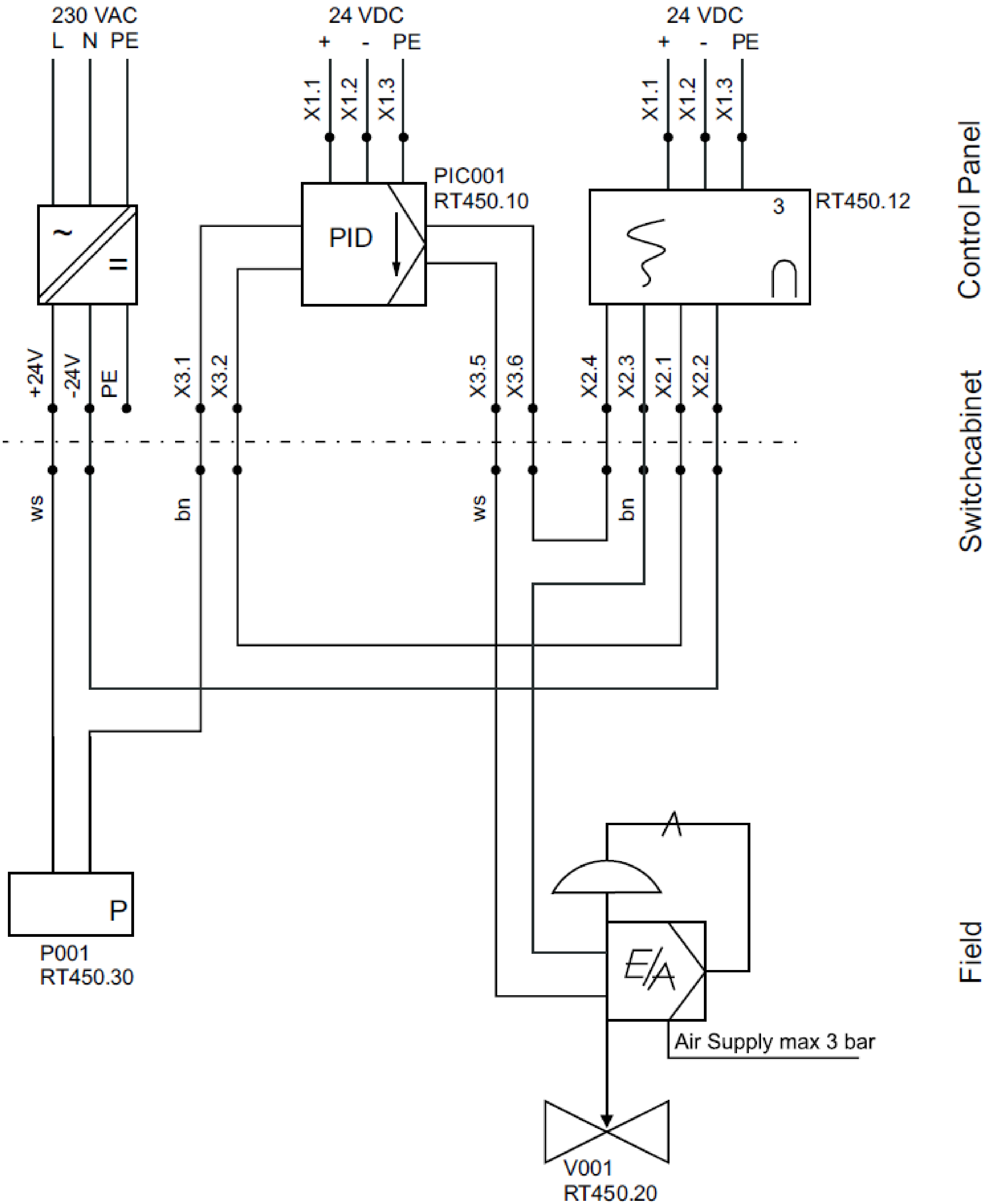
4.6 Pressure

Component bill of materials: Pressure control system				
Cons. no.	MSR number	Designation	Measuring range, variable	RT450 component
1	T001	Pressure tank 1	3 dm^3, 10 bar	RT 450.03
2	T002	Pressure tank 2	3 dm^3, 10 bar	RT 450.03
3	P001	Pressure sensor	0 – 6 bar	RT 450.30
4	PI002	Pressure gauge, pressure tank 2	0 – 10 bar	RT 450.03
5	PI003	Pressure gauge, pressure tank 1	0 – 10 bar	RT 450.03
6	PIC001	Continuous controller	Digitric 500	RT 450.10
7	V001	Control valve, pneumatically operated, I/P positioner	kv = 0.4	RT 450.20
8	V002	Needle valve connecting conduit	1/2”	RT 450.01
9	V003	Needle valve outlet	1/2”	RT 450.01
10	V004	Safety valve	6 bar	RT 450.01
11	V005	Safety valve	6 bar	RT 450.01
12	V006	Water drain valve		RT 450.03
13	V007	Water drain valve		RT 450.03

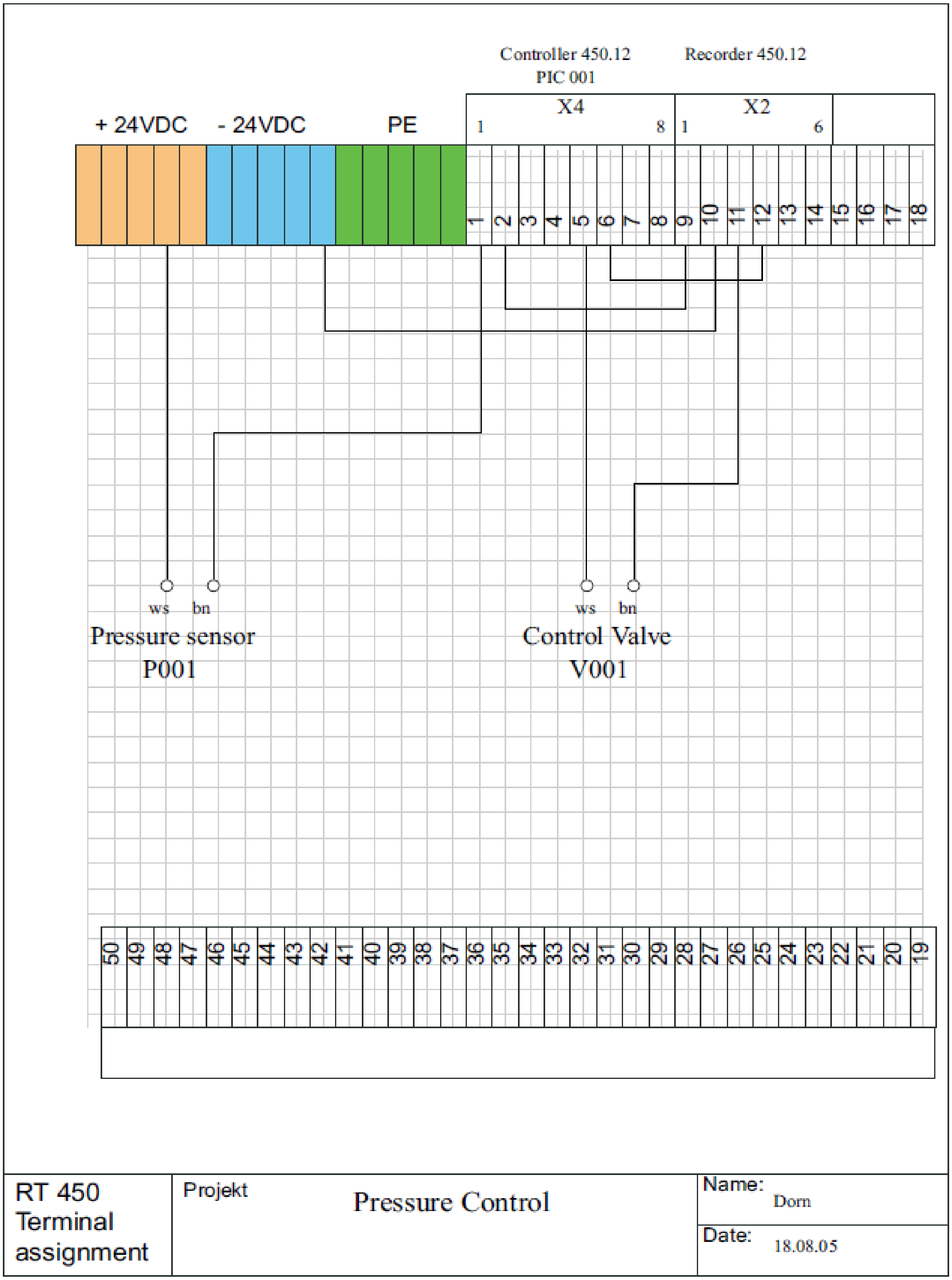


Process Flow Diagram (Pressure)

Electrical diagram (Pressure process)



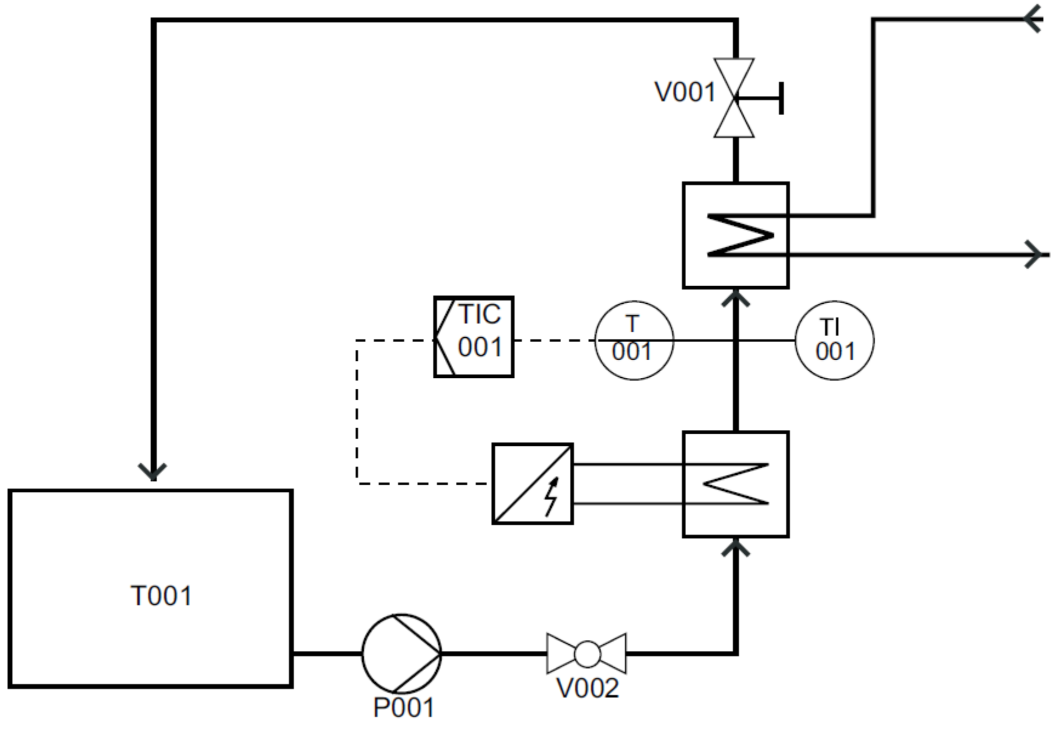
Example EMSR location diagram for pressure control system



Example terminal diagram for pressure control system

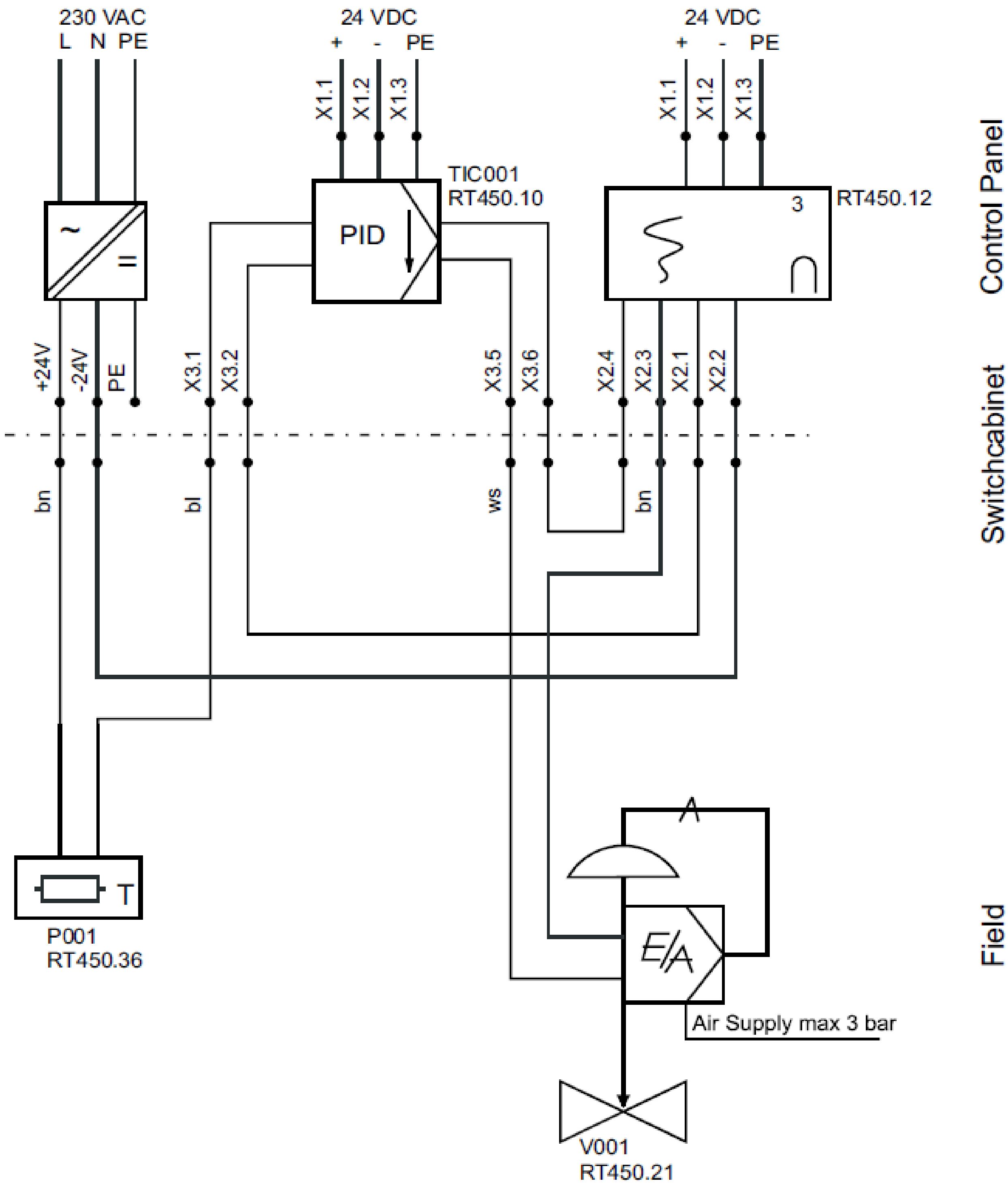
4.7 Temperature

Component bill of materials: Pressure control system				
Cons. no.	MSR number	Designation	Measuring range, variable	RT450 component
1	T001	Supply tank	75 dm^3	RT 450 Basic Module
2	P001	Pump	Hmax=20m, Qmax=4m^3/h	RT 450 Basic Module
3	T001	Temperature sensor, PT100	0- 100 °C	RT 450.36
4	TI001	Bimetallic thermometer	0- 100 °C	RT 450.04
5	TIC001	Switching controller	Digitric 100	RT 450.11
6	V001	Primary circuit control valve	1/2”	RT 450.04
7	V002	Pump delivery side stop valve	1”	RT 450 Basic Module



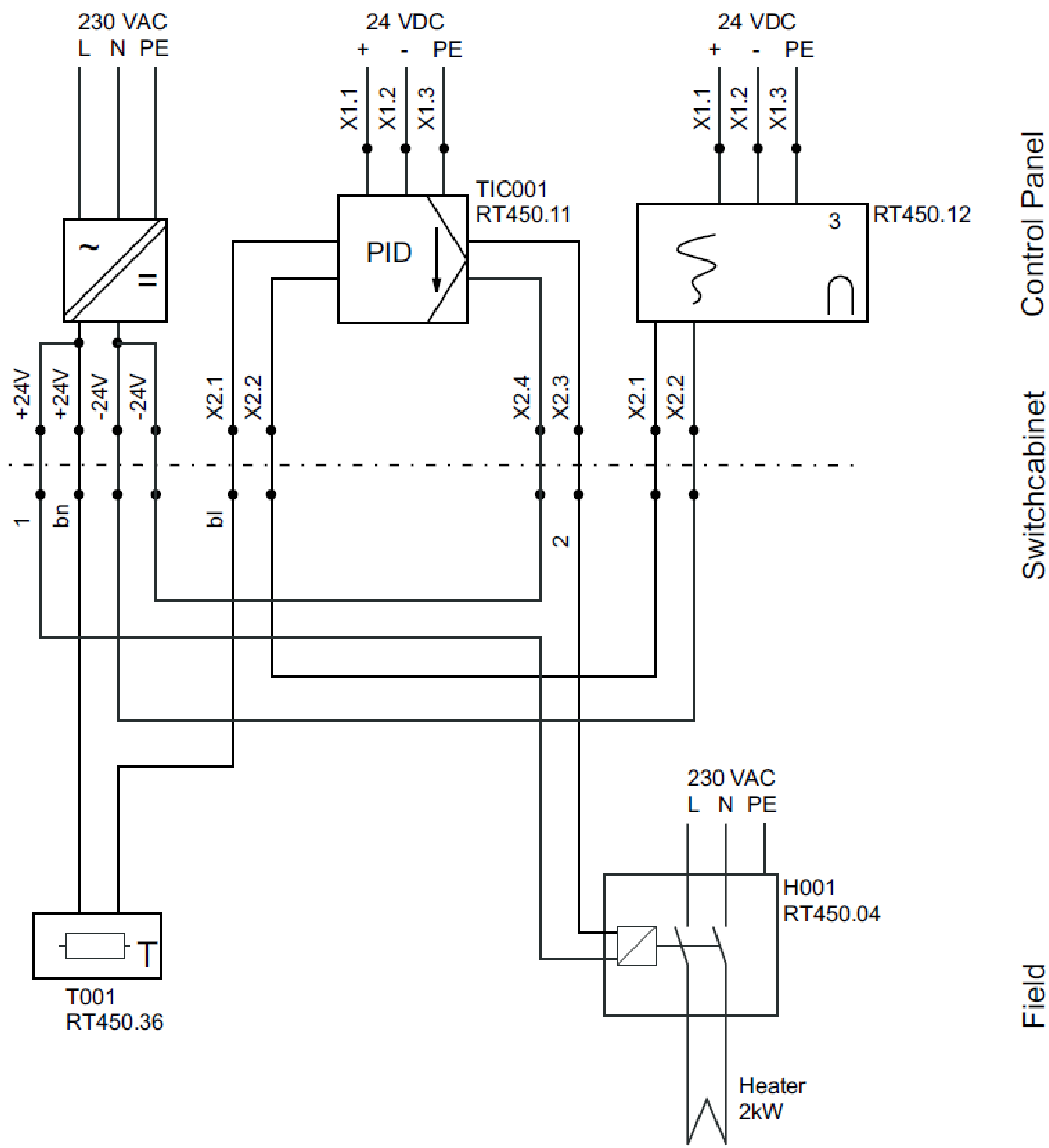
Process Flow Diagram (Temperature)

Electrical diagram (Temperature continuous process)

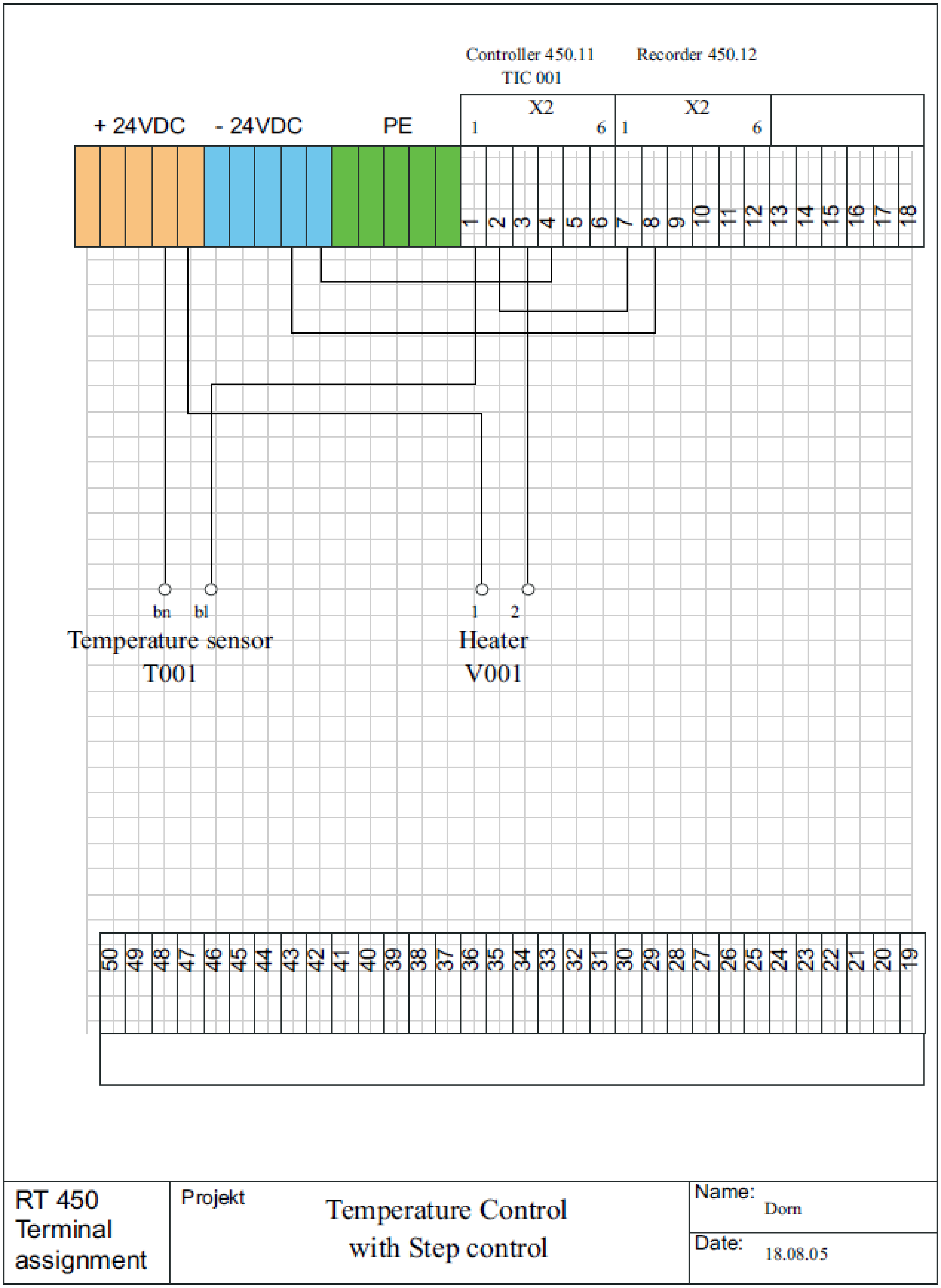


Example EMSR location diagram for temperature control system, continuous

Electrical diagram for Temperature (switching process)



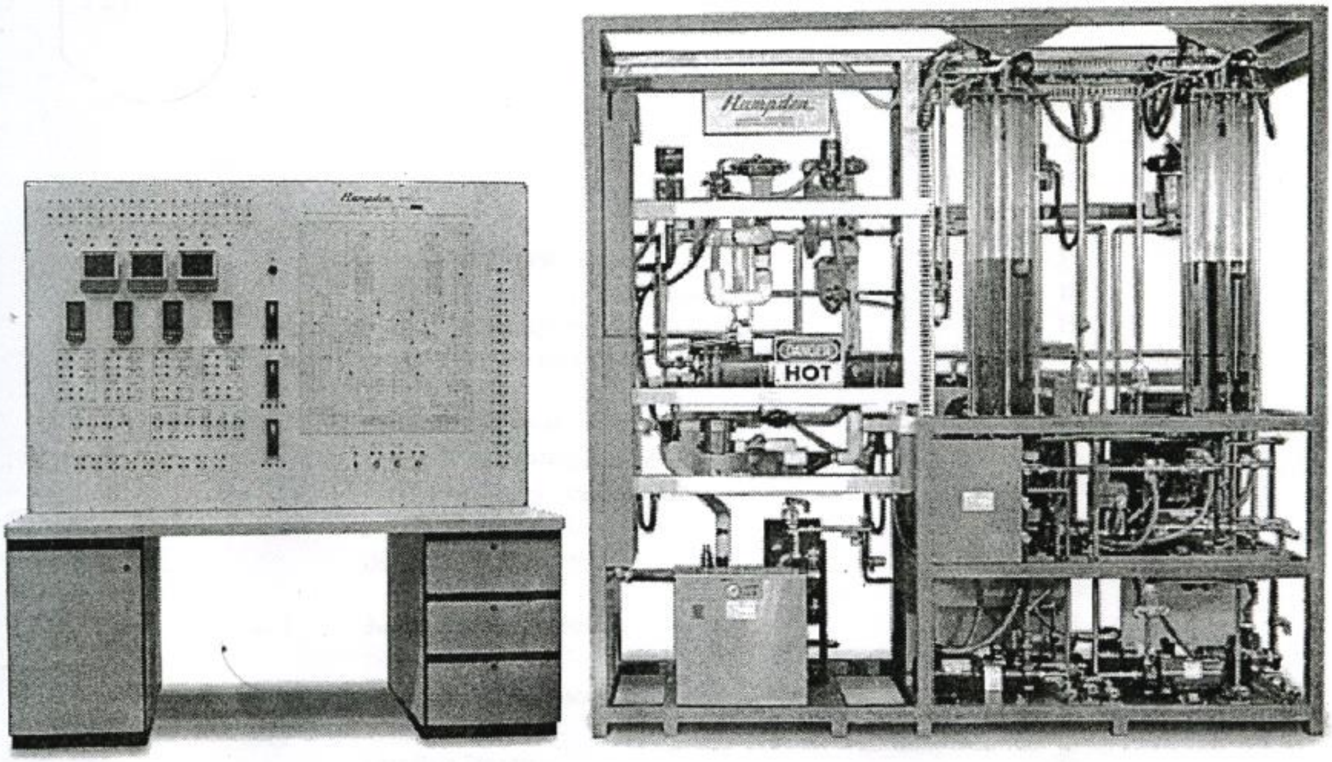
Example EMSR location diagram for temperature control system, switching



Example terminal diagram for temperature control system, switching

5. Industrial Process Plant Trainer (Hampden)

EXPERIMENT MANUAL



HAMPDEN MODEL H-IPPT-3
Industrial Process Plant Trainer

5.4 Control Panel layout

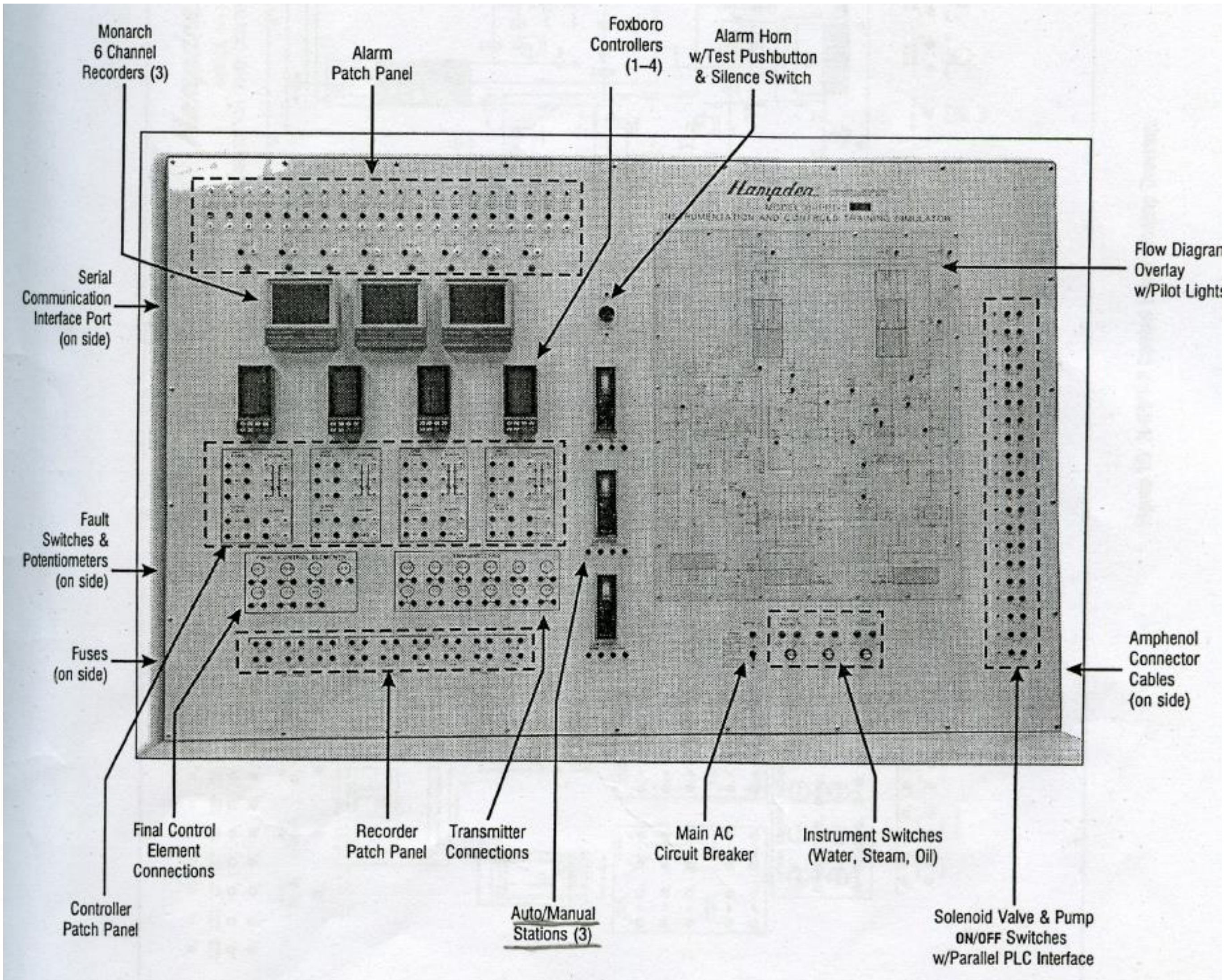
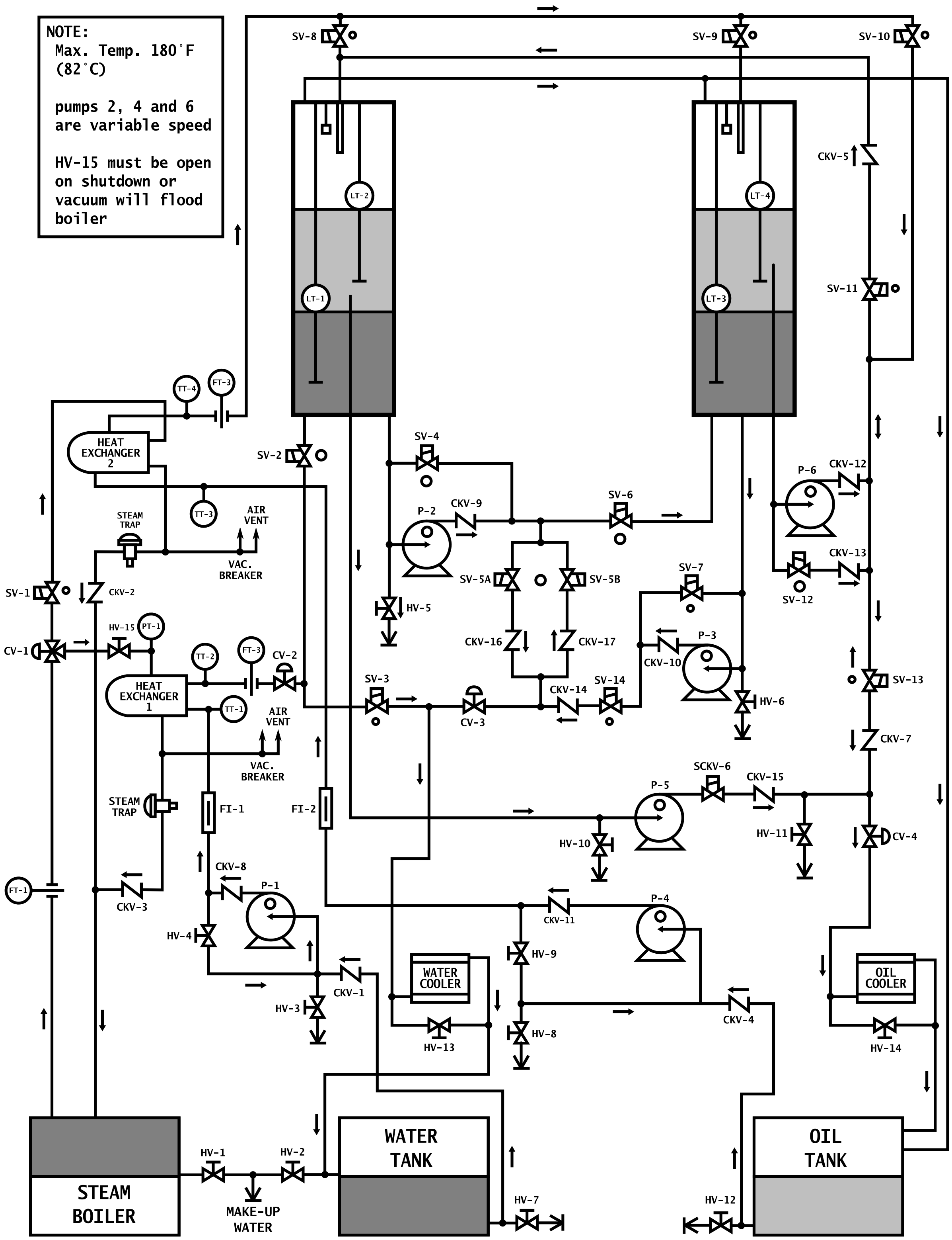


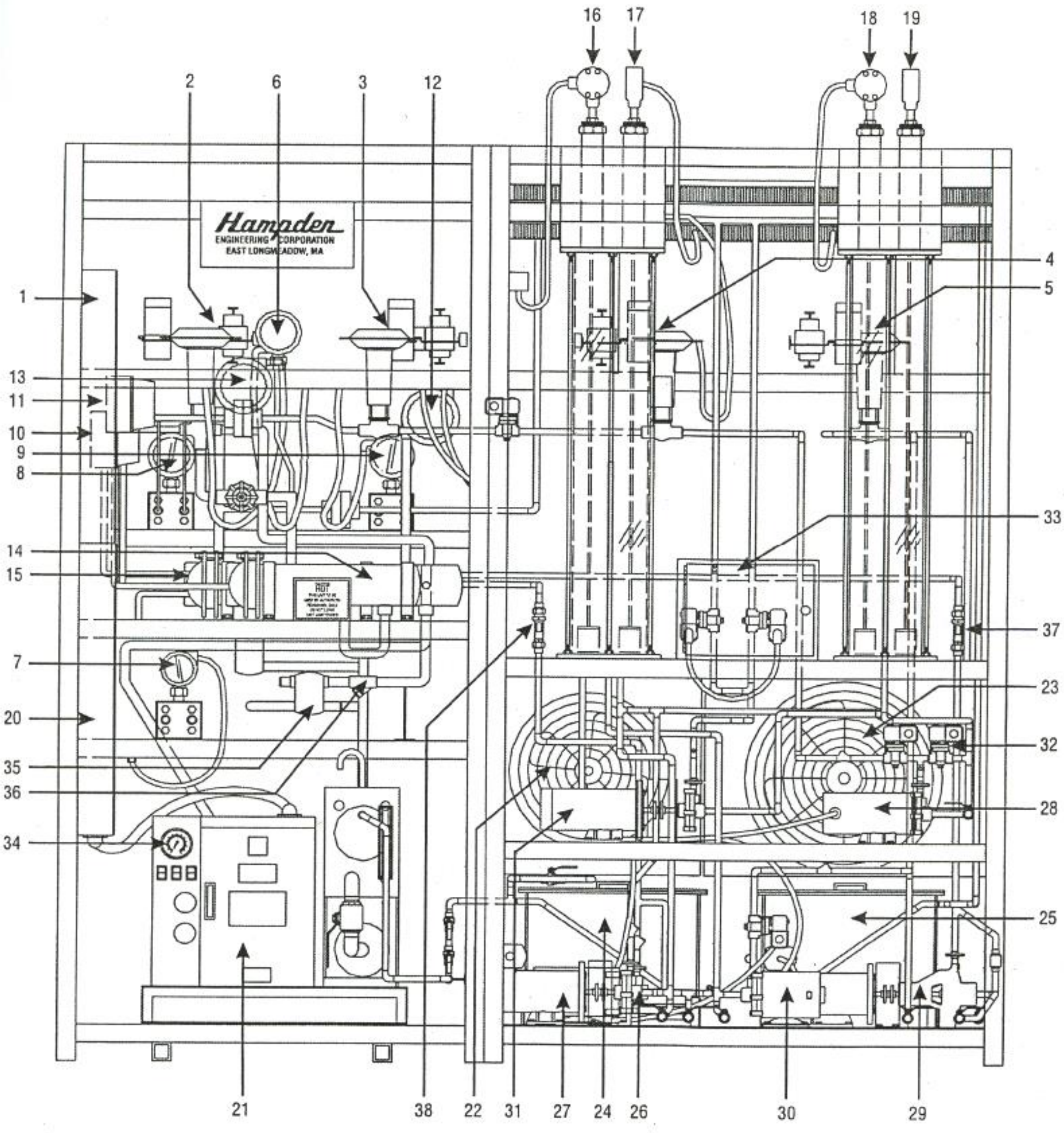
Figure 1A: H-IPPT-3 Control Panel Layout

5.5 Flow Diagram



MODEL H-IPPT-3 Component Identification

1. Load center
2. CV-1 Pneumatic three-way Control Valve with I/P converter
3. CV-2 Pneumatic Control Valve with I/P converter
4. CV-3 Pneumatic Control Valve with I/P converter
5. CV-4 Pneumatic Control Valve with I/P converter
6. PT-1 Steam Pressure Transmitter
7. FT-1 differential pressure transmitter with integral flow orifice assembly for steam flow
8. FT-2 differential pressure transmitter with integral flow orifice assembly for water flow
9. FT-3 differential pressure transmitter with integral flow orifice assembly for oil flow
10. TT-1 Temperature Transmitter with integral Type-T thermocouple element in water inlet line to heat exchanger
11. TT-2 Temperature Transmitter with integral Type-T thermocouple element in water outlet line to the heat exchanger
12. TT-3 Temperature Transmitter with integral Type-T thermocouple element in oil inlet line to the heat exchanger (*not visible)
13. TT-4 Temperature Transmitter with integral Type-T thermocouple element in oil outlet line to the heat exchanger
14. Water heat exchanger
15. Oil heat exchanger (not visible)
16. LT-1 Level Transmitter for water in Tank #1
17. LT-2 Level Transmitter for oil in Tank #1
18. LT-3 Level Transmitter for water in Tank #2
19. LT-4 Level Transmitter for oil in Tank #2
20. Relay box
21. Boiler control box
22. Water after-cooler (blue) – not shown
23. Oil after-cooler (green) – not shown
24. Water storage tank
25. Oil storage tank
26. Pump #1, centrifugal, pumps water from the water storage tank to the water heat exchanger
27. Pump #2, centrifugal AC variable speed, pumps water out of Level Tower #1
28. Pump #3, centrifugal, pumps water out of Level Tower #2
29. Pump #4, centrifugal AC variable speed, pumps oil from the oil storage tank to the oil heat exchanger
30. Pump #5, centrifugal, pumps oil from Level Tower #1 to the oil after-cooler
31. Pump #6, centrifugal AC variable speed, pumps oil from Level Tower #2 to either Level Tower #1 or the after-cooler
32. Solenoid valve
33. Variable speed motor drive box
34. Gauge
35. Steam trap
36. Strainer
37. Flowmeter (oil)
38. Flowmeter (water)


Hampden
ENGINEERING CORPORATION
EAST LONGMEADOW, MA
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Exercise 1: Feedback Control of Water Flow

Description of Experiment

Water is pumped with constant speed Pump P-1 through a loop consisting of a rotameter, a steam heat exchanger, an orifice, Control Valve CV-2, and finally a water after-cooler, before flowing back into the water storage tank.

Differential Pressure Transmitter FT-2 outputs a 4-20 milliamp signal that is directly proportional to the square of the water flow rate. This signal is received by the controller and CH-2 of Recorder #2. The controller and CH-2 of the recorder are programmed to extract the square root of the input to provide measurements that are linear with flow. This rate is displayed on the Controller #2 and will also be recorded by CH-2 or Recorder #2. The output of Controller #2 is sent to Control Valve CV-2 and CH-3 of Recorder #2.

Control Equipment Required

- Controller #2
- Recorder #2
- Flow Transmitter FT-2
- Control Valve CV-2
- Pump P-1

Operational Notes

The controller is configured so that Analog OUT-2 is the setpoint.
The rate of water flow can be modified by Hand Valve HV-4, in parallel with Pump P-1.

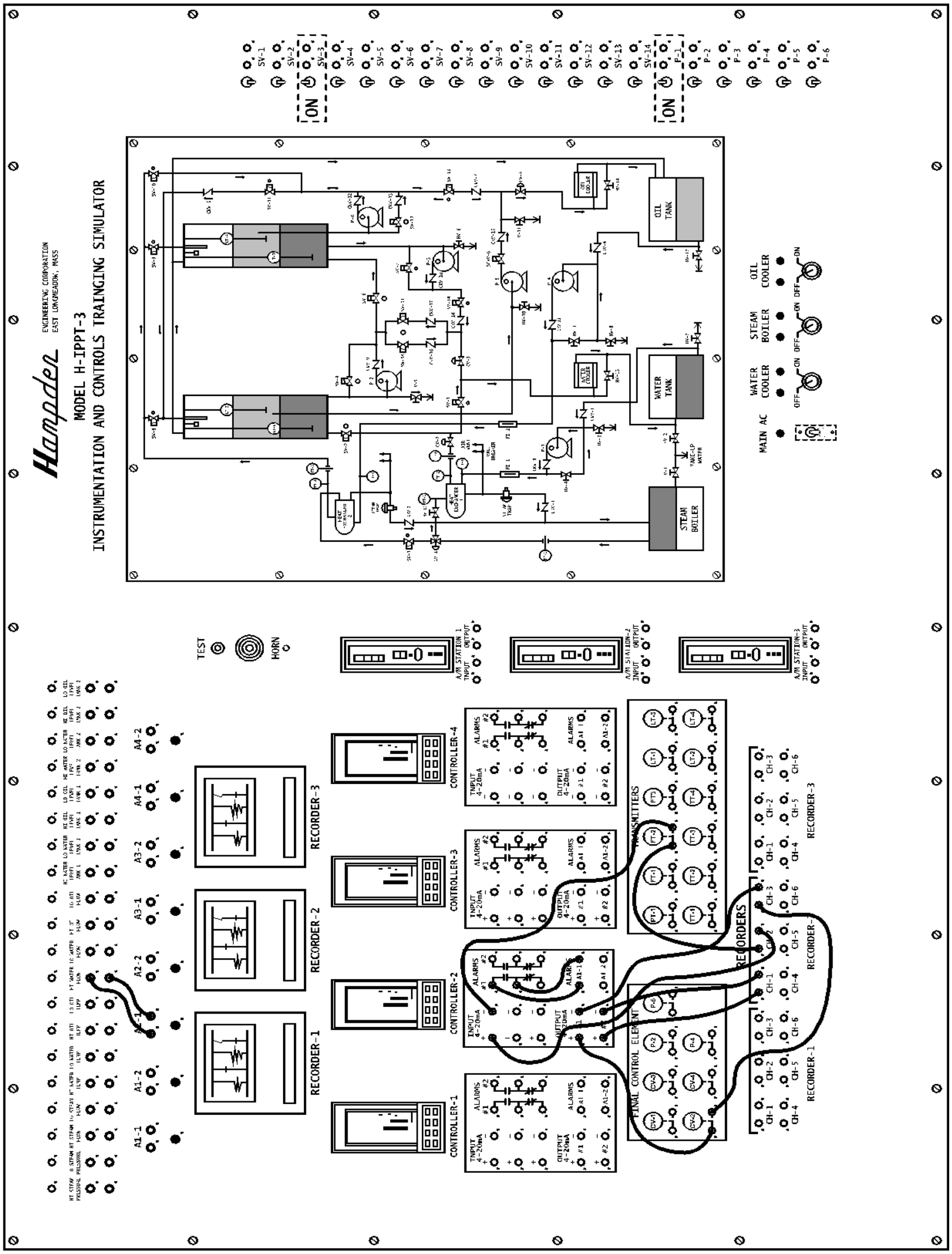


Figure 1: H-IPPT-3 Control Panel

Procedure

1. Complete all of the applicable procedures found in both the control panel and process plant operation sections.

2. Turn on the following circuit breakers in the main fuse box:
   - Main Process Plant AC power
   - Duplex AC power
   - Solenoid AC power
   - Pump AC power

3. Set the supply air pressure to 25 psig (172 kPa). **DO NOT** exceed 30 psig (207 kPa).

4. Configure the controller; enter the setpoint, tuning parameters and alarms. If the tuning parameters are not known at this time, use a large proportional band with no integral or derivative action, and then determine the optimum tuning parameters. Set Alarm A2-1 as high water flow alarm.

   Suggested recorder settings are as follows:
   - Recorder #2, Channel #1 to record controller setpoint
   - Recorder #2, Channel #2 to record water flow rate (SQRT)
   - Recorder #2, Channel #3 to record Controller #2 output

5. Interconnect the process control equipment per Figure 1.

6. Place Controller #2 (flow) in the manual mode and set the output to 100% to open Control Valve CV-2.

7. Open Solenoid Valve SV-3

8. Turn on Pump P-1

9. Set the controller setpoint to 2 gpm (7.57 lpm) and switch to AUTOMATIC. Once the automatic control has taken over, you can change the setpoint and observe the modulation of the control valve to achieve the new flow rate.

10. To produce an upset, you can change the opening of Bypass Valve HV-4, and observe the modulation of the control valve to maintain a constant flow rate.

Exercise 2: Feedback Control of Oil Flow

Description of Experiment

Oil is pumped with variable speed Pump P-4, through a loop consisting of a rotameter, steam heat exchanger, orifice, Control Valve CV-4, and oil after-cooler, then back into the oil storage tank.

Differential Pressure Transmitter FT-3 outputs a 4-20 milliamp signal that is directly proportional to the square of flow rate. This signal is received by CH-2 of Recorder #2. The oil flow rate is displayed on Controller #2 and will also be recorded by CH-2 of Recorder #2. The output of Controller #2 is sent to Control Valve #4 and CH-3 of Recorder #2.

Control Equipment Required

Controller #2
Recorder #2
Flow Transmitter FT-3
Control Valve CV-4
Manual Station #2
Pump P-4

Operational Notes

The controller is configured so that OUT-2 is the setpoint. The rate of oil flow can be upset by turning Hand Valve HV-9 in parallel with Pump P-4. The flow of oil can be regulated with either Pump P-4 or Control Valve CV-4, depending on which is the final control element.

Procedure A – Control Valve

1. Complete all of the applicable procedures found in both the control panel and process plant operation sections.

2. Switch on the following circuit breakers in the main fuse box:
   - Main Process Plant AC power
   - Duplex AC power
   - Solenoid AC power
   - Pump AC power

3. Set the supply air pressure to 25 psig (172 kPa). DO NOT exceed 30 psig (207 kPa).

4. Configure Controller #2, enter the setpoint, tuning parameters and alarms. Set the setpoint on the flow controller to 4 gpm (15 lpm). If the tuning parameters are not known at this time, use a large proportional band with no integral or derivative action, and then determine the optimum tuning parameters. Set Alarm A2-1 as a high oil flow alarm.

   Suggested recorder settings are as follows:
   - Recorder #2, Channel #1, to setpoint (Output #2)
   - Recorder #2, Channel #2, to record oil flow rate
   - Recorder #2, Channel #3, to record Controller #2 output.

5. Interconnect the process control equipment per **Error! Reference source not found.**.

6. Place Controller #2 into the MANUAL mode.

7. Turn on (open) the following solenoid valves:
   - SV-10
   - SV-13

8. Turn on Pump P-4

9. Set the output of Manual Station #3 to 100% (20 milliamps).

10. Manually increase the output of the flow until it equals setpoint. Place Controller #2 into the AUTOMATIC mode.

11. Once the automatic control has taken over, you can change the setpoint and observe the system response.

12. To produce an upset, you can open or close Bypass Valve HV-9 a small amount or change pump speed.

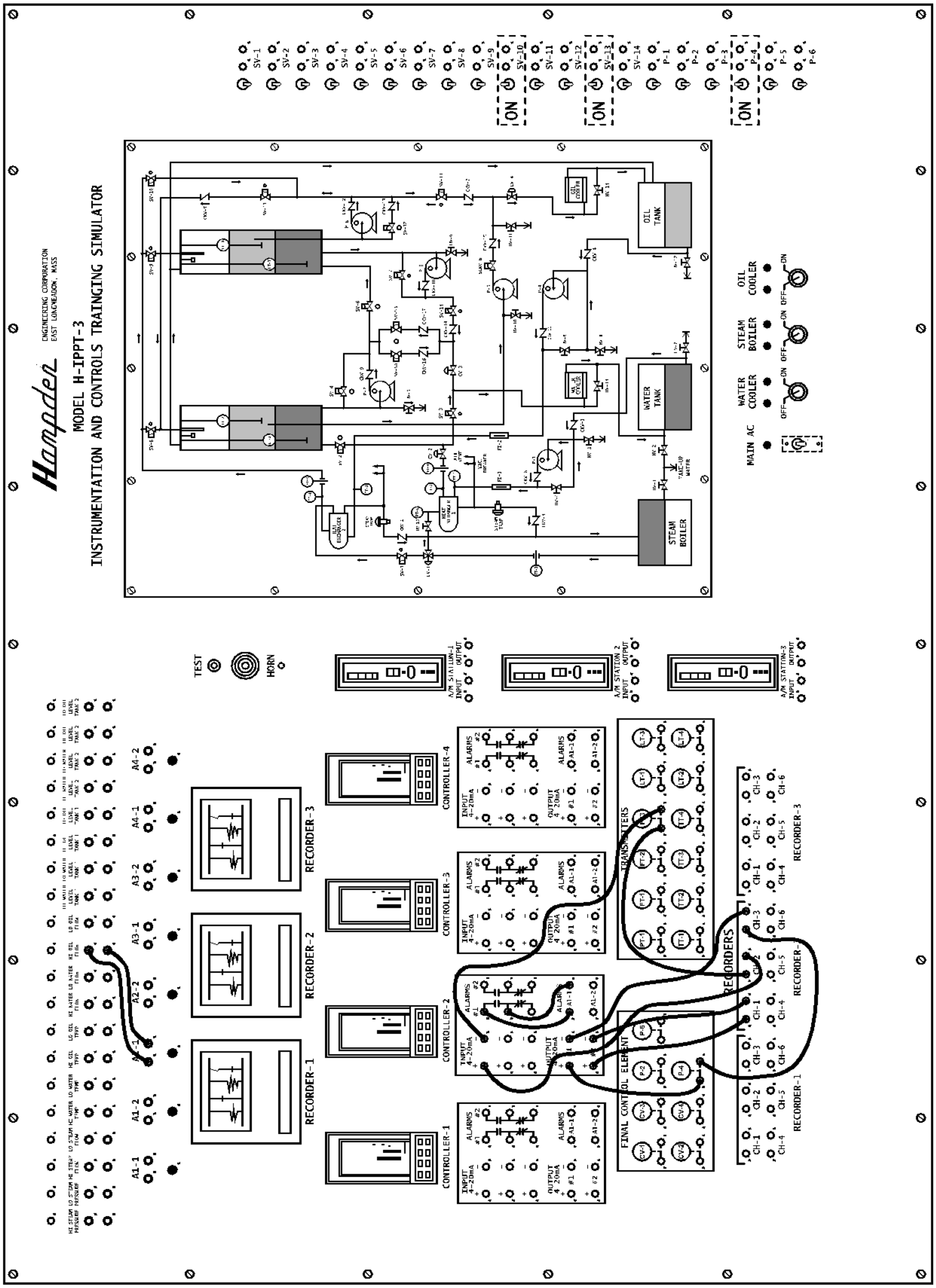


Figure 2: H-IPPT-3 Control Panel

Exercise 3: Feedback Control of Water Level in Tower #1

Description of Experiment
Water is pumped out of the water storage tank with constant speed Pump P-1, through a loop consisting of a rotometer, a steam heat exchanger, an orifice plate assembly, through Control Valve CV-2, through Solenoid Valve SV-2 into Level Tower #1. The water level in Level Tower #1 is controlled by the rate of water entering the tank through CV-2.

The water Level Transmitter LT-1 outputs a 4-20 milliamp signal proportional to water level. Water level (in inches) is displayed on Controller #3 and may be recorded (0-100%), along with the controller output. The tower level (0-100%) will be recorded on CH-5 of Recorder #2. The controller output is recorded on CH-6 of Recorder #2, the percent (0-100%) opening of CV-2. The setpoint will be recorded on CH-4 of Recorder #2.

Control Equipment Required
Controller #3
Recorder #2
Control Valve CV-2
Manual Station #2
Manual Station #3
Pump P-1
Pump P-2
Control Valve CV-3

Operational Notes
The controller is configured so that Analog Output #2 is the working setpoint.

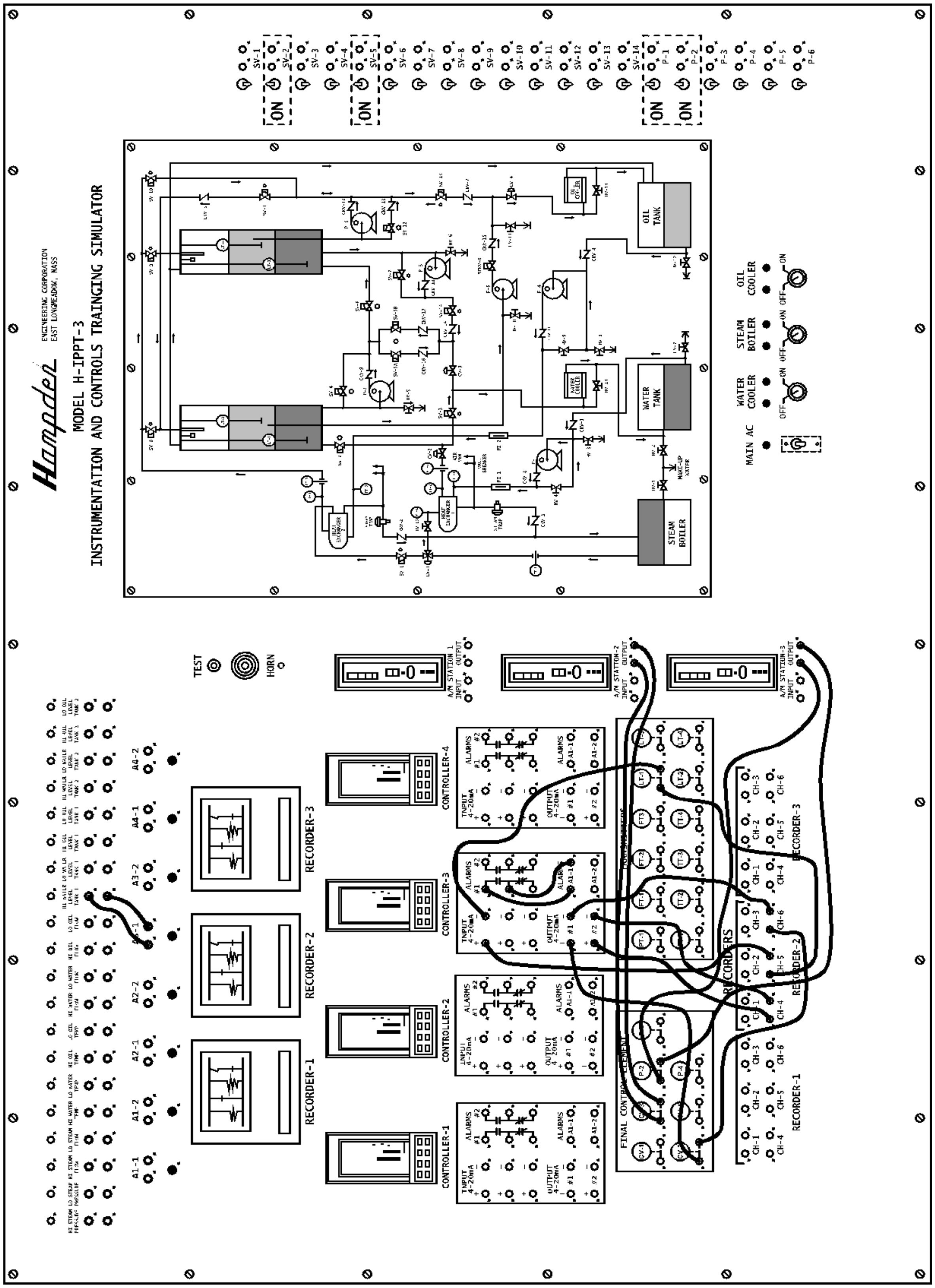

Hampden
ENGINEERING CORPORATION
EAST LONGMEADOW, MASS
MODEL H-IPPT-3
INSTRUMENTATION AND CONTROLS TRAINGING SIMULATOR
OIL TANK
WATER TANK
STEAM BOILER
MAIN AC
WATER COOLER
STEAM BOILER
OIL COOLER
TEST
HORN
CONTROLLER-1
CONTROLLER-2
CONTROLLER-3
CONTROLLER-4
RECORDER-1
RECORDER-2
RECORDER-3
RECORDERS
FINAL CONTROL ELEMENT
ON
ON
ON
ON

Figure 2

Procedure

1. Complete all of the applicable procedures found in both the control panel and process plant operation sections.

2. Switch on the following circuit breakers in the main fuse box:
   - Main Process Plant AC power
   - Duplex AC power
   - Solenoid AC power
   - Pump #1 AC power
   - Pump #2 AC power

3. Set the supply air pressure to 25 psig (172 kPa).

4. Configure the controller, enter the set point, tuning parameters and alarms. If the tuning parameters are not known at this time, us a large proportional band with no integral or derivative action, then determine the optimum tuning parameters. Set Alarm A3-1 as a high water level alarm. Place the controller into MANUAL mode with an output of 50%. Set the setpoint of water level controller somewhere between 3 and 14 inches (7.6 and 35.6 cm).

   Suggested recorder settings are as follows
   - Recorder #2, Channel #4 to record water setpoint in Tank #1
   - Recorder #2, Channel #5 to record water level measurement
   - Recorder #2, Channel #6 to record the percent opening of CV-2

5. Interconnect the process control equipment per Figure 2.

6. Set the output of Manual Station AM-2 to 0% to open Control Valve CV-3.

7. Set the output of Manual Station AM-3 to 0% (Pump P-2; reverse output).

8. Turn on (open) the following solenoid valves:
   - SV-2
   - SV-5

9. Turn on Pumps P-1 and P-2.

10. Allow the level tower to fill partially, before adjusting the output of Manual Station AM-3 to control Pump P-2. With the water level controller in MANUAL, adjust the speed of Pump P-2 until the actual level is the same as the setpoint and water is being pumped out at approximately the same rate that it is flowing in.

11. Switch the water level controller to AUTOMATIC.

12. Once the automatic control has taken over, you can change the setpoint to a new level and observe the response of the system.

13. You can produce a process upset by (1) changing the setpoint of the controller; (2) adjusting Bypass Valve HV-4; or (3) adjusting the auto-manual stations.

Exercise 4: Feedback Control of Water Level in Tower #2

Description of Experiment

Water enters Level Tower #2 through Level Tower #1 at a rate determined by the speed of Pump P2, which is controlled by the inlet water flow rate into Level Tower #1. The inlet water flow rate into Level Tower #1 can be determined from Differential Pressure Transmitter FT-2 and the controller programmed for square root extraction. The inlet water flow rate into Level Tower #1 can be regulated by either Control Valve CV-2 or Bypass Valve HV-4.

The water level in Level Tower #2 is sensed by the float of Level Transmitter LT-3, which outputs a 4-20 mA signal. This level is displayed (in inches) on Controller #3 and may be recorded (0-100%) along with controller setpoint and output.

To maintain a constant water level in Level Tower #2, the controller modulates the closing of Control Valve CV-3. Water from Level Tower #2 is continually pumped by constant speed Pump P-3, through the water after-cooler and back into water storage tank.

To begin the cycle again, water is pumped out of the water storage tank and through CKV-1 by Pump P1 which, in turn, pumps water through CKV-6, Heat Exchanger #1, CV-2 and SV-2, then back into Level Tower #1.

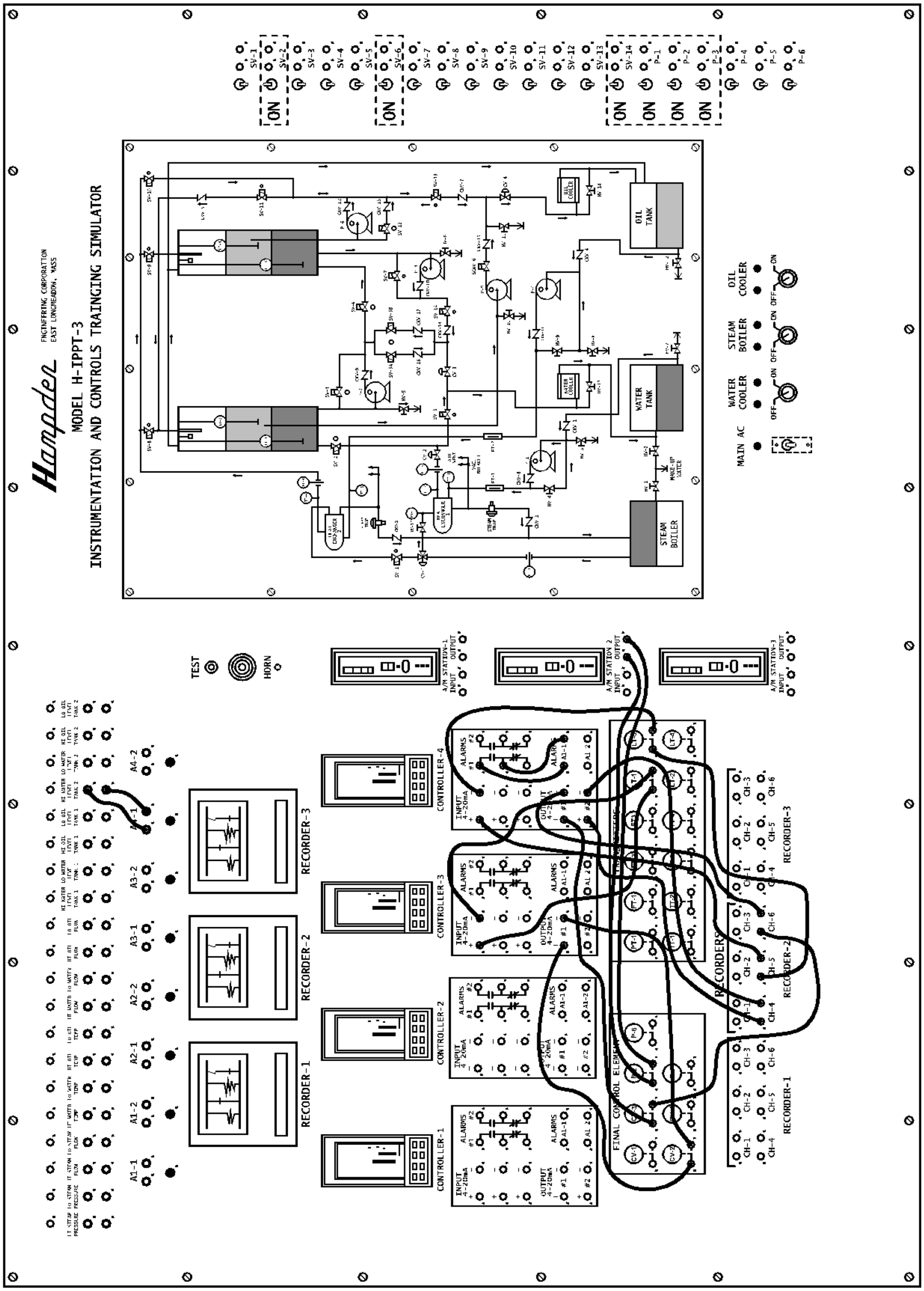

MODEL H-IPPT-3
INSTRUMENTATION AND CONTROLS TRAINGING SIMULATOR
RECORDER-1
RECORDER-2
RECORDER-3
CONTROLLER-1
CONTROLLER-2
CONTROLLER-3
CONTROLLER-4
STEAM BOILER
WATER TANK
OIL TANK
TEST
HORN
MAIN AC

Figure 3

Equipment Required

- Controller #3
- Controller #4
- Recorder #2
- Level Transmitter LT-1
- Level Transmitter LT-3
- Control Valve #2
- Control Valve #3
- Manual Station #3
- Pump P-1
- Pump P-2
- Pump P-3

Operational Notes

The controller is configured so that Analog Output #2 is the working setpoint.

Suggested recorder settings are as follows:

- Recorder #2, Channel #4 to record the setpoint for Level Tower #2
- Recorder #2, Channel #5 to record output of Level Transmitter LT-3
- Recorder #2, Channel #6 to record Controller #4 output

Procedure

1. Complete all of the applicable procedures found in both the control panel and process plant operation sections.

2. Switch on the following circuit breakers in the main fuse box:
    - Main Process Plant AC power
    - Duplex AC power
    - Solenoid AC power
    - Pump #1 AC power
    - Pump #2 AC power
    - Pump #3 AC power

3. Run Experiment 3 to set Controller #3 for control of water level in Tower #1.

4. Set the supply air pressure to 25 psig (172 kPa). **DO NOT** exceed 30 psig (207 kPa).

5. Configure Controller #4, normally used for pressure controls and enter the setpoint, tuning parameters and alarms. If the tuning parameters are not known at this time, use a large proportional band with no integral or derivative action, then determine the optimum tuning parameters. Set Alarm A4-1 as a high water level alarm and Alarm A4-2 as a low water level alarm. Place the controller into MANUAL mode with an output of 100%. This will close Control Valve CV-3 and allow the water level to rise in Level Tower #2. NOTE: You can use the tuning

parameters from Experiment 3 for initializing Controller #4. Set the set point of the water level controller somewhere between 3 and 14 inches (7.6 and 35.6 cm), eg., 8 inches.

6. Interconnect the process control equipment per Figure 3.

7. CV-2 is N.O., air controlled to close. This valve should be set by Controller #3.

8. Set the output of Manual Station AM-2 to 0% to shut off Pump P-2 (not reverse output).

9. Open the following solenoid valves:
   - SV-2
   - SV-6
   - SV-14

10. Turn on Pumps P-1 and P-2.

11. Switch Controller #3 to AUTOMATIC with a setpoint of 12” (30.5 cm).

12. Allow Level Tower #1 to fill partially before adjusting the output of Manual Station AM-2 to control Pump P-2. With the water level Controller #4 in MANUAL, adjust the speed of Pump #2, until the actual level is the same as the setpoint.

13. Adjust the output of Controller #4 to 50%.

14. Turn on Pump P-3 and place the controller in AUTOMATIC mode.

15. Once the automatic control has taken over, you can change the setpoint to a new level and observe the response of the system.

16. You can produce a process upset by (1) changing the setpoint of the controller; (2) adjusting Bypass Valve HV-4; or (3) adjusting the auto-manual stations.

Exercise 5: Feedback Control of Oil Level in Level Tower #1

Description of Experiment

Oil is drawn from the oil storage tanks, through Check Valve CKV-4 and is pumped by variable speed Pump P-4, into Heat Exchanger #2, through Solenoid Valve SV-8, and into Level Tower #1. Oil in Level Tower #1 can then be drawn off by Pump P-5, pumped through CKV-6, Control Valve CV-4, the oil cooler and back into the oil storage tank.

The oil Level Transmitter LT-2 outputs a 4-20 mA signal, proportional to the oil level, which is used to control the percent opening of CV-4.

Control Equipment Required

- Controller #3
- Recorder #3
- Control Valve #4
- Manual Station #3
- Pump P-4
- Pump P-5

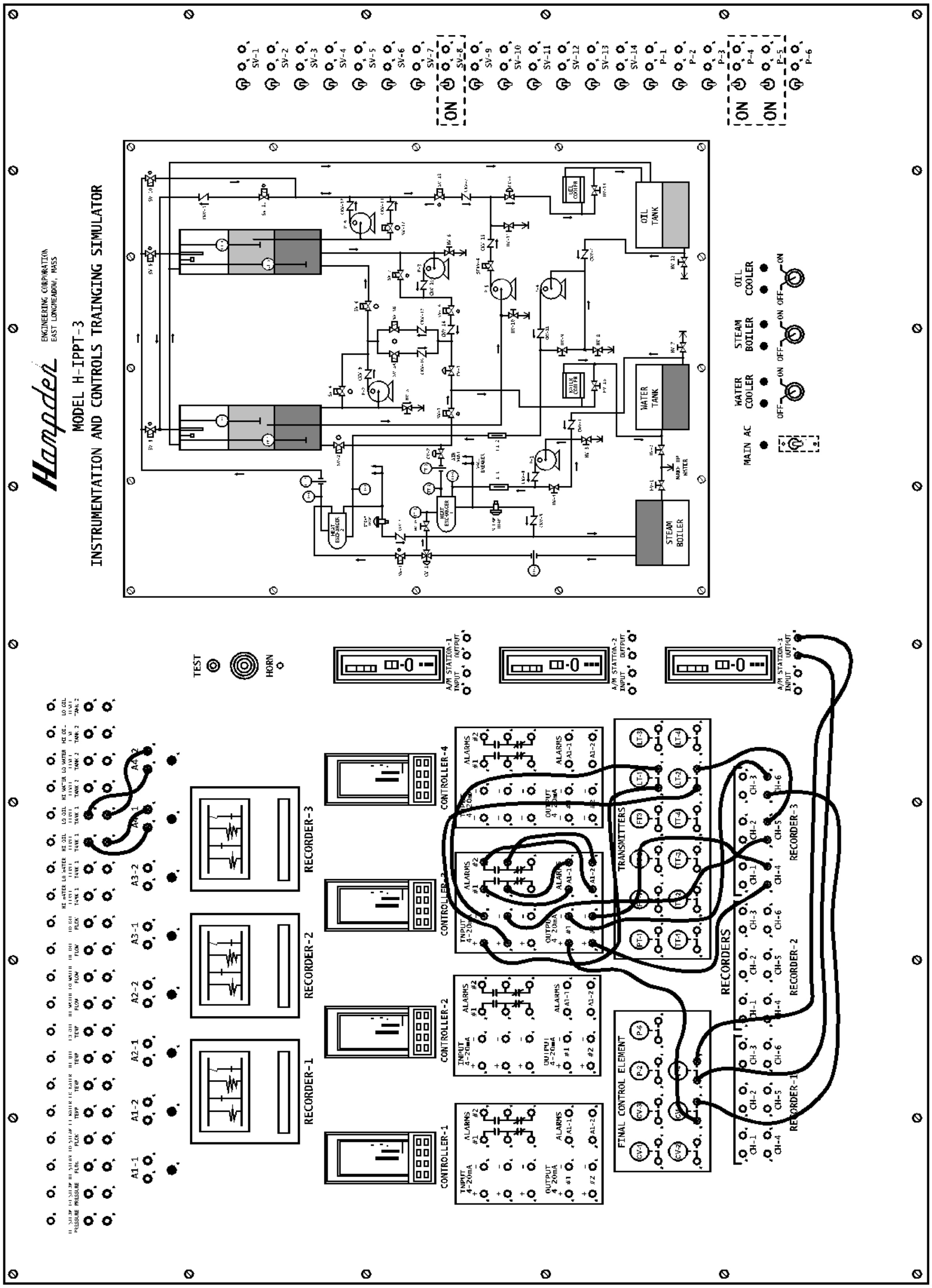


Figure 4: H-IPPT-3 Control Panel

Operational Notes

The oil level (in inches or centimeters) in Level Tower #1 is displayed on Controller #3 and may be recorded (0-100%), along with controller output.

In order to record the setpoint, Analog Output #2 is set so that its output is the working setpoint.

If ambient temperature is too low, the oil may be too viscous for good level control; in this case the steam heat exchanger can be used to heat the oil for better performance.

The output of oil Level Transmitter LT-2 is the sum of both the water level and the oil level in Level Tower #1. In order to determine the true oil level, the controller must subtract the output of water Level Transmitter LT-1 from the output of oil Level Transmitter LT-2, or the output of oil Level Transmitter LT-2 must be biased to account for the water level.

Suggested recorder settings are as follows:

- Recorder #3, Channel #4 to record the oil level setpoint
- Recorder #3, Channel #5 to record Controller #4 measurement (LT-2)
- Recorder #3, Channel #6 to record percent opening of CV-4

Procedure

1. Complete all of the applicable procedures found in both the control panel and process plant Operation sections.

2. Switch on the following circuit breakers in the main fuse box:
    - Main Process Plant AC power
    - Duplex AC power
    - Solenoid AC power
    - Pump #4 AC power
    - Pump #5 AC power

3. Set the supply air pressure to 25 psig (172 kPa). DO NOT exceed 30 psig (207 kPa).

4. Configure the controller, enter the setpoint, tuning parameters and alarms. If the tuning parameters are not known at this time, use a large proportional band with no integral or derivative action, then determine the optimum tuning parameters. Set Alarm A3-1 as a high oil level alarm. Place the controller into MANUAL mode with an output of 0%.

5. Configure CALC1 to B-A in the programming of the controller, then change the MEAS source to CALC1 for the same controller. This will set the controller to use the result of LT-2 – LT-1 = Oil Level for the measurement.

6. Interconnect the process control equipment per Figure 4.

7. Manually, fill the bottom of Level Tower #1 to the top of the oil drain with water. Refer to Experiment 3 for details on filling Level Tower #1 with water. Do not drain the water; the solenoids for the drain should be closed.

8. Open Solenoid Valve SV-8

9. Turn on Pump P-4 and adjust the output of Manual Station AM-3 to 100%

10. Fill Level Tower #1 with oil to a height of 8 inches (20.32 cm).

11. Turn on Pump P-5

12. Place the controller in AUTOMATIC mode.

Exercise 6: Feedback Control of Oil Level in Level Tower #2

Description of Experiment

The oil level in Level Tower #2 is controlled by the rate of oil being pumped from the tank by variable speed Pump P-6 through Control Valve CV-4, back into the oil storage tank. It can also be controlled by the rate at which oil is pumped into the level tower. Oil is pumped into Level Tower #2 with variable speed pump P-4. Oil Level Transmitter LT-4 outputs a 4-20 mA signal proportional to oil level.

Control Equipment Required

- Controller #3
- Recorder #3
- Level Transmitter LT-3
- Level Transmitter LT-4
- Control Valve #4
- Manual Station #2
- Manual Station #3
- Pump P-4
- Pump P-6

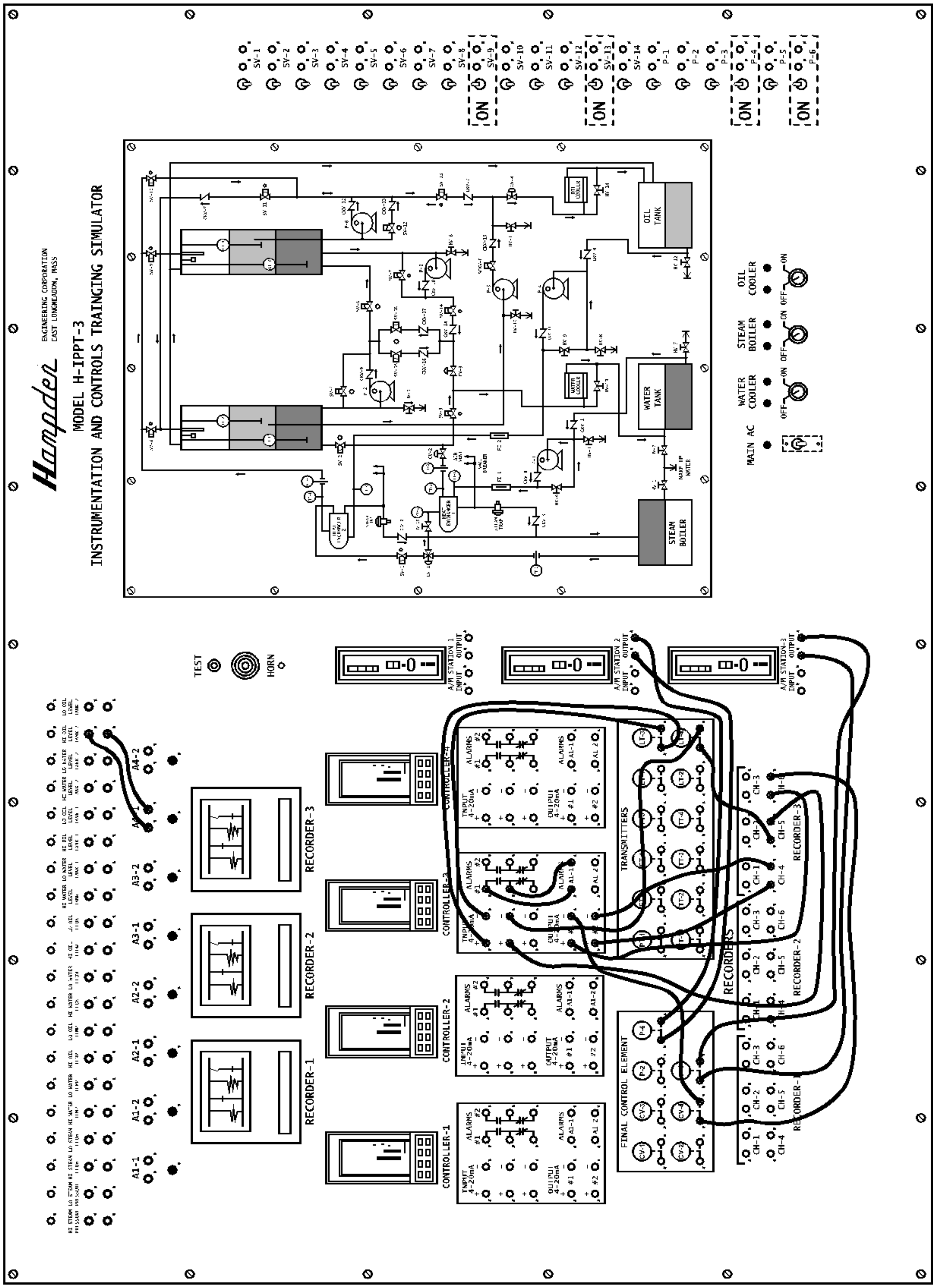


Figure 5: H-IPPT-3 Control Panel

Operational Notes

The oil level (in inches or centimeters) is displayed on Controller #3 and may be recorded (0-100%), along with controller output.

The controller is configured so that Analog Output #2 is the working setpoint.

The inlet oil flow rate can be regulated with variable speed Pump P-4 or with Bypass Valve HV-9. The oil inlet flow rate can be determined from Differential Pressure Transmitter FT-3 and another controller configured for flow.

If the oil temperature is too low, it may be too viscous for good level control. The steam heat exchanger can be used to heat the oil for better performance.

The output of the oil level transmitter is the sum of the water level and the oil level. To use the true oil level, the controller must subtract the output of the water level transmitter from the output of the oil level transmitter, or the output of the oil level transmitter must be biased to account for the water level.

Procedure A – Using the Control Valve

1. Complete all of the pertinent procedures found in the operation section. See Experiment 1

2. Turn on the following circuit breakers (see Experiment 1):
   - Main Process Plant AC power
   - Duplex AC power
   - Solenoid AC power
   - Pump #4 AC power
   - Pump #6 AC power
   - AC power

3. Set the supply air pressure to 25 psig (172 kPa). **DO NOT** exceed 30 psig (207 kPa).

4. Configure the controller, enter the setpoint, tuning parameters and alarms. If the tuning parameters are not known at this time, use a large proportional band with no integral or derivative action, then determine the optimum tuning parameters. Set Alarm A3-1 as a high oil level alarm. Place the controller into MANUAL mode with an output of 100%.

   Suggested recorder settings are as follows:
   - Recorder #3, Channel #4 to record oil setpoint
   - Recorder #3, Channel #5 to record oil level in Level Tank #2
   - Recorder #3, Channel #6 to record percent opening of CV-4

5. Interconnect the process control equipment per Figure 5.

6. Fill the bottom of Level Tower #2 to the top of the oil drain tube with water. Refer to Experiment 4 for details on filling Level Tower #2 with water.

7. Open the following solenoid valves:
   - SV-9
   - SV-13

8. Turn on Pump P-4 and adjust the output of Manual Station AM-3 to 100%.

9. Fill Level Tower #2 with oil to a height of 10 inches (25 cm).

10. Turn on Pump P-6 and adjust the output of Manual Station AM-2 to 100%.

11. Place the controller in AUTOMATIC mode.

Procedure B – Using Variable-Speed Pump P-6

1. Complete all of the pertinent procedures found in the operation section. See Experiment 1

2. Turn on the following circuit breakers (see Experiment 1):
   - Main Process Plant AC power
   - Duplex AC power
   - Solenoid AC power
   - Pump #4 AC power
   - Pump #6 AC power
   - After-cooler AC power

3. Set the supply air pressure to 25 psig (172 kPa). **DO NOT** exceed 30 psig (207 kPa).

4. Configure the controller, enter the setpoint, tuning parameters and alarms. If the tuning parameters are not known at this time, use a large proportional band with no integral or derivative action, then determine the optimum tuning parameters. Set Alarm A3-1 as a high oil level alarm. Place the controller into MANUAL mode with an output of 100%.

   Suggested recorder settings are as follows:
   - Recorder #3, Channel #4 to record oil level setpoint in Level Tower #2
   - Recorder #3, Channel #5 to record oil level in Level Tank #2
   - Recorder #3, Channel #6, Controller #4 output

5. Interconnect the process control equipment per Figure 6.

6. Fill the bottom of Level Tower #2 to the top of the oil drain tube with water. Refer to Experiment 4 for details on filling Level Tower #2 with water.

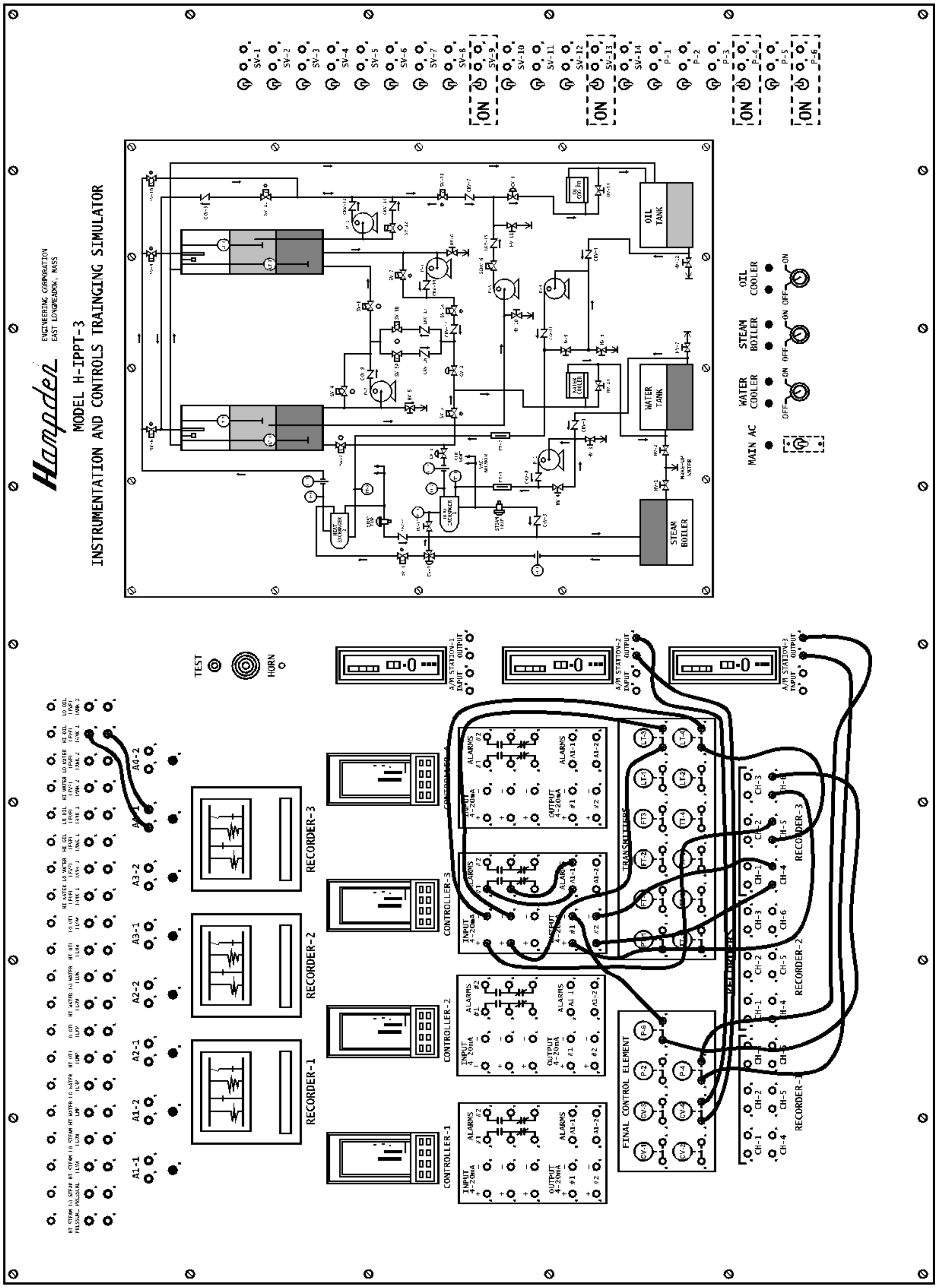


Figure 6: H-IPPT-3 Control Panel

7. Open the following solenoid valves:
    - SV-9
    - SV-13

8. Turn on Pump P-4 and adjust the output of Manual Station AM-3 to 100%.

9. Fill Level Tower #2 with oil to a height of 10 inches (25 cm).

10. Turn on Pump P-6

11. Adjust the output of Manual Station AM-2 to 100% valve open.

12. Place the controller in AUTOMATIC mode.

Procedure C – Using Variable Speed Pump P-4

1. Complete all of the pertinent procedures found in the operation section. See Experiment 1

2. Turn on the following circuit breakers (see Experiment 1):
    - Main Process Plant AC power
    - Duplex AC power
    - Solenoid AC power
    - Pump #4 AC power
    - Pump #6 AC power
    - After-cooler AC power

3. Set the supply air pressure to 25 psig (172 kPa). **DO NOT** exceed 30 psig (207 kPa).

4. Configure the controller, enter the setpoint, tuning parameters and alarms. If the tuning parameters are not known at this time, use a large proportional band with no integral or derivative action, then determine the optimum tuning parameters. Set Alarm A3-1 as a high oil level alarm. Place the controller into MANUAL mode with an output of 0%.

5. Interconnect the process control equipment per **Error! Reference source not found.**.

6. Fill the bottom of Level Tower #2 with water, until just below the top of the oil drain tube. Refer to Experiment 4 for details on filling Level Tower #2 with water.

7. Open the following solenoid valves:
    - SV-9
    - SV-13

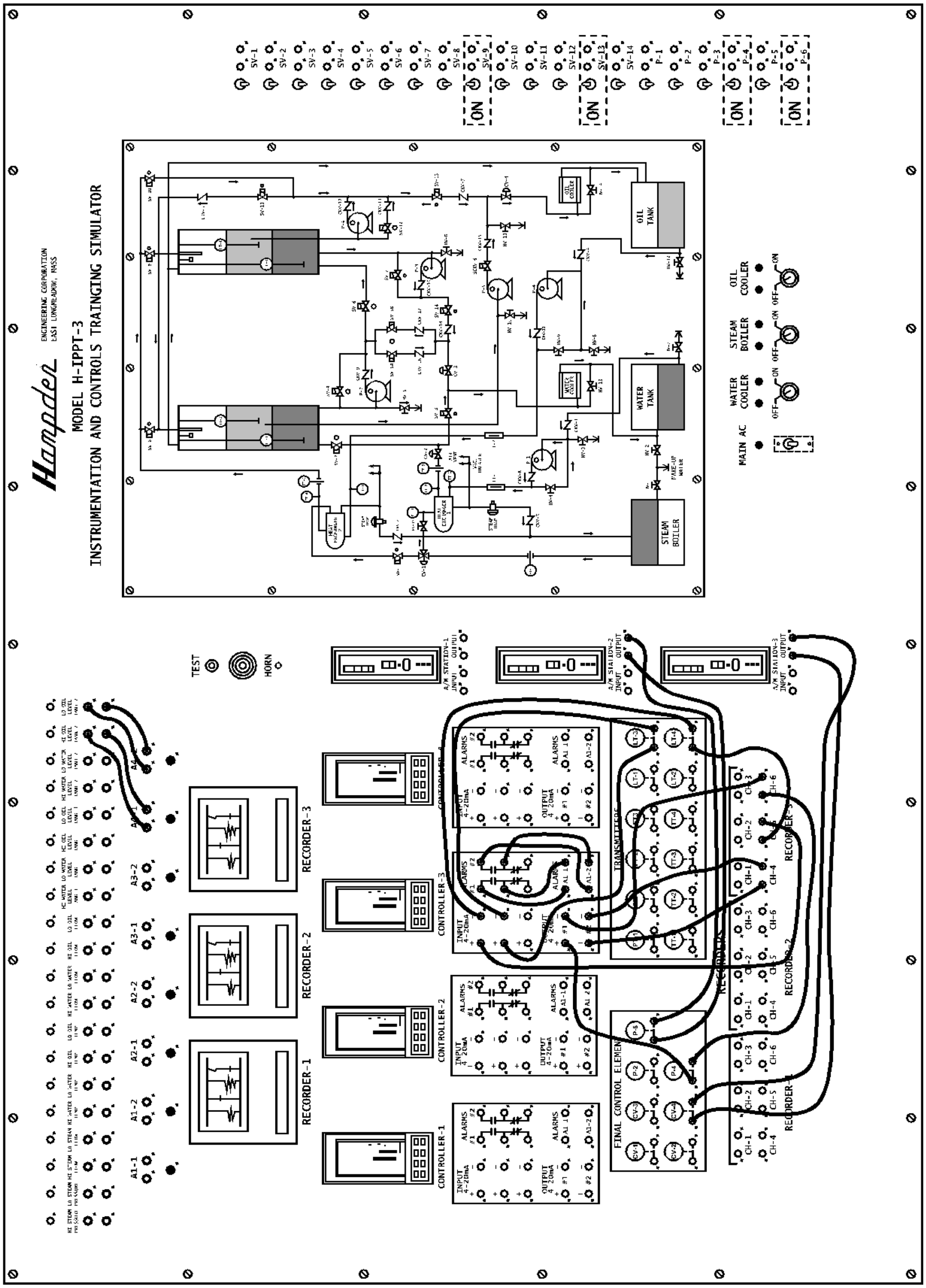


Figure 8: H-IPPT-3 Control Panel

8. Turn on Pump P-4 and adjust the output of Controller #4 to 100%.

9. Fill Level Tower #2 with oil to a height of 10 inches (25 cm).

10. Switch on Pump P-6

11. Adjust the output of Manual Station AM-2 to 100%.

12. Adjust the output of Manual Station AM-3 until the oil level increases at a reduced rate.

13. Place the controller in AUTOMATIC mode.

Exercise 7: Feedback Control of Water Temperature

Description of Experiment

Steam is generated in the boiler and flows through the steam Control Valve CV-1 and the water heat exchanger, where it gives up heat to the circulating water. Steam flow rate is controlled by Control Valve CV-1 and water temperature is measured at the outlet of the heat exchanger. The boiler cycles on and off from its own pressure controller. Boiler pressure should not exceed 10.0 psig (38.5 kPa).

A thermocouple measures water temperature at the outlet of the heat exchanger. A temperature transmitter converts the millivolt output of the thermocouple into a 4-20 mA current signal that is linear with temperature.

The programming location 1.5E of the temperature controller is used for setting the input scale in engineering units.

In this experiment, the temperature of water through the heat exchanger will be controlled.

Control Equipment Required

- Controller #1
- Recorder #1
- Temperature Transmitter TT-2
- Control Valve CV-1
- Control Valve CV-2
- Manual Station #2
- Pump P-1

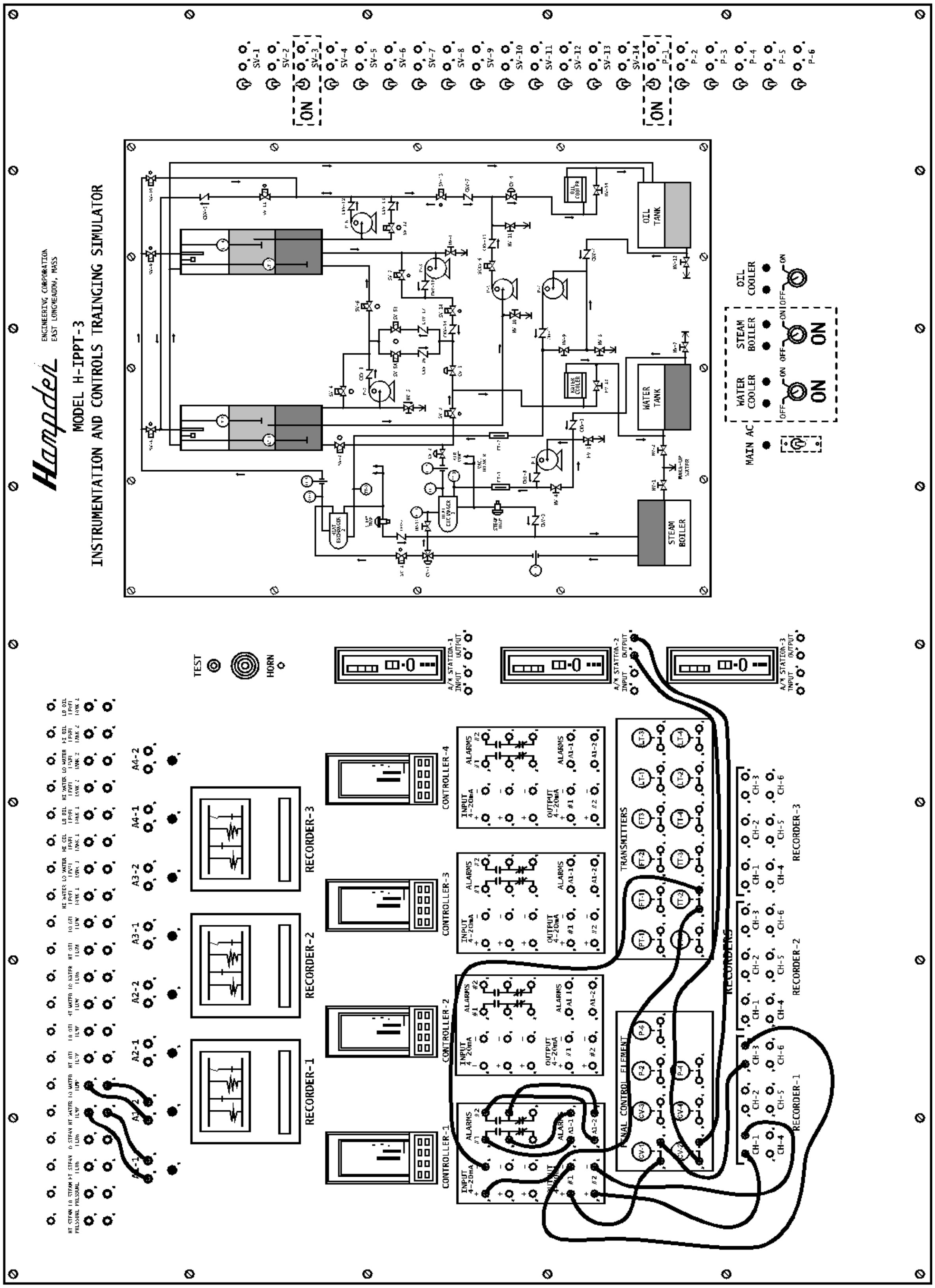

Hampden
ENGINEERING CORPORATION
EAST LONGMEADOW, MASS
MODEL H-IPPT-3
INSTRUMENTATION AND CONTROLS TRAINGING SIMULATOR
OIL TANK
WATER TANK
STEAM BOILER
OIL COOLER
STEAM BOILER
WATER COOLER
MAIN AC
ON
TEST
HORN
CONTROLLER-1
CONTROLLER-2
CONTROLLER-3
CONTROLLER-4
RECORDER-1
RECORDER-2
RECORDER-3
TRANSMITTERS
FINAL CONTROL ELEMENT
RECORDERS
A/M STATION-1
A/M STATION-2
A/M STATION-3

Figure 7

Procedure

1. Complete all of the pertinent procedures found in the operation section.

2. Turn on the following circuit breakers:
   - Main Process Plant AC power
   - Duplex AC power
   - Steam Boiler AC power
   - Solenoid AC power
   - Pump #1 AC power
   - After-cooler AC power

3. Set the supply air pressure to 25 psig (172 kPa). **DO NOT** exceed 30 psig (207 kPa).

4. Configure the controller, enter the setpoint, tuning parameters and alarms. If the tuning parameters are not known at this time, use a large proportional band with no integral or derivative action, then determine the optimum tuning parameters. Set Alarm A1-1 as a high water temperature alarm and Alarm A1-2 as a low water temperature alarm. Place the controller into MANUAL mode with an output of 0%. Set the setpoint to 150°F (65°C).

5. Interconnect the process control equipment per Figure 7.

6. Turn on the electric steam boiler.

7. Open Solenoid Valve SV-3.

8. Turn on Pump P-1 and adjust the output of Manual Station AM-1 so that 1 gpm (3.85 lpm) of water is flowing (AM-1 ≈ 58% ≈ 1 gpm).

9. Turn on the water after-cooler.

10. After steam begins to flow, water temperature will begin to increase. Place the controller in AUTOMATIC (A on A/M). When temperature rises above setpoint, the valve will begin to close to maintain the setpoint.

11. To test system response, you can change either the setpoint or the water flow rate.

Exercise 8: Feedback Control of Oil Temperature

Description of Experiment

Steam is generated in the boiler and flows through the steam Control Valve CV-1 and the oil heat exchanger, where it gives up heat to the circulating oil. Steam flow rate is controlled by Control Valve CV-1 and oil temperature is measured at the outlet of the heat exchanger. The boiler cycles on and off from its pressure controller. Boiler pressure should not exceed 10.0 psig (68.9 kPa).

In this experiment, the oil temperature through the heat exchanger will be controlled.

> **IMPORTANT –** Since water temperature is not being controlled, use an alarm from another controller to monitor it. The water loop must be circulating while running experiments involving oil temperature.

Control Equipment Required

- Controller #1
- Recorder #1
- Temperature Transmitter TT-4
- Control Valve CV-1
- Control Valve CV-4
- Manual Station #2
- Manual Station #3
- Pump P-1
- Pump P-4

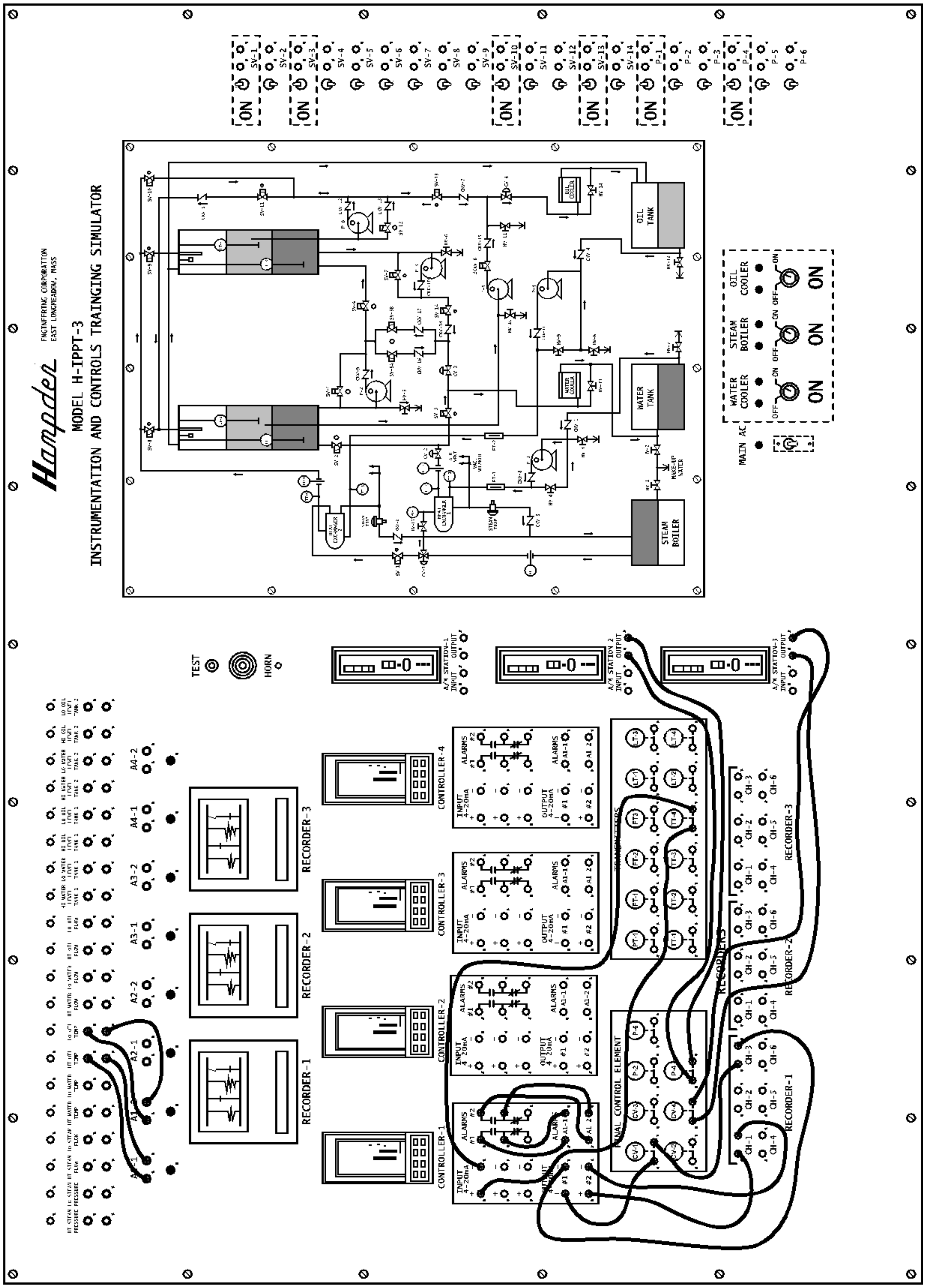

Hampden
MODEL H-IPPT-3
INSTRUMENTATION AND CONTROLS TRAINGING SIMULATOR
RECORDER-1
RECORDER-2
RECORDER-3
CONTROLLER-1
CONTROLLER-2
CONTROLLER-3
CONTROLLER-4
FINAL CONTROL ELEMENT
RECORDERS
TRANSMITTERS
TEST
HORN
MAIN AC
WATER COOLER
STEAM BOILER
OIL COOLER
ON
OIL TANK
WATER TANK
STEAM BOILER

Figure 8

Procedure

1. Complete all of the pertinent procedures found in the operation section.

2. Turn on the following circuit breakers:
   - Main Process Plant AC power
   - Duplex AC power
   - Steam Boiler AC power
   - Solenoid AC power
   - Pump #1 AC power
   - Pump #4 AC power
   - After-cooler AC power

3. Set the supply air pressure to 25 psig (172 kPa). **DO NOT** exceed 30 psig (207 kPa).

4. Configure the controller, enter the setpoint, tuning parameters and alarms. If the tuning parameters are not known at this time, use a large proportional band with no integral or derivative action, then determine the optimum tuning parameters. Set Alarm A1-1 as a high oil temperature alarm and Alarm A1-2 as a low oil temperature alarm. Place the controller into MANUAL mode.

5. Interconnect the process control equipment per Figure 8.

6. Turn on the electric steam boiler.

7. Turn on the water and oil after-coolers

8. Open the following solenoid valves
   - SV-1
   - SV-3
   - SV-10
   - SV-13

9. Turn on Pump P-1, adjust the output of Manual Station AM-3 until 1 gpm (3.85 lpm) of water is flowing (≈ 58% of full scale).

10. Turn on Pump P-4, adjust the output of Manual Station AM-2 until 1 gpm (3.85 lpm) of oil is flowing.

11. Place the controller into AUTOMATIC mode.

Exercise 9: Feedback Control of Steam Pressure

Description of Experiment

Steam is generated in the boiler and flows through the steam Control Valve CV-1 and the water heat exchanger, where it gives up heat to the circulating water. Pressure is measured on the downstream side of Control Valve CV-1 by steam Pressure Transmitter PT-1, and water temperature is measured at both the inlet and the outlet of the heat exchanger. The boiler cycles on and off from its own pressure controller. Boiler pressure should not exceed 10.0 psig (68.9 kPa).

> **IMPORTANT –** Since water temperature is not being controlled, use an alarm from another controller to monitor it.

Control Equipment Required

- Controller #1
- Controller #4
- Recorder #1
- Temperature Transmitter TT-2
- Control Valve CV-1
- Control Valve CV-2
- Manual Station #2
- Pump P-1

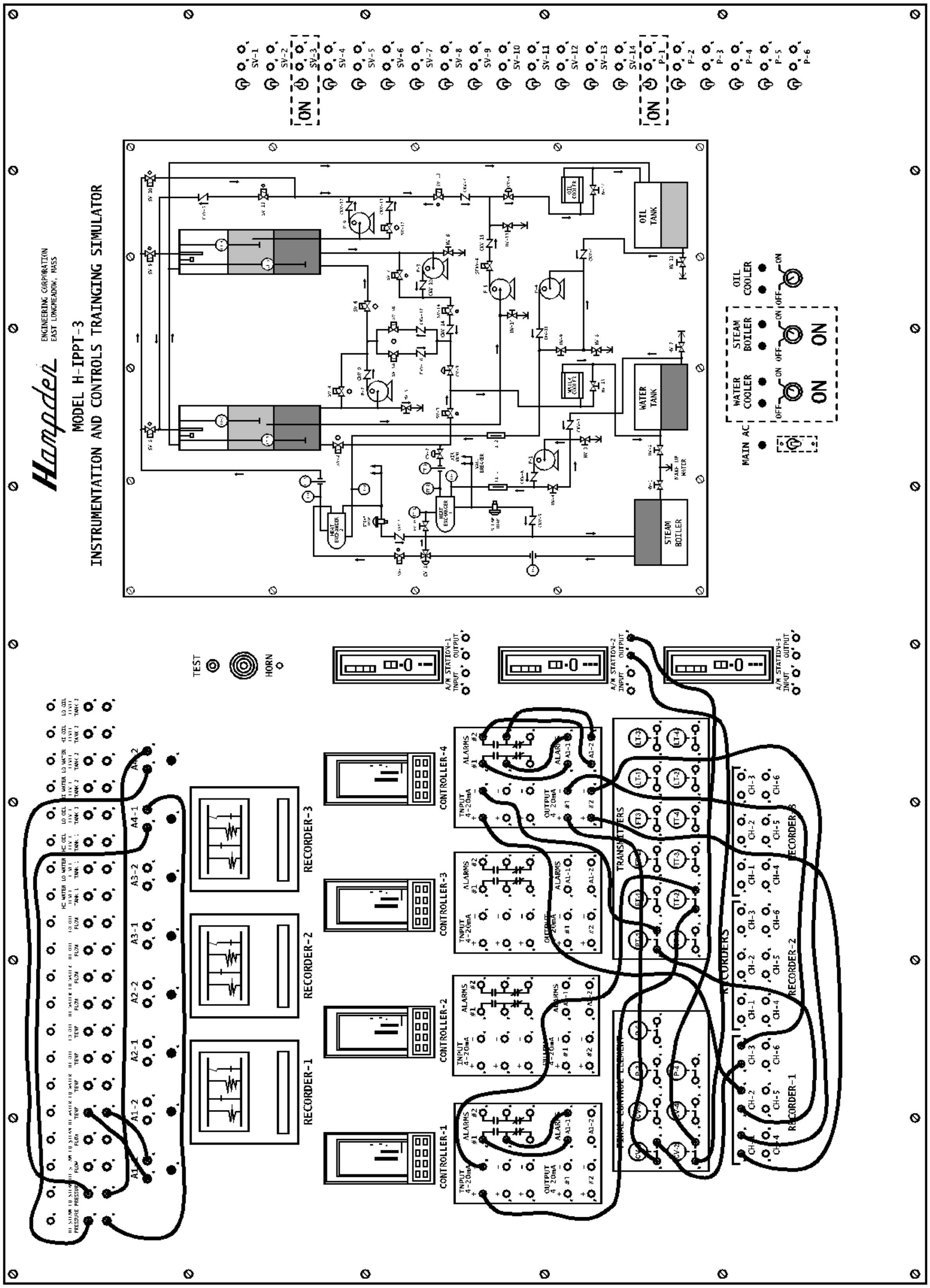

Hampden
ENGINEERING CORPORATION
EAST LONGMEADOW, MASS
MODEL H-IPPT-3
INSTRUMENTATION AND CONTROLS TRAINGING SIMULATOR
OIL TANK
WATER TANK
STEAM BOILER
OIL COOLER
STEAM BOILER
WATER COOLER
MAIN AC
ON
OFF
TEST
HORN
CONTROLLER-1
CONTROLLER-2
CONTROLLER-3
CONTROLLER-4
RECORDER-1
RECORDER-2
RECORDER-3
TRANSMITTERS
RECORDERS

Figure 9

Procedure

1. Complete all of the pertinent procedures found in the operation section.

2. Turn on the following circuit breakers:
   - Main Process Plant AC power
   - Duplex AC power
   - Steam Boiler AC power
   - Solenoid AC power
   - Pump #1 AC power
   - After-cooler AC power

3. Set the supply air pressure to 25 psig (172 kPa). **DO NOT** exceed 30 psig (207 kPa).

4. Configure Controller #4, enter the setpoint, tuning parameters and alarms. If the tuning parameters are not known at this time, use a large proportional band with no integral or derivative action, then determine the optimum tuning parameters. Set Alarm A4-1 as a high steam pressure alarm. Place the controller into MANUAL mode with an output of 0%. Set Alarm A1-1 as a high water temperature alarm and configure Controller #1 as an indicator of temperature. Controller #1 can be operated manually, and is only scaling the input measurement and monitoring system water temperature.

5. Turn on the electric steam boiler.

6. Interconnect the process control equipment per Figure 9.

7. Open the Solenoid Valve SV-3 and turn on the water after-cooler

8. Turn on Pump P-1, adjust the output of Manual Station AM-2 until 1 gpm (3.85 lpm) of water is flowing (≈ 55% of full scale).

9. Turn on the water after-cooler.

10. Place the controller into AUTOMATIC mode.

6. PLC & Variable Speed Drives

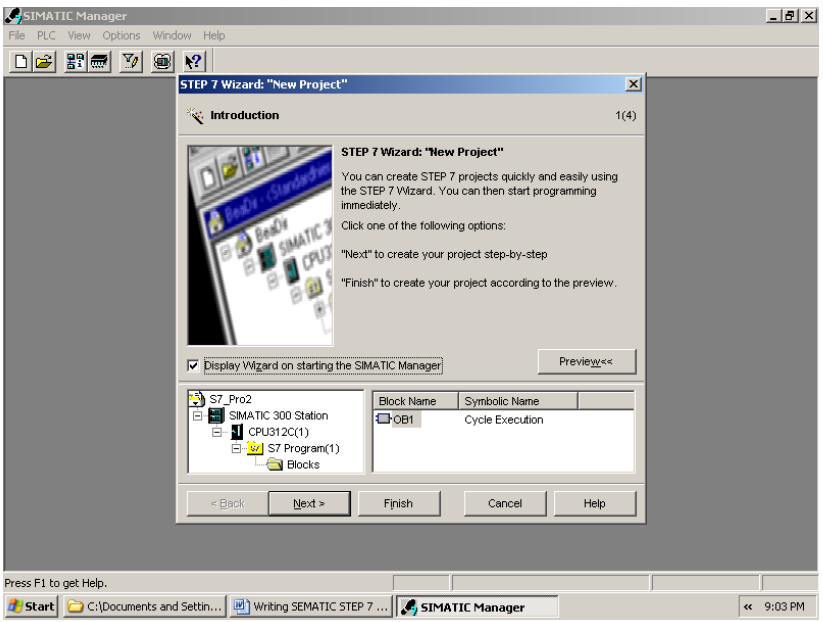
Exercise 10: Working With SIEMENS SIMATIC S7

To write a SIMATIC Step 7 PLC Program we basically have to do 3 steps:

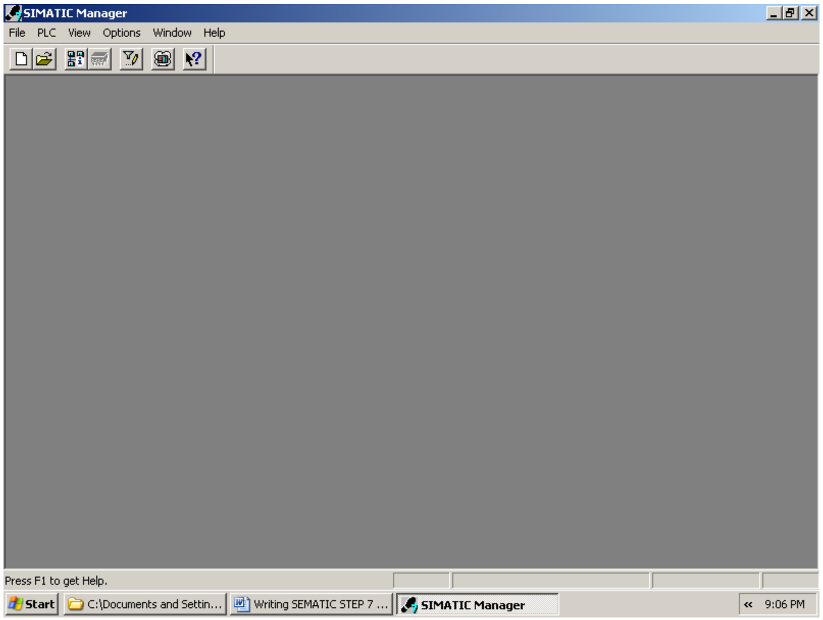
1) Setup the HARDWARE.
2) Write the LADDER diagram.
3) Run the program.

The following is procedure to establish the above steps:

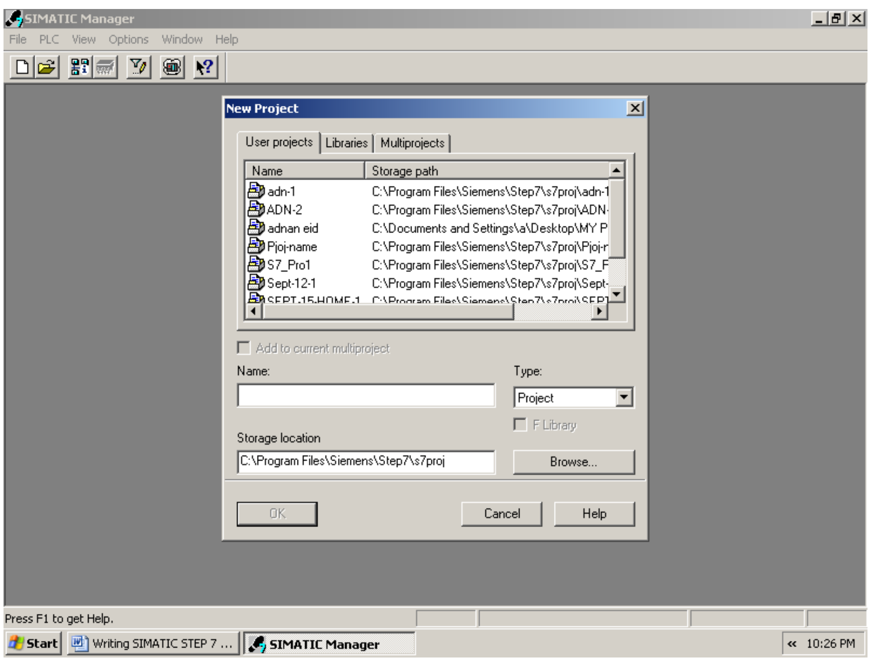
1- Start the SIMATIC Manager software and you will see the following screen.



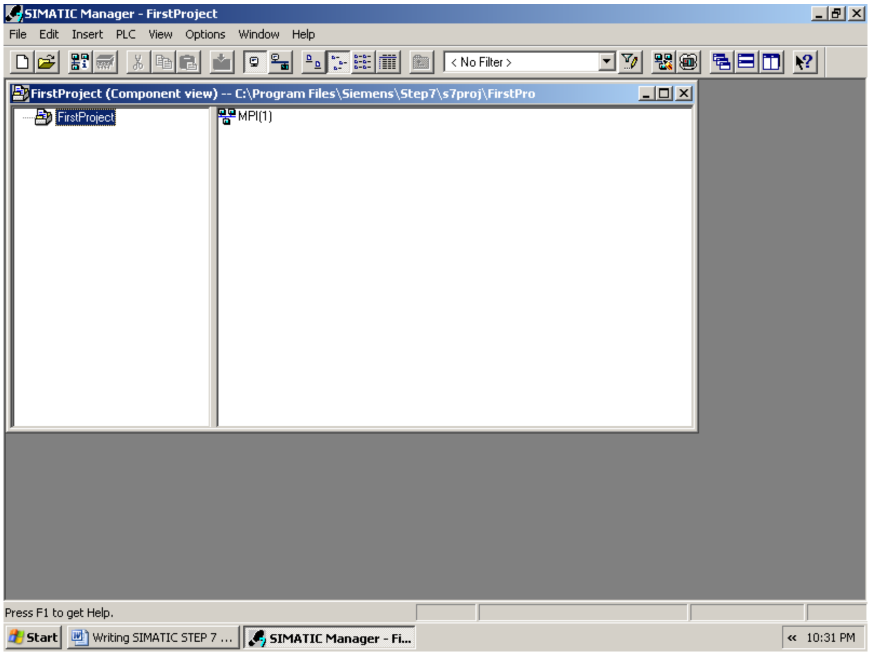
2- Because we want to start new program, click cancel and you will see the following screen.



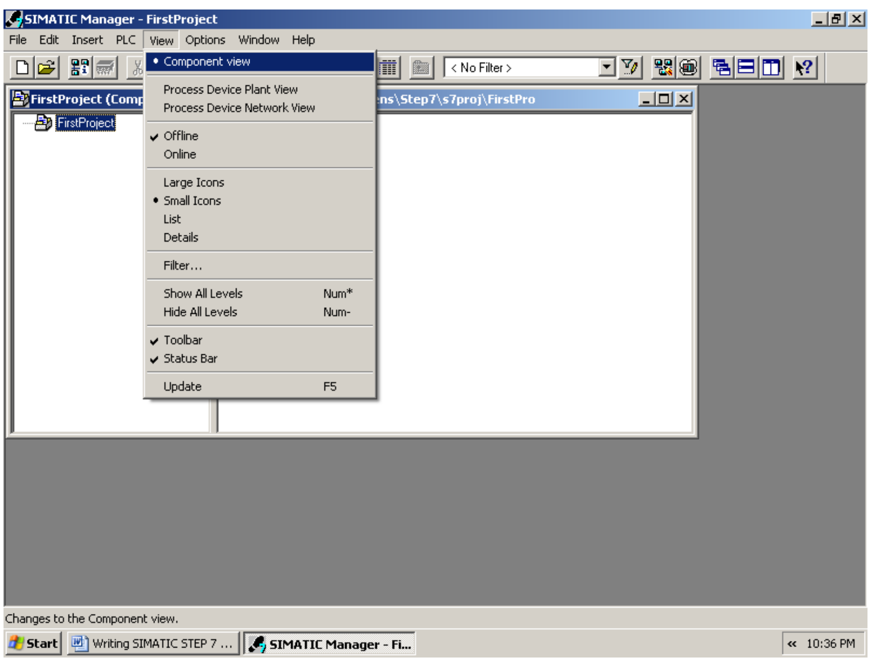
3- Click the New Project/Libraries icon and you will see the following screen.



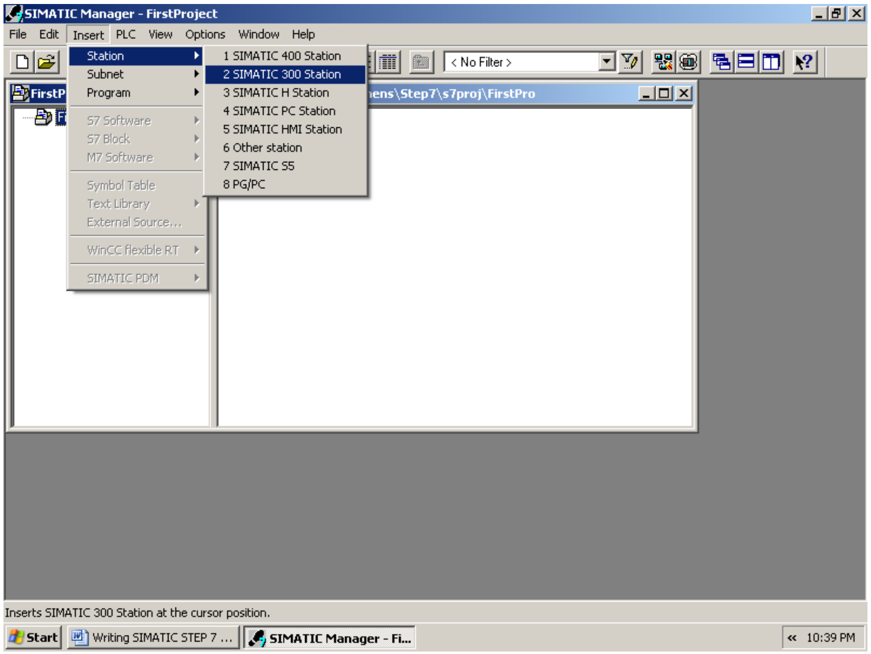
4- Write the project name (say “FirstProject”) and click OK. You will see the following screen.



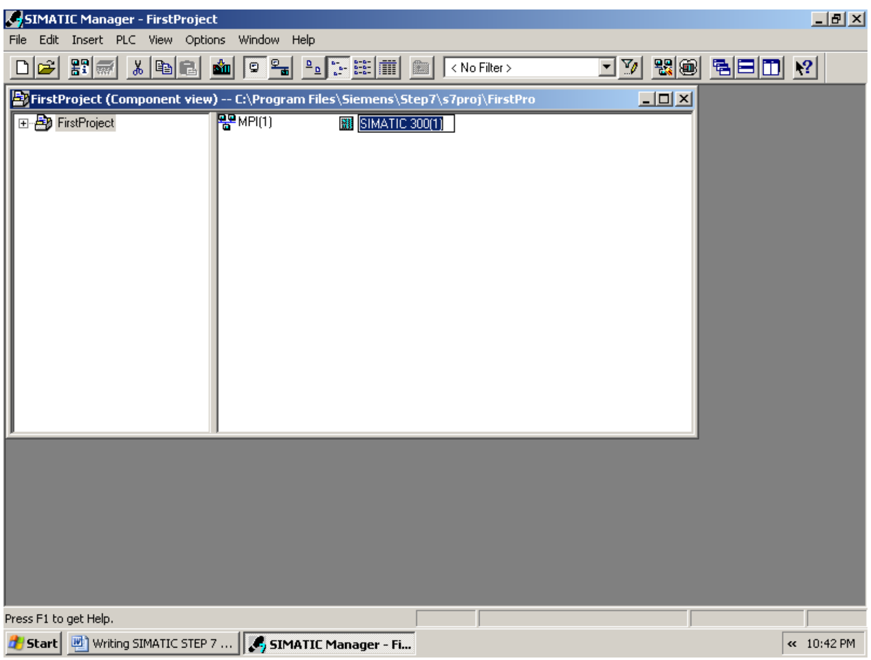
5- From the pull-down press view and then component view.



6- From the pull-down press Insert, Station and then SIMATIC 300 Station.

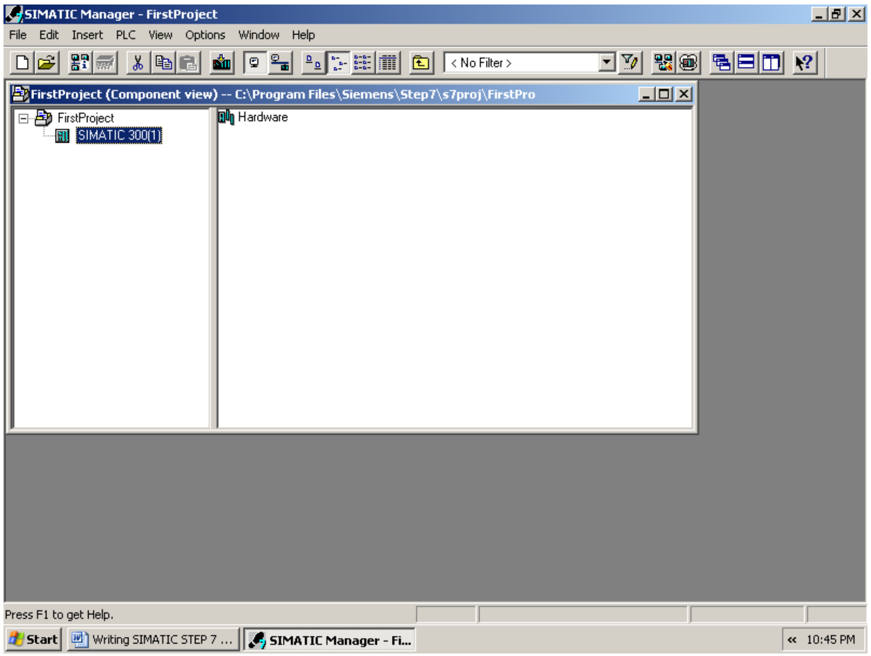


You will see the following screen.



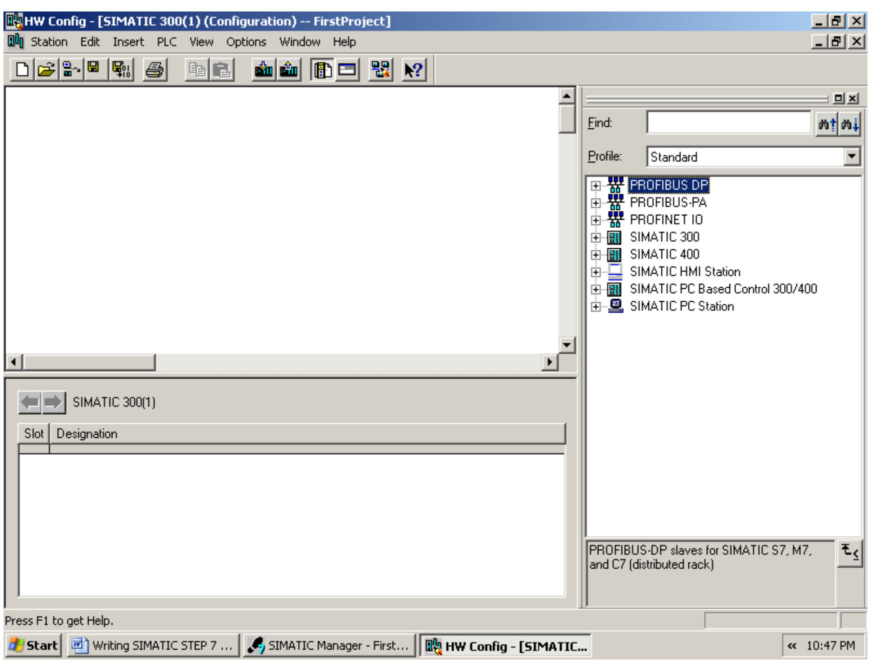
7- Double Click SIMATIC 300(1) and you will see the following screen.

Exercise 11: Hardware Configuration



8- Double Click Hardware and you will see the following screen.

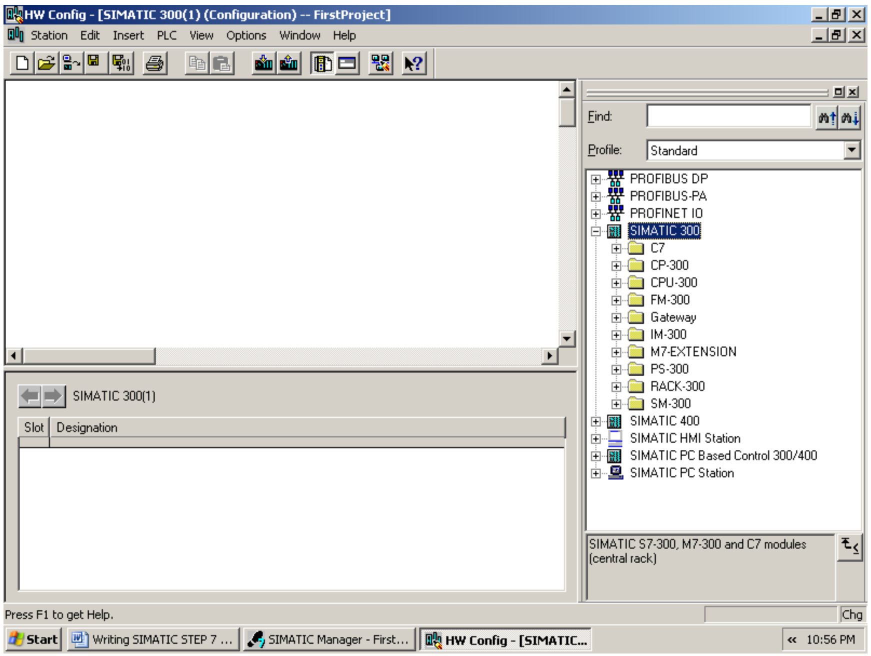
This is the hardware configuration screen.



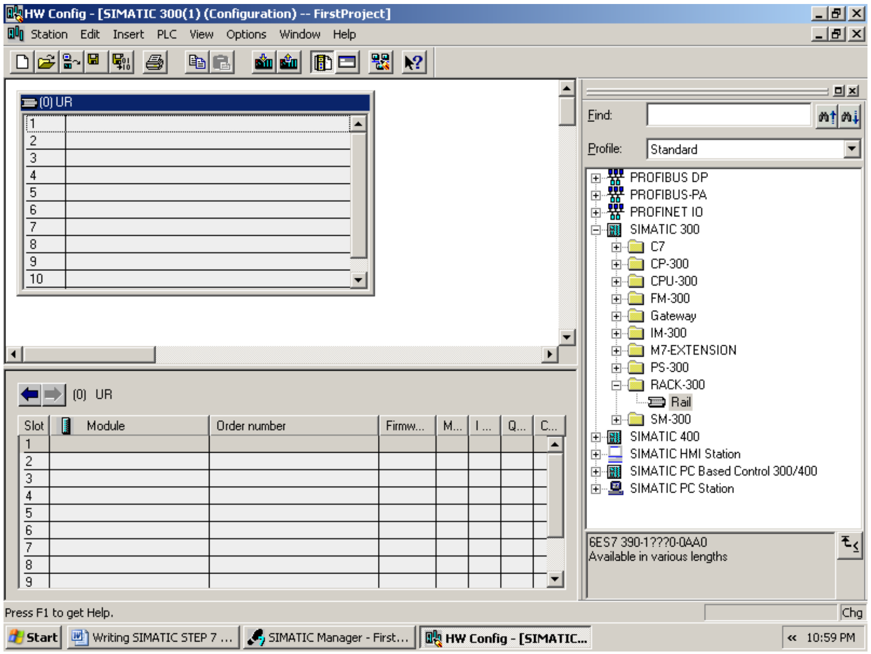
Now we are going to configure the hardware needed in our project. We are going to select the following:

1) Rail module.
2) Power supply module.
3) CPU module.
4) DI and DO modules.

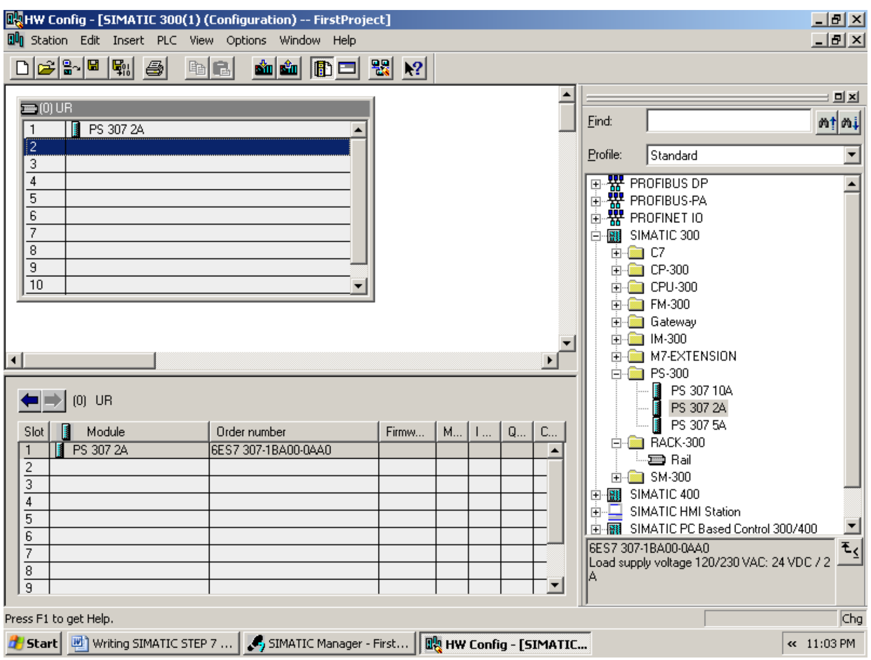
9- In the right hand window Double Click the SIMATIC 300. You will see the following screen.



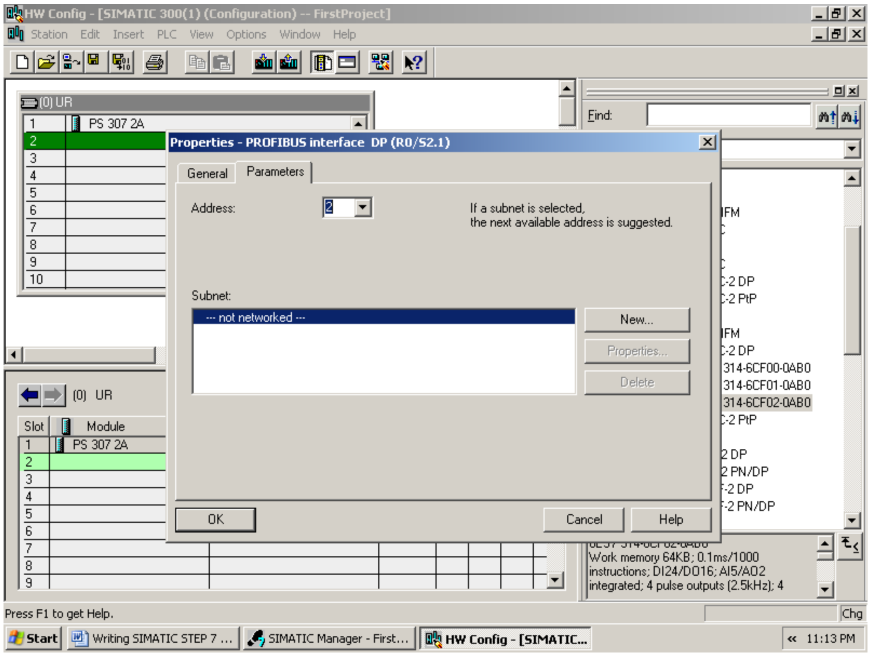
10- In the right hand window Double Click the RACK 300 and then double click Rail. you will see the following screen.



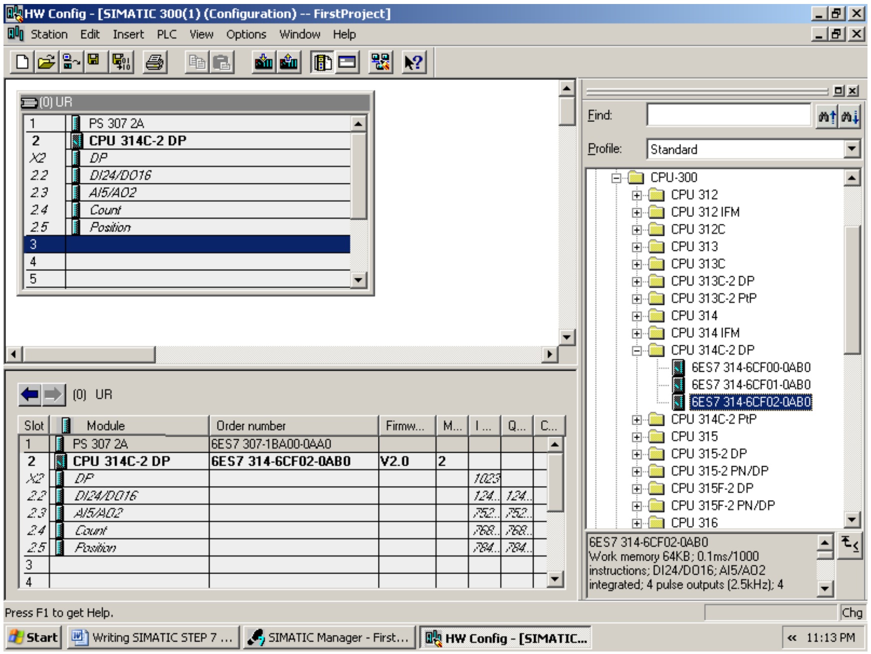
11- Select slot number “1” in the Rail table. In the right hand window Double Click the PS 300 and then double click PS 307 2A. you will see the following screen.



12- Select slot number “2” in the Rail table. In the right hand window Double Click the CPU 300, then Double Click the CPU 314C-2 DP, then Double Click the 6ES7 314-6CF02-0AB0 and you will see the following screen.



13- Make sure the address is 2 and click OK. You will get the following screen.



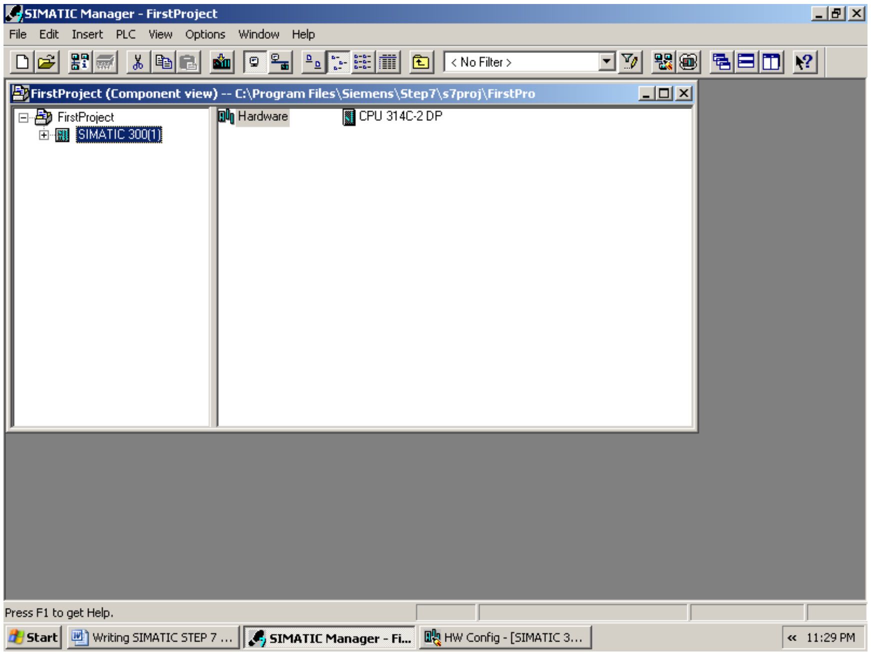
We are finished with the hardware setup, because in our case we have compact CPU module that means the DI and DO modules are integrated in the CPU module. (If we did not have the compact CPU module, then we will have to add DI and DO modules to the hardware).

14- Click Save and compile the hardware.

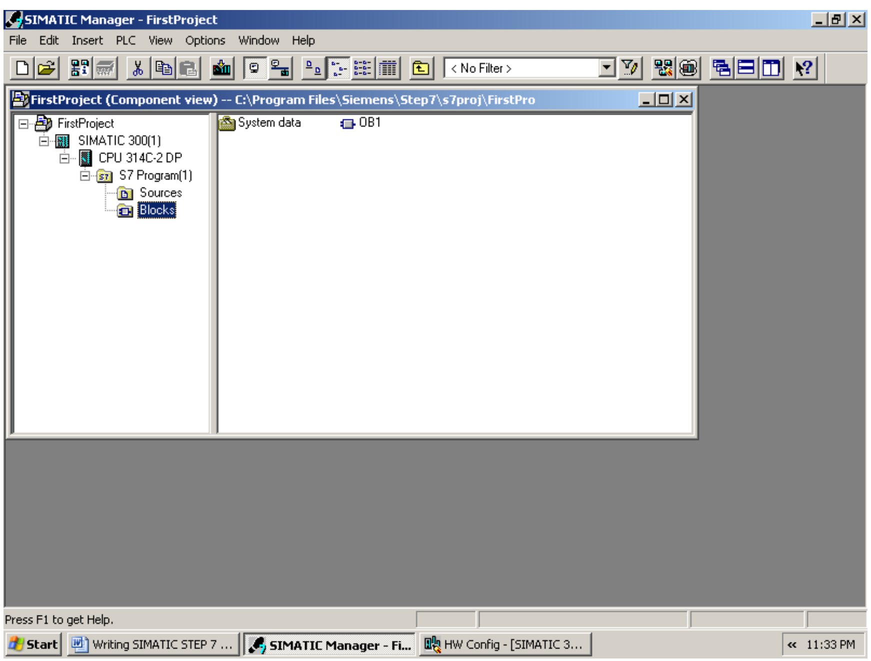
15- Click Download to module icon. This step should be done when the PC is connected to the actual PLC or when the PLCSIM is ON.

Now we are going to write the Ladder Diagram Program.

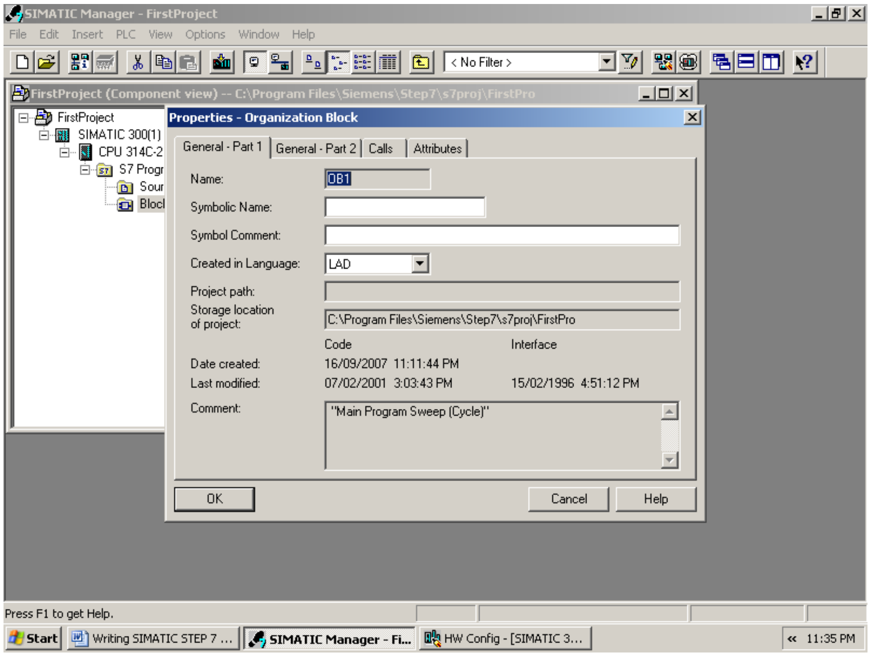
16- Select the SIMATIC Manager screen and you will see the following screen.



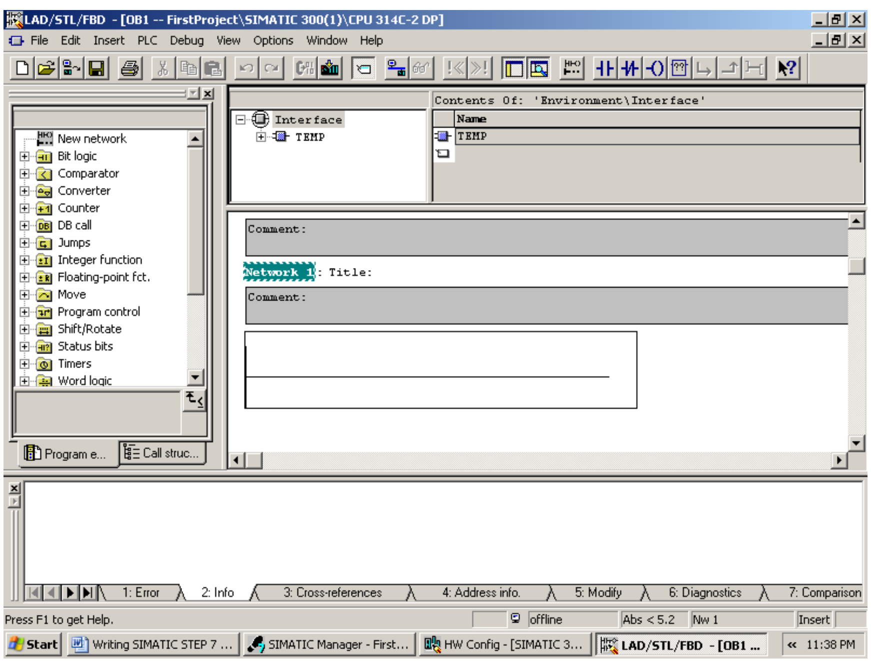
17- In the left side window, double click the SIMATIC 300(1), then double click CPU 314C-2DP, then double click S7 Program(1), then double click blocks and you will see the following screen.



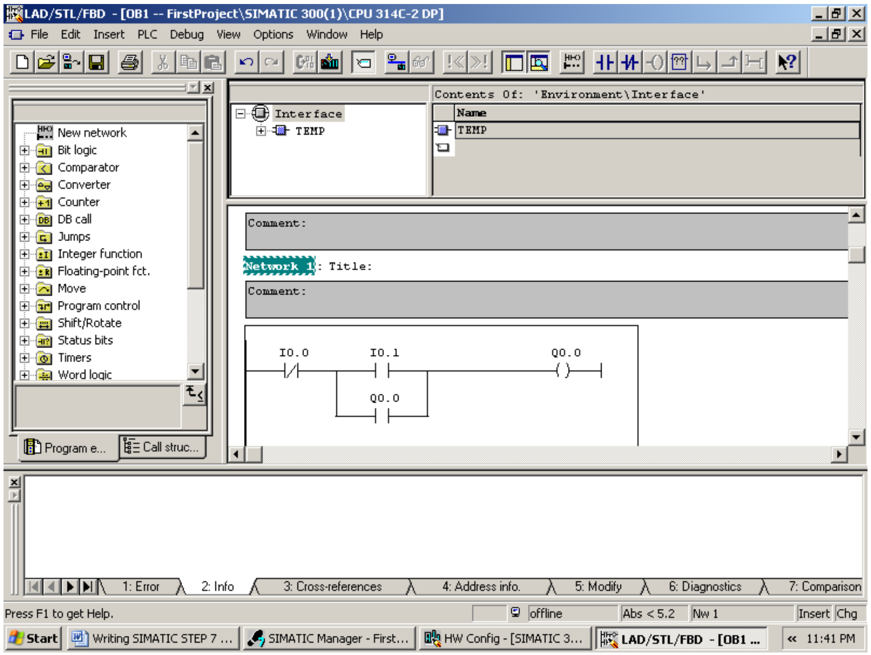
18- In the right hand window, double click OB1, and you will see the following screen.



19- Click OK to accept LAD (Ladder Diagram) and you will see the following screen.



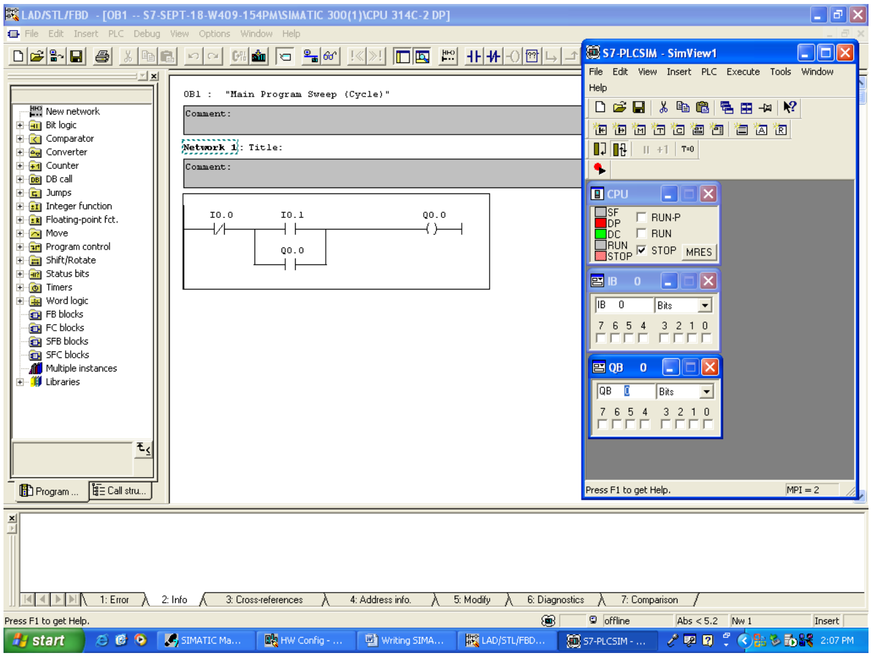
20- Now write the Ladder diagram. Just write one rung program as shown below.



21- Click the save icon to save your program. The screen will stay the same.

To simulate your program you must download your program to S7-PLCSIM

22- Go to SIMATIC MANAGER screen and click the simulation on/off icon. Go back LAD/STL/FBD screen by selecting tabs at the bottom of the screen. And also place the simulator on the screen as shown below.



23- Click the download icon to download your program to the simulator.

24- Go to the simulator and make sure the input and output module numbers are correct. Place the simulator in the RUN mode and simulate your program by:

Pressing input I0.1 to turn ON output Q0.0
Pressing input I0.0 to turn OFF output Q0.0

You can also place the operation ONLINE using the simulator just as you do with actual PLC.

25- Click the monitor (on/off) icon to place the operation on-line.

26- Go back and practice simulation as you did earlier. Place the simulator in the RUN mode and simulate your program by:

Pressing input I0.1 to turn ON output Q0.0
Pressing input I0.0 to turn OFF output Q0.0

Watch your Ladder diagram as you are doing the simulation and should see switches are closing and opening also output are turning ON and OFF.

To DOWNLOAD and RUN your program on actual PLC.

1- Make sure the PLC is turned ON.

2- Go to the HARDWARE screen after selecting your hardware, Click save & Compile icon.

3- Go to SIMATIC MANAGER S7 Click SIMATIC 300(1) and click the download icon to download the CPU to the PLC.

4- In the SIMATIC MANAGER S7 screen expand the SIMATIC 300(1) to the blocks. And in the right side screen double click the OB1 to go to the LAD?STL/FBD screen and write your ladder diagram.

5- When you complete your program, click the save icon to save your program and click the download icon to download the program. The screen will stay the same.

6- Click the monitor (on/off) icon to place the operation on-line.

7- Now you can test your program as you have done earlier with the simulator.

Pressing input I0.1 to turn ON output Q0.0
Pressing input I0.0 to turn OFF output Q0.0

Watch your Ladder diagram as you are doing the simulation and should see switches are closing and opening also output are turning ON and OFF.

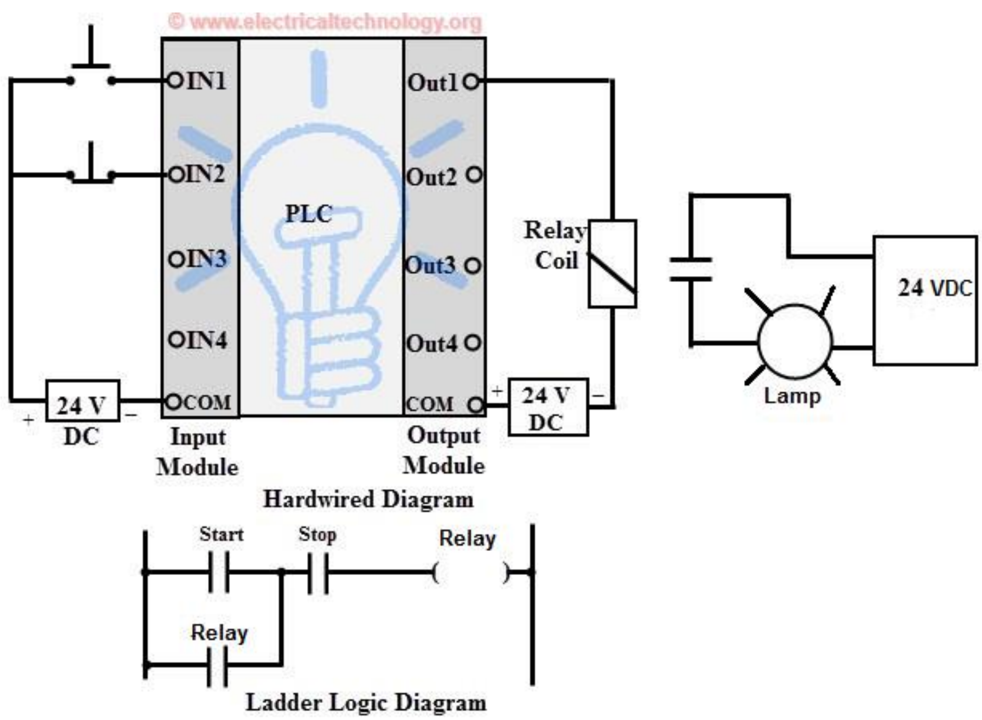
Practical : Connect Lamp using Siemens S7-300 PLC.

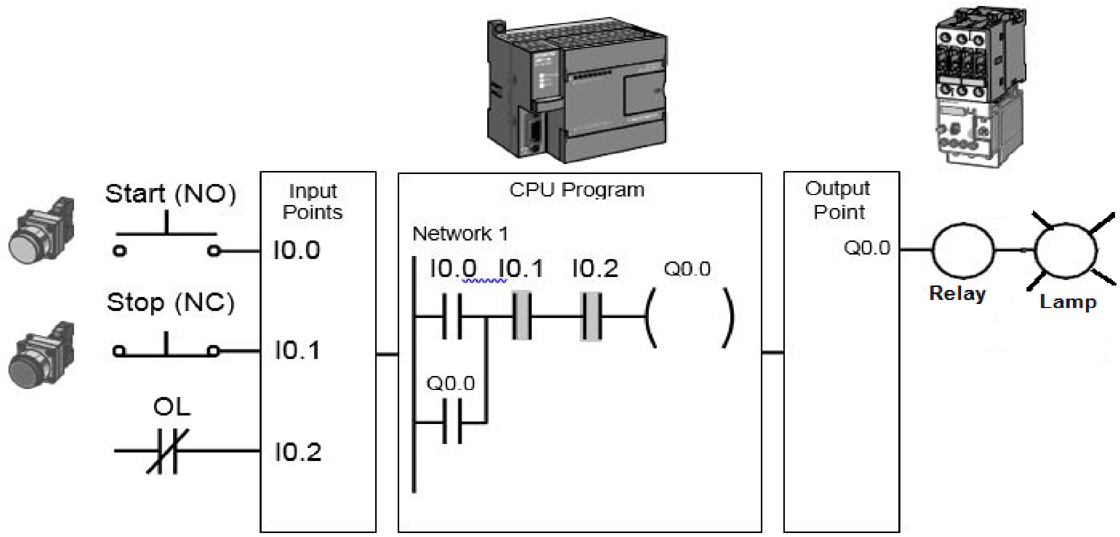
Objective:

- To study the application of connecting lamp using Siemens S7-300 PLC

Equipment List:

- Relay
- 24 DCV power supply.
- Lamp
- Start/Stop Button
- Digital multimeter
- Wires and screw drivers.





Start (NO)
Stop (NC)
OL
Input Points
I0.0
I0.1
I0.2
CPU Program
Network 1
I0.0
I0.1
I0.2
Q0.0
Q0.0
Output Point
Q0.0
Relay
Lamp

Exercise 12: Siemens Simatic S7, working with Micromaster 420

The Siemens MICROMASTER 420

The MICROMASTER 420s are a range of frequency inverters for controlling the speed of three phase AC motors. The various models available range from the 120 W single phase input to the 11 kW three phase input.

The inverters are microprocessor-controlled and use state-of-the-art Insulated Gate Bipolar Transistor (IGBT) technology. This makes them reliable and versatile. A special pulse-width modulation method with selectable Pulse frequency permits quiet motor operation. Comprehensive protective functions provide excellent inverter and motor protection.

The MICROMASTER 420 with its default factory settings, is ideal for a large range of simple motor control applications. The MICROMASTER 420 can also be used for more advanced motor control applications via its comprehensive parameter lists. The MICROMASTER 420 can be used in both 'stand-alone' applications as well as being integrated into 'Automation Systems'.

Micromaster MM420 Drive (setup & operation)

The drive can be operated in different modes:

1. BOP- (Basic operating panel)
It is small operating panel attached on the drive. By this the drive can start, stop, jog and vary the speed of the drives. Moreover we can change the direction of rotation.

2. External wiring
It is hard wired connected to the drives input and output. By this you can have the starter panel and can operate from there. By using this mode we can Start/Stop/Jog/Direction changes/Speed variations can be performed.

3. Profibus
This is the mode where we will be operating the drives on Profibus. This is usually used in combination with PLC. The PLC will give command for Start/stop/Speed variations.

The drive will have On/Off command and speed source. The following table shows different ways of operating the drives.

1. Directly on BOP or External or Profibus
2. Starting from BOP and speed variation from external source
3. Stating from external and speed variation from BOP

The following are the parameters used for different settings

1. Factory Default settings – In this mode the drive parameters will be reset to factory default values.
This is usually performed before starting any operation. The following are the parameter Settings
P10=30, P970=1

2. Quick Commissioning – In this mode motor ratings will be feed through panel. In general the drive will be connected to the motor and motor ratings are entered in the parameters. The following are the parameters

P10=1 (Start quick commissioning)
P304=Voltage
P305=Current
P307=Power
P310=Frequency
P311=RPM
P3900=1(Saving the Quick commissioning)
3. Commissioning
P700= Command source (Start/Stop)
=1(BY BOP)
=2(BY EXTERNAL DIGITAL TERMINALS)
=4(BY BOP ON COM LINK)
=5(BY BOP ON USS LINK)
=6(BY COMMUNICATION BOARD, PROFIBUS)

P701- FIRST DIGITAL INPUT
P702- SECOND DIGITAL INPUT

P703- THIRD SIGITAL INPUT
P918- PROFIBUS ADDRESS
P2041- PPO TYPE (1 OR 3)
P2051=FEEDBACK TYPE
=21(FREQUENCY)
=27(CURRENT)
=52(STATUS WORD)
=25(VOLTAGE)

For operation in Profibus, the following method is followed

1. Connect the drive to PLC on MPI port with Profibus cable.
2. Make the end terminating resistor high (ON)
3. Set the drives address and baud rate by parameter zing
4. In PLC hardware configuration add the drives with same address and baud rate
5. Add ppo3 as the control/status word in configuration
6. Now write the logic for starting and stopping in the PLC and mention speed
7. The first two words will be the control word and next two word will be status word
8. The following values shall be loaded in the On/Off control word for the following operations.

a) 16#047E – For drive stop
b) 16#047F – For drive start
c) 16#04CE – For drive in reverse direction

9. Following values shall be loaded in the speed control word.

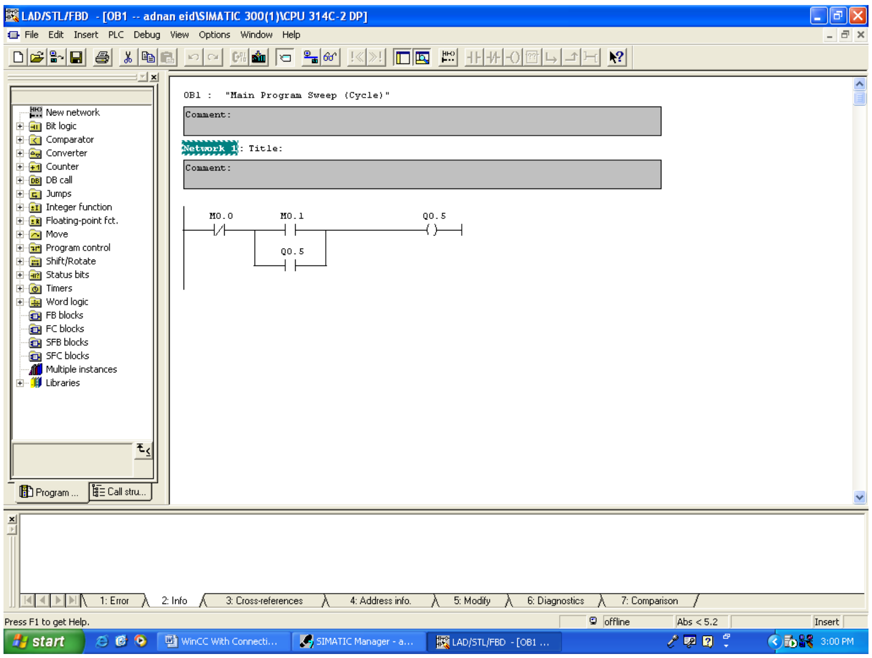
a) 16384 – to run at 50Hz
b) 8192 – to run at 25Hz
c) 4096 to run at 12.5Hz
d) 2048- to run at 6.25Hz

10. In this way operate the drive on Profibus

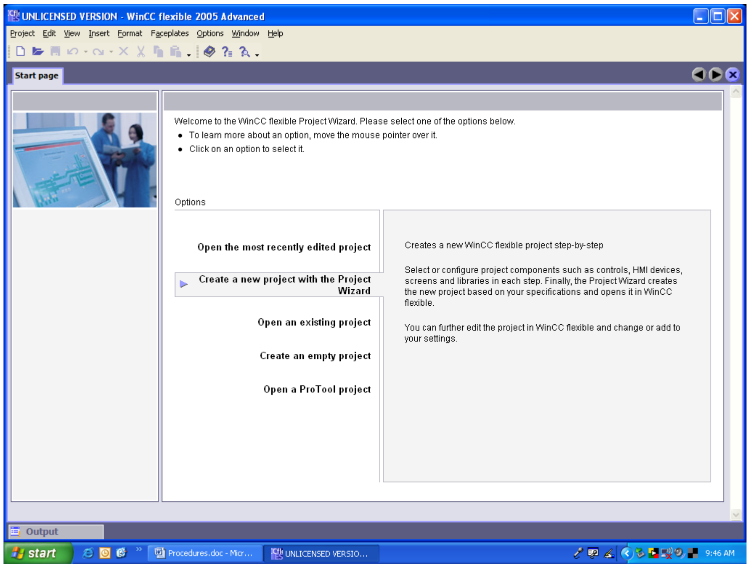
Exercise 13: WINCC Flexible & Integration with Simatic S7

a) WinCC Procedure With Connection to PLCSIM and Tags

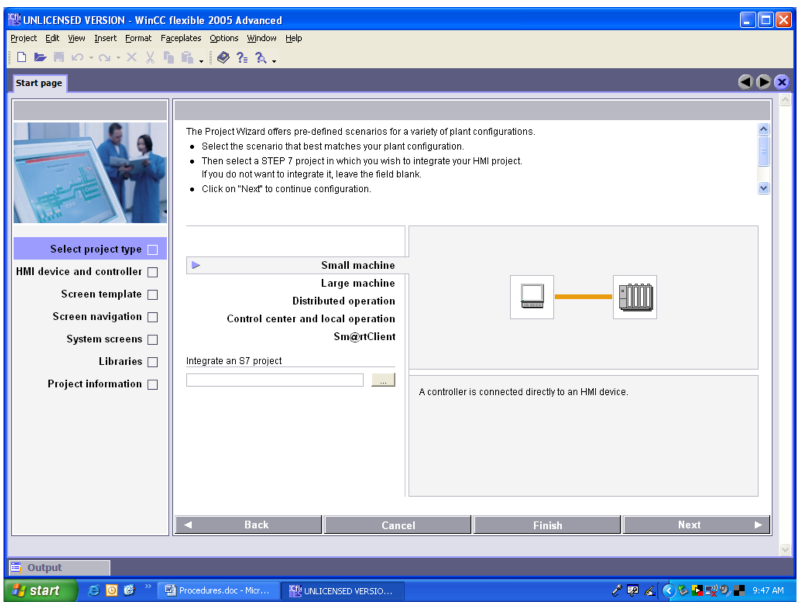
First you need to have PLC program and the PLCSIM ready and tested. The program which we are going to interface to WinnCC is only one rung as shown in the following figure.



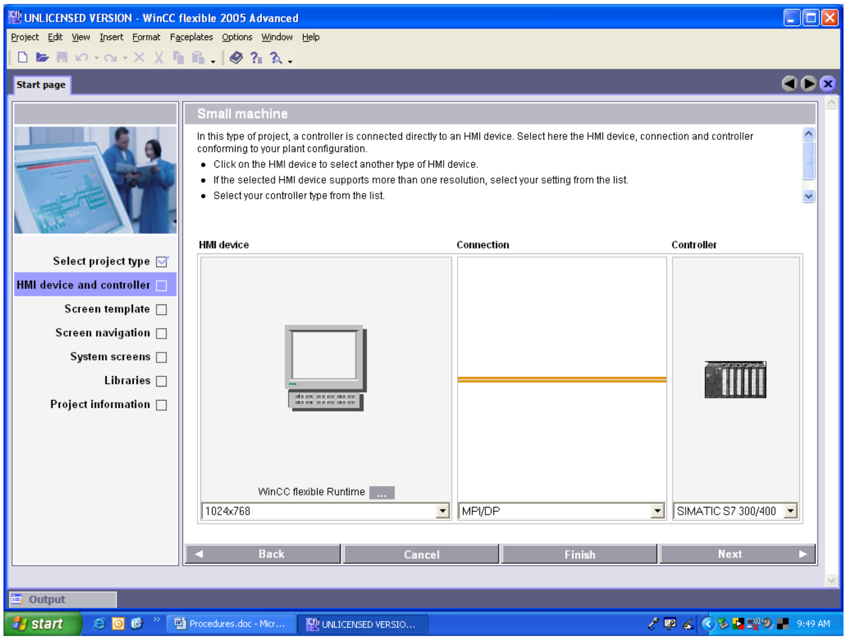
1- Start WinCC flexible



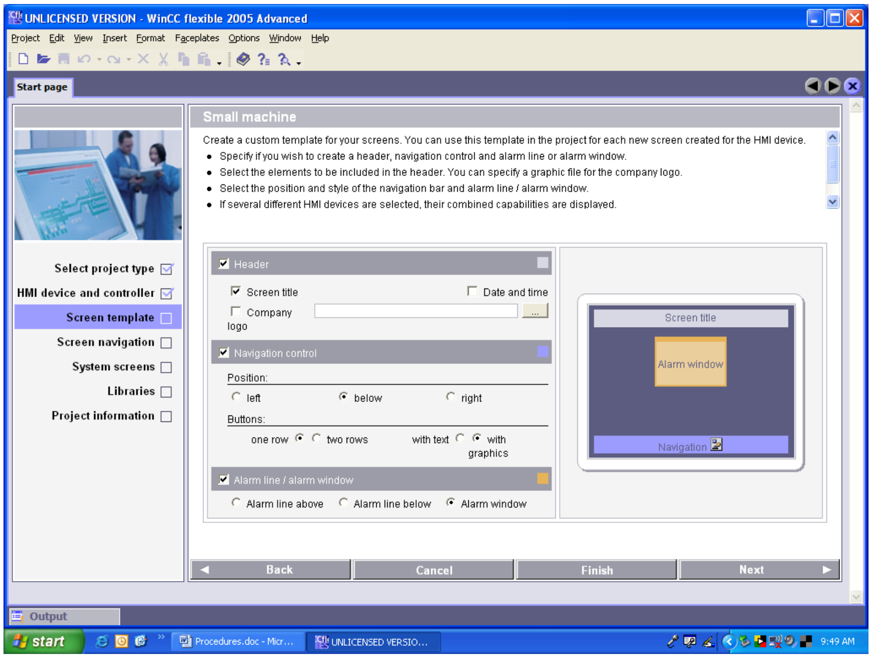
2- Click the create a new project with the project wizard



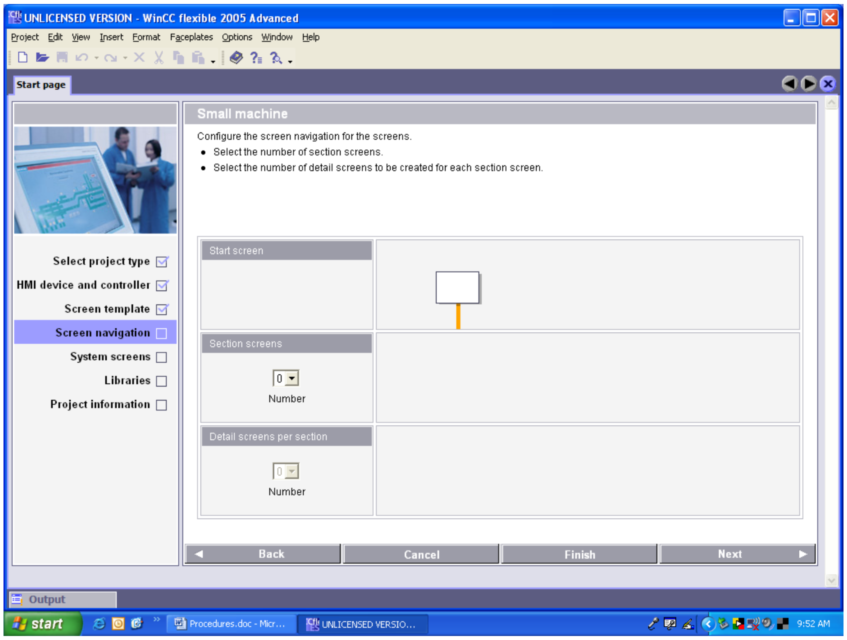
3- Next



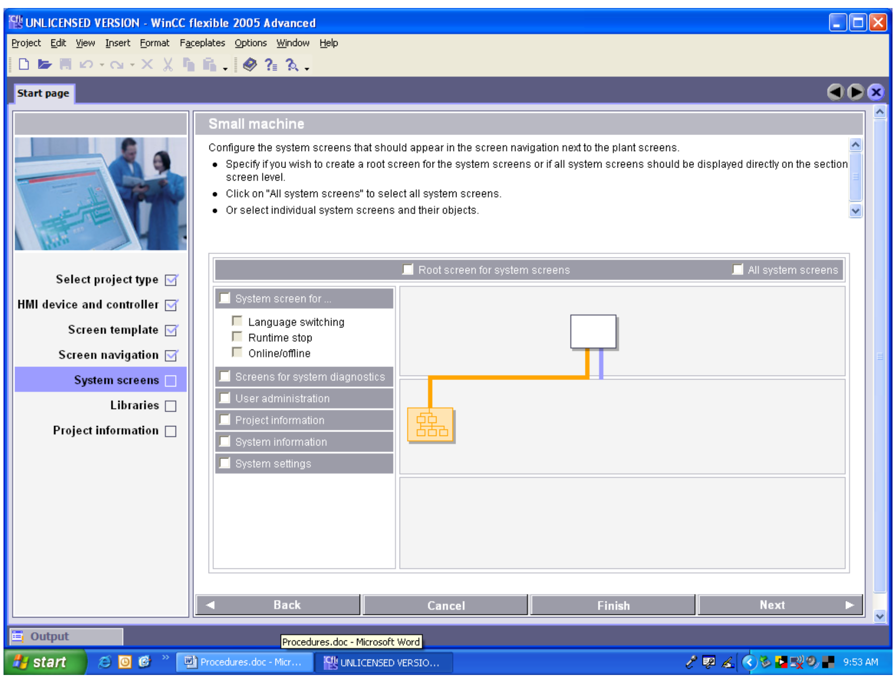
4- Next



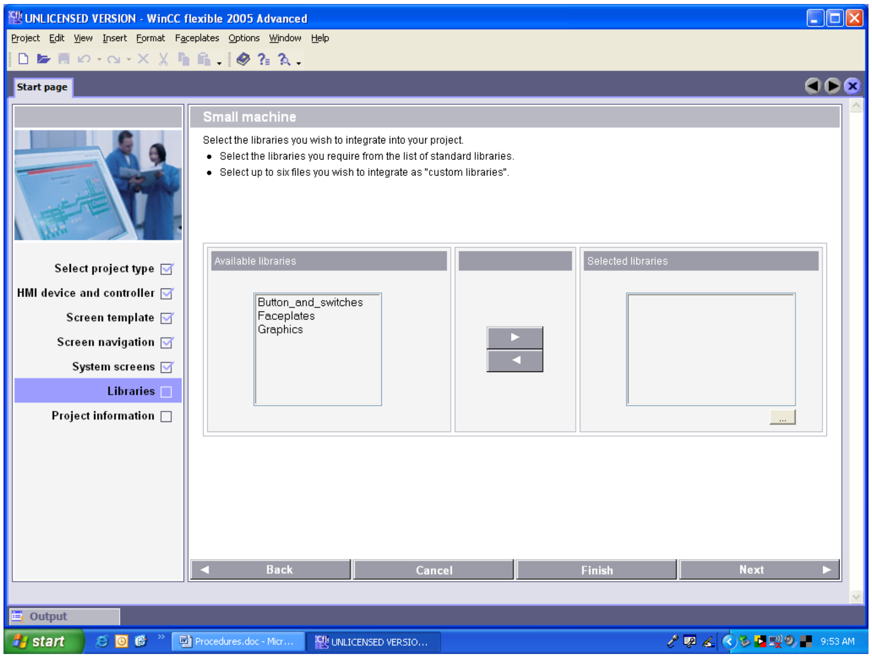
5- Next



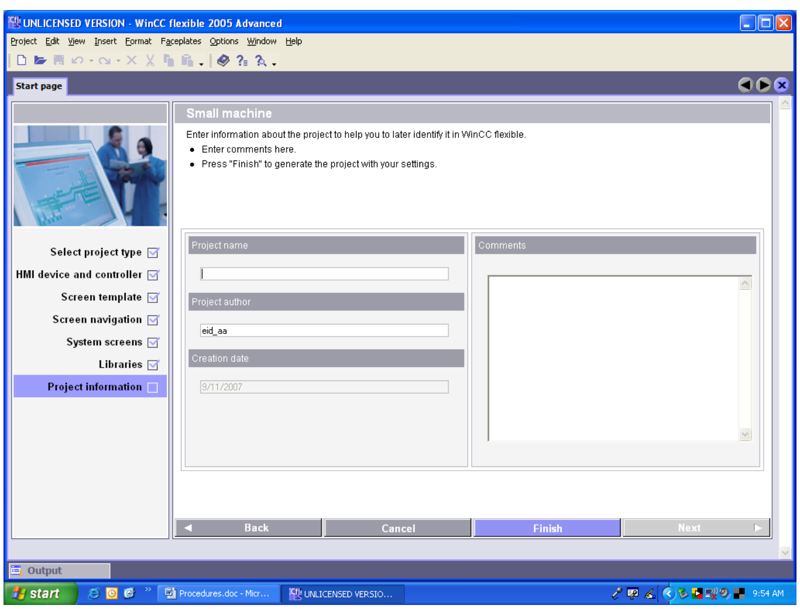
6- Next



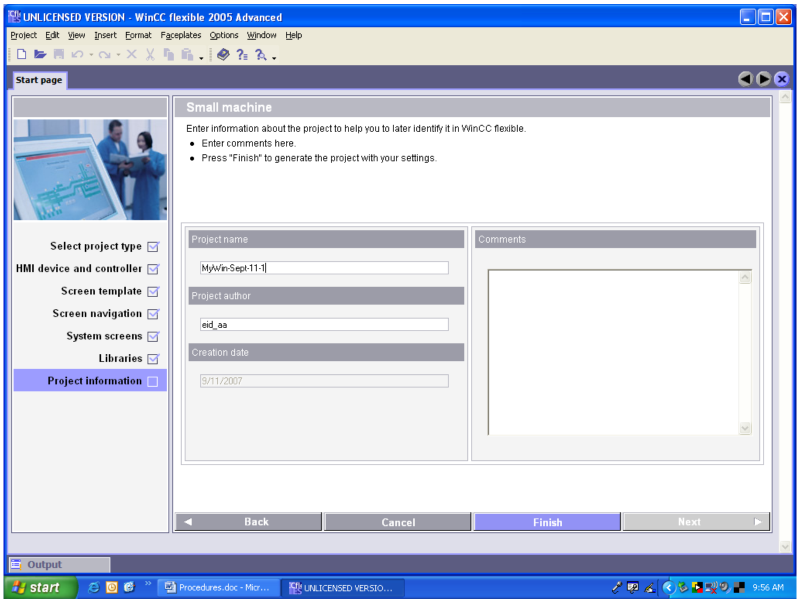
7- Next


UNLICENSED VERSION - WinCC flexible 2005 Advanced
Start page
Small machine
Select the libraries you wish to integrate into your project.
Select the libraries you require from the list of standard libraries.
Select up to six files you wish to integrate as "custom libraries".
Select project type
HMI device and controller
Screen template
Screen navigation
System screens
Libraries
Project information
Available libraries
Selected libraries
Button_and_switches
Faceplates
Graphics
Back
Cancel
Finish
Next
Output

8- Next


UNLICENSED VERSION - WinCC flexible 2005 Advanced
Start page
Small machine
Enter information about the project to help you to later identify it in WinCC flexible.
Enter comments here.
Press "Finish" to generate the project with your settings.
Select project type
HMI device and controller
Screen template
Screen navigation
System screens
Libraries
Project information
Project name
Comments
Project author
eid_aa
Creation date
9/11/2007
Back
Cancel
Finish
Next
Output

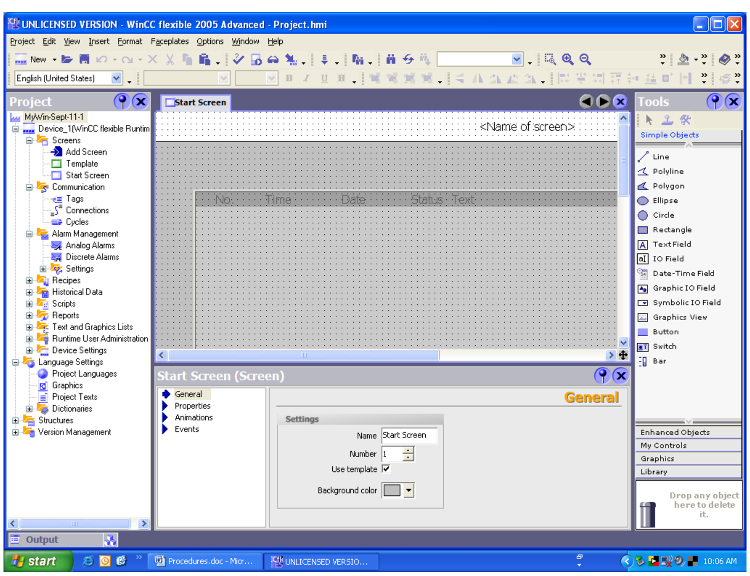
9- Write the project name example: MyFirstProject



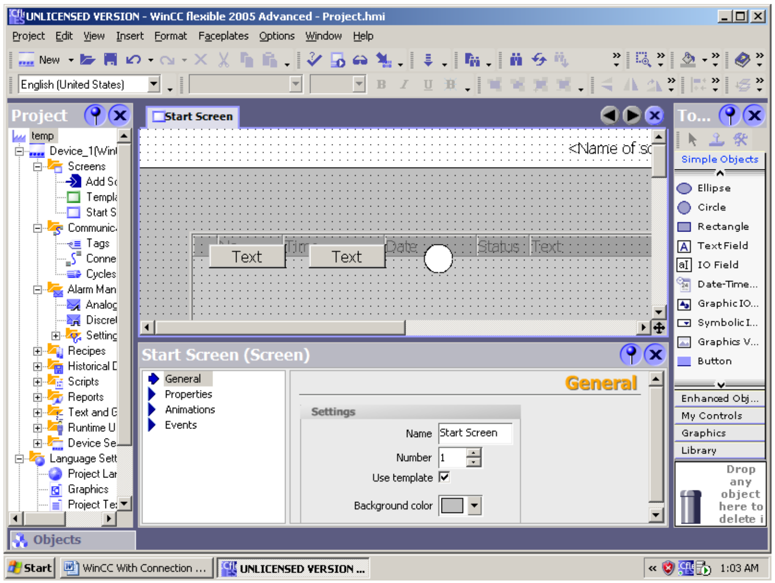
10- Then click finish

Project wizard will create the project work screen below:

On the right side you have simple objects to choose from for your project.



11- Drag two buttons one for STOP and one for START controls also one Circle to represent the motor as shown.



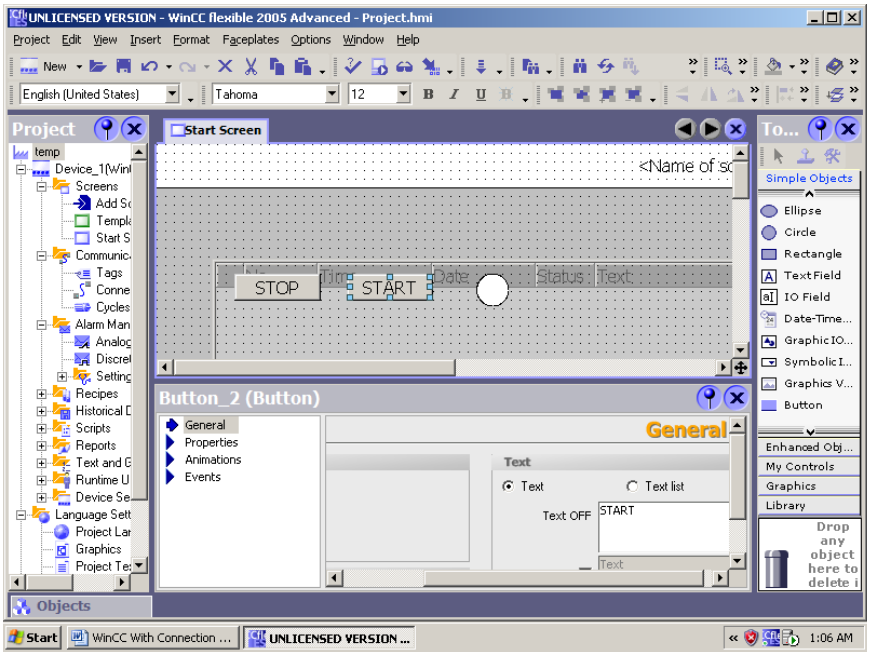
12- Now we are going to define the General specification of objects.

Select the first button (STOP). Click General in the lower window.
Select text for button mode.
In the Text-OFF window Change the text to "STOP"

13- Now we are going to define the general specification of objects.

Select the second button (START). Click general in the lower window.
Select text for button mode.
In the Text-OFF window Change the text to "START"

After finishing setting up the General specifications, you will have the following screen:

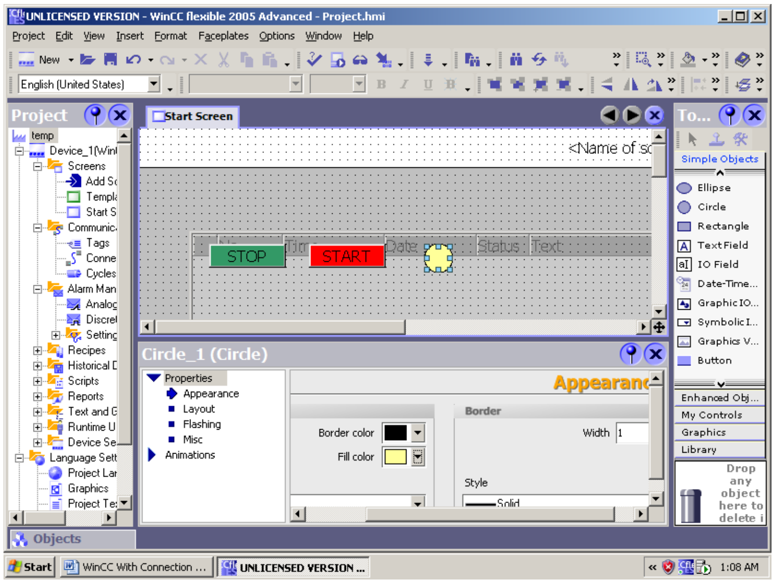


14- Now we are going to define the colors of objects.

Select the STOP button. Click properties and appearance in the lower window. Select the background color. (RED)

Select the START button. Click properties and appearance in the lower window. Select the background color. (GREEN)

Select the CIRCLE (Motor) button. Click properties in the lower window. Select the fill color. (YELLOW)



15- Now we are going to define the "TAGS"

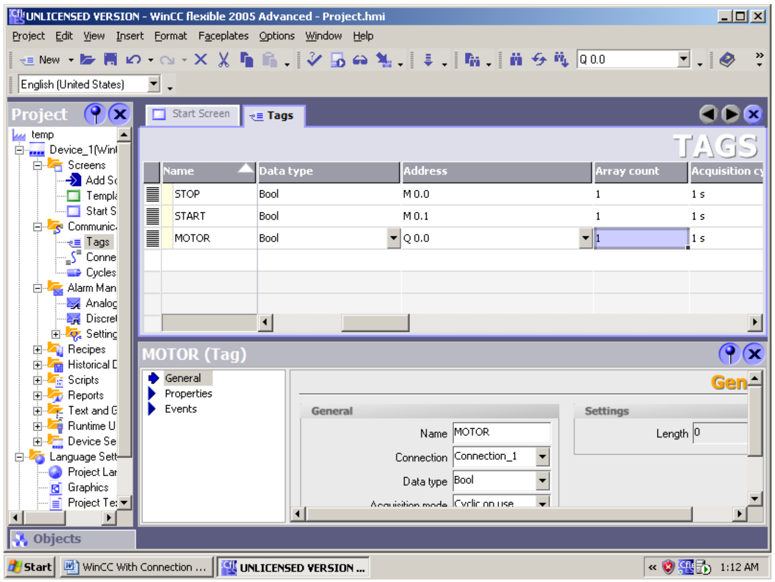
Double click "Tags" in the project window on the left. You will see the tags table shown below.

Because this is connected to PLCSIM it is just like it is connected to an actual PLC, we will not make only one tag but we will have to make one tag for each address.

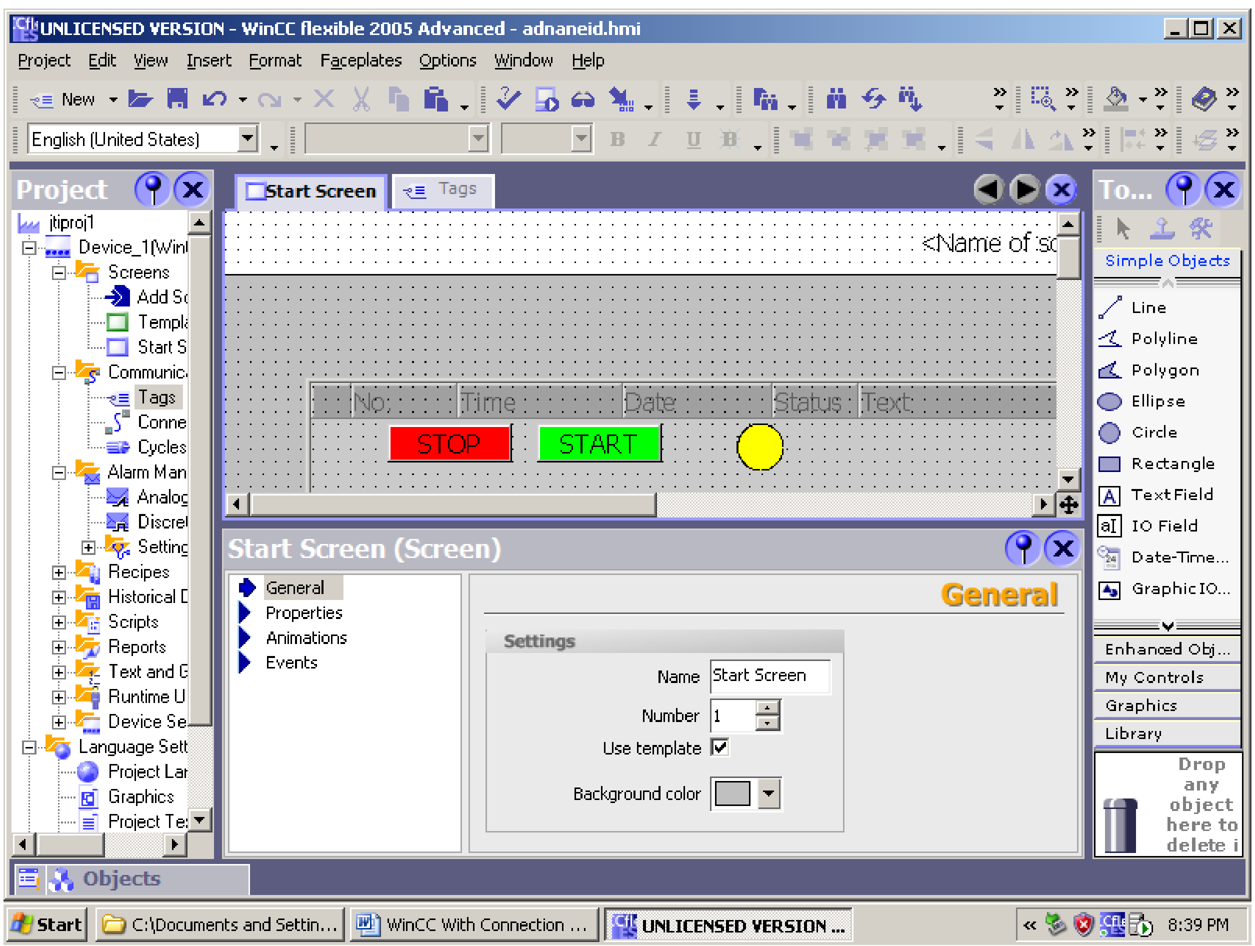
Double click cell under Name in the table and type the name of the first tag. (say “STOP”)
Click the cell under Connection and select "Internal tag".
Click the cell under Data type and select "Bool".

Do the same for the tags: “START” and “MOTOR”

When you finish the tags assignments, you should have the following screen.



16- Select start screen tab and you will go back to the original screen.



17- Now we are going to define the events (logic).

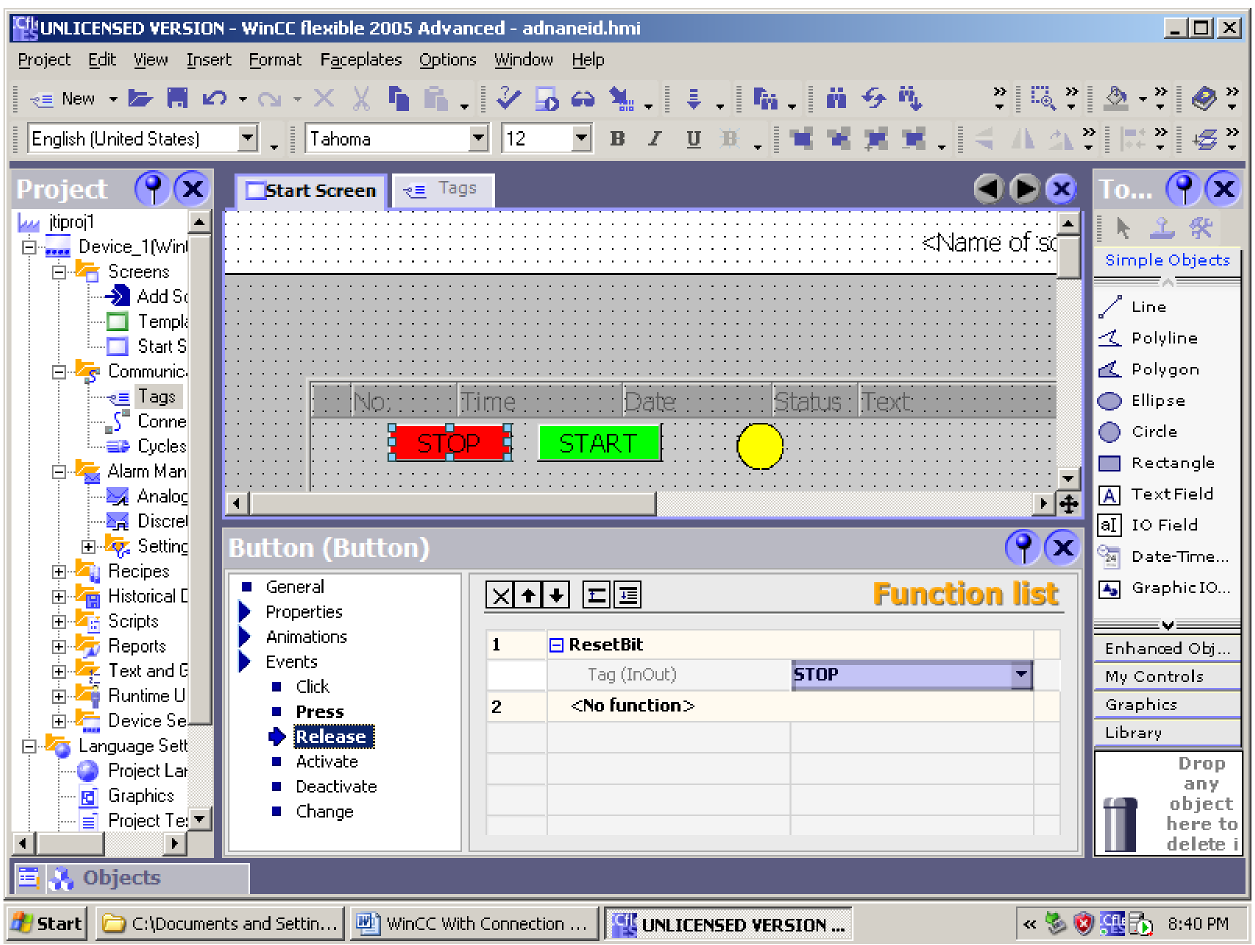
Logic for STOP button:

Select STOP button.
Click Events.

Select Press. Click <No function> in the Function list window.
Click the pull-down menu. Select "Edit Bits" then "SetBit"
Click on the orange <No value> in the Function list window
Click the orange pull-down menu.
Select "STOP" this is the name of the tag as you named it earlier.

Select Release. Click <No function> in the Function list window.
Click the pull-down menu. Select "Edit Bits" then "ResetBit"
Click on the orange <No value> in the Function list window
Click the orange pull-down menu.
Select "STOP" this is the name of the tag as you named it earlier.

After finishing setting up the logic for the STOP, you will have the following screen:



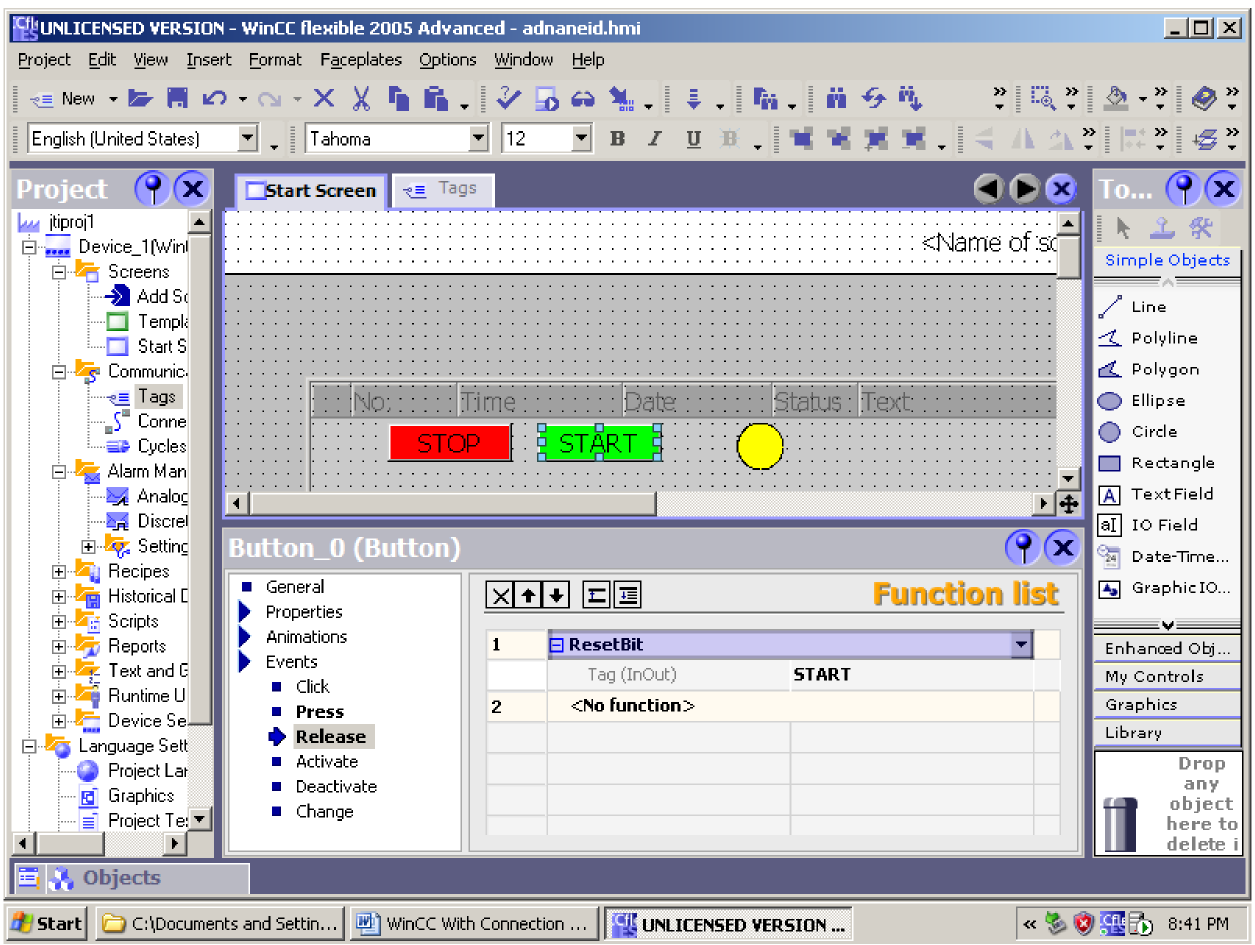
Logic for START button:

Select START button.
Click Events.

Select Press. Click <No function> in the Function list window.
Click the pull-down menu. Select "Edit Bits" then "SetBit"
Click on the orange <No value> in the Function list window
Click the orange pull-down menu.
Select "START" this is the name of the tag as you named it earlier.

Select Release. Click <No function> in the Function list window.
Click the pull-down menu. Select "Edit Bits" then "ResetBit"
Click on the orange <No value> in the Function list window
Click the orange pull-down menu.
Select "START" this is the name of the tag as you named it earlier.

After finishing setting up the logic for the START, you will have the following screen:



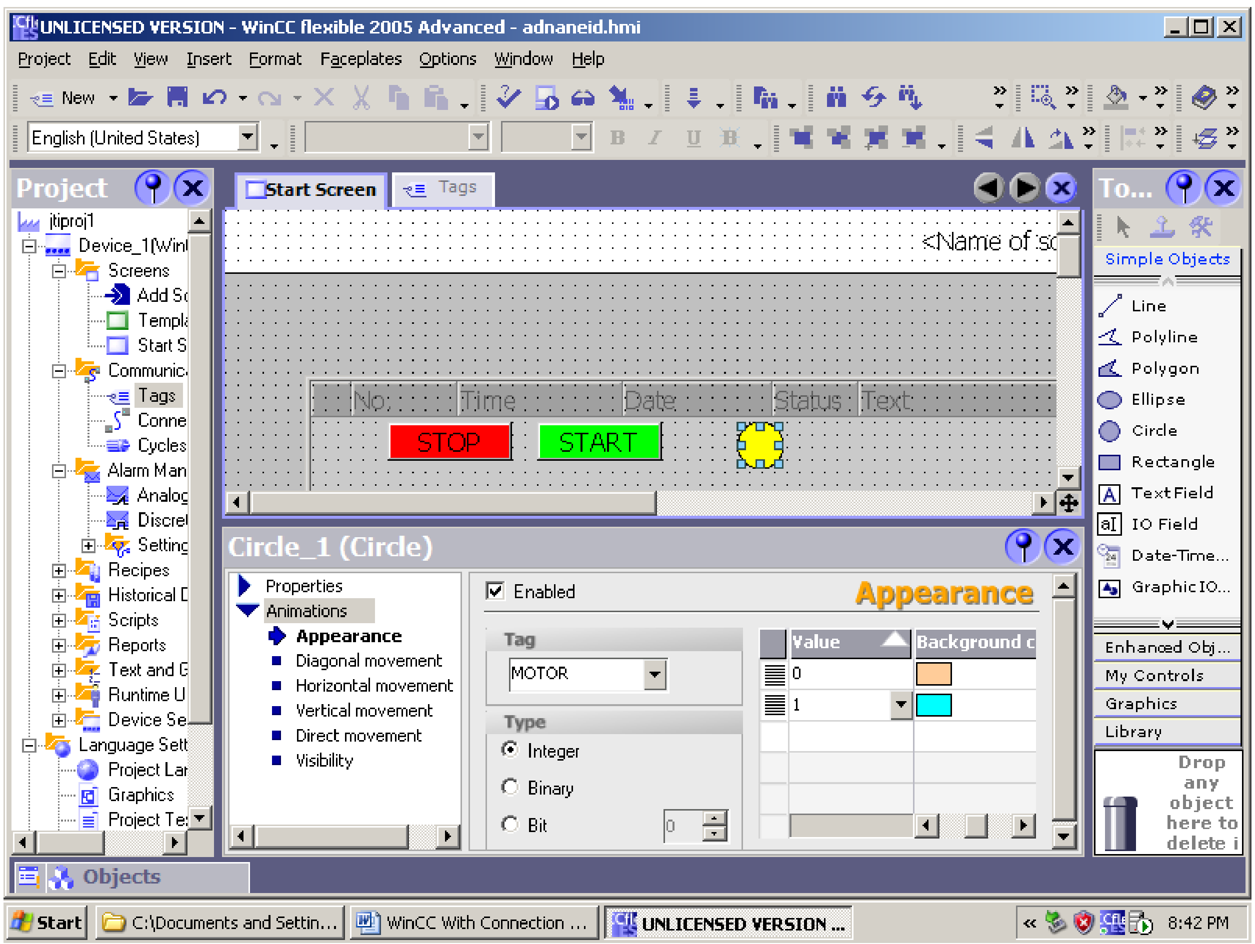
Logic for MOTOR symbol:

Select MOTOR symbol.
Click Animations.
Select (check) Enabled
Click the Tag pull-down menu and select "MOTOR"
For Type select "Integer"

Click on the first cell under value and type 0
Select the background color for this logic "0". (say blue)

Click on the second cell under value and type 1
Select the background color for this logic "1". (say purple)

After finishing setting up the logic for the MOTOR, you will have the following screen:



19- Make sure that SIMATIC MANAGER PLC program is ON and ON-LINE.

20- Make sure the PLCSIM is ON and in the RUN mode.

21- Now in WinCC Click "Save current project" icon to save your WinCC work and you will be asked to name your program. Type the "NAME" and click save.

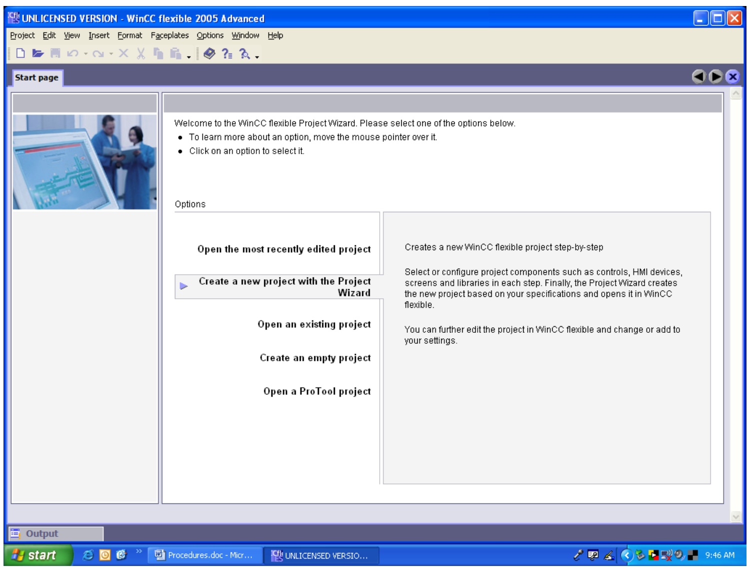
22- Click "Check project consistency" icon and wait till it is complete without errors.

If there are errors, they would be listed in the lower part of the screen.

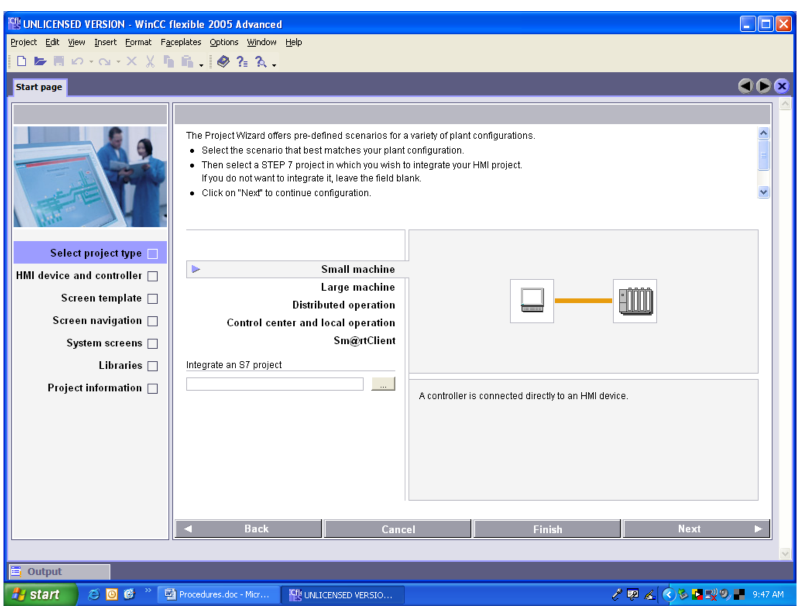
23- Run your program.

B) WinCC with Internal Tag Procedure

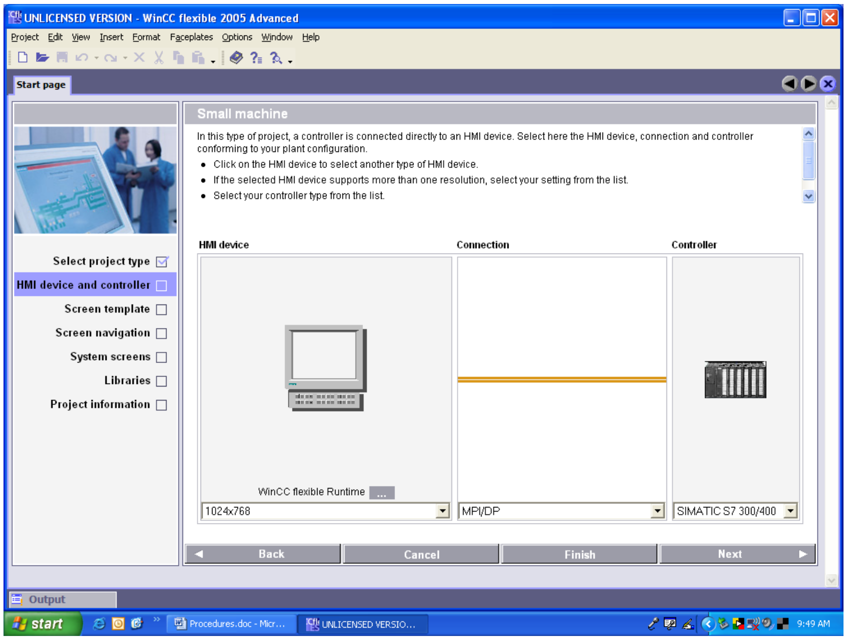
1- Start WinCC flexible



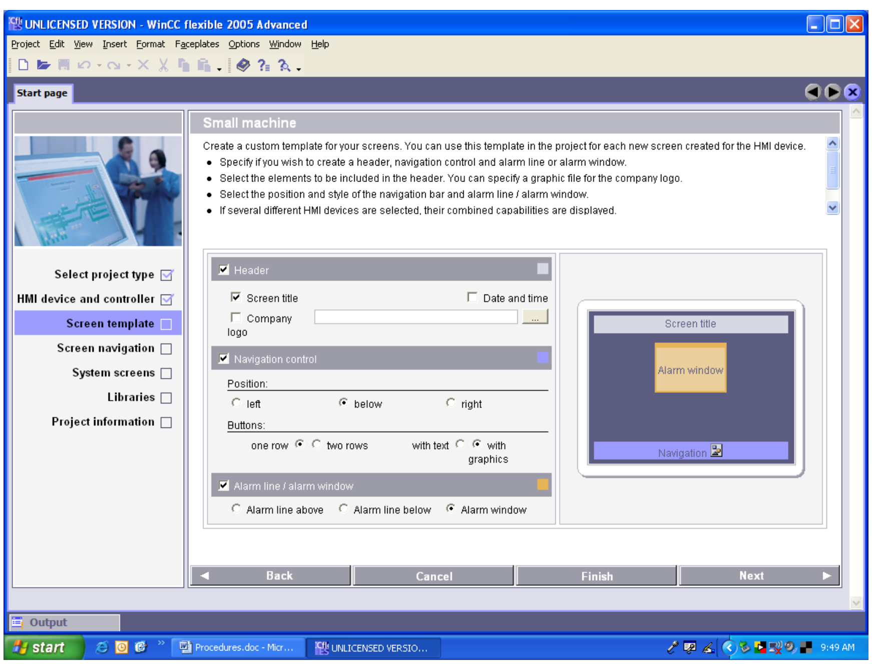
2- Click the create a new project with the project wizard



3- Next


UNLICENSED VERSION - WinCC flexible 2005 Advanced
Project Edit View Insert Format Faceplates Options Window Help
Start page
Small machine
In this type of project, a controller is connected directly to an HMI device. Select here the HMI device, connection and controller conforming to your plant configuration.
Click on the HMI device to select another type of HMI device.
If the selected HMI device supports more than one resolution, select your setting from the list.
Select your controller type from the list.
Select project type
HMI device and controller
Screen template
Screen navigation
System screens
Libraries
Project information
HMI device
Connection
Controller
WinCC flexible Runtime
1024x768
MPI/DP
SIMATIC S7 300/400
Back
Cancel
Finish
Next
Output
start
Procedures.doc - Micr...
UNLICENSED VERSIO...
9:49 AM

4- Next


UNLICENSED VERSION - WinCC flexible 2005 Advanced
Project Edit View Insert Format Faceplates Options Window Help
Start page
Small machine
Create a custom template for your screens. You can use this template in the project for each new screen created for the HMI device.
Specify if you wish to create a header, navigation control and alarm line or alarm window.
Select the elements to be included in the header. You can specify a graphic file for the company logo.
Select the position and style of the navigation bar and alarm line / alarm window.
If several different HMI devices are selected, their combined capabilities are displayed.
Select project type
HMI device and controller
Screen template
Screen navigation
System screens
Libraries
Project information
Header
Screen title
Date and time
Company logo
Navigation control
Position:
left
below
right
Buttons:
one row
two rows
with text
with graphics
Alarm line / alarm window
Alarm line above
Alarm line below
Alarm window
Screen title
Alarm window
Navigation
Back
Cancel
Finish
Next
Output
start
Procedures.doc - Micr...
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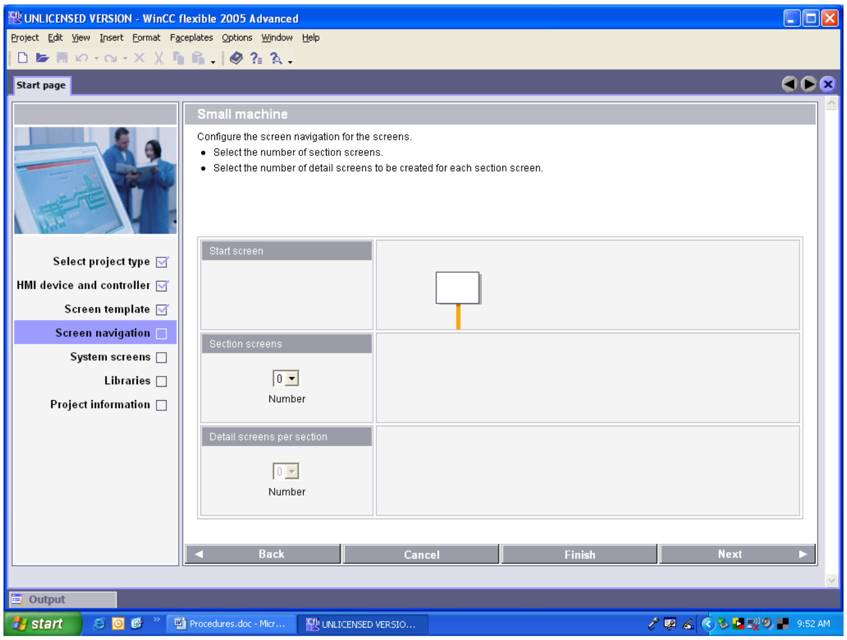
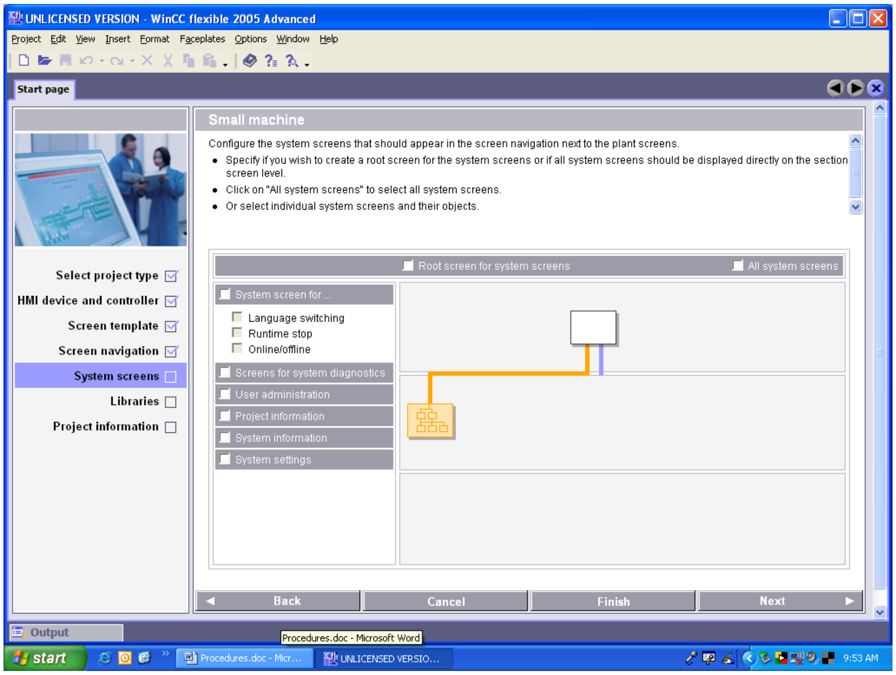
9:49 AM

5- Next


UNLICENSED VERSION - WinCC flexible 2005 Advanced
Project Edit View Insert Format Faceplates Options Window Help
Start page
Small machine
Configure the screen navigation for the screens.
Select the number of section screens.
Select the number of detail screens to be created for each section screen.
Select project type
HMI device and controller
Screen template
Screen navigation
System screens
Libraries
Project information
Start screen
Section screens
Number
Detail screens per section
Number
Back
Cancel
Finish
Next
Output
start
9:52 AM

6- Next


UNLICENSED VERSION - WinCC flexible 2005 Advanced
Project Edit View Insert Format Faceplates Options Window Help
Start page
Small machine
Configure the system screens that should appear in the screen navigation next to the plant screens.
Specify if you wish to create a root screen for the system screens or if all system screens should be displayed directly on the section screen level.
Click on "All system screens" to select all system screens.
Or select individual system screens and their objects.
Root screen for system screens
All system screens
System screen for ...
Language switching
Runtime stop
Online/offline
Screens for system diagnostics
User administration
Project information
System information
System settings
Select project type
HMI device and controller
Screen template
Screen navigation
System screens
Libraries
Project information
Back
Cancel
Finish
Next
Output
Procedures.doc - Microsoft Word
start
Procedures.doc - Micr...
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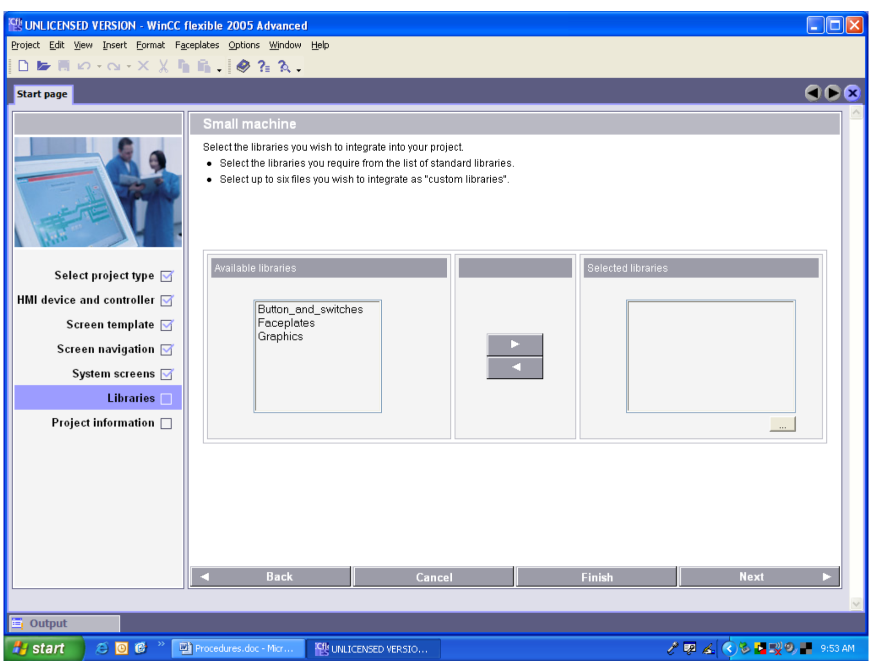
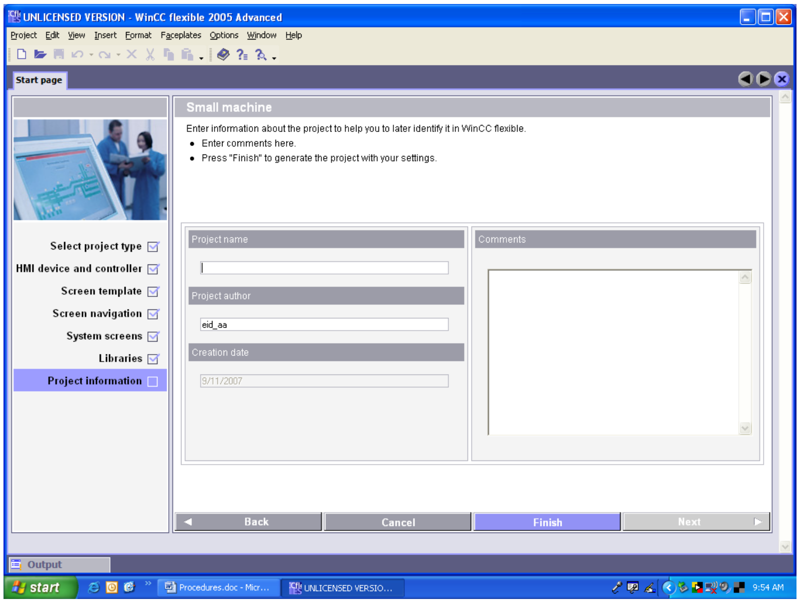
9:53 AM

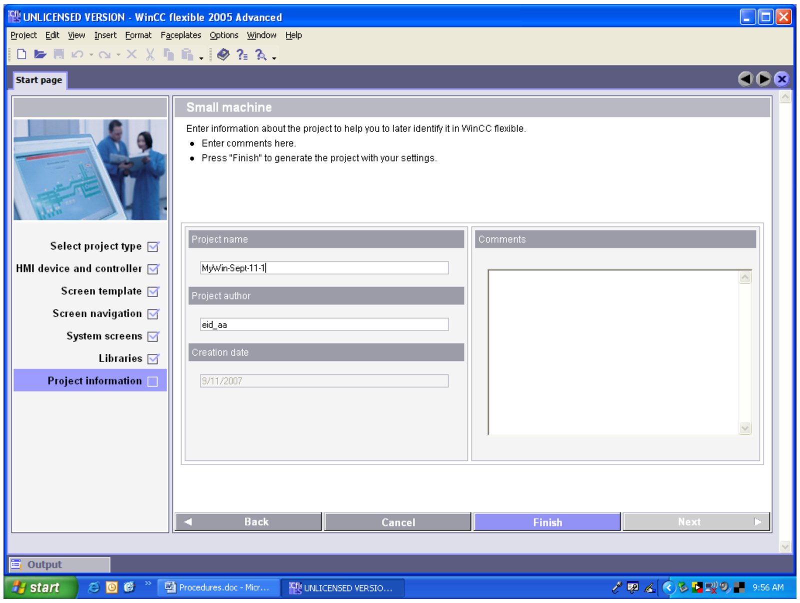
7- Next


UNLICENSED VERSION - WinCC flexible 2005 Advanced
Project Edit View Insert Format Faceplates Options Window Help
Start page
Small machine
Select the libraries you wish to integrate into your project.
Select the libraries you require from the list of standard libraries.
Select up to six files you wish to integrate as "custom libraries".
Available libraries
Button_and_switches
Faceplates
Graphics
Selected libraries
Select project type
HMI device and controller
Screen template
Screen navigation
System screens
Libraries
Project information
Back
Cancel
Finish
Next
Output
start
Procedures.doc - Micr...
UNLICENSED VERSIO...
9:53 AM

8- Next



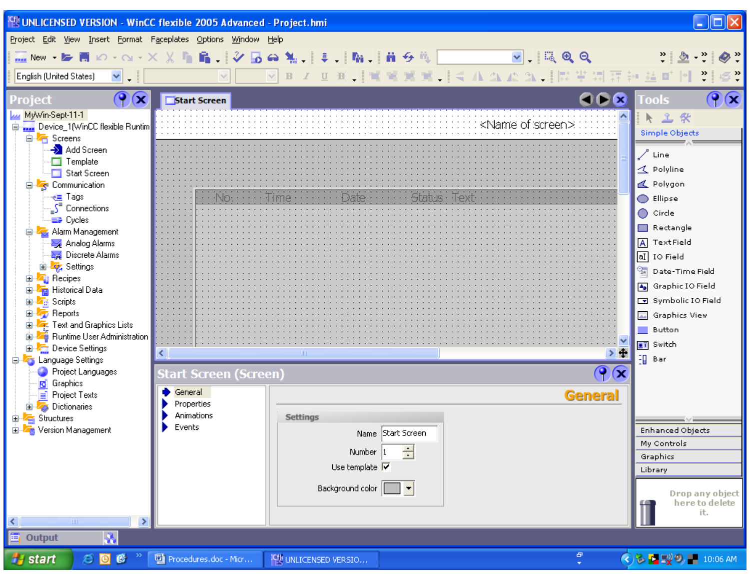
9- Write the project name example: MyFirstProject



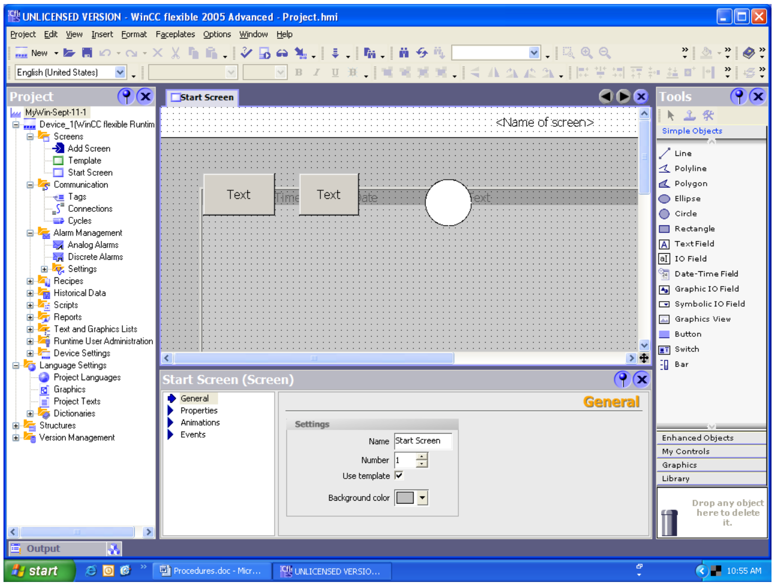
10- Then click finish

Project wizard will create the project work screen below:

On the right side you have simple objects to choose from for your project.



11- Drag two buttons one for STOP and one for START controls also one Circle to represent the motor as shown.



12- Now we are going to define the General specification of objects.

Select the first button (STOP). Click General in the lower window.
Select text for button mode.
In the Text-OFF window Change the text to "STOP-OFF"

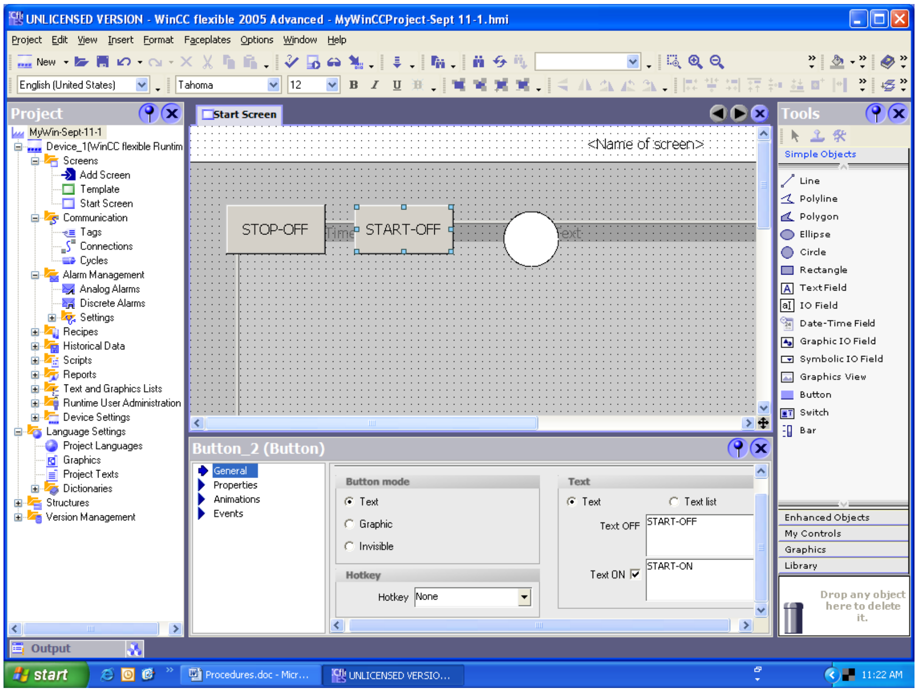
Select text ON
In the Text ON window Change the text to "STOP-ON"

13- Now we are going to define the general specification of objects.

Select the second button (START). Click general in the lower window.
Select text for button mode.
In the Text-OFF window Change the text to "START-OFF"

Select text ON
In the Text ON window Change the text to "START-ON"

After finishing setting up the General specifications, you will have the following screen:

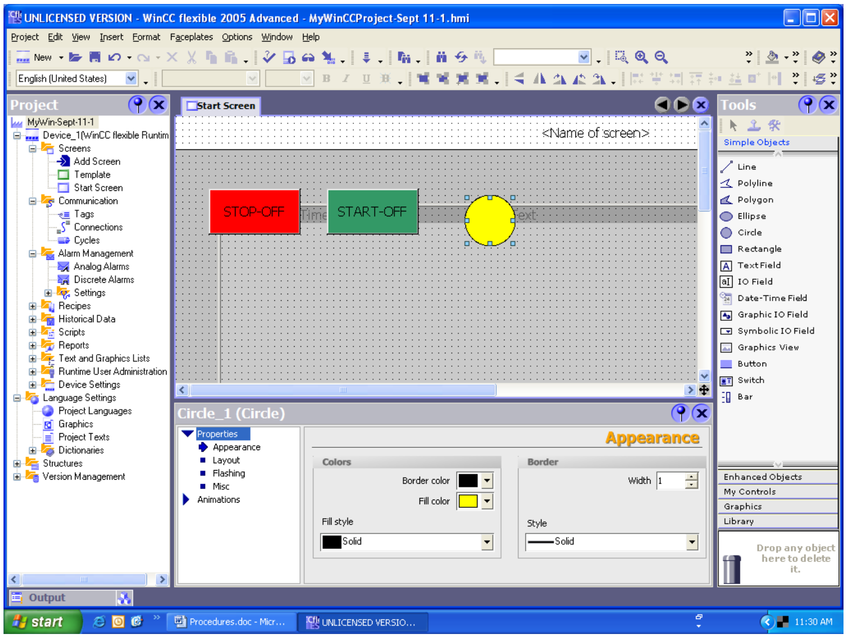


14- Now we are going to define the colors of objects.

Select the STOP button. Click properties and appearance in the lower window. Select the background color. (RED)

Select the START button. Click properties and appearance in the lower window. Select the background color. (GREEN)

Select the CIRCLE (Motor) button. Click properties in the lower window. Select the fill color. (YELLOW)



15- Now we are going to define the "TAGS"

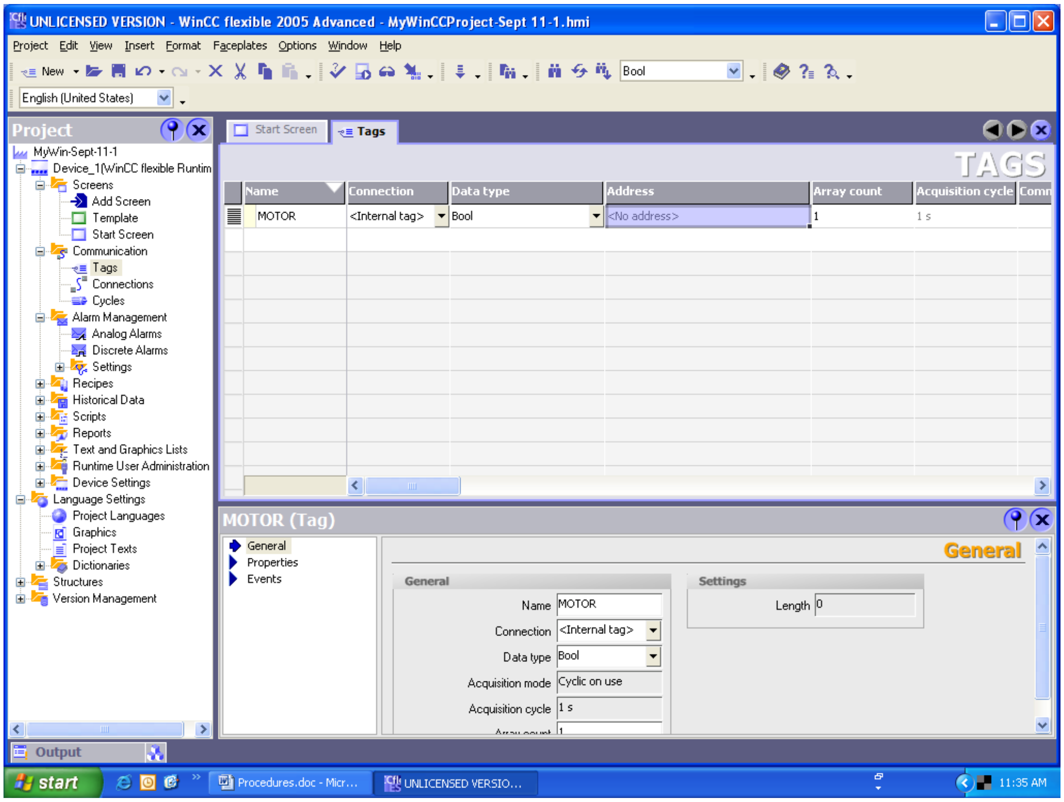
Double click "Tags" in the project window on the left. You will see the tags table shown below.

Because this is not connected to an actual PLC, we will make only one tag.

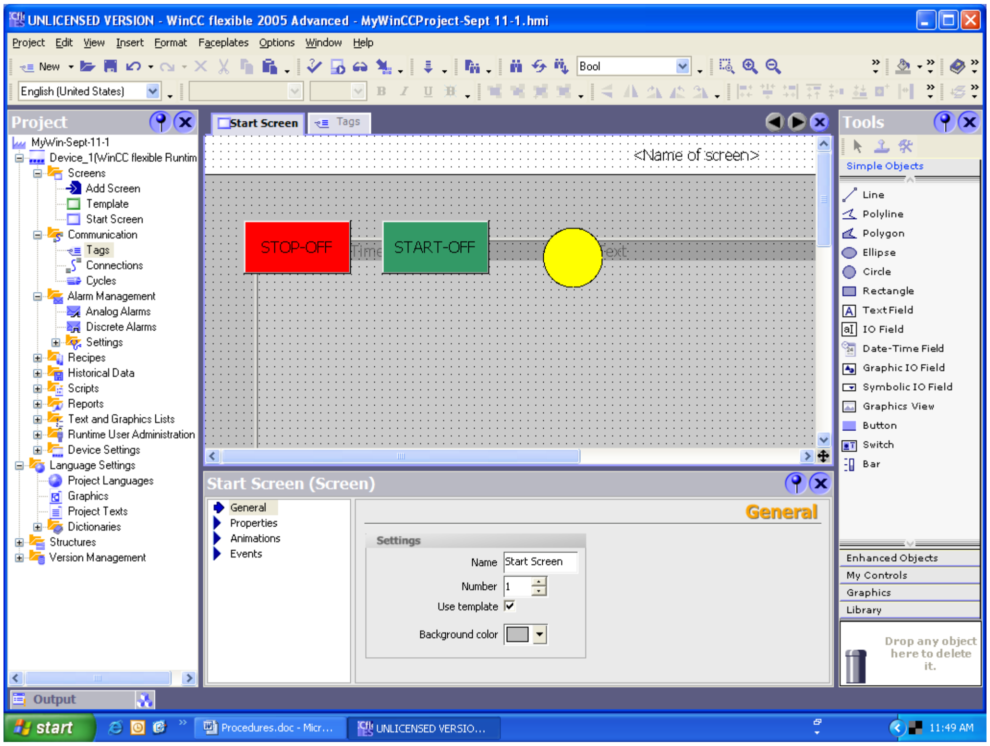
Double click cell under Name in the table and type the name of the tag. (say MOTOR)

Click the cell under Connection and select "Internal tag".

Click the cell under Data type and select "Bool".



16- Select start screen tab and you will go back to the original screen.

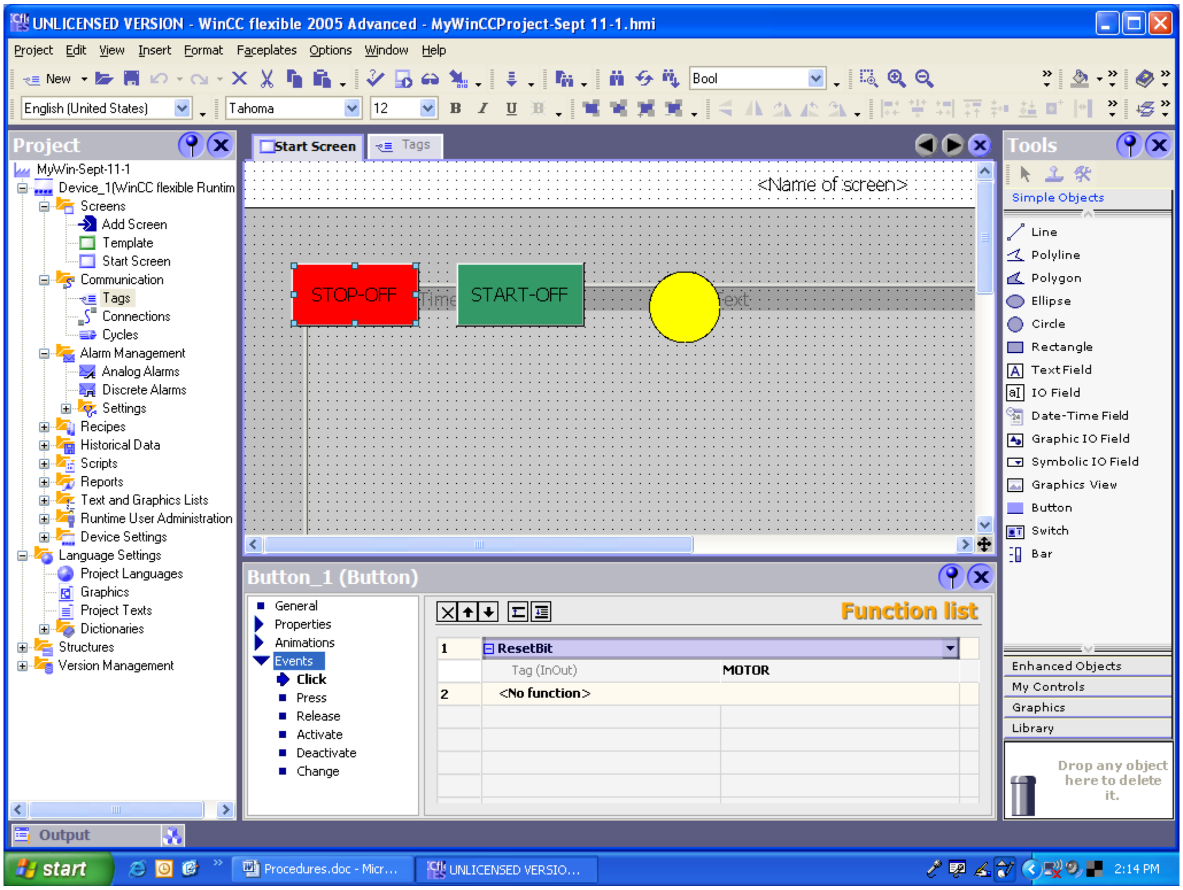


17- Now we are going to define the events (logic).

Logic for STOP button:

Select STOP button.
Click Events.
Select Click.
Click <No function> in the Function list window.
Click the pull-down menu.
Select "Edit Bits" then "ResetBit"
Click on the orange <No value> in the Function list window
Click the orange pull-down menu.
Select "MOTOR" this is the name of the tag as you named it earlier.

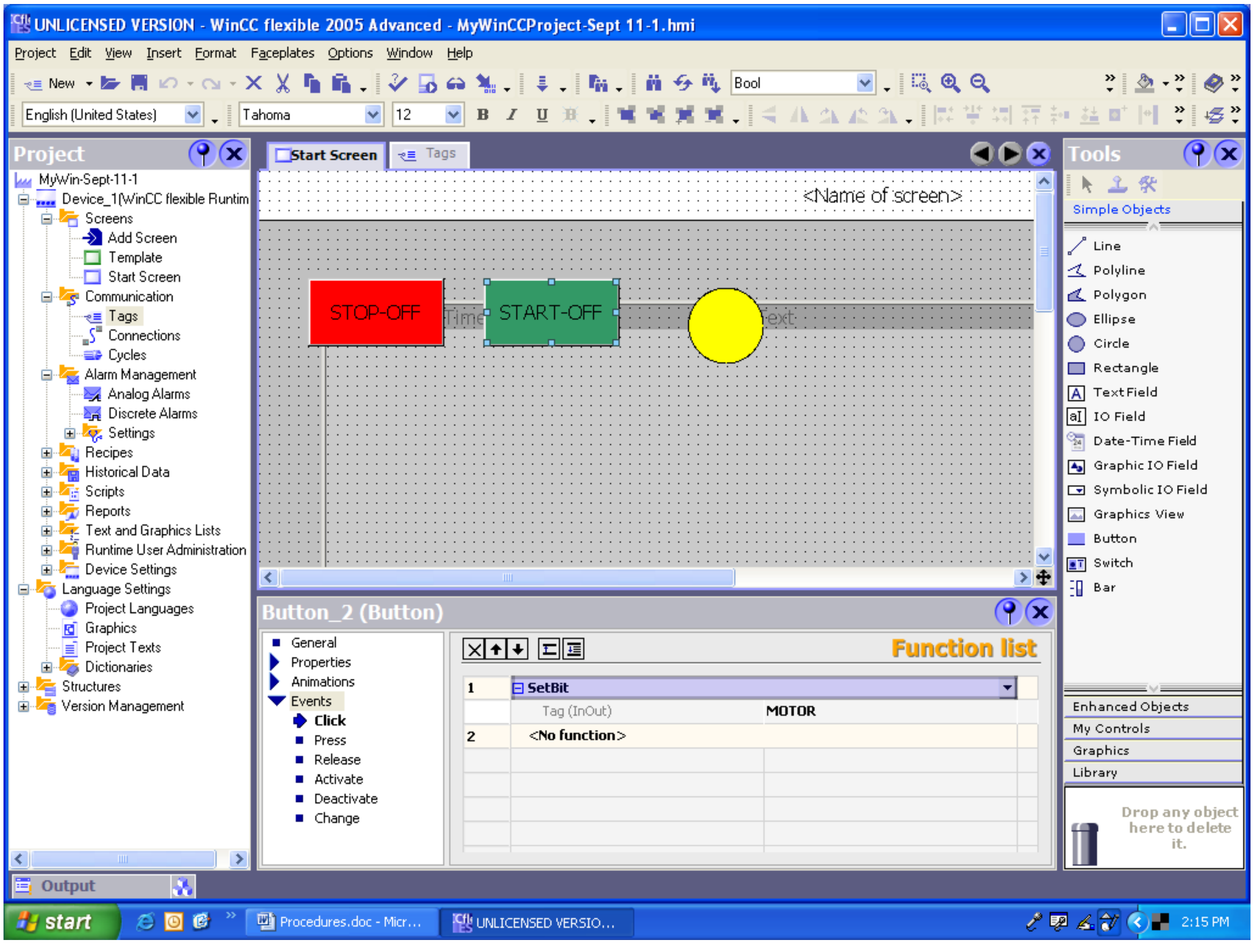
After finishing setting up the logic for the STOP, you will have the following screen:



Logic for START button:

Select START button.
Click Events.
Select Click.
Click <No function> in the Function list window.
Click the pull-down menu.
Select "Edit Bits" then "SetBit"
Click on the orange <No value> in the Function list window
Click the orange pull-down menu.
Select "MOTOR" this is the name of the tag as you named it earlier.

After finishing setting up the logic for the START, you will have the following screen:



Logic for MOTOR symbol:

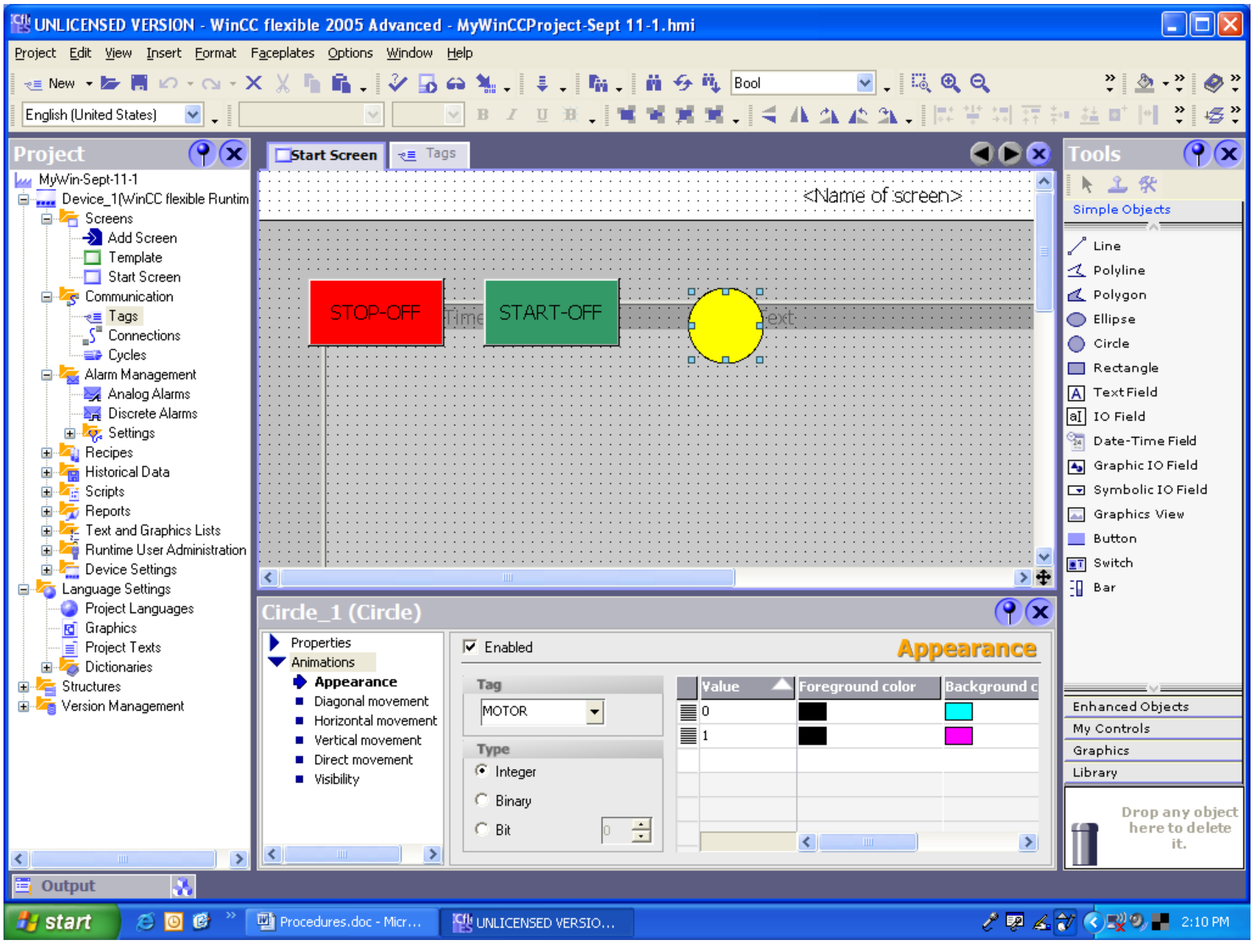
Select MOTOR symbol.
Click Animations.
Select (check) Enabled
Click the Tag pull-down menu and select "MOTOR"
For Type select "Integer"

Click on the first cell under value and type 0
Select the background color for this logic "0". (say blue)

Click on the second cell under value and type 1

Select the background color for this logic "1". (say purple)

After finishing setting up the logic for the MOTOR, you will have the following screen:



19- Click "Save" and you will be asked to name your program. Type the "NAME" and click save.

20- Click "Check project consistency" icon and wait till it is complete without errors.

If there are errors, they would be listed in the lower part of the screen.

21- Run your program.