# Before the lecture

# Multivariable Process Control System (Flow, Level, Temperature, Pressure) Volume 1/2

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**Checked by: Karl Marx**

# Plan

Part 1. Introduction to FLTP
Part 2. Main Units of the trainer
Part 3. Control Units
Part 4. Control Techniques
Part 5. Conclusion
Part 6 Self-Test (No cheating)
Part 7. Lab work

# Introduction

**How do we control the tank in the field without the manual control?** Do we often open the tank and measure the flow rates, Pressures and fluid level by hand  in winter ? We are tired by doing so. Let’s overcome the problem.

# Introduction

It is difficult to control the liquid vessel manually because it is time consuming and requires too much physical work

# Introduction (Cont'd)

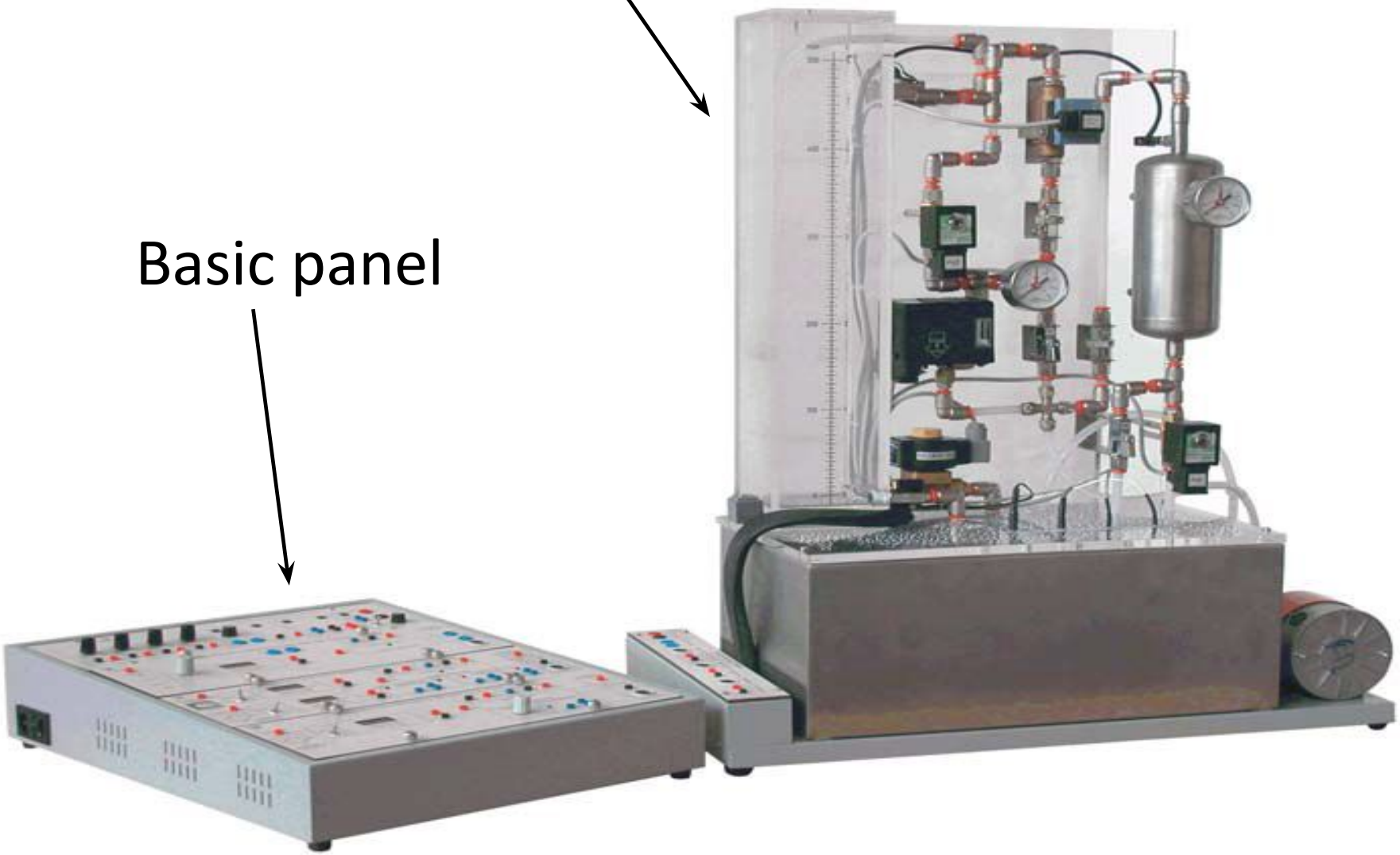
Therefore, the Process Control System is helpful by controlling the unit parameters even at a high distance automatically.

# Introduction Cont'd

Multivariable Process Control System can control the flow rate, level, Pressure and Temperature of the fluid inside the vessel

External Process Unit FLTP-U/EV

Basic panel



# 1) Main Units of the trainer FLTP

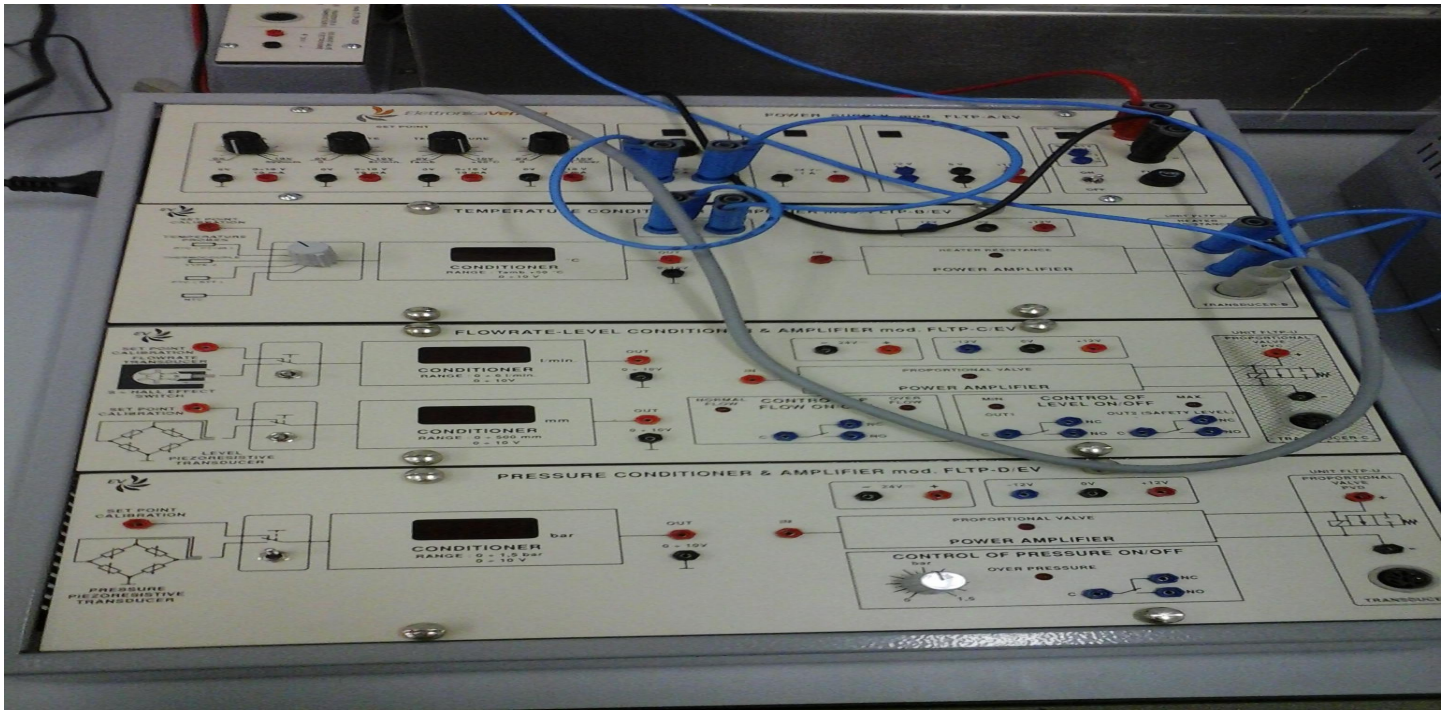
1)Power supply unit mod. FLTP-A/EV

2) Module for temperature control mod. FLTP-B/EV

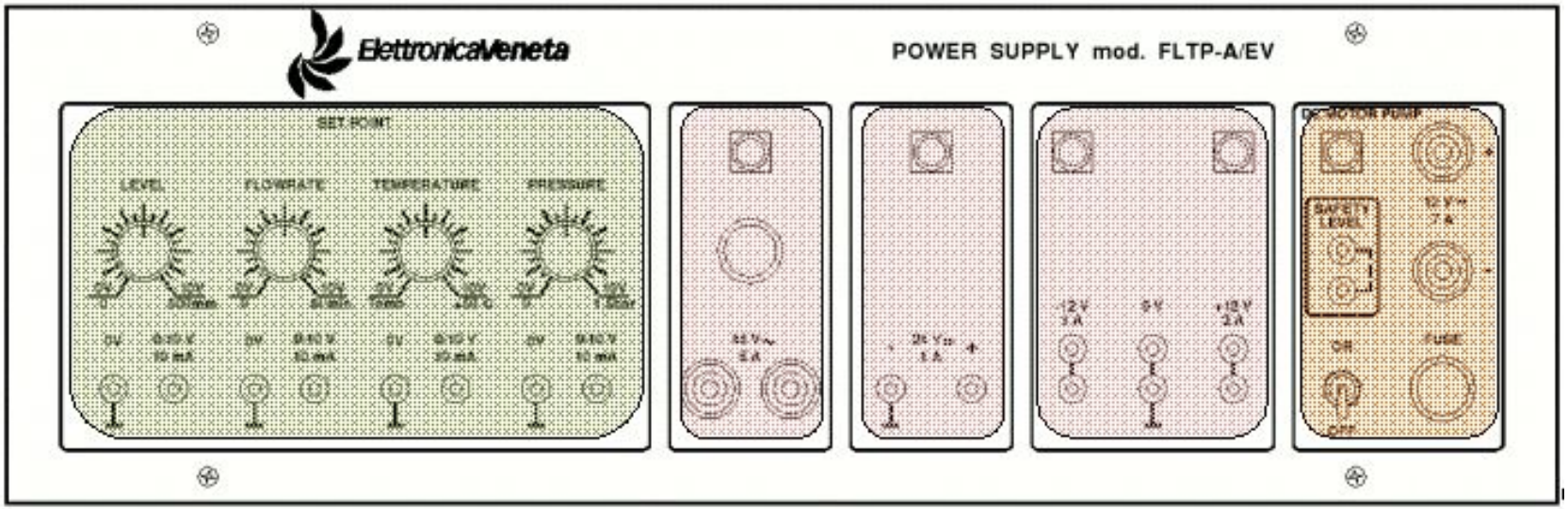
3) Module for level and flow-rate control mod. FLTP-C/EV

4) Module for pressure control mod. FLTP-D/EV

5) Process units mod. FLTP-U/EV



# 1.1 Power Supply Unit (FLTP-A/EV) Consists of 5 windows




1st window has 4 potentiometers of the process variables (Level, Flow rate, Temperature and Pressure)

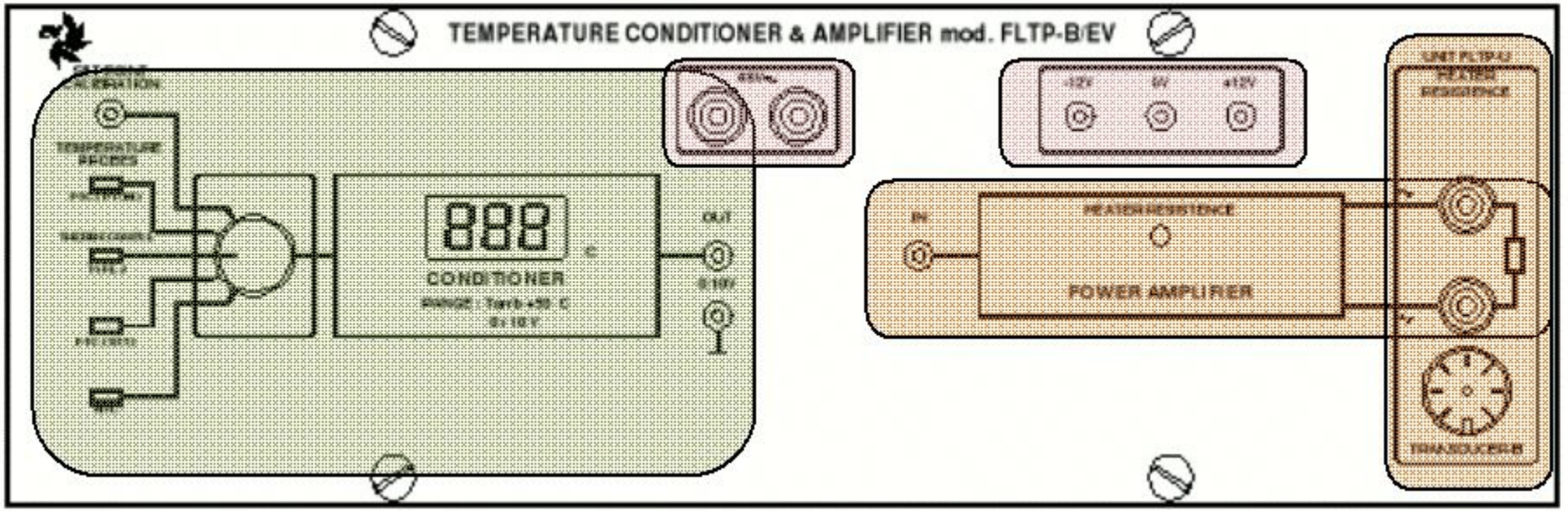
2nd 3rd and 4th windows are the switches of the other units (Temperature, Level and Pressure).

5th window works with the pump

# 1.2 Module for temperature control mod. FLTP-B/EV

- Has Conditioner on the left side
- Has Amplifier on the right side
- Temperature unit requires these voltages:

  -12V; 0V; +12V and 48V



# Question

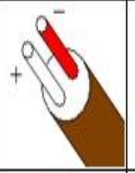
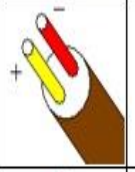
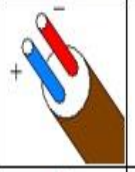
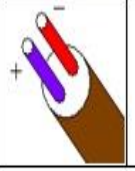
- Which kind of thermocouples do you know?

# 1.2.1 Types of thermal sensors

**For FLTP Conditioner**

- Thermocouple J
- STT – Smart Temp. Transmitter
- NTC – Negative Temperature Coefficient Thermistor
- Pt100 with more accuracy

## In general

| Type | Material | | Color Code | Range (°C) | |
|---|---|---|---|---|---|
| Thermocouple Grade | Positive Wire | Negative Wire | | Minimum | Maximum |
| J | Iron | Constantan |  | 0 | 750 |
| K | Chromel | Alumel |  | -200 | 1250 |
| T | Copper | Constantan |  | -200 | 350 |
| E | Chromel | Constantan |  | -200 | 900 |

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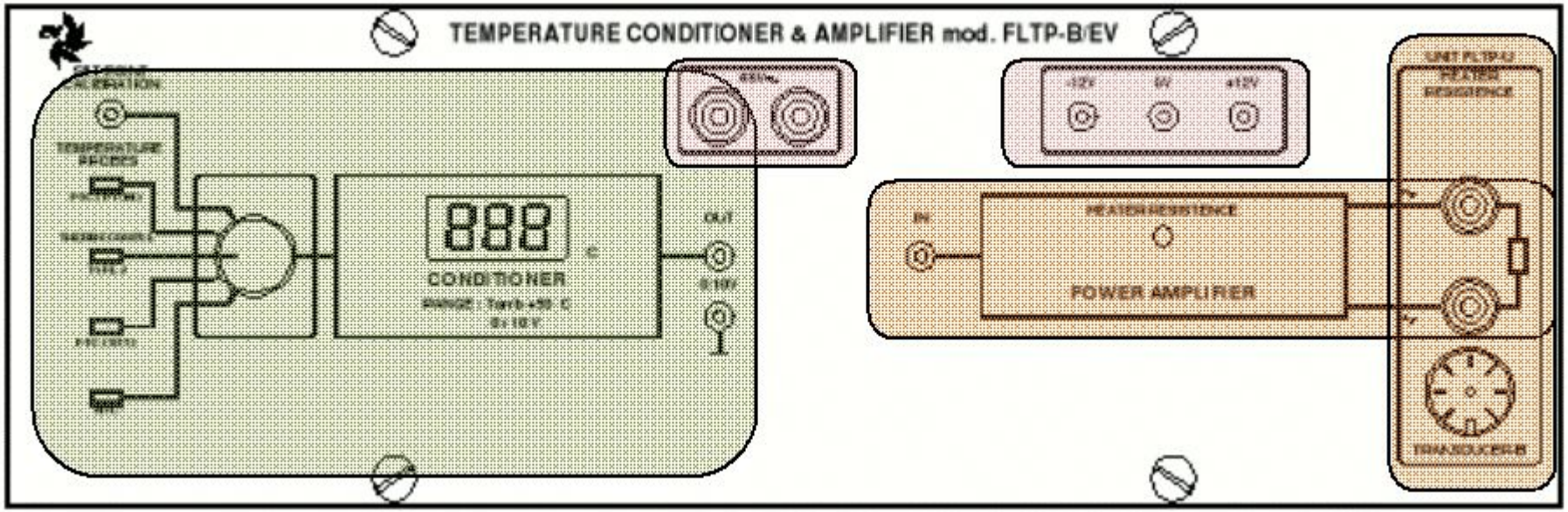
# 1.2.1 Module for temperature control mod. FLTP-B/EV

- Has Conditioner on the left side and deals with thermocouples.
- Conditioner has 5 inputs and 1 output



# Question.

- What is amplifier?

# 1.2.2 Amplifier (Brief explanation)

- ***Amplifier*** – modulates the output stronger than input signal

For example:

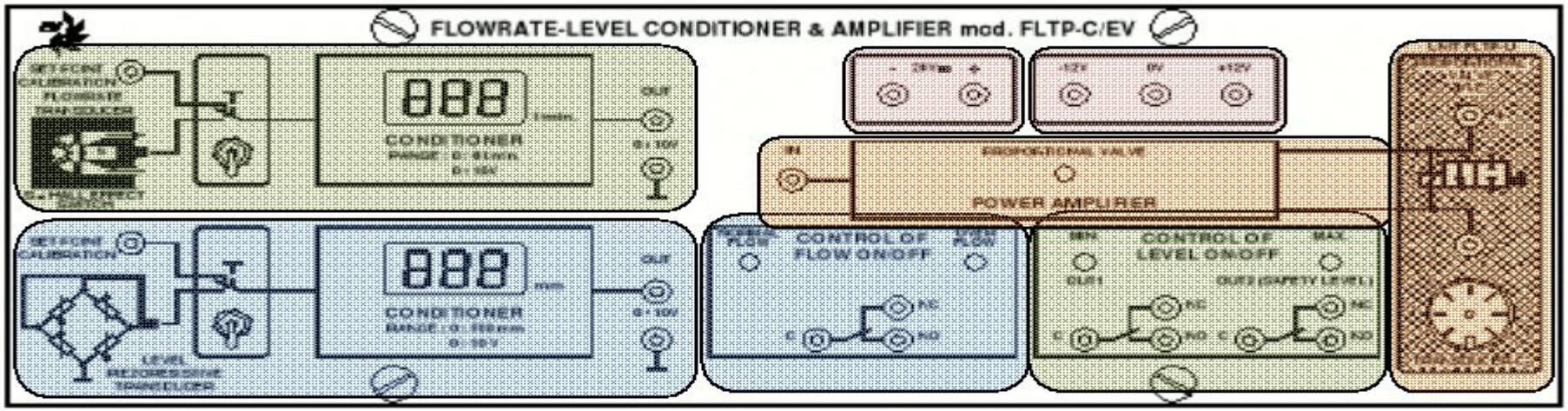
Input voltage is 3V and output is 5V after amplification

- Has 1 input and 1 output signal to the heating resistor

# 1.3. Flow Rate- Level Control (FLTP-C/EV)

- Has 2 conditioners, 1 amplifier and 2 controllers
- Flow rates deal with the top window
- Level measurements are at the bottom
- Has the voltage requirements:

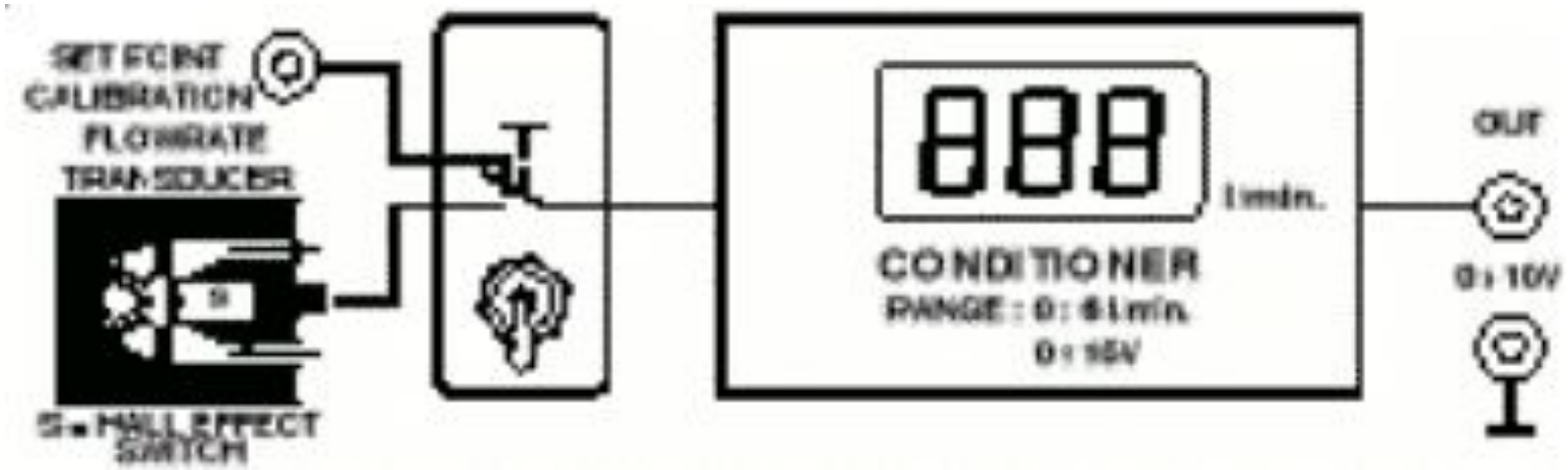
-12V; 0V; +12V and 48V




Retrieved from: MULTIVARIABLE PROCESS CONTROL SYSTEM (Flow, Level, Temperature, Pressure) mod. FLTP/EV, *TEACHER/STUDENT manual,* Electronica Veneta

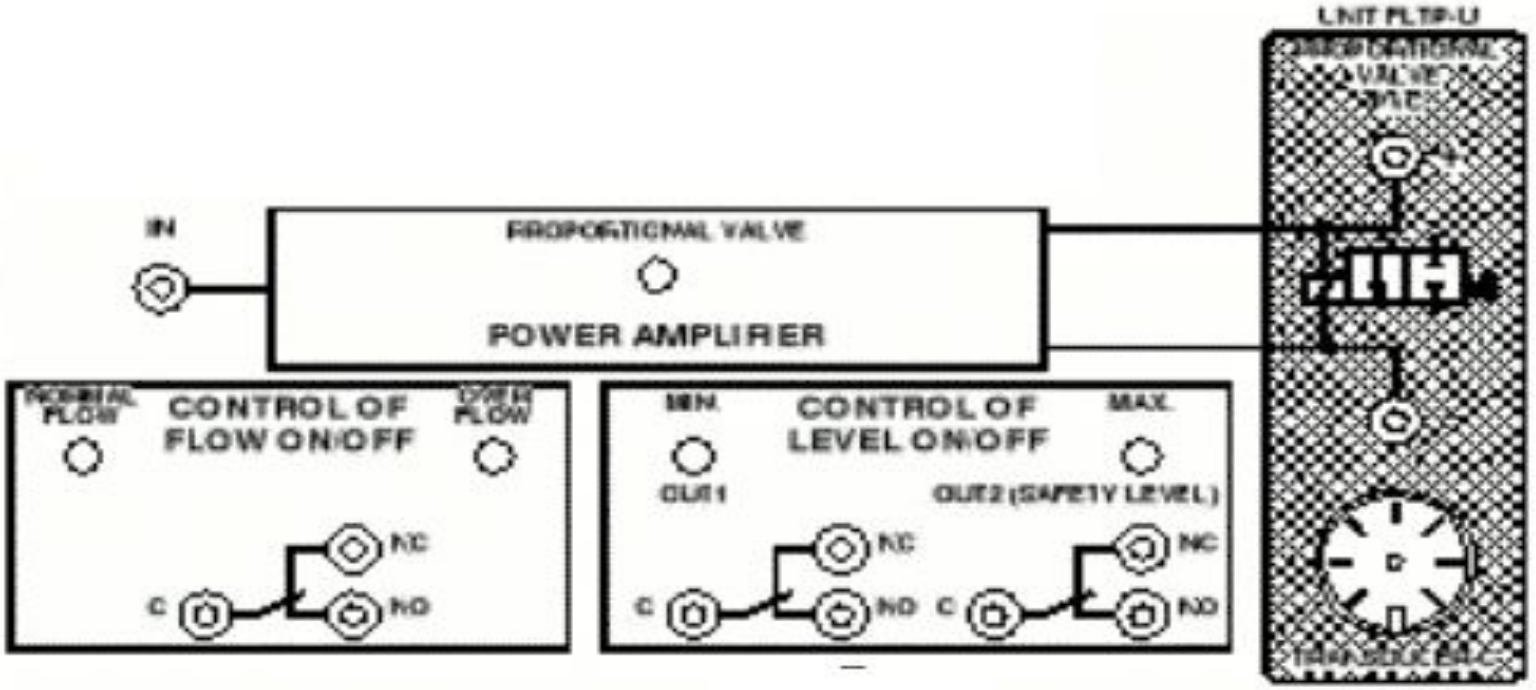
# 1.3.1 Flow Rate Control

- Measures the flow rate with  a paddle wheel
- Unit : l/min
- Has 2 inputs and 1 Output
- Has a switch



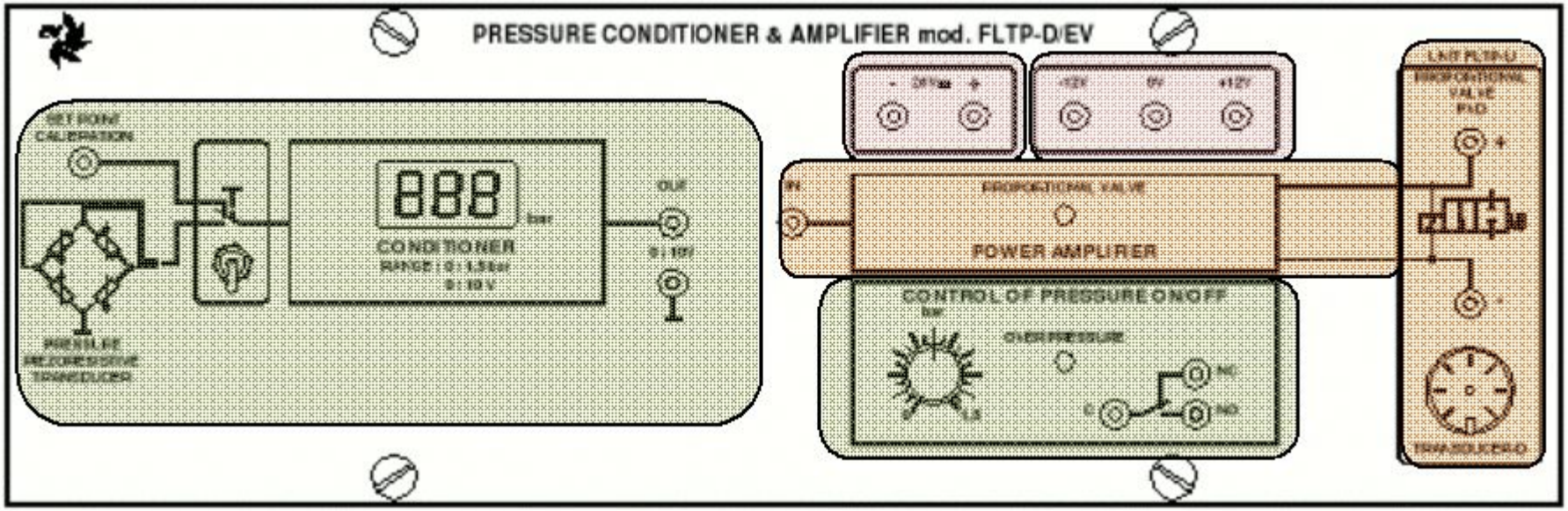
# 1.3.2 Level Control

- Shows the level of the tank
- Measured with piezometric sensor



# 1.4 Pressure Unit (FLTP-D/EV)

- Has signal conditioner and amplifier
- Pressure is measured in bars.
- Has 1 input and 1 output controlled with the PVD valve
- Managed with the pump

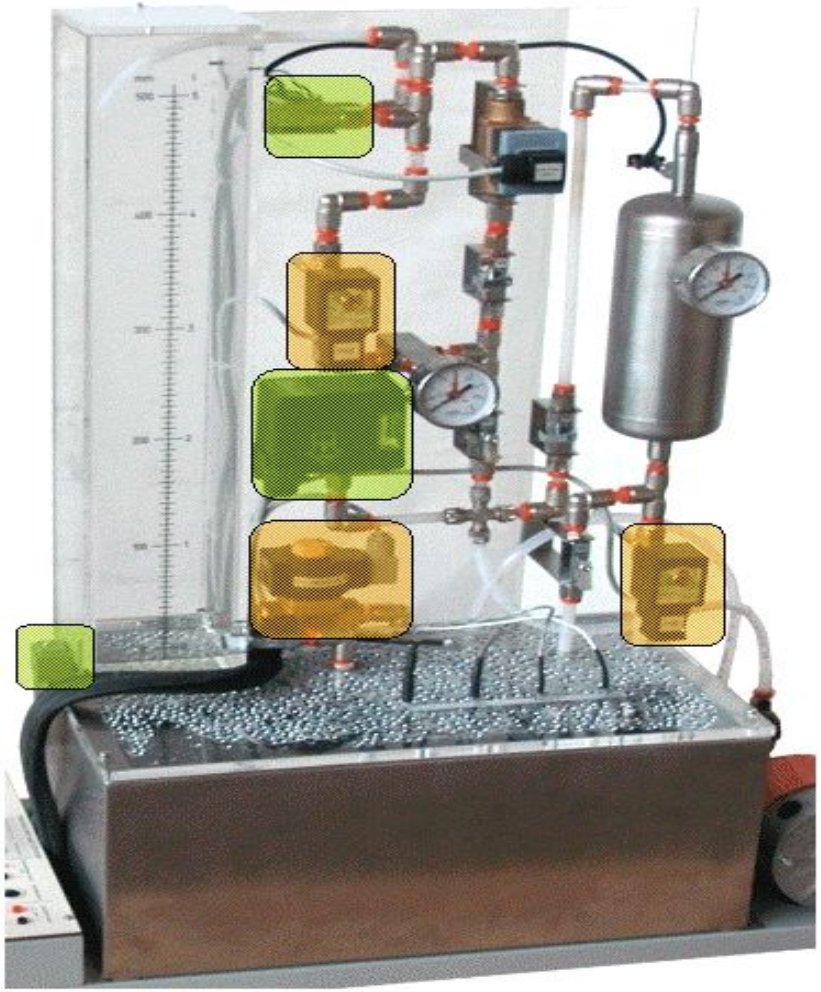


# 1.5. External Unit (FLTP-U/EV)

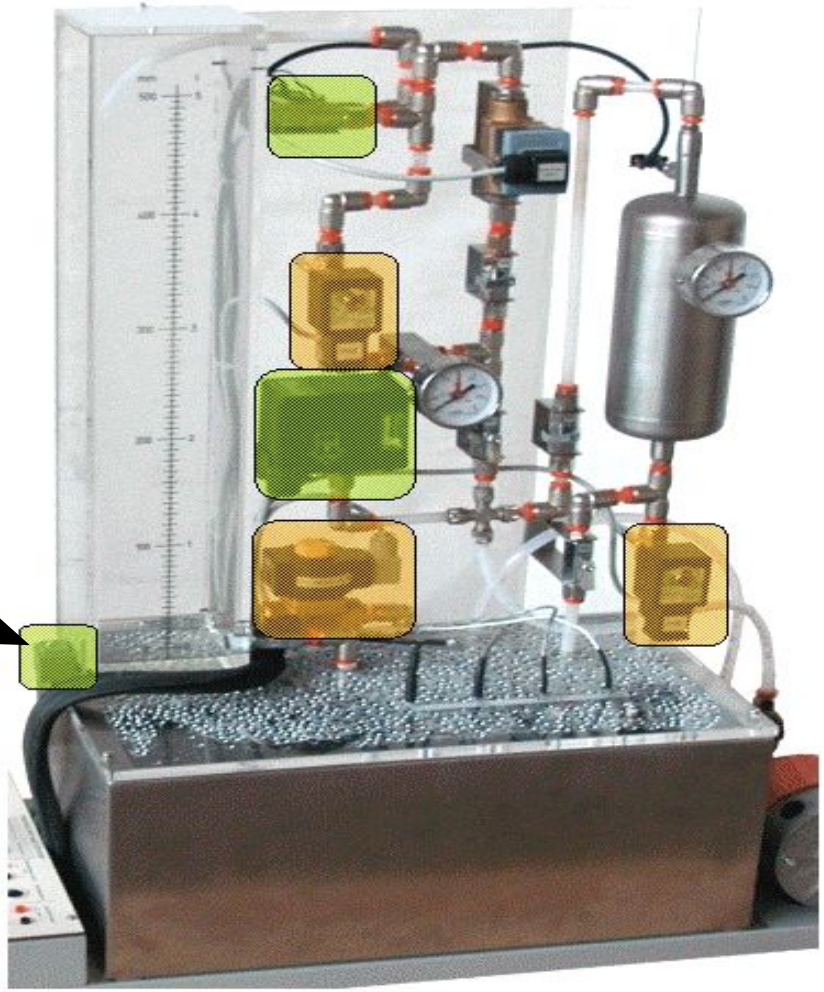
- Has plexiglass panel
- Has 3 tanks:

1) 25litres stainless steel at the bottom;
2) 5liters vertical plexiglass;
3) 1litre vertical steel tank

- Has a recirculation pump
- Manual Control Valves
- Water Heater with Resistor
- 2 Proportional Valves
- 2Pressure gauges
- On/ Off Solenoid Valve
- Process variable Sensors
- 1 glass mercury thermometer

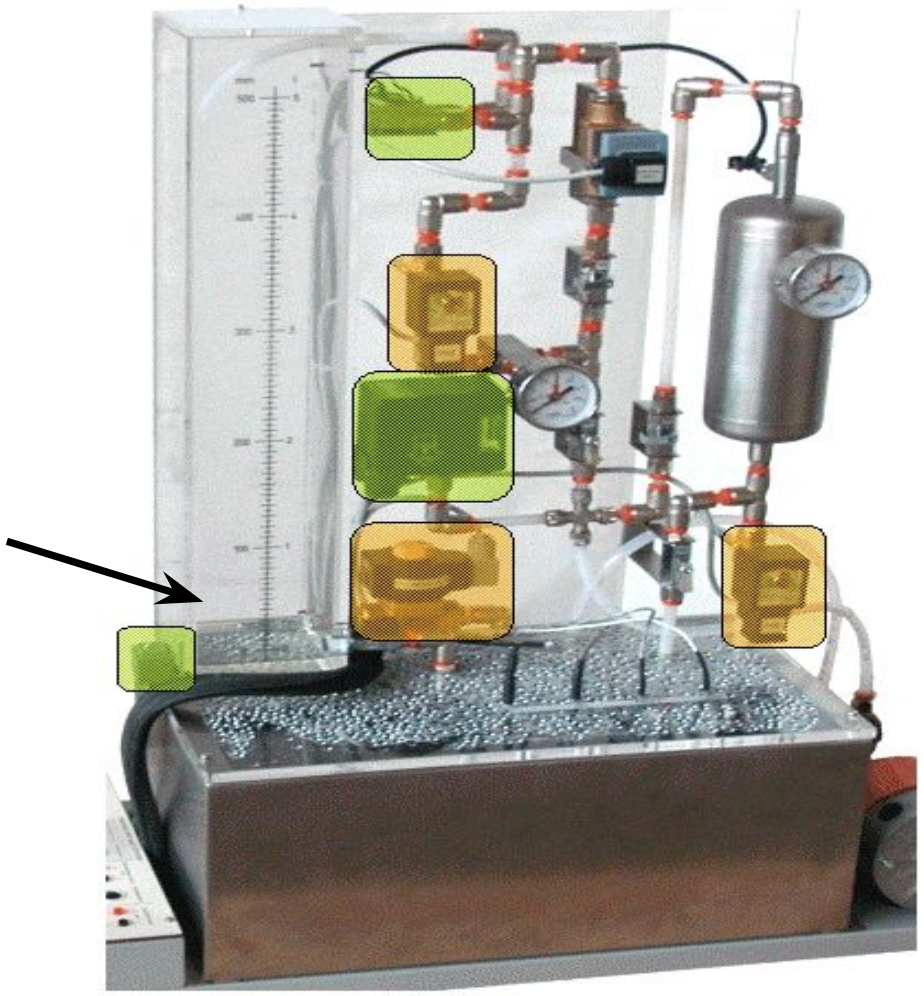


# 1.5. External Unit (FLTP-U/EV)



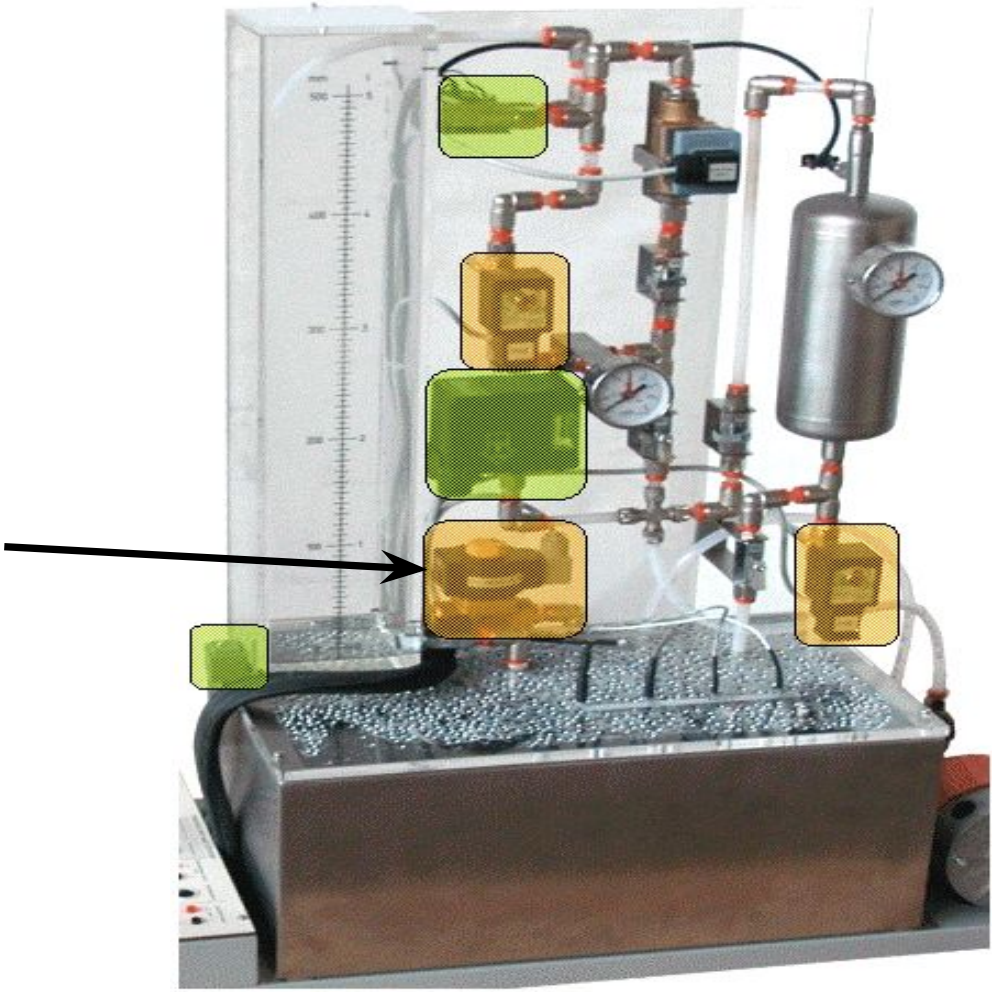
# 1.5. External Unit (FLTP-U/EV)

**Thermostat (0-50C)**

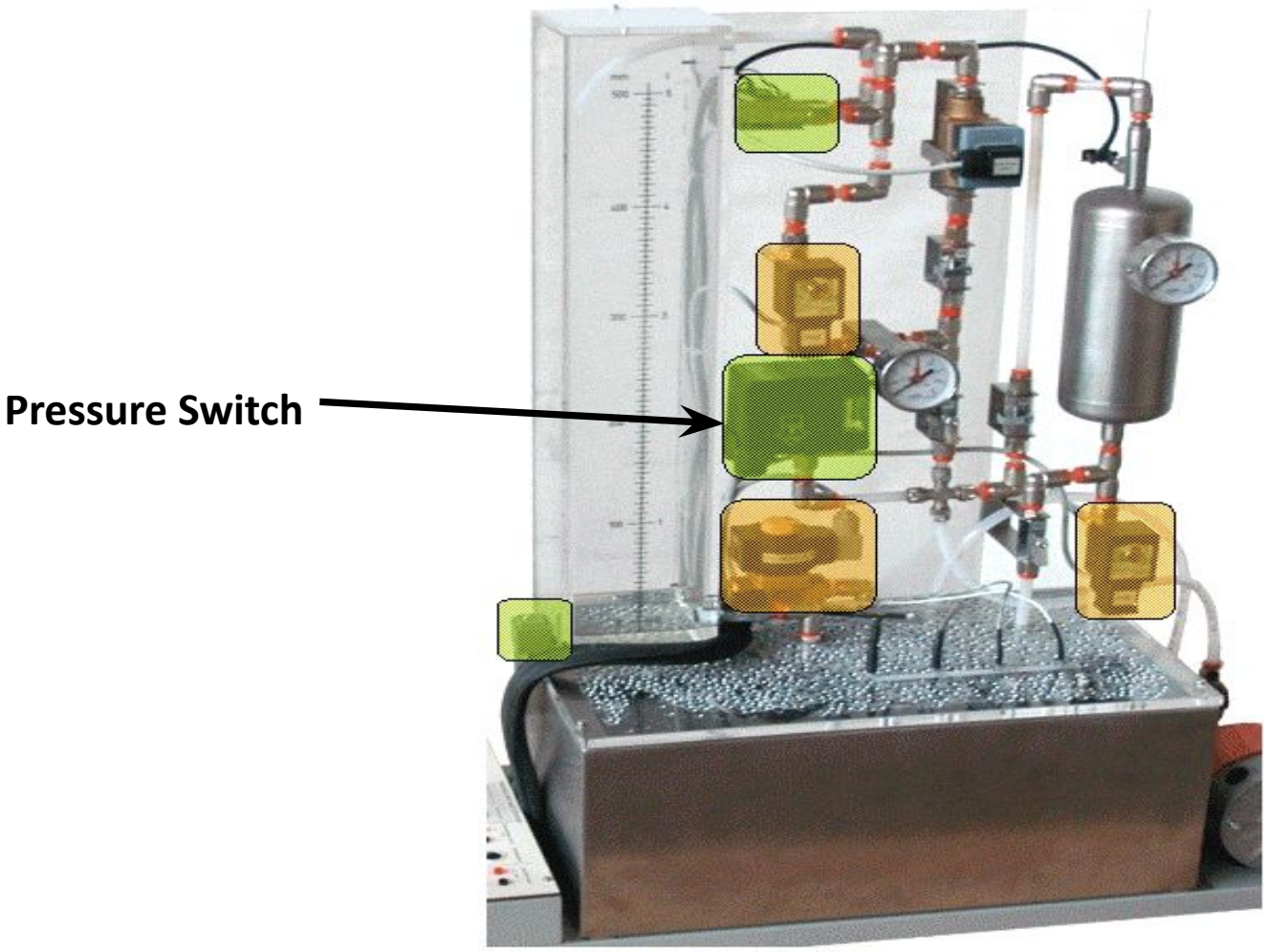


# 1.5. External Unit (FLTP-U/EV)

**On/ Off Exhaust Solenoid Valve**



# 1.5. External Unit (FLTP-U/EV)



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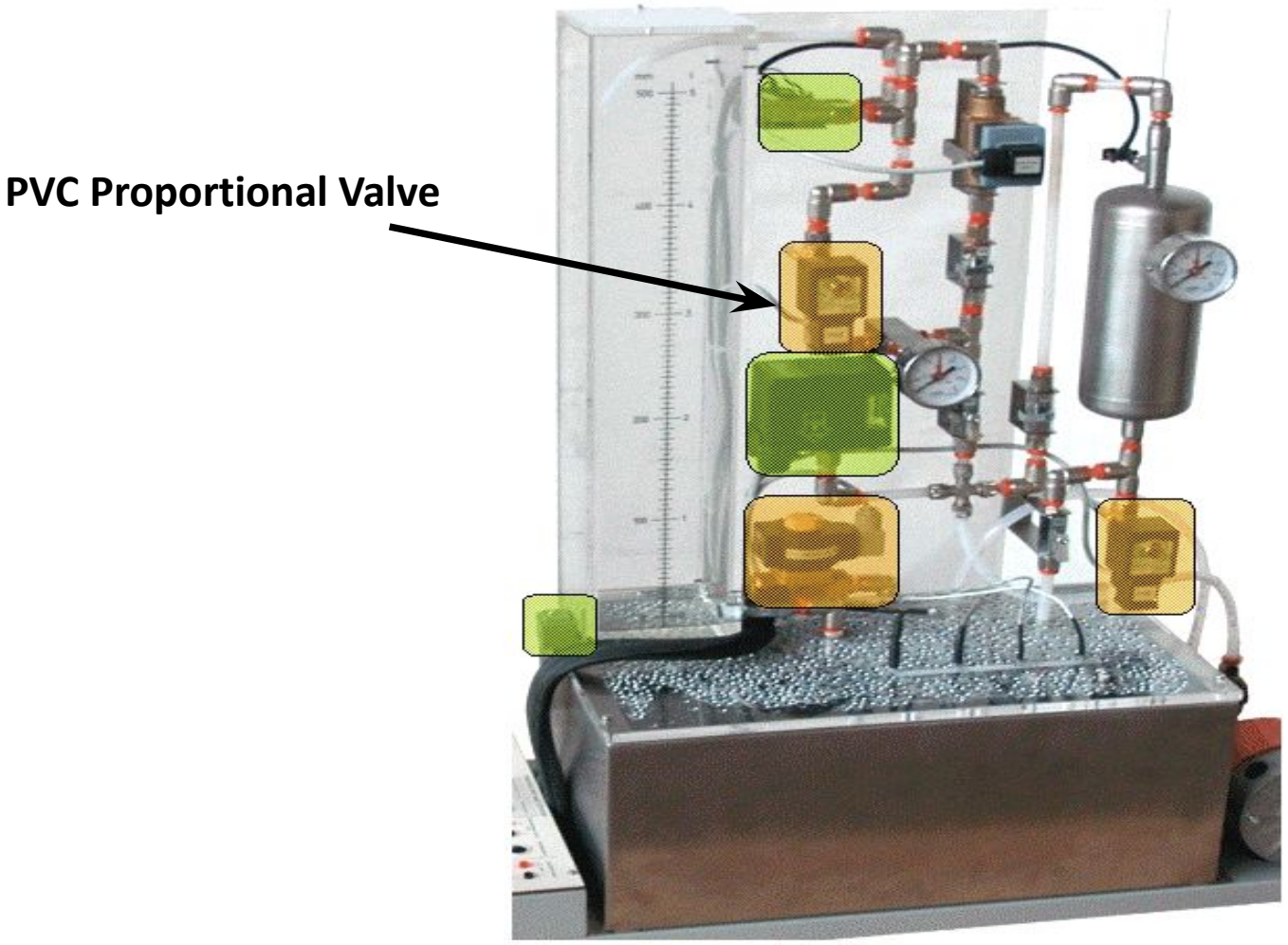
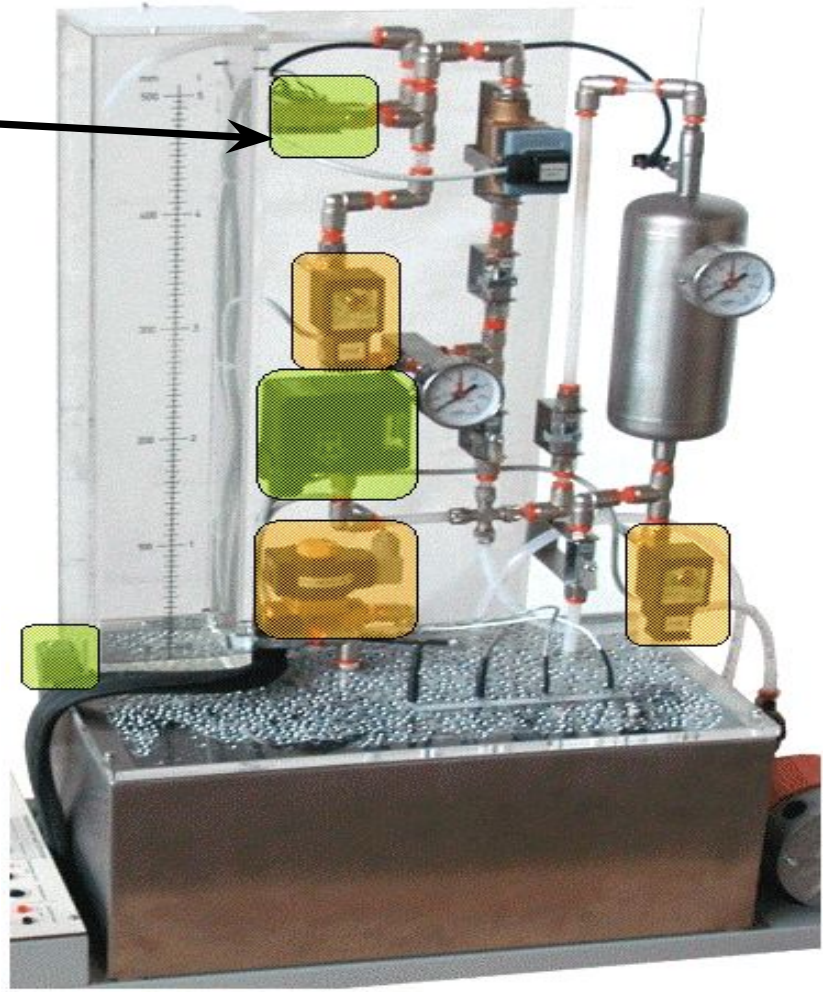


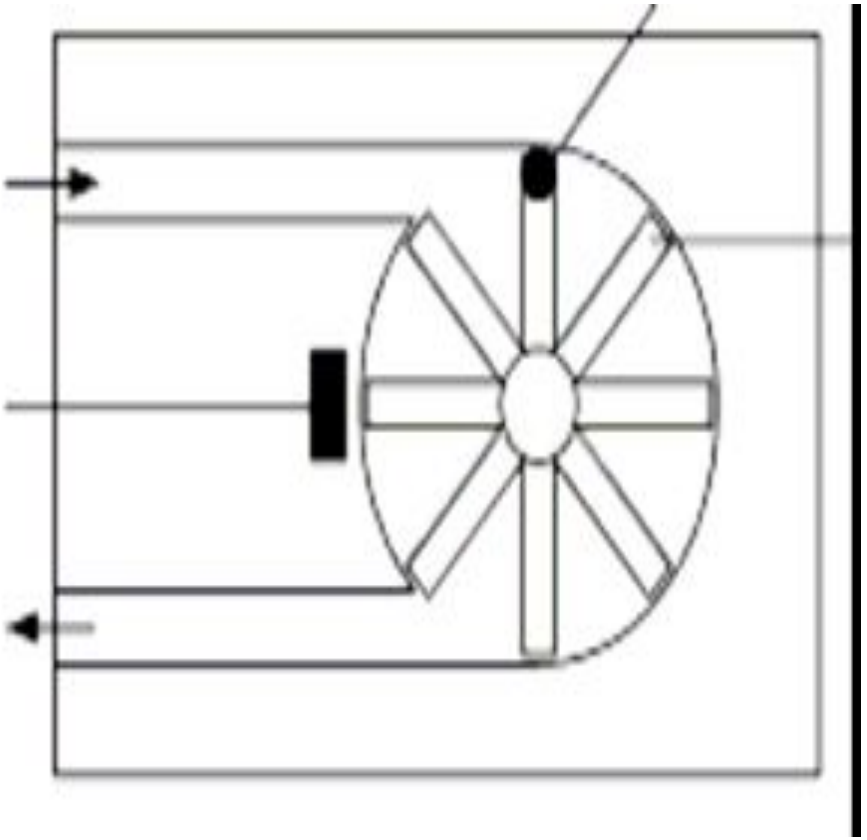
# 1.5. External Unit (FLTP-U/EV)

**Paddle Wheel Flow meter**

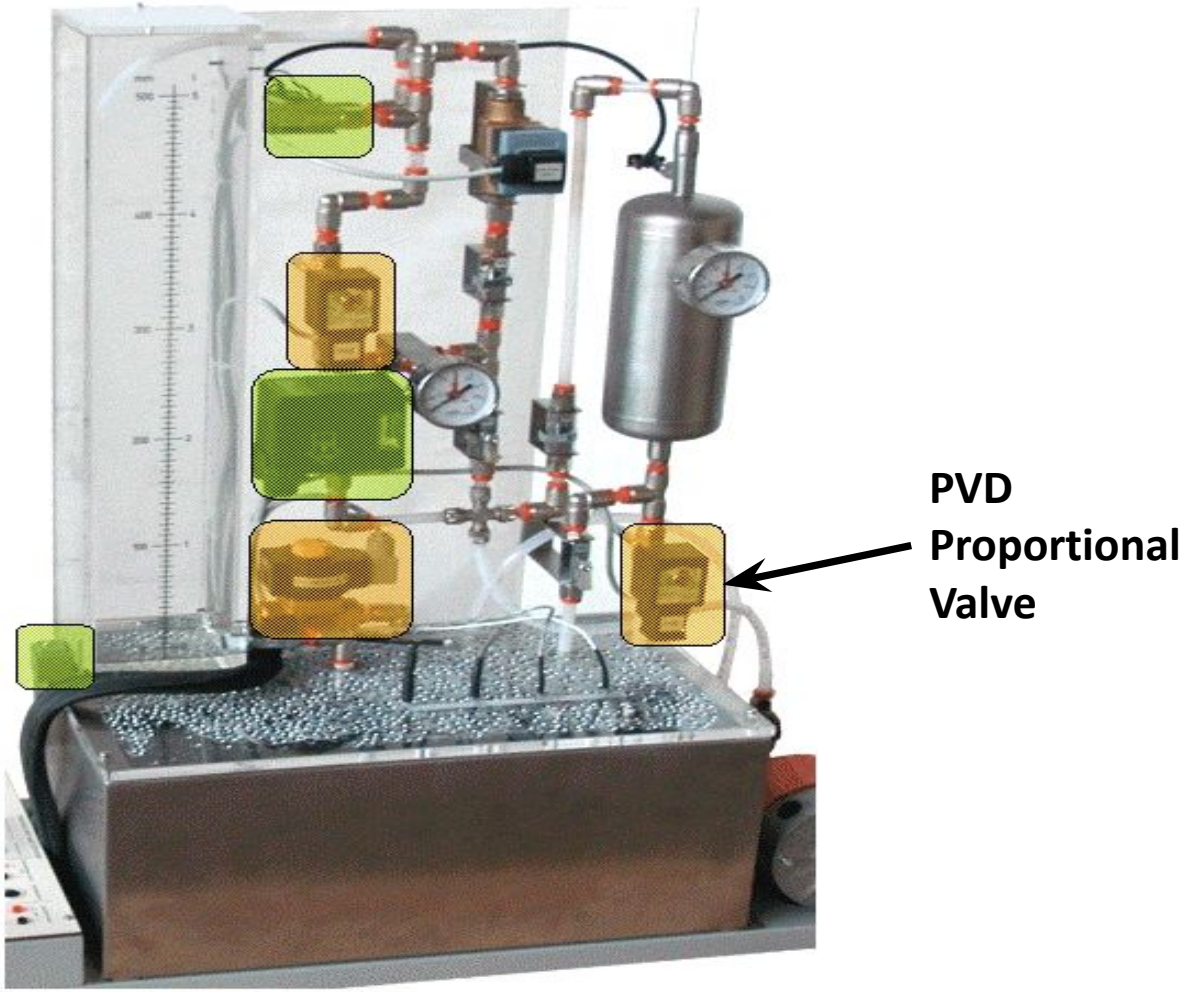


# Paddle wheel flow measurement

- Has a magnet in one of the paddles
- Hall effect is represented by magnetic vibration as the wheel rotates quickly
- Q = Number of pulse(litre)/ time(sec)



# 1.5. External Unit (FLTP-U/EV)



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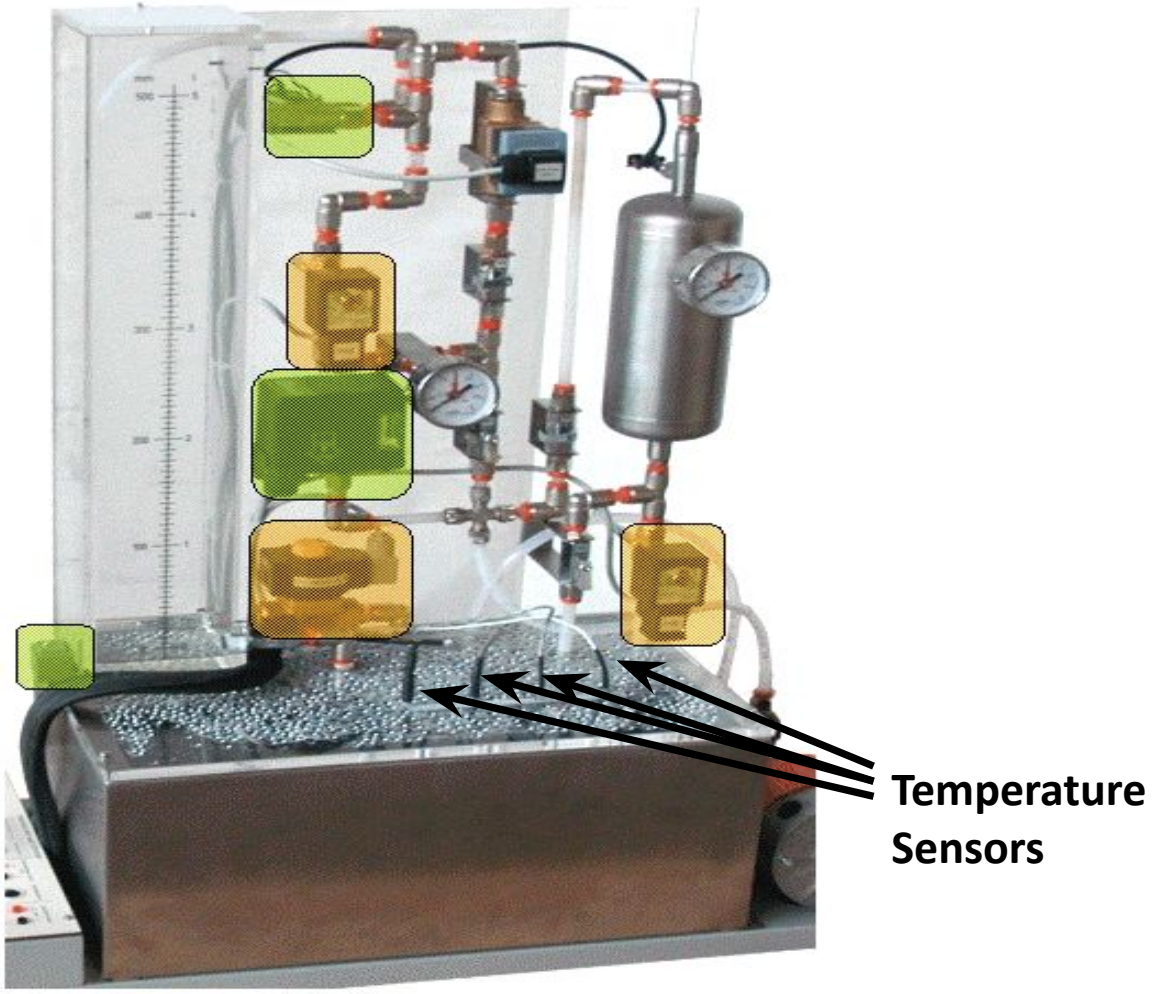

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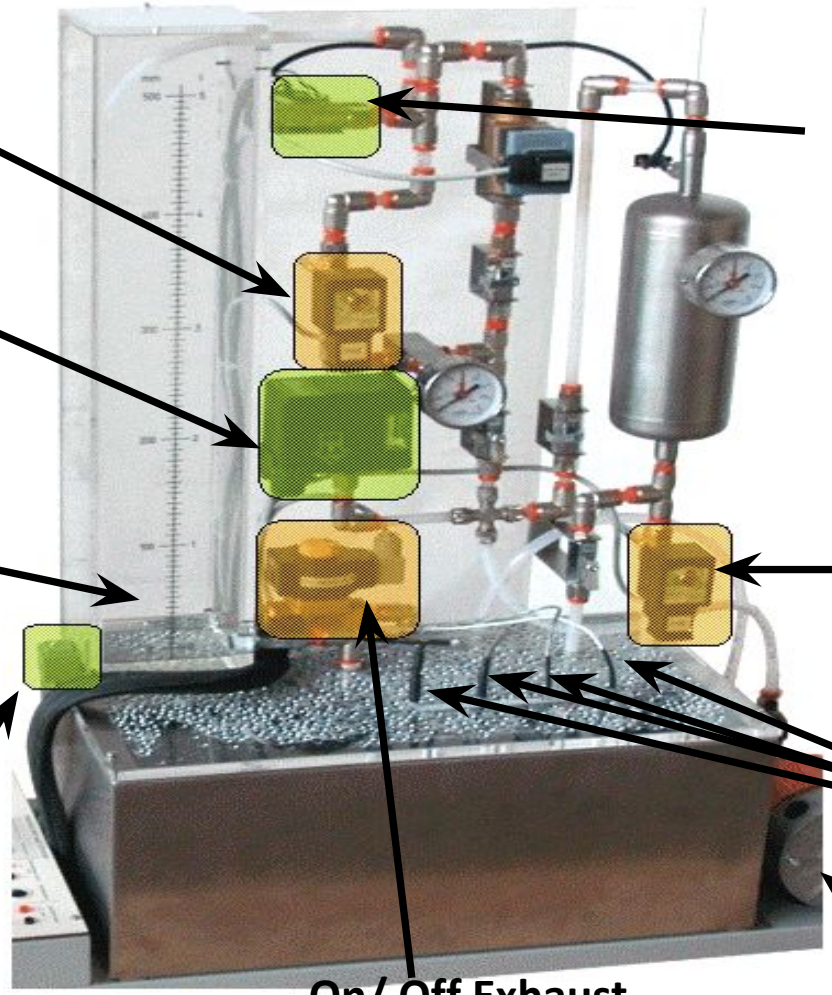


PVC Proportional Valve

Paddle Wheel Flow meter

Pressure Switch

Thermostat (0-50C)

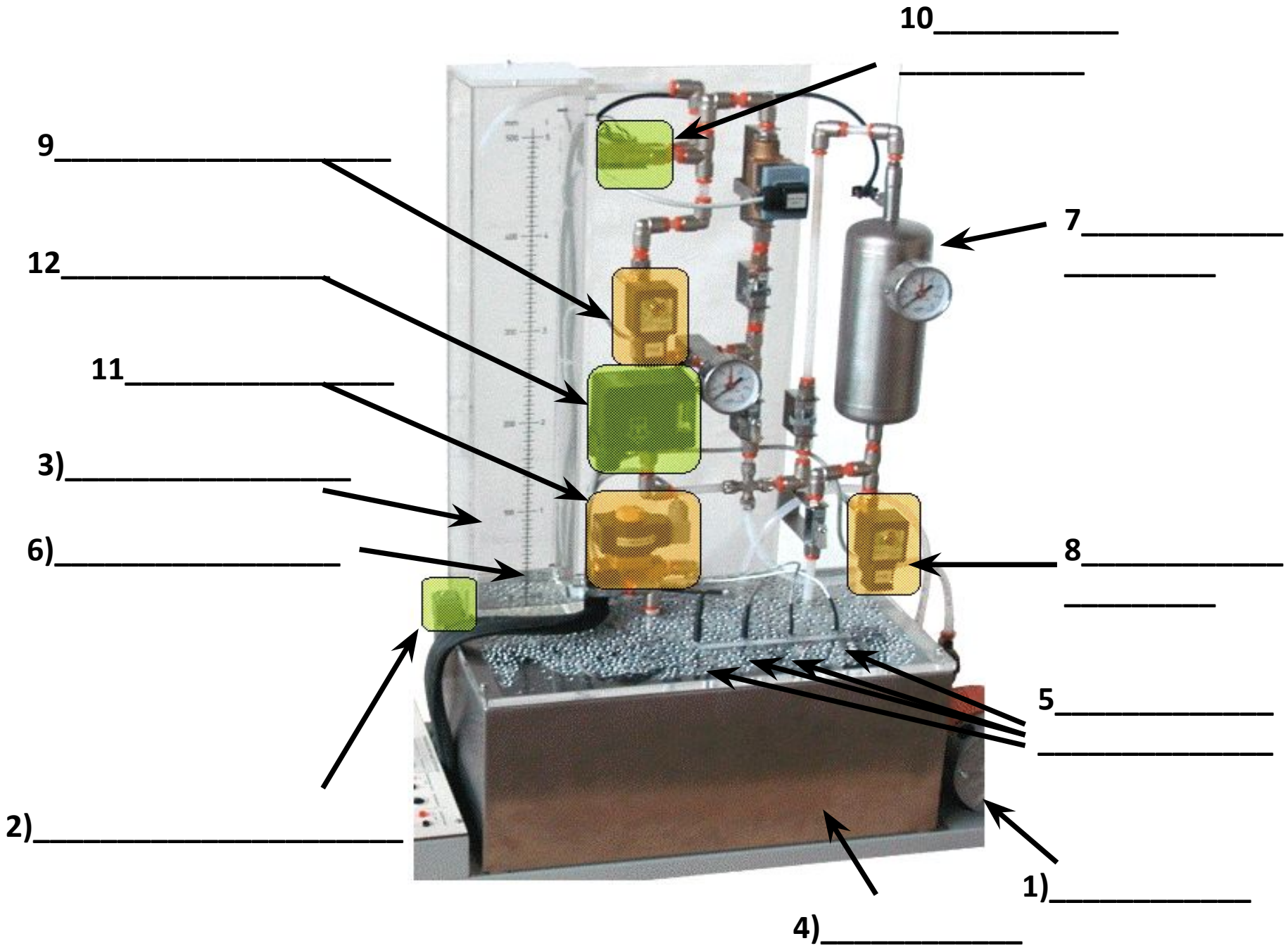
PVD Proportional Valve

Temperature Sensors

Piezometric Level Sensor

On/ Off Exhaust Solenoid Valve

1)_____


10
9
7
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3)
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2)
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4)

# Valves

- Positive crankcase ventilation (PVC) is used to limit the pressure or flow rate
- PVD Power valve Double acting
- Solenoid Valve


# 1.5 Work Principle of External Unit.

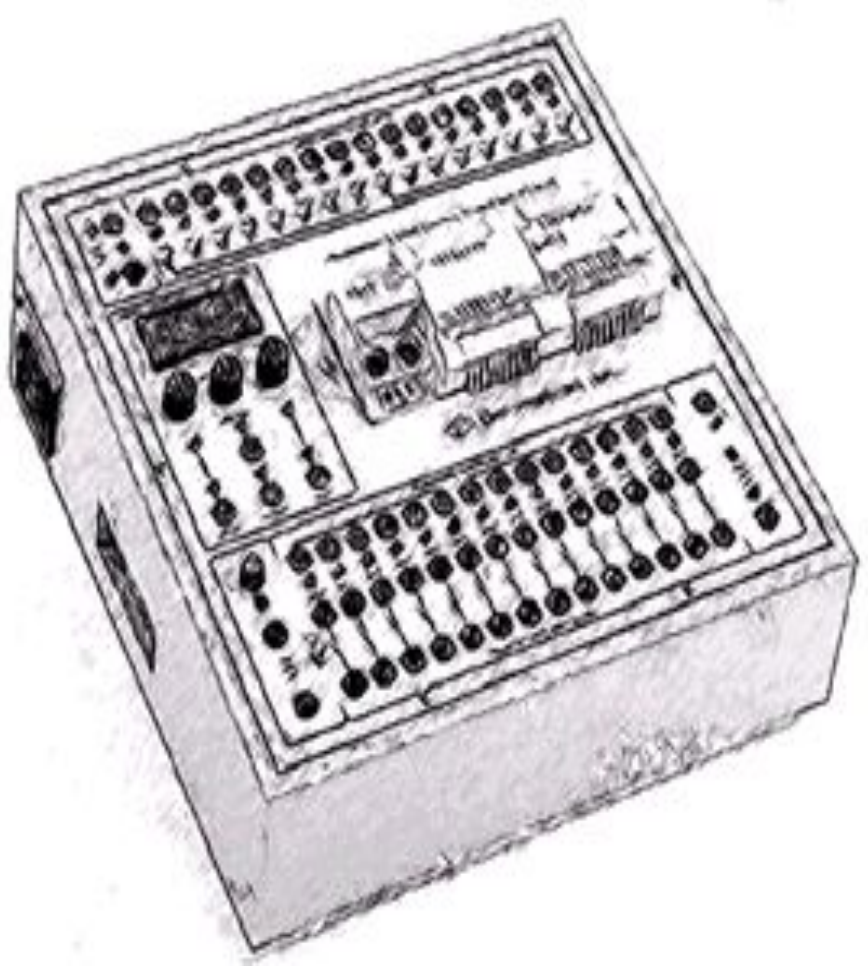
- Liquid is kept in the metal vessel
- pump injects the liquid from vessel into the plexiglass tank through lines.
- Liquid Pressures, flow rates and level are measured when the pump works
- Heater warms up the liquid
- Temperatures are measured with thermal snesors on the metal vessel
- Valves help control the pressures and flow rates

# 2. Control Units

- PLC Trainer
- Industrial PID
- Control Card

# 2.1 PLC Trainer (PLC-5A/EV)
# Учебная панель

- Has 16 digital inputs
- 14 digital outputs
- 4 Analog Inputs
- 1 Analog Output
- Connects to the touch screen

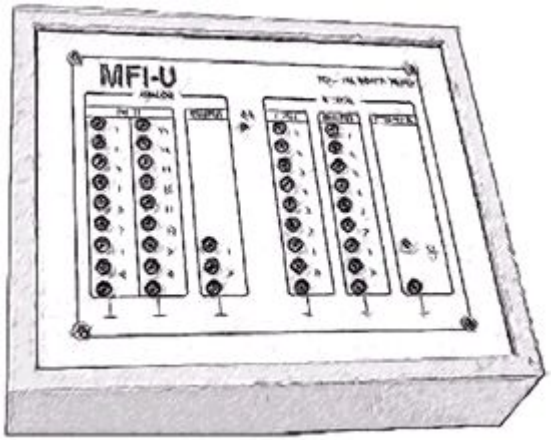


# 2.2 PID Controller

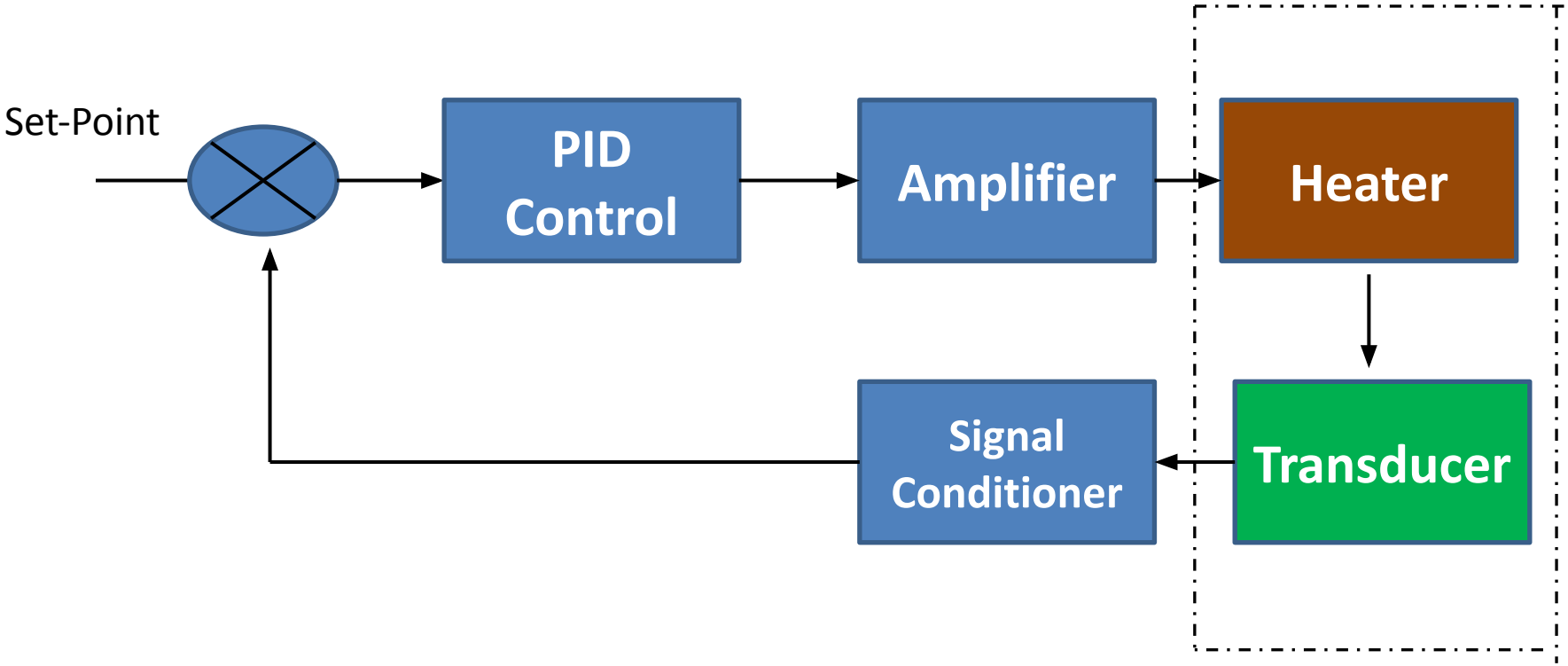
- Has inputs
- Outputs

# Control Card (MFI-U/EV)

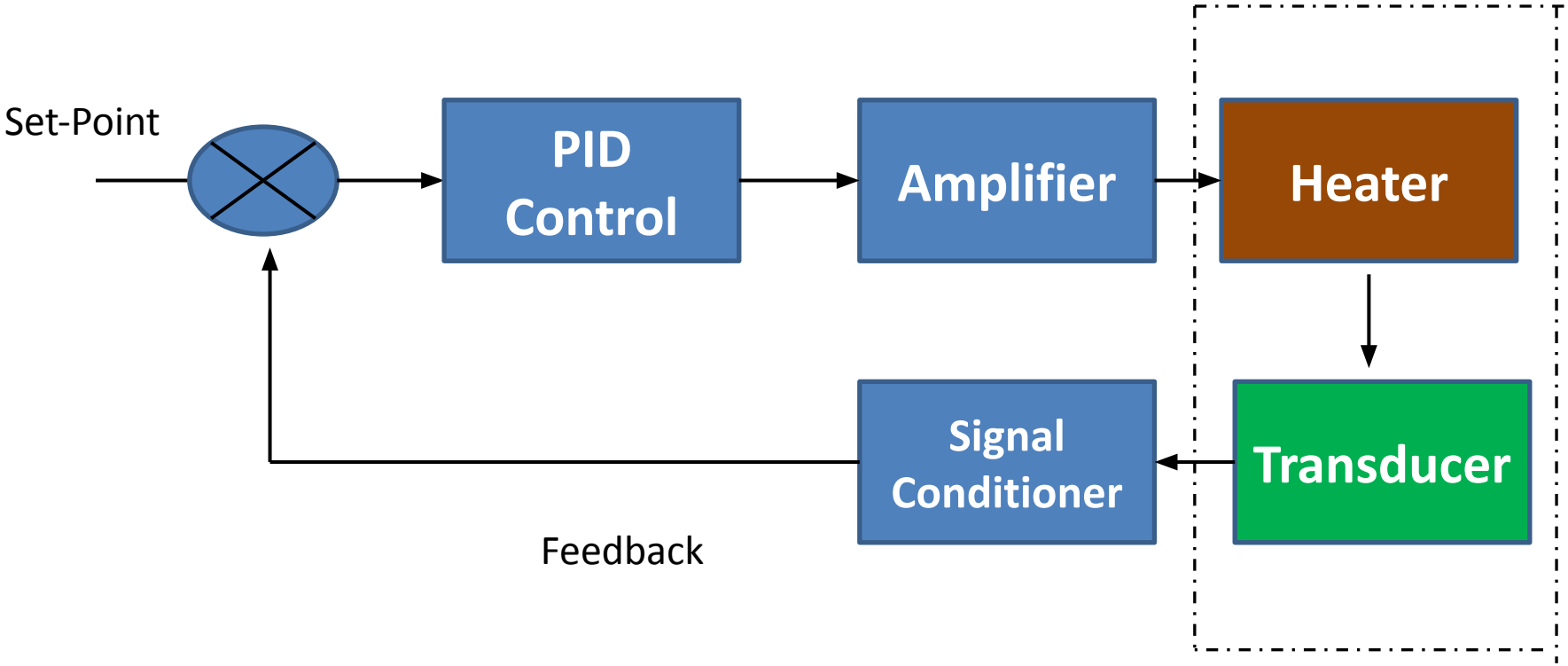
- Has 8Digital Inputs;
- 8Digital Outputs
- 16 Analog inputs
- 2 Analog Outputs



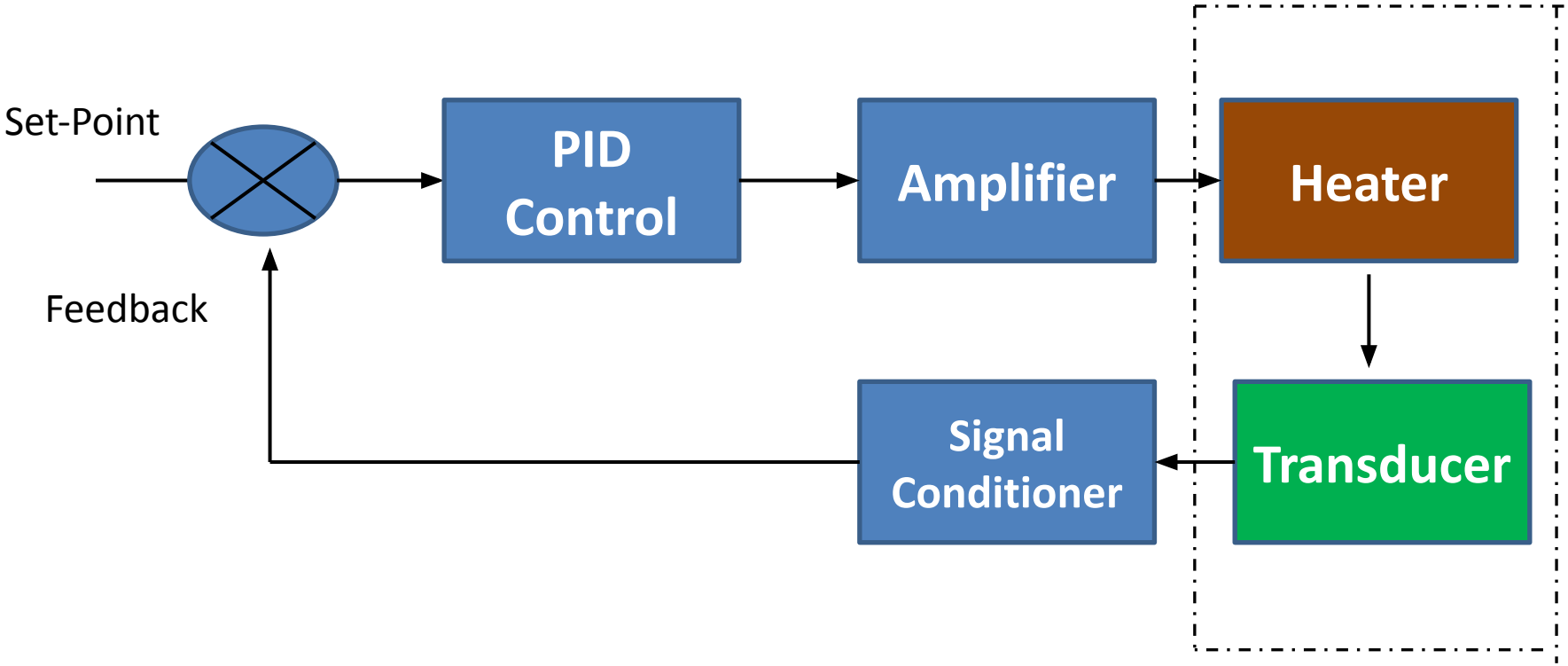
# 3 Control Techniques



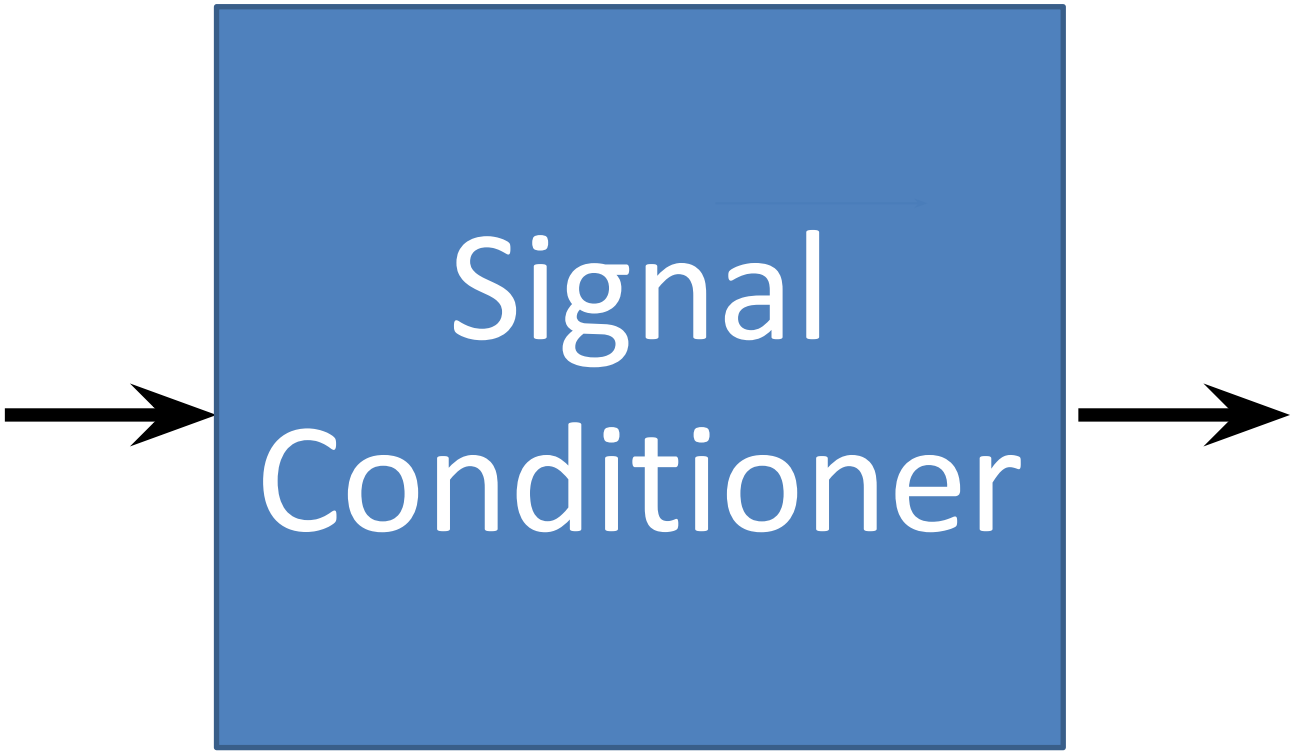
# Question. Is it open loop or closed loop control?



**Answer:** It is closed loop control because of PID Control and feedback



# Open Loop Control



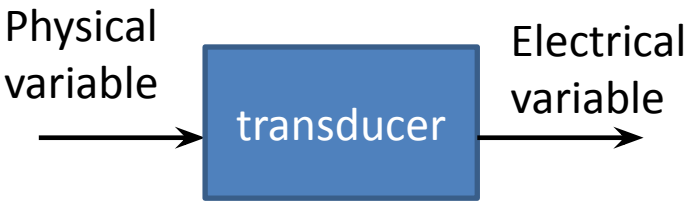
# Question

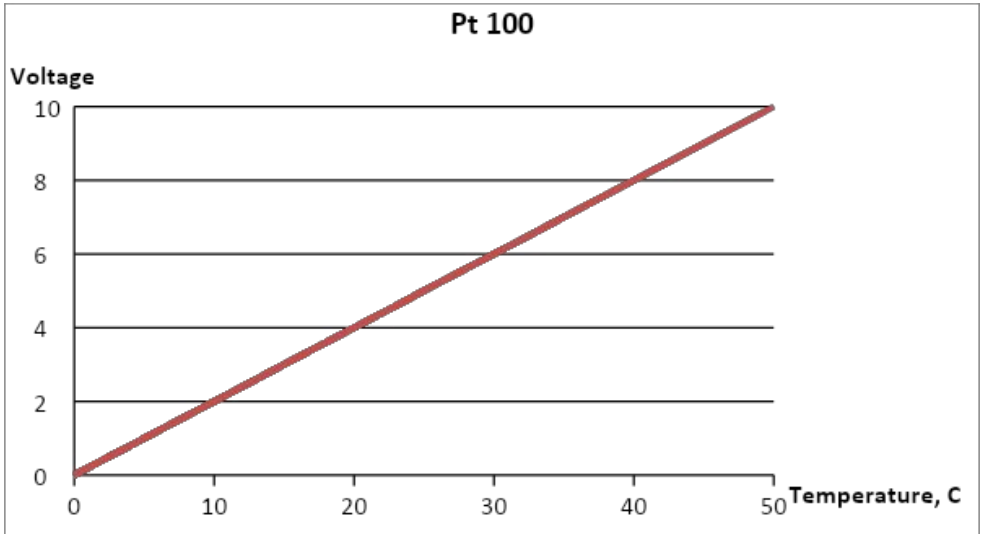
- What are the transducers?

# 3 Transducers

- Converter from physical variable to the electrical variable.

  Example: Pressure at 4 bars is converted to voltage at 7 Volts
- The transducer shows mostly the linear function
- Cannot be formed without the conditioner



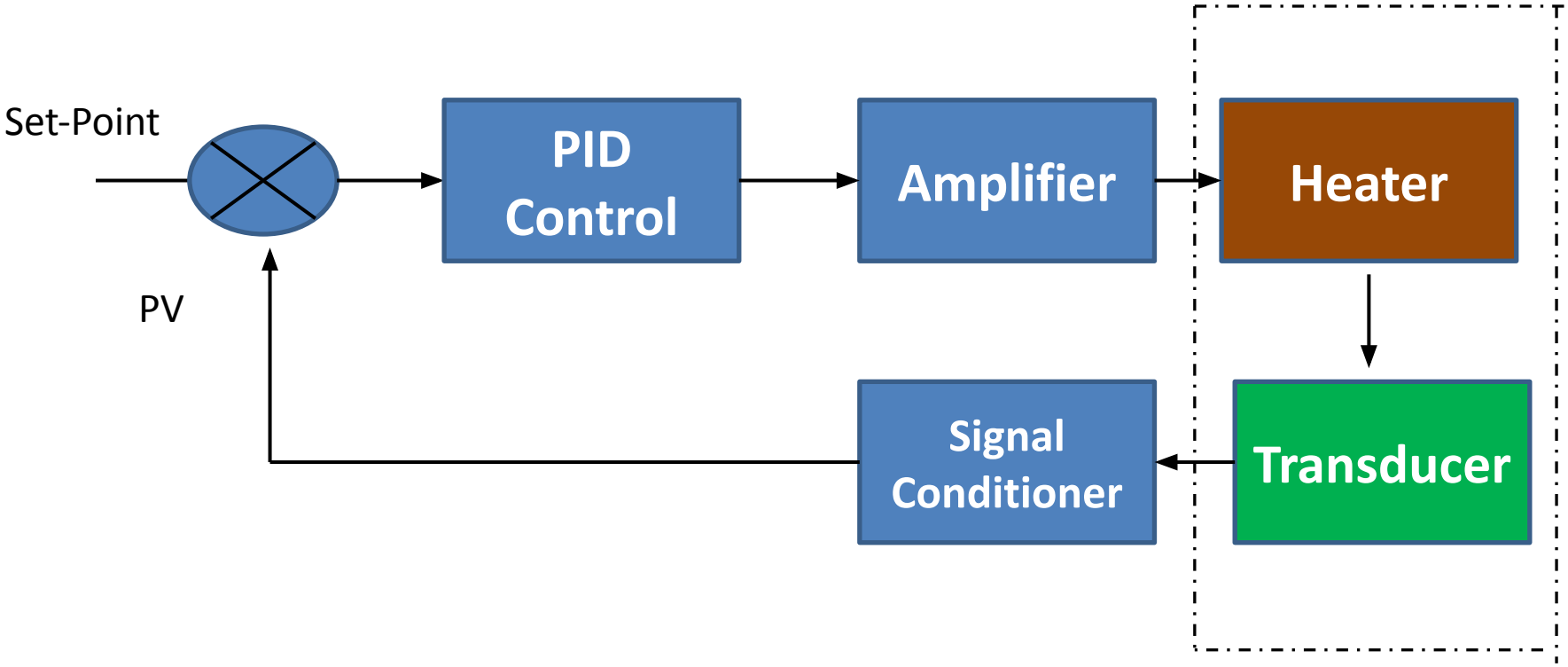
# Question

- What is the Conditioner?

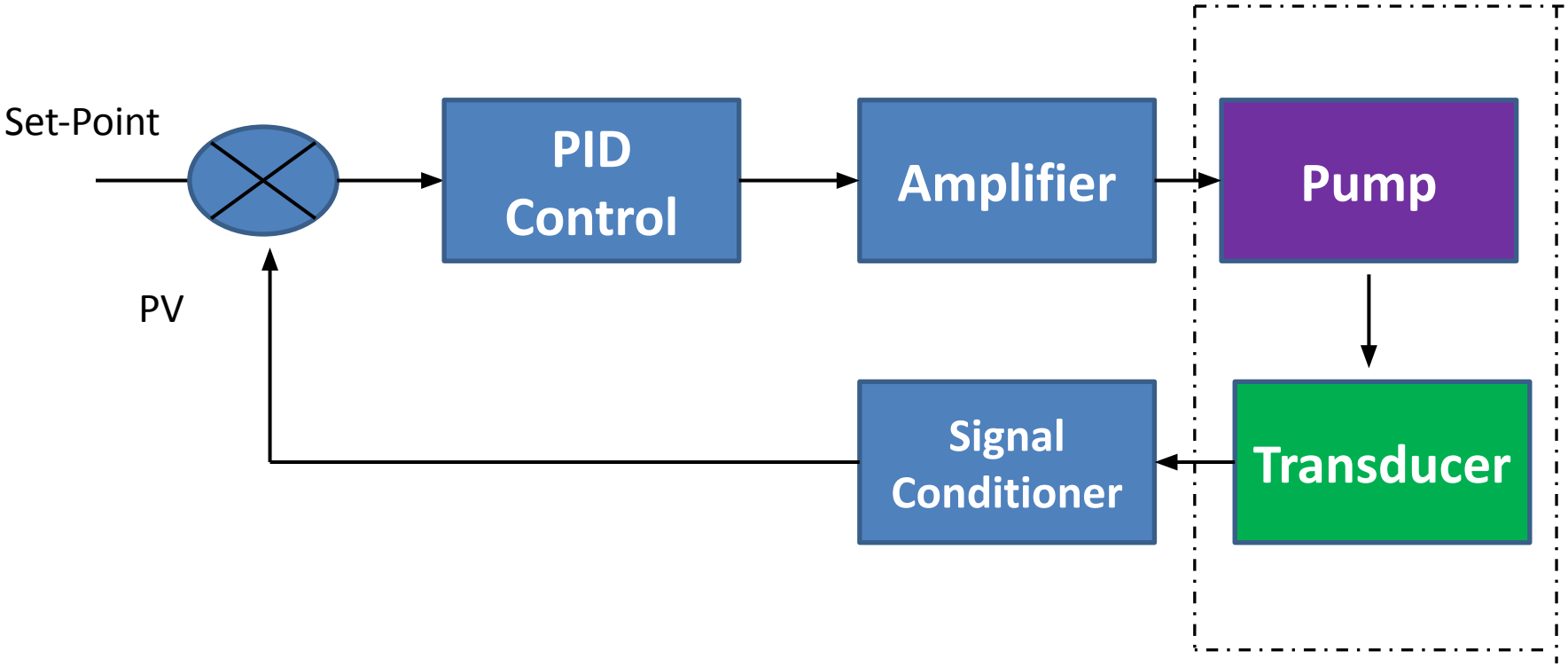
# Conditioner

- Converter from undesirable electrical variable into suitable electrical variable
- Always comes with transducer

# Temperature Control



# Pressure Control



# Summary

- Process Control System requires the control techniques, such as Amplifier, Conditioner, transducer and Heater or pump in the lab
- Without the Conditioner, transducer does not work
- Circulated control system makes closed loop control with PID technique, while  open loop control misses PID control