Overview

The test bench has been developed for the experimental study of Process Control and Monitoring basic principles.

The test bench is based on a universal simulation platform for various technological processes, which includes flow meters, level and pressure sensors and means for control over different actuating units.

The test bench consists of the main reservoir and two tanks connected/disconnected from each other by electromagnetic valves. The pumps independently deliver the liquid from the main reservoir to the tanks. The liquid in the tanks can also be drained back to the main reservoir.

The experimental setup also includes a National Instruments cRIO industrial controller with I/O modules to control the operation of electromagnetic valves and pumps. The controller is also responsible for data acquisition from all the sensors.

Features

- Pressure gauge
- Flow meter
- Cumulative flow
- Electromagnetic valves control
- Liquid level control in the tanks
- Pumps control

List of labs

- Maintaining a liquid level range in the first tank
- Maintaining a liquid level range in the first tank with liquid flow from the first tank
- Maintaining a given range of liquid flow
- Automatic suspension of liquid inflow when the desired volume has been reached.
- Maintaining liquid pressure in the tanks in a given range, using PID control
The test bench consists of tanks I and II, reservoir III, power switch 1, pressure gauges 2, pipes 3, filling/draining valve 4, ultrasonic level sensors 5, electromagnetic valves 6, flow meter 7, pumps 8, status indicators 9.

Pumps 8 deliver the liquid from the reservoir III into the tanks I and II. Liquid level in the tanks is determined by level sensors 5. Liquid pressure at tank bottom is determined by pressure gauges 2. Tanks I and II are connected by pipes 3. Inwards and outwards flow of liquid is controlled by electromagnetic valves 6. Indicators 9 on the front panel show the on/off state for each of the actuating devices.

**Deliverables**
- Laboratory test bench
- Software
- Instructions
- Operations Manual
Pressure Control Trainer

Overview
A bench-mount trainer for teaching pressure control. It includes all the required sensors and actuators to perform a full experiments list for teaching pressure control.

Developed for use with a wide variety of National Instruments data acquisition and control platforms - easy-to-use, highly expandable programmable automation controllers, intelligent communication interfaces, and rugged I/O modules. These industrial I/O modules filter, calibrate, and scale raw sensor signals to engineering units and perform self-diagnostics to look for problems.

The curriculum covered includes teaching the principles of On/Off Control, PID control, Feedforward and other types of control used in the industry.

Features
- Computer based Pressure Control Trainer used to teach pressure control
- Includes all required sensors to measure the pressure
- For use with National Instruments Data Acquisition & Control hardware

Required Hardware and Software
- MS windows -2000/XP/Vista/Windows7, Microsoft office
- Compatible with National Instruments’ data acquisition hardware (PXie, cRIO or cDAQ)
- PC with monitor
Pressure Control Trainer

List of labs
1. Acquiring Physical Phenomena
2. On/Off Control
3. PID Feedback Control
4. Lead-Lag Compensation
5. Feedback/Feedforward Control

Components
- Level Switches
- Pressure Sensor
- Flow Control Valve
- Pump
- Variable Frequency Drive
Process Control & Measurement Trainer

Curriculum Coverage

- Acquiring Physical Phenomena
- On/Off Control
- PID Feedback Control
- Setpoint Profile Generation
- Lead-Lag Compensation
- Feedback/Feedforward Control
- Multiloop Cascade Control
- Ratio Control
- Flow Meters Comparison (with option)

Features

- Computer based Process Trainer used to teach level, flow, temperature, and pressure Measurement & Control
- Includes all required sensors to measure different process variables
- For use with National Instruments Data Acquisition & Control hardware

Description

A bench-mount trainer for teaching Process Measurement & Control through level, flow, temperature, and pressure. The PT001 trainer includes all the required sensors and actuators to perform the full experiment list for teaching process control and measurement. Using PT001, the student will acquire better understanding and hands-on experience in process control.

The PT001 was developed for use with National Instruments measurement and control platforms. It utilizes the platform features such as; real-time and FPGA processing, intelligent communication interfaces, rugged I/O modules, among others. The industrial I/O modules filter, calibrate, and scale raw sensor signals to engineering units and performs self diagnostics.

The curriculum covered includes teaching the principles of acquiring different physical phenomena, On/Off Control, PID control, Feedforward and other types of control used in the industry.

Components

- Thermocouples
- Heater
- Level Sensor
- Pressure Sensor
- Magnetic Flow Meters
- Flow Control Valve
- Pump
- Variable Frequency Drive
- Turbine Flow Meter (Option)

NI\(^1\) Compatible Platforms

- PXIe
- Compact RIO
- Others\(^2\)

\(^1\) NI: National Instruments

\(^2\) Please check with us about compatibility of other NI Platforms

Required NI Modules

- PXIe\(^3\): PXI-6236, PXIe-6251, PXI-6513, PXIe-4353
- cRIO: NI-9211, NI-9207, NI-9472, NI-9263
- PXIe: for Turbine Flow Meter option, replace PXI-6236 with PXI-6238

Ordering information

PT001 - A - B - C

<table>
<thead>
<tr>
<th>NI(^*) Platform</th>
<th>Power</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1... PXIe</td>
<td>1... 110 VAC</td>
<td>0... No Option</td>
</tr>
<tr>
<td>2... cRIO</td>
<td>2... 220 VAC</td>
<td>1... Turbine Flow Meter</td>
</tr>
</tbody>
</table>

\(^*\)Purchase NI Hardware Separately

For complete product specifications, pricing, and information:
e-mail: info@ti-acad.jo / website: www.ti-acad.jo

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**Curriculum Coverage**

- Thermocouple Characteristics
- RTD Characteristics
- Thermistor Characteristics
- Comparison between Temperature Sensing Devices

**Features**

- Computer based Temperature Measurement Trainer used to teach temperature sensing technologies
- Comprises all required sensors to measure temperature in a chamber
- For use with National Instruments Data Acquisition & Control hardware

**Description**

TMT001 is a bench-mount trainer that is used to teach students how to measure temperature using different types of sensing devices; Thermocouple (TC), Resistive Temperature Device (RTD) and Thermistor.

Developed for use with a wide variety of National Instruments data acquisition and control platforms - easy-to-use, highly expandable programmable automation controllers, intelligent communication interfaces, and rugged I/O modules.

The curriculum covered includes understanding the characteristics of the different temperature measuring devices and comparing between their different behaviors and characteristics.

**Components**

- Thermocouple
- RTD
- Thermistor
- Heater
- Fan
- Temperature Controller

**NI¹ Compatible Platforms**

- Compact RIO
- Others²

¹ National Instruments
² Please check with us about compatibility of other NI Platforms

**Required NI Modules**

- cRIO: NI-9219, NI-9474

**Software**

- User friendly with easy to use interface
- Developed using NI LabVIEW package
- Built-in safety features & limitations, and designed for students’ use
Temperature Measurement Trainer Specifications:

**Dimensions:**
- Dimensions (LxWxH): 30 x 20 x 25 mm

**Safety Considerations:**
- Maximum Allowable Temperature: 90 °C

**Thermocouple:**
- J-Type
- Probe Length: 10 cm

**Thermistor:**
- Resistance @ 25 °C 6000 ohms
- Probe Length: 10 cm

**RTD:**
- PT100
- Class B
- Probe Length: 10 cm

**Glass Thermometer:**
- Mercury
- 0-200 °C

**Heater:**
- Dimensions: 15 x 10 cm
- Power: 150 Watt
- 220 Volt 50 Hz

**Temperature Controller:**
- Set point: 30 °C
- On/off control

For complete product specifications, pricing, and information:
e-mail: info@ti-grad.jo / website: www.ti-grad.jo
Curriculum Coverage

- Magnetic Flow Meter Characteristics
- Paddle Wheel Flow Meter Characteristics
- Differential Pressure Flow Meter Characteristics
- Vortex Flow Meter Characteristics (with option)
- Comparison between Flow Meters

Features

- Computer based Flow Measurement Trainer used to teach flow sensing technologies
- Includes all required sensors to measure flow
- For use with National Instruments Data Acquisition & Control hardware

Description

FMT001 is a bench-mount trainer that is used to teach students how to measure flow between two tanks using different flow measuring devices; Magnetic Flow Meter, Paddle Wheel Flow Meter, Venturi Flow Meter, Rota Meter and Vortex Flow Meter (option).

Developed for use with a wide variety of National Instruments data acquisition and control platforms - easy-to-use, highly expandable programmable automation controllers, intelligent communication interfaces, and rugged I/O modules. These industrial I/O modules filter, calibrate, and scale raw sensor signals to engineering units and perform self-diagnostics to look for problems.

The curriculum covered includes understanding the characteristics of the different flow measuring devices and comparing between their different behaviors and characteristics.

Components

- Pump
- Magnetic Meter
- Paddle Wheel Meter
- Diff. Pressure Meter
- Rota Meter
- Flow Control Valve
- Vortex Flow Meter (Option)

NI\(^1\) Compatible Platforms

- PXIe
- Compact RIO
- Others\(^2\)

\(^1\) NI: National Instruments
\(^2\) Please check with us about compatibility of other NI Platforms

Required NI Modules

- PXIe: PXI-6236, PXIe-6251, PXI-6514
- cRIO: NI-9215, NI-9203, NI-9474, NI-9263, NI-9422

Software

- User friendly with easy to use interface
- Developed using NI LabVIEW package
- Built-in safety features & limitations, and designed for students' use

Ordering Information

Flow Measurement Trainer

FMT001 - A - B - C

NI\(^*\) Platform

1... PXIe
2... cRIO

Power

1... 110 VAC
2... 220 VAC

Options

0... No Option
1... Vortex Flow Meter

*Purchase NI Hardware Separately

For complete product specifications, pricing, and information:
e-mail: info@t-acad.jo / website: www.t-acad.jo

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Technical Specifications

Flow Measurement Trainer Specifications:

Dimensions & Volumes:
- Dimensions (LxWxH): 1200 x 700 x 600 mm
- Lower Tank Dimensions: 400 x 255 x 205 mm
- Upper Tank Dimensions: 300 x 255 x 205 mm
- Lower Tank Volume: 18.7 Liters
- Upper Tank Volume: 14 Liters

Safety Considerations:
- Maximum allowable temperature: 55 °C
- Maximum allowable water level in the upper tank: 23 cm

Electromagnetic Flow Meter:
- Flow Rate: 0.01-0.5 ... 35-700 L/min
- Maximum pressure: 10 BAR
- Maximum temperature: 80 °C
- Output: 4-20 mA, 3-wire
- Max. Load: 500 Ω
- Power Supply: 24 VDC
- Power Consumption: 80 mA

Differential Pressure Flow Meter:
- Flow Rate: 0.5-3.3,….,300-2350 L/Min. water
- Output: 4-20 mA, 3-wire
- Maximum pressure: 10 BAR
- Maximum temperature  80 °C
- Power Supply: 24 VDC
- Power Consumption: 100 mA

Rotating Vane Flow Meter:
- Flow Rate: 1-26 L/min water
- Output: 4-20 mA, 3-wire
- Maximum pressure: 16 BAR
- Maximum temperature: 80 °C
- Power Supply: 24 VDC
- Power Consumption: 15 mA

Maximum Flow Rate:
- Upper: 4-5 Liters/minute
- Lower: 11-12 Liters/minute

Pump:
- Pressure: Max. 10 Bars
- Power: 115 Watts
Flow Control Trainer

Curriculum Coverage

- Acquiring Physical Phenomena
- On/Off Control
- PID Feedback Control
- Lead-Lag Compensation
- Feedback/Feedforward Control
- Ratio Control

Features

- Computer based Flow Control Trainer used to teach Flow Control
- Includes all required sensors to measure the flow
- For use with National Instruments Data Acquisition & Control hardware

Description

A bench-mount trainer for teaching flow control. It includes all the required sensors and actuators to perform a full experiments list for teaching flow control.

Developed for use with a wide variety of National Instruments data acquisition and control platforms - easy-to-use, highly expandable programmable automation controllers, intelligent communication interfaces, and rugged I/O modules. These industrial I/O modules filter, calibrate, and scale raw sensor signals to engineering units and perform self-diagnostics to look for problems.

The curriculum covered includes teaching the principles of On/Off Control, PID control, Feedforward and other types of control used in the industry.

Components

- Level Switches
- Flow Meters
- Flow Control Valve
- Pump
- Variable Frequency Drive

NI\(^1\) Compatible Platforms

- PXIe
- Compact RIO
- Others\(^2\)

\(^1\) NI: National Instruments

\(^2\) Please check with us about compatibility of other NI Platforms

Required NI Modules

- PXIe: PXI-6236, PXIe-6251, PXI-6514
- cRIO: NI-9215, NI-9203, NI-9474, NI-9263

Software

- User friendly with easy to use interface
- Developed using NI LabVIEW package
- Built-in safety features & limitations, and designed for students’ use

Ordering Information

Flow Control Trainer

<table>
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<th>FLCT001 - A - B</th>
<th>Power</th>
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<td>1... PXIe</td>
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<tr>
<td>2... cRIO</td>
<td>2... 220 VAC</td>
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For complete product specifications, pricing, and information:
e-mail: info@ti-acad.jo / website: www.ti-acad.jo

*Purchase NI Hardware Separately

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Curriculum Coverage

- Acquiring Physical Phenomena
- Flow Measurement
- Pressure Measurement
- Level Measurement
- Temperature Measurement
- Humidity Measurement (with option)

Features

- Computer based Process Variables Measurement Trainer used to teach acquiring and measuring different physical phenomena
- Includes all required sensors to measure process variables
- For use with National Instruments Data Acquisition & Control hardware

Description

PVMT001 is a bench-mount trainer that is used to teach students how to acquire and measure different physical phenomena. The sensors used include: Electromagnetic and Paddle Wheel for Flow; Piezoresistive for Pressure; Capacitance for Level; Thermocouple, RTD and Thermistor for Temperature; and Humidity Sensor for Humidity (option).

Developed for use with a wide variety of National Instruments data acquisition and control platforms - easy-to-use, highly expandable programmable automation controllers, intelligent communication interfaces, and rugged I/O modules. These industrial I/O modules filter, calibrate, and scale raw sensor signals to engineering units and perform self-diagnostics to look for problems.

The curriculum covered includes understanding the characteristics of the different sensing devices and comparing between their different behaviors and characteristics.

Components

- Electromagnetic Sensor
- Paddle Wheel Sensor
- Piezoresistive Sensor
- Capacitance Sensor
- Thermocouple
- RTD
- Thermistor
- Flow Control Valve
- Pump
  - Humidity Sensor (Option)

NI Compatible Platforms

- Compact RIO
- Others

Power

- 1... 110 VAC
- 2... 220 VAC

Required NI Modules

- cRIO: NI-9219, NI-9203, NI-9474, NI-9263, NI-9215, NI-9422

Software

- User friendly with easy to use interface
- Developed using NI LabVIEW package
- Built-in safety features & limitations, and designed for students’ use

For complete product specifications, pricing, and information:
e-mail: info@ti-acad.jo / website: www.ti-acad.jo

*Purchase NI Hardware Separately

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Level & Pressure Measurement Trainer

Curriculum Coverage

- Capacitance Level Meter Characteristics
- Ultrasonic Level Meter Characteristics
- Piezoresistive Sensor Characteristics
- Capacitance Change Sensor Characteristics (with option)

Features

- Computer based Level & Pressure Measurement Trainer used to teach level and pressure sensing technologies
- Includes all required sensors to measure level and pressure
- For use with National Instruments Data Acquisition & Control hardware

Description

LPMT001 is a bench-mount trainer that is used to teach students how to measure level and pressure using different types of measuring devices; Capacitance Level Meter, Ultrasonic Level Meter, Piezoresistive Pressure Sensor and Capacitance Change Pressure Sensor (option).

Developed for use with a wide variety of National Instruments data acquisition and control platforms - easy-to-use, highly expandable programmable automation controllers, intelligent communication interfaces, and rugged I/O modules. These industrial I/O modules filter, calibrate, and scale raw sensor signals to engineering units and perform self-diagnostics to look for problems.

The curriculum covered includes understanding the characteristics of the different level measuring devices and comparing between their different behaviors and characteristics.

Components

- Pump
- Flow Control Valve
- Piezoresistive Sensor
- Ultrasonic Level Meter
- Capacitance Level
- Capacitance Change Pressure Sensor (Option)

NI\(^1\) Compatible Platforms

- PXIe
- Compact RIO
- Others\(^2\)

\(^1\) NI: National Instruments
\(^2\) Please check with us about compatibility of other NI Platforms

Required NI Modules

- PXIe: PXI-6236, PXIe-6251, PXI-6514
- cRIO: NI-9215, NI-9203, NI-9474, NI-9263

Software

- User friendly with easy to use interface
- Developed using NI LabVIEW package
- Built-in safety features & limitations, and designed for students’ use

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Curriculum Coverage

- Acquiring Physical Phenomena
- On/Off Control
- PID Feedback Control
- Lead-Lag Compensation
- Feedback/Feedforward Control

Features

- Computer based Pressure Control Trainer used to teach Pressure Control
- Includes all required sensors to measure the Pressure
- For use with National Instruments Data Acquisition & Control hardware

Description

A bench-mount trainer for teaching pressure control. It includes all the required sensors and actuators to perform a full experiments list for teaching pressure control.

Developed for use with a wide variety of National Instruments data acquisition and control platforms - easy-to-use, highly expandable programmable automation controllers, intelligent communication interfaces, and rugged I/O modules. These industrial I/O modules filter, calibrate, and scale raw sensor signals to engineering units and perform self-diagnostics to look for problems.

The curriculum covered includes teaching the principles of On/Off Control, PID control, Feedforward and other types of control used in the industry.

Components

- Level Switches
- Pressure Sensor
- Flow Control Valve
- Pump
- Variable Frequency Drive

NI® Compatible Platforms

- PXIe
- Compact RIO
- Others ²

¹ NI: National Instruments
² Please check with us about compatibility of other NI Platforms

Required NI Modules

- PXIe: PXI-6236, PXIe-6251, PXI-6514
- cRIO: NI-9215, NI-9203, NI-9474, NI-9263

Software

- User friendly with easy to use interface
- Developed using NI LabVIEW package
- Built-in safety features & limitations, and designed for students’ use

Ordering Information

Pressure Control Trainer

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<thead>
<tr>
<th>Platform</th>
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<td>PXIe ¹</td>
<td>1... 110 VAC</td>
</tr>
<tr>
<td>cRIO ²</td>
<td>2... 220 VAC</td>
</tr>
</tbody>
</table>

¹ Purchase NI Hardware Separately
² Power specifications vary depending on specific model.

For complete product specifications, pricing, and information: e-mail: info@ti-acad.jo / website: www.ti-acad.jo

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**Curriculum Coverage**

- Acquiring Physical Phenomena
- On/Off Control
- PID Feedback Control
- Lead-Lag Compensation
- Feedback/Feedforward Control

**Features**

- Computer based Level Control Trainer used to teach Level Control
- Includes all required sensors to measure the Level
- For use with National Instruments Data Acquisition & Control hardware

**Description**

A bench-mount trainer for teaching level control. It includes all the required sensors and actuators to perform a full experiments list for teaching level control.

Developed for use with a wide variety of National Instruments data acquisition and control platforms - easy-to-use, highly expandable programmable automation controllers, intelligent communication interfaces, and rugged I/O modules. These industrial I/O modules filter, calibrate, and scale raw sensor signals to engineering units and perform self-diagnostics to look for problems.

The curriculum covered includes teaching the principles of On/Off Control, PID control, Feedforward and other types of control used in the industry.

**Components**

- Level Switches
- Level Sensor
- Flow Control Valve
- Pump
- Variable Frequency Drive

**NI**¹ Compatible Platforms

- PXIe
- Compact RIO
- Others²

¹ NI: National Instruments
² Please check with us about compatibility of other NI Platforms

**Required NI Modules**

- PXIe: PXI-6236, PXIe-6251, PXI-6514
- cRIO: NI-9215, NI-9203, NI-9474, NI-9263

**Software**

- User friendly with easy to use interface
- Developed using NI LabVIEW package
- Built-in safety features & limitations, and designed for students’ use

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