Process Control

- Level & Flow Process Control
- Temperature Process Control
- Level, Flow & Temperature Process Control
- Pressure Process Control
- pH Process Control
- Industrial Process Control
- Process Instrumentation
- Fault Finding
- Refrigeration & Air Conditioning

Process Control is a fundamental engineering discipline which needs to be studied in many institutions.

Process Control depends upon measurement - requiring a detailed understanding of the relevance, accuracy and different techniques which may be used and applied in open and closed loop systems.

The requirement for Process Control is evident not only to maintain quality and efficiency, but also to conserve energy and materials. There are many different processes which need to be controlled including level, flow, temperature, pressure, pH, etc. All these and many more processes can be found in industries such as Petrochemical, Chemical, Pharmaceutical, Brewing, Water and Foods etc.

Whilst addressing some aspects of advanced control theory, this range of products is designed to present the subject with a practical 'hands on' approach.

Depending on the process requirement, different levels of control are also addressed - using different devices such as Industrial Process Controllers and PLCs.

Process Control with Feedback's products involves a wide range of equipment from computer based trainers using industrial control, to conventional fault finding and measurement in order to deliver training applicable to process industries from refrigeration maintenance, to the 'state of the art' technology used in oil and gas refining.

Features

- Ideally suited for Technician and Vocational courses
- Extendable to cover more complex process control problems
- Covers a wide range of competencies
- Industrially relevant processes & components
- Compact bench-top systems
- Clean process fluids of water or air used by appropriate trainers

Software

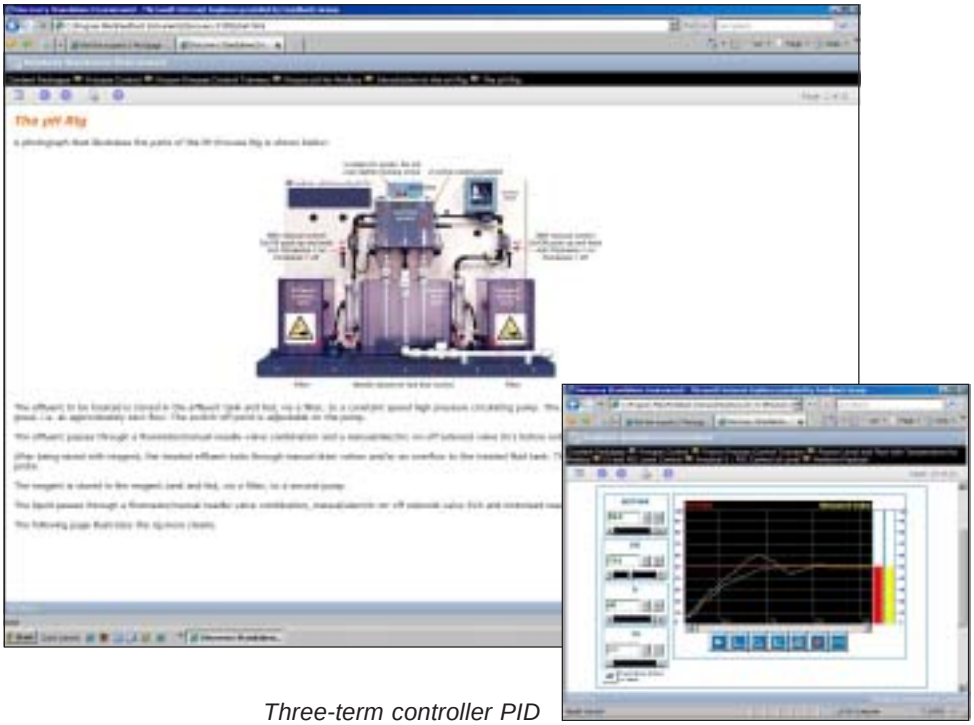
Procon 38 Series - Process Control

Features

- Trainers for Level and Flow, Temperature, Pressure and pH
- Uses industry standard Process Controller, 4-20mA signals and RS232/RS485 serial communication bus
- High degree of modularity - easily reconfigurable using modern push fittings
- Discovery Software
- Fully protected by earth leakage circuit breaker

System Benefits

- Complete with on-screen courseware, instruction and questions
- Provides all required virtual instrumentation with unique Discovery Software

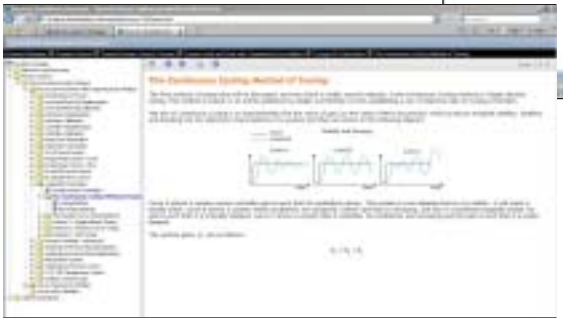


Three-term controller PID

A range of Industrial Process Control Trainers supplied with computer based learning material.
"Discovery" Software provides real-time control of the processes, on-screen simulation of process monitoring with animated mimic screens, together with theory, simulation, background information and questions. The free movement between screens allows a user-friendly graphical interface. Systems may be configured for the study of Level and Flow, Temperature, Pressure and pH control, using a series of units including Process Rigs, Valves, Interfaces, Controllers and a variety of Sensors that measure the process variables.

System interconnections above

Introduction to Procon



Theory -
Cycling method of tuning

Feedback
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Procon Level & Flow

Discovery Software

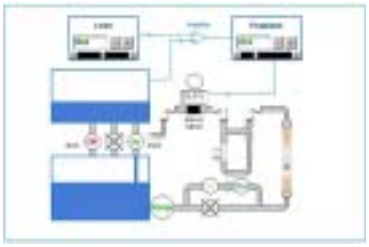
Level/Flow Process Control 38-001

Features

- Contains a selection of level and flow sensors & indicators
- Flow controlled by linear motorised control valve
- On/Off and proportional control
- P, PI and full PID control with autotune facility
- Couples with Temperature Trainer for dual loop control
- Modern push fittings
- Water used as the process fluid
- Comprehensive lab notes and Discovery Software

The Level/Flow Process Trainer is a single loop system allowing the study of the principles of process control, using liquid level and flow rates as the measured process variables. The system is a completely self-contained, low pressure flowing water circuit supported on a benchtop-mounted panel, making it suitable for individual student work or for group demonstrations.

It comprises a dual compartment process tank, linked to a sump tank by manual and solenoid operated valves. Water is pumped through the system, via a variable area flow meter and motorised control valve. Level is measured in the process tank. Flow is measured through an optical pulse flowmeter.
The PC Computer & Monitor are not supplied.



System with Proportional Control

Curriculum Coverage

- Flow & Level familiarisation and calibration
- Interface familiarisation and calibration
- Controller familiarisation and calibration
- Float level transmitter
- Pulse flow transmitter
- On-Off control
- Study of P, PI and PID control of Level and Flow
- Tuning PID controllers
- Advanced process control

Required Equipment - supplied with all Procon Training Systems

Process Interface 38-200

The Process Interface is connected to the system and provides all necessary power outlets for the Process Trainer, sensors and Process Controller. It accepts up to four 4-20mA transmitter signal inputs and allows signal patching so that different control schemes can be quickly configured. It also provides a 4-20mA current source, two current to voltage converters and a voltage comparator with adjustable hysteresis which can be used to provide a simple 2-state control loop in addition to the main controller loop. Protection is provided by a residual current circuit breaker.

Process Controller 38-300

The ABB Industrial Process Controller contained within the Process Controller is microprocessor based and is easily configured by the user to provide a range of control functions from 2-state control to 3-term PID control. It also features local or remote set-point, re-transmission of set-point or process variable, 4 logic inputs, 4 relay outputs, ramp/soak (profile sequencing) and an autotune facility which can analyse the requirements of a process and configure the control parameters for optimum performance. Together with the Process Interface, it provides a simple and convenient means of controlling the system.

Process Controller (top) with Process Interface

Procon Temperature

Discovery Software

Temperature Process Control 38-002

Features

- Temperature monitored in primary & secondary circuits, flow also monitored
- P, PI and PID control with autotune facility
- Primary circuit flow controlled by motorised control valve
- Primary circuit heater and pump
- Secondary circuit fan-assisted cooling radiator
- Modern push fittings
- Water used as the process fluid.
- Operates from mains water supply using water pressure regulator 38-481

Curriculum Coverage

- Temperature familiarisation and calibration
- Interface familiarisation and calibration
- Controller familiarisation and calibration
- Pulse flow transmitter
- On-Off control
- Study of P, PI and PID control of Temperature and Flow
- Manual flow control
- Temperature process control
- Complex control loops

Dual loop (process) control - using Level/Flow and Temperature Trainers:

- Remote Set Point Control
- Set Point Ratio Control
- Cascade Control
- Feedforward Control

The Temperature Training System is a two loop system, using water as the process fluid which allows the study of the principles of process control using primary and secondary circuit temperatures as the process variables to be controlled.
Both circuits pass through the heat exchanger and the secondary circuit contains a fan-assisted cooling radiator. Thermistor temperature sensors are located in the inlet and outlet streams of both primary and secondary sides of the heat exchanger and the outlet of the radiator. The primary flow is also monitored.
The Trainer can be used with a cold mains water supply through the Auxiliary Temperature Control Pack 38-480 which is supplied as part of the system. This comprises a motorised control valve, a flow meter and a signal conditioning unit. Alternatively the Temperature Trainer can be connected to the Level & Flow Process Trainer, which then supplies the cold water circuit. This combination allows more complex control systems to be investigated.
A Forced Air Cooler 38-610 is also available. It accelerates the process dynamics using a constant input temperature, allowing a high temperature differential to be monitored for longer periods (see below).
Please note, the PC Computer & Monitor are not supplied with the system.

Optional Equipment for Temperature Process Control 38-002 and 38-003

Forced Air Cooler 38-610
This equipment is designed to be used with the Temperature Trainer, or between the Temperature and Level and Flow Trainers to maintain a constant fluid input temperature.

Optional Accessory:
Water Pressure Regulator 38-481
(required for direct mains operation)

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Procon Level/Flow & Temperature

Discovery Software

Level/Flow & Temperature Process Control 38-003

Features

- Contains a selection of level flow and temperature sensors and indicators
- Primary and secondary flow controlled by linear motorised control valves
- On/Off and proportional control
- P, PI and full PID control with autotune facility
- Can perform dual loop cascade control
- Modern push fittings
- Water used as the process fluid
- Comprehensive lab notes and Discovery Software

The combined PROCON Level/Flow and Temperature Process Control System is self-contained and has all of the features of the individual Level/Flow and Temperature systems plus Remote Set Point Control.

Remote Set-Point Control can be affected with the PROCON Level/Flow and Temperature Process Control System by using two Process Controllers. The 4-20mA Analogue Remote Set-Point input allows various forms of cascade control to be implemented between linked or interactive control loops.

The process set-point can be Local and Remote or Dual, selected from the front panel, or in response to a logic input. When Dual Set-Point is selected the function can be ratio or bias action.

A Programmable Logic Controller (PLC) 38-350 is also available. It can be used with the Process Interface 38-200 to provide an alternative control method with on/off elements to the standard Process Controller 38-300.

Heat exchange theory

Dual loop (process) control - using Level/Flow and Temperature Trainers:

- Remote Set Point Control
- Set Point Ratio Control
- Cascade Control
- Feedforward Control

Remote set-point facility covering:

- Setting-up a primary and secondary controller
- Set-point Ratio Control (dual loop)
- Cascade Control (temperature and flow)
- Feedforward Control (flow & flow)

Curriculum Coverage

- Flow and Level familiarisation and calibration
- Interface familiarisation and calibration
- Controller familiarisation and calibration
- Float level transmitter
- Pulse flow transmitter
- On-Off control
- Study of P, PI and PID control of Level and Flow
- Tuning PID controllers
- Advanced process control
- Temperature familiarisation and calibration
- Interface familiarisation and calibration
- Controller familiarisation and calibration
- Pulse flow transmitter
- On-Off control
- Study of P, PI and PID control of Temperature and Flow
- Manual flow control
- Temperature process control
- Complex control loops

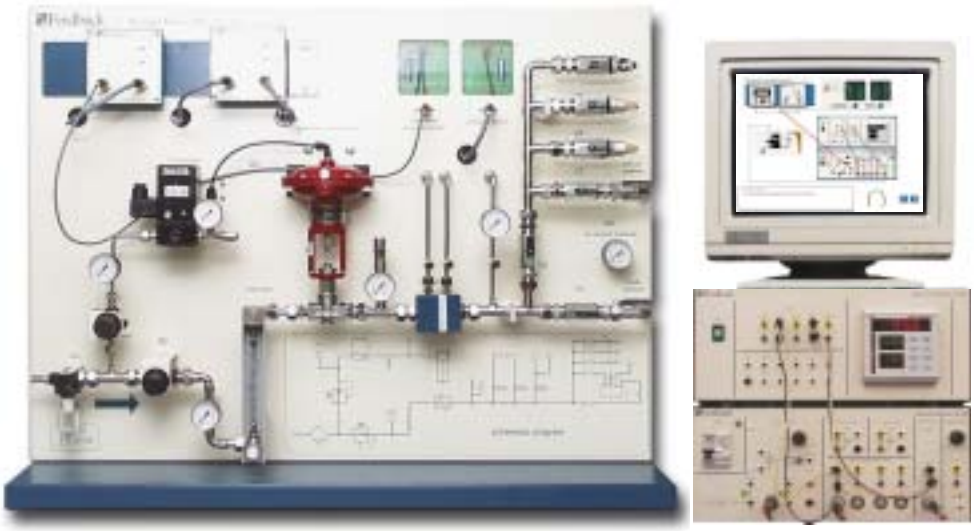
Procon Pressure

Discovery Software

Pressure Process Control 38-004

Features

- Safe low pressure operation
- Fully gauged for pressure and flow rate
- Differential and Gauge pressure sensors
- Current controlled (4-20mA) pneumatically operated control valve
- Standard industrial components
- Self-sealing outlets for manometer
- Safety valves fitted as standard
- Air used as the process fluid



Curriculum Coverage

- Pressure safety, familiarisation and calibration
- I/P converter and Pneumatic control valve operation
- Controller familiarisation and calibration
- Automatic control systems
- Serial communication
- Pressure sensor, transmitter and I/P converter- Linearity and Hysteresis
- Pneumatic control valve - characteristics at different pressure ranges
- System response and Air receiver
- Principles of Proportioning valve and proportional process control
- Study of P, PI and PID control of Pressure
- Calibration of the differential pressure sensor & transmitter
- Flow control in the Process rig

The Pressure Training System is a single loop pneumatic control system. It enables the study of the principles of both pressure regulation of a process and the control of flow in a pressurised system.

The System comprises a low pressure air circuit supported on a panel for use on a benchtop, making it suitable for individual student work or for group demonstration.

The Pressure Trainer requires a compressed air supply at a recommended input pressure of 40psi. An input filter/drier is used to clean the supplied air. Separately regulated branches provide air for the process and for valve control.

The process branch comprises a regulator, a variable area flow meter, a pneumatically operated control valve, an orifice block with changeable orifice plates and both differential and point of measure pressure sensors. The process air flow can be discharged to atmosphere via adjustable diffused outlets.

An air receiver tank can be switched in and out of the circuit. The valve control branch comprises a regulator and an electrically operated current to pressure input converter. This is used to regulate the pneumatic control valve in the process line.

The input converter operates from a 4-20mA signal.

Signal conditioning for the sensors is provided by pressure transmitters. The Differential Pressure Transmitter gives a linear differential pressure sensor output.

The system is fully equipped with pressure gauges to indicate the pressures around the system.

Please note, the PC Computer & Monitor are not supplied with the system.

Optional Accessory: Air Compressor 38-820

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Procon pH

Discovery Software

pH Process Control 38-005

Features

- All components resistant to agressive fluids
- Motorised agitator
- Removable pH probe
- Industry standard 4-20mA control signals
- A precision motorised control valve
- Four tanks
- Modern push fittings
- Comprehensive lab notes and Discovery Software

The pH Training System is based around the pH Rig and is a self-contained educational platform for teaching pH control.

The System comprises two independently pumped fluid circuits mounted on a robust panel for use on a bench top which allows the study of the principles of process control using the pH of the mixed effluent and reagent fluids as the process variable. The system is suitable for individual student work or for group demonstrations.

Effluent and reagent are contained in separate holding tanks prior to being pumped into the reaction tank where mixing is carried out.

The reaction tank contains an accurate pH probe and agitator. The agitator is designed to constantly mix the contents of the reaction tank. The pH probe is designed to monitor the pH level of the effluent/reagent mixture and is supplied with a transmitter which produces a standard 4-20mA output signal.

The signal is passed to the Process Controller as the process variable.
A precision, motorised control valve is present in the reagent feed to allow accurate delivery control. The valve is designed to be controlled by standard 4-20mA control signals. Total effluent and reagent fluid shut-off capability is provided by two normally-closed solenoid valves.

A treated fluid tank is provided to facilitate easy disposal of the process fluid. All components have been carefully selected to be resistant to aggressive fluids.

Recommended chemical solutions (customer supplied)
Reagent tank: Hydrochloric Acid at 0.05 Mole.
Effluent tank: Sodium Hydroxide at 0.05 Mole.

Please note, the PC Computer & Monitor are not supplied with the system.

Curriculum Coverage

- Introduction, familiarisation and calibration of the pH rig
- Interface familiarisation and calibration
- Controller familiarisation and calibration
- Valve characteristics
- Manual control of pH
- Open loop response
- On/off control of pH
- Simple proportional control
- Effect of proportional band
- Study of proportional and integral control
- Study of proportional and derivative control
- Study of proportional, integral and derivative control

Process Instrumentation Trainer 38-023

Features

- Totally self-contained with all power supplies and fluid sources
- Industrial control devices and sensors
- PC programmable devices
- Modular and versatile
- Allows calibration & testing of process transmitters
- 4-20mA Current Loops
- Mobile wheeled trolley
- Fully developed curriculum

Curriculum Coverage

- 4-20mA Current Loops
- 4-20mA Programmable display
- Capacitive Level Sensor and Transmitter
- Temperature Sensors and Transmitter
- Flow Meter and Pulse Flow Sensor
- Introduction to Control Valves
- Pressure Devices
- Current to Pressure (I-P) Converter
- The Orifice Block
- Universal Transmitter

Modern control devices and sensors are becoming increasingly complex and functionally very powerful.

To expose students to these devices and give them experience in the selection and utilisation of them Feedback has designed this process instrumentation rig.

The sensors, actuators and PC programmable devices are all typical industrial units. The system has been specifically designed to give students hands-on experience of industrial process devices and systems.

Based on a mobile trolley that incorporates all electrical, water (including a water heater) and air supplies, the system is a totally self-contained unit.

The keyhole slotted front panel provides a construction area allowing devices to be fixed to it via a series of keyholes. The instrumentation devices are mounted on robust carriers that allows them to be located and locked onto the front panel.

Optional Accessory:
Air Compressor 38-540-AC

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Feedback Instruments Limited

Temperature
Process Control

Process Control Trainer 37-100

Features

- A practical process in miniature
- Closed and open-loop continuous control as well as two-step control
- Fast response times
- Thermal time constants and time transport lag
- Easy-to-read metering

The Process Control Trainer comprises a heating element controlled by a thyristor circuit which feeds heat into an airstream circulated by an axial fan along a polypropylene tube. A thermistor detector, which may be placed at one of three points along the tube length, senses the temperature at that point.

The volume of air flow is controlled by varying the speed of the fan via a potentiometer. A change in setting represents a supply side disturbance and the effects are easily demonstrated.

The detector output is amplified to provide both an indication of the measured temperature and a feedback signal for comparison with a set value derived from a separate control. A comparison of these signals generates a deviation signal which is applied to the heater control circuit such that the controlled condition is maintained at the desired value. Two step (ON/OFF) and Proportional band control is standard.

An external controller is available to enable the operation of compound control to be investigated. The three term controller module PID150Y provides variable controls for adjustment of proportional, integral and derivative terms.

An external ±15V, 100mA power supply is required for the PID150Y module.

Optional Accessories:
Function Generator FG601
Electronic Wattmeter EW1604

Curriculum Coverage

- Distance/Velocity Lag
- Transfer Lag
- Calibration
- Two-step Control
- Proportional Control
- System Response
- Frequency Response

Industrial Process Trainer

Industrial Process Trainer 34-250

Features

- Teaches fault diagnosis and fault finding methodologies
- Capable of being externally controlled using Process Controllers and PLCs
- Self contained process
- Wide range of easy to apply faults
- Mechanical, electrical & electronic faults can be applied
- Fully protected for safety
- Comprehensive Instructor's and Student's Manuals

Curriculum Coverage

- Introduction to the system
- Fault finding methodologies
- Fault analysis flow charts
- Fault finding from circuit diagrams
- Fault identification to Line Replaceable Unit level
- Simple electronic fault finding
- Diagnostic tools
- Maintenance procedures
- Process control techniques
- Fault finding processes controlled from electronic controllers
- Interfacing to Programmable Logic Controllers (PLCs)

The Industrial Process Trainer has been designed to teach a methodical approach to fault diagnosis in industrial processes. The methodologies taught within the system are equally relevant to any student or trainee studying fault diagnosis.

Faults can be introduced by the instructor via switches concealed behind a locked compartment, to which the student does not have access. These switches provide both short circuits and open circuits and can also switch in or out circuit elements to simulate a variety of fault conditions. Additional faults can be inserted into the process through the replacement of working components with faulty ones, e.g. faulty flow switches; faulty relays; faulty solenoid coils and faulty control valve electronic circuit board.

The process involves initially filling a header tank with water and then cycling the level between a set upper and lower limit, whilst simultaneously creating a demand from the header tank via two on/off solenoid drain valves into a sump tank. Flow is produced by a pump and controlled by relay operated on/off solenoid valves which control:

the inflow of water to the header tank from the sump tank
the outflow of water from the header tank to the sump tank

The level of water in the header tank is monitored by float switches which open and close at the following points:

Header tank low (nearly empty)
Header tank normal operation lower limit
Header tank normal operation upper limit
Header tank overflow

Designed for students studying industrial process maintenance, it can also be used as a process trainer in its own right, using either Industrial Process Controllers or Programmable Logic Controllers (PLCs).

A PLC interface board 34-252-1 is available for users to develop their own PLC programs.

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Refrigeration & Air-conditioning Trainer 39-103

This self-contained refrigeration unit uses industrial standard components. The design allows practical instruction to be given on methods of identifying and correcting faults in industrial systems, in exactly the same way as experienced in field service conditions.

The system consists of a mobile, floor-standing process unit comprising a twin cylinder semi-hermetic compressor, finned-tube condenser with fan, liquid receiver and forced air evaporator. The Trainer uses environmentally friendly R134a refrigerant.

All the above are mounted on a common base-plate for easy access.

Ancillary Equipment

Refrigeration Servicing Package 39-203

The Refrigeration Servicing Package contains the additional specialist tools and measuring instruments required for servicing work on the Air-conditioning trainer.

Leak Detector 39-202

This hand-held leak detector combines high sensitivity to a wide range of refrigerations, CFC, HCFC and HFC, with proven reliability. It provides a useful aid to any refrigeration and air-conditioning training programme.
Note: The Leak Detector is included in 39-203.

Features

- A complete ready to use training package
- Fault diagnosis by logical elimination
- Actual faults produced and not simulated
- Designed for fail-safe operation
- Uses environmentally friendly R134a refrigerant
- Fully documented assignments

Curriculum Coverage

- Unit performance and operation
- Normal and abnormal operating pressures
- Refrigerant changes of state
- Compressor testing and overhaul
- Thermostatic expansion valves
- Removal of system contamination and plant charging
- Electrical components and controls
- Air conditioning applications

Ordering Information

Complete Training Systems

Level/Flow Process Control	38-001
Temperature Process Control	38-002
Level/Flow & Temperature Process Control	38-003
Pressure Process Control	38-004
pH Process Control	38-005
Complete Procon System (five processes)	38-010
Process Instrumentation Trainer	38-023
Process Control Trainer	37-100
Industrial Process Trainer	34-250
Refrigeration & Air-conditioning Trainer	39-103

Components, Accessories and Upgrades

Programmable Logic Controller (for Procon range)	38-350
Forced Air Cooler (for use with Procon Temperature 38-002 & 38-003)	38-610
Air Compressor (for use with Procon Pressure 38-004)	38-820
Water Pressure Regulator (for use with Procon Temperature 38-002 & 38-003)	38-481
Air Compressor (for 38-023)	38-540-AC
Proportional, Integral and Derivative Unit (for use with 37-100)	PID150Y
Industrial Process Trainer PLC Interface	34-252-1
Refrigeration Servicing Package (for use with the 39-103)	39-203
Refrigeration Leak Detector (for use with 39-103 and included with 39-203)	39-202
Function Generator	FG601
Electronic Wattmeter	EW1604

A PC compatible computer with a RS232 interface is required to run the PROCON Trainers and is not supplied with any of the systems.

Process Control - 0907-6

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