



KEY FEATURES OF 50 SERIES

The Essentials of Process Control (EPC) range of products takes students through the fundamentals and principles of process control and progresses to give them a thorough grounding in the control of physical processes. Four independent process units demonstrate level, flow, temperature and pressure as the controlled variable.

The concepts of closed loop control, including on/off control, proportional control, proportional/integral and proportional/integral/derivative (PID) control can be explored and demonstrated. Some units also cover both time proportioning and analogue control of the same parameter.

Each process is supplied complete with software that allows it to be controlled using a Windows PC via a USB connection. The effect of making changes to the system or to the controller configuration can be quickly investigated by applying repeatable disturbances or step changes to the process. Comparison of the responses obtained with different control settings clearly demonstrates the need for correct matching of the controller to the system characteristics.

To demonstrate industrial control systems, two further controlling devices are available, a full function commercial PID controller with autotune, and a programmable logic controller (PLC). The PLC has the control algorithms implemented in ladder logic and so are fully accessible to the user.

Another fundamental aspect of process control is an understanding of sensors and how they are calibrated. This is demonstrated by a sensor calibration apparatus designed specifically to demonstrate this subject.

- > Open Loop and Closed loop processes
- > On/off control (Fixed Dead Band)
- > P, PI and PID control
- > Underdamping and overdamping
- > Time proportioning control
- > Onset of instability
- > Manual loop tuning
- > Effect of filtering on sensor outputs
- > Commercial PID controllers
- > Autotuning
- > Ladder Logic controllers
- > Effect of Sample Time and Cycle Time
- > Sensor Calibration
- > Sensor electrical characteristics



PCT50 LEVEL CONTROL



Essentials of Process Control - Level Control - PCT50

PCT50 is a highly visible and easy to understand water level control process. It comprises two clear acrylic tanks; a process tank mounted above a sump tank. Water is pumped up to the process tank and drains back to the sump tank via two valves, one manually variable and the other switched by software. Each valve can also be fitted with different sized external orifices to change their characteristics.

This flexible arrangement allows a wide range of control scenarios to be set up, including two fundamentally different processes, i.e.:

Level control by proportionally varying pump speed (Inflow control)

Level control by time-proportioned opening of a solenoid valve (Outflow control)

When using inflow control, repeatable disturbances can be implemented using the solenoid valve, and varied by using different orifice sizes. When using outflow control the pump speed can be stepped to provide a full range of repeatable disturbances. These techniques allow direct comparison of different controller settings.

PCT51 FLOW CONTROL

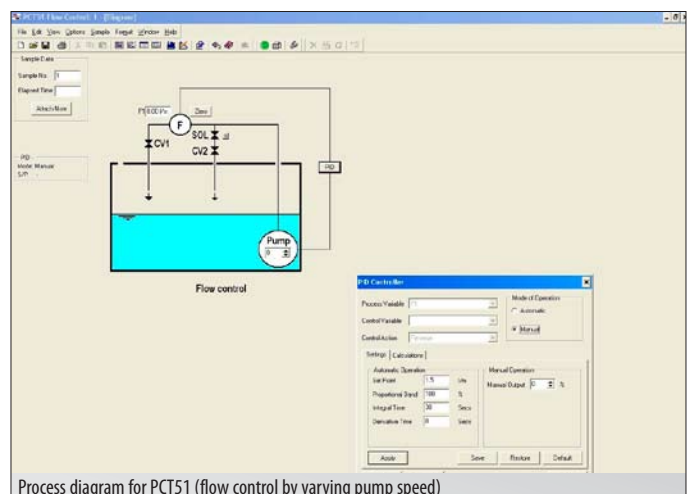


Essentials of Process Control - Flow Control - PCT51

PCT51 is a visible and easy to understand water flow control process. Water stored in the sump tank is pumped through a parallel pipe arrangement mounted on the lid of the tank and returns to the tank via two outlets, a software switched divert valve prior to the flowmeter and a manually operated variable valve after the flowmeter. Both outlets also incorporate interchangeable orifices to vary their characteristics.

The PCT51 demonstrates flow control by varying pump speed. Repeatable disturbances can be implemented using the solenoid valve and a wide range of different control investigations can be implemented using the interchangeable orifices and adjustable valves.

The PCT51 is an ideal system for demonstrating the onset of instability, the importance of filtering on the sensor output, and the trade-off between filter weighting and proportional gain on stability.



Process diagram for PCT51 (flow control by varying pump speed)

PCT52 TEMPERATURE CONTROL



Essentials of Process Control - Temperature Control - PCT52

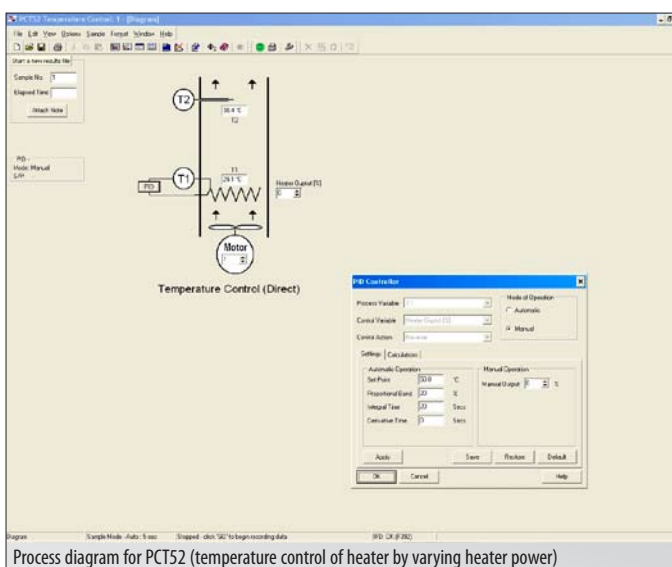
PCT52 is a visible and easy to understand temperature control process.

A fan blows air over a heater with radial fins and through a vertical clear acrylic duct. Sensors measure the surface temperature of the heater and the air temperature in the duct. This allows two different control implementations to be demonstrated with very different parameters, i.e.:

Temperature control of the heater surface (Direct Heating)

Temperature control of the air (Indirect Heating)

In each case the temperature is controlled by varying the heater power and repeatable disturbances implemented by switching the fan speed, hence allowing direct comparison of different controller settings.



Process diagram for PCT52 (temperature control of heater by varying heater power)

PCT53 PRESSURE CONTROL



Essentials of Process Control - Pressure Control - PCT53

PCT53 is a highly visible and easy to understand pressure control process, which uses pumped water to generate air pressure in a closed tank.

It comprises two clear acrylic vessels, an upper process vessel mounted above an open sump tank. The process vessel is sealed and so the air inside the tank is pressurised as water from the sump tank is pumped into it. Water drains from the process tank back into the lower sump tank via two outlets, one continuous and one incorporating a remotely controlled solenoid valve. Both outlets incorporate interchangeable orifices plus a hand operated variable valve, allowing the flow of water to be varied continuously to suit particular demonstrations.

This flexible arrangement allows a wide range of control scenarios to be set up, including two fundamentally different processes, i.e.

Pressure control by proportionally varying pump speed (Inflow control)

Pressure control by time-proportioned opening of a solenoid valve (Outflow control)

When using inflow control, repeatable disturbances can be implemented using the solenoid valve, and varied by using the different orifice sizes.

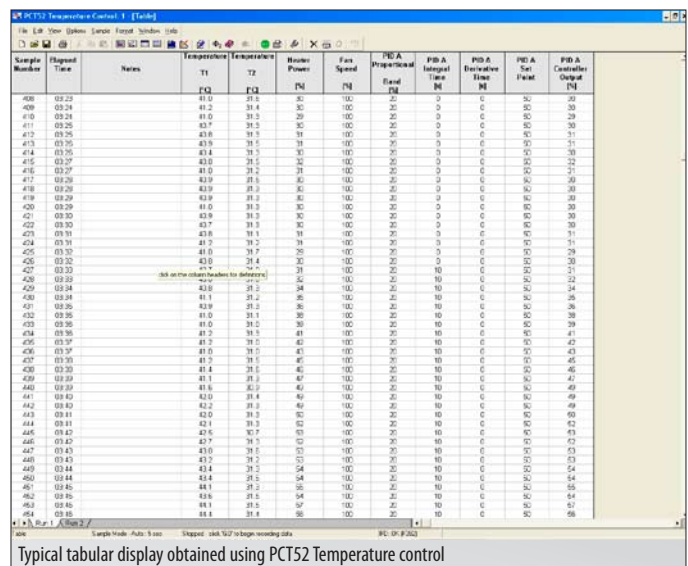
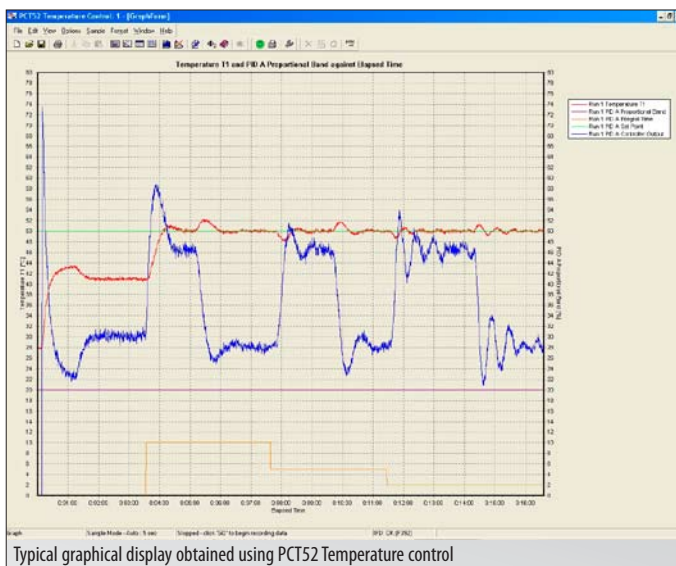
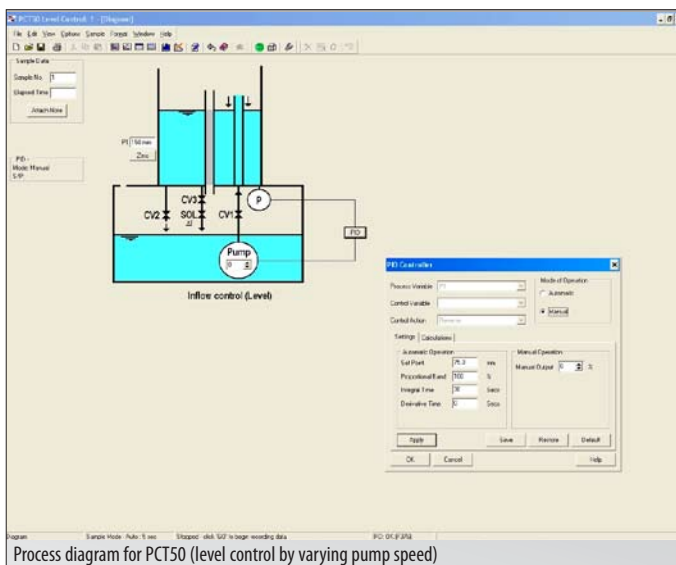
When using outflow control the pump speed can be stepped to provide a full range of repeatable disturbances. These techniques allow direct comparison of different controller settings.

SOFTWARE AND INTERFACING TO THE PROCESS UNITS

Each process unit is supplied with computer software and interfaces to a Windows PC (not supplied) via a USB connection. The software controls the process units and allows all the demonstrations to be performed. It also provides powerful data collection, graph plotting, and analysis features.

However the process units can also be controlled from external devices, such as the Armfield PCT54 or PCT55 as described below. This is implemented by simple plug in terminal connections and instrument leads. When using an external controller the powerful datalogging and analysis tools of the Armfield software can still be used to display and save the results.

Similarly users can write their own PC control programs using tools such as LabView, and interface to the process units using the USB interface.



PCT54 INDUSTRIAL PID CONTROLLER



Essentials of Process Control - Industrial PID Controller - PCT54

PCT 54 is an industrial PID controller incorporated in a console with input and output connections and controls on the front panel, designed primarily for use with the Armfield EPC series of process control products but suitable for use as a general purpose PID controller. It is supplied preconfigured for proportional analogue PID control but can be reconfigured to give time proportioned control using a digital output. The user has full access to the configuration of the controller menus via the buttons on the front or using a USB connection to a PC.

An additional analog output and digital switch allow an uncontrolled device on the process, such as a water pump or solenoid valve, to be operated remotely allowing disturbances to be applied to the process.

PCT55 PROGRAMMABLE LOGIC CONTROLLER



Essentials of Process Control - Programmable Logic Controller - PCT55 (with PID algorithm)

PCT 55 is a programmable logic controller (PLC) with graphical touch screen control panel designed primarily for use with the Armfield EPC series of process control products, but can also be used to control other items.

It is supplied with PID control algorithms implemented in ladder logic and configured to suit each of the EPC processes. The user has full access to all the software and algorithms with the following features:

Calibration of the sensors associated with each product, calibration values can be stored in the PLC

Specific control exercises written for the four Armfield process units

Both proportional analogue and time proportioning discrete outputs

Individual Control of P, I & D parameters, reverting to default parameters for each product on start up

User selection of sample time, cycle time, filter weighting

The control algorithms are written as separate sub-routines, making it straightforward for advanced users to write and use their own ladder logic control algorithms

Control facilities exist for a user defined process as well as the four Armfield process rigs without having to change the programming

Freely available programming software for the PLC and touch screen downloadable from the manufacturer's website.

PCT56 SENSOR CONDITIONING AND CALIBRATION TRAINER



PCT56 is a trainer designed to introduce the essentials of signal conditioning applicable to process measurement sensors. It comprises an electronic console with inputs for sensors with three different types of electrical output, voltage current and resistance. The resistance input can be configured as 2 terminal or a 4 terminal bridge drive.

Controls on the console allow for ranging, fine scaling and offsetting of the measured values, the output being displayed on a 3.5 digit LCD display. Terminals allow the voltages to be monitored at each stage (voltmeter required). Thus many different sensors with different electrical outputs can be investigated and calibrated on this equipment.

For training purposes, the PCT56 is supplied with three pressure sensors of the same range, but different electrical outputs, plus a simple pressure vessel which can be pressurized using a hand pump.

The pressure vessel also incorporates a fitting for a reference instrument, such as the Armfield H12-8 digital pressure meter. The calibration vessel is fitted with a direct reading Bourdon gauge to give continuous indication of pressure inside the vessel for safety purposes.

ORDERING SPECIFICATIONS

PCT50 LEVEL CONTROL PROCESS

A level control process trainer, comprising:

- 4.25 litre Process tank, with overflow, mounted above 8 litre sump tank
- Level sensor range 0-150mm H₂O
- Two discharge ports, one with remote controlled solenoid valve and one with manually controlled valve.
- Four interchangeable orifices for use with the discharge valves
- Variable speed submersible centrifugal pump
- Capable of both analogue PID control using the pump and time proportioning PID control using the solenoid valve
- USB interface to PC, plus connection terminals for interfacing to external controllers
- Supplied with educational software for PID control as well as data logging.

PCT51 FLOW CONTROL PROCESS

A flow control process trainer, comprising:

- 0-4l/min flowmeter, mounted above 8 litre sump tank
- Two discharge ports, one with remote controlled solenoid valve and one with manually controlled valve.
- Four interchangeable orifices for use with the discharge valves
- Variable speed submersible centrifugal pump
- USB interface to PC, plus connection terminals for interfacing to external controllers
- Supplied with educational software for PID control as well as data logging.

PCT52 TEMPERATURE CONTROL PROCESS

A temperature control process trainer, comprising:

- 50W nominal heater mounted in a 60mm diameter duct
- Remotely switchable two speed fan blowing air over the heater
- Two platinum resistance temperature sensors, 0-150°C range, one measuring the heater surface temperature and one measuring the air temperature
- Capable of demonstrating control of both the heater surface or the air temperature
- Capable of demonstrating the difference between fast reacting and slow reacting sensors
- USB interface to PC, plus connection terminals for interfacing to external controllers
- Supplied with educational software for PID control as well as data logging.

PCT53 PRESSURE CONTROL PROCESS

A pressure control process trainer, comprising:

- 2 litre Process tank, mounted above a 3.5 litre sump tank
- 0-1 bar pressure range
- Two discharge ports, one with remote controlled solenoid valve and one with manually controlled valve.
- Four interchangeable orifices for use with the discharge valves

- Variable speed submersible centrifugal pump used to pressurise the air by water pressure.
- Capable of both analogue PID control using the pump and time proportioning PID control using the solenoid valve
- USB interface to PC, plus connection terminals for interfacing to external controllers
- Supplied with educational software for PID control as well as data logging.

PCT54 INDUSTRIAL PID CONTROLLER

An industrial PID controller in an electrical enclosure

- Includes manual controls to apply step changes to the process loops
- Can be set up by computer, using a USB interface.
- Autotune capability
- Analogue or time proportioning digital outputs
- Connects to the process under evaluation using simple plug connections:
 - 1 Analogue input, 0-5V (from sensor)
 - 2 Analogue outputs, 0-5V, (one from controller, one from manual control)
 - 2 Digital outputs (one from controller, one from manual switch)

PCT55 PROGRAMMABLE LOGIC CONTROLLER

A programmable logic controller (PLC) with a touch screen control panel mounted in an electrical enclosure.

- Supplied pre-programmed with specific control exercises for the four Armfield EPC processes
- Proportional analogue and time proportioning discrete PID outputs
- Freely accessible programming software from plc manufacturer for both plc and touch screen
- USB interface to PC for monitoring and programming
- Users can access and modify the ladder logic control algorithms
- Connects to the process under evaluation using simple plug connections:
 - 2 analogue inputs, 0-5V (from sensors), one analogue output and one digital output
- Additional terminals implemented on the front panel for user programming:
 - 1 analogue output, 1 digital output and 2 digital inputs.

PCT56 SENSOR CONDITIONING AND CALIBRATION TRAINER

An electronic console and accompanying calibration vessel designed to demonstrate the principles of signal conditioning applicable to sensors used in process measurement.

- Voltage input ranges from 0-50mV to 0-5V
- Current inputs, 0-20mA, 4-20ma
- Scalable resistance and bridge circuit input
- Gain and offset adjustment controls
- Supplied with three 0-1 bar pressure sensors, one voltage output, one current output and one resistance output
- Includes pressure vessel and hand air pump to generate test pressures for the sensors

COMPLEMENTARY PRODUCTS

The EPC range of products demonstrate the fundamental principles of Process Control, leaving the student ideally placed to explore more sophisticated control techniques using the Armfield PCT40 Multifunction Process Control Teaching System. This allows a wide variety of process scenarios to be set up including multiple loops, remote set points and a wider range of processes.

Similarly the PCT23-MKII Process Plant Trainer demonstrates a true production process with cascade loops, includes fault simulation and provides a SCADA option utilising the Armfield PCT19BR Industrial PLC Unit.

REQUIREMENTS - PCT50, 51, 52, 53

Mains electrical supply:

110 to 240 V, 50 or 60 Hz.

(Note, the units are supplied with IEC leads to suit European and UK 230V, 50Hz outlets and USA 115V, 60 Hz outlets.)

PC computer with 2 spare USB ports (not supplied by Armfield) or external controller (PCT54 or PCT55)

REQUIREMENTS - PCT54, 55

Electrical supply:

PCT 54 and 55 usually derive power from the Process unit, but if used independently require a 24V dc adaptor.

REQUIREMENTS - PCT56

Electrical supply:

PCT56 requires a mains supply as above.



Armsoft 306 - 64/32-bit Windows compatible software

FOR FURTHER INFORMATION ON THE ADVANCED FEATURES OF THE SOPHISTICATED ARMFIELD SOFTWARE VISIT:

www.discoverarmfield.co.uk/data/armsoft



Overall dimensions	Equipment						
	PCT50	PCT51	PCT52	PCT53	PCT54	PCT55	PCT56
Height	0.575m	0.450m	0.250m	0.550m	0.145m	0.120m	0.225m
Width	0.425m	0.425m	0.230m	0.425m	0.258m	0.305m	0.450m (total)
Depth	0.350m	0.350m	0.255m	0.350m	0.280m	0.280m	0.200m

Shipping specifications	Equipment						
	PCT50	PCT51	PCT52	PCT53	PCT54	PCT55	PCT56
Volume	0.18m ³	0.15m ³	0.1m ³	0.2m ³	0.1m ³	0.1m ³	0.12m ³
Gross weight	25kg	20kg	15kg	25kg	10kg	10kg	10kg



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