Process Trainer System

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Acknowledgements

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PROCESS TRAINER SYSTEM

OVERVIEW

KentRidge Instruments offers a process trainer system for teaching instrumentation and control technology from an elementary to an advanced level. Our technology is the result of local expertise developed at the National University of Singapore and specially oriented to the needs of modern institutions and industry.

- The system is capable of simulating dynamic behaviour of simple to complex processes covering a wide spectrum of industrial processes.
- Following current industrial practice, our system uses microprocessor based PID controllers which can be configured to have either traditional or modern front panels.
- Mimic diagrams/animation allow students to relate the process trainer to industrial plants.
- Versatile configuration of user interface, for example, to emulate the front panels of commercial controllers.

A notable feature of this product is the courseware which can be customized to meet individual requirements.

The Process Trainer System described in this application note uses the *KRi* Dual Process Simulator. Note that the same control hardware and software can also be set up using KentRidge Instruments' control apparatuses:-

- Coupled-Tank Control Apparatus PP-100
- Fan & Plate Control Apparatus PP-200
- Inverted Pendulum PP-300
- FlexiDrive PP-400

SYSTEM CONFIGURATION

The Process Trainer System can be set up in two configurations which will be described in the next two sections. Details of the individual hardware/software components are provided.

Configuration 1

In the first configuration, our Dual Process Simulator KI-101 is connected to a Kent Ridge Instruments microprocessor based single loop controller as shown in Figure 1. This simple configuration provides a low cost tool for training technicians in using and tuning conventional industrial feedback controllers.

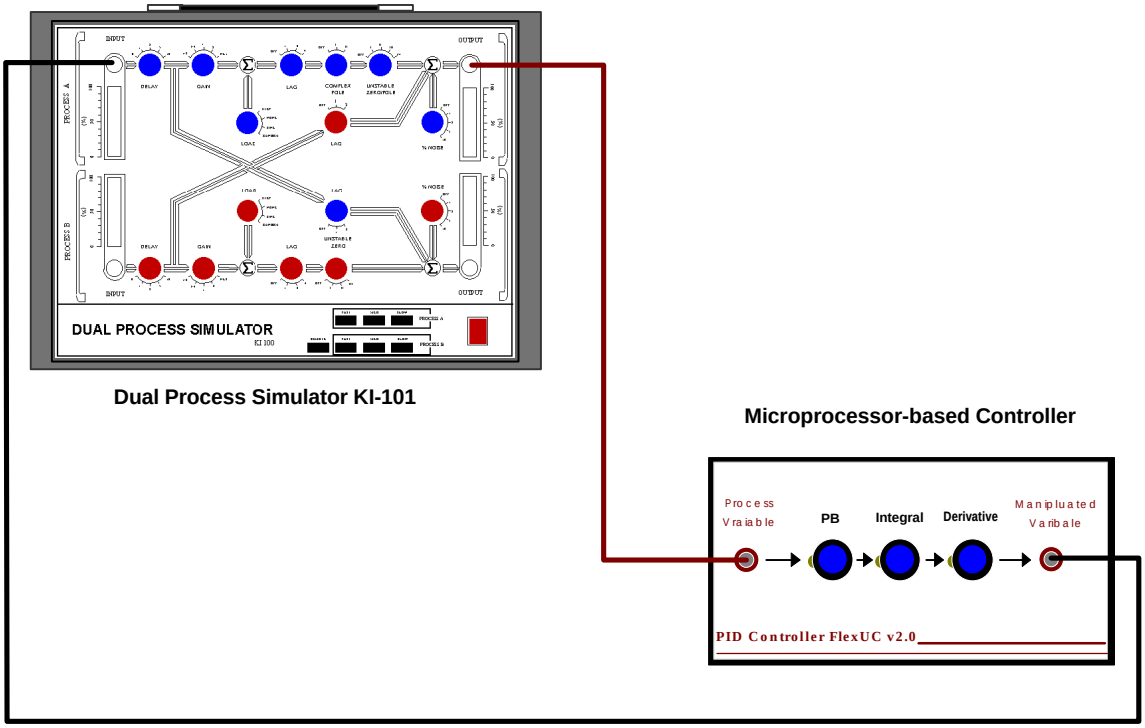

Figure 1 First configuration of Process Trainer System

Configuration 2

In the second configuration, the Dual Process Simulator KI-101 is connected to a process computer via an interface unit as shown Figure 2. This configuration offers maximum versatility for training. The Process computer is configured to provide mimic panel functions, a full range of control functions, a chart recorder as well as data logging.

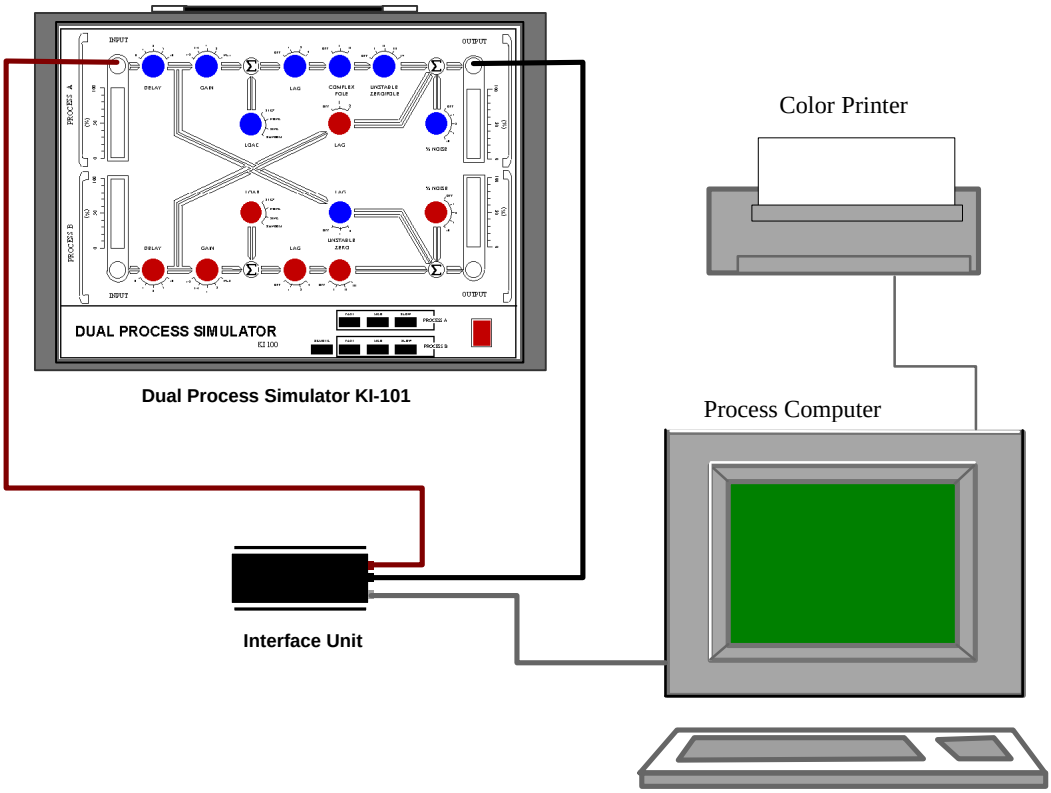

Figure 2 Second configuration of Process Trainer System

SYSTEM COMPONENTS

Dual Process Simulator

The *KRi* Dual Process Simulator, Model KI-100 or KI-101 dynamically simulates a wide range of common industrial processes suitable for education, research and development, testing, and evaluation of standard or advanced process controllers or control computers.

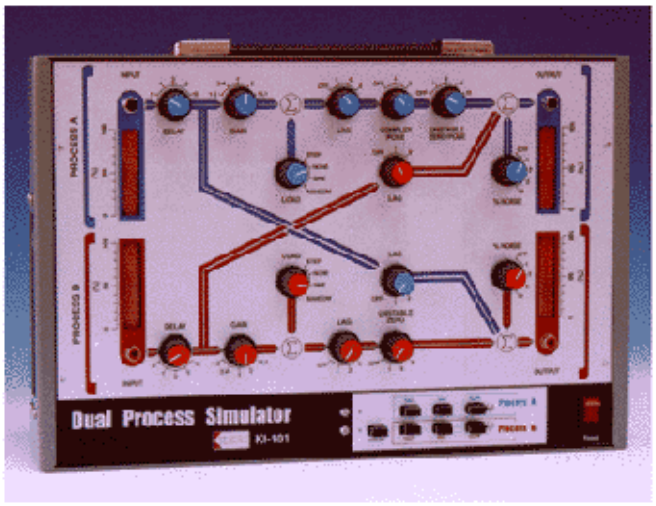

Figure 3 *KRi* Dual Process Simulator Model KI-101

Each process simulator set provides concurrent simulation of two dynamic processes that may be used independently, cascaded, or coupled. It can be configured to simulate a wide range of stable or unstable industrial processes (including a two-by-two multi-variable system) using a generic set of process dynamic elements. There are also provisions for introducing load disturbances and measurement noise.

The *KRi* Dual Process Simulator eliminates the need for pilot plants which are often costly to acquire and to maintain. It is also a low-cost alternative to an analog computer used for process simulations. Analog computers usually have problems of DC drifts and it is not easy to perform scaling. These two problems do not exist on the Dual Process Simulator. Furthermore, there is no programming (or computation) required and the setup time is minimal. A well-planned front panel is provided for the user to quickly configure or change the process dynamics.

Microprocessor-based Single-Loop Controller

The microprocessor-based single loop controller is an advanced embedded control design. It implements full proportional, integral and derivative (PID) control. The proportional band, reset action time and derivative action time are set locally by switches.

Range of PID Settings:

Proportional band (P): 1% to 200%
Integral action time: (Ti): 5ms to 100s
Derivative action time (Td): 0 to 10s

Interface Unit

The interface unit is an embedded control system based on the INTEL 80C196KC which serves as a low-cost front-end for the process computer. It performs analog-to-digital and digital-to- analog conversion, implements PID control, receives PID settings from process computer and logs data to the process computer. The interface unit communicates with the process computer via serial RS232 link.

Process Computer

The process computer is PC compatible or equivalent. It functions as a versatile configurable man-machine-interface for the process trainer system. The use of a process computer provides more flexibility to the trainer system.

The monitoring software on the process computer can:

- relate the simulation on the Dual Process Simulator KI-100 to an industrial process with mimic diagram/animation, see example in Figure 4
- emulate front panels of commercial controllers, see example in Figure 5
- allows the variation of setpoint, process variable (PV) and manipulated variable (MV) to be observed as trends on screen see example in Figure 6 (no need for chart recorders or storage oscilloscopes)
- support data logging for permanent storage or production of hardcopies on printer (cheaper alternative to chart paper)

With a process computer, the training system also provides the student first exposure to industrial SCADA systems.

The monitoring software is developed on National Instruments' LABVIEW using its virtual instrument concept. It offers an easy path towards incorporating technological innovations in instrumentation and control.

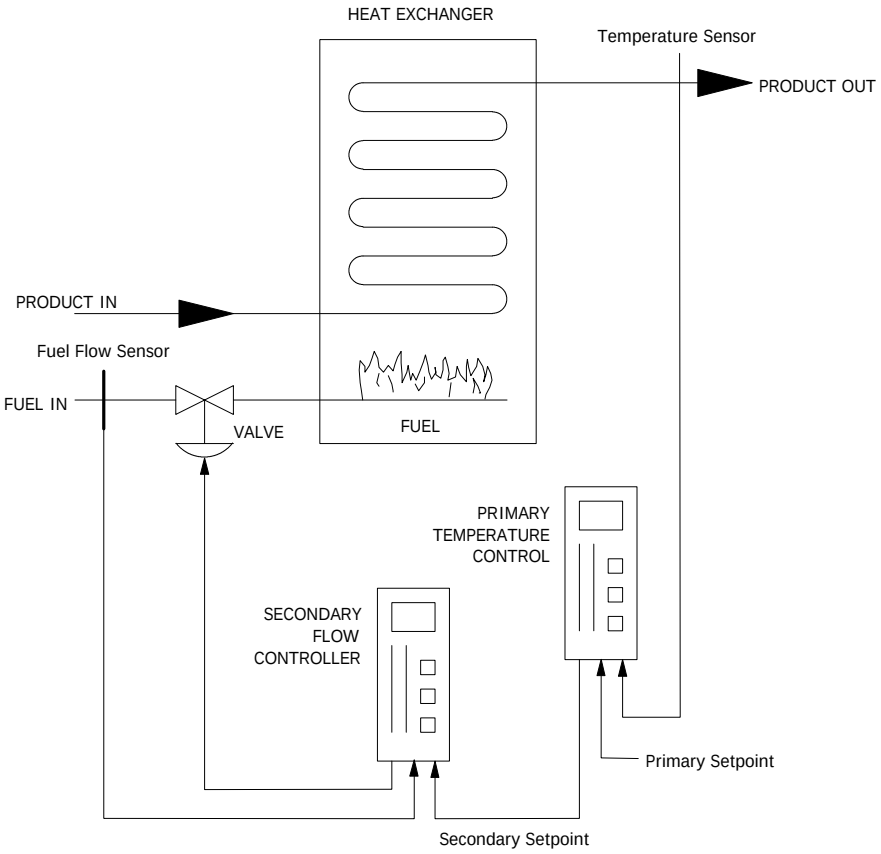

Figure 4 Mimic diagram of a heat exchanger

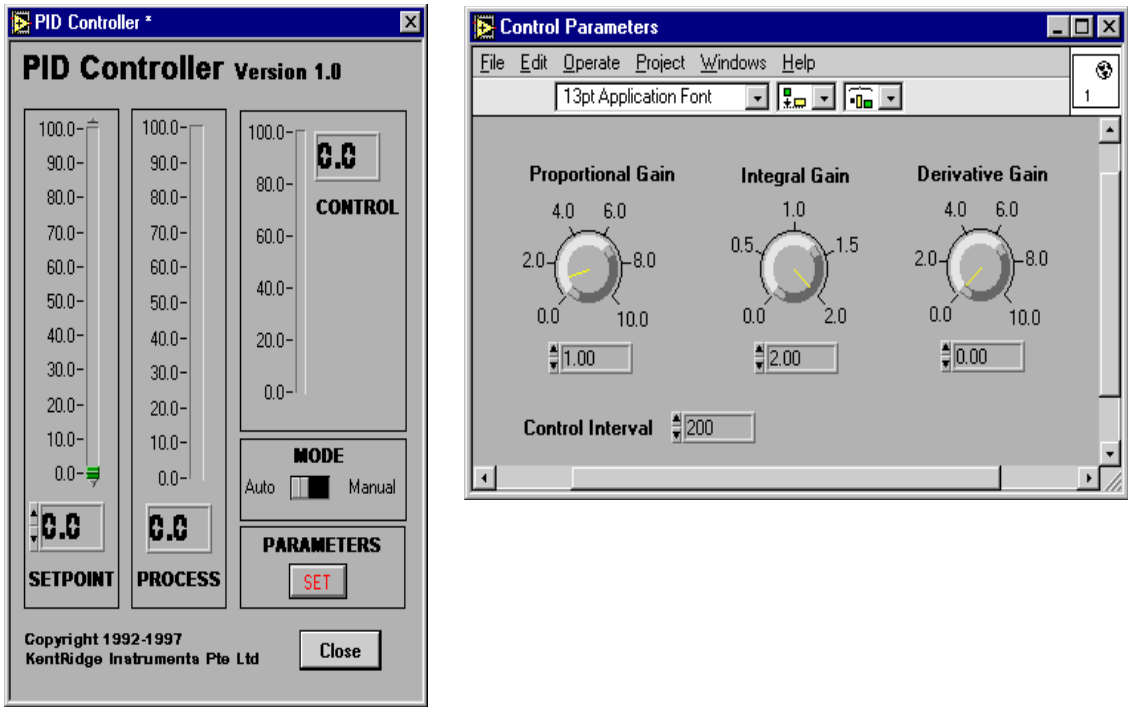

Figure 5 Examples of controller panels

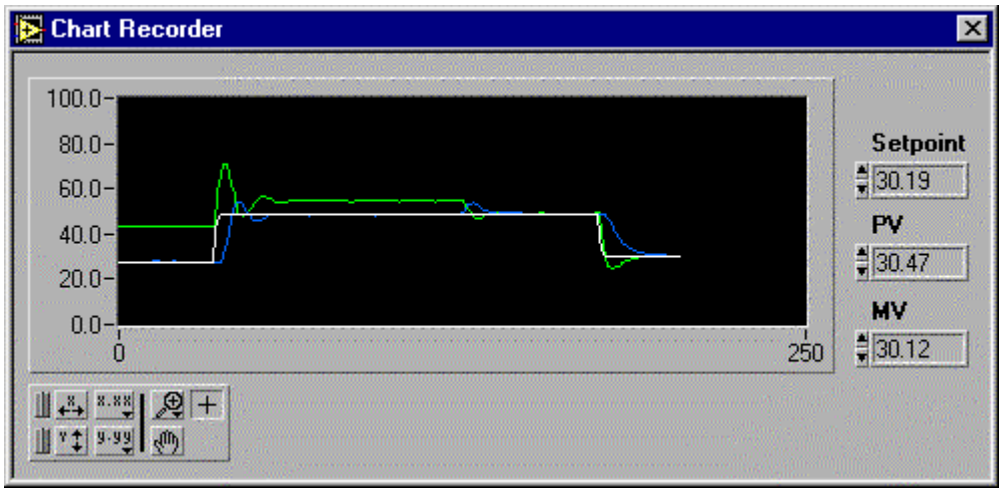

Figure 6 Data trends observed on process computer screen

RELATED REFERENCES

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3. Ramaganesan S, PB Deshpande, CC Hang and KK Sin, *Constrained Model Predictive Control: A Demonstration Experiment*, Application Note: DPS-102, KentRidge Instruments, 1994.
4. Lim KW, CC Hang and KK Sin, *Experiments Using the KRi Dual Process Simulator*, Application Note: DPS-103, KentRidge Instruments, 1996.
5. *DPS Trend User Guide for Dual Process Simulator* KentRidge Instruments, 1st Ed, 1994.

OTHER *KRi* PRODUCTS

KentRidge Instruments Pte Ltd offers a family of control apparatus or equipment for teaching and research in control engineering:

- Coupled-Tank Control Apparatus PP-100
- Fan & Plate Control Apparatus PP-200
- Inverted Pendulum PP-300
- FlexiDrive PP-400
- Mixed Signal Test Unit TU-100
- Controller Boards UC96

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