SPECIFICATION FOR INSTRUMENTATION TRAINERS

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1 Calibration Test Bench for AC and DC Voltmeter, AC and DC Ammeter, Ohmmeter, Digital Type

1.1 Basic Indicative Diagram

1.2 An integrated Test Bench consisting of instrument panel and working table should suitable for students to learn and perform various experiments for Calibration Test Bench. Measuring Instruments should be internally electrically connect and should be fitted in the panel such that only front panel and necessary interfaces are easily accessible to user. Structure of workbench should be made up of 1.5 mm thick CRC powder coated pipes with top made up of good quality 19 mm thick marine plywood and covered with 1.8 mm off white color mica. The bench working area should be covered by 2 mm thick antistatic mat which help students to controls static discharge as static cause interference or damage to students, equipment and circuitry.

1.3 **Structure and design of Test Bench should follow the below specifications:**

1.3.1 The basic structure should be made of 38 X 38 X 1.5 mm CRC powder coated pipes for sturdiness.

1.3.2 The overall dimensions of Workbench should be not less than W = 1500 mm; D = 900 mm; H = 1500 mm

1.3.3 MS drawers 03 numbers 415 X 290 X 133 mm (H X W X D) and Thickness 1.2mm with handle & separate lock on each drawer should be provided

1.3.4 For the panel section, raised back height of 1200mm from floor with matching height support from the side at a depth 500mm for instrument housing with a MS Panel strip below it for housing Electrical Sockets and Switches for external use.

1.3.5 Two Pole MCB (32A – Havells / Siemens) to be provided for safety of Workbench

1.3.6 Workbench should work on Mains Supply - 230V AC, 50 Hz

1.3.7 Calibration certificate from any government authorized laboratory should be provided for standard meters / supply.

1.4 **Control Board**

1.4.1 Meter Calibration test bench should give a standard output for AC Voltage, DC Voltage, AC Current & DC Current. Keys or Knob help to adjust the magnitude of the output signals. Important features include easy operation. The Calibrator should be ideal for testing ammeters, voltmeters and ohmmeters.

1.4.2 On board AC and DC Power Supply with suitable protection

1.4.3 Designed considering all safety standards
1.4.4 Separate AC and DC Measuring Sections
1.4.5 Rust Free Powder Coating
1.4.6 Standard BS-10 terminals, patch cords for safety purpose
1.4.7 Easy illustration of different blocks of calibration unit
1.4.8 Designed by considering all the safety measures
1.4.9 BS10 safety terminals are in compliance with IS302-1/IEC60335-1, tested from NABL accredited Lab

1.5 **Meters & Power Supplies**

1.5.1	Input Mains:	230V AC ±10%, 50Hz
1.5.2	DC Output Voltage Fixed:	220V ±10%
1.5.3	Variable:	0-220V ±10%
1.5.4	Rated Current:	10A
1.5.5	Digital Voltmeter:	300V
1.5.6	Digital Ammeter:	10A
1.5.7	Single Phase MCB:	16A

1.6 **AC Variable Supply**

1.6.1	Input Voltage:	415 V, 50 Hz
1.6.2	Voltage Rating:	0-415 V
1.6.3	Current Rating:	10 A
1.6.4	Type:	Closed
1.6.5	Nature of Cooling:	Air Cooled
1.6.6	Digital Voltmeter:	500V
1.6.7	Digital Ammeter:	10A

1.7 **AC/DC Load:**

1.7.1	Mains Supply:	AC / DC, 230 V ±10%
1.7.2	Load Range:	0 - 1.2 kW, in steps of 100 W
1.7.3	Load Type:	Resistive (Lamp Load)
1.7.4	Ammeter (MI):	10 A

1.8 **Multifunction Calibration Unit:**

1.8.1 On board Schematic lay out to understand the flow of calibration of Voltage, Current, Resistance

1.8.2	Mains Supply:	230V ±10%, 50Hz
1.8.3	Voltage DC Voltage:	0 - 350V
1.8.4	AC RMS Voltage:	0 - 350V
1.8.5	Current DC Current:	0 - 2A
1.8.6	AC Current:	0 - 2A
1.8.7	Resistance:	0 - 2MV
1.8.8	On Board Fuse:	200mA, 2A

1.9 **The test bench should be able to perform following experiments:**

1.9.1 Study of DC and AC Voltage Measurement and calibration
1.9.2 Study of DC and AC Current Measurement and calibration
1.9.3 Study of Resistance Measurement and calibration

2 Multifunction Process Work Bench (Flow, Level, Temperature and Pressure)

2.1 Basic Indicative Diagram

2.2 **Basic Item Description**

2.2.1 Trainer should be modular panels for easy site servicing not close control; panel box no wiring should not be there & shrouded 4 mm banana patch cords & shrouded sockets arrangements for the safety of the student

2.2.2 Lightweight, yet sturdy, tabletop, Aluminium profile flat panel setup, with SS (304/316) piping for & wide angle view of every component in process. No hidden parts.

2.2.3 Individual control loops as well as Advance control schemes like Ratio, Cascade, Feed forward, coupled tank made easy for student.

2.2.4 Connection through polarized FRC connectors, sturdy 4mm Banana sockets & Patch cords enabling quick setting up of variety of process control experiments.

2.2.5 P4/XP / win 7 window based PID controller (DDC) software package with P, PI & PID control, Ratio & cascade control, three operating modes, Online graph drawing & data acquisition modes (SCADA).

2.3 **Computer Interface Panel**

2.3.1 Connects to PC (P4/XP) parallel port through 25 pin M to F cable / 1.5 meter

2.3.2 4 ADC channels I/P: 0 to 2.5V FS with 1no input simulation pot. 1 DAC channel O/P 2.5V FS.

2.3.3 V to I function block: I/P 0 to 2.5V & O/P 0-20 or 4-20mA (100W load) switch settable.

2.3.4 I to V function block: I/P 4 to 20mA & O/P 0 - 2.5V

2.3.5 USB converter to interface 25 pin D connector on CIP panel to USB using PIC18F microcontroller 28 Pin SOIC enclosed in 25 Pin D shell using Type A to mini B cable.

2.3.6 Hardware module of square root extractor is provided so that PLC/Panel mount PID may be interfaced.

2.4 **Instrumentation Power supply cum Multichannel DPM Panel**

2.4.1 ±12V/500 mA, +5V/300mA, Unregulated 17V dc/750 mA, line synchronizing signal. 4 to 20 mA source

2.4.2 Multi channel DPM for digital display of process parameters.

2.4.3 20 pin FRC power bus to supply power to neighbouring panels.

2.5 **Thyristor Actuator cum Signal Conditioning Panel**

2.5.1 Thyristor bridge based 0-200V/3A using cosine firing circuit, I/P 0 to 2.5Vdc.

2.5.2 Supports signal conditioning for RTD, Pressure sensor with Instrumentation Amplifier & flow sensor (water / air) with F to V converter to generate 0-2.5Vdc (FS).

2.5.3 facilitates closed loop control experiments based on temperature, light intensity, speed measurement using built in P/PI controller as well as external Analog / Digital PID controller.

2.5.4 2No. Panels may be needed to cover signal conditioning needs of the selected process.

2.6 **PC (WIN7/8/10) based digital PID Controller:**

2.6.1 Online monitoring / Data acquisition / PID Software on Installable (CD) works under XP, WIN7. PC with parallel port / USB needed.

2.7 **Operating Modes:**

2.7.1 Simulator Mode: Tests data stored in files (*.txt) Draw graph for all P,PI,PD & PID modes.

2.7.2 **Process Monitoring Mode:** Draw graphs of analog data presented at CH 0 & CH 1 of CIP. Cursors for X & Y axis for measurement & online graphs saving for reproduction.

2.7.3 **PID controller Mode**

2.7.3.1 PID controller with parameter like Integral Time Ti (0.01-64000), Sampling Time Ts(0.1-99.9), Derivative Time Td(0-99.9), Proportional Band Pb(1-999), Derivative Gain Kd(1-999), Set Value Rn(0-99.9), PID output Upper Limit Uh(0-99.9), PID output Lower Limit Ul (0-99.9).

2.7.3.2 Facility to set units for output viz. (%) oC, RPM, V, mm, LPH, kg/cm², msi/cm, Degree. experiments with advance process control scheme viz; Ratio, Cascade, feedforward with Aux PID, Ratio station & FF transfer function calculator, Alarm setting, ON/OFF control, square root extractor for Orifice.

2.7.3.3 Function Generator: Sine / Triangular / Square wave generator with frequency 0.01 Hz to 1 Hz, Amplitude is 0 to 2.5 V i.e. 0 - 100%.

2.8 **Pressure/ Temperature / Air Flow Trainer Module:**

2.8.1 Controlled Medium: Air for pressure / Flow, Water for temp. & air (air bubbler) for Cooling

2.8.2 Storage tank material/Capacity: 1 No., 10 litre plexiglass tank for water

2.8.3 Process tank capacity/material: 1 No. 5 liter, stainless steel tank with temp, pressure sensors attachment. Pressure relief valve (10 Bar)

2.8.4 Electronic sensor Type/Output/ Range: Pressure: piezo-resistive pressure sensor 0 to 30PSI, O/P = 0 to 2.5V

2.8.5 Temp: PT100, O/P =0 to 2.5V, ambient to 1000C

2.8.6 Flow: Turbine flow sensor 1No. OP=0to2.5V, 0-150LPM

2.8.7 Control Valve: Pneumatically operated air to close, linear type, ½ " Size Diaphragm operated, C=0.4 with I to P Converter I/P 4 to 20mA O/P 4 to20 mA O/P 3 to 15 psi.

2.8.8 TAP panel: SCR controlled full bridge (200VDC) for 75^0 for temperature. Control I/P 0 to 2.5VDC.

2.8.9 Rotameter: 2 Nos. Acrylic body ½ “size 0 to 50LPM

2.8.10 Generation & Distribution Pump: 230VAC 10W submersible water pump with ¼" pvc pipe to fill in process vessel for temp. Control expt.

2.8.11 Bourdon gauges: 2 Nos. 0 to 2 bars, 2Nos 0 to 10 bar 0-300^{0}C gauge thermometer
2.8.12 Manual SS valves: 1/4" size = 7 Nos.
2.8.13 Piping material/size: Stainless steel, 1/4" for air
2.8.14 Air filter & regulators AND accessories: 3 Nos, 0 to 10 bars size 1/4" Oil catcher (1/4" size max. pressure = 10 bars)-1No.
2.8.15 Air compressor: 0 to 10 bars, 2 HP, 230VAC supply Tank Capacity: 110 Ltrs.
2.8.16 Ratio: Between 2 water flows
2.8.17 Cascade: Inner (fast) loop flow. Outer loop temp.
2.8.18 Feed forward: Air Flow or temp loop.
2.8.19 For temperature control (60 degree to 40 degree celcius) heat exchanger or jacketed vessel should be provided
2.8.20 All sensors & gauges also compactable to communicate with HART protocol

2.9 **Level and Water Flow Trainer Module**

2.9.1 Controlled Medium: Water
2.9.2 Storage tank material/Capacity: 1 No. 20 litre, plastic/PVC
2.9.3 Process tank capacity/material: Vertically mounted tank, 1 no. 20 liters, plexiglass
2.9.4 Electronic sensor Type/Output/ Range: l Flow: Turbine flow sensors 2Nos. 0-200 LPH Level WC pressure sensor 0 to 500 mm, level measurement by bubbler method, O/P - 0 to 2.5V
2.9.5 Control Valve: Pneumatically operated air to close, liner type ½" Size Diaphragm operated, CV =0.4 with I to P. Converter I/P 4 to 20mA, O/P 3 to 15 psi.
2.9.6 Rotameter: 2 Nos. Acrylic body 1/2" size 0 to 200LPH
2.9.7 Generation & Distribution Pump: 1 No. 0.062KW, 1/12HP, 2800RPM, ½"outlet, 500 LPH
2.9.8 Head 9 meters, with brass impeller
2.9.9 Bourdon gauges: 4 Nos. [0-2 bars, 3 Nos. 0 to 500 mm of water column = 1 No.]
2.9.10 Manual SS valves: 1/2" size =4 nos., 1/4" size = 3 nos.
2.9.11 Piping material/size: Stainless steel 1/2" for water, 1/4" for air
2.9.12 Air filter & regulators and accessories: 2 nos, 0 to 10 bars, size ¼", oil catcher (1/4" size max. pressure = 10 bars) = 1 No.
2.9.13 Air compressor: 0 to 7 bars, ½ HP, 230VAC supply
2.9.14 Advance control Expt.: Transfer function determination, Ziglor Nicholas PID tunning
2.9.15 Ratio: Between 2 water flows
2.9.16 Cascade: Inner (fast) loop flow, outer (slow) loop level
2.9.17 Feed forward: Water flow disturbance on level loop.

2.10 **Computer: 2 Nos.**

2.10.1 The computer should be fixed on the trainer kit using two rodas and mounting plate. This should be ergonomically mounted such that the user can easily access the PC.
2.10.2 Operating system Windows 10 Pro 64
2.10.3 Processor: Intel® Core™ i5 processor
2.10.4 Form factor All-in-one
2.10.5 Memory 8 GB DDR4-2666 SDRAM (1 X 8 GB)

2.10.6 Hard drive description 1 TB
2.10.7 Display 60.45 CM (23.8) diagonal

2.11 **List of experiments for Pressure/ Temperature / Air Flow:**

2.11.1 Study of temperature control loop open loop response & close loop response with P, PI, PID
2.11.2 Study of pressure control
2.11.3 loop open loop response & close loop response with P, PI, PID
2.11.4 Study of Air Flow control loop open loop response & close loop response with P, PI, PID
2.11.5 Study of ratio control loop
2.11.6 Study of cascade control loop
2.11.7 Study of ON-OFF control loop
2.11.8 Study of feed forward control loop
2.11.9 Study of control valve [Gain scheduler Hysteresis] V to I converter, I to P converter.
2.11.10 Study the calibration of control valve & valve positioner
2.11.11 All sensors should be easily accessible for calibration

2.12 **List of Experiments for Level and Water Flow:**

2.12.1 Study of Level loop-open response & close loop response with P, PI, PID.
2.12.2 Study of Flow control loop - open loop response & close loop response with P, PI, PID.
2.12.3 Study of Control Valve (Gain scheduler Hysteresis), V to I converter, I to P converter
2.12.4 Study of Ratio control loop
2.12.5 Study of Cascade control loop
2.12.6 Study of Level ON-OFF control loop
2.12.6.1 Study of Feed - Forward control loop
2.12.6.2 Study of Pressure loop
2.12.7 Input & output characteristics recording instrument (graphical recorder) with printer & current status of PID action should display on oscilloscope
2.12.8 Trainer should be operated by PID & its parameters, PLC, SCADA

3 PLC & SCADA Trainer

3.1 Basic Indicative Diagram

3.2 **Basic Item Features**

3.2.1 Rack based table top using Aluminum profile rack.

3.2.2 Table Top Model: Electronic desk with ergonically designed ABS Moulded enclosure with slick looking replaceable experiment panel in central slot.

3.2.3 Can learn about different aspects of application trainers like Industrial PLC, SCADA. using simulated building blocks / replaceable static application panels (SAPs)

3.2.4 Analog I/O channel with potentiometer for AI simulation

3.2.5 Connection through sturdy 4mm Banana sockets & Patch cords

3.2.6 Students workbook & Instructor's Guide provided with each unit

3.3 **Interfacing panels:** Aluminum profile sturdy Flat panel system carrying various high voltage components housed in modular plastic enclosures to minimize shock possibility.

3.4 **CPU (DIO):** Model S7-1200

3.5 **DIO:** 24 DI + 16 DO

3.6 **AIO**

3.6.1 4AI + 2AO

3.6.2 Input range- +10V, Resolution- 10 bit

3.7 **Software:** STEP 7 – MicroWIN SMART support Ladder / Function Blocks Diagram Programming & monitoring troubleshooting & instruction set, Simulation Software.

3.8 **Com Ports:** Ethernet Port(RJ45) for Ladder Programing, RS485 for HMI

3.9 **Converter cum Distribution Panel**

3.9.1 Converts screw driver terminal strip of PLC into 4mm sockets total 16 nos.

3.9.2 Provided for input on AIO panel located on top board.

3.10 **Panel 1 - Simulation cum Extension Panel**

3.10.1 Located on left side panel, consisting of 16 nos. of digital inputs.(8 slider switches + 8 push to ON switches, No. of 4mm banana sockets=16.

3.11 **Panel 2 - Simulation cum Extension Panel**

3.11.1 Located on right side panel, 16 nos. of output LED indications, 4 nos. of relay panel with coil rating 24V & contact rating of 230VAC /5A, no. of 4mm banana sockets =20, shrouded sockets for relay contact = 8 nos.

3.12 **Panel 3 - Simulation cum Extension Panel**

3.12.1 Located on Top board, 4 nos. of simulation pots & 4 Nos. of AI,

3.12.2 2 Nos. of analog outputs, LED bar graph of 10 LEDs for AO simulation, settable range 5V/10V. No. of 4mm banana sockets =19

3.13 **Operating Voltage**

3.13.1 SMPS Power Supply inside main unit with Power ON /OFF switch on hind panel

3.13.2 SMPS I/P: 110/20/230Vac + 10% 50/60 Hz, O/P: 24V / 2 A

3.13.3 6 Nos. of 4mm Banana Sockets (3nos. for +24V, 3nos. for common) for extension provided on AIO/SEP Panel

3.14 **37 Pin D Connector (f)**

3.14.1 Provided 37 pin D type connector for complex working models like lift elevator to save on wiring time. It supports DI= 21, DO=13, +24V= 1, GND=2

3.15 **Static Application Panel - SAPs**

3.15.1 Common Base Board consisting of 54 LEDs, with 10 LEDs for Bar Graph for AO. No. of 4mm banana sockets = 32

3.15.2 Replaceable 19 Nos. of Static Application Panel which may be inserted onto common baseboard panel with selectively LEDs exposed:-

- 3.15.2.1 Door Bell Operation,
- 3.15.2.2 Switching of lights,
- 3.15.2.3 Silo Control,
- 3.15.2.4 Seven Segment Display,
- 3.15.2.5 Starter Control,
- 3.15.2.6 Sequential Control of Motors,
- 3.15.2.7 Star Delta Control,
- 3.15.2.8 Resistance Welding,
- 3.15.2.9 Tank Level Control,
- 3.15.2.10 Traffic Light Control,
- 3.15.2.11 Bottling Plant,
- 3.15.2.12 Drink Dispenses,
- 3.15.2.13 Reaction Vessel,
- 3.15.2.14 Oven,
- 3.15.2.15 Parking Garage
- 3.15.2.16 Combination Lock
- 3.15.2.17 Elevator Simulator
- 3.15.2.18 Process Control Trainer
- 3.15.2.19 Washing Machine

3.16 **SCADA Trainer**

3.16.1 SCADA software development suite supplied on installable DVD. Supports 2048 tags, with USB hardware lock provided, 19 projects for 19 Static Application Panels

3.17 **Computer**

3.17.1 I3 / Win7 / 8.1 / 10, RAM 4GB

3.17.2 Should Interfaces with PLC through RJ 45 ethernet comport.

4 PLC Trainer

4.1 Basic Indicative Diagram

4.2 **Basic Item Features**

4.2.1 Electronic desk with ergonically designed ABS Molded enclosure with slick looking replaceable experimental panel.

4.2.2 Can learn about different applications of Industrial PLC using simulated building blocks / replaceable static application panels (SAPs) & simulation cum extension panels (SEPs).

4.2.3 SEPs to provide input switches, push buttons, O/P LED

4.2.4 Analog I/O with potentiometer for AI simulation & Bar graph for AO simulation..

4.2.5 Connection through sturdy 4mm Banana sockets & Patch cords.

4.2.6 Student's workbook & Instructor's Guide should be provided.

4.3 **CPU (DIO):** Model S7-1200

4.4 **DIO:** 24 DI + 16 DO

4.5 **AIO**

4.5.1 4AI + 2AO

4.5.2 Input range- +10V, Resolution- 10 bit

4.6 **Software:** STEP 7 – Micro WIN SMART support Ladder / Function Blocks Diagram Programming & monitoring troubleshooting & instruction set, Simulation Software.

4.7 **Com Ports:** Ethernet Port(RJ45) for Ladder Programing, RS485 for HMI

4.8 **Converter cum Distribution Panel**

4.8.1 Converts screw driver terminal strip of PLC into 4mm sockets total 16 nos.

4.8.2 Provided for input ion AIO panel located on top board.

4.9 **Panel 1 - Simulation cum Extension Panel**

4.9.1 Located on left side panel, consisting of 16 nos. of digital inputs.(8 slider switches + 8 push to ON switches, No. of 4mm banana sockets=16.

4.10 **Panel 2 - Simulation cum Extension Panel**

4.10.1 Located on right side panel, 16 nos. of output LED indications, 4 nos. of relay panel with coil rating 24V & contact rating of 230VAC /5A, no. of 4mm banana sockets =20, shrouded sockets for relay contact = 8 nos.

4.11 **Panel 3 - Simulation cum Extension Panel**

4.11.1 Located on Top board, 4 nos. of simulation pots & 4 nos. of AI,

4.11.2 2 nos. of analog outputs, Led bar graph of 10 leds for AO simulation, settable range 5V/10V. No. of 4mm banana sockets =19

4.12 **Operating Voltage**

4.12.1 SMPS Power Supply inside main unit with Power ON /OFF switch on hind panel

4.12.2 SMPS I/P: 110/20/230Vac + 10% 50/60 Hz, O/P: 24V / 2 A

4.12.3 6 Nos. of 4mm Banana Sockets (3nos. for +24V, 3nos. for common) for extension provided on AIO/SEP Panel

4.13 **37 Pin D Connector (f)**

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- 4.14.2.5 Starter Control,
- 4.14.2.6 Sequential Control of Motors,
- 4.14.2.7 Star Delta Control,
- 4.14.2.8 Resistance Welding,
- 4.14.2.9 Tank Level Control,
- 4.14.2.10 Traffic Light Control,
- 4.14.2.11 Bottling Plant,
- 4.14.2.12 Drink Dispenses,
- 4.14.2.13 Reaction Vessel,
- 4.14.2.14 Oven,
- 4.14.2.15 Parking Garage
- 4.14.2.16 Combination Lock
- 4.14.2.17 Elevator Simulator
- 4.14.2.18 Process Control Trainer
- 4.14.2.19 Washing Machine

4.15 **Accessories**

4.15.1 Mains cord

4.15.2 Ethernet cable1.5m

4.15.3 Patch cords red & black 600mm length 15nos. each

5 Real PID Controller Trainer

5.1 Basic Indicative Diagram

5.2 **Basic Item Features**

5.2.1 Students should be able to learn how an Analog as well as Digital PID works.

5.2.2 Facility to monitor behavior of the controller output (Un) & process variable (MV) either on PC screen or on CRO. Settable time constants.

5.2.3 P4/XP or latest version window based PID controller (DDC) software package with P, PI & PID control, Ratio & cascade control, three operating modes, Online graph drawing & data acquisition modes (SCADA).

5.2.4 Graph printing facility for laboratory journal entries.

5.2.5 Aesthetically designed injection molded electronic desk carrying useful experiment resources like Power supplies, DPMs, Computer Interface, Analog PID controller with central slot to hold various replaceable experiment panels / processes.

5.2.6 Connection through sturdy 4mm Banana sockets & Patch cords, Students workbook & Instructor's Guide provided.

5.3 **Built in Power Supply**

5.3.1 DC supply +12V,500mA.

5.3.2 1phase sine reference for cosine firing 30Vpp max.

5.3.3 17Vdc, 500mA unregulated for driving pulse X'mer

5.3.4 Variable DC power supply: 7 to 14V/3A

5.4 **Display**

5.4.1 DPM – 2 Nos.

5.4.1.1 For Temp. upto 1000C & intensity in Lux (2000)

5.4.1.2 For speed 2000 rpm & voltage upto 20V.

5.4.2 Analog Meter – 2 Nos.

5.4.2.1 Centre zero for display of process error (+9V)

5.4.2.2 For MV/SP (0-2.5V)

5.5 **Operating Voltage**

5.5.1 Switch selectable 220-240Vac, ±10%, 50Hz, 75VA

5.6 **PC (WIN7/8/10) based PID controller**

5.7 **Online monitoring / Data acquisition / PID Software**

5.7.1 Should be supplied on Installable (CD) works under XP, WIN7/8/10

5.7.2 PC with parallel port / USB needed and will be supplied by the consignee

5.8 **Operating Modes**

5.8.1 **Simulator Mode:** Tests data already stored in files (*.txt) & Drawing graph for all P,PI,PD & PID modes.

5.8.2 **Process Monitoring Mode:** Drawing graphs of analog data presented at CH 0 & CH of Computer Interface. Cursors for X & Y axis for measurement & online graphs savings for reproduction

5.8.3 **PID controller Mode**

5.8.3.1 PID controller with parameters like Integral Time Ti (0.01-64000), Sampling Time Ts (0.1- 99.9), Derivative Time Td (0.1-99.9), Proportional Band Pb(1-999), Derivative Gain Kd(1-999), Set Value Rn (0- 99.9), PID output Upper Limit Uh(0-99.9), PID output Lower Limit Ul (0- 99.9).

5.8.3.2 Facility to set units for output viz. Percentage (%), oC, RPM, Voltage(V), mm, LPH, kg/cm2, degree.

5.8.3.3 Supports experiments with advance process control scheme viz; Ratio, Cascade, feed forward with user selectable Aux PID, Ratio station & programmable FF transfer function calculator, selective & split control strategies, Multi DPM Screen.

5.9 **Computer Interface Adapter**

5.9.1 Optoisolated Adaptor to prevent damage to PC parallel port (25 pin LPT) due to wrong connections. Interfaces through 25 pin M to F cable 1mtr Length. PC/WINXP/7/8/10 not in scope of supply.

5.9.2 4 ADC channels: 0 to 2.5V full scale.

5.9.3 1 DAC channel: O/P 2.5 V FS.

5.9.4 V to I Function block: Input: 0-2.5Vdc

5.9.5 O/p: 0-20 or 4-20mA, in 100E load Max

5.9.6 USB IO module to interface 25 pin D connector on CIA panel to USB PC port enclosed in 25 Pin D shell using Type A to mini B cable.

5.9.7 V to PWM function block: I/P -0-2.5V, O/P-1KHz PWM O/P ±9V.

5.10 **Analog PID (APID) controller** with built in low freq. function generator

5.11 **Controller selection P,PI,PD,PID with slide switch**

5.11.1 Parameter settings

5.11.1.1 Integral Time Ti (0.5-25Sec)

5.11.1.2 Derivative Time Td (0-2Sec)

5.11.1.3 Proportional Band Pb (5- 200%)

5.11.1.4 Set point (-9V- +9V)

5.12 **Operating modes**

5.12.1 Fast (X 100/10mSec) for Oscilloscope

5.12.2 Slow (X 0.1/1Sec) for PC Interface.

5.12.2.1 2 No. Level shifter converting process O/p (+9V) to 0-2.5V for PC interface & Actuator panel

5.12.2.2 Test points for Process Error, Set Point (Rn), Measured Value (Cn), Controller output (Un).

5.13 **Built in Function Generator**

5.13.1 O/p waveform selectable sine, triangular & square.

5.13.2 O/p freq. range from 0.016Hz to 166Hz, 4 steps & fine control pot.

5.13.3 Variable amplitude control 0 to +9V

5.14 **Real Life Process Control Panel**

5.14.1 Thyristor Actuator Panel

Thyristor bridge based 0-200V/3A cosine firing circuit. Supports signal conditioning of RTD (PT100), Thermocouple K type & Photodiode to output 0-2.5Vdc (FS). Should facilitates closed loop control experiments based on temperature, light intensity, speed measurement using built in P/PI controller as well as external Analog / Digital PID controller.

Should have following real life process

5.14.1.1 Process Temp/Light: Process box contains 3 high wattage (60W) bulbs under aluminum plate heater.

5.14.1.2 Built in fan, lamp as disturbance generator.

5.14.1.3 Sensor RTD for temperature control upto 100 degree C with built in CAL facility, Photodiode for light intensity control upto 2000lux

5.15 **List of Experiments**

5.15.1 PID tunning by Ziegler - Nichols

5.15.2 Transfer function determination

5.15.3 Operation under various P/I/D

5.15.4 Open loop response to step input (transfer function determination)

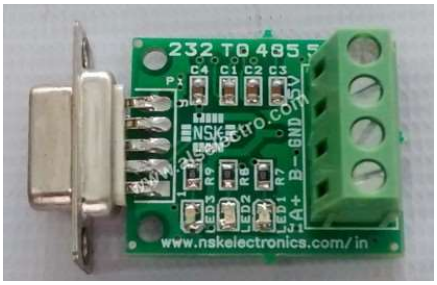
5.15.5 Close loop control with Analog PID

5.15.6 Close loop control with Digital PID

5.15.7 Close loop control with built in Proportional controller / lag compensator (PI controller) PID control with PWM O/P

6 RS485 to RS232 Converter Trainer

6.1 Basic Indicative Diagram



6.2 **Basic Item Features**

6.2.1 Aesthetically designed Injection moulded Plastic enclosure.

6.2.2 Supports use of 5V tolerant ICs obviating need of special precautions by students.

6.2.3 Set of Users Guide provided with each unit with emphasis on C Programming as well as assembly language programming.

6.2.4 In circuit system programming (ICSP) supported through PC ports of COM/LPT (JTAG).

6.2.5 Can interface to application boards of XPO series microprocessor trainers saving customer investment.

6.2.6 I2C, SPI bus interface.

6.3 **Onboard Resources:**

Following Onboard Resources are offered for experimentation. However not every resource may be used fully with particular ECU due to paucity of its IO capacity.

6.3.1 Speed: 16 MHz crystal operated multi-output clock source to operate various resources on Mother Board like CPU, Baud rate, T/C etc.

6.3.2 I/O Pins: 48 I/O lines through 2 Nos. of 26 pin FRC header.

6.3.3 Serial Interface: RS-232c serial interface using RS232 driver IC through 9 Pin male D connector.

6.3.4 Parallel Interface: 25 pin male D connector for Parallel interface for JTAG based programming.

6.3.5 Display: 16 X 2 LCD (Backlit)

6.3.6 Key Board - Keyboard interface to support 101 keys PC AT/PS2 keyboard.

6.3.7 Battery Backup: Lithium battery (3V/48mAH) provided to supply power to RTC.

6.3.8 Additional Resources**:**

6.3.8.1 Ext. L/S (8□/0.5W) I/F for experiments on frequency synthesis.

6.3.8.2 Reset push button.

6.3.8.3 Variable Slow CLK (2Hz-64Hz) provided for internal timers/counter functions applications.

6.3.8.4 Variable Pot (0 -5V) to stimulate analog I/P for built in ADC wherever applicable.

6.3.8.5 General purpose bicolor (green, red) 8 x 2 LEDs & 8 Push Button Switches & DIP switches.

6.3.8.6 I2C based 24C512 (EEPROM), DS1307 & SPI based 93C46 [EEPROM]

6.4 **Power Supply: SMPS**

6.4.1 5V/2.5Amp. With RCA plug +12V/850mA, -12V/250mA with 4 pin reliamate SMPS. AC P230Vac +/-10% / 50Hz.

6.5 **ISP Cables**

6.5.1 9 pin Female to 9 pin male RS-232C cable

6.5.2 26 pin FRC IO cable

6.5.3 25 pin female to 25 pin male for Parallel Interface

6.6 **89C51RD2**

6.6.1 Manufacture Model: ATMEL/Phillips/ NXP

6.6.2 Package: 40 Pin DIP Package

6.6.3 Capacity on Chip RAM Flash/ EEPROM: 256 Bytes (1KB) 8(KB) (64KB)

6.6.4 Operating Frequency: 16 MHz

6.6.5 I/O Capacity ; 4X8 I/O ports. (32)

6.6.6 Operating System ICSP S/W PC Port: Window/XP Flash Magic (winlsp) Comp Port

6.6.7 Special Purpose IOs: 7 interrupt sources, depending on device.

6.6.8 Execution Method: From Flash

6.6.9 Programming Language: C Language Assembly Language

6.7 **RS485 Interface:**

6.7.1 Input: TTL RS232

6.7.2 Output RS485 differential

6.7.3 Power supply: +5V

6.7.4 Uses IC MAX 485 & communicates with PC using Modscan

6.7.5 LAN topology: MODBUS (half duplex)

6.7.6 RS232 to RS485 converter at PC side

6.8 **List of Experiments:**

6.8.1 Select device ID/Transmits key, Led status, frequency on PC using MODSCAN