Skills for Life!

Jubail Technical Institute

معهد الجبيل التقني

Department of Electrical and Electronics Skills

STUDENT HANDBOOK

Instrumentation Skills Practice 1

INCT 1429

2020

Prepared by

Industrial Instrumentation & Control Skills Team

Instrumentation Skills Practice 1

INCT 1429

CONTENTS

Project No. 1
Measuring pneumatic signal and converting it into current signal.

Objectives:
Students will be able to:

- Measure pneumatic signals and preparing the measurement to be displayed on the DCS system.

Discussion:
For something to be sent to the DCS, it has to be in the electronic form. Since we don't have instruments that measure 0-40 psi and give an electronic output, a pressure transmitter is needed to produce a standard pneumatic output.
The 3-15 psi output from the pneumatic pressure transmitter can then be connected to a pressure to current converter. This instrument will convert a 3-15 psi pneumatic signal to 4-20 mA current signals. The signal, therefore, will be ready to be sent to a DCS station.

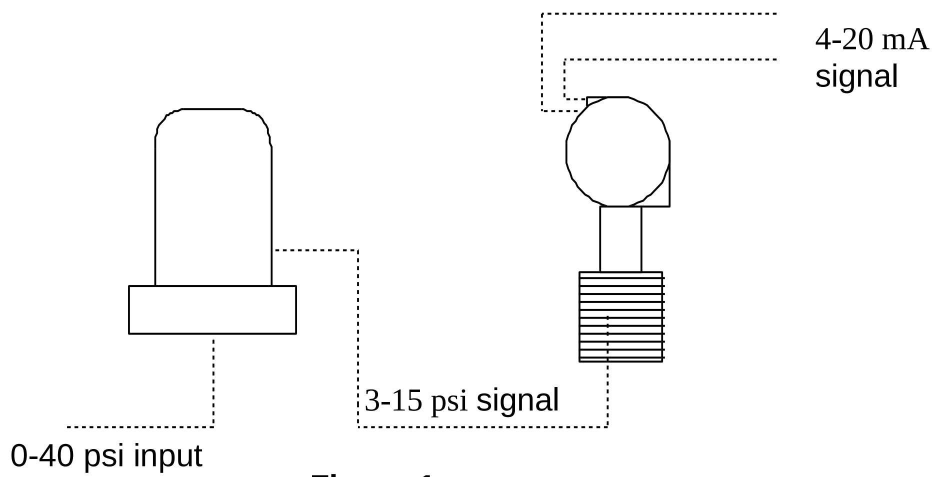


Figure:1

Equipment & Tools List:

- A pneumatic gauge pressure transmitter.
- A pneumatic to current signal converter.

Write down name, model no.& functional specification of each instrument used in this exercise:

Name:________________

Model no._____________

Specifications:

1) __________________

2) __________________

3) __________________

4) __________________

Name:________________

Model no._____________

Specifications:

1) __________________

2) __________________

3) __________________

4) __________________

Procedure

1. Connect 20 psi output to the supply input of the pneumatic pressure transmitter.
2. Connect the input pneumatic signal (0-40 psi) to the input plug of the pneumatic pressure transmitter.
3. Connect the 3-15 psi output of the pneumatic pressure transmitter to the input of the pressure-to-current P/I converter.
4. Apply different inputs and observe the output

Review Questions

1. What is the input and the output of the project?

   ----
2. What effect will the removal of the P/I converter have on the process?

Project No. 2
Operating Control valve through I/P converter and Process calibrator.

Objectives:

- Measure pneumatic signals and prepare the measurement to operate a Control Valve using a Process Calibrator

Discussion:

First, we need to supply the electronic signal, so we use a process calibrator for that purpose. The output of the calibrator is electronic but as the valve responds to 3-15 psi pneumatic signal. Therefore, we should use a current-to-pneumatic signal converter to convert the 4-20 mA to 3-15 psi. Now, the signal is ready to be connected to the control valve.

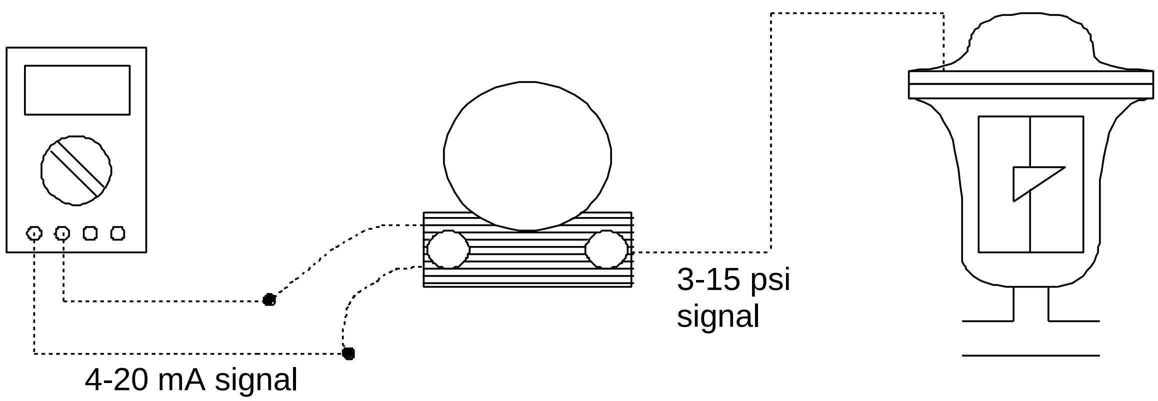


Figure:1

Equipment & Tools List:

- Process calibrator
- Current-to-pressure I/P signal converter
- A control valve
- Connection tubes
- Wires

Write down name, model no.& functional specification of each instrument used in this exercise:

Name:_________________

Model no.______________

Specifications:

1) __________________

2) __________________

3) __________________

4) __________________

Name:_________________

Model no.______________

Specifications:

1) __________________

2) __________________

3) __________________

4) __________________

Procedure:

1. Connect the process calibrator to the electrical input of the I/P converter.
2. Connect a 20-psi supply input to the I/P converter.
3. Connect the 3-15 psi pneumatic signal out of the I/P converter to the control valve input.
4. Apply different current signals to the I/P converter and observe the results.

Fill the following table:

Sl.No.	**Current Input(mA)**	**I/P output in in (PSI)**	**Control valve opening in %**	**Remarks.**

Conclusion:

What did you observe for different values of Current?

Review Questions:

1) What is the input to the I/P Convertor?

----

2) What is the o/p of I/P convertor?

----

3) What is the importance of I/P convertor?

Project No. 3
Valve control against high pressures

Objectives:

- To establish a system where a control valve is controlled electronically and also to protect that valve from pressure higher than its maximum input range.

Discussion:

Since the I/P converter is working fine, the problem must be from the electrical input to the I/P. We need a way so that when anyone tries to give the I/P more than 20 mA, the signal is interrupted and no pressure goes to the valve until the input current is decreases. This job is for the pressure switch. When we apply more than 20 mA, the I/P converter will try to give an output beyond 15 psi. The pressure switch is set to close at 15 psi, and therefore, it will not allow the 15+ psi signal to go through. It will stop the 4-20 mA signal from the process and that will protect the valve from high pressure. See the figure below.

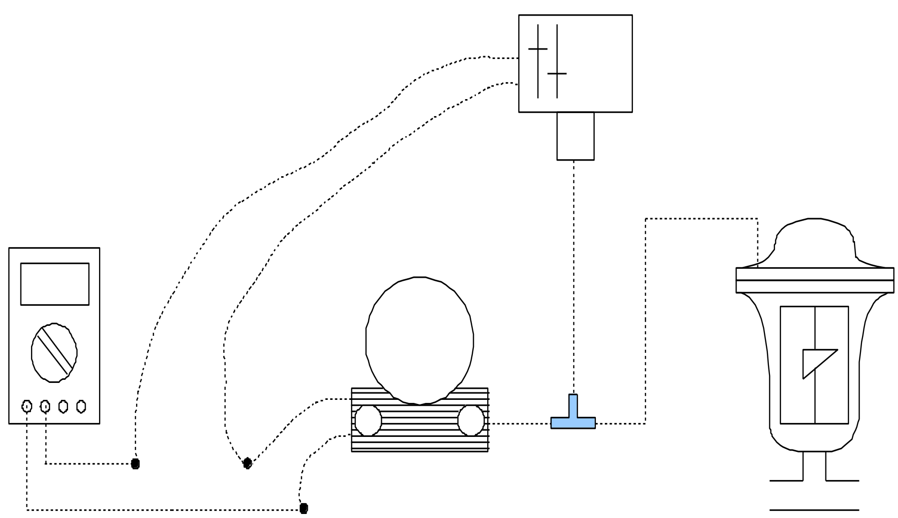


Figure:1

Equipment Tools List:

- Process calibrator multimeter
- I/P converter
- Pressure switch
- Control valve
- T-connector and some connection tubes and wires

Write down name, model no.& functional specification of each instrument used in this exercise:

Name:________________

Model no._____________

Specifications:

1)__________________

2)__________________

3)__________________

4)__________________

Name:________________

Model no._____________

Specifications:

1)__________________

2)__________________

3)__________________

4)__________________

Procedure:

1. Connect the components as shown in the figure above.
2. Apply some input values and observe the output
3. Apply slightly more than 20 mA to the input and observe what happens.

Conclusions:

What did you observe?

Review Questions:

1) What is the most important device?

   ----
2) How does it work?

   ----

4) How the pressure switch is connected? NO or NC type.

Project No. 4
Solenoid Valve control using pneumatic cylinder and limit switch.

Objectives:

Operating a pneumatic cylinder and a solenoid valve

Students will be able to:

- Use pneumatic cylinder to open and close limit switch.
- Control on/off solenoid valve using pneumatic cylinder and limit switch.

Discussion:

When 3psi is applied to the pneumatic cylinder the limit switch will be open and the circuit of solenoid valve is opened. Therefore the solenoid valve de-energizes when 15psi is applied to the pneumatic cylinder pushes the limit switch to be closed and the circuit of solenoid valve is closed. Therefore the solenoid valve energizes.

So by using 3psi to 15psi, the on/off solenoid valve can be controlled using pneumatic cylinder and limit switch. The figure below shows the basic cylinder and the limit switches mounted on it.

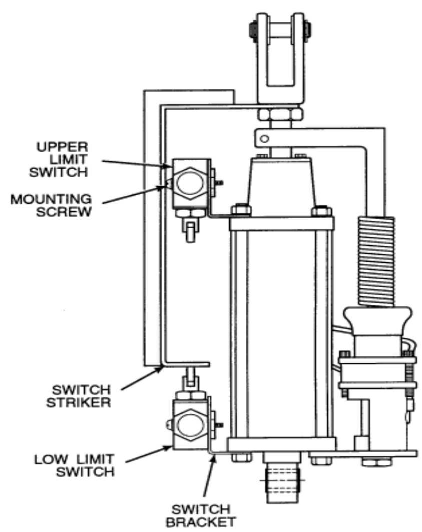


Figure:1

Equipment & Tools:

- Pneumatic cylinder
- Limit switch
- Pneumatic tubes
- Wires
- Spanners
- Screw drivers

Write down name, model no.& functional specification of each instrument used in this exercise:

Name:________________

Model no._____________

Specifications:

1)__________________

2)__________________

3)__________________

4)__________________

Name:________________

Model no._____________

Specifications:

1)__________________

2)__________________

3)__________________

4)__________________

Procedure:

1. Adjust the pneumatic cylinder and limit switch where the limit switch is open at 3psi applied to the pneumatic cylinder and close at 15psi applied to the pneumatic cylinder.

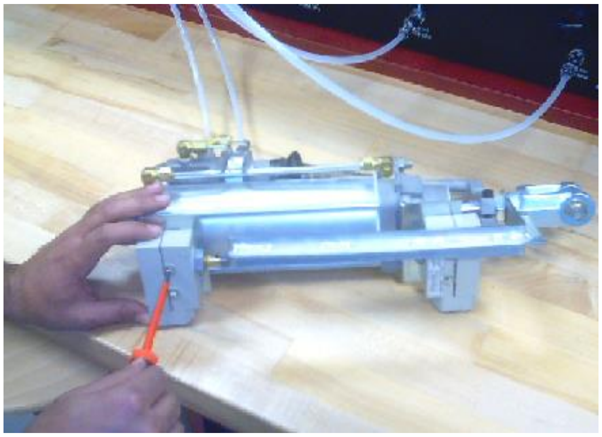


Figure:2

2. Connect the following circuit the limit switch and the solenoid valve:

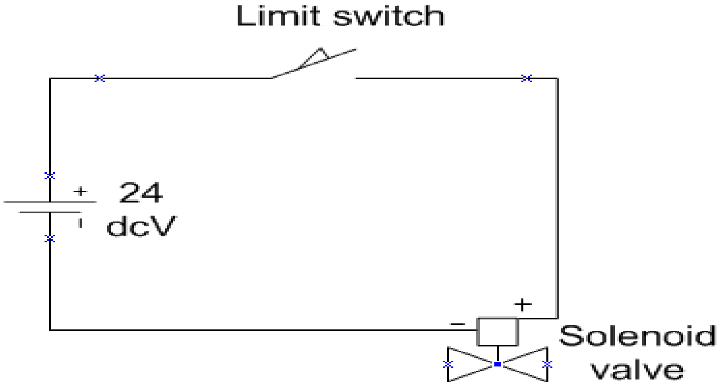


Figure:3

3. Ask your instructor to check your circuit. Then turn the power supply on.

4. Apply 3psi to the pneumatic cylinder and check the following:
   Is the Limit switch opened or closed?
   Is the solenoid valve energized or de-energized?

5. Apply 15psi to the pneumatic cylinder and check the following:
   Is the Limit switch opened or closed?
   Is the solenoid valve energized or de-energized?

6. Disconnect all equipment and retain them to their places.

Conclusion:

1. What is pneumatic cylinder used for?

   it can be used as part of a valve,
   or to move a machanism or material

2. How solenoid valve controlled using pneumatic cylinder and limit switch?

   The cylinder moves in reponse to pressure. When the
   cylinder reaches its maximum height, it presses the switch
   which opens or closes the solenoid valve.

Project No. 5
Temperature control loop connection using RTD, Temperature Transmitter, I/P Converter and Pneumatic Cylinder

Objective:
Connect the Temperature Control loop by using RTD, Temperature Transmitter, I/P Converter and Pneumatic cylinder with Limit Switches for lamp indication.

Discussion:
The RTD gets heated up through dry block and temperature transmitter gives corresponding output 4-20 mA signal to I/P converter to operate pneumatic actuator from
3-15 psi.operates a pneumatic cylinder on which the Limit switches is mounted the on/off operation of the switch depending on pressure applied in turn operates a lamp.

Equipment & Tools:

- Dry Block (Fluke)
- RTD
- Temperature Transmitter
- I/P Converter
- Pneumatic Cylinder
- Connecting leads,24 V Dc Bulb
- Multimeter
- Screwdriver, Spanners etc.

Write down name, model no.& functional specification of each instrument used in this exercise:

Name:________________

Model no._____________

Specifications:

1)__________________

2)__________________

3)__________________

4)__________________

Name:________________

Model no._____________

Specifications:

1)__________________

2)__________________

3)__________________

4)__________________

Procedure:

1) Connect the loop as per the circuit diagram shown in the below figure.
2) Increase the temperature from 0 Deg to 100 Deg in the step of 10 Deg each.
3) Check for the operation of the pneumatic cylinder
4) Check for the operation of the switch on cylinder
5) Decrease the temp and see whether it performs the reverse operation.

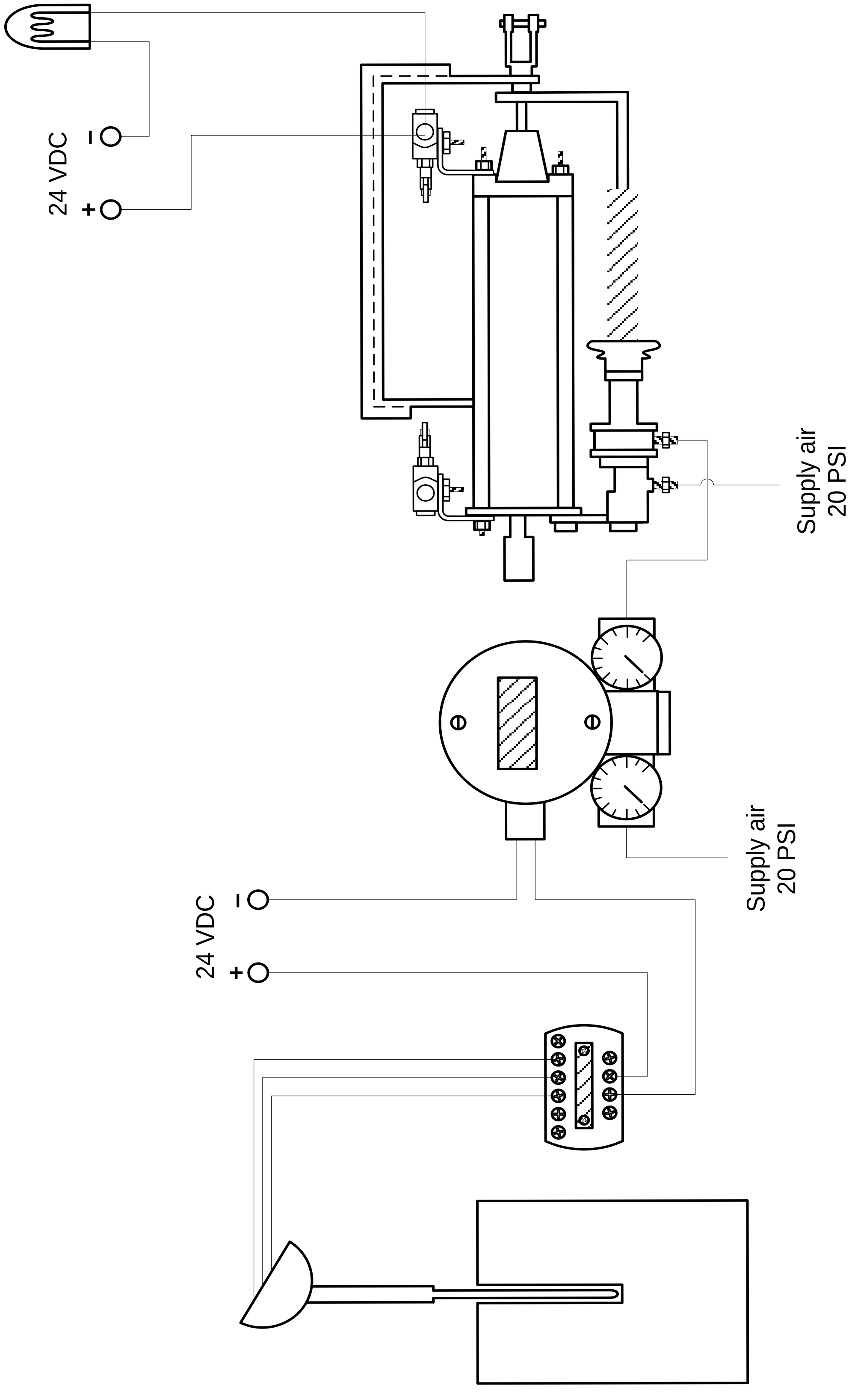


Figure:1

Review Questions:

1 - What is the purpose of Dry Block Calibrator?

----

2 - What happens with increasing and decreasing temperatures?

----

3 – Is it possible to carry out the entire operation without dry block calibrator?

Project No. 6
Temperature control loop connection using RTD, Temperature Transmitter and Strip Chart Recorder.

Objective:
Connect the Temperature Control Loop by using RTD, Temperature Transmitter and Strip Chart Recorder.

Discussion:
The temperature transmitter gets heated up through Dry Block and corresponding temperature is measured by the transmitter whose voltage supply is 24 V DC and output
is 4-20mA.The Temperature is finally recorded on the strip chart recorder in terms of degree centigrade.

Equipment & Tools:
- Dry Block (Fluke)
- RTD
- Temperature Transmitter
- Strip Chart Recorder
- Multimeter
- Screwdriver
- Connecting Leads etc.

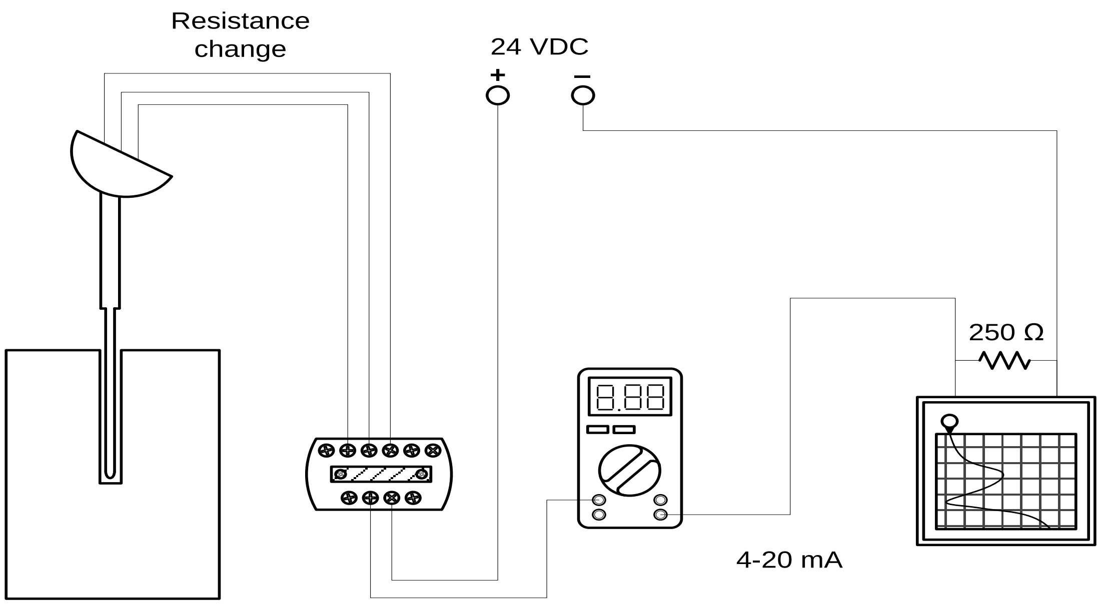


Figure:1

Write down name, model no.& functional specification of each instrument used in this exercise:

Name:________________

Model no._____________

Specifications:

1)________________

2)________________

3)________________

4)________________

Name:________________

Model no._____________

Specifications:

1)________________

2)________________

3)________________

4)________________

Procedure:
1) Connect the loop as per the circuit diagram shown in the below figure.
2) Increase the temperature from 0 Deg to 100 Deg in the step of 10 Deg each.
3) Check for the operation of the Strip Chart Recorder
4) Check for the variation of the output
5) Decrease the temp and see whether it performs the reverse operation.

Fill the following Table:

Sl.No.	**Dry Block temperature**	**Temperature Tx output in mA**	**Recorder reading**	**Remarks.**

Review Questions:
1 - What is the purpose of Strip Chart Recorder?

----

2 - What happens with increasing and decreasing temperatures?

----

3 – Is it possible to carry out the entire operation without dry block calibrator?

Project No.7
Connection of Foxboro Pneumatic Controller, Pressure Transmitter and Control Valve in one loop and operating the control valve by putting Foxboro controller in manual mode and auto mode

Objective:
Connect Foxboro Pneumatic Controller, Pressure Transmitter and Control Valve in one loop and operate the Control Valve by putting Foxboro controller in manual mode and auto mode.

Equipment & Tools:

- Pneumatic Controller (Foxboro)
- Pressure Transmitter (Foxboro)
- Connecting tubes
- Control Valve
- Screwdriver, Spanners, etc.

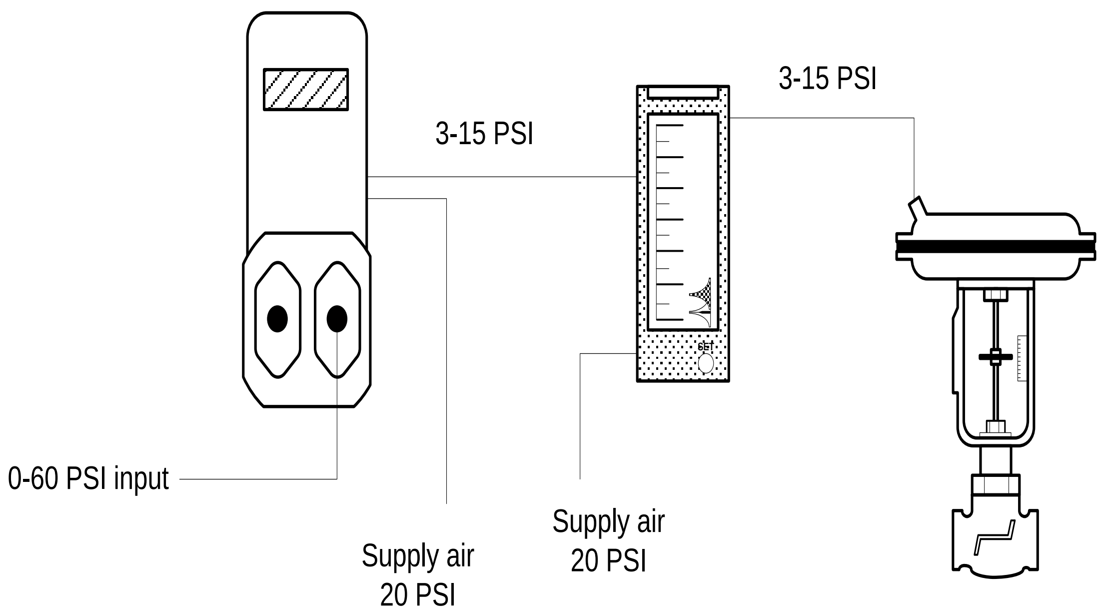


Figure:1

Write down name, model no.& functional specification of each instrument used in this exercise:

Name:________________

Model no._____________

Specifications:

1)__________________

2)__________________

3)__________________

4)__________________

Name:________________

Model no._____________

Specifications:

1)__________________

2)__________________

3)__________________

4)__________________

Procedure:
Connect the loop as per the loop diagram shown below and operate the valve manually and then put the controller in auto mode.

Fill following table:

Sl.No.	Input to Pneumatic Tx in PSI	Output of Tx in (PSI)	Controller Output	Control valve opening in %	Remarks.

Review Questions:
1 - What is the purpose of 0-60 psi input pressure supply?

----
2 - What is the supply pressure?

----

3 - What is the output of Foxboro controller?

Project No.8
Pneumatic control loop connection using Process Calibrator, Foxboro Pneumatic Controller, I/P converter and Control Valve.

Objective:
Connect Pneumatic control loop using Process Calibrator, Foxboro Pneumatic Controller, I/P converter and Control Valve.

Equipment & Tools:

- Process Calibrator
- Pneumatic Controller (Foxboro)
- I/P Converter
- Control Valve
- Connecting tubes
- Screwdriver, Spanners, etc.

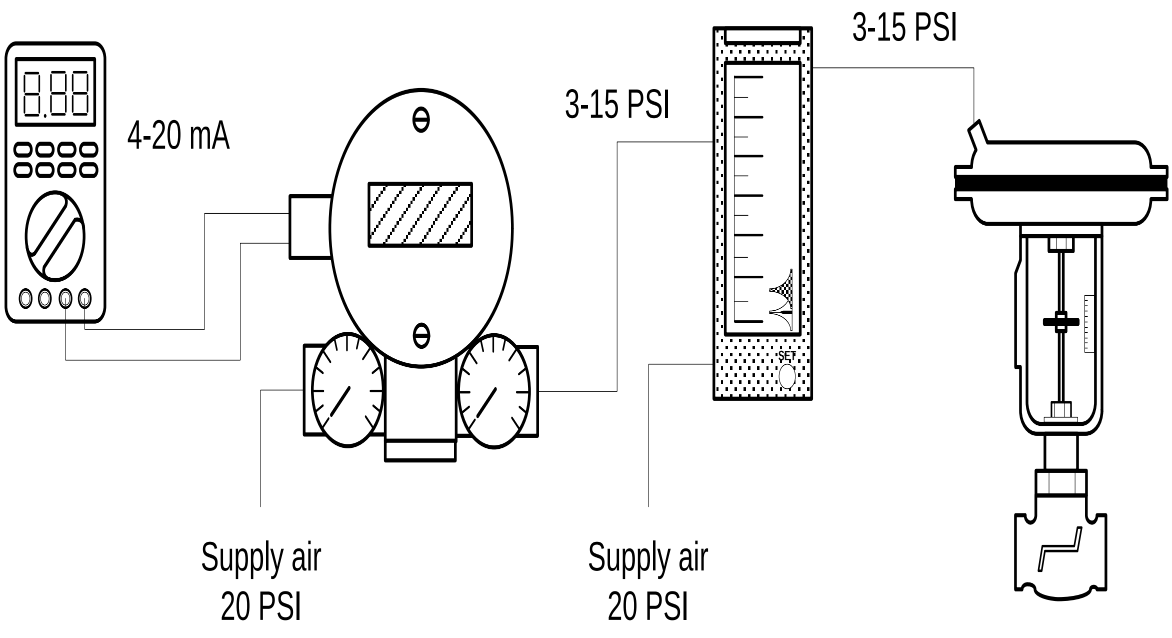


Figure:1

Write down name, model no.& functional specification of each instrument used in this exercise:

Name:________________

Model no._____________

Specifications:

1)_________________

2)_________________

3)_________________

4)_________________

Name:________________

Model no._____________

Specifications:

1 _________________

2 _________________

3 _________________

4 _________________

Procedure:
Connect the loop as per the loop diagram shown below and operate the valve manually and then putting Pneumatic Controller in manual & auto mode.

Fill the following Table:

Sl.No.	Input to I/P converter (mA)	Output of I/P in (PSI)	Controller Output	Control valve opening in %	Remarks.

Review Questions:

1 - What is the purpose of I/P Converter?

----
2 - What happens with increasing and decreasing Current from Calibrator?

----

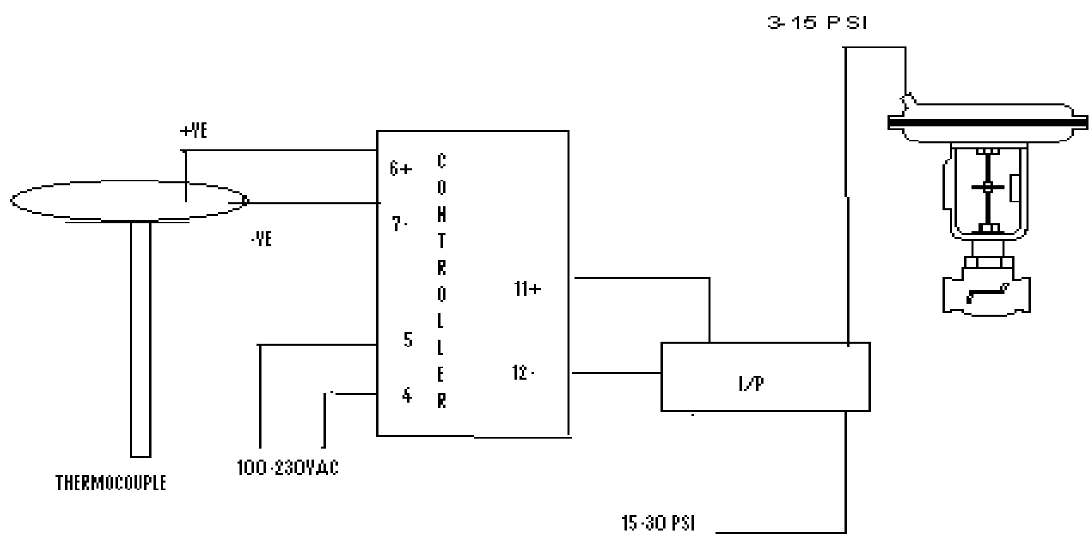
3 – Is it possible to carry out the entire operation without Process calibrator?

Project-9
Electronically Controlling a Control Valve

Objective:
Using OMRON Controller, Pressure Transmitter and Control Valve in a loop, and thermocouple, Operate the Control valve and observe the operation as linear function of temp.

Equipment & Tools:
1) Omron Controller
2) I/p Convertor
3) Thermocouple
4) Connecting tubes
5) Control Valve
6) Screwdriver, spanners, etc.

Procedure :
Connect the loop as per the loop diagram shown in Figure 1 and operate the valve manually and then put the controller in auto mode.



CONTROLLING A VALVE USING ELECTRONIC CONTROLLER IN A LOOP

Figure:1

Write down name, model no.& functional specification of each instrument used in this exercise:

Name:________________

Model no._____________

Specifications:

1)_________________

2)_________________

3)_________________

4)_________________

Name:________________

Model no._____________

Specifications:

1)_________________

2)_________________

3)_________________

4) _________________

1) The +ve terminal of the thermocouple to be connected to the +ve (6) terminal of controller.
2) The –ve terminal of the thermocouple to the –ve (7) terminal of the controller.
3) Connect the supply voltage of 85 -230 vac between 4 and 5 of controller.
4) Connect the o/p +ve (11) and –ve (12) to the i/ps of I/P convertor.
5) Supply a reference air pressure abobe 30 psi to the I/P convertor.
6) Connect the o/p of I/P convertor to the input of Valve.
7) Program the controller for thermocouple input.
8) Manually increase and decrease the values and check the valve for the operation.
9) Take readings as mentioned in the observation table. 1

Observation table: 1

Sr No	Temp	Percentage opening of valve	Current (ma)
1	40		
2	45		
3	50		
4	55		
5	60		
6	65		
7	70		

Review Questions:

1) What is the function of controller?

____

2) What is the function of i/p Convertor?

____

3) What is the necessity of applying 15-30 psi.

____

4) Can we use a RTD or another temp sensor instead of thermocouple?

____

5) Suggest suitable measures to be taken into consideration for modifying?

____

Project-10
Connecting the RTD to a control loop

Objective:
Connect the Temperature Control loop by using RTD, Temperature Transmitter, and a Eurotherm Temp indicator.

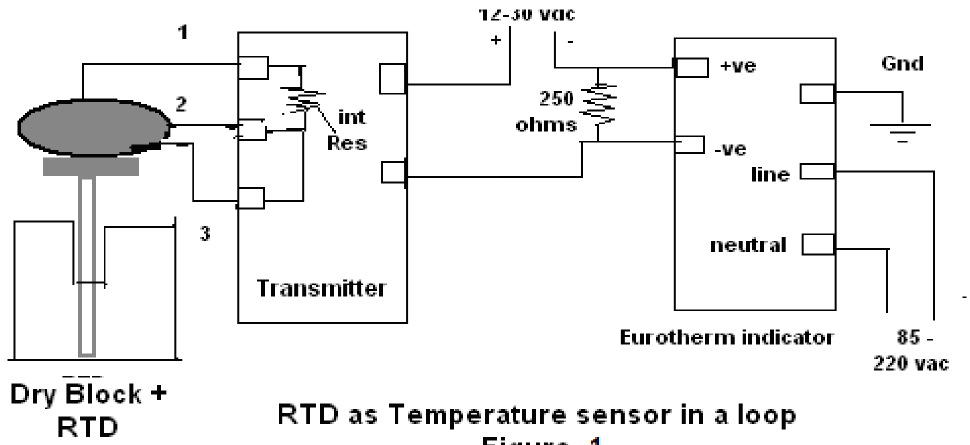
Discussion :
The RTD gets heated up through dry block and temperature transmitter gives corresponding output 4-20 mA signal to the input of the eurotherm indicator. The indicator thus measures this current to display its analogous temperature.

Equipment & Tools :

5) Dry Block (Fluke)
6) RTD
7) Temperature Transmitter
8) Eurotherm indicator
9) 220 ohms resistor
10) Power supply
11) Multimeter
12) Screwdriver, Spanners etc.

Procedure :
Connect the loop as per the circuit diagram shown in the below Figure-2.

1) Check for the given RTD.
2) Measure the resistance between two terminals of RTD and connect it to the terminals on transmitter identified by resistor symbol.
3) Connect the third terminal of the RTD to third terminal of transmitter.
4) Connect +ve terminal of the Xmitter to +ve terminal of Dc Voltage source.
5) Grab the –ve terminal of Dc Voltage source to +ve terminal of Indicator.
6) Connect the –ve terminal of the Indicator to –ve terminal of the Xmitter.
7) Connect line voltage between 85-230 volts to the eurotherm indicator.
8) Check for necessary connections if loose.
9) Take readings as per the observation table.
10) If there is a drift in the reading, identify the cause using calibration.



RTD as Temperature sensor in a loop
Figure -1

Write down name, model no.& functional specification of each instrument used in this exercise:

Name:________________

Model no._____________

Specifications:

1) __________________

2) __________________

3) __________________

4) __________________

Name:________________

Model no._____________

Specifications:

1 __________________

2 __________________

3 __________________

4 __________________

Observations table:

Temp	Standard values	Observed values	Error	Percentage error
30				
35				
40				
45				
50				
55				
60				
65				
70				
75				
80				

Review Questions:

1) What do you conclude from the readings?

____

2) What happens to the indicator if the RTD connection is broken?

____

3) What happens if the supply to the indicator is removed?

____

4) Is it necessary for the RTD to measure the temperature with the indicator ON?

____

5) What is the function of the transmitter?

____

Project No.11
Introduction for Gas detector, sensor calibration and connecting its alarm circuit

M Detcon Model Series X40

Detcon Model Series X40 systems are a family of control products that supervise from 1 to 8 inputs, display the real time status of each input and output critical alarm action in accordance with user configurable requirements. The design is a microprocessor based control circuit that can supervise and display the condition of virtually any type of field mounted gas detection sensor or process control function with a 4-20mA analog signal, a serial RS-485 output or a contact closure.

The controller is completely user programmable. A backlit alpha/numeric display provides real time reading and status for each field device. The display is also used to provide simple menu driven operator interface during system programming including type of input, range of sensitivity, alarm level adjustment and alarm relay configuration. One of the unique features of Model X40 control systems is logging of calibration and alarm history. Historical calibration and alarm data can be displayed on the LCD or the data can be downloaded to a PC via the RS-232 serial port.


Anatomy of an X40 Controller
Design Features
▷ Fully Field Programmable
▷ Simple User Interface
▷ Full Data Logging Capability
▷ Totally Modular Design
▷ Readily Field Replaceable Subassemblies
▷ Flexible Integration Options
▷ Built for Industrial Environments
Backlit LCD Display
Model 440-N4X
Gas Detection / Alarm System
CH1 00 PPM CL2
CH2 00 PPM SO2
CH3 00 PPM H2S
CH4 00 PPM NH3
Front Panel Alarm & Fault LEDs
4 Button User Interface
One Touch
Alarm Reset/
Acknowledge

Figure:1

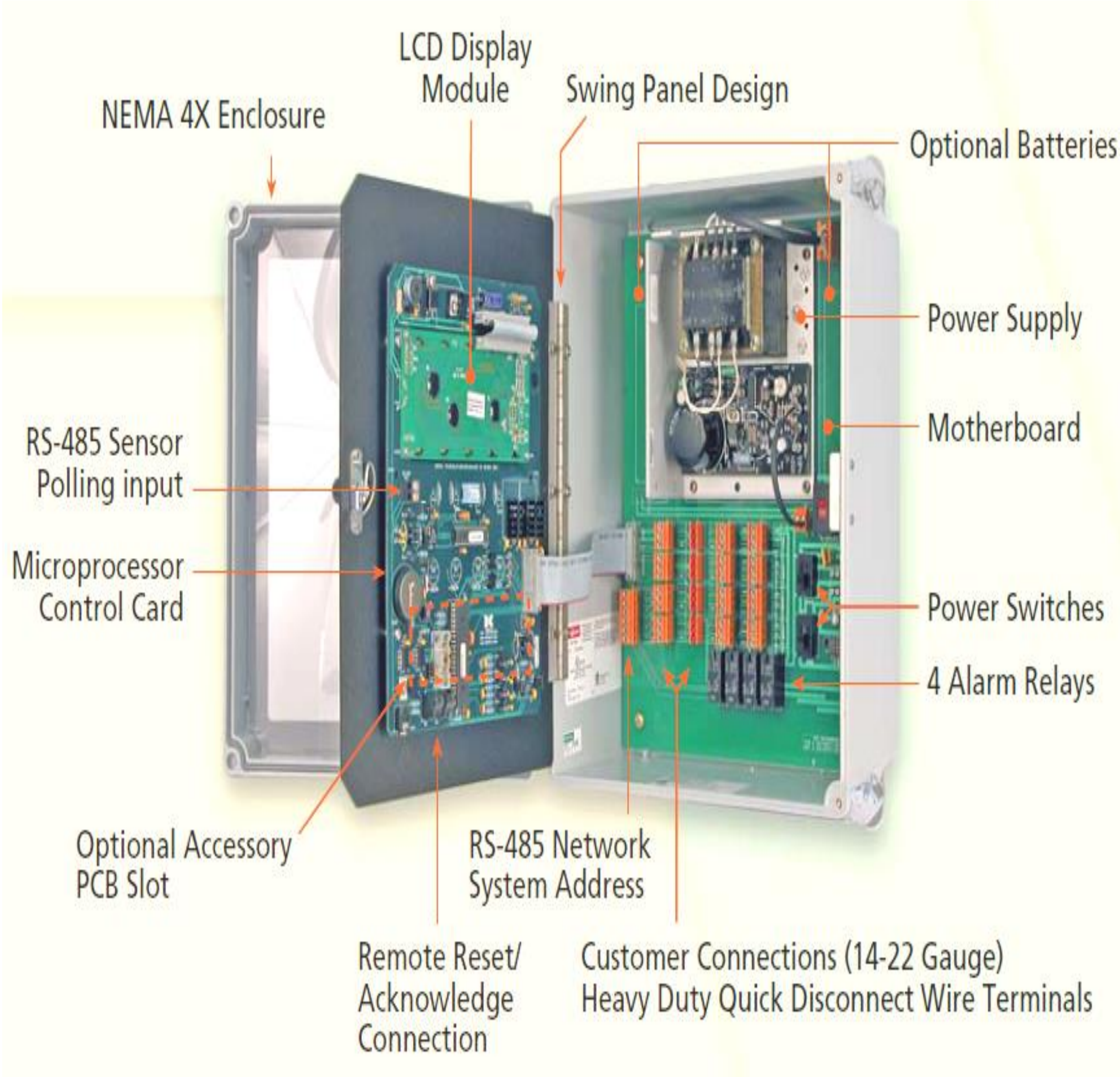

LCD Display
Module
Swing Panel Design
NEMA 4X Enclosure
Optional Batteries
Power Supply
Motherboard
RS-485 Sensor
Polling input
Microprocessor
Control Card
Power Switches
4 Alarm Relays
Optional Accessory
PCB Slot
RS-485 Network
System Address
Remote Reset/
Acknowledge
Connection
Customer Connections (14-22 Gauge)
Heavy Duty Quick Disconnect Wire Terminals

Figure:2

Typical Applications

Oil and Gas Industry
- Remote Well Sites
- Small Treating Plants
- Offshore Production Platforms
- Tank Farms
- Gas Metering Stations

Refining and Petrochemical
- Analyzer Shelters
- Skid Mounted Process Manifolds
- Control Room Air Quality Monitoring
- Loading Racks
- Flare Stacks

Municipal, Waste Water and Sewage Treatment
- Chemical Feed Systems (Chlorine, Sulfur Dioxide)
- Confined Space Monitoring (Wet wells, Dry Wells)
- Digesters and Waste Treatment Plants

Other Industrial Applications
- Underground Vaults
- Fence Line Monitoring
- Beverage and Bottling Processes
- Indoor/Outdoor Air Quality
- Laboratories
- Pulp and Paper Mills
- Fruit and Produce Processing
- Green House Monitoring and Control

Monitoring and Control Options

Gas Detection Sensor Technology
- **Combustible Gas**
  Catalytic & Infrared
- **Hydrogen Sulfide Gas**
  Solid State MOS & Electrochemical
- **Toxic Gas**
  Electrochemical & Photo Ionization
- **Oxygen Deficiency/Enrichment**
  Air Battery Electrochemical

Process Controls
- Pressure
- Temperature
- Humidity
- Flow
- Liquid Level

Safety Controls
- Intrusion
- Thermal
- Smoke
- Flame

Installation & Integration Options

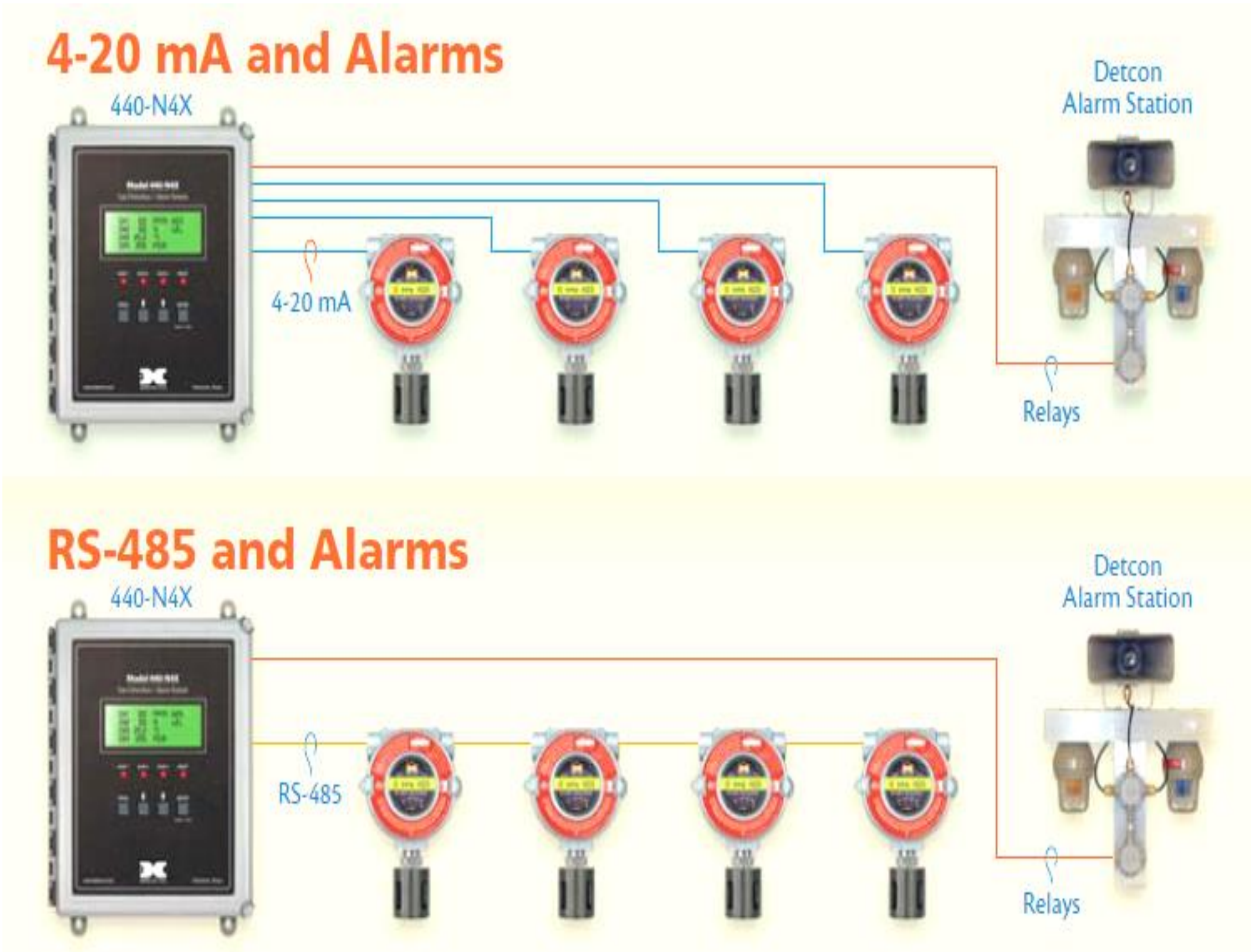


Figure:3

Project No. 12

Connection of plunger-switch control circuit and load circuit

Equipment Details:

Special connectors called Foil blocks are used to connect the foil to the wires which run to the alarm control panel. Foil blocks are also used to allow opening of the window without damaging the Foil when the alarm is turned off.

A major disadvantage of both foil and break wire sensor is that they are prone to damage. Break wires and foil are both very thin and can be damaged when cleaning. Foil can also be damaged near the foil block if the window is opened very often. Break wire and foil must also be repaired or replaced If they are damaged due to a break in attempt. The plunger switch is a rugged device which will operate without failure for a very long time, even when subjected to regular use.

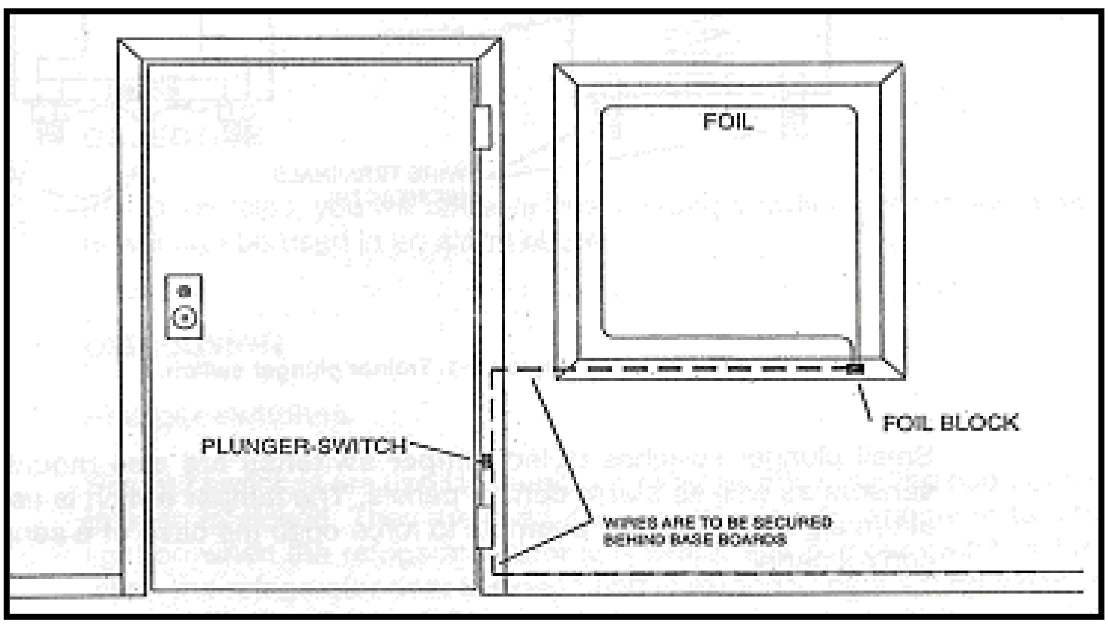


Figure 1: plunger-switch and foil sensor

Figure 1: shows how foil may be applied to a window using a foil block. If the wires connecting the Sensor to the control panel can not be concealed by running them through walls and under floors, then they should be concealed as well as possible by running them behind window trim. Door trim and base boards.

Procedure summary

In this exercise, you will connect a basic plunger -switch circuit and see how a plunger switch operates.

EQUIPMENT REQUIRED
Exploring Sensors trainer
4 electrical leads

Figure:2

Introduction to Mechanical sensors-

The Plunger Switch

Procedure:

1. Connect the plunger –switch control circuit shown in figure 3-3 by performing the following steps:
   a) First, connect a lead between one of the 12-V DC terminals of the power supply and the left terminal of plunger switch S1.

b) Then, connect a lead between the right terminals of plunger switch S1 to the left terminal of relay coil CR1.

c) Finally, connect a lead between the right terminal of relay coil CR1 and one of the common terminals of the power supply.

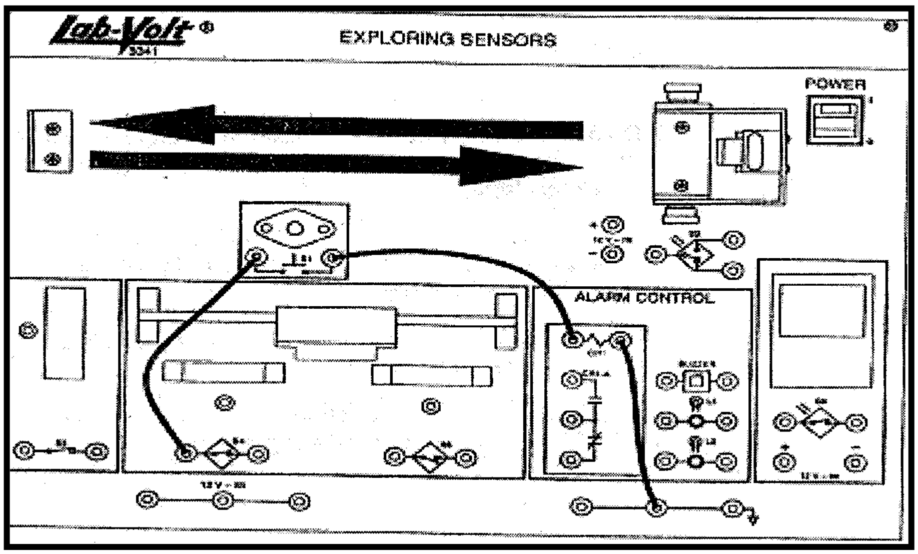


Figure:3 plunger-switch control circuit.

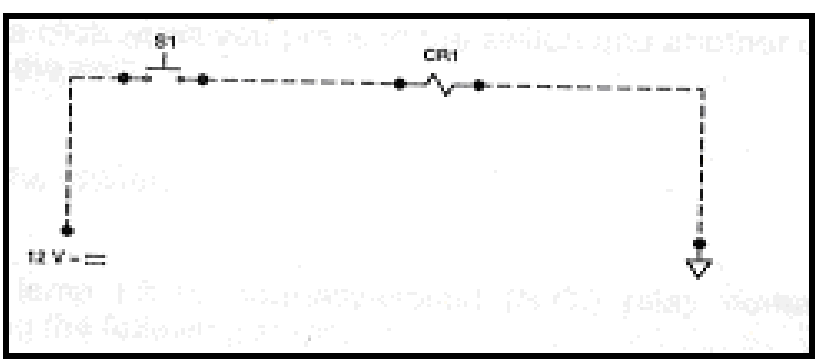


Figure:4 plunger-switch control circuit.

2. Turn on trainer.
3. Press plunger switch S1 two or three times. Every time you press the plunger switch, pair of contacts in the switch touch, allowing the current to flow through them. When the plunger switch is not pressed. Spring pressure keeps the contacts of the switch apart.

Do you hear a clicking sound every time you press and release) plunger switch S1? If you do not, check your connections and compare them to figure 3-3. The clicking sound Is caused by the movement of the armature in the relay. When the relay coil is energized, the magnetic force overpowers the spring holding the armature. The actual click is the armature striking normally -open (N.O) relay contact CR1-A.

4. Turn off the trainer.
5. Do not disconnect the plunger -switch control circuit in Figure.3-3. Connect the plunger-switch load circuit shown in Figure 3-4 by performing the following steps.
    a. First connect a lead between one of the 12-V DC terminals of the power supply and the common (middle) terminal of the N.O. and N,C relay contacts.
    b. Then, connect a lead between normally open relay contact CR1-A and the left terminal of lamp L1.
    c. Finally, connect a lead between the right terminal of lamp L1 and one of the common terminals of the power supply.

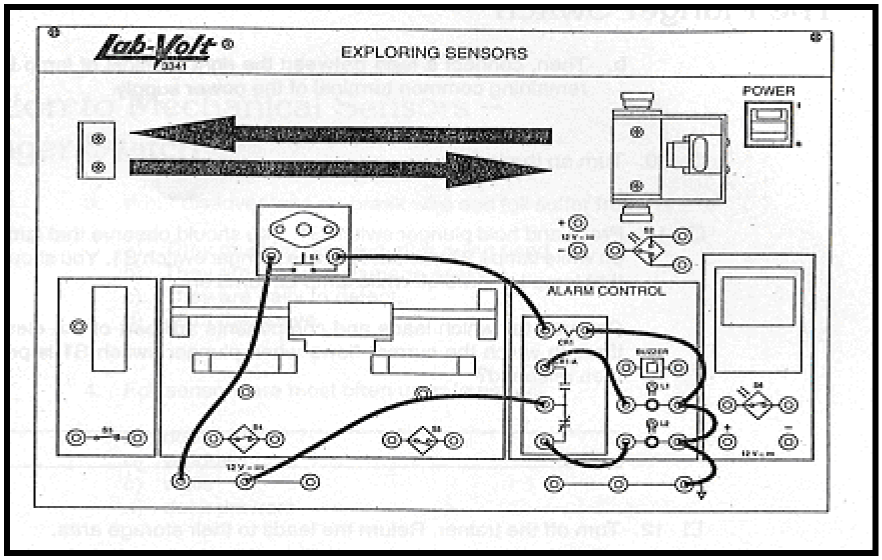


Figure:5 plunger-switch load circuit.

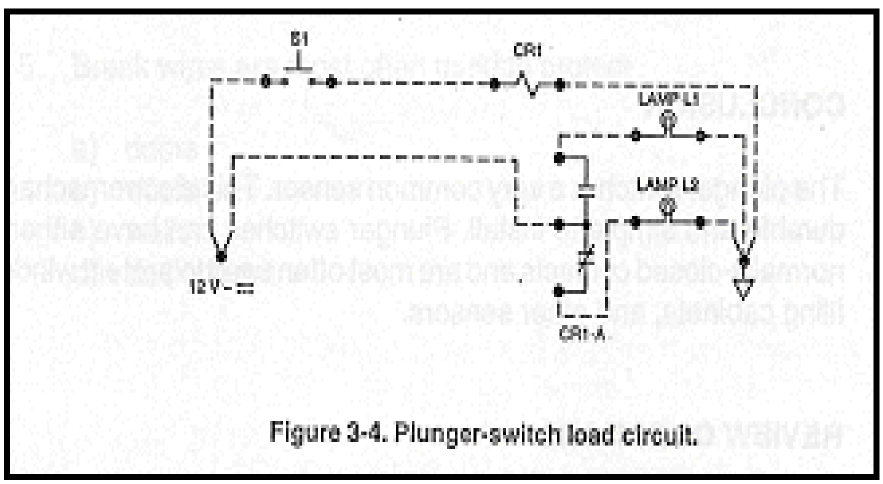


Figure 3-4. Plunger-switch load circuit.

Figure:6 plunger-switch load circuit.

6. Turn on the trainer.
7. Press plunger switch S1 for two seconds and release it. You should have heard one click when you pressed the switch and another click when you released the switch.
8. Turn off the trainer.
9. Connect lamp L2 to normally –closed (N.C.) relay contact CR1-A by performing the following steps:

a. First, connect a lead between N.C. relay contact CR1-A and the left terminal of lamp L2.
b. Then, connect a lead between the right terminal of lamp L2 and the remaining common terminal of the power supply.

10. Turn on the trainer.

11. Press and hold plunger switch S1. You should observe that lamp L1 turns on while lamp L2 turns off. Release plunger switch S1, you should observe that lamp L1 turns off while lamp L2 turns on.

Can you tell which leads and components are part of the electrical path through which the current flows when plunger switch S1 is pressed and then released?

----

12. Turn off the trainer, return the leads to their storage area.

CONCLUSION

The plunger switch is very common sensor. This electromechanical device is both durable and simple to install. Plunger switches can have either normally –open or normally –closes contacts and are most often used to protect windows, doors, desks, filling cabinets and other sensors.

REVIEW QUESTIONS:

1. Which of the following will a plunger switch not protect?

   a. Doors
   b. Walls
   c. Sliding windows
   d. Desk drawers.

2. What is the name of a plunger switch that is used to protect other sensors?

   a. Protection switch
   b. Tamper switch
   c. Sensor switch
   d. Safety switch

Project No.13
Connection of infrared photoelectric Control Circuit and load circuit

Objective: In this exercise, you will connect an infrared photoelectric sensor circuit and see how it operates.

Note: Be sure to follow the steps in the procedure carefully and compare these steps to a diagram often. If the leads are not connected properly, the sensor will not operate as it should and you will end up with improper results.

Equipment required:
1. Exploring sensor trainer.
2. Connecting leads.

Infrared Photo sensor details:

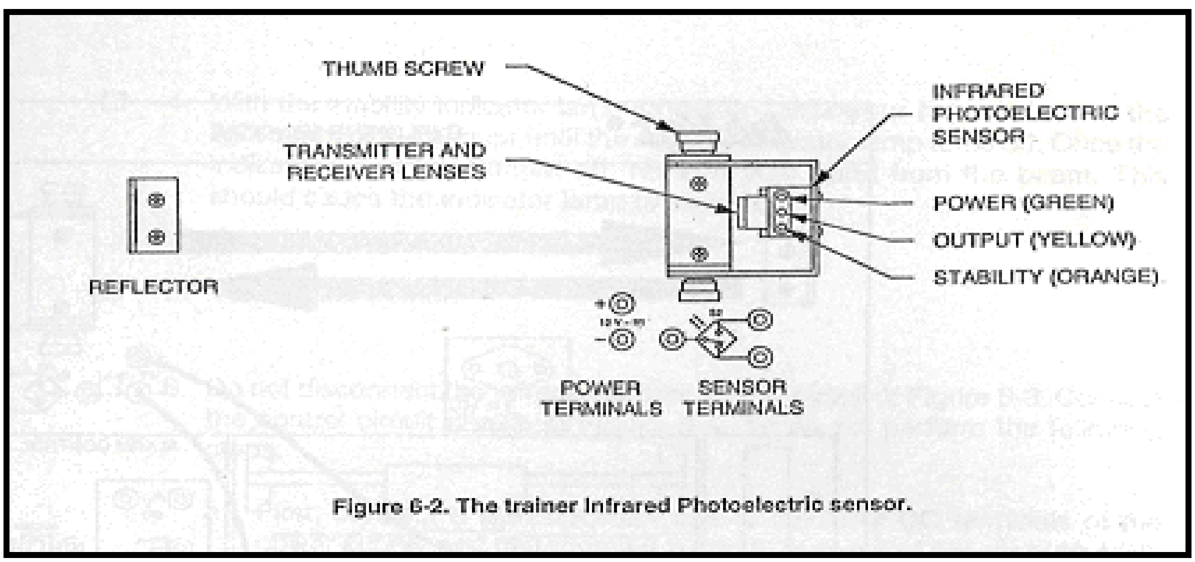


Fig:1 Trainer infrared photoelectric sensor.

1. **Receiver lens:** This lens focuses the reflected infrared light beam onto the interns.' beam sensor located behind the lens

2. **Transmitter lens:** This lens focuses the infrared beam which is projected from within the sensor by an Infrared diode. (An infrared diode is a device which produces infrared light.)

3. **Indicator:** The infrared photoelectric sensor has a power indicator (green L.E.D), an output indicator (yellow LED) that lights when the sensor output is actuated, meaning that a light beam is detected and a suitable indicator (orange LED) that lights when the light intensity of the detected beam exceeds 2.5times the minimum light Intensity that is required to trigger the sensor.

4. **Thumb screws:** The thumb screws are used to align the infrared light beam. They can be loosened by turning them counter clockwise. With the screws loosened, the sensor can easily be aligned with the reflector. Once the sensor is· aligned. The thumb screws should be tightened by turning them clockwise.

5. **Reflector:** The reflector reflects the infrared beam being projected by the infrared diode to the infrared detector located behind the receiver lens.

How the trainer infrared photoelectric sensor works.

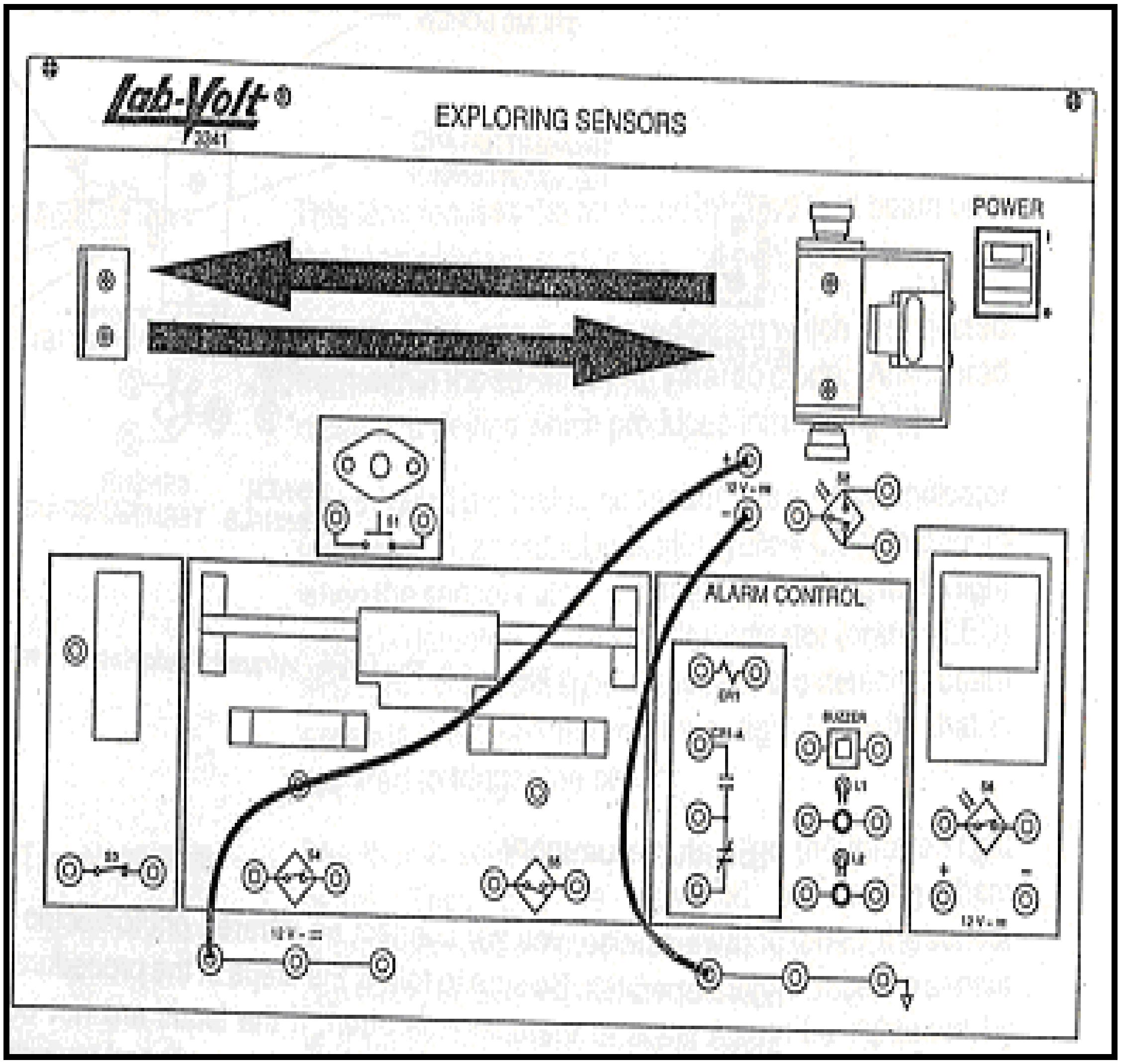
The Infrared diode and transmitter lens emit a light beam that will reflect back to the receiver lens if the reflector is mounted at no more than 3 m (10 ft) away from the sensor. The sensor alarm contacts will remain unchanged. Provided nothing blocks or interrupts the beam. If the beam is interrupted, the relay built into the sensor will trip, causing an alarm. The relay will also trip if power is removed from the sensor. This prevents an intruder from disabling the sensor by cutting its power line. As long as the light beam is interrupted, the alarm will be triggered.

Procedure:

1. Connect the infrared-sensor supply circuit shown in figure 6-3. to do so, perform the following steps:

    a. Connect a lead between one of the 12-VDC terminals of the power supply and the positive (+) supply terminal of the infrared photoelectric sensor.

    b. Connect a lead between one of the common terminals of the power supply and the common (-) supply terminal of the infrared photoelectric sensor.



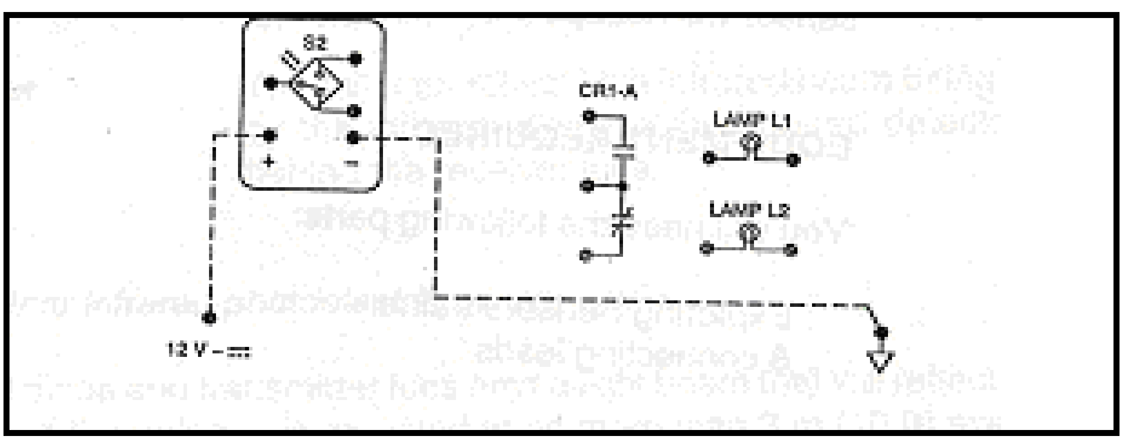


Fig: 2 Infrared photoelectric sensor supply circuit.

2. Turn on the trainer.
3. Wait a few seconds and observe the operation of the sensor indicator lamps. If the power indicator lamp turns on but the output and stability indicator lamps do not, this means that the infrared photoelectric sensor is powered, but it is not correctly aligned. To align the sensor, loosen the thumb screws by turning them counterclockwise. Adjust the angle of the beam by tilting the sensor towards the reflector until both the output and stability indicator lamps turn on. Once the sensor is aligned, tighten the thumb screws. Be careful not to over tighten the thumb screws.
4. With the stability indicator lamps turned on, pass your hand in front of the light beam of the sensor until the stability indicator lamp turns off. Once the indicator lamp has turned off, remove your hand from beam. This should cause the indicator lamp to turn on.
5. Turn off the trainer.
6. Do not disconnect the infrared-sensor supply circuit of Fig 6-3.Connect the control circuit shown in figure 6-4. To do so , perform the following steps:
   a. First, connect a lead between one of the 12-V DC terminals of the power supply and the common (middle) terminal of sensor output S2.
   b. Then, connect a lead between the normally-open contact of sensor output S2 and the left terminal of relay coil CR 1.
   c. Then, connect a lead between the right terminal of relay coil CR1 and one of the common terminals of the power supply.
7. Turn on the trainer. Pass your hand in front of sensor S2.Did you hear a clicking sound when the beam was broken and the output indicator lamp turned off? If you did not check your connections and compare them to a fig .6-4.
8. Do not disconnect the circuits of figure 6-3 and 6-4. Connect the load circuit shown in fig. 6-5. To do so , perform the following steps:
   a. First, connect a lead between one of the 12-V DC terminals of the power supply and the common (Middle) terminal of relay contacts CR1-A.
   b. Then, connect a lead between normally-open relay contact CR1-A and the left terminal of lamp L1.
   c. Finally, connect a lead between the right terminal of lamp L1 and one of the common terminals of the power supply.
9. Pass your hand in front of sensor S2. You should hear a click when you break the light beam.
   What occurs in the load circuit when the light beam is broken? Does lamp L1 represent an alarm?
   a. YES.
   b. NO.

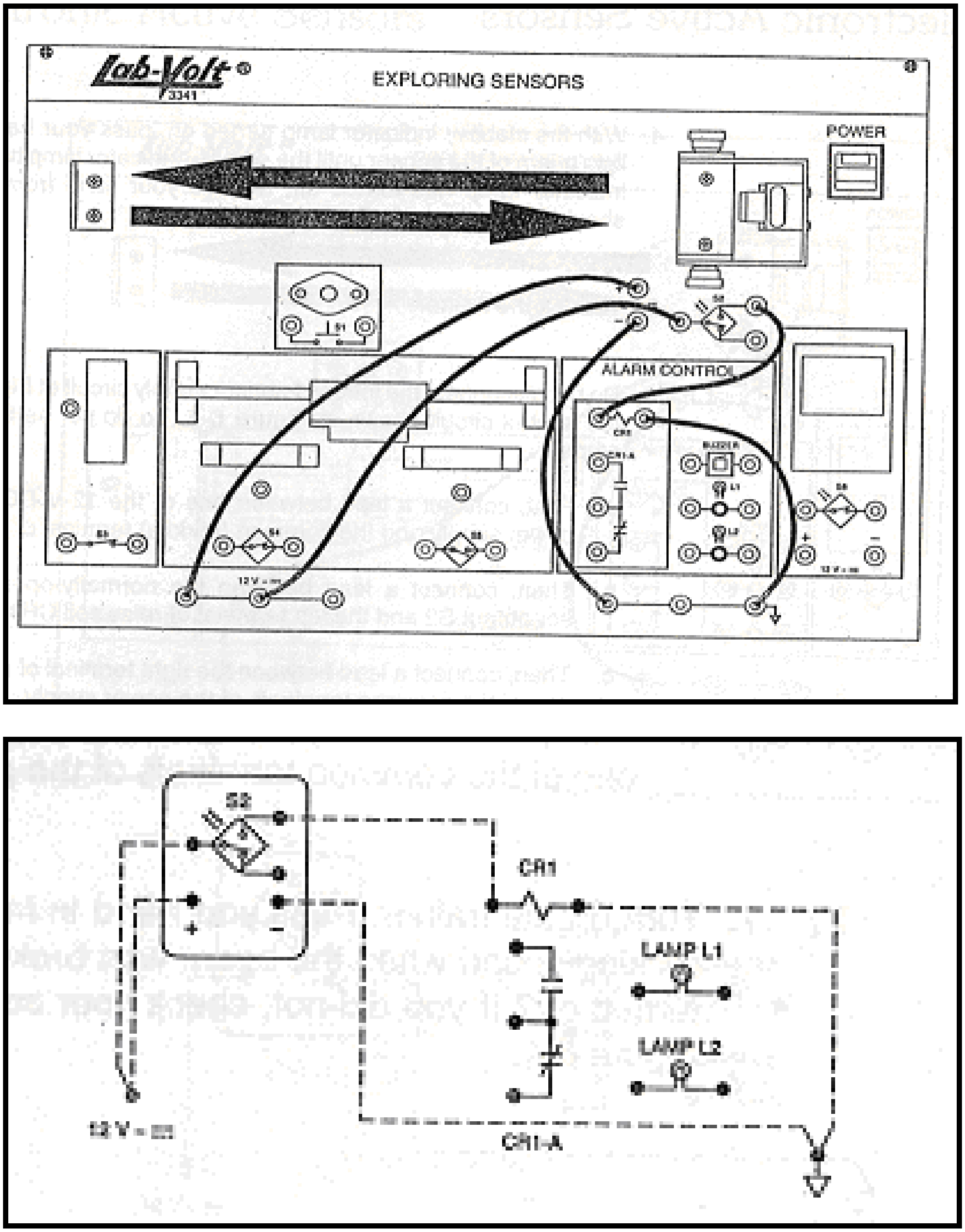
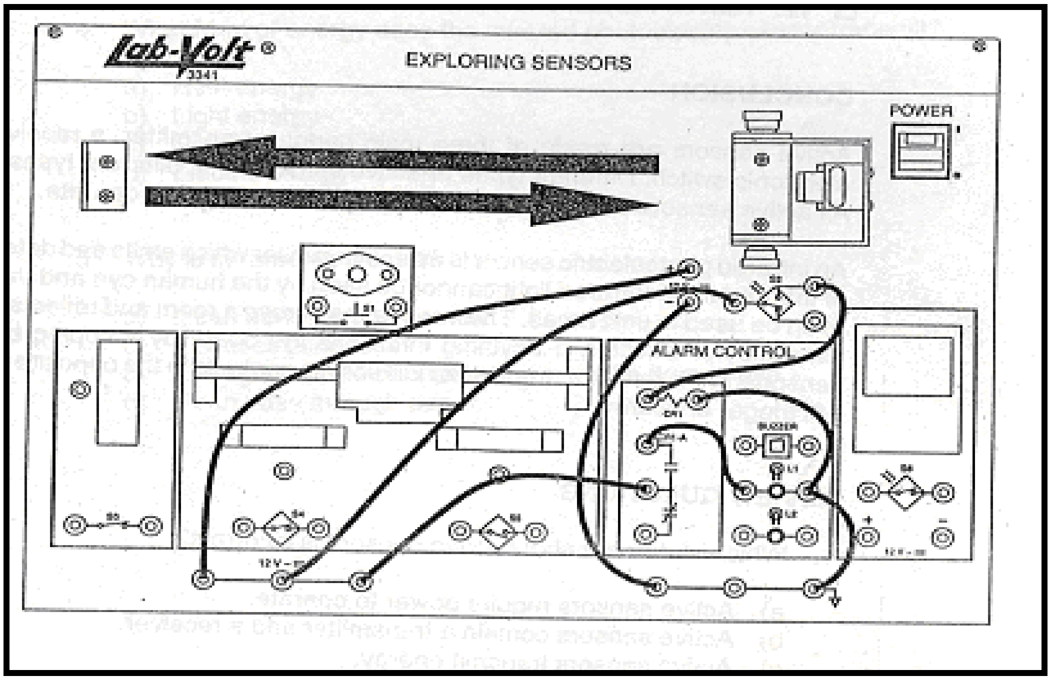


Fig. 3 Infrared Photoelectric sensor control circuit.



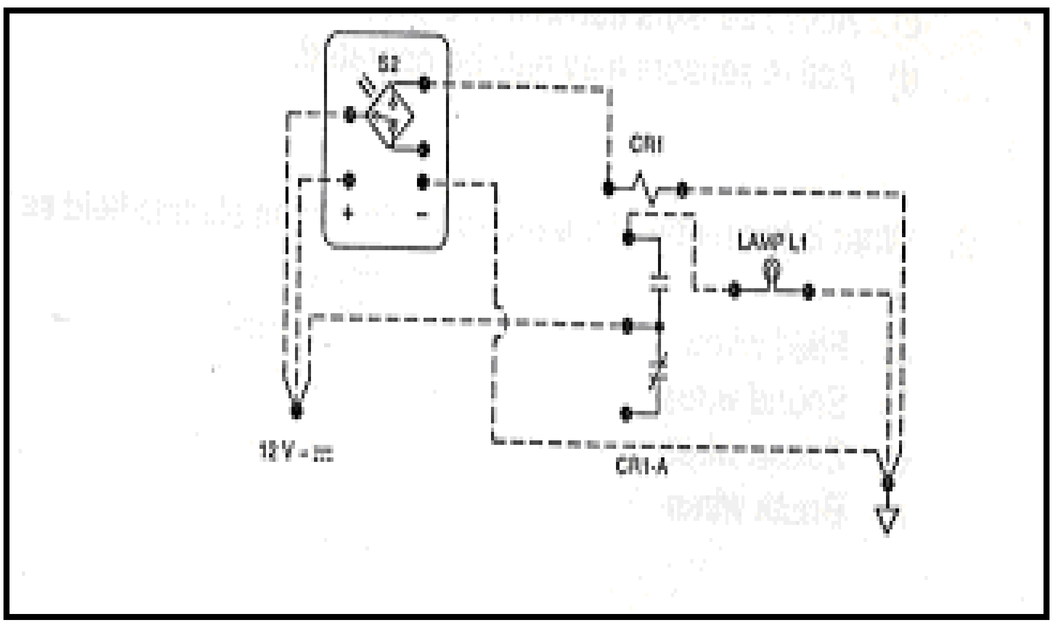


Fig. 4 Infrared Photoelectric sensor load circuit

10. Try using other items to break the light beam such as glass or clean plastic, Use whatever is available in the room and experiment with as many different things as possible.

11. Remove the lead connecting the common (-) supply terminal of sensor S2 to the common terminal of the power supply and observe what happens to lamp L1.

Based on what you observed, would disconnecting the supply leads to sensor S2 trigger an alarm signal?

a. YES
b. NO

12. Turn off the trainer, return the leads to their storage area.

CONCLUSION:

Active sensors are made of three main parts: a transmitter, a receiver and an electronic switch. Different types of active sensors emit different types of energy. All active sensors therefore require some form of energy to operate.

An infrared photoelectric sensor is an active sensor which emits and detects a beam of infrared light. Infrared light cannot be seen by the human eye and therefore can even be used in unlit areas. The beam aims across a room and reflects back to the sensor by reflector. If anything interrupts the beam by stepping between the sensor and the reflector, the sensor will shift it's contacts to the opposite state, which will trigger an alarm.

REVIEW QUESTIONS:

1. Which statement about active sensor is incorrect?

a. Active sensor require power to operate
b. Active sensor contains a transmitter and a receiver.
c. Active sensor may only be operated

2. What is the name of the receiver wires in an electric –field sensor?

a. Field wires
b. Sound wires
c. Sense wires
d. Break wires.

3. What form of energy does an ultrasonic sensor transmit?

a. Heat energy
b. Light energy
c. Sound energy
d. Electric energy.

4. What form of energy does the infrared photoelectric sensor transmit?

a. Heat energy
b. Light energy
c. Sound energy
d. Electric energy.

5. Why is infrared light used?

a. It can bend around corners
b. It causes blindness
c. The light emits cannot be seen by the human eye.
d. It can pass through paper.

Project:14
Soldering and wire splicing Techniques

1) Soldering Electronic Components

The steps below outline the basic procedures for preparing, soldering and inspecting many kinds of electronic components. With a few tools and a little patience you will have no trouble assembling, testing and displaying your kit.

Tools needed:

- Soldering iron
- Soldering iron stand with a wet sponge
- Electronic solder
- Needle nose pliers
- Side cutters

Procedure:

Bend the component leads to fit the holes on the board.

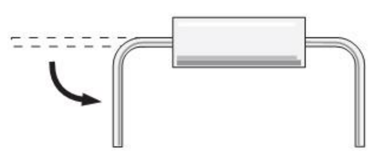


Figure:1

Insert the component, observing any special orientation it may require. Bend the leads enough to hold the part flush against the board, but do not over bend.

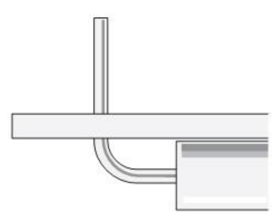


Figure:2

Wipe the tip clean and tin with a small amount of solder.

Heat the joint by placing the soldering iron's tip against both the component lead and the circuit board pad.

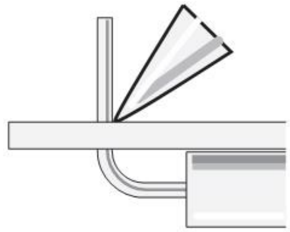


Figure:3

After a moment of heating, touch the solder to the lead and pad only. (If touched on the iron it will blob up.) When the solder flows, remove it and hold the tip in place for one second. Remove the iron without moving the part or board and let the joint cool.

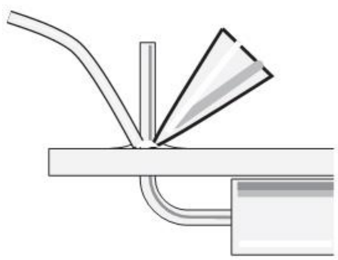
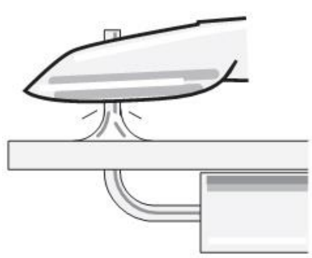


Figure:4

Trim excess component lead with the side cutter. Parts with short leads do not need to be trimmed.



Inspect the joint.

Figure:5

- A good joint blends the lead and pad smoothly together, and has a smooth, bright finish
- If the joint looks like a ball, a blob, if it bulges or bridges to other pads, remelt it, and remove the excess solder with the soldering iron.

Solder Coverage

The final key to a successful solder joint is to apply an appropriate amount of solder. Too much solder is an unnecessary waste and may cause short circuits with adjacent joints. Too little and it may not support the component properly, or may not fully form a working joint. How much to apply, only really comes with practice. A few millimeters only, is enough for an "average" p.c.b. joint, (if there is such a thing).

Desoldering methods

A soldered joint which is improperly made will be electrically "noisy", unreliable and is likely to get worse in time. It may even not have made any electrical connection at all, or could work initially and then cause the equipment to fail at a later date! It can be hard to judge the quality of a solder joint purely by appearances, because you cannot say how the joint actually formed on the inside, but by following the guidelines there is no reason why you should not obtain perfect results.

A joint which is poorly formed is often called a "dry joint". Usually it results from dirt or grease preventing the solder from melting onto the parts properly, and is often noticeable because of the tendency of the solder not to "spread" but to form beads or globules instead, perhaps partially. Alternatively, if it seems to take an inordinately long time for the solder to spread, this is another sign of possible dirt and that the joint may potentially be a dry one.

There will undoubtedly come a time when you need to remove the solder from a joint: possibly to replace a faulty component or fix a dry joint. The usual way is to use a desoldering pump which works like a small spring-loaded bicycle pump, only in reverse! (More demanding users using CMOS devices might need a pump which is ESD safe.) A spring-loaded plunger is released at the push of a button and the molten solder is then drawn up into the pump. It may take one or two attempts to clean up a joint this way, but a small desoldering pump is an invaluable tool especially for p.c.b. work.

Sometimes, it's effective to actually add more solder and then desolder the whole lot with a pump, if the solder is particularly awkward to remove. Care is needed, though, to ensure that the boards and parts are not damaged by excessive heat; the pumps themselves have a P.T.F.E. nozzle which is heat proof but may need replacing occasionally.

An excellent alternative to a pump is to use desoldering braid, including the famous American "Soder-Wick" (sic) or Arcola "TISA-Wick" which are packaged in small dispenser reels. This product is a specially treated fine copper braid which draws molten solder up into the braid where it solidifies. The best way is to use the tip of the hot iron to press a short length of braid down onto the joint to be de-soldered. The iron will subsequently melt the solder, which will be drawn up into the braid. Take extreme care to ensure that you don't allow the solder to cool with the braid adhering to the work, or you run the risk of damaging p.c.b. copper tracks when you attempt to pull the braid off the joint.

I recommend buying a small reel of de-soldering braid, especially for larger or difficult joints which would take several attempts with a pump. It is surprisingly effective, especially on difficult joints where a desoldering pump may prove a struggle.

Here's a summary of how to make the perfect solder joint.

1. All parts must be clean and free from dirt and grease.
2. Try to secure the work firmly.
3. "Tin" the iron tip with a small amount of solder. Do this immediately, with new tips being used for the first time.
4. Clean the tip of the hot soldering iron on a damp sponge.
5. Many people then add a tiny amount of fresh solder to the cleansed tip.
6. Heat all parts of the joint with the iron for under a second or so.
7. Continue heating, and then apply sufficient solder only, to form an adequate joint.
8. Remove and return the iron safely to its stand.
9. It only takes two or three seconds at most, to solder the average p.c.b. joint.
10. Do not move parts until the solder has cooled.

2) Splicing using wire nuts

This technique is acceptable for home applications where the wire is not moving in. But in cars they tend to vibrate off the wire. These also have a higher added resistance than other methods.

Strip back about half to one inch of the insulation of both wires to be spliced

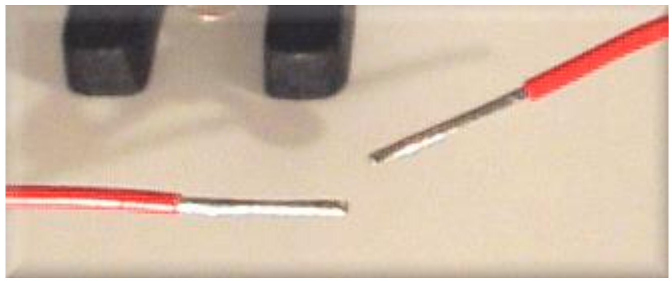


Figure:1

Twist the wires as shown in the figure below

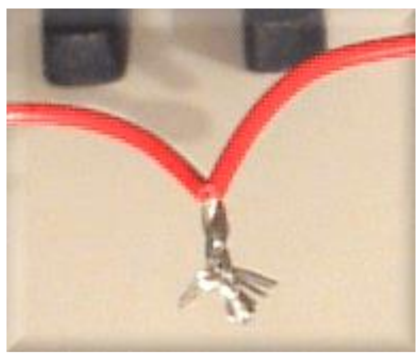


Figure:2

Use the wire nuts to cover the joint.

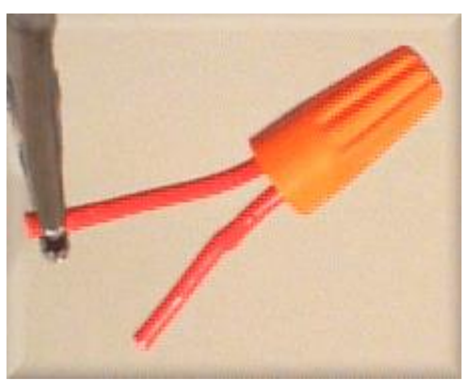


Figure:3

3) Butt Splicing

This technique the best for all splicing needs, although it takes more time to do than wire nuts.
Strip back about an inch of insulation off of all the wires to be butt-soldered.

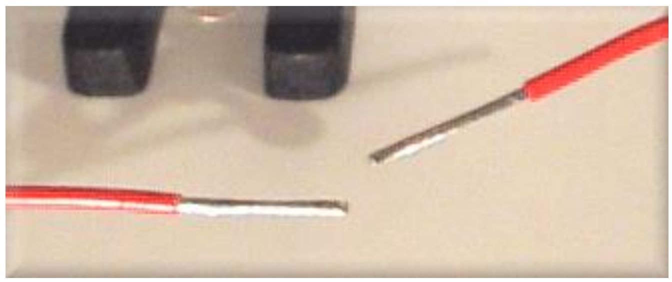


Figure:4

Install heat-shrink tubing on one of the wires. Make sure the length of the tubing can cover the splice.

Holding the wires at a 90 degree angle to each other in the middle of the stripped end, start twisting the wires around each other along the wire length. This type of connection is called a "Western Union" splice.

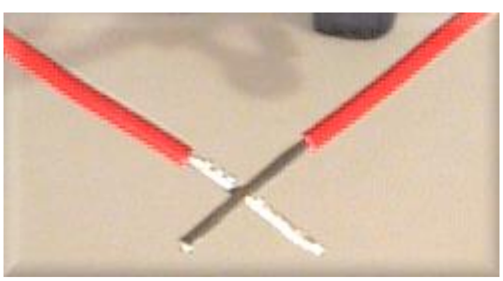


Figure:5

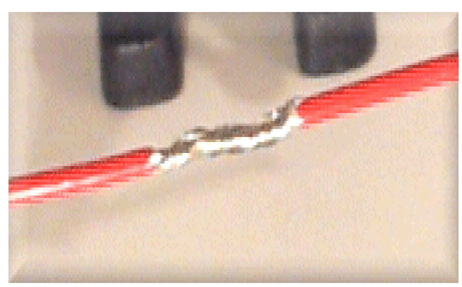


Figure:6

Make sure the soldering iron you have has a tinned head. Hold the iron on the wire until a little solder flows into the wire. Now apply the solder to the point where wire and iron meet letting solder be drawn into the whole connection.

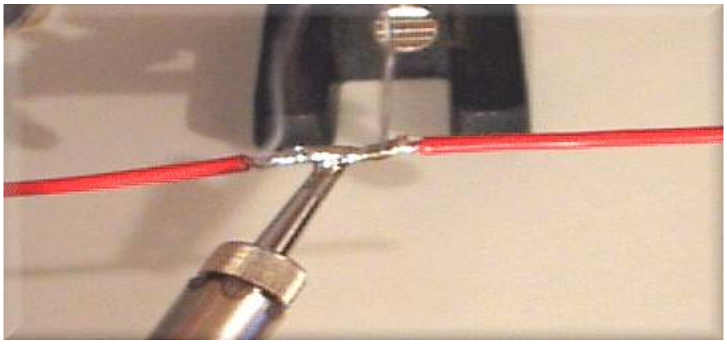


Figure:7

Allow the joint to cool down. Run your fingers over the entire length of the solder to make sure no wires are sticking out that might pierce the insulation. If you find any, use your pliers to smooth them out.

Slide the heat-shrink tubing over the connection. Use a torch or a heat gun to shrink the tubing. Be careful not to scorch the heat shrink.

Figure:8

A better way than twisting the wires is to use splice clips and crimping them with the crimping tool. This will tightly hold the wires together, then solder the connection to strengthen it further.

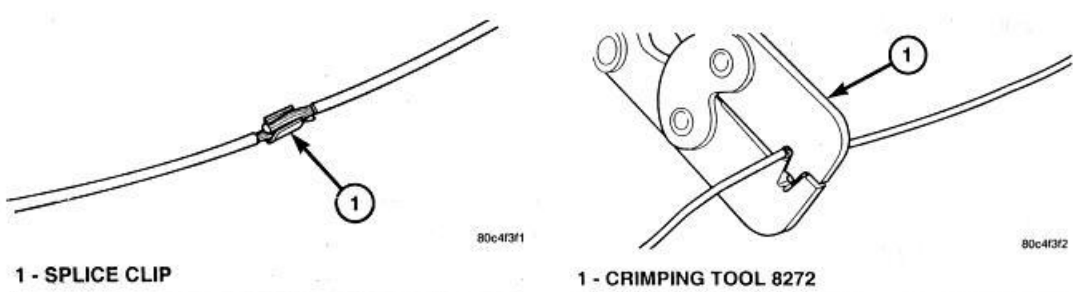


Figure:9

Project-15
Auto/manual Start/Stop level Control

Figure:1

Objective: To build a small project to distribute water from main storage tank to distribution tank in Automatic mode using relay logics ,along with provision to control level in manually also.

Equipment & Tools:

- Pump 110vac
- Isolator circuit breaker 10 Amp.
- Start & Stop pushbutton switches
- Solenoid valve.
- Dual contact level switch
- Auto/manual selector switch.
- Start & Stop Indicator lamp assembly.
- Contactors relay assembly.
- Storage & Distribution Tanks Approx. 10-15 liters.

Procedure:

1. Identify all the equipments required for project.
2. Make sure the incoming electrical supply is not plugged and Circuit breaker in “OFF” condition.
3. Make connections as shown in “Electrical wiring Diagram”
4. Test your circuit connections using Multimeter by simulating “Start”, “Stop “ , “Auto/manual “ change over switch & Level switch.
5. Make sure there is enough water (up to 80%) in storage tank, If not get it filled.
6. Fix the main incoming supply plug to 110vac distribution board. And switch ON the main breaker on level control system.
7. Check the manual valve “V1” at Pump Discharge is fully open and outlet valve at distribution tank is fully open
8. Keep the Auto/ Manual selector in Manual position and start the Pump and observe that water is flowing from storage tank to distribution tank and there is no leak from joints.
9. Now keep the selector switch in “Auto” position and observe that pump (P1) stops when level in distribution tank reaches level marked on distribution tank.
10. Keep observing the level in distribution tank. Once level reaches the low mark on distribution tank pump P1 starts automatically.
11. Observe the “Run “and “STOP” lamps glowing depend upon Pump p-1 status.

Electrical Logic Diagram:

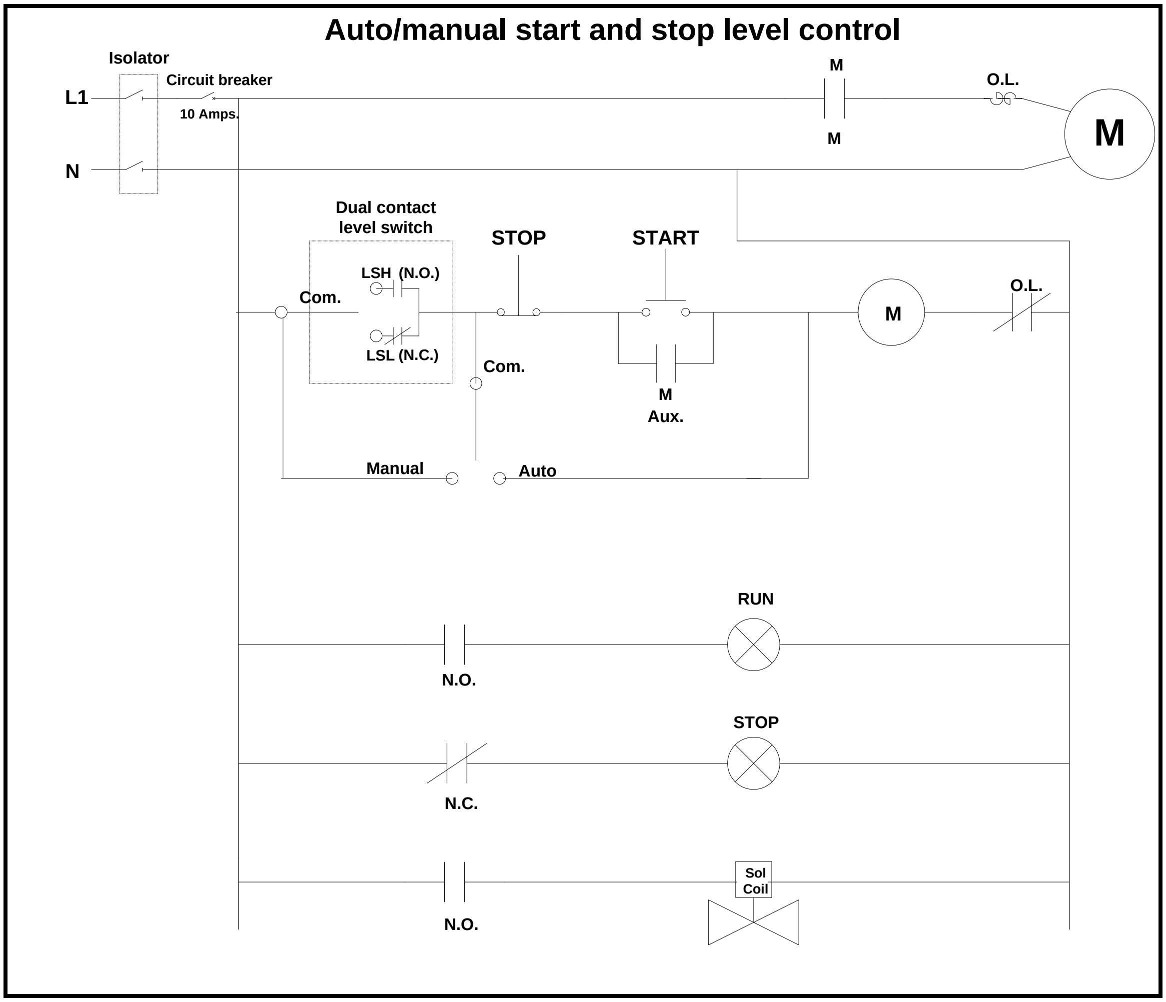


Figure: 2

Piping Diagram:

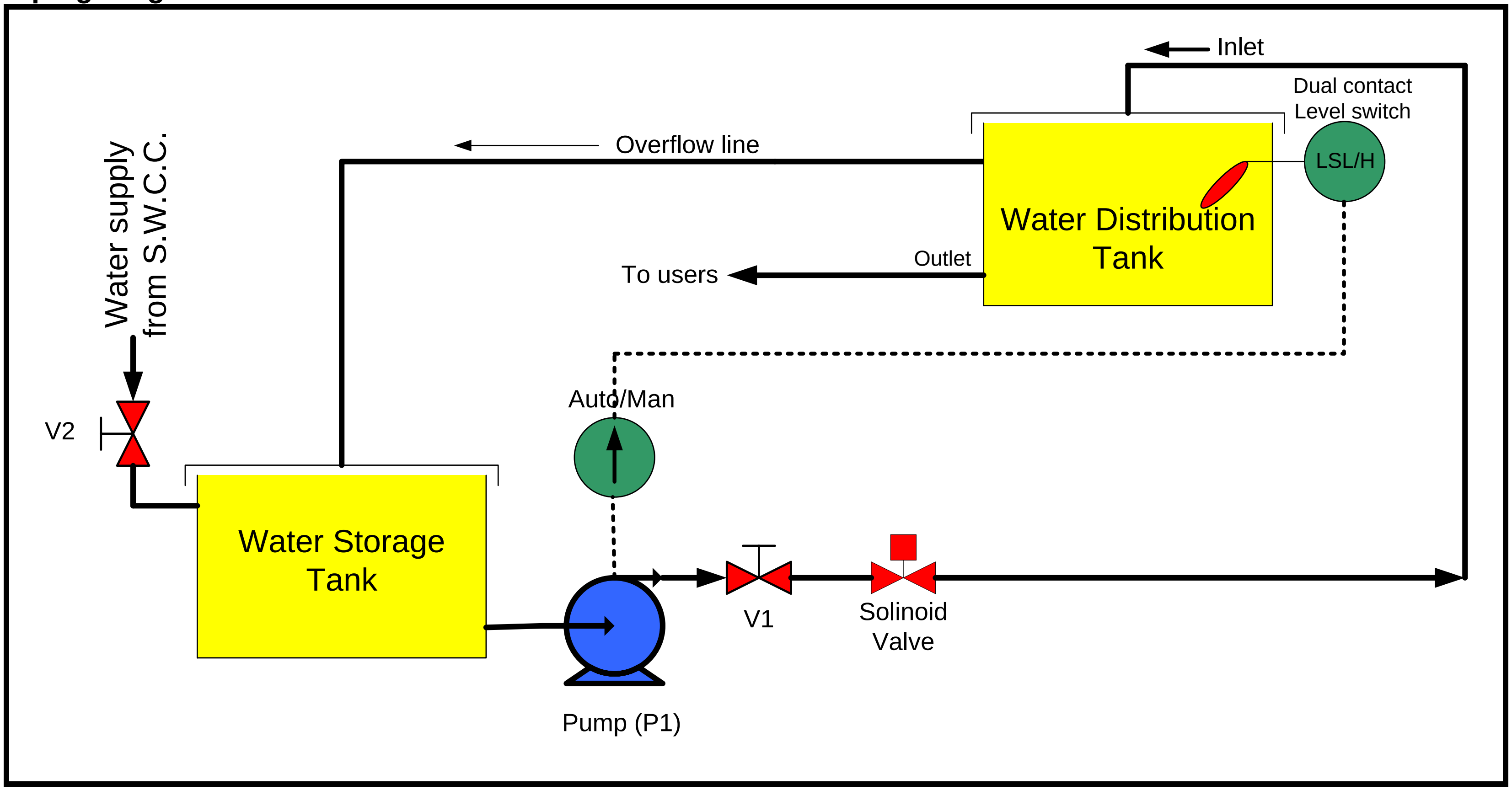


Figure: 3

Electrical wiring Termination Diagram:

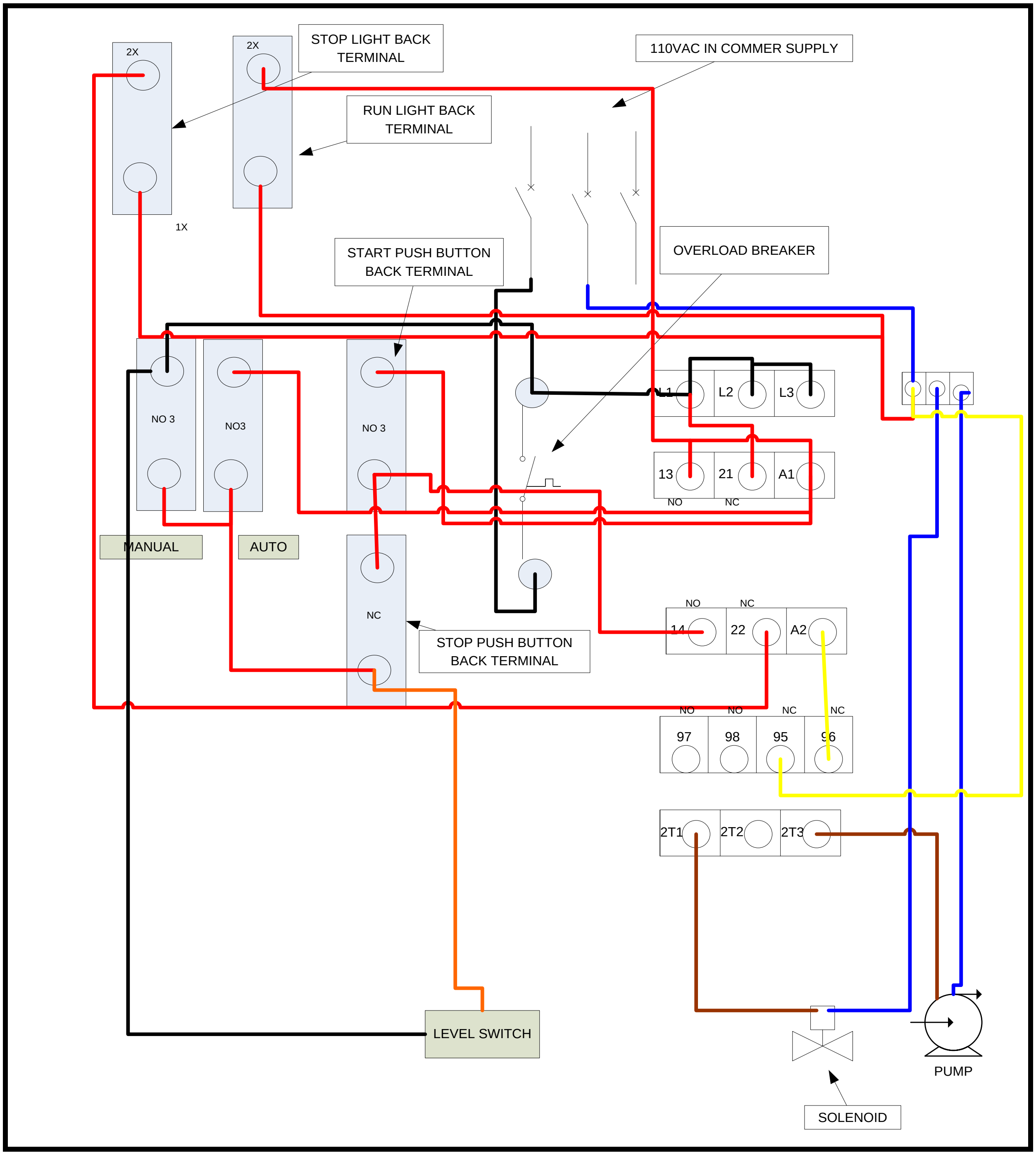


Figure 4: Electrical wiring Diagram Auto / Manual Start/Stop Level Control

Review Questions:

1 - What is the purpose of Dual contact level switch?

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2 - What happens when water level in distribution tank increases & decreases?

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3 – Why do we need Auto/manual Switch?

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4 – Why do we need Auto/manual Switch?

----

5 – When solenoid valve opens and what is its purpose?

Project:16
Exploring control circuits.

Objective: To familiarize the student with lab Volt 3343-00, exploring electricity equipment to learn to build variety of control circuits using wire leads, relay switches, resistors and Lamps.

Equipment:

Exploring Electricity Lab Volt 3343-00.

Wire leads.

Figure:1

Equipment Details:

Lab-Volt's Exploring Electricity self-contained trainer delivers ground-level instruction in the basics of electricity. A transparent front panel window gives students an opportunity to visually explore otherwise unseen parts and

sections of components such as resistors, the rear of switches, and the potentiometer
Features include a permanently mounted digital multimeter, switches, a relay, a potentiometer, and indicator lamps. A built-in 15-inch wide top-mounted storage area with cover conveniently stores cables used by students. This trainer is circuit-breaker protected and has a reset switch on rear panel
Exploring Electricity teaches students the basic characteristics of simple electrical circuits. The Module is supplied with a built-in regulated 12-Vdc power supply. Other components include a digital multimeter, and electric relay, and an assortment of lamps, switches, and resistors.

Students build a variety of circuits using wire leads. There are series circuits, parallel circuits, and logic circuits. Students also learn how to calculate electric values and measure them with a digital multimeter.

The equipment contains following components:

- Regulated 12 Vdc power supply
- Digital Multimeter
- Assorted resistors
- Electromechanical relay
- Fan used as a circuit load
- Switches, relays, and indicator lamps

Exercise 1: working with series circuit.

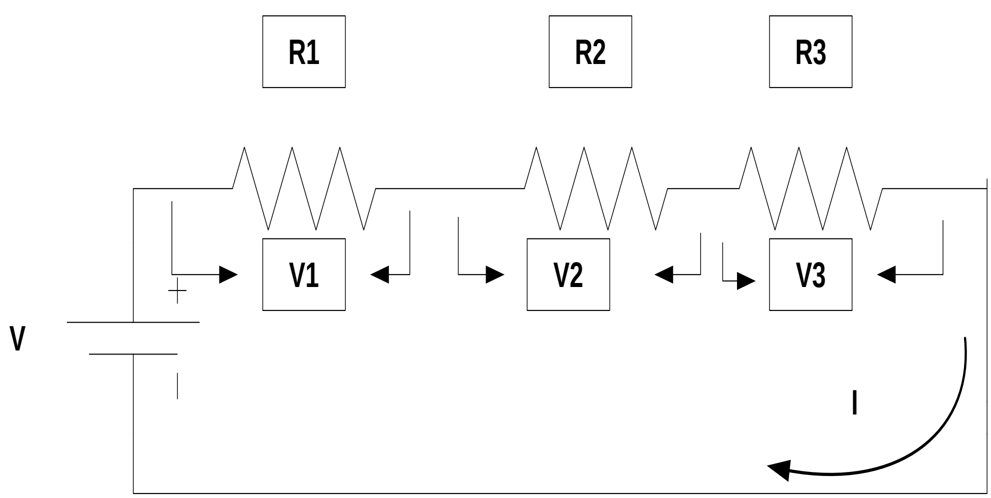

Figure: 2

Steps:

1. Build a series circuit as shown above with resistors R1, R2 and R3.
2. Measure voltages V1, V2 and V3 and fill the table shown below.

Sl.No	**V1**	**V2**	**V3**	**V1+V2+V3**	**V- source voltage**

3. Verify that source voltage is equal to sum of voltage drops across resistors. V= V1+V2+v3.
4. Measure the current flowing in the circuit by connecting multimeter in series

   I = mA.

5. Calculate the value of resistors R1,R2 and R3 and fill the table below

   R1= V1/I , R2= V2/ I and R3 = V3/ I

Sl.No	R1	R2	R3

6. Now directly measure the resistance of resistors R1, R2 & R3 using multimeter and compare with the calculated Resistance value in the table.

Exercise 2: Produce Binary “0” and Binary “1” logic by constructing following circuit.

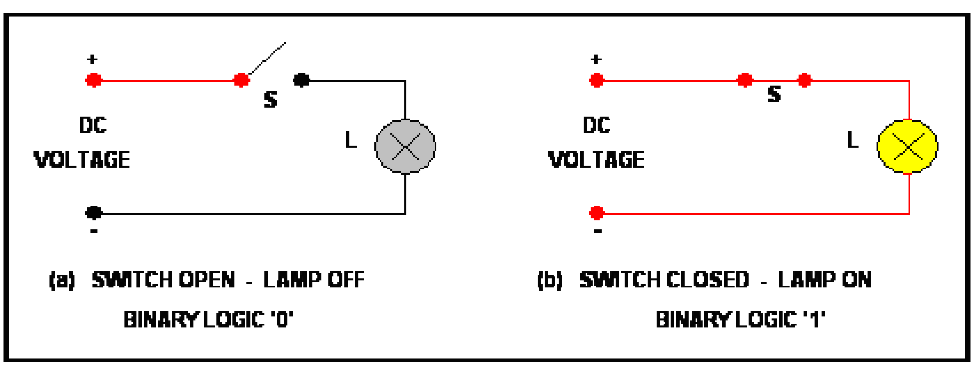

Figure: 3

Conclusion: The switch (and lamp) can only have two logic states:

Logic Status '0' - **OFF** (or **OPEN**)

Logic Status '1' - **ON** (or **CLOSED**)

Exercise 3: Construct a logic control circuit shown below and verify truth table.

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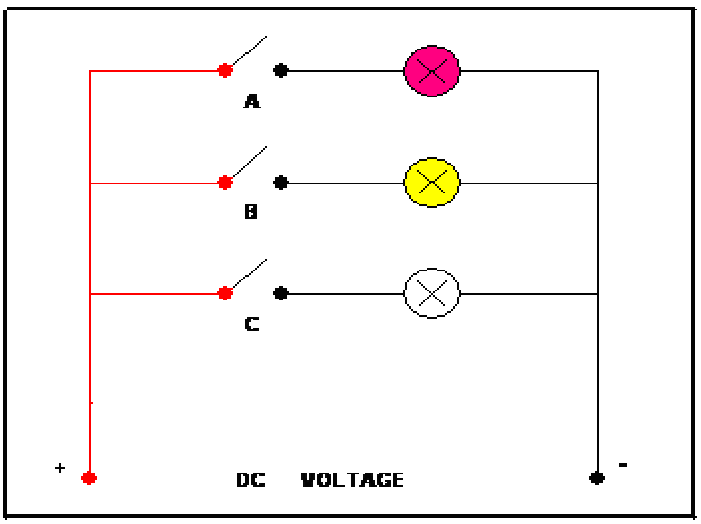

Figure: 4

Verify the table below for the above circuit:

SWITCH A	**SWITCH B**	**SWITCH C**	**Lamp status Red, Yellow, White (Binary Code)**	**Decimal Code.**
0	0	0	000	0
0	0	1	001	1
0	1	0	010	2
0	1	1	011	3
1	0	0	100	4
1	0	1	101	5
1	1	0	110	6
1	1	1	111	7

Exercise 4: Construct a control circuit shown below to start Fan.

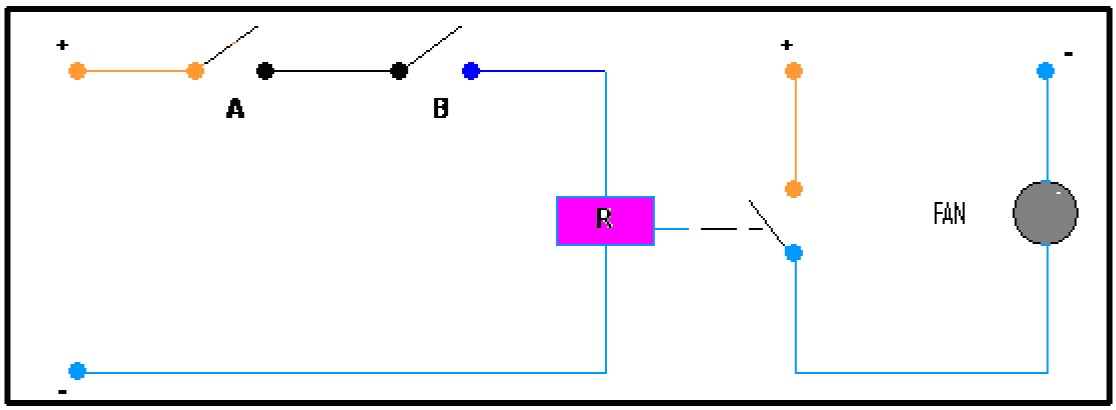

Figure: 5

Verify that Fan starts for the condition of switches A & B as shown in below Table and fill the Fan Status in the Table.

Switch A	Switch B	R	Fan Status ON / OFF
0	0	0	
0	1	0	
1	0	0	
1	1	1	

Exercise 5: Build the following control circuit to start Fan.

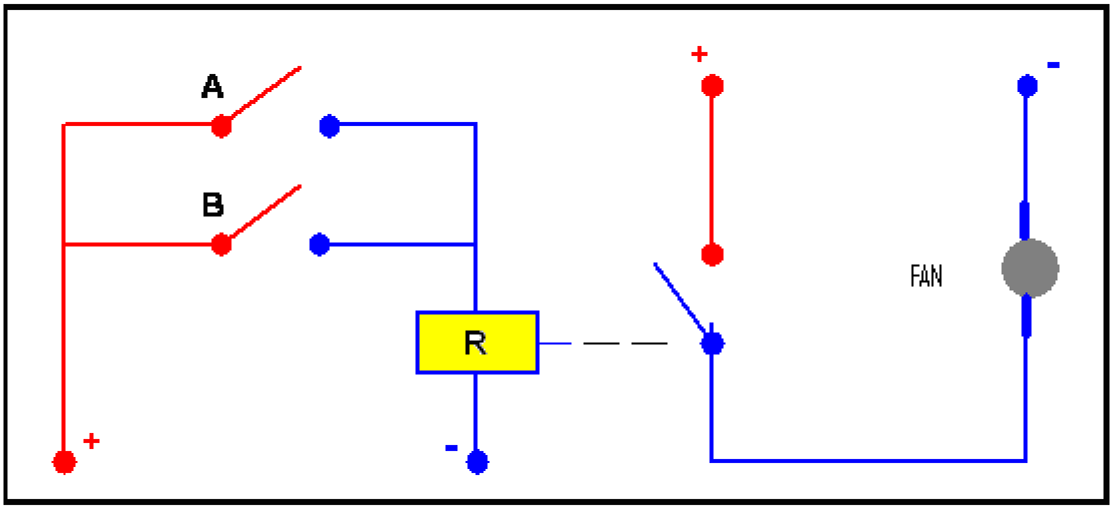

Figure: 6

Verify Relay (R) & Fan ON/OFF status for the following switch positions and fill the table.

Switch A	Switch B	R	Fan Status ON / OFF
0	0		
0	1		
1	0		
1	1		