Federal Urdu University of Arts,Science & Technology

LAB MANUAL

SEVENTH SEMESTER

INDUSTRIAL ELECTRONICS

BASIC ELECTRICAL & ELECTRONICS LAB

DEPARTMENT OF ELECTRICAL ENGINEERING

Prepared By:

Engr. Asad Jamal

Lecturer (Lab) Electrical,
FUUAST-Islamabad

Checked By:

Engr. M.Nasim Khan

Senior Lab Engineer Electrical,
FUUAST-Islamabad

Approved By:

Dr.Noman Jafri

Dean,
FUUAST-Islamabad

Name: ____

Registration No: ________________________________

Roll No: _______________________________________

Semester: ______________________________________

Batch: ____

CONTENTS

EXPERIMENT NO – 01

PHOTO-TRANSISTOR

DISCRIPTION

The circuit of figure is a light-controlled switch using a phototransistor. When incident light is absent, the resistance across C and E is high and the output voltage Vo is high. If incident light applied, the output voltage will reduce in response to incident illumination.

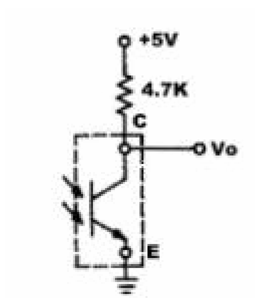
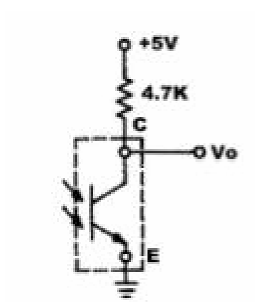


Figure. A light-controlled switch.

PROCEDURE

1. Complete the circuit of Figure on KL-64001 and KL-62001 breadboard



2. Connect the Vo1 to KL-62001 STATUS DISPLAY & DCV INPUT + and the E to -.

3. Complete the following connections on KL-62001.

SECTION	AREA	SIGNAL SECTION	TO	AREA	SIGNAL
SELECT	MANUAL/SINGLE CHIP	MANUAL SELECT	→	MANUAL/SINGLE CHIP	GND

4. Switch power ON and the display should be ON.

5. Set STATUS DISPLAY & DCV MODE switch to DCV position and RANGE to 20V.

6. Cover the phototransistor window with hand and record the output voltage Vo1.

   Vo1 = _____________ V.

7. Lighten the phototransistor with fluorescent lamp and record the output voltage Vo1.

   Vo1 = _____________ V.

8. Adjust the distance between source and phototransistor and complete Table 1

Results

Table 1

Distance	0cm	5cm	10cm	15cm	20cm	30cm	40cm	50cm
Vo								

EXPERIMENT NO – 2

PHOTO INTERRUPTOR / PHOTO COUPLER / OBJECT DETECTOR

DISCRIPTION

Figure shows an object detector using a fixed-distance photo coupler. In normal situation, the detector receives light signal from LED and the output voltage Vo is low. If an object passes through the window and blocks the light beam, the collector current Ic decreases and the output Vo rises to a high potential. The two inverters act as a wave shaper.

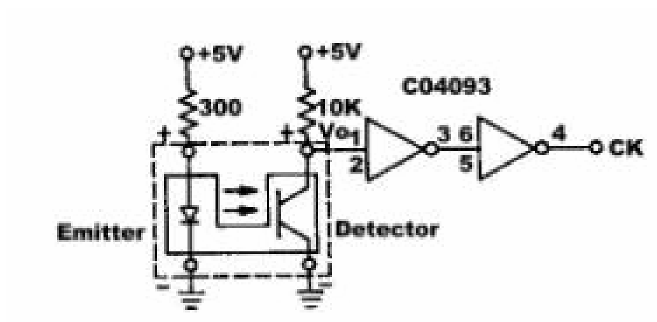
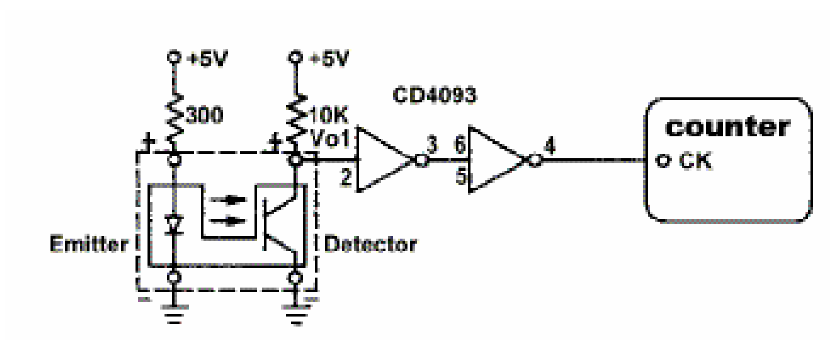


Figure Object detector

PROCEDURE

1. Complete the circuit of Figure on KL-64001 and KL-62001 breadboard



2. Connect the Vo2 to KL-62001 STATUS DISPLAY & DCV INPUT + and the - to GND. Connect the output CK to COUNTER input or Oscilloscope input.

3. Complete the following connections on KL-62001.

SECTION	AREA	SIGNAL TO SECTION	AREA	SIGNAL
SELECT	MANUAL/SINGLE CHIP	MANUAL $\rightarrow$ SELECT	MANUAL/SINGLE CHIP	GND

4. Switch power ON and the display should be ON.

5. Set STATUS DISPLAY & DCV MODE switch to DCV position and RANGE to 20V.

6. In the absence of object between emitter and detector, measure and record the output voltage Vo2 = __________ V.

7. In the presence of object between emitter and detector, measure and record the output voltage Vo2 = __________ V.

8. Cut a sheet of paper to a pulse shape and move it between emitter and detector, and record the output waveform.

EXPERIMENT NO – 3

CDS SENSOR

DESCRIPTION

In this experimental circuit, we used CDS can change the light stronger or week to resistance value characteristics and get the purpose of light controlled circuit. As the Fig. 1 circuit the CDS is under the normal lighting operation. Adjusted the R1 make the LED 1 just from the dark to lighting, because the CDS resistance don't have to much range, the voltage through CDS make R1 and R2 divided the voltage, let the Vb1 have a potential. This potential enough make Q1 turn on and make Vb2 potential get down. The Q2 is a PNP transistor, when B voltage (Vb) get down and lower to Emitter voltage (Vcc) a Vbe Bias, the Q2 will turn so the LED is lighting.

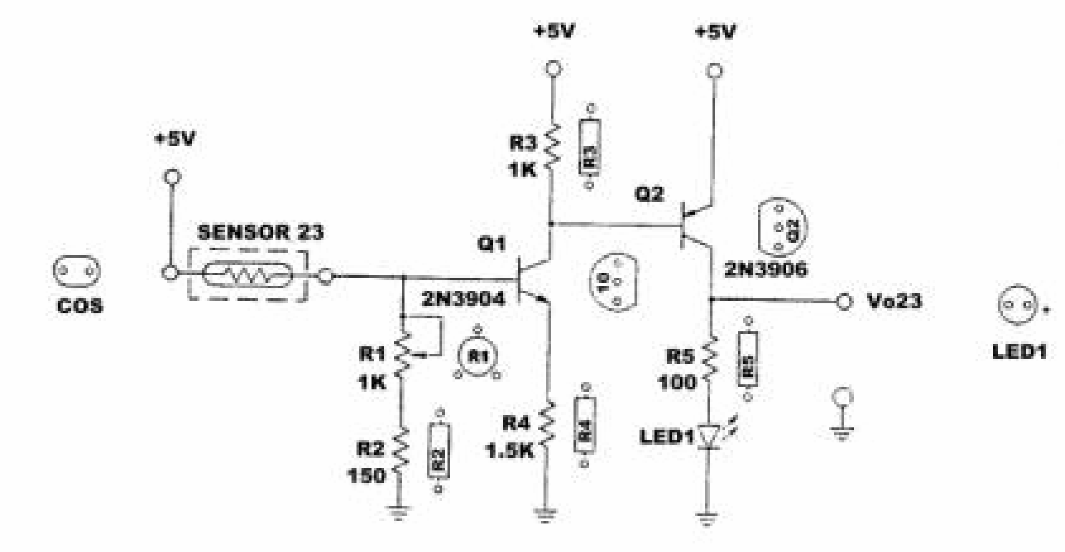


Fig. 1 CDS light controlled circuit.

Opposite, when you used the hand covered lighting of the CDS received, the CDS resistance will increased it make the Vb1 voltage get down suddenly. When Vb1 lower 0.7V, the Q1 cut off. It will make the Vb2 voltage increased, and Q2 Base voltage increases also make the Q2 cut off and LED turn off. It means the CDS received light, the LED1 will be lighting. If the CDS is not received the light, the LED also turn off.

PROCEDURE

1. Find the CDS connect terminal.
2. Used the meter measuring the CDS on the normal lighting, the resistance is __________ Ohm.
3. When used the hand covered CDS, what change about the resistance? __________ (increase or reduce?), in the same time the CDS resistance is __________ Ohm.
4. Get a 60W bulb lighting to CDS, what change about the resistance?
   a. __________ (increase or reduce?), in the same time the CDS resistance is __________ Ohm.
5. Can you used the CDS design a sample automatic lighting circuit?
6. Set the Module KL-64009 on the Trainer KL-62001. and connect the power source.
7. On the KL-62001 main Trainer ¡§SELECT¡¨ block, in the ¡§MANUAL/SINGLE CHIP¡¨ area, put the ¡§MANUAL¡¨ to ¡§GND¡¨. and in the ¡§STATUS DISPLAY & DCV, MODE¡¨ area, push on the ¡§DCV¡¨ and the range on the 20V.
8. Adjusting the R1, make the LED just on the lighting position. Used the voltmeter measuring the Vb1, Vb2, V023, 3 points voltage value and record on the Table.
9. Used the hand covered the lighting of the CDS received, even the CDS didn¡¦t received lighting but in this time the LED is turn ¡§ON¡¨ or ¡§OFF¡¨? MEASURING THE Vb1, Vb2, V023, the 3 points voltage and record on the Table.
10. If CDS and R1, R2 change the position, than when the CDS received the lighting which the LED1 is turn ¡§ON¡¨ or ¡§OFF¡¨?

RESULTS

STATUS	Vb1	Vb2	V023	LED1 STATUS
CDS lighting				
No-ighting				

CONCLUSION

EXPERIMENT NO – 4

SENSORS OBJECT DETECTOR

PURPOSE OF EXPERIMENT

1) To work On KL-62001 Trainer.
2) To build Circuit on KL-64001.

DISCRIPTION OF EXPERIMENTAL CIRCUITS

Figure shows an object detector using a fixed-distance photocoupler. In normal situation, the detector receives light signal from LED and the output voltage Vo is low. If an object passes through the window and blocks the light beam, the collector current Ic decreases and the output Vo rises to a high potential. The two inverters act as a wave shaper.

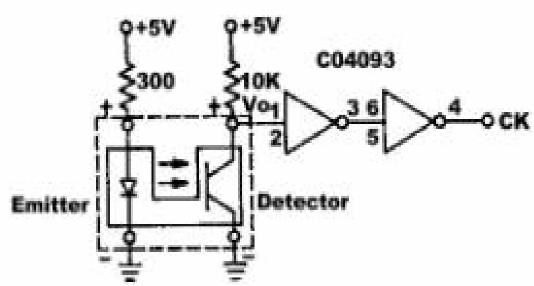


Figure Object detector.

EXPERIMENTS AND RECORDS

1) Complete the circuit of Figure on KL-64001 and KL-62001 breadboard.
2) Connect the Vo2 to KL-62001 STATUS DISPLAY & DCV INPUT + and the - to GND. Connect the output CK to COUNTER input or Oscilloscope input.
3) Complete the following connections on KL-62001.

SECTION	AREA	SIGNAL TO SECTION	AREA	SIGNAL
SELECT	MANUAL/SINGLE CHIP	MANUAL $\rightarrow$ SELECT	MANUAL/SINGLE CHIP	GND

4) Switch power ON and the display should be ON.
5) Set STATUS DISPLAY & DCV MODE switch to DCV position and RANGE to 20V.

6) In the absence of object between emitter and detector, measure and record the output voltage Vo2 = __________ V.
7) In the presence of object between emitter and detector, measure and record the output voltage Vo2 = __________ V.
8) Cut a sheet of paper to a pulse shape and move it between emitter and detector, and record the output waveform.

EXPERIMENT No. 5

DIGITAL HALL SENSOR

DESCRIPTION:

Figure 3 Digital Hall circuit shows the circuit. The block diagram of IC 3503 is shown in Figure 4 Block diagram of IC 3503. The internal power regulator Vref provides a constant-current to the Hall element X and a regulated voltage to amplifiers. The output transistor is an open-collector configuration which can sink the current up to 5mA.

When a magnet is placed in close proximity with a magnetic field, as shown in Figure 5 The sensing method for Hall and magnet, its output is inversely proportional to the strength of; and the proximity to the magnetic field. To determine its output state (high or low), the output must be amplified by a differential amplifier. The amplified output is then send to a Schmitt latch, which determines the output state. To reverse the output state, a magnetic field of opposite polarity should be added. Refer to Figure 6 for the output voltage versus distance characteristics of IC 3503.

PROCEDURE

A.

1. Complete the circuit of Figure on KL-64001 and KL-62001 breadboard.

2. Connect the Vo4 to KL-62001 STATUS DISPLAY & DCV INPUT +.

3. Complete the following connections on KL-62001.

SECTION	AREA	SIGNAL TO SECTION	AREA	SIGNAL
SELECT	MANUAL/SINGLE CHIP	MANUAL → SELECT	MANUAL/SINGLE CHIP	GND

4. Switch power ON and the display should be ON.

5. Set STATUS DISPLAY & DCV MODE switch to DCV position and RANGE to 20V.

6. In the absence of magnetic field, adjust the VR 10K to make the output voltage Vo=0V.

7. Move the magnet toward Hall sensor, observe and record the side of Hall having no reaction.

8. Move the magnet toward Hall sensor, observe and record the distance between magnet and Hall if a change occurs at the output.

9. Change the poles of magnet and repeat Steps 7 and 8.

Digital hall IC

1. Set the Module KL-64001 on the Trainer KL-62001.

2. Connect the Vo3 in HALL-EFFECT Digital SENSOR area to the DCV INPUT + and switch power ON.

3. Move the magnet toward the Hall IC and try to find out which side the Hall has no response.

4. Record the distance between magnet and Hall if the change occurs at output.

5. Change the polarities of magnet and record the output variation of Hall IC.

EXPERIMENT NO - 6

ANALOG HALL SENSOR

DESCRIPTION:

The Hall sensor in Figure 1 is an analog element and the equivalent circuit is shown in Figure 2 Since the bridge arms are not balance, the 13K resistor is for the compensation. The VR 10K in Figure 1 acts as an adjuster for the offset of differential amplifier.

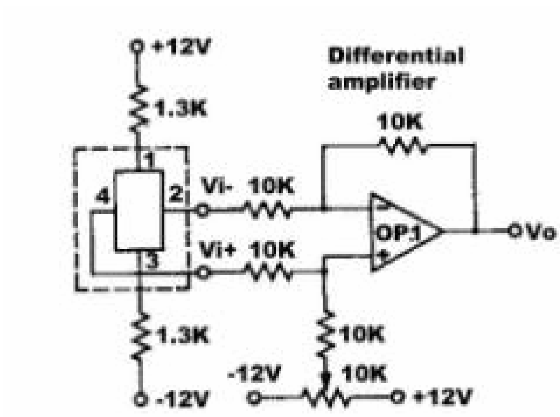


Figure 1. Analog Hall sensor circuit.

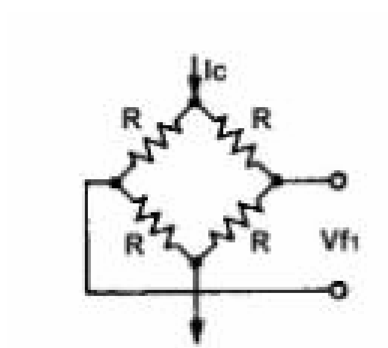


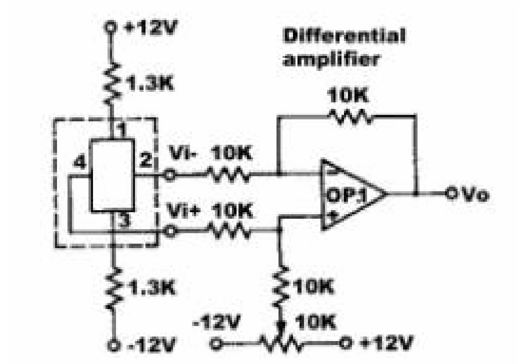
Figure 2. The equivalent circuit of analog Hall sensor.

Fig 1 Analog Hall IC shows a Hall detector using an analog Hall IC LT110. The output of this Hall element is directly proportional to the distance from the magnetic field. The analog signal is amplified by the differential amplifier U3.

PROCEDURE:

A.

1. Complete the circuit of Figure on KL-64001 and KL-62001 breadboard.



2. Connect the Vo4 to KL-62001 STATUS DISPLAY & DCV INPUT +.

3. Complete the following connections on KL-62001.

SECTION	AREA	SIGNAL TO SECTION	AREA	SIGNAL
SELECT	MANUAL/SINGLE CHIP	MANUAL → SELECT	MANUAL/SINGLE CHIP	GND

4. Switch power ON and the display should be ON.

5. Set STATUS DISPLAY & DCV MODE switch to DCV position and RANGE to 20V.

6. In the absence of magnetic field, adjust the VR 10K to make the output voltage Vo=0V.

7. Move the magnet toward Hall sensor, observe and record the side of Hall having no reaction.

8. Move the magnet toward Hall sensor, observe and record the distance between magnet and Hall if a change occurs at the output.

9. Change the poles of magnet and repeat Steps 7 and 8.\

Analog hall IC

1. Set the Module KL-64001 on the Trainer KL-62001.

2. Connect the Vo4 in HALL-EFFECT Analog SENSOR area to the DCV INPUT + and switch power ON.
3. Move the magnet toward the Hall IC and try to find out which side the Hall has non response.

4. Record the distance between magnet and Hall if the change occurs at output.
5. Change the polarities of magnet and record the output variation of Hall IC.

EXPERIMENT NO - 7

TEMPERATURE SENSOR

DESCRIPTION

The AD590 is an excellent sensor for temperature-to-current conversion due to its good linearity with a transduction ratio of 1(A/((K.

The circuit of Figure 1 is the AD590 transduction circuit with two different transduction outputs, the 10mV/((K at U1 PIN6 and the 100mV/¢J at Vo15. The U1 acts as a voltage follower. The output of U1 can obtain the voltage of 10mV/((K by adjusting the R2 for R2+R3=10K(.

In many applications, the Celsius scale is more convenient than absolute temperature. The relationship of these two temperature scales is ((K =((C+273.2, and 273.2((K =0((C. In other words, if the temperature is at 273.2((K (0((C), the output voltages at Vf1 and U1 should be 2.732V and 0V, respectively. In order to yield the 2.732V stabilized voltage, a voltage regulator which consist of R6, CR1, R7, R8, R9 and U3 is used.

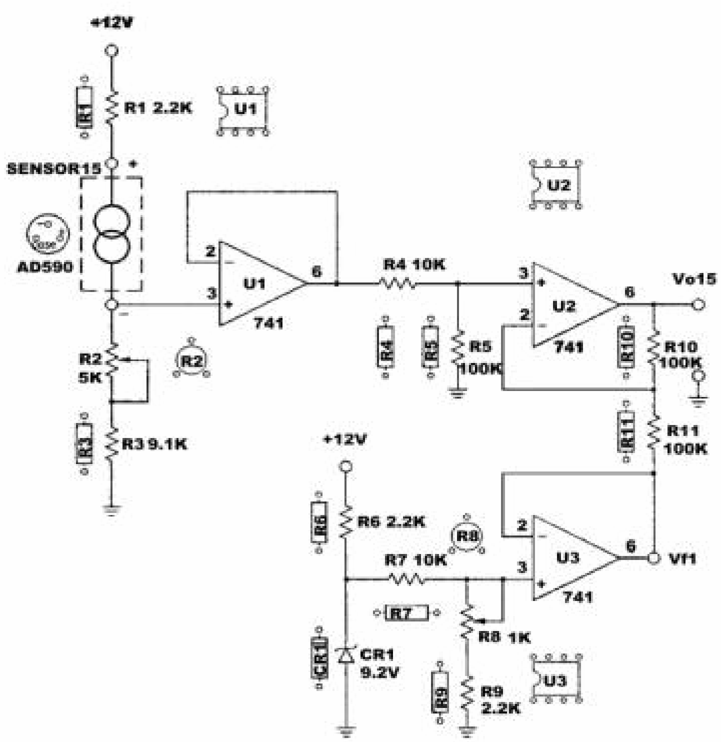


Figure 1. AD590 transducer circuit.

A digital thermometer shown in Figure 2 is built with the AD590 transducer module and the

7135 A/D converter. Since the transduction output of the AD590 transducer is 100mV/¢J, such that the full-scale voltage of the A/D converter must be set to 20V.

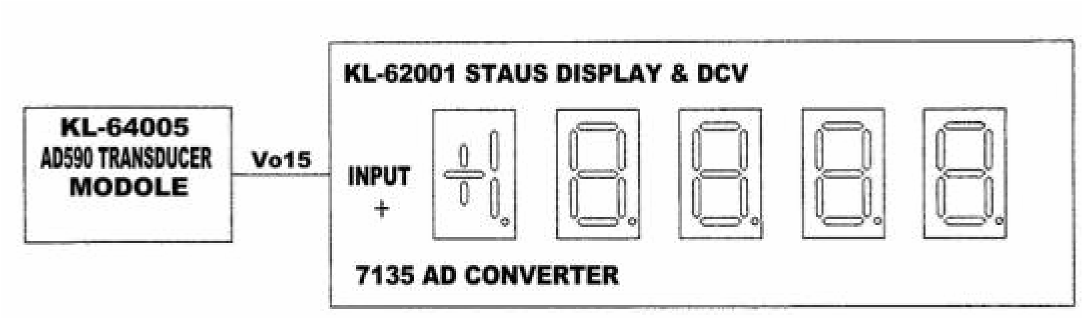


Figure 2. Digital thermometer.

PROCEDURE

A. Characteristics and transduction circuit of the AD590

1. Place Module KL-64005 Block 15 on the Trainer KL-62001.
2. Measure the resistance between U1 pin3 GND with the DMM and adjust the R2 for the resistance value of 10KΩ.
3. Adjust the R8 to make Vf1=2.732V.
4. Put the AD590 in the Thermostatic Container. (The pins of AD590 must be isolated from water) Measure and record the output voltages at U1 pin6 and Vo15 for each temperature setting in Table 1.
5. From Table 1 the voltage difference between U1 pin6 and Vo15=_______ V.
6. Construct the conversion curve of AD590 transducer using data in Table 1.
7. Review the curve in Step 6, calculate and record the temperature-to-voltage transduction ratio = _____________ mV/¢J.

B. Digital thermometer

1. Place module KL-64005 on KL-62001.
2. Repeat Steps 2 to 5 from section **A**.

3. Set the MODE switch to the SENSOR position, the RANGE switch to the ¢J position and connect MANUAL (SELECT area) to GND on the Module KL-62001.
4. Connect the Vo15 on KL-64005 to the DCV INPUT+ on KL-62001.
5. Insert the AD590 into the Thermostatic Container.Read and record the readout for each temperature setting in Table 2.
6. Compare the settings with the readouts.

C. Computer interface and control

Figure shows the functional blocks of module KL-62001. The transducer output (0 to +5VDC) applies to inputs of the 12-bit A/D converter, and then is converted to digital signals to the PIO chip or the single-chip microcomputer 8031 according to control signals. The PIO chip is a interface for transmitting the digital signals to a buffer card in a personal computer. The RS-232 is a communication-interface for communication between the single-chip 8031 and serial ports of the personal computer. Refers to the KL-62001 USER'S MANUAL for details.

KL-62001

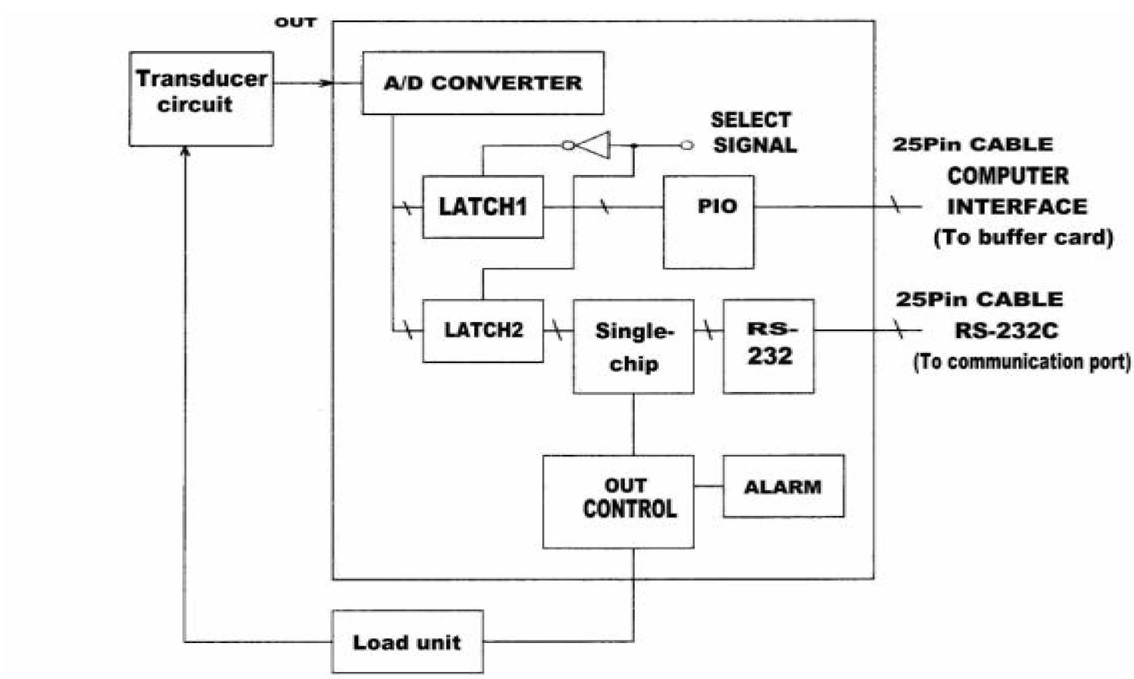


Figure. Functional diagram of KL-62001.

1. Complete the connections as follows:

SECTION	AREA	SIGNAL TO SECTION	AREA	SIGNAL

SELECT	MANUAL / SINGLE CHIP	CHIP → SELECT	MANUAL / SINGLE CHIP	GND
SINGLE CHIP & EPROM	OUT CONTROL	1 → AMPLIFIER	ALARM AMPLIFIER	SIN IN
A / D CONVERTER	CONTROL	A /D IN→ KL-64005	Vo15	
A / D CONVERTER	CONTROL	GND → KL-64005	GND	

2. Using 25-pin cable, connect the RS-232 interface to any serial port of personal computer.
3. Set the AD590 Transducer Module KL-64005 on the Trainer KL-62001.
4. Repeat Steps 2 to 3 from section **A**.
5. Set the DIP switches to the value of 4095.
6. Turn on KL-62001.
7. Complete Table 3.
8. When the temperature exceeds the setting, the potential at OUT CONTROL pin4 should be LOW and the alarm buzzer is turned on. Previous Steps are used to display the temperature values of the AD590 transducer through the single-chip microcomputer.
9. Connect the SINGLE CHIP & EPROM OUT CONTROL CTRL to the GND.
10. Boot the computer using the KL-62001 disk.

    At A> type

        CD BASIC <ENTER>

    Then type

        (YOURBASIC) <ENTER>

    At OK type

        LOAD "KLPLOTER <ENTER>

    At OK type

        RUN <ENTER>

11. The screen will display

    Select Monochrome or Color display : (M/C)

    (M=monochrome; C=color; default=C)

    Select RS232 ON COM1 or COM2 : (1/2)

    (1=COM1; 2=COM2; default=COM2)

12. After your selections, the screen shows 9 functions:

    1. Acquire Data

2. Load Data
3. Save Data
4. Plot Data
5. Sample Times $\Rightarrow$ 10000
6. Range(Voltage) .25 to 5 $\Rightarrow$ 5
7. Sample Rate HR:MN:SC $\Rightarrow$ MAX
8. Print Data
9. EXIT

13. Select function 1 by typing.

    (i) 1 <ENTER>

    (b) Change the temperature values and observe the temperature curve on the screen. (1V = 10¢J)

    (c) If the screen displays the error message " Device Timeout in 600 ", please

    (d) retry from Step 12 for a correct selection of the RS232 port.

14. Type 9 <ENTER> to exit.

RESULTS

Table 1

Temperature(¢J)	30Ξ′	40Ξ′	50Ξ′	60Ξ′	70Ξ′	80Ξ′	90Ξ′	100Ξ′
U1 pin6 (V)								
Vo15 (V)								

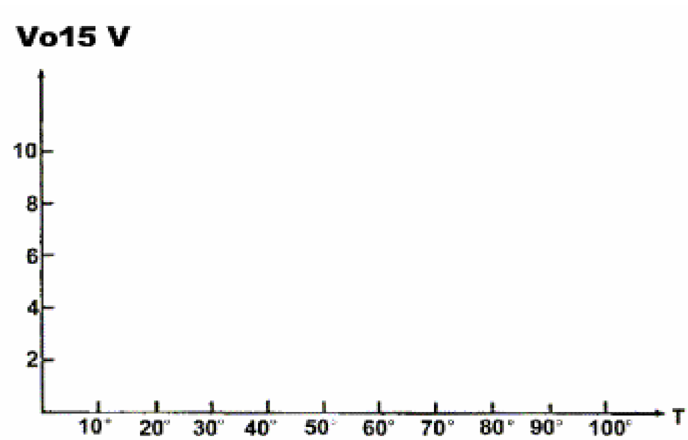


Table 2

Temperature(¢J)	30	40	50	60	70	80	90	100
Readout								

Table 3

DIP-switch Settings	0819 (10¢J)	1638 (20¢J)	2457 (30¢J)	3276 (40¢J)	4095 (50¢J)
KL-62001 readout					
Temperature(¢J)					
OUT CONTROL pin1					
OUT CONTROL pin4					
KL-64005 Vo15 volts					

EXPERIMENT NO. 8

HUMIDITY SENSOR

DESCRIPTION

The circuit of Figure 1 is a humidity transducer circuit for this experiment. This circuit consists of four sections:

The first section is an oscillator consisted of U5 and U6.The U6, Wein oscillator, generates a sine wave. The U5 acts as an amplitude limiter to limit the sine wave at 250 Hz and 0.5 Vrms. The second section serves amplification, filtering, and rectification. It consists of U4, C1, and CR2. The magnitude of negative output is proportional to sensed humidity. The R17 is for gain adjustment and the R14 is for zero level calibration. Figure 2 shows the characteristic of humidity sensor.

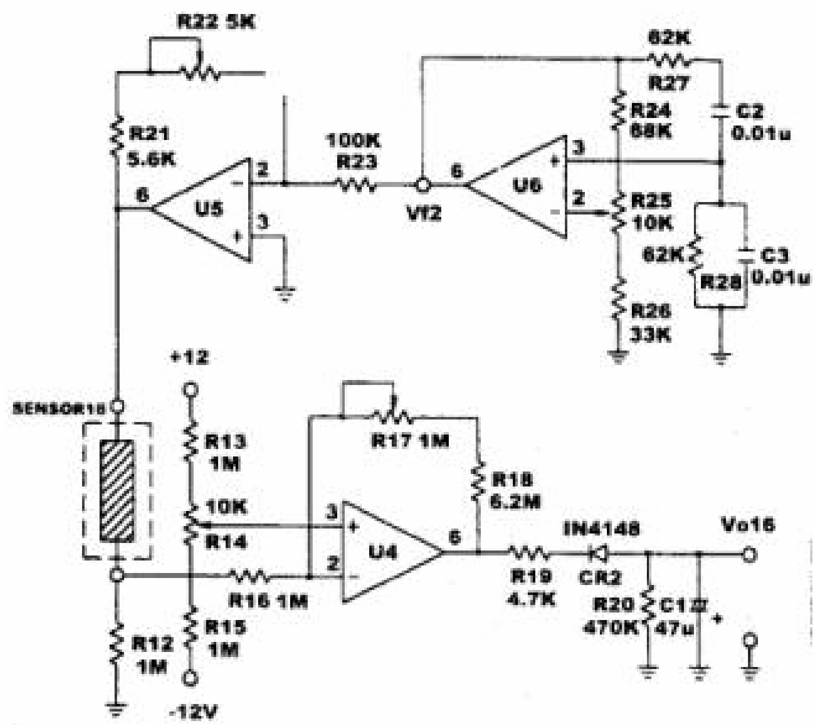


Figure 1. Humidity transducer circuit

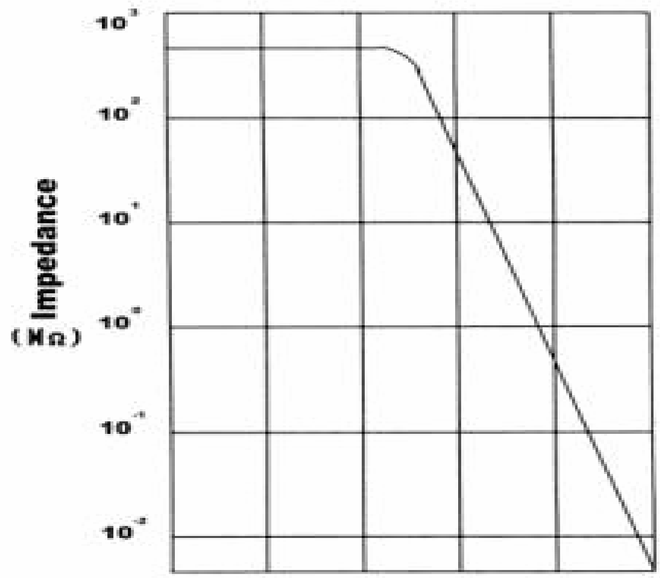


Figure 2. Characteristic of HOS201.

HYGROMETER

In Figure 1, we measure the output voltage of Vo16 using DMM or AD converter. Using DMM, the voltage reading must divide by 100 mV to obtain the value of humidity. Using AD converter, the readout represents the value of humidity. The operating range of HOS201 is from 55 to 100 %RH and a tolerance of ©ϒ3 %RH.

PROCEDURE

A. Basic measurement

1. Set the Humidity Transducer Module KL-64005 Block 16 on the Trainer KL-62001. Supply the power.
2. Using scope, measure and record the signal at Vf2.

   f = ____________ Hz, Vp-p = ___________ V.
3. Using scope, measure and record the signal at SENSOR16.

   f = ____________ Hz, Vp-p = ___________ V.

B. Impedance measurement

1. Connect the DMM probes to HOS201 lead wires.

2. Set humidity disk with water, hygrometer and HOS201 in the Thermostatic.
3. Complete Table 1 using the fan and water.
4. Plot the impedance vs. humidity curve using the data in Table 1.
5. Compare the curve in Step 4 to the curve in Figure 2 and explain the difference.
6. Compare the humidified impedance to the dehumidified impedance and explain the difference.

C. Conversion voltage measurement

1. Set the Humidity Transducer Module KL-64005 Block 16 on the Trainer KL-62001. supply the power.
2. Connect the HUMIDITY SENSOR leads to SENSOR IN.
3. Repeat Step 2 in experiment **B**.
4. Complete Table 2.
5. Plot V sensor16 vs. humidity, Vu4, pin6 vs. humidity, and Vo16 vs. humidity curves.

D. Computer control

1. Complete the following connections:

SECTION	AREA	SIGNAL TO SECTION	AREA	SIGNAL
SINGLE CHIP & EPROM	OUT CONTROL	1 → AMPLIFIER	ALARM	SIN IN
	KL-64005	Vo16 → POTENTIO- METER		VR1
	KL-64005	GND → POTENTIO- METER		VR3
POTENTIO-METER		VR2 → A/D CONVERTER	CONTROL	A/D IN
POTENTIO-METER		VR3 → SELECT MANUAL/SINGLE CHIP		GND

2. Repeat Steps 1 and 2 in experiment **C**.
3. Complete Table 3.
4. Connect the SINGLE CHIP & EPROM OUT CONTROL CTRL to the GND. This step performs the data communications between the transducer circuit and the personal computer via the RS-232 port.

5. Follow the steps for the RS-232C control in experiment **temperature(AD590) computer control** and proceed the following steps.
6. (Note: 1V=10%RH)

RESULTS

Table 1

Humidity	40% RH	45% RH	50% RH	55% RH	60% RH	65% RH	70% RH	75% RH	80% RH	85% RH	90% RH	95% RH
Humidified impedance												
Dehumidified impedance												

Table 2

Humidity	40% RH	45% RH	50% RH	55% RH	60% RH	65% RH	70% RH	75% RH	80% RH	85% RH	90% RH	95% RH
V sensor16												
V u4,pin6												
Vo16												

Table 3

DIP-switch settings	0082 10%RH	0164 20%RH	0246 30%RH	0328 40%RH	0409 50%RH
KL-62001 Readout					
Temperature (¢J)					
OUT CONTROL pin1					
OUT CONTROL pin4					
KL-64005 Vo16					

Table 4

DIP-switch settings	0491 60%RH	0573 70%RH	0655 80%RH	0737 90%RH	0819 100%RH
KL-62001 Readout					
Temperature (¢J)					
OUT CONTROL pin1					
OUT CONTROL pin4					
KL-64005 Vo16					

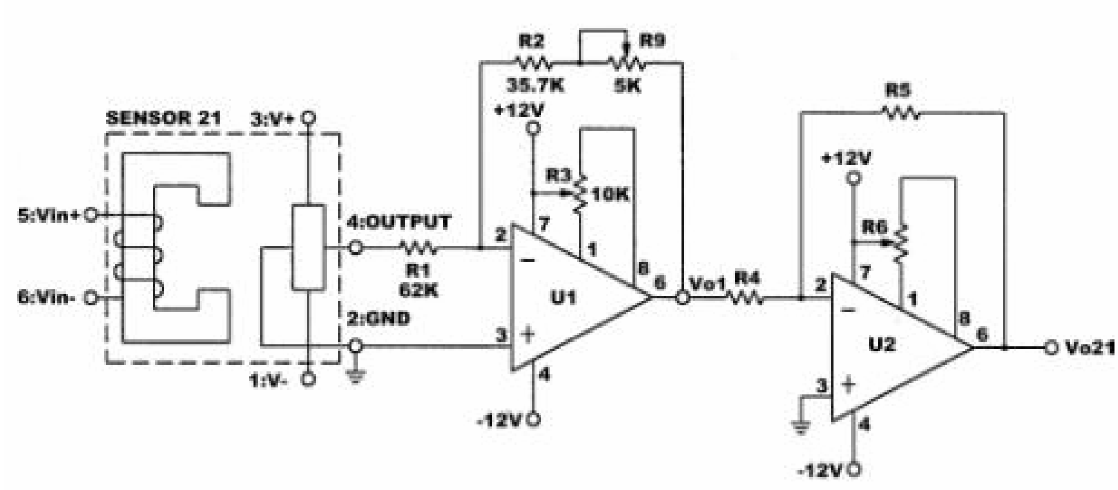
EXPERIMENT NO- 9

HALL CURRENT SENSOR / MAGNETIC DEVICE

DESCRIPTION

The SY-03 Characteristics:

PARAMETER	SAMBOL	CHARACTERISTICS
Nominal input current(F.S)	If	©ϒ 3A DC
Linear range		0~©ϒ 6A DC
Output voltage	Vh	4V ©ϒ 1% at If
Zero current offset	Vo	within ©ϒ 0.04V at If = 0
Linearity	ρ	within ©ϒ 1% of Vh at If = F.S
Power supply	Vcc	©ϒ 15V DC
Rating		within ©ϒ 5%
Resoponse time	Trr	3 μS Max. at di/dt = 100A / μS
Thermal characteristics		within ©ϒ 0.1% / ¢J (within ©ϒ0.08% / ¢J Typical) at RL=10KΩ
Hystersis error		within 0.02V at If = 100A → 0
Insulation resistance		500MΩ Min.at 500V DC
Operation temperature	Ta	-10¢J ~ +70¢J
Storage temperature	Ts	-15¢J ~ +85¢J



From the charateristics we know the input current (If) is 0~3A, so that: output voltage (Vh) is 0~4V, for the proportion of the value of output voltage to input current, so that:

Vo1 = -(R2+R9) / R1¡DVi
= -0.75¡D(4V)
= -3V

Vo = -R5 / R4¡DVo1
= -(10K / 10K)¡D(-3V)
= 3V

When the input current change from 0~3A, output voltage is 0~3V; R3, R6 are DC offsetadjustment. The input current is 0, adjusting is knob make the output voltage is 0.

PROCEDURE

1. On the KL-62001 main Trainer ¡§SELECT¡¨ block, in the ¡§MANUAL/SINGLE CHIP¡¨ aera, put the ¡§MANUAL¡¨ to ¡§GND¡¨. and in the ¡§STATUS DISPLAY & DCV, MODE¡¨ area, push on the ¡§DCV¡¨ and the range on the 20V. The main unit provides the power supply to the module.
2. Turn on the power supply, put the voltage in 10V, current in 100mA. Connecting the main unit power supply to KL-64008 Vin+ and Vin-.
3. Kept the voltage in same, adjust the current to 0 mA.
4. Adjust R3, make Vo1 output is 0V, and adjust R6 make Vo21 output voltage is 0V.
5. Change the power supply current to 1A, adjust the R9 make Vo21 voltage to 1V.
6. Above adjustment is for calibration voltage output, to make it is an calibrated current detector.
7. Change the terminals of power supply to any other current circuit, willknow the circuit current are how many? (Attention the current can not over 3A)

EXPERIMENT No. 10

PREXIMITY SENSOR

DESCRIPTION

As Fig. 1 is used the capacititive type proximity switches for the experimental circuit

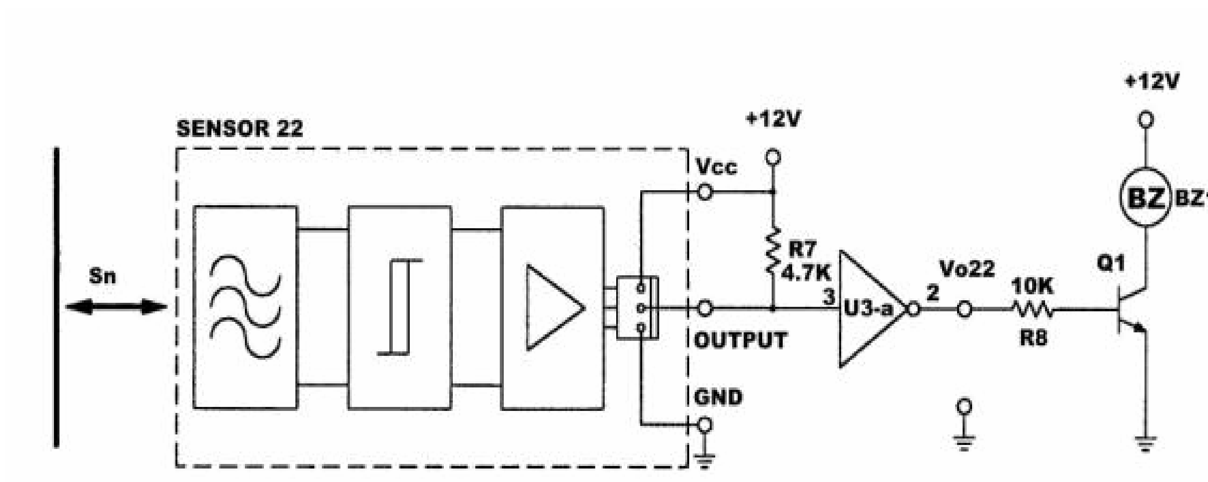


Fig. 1 Capacititive type proximity switches

SPECIFICATION:

D.C.Current: 10--30VDC

Max. Ripple: 10%

Real Dis.: <80%(Sr)

Magnetic hysteresis: <15%(Sr)

Accurancy: <5%

The sensor is on the ¡§HIGH¡¨ position when they are no metal approach, through the U3-a Schmitt reverser the Vo22 point is low position that why the buzzer no alarm.

When the metal objector near the sensor, the LED turn on and output become low level, through the reverser become high position than the transistor turn on, the buzzer alarm.

PROCEDURE

1. Set the Module KL-64008 on the Trainer KL-62001. and connect the power source.
2. Plug-in the capacitive proximity switch to the module, Switch the power on.
3. When no metal approach the proximity switch, what voltage on the output and Vo22?
4. When the metals approach the proximity switch, how long the distance the buzzer will be alarm?

EXPERIMENT NO – 11

INTRODUCTION TO PLC'S

BASICS

A **programmable logic controller** (**PLC**) or **programmable controller** is a digital computer used for automation of electromechanical processes,such as control of machinery on factory assembly lines, amusement rides, or lighting fixtures. PLCs are used in many industries and machines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed or non-volatile memory. A PLC is an example of a real time system since output results must be produced in response to input conditions within a bounded time, otherwise unintended operation will result

The main difference from other computers is that PLCs are armored for severe conditions (such as dust, moisture, heat, cold) and have the facility for extensive input/output (I/O) arrangements. These connect the PLC to sensors and actuators. PLCs read limit switches, analog process variables (such as temperature and pressure), and the positions of complex positioning systems. Some use machine vision. On the actuator side, PLCs operate electric motors, pneumatic or hydraulic cylinders, magnetic relays, solenoids, or analog outputs. The input/output arrangements may be built into a simple PLC, or the PLC may have external I/O modules attached to a computer network that plugs into the PLC.

PLCs are well-adapted to a range of automation tasks. These are typically industrial processes in manufacturing where the cost of developing and maintaining the automation system is high relative to the total cost of the automation, and where changes to the system would be expected during its operational life. PLCs contain input and output devices compatible with industrial pilot devices and controls; little electrical design is required, and the design problem centers on expressing the desired sequence of operations. PLC applications are typically highly customized systems so the cost of a packaged PLC is low compared to the cost of a specific custom-built controller design. On the other hand, in the case of mass-produced goods, customized control systems are economic due to the lower cost of the components, which can be optimally chosen instead of a "generic" solution, and where the non-recurring engineering charges are spread over thousands or millions of units.

A microcontroller-based design would be appropriate where hundreds or thousands of units will be produced and so the development cost (design of power supplies, input/output hardware and necessary testing and certification) can be spread over many sales, and where the end-user would not need to alter the control. Automotive applications are an example; millions of units are built each year, and very few end-users alter the programming of these controllers. However, some specialty vehicles such as transit busses economically use PLCs instead of custom-designed controls, because the volumes are low and the development cost would be uneconomic.

Very complex process control, such as used in the chemical industry, may require algorithms and performance beyond the capability of even high-performance PLCs. Very high-speed or precision controls may also require customized solutions; for example, aircraft flight controls.

Programmable controllers are widely used in motion control, positioning control and torque control. Some manufacturers produce motion control units to be integrated with PLC so that G-code (involving a CNC machine) can be used to instruct machine movements.[citation needed]

1.1 Introduction

A Standard T100MD+ PLC features the following:

1) 4 to 8 channels of 10-bit Analog Inputs. (4 on T100MD1616+)
2) 1 to 2 channels of 8-bit Analog outputs.
3) 2-channel programmable Motion Controllers for controlling stepper motors up to 20,000 pulses-per-second.
4) 2-channel Pulse Width Modulated (PWM) outputs.
5) 2-channel 32-bit High Speed Counters (HSC) counts up to 10,000 Hz.
6) 4-channel Interrupt Inputs.
7) 2-channel pulse measurement inputs capable of measuring frequency and pulse-width of incoming pulses up to 10,000 Hz.
8) Real time Clock/Calendar for programming scheduled ON/OFF events.
9) 6016 Words (16-bit) of EEPROM Program Memory, expandable to 8190 Words with optional IC - M2018P.
10) 1700 Words (16-bit) of programmable EEPROM for user's data, expandable to 7750 Words with optional IC – M2018P.
11) Built-in 16 channels of PID-computation engines let T100M+ PLCs directly provide PID type digital control for process automation.
12) One Independent RS232 port for connection to a host PC for programming or monitoring.
13) One independent RS485 port for networking or for connecting to external peripherals such as LCD display and RS485-based analog I/O cards, etc.
14) Industry Standard Protocols: Both RS232 and RS485 serial port simultaneously support multiple communication protocols, as follow:
    i) Native ASCII based Host Link Commands.
    ii) MODBUS RTU protocols
    iii) MODBUS ASCII Protocols
    iv) OMRON C20H Host Link Commands.
15) Watch-Dog Timer (WDT) which resets the PLC if the CPU malfunctions due to hardware or software error. A system reset by WDT can be determined by the STATUS(1) command.

1.2 Special Digital I/Os

Four of the first 8 ON/OFF inputs of the T100M+ PLC can be configured as "special inputs" such as High Speed Counters, Interrupts and Pulse Measurement. Some of the first 8 outputs can also be configured as PWM and the stepper controller pulse-outputs. If these special I/Os are not used, then they can be used as ordinary ON/OFF type I/O in the ladder diagram. Note that if two special functions share the same I/O then only one of them can be active at any one time. The location of these special I/O are tabulated as follows:

Special Inputs

Input #	High Speed Counter	Interrupt	Pulse Measurement
1	-	-	-
2	-	-	-
3	Ch #1: Phase A	Ch #1	Ch #1
4	Ch #1: Phase B	Ch #2	Ch #2
5	Ch #2: Phase A	Ch #3	-
6	Ch #2: Phase B	Ch #4	-
7	-	-	-
8	-	-	-

Note: A pin defined as a special input cannot simultaneously act as another special input. E.g. Pin 3 cannot be used as high speed counter and at the same time serves as a pulse measuring pin.

Special Outputs

Output #	Stepper pulse output	PWM output
1	Direction for Ch #1	-
2	Direction for Ch #2	-
3		-
4		-
5	Ch #1	-
6	Ch #2	-
7	-	Ch #1
8	-	Ch #2

These special I/O therefore share the same electrical specifications as the ON/OFF type I/O, which have already been described in the Installation Guide.

1.3 Stepper Motors Controller Outputs

Technical Specifications:

No. of Channels	2
Max. Pulse Rate (pps)	20000 (single channel running) 10000 (two channels running)
Maximum Load Current	1A @24V DC
Velocity Profile (Defined by STEPSPEED)	Trapezoidal -accelerate from 1/8 max pps to max pps. -decelerate from max pps to 1/8 max pps)
Maximum number of steps	$2 \sim 2^{31}$ (= 2.1×10^{5})
TBASIC commands	STEPSPEED, STEPMOVEABS, STEPCOUNTABS( ), STEPMOVE, STEPSTOP, STEPCOUNT( )

It is essential to understand the difference between a stepper motor "Controller" and a stepper motor "Driver". A stepper motor "Driver" comprises the power electronics circuitry that provides the voltage, current and phase rotation to the stepper motor coils.

The T100M+'s built-in Stepper-Motor Controller, on the other hand, only generates the required number of "pulses" and sets the direction signal according to the defined acceleration and maximum pulsing rate specified by "STEPSPEED" and "STEPMOVE" commands. You cannot directly connect the "pulses" to the stepper motor. You will need a stepper motor "driver" which you can buy from the motor vendor. Depending on the power output, the number of phases of the stepper motor, and whether you need micro-stepping, the driver can vary in size and cost. Most stepper motor drivers have opto-isolated inputs which accept a direction signal and stepping-pulse signal from the "Stepper Motor Controller". In this case the T100M+ is the "Stepper Motor Controller" which will supply the required pulse and direction-select signals to the driver.

Note that the digital output #1 and #2 automatically become the direction-select signals for Stepper controller #1 and #2, respectively when the stepper controllers are being used. The direction pin is turned ON when the motor moves in the negative direction and turned OFF when the stepper motor moves in the positive direction. The STEPMOVEABS command makes it extremely simple to position the motor at an absolute location, while the STEPMOVE command let you implement incremental move in either directions for each channel.

Interfacing to 5V Stepper Motor Driver Inputs

Some stepper motor drivers accept only 5V signals from the stepper motor controller. In such case you need to determine whether the driver's inputs are opto-isolated. If they are then you can simply connect a 2.2K current limiting resistor in series to the path from the PLC's output to the driver's inputs, as shown in the following diagram:

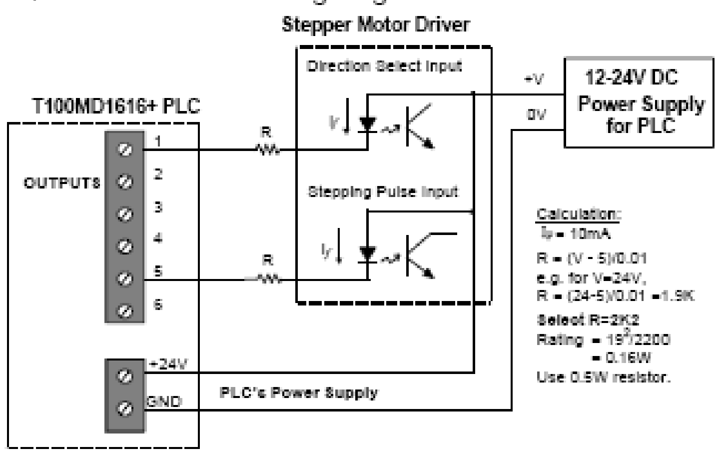


Figure 1.1

However, if the stepper motor driver input is only 5V CMOS level and non opto-isolated, then you need to convert the 12-24V outputs to 5V. This can be achieved using low cost transistor such as a 2N4403. A better way is to use an opto-isolator with logic level output as shown in Figure 1.2. This provides a galvanic isolation between the PLC and the stepper motor driver.

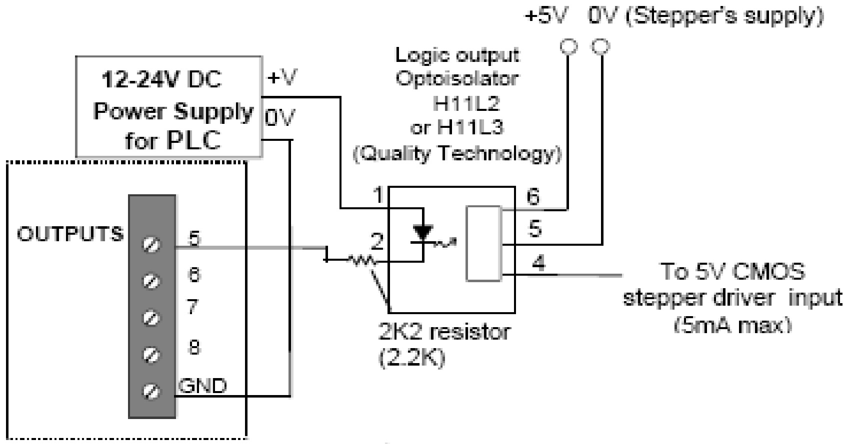
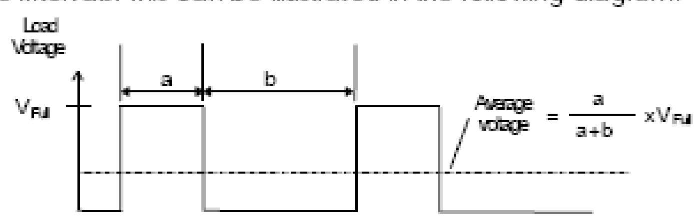


Figure 1.2 Conversion of T100MD+ outputs to 5V logic level

1.4 PWM Outputs

Pulse-Width Modulation (PWM) is a highly efficient and convenient way of controlling output voltage to devices with large time constants, such as controlling the speed of a DC motor, the power to a heating element or the position of a proportional valve.

PWM works by first turning the output to full voltage for a short while and then shutting it off for another short while and then turning it on again and so on in accurate time intervals. This can be illustrated in the following diagram:



The average voltage seen by the load is determined by the "duty cycle" of the PWM wave form. The duty cycle is defined as follow:

$$\text{Duty Cycle} = \frac{a}{a+b} \times 100\%$$

Period = (a + b)

Frequency = 1/period Hz

1-4

EXPERIMENT NO – 12

MOTOR START/STOP CONTROL PROGRAM

PURPOSE OF EXPERIMENT

1) Understand motor's starting principle using PLC.
2) Learn about I/O MAP of PLC.
3) Understand the structure and principle of PLC SIMULATOR

PREPARATION

1) PC (FXGPWIN Installed)
2) PC (GMWIN Installed)

RELATED KNOWLEDGE

1) One should be able to understand motor's starting method.
2) One should be able to understand basic sequence circuit.
3) One should be able to design PLC I/O MAP.

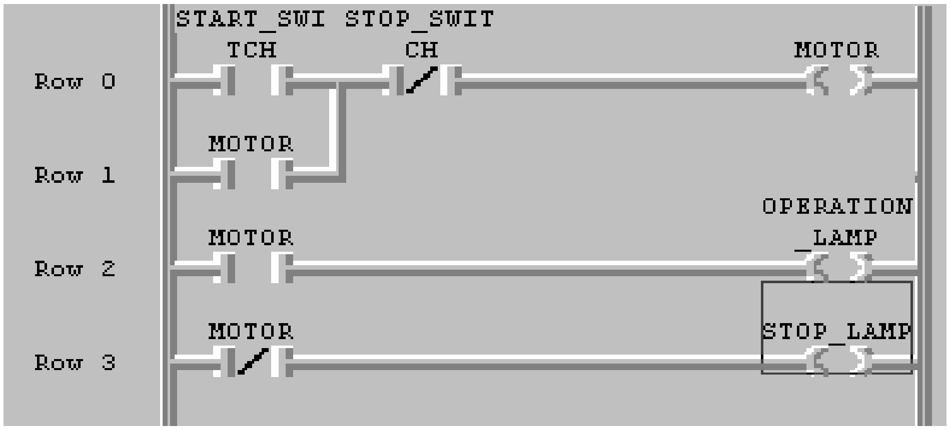
ACTIVATION CONDITION

1) Build motor's start circuit by using two input switches (start, stop). (Output consists of output coil for electronic contact maker, operation lamp, and stop lamp.) Initially stop lamp must glow.
2) If start input switch is turned on, motor gets started, and then operation lamp turns on whereas stop lamp turns off.
3) If one turns on stop lamp during operation, motor stops, and lamp turns on, and operation lamp turns off.
4) PLC I/O MAP is configured below.

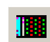
Section	Indirect Variable Name	Comments
Inputs	START_SWITCH	Push Switch S-2
	STOP_SWITCH	Push Switch S-3
Outputs	MOTOR	MOTOR-1 (-)
	OPERATION _LAMP	Lamp L-2
	STOP_LAMP	Lamp L-1

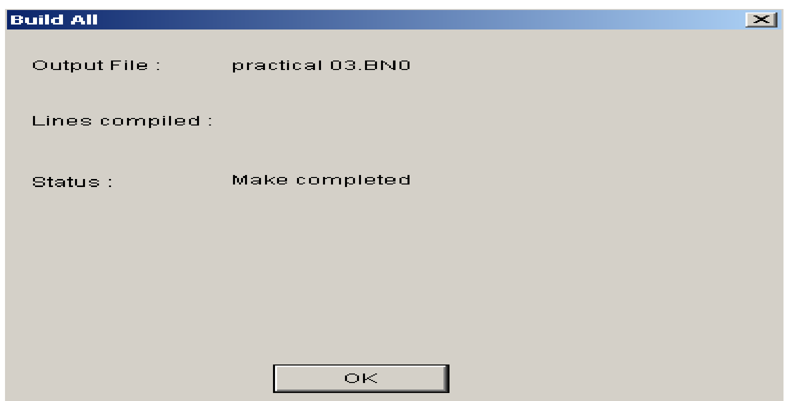
PROGRAM PRACTICE

1) Execute the GMWIN and open the Project window and the program window.
2) Write a program using PLC I/O MAP
3) Write ladder program as shown below.

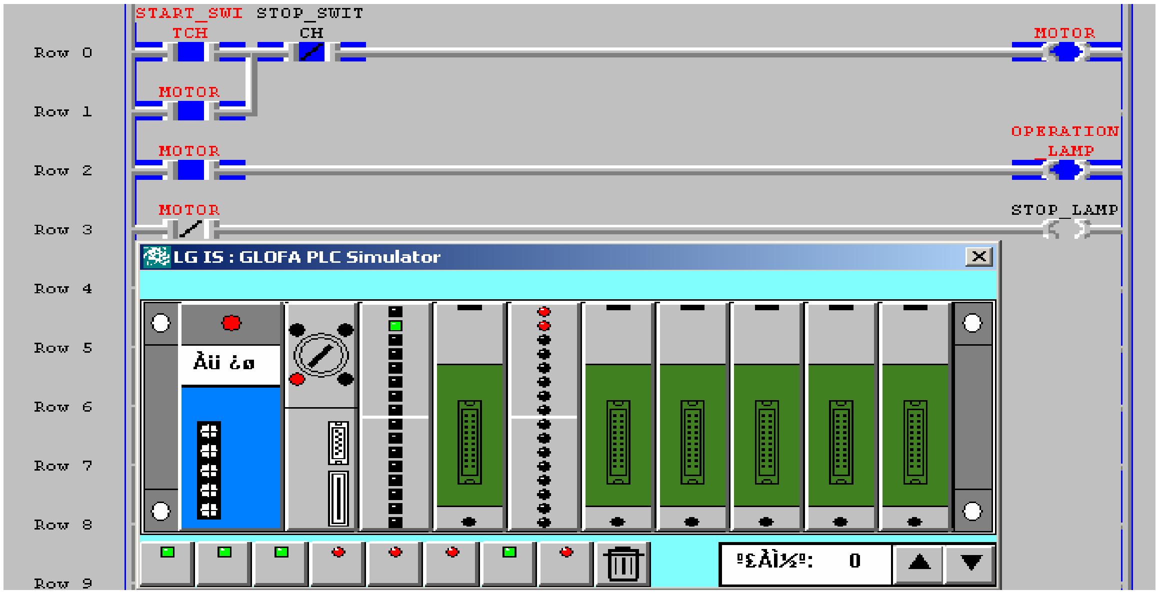


EXECUTION OF PROGRAM (USING SIMULATOR)

1) To verify what was mentioned above, one uses a simulator, which is characteristic of GLOFA t perform an experiment to check whether there is any abnormality in the circuit and its activation.
2) Simulator starts when one clicks the icon  on Basic tool bar. When one clicks on this icon, firstly following window opens



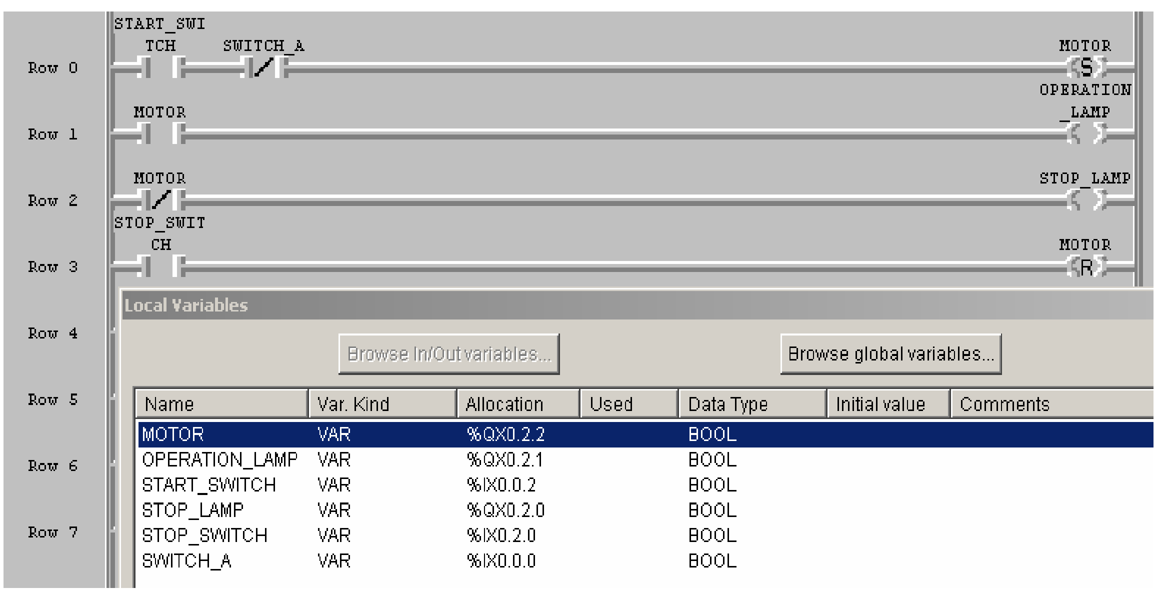
If one clicks OK than simulator starts and we can use inputs and outputs of simulator to monitor our program.



3) The above figure shows that when simulator is in RUN mode and start switch is pressed, the output related to operation lamp and motor status are activated which means that program is working properly.

LAB TASK

1) Implement the above lab in FXGPWIN and also configure the hardware.
2) Also mentioned that in what sequence the hardware is connected.
3) Also implement the above ladder with set and reset command as discussed in class (in GMWIN).



LADDER DIAGRAM

WORKING DESCRIPTION

CONCLUSION

EXPERIMENT NO – 13

CONTROL SYSTEM FOR MOTORS WITH EMERGENCY BACKUP

PURPOSE OF EXPERIMENT

1) Understand motor's PLC Commands.
2) Learn about I/O MAP of PLC.

PREPARATION

1) FXGP-WIN

RELATED KNOWLEDGE

1) One should be able to understand basic commands of PLC.
2) One should be able to understand the basics of motors controlling logic and basic sequence circuit..
3) One should be able to design PLC I/O MAP.

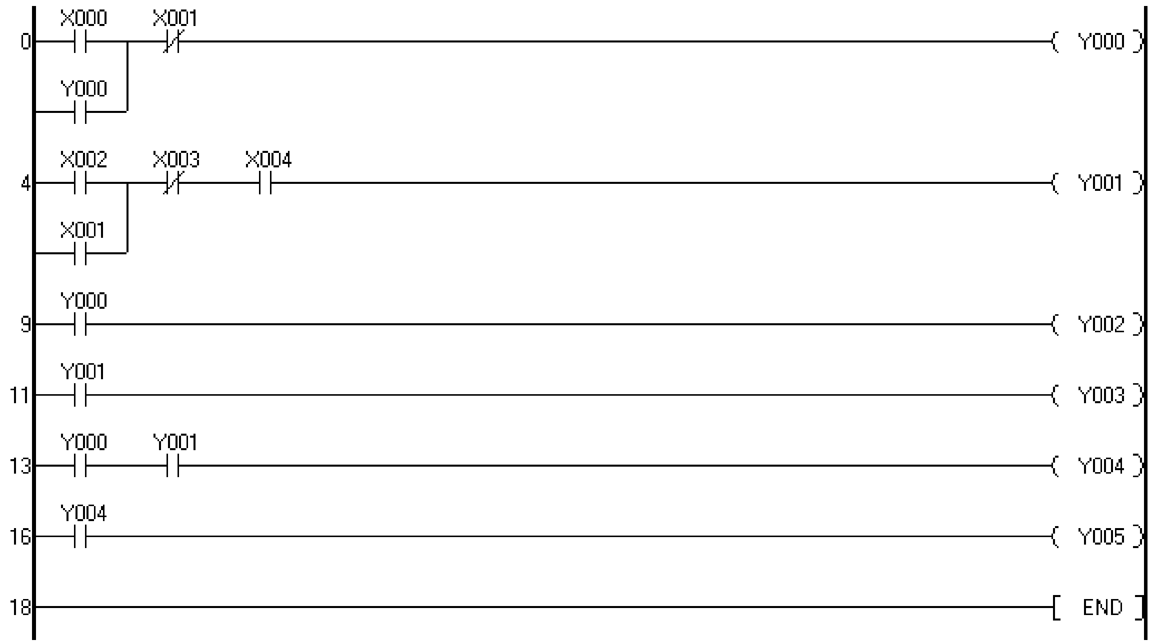
ACTIVATION CONDITION

1) Build motor's start/stop circuit by using four input switches (operation, stop).
2) PLC I/O MAP is configured below.

Section	Indirect Variable Name	I/O Allocation	Comments
Inputs	START_SWITCH_M1	X.0	Switch S-1
	STOP_SWITCH_M1	X.1	Switch S-2
	START_SWITCH_M2	X.2	Switch S-3
	STOP_SWITCH_M2	X.3	Switch S-4
	EMERGENCY	X.4	Switch S-4
Outputs	MOTOR_M1	Y0	MOTOR-1 (-)
	M1 _LAMP	Y2	Lamp L-1
	MOTOR_M2	Y1	Lamp L-2
	M2 _LAMP	Y3	MOTOR-1 (-)
	EMERGENCY_LAMP	Y4	Lamp L-3
	BUZZER	Y5	Buzzer B-1

PROGRAM PRACTICE

1) Execute the FXGP-WIN and open the Project window and the program window.
2) Write a program using PLC I/O MAP
3) Write ladder program as shown below.



EXECUTION OF PROGRAM (USING SIMULATOR)

Execute the program by converting and then writing to the plc. Follow the steps used in the previous lab.

SUMMARY OF LOGIC USED/PROGRAM SUMMARY

EXPERIMENT NO – 14

WATER LEVEL CONTROL SYSTEM

PURPOSE OF EXPERIMENT

3) Understand motor's PLC Commands.
4) Learn about I/O MAP of PLC.

PREPARATION

2) FXGP-WIN

RELATED KNOWLEDGE

4) One should be able to understand basic commands of PLC.
5) One should be able to understand the basics of motors controlling logic and basic sequence circuit..
6) One should be able to design PLC I/O MAP.

ACTIVATION CONDITION

3) Build motor's start/stop circuit by using four input switches (operation, stop).
4) PLC I/O MAP is configured below.

Section	Indirect Variable Name	I/O Allocation	Comments
Inputs			
Outputs			

PROGRAM PRACTICE

4) Execute the FXGP-WIN and open the Project window and the program window.
5) Write a program using PLC I/O MAP
6) Write ladder program as shown below.

LADDER DIAGRAM

WORKING DESCRIPTION

CONCLUSION

EXPERIMENT NO – 15

MOTORS LOAD DISTRIBUTION CONTROL SYSTEM

PURPOSE OF EXPERIMENT

5) Understand motor's PLC Commands.
6) Learn about I/O MAP of PLC.

PREPARATION

3) FXGP-WIN

RELATED KNOWLEDGE

7) One should be able to understand basic commands of PLC.
8) One should be able to understand the basics of motors controlling logic and basic sequence circuit..
9) One should be able to design PLC I/O MAP.

ACTIVATION CONDITION

5) Build motor's start/stop circuit by using four input switches (operation, stop).
6) PLC I/O MAP is configured below.

Section	Indirect Variable Name	I/O Allocation	Comments
Inputs			
Outputs			

LADDER DIAGRAM

WORKING DESCRIPTION

CONCLUSION

EXPERIMENT NO – 16

TIMERS USING PLC

A driven coil sets internal PLC contacts (NO and NC contacts available). Various timer resolutions are possible, from 1 to 100 msec, but availability and quantity vary from PLC to PLC.

Timer Resolution	FX0(S)	FX0N	FX	FX(2C)	FX2N(C)
100 msec	56 (T0 - 55)	63 (T0 - 62)	200 (T0 - 199)		
10 msec	\ 24 (T32 - 55)	\ 31 (T32 - 62)	46 (T200 - 245)		
1 msec	N/A	1 (T63)	N/A		
Retentive 1 msec	N/A	N/A	4 (T246 - 249)		
Retentive 100 msec	N/A	N/A	6 (T250 - 255)		

Selectable timers taken from the main range of 100 msec timers.

Timers operate by counting clock pulses (1, 10 and 100 msec). The timer output contact is activated when the count data reaches the value set by the constant K. The overall duration or elapsed time, for a timers operation cycle, is calculated by multiplying the present value by the timer resolution, i.e.
A 10 msec timer with a present value of 567 has actually been operating for:

567 × 10 msec
567 × 0.01 sec = 5.67 seconds

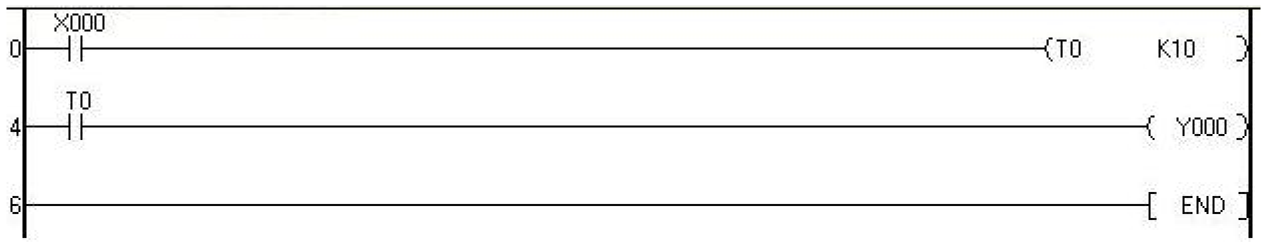
Timers can either be set directly by using the constant K to specify the maximum duration or indirectly by using the data stored in a data register (ex. D). For the indirect setting, data registers which are battery backed/ latched are usually used; this ensures no loss of data during power down situations. If however, the voltage of the battery used to perform the battery backed service, reduces excessively, timer malfunctions may occur.

On certain programmable controllers, driving a special auxiliary coil redefines approximately half of the 100 msec timers as 10 msec resolution timers. The following PLC's and timers are subject to this type of selection.

- FX0, FX0S driving M8028 ON, timers T32 to 55 (24 points) are changed to 10 msec resolution.
- FX0N driving M8028 ON, timers T32 to 62 (31 points) are changed to 10 msec resolution.

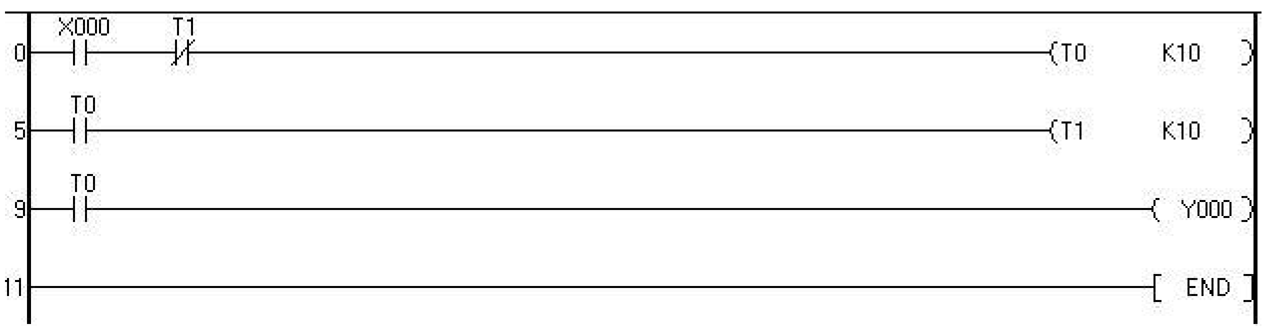
PROGRAM FOR OPERATING A BUZZER FOR 1ms

1. Build buzzer's start/stop circuit by using one input switch, a 1ms timer and a buzzer as an output.
2. Execute the FXGP-WIN and open the Project window and the program window.
3. Write ladder program as shown below.



PROGRAM FOR TURNING A DEVICE ON/OFF AT A CONTROLLED RATE.

In this example, the Output Y0 will be ON for 1 sec and then OFF for 1 sec. It will be used to describe how a PLC ladder can be produced, modified and tested. Then using a Mitsubishi FX2NPLC, the program will be downloaded, run and monitored
The ladder diagram for the circuit and its explanation is given below.



1. Line 0
(a) On closing the input switch X0, the timer T0 will be enabled via the normally closed contact of timer T1.
(b) Timer T0 will now start timing out, and after 1 sec, the Timer will operate. This means:
(i) Any T0 normally open contacts -jj-, will close.
(ii) Any T0 normally closed contacts -j / j-, will open.
2. Lines 5 and 9
There are two T0 contacts, which are both normally open, therefore both of them will close, causing the following to occur:
(a) Timer T1 will become enabled and start timing out.
(b) Output Y0 will become energized, i.e. output Y0 will turn ON.
3. Line 5
After timer T1 has been energized for 1 sec, it will also operate and its normally closed contact will open, causing Timer T0 to dropout.
4. With Timer T0 dropping-out, its normally open contact will now re-open causing:
(a) Timer T1 to dropout even though T1 has just timed out.

(b) Output Y0 to become de-energized, i.e. output Y0 will turn OFF.

5. Hence it can be seen that timer T1 is part of a 'cut-throat' circuit in that when it does time out, it immediately de-energizes itself.

6. With timer T1 dropping-out, its normally closed contact will close, and for as long as input X0 is closed, the operation will be constantly repeated.

7. Line 9

Hence the output Y0 will be continuously OFF for 1 sec and then ON for 1 sec.

LAB ASSIGNMENT

Design a system controlling three motors with conditions:

1. All the three motors should operate for 1 second.
2. When motor 1 is on, the others two should be off i.e. only one motor should operate at a time.

CONCLUSION