Investigation of Transmitter-Receiver Circuit with IR Diode

1. Inroduction

The Infra Red region covers light temperatures with wavelengths above **700 nm**, which start after the color red and are invisible to the human eye. The operating ranges of the transmitting and receiving electronic elements used in this region are between **720 nm-760** nm. The wavelength information provided by the manufacturers is the wavelength at which the element responds at the maximum amount. For example, it can be seen that the photo transistor used on the circuit can also detect 660 nm laser heat, but the detection distance will be much shorter than an IR transmitter of equal power.

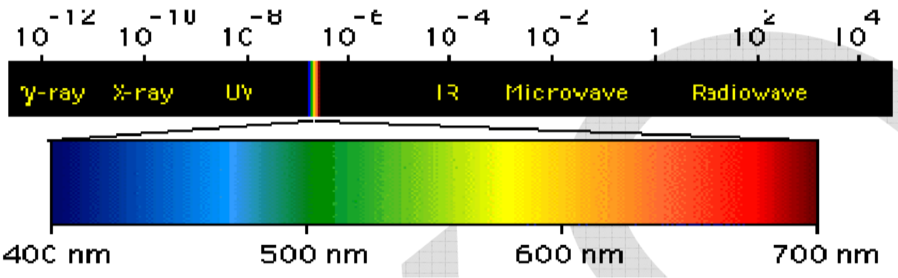


Figure 1. Electromagnetic Wave Spectrum and Visible Region

Data transfer with an IR diode is a frequently used method, especially in remote control circuits. In this method, data transfer is done with infrared light. There is an IR LED in the transmitter circuit and a photodiode or phototransistor in the receiver circuit that can detect the light information sent from the transmitter. In circuits that transfer data with light in this way, the transmitter and receiver elements must see each other.

2. Circuit Operation

Supply voltage is applied to the transmitter circuit by making the **+12 V** connection on Block-A and to the receiver circuit by making the **+12 V** and **-12 V** connections on Block-B. The transmitter circuit consists of an astable multivibrator made with NE555 integration. At the output of the NE555 (leg 3), there is a square wave signal whose frequency is determined by R1, R2 and C1. When button B1 is pressed, the square wave signal is applied to the IR LED and the IR LED flashes in the infrared region. The phototransistor (Q1) in the receiver detects the light sent by the IR LED and applies it to the LM741 (OP-AMP) integration via capacitor C3 at the collector end. The LM741 integrator drives the Q2 transistor by amplifying the signal at its input. The LED at the collector end of transistor Q2 flashes in synchronization with the IR LED on the transmitter. If the button is not pressed, the LED at the receiver output will remain off as no information is sent from the transmitter.

3. Circuit Diagram

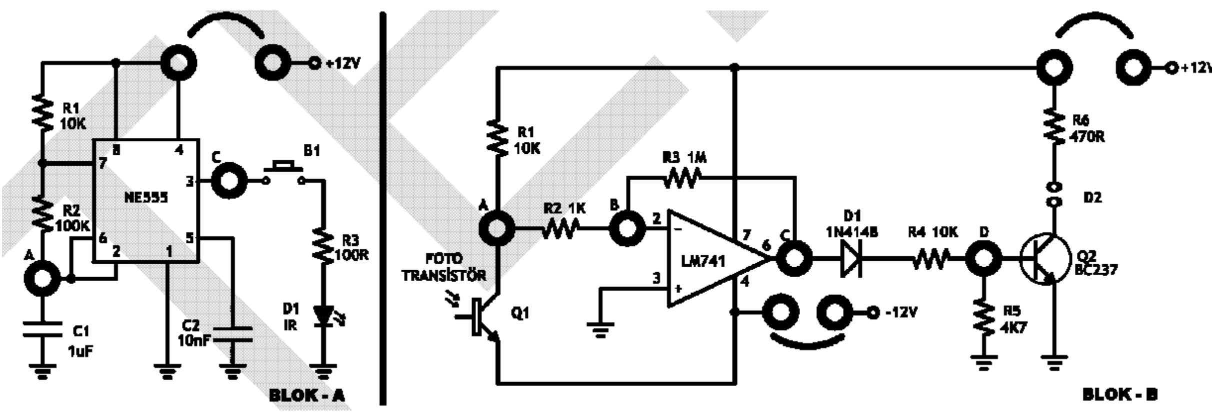


Figure 2. Experiment 1 Circuit Diagram

4. Experiment

1. Find blocks A and B by putting the SN02-M1 module into the main unit.
2. Make **12 V** voltage connections and energize the transmitter and receiver circuits. Observe that the LED at the receiver output is off.
3. Close the B_1 button (hold it pressed) to allow information to flow from the transmitter circuit to the receiver circuit. Observe that the LED in the receiver circuit lights up..
4. When the B_1 button is off, place a physical **obstacle** (paper, pen, etc.) between the IR LED and the phototransistor to prevent these two elements from seeing each other. Observe the state of the LED in the receiver circuit.

Observation Table:

B_1	LED (on the receiver)
Open	
Closed	

Investigation of Optical Pair (Transistor output)

1. Introduction:

This element, also known as optocoupler and optoisolator, has the feature of connecting two circuits to each other with light and thus electrically isolating them. This feature prevents the load circuit from drawing current from the control circuit and ensures that the operating characteristics of the control circuit do not change. In all optocoupler types, the input circuit (Input/Emitter) consists of one or more LEDs (mostly GaAs IR LEDs). The output circuit (Output/Detector), on the other hand, can be any of a photosensitive phototransistor, photocryistor, logic gate, phototriac or MOSFET. There are types that are optically isolated from the external environment as well as types with exposed transmitter and receiver elements for different applications.

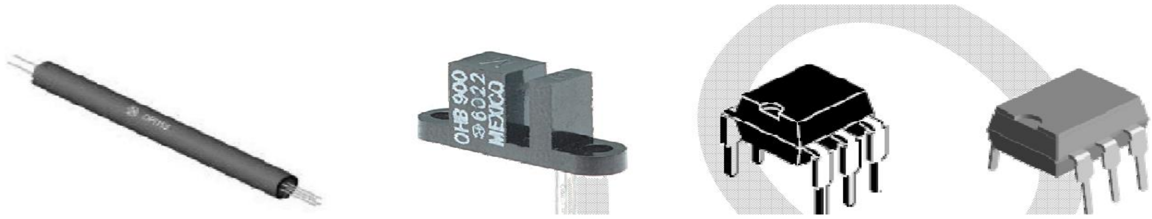


Figure 3. Views of various types of optocouplers

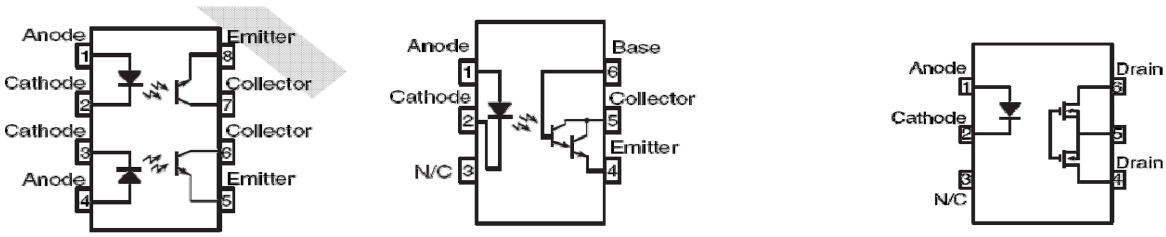


Figure 4. Internal structures of various optocouplers

2. Circuit Operation

12 V connections are made and supply voltage is applied to the circuit. As long as the B1 button is on, no current will flow through the LED in the optocoupler and this LED will not glow. As a result, the phototransistor whose white region does not receive light is insulating. As long as the B1 button is pressed, the LED in the optocoupler glows, making the phototransistor conductive. D1 lights up when the phototransistor goes into conduction.

3. Circuit Diagram

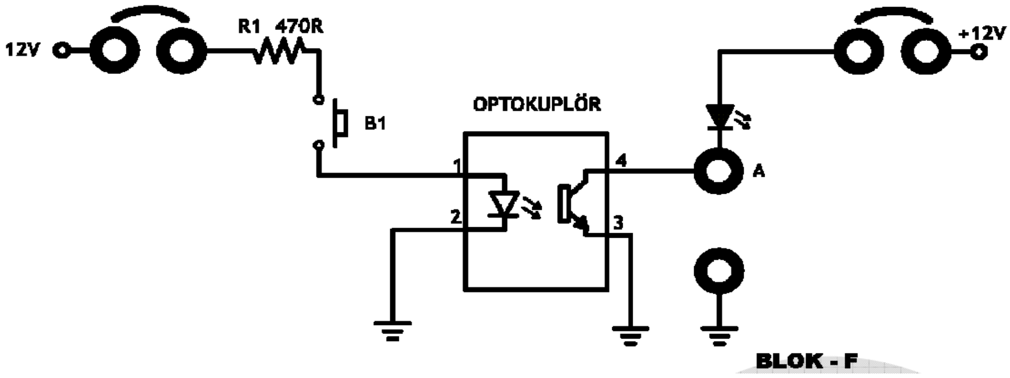


Figure 5. Experiment 2 Circuit Diagram

4. Experiment

1. Put the SN02-M1 module into the main unit and locate the F-block.
2. Give energy the circuit by making **+12 V** connections. Observe that D1 is off.
3. Press the B_1 button to allow current to flow through the LED in the optocoupler. Observe that D1 lights up.
4. Turn on the B_1button and observe that D1 goes out again.

Note: Since the transmitter and receiver elements on the optical pair are open to the external environment, it can be observed that the led lights up when light of sufficient intensity and appropriate wavelength falls on the phototransistor from outside. At the same time, if a strip or wheel-like obstacle is placed between the transmitter and receiver, it can be observed that the LED flashes in accordance with the transition speed.

Observation Table:

B_1	D_1
Open	
Closed	
Open	

Strain Gauge

1. Strain Gauge

Strain Gage sensors have been developed to take advantage of the resistance changes caused by the elongation and stretching of materials. Theoretically, we know that when you pull a wire from both ends, its cross-sectional diameter will shrink and its resistance will increase. In order for this change to reach measurable levels, the initial size of the wire must be long. In order to fit this wire size into the smallest space, the conductor in strain gage sensors is placed in the form of intertwined spirals as shown in the figure. The resulting sensor can be fixed on different grounds and the elongation and stretching of the ground can be measured at very sensitive values. Since the resistance change that occurs here is at milli ohm levels, the voltage changes that occur are at mV levels, so in industrial applications, the signal level is converted into **0-10V** voltage or **4-20 mA** current change by using ready-made amplifier circuits.

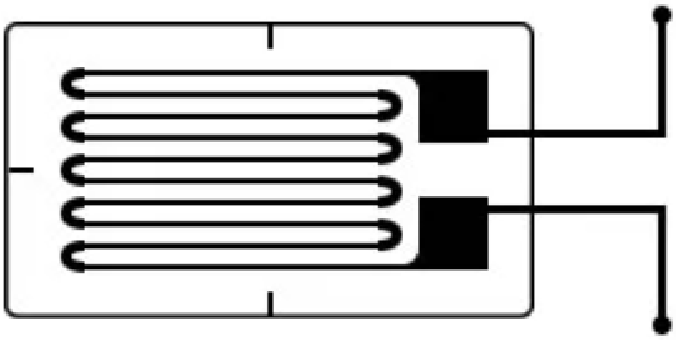
$$\frac{\Delta R}{R} = Ks \times \varepsilon$$

ΔR : Initial resistance of the strain gauge, Ω (ohm)

R : Change in resistance, Ω (ohm)

Ks : Indicating Factor, Proportional constant

ε : Strain



$$\varepsilon = \frac{\Delta l}{l}$$

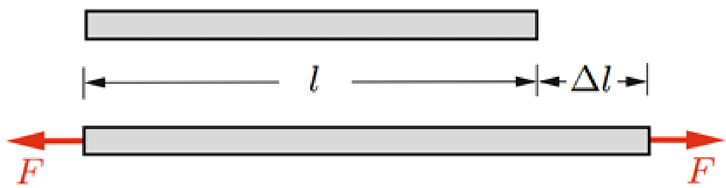


Figure 6. Resistance Component

2. Circuit Operation

When force is applied to the sensor, very small voltage changes occur at its terminals **(1-40 mV)**. In order to separate this voltage difference from the current voltage, a differential opamp was used. The **10K** trimpot voltage connected to the inverting input of the differential receiver circuit is set to a voltage value equal to the no-load voltage of the sensor and the difference is **0V**. When force is applied to the sensor, its resistance decreases and the voltage at point B is mV lower than the voltage at point A. In this case, the potential difference measured at point C varies between **-1mV** and **- 40mV**, the second opamp is used as an inverting amplifier and its gain is **-500**. The voltage at point D varies between **500 mV** and **2 V** depending on the point you set. Strain gage is to ensure that the surface is coupled to a special apparatus so that intermediate stretch values can be measured at the output.

3. Circuit Diagram

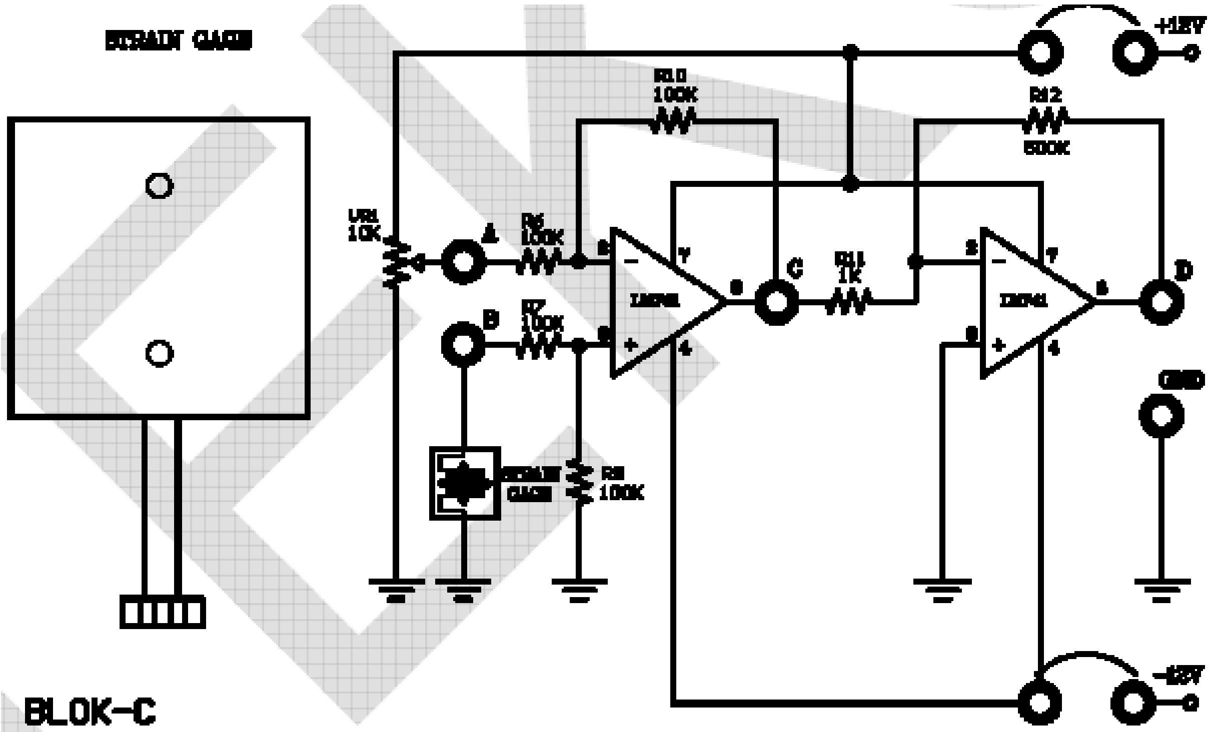


Figure 7. Experiment 3 Circuit Diagram

4. Experiment

1. Put the SN02-M4 module into the base unit and find the C-block.
2. Apply energy to the circuit by making **+12 V** and **-12 V** connections.
3. Set the point C output voltage to **0 V** for the desired strain gage position.
4. Change the position of the strain gage and observe the change of the stress at point D for three different positions on the oscilloscope screen.

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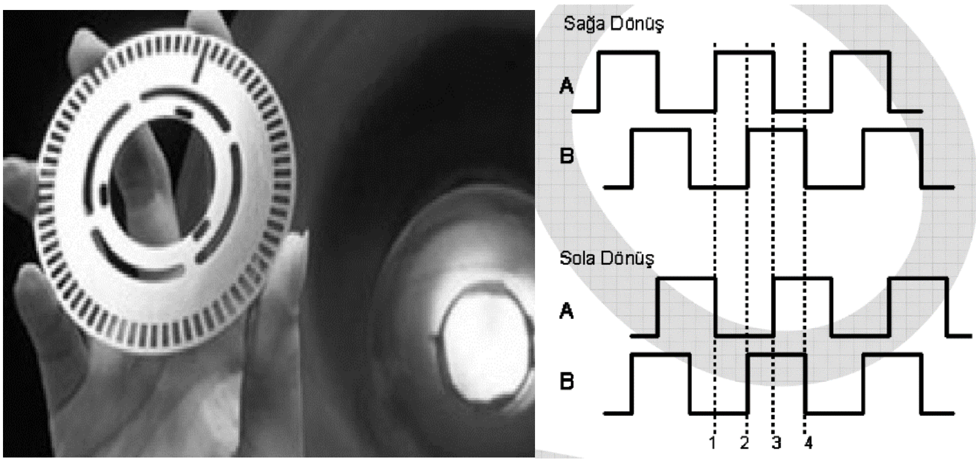
Encoder

1. Encoder

Encoder is a general name given to encoder circuits in the digital electronics literature. Basically, they convert 2^n numbers of input information into n numbers of output information. In industrial applications, when we think of encoders, we should first think of encoder circuits that we use to measure motor direction and speed information. There are encoder circuits integrated with the motor blog as well as encoder circuits that can be coupled to the motor shaft. Their basic operating logic is similar to the operation of the optical pairs we examined in Experiment 5. The rotational speed and direction of the motor shaft can be measured by means of a spaced wheel between the transmitter and receiver. The rotation direction can be measured with the 90^0 phase difference between the encoder outputs (A-B) and the rotation speed can be measured with the frequency of the incoming pulses. In this way, it is possible to control position using sensitive circuits. Similar applications are made with magnetic encoder circuits obtained by using single or two-point magnets and hall-effect sensors.



Figüre 8.

2. Circuit Operation

Motor applications are simulated using the encoder generator in the circuit. Depending on the direction you turn the encoder generator, you can see that the priorities of the LEDs on the A and B terminals change, and the frequency of the LEDs changes according to your rotation speed. Using the frequency of the signal generated in the circuit, you can find the number of revolutions per minute (rpm-revolutions per minute) of the encoder shaft. In order to do this properly, you need to know the number of slots on the wheel used, if there is only one slot, the rpm value can be found by multiplying the signal frequency by **60**. For example, if there are **360** slots on a wheel and the frequency of the signal produced is **720 Hz**, the number of revolutions per second of the motor is **720 / 360 = 2** and the number of revolutions per minute is **2 x 60 = 120 rpm.**

3. Circuit Diagram

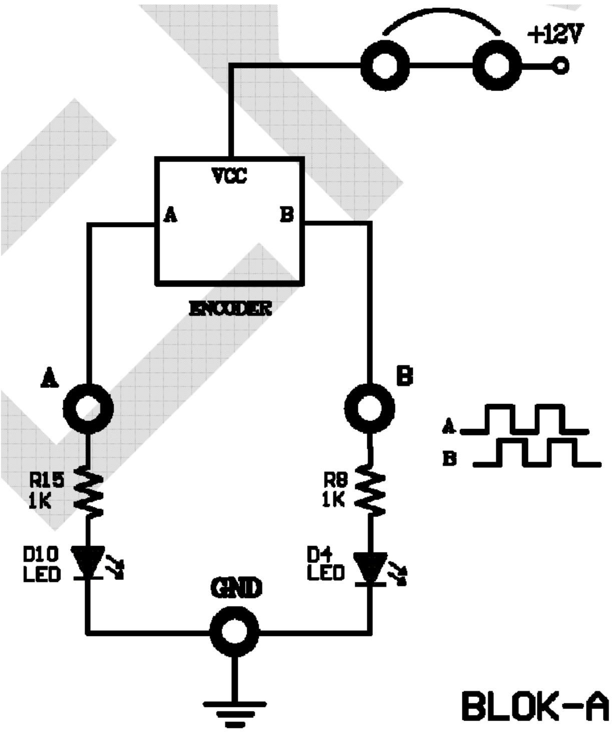


Figure 9. Experiment 4 Circuit Diagram

4. Experiment

1. Put the SN02-M4 module into the main unit and find block A.
2. Give energy to the circuit by making the **+12 V** connection.
3. Turn the encoder shaft clockwise and counterclockwise to observe the priority of the LEDs lighting up.
4. Observe the outputs A and B on the oscilloscope and calculate the frequency of the output waveforms for two different speeds, compare your calculation with the result you read on the frequency meter.

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