| EXP NO : 2 | Light-Emitting and Zener Diodes Characteristics |

RESUME OF THEORY

The emitting diode (LED) is, as the name implies, a diode that will give off visible light when sufficiently energized. In any forward-biased *p-n* junction there is, close to the junction, a recombination of holes and electrons. This recombination requires that the energy possessed by unbound free electrons be transferred to another state. In LED materials such as gallium arsenide phosphide (GaAsP) or gallium phosphide (GaP), photons of light energy are emitted in sufficient numbers to create a visible light source—a process referred to as *electroluminescence.* For every LED there is a distinct forward voltage and current that will result in a bright, clear light whether it be red, yellow, or green. The diode may, therefore, be forward biased, but until the distinct level of voltage and current are reached the light may not be visible. In this experiment the characteristics of an LED will be plotted.

The Zener diode is a p-n junction device designed to take full advantage of the Zener breakdown region. Once the reverse-bias potential reaches the Zener region, the ideal Zener diode is assumed to have a fixed terminal voltage and zero internal resistance. All practical diodes have some internal resistance even though, typically, it is limited to 5 to 20 Ω The internal resistance is the source of the variation in Zener voltage with current level the experimental procedure will demonstrate the variation in terminal voltage for different loads and resulting current levels.

For most configurations, the state of the Zener diode can usually be determined simply by replacing the Zener diode with an open circuit and calculating the voltage across the resulting open circuit. If the open-circuit voltage equals or exceeds the Zener potential, the Zener diode is "on" and the Zener diode can be replaced by a DC supply equal to the Zener potential. liven though the open-circuit voltage may be greater than the Zener potential, the diode is still replaced by a supply equal to the Zener potential the foregoing procedure is used to determine the state of the Zener diode Once the Zener voltage is substituted, the remaining voltages and currents of the network can be determined.

Z diode characteristics

Objectives:

To study the characteristics of Zener diode:

- Static recording of the current-voltage characteristic $I_Z = f(V_Z)$ of a Z diode

- Dynamic representation of the current-voltage characteristic $I = f(V)$ of a Z diode

- Differential resistance of Z diodes

Equipment

Circuit elements:

1   Resistor 330 Ω/2W
1   Z diode ZPD 6.2
1   Z diode ZPD 9.1

Measuring devices:

2 Multimeters

1   oscilloscope
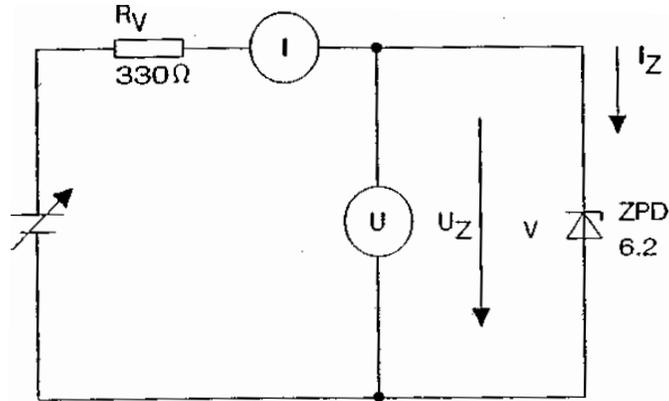
DC. Power supply units:

AC. Power supply unit

Accessories:

1   Plug-in board 297x300
1   Measuring cable BNC/4mm
1   Set of bridging plugs 19 mm
1   Set of connecting leads

Z diode characteristics
Exercise 1

Static recording of the current-voltage characteristic $I_z = f(V_z)$ of a Z diode

Assemble the circuit as shown in fig.1 and carry out the measurements for the voltages given in table 1.

ZPD 6.2 V	
V_z / V	I_z mA
0	
1	
2	
3	
4	
5	
5.5	
6.0	
6.1	
6.2	

Enter the measured values from table.1 into the diagram in fig.2 and draw the corresponding current-voltage characteristic $I_z = f(V_z)$.
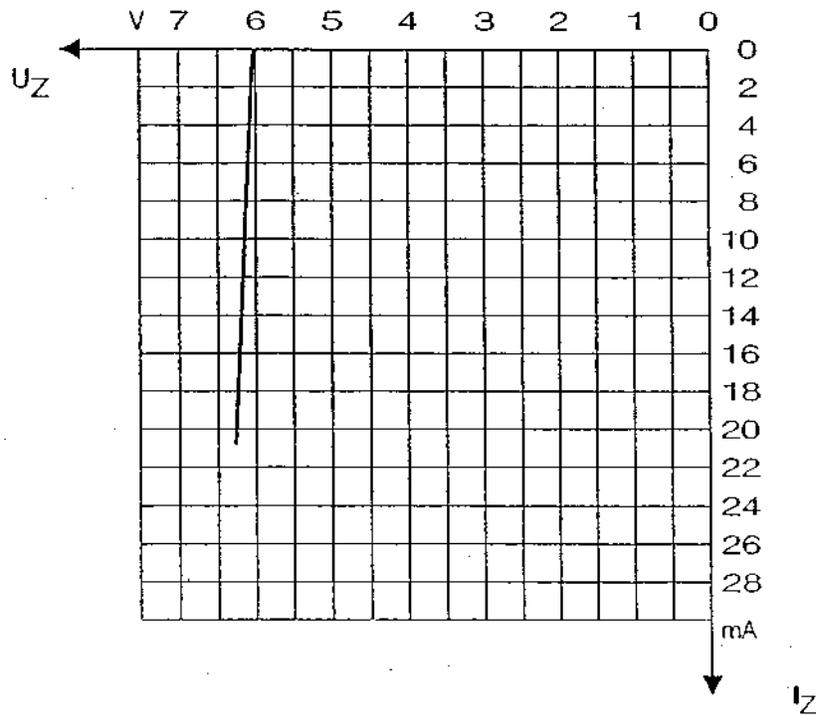

Fig. 2

1. What function does the series resistor R_v have?
2. Determine the Z voltage V_{zo} of the diode by drawing a tangent to the approximately linear part of the curve (fig. 2) and reading the voltage from the voltage axis where the tangent intersects it.

3. Set the DC supply (E) to the values appearing in Table 2.1 and measure both V_Z and V_R. Calculate the Zener current, I_z using the Ohm's law given in the table and complete the table.
4. Plot I_z versus V_Z using the data in Table 2.1 on a graph paper.

Results and Calculations:

E (V)	0	1	3	5	7	9	11	13	15
V_Z (V)									
V_R (V)									
$I_Z = V_R / R_{meas}$ (mA)									

1. R (measured) = _____

Exercise 2

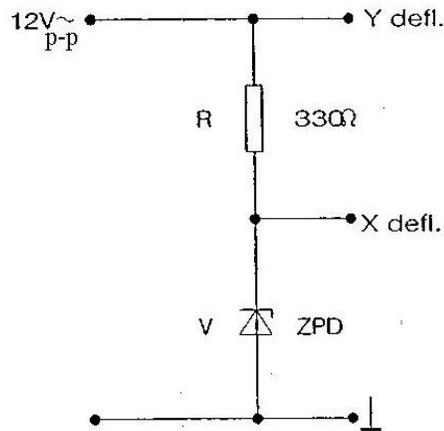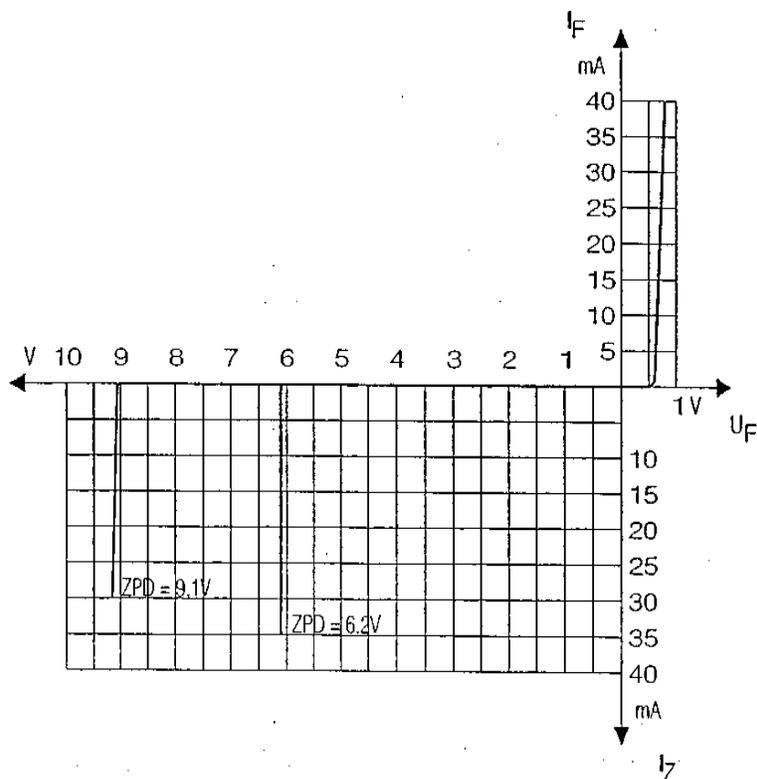Dynamic representation of the current-voltage characteristic $I_z = f(V_z)$ of a Z diode.

Fig.3

1 Assemble the circuit as shown in fig.3 and apply a sinusoidal a.c. voltage Vp-p = 12 V, f = 50 Hz.

2 Display the current-voltage characteristic of the Z diodes ZPD 6.2 V and ZPD 9.1 V on the oscilloscope and enter the graphs into the diagram in fig. 4.

3 Settings on the oscilloscope:

X-deflection: 2 volts/div (DC)

Y-deflection: 5 volts/div (DC, Inverted)

4 Compare the two characteristics and list three differences between them.

LED characteristics

Objectives

- Dependence of the emission of light from an LED on the polarity of the operating voltage

- Static recording of the current-voltage characteristic $I_F = f(V_F)$ of a red LED and an infrared LED

- Dynamic representation of the current-voltage characteristic $I_F = f(V_F)$ of a red LED, and a green LED.

- Threshold voltages of LEDs

Equipment

Circuit elements:

1   Resistor 100 Ω/2W
1   Resistor 1 kΩ/2W
1   Si diode 1N4007
1   LED LD57C, green
1   LEDCQV51J, red

Measuring devices:

1 Multimeter M2032
1 Multimeter M3E
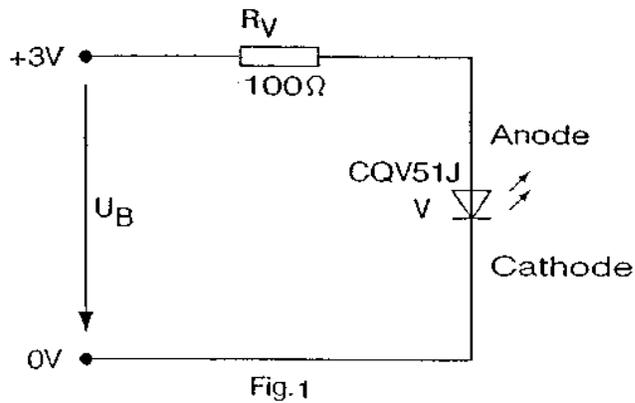1   Two oscilloscope 203-6

Power supply units:

1 Power supply unit

Accessories:

1   Plug-in board 297x300

2   Measuring cable BNC/4mm

1   Set of bridging plugs 19 mm

2   Set of connecting leads

LED characteristics

Exercise 1

Dependence of the emittence of light from an LED on the polarity of the operating voltage

Fig. 1

Assemble the circuit as shown in fig. 6.1 and apply an operating voltage of $U_B = 3$ V to the input. Record the result.

The LED lights up.

Switch the operating voltage off. Interchange the diode connections (cathode to +3V) and then switch the power unit on again.

The LED does not light up.

Use your results to summarize the relation between the polarity of the power source at the diode and the current required to light up the LED.

Exercise 2

Static recording of the current-voltage characteristic $I_F = f(V_F)$ of a red LED and of an infrared LED.
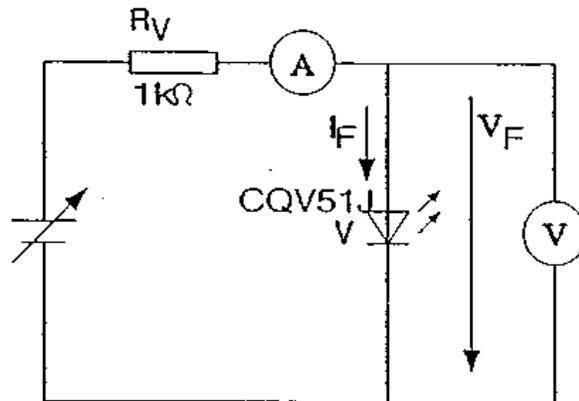

Fig.2

Assemble the circuit as shown in fig.2 and carry out the measurements for the voltages given in tables 6.1 and 2.

LED red	
V_F [V]	I_F [mA]
0.00	
0.50	
1.00	
1.50	
1.60	
1.65	
1.70	
1.75	
1.80	
1.85	
1.90	
1.95	
2.00	

Table.1

LED green	
V_F [V]	I_F [mA]
0.00	
0.50	
1.00	
1.50	
1.60	
1.65	
1.70	
1.75	
1.80	
1.85	
1.90	
1.95	
2.00	

Table.2

1. Enter the measured values from tables 1 and 2 into the diagram in fig. 3 and draw the corresponding current-voltage characteristics $I_F = f(V_F)$

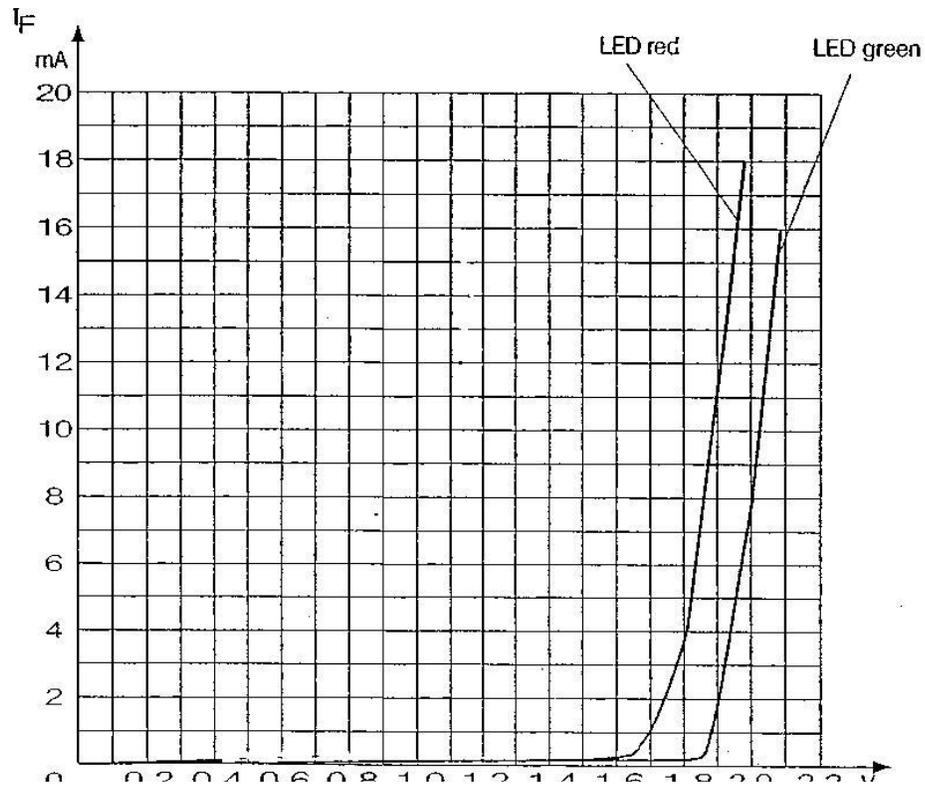2. Label the characteristics of the red and the green LEDs.

Fig...3

Exercise 3

Dynamic representation of the current-voltage characteristic $I_F = f(V_F)$ of a red, an infrared and a green LED
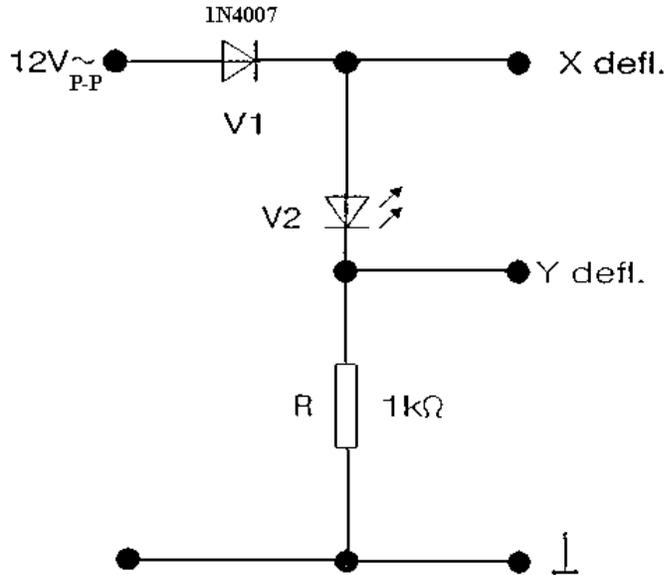

1N4007

12V~ P-P   X defl.

V1

V2

Y defl.

R   1kΩ

Fig. 4

1. Assemble the circuit as shown in fig.4 and apply an a.c. voltage U = 12 V, f = 50 Hz.

2. Settings on the oscilloscope:

    X-deflection = 0.5 volts/div (DC)

    Y-deflection = 5 volts/div (DC) (invert.)

3. Display the characteristics of the red, infrared and green LEDs on the oscilloscope and compare these with the statically recorded diode characteristics. Enter the characteristic of the green LED into the diagram in fig. 6.3.

4. Compare the characteristics in terms of threshold voltage and differential resistance and comment on your observations.

Exercise 4

Threshold voltages of LEDs

Determine the threshold voltage V(th) of the LEDs from the characteristics (fig. 3)

LED	
red	green
V(th)	V(th)= 1.90 V

Table .3

Explain the different threshold voltage values (see Information Section).