Applications of DR Circuits

I. OBJECTIVES

a) Finding out the VTC of a two-port DR network.
b) Finding out the electrical function of a three-port network DR of space extreme and its use as a logical circuit.

II. COMPONENTS AND INSTRUMENTATION

You will use the experimental assembly equipped with 2 semiconducting diodes and one resistor. Because you will apply and measure both dc and ac voltages you will need a dc regulated voltage supply, a signal generator, a digital multimeter and a dual channel oscilloscope.

III. PREPARATION

1.P. CLAMP TWO-PORT DR NETWORK

1.1.P. VTC

– For the circuit in Fig.2.1. how does VTC look like, considering that the v_I (t) $\in$[-10V, 10V]? What if v_I (t)$\in$[1,1.5][V]?
– What is the circuit's function?
– What is the expression of the output voltage for both branches of the VTC?

2.P. SPACE EXTREME THREE-PORT DR NETWORK

2.1.P. THE ELECTRIC FUNCTION

– What is the electric function of the three-port DR network represented in Fig.2.2.? How do you express mathematically this function?
– For the circuit shown in Fig.2.2., what is the time variation of the output voltage v_O(t), for v_A(t) =5V and v_B(t)=10 sinωt[V]?
– But for v_B(t)=10sinωt[V] and v_A(t)=-1V?
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2.2.P. THREE-PORT DR NETWORK –LOGICAL CIRCUIT

For the circuit shown in Fig.2.2. the electric variables v_A, v_B, v_O are associated to the logical variables, A, B and Y. What is the logical function of the circuit? You will consider:

"1" logic$\Leftrightarrow$10V
"0" logic$\Leftrightarrow$0V

IV. EXPLORATIONS AND RESULTS

1. CLAMP TWO-PORT DR NETWORK

From the four types of possible circuit configurations with 1R, 1D and a voltage source we have chosen, for the experiment, the one shown in Fig.2.1. which is less familiar than the one with the output on R, but having the same importance.

1.1. VTC

Exploration:
Build the assembly from Fig.2.1.
a) VTC using the point-by-point method.
The v_I =10V is obtained from the dc regulated voltage supply.
You will measure v_I and v_O with a digital multimeter.
You will also measure v_o for the following values of v_I : 5V, 1.5V, 0.8V, 0.4V, 0V, -1V, -5V, -10V.

Results:
a) VTC using the point-by-point method.
Table with v_I and v_O for v_I=-10V, -5V, 0V, +5V, +10V.
Table with v_I and v_O for v_I=-1V, 0V, +0.4V, +0.8V, +1.5V.
Draw two graphs representing $v_O(v_I)$ for the data from the two tables.
Specify on the graphs the on and the off states of the diode.
In what situation the threshold voltage different from zero should be taken into account? Why?

Exploration:
b) VTC on the oscilloscope.
You will obtain v_I from the signal generator, which is set to generate a sinusoidal voltage having an amplitude of 10V and a frequency of 100Hz.
Results:
b) VTC on the oscilloscope.
Compare the VTC obtained on the screen of the oscilloscope with the one obtained using the point-by-point method. For what value of the input voltage the diode goes from the on state to the off one?

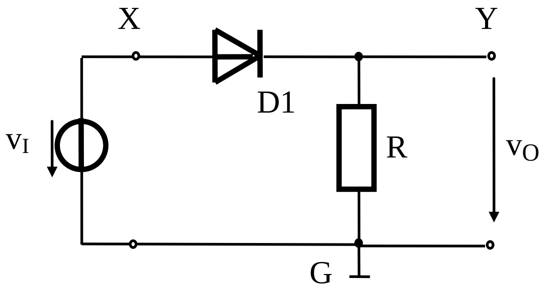

Fig. 2.1 Clamp two-port DR network

With the oscilloscope set on the Y-X mode you will set the origin of the system axis in the centre of the screen and then you will connect the input of the circuit to the X terminal and the output to the Y terminal.
Advice: you will connect the ground points (of the circuit, of the signal generator and of the oscilloscope) in the point M.

2. SPACE EXTREME THREE-PORT DR NETWORK

For the experiment you will use the three-port network from Fig. 2.4 with A, B as inputs and Y as output.

2.1. THE ELECTRICAL FUNCTION

Build the assembly from Fig.2.2.

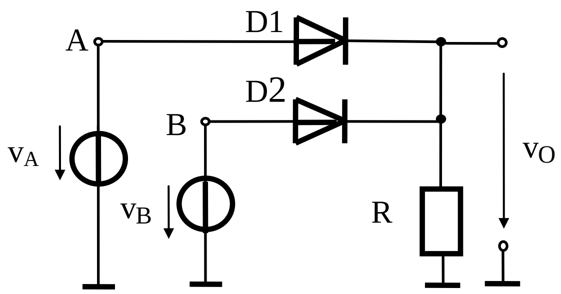

Fig 2.2 DR three-port

Exploration:

- v_A is a sinusoidal voltage with 100Hz frequency and 10V amplitude from the signal generator.
- v_B =5V is a dc voltage.
- With the oscilloscope having 0Vin the centre of the screen you will visualize v_O and v_A.
- You will repeat the visualization of v_A and v_O for v_B=-1V.

Results:

- Plot the waveforms for v_A, v_B, v_O, for v_B(t)=5V and then for v_B(t)=-1V.
- Show the time domains, on the waveforms, which represent the on and off states of the diode.
- Compare these results with the ones obtained at 2.1.P. Interpret it.
- Is it possible for both diodes to be simultaneous turned on? What about turned off?

2.2. THREE-PORT DR NETWORK- LOGICAL CIRCUIT

Build the assembly from Fig.2.2.

Exploration:

- The voltages v_A and v_B can have any value from: 0V and 5V. This can be done by connecting the points A and B to the ground or to the dc regulated voltage source adjusted at 5V.
- v_o is measured with a digital multimeter used as a DC voltmeter.
- You will do all the possible combinations of the values of v_A and v_B measuring v_o each time.

Results:

- Table with v_A, v_B, v_o for all the combination of v_A and v_B from {0V, 5V}.
- Logical (truth) Table with A,B, Y considering the conventions from 2.2.P.
- What values of the voltage correspond to the “1” logical level at the input and output of the circuit?
- Name some advantages and disadvantages of the DR three-port network, used as a logical circuit.