Hybrid Parameters

Pair of terminals is known as a port. Here, the current enters through one terminal and leaves from the other terminal. So, the electrical components like resistor, inductor and capacitor are examples of one port network. It is known as a two-port network if the network has two such ports. In the following two-port network, there are two ports, namely port 1 and port 2. V_1 and V_2 are the voltages across port 1 and port 2, respectively. Similarly, I_1 and I_2 are the currents flowing through port 1 and port 2, respectively. Any linear circuit with two pair of terminals can be regarded as two port network provided that it does not contain independent source and satisfies the port conditions.

Examples are transmission lines, transformer, small signal amplifiers, filters.

In the two-port network, we can give the input to any port; similarly, we can take the output from any port. Since we have two electrical quantities, voltage and current, obviously, the input and output also will be among those two forms.

The parameters that we will use in two-port networks are known as two-port network parameters. Since there are four variables, V_1, V_2, I_1 and I_2, we will get six sets of parameters for the two port networks. Now, let's see the following two port network parameters.

- Z Parameters
- Y Parameters
- T Parameters
- T' Parameters
- h Parameters
- g Parameters

h Parameters

Among the four variables V_1, V_2, I_1 and I_2 of a two-port network, let's consider I_1 and V_2 as independent variables and V_1 and I_2 as dependent variables. That means I_1 and V_2 are the inputs, whereas V_1 and I_2 are the outputs of the two-port network. The two equations of this two-port network and the corresponding h parameters are mentioned below.

- $V_1=h_{11}I_1+h_{12}V_2$
- $I_2=h_{21}I_1+h_{22}V_2$
- $h_{11}=V_1/I_1$, when $V_2=0$
- $h_{12}=V_1/V_2$, when $I_1=0$
- $h_{21}=I_2/I_1$, when $V_2=0$
- $h_{22}=I_2/V_2$, when $I_1=0$

Here, h_{12} and h_{21} do not have any units. The units of h_{11} and h_{22} are ohm (Ω) and mho (℧), respectively. The h parameters are also called Hybrid parameters. We can find two h parameters, h_{11} and $h_{21,}$ by making port 2 a short circuit. Similarly, we can see the other two h parameters, h_{12} and $h_{22,}$ by making port 1 an open circuit.

The relationship between voltages and current in h parameters can be represented as:

$$V_1=h_{11}I_1+h_{12}V_2$$

$$I_2=h_{21}I_1+h_{22}V_2$$

Let us short circuit the output port of a two port network as shown below,

Now, ratio of input voltage to input current, at short circuited output port is:

$V_1/I_1|V_2=0 \;=\; h_{11}$

This is referred to as the short circuit input impedance.

Now, the ratio of the output current to input current at the short-circuited output port is:

$I_2/I_1|V_2=0 \;=\; h_{21}$

This is called short-circuit current gain of the network.

Now, let us open circuit the port 1. At that condition, there will be no input current (I_1=0) but open circuit voltage V_1 appears across the port 1, as shown below:

$V_1/V_2|I_1=0 = h_{12}$

This is referred as reverse voltage gain because, this is the ratio of input voltage to the output voltage of the network, but voltage gain is defined as the ratio of output voltage to the input voltage of a network.

Now:

$I_2/V_2|I_1=0 = h_{21}$

It is referred as open circuit output admittance.