Measurement of Directional coupler with the help of RFME signal source and power detector:

This application note describes the measurement of directional coupler and its basic parameters with the help of RFME's Signal Source and Power Detector.

A Directional coupler is a 4 port electronic passive device in which, the port 1 is the input port, port 2 is the output port or through port where the incident signal exists, port 3 is the coupled port where a fixed fraction of the input signal appears which is expressed in dB and the port 4 is the isolated port which is usually terminated with 50 Ohms. Ideally all four ports are matched and circuit is lossless. An incoming signal is partially split between the output port 2 and the coupled port 3, and no signal appears at the isolated port4.

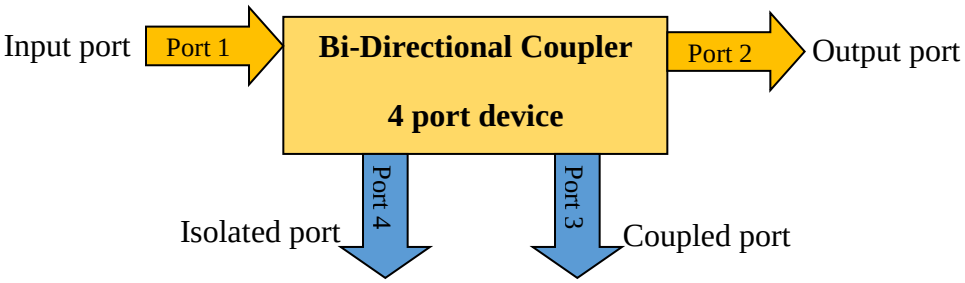

Figure 1: Directional Coupler

The directional couplers are realized in microstrip, stripline, coax and waveguide and are available in various types like the two-hole directional coupler, four-hole directional coupler, reverse coupling directional coupler and Bethe hole directional coupler.

The Directional couplers are used for sampling a signal. It can sample both incident and reflected wave and that is known as a reflectometer which is an important part of a network analyzer. They are also used in power measurements, to determine VSWR by measuring the incident and reflected power, signal levelling and reflection coefficient measurement.

They are good for combining signals if the isolation is high to feed into a single line to a receiver for two tone receiver tests. Frequently available directional couplers are 3dB, 6dB, 10dB, 20dB and 30 dB.

Basic parameters for the directional couplers for measurement:

Coupling: The relative signal attenuation between an input port 1 and its corresponding coupled port 3. Coupling is measured in dB over a specified frequency range.

Main Line Loss: The total insertion loss in the main line as measured in a matched system from input port1 to the output port2.

Directivity: Directivity should be as high as possible. It is not measured directly as it is the addition of the isolation and negative coupling measurements.

In order to do the measurement of any component, the user first needs to take the direct reading with the help of two 50 Ohms coaxial cables and an adaptor in between. Following are the setups for better understanding of the measurement of a 20dB directional coupler.

(1) Direct reading measurement:

Take the RFME signal source and set its frequency to 2.25 GHz and signal level to -1dBm which is given as an input to the RFME power detector with the help of two coaxial cables and one adaptor in between as shown in the Figure: 1. The received signal can be easily measured at RFME power detector of -1.6dBm if there is a loss of -0.6dB in the coaxial cables and adaptor connected.

The below setup shows the selection of Single mode with the switch position at 'S" on RFME signal source and on the RFME power detector the switch is selected for dBm. Thus on RFME signal source, it will be displayed as "2.250" for 2.25GHz and on RFME power detector results will be displayed in dBm as "-01.6" for -1.6 dBm**.** In Figure: 1 direct reading with two 50 Ohms coaxial cable and an adaptor in between is shown. Results on RFME power detector are displayed in dBm.

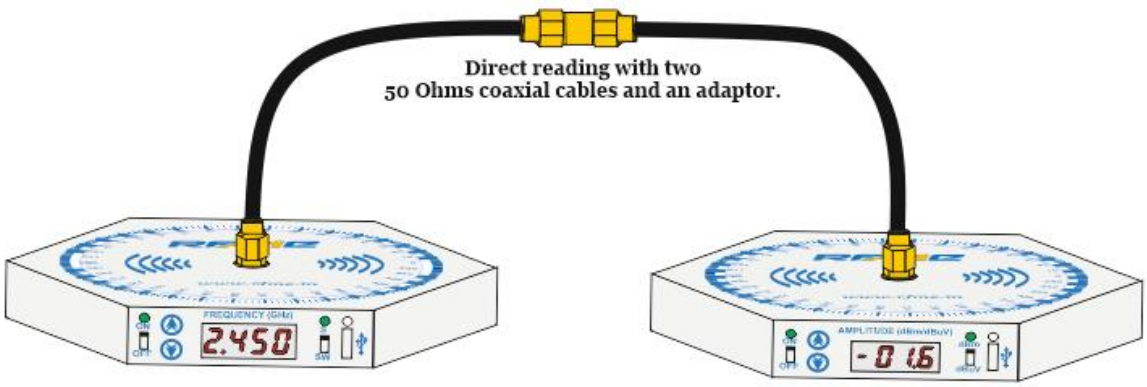

Figure: 1

(2) Insertion loss measurement:

The direct reading at 2.25 GHz is "-01.6" dBm which is considered as an input to the Directional coupler. *1

Thus in order to measure the insertion loss of Directional coupler, connect it to the RFME power detector at port2. The displayed output is "-01.8" dBm. This result shows that the Directional coupler under test at 2.25 GHz has an insertion loss of -0.2dB at port2 since the direct reading is -1.6dBm. Here the RFME power detector is on the dBm selection. To check other frequencies which comes under the band of RFME signal source and Directional coupler. Measurements with the same procedures listed above can be carried out. *2

Note: *1) 1.6dB loss in the direct reading as measured.

*2) Directional coupler can be checked in single mode as well as on the scan mode according to the frequency band of the chosen Signal Source and Power Detector models.

In Figure: 2; a setup to measure insertion loss at port2 is shown with results on RFME power detector in dBm. Here the adaptor is replaced by the 20dB directional coupler.

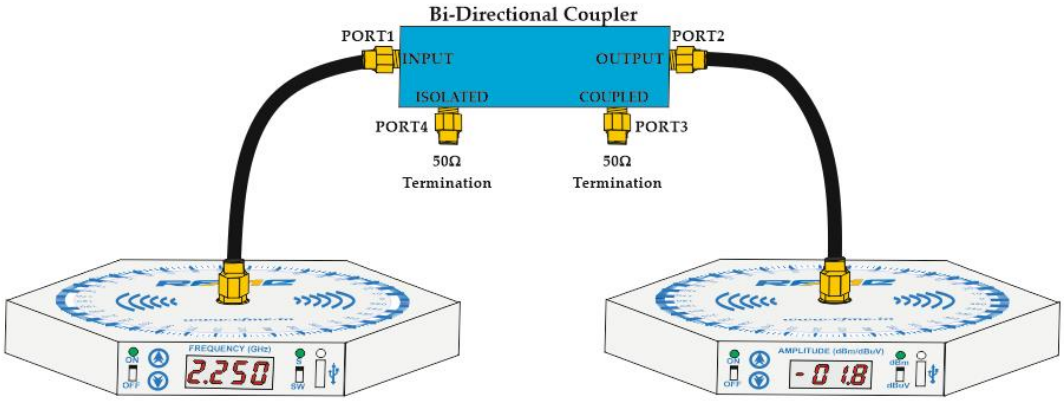

Figure: 2

(3) Coupling measurement:

For coupling measurement, the input signal is given on the port1 of the directional coupler with the help of the RFME signal source and the output is measured at port3 with the help of RFME power detector. For coupling measurement on port3 terminate port2 and port4 with 50 ohms. The result at 2.25GHz on RFME power detector is

displayed as "-20.4dB" which shows the coupling of 20dB and insertion loss of 1.8dB. Thus the signal at coupled port3 is 20dB down.

In Figure: 3 A setup to measure coupling at port3 is shown with results on RFME power detector in dBm.

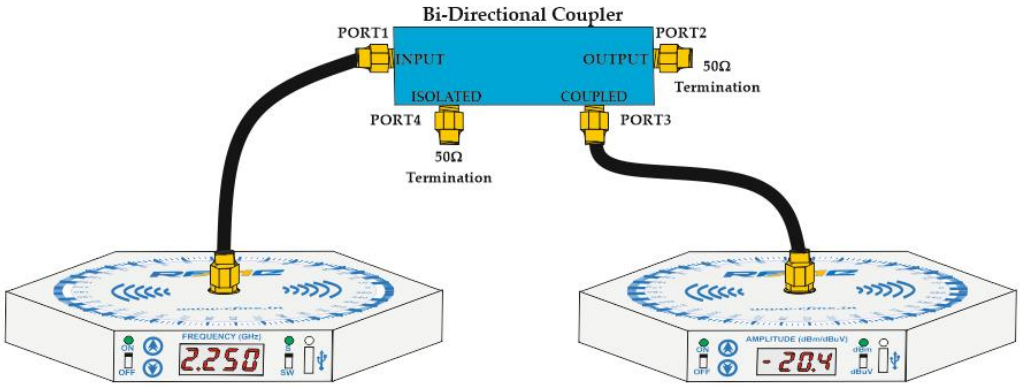

Figure: 3

(4) Directivity measurement:

For directivity measurement the input signal is given on the port1 of the directional coupler with the help of the RFME signal source and output is measured at port4 with the help of the RFME power detector. For directivity measurement on port4 terminate port2 and port3 with 50 Ohms. Result of 2.25GHz on RFME power detector is displayed as "-45.6 dB" which is the isolation. Thus the signal at isolated port4 is 45.6dB down. Thus directivity is the difference of coupling and isolation which is calculated as 25.2dB.

In Figure: 4; A setup to measure isolation at port4 is shown with results on RFME power detector in dBm.

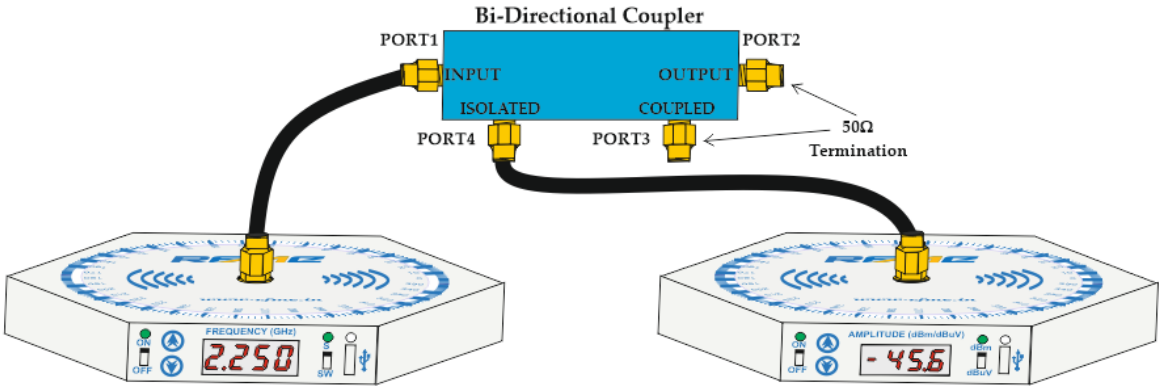

Figure: 4

Following is the table showing the Directional coupler measurement parameters on Signal Sources and Power Detector:

Sr.#	Frequency on RFtx	Direct Reading on RFrx	Reading on RFrx for Thru(With Port 3 & 4 terminated)	Reading on Rx for Coupling(With Port 2 & 4 terminated)	Reading on Rx for Isolation(With Port 2 & 3 terminated)	Directivity measurement (Difference of isolation and coupling)
1	2.25 GHz	-01.6dBm	-01.8dBm	-20.4dB	-45.6 dB	25.2dB

Note: 1) The user can use any RFME Signal Source devices which meets your frequency measurement requirements for the EUT.
2) The measured data on the RFME power detector can also be displayed in the dBuV when selected for dBuV with the help of the switch on the front panel.

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