



Department of Electronics & Telecommunication Engineering

CLASS: B.E. E &TC

EXPT. NO.: 5

Roll No.: 42428

SUBJECT: RMT

DATE:

TITLE: - To measure and verify port characteristics of directional coupler and calculate coupling factor, insertion loss and directivity.

OBJECTIVE:-

1. To study the function of multi-hole directional coupler.
2. To measure Coupling factor, Directivity, Insertion Loss

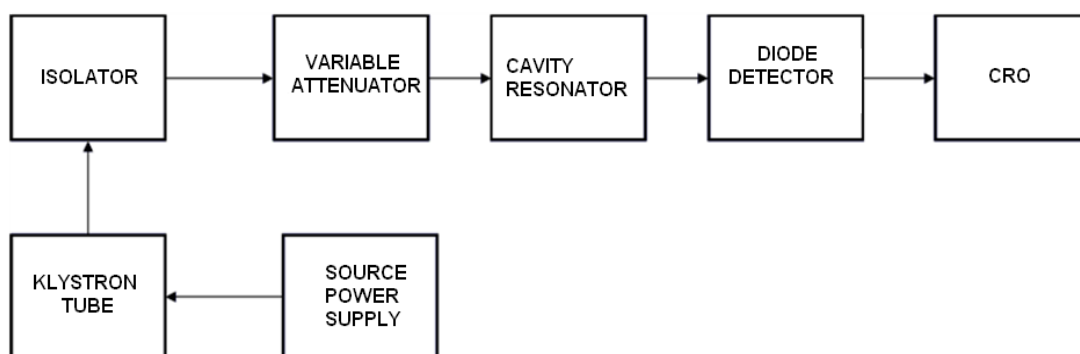
EQUIPMENTS:-

Microwave power source
Source power supply
Cooling fan
Variable calibrated attenuator
Frequency meter
Tuned detector
C.R.O.
Cables and accessories.
Matched termination
Directional coupler

PROCEDURE and SETUP DIAGRAMS:-

Measurement of coupling and insertion loss and directivity

- i. Assemble the setup as shown



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- ii. Energize the microwave source for particular operation of frequency.
- iii. Determine power P_i , the reference power or the input power, fed to the main line input port of the directional coupler and record the observations in observation table. This is V_{in} .
- iv. Insert the directional coupler as shown in fig:2 with detector to auxiliary port 3 and matched termination to port 2. & measure power P_f i.e. the power coupled in auxiliary line. This is V_f .

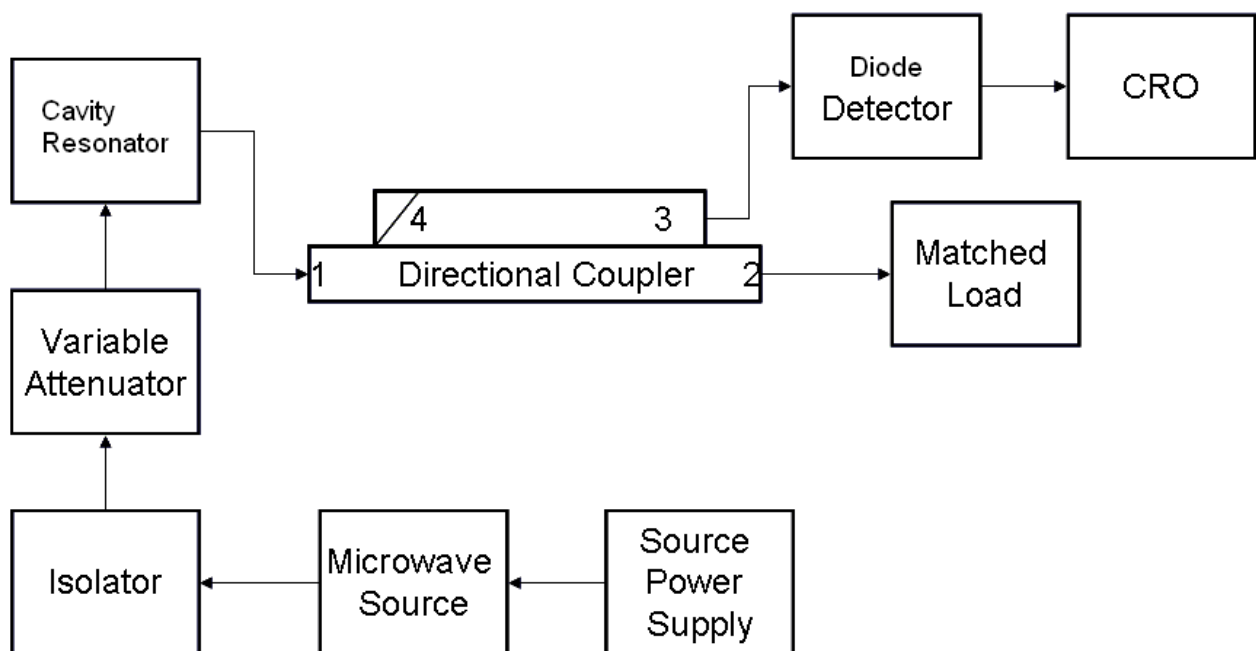


Fig 2- Output at port 3

- v. Coupling is calculated using equation.
- vi. Now carefully disconnect the detector from the auxiliary line output port 3 and matched termination from the main line output port 2 without disturbing the set up.
- vii. Connect the matched termination at auxiliary line output port 3 and detector to main line output port 2 as shown in fig:3 . Measure the power P_r at main line output port the same in observation table. This is V_r .

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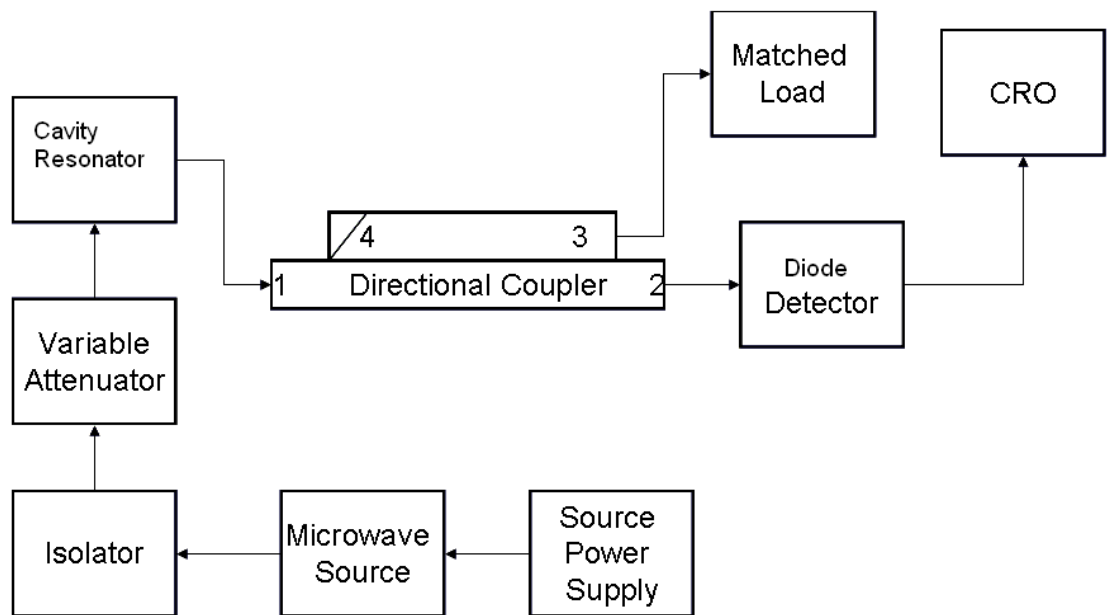


Fig 3-Output at port 2

- viii. The insertion loss is calculated using equation.
- ix. Connect directional coupler in reverse direction as shown in Fig.4 i.e. port 2 to frequency meter side, matched termination to port 1 and detector to port 3 without disturbing settings.

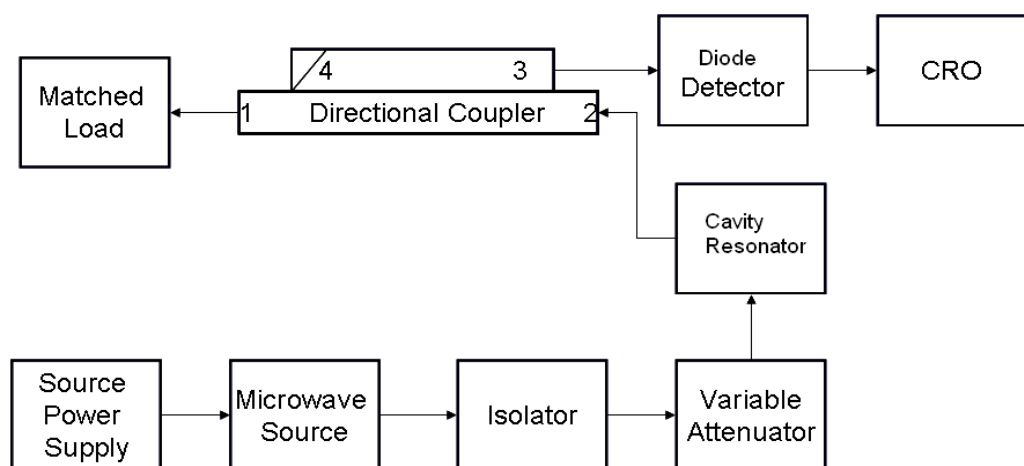


Fig 4- Output at port 3 with input at port 2

- x. Measure the back power (P_b) output with the coupler reversed. This is V_b .
- xi. The directivity is calculated using equation



OBSERVATION TABLE:

Beam voltage = 247 V

Beam current = 14 mA

Repeller Voltage = 198 mV

Frequency = 11.75 GHz

Voltages	10 dB	20 dB
V_{in}	2.84V	982mV
V_r (main line)	2.7V	796mV
V_f (auxiliary line)	920mV	141mV
V_b (auxiliary line)	6.64mV	5mV

CALCULATIONS

i. Coupling factor

$$C = 20 \log \frac{V_{in}}{V_f}$$

$$C_{10dB} = 20 \log(2.84/0.920) = 20 \log(3.08695) = \mathbf{9.79061 \text{ dB}}$$

$$C_{20dB} = 20 \log(0.982/0.141) = 20 \log(6.964539) = \mathbf{16.85784 \text{ dB}}$$

ii. Insertion loss

$$L = 20 \log \frac{V_{in}}{V_r}$$



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$$L_{10\text{dB}} = 20\log(2.84/2.7) = 20\log(1.05185) = \mathbf{0.4390915 \text{ dB}}$$

$$L_{20\text{dB}} = 20\log(0.982/0.796) = 20\log(1.233668) = \mathbf{1.823968 \text{ dB}}$$

iii. Directivity

$$D = 20\log \frac{V_f}{V_b}$$

$$D_{10\text{dB}} = 20\log(920/6.64) = 20\log(138.5542) = \mathbf{42.832395 \text{ dB}}$$

$$D_{20\text{dB}} = 20\log(141/5) = 20\log(28.2) = \mathbf{29.0049822 \text{ dB}}$$

iv. Isolation

$$I = 20\log \frac{V_{in}}{V_b}$$

$$I_{10\text{dB}} = 20\log(2.84/0.00664) = 20\log(427.71084) = \mathbf{52.623 \text{ dB}}$$

$$I_{20\text{dB}} = 20\log(0.982/0.005) = 20\log(196.4) = \mathbf{45.86283 \text{ dB}}$$

CONCLUSION:-

In this experiment, we observed functionality of multi-hole directional coupler and measured Coupling factor, Directivity, Insertion Loss, and Isolation by applying the source from klystron oscillator. The coupling factor for 10dB and 20dB was found to be 9.79061 dB and 16.85784 dB respectively. The insertion loss for 10dB and 20dB was found to be 0.4390915 dB and 1.823968 dB respectively. The Directivity for 10dB and 20dB was found to be 42.832395 dB and 29.0049822 dB respectively. The



Isolation for 10dB and 20dB was found to be 52.623 dB and 45.86283 dB respectively.

REFERENCES:-

1. Microwave and Radar Engineering—M.Kulkarni
2. Basic Microwave Lab Manual—Sisodia