Laboratory Journal

of

MICROWAVE THEORY AND TECHNIQUES

For completion of term work of 7th *semester*

curriculum program

Bachelor of Technology

In

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION

ENGINEERING

Dr. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY

Lonere-402 103, Tal. Mangaon, Dist. Raigad (MS)

INDIA

List of Experiment

Sr No.	Name of the experiment
1	Introduction of microwave signal generator and Receiver.
2	To measure coupling factor, isolation and directivity of coupled line coupler.
3	To measure power division and isolation characteristics of microstrip Wilkinson power divider and measure VSWR of all the ports.
4	To measure the dielectric constant of substrate using Ring resonator and half wave resonator.
5	To measure the VSWR of ports of match load, open stub, short stub, and mismatch.
6	Measure Insertion loss, Isolation and VSWR of ports microwave SPST PIN Diode switch.
7	To measure gain, isolation, VSWR of ports of MMIC amplifier.
8	To measure Insertion loss, VSWR of ports of filter and measure pass band and stop band characteristics.

Experiment no:1

AIM: To get introduced to microwave signal generator and receiver.

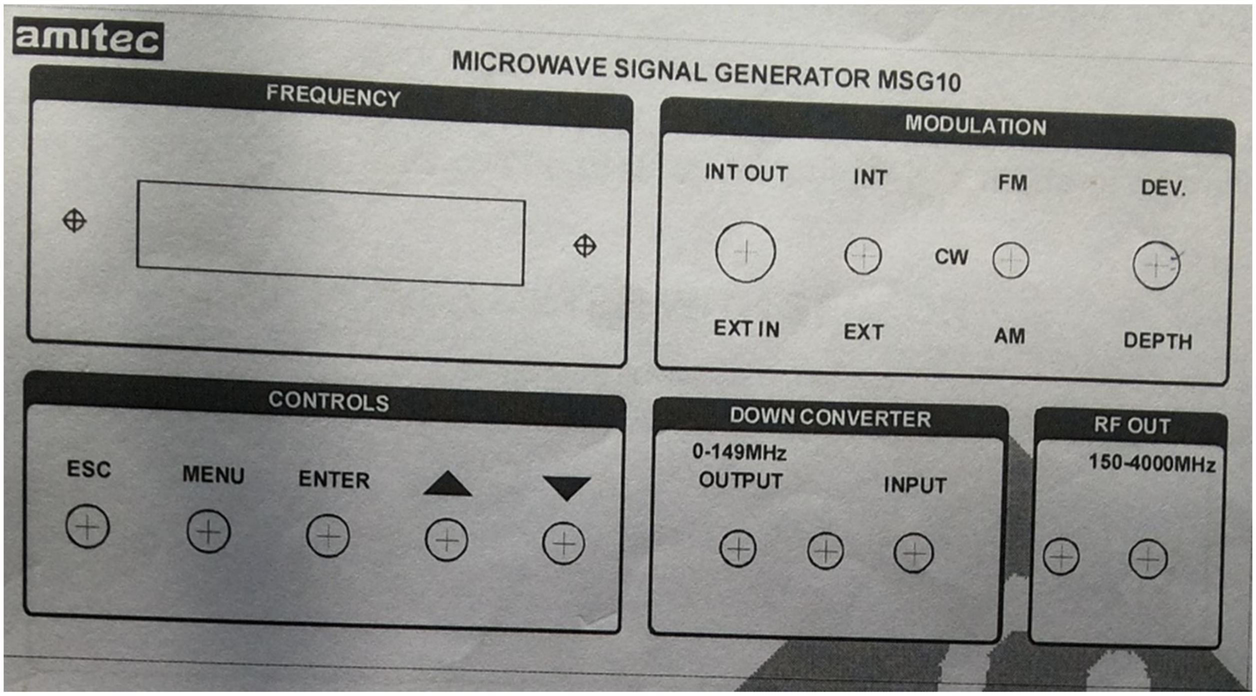


FIG. Front Panel Layout of Source

CONTROLS AND THEIR DESCRIPTION:

LCD: This 16x2 Liquid Crystal Display Is Used To Display The Frequency Of Signal Being Generated Along With Memory Location Etc. The Range Is From 2 GHz To 4 GHz.

COARSE TUNE: This potentiometer is used to set the frequency of operation of the unit. Clockwise rotation increases the frequency.

FINE TUNE: This potentiometer is used to fine the frequency of operation of the unit. Clockwise rotation increases the frequency.

FM/CW: This toggle switch is used to select thee modulation cw is used for taking measurements, as level remain stable in this mode.fm is used to frequency modulation externally connected voice/function generator waveform or internally generated 1 kHz tone etc. for communication.

CW/AM: This toggle switch is used to enable amplitude modulation of output signal

CW/SWEEP: Toggle switch is used to enable 50 Hz line synchronize linear frequency sweep modulation of output signal

AM DEPTH/FM DEV: This potentiometer provides continuous adjustable am depth and FMdeviation. Clockwise rotation increases depth/deviation depth of modulation may vary upon change in frequency

INT/EXT: This toggle switch is used to select between internal and external source of modulation keep the switch of internal to 1 kHz internal sine wave for am/fm.in external position the internal source is disabled and external source can be connected from say a function generator.

1KHZ OUT/EXT MODE IN: ThisBNC has internal 1 kHz sine wave output for triggering cro when observing am.th same bnc is used to input the external modulating source.

SWEEP OUT: ThisBNC has internal 50 Hz triangular wave output for triggering CRO when observing sweep. This can used as x input for x-y mode of operation of CRO.

MICROWAVE RF POWER METER WITH SENSOR:

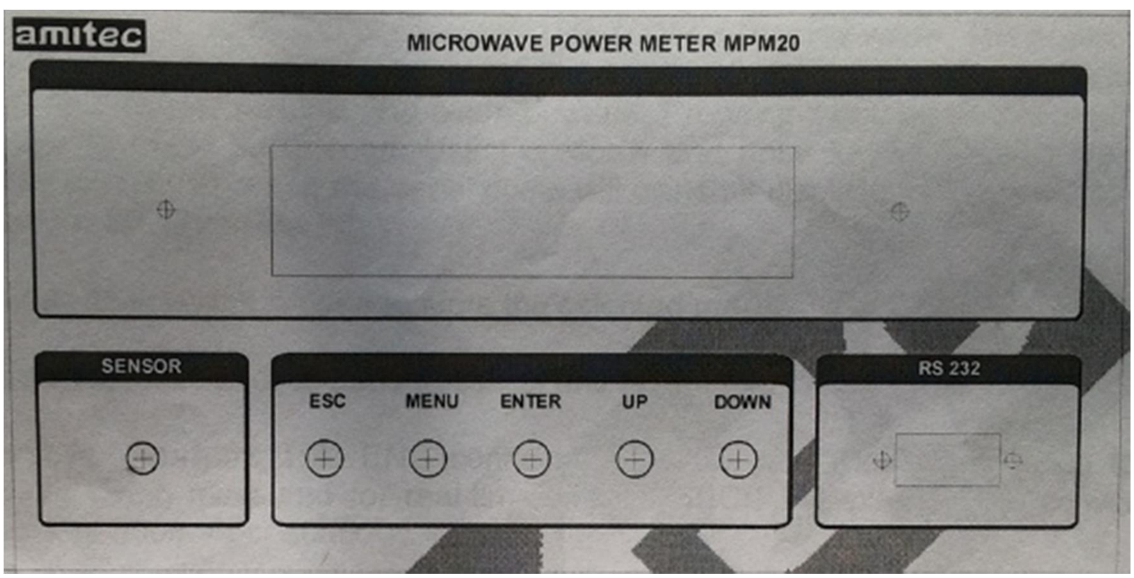


FIG. Front Panel Layout of Receiver

CONTROLS AND THEIR DESCRIPTION:

UP: Thisselect switch is used to scroll the menu option up.

DOWN: Select switch is used to scroll the menu option down.

MENU: This switch is used to select the different menu option like measurement unit, averaging time etc. Pressing the menu button once bring up the resolution option. Press up or down key to select the resolution between 0.1, 0.5 or 1 db. For normal use you can select 0.1 dB as resolution. Pressing menu button twice form main menu will show relative unit option. Pressing up or down key reveal relative or absolute unit options pressing menu key while LCD display is relative unitwill show 0dbr=-30dbm. Pressing up or down key will scroll -30dbm to +20dbm. One can select any desire relative unit to account for say the coupling factor of directional coupler. Say 0 dbr = -10dbm. This means that unit will display measure power as 0dbr for an input power of -10dbm. This means that +0dbm will be displayed as +10dbr and so on. Pressing menu key while unit displays absolute unit will show absence of mw,dbm,dbw and dbu.: Upon pressing up or down keys. One can select either these unit by pressing enter key. The power meter will measure and display the result in the selected units. One can select desired unit as dbm. Pressing menu key 4 times will show option of bar graph required. Pressing up or down will display “bargraphreqd” or not required. Pressing enter key on displayed option will select the bargraph. Pressing menu key 5 times will display of band select=x. pressing up or down key will display l,s,c,s or k bands. Use enter key or select the desired operation. Use X-band for normal operation. The instrument is calibrated in different frequency bands and corresponding errors are memorized In EE-PROM. The errors in different bands are mostly within 1-2dB.Pressing menu key again sill display “Band-X=+0.0”.This option can be used to add or subtractup to 3dB from displayed value as form of user setting. This can compensate of power losses in long RF cables, connectors used ahead of the sensor. Pressing menu again will display “Averagingreqd”. Pressing up and down can select between averaging and peak measurement options.

ENTER: This Switch is used to store the selected menu option.

ESCAPE: This Switch is used to cancel any command.

RECORDER OUTPUT: This BNC connector provides a dc level in relation to the power begin measured for real-time display on CRO or plotter. The conversion factor is 500mv per 10dB.

SENSOR: This provides power supply to sensor and reads the sensor output.

RS 232: This 9 pin connector is used to connect the equipment to the pc for display and storage of measured data.

Select com-port to witch data out of Power meter is to be connected.

EQUIPMENT SETUP:

1. Connect the mains cord at the back panel of the equipment and connect at to the AC220V outlet.
2. Ensure that a three pin socket is used and is properly earthed.
3. Switch on instrument from the switch provided on the back panel.
4. The LCD display will lighted up displays. 'Warming up 60 seconds to go''. Generally all power meters takes 5-10 min to warm up. An option of minimum 60 seconds is given in case user don't have enough time. In that case readings will be inaccurate by 0.2-0.5dB.
5. Wait for 5minutes for warm up.
6. After 60 seconds have passed power meter will display ''Remove Sensor''(i.e.) remove sensor from any external Microwave source or switch the power OFF of any microwave source say , DRO, Gunn, Klystrons etc. such that the sensor doesn't receive any microwave power.
7. It also displays ''Press Enter''. After removing sensor, now press enter key.
8. Press the menu switch and select the measurement units to dbm.
9. Select the measurement band to S band.
10. Connect the sensor input to the microwave source.
11. The display should read X dbm
12. Now connect the sensor to the point where the power is to be measured.

Conclusion:

EXPERIMENT NO.2

COUPLED LINE COUPLERS

AIM: To measure coupling factor, Isolation and Directivity of coupled line coupler.

EQUIPMENT: RFsource,Receiver,connecting cable, coupled line coupler.

THEORY:

COUPLED LINE COUPLER

Coupled lines occur when two transmission lines are closed enough in proximity so that energy from one line passed to the other. Coupled lines are used in coupler (usually the quadrature couplers)aswell as transmission filters.

Lines can be coupled in 3 ways:

1. Edge coupled
2. End coupled
3. Boardside coupled

In order to make quadrature Coupled lines coupler your need to coupler you need to couple a quarter-wave section; end-coupled structures are not useful in this case. That leaves two broad categories of coupled line coupler,edge coupled and boardside coupled both can be realized in micro strip or strapline but strapline is best.

For few word coupled line forming a four port network, two things have to occur with coupled lines to become a usable coupler with directivity and quadrature phase:

1.Coupled with directivity and quarter wave.

2.The product of even and odd mode impedance must be equal to zo^2.

Let port 1 is the input port. The port that is directly coupled to port 2 whichis one of two ports.The other output port is directly acrossfrom input port i.e port 3.Under ideal conditions, A signal incident on is will transfer zero power to port 4; this is called the isolated port.

Bandwidth is better than directed-coupled couplers like the branch line. The coupling occurs via two mechanisms, voltage, and mutual inductance (current). The mutual inductance coupling has a minus sign associated with it, thee voltage coupling does not. The combined effect not only reverse the signal flow in the coupled line(backward coupling) but also it puts the two signals 90 degrees out of phase.

COUPLING FACTOR

The coupling factor is defined as:

Coupling factor = -10*log(p3/p1)

Where p1 is the input power at port 1 and p3 is the output power from the coupled port 3. The couplingfactor represents the primary property of a directional coupler.

Coupling is not constant but varies with frequency. While difference designs may reduce the variance a perfectly flat coupler theoretically can't be built. Directional couplers are specified in terms of the coupling accuracy at the frequency band centre. The accuracy is due to dimensional tolerances that can be hold for the spacing on the two coupled lines sensitivity. Largest frequency sensitivity will allow a large frequency band of operation.

LOSS

In an ideal directional coupler , the main line loss from port 1 to port 2 (p1-p2) due to power coupled to the coupled output port is :

Insertion loss(dB) = 10*log (1-(p3/p1))

The actual directional coupler loss will be a combinational of coupling loss, conductor loss and VSWR loss. Depending on the frequency range coupling loss becomes less significant above 15dB coupling where the other losses constitute the majority of the total loss.

ISOLATION

Isolation of a directional coupler can be defined as the difference in signal level in dB between the input port and the isolated port when the two other ports are

Isolation (dB) =-10*log (p4/p1)

Terminated by the matched loads, or:

Isolation can be defined between the two output ports. In this case, one of the output ports is used as input the other is considered the output port while the other two ports (input and isolated)Are terminated by matched loads.

Isolation (dB) =-10*log (p3/p2)

DIRECTIVITY

Directivity is directly related to isolation. It is defined as,

Directivity (dB) =-10*log(p4/p3)

=-10*log (p4/p1) +10*log (p3/p1)

Where, p3 is the output power from coupled port and p4 is the power output from the isolated port.

The directivity should be as high as possible. The directivity is very high at the design frequency and is a more sensitive function of frequency because it depends on the cancellation of two wave components. Wave guide directional couplers will have the best directivity. Directivity is not directly measurable, and is calculated from the isolation and coupling measurements as:

Directivity (dB) =Isolation (dB)-Coupling (dB)

PROCEDURE:

1 .Set the frequency of the source to 3GHZ.

2. Connect a 30cm RG316 SMA Cable to source.

3. Connect another cable RG316 30cm to power sensor.

4. Convert the actual power to dB scale in power meter and convert it as 0 dB.

5. Connect directional coupler in part 1 to source and coupled part 3 to receiver (power meter).the out part 2of coupler is terminated in termination load 50ohm. Isolated part 4 is also terminated in 50ohm load. Plot the source and receiver over frequency range 2-4GHz in say 100MHz intervals and measure the power level. This power level is called forward power level.

6. Now reverse the directional coupler and connect the load 50ohm at in part 1 of the directional coupler. The coupled part 3 remains connected to receiver power meter sensor. The source is connected at the part 2 of directional coupler. Plot the source and receiver over frequency range 2-4 GHz and measure the level. This power level is called as reverse power level. The difference in power level between forward power level and reverse level with load 50ohm will be the return loss of the load 50ohm.

7. Connect source to RF in part 1 of coupler. Connect the part 2 of coupler to receiver.

8. The, 0-(0-1) =1 dB is the insertion loss s12 of coupler. Now let's measure insertion loss in entire frequency range from 2 to 4 GHz in 100MHz steps. Make a chart of insertion loss vs. Frequency of coupler in entire range.

9. Now let's measure coupling factor s13 of coupled line coupler.

10. Bring source to 2GHz and then connect source to part 1 of coupler.

11. connect part 3 of coupler to receiver.

12. Terminated the part 2 of coupler using 50ohm load. Also terminated isolated part in 50ohm.

13. Now, let's measure coupling factor in entire frequency range from 2 to 4 GHz in 100MHz steps. Make a chart of coupling factor vs. Frequency of coupler in entire range.

14. Now, in order to measure directivity (s14-s13) connect coupler in part 1 part to source and coupled part 3 to receiver. Connect the termination or 50ohm load at out part2 of coupler part3 to receiver. Connect the termination or 50ohm load at out part2 of coupler. Also terminate isolated part4 in 50ohm.

15. Now keep the source connected to part1 and termination connected to part 2. Interchange part 3 and 4, by connecting power sensor at part 4 and part 3.

16. For measuring isolation s41, connect source to part 1 of coupler.

17. Connect Isolation part 4 of coupler to receiver.

18. Terminate the out port 2 of coupler using 50Ω load. Also terminate coupled port 3 in 50Ω.

RESULT:

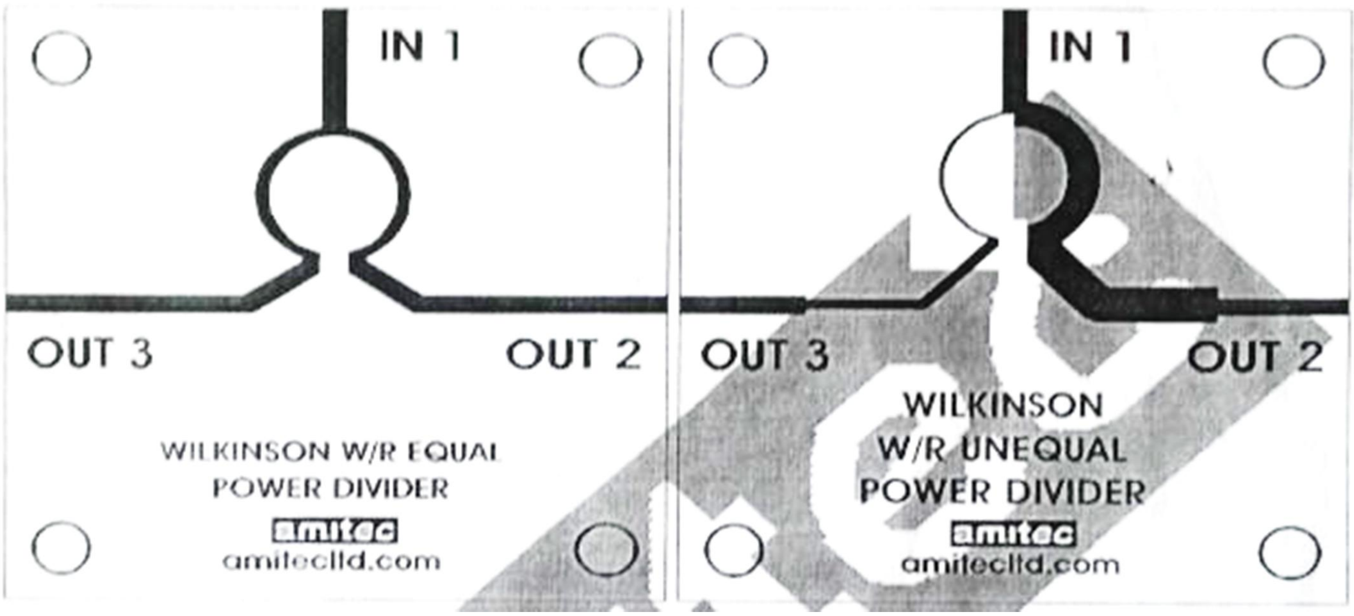
CONCLUSION:

EXPERIMENT NO.3

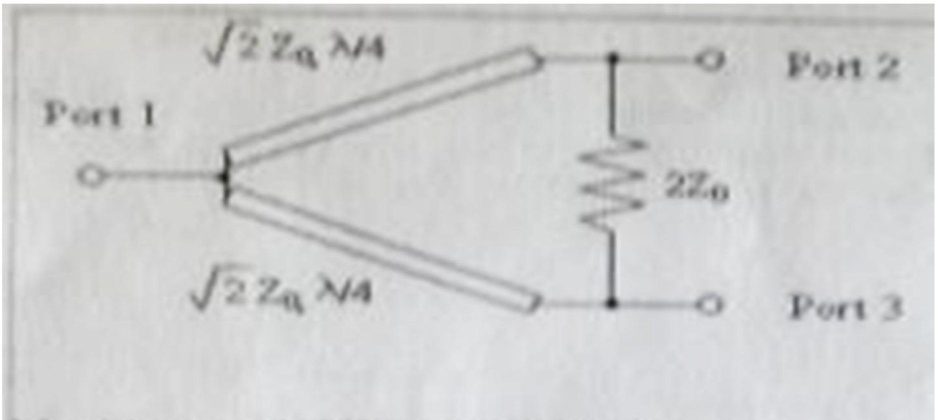
POWER DIVIDER

OBJECTIVE: To measure power division and isolation characteristics ofmicrostrip Wilkinson power divider and measure VSWR of all the ports.

EQUIPMENT: RF source, Receiver, Wilkinson Power divider, connecting cables, directional coupler



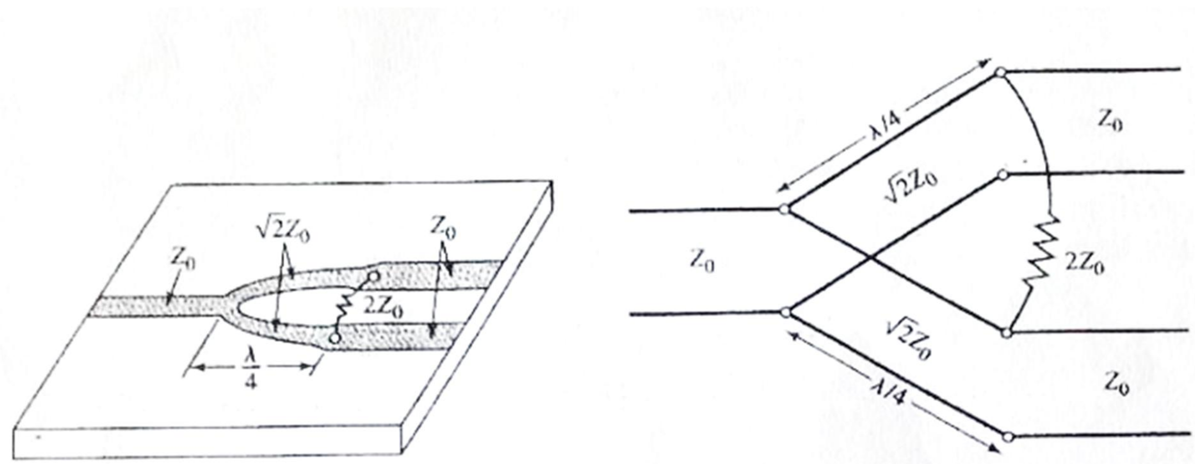
THEORY: Wilkinson power splitter It splits an input signal into two equal phase output signals, or combines two equal-phase signal into one in the opposite direction .Wilkinson relied on quarter wave transformer to match the split ports to the common port. The resistor does a lot more than allow all three ports to be matched , It fully isolates port 2 from port 3 at the center frequency .The resistor adds no resistive loss to the power split, so an ideal Wilkinson splitter is 100%efficient .In its simplest form ,an equal-amplitude ,two-way split, single-stage Wilkinson is shown the figure below. The arms are quarter-wave transformers of impedance 1. 414*Z_0 (thanks for the correction,rod) Here we show a three-port circuit (the most common in practice by far, but Wilkinson described an N-way divider).



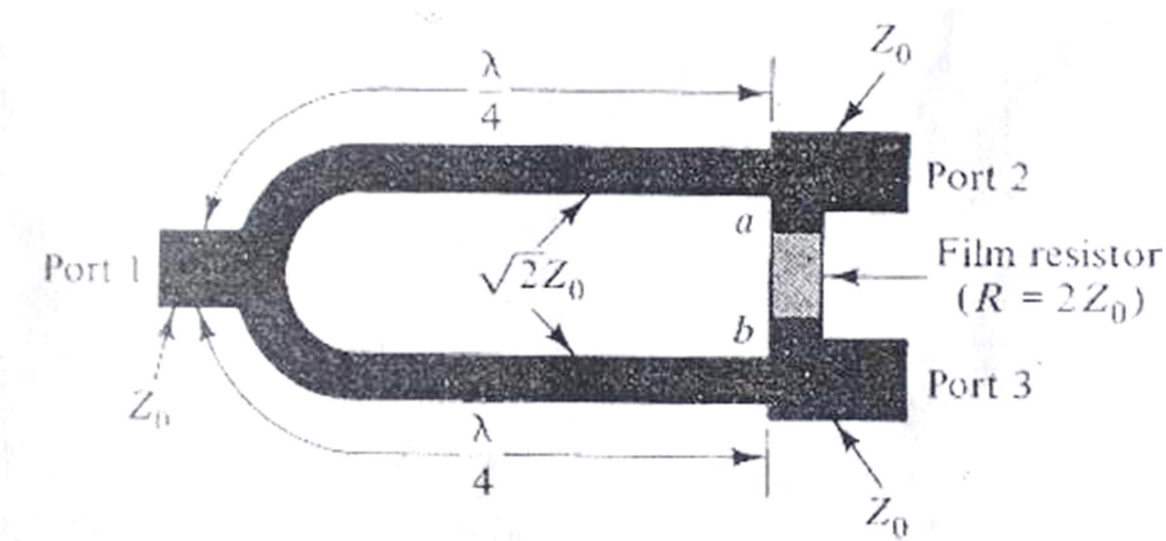
Ideal two-port Wilkinson splitter

Here is how the Wilkinson splitter works as a power divider: when a signal enters port 1,it split into equal-amplitude ,equal-phase output signals at port 2 and 3 Since each end of isolation resistor between port 2 and 3 is at the same potential , no current flows through it and therefore the resistor is decoupled from the input .The two output port terminations will add in parallel at the input ,so they must be transformed to $2*Z_0$ each at the input port to combine to Z_0 the quarter wave transformer in each accomplish this without the quarter wave transformers, the combined impedance of two outputs at port 1 would be $Z_0/2$ .The characteristic impedance of the quarter-wave lines must be equal to $1.414*Z_0$ So that the input is matched when ports 2 and 3 are terminated in Z_0 .

Consider a signal input at port 2 .In this case, it splits equally between port 1 and the resistor R with none appearing at port 3 .The resistor thus serves the important function of decoupling ports 2 and 3 .Note that for a signal input at the either port 2 and 3, half the power is dissipated in the Resistor and half is delivered to the port 1, why is port 2 isolated from port 3 and vice-versa. consider that the signal splits when it enters port 2 .Part of its goes clockwise through the resistor and part goes counterclockwise through the upper arm ,then splits at the input port then continues counterclockwise through the lower arm toward port 3.The recombining signals at port 3 end up equal in amplitude (half power or the CW signals lost in resistor R1 ,while half of the CCW signals is output port 1).And they are 180 degrees out of phase due to the half-wavelength that the CCW signals travels that the CW signals doesn't. The two signal voltages subtract to zero at port 3 and the signal disappears, at least under circumstances .In real couplers, there is finite phase through the resistor that will limit the isolation of the output ports.



The Wilkinson power divider (a).An equal split Wilkinson power divider in micro stripform. (b) Equivalent Transmission line circuit.



Wilkinson power divider

PROCEDURE:

1. Connect output of source to input of receiver.
2. Vary frequency of source from 2 GHz to 4GHz and note down the receiver reading at each frequency at an interval of say, 100MHz in order to measure the level flatness at

each frequencies .The receiver level readings at each frequency will be the reference level (A).The reads say 0dBr.

3. Connect the output of source to input (PORT 1) of power divider and connect one of the output port 2 of Power divider to receiver .Terminate the output PORT3 of power divider with a 50 ohms termination .Now Rx reads -3dBr to 1.5dBr .Similarly measure at output port 2 being terminated .Again Rx will read -3dBr to 1.5dBr.
4. Vary frequency of source from 2GHz to 4 GHz in steps of 100MHz and note the Receiver reading at each frequency at interval of 100MHz in order to measure the response of Power Divider at each frequencies.
5. Plot the above readings for frequency v/s Power in dB for measurement.
6. Difference between Power Level at a given frequency on a reference plot to power output of power divider will give power division at frequency range from 2 GHz to 4 GHz.
7. Now connect directional coupler input port 1 to source sample port 3 to receiver .The output port of coupler is connected to IN port (port 1) of Power divider (device under test) and terminate both port 2 and port 3 of power divider .Plot the source and receiver over frequency of 2-4 GHz and measure the level .This power level is called as forward power level A. The Rx reads -13dBr 1.5Db.
8. Now reverse the directional coupler and connect the device under test at Input port 1 of the directional coupler .the sample port 3 remains connected to receiver .The source is connected at the output port 2 of directional coupler. Plot the source and receiver over frequency range of 2-4 GHz and measure the level .This power level is called reverse power level B. The Rx reads -25dBr to 2dB. The difference in power level between forward power level and reverse power level with device under test will be the return loss of the port of the device under test.
9. The return loss of the power is around 12db to 1.5 db (VSWR=1.67) at 3 GHz at the ports.
10. The isolation of the power divider can be measured by connecting the source at output port 3.Terminate the input port at 50ohms termination .Since the structure is balanced at 3GHz, there will be minimum power transfer between output ports, resulting in power loss or isolation of around 20db.

11 .Similarly test the unequal power as well.

RESULT:

Conclusion:

EXPERIMENT NO:4

Aim: To measure the dielectric constant of substrate using Ring resonator and half wave resonator..

Equipment: RF source, receiver, Ring resonator,Half wave resonator, connecting cables directional couplers.

Theory: There are many ways to measure dielctric constant of a material of effective dielectric constant of a media .A complete dielectric constant measurement includes loss tangent data , which can be even harder to measure , because its effect is usually swamp by other loss mechanism Lets mention the difference between dielectric constant and effective dielectric constant. dielectric constant is a bulk material property , effective dielectric constant is a parameter that depends on transmission line geometry. Most often thedielectric constant that engineers try to measure is the bulk measurement .

If you are considering measuring permittivity with a microstripstructure , you will be measuring the effective dielectric constant , no ifs and or buts. If the technique involves coax , waveguide or stripline, and you are careful not to introduce appreciable airgaps or blue layer , you just might be able to directly measure the real dielectric constant !

The most satisfactory method for measuring the attenuation constant for low loss substrate is from the Q factor of a resonant section of line. The attenuation constant and the unloaded Q factor are related by expression .

Attenuation=(27.3)(n)/(Q)(guide wavelenth)dB/cm where n is no of half wavelength. The Q is centre frequency /Bandwidth

Ring Resonator technique:

A microstrip ring resonator is a microstrip line bent in circuler shape to close upon itself . The main advantage in constrast to linear resonator is that no end effects need to be consider . The resonant frequency could be calculated assuming mean length of the resonators is multiple of the guide wavelength of the microstrip. There are two ways to loosely couple a ring resonator, one is end coupling , and the other is edge coupling . The end couple structure shown below provides a pass band whenever tht ring is multiple of wavelength .

Theedge couple technique a “suck-out” is seen in the reflection coefficient (S11) whenever the ring is an integen no. of wavelengths behaving like a Band reject filter.This is the prefer method if you asked us , the dips in S11 are very narrow band and therefore the resonant frequency is more accurately known .

It has been pointed out that the ring resonator technique is less suitable for accurate measurement of microstrip losses because of tht increase surface wave radiation loss.

The effective dielectric constant =n(Free space wavelength/circumference)^2

Coupled Half wave resonator technique:

The main difficulty with the use of a linear resonator is caused by the end effects.

The effective dielectric constant=(Free space wavelength/circumference)^2

Procedure :

1. Vary frequency of source form 2 GHz to 4GHz and note down the receiver reading at each frequency at an interval of 100MHz in order to measure level at each frequencies. Store this as reference level /direct level(A).
2. Connect the output of source to input of ring resonator. And connect the output of ring resonator to receiver.
3. Vary frequency of source from 2 GHz to 4GHz insteps of 100MHz and note down the receiver readings at each frequency.
4. Store these as Series level (B).
5. Difference between power level at a given frequency on a reference plot to power output of ring resonator will give resonant frequency in the frequency range from 2 GHz to 4GHz of ring resonator.
6. Replace the ring resonator with the half wave resonator find the resonant frequency and bandwidth of peak.

Result:

Conclusion:

EXPERIMENT NO.5

AIM: To measure the VSWR of ports of match load, open stub, short stub, and mismatch.

EQUIPMENTS:RF source,receiver,matched load, open stub,short stub, mismatch,connecting cable,directional coupler/slotted line.

THEORY:

SHORT AND OPEN CIRCUITS

A coaxial short circuit may be realized by terminating the line with a metal plate. The plate creates a boundary at which the electric field associated with the TEM mode is zero. One might be tempered to create a short circuit by merely connecting low frequencies but not at microwaves since the reactance associated with inductance would be appreciable. Coaxial and strip line versions of an open circuit of an open circuit are shown in fig. Note that in the coaxial line. The diameter of the other line conductor D must be chosen so that circular waveguide section.

1. Connect output of source to input of receiver. .
2. Vary the frequency of source from 2-4 Ghz and note down the receiver reading at each frequency at an interval of say, 100MHz in order to measure level flatness ateach frequencies. The receiver level readings at each frequency will be the reference level.
3. Now connect the standard directional coupler in port to source and sampled port to receiver. The output port is terminated in one port oftapered line transformer. The other port of microstrip line is terminated in 50 ohms load. Plot the source and receiver over the frequency range of 2-4 GHz and measure the level. This power level is called forward power level. The Rx leads 17.5dBr.
4. Now reverse the directional coupler and connect the device under testat the input port of directional coupler. The sampled port remains connected to the receiver. The source is connected at the output port of directional coupler. Plot the source and the receiver over the frequency range of 2-4 GHz and measure the level. This power level is called as reverse power level. The Rx reads 29.5 dBr. The difference in power level between

forward and reverse power level with device under test will be the return loss of the device. 12dB return loss is equal to VSWR of 1.67.

5. Now connect open stub, short stub and mismatch loads to the directional coupler. Now measure the return loss. The tapered line transformer is terminated in 150 ohms, which is also termination for mismatched load but the return loss of the tapered line transformer is more as compared to mismatch load indicating efficiency of transformer in matching 150 ohms to 50 ohms.

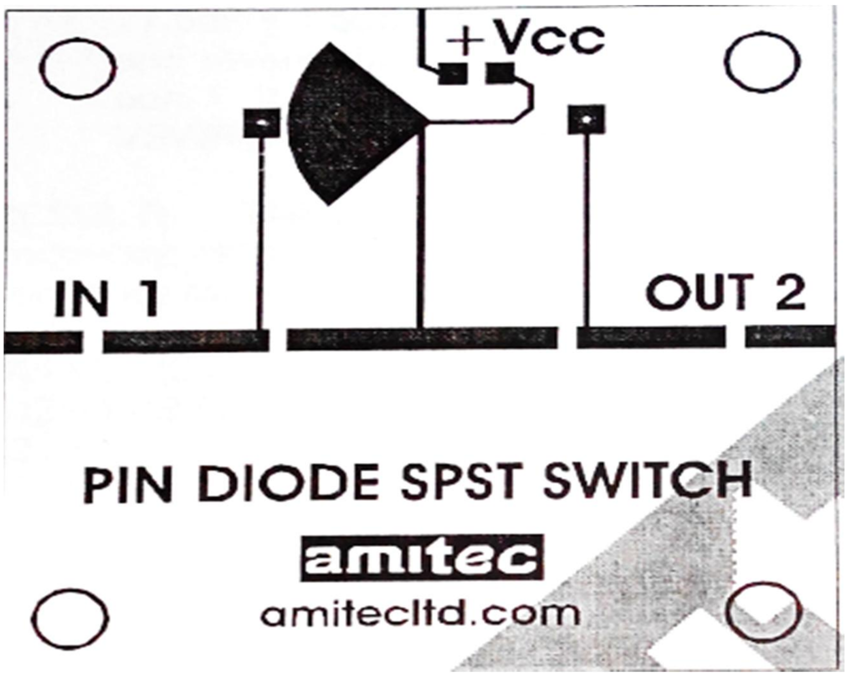
RESULT:

CONCLUSION:

EXPERIMENT NO:6

Aim: To measure Insertion loss, Isolation and VSWR of ports microwave SPST PIN Diode switch

Equipments:RFswitch,receiver, SPST PIN Diode switch pin. Connecting wires, Termination Load, Slotted line.



Procedure:

1. Connect output of source to input of source.
2. Vary frequency of source from 2 GHz to 4 GHz and note down the receiver reading at each frequency at an interval of say 100 MHz in order to measure the level flatness at each frequencies. The receiver level readings (A) at each will be reference level 0 DBr +_1.5dB.
3. Now connect the output of source to port 1 of pin diode switch and connect port 2 receiver .Apply a Dc voltage of 15 Dc t0 +Vcc port of switch. This voltage will apply forward bias to pin diode and allow it to conduct and PIN switch to short. The receiver will read -1dBr (reading B) wherein 1 dB would be due to insertion loss.
4. Vary frequency of source from 2GHz to 4GHz. Insteps of 100MHz and note down the receiver reading at each frequency.
5. Plot the above reading for frequency/s level in dB.
6. Difference in the power level at receiver with switch connected and reference level will give us insertion loss (B-A) of the switch. Now remove +15 V supply so that switch is

not conducting. This will measure the isolation of switch. This is read as -11dbr. Hence -1-(-11) =10dB is the isolation of switch.

7. Now connect directional coupler input port 1to source and sample port to receiver. The output port 2 of a coupler is connected to port1 of switch. Port 2 of a switch is terminated in 50 ohms load. Plot the source and the receiver over frequency range of 2 to 4 GHz and measure the level. This power level is called forward power level.
8. Now reverse the directional coupler. Connect directional couplers output port to source and sample port to receiver. The input port of a coupler is connected to input port1 of a switch. Theother port 2 of a switch is terminated in 50 ohms load. The sample port remains connected to receiver .the source remains connected at the input port of a directional coupler. Plot the source and receiver over frequency range 2 to 4 Ghz. And measure the level. This power level is called reverse power level. This is read as -27.5dB +_1.5dB.the difference in power level between forward power level and reverse power level with switch will be the return loss of the switch port1 .It is read as 10dB+_1.5dB. If it comes more than 10 dB it means VSWR is less. Hence more there return loss, lower the VSWR.

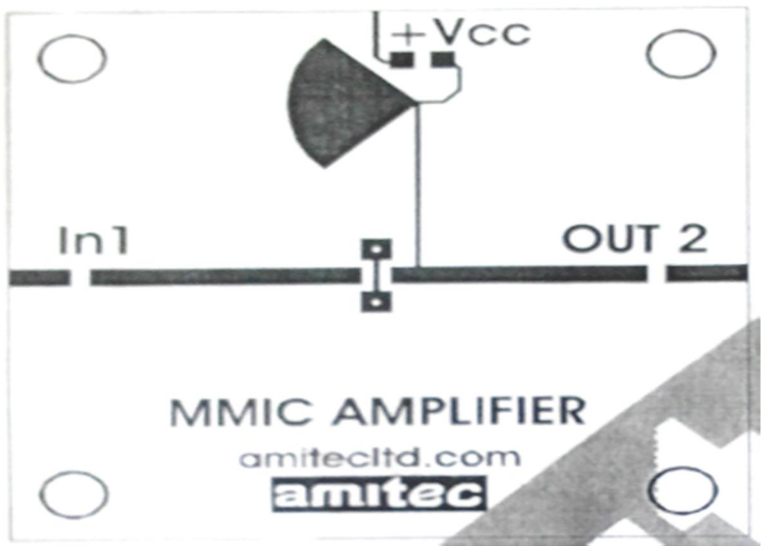
Result:

Conclusion:

EXPERIMENT NO.7

AIM: To measure gain, isolation, VSWR of ports of MMIC amplifier.

Equipment: RF source, receiver, MMIC amplifier, connecting cables, directional coupler and attenuator.



Procedure:

1) Connect the output of source to input of receiver using a 20dB attenuator in between so that receiver level reading stays to -20dBr ± 1.5dB and Rx doesn't gets saturated.
2) Set the frequency of source at 3GHz.
3) Note reading under column A of the table.
4) Change the frequency in steps of 100MHz.
5) Note reading under column A of the table. The receiving level reading at each frequency level is reference level.
6) Now connect output of source to input 1 of mmic amplifier using 20dB attenuator and connect output 2 of amplifier to receiver. Apply a dc voltage of +15V DC to power supply port +Vcc of amplifier from instrument.
7) Vary frequency of source from 2GHz to 4GHz in steps of 100MHz and note down receiver reading at each frequency of column B. Make sure that there is no loose connections otherwise receiver reading will fluctuate. The Rx will read -5dBr ± 1.5dB.
8) Plot the above readings for frequency v/s level in dB.
9) Difference in power level at receiver with amplifier and reference level will give us gain of the amplifier. The measured gain is 15dB ± 2dB.

10) In order to measure isolation reverse the ports of amplifier (i.e. connect the source to port 2 and connect Rx at port 1) and repeat the steps 1 to 8.Rx will read -30dBr.hence

-20- (-30) = 10dB.

Isolation is read as 10dB ± 1.5dB in entire range.

11) Now connect direction coupler's input to source (with 20dB attenuator) and sample port to receiver. The output port of coupler is connected to input port 1 of amplifier. The other port 2 of amplifier is terminated in 50Ω load. Plot the source and receiver over frequency range of 2-4GHz and measure the level. This power level is called forward power level. It is read as -13dBr ± 2dB.
12) Now reverse the directional coupler. Connect the directional coupler's output port to source and sample port to receiver. The input port of coupler is connected to the input port 1 of amplifier. The other port 2 of amplifier is terminated in 50 ohms load. The sample port remains connected to receiver. The source remains connected at the input port of directional coupler. Plot the source and receiver over frequency range of 2-4GHz and measure level. This power level is called as reverse power level. This is read as -23dB ± 2dB. The difference in the power level between forward power level and reverse power level with amplifier will be the return loss of amplifier at port 1. It is read as 10dB ± 2dB. If it comes more than 10dB it means VSWR is less. Hence more the return loss lowers the VSWR.

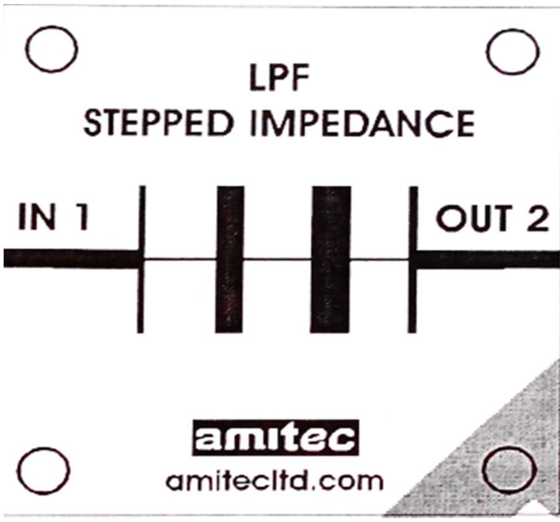
Result :

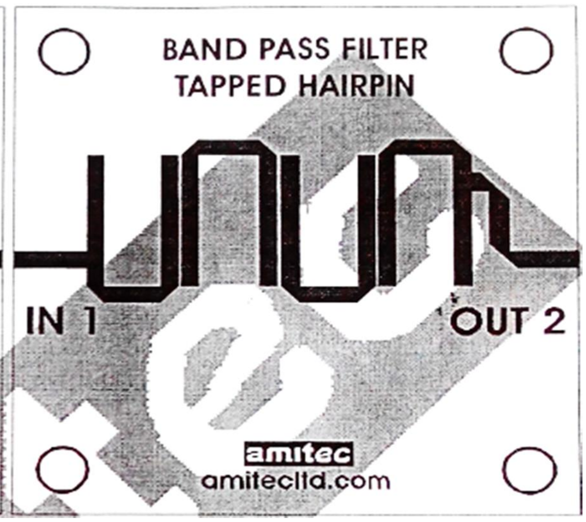
Conclusion:

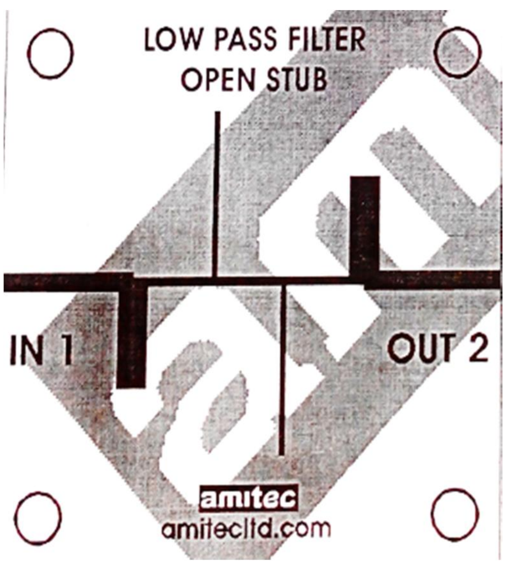
EXPERIMENT NO:8

Aim: To measure Insertion loss, VSWR of ports of filter and measure pass band and stop bandcharacteristics.

Equipment:RFsource,receiver, filter connecting cables directional couplers,slotted lines.







Procedure:

1. Set of the frequency of source and receiver at 2 GHz.
2. Note the reading under the column A of the table.
3. Change the frequency in steps of 100 MHz
4. Note the reading under the column of the table. The receiver level reading at each frequency is the reference level.
5. Now connect the output of source to input 1 of LPF and connect output 2 to receiver.
6. Vary frequency of source from 2 Ghz to 4ghz in steps of 100 MHz and note down the receiver reading at each frequencyunder column b.make sure there is no losses connection otherwise receiver reading will fluctuate. TheRX reading will change depending on frequency.
7. Plot the above readings for frequency vs. level in db.
8. Difference in power level at receiver with LPF and reference will give us the frequency response of lpf. The low pass filter is designed for cut off frequency of 3 GHz it will have low insertion loss at frequency from 2 GHz to 3 GHz. After 3 GHz it will start attenuating the signal and insertion loss will increase with frequency and will be highest at 4 GHz. The frequency at which insertion loss increases by 3 dB from the pass band is called as cut off frequency.
9. Now connect directional couplers input port to source and sample port to receiver. The output port to coupler is connected to input port 1 of lpf. The other port 2 of lpf is terminated in 50 ohm load. Plot the source and receiver over frequency range 2 to 4 GHz and measure the level. This power level is called as forward power level.it is read as say -17.5 dbr±1.5db.
10. Now reverse the directional coupler. Connect directional couplers output port to source and sample port to receiver.Input port of coupler is connected to input port 1 of lpf. The other port 2 of lpf is terminate din 50 ohm load .the sample port remain s connected to receiver. The source remains connected at the input port of directional coupler. Plot the source and receiver over frequency range of 2-4 GHz and measure the level. This power level s called reverse power level. This is read as say (-32.5dbr±1.5db in pass band at 3.2 GHzand -22.5dbr in stop band). The difference in power level between forward power level and revers e power level with lpf will be the return loss of lpf of port 1.it is read as

15db±1.5db.if it comes more than 15 dB it means vswr is less(15 dBreturn loss =1.43 vswr). Hence more then return loss, lower the vswr.

11. Replace the lpf stepped impedance with band pass filter and lpf open stub and repeat the procedure.

Result:

Conclusion: