Power Divider for 4X4 Multiport Amplifier

[1]Nikunjbhai V.Prajapati, [2]A K. Sisodia

[1]M.E.Scholar, [2]Associate professor
LJIET, Gujarat Technological University-Ahmedabad
[1]nikunjldec@gmail.com, [2]ak_sisodia@yahoo.co.in

Abstract: **This paper presents the design and simulation of 2.5 GHz 90 degree Hybrid power divider for 4X4 multiport amplifier. The multiport amplifier is an advanced technique which provides the flexibility of channel capacity per beam in a multi beam system. It is also used the implementation of the mobile base station for shearing the power in each transmission path. Most of the multiport amplifiers use butler matrix using the 90 degree hybrid power divider (4X4). The output amplitude and phase shift of the 90 degree hybrid power divider are critical parameters for achieving the optimum performance of the MPA. The key point is analysis of 2.5 GHz 90 degree Hybrid power divider (4X4) for better power on the multiport amplifier. Hence a four way power divider for MPA for base station has been design, simulated and optimizes using the Advance design system software 2011.**

Keywords: 4 Way 90 degree Hybrid power divider, ADS software, Optimization design

I. INTRODUCTION

Power dividers and combiners are widely used in various microwave and millimeter wave systems. In multi beam, mobile base station satellite communication systems, traffic distribution among the multiple beams fluctuates over time. Each corresponding to a respective beam are distributed to all HPAs by the power divider, jointly amplified at the amplifier stage and then combined by the power combiner and transmitted to the output port corresponding to a particular input port. The input signal from one port is thereby sent to a specified output port. This paper reported 4way hybrid power divider using distributed than multiport amplifier at 2.5 GHz with good (better than -20) return loss and less insertion loss(0.3dB). In this particular domain, the power dividers should satisfy several critical requirements, which include high power handling capacity.

II. PARAMETERS

Frequency Range (Hz):
This is application specific for the using various power divider and combiner.

VSWR:
Voltage Standing Wave Ratio (VSWR) is the ratio of maximum and minimum voltage at a given point along a transmission line. VSWR is a good measure of power transfer efficiency. A low VSWR (i.e. closer to unity with little or no reflections) means more power is delivered from the source to the load, while a high VSWR (i.e. much greater than 1 with lots of reflection within unit) has less power delivered to the load. The VSWR is calculated by the given equations,

$$\mathrm{VSWR} = \frac{V_{max}}{V_{min}}$$

$$\mathrm{VSWR} = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

Return loss (dB):
Return loss is the negative of the magnitude of the reflection coefficient in dB since power is proportional to the square of the voltage; return loss is given by,

$$R_l = -20 \log|\Gamma| \ dB$$

Insertion Loss (dB):
Insertion loss is the decrease in the transmitted signal power due to the insertion of a device in a transmission line. It is defined as the ratio of the output to input power.

Phase:
We are measuring the phase output port to the input port like S21 parameters.

Specification of power divider (4X4)

Central frequency	2.5 GHz
Power coupling	6 dB
Insertion loss	<0.3 dB
Return loss	Better than 20 dB
Phase accuracy	Better than 20 degree
Amplitude accuracy	0.2 dB

III. DESIGN 90 DEGREE HYBRID POWER DIVIDER

Components MLIN

- Frequency: 2.5 GHz
- Dielectric properties: Er = 4.6
- Height = 1.6 mm
- Loss Tangent = 0.0023
- Metal Height = 0.035mm
- Metal Conductivity = 5.8E7

50Ω Line:
Width – 2.92 mm
Length – 16.06 mm
35.35Ω Line:
Width – 5.0092 mm
Length – 15.620 mm

Create a circuit of the 90 degree hybrid power divider in the schematic window of ADS. The circuit can be created by using the available Micro strip library components. Setup the S-Parameter simulation from 1 GHz-5 GHz with step size of 0.01 GHz.

IV. SIMULATION CIRCUIT & RESULTS

By using advance design system (ADS) software design a 90 degree Hybrid power divider circuit. The schematic diagram is show in figure. The designed return loss (S11= -55.22, S22= -57.18, S33= -66.38, S44= -68.43, S55= -59.14) at 2.5GHz, phase differ from (S21=- 90, S31= 179.9, S41= 89.9, S51= 0.0) degree and VSWR at (S11= 1.003, S22= 1.003, S33= 1.001, S44= 1.001, S55= 1.002) and Insertion loss is (S21= -6.22, S31= -6.161, S41= -6.180, S51= -6.119) dB in the circuit S-parameters.

Table: 01 Return loss

Parameters	Value (dB)
S11	-55.22
S22	-57.18
S33	-66.38
S44	-68.43
S55	-59.14

Table: 02 Insertion loss

Parameters	Value (dB)
S21	-6.22
S31	-6.16
S41	-6.18
S51	-6.11

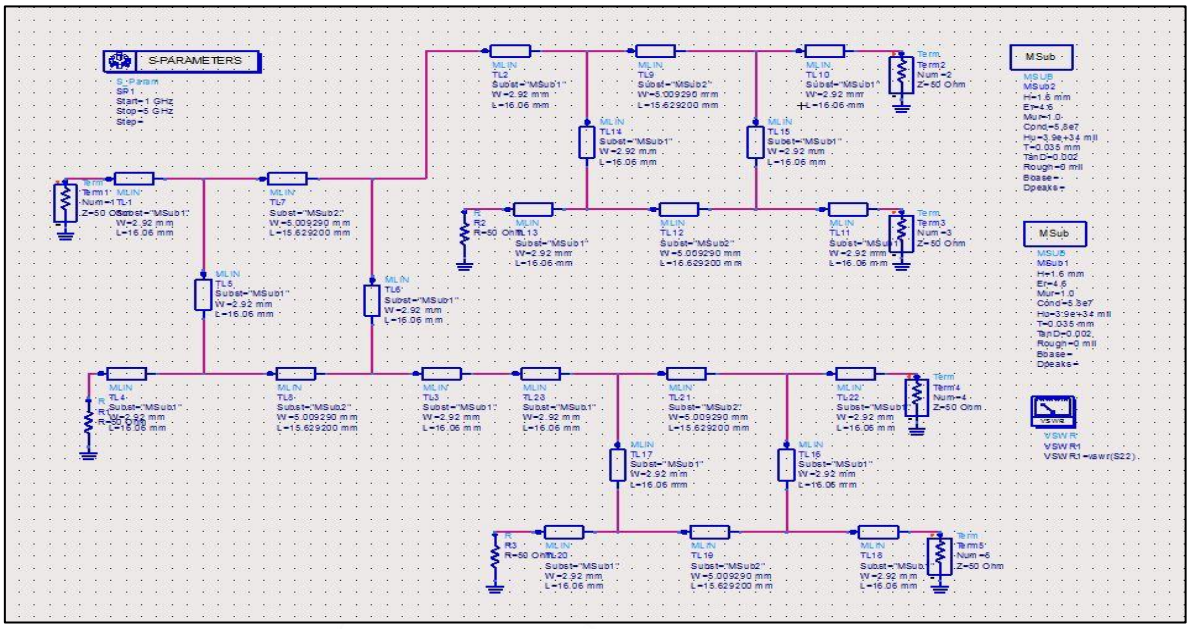
Table: 03 Phase

Parameters	Degree
S21	-90
S31	179.9
S41	89.90
S51	0

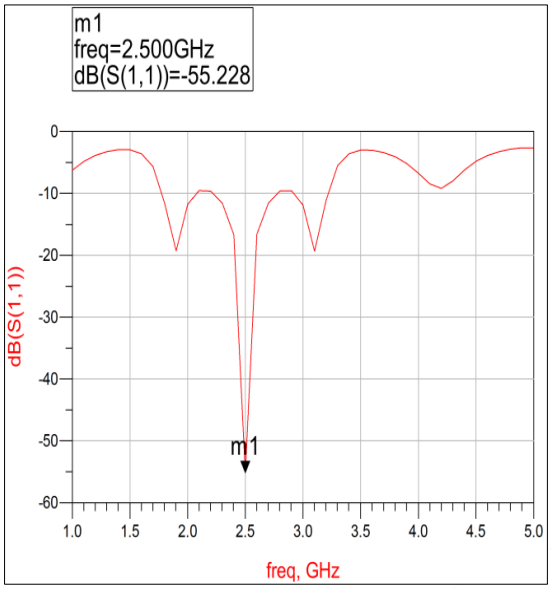
Table: 04 VSWR

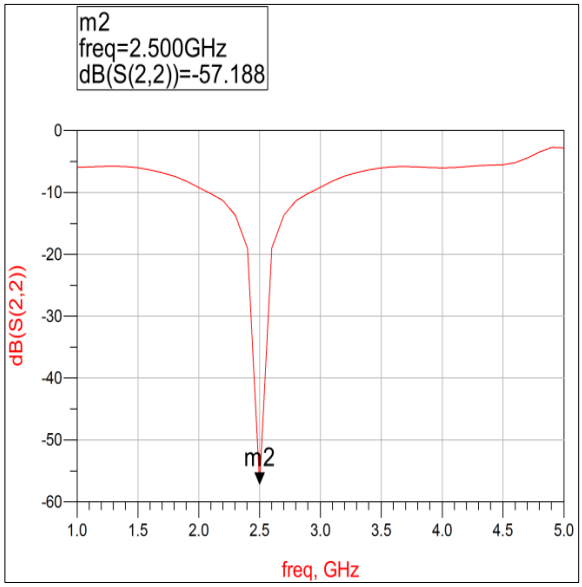
Parameters	Value
S11	1.0031
S22	1.0031
S33	1.0010
S44	1.0010
S55	1.0020

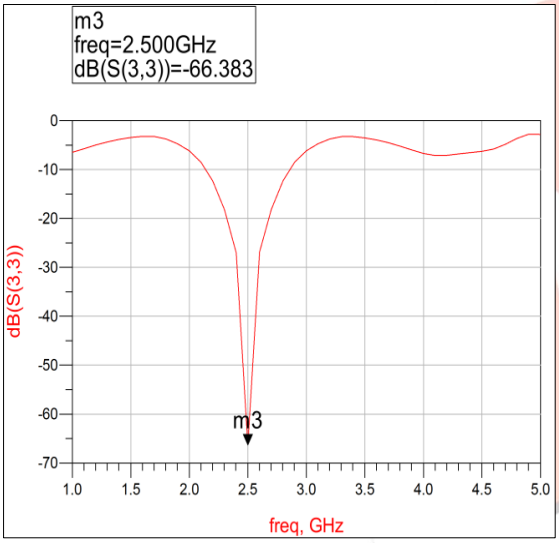
Circuit 4way hybrid power divider

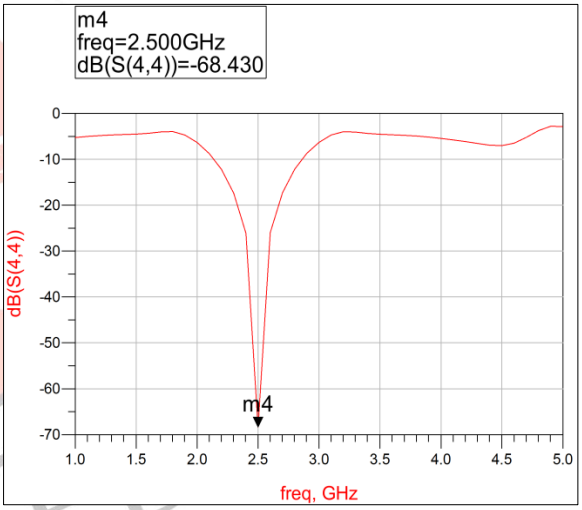


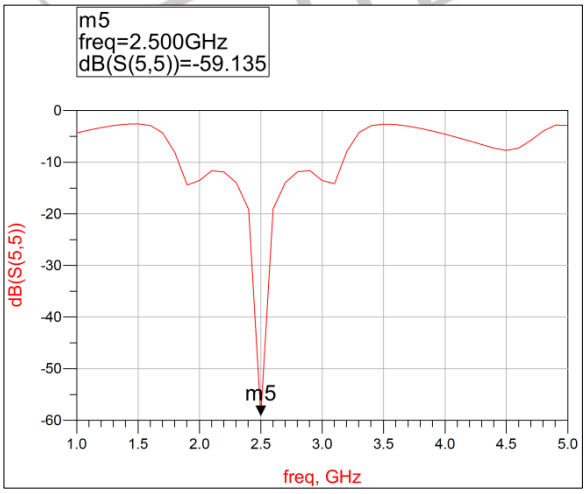
Return Loss


m1
freq=2.500GHz
dB(S(1,1))=-55.228
dB(S(1,1))
freq, GHz

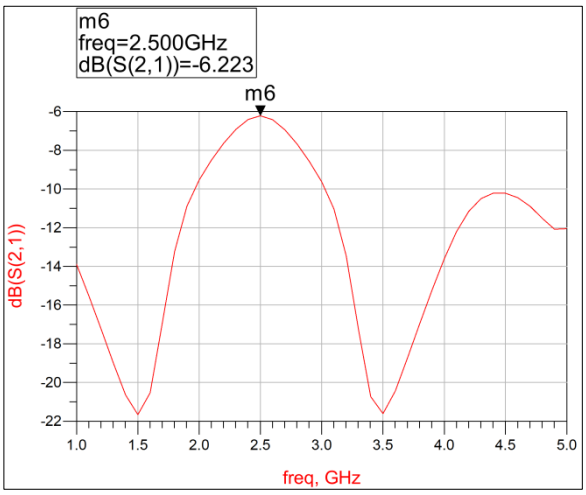

m2
freq=2.500GHz
dB(S(2,2))=-57.188
dB(S(2,2))
freq, GHz

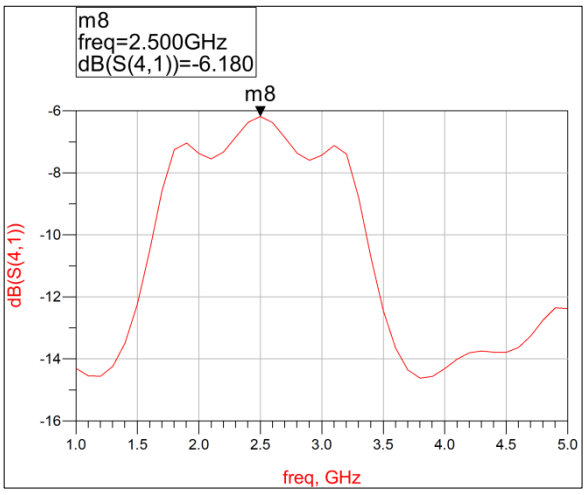

m3
freq=2.500GHz
dB(S(3,3))=-66.383
dB(S(3,3))
freq, GHz

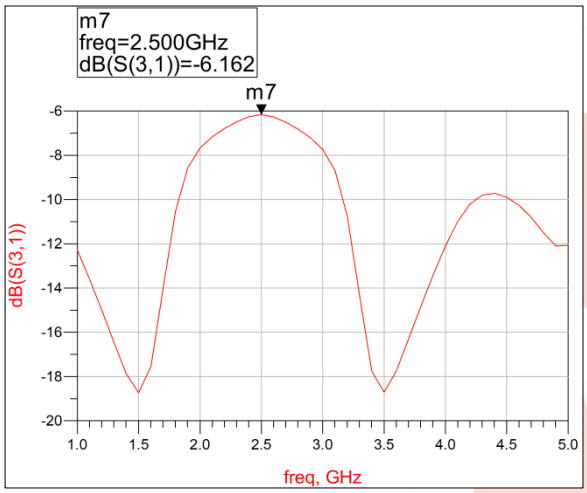

m4
freq=2.500GHz
dB(S(4,4))=-68.430
dB(S(4,4))
freq, GHz


m5
freq=2.500GHz
dB(S(5,5))=-59.135
dB(S(5,5))
freq, GHz

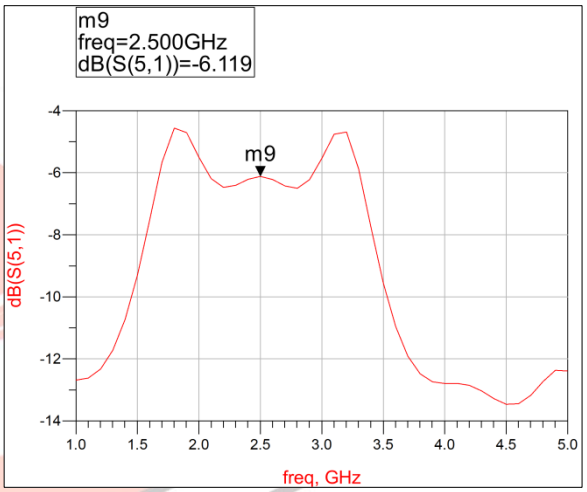
Insertion Loss

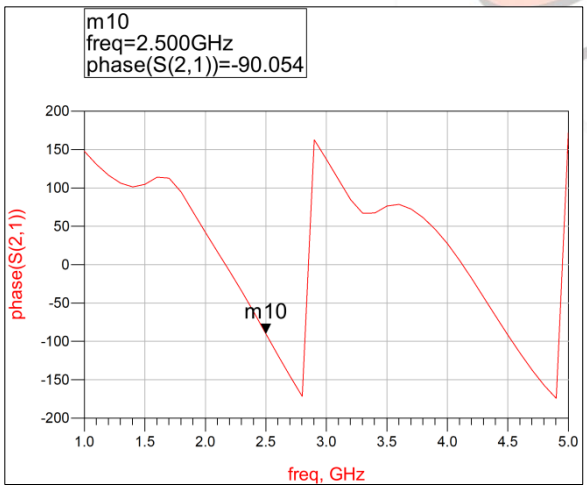


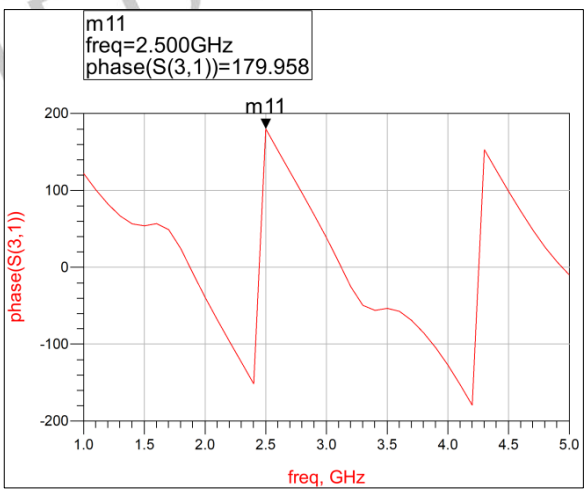


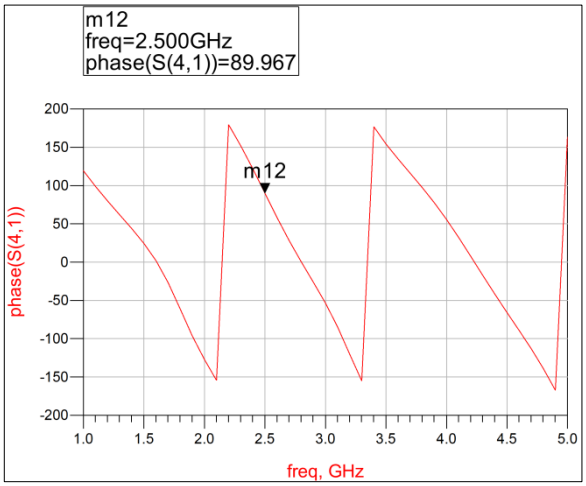


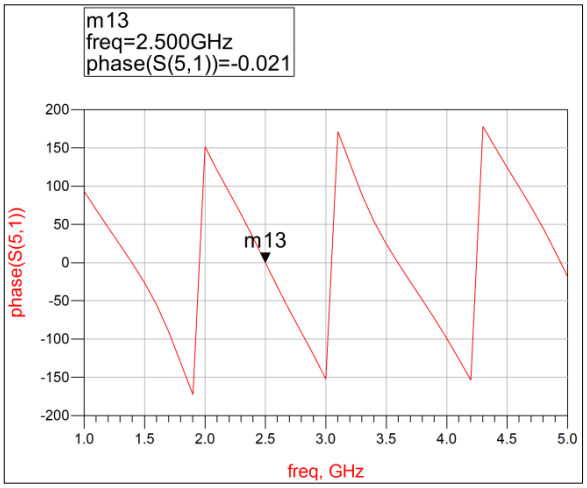
Phase











V. CONCLUSION

In this 90 degree hybrid paper power divider for multiport amplifier has been design simulated and optimize at 2.5 GHz for mobile base station. The result indicates the return loss or VSWR much better than target specifications. Similarly the insertion loss is better than 0.3 dB and phase accuracy is less than 2 degree. Hence this power divider will be used for the designing the multiport amplifier at 2.5 GHZ for mobile base stations.

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