PERFORMANCE ANALYSIS OF POWER DIVIDERS OF FIVE PORT STRUCTURE FOR SDR APPLICATION

Karthikeyan K.V.[1], Vasudevan N.[2]

[1]Research Scholar, Sathyabama University
[2]SRM University
Email: [1]kandvas@yahoo.com

ABSTRACT

In this paper a power divider is designed using ADS and the performance is analyzed using scattering parameters. Power dividers are used in port structures of Software Defined Radio. Software defined Radio offers Re-configurability, which in turn provides several advantages of reusability of the hardware by making changes in the software according to the requirements. The results obtained show the performance of equal and unequal power dividers. Simulations are performed using ADS software and also the layouts of these equal and unequal power dividers are obtained.

Keywords: Power divider, SDR, Five Port Structure, micro strip line.

I. INTRODUCTION

Software Defined Radio is an unconventional methodology of receiving the RF signal and thereby obtaining base band signal. This process takes place in two modules, Hardware and Software. There are many researchers worked in this SDR, whereas less focus was emphasized on the Hardware Module. The developments in Micro strip structure designing paved a way for the exploration of even this hardware section of SDR in the recent past. Micro strip based design of port structures involves challenges in the proper selection of the strip, performance parameters, line calculations and complexity. A High Degree of need exists in the innovation of these structures towards smartness in the design and efficiency in the performance. The pragmatic approach of these structures has taken different directions in the last decade, with the developments in the simulation tools and developing environments.

Software Defined Radio offers direct conversion when the mixer in the RF front end is replaced by port structures. Direct conversion means demodulating RF signal to Audio signal without intermediate stages. This ultimately achieves less complexity in the design, reduction of non linearity issues and lesser power consumption. Xinyu Xu and Bosisio [1] proposed different theories and also practical solutions to various issues in the design and development of software defined radio. SDR has wide variety of applications in video broadcasting. Developments in the communication technology reflect in the diversity in the design of port structures in SDR platform. Six port structures and their performance was studied by many researchers like Collier and Ghannouchi .Design Improvements in FPGA's and Data converters made the realizations of SDR a reality. SDR feature of Re-Configurability is to support multiple standards in the transmission and reception of signals across the globe. Using SDR newer technologies can be adapted fastly, with good amount of flexibility, apart from cost effectiveness. There should be a generic architecture to design radios which are capable of communicating each other and also suitable to support different operations in a broader spectrum of domains. The advent of 3G, 4G technologies poses new challenges in the field of communication. This helps for the development in the associated applications like SDR architecture. This paper is organized into four sections, in which first section is about the introduction of SDR, second section describes port structures, third section deals with design of power dividers and last section i.e., fourth section is with results and conclusions of the work carried out.

II. PORT STRUCTURES IN SDR ARCHITECTURE

Port technology is used in the design of port structure based receiver particularly at higher frequencies, where the measurement of phase and amplitude is a main task to accomplish. [4]. The exploration of six port direct conversion receivers was taken place in the mid 1990's. [2]. Microwave communications demands novel methodologies, which then followed by the developments in the six-port

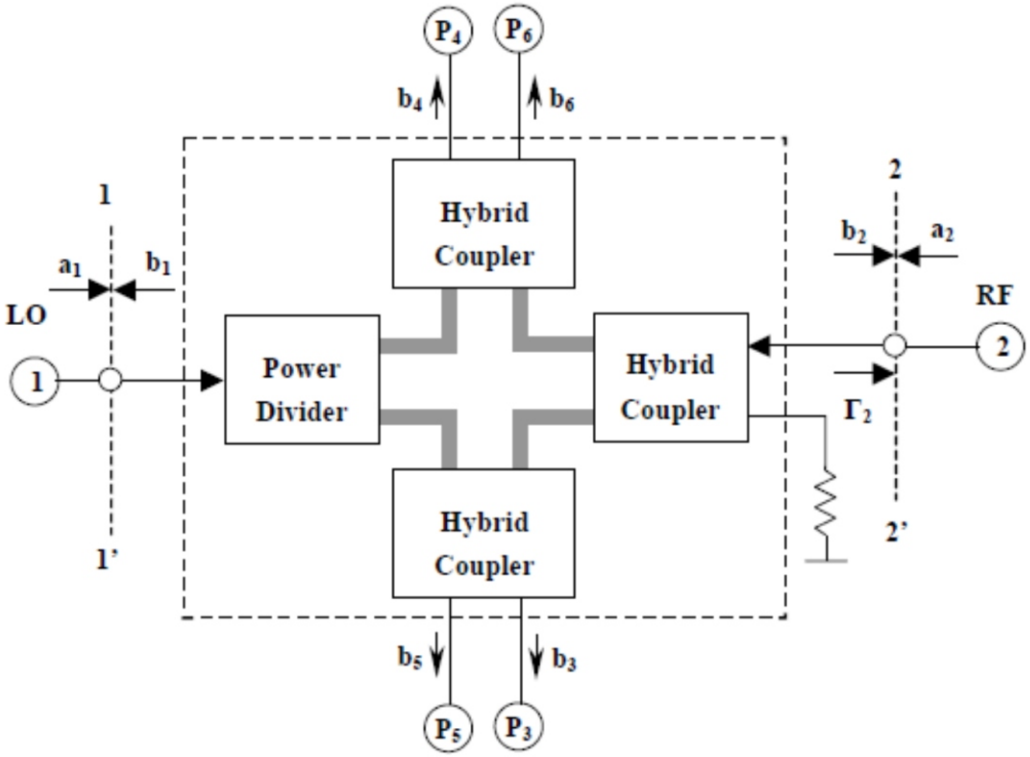


Fig. 1. Six port structure block diagram

receivers. Several methods such as carrier recovery were advanced for six-port receivers. [3]. Six port receivers were later developed in the direction of achieving towards low power consumption, cost effectiveness and robust in the design. In six port structure different vector additions of reference signal and input signal are obtained, which was facilitated by the interconnection of dividers and other RF components. The input phasors involve in the vector addition thereby output is obtained at four output ports, where different phases were generated by the combination of two RF signals by the use of phase shifter. Obtained combination of outputs at four output ports is measured by power detectors and diode detectors. Magnitude and phase of received signal is measured by choosing proper signal processing methods or algorithms for the intended modulation or application. [2]. A lot of exploration is needed in this area because of the potential this technology has in solving bottlenecks in the design of communication receivers and issues in the marketing, lower cost and operating bandwidth.

The structure of a six-port receiver was shown in Fig.1. [5].

In the six port receiver, port 1connects to LO signal and Port 2 connects to RF signal and four ports are connected to power detectors. RF signals from port 1 and port 2 are directly down-converted from radio frequency to audio frequency which can be detected from the output levels of the power detectors. The base band signal levels from power detectors are digitized and sent to DSP. [5]. DSP stage takes care about the software part of the receiver. Six-port receivers were designed at to operate at a center frequency of 24 GHz for SIW, 28 GHz, 24 GHz, 5.8 GHz and 2.4 GHz for MMIC or MHMIC technologies. The principle is to design a port structure, which has six ports so that it can be used in an SDR receiver operated at a center frequency of 5.8 GHz with good receiver stability and high sensitivity. The design objectives include, Minimum insertion loss, between the RF input port and power detector ports such as to increase power levels at output ports and maximum isolation between RF input ports and LO port to reduce leakage to antenna.

The block diagram of Five-port Structure was shown in Fig.2.

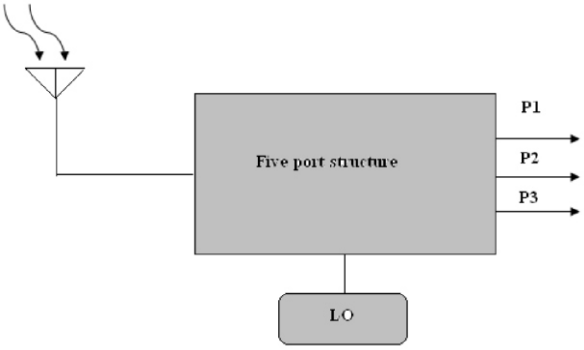
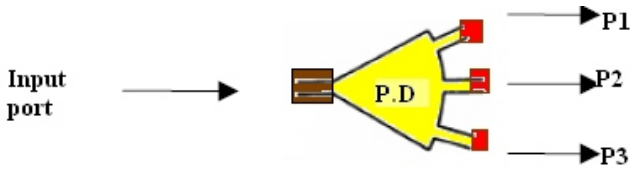


Fig. 2. Five port structure block diagram

III. DESIGN OF POWER DIVIDERS

A power divider or power splitter divides a Radio Frequency signal, while maintaining good impedance match at all ports. It is a passive device that receives an input signal and produces two or more output signals. Power divider is used in a wide variety of applications and satisfy almost all requirements where the power signal need to be distributed like power splitting, source leveling, transmission line fault testing and other critical signal processing applications. Important power dividers properties are Equal amplitude, 0° phase relationship among the output ports, High isolation between each output signal, Impedance match at all ports over a broad bandwidth,



Load impedance maintain at 50 Ω. Fig.3 shows the Power divider with one input port and 3 output ports.

Fig. 3. Power Divider

The passive power divider is used extensively at microwave and millimeter wave frequencies. [6].When the power divider circuit is needed in planar configurations, two particular circuits are often used; radially oriented lines and fan-out (or also known as Wilkinson) type power divider. The power divider of Wilkinson-type geometry is used mostly because [6] there is a need to replace the lossy corporate feed structure that feeds into the linear array of antenna elements. Its sector geometry with almost linearly aligns output ports are topologically suitable. Furthermore, the structure requires quarter-wavelength multiple lines and handle low-to-medium power transmission. Other topologies such as radial and circular structures have the disadvantages that the output ports are non-collinearly aligned.

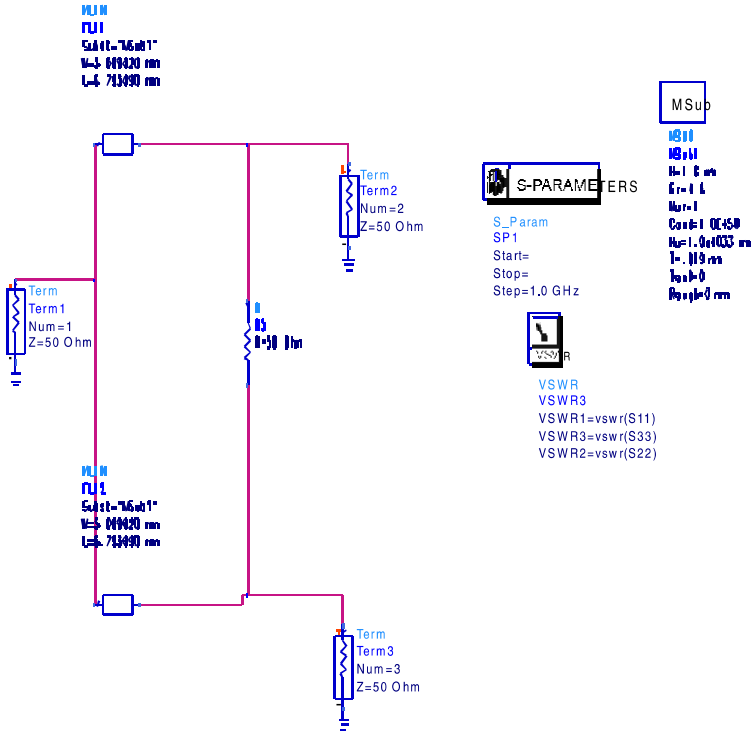


Fig. 4. Design of Equal Power Splitter

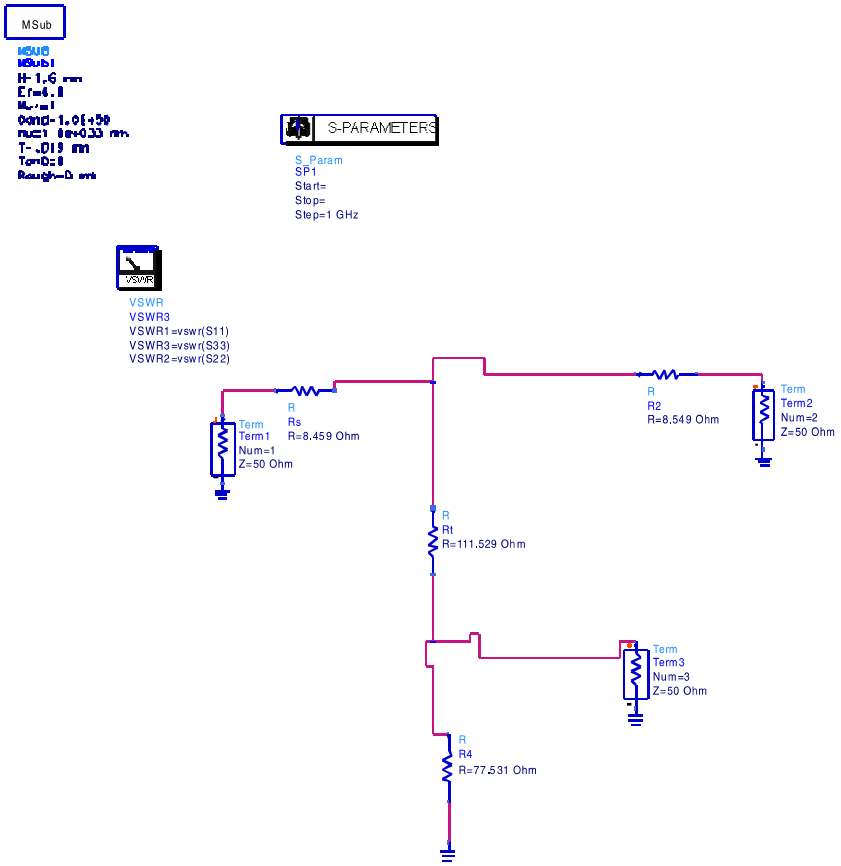


Fig. 5. Design of Unequal Power Splitter

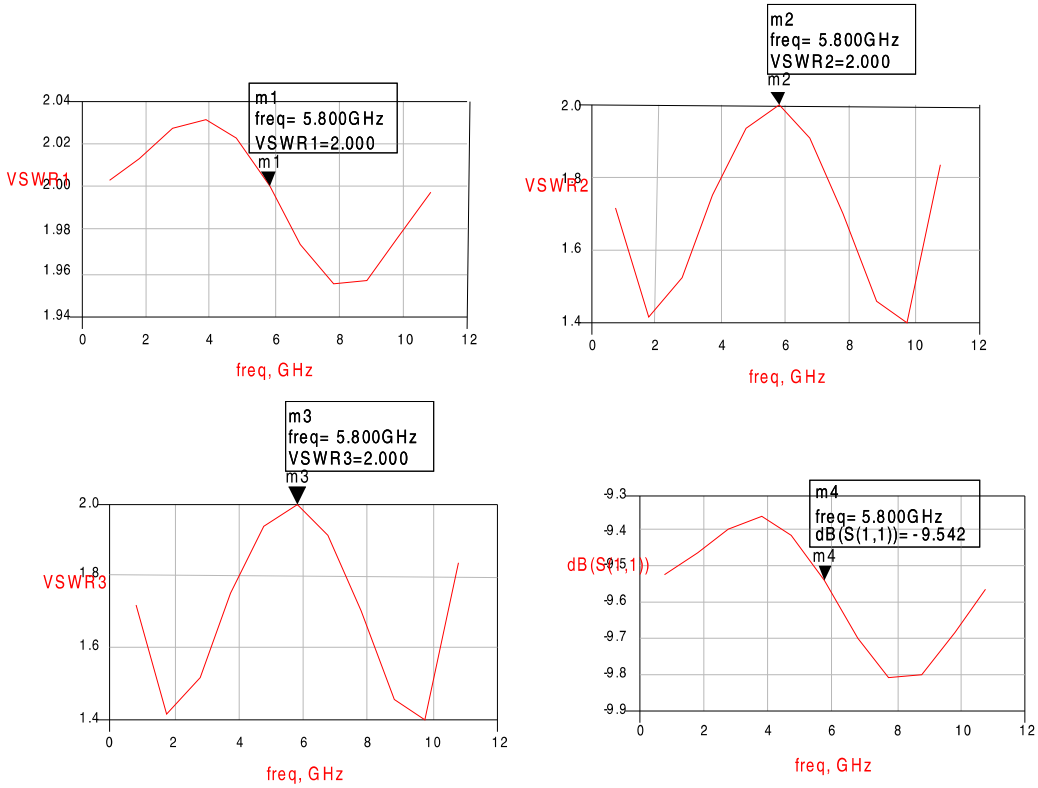


Fig. 6. VSWR and S11 of Equal Power Splitter

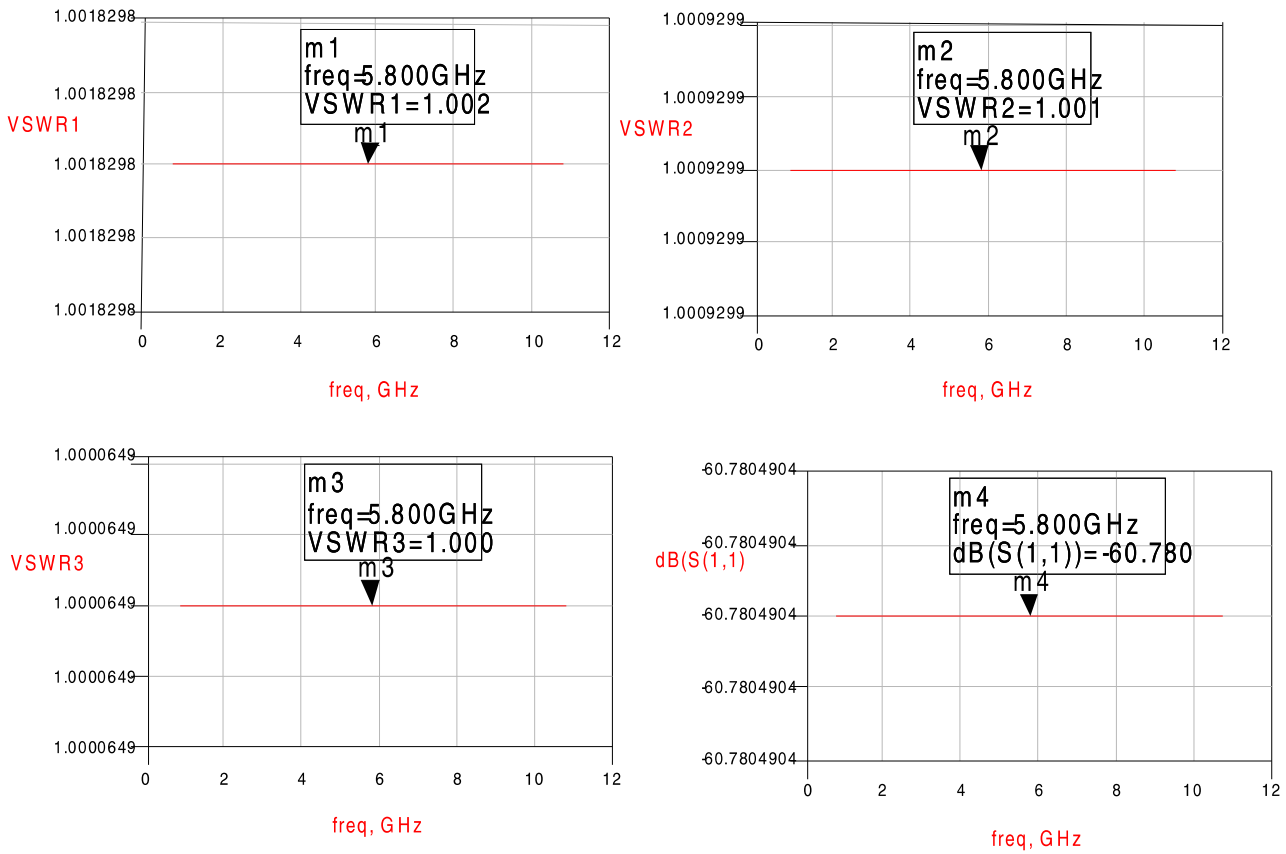


Fig. 7. VSWR and S11 of Unequal Power Splitter

The design of equal splitter or equal power divider is done by performing the line calculation of a microstrip line with $E_r = 4.6$, a resistor of 50 ohm is used to separate these microstrip line structures as shown in the Fig. 4. Design of Unequal power divider is as shown in the Fig. 5.

IV. RESULTS AND CONCLUSION

The variation of VSWR w.r.t to frequency is evident of Fig.6 and Fig.7 and the S11 values are obtained as -9.542 and -60.780 for Equal and Unequal power dividers respectively. Fig.8 and Fig.9 represents the layout structures for Equal and Unequal power dividers. Fig.10. clearly shows the comparative

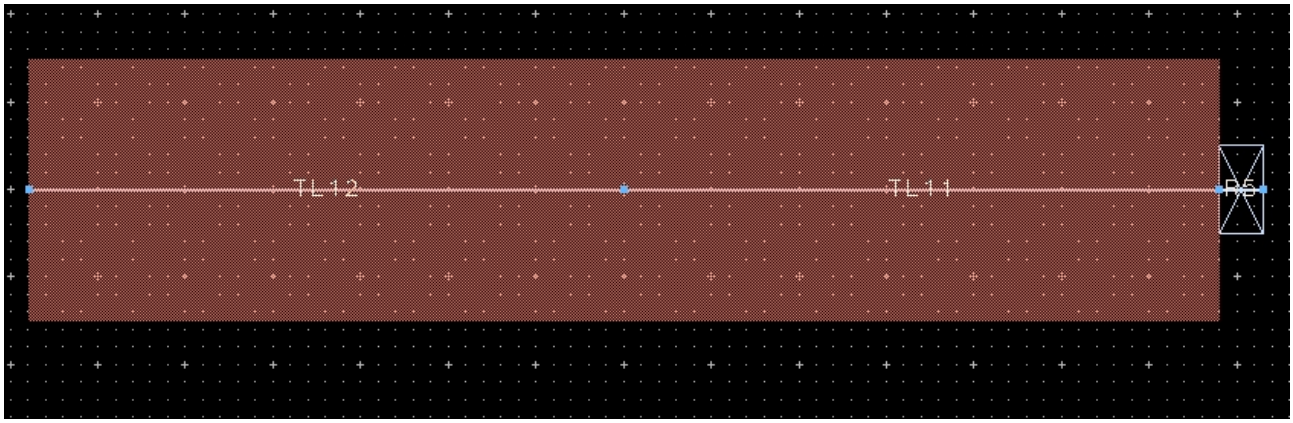


Fig. 8. Layout of Equal Power Divider

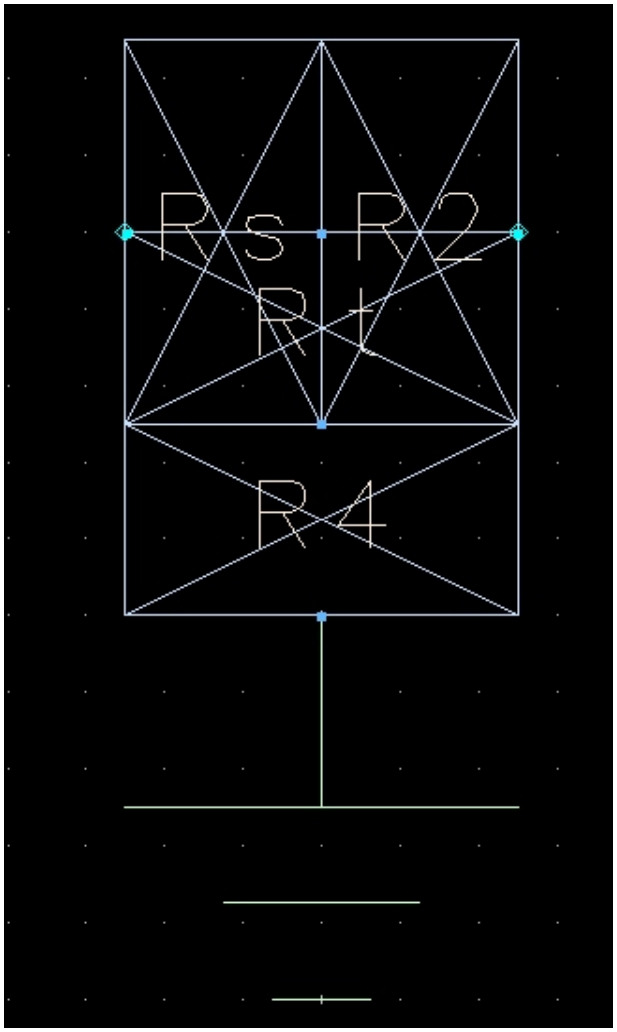


Fig. 9. Layout of Unequal Power Divider

analysis of Equal and Unequal Power Dividers in terms of VSWR values.

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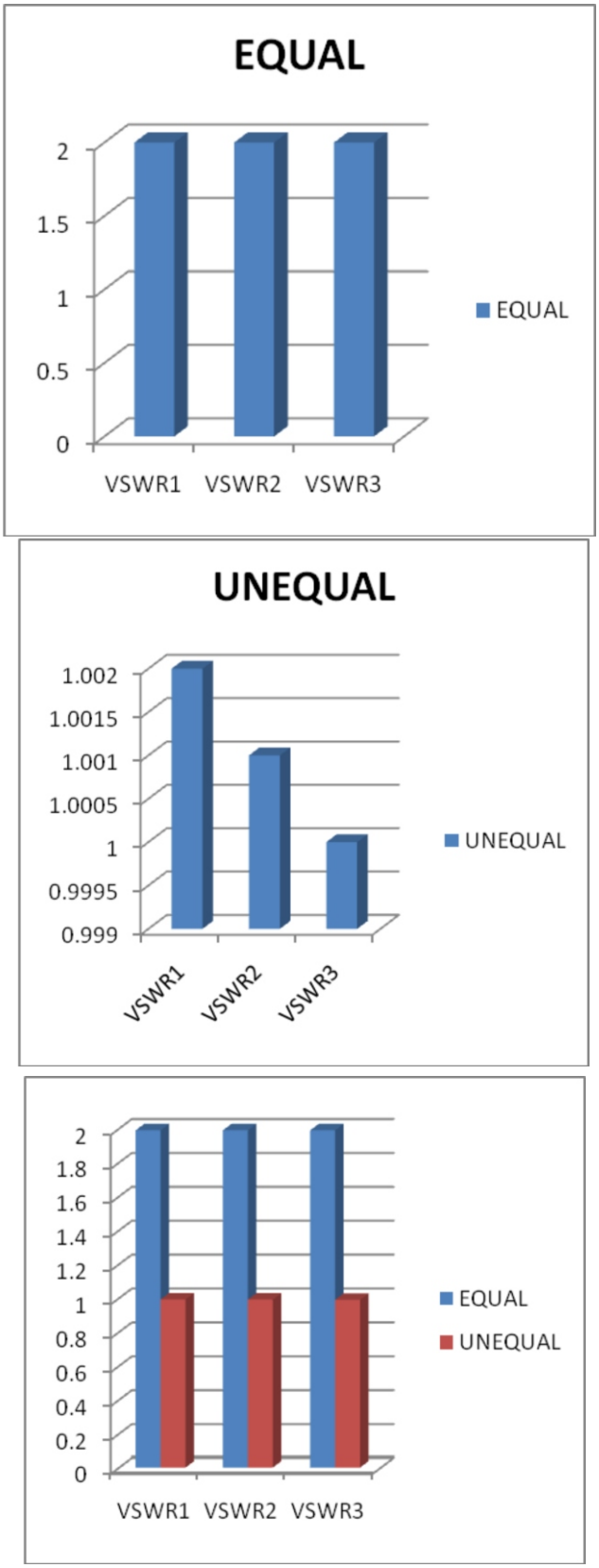

Fig. 10 Comparative Analysis of Equal and Unequal Power Dividers

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K.V.Karthikeyan graduated from Crescent Engineering College, Chennai, and is a research scholar of Sathyabama University. He is currently the Assistant Professor of Department Electronics and Communication Engineering in Sathyabama University, Chennai, India. He possess over 8 years of teaching experience and 8 years of industrial experience. He has published around 12 research International and National publications. His current areas of research include Embedded systems, Software Defined Radio, VLSI Design and Wireless Communication. He has presented several technical papers in National and International journals and conferences.

Dr.N.Vasudevan graduated from Regional Engineering College, Trichy and obtained his PhD from Anna University. He possess over 20 years of teaching experience. His current areas of research include Artificial neural networks, Machine intelligence, Intelligent control. He is an approved supervisor for M.S./PhD for various Universities. He has published 41 research papers in National and International journals and conferences. He is a member of IEEE, ISTE and ISA.