

DESIGN AN ULTRA-WIDEBAND MODIFIED WILKINSON POWER DIVIDER FED-BY BALANCED ANTIPODAL VIVALDI ANTENNA ARRAY FOR IMAGING APPLICATIONS

Faraz Ahmed Shaikh¹, Sheroz Khan¹, AHM Zahirul Alam¹, Mohamed Hadi Habaebi¹ and Dominique Baillargeat²

¹Department of Electrical and Computer Engineering,
International Islamic University Malaysia (IIUM), Gombak, 53100,
Selangor, Kuala Lumpur, Malaysia.

²Department of Research XLIM, University of Limoges,
Limoges, France.

Corresponding Authors' Email: ¹ farazshaikh@hotmail.com; sheroz@iium.edu.my

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ABSTRACT: In this paper, design of compact and modified geometrical structure of 1-to-4 way ultra-wideband Wilkinson power divider used as a feeding network for 4-element of balanced antipodal Vivaldi antenna (BAVA) array has introduced. The proposed Wilkinson power divider has been designed and printed on low-cost Epoxy laminate substrate FR4 along with the thickness of 1.6mm and relative permittivity of $\epsilon_r = 4.3$ respectively. The transformation of power divider network which are based on bent corners as a replacement of sharp corners or edges used for the decrement in unintended radiation and employing a single radial stub on each branch to encounter the antenna-specifications. Further some adjustments in the dimension of stubs matching in order to increase the reflection of the power divider network. The design presents the model of a power divider and maintains an equal power splitting at different ports with practical insertion loss and conventional return loss below -10dB. The reasonable impedance matching has achieved at every single port with acceptable isolation performance values over the (3-to-10 GHz) frequency range. The divider as well as antenna elements design and its optimization are practicable via computer simulation technology (CST) simulation software. The experimental results are revealed to encounter the array-specifications under ultra-wideband frequency range..

KEYWORDS: UWB; BAVA and CST.

1.0 INTRODUCTION

Power Splitter or Divider is considered as a significant component especially in microwave circuit design as well as interconnected subsystems. It is extensively used in power amplifiers, mixers and phase shifters. At this time the power divider strongly considers as a significant component mainly in an ultra-wide band application [1] and antenna array related system feeding network [2-5]. The design model of Wilkinson power divider is very popular due to its narrow bandwidth and particularly used in

UWB antenna array application [6], [7]. For the further advancement in frequency bandwidth and expansion in channel frequency a general design of power divider with some modification in basic geometrical shape has been developed [8-10]. The following parameters like return loss, isolation, insertion loss, group delay and bandwidth achieved from divider network has necessary for the configuration of any power divider and the mentioned parameters generally used to evaluate the specific performance in many satellite and radar communication application system [11], [12].

Currently, the most focused type of power divide named Wilkinson [13] is an optimal selection of several researchers. It is typically used in feeding network of antenna array system because of its simple geometrical structure, low insertion losses and compacted in size. Although, the isolation circuit is associated with output ports and it also offers electrical separation but cannot physical isolation to the circuit.

A novel conceptual idea of power divider network has been introduced in 2010 [14]. The isolation components has positioned among the $\lambda/4$ transmission lines by arbitrary phase angle understudy of 90° while in conventional Wilkinson power divider to enhance physical separation as well as electrical isolation instantly. The geometrical configuration of divider network has been published in [15].

In this study the design approach of modified Wilkinson power divider linked with 4-element of balanced antipodal Vivaldi antenna (BAVA) [16], [17] has been introduced. The paper is discussing a practical technique of Wilkinson power divider along with structural alteration by consuming conventional power splitter for feeding network [18-20]. This research based on two different stages of 1-to-2 way Wilkinson power dividers along with 3GHz to 10GHz range of frequency. The material Epoxy laminate (FR4) using total-thickness of 1.6 mm with permittivity of $\epsilon_r = 4.3$ is used for print development. For the expansion in performance parameters a number of modifications have been ended in an actual design. The placement of curved corners instead of pointed edges is used for the decrement in unintended as well as non-uniform radiation by the feeding-network [21], [22]. An additional alteration has been made in the stubs length. Further four element of BAVA connected with modified power divider are exposed to observe the antenna array specification. The impedance matching-bandwidth of the projected Wilkinson power divider covers the well-defined UWB frequency range. The CSTMWS simulation software is considered for authenticate the outcomes [23].

2.0 CONVENTIONAL DESIGN

Two parallel uncoupled quarter wavelength transmission-lines have been used for the formation of conventional Wilkinson power divider. The characteristic impedance of all uncoupled lines is $\sqrt{2}Z_0$ and matched with the input port of divider. For the better isolation of divider a shunt resistor $2Z_0$ would be associated among the output ends of the port. The basic structural configuration of 1 to 2 sections power divider is represented in Figure 1(a) and Figure 1(b) correspondingly [14].

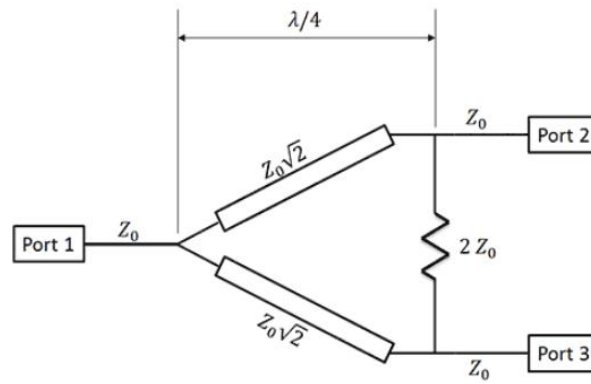


FIGURE 1(a). Equally-Split 2-way Wilkinson Power Divider

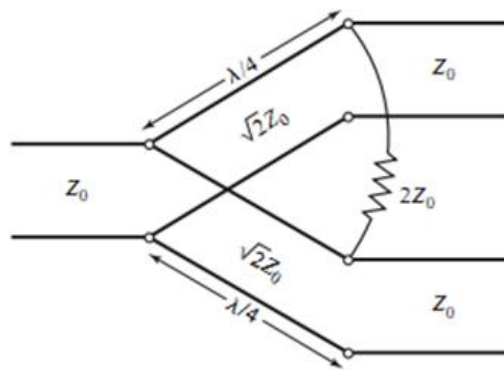


FIGURE 1(b). Equivalent Circuit of Conventional Power Divider Network

The dimensional analysis of Wilkinson power divider can be find by the following general expression (1)-(5) [24].

$$A = \frac{Z_0}{60} \sqrt{\frac{\epsilon_r + 1}{2}} + \frac{\epsilon_r - 1}{\epsilon_r + 1} \left(0.23 + \frac{0.1}{\epsilon_r} \right) \quad (1)$$

$$\frac{W}{d} = \frac{8e^A}{e^{2A} - 2} \quad (2)$$

$$\epsilon_{\text{eff}} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[\frac{1}{\sqrt{1 + 12 \left(\frac{d}{W1} \right)}} \right] \quad (3)$$

$$\lambda_g = \frac{c}{f_0 \sqrt{\epsilon_{\text{eff}}}} \quad (4)$$

$$l = \frac{\lambda_g}{4} \quad (5)$$

The concept of N-way divider is formally used for improvement in the number of output ports as signify in Figure 2. The elementary circuitry of mentioned power-divider can be coordinated at all network ports and corresponding port is matched with isolation among all network ports.

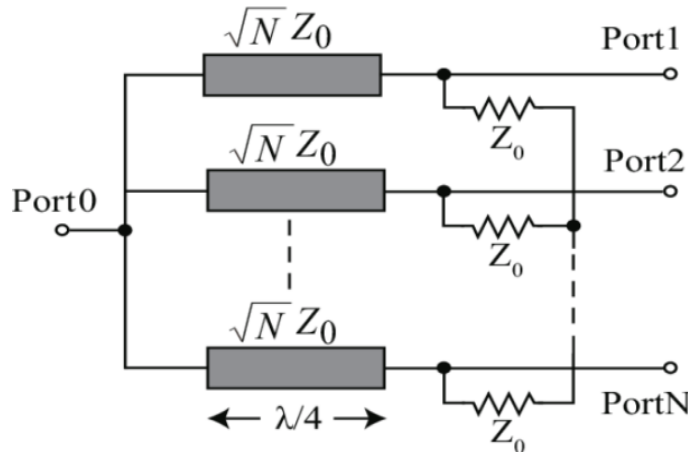


FIGURE 2. N-Way Power Divider for Equal Power Split

3.0 PROPOSED DESIGN OF 4-WAY WILKINSON POWER DIVIDER

A recommended scheme of 1-to-4 way Modified Wilkinson power divider is represented in Figure 3. The matching-impedance of both ports like input or output has around 50Ω. The first transmission line has characteristic impedance of $Z_1=70.7\Omega$ and as well as for the another transmission lines $Z_2=100\Omega$. The separation distance among the output ports are 0.6λ to avoid grating lobes. The Table-1 has presented the adjusted dimensions of improved Wilkinson power divider and the suggested idea of power divider has been presented [5].

TABLE 1. Measurements of Modified1-to-4 Way Wilkinson Power Divider

| X | X ₁ | X ₂ | X ₃ | X ₄ | X ₅ | X ₆ |
|------|----------------|----------------|----------------|----------------|----------------|----------------|
| 66.3 | 4.5 | 5.7 | 2 | 5 | 18.4 | 17.5 |
| W | W ₁ | W ₂ | W ₃ | W ₄ | W ₅ | W ₆ |
| 100 | 3.1 | 5.8 | 7.8 | 50.14 | 2.5 | 23.86 |

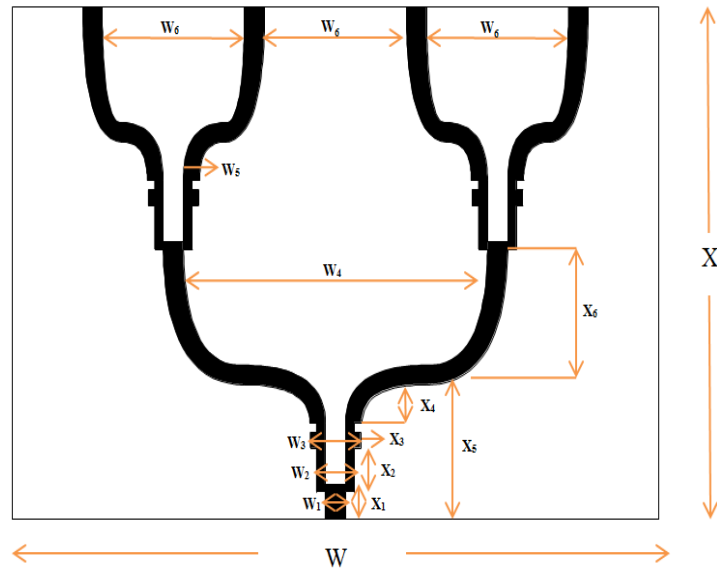


FIGURE 3. Schematic Diagram of Proposed-Power Divider

4.0 SIMULATION RESULTS OF PROPOSED POWER DIVIDER AND DISCUSSION

The simulation software CST is used for result validation. The proposed power divider has operating under UWB frequency range (3-to-10GHz) and the reasonable outcome has been derived to claim this work novel in research society. The low cost material FR4 has been used in fabrication with a material thickness of 1.6mm. It has constant dielectric value which is $\epsilon_r = 4.3$ respectively. The layout view of a model on CST has shown in Figure 4.

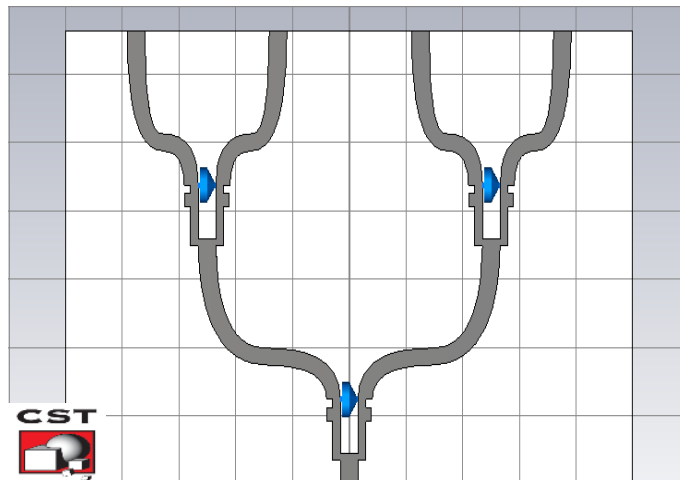


FIGURE 4. Schematic Diagram of Proposed Power Divider

4.1 Return Loss

The reflection coefficient of proposed model has been depicted in Figure 5. The satisfactory amount of reflection from input and output port has been received which is better than -10dB at (3-to-10GHz) of frequency range. The standard input impedance matching value of 50Ω has been decided for defined frequency range. The bandwidth of recommended power divider is extended from frequency 3-to-10GHz for ultra-wide band range.

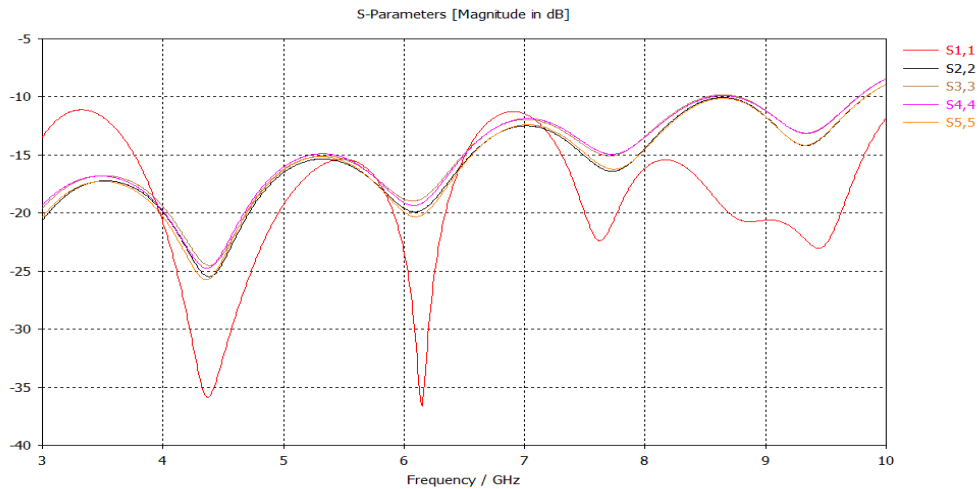


FIGURE 5. Reflection-Coefficient of proposed Power Divider (S_{11} , S_{22} , S_{33} , S_{44} , S_{55})

4.2 Insertion loss

The insertion loss S_{21} , S_{31} , S_{41} and S_{51} with respect to S_{11} of proposed divider network has been presented in Figure 6. The maximum insertion loss around -10 dB at (7-to-10 GHz) has been observed, which may be accounted for the separation distance of the output terminals. It has been proved by the results, input-power has been shared equally and splits to all output ports. A reasonable performance and low insertion-loss has been observed over the entire UWB frequency range.

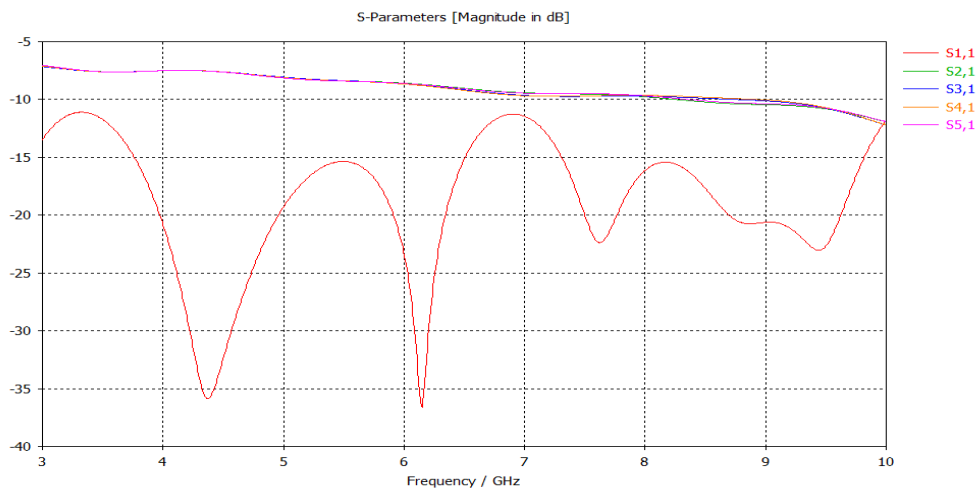


FIGURE 6. Insertion Loss of Proposed Power Divider (S_{11} , S_{21} , S_{31} , S_{41} , S_{51})

4.3 Isolation

The Isolation result of recommended power divider has shown in Figure 7. The graph represents all output ports have received equal amount of power from the input port. The isolation between all ports has less than -10 dB and offering excellent presentation at UWB frequency range.

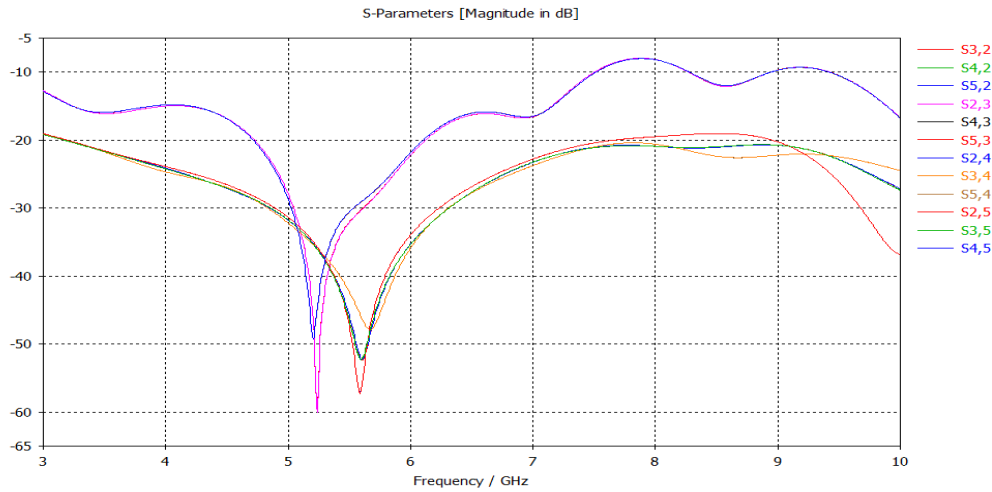


FIGURE 7. Isolation of Proposed Power Divider (S₃₂, S₄₂, S₅₂, S₂₃, S₄₃, S₅₃, S₂₄, S₃₄, S₅₄, S₂₅, S₃₅, S₄₅)

4.4 Voltage Standing Wave Ratio (VSWR)

VSWR of proposed divider has depicted in Figure 8. According to standard and for better performance the value of ratio should be less than 2. However, it can notice that the VSWR is little high at 9.8-to-10 GHz frequency range, which may be accounted for the inappropriate selection of separation distance between the ports. The simulation result has been shown a very good agreement and proposed UWB model has considered as an excellent power splitter for antenna based array feeding network.

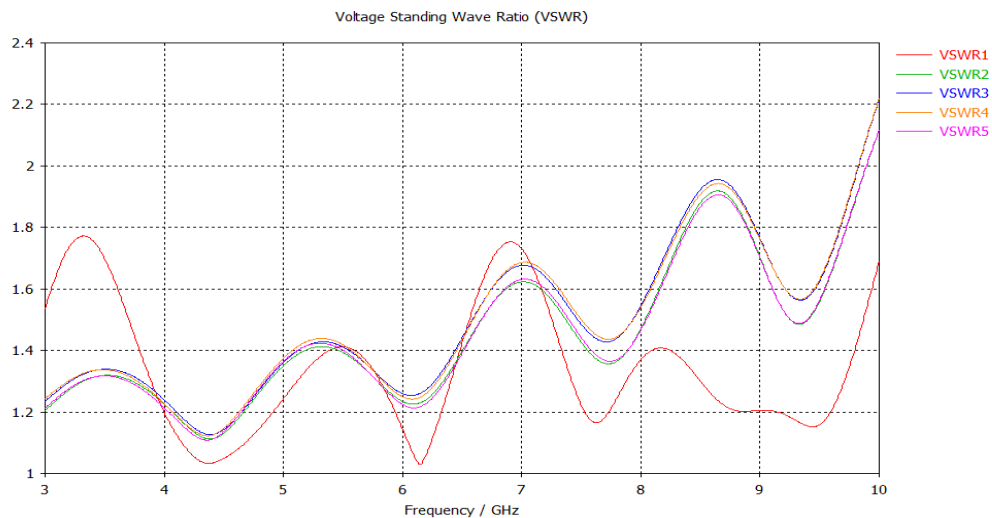


FIGURE 8. VSWR of Proposed Power Divider

5.0 PROPOSED ANTENNA DESIGN FOR ARRAY CONFIGURATION

The proposed geometrical structure and software layout of BAVA antenna element is designed on Rogers RT/Duroid 5880 with a thickness of 1.57mm and permittivity constant of $\epsilon_r = 2.2$ respectively, as shown in Figure 9(a) and 9(b). The design contain rectangular slit which equally in size placed on both ends of antenna in order to improve antenna realized gain as well as directivity. The EBG (Electro-magnetic band gap) circular-shape in structure is placed on both antenna arms for bandwidth expansion. The performance parameters of BAVA antenna element will be estimated upon feed lines and radiation flares. The elliptical in shape curves is used for design an antenna element in order to achieve better broad-band features [25]. The optimized dimensions of proposed antenna are mentioned in Table 2.

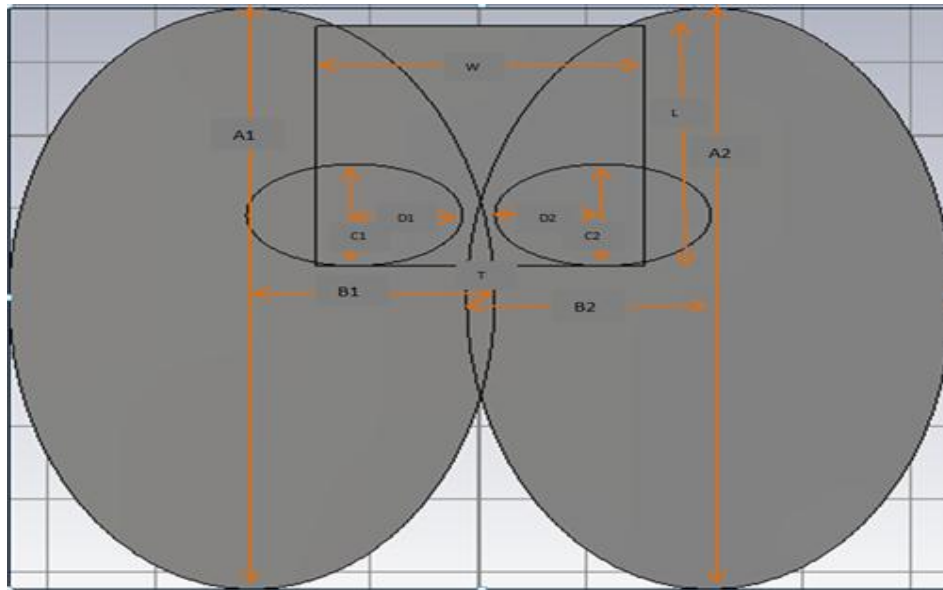


Figure 9(a). Antenna Geometry

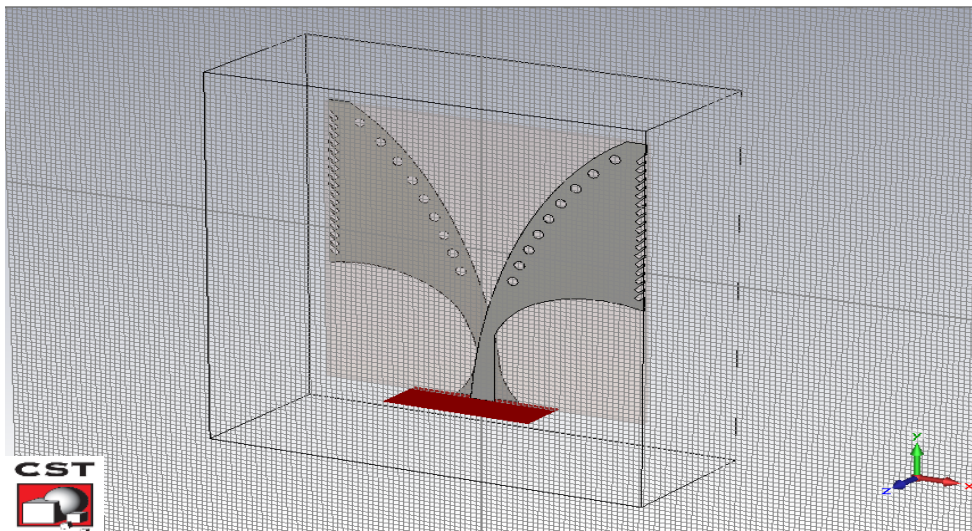


Figure 9(b). CST layout of Proposed Antenna

Table 2: Antenna Optimized Dimensions

| Parameter | Dimension |
|---------------|-----------|
| W | 60.75mm |
| L | 66mm |
| A1 | 80mm |
| B1 | 22.5mm |
| A2 | 80mm |
| B2 | 22.5mm |
| C1 | 14mm |
| D1 | 10mm |
| C2 | 14mm |
| D2 | 10mm |
| T(feed width) | 4.56mm |
| SL | 1mm |
| SW | 2mm |
| h | 1.5mm |
| t | 0.035mm |

The simulated and measured results of proposed antenna are presented in Figure 10. The port of an antenna has provided good impedance-matching bandwidth ($|S_{11}| \leq 10$) as shown in Figure 10.

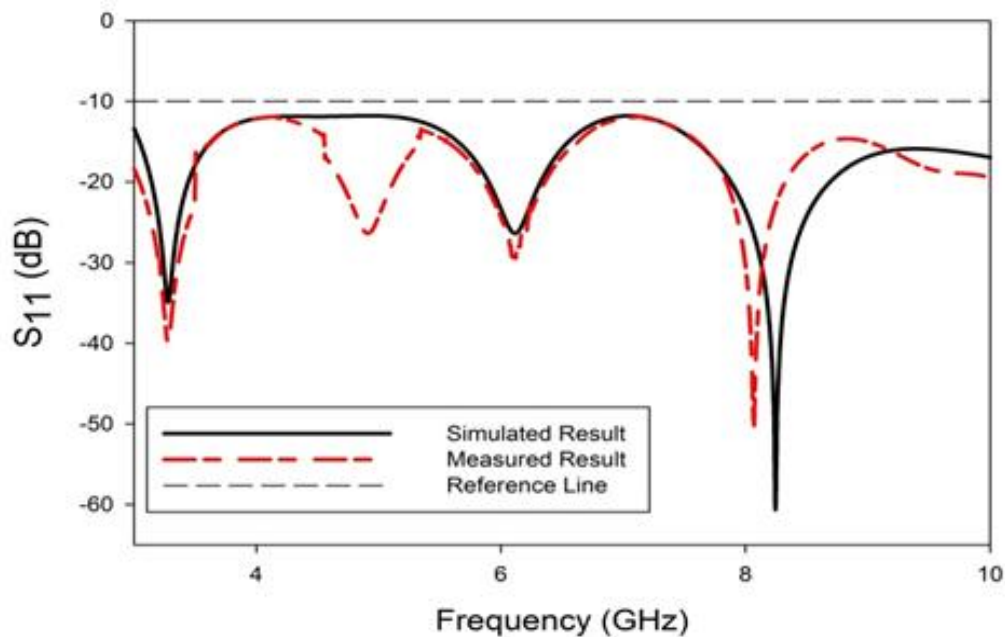


FIGURE 10. Return-loss of the Proposed Antenna

6.0 EXPERIMENTAL RESULTS OF PROPOSED POWER-DIVIDER FED BY 4-ANTENNA ELEMENTS AND DISCUSSION

An array principle has adopted in order to expand the scanning process of network. The 4-antenna elements of BAVA are fabricated and associated with suggested UWB 4-way modified Wilkinson power divider for the development of antenna array feeding network [26-32] as shown in Figure 11.

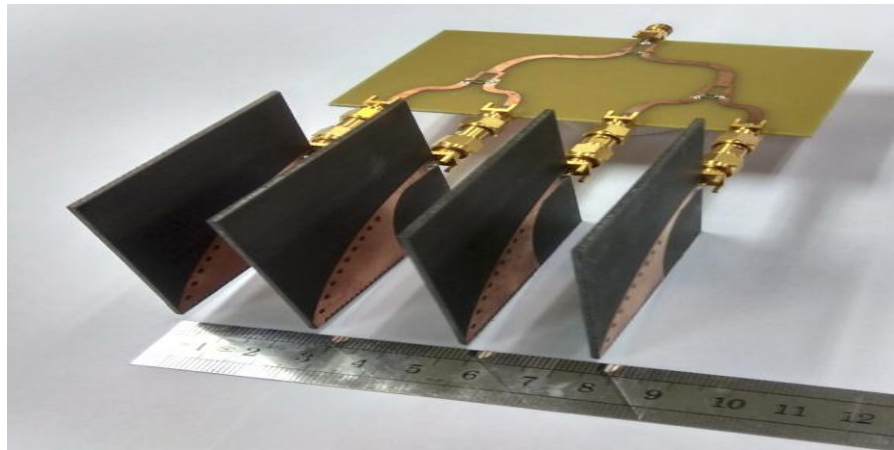


FIGURE 11. Fabricated Model of UWB Modified-Wilkinson Power Divider Fed By 4-Elements of BAVA Antenna Array

To avoid grating lobes, the separation-distance among the antenna elements are preferred to be 0.6λ , from the center of the UWB range. The VNA reflection coefficient (S_{11}) measurements of proposed antenna array system has been covered the majority of the UWB frequency range as shown in Figure 12, except for a very narrow band from around (8.9-to-9.1 GHz) and (9.5-to-9.8 GHz) where S_{11} is not better than -10dB, which may be accounted for the improper orientation, handmade soldering and SMA connector quality of the antenna elements.

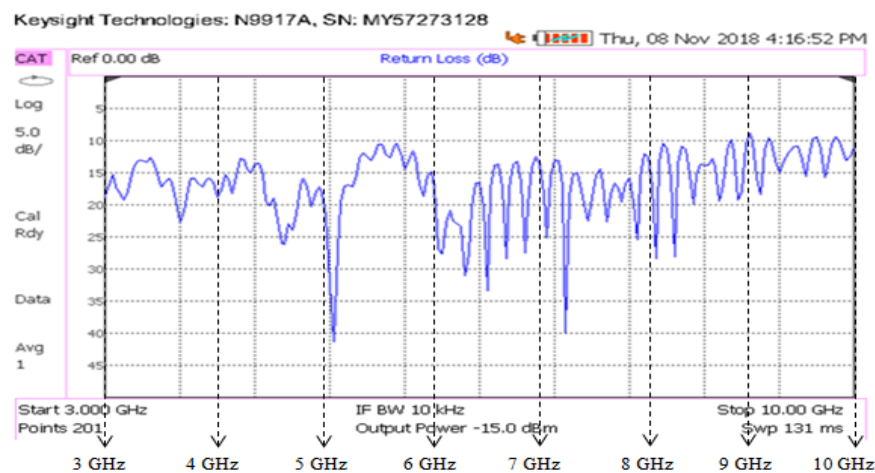


FIGURE 12. Measured Reflection Coefficient (S_{11}) of UWB Modified Wilkinson Power Divider Fed 4-Element of BAVA Antenna Array

7.0 CONCLUSION

In this research a compact and modified design of UWB Wilkinson power divider has been proposed. In projected structure, the curved corner has been used as replacement of pointed ends or edges for the decrement in unintended radiation. For the enhancement in performance parameter the length of matching stub has been modified. Now this compact and modified design has been practically tested and verified under frequency range 3-to-10 GHz. The suggested Wilkinson power-divider is producing improved results in a capacity of radiative performance, reduced in structural size and low cost in nature as compared to the traditional 1-to-4 Wilkinson power-divider. The divider model represent the equal power-shared at all output ports with good insertion-loss. It also presented improved isolation and suitable return loss for all output ports which shown improved linearity at UWB frequency range. A stacked of 4-elements of BAVA connected with UWB modified Wilkinson power-divider as a feeding network has been realized in order to meet the design specifications. The recommended power divider is more appropriate to be integrated with array feeding network and UWB imaging applications. Further the uses of different substrate for results improvement will consider in the future work.

ACKNOWLEDGMENT

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REFERENCES

- [1] Pang, B., & Yin, Y. Z. (2018, July). Development of Wilkinson Power Divider for UWB Application. In 2018 Cross Strait Quad-Regional Radio Science and Wireless Technology Conference (CSQRWC) (pp. 1-3). IEEE.
- [2] Altaf, A., Mehdi, G., Xi, C., & Miao, J. (2019, January). Design and analysis of three stage one into four-way equal Wilkinson Power Divider. In 2019 16th International Bhurban Conference on Applied Sciences and Technology (IBCAST) (pp. 908-912). IEEE.
- [3] Ahmed, B. T., Masa Campos, J. L., & Brande Hernández, D. (2019). UWB four elements antenna array. *Microwave and Optical Technology Letters*, 61(5), 1284-1294
- [4] Ali, A. H., Abd-Alhameed, R. A., Noras, J. M., & Child, M. B. (2016, November). An ultra-wide band power divider for antenna array feeding network. In *Antennas & Propagation Conference (LAPC)*, 2016 Loughborough (pp. 1-4). IEEE.
- [5] Shaikh, F. A., Khan, S., Alam, A. Z., Habaebi, M. H., Khalifa, O. O., & Khan, T. A. (2018, May). Design and analysis of 1-to-4 wilkinson power divider for antenna array feeding network. In *Innovative Research and Development (ICIRD)*, 2018 IEEE International Conference on (pp. 1-4). IEEE.

- [6] Hazeri, Ali Reza. "An ultra-wideband Wilkinson power divider." *International Journal of Electronics* 99.4 (2012): 575-584.
- [7] Naidu, P. V., Charan, M. S., Kumar, A., Sharma, D., Sharma, P., & Harish, K. S. (2018, August). Design of 5 Way Wide Band Wilkinson Power Divider for 6 to 18 GHz Applications. In 2018 Progress in Electromagnetics Research Symposium (PIERS-Toyama) (pp. 838-842). IEEE.
- [8] Bhaskar, V. S., Tan, E. L., Li, K. H. H., & Tse, M. S. (2018, May). 1 to 4 Way wideband power divider using substrate integrated waveguide and modified Wilkinson structures. In 2018 IEEE International Symposium on Electromagnetic Compatibility and 2018 IEEE Asia-Pacific Symposium on Electromagnetic Compatibility (EMC/APEMC) (pp. 554-557). IEEE.
- [9] Ou, X. P., & Chu, Q. X. (2008, April). A modified two-section UWB Wilkinson power divider. In *Microwave and Millimeter Wave Technology, 2008. ICMMT 2008. International Conference on* (Vol. 3, pp. 1258-1260). IEEE.
- [10] Ahmed, O., & Sebak, A. R. (2009, June). A modified Wilkinson power divider/combiner for ultra-wideband communications. In *Antennas and Propagation Society International Symposium, 2009. APSURSI'09. IEEE* (pp. 1-4). IEEE
- [11] Rayisiwi, Y. A., & Hariyadi, T. (2018, July). Design of A 1: 12 Power Divider at 5 GHz for Ground Surveillance Radar Application. In *IOP Conference Series: Materials Science and Engineering* (Vol. 384, No. 1, p. 012053). IOP Publishing.
- [12] Anjaneyulu, G., & Varma, J. S. (2018, March). Design and simulation of multi band microstrip antenna Array for satellite applications. In 2018 Second International Conference on Electronics, Communication and Aerospace Technology (ICECA) (pp. 140-143). IEEE.
- [13] Zhou, Bo, Hao Wang, and Weixing Sheng. "A novel UWB Wilkinson power divider." *Information Science and Engineering (ICISE), 2010 2nd International Conference on*. IEEE, 2010.
- [14] C.-J. Trantanella, "A novel power divider with enhanced physical and electrical port isolation," *IEEE MTT-S Int.*, pp. 129-132, 2010.
- [15] X. Wang, I. Sakagami, A. Mase, and M. Ichimura, "Trantanella Wilkinson power divider with additional transmission lines for simple layout.," *IET Microwaves, Antennas & Propagation*, vol. 8, no. 9, pp. 666-672, 2014.
- [16] Shaikh, F.A, and S. Khan. "Design and Optimization of Ultra-Wideband Antipodal Vivaldi Antenna for Radar and Microwave Imaging Application." *Sindh University Research Journal (Science Series)* 50, no. 3D (2018): 06-09.
- [17] Shaikh, F. A., Khan, S., Alam, A. Z., Baillargeat, D., Habaebi, M. H., Yaacob, M. B., ... & Shahid, Z. (2018, September). Comparative Analysis of UWB Balance Antipodal Vivaldi Antenna for Array Configuration. In 2018 7th International Conference on Computer and Communication Engineering (ICCCE) (pp. 124-129). IEEE
- [18] Ou, X. P., & Chu, Q. X. (2008, April). A modified two-section UWB Wilkinson power divider. In *Microwave and Millimeter Wave Technology, 2008. ICMMT 2008. International Conference on* (Vol. 3, pp. 1258-1260). IEEE.
- [19] Mazhar, Waqas, David Klymyshyn, and Aqeel Qureshi. "Design and analysis of wideband eight-way SIW power splitter for mm-wave applications." *International Journal of RF and Microwave Computer-Aided Engineering* 28.2 (2018): e21196.

- [20] Kao, J. C., Tsai, Z. M., Lin, K. Y., & Wang, H. (2012). A modified Wilkinson power divider with isolation bandwidth improvement. *IEEE transactions on microwave theory and techniques*, 60(9), 2768-2780.
- [21] Peters, F. D., Hammou, D., Tatu, S. O., & Denidni, T. A. (2010). Modified Millimeter-Wave Wilkinson Power Divider for Antenna Feeding Networks. *Progress In Electromagnetics Research*, 17, 11-18.
- [22] Rahim, N. H. A., et al. "Wideband power divider using radial stub for six-port interferometer." *Applied Electromagnetics (APACE)*, 2016 IEEE Asia-Pacific Conference on. IEEE, 2016.
- [23] CST Microwave Studio, Ver. 2015 Computer Simulation Technology, Framing-ham, MA, USA.
- [24] D. M. Pozar, *Microwave Engineering*. New York: Wiley, 2012.
- [25] M. Abbosh and M. E. Bialkowski, "Design of Ultrawideband Planar Monopole Antennas of Circular and Elliptical Shape", *IEEE Transactions on Antennas and Propagation*, Vol. 56, pp. 17-23, January 2008.
- [26] Shaikh, Faraz Ahmed, Sheroz Khan, A. HM Zahirul Alam, Dominique Baillargeat, Mohamed Hadi Habaebi, Mashkuri Bin Yaacob, Jawad Shah, and Zeeshan Shahid. "Design and parametric evaluation of UWB antenna for array arrangement." *Bulletin of Electrical Engineering and Informatics* 8, no. 2 (2019): 644-652.
- [27] Kasi, Baskaran, and Chandan Kumar Chakrabarty. "Ultra-wideband antenna array design for target detection." *Progress in Electromagnetics Research* 25, 67-79, 2012.
- [28] Strackx, Maarten, Karel Janssen, Emiliano D'Agostino, G. A. E. Vandenbosch, Patrick Reynaert, and Paul Leroux. "Ultra-wideband antipodal Vivaldi antenna array with Wilkinson power divider feeding network." In *2011 IEEE International Conference on Ultra-Wideband (ICUWB)*, IEEE, pp. 1-4, Sept 14. 2011.
- [29] Shaikh, Faraz Ahmed, Sheroz Khan, Zarimin Zaharudin, AHM Zahirul Alam, Farah Diyana Bt Abdul Rahman, Khairayu Bt Badron, Dominique Baillargeat, Mashkuri Bin Yaacob, and Zeeshan Shahid. "Recognition of Metal Objects inside Wall using Antipodal Vivaldi Antenna." *Indonesian Journal of Electrical Engineering and Computer Science* 11, no. 1 (2018): 27-35.
- [30] Shaikh, Faraz Ahmed, Sheroz Khan, Zahirul Alam, A. Hassan, A. Hashim, KBT Badron, And MB Yaacob. "High Gain UWB Horn Antenna for Concealed Metal Detection and Microwave Imaging Application." *Sindh University Research Journal (Science Series)* 50, no. 3D (2018): 161-164.
- [31] Ray, K. P., K. Nirmala, S. S. Kakatkar, N. S. Madaka, and C. Prince. "Broadband modified Wilkinson power divider fed antipodal Vivaldi antenna array." In *2013 International Conference on Microwave and Photonics (ICMAP)*, IEEE, pp.1-4, Dec 13.2013.
- [32] Kasi, Baskaran, and Chandan Kumar Chakrabarty. "Ultra-wideband antenna array design for target detection." *Progress in Electromagnetics Research* 25, pp.67-79. 2012.



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