Indonesian Journal of Electrical Engineering and Computer Science
Vol. 16, No. 3, December 2019, pp. 1392~1397
ISSN: 2502-4752, DOI: 10.11591/ijeecs.v16.i3.pp1392-1397

Numerical investigation of V shaped three elements resonator for optical closed loop system

IS Amiri[1], Ahmed Nabih Zaki Rashed[2]
[1]Computational Optics Research Group, Advanced Institute of Materials Science,
Ton Duc Thang University, Ho Chi Minh City, Vietnam
[1]Faculty of Applied Sciences, Ton Duc Thang University, Ho Chi Minh City, Vietnam
[2]Electronics and Electrical Communications Engineering Department Faculty of Electronic Engineering,
Menoufia University, Egypt

Article Info

Article history:

Received Feb 25, 2019
Revised May 28, 2019
Accepted Jun 22, 2019

Keywords:

Back mirror
Focusing mirror
Resonator
V shaped

ABSTRACT

This study have outlined numerical investigation of V shaped three element resonator. The stability parameter is measured against back mirror curvature radius, back mirror phase angle, focusing length, focusing mirror phase angle, folding range in both S plane and T plane. The stability parameter is changed in positive and negative trend under the operating system parameters. The stability parameter should be optimized in order to achieve high performance efficiency of resonator system. Beam radius variations are also measured versus focusing range, folding range, and back mirror phase angle. It is clear that the negative effects of increasing system parameters on beam radius variation in both S plane and T plane.

Corresponding Author:

Ahmed Nabih Zaki Rashed,
Electronics and Electrical Communications Engineering Department,
Faculty of Electronic Engineering, Menoufia University,
Menouf 32951, Egypt.
Email: ahmed_733@yahoo.com

1. INTRODUCTION

Three are many types of resonators system that are namely T shaped and V shaped according to its applications [1-2]. The basic concepts for resonator systems are back mirror with curvature radius and alpha phase angle variations [3-4]. The folding range is the separation between back mirror and focusing mirror. In many studies the focusing mirror with curvature radius ranges from 100 mm to 300 mm and alpha phase angle variations from one degree to seven degree in many applications. [5-6]. The difference between focusing mirror and output flat mirror id the space length which is taken from 50 mm to 300 mm in many research applications [7-9].

Many attempts in other studies for optimization of the stability parameter over the operation parameters of back mirror curvature radius [10-13], back mirror phase angle, focusing length, focusing mirror phase angle, folding range in both S plane and T plane [14-17]. Many papers study the beam radius variations are also measured versus focusing range, folding range, and back mirror phase angle for short applications [18-20].

2. MODEL DESCRIPTION AND RESEARCH METHOD

Figure 1 shows the basic schematic view of v shaped three elements resonator. The system consists of back mirror with curvature radius variations in mm units and alpha phase in degree. L-foc is the focusing range from back mirror to focusing mirror. M¯foc represents the focusing mirror with curvature radius variations in mm units and alpha phase in degree. L is the space length and expressed in mm units.

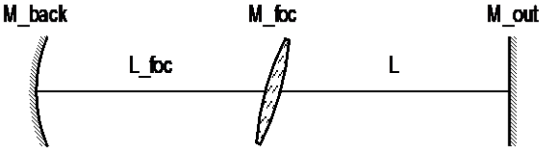

Figure 1. Basic schematic view of three element resonator

M¯out is the output mirror and in the difference of focusing mirror by the space length (L). The back mirror curvature radius variations from 10 mm to 30 mm and its phase ranges from 1 degree to 20 degree. The focusing ranges from 10 mm to 60 mm. The focusing mirror curvature radius variations from 100 mm to 300 mm with a step size of 50 mm. and its alpha phase ranges from 5 degree to 30 degree.

3. RESULTS AND ANALYSIS

We have analyzed V shaped three elements resonator under the operating parameters. The back mirror curvature radius variations from 10 mm to 30 mm and its phase ranges from 1 degree to 20 degree. The focusing ranges from 10 mm to 60 mm. The focusing mirror curvature radius variations from 100 mm to 300 mm with a step size of 50 mm. and its alpha phase ranges from 5 degree to 30 degree. It is observed from Figure 2 the variations of stability parameter against variations of back mirror curvature radius in both S and T planes. It is observed that as back mirror curvature radius increases, this leading to increasing of stability parameter in both S plane and T plane.

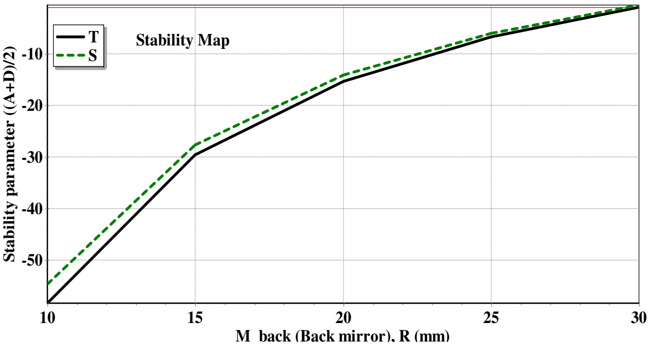

Figure 2. Variations of stability parameter against variations of back mirror curvature radius

Figure 3 shows the variations of stability parameter against variations of back mirror phase angle. It is indicated that stability parameter increasing in S plane with increasing of back mirror phase angle. As well as stability parameter decreasing in T plane with increasing of back mirror phase angle. Figure 4 presents the variations of Stability parameter in relation to focusing length variations. It is clear that as focusing length increases, this leading to increase of stability parameter in both S plane and T plane up to 40 mm focusing length. After 40 mm focusing length, the performance of stability decreases consequently.

Figure 5 shows the stability parameter variations in relation to curvature radius of focusing mirror variations. It is observed that the stability increases sequent up to 40 mm curvature radius of focusing mirror. The stability parameter is still constant and in steady state performance up to 50 mm curvature radius of focusing mirror. Figure 6 outlines the variations of stability parameter against variations of focusing mirror phase angle. It is found that as focusing mirror phase angle increases, this results in increasing of stability parameter in S plane. But as focusing mirror phase angle increases, this results in decreasing of stability parameter in T plane. Figure 7 shows the variations of stability parameter against variations of folding range or space length. It is clear that as folding range or space length increases, this results in decreasing of stability parameter in both T and S planes. The stability parameter degraded larger than in T plane than S plane.

As shown in Figure 8 the beam radius variations versus focusing range variations from 10 mm to 50 mm. It is observed that beam radius variations tend to decrease in both S plane and T plane. Beam radius variations in T plane is larger than S plane. As well as Figure 9 shows the beam radius variations in relation to variations of folding ranges from 0 mm to 300 mm. It is indicated that beam radius variations tend to decrease in both S and T planes. Beam radius variations in T plane is larger than S plane up to 250 mm folding range. After 250 mm folding range the beam radius variations in S plane is larger than T plane. Beam radius at back mirror variations against back mirror phase angle variations as shown in Figure 10. It is clear that beam radius at back mirror decreases with increasing back mirror phase angle variations in only S plane and almost constant in T plane. Intermode beat frequency of the system is 419.877 MHz, Total cavity length is 57(L_foc) + 300(L) = 357 mm.

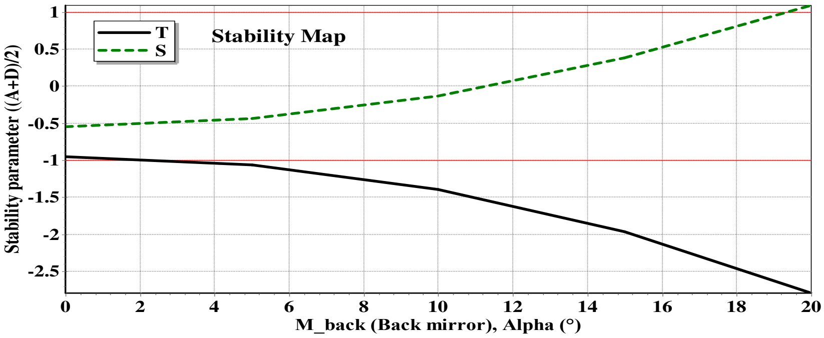

Figure 3. Variations of stability parameter against variations of back mirror phase angle

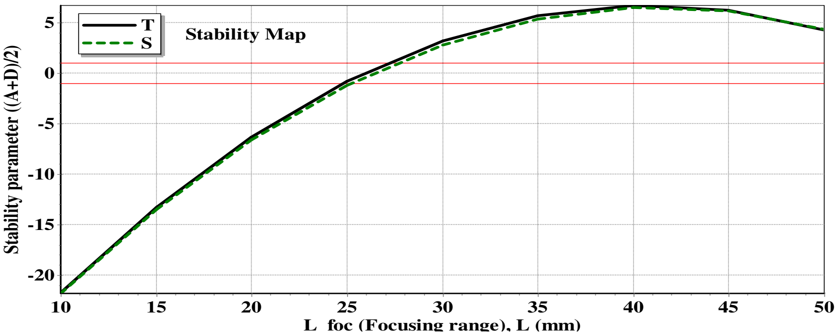

Figure 4. Stability parameter in relation to focusing length

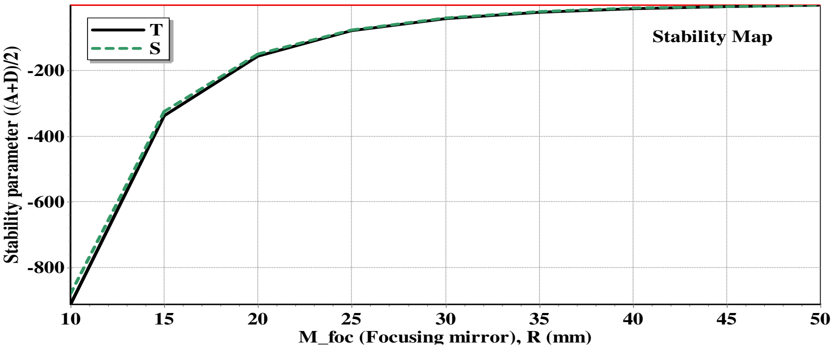

Figure 5. Stability parameter in relation to curvature radius of focusing mirror

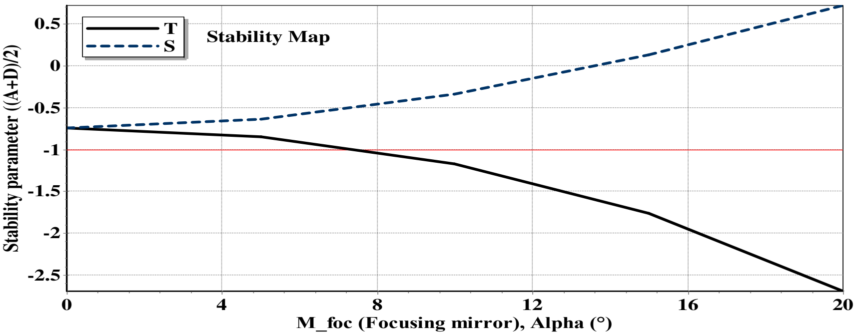

Figure 6. Variations of stability parameter against variations of focusing mirror phase angle

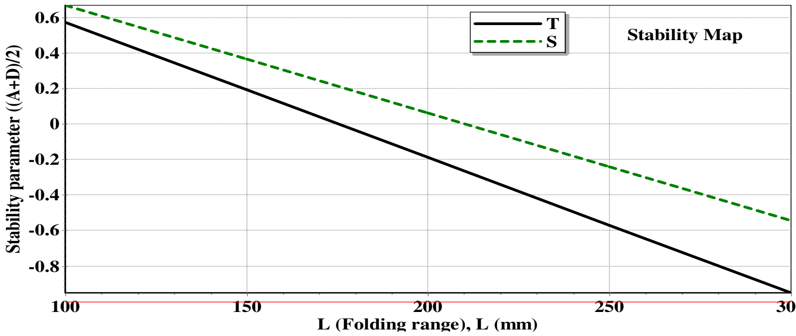

Figure 7. Variations of stability parameter against variations of folding range or space length

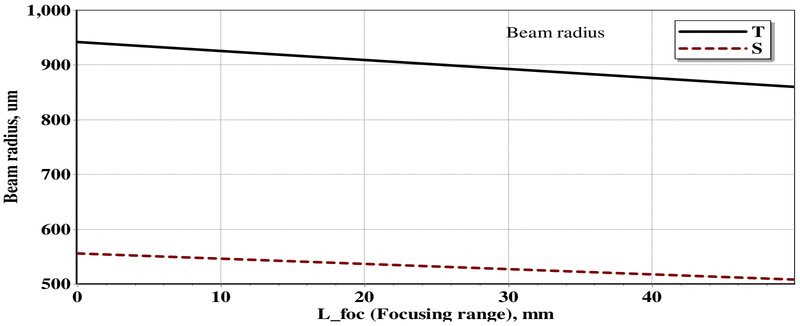

Figure 8. Beam radius variations versus focusing range variations

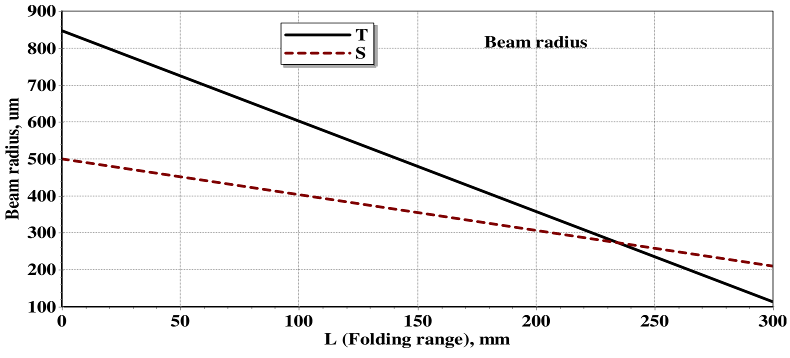

Figure 9. Beam radius variations in relation to variations of folding range

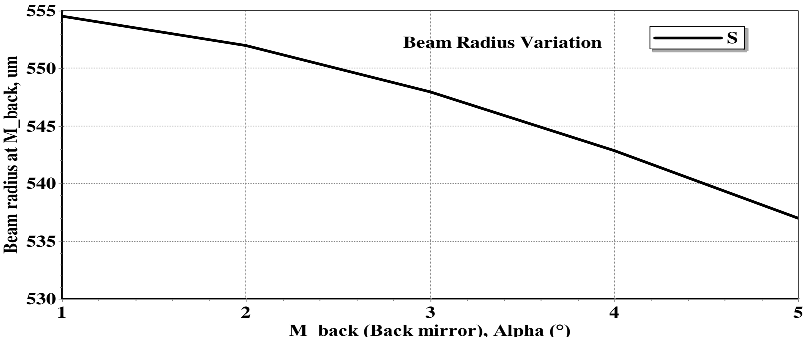

Figure 10. Beam radius at back mirror variations against back mirror phase angle variations

4. CONCLUSION

In a summary, it is found that the intermode beat frequency of the resonator system is 419.877 MHz, with total cavity length is 57(L_foc) + 300(L) = 357 mm. It is observed that the positive and negative effects of increasing operating system parameters on the beam radius of resonator system efficiency. It is clear that the optimized beam radius is obtained with T plane. As well as it is observed that the optimized stability parameter is obtained with S plane. After 250 mm folding range the beam radius variations in S plane is larger than T plane. It is indicated that the beam radius variations in T plane is larger than S plane. Moreover the stability increases sequent up to 40 mm curvature radius of focusing mirror. The stability parameter is still constant and in steady state performance up to 50 mm curvature radius of focusing mirror

REFERENCES

[1] S.-C. Wang, et al., "Optically Pumped GaN Based Vertical Cavity Surface Emitting Lasers: Technology and Characteristics," *Jpn. J. Appl. Phys.*, vol. 46, pp. 5397-5407, 2007.

[2] T.-C. Lu, et al., "CW Lasing of Current Injection Blue GaN Based Vertical Cavity Surface Emitting Laser," *Appl. Phys. Lett.*, vol. 92, pp. 1-3, 2008.

[3] Christopher J. Stapels, et al., "CMOS Based Avalanche Photodiodes for Direct Particle Detection," *Nuclear Instruments and Methods in Physics Research A*, vol. 579, no. 1, pp. 94-98, Aug. 2007.

[4] Pulvirenti, et al., "Characterization of Avalanche Photodiodes (APDs) for the Electromagnetic Calorimeter in the ALICE Experiment," *Nuclear Instruments and Methods in Physics Research A*, vol. 596, no. 1, pp. 122-125, Oct. 2008.

[5] Abd El-Naser A. Mohammed, et al., "Transient behavior and transmission bit rates analysis of optoelectronic integrated devices laser diode (LD) and light emitting diode (LED) under amplification and ionizing irradiation environments," *Journal of Electrical and Electronics Engineering Research*, vol. 3, no. 7, pp. 121-133, 2011.

[6] T. Lima, et al., "A Receiver Model for Optical Fiber Communication Systems With Arbitrarily Polarized Noise," *Journal of Lightwave Technology*, vol. 23, no. 3, pp. 1478-1490, Mar 2005.

[7] S. Norimatsu and M. Maruoka, "Accurate Q-factor Estimation of Optically Amplified Systems in the Presence of Waveform Distortions," *Journal of Lightwave Technology*, vol. 20, no. 1, pp. 19-27, Jan 2002.

[8] S. M. Jahangir Alam, et al., "Bit Error Rate Optimization in Fiber Optic Communications," *International Journal of Machine Learning and Computing*, vol. 1, no. 5, pp. 435-440, Dec 2011.

[9] Z. Kornain, et al., "The Simulation of Indoor Service Range Prediction of Wireless Radio Access Point for Radio over Fiber System," *IACSIT International Journal of Engineering and Technology*, vol. 5, no. 1, pp. 136-140, Feb 2013.

[10] Ahmed Nabih Zaki Rashed, "High Performance Photonic Devices For Multiplexing/Demultiplexing applications in Multi Band Operating Regions," *Journal of Computational and Theoretical Nanoscience*, vol. 9, no. 4, pp. 522-531, April 2012.

[11] S. M. J. Alam, et al., "Improvement of Bit Error Rate in Fiber Optic Communications," *International Journal of Future Computer and Communication*, vol. 3, no. 4, pp. 281-286, Aug 2014.

[12] Ahmed Nabih Zaki Rashed, and Mohamed A. Metwae'e, "Optical Filters Dimensions and Thermal Operation Conditions Impact on Its Transmission Considerations in Near Infrared (NIR) Optical Spectrum Transmission Region," *Optoelectronics and Advanced Materials Journal-Rapid Communications*, vol. 8, no. 3-4, p. 175-184, March-April 2014.

[13] Taya, et al., "Design and Analysis of Low Power Universal Line Encoder & Decoder," *Microelectronics and Solid State Electronics Journal*, vol. 5, no. 1, pp. 7-13, 2016.

[14] C.T. Manimegalai and S. G. Kalimuthu, "Underwater Optical Channel Analysis Using DPIM & PPM," *European Journal of Applied Sciences*, vol. 9, no. 3 pp.154-162, 2017.

[15] M. V. Raghavendra, et al., “Estimation of Optical Link Length for Multi Haul Applications,” *International Journal of Engineering Science and Technology*, vol. 2, no. 6, pp. 1485-1491, 2010.
[16] E. Feltin, et al., “Blue Lasing at Room Temperature in an Optically Pumped Lattice Matched AlInN/GaN VCSEL Structure,” *Electron. Lett.*, vol. 43, pp. 924-926, 2007.
[17] J.-T. Chu, et al., “Room-Temperature Operation of Optically Pumped Blue Violet GaN Based Vertical Cavity Surface Emitting Lasers Fabricated by Laser Lift Off,” *Jpn. J. Appl. Phys*, vol. 45, pp. 2556-2560, 2006.
[18] J.-T. Chu, et al., “Emission Characteristics of Optically Pumped GaN Based Vertical Cavity Surface- Emitting Lasers,” *Appl. Phys. Lett.*, vol. 89, pp. 1-3, 2006.
[19] M. C. Shih and C. S. Chen, “A Semiconductor Soliton Cavity Laser Diode and its Output Characteristics,” *Japanese Journal of Applied Physics*, vol. 50, no. 4, pp. 17-22, 2011.
[20] C.-C. Kao, et al., “The Lasing Characteristics of GaN Based Vertical Cavity Surface Emitting Laser With AlN–GaN and Ta2O5 –SiO2 Distributed Bragg Reflectors,” *IEEE Photon. Technol. Lett.*, vol. 18, no. 7, pp. 877-879, 2006.

BIOGRAPHIES OF AUTHORS

Dr. IS Amiri has been doing research on several topics such as the optical soliton communications, laser physics, fiber lasers, fiber grating, electro-optical modulators, nanofabrications, semiconductor design and modelling, Lumerical modelling, plasmonics photonics devices, nonlinear fiber optics, optoelectronics devices using 2D materials, semiconductor waveguide design and fabrications, photolithography fabrications, E Beam lithography, quantum cryptography and nanotechnology engineering.

Assoc. Prof. Ahmed Nabih Zaki Rashed was born in Menouf city, Menoufia State, Egypt country in 23 July, 1976. Received the B.Sc., M.Sc., and Ph.D. scientific degrees in the Electronics and Electrical Communications Engineering Department from Faculty of Electronic Engineering, Menoufia University in 1999, 2005, and 2010 respectively. Currently, his job carrier is a scientific lecturer in Electronics and Electrical Communications Engineering Department, Faculty of Electronic Engineering, Menoufia university, Menouf. Postal Menouf city code: 32951, EGYPT. His scientific master science thesis has focused on polymer fibers in optical access communication systems. Moreover his scientific Ph. D. thesis has focused on recent applications in linear or nonlinear passive or active in optical networks. His interesting research mainly focuses on transmission capacity, a data rate product and long transmission distances of passive and active optical communication networks, wireless communication, radio over fiber communication systems, and optical network security and management.

He has published many high scientific research papers in high quality and technical international journals in the field of advanced communication systems, optoelectronic devices, and passive optical access communication networks. His areas of interest and experience in optical communication systems, advanced optical communication networks, wireless optical access networks, analog communication systems, optical filters and Sensors. As well as he is editorial board member in high academic scientific International research Journals. Moreover he is a reviewer member in high impact scientific research international journals in the field of electronics, electrical communication systems, optoelectronics, information technology and advanced optical communication systems and networks. His personal electronic mail ID (E-mail:ahmed_733@yahoo.com). His published paper under the title **"High reliability optical interconnections for short range applications in high performance optical communication systems"** in Optics and Laser Technology, Elsevier Publisher has achieved most popular download articles in 2013.