

Analytical solution of the rate equation in direct modulation of semiconductor laser

Nhat H.N., Thuy D.T.T., Duc N.A.

Faculty of Physics, College of Science, Vietnam National University, 334 Nguyen Trai, Thanh Xuan, Hanoi,
Viet Nam

Abstract: We studied the rate equations of a semiconductor laser operating in a direct modulation mode for the purpose of obtaining the direct dependence of output photon density on modulating current. We show that the system of differential equations may be reduced to a special case when the spontaneous carrier decay rate is equal to the photon decay rate. The unique solution is obtained for this case. We also show that a laser operating in direct modulation exhibits an inertia in switching between the optical and electrical fields which introduces a corresponding loss in the modulating current. The output photon density and the input carrier density depend directly on this loss. For the systems with a minimal and maximal loss, the output photon density can be obtained analytically. © 2008 IEEE.

Index Keywords: Decay (organic); Electric conductivity; Heterojunctions; Lasers; Modulation; Photons; Semiconductor materials; Analytical solutions; Carrier decays; Carrier densities; Direct modulations; Electrical fields; Photon decays; Photon densities; Rate equations; System of differential equations; Semiconductor lasers

Year: 2008

Source title: Proceedings - 2008 International Conference on Advanced Technologies for Communications, ATC 2008, Held in Conjunction with REV Meeting

Art. No.: 4760600

Page : 371-375

Link: [Scopus Link](#)

Correspondence Address: Nhat, H. N.; Faculty of Physics, College of Science, Vietnam National University, 334 Nguyen Trai, Thanh Xuan, Hanoi, Viet Nam; email: namnhat@gmail.com

Conference name: 2008 International Conference on Advanced Technologies for Communications, ATC 2008

Conference date: 6 October 2008 through 9 October 2008

Conference location: Hanoi

Conference code: 75765

ISBN: 9.78E+12

DOI: 10.1109/ATC.2008.4760600

Language of Original Document: English

Abbreviated Source Title: Proceedings - 2008 International Conference on Advanced Technologies for Communications, ATC 2008, Held in Conjunction with REV Meeting

Document Type: Conference Paper

Source: Scopus

Authors with affiliations:

- Nhat, H.N., Faculty of Physics, College of Science, Vietnam National University, 334 Nguyen Trai, Thanh Xuan, Hanoi, Viet Nam
- Thuy, D.T.T., Faculty of Physics, College of Science, Vietnam National University, 334 Nguyen Trai, Thanh Xuan, Hanoi, Viet Nam
- Duc, N.A., Faculty of Physics, College of Science, Vietnam National University, 334 Nguyen Trai, Thanh Xuan, Hanoi, Viet Nam

References:

- Riyopoulos, S., Elimination of transient vertical-cavity surface-emitting laser oscillations using photoactive feedback (1999) Appl. Phys. Lett, 75, pp. 3057-3059. , Nov
- Mirasso, C.R., Hernandez-Garcia, E., Dellunde, J., Torrent, M.C., Sancho, J.M., Analytical calculations of switch-on time and timing jitter in diode lasers subjected to optical feedback and external light injection (1995) Opt. Comm, 115, pp. 523-527. , April
- Suematsu, Y., Hong, T.H., Suppression of Relaxation Oscillation in Light Output of Injection by Electrical Resonance Circuit (1977) IEEE J. Quantum Electron, QE-13, pp. 756-762. , Sept
- Dokhane, N., Lippi, G.L., Improved direct modulation technique for faster switching of diode laser (2002) IEE Proc.- Optoelectron, 149, pp. 7-16. , Feb
- Illing, L., Kennel, M.B., Shaping current waveforms for direct modulation of semiconductor laser (2004) IEEE J. Quantum Electron, 40, p. 445
- Colet, P., Mirasso, C.R., Miguel, M.S., Memory Diagram of Single-Mode Semiconductor Lasers (1993) IEEE J. Quantum Electron, QE-29, pp. 1624-1630. , June
- Petermann, K., (1988) Laser Diode Modulation and Noise, , Kluwer, Tokyo
- Hoang, N.N., Pham, B.V., Field Stability in Direct Modulation of Semiconductor Laser (2006) Proceedings of the REV, p. 375