

Estimate of the limitations in data transmission imposed on digitally modulated laser diodes by the bit pattern

Mazen Radhe Hassan · Mohammad Syuhaimi Ab-Rahman

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Abstract In this paper, the cut-off bit-pattern phenomenon of a digitally-modulated semiconductor laser diode (LD) is calculated. The cut-off bit-pattern ($Q_{off}^{cut-off}$) is defined as the number of “0” bits (i.e., OFF pulses) preceding the considered “1” bit (i.e., ON pulse) above which an LD cannot respond normally to an injected data pattern and will consequently shutdown or become inoperable. The latter case occurs when the turn-on time delay of an LD exceeds the bit-time interval of the injected current pulse. An analytical calculation for an LD’s cut-off bit-pattern is derived in terms of laser cavity parameters, bit rate, modulation and dc-bias currents. This calculation can be used to predetermine, based on typical values for an LD, accurate dc-bias and modulation current values that should be utilized to ensure an LD is operational for high-speed optical communications applications.

Keywords Cut-off bit-pattern · Digital modulation · Laser diode · Theoretical analysis

1 Introduction

Direct modulation of injection current in a semiconductor laser diode (LD) was the first technique used to encode logical bits into the optical output of an LD (Dokhane and Lippi 2002). When considering use of an LD in high-speed optical communications systems, it is important to keep the turn-on time delay (t_{on}) as low as possible (Dokhane and Lippi 2002; Ab-Rahman and Hassan 2012, 2011, 2010a,b,c,d,e; Hassan 2008; Zei et al. 2000, 1999;

M. R. Hassan (✉)

School of Engineering (Telecommunication Division), Asia Pacific University of Technology & Innovation (APU), Lot 6, Technology Park Malaysia (TPM), Bukit Jalil, 57000 Kuala Lumpur, Malaysia
e-mail: mazen@apu.edu.my; mrhassan75@yahoo.com

M. S. Ab-Rahman

Department of Electrical, Electronic and Systems Engineering, Faculty of Engineering & Built Environment, Computer & Network Security Research Group, University Kebangsaan Malaysia (UKM) (National University of Malaysia), 43600 Bangi, Selangor, Malaysia