

Characterization of a Quantum Dot Mode Locked Laser Functioning as a Photonic Microwave Source

Georgios Atmatzakis*¹, David Murell², Christos G. Christodoulou¹,
and Luke F. Lester²

¹ Dept. of Electrical & Computer Eng., The University of New Mexico,
Albuquerque, NM 87131-0001, USA

² Center for High Technology Materials, The University of New Mexico,
Albuquerque, NM 87131-0001, USA

Microwave signals can be photonically generated by a quantum dot, passively mode locked laser. The main advantages of using this microwave source configuration are the small size of the device (approximately 8000x300 microns at a frequency of 5GHz), the stable signal output with low phase noise, the reconfigurability (tunable output power and frequency by controlling the dc biasing) and high optical to electrical conversion efficiency. Although some work on the subject has been published in the past, a detailed description of the microwave properties of the QDMLL is missing. In order for the QDMLL to be used as a microwave source, its microwave functionality need to be studied. In this current work, a QDMLL is characterized in terms of its output microwave impedance, the maximum output microwave power, the resonant frequency, the linewidth of the signal, the phase noise as well as the optical to electrical power conversion efficiency.

In more detail, the laser device is producing optical pulses, the repetition rate of which is determined by the length of the laser cavity. When the laser is passively mode locked, part of its active region is reverse biased, acting as a reverse biased diode. This part is called the absorber section and it is responsible for the microwave generation. In this paper, first, the construction details of a microwave SMA interface to the laser device are presented. For this purpose, both a 50 Ohm microstrip line with an SMA connector attached to one end and a QDMLL are grounded on the same ground plane. Next, the upper absorber section pad of the laser is wirebonded to the microstrip line. Also, in order for the maximum microwave power extraction to be achieved, a new method for measuring the microwave output impedance of the QDMLL by using the load-pull technique is presented. Furthermore, in this paper, the different output power levels, resonant frequencies and linewidths for different absorber section biasing conditions, maintaining a constant temperature of 25°C and a constant biasing current of the gain section of the laser, are presented. From the measurements and for a reverse absorber biasing voltage range of 2.5 to 3.5 Volts, a gradual frequency drift from 4.984 to 4.992 GHz is observed, indicating a tunable operating frequency. A maximum power of -10.83 dBm is extracted and a linewidth as low as 0.06 MHz at the frequency of 4.986 GHz is observed. In addition, by measuring the dc supplied power to the QDMLL device, the optical to electrical efficiency of the device is calculated and is demonstrated in this work. Finally, the phase noise (jitter) of the device is calculated from the measurements and presented.