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Voltage-Based Wavelength Tuning of a DFB Laser Using an Enhanced LM331 Frequency-to-Voltage Converter for OPLL Applications

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This research demonstrates voltage-based control of a Distributed Feedback (DFB) laser, forming a foundational step toward the implementation of an Optical Phase-Locked Loop (OPLL). The voltage control mechanism is realized through a Frequency-to-Voltage Converter (FVC) using the LM331, which converts an offset frequency - generated by frequency mixing of a signal generator and a stable crystal oscillator - into a corresponding DC voltage signal. This voltage is then fed directly into the DFB laser, effectively tuning its emission wavelength. The tuning behavior is monitored using an Optical Spectrum Analyzer (OSA), providing real-time feedback on the laser's spectral response. A key challenge addressed in this work is the inherent 100 kHz upper limit of the LM331-based FVC. By carefully modifying the circuit design, the conversion range is extended to accommodate frequencies up to 3 MHz.The experimental results show a clear voltage response starting from 40 kHz, reaching approximately 4.6 V at 3 MHz, and remaining at 0 V at 0 kHz—demonstrating a consistent and usable voltage-frequency relationship. This extended range enables more flexible and precise laser control, which is essential for the operation of OPLLs. Such systems require accurate phase locking between optical sources, a capability critical in high-speed optical communication, coherent detection schemes, and technologies like Radio over Fiber for 5G and beyond. By successfully enhancing the FVC's range and demonstrating practical wavelength tuning of the DFB laser, this work contributes a crucial building block toward scalable and stable OPLL systems.

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