Abstracts

Optical Transmission of Narrowband Millimeter-Wave Signals

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We describe experimentally and theoretically three techniques used to transmit narrowband millimeter-wave (mm-wave) analog signals over optical fiber: 1) narrowband mm-wave optical transmitters based on resonant modulation of monolithic semiconductor lasers, 2) feedforward optical modulation, and 3) a passively mode-locked laser operating in an optoelectronic phase-locked loop. The resonant modulation response at the cavity round-trip frequency is fully characterized for multiple-contact lasers under various bias conditions. Issues such as modulation efficiency, passband bandwidth, noise, and intermodulation distortion are addressed. A system implementation of resonant modulation is presented in which two simultaneous 2.5-Mb/s BPSK channels centered at a subcarrier frequency of 41 GHz is transmitted over 400 m of single-mode fiber. Simple microstrip matching circuits are fabricated at 41 GHz to couple the mm-wave signals into the laser. Resonant modulation of single-contact lasers is also reported. Next, implementation of a tunable mm-wave (30-300 GHz) optical transmitter based on feedforward optical modulation is presented, and the fundamental performance of this technique investigated in terms of noise and dynamic range. Feedforward modulation is used to transmit 300-Mb/s data at 39 GHz over 2.2 km of single-mode fiber. Finally, a passively mode-locked monolithic semiconductor laser operating in an optoelectronic phase-locked loop is implemented as a narrowband mm-wave optical transmitter at 46 GHz. The phase-locked loop bandwidth, mm-wave tracking capability, and fundamental limit to the stability of the mm-wave subcarrier is established. The relative merits of the three techniques are discussed and compared. The mm-wave subcarrier transmission results presented here represent the highest reported to date.

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