RADIOFREQUENCY GENERATION

Radiofrequency (RF) sources are widely used in our modern world. All the radar systems, GPS and a broad range of other technologies are based on generating and comparing RF signals. The need to have more precise measurement systems and faster communication solutions puts stringent requirements on phase noise and timing-jitter.

We show here how a photonic solution, using the MENHIR-1550 laser as a low phase-noise oscillator, meets the current and future needs for RF generation. This solution is straightforward to integrate with current RF technology and can be used in harsh environments as well as in laboratory conditions.

Menhir Photonics' product strengths

Photonic solution with lowest phase noise

Wide frequency range synthesis capability

Ultra-high reliability and shock-resistant

Application use case

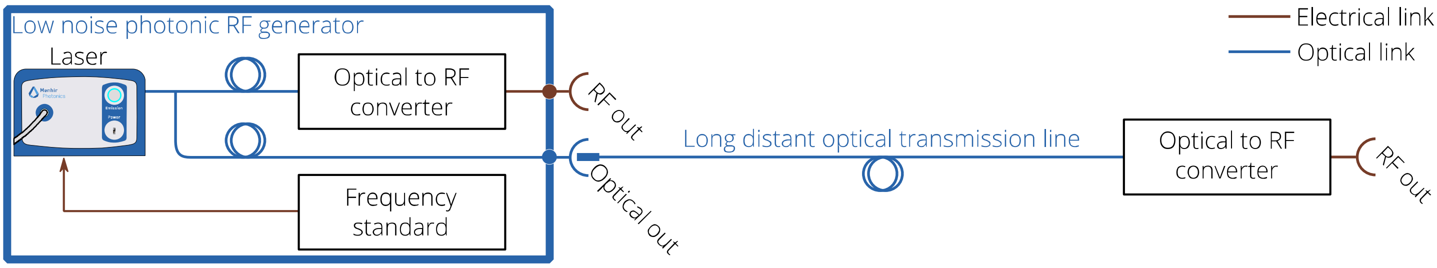

Figure 1 — Schematic of the photonic low-noise RF generator (blue box) using the MENHIR-1550 laser as photonic source. The output RF frequencies are defined by two factors: the oscillator (laser) fundamental frequency and the optical to RF converter bandwidth. The optical output can serve to disseminate the RF signal to a distant location from the local oscillator. The transmission of a RF signal via optical fiber provides significantly higher performance than traditional bulky and stiff RF waveguides.

Low-noise photonic system

The RF generator depicted in Figure 1 can be used as a standard element in a conventional RF synthesizer. Signal generation relies on the production of a signal with respect to a reference. The quality of this reference (RF out in Fig. 1) will directly impact the quality of the generated signal.

Figure 2 depicts the phase noise of the MENHIR-1550 laser. By using a high-quality optical to RF converter (i.e. photodiode), the excellent phase-noise performance of the MENHIR-1550 laser is transferred to the RF output signal. The photonic solution is the best choice for low phase-noise and ultra-low timing-jitter source, outperforming any quartz-based RF generator.

One key advantage of a photonic solution is the ability of using optical fiber for the signal distribution instead of inefficient and expensive RF waveguides. The optical output can be sent over 100's of meters, even in harsh environments, allowing the RF signal to be generated where it is needed most.

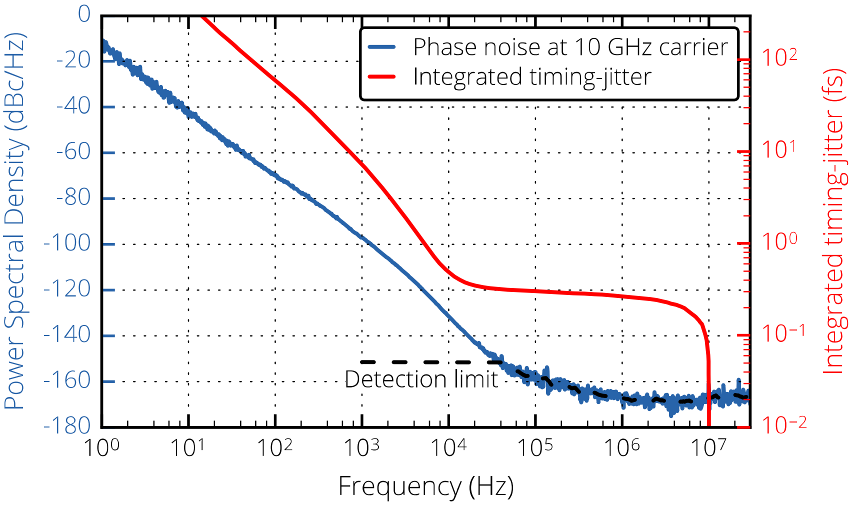

Figure 2 — Phase noise (left/blue) and timing-jitter (right/red) of the MENHIR-1550 laser, measured on the 10th harmonic signal (10 GHz). The black dashed-line represents the detection limit of the characterization setup and does not represent the intrinsic limit of the laser.

Bandwidth of the photonic system

The optical to RF converter produces multiple harmonics of the laser fundamental frequency. Figure 3 shows the typical content of its spectral components. The bandwidth is limited by the optical to RF converter (photodiode). Commercial optical to RF converters are available with a bandwidth up to 100 GHz. This allows the generation of a 10 GHz reference signal with phase noise and timing-jitter as low as < -130 dBc/Hz and < 1 fs, respectively, at 10 kHz offset frequency (Fig. 2).

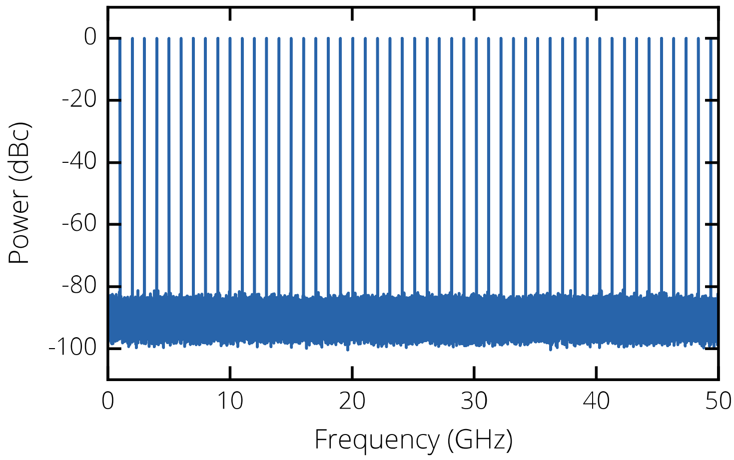

Figure 3 — Typical RF output from a photonic solution.

References

1. M. Bahmanian, J. C. Scheytt, *A 2-20-GHz Ultralow Phase Noise Signal Source Using a Microwave Oscillator Locked to a Mode-Locked Laser*, Microwave, IEEE Trans. Microw. Theory Techn., (2020)
2. M. Kalubovilage, M. Endo, T. R. Schibli, *Ultra-low phase noise microwave generation with a free-running monolithic femtosecond laser*, Opt. Express 28, 25400 (2020)

Related product: MENHIR-1550 at 1.0 GHz

Fundamental frequency	1.0 GHz
Average power	> 50 mW without amplifier
Integrated timing-jitter	< 1 fs [10 kHz – 10 MHz]
Phase noise at 10 kHz / 1 MHz	< -130 dBc/Hz / < -160 dBc/Hz (10 GHz carrier)