A link noise clean-up system based on fiber optical time transfer

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In recent years, the fiber optic time transfer technology has experienced significant advancements in long-distance and high-precision applications, thereby playing a crucial role in both fundamental scientific research and socio-economic development[1][2]. However, the 1PPS signal is susceptible to environmental temperature fluctuations, electromagnetic interference, random vibration, and other external factors when transmitted over long distances through optical fibers[3]. Consequently, this leads to a more pronounced deterioration of both the phase noise and stability index of the 1PPS signal[4]. Here, we propose a multi-channel seamless switching purification scheme based on fiber optic time transfer. This scheme enables the relay node to transition seamlessly to the optimal input channel without experiencing phase bouncing when multiple input time signals are present. Based on the collected phase difference data from each relay node, the loop filtering bandwidth of the phase-locked loop is adaptively adjusted to effectively control the highly stable crystals at the relay sites. The tamed high-stability crystal produces a 10MHz signal, serving as a clock reference and generating a low-noise, high-stability 1PPS signal that is distributed to users at each relay node. The experimental results demonstrate that the stability of the 1PPS time signal is 2.4 ps/s, while for the 10 MHz signal it remains at a level of 3.4E-13/s. Additionally, the 1PPS signal and the 10MHz signal experience jumps of within 1.3ps and 0.67ps, respectively, during the automatic switching of fiber optic routing. These results validate the system's performance and reliability.

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