Dissemination of time and RF frequency via an optical link in KRISS

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We implemented a fiber-optic dissemination system of time and frequency between two buildings connected by about 1 km underground optical fiber inside KRISS (Korean Research Institute of Standards and Science). This optical link will be used to confirm stable operations of H-masers which will be relocated to a new building one by one. As a backup of satellite-based systems, time transfer was made simply by using an existing commercial unit (Universal Time and Frequency System, Symmetricom) which can transmit and receive fiber-optic timing signals. Although this unit does not provide a real-time actuator to compensate fluctuations of the optical fiber, we could accurately estimate time delay every second at the remote site by returning a part of the timing signal to the local site. Figure 1(a) shows good stability (black solid squares) of this estimation despite drift of time delay at the remote site (open circles). For the frequency link, a stable radio frequency was transferred by an intensity modulation[1] at 1 GHz locked to 5 MHz from H-maser. At the remote site this was down-converted to 5 MHz using dividers in order to compare frequencies with other atomic clocks in a dual mixer time difference system. The signal at the remote site was actively locked to a 1 GHz reference at the local site through phase comparison using an intermediate frequency[2] (100 MHz). This was first applied to 23 km fiber spool. As is seen in Fig. 1(b), the stability of the remote signal was 10^{-14} at 1s integration time and 8×10^{-17} at 10000 s for 1 GHz, and 3×10^{-13} at 1 s and 4×10^{-16} at 10000 s for 5 MHz. The degradation of stability was found to be mainly due to up-conversion system at the local site. For the underground fiber, the stability of transferred 5MHz was well below typical specification of our H-masers.

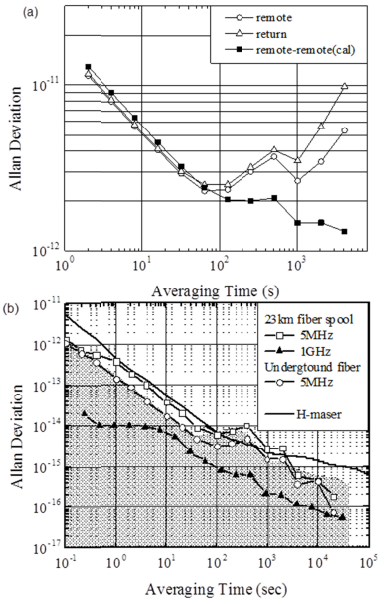

Figure 1 (a) Stability of transferred time. The estimated remote time delay agrees well with the measured value (soild squares). (b) Stability of transferred frequency. Shaded area is noise limit set by up-conversion system.

[1] Seth M. Foreman, Kevin W. Holman, Darren D. Hudson, David J. Jones, and Jun Ye, "Remote transfer of ultrastable frequency references via fiber", Rev. Sci. Inst., vol. 78, p. 021101, 2007

[2] F. Narbonneau, M. Lours, S. Bize, A. Clairon, G. Santarelli, O. Lopez, Ch. Daussy, A. Amy-Klein, and Ch. Chardonnet, "High resolution frequency standard dissemination via optical fiber metropolitan network", Rev. Sci. Inst., vol. 77, p. 064701, 2006