Verification of TIC Characteristics for Precise Optical Fiber Time Transfer Links

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Accuracy and precision of optical fiber time transfer links depends on several key factors, i.e.: stability and symmetry of the optical fiber delays and optical equipment, accuracy of the method of calibration of the link, accuracy and stability of time interval measurements at the one or both ends of the link as well as, for typical two way time transfer, synchronization of time interval measurement at the both ends of the link. For time transfer links with stabilization of propagation delay[1,2], such as between GUM and AOS at distance of 420 km, the crucial is actual accuracy and precision of TIC (Time Interval Counter) used for calibration of the link and used for time interval measurements at the far end of the link. The current standard uncertainty of calibration of the link GUM-AOS of 112.3 ps is dominated by SR620, due to non-linearity effects in time interval measurements.

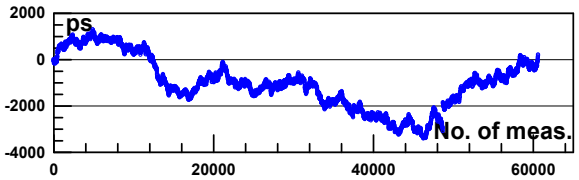

Fig. 1a: Exemplary data of the observed changes of the measured time intervals between 1 pps signals taken from two 5071A clocks.

In the above context, it is desirable to verify characteristics of TICs and select the most appropriate TICs for the needs of optical fiber time transfer link. Verification measurements can be performed for pairs of 1 pps signals taken: (1) from two atomic clocks with known slowly varying phase difference (Fig. 1a) (measured with standard frequency comparator) or (2) from the same atomic clock (with constant phase difference). It allows to detect the non-linearity effects appearing in TICs during time interval measurements (Fig. 1b). The obtained results are with picoseconds resolution, in the range of measured time intervals of a few hundred nanoseconds. A such investigations are also interesting for other precise time interval measurements, especially at comparison of different methods of precise time transfer. The results of our tests of TIC characteristics are planned to be presented and discussed in a poster form.

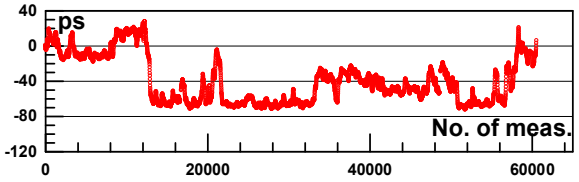

Fig. 1b: The observed changes of a difference between results of time interval measurements (with the usage of TIC under test) and phase-time variations obtained from frequency measurements. (the same set of data as for the Fig. 1a)

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[1] P. Krehlik, Ł. Śliwczyński, Ł. Buczek and M. Lipiński, "Fiber optic joint time and frequency transfer with active stabilization of the propagation delay", IEEE Trans. Instrum. Meas. vol. pp.61 2844–51, 2012.

[2] Ł Śliwczyński, P. Krehlik, A. Czubla, Ł. Buczek and M. Lipiński, "Dissemination of time and RF frequency via a stabilized fibre optic link over a distance of 420 km", Metrologia vol. 50, 2013.