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Phase drift compensating RF link for femtosecond synchronization of E-XFEL

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Modern high-energy particle accelerators and free-electron lasers incorporate large quantities of sensitive RF and microwave frequency devices distributed over kilometer distances. Such devices require extreme stable phase and time synchronization by means of high frequency signal distributed along the accelerator facility.

Coaxial cables are commonly used to distribute the reference signal over the large machine to synchronize electronic systems and they are the main source of undesirable phase drifts in the synchronization system. Signal phase drifts in cables are mainly caused by temperature and humidity variations and their values usually exceed required phase synchronization accuracy by more than order of magnitude.

There are several approaches to reduce signal phase drifts in coaxial cables. This paper describes the realization of active phase stabilization system based on interference phenomenon. A phase-locked signal from the transmitter is reflected at the end of a coaxial cable link. Directional couplers placed along the cable pick up the forward and reflected signals and interfere them to cancel out the cable phase drifts. Distributed hardware including interferometer controller/transmitter and receiver modules were built demonstrate system concept and performance. Link input and output devices used FPGA I/O boards with Ethernet interface to control system operation. Specialized firmware and software was developed to calibrate and control the system.

This paper describes the concept of interferometer link, designed hardware, basic control algorithms and performance evaluation results. The link prototype was built to distribute 1.3 GHz signal through a coaxial cable. Measured phase drift suppression factor value exceeded level of 100.

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Yes

Description

Synch at fs level

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