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# Automatic Synchronizer of Digital Signals and Telecommunication Streams

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**Abstract**—The paper proposes a principle of constructing an automatic digital synchronizer of digital or bit data stream from the primary reference oscillator of frequency generating equipment of telecommunication network without the transfer of synchronizing signals from the network reference oscillator. This principle can be used in optical transport networks (OTN), cable channels and in 5G radio relay networks (10–100 Gbit/s). Automatic digital synchronizer enables us to receive asynchronous signals in synchronous mode (RS 232C, CAN) maintaining the synchronous operation of computer or telecommunication network with complete elimination of wander and significant reduction of jitter.

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Synchronization is a means of maintaining a high quality operation of digital equipment in communication networks, different microprocessor interfaces, data processing and data storing centers operating at a fixed speed. Enhanced requirements are always imposed on synchronizing devices from the viewpoint of stable operation for ensuring the phase synchronism of signal received and the timing signal.

Synchronization of digital networks in the generalized form is a synchronization problem of digital sequences that can be synchronized in terms of the following factors:

1) duration of time interval $T$ (repetition period) or frequency $f = 1/T$ representing the frequency synchronization;

2) initial phase φ of synchronized signal representing the phase synchronization;

3) time of arrival $t$ into the device or system of signal (packet) representing the time synchronization.

The state-of-the-art telecommunication systems (TS) and local area networks (LAN) make use of all three kinds of above types of synchronization. The problem of time synchronization is of global nature, and it can be solved by different techniques using the Universal Time Coordinated service (UTC), navigation systems GPS/GLONASS, etc. The phase synchronization is important for a specific device (computer interface, regenerator, multiplexer, etc.), and it can be implemented by using the phase locked loops (PLL) systems that makes it possible to eliminate jitter [1–3].

The frequency synchronization is the most challenging kind of synchronization, because it is important for all elements of TS and LAN and can be solved by using the reference oscillators of different levels, constructing the special telecommunication synchronization networks (TSN) and using special signals that can be transmitted via TSN or LAN separately or can be separated from the transmitted signal [4, 5].

The main kind of synchronization in digital systems with pulse-coded modulation (PCM) is the clock frequency synchronization (CLK). This kind of synchronization is used in data transmission systems (DTS) with Plesiochronous Digital Hierarchy (PDH) and Synchronous Digital Hierarchy (SDH), and also in modern optical transport networks (OTN) operating at speeds 2.5–100 Gbit/s and more [4, 6]. The skip of clock synchronization that determines the frame and multiframe alignment results in the loss of the remaining kinds of synchronization. General issues of synchronization are described in recommendations of the International Telecommunications Union, standards ITU-T G.703 and G.810.

Reference sources (oscillators) of different levels generate the following signals:

– reference synchro signal with frequency 2048 kHz representing the frequency synchro signal in accordance with standard ITU-T G.703/13 that is used for the synchronization of automatic telephone exchanges (ATX), automatic switching units (ASU), PDH, SDH, and OTN systems;

## CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

## ADDITIONAL INFORMATION

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