ISSN 0735-2727, Radioelectronics and Communications Systems, 2008, Vol. 51, No. 8, pp. 417–420. © Allerton Press, Inc., 2008.
Original Russian Text © S.V. Sokolov V.V. Kamenskij, 2008, published in Izv. Vyssh. Uchebn. Zaved., Radioelektron., 2008, Vol. 51, No. 8, pp. 17–24.

An Optical Analog-to-Digital Converter for Bitwise Coding

S. V. Sokolov and V. V. Kamenskij

Rostov State University of Railway Engineering, Rostov, Russia

Received in final form 7 February, 2008

Abstract—It is proposed an optical ADC for bitwise coding, which is applied for both electric and optic signals conversion to binary code. ADC operation speed is comparative with purely optic information processing devices.

DOI: 10.3103/S0735272708080025

Among different actual problems of theory and practice of digital signal processing it should be mentioned a problem of analog to digital converters providing with high operating speed. Developed by now constructions of analog-to-digital converters (ADC) [1–3] are characterized, as a rule, by low operation speed and high complexity. In this connection, mentioned problem solution lies in alternative technology, i.e. optical technology, application.

In fact, optical methods of signal procession application provides essential power reduction and elimination of electromagnetic interferences influence on conversion results. Moreover, integrated optical devices application allows to reduce overall dimensions of ADC. And above all, high operating speed of optical converters allows to realize more complicated and accurate algorithms of analog-to-digital conversion [2–7].

Among widely known at present time ADCs, which are based on optical method of signal processing, we should underline electric-optical ADC based on wave guide modulators of Mach-Zender type [2, 3]. Common drawback of these ADCs is small operating speed due to electronic components application in final stages.

In the paper [8] it is considered purely optical ADC, which realizes a method of serial counting. Drawback of this ADC is its relatively small (with regard to potentially possible) operating speed, which is specified by chosen conversional method. Comparative analysis of existing analog-to-digital conversion methods shows that ADC operating speed can be essentially increased due to method of bitwise (weighting) coding application. At that, bitwise coding conversion time in ADC is independent on input voltage value, and it is directly proportional to bits count of input ADC code.

Proposed optical ADC uses method of bitwise coding and converts both optical and electric analog signals F into binary code $D_0, D_1, \ldots, D_N$, where N is digits count in analog to digital conversion.

Optical ADC (Fig. 1) consists of following functional units: optical pulses shaper (OPS), optical pulses commutator (OPC), optical controlled integrator (OCI), optical unitor (OpU), optical comparator (OC), and optical code converter (OCC).

Optical pulses shaper (OPS) provides optical pulses shaping, a number of pulses N is equal to ADC digits. At that, intensity of the first output pulse of OPS is equal to intensity of 2^{N-1} relative units of pulse "S", which is applied to the input, intensity of the next pulse is twice less than previous pulse one.

Optical pulse commutator (OPC) passes pulses from information input in case of presence of signal with intensity of 1 relative units at the controlling input, in the other case it shapes signal with zero intensity (0 relative units).

Optical controlled integrator (OCI) realizes addition of current input pulse intensity to intensities of all previous pulses. Possibility of initial (zero) state setting by pulse signal application to the input "R" is provided in OCI.

Optical comparator provides comparison of analog signals F with output signals of optical unitor (OpU), if the last signals are less or equal to F, then signal with intensity of 1 relative unit is shaped at the OC output, if they are greater, then the signal with zero intensity is shaped.

Optical code converter (OCC) realizes conversion of N optical sequential pulses into parallel optical N-digit code. Active optical Y-splitters are further applied with purpose of functional realization