RECORDING AND DATA TRANSMISSION SYSTEM OF AN IR LIDAR BUILT AROUND IBM–PC/AT/386/486 AND INTENDED FOR VERTICAL SOUNDING OF TROPOSPHERIC OZONE

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A modification of design of a lidar recording system built around an IBM personal computer has been proposed.

High power and excellent graphics[1] of the IBM personal computers attract much attention of experimenters from the viewpoint of their application to investigation of the atmosphere. However, the IBM PC is a complicated and expensive computer requiring tender operating conditions; therefore, not every researcher makes a decision to place it near the experimental setup operating outdoors especially under our Siberian weather conditions. The modern lidars applied to investigation of the atmosphere comprise, as a rule, a powerful pulsed laser being a source of high–power electromagnetic noise. The noise power can be so high that this renders the PC operation in the neighborhood of a lidar location impossible. Taking the preceding into account, I have developed several instrumentation–program complexes for different lidars. Below a system of an IR bifrequency sequential lidar intended for vertical sounding of tropospheric ozone is described.

The system consists of two separate systems. The first is placed in the neighborhood of the experimental setup while the second is built in the personal computer. Their block diagrams are shown in Figs. 1 and 2, respectively. The external system of the lidar is connected with the second system built in the PC with the help of a radio–frequency cable with galvanic decoupling from the latter. Data are transmitted in digital form through a high performance modem which is the part of both systems. The specifications of the system of bifrequency lidar are given in Table I.

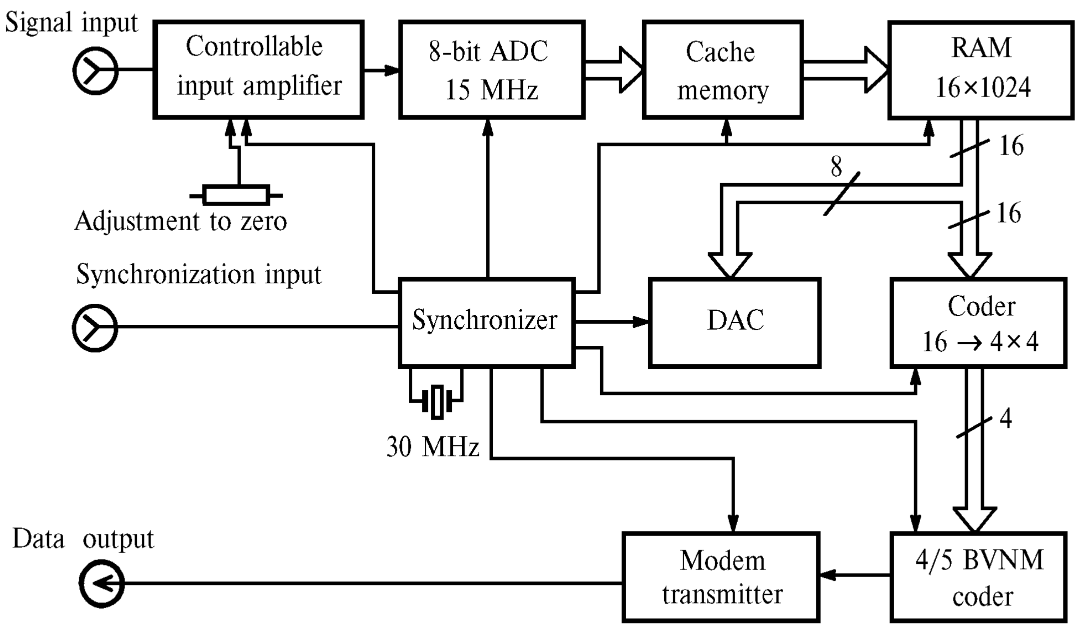

FIG. 1. Block diagram of the first system of data recording and transmission of the bifrequency lidar intended for vertical sounding of tropospheric ozone. The system is placed in the neighborhood of the experimental setup.

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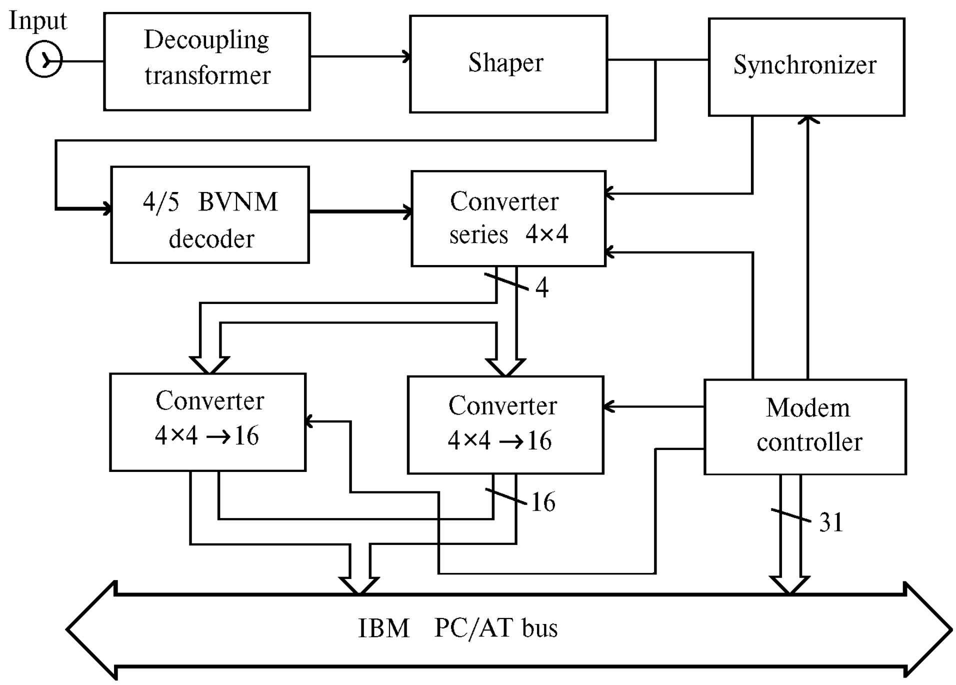

FIG. 2. Block diagram of the second system of data recording and transmission of the bifrequency lidar intended for vertical sounding of tropospheric ozone. The system is built in the IBM PC/AT.

TABLE I. Specifications of lidar systems.

Maximum amplitude of input signal	1 V
Frequency range of input signal	0–7.5 MHz
Dynamic range of input signal	56 dB
Input impedance	50 Ω
Sampling rate	15 MHz
Repetition frequency of pairwise sounding pulses	≤92 Hz
Stabilization of working frequency of synchronizer	Crystal control
The number of bits of the ADC	8 bit
Volume of recorded information	2×1024 counts
The number of bits of the ADC	8 bit
Synchronization mode	Pairwise electric pulse
Amplitude of timing pulse	≥5 V
Input impedance of lock input	50 Ω
Modem coding scheme	4/5 BVNM group
Output impedance of modem	50Ω
Communication cable length	≤500 m
Voltage of galvanic decoupling	300 V

Let us briefly describe the operation of the first remote system. An analog return signal from lidar photodetector is applied at the input of a controllable amplifier. This amplifier can change its gain stepwise according to a timing signal. This allows one to record a signal with satisfactory accuracy from both the near and far zones during one sounding pulse of the lidar. After amplification, the signal is applied at the input of an 1107PV2 concurrent analog–to–digital converter (ADC). This is a very sensitive device requiring special conditions for its operation, i.e., filtration of supply voltage and selection of relative pulse duration and fronts of timing signal. But one has to use it for lack of better devices in the domestic base components of the ADC. Further the information flow in the form of a 8–bit concurrent code enters the input of a cache memory, which used for lack of high–performance memory chips. There are a 8–bit input and 16–bit output in the cache memory for halved rate of arrival of output information. A 16–bit code from the cache memory is stored in the random–access memory (RAM), which is filled only after arrival of two triggering timing pulses. After the RAM has been filled with data, the synchronizer issues an instruction to the modem TRANSMIT INFORMATION. On this instruction modem forms an information batch header, converts the RAM to the read mode, and on conversion of a 16–bit word of the RAM to the 4/5 BVNM self–synchronizing tri–frequency code,[1] transmits it to the communication line. On completion of transmission, the modem issues a message to synchronizer, which prepares the RAM and input circuits for the reception of the next portion of the analog data. In this way the cycle is closed. There is a digital–to–analog converter (DAC) in the external system designed for control and checkout. Its output connector is at the front panel. The DAC allows us to display the information stored in the RAM on the oscillograph screen in the modes of operation and adjustment. In this case in the adjustment mode the rate of data refresh from the random–access memory is independent of the repetition frequency of sounding pulses of the transmitter and is maximum. In this mode the modem also transmits the data in cycles from the random–access memory to the communication line. Thus, one can qualitatively estimate the return signal on the oscillograph screen and investigate it in detail on the PC having carried out a single sounding of the atmosphere in the adjustment mode.

Let us consider the operation of the second system of the lidar built in the PC. A digital data package from the communication line through a decoupling transformer enters a modem receiver. Here, in a shaper, the synchronization and information are discriminated. The former enters the synchronizer, the latter enters a decoder. After decoding the data are converted into the concurrent–sequential code 4×4 and then into the concurrent 16–bit code by means of two shapers. These converters alternately operate in the read mode on instructions from the synchronizer. They are controlled by a modem controller with two 16–bit data registers and 8–bit register of commands and states. The controller occupies the addresses from 300 H to 304 H in the address space of the PC input–output in accordance with the IBM recommendations. The high–performance modem of lidar system imposes some restrictions on the employed PC. The IBM–compartible PC/AT and that of a higher class whose clock rate is no less than 12 MHz can be employed in lidar technology. In this case the computer resources are completely used to receive the modem information.

The majority of programmers and users of the IBM–compartible computers writes their programs in the Microsoft and Borland programming languages. I decided to write two program–functions serving the modem (in this case the lidar) because they have different protocols of parameter exchange. Both program–functions were written in assembler and translated using compilators from the MASM and TASM versions of assembler (of each firm, respectively).

The function Modem 5(M, N, K, L) serves the modem in the Microsoft programming environments, where M is a fragment of working integral array, N is a displacement of working integral array, K is the number of 16–bit words in a package, and L is the number of packages.

The function Modem 5b(M, K, L) serves the modem in the Borland programming environments, where M is a working integral array, K is the number of 16–bit words in a package, and L is the number of packages.

The proposed software considerably simplifies writing of application programs of ozone sounding by experimenter, since it does not require special knowledge in the field of electronics of communication facilities, datamation, and system programming.

Experimental operation of these systems as part of LOZA lidars and setup intended for investigation of the atmospheric turbulence has shown convenience and high reliability of this experimental system design as well as its extremal adaptability and mobility.

The development of an intellectual controller of lidar systems is being completed at present. It will allow one to exchange instructions and messages at distances up to 500 m between the PC and lidar in an interactive mode using a standard IBM/PC communication port. But it will be reported in the next papers.

REFERENCES

1. V.A. Ryzhkov, *External Memory on Magnetic Disk* (Energia, Moscow, 1978), 247 pp.