УДК 621.396:550.3

WAYS TO MODERNIZE AN AUTOMATIC ANGLEMETER

Antipov I. E., Ovcharenko K. S., Khriebtov M. V.
e-mail: kostiantyn.ovcharenko@nure.ua
Scientific supervisor – Dr. Sci., Prof. Antipov I. E.
Kharkiv National University of Radio Electronics, Dep CRETISS

This thesis discusses the possibility of upgrading the Automatic Anglemeter, which is part of the Balakliya Geophysical Complex and is recognized as a National Scientific Heritage of Ukraine. The purpose and accuracy characteristics of the system are described, as well as the problems caused by the aging of feeders and other equipment. The modernization should include not only replacing old devices and feeder lines with new ones but also implementing new signal processing principles enabled by modern technology.

The VETA meteor radar system is designed to study the dynamic parameters of the Earth's atmosphere. It includes an Automatic Anglemeter (AA), which is intended to analyze the dynamic parameters of the Earth's atmosphere at altitudes within the meteor zone (80–105 km) and has the capability to identify the altitude structure of wind movements.

The AA consists of an antenna system, phase-stable radio receiving devices, a radio transmitting device with a transmitting antenna, digital pulse phase meters, a control computing complex, and other units [1].

The receiving antenna system is a multi-scale measuring system consisting of five Udo-Yagi antennas arranged in a cross formation (Fig. 1). The RMS error in measuring angular coordinates does not exceed 17’, which enables the study of small-scale atmospheric dynamic processes in the meteor zone.

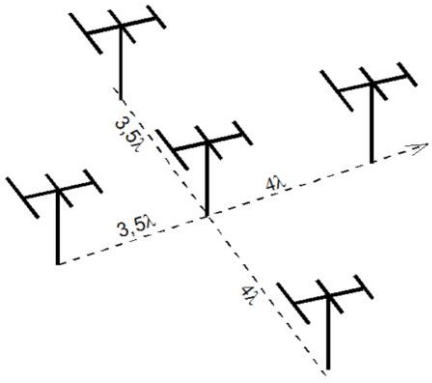

Fig. 1

However, the AA was built in the 1970s using the element base and computing equipment of that time. The subsequent modernization in the mid-1990s affected only the control computing complex, while the hardware remained unchanged. One of the main problems of the AA is the aging of the radio frequency cables connecting the antennas. As a result, signal attenuation increases, and the SNR at the amplifier inputs deteriorates. Strict requirements for the similarity and stability of the introduced phase shifts are imposed on the feeders connecting the antennas to the radio receivers, necessitating the use of phase-stable cables. The electrical length of each antenna cable is selected as a multiple of π to ensure phase shift constancy. However, damage to the cable insulation leads

to moisture penetration, altering the permittivity and delay time in the cable. Consequently, phase measurements may be performed with errors.

This report examines modernization options that involve not only replacing the feeders but also using modern components and signal processing methods. These improvements will not only maintain but potentially enhance the characteristics of the AA.

Various upgrade options were considered, including placing different components directly on the antennas:

- amplifiers only;
- amplifiers and frequency converters (FC);
- amplifiers, FC, and ADC.

An analysis of the advantages and disadvantages of each option led to the selection of the last one. If the amplifier, FC, and ADC are placed directly on the antenna, the signal is transmitted in digital form via the connecting cable.

This configuration is not sensitive to delay variations along the path from the ADC to the phase measurement device. However, it requires precise phase matching of the heterodyne signals that are fed to the frequency converters and the ADC pulse generators (Fig. 2).

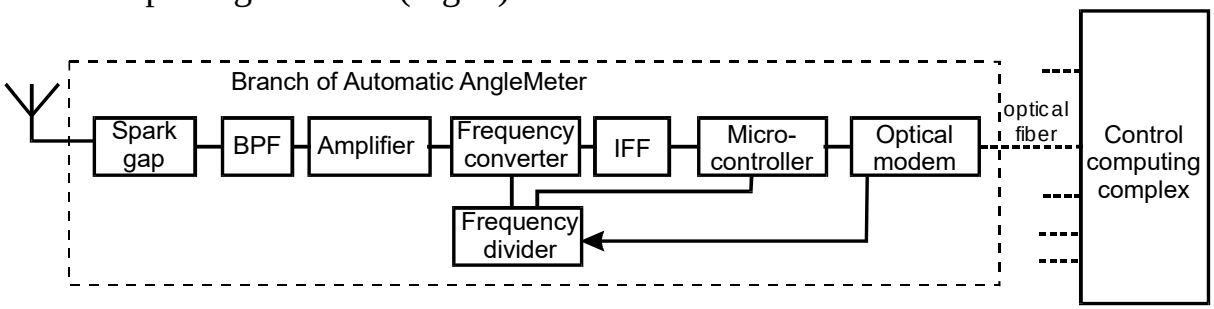

Fig.2

The coupling variants for such a system were also analyzed. The most rational approach is considered to be the formation of clock pulses by a single generator, followed by their transmission to each receiver. Among the considered transmission methods–Wi-Fi, radio frequency feeder, and optical fiber–the choice was made in favor of optical fiber. The bit depth and speed of the ADC, the required data transfer rate, and the volume of traffic during the measurement process were also estimated.

Reference

1. Б. Л. Кащеев, В. В. Жуков. Автоматический угломер. Сообщение I. Принцип построения // Радиотехника. 1978. Вып. 47. С. 3-9.