Experimental and calculated Studying for the effect of the orientation on photovoltaic effectiveness

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Solar radiation which comes onto an oriented surface is the sum of the direct radiation from the sun from the sky diffuse and reflected from the surface of the earth. Direct radiation R_{dir} is the main source of energy for photovoltaic installations (PVI). The value of the direct solar radiation can be calculated by the following formula:

$$R_{dir} = R_{CH} \cos i, \tag{1}$$

where i – angle between the surface normal and the direction of the solar panel on the sun, R_{CH} – measured solar radiation comes on a perpendicular surface.

$$\cos i = \cos \alpha \cdot \sin h + \sin \alpha \cdot \cos h \cdot \cos A, \tag{2}$$

where α – the angle between the surface and the horizon, h – the height of the Sun position, A – the difference between azimuth of the Sun and the surface normal projection onto the horizontal plane [1]. Due to the fact that the sun changes its position in the sky the value of $\cos i$ is constantly changing. As a result the value of the direct solar radiation reaching the PVI changes. Therefore, the maximum efficiency cannot be achieved with a rigid fixing PVI constructs. One possible solution to this problem is the automatic orientation of the PVI in the sun. Today, there are many different ways of automatic orientation PMT in the sun. Most of them react to deviations of solar panels on the direction of the Sun, using the visible range of solar radiation, current sensors with solar cells solar panels, temperature sensors. In other words, these systems are oriented to the sun in terms of its direct impact on the bodies of data tracking systems that may entail certain difficulties associated with atmospheric and climatic conditions [6].

At the department of nuclear power plants and renewable energy sources in the Ural Federal University (hereinafter Department NPRES) propose a method for automatic orientation of the PMT in the sun, namely, the orientation of the PMT on a predetermined path of movement of the sun across the sky. The following equipment is used to allow for the orientation of the PMT in the sun: the rotator azimuth-elevation Radant AZ1000V for satellite and parabolic antennas (Fig. 1) [2] and the antenna rotator controller AZV (Fig. 2). [3]

The controller controls the antenna rotator supports connection to a PC via the serial port. PC control is performed on the interface Yaesu GS-232 and its own team of developing MS-232 provides precision installation to 0.1°.

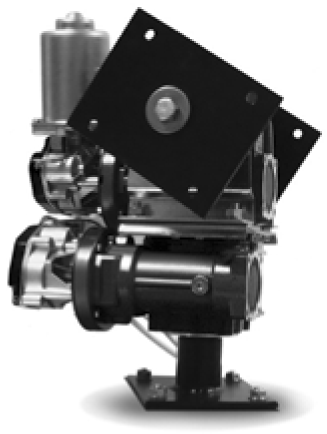

Fig. 1 Image of rotator azimuth-elevation Radant AZ1000V for satellite and dish antennas

Fig. 2 Image of management antenna rotator controller AZV

The protocol supports the following set of commands:

- Team Aaa.a (-) eeee <CR> sets the position on the azimuth angle and the angle of elevation aaa.a eee.e. The minus sign is placed in the case, if the value of the angle of elevation is negative.
- Y command requests the current value of the azimuth angles and elevation.
- The S command immediately stops the plant [4].

Also, at the department NPRES software enabling automatic orientation of the sun with a PC was developed. The program reads from a file of a particular sequence of dates, time intervals and azimuth angles and elevation, wherein the predetermined value of the azimuth and elevation for each point in time. The sequence is made automatically on the basis of statistical data on the movement of the sun across the sky. Next the program requests the current values of the azimuth and elevation angles from the installation and according to the read sequence sets are the azimuth and elevation angles, which correspond to the maximum efficiency of the PMT.

The use of such automated systems orientation to the sun can increase the coefficient of performance in the PMT tracking the sun by 25%. Further steps on the way to improve the system and the software will: support for multiple PVI and synchronize their rotation with each other, automation generation rotary sequence based on the statistical data on the movement of the sun and the geographical position of installation, creating a common base for monitoring such systems for the collection of statistical data and their subsequent analysis.

References

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