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A MATHEMATICAL MODEL OF REMOTE CONTROL OF SIGNALS RADIATED BY A GLIDE-PATH BEACON

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A new mathematical model of the glide-path radio beacon of remote control was suggested. The control consisted of the measurement of the angle of slope and the border of the vertical sector of the glide path.

As a rule, the control equipment of a glide-path beacon includes three types of control: built-in, aperture-type, and remote [1]. However, in the presence of external destabilizing factors, the control equipment of contemporary glide-path radio beacons does not guarantee uniqueness of measurement of guidance signals on the air. It occurs, for example, at variations of snow layers on the land surface used for calculation of the glide paths.

In the general case, a wave reflected from the land surface is a result of summation of several waves: the wave reflected by the “air — land surface” interface, and the waves passing the “air — land surface” interface and reflected by a lower surface of discontinuity one or several times [2].

For radiators with weak directivity in the vertical plane (traditionally used in the transmission antenna system of glide-path beacons), the following relations are valid:

$$\dot{E}_{\text{ref}.i} = \dot{E}_{\text{ref.id}.i} - \Delta \dot{E}_{\text{ref}.i}, \qquad \dot{E}_{\text{ref.id}.i} = \sum_{m=1}^{M} E_{m\,\text{for}.i} \cdot e^{-j\,\varphi_{m\,\text{ref.id}.i}},$$

$$\Delta \dot{E}_{m\,\text{ref}.i} = \sum_{m=1}^{M} E_{m\,\text{for}.i} \left\{ 1 + W_{m\,\text{rf}\,i} \cdot e^{-j\,\Delta\varphi_{m\,\text{rf}\,i}} + \sum_{n=1}^{N} W_{mni} \cdot e^{-j\left[\frac{2\pi}{\lambda}(r_{mni} - r_{m\,\text{rf}\,i}) + \Delta\varphi_{mni}\right]} \right\} e^{-j\,\varphi_{m\,\text{rf ref.id.}\,i}},$$

$$\varphi_{m\,\text{ref.id.}\,i} = \frac{2\pi}{\lambda} r_{m\,\text{rf}\,i} + \varphi_{m\,\text{rf}} + \pi, \tag{1}$$

where $\dot{E}_{\text{ref.}\,i}$ is the complex amplitude of the wave reflected by the land surface, for the *i*th observation point; $\dot{E}_{\text{ref.id.}\,i}$ is the complex amplitude of the wave reflected by an ideally reflecting “air — land surface” interface, for the *i*th observation point; $\Delta\dot{E}_{\text{ref.}\,i}$ is the complex amplitude of the reflected wave increment in the *i*th observation point, when the “air — land surface” interface is not ideally reflecting; $E_{m\ \text{for}.i}$ is the amplitude of the forward wave of the *m*th radiator for the *i*th observation point; $\varphi_{m\,\text{ref.id.}\,i}$ is the phase of the wave reflected by the ideally reflecting “air — land surface” interface, for the *m*th radiator and for the *i*th observation point; $m = 1, 2, \ldots M$ is the ordinal number of a radiator of the transmitting antenna system of the glide-path beacon; $W_{m\,\text{rf}\,i}$ and $\Delta\,\varphi_{m\,\text{rf}\,i}$ are the module and argument of Fresnel’s reflection factor [2] of the “air — land surface” interface, for the *m*th radiator and for the *i*th observation point; W_{mni} and $\Delta\varphi_{mni}$ are the module and argument of the reflection factor of the layered land surface for the waves of the *m*th radiator, when the waves are passing the “air — land surface” interface and are reflected by a lower surface of discontinuity one or several times, being picked up

REFERENCES

1. K. V. Makarov et al., Radio-Navigational Systems of Airports [in Russian], Transport, Moscow, 1978.
2. B. Kh. Krivitskii and V. N. Dulin (editors), Handbook of Theoretical Foundations of Radioelectronics [in Russian], Vol. 1, Energiya, Moscow, 1977.
3. S. G. Rabinovitch, Measurement Errors [in Russian], Energiya, Leningrad, 1978.

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