Spatial (aperture) noise generators

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***Abstract*— Spatial noise generators with apertures of 200 mm, 270 mm, 1500 mm were developed in OKB MEI. Spatial noise generators with apertures of 200, 270 mm are Djuar vessels filled up by boiling liquid nitrogen, with metal cylinder, fixed in liquid nitrogen's zone. One of cylinder's founding is cooled by boiling nitrogen. It is covered by radio-absorption material. Another founding, covered by heat protection radio-transparent material, is radiating aperture of spatial noise generator. Spatial noise generators with aperture of 1500 mm is a collimating system, which consists of the parabolic reflector (part of parabolic) and radiator, which consists of aperture noise generator and additional reflector (contra-reflector). Additional reflector also provides lighting of main mirror (parabolic reflector) and forming of plane parallel collimation beam. Methodology of noise temperature unevenness measurements in the section of the collimation beam is presented.**

I. Introduction

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Currently a lot of attention is paid to remote sensing of the Earth and atmosphere from outer space using radiometric complex. To achieve high measurement accuracy of brightness temperature simulators of brightness temperature are to be created. Such simulators are spatial noise generators. Also to obtain high stability of on-board radiometric complex one needs to carry out regular calibration of radiometer using spatial noise generator and "cold" space. Due to these reasons the most important element of design of the radiometric space based receiver is the on-board noise generator (BNG) which is a source of calibrating noise for radiometer calibration. BNG is a "black body" (in radio frequency band) heated up to the necessary temperature.

Design of noise generator is to provide the following:

- high degree of permanency for thermodynamic temperature of the "black body" and consequently permanency of the BNG brightness temperature;
- permanency of temperature distribution along aperture of the «black body».

As far as design is concerned the BNG consists of metal case with heating element inside and radiating plate made from absorbing material which is reliable contact with the case. The shape of plate provides for maximum achievable radiation coefficient. The BNG aperture is closed with a lid from radio transparent material. Design of the cooled spatial noise generator is a Djuar vessel filled with liquid nitrogen with radio transparent window. Radiator made from absorbing material is located inside the Djuar vessel. At this the brightness temperature will be close to nitrogen boiling temperature of $T_N \approx 78K$.

For Creation spatial noise generator with high lever of brightness temperature heated absorbing material is need.

Spatial noise generator with aperture of 1500 mm is a collimating system consisting of parabolic reflector (part of parabolic) and radiator, which consists of aperture noise generator and additional reflector (contra-reflector) providing such lighting of parabolic reflector which forms plane parallel collimation beam of electromagnetic waves. Outer appearance of the contra-reflector is presented at picture.

II. Dielectrics Layer Brightness Temperature

Let's look at the dielectric layer (plate) with losses which it thermally insulated from the outer environment as there is no heat transfer and the temperature inside the plate will remain constant.

In real conditions with one side heating temperatures inside dielectric and on its outer side are different as there is a temperature gradient according to dielectric thickness.

Let's look at heated dielectric layer as a flat model with thickness of l, described by parameter $\varepsilon^*=\varepsilon\text{-}j60\lambda\sigma(z)$ and $T_p(z)$.

Given that T_p and absorption coefficient $|\gamma|$ change in dielectric layer according to linear law, i.e.

$$T_p(z) = T_1 + \frac{z}{l}(T_2 - T_1), \quad |\gamma(z)| = |\gamma_1| + \frac{z}{l}(|\gamma_2| - |\gamma_1|),$$

where T_1 and T_2 are temperatures of outer and inner surface correspondingly;

$|\gamma_1|$ and $|\gamma_2|$ are absorption coefficients corresponding to temperatures of outer and inner surface, and z is a current coordinate.