Transfer Functions of the Focal Plane Arrays Linearization

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***Abstract* – In this paper the new method of transfer function linearization without limitation for calibration flux was suggested. Suggested method was tested on the test transfer function and the mean transfer function of photodetector array. Tests have shown method effectiveness.**

***Index Terms* – linearization, transfer functions, focal plane arrays.**

I. Introduction

FOCAL plane arrays (FPA) are applicable for speeding of spectrum scanning in modern spectral instruments [1]. Radiation spectrum of the source and radiation spectrum which get by material are recorded for measurement of the transmission spectrum of materials. Spectral peculiarities of absorptions of various gases and water vapor are visible on the spectra. Transmission spectrum is ratio of second spectrum to first spectrum. If photodetector's transfer functions are linear then spectral region of the absorption must be shortcut and must be missing on the transmission spectrum. However these regions maybe marked on the real spectrum. Nonlinearity of photodetectors' transfer function maybe cause of such effect. The purpose of this paper is trying to remove such effect by applying linearization of each element's transfer function.

II. Measurement of Calibration

Experimental data need be measured for realization of calibration's (linearization's) process. Scheme of this experiment is shown on Fig. 1.

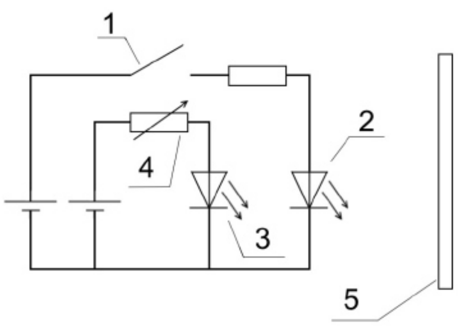

Fig. 1. Scheme for measurement FPA's transfer function. 1 is switch for calibration LED turn on/off, 2 is a calibration LED, 3 is a basic LED, 4 is a variable resistor for change of the basic level, 5 is a FPA.

IR-LED with variable intensity (basic LED (b-LED)) used for setting basic flux level. IR-LED with constant intensity (calibration LED (c-LED)) used for flux modulation. It was used to increase on constant level flux on FPA.

Algorithm for measurement of calibration data:

1) signals on some basic flux are measured (only b-LED is turn on)
2) c-LED is turn on (switch 1 is close)
3) signals on sum basic and calibration fluxes is measure (b-LED and c-LED are turn on)
4) c-LED is turn off (switch 2 is open)
5) basic's level up

Algorithm will have cycled before of saturation FPA (no reactions on the calibration flux).

As result of this operation we was received two arrays of experimental data with dimensionality n × m, where n – number of experiment's cycles, m – number of elements in FPA's line. Signal values of FPA when it was lightened by only b-LED was designated $\vec{S}_0$ and lightened by b-LED and c-LED – $\vec{S}_1$.

III. Differential Method of Calibration Data Processing

Differential method of calibration was offered in [2]. IR-microscope's FPA was calibrated by applying this method. If differences of photosignals $\delta S = S_1 - S_0$ are sufficiently small we can represent them on differential form.

$$\delta S = F(S)\delta I \tag{1}$$

or

$$\frac{\delta S}{\delta I} = F(S) \approx \frac{dS}{dI} \tag{2}$$

This equation maybe transformed by integrations

$$I(S) - I(S_0) = \int_{S_0}^{S} \frac{dS}{F(S)} \tag{3}$$

The result function I(S) transform values of signals to values proportional intensity photon's flux.

Differential method has a limitation – calibration flux's value must be sufficiently small in order to differential form (2) will be valid. But in this case noise influence to the result may be significant.