Low cost microwave thermometers for detection of subsurface fire's edge and airbourne complex of remote mapping of underlying surface in microwave band

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ABSTRACT

Usage of microwave passive radiometry to solve applied tasks of remote subsurface fire detection is limited by high equipment cost. Every radiometer is a unique specific device, usually produced in small quantities. Still it is possible to reduce greatly the cost of production by using commercial TV-SAT components. This article displays some test results of experimental low-cost microwave band device created for surface and airborne cushion course remote mapping.

I. INTRODUCTION

Every heated body radiates broad band electromagnetic waves. Noncontact reception of this emission by means of highly sensitive receiver is the basic principle for remote detection of forest fire and subsurface fire's edge.

The advantage of microwave band (λ=30cm-3mm) over widely used infrared band (λ=0.3-12.5 μm) allows to probe underlying surface at significant depths and to work in the all-weather survey through cloud, mist and dense smoke.

II. LOW COST TERRAIN MICROWAVE DEVICE

To create the low-cost terrain device for detection of subsurface fire's edge the use of full-power direct radiometer scheme was proposed [1]. This elementary scheme is optimal for significant contrast detections, when seat of fire temperature is about several hundred degrees. For better reliability and cost reduction it is possible to use commercially available TV-SAT Ku and C band converters. It is necessary to add detector, low frequency filter, indicator and built-in power source. Approximate price of TV converter is €10-100.

On figure 1 you can see the general view of Ku and C band devices. On picture 2 are shown dependencies standardized to one response values for emission of artificial "seat of fire" with 50˚contrast. This emission goes through different depth peat layer with 9% gravimetric moisture.

Long wave channel usage with λ=7.89 cm (C-band) makes confident detection of "seat of fire" with 50˚contrast at 0.5 m depth. Detection depth is made variable for better contrast and different peat moisture values. Field trials have shown that seat of peat fire with temperature 300˚ is found on the depth 0,1÷0,15 m by peat moisture 30% (C-band).

12V DC voltage and 100mA current allow 8 hours operation using built-in batteries.

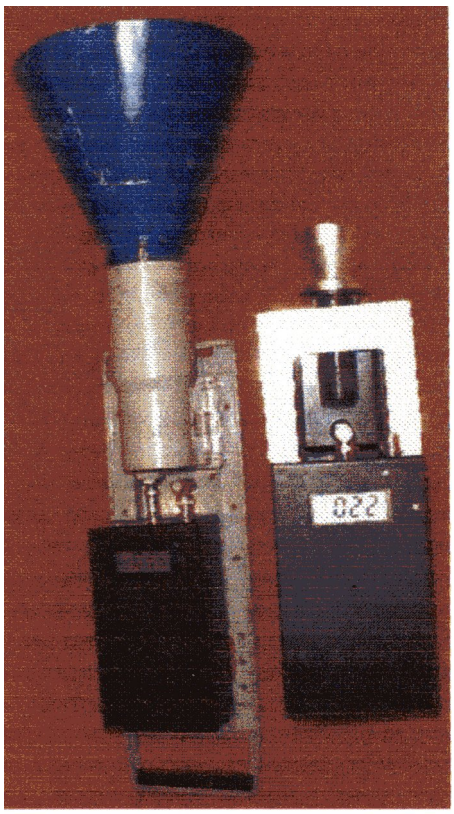

Fig. 1

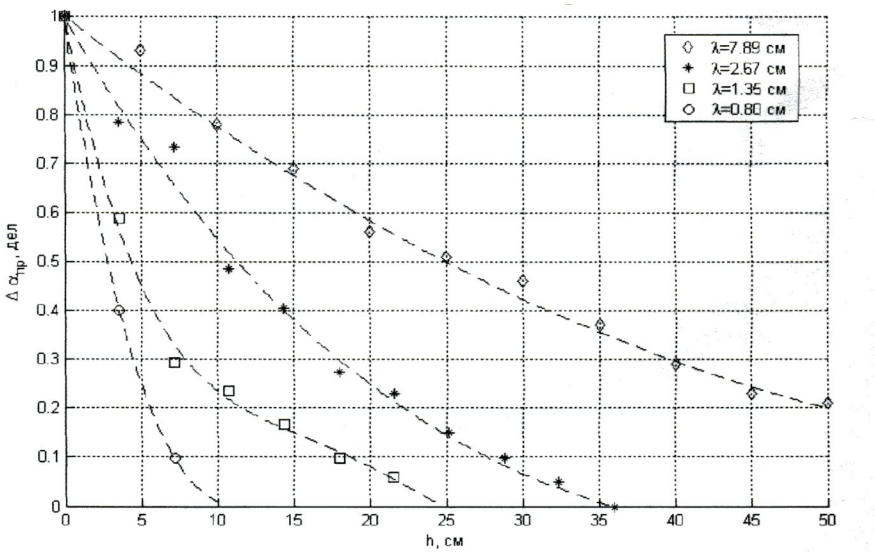

Fig. 2

III. LOW COST AIRBOURNE COMPEX OF REMOTE MAPPING OF UNDERLYING SURFACE

Similar receivers were used recently for modeling (fig. 3) of multibeam airbourne complex of remote mapping [2]. Complex consists of multibeam antenna with 8 or more microwave band receivers-radiometers, data collection system and computer (fig. 4).

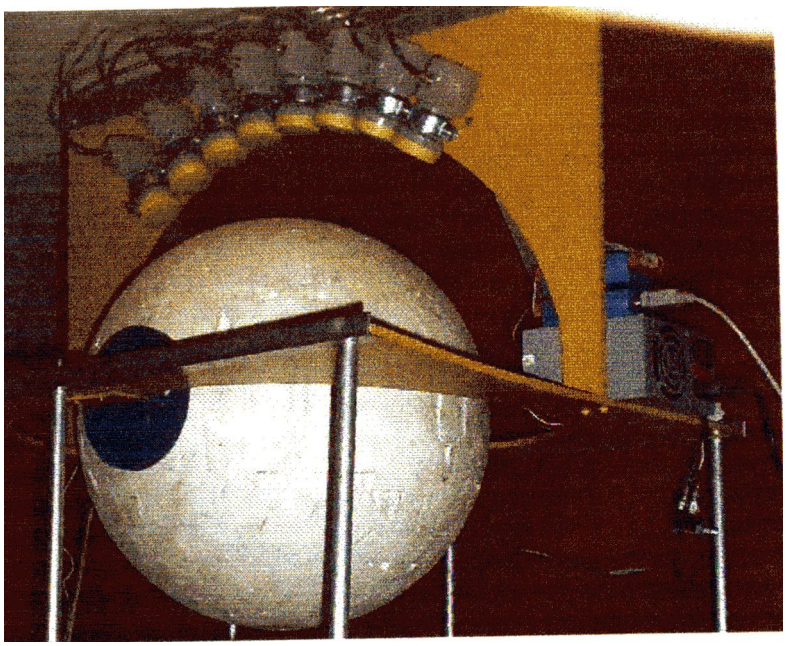

Fig. 3

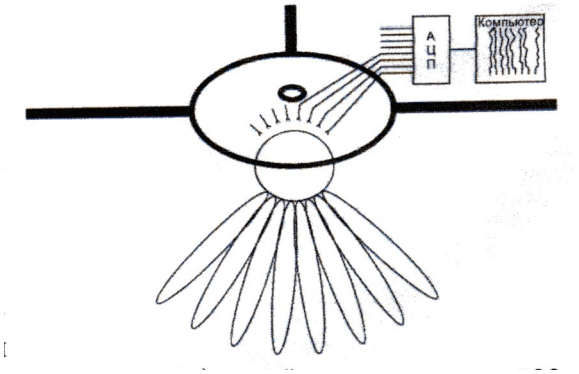

Fig. 4

Commercially available special dielectric lens with central symmetry (Luneberg lens) with 460 mm diameter are used as antenna (approximate cost of this lens is € 1000-5000).

8 similar feeds (f=10,7-11,7 GHz) placed on the area with 1,5R. They form fan of beams in the observable area. Radiometers are built with standard LNB blocks (antenna+converter). Radiometer signals come through analog to digital coder (ICP DUS) to computer that displays line scan of the observable surface. Frame scan is formed due to the own moving of aircraft carrier. Every beam forms the spot on the observed surface. Its size is proportional h* λ/D where h- flight attitude, λ – wave length, D- the size of antenna aperture. For used aperture and Ku band the diameter of the spot is equal approximately 0,1h.

The complex receives area average signal. Signal intensity is between 150K (for water surface) and 500-580K for the forest or peat subsurface fire areas. Similar device for monitoring of forest fire environment was reported in [3]. For this purpose single beam TV-SAT antenna with standard parabolic mirror was used.

IV. CONCLUSIONS

The usage of commercial TV-SAT components allows the realization of low cost terrain and airbourne devices.

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