NOISE WAVE ANALYSIS OF DICKE AND NOISE INJECTION RADIOMETERS: COMPLETE S-PARAMATER ANALYSIS AND EFFECT OF TEMPERATURE GRADIENTS

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1. INTRODUCTION

The performance analysis of microwave radiometers is often simplified assuming that most/all circuits are perfectly matched and that all are at the same physical temperature. However, the increasing performances demanded to future instruments makes necessary to assess their performance including all these effects: actual complex S-parameters of the different subsystems (non-zero insertion losses, finite matching, finite isolation….), physical temperature gradients etc. in view to devise a software correction, when it is not possible to warrant them by design. A full noise-wave analysis will be presented in this paper.

2. NOISE-WAVE ANALYSIS

Following the techniques devised in [1] and [2], noise-wave analyses have been performed for total power [3] and correlation radiometers [3,4], as well as to –under some simplifications- find the optimum integration times as a function of the antenna temperature for total power, Dicke, and Noise Injection Radiometers [5]. This manuscript will present the extension of these previous works to two cases of interest: the Dicke radiometer and the Noise Injection radiometer in which each subsystem is defined by its S-parameters matrix and they are all interconnected. The overall S-matrix is computed by cascading the individual subsystem ones as described in [6], which allows to assess the noise delivered at a given port coming from the different input ports (eventually at different physical temperatures) and the noise generated internally because of the losses. Mismatches between ports are implicitly accounted for in this formulation.

3. DISCUSSION OF RESULTS

Theoretical analyses and simulation results will be presented for typical subsystem values and their measured uncertainties, such as insertion losses (*IL*), matching (*RL*), and isolation (*I*). To simplify the mathematical formulation and obtain closed-form expressions, it will be assumed that only that $IL \sim 1$, and $RL, I << 0$, which is very often the case. It will be shown how the analytical expressions for the case of having a temperature gradient tend to the well-known expressions found in most text books when everything is assumed to be at the same physical temperature T_{ph}, for example: in the case of a Dicke radiometer that $T_0 = T_{ph} - T_A$. The results achieved in each different configuration will be discussed.

4. REFERENCES

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