# Microstrip switch at 1.6 GHz for a mobile communication Antenna Array

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*Abstract: We are developing a 12 channel microstrip switch at 1.6 GHz for mobile communications. The EEsof simulations showed that the insertion losses are lower than -1.5 dB and the reflections lower than -12 dB in the whole operation band from 1.5250 GHz to 1.6605 GHz. Insertion losses below -1.13 dB and reflections below -13 dB in the operation band have been tested with the first sample switch. We showed that a pair of tuning stubs and another kind of diodes can be used to lower down the insertion losses and reflections to -0.5 dB and -18 dB, respectively.*

*Résumé: Nous développons un commutateur microruban à 12 canaux opérant à 1.6 GHz pour une antenne réseau de communications mobiles par satellite. Les simulations EEsof ont montré des pertes d'insertion plus faibles que -1.5 dB et des réflexions en bas de -12 dB dans toute la bande d'opération de 1.5250 à 1.6605 GHz. Des pertes d'insertion en dessous de -1.13 dB et des réflexions plus faibles que -13 dB ont été mesurées sur la largeur de bande désirée. En modifiant les stubs et les diodes, nous pouvons améliorer les pertes d'inserion à -0.5 dB et les réflections à -18dB.*

We are developing a microstrip antenna system for MSAT and INMARSAT mobile communications. The system operates from 1.525 GHz to 1.661 GHz and consists of 12 electrically-coupled patch antennas and 12 phase shifters. The function of the switch is to activate the 3 adjacent elements closest to the direction of the satellite. For proper operation, the switch should have small reflections at its feeding port and low insertion losses between the feeding port and the activated ports. As a commercial project, it is also very important to keep the price of the whole system as low as possible.

The configuration of the switch is very similar to that developed by Bialkowski and al [1] for the Australian mobile communication system. Based on the requirements and as the first step we implemented a microstrip as shown in Fig.1. We used a GIL substrate with a permittivity of 3.20, a loss tangent of 0.003 and a thickness of 0.762mm. The switch is fed at its center and is composed of 12 quarter-wavelength transformers, 12 HP 4890 diodes and 12 quarter-wavelength radial stubs in parallel with each of the transmission lines. When such a diode is forwardly biased, it is mainly a small resister(< 2.5 Ohms) and the radial open stub connected to it appears a low resistance in parallel with the transmission line. The RF power in this channel is reflected and this channel is deactivated.. While the diode is reverse-biased, the diode behaves as a small capacitance (< 0.33 pF) and it will behave as a high reactance and the quarter wavelength open stub will be decoupled from this channel and this channel will be activated. The diode used has dual anodes and single cathode and for each pole the lead inductance is about 0.5 nH. The reflection and transmission of the switch were simulated using EEsof and are displayed in Fig.2. The reflection is less than -12 dB and the insertion loss is less than -1.5 dB in the whole operation band.

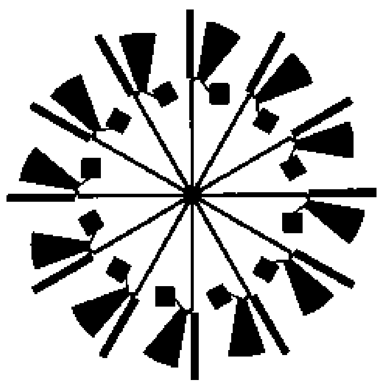

**Fig.1** Microstrip switch configuration

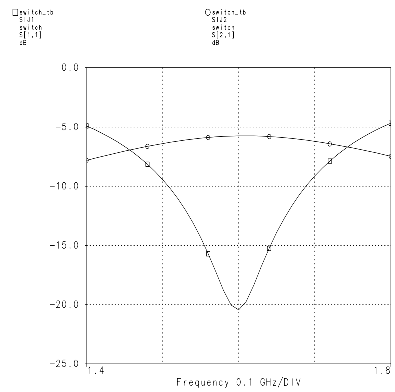


**Fig.2** EEsof simulation of the switch

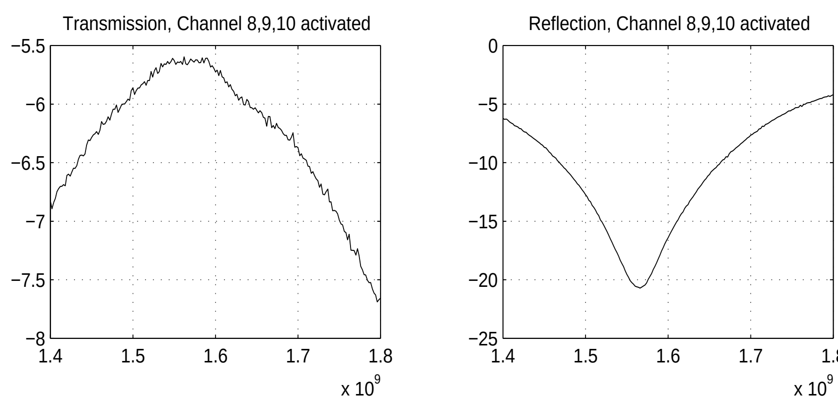


**Fig.3** Measured insertion loss and reflection of the microstrip switch

A sample switch was fabricated according to the simulations and then tested. The tested results, as displayed in Fig.3, show that the reflections are lower than -13 dB from 1.498 GHz to 1.634 GHz and the insertion losses are lowe than -1.13 dB in this band. When we switch from certain 3 adjacent channels to another adjacent 3 ones, the transmission and return will remain almost unchanged and the isolation from the feeding port to the deactivated channels is better than -22 dB in the whole band.

In the measurements we found that the center frequency was 34 MHz lower than in the simulations. This discrepancy was because of the copper disc at the center of the switch. Due to this effect, the actual length of the transformers was a little larger than that used in the simulations. We have shortened the transformers by about 0.9 mm in a recent design to compensate for this and this new design will be tested soon.

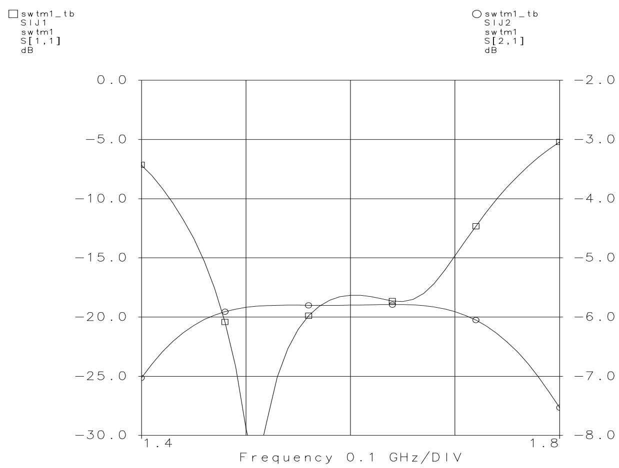


**Fig.4** Simulation results of a microstrip switch with tuning stubs

The reflections and insertion losses can be optimized by adding a pair of parellel tuning stubs one quarter-wavelength before the  feed of the switch. EEsof simulations, as shown in Fig.4, revealed that -1.0 dB insertion loss and -18 dB reflection can be achived  in the whole operation bandwidth. we are also trying the possibility of using HP4820 diodes instead of HP4890. Simulations showed that using this new diode, it ispossible to further lower down the insertion losses to about -0.5 dB.

Asecond project focuses on indoor communication antenna systems at 18 GHz and 29 GHz. The key issue in such a system is to increase the bandwidth of the patch arrays. For this purpose, we proposed and simulated a single patch antenna with tuning stubs at 18 GHz. The simulations using Ensemble proved that the reflection is lower than -14 dB from 17.0 GHz to 18.4 GHz and the radiation pattern are quite satisfactory in the whole band. We are designing patch arrays using this kind of patch antennas.

Acknowledgement:

We would like to thank Mr. Claude Vergnolle for his helpful suggestions.

**Reference:**

[1] M.E. Bialkowski, S. T. Jellett, R. S. Varnes, “Electronically steered antenna system for the Australian Mobilesat”, IEE Pro-Microw. Antennas Propag., Vol. 143, No. 4, August 1996.