A 20 GHz Antenna Integrated RF MEMS based Router and Switching Networks made on Quartz

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Abstract— **In this paper, we summarize the main results of a research activity within the Nordic countries with focus on smart subsystem integration – Nordic Antenna Integrated RF MEMS router (NAME project). A microwave antenna router based on MEMS switches is a novel and application driven integration method with advantages in terms of improved RF performance, reduced power consumption and size (compared with existing technology solutions). A compact, low-cost and low-power MEMS router is envisaged to be a cost-effective solution for certain applications related to wireless communication, automotive radar, traffic control and safety, for example. Figure 1 show photographs of a 20 GHz array antenna integrated MEMS router made on quartz substrate (circuit area 21x8 mm^2). The router which has been fabricated using a capacitive RF MEMS process at the Ferdinand Braun Kessler (FBK) institute in Trento, Italy, contains a single-pole double throw (SPDT) MEMS switch network connected to two quasi-Yagi Uda antenna elements. With the two antenna elements, the antenna-beam can be electrically switched between two opposite directions using the two MEMS switches in the router network. The two-element array antenna router has been characterized when applying different combinations of actuation voltage to the MEMS switches. Figure 2 shows the measured reflection coefficients of the antenna router. The reflection coefficient is below -10 dB between 16-22 GHz (28% bandwidth) when the actuation voltage is applied to either of the two switches. The measured radiation patterns of the antenna integrated MEMS router demonstrate that the antenna beam can be switched between two opposite directions with a gain of 4.6 dBi, a half power beamwidth of 82° and a front-to-back ratio of 14 dB. In addition to the 20 GHz antenna router, we have made several switch designs that were fabricated in RF MEMS process runs at FBK, VTT and SINTEF, respectively. For example, two different SPDT switch networks made on quartz show a measured loss of 1 dB at 24 GHz and also at 36 GHz (together with 39 dB and 18 dB of isolation, respectively). The evaluation of fabricated switches and the 20 GHz array antenna integrated router demonstrates that the proposed MEMS based router concept works as designed. The MEMS router topology could easily be extended to contain additional antenna elements and also be realized at higher frequencies.**

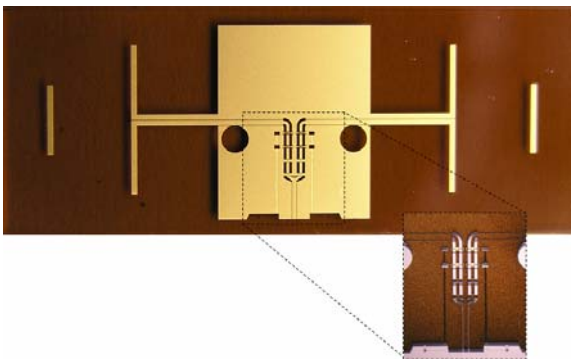

Fig. 1. Photographs of the array antenna integrated with RF MEMS based router made on a quartz substrate (circuit dimensions are equal to 21 mm x 8 mm).

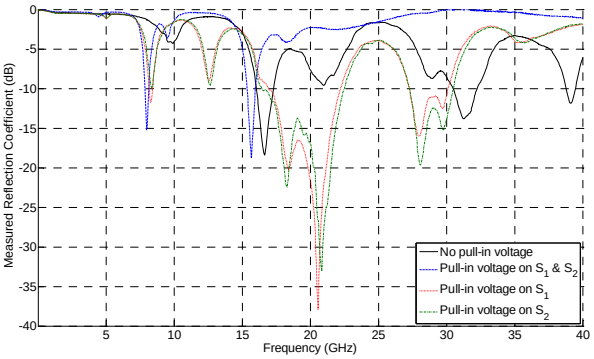

Fig. 2. Measured reflection coefficients of the array antenna integrated with a MEMS router switch network (the lines show measured curves when different combinations of actuation voltage were applied to the MEMS switches in the router network).