Abstracts

Phase-noise analysis of MEMS-based circuits and phase shifters

G.M. Rebeiz. "Phase-noise analysis of MEMS-based circuits and phase shifters." 2002 Transactions on Microwave Theory and Techniques 50.5 (May 2002 [T-MTT]): 1316-1323.

The effect of Brownian, acceleration, acoustic, and power-supply noise on MEMS based circuits has been calculated for MEMS.-based circuits (phase shifters, delay circuits). The calculations are done for capacitive shunt MEMS switches and metal-to-metal contact series MEMS switches. It is found that these effects result in both an amplitude and phase noise, with the phase noise being around 100/spl times/ larger than the amplitude noise. The phase noise due to Brownian motion is negligible for MEMS switches with k /spl sime/ 1.0 N/m, g/sub 0/ > 2 /spl mu/m, Q > 0.5, and f/sub 0/ /spl sime/ 50 kHz. The effect of acceleration and acoustic noise is negligible for a total acceleration noise of 10 g or less and a total acoustic noise of 74-dB sound pressure level. The power-supply noise depends on the bias conditions of the MEMS element, but is negligible for MEMS switches with a bias voltage of 0 V and a total noise voltage of 0.1 V or less. It is also found that metal-to-metal contact series switches result in much less phase noise than standard capacitive shunt switches. The phase noise increases rapidly for low spring-constant bridges (k = 0.24 N/m), low-height bridges, and bridges with a large mechanical damping (Q < 0.3). Also, varactor-based designs result in 30-40 dB more phase noise than switch-based circuits. This paper proves that microwave passive circuits built using MEMS switches (with a proper mechanical design) can be used in most commercial and military applications without any phase-noise penalty.

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