MODIFIED CONDUCTOR LOADED CAVITY RESONATOR WITH IMPROVED SPURIOUS PERFORMANCE

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***ABSTRACT* -- The paper introduces a new resonator configuration to realize conductor-loaded cavity filters with improved spurious performance. Theoretical results are presented for the field distribution and resonant frequencies of the proposed structure. The results show that shaping the metal resonator inside the cavity can considerably improve its spurious performance. Experimental results are presented to verify the concept presented in this paper.**

I. INTRODUCTION

The use of dual-mode conductor loaded cavity has been proposed in [1] as an alternative low-cost design to dual-mode dielectric loaded cavity resonators. Even though the attainable spurious performance of conductor loaded cavity filters exceeds that of traditional dielectric resonator filters, there is a need for further spurious improvement. An approach has been suggested in [2] to improve the spurious performance of dual-mode conductor-loaded resonator filters by using different size resonators and enclosures.

In this paper, we extend the concept proposed in [3] for dielectric resonators to conductor-loaded cavity resonators. We introduce a half-cut conductor-loaded cavity resonator and we modify its shape to improve the spurious performance. The end result is a new class of single-mode conductor-loaded cavity resonators that have excellent spurious performance in comparison with dual-mode conductor-loaded resonators.

We present theoretical results for the field distribution illustrating the technique we used to improve the resonator spurious performance. Experimental results are presented for a 2-pole filter to demonstrate that a wide spurious free window can indeed be achieved with the use of the proposed resonator.

II. ANALYSIS

Figure 1 illustrates the traditional dual-mode conductor-loaded cavity resonator. The resonator is mounted in a planar configuration inside a rectangular cavity. Figure 2 gives the field distribution of the first three modes while Table 1 provides the resonant frequency of these modes as obtained using ANSOFT HFSS software package [4]. The results are in close agreement with those obtained in [1], for a conductor loaded resonator in a cylindrical cavity, using the mode matching technique. It can be seen that the TM_{01} mode limits the spurious performance of the dual-mode conductor-loaded resonator.

In realizing dual-mode filters the resonators can be mounted axially in cylindrical cavities as shown in Figure 3a or in rectangular cavities (planar configuration) as shown in Figure 3b. The planar configuration makes it easy to mount the conductor resonator inside the enclosure by using low-loss low-dielectric constant support structures. This configuration, however, requires the coupling and tuning screws to be mounted vertically in the cavity as shown in Figure 3b. The vertically mounted screws usually interfere with the TM_{01} mode pushing its resonant frequency even closer to the dominant HE_{11} mode, which in turn limits the filter spurious performance. The problem may not of a major concern in the cylindrically-mounted configuration since the coupling and tuning screws can be inserted in the r-ϕ plane without interfering with the E_z component of the TM_{01} mode [1].

Table 1 Resonant frequency of dual-mode conductor loaded cavity resonators
Metal puck: 0.222" x 2.4" dia.
Rectangular cavity: 1.9" x 3.2" x 3.2"
Cylindrical cavity: 1.9" x 3.2" dia.

Mode	ANSOFT-HFSS Rectangular Cavity	Mode-Matching [1] Cylindrical Cavity
HE_{11}	1.889 GHz	1.940 GHz
TM_{01}	2.506 GHz	2.733 GHz
HE_{21}	3.434 GHz	3.322 GHz

III. PROPOSED RESONATOR

With the use of the magnetic wall concept presented in [3] for dielectric resonators, a half-cut version of the conductor-loaded resonator can be realized. The half-cut resonator would have a slightly higher resonant frequency with a size that is 50% of the original dual-mode cavity. Figure 4 illustrates the resonator configuration while Figure 5 shows the field distribution of the first three modes. It can be observed that the field distribution of the dominant mode in the half-cut resonator resembles that of the dominant HE_{11} mode in dual-mode conductor-loaded resonators. On the other hand, it can be seen that the second mode in the half-cut resonator is no longer the TM mode. The use of magnetic wall concept [3] has shifted the TM mode away from the dominant mode.

Table 2 gives the resonant frequencies of the first three modes of the half-cut conductor-loaded resonator. Even though the TM mode has been shifted away, the spurious performance of the resonator has degraded. We apply then the technique proposed in [3], [5] for shaping dielectric resonators to conductor-loaded cavity resonators. Figure 6 illustrates the modified half-cut resonator. The original half-cut resonator is selectively machined to enhance the separation between the resonant frequencies of the dominant and the first higher-order mode.

Table 3 gives the resonant frequencies of the first three modes of the modified half-cut resonator. A comparison between Tables 1 and 3 illustrates that the spurious performance of the modified half-cut resonator is superior to that of dual-mode resonators. It is interesting to note that shaping the resonator as shown in Figure 6 has shifted mode 1 down in frequency while shifting mode 2 up in frequency. This translates to a size reduction and a significant improvement in spurious performance.

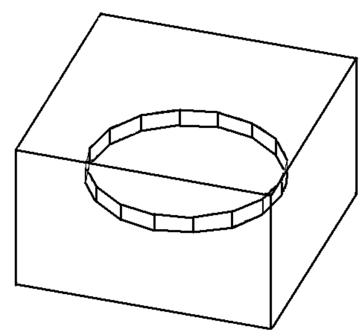


Figure 1. Traditional dual-mode conductor-loaded cavity resonator

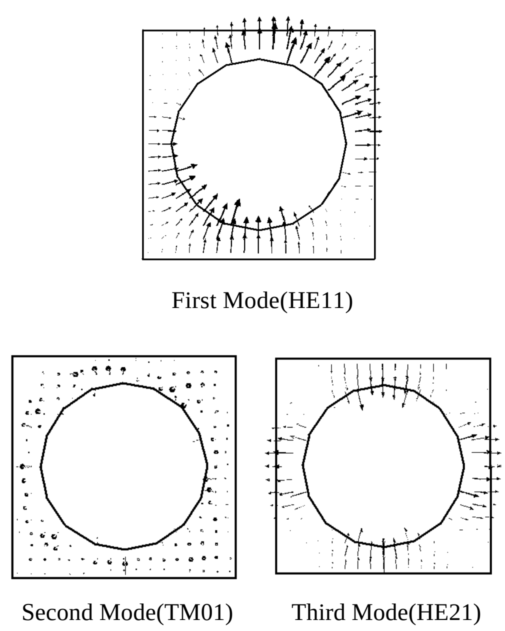


Figure 2. The field distribution of the first three modes of the resonator shown in Figure 1.

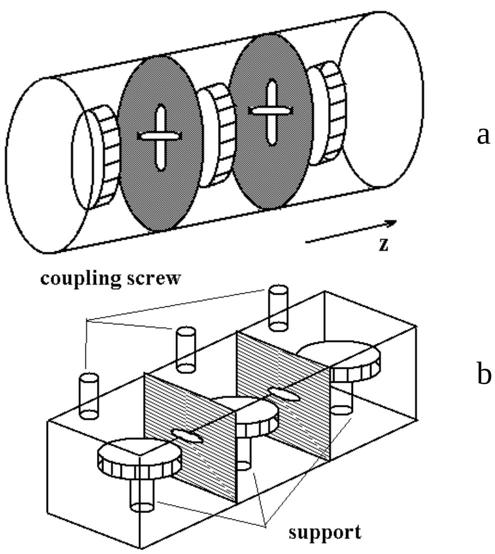


Figure 3. A 6-pole conductor-loaded cavity resonator mounted in a) cylindrical cavities b) rectangular cavities

Table 2 The resonant frequencies of the first three modes of the half-cut conductor-loaded resonator

Mode	Resonant Frequency
Mode 1	2.119 GHz
Mode 2	2.234 GHz
Mode 3	3.824 GHz

Table 3. The resonant frequencies of the first three modes of the modified half-cut conductor-loaded resonator

Mode	Resonate Frequency
Mode 1	1.559 GHz
Mode 2	2.980 GHz
Mode 3	3.535 GHz

In order to verify the concept proposed in this paper, a 2-pole filter was designed, built and tested. The ANSOFT HFSS package [4] was used to simulate overall filter including input/output probes. Figure 7 shows the filter layout while Figure 8. Illustrates the simulated results. The measured results are given in Figure 9. The spurious is located at approximately twice the filter center frequency.

The disadvantage of the half-cut resonator is Q reduction. The half-cut resonator exhibits almost 60 % the Q of the dual-mode version. However, the half-cut resonator offers layout flexibility allowing ease of realization of tri-sections to realize filters with asymmetrical characteristics and is particularly useful in applications where the spurious performance is the main design consideration. The structure is also amenable to superconductor technology (through thick film coating), allowing the ease of realization and tuning of high-order low-loss superconductor filters with excellent spurious performance.

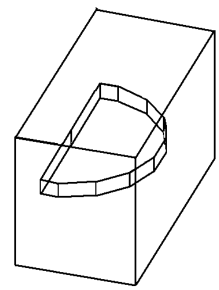
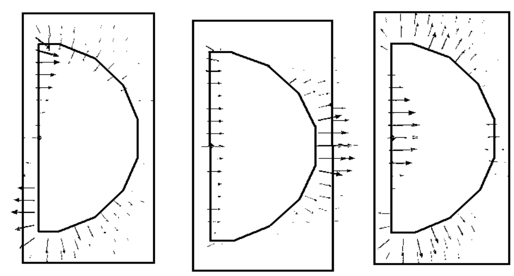


Figure 4. Proposed conductor-loaded half-cut resonator



a) First Mode b) Second Mode c) Third Mode

Figure 5. Field distribution of the first three modes of the half-cut resonator shown in Figure 4.

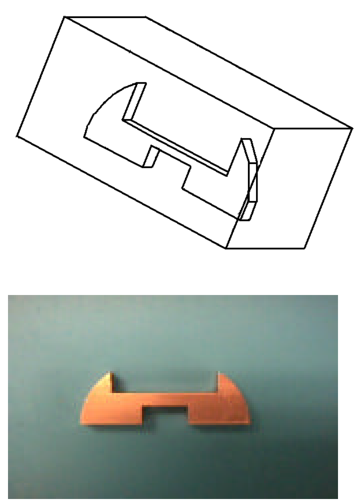


Figure 6. Modified half-cut conductor-loaded cavity resonator

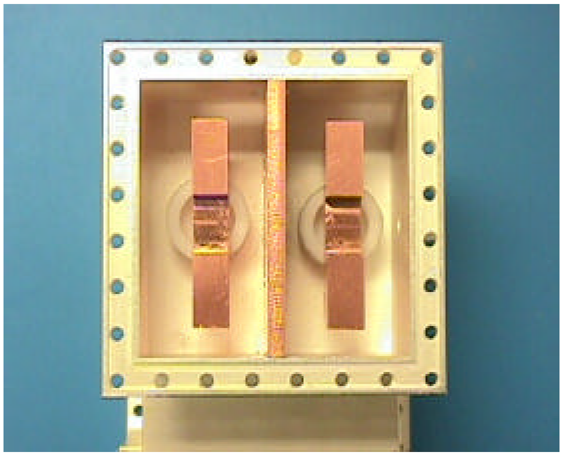


Figure 7. A 2-pole filter employing the modified half-cut conductor-loaded resonator.

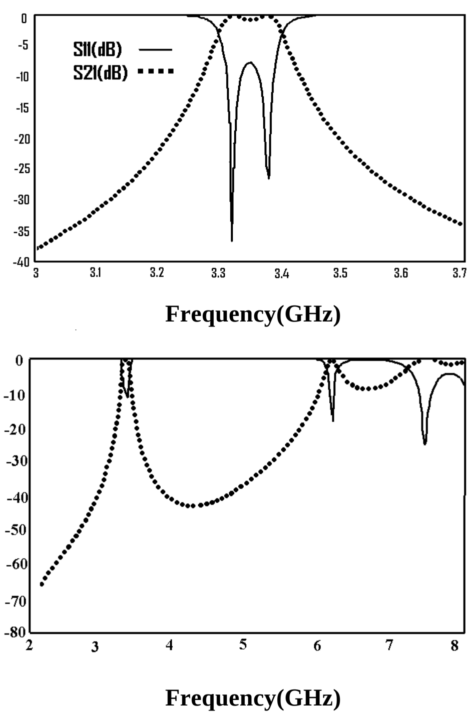


Figure 8. The simulated performance of the filter shown in Figure 7 using Ansoft HFSS.

IV: CONCLUSIONS

The paper has presented a new configuration for a single-mode conductor-loaded cavity resonator. It has been shown that shaping the conductor inside cavity, while maintaining the cavity dimensions, can lead to a considerable improvement in spurious performance, In comparison with dual-mode conductor-loaded cavity resonators, the proposed resonator can compete in size and spurious performance but not in Q.

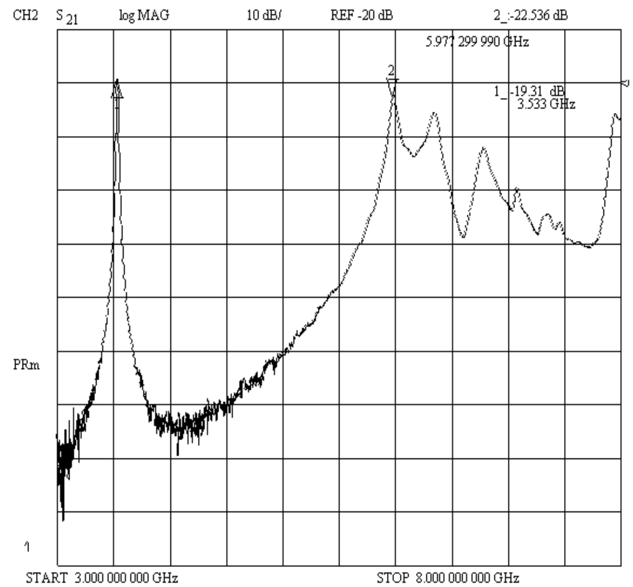


Figure 9. The measured results of the filter given in Figure 7.

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