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'ENGINE-BLOCK', DUAL MODE DIELECTRIC RESONATOR LOADED CAVITY FILTER WITH NONADJACENT CAVITY COUPLINGS

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ABSTRACT

A degenerate mode in a dielectric resonator loaded cavity is utilized to realize a flat, miniature, high performance bandpass filter in side coupled, "engine block" configuration. A novel way of providing coupling between nonadjacent electrical cavities by an interchangeable iris-probe combination is employed to achieve high performance elliptic function response.

Introduction

A typical, narrow-band, high performance bandpass filter utilizing a degenerate TE_{111}(3) mode in a cylindrical cavity is usually realized in so called "in-line" configuration. A similar structure is described in (1), employing a dual mode, dielectric resonator loaded cavity. However, even in the case of miniature filters with dielectric resonators, mounting and assembling of such a cylindrical form is difficult from a mechanical point of view, and as an example; in satellite transponder applications complicated bracketing is necessary. Furthermore a space between individual filters and equalizers due to a circular "footprint" of the filter, is not fully utilized. The "engine block", a folded filter configuration overcomes these basic limitations and makes the filters more compatible with transponder MIC devices which are typically arranged in a tray form. An interchangeable side iris-probe coupling proposed in (2) for Chebyshev type filters is utilized to achieve additional couplings between nonadjacent electrical cavities (in a dual mode approach one physical cavity corresponds to two electrical cavities), and realize steep rejection, quasi-elliptic or canonic filters. The configuration which was developed results in excellent electrical performance and convenient access to individual cavities, making tuning and development easier. The "engine block" structure has better heat transfer characteristics especially in a vacuum environment. Therefore application at higher power levels is possible.

Filter Description

A dielectric resonator loaded cavity resonating in a doubly degenerate mode forms a basic building element of the filter. The resonator frequency of such a cavity can be calculated using the method described in (1). In the filter, the individual cavities are arranged in a folded "side-by-side" configuration and form an "engine block" like structure. Coupling between each cavity is achieved either by a long slot in a side wall or by a small coaxial probe. Input and output coupling of the filter can be obtained by slots in the bottom or top walls, slots in side walls, and coaxial probes, or any combination of the above. Tuning and coupling screws are arranged similar to a standard dual-mode filter. To achieve quasi-elliptic or canonic response, filter configurations presented in Fig. 1 can be used (8-pole filter with probes as an input/output means is pictured). It can be seen that an alternate coupling to electric fields in the cavities make possible a realization of nonadjacent couplings. At present, suitable coupling coefficient formulas for a probe or side-slot are not available, and experimentally determined values were successfully used to realize such filters.

Experimental Results

To verify feasibility of the proposed configuration, several C-band filters were designed, built and tested. The basic electrical design for the filters is identical to that of a conventional filter obtained from available designs for a quasi-elliptic and canonic response (e.g., the approach described in (4) can be used). Initial tuning and adjustment of the couplings was accomplished using a method described by Atia and Williams in(3). An alternate method reported by McDonald(5) was also successfully used. Measured performance of an 8-pole, quasi-elliptic filter (Fig. 2) is presented in Fig. 3. The insertion loss at the filter is determined by the Q-factor of the individual dielectric resonator loaded cavities, which in turn depends upon the loss of the dielectric resonator material and selected dielectric mounting. All filters were implemented using ceramic material with Q = 8000 at C band. The resonators were mounted in low-loss, low dielectric constant rings in silver plated aluminum housing. Measured results indicate that minimal degradation of the resonator Q takes place. One of the realized 4-pole filters exhibited an insertion loss of $\approx$.2 dB (40 MHz equal ripple bandwidth) at C band, corresponding to a Q of about 8000 (Fig. 4). The temperature characteristics of the filters are mainly determined by the stability of the dielectric resonator and therefore excellent stability (better than INVAR) can be achieved. Weight of the typical C band 8-pole filter is in the range of 100 grams which is about 1/2 the weight of comparable, lightweight GFRP (Graphite Fiber Reinforced Plastic) in-line filters, and 1/3 the weight of thin-wall INVAR filters.

References

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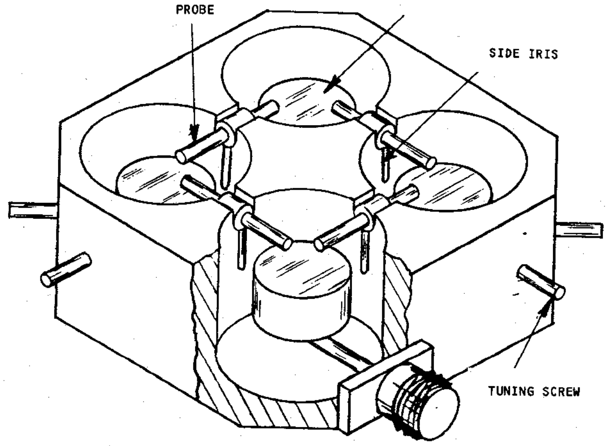

Figure 1

Basic configuration of an "engine-block", 8-pole, dual-mode dielectric resonator filter.

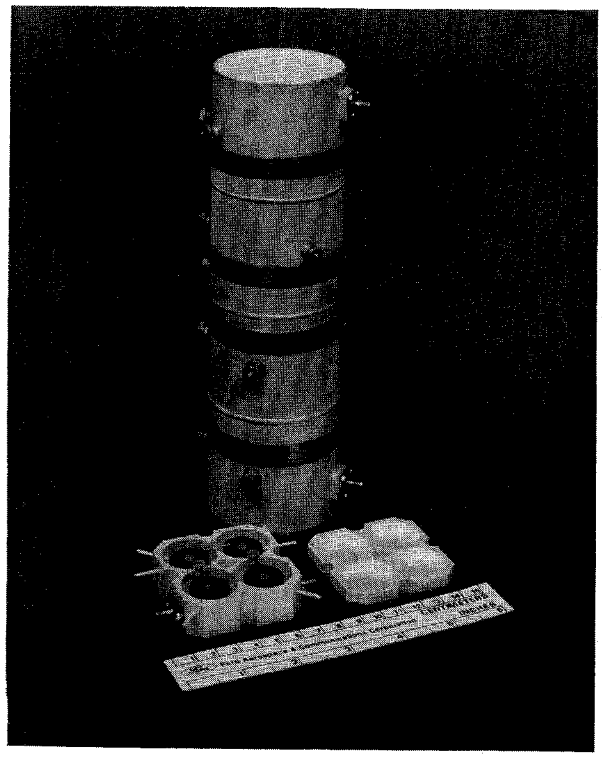

Figure 2

Comparison of the filter in "engine-block" configuration with conventional cavity INVAR filter.

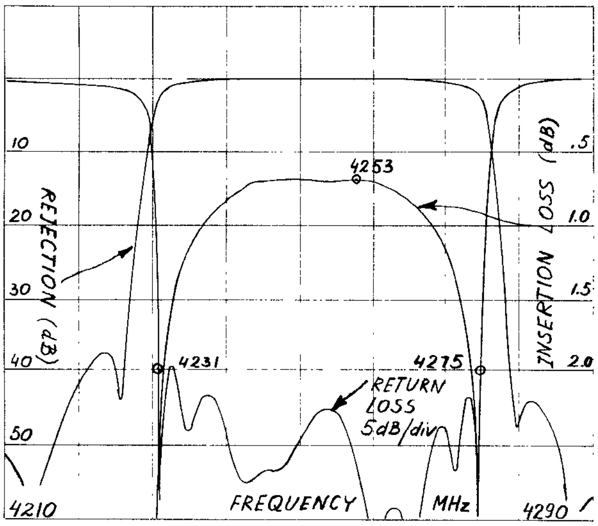

Figure 3
Performance of a quasi-elliptic 8-pole filter in "engine block" configuration.

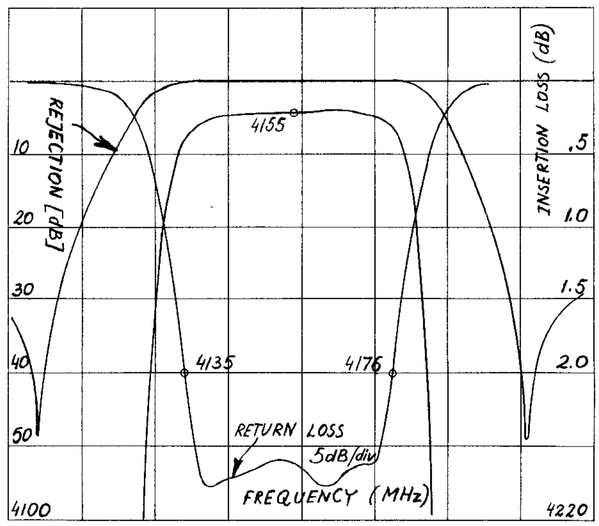

Figure 4
Performance of a 4-pole elliptic function filter in "engine-block" configuration.