

Using high Power Efficient Comblin Filter for Space Applications

S.Lakshmi¹, B.Jaiganesh²

Department of ECE, Saveetha University, Tiruvallur, Tamilnadu, India

Abstract—For the intention of the Mars Orbiter Duty that is usually recognized as (MOM), of Indian Space Scutiny Association (ISRO), an S-band compact, efficient comblin elevated manipulation filter has been designed. The main target of this filter is to manipulation the emission of electrons and to protect the mechanism from damage shouted multipaction Here an exceptional method of telemetry, pursuing, and demanding (TT&C) transponder of MOM is used. This helps to uphold the isolation larger than 145dBc in telecommand path, at the alike period it will grasp the constant RF manipulation of the scope 200 W in the telemetry path. This can be attained alongside the aid of an elevated manipulation convoluted diplexer elevated rejection trail filter at the transmitter, and a low manipulation trail filter at the receiver. The intricacy of multipaction free design and assessing is decreased by the send trail filter of the diplexer is tear into a low rejection filter integral to the diplexer and an external elevated rejection filter. This paper generally focus on the design and space qualification periods of this elevated rejection filter. Consequence of the Multipaction examination is 6dB margin. Main spans to be pondered as arranging this filter are isolation, insertion defeat, and multipaction. The presentation of the Duty in on board filter is normal.

I. INTRODUCTION

Generally filters are work to work the signals that are the frequency scope of MHz to GHz. This scope is utilized to show wireless television etc. Therefore most RF and microwave mechanisms will contain a little kind of filtering on the signals that are sent or received. Such filters are usually utilized as constructing blocks for duplexers and to join or distinct several frequency bands. filters are operate to operate the signals which are the frequency range of MHz to GHz. This range is used to broadcast radio television etc. Thus most RF and microwave devices will include some kind of filtering on the signals that are transmitted or received. Such filters are commonly used as building blocks for duplexers and to combine or separate multiple frequency bands.

Normally filters are of different types namely

Types of Filters

- 1 Low pass filter
- 2 High pass filter

3 Band pass filter

4 Band reject filter

Filter Technologies

Most of the RF and microwave filters are frequently made up of one or extra coupled resonators. Each method that is utilized to make resonators are utilized to make filters also. Contrasted to supplementary filter technologies like Lumped- agent LC filters, Wave-guide filters, Planar filters, Co-axial filters, Dielectric filters, Cavity filters etc. The Comblin filter is extra effectual because this filter avoids Multipaction effect. of the RF and microwave filters are frequently made up of one or extra coupled resonators. Each method that is utilized to make resonators are utilized to make filters also. Contrasted to supplementary filter technologies like Lumped- agent LC filters, Wave-guide filters, Planar filters, Co-axial filters, Dielectric filters, Cavity filters etc. The Comblin filter is extra effectual because this filter avoids Multipaction effect.

II. COMBLIN FILTERS

Comblin filters are bandpass filters. The frequency scope for comblin filter is amid 100MHz to 20GHz. The construction of comblin filter consists of a sequence of Transmission Electron Microscope (TEM) resonators that is of the form circular or rectangular cross-section alongside a capacitor at the open route end. By coupling every single resonator to its subsequent instant resonator the bandwidth is achieved. This is a purpose of the resonator size, resonator spacing and earth plane separation. Comblin filters are normally a silver-plated aluminium. which maintains the lowest bandpass defeat and light in weight. The design plans aftermath in the correlation amid the useful and hypothetical performance.

Concept

Transponder that is utilized in a spacecraft is generally meant for deep space duty. It needs an elevated manipulation nearly 100W at the transmitter conclude and, an elevated sensitive, approx. 135dBm at the receiver side. Separately from this an elevated gain antenna arrangement is additionally needed. As both the transmitter and the receiver side needs the comparable antennas there will be a heavy on Comblin filter. Telemetry, pursuing, and -board heaviness, more above it consumes elevated volume for two autonomous antennas. It is larger to use a public antenna arrangement for both

uplink and down link alongside diplexer. Diplexer is a passive constituent that links the public antenna feed, to both transmitter and receiver simultaneously. There will be proper isolation. Diplexer consists of an elevated manipulation send filter, an accord filter, and a joining network.

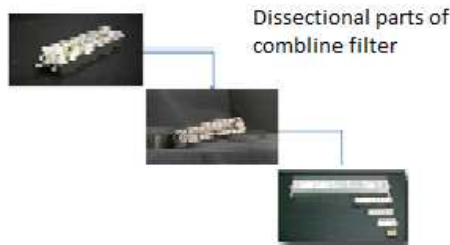


Fig.1 Comblin Filter

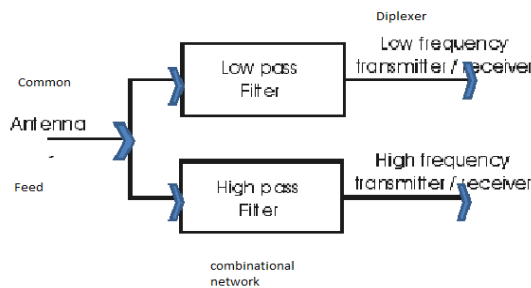


Fig.2 Diplexer

Multipactor is an electron resonance phenomenon that occurs at wireless frequencies in elevated manipulation constituents like filters and resonators and transmission lines working in vacuum. When the emission of secondary electrons is too elevated it reasons damage to the RF devices. It leads to probable payload wreck mechanism for contact satellites. This can even obliterate microwave constituents or transmission lines, or it can rise the sound level also.

III. EFFECT OF MULTIPACTION

Multipactor result is a critical setback in satellite contact arrangement applications. This could even flounder to send manipulation by rising number of messengers that leads to wider bandwidth. Multipactor occurs whenever the electrons are extra energized by the RF waves next they are driven back into an external and secondary electrons are produced. The competent secondary electron's yield depends on the encounter power, angle of incidence, the external properties, and the association of the RF earth at the period of encounter. The period of the secondary electrons stays locked alongside the RF earth steering the encounters, so that secondary electron emissions incline to be in period alongside the requested

RF earth emerging in multiplication of the electrons. This in the end aftermath in cutting the manipulation output of the constituent and rising its revisit loss. The main target of this paper is to stop the result of multipaction breakdown and all the hardware constituents of compact size and less weight.

The main intention of this elevated manipulation filter is to suppress the receiver group frequency pending from the TWTA amplifier and bypass the send group RF gesture alongside minimum loss. It is vital to furnish an isolation of at least 120 dBc to the consented gesture and it will do in elucidating the diplexer design by allocating the rejection requirement.

This is completed by the elevated manipulation filter. Otherwise the diplexer alone has to furnish this higher isolation (>145 dBc) for the consented gesture, this will rise the design, realization, and assessing complexity.

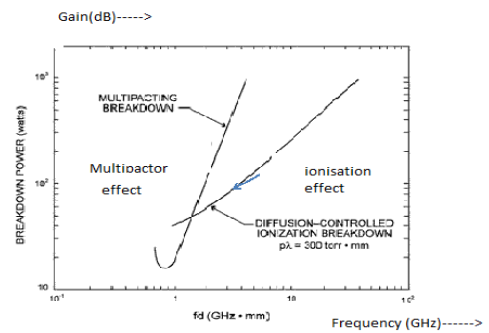


Fig.3 Multipaction

The filter design additionally aims at accomplished the needed presentation in a compact and low heaviness system. Accordingly suitable design-cum-fabrication methods and physical reduction were additionally implemented. Compact implementation of filtering constructions for space requests is established on transient mode waveguides, whose normal configuration is by employing symmetrical metal ridges.

These filters are vitally composed of a hollow waveguide that transmits the power amid average waveguide admission seaports across shunt capacitive agents (ridges). The waveguide servings allocated amid consecutive ridges. After joined alongside the capacitances, these waveguides furnish the needed filter resonances. Transient mode filters are a good for the input and output periods of satellite payloads, as they can furnish reasonable bandwidth replies alongside brilliant out-of-band presentation and sharp selectivity. Initially, after the MOM arrangement was evolving, autonomous polarizations for uplink and downlink were projected and there was no necessity for a diplexer. To encounter these necessities, specifications for the elevated manipulation filter were derived for that a 12-pole double-side ridged

waveguide filter was designed. Instituted on earth theory description of the ridge waveguide is utilized to devise the modal dispersing matrix of the waveguide-to- ridge-waveguide discontinuity, that is the frank constructing block for the design. The ridged waveguide filter consolidated alongside the quarter height waveguide to double-side ridged waveguide transitions optimization was grasped out.

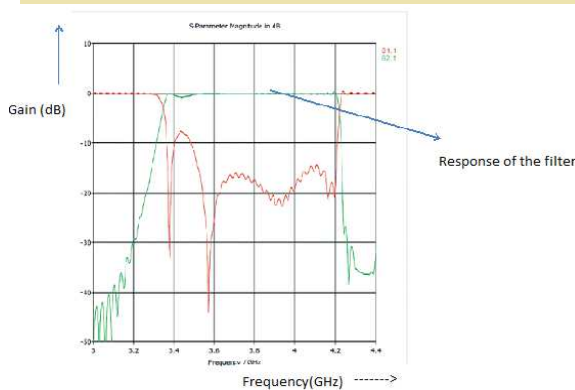
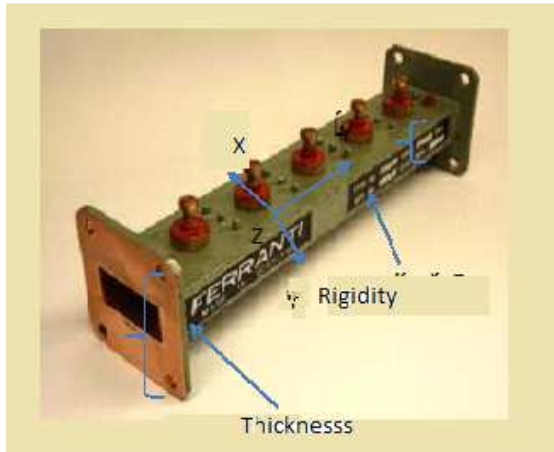


Fig.4 Rigid Waveguide filter of double-sided and its response.

Simulated reply on HFSS was encounter all the needed mechanical specifications, including manipulation grasping, and has the cross serving as 35 mm 35 mm alongside the finished length as 622 mm. It is facile to fabricate this filter into two symmetric halves. But the sensitivity scutiny displays that this construction is complex to fabrication tolerances and afterward fabrication the scope for tuning is extremely remote. For this construction, penetrations depths of the higher and lower metal insert critically alter the ridge gap dimension that is recognized to be extremely sensitive parameter. Additionally, tiny misalignments can facilely ruin the needed symmetry of this filter design. Hence this filter was not fabricated. To vanquish such drawbacks, a possible alternative encompassing of an asymmetrical configuration, alongside metal inserts allocated merely in one wall of the waveguide .A combline established filter structure, is. Designed.Comblin resonator is a hybrid

construction whereas a coaxial transmission line is industrialized by a partial height post in sequence alongside a gap capacitor allocated in a rectangular or circular cavity. Comblin cavities use cut-off waveguide construction and hence are tiny contrasted to their counter portions in normal propagating waveguide structures.

Unlike the established comb-line filter, that has no metallic obstacle amid resonators, this filter employs rectangular cavities alongside coupling slots. This more reduces resonator lengths and thereby the finished filter length. This construction yields a somewhat higher unloaded quality factor because extra of the earth is enclosed. The coupling amid resonators is manipulated via the width of the slot, that in coil manipulation the bandwidth of the filter.

Relatively this construction has larger symmetry in the reply and the needed rejection might be encountered alongside eleven resonators. The cavity size/dimension is selected by the centre frequency and suppression reply of the filter. To comprehend the given filter specifications in an iris-coupled combline construction, the transmission and reflection parameters of Chebyshev transfer purpose and the coupling coefficient matrix from the low-pass prototype agents are determined.

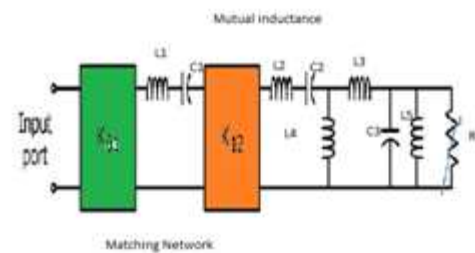


Fig.5 Iris circuit of combline filter

The manipulation grasping capacity of combline filter is manipulated by the gap capacitance industrialized amid the resonator open conclude and earth plane whereas the mechanical earth has its maximum intensity. This gap is normally a tiny fraction of the wavelength, making it susceptible to corona or multipaction. Due to this reason combline filters are normally not utilized for elevated manipulation applications. Though this paper displays the supplementary method of manipulation grasping capacity.Finished length of the filter, construction became decreased to nearly 450mm and the cavity cross-sectional dimension has been finalized to be 35mm × 32mm for the optimum performance. Due to impedance mismatch, these optimum dimensions cannot be undeviatingly interfaced alongside the preceding and achieving servings to save on heaviness and volume. To match the filter impedance to the rest of the suitable impedance transformers were projected and attached. By trying to rise the manipulation grasping skill of the filter, the earth outline was learned

employing HFSS. It is discovered that the top benefits of earth are pondered adjacent the sharp borders of the posts towards the basing planes. These sharp borders were rounded off alongside 1 mm radius and earth outline is noted again. It is noted that rounding of these borders the manipulation grasping capacity of the filter is enhanced by 57%. So this method is utilized widely. Estimation of multipactor is completed by the combine construction filter. The voltages of every single resonator of the elevated manipulation filter were discovered employing HFSS ideal and 200 W of input power. This is attained from the 3D ideal of the filter employing HFSS “field calculator” and by illustrating “polyline on every single field. Later ascertaining the voltages of the combine resonators, multipaction can be computed for disparate gaps employing multipactor threshold voltage by frequency in GHz and group gap in millimetres. Comblines Filters are silver plated inside. The hill of 63 V/(GHz•mm) for silver has been used. The scrutiny is established on the parallel plate ideal and the quality does not matters of the plating procedure in multipaction breakdown. It can additionally be utilized to ascertain the indicative multipaction thresholds ,but not precise values. The critical gap span of the combine filter, amid the resonator post open conclude and top cover, is distant from infinite parallel plate. In fact the aspect ratio of the gap (height/length) is >1. Consequently it is anticipated that multipactor threshold will be higher than the early one. When the tuning agents is gave in the filter the gap reduces. . Higher bandwidth is believed to accomplish lower insertion defeat and larger margin for multipaction.

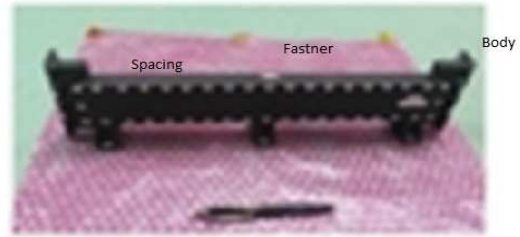


Fig.7 High Power Comblines Filter

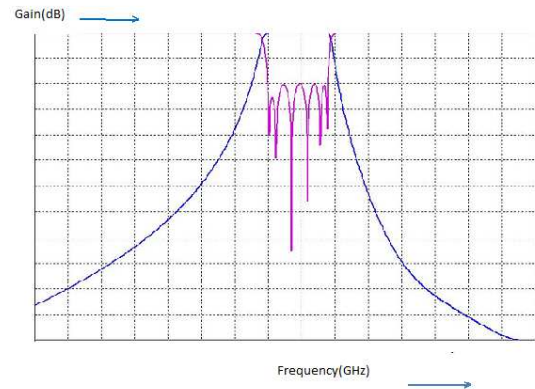


Fig.8 Response of Comblines Filter

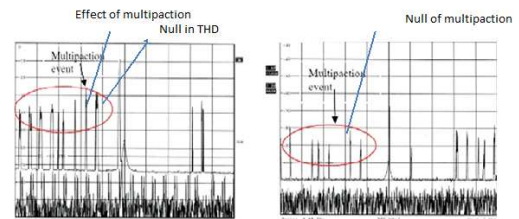


Fig.9 Result of Effect of Multipactor

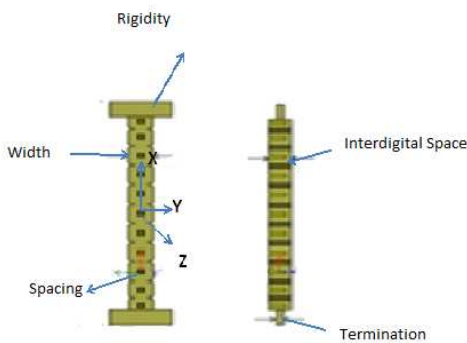


Fig.6 Comblines Filter for 11 pole iris

IV. CONCLUSION

Filter is projected for specifications of multipaction, insertion defeat, rejection, mass, and compact size. According to the number of servings, cavity cross serving, and supplementary parameters were optimized to encounter the main specifications. This arose in a bypass group bandwidth of concerning 100 MHz. This additionally caters to cover both the main and redundant frequencies in transmit/receive groups, dispersion due to temperature, and fabrication tolerances. This higher bandwidth helped to cut the insertion defeat and to spread the multipaction threshold margin to higher powers. The disadvantage of the increased bandwidth lies in the increased number of servings for the alike rejection and thereby physical length. But the disadvantage of possessing lesser bandwidth is that it needs loose coupling amid adjacent resonators that demands extra spacing amid them and thereby increases the finished

filter length. Consequently a bandwidth of 100 MHz for the design is chosen. IN supplement to these countless steps has to be seized for eg. circumventing tuning screws, circumventing dissimilar metal joints and uniform silver-plating the inner external, proper matching at the input/output, rounding off the sharp borders, etc. Later prosperous examinations the elevated manipulation filter is consolidated alongside the spacecraft.

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