A NOVEL MATCHED DIPLEXER CONFIGURATION IN E-PLANE TECHNOLOGY

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ABSTRACT

A new arrangement for the realization of waveguide diplexers is proposed.

A single inductive post, located in the cavity between the input waveguide and the bifurcation is used as matching element retaining full planar technology.

This provides a inexpensive and effective solution.

OUTLINE

Modal analyses of the E-plane technology diplexers have been presented in the literature [1,2,3], also including cascaded steps as matching elements.

Although such matching devices do improve the performance of the diplexers, their fabrication is mechanically critical and expensive.

If a single inductive sept , of the kind already used in the realization of branching filters, is employed as a matching device in the cavity between junction and filters, E-plane technology is maintained and considerable mechanical simplification ensues.

The resulting E-plane mask is shown in fig.1a and the abrupt E-plane step provides the housing. (fig.1b)

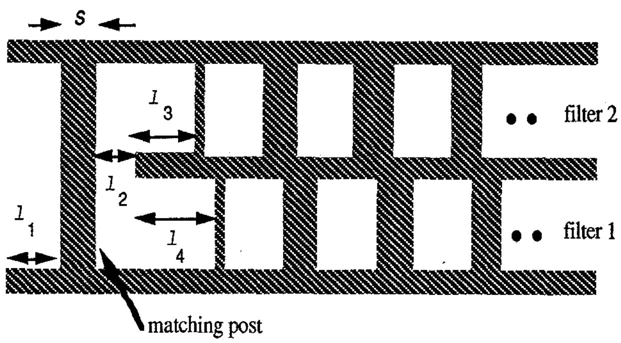


fig.1a mask of filters and matching post

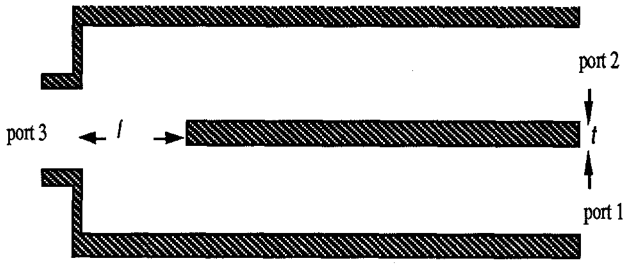
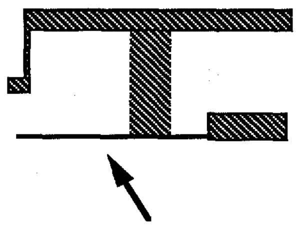


fig.1b longitudinal E-plane section of the housing

ANALYSIS

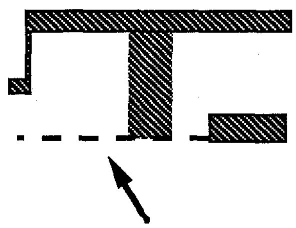
The structure under study is composed of a three-port junction two arms of which are closed by inductive filters. We focus now on the analysis of the three-port junction, whereas reference is made to [4] for that of the filters.

The problem is reduced by even and odd excitation mode decomposition to the two two-port configuration shown in fig. 2.



electric wall (even excitation at ports 1 and 2)

fig. 2a



magnetic wall (odd excitation at ports 1 and 2)

fig. 2b

DD

We recognize that each of the latter configurations consists of a cascade of three discontinuities; e.g. in fig. 2a an E-plane step, an inductive post and a second E-plane step. In fig. 2b, the problem is somewhat modified in order to account for the presence of a magnetic wall instead of a electric one over part of the lower boundary.

We employ the concept of 'accessible modes' [5] for each building block discontinuity.

The whole equivalent circuit of the two port, corresponding to the even excitation, is shown in fig. 3a.

Each block T_{ei} represents the transmission matrix of the i-th junction, considering TE_{10}, TE_{11}, TM_{11} and TE_{30} as accessible modes; Y are the corresponding modal characteristic admittances.

In the odd case, the whole equivalent circuit (fig.3b) reduces to a one port because of the absence of modes above cutoff in the regions containing the magnetic wall.

In the odd case the choice of the accessible modes depends on the kind of discontinuity.

For the first two kinds (the E-plane step and the post, both on a magnetic wall), a proper choice is TE_{11} and TM_{11}.

For the third kind (the E-plane step from a guide with a magnetic wall to a standard guide) we take TE_{11} and TM_{11} to the left and TE_{11} and TE_{10} to the right of the juntion.

The parameters of the matrices T_{ei} and T_{oi} are determined by the Galerkin variational method employing singular expanding functions with built in edge conditions [4].

Convergence of the admittance operators is accelerated by accurate asymptotic expansions.

Moreover, by keeping track analytically of the frequency dependence in the waveguide admittance operator, computing time for a simulation over the full band is little different from that of a spot-frequency calculation.

All these analytical manipulations result in a very agile code requiring little memory and capable of being accommodated on a small personal computer.

In term, this renders feasible an effective CAD synthesis of the diplexers with modest computing means.

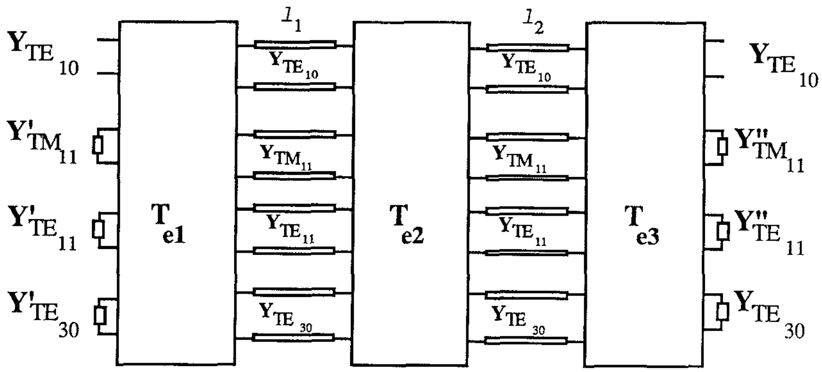


fig. 3a black-box equivalent circuit of the three ports junction under even excitation

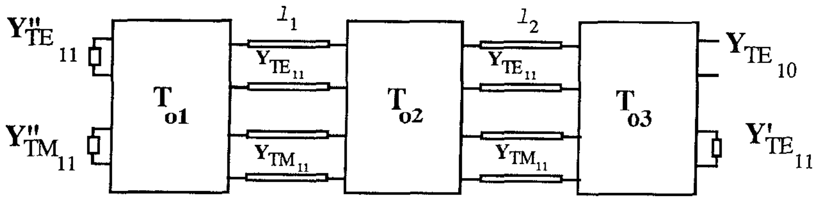


fig. 3b black-box equivalent circuit of the three ports junction under odd excitation

RESULTS

First, we tested the effectiveness of the matching arrangement, by simulating the three-ports junction with the post.

Fig. 4 shows the reflection coefficient at the common port (port3) of this junction for two different values of the lengths of the cavity and with the same post. For this thickness of the wall separating the two output waveguides, the junction would be considerably mismatched, but for the use of the matching post that recovers a good match over a wide band. Moreover, it is apparent how easily the junction can be tuned.

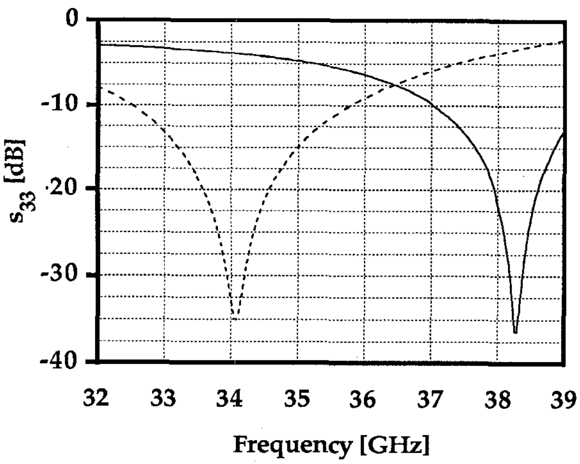


fig.4 Magnitudes of reflection coefficients at the ports of the three ports junction with the matching post: s=0.3mm, t=2mm
- - - l_1=5 mm, l_2=5mm; —— l_1=4.25 mm, l_2=6mm

Fig.5 shows the predicted performance of a diplexer, containing the filters described in table 1, optimized with the matching post in frequency band 35-39 GHz.

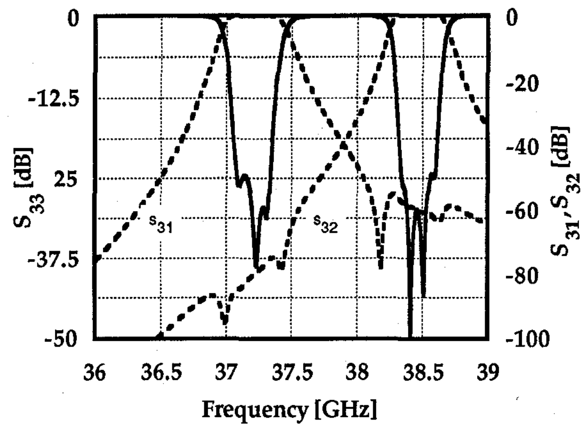


fig.5 Magnitudes of reflection coefficients at the ports of the diplexer with the matching postt l_1=3.952mm, l_2=4.302mm, s=0.3mm, l_3=1.593mm, l_4=2.601mm, t=2mm

length	Filter 1	Filter 2
s_1	2.198	2.540
l_2	3.053	2.798
s_3	6.440	7.367
l_4	3.076	2.774
s_5	7.113	8.120
l_6	3.076	2.774
s_7	6.440	7.367
l_8	3.053	2.798
s_9	2.198	2.540

table 1 lengths of septa (s) and cavities (l) of the simulated filters

In fig.6 we report a comparison between the reflection coefficients at the common port of the diplexer with and without the matching inductive post.In both cases, the dimension of the cavity was optimized to give the minimum insertion loss over the band of the filters.

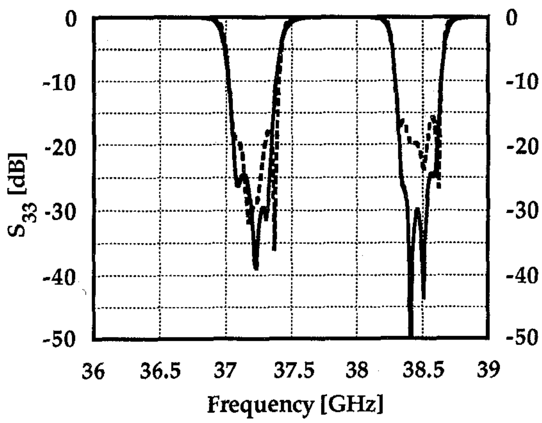


fig.6 Magnitude of reflection coefficient at the common port (port 3) of the diplexer with and without the matching post.

Analogous behaviour was found at different bands

It is also interesting to compare with fig.5, the performances of the individual 4-cavities filters used in both diplexers; this can be seen in fig.7.

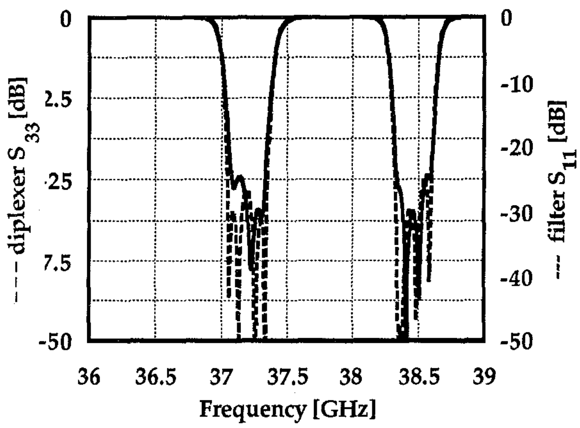


fig.7 Comparison between the magnitude of reflection coefficient at the common port of the diplexer with the matching post and those of the filters.

CONCLUSIONS

We propose a new E-plane solution to the problem of matching diplexer junctions.

The behaviour of the whole matched diplexer is investigated by rigourous field analysis and the numerical predictions of performance are promising.

Experimental prototypes are being constructed

REFERENCES

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