OSA

MULTIPLEXER FEASIBILITY STUDY

PART I: 12 GHZ

OSA-86-MX-1-R

January 7, 1986

Optimization Systems Associates

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Summary of Parameters

number of channels	12
order of the filters	6
center frequencies	11160, 11280, 11400, 11520 11640, 11760, 11880, 12000 12120, 12240, 12360, 12480
unloaded Q of filters	12000
filter diameters (inches)	1.07
mode of propagation	TE113
bandwidth parameter (MHz)	117
manifold width (inches)	0.75

Legend of Symbols

CM — symmetrical matrix of coupling parameters (channel,row, column) including nonzero diagonal elements to model asynchronous designs

PN1 — vector of input transformer ratios

PN2 — vector of output transformer ratios

WGL — vector of waveguide spacings for each channel, measured in inches from the adjacent channel or from the short circuit for the first channel

Remark

Nonzero diagonal elements in the coupling matrix indicate deviations from synchronous tuning which can be estimated from

$$M(i,i) = (w(i) - 1/w(i))/b$$

where M(i,i) is the nonzero diagonal coupling, w(i) is the ith cavity resonant frequency divided by the filter center frequency and b is the bandwidth parameter divided by the filter center frequency.

Discussion

Theory, models and algorithms are consistent with those presented in the papers listed in the bibliography. Details may be found in these two papers as well as the references listed in the papers. Dispersion, losses and parasitic effects are taken into account similarly to those used in the work reported in the bibliography. While the equivalent circuits used are felt to be reasonable given the current state of the art it is definitely recommended that the responses be verified by inhouse simulation and design programs with circuit parameters converted to appropriate ones as actually used.

With the foregoing caution in mind it does appear that one could expect successful results.

Close examination of the passband insertion loss for channels 2 and 11 do indicate somewhat poorer responses than for the other channels.

Not all the possible variables in each channel were actually optimized. Some of the diagonal elements and elements 4,5 and 5,6 of the coupling matrices were not adjusted. In all 96 variables were optimized using the given 20dB return loss specification. It can be expected, therefore, that improved responses could be obtained if more variables were released. More stringent insertion loss specifications on the other hand would probably degrade the return loss and isolation.

The numerical data presented in this report is not represented as exact. The number of digits should not be taken to imply accuracy or robustness of the solution. No sensitivity or tolerance analysis has been conducted to estimate the effects of cumulative errors or of possible mechanical tolerances. A relevant study is recommended for the future, particularly if difficulties in realization are encountered. The variable values are, of course, critically dependent on the models used.

In conclusion, if the models used in our computer program are valid and representative then equivalent results should be expected at 4GHz.

Bibliography

[1] J.W. Bandler, W. Kellermann and K.Madsen, "A superlinearly convergent minimax algorithm for microwave circuit design," IEEE Transactions on Microwave Theory and Techniques, vol. MTT-33, 1985 (December issue).

[2] J.W. Bandler, S. Daijavad and Q.J. Zhang, "Exact simulation and sensitivity analysis of multiplexing networks," IEEE Transactions on Microwave Theory and Techniques, vol. MTT-34, 1986 (January issue).

NUMBER OF CHANNELS: 12
ORDER OF THE FILTERS: 6

CM(1, 1, 1)	.07134711
CM(1, 1, 2)	.65234135
CM(1, 2, 2)	.00000000
CM(1, 2, 3)	.60143580
CM(1, 3, 3)	.00000000
CM(1, 3, 4)	.33433787
CM(1, 3, 6)	-.75252487
CM(1, 4, 4)	.00000000
CM(1, 4, 5)	1.04102000
CM(1, 5, 5)	.00000000
CM(1, 5, 6)	1.04238999
CM(1, 6, 6)	.00000000
PN1(1)	.84847387
PN2(1)	1.39721375
WGL(1)	.73386364

CM(2, 1, 1)	.14050786
CM(2, 1, 2)	.56034227
CM(2, 2, 2)	.00000000
CM(2, 2, 3)	.51581358
CM(2, 3, 3)	.00000000
CM(2, 3, 4)	.26937140
CM(2, 3, 6)	-.71377041
CM(2, 4, 4)	.00000000
CM(2, 4, 5)	1.04102000
CM(2, 5, 5)	.00000000
CM(2, 5, 6)	1.04238999
CM(2, 6, 6)	.00000000
PN1(2)	.94738240
PN2(2)	1.35425503
WGL(2)	.60468089

CM(3, 1, 1)	.08191081
CM(3, 1, 2)	.63249099
CM(3, 2, 2)	.00000000
CM(3, 2, 3)	.57278204
CM(3, 3, 3)	.00000000
CM(3, 3, 4)	.34987205
CM(3, 3, 6)	-.69495224
CM(3, 4, 4)	.00000000
CM(3, 4, 5)	1.04102000
CM(3, 5, 5)	.00000000
CM(3, 5, 6)	1.04238999
CM(3, 6, 6)	.00000000
PN1(3)	.95040848
PN2(3)	1.36064453
WGL(3)	.59346231

CM(4, 1, 1)	.07508871
CM(4, 1, 2)	.59747239
CM(4, 2, 2)	.00000000
CM(4, 2, 3)	.53624861
CM(4, 3, 3)	.00000000
CM(4, 3, 4)	.31224174
CM(4, 3, 6)	-.69671135
CM(4, 4, 4)	.00000000
CM(4, 4, 5)	1.04102000
CM(4, 5, 5)	.00000000
CM(4, 5, 6)	1.04238999
CM(4, 6, 6)	.00000000
PN1(4)	.91071337
PN2(4)	1.33703638
WGL(4)	.61494032

CM(5, 1, 1)	.05906465
CM(5, 1, 2)	.60957909
CM(5, 2, 2)	.00000000
CM(5, 2, 3)	.55331081
CM(5, 3, 3)	.00000000
CM(5, 3, 4)	.31703297
CM(5, 3, 6)	-.70477412
CM(5, 4, 4)	.00000000
CM(5, 4, 5)	1.04102000
CM(5, 5, 5)	.00000000
CM(5, 5, 6)	1.04238999
CM(5, 6, 6)	.00000000
PN1(5)	.90488734
PN2(5)	1.32833173
WGL(5)	.63220406

CM(6, 1, 1)	.08621262
CM(6, 1, 2)	.61913219
CM(6, 2, 2)	.00000000
CM(6, 2, 3)	.55298028
CM(6, 3, 3)	.00000000
CM(6, 3, 4)	.30671835
CM(6, 3, 6)	-.70608256
CM(6, 4, 4)	.00000000
CM(6, 4, 5)	1.04102000
CM(6, 5, 5)	.00000000
CM(6, 5, 6)	1.04238999
CM(6, 6, 6)	.00000000
PN1(6)	.92227006
PN2(6)	1.31925091
WGL(6)	.64507682

CM(7, 1, 1)	-.04841412
CM(7, 1, 2)	.57536292
CM(7, 2, 2)	.00000000
CM(7, 2, 3)	.55064605
CM(7, 3, 3)	.00000000
CM(7, 3, 4)	.32062915
CM(7, 3, 6)	-.72362593
CM(7, 4, 4)	.00000000
CM(7, 4, 5)	1.04102000
CM(7, 5, 5)	.00000000
CM(7, 5, 6)	1.04238999
CM(7, 6, 6)	.00000000
PN1(7)	.83209328
PN2(7)	1.30685593
WGL(7)	.63421545

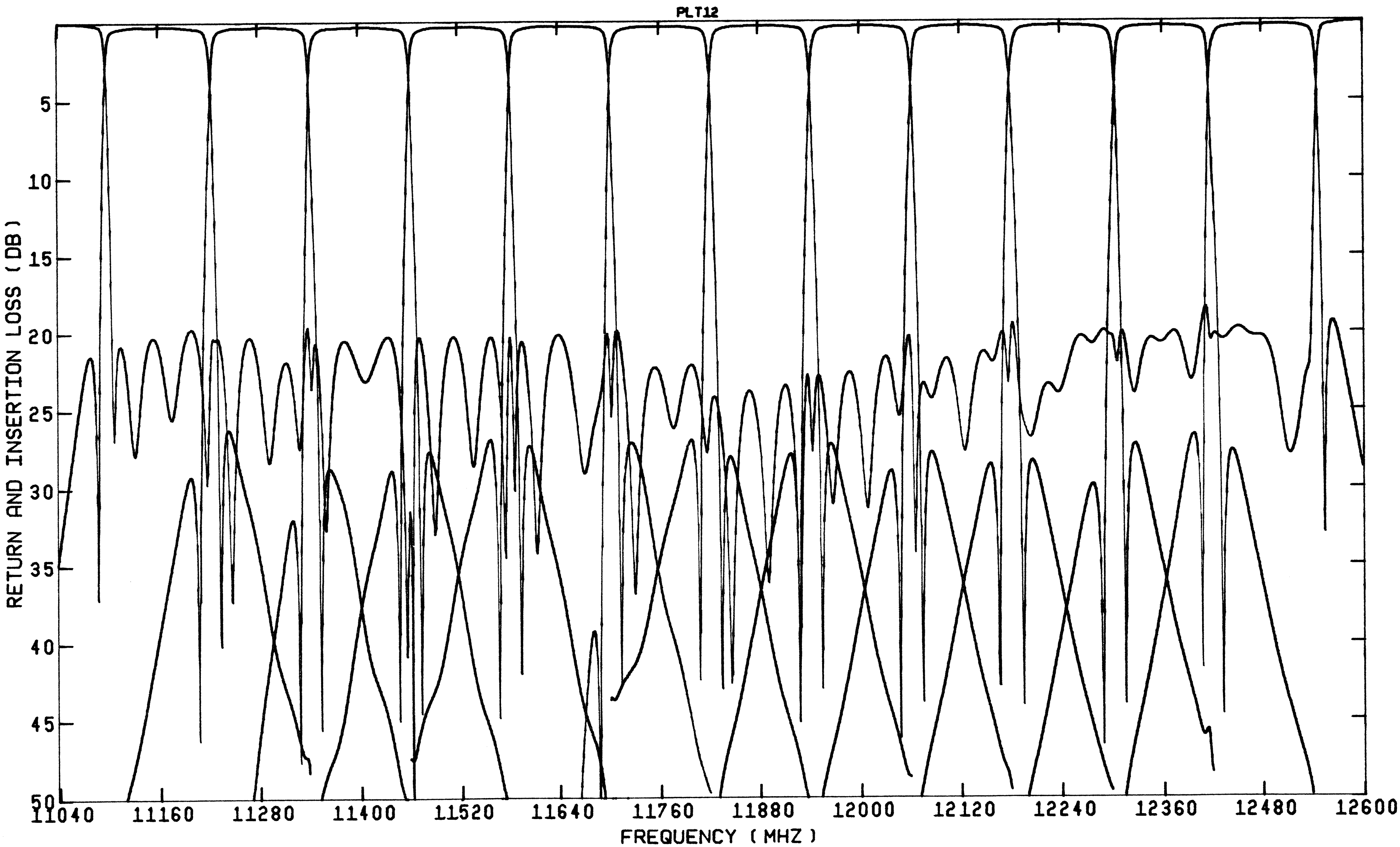
CM(8, 1, 1)	.05177514
CM(8, 1, 2)	.61642706
CM(8, 2, 2)	.00000000
CM(8, 2, 3)	.54256619
CM(8, 3, 3)	.00000000
CM(8, 3, 4)	.28996656
CM(8, 3, 6)	-.71183683
CM(8, 4, 4)	.00000000
CM(8, 4, 5)	1.04102000
CM(8, 5, 5)	.00000000
CM(8, 5, 6)	1.04238999
CM(8, 6, 6)	.00000000
PN1(8)	.85368863
PN2(8)	1.26461328
WGL(8)	.43194193

CM(9, 1, 1)	-.05545578
CM(9, 1, 2)	.58706571
CM(9, 2, 2)	.00000000
CM(9, 2, 3)	.55290187
CM(9, 3, 3)	.00000000
CM(9, 3, 4)	.31491691
CM(9, 3, 6)	-.71483163
CM(9, 4, 4)	.00000000
CM(9, 4, 5)	1.04102000
CM(9, 5, 5)	.00000000
CM(9, 5, 6)	1.04238999
CM(9, 6, 6)	.00000000
PN1(9)	.75125672
PN2(9)	1.28019143
WGL(9)	.65139710

CM(10, 1, 1)	-.09485008
CM(10, 1, 2)	.56860700
CM(10, 2, 2)	.00000000
CM(10, 2, 3)	.54407664
CM(10, 3, 3)	.00000000
CM(10, 3, 4)	.30549431
CM(10, 3, 6)	-.73453571
CM(10, 4, 4)	.00000000
CM(10, 4, 5)	1.04102000
CM(10, 5, 5)	.00000000
CM(10, 5, 6)	1.04238999
CM(10, 6, 6)	.00000000
PN1(10)	.72803922
PN2(10)	1.28107477
WGL(10)	.79730684

CM(11, 1, 1)	-.07084250
CM(11, 1, 2)	.57095237
CM(11, 2, 2)	.00000000
CM(11, 2, 3)	.53118372
CM(11, 3, 3)	.00000000
CM(11, 3, 4)	.29846584
CM(11, 3, 6)	-.71689392
CM(11, 4, 4)	.00000000
CM(11, 4, 5)	1.04102000
CM(11, 5, 5)	.00000000
CM(11, 5, 6)	1.04238999
CM(11, 6, 6)	.00000000
PN1(11)	.74127486
PN2(11)	1.29473739
WGL(11)	1.01944152

CM(12, 1, 1)	-.01015459
CM(12, 1, 2)	.62183695
CM(12, 2, 2)	.00000000
CM(12, 2, 3)	.58294073
CM(12, 3, 3)	.00000000
CM(12, 3, 4)	.32566348
CM(12, 3, 6)	-.73831006
CM(12, 4, 4)	.00000000
CM(12, 4, 5)	1.04102000
CM(12, 5, 5)	.00000000
CM(12, 5, 6)	1.04238999
CM(12, 6, 6)	.00000000
PN1(12)	.80305336
PN2(12)	1.35300021
WGL(12)	.82512007



Response of the 12 GHz multiplexer after optimization