OSA

MULTIPLEXER FEASIBILITY STUDY

PART II: 4 GHZ

OSA-86-MX-3-R

February 17, 1986

Optimization Systems Associates

163 Watson's Lane, Dundas, Ontario, Canada

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Summary of Parameters

number of channels	12
order of the filters	6
center frequencies	3720, 3760, 3800, 3840 3880, 3920, 3960, 4000 4040, 4080, 4120, 4160
unloaded Q of filters	12000
filter diameters (inches)	2.092
mode of propagation	TE113
bandwidth parameter (MHz)	39.0
manifold width (inches)	2.29

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. The deviations 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[1,2] 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. Reoptimization will be required if equivalent circuits, models, parasitics, etc. differ from those used to generate the results of this report.

Close examination of the passband insertion loss indicates somewhat better responses than those obtained under similar conditions for the 12 GHz study[3]. This is principally because more variables were optimized than before.

Most of the possible variables in every channel were actually optimized. A few elements of the coupling matrices were not adjusted. In all, however, some 170 variables were candidates for optimization using the given 20dB return loss specification. At most 96 variables were optimized at any one time. Groups of channels were optimized selectively using additional variables to improve their response as necessary. The tabulated results indicate only nonzero variable values. The number of such variables for each channel is not always the same.

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 of tolerance and parasitic effects is recommended for the future, particularly if difficulties in realization are encountered. The actual design values are, of course, critically dependent on the circuit models used and assumptions made.

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, pp. 1519-1530.

[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, pp. 93-102.

[3] "Multiplexer feasibility study Part I:12 GHz," Report OSA-86-MX-1-R, January 7,1986.

NUMBER OF CHANNELS:	12
ORDER OF THE FILTERS:	6

CM(1, 1, 1)	-.11040303
CM(1, 1, 2)	.64758170
CM(1, 2, 2)	-.03245751
CM(1, 2, 3)	.55924828
CM(1, 3, 3)	-.00500703
CM(1, 3, 4)	.44466410
CM(1, 3, 6)	-.39676800
CM(1, 4, 4)	.01169935
CM(1, 4, 5)	.83561887
CM(1, 5, 5)	.00661345
CM(1, 5, 6)	.76644075
CM(1, 6, 6)	.00082371
PN1(1)	.67640684
PN2(1)	1.05665119
WGL(1)	2.02053969

CM(2, 1, 1)	-.01720271
CM(2, 1, 2)	.57412882
CM(2, 2, 2)	-.00667832
CM(2, 2, 3)	.51992778
CM(2, 3, 3)	-.00209813
CM(2, 3, 4)	.39493661
CM(2, 3, 6)	-.42615332
CM(2, 4, 4)	.00175487
CM(2, 4, 5)	.83221524
CM(2, 5, 5)	.00156100
CM(2, 5, 6)	.76060462
CM(2, 6, 6)	-.00139186
PN1(2)	.67632935
PN2(2)	1.07158472
WGL(2)	1.85096207

CM(3, 1, 1)	-.02545589
CM(3, 1, 2)	.59652643
CM(3, 2, 2)	-.00588439
CM(3, 2, 3)	.54568924
CM(3, 3, 3)	-.00192424
CM(3, 3, 4)	.44339627
CM(3, 3, 6)	-.39250901
CM(3, 4, 4)	-.00113141
CM(3, 4, 5)	.83731011
CM(3, 5, 5)	-.00070307
CM(3, 5, 6)	.76551868
CM(3, 6, 6)	-.00166686
PN1(3)	.72958560
PN2(3)	1.05634042
WGL(3)	1.88425933

CM(4, 1, 1)	-.02303376
CM(4, 1, 2)	.58022074
CM(4, 2, 2)	.00012310
CM(4, 2, 3)	.52910378
CM(4, 3, 3)	.00039939
CM(4, 3, 4)	.41486134
CM(4, 3, 6)	-.40902717
CM(4, 4, 5)	.83371000
CM(4, 5, 6)	.76313000
PN1(4)	.74493965
PN2(4)	1.07105427
WGL(4)	1.92274760

CM(5, 1, 1)	-.01492996
CM(5, 1, 2)	.59093781
CM(5, 2, 2)	.00041848
CM(5, 2, 3)	.53835936
CM(5, 3, 3)	.00009137
CM(5, 3, 4)	.43411212
CM(5, 3, 6)	-.39857738
CM(5, 4, 5)	.83371000
CM(5, 5, 6)	.76313000
PN1(5)	.79222746
PN2(5)	1.05455736
WGL(5)	1.96531430

CM(6, 1, 1)	.02528255
CM(6, 1, 2)	.58766883
CM(6, 2, 2)	-.00725504
CM(6, 2, 3)	.52671312
CM(6, 3, 3)	.00061589
CM(6, 3, 4)	.40640760
CM(6, 3, 6)	-.42794812
CM(6, 4, 4)	.00124374
CM(6, 4, 5)	.83781895
CM(6, 5, 5)	.00121006
CM(6, 5, 6)	.76663791
CM(6, 6, 6)	-.00222430
PN1(6)	.86932329
PN2(6)	1.07330259
WGL(6)	2.00367826

CM(7, 1, 1)	.08626233
CM(7, 1, 2)	.62712625
CM(7, 2, 2)	.00761155
CM(7, 2, 3)	.54413087
CM(7, 3, 3)	.01476916
CM(7, 3, 4)	.43848729
CM(7, 3, 6)	-.39364246
CM(7, 4, 4)	.01082620
CM(7, 4, 5)	.84096963
CM(7, 5, 5)	.00165451
CM(7, 5, 6)	.77446829
CM(7, 6, 6)	.00185591
PN1(7)	.92436657
PN2(7)	1.06685677
WGL(7)	1.97441441

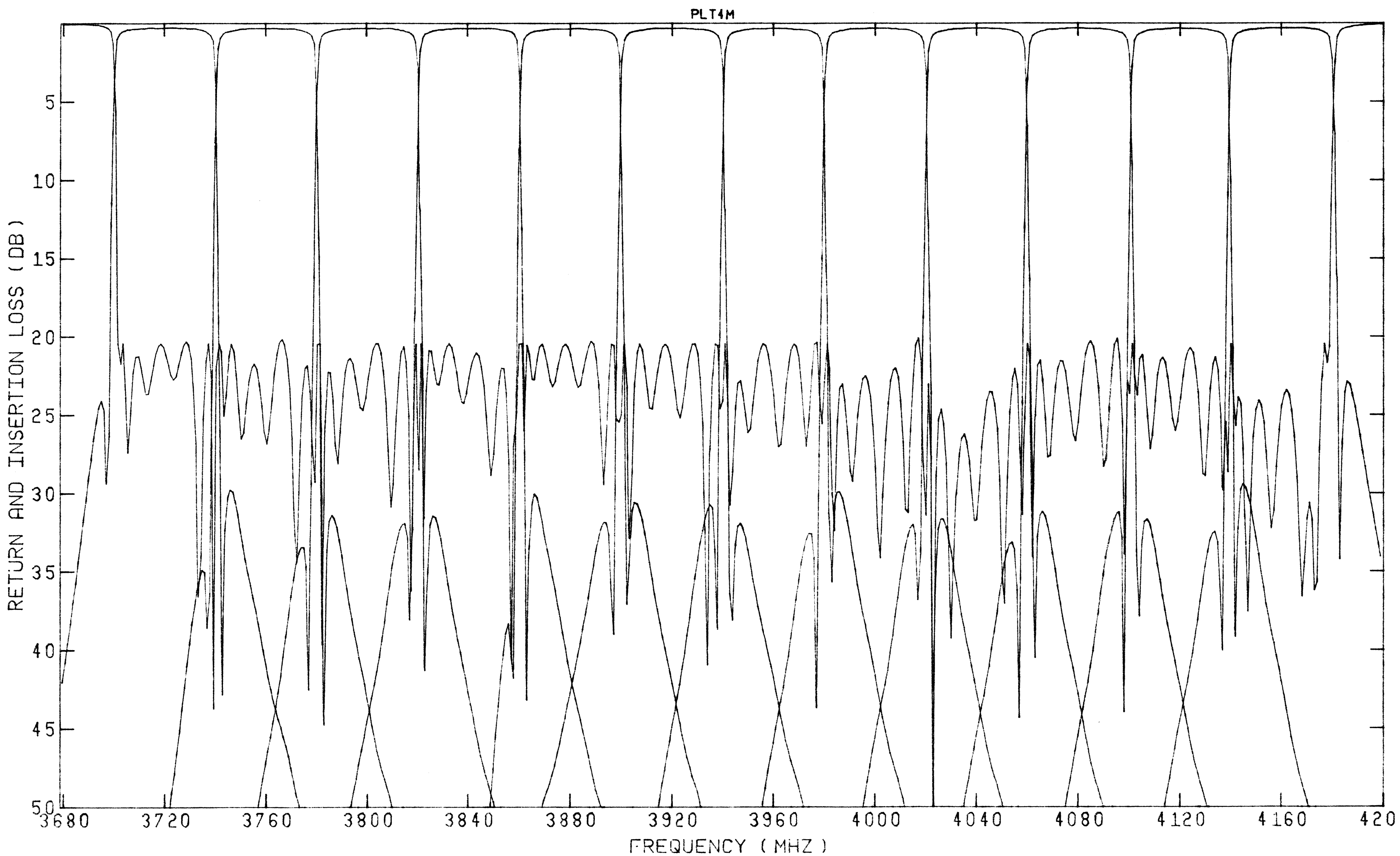
CM(8, 1, 1)	-.06569636
CM(8, 1, 2)	.56014040
CM(8, 2, 2)	-.01082428
CM(8, 2, 3)	.52273261
CM(8, 3, 3)	.01293952
CM(8, 3, 4)	.40205792
CM(8, 3, 6)	-.43270044
CM(8, 4, 4)	.00533929
CM(8, 4, 5)	.83542837
CM(8, 5, 5)	.01313653
CM(8, 5, 6)	.78222518
CM(8, 6, 6)	.01053222
PN1(8)	.83054641
PN2(8)	1.10614679
WGL(8)	1.86808734

CM(9, 1, 1)	-.02971233
CM(9, 1, 2)	.58743648
CM(9, 2, 2)	-.00922478
CM(9, 2, 3)	.53534564
CM(9, 3, 3)	-.00137679
CM(9, 3, 4)	.41547600
CM(9, 3, 6)	-.42719498
CM(9, 4, 4)	-.00378127
CM(9, 4, 5)	.84373034
CM(9, 5, 5)	-.00217508
CM(9, 5, 6)	.79588598
CM(9, 6, 6)	-.00486491
PN1(9)	.79210718
PN2(9)	1.10361853
WGL(9)	1.27961365

CM(10, 1, 1)	-.08834370
CM(10, 1, 2)	.57724689
CM(10, 2, 2)	-.00373800
CM(10, 2, 3)	.53922161
CM(10, 3, 3)	.00060391
CM(10, 3, 4)	.43053728
CM(10, 3, 6)	-.39772896
CM(10, 4, 5)	.83371000
CM(10, 5, 6)	.76313000
PN1(10)	.72571318
PN2(10)	1.06270312
WGL(10)	2.07476529

CM(11, 1, 1)	-.10383797
CM(11, 1, 2)	.55882927
CM(11, 2, 2)	-.01063315
CM(11, 2, 3)	.52855224
CM(11, 3, 3)	-.00335691
CM(11, 3, 4)	.41491326
CM(11, 3, 6)	-.40678665
CM(11, 4, 4)	-.00173728
CM(11, 4, 5)	.83517140
CM(11, 5, 5)	-.00057171
CM(11, 5, 6)	.76297283
CM(11, 6, 6)	.00003896
PN1(11)	.69698387
PN2(11)	1.06116529
WGL(11)	2.34938501

CM(12, 1, 1)	-.00168563
CM(12, 1, 2)	.61821317
CM(12, 2, 2)	.02122902
CM(12, 2, 3)	.54525247
CM(12, 3, 3)	.02628280
CM(12, 3, 4)	.42199565
CM(12, 3, 6)	-.42024848
CM(12, 4, 4)	.00631661
CM(12, 4, 5)	.83716958
CM(12, 5, 5)	-.00058774
CM(12, 5, 6)	.76875345
CM(12, 6, 6)	-.00393626
PN1(12)	.78290625
PN2(12)	1.09196255
WGL(12)	2.81190269



Response of the 4 GHz multiplexer after optimization