CONTIGUOUS BAND MULTIPLEXER

SIMULATION AND OPTIMIZATION

OSA-84-MX-9-T

February 29, 1984

SUMMARY

This document contains the main segment MXSOS2 (pp. 3-14) of the MXSOS2 package compatible with Document OSA-84-MX-7-L[1] as well as Subroutine FDF2 (pp. 15-17) as called by the MMLC optimization package[2]. Dimension and executable statements clearly identify a 45 variable optimization problem related to a 3-channel multiplexer. (See [3]).

Specifically, all degrees of freedom currently available to MXSOS2 are optimized for all of the three channels. Data is explicitly presented and easily verified. Appropriate specifications have been imposed on channel insertion loss at 45 frequencies. Twenty dB return loss specifications have been imposed at the same 45 frequencies as well as at the two interior crossover frequencies. This problem resulted from a 5-channel multiplexer whose dummy channels 1 and 5 have been removed. Starting parameter values correspond to ComDev optimized values. The filters are lossy and dispersive with unloaded Q=12000; nonideal junctions are assumed.

As Fig. 1 on page 22 demonstrates the 20 dB return loss specification is well-satisfied over the entire band of interest. However, it may be seen that the degrees of freedom have resulted in crossover behaviour which may not be regarded as totally acceptable. This should be easily overcome by tighter specifications on insertion loss at a wider selection of passband frequencies, coming closer to the crossovers.

In conclusion, 92 nonlinear minimax functions of 45 variables have been optimized in 65 complete response evaluations taking about 460 CPU seconds, as exemplified by actual output from MMLC (pp. 18-21).

REFERENCES

[1] Document OSA-84-MX-7-L, "Contiguous band multiplexer simulation and optimization," Optimization Systems Associates, Dundas, Ontario, Canada, February 29, 1984.

[2] J. W. Bandler and W. M. Zuberek, "MMLC - a Fortran package for linearly constrained minimax optimization," McMaster University, Hamilton, Canada, Report SOS-82-5-U2/L2, August 1983.

[3] Document OSA-84-MX-4-T, "Contiguous band multiplexer simulation and optimization," Optimization Systems Associates, Dundas, Ontario, Canada, January 31, 1984.

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      PROGRAM MXSOS2(OUTPUT,TAPE6=OUTPUT)                                    000001
C                                                                            000002
C     THIS PROGRAM IS A USER DEFINED MAIN SEGMENT OF THE MXSOS2 PACKAGE      000003
C     FOR MULTIPLEXER SIMULATION, SENSITIVITY ANALYSIS AND OPTIMIZATION.     000004
C     THE PROGRAM SETS UP ARRAYS, INITIALIZES THE DATA AND EXECUTES SOME     000005
C     SIMPLE STEPS TO ORGANIZE THE PROBLEM AS REQUIRED BY THE PACKAGE.       000006
C     IT CONSISTS OF THREE PARTS. THE FIRST PART INITIALIZES THE DATA        000007
C     REQUIRED FOR SIMULATION, THE SECOND PART INITIALIZES ADDITIONAL        000008
C     DATA REQUIRED FOR SENSITIVITY ANALYSIS AND THE THIRD PART INITIA-      000009
C     LIZES THE DATA REQUIRED FOR THE MULTIPLEXER OPTIMIZATION PROBLEM       000010
C     OF INTEREST INCLUDING SPECIFICATIONS AND WEIGHTING FACTORS AS WELL     000011
C     AS THE DATA REQUIRED BY THE MINIMAX OPTIMIZATION PACKAGE MMLC. AT      000012
C     THIS TIME ONLY COMMON PORT RETURN LOSS AND CHANNEL INSERTION LOSS      000013
C     IN DB ARE HANDLED FOR OPTIMIZATION. IN THE CASE OF SIMULATION          000014
C     GROUP DELAY IS ESTIMATED BY DIFFERENCING THE PHASE AT A PAIR           000015
C     OF FREQUENCIES.                                                        000016
C                                                                            000017
C     THE USER MUST PROVIDE APPROPRIATE DIMENSIONS FOR THE FOLLOWING         000018
C     VARIABLES AFTER STUDYING THE COMMENTS PLACED THROUGHOUT THE MAIN        000019
C     SEGMENT MXSOS2. CORRESPONDING DIMENSIONS MUST BE DECLARED IN ALL       000020
C     SUBROUTINES EXCEPT FOR THE MMLC PACKAGE.                               000021
C                                                                            000022
      REAL X(45),W(20000),B(1),C(1,1),T(3),DISP(16),QO(16)                   000023
      REAL OMEGA(47),SURL(47),SLRL(47),WURL(47),WLRL(47),                    000024
     1     SU(20,16),SL(20,16),WU(20,16),WL(20.16)                           000025
      INTEGER RLSCODE(47),SPCODE(20,16),CHBCODE(16,2)                        000026
      REAL WO(16),BW(16),CM(16,8,8),PN1(16),PN2(16),SPN1(16),SPN2(16),       000027
     1          GL(16),WGL(16),DIA(16)                                       000028
      INTEGER CEL(16,8,8)                                                    000029
      REAL FCNST(16),LAMRES(16),LAMDEL(16)                                   000030
      REAL DRL(100),FIL(16),DIL(16,100)                                      000031
      REAL ANGLE1(16),ANGLE2(16),GRDEL(16)                                   000032
      INTEGER IR(16),IRT(16),IPN1(16),IPN2(16),IWG(16)                       000033
      INTEGER LC(16,36),KC(16,36)                                            000034
      EXTERNAL FDF2                                                          000035
      COMMON /BLK1/WO,BW,PN1,PN2,GL,VS,RS,PI2,WIDTH,NP1                      000036
      COMMON /BLK2/CM,WGL                                                    000037
      COMMON /BLK3/OMEGA,SURL,SLRL,WURL,WLRL,SU,SL,WU,WL,                    000038
     1            RLSCODE,SPCODE,NCOUNT,MODE,NCH,MO,NFREQ,NFRL,              000039
     2       CHBCODE,IFLAGJS,IFLAGDP,IDISPER                                 000040
      COMMON /BLK4/CBR,FCUT                                                  000041
      COMMON /BLK5/DISP                                                      000042
      COMMON/BLK6/FCNST,LAMRES,LAMDEL                                        000043
      COMMON/BLK7/CEL                                                        000044
      COMMON/BLK8/IR,IRT,IPN1,IPN2,IWG,LC,KC                                 000045
      DATA T/10HMULTIPLEXE,10HR PROBLEM ,10HMXTST6C    /                     000046
C                                                                            000047
C     THE MXSOS2 PACKAGE CAN OPERATE IN THREE MODES: SIMULATION, SENSITI     000048
C     VITY ANALYSIS AND OPTIMIZATION. TO SELECT THE REQUIRED FUNCTION OF     000049
C     THE PACKAGE SET LMODE TO                                               000050
C     1 - IF MULTIPLEXER SIMULATION IS REQUIRED,                             000051
C     2 - IF MULTIPLEXER SENSITIVITY ANALYSIS IS REQUIRED,                   000052
C     3 - IF MULTIPLEXER OPTIMIZATION IS REQUIRED.                           000053
C                                                                            000054
C     SELECT MODE OF OPERATION OF THE PACKAGE                                000055
C                                                                            000056
      LMODE=3                                                                000057
C                                                                            000058
C     THIS PART OF THE MAIN SEGMENT IS USED TO DEFINE THE DATA FOR           000059
C     MULTIPLEXER SIMULATION. IT MUST ALWAYS BE DEFINED, REGARDLESS OF       000060
C     THE MODE OF OPERATION OF THE PACKAGE SELECTED.                         000061
C                                                                            000062
C     NCH     - NUMBER OF FILTER CHANNELS INCLUDING DUMMY CHANNELS           000063
C     MO      - ORDER OF FILTERS(THE SAME FOR ALL FILTERS, ODD OR EVEN)      000064
C     WO      - VECTOR OF CENTER FREQUENCIES IN MHZ, ONE PER CHANNEL         000065
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C      QO      - VECTOR OF UNLOADED Q FOR THE FILTERS, ONE PER CHANNEL      000066
C      DIA     - VECTOR OF FILTER DIAMETERS IN INCHES, ONE PER CHANNEL      000067
C      BW      - VECTOR OF CHANNEL BANDWIDTHS IN MHZ, ONE PER CHANNEL       000068
C      SPN1    - VECTOR OF INPUT TRANSFORMER RATIOS(SQUARED), ONE PER       000069
C                CHANNEL                                                    000070
C      SPN2    - VECTOR OF OUTPUT TRANSFORMER RATIOS(SQUARED), ONE PER      000071
C                CHANNEL                                                    000072
C      GL      - VECTOR OF CHANNEL TERMINATING CONDUCTANCES, ONE PER        000073
C                CHANNEL                                                    000074
C      CM      - SYMMETRICAL MATRIX OF COUPLING PARAMETERS(CHANNEL,ROW,     000075
C                COLUMN), INCLUDING NONZERO DIAGONAL ELEMENTS TO MODEL      000076
C                ASYNCHRONOUS DESIGNS                                       000077
C      CEL     - SYMMETRICAL MATRIX FOR TYPE OF COUPLING, +1 FOR SCREW,     000078
C                -1 FOR IRIS, CORRESPONDING TO CM AS ABOVE                  000079
C      WGL     - VECTOR OF WAVEGUIDE SPACINGS FOR EACH CHANNEL, MEASURED    000080
C                IN INCHES ALONG THE MANIFOLD FROM THE ADJACENT CHANNEL     000081
C                (DISTANCE FROM THE SHORT CIRCUIT FOR THE FIRST CHANNEL)    000082
C      VS      - SOURCE VOLTAGE AT THE COMMON PORT                          000083
C      RS      - SOURCE RESISTANCE AT THE COMMON PORT                       000084
C      PI2     - CONSTANT EQUAL TO TWICE PI                                 000085
C      WIDTH   - MANIFOLD WIDTH IN INCHES                                   000086
C                                                                           000087
C      DEFINE THE NUMBER OF CHANNELS AND THE ORDER OF THE FILTERS           000088
C                                                                           000089
       NCH=3                                                               000090
       MO=6                                                                000091
       NP1=NCH+1                                                           000092
C                                                                          000093
C      DEFINE CENTER FREQUENCIES IN MHZ                                    000094
C                                                                          000095
       WO(1)=12060.0                                                       000096
       WO(2)=12020.0                                                       000097
       WO(3)=11980.0                                                       000098
C                                                                          000099
C      DEFINE UNLOADED Q FACTORS OF THE FILTERS                            000100
C                                                                          000101
       DO 5 I=1,NCH                                                        000102
       QO(I)=12000.0                                                       000103
     5 CONTINUE                                                            000104
C                                                                          000105
C      DEFINE THE DIAMETER OF THE FILTERS IN INCHES                        000106
C                                                                          000107
       DO 70 I=1,NCH                                                       000108
       DIA(I)=1.07                                                         000109
    70 CONTINUE                                                            000110
C                                                                          000111
C      DEFINE BANDWIDTHS, INPUT/OUTPUT TRANSFORMER RATIOS AND OUTPUT       000112
C      CONDUCTANCES                                                        000113
C                                                                          000114
       DO 1 I=1,NCH                                                        000115
       BW(I)=39.5                                                          000116
       GL(I)=1.0                                                           000117
       SPN1(I)=0.69967                                                     000118
       SPN2(I)=1.09450                                                     000119
       PN1(I)=SQRT(SPN1(I))                                                000120
       PN2(I)=SQRT(SPN2(I))                                                000121
     1 CONTINUE                                                            000122
C                                                                          000123
C      DEFINE THE SYMMETRICAL COUPLING MATRIX. ONLY THE UPPER PART OF THE  000124
C      CM MATRIX HAS TO BE DEFINED.                                        000125
C                                                                          000126
       DO 30 I=1,NCH                                                       000127
       DO 30 J=1,MO                                                        000128
       DO 30 KK=1,MO                                                       000129
       CM(I,J,KK)=0.0                                                      000130
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   30 CONTINUE                                                          000131
      DO 2 I=1,NCH                                                      000132
      CM(I,1,2)=0.59395                                                 000133
      CM(I,2,3)=0.53514                                                 000134
      CM(I,3,4)=0.42471                                                 000135
      CM(I,3,6)=-0.39967                                                000136
      CM(I,4,5)=0.83371                                                 000137
      CM(I,5,6)=0.76313                                                 000138
    2 CONTINUE                                                          000139
C                                                                       000140
C     DEFINE THE TYPE OF COUPLING IN THE FILTER                         000141
C              +1 >> SCREW COUPLING    -1 >> IRIS COUPLING              000142
C                                                                       000143
      DO 71 I=1,NCH                                                     000144
      DO 71 J=1,MO                                                      000145
      DO 71 KK=1,MO                                                     000146
      CEL(I,J,KK)=0                                                     000147
   71 CONTINUE                                                          000148
C                                                                       000149
      DO 72 I=1,NCH                                                     000150
      CEL(I,1,2)=1                                                      000151
      CEL(I,2,3)=-1                                                     000152
      CEL(I,3,4)=1                                                      000153
      CEL(I,3,6)=-1                                                     000154
      CEL(I,4,5)=-1                                                     000155
      CEL(I,5,6)=1                                                      000156
C                                                                       000157
      DO 72 J=1,MO                                                      000158
      DO 72 KK=1,J                                                      000159
      CEL(I,J,KK)=CEL(I,KK,J)                                           000160
   72 CONTINUE                                                          000161
C                                                                       000162
C     DEFINE THE SECTION LENGTHS (SPACINGS ALONG THE WAVEGUIDE MANIFOLD) 000163
C                                                                       000164
      WGL(1)=0.641                                                      000165
      WGL(2)=0.631                                                      000166
      WGL(3)=0.633                                                      000167
C                                                                       000168
C     DEFINE SOME CONSTANTS, SOURCE VOLTAGE, SOURCE RESISTANCE, TWICE PI 000169
C     MANIFOLD WIDTH                                                    000170
C                                                                       000171
      VS=1.0                                                            000172
      RS=1.0                                                            000173
      PI2=8.0*ATAN(1.0)                                                 000174
      WIDTH=0.75                                                        000175
C                                                                       000176
C     THE MXSOS2 PACKAGE CAN EXPLOIT THREE PRACTICAL MODELS OF THE      000177
C     MULTIPLEXER AS DETERMINED BY THE PARAMETERS IFLAGJS, IFLAGDP      000178
C     AND IDISPER.                                                      000179
C                                                                       000180
C     IFLAGJS                                                           000181
C     0 - IF JUNCTIONS ARE IDEAL                                        000182
C     1 - IF JUNCTIONS ARE NONIDEAL                                     000183
C                                                                       000184
C     IFLAGDP                                                           000185
C     0 - IF FILTERS ARE LOSSLESS                                       000186
C     1 - IF FILTERS ARE LOSSY                                          000187
C                                                                       000188
C     IDISPER                                                           000189
C     0 - IF FILTERS ARE DISPERSIVE                                     000190
C     1 - IF FILTERS ARE NONDISPERSIVE                                  000191
C                                                                       000192
C     FLAG FOR JUNCTION SUSCEPTANCE (SET TO 0 OR 1)                     000193
C                                                                       000194
      IFLAGJS=1                                                         000195
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      IF(IFLAGJS.NE.1)GO TO 42                                          000196
C                                                                       000197
      CALL CONST1(WIDTH)                                                000198
C                                                                       000199
   42 CONTINUE                                                          000200
C                                                                       000201
C     FLAG FOR FILTER DISSIPATION (SET TO 0 OR 1)                       000202
C                                                                       000203
      IFLAGDP=1                                                         000204
      IF(IFLAGDP.NE.1)GO TO 43                                          000205
C                                                                       000206
      CALL DISPAT(NCH,WO,BW,QO)                                         000207
C                                                                       000208
   43 CONTINUE                                                          000209
C                                                                       000210
C     FLAG FOR DISPERSIVE EFFECTS IN THE COUPLED CAVITY FILTERS         000211
C     (SET TO 0 OR 1)                                                   000212
C                                                                       000213
      IDISPER=1                                                         000214
      IF(IDISPER.NE.1)GO TO 44                                          000215
C                                                                       000216
      CALL DISPER(NCH,WO,BW,DIA)                                        000217
C                                                                       000218
   44 CONTINUE                                                          000219
C                                                                       000220
C     CHECK WHETHER THE SIMULATION MODE IS REQUIRED                     000221
C                                                                       000222
      IF(LMODE.NE.1)GO TO 16                                            000223
C                                                                       000224
C     SIMULATION, CORRESPONDING TO LMODE=1                              000225
C                                                                       000226
C     THIS PART OF THE MAIN SEGMENT IS USED TO GENERATE FREQUENCIES AT  000227
C     WHICH SIMULATION IS TO BE PERFORMED. A FREQUENCY STEP OF 1 MHZ IS 000228
C     ASSUMED. NONE OF THE GENERATED FREQUENCIES MUST BE SET EQUAL TO   000229
C     ANY OF THE CENTER FREQUENCIES. SUBROUTINE "SIMUL" IS CALLED AT    000230
C     EACH GENERATED FREQUENCY. IF A DIFFERENT FREQUENCY STEP IS REQUI- 000231
C     RED THE FREQUENCY POINTS FOR SIMULATION HAVE TO BE GENERATED IN A 000232
C     DIFFERENT WAY.                                                    000233
C                                                                       000234
C     FREQST - START FREQUENCY FOR SIMULATION                           000235
C     FREQ   - ACTUAL FREQUENCY AT WHICH "SIMUL" IS CALLED              000236
C     NFRSIM - NUMBER OF FREQUENCY POINTS FOR SIMULATION                000237
C                                                                       000238
      PRINT(6,199)                                                      000239
  199 FORMAT(1H1)                                                       000240
      PRINT(6,205)                                                      000241
  205 FORMAT(6X,"FREQUENCY",5X,"RETURN LOSS",5X,"INSERTION LOSS",       000242
     1         8X,"FREQUENCY FOR",7X,"GROUP DELAY")                     000243
      PRINT(6,206)                                                      000244
  206 FORMAT(8X,"MHZ",9X,"COMMON PORT",9X,"DB",17X,"GROUP DELAY",       000245
     1        9X,"NANO SECS")                                           000246
C                                                                       000247
C                                                                       000248
C     THE FOLLOWING TWO PARAMETERS MUST BE DEFINED                      000249
C                                                                       000250
      FREQST=11919.0                                                    000251
      NFRSIM=200                                                        000252
C                                                                       000253
      NCHAN=NCH                                                         000254
      MORDER=MO                                                         000255
      IREL=NCH+1                                                        000256
      DO 200 ICOUNT=1,NFRSIM                                            000257
      FREQ=FREQST+FLOAT(ICOUNT)                                         000258
      ITEST=INT(FREQ)                                                   000259
C                                                                       000260
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C       THE FOLLOWING STATEMENT PRINTS DASHED LINE EVERY 20 MHZ                 000261
C                                                                               000262
        IF(MOD(ITEST,20).EQ.0)PRINT(6,208)                                      000263
  208   FORMAT(90("-"))                                                         000264
        DO 210 I=1,NCH                                                          000265
        IF(ABS(FREQ-WO(I)).LT.1.E-10)FREQ=FREQ+0.001                            000266
  210   CONTINUE                                                                000267
C                                                                               000268
C       GROUP DELAY IS ESTIMATED FROM THE PHASE DIFFERENCE AT TWO               000269
C       FREQUENCIES, NAMELY, THE SELECTED FREQUENCY AND THE SELECTED            000270
C       FREQUENCY MINUS 0.5 MHZ. CONSEQUENTLY, THE EVALUATION IS A              000271
C       TRUE QUADRATIC APPROXIMATION AT THE SELECTED FREQUENCY MINUS            000272
C       0.25 MHZ. THUS, A SEPARATE COLUMN OF FREQUENCIES AND GROUP              000273
C       DELAYS IS GENERATED AND PRINTED OUT.                                    000274
C                                                                               000275
C       SUBTRACT 0.5 MHZ FROM FREQ                                              000276
C                                                                               000277
        FREQ=FREQ-0.5                                                           000278
C                                                                               000279
        CALL SIMUL(FREQ,NCHAN,MORDER,ICOUNT,IFLAGJS,IFLAGDP,IDISPER,            000280
       1           FRL,FIL,ANGLE1)                                              000281
C                                                                               000282
C       RESET FREQ BY ADDING 0.5 MHZ                                            000283
C                                                                               000284
        FREQ=FREQ+0.5                                                           000285
C                                                                               000286
        CALL SIMUL(FREQ,NCHAN,MORDER,ICOUNT,IFLAGJS,IFLAGDP,IDISPER,            000287
       1           FRL,FIL,ANGLE2)                                              000288
C                                                                               000289
        DO 300 I=1,NCH                                                          000290
        DELANG=ANGLE2(I)-ANGLE1(I)                                              000291
        PI=PI2/2.0                                                              000292
        IF(DELANG.GT.PI)DELANG=DELANG-PI2                                       000293
        GRDEL(I)=-2000.0*DELANG/PI2                                             000294
  300   CONTINUE                                                                000295
C                                                                               000296
C       THE FOLLOWING STATEMENT CAUSES THE PRINTING OF INSERTION LOSS           000297
C       FUNCTION VALUES ONLY FOR THE BAND OF INTEREST.                          000298
C                                                                               000299
        IF(MOD(ITEST,40).EQ.0)IREL=IREL-1                                       000300
C                                                                               000301
C       GROUP DELAY IS ESTIMATED AT FREQ MINUS 0.25 MHZ                         000302
C                                                                               000303
        FRGROUP=FREQ-0.25                                                       000304
        PRINT(6,207)FREQ,FRL,FIL(IREL),FRGROUP,GRDEL(IREL)                      000305
  207   FORMAT(6X,F7.1,9X,F5.2,12X,F5.2,17X,F8.2,10X,F8.2)                      000306
  200   CONTINUE                                                                000307
        GO TO 900                                                               000308
C                                                                               000309
C       SENSITIVITY ANALYSIS, CORRESPONDING TO LMODE=2                          000310
C                                                                               000311
C       THIS PART OF THE MAIN PROGRAM IS USED TO DEFINE CODES FOR MULTI-        000312
C       PLEXER PARAMETERS W.R.T. WHICH WE WANT TO FIND THE SENSITIVITIES.       000313
C       THE PARAMETER IR(I)=0 SIGNIFIES THAT NO ELEMENTS OF THE FILTER          000314
C       COUPLING MATRICES ARE OPTIMIZATION VARIABLES. SUBROUTINE                000315
C       "SIMGRD2" IS CALLED AT EACH FREQUENCY DEFINED IN THE VECTOR             000316
C       OMEGA(I).                                                               000317
C                                                                               000318
C       IR      - VECTOR CONTAINING THE NUMBER OF COUPLING PARAMETERS BE-       000319
C                 ING VARIABLES FOR EACH CHANNEL                                000320
C       LC      - MATRIX CONTAINING THE ROW INDICES OF COUPLING PARAMETERS      000321
C                 BEING VARIABLES FOR EACH CHANNEL                              000322
C       KC      - MATRIX CONTAINING THE COLUMN INDICES OF COUPLING PARAME-      000323
C                 TERS BEING VARIABLES FOR EACH CHANNEL                         000324
C       IPN1    - INTEGER ARRAY OF DIMENSION AT LEAST NCH INDICATING            000325
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C                 WHETHER THE INPUT TRANSFORMER RATIO IS AN OPTIMIZATION      000326
C                 VARIABLE (IPN1(I)=1) OR NOT (IPN1(I)=0).                    000327
C       IPN2    - INTEGER ARRAY OF DIMENSION AT LEAST NCH INDICATING          000328
C                 WHETHER THE OUTPUT TRANSFORMER RATIO IS AN OPTIMIZA-        000329
C                 TION VARIABLE (IPN2(I)=1) OR NOT (IPN2(I)=0).               000330
C       IWG     - INTEGER ARRAY OF DIMENSION AT LEAST NCH INDICATING          000331
C                 WHETHER THE WAVEGUIDE SECTION LENGTH IS AN OPTIMIZA-        000332
C                 TION VARIABLE (IWG(I)=1) OR NOT (IWG(I)=0).                 000333
C       OMEGA   - VECTOR OF ARBITRARY FREQUENCIES (EXCEPT CENTER FREQUEN-     000334
C                 CIES) AT WHICH THE SENSITIVITY ANALYSIS IS TO BE PERFOR-    000335
C                 MED.                                                        000336
C       FRSNS   - ACTUAL FREQUENCY AT WHICH THE SUBROUTINE "SIMGRD" IS        000337
C                 CALLED                                                      000338
C       NV      - TOTAL NUMBER OF VARIABLES W.R.T. WHICH THE SENSITIVITIES    000339
C                 ARE REQUIRED                                                000340
C       FRL     - VALUE OF THE COMMON PORT RETURN LOSS IN DB AT THE FREQU-    000341
C                 ENCY FRSNS                                                  000342
C       DRL     - SENSITIVITIES OF THE COMMON PORT RETURN LOSS W.R.T. ALL     000343
C                 VARIABLES                                                   000344
C       FIL     - VECTOR OF THE INSERTION LOSS FUNCTION IN DB FOR EACH        000345
C                 CHANNEL AT THE FREQUENCY FRSNS                              000346
C       DIL     - MATRIX OF SENSITIVITIES OF THE INSERTION LOSS FUNCTION      000347
C                 FOR EACH CHANNEL W.R.T. ALL VARIABLES                       000348
C                                                                             000349
C       DEFINE THE NUMBER OF COUPLING VARIABLES PER CHANNEL                   000350
C                                                                             000351
   16 CONTINUE                                                                000352
      IR(1)=12                                                                000353
      IR(2)=12                                                                000354
      IR(3)=12                                                                000355
C                                                                             000356
C       DEFINE CODES TO IDENTIFY VARIABLES FOR INPUT-OUTPUT TRANSFORMER       000357
C       RATIOS AND WAVEGUIDE SPACINGS                                         000358
C                                                                             000359
      DO 55 I=1,NCH                                                           000360
      IWG(I)=1                                                                000361
      IPN1(I)=1                                                               000362
      IPN2(I)=1                                                               000363
   55 CONTINUE                                                                000364
C                                                                             000365
C       EVALUATE THE TOTAL NUMBER OF VARIABLES ACCUMULATED AFTER              000366
C       EACH SECTION                                                          000367
C                                                                             000368
      CALL TOTAL2(NCH,IR,IRT,IPN1,IPN2,IWG)                                   000369
C                                                                             000370
C       DEFINE CODES FOR THE VARIABLES CONTAINED IN THE COUPLING MATRICES     000371
C                                                                             000372
      DO 127 I=1,3                                                            000373
      LC(I,1)=1                                                               000374
      LC(I,2)=1                                                               000375
      LC(I,3)=2                                                               000376
      LC(I,4)=2                                                               000377
      LC(I,5)=3                                                               000378
      LC(I,6)=3                                                               000379
      LC(I,7)=3                                                               000380
      LC(I,8)=4                                                               000381
      LC(I,9)=4                                                               000382
      LC(I,10)=5                                                              000383
      LC(I,11)=5                                                              000384
      LC(I,12)=6                                                              000385
      KC(I,1)=1                                                               000386
      KC(I,2)=2                                                               000387
      KC(I,3)=2                                                               000388
      KC(I,4)=3                                                               000389
      KC(I,5)=3                                                               000390
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      KC(I,6)=4                                                          000391
      KC(I,7)=6                                                          000392
      KC(I,8)=4                                                          000393
      KC(I,9)=5                                                          000394
      KC(I,10)=5                                                         000395
      KC(I,11)=6                                                         000396
      KC(I,12)=6                                                         000397
  127 CONTINUE                                                           000398
                                                                         000399
C                                                                        000400
C     CHECK WHETHER THE SIMULATION AND SENSITIVITY ANALYSIS MODE         000401
C     IS REQUIRED                                                        000402
C                                                                        000403
      IF(LMODE.NE.2) GO TO 17                                            000404
C                                                                        000405
C     GENERATE FREQUENCY POINTS IN MHZ                                   000406
C                                                                        000407
      NFREQ=1                                                            000408
      OMEGA(1)=12062.0                                                   000409
      NCHAN=NCH                                                          000410
      MORDER=MO                                                          000411
      DO 18 ICOUNT=1,NFREQ                                               000412
      FRSNS=OMEGA(ICOUNT)                                                000413
C                                                                        000414
      CALL SIMGRD2(FRSNS,FRL,DRL,FIL,DIL,NCHAN,MORDER,ICOUNT,IFLAGJS,    000415
     1             IFLAGDP,IDISPER)                                      000416
C                                                                        000417
   18 CONTINUE                                                           000418
      GO TO 900                                                          000419
C                                                                        000420
C     OPTIMIZATION, CORRESPONDING TO LMODE=3                             000421
C                                                                        000422
C     THIS PART OF THE MAIN SEGMENT IS USED TO DEFINE ALL VARIABLES AND  000423
C     ARRAYS FOR MULTIPLEXER OPTIMIZATION. TO SELECT THE MULTIPLEXER PA- 000424
C     RAMETERS WHICH ARE THE OPTIMIZATION VARIABLES THE MATRICES LC AND  000425
C     KC HAVE TO BE USED AS DESCRIBED IN THE SENSITIVITY ANALYSIS PART.  000426
C     THREE MODES OF OPTIMIZATION ARE ALLOWED. TO SELECT THE DESIRED     000427
C     MODE OF OPTIMIZATION SET PARAMETER MODE TO                         000428
C     0 - IF ONLY COMMON PORT RETURN LOSS OPTIMIZATION IS REQUIRED       000429
C     1 - IF ONLY INSERTION LOSS OPTIMIZATION IS REQUIRED                000430
C     2 - IF BOTH RETURN LOSS AND INSERTION LOSS OPTIMIZATION ARE        000431
C         REQUIRED.                                                      000432
C     IN EACH CASE A DIFFERENT HEADER FOR THE PRINTOUT OF OPTIMIZATION   000433
C     RESULTS CAN BE OBTAINED BY CALLING THE SUBROUTINE "MMXHDR" FOR     000434
C     WHICH THE ARGUMENT T CAN BE DEFINED USING THE DATA STATEMENT. VA-  000435
C     LUES OF OPTIMIZATION VARIABLES AT THE STARTING POINT MUST BE SUP-  000436
C     PLIED BY DEFINING THE X VECTOR USING EITHER THE DATA STATEMENT OR  000437
C     EXPLICITLY. THE MINIMAX FUNCTIONS ARE CREATED AT THE FREQUENCIES   000438
C     DEFINED IN THE VECTOR OMEGA(I), WHICH IS A REAL ARRAY OF LENGTH    000439
C     AT LEAST NFREQ.                                                    000440
C                                                                        000441
C     NFREQ  - NUMBER OF FREQUENCY POINTS AT WHICH THE MINIMAX FUNCTI-   000442
C              ONS ARE TO BE CREATED                                     000443
C     OMEGA  - VECTOR OF ARBITRARY FREQUENCY POINTS (EXCEPT CENTER FRE-  000444
C              QUENCIES) IN MHZ AT WHICH THE MINIMAX FUNCTIONS ARE TO    000445
C              BE CREATED                                                000446
C     NFRL   - NUMBER OF MINIMAX FUNCTIONS CREATED DUE TO RETURN LOSS    000447
C              SPECIFICATIONS                                            000448
C                                                                        000449
C     ARRAYS AND CODES FOR COMMON PORT RETURN LOSS OPTIMIZATION          000450
C                                                                        000451
C     RLSCODE- INTEGER ARRAY OF LENGTH AT LEAST NFREQ. EACH ELEMENT MUST 000452
C              BE SET TO THE FOLLOWING SPECIFICATION CODE VALUE AT EACH  000453
C              FREQUENCY :                                               000454
C               0 - NO SPECIFICATION REQUIRED                            000455
C              -1 - ONLY LOWER SPECIFICATION REQUIRED
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C                1 - ONLY UPPER SPECIFICATION REQUIRED                          000456
C                2 - BOTH UPPER AND LOWER SPECIFICATIONS REQUIRED               000457
C      SURL    - REAL ARRAY OF LENGTH AT LEAST NFREQ. IT MUST CONTAIN THE       000458
C                UPPER SPECIFICATIONS APPLICABLE AT EACH FREQUENCY              000459
C      SLRL    - REAL ARRAY OF LENGTH AT LEAST NFREQ. IT MUST CONTAIN THE       000460
C                LOWER SPECIFICATIONS APPLICABLE AT EACH FREQUENCY              000461
C      WURL    - REAL ARRAY OF LENGTH AT LEAST NFREQ. IT MUST CONTAIN THE       000462
C                WEIGHTING FACTORS CORRESPONDING TO UPPER SPECIFICATIONS        000463
C      WLRL    - REAL ARRAY OF LENGTH AT LEAST NFREQ. IT MUST CONTAIN THE       000464
C                WEIGHTING FACTORS CORRESPONDING TO LOWER SPECIFICATIONS         000465
C                                                                               000466
C      ARRAYS AND CODES FOR INSERTION LOSS OPTIMIZATION                         000467
C                                                                               000468
C      CHBCODE- INTEGER ARRAY OF DIMENSIONS AT LEAST NCH BY 2. EACH ROW         000469
C               MUST CONTAIN THE RANGE OF FREQUENCIES OVER WHICH SPECI-         000470
C               FICATIONS FOR THE CORRESPONDING CHANNEL ARE GIVEN. THE          000471
C               FIRST ELEMENT OF A ROW INDICATES THE LOWER FREQUENCY            000472
C               EDGE OF INTEREST, THE SECOND THE UPPER FREQUENCY EDGE.          000473
C      SPCODE - INTEGER ARRAY OF DIMENSIONS AT LEAST NSPMAX BY NCH.             000474
C               NSPMAX IS THE MAXIMUM NUMBER OF FREQUENCY POINTS CONSI-         000475
C               DERED FOR ANY OF THE CHANNELS.                                  000476
C               EACH COLUMN MUST CONTAIN THE SPECIFICATION CODE AT EACH         000477
C               FREQUENCY FOR THE CORRESPONDING CHANNEL. EACH ELEMENT           000478
C               OF A COLUMN MUST BE SET TO ONE OF THE FOLLOWING VALUES:         000479
C               0 - NO SPECIFICATION REQUIRED                                   000480
C              -1 - ONLY LOWER SPECIFICATION REQUIRED                           000481
C               1 - ONLY UPPER SPECIFICATION REQUIRED                           000482
C               2 - BOTH UPPER AND LOWER SPECIFICATIONS REQUIRED                000483
C      SU      - REAL ARRAY OF DIMENSIONS AT LEAST NSPMAX BY NCH. IT            000484
C               MUST CONTAIN THE UPPER SPECIFICATIONS FOR EACH CHANNEL          000485
C               ORDERED CONSECUTIVELY W.R.T. FREQUENCY INDEX IMPLIED            000486
C               BY THE CHBCODE MATRIX IN THE FORM (FREQUENCY INDEX,             000487
C               CHANNEL).                                                       000488
C      SL      - REAL ARRAY OF DIMENSIONS AT LEAST NSPMAX BY NCH. IT            000489
C               MUST CONTAIN THE LOWER SPECIFICATIONS FOR EACH CHANNEL          000490
C               ORDERED CONSECUTIVELY W.R.T. FREQUENCY INDEX IMPLIED            000491
C               BY THE CHBCODE MATRIX IN THE FORM (FREQUENCY INDEX,             000492
C               CHANNEL).                                                       000493
C      WU      - REAL ARRAY OF DIMENSIONS AT LEAST NSPMAX BY NCH. IT            000494
C               MUST CONTAIN THE WEIGHTING FACTORS FOR UPPER SPECIFI-           000495
C               CATIONS. IT IS ARRANGED TO CORRESPOND TO SU.                    000496
C      WL      - REAL ARRAY OF DIMENSIONS AT LEAST NSPMAX BY NCH. IT            000497
C               MUST CONTAIN THE WEIGHTING FACTORS FOR LOWER SPECIFI-           000498
C               CATIONS. IT IS ARRANGED TO CORRESPOND TO SL.                    000499
C                                                                               000500
C                                                                               000501
   17 CALL MMXHDR(3,T)                                                          000502
C                                                                               000503
C      SELECT THE DESIRED MODE OF OPTIMIZATION                                  000504
C                                                                               000505
      MODE=2                                                                    000506
C                                                                               000507
C     THE STARTING POINT FOR OPTIMIZATION MUST BE INITIALIZED BY                000508
C     SETTING CONSECUTIVELY NUMBERED X VALUES. IT IS IMPERATIVE THAT            000509
C     THE OPTIMIZATION VARIABLES FOR EACH CHANNEL ARE DEFINED CON-              000510
C     SECUTIVELY AS FOLLOWS: VARIABLE FILTER COUPLINGS COME FIRST,              000511
C     FOLLOWED BY VARIABLE INPUT, THEN OUTPUT, TRANSFORMER RATIOS,              000512
C     THE SECTION LENGTH BEING THE LAST VARIABLE IN THE SET OF OPTI-            000513
C     MIZATION VARIABLES FOR A PARTICULAR CHANNEL.                              000514
C                                                                               000515
      X(1)=CM(1,1,1)                                                            000516
      X(2)=CM(1,1,2)                                                            000517
      X(3)=CM(1,2,2)                                                            000518
      X(4)=CM(1,2,3)                                                            000519
      X(5)=CM(1,3,3)                                                            000520
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      X(6)=CM(1,3,4)                                                    000521
      X(7)=CM(1,3,6)                                                    000522
      X(8)=CM(1,4,4)                                                    000523
      X(9)=CM(1,4,5)                                                    000524
      X(10)=CM(1,5,5)                                                   000525
      X(11)=CM(1,5,6)                                                   000526
      X(12)=CM(1,6,6)                                                   000527
      X(13)=PN1(1)                                                      000528
      X(14)=PN2(1)                                                      000529
      X(15)=WGL(1)                                                      000530
      X(30)=WGL(2)                                                      000531
      X(45)=WGL(3)                                                      000532
      DO 128 I=1,14                                                     000533
      II=I+15                                                           000534
      X(II)=X(I)                                                        000535
      III=I+30                                                          000536
      X(III)=X(I)                                                       000537
  128 CONTINUE                                                          000538
C                                                                       000539
C     GENERATE FREQUENCY POINTS IN MHZ                                  000540
C                                                                       000541
      NFREQ=47                                                          000542
      OMEGA(1)=11962.0                                                  000543
      OMEGA(2)=11964.0                                                  000544
      OMEGA(3)=11966.0                                                  000545
      OMEGA(4)=11968.0                                                  000546
      OMEGA(5)=11970.0                                                  000547
      OMEGA(6)=11972.0                                                  000548
      OMEGA(7)=11976.0                                                  000549
      OMEGA(8)=11980.0001                                               000550
      OMEGA(9)=11984.0                                                  000551
      OMEGA(10)=11988.0                                                 000552
      OMEGA(11)=11990.0                                                 000553
      OMEGA(12)=11992.0                                                 000554
      OMEGA(13)=11994.0                                                 000555
      OMEGA(14)=11996.0                                                 000556
      OMEGA(15)=11998.0                                                 000557
      DO 10 I=16,45                                                     000558
      OMEGA(I)=OMEGA(I-15)+40.0                                         000559
   10 CONTINUE                                                          000560
      OMEGA(46)=12000.0                                                 000561
      OMEGA(47)=12040.0                                                 000562
C                                                                       000563
C     DEFINE THE NUMBER OF MINIMAX FUNCTIONS RESULTING FROM THE         000564
C     SPECIFICATIONS ON RETURN LOSS                                     000565
C                                                                       000566
      NFRL=47                                                           000567
C                                                                       000568
C     DEFINE CODES AND ARRAYS REQUIRED FOR RETURN LOSS OPTIMIZATION     000569
C                                                                       000570
      DO 150 I=1,47                                                     000571
      RLSCODE(I)=-1                                                     000572
      SLRL(I)=20.0                                                      000573
      WLRL(I)=1.0                                                       000574
  150 CONTINUE                                                          000575
C                                                                       000576
C     DEFINE CHANNEL BAND CODE (CHANNEL, FREQUENCY EDGE INDEX), WHERE   000577
C     THE FIRST CHANNEL IS CLOSEST TO THE SHORT CIRCUIT AND CORRESPONDS 000578
C     TO THE HIGHEST CENTER FREQUENCY, AND THE FREQUENCY EDGES ARE 1    000579
C     FOR LOWER EDGE AND 2 FOR UPPER EDGE. THE VALUE OF CHBCODE CORRES- 000580
C     PONDS TO THE FREQUENCY POINT INDEX USED AS ARGUMENT OF OMEGA(I).  000581
C     IF THERE IS NO SPECIFICATION FOR A PARTICULAR CHANNEL, THE VALUE  000582
C     OF CHBCODE MUST BE SET TO 0.                                      000583
C                                                                       000584
      CHBCODE(1,1)=31                                                   000585
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      CHBCODE(1,2)=45                                                    000586
      CHBCODE(2,1)=16                                                    000587
      CHBCODE(2,2)=30                                                    000588
      CHBCODE(3,1)=1                                                     000589
      CHBCODE(3,2)=15                                                    000590
C                                                                        000591
C     DEFINE THE SPECIFICATION CODE FOR INSERTION LOSS OPTIMIZATION      000592
C     (FREQUENCY INDEX, CHANNEL)                                         000593
C                                                                        000594
      DO 20 I=1,15                                                       000595
      DO 20 J=1,3                                                        000596
      SPCODE(I,J)=1                                                      000597
   20 CONTINUE                                                           000598
C                                                                        000599
C     DEFINE VALUES FOR THE SPECIFICATIONS (FREQUENCY INDEX, CHANNEL)    000600
C                                                                        000601
      DO 25 I=1,3                                                        000602
      SU(1,I)=2.79                                                       000603
      SU(2,I)=1.77                                                       000604
      SU(3,I)=1.41                                                       000605
      SU(4,I)=1.24                                                       000606
      DO 33 J=5,11                                                       000607
      SU(J,I)=1.12                                                       000608
   33 CONTINUE                                                           000609
      SU(12,I)=1.24                                                      000610
      SU(13,I)=1.41                                                      000611
      SU(14,I)=1.77                                                      000612
      SU(15,I)=2.79                                                      000613
   25 CONTINUE                                                           000614
C                                                                        000615
C     DEFINE WEIGHTING FACTORS CORRESPONDING TO THE SPECIFICATIONS       000616
C                                                                        000617
      DO 35 I=1,15                                                       000618
      DO 35 J=1,3                                                        000619
      WU(I,J)=1.0                                                        000620
   35 CONTINUE                                                           000621
C                                                                        000622
C     ARGUMENTS OF THE MINIMAX OPTIMIZATION(MMLC) CALL STATEMENT         000623
C                                                                        000624
C     FDF2    - NAME OF A SUBROUTINE CALCULATING MINIMAX FUNCTIONS AND   000625
C               THEIR DERIVATIVES AT THE POINT DEFINED BY THE X VECTOR.  000626
C               THE NAME FDF2 IS ARBITRARY AND MUST APPEAR IN THE EXTER- 000627
C               NAL STATEMENT IN THE SEGMENT CALLING MMLC1A.             000628
C     NV      - INTEGER ARGUMENT WHICH MUST BE SET TO THE NUMBER OF OP-   000629
C               TIMIZATION VARIABLES. ITS VALUE MUST BE POSITIVE AND IS  000630
C               NOT CHANGED BY THE PACKAGE.                              000631
C     MF      - INTEGER ARGUMENT WHICH MUST BE SET TO THE NUMBER OF RE-   000632
C               SIDUAL FUNCTIONS DEFINING THE MINIMAX OBJECTIVE FUNCTION. 000633
C               ITS VALUE MUST BE POSITIVE AND IS NOT CHANGED BY THE PA- 000634
C               CKAGE.                                                   000635
C     L       - INTEGER ARGUMENT WHICH MUST BE SET TO THE TOTAL NUMBER    000636
C               OF EQUALITY AND INEQUALITY CONSTRAINTS. ITS VALUE MUST   000637
C               BE POSITIVE OR ZERO AND IT IS NOT CHANGED BY THE PACKA-  000638
C               GE.                                                      000639
C     LEQ     - INTEGER ARGUMENT WHICH MUST BE SET TO THE NUMBER OF EQ-   000640
C               UALITY CONSTRAINTS. ITS VALUE MUST BE POSITIVE OR ZERO   000641
C               AND NOT GREATER THAN NV, AND NOT GREATER THAN L. ITS     000642
C               VALUE IS NOT CHANGED BY THE PACKAGE.                     000643
C     B       - REAL ARRAY OF LENGTH IIC > L. THE ELEMENTS OF B MUST BE  000644
C               SET TO THE CONSTANT TERMS IN THE LINEAR CONSTRAINTS.     000645
C               THE CONTENTS OF B ARE NOT CHANGED BY THE PACKAGE.        000646
C     C       - REAL MATRIX OF DIMENSIONS (IIC,NV). THE FIRST L ROWS OF  000647
C               C MUST BE SET TO THE COEFFICIENTS OF X IN THE LINEAR     000648
C               CONSTRAINTS.                                             000649
C     IIC     - INTEGER ARGUMENT WHICH MUST BE SET TO THE LENGTH OF THE  000650
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C                ARRAY B AND TO NUMBER OF ROWS OF THE MATRIX C. ITS VA-      000651
C                LUE MUST NOT BE LESS THAN L, AND IT IS NOT CHANGED BY       000652
C                THE PACKAGE.                                                000653
C       X        - REAL ARRAY OF LENGTH AT LEAST NV WHICH, ON ENTRY, MUST    000654
C                BE SET TO THE INITIAL APPROXIMATION OF THE SOLUTION.        000655
C                ON EXIT X CONTAINS THE BEST SOLUTION FOUND BY THE PACK-     000656
C                AGE.                                                        000657
C       DX       - REAL VARIABLE WHICH CONTROLS THE STEP LENGTH OF THE ITER- 000658
C                ATIVE ALGORITHM. ON ENTRY IT MUST BE SET TO AN INITIAL      000659
C                VALUE APPROXIMATELY EQUAL TO 0.1* X. THE VALUE OF DX        000660
C                MUST BE POSITIVE. ON EXIT DX CONTAINS THE LAST VALUE OF     000661
C                THE STEPSIZE. FOR EXTENSIVE DETAILS PLEASE REFER TO         000662
C                REPORT SOS-82-5-U2, AUGUST 1983.                            000663
C       EPS      - REAL VARIABLE WHICH ON ENTRY MUST BE SET TO THE REQUIRED  000664
C                ACCURACY OF THE SOLUTION. ON EXIT EPS CONTAINS THE LENGTH   000665
C                OF THE LAST STEP TAKEN IN THE ITERATION.                    000666
C       MAXF     - INTEGER VARIABLE WHICH MUST BE SET TO AN UPPER BOUND ON   000667
C                THE NUMBER OF CALLS OF FDF2. ON EXIT MAXF CONTAINS THE      000668
C                NUMBER OF CALLS OF FDF THAT HAVE BEEN PERFORMED BY THE      000669
C                PACKAGE.                                                    000670
C       KEQS     - INTEGER VARIABLE WHICH MUST BE SET TO THE NUMBER OF SUC=  000671
C                CESSIVE ITERATIONS WITH IDENTICAL SETS OF ACTIVE RESIDUAL   000672
C                FUNCTIONS AND ACTIVE CONSTRAINTS THAT IS REQUIRED BEFORE    000673
C                A SWITCH TO STAGE 2 IS MADE. ON EXIT KEQS CONTAINS THE      000674
C                NUMBER OF SWITCHES TO STAGE 2 THAT HAVE TAKEN PLACE.        000675
C       W        - REAL ARRAY WHICH IS USED FOR WORKING SPACE. ITS LENGTH    000676
C                IS GIVEN BY IW. ON EXIT THE FIRST MF ELEMENTS OF W CON-     000677
C                TAIN THE RESIDUAL FUNCTION VALUES AT THE SOLUTION.          000678
C       IW       - INTEGER ARGUMENT WHICH MUST BE SET TO THE LENGTH OF W.    000679
C                ITS VALUE MUST BE AT LEAST                                  000680
C                                                                            000681
C                     IWR=2*MF*NV+5*NV*NV+4*MF+8*NV+4*IIC+3                  000682
C                                                                            000683
C       ICH      - INTEGER ARGUMENT WHICH MUST BE SET TO THE UNIT NUMBER     000684
C                THAT IS TO BE USED FOR THE PRINTED OUTPUT GENERATED BY      000685
C                THE PACKAGE. IF ICH IS LESS THAN OR EQUAL TO ZERO, NO       000686
C                PRINTED OUTPUT WILL BE GENERATED BY THE PACKAGE.            000687
C       IPR      - INTEGER ARGUMENT WHICH CONTROLS THE PRINTED OUTPUT GE-    000688
C                NERATED BY THE PACKAGE. FOR EXTENSIVE DETAILS PLEASE        000689
C                REFER TO REPORT SOS-82-5-U2, AUGUST 1983.                   000690
C       IFALL    - INTEGER VARIABLE WHICH ON EXIT CONTAINS INFORMATION       000691
C                ABOUT THE SOLUTION:                                         000692
C                IFALL=-2 FEASIBLE REGION IS EMPTY,                          000693
C                IFALL=-1 INCORRECT INPUT DATA,                              000694
C                IFALL= 0 REGULAR SOLUTION; REQUIRED ACCURACY OBTAINED,      000695
C                IFALL= 1 SINGULAR SOLUTION; REQUIRED ACCURACY OBTAINED,     000696
C                IFALL= 2 MACHINE ACCURACY REACHED,                          000697
C                IFALL= 3 MAXIMUM NUMBER OF FUNCTION EVALUATIONS REACHED,    000698
C                IFALL= 4 ITERATION TERMINATED BY THE USER.                  000699
C                                                                            000700
C       DEFINE PARAMETERS FOR THE MMLC PACKAGE                               000701
C                                                                            000702
        NV=45                                                                000703
        MF=92                                                                000704
        L=0                                                                  000705
        LEQ=0                                                                000706
        IIC=1                                                                000707
        DX=0.05                                                              000708
        EPS=1.E-6                                                            000709
        MAXF=65                                                              000710
        KEQS=3                                                               000711
        IW=20000                                                             000712
        ICH=6                                                                000713
        IPR=10                                                               000714
        NCOUNT=1                                                             000715
```

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C                                                                       000716
      CALL MMLC1A(FDF2,NV,MF,L,LEQ,B,C,IIC,X,DX,EPS,MAXF,KEQS,W,IW,ICH, 000717
     1            IPR,IFALL)                                            000718
C                                                                       000719
  900 STOP                                                              000720
      END                                                               000721
C                                                                       000722
```

```
C                                                                       000723
      SUBROUTINE FDF2(NV,MF,X,DF,F)                                     000724
      REAL X(NV),F(MF),DF(MF,NV)                                        000725
      REAL OMEGA(47),SURL(47),SLRL(47),WURL(47),WLRL(47),               000726
     1     SU(20,16),SL(20,16),WU(20,16),WL(20,16)                      000727
      INTEGER RLSCODE(47),SPCODE(20,16),CHBCODE(16,2)                   000728
      REAL CM(16,8,8),WGL(16),DRL(100),FIL(16),DIL(16,100)              000729
      INTEGER IR(16),IRT(16),LC(16,36),KC(16,36)                        000730
      INTEGER IPN1(16),IPN2(16),IWG(16)                                 000731
      REAL WO(16),BW(16),PN1(16),PN2(16),GL(16)                         000732
      COMMON /BLK2/CM,WGL                                               000733
      COMMON /BLK1/WO,BW,PN1,PN2,GL,VS,RS,PI2,WIDTH,NP1                 000734
      COMMON /BLK3/OMEGA,SURL,SLRL,WURL,WLRL,SU,SL,WU,WL,               000735
     1             RLSCODE,SPCODE,NCOUNT,MODE,NCH,MO,                   000736
     2             NFREQ,NFRL,CHBCODE,IFLAGJS,IFLAGDP,IDISPER           000737
      COMMON/BLK8/IR,IRT,IPN1,IPN2,IWG,LC,KC                            000738
C                                                                       000739
C     UPDATE OPTIMIZATION VARIABLES                                     000740
C                                                                       000741
      IF(IRT(1).EQ.0)GO TO 20                                           000742
      IF(IR(1).EQ.0)GO TO 11                                            000743
      IR1=IR(1)                                                         000744
      DO 10 IV=1,IR1                                                    000745
      CM(1,LC(1,IV),KC(1,IV))=X(IV)                                     000746
   10 CONTINUE                                                          000747
   11 IF(IPN1(1).EQ.0)GO TO 12                                          000748
      IV=IR(1)+IPN1(1)                                                  000749
      PN1(1)=X(IV)                                                      000750
   12 IF(IPN2(1).EQ.0)GO TO 13                                          000751
      IV=IR(1)+IPN1(1)+IPN2(1)                                          000752
      PN2(1)=X(IV)                                                      000753
   13 IF(IWG(1).EQ.0)GO TO 14                                           000754
      IV=IR(1)+IPN1(1)+IPN2(1)+IWG(1)                                   000755
      WGL(1)=X(IV)                                                      000756
   14 CONTINUE                                                          000757
C                                                                       000758
   20 CONTINUE                                                          000759
      DO 40 I=2,NCH                                                     000760
      IF(IRT(I).EQ.0)GO TO 40                                           000761
      IX=IRT(I-1)                                                       000762
      IF(IR(I).EQ.0)GO TO 15                                            000763
      IRI=IR(I)                                                         000764
      DO 30 IP=1,IRI                                                    000765
      IXX=IX+IP                                                         000766
      CM(I,LC(I,IP),KC(I,IP))=X(IXX)                                    000767
   30 CONTINUE                                                          000768
   15 IF(IPN1(I).EQ.0)GO TO 16                                          000769
      IXX=IX+IR(I)+IPN1(I)                                              000770
      PN1(I)=X(IXX)                                                     000771
   16 IF(IPN2(I).EQ.0)GO TO 17                                          000772
      IXX=IX+IR(I)+IPN1(I)+IPN2(I)                                      000773
      PN2(I)=X(IXX)                                                     000774
   17 IF(IWG(I).EQ.0)GO TO 18                                           000775
      IXX=IX+IR(I)+IPN1(I)+IPN2(I)+IWG(I)                               000776
      WGL(I)=X(IXX)                                                     000777
   18 CONTINUE                                                          000778
C                                                                       000779
   40 CONTINUE                                                          000780
C                                                                       000781
C     DEFINE MINIMAX FUNCTIONS AND THEIR GRADIENTS                      000782
C                                                                       000783
      NCHAN=NCH                                                         000784
      MORDER=MO                                                         000785
      KFRL=0                                                            000786
      KFUN=NFRL                                                         000787
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      DO 100 I=1,NFREQ                                                  000788
      FREQ=OMEGA(I)                                                     000789
C                                                                       000790
      CALL SIMGRD2(FREQ,FRL,DRL,FIL,DIL,NCHAN,MORDER,I,IFLAGJS,         000791
     1             IFLAGDP,IDISPER)                                     000792
C                                                                       000793
      IF(MODE.EQ.1)GO TO 199                                            000794
      IF(RLSCODE(I).EQ.0)GO TO 199                                      000795
      IF(RLSCODE(I).EQ.-1)GO TO 70                                      000796
      IF(RLSCODE(I).EQ.1)GO TO 75                                       000797
      KFRL=KFRL+1                                                       000798
      F(KFRL)=WURL(I)*(FRL-SURL(I))                                     000799
      DO 80 K1=1,NV                                                     000800
      DF(KFRL,K1)=WURL(I)*DRL(K1)                                       000801
   80 CONTINUE                                                          000802
      KFRL=KFRL+1                                                       000803
      F(KFRL)=-WLRL(I)*(FRL-SLRL(I))                                    000804
      DO 85 K2=1,NV                                                     000805
      DF(KFRL,K2)=-WLRL(I)*DRL(K2)                                      000806
   85 CONTINUE                                                          000807
      GO TO 199                                                         000808
   70 KFRL=KFRL+1                                                       000809
      F(KFRL)=-WLRL(I)*(FRL-SLRL(I))                                    000810
      DO 90 K3=1,NV                                                     000811
      DF(KFRL,K3)=-WLRL(I)*DRL(K3)                                      000812
   90 CONTINUE                                                          000813
      GO TO 199                                                         000814
   75 KFRL=KFRL+1                                                       000815
      F(KFRL)=WURL(I)*(FRL-SURL(I))                                     000816
      DO 95 K4=1,NV                                                     000817
      DF(KFRL,K4)=WURL(I)*DRL(K4)                                       000818
   95 CONTINUE                                                          000819
  199 CONTINUE                                                          000820
      IF(MODE.EQ.0)GO TO 100                                            000821
      DO 105 J=1,NCH                                                    000822
      NCHECK=0                                                          000823
      IF(I.GE.CHBCODE(J,1).AND.I.LE.CHBCODE(J,2))NCHECK=1               000824
      IF(NCHECK.EQ.0)GO TO 105                                          000825
      K=I-CHBCODE(J,1)+1                                                000826
      IF(SPCODE(K,J).EQ.0)GO TO 105                                     000827
      IF(SPCODE(K,J).EQ.-1)GO TO 110                                    000828
      IF(SPCODE(K,J).EQ.1)GO TO 115                                     000829
      KFUN=KFUN+1                                                       000830
      F(KFUN)=WU(K,J)*(FIL(J)-SU(K,J))                                  000831
      DO 120 I1=1,NV                                                    000832
      DF(KFUN,I1)=WU(K,J)*DIL(J,I1)                                     000833
  120 CONTINUE                                                          000834
      KFUN=KFUN+1                                                       000835
      F(KFUN)=-WL(K,J)*(FIL(J)-SL(K,J))                                 000836
      DO 125 I2=1,NV                                                    000837
      DF(KFUN,I2)=-WL(K,J)*DIL(J,I2)                                    000838
  125 CONTINUE                                                          000839
      GO TO 105                                                         000840
  110 KFUN=KFUN+1                                                       000841
      F(KFUN)=-WL(K,J)*(FIL(J)-SL(K,J))                                 000842
      DO 130 I3=1,NV                                                    000843
      DF(KFUN,I3)=-WL(K,J)*DIL(J,I3)                                    000844
  130 CONTINUE                                                          000845
      GO TO 105                                                         000846
  115 KFUN=KFUN+1                                                       000847
      F(KFUN)=WU(K,J)*(FIL(J)-SU(K,J))                                  000848
      DO 135 I4=1,NV                                                    000849
      DF(KFUN,I4)=WU(K,J)*DIL(J,I4)                                     000850
  135 CONTINUE                                                          000851
  105 CONTINUE                                                          000852
```

```
100  CONTINUE                                                          000853
     NCOUNT=NCOUNT+1                                                   000854
     RETURN                                                            000855
     END                                                               000856
```

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LINEARLY CONSTRAINED MINIMAX OPTIMIZATION (MMLC PACKAGE) (V:82.04)

MULTIPLEXER PROBLEM MXTST6C

INPUT DATA

NUMBER OF VARIABLES (N)	45
NUMBER OF FUNCTIONS (M)	92
TOTAL NUMBER OF LINEAR CONSTRAINTS (L)	0
NUMBER OF EQUALITY CONSTRAINTS (LEQ)	0
STEP LENGTH (DX)	5.000E-02
ACCURACY (EPS)	1.000E-06
MAX NUMBER OF FUNCTION EVALUATIONS (MAXF)	65
NUMBER OF SUCCESSIVE ITERATIONS (KEQS)	3
WORKING SPACE (IW)	20000
PRINTOUT CONTROL (IPR)	10

STARTING POINT :

	VARIABLES		FUNCTION VALUES
1	0.	1	1.376617388788E+01
2	5.939500000000E-01	2	1.210725700872E+01
3	0.	3	1.022508793930E+01
4	5.351400000000E-01	4	9.539332832200E+00
5	0.	5	9.242400838775E+00
6	4.247100000000E-01	6	8.322091837541E+00
7	-3.996700000000E-01	7	4.652810008359E+00
8	0.	8	3.867665333761E+00
9	8.337100000000E-01	9	3.126529123101E+00
10	0.	10	-3.154641846770E+00
11	7.631300000000E-01	11	-6.266536400448E+00
12	0.	12	-4.410253562100E+00
13	8.364627905651E-01	13	-3.953338929107E+00
14	1.046183540303E+00	14	-6.912146772112E+00
15	6.410000000000E-01	15	-1.435396827914E+01
16	0.	16	3.119334122250E+00
17	5.939500000000E-01	17	-7.712442950287E-01
18	0.	18	-2.665683411725E+00
19	5.351400000000E-01	19	-9.916907250456E-01
20	0.	20	-1.396690512709E+00
21	4.247100000000E-01	21	-4.630832122157E+00
22	-3.996700000000E-01	22	-1.427203203127E+01
23	0.	23	-7.070225476307E+00
24	8.337100000000E-01	24	-3.329177425626E+01
25	0.	25	-3.455972276484E+00
26	7.631300000000E-01	26	-2.209056470880E+00
27	0.	27	-3.964880382496E+00
28	8.364627905651E-01	28	-4.320417138471E+00
29	1.046183540303E+00	29	7.904485223746E-01
30	6.310000000000E-01	30	1.344999825989E+00

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LINEARLY CONSTRAINED MINIMAX OPTIMIZATION (MMLC PACKAGE) (V:82.04)

MULTIPLEXER PROBLEM MXTST6C

31	0.	6.789481124746E+00
32	5.939500000000E-01	3.095280387081E+00
33	0.	3.070596484094E+00
34	5.351400000000E-01	3.361977223309E+00
35	0.	1.677997351072E+00
36	4.247100000000E-01	-3.810497037170E-01
37	-3.996700000000E-01	3.350534703400E+00
38	0.	4.529973627815E+00
39	8.337100000000E-01	4.448045941187E+00
40	0.	6.155693274774E+00
41	7.631300000000E-01	9.198413795891E+00
42	0.	9.507740957316E+00
43	8.364627905631E-01	1.010188526819E+01
44	1.046183540303E+00	1.199833518187E+01
45	6.330000000000E-01	1.373588782520E+01
		5.881726899296E-01
		5.606073452421E+00
		3.397343518383E-01
		4.272216573252E-01
		2.547630170446E-01
		2.088061948320E-01
		2.171340363827E-01
		9.014140138119E-02
		-1.459429271873E-01
		-1.840639900810E-01
		-1.722974051960E-01
		-1.668893351765E-01
		-1.130228510226E-01
		-1.273117826421E-01
		-1.326792957479E-01
		-2.116054575533E-01
		-5.411054170164E-01
		-1.280821750845E-01
		-7.401366925222E-02
		-6.622988776045E-02
		-6.449319252491E-02
		-5.698638585295E-02
		-1.450000956344E-01
		-2.378459752295E-01
		-2.557855803587E-01
		-2.432559645821E-01
		-1.535450722065E-01
		-8.290833706865E-02
		-1.117050256841E-01
		-1.204251798056E-01
		-1.527941620359E-01
		-4.575620274459E-01
		-2.520671425147E-02
		-2.745971306157E-02
		-6.062636513491E-03
		-1.005897550820E-02
		-3.099896085189E-02
		-1.275063411426E-01
		-1.557719685368E-01
		-1.569355189001E-01
		-1.439201763664E-01
		8.470500807513E-02
		2.194009772458E-01

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LINEARLY CONSTRAINED MINIMAX OPTIMIZATION (MMLC PACKAGE) (V:82.04)

MULTIPLEXER PROBLEM MXTST6C

89	2.125154002832E-01
90	2.481392931055E-01
91	4.141733127239E-01
92	3.340379043190E-01

SOLUTION

	VARIABLES		FUNCTION VALUES
1	-6.044027292422E-02	1	-2.600085010356E+00
2	7.325746553578E-01	2	-2.156044754964E-01
3	-6.939183412333E-02	3	-9.891552359371E-01
4	5.598321723712E-01	4	-2.157316419238E-01
5	1.283843451561E-02	5	-3.991827490066E-01
6	4.124508825067E-01	6	-2.181897820656E+00
7	-4.717569056358E-01	7	-3.598592803821E+00
8	4.182049301334E-02	8	-2.154877885846E-01
9	8.863784882748E-01	9	-1.966507434300E+00
10	5.792510733123E-02	10	-1.395234024877E+01
11	7.824970565547E-01	11	-1.518816774199E+01
12	1.346337934973E-02	12	-9.637264457316E+00
13	1.099062965387E+00	13	-8.808497172878E+00
14	1.082354644330E+00	14	-5.262709505118E+00
15	6.736038935441E-01	15	-3.502156885571E-01
16	1.244478609904E-01	16	-2.135127807545E-01
17	6.360872160508E-01	17	-5.223925285351E+00
18	2.427646151828E-03	18	-5.718853056122E+00
19	5.573920279614E-01	19	-5.897830464558E+00
20	-4.178151147506E-03	20	-9.064871534898E+00
21	3.962409124580E-01	21	-1.223432408220E+01
22	-5.640839269006E-01	22	-2.647233965705E+00
23	-8.155794850229E-03	23	-2.153255352886E-01
24	9.544738710356E-01	24	-3.241526245149E+00
25	2.981639393973E-02	25	-1.724416757945E+01
26	7.639824046422E-01	26	-1.813109509977E+01
27	-3.907219043917E-03	27	-1.269197050951E+01
28	9.161514328102E-01	28	-1.080341247641E+01
29	1.111196296523E+00	29	-6.132157719754E+00
30	5.954929663106E-01	30	-1.911168646363E+00
31	1.944047789431E-01	31	-2.152583924184E-01
32	6.707241120483E-01	32	-8.217857458398E+00
33	4.771501445755E-02	33	-5.225706073917E+00
34	5.597795068260E-01	34	-6.282945195725E+00
35	-3.131345747253E-02	35	-1.207969028079E+01
36	3.990367533710E-01	36	-1.015363029176E+01
37	-5.117829489607E-01	37	-7.797221497376E-01
38	-6.068193434428E-02	38	-2.156857538054E-01
39	8.945300524320E-01	39	-5.101679674491E+00
40	-3.206380870620E-02	40	-1.997019524539E+00
41	7.650458312043E-01	41	-2.158398189908E-01
42	-2.231361222110E-02	42	-2.156920079480E-01
43	8.768413389939E-01	43	-1.054938612420E+00
44	1.101422627599E+00	44	-2.162664418719E-01
45	5.914808559808E-01	45	-1.415136100738E+00
		46	-2.934662010578E+00
		47	-4.141597151497E-01

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LINEARLY CONSTRAINED MINIMAX OPTIMIZATION (MMLC PACKAGE) (V:82.04)

MULTIPLEXER PROBLEM MXTST6C

48	-8.347119169367E-01
49	-4.425855756481E-01
50	-3.256185083914E-01
51	-2.725304850270E-01
52	-2.272671082234E-01
53	-2.863173703093E-01
54	-3.409583914303E-01
55	-3.266562886133E-01
56	-3.139281536477E-01
57	-2.730857906156E-01
58	-2.157826056607E-01
59	-2.456825672138E-01
60	-2.769562554074E-01
61	-3.651902579738E-01
62	-2.157696631117E-01
63	-2.157196992603E-01
64	-3.811982727378E-01
65	-2.830739402179E-01
66	-2.470357889608E-01
67	-2.157916545424E-01
68	-2.728217883209E-01
69	-3.101051626394E-01
70	-3.081341083730E-01
71	-3.104423097136E-01
72	-2.703212918590E-01
73	-2.157913531143E-01
74	-2.508910657283E-01
75	-2.857491590066E-01
76	-3.749970668668E-01
77	-3.303927216596E-01
78	-2.156788102678E-01
79	-3.613019739373E-01
80	-2.630637461334E-01
81	-2.383578516485E-01
82	-2.157885426435E-01
83	-2.743326868713E-01
84	-3.116311892216E-01
85	-3.338275754181E-01
86	-3.540731267118E-01
87	-2.940987378800E-01
88	-2.353741911750E-01
89	-2.837203985432E-01
90	-3.408965626962E-01
91	-4.694010789191E-01
92	-9.218129405197E-01

TYPE OF SOLUTION (IFALL) 3

NUMBER OF FUNCTION EVALUATIONS 65

NUMBER OF SHIFTS TO STAGE-2 3

EXECUTION TIME (IN SECONDS) 455.042

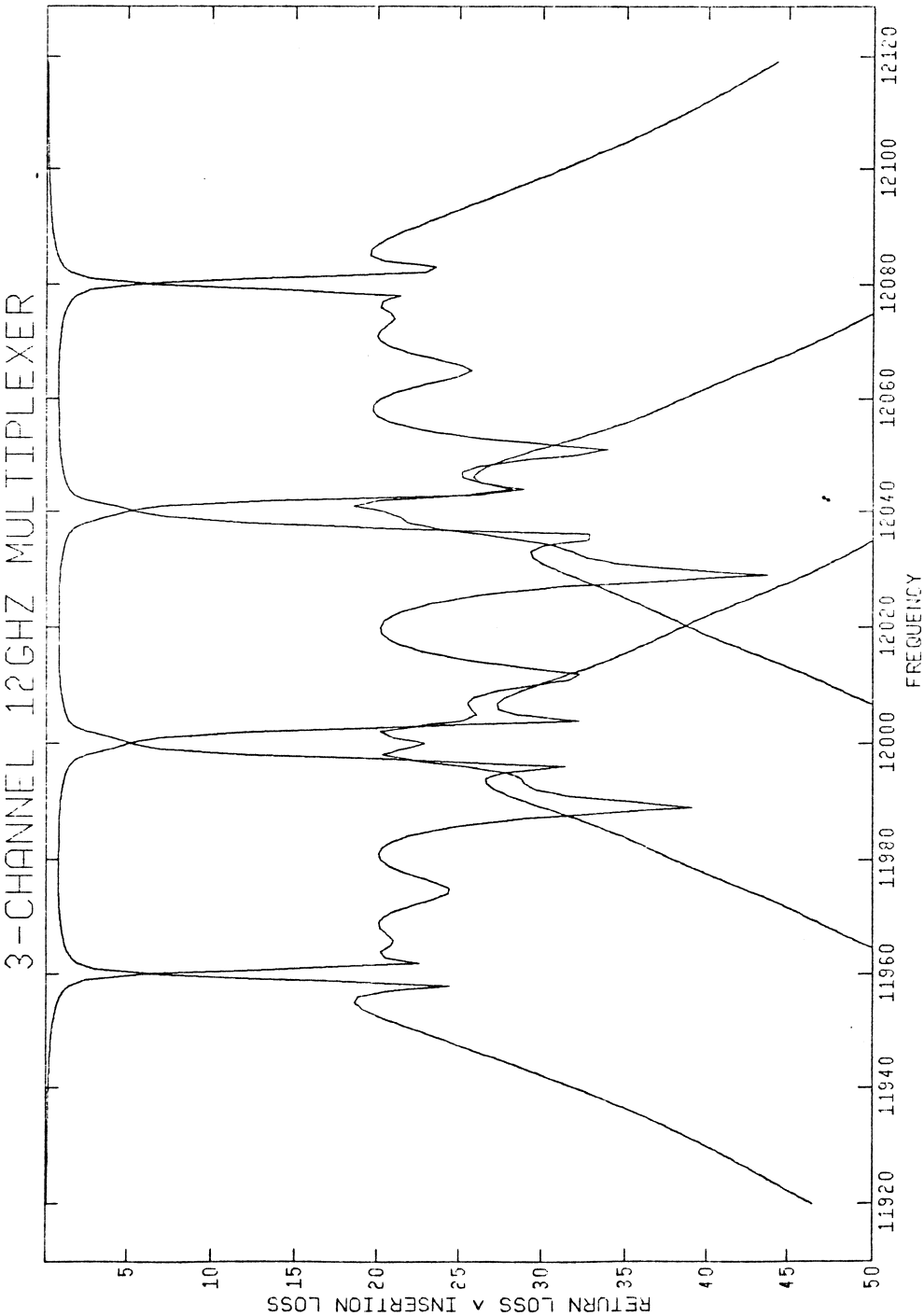

Fig. 1 Responses in dB of a 3-channel multiplexer with optimized spacings, input and output transformer ratios and coupling parameters as well as cavity resonant frequencies. The filters are lossy and dispersive with unloaded Q=12000; nonideal junctions are assumed.