CONTIGUOUS BAND MULTIPLEXER

SIMULATION AND OPTIMIZATION

OSA-84-MX-8-T

February 29, 1984

SUMMARY

This document contains the main segment MXSOS2 (pp. 3-13) compatible with Document OSA-84-MX-7-L[1] as well as Subroutine FDF2 (pp. 14-16) as called by the MMLC optimization package [2]. Dimension and executable statements clearly identify a 30 variable optimization problem related to a 14-channel multiplexer (see [3]).

Specifically, the variables include 6 spacings, 6 input transformer ratios and 6 output transformer ratios of channels 9 through 14. Furthermore, for each of these channels, the elements M(1,1) and M(1,2) are also declared variable. Return loss specifications are placed only at 49 uniformly spaced frequency points covering the range 11720 MHz to 11960 MHz. Thus, the dummy channel 14 (11680-11720 MHz) is neglected but channel 8 (11920-11960 MHz) is constrained because of the influence of the variables associated with adjacent channel 9. Starting parameter values correspond to the final values obtained by ComDev from spacing optimization. The filters are lossy and dispersive with unloaded Q=12000; nonideal junctions are assumed.

As Fig. 1 on page 23 demonstrates, the 20 dB return loss specification is well-satisfied over the entire band of interest covering channels 2 to 13. The versatility of MXSOS2 in optimizing only those variables and those responses selected by the user as important is amply verified. This provides an important step in the direction of tuning.

In conclusion, 49 nonlinear minimax functions of 30 variables have been optimized in 32 complete response evaluations taking about 400 CPU seconds, as exemplified by actual output from MMLC (pp. 17-22).

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-6-T,"Contiguous band multiplexer simulation and optimization," Optimization Systems Associates, Dundas, Ontario, Canada, February 1, 1984.

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      PROGRAM MXSOS2(OUTPUT,TAPE6=OUTPUT)
C
C     THIS PROGRAM IS A USER DEFINED MAIN SEGMENT OF THE MXSOS2 PACKAGE
C     FOR MULTIPLEXER SIMULATION, SENSITIVITY ANALYSIS AND OPTIMIZATION.
C     THE PROGRAM SETS UP ARRAYS, INITIALIZES THE DATA AND EXECUTES SOME
C     SIMPLE STEPS TO ORGANIZE THE PROBLEM AS REQUIRED BY THE PACKAGE.
C     IT CONSISTS OF THREE PARTS. THE FIRST PART INITIALIZES THE DATA
C     REQUIRED FOR SIMULATION, THE SECOND PART INITIALIZES ADDITIONAL
C     DATA REQUIRED FOR SENSITIVITY ANALYSIS AND THE THIRD PART INITIA-
C     LIZES THE DATA REQUIRED FOR THE MULTIPLEXER OPTIMIZATION PROBLEM
C     OF INTEREST INCLUDING SPECIFICATIONS AND WEIGHTING FACTORS AS WELL
C     AS THE DATA REQUIRED BY THE MINIMAX OPTIMIZATION PACKAGE MMLC. AT
C     THIS TIME ONLY COMMON PORT RETURN LOSS AND CHANNEL INSERTION LOSS
C     IN DB ARE HANDLED FOR OPTIMIZATION. IN THE CASE OF SIMULATION
C     GROUP DELAY IS ESTIMATED BY DIFFERENCING THE PHASE AT A PAIR
C     OF FREQUENCIES.
C
C     THE USER MUST PROVIDE APPROPRIATE DIMENSIONS FOR THE FOLLOWING
C     VARIABLES AFTER STUDYING THE COMMENTS PLACED THROUGHOUT THE MAIN
C     SEGMENT MXSOS2. CORRESPONDING DIMENSIONS MUST BE DECLARED IN ALL
C     SUBROUTINES EXCEPT FOR THE MMLC PACKAGE.
C
      REAL X(30),W(14000),B(1),C(1,1),T(3),DISP(16),QO(16)
      REAL OMEGA(49),SURL(49),SLRL(49),WURL(49),WLRL(49),
     1     SU(20,16),SL(20,16),WU(20,16),WL(20,16)
      INTEGER RLSCODE(49),SPCODE(20,16),CHBCODE(16,2)
      REAL WO(16),BW(16),CM(16,8,8),PN1(16),PN2(16),SPN1(16),SPN2(16),
     1          GL(16),WGL(16),DIA(16)
      INTEGER CEL(16,8,8)
      REAL FCNST(16),LAMRES(16),LAMDEL(16)
      REAL DRL(100),FIL(16),DIL(16,100)
      REAL ANGLE1(16),ANGLE2(16),GRDEL(16)
      INTEGER IR(16),IRT(16),IPN1(16),IPN2(16),IWG(16)
      INTEGER LC(16,36),KC(16,36)
      EXTERNAL FDF2
      COMMON /BLK1/WO,BW,PN1,PN2,GL,VS,RS,PI2,WIDTH,NP1
      COMMON /BLK2/CM,WGL
      COMMON /BLK3/OMEGA,SURL,SLRL,WURL,WLRL,SU,SL,WU,WL,
     1           RLSCODE,SPCODE,NCOUNT,MODE,NCH,MO,NFREQ,NFRL,
     2       CHBCODE,IFLAGJS,IFLAGDP,IDISPER
      COMMON /BLK4/CBR,FCUT
      COMMON /BLK5/DISP
      COMMON/BLK6/FCNST,LAMRES,LAMDEL
      COMMON/BLK7/CEL
      COMMON/BLK8/IR,IRT,IPN1,IPN2,IWG,LC,KC
      DATA T/10HMULTIPLEXE,10HR PROBLEM ,10HMXTST5A   /
C
C     THE MXSOS2 PACKAGE CAN OPERATE IN THREE MODES: SIMULATION, SENSITI
C     VITY ANALYSIS AND OPTIMIZATION. TO SELECT THE REQUIRED FUNCTION OF
C     THE PACKAGE SET LMODE TO
C     1 - IF MULTIPLEXER SIMULATION IS REQUIRED,
C     2 - IF MULTIPLEXER SENSITIVITY ANALYSIS IS REQUIRED,
C     3 - IF MULTIPLEXER OPTIMIZATION IS REQUIRED.
C
C     SELECT MODE OF OPERATION OF THE PACKAGE
C
      LMODE=3
C
C     THIS PART OF THE MAIN SEGMENT IS USED TO DEFINE THE DATA FOR
C     MULTIPLEXER SIMULATION. IT MUST ALWAYS BE DEFINED, REGARDLESS OF
C     THE MODE OF OPERATION OF THE PACKAGE SELECTED.
C
C     NCH    - NUMBER OF FILTER CHANNELS INCLUDING DUMMY CHANNELS
C     MO     - ORDER OF FILTERS(THE SAME FOR ALL FILTERS, ODD OR EVEN)
C     WO     - VECTOR OF CENTER FREQUENCIES IN MHZ, ONE PER CHANNEL
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C       QO        - VECTOR OF UNLOADED Q FOR THE FILTERS, ONE PER CHANNEL
C       DIA       - VECTOR OF FILTER DIAMETERS IN INCHES, ONE PER CHANNEL
C       BW        - VECTOR OF CHANNEL BANDWIDTHS IN MHZ, ONE PER CHANNEL
C       SPN1      - VECTOR OF INPUT TRANSFORMER RATIOS(SQUARED), ONE PER
C                   CHANNEL
C       SPN2      - VECTOR OF OUTPUT TRANSFORMER RATIOS(SQUARED), ONE PER
C                   CHANNEL
C       GL        - VECTOR OF CHANNEL TERMINATING CONDUCTANCES, ONE PER
C                   CHANNEL
C       CM        - SYMMETRICAL MATRIX OF COUPLING PARAMETERS(CHANNEL,ROW,
C                   COLUMN), INCLUDING NONZERO DIAGONAL ELEMENTS TO MODEL
C                   ASYNCHRONOUS DESIGNS
C       CEL       - SYMMETRICAL MATRIX FOR TYPE OF COUPLING, +1 FOR SCREW,
C                   -1 FOR IRIS, CORRESPONDING TO CM AS ABOVE
C       WGL       - VECTOR OF WAVEGUIDE SPACINGS FOR EACH CHANNEL, MEASURED
C                   IN INCHES ALONG THE MANIFOLD FROM THE ADJACENT CHANNEL
C                   (DISTANCE FROM THE SHORT CIRCUIT FOR THE FIRST CHANNEL)
C       VS        - SOURCE VOLTAGE AT THE COMMON PORT
C       RS        - SOURCE RESISTANCE AT THE COMMON PORT
C       PI2       - CONSTANT EQUAL TO TWICE PI
C       WIDTH     - MANIFOLD WIDTH IN INCHES
C
C       DEFINE THE NUMBER OF CHANNELS AND THE ORDER OF THE FILTERS
C
        NCH=14
        MO=6
        NP1=NCH+1
C
C       DEFINE CENTER FREQUENCIES IN MHZ
C
        WO(1)=12220.0
        WO(2)=12180.0
        WO(3)=12140.0
        WO(4)=12100.0
        WO(5)=12060.0
        WO(6)=12020.0
        WO(7)=11980.0
        WO(8)=11940.0
        WO(9)=11900.0
        WO(10)=11860.0
        WO(11)=11820.0
        WO(12)=11780.0
        WO(13)=11740.0
        WO(14)=11700.0
C
C       DEFINE UNLOADED Q FACTORS OF THE FILTERS
C
        DO 5 I=1,NCH
        QO(I)=12000.0
      5 CONTINUE
C
C       DEFINE THE DIAMETER OF THE FILTERS IN INCHES
C
        DO 70 I=1,NCH
        DIA(I)=1.07
     70 CONTINUE
C
C       DEFINE BANDWIDTHS, INPUT/OUTPUT TRANSFORMER RATIOS AND OUTPUT
C       CONDUCTANCES
C
        DO 1 I=1,NCH
        BW(I)=39.0
        GL(I)=1.0
        SPN1(I)=0.69967
        SPN2(I)=1.09450
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      PN1(I)=SQRT(SPN1(I))
      PN2(I)=SQRT(SPN2(I))
    1 CONTINUE
C
C     DEFINE THE SYMMETRICAL COUPLING MATRIX.  ONLY THE UPPER PART OF THE
C     CM MATRIX HAS TO BE DEFINED.
C
      DO 30 I=1,NCH
      DO 30 J=1,MO
      DO 30 KK=1,MO
      CM(I,J,KK)=0.0
   30 CONTINUE
      DO 2 I=1,NCH
      CM(I,1,2)=0.59395
      CM(I,2,3)=0.53514
      CM(I,3,4)=0.42471
      CM(I,3,6)=-0.39967
      CM(I,4,5)=0.83371
      CM(I,5,6)=0.76313
    2 CONTINUE
C
C     DEFINE THE TYPE OF COUPLING IN THE FILTER
C               +1 >> SCREW COUPLING     -1 >> IRIS COUPLING
C
      DO 71 I=1,NCH
      DO 71 J=1,MO
      DO 71 KK=1,MO
      CEL(I,J,KK)=0
   71 CONTINUE
C
      DO 72 I=1,NCH
      CEL(I,1,2)=1
      CEL(I,2,3)=-1
      CEL(I,3,4)=1
      CEL(I,3,6)=-1
      CEL(I,4,5)=-1
      CEL(I,5,6)=1
C
      DO 72 J=1,MO
      DO 72 KK=1,J
      CEL(I,J,KK)=CEL(I,KK,J)
   72 CONTINUE
C
C     DEFINE THE SECTION LENGTHS (SPACINGS ALONG THE WAVEGUIDE MANIFOLD)
C
      WGL(1)=0.612
      WGL(2)=0.649
      WGL(3)=0.635
      WGL(4)=0.639
      WGL(5)=0.642
      WGL(6)=0.655
      WGL(7)=0.659
      WGL(8)=0.664
      WGL(9)=0.658
      WGL(10)=0.640
      WGL(11)=0.965
      WGL(12)=0.681
      WGL(13)=0.582
      WGL(14)=0.342
C
C     DEFINE SOME CONSTANTS, SOURCE VOLTAGE, SOURCE RESISTANCE, TWICE PI
C     MANIFOLD WIDTH
C
      VS=1.0
      RS=1.0
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      PI2=8.0*ATAN(1.0)
      WIDTH=0.75
C
C     THE MXSOS2 PACKAGE CAN EXPLOIT THREE PRACTICAL MODELS OF THE
C     MULTIPLEXER AS DETERMINED BY THE PARAMETERS IFLAGJS, IFLAGDP
C     AND IDISPER.
C
C     IFLAGJS
C     0 - IF JUNCTIONS ARE IDEAL
C     1 - IF JUNCTIONS ARE NONIDEAL
C
C     IFLAGDP
C     0 - IF FILTERS ARE LOSSLESS
C     1 - IF FILTERS ARE LOSSY
C
C     IDISPER
C     0 - IF FILTERS ARE DISPERSIVE
C     1 - IF FILTERS ARE NONDISPERSIVE
C
C     FLAG FOR JUNCTION SUSCEPTANCE (SET TO 0 OR 1)
C
      IFLAGJS=1
      IF(IFLAGJS.NE.1)GO TO 42
C
      CALL CONST1(WIDTH)
C
   42 CONTINUE
C
C     FLAG FOR FILTER DISSIPATION (SET TO 0 OR 1)
C
      IFLAGDP=1
      IF(IFLAGDP.NE.1)GO TO 43
C
      CALL DISPAT(NCH,WO,BW,QO)
C
   43 CONTINUE
C
C     FLAG FOR DISPERSIVE EFFECTS IN THE COUPLED CAVITY FILTERS
C     (SET TO 0 OR 1)
C
      IDISPER=1
      IF(IDISPER.NE.1)GO TO 44
C
      CALL DISPER(NCH,WO,BW,DIA)
C
   44 CONTINUE
C
C     CHECK WHETHER THE SIMULATION MODE IS REQUIRED
C
      IF(LMODE.NE.1)GO TO 16
C
C     SIMULATION, CORRESPONDING TO LMODE=1
C
C     THIS PART OF THE MAIN SEGMENT IS USED TO GENERATE FREQUENCIES AT
C     WHICH SIMULATION IS TO BE PERFORMED. A FREQUENCY STEP OF 1 MHZ IS
C     ASSUMED. NONE OF THE GENERATED FREQUENCIES MUST BE SET EQUAL TO
C     ANY OF THE CENTER FREQUENCIES. SUBROUTINE "SIMUL" IS CALLED AT
C     EACH GENERATED FREQUENCY. IF A DIFFERENT FREQUENCY STEP IS REQUI-
C     RED THE FREQUENCY POINTS FOR SIMULATION HAVE TO BE GENERATED IN A
C     DIFFERENT WAY.
C
C     FREQST - START FREQUENCY FOR SIMULATION
C     FREQ   - ACTUAL FREQUENCY AT WHICH "SIMUL" IS CALLED
C     NFRSIM - NUMBER OF FREQUENCY POINTS FOR SIMULATION
C
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      PRINT(6,199)
  199 FORMAT(1H1)
      PRINT(6,205)
  205 FORMAT(6X,"FREQUENCY",5X,"RETURN LOSS",5X,"INSERTION LOSS",
     1        8X,"FREQUENCY FOR",7X,"GROUP DELAY")
      PRINT(6,206)
  206 FORMAT(8X,"MHZ",9X,"COMMON PORT",9X,"DB",17X,"GROUP DELAY",
     1       9X,"NANO SECS")
C
C
C     THE FOLLOWING TWO PARAMETERS MUST BE DEFINED
C
      FREQST=11919.0
      NFRSIM=200
C
      NCHAN=NCH
      MORDER=MO
      IREL=NCH+1
      DO 200 ICOUNT=1,NFRSIM
      FREQ=FREQST+FLOAT(ICOUNT)
      ITEST=INT(FREQ)
C
C     THE FOLLOWING STATEMENT PRINTS DASHED LINE EVERY 20 MHZ
C
      IF(MOD(ITEST,20).EQ.0)PRINT(6,208)
  208 FORMAT(90("-"))
      DO 210 I=1,NCH
      IF(ABS(FREQ-WO(I)).LT.1.E-10)FREQ=FREQ+0.001
  210 CONTINUE
C
C     GROUP DELAY IS ESTIMATED FROM THE PHASE DIFFERENCE AT TWO
C     FREQUENCIES, NAMELY, THE SELECTED FREQUENCY AND THE SELECTED
C     FREQUENCY MINUS 0.5 MHZ. CONSEQUENTLY, THE EVALUATION IS A
C     TRUE QUADRATIC APPROXIMATION AT THE SELECTED FREQUENCY MINUS
C     0.25 MHZ. THUS, A SEPARATE COLUMN OF FREQUENCIES AND GROUP
C     DELAYS IS GENERATED AND PRINTED OUT.
C
C     SUBTRACT 0.5 MHZ FROM FREQ
C
      FREQ=FREQ-0.5
C
      CALL SIMUL(FREQ,NCHAN,MORDER,ICOUNT,IFLAGJS,IFLAGDP,IDISPER,
     1           FRL,FIL,ANGLE1)
C
C     RESET FREQ BY ADDING 0.5 MHZ
C
      FREQ=FREQ+0.5
C
      CALL SIMUL(FREQ,NCHAN,MORDER,ICOUNT,IFLAGJS,IFLAGDP,IDISPER,
     1           FRL,FIL,ANGLE2)
C
      DO 300 I=1,NCH
      DELANG=ANGLE2(I)-ANGLE1(I)
      PI=PI2/2.0
      IF(DELANG.GT.PI)DELANG=DELANG-PI2
      GRDEL(I)=-2000.0*DELANG/PI2
  300 CONTINUE
C
C     THE FOLLOWING STATEMENT CAUSES THE PRINTING OF INSERTION LOSS
C     FUNCTION VALUES ONLY FOR THE BAND OF INTEREST.
C
      IF(MOD(ITEST,40).EQ.0)IREL=IREL-1
C
C     GROUP DELAY IS ESTIMATED AT FREQ MINUS 0.25 MHZ
C
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      FRGROUP=FREQ-0.25
      PRINT(6,207)FREQ,FRL,FIL(IREL),FRGROUP,GRDEL(IREL)
  207 FORMAT(6X,F7.1,9X,F5.2,12X,F5.2,17X,F8.2,10X,F8.2)
  200 CONTINUE
      GO TO 900
C
C     SENSITIVITY ANALYSIS, CORRESPONDING TO LMODE=2
C
C     THIS PART OF THE MAIN PROGRAM IS USED TO DEFINE CODES FOR MULTI-
C     PLEXER PARAMETERS W.R.T. WHICH WE WANT TO FIND THE SENSITIVITIES.
C     THE PARAMETER IR(I)=0 SIGNIFIES THAT NO ELEMENTS OF THE FILTER
C     COUPLING MATRICES ARE OPTIMIZATION VARIABLES. SUBROUTINE "SIMGRD2"
C     IS CALLED AT EACH FREQUENCY DEFINED IN THE VECTOR OMEGA(I).
C
C     IR       - VECTOR CONTAINING THE NUMBER OF COUPLING PARAMETERS BE-
C                ING VARIABLES FOR EACH CHANNEL
C     LC       - MATRIX CONTAINING THE ROW INDICES OF COUPLING PARAMETERS
C                BEING VARIABLES FOR EACH CHANNEL
C     KC       - MATRIX CONTAINING THE COLUMN INDICES OF COUPLING PARAME-
C                TERS BEING VARIABLES FOR EACH CHANNEL
C     IPN1     - INTEGER ARRAY OF DIMENSION AT LEAST NCH INDICATING
C                WHETHER THE INPUT TRANSFORMER RATIO IS AN OPTIMIZATION
C                VARIABLE (IPN1(I)=1) OR NOT (IPN1(I)=0).
C     IPN2     - INTEGER ARRAY OF DIMENSION AT LEAST NCH INDICATING
C                WHETHER THE OUTPUT TRANSFORMER RATIO IS AN OPTIMIZATION
C                VARIABLE (IPN2(I)=1) OR NOT (IPN2(I)=0).
C     IWG      - INTEGER ARRAY OF DIMENSION AT LEAST NCH INDICATING
C                WHETHER THE WAVEGUIDE SECTION LENGTH IS AN OPTIMIZA-
C                TION VARIABLE (IWG(I)=1) OR NOT (IWG(I)=0).
C     OMEGA    - VECTOR OF ARBITRARY FREQUENCIES (EXCEPT CENTER FREQUEN-
C                CIES) AT WHICH THE SENSITIVITY ANALYSIS IS TO BE PERFOR-
C                MED.
C     FRSNS    - ACTUAL FREQUENCY AT WHICH THE SUBROUTINE "SIMGRD" IS
C                CALLED
C     NV       - TOTAL NUMBER OF VARIABLES W.R.T. WHICH THE SENSITIVITIES
C                ARE REQUIRED
C     FRL      - VALUE OF THE COMMON PORT RETURN LOSS IN DB AT THE FREQU-
C                ENCY FRSNS
C     DRL      - SENSITIVITIES OF THE COMMON PORT RETURN LOSS W.R.T. ALL
C                VARIABLES
C     FIL      - VECTOR OF THE INSERTION LOSS FUNCTION IN DB FOR EACH
C                CHANNEL AT THE FREQUENCY FRSNS
C     DIL      - MATRIX OF SENSITIVITIES OF THE INSERTION LOSS FUNCTION
C                FOR EACH CHANNEL W.R.T. ALL VARIABLES
C
C     DEFINE THE NUMBER OF COUPLING VARIABLES PER CHANNEL
C
   16 CONTINUE
      DO 166 I=1,NCH
      IR(I)=0
      IWG(I)=0
      IPN1(I)=0
      IPN2(I)=0
  166 CONTINUE
      DO 167 I=9,NCH
      IR(I)=2
  167 CONTINUE
C
C     DEFINE  CODES TO IDENTIFY VARIABLES FOR INPUT-OUTPUT
C     TRANSFORMER RATIOS AND WAVEGUIDE SPACINGS
      DO 55 I=9,NCH
      IWG(I)=1
      IPN1(I)=1
      IPN2(I)=1
      LC(I,1)=1
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      LC(I,2)=1
      KC(I,1)=1
      KC(I,2)=2
   55 CONTINUE
C
C     EVALUATE THE TOTAL NUMBER OF VARIABLES ACCUMULATED AFTER
C     EACH SECTION
C
      CALL TOTAL2(NCH,IR,IRT,IPN1,IPN2,IWG)
C
C     DEFINE CODES FOR THE VARIABLES CONTAINED IN THE COUPLING MATRICES
C
C
C     CHECK WHETHER THE SIMULATION AND SENSITIVITY ANALYSIS MODE
C     IS REQUIRED
C
      IF(LMODE.NE.2) GO TO 17
C
C     GENERATE FREQUENCY POINTS IN MHZ
C
      NFREQ=1
      OMEGA(1)=12062.0
      NCHAN=NCH
      MORDER=MO
      DO 18 ICOUNT=1,NFREQ
      FRSNS=OMEGA(ICOUNT)
C
      CALL SIMGRD2(FRSNS,FRL,DRL,FIL,DIL,NCHAN,MORDER,ICOUNT,IFLAGJS,
     1             IFLAGDP,IDISPER)
C
   18 CONTINUE
      GO TO 900
C
C     OPTIMIZATION, CORRESPONDING TO LMODE=3
C
C     THIS PART OF THE MAIN SEGMENT IS USED TO DEFINE ALL VARIABLES AND
C     ARRAYS FOR MULTIPLEXER OPTIMIZATION. TO SELECT THE MULTIPLEXER PA-
C     RAMETERS WHICH ARE THE OPTIMIZATION VARIABLES THE MATRICES LC AND
C     KC HAVE TO BE USED AS DESCRIBED IN THE SENSITIVITY ANALYSIS PART.
C     THREE MODES OF OPTIMIZATION ARE ALLOWED. TO SELECT THE DESIRED
C     MODE OF OPTIMIZATION SET PARAMETER MODE TO
C     0 - IF ONLY COMMON PORT RETURN LOSS OPTIMIZATION IS REQUIRED
C     1 - IF ONLY INSERTION LOSS OPTIMIZATION IS REQUIRED
C     2 - IF BOTH RETURN LOSS AND INSERTION LOSS OPTIMIZATION ARE
C         REQUIRED.
C     IN EACH CASE A DIFFERENT HEADER FOR THE PRINTOUT OF OPTIMIZATION
C     RESULTS CAN BE OBTAINED BY CALLING THE SUBROUTINE "MMXHDR" FOR
C     WHICH THE ARGUMENT T CAN BE DEFINED USING THE DATA STATEMENT. VA-
C     LUES OF OPTIMIZATION VARIABLES AT THE STARTING POINT MUST BE SUP-
C     PLIED BY DEFINING THE X VECTOR USING EITHER THE DATA STATEMENT OR
C     EXPLICITLY. THE MINIMAX FUNCTIONS ARE CREATED AT THE FREQUENCIES
C     DEFINED IN THE VECTOR OMEGA(I), WHICH IS A REAL ARRAY OF LENGTH
C     AT LEAST NFREQ.
C
C     NFREQ  - NUMBER OF FREQUENCY POINTS AT WHICH THE MINIMAX FUNCTI-
C              ONS ARE TO BE CREATED
C     OMEGA  - VECTOR OF ARBITRARY FREQUENCY POINTS (EXCEPT CENTER FRE-
C              QUENCIES) IN MHZ AT WHICH THE MINIMAX FUNCTIONS ARE TO
C              BE CREATED
C     NFRL   - NUMBER OF MINIMAX FUNCTIONS CREATED DUE TO RETURN LOSS
C              SPECIFICATIONS
C
C     ARRAYS AND CODES FOR COMMON PORT RETURN LOSS OPTIMIZATION
C
C     RLSCODE- INTEGER ARRAY OF LENGTH AT LEAST NFREQ. EACH ELEMENT MUST
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C            BE SET TO THE FOLLOWING SPECIFICATION CODE VALUE AT EACH
C            FREQUENCY :
C            0 - NO SPECIFICATION REQUIRED
C           -1 - ONLY LOWER SPECIFICATION REQUIRED
C            1 - ONLY UPPER SPECIFICATION REQUIRED
C            2 - BOTH UPPER AND LOWER SPECIFICATIONS REQUIRED
C     SURL   - REAL ARRAY OF LENGTH AT LEAST NFREQ. IT MUST CONTAIN THE
C              UPPER SPECIFICATIONS APPLICABLE AT EACH FREQUENCY
C     SLRL   - REAL ARRAY OF LENGTH AT LEAST NFREQ. IT MUST CONTAIN THE
C              LOWER SPECIFICATIONS APPLICABLE AT EACH FREQUENCY
C     WURL   - REAL ARRAY OF LENGTH AT LEAST NFREQ. IT MUST CONTAIN THE
C              WEIGHTING FACTORS CORRESPONDING TO UPPER SPECIFICATIONS
C     WLRL   - REAL ARRAY OF LENGTH AT LEAST NFREQ. IT MUST CONTAIN THE
C              WEIGHTING FACTORS CORRESPONDING TO LOWER SPECIFICATIONS
C
C     ARRAYS AND CODES FOR INSERTION LOSS OPTIMIZATION
C
C     CHBCODE- INTEGER ARRAY OF DIMENSIONS AT LEAST NCH BY 2. EACH ROW
C              MUST CONTAIN THE RANGE OF FREQUENCIES OVER WHICH SPECI-
C              FICATIONS FOR THE CORRESPONDING CHANNEL ARE GIVEN. THE
C              FIRST ELEMENT OF A ROW INDICATES THE LOWER FREQUENCY
C              EDGE OF INTEREST, THE SECOND THE UPPER FREQUENCY EDGE.
C     SPCODE - INTEGER ARRAY OF DIMENSIONS AT LEAST NSPMAX BY NCH.
C              NSPMAX IS THE MAXIMUM NUMBER OF FREQUENCY POINTS CONSI-
C              DERED FOR ANY OF THE CHANNELS.
C              EACH COLUMN MUST CONTAIN THE SPECIFICATION CODE AT EACH
C              FREQUENCY FOR THE CORRESPONDING CHANNEL. EACH ELEMENT
C              OF A COLUMN MUST BE SET TO ONE OF THE FOLLOWING VALUES:
C              0 - NO SPECIFICATION REQUIRED
C             -1 - ONLY LOWER SPECIFICATION REQUIRED
C              1 - ONLY UPPER SPECIFICATION REQUIRED
C              2 - BOTH UPPER AND LOWER SPECIFICATIONS REQUIRED
C     SU     - REAL ARRAY OF DIMENSIONS AT LEAST NSPMAX BY NCH. IT
C              MUST CONTAIN THE UPPER SPECIFICATIONS FOR EACH CHANNEL
C              ORDERED CONSECUTIVELY W.R.T. FREQUENCY INDEX IMPLIED
C              BY THE CHBCODE MATRIX IN THE FORM (FREQUENCY INDEX,
C              CHANNEL).
C     SL     - REAL ARRAY OF DIMENSIONS AT LEAST NSPMAX BY NCH. IT
C              MUST CONTAIN THE LOWER SPECIFICATIONS FOR EACH CHANNEL
C              ORDERED CONSECUTIVELY W.R.T. FREQUENCY INDEX IMPLIED
C              BY THE CHBCODE MATRIX IN THE FORM (FREQUENCY INDEX,
C              CHANNEL).
C     WU     - REAL ARRAY OF DIMENSIONS AT LEAST NSPMAX BY NCH. IT
C              MUST CONTAIN THE WEIGHTING FACTORS FOR UPPER SPECIFI-
C              CATIONS. IT IS ARRANGED TO CORRESPOND TO SU.
C     WL     - REAL ARRAY OF DIMENSIONS AT LEAST NSPMAX BY NCH. IT
C              MUST CONTAIN THE WEIGHTING FACTORS FOR LOWER SPECIFI-
C              CATIONS. IT IS ARRANGED TO CORRESPOND TO SL.
C
C
   17 CALL MMXHDR(3,T)
C
C     SELECT THE DESIRED MODE OF OPTIMIZATION
C
      MODE=0
C
C     THE STARTING POINT FOR OPTIMIZATION MUST BE INITIALIZED BY
C     SETTING CONSECUTIVELY NUMBERED X VALUES. IT IS IMPERATIVE
C     THAT THE OPTIMIZATION VARIABLES FOR EACH CHANNEL ARE DEFINED
C     CONSECUTIVELY AS FOLLOWS: VARIABLE FILTER COUPLINGS COME FIRST,
C     FOLLOWED BY VARIABLE INPUT, THEN OUTPUT, TRANSFORMER RATIOS,
C     THE SECTION LENGTH BEING THE LAST VARIABLE IN THE SET OF
C     OPTIMIZATION VARIABLES FOR A PARTICULAR CHANNEL.
C
      DO 7 I=1,6
```

```
      ICHAN=I+8
      I5=I*5
      I5M1=I5-1
      I5M2=I5-2
      I5M3=I5-3
      I5M4=I5-4
      X(I5M4)=CM(ICHAN,1,1)
      X(I5M3)=CM(ICHAN,1,2)
      X(I5M2)=PN1(ICHAN)
      X(I5M1)=PN2(ICHAN)
      X(I5)=WGL(ICHAN)
    7 CONTINUE
C
C     GENERATE FREQUENCY POINTS IN MHZ
C
      NFREQ=49
      NFREQ1=NFREQ-1
      OMEGA(1)=11720.0001
      DO 10 I=1,NFREQ1
      I1=I+1
      OMEGA(I1)=OMEGA(I)+5.0
   10 CONTINUE
C
C     DEFINE THE NUMBER OF MINIMAX FUNCTIONS RESULTING FROM THE
C     SPECIFICATIONS ON RETURN LOSS
C
      NFRL=49
C
C     DEFINE CODES AND ARRAYS REQUIRED FOR RETURN LOSS OPTIMIZATION
C
      DO 150 I=1,49
      RLSCODE(I)=-1
      SLRL(I)=20.0
      WLRL(I)=1.0
  150 CONTINUE
C
C     DEFINE CHANNEL BAND CODE (CHANNEL, FREQUENCY EDGE INDEX), WHERE
C     THE FIRST CHANNEL IS CLOSEST TO THE SHORT CIRCUIT AND CORRESPONDS
C     TO THE HIGHEST CENTER FREQUENCY, AND THE FREQUENCY EDGES ARE 1
C     FOR LOWER EDGE AND 2 FOR UPPER EDGE. THE VALUE OF CHBCODE CORRES-
C     PONDS TO THE FREQUENCY POINT INDEX USED AS ARGUMENT OF OMEGA(I).
C     IF THERE IS NO SPECIFICATION FOR A PARTICULAR CHANNEL, THE VALUE
C     OF CHBCODE MUST BE SET TO 0.
C
C
C     DEFINE THE SPECIFICATION CODE FOR INSERTION LOSS OPTIMIZATION
C     (FREQUENCY INDEX, CHANNEL)
C
C
C     DEFINE VALUES FOR THE SPECIFICATIONS (FREQUENCY INDEX, CHANNEL)
C
C
C     DEFINE WEIGHTING FACTORS CORRESPONDING TO THE SPECIFICATIONS
C
C
C     ARGUMENTS OF THE MINIMAX OPTIMIZATION(MMLC) CALL STATEMENT
C
C     FDF2   - NAME OF A SUBROUTINE CALCULATING MINIMAX FUNCTIONS AND
C              THEIR DERIVATIVES AT THE POINT DEFINED BY THE X VECTOR.
C              THE NAME FDF2 IS ARBITRARY AND MUST APPEAR IN THE EXTER-
C              NAL STATEMENT IN THE SEGMENT CALLING MMLC1A.
C     NV     - INTEGER ARGUMENT WHICH MUST BE SET TO THE NUMBER OF OP-
C              TIMIZATION VARIABLES. ITS VALUE MUST BE POSITIVE AND IS
C              NOT CHANGED BY THE PACKAGE.
C     MF     - INTEGER ARGUMENT WHICH MUST BE SET TO THE NUMBER OF RE-
```

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C                 SIDUAL FUNCTIONS DEFINING THE MINIMAX OBJECTIVE FUNCTION.
C                 ITS VALUE MUST BE POSITIVE AND IS NOT CHANGED BY THE PA-
C                 CKAGE.
C     L         - INTEGER ARGUMENT WHICH MUST BE SET TO THE TOTAL NUMBER
C                 OF EQUALITY AND INEQUALITY CONSTRAINTS. ITS VALUE MUST
C                 BE POSITIVE OR ZERO AND IT IS NOT CHANGED BY THE PACKA-
C                 GE.
C     LEQ       - INTEGER ARGUMENT WHICH MUST BE SET TO THE NUMBER OF EQ-
C                 UALITY CONSTRAINTS. ITS VALUE MUST BE POSITIVE OR ZERO
C                 AND NOT GREATER THAN NV, AND NOT GREATER THAN L. ITS
C                 VALUE IS NOT CHANGED BY THE PACKAGE.
C     B         - REAL ARRAY OF LENGTH IIC > L. THE ELEMENTS OF B MUST BE
C                 SET TO THE CONSTANT TERMS IN THE LINEAR CONSTRAINTS.
C                 THE CONTENTS OF B ARE NOT CHANGED BY THE PACKAGE.
C     C         - REAL MATRIX OF DIMENSIONS (IIC,NV). THE FIRST L ROWS OF
C                 C MUST BE SET TO THE COEFFICIENTS OF X IN THE LINEAR
C                 CONSTRAINTS.
C     IIC       - INTEGER ARGUMENT WHICH MUST BE SET TO THE LENGTH OF THE
C                 ARRAY B AND TO NUMBER OF ROWS OF THE MATRIX C. ITS VA-
C                 LUE MUST NOT BE LESS THAN L, AND IT IS NOT CHANGED BY
C                 THE PACKAGE.
C     X         - REAL ARRAY OF LENGTH AT LEAST NV WHICH, ON ENTRY, MUST
C                 BE SET TO THE INITIAL APPROXIMATION OF THE SOLUTION.
C                 ON EXIT X CONTAINS THE BEST SOLUTION FOUND BY THE PACK-
C                 AGE.
C     DX        - REAL VARIABLE WHICH CONTROLS THE STEP LENGTH OF THE ITER-
C                 ATIVE ALGORITHM. ON ENTRY IT MUST BE SET TO AN INITIAL
C                 VALUE APPROXIMATELY EQUAL TO 0.1* X. THE VALUE OF DX
C                 MUST BE POSITIVE. ON EXIT DX CONTAINS THE LAST VALUE OF
C                 THE STEPSIZE. FOR EXTENSIVE DETAILS PLEASE REFER TO
C                 REPORT SOS-82-5-U2, AUGUST 1983.
C     EPS       - REAL VARIABLE WHICH ON ENTRY MUST BE SET TO THE REQUIRED
C                 ACCURACY OF THE SOLUTION. ON EXIT EPS CONTAINS THE LENGTH
C                 OF THE LAST STEP TAKEN IN THE ITERATION.
C     MAXF      - INTEGER VARIABLE WHICH MUST BE SET TO AN UPPER BOUND ON
C                 THE NUMBER OF CALLS OF FDF2. ON EXIT MAXF CONTAINS THE
C                 NUMBER OF CALLS OF FDF THAT HAVE BEEN PERFORMED BY THE
C                 PACKAGE.
C     KEQS      - INTEGER VARIABLE WHICH MUST BE SET TO THE NUMBER OF SUC=
C                 CESSIVE ITERATIONS WITH IDENTICAL SETS OF ACTIVE RESIDUAL
C                 FUNCTIONS AND ACTIVE CONSTRAINTS THAT IS REQUIRED BEFORE
C                 A SWITCH TO STAGE 2 IS MADE. ON EXIT KEQS CONTAINS THE
C                 NUMBER OF SWITCHES TO STAGE 2 THAT HAVE TAKEN PLACE.
C     W         - REAL ARRAY WHICH IS USED FOR WORKING SPACE. ITS LENGTH
C                 IS GIVEN BY IW. ON EXIT THE FIRST MF ELEMENTS OF W CON-
C                 TAIN THE RESIDUAL FUNCTION VALUES AT THE SOLUTION.
C     IW        - INTEGER ARGUMENT WHICH MUST BE SET TO THE LENGTH OF W.
C                 ITS VALUE MUST BE AT LEAST
C
C                      IWR=2*MF*NV+5*NV*NV+4*MF+8*NV+4*IIC+3
C
C     ICH       - INTEGER ARGUMENT WHICH MUST BE SET TO THE UNIT NUMBER
C                 THAT IS TO BE USED FOR THE PRINTED OUTPUT GENERATED BY
C                 THE PACKAGE. IF ICH IS LESS THAN OR EQUAL TO ZERO, NO
C                 PRINTED OUTPUT WILL BE GENERATED BY THE PACKAGE.
C     IPR       - INTEGER ARGUMENT WHICH CONTROLS THE PRINTED OUTPUT GE-
C                 NERATED BY THE PACKAGE. FOR EXTENSIVE DETAILS PLEASE
C                 REFER TO REPORT SOS-82-5-U2, AUGUST 1983.
C     IFALL     - INTEGER VARIABLE WHICH ON EXIT CONTAINS INFORMATION
C                 ABOUT THE SOLUTION:
C                 IFALL=-2 FEASIBLE REGION IS EMPTY,
C                 IFALL=-1 INCORRECT INPUT DATA,
C                 IFALL= 0 REGULAR SOLUTION; REQUIRED ACCURACY OBTAINED,
C                 IFALL= 1 SINGULAR SOLUTION; REQUIRED ACCURACY OBTAINED,
C                 IFALL= 2 MACHINE ACCURACY REACHED,
```

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C                IFALL= 3 MAXIMUM NUMBER OF FUNCTION EVALUATIONS REACHED,
C                IFALL= 4 ITERATION TERMINATED BY THE USER.
C
C     DEFINE PARAMETERS FOR THE MMLC PACKAGE
C
      NV=30
      MF=49
      L=0
      LEQ=0
      IIC=1
      DX=0.05
      EPS=1.E-4
      MAXF=50
      KEQS=3
      IW=14000
      ICH=6
      IPR=9100
      NCOUNT=1
C
      CALL MMLC1A(FDF2,NV,MF,L,LEQ,B,C,IIC,X,DX,EPS,MAXF,KEQS,W,IW,ICH,
     1            IPR,IFALL)
C
  900 STOP
      END
C
```

```
C
      SUBROUTINE FDF2(NV,MF,X,DF,F)
      REAL X(NV),F(MF),DF(MF,NV)
      REAL OMEGA(49),SURL(49),SLRL(49),WURL(49),WLRL(49),
     1      SU(20,16),SL(20,16),WU(20,16),WL(20,16)
      INTEGER RLSCODE(49),SPCODE(20,16),CHBCODE(16,2)
      REAL CM(16,8,8),WGL(16),DRL(100),FIL(16),DIL(16,100)
      INTEGER IR(16),IRT(16),LC(16,36),KC(16,36)
      INTEGER IPN1(16),IPN2(16),IWG(16)
      REAL WO(16),BW(16),PN1(16),PN2(16),GL(16)
      COMMON /BLK2/CM,WGL
      COMMON /BLK1/WO,BW,PN1,PN2,GL,VS,RS,P12,WIDTH,NP1
      COMMON /BLK3/OMEGA,SURL,SLRL,WURL,WLRL,SU,SL,WU,WL,
     1              RLSCODE,SPCODE,NCOUNT,MODE,NCH,MO,
     2              NFREQ,NFRL,CHBCODE,IFLAGJS,IFLAGDP,IDISPER
      COMMON/BLK8/IR,IRT,IPN1,IPN2,IWG,LC,KC
C
C     UPDATE OPTIMIZATION VARIABLES
C
      IF(IRT(1).EQ.0)GO TO 20
      IF(IR(1).EQ.0)GO TO 11
      IR1=IR(1)
      DO 10 IV=1,IR1
      CM(1,LC(1,IV),KC(1,IV))=X(IV)
   10 CONTINUE
   11 IF(IPN1(1).EQ.0)GO TO 12
      IV=IR(1)+IPN1(1)
      PN1(1)=X(IV)
   12 IF(IPN2(1).EQ.0)GO TO 13
      IV=IR(1)+IPN1(1)+IPN2(1)
      PN2(1)=X(IV)
   13 IF(IWG(1).EQ.0)GO TO 14
      IV=IR(1)+IPN1(1)+IPN2(1)+IWG(1)
      WGL(1)=X(IV)
   14 CONTINUE
C
   20 CONTINUE
      DO 40 I=2,NCH
      IF(IRT(I).EQ.0)GO TO 40
      IX=IRT(I-1)
      IF(IR(I).EQ.0)GO TO 15
      IRI=IR(I)
      DO 30 IP=1,IRI
      IXX=IX+IP
      CM(I,LC(I,IP),KC(I,IP))=X(IXX)
   30 CONTINUE
   15 IF(IPN1(I).EQ.0)GO TO 16
      IXX=IX+IR(I)+IPN1(I)
      PN1(I)=X(IXX)
   16 IF(IPN2(I).EQ.0)GO TO 17
      IXX=IX+IR(I)+IPN1(I)+IPN2(I)
      PN2(I)=X(IXX)
   17 IF(IWG(I).EQ.0)GO TO 18
      IXX=IX+IR(I)+IPN1(I)+IPN2(I)+IWG(I)
      WGL(I)=X(IXX)
   18 CONTINUE
C
   40 CONTINUE
C
C     DEFINE MINIMAX FUNCTIONS AND THEIR GRADIENTS
C
      NCHAN=NCH
      MORDER=MO
      KFRL=0
      KFUN=NFRL
```

```
      DO 100 I=1,NFREQ
      FREQ=OMEGA(I)
C
      CALL SIMGRD2(FREQ,FRL,DRL,FIL,DIL,NCHAN,MORDER,I,IFLAGJS,
     1             IFLAGDP,IDISPER)
C
      IF(MODE.EQ.1)GO TO 199
      IF(RLSCODE(I).EQ.0)GO TO 199
      IF(RLSCODE(I).EQ.-1)GO TO 70
      IF(RLSCODE(I).EQ.1)GO TO 75
      KFRL=KFRL+1
      F(KFRL)=WURL(I)*(FRL-SURL(I))
      DO 80 K1=1,NV
      DF(KFRL,K1)=WURL(I)*DRL(K1)
   80 CONTINUE
      KFRL=KFRL+1
      F(KFRL)=-WLRL(I)*(FRL-SLRL(I))
      DO 85 K2=1,NV
      DF(KFRL,K2)=-WLRL(I)*DRL(K2)
   85 CONTINUE
      GO TO 199
   70 KFRL=KFRL+1
      F(KFRL)=-WLRL(I)*(FRL-SLRL(I))
      DO 90 K3=1,NV
      DF(KFRL,K3)=-WLRL(I)*DRL(K3)
   90 CONTINUE
      GO TO 199
   75 KFRL=KFRL+1
      F(KFRL)=WURL(I)*(FRL-SURL(I))
      DO 95 K4=1,NV
      DF(KFRL,K4)=WURL(I)*DRL(K4)
   95 CONTINUE
  199 CONTINUE
      IF(MODE.EQ.0)GO TO 100
      DO 105 J=1,NCH
      NCHECK=0
      IF(I.GE.CHBCODE(J,1).AND.I.LE.CHBCODE(J,2))NCHECK=1
      IF(NCHECK.EQ.0)GO TO 105
      K=I-CHBCODE(J,1)+1
      IF(SPCODE(K,J).EQ.0)GO TO 105
      IF(SPCODE(K,J).EQ.-1)GO TO 110
      IF(SPCODE(K,J).EQ.1)GO TO 115
      KFUN=KFUN+1
      F(KFUN)=WU(K,J)*(FIL(J)-SU(K,J))
      DO 120 I1=1,NV
      DF(KFUN,I1)=WU(K,J)*DIL(J,I1)
  120 CONTINUE
      KFUN=KFUN+1
      F(KFUN)=-WL(K,J)*(FIL(J)-SL(K,J))
      DO 125 I2=1,NV
      DF(KFUN,I2)=-WL(K,J)*DIL(J,I2)
  125 CONTINUE
      GO TO 105
  110 KFUN=KFUN+1
      F(KFUN)=-WL(K,J)*(FIL(J)-SL(K,J))
      DO 130 I3=1,NV
      DF(KFUN,I3)=-WL(K,J)*DIL(J,I3)
  130 CONTINUE
      GO TO 105
  115 KFUN=KFUN+1
      F(KFUN)=WU(K,J)*(FIL(J)-SU(K,J))
      DO 135 I4=1,NV
      DF(KFUN,I4)=WU(K,J)*DIL(J,I4)
  135 CONTINUE
  105 CONTINUE
```

```
100 CONTINUE
    NCOUNT=NCOUNT+1
    RETURN
    END
```

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

MULTIPLEXER PROBLEM MXTST5A

INPUT DATA

NUMBER OF VARIABLES (N) 30

NUMBER OF FUNCTIONS (M) 49

TOTAL NUMBER OF LINEAR CONSTRAINTS (L) 0

NUMBER OF EQUALITY CONSTRAINTS (LEQ) 0

STEP LENGTH (DX) 5.000E-02

ACCURACY (EPS) 1.000E-04

MAX NUMBER OF FUNCTION EVALUATIONS (MAXF) 50

NUMBER OF SUCCESSIVE ITERATIONS (KEQS) 3

WORKING SPACE (IW) 14000

PRINTOUT CONTROL (IPR) 9100

FUNCTION EVALUATION : 1 / 0

	VARIABLES		FUNCTION VALUES
1	0.	1	8.441321074016E+00
2	5.939500000000E-01	2	1.076762154494E+01
3	8.364627905651E-01	3	9.265938782567E+00
4	1.046183540303E+00	4	9.580299717479E+00
5	6.580000000000E-01	5	8.541161677208E+00
6	0.	6	7.823582669305E+00
7	5.939500000000E-01	7	8.534286069523E+00
8	8.364627905651E-01	8	8.280159323484E+00
9	1.046183540303E+00	9	1.263209543037E+01
10	6.400000000000E-01	10	6.069099250383E+00
11	0.	11	3.446645400188E+00
12	5.939500000000E-01	12	-4.411854048157E+00
13	8.364627905651E-01	13	-1.798859126660E+00
14	1.046183540303E+00	14	-1.648769338535E+01
15	9.650000000000E-01	15	-4.316974646699E+00
16	0.	16	-1.020390804742E+01
17	5.939500000000E-01	17	-2.465549851873E+00
18	8.364627905651E-01	18	-1.051439381778E+01
19	1.046183540303E+00	19	-8.459744366272E+00
20	6.810000000000E-01	20	-9.838670050937E+00
21	0.	21	-9.424023791436E+00
22	5.939500000000E-01	22	-1.202364788866E+01
23	8.364627905651E-01	23	-1.535463389563E+01
24	1.046183540303E+00	24	3.639745529238E+00
25	5.820000000000E-01	25	1.608221853995E+01
26	0.	26	1.117923120592E+01
27	5.939500000000E-01	27	7.611777815652E+00
28	8.364627905651E-01	28	7.206776391601E+00
29	1.046183540303E+00	29	3.542946897279E+00

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

MULTIPLEXER PROBLEM MXTST5A

30	3.420000000000E-01	30	4.634275476596E+00
		31	2.437705976437E+00
		32	3.385835725378E+00
		33	5.022901175288E+00
		34	-1.531687327684E+01
		35	-1.473372822613E+01
		36	-7.058783341340E+00
		37	-3.880235261511E+01
		38	-5.428339377337E+00
		39	-9.891323651016E+00
		40	-5.139128468940E+00
		41	-5.258273641275E-01
		42	-1.323975538877E+01
		43	-5.001866359317E+00
		44	-1.440862373976E+01
		45	-7.784509841135E+00
		46	-6.807676959395E+00
		47	-1.754610554911E+01
		48	-9.652265605859E+00
		49	-8.695288891806E+00

FUNCTION EVALUATION : 9 / 1

	VARIABLES		FUNCTION VALUES
1	-2.642064237792E-03	1	8.922100028618E+00
2	5.963350488114E-01	2	8.403981260673E+00
3	8.360577808484E-01	3	7.084269834317E+00
4	1.046175386947E+00	4	8.139051769408E+00
5	6.516863317351E-01	5	7.367209448072E+00
6	-1.595805950733E-02	6	6.998659893400E+00
7	5.734746775523E-01	7	7.768732604105E+00
8	8.127577305406E-01	8	7.161837424287E+00
9	1.047056096500E+00	9	8.590691771324E+00
10	6.165195829943E-01	10	1.875770183820E+00
11	1.746302114070E-04	11	1.697883710774E+00
12	5.790095722627E-01	12	4.212651832501E-01
13	8.255003976891E-01	13	1.078429537181E+00
14	1.053268136298E+00	14	-4.980950997312E+00
15	9.819997786105E-01	15	-1.198134890344E+00
16	1.333114070373E-02	16	-4.873144507838E+00
17	6.183764732641E-01	17	5.971674313684E+00
18	8.414666291001E-01	18	-2.973495492446E+00
19	1.047278597017E+00	19	-3.974162249638E+00
20	6.759685626422E-01	20	-3.287095167051E+00
21	1.388728440255E-03	21	-2.185828753385E+00
22	5.839641428075E-01	22	-1.097482420987E+00
23	8.216303842794E-01	23	1.805157823443E+00
24	1.047750048342E+00	24	7.709098542033E-01
25	6.113639696812E-01	25	8.743597281611E+00
26	1.045894123253E-03	26	8.915862815241E+00
27	5.916712854934E-01	27	6.033475434354E+00
28	8.357136739945E-01	28	6.972642728398E+00
29	1.046095806908E+00	29	4.472103076983E+00
30	3.491894344521E-01	30	5.233245047225E+00
		31	4.848014845564E+00
		32	4.942738325256E+00
		33	7.586937151091E+00

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

MULTIPLEXER PROBLEM MXTST5A

34	-4.552213038167E+00
35	-4.735464542337E+00
36	-2.003917853462E+01
37	-1.131921562194E+01
38	-9.362454505874E+00
39	-1.200206501364E+01
40	-6.857358031525E+00
41	2.161829179517E+00
42	-5.490215932066E+00
43	-1.961803197254E+00
44	-1.169491375332E+01
45	-4.503220759153E+00
46	-6.211576009403E+00
47	-1.092967965780E+01
48	-1.020796937659E+01
49	-7.669413171802E+00

FUNCTION EVALUATION : 18 / 1

	VARIABLES		FUNCTION VALUES
1	7.150294618764E-02	1	-7.185752880280E+00
2	6.170887380047E-01	2	-7.654572445450E+00
3	8.913155467290E-01	3	-6.192002433160E+00
4	1.047175701207E+00	4	-9.391693894055E+00
5	6.676853231613E-01	5	-8.350659907981E+00
6	-1.125533987187E-01	6	-9.830406191255E+00
7	5.697838141948E-01	7	-6.165784896459E+00
8	7.229992243922E-01	8	-6.200400974960E+00
9	1.065653495321E+00	9	-6.275761213276E+00
10	6.002924267448E-01	10	-6.213940904754E+00
11	1.270818284712E-02	11	-1.049012456415E+01
12	5.877917625923E-01	12	-6.182015812479E+00
13	8.128270305659E-01	13	-8.092739397554E+00
14	1.062829372518E+00	14	-9.780681693145E+00
15	9.934553998619E-01	15	-8.042021937530E+00
16	7.155026024124E-02	16	-9.197785446183E+00
17	6.156926085223E-01	17	-1.377851171489E+01
18	8.517336061195E-01	18	-6.362824232672E+00
19	1.062225842305E+00	19	-1.505678222700E+01
20	6.918056884723E-01	20	-6.234571714859E+00
21	-1.109165791608E-01	21	-9.533967734140E+00
22	5.677578223678E-01	22	-6.211945467340E+00
23	7.059451588491E-01	23	-6.313240877164E+00
24	1.053847918320E+00	24	-7.216202861174E+00
25	6.183315244497E-01	25	-5.810185723416E+00
26	1.028763846148E-03	26	-1.367008163122E+01
27	5.681597504019E-01	27	-6.928113552016E+00
28	8.695734979502E-01	28	-7.278005845497E+00
29	1.043535147737E+00	29	-6.786934816381E+00
30	2.971630348734E-01	30	-6.205380738968E+00
		31	-1.014575684455E+01
		32	-6.611944374744E+00
		33	-6.083605014109E+00
		34	-6.092039058230E+00
		35	-6.146988407953E+00
		36	-8.963885703798E+00
		37	-1.105607297365E+01

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

MULTIPLEXER PROBLEM MXTST5A

38	-6.502072336325E+00
39	-2.337229447704E+01
40	-6.116578739374E+00
41	-6.154636329539E+00
42	-1.875666226091E+01
43	-6.168083680370E+00
44	-1.316545336389E+01
45	-9.215463130608E+00
46	-7.255474241568E+00
47	-1.984688606847E+01
48	-9.862014543005E+00
49	-7.776040408022E+00

FUNCTION EVALUATION : 27 / 1

	VARIABLES		FUNCTION VALUES
1	9.830635093134E-02	1	-7.208922213026E+00
2	6.231068525093E-01	2	-1.690338205745E+01
3	9.031916219314E-01	3	-7.307727573702E+00
4	1.039981915767E+00	4	-1.667330784896E+01
5	6.721681715777E-01	5	-1.181349600931E+01
6	-1.094928910554E-01	6	-1.065310618802E+01
7	5.686381378430E-01	7	-7.318103870511E+00
8	7.237872617615E-01	8	-7.321023582432E+00
9	1.069339718678E+00	9	-7.313048494156E+00
10	5.911574960009E-01	10	-7.319457486324E+00
11	-1.003180793082E-02	11	-1.403647056977E+01
12	5.891369907201E-01	12	-7.320625287002E+00
13	8.017004406427E-01	13	-1.033757182204E+01
14	1.059221398701E+00	14	-1.124152126769E+01
15	9.910146118533E-01	15	-1.031549430898E+01
16	5.079187582520E-02	16	-7.322237739052E+00
17	6.136170709220E-01	17	-7.332764898850E+00
18	8.438318817283E-01	18	-7.315638387166E+00
19	1.059678643775E+00	19	-1.556012646165E+01
20	6.995458139330E-01	20	-7.320576862186E+00
21	-1.204071932269E-01	21	-1.228244788546E+01
22	5.630283973910E-01	22	-7.805497302155E+00
23	6.967603813108E-01	23	-8.450559552305E+00
24	1.050204994705E+00	24	-7.316828556576E+00
25	6.275465859836E-01	25	-7.303669877623E+00
26	-1.282478560135E-02	26	-1.309571878612E+01
27	5.747662166892E-01	27	-7.339307949442E+00
28	8.728372397582E-01	28	-7.309390114269E+00
29	1.041957952469E+00	29	-7.360351410585E+00
30	2.919305888658E-01	30	-7.345456832044E+00
		31	-1.007783444266E+01
		32	-7.324827026891E+00
		33	-7.447508903295E+00
		34	-7.321619285135E+00
		35	-7.361541174451E+00
		36	-9.621958696257E+00
		37	-9.904908801446E+00
		38	-7.320894342554E+00
		39	-1.756785145254E+01
		40	-7.320705233861E+00
		41	-1.357986377810E+01

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

MULTIPLEXER PROBLEM MXTST5A

42	-1.560214860238E+01
43	-7.320844788810E+00
44	-1.171887498252E+01
45	-1.099481808197E+01
46	-7.321290366687E+00
47	-2.034222686017E+01
48	-9.385100156552E+00
49	-7.320168163061E+00

SOLUTION

VARIABLES

1	9.809979608664E-02
2	6.230176194736E-01
3	9.031345086577E-01
4	1.040119679438E+00
5	6.721824820894E-01
6	-1.095891964942E-01
7	5.686572261988E-01
8	7.238125702709E-01
9	1.069216189429E+00
10	5.911477976163E-01
11	-1.001585625069E-02
12	5.891131653622E-01
13	8.016807272696E-01
14	1.059230444296E+00
15	9.910198302290E-01
16	5.078867118567E-02
17	6.136330979866E-01
18	8.438368703708E-01
19	1.059662572795E+00
20	6.995487241031E-01
21	-1.201607100966E-01
22	5.631415090388E-01
23	6.968002263226E-01
24	1.050350325485E+00
25	6.275272086035E-01
26	-1.261337495165E-02
27	5.736115725122E-01
28	8.729798351569E-01
29	1.041859789212E+00
30	2.918914819617E-01

FUNCTION VALUES

1	-7.320087249382E+00
2	-1.680415146096E+01
3	-7.320131399535E+00
4	-1.657884983798E+01
5	-1.177103856442E+01
6	-1.069172260952E+01
7	-7.320134229959E+00
8	-7.320140555285E+00
9	-7.320128935578E+00
10	-7.320146081443E+00
11	-1.403746141277E+01
12	-7.320142469940E+00
13	-1.033894064436E+01
14	-1.124998081470E+01
15	-1.032353308227E+01
16	-7.320140039547E+00
17	-7.320141337500E+00
18	-7.320134054643E+00
19	-1.558029146001E+01
20	-7.320138977293E+00
21	-1.228691049383E+01
22	-7.800660563633E+00
23	-8.449627152575E+00
24	-7.320127500264E+00
25	-7.320127090998E+00
26	-1.314555564145E+01
27	-7.319959098532E+00
28	-7.320024708530E+00
29	-7.354057201811E+00
30	-7.326021909334E+00
31	-1.011332694973E+01
32	-7.320140922407E+00
33	-7.359431203971E+00
34	-7.320140029481E+00
35	-7.337331931599E+00
36	-9.650178440631E+00
37	-9.921030509647E+00
38	-7.320138718261E+00
39	-1.757838729393E+01
40	-7.320138332706E+00
41	-1.362642059005E+01
42	-1.558228645540E+01
43	-7.320138197519E+00

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

MULTIPLEXER PROBLEM MXTST5A

                                                      44  -1.171444542528E+01
                                                      45  -1.099513076284E+01
                                                      46  -7.320139326155E+00
                                                      47  -2.034516348663E+01
                                                      48  -9.384745938269E+00
                                                      49  -7.320136150390E+00

  TYPE OF SOLUTION (IFALL) . . . . . . . . . . . . . . . . . . . . . . . . . . . . .       1
  NUMBER OF FUNCTION EVALUATIONS . . . . . . . . . . . . . . . . . . . . . . . . .        32
  NUMBER OF SHIFTS TO STAGE-2 . . . . . . . . . . . . . . . . . . . . . . . . . . . .      0
  EXECUTION TIME (IN SECONDS) . . . . . . . . . . . . . . . . . . . . . . . . . . . .396.866
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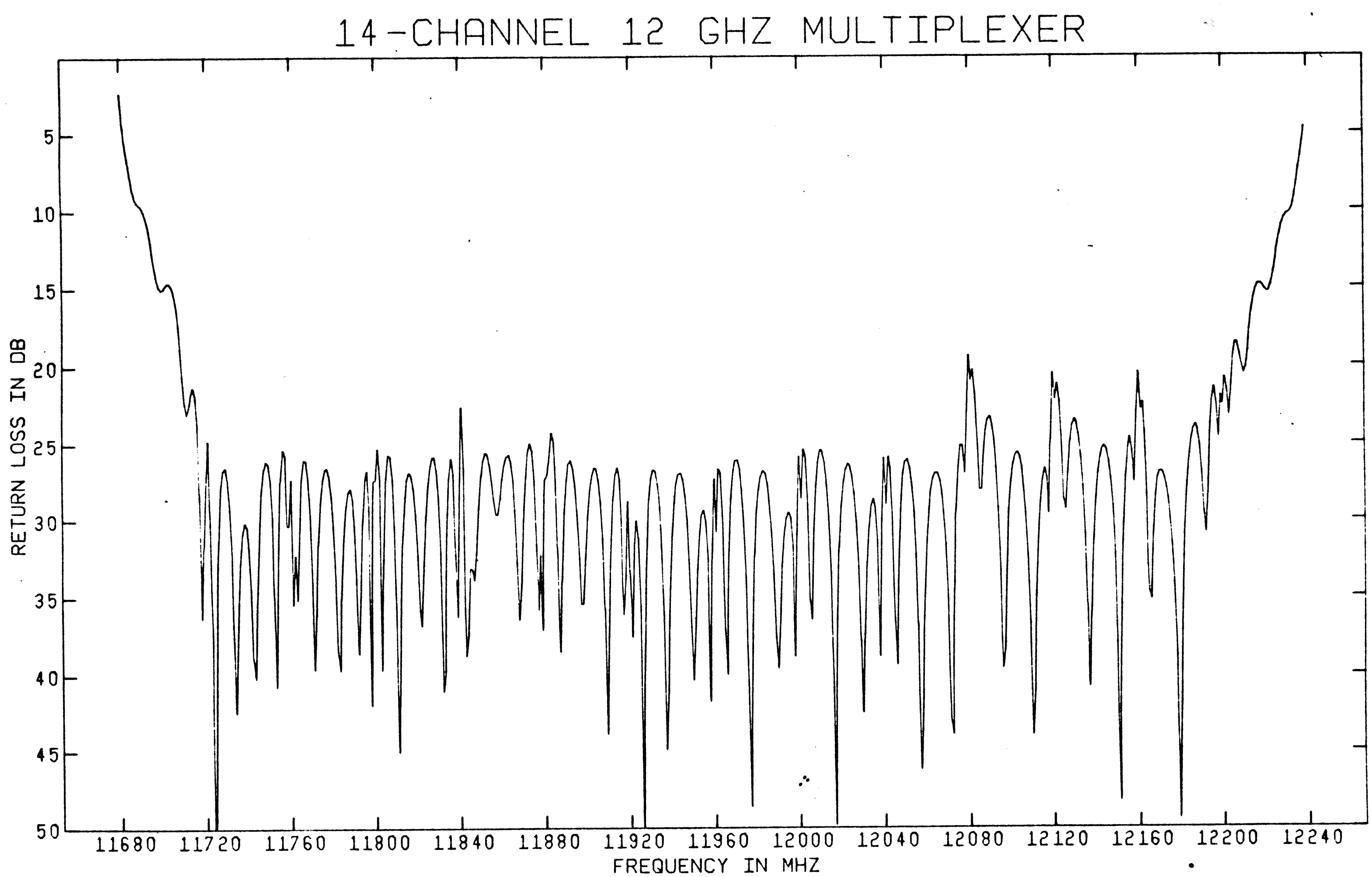

Fig. 1 Return loss in dB of a 14-channel multiplexer (including channels 1 and 14 as dummies) with optimized spacings, input and output transformer ratios and variable elements M(1,1) (cavity resonant frequency) and M(1,2) for channels 9-14. Other design parameters correspond to ComDev optimized values. The filters are lossy and dispersive with unloaded Q=12000; nonideal junctions are assumed.