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(54) Diode patch phase shifter.

(57) A phased array waveguide antenna having a plurality of longitudinally extending parallel waveguides (11) arranged in rows and columns, and electrically controlled phase shifter strips (17) disposed in longitudinally extending slots (15) centrally located in respective columns ot waveguides (11). The electrically controlled phase shifter strips (17) include conductive patches (25a, 25b) that are selectively conductively connected together by microwave diodes (27) to provide for variable susceptances (Figure 3).

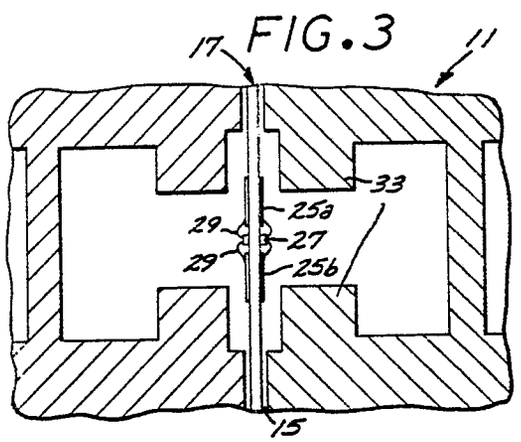


FIG. 3

EP 0 357 955 A1

DIODE PATCH PHASE SHIFTER

BACKGROUND OF THE INVENTION

The disclosed invention is generally directed to electronically steered phased array antennas, and is more particularly directed to waveguide phase shifter circuitry for controllably phase shifting waveguide propagated electromagnetic energy.

A phased array antenna is a directive antenna comprising, for example, individual radiating elements which generate an electromagnetic radiation pattern having a direction that is controlled by the relative phases of the energy radiated by the individual radiation elements. Thus, the radiation of the phased array is steered by appropriately varying the relative phases of the individual radiation elements. Such variation is provided by appropriately phase shifting the radiation emanated by each element. Such steering is sometimes referred to as beam steering or scanning.

In essence, a phased array antenna provides scanning (i.e., changing beam direction) without mechanically moving the radiation elements, in contrast to a mechanically scanned antenna wherein the radiating elements are mechanically moved. An example of a phased array antenna is a group of parallel, open-ended waveguides, where each waveguide is a radiating element.

It should be understood by persons skilled in the art that phased array antennas also include receiving antennas where the received electromagnetic energy is phase shifted to provide electronic scanning.

Background information on phased array antennas can be found in the textbook Introduction To Radar Systems, Skolnik, McGraw-Hill Book Company, 1980, 1962, Chapter 8.

Known phase shifters include structures which utilize diodes to change impedance. An example is the periodically loaded-line phase shifter discussed in the above-reference Skolnik textbook at page 289, which utilizes diodes as switching elements. Important considerations with the loaded-line phase shifter include the requirement of quarter wavelength spacing between susceptance patches which constrains the locations of the diodes, and also the attendant use of many diodes. Moreover, the loaded-line phase shifter would require a large package if adapted for use with waveguides.

Another example of a phase shifter which utilizes diodes is RADANT system, which is discussed in "RADANT: New Method of Electronic Scanning," Microwave Journal, February 1981, pp. 45-53. Important considerations with the RADANT system include the necessity of a feed antenna such as a horn, and the location of the diode grids or screens outside the waveguide.

A diode phase shifter for a waveguide is disclosed and modelled in the article entitled "Diode Phase Shifter and Model In Waveguide," Lester et al., 1987 IEEE MTT-S Digest, pages 599-602. However, that phase shifter is directed to a single diode circuit forming a transversely oriented structure, which presents implementation complications if used with waveguides.

Known phase shifters also include electromechanical phase shifters wherein circuit elements are mechanically moved. Important considerations as to electromechanical phase shifters include slower switching speeds, size, weight, and complex electromechanical-driving circuitry.

Other types of known phase shifters require phase shift apparatus, for example microstrips, that are separate from the main energy propagating medium, for example coaxial cable. Important considerations with such separate phase shift apparatus include transitions, mismatching and power loss.

SUMMARY OF THE INVENTION

It would therefore be an advantage to provide an electronic phase shifter structure for waveguides which is compact and provides high switching speeds.

Another advantage would be to provide an electronically controlled phase shifter structure which is readily incorporated in a waveguide array.

The foregoing and other advantages and features are provided by the invention in a phase shifting structure which includes a waveguide having longitudinal extent for propagating electromagnetic energy. First and second conductive patches and a switching device for controllably conductively coupling the patches are located within the waveguide. The conductive patches are capacitively coupled to the waveguide, whereby the phase of the electromagnetic energy propagated by the waveguide is controlled by the coupled and uncoupled states of the first and second conductive patches as controlled by the switching device.

BRIEF DESCRIPTION OF THE DRAWING

The advantages and features of the disclosed invention will readily be appreciated by persons

skilled in the art from the following detailed description when read in conjunction with the drawing wherein:

FIG. 1 is a schematic partial cut-away perspective of a waveguide phased antenna array that incorporates the phase shifter circuitry of the invention.

FIG. 2. is a schematic illustration of a phase shifter strip in accordance with the invention.

FIG. 3 is a sectional view of one of the waveguides of FIG. 1.

FIG. 4 is a further embodiment of a phase shifter strip in accordance with the invention.

DETAILED DESCRIPTION

In the following detailed description and in the several figures of the drawing, like elements are identified with like reference numerals.

Referring now to FIG. 1, shown therein is a schematic partial cut-away perspective view illustrating a waveguide antenna array 10 having a plurality of parallel, rectangular waveguides 11 arranged in rows and columns, as partially shown in FIG. 1. The electromagnetic energy radiated by the waveguides 11 emanates from the open ends thereof, which together comprise the aperture 13 of the antenna.

The waveguide antenna array 10 includes a plurality of longitudinal slots 15 which respectively extend through the center of each column of waveguides 11. Each longitudinal slot accepts a phase shifter strip 17, each of which is controllable to change the phase of radiation provided by the column of waveguides with which it is associated.

Referring now to FIG. 2 and 3, each of the phase shifter strips 17 includes a planar dielectric substrate 19, which by way of example can comprise Teflon quartz. A plurality of shifter circuits 20 are secured in columnar arrangement to each side of the substrate 19, the shifter circuits on one side of the substrate 17 being a mirror image of the shifter circuits 20 on the other side for symmetry. Also, the arrangement of the shifter circuits 20 are symmetrical about the vertical centerline of the substrate 19.

Each shifter circuit 20 is connected at each end to top and bottom driver pads 21, 23 located on each side of the substrate 19. The top driver pads 21 are conductively connected together, and the bottom driver pads 23 are conductively connected together. As discussed further herein, control voltages are applied across the top and bottom driver pads 21, 23.

Each shifter circuit 20 includes serially connected diode/patch circuits 30, each of which is associated with a certain waveguide, as indicated on FIG. 2. Each diode/-patch circuit 30 includes first and second conductive patches 25a, 25b respectively connected via short, high conductance conductors 29 to the anode and cathode of a microwave diode 27 which by way of example can be PIN diode. Each diode/patch circuit 30 is connected via high inductance conductors 31 to the susceptance patches of another diode/patch circuit or to a driver pad, as appropriate, in such a manner that the microwave diodes 27 are oriented to conduct in the same direction. Thus, by way of specific illustration, the anode connected patch 25a of a given diode/patch circuit 30 is connected to the cathode connected patch 25b of an adjacent diode/patch circuit 30, if there is one.

As oriented in the figures, each susceptance patch 25a, 25b has a height and width associated therewith, height being in the vertical direction and width being in the lateral or horizontal direction.

To reduce coupling between the waveguides 11, the high inductance conductors 31 interconnecting the conductive patches 25a, 25b on adjacent diode/patch circuits 30 can include RF choke inductors (not shown) at the ends connected to the patches.

As illustrated in FIG. 2, the anode connected conductive patches 25a of the top diode/patch circuits 30 are connected via high inductance conductors 31 to a top driver pad 21. The cathode connected susceptance patches 25b of the bottom diode/patch circuits 30 are connected via high inductance conductors 31 to a bottom driver pad 23.

While FIG. 2 schematically illustrates the microwave diodes 27 as being located between their associated patches 25a, 25b, such diodes can also be secured to an edge portion of an associated conductive patch.

The susceptance presented to the waveguide by a phase shifter strip 17 is determined by the forward bias and reverse bias states of the microwave diodes 27. When the microwave diodes 27 are forward biased, the first and second conductive patches of each diode/patch circuit 30 are conductively coupled, and a higher susceptance is presented. Such higher susceptance results in radiated energy having a different phase relative to the radiated energy when the diodes 27 are reverse biased. In essence, each phase shifter strip 17 has two states, forward biased and reverse biased, and there is a difference in the phases associated with the two states.

The amount of differential phase shift for a phase shifter strip is controlled by the sizes of the several individual conductive patches, and the effective sizes of connected conductive patches. The differential phase shift refers to the difference in phase between (1) the energy radiated when the

shifter is reverse biased and (2) the energy radiated when the shifter is forward biased. Impedance matching is achieved by selective positioning of the respective diode/patch circuits on a given phase shifter strip. The longitudinal spacing between the phase shifter strips for a given column of waveguides should be sufficiently large to prevent interference between the phase shifter strips.

The diodes 27 in a given phase shifter strip 17 are forward biased by selective application of a sufficient voltage across the top and bottom driver pads 21, 23, with the top driver pad 21 being positive relative to the bottom driver pad. Such voltage should be greater than the sum of the forward bias voltage drops of the diodes 27 in such shifter circuit. Thus, if there are five (5) diode/patch circuits 30 serially connected in each shifter circuit 20, and each diode 27 has a forward drop of 1.2 volts, the forward biasing voltage across the top and bottom driver terminals should be at least 6 volts.

Reverse bias is provided by applying a sufficiently negative voltage to the top driver pad to prevent the diodes from being forward biased by the waveguide propagated energy, for example, -5 to -100 volts for each diode.

Referring now to FIG. 3, shown therein is a cross-sectional view of one of the waveguides 11, which is generally H-shaped in cross-section with centrally located parallel ridges 33 that are symmetrically disposed on either side of the longitudinal slots. For symmetry, the top and bottom ridges 33 are mirror images.

As illustrated in FIG. 3, the conductive patches at the top of the diode/patch circuits 30 for a given waveguide 11 are adjacent the top ridges 33, while the conductive patches at the bottom of the diode/patch circuits are adjacent the bottom ridges 33. The proximity of the conductive patches to the ridges 33 provides for capacitive coupling of the conductive patches to the waveguide.

By way of example, the phase shifter strips 17 can comprise digitally switched phase shifters wherein discrete phase shifts are provided, and each of the phase shifter strips 17 for a given column of waveguides can provide a predetermined differential phase shift.

The amount of phase shift that is controllably introduced by each shifter strip 17 is determined by the incremental phase shift desired. Thus, for a phase shift increment of 11.5 degrees, five shifters would be utilized, each providing successively increasing phase shifts beginning with 11.5 degrees. Each successive shifter would provide twice the phase shift of the next lowest shifter strip. In this example, the shifter strips would provide, in increasing order, phase shifts of 11.25, 22.5, 45, 90 and 180 degrees. It should be readily appreciated that with such phase shifter strips, phase shifts of (Nx11.25) degrees can be obtained, where N is an integer from 0 to 31.

In this arrangement, each of the phase shifter strips is called a "bit," and the desired phase shift is provided by turning on the appropriate bits. Thus, for example, a phase shift of 33.75 degrees would be provided by turning on the 11.25 degree bit and the 22.5 degree bit.

If greater phase resolution is required, then additional bits can be utilized. For example, using a 5.625 degree bit and a 2.8125 degree bit, resulting in a 7-bit system, would provide for 2.1825 degree increments.

The foregoing described phase shifter strip 17 basically has two states: reverse biased and forward biased. As a result, several phase shifter strips are utilized to provide the capability of producing different phase shifts.

It is also contemplated that each of the phase shifter circuits 20 on the phase shifter strip 17 can be individually controlled to be reverse biased or forward biased. As shown in FIG. 4, this is achieved, for example, by providing individual top driver pads 21a for each of the phase shifter circuits 20. For symmetry, it would be appropriate to conductively connect the driver pads 21a for corresponding mirror image phase shifter circuits 20 on both sides of the substrate 19. All of the phase shifter circuits 20 on the phase shifter strip 17 can be connected together at the bottom driver pad 23, which by way of example are connected to a common reference voltage such as ground, while the individual top driver pads 21a would be individually selectively coupled to forward bias and reverse bias voltages. By way of example, for a phase shifter strip 17 having three (3) phase shifter circuits 20 on each side of the substrate, eight (8) different combinations of susceptances can be provided.

With such a phase shifter strip 17 having multiple forward biased states, the number of phase shifter strips 17 required for a given column of waveguides could be reduced to as few as one.

Referring again to FIG. 3, while the illustrated waveguide 11 includes ridges 33, a rectangular waveguide having top and bottom, centrally located, longitudinally extending channels could be utilized to enhance capacitive coupling, with the conductive patches being reasonably close to the channels. Alternatively, a rectangular waveguide without ridges or channels could also be used, with the conductive patches being very close to the upper and lower waveguide walls. It should be readily appreciated that without ridges or channels, the alignment tolerances are more stringent.

It should also be appreciated that the phase shift strips can be used with circular waveguides,

with or without capacitive coupling enhancing ridges or channels.

While the foregoing phased array antenna has generally been discussed in the context of radiating electromagnetic energy, it can also be used to differentially phase shift received electromagnetic energy. The waveguides propagate energy, either received or for radiation.

In terms of implementation, the specific number of diode patch circuits, and the sizes of the patches will depend upon factors including desired phase shift, the characteristics of the waveguide, and the desired VSWR (voltage standing wave ratio), and known design procedures can be adapted to designing specific phase shifter strips. For example, the characteristics of different individual diode/patch circuits can be determined as to the waveguide structure to be utilized, for example, by measuring the 2-port scattering parameters. From the scattering parameters, corresponding transmission parameters can be determined, which in turn are utilized for designing a plurality of diode/patch circuits on a phase shifter strip.

Such design can be done with the assistance of an optimization computer program, such as the optimization program entitled DPSYN15.FORT which is set forth at the end of this description together with listings of a third order Lagrangian interpolation routine called LAGRAN, a sample input data set DPSYN15.DATA, an output data set DPOUT15.DATA based on the sample input data set, and sample basic datasets KTPARM.H040F.DATA, KTPARM.H040R. DATA, KTPARM.H050F.DATA, KTPARM.H050R.DATA, KTPARM.H065F. DATA, and KTPARM.H065R.DATA.

The optimization program DPSYN15.FORT utilizes an optimization routine ZXSSQ which is in a special function FORTRAN library called the IMSL Library, 1982, which was obtained from IMSL, Inc., Houston, Texas. An error residual calculating subroutine must be utilized with the optimization routine ZXSSQ, and the optimization program DPSYN15.FORT includes the subroutine SUB for that purpose.

Generally, the optimization program DPSYN15.FORT accepts initial approximations of the dimensions and separations of conductive patches for a phase shifter strip of a predetermined differential phase shift. Based on the measured T-parameters set forth in the basic datasets, the program computes the voltage standing wave ratio (VSWR) responses of the all diodes on condition and the all diodes off condition, together with the corresponding phase shift response for the dimension and separation approximations. The difference between the actual overall response and the desired overall response is calculated and the approximations are adjusted to reduce the difference. This process is repeated until the difference is less than a predetermined amount, or until a specified maximum number of iterations is reached.

Referring now to the sample input dataset DPSYN15.DATA, line 20 sets forth the desired differential phase shift. Line 30 sets forth the maximum number of calls to the error residual subroutine SUB, and two parameters utilized by the optimization routine ZXSSQ. Line 40 also sets forth parameters utilized by the optimization routine.

Line 50 sets forth a number which is one greater than the number of patches, and also the number of frequencies of interest. Line 60 sets forth the minimum separation between patches and the maximum width of any patch. Lines 70 through 130 set forth the initial approximations to be utilized by the optimization program.

As to lines 140-340, the first column sets forth identifications of predetermined frequencies which are not explicitly called out, but correspond to the frequencies associated with the T-parameters set forth in the basic datasets. The second column sets forth the desired VSWR'S, and the third column sets forth the desired phases which should be negative. The fourth column sets forth desired VSWR weights, while the fifth column sets forth phase shift weights. The VSWR and phase shift weights allows the specification of critical frequencies. The sixth column sets forth the propagation constants of the dielectrically loaded waveguide of interest, while the seventh column sets forth the propagation constants of such waveguide unloaded. Such propagation constants must also be for the frequencies implicitly identified by the first column.

The optimization program DPSYN15.FORT also requires T-parameters for individual mirror image pairs of diode/patch circuits 30, where each pair comprises a first diode/patch circuit (2 patches and 1 diode) on one side of a substrate and a mirror image thereof in the form of a second diode/patch circuit (2 patches and 1 diode) on the other side of the substrate. Such T-parameters are set forth in basic datasets, the number of which will depend on the number of patch heights desired to be included. For each patch height, two basic data sets are required, the first one for the forward biased condition and the second for the reverse biased condition. The two basic datasets for each height can include data for several widths (e.g., six widths). The first line below a basic dataset name (for example, line 20 of KTPARM.H050F.DATA) sets forth the patch height, the number of patch widths, and the number of frequencies. The next line sets forth the first patch width, followed by N groups of three lines, where N is the number of frequencies. The left most entry in the first line in

each group of three lines is a frequency identifier (a real number having a fractional part of all 0's, for example 4.00000000). The frequency identifiers represent the actual frequencies associated with the T-parameters. The eight numbers following each frequency identifier are the magnitude and phase terms of four T-parameters.

The T-parameters for each of the other patch widths in a basic dataset are similarly set forth, preceded by a line including a single entry that specifies patch width. Thus, for example, line 670 of KTPARM.H050.DATA sets forth the second patch width, and is followed by 21 groups of three lines, since there are 21 frequencies in this basic dataset.

The basic data sets are read by the optimization program at lines 1470-1560 for one height, lines 1570-1660 for a second height, and lines 1670-1760 for a third height. For each height, the forward biased data is read first, followed by the reverse biased data.

The optimization program utilizes the basic datasets to calculate the T-parameters of any size patch provided the dimensions are in the range of the measured data.

The T-parameters of the approximated patch dimensions and separations are computed by performing a double interpolation over the basic dataset of measured T-parameters.

The first interpolation is an interpolation over the patch widths for each height for each of the T-parameters. The interpolation in this dimension is a third order Lagrangian interpolation and utilizes the above-mentioned LAGRAN subroutine.

The second interpolation is a cubic interpolation for each patch width over the patch heights and is provided by the subroutine GNTERP. For a cubic interpolation, four patch heights are required for each given patch width, one of which can be a height of zero.

The output dataset DPOUT15.DATA sets forth a copy of the input dataset at lines 20-550. Line 620 identifies the number of calls to the optimization subroutine SUB, while line 680 sets forth the sum of the squares of the error residuals SSQ for the response with the final patch dimension and separation approximations. Line 710 indicates whether the criteria of the optimization routine were satisfied.

Lines 740-880 set forth the final patch dimension and separation approximations arrived at by the optimization program.

Lines 900-1150 set forth the response of the final patch approximations in the forward biased condition. The first column indicates frequency; the second column indicates voltage standing wave ratio; the third column indicates the transmission phase of the phase shifter section; the fourth column specifies the magnitude of the transmission coefficient; and the fifth column specifies insertion loss in dB.

Lines 1170-1410 set forth the response of the final patch approximations in the reverse biased or off condition. The columns are arranged as with the forward biased response in lines 900-150.

Lines 1430-1640 set forth the differential phase shift response of the final patch approximations. The first column indicates frequency while the second column indicates differential phase shift. The entries in the second column are calculated by subtracting, for each frequency, the off condition transmission phase from the on condition transmission phase.

The foregoing has been a disclosure of waveguide phase shifter circuitry which is incorporated within a waveguide by longitudinal slots that do not affect the operation of the waveguide, providing for a compact antenna structure of relatively light weight. The phase shifter circuitry does not require media transitions, and provides for excellent impedance matching. The phase shifter circuitry is not structurally complex, and is amenable to automated manufacturing procedures.

Although the foregoing has been a description and illustration of specific embodiments of the invention, various modifications and changes thereto can be made by persons skilled in the art without departing from the scope and spirit of the invention as defined by the following claims.

Claims

1. A phase shifting structure, characterized by:
- waveguide (11) having a longitudinal extent for propagating electromagnetic energy; and
- phase shifting means (17) located within said waveguide (11) and capacitively coupled thereto for varying the phase of the electromagnetic energy propagated by said waveguide (11).

2. The phase shifting structure of claim 1, characterized in that said phase shifting means (17) comprises:
- first and second conductive regions located within said waveguide (11) and capacitively coupled thereto; and
- switching means for controllably conductively connecting said first and second conductive areas.

3. The phase shifting structure of claim 2, characterized in that said first and second conductive regions include first and second conductive patches (25a, 25b) secured to a substrate (19) and wherein said switching means comprises a diode (27) coupled between said first and second conductive patches (25a, 25b).

4. The phase shifting structure of any of claims

1 through 3, characterized in that said waveguide (11) includes means for capacitively coupling said phase shifting means (17) to said waveguide.

5. The phase shifting structure of claim 4, characterized in that said means for capacitively coupling comprises longitudinally extending capacitive coupling ridges (33).

6. A phase shifting structure, characterized by:
- a waveguide (11) having a longitudinal extent for propagating electromagnetic energy;
- a planar substrate (19);
- first and second conductive regions on said substrate (19);
- switching means for controllably conductively coupling said first and second conductive region;
- a centrally located, longitudinally extending slot (15) formed in said waveguide (11) for accepting said planar substrate (19) to locate said first and second conductive means within said waveguide (11); and
- means for capacitively coupling said first and second conductive regions to the waveguide (11), whereby the phase of the electromagnetic energy propagated by said waveguide (11) is controlled by the coupled and uncoupled states of said first and second conductive regions as controlled by said switching means.

7. The phase shifting structure of claim 6, characterized in that said first and second conductive regions comprise conductive patches (25a, 25b) on said substrate (19) and wherein said switching means comprises a diode (27).

8. The phase shifting structure of claims 6 or 7, characterized in that said means for capacitively coupling comprises walls of the waveguide (11).

9. The phase shifting structure of claim 6 or 7, characterized in that said means for capacitively coupling comprises longitudinally extending ridges (33).

10. A phase shifting circuit comprising:
- a waveguide (11) having longitudinal extent for propagating electromagnetic energy;
- a planar substrate (19);
- first and second conductive patches (25a, 25b) on said substrate (19);
- switching means for controllably conductively coupling said first and second conductive patches (25a, 25b);
- a centrally located, longitudinally extending slot (15) formed in said waveguide (11) for accepting said planar substrate (19) to locate said first and second conductive means within said waveguide (11); and
- longitudinally extending means for capacitively coupling said first and second conductive regions to the waveguide (11), whereby the phase of the electromagnetic energy propagated by said waveguide (11) is controlled by the coupled and uncoupled states of said first and second conductive patches (25a, 25b) as controlled by said switching means.

FIG.1

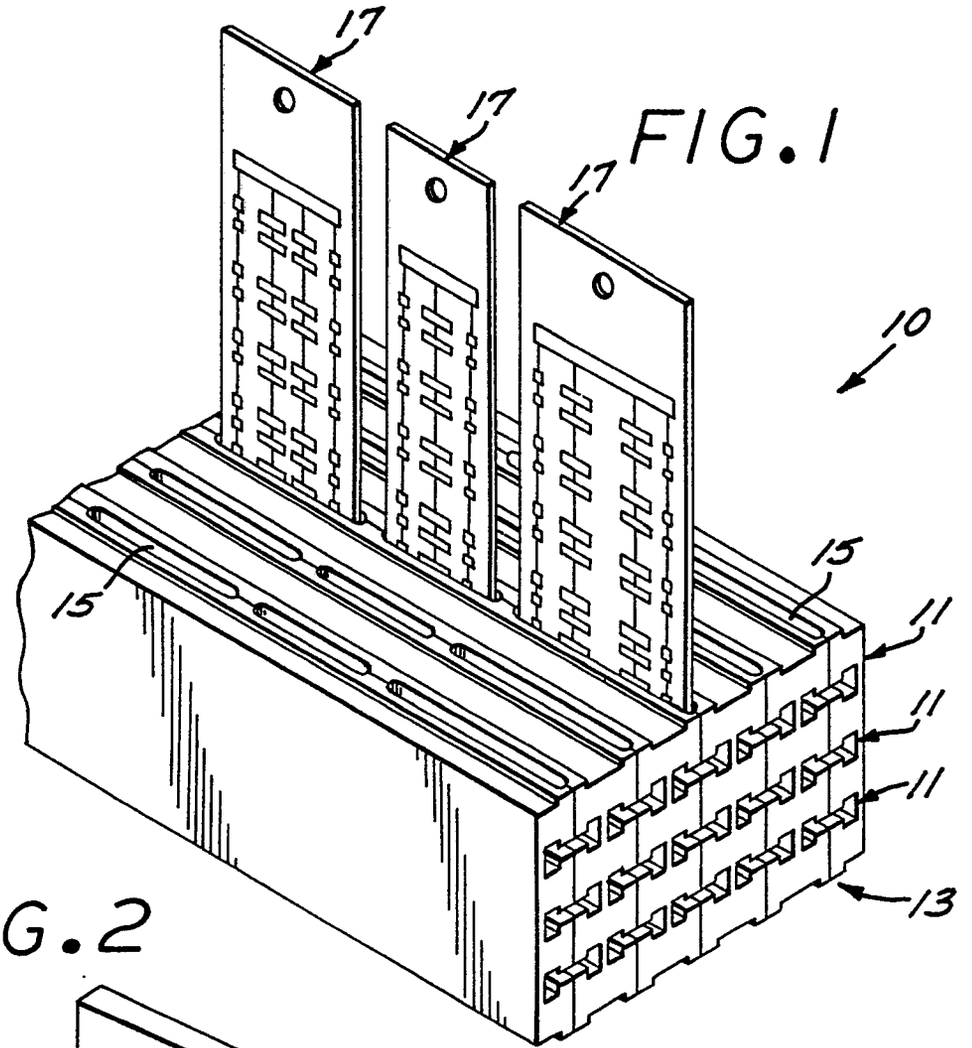


FIG.2

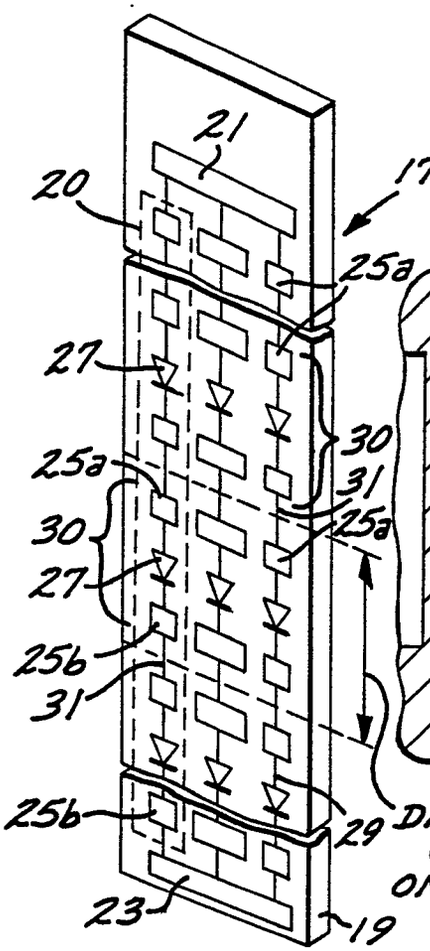
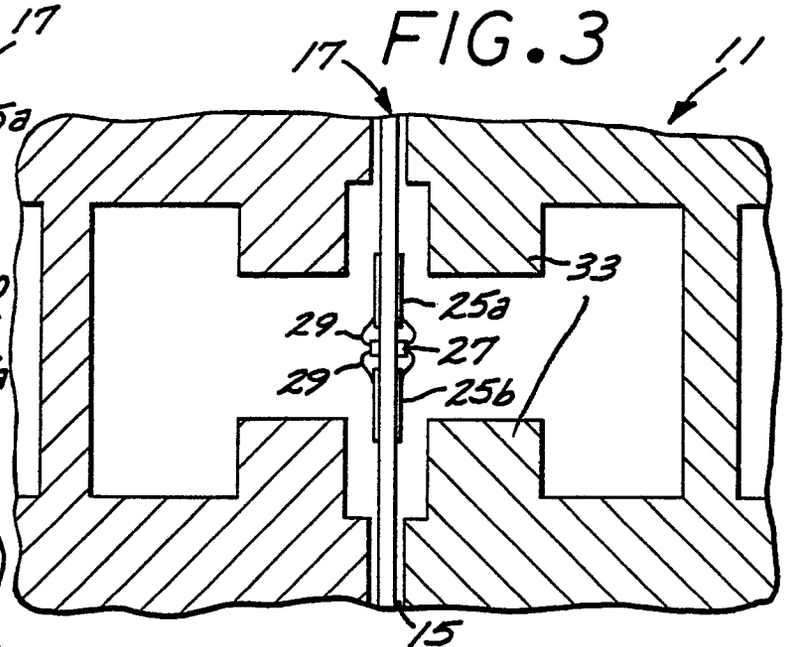


FIG.3



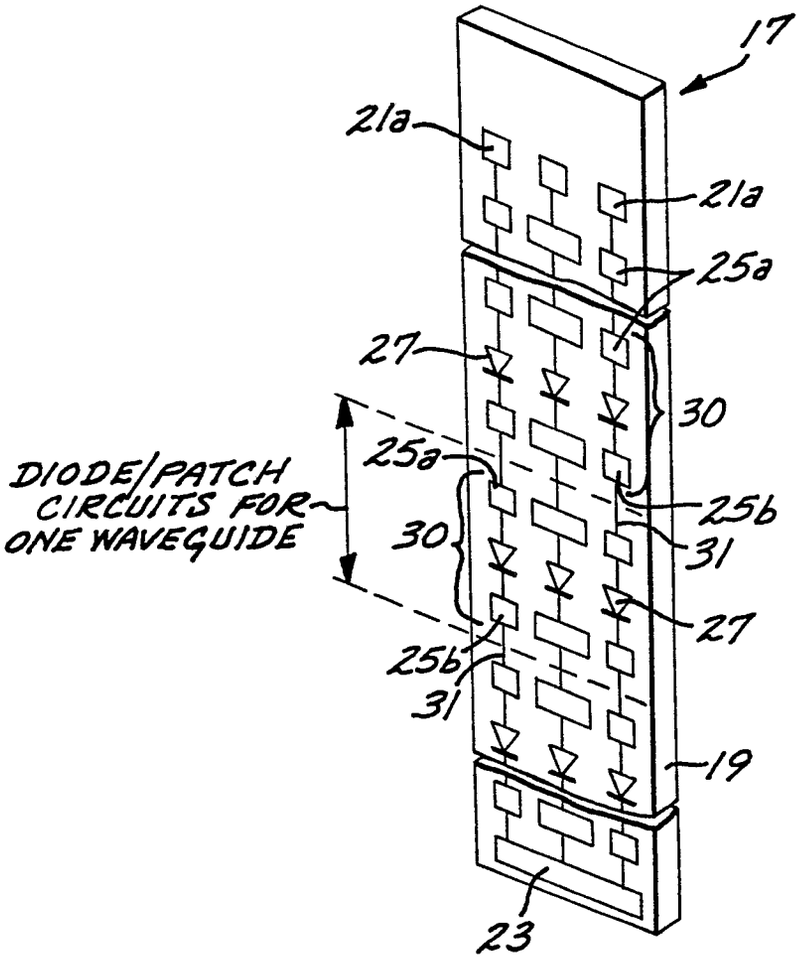

17
21a
21a
25a
27
30
DIODE/PATCH CIRCUITS FOR ONE WAVEGUIDE
25a
25b
30
31
27
25b
31
19
23

FIG. 4

```
**** TSO FOREGROUND HARDCOPY ****
DSNAME=EGA7476.DPSYN15.FORT

C                                                                       00000010
C*********************************************************************  00000020
C*                                                                      00000030
C*  DPSYN15.FORT                                                        00000040
C*      10/30/87                                                        00000050
C*                                                                      00000060
C*  THIS PROGRAM COMPUTES THE PATCH LENGTHS AND THEIR SEPARATIONS       00000070
C*  OF A COMPLETE PHASE SHIFTER TO PROVIDE A PRESCRIBED PHASE           00000080
C*  AND VSWR AT SPECIFIED FREQUENCIES. TWO SETS OF MEASURED DATA        00000090
C*  TABLES ARE USED; ONE SET FOR THE PHASE POSITION AND ONE SET         00000100
C*  FOR THE ZERO POSITION.  IT IS IMPORTANT TO NOTE THAT THE PHASE      00000110
C*  POSITION AND ZERO POSITION DESIGNS ARE DEPENDENT UPON EACH OTHER    00000120
C*  STATES.                                                             00000130
C** IT REQUIRES AN INITIAL DESIGN AND USES A SUBROUTINE ZXSSQ, A        00000140
C*  LEAST SQUARES MINIMIZATION ROUTINE TO OPTIMIZE THE PARAMETERS.      00000150
C*  ZXSSQ IS AN IMSL ROUTINE. IN THE CALL STATEMENT FOR ZXSSQ           00000160
C*   IXJAC MUST EQUAL THE ROW DIMENSION OF XJAC IN THE DIMENSION        00000170
C*  STATEMENT OF THE CALLING PROGRAM. THE DIMENSION XJAC IS AT          00000180
C*  LEAST NR-BY-NP. THE DIMENSION OF WORK IS 5*N+2*NR+(N+1)*N/2,        00000190
C*  AND THE DIMENSION OF XJTJ IS(N+1)*N/2. SEE DESCRIPTION IN IMSL      00000200
C*  MANUAL FOR MORE DETAILS. THIS PROGRAM UTILIZES A ROUTINE TO         00000210
C*  INTERPOLATE BETWEEN VARIOUS HEIGHT CURVES.                          00000220
C*                                                                      00000230
C*  THE MODEL HERE CASCADES TRANSMISSION MATRICES TO CALCULATE THE      00000240
C*  OVERALL PERFORMANCE.                                                00000250
C*                                                                      00000260
C*                                                                      00000270
C*********************************************************************  00000280
C                                                                       00000290
C                                                                       00000300
C***    PROGRAM VARIABLES AND PARAMETERS      ********************      00000310
C                                                                       00000320
C   FRE(20)       ARRAY CONTAINING DESIGN FREQUENCIES                   00000330
C   VSWR0(20)     ARRAY CONTAINING DESIGN VSWRS                         00000340
C   RPHAZ0(20)    ARRAY DESIGN PHASES FOR RELATIVE PHASE                00000350
C   WM(20)        ARRAY DESIGN WEIGHTINGS FOR VSWR                      00000360
C   WP(20)        ARRAY DESIGN WEIGHTINGS FOR PHASES                    00000370
C   XON(15)         ARRAY WITH DESIGN PARAMETERS, TO BE OPTIMIZED       00000380
C   E(60)         ARRAY ERROR RESIDUAL FOR OPTIMIZATION ROUTINE         00000390
C   VSWRZ(20)     ARRAY CALCULATED VSWR FOR ZERO POSITION               00000400
C   VSWRP(20)     ARRAY CALCULATED VSWR FOR PHASE POSITION              00000410
C   PHASEZ(20)    ARRAY CALCULATED PHASE FOR ZERO POSTION               00000420
C   PHASEP(20)    ARRAY CALCULATED PHASE FOR PHASE POSITION             00000430
C   RPHAZD(20)    ARRAY CALCULATED FOR RELATIVE PHASE RESPONSE          00000440
C   XJAC(60,15)   ARRAY AREA ASSOCIATED WITH ZXSSQ                      00000450
C   WORK(300)     WORK AREA ASSOCIATED WITH ZXSSQ                       00000460
C   XJTJ(105)     ARRAY ASSOCIATED WITH ZXSSQ                           00000470
C   PARM                "                                             00000480
C   MAX           MAXIMUM NUMBER OF TRIPS THROUGH ZXSSQ                 00000490
C   NSIG          SIGNIFICANT FIGURES OF MATCH                          00000500
C   ELEND         END LENGTH DIELECTRIC ON BOTH SIDES OF BIT            00000510
C   EN            TRANSFORMER RATIO                                     00000520
C                 1 FOR ON, 0 FOR OFF                                   00000530
C   IPRINT        INTEGER INDICATOR FOR PRINTING RESPONSES              00000540
C   THETAW        PHASE SHIFT COUNTER THROUGH LINE OF EQ. WVGUIDE       00000550
C   THETAD        PHASE SHIFT COUNTER THROUGH LINE OF EQ. DIELTRIC      00000560
```

```
C   ZKG          GUIDE PHASE CONSTANT                                        00000570
C   ZKG2         DIELECTRIC PHASE CONSTANT                                   00000580
C                                                                            00000590
      EXTERNAL SUB                                                           00000600
      DOUBLE PRECISION DATE,DATANM,PATNM,PATNM1,PATNM2                       00000610
      DOUBLE PRECISION PATNM3,PATNM4,PATNM5                                  00000620
      DIMENSION FRE(21),VSWR0(21),RPHAZ0(21),WM(21),RPHAZD(21)               00000630
      DIMENSION WP(21),X(15),X1(20),E(63),VSWRZ(21),VSWRP(21)                00000640
      DIMENSION PHASEZ(21),PHASEP(21),XJAC(63,15),WORK(321)                  00000650
      DIMENSION XJTJ(120),PARM(4),ZKG2(21),ZKG(21)                           00000660
      DIMENSION HP(15),EN(21),EN2(21)                                        00000670
C                                                                            00000680
C                                                                            00000690
      DIMENSION ELPD(21),FREQD(21),ARD(21,21),AID(21,21),                    00000700
     |  BRD(21,21),BID(21,21),CRD(21,21),CID(21,21),                        00000710
     |  DRD(21,21),DID(21,21)                                               00000720
C                                                                            00000730
      DIMENSION ELPE(21),ARE(21,21),AIE(21,21),BRE(21,21),                   00000740
     |  BIE(21,21),CRE(21,21),CIE(21,21),DRE(21,21),DIE(21,21)              00000750
C                                                                            00000760
      DIMENSION ELPF(21),ARF(21,21),AIF(21,21),BRF(21,21),                   00000770
     |  BIF(21,21),CRF(21,21),CIF(21,21),DRF(21,21),DIF(21,21)              00000780
C                                                                            00000790
      DIMENSION ELPG(21),ARG(21,21),AIG(21,21),BRG(21,21),                   00000800
     |  BIG(21,21),CRG(21,21),CIG(21,21),DRG(21,21),DIG(21,21)              00000810
C                                                                            00000820
      DIMENSION ELPH(21),ARH(21,21),AIH(21,21),BRH(21,21),                   00000830
     |  BIH(21,21),CRH(21,21),CIH(21,21),DRH(21,21),DIH(21,21)              00000840
C                                                                            00000850
      DIMENSION ELPI(21),ARI(21,21),AII(21,21),BRI(21,21),                   00000860
     |  BII(21,21),CRI(21,21),CII(21,21),DRI(21,21),DII(21,21)              00000870
C                                                                            00000880
      INTEGER NF,NR,NP                                                       00000890
      COMPLEX CJ                                                             00000900
      COMMON/INPUT/NF,FRE,ZKG2,ZKG,ELEND,NT,EN,EN2                           00000910
      COMMON/INPUT2/VSWR0,WM,WP,NTRIPS,RPHAZ0,HP,ELMIN,ELMAX                 00000920
      COMMON/INPUT3/DPHAZ                                                    00000930
      COMMON/OUTPUT/VSWRZ,PHASEZ,PHASEP,VSWRP,RPHAZD                         00000940
      COMMON/INTRP/NPD,NPE,NPF,NFD,ELPD,FREQD,ARD,AID,BRD,BID,CRD,CID,       00000950
     |DRD,DID,ARE,AIE,BRE,BIE,CRE,CIE,DRE,DIE,ARF,AIF,BRF,BIF,               00000960
     |CRF,CIF,DRF,DIF,ARG,AIG,BRG,BIG,CRG,CIG,DRG,DIG,ARH,AIH,               00000970
     |BRH,BIH,CRH,CIH,DRH,DIH,ARI,AII,BRI,BII,CRI,CII,DRI,DII,               00000980
     |ELPE,ELPF,ELPG,ELPH,ELPI,HPD,HPE,HPF,HPG,HPH,HPI                       00000990
C                                                                            00001000
      READ (7,5) DATANM                                                      00001010
    5 FORMAT(2A8)                                                            00001020
      READ (13,5) PATNM                                                      00001030
      READ (14,5) PATNM1                                                     00001040
      READ (15,5) PATNM2                                                     00001050
      READ (16,5) PATNM3                                                     00001060
      READ (17,5) PATNM4                                                     00001070
      READ (18,5) PATNM5                                                     00001080
      CALL CLOCK(TIME,DATE)                                                  00001090
      WRITE(9,18) TIME,DATE                                                  00001100
   18 FORMAT(//'    TIME    ',A4,'    DATE  ',A8)                           00001110
      WRITE(9,19) DATANM,PATNM,PATNM1,PATNM2                                 00001120
   19 FORMAT(//,5X,'   NAME OF PROGRAM USED IS DPSYN15.FORT',                00001130
     |  //,5X,'    DATA SET USED:  ',A8,/,15X,A8,/,15X,A8,/,15X,            00001140
     |  A8,/)                                                                00001150
C                                                                            00001160
```

```
      READ(7,*) DPHAZ                                                    00001170
      WRITE(9,*) DPHAZ                                                   00001180
C                                                                        00001190
C*****************************************                               00001200
C       READ INPUT DATA                 *                              00001210
C*****************************************                               00001220
C                                                                        00001230
C***** A1)  READ PARAMETERS FOR ZXSSQ                                   00001240
C                                                                        00001250
      READ(7,*) MAX,NSIG,IOPT                                            00001260
      READ(7,*) EPS,DELTA                                                00001270
      PI=3.141593                                                        00001280
      CJ=CMPLX(0.,1.)                                                    00001290
      RTD=180./PI                                                        00001300
C     NP=(NO. OF PATCHES)+1                                              00001310
      READ (7,*) NP,NF                                                   00001320
      READ(7,*) ELMIN,ELMAX                                              00001330
      NT=(2*NP)-1                                                        00001340
C                                                                        00001350
C----   A2)  READ IN PATCH DATA A MATRIX TABLES                         00001360
C                                                                        00001370
C                                                                        00001380
C                                                                        00001390
      READ(13,*) HPD,NPD,NFD                                             00001400
      READ(14,*) HPE,NPE,NFD                                             00001410
      READ(15,*) HPF,NPF,NFD                                             00001420
      READ(16,*) HPG,NPG,NFD                                             00001430
      READ(17,*) HPH,NPH,NFD                                             00001440
      READ(18,*) HPI,NPI,NFD                                             00001450
C                                                                        00001460
      DO 400 I=1,NPD                                                     00001470
        READ(13,*) ELPD(I)                                               00001480
        READ(16,*) ELPG(I)                                               00001490
        DO 410 J=1,NFD                                                   00001500
          READ(13,*) FREQD(J),ARD(I,J),AID(I,J),BRD(I,J),BID(I,J),       00001510
     |      CRD(I,J),CID(I,J),DRD(I,J),DID(I,J)                          00001520
          READ(16,*) FREQD(J),ARG(I,J),AIG(I,J),BRG(I,J),BIG(I,J),       00001530
     |      CRG(I,J),CIG(I,J),DRG(I,J),DIG(I,J)                          00001540
 410    CONTINUE                                                         00001550
 400  CONTINUE                                                           00001560
      DO 401 I=1,NPE                                                     00001570
        READ(14,*) ELPE(I)                                               00001580
        READ(17,*) ELPH(I)                                               00001590
        DO 411 J=1,NFD                                                   00001600
          READ(14,*) FREQD(J),ARE(I,J),AIE(I,J),BRE(I,J),BIE(I,J),       00001610
     |      CRE(I,J),CIE(I,J),DRE(I,J),DIE(I,J)                          00001620
          READ(17,*) FREQD(J),ARH(I,J),AIH(I,J),BRH(I,J),BIH(I,J),       00001630
     |      CRH(I,J),CIH(I,J),DRH(I,J),DIH(I,J)                          00001640
 411    CONTINUE                                                         00001650
 401  CONTINUE                                                           00001660
      DO 402 I=1,NPF                                                     00001670
        READ(15,*) ELPF(I)                                               00001680
        READ(18,*) ELPI(I)                                               00001690
        DO 412 J=1,NFD                                                   00001700
          READ(15,*) FREQD(J),ARF(I,J),AIF(I,J),BRF(I,J),BIF(I,J),       00001710
     |      CRF(I,J),CIF(I,J),DRF(I,J),DIF(I,J)                          00001720
          READ(18,*) FREQD(J),ARI(I,J),AII(I,J),BRI(I,J),BII(I,J),       00001730
     |      CRI(I,J),CII(I,J),DRI(I,J),DII(I,J)                          00001740
 412    CONTINUE                                                         00001750
 402  CONTINUE                                                           00001760
```

```
C                                                                       00001770
C                                                                       00001780
C*************************************                                  00001790
C      B)  READ INPUT GUESS           *                                 00001800
C*************************************                                  00001810
C                                                                       00001820
      I5=MOD(NP,2)                                                      00001830
C                                                                       00001840
        DO 41 I=1,NP-1                                                  00001850
        I2=MOD(I,2)                                                     00001860
        IF(I2.EQ.0) READ(7,*) X(I),HP(I)                                00001870
   41   IF(I2.EQ.1) READ(7,*) X(I)                                      00001880
        IF(I5.EQ.0) READ(7,*) X(NP),HP(NP)                              00001890
        IF(I5.EQ.1) READ(7,*) X(NP)                                     00001900
C                                                                       00001910
      READ(7,*) ELEND                                                   00001920
C                                                                       00001930
C*****READ IN DESIGN GOALS                                              00001940
C                                                                       00001950
        DO 42 I=1,NF                                                    00001960
   42   READ(7,*) FRE(I),VSWRO(I),RPHAZO(I),WM(I),WP(I),ZKG2(I),        00001970
     | ZKG(I)                                                           00001980
C                                                                       00001990
C                                                                       00002000
C*********************************************************             00002010
C      C)  WRITE OUT PARAMETERS IN OUTPUT LISTING    *                  00002020
C*********************************************************             00002030
C                                                                       00002040
      WRITE(9,21) MAX,NSIG,IOPT                                         00002050
   21 FORMAT(15X,' "INPUT DATA" ',///10X,'MAX= ',I6,'   NSIG= ',        00002060
     |I4,' IOPT =  ',I4/)                                              00002070
      WRITE(9,22) EPS,DELTA                                             00002080
   22 FORMAT(10X,'EPS=  ',F7.3,'  DELTA=  ',F7.3/)                      00002090
      WRITE(9,23) NP,NF                                                 00002100
   23 FORMAT(10X,'  NUMBER OF VARIABLES =  ',I5//,                      00002110
     |10X,'  NUMBER OF FREQUENCIES =  ',I3/)                           00002120
C                                                                       00002130
      DO 44 I=1,NP-1                                                    00002140
      I2=MOD(I,2)                                                       00002150
      IF(I2.EQ.1) WRITE(9,25) I,X(I)                                    00002160
  44  IF(I2.EQ.0) WRITE(9,24) I,X(I),HP(I)                              00002170
      IF(I5.EQ.1) WRITE(9,25) NP,X(NP)                                  00002180
      IF(I5.EQ.0) WRITE(9,24) NP,X(NP),HP(NP)                           00002190
C                                                                       00002200
   24 FORMAT(1X,I5,2F10.5)                                              00002210
   25 FORMAT(1X,I5,F20.5)                                               00002220
C                                                                       00002230
C                                                                       00002240
C*****************************************                              00002250
C* SCALE NUMBERS TO MIN/MAX LIMITS       *                              00002260
C*****************************************                              00002270
C                                                                       00002280
      DO 28 I=1,NP                                                      00002290
      IF(I.EQ.1) THEN                                                   00002300
        X(I)=SQRT(X(I))                                                 00002310
      ELSE                                                              00002320
        I2=MOD(I,2)                                                     00002330
        IF(I2.EQ.1) THEN                                                00002340
          X(I)=SQRT(X(I)-ELMIN)                                         00002350
        ELSE                                                            00002360
```

```
          X(I)=ARSIN(SQRT(X(I)/ELMAX))                                  00002370
        ENDIF                                                           00002380
      ENDIF                                                             00002390
   28 CONTINUE                                                          00002400
C                                                                       00002410
C                                                                       00002420
      IF(MAX.EQ.0) GO TO 43                                             00002430
      WRITE(9,26)                                                       00002440
   26 FORMAT(//3X,' FREQ ',2X,' VSWR ',4X,'RELATIVE PHASE',             00002450
     |6X,'WM',5X,'WP',6X,'ZKG2 RAD/IN',/)                              00002460
C                                                                       00002470
C                                                                       00002480
      DO 43 I=1,NF                                                      00002490
      WRITE(9,27) FRE(I),VSWR0(I),RPHAZ0(I),WM(I),WP(I),ZKG2(I)         00002500
   27 FORMAT(2X,2F7.3,4X,F10.3,5X,F7.3,3X,F7.3,2X,F7.3)                 00002510
      RPHAZ0(I)=RPHAZ0(I)/RTD                                           00002520
   43 CONTINUE                                                          00002530
C                                                                       00002540
C                                                                       00002550
C  ** CALCULATE TRANSFORMER RATIOS                                      00002560
C                                                                       00002570
      DO 600 K=1,NF                                                     00002580
       EN2(K)=ZKG(K)/ZKG2(K)                                            00002590
       EN(K)=SQRT(EN2(K))                                               00002600
  600 CONTINUE                                                          00002610
C                                                                       00002620
C ** SET UP ARRAY SIZE FOR RESIDUAL                                     00002630
C                                                                       00002640
      NR=3*NF                                                           00002650
      IF(MAX.EQ.0) GO TO 200                                            00002660
C                                                                       00002670
C                                                                       00002680
C*****************************************************                00002690
C*  CALL OPTIMIZATION SUBROUTINE                     *                00002700
C*****************************************************                00002710
C                                                                       00002720
      CALL ZXSSQ(SUB,NR,NP,NSIG,EPS,DELTA,MAX,IOPT,PARM,X,SSQ,E,        00002730
     |XJAC,63,XJTJ,WORK,INFER,IER)                                      00002740
C**                                                                     00002750
  200 CONTINUE                                                          00002760
C                                                                       00002770
C                                                                       00002780
C*************************************************                    00002790
C      E)  WRITE OUT DESIGNED PARAMETERS          *                    00002800
C*************************************************                    00002810
C                                                                       00002820
      WRITE(9,56)                                                       00002830
   56 FORMAT(/9X,'***********  "OUTPUT DATA " ***********',///)          00002840
      IF(NTRIPS.LE.MAX) THEN                                            00002850
        WRITE(9,30) NTRIPS                                              00002860
      ELSE                                                              00002870
        WRITE(9,31) NTRIPS                                              00002880
      ENDIF                                                             00002890
   30 FORMAT(5X,'NUMBER OF TRIPS THRU OPTIMIZATION ROUTINE =',          00002900
     |I5//)                                                            00002910
   31 FORMAT(10('******'),/5X,'VALUE NOT OPTIMIZED',/6X,                00002920
     |'NUMBER OF TRIPS THRU OPTIMIZATION ROUTINE =',I5,                 00002930
     |'  EXCEEDS MAX',//10('******')///)                                00002940
C                                                                       00002950
      WRITE(9,52) SSQ                                                   00002960
```

```
  52  FORMAT(3X,' THE FINAL VALUE OF SSQ IS ',E15.5,//)                    00002970
      WRITE(9,53) INFER                                                    00002980
  53  FORMAT(3X,'INFER = ',I1,//)                                          00002990
C                                                                          00003000
C*************************************************                         00003010
C          WRITE OUT DESIGN DIMENSIONS          *                         00003020
C*************************************************                         00003030
C                                                                          00003040
C                                                                          00003050
      IC=0                                                                 00003060
C                                                                          00003070
C************************************************************             00003080
C  SCALE NUMBERS UP AND PUT IN A SYMMETRICAL MANNER      *                 00003090
C   FOR FINAL RESPONSE SUBROUTINE CALL                   *                 00003100
C************************************************************             00003110
C                                                                          00003120
        N2=NT+1                                                            00003130
      DO 60 I=1,NP                                                         00003140
        N2=N2-1                                                            00003150
        IF(I.EQ.1) THEN                                                    00003160
          X1(I)=X(I)**2                                                    00003170
        ELSE                                                               00003180
          I2=MOD(I,2)                                                      00003190
          IF(I2.GT.0) THEN                                                 00003200
            X1(I)=ELMIN+X(I)**2                                            00003210
          ELSE                                                             00003220
            X1(I)=ELMAX*SIN(X(I))**2                                       00003230
          ENDIF                                                            00003240
        ENDIF                                                              00003250
        X1(N2)=X1(I)                                                       00003260
        IF(I2.GT.0) GO TO 60                                               00003270
        HP(N2)=HP(I)                                                       00003280
   60 CONTINUE                                                             00003290
C                                                                          00003300
C                                                                          00003310
      DO 62 I=1,NP-1                                                       00003320
        I2=MOD(I,2)                                                        00003330
        IF(I2.GT.0) THEN                                                   00003340
          IC=IC+1                                                          00003350
          WRITE(9,35) IC,X1(I)                                             00003360
        ELSE                                                               00003370
          WRITE(9,34) IC,X1(I),HP(I)                                       00003380
        ENDIF                                                              00003390
  62  CONTINUE                                                             00003400
C                                                                          00003410
C                                                                          00003420
      IF(I5.EQ.0) WRITE(9,34) IC,X1(NP),HP(NP)                             00003430
      IF(I5.EQ.1) WRITE(9,35) IC+1,X1(NP)                                  00003440
      WRITE(9,36) ELEND                                                    00003450
C                                                                          00003460
C                                                                          00003470
   34 FORMAT(/7X,'DESIGN VALUES FOR PATCH ',I3,': ',                       00003480
     |/8X,'PATCH LENGTH = ',F7.5,' INCHES  PATCH HEIGHT = ',F7.5,          00003490
     |' INCHES')                                                          00003500
   35 FORMAT(7X,'LINE LENGTH ',I3,'  = ',F7.5,' INCHES' )                  00003510
   36 FORMAT(/7X,'END LENGTH  = ',F7.5,' INCHES' )                         00003520
C                                                                          00003530
C                                                                          00003540
C************************************                                     00003550
C     CALCULATE TOTAL LENGTH OF BIT  *                                     00003560
```

```
C*************************************                                00003570
C                                                                    00003580
      SUM=0.                                                         00003590
      DO 61 I=1,NP-1                                                 00003600
          SUM=SUM+2.*X1(I)                                           00003610
   61 CONTINUE                                                       00003620
      SUM=SUM+X1(NP)                                                 00003630
C                                                                    00003640
        SUM=SUM+2.*ELEND                                             00003650
      WRITE(9,57) SUM                                                00003660
   57 FORMAT(//5X,'TOTAL LENGTH OF BIT ',F10.5,' INCHES')            00003670
C                                                                    00003680
C                                                                    00003690
C                                                                    00003700
C*********************************************************************00003710
C** CALCULATE RESPONSE OF FINAL DESIGN AND PRINT OUT RESULTS          00003720
C    FOR EACH FREQUENCY.                                             00003730
C*********************************************************************00003740
C                                                                    00003750
      IPRINT=1                                                       00003760
C                                                                    00003770
C                                                                    00003780
C                                                                    00003790
      CALL RESPON(X1,HP,IPRINT)                                      00003800
C                                                                    00003810
C                                                                    00003820
      STOP                                                           00003830
      END                                                            00003840
C                                                                    00003850
C*************************************************************      00003860
C************************************************** *               00003870
C                                                 * *                00003880
      SUBROUTINE SUB(X,NR,NP,E)                                      00003890
C                                                 * *                00003900
C*************************************************************      00003910
C*************************************************************      00003920
C                                                                    00003930
C                                                                    00003940
C*************************************************************      00003950
C*                                                                   00003960
C*  THIS SUBROUTINE COMPUTES THE ERROR RESIDUAL OF THE               00003970
C*    RESPONSE AND THE DESIRED RESPONSES FOR BOTH THE PHASE          00003980
C*    AND THE ZERO POSITIONS. IT USES SUBROUTINE RESPON              00003990
C*    TO PROVIDE THE CALCULATED RESPONSES.                           00004000
C*                                                                   00004010
C*************************************************************      00004020
C                                                                    00004030
      DIMENSION FRE(21),VSWR0(21),RPHAZ0(21),WM(21)                  00004040
      DIMENSION WP(21),X(15),E(63),X1(20)                            00004050
      DIMENSION VSWRZ(21),PHASEZ(21),PHASEP(21),ZKG2(21)             00004060
      DIMENSION VSWRP(21),RPHAZD(21),ZKG(21)                         00004070
      DIMENSION HP(15),EN(21),EN2(21)                                00004080
C                                                                    00004090
      COMMON/INPUT/NF,FRE,ZKG2,ZKG,ELEND,NT,EN,EN2                   00004100
      COMMON/INPUT2/VSWR0,WM,WP,NTRIPS,RPHAZ0,HP,ELMIN,ELMAX         00004110
      COMMON/OUTPUT/VSWRZ,PHASEZ,PHASEP,VSWRP,RPHAZD                 00004120
C                                                                    00004130
C                                                                    00004140
      NTRIPS=NTRIPS+1                                                00004150
C     WRITE(9,415) NTRIPS                                            00004160
```

```
  415 FORMAT(//,' ********** NTRIPS = ',I5,/)                          00004170
C                                                                     00004180
C*****************************************************************  00004190
C     SET VALUES IN ARRAY TO CALCULATE RESONSE FOR 'ON'               00004200
C     SUSCEPTANCE VALUES. SCALE UP PREVIOUSLY SCALED DOWN             00004210
C     PARAMETERS AND PUT IN X1 ARRAY IN A SYMMETRICAL                 00004220
C     MANNER.                                                         00004230
C*****************************************************************  00004240
C                                                                     00004250
      IPRINT=0                                                        00004260
      N2=NT+1                                                         00004270
      DO 31 I=1,NP                                                    00004280
        N2=N2-1                                                       00004290
        IF(I.EQ.1) THEN                                               00004300
          X1(I)=X(I)**2                                               00004310
        ELSE                                                          00004320
          I2=MOD(I,2)                                                 00004330
          IF(I2.GT.0) THEN                                            00004340
            X1(I)=ELMIN+X(I)**2                                       00004350
          ELSE                                                        00004360
            X1(I)=ELMAX*SIN(X(I))**2                                  00004370
          ENDIF                                                       00004380
        ENDIF                                                         00004390
        X1(N2)=X1(I)                                                  00004400
        IF(I2.GT.0) GO TO 31                                          00004410
        HP(N2)=HP(I)                                                  00004420
   31 CONTINUE                                                        00004430
C                                                                     00004440
C                                                                     00004450
C*****************************************************************  00004460
C*     CALL RESPONSE SUBROUTINE                                  *     00004470
C*****************************************************************  00004480
C                                                                     00004490
C                                                                     00004500
      CALL RESPON(X1,HP,IPRINT)                                       00004510
C                                                                     00004520
C                                                                     00004530
C ***************************************************************** 00004540
C    NOW THAT RESPONSE OF BOTH POSITIONS HAS BEEN CALCULATED          00004550
C     CALCULATE THE RESIDUAL ARRAY WHERE                              00004560
C     E(1-NF) IS ZERO STATE VSWR RESIDUAL                             00004570
C     E(NF+1-2NF) IS  PHASE STATE VSWR RESIDUAL                       00004580
C     E(2NF+1-3NF) IS RELATIVE PHASE RESIDUAL                         00004590
C*****************************************************************  00004600
C                                                                     00004610
C                                                                     00004620
      DO 201 K=1,NF                                                   00004630
      RPHAZD(K)=PHASEP(K)-PHASEZ(K)                                   00004640
      K1=K+NF                                                         00004650
      K2=K+2*NF                                                       00004660
      K3=K+3*NF                                                       00004670
      E(K)=(RPHAZO(K)-RPHAZD(K))*WP(K)                                00004680
      E(K1)=(VSWRO(K)-VSWRP(K))*WM(K)                                 00004690
      E(K2)=(VSWRO(K)-VSWRZ(K))*WM(K)                                 00004700
C                                                                     00004710
  201 CONTINUE                                                        00004720
C                                                                     00004730
      RETURN                                                          00004740
      END                                                             00004750
C                                                                     00004760
```

```
C                                                                       00004770
C     DEBUG UNIT(6)                                                     00004780
C     AT 493                                                            00004790
C     WRITE(6,*) K                                                      00004791
C     WRITE(6,*) MATP(1,1),MATP(1,2)                                    00004800
C     WRITE(6,*) MATP(2,1),MATP(2,2)                                    00004810
C     WRITE(6,*) CHET,CHET2                                             00004820
C     WRITE(6,*)                                                        00004821
C                                                                       00004822
C     AT 494                                                            00004823
C     WRITE(6,*) MATZ(1,1),MATZ(1,2)                                    00004824
C     WRITE(6,*) MATZ(2,1),MATZ(2,2)                                    00004825
C     WRITE(6,*) CHET,CHET2                                             00004826
C     WRITE(6,*)                                                        00004827
C     END DEBUG                                                         00004828
C                                                                       00004830
C*************************************************************        00004840
C************************************************************ *       00004850
C                                                           * *       00004860
      SUBROUTINE RESPON(X1,HP,IPRINT)                                   00004870
C                                                           * *       00004880
C************************************************************ *       00004890
C*************************************************************        00004900
C                                                                       00004910
C***********************************************************************00004920
C*                                                                      00004930
C* THIS SUBROUTINE CALCULATES THE RESPONSE OF BOTH THE ON               00004940
C* AND OFF NETWORKS AT EACH SPECIFIED FREQUENCY.                        00004950
C*                                                                      00004960
C***********************************************************************00004970
C                                                                       00004980
      DIMENSION X1(20),FRE(21),VSWRZ(21),VSWRP(21),PHASEZ(21)           00004990
      DIMENSION PHASEP(21),ZKG2(21),ZILP(21),ZILZ(21)                   00005000
      DIMENSION MAT1P(2,2),MAT2P(2,2),MATP(2,2),MAT1Z(2,2),             00005010
     |MAT2Z(2,2),MATZ(2,2),ZKG(21)                                      00005020
      DIMENSION TPMAG(21),TZMAG(21)                                     00005030
      DIMENSION HP(15),EN(21),EN2(21)                                   00005040
C                                                                       00005050
      DIMENSION ELPD(21),FREQD(21),ARD(21,21),AID(21,21),               00005060
     |  BRD(21,21),BID(21,21),CRD(21,21),CID(21,21),                    00005070
     |  DRD(21,21),DID(21,21)                                           00005080
C                                                                       00005090
      DIMENSION ELPE(21),ARE(21,21),AIE(21,21),BRE(21,21),              00005100
     |  BIE(21,21),CRE(21,21),CIE(21,21),DRE(21,21),DIE(21,21)          00005110
C                                                                       00005120
      DIMENSION ELPF(21),ARF(21,21),AIF(21,21),BRF(21,21),              00005130
     |  BIF(21,21),CRF(21,21),CIF(21,21),DRF(21,21),DIF(21,21)          00005140
C                                                                       00005150
      DIMENSION ELPG(21),ARG(21,21),AIG(21,21),BRG(21,21),              00005160
     |  BIG(21,21),CRG(21,21),CIG(21,21),DRG(21,21),DIG(21,21)          00005170
C                                                                       00005180
      DIMENSION ELPH(21),ARH(21,21),AIH(21,21),BRH(21,21),              00005190
     |  BIH(21,21),CRH(21,21),CIH(21,21),DRH(21,21),DIH(21,21)          00005200
C                                                                       00005210
      DIMENSION ELPI(21),ARI(21,21),AII(21,21),BRI(21,21),              00005220
     |  BII(21,21),CRI(21,21),CII(21,21),DRI(21,21),DII(21,21)          00005230
C                                                                       00005240
      COMPLEX MAT1P,MAT2P,MATP,CJ,TD,CHET                               00005250
      COMPLEX MAT1Z,MAT2Z,MATZ,TP,TZ                                    00005260
C                                                                       00005270
```

```
      COMMON/INPUT/NF,FRE,ZKG2,ZKG,ELEND,NT,EN,EN2                          00005280
      COMMON/INPUT3/DPHAZ                                                   00005290
      COMMON/OUTPUT/VSWRZ,PHASEZ,PHASEP,VSWRP,RPHAZD                        00005300
      COMMON/INTRP/NPD,NPE,NPF,NFD,ELPD,FREQD,ARD,AID,BRD,BID,CRD,CID,      00005310
     |DRD,DID,ARE,AIE,BRE,BIE,CRE,CIE,DRE,DIE,ARF,AIF,BRF,BIF,             00005320
     |CRF,CIF,DRF,DIF,ARG,AIG,BRG,BIG,CRG,CIG,DRG,DIG,ARH,AIH,             00005330
     |BRH,BIH,CRH,CIH,DRH,DIH,ARI,AII,BRI,BII,CRI,CII,DRI,DII,             00005340
     |ELPE,ELPF,ELPG,ELPH,ELPI,HPD,HPE,HPF,HPG,HPH,HPI                     00005350
C                                                                           00005360
      CJ=CMPLX(0.,1.)                                                       00005370
      PI=3.141593                                                           00005380
      RTD=180./PI                                                           00005390
      ECHEK=.0100                                                           00005400
C                                                                           00005410
C*********************************                                        00005420
C** START FREQUENCY LOOP                                                   00005430
C*********************************                                        00005440
C                                                                           00005450
      DO 201 K=1,NF                                                         00005460
C                                                                           00005470
C************** CALCULATE TRANSFORMER MATRIX                               00005480
C                                                                           00005490
      TN11=(EN2(K)+1.)/(2.*EN(K))                                           00005500
      TN12=(EN2(K)-1.)/(2.*EN(K))                                           00005510
      TN21=TN12                                                             00005520
      TN22=TN11                                                             00005530
C                                                                           00005540
C     WRITE(9,401) WVL,WVLG,ZKG,EN2,EN                                      00005550
  401 FORMAT(//,3X,'WVL ',F14.7,/,                                          00005560
     |3X,'WVLG ',F14.7,/,                                                  00005570
     |3X,'ZKG  ',F14.7,/,                                                  00005580
     |3X,'EN2  ',F14.7,/,                                                  00005590
     |3X,'EN   ',F14.7,/)                                                  00005600
C                                                                           00005610
C*************** SET THETA COUNTERS TO ZERO                                00005620
      THETAW=0.                                                             00005630
      THETAD=0.                                                             00005640
C                                                                           00005650
C*************************************************************************00005660
C* CALCULATE THE A,B,C,D PARAMETERS OF EACH SECTION AND MULTIPLY           00005670
C  THEM IN CASCADE                                                          00005680
C*************************************************************************00005690
C                                                                           00005700
C                                                                           00005710
C*********************************                                        00005720
C   START PATCH PARAMETER LOOP                                              00005730
C*********************************                                        00005740
C                                                                           00005750
C                                                                           00005760
      DO 101 I=1,NT                                                         00005770
C      WRITE(9,402) I                                                       00005780
 402  FORMAT(//,'PARAMETER ',I3,/)                                          00005790
        IF(I.EQ.1) THEN                                                     00005800
          THET0=ZKG(K)*X1(I)                                                00005810
          THET=ZKG2(K)*X1(I)                                                00005820
          THETAW=THETAW+THET0                                               00005830
          THETAD=THETAD+THET                                                00005840
          MATP(1,1)=CEXP(-CJ*THET)                                          00005850
          MATP(1,2)=(0.,0.)                                                 00005860
          MATP(2,1)=(0.,0.)                                                 00005870
```

```
          MATP(2,2)=1./MATP(1,1)                                        00005880
C                                                                       00005890
C         WRITE(9,404)                                                  00005900
  404 FORMAT(/,' MATP  ',/)                                             00005910
C     WRITE(9,403) ((MATP(KR,KC),KR=1,2),KC=1,2)                        00005920
 403  FORMAT(4F10.3)                                                    00005930
C                                                                       00005940
          MATZ(1,1)=MATP(1,1)                                           00005950
          MATZ(1,2)=MATP(1,2)                                           00005960
          MATZ(2,1)=MATP(2,1)                                           00005970
          MATZ(2,2)=MATP(2,2)                                           00005980
C                                                                       00005990
C      WRITE(9,405)                                                     00006000
  405 FORMAT(/,' MATZ  ',/)                                             00006010
C     WRITE(9,403) ((MATZ(KR,KC),KR=1,2),KC=1,2)                        00006020
          GO TO 101                                                     00006030
        ENDIF                                                           00006040
C                                                                       00006050
C*****MOVE THE SUM MATRIX OVER TO THE FIRST MATRIX POSITION             00006060
C                                                                       00006070
      DO 40 L=1,2                                                       00006080
        DO 50 J=1,2                                                     00006090
          MAT1P(L,J)=MATP(L,J)                                          00006100
          MAT1Z(L,J)=MATZ(L,J)                                          00006110
   50 CONTINUE                                                          00006120
   40 CONTINUE                                                          00006130
C                                                                       00006140
C******CHECK TO SEE IF X1(I) PARAMETER IS A LENGTH OF LINE OR A         00006150
C       COPPER PATCH (EVEN X1'S ARE COPPER PATCHES, ODD X1'S            00006160
C       ARE LINE LENGTHS.)--- PHASES USED ARE VALUES ON THE             00006170
C       DIELECTRIC.                                                     00006180
C                                                                       00006190
          THET0=ZKG(K)*X1(I)                                            00006200
          THET=ZKG2(K)*X1(I)                                            00006210
          THETAW=THETAW+THET0                                           00006220
          THETAD=THETAD+THET                                            00006230
      IF((-1)**I.GT.0) GO TO 62                                         00006240
          MAT2P(1,1)=CEXP(-CJ*THET)                                     00006250
          MAT2P(1,2)=(0.,0.)                                            00006260
          MAT2P(2,1)=(0.,0.)                                            00006270
          MAT2P(2,2)=1./MAT2P(1,1)                                      00006280
C                                                                       00006290
          MAT2Z(1,1)=MAT2P(1,1)                                         00006300
          MAT2Z(1,2)=MAT2P(1,2)                                         00006310
          MAT2Z(2,1)=MAT2P(2,1)                                         00006320
          MAT2Z(2,2)=MAT2P(2,2)                                         00006330
C                                                                       00006340
      CALL MATMLT(MAT1P,MAT2P,MATP)                                     00006350
      CALL MATMLT(MAT1Z,MAT2Z,MATZ)                                     00006360
C                                                                       00006370
C                                                                       00006380
      GO TO 103                                                         00006390
C                                                                       00006400
C                                                                       00006410
C  ************************************************                     00006420
C       INTERPOLATION ROUTINES                    *                     00006430
C ************************************************                      00006440
C                                                                       00006450
   62 ARGUM=ZKG2(K)*X1(I)                                               00006460
      AR0=1.                                                            00006470
```

```
      AIO=-ARGUM*RTD                                                    00006480
      BRO=0.                                                            00006490
      BIO=-90.                                                          00006500
      CRO=0.                                                            00006510
      CIO=-BIO                                                          00006520
      DRO=ARO                                                           00006530
      DIO=-AIO                                                          00006540
C                                                                       00006550
C ***** CALL ON DIODE TRANSMISION MATRIX TABLES                        00006560
C                                                                       00006570
      CALL LAGRAN(X1(I),FRE(K),ELPD,FREQD,ARD,3,3,NPD,NFD,21,AR1)       00006580
      CALL LAGRAN(X1(I),FRE(K),ELPD,FREQD,AID,3,3,NPD,NFD,21,AI1)       00006590
      CALL LAGRAN(X1(I),FRE(K),ELPD,FREQD,BRD,3,3,NPD,NFD,21,BR1)       00006600
      CALL LAGRAN(X1(I),FRE(K),ELPD,FREQD,BID,3,3,NPD,NFD,21,BI1)       00006610
      CALL LAGRAN(X1(I),FRE(K),ELPD,FREQD,CRD,3,3,NPD,NFD,21,CR1)       00006620
      CALL LAGRAN(X1(I),FRE(K),ELPD,FREQD,CID,3,3,NPD,NFD,21,CI1)       00006630
      CALL LAGRAN(X1(I),FRE(K),ELPD,FREQD,DRD,3,3,NPD,NFD,21,DR1)       00006640
      CALL LAGRAN(X1(I),FRE(K),ELPD,FREQD,DID,3,3,NPD,NFD,21,DI1)       00006650
C                                                                       00006660
      CALL LAGRAN(X1(I),FRE(K),ELPE,FREQD,ARE,3,3,NPE,NFD,21,AR2)       00006670
      CALL LAGRAN(X1(I),FRE(K),ELPE,FREQD,AIE,3,3,NPE,NFD,21,AI2)       00006680
      CALL LAGRAN(X1(I),FRE(K),ELPE,FREQD,BRE,3,3,NPE,NFD,21,BR2)       00006690
      CALL LAGRAN(X1(I),FRE(K),ELPE,FREQD,BIE,3,3,NPE,NFD,21,BI2)       00006700
      CALL LAGRAN(X1(I),FRE(K),ELPE,FREQD,CRE,3,3,NPE,NFD,21,CR2)       00006710
      CALL LAGRAN(X1(I),FRE(K),ELPE,FREQD,CIE,3,3,NPE,NFD,21,CI2)       00006720
      CALL LAGRAN(X1(I),FRE(K),ELPE,FREQD,DRE,3,3,NPE,NFD,21,DR2)       00006730
      CALL LAGRAN(X1(I),FRE(K),ELPE,FREQD,DIE,3,3,NPE,NFD,21,DI2)       00006740
C                                                                       00006750
      CALL LAGRAN(X1(I),FRE(K),ELPF,FREQD,ARF,3,3,NPF,NFD,21,AR3)       00006760
      CALL LAGRAN(X1(I),FRE(K),ELPF,FREQD,AIF,3,3,NPF,NFD,21,AI3)       00006770
      CALL LAGRAN(X1(I),FRE(K),ELPF,FREQD,BRF,3,3,NPF,NFD,21,BR3)       00006780
      CALL LAGRAN(X1(I),FRE(K),ELPF,FREQD,BIF,3,3,NPF,NFD,21,BI3)       00006790
      CALL LAGRAN(X1(I),FRE(K),ELPF,FREQD,CRF,3,3,NPF,NFD,21,CR3)       00006800
      CALL LAGRAN(X1(I),FRE(K),ELPF,FREQD,CIF,3,3,NPF,NFD,21,CI3)       00006810
      CALL LAGRAN(X1(I),FRE(K),ELPF,FREQD,DRF,3,3,NPF,NFD,21,DR3)       00006820
      CALL LAGRAN(X1(I),FRE(K),ELPF,FREQD,DIF,3,3,NPF,NFD,21,DI3)       00006830
C                                                                       00006840
 491  CONTINUE                                                          00006841
      CALL GNTERP(0.,HPD,HPE,HPF,ARO,AR1,AR2,AR3,HP(I),AR)              00006850
      CALL GNTERP(0.,HPD,HPE,HPF,AIO,AI1,AI2,AI3,HP(I),AI)              00006860
      CALL GNTERP(0.,HPD,HPE,HPF,BRO,BR1,BR2,BR3,HP(I),BR)              00006870
      CALL GNTERP(0.,HPD,HPE,HPF,BIO,BI1,BI2,BI3,HP(I),BI)              00006880
      CALL GNTERP(0.,HPD,HPE,HPF,CRO,CR1,CR2,CR3,HP(I),CR)              00006890
      CALL GNTERP(0.,HPD,HPE,HPF,CIO,CI1,CI2,CI3,HP(I),CI)              00006900
      CALL GNTERP(0.,HPD,HPE,HPF,DRO,DR1,DR2,DR3,HP(I),DR)              00006910
      CALL GNTERP(0.,HPD,HPE,HPF,DIO,DI1,DI2,DI3,HP(I),DI)              00006920
C                                                                       00006930
C ******** SET VALUES INTO PHASE MATRIX                                 00006940
C                                                                       00006950
      MAT2P(1,1)=AR*CEXP(CJ*AI/RTD)                                     00006960
      MAT2P(1,2)=BR*CEXP(CJ*BI/RTD)                                     00006970
      MAT2P(2,1)=CR*CEXP(CJ*CI/RTD)                                     00006980
      MAT2P(2,2)=DR*CEXP(CJ*DI/RTD)                                     00006990
C                                                                       00007000
C     CHET=1./MAT2P(2,2)                                                00007001
C     CHET2=CABS(CHET)                                                  00007002
C 493 CONTINUE                                                          00007003
C                                                                       00007010
C***** CALL OFF DIODE TRANSMISSION MATRIX TABLES                        00007020
C                                                                       00007030
```

```
      CALL LAGRAN(X1(I),FRE(K),ELPG,FREQD,ARG,3,3,NPD,NFD,21,AR1)      00007040
      CALL LAGRAN(X1(I),FRE(K),ELPG,FREQD,AIG,3,3,NPD,NFD,21,AI1)      00007050
      CALL LAGRAN(X1(I),FRE(K),ELPG,FREQD,BRG,3,3,NPD,NFD,21,BR1)      00007060
      CALL LAGRAN(X1(I),FRE(K),ELPG,FREQD,BIG,3,3,NPD,NFD,21,BI1)      00007070
      CALL LAGRAN(X1(I),FRE(K),ELPG,FREQD,CRG,3,3,NPD,NFD,21,CR1)      00007080
      CALL LAGRAN(X1(I),FRE(K),ELPG,FREQD,CIG,3,3,NPD,NFD,21,CI1)      00007090
      CALL LAGRAN(X1(I),FRE(K),ELPG,FREQD,DRG,3,3,NPD,NFD,21,DR1)      00007100
      CALL LAGRAN(X1(I),FRE(K),ELPG,FREQD,DIG,3,3,NPD,NFD,21,DI1)      00007110
C                                                                      00007120
      CALL LAGRAN(X1(I),FRE(K),ELPH,FREQD,ARH,3,3,NPE,NFD,21,AR2)      00007130
      CALL LAGRAN(X1(I),FRE(K),ELPH,FREQD,AIH,3,3,NPE,NFD,21,AI2)      00007140
      CALL LAGRAN(X1(I),FRE(K),ELPH,FREQD,BRH,3,3,NPE,NFD,21,BR2)      00007150
      CALL LAGRAN(X1(I),FRE(K),ELPH,FREQD,BIH,3,3,NPE,NFD,21,BI2)      00007160
      CALL LAGRAN(X1(I),FRE(K),ELPH,FREQD,CRH,3,3,NPE,NFD,21,CR2)      00007170
      CALL LAGRAN(X1(I),FRE(K),ELPH,FREQD,CIH,3,3,NPE,NFD,21,CI2)      00007180
      CALL LAGRAN(X1(I),FRE(K),ELPH,FREQD,DRH,3,3,NPE,NFD,21,DR2)      00007190
      CALL LAGRAN(X1(I),FRE(K),ELPH,FREQD,DIH,3,3,NPE,NFD,21,DI2)      00007200
C                                                                      00007210
      CALL LAGRAN(X1(I),FRE(K),ELPI,FREQD,ARI,3,3,NPF,NFD,21,AR3)      00007220
      CALL LAGRAN(X1(I),FRE(K),ELPI,FREQD,AII,3,3,NPF,NFD,21,AI3)      00007230
      CALL LAGRAN(X1(I),FRE(K),ELPI,FREQD,BRI,3,3,NPF,NFD,21,BR3)      00007240
      CALL LAGRAN(X1(I),FRE(K),ELPI,FREQD,BII,3,3,NPF,NFD,21,BI3)      00007250
      CALL LAGRAN(X1(I),FRE(K),ELPI,FREQD,CRI,3,3,NPF,NFD,21,CR3)      00007260
      CALL LAGRAN(X1(I),FRE(K),ELPI,FREQD,CII,3,3,NPF,NFD,21,CI3)      00007270
      CALL LAGRAN(X1(I),FRE(K),ELPI,FREQD,DRI,3,3,NPF,NFD,21,DR3)      00007280
      CALL LAGRAN(X1(I),FRE(K),ELPI,FREQD,DII,3,3,NPF,NFD,21,DI3)      00007290
C                                                                      00007300
  492 CONTINUE                                                         00007301
      CALL GNTERP(0.,HPG,HPH,HPI,AR0,AR1,AR2,AR3,HP(I),AR)             00007310
      CALL GNTERP(0.,HPG,HPH,HPI,AI0,AI1,AI2,AI3,HP(I),AI)             00007320
      CALL GNTERP(0.,HPG,HPH,HPI,BR0,BR1,BR2,BR3,HP(I),BR)             00007330
      CALL GNTERP(0.,HPG,HPH,HPI,BI0,BI1,BI2,BI3,HP(I),BI)             00007340
      CALL GNTERP(0.,HPG,HPH,HPI,CR0,CR1,CR2,CR3,HP(I),CR)             00007350
      CALL GNTERP(0.,HPG,HPH,HPI,CI0,CI1,CI2,CI3,HP(I),CI)             00007360
      CALL GNTERP(0.,HPG,HPH,HPI,DR0,DR1,DR2,DR3,HP(I),DR)             00007370
      CALL GNTERP(0.,HPG,HPH,HPI,DI0,DI1,DI2,DI3,HP(I),DI)             00007380
C                                                                      00007390
C********** SET VALUES INTO ZERO MATRIX                               00007400
C                                                                      00007410
      MAT2Z(1,1)=AR*CEXP(CJ*AI/RTD)                                    00007420
      MAT2Z(1,2)=BR*CEXP(CJ*BI/RTD)                                    00007430
      MAT2Z(2,1)=CR*CEXP(CJ*CI/RTD)                                    00007440
      MAT2Z(2,2)=DR*CEXP(CJ*DI/RTD)                                    00007450
C                                                                      00007460
C     CHET=1./MAT2Z(2,2)                                               00007461
C     CHET2=CABS(CHET)                                                 00007462
C 494 CONTINUE                                                         00007463
C                                                                      00007464
      CALL MATMLT(MAT1P,MAT2P,MATP)                                    00007470
      CALL MATMLT(MAT1Z,MAT2Z,MATZ)                                    00007480
C                                                                      00007490
  103 CONTINUE                                                         00007500
C     WRITE(9,408)                                                     00007510
 408  FORMAT(/,'  MAT1P ',/)                                           00007520
C     WRITE(9,403)   ((MAT1P(KR,KC),KR=1,2),KC=1,2)                    00007530
C     WRITE(9,409)                                                     00007540
  409 FORMAT(/,'  MAT2P ',/)                                           00007550
C     WRITE(9,403)  ((MAT2P(KR,KC),KR=1,2),KC=1,2)                     00007560
C                                                                      00007570
C     WRITE(9,411)                                                     00007580
```

```
 411  FORMAT(/,'  MAT1Z ',/)                                          00007590
C     WRITE(9,403)  ((MAT1Z(KR,KC),KR=1,2),KC=1,2)                   00007600
C     WRITE(9,412)                                                   00007610
  412 FORMAT(/,'  MAT2Z ',/)                                          00007620
C     WRITE(9,403)  ((MAT2Z(KR,KC),KR=1,2),KC=1,2)                   00007630
C                                                                    00007640
C     WRITE(9,404)                                                   00007650
C     WRITE(9,403)  ((MATP(KR,KC),KR=1,2),KC=1,2)                    00007660
C     WRITE(9,405)                                                   00007670
C     WRITE(9,403)  ((MATZ(KR,KC),KR=1,2),KC=1,2)                    00007680
                                                                     00007690
  101 CONTINUE                                                       00007700
C                                                                    00007710
C****    ADD CONTRIBUTION OF END LENGTHS                             00007720
C     ********************************************                   00007730
C                                                                    00007740
      THET0=ZKG(K)*ELEND                                             00007750
      THET=ZKG2(K)*ELEND                                             00007760
C                                                                    00007770
C          A) TACK END LENGTH ON TO THE FRONT                        00007780
C          ----------------------------------                        00007790
C                                                                    00007800
      MAT1P(1,1)=CEXP(-CJ*THET)                                      00007810
      MAT1P(1,2)=(0.,0.)                                             00007820
      MAT1P(2,1)=(0.,0.)                                             00007830
      MAT1P(2,2)=1./MAT1P(1,1)                                       00007840
C                                                                    00007850
      MAT1Z(1,1)=MAT1P(1,1)                                          00007860
      MAT1Z(1,2)=MAT1P(1,2)                                          00007870
      MAT1Z(2,1)=MAT1P(2,1)                                          00007880
      MAT1Z(2,2)=MAT1P(2,2)                                          00007890
C                                                                    00007900
      THETAW=THETAW+2.*THET0                                         00007910
      THETAD=THETAD+2.*THET                                          00007920
      DO 250 L=1,2                                                   00007930
        DO 251 J=1,2                                                 00007940
          MAT2P(L,J)=MATP(L,J)                                       00007950
          MAT2Z(L,J)=MATZ(L,J)                                       00007960
  251 CONTINUE                                                       00007970
  250 CONTINUE                                                       00007980
C                                                                    00007990
      CALL MATMLT(MAT1P,MAT2P,MATP)                                  00008000
      CALL MATMLT(MAT1Z,MAT2Z,MATZ)                                  00008010
C                                                                    00008020
C          B) TACK END LENGTH ON TO THE BACK                         00008030
C              ---------------------------                           00008040
C                                                                    00008050
      DO 252 L=1,2                                                   00008060
        DO 253 J=1,2                                                 00008070
          MAT2P(L,J)=MAT1P(L,J)                                      00008080
          MAT1P(L,J)=MATP(L,J)                                       00008090
C                                                                    00008100
          MAT2Z(L,J)=MAT1Z(L,J)                                      00008110
          MAT1Z(L,J)=MATZ(L,J)                                       00008120
  253 CONTINUE                                                       00008130
  252 CONTINUE                                                       00008140
C                                                                    00008150
      CALL MATMLT(MAT1P,MAT2P,MATP)                                  00008160
      CALL MATMLT(MAT1Z,MAT2Z,MATZ)                                  00008170
C                                                                    00008180
```

```
C      CHET=1./MATP(2,2)                                                00008181
C      CHET2=CABS(CHET)                                                 00008182
C 493 CONTINUE                                                          00008183
C                                                                       00008184
C      CHET=1./MATZ(2,2)                                                00008185
C      CHET2=CABS(CHET)                                                 00008186
C 494 CONTINUE                                                          00008187
C*******************************************************               00008190
C   ADD CONTRIBUTION OF TRANSFORMER EFFECTS                             00008200
C*******************************************************               00008210
C                                                                       00008220
C*****  N:1 **********                                                  00008230
C                                                                       00008240
      MAT1P(1,1)=TN11                                                   00008250
      MAT1P(1,2)=TN12                                                   00008260
      MAT1P(2,1)=TN21                                                   00008270
      MAT1P(2,2)=TN22                                                   00008280
C                                                                       00008290
      MAT1Z(1,1)=MAT1P(1,1)                                             00008300
      MAT1Z(1,2)=MAT1P(1,2)                                             00008310
      MAT1Z(2,1)=MAT1P(2,1)                                             00008320
      MAT1Z(2,2)=MAT1P(2,2)                                             00008330
C                                                                       00008340
      DO 254 L=1,2                                                      00008350
        DO 255 J=1,2                                                    00008360
          MAT2P(L,J)=MATP(L,J)                                          00008370
          MAT2Z(L,J)=MATZ(L,J)                                          00008380
  255 CONTINUE                                                          00008390
  254 CONTINUE                                                          00008400
C                                                                       00008410
      CALL MATMLT(MAT1P,MAT2P,MATP)                                     00008420
      CALL MATMLT(MAT1Z,MAT2Z,MATZ)                                     00008430
C                                                                       00008440
C      CHET=1./MATP(2,2)                                                00008441
C      CHET2=CABS(CHET)                                                 00008442
 493  CONTINUE                                                          00008443
C                                                                       00008444
C      CHET=1./MATZ(2,2)                                                00008445
C      CHET2=CABS(CHET)                                                 00008446
  494 CONTINUE                                                          00008447
C******* 1:N ***********                                                00008450
C                                                                       00008460
      MAT2P(1,1)=TN22                                                   00008470
      MAT2P(1,2)=-TN21                                                  00008480
      MAT2P(2,1)=-TN12                                                  00008490
      MAT2P(2,2)=TN11                                                   00008500
C                                                                       00008510
      MAT2Z(1,1)=MAT2P(1,1)                                             00008520
      MAT2Z(1,2)=MAT2P(1,2)                                             00008530
      MAT2Z(2,1)=MAT2P(2,1)                                             00008540
      MAT2Z(2,2)=MAT2P(2,2)                                             00008550
C                                                                       00008560
      DO 256 L=1,2                                                      00008570
        DO 257 J=1,2                                                    00008580
          MAT1P(L,J)=MATP(L,J)                                          00008590
          MAT1Z(L,J)=MATZ(L,J)                                          00008600
  257 CONTINUE                                                          00008610
  256 CONTINUE                                                          00008620
C                                                                       00008630
      CALL MATMLT(MAT1P,MAT2P,MATP)                                     00008640
```

```
      CALL MATMLT(MAT1Z,MAT2Z,MATZ)                                    00008650
C                                                                      00008660
C     CALCULATE PERFORMANCE OF CASCADED PARAMETERS                     00008670
C                                                                      00008680
C                                                                      00008690
      TP=1./MATP(2,2)                                                  00008700
      TPMAG(K)=CABS(TP)                                                00008710
      REFP=CABS(MATP(1,2)/MATP(2,2))                                   00008720
      IF(REFP.EQ.1.) REFP=.9999                                        00008730
      VSWRP(K)=(1.+REFP)/(1.-REFP)                                     00008740
      ZILP(K)=10.*ALOG10(TPMAG(K)**2)                                  00008750
C                                                                      00008760
      TZ=1./MATZ(2,2)                                                  00008770
      TZMAG(K)=CABS(TZ)                                                00008780
      REFZ=CABS(MATZ(1,2)/MATZ(2,2))                                   00008790
      IF(REFZ.EQ.1.) REFZ=.9999                                        00008800
      VSWRZ(K)=(1.+REFZ)/(1.-REFZ)                                     00008810
      ZILZ(K)=10.*ALOG10(TZMAG(K)**2)                                  00008820
C                                                                      00008830
C                                                                      00008840
C**  CALCULATE PARAMETERS OF AN EQUIVALENT LENGTH OF DIELECTRIC        00008850
C     (RECALL MAT2 IS THE SECOND INTERFACE TRANFORMER MATRIX)          00008860
C                                                                      00008870
      MAT1P(1,1)=CEXP(-CJ*THETAD)                                      00008880
      MAT1P(1,2)=(0.,0.)                                               00008890
      MAT1P(2,1)=(0.,0.)                                               00008900
      MAT1P(2,2)=1./MAT1P(1,1)                                         00008910
C                                                                      00008920
      CALL MATMLT(MAT1P,MAT2P,MATP)                                    00008930
C                                                                      00008940
      MAT1P(1,1)=TN11                                                  00008950
      MAT1P(1,2)=TN12                                                  00008960
      MAT1P(2,1)=TN21                                                  00008970
      MAT1P(2,2)=TN22                                                  00008980
      DO 258 L=1,2                                                     00008990
        DO 259 J=1,2                                                   00009000
          MAT2P(L,J)=MATP(L,J)                                         00009010
  259 CONTINUE                                                         00009020
  258 CONTINUE                                                         00009030
C                                                                      00009040
      CALL MATMLT(MAT1P,MAT2P,MATP)                                    00009050
C                                                                      00009060
C**** CALCULATE PERFORMANCE OF PARAMETERS IN EQUIVALENT SLAB           00009070
C     OF DIELECTRIC.                                                   00009080
C                                                                      00009090
C                                                                      00009100
      TD=1./MATP(2,2)                                                  00009110
C                                                                      00009120
C** PUT PERFORMANCE RESULTS IN PROPER ARRAYS DEPENDING WHETHER         00009130
C   IT IS 'ON' OR 'OFF'.                                               00009140
C                                                                      00009150
      PHASEP(K)=ATAN2(AIMAG(TP),REAL(TP))-ATAN2(AIMAG(TD),             00009160
     |REAL(TD))                                                       00009170
      PHASEZ(K)=ATAN2(AIMAG(TZ),REAL(TZ))-ATAN2(AIMAG(TD),             00009180
     |REAL(TD))                                                       00009190
      IF(PHASEP(K).GT.0) PHASEP(K)=PHASEP(K)-2.*PI                     00009200
      IF(PHASEZ(K).GT.0) PHASEZ(K)=PHASEZ(K)-2.*PI                     00009210
C                                                                      00009220
C                                                                      00009230
  201 CONTINUE                                                         00009240
```

```
C                                                                       00009250
  302 FORMAT(5X,F8.3,5X,F7.3,4X,F8.2,3X,F10.5,3X,F10.5)'                00009260
C                                                                       00009270
C                                                                       00009280
C***********************************************************************00009290
C      PRINT OUT RESPONSE FOR EACH FREQUENCY IF THE PRINT     *         00009300
C      COUNTER IS ON.                                         *         00009310
C***********************************************************************00009320
C                                                                       00009330
C                                                                       00009340
      IF (IPRINT.EQ.1) THEN                                             00009350
      RMS=0.0                                                           00009360
C                                                                       00009370
       WRITE(9,300)                                                     00009380
  300 FORMAT(//10X,'       "ON DESIGN RESPONSE  "  ')                   00009390
       WRITE(9,301)                                                     00009400
  301 FORMAT(/6X,'FREQ GHZ',6X,'VSWR',5X,'PHASE DEG',7X,                00009410
     |'TMAG',5X,'I.L. DB',/)                                           00009420
C                                                                       00009430
       DO 514 K=1,NF                                                    00009440
       PHASEW=PHASEP(K)*RTD                                             00009450
       WRITE(9,302) FRE(K),VSWRP(K),PHASEW,TPMAG(K),ZILP(K)             00009460
  514  CONTINUE                                                         00009470
C                                                                       00009480
C                                                                       00009490
       WRITE(9,303)                                                     00009500
  303 FORMAT(//10X,'       "OFF DESIGN RESPONSE  "  ')                  00009510
       WRITE(9,301)                                                     00009520
C                                                                       00009530
       DO 515 K=1,NF                                                    00009540
       PHASEW=PHASEZ(K)*RTD                                             00009550
       WRITE(9,302) FRE(K),VSWRZ(K),PHASEW,TZMAG(K),ZILZ(K)             00009560
  515 CONTINUE                                                          00009570
C                                                                       00009580
      WRITE(9,315)                                                      00009590
  315 FORMAT(/)                                                         00009600
C                                                                       00009610
      DO 512 K=1,NF                                                     00009620
        PHASEI=PHASEP(K)-PHASEZ(K)                                      00009630
        PHASEI=PHASEI*RTD                                               00009640
        IF((K.GT.8).AND.(K.LT.14)) RMS=RMS+(DPHAZ+PHASEI)**2            00009650
        WRITE(12,311) FRE(K), PHASEI                                    00009660
        WRITE(9,311) FRE(K), PHASEI                                     00009670
  512 CONTINUE                                                          00009680
  311 FORMAT(5X,F8.3,5X,F9.3)                                           00009690
C                                                                       00009700
       RMS=RMS/5                                                        00009710
       RMS=SQRT(RMS)                                                    00009720
       WRITE(9,314) RMS                                                 00009730
  314  FORMAT(/5X,'RMS PHASE ERROR = ',F7.3)                            00009740
       ENDIF                                                            00009750
C                                                                       00009760
      RETURN                                                            00009770
      END                                                               00009780
C                                                                       00009790
C                                                                       00009800
C***********************************************************************00009810
      SUBROUTINE MATMLT(MAT1,MAT2,MAT)                                  00009820
C***********************************************************************00009830
C*                                                                      00009840
```

```
C* THIS SUBROUTINE MULTIPLIES TWO TWO-BY-TWO COMPLEX MATRICES.          00009850
C*                                                                     00009860
C*********************************************************************00009870
      DIMENSION MAT1(2,2),MAT2(2,2),MAT(2,2)                           00009880
      COMPLEX MAT1,MAT2,MAT                                            00009890
      MAT(1,1)=MAT1(1,1)*MAT2(1,1)+MAT1(1,2)*MAT2(2,1)                 00009900
      MAT(1,2)=MAT1(1,1)*MAT2(1,2)+MAT1(1,2)*MAT2(2,2)                 00009910
      MAT(2,1)=MAT1(2,1)*MAT2(1,1)+MAT1(2,2)*MAT2(2,1)                 00009920
      MAT(2,2)=MAT1(2,1)*MAT2(1,2)+MAT1(2,2)*MAT2(2,2)                 00009930
      RETURN                                                           00009940
      END                                                              00009950
C                                                                      00009960
C                                                                      00009970
C*********************************************************************00009980
      SUBROUTINE INTERP(X1,X2,X3,X4,Y1,Y2,Y3,Y4,X,Y)                   00009990
C*********************************************************************00010000
C*********************************************************************00010010
C*                                                                     00010020
C*  THIS SUBROUTINE INTERPOLATES AMONG FOUR DAA POINTS USING           00010030
C*  CUBIC APPROXIMATION. IT IS SPECIALIZED IN THAT THE INTERVAL        00010040
C*  BETWEEN POINTS X1 AND X2 IS 0.2 WHILE BETWEEN REMAINING            00010050
C*  POINTS IT IS 0.1.                                                  00010060
C*                                                                     00010070
C*********************************************************************00010080
C                                                                      00010090
      DELTA=.1000                                                      00010100
      A=(-2.*Y1-6.*Y4-24.*Y2+32.*Y3)/2.4                               00010110
      B=(Y1+Y4-2.*Y2)/.08                                              00010120
      C=(3.*Y4-Y1+6.*Y2-8.*Y3)/.024                                    00010130
      Z=X-X2                                                           00010140
      Y=Y2+A*Z+B*Z**2+C*Z**3                                           00010150
      RETURN                                                           00010160
      END                                                              00010170
C                                                                      00010180
C                                                                      00010190
C*********************************************************************00010200
      SUBROUTINE GNTERP(X1,X2,X3,X4,Y1,Y2,Y3,Y4,X,Y)                   00010210
C*********************************************************************00010220
C*********************************************************************00010230
C*                                                                     00010240
C*  THIS SUBROUTINE INTERPOLATES AMONG FOUR DATA POINTS                00010250
C*  USING CUBIC APPROXIMATION. IT IS A GENERAL INTERPOLATION           00010260
C*  ROUTINE.                                                           00010270
C*  THE INTERPOLATED VALUES IS CALCULATED IN REFERENCE TO THE          00010280
C*  TO THE Y2 VALUE.                                                   00010290
C*                                                                     00010300
C*********************************************************************00010310
C                                                                      00010320
      D1=X1-X2                                                         00010330
      D2=X3-X2                                                         00010340
      D3=X4-X2                                                         00010350
      D12=D1**2                                                        00010360
      D22=D2**2                                                        00010370
      D32=D3**2                                                        00010380
      D13=D1**3                                                        00010390
      D23=D2**3                                                        00010400
      D33=D3**3                                                        00010410
C                                                                      00010420
      DEN=D1*(D22*D33-D23*D32)-D12*(D2*D33-D23*D3)                     00010430
     |+D13*(D2*D32-D22*D3)                                            00010440
```

```
C                                                                       00010450
      A=(Y1*(D22*D33-D32*D23)-Y3*(D12*D33-D13*D32)                      00010460
     |+Y4*(D12*D23-D22*D13)-Y2*((D22*D33-D32*D23)                      00010470
     |-D12*(D33-D23)+D13*(D32-D22)))/DEN                               00010480
C                                                                       00010490
      B=(-Y1*(D2*D33-D23*D3)+Y3*(D1*D33-D3*D13)                         00010500
     |-Y4*(D1*D23-D13*D2)+Y2*((D2*D33-D3*D23)                          00010510
     |-D1*(D33-D23)+D13*(D3-D2)))/DEN                                  00010520
C                                                                       00010530
      C=(Y1*(D2*D32-D3*D22)-Y3*(D1*D32-D12*D3)                          00010540
     |+Y4*(D1*D22-D2*D12)-Y2*((D2*D32-D3*D22)                          00010550
     |-D1*(D32-D22)+D12*(D3-D2)))/DEN                                  00010560
C                                                                       00010570
      Z=X-X2                                                            00010580
      Y=Y2+A*Z+B*Z**2+C*Z**3                                            00010590
      RETURN                                                            00010600
      END                                                               00010610
```

```
C          LAGRAN - ONE- AND TWO-DIMENSIONAL INTERPOLATION                31791500
      SUBROUTINE LAGRAN(XA,YA,TABX,TABY,TABZ,IDX,IDY,KX,KY,NR,ANS)        31791501
C          ONE- AND TWO-DIMENSIONAL INTERPOLATION                         31791502
C   WHERE Z IS A FUNCTION OF X AND Y.                                     31791503
C        KX IS THE LENGTH OF THE X TABLE.                                 31791504
C        KY IS THE LENGTH OF THE Y TABLE                                  31791505
C        TABZ IS AN ARRAY WHICH HAS NR ROWS.  IF TABX HAS 2 DIMENSIONS,   31791506
C           IT ALSO HAS NR ROWS                                           31791507
C   LAGRA1 SEARCHES VARIABLE TABLE FOR STARTING VALUE FOR INTERPOLATION   31791508
C   LAGRA2 DOES THE INTERPOLATION. GIVEN THE LOCATIONS FOR STARTING AND   31791509
C           THE DEGREE.                                                   31791510
      DIMENSION TABX(1),TABY(1),TABZ(1),NPX(8),NPZ(8),YY(8)               31791511
      NY=KY                                                               31791512
      NZ=IABS(NY*KX)                                                      31791513
      IF(NY.EQ.0) NZ=KX                                                   31791514
      IDX1=IDX                                                            31791515
      IDY1=IDY                                                            31791516
COMMENT - IF IDX OR IDY IS GREATER THAN 7. THEN SET TO 7.                 31791517
      IF (IDX1.GT.7) IDX1=7                                               31791518
      IF (IDY1.GT.7) IDY1=7                                               31791519
      IF (NY-1)  5,5,10                                                   31791520
    5 CALL LAGRA1(XA,TABX,1,NZ ,IDX1,NN)                                  31791521
      CALL LAGRA2(XA,TABX(NN),TABZ(NN),IDX1,ANS)                          31791522
      RETURN                                                              31791523
   10 CALL LAGRA1(YA,TABY,1,NY,IDY1,NPY)                                  31791524
      NX=IABS(KX)                                                         31791525
      NPYL=NPY+IDY1                                                       31791526
      I=1                                                                 31791527
      IF(KX) 40,30,30                                                     31791528
   30 CALL LAGRA1(XA,TABX,1,NX,IDX1,NPX)                                  31791529
      DO 35 JJ=NPY,NPYL                                                   31791530
      NPZ(I)=(JJ-1)*NR+NPX(1)                                             31791531
      NPX(I)= NPX(1)                                                      31791532
   35 I=I+1                                                               31791533
      GO TO 50                                                            31791534
   40 DO 45 JJ=NPY,NPYL                                                   31791535
      IS = (JJ-1)*NR+1                                                    31791536
      CALL LAGRA1(XA,TABX,IS,NX,IDX1,NPX(I))                              31791537
      NPZ(I) = NPX(I)                                                     31791538
   45 I=I+1                                                               31791539
   50 IDY2 = IDY1+1                                                       31791540
      DO 55 I=1,IDY2                                                      31791541
      NLOC = NPX(I)                                                       31791542
      NLOCZ= NPZ(I)                                                       31791543
   55 CALL LAGRA2(XA,TABX(NLOC),TABZ(NLOCZ),IDX1,YY(I))                   31791544
      CALL LAGRA2(YA,TABY(NPY),YY,IDY1,ANS)                               31791545
      RETURN                                                              31791546
      END                                                                 31791547
```

```
C          LAGRA1 - CALLED BY LAGRAN                                    31791100
      SUBROUTINE LAGRA1(XA,TAB,I,NX,ID,NPX)                             31791101
      DIMENSION TAB(1)                                                  31791102
      NPT=ID+1                                                          31791103
      NPB=NPT/2                                                         31791104
      NPU=NPT-NPB                                                       31791105
      IF (NX-NPT)   10,5,10                                             31791106
    5 NPX=I                                                             31791107
      RETURN                                                            31791108
   10 NLOW=I+NPB                                                        31791109
      NUPP=I+NX-(NPU+1)                                                 31791110
      DO 15 II=NLOW,NUPP                                                31791111
      NLOC=II                                                           31791112
      IF (TAB(II).GE.XA) GO TO 20                                       31791113
   15 CONTINUE                                                          31791114
      NL = NUPP-NPB + 1                                                 31791115
      GO TO 22                                                          31791116
   20 NL=NLOC-NPB                                                       31791117
   22 NU = NL + ID                                                      31791118
      DO 25 JJ=NL,NU                                                    31791119
      NDIS=JJ                                                           31791120
      IF (TAB(JJ).EQ.TAB(JJ+1)) GO TO 30                                31791121
   25 CONTINUE                                                          31791122
      NPX=NL                                                            31791123
      RETURN                                                            31791124
   30   IF (TAB(NDIS) - XA) 40,351,35                                   31791125
   35 NPX=NDIS-ID                                                       31791126
      RETURN                                                            31791127
   40 NPX=NDIS+1                                                        31791128
      RETURN                                                            31791129
  351  NPX = NDIS                                                       31791130
      ID = 1                                                            31791131
      RETURN                                                            31791132
      END                                                               31791133
```

```
C          LAGRA2 - CALLED BY LAGRAN                                    31791209
      SUBROUTINE LAGRA2(XA,X,Y,N,ANS)                                   31791201
      DIMENSION X(1),Y(1)                                               31791202
      IF (XA.EQ.X(1) .AND. X(1).EQ.X(2)) GO TO 5                        31791203
      N1 = N+1                                                          31791204
      SUM=0.0                                                           31791205
       DO 3 I=1,N1                                                      31791206
      PROD=Y(I)                                                         31791207
      DO 2 J=1,N1                                                       31791208
      A=X(I)-X(J)                                                       31791209
      IF (A)    1,2,1                                                   31791210
    1 B=(XA-X(J))/A                                                     31791211
      PROD=PROD*B                                                       31791212
    2 CONTINUE                                                          31791213
    3 SUM=SUM+PROD                                                      31791214
      ANS=SUM                                                           31791215
      RETURN                                                            31791216
    5 ANS = .5*(Y(1)+Y(2))                                              31791217
      RETURN                                                            31791218
      END                                                               31791219
```

```
**** TSO FOREGROUND HARDCOPY ****
DSNAME=EGA7476.DPSYN15.DATA

 DPSYN15.DATA                                                                  00000010
   22.50          (BIT SIZE)                                                   00000020
   200  4   1     (MAX. # OF ITERATIONS, VALUES FOR OPT. ROUTINE)              00000030
   0.   0.        (TWO VALUES USED FOR OPTIMIZATION ROUTINE)                   00000040
   5    21        (NUMBER OF PATCHES + 1, NUMBER OF FREQUENCIES)               00000050
   .0600  .1500   (MIN. SPACE BETWEEN PATCHES, MAX. WIDTH OF PATCHES)         00000060
   0.28000  (INITIAL GUESS,DIELECTRIC AFTER END PATCHES,TO BE OPTIMIZED       00000070
   0.06000  0.03500   FIRST AND LAST PATCH: HEIGHT, WIDTH                     00000080
   0.10000            SEPARATION BETWEEN FIRST AND SECOND PATCHES            00000090
   0.05100  0.05500   2ND AND NEXT TO LAST PATCH: HEIGHT, WIDTH               00000100
   0.10000            SEPARATION BETWEEN SECOND AND THIRD PATCHES            00000110
   0.0000             END LENGTH (NOT AN OPTIMIZED VALUE)                    00000130
  0.00    1.00     -22.500    0.10    0.0      5.689     5.127               00000140
  1.00    1.00     -22.500    0.10    0.0      5.778     5.214               00000150
  2.00    1.00     -22.500    1.00    0.0      5.862     5.301               00000160
  3.00    1.00     -22.500    0.10    0.0      5.947     5.388               00000170
  4.00    1.00     -22.500    1.00    0.0      6.030     5.473               00000180
  5.00    1.00     -22.500    0.10    0.0      6.113     5.557               00000190
  6.00    1.00     -22.500    1.00    0.0      6.198     5.642               00000200
  7.00    1.00     -22.500    0.10    0.0      6.279     5.724               00000210
  8.00    1.00     -22.500    1.00    0.0      6.360     5.807               00000220
  9.00    1.00     -22.500    0.10    0.0      6.441     5.888               00000230
  10.00   1.00     -22.500    1.00    0.0      6.523     5.969               00000240
  11.00   1.00     -22.500    0.10    0.0      6.602     6.050               00000250
  12.00   1.00     -22.500    1.00    1.0      6.681     6.129               00000260
  13.00   1.00     -22.500    0.10    1.0      6.760     6.209               00000270
  14.00   1.00     -22.500    1.00    1.0      6.840     6.288               00000280
  15.00   1.00     -22.500    0.10    1.0      6.917     6.366               00000290
  16.00   1.00     -22.500    1.00    1.0      6.995     6.443               00000300
  17.00   1.00     -22.500    0.10    1.0      7.072     6.520               00000310
  18.00   1.00     -22.500    1.00    1.0      7.150     6.597               00000320
  19.00   1.00     -22.500    0.10    0.0      7.226     6.673               00000330
  20.00   1.00     -22.500    1.00    0.0      7.302     6.749               00000340
 (FREQ.  DESIRED   DESIRED     VSWR    PHASE     LOADED     UNLOADED  )      00000350
 (        VSWR     PHASE     WEIGHTS  WEIGHTS   GUIDE      GUIDE     )      00000360
 (                           (LETS US SPECIFY ) PROPAGATION PROPAGATION)     00000370
 (                           (IMPORTANT FREQS.)  CONSTANTS  CONSTANTS )      00000380
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```
**** TSO FOREGROUND HARDCOPY ****
DSNAME=EGA7476.DPOUT15B.DATA                    (B31A     )

                                                                    00000010
                                                                    00000020
 TIME    1440     DATE  10/31/87                                    00000030
                                                                    00000040
                                                                    00000050
     NAME OF PROGRAM USED IS DPSYN15.FORT                           00000060
                                                                    00000070
      DATA SET USED:    DPSYN1          (NAMES OF DATASETS USED.    00000080
                KTPAR                    ARE NOT WRITTEN OUT IN     00000090
               KTPARM                    THEIR ENTIRETY, BUT USED FOR 00000100
                KTPAR B                  BOOKKEEPING PURPOSES ONLY.) 00000110
                                                                    00000120
 22.5000000 (DESIRED PHASE SHIFT)                                   00000130
            "INPUT DATA"                                            00000140
                                                                    00000150
                                                                    00000160
       MAX=     200   NSIG=     4 IOPT =      1   (OPTIMIZATION    00000170
                                                    ROUTINE         00000180
       EPS=     0.000  DELTA=     0.000            PARAMETERS)     00000190
                                                                    00000200
         NUMBER OF VARIABLES =      5                               00000210
                                                                    00000220
         NUMBER OF FREQUENCIES =   21                               00000230
                        (INITIAL GUESS,                             00000240
  1           0.28000 DIELECTRIC BETWEEN END PATCHES ANDEND LENGTH  00000250
  2    0.06000 0.03500 FIRST AND LAST PATCH WIDTH & HEIGHT          00000260
  3           0.10000 SEPARATION BETWEEN FIRST AND SECOND PATCHES   00000270
  4    0.05100 0.05500 SECOND AND NEXT TO LAST PATCH, WIDTH & HEIGHT 00000280
  5           0.10000 SEPARATION BETWEEN SECOND AND THIRD PATCH     00000290
                                                                    00000300
 (DESIRED RESPONSE AND INFORMATION ABOUT WAVEGUIDE AND DIELECTRIC)  00000310
 FREQ     VSWR      RELATIVE PHASE.      WM      WP      ZKG2 RAD/IN 00000320
                                                                    00000330
 0.000   1.000        -22.500          0.100     0.000     5.689    00000340
 1.000   1.000        -22.500          0.100     0.000     5.778    00000350
 2.000   1.000        -22.500          1.000     0.000     5.862    00000360
 3.000   1.000        -22.500          0.100     0.000     5.947    00000370
 4.000   1.000        -22.500          1.000     0.000     6.030    00000380
 5.000   1.000        -22.500          0.100     0.000     6.113    00000390
 6.000   1.000        -22.500          1.000     0.000     6.198    00000400
 7.000   1.000        -22.500          0.100     0.000     6.279    00000410
 8.000   1.000        -22.500          1.000     0.000     6.360    00000420
 9.000   1.000        -22.500          0.100     0.000     6.441    00000430
10.000   1.000        -22.500          1.000     0.000     6.523    00000440
11.000   1.000        -22.500          0.100     0.000     6.602    00000450
12.000   1.000        -22.500          1.000     1.000     6.681    00000460
13.000   1.000        -22.500          0.100     1.000     6.760    00000470
14.000   1.000        -22.500          1.000     1.000     6.840    00000480
15.000   1.000        -22.500          0.100     1.000     6.917    00000490
16.000   1.000        -22.500          1.000     1.000     6.995    00000500
17.000   1.000        -22.500          0.100     1.000     7.072    00000510
18.000   1.000        -22.500          1.000     1.000     7.150    00000520
19.000   1.000        -22.500          0.100     0.000     7.226    00000530
20.000   1.000        -22.500          1.000     0.000     7.302    00000540
                                                                    00000550
      **********  "OUTPUT DATA " **********                         00000560
```

```
**********************************************************************  00000570
                                                                        00000580
     VALUE NOT OPTIMIZED                                                00000590
      NUMBER OF TRIPS THRU OPTIMIZATION ROUTINE =  203  EXCEEDS MAX     00000600
                                                                        00000610
**********************************************************************  00000620
                                                                        00000630
                                                                        00000640
                                                                        00000650
                                                                        00000660
                                                                        00000670
    THE FINAL VALUE OF SSQ IS     0.63229E-01 (VALUE FROM OPTIMIZATION  00000680
                                              ROUTINE: SUM OF SQUARES   00000690
                                    OF RESIDUALS OF FINAL RESPONSE)     00000700
   INFER = 0 (FLAG:INDICATES WHAT OPTIMIZATION CRITERIA WAS MET)        00000710
                                                                        00000720
     (FINAL DESIGN THE PROGRAM USED- WHETHER OPTIMIZED OR NOT)          00000730
       LINE LENGTH  1  = 0.27879 INCHES (SEPARATION BETWEEN END PATCH   00000740
                                         AND END LENGTH)                00000750
       DESIGN VALUES FOR PATCH   1:                                     00000760
        PATCH LENGTH = 0.05730 INCHES  PATCH HEIGHT = 0.03500 INCHES    00000770
        LINE LENGTH  2  = 0.09096 INCHES (SEPARATION BETWEEN FIRST AND  00000780
              SECOND PATCHES AND LAST AND NEXT TO LAST PATCHES)         00000790
       DESIGN VALUES FOR PATCH   2:                                     00000800
        PATCH LENGTH = 0.03954 INCHES  PATCH HEIGHT = 0.05500 INCHES    00000810
       LINE LENGTH   3  = 0.07650 INCHES (SEPARATION BETWEEN SECOND AND 00000820
              THIRD PATCHES AND NEXT TO AND THIRD TO LAST PATCHES)       00000830
       END LENGTH  = 0.00000 INCHES (EXTRA DIELECTRIC AT EDGE OF PATCH, 00000840
                                     NOT AN OPTIMIZED VALUE)            00000850
                                                                        00000860
     TOTAL LENGTH OF BIT    1.00966 INCHES                              00000870
                                                                        00000880
      (PERFORMANCE OF ABOVE LISTED FINAL DESIGN)                        00000890
              "ON DESIGN RESPONSE  "                                    00000900
                                                                        00000910
       FREQ        VSWR     PHASE DEG       TMAG      I.L. DB         00000920
                                                                        00000930
       0.000       1.173      -109.13       0.96119     -0.34381       00000940
       1.000       1.132      -111.08       0.93257     -0.60633       00000950
       2.000       1.082      -112.47       0.90499     -0.86716       00000960
       3.000       1.069      -115.28       0.92330     -0.69313       00000970
       4.000       1.065      -116.78       0.91213     -0.79890       00000980
       5.000       1.066      -119.80       0.89745     -0.93983       00000990
       6.000       1.049      -121.34       0.85551     -1.35547       00001000
       7.000       1.054      -121.25       0.86994     -1.21024       00001010
       8.000       1.038      -121.85       0.85101     -1.40128       00001020
       9.000       1.056      -123.26       0.90097     -0.90575       00001030
      10.000       1.065      -126.70       0.92141     -0.71096       00001040
      11.000       1.076      -130.83       0.95560     -0.39450       00001050
      12.000       1.043      -134.46       0.89920     -0.92290       00001060
      13.000       1.021      -137.24       0.88988     -1.01337       00001070
      14.000       1.012      -139.61       0.87240     -1.18569       00001080
      15.000       1.012      -139.96       0.87866     -1.12359       00001090
      16.000       1.014      -143.95       0.88743     -1.03735       00001100
      17.000       1.019      -146.15       0.90838     -0.83463       00001110
      18.000       1.031      -151.16       0.95065     -0.43962       00001120
      19.000       1.011      -153.75       0.92389     -0.68756       00001130
      20.000       1.011      -160.99       0.91293     -0.79122       00001140
                                          (TRANSMISSION) (INSERTION)    00001150
                                          (COEFFICIENTS) (  LOSS   )    00001160
```

"OFF DESIGN RESPONSE"

FREQ	VSWR	PHASE DEG	TMAG	I.L. DB
0.000	1.041	-92.25	0.95466	-0.40298
1.000	1.030	-93.78	0.94397	-0.50081
2.000	1.041	-95.06	0.92523	-0.67504
3.000	1.051	-97.48	0.95004	-0.44516
4.000	1.057	-98.30	0.94030	-0.53463
5.000	1.057	-100.80	0.93631	-0.57158
6.000	1.060	-102.48	0.91058	-0.81365
7.000	1.072	-103.36	0.93175	-0.61397
8.000	1.080	-105.17	0.90025	-0.91274
9.000	1.070	-106.35	0.91796	-0.74355
10.000	1.053	-108.45	0.90414	-0.87529
11.000	1.047	-109.73	0.92286	-0.69732
12.000	1.048	-111.48	0.89256	-0.98723
13.000	1.042	-113.16	0.92300	-0.69593
14.000	1.031	-116.45	0.93089	-0.62201
15.000	1.038	-117.79	0.94225	-0.51664
16.000	1.036	-123.67	0.91226	-0.79763
17.000	1.056	-125.19	0.87684	-1.14156
18.000	1.062	-126.64	0.86768	-1.23284
19.000	1.078	-125.23	0.84591	-1.45352
20.000	1.096	-128.09	0.86167	-1.29319
			(TRANSMISSION)	(INSERTION)
			(COEFFICIENTS)	(LOSS)
0.000	-16.873			
1.000	-17.299			
2.000	-17.416			
3.000	-17.792			
4.000	-18.484			
5.000	-18.997			
6.000	-18.865	(ON DESIGN PHASES - OFF DESIGN PHASES,		
7.000	-17.891			
8.000	-16.677	DIFFERENTIAL PHASE SHIFT OF THE		
9.000	-16.917			
10.000	-18.251	PHASE SHIFTER)		
11.000	-21.108			
12.000	-22.981			
13.000	-24.087			
14.000	-23.155			
15.000	-22.166			
16.000	-20.282			
17.000	-20.964			
18.000	-24.524			
19.000	-28.522			
20.000	-32.905			

(RMS PHASE ERROR BETWEEN ACTUAL AND)

RMS PHASE ERROR = 4.130 (DESIRED PHASE SHIFT)

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**** TSO FOREGROUND HARDCOPY ****
DSNAME=EGA7476.KTPARM.H040F.DATA

 KTPARM.H040F.DATA                                                    00000010
 0.040   4          21 (PATCH HEIGHT,# OF WIDTHS, # OF FREQS.)        00000020
0.368999988E-01 (PATCH 1 WIDTH)                                       00000030
0.000000000E+00   1.07201385      -38.3371124       0.484068751       00000040
-92.8164062       0.484068751      87.1835785        1.15054512        00000050
 37.2686615                                                           00000060
 1.00000000        1.07613182      -38.6893311       0.488964319       00000070
-92.8782654       0.488964200      87.1217804        1.15051365        00000080
 37.5795288                                                           00000090
 2.00000000        1.07729626      -39.4162598       0.499973059       00000100
-92.8003998       0.499972939      87.1995850        1.15939426        00000110
 38.2970581                                                           00000120
 3.00000000        1.08164883      -39.7025146       0.506505251       00000130
-92.7762451       0.506505370      87.2237396        1.16080379        00000140
 38.5697174                                                           00000150
 4.00000000        1.08338547      -40.4589691       0.519275188       00000160
-92.6698608       0.519275188      87.3301239        1.17107010        00000170
 39.3256836                                                           00000180
 5.00000000        1.09346771      -40.8016052       0.527177930       00000190
-92.8230743       0.527178049      87.1769104        1.16771698        00000200
 39.5746307                                                           00000210
 6.00000000        1.09803486      -41.5631714       0.537761331       00000220
-92.6440735       0.537761211      87.3559113        1.17321587        00000230
 40.3777313                                                           00000240
 7.00000000        1.10209942      -42.2617950       0.549344420       00000250
-92.6403046       0.549344420      87.3596954        1.18028450        00000260
 41.0383759                                                           00000270
 8.00000000        1.11122704      -43.2807159       0.561148643       00000280
-92.6409607       0.561148643      87.3590393        1.18235588        00000290
 42.0165405                                                           00000300
 9.00000000        1.10994720      -43.5028381       0.572010994       00000310
-92.6557617       0.572011113      87.3442230        1.19477081        00000320
 42.1941071                                                           00000330
 10.0000000        1.11670685      -44.0502777       0.582364678       00000340
-92.5008545       0.582364559      87.4991302        1.19832516        00000350
 42.7841492                                                           00000360
 11.0000000        1.12170792      -45.0157623       0.596101165       00000370
-92.4870300       0.596101046      87.5129089        1.20739555        00000380
 43.7122955                                                           00000390
 12.0000000        1.13135719      -45.4631348       0.605007648       00000400
-92.4376373       0.605007648      87.5623474        1.20656872        00000410
 44.1573792                                                           00000420
 13.0000000        1.13497829      -46.3733978       0.620248199       00000430
-92.4806824       0.620248079      87.5193024        1.21910572        00000440
 44.9956055                                                           00000450
 14.0000000        1.13955021      -47.0119629       0.637473822       00000460
-92.3965912       0.637473822      87.6033936        1.23325634        00000470
 45.6274719                                                           00000480
 15.0000000        1.14767456      -47.8366547       0.647913337       00000490
-92.5698700       0.647913456      87.4301147        1.23606110        00000500
 46.3175812                                                           00000510
 16.0000000        1.14967632      -48.3237915       0.662652493       00000520
-92.6798096       0.662652373      87.3201752        1.25058556        00000530
 46.6891022                                                           00000540
 17.0000000        1.15867805      -49.1332397       0.676642418       00000550
-92.7494202       0.676642418      87.2505646        1.25693989        00000560
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 47.4069366                                                          00000570
 18.0000000        1.16825008      -50.0372162       0.691932201     00000580
-92.8321381        0.691932082      87.1678467       1.26443768      00000590
 48.2040863                                                          00000600
 19.0000000        1.17320061      -50.5857849       0.705176592     00000610
-92.8562927        0.705176592      87.1436920       1.27481651      00000620
 48.6892395                                                          00000630
 20.0000000        1.17861271      -51.6273499       0.724487066     00000640
-93.1361694        0.724487066      86.8638153       1.29203510      00000650
 49.4692841                                                          00000660
0.568999983E-01  (PATCH 2 WIDTH)                                     00000670
0.000000000E+00   1.10764217      -48.5502930       0.570651650     00000680
-93.1407623        0.570651650      86.8592224       1.19547939      00000690
 47.0084534                                                          00000700
 1.00000000        1.10786533      -49.3395081       0.581374645     00000710
-93.1449127        0.581374645      86.8550720       1.20634365      00000720
 47.7518005                                                          00000730
 2.00000000        1.10881901      -49.7808380       0.593225360     00000740
-93.2081299        0.593225360      86.7918549       1.21776199      00000750
 48.1118927                                                          00000760
 3.00000000        1.11694527      -50.6323547       0.600007057     00000770
-93.3809662        0.600007057      86.6190186       1.21595573      00000780
 48.8438721                                                          00000790
 4.00000000        1.11839867      -50.9451904       0.610650897     00000800
-93.3392181        0.610650897      86.6607666       1.22589588      00000810
 49.1326752                                                          00000820
 5.00000000        1.12008095      -52.2113037       0.619301677     00000830
-93.7441711        0.619301677      86.2558136       1.23309135      00000840
 50.1373901                                                          00000850
 6.00000000        1.11708450      -52.9239960       0.632276058     00000860
-93.7246552        0.632276058      86.2753754       1.25089550      00000870
 50.7983856                                                          00000880
 7.00000000        1.12135410      -53.5942230       0.637489438     00000890
-94.7606049        0.637489319      85.2394409       1.25063038      00000900
 50.8467865                                                          00000910
 8.00000000        1.12312222      -54.0286102       0.648279309     00000920
-94.7827911        0.648279428      85.2171326       1.26089478      00000930
 51.2018585                                                          00000940
 9.00000000        1.13094521      -54.4190369       0.652149916     00000950
-94.9981384        0.652150035      85.0018463       1.25625515      00000960
 51.4404602                                                          00000970
 10.0000000        1.13859844      -55.1490631       0.660243511     00000980
-94.2461090        0.660243392      85.7538757       1.25819778      00000990
 52.5735474                                                          00001000
 11.0000000        1.14912701      -55.9123230       0.669672966     00001010
-93.9899445        0.669672847      86.0101013       1.25787163      00001020
 53.4437408                                                          00001030
 12.0000000        1.14918232      -57.0447540       0.686004519     00001040
-93.9875946        0.686004400      86.0123901       1.27699375      00001050
 54.4946442                                                          00001060
 13.0000000        1.15342236      -57.7484131       0.702278852     00001070
-93.7106171        0.702278852      86.2893677       1.29217243      00001080
 55.2987671                                                          00001090
 14.0000000        1.16354084      -58.4293518       0.719027042     00001100
-93.8527985        0.719027042      86.1471863       1.30112457      00001110
 55.8050079                                                          00001120
 15.0000000        1.16847324      -58.5811462       0.731852293     00001130
-93.7427979        0.731852293      86.2572479       1.31164646      00001140
 55.9717865                                                          00001150
 16.0000000        1.17556000      -59.6823425       0.746186018     00001160
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-94.0565491       0.746186137       85.9434357       1.32124710        00001170
 56.7824860                                                            00001180
 17.0000000       1.18172932       -60.5881958       0.758882880       00001190
-94.1417847       0.758882880       85.8582458       1.33031750        00001200
 57.5629120                                                            00001210
 18.0000000       1.19213009       -61.9169006       0.767692566       00001220
-94.9873657       0.767692685       85.0126190       1.32848835        00001230
 58.2212830                                                            00001240
 19.0000000       1.19714642       -62.5499878       0.790265679       00001250
-94.8148651       0.790265679       85.1851196       1.35245323        00001260
 58.8505402                                                            00001270
 20.0000000       1.20894051       -63.6775055       0.808117270       00001280
-94.9566040       0.808117151       85.0433807       1.36246204        00001290
 59.7637634                                                            00001300
0.795000196E-01 (PATCH 3 WIDTH)                                        00001310
0.000000000E+00   1.17616272       -74.0395660       0.754353762       00001320
-94.6714935       0.754353881       85.3285065       1.32993603        00001330
 70.6537628                                                            00001340
 1.00000000       1.18769836       -74.8052063       0.775029898       00001350
-94.4773407       0.775029778       85.5226440       1.34384251        00001360
 71.4469910                                                            00001370
 2.00000000       1.19831657       -75.4534607       0.794385076       00001380
-94.6138458       0.794385076       85.3861389       1.35692215        00001390
 71.8854370                                                            00001400
 3.00000000       1.21267796       -76.4683228       0.811089396       00001410
-94.5695190       0.811089277       85.4304657       1.36293983        00001420
 72.8437347                                                            00001430
 4.00000000       1.22086143       -76.7136688       0.830589056       00001440
-94.4184418       0.830589056       85.5815430       1.38018322        00001450
 73.1076508                                                            00001460
 5.00000000       1.23037815       -77.7945862       0.850322008       00001470
-94.5959167       0.850321889       85.4040680       1.39602375        00001480
 73.9389648                                                            00001490
 6.00000000       1.23742485       -78.2839508       0.870247126       00001500
-94.3517761       0.870247126       85.6482086       1.41612530        00001510
 74.5342865                                                            00001520
 7.00000000       1.25239944       -79.0970154       0.885111928       00001530
-94.7196808       0.885111809       85.2803040       1.41923523        00001540
 74.9517517                                                            00001550
 8.00000000       1.26252842       -79.6396637       0.907382607       00001560
-94.4864197       0.907382488       85.5135651       1.43980789        00001570
 75.5888214                                                            00001580
 9.00000000       1.27504063       -80.2937164       0.926771045       00001590
-94.7049866       0.926771164       85.2949982       1.45302391        00001600
 75.9466553                                                            00001610
 10.0000000       1.28732014       -80.9286499       0.950794816       00001620
-94.4894714       0.950794816       85.5105591       1.47451496        00001630
 76.6660156                                                            00001640
 11.0000000       1.30171871       -81.3357391       0.967951417       00001650
-94.5867920       0.967951417       85.4131927       1.48320961        00001660
 76.8986816                                                            00001670
 12.0000000       1.31161499       -82.2528381       0.989110589       00001680
-94.9473724       0.989110589       85.0526123       1.50269890        00001690
 77.3597412                                                            00001700
 13.0000000       1.32453823       -82.7575073       1.00297832        00001710
-94.7242126       1.00297832        85.2757721       1.50931168        00001720
 78.0192108                                                            00001730
 14.0000000       1.34516048       -83.5785980       1.02549553        00001740
-94.6689148       1.02549553        85.3310699       1.52013874        00001750
 78.7919464                                                            00001760
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 15.0000000      1.35621166     -83.6425934      1.04395952      00001770
-94.2453918      1.04395962      85.7545929      1.53672218      00001780
 79.2143402                                                      00001790
 16.0000000      1.36793613     -84.7750397      1.07049847      00001800
-94.2092743      1.07049847      85.7907104      1.56454849      00001810
 80.2789612                                                      00001820
 17.0000000      1.38004684     -85.0942993      1.09736252      00001830
-94.0625000      1.09736156      85.9374847      1.59321117      00001840
 80.6547852                                                      00001850
 18.0000000      1.39327717     -86.0137024      1.11769009      00001860
-94.7364502      1.11769009      85.2635345      1.60889530      00001870
 80.7512360                                                      00001880
 19.0000000      1.40998745     -85.9971466      1.14468098      00001890
-94.7321930      1.14467907      85.2678528      1.63302994      00001900
 80.6280212                                                      00001910
 20.0000000      1.42892647     -86.9983978      1.16487026      00001920
-95.1874084      1.16486835      84.8125763      1.64282799      00001930
 81.0233459                                                      00001940
0.979999900E-01 (PATCH 4 WIDTH)                                  00001950
0.000000000E+00  1.44391918     -82.5088806      1.21513081      00001960
-94.7879333      1.21512890      85.2120514      1.70938206      00001970
 76.7976532                                                      00001980
 1.00000000      1.45736694     -83.0041656      1.23048401      00001990
-94.6211090      1.23048306      85.3788757      1.71971321      00002000
 77.4361267                                                      00002010
 2.00000000      1.47058201     -84.2045288      1.25110817      00002020
-94.8072205      1.25110722      85.1927643      1.73854828      00002030
 78.3356934                                                      00002040
 3.00000000      1.48007393     -85.3547821      1.26360989      00002050
-95.0861664      1.26361084      84.9138184      1.74789715      00002060
 79.0969696                                                      00002070
 4.00000000      1.49568272     -86.4069061      1.29468250      00002080
-94.9937592      1.29468250      85.0062256      1.78292656      00002090
 80.1483765                                                      00002100
 5.00000000      1.51184368     -87.3374481      1.31681824      00002110
-95.1076355      1.31681728      84.8923492      1.80173302      00002120
 80.8552246                                                      00002130
 6.00000000      1.53209782     -88.1963043      1.35147858      00002140
-95.2121124      1.35147762      84.7878723      1.83787441      00002150
 81.4563293                                                      00002160
 7.00000000      1.54942703     -89.0031891      1.37168789      00002170
-95.3720398      1.37168789      84.6279449      1.85233116      00002180
 81.9833984                                                      00002190
 8.00000000      1.57092953     -90.6517334      1.39687252      00002200
-95.6836700      1.39687252      84.3163147      1.87038994      00002210
 83.1306610                                                      00002220
 9.00000000      1.58567905     -91.7125397      1.41890240      00002230
-95.9983978      1.41890240      84.0015869      1.89108753      00002240
 83.6903992                                                      00002250
 10.0000000      1.61427021     -92.7970123      1.45228481      00002260
-95.8650818      1.45228577      84.1349030      1.91723061      00002270
 84.8331757                                                      00002280
 11.0000000      1.64001274     -93.9783020      1.49191284      00002290
-95.8287964      1.49191380      84.1711884      1.95823765      00002300
 85.9279175                                                      00002310
 12.0000000      1.67667294     -94.9784698      1.53334999      00002320
-95.7068939      1.53334904      84.2931519      1.99040413      00002330
 86.9641876                                                      00002340
 13.0000000      1.70422935     -96.0380096      1.57785511      00002350
-95.7528992      1.57785511      84.2470856      2.03919601      00002360
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 87.8224945                                                          00002370
 14.0000000      1.73109055     -96.9580078      1.61836338          00002380
-95.8401031      1.61836243      84.1598816      2.08196831          00002390
 88.4978180                                                          00002400
 15.0000000      1.76580238     -98.7540283      1.66209030          00002410
-96.2736816      1.66209126      83.7263031      2.12082672          00002420
 89.5321808                                                          00002430
 16.0000000      1.79995251     -99.9273987      1.71286011          00002440
-96.5342712      1.71285915      83.4657135      2.17479324          00002450
 90.1703339                                                          00002460
 17.0000000      1.83444691    -101.388397       1.76252556          00002470
-96.9144592      1.76252556      83.0855255      2.22656059          00002480
 90.9143372                                                          00002490
 18.0000000      1.87169456    -102.942902       1.81471443          00002500
-97.2992554      1.81471348      82.7007294      2.28047180          00002510
 91.7297516                                                          00002520
 19.0000000      1.91666412    -104.124298       1.87114239          00002530
-97.5601044      1.87114048      82.4398804      2.33434677          00002540
 92.3464355                                                          00002550
 20.0000000      1.96065998    -106.002609       1.93336010          00002560
-98.1357574      1.93336105      81.8642883      2.40029907          00002570
 93.1444244                                                          00002580
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**** TSO FOREGROUND HARDCOPY ****
DSNAME=EGA7476.KTPARM.H040R.DATA

 KTPARM.H040R.DATA                                                      00000010
 0.040   4        21    (PATCH HEIGHT, # OF WIDTHS, # OF FREQS.)        00000020
0.368999988E-01 (PATCH 1 WIDTH)                                         00000030
0.000000000E+00   1.05675602      -34.7976532       0.414059997        00000040
-91.7373962       0.414059997      88.2625885        1.10827160         00000050
 34.2892914                                                             00000060
 1.00000000        1.06164074      -35.0312958       0.417894721        00000070
-91.6849976       0.417894721      88.3149872        1.10618496         00000080
 34.5304413                                                             00000090
 2.00000000        1.06208897      -35.7382660       0.426778316        00000100
-91.7100220       0.426778197      88.2899628        1.11276817         00000110
 35.2114868                                                             00000120
 3.00000000        1.06584835      -35.9733124       0.430783868        00000130
-91.6991577       0.430783987      88.3008270        1.11206532         00000140
 35.4415588                                                             00000150
 4.00000000        1.06580257      -36.7341614       0.440445065        00000160
-91.5010834       0.440445065      88.4989014        1.12006187         00000170
 36.2465210                                                             00000180
 5.00000000        1.07350349      -36.9595795       0.447251678        00000190
-91.5265350       0.447251678      88.4734497        1.11764622         00000200
 36.4508209                                                             00000210
 6.00000000        1.07581806      -37.5947266       0.455923915        00000220
-91.2778168       0.455923915      88.7221680        1.12258244         00000230
 37.1550293                                                             00000240
 7.00000000        1.07944965      -38.1111603       0.465561748        00000250
-91.2595062       0.465561748      88.7404785        1.12702942         00000260
 37.6625519                                                             00000270
 8.00000000        1.08817863      -38.9793396       0.473934770        00000280
-91.3086853       0.473934770      88.6912994        1.12520027         00000290
 38.4993744                                                             00000300
 9.00000000        1.08479404      -39.2260742       0.481974602        00000310
-91.3540344       0.481974602      88.6459503        1.13577843         00000320
 38.7157135                                                             00000330
 10.0000000        1.08985519      -39.7260895       0.489899397        00000340
-91.2581482       0.489899397      88.7418518        1.13759136         00000350
 39.2391663                                                             00000360
 11.0000000        1.09296417      -40.5290680       0.502062917        00000370
-91.3193359       0.502063036      88.6806488        1.14537144         00000380
 39.9979553                                                             00000390
 12.0000000        1.10062504      -40.8282623       0.507352710        00000400
-91.3153534       0.507352710      88.6845856        1.14225006         00000410
 40.2898102                                                             00000420
 13.0000000        1.10347462      -41.5166779       0.518161058        00000430
-91.2912598       0.518161178      88.7087250        1.14934254         00000440
 40.9701538                                                             00000450
 14.0000000        1.10760689      -42.1089783       0.530681014        00000460
-91.1594543       0.530681014      88.8405304        1.15694237         00000470
 41.5994873                                                             00000480
 15.0000000        1.11559582      -42.8882446       0.536291122        00000490
-91.2906494       0.536291242      88.7093353        1.15398026         00000500
 42.3117676                                                             00000510
 16.0000000        1.11444855      -43.3984070       0.548085809        00000520
-91.2559509       0.548085690      88.7439728        1.16665173         00000530
 42.8182373                                                             00000540
 17.0000000        1.11961079      -44.1172180       0.559865117        00000550
-91.2038879       0.559865117      88.7960968        1.17293453         00000560
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 43.5426941                                                          00000570
 18.0000000      1.12450600     -44.7078247      0.572804928         00000580
-91.1214294      0.572804928     88.8785553       1.18088341         00000590
 44.1538086                                                          00000600
 19.0000000      1.12777710     -44.9227600      0.583129644         00000610
-91.0405579      0.583129644     88.9594269       1.18805981         00000620
 44.3947601                                                          00000630
 20.0000000      1.13109493     -45.7351685      0.596016169         00000640
-91.1548157      0.596016169     88.8451691       1.19796562         00000650
 45.1298370                                                          00000660
0.568999983E-01  (PATCH 2 WIDTH)                                     00000670
0.000000000E+00  1.08244228     -44.3494263      0.485893965         00000680
-92.1045380      0.485893965     87.8955078       1.14146709         00000690
 43.5458984                                                          00000700
 1.00000000      1.08280849     -45.0120544      0.493376970         00000710
-92.1061249      0.493376970     87.8938599       1.14783287         00000720
 44.1878204                                                          00000730
 2.00000000      1.08323479     -45.4074097      0.501934171         00000740
-92.1306000      0.501934052     87.8693848       1.15522099         00000750
 44.5503387                                                          00000760
 3.00000000      1.09168720     -46.2220612      0.506956339         00000770
-92.2854004      0.506956339     87.7145844       1.15082741         00000780
 45.2880096                                                          00000790
 4.00000000      1.09155655     -46.5356903      0.515463352         00000800
-92.1347046      0.515463233     87.8652802       1.15899944         00000810
 45.6398621                                                          00000820
 5.00000000      1.09276867     -47.6131287      0.523119450         00000830
-92.4417877      0.523119450     87.5581970       1.16481018         00000840
 46.5644836                                                          00000850
 6.00000000      1.08884144     -48.2281342      0.532331467         00000860
-92.3885651      0.532331467     87.6114197       1.17795467         00000870
 47.1738586                                                          00000880
 7.00000000      1.09487152     -48.6742401      0.536829472         00000890
-93.1657257      0.536829591     86.8342590       1.17530823         00000900
 47.2590332                                                          00000910
 8.00000000      1.09470749     -49.1547546      0.544835210         00000920
-93.0077667      0.544835329     86.9922180       1.18349266         00000930
 47.7788544                                                          00000940
 9.00000000      1.09943962     -49.5700531      0.548637509         00000950
-93.3484497      0.548637509     86.6515350       1.18189144         00000960
 48.0220642                                                          00000970
 10.0000000      1.10272503     -50.2883911      0.556008339         00000980
-92.8367920      0.556008339     87.1631927       1.18613625         00000990
 48.9494781                                                          00001000
 11.0000000      1.10921955     -50.7721100      0.562263846         00001010
-92.7361450      0.562263846     87.2638397       1.18555355         00001020
 49.4584808                                                          00001030
 12.0000000      1.10920811     -51.6472015      0.573032856         00001040
-92.9043274      0.573032856     87.0956573       1.19643211         00001050
 50.2122803                                                          00001060
 13.0000000      1.11424637     -52.2423248      0.580833077         00001070
-92.6807861      0.580832958     87.3191986       1.19924736         00001080
 50.8905334                                                          00001090
 14.0000000      1.12422657     -53.0323792      0.591508508         00001100
-92.6871185      0.591508389     87.3128662       1.19970131         00001110
 51.6401520                                                          00001120
 15.0000000      1.12617683     -53.2796631      0.599484801         00001130
-92.3850708      0.599484801     87.6149139       1.20625877         00001140
 52.0191040                                                          00001150
 16.0000000      1.12923717     -54.4905548      0.612222791         00001160
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-92.3008575      0.612222791      87.6991730      1.21669197      00001170
 53.2364807                                                       00001180
 17.0000000      1.13036251       -55.0346527     0.626384258     00001190
-92.1132202      0.626384377      87.8868103      1.23109341      00001200
 53.8440247                                                       00001210
 18.0000000      1.13647747       -55.7345734     0.635529876     00001220
-92.7277222      0.635529995      87.2722626      1.23415279      00001230
 54.1658020                                                       00001240
 19.0000000      1.13744450       -55.8625336     0.649706841     00001250
-92.5870819      0.649706841      87.4129028      1.24920464      00001260
 54.3273315                                                       00001270
 20.0000000      1.14869690       -56.8183746     0.663136840     00001280
-92.9567261      0.663136840      87.0432587      1.25195408      00001290
 55.0130920                                                       00001300
0.795000196E-01  (PATCH 3 WIDTH)                                  00001310
0.000000000E+00  1.11934471       -65.7378845     0.577512980     00001320
-92.2146912      0.577512980      87.7852936      1.19067001      00001330
 64.6304626                                                       00001340
 1.00000000      1.12345028       -66.5186462     0.592034936     00001350
-92.1014252      0.592035055      87.8985596      1.20147800      00001360
 65.4282227                                                       00001370
 2.00000000      1.12986755       -67.0374756     0.610511541     00001380
-92.2816925      0.610511661      87.7183075      1.21417427      00001390
 65.7988586                                                       00001400
 3.00000000      1.14107037       -67.8626709     0.622475386     00001410
-92.4037476      0.622475505      87.5962372      1.21507168      00001420
 66.5205688                                                       00001430
 4.00000000      1.14409161       -68.0181732     0.636401415     00001440
-92.3430481      0.636401534      87.6569977      1.22720146      00001450
 66.6678162                                                       00001460
 5.00000000      1.15255928       -68.9052277     0.649614930     00001470
-92.4163208      0.649614930      87.5836639      1.23284912      00001480
 67.4716034                                                       00001490
 6.00000000      1.15688992       -69.4397888     0.664345384     00001500
-92.0232849      0.664345264      87.9766998      1.24521732      00001510
 68.2010040                                                       00001520
 7.00000000      1.16849709       -70.1064148     0.673700333     00001530
-92.3266602      0.673700333      87.6733246      1.24333191      00001540
 68.6542053                                                       00001550
 8.00000000      1.17254925       -70.7488861     0.691948295     00001560
-92.0591278      0.691948175      87.9408569      1.26045609      00001570
 69.4158478                                                       00001580
 9.00000000      1.17793560       -71.3119659     0.706416607     00001590
-92.3700409      0.706416607      87.6298828      1.27160931      00001600
 69.7344208                                                       00001610
 10.0000000      1.18454361       -71.9044952     0.725581884     00001620
-92.2178650      0.725581884      87.7821198      1.28777409      00001630
 70.3749695                                                       00001640
 11.0000000      1.19371986       -72.1102295     0.737496734     00001650
-92.3908081      0.737496734      87.6091766      1.29231834      00001660
 70.4261169                                                       00001670
 12.0000000      1.20049572       -72.8223724     0.752054930     00001680
-92.7902374      0.752054930      87.2097473      1.30268192      00001690
 70.8069763                                                       00001700
 13.0000000      1.21251297       -73.3068695     0.761035085     00001710
-92.5969696      0.761035204      87.4029694      1.30114651      00001720
 71.4024048                                                       00001730
 14.0000000      1.22785664       -74.1248627     0.776919603     00001740
-92.4838104      0.776919603      87.5161743      1.30486012      00001750
 72.2554016                                                       00001760
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 15.0000000      1.23228264     -74.2528839      0.787563086     00001770
-92.0897827      0.787563205     87.9101410      1.31400871      00001780
 72.6531372                                                      00001790
 16.0000000      1.23952579     -75.3640747      0.808238149     00001800
-92.0437775      0.808238149     87.9561615      1.33295918      00001810
 73.7491455                                                      00001820
 17.0000000      1.24495220     -75.6519318      0.827806115     00001830
-91.8858032      0.827806115     88.1141815      1.35296154      00001840
 74.1184692                                                      00001850
 18.0000000      1.25342369     -76.1730347      0.838870168     00001860
-92.3227692      0.838870168     87.6772156      1.35814762      00001870
 74.2544098                                                      00001880
 19.0000000      1.25881100     -76.1430969      0.855307817     00001890
-92.2855072      0.855307817     87.7144775      1.37446594      00001900
 74.2121277                                                      00001910
 20.0000000      1.27425861     -76.8550720      0.872279644     00001920
-92.4431000      0.872279644     87.5568848      1.38063335      00001930
 74.7439423                                                      00001940
0.979999900E-01  (PATCH 4 WIDTH)                                 00001950
0.000000000E+00  1.26707077     -71.3445282      0.877863765     00001960
-91.4052887      0.877863884     88.5946960      1.39701271      00001970
 70.1213226                                                      00001980
 1.00000000      1.27936459     -71.8614960      0.890374422     00001990
-91.2241516      0.890374303     88.7758331      1.40096664      00002000
 70.7788849                                                      00002010
 2.00000000      1.28116608     -72.9724731      0.900468469     00002020
-91.5364838      0.900468588     88.4635620      1.41292286      00002030
 71.5965424                                                      00002040
 3.00000000      1.28726387     -73.8887024      0.909137487     00002050
-91.8874512      0.909137487     88.1125336      1.41815186      00002060
 72.1806030                                                      00002070
 4.00000000      1.28767204     -74.7336731      0.922029853     00002080
-92.0242767      0.922029853     87.9757233      1.43591022      00002090
 72.8734589                                                      00002100
 5.00000000      1.29269028     -75.2501526      0.924271226     00002110
-92.0524139      0.924271226     87.9475708      1.43350792      00002120
 73.3591156                                                      00002130
 6.00000000      1.30055904     -75.9105377      0.940075159     00002140
-91.7856445      0.940075159     88.2143402      1.44769859      00002150
 74.2351837                                                      00002160
 7.00000000      1.31064701     -76.4864044      0.949341297     00002170
-91.6533051      0.949341297     88.3466797      1.45000553      00002180
 74.9191284                                                      00002190
 8.00000000      1.32077217     -77.7409821      0.962120652     00002200
-91.6208038      0.962120533     88.3791962      1.45740032      00002210
 76.1828766                                                      00002220
 9.00000000      1.32921505     -78.2962494      0.977228165     00002230
-91.7480621      0.977228165     88.2519226      1.47008038      00002240
 76.5885315                                                      00002250
 10.0000000      1.34395027     -78.9821014      0.994574070     00002260
-91.4822235      0.994574070     88.5177612      1.47959328      00002270
 77.5079803                                                      00002280
 11.0000000      1.35453796     -79.9187775      1.01349545      00002290
-91.4001007      1.01349545      88.5998840      1.49612331      00002300
 78.4999542                                                      00002310
 12.0000000      1.37195110     -80.7520599      1.02871227      00002320
-91.2942047      1.02871227      88.7057343      1.49984741      00002330
 79.4212036                                                      00002340
 13.0000000      1.38326645     -81.8353729      1.05168533      00002350
-91.2077026      1.05168533      88.7922821      1.52216911      00002360
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 80.5669250                                                          00002370
 14.0000000    1.39307880   -82.5740204    1.07233429              00002380
-91.2563934    1.07233334    88.7435455    1.54289913              00002390
 81.2300110                                                          00002400
 15.0000000    1.40877724   -83.9218140    1.09440517              00002410
-91.6311798    1.09440517    88.3688049    1.55938816              00002420
 82.1439362                                                          00002430
 16.0000000    1.42203999   -84.5310059    1.11514187              00002440
-91.8101349    1.11514187    88.1898499    1.57691193              00002450
 82.5243530                                                          00002460
 17.0000000    1.43387127   -85.4752655    1.12837696              00002470
-91.9772186    1.12837601    88.0228119    1.58444595              00002480
 83.2603760                                                          00002490
 18.0000000    1.44637012   -86.5740051    1.14016533              00002500
-91.8237915    1.14016628    88.1761932    1.58937836              00002510
 84.5122681                                                          00002520
 19.0000000    1.46254539   -87.5473785    1.16058636              00002530
-91.5643005    1.16058731    88.4357452    1.60412121              00002540
 85.7518616                                                          00002550
 20.0000000    1.47126102   -88.9119415    1.18925762              00002560
-91.3098297    1.18925858    88.6901550    1.64057636              00002570
 87.3773346                                                          00002580
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**** TSO FOREGROUND HARDCOPY ****
DSNAME=EGA7476.KTPARM.H050F.DATA

 KTPARM.H050F.DATA                                                        00000010
 0.050    6          21 (PATCH HEIGHT, # OF WIDTHS, # OF FREQS.)          00000020
 0.304999985E-01 (PATCH 1 WIDTH)                                          00000030
 0.000000000E+00   1.13277817      -41.7889099      0.630950212          00000040
 -92.9330597       0.630950212      87.0669250       1.23290062          00000050
  40.1195068                                                              00000060
  1.00000000       1.14323616      -42.0583496      0.637961745          00000070
 -92.8538971       0.637961745      87.1460876       1.22945213          00000080
  40.4081268                                                              00000090
  2.00000000       1.14435291      -42.9600983      0.648813009          00000100
 -93.0041504       0.648813009      86.9958344       1.24028492          00000110
  41.1811371                                                              00000120
  3.00000000       1.14766884      -43.5340881      0.657468915          00000130
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-95.1747894       1.65763283        84.8251953        2.09211540        00003490
 86.0309753                                                             00003500
 9.00000000       1.81636333       -94.6701813        1.70260811        00003510
-95.5597992       1.70260715        84.4401855        2.13882637        00003520
 86.3960876                                                             00003530
 10.0000000       1.83922291       -95.4232941        1.73525333        00003540
-95.6543274       1.73525524        84.3457184        2.17292786        00003550
 86.9270325                                                             00003560
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-95.8781891      1.77725315      84.1218367       2.21656799      00003580
 87.5871124                                                       00003590
 12.0000000      1.89715767     -97.4160156       1.80586529      00003600
-96.1057739      1.80586529      83.8942108       2.23692513      00003610
 88.0614014                                                       00003620
 13.0000000      1.93045044     -98.8671875       1.84926796      00003630
-96.2020569      1.84926701      83.7979431       2.28013420      00003640
 89.2602234                                                       00003650
 14.0000000      1.96430016     -100.133621       1.89445591      00003660
-96.6991730      1.89445686      83.3008118       2.32532120      00003670
 89.6431580                                                       00003680
 15.0000000      1.99534225     -102.104752       1.93512440      00003690
-97.2305603      1.93512440      82.7694702       2.36532784      00003700
 90.6767578                                                       00003710
 16.0000000      2.04780197     -102.655594       2.00655937      00003720
-96.9818420      2.00655937      83.0182037       2.44288826      00003730
 91.4568787                                                       00003740
 17.0000000      2.09005356     -102.955307       2.05168724      00003750
-96.8187866      2.05168533      83.1811981       2.48155403      00003760
 91.9232941                                                       00003770
 18.0000000      2.14476776     -103.614334       2.12049294      00003780
-96.6845856      2.12049294      83.3153992       2.55238342      00003790
 92.6660309                                                       00003800
 19.0000000      2.19326782     -104.021576       2.18430519      00003810
-96.3361969      2.18430519      83.6638489       2.62211609      00003820
 93.5353851                                                       00003830
 20.0000000      2.23872948     -105.588867       2.24292374      00003840
-96.5509338      2.24292374      83.4490509       2.68408775      00003850
 94.6489716                                                       00003860
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**** TSO FOREGROUND HARDCOPY ****
DSNAME=EGA7476.KTPARM.H050R.DATA

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KTPARM.H050R.DATA                                                       00000010
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0.000000000E+00   1.09921646      -36.6304932       0.522564292       00000040
-91.6775665       0.522564292       88.3224182        1.15782642       00000050
 35.9110413                                                             00000060
 1.00000000       1.10639763       -36.9065552       0.528860688       00000070
-91.5599823       0.528860688       88.4400024        1.15633297       00000080
 36.2248230                                                             00000090
 2.00000000       1.10463428       -37.6346588       0.537585378       00000100
-91.7475586       0.537585258       88.2523651        1.16651726       00000110
 36.8512726                                                             00000120
 3.00000000       1.10554790       -37.9329681       0.543727756       00000130
-91.8572845       0.543727756       88.1427002        1.17150211       00000140
 37.0856476                                                             00000150
 4.00000000       1.10985565       -38.7485657       0.553417802       00000160
-92.0692902       0.553417921       87.9306946        1.17642021       00000170
 37.7785797                                                             00000180
 5.00000000       1.11612225       -38.7198181       0.557739377       00000190
-92.1867218       0.557739377       87.8132629        1.17404652       00000200
 37.6825562                                                             00000210
 6.00000000       1.12019062       -39.3502197       0.567532778       00000220
-91.9449921       0.567532778       88.0550079        1.17973614       00000230
 38.4028320                                                             00000240
 7.00000000       1.12524891       -39.8146362       0.571944714       00000250
-91.9739990       0.571944833       88.0259857        1.17887688       00000260
 38.8417969                                                             00000270
 8.00000000       1.12858963       -40.7259674       0.585628271       00000280
-92.0567322       0.585628271       87.9432068        1.18935871       00000290
 39.6758270                                                             00000300
 9.00000000       1.12933159       -40.9652710       0.593260765       00000310
-91.9283142       0.593260884       88.0716095        1.19660473       00000320
 39.9615326                                                             00000330
 10.0000000       1.13652134       -41.2991333       0.601257443       00000340
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 40.3712616                                                             00000360
 11.0000000       1.14080811       -42.0196533       0.612074375       00000370
-91.8849945       0.612074375       88.1149902        1.20444489       00000380
 40.9925079                                                             00000390
 12.0000000       1.14664173       -42.5369110       0.619318128       00000400
-91.8922577       0.619318247       88.1077271        1.20608521       00000410
 41.4880066                                                             00000420
 13.0000000       1.15161133       -43.1135406       0.630481601       00000430
-91.9404449       0.630481601       88.0595398        1.21295071       00000440
 42.0099335                                                             00000450
 14.0000000       1.15231037       -43.8269043       0.643147945       00000460
-91.9334564       0.643147945       88.0664825        1.22620392       00000470
 42.6956635                                                             00000480
 15.0000000       1.16028786       -44.0987854       0.652122259       00000490
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 42.8587799                                                             00000510
 16.0000000       1.16488934       -44.5467224       0.663266659       00000520
-92.1499939       0.663266659       87.8499908        1.23535824       00000530
 43.2333679                                                             00000540
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 44.5034790                                                              00000600
 19.0000000      1.18283558     -46.2740936      0.690762758             00000610
-92.2355194      0.690762758     87.7644653      1.24798679              00000620
 44.8302460                                                              00000630
 20.0000000      1.18696213     -47.1740570      0.705433846             00000640
-92.3434296      0.705433846     87.6565552      1.26079559              00000650
 45.6170959                                                              00000660
0.381999984E-01  (PATCH 2 WIDTH)                                         00000670
0.000000000E+00  1.10449886     -40.6559143      0.536336541             00000680
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 39.9225616                                                              00000700
 1.00000000      1.11297989     -40.8765564      0.543125153             00000710
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 40.1197205                                                              00000730
 2.00000000      1.11262894     -41.7600250      0.551990390             00000740
-92.0193481      0.551990390     87.9806366      1.17209530              00000750
 40.8171539                                                              00000760
 3.00000000      1.11837387     -42.3893890      0.557953119             00000770
-92.1538849      0.557953119     87.8460999      1.17191124              00000780
 41.3671417                                                              00000790
 4.00000000      1.11891556     -43.0321808      0.570117116             00000800
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 42.0072479                                                              00000820
 5.00000000      1.12340641     -43.2174530      0.573130965             00000830
-92.1037750      0.573130965     87.8962097      1.18194962              00000840
 42.1774902                                                              00000850
 6.00000000      1.12616253     -43.6763916      0.583422780             00000860
-91.9359741      0.583422780     88.0640106      1.18970490              00000870
 42.6934357                                                              00000880
 7.00000000      1.13331699     -44.2108459      0.589532852             00000890
-91.9026947      0.589532733     88.0972900      1.18852329              00000900
 43.2296600                                                              00000910
 8.00000000      1.13502312     -45.1132507      0.600744367             00000920
-91.8938446      0.600744486     88.1061401      1.19848633              00000930
 44.1090698                                                              00000940
 9.00000000      1.13889027     -45.5967865      0.610112667             00000950
-92.0180969      0.610112667     87.9818878      1.20429325              00000960
 44.5022583                                                              00000970
 10.0000000      1.14081764     -45.8859863      0.621903896             00000980
-91.8560333      0.621903896     88.1439514      1.21506977              00000990
 44.8509979                                                              00001000
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 45.2854462                                                              00001030
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-92.2305908      0.640664220     87.7693939      1.22542858              00001050
 45.4688568                                                              00001060
 13.0000000      1.16124535     -47.1815491      0.647066116             00001070
-92.2355194      0.647065997     87.7644653      1.22092056              00001080
 45.8624573                                                              00001090
 14.0000000      1.16472340     -47.8962860      0.657022595             00001100
-91.9555817      0.657022595     88.0444031      1.22859192              00001110
 46.7172394                                                              00001120
 15.0000000      1.17484474     -48.5364380      0.661139369             00001130
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-91.6195374       0.703261137       88.3804474       1.26473808      00001230
 49.4719849                                                          00001240
 19.0000000       1.18344021        -50.3501587      0.713348150     00001250
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 49.3081970                                                          00001270
 20.0000000       1.19065094        -51.0068054      0.725694776     00001280
-91.8452606       0.725694776       88.1546631       1.28157425      00001290
 49.7339172                                                          00001300
0.483999997E-01   (PATCH 3 WIDTH)                                   00001310
0.000000000E+00   1.14632607        -47.2673645      0.633705497     00001320
-90.7851715       0.633705497       89.2148285       1.22257423      00001330
 46.8174896                                                          00001340
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-90.7298737       0.638752937       89.2701263       1.22072887      00001360
 47.1438904                                                          00001370
 2.00000000       1.15571976        -48.3373871      0.649851918     00001380
-90.8475037       0.649851918       89.1524811       1.23055077      00001390
 47.8341675                                                          00001400
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-90.9926910       0.652211666       89.0072937       1.23021984      00001420
 48.0749359                                                          00001430
 4.00000000       1.15804958        -49.4006500      0.664036870     00001440
-90.9848175       0.664036870       89.0151672       1.24412537      00001450
 48.7979889                                                          00001460
 5.00000000       1.16618061        -49.6954346      0.669145465     00001470
-91.2068329       0.669145465       88.7931519       1.24121380      00001480
 48.9490204                                                          00001490
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-91.0643311       0.677457571       88.9356537       1.24869823      00001510
 49.5406036                                                          00001520
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-91.0453186       0.686834216       88.9546661       1.25464153      00001540
 49.9700775                                                          00001550
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-91.1424103       0.694474220       88.8575134       1.25358868      00001570
 50.7592010                                                          00001580
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 50.8246002                                                          00001610
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-90.9586029       0.708917975       89.0413971       1.26410580      00001630
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-90.9524231       0.720867515       89.0475616       1.27296829      00001660
 52.2414093                                                          00001670
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-90.7985535       0.726686120       89.2014313       1.27117062      00001690
 52.6787415                                                          00001700
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-90.8074036       0.739130735       89.1925812       1.28360844      00001720
 53.3570251                                                          00001730
 14.0000000       1.20865059        -54.3320618      0.754297733     00001740
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 54.4074097                                                     00001820
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 55.6587524                                                     00001880
 19.0000000      1.24281406     -56.8578339      0.796721697    00001890
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 56.1737061                                                     00001910
 20.0000000      1.24690437     -57.9003143      0.811624527    00001920
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 57.3150482                                                     00001940
0.588999987E-01  (PATCH 4 WIDTH)                               00001950
0.000000000E+00  1.25631142     -58.1333160      0.857969046    00001960
-92.4280701      0.857969165     87.5719147      1.38069057     00001970
 56.0745087                                                     00001980
 1.00000000      1.26390266     -58.1385040      0.859985232    00001990
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 56.3081207                                                     00002010
 2.00000000      1.27052879     -58.8326111      0.868596792    00002020
-92.1857910      0.868596792     87.8142548      1.37989330     00002030
 56.9529877                                                     00002040
 3.00000000      1.27607632     -59.5419769      0.873067498    00002050
-92.1564484      0.873067498     87.8435364      1.38001728     00002060
 57.6766205                                                     00002070
 4.00000000      1.27868938     -60.2893066      0.890319109    00002080
-92.0613708      0.890319109     87.9386139      1.40105343     00002090
 58.4664612                                                     00002100
 5.00000000      1.28753757     -60.7291718      0.899502158    00002110
-92.1876984      0.899502158     87.8122864      1.40406895     00002120
 58.7725067                                                     00002130
 6.00000000      1.29462814     -61.2113190      0.912997723    00002140
-92.0983124      0.912997603     87.9016724      1.41533852     00002150
 59.3035736                                                     00002160
 7.00000000      1.29965115     -61.5336456      0.918895364    00002170
-92.0532837      0.918895364     87.9467010      1.41821194     00002180
 59.6537628                                                     00002190
 8.00000000      1.31056404     -62.6126556      0.930760026    00002200
-92.1171112      0.930760026     87.8828278      1.42307758     00002210
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 61.3921356                                                     00002280
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-92.2621307      0.972657800     87.7378693      1.46013546     00002300
 62.0177155                                                     00002310
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-92.2656708      0.979226112     87.7343140      1.45751572     00002330
 62.5093842                                                     00002340
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 15.0000000      1.37205982     -66.7684174      1.02143860          00002410
-92.1795044      1.02143860      87.8204803      1.48816299          00002420
 64.5427094                                                          00002430
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-92.1188049      1.03905773      87.8811798      1.50333214          00002450
 65.0781403                                                          00002460
 17.0000000      1.38877583     -68.1066437      1.05598068          00002470
-92.2609711      1.05598068      87.7390137      1.52180195          00002480
 65.7226410                                                          00002490
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-92.2884064      1.07307625      87.7115784      1.53325558          00002510
 66.2856598                                                          00002520
 19.0000000      1.41209602     -69.3166199      1.08918095          00002530
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 66.7095642                                                          00002550
 20.0000000      1.42696190     -70.0895844      1.11082268          00002560
-92.6911163      1.11082268      87.3088684      1.56379795          00002570
 67.1164856                                                          00002580
0.794000030E-01  (PATCH 5 WIDTH)                                     00002590
0.000000000E+00  1.30837536     -64.6970062      0.927922010         00002600
-91.2174835      0.927922130     88.7825012      1.42208004          00002610
 63.5704651                                                          00002620
 1.00000000      1.32014275     -64.9729462      0.933165073         00002630
-91.1799469      0.933165073     88.8200989      1.41681004          00002640
 63.8746033                                                          00002650
 2.00000000      1.32260799     -65.9398956      0.941409826         00002660
-91.4675751      0.941409707     88.5324097      1.42568588          00002670
 64.5609589                                                          00002680
 3.00000000      1.32927990     -66.6663971      0.945421457         00002690
-91.4619598      0.945421576     88.5380249      1.42422390          00002700
 65.2864380                                                          00002710
 4.00000000      1.33317757     -67.3316040      0.962211370         00002720
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 66.0417938                                                          00002740
 5.00000000      1.33824730     -67.4948730      0.967002749         00002750
-91.1507111      0.967002869     88.8492737      1.44569206          00002760
 66.3828125                                                          00002770
 6.00000000      1.34655094     -67.7142639      0.976376891         00002780
-90.8289795      0.976376891     89.1710052      1.45044422          00002790
 66.9051361                                                          00002800
 7.00000000      1.35545063     -68.3781586      0.980264544         00002810
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 67.6602173                                                          00002830
 8.00000000      1.36255455     -70.0169678      0.993924022         00002840
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 69.3595734                                                          00002860
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 74.3452759                                                          00003160
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-91.2252502       1.14153671       88.7747345       1.57749081       00003180
 74.9225159                                                          00003190
 20.0000000       1.47203159       -76.9690094      1.16094017       00003200
-91.2954102       1.16094112       88.7046356       1.59452629       00003210
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0.982999802E-01   (PATCH 6 WIDTH)                                   00003230
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-90.9506226       0.976314187      89.0493622       1.45481300       00003250
 71.7594299                                                          00003260
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-90.9736176       0.992365241      89.0263672       1.46490860       00003280
 72.6881714                                                          00003290
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-91.4119568       1.00550747       88.5880280       1.48182011       00003310
 73.1036682                                                          00003320
 3.00000000       1.36398411       -75.2057800      1.01647758       00003330
-91.6375122       1.01647758       88.3624725       1.49003220       00003340
 73.5415649                                                          00003350
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 74.1379700                                                          00003380
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-91.9054718       1.03295708       88.0945129       1.50107479       00003400
 74.6495819                                                          00003410
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 75.4777832                                                          00003440
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-91.7987671       1.06095600       88.2012177       1.52452374       00003460
 76.1707458                                                          00003470
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-91.8050537       1.07482624       88.1949310       1.53280735       00003490
 77.0531006                                                          00003500
 9.00000000       1.41257191       -79.7137604      1.08878899       00003510
-92.1190186       1.08878803       87.8809662       1.54609489       00003520
 77.4148712                                                          00003530
 10.0000000       1.41914177       -80.2921906      1.09674454       00003540
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 78.0085602                                                          00003560
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 79.7293243                                                      00003620
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-91.6954956      1.14599895      88.3044891      1.59221840      00003640
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 82.6655426                                                      00003740
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 86.3934021                                                      00003860
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**** TSO FOREGROUND HARDCOPY ****
DSNAME=EGA7476.KTPARM.H065F.DATA

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-92.4512329      1.19372940       87.5487976      1.65650272          00000050
 54.9346924                                                           00000060
 1.00000000      1.47572613      -58.1245117      1.21150875          00000070
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 55.4591064                                                           00000090
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 55.9543610                                                           00000120
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 56.1709595                                                           00000150
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 56.6998138                                                           00000180
 5.00000000      1.54127884      -61.3831635      1.30822372          00000190
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 57.0491486                                                           00000210
 6.00000000      1.55672741      -62.1876526      1.33619213          00000220
-93.5282745      1.33619022       86.4717102      1.78615093          00000230
 57.6633911                                                           00000240
 7.00000000      1.58365345      -62.7214508      1.36949444          00000250
-93.5495911      1.36949444       86.4503937      1.81258678          00000260
 58.0899200                                                           00000270
 8.00000000      1.60533524      -63.5262604      1.39562893          00000280
-93.4686584      1.39562893       86.5313721      1.83322239          00000290
 58.9411926                                                           00000300
 9.00000000      1.62176228      -63.7334137      1.41926193          00000310
-93.5163116      1.41926193       86.4836731      1.85555553          00000320
 59.0325470                                                           00000330
 10.0000000      1.64272308      -64.3205872      1.44593143          00000340
-93.2786713      1.44593239       86.7213593      1.87876415          00000350
 59.8838654                                                           00000360
 11.0000000      1.67553616      -65.3666992      1.49037457          00000370
-93.3441925      1.49037457       86.6557922      1.91969395          00000380
 60.7534790                                                           00000390
 12.0000000      1.70456123      -65.8854675      1.52312756          00000400
-93.1855164      1.52312756       86.8144684      1.94513512          00000410
 61.4324036                                                           00000420
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-93.2631073      1.56622791       86.7368774      1.98892403          00000440
 61.9270782                                                           00000450
 14.0000000      1.77292061      -66.9258881      1.61481190          00000460
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 62.3483582                                                           00000480
 15.0000000      1.79474735      -68.0603638      1.64281178          00000490
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 63.2669830                                                           00000510
 16.0000000      1.83360863      -68.7985077      1.69598007          00000520
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 64.8814850                                                          00000630
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 65.1322327                                                          00000660
0.498000011E-01  (PATCH 2 WIDTH)                                     00000670
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 67.0061035                                                          00000700
 1.00000000      1.65533924     -73.1490173      1.46969891          00000710
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 67.5653687                                                          00000730
 2.00000000      1.67426968     -73.6587677      1.49298573          00000740
-94.2324371      1.49298477      85.7675476      1.92410183          00000750
 67.8128967                                                          00000760
 3.00000000      1.69619656     -74.2104797      1.51173306          00000770
-94.1977386      1.51173306      85.8022461      1.93248367          00000780
 68.3680420                                                          00000790
 4.00000000      1.72093105     -75.6223602      1.54149532          00000800
-94.5009460      1.54149532      85.4990387      1.95680618          00000810
 69.2836151                                                          00000820
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-94.2761078      1.55748081      85.7238922      1.96307850          00000840
 69.7024536                                                          00000850
 6.00000000      1.76980305     -76.1162109      1.58995819          00000860
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 70.7074127                                                          00000880
 7.00000000      1.79081535     -76.9435425      1.61837959          00000890
-93.8555756      1.61837864      86.1444092      2.01729012          00000900
 71.3609772                                                          00000910
 8.00000000      1.81574535     -78.1403503      1.65729141          00000920
-94.2618866      1.65729141      85.7380981      2.05893898          00000930
 71.8888702                                                          00000940
 9.00000000      1.83666515     -79.1192627      1.67830563          00000950
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 72.1192932                                                          00000970
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 74.2804718                                                          00001030
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 75.0504913                                                          00001060
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-93.9056244      1.83974171      86.0944061      2.22138023          00001080
 75.8502808                                                          00001090
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 78.0155029                                                     00001240
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 78.3869019                                                     00001270
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-96.2852173     2.16961288      83.7147675      2.53645515      00001290
 79.4026337                                                     00001300
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-93.7541046     2.00799370      86.2458801      2.40854263      00001330
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 83.3987732                                                     00001400
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-94.5514984     2.11905670      85.4484863      2.52205467      00001420
 83.5701904                                                     00001430
 4.00000000     2.19409370      -92.2556763     2.14892387      00001440
-95.1000977     2.14892387      84.8998871      2.55452156      00001450
 83.8659668                                                     00001460
 5.00000000     2.22181892      -93.2405396     2.17295647      00001470
-95.2817841     2.17295837      84.7182007      2.56894493      00001480
 84.5175629                                                     00001490
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-95.4488220     2.22211647      84.5511627      2.61603737      00001510
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-95.4445496     2.25402069      84.5554352      2.65107346      00001540
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 86.2777863                                                     00001580
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-95.5944366     2.32372856      84.4055481      2.71245193      00001600
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 87.1925964                                                     00001640
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 88.5028992                                                     00001670
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-94.9616394     2.47101402      85.0383453      2.86001015      00001690
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 89.6150665                                                     00001760
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-97.6955109      2.73692322      82.3044739      3.13686180      00001840
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 91.2555695                                                      00001880
 19.0000000      2.81045914     -105.605743      2.86719131      00001890
-97.5714722      2.86719131      82.4285126      3.26984596      00001900
 92.0917511                                                      00001910
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 92.6802368                                                      00001940
0.978999734E-01  (PATCH 4 WIDTH)                                 00001950
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-95.2871399      2.60247421      84.7128601      3.01457977      00001970
 90.2045441                                                      00001980
 1.00000000      2.61796188     -100.145691      2.64918518      00001990
-95.3111267      2.64918518      84.6888580      3.05702019      00002000
 90.8433533                                                      00002010
 2.00000000      2.64650345     -101.033829      2.69151306      00002020
-95.4963074      2.69151306      84.5036926      3.10904503      00002030
 91.3691711                                                      00002040
 3.00000000      2.68540001     -102.336868      2.73499298      00002050
-95.8850250      2.73499489      84.1149597      3.15097237      00002060
 91.9483185                                                      00002070
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-96.2344513      2.79928970      83.7655334      3.22090912      00002090
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 93.0779724                                                      00002130
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 93.3986053                                                      00002160
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 93.9270477                                                      00002190
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 96.0434875                                                      00002340
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 98.3127441                                                         00002430
 16.0000000   3.56546783   -115.463516   3.74479485                 00002440
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 91.6164246                                                          00002580
```

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 11 4258

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	PATENT ABSTRACTS OF JAPAN, vol. 8, no. 206 (E-267)[1643], 20th September 1984; & JP-A-59 91 701 (MITSUBISHI DENKI K.K.) 26-05-1984 * Abstract * ---	1-10	H 01 P 1/185
D,A	1987 IEEE MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM DIGEST, Las Vegas, Nevada, 9th-11th June 1987, vol. II, pages 599-602, IEEE, New York, US; J.A. LESTER et al.: "Diode phase shifter and model in waveguide" * Page 599, left-hand column, lines 16-28; page 600, left-hand column, lines 12-14; figure 1 * ---	1-3,6,7 ,10	
A	FR-A-2 412 960 (SOC. D'ETUDES DU RADANT) * Page 3, line 30 - page 4, line 14; figure 1 * ---	1-3,6,7 ,10	
A	FR-A-2 509 095 (SOC. D'ETUDES DU RABANT) * Page 3, line 25 - page 4, line 30; figures 1-3 * ---	1-3,6,7 ,10	TECHNICAL FIELDS SEARCHED (Int. Cl.4) H 01 P H 01 Q H 03 C
A	US-A-2 928 056 (LAMPERT) * Column 4, line 59 - column 5, line 24; figure 3 * ---	1-10	
A	DE-A-3 617 568 (LICENTIA PATENT-VERWALTUNGS GmbH) * Whole document * ---	1,6,10	
A	GB-A-2 161 990 (PHILIPS ELECTRONIC & ASSOC. IND. LTD) * Whole document * -----	1-3,6,7 ,10	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17-11-1989	DEN OTTER A.M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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P : intermediate document

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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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