NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Technical Report No. 32-979

Computer Programs for Antenna Feed System Design and Analysis

Volume I: Programs and Sample Cases

Edited by
A. Ludwig

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

April 15, 1967

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Technical Report No. 32-979

Computer Programs for Antenna Feed System Design and Analysis

Volume I: Programs and Sample Cases

Edited by

A. Ludwig

Approved by:

P. D. Potter

P. D. Potter, Manager
Communications Elements Section

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

April 15, 1967

Prepared Under Contract No. NAS 7-100
National Aeronautics & Space Administration

FOREWORD

The intent of this Technical Report is to (1) present, in a concise form, the current Jet Propulsion Laboratory library of computer programs for antenna feed system design and analysis, and (2) provide a handbook for using them. These programs have generally been used in the sequences shown in the flow chart (p. viii). The system depicted by this flow chart has evolved in response to the need for analysis of large, low-noise, Cassegrainian, paraboloidal antennas. Some of the programs are useful for this specific application only; however, many are useful for a wide range of antenna problems.

For the analysis of a given antenna, with experimental data on reflector illumination and surface deformations, the key programs are the Efficiency Program (IX) and the Best-Fit Paraboloid Programs (either XI or XII). The illumination may be directly input to Program IX to determine illumination efficiency and other factors as a function of the angle subtended by the main reflector (it will be seen immediately, for example, whether the actual angle subtended by the reflector is near optimum), and the surface data is directly input to Program XI or XII to yield net RMS error to compute surface error loss. A gain prediction can be calculated from these results in conjunction with data on aperture blockage. If only the primary feed pattern for a Cassegrainian system has been measured, the Scattering Program (VI) may be used to compute the main reflector illumination. In past usage, computed patterns from this program virtually overlay experimental patterns (for subreflectors of 8 to 50 wavelengths in diameter); in fact, where differences exist, in most cases they can be shown to be due to certain measurement errors.

Contributions to antenna noise temperature may be calculated approximately by using the energy distribution data generated by the Antenna Feed Efficiency Program (IX), or directly computed using the Antenna Noise Temperature Program (XIV).

The radiation pattern of the main reflector may be computed by inputting reflector illumination and surface deformations to the Antenna Radiation Pattern Program (XIII).

FOREWORD (Cont'd)

For design and optimization of an antenna, there are many possible applications of these programs. The Cassegrainian Synthesis Program (II) is useful in determining ultimate limitations of feed system performance, and in providing insight into how performance may be improved. The Multimode Feed Pattern Synthesis Program may be used to generate a large class of potentially realizable primary feed patterns. A key program in design and optimization of Cassegrainian systems is the Scattering Program (VI), since feed patterns and/or subreflectors may be evaluated without resorting to unrealistically large experimental programs. (Usually, it will be desirable to verify only the computations for the final design.)

The design applications of the Structural Programs (X, XI, and XII) are somewhat outside the scope of feed system design and analysis; however, in some respects, they are related (e.g., the structural variations with various f/D ratios and probable limitations on frequency).

It should be noted that the procedure for design and optimization of feed systems using this system of computer programs is largely empirical. A master program that automatically optimizes everything is an intriguing idea, but is difficult to realize. At present, the basic value of the majority of these programs is as a relatively inexpensive and rapid substitute for experimental work, and as a good independent check on final experimental results.

Volume I of this Report covers program descriptions, applications, and input and output samples. Further information is available in Volume II which gives program listings.

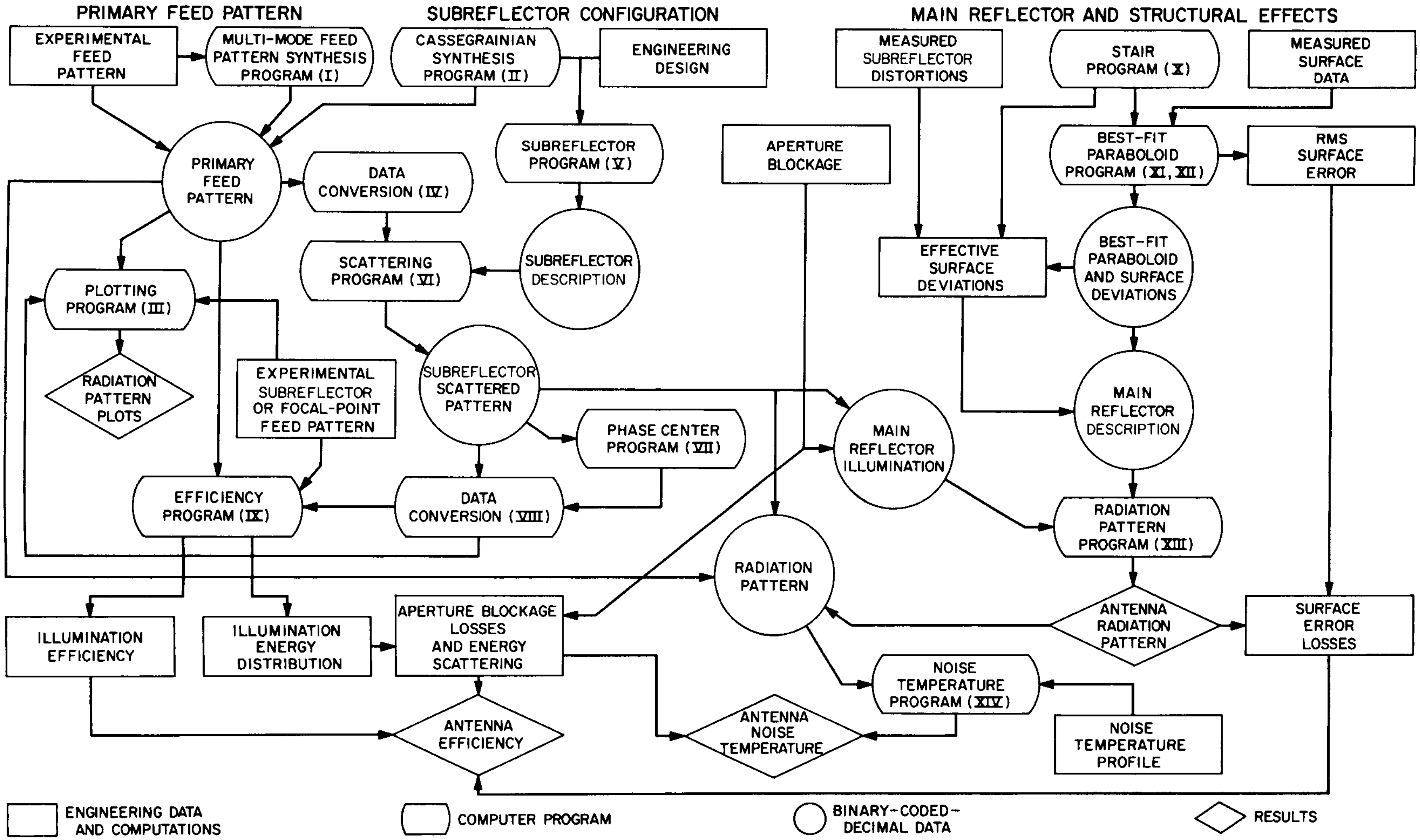
In a report of this type and size, it is difficult to guarantee 100% accuracy of the manuscript. The only real check on accuracy is to use the programs as specified.

CONTENTS

FIGURES

ABSTRACT

A library of computer programs for antenna feed system design and analysis is described, with emphasis on instructions for using the programs. The programs cover a large spectrum of feed design problems, from primary feed pattern synthesis to the far-field pattern of the main reflector, including analyses of structural distortions.



Computer Programs for Antenna Feed System Design and Analysis

I. MULTIMODE FEED PATTERN SYNTHESIS PROGRAM

A. Ludwig

Program: 5486, binary in Jet Propulsion Laboratory Library (revised May 14, 1964)

Engineer: A. Ludwig

Programmer: T. Haskell

A. Program Description

This program computes theoretical radiation patterns of a horn antenna aperture excited with a combination of cylindrical waveguide modes. These patterns are given by (Ref. 1)

H-Plane

$$E_\phi = \sum_{N=0}^{N} a_n e^{j\alpha_n} \frac{(\epsilon'_n)^3}{[1-(\epsilon'_n)^2]\, J_1(\epsilon'_n)} (1+\cos\theta) \times \frac{J'_1(ka\sin\theta)}{(ka\sin\theta)^2-(\epsilon'_n)^2} \qquad (1)$$

E-Plane

$$E_\theta = \sum_{N=1}^{N} b_n e^{j\beta_n} \frac{1}{J'_1(\epsilon_n)} (1+\cos\theta) \frac{ka\sin\theta\, J_1(ka\sin\theta)}{(ka\sin\theta)^2-(\epsilon_n)^2} \qquad (2)$$

where

a_n and α_n = amplitude and phase coefficients of TE_{1n} mode

b_n and β_n = amplitude and phase coefficients of TM_{1n} mode

ϵ_n and ϵ'_n = nth roots of first-order Bessel function J_1 and its derivative, respectively

θ = polar angle of radiation pattern

a = radius of horn aperture

k = free-space propagation constant $2\pi/\lambda$

The factors in Eqs. (1) and (2) result in a value near 0 db for the maxima of the individual mode patterns, for unity coefficients.

B. Applications

Any pattern obtainable with a circular horn antenna excited with TE_{1n} and TM_{1n} modes ($n \leq 10$) may be synthesized with this program. For example, the program has been used to determine optimum mode combinations that maximize gain of a paraboloid illuminated by a multi-mode horn (Refs. 1 and 2).

Another application is the matching of an experimental feed pattern by judicious choice of mode coefficients (Ref. 3). This application is useful in optimizing feed aperture diameter; once the mode coefficients are determined, various aperture diameters may be input to the program, and the optimum diameter determined by evaluating the resulting patterns through use of the Scattering Program (VI) and/or Efficiency Program (IX).

C. Input

Card	Parameters	Format
1	*NAME*	12A6
2	*AK DELTA ABMAX N IPNC*	3F10.5,2I5
3	*A(1) ALPHD(1) B(1) BETD(1)*	4F10.6
.	. . . .	.
.	. . . .	.
.	. . . .	.
$N+2$	*A(N) ALPHD(N) B(N) BETD(N)*	.

NAME = any alphanumeric statement, Columns 1 through 72

AK = ka, the propagation constant times the horn aperture radius

DELTA = angular increment in θ for output data, $0.2° \leq DELTA \leq 2.0°$

ABMAX = normalizing factor; output field amplitudes are divided by this number

N = maximum mode order n for which coefficients will be input, $N \leq 10$

IPNC = 1 for binary-coded-decimal punched output, 0 for no cards

A(N) = a_n, TE_{1n} mode amplitude coefficient

ALPHD(N) = α_n, TE_{1n} mode phase coefficient, deg

B(N) = b_n, TM_{1n} mode amplitude coefficient

BETD(N) = β_n, TM_{1n} mode phase coefficient, deg

Consecutive cases may be stacked without limit, each set of input starting with a name card. 7094 machine time is roughly proportional to N times the number of output *THETA* values, and was 20 sec for the sample case following, with $N = 2$ and 45 output values.

D. Output

Program prints out name and pertinent input parameters, and field strength (in volts and decibels) and phase angle (in degrees) of the radiation pattern from $\theta = 0°$ to $\theta = 90°$. The binary-coded-decimal output consists of first a name card, and then the field amplitude (in volts) and phase (in degrees). The card output is in a format compatible with Programs III, IV, and IX, after addition of control cards applicable to those programs. The program also outputs Stromberg-Carlson 4020 photographic plots of the feed amplitude patterns.

E. Sample Case

Sample input

```
DUAL MODE FIT, 2388 MC, 23.084 DIA APERTURE
14.673     2.0       1.52149      2    1
1.0        0.0       0.295       13.584
0.113     69.0       0.0          0.0
```

Sample output

```
DUAL MODE FIT, 2388 MC, 23.084 DIA APERTURE

KA  14.67300      ABMAX   1.52149

MODE      AMP         PHASE       MODE      AMP          PHASE
TE 11   1.00000     0.            TM 11   0.29500      13.58400
TE 12   0.11300     69.00000      TM 12   0.           0.
```

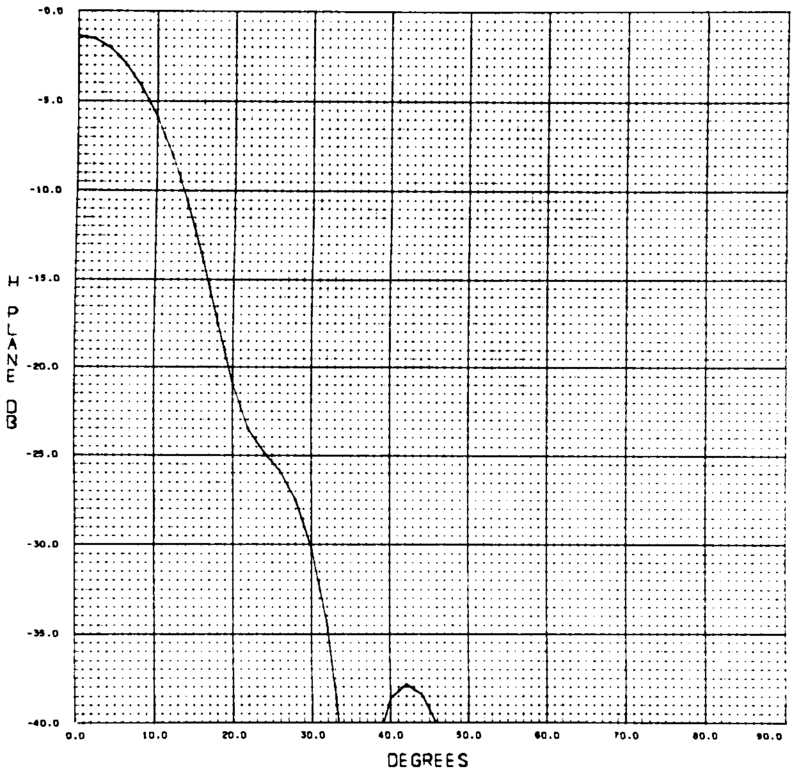
	H-PLANE			E-PLANE		
PSI	VOLTS	DB	PHASE	VOLTS	DB	PHASE
0.	0.85613	-1.35	357.39	0.85613	-1.35	357.39
2.0	0.83894	-1.53	357.57	0.83626	-1.55	357.55
4.0	0.78914	-2.06	358.14	0.77898	-2.17	358.06
6.0	0.71172	-2.95	359.14	0.69093	-3.21	358.95
8.0	0.61423	-4.23	0.69	0.58196	-4.70	0.33
10.0	0.50571	-5.92	2.98	0.46354	-6.68	2.37
12.0	0.39558	-8.06	6.34	0.34702	-9.19	5.38
14.0	0.29252	-10.68	11.39	0.24216	-12.32	9.93
16.0	0.20376	-13.82	19.25	0.15599	-16.14	17.11
18.0	0.13474	-17.41	31.93	0.09240	-20.69	29.07
20.0	0.08898	-21.01	52.05	0.05211	-25.66	49.29
22.0	0.06595	-23.62	78.35	0.03170	-29.98	77.99
24.0	0.05691	-24.90	101.91	0.02165	-33.29	104.34
26.0	0.05057	-25.92	117.68	0.01278	-37.87	121.24
28.0	0.04186	-27.56	127.49	0.00283	-50.97	131.24
30.0	0.03068	-30.26	133.78	0.00677	-43.39	317.45
32.0	0.01862	-34.60	138.04	0.01416	-36.98	321.56
34.0	0.00740	-42.61	141.06	0.01819	-34.81	324.44
36.0	0.00172	-55.27	323.29	0.01863	-34.59	326.55
38.0	0.00812	-41.80	325.00	0.01600	-35.92	328.15
40.0	0.01171	-38.63	326.33	0.01125	-38.98	329.40
42.0	0.01280	-37.86	327.40	0.00548	-45.23	330.39
44.0	0.01195	-38.45	328.27	0.00029	-70.85	151.20
46.0	0.00980	-40.18	328.99	0.00526	-45.59	151.86
48.0	0.00696	-43.14	329.59	0.00894	-40.97	152.41
50.0	0.00395	-48.06	330.09	0.01114	-39.06	152.88
52.0	0.00115	-58.78	330.52	0.01191	-38.48	153.27
54.0	0.00121	-58.33	150.89	0.01144	-38.83	153.61
56.0	0.00302	-50.41	151.21	0.01005	-39.96	153.90
58.0	0.00425	-47.44	151.48	0.00806	-41.88	154.16
60.0	0.00494	-46.12	151.72	0.00576	-44.78	154.38
62.0	0.00520	-45.68	151.93	0.00343	-49.30	154.57
64.0	0.00511	-45.82	152.11	0.00123	-58.19	154.73
66.0	0.00479	-46.40	152.27	0.00070	-63.05	334.88
68.0	0.00431	-47.31	152.41	0.00232	-52.70	335.01
70.0	0.00376	-48.51	152.53	0.00359	-48.89	335.12
72.0	0.00318	-49.94	152.64	0.00454	-46.85	335.21
74.0	0.00263	-51.59	152.73	0.00521	-45.67	335.30
76.0	0.00213	-53.43	152.81	0.00563	-44.99	335.37
78.0	0.00169	-55.42	152.87	0.00587	-44.63	335.43
80.0	0.00133	-57.53	152.93	0.00595	-44.51	335.46
82.0	0.00104	-59.69	152.97	0.00594	-44.53	335.51
84.0	0.00081	-61.80	153.00	0.00585	-44.66	335.54
86.0	0.00065	-63.68	153.02	0.00571	-44.86	335.57
88.0	0.00056	-65.09	153.04	0.00555	-45.11	335.58
90.0	0.00051	-65.79	153.04	0.00537	-45.40	335.58

Sample output, punched, BCD cards

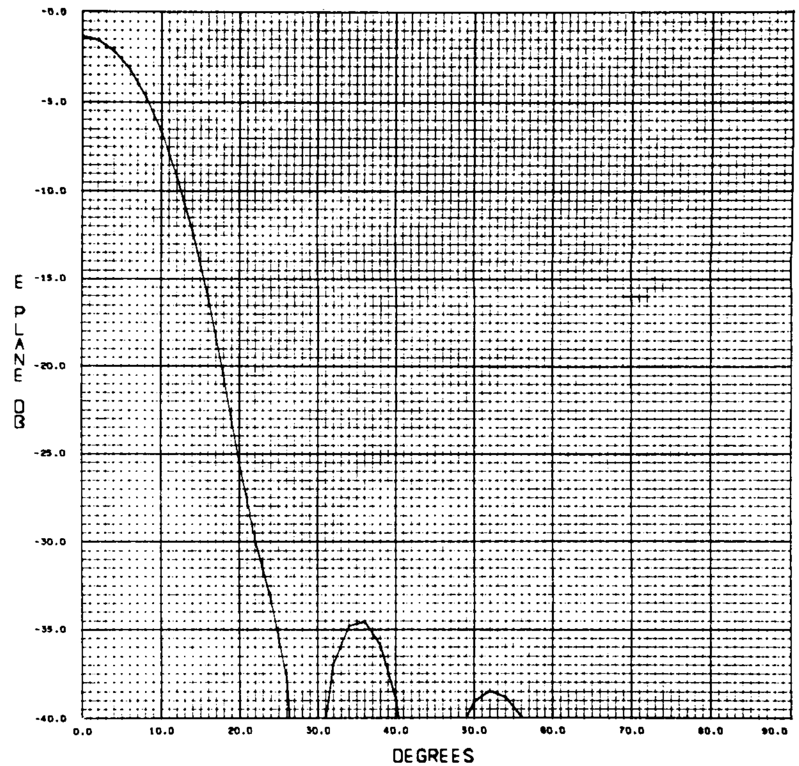
```
DUAL MODE FIT, 2388 MC, 23.084 DIA APERTURE
 91    0    46    2    0
```

0.	0.85613	357.39283	0.85613	357.39283
2.00000	0.83894	357.57479	0.83626	357.55461
4.00000	0.78914	358.13817	0.77898	358.05558
6.00000	0.71172	359.13950	0.69093	358.94635
8.00000	0.61423	0.68835	0.58196	0.32536
10.00000	0.50571	2.97750	0.46354	2.36690
12.00000	0.39558	6.34405	0.34702	5.37923
14.00000	0.29252	11.39382	0.24216	9.92826
16.00000	0.20376	19.24903	0.15599	17.10678
18.00000	0.13474	31.93022	0.09240	29.06619
20.00000	0.08898	52.04779	0.05211	49.28807
22.00000	0.06595	78.34972	0.03170	77.99481
24.00000	0.05691	101.91210	0.02165	104.34447
26.00000	0.05057	117.68370	0.01278	121.23688
28.00000	0.04186	127.48676	0.00283	131.23816
30.00000	0.03068	133.77880	0.00677	317.44831
32.00000	0.01862	138.03638	0.01416	321.56280
34.00000	0.00740	141.05999	0.01819	324.44467
36.00000	0.00172	323.29434	0.01863	326.55419
38.00000	0.00812	324.99916	0.01600	328.15290
40.00000	0.01171	326.33402	0.01125	329.39841
42.00000	0.01280	327.40144	0.00548	330.39059
44.00000	0.01195	328.26996	0.00029	151.19546
46.00000	0.00980	328.98688	0.00526	151.85827
48.00000	0.00696	329.58586	0.00894	152.41096
50.00000	0.00395	330.09137	0.01114	152.87667
52.00000	0.00115	330.52164	0.01191	153.27253
54.00000	0.00121	150.89048	0.01144	153.61149
56.00000	0.00302	151.20850	0.01005	153.90349
58.00000	0.00425	151.48402	0.00806	154.15624
60.00000	0.00494	151.72357	0.00576	154.37585
62.00000	0.00520	151.93240	0.00343	154.56718
64.00000	0.00511	152.11472	0.00123	154.73414
66.00000	0.00479	152.27397	0.00070	334.87990
68.00000	0.00431	152.41294	0.00232	335.00705
70.00000	0.00376	152.53393	0.00359	335.11771
72.00000	0.00318	152.63884	0.00454	335.21365
74.00000	0.00263	152.72922	0.00521	335.29627
76.00000	0.00213	152.80638	0.00563	335.36679
78.00000	0.00169	152.87135	0.00587	335.42616
80.00000	0.00133	152.92501	0.00595	335.47519
82.00000	0.00104	152.96803	0.00594	335.51449
84.00000	0.00081	153.00097	0.00585	335.54457
86.00000	0.00065	153.02421	0.00571	335.56580
88.00000	0.00056	153.03804	0.00555	335.57844
90.00000	0.00051	153.04264	0.00537	335.58264

Sample output, plotted



DUAL MODE FIT, 2388 MC, 23.084 DIA APERTURE



DUAL MODE FIT, 2388 MC, 23.084 DIA APERTURE

II. CASSEGRAINIAN SYNTHESIS PROGRAM

P. Potter

Program: 5512, binary in Jet Propulsion Laboratory Library (revised September 9, 1965)

Engineer: P. Potter

Programmer: R. Garrett, modified by W. R. Bunton

A. Program Description

This program synthesizes a theoretically realizable subreflector/feedhorn system that would provide maximum possible performance when used as a feed system for a paraboloidal antenna. Based on a few parameter inputs, the program generates the required subreflector surface, the required feedhorn radiation pattern, and various related parameters of interest to the user.

The solution obtained is frequency-dependent and is an exact boundary value solution to the problem. The analytical formulation uses an orthogonal mode solution to the vector wave equation in spherical coordinates; the method is described in detail in Refs. 4 through 7. The basic operations performed by the program are:

(1) The subreflector scattered vector field at infinity is defined to be a truncated series of spherical wave functions of azimuthal order one to produce a linearly polarized distribution with azimuthal symmetry.

(2) The wave series is fitted to an "ideal" scattered field pattern and the mode coefficients determined.

(3) The feedhorn radiation pattern is expressed as an arbitrary polar dependence and with order one azimuthal dependence.

(4) The total field at the subreflector surface is set equal to the sum of the spherical wave series and the feedhorn radiation pattern.

(5) The subreflector is defined to be a surface of revolution.

(6) An approximate (hyperboloidal) surface is chosen.

(7) The approximate surface is perturbed and the feedhorn azimuthal pattern chosen such that the azimuthal component of the total electric field is zero on the subreflector surface. This defines the surface and the feedhorn azimuthal field component.

(8) The feedhorn polar component is varied until the total electric field is everywhere normal to the subreflector surface.

The resulting subreflector surface is infinite; the performance effect of truncation has been investigated by use of the Scattering Program (VI) (Ref. 8). Because of the truncation problem and also to provide flexibility, the Cassegrainian Synthesis Program has an optional card output for driving the Scattering Program.

B. Applications

The originally intended application of this program was to synthesize ultimate-performance feed systems; however, this application has not yet been proved too successful because of difficulties in feedhorn pattern synthesis (Ref. 9).

A second application of the program is in the synthesis of subreflector vertex matching plates. In this application, the "ideal" scattered field pattern is chosen to suppress axial backscatter; a subreflector surface with a centrally located matching structure is then synthesized.

The third application of this program is as a check on the performance of other less rigorous synthesis techniques (Ref. 10).

C. Input

Card	Parameters	Format
1	*NCASE, NOPT, NUMDH, N, NFN, ISPOT*	12I5
2	*EK, C, A*	3E20.8
3	*PSIMAX, PSI1, PSIZ*	3E20.8
4	*DPSI, EM, PSIBLK*	3E20.8
5	*FLP*	3E20.8
6	See below	10A6
7	See below	12A6

NCASE = case number

NOPT = 0, if no delta-H matrix is to be read in

NUMDH = 0, if no delta-H matrix is to be read in;
= number of delta-H points if it is to be read in

N = maximum wave order

NFN = 1, if a printout of *FN* is desired

ISPOT = 0 if output is desired for Scattering Program;
= 1 if this output is not desired

EK = *K*, propagation constant, in.$^{-1}$

C = nominal subreflector half foci separation, in.

A = nominal subreflector vertex location, in.

PSIMAX = 91° = last point calculated

PSI 1 = lower bound of desired scattering function, $F(\psi)$, deg

PSIZ = upper bound of desired scattering function, $F(\psi)$, deg

DPSI = delta-psi, increment in ψ, deg

EM = epsilon, accuracy requirement on subreflector surface, in.

PSIBLK = central angular blocked region for efficiency calculation, deg

FLP = paraboloid focal length, in.

CARD 6 = appears as a descriptive heading for the case

CARD 7 = appears as a descriptive ending for the case

Note: If *NOPT* > 0, then tables are to be read in between Cards 4 and 5. The cards have *DH(J), GAM(J)* from *J* = 1 to *NUMDH,* two values per card on 2E20.8 format.

J = index of a feedhorn polar angle

DH(J) = feedhorn pattern phase error, deg

GAM(J) = feedhorn polar angle, deg

The 7094 machine time varies with wave order *N* as shown in Fig. 1. The time is expected to be sensitive to the quotient of epsilon and wavelength (probably roughly inversely proportional); however, this has not been quantitatively investigated.

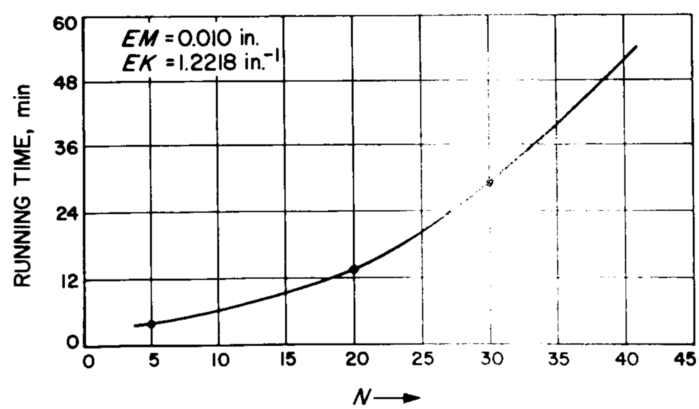


Fig. 1. Running time versus *N*

D. Output

The program prints out the various input parameters, and the mode coefficients *AN*. The following parameters are printed versus the polar angle *PSI*:

Parameter	Physical quantity	Units
RM	Subreflector radius from focal point	Inches
RHO	Subreflector radius from focal point	Radians
DELTAR	Subreflector deviation from hyperboloid	Inches
DELTAM	Phase deviation of scattered field at hyperboloid surface	Degrees
GAMMA	Feedhorn polar angle	Degrees
FSM, *FSMDB*	Amplitude of scattered field at subreflector surface	Relative field, db
FSINF, *FSINFDB*	Far-field polar pattern	Relative field, db
RP	Paraboloid radius from focal point	Inches
DELTAP	Phase deviation of scattered field at paraboloid surface	Degrees
FSP, *FSPDB*	Amplitude of scattered field at paraboloid surface	Relative field, db
ETA, *ETAS*, *ETA I*, *ETAX*, *ETAP*, *ETAB*	Various aperture efficiency factors. See Efficiency Program (IX)	None

The following are printed versus the feedhorn polar angle, *GAMMA*:

Parameter	Physical quantity	Units
FHXI, *FXIDB*	Required feedhorn azimuthal field component	Relative field, db
FHGAMMA, *FHGAMMADB*	Required feedhorn polar field component	Relative field, db
LCR	Radius from feedhorn center of radiation to subreflector	Inches

The Synthesis program has an optional card output (controlled by the *ISPOT* input) for use with the Scattering Program (VI). The card output is in groups of cards, corresponding to $F(X)$, $G(X)$, X, $AR(X)$, $AI(X)$, $BR(X)$, $BI(X)$, $CR(X)$, $CI(X)$, $DR(X)$, $DI(X)$ and X. The first card prior to the $F(X)$ group is a header card which must be discarded. For use with Program VI, *KC* should be input to that program as $2\pi/\lambda$. Several minor programming errors exist in the Synthesis Program that require minor hand-calculated modifications to the card output; these modifications are described below in the sample case discussion.

E. Sample Case

A typical sample of printed output is included. The output should be self-explanatory with the exception of certain erroneous data caused by presently existing minor programming errors. The data for values of *PSI* greater than 86° is incorrect because the program has caused an incorrect quadrant count for the phase angle *DELTAM*. Generally, this error will not cause engineering difficulty because the subreflector will be truncated prior to the point at which the quadrant-counting logic fails.

A second sample output is a listing of the cards produced for the Scattering Program. As shown, the $F(X)$, $G(X)$, $AR(X)$ and $AI(X)$ groups will have obvious errors which must be corrected by hand calculation. The corrected first $F(X)$ value is obtained from the printed output by the following relations:

$$LCR(PSI = 0) = 2C - RM(PSI = 0) \quad \text{(1a)}$$

$$F(X_1) = \frac{-1}{LCR(PSI = 0)} \quad \text{(1b)}$$

The corrected first value of $G(X)$ is always zero. The second value for $G(X)$ is obtained from the printed output by the following relation:

$$G(X_2) = \frac{F(X_3) - F(X_1)}{X_3 - X_1} \tag{2}$$

where $F(X_1)$ is the corrected value.

The corrected first values of $AR(X)$ and $AI(X)$ are obtained from the printed output by the following relations:

$$FHXI(PSI = 0) = \left[\frac{2C - RM(PSI = 0)}{RM(PSI = 0)}\right] FSM(PSI = 0) \tag{3a}$$

$$\phi \equiv \tan^{-1}\left[\frac{DI(X_1)}{DR(X_1)}\right] \tag{3b}$$

$$AR(X_1) = [FHXI(PSI = 0)] \cos \phi \tag{3c}$$

$$AI(X_1) = [FHXI(PSI = 0)] \sin \phi \tag{3d}$$

Care must be taken with (3c) and (3d) that the correct signs are obtained; the AR and AI values for X_1 should be very similar to those for X_2.

Sample input

```
100     0     0    22     0     0
1.2909              114.0               75.2670
91.                  0.                  60.
1.0                  0.01                0.
432.
65 FOOT SYNTHESIS, 2425 MC, NO VERTEX
END OF CASE 100
```

Sample output

```
        CASSEGRAIN SYNTHESIS


CASE   100          85 FOOT SYNTHESIS, 2425 MC, NO VERTEX

        INITIAL AND INPUT QUANTITIES


MAXIMUM WAVE ORDER =    22          NUMBER OF DELTA-H POINTS =     0

        SUBREFLECTOR ANGLES IN DEGREES

PSI1 =     0.00    PSI2 =    60.00    DELTA-PSI =    1.00    PSI-MAX =    91.00

        GEOMETRY AND SPACE CONSTANTS

K =     1.2909        C =   114.0000        A =    75.2670

PSIBLK =  0.00        F =      432.00

        ACCURACY REQUIREMENT

    EPSILON =   0.010
```

Sample output

AN TABLES

N	AN
1	0.74999999E 00
2	0.62499999E 00
3	0.10937500E 00
4	-0.35156250E 00
5	-0.40820313 00
6	-0.88867188E-01
7	0.26458740 00
8	0.32736206 00
9	0.76393129 -01
10	-0.22117996 00
11	-0.26132105E 00
12	-0.67955257E-01
13	0.19345107 00
14	0.25054851E 00
15	0.61787666E-01
16	-0.17482356E 00
17	-0.22810091 00
18	-0.57033583E-01
19	0.16044640E 00
20	0.21576738E 00
21	0.53226898E-01
22	-0.14910586E 00

Sample output

PSI	RM	DELTAR	DELTAM	RHO	GAMMA
0.0	38.781	0.048	7.08	50.062	0.00
1.0	38.783	0.046	6.84	50.065	0.20
2.0	38.789	0.042	6.13	50.073	0.41
3.0	38.799	0.034	5.05	50.086	0.61
4.0	38.815	0.025	3.71	50.107	0.82
5.0	38.837	0.015	2.25	50.135	1.02
6.0	38.866	0.005	0.79	50.173	1.23
7.0	38.904	-0.004	-0.55	50.221	1.43
8.0	38.950	-0.012	-1.67	50.280	1.64
9.0	39.005	-0.017	-2.48	50.351	1.84
10.0	39.070	-0.021	-2.95	50.435	2.05
11.0	39.145	-0.021	-3.05	50.532	2.26
12.0	39.230	-0.019	-2.77	50.642	2.46
13.0	39.326	-0.015	-2.14	50.765	2.67
14.0	39.431	-0.008	-1.24	50.901	2.88
15.0	39.545	0.000	-0.17	51.048	3.09
16.0	39.667	0.008	0.94	51.206	3.30
17.0	39.796	0.016	1.93	51.372	3.51
18.0	39.931	0.021	2.69	51.547	3.72
19.0	40.071	0.024	3.10	51.728	3.93
20.0	40.216	0.023	3.12	51.915	4.14
21.0	40.367	0.019	2.76	52.109	4.35
22.0	40.523	0.013	2.06	52.311	4.56
23.0	40.685	0.004	1.09	52.521	4.77
24.0	40.856	-0.005	-0.05	52.740	4.98
25.0	41.035	-0.015	-1.23	52.971	5.19
26.0	41.223	-0.024	-2.36	53.215	5.41
27.0	41.423	-0.031	-3.30	53.473	5.62
28.0	41.636	-0.035	-3.95	53.748	5.84
29.0	41.862	-0.035	-4.21	54.040	6.05
30.0	42.103	-0.030	-4.00	54.351	6.27
31.0	42.359	-0.020	-3.27	54.681	6.49
32.0	42.620	-0.015	-2.04	55.018	6.71
33.0	42.899	-0.003	-0.39	55.378	6.94
34.0	43.191	0.012	1.50	55.755	7.16
35.0	43.494	0.026	3.41	56.147	7.39
36.0	43.808	0.040	5.08	56.551	7.62
37.0	44.129	0.050	6.30	56.966	7.84
38.0	44.458	0.055	6.93	57.391	8.07
39.0	44.798	0.059	6.92	57.829	8.30
40.0	45.133	0.047	6.29	58.263	8.53
41.0	45.490	0.042	5.13	58.723	8.76
42.0	45.851	0.029	3.53	59.190	8.99
43.0	46.224	0.013	1.61	59.670	9.22
44.0	46.608	-0.005	-0.55	60.166	9.45
45.0	47.005	-0.025	-2.85	60.679	9.68
46.0	47.416	-0.046	-5.23	61.210	9.92
47.0	47.842	-0.067	-7.64	61.760	10.15
48.0	48.284	-0.089	-10.05	62.330	10.39
49.0	48.742	-0.111	-12.39	62.921	10.63
50.0	49.218	-0.133	-14.64	63.536	10.87
51.0	49.713	-0.154	-16.72	64.174	11.11
52.0	50.227	-0.173	-18.53	64.839	11.36
53.0	50.763	-0.191	-19.94	65.529	11.60
54.0	51.327	-0.199	-20.78	66.258	11.85
55.0	51.917	-0.203	-20.84	67.019	12.11
56.0	52.538	-0.197	-19.92	67.821	12.37
57.0	53.193	-0.179	-17.79	68.667	12.63
58.0	53.886	-0.146	-14.31	69.561	12.91
59.0	54.618	-0.098	-9.43	70.506	13.18
60.0	55.388	-0.037	-3.21	71.500	13.47
61.0	56.204	0.044	4.13	72.554	13.76
62.0	57.056	0.134	12.28	73.654	14.06
63.0	57.945	0.231	20.94	74.801	14.36
64.0	58.870	0.336	29.90	75.996	14.66
65.0	59.834	0.448	39.11	77.239	14.98
66.0	60.839	0.569	48.75	78.537	15.29
67.0	61.892	0.705	59.15	79.897	15.62
68.0	63.004	0.863	70.91	81.332	15.95
69.0	64.186	1.055	84.85	82.858	16.29
70.0	65.456	1.295	101.94	84.498	16.65
71.0	66.825	1.593	122.68	86.264	17.03
72.0	68.280	1.934	145.83	88.143	17.43
73.0	69.802	2.297	168.37	90.108	17.83
74.0	71.338	2.626	187.92	92.091	18.22
75.0	72.898	2.928	204.42	94.104	18.61
76.0	74.500	3.220	219.17	96.172	19.00
77.0	76.175	3.528	233.96	98.334	19.39
78.0	77.969	3.896	251.54	100.650	19.80
79.0	79.976	4.415	277.17	103.241	20.26
80.0	82.325	5.209	317.56	106.274	20.78
81.0	84.825	6.083	359.78	109.501	21.31
82.0	87.178	6.737	386.39	112.539	21.80
83.0	89.469	7.247	402.94	115.495	22.25
84.0	91.799	7.713	415.37	118.503	22.69
85.0	94.230	8.190	426.82	121.642	23.13
86.0	96.831	8.740	440.29	124.999	23.59
87.0	92.201	1.956	97.03	119.022	22.42
88.0	95.797	3.288	157.27	123.664	23.08
89.0	99.508	4.618	212.45	128.455	23.74
90.0	94.371	-3.027	-137.28	121.823	22.49
91.0	97.181	-2.862	-124.65	125.451	22.93

ERRONROUS DATA

Sample output

PSI	FSN	FSINF	FSNDB	FSINFDB	GAMMA
0.0	0.95787	1.05530	-0.37	0.47	0.00
1.0	0.96018	1.05377	-0.35	0.45	0.20
2.0	0.96686	1.04930	-0.29	0.42	0.41
3.0	0.97719	1.04223	-0.20	0.36	0.61
4.0	0.99003	1.03313	-0.09	0.28	0.82
5.0	1.00382	1.02274	0.03	0.20	1.02
6.0	1.01681	1.01192	0.14	0.10	1.23
7.0	1.02727	1.00163	0.23	0.01	1.43
8.0	1.03376	0.99279	0.29	-0.06	1.64
9.0	1.03541	0.98628	0.30	-0.12	1.84
10.0	1.03206	0.98278	0.27	-0.15	2.05
11.0	1.02439	0.98270	0.21	-0.15	2.26
12.0	1.01382	0.98618	0.12	-0.12	2.46
13.0	1.00230	0.99296	0.02	-0.06	2.67
14.0	0.99206	1.00246	-0.07	0.02	2.88
15.0	0.98515	1.01378	-0.13	0.12	3.09
16.0	0.98318	1.02579	-0.15	0.22	3.30
17.0	0.98698	1.03727	-0.11	0.32	3.51
18.0	0.99654	1.04702	-0.03	0.40	3.72
19.0	1.01104	1.05405	0.10	0.46	3.93
20.0	1.02902	1.05770	0.25	0.49	4.14
21.0	1.04862	1.05776	0.41	0.49	4.35
22.0	1.06782	1.05452	0.57	0.46	4.56
23.0	1.08460	1.04877	0.71	0.41	4.77
24.0	1.09721	1.04171	0.81	0.35	4.98
25.0	1.10424	1.03484	0.86	0.30	5.19
26.0	1.10478	1.02973	0.87	0.25	5.41
27.0	1.09859	1.02784	0.82	0.24	5.62
28.0	1.08612	1.03028	0.72	0.26	5.84
29.0	1.06866	1.03762	0.58	0.32	6.05
30.0	1.04827	1.04978	0.41	0.42	6.27
31.0	1.02770	1.06600	0.24	0.56	6.49
32.0	1.01010	1.08487	0.09	0.71	6.71
33.0	0.99890	1.10451	-0.01	0.86	6.94
34.0	0.99693	1.12280	-0.03	1.01	7.16
35.0	1.00613	1.13767	0.05	1.12	7.39
36.0	1.02716	1.14745	0.23	1.19	7.62
37.0	1.05933	1.15110	0.50	1.22	7.84
38.0	1.10081	1.14844	0.83	1.20	8.07
39.0	1.14896	1.14032	1.21	1.14	8.30
40.0	1.20085	1.12851	1.59	1.05	8.53
41.0	1.25296	1.11559	1.96	0.95	8.76
42.0	1.30210	1.10466	2.29	0.86	8.99
43.0	1.34493	1.09889	2.57	0.82	9.22
44.0	1.37835	1.10111	2.79	0.84	9.45
45.0	1.39968	1.11333	2.92	0.93	9.68
46.0	1.40684	1.13633	2.96	1.11	9.92
47.0	1.39861	1.16937	2.91	1.36	10.15
48.0	1.37475	1.21011	2.76	1.66	10.39
49.0	1.33618	1.25461	2.52	1.97	10.63
50.0	1.28459	1.29765	2.18	2.26	10.87
51.0	1.22254	1.33316	1.75	2.50	11.11
52.0	1.15298	1.35482	1.24	2.64	11.36
53.0	1.07892	1.35672	0.66	2.65	11.60
54.0	1.00320	1.33401	0.03	2.50	11.85
55.0	0.92814	1.28356	-0.65	2.17	12.11
56.0	0.85574	1.20432	-1.35	1.61	12.37
57.0	0.78760	1.09762	-2.07	0.81	12.63
58.0	0.72513	0.96715	-2.79	-0.29	12.91
59.0	0.66943	0.81872	-3.49	-1.74	13.18
60.0	0.62109	0.65974	-4.14	-3.61	13.47
61.0	0.57978	0.49862	-4.73	-6.04	13.76
62.0	0.54395	0.34395	-5.29	-9.27	14.06
63.0	0.51094	0.20370	-5.83	-13.82	14.36
64.0	0.47755	0.08454	-6.42	-21.46	14.66
65.0	0.44089	-0.00882	-7.11	-41.09	14.98
66.0	0.39919	-0.07399	-7.98	-22.62	15.29
67.0	0.35237	-0.11102	-9.06	-19.09	15.62
68.0	0.30221	-0.12228	-10.39	-18.25	15.95
69.0	0.25229	-0.11213	-11.96	-19.01	16.29
70.0	0.20764	-0.08632	-13.65	-21.28	16.65
71.0	0.17359	-0.05133	-15.21	-25.79	17.03
72.0	0.15321	-0.01363	-16.29	-37.31	17.43
73.0	0.14413	0.02097	-16.82	-33.57	17.83
74.0	0.13947	0.04793	-17.11	-26.39	18.22
75.0	0.13239	0.06434	-17.56	-23.83	18.61
76.0	0.11927	0.06905	-18.47	-23.22	19.00
77.0	0.09977	0.06270	-20.02	-24.05	19.39
78.0	0.07625	0.04736	-22.36	-26.49	19.80
79.0	0.05369	0.02619	-25.40	-31.64	20.26
80.0	0.04082	0.00286	-27.78	-50.88	20.78
81.0	0.04384	-0.01899	-27.16	-34.43	21.31
82.0	0.05351	-0.03621	-25.43	-28.82	21.80
83.0	0.05993	-0.04660	-24.45	-26.63	22.25
84.0	0.05951	-0.04911	-24.51	-26.18	22.69
85.0	0.05193	-0.04391	-25.69	-27.15	23.13
86.0	0.03868	-0.03231	-28.25	-29.81	23.59
87.0	0.02422	-0.01645	-32.32	-35.68	22.42
88.0	0.01536	0.00101	-36.27	-59.89	23.08
89.0	0.02347	0.01734	-32.59	-35.22	23.74
90.0	0.03550	0.03013	-28.99	-30.42	22.49
91.0	0.04208	0.03763	-27.52	-28.49	22.93

Sample output

GAMMA	FHXI	FHGAMMA	FHXIDB	FHGAMMADB	LCR
0.20	4.68477	4.68523	13.41	13.41	189.224
0.41	4.71781	4.72878	13.47	13.48	189.240
0.61	4.76679	4.77044	13.56	13.57	189.265
0.82	4.82829	4.83402	13.68	13.69	189.299
1.02	4.89384	4.90143	13.79	13.81	189.341
1.23	4.95472	4.96358	13.90	13.92	189.390
1.43	5.00238	5.01156	13.98	14.00	189.446
1.64	5.02970	5.03806	14.03	14.05	189.507
1.84	5.03234	5.03862	14.04	14.05	189.574
2.05	5.00962	5.01262	14.00	14.00	189.645
2.26	4.96486	4.96358	13.92	13.92	189.721
2.46	4.90502	4.89888	13.81	13.80	189.802
2.67	4.83976	4.82878	13.70	13.68	189.889
2.88	4.77982	4.76481	13.59	13.56	189.980
3.09	4.73531	4.71786	13.51	13.47	190.078
3.30	4.71390	4.69633	13.47	13.44	190.184
3.51	4.71963	4.70462	13.48	13.45	190.299
3.72	4.75236	4.74256	13.54	13.52	190.424
3.93	4.80806	4.80568	13.64	13.64	190.559
4.14	4.87965	4.88608	13.77	13.78	190.706
4.35	4.95818	4.97376	13.91	13.93	190.864
4.56	5.03390	5.05788	14.04	14.08	191.032
4.77	5.09737	5.12785	14.15	14.20	191.211
4.98	5.14020	5.17429	14.22	14.28	191.399
5.19	5.15586	5.18981	14.25	14.30	191.597
5.41	5.14028	5.16971	14.22	14.27	191.802
5.62	5.09242	5.11267	14.14	14.17	192.015
5.84	5.01467	5.02130	14.00	14.02	192.234
6.05	4.91315	4.90257	13.83	13.81	192.460
6.27	4.79758	4.76796	13.62	13.57	192.691
6.49	4.68078	4.65195	13.41	13.35	192.929
6.71	4.57848	4.54518	13.21	13.15	193.181
6.94	4.50421	4.45241	13.07	12.97	193.438
7.16	4.47108	4.41448	13.01	12.90	193.705
7.39	4.48729	4.43237	13.04	12.93	193.982
7.62	4.55514	4.50880	13.17	13.08	194.273
7.84	4.67088	4.63955	13.39	13.33	194.578
8.07	4.82581	4.80662	13.67	13.64	194.898
8.30	5.00727	5.02925	13.99	14.03	195.232
8.53	5.20397	5.24881	14.33	14.40	195.589
8.76	5.39733	5.44563	14.64	14.72	195.954
8.99	5.57566	5.65584	14.93	15.05	196.338
9.22	5.72425	5.82168	15.15	15.30	196.736
9.45	5.83036	5.94096	15.31	15.48	197.150
9.68	5.88328	6.00282	15.39	15.57	197.578
9.92	5.87526	5.99964	15.38	15.56	198.021
10.15	5.80232	5.92767	15.27	15.46	198.480
10.39	5.66480	5.78741	15.06	15.25	198.954
10.63	5.46740	5.58354	14.76	14.94	199.444
10.87	5.21869	5.32435	14.35	14.53	199.950
11.11	4.93004	5.02080	13.86	14.02	200.473
11.36	4.61426	4.69049	13.28	13.42	201.012
11.60	4.28419	4.33027	12.64	12.73	201.569
11.85	3.95091	3.96333	11.93	11.96	202.142
12.11	3.62436	3.60824	11.18	11.15	202.733
12.37	3.31203	3.26144	10.40	10.27	203.341
12.63	3.02004	2.93597	9.60	9.36	203.968
12.91	2.75343	2.63964	8.80	8.43	204.613
13.18	2.51602	2.38208	8.01	7.54	205.280
13.47	2.30963	2.15632	7.27	6.67	205.969
13.76	2.13205	1.96829	6.58	5.88	206.683
14.06	1.97751	1.81557	5.92	5.18	207.424
14.36	1.83582	1.67801	5.28	4.50	208.197
14.66	1.69541	1.54447	4.59	3.78	209.002
14.98	1.54623	1.40284	3.79	2.94	209.841
15.29	1.38260	1.24602	2.81	1.91	210.717
15.62	1.20485	1.07360	1.62	0.62	211.630
15.95	1.01967	0.89236	0.17	-0.99	212.582
16.29	0.83949	0.71570	-1.52	-2.91	213.576
16.65	0.68080	0.56217	-3.34	-5.00	214.616
17.03	0.56033	0.45036	-5.03	-6.93	215.705
17.43	0.48659	0.38641	-6.26	-8.26	216.852
17.83	0.45026	0.36293	-6.93	-8.80	218.060
18.22	0.42880	0.35629	-7.35	-8.96	219.332
18.61	0.40076	0.34047	-7.94	-9.36	220.668
19.00	0.35552	0.30435	-8.98	-10.33	222.071
19.39	0.29280	0.24706	-10.67	-12.14	223.546
19.80	0.22013	0.17637	-13.15	-15.07	225.102
20.26	0.15224	0.11037	-16.35	-19.14	226.763
20.78	0.11334	0.07707	-18.91	-22.26	228.567
21.31	0.11912	0.08582	-18.48	-21.33	230.496
21.80	0.14271	0.11476	-16.91	-18.80	232.490
22.25	0.15712	0.13493	-16.08	-17.40	234.556
22.69	0.15346	0.13506	-16.28	-17.39	236.718
23.13	0.13170	0.11525	-17.61	-18.77	238.994
23.59	0.09644	-0.10706	-20.32	-19.41	241.413
22.42	0.06342	-0.09979	-23.96	-20.02	241.422
23.08	0.03917	0.02333	-28.14	-32.64	244.206
23.74	0.05830	-0.07620	-24.69	-22.36	247.172
22.49	0.09283	-0.08969	-20.65	-20.95	246.759

Sample output

SCATTERED FIELD AT THE PARABOLOID SURFACE

PSI	RP	DELTAP	FSP	FSPDB
0.0	432.000	-1.03	1.05271	0.45
1.0	432.033	-1.01	1.05121	0.43
2.0	432.132	-0.93	1.04685	0.40
3.0	432.296	-0.82	1.03998	0.34
4.0	432.527	-0.66	1.03117	0.27
5.0	432.824	-0.47	1.02117	0.18
6.0	433.187	-0.25	1.01085	0.09
7.0	433.616	-0.03	1.00114	0.01
8.0	434.112	0.18	0.99295	-0.06
9.0	434.676	0.37	0.98706	-0.11
10.0	435.307	0.50	0.98411	-0.14
11.0	436.005	0.57	0.98444	-0.14
12.0	436.772	0.57	0.98812	-0.10
13.0	437.608	0.50	0.99486	-0.04
14.0	438.513	0.36	1.00406	0.04
15.0	439.488	0.18	1.01487	0.13
16.0	440.533	-0.03	1.02621	0.22
17.0	441.649	-0.23	1.03694	0.32
18.0	442.837	-0.41	1.04597	0.39
19.0	444.098	-0.52	1.05238	0.44
20.0	445.431	-0.59	1.05562	0.47
21.0	446.839	-0.56	1.05554	0.47
22.0	448.323	-0.46	1.05247	0.44
23.0	449.882	-0.28	1.04719	0.40
24.0	451.518	-0.06	1.04087	0.35
25.0	453.232	0.19	1.03492	0.30
26.0	455.026	0.42	1.03079	0.26
27.0	456.900	0.62	1.02979	0.25
28.0	458.855	0.72	1.03287	0.28
29.0	460.893	0.72	1.04050	0.34
30.0	463.016	0.61	1.05253	0.44
31.0	465.225	0.40	1.06820	0.57
32.0	467.520	0.13	1.08618	0.72
33.0	469.905	-0.18	1.10471	0.86
34.0	472.389	-0.46	1.12181	1.00
35.0	474.947	-0.70	1.13560	1.10
36.0	477.607	-0.84	1.14452	1.17
37.0	480.364	-0.87	1.14766	1.20
38.0	483.219	-0.78	1.14495	1.18
39.0	486.173	-0.55	1.13727	1.12
40.0	489.229	-0.22	1.12639	1.03
41.0	492.389	0.19	1.11483	0.94
42.0	495.656	0.62	1.10554	0.87
43.0	499.031	1.01	1.10148	0.84
44.0	502.518	1.28	1.10521	0.87
45.0	506.119	1.37	1.11850	0.97
46.0	509.837	1.26	1.14194	1.15
47.0	513.675	0.94	1.17473	1.40
48.0	517.635	0.45	1.21456	1.69
49.0	521.721	-0.15	1.25768	1.99
50.0	525.935	-0.80	1.29906	2.27
51.0	530.282	-1.44	1.33287	2.50
52.0	534.765	-2.03	1.35295	2.63
53.0	539.388	-2.52	1.35355	2.63
54.0	544.154	-2.89	1.32993	2.48
55.0	549.068	-3.12	1.27896	2.14
56.0	554.133	-3.18	1.19965	1.58
57.0	559.354	-3.04	1.09330	0.77
58.0	564.736	-2.66	0.96359	-0.32
59.0	570.283	-1.95	0.81631	-1.76
60.0	576.000	-0.77	0.65889	-3.62
61.0	581.893	1.18	0.49961	-6.02
62.0	587.966	4.61	0.34795	-9.17
63.0	594.227	11.54	0.21228	-13.46
64.0	600.679	30.39	0.10401	-19.66
65.0	607.331	93.33	0.05761	-24.76
66.0	614.187	140.11	0.08972	-20.94
67.0	621.256	153.80	0.11891	-18.50
68.0	628.543	159.96	0.12686	-17.93
69.0	636.057	163.99	0.11493	-18.79
70.0	643.806	167.79	0.08814	-21.10
71.0	651.796	173.71	0.05283	-25.54
72.0	660.037	194.20	0.01682	-35.48
73.0	668.538	321.70	0.02298	-32.77
74.0	677.308	336.24	0.04888	-26.22
75.0	686.358	340.54	0.06500	-23.74
76.0	695.696	342.98	0.06956	-23.15
77.0	705.334	344.95	0.06308	-24.00
78.0	715.284	347.16	0.04766	-26.44
79.0	725.557	351.35	0.02649	-31.54
80.0	736.166	393.84	0.00437	-47.19
81.0	747.124	516.17	0.01929	-34.30
82.0	758.445	521.66	0.03639	-28.78
83.0	770.143	523.77	0.04675	-26.60
84.0	782.234	525.15	0.04923	-26.16
85.0	794.734	526.39	0.04401	-27.13
86.0	807.680	527.91	0.03239	-29.79
87.0	821.031	531.18	0.01654	-35.62
88.0	834.864	650.31	0.00182	-54.80
89.0	849.180	702.19	0.01742	-35.18
90.0	864.000	704.92	0.03019	-30.40

Sample output

END OF CASE 100
HYP FIELD

PSI	ETA	ETA S	ETA E	ETA X	ETA P	ETA B
1.0	0.00026	0.00026	1.00000	1.00000	1.00000	1.00000
2.0	0.00104	0.00104	1.00000	1.00000	1.00000	1.00000
3.0	0.00233	0.00233	0.99999	1.00000	1.00000	1.00000
4.0	0.00410	0.00410	0.99996	1.00000	1.00000	1.00000
5.0	0.00634	0.00634	0.99991	1.00000	0.99999	1.00000
6.0	0.00902	0.00902	0.99985	1.00000	0.99998	1.00000
7.0	0.01212	0.01212	0.99976	1.00000	0.99997	1.00000
8.0	0.01563	0.01564	0.99967	1.00000	0.99996	1.00000
9.0	0.01955	0.01956	0.99958	1.00000	0.99995	1.00000
10.0	0.02389	0.02391	0.99952	1.00000	0.99994	1.00000
11.0	0.02867	0.02869	0.99950	1.00000	0.99993	1.00000
12.0	0.03393	0.03394	0.99951	1.00000	0.99993	1.00000
13.0	0.03969	0.03971	0.99956	1.00000	0.99993	1.00000
14.0	0.04601	0.04603	0.99961	1.00000	0.99994	1.00000
15.0	0.05292	0.05294	0.99966	1.00000	0.99995	1.00000
16.0	0.06046	0.06049	0.99969	1.00000	0.99995	1.00000
17.0	0.06865	0.06868	0.99970	1.00000	0.99995	1.00000
18.0	0.07749	0.07751	0.99968	1.00000	0.99995	1.00000
19.0	0.08694	0.08698	0.99966	1.00000	0.99995	1.00000
20.0	0.09699	0.09703	0.99964	1.00000	0.99994	1.00000
21.0	0.10755	0.10760	0.99965	1.00000	0.99994	1.00000
22.0	0.11858	0.11863	0.99966	1.00000	0.99994	1.00000
23.0	0.13001	0.13006	0.99969	1.00000	0.99994	1.00000
24.0	0.14179	0.14183	0.99971	1.00000	0.99995	1.00000
25.0	0.15389	0.15394	0.99972	1.00000	0.99995	1.00000
26.0	0.16632	0.16638	0.99971	1.00000	0.99995	1.00000
27.0	0.17915	0.17921	0.99968	1.00000	0.99995	1.00000
28.0	0.19244	0.19252	0.99965	1.00000	0.99994	1.00000
29.0	0.20633	0.20642	0.99963	1.00000	0.99993	1.00000
30.0	0.22094	0.22103	0.99964	1.00000	0.99993	1.00000
31.0	0.23640	0.23649	0.99966	1.00000	0.99993	1.00000
32.0	0.25283	0.25292	0.99968	1.00000	0.99994	1.00000
33.0	0.27029	0.27039	0.99968	1.00000	0.99994	1.00000
34.0	0.28882	0.28893	0.99967	1.00000	0.99994	1.00000
35.0	0.30835	0.30848	0.99963	1.00000	0.99994	1.00000
36.0	0.32878	0.32893	0.99959	1.00000	0.99993	1.00000
37.0	0.34992	0.35010	0.99956	1.00000	0.99992	1.00000
38.0	0.37158	0.37178	0.99955	1.00000	0.99991	1.00000
39.0	0.39354	0.39374	0.99957	1.00000	0.99991	1.00000
40.0	0.41561	0.41582	0.99959	1.00000	0.99992	1.00000
41.0	0.43770	0.43792	0.99959	1.00000	0.99992	1.00000
42.0	0.45980	0.46004	0.99956	1.00000	0.99992	1.00000
43.0	0.48204	0.48233	0.99948	1.00000	0.99991	1.00000
44.0	0.50468	0.50504	0.99940	1.00000	0.99990	1.00000
45.0	0.52810	0.52852	0.99933	1.00000	0.99988	1.00000
46.0	0.55274	0.55321	0.99930	1.00000	0.99986	1.00000
47.0	0.57910	0.57958	0.99932	1.00000	0.99986	1.00000
48.0	0.60761	0.60810	0.99935	1.00000	0.99986	1.00000
49.0	0.63859	0.63911	0.99932	1.00000	0.99986	1.00000
50.0	0.67216	0.67279	0.99921	1.00000	0.99986	1.00000
51.0	0.70817	0.70900	0.99898	1.00000	0.99985	1.00000
52.0	0.74614	0.74724	0.99872	1.00000	0.99981	1.00000
53.0	0.78523	0.78661	0.99850	1.00000	0.99975	1.00000
54.0	0.82424	0.82582	0.99842	1.00000	0.99967	1.00000
55.0	0.86167	0.86335	0.99846	1.00000	0.99959	1.00000
56.0	0.89581	0.89766	0.99844	1.00000	0.99951	1.00000
57.0	0.92491	0.92737	0.99789	1.00000	0.99945	1.00000
58.0	0.94731	0.95157	0.99610	1.00000	0.99942	1.00000
59.0	0.96167	0.96990	0.99210	1.00000	0.99941	1.00000
60.0	0.96713	0.98265	0.98478	1.00000	0.99942	1.00000
61.0	0.96341	0.99061	0.97310	1.00000	0.99943	1.00000
62.0	0.95083	0.99493	0.95627	1.00000	0.99938	1.00000
63.0	0.93033	0.99685	0.93402	1.00000	0.99919	1.00000
64.0	0.90325	0.99748	0.90687	1.00000	0.99852	1.00000
65.0	0.87122	0.99765	0.87694	1.00000	0.99582	1.00000
66.0	0.83650	0.99778	0.84796	1.00000	0.98868	1.00000
67.0	0.80047	0.99806	0.82183	1.00000	0.97591	1.00000
68.0	0.76475	0.99843	0.79773	1.00000	0.96016	1.00000
69.0	0.73060	0.99880	0.77455	1.00000	0.94439	1.00000
70.0	0.69885	0.99907	0.75137	1.00000	0.93097	1.00000
71.0	0.66998	0.99920	0.72762	1.00000	0.92152	1.00000
72.0	0.64408	0.99923	0.70308	1.00000	0.91680	1.00000
73.0	0.62085	0.99924	0.67880	1.00000	0.91533	1.00000
74.0	0.60012	0.99928	0.65629	1.00000	0.91508	1.00000
75.0	0.58123	0.99936	0.63565	1.00000	0.91497	1.00000
76.0	0.56357	0.99948	0.61628	1.00000	0.91494	1.00000
77.0	0.54656	0.99959	0.59760	1.00000	0.91496	1.00000
78.0	0.52975	0.99968	0.57913	1.00000	0.91502	1.00000
79.0	0.51279	0.99971	0.56053	1.00000	0.91509	1.00000
80.0	0.49555	0.99972	0.54167	1.00000	0.91511	1.00000
81.0	0.47818	0.99973	0.52335	1.00000	0.91393	1.00000
82.0	0.46052	0.99975	0.50640	1.00000	0.90962	1.00000
83.0	0.44297	0.99979	0.49063	1.00000	0.90304	1.00000
84.0	0.42584	0.99986	0.47568	1.00000	0.89534	1.00000
85.0	0.40940	0.99991	0.46119	1.00000	0.88777	1.00000
86.0	0.39389	0.99995	0.44686	1.00000	0.88149	1.00000
87.0	0.37945	0.99997	0.43247	1.00000	0.87741	1.00000
88.0	0.36618	0.99997	0.41798	1.00000	0.87607	1.00000
89.0	0.35388	0.99998	0.40401	1.00000	0.87594	1.00000
90.0	0.34256	0.99999	0.39106	1.00000	0.87599	1.00000

Sample output

FOFR

0.25785818E-01	-0.52847367E-02	-0.52843060E-02	-0.52836049E-02	-0.52826553E-02	-0.52814821E-02
-0.52831098E-02	-0.52785682E-02	-0.52768515E-02	-0.52749976E-02	-0.52730080E-02	-0.52708879E-02
-0.52686369E-02	-0.52662470E-02	-0.52637050E-02	-0.52609844E-02	-0.52580552E-02	-0.52548846E-02
-0.52514481E-02	-0.52477182E-02	-0.52436765E-02	-0.52393435E-02	-0.52347215E-02	-0.52298270E-02
-0.52246796E-02	-0.52193009E-02	-0.52137126E-02	-0.52079360E-02	-0.52019904E-02	-0.51958918E-02
-0.51896484E-02	-0.51832569E-02	-0.51764866E-02	-0.51696098E-02	-0.51624973E-02	-0.51551073E-02
-0.51473968E-02	-0.51393297E-02	-0.51308831E-02	-0.51221111E-02	-0.51127537E-02	-0.51032279E-02
-0.50932649E-02	-0.50829488E-02	-0.50722889E-02	-0.50612912E-02	-0.50499582E-02	-0.50382898E-02
-0.50262838E-02	-0.50139370E-02	-0.50012462E-02	-0.49882093E-02	-0.49748254E-02	-0.49610729E-02
-0.49470223E-02	-0.49326071E-02	-0.49178491E-02	-0.49027418E-02	-0.48872699E-02	-0.48714065E-02
-0.48550921E-02	-0.48383388E-02	-0.48210336E-02	-0.48031497E-02	-0.47846506E-02	-0.47655108E-02
-0.47457117E-02	-0.47252369E-02	-0.47040659E-02	-0.46821681E-02	-0.46594921E-02	-0.46359531E-02
-0.46114443E-02	-0.45858914E-02	-0.45592948E-02	-0.45316844E-02	-0.45030573E-02	-0.44733547E-02
-0.44424224E-02	-0.44098861E-02	-0.43750938E-02	-0.43384720E-02	-0.43012654E-02	-0.42633680E-02
-0.42244347E-02	-0.41841979E-02	-0.41422826E-02	-0.41421219E-02	-0.40949062E-02	-0.40457688E-02
-0.40525413E-02					

GOFR

0.86862172E 01	0.86862172E 01	-0.12047589E-03	-0.19608438E-03	-0.26565790E-03	-0.32825768E-03
-0.38389862E-03	-0.43331087E-03	-0.47740340E-03	-0.51735342E-03	-0.55424869E-03	-0.58932602E-03
-0.62407553E-03	-0.66047907E-03	-0.70078671E-03	-0.74754655E-03	-0.80262125E-03	-0.86675584E-03
-0.93907118E-03	-0.10172129E-02	-0.10979772E-02	-0.11782795E-02	-0.12553781E-02	-0.13273209E-02
-0.13928860E-02	-0.14511794E-02	-0.15019476E-02	-0.15449375E-02	-0.15805215E-02	-0.16095936E-02
-0.16342402E-02	-0.16582161E-02	-0.17555803E-02	-0.17625540E-02	-0.18099099E-02	-0.18694103E-02
-0.19420683E-02	-0.20261705E-02	-0.21179616E-02	-0.21898150E-02	-0.23585558E-02	-0.23702383E-02
-0.24834424E-02	-0.25636256E-02	-0.26387870E-02	-0.27098060E-02	-0.27775168E-02	-0.28428286E-02
-0.29062182E-02	-0.29677302E-02	-0.30269921E-02	-0.30829459E-02	-0.31341612E-02	-0.31911880E-02
-0.32025874E-02	-0.32411069E-02	-0.32573044E-02	-0.32647699E-02	-0.32669753E-02	-0.32692552E-02
-0.32916740E-02	-0.32870024E-02	-0.33383593E-02	-0.33917725E-02	-0.34550279E-02	-0.35203323E-02
-0.35794154E-02	-0.36243051E-02	-0.36472529E-02	-0.36413148E-02	-0.36064833E-02	-0.35660192E-02
-0.35785809E-02	-0.36571026E-02	-0.38702637E-02	-0.40673763E-02	-0.42216852E-02	-0.43091550E-02
-0.42985603E-02	-0.41281730E-02	-0.38321950E-02	-0.38972311E-02	-0.44092238E-02	-0.48341453E-02
-0.50828084E-02	-0.43007918E-02	-0.43007955E-02	-0.50826010E-02	-0.40866658E-02	-0.43007955E-02
-0.50828084E-02					

X

0.31415926E 01	0.31380156E 01	0.31344391E 01	0.31308635E 01	0.31272888E 01	0.31237144E 01
0.31201397E 01	0.31165635E 01	0.31129843E 01	0.31094006E 01	0.31058107E 01	0.31022131E 01
0.30986062E 01	0.30949888E 01	0.30913603E 01	0.30877208E 01	0.30840712E 01	0.30804131E 01
0.30767483E 01	0.30730784E 01	0.30694046E 01	0.30657272E 01	0.30620454E 01	0.30583578E 01
0.30546623E 01	0.30509558E 01	0.30472350E 01	0.30434959E 01	0.30397341E 01	0.30359451E 01
0.30321248E 01	0.30282703E 01	0.30244138E 01	0.30205122E 01	0.30165824E 01	0.30126292E 01
0.30086589E 01	0.30046775E 01	0.30006894E 01	0.29966835E 01	0.29927160E 01	0.29886971E 01
0.29846853E 01	0.29806612E 01	0.29766215E 01	0.29725630E 01	0.29684827E 01	0.29643782E 01
0.29602470E 01	0.29560867E 01	0.29518941E 01	0.29476654E 01	0.29433950E 01	0.29390855E 01
0.29346982E 01	0.29302506E 01	0.29257198E 01	0.29210924E 01	0.29163565E 01	0.29115042E 01
0.29065479E 01	0.29014511E 01	0.28962673E 01	0.28909946E 01	0.28856403E 01	0.28802034E 01
0.28746720E 01	0.28690226E 01	0.28632180E 01	0.28572043E 01	0.28509167E 01	0.28443158E 01
0.28374670E 01	0.28304798E 01	0.28236077E 01	0.28168195E 01	0.28100385E 01	0.28031456E 01
0.27959496E 01	0.27880681E 01	0.27789891E 01	0.27695922E 01	0.27611538E 01	0.27533143E 01
0.27456545E 01	0.27379428E 01	0.27299406E 01	0.27502985E 01	0.27387449E 01	0.27273197E 01
0.27491547E 01					

AR

-0.86067118E 00	0.42097915E 01	0.42399383E 01	0.42863553E 01	0.43434805E 01	0.44040542E 01
0.44598977E 01	0.45030095E 01	0.45268142E 01	0.45273212E 01	0.45039572E 01	0.44598922E 01
0.44017614E 01	0.43387725E 01	0.42612907E 01	0.42391116E 01	0.42197613E 01	0.42272093E 01
0.42613063E 01	0.43180158E 01	0.43902572E 01	0.44690434E 01	0.45446258E 01	0.46074962E 01
0.46492237E 01	0.46631665E 01	0.46451104E 01	0.45938582E 01	0.45117545E 01	0.44050750E 01
0.42841287E 01	0.41798850E 01	0.40839536E 01	0.40005945E 01	0.39665192E 01	0.39825865E 01
0.40512673E 01	0.41687458E 01	0.43188652E 01	0.45189035E 01	0.47161772E 01	0.48930276E 01
0.50819089E 01	0.52309213E 01	0.53380896E 01	0.53936727E 01	0.53908185E 01	0.53261561E 01
0.52001292E 01	0.50169401E 01	0.47840520E 01	0.45113050E 01	0.42145150E 01	0.38908545E 01
0.35611450E 01	0.32420881E 01	0.29304805E 01	0.26380429E 01	0.23717754E 01	0.21403542E 01
0.19375031E 01	0.17685545E 01	0.16313287E 01	0.15077339E 01	0.13877388E 01	0.12604884E 01
0.11195794E 01	0.96465924E 00	0.80180298E 00	0.64307357E 00	0.50512233E 00	0.40465870E 00
0.34719419E 00	0.32609874E 00	0.32013608E 00	0.30591761E 00	0.27346367E 00	0.22199004E 00
0.15847420E 00	0.99169598E-01	0.69252137E-01	0.77111484E-01	0.10311358E 00	0.12123597E 00
0.12135480E 00	0.10355069E 00	-0.96192952E-01	-0.89663452E-01	0.20959395E-01	-0.68468819E-01
-0.80586753E-01					

AI

0.42043407E 00	-0.20564645E 01	-0.20711911E 01	-0.20938657E 01	-0.21217710E 01	-0.21513610E 01
-0.21786403E 01	-0.21997003E 01	-0.22113287E 01	-0.22115764E 01	-0.22001632E 01	-0.21786377E 01
-0.21502410E 01	-0.21194712E 01	-0.20913916E 01	-0.20707874E 01	-0.20613348E 01	-0.20649731E 01
-0.20816293E 01	-0.21093316E 01	-0.21446213E 01	-0.21831080E 01	-0.22200296E 01	-0.22507415E 01
-0.22711252E 01	-0.22779362E 01	-0.22691159E 01	-0.22440795E 01	-0.22039721E 01	-0.21518597E 01
-0.20927779E 01	-0.20418554E 01	-0.19949933E 01	-0.19542727E 01	-0.19376271E 01	-0.19454759E 01
-0.19790262E 01	-0.20364139E 01	-0.21097466E 01	-0.22074644E 01	-0.23038318E 01	-0.23902224E 01
-0.24824901E 01	-0.25552820E 01	-0.26076332E 01	-0.26347853E 01	-0.26333911E 01	-0.26018037E 01
-0.25402402E 01	-0.24507531E 01	-0.23369883E 01	-0.22037525E 01	-0.20587720E 01	-0.19006652E 01
-0.17396036E 01	-0.15837457E 01	-0.14315268E 01	-0.12886723E 01	-0.11586018E 01	-0.10455536E 01
-0.94646171E 00	-0.86393107E 00	-0.79689686E 00	-0.73652136E 00	-0.67790429E 00	-0.61574300E 00
-0.54690960E 00	-0.47123178E 00	-0.39167721E 00	-0.31413860E 00	-0.24675003E 00	-0.19767399E 00
-0.16960283E 00	-0.15929779E 00	-0.15638506E 00	-0.14943940E 00	-0.13358580E 00	-0.10844115E 00
-0.77413946E-01	-0.48443911E-01	-0.33829363E-01	-0.37668619E-01	-0.50370527E-01	-0.59223238E-01
-0.59281285E-01	-0.50584053E-01	0.46989833E-01	0.43800201E-01	-0.10238572E-01	0.33446716E-01
0.39366273E-01					

Sample output (contd)

DR

-0.41993564E 01	-0.42093734E 01	-0.42383499E 01	-0.42830785E 01	-0.43383329E 01	-0.43972285E 01
-0.44519410E 01	-0.44947591E 01	-0.45193058E 01	-0.45216792E 01	-0.45012661E 01	-0.44610443E 01
-0.44072814E 01	-0.43486364E 01	-0.42947838E 01	-0.42547876E 01	-0.42355534E 01	-0.42407022E 01
-0.42701107E 01	-0.43201554E 01	-0.43844845E 01	-0.44550394E 01	-0.45230825E 01	-0.45801046E 01
-0.46185889E 01	-0.46326622E 01	-0.46186674E 01	-0.45756605E 01	-0.45058035E 01	-0.44145823E 01
-0.43107408E 01	-0.42057961E 01	-0.41138698E 01	-0.40471424E 01	-0.40173739E 01	-0.40319368E 01
-0.40928991E 01	-0.41968998E 01	-0.43361072E 01	-0.44991493E 01	-0.46758870E 01	-0.48496337E 01
-0.50098633E 01	-0.51433722E 01	-0.52387135E 01	-0.52862675E 01	-0.52790632E 01	-0.52135259E 01
-0.50899578E 01	-0.49125885E 01	-0.46891147E 01	-0.44297614E 01	-0.41460208E 01	-0.38494501E 01
-0.35499862E 01	-0.32565721E 01	-0.29759363E 01	-0.27135804E 01	-0.24740262E 01	-0.22607040E 01
-0.20752560E 01	-0.19157007E 01	-0.17768360E 01	-0.16495317E 01	-0.15233660E 01	-0.13893239E 01
-0.12423033E 01	-0.10825907E 01	-0.91620197E 00	-0.75430281E 00	-0.61171748E 00	-0.50346639E 00
-0.43721038E 00	-0.40457245E 00	-0.38528360E 00	-0.36009181E 00	-0.31944461E 00	-0.26308850E 00
-0.19779384E 00	-0.13679343E 00	-0.10183697E 00	-0.10702932E 00	-0.12822433E 00	-0.14117214E 00
-0.13788360E 00	-0.11833522E 00	-0.86649415E-01	-0.56983212E-01	-0.35193288E-01	-0.52383516E-01
-0.83411145E-01					

DI

0.20513671E 01	0.20562603E 01	0.20704152E 01	0.20922649E 01	0.21192564E 01	0.21480267E 01
0.21747535E 01	0.21956899E 01	0.22076609E 01	0.22088203E 01	0.21988486E 01	0.21792004E 01
0.21529375E 01	0.21242897E 01	0.20979829E 01	0.20784449E 01	0.20690491E 01	0.20715643E 01
0.20859302E 01	0.21103768E 01	0.21418013E 01	0.21762671E 01	0.22095058E 01	0.22373609E 01
0.22561603E 01	0.22630351E 01	0.22561986E 01	0.22351899E 01	0.22010651E 01	0.21565039E 01
0.21057779E 01	0.20545128E 01	0.20096072E 01	0.19770112E 01	0.19624694E 01	0.19695833E 01
0.19993631E 01	0.20501670E 01	0.21181692E 01	0.21978146E 01	0.22841502E 01	0.23690247E 01
0.24472961E 01	0.25125146E 01	0.25590884E 01	0.25823183E 01	0.25787991E 01	0.25467844E 01
0.24864219E 01	0.23997778E 01	0.22906118E 01	0.21639189E 01	0.20253128E 01	0.18804394E 01
0.17341526E 01	0.15908211E 01	0.14537317E 01	0.13255720E 01	0.12085509E 01	0.11043439E 01
0.10137534E 01	0.93581132E 00	0.86797655E 00	0.80578896E 00	0.74415756E 00	0.67867862E 00
0.60685966E 00	0.52884076E 00	0.44756062E 00	0.36847359E 00	0.29882129E 00	0.24594111E 00
0.21357534E 00	0.19763186E 00	0.18820934E 00	0.17590326E 00	0.15604728E 00	0.12851757E 00
0.96621415E-01	0.66822984E-01	0.49746911E-01	0.52283352E-01	0.62637019E-01	0.68961966E-01
0.67355530E-01	0.57806235E-01	0.42327857E-01	0.27836047E-01	0.17191766E-01	0.25589116E-01
0.40745976E-01					

Sample output: punched cards

CORRECT VALUE: -0.52848810E-02

DELETE

F(x)

```
-0.[illegible]     (DELETE)
[illegible]E-0[illegible]-0.52847367E-02-0.52843060E-02-0.52836049E-02-0.52826553E-02
-0.52[illegible]21E-02-0.52801098E-02-0.52785602E-02-0.52766515E-02-0.52749976E-02
-0.5273[illegible]E-02-0.5270[illegible]879E-02-0.52686369E-02-0.52662478E-02-0.52637050E-02
-0.5260[illegible]E-02-0.52580552E-02-0.52548846E-02-0.52514431E-02-0.52477102E-02
-0.5243[illegible]E-02-0.52393435E-02-0.52347215E-02-0.52298270E-02-0.52246796E-02
-0.5219300[illegible]E-02-0.52137126E-02-0.52079360E-02-0.52019904E-02-0.51958918E-02
-0.51896[illegible]E-02-0.51832569E-02-0.51764866E-02-0.51696098E-02-0.51624973E-02
-0.51551073E-02-0.51473968E-02-0.51393297E-02-0.51306831E-02-0.51221111E-02
-0.51127537E-02-0.51032279E-02-0.50932649E-02-0.50829486E-02-0.50722689E-02
-0.50612912E-02-0.50499582E-02-0.50382896E-02-0.50262838E-02-0.50139370E-02
-0.50012462E-02-0.49882093E-02-0.49748254E-02-0.49610729E-02-0.49470223E-02
-0.49326071E-02-0.49178491E-02-0.49027416E-02-0.48872699E-02-0.48714065E-02
-0.48550921E-02-0.48383388E-02-0.48210336E-02-0.48031497E-02-0.47846506E-02
-0.47655106E-02-0.47457117E-02-0.47252369E-02-0.47040659E-02-0.46821681E-02
-0.46594921E-02-0.46359531E-02-0.46114443E-02-0.45856914E-02-0.45592948E-02
-0.45316844E-02-0.45030573E-02-0.44733547E-02-0.44424224E-02-0.44098861E-02
-0.4376[illegible]93[illegible]E-02-0.43384720E-02-0.43012654E-02-0.42633680E-02-0.42244347E-02
-0.41841979E-02-0.41422825E-02-0.41421219E-02-0.40949062E-02-0.40457688E-02
-0.[illegible]525415E-02
```

CORRECT VALUE: -0.00000000E-38

CORRECT VALUE: -0.80380230E-04

G(x)

```
0.[illegible]62172E 01 0.86562172E 01-0.12047589E-03-0.19608436E-03-0.26565790E-03
-0.3282[illegible]76[illegible]E-03-0.38389862E-03-0.43331067E-03-0.47740340E-03-0.51735342E-03
-0.55424869E-03-0.58932602E-03-0.62407553E-03-0.66047907E-03-0.70078671E-03
-0.74754655E-03-0.80262125E-03-0.86675584E-03-0.93907118E-03-0.10172129E-02
-0.10979772E-02-0.11782795E-02-0.12553781E-02-0.13273209E-02-0.13928860E-02
-0.14511794E-02-0.15019476E-02-0.15449375E-02-0.15805215E-02-0.16095936E-02
-0.163[illegible]2402E-02-0.16582161E-02-0.17555803E-02-0.17625540E-02-0.18099099E-02
-0.18694103E-02-0.19420683E-02-0.20261705E-02-0.21179616E-02-0.21898150E-02
-0.2354555[illegible]E-02-0.23702383E-02-0.24634424E-02-0.25636256E-02-0.26387870E-02
-0.270[illegible]060E-02-0.27775168E-02-0.28428260E-02-0.29062182E-02-0.29677302E-02
-0.30269921E-02-0.30829459E-02-0.31341612E-02-0.31911880E-02-0.32025874E-02
-0.32411069E-02-0.32573044E-02-0.32647699E-02-0.32669753E-02-0.32692552E-02
-0.32916740E-02-0.32870024E-02-0.33565595E-02-0.33917725E-02-0.34550279E-02
-0.35203323E-02-0.35794154E-02-0.36243051E-02-0.36472529E-02-0.36413148E-02
-0.36064833E-02-0.35660192E-02-0.35765609E-02-0.36571026E-02-0.38702637E-02
-0.40673763E-02-0.42216852E-02-0.43091550E-02-0.42985603E-02-0.41281730E-02
-0.3[illegible]321950E-02-0.38972311E-02-0.44092238E-02-0.48341453E-02-0.50828084E-02
-0.45007915E-02-0.43007955E-02-0.50626010E-02-0.40866658E-02-0.43007955E-02
-0.50[illegible]28084E-02
```

X

```
0.31415926E 01 0.31380156E 01 0.31344391E 01 0.31308635E 01 0.31272888E 01
0.31237144E 01 0.31201397E 01 0.31165635E 01 0.31129843E 01 0.31094006E 01
0.31058107E 01 0.31022131E 01 0.30986062E 01 0.30949888E 01 0.30913603E 01
0.30877206E 01 0.30840712E 01 0.30804131E 01 0.30767483E 01 0.30730784E 01
0.30694046E 01 0.30657272E 01 0.30620454E 01 0.30583578E 01 0.30546623E 01
0.30509558E 01 0.30472350E 01 0.30434959E 01 0.30397341E 01 0.30359451E 01
0.30321246E 01 0.30282703E 01 0.30244138E 01 0.30205122E 01 0.30165824E 01
0.30126292E 01 0.30086589E 01 0.30046775E 01 0.30006894E 01 0.29966835E 01
0.29927160E 01 0.29886971E 01 0.29846853E 01 0.29806612E 01 0.29766215E 01
0.29725[illegible]30E 01 0.29684827E 01 0.29643782E 01 0.29602470E 01 0.29560867E 01
0.29518941E 01 0.29476654E 01 0.29433950E 01 0.29390855E 01 0.29346982E 01
0.29302506E 01 0.29257198E 01 0.29210924E 01 0.29163565E 01 0.29115042E 01
0.29065479E 01 0.29014511E 01 0.28962673E 01 0.28909946E 01 0.28856403E 01
0.28802034E 01 0.28746720E 01 0.28690226E 01 0.28632180E 01 0.28572043E 01
0.28509167E 01 0.28443158E 01 0.28374670E 01 0.28304796E 01 0.28236077E 01
0.281[illegible]195E 01 0.28100385E 01 0.28031456E 01 0.27959496E 01 0.27880681E 01
0.277[illegible]891E 01 0.27695922E 01 0.27611556E 01 0.27555143E 01 0.27456545E 01
0.2737[illegible]2[illegible]E 01 0.27299[illegible]E 01 0.27502985E 01 0.27387449E 01 0.27273197E 01
0.27491547E 01
              0.42097915E 01 0.42399363E 01 0.42765555E 01 0.43434605E 01
```

CORRECT VALUE: 0.41993700E 01

AR(x)

```
0.86067116E 00
0.44040542E 01 0.44598977E 01 0.45030095E 01 0.45268142E 01 0.45273212E 01
0.45039572E 01 0.44598922E 01 0.44017614E 01 0.43387725E 01 0.42812907E 01
0.42391118E 01 0.42197613E 01 0.42272093E 01 0.42613063E 01 0.43180158E 01
0.43902572E 01 0.44690434E 01 0.45446258E 01 0.46074962E 01 0.46492237E 01
0.46631665E 01 0.46451104E 01 0.45938582E 01 0.45117545E 01 0.44050750E 01
0.42841287E 01 0.41798850E 01 0.40839536E 01 0.40005945E 01 0.39665192E 01
0.39825865E 01 0.40512673E 01 0.41687458E 01 0.43188652E 01 0.45189035E 01
0.47161772E 01 0.48930276E 01 0.50819089E 01 0.52309213E 01 0.53380896E 01
0.53936727E 01 0.53908185E 01 0.53261561E 01 0.52001292E 01 0.50169401E 01
0.47840520E 01 0.45113050E 01 0.42145150E 01 0.38908545E 01 0.35611450E 01
0.32420881E 01 0.29304805E 01 0.26380429E 01 0.23717754E 01 0.21403542E 01
0.19375031E 01 0.17685545E 01 0.16313287E 01 0.15077339E 01 0.13877388E 01
0.12604884E 01 0.11195794E 01 0.96465924E 00 0.80180298E 00 0.64307357E 00
0.50512233E 00 0.40465870E 00 0.34719419E 00 0.32609874E 00 0.32013608E 00
0.30591761E 00 0.27346367E 00 0.22199004E 00 0.15847420E 00 0.99169598E-01
0.69252137E-01 0.77111484E-01 0.10311358E 00 0.12123597E 00 0.12135480E 00
0.10355069E 00-0.96192952E-01-0.89663452E-01 0.20959395E-01-0.68468819E-01
-0.60586753E-01
```

CORRECT VALUE: -0.20513400E 01

AI(x)

```
0.42043407E 00-0.20564645E 01-0.20711911E 01-0.20938657E 01-0.21217710E 01
-0.21513610E 01-0.21786403E 01-0.21997003E 01-0.22113287E 01-0.22115764E 01
-0.22001632E 01-0.21786377E 01-0.21502410E 01-0.21194712E 01-0.20913916E 01
-0.20707874E 01-0.20613348E 01-0.20649731E 01-0.20816293E 01-0.21093316E 01
-0.21446213E 01-0.21831080E 01-0.22200296E 01-0.22507415E 01-0.22711252E 01
-0.22779362E 01-0.22691159E 01-0.22440795E 01-0.22039721E 01-0.21518597E 01
-0.20927779E 01-0.20418554E 01-0.19949933E 01-0.19542727E 01-0.19376271E 01
-0.19454759E 01-0.19790262E 01-0.20364139E 01-0.21097466E 01-0.22074644E 01
-0.23038318E 01-0.23902224E 01-0.24824901E 01-0.25552820E 01-0.26076332E 01
-0.26347853E 01-0.26333911E 01-0.26018037E 01-0.25402402E 01-0.24507531E 01
-0.23369883E 01-0.22037525E 01-0.20587720E 01-0.19006652E 01-0.17396036E 01
-0.15837457E 01-0.14315268E 01-0.12886723E 01-0.11586018E 01-0.10455536E 01
-0.94646171E 00-0.86393107E 00-0.79689686E 00-0.73652136E 00-0.67790429E 00
-0.61574300E 00-0.54690960E 00-0.47123178E 00-0.39167721E 00-0.31413860E 00
-0.24675003E 00-0.19767399E 00-0.16960283E 00-0.15929779E 00-0.15638506E 00
-0.14943940E 00-0.13358580E 00-0.10844115E 00-0.77413946E-01-0.48443911E-01
-0.33829363E-01-0.37668619E-01-0.50370527E-01-0.59223238E-01-0.59281285E-01
-0.50584053E-01 0.46989833E-01 0.43800201E-01-0.10238572E-01 0.33446716E-01
0.39366273E-01
```

Sample output: punched cards (contd)

BR(x)

```
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38
```

BI(x)

```
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38
```

CR(x)

```
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38
```

CI(x)

```
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38 0.00000000E-38
0.00000000E-38
```

DR(x)

```
-0.41993564E 01-0.42093734E 01-0.42363499E 01-0.42830765E 01-0.43363329E 01
-0.43972285E 01-0.44519410E 01-0.44947591E 01-0.45193058E 01-0.45216792E 01
-0.45012651E 01-0.44610443E 01-0.44072814E 01-0.43486367E 01-0.42947838E 01
-0.42547870E 01-0.42355534E 01-0.42407022E 01-0.42701107E 01-0.43201554E 01
-0.43844845E 01-0.44550394E 01-0.45230725E 01-0.45501046E 01-0.46185889E 01
-0.46325822E 01-0.46136674E 01-0.45750005E 01-0.45058035E 01-0.44145823E 01
-0.43107403E 01-0.42057961E 01-0.41138698E 01-0.40471424E 01-0.40173739E 01
-0.40319366E 01-0.40928991E 01-0.41968998E 01-0.43361072E 01-0.44991493E 01
-0.46758870E 01-0.48496337E 01-0.50096033E 01-0.51433722E 01-0.52387135E 01
-0.52862675E 01-0.52790632E 01-0.52155259E 01-0.50899578E 01-0.49125885E 01
-0.46891147E 01-0.44297614E 01-0.41460208E 01-0.38494501E 01-0.35499862E 01
-0.32565772E 01-0.29759363E 01-0.27135804E 01-0.24740262E 01-0.22607040E 01
-0.20752560E 01-0.19157007E 01-0.17708360E 01-0.16495317E 01-0.15233660E 01
-0.13893239E 01-0.12423033E 01-0.10825907E 01-0.91620197E 00-0.75430281E 00
-0.61171748E 00-0.50346639E 00-0.43721036E 00-0.40457245E 00-0.38528360E 00
-0.36009181E 00-0.31944461E 00-0.26308850E 00-0.19779384E 00-0.13679343E 00
-0.10183697E 00-0.10702932E 00-0.12822453E 00-0.14117214E 00-0.13788360E 00
-0.11833522E 00-0.86649415E-01-0.56983212E-01-0.35195288E-01-0.52383516E-01
-0.83411145E-01
```

Sample output: punched cards (contd)

	0.20513671E 01	0.20562603E 01	0.20704152E 01	0.20922649E 01	0.21192564E 01
	0.21480267E 01	0.21747535E 01	0.21956699E 01	0.22076609E 01	0.22088203E 01
	0.21988486E 01	0.21792004E 01	0.21529375E 01	0.21242897E 01	0.20979829E 01
	0.20784449E 01	0.20690491E 01	0.20715643E 01	0.20859302E 01	0.21103768E 01
	0.21418013E 01	0.21762671E 01	0.22095058E 01	0.22373609E 01	0.22561603E 01
	0.22630351E 01	0.22561986E 01	0.22351899E 01	0.22010651E 01	0.21565039E 01
	0.21057779E 01	0.20545128E 01	0.20096072E 01	0.19770112E 01	0.19624694E 01
	0.19695833E 01	0.19993631E 01	0.20501670E 01	0.21181692E 01	0.21978146E 01
	0.22841502E 01	0.23690247E 01	0.24472961E 01	0.25125146E 01	0.25590884E 01
	0.25823183E 01	0.25787991E 01	0.25467844E 01	0.24864219E 01	0.23997778E 01
DI(x)	0.22906118E 01	0.21639189E 01	0.20253128E 01	0.18804394E 01	0.17341526E 01
	0.15908211E 01	0.14537317E 01	0.13255720E 01	0.12085509E 01	0.11043439E 01
	0.10137534E 01	0.93581132E 00	0.86797655E 00	0.80578896E 00	0.74415756E 00
	0.67867862E 00	0.60685966E 00	0.52884076E 00	0.44756062E 00	0.36847359E 00
	0.29882129E 00	0.24594111E 00	0.21357534E 00	0.19763186E 00	0.18820934E 00
	0.17590326E 00	0.15604728E 00	0.12851757E 00	0.96621415E-01	0.66822984E-01
	0.49746911E-01	0.52283352E-01	0.62637019E-01	0.68961966E-01	0.67355530E-01
	0.57806235E-01	0.42327857E-01	0.27836047E-01	0.17191766E-01	0.25589116E-01
	0.40745976E-01				
	0.31415926E 01	0.31380156E 01	0.31344391E 01	0.31308635E 01	0.31272888E 01
	0.31237144E 01	0.31201397E 01	0.31165635E 01	0.31129843E 01	0.31094006E 01
	0.31058107E 01	0.31022131E 01	0.30986062E 01	0.30949888E 01	0.30913603E 01
	0.30877208E 01	0.30840712E 01	0.30804131E 01	0.30767483E 01	0.30730784E 01
	0.30694046E 01	0.30657272E 01	0.30620454E 01	0.30583578E 01	0.30546623E 01
	0.30509558E 01	0.30472350E 01	0.30434959E 01	0.30397341E 01	0.30359451E 01
	0.30321248E 01	0.30282703E 01	0.30244138E 01	0.30205122E 01	0.30165824E 01
	0.30126292E 01	0.30086589E 01	0.30046775E 01	0.30006894E 01	0.29966835E 01
X	0.29927160E 01	0.29886971E 01	0.29846853E 01	0.29806612E 01	0.29766215E 01
	0.29725630E 01	0.29684827E 01	0.29643782E 01	0.29602470E 01	0.29560867E 01
	0.29518941E 01	0.29476654E 01	0.29433950E 01	0.29390855E 01	0.29346982E 01
	0.29302506E 01	0.29257198E 01	0.29210924E 01	0.29163565E 01	0.29115042E 01
	0.29065479E 01	0.29014511E 01	0.28962673E 01	0.28909946E 01	0.28856403E 01
	0.28802034E 01	0.28746720E 01	0.28690226E 01	0.28632180E 01	0.28572043E 01
	0.28509167E 01	0.28443158E 01	0.28374670E 01	0.28304798E 01	0.28236077E 01
	0.28168195E 01	0.28100385E 01	0.28031456E 01	0.27959496E 01	0.27880681E 01
	0.27789891E 01	0.27695922E 01	0.27611538E 01	0.27533143E 01	0.27456545E 01
	0.27379428E 01	0.27299406E 01	0.27502985E 01	0.27387449E 01	0.27273197E 01
	0.27491547E 01				

Page intentionally left blank

III. PLOTTING PROGRAM

A. Ludwig

N67-28724

Program: IBM 1620 only, source deck in Antenna and Propagation Group Library (revised May 18, 1966)

Programmer: A. Ludwig

A. Program Description

This program plots radiation amplitude and phase patterns (or other data) using the IBM 1627 plotter. The grid that the program draws is identical in size to antenna pattern recorder chart paper (Scientific-Atlanta Chart 121 or equivalent). E- and H-plane amplitude patterns are plotted on one grid (in decibels) and then phase patterns (in degrees) on a second grid. There is linear interpolation between data points. Program halts after completing each grid or pattern to allow a change of pens if multi-color plots are desired. Plotting is resumed by pressing "start" on console.

B. Applications

Plotting is an excellent method for checking output of computer programs such as the Scattering Program (VI), either against experimental data, or against what is reasonably to be expected for a given set of input data. Also, the data reduction of experimental patterns may be checked by plotting and overlaying with the originals.

C. Input

Input is identical to the input for the Antenna Feed Efficiency Program (IX), except that the program utilizes some parameters somewhat differently, as follows:

JO not used by program

ICI = 0 or -2 for amplitude input (in decibels); for 0, program plots values as input; for -2, program sets maximum data point equal to 0 db

= 1 or 2 for amplitude input (in volts); maximum data point set equal to 0 db for $ICI = 2$

$IC2$ = 1 to skip phase plots;

= 0 for phase plots expanded scale ($-30°$ to $+30°$ polar angle)

= -1 for phase plots normal scale ($-180°$ to $+180°$ polar angle)

Consecutive cases may be stacked without limit; 1620 machine time is approximately 5 min for 90 input points. If *ICI* = 0 or 1, amplitudes should be ≤ 0 db (≤ 1 v).

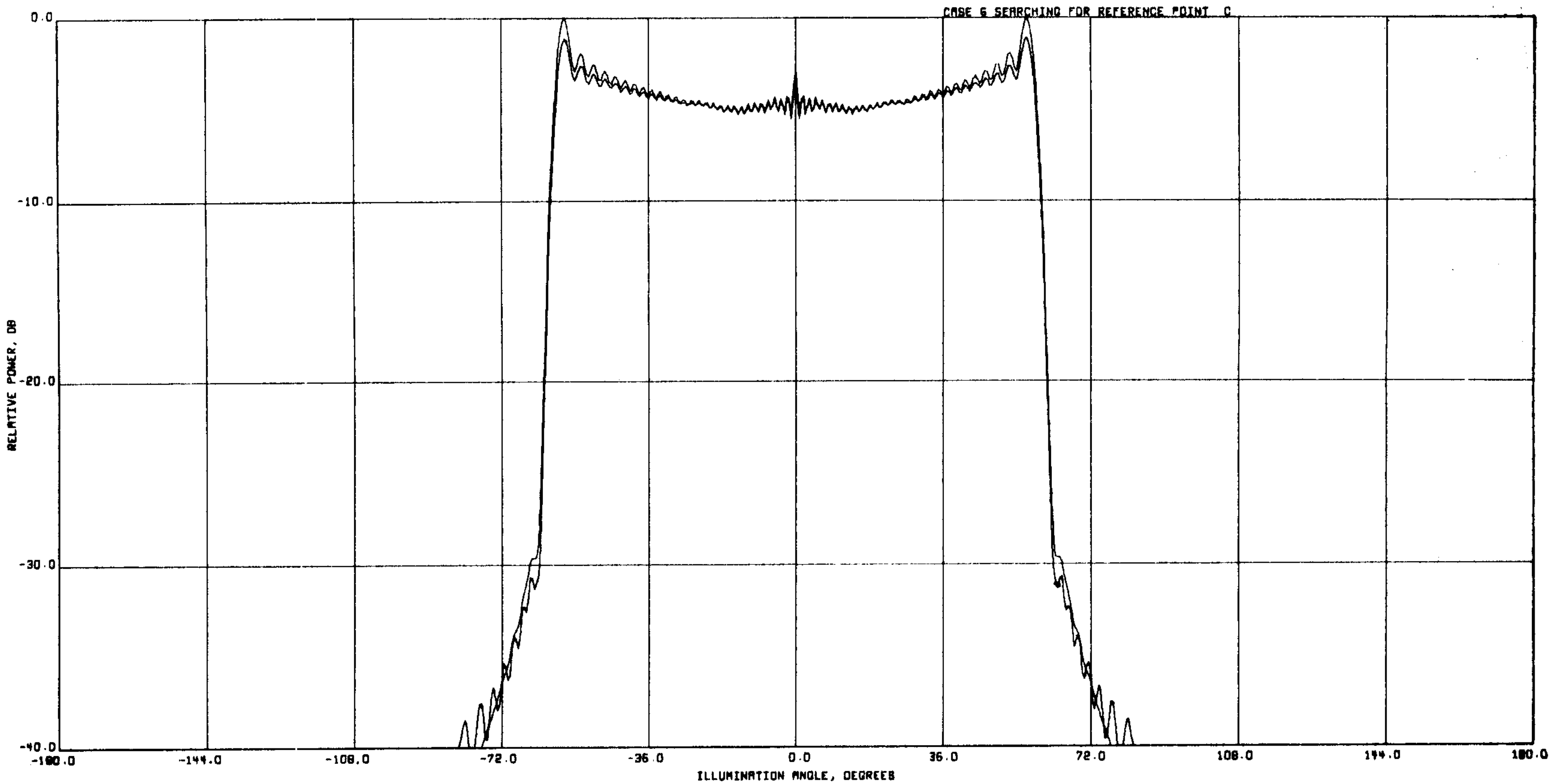
D. Output

Program always plots amplitude (in decibels), from 0 to -40 db, and from *PSI* = $-180°$ to $+180°$. Program plots amplitudes below -40 db as -40 db. Phase values are plotted from $+90°$ to $-90°$ of phase angle for normal scale, and $+45°$ to $-45°$ of phase angle for expanded scale; the value at *PSI* = $0°$ is set to $0°$ phase angle.

E. Sample Case

Input is identical to that of sample case for Antenna Feed Efficiency Program (IX).

Sample output: plotted



Page intentionally left blank

IV. DATA CONVERSION[1]

A. Ludwig

Program: IBM 1620 only, source deck in Antenna and Propagation Group Library (revised May 18, 1966)

Programmer: A. Ludwig

A. Program Description

This program converts feed pattern data from format compatible with Programs III, IX, and XIV to format compatible with Program VI. Field values are converted from amplitude (in decibels or volts) and phase (in degrees) to real and imaginary parts (in volts). The polar angle *PSI* (in degrees) is converted to $PSI = \pi - PSI$ (in radians).

[1]This program and Program VIII exist because several of the programs described in this Technical Report evolved independently, without coordination of input/output formats. Although these programs could be eliminated by modifying the other programs, the complicated interfaces within this system, and with other programs not described here, create a considerable reprogramming job that has not yet been undertaken.

B. Applications

See flow chart.

N67-28725

C. Input

Identical with the Antenna Feed Efficiency Program (IX).

D. Output

The data blocks Re *E*, Im *E*, Re *H*, Im *H*, and *PSI* are printed out. The same data is punched on binary-coded-decimal cards; in addition, four data blocks of zeros are punched, which are values of cross-polarization fields, always zero in the principal (E and H) planes for the types or fields assumed for Programs I, IX, and XIV.

E. Sample Case

Input is identical to that of sample case for Antenna Feed Efficiency Program (IX).

Sample output

.85524	.83818	.78872	.71163	.61418	.50502	.39315	.28675
.19236	.11435	.05472	.01331	-.01174	-.02349	-.02547	-.02122
-.01384	-.00575	.00137	.00665	.00974	.01078	.01016	.00839
.00600	.00342	.00100	-.00105	-.00264	-.00373	-.00435	-.00458
-.00451	-.00424	-.00381	-.00333	-.00282	-.00233	-.00189	-.00150
-.00118	-.00092	-.00072	-.00057	-.00049	-.00045	0.00000	0.00000
-.03894	-.03549	-.02563	-.01068	.00737	.02626	.04371	.05778
.06717	.07126	.07016	.06459	.05568	.04478	.03321	.02215
.01245	.00465	-.00102	-.00465	-.00649	-.00689	-.00628	-.00504
-.00352	-.00196	-.00056	.00058	.00145	.00202	.00234	.00244
.00238	.00222	.00199	.00173	.00146	.00120	.00097	.00077
.00060	.00047	.00036	.00029	.00025	.00023	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
-.85524	-.83549	-.77853	-.69081	-.58195	-.46314	-.34549	-.23853
-.14908	-.08076	-.03398	-.00659	.00536	.00662	.00186	-.00498
-.01109	-.01479	-.01554	-.01359	-.00968	-.00476	.00025	.00463
.00792	.00991	.01063	.01024	.00902	.00725	.00519	.00309
.00111	-.00063	-.00210	-.00325	-.00412	-.00473	-.00511	-.00533
-.00541	-.00540	-.00532	-.00519	-.00505	-.00488	0.00000	0.00000
.03894	.03568	.02643	.01270	-.00330	-.01914	-.03253	-.04175
-.04588	-.04488	-.03949	-.03100	-.02097	-.01092	-.00212	.00457
.00880	.01057	.01026	.00844	.00572	.00270	-.00013	-.00248
-.00414	-.00507	-.00535	-.00508	-.00442	-.00351	-.00249	-.00147
-.00052	.00029	.00098	.00151	.00190	.00217	.00234	.00244
.00246	.00246	.00242	.00236	.00229	.00221	0.00000	0.00000
3.14159	3.10668	3.07177	3.03687	3.00196	2.96705	2.93215	2.89724
2.86234	2.82743	2.79252	2.75762	2.72271	2.68780	2.65290	2.61799
2.58308	2.54818	2.51327	2.47836	2.44346	2.40855	2.37364	2.33874
2.30383	2.26892	2.23402	2.19911	2.16420	2.12930	2.09439	2.05948
2.02458	1.98967	1.95476	1.91986	1.88495	1.85004	1.81514	1.78023
1.74532	1.71042	1.67551	1.64060	1.60570	1.57079	1.56979	0.00000

V. SUBREFLECTOR PROGRAM

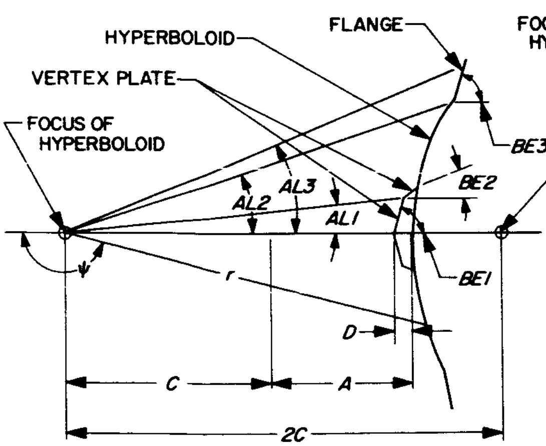
A. Ludwig

Program: IBM 1620 only, source deck in Antenna and Propagation Group Library (revised May 18, 1966)

Programmer: A. Ludwig

A. Program Description

This program generates binary-coded-decimal punched cards for use in the Scattering Program (VI), describing a subreflector consisting of a vertex plate, a hyperboloidal section, and a flange (Fig. 2). Subreflector must be a figure of revolution.



ALL LINEAR DIMENSIONS ARE IN CONSISTENT UNITS; ALL ANGLES ARE IN DEGREES

Fig. 2. Subreflector geometry

B. Applications

Various subreflector shapes may be generated to empirically optimize design parameters. (Results from the Cassegrainian Synthesis Program may be used to indicate potentially good configurations.)

C. Input

Card	Parameters	Format
1	*C A D AL1 AL2 AL3 BE1 BE2*	8F10.0
2	*BE3*	8F10.0
3	*IGO*	10I5

C = one-half the distance between the foci of the hyperboloidal section

A = *C*/*e*, where *e* is the eccentricity of the hyperboloidal section

D = height of vertex plate

AL1 = angle subtended by first section of vertex plate

AL2 = angle subtended by edge of hyperboloid

AL3 = angle subtended by edge of subreflector, with or without a flange

BE1 = cone angle of first section of vertex plate

BE2 = cone angle of second section of vertex plate

BE3 = cone angle of flange

IGO = 1 for general case

= 2 for single segment vertex plate described by *D* and *BE2* (set *AL1* = 0.0)

= 3 for no vertex plate. Program ignores *AL1*, *D*, *BE1*, and *BE2*.

For no flange, set *AL3* = *AL2*.

Consecutive cases may be stacked without limit. 1620 time is roughly 5 min/case.

D. Output

The program first prints out $g(\psi) = -1/r$, $(d/d\psi)\, g(\psi)$ and ψ (Fig. 2), in the form required for the Scattering Program (VI). All of the g values are printed, then all of the g' values, and then all of the ψ values (in radians). This portion of the output is identical to the punched output. The program then prints out r and ψ' (in degrees), where $\psi' = \psi - \pi$. The printed data is in a raw form because its primary use is for spot checks. The punched data is the primary output and is in exactly the correct form to use in the Scattering Program. 100 data points are always computed, which is the maximum that the Scattering Program will accept.

E. Sample Case

Sample input

```
285.0      188.16769 0.356      1.103      13.4766    14.655     88.881     84.032
71.5
3
```

Sample output, punched BCD cards

```
-.21134156E-02 -.21133946E-02 -.21133324E-02 -.21132285E-02 -.21130834E-02
-.21128963E-02 -.21126680E-02 -.21123983E-02 -.21120868E-02 -.21117339E-02
-.21113395E-02 -.21109037E-02 -.21104261E-02 -.21099073E-02 -.21093469E-02
-.21087449E-02 -.21081015E-02 -.21074166E-02 -.21066903E-02 -.21059224E-02
-.21051131E-02 -.21042624E-02 -.21033702E-02 -.21024365E-02 -.21014613E-02
-.21004447E-02 -.20993866E-02 -.20982872E-02 -.20971464E-02 -.20959641E-02
-.20947403E-02 -.20934753E-02 -.20921689E-02 -.20908209E-02 -.20894317E-02
-.20880013E-02 -.20865294E-02 -.20850160E-02 -.20834616E-02 -.20818655E-02
-.20802283E-02 -.20785497E-02 -.20768299E-02 -.20750690E-02 -.20732667E-02
-.20714231E-02 -.20695380E-02 -.20676121E-02 -.20656447E-02 -.20636364E-02
-.20615865E-02 -.20594956E-02 -.20573637E-02 -.20551905E-02 -.20529763E-02
-.20507209E-02 -.20484244E-02 -.20460867E-02 -.20437081E-02 -.20412883E-02
-.20388275E-02 -.20363259E-02 -.20337830E-02 -.20311993E-02 -.20285745E-02
-.20259088E-02 -.20232022E-02 -.20204546E-02 -.20176661E-02 -.20148367E-02
-.20119666E-02 -.20090555E-02 -.20061036E-02 -.20031109E-02 -.20000774E-02
-.19970033E-02 -.19938883E-02 -.19907326E-02 -.19875362E-02 -.19842991E-02
-.19810213E-02 -.19777030E-02 -.19743440E-02 -.19709445E-02 -.19675041E-02
-.19640236E-02 -.19605023E-02 -.19569406E-02 -.19533385E-02 -.19496958E-02
-.19460127E-02 -.19422891E-02 -.19391263E-02 -.19359749E-02 -.19328105E-02
-.19296331E-02 -.19264429E-02 -.19232399E-02 -.19200240E-02 -.19167953E-02
 .00000000E-99 -.16070777E-04 -.32141451E-04 -.48211910E-04 -.64282041E-04
-.80351751E-04 -.96420917E-04 -.11248944E-03 -.12855722E-03 -.14462413E-03
-.16069009E-03 -.17675497E-03 -.19281868E-03 -.20888109E-03 -.22494211E-03
-.24100161E-03 -.25705952E-03 -.27311573E-03 -.28917010E-03 -.30522253E-03
-.32127293E-03 -.33732119E-03 -.35336721E-03 -.36941084E-03 -.38545203E-03
-.40149065E-03 -.41752658E-03 -.43355972E-03 -.44958995E-03 -.46561719E-03
-.48164134E-03 -.49766227E-03 -.51367987E-03 -.52969404E-03 -.54570468E-03
-.56171169E-03 -.57771492E-03 -.59371432E-03 -.60970974E-03 -.62570104E-03
-.64168825E-03 -.65767113E-03 -.67364964E-03 -.68962367E-03 -.70559303E-03
-.72155775E-03 -.73751766E-03 -.75347253E-03 -.76942251E-03 -.78536723E-03
-.80130682E-03 -.81724105E-03 -.83316979E-03 -.84909302E-03 -.86501043E-03
-.88092220E-03 -.89682814E-03 -.91272796E-03 -.92862175E-03 -.94450933E-03
-.96039062E-03 -.97626550E-03 -.99213379E-03 -.10079955E-02 -.10238506E-02
-.10396987E-02 -.10555399E-02 -.10713741E-02 -.10872011E-02 -.11030209E-02
-.11188333E-02 -.11346383E-02 -.11504356E-02 -.11662253E-02 -.11820072E-02
-.11977812E-02 -.12135472E-02 -.12293051E-02 -.12450549E-02 -.12607963E-02
-.12765293E-02 -.12922537E-02 -.13079696E-02 -.13236767E-02 -.13393750E-02
-.13550642E-02 -.13707446E-02 -.13864157E-02 -.14020776E-02 -.14177301E-02
-.14333731E-02 -.14490067E-02 -.12172979E-02 -.12223038E-02 -.12273015E-02
-.12322910E-02 -.12372724E-02 -.12422455E-02 -.12472102E-02 -.12521666E-02
 .31415927E+01  .31390091E+01  .31364255E+01  .31338419E+01  .31312583E+01
 .31286747E+01  .31260911E+01  .31235074E+01  .31209238E+01  .31183402E+01
 .31157566E+01  .31131730E+01  .31105894E+01  .31080057E+01  .31054221E+01
 .31028385E+01  .31002549E+01  .30976713E+01  .30950877E+01  .30925040E+01
 .30899204E+01  .30873368E+01  .30847532E+01  .30821696E+01  .30795860E+01
 .30770023E+01  .30744187E+01  .30718351E+01  .30692515E+01  .30666679E+01
 .30640843E+01  .30615007E+01  .30589170E+01  .30563334E+01  .30537498E+01
 .30511662E+01  .30485826E+01  .30459990E+01  .30434153E+01  .30408317E+01
 .30382481E+01  .30356645E+01  .30330809E+01  .30304973E+01  .30279136E+01
 .30253300E+01  .30227464E+01  .30201628E+01  .30175792E+01  .30149956E+01
 .30124119E+01  .30098283E+01  .30072447E+01  .30046611E+01  .30020775E+01
 .29994939E+01  .29969102E+01  .29943266E+01  .29917430E+01  .29891594E+01
 .29865758E+01  .29839922E+01  .29814086E+01  .29788249E+01  .29762413E+01
 .29736577E+01  .29710741E+01  .29684905E+01  .29659069E+01  .29633232E+01
 .29607396E+01  .29581560E+01  .29555724E+01  .29529888E+01  .29504052E+01
 .29478215E+01  .29452379E+01  .29426543E+01  .29400707E+01  .29374871E+01
 .29349035E+01  .29323198E+01  .29297362E+01  .29271526E+01  .29245690E+01
 .29219854E+01  .29194018E+01  .29168181E+01  .29142345E+01  .29116509E+01
 .29090673E+01  .29064837E+01  .29039001E+01  .29013165E+01  .28987328E+01
 .28961492E+01  .28935656E+01  .28909820E+01  .28883984E+01  .28858148E+01
```

Page intentionally left blank

/M 3

VI. SCATTERING OF AN ARBITRARY SPHERICAL WAVE BY AN ARBITRARY SURFACE OF REVOLUTION

W. V. T. Rusch

N67-28727

Program: 5513, source and binary decks in Jet Propulsion Laboratory Library (written September 28, 1964)

Engineer: W. V. T. Rusch

Mathematician: W. V. T. Rusch

Programmer: W. Bunton

A. Program Description

This program computes the far-field scattering pattern of an arbitrary spherical wave scattered from an arbitrary surface of revolution (Ref. 11). The phase center of the incident spherical wave must lie on the axis of symmetry of the scatterer. This incident field may be expressed as a truncated Fourier series in the azimuthal coordinate containing a fundamental and second, third, and fourth harmonics.

The reflecting surface and the form of the incident field may be computed from analytical expressions (if available) or may be inputted into the computer in the form of discrete empirical data. The magnitude and phase of the incident field are described in terms of the real and imaginary parts of phasor functions of the polar coordinate.

The magnitude, phase, and polarization of the scattered field may be computed in any azimuthal plane.

B. Applications

This program has been used primarily to compute the scattered field from the subdish in a Cassegrainian feed system. However, the scattered fields from other conicoids may also be computed (paraboloids, cones, discs, ellipsoids, spheres, etc.) as well as arbitrary surfaces.

C. Input

The input to this program is compatible with the output from the Cassegrainian Synthesis Program (II). 7094 machine time is roughly proportional to $NY(N1 + N2)$ $(NP + 1)$, i.e., the number of integration points times the number of output angles. Typical production running time is approximately 5 min for 20 output angles, $NP = 1$; and 500 integration points.

Card	Parameters	Format
1	*JOB DESCRIPTION*	5A6
2	*KC Y1 DY X1 X2 X3 P1*	7F10.5
3	*DP*	F10.5
4	*M1 M2 N1 N2 NY NP IFN IAR ISPOT*	9I5
5	Reflector data	8F10.8
·		for 5513001
·		for 5513002
·		for 5513003
6	Incident field data	8F10.8 for 5513001
·		8F10.8 for 5513002
·		5E15.8 for 5513003

JOB DESCRIPTION = Card for binary-coded-decimal information to identify the particular job, Columns 2 to 30

KC = normalizing parameter for reflector dimensions

Y1 = initial output angle (measured as θ in Fig. 3), deg

DY = differential output angle, deg

X1 = lower limit of integration (Fig. 3), deg

X2 = intermediate limit of integration, deg

X3 = upper limit of integration, deg

P1 = initial azimuthal angle (measured as ϕ in Fig. 3), deg

DP = differential azimuthal angle, deg

M1 = first harmonic number of incident field (1 through 4)

M2 = final harmonic number of incident field (1 through 4)

N1 = number of points in the integration from *X1* to *X2* (*N1* must be even and $\leq$ 898)

N2 = number of points in the integration from *X2* to *X3* (*N2* must be even and $\leq$ 898)

NY = number of values of output polar angle minus one; NY $\leq$ 500

NP = number of output azimuthal angles (cuts) wanted minus one

IFN = number of values of $F(X)$, $G(X)$, independent variable for $F(X)$, $G(X)$, if these functions are to be read from cards (*IFN* may not be greater than 100.) *IFN* = 0 if subroutine *FIX* is to calculate $F(X)$ and $G(X)$

IAR = number of values for *AR*, *AI*, $\cdots$, *DR*, *DI* to describe incident field. (*IAR* may not be greater than 100.) *IAR* = 0 if subroutine *FIX* is to calculate these functions.

ISPOT = 1 if intermediate printout is desired; = 0 for production runs.

Reflector data = block of values of $F(X)$, then a block of values of $G(X)$, then a block of values of X. $F(X) \equiv 1/kr$, $G(X) \equiv (d/dX)$. $F(X)$, $X \equiv \theta'$ (in radians, see Fig. 3). The sequence of $F(X)$ and $G(X)$ must correspond to the sequence of X values (also see Program V). $F(X)$ may be input as $F(X) = -1/r$, if *KC* is input as $KC = 2\pi/\lambda$.

Incident field data = the values *AR*, *AI*, *BR*, *BI*, *CR*, *CI*, *DR*, *DI*, and *X*, the independent variable for these functions. Values are input in data blocks, i.e., a deck of cards for *AR*, then a deck of cards for *AI*, etc. $A = E_\phi$ at $\phi' = 0$; $B = E_\theta$ at $\phi' = 0$; $C = E_\phi$ at $\phi' = 90°$; $D = E_\theta$ at $\phi' = 90°$; *R* and *I* represent real and imaginary parts, respectively, and **E** is the incident field complex vector. Note

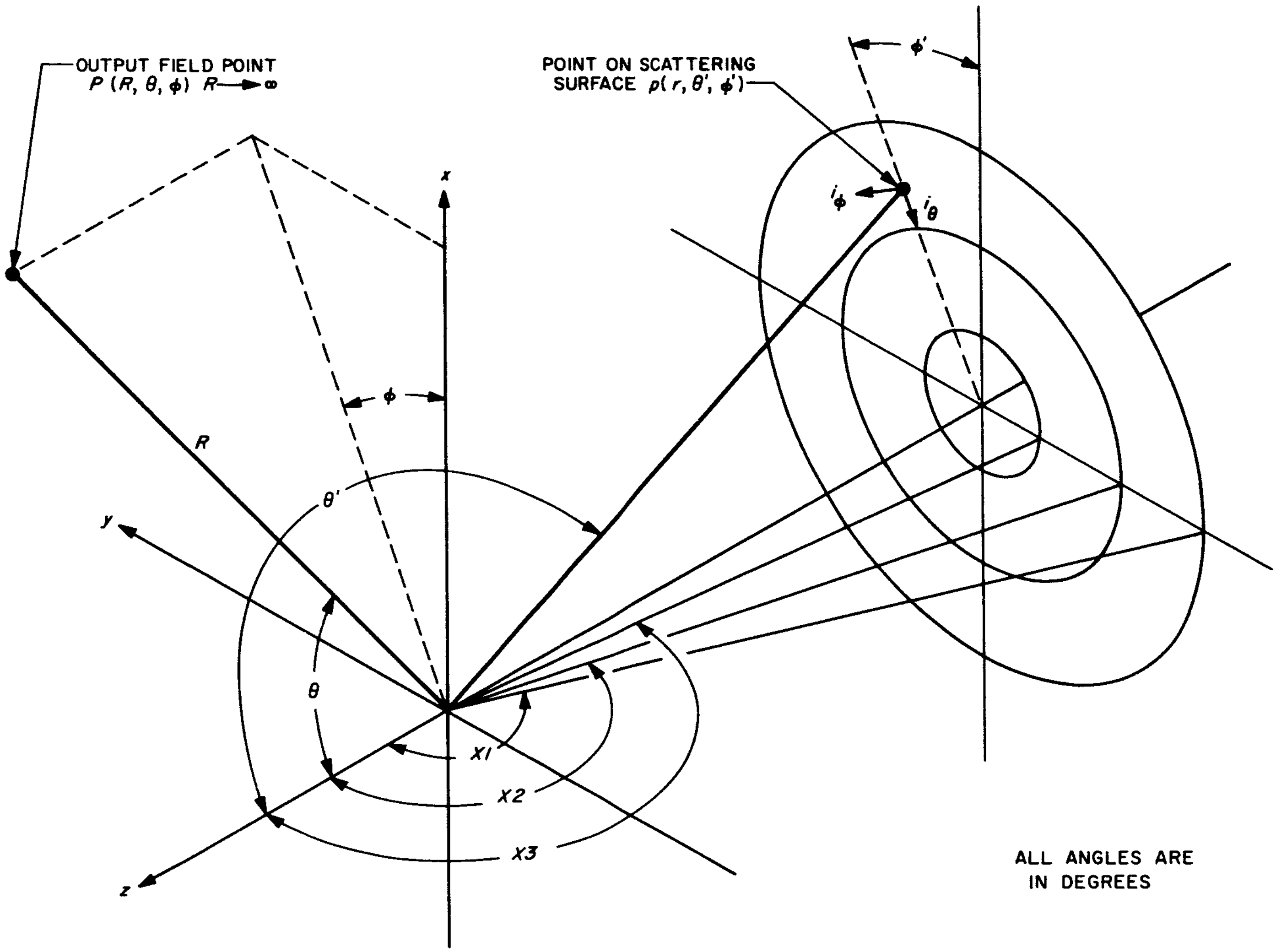


Fig. 3. Scattering surface geometry

that $D = (E_\theta \text{ at } \phi = 90°) = -(E_Y \text{ at } \phi = 90°)$. $X \equiv \theta'$, but not necessarily the same values as used for the reflector input data (also see Program IV).

D. Output

The output consists of both paper printout and punched cards. The printout initially repeats all input data and functions that may have been computed by subroutine *FIX*. For each azimuth angle *P*, the printed output consists of *Y*, the output angle, *S* and *T*, the real and imaginary parts of the θ-component of the electric field, *U* and *V*, the real and imaginary parts of the ϕ-component of the electric fields, and the magnitudes of both components. The punched card output for Program 5513001 consists of four cards for each value of *Y*, one with *Y* and *S*, one with *Y* and *T*, one with *Y* and *U*, and one with *Y* and *V* (Format F10.5, E20.8, 5A6). A data block is output for each value of *P*. This output is compatible with Program VII. The punched card output for Program 5513002 consists of one card for each value of *Y*, with *Y*, *S*, *T*, *U*, and *V* (Format F10.5, 4E17.8). This output is compatible with Program VIII.

E. Sample Case

Sample input

```
HYPERBOLOID SCATTERING
1.0000     0.0          0.50        163.500   171.250   180.0     0.0
90.0
    1     1  250  250   20    1    0   32    0
1.0            1.0            1.0            1.0            1.0
1.0            1.0            1.0            1.0            1.0
1.0            1.0            1.0            1.0            1.0
1.0            1.0            1.0            1.0            1.0
1.0            1.0            1.0            1.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0

0.0            0.0
-1.0           -1.0           -1.0           -1.0           -1.0
-1.0           -1.0           -1.0           -1.0           -1.0
-1.0           -1.0           -1.0           -1.0           -1.0
-1.0           -1.0           -1.0           -1.0           -1.0
-1.0           -1.0           -1.0           -1.0           0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0            0.0            0.0            0.0
0.0            0.0
  0.31415925E01  0.31290717E01  0.31165508E01  0.31040300E01  0.30915093E01
  0.30789883E01  0.30664676E01  0.30539466E01  0.30414259E01  0.30289050E01
  0.30163842E01  0.30038633E01  0.29913425E01  0.29788216E01  0.29663008E01
  0.29537799E01  0.29412591E01  0.29287382E01  0.29162174E01  0.29036965E01
  0.28911757E01  0.28786548E01  0.28661340E01  0.28536131E01  0.28500000E01
  0.27999999E01  0.23000000E01  0.17999999E01  0.13000000E01  0.80000000E00
  .30000000E 000.0
```

Sample output*

THE RUSCH INTEGRALS

```
KC=   1.22180     Y1(DEGREES)=   0.          DY=   1.00000     NO. INTERVALS FOR Y =    80
X1= 163.41000     X2= 172.00000     X3= 180.00000     NO. INTERVALS X1,X2=  250
NO. INTERVALS X2,X3 =  250     P1=   0.          DP=  90.00000     NO. INTERVALS FOR P=     1
M1=    1     M2=    1
POTTER RUSCH 1/12/65
```

THE F(X) FUNCTION FOLLOWS

-0.21131825E-02	-0.21131571E-02	-0.21130983E-02	-0.21129434E-02	-0.21127400E-02	-0.21124546E-02	-0.21120714E-02
-0.21115778E-02	-0.21109711E-02	-0.21102574E-02	-0.21094493E-02	-0.21085604E-02	-0.21076012E-02	-0.21065781E-02
-0.21054924E-02	-0.21043417E-02	-0.21031193E-02	-0.21018150E-02	-0.21004169E-02	-0.20989153E-02	-0.20973051E-02
-0.20955884E-02	-0.20937715E-02	-0.20918628E-02	-0.20898695E-02	-0.20877966E-02	-0.20856459E-02	-0.20834155E-02
-0.20811003E-02	-0.20786907E-02	-0.20761754E-02	-0.20735440E-02	-0.20707907E-02	-0.20679147E-02	-0.20649203E-02
-0.20618133E-02	-0.20586339E-02	-0.20553222E-02	-0.20519014E-02	-0.20483553E-02	-0.20447400E-02	-0.20409801E-02
-0.20371126E-02	-0.20331228E-02	-0.20290013E-02	-0.20247389E-02	-0.20203371E-02	-0.20157644E-02	-0.20110445E-02
-0.20061666E-02	-0.20011286E-02	-0.19959295E-02	-0.19905689E-02	-0.19850483E-02	-0.19793704E-02	-0.19735391E-02
-0.19675493E-02	-0.19614292E-02	-0.19551530E-02	-0.19487131E-02	-0.19421097E-02	-0.19353344E-02	-0.19283611E-02
-0.19211648E-02	-0.19137256E-02	-0.19060349E-02	-0.18980920E-02	-0.18898985E-02	-0.18814514E-02	-0.18727262E-02
-0.18636714E-02	-0.18542659E-02	-0.18445215E-02	-0.18344405E-02	-0.18239973E-02	-0.18131134E-02	-0.18032301E-02
-0.17920329E-02	-0.17804857E-02	-0.17685463E-02	-0.17561001E-02	-0.17427915E-02	-0.17291155E-02	-0.17152827E-02
-0.17010669E-02	-0.16863602E-02	-0.16709024E-02	-0.16607150E-02	-0.16443571E-02	-0.16279492E-02	-0.16110718E-02

Δ = +.00332153E-02

THE G(X) FUNCTION FOLLOWS

-0.71227551E-05	-0.71376562E-05	-0.16510487E-04	-0.43362378E-04	-0.56855381E-04	-0.79698861E-04	-0.10697544E-03
-0.13764203E-03	-0.16918778E-03	-0.19890814E-03	-0.22502244E-03	-0.24722517E-03	-0.26629119E-03	-0.28344989E-03
-0.29995292E-03	-0.31700730E-03	-0.33577532E-03	-0.35730749E-03	-0.38208812E-03	-0.40961801E-03	-0.43842196E-03
-0.46662986E-03	-0.49273670E-03	-0.51610172E-03	-0.53697824E-03	-0.55599958E-03	-0.57405978E-03	-0.59220195E-03
-0.61161070E-03	-0.63347816E-03	-0.65857171E-03	-0.68666041E-03	-0.71646272E-03	-0.74617565E-03	-0.77419727E-03
-0.79974531E-03	-0.81074238E-03	-0.84193051E-03	-0.86430459E-03	-0.89197606E-03	-0.89792161E-03	-0.93097985E-03
-0.94911084E-03	-0.97192451E-03	-0.99727510E-03	-0.10254420E-02	-0.10520183E-02	-0.10912605E-02	-0.11196025E-02
-0.11519194E-02	-0.11841989E-02	-0.12161285E-02	-0.12470520E-02	-0.12758896E-02	-0.13013072E-02	-0.13221911E-02
-0.13429411E-02	-0.13425685E-02	-0.13522542E-02	-0.13613664E-02	-0.13637020E-02	-0.13637133E-02	-0.13735183E-02
-0.13943203E-02	-0.14240332E-02	-0.14550202E-02	-0.14785527E-02	-0.14865658E-02	-0.14741458E-02	-0.14598443E-02
-0.14948434E-02	-0.15736222E-02	-0.16413294E-02	-0.16736053E-02	-0.16492157E-02	-0.15555508E-02	-0.15555470E-02
-0.17520189E-02	-0.18489546E-02	-0.18860921E-02	-0.18421710E-02	-0.16512517E-02	-0.17894842E-02	-0.20183474E-02
-0.21055788E-02	-0.21374989E-02	-0.20519140E-02	0.41420534E-02	-0.20519160E-02	-0.22720788E-02	-0.23444816E-02

→ G(x) = .00332153E-02 / .0144205 = -0.2308193E-02

THE INDEPENDENT VARIABLE OF F(X),G(X)

0.31415924E 01	0.31380229E 01	0.31344514E 01	0.31308784E 01	0.31273016E 01	0.31237213E 01	0.31201380E 01
0.31165525E 01	0.31129656E 01	0.31093770E 01	0.31057858E 01	0.31021900E 01	0.30985881E 01	0.30949783E 01
0.30913588E 01	0.30877288E 01	0.30840881E 01	0.30804376E 01	0.30767786E 01	0.30731124E 01	0.30694398E 01
0.30657607E 01	0.30620732E 01	0.30583748E 01	0.30546627E 01	0.30509343E 01	0.30471877E 01	0.30434217E 01
0.30396360E 01	0.30358323E 01	0.30320130E 01	0.30281808E 01	0.30243377E 01	0.30204833E 01	0.30166156E 01
0.30127306E 01	0.30088090E 01	0.30048756E 01	0.30009177E 01	0.29969420E 01	0.29929159E 01	0.29888771E 01
0.29848022E 01	0.29806971E 01	0.29765643E 01	0.29724076E 01	0.29682235E 01	0.29640333E 01	0.29598176E 01
0.29555827E 01	0.29513285E 01	0.29470532E 01	0.29427546E 01	0.29384277E 01	0.29340646E 01	0.29296541E 01
0.29251940E 01	0.29206353E 01	0.29159942E 01	0.29112636E 01	0.29064212E 01	0.29014530E 01	0.28963762E 01
0.28912149E 01	0.28859908E 01	0.28807051E 01	0.28753331E 01	0.28698213E 01	0.28640912E 01	0.28581143E 01
0.28520569E 01	0.28460801E 01	0.28401431E 01	0.28341196E 01	0.28277873E 01	0.28207906E 01	0.28238806E 01
0.28174896E 01	0.28112444E 01	0.28049140E 01	0.27981577E 01	0.27900980E 01	0.27824558E 01	0.27756021E 01
0.27688506E 01	0.27619702E 01	0.27545214E 01	0.27569810E 01	0.27490091E 01	0.27417874E 01	0.27345886E 01

Δ = -.00144205E+01
= -.0144205

*Sample output does not relate to sample input shown on p. 34.

Sample output

```
THE INPUT FUNCTIONS   AR,AI,....DR,DI WITH M=     1

AR FUNCTION
   0.23338953E 01    0.23132119E 01    0.22564832E 01    0.21778174E 01    0.20947453E 01    0.20250852E 01    0.19805586E 01
   0.19661534E 01    0.19805936E 01    0.20174737E 01    0.20661529E 01    0.21133158E 01    0.21459749E 01    0.21552002E 01
   0.21389546E 01    0.21027377E 01    0.20577289E 01    0.20171545E 01    0.19923058E 01    0.19896439E 01    0.20096172E 01
   0.20469122E 01    0.20916943E 01    0.21317907E 01    0.21557418E 01    0.21560857E 01    0.21318153E 01    0.20890563E 01
   0.20395847E 01    0.19975238E 01    0.19752622E 01    0.19799478E 01    0.20115881E 01    0.20630431E 01    0.21216623E 01
   0.21678866E 01    0.21951564E 01    0.21965881E 01    0.21643216E 01    0.20993249E 01    0.20232400E 01    0.19565392E 01
   0.19091111E 01    0.19013608E 01    0.19386704E 01    0.20156027E 01    0.21231794E 01    0.22386239E 01    0.23363767E 01
   0.24031805E 01    0.24254560F 01    0.23997232E 01    0.23299312E 01    0.22243305E 01    0.20913927E 01    0.19390149E 01
   0.17623194E 01    0.15684134E 01    0.13691154E 01    0.11675946E 01    0.97800995E 00    0.81812004E 00    0.69517168E 00
   0.60142492E 00    0.52039888E 00    0.43716953E-00    0.34688661E-00    0.25660425E-00    0.18268394E-00    0.14124028E-00
   0.12947629E-00    0.12508303E-00    0.11021382E-00    0.82276043E-01    0.50585490E-01    0.12599757E-00    0.16914026E-00
   0.52542482E-01    0.51150163E-01    0.38171814E-01    0.19947217E-01    0.12858126E-01    0.21873327E-01    0.30159573E-01
   0.29694446E-01    0.21254317E-01    0.31979988E-01    0.20593189E-01    0.15184283E-01    0.20881171E-01    0.20041896E-01
  -0.               -0.               -0.               -0.

AI FUNCTION
   0.49997930E 01    0.49554840E 01    0.48339570E 01    0.46654352E 01    0.44874732E 01    0.43382441E 01    0.42428568E 01
   0.42119969E 01    0.42429315E 01    0.43219383E 01    0.44262214E 01    0.45272562E 01    0.45972199E 01    0.46169830E 01
   0.45821811E 01    0.45045954E 01    0.44081751E 01    0.43212543E 01    0.42680223E 01    0.42623197E 01    0.43051074E 01
   0.43850027E 01    0.44809373E 01    0.45668342E 01    0.46181432E 01    0.46188802E 01    0.45668868E 01    0.44752865E 01
   0.43693057E 01    0.42792003E 01    0.42315103E 01    0.42415481E 01    0.43093295E 01    0.44195596E 01    0.45451367E 01
   0.46441606E 01    0.47025795E 01    0.47056465E 01    0.46365235E 01    0.44972842E 01    0.43342914E 01    0.41914009E 01
   0.40897981E 01    0.40731949E 01    0.41531216E 01    0.43179301E 01    0.45483864E 01    0.47956977E 01    0.50051089E 01
   0.51482197E 01    0.51959394E 01    0.51408132E 01    0.49913010E 01    0.47650775E 01    0.44802915E 01    0.41538598E 01
   0.37753335E 01    0.33599375E 01    0.29329912E 01    0.25012828E 01    0.20951442E 01    0.17526197E 01    0.14892332E 01
   0.12884039E 01    0.11148258E 01    0.93652754E 00    0.74311870E 00    0.54971111E 00    0.39135513E-00    0.30257235E-00
   0.27737091E-00    0.26795944E-00    0.23610587E-00    0.17625605E-00    0.10836688E-00    0.26991864E-00    0.36234116E-00
   0.11255926E-00    0.10957655E-00    0.81773669E-01    0.42731978E-01    0.27545355E-01    0.46858189E-01    0.64609423E-01
   0.63613005E-01    0.45532116E-01    0.68509210E-01    0.44115814E-01    0.32528567E-01    0.44732741E-01    0.42934801E-01
  -0.               -0.               -0.               -0.

BR FUNCTION
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
  -0.               -0.               -0.               -0.

BI FUNCTION
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
  -0.               -0.               -0.               -0.

CR FUNCTION
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
  -0.               -0.               -0.               -0.

CI FUNCTION
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
   0.                0.                0.                0.                0.                0.                0.
  -0.               -0.               -0.               -0.
```

Sample output (contd)

```
DR FUNCTION
   -0.23338953E 01   -0.23134511E 01   -0.22571349E 01   -0.21788950E 01   -0.20964662E 01   -0.20268815E 01   -0.19818743E 01
   -0.19664709E 01   -0.19796503E 01   -0.20153896E 01   -0.20634151E 01   -0.21106395E 01   -0.21441048E 01   -0.21547186E 01
   -0.21401267E 01   -0.21054094E 01   -0.20613047E 01   -0.20206992E 01   -0.19947854E 01   -0.19902427E 01   -0.20080155E 01
   -0.20434088E 01   -0.20871361E 01   -0.21273483E 01   -0.21526147E 01   -0.21552160E 01   -0.21336462E 01   -0.20933657E 01
   -0.20454425E 01   -0.20034485E 01   -0.19795951E 01   -0.19813365E 01   -0.20093942E 01   -0.20575301E 01   -0.21139293E 01
   -0.21639057E 01   -0.21932194E 01   -0.21927645E 01   -0.21599890E 01   -0.21009506E 01   -0.20285896E 01   -0.19613160E 01
   -0.19171592E 01   -0.19103114E 01   -0.19468222E 01   -0.20226527E 01   -0.21242829E 01   -0.22323360E 01   -0.23252971E 01
   -0.23851874E 01   -0.24008489E 01   -0.23697320E 01   -0.22969680E 01   -0.21920113E 01   -0.20641389E 01   -0.19189937E 01
   -0.17582136E 01   -0.15819681E 01   -0.13937002E 01   -0.12023465E 01   -0.10217320E 01   -0.86589221E 00   -0.74168625E 00
   -0.64357711E 00   -0.55710001E 00   -0.46908452E-00   -0.37559713E-00   -0.28345349E-00   -0.20741790E-00   -0.16257174E-00
   -0.14694988E-00   -0.13863739E-00   -0.12100255E-00   -0.92060582E-01   -0.60190377E-01   -0.42440836E-01   -0.50728851E-01
   -0.58209260E-01   -0.55590361E-01   -0.42553435E-01   -0.24797013E-01   -0.16593838E-01   -0.25585447E-01   -0.32612764E-01
   -0.31688628E-01   -0.23482151E-01   -0.11746039E-01   -0.89065889E-02   -0.17258739E-01   -0.22171634E-01   -0.21147832E-01
   -0.               -0.               -0.               -0.

DI FUNCTION
   -0.49997931E 01   -0.49559968E 01   -0.48353532E 01   -0.46677435E 01   -0.44911604E 01   -0.43420922E 01   -0.42456751E 01
   -0.42126773E 01   -0.42409109E 01   -0.43174734E 01   -0.44203564E 01   -0.45215230E 01   -0.45932138E 01   -0.46159513E 01
   -0.45846920E 01   -0.45103187E 01   -0.44158352E 01   -0.43288480E 01   -0.42733339E 01   -0.42636025E 01   -0.43016765E 01
   -0.43774978E 01   -0.44711727E 01   -0.45573172E 01   -0.46114444E 01   -0.46170172E 01   -0.45708092E 01   -0.44845182E 01
   -0.43818543E 01   -0.42918925E 01   -0.42407925E 01   -0.42445233E 01   -0.43046301E 01   -0.44077490E 01   -0.45285705E 01
   -0.46356324E 01   -0.46984300E 01   -0.46974554E 01   -0.46272421E 01   -0.45007669E 01   -0.43457514E 01   -0.42016343E 01
   -0.41070390E 01   -0.40923696E 01   -0.41705848E 01   -0.43330332E 01   -0.45507504E 01   -0.47822274E 01   -0.49813739E 01
   -0.51096738E 01   -0.51432245E 01   -0.50765645E 01   -0.49206855E 01   -0.46958417E 01   -0.44219067E 01   -0.41109690E 01
   -0.37665375E 01   -0.33889753E 01   -0.29856580E 01   -0.25757299E 01   -0.21888082E 01   -0.18549597E 01   -0.15888792E 01
   -0.13787047E 01   -0.11934488E 01   -0.10048974E 01   -0.80462394E 00   -0.60722898E 00   -0.44434153E-00   -0.34826972E-00
   -0.31480376E-00   -0.29699629E-00   -0.25921801E-00   -0.19721702E-00   -0.12894299E-00   -0.90918989E-01   -0.10867400E-00
   -0.12469893E-00   -0.11908858E-00   -0.91160202E-01   -0.53121465E-01   -0.35548192E-01   -0.54810487E-01   -0.69864777E-01
   -0.67885042E-01   -0.50304700E-01   -0.25162984E-01   -0.19080161E-01   -0.36972579E-01   -0.47497240E-01   -0.45303997E-01
   -0.               -0.               -0.               -0.

THE INDEP. VARIABLE FOR THE AR,.....,DI
    0.31415924E 01    0.31380229E 01    0.31344514E 01    0.31308784E 01    0.31273016E 01    0.31237213E 01    0.31201380E 01
    0.31165525E 01    0.31129656E 01    0.31093770E 01    0.31057858E 01    0.31021900E 01    0.30985881E 01    0.30949783E 01
    0.30913588E 01    0.30877288E 01    0.30840881E 01    0.30804376E 01    0.30767786E 01    0.30731124E 01    0.30694398E 01
    0.30657607E 01    0.30620732E 01    0.30583748E 01    0.30546627E 01    0.30509343E 01    0.30471877E 01    0.30434217E 01
    0.30396360E 01    0.30358323E 01    0.30320130E 01    0.30281808E 01    0.30243377E 01    0.30204833E 01    0.30166156E 01
    0.30127306E 01    0.30088090E 01    0.30048756E 01    0.30009177E 01    0.29969420E 01    0.29929159E 01    0.29888771E 01
    0.29848022E 01    0.29806971E 01    0.29765643E 01    0.29724076E 01    0.29682235E 01    0.29640333E 01    0.29598176E 01
    0.29555827E 01    0.29513285E 01    0.29470532E 01    0.29427546E 01    0.29384277E 01    0.29340646E 01    0.29296541E 01
    0.29251940E 01    0.29206353E 01    0.29159942E 01    0.29112636E 01    0.29064212E 01    0.29014530E 01    0.28963762E 01
    0.28912149E 01    0.28859908E 01    0.28807051E 01    0.28753331E 01    0.28698213E 01    0.28640912E 01    0.28581143E 01
    0.28520569E 01    0.28460801E 01    0.28401431E 01    0.28341196E 01    0.28277873E 01    0.28207906E 01    0.28238806E 01
    0.28174896E 01    0.28112444E 01    0.28049140E 01    0.27981577E 01    0.27900980E 01    0.27824558E 01    0.27756021E 01
    0.27688506E 01    0.27619702E 01    0.27545214E 01    0.27569810E 01    0.27490091E 01    0.27417874E 01    0.27345886E 01
    0.27299999E 01    0.20000000E 01    0.09999999E 01   -0.
```

Sample output

THE VALU OF P= 0.

Y	S	T	U	V	SQRT(S2+T2)	SQRT(U2+V2)
0.	0.	0.	0.35583942E-00	0.77949439E 00	0.	0.85687408E 00
0.99999998E 00	0.	0.	0.35948051E-00	0.73864448E 00	0.	0.82147545E 00
0.19999999E 01	0.	0.	0.10958829E-00	0.88032847E 00	0.	0.88712333E 00
0.29999999E 01	-0.	0.	-0.31417049E-00	0.84997202E 00	0.	0.90617631E 00
0.39999998E 01	-0.	0.	-0.89861312E 00	0.40380753E-00	0.	0.98517311E 00
0.49999998E 01	-0.	-0.	-0.89051682E 00	-0.49561550E-00	0.	0.10191441E 01
0.59999998E 01	0.	-0.	0.11706554E-00	-0.10622702E 01	0.	0.10687012E 01
0.69999997E 01	0.	-0.	0.10515655E 01	-0.10991607E-00	0.	0.10572945E 01
0.79999997E 01	0.	0.	0.78987770E-01	0.10767899E 01	0.	0.10796831E 01
0.89999995E 01	-0.	-0.	-0.10359456E 01	-0.15066653E-00	0.	0.10468446E 01
0.99999996E 01	0.	-0.	0.58222304E 00	-0.86397347E 00	0.	0.10418415E 01
0.10999999E 02	0.	0.	0.31157880E-00	0.92885739E 00	0.	0.97972312E 00
0.11999999E 02	-0.	-0.	-0.84169162E 00	-0.48625427E-00	0.	0.97205349E 00
0.13000000E 02	0.	0.	0.94435875E 00	0.12009265E-01	0.	0.94443510E 00
0.13999999E 02	-0.	0.	-0.92186511E 00	0.29001655E-00	0.	0.96640824E 00
0.14999999E 02	0.	-0.	0.90105813E 00	-0.37498027E-00	0.	0.97596923E 00
0.16000000E 02	-0.	0.	-0.96650655E 00	0.30504087E-00	0.	0.10135012E 01
0.16999999E 02	0.	0.	0.10443615E 01	0.20427314E-01	0.	0.10445613E 01
0.17999999E 02	-0.	-0.	-0.92288458E 00	-0.52702487E 00	0.	0.10627658E 01
0.18999999E 02	0.	0.	0.34595560E-00	0.10287235E 01	0.	0.10853374E 01
0.19999999E 02	0.	-0.	0.59289885E 00	-0.89319792E 00	0.	0.10720688E 01
0.20999999E 02	-0.	-0.	-0.10614447E 01	-0.14782046E-00	0.	0.10716883E 01
0.21999999E 02	0.	0.	0.11784641E-00	0.10267852E 01	0.	0.10335258E 01
0.22999999E 02	0.	-0.	0.10023774E 01	-0.19139627E-00	0.	0.10204867E 01
0.23999999E 02	-0.	-0.	-0.37615367E-01	-0.10079500E 01	0.	0.10086516E 01
0.24999999E 02	-0.	-0.	-0.96311066E 00	-0.27467603E-00	0.	0.10015133E 01
0.25999999E 02	-0.	0.	-0.73974991E 00	0.70365422E 00	0.	0.10209599E 01
0.26999999E 02	0.	0.	0.52987199E-01	0.10273910E 01	0.	0.10287564E 01
0.27999999E 02	0.	0.	0.71450171E 00	0.79560144E 00	0.	0.10693429E 01
0.28999999E 02	0.	0.	0.10202779E 01	0.38996771E-00	0.	0.10922645E 01
0.29999999E 02	0.	0.	0.11049651E 01	0.69662765E-01	0.	0.11071589E 01
0.30999999E 02	0.	-0.	0.11146947E 01	-0.69282426E-01	0.	0.11168457E 01
0.31999999E 02	0.	0.	0.11139174E 01	0.12973332E-01	0.	0.11139929E 01
0.32999999E 02	0.	0.	0.10604945E 01	0.27243827E-00	0.	0.10949297E 01
0.33999999E 02	0.	0.	0.85155923E 00	0.67837668E 00	0.	0.10887369E 01
0.34999999E 02	0.	0.	0.29256057E-00	0.10281601E 01	0.	0.10689737E 01
0.35999998E 02	-0.	0.	-0.49552656E-00	0.92830712E 00	0.	0.10522835E 01
0.36999999E 02	-0.	0.	-0.10571170E 01	0.14402821E-00	0.	0.10668836E 01
0.37999999E 02	-0.	-0.	-0.59688690E 00	-0.91466112E 00	0.	0.10921899E 01
0.38999999E 02	0.	-0.	0.72461181E 00	-0.84910904E 00	0.	0.11162654E 01
0.39999998E 02	0.	0.	0.96758746E 00	0.62570827E 00	0.	0.11522744E 01
0.40999998E 02	-0.	0.	-0.69641110E 00	0.97690639E 00	0.	0.11997227E 01
0.41999999E 02	-0.	-0.	-0.82139523E 00	-0.88681967E 00	0.	0.12087759E 01
0.42999998E 02	0.	-0.	0.11105522E 01	-0.46599419E-00	0.	0.12043574E 01
0.43999998E 02	-0.	0.	-0.12339185E-00	0.11897402E 01	0.	0.11961217E 01
0.44999998E 02	-0.	-0.	-0.84560654E 00	-0.82740641E 00	0.	0.11830688E 01
0.45999999E 02	0.	0.	0.11402673E 01	0.35384563E-01	0.	0.11408161E 01
0.46999998E 02	-0.	0.	-0.92547237E 00	0.60661738E 00	0.	0.11065639E 01
0.47999998E 02	0.	-0.	0.53772312E 00	-0.95372636E 00	0.	0.10948698E 01
0.48999998E 02	-0.	0.	-0.21709462E-00	0.11099473E 01	0.	0.11309788E 01
0.49999999E 02	0.	-0.	0.22898634E-01	-0.11758139E 01	0.	0.11760368E 01
0.50999998E 02	0.	0.	0.18718120E-01	0.12285827E 01	0.	0.12287253E 01
0.51999998E 02	0.	-0.	0.79904718E-01	-0.12779051E 01	0.	0.12804008E 01
0.52999998E 02	-0.	0.	-0.35398300E-00	0.12915006E 01	0.	0.13391332E 01
0.53999998E 02	0.	-0.	0.78567005E 00	-0.11469709E 01	0.	0.13902588E 01
0.54999998E 02	-0.	0.	-0.12360977E 01	0.67058934E 00	0.	0.14062814E 01
0.55999998E 02	0.	0.	0.13550798E 01	0.13870373E-00	0.	0.13621600E 01
0.56999999E 02	-0.	-0.	-0.84483992E 00	-0.91456699E 00	0.	0.12450651E 01
0.57999998E 02	-0.	0.	-0.86083589E-01	0.10685895E 01	0.	0.10720513E 01
0.58999998E 02	0.	-0.	0.72038381E 00	-0.45679802E-00	0.	0.85300484E 00
0.59999998E 02	-0.	-0.	-0.56812100E 00	-0.27544753E-00	0.	0.63137374E 00
0.60999998E 02	0.	0.	0.13376089E-01	0.41977100E-00	0.	0.41998406E-00
0.61999997E 02	0.	-0.	0.22219061E-00	-0.10137112E-00	0.	0.24422279E-00
0.62999998E 02	-0.	-0.	-0.83168143E-01	-0.77879947E-01	0.	0.11393957E-00
0.63999999E 02	0.	0.	0.14245050E-02	0.22456586E-01	0.	0.22501722E-01
0.64999998E 02	-0.	-0.	-0.27361146E-01	-0.27414372E-01	0.	0.38732158E-01
0.65999998E 02	-0.	0.	-0.37178183E-01	0.56391162E-01	0.	0.67543915E-01
0.66999998E 02	0.	0.	0.71956424E-01	0.34734770E-01	0.	0.79901384E-01
0.67999998E 02	0.	-0.	0.28671619E-01	-0.68140662E-01	0.	0.73927069E-01
0.68999998E 02	-0.	-0.	-0.56786953E-01	-0.28470641E-01	0.	0.63524289E-01
0.69999998E 02	-0.	0.	-0.26436549E-01	0.45656582E-01	0.	0.52758076E-01
0.70999998E 02	0.	0.	0.31300633E-01	0.21685351E-01	0.	0.38078656E-01
0.71999997E 02	0.	-0.	0.19296990E-01	-0.17596524E-01	0.	0.26115350E-01
0.72999997E 02	-0.	-0.	-0.10522278E-01	-0.16904000E-01	0.	0.19911392E-01
0.73999998E 02	-0.	0.	-0.10790598E-01	0.79506353E-02	0.	0.13403343E-01
0.74999997E 02	0.	0.	0.55681641E-02	0.33394406E-02	0.	0.64927894E-02
0.75999998E 02	0.	-0.	-0.10645586E-02	-0.31587607E-02	0.	0.33333248E-02
0.76999997E 02	-0.	0.	-0.26460582E-02	0.16443101E-02	0.	0.31153458E-02
0.77999998E 02	0.	0.	0.36648958E-03	0.43266796E-02	0.	0.43421734E-02
0.78999998E 02	0.	-0.	0.64463460E-02	0.10106317E-02	0.	0.65250864E-02
0.79999997E 02	0.	-0.	0.22490308E-02	-0.73353118E-02	0.	0.76723489E-02

Sample output

THE VALU OF P= 0.89999997E 02

Y	S	T	U	V	SQRT(S2+T2)	SQRT(U2+V2)
0.	0.35583947E-00	0.77949440E 00	0.21209682E-07	0.46461486E-07	0.85687411E 00	0.51073675E-07
0.99999998E 00	0.35839374E-00	0.73802535E 00	0.21426708E-07	0.44026642E-07	0.82044347E 00	0.48963752E-07
0.19999999E 01	0.10514468E-00	0.88283475E 00	0.65319709E-08	0.52471665E-07	0.88907401E 00	0.52876671E-07
0.29999999E 01	-0.31532001E-00	0.84931441E 00	-0.18726020E-07	0.50662280E-07	0.90595897E 00	0.54012317E-07
0.39999998E 01	-0.89990613E 00	0.40292852E-00	-0.53561515E-07	0.24068804E-07	0.98599312E 00	0.58720893E-07
0.49999998E 01	-0.88894889E 00	-0.49507548E-00	-0.53078938E-07	-0.29540986E-07	0.10175116E 01	0.60745727E-07
0.59999998E 01	0.11944111E-00	-0.10624373E 01	0.69776500E-08	-0.63316241E-07	0.10691302E 01	0.63699560E-07
0.69999997E 01	0.10514493E 01	-0.10754875E-00	0.62678191E-07	-0.65515084E-08	0.10569353E 01	0.63019662E-07
0.79999997E 01	0.76697899E-01	0.10757448E 01	0.47080379E-08	0.64181684E-07	0.10784755E 01	0.64354130E-07
0.89999995E 01	-0.10315944E 01	-0.15116940E-00	-0.61747172E-07	-0.89804252E-08	0.10426117E 01	0.62396803E-07
0.99999996E 01	0.58037109E 00	-0.86059596E 00	0.34703197E-07	-0.51496831E-07	0.10380057E 01	0.62098596E-07
0.10999999E 02	0.31219637E-00	0.92401942E 00	0.18571544E-07	0.55364214E-07	0.97533505E 00	0.58396048E-07
0.11999999E 02	-0.84163519E 00	-0.48301911E-00	-0.50168730E-07	-0.28983013E-07	0.97039025E 00	0.57938903E-07
0.13000000E 02	0.94285035E 00	0.95991826E-02	0.56288168E-07	0.71580797E-09	0.94289921E 00	0.56292719E-07
0.13999999E 02	-0.92170834E 00	0.29173486E-00	-0.54947443E-07	0.17286333E-07	0.96677581E 00	0.57602420E-07
0.14999999E 02	0.90049300E 00	-0.37640260E-00	0.53707249E-07	-0.22350565E-07	0.97599516E 00	0.58172299E-07
0.16000000E 02	-0.96775816E 00	0.30641720E-00	-0.57608279E-07	0.18181852E-07	0.10151095E 01	0.60409383E-07
0.16999999E 02	0.10447371E 01	0.21217349E-01	0.62248801E-07	0.12175628E-08	0.10449525E 01	0.62260707E-07
0.17999999E 02	-0.92266936E 00	-0.52758215E 00	-0.55008207E-07	-0.31413130E-07	0.10628554E 01	0.63345778E-07
0.18999999E 02	0.34330761E-00	0.10283308E 01	0.20620561E-07	0.61316701E-07	0.10841237E 01	0.64691152E-07
0.19999999E 02	0.59282554E 00	-0.88948777E 00	0.35339525E-07	-0.53238744E-07	0.10689390E 01	0.63900281E-07
0.20999999E 02	-0.10570139E 01	-0.14959529E-00	-0.63267040E-07	-0.88107859E-08	0.10675472E 01	0.63877604E-07
0.21999999E 02	0.11563162E-00	0.10212856E 01	0.70241940E-08	0.61201166E-07	0.10278107E 01	0.61602938E-07
0.22999999E 02	0.99744990E 00	-0.18924510E-00	0.59746353E-07	-0.11408106E-07	0.10152438E 01	0.60825747E-07
0.23999999E 02	-0.36932743E-01	-0.10020477E 01	-0.22420506E-08	-0.60078505E-07	0.10027281E 01	0.60120326E-07
0.24999999E 02	-0.95710243E 00	-0.27163327E-00	-0.57405868E-07	-0.16371967E-07	0.99490185E 00	0.59694849E-07
0.25999999E 02	-0.73404960E 00	0.70384910E 00	-0.44092530E-07	0.41941059E-07	0.10169721E 01	0.60853954E-07
0.26999999E 02	0.56855125E-01	0.10249964E 01	0.31582832E-08	0.61237276E-07	0.10265721E 01	0.61318664E-07
0.27999999E 02	0.71754570E 00	0.79092519E 00	0.42587620E-07	0.47421540E-07	0.10679112E 01	0.63737806E-07
0.28999999E 02	0.10233786E 01	0.38804960E-00	0.60813302E-07	0.23243887E-07	0.10944799E 01	0.65104039E-07
0.29999999E 02	0.11048826E 01	0.67006972E-01	0.65861055E-07	0.41522243E-08	0.11069126E 01	0.65991814E-07
0.30999999E 02	0.11171146E 01	-0.69632374E-01	0.66440985E-07	-0.41295544E-08	0.11192827E 01	0.66569194E-07
0.31999999E 02	0.11146495E 01	0.17489292E-01	0.66394653E-07	0.77327091E-09	0.11147866E 01	0.66399155E-07
0.32999999E 02	0.10560650E 01	0.27693760E-00	0.63210400E-07	0.16238586E-07	0.10917728E 01	0.65262901E-07
0.33999999E 02	0.84240985E 00	0.68069623E 00	0.50756885E-07	0.40434401E-07	0.10830520E 01	0.64893776E-07
0.34999999E 02	0.28455019E-00	0.10231845E 01	0.17437968E-07	0.61283118E-07	0.10620148E 01	0.63715800E-07
0.35999998E 02	-0.49601373E-00	0.91629761E 00	-0.29535684E-07	0.55331416E-07	0.10419361E 01	0.62720986E-07
0.36999999E 02	-0.10472249E 01	0.14032732E-00	-0.63009086E-07	0.85847502E-08	0.10565849E 01	0.63591217E-07
0.37999999E 02	-0.59161086E 00	-0.90662945E 00	-0.35577232E-07	-0.54518051E-07	0.10825804E 01	0.65099595E-07
0.38999999E 02	0.71430877E 00	-0.84221540E 00	0.43190229E-07	-0.50610843E-07	0.11043385E 01	0.66534601E-07
0.39999998E 02	0.96337973E 00	0.61485883E 00	0.57672707E-07	0.37295119E-07	0.11428700E 01	0.68680906E-07
0.40999998E 02	-0.68305468E 00	0.97555890E 00	-0.41509335E-07	0.58228158E-07	0.11909151E 01	0.71509044E-07
0.41999999E 02	-0.82343429E 00	-0.87676912E 00	-0.48958971E-07	-0.52858571E-07	0.12028167E 01	0.72048659E-07
0.42999998E 02	0.11002283E 01	-0.47137572E-00	0.66194069E-07	-0.27775417E-07	0.11969533E 01	0.71785295E-07
0.43999998E 02	-0.11262449E-00	0.11850556E 01	-0.73547275E-08	0.70914044E-07	0.11903954E 01	0.71294414E-07
0.44999998E 02	-0.85083974E 00	-0.81612578E 00	-0.50402077E-07	-0.49317265E-07	0.11789782E 01	0.70516395E-07
0.45999999E 02	0.11462037E 01	0.23354862E-01	0.67965226E-07	0.21090843E-08	0.11464415E 01	0.67997942E-07
0.46999998E 02	-0.92988645E 00	0.62068871E 00	-0.55162451E-07	0.36157213E-07	0.11180086E 01	0.65956350E-07
0.47999998E 02	0.54724137E 00	-0.97276606E 00	0.32050795E-07	-0.56846520E-07	0.11161303E 01	0.65259331E-07
0.48999998E 02	-0.22603655E-00	0.11291497E 01	-0.12939848E-07	0.66158013E-07	0.11515518E 01	0.67411589E-07
0.49999999E 02	0.37202816E-01	-0.11954211E 01	0.13648649E-08	-0.70083971E-07	0.11959998E 01	0.70097260E-07
0.50999998E 02	0.28620856E-02	0.12424120E 01	0.11156869E-08	0.73229238E-07	0.12424153E 01	0.73237737E-07
0.51999998E 02	0.10246076E-00	-0.12840051E 01	0.47626923E-08	-0.76169081E-07	0.12880867E 01	0.76317836E-07
0.52999998E 02	-0.37721869E-00	0.12834326E 01	-0.21099031E-07	0.76979440E-07	0.13377194E 01	0.79818565E-07
0.53999998E 02	0.80431224E 00	-0.11205453E 01	0.46829583E-07	-0.68364796E-07	0.13793258E 01	0.82865887E-07
0.54999998E 02	-0.12309881E 01	0.63428732E 00	-0.73677165E-07	0.39970239E-07	0.13847931E 01	0.83820908E-07
0.55999998E 02	0.13211381E 01	0.16589900E-00	0.80769051E-07	0.82673869E-08	0.13315136E 01	0.81191065E-07
0.56999999E 02	-0.80556335E 00	-0.90522562E 00	-0.50356383E-07	-0.54512440E-07	0.12117614E 01	0.74211666E-07
0.57999998E 02	-0.98572087E-01	0.10312427E 01	-0.51309817E-08	0.63692903E-07	0.10359430E 01	0.63899239E-07
0.58999998E 02	0.69916279E 00	-0.43723382E-00	0.42938221E-07	-0.27227283E-07	0.82462235E 00	0.50843050E-07
0.59999998E 02	-0.54867706E 00	-0.25880721E-00	-0.33862650E-07	-0.16417952E-07	0.60665285E 00	0.37632807E-07
0.60999998E 02	0.23792957E-01	0.40384331E-00	0.79727708E-09	0.25020301E-07	0.40454360E-00	0.25033000E-07
0.61999997E 02	0.20786224E-00	-0.11500550E-00	0.13243593E-07	-0.60421899E-08	0.23755626E-00	0.14556812E-07
0.62999998E 02	-0.93146937E-01	-0.63214964E-01	-0.49572076E-08	-0.46420065E-08	0.11257213E-00	0.67913277E-08
0.63999999E 02	0.11978864E-01	0.33846395E-01	0.84907116E-10	0.13385168E-08	0.35903644E-01	0.13412071E-08
0.64999998E 02	-0.17159341E-01	-0.38985381E-01	-0.16308514E-08	-0.16340239E-08	0.42594634E-01	0.23086166E-08
0.65999998E 02	-0.43640230E-01	0.49138859E-01	-0.22159924E-08	0.33611752E-08	0.65719838E-01	0.40259311E-08
0.66999998E 02	0.63253110E-01	0.38465071E-01	0.42889371E-08	0.20703536E-08	0.74030517E-01	0.47624936E-08
0.67999998E 02	0.31602101E-01	-0.62971369E-01	0.17089616E-08	-0.40614999E-08	0.70456271E-01	0.44063967E-08
0.68999998E 02	-0.54714333E-01	-0.26161514E-01	-0.33847661E-08	-0.16969824E-08	0.60647201E-01	0.37863427E-08
0.69999998E 02	-0.21746837E-01	0.42750673E-01	-0.15757411E-08	0.27213443E-08	0.47963996E-01	0.31446263E-08
0.70999998E 02	0.30156501E-01	0.18386759E-01	0.18656631E-08	0.12925476E-08	0.35319789E-01	0.22696648E-08
0.71999997E 02	0.15375905E-01	-0.19748231E-01	0.11501902E-08	-0.10488345E-08	0.25028206E-01	0.15565961E-08
0.72999997E 02	-0.12298767E-01	-0.11717156E-01	-0.62717663E-09	-0.10075569E-08	0.16986801E-01	0.11868114E-08
0.73999998E 02	-0.78043965E-02	0.73048233E-02	-0.64316975E-09	0.47389479E-09	0.10689670E-01	0.79890149E-09
0.74999997E 02	0.45718752E-02	0.44827428E-02	0.33188844E-09	0.19904616E-09	0.64028919E-02	0.38700040E-09
0.75999998E 02	0.18644448E-02	-0.37256221E-02	-0.63452636E-10	-0.18827681E-09	0.41661030E-02	0.19868164E-09
0.76999997E 02	-0.36048935E-02	0.13952108E-03	-0.15771736E-09	0.98008519E-10	0.36075924E-02	0.18568908E-09
0.77999998E 02	0.11460397E-02	0.31042541E-02	0.21844482E-10	0.25789019E-09	0.33090483E-02	0.25881370E-09
0.78999998E 02	0.20195983E-02	-0.66151044E-03	0.38423216E-09	0.60238343E-10	0.21251761E-02	0.38892546E-09
0.79999997E 02	0.11590564E-02	-0.91455085E-03	0.13405268E-09	-0.43721865E-09	0.14764196E-02	0.45730763E-09

Page intentionally left blank

VII. PHASE-CENTER PROGRAM

W. V. T. Rusch

Program: 5433, binary in Jet Propulsion Laboratory Library

Engineer: W. V. T. Rusch

Programmer: R. Brodie

A. Program Description

The input consists of the real and imaginary parts of the E- and H-plane fields of an electromagnetic wave. Usually the input consists of the card output from the Scattering Program (VI). These fields are centered about some arbitrary origin. The program determines a best-fit phase center in terms of a distance from the origin (in wave-numbers) along the negative z-axis. The phase characteristic of the scattered wave is then determined with respect to the E- and H-plane phase centers.

B. Applications

This program determines the E- and H- plane phase centers of fields scattered from surfaces of revolution (Ref. 12).

C. Input

Card	Parameters	Format
1	*IPLOT N PCK21 PCK22 NX NY NOVX NOVY XZERO XMAX YZERO, YMAX*	(I1, I4, 2F15.8, I4, 3I3; 4F6.1)
Cards for		
S		(F10.5, E20.8)
T		(10X, E20.8)
U		(10X, E20.8)
V		(10X, E20.8)

IPLOT = 1 if plot desired

= 0 if plot not desired

N = number of angles for which field is inputted

PCK21 = predicted phase center for *S* and *T*

PCK22 = predicted phase center for *U* and *V*

NX = number of lines for *X*-coordinate

NY = number of lines for Y-coordinate

$NOVX$ = number of heavy lines for X-coordinate

$NOVY$ = number of heavy lines for Y-coordinate

$XZERO$ = lower value of X

$XMAX$ = upper value of X

$YZERO$ = lower value of Y

$YMAX$ = upper value of Y

In its original form, only one case can be run at a time. 7094 time is proportional to N. In the case below, N was 241; the time was 25 sec.

D. Output

Program prints out computed E- and H-plane phase centers and resulting phase characteristics relative to these phase centers. Plots may also be obtained.

E. Sample Case

Sample input

```
1 241 145.54870941   145.54870941    75 40 15  8    0.    75.   147.   151.
0.0               -0.1786173E-00
0.0                0.4161537E-02
0.0               -0.1786173E-00
0.0                0.4161543E-02
0.25              -0.1786889E-00
0.25               0.3594741E-02
0.25              -0.1786779E-00
0.25               0.3618177E-02
0.5               -0.1788952E-00
0.5                0.1897233E-02
0.5               -0.1788517E-00
0.5                0.1990746E-02
0.75              -0.1792123E-00
0.75              -0.9209326E-03
0.75              -0.1791171E-00
0.75              -0.7110817E-03
1.0               -0.1796003E-00
1.0               -0.4843148E-02
1.0               -0.1794378E-00
1.0               -0.4471658E-02
1.25              -0.1800043E-00
1.25              -0.9845169E-02
1.25              -0.1797636E-00
1.25              -0.9268107E-02
1.5               -0.1803562E-00
1.5               -0.1589540E-01
1.5               -0.1800323E-00
1.5               -0.1507065E-01
1.75              -0.1805759E-00
1.75              -0.2295273E-01
1.75              -0.1801709E-00
1.75              -0.2184078E-01
2.0               -0.1805717E-00
2.0               -0.3096719E-01
2.0               -0.1800954E-00
2.0               -0.2953170E-01
2.25              -0.1802450E-00
2.25              -0.3987774E-01
2.25              -0.1797153E-00
2.25              -0.3808664E-01
2.5               -0.1794902E-00
2.5               -0.4961277E-01
2.5               -0.1789335E-00
2.5               -0.4743907E-01
2.75              -0.1781985E-00
2.75              -0.6008833E-01
2.75              -0.1776497E-00
2.75              -0.5751113E-01
3.0               -0.1762605E-00
3.0               -0.7120790E-01
3.0               -0.1757625E-00
3.0               -0.6621369E-01
3.25              -0.1735687E-00
3.25              -0.8286319E-01
3.25              -0.1731716E-00
3.25              -0.7944676E-01
3.5               -0.1700215E-00
3.5               -0.9493272E-01
3.5               -0.1697817E-00
3.5               -0.9109835E-01
3.75              -0.1655250E-00
3.75              -0.1072826E-00
3.75              -0.1655036E-00
3.75              -0.1030450E-00
4.0               -0.1599970E-00
4.0               -0.1197682E-00
4.0               -0.1602579E-00
4.0               -0.1151532E-00
4.25              -0.1533694E-00
4.25              -0.1322345E-00
4.25              -0.1539776E-00
4.25              -0.1272796E-00
4.5               -0.1455915E-00
4.5               -0.1445177E-00
4.5               -0.1466103E-00
4.5               -0.1392726E-00
4.75              -0.1366317E-00
4.75              -0.1564484E-00
4.75              -0.1381206E-00
4.75              -0.1509745E-00
5.0               -0.1264800E-00
5.0               -0.1678527E-00
5.0               -0.1284916E-00
5.0               -0.1622228E-00
5.25              -0.1151491E-00
5.25              -0.1785567E-00
5.25              -0.1177266E-00
5.25              -0.1728537E-00
5.5               -0.1026761E-00
5.5               -0.1883881E-00
5.5               -0.1058507E-00
5.5               -0.1827036E-00
5.75              -0.8912187E-01
5.75              -0.1971805E-00
5.75              -0.9291029E-01
5.75              -0.1916128E-00
6.0               -0.7457148E-01
6.0               -0.2047774E-00
6.0               -0.7897390E-01
6.0               -0.1994283E-00
6.25              -0.5913222E-01
```

Sample input (contd)

6.25	-0.2110342E-00
6.25	-0.6413065E-01
6.25	-0.2060068E-00
6.5	-0.4293284E-01
6.5	-0.2158226E-00
6.5	-0.4849016E-01
6.5	-0.2112172E-00
6.75	-0.2612090E-01
6.75	-0.2190332E-00
6.75	-0.3218038E-01
6.75	-0.2149434E-00
7.0	-0.8858575E-02
7.0	-0.2205779E-00
7.0	-0.1534456E-01
7.0	-0.2170869E-00
7.25	0.8679131E-02
7.25	-0.2203914E-00
7.25	0.1860055E-02
7.25	-0.2175682E-00
7.5	0.2630926E-01
7.5	-0.2184333E-00
7.5	0.1926566E-01
7.5	-0.2163283E-00
7.75	0.4384469E-01
7.75	-0.2146871E-00
7.75	0.3669741E-01
7.75	-0.2133293E-00
8.0	0.6109810E-01
8.0	-0.2091610E-00
8.0	0.5397601E-01
8.0	-0.2085547E-00
8.25	0.7788572E-01
8.25	-0.2018855E-00
8.25	0.7092084E-01
8.25	-0.2020088E-00
8.5	0.9403041E-01
8.5	-0.1929124E-00
8.5	0.8735252E-01
8.5	-0.1937155E-00
8.75	0.1093639E-00
8.75	-0.1823111E-00
8.75	0.1030947E-00
8.75	-0.1837174E-00
9.0	0.1237300E-00
9.0	-0.1701663E-00
9.0	0.1179770E-00
9.0	-0.1720733E-00
9.25	0.1369830E-00
9.25	-0.1565747E-00
9.25	0.1318339E-00
9.25	-0.1588571E-00
9.5	0.1489901E-00
9.5	-0.1416411E-00
9.5	0.1445072E-00
9.5	-0.1441551E-00
9.75	0.1596278E-00
9.75	-0.1254767E-00
9.75	0.1558441E-00
9.75	-0.1280656E-00
10.0	0.1687811E-00
10.0	-0.1081965E-00
10.0	0.1656965E-00
10.0	-0.1106976E-00
10.25	0.1763411E-00
10.25	-0.8991794E-01
10.25	0.1739206E-00
10.25	-0.9216967E-01
10.50	0.1822002E-00
10.50	-0.7076192E-01
10.50	0.1803745E-00
10.50	-0.7261263E-01
10.75	0.1862504E-00
10.75	-0.5085424E-01
10.75	0.1849172E-00
10.75	-0.5217011E-01
11.0	0.1883801E-00
11.0	-0.3032838E-01
11.0	0.1874081E-00
11.0	-0.3100151E-01
11.25	0.1884721E-00
11.25	-0.9330965E-02
11.25	0.1877073E-00
11.25	-0.9286489E-02
11.5	0.1864035E-00
11.5	0.1197275E-01
11.5	0.1856766E-00
11.5	0.1277100E-01
11.75	0.1820481E-00
11.75	0.3339131E-01
11.75	0.1811838E-00
11.75	0.3493688E-01
12.0	0.1752798E-00
12.0	0.5470109E-01
12.0	0.1741070E-00
12.0	0.5694327E-01
12.25	0.1659804E-00
12.25	0.7563772E-01
12.25	0.1643431E-00
12.25	0.7848253E-01
12.5	0.1540488E-00
12.5	0.9589197E-01
12.5	0.1518168E-00

Sample input (contd)

12.5	0.9920590E-01
12.75	0.1394144E-00
12.75	0.1151050E-00
12.75	0.1364927E-00
12.75	0.1187214E-00
13.0	0.1220516E-00
13.0	0.132868[illegible]E-[illegible]
13.0	0.[illegible]83891E-00
13.0	0.1365963E-00
13.25	0.1019969E-00
13.25	0.148726[illegible]E-00
13.25	0.9759169E-01
13.25	0.1523630E-00
13.5	0.7936645E-01
13.5	0.1621859E-00
13.5	0.7426909E-01
13.5	0.1655282E-00
13.75	0.5437309E-01
13.75	0.1727294E-00
13.75	0.4868596E-01
13.75	0.1755874E-00
14.0	0.2734120E-01
14.0	0.1798328E-00
14.0	0.2121444E-01
14.0	0.1820444E-00
14.25	-0.1280848E-02
14.25	0.1829908E-00
14.25	-0.7657176E-02
14.25	0.1844335E-00
14.5	-0.3091558E-01
14.5	0.1817464E-00
14.5	-0.3732256E-01
14.5	0.1823480E-00
14.75	-0.6085553E-01
14.75	0.1757237E-00
14.75	-0.670594[illegible]E-01
14.75	0.1754692E-00
15.0	-0.9027412E-01
15.0	0.1646628E-00
15.0	-0.9604232E-01
15.0	0.1635986E-00
15.25	-0.1182427E-00
15.25	0.1484556E-00
15.25	-0.1233604E-00
15.25	0.1466878E-00
15.5	-0.1437585E-00
15.5	0.1271782E-00
15.5	-0.1480460E-00
15.5	0.1248674E-00
15.75	-0.1657845E-00
15.75	0.1011194E-00
15.75	-0.1691111E-00
15.75	0.9847004E-01
16.0	-0.1832951E-00
16.0	0.7079917E-01
16.0	-0.1855913E-00
16.0	0.6804520E-01
16.25	-0.1953314E-00
16.25	0.3697826E-01
16.25	-0.1965967E-00
16.25	0.3436520E-01
16.5	-0.2010603E-00
16.5	0.6538856E-03
16.5	-0.2013649E-00
16.5	-0.1580966E-02
16.75	-0.1998353E-00
16.75	-0.3696031E-01
16.75	-0.1993171E-00
16.75	-0.3860817E-01
17.0	-0.1912550E-00
17.0	-0.7446937E-01
17.0	-0.1901100E-00
17.0	-0.7536915E-01
17.25	-0.1752151E-00
17.25	-0.1103485E-00
17.25	-0.1736822E-00
17.25	-0.1104029E-00
17.5	-0.1519487E-00
17.5	-0.1430104E-00
17.5	-0.1502902E-00
17.5	-0.1421976E-00
17.75	-0.1220516E-00
17.75	-0.1708829E-00
17.75	-0.1205298E-00
17.75	-0.1692618E-00
18.0	-0.8648827E-01
18.0	-0.1924976E-00
18.0	-0.8534151E-01
18.0	-0.1902063E-00
18.25	-0.4657501E-01
18.25	-0.2065812E-00
18.25	-0.4599364E-01
18.25	-0.2038279E-00
18.5	-0.3941256E-02
18.5	-0.2121446E-00
18.5	-0.4047180E-02
18.5	-0.2091915E-00
18.75	0.3953579E-01
18.75	-0.2085647E-00
18.75	0.3870447E-01
18.75	-0.2057056E-00
19.0	0.8181524E-01

Sample input (contd)

19.0	-0.1956506E-00
19.0	0.8031247E-01
19.0	-0.1931839E-00
19.25	0.1207973E-00
19.25	-0.1736893E-00
19.25	0.1187687E-00
19.25	-0.1718893E-00
19.5	0.1544411E-00
19.5	-0.1434650E-00
19.5	0.1521149E-00
19.5	-0.1425532E-00
19.75	0.1808874E-00
19.75	-0.1062493E-00
19.75	0.1785556E-00
19.75	-0.1063690E-00
20.0	0.1985808E-00
20.0	-0.6375767E-01
20.0	0.1965740E-00
20.0	-0.6495544E-01
20.25	0.2063822E-00
20.25	-0.1807499E-01
20.25	0.2050373E-00
20.25	-0.2029006E-01
20.5	0.2036608E-00
20.5	0.2844727E-01
20.5	0.2032872E-00
20.5	0.2538314E-01
20.75	0.1903606E-00
20.75	0.7331968E-01
20.75	0.1912063E-00
20.75	0.6967124E-01
21.0	0.1670332E-00
21.0	0.1140601E-00
21.0	0.1692549E-00
21.0	0.1101669E-00
21.25	0.1348325E-00
21.25	0.1483474E-00
21.25	0.1384739E-00
21.25	0.1445931E-00
21.5	0.9546960E-01
21.5	0.1741716E-00
21.5	0.1004499E-00
21.5	0.1709463E-00
21.75	0.5112775E-01
21.75	0.1899735E-00
21.75	0.5724224E-01
21.75	0.1876335E-00
22.0	0.4344331E-02
22.0	0.1947589E-00
22.0	0.1127906E-01
22.0	0.1935876E-00
22.25	-0.4213982E-01
22.25	0.1881815E-00
22.25	-0.3478152E-01
22.25	0.1883557E-00
22.5	-0.8554729E-01
22.5	0.1705860E-00
22.5	-0.7820736E-01
22.5	0.1721518E-00
22.75	-0.1232411E-00
22.75	0.1430053E-00
22.75	-0.1163625E-00
22.75	0.1458676E-00
23.0	-0.1528988E-00
23.0	0.1071139E-00
23.0	-0.1468787E-00
23.0	0.1110404E-00
23.25	-0.1726704E-00
23.25	0.6513402E-01
23.25	-0.1678163E-00
23.25	0.6977481E-01
23.5	-0.1813090E-00
23.5	0.1970555E-01
23.5	-0.1778025E-00
23.5	0.2462751E-01
23.75	-0.1782655E-00
23.75	-0.2627796E-01
23.75	-0.1761390E-00
23.75	-0.2154625E-01
24.0	-0.1637390E-00
24.0	-0.6985331E-01
24.0	-0.1628681E-00
24.0	-0.6576981E-01
24.25	-0.1386782E-00
24.25	-0.1081795E-00
24.25	-0.1387926E-00
24.25	-0.1051363E-00
24.5	-0.1047333E-00
24.5	-0.1387288E-00
24.5	-0.1054451E-00
24.5	-0.1370052E-00
24.75	-0.6416162E-01
24.75	-0.1594579E-00
24.75	-0.6500837E-01
24.75	-0.1591848E-00
25.0	-0.1968948E-01
25.0	-0.1689535E-00
25.0	-0.2018850E-01
25.0	-0.1700945E-00
25.25	0.2565959E-01
25.25	-0.1665396E-00
25.25	0.2595268E-01

Sample input (contd)

25.25	-0.1688911E-00
25.5	0.6875825E-01
25.5	-0.1523383E-00
25.5	0.7019339E-01
25.5	-0.1555511E-00
25.75	0.1065840E-00
25.75	-0.1272815E-00
25.75	0.1093704E-00
25.75	-0.1309002E-00
26.0	0.1364254E-00
26.0	-0.93[illegible]E-01
26.0	0.1406015E-00
26.0	-0.9658707E-01
26.25	0.1560758E-00
26.25	-0.5207701E-01
26.25	0.1614994E-00
26.25	-0.5499844E-01
26.5	0.1640016E-00
26.5	-0.7214558E-02
26.5	0.1703635E-00
26.5	-0.9118796E-02
26.75	0.1594731E-00
26.75	0.3825725E-01
26.75	0.1663326E-00
26.75	0.3766080E-01
27.0	0.1426490E-00
27.0	0.8094115E-01
27.0	0.1494873E-00
27.0	0.8177281E-01
27.25	0.1146044E-00
27.25	0.1175414E-00
27.25	0.1208905E-00
27.25	0.1197326E-00
27.5	0.7729724E-01
27.5	0.1451097E-00
27.5	0.8255618E-01
27.5	0.1484092E-00
27.75	0.3347022E-01
27.75	0.1612820E-00
27.75	0.3734659E-01
27.75	0.1652869E-00
28.0	-0.1351468E-01
28.0	0.1644940E-00
28.0	-0.1120921E-01
28.0	0.1687020E-00
28.25	-0.5989845E-01
28.25	0.1541515E-00
28.25	-0.5915903E-01
28.25	0.1580278E-00
28.5	-0.1018010E-00
28.5	0.1307414E-00
28.5	-0.1024302E-00
28.5	0.1337917E-00
28.75	-0.1355326E-00
28.75	0.9586683E-01
28.75	-0.1371677E-00
28.75	0.9770489E-01
29.0	-0.1579179E-00
29.0	0.5219128E-01
29.0	-0.1600823E-00
29.0	0.5259272E-01
29.25	-0.1666109E-00
29.25	0.3287102E-02
29.25	-0.1687821E-00
29.25	0.2219791E-02
29.5	-0.1603679E-00
29.5	-0.4661571E-01
29.5	-0.1620528E-00
29.5	-0.4898883E-01
29.75	-0.1392475E-00
29.75	-0.9296305E-01
29.75	-0.1400529E-00
29.75	-0.9631010E-01
30.0	-0.1047087E-00
30.0	-0.1312821E-00
30.0	-0.1043974E-00
30.0	-0.1351538E-00
30.25	-0.5958275E-01
30.25	-0.1576191E-00
30.25	-0.5810507E-01
30.25	-0.1615179E-00
30.5	-0.7902339E-02
30.5	-0.1689746E-00
30.5	-0.5398780E-02
30.5	-0.1724312E-00
30.75	0.4541025E-01
30.75	-0.1636842E-00
30.75	0.4863721E-01
30.75	-0.1663289E-00
31.0	0.9498545E-01
31.0	-0.1417000E-00
31.0	0.9852535E-01
31.0	-0.1433173E-00
31.25	0.1355407E-00
31.25	-0.1047246E-00
31.25	0.1389466E-00
31.25	-0.1052819E-00
31.5	0.1624644E-00
31.5	-0.5616440E-01
31.5	0.1653300E-00
31.5	-0.5580863E-01
31.75	0.1723802E-00

Sample input (contd)

31.75	-0.8833818E-03
31.75	0.1744092E-00
31.75	0.9262526E-04
32.0	0.1636257E-00
32.0	0.5523715E-01
32.0	0.1646817E-00
32.0	0.5645502E-01
32.25	0.1365752E-00
32.25	0.1059020E-00
32.25	0.1367015E-00
32.25	0.1069733E-00
32.5	0.9374489E-01
32.5	0.1451170E-00
32.5	0.9315109E-01
32.5	0.1457210E-00
32.75	0.3964696E-01
32.75	0.1679284E-00
32.75	0.3866340E-01
32.75	0.1678776E-00
33.0	-0.1962122E-01
33.0	0.1711049E-00
33.0	-0.2061338E-01
33.0	0.1703855E-00
33.25	-0.7702680E-01
33.25	0.1536585E-00
33.25	-0.7767754E-01
33.25	0.1524375E-00
33.5	-0.1254276E-00
33.5	0.1171218E-00
33.5	-0.1254966E-00
33.5	0.1157167E-00
33.75	-0.1584841E-00
33.75	0.6551578E-01
33.75	-0.1579002E-00
33.75	0.6433327E-01
34.0	-0.1715376E-00
34.0	0.4985096E-02
34.0	-0.1704261E-00
34.0	0.4437355E-02
34.25	-0.1623330E-00
34.25	-0.5688307E-01
34.25	-0.1610047E-00
34.25	-0.5646833E-01
34.5	-0.1314683E-00
34.5	-0.1119931E-00
34.5	-0.1303683E-00
34.5	-0.1104509E-00
34.75	-0.8248075E-01
34.75	-0.1528137E-00
34.75	-0.8210692E-01
34.75	-0.1501924E-00
35.0	-0.2152741E-01
35.0	-0.1734512E-00
35.0	-0.2233076E-01
35.0	-0.1700228E-00
35.25	0.4333330E-01
35.25	-0.1705668E-00
35.25	0.4104568E-01
35.25	-0.1667928E-00
35.5	0.1031800E-00
35.5	-0.1439871E-00
35.5	0.9932054E-01
35.5	-0.1404428E-00
35.75	0.1494654E-00
35.75	-0.9689557E-01
35.75	0.1442032E-00
35.75	-0.9416562E-01
36.0	0.1752774E-00
36.0	-0.3553988E-01
36.0	0.1690266E-00
36.0	-0.3410414E-01
36.25	0.1764371E-00
36.25	0.3153647E-01
36.25	0.1697942E-00
36.25	0.3140433E-01
36.5	0.1522499E-00
36.5	0.9465610E-01
36.5	0.1458911E-00
36.5	0.9295569E-01
36.75	0.1057707E-00
36.75	0.1444120E-00
36.75	0.1003254E-00
36.75	0.1414328E-00
37.0	0.4350597E-01
37.0	0.1731093E-00
37.0	0.3943152E-01
37.0	0.1693899E-00
37.25	-0.2543822E-01
37.25	0.1760228E-00
37.25	-0.2795471E-01
37.25	0.1722565E-00
37.5	-0.9066228E-01
37.5	0.1522542E-00
37.5	-0.9175354E-01
37.5	0.1491570E-00
37.75	-0.1420545E-00
37.75	0.1050254E-00
37.75	-0.1421595E-00
37.75	0.1031913E-00
38.0	-0.1714045E-00
38.0	0.4132622E-01
38.0	-0.1711907E-00

Sample input (contd)

38.0	0.4109832E-01
38.25	-0.1737848E-00
38.25	-0.2906408E-01
38.25	-0.1740192E-00
38.25	-0.2767798E-01
38.5	-0.1484745E-00
38.5	-0.9505928E-01
38.5	-0.1498560E-00
38.5	-0.9240563E-01
38.75	-0.9920012E-01
38.75	-0.1460297E-00
38.75	-0.1022147E-00
38.75	-0.1427543E-00
39.0	-0.3368641E-01
39.0	-0.1735679E-00
39.0	-0.3847786E-01
39.0	-0.1704928E-00
39.25	0.3751280E-01
39.25	-0.1729540E-00
39.25	0.3119683E-01
39.25	-0.1709085E-00
39.5	0.1026998E-00
39.5	-0.1440577E-00
39.5	0.9548215E-01
39.5	-0.1436943E-00
39.75	0.1509778E-00
39.75	-0.9148910E-01
39.75	0.1437440E-00
39.75	-0.9312519E-01
40.0	0.1741340E-00
40.0	-0.2393890E-01
40.0	0.1678582E-00
40.0	-0.2745849E-01
40.25	0.1681215E-00
40.25	0.4721412E-01
40.25	0.1636605E-00
40.25	0.4237176E-01
40.5	0.1338630E-00
40.5	0.1098154E-00
40.5	0.1317579E-00
40.5	0.1045713E-00
40.75	0.7720139E-01
40.75	0.1530465E-00
40.75	0.7753271E-01
40.75	0.1485123E-00
41.0	0.7971362E-02
41.0	0.1693657E-00
41.0	0.1030191E-01
41.0	0.1666188E-00
41.25	-0.6167083E-01
41.25	0.1559168E-00
41.25	-0.5824611E-01
41.25	0.1557650E-00
41.5	-0.1193914E-00
41.5	0.1151309E-00
41.5	-0.1160906E-00
41.5	0.1179161E-00
41.75	-0.1549093E-00
41.75	0.5437886E-01
41.75	-0.1530298E-00
41.75	0.5986564E-01
42.0	-0.1619093E-00
42.0	-0.1529564E-01
42.0	-0.1625592E-00
42.0	-0.7916657E-02
42.25	-0.1392656E-00
42.25	-0.8115646E-01
42.25	-0.1431163E-00
42.25	-0.7314236E-01
42.5	-0.9132315E-01
42.5	-0.1311154E-00
42.5	-0.9843800E-01
42.5	-0.1239411E-00
42.75	-0.2715474E-01
42.75	-0.1560063E-00
42.75	-0.3693490E-01
42.75	-0.1510734E-00
43.0	0.4109607E-01
43.0	-0.1513490E-00
43.0	0.2982844E-01
43.0	-0.1496924E-00
43.25	0.1004930E-00
43.25	-0.1182539E-00
43.25	0.8928414E-01
43.25	-0.1203089E-00
43.5	0.1397807E-00
43.5	-0.6326385E-01
43.5	0.1302455E-00
43.5	-0.6874820E-01
43.75	0.1515764E-00
43.75	0.2863800E-02
43.75	0.1450695E-00
43.75	-0.5078742E-02
44.0	0.1338385E-00
44.0	0.6721744E-01
44.0	0.1311655E-00
44.0	0.5830056E-01
44.25	0.9030640E-01
44.25	0.1172811E-00
44.25	0.915[illegible]
44.25	0.1090[illegible]
44.5	0.29[illegible]

Sample input (contd)

44.5	0.1432694E-00
44.5	0.3425019E-01
44.5	0.1373841E-00
44.75	-0.3552325E-01
44.75	0.1403743E-00
44.75	-0.2917535E-01
44.75	0.1378995E-00
45.0	-0.9256590E-01
45.0	0.1094723E-00
45.0	-0.8600702E-01
45.0	0.1108092E-00
45.25	-0.1299628E-00
45.25	0.5711372E-01
45.25	-0.1248791E-00
45.25	0.6186275E-01
45.5	-0.1403858E-00
45.5	-0.5821920E-02
45.5	-0.1380994E-00
45.5	0.1219698E-02
45.75	-0.1220608E-00
45.75	-0.6634554E-01
45.75	-0.1232367E-00
45.75	-0.5860782E-01
46.0	-0.7914517E-01
46.0	-0.1120355E-00
46.0	-0.8364134E-01
46.0	-0.1053206E-00
46.25	-0.2087064E-01
46.25	-0.1336217E-00
46.25	-0.2776915E-01
46.25	-0.1293822E-00
46.5	0.4038543E-01
46.5	-0.1269258E-00
46.5	0.3256811E-01
46.5	-0.1260155E-00
46.75	0.9170592E-01
46.75	-0.9374202E-01
46.75	0.8467386E-01
46.75	-0.9621655E-01
47.0	0.1223724E-00
47.0	-0.4145248E-01
47.0	0.1176479E-00
47.0	-0.4655569E-01
47.25	0.1261491E-00
47.25	0.1855443E-01
47.25	0.1247070E-00
47.25	0.1221170E-01
47.5	0.1026116E-00
47.5	0.7333583E-01
47.5	0.1046391E-00
47.5	0.6744133E-01
47.75	0.5722449E-01
47.75	0.1111931E-00
47.75	0.6206724E-01
47.75	0.1073200E-00
48.0	0.1332878E-03
48.0	0.1242097E-00
48.0	0.6447241E-02
48.0	0.1234224E-00
48.25	-0.5606871E-01
48.25	0.1099647E-00
48.25	-0.4999184E-01
48.25	0.1125416E-00
48.5	-0.9912049E-01
48.5	0.7204087E-01
48.5	-0.9492845E-01
48.5	0.7738489E-01
48.75	-0.1198019E-00
48.75	0.1920041E-01
48.75	-0.1186597E-00
48.75	0.2596669E-01
49.0	-0.1139654E-00
49.0	-0.3659339E-01
49.0	-0.1162415E-00
49.0	-0.3017784E-01
49.25	-0.8342965E-01
49.25	-0.8287261E-01
49.25	-0.8857223E-01
49.25	-0.7857000E-01
49.5	-0.3552609E-01
49.5	-0.1094722E-00
49.5	-0.4216822E-01
49.5	-0.1085822E-00
49.75	0.1860161E-01
49.75	-0.1108084E-00
49.75	0.1232713E-01
49.75	-0.1138158E-00
50.0	0.6656540E-01
50.0	-0.8710937E-01
50.0	0.6257151E-01
50.0	-0.9352448E-01
50.25	0.9757589E-01
50.25	-0.4430761E-01
50.25	0.9733724E-01
50.25	-0.5274709E-01
50.5	0.1049066E-00
50.5	0.7380508E-02
50.5	0.1090668E-00
50.5	-0.1116801E-02
50.75	0.8740468E-01
50.75	0.5586376E-01
50.75	0.9557768E-01

Sample input (contd)

50.75	0.4939434E-01
51.0	0.4969382E-01
51.0	0.9000533E-01
51.0	0.6051622E-01
51.0	0.8724495E-01
51.25	0.1025252E-02
51.25	0.1022139E-00
51.25	0.1245622E-01
51.25	0.1040097E-00
51.5	-0.4695549E-01
51.5	0.9018149E-01
51.5	-0.3715440E-01
51.5	0.9630482E-01
51.75	-0.8299061E-01
51.75	0.5735691E-01
51.75	-0.7671069E-01
51.75	0.6652383E-01
52.0	-0.9887673E-01
52.0	0.1204676E-01
52.0	-0.9718750E-01
52.0	0.2220254E-01
52.25	-0.9137029E-01
52.25	-0.3463994E-01
52.25	-0.9424636E-01
52.25	-0.2583645E-01
52.5	-0.6293134E-01
52.5	-0.7149842E-01
52.5	-0.6920234E-01
52.5	-0.6610780E-01
52.75	-0.2095856E-01
52.75	-0.8993305E-01
52.75	-0.2862752E-01
52.75	-0.8922653E-01
53.0	0.2400380E-01
53.0	-0.8599946E-01
53.0	0.1731506E-01
53.0	-0.9013887E-01
53.25	0.6093084E-01
53.25	-0.6128734E-01
53.25	0.5739209E-01
53.25	-0.6927749E-01
53.5	0.8101778E-01
53.5	-0.2243552E-01
53.5	0.8205694E-01
53.5	-0.3236557E-01
53.75	0.7980927E-01
53.75	0.2059330E-01
53.75	0.8576205E-01
53.75	0.1107748E-01
54.0	0.5822295E-01
54.0	0.5703796E-01
54.0	0.6825692E-01
54.0	0.5014965E-01
54.25	0.2222178E-01
54.25	0.7803180E-01
54.25	0.3455574E-01
54.25	0.7529613E-01
54.5	-0.1877237E-01
54.5	0.7878311E-01
54.5	-0.6409262E-02
54.5	0.8066816E-01
54.75	-0.5431238E-01
54.75	0.5970112E-01
54.75	-0.4410112E-01
54.75	0.6552269E-01
55.0	-0.7558388E-01
55.0	0.2619128E-01
55.0	-0.6906673E-01
55.0	0.3431530E-01
55.25	-0.7760925E-01
55.25	-0.1281621E-01
55.25	-0.7531560E-01
55.25	-0.4527986E-02
55.5	-0.6043856E-01
55.5	-0.4721215E-01
55.5	-0.6178283E-01
55.5	-0.4083351E-01
55.75	-0.2903521E-01
55.75	-0.6832171E-01
55.75	-0.3251133E-01
55.75	-0.6532242E-01
56.0	0.8102244E-02
56.0	-0.7110632E-01
56.0	0.4485238E-02
56.0	-0.7198668E-01
56.25	0.4120901E-01
56.25	-0.5539013E-01
56.25	0.3937176E-01
56.25	-0.5958628E-01
56.5	0.6181612E-01
56.5	-0.2580321E-01
56.5	0.6308746E-01
56.5	-0.3188543E-01
56.75	0.6492864E-01
56.75	0.9526548E-02
56.75	0.6970154E-01
56.75	0.3621501E-02
57.0	0.5025994E-01
57.0	0.4117596E-01
57.0	0.5791865E-01
57.0	0.3680240E-01
57.25	0.2220523E-01

Sample input (contd)

57.25	0.6093105E-01
57.25	0.3134044E-01
57.25	0.5943650E-01
57.5	-0.1142018E-01
57.5	0.6392830E-01
57.5	-0.2573028E-02
57.5	0.6554155E-01
57.75	-0.4152608E-01
57.75	0.4986994E-01
57.75	-0.3455373E-01
57.75	0.5386304E-01
58.0	-0.6019425E-01
58.0	0.2300194E-01
58.0	-0.5603397E-01
58.0	0.2793508E-01
58.25	-0.6276512E-01
58.25	-0.9120650E-02
58.25	-0.6143247E-01
58.25	-0.4944769E-02
58.5	-0.4901414E-01
58.5	-0.3773268E-01
58.5	-0.4961071E-01
58.5	-0.3574009E-01
58.75	-0.2311118E-01
58.75	-0.5524417E-01
58.75	-0.2411048E-01
58.75	-0.5614417E-01
59.0	0.7605294E-02
59.0	-0.5726181E-01
59.0	0.7878155E-02
59.0	-0.6081913E-01
59.25	0.3468951E-01
59.25	-0.4370567E-01
59.25	0.3752718E-01
59.25	-0.4880181E-01
59.5	0.5091037E-01
59.5	-0.1872964E-01
59.5	0.5680250E-01
59.5	-0.2369844E-01
59.75	0.5219423E-01
59.75	0.1051036E-01
59.75	0.6064632E-01
59.75	0.7369867E-02
60.0	0.3866553E-01
60.0	0.3588715E-01
60.0	0.4831818E-01
60.0	0.3577340E-01

Sample output

PROGRAM TO FIND 2KC SUCH THAT PSI(THETA)=PHI(THETA)+2KC(COS(THETA)) = CONSTANT

GEOMETRICAL OPTICS PREDICTS 2KC = 145.54870796 USING S AND T. CORRESPONDING AVERAGE VALUE OF PSI = 149.03105927
GEOMETRICAL OPTICS PREDICTS 2KC = 145.54870796 USING U AND V. CORRESPONDING AVERAGE VALUE OF PSI = 149.00415993
THIS PROGRAM FINDS VALUE OF 2KC = 145.88204956 USING S AND T. CORRESPONDING AVERAGE VALUE OF PSI = 149.30662727
THIS PROGRAM FINDS VALUE OF 2KC = 145.69289398 USING U AND V. CORRESPONDING AVERAGE VALUE OF PSI = 149.12335205

	USING S AND T		USING U AND V	
THETA IN DEGREES	PSI(THETA) PREDICTED	PSI(THETA) CALCULATED	PSI(THETA) PREDICTED	PSI(THETA) CALCULATED
0.	0.14866700E 03	0.14900034E 03	0.14866700E 03	0.14881118E 03
0.25000	0.14866880E 03	0.14900213E 03	0.14866866E 03	0.14881285E 03
0.5C000	0.14867415E 03	0.14900748E 03	0.14867362E 03	0.14881780E 03
0.75000	0.14868296E 03	0.14901628E 03	0.14868180E 03	0.14882597E 03
1.00000	0.14869509E 03	0.14902838E 03	0.14869304E 03	0.14883721E 03
1.25000	0.14871030E 03	0.14904356E 03	0.14870717E 03	0.14885132E 03
1.50000	0.14872833E 03	0.14906155E 03	0.14872394E 03	0.14886807E 03
1.75000	0.14874884E 03	0.14908203E 03	0.14874304E 03	0.14888716E 03
2.00000	0.14877147E 03	0.14910461E 03	0.14876416E 03	0.14890826E 03
2.25000	0.14879582E 03	0.14912890E 03	0.14878692E 03	0.14893100E 03
2.50000	0.14882144E 03	0.14915446E 03	0.14881092E 03	0.14895497E 03
2.75000	0.14884791E 03	0.14918087E 03	0.14883576E 03	0.14897978E 03
3.0C000	0.14887477E 03	0.14920765E 03	0.14886104E 03	0.14900502E 03
3.25000	0.14890162E 03	0.14923442E 03	0.14888633E 03	0.14903028E 03
3.50000	0.14892805E 03	0.14926077E 03	0.14891128E 03	0.14905521E 03
3.75000	0.14895373E 03	0.14928636E 03	0.14893555E 03	0.14907943E 03
4.00000	0.14897833E 03	0.14931086E 03	0.14895881E 03	0.14910264E 03
4.25000	0.14900160E 03	0.14933402E 03	0.14898082E 03	0.14912461E 03
4.50000	0.14902332E 03	0.14935563E 03	0.14900135E 03	0.14914510E 03
4.75000	0.14904332E 03	0.14937551E 03	0.14902024E 03	0.14916393E 03
5.00000	0.14906149E 03	0.14939356E 03	0.14903735E 03	0.14918099E 03
5.25000	0.14907773E 03	0.14940967E 03	0.14905259E 03	0.14919617E 03
5.50000	0.14909200E 03	0.14942381E 03	0.14906591E 03	0.14920943E 03
5.75000	0.14910427E 03	0.14943593E 03	0.14907728E 03	0.14922074E 03
6.00000	0.14911453E 03	0.14944604E 03	0.14908671E 03	0.14923010E 03
6.25000	0.14912280E 03	0.14945416E 03	0.14909420E 03	0.14923754E 03
6.5C000	0.14912912E 03	0.14946032E 03	0.14909982E 03	0.14924308E 03
6.75000	0.14913352E 03	0.14946455E 03	0.14910360E 03	0.14924679E 03
7.00000	0.14913605E 03	0.14946691E 03	0.14910562E 03	0.14924874E 03
7.25000	0.14913678E 03	0.14946746E 03	0.14910597E 03	0.14924900E 03
7.50000	0.14913577E 03	0.14946626E 03	0.14910472E 03	0.14924768E 03
7.75000	0.14913309E 03	0.14946339E 03	0.14910199E 03	0.14924486E 03
8.0C000	0.14912882E 03	0.14945892E 03	0.14909787E 03	0.14924066E 03
8.25000	0.14912306E 03	0.14945295E 03	0.14909250E 03	0.14923519E 03
8.50000	0.14911591E 03	0.14944558E 03	0.14908599E 03	0.14922860E 03
8.75000	0.14910746E 03	0.14943691E 03	0.14907850E 03	0.14922100E 03
9.00000	0.14909784E 03	0.14942708E 03	0.14907016E 03	0.14921257E 03
9.25000	0.14908719E 03	0.14941619E 03	0.14906114E 03	0.14920344E 03
9.50000	0.14907566E 03	0.14940443E 03	0.14905160E 03	0.14919381E 03
9.75000	0.14906341E 03	0.14939193E 03	0.14904173E 03	0.14918383E 03
10.00000	0.14905062E 03	0.14937890E 03	0.14903170E 03	0.14917369E 03
10.25000	0.14903749E 03	0.14936551E 03	0.14902171E 03	0.14916360E 03
10.50000	0.14902422E 03	0.14935198E 03	0.14901195E 03	0.14915372E 03

Sample output (contd)

10.75000	0.14901102E 03	0.14933851E 03	0.14900258E 03	0.14914424E 03
11.00000	0.14899813E 03	0.14932534E 03	0.14899381E 03	0.14913535E 03
11.25000	0.14898574E 03	0.14931268E 03	0.14898578E 03	0.14912719E 03
11.50000	0.14897410E 03	0.14930075E 03	0.14897863E 03	0.14911992E 03
11.75000	0.14896338E 03	0.14928974E 03	0.14897247E 03	0.14911364E 03
12.00000	0.14895380E 03	0.14927986E 03	0.14896739E 03	0.14910842E 03
12.25000	0.14894549E 03	0.14927124E 03	0.14896344E 03	0.14910434E 03
12.50000	0.14893859E 03	0.14926402E 03	0.14896061E 03	0.14910137E 03
12.75000	0.14893317E 03	0.14925829E 03	0.14895887E 03	0.14909951E 03
13.00000	0.14892929E 03	0.14925408E 03	0.14895817E 03	0.14909866E 03
13.25000	0.14892694E 03	0.14925140E 03	0.14895838E 03	0.14909873E 03
13.50000	0.14892606E 03	0.14925020E 03	0.14895941E 03	0.14909961E 03
13.75000	0.14892659E 03	0.14925038E 03	0.14896108E 03	0.14910113E 03
14.00000	0.14892839E 03	0.14925183E 03	0.14896326E 03	0.14910316E 03
14.25000	0.14893128E 03	0.14925437E 03	0.14896578E 03	0.14910553E 03
14.50000	0.14893510E 03	0.14925783E 03	0.14896850E 03	0.14910810E 03
14.75000	0.14893965E 03	0.14926201E 03	0.14897131E 03	0.14911074E 03
15.00000	0.14894472E 03	0.14926670E 03	0.14897408E 03	0.14911336E 03
15.25000	0.14895012E 03	0.14927173E 03	0.14897676E 03	0.14911587E 03
15.50000	0.14895567E 03	0.14927688E 03	0.14897927E 03	0.14911821E 03
15.75000	0.14896119E 03	0.14928202E 03	0.14898160E 03	0.14912038E 03
16.00000	0.14896657E 03	0.14928700E 03	0.14898375E 03	0.14912235E 03
16.25000	0.14897169E 03	0.14929172E 03	0.14898574E 03	0.14912416E 03
16.50000	0.14897650E 03	0.14929611E 03	0.14898760E 03	0.14912584E 03
16.75000	0.14898094E 03	0.14930014E 03	0.14898938E 03	0.14912745E 03
17.00000	0.14898501E 03	0.14930378E 03	0.14899114E 03	0.14912903E 03
17.25000	0.14898873E 03	0.14930708E 03	0.14899292E 03	0.14913062E 03
17.50000	0.14899215E 03	0.14931006E 03	0.14899478E 03	0.14913230E 03
17.75000	0.14899532E 03	0.14931280E 03	0.14899676E 03	0.14913408E 03
18.00000	0.14899835E 03	0.14931538E 03	0.14899886E 03	0.14913599E 03
18.25000	0.14900130E 03	0.14931788E 03	0.14900112E 03	0.14913806E 03
18.50000	0.14900428E 03	0.14932039E 03	0.14900351E 03	0.14914025E 03
18.75000	0.14900737E 03	0.14932302E 03	0.14900601E 03	0.14914254E 03
19.00000	0.14901065E 03	0.14932583E 03	0.14900857E 03	0.14914490E 03
19.25000	0.14901419E 03	0.14932889E 03	0.14901114E 03	0.14914726E 03
19.50000	0.14901805E 03	0.14933227E 03	0.14901366E 03	0.14914957E 03
19.75000	0.14902223E 03	0.14933597E 03	0.14901605E 03	0.14915176E 03
20.00000	0.14902674E 03	0.14933998E 03	0.14901827E 03	0.14915376E 03
20.25000	0.14903155E 03	0.14934429E 03	0.14902027E 03	0.14915554E 03
20.50000	0.14903658E 03	0.14934881E 03	0.14902201E 03	0.14915707E 03
20.75000	0.14904174E 03	0.14935346E 03	0.14902352E 03	0.14915835E 03
21.00000	0.14904692E 03	0.14935812E 03	0.14902480E 03	0.14915941E 03
21.25000	0.14905199E 03	0.14936268E 03	0.14902592E 03	0.14916030E 03
21.50000	0.14905683E 03	0.14936697E 03	0.14902698E 03	0.14916113E 03
21.75000	0.14906127E 03	0.14937090E 03	0.14902809E 03	0.14916201E 03
22.00000	0.14906527E 03	0.14937434E 03	0.14902938E 03	0.14916307E 03
22.25000	0.14906868E 03	0.14937720E 03	0.14903099E 03	0.14916444E 03
22.50000	0.14907148E 03	0.14937944E 03	0.14903305E 03	0.14916626E 03
22.75000	0.14907362E 03	0.14938103E 03	0.14903568E 03	0.14916865E 03
23.00000	0.14907516E 03	0.14938200E 03	0.14903892E 03	0.14917165E 03
23.25000	0.14907612E 03	0.14938239E 03	0.14904280E 03	0.14917527E 03

Sample output (contd)

23.50000	0.14907661E 03	0.14938231E 03	0.14904723E 03	0.14917947E 03
23.75000	0.14907672E 03	0.14938183E 03	0.14905208E 03	0.14918406E 03
24.00000	0.14907656E 03	0.14938106E 03	0.14905712E 03	0.14918884E 03
24.25000	0.14907622E 03	0.14938015E 03	0.14906204E 03	0.14919350E 03
24.50000	0.14907576E 03	0.14937911E 03	0.14906649E 03	0.14919769E 03
24.75000	0.14907527E 03	0.14937799E 03	0.14907011E 03	0.14920106E 03
25.00000	0.14907467E 03	0.14937678E 03	0.14907255E 03	0.14920323E 03
25.25000	0.14907391E 03	0.14937540E 03	0.14907351E 03	0.14920392E 03
25.50000	0.14907286E 03	0.14937373E 03	0.14907278E 03	0.14920292E 03
25.75000	0.14907135E 03	0.14937159E 03	0.14907026E 03	0.14920012E 03
26.00000	0.14906919E 03	0.14936879E 03	0.14906595E 03	0.14919554E 03
26.25000	0.14906617E 03	0.14936514E 03	0.14906000E 03	0.14918931E 03
26.50000	0.14906213E 03	0.14936045E 03	0.14905262E 03	0.14918166E 03
26.75000	0.14905693E 03	0.14935461E 03	0.14904415E 03	0.14917291E 03
27.00000	0.14905052E 03	0.14934753E 03	0.14903496E 03	0.14916343E 03
27.25000	0.14904290E 03	0.14933924E 03	0.14902544E 03	0.14915362E 03
27.50000	0.14903418E 03	0.14932986E 03	0.14901599E 03	0.14914388E 03
27.75000	0.14902454E 03	0.14931954E 03	0.14900694E 03	0.14913455E 03
28.00000	0.14901421E 03	0.14930853E 03	0.14899858E 03	0.14912589E 03
28.25000	0.14900348E 03	0.14929711E 03	0.14899107E 03	0.14911808E 03
28.50000	0.14899263E 03	0.14928558E 03	0.14898445E 03	0.14911117E 03
28.75000	0.14898197E 03	0.14927422E 03	0.14897866E 03	0.14910507E 03
29.00000	0.14897172E 03	0.14926327E 03	0.14897349E 03	0.14909960E 03
29.25000	0.14896209E 03	0.14925293E 03	0.14896867E 03	0.14909447E 03
29.50000	0.14895318E 03	0.14924330E 03	0.14896386E 03	0.14908936E 03
29.75000	0.14894502E 03	0.14923443E 03	0.14895876E 03	0.14908395E 03
30.00000	0.14893756E 03	0.14922624E 03	0.14895312E 03	0.14907799E 03
30.25000	0.14893060E 03	0.14921863E 03	0.14894676E 03	0.14907131E 03
30.50000	0.14892422E 03	0.14921144E 03	0.14893965E 03	0.14906389E 03
30.75000	0.14891806E 03	0.14920454E 03	0.14893193E 03	0.14905584E 03
31.00000	0.14891207E 03	0.14919780E 03	0.14892380E 03	0.14904740E 03
31.25000	0.14890622E 03	0.14919120E 03	0.14891564E 03	0.14903890E 03
31.50000	0.14890058E 03	0.14918479E 03	0.14890787E 03	0.14903080E 03
31.75000	0.14889529E 03	0.14917874E 03	0.14890094E 03	0.14902356E 03
32.00000	0.14889061E 03	0.14917330E 03	0.14889531E 03	0.14901759E 03
32.25000	0.14888690E 03	0.14916882E 03	0.14889133E 03	0.14901327E 03
32.50000	0.14888452E 03	0.14916566E 03	0.14888930E 03	0.14901090E 03
32.75000	0.14888383E 03	0.14916418E 03	0.14888932E 03	0.14901058E 03
33.00000	0.14888513E 03	0.14916470E 03	0.14889135E 03	0.14901228E 03
33.25000	0.14888859E 03	0.14916735E 03	0.14889518E 03	0.14901576E 03
33.50000	0.14889418E 03	0.14917214E 03	0.14890046E 03	0.14902070E 03
33.75000	0.14890166E 03	0.14917883E 03	0.14890677E 03	0.14902665E 03
34.00000	0.14891063E 03	0.14918698E 03	0.14891365E 03	0.14903319E 03
34.25000	0.14892045E 03	0.14919598E 03	0.14892072E 03	0.14903991E 03
34.50000	0.14893042E 03	0.14920513E 03	0.14892772E 03	0.14904655E 03
34.75000	0.14893985E 03	0.14921374E 03	0.14893449E 03	0.14905296E 03
35.00000	0.14894818E 03	0.14922123E 03	0.14894106E 03	0.14905917E 03
35.25000	0.14895505E 03	0.14922727E 03	0.14894755E 03	0.14906530E 03
35.50000	0.14896037E 03	0.14923175E 03	0.14895413E 03	0.14907152E 03
35.75000	0.14896431E 03	0.14923464E 03	0.14896099E 03	0.14907800E 03
36.00000	0.14896726E 03	0.14923694E 03	0.14896821E 03	0.14908487E 03

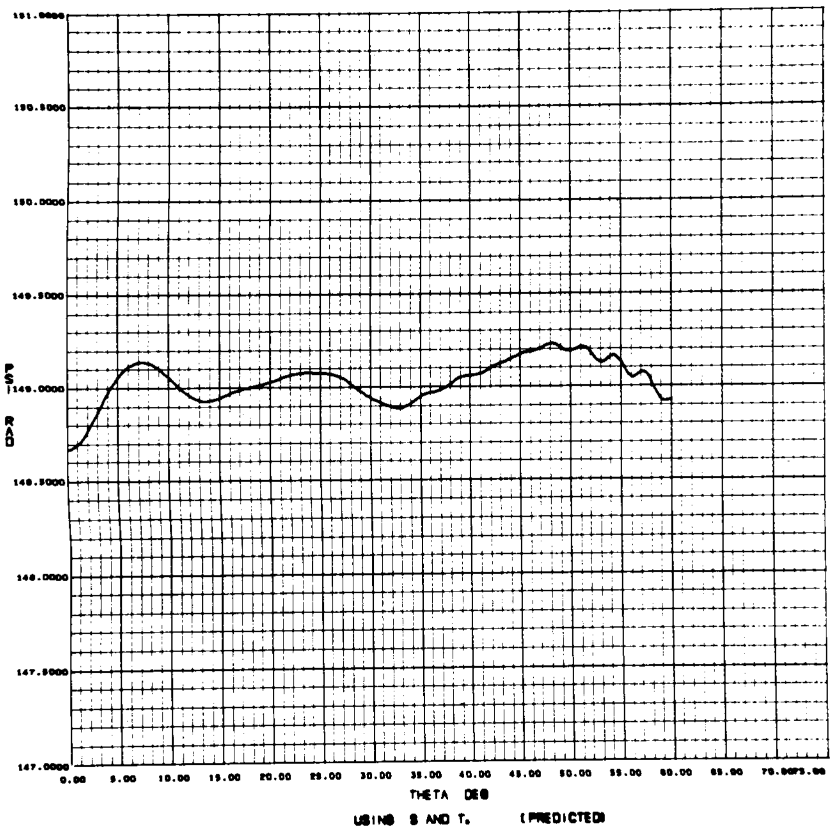
Sample output (contd)

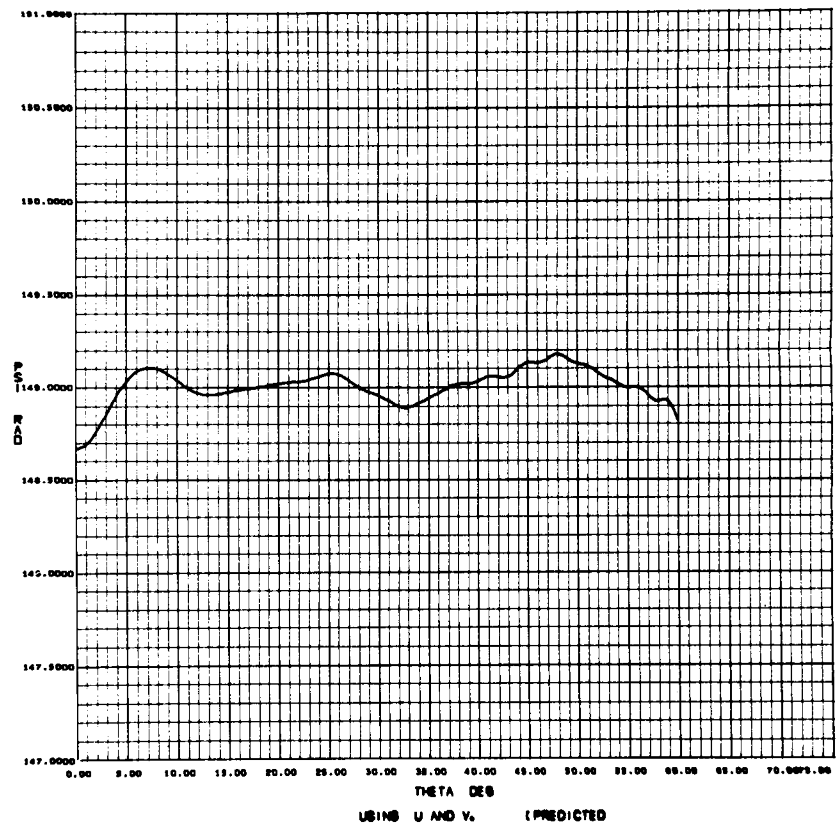
36.25000	0.14896977E 03	0.14923859E 03	0.14897579E 03	0.14909206E 03
36.50000	0.14897250E 03	0.14924045E 03	0.14898355E 03	0.14909945E 03
36.75000	0.14897603E 03	0.14924312E 03	0.14899121E 03	0.14910674E 03
37.00000	0.14898087E 03	0.14924709E 03	0.14899838E 03	0.14911354E 03
37.25000	0.14898732E 03	0.14925265E 03	0.14900468E 03	0.14911944E 03
37.50000	0.14899536E 03	0.14925982E 03	0.14900976E 03	0.14912415E 03
37.75000	0.14900473E 03	0.14926830E 03	0.14901348E 03	0.14912749E 03
38.00000	0.14901488E 03	0.14927756E 03	0.14901586E 03	0.14912947E 03
38.25000	0.14902510E 03	0.14928687E 03	0.14901712E 03	0.14913035E 03
38.50000	0.14903461E 03	0.14929549E 03	0.14901769E 03	0.14913053E 03
38.75000	0.14904279E 03	0.14930276E 03	0.14901810E 03	0.14913055E 03
39.00000	0.14904922E 03	0.14930826E 03	0.14901894E 03	0.14913100E 03
39.25000	0.14905375E 03	0.14931189E 03	0.14902072E 03	0.14913237E 03
39.50000	0.14905662E 03	0.14931384E 03	0.14902377E 03	0.14913503E 03
39.75000	0.14905825E 03	0.14931454E 03	0.14902819E 03	0.14913905E 03
40.00000	0.14905928E 03	0.14931463E 03	0.14903375E 03	0.14914420E 03
40.25000	0.14906040E 03	0.14931481E 03	0.14903995E 03	0.14915000E 03
40.50000	0.14906225E 03	0.14931573E 03	0.14904609E 03	0.14915573E 03
40.75000	0.14906533E 03	0.14931786E 03	0.14905138E 03	0.14916061E 03
41.00000	0.14906989E 03	0.14932147E 03	0.14905517E 03	0.14916398E 03
41.25000	0.14907588E 03	0.14932650E 03	0.14905707E 03	0.14916547E 03
41.50000	0.14908301E 03	0.14933267E 03	0.14905705E 03	0.14916503E 03
41.75000	0.14909080E 03	0.14933949E 03	0.14905550E 03	0.14916307E 03
42.00000	0.14909867E 03	0.14934639E 03	0.14905314E 03	0.14916030E 03
42.25000	0.14910614E 03	0.14935289E 03	0.14905097E 03	0.14915770E 03
42.50000	0.14911290E 03	0.14935866E 03	0.14905006E 03	0.14915636E 03
42.75000	0.14911886E 03	0.14936364E 03	0.14905142E 03	0.14915730E 03
43.00000	0.14912423E 03	0.14936803E 03	0.14905579E 03	0.14916123E 03
43.25000	0.14912934E 03	0.14937214E 03	0.14906340E 03	0.14916842E 03
43.50000	0.14913460E 03	0.14937640E 03	0.14907394E 03	0.14917853E 03
43.75000	0.14914034E 03	0.14938113E 03	0.14908645E 03	0.14919060E 03
44.00000	0.14914671E 03	0.14938650E 03	0.14909954E 03	0.14920326E 03
44.25000	0.14915362E 03	0.14939240E 03	0.14911165E 03	0.14921493E 03
44.50000	0.14916073E 03	0.14939848E 03	0.14912146E 03	0.14922430E 03
44.75000	0.14916752E 03	0.14940426E 03	0.14912816E 03	0.14923056E 03
45.00000	0.14917350E 03	0.14940920E 03	0.14913163E 03	0.14923358E 03
45.25000	0.14917827E 03	0.14941295E 03	0.14913239E 03	0.14923389E 03
45.50000	0.14918178E 03	0.14941543E 03	0.14913150E 03	0.14923257E 03
45.75000	0.14918427E 03	0.14941687E 03	0.14913031E 03	0.14923092E 03
46.00000	0.14918630E 03	0.14941785E 03	0.14913015E 03	0.14923032E 03
46.25000	0.14918859E 03	0.14941910E 03	0.14913210E 03	0.14923181E 03
46.50000	0.14919186E 03	0.14942133E 03	0.14913672E 03	0.14923598E 03
46.75000	0.14919661E 03	0.14942501E 03	0.14914387E 03	0.14924266E 03
47.00000	0.14920286E 03	0.14943020E 03	0.14915266E 03	0.14925099E 03
47.25000	0.14921010E 03	0.14943638E 03	0.14916167E 03	0.14925955E 03
47.50000	0.14921729E 03	0.14944249E 03	0.14916928E 03	0.14926670E 03
47.75000	0.14922312E 03	0.14944725E 03	0.14917407E 03	0.14927102E 03
48.00000	0.14922631E 03	0.14944936E 03	0.14917519E 03	0.14927167E 03
48.25000	0.14922602E 03	0.14944799E 03	0.14917253E 03	0.14926854E 03
48.50000	0.14922209E 03	0.14944297E 03	0.14916664E 03	0.14926218E 03
48.75000	0.14921510E 03	0.14943489E 03	0.14915858E 03	0.14925364E 03

Sample output (contd)

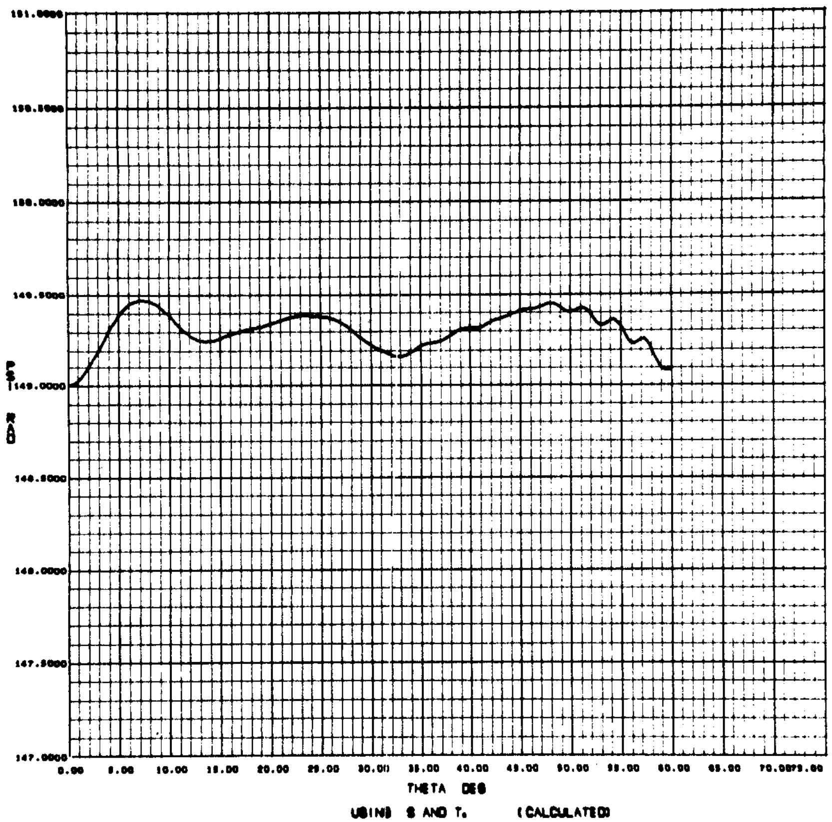
49.00000	0.14920633E 03	0.14942501E 03	0.14914963E 03	0.14924423E 03
49.25000	0.14919747E 03	0.14941506E 03	0.14914105E 03	0.14923517E 03
49.50000	0.14919040E 03	0.14940690E 03	0.14913378E 03	0.14922742E 03
49.75000	0.14918671E 03	0.14940209E 03	0.14912828E 03	0.14922144E 03
50.00000	0.14918729E 03	0.14940156E 03	0.14912443E 03	0.14921711E 03
50.25000	0.14919195E 03	0.14940511E 03	0.14912160E 03	0.14921380E 03
50.50000	0.14919928E 03	0.14941131E 03	0.14911881E 03	0.14921053E 03
50.75000	0.14920682E 03	0.14941773E 03	0.14911512E 03	0.14920634E 03
51.00000	0.14921177E 03	0.14942155E 03	0.14910980E 03	0.14920054E 03
51.25000	0.14921180E 03	0.14942045E 03	0.14910264E 03	0.14919288E 03
51.50000	0.14920573E 03	0.14941324E 03	0.14909388E 03	0.14918364E 03
51.75000	0.14919385E 03	0.14940022E 03	0.14908420E 03	0.14917346E 03
52.00000	0.14917777E 03	0.14938299E 03	0.14907441E 03	0.14916318E 03
52.25000	0.14916005E 03	0.14936412E 03	0.14906527E 03	0.14915355E 03
52.50000	0.14914376E 03	0.14934668E 03	0.14905725E 03	0.14914501E 03
52.75000	0.14913186E 03	0.14933364E 03	0.14905036E 03	0.14913764E 03
53.00000	0.14912666E 03	0.14932726E 03	0.14904425E 03	0.14913102E 03
53.25000	0.14912892E 03	0.14932837E 03	0.14903829E 03	0.14912456E 03
53.50000	0.14913740E 03	0.14933568E 03	0.14903186E 03	0.14911763E 03
53.75000	0.14914875E 03	0.14934585E 03	0.14902467E 03	0.14910994E 03
54.00000	0.14915837E 03	0.14935430E 03	0.14901690E 03	0.14910165E 03
54.25000	0.14916201E 03	0.14935677E 03	0.14900919E 03	0.14909343E 03
54.50000	0.14915714E 03	0.14935072E 03	0.14900251E 03	0.14908624E 03
54.75000	0.14914357E 03	0.14933595E 03	0.14899781E 03	0.14908104E 03
55.00000	0.14912320E 03	0.14931440E 03	0.14899565E 03	0.14907835E 03
55.25000	0.14909941E 03	0.14928941E 03	0.14899580E 03	0.14907798E 03
55.50000	0.14907630E 03	0.14926511E 03	0.14899717E 03	0.14907884E 03
55.75000	0.14905793E 03	0.14924554E 03	0.14899798E 03	0.14907912E 03
56.00000	0.14904752E 03	0.14923391E 03	0.14899629E 03	0.14907692E 03
56.25000	0.14904642E 03	0.14923161E 03	0.14899068E 03	0.14907078E 03
56.50000	0.14905334E 03	0.14923732E 03	0.14898080E 03	0.14906038E 03
56.75000	0.14906411E 03	0.14924687E 03	0.14896747E 03	0.14904653E 03
57.00000	0.14907293E 03	0.14925449E 03	0.14895261E 03	0.14903114E 03
57.25000	0.14907451E 03	0.14925484E 03	0.14893874E 03	0.14901674E 03
57.50000	0.14906589E 03	0.14924499E 03	0.14892834E 03	0.14900582E 03
57.75000	0.14904711E 03	0.14922499E 03	0.14892314E 03	0.14900008E 03
58.00000	0.14902070E 03	0.14919735E 03	0.14892323E 03	0.14899964E 03
58.25000	0.14899071E 03	0.14916611E 03	0.14892672E 03	0.14900259E 03
58.50000	0.14896171E 03	0.14913588E 03	0.14892993E 03	0.14900526E 03
58.75000	0.14893800E 03	0.14911092E 03	0.14892859E 03	0.14900339E 03
59.00000	0.14892261E 03	0.14909430E 03	0.14891938E 03	0.14899365E 03
59.25000	0.14891639E 03	0.14908682E 03	0.14890102E 03	0.14897475E 03
59.50000	0.14891727E 03	0.14908645E 03	0.14887454E 03	0.14894772E 03
59.75000	0.14892060E 03	0.14908853E 03	0.14884282E 03	0.14891545E 03
60.00000	0.14892074E 03	0.14908741E 03	0.14880990E 03	0.14888199E 03

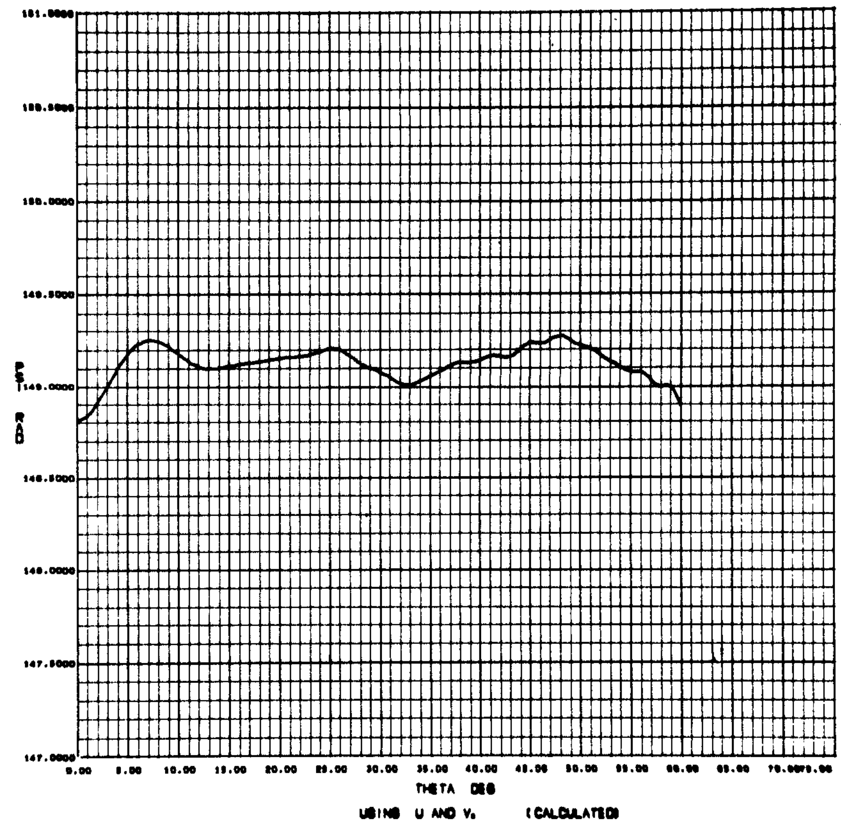
Sample output, plotted





Sample output, plotted





Page intentionally left blank

VIII. DATA CONVERSION

A. Ludwig

Program: 1620 only, source deck in Antenna and Propagation Group Library (revised February 18, 1966)

Programmer: A. Ludwig

A. Program Description

This program converts output from the Scattering Program (VI) to format compatible with Programs III, IX, and XIV. Field values are converted from real and imaginary values (in volts) to amplitude (in volts) and phase angle (in degrees). The phase pattern as output from VI uses the phase center of the feed horn as the center of a spherical coordinate system; the phase center of the scattered pattern will normally be at the focal point of the paraboloid. The distance between the feed phase center and the expected phase center of the scattered fields is input to this program, and phase values are transformed to this new coordinate system. Usually, the expected phase center may be computed with geometrical optics; otherwise, the phase center may be computed with the Phase Center Program (VII). Since the scattered fields are computed for the far-field region (i.e., infinitely far away from the scattering surface), amplitude values are not affected by the coordinate transformation.

B. Applications

See flow chart on page

C. Input

The output from the Scattering Program for this application is in the form of a data block for the E-plane and a data block for the H-plane. Each data block is preceded by a title card; these title cards, blank cards, and IBM 7094 job cards must be removed. Then control cards are added as shown below:

Card	Parameter					Format
1	*TITLE*					20A4
2	*TKC PSIMAX PSIBLK NMAX*					3F10.0, I5
3	*PSI*	*S*	*T*	*U*	*V*	F10.5, 4E17.8
4	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
NMAX+2	*PSI*	*S*	*T*	*U*	*V*	F10.5, 4E17.8

TITLE = any alphanumeric statement, Columns 1 through 72

TKC = distance between feed phase center and expected phase center of scattered fields, times the propagation constants $2\pi/\lambda$

PSIMAX = maximum value of *PSI* output by Scattering Program

PSIBLK = angle (in degrees) of blocked region at vertex of paraboloid illuminated by scattered fields; this is punched on the output cards to be used by the Efficiency Program (IX)

NMAX = number of data points output by Scattering Program

PSI, *S*, *T*, *U*, and *V* = data output from Scattering Program

D. Output

The output of this program is identical to the input of the Antenna Feed Efficiency Program.

E. Sample Case

Sample input

AAS SUB, NO FLANGE, S-BAND

696.386	90.0	7.0	181		
0.	0.		-0.	0.24075336E-00	-0.94946442E-02
0.50000	0.		-0.	0.21951603E-00	-0.66851991E-02
1.00000	0.		-0.	0.17883942E-00	0.78757155E-03
1.50000	0.		0.	0.15900845E-00	0.17251216E-01
2.00000	0.		0.	0.16616526E-00	0.53590001E-01
2.50000	0.		0.	0.16488385E-00	0.10629158E-00
3.00000	0.		0.	0.12675155E-00	0.14915850E-00
3.50000	0.		0.	0.63877908E-01	0.16510948E-00
4.00000	-0.		0.	-0.35980932E-02	0.16666191E-00
4.50000	-0.		0.	-0.80104546E-01	0.15774243E-00
5.00000	-0.		0.	-0.15791722E-00	0.10794757E-00
5.50000	-0.		0.	-0.18954110E-00	0.73380341E-02
6.00000	-0.		-0.	-0.14608619E-00	-0.97157673E-01
6.50000	-0.		-0.	-0.51852974E-01	-0.16020871E-00
7.00000	0.		-0.	0.65688871E-01	-0.16385413E-00
7.50000	0.		-0.	0.16870304E-00	-0.80694465E-01
8.00000	0.		0.	0.17212647E-00	0.69349104E-01
8.50000	0.		0.	0.47609200E-01	0.16934558E-00
9.00000	-0.		0.	-0.10654960E-00	0.13439518E-00
9.50000	-0.		-0.	-0.17583204E-00	-0.68720208E-02
10.00000	-0.		-0.	-0.94121763E-01	-0.15516198E-00
10.50000	0.		-0.	0.94502414E-01	-0.15429340E-00
11.00000	0.		0.	0.17485672E-00	0.30080133E-01
11.50000	0.		0.	0.32853743E-01	0.17255869E-00
12.00000	-0.		0.	-0.14772206E-00	0.92880759E-01
12.50000	-0.		-0.	-0.13487130E-00	-0.10890892E-00
13.00000	0.		-0.	0.77131619E-01	-0.15612771E-00
13.50000	0.		0.	0.16835232E-00	0.57734620E-01
14.00000	-0.		0.	-0.40528297E-01	0.17496004E-00
14.50000	-0.		0.	-0.17242231E-00	-0.23052398E-01
15.00000	0.		-0.	0.13647605E-01	-0.16618405E-00
15.50000	0.		0.	0.16651242E-00	0.17792775E-01
16.00000	-0.		0.	-0.33827087E-01	0.17225955E-00
16.50000	-0.		-0.	-0.17043169E-00	-0.58179921E-01
17.00000	0.		-0.	0.87307683E-01	-0.15169679E-00
17.50000	0.		0.	0.11957154E-00	0.11706173E-00
18.00000	-0.		0.	-0.14425875E-00	0.81829571E-01
18.50000	-0.		-0.	-0.37037598E-01	-0.16557397E-00
19.00000	0.		0.	0.17082416E-00	0.23256023E-01
19.50000	-0.		0.	-0.95658630E-01	0.14313349E-00
20.00000	-0.		-0.	-0.75172551E-01	-0.15474330E-00
20.50000	0.		0.	0.17042014E-00	0.16406160E-01
21.00000	-0.		0.	-0.10101900E-00	0.13244667E-00
21.50000	-0.		-0.	-0.50284563E-01	-0.15339600E-00
22.00000	0.		0.	0.15184575E-00	0.57423691E-01
22.50000	-0.		0.	-0.15059081E-00	0.76682631E-01
23.00000	0.		-0.	0.53239851E-01	-0.16452646E-00
23.50000	0.		0.	0.68143353E-01	0.15495401E-00
24.00000	-0.		-0.	-0.14388943E-00	-0.76894971E-01
24.50000	0.		-0.	0.15886961E-00	-0.23742551E-01
25.00000	-0.		0.	-0.11425699E-00	0.11311352E-00
25.50000	0.		-0.	0.32375829E-01	-0.15744466E-00
26.00000	0.		0.	0.47306072E-01	0.15453497E-00
26.50000	-0.		-0.	-0.10904832E-00	-0.12440437E-00
27.00000	0.		0.	0.15046205E-00	0.75649699E-01
27.50000	-0.		-0.	-0.16403492E-00	-0.18453808E-01
28.00000	0.		-0.	0.15476992E-00	-0.30222554E-01
28.50000	-0.		0.	-0.13798595E-00	0.67405085E-01
29.00000	0.		-0.	0.11865727E-00	-0.99168359E-01
29.50000	-0.		0.	-0.96688360E-01	0.12333215E-00
30.00000	0.		-0.	0.79334466E-01	-0.13594897E-00
30.50000	-0.		0.	-0.72852081E-01	0.14127600E-00
31.00000	0.		-0.	0.73752296E-01	-0.14389192E-00
31.50000	-0.		0.	-0.76526504E-01	0.14143804E-00
32.00000	0.		-0.	0.81592092E-01	-0.13117472E-00
32.50000	-0.		0.	-0.91469610E-01	0.11624581E-00
33.00000	0.		-0.	0.10527579E-00	-0.10100789E-00
33.50000	-0.		0.	-0.12023734E-00	0.84013288E-01
34.00000	0.		-0.	0.13472328E-00	-0.58624668E-01
34.50000	-0.		0.	-0.14618795E-00	0.19473861E-01
35.00000	0.		0.	0.14728479E-00	0.32126486E-01
35.50000	-0.		-0.	-0.12736782E-00	-0.86920396E-01
36.00000	0.		0.	0.80247121E-01	0.13017099E-00
36.50000	-0.		-0.	-0.11579309E-01	-0.14702591E-00
37.00000	-0.		0.	-0.61131746E-01	0.12907245E-00
37.50000	0.		-0.	0.11623532E-00	-0.78384912E-01
38.00000	-0.		0.	-0.15673919E-00	0.66434049E-02
38.50000	0.		0.	0.11417712E-00	0.68046524E-01
39.00000	-0.		-0.	-0.49622994E-01	-0.12225141E-00
39.50000	-0.		0.	-0.41077366E-01	0.12906494E-00
40.00000	0.		-0.	0.12012175E-00	-0.71184357E-01
40.50000	-0.		-0.	-0.13662207E-00	-0.34348354E-01
41.00000	0.		0.	0.63979214E-01	0.12522137E-00
41.50000	0.		-0.	0.59216504E-01	-0.12861902E-00
42.00000	-0.		0.	-0.13870747E-00	0.30013535E-01
42.50000	-0.		0.	0.10210997E-00	0.93195150E-01
43.00000	0.		-0.	0.22229653E-01	-0.13004907E-00
43.50000	-0.		0.	-0.11899374E-00	0.44729527E-01
44.00000	0.		-0.	0.95493287E-01	0.79585744E-01
44.50000	0.		-0.	0.22493288E-01	-0.11865538E-00
45.00000	-0.		0.	-0.11161777E-00	0.32471820E-01
45.50000	-0.		-0.	0.73549327E-01	0.87155674E-01
46.00000	0.		-0.	0.54462421E-01	-0.10181443E-00
46.50000	-0.		-0.	-0.11736710E-00	-0.15782401E-01
47.00000	0.		0.	0.21779075E-01	0.11703308E-00
47.50000	0.		-0.	0.10930731E-00	-0.50680274E-01
48.00000	-0.		-0.	-0.72317148E-01	-0.99499349E-01
48.50000	-0.		-0.	-0.88891701E-01	0.90329325E-01
49.00000	0.		0.	0.10295500E-00	0.76576576E-01

Sample input (contd)

49.50000	0.	-0.	0.66387752E-01	-0.10822129E-00
50.00000	-0.	-0.	-0.10916561E-00	-0.61978396E-01
50.50000	-0.	0.	-0.61833969E-01	0.10929592E-00
51.00000	0.	0.	0.10767144E-00	0.62927607E-01
51.50000	0.	-0.	0.65517170E-01	-0.10155477E-00
52.00000	-0.	-0.	-0.90986023E-01	-0.71524696E-01
52.50000	-0.	0.	-0.80348641E-01	0.78219093E-01
53.00000	0.	0.	0.64104216E-01	0.88681389E-01
53.50000	0.	-0.	0.93677585E-01	-0.47202323E-01
54.00000	-0.	-0.	-0.26265647E-01	-0.94766611E-01
54.50000	-0.	-0.	-0.92370974E-01	0.24403721E-02
55.00000	-0.	0.	-0.21181457E-01	0.85970639E-01
55.50000	0.	0.	0.74015377E-01	0.41541745E-01
56.00000	0.	-0.	0.56757260E-01	-0.55513224E-01
56.50000	-0.	-0.	-0.31469537E-01	-0.65823679E-01
57.00000	-0.	0.	-0.67826353E-01	0.49709734E-02
57.50000	-0.	0.	-0.19887976E-01	0.61846696E-01
58.00000	0.	0.	0.47687408E-01	0.39247801E-01
58.50000	0.	-0.	0.50296224E-01	-0.26781506E-01
59.00000	0.	-0.	-0.25152711E-02	-0.51635478E-01
59.50000	-0.	-0.	-0.43429047E-01	-0.20336609E-01
60.00000	-0.	0.	-0.36844336E-01	0.27514022E-01
60.50000	0.	0.	0.73363195E-02	0.43361438E-01
61.00000	0.	0.	0.38662203E-01	0.12512143E-01
61.50000	0.	-0.	0.27258713E-01	-0.24442389E-01
62.00000	-0.	-0.	-0.49921405E-02	-0.33258116E-01
62.50000	-0.	-0.	-0.29206941E-01	-0.13927756E-01
63.00000	-0.	0.	-0.26752741E-01	0.16779342E-01
63.50000	-0.	0.	0.30199631E-03	0.29864976E-01
64.00000	0.	0.	0.22829591E-01	0.14558961E-01
64.50000	0.	-0.	0.22744169E-01	-0.86377726E-02
65.00000	0.	-0.	0.72832068E-02	-0.21674676E-01
65.50000	-0.	-0.	-0.12279634E-01	-0.19018482E-01
66.00000	-0.	-0.	-0.22425346E-01	-0.12818446E-02
66.50000	-0.	0.	-0.13273827E-01	0.16765086E-01
67.00000	0.	0.	0.50152146E-02	0.18747659E-01
67.50000	0.	0.	0.15661930E-01	0.74240466E-02
68.00000	0.	-0.	0.15073574E-01	-0.57730307E-02
68.50000	0.	-0.	0.61728503E-02	-0.14834391E-01
69.00000	-0.	-0.	-0.73620903E-02	-0.14650869E-01
69.50000	-0.	-0.	-0.15945992E-01	-0.33123285E-02
70.00000	-0.	0.	-0.11778820E-01	0.99123041E-02
70.50000	-0.	0.	-0.27607488E-04	0.13932672E-01
71.00000	0.	0.	0.89827778E-02	0.86660514E-02
71.50000	0.	0.	0.11676181E-01	0.21710541E-03
72.00000	0.	-0.	0.87434242E-02	-0.78070579E-02
72.50000	-0.	-0.	0.56136565E-03	-0.12207314E-01
73.00000	-0.	-0.	-0.90544280E-02	-0.87762848E-02
73.50000	-0.	0.	-0.12471612E-01	0.13005535E-02
74.00000	-0.	0.	-0.66732274E-02	0.98905357E-02
74.50000	0.	0.	0.27516761E-02	0.10578796E-01
75.00000	0.	0.	0.85520472E-02	0.48320094E-02
75.50000	0.	-0.	0.86992052E-02	-0.20719003E-02
76.00000	0.	-0.	0.49852667E-02	-0.69433879E-02
76.50000	-0.	-0.	-0.86840744E-03	-0.86095066E-02
77.00000	-0.	-0.	-0.68832260E-02	-0.58717262E-02
77.50000	-0.	0.	-0.94170316E-02	0.95814227E-03
78.00000	-0.	0.	-0.57358342E-02	0.78527679E-02
78.50000	0.	0.	0.21677904E-02	0.94909104E-02
79.00000	0.	0.	0.83886696E-02	0.44342916E-02
79.50000	0.	-0.	0.84248782E-02	-0.32529658E-02
80.00000	0.	-0.	0.29747705E-02	-0.78883708E-02
80.50000	-0.	-0.	-0.34628063E-02	-0.69597510E-02
81.00000	-0.	-0.	-0.68117638E-02	-0.21789201E-02
81.50000	-0.	0.	-0.59256764E-02	0.29894356E-02
82.00000	-0.	0.	-0.21100662E-02	0.59202023E-02
82.50000	0.	0.	0.24605764E-02	0.55933920E-02
83.00000	0.	0.	0.56357870E-02	0.23203403E-02
83.50000	0.	-0.	0.57164858E-02	-0.23753919E-02
84.00000	0.	-0.	0.23048522E-02	-0.59201241E-02
84.50000	-0.	-0.	-0.28775179E-02	-0.58712734E-02
85.00000	-0.	-0.	-0.64740597E-02	-0.17879259E-02
85.50000	-0.	0.	-0.57034286E-02	0.38336926E-02
86.00000	0.	0.	-0.73031542E-03	0.69577298E-02
86.50000	0.	0.	0.49871958E-02	0.50336833E-02
87.00000	0.	-0.	0.71019112E-02	-0.74499617E-03
87.50000	0.	-0.	0.38264880E-02	-0.60637829E-02
88.00000	-0.	-0.	-0.24487489E-02	-0.67442679E-02
88.50000	-0.	-0.	-0.68322734E-02	-0.21417912E-02
89.00000	-0.	0.	-0.57928862E-02	0.41552694E-02
89.50000	0.	0.	-0.10779946E-03	0.70838100E-02
90.00000	0.	0.	0.56157599E-02	0.42271210E-02
0.	0.24075337E-00	-0.94946396E-02	0.14350019E-07	-0.56592489E-09
0.50000	0.21917173E-00	-0.69501997E-02	0.13084175E-07	-0.39846892E-09
1.00000	0.17803186E-00	-0.43444423E-04	0.10659660E-07	0.46942922E-10
1.50000	0.15845454E-00	0.16202460E-01	0.94776422E-08	0.10282525E-08
2.00000	0.16630799E-00	0.53184728E-01	0.99042217E-08	0.31942130E-08
2.50000	0.16509566E-00	0.10682249E-00	0.98278436E-08	0.65554716E-08
3.00000	0.12637936E-00	0.14965785E-00	0.75549814E-08	0.88905394E-08
3.50000	0.63551494E-01	0.16464058E-00	0.38074200E-08	0.98412920E-08
4.00000	-0.30076622E-02	0.16590522E-00	-0.21446307E-09	0.99338239E-08
4.50000	-0.79280589E-01	0.15782581E-00	-0.47746029E-08	0.94021819E-08
5.00000	-0.15794159E-00	0.10841011E-00	-0.94126001E-08	0.64341768E-08
5.50000	-0.18992241E-00	0.74153709E-02	-0.11297530E-07	0.43738091E-09
6.00000	-0.14642171E-00	-0.96773995E-01	-0.87074158E-08	-0.57910486E-08
6.50000	-0.53196777E-01	-0.15963645E-00	-0.30906780E-08	-0.95491833E-08
7.00000	0.63879237E-01	-0.16484380E-00	0.39153618E-08	-0.97664671E-08
7.50000	0.16875581E-00	-0.82765763E-01	0.10055485E-07	-0.48097648E-08
8.00000	0.17386591E-00	0.68449076E-01	0.10259537E-07	0.41335287E-08
8.50000	0.49575837E-01	0.16976718E-00	0.28577294E-08	0.10093783E-07
9.00000	-0.10473033E-00	0.13628523E-00	-0.63508509E-08	0.80105773E-08
9.50000	-0.17641085E-00	-0.36574220E-02	-0.10480406E-07	-0.40960436E-09

Sample input (contd)

10.00000	-0.97589967E-01	-0.15463383E-00	-0.56100942E-08	-0.92483748E-08
10.50000	0.92948636E-01	-0.15764287E-00	0.56327828E-08	-0.91966032E-08
11.00000	0.17711279E-00	0.27110759E-01	0.10422272E-07	0.17929156E-08
11.50000	0.36659024E-01	0.17266130E-00	0.19582357E-08	0.10285299E-07
12.00000	-0.14609905E-00	0.96727767E-01	-0.88049211E-08	0.55361246E-08
12.50000	-0.13900021E-00	-0.10648838E-00	-0.80389562E-08	-0.64914776E-08
13.00000	0.73976878E-01	-0.16065706E-00	0.45974027E-08	-0.93059371E-08
13.50000	0.17230027E-00	0.53811260E-01	0.10034580E-07	0.34412514E-08
14.00000	-0.36354183E-01	0.17753480E-00	-0.24156747E-08	0.10428431E-07
14.50000	-0.17415203E-00	-0.18772662E-01	-0.10277171E-07	-0.13740300E-08
15.00000	0.86637317E-02	-0.16811782E-00	0.81346063E-09	-0.99053410E-08
15.50000	0.16908856E-00	0.11954291E-01	0.99249141E-08	0.10605320E-08
16.00000	-0.28168509E-01	0.17531923E-00	-0.20162515E-08	0.10267469E-07
16.50000	-0.17378819E-00	-0.53849269E-01	-0.10158520E-07	-0.34677935E-08
17.00000	0.84220579E-01	-0.15542803E-00	0.52039434E-08	-0.90418334E-08
17.50000	0.12403946E-00	0.11429024E-00	0.71270195E-08	0.69774234E-08
18.00000	-0.14174256E-00	0.87386897E-01	-0.85984920E-08	0.48774225E-08
18.50000	-0.43309810E-01	-0.16477774E-00	-0.22076129E-08	-0.98689780E-08
19.00000	0.17318284E-00	0.17699981E-01	0.10181913E-07	0.13861670E-08
19.50000	-0.92296385E-01	0.14820193E-00	-0.57016987E-08	0.85314210E-08
20.00000	-0.81069246E-01	-0.15378727E-00	-0.44806331E-08	-0.92234194E-08
20.50000	0.17132723E-00	0.11062642E-01	0.10157832E-07	0.97788334E-09
21.00000	-0.96953635E-01	0.13546952E-00	-0.60212019E-08	0.78944367E-08
21.50000	-0.55745488E-01	-0.15219404E-00	-0.29971935E-08	-0.91431142E-08
22.00000	0.15513995E-00	0.51625665E-01	0.90507125E-08	0.34227187E-08
22.50000	-0.14819957E-00	0.83051175E-01	-0.89759120E-08	0.45706409E-08
23.00000	0.47951349E-01	-0.16677040E-00	0.31733424E-08	-0.98065414E-08
23.50000	0.72867444E-01	0.15348780E-00	0.40616603E-08	0.92359788E-08
24.00000	-0.14643330E-00	-0.72198835E-01	-0.85764787E-08	-0.45832974E-08
24.50000	0.15668259E-00	-0.29561654E-01	0.94693669E-08	-0.14151663E-08
25.00000	-0.10848886E-00	0.11608220E-00	-0.68102478E-08	0.67420910E-08
25.50000	0.26223053E-01	-0.15738188E-00	0.19297498E-08	-0.93844330E-08
26.00000	0.53262417E-01	0.15229609E-00	0.28196616E-08	0.92110025E-08
26.50000	-0.11352156E-00	-0.11941598E-00	-0.64997868E-08	-0.74150785E-08
27.00000	0.15135568E-00	0.69541237E-01	0.89682374E-08	0.45090734E-08
27.50000	-0.16216478E-00	-0.13484918E-01	-0.97772432E-08	-0.10999326E-08
28.00000	0.15149713E-00	-0.34498752E-01	0.92250060E-08	-0.18014046E-08
28.50000	-0.13268510E-00	0.71431659E-01	-0.82246038E-08	0.40176561E-08
29.00000	0.11154353E-00	-0.10170204E-00	0.70725244E-08	-0.59108948E-08
29.50000	-0.89690601E-01	0.12428810E-00	-0.57630753E-08	0.73511691E-08
30.00000	0.73115670E-01	-0.13679861E-00	0.47287027E-08	-0.81031904E-08
30.50000	-0.66449503E-01	0.14223407E-00	-0.43423224E-08	0.84207060E-08
31.00000	0.67063155E-01	-0.14376578E-00	0.43959793E-08	-0.85766265E-08
31.50000	-0.70494196E-01	0.14009318E-00	-0.45613351E-08	0.84303643E-08
32.00000	0.76171245E-01	-0.12996871E-00	0.48632676E-08	-0.78186228E-08
32.50000	-0.85394239E-01	0.11616720E-00	-0.54520136E-08	0.69287903E-08
33.00000	0.97991104E-01	-0.10190653E-00	0.62749261E-08	-0.60205395E-08
33.50000	-0.11289857E-00	0.85704295E-01	-0.71667039E-08	0.50075822E-08
34.00000	0.12901839E-00	-0.61635693E-01	0.80301331E-08	-0.34943026E-08
34.50000	-0.14278989E-00	0.24295304E-01	-0.87134807E-08	0.11607325E-08
35.00000	0.14569544E-00	0.25999270E-01	0.87788576E-08	-0.19148878E-08
35.50000	-0.12691811E-00	-0.80774752E-01	-0.75917137E-08	-0.51808593E-08
36.00000	0.80971234E-01	0.12507015E-00	0.47831012E-08	0.77587955E-08
36.50000	-0.14175843E-01	-0.14332742E-00	-0.69018062E-09	-0.87634269E-08
37.00000	-0.56152109E-01	0.12694146E-00	-0.36437359E-08	0.76933176E-08
37.50000	0.10957336E-00	-0.78415059E-01	0.69281655E-08	-0.46721049E-08
38.00000	-0.13064736E-00	0.95129816E-02	-0.81502911E-08	0.39597779E-09
38.50000	0.11151025E-00	0.62736717E-01	0.68054866E-08	0.40558889E-08
39.00000	-0.51944037E-01	-0.11658161E-00	-0.29577609E-08	-0.72867519E-08
39.50000	-0.34883437E-01	0.12579825E-00	-0.24484017E-08	0.76928698E-08
40.00000	0.11335966E-00	-0.71857578E-01	0.71598148E-08	-0.42429183E-08
40.50000	-0.13272294E-00	-0.30447790E-01	-0.81433103E-08	-0.20473215E-08
41.00000	0.64648487E-01	0.12041891E-00	0.38134583E-08	0.74637754E-08
41.50000	0.54481831E-01	-0.12555982E-00	0.35295787E-08	-0.76662911E-08
42.00000	-0.13232052E-00	0.30670685E-01	-0.82676097E-08	0.17889461E-08
42.50000	0.97847620E-01	0.88678894E-01	0.60862288E-08	0.55548638E-08
43.00000	0.21107081E-01	-0.12465137E-00	0.13249905E-08	-0.77515287E-08
43.50000	-0.11311651E-00	0.43536612E-01	-0.70925801E-08	0.26660875E-08
44.00000	0.90477389E-01	0.74196681E-01	0.56918434E-08	0.47438800E-08
44.50000	0.21053258E-01	-0.11102999E-00	0.13407044E-08	-0.70724121E-08
45.00000	-0.10510658E-00	0.30252858E-01	-0.66529376E-08	0.19354713E-08
45.50000	0.69746502E-01	0.81898384E-01	0.43719725E-08	0.51935717E-08
46.00000	0.49886720E-01	-0.96083071E-01	0.32462132E-08	-0.60686135E-08
46.50000	-0.10932871E-00	-0.14069843E-01	-0.69956248E-08	-0.94070443E-09
47.00000	0.19820627E-01	0.11027084E-00	0.12981340E-08	0.70234461E-08
47.50000	0.10343662E-00	0.47254197E-01	0.65152238E-08	-0.30207797E-08
48.00000	-0.68192412E-01	-0.93831169E-01	-0.43104379E-08	-0.59306233E-08
48.50000	-0.83354235E-01	0.84079193E-01	-0.52983582E-08	0.53840472E-08
49.00000	0.94747461E-01	0.72949274E-01	0.61365963E-08	0.45643196E-08
49.50000	0.64763357E-01	-0.10009742E-00	0.39570184E-08	-0.64504913E-08
50.00000	-0.10169650E-00	-0.60430299E-01	-0.65067777E-08	-0.36942003E-08
50.50000	-0.59528663E-01	0.10106263E-00	-0.36855917E-08	0.65145446E-08
51.00000	0.98065034E-01	0.60943674E-01	0.64177182E-08	0.37507776E-08
51.50000	0.64428954E-01	-0.91895266E-01	0.39051276E-08	-0.60531364E-08
52.00000	-0.82525497E-01	-0.70048672E-01	-0.54231896E-08	-0.42632041E-08
52.50000	-0.76923374E-01	0.70538291E-01	-0.47891521E-08	0.46622212E-08
53.00000	0.56141949E-01	0.83294977E-01	0.38209090E-08	0.52858226E-08
53.50000	0.87491093E-01	-0.39090101E-01	0.55836192E-08	-0.28134777E-08
54.00000	-0.19495943E-01	-0.88453131E-01	-0.15655545E-08	-0.56485301E-08
54.50000	-0.85448371E-01	-0.15638145E-02	-0.55057391E-08	0.14545751E-09
55.00000	-0.22210250E-01	0.77728622E-01	-0.12625133E-08	0.51242494E-08
55.50000	0.64735346E-01	0.40344521E-01	0.44116602E-08	0.24760809E-08
56.00000	0.54030814E-01	-0.46650351E-01	0.33829963E-08	-0.33088460E-08
56.50000	-0.24797774E-01	-0.61628580E-01	-0.18757305E-08	-0.39233970E-08
57.00000	-0.61914953E-01	0.15852997E-02	-0.40427656E-08	0.29629309E-09
57.50000	-0.19928985E-01	0.54411747E-01	-0.11854157E-08	0.36863504E-08
58.00000	0.39794011E-01	0.36620901E-01	0.28423910E-08	0.23393513E-08
58.50000	0.45908917E-01	-0.20139272E-01	0.29978886E-08	-0.15963022E-08
59.00000	0.12087847E-02	-0.46325424E-01	-0.14992184E-09	-0.30777144E-08
59.50000	-0.37969638E-01	-0.20220404E-01	-0.25885729E-08	-0.12121563E-08
60.00000	-0.33083741E-01	0.22728513E-01	-0.21960936E-08	0.18399[illegible]E-08

Sample input (contd)

60.50000	0.40926131E-02	0.37203412E-01	0.43727872E-09	0.25845431E-08
61.00000	0.31996115E-01	0.13507660E-01	0.23044468E-08	0.74578185E-09
61.50000	0.25773226E-01	-0.19225819E-01	0.16247459E-08	-0.14568799E-08
62.00000	-0.26846904E-02	-0.29751924E-01	-0.29755476E-09	-0.19823382E-08
62.50000	-0.24800938E-01	-0.12778090E-01	-0.17408694E-08	-0.83015900E-09
63.00000	-0.22670558E-01	0.12924772E-01	-0.15945876E-08	0.10001267E-08
63.50000	-0.17407776E-02	0.24293627E-01	0.18000382E-10	0.17800912E-08
64.00000	0.17684010E-01	0.14225653E-01	0.13607496E-08	0.86778175E-09
64.50000	0.20422143E-01	-0.56703138E-02	0.13556581E-08	-0.51485137E-09
65.00000	0.70968741E-02	-0.18572532E-01	0.43411295E-09	-0.12919114E-08
65.50000	-0.99371443E-02	-0.15850011E-01	-0.73192324E-09	-0.11335898E-08
66.00000	-0.17532278E-01	-0.16763762E-02	-0.13366548E-08	-0.76403894E-10
66.50000	-0.11441790E-01	0.11999375E-01	-0.79118174E-09	0.99927702E-09
67.00000	0.20539632E-02	0.15494698E-01	0.29893008E-09	0.11174475E-08
67.50000	0.12551909E-01	0.77836140E-02	0.93352381E-09	0.44250766E-09
68.00000	0.13255631E-01	-0.44124884E-02	0.89845506E-09	-0.34409945E-09
68.50000	0.49086269E-02	-0.12254858E-01	0.36793055E-09	-0.88419860E-09
69.00000	-0.57234117E-02	-0.11068500E-01	-0.43881477E-09	-0.87325989E-09
69.50000	-0.11423402E-01	-0.28814564E-02	-0.95045518E-09	-0.19743016E-09
70.00000	-0.93087427E-02	0.62286028E-02	-0.70207239E-09	0.59081936E-09
70.50000	-0.15902273E-02	0.10601572E-01	-0.16455345E-11	0.83045200E-09
71.00000	0.65006520E-02	0.79847742E-02	0.53541528E-09	0.51653691E-09
71.50000	0.98536347E-02	0.53738649E-03	0.69595467E-09	0.12940491E-10
72.00000	0.67129863E-02	-0.65807429E-02	0.52114869E-09	-0.46533691E-09
72.50000	-0.23105983E-03	-0.88992943E-02	0.33460000E-10	-0.72761267E-09
73.00000	-0.62408745E-02	-0.56531584E-02	-0.53968596E-09	-0.52310733E-09
73.50000	-0.79971314E-02	0.48840410E-03	-0.74336600E-09	0.77519029E-10
74.00000	-0.50728381E-02	0.58011644E-02	-0.39775535E-09	0.58952186E-09
74.50000	0.56360636E-03	0.74692471E-02	0.16401267E-09	0.63054541E-09
75.00000	0.56271632E-02	0.46749613E-02	0.50974174E-09	0.28801020E-09
75.50000	0.70760508E-02	-0.83913605E-03	0.51851303E-09	-0.12349488E-09
76.00000	0.40863100E-02	-0.55361909E-02	0.29714505E-09	-0.41385817E-09
76.50000	-0.11804473E-02	-0.64648339E-02	-0.51761117E-10	-0.51316658E-09
77.00000	-0.51976942E-02	-0.34069062E-02	-0.41027224E-09	-0.34998215E-09
77.50000	-0.57068741E-02	0.12671577E-02	-0.56129882E-09	0.57109730E-10
78.00000	-0.29567063E-02	0.46485279E-02	-0.34188236E-09	0.46806144E-09
78.50000	0.10869842E-02	0.51243693E-02	0.12921038E-09	0.56570234E-09
79.00000	0.41967612E-02	0.28101840E-02	0.50000367E-09	0.26430437E-09
79.50000	0.48559701E-02	-0.91561384E-03	0.50216187E-09	-0.19389187E-09
80.00000	0.27466736E-02	-0.40422077E-02	0.17731014E-09	-0.47018354E-09
80.50000	-0.99050517E-03	-0.47556924E-02	-0.20639934E-09	-0.41483349E-09
81.00000	-0.41184446E-02	-0.25151743E-02	-0.40601276E-09	-0.12987375E-09
81.50000	-0.45838058E-02	0.13274766E-02	-0.35319784E-09	0.17818424E-09
82.00000	-0.20309150E-02	0.42232329E-02	-0.12576974E-09	0.35287155E-09
82.50000	0.17787945E-02	0.42051103E-02	0.14666178E-09	0.33339214E-09
83.00000	0.41946827E-02	0.13740404E-02	0.33591908E-09	0.13830306E-09
83.50000	0.36304996E-02	-0.21828571E-02	0.34072910E-09	-0.14158439E-09
84.00000	0.67928600E-03	-0.39846854E-02	0.13737990E-09	-0.35286689E-09
84.50000	-0.24553642E-02	-0.29515699E-02	-0.17151343E-09	-0.34995516E-09
85.00000	-0.36345689E-02	-0.44795576E-04	-0.38588402E-09	-0.10656869E-09
85.50000	-0.22552446E-02	0.25913681E-02	-0.33995084E-09	0.22850589E-09
86.00000	0.49734063E-03	0.32064465E-02	-0.43530191E-10	0.41471301E-09
86.50000	0.26255643E-02	0.15837207E-02	0.29726003E-09	0.30003091E-09
87.00000	0.27384204E-02	-0.95821469E-03	0.42330690E-09	-0.44405232E-10
87.50000	0.93672732E-03	-0.25852624E-02	0.22807646E-09	-0.36142962E-09
88.00000	-0.13595260E-02	-0.22295681E-02	-0.14595681E-09	-0.40198969E-09
88.50000	-0.24678298E-02	-0.29204758E-03	-0.40723523E-09	-0.12766070E-09
89.00000	-0.16518892E-02	0.16990087E-02	-0.34528293E-09	0.24767336E-09
89.50000	0.35922077E-03	0.22357451E-02	-0.64253490E-11	0.42222798E-09
90.00000	0.19377048E-02	0.97442991E-03	0.33472537E-09	0.25195605E-09

Sample output

AAS SUB NO FLANGE, S-BAND

361 14 181 2 -1

0.00	.240940	-2.25	.240940	-2.25
.50	.219281	-3.33	.219617	-3.26
1.00	.178031	-6.09	.178841	-5.82
1.50	.159280	-7.83	.159941	-7.48
2.00	.174605	-6.57	.174593	-6.43
2.50	.196640	-5.07	.196174	-5.16
3.00	.195880	-4.86	.195740	-5.03
3.50	.176480	-5.52	.177035	-5.57
4.00	.165932	-6.15	.166700	-5.95
4.50	.176619	-6.32	.176916	-6.07
5.00	.191567	-6.29	.191286	-6.18
5.50	.190067	-5.92	.189683	-5.90
6.00	.175512	-5.11	.175444	-4.94
6.50	.168266	-4.91	.168391	-4.41
7.00	.176788	-6.22	.176531	-5.56
7.50	.187959	-7.47	.187008	-6.91
8.00	.186854	-6.81	.185571	-6.36
8.50	.176857	-4.54	.175910	-3.97
9.00	.171878	-3.69	.171507	-2.82
9.50	.176448	-6.01	.175966	-4.96
10.00	.182853	-8.42	.181477	-7.41
10.50	.183004	-7.60	.180934	-6.64
11.00	.179175	-4.37	.177425	-3.31
11.50	.176510	-2.99	.175658	-1.78
12.00	.175217	-5.41	.174495	-4.07
12.50	.175102	-8.33	.173353	-6.86
13.00	.176870	-7.90	.174141	-6.34
13.50	.180507	-5.09	.177976	-3.51
14.00	.181218	-3.62	.179592	-2.15
14.50	.175160	-4.75	.173956	-3.29
15.00	.168340	-6.60	.166743	-4.86
15.50	.169510	-7.10	.167460	-5.04
16.00	.177567	-6.52	.175549	-4.54
16.50	.181939	-5.87	.180088	-4.24
17.00	.176779	-4.98	.175027	-3.51
17.50	.168665	-4.03	.167334	-2.30
18.00	.166515	-4.49	.165851	-2.40
18.50	.170374	-6.61	.169665	-4.49
19.00	.174084	-7.97	.172399	-6.05
19.50	.174592	-6.69	.172156	-4.84
20.00	.173846	-4.05	.172036	-2.17
20.50	.171684	-3.08	.171208	-1.28
21.00	.166589	-4.54	.166574	-2.80
21.50	.162082	-6.45	.161427	-4.48
22.00	.163504	-6.95	.162341	-4.64
22.50	.169884	-6.47	.168990	-4.19
23.00	.173527	-5.81	.172926	-3.92
23.50	.169906	-4.69	.169275	-3.04
24.00	.163264	-3.28	.163147	-1.41
24.50	.159446	-3.22	.160833	-1.04
25.00	.158886	-5.25	.160777	-3.03
25.50	.159551	-7.38	.160738	-5.22
26.00	.161341	-7.39	.161613	-5.13
26.50	.164764	-5.66	.165432	-3.35
27.00	.166566	-4.16	.168409	-2.14
27.50	.162724	-3.51	.165069	-1.84
28.00	.155375	-3.21	.157693	-1.43
28.50	.150691	-3.49	.153569	-1.23
29.00	.150947	-5.02	.154641	-2.55
29.50	.153270	-6.99	.156714	-4.71
30.00	.155112	-7.46	.157404	-5.31
30.50	.156990	-5.95	.158953	-3.71
31.00	.158638	-4.01	.161691	-1.88
31.50	.156829	-2.94	.160813	-1.23
32.00	.150645	-2.50	.154480	-.99
32.50	.144176	-2.35	.147918	-.48
33.00	.141376	-3.16	.145895	-.85
33.50	.141743	-5.15	.146680	-2.89
34.00	.142984	-6.93	.146925	-4.91
34.50	.144842	-7.01	.147479	-4.94
35.00	.147997	-5.71	.150747	-3.52
35.50	.150441	-4.31	.154200	-2.47
36.00	.148992	-3.13	.152918	-1.87
36.50	.144026	-1.75	.147481	-.61
37.00	.138806	-.57	.142817	.90
37.50	.134741	-.78	.140195	.80
38.00	.130993	-2.53	.136900	-1.14
38.50	.127946	-4.56	.132916	-3.13
39.00	.127630	-5.88	.131938	-3.96
39.50	.130545	-6.67	.135444	-4.52
40.00	.134215	-7.19	.139629	-5.47
40.50	.136170	-6.87	.140873	-5.68
41.00	.136675	-5.31	.140619	-4.14
41.50	.136870	-3.20	.141596	-1.93
42.00	.135828	-1.56	.141917	-.72
42.50	.132053	-.44	.138245	-.24
43.00	.126425	.62	.131935	.71
43.50	.121205	1.39	.127122	1.84
44.00	.117009	1.01	.124309	1.47
44.50	.113008	-.56	.120768	-.56
45.00	.109373	-2.49	.116245	-2.65
45.50	.107572	-4.13	.113896	-3.80
46.00	.108261	-5.68	.115465	-4.98
46.50	.110230	-7.31	.118423	-6.98
47.00	.112038	-8.44	.119829	-8.73
47.50	.113719	-8.49	.120484	-8.81
48.00	.115993	-7.69	.123003	-7.69
48.50	.118394	-6.70	.126732	-6.91
49.00	.119577	[illegible]	.128310	-6.59

Sample output (contd)

49.50	.119221	-4.11	.126961	-5.48
50.00	.118296	-2.04	.125532	-3.18
50.50	.117291	.02	.125574	-.97
51.00	.115459	1.74	.124711	.19
51.50	.112231	3.37	.120854	1.16
52.00	.108246	5.22	.115733	3.07
52.50	.104368	7.06	.112134	5.35
53.00	.100448	8.44	.109424	6.56
53.50	.095826	9.36	.104897	6.69
54.00	.090576	10.21	.098339	7.14
54.50	.085462	11.10	.092403	8.54
55.00	.080839	11.65	.088541	9.54
55.50	.076278	11.54	.084876	8.91
56.00	.071383	10.99	.079392	7.43
56.50	.066430	10.37	.072959	6.74
57.00	.061935	9.63	.068008	6.91
57.50	.057946	8.38	.064965	6.09
58.00	.054080	6.41	.061761	3.24
58.50	.050132	4.01	.056982	-.33
59.00	.046341	1.52	.051696	-2.75
59.50	.043018	-1.17	.047954	-4.11
60.00	.040138	-4.47	.045983	-6.73
60.50	.037427	-8.56	.043977	-11.89
61.00	.034730	-13.19	.040636	-18.15
61.50	.032154	-18.07	.036612	-23.23
62.00	.029872	-23.22	.033630	-26.60
62.50	.027899	-28.96	.032357	-30.72
63.00	.026096	-35.45	.031579	-37.86
63.50	.024355	-42.59	.029866	-47.27
64.00	.022695	-50.16	.027076	-56.45
64.50	.021194	-58.10	.024329	-63.38
65.00	.019882	-66.60	.022865	-68.94
65.50	.018707	-75.81	.022638	-76.57
66.00	.017612	-85.73	.022461	-87.92
66.50	.016580	-96.26	.021383	-101.52
67.00	.015630	-107.36	.019406	-114.79
67.50	.014769	-119.11	.017332	-125.55
68.00	.013970	-131.59	.016141	-134.14
68.50	.013201	-144.75	.016067	-143.99
69.00	.012460	-158.44	.016396	-157.78
69.50	.011781	-172.55	.016286	-174.97
70.00	.011200	-187.17	.015394	-193.46
70.50	.010720	-202.56	.013932	-210.97
71.00	.010296	-218.96	.012481	-225.84
71.50	.009868	-236.40	.011678	-238.46
72.00	.009400	-254.63	.011721	-251.96
72.50	.008902	-273.31	.012220	-269.19
73.00	.008420	-292.18	.012609	-290.24
73.50	.008012	-311.26	.012539	-313.72
74.00	.007706	-330.88	.011931	-338.04
74.50	.007490	-351.48	.010930	-361.75
75.00	.007315	-373.38	.009822	-383.63
75.50	.007125	-396.58	.008942	-403.21
76.00	.006880	-420.86	.008547	-421.62
76.50	.006571	-445.86	.008653	-441.27
77.00	.006214	-471.19	.009047	-463.96
77.50	.005845	-496.56	.009465	-489.85
78.00	.005509	-521.84	.009724	-518.16
78.50	.005238	-547.17	.009735	-548.06
79.00	.005050	-572.89	.009488	-578.84
79.50	.004941	-599.46	.009031	-609.89
80.00	.004887	-627.22	.008430	-640.75
80.50	.004857	-656.34	.007773	-671.03
81.00	.004825	-686.83	.007151	-700.50
81.50	.004772	-718.53	.006637	-729.15
82.00	.004686	-751.29	.006284	-757.35
82.50	.004565	-784.91	.006110	-785.72
83.00	.004413	-819.25	.006094	-815.01
83.50	.004236	-854.18	.006190	-845.73
84.00	.004042	-889.62	.006352	-878.02
84.50	.003839	-925.49	.006538	-911.84
85.00	.003634	-961.76	.006716	-947.02
85.50	.003435	-998.42	.006872	-983.36
86.00	.003244	-1035.51	.006995	-1020.70
86.50	.003066	-1073.04	.007085	-1058.87
87.00	.002901	-1111.05	.007140	-1097.76
87.50	.002749	-1149.64	.007170	-1137.31
88.00	.002611	-1188.86	.007175	-1177.44
88.50	.002485	-1228.76	.007160	-1218.11
89.00	.002369	-1269.43	.007129	-1259.27
89.50	.002264	-1310.91	.007084	-1300.91
90.00	.002168	-1353.28	.007028	-1343.00

IX. ANTENNA FEED EFFICIENCY

A. Ludwig

Program: J127001, binary in Jet Propulsion Laboratory Library (revised May 18, 1966). Also available in IBM 1620 version, source deck in Antenna and Propagation Group Library

Engineer: A. Ludwig

Programmer: A. Ludwig

A. Program Description

This program computes the efficiency of a circular paraboloidal antenna illuminated by a given feed pattern. Efficiency is relative to the case of uniform amplitude and phase illumination of the aperture, which is defined to be 100% efficiency. The illumination pattern should be of the form

$$\mathbf{E}(\rho, \xi, \psi) = \frac{e^{-jk\rho}}{\rho}\left[A(\psi)\sin\xi\,\mathbf{i}_\psi + B(\psi)\cos\xi\,\mathbf{i}_\xi\right] \quad (1)$$

where ρ, ξ, ψ are spherical coordinates, with ξ and ψ the azimuthal and polar angles, respectively; $\mathbf{i}_\psi$ and $\mathbf{i}_\xi$ are unit vectors; and $A(\psi)$ and $B(\psi)$ are in general complex,

$$A(\psi) = |A(\psi)|\,e^{j\Phi_A(\psi)}$$

$$B(\psi) = |B(\psi)|\,e^{j\Phi_B(\psi)}$$

It is not necessary to obtain these functions analytically. The program accepts the functions in tabular form, and typically the functions are obtained directly from experimental patterns. The form of Eq. (1) is completely general for feed systems with total physical circular symmetry (the feed *pattern* does not have to be circularly symmetric), excited by fields with the same form as Eq. (1). For example, far-field patterns of conical feed horns excited by TE_{1n} and TM_{1n} modes satisfy this condition.[2]

For experimental patterns of systems satisfying these symmetry conditions, $|A(\psi)|$ and $|B(\psi)|$ are the E- and H-plane amplitude patterns, respectively, and $\Phi_A(\psi)$ and $\Phi_B(\psi)$ are the E- and H-plane phase patterns, respectively. This set of patterns defines the radiation everywhere by Eq. (1).

Antenna efficiency η is then given by (Ref. 13)

$$\eta = \cot^2\frac{\Psi}{2}\,\frac{\left|\int_{\psi_B}^{\Psi}[A(\psi)+B(\psi)]\tan\frac{\psi}{2}\,d\psi\right|^2}{\int_0^{\pi}\left[|A(\psi)|^2+|B(\psi)|^2\right]\sin\psi\,d\psi} \quad (2)$$

where Ψ is the edge-angle of the paraboloidal reflector, and ψB is the angle subtended by a blocked portion of the aperture at the vertex of the reflector.

The gain of an antenna of diameter D is related to η by

$$G = \eta\left(\frac{\pi D}{\lambda}\right)^2 \quad (3)$$

where λ is the free space wavelength.

[2]The computed results will be only approximately correct for radiation patterns from rectangular feed horns.

The program divides η into loss components due to spillover, non-uniform amplitude illumination, cross polarization, phase errors, and vertex blockage. The definition of these terms is given in Ref. 13. The program also computes total radiated power (in watts), for field input (in volts, or decibels below 1 v), feed pattern gain above isotropic radiation at $\psi = 0$, and a resultant phase angle that is an amplitude-weighted average of the feed phase pattern.

B. Applications

This program may be used for predicting gain of a paraboloidal antenna with known illumination, for optimizing feed system parameters, for determining spatial energy distributions for a given feed pattern (for noise temperature calculations, for example), or for directly computing the primary pattern gain of a given feed pattern. The last calculation is useful primarily for patterns with gain below 25 db. The breakdown in loss components is useful in pointing out which aspect of the feed pattern is causing the most loss, and therefore areas of potential improvement.

C. Input

Card	Parameters					Format
1	*TITLE*					72H
2	*JMAX*	*JO*	*JIN*	*IC1*	*IC2*	515
3	*PSI*	*E(1)*	*EP(1)*	*H(1)*	*HP(1)*	5F10.6
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
JIN+2	*PSI*	*E(JIN)*	*EP(JIN)*	*H(JIN)*	*HP(JIN)*	5F10.6

TITLE = any alphanumeric statement, Columns 1 through 72

JMAX = $1 + 180/\Delta\psi$, where $\Delta\psi$ is increment of input data

JO = $1 + \psi B/\Delta\psi$, where ψB is angle of blocked region at vertex

JIN = number of input points, $\leq$ *JMAX*. Program sets data values equal to zero for points between *JIN* and *JMAX*. *JIN* ≤ 500

IC1 ≤ 0 for field input, db, > 0 for field input, v

IC2 ≤ 0 to compute phase error loss, 0 to set phase patterns equal to zero everywhere

PSI = polar angle. Data must be spaced with a constant increment $\Delta\psi$, and must start with *PSI* = 0. Data may be truncated at any point *PSI* ≤ 180, as specified by *JIN*

$E(J) = |A(\psi)|$, v or db

$EP(J) = \Phi_A(\psi)$, deg

$H(J) = |B(\psi)|$, v or db

$HP(J) = \Phi_B(\psi)$, deg

Consecutive cases may be stacked without limit. 7094 machine time is roughly proportional to *JIN*, and is 10 sec for *JIN* = 31. 1620 time is roughly 5 min for the same case.

D. Output

This program outputs six factors vs *PSI* from *PSI* = $\Delta\psi$ to *PSIMAX*, where *PSIMAX* is the maximum value of *PSI* input (corresponding to $J = JIN$). The factors are:

PSI = polar angle, deg

ETA = η, overall efficiency for a main reflector truncated at *PSI*

ETA S = fractional power contained betweeen *PSI* = 0 and the printed value of *PSI*, which is the fractional loss due to spillover if the main reflector is truncated at *PSI*

ETA I = fractional illumination efficiency at *PSI*

ETA X = fractional loss due to cross-polarization at *PSI*

ETA P = fractional loss due to phase errors at *PSI*

ETA B = fractional loss due to vertex blockage at *PSI*

Overall efficiency is the product of factors:

$$ETA = (ETA\ S)\,(ETA\ I)\,(ETA\ X)\,(ETA\ P)\,(ETA\ B)$$

Each factor is the ratio of gain with the given loss factor present to gain in the absence of the given loss factor.

Program also prints out total radiated power (in watts), resultant phase angle as defined above, and primary pattern gain (in decibels) above isotropic.

E. Sample Case

The input for this case consists of punched output from the sample case for Multimode Feed Pattern Synthesis Program (I), plus the addition of Control Card 2.

Sample input

```
DUAL MODE FIT, 2388 MC, 23.084 DIA APERTURE
 91     0    46     2     0
 0.           0.85613 357.39283    0.85613 357.39283
 2.00000      0.83894 357.57479    0.83626 357.55461
 4.00000      0.78914 358.13817    0.77898 358.05558
 6.00000      0.71172 359.13950    0.69093 358.94635
 8.00000      0.61423   0.68835    0.58196   0.32536
10.00000      0.50571   2.97750    0.46354   2.36690
12.00000      0.39558   6.34405    0.34702   5.37923
14.00000      0.29252  11.39382    0.24216   9.92826
16.00000      0.20376  19.24903    0.15599  17.10678
18.00000      0.13474  31.93022    0.09240  29.06619
20.00000      0.08898  52.04779    0.05211  49.28807
22.00000      0.06595  78.34972    0.03170  77.99481
24.00000      0.05691 101.91210    0.02165 104.34447
26.00000      0.05057 117.68370    0.01278 121.23688
28.00000      0.04186 127.48676    0.00283 131.23816
30.00000      0.03068 133.77880    0.00677 317.44831
32.00000      0.01862 138.03638    0.01416 321.56280
34.00000      0.00740 141.05999    0.01819 324.44467
36.00000      0.00172 323.29434    0.01863 326.55419
38.00000      0.00812 324.99916    0.01600 328.15290
40.00000      0.01171 326.33402    0.01125 329.39841
42.00000      0.01280 327.40144    0.00548 330.39059
44.00000      0.01195 328.26996    0.00029 151.19546
46.00000      0.00980 328.98688    0.00526 151.85827
48.00000      0.00696 329.58586    0.00894 152.41096
50.00000      0.00395 330.09137    0.01114 152.87667
52.00000      0.00115 330.52164    0.01191 153.27253
54.00000      0.00121 150.89048    0.01144 153.61149
56.00000      0.00302 151.20850    0.01005 153.90349
58.00000      0.00425 151.48402    0.00806 154.15624
60.00000      0.00494 151.72357    0.00576 154.37585
62.00000      0.00520 151.93240    0.00343 154.56718
64.00000      0.00511 152.11472    0.00123 154.73414
66.00000      0.00479 152.27397    0.00070 334.87990
68.00000      0.00431 152.41294    0.00232 335.00705
70.00000      0.00376 152.53393    0.00359 335.11771
72.00000      0.00318 152.63884    0.00454 335.21365
74.00000      0.00263 152.72922    0.00521 335.29627
76.00000      0.00213 152.80638    0.00563 335.36679
78.00000      0.00169 152.87135    0.00587 335.42616
80.00000      0.00133 152.92501    0.00595 335.47519
82.00000      0.00104 152.96803    0.00594 335.51449
84.00000      0.00081 153.00097    0.00585 335.54457
86.00000      0.00065 153.02421    0.00571 335.56580
88.00000      0.00056 153.03804    0.00555 335.57844
90.00000      0.00051 153.04264    0.00537 335.58264
```

Sample output

DUAL MODE FIT, 2388 MC, 23.084 DIA APERTURE

PSI	ETA	ETA S	ETA I	ETA X	ETA P	ETA B
2.0	0.04486	0.04485	1.00005	1.00000	1.00000	1.00000
4.0	0.16808	0.16820	0.99938	0.99999	0.99998	1.00000
6.0	0.33945	0.34065	0.99665	0.99993	0.99990	1.00000
8.0	0.51952	0.52543	0.98926	0.99980	0.99970	1.00000
10.0	0.67139	0.69046	0.97358	0.99956	0.99921	1.00000
12.0	0.77007	0.81672	0.94542	0.99919	0.99813	1.00000
14.0	0.80667	0.90008	0.90110	0.99872	0.99587	1.00000
16.0	0.78695	0.94756	0.83932	0.99819	0.99129	1.00000
18.0	0.72611	0.97101	0.76310	0.99768	0.98220	1.00000
20.0	0.64238	0.98154	0.68024	0.99724	0.96477	1.00000
22.0	0.55201	0.98658	0.60082	0.99684	0.93421	1.00000
24.0	0.46648	0.98975	0.53164	0.99642	0.88971	1.00000
26.0	0.39211	0.99218	0.47312	0.99591	0.83874	1.00000
28.0	0.33102	0.99399	0.42201	0.99531	0.79287	1.00000
30.0	0.28269	0.99517	0.37729	0.99487	0.75680	1.00000
32.0	0.24524	0.99585	0.33915	0.99477	0.72994	1.00000
34.0	0.21637	0.99628	0.30604	0.99476	0.71338	1.00000
36.0	0.19384	0.99666	0.27676	0.99466	0.70652	1.00000
38.0	0.17572	0.99701	0.25181	0.99457	0.70374	1.00000
40.0	0.16050	0.99734	0.23081	0.99456	0.70104	1.00000
42.0	0.14706	0.99760	0.21208	0.99455	0.69886	1.00000
44.0	0.13469	0.99781	0.19471	0.99450	0.69711	1.00000
46.0	0.12302	0.99797	0.17921	0.99445	0.69171	1.00000
48.0	0.11194	0.99813	0.16596	0.99445	0.67952	1.00000
50.0	0.10145	0.99831	0.15425	0.99444	0.66252	1.00000
52.0	0.09167	0.99851	0.14359	0.99438	0.64300	1.00000
54.0	0.08269	0.99871	0.13386	0.99430	0.62210	1.00000
56.0	0.07458	0.99888	0.12514	0.99425	0.60011	1.00000
58.0	0.06737	0.99903	0.11727	0.99422	0.57838	1.00000
60.0	0.06102	0.99914	0.10996	0.99422	0.55864	1.00000
62.0	0.05548	0.99921	0.10304	0.99422	0.54199	1.00000
64.0	0.05067	0.99926	0.09641	0.99421	0.52900	1.00000
66.0	0.04650	0.99930	0.09014	0.99420	0.51924	1.00000
68.0	0.04288	0.99934	0.08442	0.99419	0.51120	1.00000
70.0	0.03972	0.99938	0.07930	0.99419	0.50405	1.00000
72.0	0.03694	0.99943	0.07467	0.99419	0.49792	1.00000
74.0	0.03449	0.99949	0.07043	0.99419	0.49285	1.00000
76.0	0.03230	0.99955	0.06650	0.99418	0.48877	1.00000
78.0	0.03033	0.99961	0.06285	0.99417	0.48561	1.00000
80.0	0.02854	0.99968	0.05942	0.99415	0.48325	1.00000
82.0	0.02690	0.99975	0.05620	0.99413	0.48155	1.00000
84.0	0.02538	0.99981	0.05315	0.99411	0.48041	1.00000
86.0	0.02397	0.99987	0.05027	0.99409	0.47967	1.00000
88.0	0.02265	0.99993	0.04755	0.99406	0.47922	1.00000
90.0	0.02141	0.99998	0.04496	0.99404	0.47891	1.00000

TOTAL RADIATED POWER 0.806420E-04 WATTS
RESULTANT PHASE ANGLE 12.1 DEGREES
GAIN 21.81 DB

Page intentionally left blank

X. STAIR PROGRAM

M. S. Katow

N67-28731

Since this program is to be described in detail in Technical Memorandum 33-304, only a brief summary will be presented here.

The Structural Analysis Interpretive Routine (STAIR) 7094 Program computes joint deflections and bar stresses of large three-dimensional structures, i.e., the Advanced Antenna System 210-ft reflector assembly, assuming frictionless pin joints and axially loaded bars. The program calculates gravity loads of the bars on the joints of the structure and will accept inputted joint loads such as panel weights, wind loading, etc. The program in Fortran II was developed by MIT, Lincoln Laboratory, Lexington, Mass.

To use STAIR at the Jet Propulsion Laboratory, the program was first modified to satisfy the operational requirements of the Laboratory's 7094 system. Later, an input data generating subroutine was added to reduce the quantity of the input cards.

For input data checking purposes, subroutines were added to: (1) plot on the Stromberg-Carlson 4020 printer-plotter, for position checks, the structural joint coordinates and the bar members; (2) analyze the whole structure, including the effects of the reaction components, for the planar condition of all joints; and (3) sum the number of bars at each joint and output the answers in a suitable table for a check on the structural configuration. For more efficient computer operation, a restarting capability was added at selected points throughout the computation period to recover computer time that may otherwise be lost due to computer errors such as bad spots on tapes, etc.

Page intentionally left blank

XI. UTKU/SCHMELE PARABOLOID RMS BEST-FIT PROGRAM

M. S. Katow and L. Schmele

N67-28732

Program: 5577,000 symbolic in Jet Propulsion Laboratory Library

Engineer: M. S. Katow

Programmer: L. Schmele

A. Program Description

This program computes the coefficients for the equation of a paraboloid of revolution that best fits, in the least-squares sense, a set of coordinates representing points on the surface of a deformed paraboloidal antenna. The distortions, calculated with respect to the points on the best-fitted perfect paraboloid described above, are the normal and the pathlength errors. From the distortions, a weighted RMS of one-half the path length error is computed.

A rigid body fit, i.e., a fit without a change in focal length of the best-fitting paraboloid, is made initially; this is followed by a best fit that includes the focal length change. From the computed vertex position and rotation of the symmetrical axis (z-axis) of the best-fit paraboloid, the RF boresight may be calculated.

Capability is provided to assign values to any of the coefficients (i.e., the vertex x, y, and z translation and the rotation of the symmetrical axis about x-, y- and z-axes) of the best-fitting paraboloid before the fit.

Provision is made to combine and multiply the input distortion data by a constant as required. Separate distortions from symmetric and asymmetric loads may also be inputted and combined before the best fit. Field data in the form of distortion readings at right angles to the line of sight and its elevation angle may be inputted.

Contour plots may be generated on the Stromberg-Carlson 4020 printer-plotter. The contour levels are constant deviations of ½ pathlength from the best-fit paraboloid. Other information on these programs may be found in Refs. 14 and 15.[3]

B. Applications

The vector distortions in x-, y-, and z-directions from the structural computing program, i.e., the STAIR Program (X), may be evaluated with respect to the best-fit paraboloid resulting in the RMS figure for RF evaluation.

[3] See also L. Schmele, "RMS/Fortran IV Program for the Calculation of Weighted Root-Mean-Square of Path-Length Change for Paraboloidal Antennas," Jet Propulsion Laboratory Program Writeup 5577000, September 1965. (See also JPL Space Programs Summary 37-40, Vol. IV.)

Also, the individual distortion at each point or joint is outputted for evaluation. From the vertex motion and the rotation of the axis of symmetry, the RF boresight direction may be computed if the position of the RF feed system is known.

To determine the vector distortions computed by a structural computing program for gravity loads, distortions from gravity *off/on* for the symmetric gravity load and the gravity *off/on* for the anti-symmetric gravity load may be inputted separately. The program will multiply the distortions by an inputted constant and combine them. For this operation, the program is coded to use either the first quadrant or first and fourth quadrant data.

In order to simulate the field data on distortions due to gravity loads, the vertex and axis motion of the best-fitting paraboloid may be assigned values determined by the deflections of the datum targets of the theodolite. The contour levels chart will be useful in comparing the distortions.

C. *Input*

Card	Parameters	Format
1	*TITLE*	12A6
2	*NOPT NP F C1 C2 YOFF ZOFF XROT*	2I10, 6F10.0
3[a]	*NXOFF NYOFF NZOFF NXROT NYROT*	5I10
4[a]	*XOFF YOFF ZOFF XROT YROT*	5F10.0
5A[b]	*X Y Z U V W A PN*	7F10.3, 4X, A6
5B[b]	*X Y Z θ R DZ A PN*	7F10.3, 4X, A6
.	. . . .	.
.	. . . .	.
.	. . . .	.
NP + 3 or *NP* + 5[a]	*IPLOT C1 C2 C3 C4 C5 C6 C7 C8 C9*	I10, 7F10.4 8F10.4
.		.
.		.
.		.

[a]These cards required only for NOPT = 6 or 7, or −1.

[b]5*A* for data from analytic computation; 5*B* for field data, *NOPT* = 5 or 6.

TITLE = any alphanumeric statement, Columns 1 through 72

NOPT = input option control, described in the tabulation on p. 81.

NP = number of data points, 2000 maximum. For polar matrix plotting, the maximum number of points must be $<$ 28 in the radial direction and $<$ 200 in the circumferential direction

F = nominal focal length

C1 = weighting factor for first set of symmetric data; value ignored except for *NOPT* = ±3 and ±4

C2 = weighting factor for second set of anti-symmetric data; value ignored except for *NOPT* = ±3 and ±4

YOFF = assigned offset of vertex *Y*-coordinate; value ignored except for *NOPT* = ±4

ZOFF = assigned offset of vertex Z-coordinate; value ignored except for *NOPT* = ±4

XROT = assigned rotation about *x*-axis; value ignored except for *NOPT* = ±4

NXOFF, *NYOFF*, *NZOFF*, *NXROT*, *NYROT* = 1 for assigned value, or 0 for value to be computed, for *X*-, *Y*-, and Z-coordinates of vertex, and rotation about *x*- and *y*-axes, respectively

XOFF, *YOFF*, *ZOFF*, *XROT*, *YROT* = assigned values for these parameters to be used or not used as directed by the preceding card

X, *Y*, *Z* = coordinates of data points. Z nominally directed along axis of paraboloid. Program recomputes Z to value for nominal paraboloid at given *X*-*Y* coordinates, and writes over any input Z-value, if any

U, *V*, *W* = *X*, *Y*, and Z distortion vector components for calculated input data.

θ = angle from X-Y plane, as measured by instrument leveled to datum targets

R = deflection of data point from nominal position, measured perpendicular to instrument line-of-sight

DZ = Z-deflection component. Program computes this value from θ and R and writes over any input value

A = weighting function, normally the area associated with the data point

PN = six-letter alphanumeric point identification

$IPLOT = -1$ = no contour plots

0 = plots with program-computed contour interval levels

N = plots with N-input contour levels $(0 |<N| \leq 26)$

$C1, C2, \cdots, CN$ = N-contour levels desired for $IPLOT = N$

1. Input Options

NOPT	Data	Number of data sets	Quadrants for which data is input	Load symmetry for which data is input (restricted to anti-symmetric loads about the x-axis	Assigned parameters
0	Analytic	1	All four	—	None
+1	↓	1	First	Symmetric	None
−1		1	First	Symmetric or anti-symmetric	Per Cards 3 and 4
+2		1	First (generated fourth)	First and fourth quadrants, anti-symmetric	None
−2		1	First and fourth	Symmetric or anti-symmetric	None
+3		2	First (generated fourth)	First set symmetric; second set anti-symmetric	None
−3		2	First and fourth	First set symmetric; second set anti-symmetric	None
+4		2	First (generated fourth)	First set symmetric; second set anti-symmetric	On Card 2
−4		2	First and fourth	First set symmetric; second set anti-symmetric	On Card 2
+5	Field	1	All four	—	None
+6	Field	1	All four	—	Per Cards 3 and 4
+7	Analytic	1	All four	—	Per Cards 3 and 4

Note:
NOPT + 10 is the same as above except coordinates are input in feet and are internally converted to inches.
Input data to be in consistent linear units, and degrees.

D. Output

This program prints out pertinent input data, point-by-point deflections relative to the computed best-fit paraboloid, and then the parameters of the best-fit paraboloid. Translations and rotations are given with respect to the coordinate system of the input data. Contour plots are output optionally.

E. Sample Case

Sample input

TEST OPTION = -3 -1.0 SYMMETRIC PLUS +1.0 ANTI-SYM HALF DISH DATA

-3	32	150.0	-1.0	1.0			
0035.12	0176.54		0.00021	0.00678	-0.03844	1499.7	R2111
0026.03	0130.87		-0.00011	0.00409	-0.03302	2380.5	R2112
0016.92	0085.08		-0.00041	0.00202	-0.02716	1667.5	R2114
0005.85	0029.42		-0.00003	0.00078	-0.02447	1304.2	R2116
0100.00	0149.66		0.00189	0.00974	-0.04156	1499.7	R2118
0074.13	0110.95		0.00021	0.00552	-0.03283	2380.5	R2119
0048.20	0072.13		-0.00041	0.00315	-0.02655	1667.5	R2121
0016.67	0024.94		-0.00008	0.00085	-0.02369	1304.2	R2126
0149.66	0100.00		-0.00394	0.00331	-0.01554	1499.7	R2201
0110.95	0074.13		-0.00298	0.00253	-0.01637	2380.5	R2202
0072.13	0048.20		-0.00207	0.00211	-0.01794	1667.5	R2204
0024.94	0016.67		-0.00079	0.00024	-0.02180	1304.2	R2209
0176.54	0035.12		-0.01032	0.00022	0.00408	1499.7	R2211
0130.87	0024.83		-0.00817	0.00019	-0.00038	2380.5	R2212
0085.08	0016.92		-0.00553	0.00114	-0.00824	1667.5	R2214
0029.42	0005.85		-0.00164	-0.00003	-0.02061	1304.2	R2216
0176.54	-035.12		-0.01032	-0.00022	0.00409	1499.7	R2221
0130.87	-024.83		-0.00817	-0.00019	-0.00038	2380.5	R2222
0085.08	-016.92		-0.00552	-0.00114	-0.00824	1667.5	R2224
0029.42	-005.85		-0.00164	0.00004	-0.02061	1304.5	R2226
0149.66	-100.00		-0.00395	-0.00331	-0.01554	1499.7	R2228
0110.95	-074.13		-0.00298	-0.00253	-0.01637	2380.5	R2229
0024.94	-016.67		-0.00079	-0.00024	-0.02180	1304.2	R2236
0026.03	-130.87		-0.00011	-0.00409	-0.03302	2380.5	R2312
0016.92	-085.88		-0.00041	-0.00202	-0.02716	1667.5	R2314
0072.13	-048.20		-0.00207	-0.00210	-0.01794	1667.5	R2231
0035.12	-176.54		0.00021	-0.00678	-0.03844	1499.7	R2311
0005.85	-029.42		-0.00003	-0.00078	-0.02447	1304.2	R2316
0100.00	-149.66		0.00189	-0.00974	-0.04156	1499.7	R2318
0074.13	-110.95		0.00021	-0.00552	-0.03283	2380.5	R2319
0048.20	-072.13		-0.00041	-0.00315	-0.02655	1667.5	R2321
0016.67	-024.94		-0.00008	-0.00085	-0.02369	1304.2	R2326
0035.12	0176.54		-0.00006	-0.07099	0.10740	1499.7	R2111
0026.03	0130.87		0.00014	-0.04919	0.06637	2380.5	R2112
0016.92	0085.08		-0.00075	-0.03913	0.04066	1667.5	R2114
0005.85	0029.42		0.00003	-0.03379	0.01264	1304.2	R2116
0100.00	0149.66		-0.00115	-0.07355	0.09368	1499.7	R2118
0074.13	0110.95		-0.00092	-0.05247	0.05968	2380.5	R2119
0048.20	0072.13		-0.00187	-0.04158	0.03695	1667.5	R2121
0016.67	0024.94		-0.00064	-0.03553	0.01317	1304.2	R2126
0149.66	0100.00		-0.00004	-0.07231	0.06304	1499.7	R2201
0110.95	0074.13		-0.00143	-0.05351	0.04467	2380.5	R2202
0072.13	0048.20		-0.00173	-0.04118	0.02653	1667.5	R2204
0024.94	0016.67		-0.00041	-0.03535	0.00878	1304.2	R2209
0176.54	0035.12		0.00617	-0.06955	0.01153	1499.7	R2211
0130.87	0024.83		0.00016	-0.05315	0.01568	2380.5	R2212
0085.08	0016.92		-0.00026	-0.04026	0.00890	1667.5	R2214
0029.42	0005.85		0.00003	-0.03519	0.00302	1304.2	R2216
0176.54	-035.12		-0.00618	-0.06955	-0.01153	1499.7	R2221
0130.87	-024.83		-0.00016	-0.05315	-0.01568	2380.5	R2222
0085.08	-016.92		0.00026	-0.04026	-0.00890	1667.5	R2224
0029.42	-005.85		-0.00003	-0.03520	-0.00302	1304.5	R2226
0149.66	-100.00		0.00004	-0.07231	-0.06304	1499.7	R2228
0110.95	-074.13		0.00143	-0.05351	-0.04467	2380.5	R2229
0072.13	-048.20		0.00173	-0.04118	-0.02653	1667.5	R2231
0024.94	-016.67		0.00041	-0.03536	-0.00878	1304.2	R2236
0035.12	-176.54		0.00006	-0.07099	-0.10740	1499.7	R2311
0026.03	-130.87		-0.00014	-0.04919	-0.06637	2380.5	R2312
0016.92	-085.88		0.00075	-0.03913	-0.04066	1667.5	R2314
0005.85	-029.42		-0.00003	-0.03379	-0.01264	1304.2	R2316
0100.00	-149.66		0.00115	-0.07355	-0.09368	1499.7	R2318
0074.13	-110.95		0.00092	-0.05247	-0.05968	2380.5	R2319
0048.20	-072.13		0.00187	-0.04158	-0.03695	1667.5	R2321
0016.67	-024.94		0.00064	-0.03553	-0.01317	1304.2	R2326
0							

-EOF

Sample output

BEST FIT PARABOLOID WITH MINIMUM PATH LENGTH IN LEAST SQUARES SENSE

TEST OPTION = -3 -1.0 SYMMETRIC PLUS +1.0 ANTI-SYM HALF DISH DATA

INPUT DATA FOR FIRST LOAD - SYMMETRIC

X COORDINATE	Y COORDINATE	Z COORDINATE	X DEFLECTION	Y DEFLECTION	Z DEFLECTION	AREA	POINT NO.
35.120	176.540	54.000	0.000	0.007	-0.038	1499.700	R2111
26.030	130.870	29.674	-0.000	0.004	-0.033	2380.500	R2112
16.920	85.080	12.541	-0.000	0.002	-0.027	1667.500	R2114
5.850	29.420	1.500	-0.000	0.001	-0.024	1304.200	R2116
100.000	149.660	53.997	0.002	0.010	-0.042	1499.700	R2118
74.130	110.950	29.675	0.000	0.006	-0.033	2380.500	R2119
48.200	72.130	12.543	-0.000	0.003	-0.027	1667.500	R2121
16.670	24.940	1.500	-0.000	0.001	-0.024	1304.200	R2126
149.660	100.000	53.997	-0.004	0.003	-0.016	1499.700	R2201
110.950	74.130	29.675	-0.003	0.003	-0.016	2380.500	R2202
72.130	48.200	12.543	-0.002	0.002	-0.018	1667.500	R2204
24.940	16.670	1.500	-0.001	0.000	-0.022	1304.200	R2209
176.540	35.120	54.000	-0.010	0.000	0.004	1499.700	R2211
130.870	24.830	29.572	-0.008	0.000	-0.000	2380.500	R2212
85.080	16.920	12.541	-0.006	0.001	-0.008	1667.500	R2214
29.420	5.850	1.500	-0.002	-0.000	-0.021	1304.200	R2216
176.540	-35.120	54.000	-0.010	-0.000	0.004	1499.700	R2221
130.870	-24.830	29.572	-0.008	-0.000	-0.000	2380.500	R2222
85.080	-16.920	12.541	-0.006	-0.001	-0.008	1667.500	R2224
29.420	-5.850	1.500	-0.002	0.000	-0.021	1304.500	R2226
149.660	-100.000	53.997	-0.004	-0.003	-0.016	1499.700	R2228
110.950	-74.130	29.675	-0.003	-0.003	-0.016	2380.500	R2229
24.940	-16.670	1.500	-0.001	-0.000	-0.022	1304.200	R2236
26.030	-130.870	29.674	-0.000	-0.004	-0.033	2380.500	R2312
16.920	-85.880	12.769	-0.000	-0.002	-0.027	1667.500	R2314
72.130	-48.200	12.543	-0.002	-0.002	-0.018	1667.500	R2231
35.120	-176.540	54.000	0.000	-0.007	-0.038	1499.700	R2311
5.850	-29.420	1.500	-0.000	-0.001	-0.024	1304.200	R2316
100.000	-149.660	53.997	0.002	-0.010	-0.042	1499.700	R2318
74.130	-110.950	29.675	0.000	-0.006	-0.033	2380.500	R2319
48.200	-72.130	12.543	-0.000	-0.003	-0.027	1667.500	R2321
16.670	-24.940	1.500	-0.000	-0.001	-0.024	1304.200	R2326

BEST FIT PARABOLOID WITH MINIMUM PATH LENGTH IN LEAST SQUARES SENSE

TEST OPTION = -3 -1.0 SYMMETRIC PLUS +1.0 ANTI-SYM HALF DISH DATA

INPUT DATA FOR SECOND LOAD - ANTI-SYMMETRIC

X COORDINATE	Y COORDINATE	Z COORDINATE	X DEFLECTION	Y DEFLECTION	Z DEFLECTION	AREA	POINT NO.
35.120	176.540	54.000	-0.000	-0.071	0.107	1499.700	R2111
26.030	130.870	29.674	0.000	-0.049	0.066	2380.500	R2112
16.920	85.080	12.541	-0.001	-0.039	0.041	1667.500	R2114
5.850	29.420	1.500	0.000	-0.034	0.013	1304.200	R2116
100.000	149.660	53.997	-0.001	-0.074	0.094	1499.700	R2118
74.130	110.950	29.675	-0.001	-0.052	0.060	2380.500	R2119
48.200	72.130	12.543	-0.002	-0.042	0.037	1667.500	R2121
16.670	24.940	1.500	-0.001	-0.036	0.013	1304.200	R2126
149.660	100.000	53.997	-0.000	-0.072	0.063	1499.700	R2201
110.950	74.130	29.675	-0.001	-0.054	0.045	2380.500	R2202
72.130	48.200	12.543	-0.002	-0.041	0.027	1667.500	R2204
24.940	16.670	1.500	-0.000	-0.035	0.009	1304.200	R2209
176.540	35.120	54.000	0.006	-0.070	0.012	1499.700	R2211
130.870	24.830	29.572	0.000	-0.053	0.016	2380.500	R2212
85.080	16.920	12.541	-0.000	-0.040	0.009	1667.500	R2214
29.420	5.850	1.500	0.000	-0.035	0.003	1304.200	R2216
176.540	-35.120	54.000	-0.006	-0.070	-0.012	1499.700	R2221
130.870	-24.830	29.572	-0.000	-0.053	-0.016	2380.500	R2222
85.080	-16.920	12.541	0.000	-0.040	-0.009	1667.500	R2224
29.420	-5.850	1.500	-0.000	-0.035	-0.003	1304.500	R2226
149.660	-100.000	53.997	0.000	-0.072	-0.063	1499.700	R2228
110.950	-74.130	29.675	0.001	-0.054	-0.045	2380.500	R2229
72.130	-48.200	12.543	0.002	-0.041	-0.027	1667.500	R2231
24.940	-16.670	1.500	0.000	-0.035	-0.009	1304.200	R2236
35.120	-176.540	54.000	0.000	-0.071	-0.107	1499.700	R2311
26.030	-130.870	29.674	-0.000	-0.049	-0.066	2380.500	R2312
16.920	-85.880	12.769	0.001	-0.039	-0.041	1667.500	R2314
5.850	-29.420	1.500	-0.000	-0.034	-0.013	1304.200	R2316
100.000	-149.660	53.997	0.001	-0.074	-0.094	1499.700	R2318
74.130	-110.950	29.675	0.001	-0.052	-0.060	2380.500	R2319
48.200	-72.130	12.543	0.002	-0.042	-0.037	1667.500	R2321
16.670	-24.940	1.500	0.001	-0.036	-0.013	1304.200	R2326

Sample output (contd)

BEST FIT PARABOLOID WITH MINIMUM PATH LENGTH IN LEAST SQUARES SENSE

TEST OPTION = -3 -1.0 SYMMETRIC PLUS +1.0 ANTI-SYM HALF DISH DATA

SUM OF INPUT DEFLECTIONS

X COORDINATE	Y COORDINATE	Z COORDINATE	X DEFLECTION	Y DEFLECTION	Z DEFLECTION	AREA	POINT NO.
35.120	176.540	54.000	-0.000	-0.078	0.146	1499.700	R2111
26.030	130.870	29.674	0.000	-0.053	0.099	2380.500	R2112
16.920	85.080	12.541	-0.000	-0.041	0.068	1667.500	R2114
5.850	29.420	1.500	0.000	-0.035	0.037	1304.200	R2116
100.000	149.660	53.997	-0.003	-0.083	0.135	1499.700	R2118
74.130	110.950	29.675	-0.001	-0.058	0.093	2380.500	R2119
48.200	72.130	12.543	-0.001	-0.045	0.064	1667.500	R2121
16.670	24.940	1.500	-0.001	-0.036	0.037	1304.200	R2126
149.660	100.000	53.997	0.004	-0.076	0.079	1499.700	R2201
110.950	74.130	29.675	0.002	-0.056	0.061	2380.500	R2202
72.130	48.200	12.543	0.000	-0.043	0.044	1667.500	R2204
24.940	16.670	1.500	0.000	-0.036	0.031	1304.200	R2209
176.540	35.120	54.000	0.016	-0.070	0.007	1499.700	R2211
130.870	24.830	29.572	0.008	-0.053	0.016	2380.500	R2212
85.080	16.920	12.541	0.005	-0.041	0.017	1667.500	R2214
29.420	5.850	1.500	0.002	-0.035	0.024	1304.200	R2216
176.540	-35.120	54.000	0.004	-0.069	-0.016	1499.700	R2221
130.870	-24.830	29.572	0.008	-0.053	-0.015	2380.500	R2222
85.080	-16.920	12.541	0.006	-0.039	-0.001	1667.500	R2224
29.420	-5.850	1.500	0.002	-0.035	0.018	1304.500	R2226
149.660	-100.000	53.997	0.004	-0.069	-0.048	1499.700	R2228
110.950	-74.130	29.675	0.004	-0.051	-0.028	2380.500	R2229
24.940	-16.670	1.500	0.001	-0.035	0.013	1304.200	R2236
26.030	-130.870	29.674	-0.000	-0.045	-0.033	2380.500	R2312
16.920	-85.880	12.769	0.001	-0.037	-0.013	1667.500	R2314
72.130	-48.200	12.543	0.004	-0.039	-0.009	1667.500	R2231
35.120	-176.540	54.000	-0.000	-0.064	-0.069	1499.700	R2311
5.850	-29.420	1.500	0.000	-0.033	0.012	1304.200	R2316
100.000	-149.660	53.997	-0.001	-0.064	-0.052	1499.700	R2318
74.130	-110.950	29.675	0.001	-0.047	-0.027	2380.500	R2319
48.200	-72.130	12.543	0.002	-0.038	-0.010	1667.500	R2321
16.670	-24.940	1.500	0.001	-0.035	0.011	1304.200	R2326

BEST FIT PARABOLOID WITH MINIMUM PATH LENGTH IN LEAST SQUARES SENSE

TEST OPTION = -3 -1.0 SYMMETRIC PLUS +1.0 ANTI-SYM HALF DISH DATA

DISTORTIONS NORMAL TO SURFACE AND CHANGE IN PATH LENGTH (LAMBDA)
AFTER MINIMIZATION OF RMS WITH RESPECT TO RIGID BODY MOTION

NORMAL	LAMBDA	POINT NO.
0.018	0.031	R2111
0.007	0.012	R2112
0.005	0.009	R2114
0.002	0.005	R2116
0.026	0.044	R2118
0.012	0.022	R2119
0.008	0.015	R2121
0.004	0.009	R2126
-0.004	-0.006	R2201
-0.000	-0.000	R2202
-0.000	-0.000	R2204
0.002	0.003	R2209
-0.039	-0.066	R2211
-0.020	-0.037	R2212
-0.013	-0.026	R2214
-0.001	-0.001	R2216
-0.015	-0.026	R2221
-0.024	-0.045	R2222
-0.015	-0.028	R2224
-0.001	-0.003	R2226
-0.008	-0.014	R2228
-0.010	-0.018	R2229
-0.001	-0.002	R2236
0.018	0.032	R2312
0.008	0.015	R2314
-0.007	-0.013	R2231
0.018	0.031	R2311
0.004	0.008	R2316
0.019	0.032	R2318
0.013	0.023	R2319
0.004	0.007	R2321
0.000	0.001	R2326

Sample output (contd)

```
BEST FIT PARABCLOID WITH MINIMUM PATH LENGTH IN LEAST SQUARES SENSE

TEST OPTICN = -3 -1.0 SYMMETRIC PLUS +1.0 ANTI-SYM   HALF DISH DATA

DISTORTIONS NORMAL TO SURFACE AND CHANGE IN PATH LENGIH (LAMBDA)
AFTER MINIMIZATION OF RMS WITH RESPECT TO FOCAL LENGTH CHANGE

   NORMAL        LAMBDA        POINT NO.
    0.017         0.030         R2111
    0.007         0.012         R2112
    0.005         0.009         R2114
    0.003         0.006         R2116
    0.025         0.043         R2118
    0.012         0.022         R2119
    0.008         0.015         R2121
    0.005         0.010         R2126
   -0.004        -0.007         R2201
   -0.000        -0.001         R2202
    0.000         0.000         R2204
    0.002         0.004         R2209
   -0.039        -0.067         R2211
   -0.021        -0.038         R2212
   -0.013        -0.025         R2214
   -0.000        -0.000         R2216
   -0.016        -0.027         R2221
   -0.025        -0.045         R2222
   -0.015        -0.028         R2224
   -0.001        -0.002         R2226
   -0.008        -0.015         R2228
   -0.010        -0.018         R2229
   -0.001        -0.001         R2236
    0.018         0.032         R2312
    0.008         0.016         R2314
   -0.007        -0.013         R2231
    0.018         0.030         R2311
    0.004         0.009         R2316
    0.018         0.031         R2318
    0.012         0.023         R2319
    0.004         0.007         R2321
    0.001         0.002         R2326


BEST FIT PARABOLOID WITH MINIMUM PATH LENGTH IN LEAST SQUARES SENSE

TEST OPTION = -3 -1.0 SYMMETRIC PLUS +1.0 ANTI-SYM   HALF DISH DATA

ORIGINAL FOCAL LENGTH =   150.000    NO. POINTS IN ANALYSIS =   32

          INPUT DISTORTIONS OBTAINED ANALYTICALLY - OPTION -3

          RIGID BODY TRANSLATIONS IN X DIRECTION CONSTRAINED

             RIGID BODY ROTATIONS ABOUT Y AXIS CONSTRAINED

          RMS =-1.0000 SYMMETRIC AND 1.0000 ANTI-SYMMETRIC

        MINIMIZATION OF RMS WITH RESPECT TO RIGID BODY MOTION

            RMS OF 1/2 LAMBDA WEIGHTED BY AREAS =    0.012

            DEVIATION OF THE MEAN - 1/2 LAMBDAS =    0.00003
            SUM-UNIT AREA*1/2 LAMBDA =                3.594
            SUM-UNIT AREAS           =            54815.498

            X CCORDINATE OF VERTEX =               -0.000

            Y CCORDINATE OF VERTEX =                0.312

            Z CCORDINATE OF VERTEX =                0.021

            ROTATION ABOUT X AXIS =                 0.001599

            ROTATION ABOUT Y AXIS =                -0.000000

        MINIMIZATION OF RMS WITH RESPECT TO FOCAL LENGTH CHANGE

            RMS OF 1/2 LAMBDA WEIGHTED BY AREAS =    0.012

            NEW FCCAL LENGTH =                     149.997

            DEVIATION OF THE MEAN - 1/2 LAMBDAS =    0.00000
            SUM-UNIT AREA*1/2 LAMBDA =                0.000
            SUM-UNIT AREAS           =            54815.498

            X CCORDINATE OF VERTEX =                0.000

            Y CCORDINATE OF VERTEX =                0.312

            Z CCORDINATE OF VERTEX =                0.021

            ROTATION ABOUT X AXIS =                 0.001599

            ROTATION ABOUT Y AXIS =                 0.000000

            ALL LENGTH UNITS ARE CONSISTENT WITH INPUT

            ROTATION UNITS ARE RADIANS

*** PLOTS COMPLETED ***
```

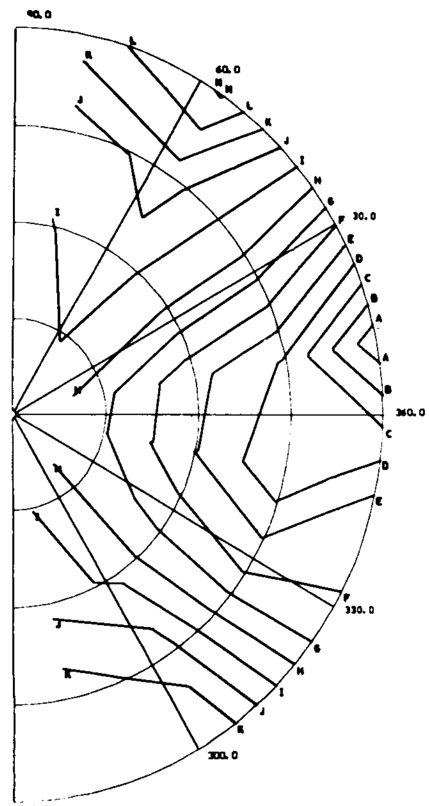
Output, plotted

TEST OPTION = -3 -1.0 SYMMETRIC PLUS +1.0 ANTI-SYM HALF DISH DATA

RIGID BODY FIT RMS = 0.012

CONTOUR DEFINITIONS

1/2 RF PATHLENGTH ERROR-INCHES	LABEL
-0.035	A
-0.030	B
-0.025	C
-0.020	D
-0.015	E
-0.010	F
-0.005	G
-0.000	H
0.005	I
0.010	J
0.015	K
0.020	L
0.025	M

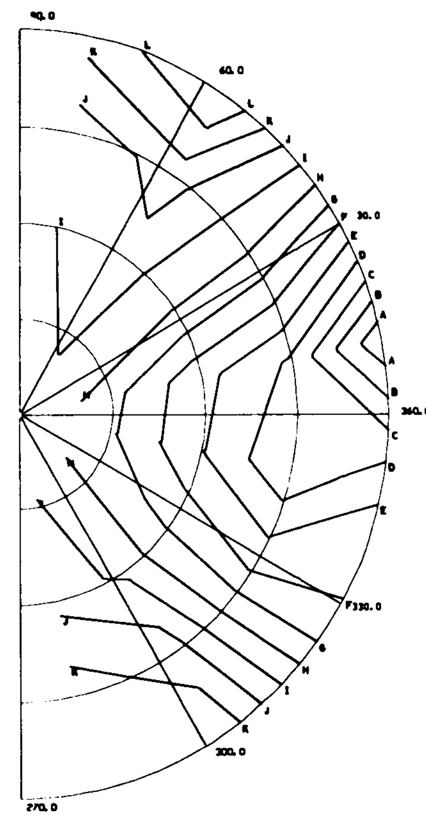


TEST OPTION = -3 -1.0 SYMMETRIC PLUS +1.0 ANTI-SYM HALF DISH DATA

FOCAL LENGTH FIT RMS = 0.012

CONTOUR DEFINITIONS

1/2 RF PATHLENGTH ERROR-INCHES	LABEL
-0.035	A
-0.030	B
-0.025	C
-0.020	D
-0.015	E
-0.010	F
-0.005	G
0.000	H
0.005	I
0.010	J
0.015	K
0.020	L
0.025	M



XII. BEST-FIT PARABOLOID PROGRAM

C. Lawson

Program:	MO95, binary in Jet Propulsion Laboratory Library
Engineer:	A. Ludwig
Mathematician:	C. Lawson
Programmer:	P. Firnett

A. Program Description[4]

For this program, a paraboloid is parameterized by a set of nine numbers b_i, which will be called the parameter vector **B** ($|b_1| < 1, |b_2| < 1$). The principal input data for this problem is a set of x–y–z coordinates representing observed or computed points lying on some structure (typically an antenna surface). The problem is to determine the parameter vector **B** identifying the paraboloid which best fits the given data.

Two different criteria of fit are available in this program. The subroutine *ZFIT* minimizes the weighted sum of squares of residuals measured parallel to the axis of the fitted parabola. The subroutine *PFIT* minimizes the weighted sum of squares of residuals measured as radiation path length errors.

The parameter vector **B** identifies a paraboloid as follows: The first two components b_1 and b_2 specify a rigid rotation of coordinates from the system C in which the data is given to a new system C'. The remaining components, $b_3, \cdots, b_9$ are coefficients of a second-degree polynomial in the C' coordinate system.

In the C' system, the paraboloid is the locus of points (X, Y, Z) satisfying:

$$Z = b_3 + b_4 X + b_5 Y + b_6 X^2 + b_7 XY + b_8 Y^2 + b_9 (X^2 + Y^2)$$

The transformation of coordinates between the C system (x, y, z) and the C' system (X, Y, Z) is given by:

$$\mathbf{A}\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} X \\ Y \\ Z \end{bmatrix} \quad \text{or} \quad \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \mathbf{A}^T \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

where the 3-by-3 orthogonal matrix **A** is completely determined by b_1 and b_2 as follows:

$$w = [1 - b_1^2 - b_2^2]^{1/2}$$

$$g = \frac{1}{1 + w}$$

$$\mathbf{A} = \begin{bmatrix} 1 - g b_1^2 & -g b_1 b_2 & -b_1 \\ -g b_1 b_2 & 1 - g b_2^2 & -b_2 \\ b_1 & b_2 & w \end{bmatrix}$$

Geometrically, this matrix is completely characterized by the fact that it produces a rotation which makes the new Z-axis $[0, 0, 1]_{C'}^T$ coincide with the old vector

[4] For a full discussion of the analysis and method, see "Antenna Surface Measurements, Part 2," Task 095, P. J. Firnett, May 15, 1965, which is filed with the Programming Analysis Group, JPL Section 314.

$[b_1, b_2, w]^T_C$; the rotation is done about the line perpendicular to both the old z-axis and the new Z-axis.

Using the input vector **L**, the user may select the subset of the components of **B** to be solved for. In particular, it would be inappropriate to solve for b_9 and (b_6, b_7, b_8) at the same time.

The problem is nonlinear in the parameter vector **B**. The problem is solved iteratively by the standard technique of linearizing about an initial estimate of **B**, solving the linear least-squares problem for a correction vector $\Delta\mathbf{B}$, then iterating this procedure using $\mathbf{B} + \Delta\mathbf{B}$ in place of **B**.

The parameter vector **B** was chosen for the computation because it avoids certain indeterminant cases and reduces the nonlinearity. Other parameters of more direct interest to the user are computed from **B** at the conclusion of the computation. The rotation parameters b_1 and b_2 are converted to angles ϕ and θ using the formulas

$$\phi = \arctan \frac{b_2}{b_1}$$

$$\theta = \arctan \frac{w}{r}$$

where

$$r = (b_2^2 + b_1^2)^{1/2}$$

When *PFIT* is used and (b_6, b_7, b_8) are not solved for, the remaining polynomial $b_3 + b_4X + b_5Y + b_9(X^2 + X^2)$ may also be expressed in the form

$$a_3 + \frac{(X - a_1)^2 + (Y - a_2)^2}{4f}$$

In this case, the parameters a_1, a_2, a_3 and f are computed using the formulas

$$f = \frac{1}{4b_9}, a_1 = -2b_4f, \quad a_2 = -2b_5f$$

and

$$a_3 = b_3 - (b_4^2 + b_5^2) f.$$

B. Applications

This program was written with the specific objective of evaluating the surface quality of large paraboloidal antennas; however, the formulation is very general and other applications are possible.

In addition to the parameters of the best-fit paraboloid, which are useful for determining optimum focusing and pointing errors, the RMS surface error is used to predict gain loss due to surface distortions.

The option to fit a paraboloid with an elliptical cross section provides information on the astigmatism of the reflector (different focal points for horizontal and vertical cuts), which is valuable in predicting defocusing effects.

C. Input

Card	Parameters							Format
1	*HEADER*[a]							12A6
2[b]	*BZERO*	*ITMAX*		*SDIN*	*KPRINT*			Name list
.								
.	*CD*	*DPRINT*						Name list
.								
$N + 2$	*DATE*	*PRBTYP*		*LVCTR*	*LAST*	*PNTOPT*		Name list
$N + 3$	*X*	*Y*	*Z*	*DX*[c]	*DZ*[c]	*W*	*ID*	7F10.5, 4XA6
.								
.	*X*	*Y*	*Z*	*DX*	*DY*	*DZ*	*W* *ID*	7F10.5, 4XA6
.								
LAST							*END*	77XA3

[a] *HEADER* = title printed on every output page.
[b] This data is optional.
[c] These parameters depend on *PNTOP*, as described below.

The following parameters are optional input, normally not used, except for *BZERO*, and are set to the values indicated unless replaced by input. See program writeup for their significance.

BZERO = (0, 0, 0 ···, 0) (floating) initial values for the coefficients of the polynomial for Z

ITMAX = 10 (fixed)

SDIN = 0.0005 (floating)

KPRINT = 0 (fixed)

CD = 1.E-8 (floating)

DPRINT (I) = 0 *I* = 1, 3 (fixed)

The following parameters are normally input:

DATE = month, day, year (fixed)

PRBTYP = 0 for *ZFIT* only

= 1 for *PFIT* only

= 2 for both *ZFIT* and *PFIT* (fixed)

LVCTR = nine-component vector specifying which components of **B** vector are to be solved for. For the *j*th component of *LVCTR* = 1, the *j*th component of **B** will be solved for; for the *j*th component of *LVCTR* = 20, the *j*th component of **B** is constrained to equal the initial value (fixed)

LAST = 0 except for final case in a stack (fixed)

PNTOPT = 1 for deflection data input as *DX*, *DY*, *DZ*

= 2 for deflection data input as θ, *R*, *DZ* (fixed)

X, *Y*, *Z* = Cartesian coordinates of nominal surface

DX, *DY*, *DZ* = deflections of actual surface from nominal position, used for *PNOPT* = 1. In this case, true coordinates of surface point are computed as $X = X + DX$, $Y = Y + DY$, $Z = Z + DZ$

θ, *R*, *DZ* = deflection data input in place of *DX*, *DY*, and *DZ* for *PNOPT* = 2. In this case, true coordinates of surface points are computed as $X = X$, $Y = Y$, $Z = Z + R/COS\theta$. *DZ* is dummy data

END = letters *END* punched in Columns 78 through 80 on a card following last data card

If *PRBTYP* = 2, the program will compute *ZFIT* first; prior to starting *PFIT*, it will read new values for any of the parameters input by *NAMELIST*, if desired. These cards are optional, but must follow the *END* card, and precede the *HEADER* card for the next case if included. This program takes less than 1 min for a few hundred data points. The maximum number of data points per case is 1000.

D. Output

A symbol table and input parameters are printed out, then the **B** vector and other data. The Cartesian coordinates of the data points are then pointed out in the original and rotated coordinate systems along with the residue (deviation from perfect paraboloid). Finally the RMS deviation, and coordinates of the fitted paraboloid axis and vertex are printed. For a *PFIT* problem, the coordinates of the paraboloid focus are also printed.

E. Sample Case

Input

```
TEST CASE 1 ZFIT ONLY ...
$INPUT DATE=5,10,65,  PRBTYP=0,  LAST=0,  PNTOPT=1,
 LVCTR=6*1,20,1,20  $
176.70420    -.37426  52.00414   0.00000   0.00000  - .03671   2.40800     5
154.56969    -.15280  39.80918   0.00000   0.00000  - .01050   3.25500     6
132.28578     .02773  29.14080   0.00000   0.00000  - .02507   1.94600     7
129.54424     .04210  27.96737   0.00000   0.00000  - .00214   1.72200     8
105.56285     .13047  18.56917   0.00000   0.00000  - .00337   2.75400     9
 72.93408    -.25958   8.84247   0.00000   0.00000  - .02327   2.05200    10
 52.09592    -.23859   4.54126   0.00000   0.00000  +.01786    1.02000    11
 30.70681    -.23072   1.58609   0.00000   0.00000  +.01448    0.50400    12
 27.56130    -.20518   1.25417   0.00000   0.00000  - .01193   0.15600    13
 18.20327    -.14474    .50095   0.00000   0.00000  - .05134   0.13300    14
 18.17219     .09574    .50153   0.00000   0.00000  - .04886   0.13300    15
 27.56865     .26083   1.28867   0.00000   0.00000  +.02183    0.15600    16
 31.47264     .34087   1.67070   0.00000   0.00000  +.01963    0.50400    17
 54.37600     .66145   4.94713   0.00000   0.00000  +.01849    1.02000    18
 72.71185     .90239   8.84602   0.00000   0.00000  +.03297    2.99700    19
129.56800    -.12535  27.98967   0.00000   0.00000  +.00987    3.56500    20
133.09945    -.20063  29.57891   0.00000   0.00000  +.05307    1.94600    21
157.70750    -.34949  41.49458   0.00000   0.00000  +.04161    3.25500    22
176.65711    -.34429  52.01734   0.00000   0.00000  +.00426    2.40800    23
    .96983 176.02622  51.63040   0.00000   0.00000  -.01320    2.40800     3
    .64840 156.11788  40.65322   0.00000   0.00000  +.03120    3.25500     4
    .31695 133.08984  29.56289   0.00000   0.00000  +.04122    1.94600     5
    .27839 129.47864  27.96593   0.00000   0.00000  +.02460    1.72200     6
    .14063  97.88346  16.00408   0.00000   0.00000  +.03543    3.16200     7
    .20163  72.87105   8.91349   0.00000   0.00000  +.06311    1.67900     8
    .22947  52.63356   4.64826   0.00000   0.00000  +.03102    1.02000     9
    .04884  31.36536   1.64899   0.00000   0.00000  +.00934    0.50400    10
    .04067  27.52934   1.27935   0.00000   0.00000  +.01624    0.15600    11
    .21070  18.16032    .55394   0.00000   0.00000  +.00421    0.13300    12
    .05979 -18.23230    .45727   0.00000   0.00000  -.09675    0.13300    13
    .03482 -27.57579   1.19033   0.00000   0.00000  -.07704    0.15600    14
    .03966 -31.42217   1.63220   0.00000   0.00000  -.01338    0.50400    15
    .29753 -53.75166   4.87139   0.00000   0.00000  +.05584    1.02000    16
    .48686 -76.08494   9.69961   0.00000   0.00000  +.05102    2.05200    17
    .38151-104.86324  18.39382   0.00000   0.00000  +.06641    2.10000    18
    .41636-116.51373  22.68059   0.00000   0.00000  +.05455    1.50800     9
    .45116-129.49434  27.99723   0.00000   0.00000  +.04891    1.01600    20
    .45859-133.18206  29.63637   0.00000   0.00000  +.07359    1.94600    21
    .56115-156.49233  40.92145   0.00000   0.00000  +.10451    3.25500    22
    .56372-176.68521  52.12315   0.00000   0.00000  +.09318    2.40800    23
                                                                         END
```

```
TEST CASE 2  PFIT ONLY ...
$INPUT  DATE=5,10,65,  PRBTYP=1,  LAST=0,  PNTOPT=1,
 BZERO=8*0.,1.,  LVCTR=5*1,3*20,1  $
176.70420    -.37426  52.00414   0.00000   0.00000  - .03671   2.40800     5
154.56969    -.15280  39.80918   0.00000   0.00000  - .01050   3.25500     6
132.28578     .02773  29.14080   0.00000   0.00000  - .02507   1.94600     7
129.54424     .04210  27.96737   0.00000   0.00000  - .00214   1.72200     8
105.56285     .13047  18.56917   0.00000   0.00000  - .00337   2.75400     9
 72.93408    -.25958   8.84247   0.00000   0.00000  - .02327   2.05200    10
 52.09592    -.23859   4.54126   0.00000   0.00000  +.01786    1.02000    11
 30.70681    -.23072   1.58609   0.00000   0.00000  +.01448    0.50400    12
 27.56130    -.20518   1.25417   0.00000   0.00000  - .01193   0.15600    13
 18.20327    -.14474    .50095   0.00000   0.00000  - .05134   0.13300    14
 18.17219     .09574    .50153   0.00000   0.00000  - .04886   0.13300    15
 27.56865     .26083   1.28867   0.00000   0.00000  +.02183    0.15600    16
 31.47264     .34087   1.67070   0.00000   0.00000  +.01963    0.50400    17
 54.37600     .66145   4.94713   0.00000   0.00000  +.01849    1.02000    18
 72.71185     .90239   8.84602   0.00000   0.00000  +.03297    2.99700    19
129.56800    -.12535  27.98967   0.00000   0.00000  +.00987    3.56500    20
133.09945    -.20063  29.57891   0.00000   0.00000  +.05307    1.94600    21
157.70750    -.34949  41.49458   0.00000   0.00000  +.04161    3.25500    22
176.65711    -.34429  52.01734   0.00000   0.00000  +.00426    2.40800    23
    .96983 176.02622  51.63040   0.00000   0.00000  -.01320    2.40800     3
    .64840 156.11788  40.65322   0.00000   0.00000  +.03120    3.25500     4
    .31895 133.08984  29.56289   0.00000   0.00000  +.04122    1.94600     5
    .27839 129.47864  27.96593   0.00000   0.00000  +.02460    1.72200     6
    .14063  97.88346  16.00408   0.00000   0.00000  +.03543    3.16200     7
    .20163  72.87105   8.91349   0.00000   0.00000  +.06311    1.67900     8
    .22947  52.63356   4.64826   0.00000   0.00000  +.03102    1.02000     9
    .04884  31.36536   1.64899   0.00000   0.00000  +.00934    0.50400    10
    .04067  27.52934   1.27935   0.00000   0.00000  +.01624    0.15600    11
    .21070  18.16032    .55394   0.00000   0.00000  +.00421    0.13300    12
    .05979 -18.23230    .45727   0.00000   0.00000  -.09675    0.13300    13
    .03482 -27.57579   1.19033   0.00000   0.00000  -.07704    0.15600    14
    .03966 -31.42217   1.63220   0.00000   0.00000  -.01338    0.50400    15
    .29753 -53.75166   4.87139   0.00000   0.00000  +.05584    1.02000    16
    .48686 -76.08494   9.69761   0.00000   0.00000  +.05102    2.05200    17
    .38151-104.86324  18.39382   0.00000   0.00000  +.06641    2.10000    18
    .41636-116.51373  22.68059   0.00000   0.00000  +.05455    1.50800     9
    .45116-129.49434  27.99723   0.00000   0.00000  +.04891    1.01600    20
    .45859-133.18206  29.63637   0.00000   0.00000  +.07359    1.94600    21
    .56115-156.49233  40.92145   0.00000   0.00000  +.10451    3.25500    22
    .56372-176.68521  52.12315   0.00000   0.00000  +.09318    2.40800    23
                                                                        (END)
```

Input (contd)

```
TEST CASE 3  ZFIT FOLLOWED BY PFIT ...
$INPUT  DATE=5,10,65,  PRBTYP=2,  LAST=0,  PNTOPT=1,
 LVCTR=6*1,20,1,20  $
176.70420   -.37426  52.00414   0.00000   0.00000  - .03671   2.40800          5
154.56969   -.15280  39.80918   0.00000   0.00000  - .01050   3.25500          6
132.28578    .02773  29.14080   0.00000   0.00000  - .02507   1.94600          7
129.54424    .04210  27.96737   0.00000   0.00000  - .00214   1.72200          8
105.56285    .13047  18.56917   0.00000   0.00000  - .00337   2.75400          9
 72.93408   -.25958   8.84247   0.00000   0.00000  - .02327   2.05200         10
 52.09592   -.23859   4.54126   0.00000   0.00000  +.01786    1.02000         11
 30.70681   -.23072   1.58609   0.00000   0.00000  +.01443    0.50400         12
 27.56130   -.20518   1.25417   0.00000   0.00000  - .01193   0.15600         13
 18.20327   -.14474    .50095   0.00000   0.00000  - .05134   0.13300         14
 18.17219    .09574    .50153   0.00000   0.00000  - .04886   0.13300         15
 27.56865    .26083   1.28867   0.00000   0.00000  +.02183    0.15600         16
 31.47264    .34087   1.67070   0.00000   0.00000  +.01963    0.50400         17
 54.37600    .66145   4.94713   0.00000   0.00000  +.01849    1.02000         18
 72.71185    .90239   8.84602   0.00000   0.00000  +.03297    2.99700         19
129.56800   -.12535  27.98967   0.00000   0.00000  +.00987    3.56500         20
133.09945   -.20063  29.57891   0.00000   0.00000  +.05307    1.94600         21
157.70750   -.34949  41.49458   0.00000   0.00000  +.04161    3.25500         22
176.65711   -.34429  52.01734   0.00000   0.00000  +.00426    2.40800         23
  .96983 176.02622  51.63040   0.00000   0.00000  -.01320    2.40800          3
  .64840 156.11788  40.65322   0.00000   0.00000  +.03120    3.25500          4
  .31895 133.08984  29.56289   0.00000   0.00000  +.04122    1.94600          5
  .27839 129.47864  27.96593   0.00000   0.00000  +.02460    1.72200          6
  .14063  97.88346  16.00408   0.00000   0.00000  +.03543    3.16200          7
  .20163  72.87105   8.91349   0.00000   0.00000  +.06311    1.67900          8
  .22947  52.63356   4.64826   0.00000   0.00000  +.03102    1.02000          9
  .04884  31.36536   1.64899   0.00000   0.00000  +.00934    0.50400         10
  .04067  27.52934   1.27935   0.00000   0.00000  +.01624    0.15600         11
  .21070  18.16032    .55394   0.00000   0.00000  +.00421    0.13300         12
  .05979 -18.23230    .45727   0.00000   0.00000  -.09675    0.13300         13
  .03482 -27.57579   1.19033   0.00000   0.00000  -.07704    0.15600         14
  .03966 -31.42217   1.63220   0.00000   0.00000  -.01338    0.50400         15
  .29753 -53.75166   4.87139   0.00000   0.00000  +.05584    1.02000         16
  .48686 -76.08494   9.69961   0.00000   0.00000  +.05102    2.05200         17
  .38151-104.86324  18.39382   0.00000   0.00000  +.06641    2.10000         18
  .41636-116.51373  22.68059   0.00000   0.00000  +.05455    1.50800          9
  .45116-129.49434  27.99723   0.00000   0.00000  +.04891    1.01600         20
  .45859-133.18206  29.63637   0.00000   0.00000  +.07359    1.94600         21
  .56115-156.49233  40.92145   0.00000   0.00000  +.10451    3.25500         22
  .56372-176.68521  52.12315   0.00000   0.00000  +.09318    2.40800         23
                                                                            END
```

```
$INPUT  BZERO=8*0.,1.,  LVCTR=5*1,3*20,1  $
TEST CASE 4  ILLUSTRATES USE OF DPRINT (ZFIT ONLY) ...
$INPUT DATE=5,10,65,  PRBTYP=0,  LAST-1,  PNTOPT=1,
 DPRINT=3*1,  LVCTR=6*1,20,1,20  $
176.70420   -.37426  52.00414   0.00000   0.00000  - .03671   2.40800          5
154.56969   -.15280  39.80918   0.00000   0.00000  - .01050   3.25500          6
132.28578    .02773  29.14080   0.00000   0.00000  - .02507   1.94600          7
129.54424    .04210  27.96737   0.00000   0.00000  - .00214   1.72200          8
105.56285    .13047  18.56917   0.00000   0.00000  - .00337   2.75400          9
 72.93408   -.25958   8.84247   0.00000   0.00000  - .02327   2.05200         10
 52.09592   -.23859   4.54126   0.00000   0.00000  +.01786    1.02000         11
 30.70681   -.23072   1.58609   0.00000   0.00000  +.01443    0.50400         12
 27.56130   -.20518   1.25417   0.00000   0.00000  - .01193   0.15600         13
 18.20327   -.14474    .50095   0.00000   0.00000  - .05134   0.13300         14
 18.17219    .09574    .50153   0.00000   0.00000  - .04886   0.13300         15
 27.56865    .26083   1.28867   0.00000   0.00000  +.02183    0.15600         16
 31.47264    .34087   1.67070   0.00000   0.00000  +.01963    0.50400         17
 54.37600    .66145   4.94713   0.00000   0.00000  +.01849    1.02000         18
 72.71185    .90239   8.84602   0.00000   0.00000  +.03297    2.99700         19
129.56800   -.12535  27.98967   0.00000   0.00000  +.00987    3.56500         20
133.09945   -.20063  29.57891   0.00000   0.00000  +.05307    1.94600         21
157.70750   -.34949  41.49458   0.00000   0.00000  +.04161    3.25500         22
176.65711   -.34429  52.01734   0.00000   0.00000  +.00426    2.40800         23
  .96983 176.02622  51.63040   0.00000   0.00000  -.01320    2.40800          3
  .64840 156.11788  40.65322   0.00000   0.00000  +.03120    3.25500          4
  .31895 133.08984  29.56289   0.00000   0.00000  +.04122    1.94600          5
  .27839 129.47864  27.96593   0.00000   0.00000  +.02460    1.72200          6
  .14063  97.88346  16.00408   0.00000   0.00000  +.03543    3.16200          7
  .20163  72.87105   8.91349   0.00000   0.00000  +.06311    1.67900          8
  .22947  52.63356   4.64826   0.00000   0.00000  +.03102    1.02000          9
  .04884  31.36536   1.64899   0.00000   0.00000  +.00934    0.50400         10
  .04067  27.52934   1.27935   0.00000   0.00000  +.01624    0.15600         11
  .21070  18.16032    .55394   0.00000   0.00000  +.00421    0.13300         12
  .05979 -18.23230    .45727   0.00000   0.00000  -.09675    0.13300         13
  .03482 -27.57579   1.19033   0.00000   0.00000  -.07704    0.15600         14
  .03966 -31.42217   1.63220   0.00000   0.00000  -.01338    0.50400         15
  .29753 -53.75166   4.87139   0.00000   0.00000  +.05584    1.02000         16
  .48686 -76.08494   9.69961   0.00000   0.00000  +.05102    2.05200         17
  .38151-104.86324  18.39382   0.00000   0.00000  +.06641    2.10000         18
  .41636-116.51373  22.68059   0.00000   0.00000  +.05455    1.50800          9
  .45116-129.49434  27.99723   0.00000   0.00000  +.04891    1.01600         20
  .45859-133.18206  29.63637   0.00000   0.00000  +.07359    1.94600         21
  .56115-156.49233  40.92145   0.00000   0.00000  +.10451    3.25500         22
  .56372-176.68521  52.12315   0.00000   0.00000  +.09318    2.40800         23
                                                                            END
```

Sample output

```
$ENTRY          ASMMNN


                IBLDR

                        M E M O R Y   M A P

SYSTEM                                                   00C00 THRU  02717

FILE BLOCK CRIGIN                                        02720

     NUMBER OF FILES -    2

     1.  UNIT05
     2.  UNIT06

FILE LIST ORIGIN                                         02750

PRE-EXECUTICN INITIALIZATICN                             02754

CALL ON OBJECT PROGRAM                                   02777

OBJECT PROGRAM                                           03C04 THRU  52735

     1.  DECK 'ASMMNN'  *          03004
     2.  DECK 'ZFIT  '  *          17354
     3.  DECK 'PFIT  '  *          22306
     4.  DECK 'AMAT  '  *          26172
     5.  DECK 'RES   '  *          26641
     6.  DECK 'QES   '  *          27373
     7.  DECK 'VERTX '  *          30044
     8.  DECK 'CCOV  '  *          30651
     9.  DECK 'RTOS  '  *          31070
    10.  DECK 'STPRGS'  *          31256
    11.  SUBR '.IBSYS'             00000
    12.  SUBR '.IOEX '             00702
    13.  SUBR '.JBCON'             02652
    14.  SUBR '.LXCON'             35176
    15.  SUBR '.IODEF'             35716
    16.  SUBR '.LXSL '             36135
    17.  SUBR '.FPTRP'             36274
    18.  SUBR '.ERAS.'             36665
    19.  SUBR 'XIT   '             36671
    20.  SUBR 'FXEM  '             36672
    21.  SUBR 'FOUT  '             37256
    22.  SUBR 'FCNV  '             37620
    23.  SUBR 'FIOS  '             42310
    24.  SUBR 'FIOH  '             42536
    25.  SUBR 'FSEL  '             43577
    26.  SUBR 'FWRD  '             44017
    27.  SUBR 'FRDD  '             44046
    28.  SUBR 'FRDU  '             44100
    29.  SUBR 'UN05  '             44136
    30.  SUBR 'UN06  '             44137
    31.  SUBR 'FIOU  '             44143
    32.  SUBR 'FSCN  '             46223
    33.  SUBR 'FSQR  '             46434
    34.  SUBR 'FATN  '             46541
    35.  SUBR 'FSLDI '             46747
    36.  SUBR 'FSLI  '             47014
    37.  SUBR 'FSLDO '             47060
    38.  SUBR 'FSLO  '             47115
    39.  SUBR '.IOCS '             47151
    40.  SUBR '.IOCSM'             52736

    (* - INSERTIONS OR DELETIONS MADE IN THIS DECK)

INPUT - OUTPUT BUFFERS                                   52736 THRU  77621

UNUSED CORE                                              77622 THRU  77777

EXECUTION    164200
```

Sample output

```
TEST CASE 1 ZFIT ONLY ...

                                        ** SYMBOL TABLE **

SYMBOL    DEFINITION

ZFIT      PARABOLOID FIT BASED ON MINIMIZING SUM OF WEIGHTED SQUARES OF Z DISTANCES
PFIT      PARABOLOID FIT BASED ON MINIMIZING SUM OF WEIGHTED SQUARES OF PATH LENGTH ERRORS
C         RECTANGULR CARTESIAN COORDINATE SYSTEM IN WHICH DATA POINTS ARE GIVEN
CPRIME    RECTANGULAR CARTESIAN COORDINATE SYSTEM IN WHICH PARABOLOID IS PARAMETERIZED WITH AXIS PARALLEL TO Z-AXIS
B         THE COEFFICIENT VECTOR (B1,B2,...,B9) WHICH DEFINES THE PARABOLOID AND IS DETERMINED BY THE PROGRAM
B0        THE INITIAL VALUE VECTOR OF B
L         THE INPUT VECTOR OF INTEGERS (L1,L2,...,L9) SUCH THAT THE VALUE OF LJ DETERMINES WHETHER BJ IS TO BE COMPUTED
PRBTYP    INPUT INTEGER SPECIFYING TYPE OF FIT DESIRED  0=ZFIT  1=PFIT  2=BOTH
PNTOPT    INPUT INTEGER SPECIFYING FORMAT OF CARDS CONTAINING DATA POINTS
LAST      INPUT INTEGER 0=ANOTHER CASE FOLLOWS  1=THIS IS LAST CASE
ITMAX     OPTIONAL INPUT PARAMETER USED BY STPRG5
SDIN      OPTIONAL INPUT PARAMETER USED BY STPRG5
KPRINT    OPTIONAL INPUT PARAMETER USED BY STPRG5
CD        OPTIONAL INPUT PARAMETER USED BY STPRG5
M         NUMBER OF DATA POINTS

PRBTYP  PNTOPT  LAST
  0       1      0

ITMAX  KPRINT      SDIN            CD
  10      0     0.5000000E-03   1.0000000E-08

DPRINT(1)= 0  DPRINT(2)= 0  DPRINT(3)= 0

M=  40



 TEST CASE 1 ZFIT ONLY ...

THIS IS A ZFIT PROBLEM

 L        B0
 1   0.
 1   0.
 1   0.
 1   0.
 1   0.
 1   0.
20   0.
 1   0.
20   0.

ZFIT IS INSTRUCTED TO PRODUCE AN ELLIPTIC PARABOLOID BY DETERMINING THE 7 PARAMETERS

              B1
              B2
              B3
              B4
              B5
              B6
              B8

WHILE HOLDING FIXED THE 2 PARAMETERS

              B7=  0.
              B9=  0.

      UNDERFLOW AT 32520 IN MQ        SET= ZERO.
```

Sample output (contd)

```
 TEST CASE 1 ZFIT ONLY ...

 PARAMETER VECTOR

B1=  0.1163099E-02
B2=  0.4007394E-02
B3=  0.5255177E-01
B4=  0.1617064E-02
B5=  0.4101518E-02
B6=  0.1664591E-02
B7=  0.
B8=  0.1669048E-02
B9=  0.

IN SYSTEM CPRIME ...

         Z=B3+B4*X+B5*Y+B6*X**2+B7*X*Y+B8*Y**2+B9*(X**2+Y**2)

STANDARD DEVIATION OF DATA=  0.4061379E-01

                        COVARIANCE MATRIX OF COEFFICIENTS

          1            2            3            4            5            6            7
1   0.27572E-05  0.22614E-08  0.28788E-06  0.30962E-05  0.23469E-08  0.35991E-10 -0.66585E-11
2   0.22614E-08  0.25772E-05 -0.45520E-07  0.23523E-08  0.28918E-05  0.18486E-10  0.48910E-10
3   0.28788E-06 -0.45520E-07  0.16477E-03  0.34008E-06 -0.55604E-07 -0.74346E-08 -0.75338E-08
4   0.30962E-05  0.23523E-08  0.34008E-06  0.34818E-05  0.24419E-08  0.38852E-10 -0.82351E-11
5   0.23469E-08  0.28918E-05 -0.55604E-07  0.24419E-08  0.32497E-05  0.21013E-10  0.55546E-10
6   0.35991E-10  0.18486E-10 -0.74346E-08  0.38852E-10  0.21013E-10  0.56102E-12  0.34035E-12
7  -0.66585E-11  0.48910E-10 -0.75338E-08 -0.82351E-11  0.55546E-10  0.34035E-12  0.57509E-12

   DIRECTION COSINES OF AXIS OF PARABOLOID

      U               V               W
 0.1163099E-02   0.4007394E-02   0.9999913E 00

COVARIANCE MATRIX OF PHI AND THETA

   0.5169707E 03  0.3941120E-01
   0.3941120E-01  0.8510499E-02

              ROTATION MATRIX A

 0.9999993E 00  -0.2330509E-05  -0.1163099E-02
-0.2330509E-05   0.9999920E 00  -0.4007394E-02
 0.1163099E-02   0.4007394E-02   0.9999913E 00
```

Sample output (contd)

TEST CASE 1 ZFIT ONLY ...

			COORDINATE SYSTEM C			COORDINATE SYSTEM CPRIME			RESIDUE
I	IDENT	WEIGHT	X	Y	Z	X	Y	Z	R
1	5	1.5046	-176.7042	-0.3743	51.9674	-176.7645	-0.5821	51.7600	-0.0162
2	6	2.0338	-154.5697	-0.1528	39.7987	-154.6159	-0.3119	39.6179	0.0227
3	7	1.2159	-132.2858	C.0277	29.1157	-132.3196	-0.0886	28.9617	-0.0209
4	8	1.0760	-129.5442	0.0421	27.9652	-129.5767	-0.0697	27.8145	0.0231
5	9	1.7208	-105.5628	0.1305	18.5658	-105.5844	0.0563	18.4434	0.0044
6	10	1.2822	-72.9341	-0.2596	8.8192	-72.9443	-0.2947	8.7333	-0.0573
7	11	0.6373	-52.0959	-0.2386	4.5591	-52.1012	-0.2567	4.4975	0.0116
8	12	0.3149	-30.7068	-0.2307	1.6006	-3.07C9	-0.0237	0.1564	-0.0008
9	13	0.0975	-27.5613	-0.2052	1.2422	-27.5627	-0.2101	1.2094	-0.0624
10	14	0.0831	-18.2033	-0.1447	C.4496	-18.2038	-0.1465	0.4279	-0.1463
11	15	0.0831	18.1722	0.0957	C.4527	18.1717	0.0939	0.4742	-0.1578
12	16	0.0975	27.5686	0.2608	1.3105	27.5671	0.2555	1.3436	-0.0197
13	17	0.3149	31.4726	0.3409	1.6903	31.4707	0.3340	1.7283	-0.0253
14	18	0.6373	54.3760	0.6614	4.9656	54.37C2	0.6414	5.0315	-0.0330
15	19	1.8726	72.7118	0.9024	8.8790	72.7015	0.8666	8.9671	-0.0060
16	20	2.2275	129.5680	-0.1253	27.9995	129.5353	-0.2379	28.1495	-0.0425
17	21	1.2159	133.0994	-0.2006	29.6320	133.0649	-0.3197	29.7857	0.0455
18	22	2.0338	157.7075	-0.3495	41.5362	157.6591	-0.5163	41.7179	0.0363
19	23	1.5046	176.6571	-0.3443	52.0216	176.5965	-0.5532	52.2252	-0.0236
20	3	1.5046	-0.9698	176.0262	51.6172	-1.03C3	175.8180	52.3210	-0.0463
21	4	2.0338	-0.6484	156.1179	40.6844	-0.6961	155.9536	41.3089	0.0233
22	5	1.2159	-0.3189	133.0898	29.6041	-0.3537	132.9701	30.1368	0.0287
23	6	1.0760	-0.2784	129.4786	27.9905	-0.3112	129.3654	28.5088	-0.0062
24	7	1.9757	0.1406	97.8835	16.0395	0.1217	97.8184	16.4318	0.0076
25	8	1.0491	-0.2016	72.8710	8.9766	-0.2122	72.8345	9.2683	0.0632
26	9	0.6373	-0.2295	52.6336	4.6793	-0.2350	52.6144	4.8899	0.0015
27	10	0.3149	-0.0488	31.3654	1.6583	-0.0508	31.3585	1.7840	-0.0384
28	11	0.0975	0.0407	27.5293	1.2956	0.0391	27.5239	1.4059	-0.0240
29	12	0.0831	0.2107	18.1603	0.5581	0.2100	18.1579	0.6312	-0.0466
30	13	0.0831	-0.0598	-18.2323	0.3605	-0.06C2	-18.2336	0.2874	-0.2452
31	14	0.0975	-0.0348	-27.5758	1.1133	-0.0361	-27.5800	1.0027	-0.2062
32	15	0.3149	0.0397	-31.4222	1.6188	0.0379	-31.4284	1.4929	-0.0794
33	16	0.6373	0.2975	-53.7517	4.9272	0.2919	-53.7710	4.7121	0.0538
34	17	1.2822	0.4869	-76.0849	9.7506	0.4757	-76.1234	9.4462	0.0330
35	18	1.3122	0.3815	-104.8632	18.4602	0.36C3	-104.9364	18.04C3	0.0384
36	9	0.9422	0.4164	-116.5137	22.7351	0.3902	-116.6039	22.2685	0.0002
37	20	0.6348	0.4512	-129.4943	28.0461	0.4188	-129.6057	27.5275	-0.0305
38	21	1.2159	0.4586	-133.1821	29.7100	0.4243	-133.3000	29.1765	0.0126
39	22	2.0338	0.5611	-156.4923	41.0260	0.5138	-156.6555	40.3991	0.0278
40	23	1.5046	0.5637	-176.6852	52.2163	0.5034	-176.8930	51.5085	-0.0462

SUM OF WEIGHTED SQUARES= C.5443284D-01

WEIGHTED RMS= 0.3688931D-01

SPHERICAL COORDINATES OF AXIS OF PARABULOIC

PHI (DEG.)	THETA (DEG.)
73.8152	89.7609

VERTEX OF PARABOLOID

X	Y	Z
-0.4856634E-CC	-0.122849CE 01	0.5512768E-01

Sample output

```
 TEST CASE 2  PFIT ONLY ...

                                          ** SYMBOL TABLE **

SYMBOL    DEFINITION

ZFIT      PARABOLOID FIT BASED ON MINIMIZING SUM OF WEIGHTED SQUARES OF Z DISTANCES
PFIT      PARABOLOID FIT BASED ON MINIMIZING SUM OF WEIGHTED SQUARES OF PATH LENGTH ERRORS
C         RECTANGULR CARTESIAN COORDINATE SYSTEM IN WHICH DATA POINTS ARE GIVEN
CPRIME    RECTANGULAR CARTESIAN COORDINATE SYSTEM IN WHICH PARABOLOID IS PARAMETERIZED WITH AXIS PARALLEL TO Z-AXIS
B         THE COEFFICIENT VECTOR (B1,B2,...,B9) WHICH DEFINES THE PARABOLOID AND IS DETERMINED BY THE PROGRAM
B0        THE INITIAL VALUE VECTOR OF B
L         THE INPUT VECTOR OF INTEGERS (L1,L2,...,L9) SUCH THAT THE VALUE OF LJ DETERMINES WHETHER BJ IS TO BE COMPUTED
PRBTYP    INPUT INTEGER SPECIFYING TYPE OF FIT DESIRED  0=ZFIT  1=PFIT  2=BOTH
PNTOPT    INPUT INTEGER SPECIFYING FORMAT OF CARDS CONTAINING DATA POINTS
LAST      INPUT INTEGER 0=ANOTHER CASE FOLLOWS  1=THIS IS LAST CASE
ITMAX     OPTICNAL INPUT PARAMETER USED BY STPRG5
SDIN      OPTICNAL INPUT PARAMETER USED BY STPRG5
KPRINT    OPTICNAL INPUT PARAMETER USED BY STPRG5
CD        OPTICNAL INPUT PARAMETER USED BY STPRG5
M         NUMBER OF DATA POINTS

PRBTYP  PNTOPT  LAST
  1       1      0

ITMAX  KPRINT       SDIN            CD
  10     0     0.5000000E-03   1.0000000E-08

DPRINT(1)= C  DPRINT(2)= 0  DPRINT(3)= 0

M=  40



 TEST CASE 2  PFIT ONLY ...

THIS IS A PFIT PROBLEM

 L        BC
 1   0.
 1   0.
 1   0.
 1   0.
 1   0.
20   0.
20   0.
20   0.
 1   1.0000000E 00

PFIT IS INSTRUCTED TO PRODUCE A  CIRCULAR PARABOLOID BY DETERMINING THE 6 PARAMETERS

              B1
              B2
              B3
              B4
              B5
              B9
```

Sample output (contd)

```
 TEST CASE 2  PFIT ONLY ...

 PARAMETER VECTOR

B1=  0.1696527E-02
B2=  0.3768811E-02
B3=  0.4926302E-01
B4=  0.2207515E-02
B5=  0.3830187E-02
B6=  0.
B7=  0.
B8=  0.
B9=  0.1667018E-02

IN SYSTEM CPRIME ...

         Z=B3+B4*X+B5*Y+B6*X**2+B7*X*Y+B8*Y**2+B9*(X**2+Y**2)

STANDARD DEVIATION OF DATA=  0.1037703E-00

                         COVARIANCE MATRIX OF COEFFICIENTS

          1            2            3            4            5            6
1    0.63291E-05  0.10200E-07  0.32425E-06  0.70708E-05  0.11013E-07  0.67624E-10
2    0.10200E-07  0.59820E-05 -0.16593E-06  0.10784E-07  0.66698E-05  0.74991E-10
3    0.32425E-06 -0.16593E-06  0.31618E-03  0.39913E-06 -0.19620E-06 -0.15161E-07
4    0.70708E-05  0.10784E-07  0.39913E-06  0.79118E-05  0.11658E-07  0.73120E-10
5    0.11013E-07  0.66698E-05 -0.19620E-06  0.11658E-07  0.74492E-05  0.85024E-10
6    0.67624E-10  0.74991E-10 -0.15161E-07  0.73120E-10  0.85024E-10  0.10273E-11

   DIRECTION COSINES OF AXIS OF PARABOLOID

     U               V               W
 0.1696527E-02   0.3768811E-02   0.9999915E 00

COVARIANCE MATRIX OF PHI AND THETA

   0.1203612E 04  0.1085629E-00
   0.1085629E-00  0.1985528E-01

                   ROTATION MATRIX A

 0.9999986E 00  -0.3196958E-05  -0.1696527E-02
-0.3196958E-05   0.9999929E 00  -0.3768811E-02
 0.1696527E-02   0.3768811E-02   0.9999915E 00



 TEST CASE 2  PFIT ONLY ...

COVARIANCE MATRIX OF  (PHI,THETA,A1,A2,A3,F)

 0.3666412E-00   0.3307015E-04   0.4675833E-00  -0.1979604E-00   0.1859664E-03   0.6721992E-03
 0.3307015E-04   0.6048265E-05   0.8734562E-03   0.1825528E-02   0.8938656E-05   0.8649086E-05
 0.4675833E-00   0.8734562E-03   0.7117439E 00   0.1023797E-02   0.1449408E-02   0.1936276E-02
-0.1979604E-00   0.1825528E-02   0.1023797E-02   0.6701083E 00   0.2617341E-02   0.2230510E-02
 0.1859664E-03   0.8938656E-05   0.1449408E-02   0.2617341E-02   0.3293679E-03   0.1376938E-02
 0.6721992E-03   0.8649086E-05   0.1936276E-02   0.2230510E-02   0.1376938E-02   0.8314077E-02
```

Sample output (contd)

TEST CASE 2 PFIT ONLY ...

			COORDINATE SYSTEM C			COORDINATE SYSTEM CPRIME			RESIDUE
I	IDENT	WEIGHT	X	Y	Z	X	Y	Z	Q
1	5	1.5046	-176.7042	-0.3743	51.9674	-176.7921	-0.5695	51.6658	-0.1412
2	6	2.0338	-154.5697	-0.1528	39.7987	-154.6370	-0.3023	39.5355	-0.0540
3	7	1.2159	-132.2858	0.0277	29.1157	-132.3350	-0.0816	28.8912	-0.0996
4	8	1.0760	-129.5442	0.0421	27.9652	-129.5915	-0.0629	27.7454	-0.0226
5	9	1.7208	-105.5628	0.1305	18.5658	-105.5942	0.0608	18.3870	-0.0300
6	10	1.2822	-72.9341	-0.2596	8.8192	-72.9489	-0.2926	8.6944	-0.1209
7	11	0.6373	-52.0959	-0.2386	4.5591	-52.1036	-0.2556	4.4698	0.0210
8	12	0.3149	-30.7068	-0.2307	1.6006	-3.0709	-0.0237	0.1548	-0.0010
9	13	0.0975	-27.5613	-0.2052	1.2422	-27.5634	-0.2098	1.1947	-0.1180
10	14	0.0831	-18.2033	-0.1447	0.4496	-18.2040	-0.1464	0.4182	-0.2846
11	15	0.0831	18.1722	0.0957	0.4527	18.1714	0.0940	0.4839	-0.3115
12	16	0.0975	27.5686	0.2608	1.3105	27.5664	0.2558	1.3582	-0.0391
13	17	0.3149	31.4726	0.3409	1.6903	31.4697	0.3344	1.7450	-0.0517
14	18	0.6373	54.3760	0.6614	4.9656	54.3675	0.6426	5.0603	-0.0765
15	19	1.8726	72.7118	0.9024	8.8790	72.6967	0.8687	9.0057	-0.0350
16	20	2.2275	129.5680	-0.1253	27.9995	129.5203	-0.2313	28.2186	-0.1360
17	21	1.2159	133.0994	-0.2006	29.6320	133.0490	-0.3127	29.8568	0.0087
18	22	2.0338	157.7075	-0.3495	41.5362	157.6368	-0.5065	41.8021	-0.0281
19	23	1.5046	176.6571	-0.3443	52.0216	176.5686	-0.5409	52.3196	-0.1329
20	3	1.5046	-0.9698	176.0262	51.6172	-1.0580	175.8304	52.2785	0.0270
21	4	2.0338	-0.6484	156.1179	40.6844	-0.7179	155.9634	41.2713	0.1191
22	5	1.2159	-0.3189	133.0898	29.6041	-0.3696	132.9773	30.1049	0.1151
23	6	1.0760	-0.2784	129.4786	27.9905	-0.3263	129.3722	28.4778	0.0545
24	7	1.9757	0.1406	97.8835	16.0395	0.1131	97.8223	16.4085	0.0582
25	8	1.0491	-0.2016	72.8710	8.9766	-0.2171	72.8367	9.2508	0.1492
26	9	0.6373	-0.2295	52.6336	4.6793	-0.2376	52.6156	4.8772	0.0230
27	10	0.3149	-0.0488	31.3654	1.6583	-0.0518	31.3589	1.7764	-0.0635
28	11	0.0975	0.0407	27.5293	1.2956	0.0384	27.5243	1.3994	-0.0362
29	12	0.0831	0.2107	18.1603	0.5581	0.2097	18.1581	0.6269	-0.0837
30	13	0.0831	-0.0598	-18.2323	0.3605	-0.0603	-18.2335	0.2917	-0.4821
31	14	0.0975	-0.0348	-27.5758	1.1133	-0.0366	-27.5798	1.0093	-0.4014
32	15	0.3149	0.0397	-31.4222	1.6188	0.0370	-31.4280	1.5004	-0.1486
33	16	0.6373	0.2975	-53.7517	4.9272	0.2893	-53.7698	4.7251	0.1190
34	17	1.2822	0.4869	-76.0849	9.7506	0.4706	-76.1211	9.4646	0.0868
35	18	1.3122	0.3815	-104.8632	18.4602	0.3505	-104.9321	18.0655	0.1109
36	9	0.9422	0.4164	-116.5137	22.7351	0.3782	-116.5986	22.2965	0.0510
37	20	0.6348	0.4512	-129.4943	28.0461	0.4040	-129.5991	27.5586	0.0092
38	21	1.2159	0.4586	-133.1821	29.7100	0.4086	-133.2931	29.2085	0.0848
39	22	2.0338	0.5611	-156.4923	41.0260	0.4920	-156.6458	40.4368	0.1274
40	23	1.5046	0.5637	-176.6852	52.2163	0.4757	-176.8807	51.5509	0.0329

SUM OF WEIGHTED SQUARES= 0.3661215D-00

1/2 LAMBDA WEIGHTED RMS= 0.4783575D-01

SPHERICAL COORDINATES OF AXIS OF PARABOLOID

PHI (DEG.)	THETA (DEG.)
65.7652	89.7632

VERTEX OF PARABOLOID			FOCUS OF PARABOLOID		
X	Y	Z	X	Y	Z
-0.6620318E 00	-0.1148629E 01	0.5178468E-01	-0.4076064E-00	-0.5834263E 00	0.1500189E 03

Sample output

```
 TEST CASE 3  ZFIT FOLLOWED BY PFIT ...

                                        ** SYMBOL TABLE **

SYMBOL    DEFINITION

ZFIT      PARABOLOID FIT BASED ON MINIMIZING SUM OF WEIGHTED SQUARES OF Z DISTANCES
PFIT      PARABOLOID FIT BASED ON MINIMIZING SUM OF WEIGHTED SQUARES OF PATH LENGTH ERRORS
C         RECTANGULR CARTESIAN COORDINATE SYSTEM IN WHICH DATA POINTS ARE GIVEN
CPRIME    RECTANGULAR CARTESIAN COORDINATE SYSTEM IN WHICH PARABOLOID IS PARAMETERIZED WITH AXIS PARALLEL TO Z-AXIS
B         THE COEFFICIENT VECTOR (B1,B2,...,B9) WHICH DEFINES THE PARABOLOID AND IS DETERMINED BY THE PROGRAM
BO        THE INITIAL VALUE VECTOR OF B
L         THE INPUT VECTOR OF INTEGERS (L1,L2,...,L9) SUCH THAT THE VALUE OF LJ DETERMINES WHETHER BJ IS TO BE COMPUTED
PRBTYP    INPUT INTEGER SPECIFYING TYPE OF FIT DESIRED  0=ZFIT  1=PFIT  2=BOTH
PNTOPT    INPUT INTEGER SPECIFYING FORMAT OF CARDS CONTAINING DATA POINTS
LAST      INPUT INTEGER 0=ANOTHER CASE FOLLOWS  1=THIS IS LAST CASE
ITMAX     OPTICNAL INPUT PARAMETER USED BY STPRG5
SDIN      OPTICNAL INPUT PARAMETER USED BY STPRG5
KPRINT    OPTICNAL INPUT PARAMETER USED BY STPRG5
CD        OPTICNAL INPUT PARAMETER USED BY STPRG5
M         NUMBER OF DATA POINTS

PRBTYP  PNTCPT  LAST
  2       1       0

ITMAX  KPRINT        SDIN            CD
  10      0     0.5000000E-03   1.0000000E-08

DPRINT(1)= C  DPRINT(2)= 0  DPRINT(3)= 0

M=  40



 TEST CASE 3  ZFIT FOLLOWED BY PFIT ...

THIS IS A ZFIT PROBLEM

 L         B0
 1   0.
 1   0.
 1   0.
 1   0.
 1   0.
 1   0.
20   0.
 1   0.
20   0.

ZFIT IS INSTRUCTED TO PRODUCE AN ELLIPTIC PARABOLOID BY DETERMINING THE 7 PARAMETERS

              B1
              B2
              B3
              B4
              B5
              B6
              B8

WHILE HOLDING FIXED THE 2 PARAMETERS

              B7=  0.
              B9=  0.

     UNDERFLOW AT 32520 IN MQ        SET= ZERO.
```

Sample output (contd)

```
 TEST CASE 3  ZFIT FOLLOWED BY PFIT ...

 PARAMETER VECTOR

B1=  0.1163099E-02
B2=  0.4007394E-02
B3=  0.5255177E-01
B4=  0.1617064E-02
B5=  0.4101518E-02
B6=  0.1664591E-02
B7=  0.
B8=  0.1669048E-02
B9=  0.

IN SYSTEM CPRIME ...

        Z=B3+B4*X+B5*Y+B6*X**2+B7*X*Y+B8*Y**2+B9*(X**2+Y**2)

STANDARD DEVIATION OF DATA=  0.4061379E-01

                       COVARIANCE MATRIX OF COEFFICIENTS

          1            2            3            4            5            6            7
1   0.27572E-05  0.22614E-08  0.28788E-06  0.30962E-05  0.23469E-08  0.35991E-10 -0.66585E-11
2   0.22614E-08  0.25772E-05 -0.45520E-07  0.23523E-08  0.28918E-05  0.18486E-10  0.48910E-10
3   0.28788E-06 -0.45520E-07  0.16477E-03  0.34008E-06 -0.55604E-07 -0.74346E-08 -0.75338E-08
4   0.30962E-05  0.23523E-08  0.34008E-06  0.34818E-05  0.24419E-08  0.38852E-10 -0.82351E-11
5   0.23469E-08  0.28918E-05 -0.55604E-07  0.24419E-08  0.32497E-05  0.21013E-10  0.55546E-10
6   0.35991E-10  0.18486E-10 -0.74346E-08  0.38852E-10  0.21013E-10  0.56102E-12  0.34035E-12
7  -0.66585E-11  0.48910E-10 -0.75338E-08 -0.82351E-11  0.55546E-10  0.34035E-12  0.57509E-12

   DIRECTION COSINES OF AXIS OF PARABOLOID

     U               V               W
 0.1163099E-02   0.4007394E-02   0.9999913E 00

COVARIANCE MATRIX OF PHI AND THETA

   0.5169707E 03  0.3941120E-01
   0.3941120E-01  0.8510499E-02

               ROTATION MATRIX A

 0.9999993E 00  -0.2330509E-05  -0.1163099E-02
-0.2330509E-05   0.9999920E 00  -0.4007394E-02
 0.1163099E-02   0.4007394E-02   0.9999913E 00
```

Sample output (contd)

TEST CASE 3 ZFIT FOLLOWEC BY PFIT ...

			COORDINATE SYSTEM C			COORDINATE SYSTEM CPRIME			RESIDUE
I	IDENT	WEIGHT	X	Y	Z	X	Y	Z	R
1	5	1.5046	-176.7042	-0.3743	51.9674	-176.7645	-0.5821	51.7600	-0.0162
2	6	2.0338	-154.5697	-0.1528	39.7987	-154.6159	-0.3119	39.6179	0.0227
3	7	1.2159	-132.2858	0.0277	29.1157	-132.3196	-0.0886	28.9617	-0.0209
4	8	1.0760	-129.5442	0.0421	27.9652	-129.5767	-0.0697	27.8145	0.0231
5	9	1.7208	-105.5628	0.1305	18.5658	-105.5844	0.0563	18.4434	0.0044
6	10	1.2822	-72.9341	-0.2596	8.8192	-72.9443	-0.2947	8.7333	-0.0573
7	11	0.6373	-52.0959	-0.2386	4.5591	-52.1012	-0.2567	4.4975	0.0116
8	12	0.3149	-30.7068	-0.2307	1.6006	-3.07C9	-0.0237	0.1564	-0.0008
9	13	0.0975	-27.5613	-0.2052	1.2422	-27.5627	-0.2101	1.2094	-0.0624
10	14	0.0831	-18.2033	-0.1447	0.4496	-18.2038	-0.1465	0.4279	-0.1463
11	15	0.0831	18.1722	0.0957	C.4527	18.1717	0.0939	0.4742	-0.1578
12	16	0.0975	27.5686	0.2608	1.3105	27.5671	0.2555	1.3436	-0.0197
13	17	0.3149	31.4726	0.3409	1.6903	31.47C7	0.3340	1.7283	-0.0253
14	18	0.6373	54.3760	0.6614	4.9656	54.37C2	0.6414	5.0315	-0.0330
15	19	1.8726	72.7118	0.9024	8.8790	72.7015	0.8666	8.9671	-0.0060
16	20	2.2275	129.5680	-0.1253	27.9995	129.5353	-0.2379	28.1495	-0.0425
17	21	1.2159	133.0994	-0.2006	29.6320	133.0649	-0.3197	29.7857	0.0455
18	22	2.0338	157.7075	-0.3495	41.5362	157.6591	-0.5163	41.7179	0.0363
19	23	1.5046	176.6571	-0.3443	52.0216	176.5965	-0.5532	52.2252	-0.0236
20	3	1.5046	-0.9698	176.0262	51.6172	-1.03C3	175.8180	52.3210	-0.0463
21	4	2.0338	-0.6484	156.1179	4C.6844	-0.6961	155.9536	41.3089	0.0233
22	5	1.2159	-0.3189	133.0898	29.6041	-0.3537	132.9701	30.1368	0.0287
23	6	1.0760	-0.2784	129.4786	27.9905	-0.3112	129.3654	28.5088	-0.0062
24	7	1.9757	0.1406	97.8835	16.0395	0.1217	97.8184	16.4318	0.0076
25	8	1.0491	-0.2016	72.8710	8.9766	-0.2122	72.8345	9.2683	0.0632
26	9	0.6373	-0.2295	52.6336	4.6793	-0.2350	52.6144	4.8899	0.0015
27	10	0.3149	-0.0488	31.3654	1.6583	-0.0508	31.3585	1.7840	-0.0384
28	11	0.0975	0.0407	27.5293	1.2956	0.0391	27.5239	1.4059	-0.0240
29	12	0.0831	0.2107	18.1603	0.5581	0.2100	18.1579	0.6312	-0.0466
30	13	0.0831	-0.0598	-18.2323	0.3605	-0.0602	-18.2336	0.2874	-0.2452
31	14	0.0975	-0.0348	-27.5758	1.1133	-0.0361	-27.5800	1.0027	-0.2062
32	15	0.3149	0.0397	-31.4222	1.6188	0.0379	-31.4284	1.4929	-0.0794
33	16	0.6373	0.2975	-53.7517	4.9272	0.2919	-53.7710	4.7121	0.0538
34	17	1.2822	0.4869	-76.0849	9.7506	0.4757	-76.1234	9.4462	0.0330
35	18	1.3122	0.3815	-104.8632	18.4602	0.3603	-104.9364	18.0403	0.0384
36	9	0.9422	0.4164	-116.5137	22.7351	0.3902	-116.6039	22.2685	0.0002
37	20	0.6348	0.4512	-129.4943	28.0461	0.4188	-129.6057	27.5275	-0.0305
38	21	1.2159	0.4586	-133.1821	29.7100	0.4243	-133.3000	29.1765	0.0126
39	22	2.0338	0.5611	-156.4923	41.0260	0.5138	-156.6555	40.3991	0.0278
40	23	1.5046	0.5637	-176.6852	52.2163	0.5034	-176.8930	51.5085	-0.0462

SUM OF WEIGHTED SQUARES= 0.5443284D-01

WEIGHTED RMS= 0.3688931D-C1

SPHERICAL CCORDINATES OF AXIS OF PARABOLOID

PHI	THETA
(DEG.)	(DEG.)
73.8152	89.7609

VERTEX OF PARABOLOID

X	Y	Z
-0.4856634E-C0	-0.1228490E 01	0.5512768E-01

Sample output

```
 TEST CASE 3  ZFIT FOLLOWED BY PFIT ...

                                             ** SYMBOL TABLE **

SYMBOL   DEFINITION

ZFIT     PARABOLOID FIT BASED ON MINIMIZING SUM OF WEIGHTED SQUARES OF Z DISTANCES
PFIT     PARABOLOID FIT BASED ON MINIMIZING SUM OF WEIGHTED SQUARES OF PATH LENGTH ERRORS
C        RECTANGULR CARTESIAN COORDINATE SYSTEM IN WHICH DATA POINTS ARE GIVEN
CPRIME   RECTANGULAR CARTESIAN COORDINATE SYSTEM IN WHICH PARABOLOID IS PARAMETERIZED WITH AXIS PARALLEL TO Z-AXIS
B        THE COEFFICIENT VECTOR (B1,B2,...,B9) WHICH DEFINES THE PARABOLOID AND IS DETERMINED BY THE PROGRAM
BO       THE INITIAL VALUE VECTOR OF B
L        THE INPUT VECTOR OF INTEGERS (L1,L2,...,L9) SUCH THAT THE VALUE OF LJ DETERMINES WHETHER BJ IS TO BE COMPUTED
PRBTYP   INPUT INTEGER SPECIFYING TYPE OF FIT DESIRED  0=ZFIT  1=PFIT  2=BOTH
PNTOPT   INPUT INTEGER SPECIFYING FORMAT OF CARDS CONTAINING DATA POINTS
LAST     INPUT INTEGER 0=ANOTHER CASE FOLLOWS  1=THIS IS LAST CASE
ITMAX    OPTIONAL INPUT PARAMETER USED BY STPRG5
SDIN     OPTIONAL INPUT PARAMETER USED BY STPRG5
KPRINT   OPTIONAL INPUT PARAMETER USED BY STPRG5
CD       OPTIONAL INPUT PARAMETER USED BY STPRG5
M        NUMBER OF DATA POINTS

PRBTYP  PNTOPT  LAST
  2       1       0

ITMAX  KPRINT        SDIN             CD
  10      0      0.5000000E-03   1.0000000E-08

OPRINT(1)= 0  OPRINT(2)= 0  OPRINT(3)= 0



 TEST CASE 3  ZFIT FOLLOWED BY PFIT ...

THIS IS A PFIT PROBLEM

 L        BO
 1   0.
 1   0.
 1   0.
 1   0.
 1   0.
20   0.
20   0.
20   0.
 1   1.0000000E 00

PFIT IS INSTRUCTED TO PRODUCE A  CIRCULAR PARABOLOID BY DETERMINING THE 6 PARAMETERS

              B1
              B2
              B3
              B4
              B5
              B9
```

Sample output (contd)

```
TEST CASE 3  ZFIT FOLLOWED BY PFIT ...

PARAMETER VECTOR

B1=  0.1696527E-02
B2=  0.3768811E-02
B3=  0.4926302E-01
B4=  0.2207515E-02
B5=  0.3830187E-02
B6=  0.
B7=  0.
B8=  0.
B9=  0.1667018E-02

IN SYSTEM CPRIME ...

        Z=B3+B4*X+B5*Y+B6*X**2+B7*X*Y+B8*Y**2+B9*(X**2+Y**2)

STANDARD DEVIATION OF DATA=  0.1037703E-00

                        COVARIANCE MATRIX OF COEFFICIENTS

          1            2            3            4            5            6
1   0.63291E-05  0.10200E-07  0.32425E-06  0.70708E-05  0.11013E-07  0.67624E-10
2   0.10200E-07  0.59820E-05 -0.16593E-06  0.10784E-07  0.66698E-05  0.74991E-10
3   0.32425E-06 -0.16593E-06  0.31618E-03  0.39913E-06 -0.19620E-06 -0.15161E-07
4   0.70708E-05  0.10784E-07  0.39913E-06  0.79118E-05  0.11658E-07  0.73120E-10
5   0.11013E-07  0.66698E-05 -0.19620E-06  0.11658E-07  0.74492E-05  0.85024E-10
6   0.67624E-10  0.74991E-10 -0.15161E-07  0.73120E-10  0.85024E-10  0.10273E-11

  DIRECTION COSINES OF AXIS OF PARABOLOID

      U               V                W
 0.1696527E-02   0.3768811E-02    0.9999915E 00

COVARIANCE MATRIX OF PHI AND THETA

  0.1203612E 04   0.1085629E-00
  0.1085629E-00   0.1985528E-01

               ROTATION MATRIX A

 0.9999986E 00  -0.3196958E-05  -0.1696527E-02
-0.3196958E-05   0.9999929E 00  -0.3768811E-02
 0.1696527E-02   0.3768811E-02    0.9999915E 00


TEST CASE 3  ZFIT FOLLOWED BY PFIT ...

COVARIANCE MATRIX OF  (PHI,THETA,A1,A2,A3,F)

 0.3666412E-00   0.3307015E-04   0.4675833E-00  -0.1979604E-00   0.1859664E-03   0.6721992E-03
 0.3307015E-04   0.6048265E-05   0.8734562E-03   0.1825528E-02   0.8938656E-05   0.8649086E-05
 0.4675833E-00   0.8734562E-03   0.7117439E 00   0.1023797E-02   0.1449408E-02   0.1936276E-02
-0.1979604E-00   0.1825528E-02   0.1023797E-02   0.6701083E 00   0.2617341E-02   0.2230510E-02
 0.1859664E-03   0.8938656E-05   0.1449408E-02   0.2617341E-02   0.3293679E-03   0.1376938E-02
 0.6721992E-03   0.8649086E-05   0.1936276E-02   0.2230510E-02   0.1376938E-02   0.8314077E-02
```

Sample output (contd)

TEST CASE 3 ZFIT FOLLOWED BY PFIT ...

			COORDINATE SYSTEM C			COORDINATE SYSTEM CPRIME			RESIDUE
I	IDENT	WEIGHT	X	Y	Z	X	Y	Z	Q
1	5	1.5046	-176.7042	-0.3743	51.9674	-176.7921	-0.5695	51.6658	-0.1412
2	6	2.0338	-154.5697	-0.1528	39.7987	-154.6370	-0.3023	39.5355	-0.0540
3	7	1.2159	-132.2858	0.0277	29.1157	-132.3350	-0.0816	28.8912	-0.0996
4	8	1.0760	-129.5442	0.0421	27.9652	-129.5915	-0.0629	27.7454	-0.0226
5	9	1.7208	-105.5628	0.1305	18.5658	-105.5942	0.0608	18.3870	-0.0300
6	10	1.2822	-72.9341	-0.2596	8.8192	-72.9489	-0.2926	8.6944	-0.1209
7	11	0.6373	-52.0959	-0.2386	4.5591	-52.1036	-0.2556	4.4698	0.0210
8	12	0.3149	-30.7068	-0.2307	1.6006	-3.0709	-0.0237	0.1548	-0.0010
9	13	0.0975	-27.5613	-0.2052	1.2422	-27.5634	-0.2098	1.1947	-0.1180
10	14	0.0831	-18.2033	-0.1447	0.4496	-18.2040	-0.1464	0.4182	-0.2846
11	15	0.0831	18.1722	0.0957	0.4527	18.1714	0.0940	0.4839	-0.3115
12	16	0.0975	27.5686	0.2608	1.3105	27.5664	0.2558	1.3582	-0.0391
13	17	0.3149	31.4726	0.3409	1.6903	31.4697	0.3344	1.7450	-0.0517
14	18	0.6373	54.3760	0.6614	4.9656	54.3675	0.6426	5.0603	-0.0765
15	19	1.8726	72.7118	0.9024	8.8790	72.6967	0.8687	9.0057	-0.0350
16	20	2.2275	129.5680	-0.1253	27.9995	129.5203	-0.2313	28.2186	-0.1360
17	21	1.2159	133.0994	-0.2006	29.6320	133.0490	-0.3127	29.8568	0.0087
18	22	2.0338	157.7075	-0.3495	41.5362	157.6368	-0.5065	41.8021	-0.0281
19	23	1.5046	176.6571	-0.3443	52.0216	176.5686	-0.5409	52.3196	-0.1329
20	3	1.5046	-0.9698	176.0262	51.6172	-1.0580	175.8304	52.2785	0.0270
21	4	2.0338	-0.6484	156.1179	40.6844	-0.7179	155.9634	41.2713	0.1191
22	5	1.2159	-0.3189	133.0898	29.6041	-0.3696	132.9773	30.1049	0.1151
23	6	1.0760	-0.2784	129.4786	27.9905	-0.3263	129.3722	28.4778	0.0545
24	7	1.9757	0.1406	97.8835	16.0395	0.1131	97.8223	16.4085	0.0582
25	8	1.0491	-0.2016	72.8710	8.9766	-0.2171	72.8367	9.2508	0.1492
26	9	0.6373	-0.2295	52.6336	4.6793	-0.2376	52.6156	4.8772	0.0230
27	10	0.3149	-0.0488	31.3654	1.6583	-0.0518	31.3589	1.7764	-0.0635
28	11	0.0975	0.0407	27.5293	1.2956	0.0384	27.5243	1.3994	-0.0362
29	12	0.0831	0.2107	18.1603	0.5581	0.2097	18.1581	0.6269	-0.0837
30	13	0.0831	-0.0598	-18.2323	0.3605	-0.0603	-18.2335	0.2917	-0.4821
31	14	0.0975	-0.0348	-27.5758	1.1133	-0.0366	-27.5798	1.0093	-0.4014
32	15	0.3149	0.0397	-31.4222	1.6188	0.0370	-31.4280	1.5004	-0.1486
33	16	0.6373	0.2975	-53.7517	4.9272	0.2893	-53.7698	4.7251	0.1190
34	17	1.2822	0.4869	-76.0849	9.7506	0.4706	-76.1211	9.4646	0.0868
35	18	1.3122	0.3815	-104.8632	18.4602	0.3505	-104.9321	18.0655	0.1109
36	9	0.9422	0.4164	-116.5137	22.7351	0.3782	-116.5986	22.2965	0.0510
37	20	0.6348	0.4512	-129.4943	28.0461	0.4040	-129.5991	27.5586	0.0092
38	21	1.2159	0.4586	-133.1821	29.7100	0.4086	-133.2931	29.2085	0.0848
39	22	2.0338	0.5611	-156.4923	41.0260	0.4920	-156.6458	40.4368	0.1274
40	23	1.5046	0.5637	-176.6852	52.2163	0.4757	-176.8807	51.5509	0.0329

SUM OF WEIGHTED SQUARES= 0.3661215D-00

1/2 LAMBDA WEIGHTED RMS= 0.4783575D-01

SPHERICAL COORDINATES OF AXIS OF PARABOLOID

PHI (DEG.)	THETA (DEG.)
65.7652	89.7632

VERTEX OF PARABOLOID			FOCUS OF PARABOLOID		
X	Y	Z	X	Y	Z
-0.6620318E 00	-0.1148629E 01	0.5178468E-01	-0.4076064E-00	-0.5834263E 00	0.1500189E 03

Sample output

TEST CASE 4 ILLUSTRATES USE OF DPRINT (ZFIT ONLY) ...

** SYMBOL TABLE **

SYMBOL	DEFINITION
ZFIT	PARABOLOID FIT BASED ON MINIMIZING SUM OF WEIGHTED SQUARES OF Z DISTANCES
PFIT	PARABOLOID FIT BASED ON MINIMIZING SUM OF WEIGHTED SQUARES OF PATH LENGTH ERRORS
C	RECTANGULR CARTESIAN COORDINATE SYSTEM IN WHICH DATA POINTS ARE GIVEN
CPRIME	RECTANGULAR CARTESIAN COORDINATE SYSTEM IN WHICH PARABOLOID IS PARAMETERIZED WITH AXIS PARALLEL TO Z-AXIS
B	THE COEFFICIENT VECTOR (B1,B2,...,B9) WHICH DEFINES THE PARABOLOID AND IS DETERMINED BY THE PROGRAM
B0	THE INITIAL VALUE VECTOR OF B
L	THE INPUT VECTOR OF INTEGERS (L1,L2,...,L9) SUCH THAT THE VALUE OF LJ DETERMINES WHETHER BJ IS TO BE COMPUTED
PRBTYP	INPUT INTEGER SPECIFYING TYPE OF FIT DESIRED 0=ZFIT 1=PFIT 2=BOTH
PNTOPT	INPUT INTEGER SPECIFYING FORMAT OF CARDS CONTAINING DATA POINTS
LAST	INPUT INTEGER 0=ANOTHER CASE FOLLOWS 1=THIS IS LAST CASE
ITMAX	OPTIONAL INPUT PARAMETER USED BY STPRG5
SDIN	OPTIONAL INPUT PARAMETER USED BY STPRG5
KPRINT	OPTIONAL INPUT PARAMETER USED BY STPRG5
CD	OPTIONAL INPUT PARAMETER USED BY STPRG5
M	NUMBER OF DATA POINTS

```
PRBTYP  PNTOPT  LAST
  0       1      1

ITMAX  KPRINT      SDIN           CD
  10     0     0.5000000E-03  1.0000000E-08

DPRINT(1)= 1  DPRINT(2)= 1  DPRINT(3)= 1

M=  40
```

TEST CASE 4 ILLUSTRATES USE OF DPRINT (ZFIT ONLY) ...

RAW INPUT DATA ...

I	X	Y	Z	WEIGHT
1	-176.70420	-0.37426	51.96743	2.40800
2	-154.56969	-0.15280	39.79868	3.25500
3	-132.28578	0.02773	29.11573	1.94600
4	-129.54424	0.04210	27.96523	1.72200
5	-105.56285	0.13047	18.56580	2.75400
6	-72.93408	-0.25958	8.81920	2.05200
7	-52.09592	-0.23859	4.55912	1.02000
8	-30.70681	-0.23072	1.60057	0.50400
9	-27.56130	-0.20518	1.24224	0.15600
10	-18.20327	-0.14474	0.44961	0.13300
11	18.17219	0.09574	0.45267	0.13300
12	27.56865	0.26083	1.31050	0.15600
13	31.47264	0.34087	1.69033	0.50400
14	54.37600	0.66145	4.96562	1.02000
15	72.71185	0.90239	8.87899	2.99700
16	129.56800	-0.12535	27.99954	3.56500
17	133.09945	-0.20063	29.63198	1.94600
18	157.70750	-0.34949	41.53619	3.25500
19	176.65711	-0.34429	52.02160	2.40800
20	-0.96983	176.02622	51.61720	2.40800
21	-0.64840	156.11788	40.68442	3.25500
22	-0.31895	133.08984	29.60411	1.94600
23	-0.27839	129.47864	27.99053	1.72200
24	0.14063	97.88346	16.03951	3.16200
25	-0.20163	72.87105	8.97660	1.67900
26	-0.22947	52.63356	4.67928	1.02000
27	-0.04884	31.36536	1.65833	0.50400
28	0.04067	27.52934	1.29559	0.15600
29	0.21070	18.16032	0.55815	0.13300
30	-0.05979	-18.23230	0.36052	0.13300
31	-0.03482	-27.57579	1.11329	0.15600
32	0.03966	-31.42217	1.61882	0.50400
33	0.29753	-53.75166	4.92723	1.02000
34	0.48686	-76.08494	9.75063	2.05200
35	0.38151	-104.86324	18.46023	2.10000
36	0.41636	-116.51373	22.73514	1.50800
37	0.45116	-129.49434	28.04614	1.01600
38	0.45859	-133.18206	29.70996	1.94600
39	0.56115	-156.49233	41.02596	3.25500
40	0.56372	-176.68521	52.21633	2.40800

Sample output (contd)

```
TEST CASE 4  ILLUSTRATES USE OF DPRINT (ZFIT ONLY) ...

NORMALIZED WEIGHTS ...  WBAR=     1.60042

  I     WEIGHT
  1     1.50460
  2     2.03383
  3     1.21593
  4     1.07596
  5     1.72079
  6     1.28216
  7     0.63733
  8     0.31492
  9     0.09747
 10     0.08310
 11     0.08310
 12     0.09747
 13     0.31492
 14     0.63733
 15     1.87263
 16     2.22753
 17     1.21593
 18     2.03383
 19     1.50460
 20     1.50460
 21     2.03383
 22     1.21593
 23     1.07596
 24     1.97573
 25     1.04910
 26     0.63733
 27     0.31492
 28     0.09747
 29     0.08310
 30     0.08310
 31     0.09747
 32     0.31492
 33     0.63733
 34     1.28216
 35     1.31215
 36     0.94225
 37     0.63483
 38     1.21593
 39     2.03383
 40     1.50460
```

```
TEST CASE 4  ILLUSTRATES USE OF DPRINT (ZFIT ONLY) ...

THIS IS A ZFIT PROBLEM

 L         B0
 1   0.
 1   0.
 1   0.
 1   0.
 1   0.
 1   0.
20   0.
 1   0.
20   0.

ZFIT IS INSTRUCTED TO PRODUCE AN ELLIPTIC PARABOLOID BY DETERMINING THE 7 PARAMETERS

               B1
               B2
               B3
               B4
               B5
               B6
               B8

WHILE HOLDING FIXED THE 2 PARAMETERS

               B7=  0.
               B9=  0.
```

Sample output (contd)

```
TEST CASE 4  ILLUSTRATES USE OF DPRINT (ZFIT ONLY) ...

MATRIX A
    1.00000     -0.          -0.
   -0.           1.00000     -0.
    0.           0.           1.00000

MATRIX AU
   -0.          -0.          -1.00000
   -0.          -0.           0.
    1.00000      0.          -0.

MATRIX AV
   -0.          -0.           0.
   -0.          -0.          -1.00000
    0.           1.00000     -0.

IT  I      X1          Y1          Z1          XU1        YU1         ZU1         XV1        YV1          ZV1
 1  1  -176.70420   -0.37426    51.96743   -51.96743    0.       -176.70420    0.       -51.96743    -0.37426

      R1               R11              R12              R13              R14
 0.5196743D 02   -0.1767042D 03   -0.3742600D-00   -1.0000000D 00    0.1767042D 03

      R15              R16              R17              R18              R19
 0.3742600D-00   -0.3122437D 05   -0.6613331D 02   -0.1400705D-00   -0.3122451D 05

      S
 0.4048563D 05

VECTOR H
 -0.21454D 04   0.10797D 04   0.11023D 04   0.21454D 04  -0.10797D 04   0.12252D 08  -0.48485D 05   0.12003D 08   0.24254D 08

MATRIX G
   0.33171D 06  -0.11186D 04  -0.20227D 02  -0.33171D 06   0.11186D 04  -0.12298D 07   0.55854D 05   0.38452D 04  -0.12260D 07
  -0.11186D 04   0.32833D 06   0.21254D 02   0.11186D 04  -0.32833D 06   0.55854D 05   0.38452D 04   0.51265D 06   0.56850D 06
  -0.20227D 02   0.21254D 02   0.40000D 02   0.20227D 02  -0.21254D 02   0.33171D 06  -0.11186D 04   0.32833D 06   0.66005D 06
  -0.33171D 06   0.11186D 04   0.20227D 02   0.33171D 06  -0.11186D 04   0.12298D 07  -0.55854D 05  -0.38452D 04   0.12260D 07
   0.11186D 04  -0.32833D 06  -0.21254D 02  -0.11186D 04   0.32833D 06  -0.55854D 05  -0.38452D 04  -0.51265D 06  -0.56850D 06
  -0.12298D 07   0.55854D 05   0.33171D 06   0.12298D 07  -0.55854D 05   0.73494D 10  -0.21385D 07   0.14332D 06   0.73496D 10
   0.55854D 05   0.38452D 04  -0.11186D 04  -0.55854D 05  -0.38452D 04  -0.21385D 07   0.14332D 06  -0.26878D 08  -0.29016D 08
   0.38452D 04   0.51265D 06   0.32833D 06  -0.38452D 04  -0.51265D 06   0.14332D 06  -0.26878D 08   0.71810D 10   0.71811D 10
  -0.12260D 07   0.56850D 06   0.66005D 06   0.12260D 07  -0.56850D 06   0.73496D 10  -0.29016D 08   0.71811D 10   0.14531D 11

      UNDERFLOW AT 32520 IN MQ        SET= ZERO.

VECTOR B   IT=  1
   0.            0.            0.52547E-01   0.31130E-03  -0.39483E-03   0.16646E-02   0.            0.16690E-02   0.


TEST CASE 4  ILLUSTRATES USE OF DPRINT (ZFIT ONLY) ...

MATRIX A
    1.00000     -0.          -0.
   -0.           1.00000     -0.
    0.           0.           1.00000

MATRIX AU
   -0.          -0.          -1.00000
   -0.          -0.           0.
    1.00000      0.          -0.

MATRIX AV
   -0.          -0.           0.
   -0.          -0.          -1.00000
    0.           1.00000     -0.

IT  I      X1          Y1          Z1          XU1        YU1         ZU1         XV1        YV1          ZV1
 2  1  -176.70420   -0.37426    51.96743   -51.96743    0.       -176.70420    0.       -51.96743    -0.37426

      R1               R11              R12              R13              R14
-0.5423119D-02   -0.2072589D 03   -0.4597007D-00   -1.0000000D 00    0.1767042D 03

      R15              R16              R17              R18              R19
 0.3742600D-00   -0.3122437D 05   -0.6613331D 02   -0.1400705D-00   -0.3122451D 05

      S
 0.6552302D-01

VECTOR H
  0.69388D 00   0.25662D 01   0.52428D-05   0.38119D-05  -0.68577D-05   0.22071D-01   0.88632D 01   0.92820D-01   0.11489D-00

MATRIX G
   0.41890D 06  -0.14666D 04  -0.27713D 02  -0.37250D 06   0.12803D 04  -0.14677D 07   0.65466D 05   0.25521D 04  -0.14652D 07
  -0.14666D 04   0.41400D 06   0.25293D 02   0.12812D 04  -0.36840D 06   0.70314D 05   0.62760D 04   0.59236D 06   0.66267D 06
  -0.27713D 02   0.25293D 02   0.40000D 02   0.20227D 02  -0.21254D 02   0.33171D 06  -0.11186D 04   0.32833D 06   0.66005D 06
  -0.37250D 06   0.12812D 04   0.20227D 02   0.33171D 06  -0.11186D 04   0.12298D 07  -0.55854D 05  -0.38452D 04   0.12260D 07
   0.12803D 04  -0.36840D 06  -0.21254D 02  -0.11186D 04   0.32833D 06  -0.55854D 05  -0.38452D 04  -0.51265D 06  -0.56850D 06
  -0.14677D 07   0.70314D 05   0.33171D 06   0.12298D 07  -0.55854D 05   0.73494D 10  -0.21385D 07   0.14332D 06   0.73496D 10
   0.65466D 05   0.62760D 04  -0.11186D 04  -0.55854D 05  -0.38452D 04  -0.21385D 07   0.14332D 06  -0.26878D 08  -0.29016D 08
   0.25521D 04   0.59236D 06   0.32833D 06  -0.38452D 04  -0.51265D 06   0.14332D 06  -0.26878D 08   0.71810D 10   0.71811D 10
  -0.14652D 07   0.66267D 06   0.66005D 06   0.12260D 07  -0.56850D 06   0.73496D 10  -0.29016D 08   0.71811D 10   0.14531D 11

VECTOR B   IT=  2
   0.11631E-02   0.40107E-02   0.52536E-01   0.16171E-02   0.41052E-02   0.16646E-02   0.            0.16690E-02   0.
```

Sample output (contd)

```
TEST CASE 4  ILLUSTRATES USE OF DPRINT (ZFIT ONLY) ...

MATRIX A
    1.00000    -0.00000    -0.00116
   -0.00000     0.99999    -0.00401
    0.00116     0.00401     0.99999

MATRIX AU
   -0.00116    -0.00201    -1.00000
   -0.00201    -0.00000     0.
    1.00000     0.         -0.00116

MATRIX AV
   -0.00000    -0.00058     0.
   -0.00058    -0.00401    -1.00000
    0.          1.00000    -0.00401

IT  I       X1           Y1          Z1          XU1          YU1         ZU1          XV1         YV1          ZV1
 3  1  -176.76452     -0.58227    51.75995    -51.76115     0.35436  -176.76464     0.00022   -51.86316     -0.58269

      R1               R11              R12              R13              R14
-0.1566057D-01  -0.2071418D 03  -0.4704542D-00  -1.0000000D 00   0.1767645D 03

      R15              R16              R17              R18              R19
 0.5822724D 00  -0.3124570D 05  -0.1029251D 03  -0.3390412D-00  -0.3124603D 05

       S
 0.5444851D-01

VECTOR H
 -0.31131D-01   0.11770D-01   0.20352D-01   0.24419D-01  -0.18157D-01   0.13497D 03  -0.36396D 01   0.30846D 03   0.44343D 03

MATRIX G
    0.41892D 06  -0.14662D 04  -0.28983D 02  -0.37250D 06   0.12910D 04  -0.14635D 07   0.12131D 06   0.26735D 04  -0.14609D 07
   -0.14662D 04   0.41399D 06   0.20904D 02   0.12811D 04  -0.36840D 06   0.70977D 05   0.22294D 05   0.60666D 06   0.67763D 06
   -0.28983D 02   0.20904D 02   0.40000D 02   0.18945D 02  -0.25674D 02   0.33171D 06  -0.11272D 04   0.32834D 06   0.66004D 06
   -0.37250D 06   0.12811D 04   0.18945D 02   0.33171D 06  -0.11272D 04   0.11871D 07  -0.10488D 06  -0.17413D 05   0.11696D 07
    0.12910D 04  -0.36840D 06  -0.25674D 02  -0.11272D 04   0.32834D 06  -0.10488D 06  -0.17413D 05  -0.65706D 06  -0.76194D 06
   -0.14635D 07   0.70977D 05   0.33171D 06   0.11871D 07  -0.10488D 06   0.73491D 10  -0.24205D 07   0.17707D 06   0.73493D 10
    0.12131D 06   0.22294D 05  -0.11272D 04  -0.10488D 06  -0.17413D 05  -0.24205D 07   0.17707D 06  -0.26852D 08  -0.29273D 08
    0.26735D 04   0.60666D 06   0.32834D 06  -0.17413D 05  -0.65706D 06   0.17707D 06  -0.26852D 08   0.71811D 10   0.71813D 10
   -0.14609D 07   0.67763D 06   0.66004D 06   0.11696D 07  -0.76194D 06   0.73493D 10  -0.29273D 08   0.71813D 10   0.14531D 11

VECTOR B  IT=  3
    0.11631E-02   0.40074E-02   0.52552E-01   0.16171E-02   0.41015E-02   0.16646E-02   0.            0.16690E-02   0.


TEST CASE 4  ILLUSTRATES USE OF DPRINT (ZFIT ONLY) ...

MATRIX A
    1.00000    -0.00000    -0.00116
   -0.00000     0.99999    -0.00401
    0.00116     0.00401     0.99999

MATRIX AU
   -0.00116    -0.00200    -1.00000
   -0.00200    -0.00000     0.
    1.00000     0.         -0.00116

MATRIX AV
   -0.00000    -0.00058     0.
   -0.00058    -0.00401    -1.00000
    0.          1.00000    -0.00401

IT  I       X1           Y1          Z1          XU1          YU1         ZU1          XV1         YV1          ZV1
 4  1  -176.76452     -0.58210    51.75995    -51.76115     0.35406  -176.76464     0.00022   -51.86317     -0.58252

      R1               R11              R12              R13              R14
-0.1622755D-01  -0.2071422D 03  -0.4704457D-00  -1.0000000D 00   0.1767645D 03

      R15              R16              R17              R18              R19
 0.5820992D 00  -0.3124570D 05  -0.1028945D 03  -0.3388394D-00  -0.3124603D 05

       S
 0.5443284D-01

VECTOR H
 -0.48689D-02  -0.77974D-03   0.98830D-05   0.38247D-02   0.67925D-03   0.11441D-00  -0.24373D 01   0.10325D-00   0.21767D-00

MATRIX G
    0.41892D 06  -0.14662D 04  -0.28983D 02  -0.37250D 06   0.12910D 04  -0.14635D 07   0.12127D 06   0.26736D 04  -0.14609D 07
   -0.14662D 04   0.41399D 06   0.20908D 02   0.12811D 04  -0.36840D 06   0.70976D 05   0.22294D 05   0.60665D 06   0.67762D 06
   -0.28983D 02   0.20908D 02   0.40000D 02   0.18945D 02  -0.25671D 02   0.33171D 06  -0.11272D 04   0.32834D 06   0.66004D 06
   -0.37250D 06   0.12811D 04   0.18945D 02   0.33171D 06  -0.11272D 04   0.11871D 07  -0.10484D 06  -0.17413D 05   0.11696D 07
    0.12910D 04  -0.36840D 06  -0.25671D 02  -0.11272D 04   0.32834D 06  -0.10484D 06  -0.17413D 05  -0.65694D 06  -0.76178D 06
   -0.14635D 07   0.70976D 05   0.33171D 06   0.11871D 07  -0.10484D 06   0.73491D 10  -0.24203D 07   0.17704D 06   0.73493D 10
    0.12127D 06   0.22294D 05  -0.11272D 04  -0.10484D 06  -0.17413D 05  -0.24203D 07   0.17704D 06  -0.26852D 08  -0.29272D 08
    0.26736D 04   0.60665D 06   0.32834D 06  -0.17413D 05  -0.65694D 06   0.17704D 06  -0.26852D 08   0.71811D 10   0.71813D 10
   -0.14609D 07   0.67762D 06   0.66004D 06   0.11696D 07  -0.76178D 06   0.73493D 10  -0.29272D 08   0.71813D 10   0.14531D 11
```

Sample output (contd)

```
 TEST CASE 4  ILLUSTRATES USE OF DPRINT (ZFIT ONLY) ...

 PARAMETER VECTOR

B1=  0.1163099E-02
B2=  0.4007394E-02
B3=  0.5255177E-01
B4=  0.1617064E-02
B5=  0.4101518E-02
B6=  0.1664591E-02
B7=  0.
B8=  0.1669048E-02
B9=  0.

IN SYSTEM CPRIME ...

         Z=B3+B4*X+B5*Y+B6*X**2+B7*X*Y+B8*Y**2+B9*(X**2+Y**2)

STANDARD DEVIATION OF DATA=  0.4061379E-01

                         COVARIANCE MATRIX OF COEFFICIENTS

          1            2            3            4            5            6            7
1   0.27572E-05  0.22614E-08  0.28788E-06  0.30962E-05  0.23469E-08  0.35991E-10 -0.66585E-11
2   0.22614E-08  0.25772E-05 -0.45520E-07  0.23523E-08  0.28918E-05  0.18486E-10  0.48910E-10
3   0.28788E-06 -0.45520E-07  0.16477E-03  0.34008E-06 -0.55604E-07 -0.74346E-08 -0.75338E-08
4   0.30962E-05  0.23523E-08  0.34008E-06  0.34818E-05  0.24419E-08  0.38852E-10 -0.82351E-11
5   0.23469E-08  0.28918E-05 -0.55604E-07  0.24419E-08  0.32497E-05  0.21013E-10  0.55546E-10
6   0.35991E-10  0.18486E-10 -0.74346E-08  0.38852E-10  0.21013E-10  0.56102E-12  0.34035E-12
7  -0.66585E-11  0.48910E-10 -0.75338E-08 -0.82351E-11  0.55546E-10  0.34035E-12  0.57509E-12

   DIRECTION COSINES OF AXIS OF PARABOLOID

     U               V               W
 0.1163099E-02   0.4007394E-02   0.9999913E 00

COVARIANCE MATRIX OF PHI AND THETA

   0.5169707E 03  0.3941120E-01
   0.3941120E-01  0.8510499E-02

                 ROTATION MATRIX A

 0.9999993E 00  -0.2330509E-05  -0.1163099E-02
-0.2330509E-05   0.9999920E 00  -0.4007394E-02
 0.1163099E-02   0.4007394E-02   0.9999913E 00
```

Sample output (contd)

TEST CASE 4 ILLUSTRATES USE OF DPRINT (ZFIT ONLY) ...

			COORDINATE SYSTEM C			COORDINATE SYSTEM CPRIME			RESIDUE
I	IDENT	WEIGHT	X	Y	Z	X	Y	Z	R
1	5	1.5046	-176.7042	-0.3743	51.9674	-176.7645	-0.5821	51.7600	-0.0162
2	6	2.0338	-154.5697	-0.1528	39.7987	-154.6159	-0.3119	39.6179	0.0227
3	7	1.2159	-132.2858	0.0277	29.1157	-132.3196	-0.0886	28.9617	-0.0209
4	8	1.0760	-129.5442	0.0421	27.9652	-129.5767	-0.0697	27.8145	0.0231
5	9	1.7208	-105.5628	0.1305	18.5658	-105.5844	0.0563	18.4434	0.0044
6	10	1.2822	-72.9341	-0.2596	8.8192	-72.9443	-0.2947	8.7333	-0.0573
7	11	0.6373	-52.0959	-0.2386	4.5591	-52.1012	-0.2567	4.4975	0.0116
8	12	0.3149	-30.7068	-0.2307	1.6006	-3.0709	-0.0237	0.1564	-0.0008
9	13	0.0975	-27.5613	-0.2052	1.2422	-27.5627	-0.2101	1.2094	-0.0624
10	14	0.0831	-18.2033	-0.1447	0.4496	-18.2038	-0.1465	0.4279	-0.1463
11	15	0.0831	18.1722	0.0957	0.4527	18.1717	0.0939	0.4742	-0.1578
12	16	0.0975	27.5686	0.2608	1.3105	27.5671	0.2555	1.3436	-0.0197
13	17	0.3149	31.4726	0.3409	1.6903	31.4707	0.3340	1.7283	-0.0253
14	18	0.6373	54.3760	0.6614	4.9656	54.3702	0.6414	5.0315	-0.0330
15	19	1.8726	72.7118	0.9024	8.8790	72.7015	0.8666	8.9671	-0.0060
16	20	2.2275	129.5680	-0.1253	27.9995	129.5353	-0.2379	28.1495	-0.0425
17	21	1.2159	133.0994	-0.2006	29.6320	133.0649	-0.3197	29.7857	0.0455
18	22	2.0338	157.7075	-0.3495	41.5362	157.6591	-0.5163	41.7179	0.0363
19	23	1.5046	176.6571	-0.3443	52.0216	176.5965	-0.5532	52.2252	-0.0236
20	3	1.5046	-0.9698	176.0262	51.6172	-1.0303	175.8180	52.3210	-0.0463
21	4	2.0338	-0.6484	156.1179	40.6844	-0.6961	155.9536	41.3089	0.0233
22	5	1.2159	-0.3189	133.0898	29.6041	-0.3537	132.9701	30.1368	0.0287
23	6	1.0760	-0.2784	129.4786	27.9905	-0.3112	129.3654	28.5088	-0.0062
24	7	1.9757	0.1406	97.8835	16.0395	0.1217	97.8184	16.4318	0.0076
25	8	1.0491	-0.2016	72.8710	8.9766	-0.2122	72.8345	9.2683	0.0632
26	9	0.6373	-0.2295	52.6336	4.6793	-0.2350	52.6144	4.8899	0.0015
27	10	0.3149	-0.0488	31.3654	1.6583	-0.0508	31.3585	1.7840	-0.0384
28	11	0.0975	0.0407	27.5293	1.2956	0.0391	27.5239	1.4059	-0.0240
29	12	0.0831	0.2107	18.1603	0.5581	0.2100	18.1579	0.6312	-0.0466
30	13	0.0831	-0.0598	-18.2323	0.3605	-0.0602	-18.2336	0.2874	-0.2452
31	14	0.0975	-0.0348	-27.5758	1.1133	-0.0361	-27.5800	1.0027	-0.2062
32	15	0.3149	0.0397	-31.4222	1.6188	0.0379	-31.4284	1.4929	-0.0794
33	16	0.6373	0.2975	-53.7517	4.9272	0.2919	-53.7710	4.7121	0.0538
34	17	1.2822	0.4869	-76.0849	9.7506	0.4757	-76.1234	9.4462	0.0330
35	18	1.3122	0.3815	-104.8632	18.4602	0.3603	-104.9364	18.0403	0.0384
36	9	0.9422	0.4164	-116.5137	22.7351	0.3902	-116.6039	22.2685	0.0002
37	20	0.6348	0.4512	-129.4943	28.0461	0.4188	-129.6057	27.5275	-0.0305
38	21	1.2159	0.4586	-133.1821	29.7100	0.4243	-133.3000	29.1765	0.0126
39	22	2.0338	0.5611	-156.4923	41.0260	0.5138	-156.6555	40.3991	0.0278
40	23	1.5046	0.5637	-176.6852	52.2163	0.5034	-176.8930	51.5085	-0.0462

SUM OF WEIGHTED SQUARES= 0.5443284D-01

WEIGHTED RMS= 0.3688931D-01

SPHERICAL COORDINATES OF AXIS OF PARABOLOID

PHI (DEG.)	THETA (DEG.)
73.8152	89.7609

VERTEX OF PARABOLOID

X	Y	Z
-0.4856634E-00	-0.1228490E 01	0.5512768E-01

/M3

XIII. RADIATION PATTERN PROGRAMS

D. Bathker

N67-28734

Program:	5338, source deck in Jet Propulsion Laboratory Library (revised March 17, 1965)
Program:	5345, source deck in Jet Propulsion Laboratory Library (revised to Fortran IV, June 1966)
Engineer:	P. Potter (5338); M. S. Katow (5345)
Mathematician:	C. Lawson
Programmer:	R. Matsumoto

A. Program Description

Each program numerically evaluates the scalar far-field radiation pattern integral (Ref. 16) by a trapezoid rule approximation. The secondary radiation pattern of a large paraboloidal antenna is obtained given the feed amplitude and phase and reflector surface characteristics.

Reflector surface distortion input for Program 5338 is specified as full RF path length error at points in a cylindrical coordinate system. Reflector surface distortion input for Program 5345 is specified as x-, y-, z-deflections at points in a rectangular coordinate system. The feed amplitude function $W(I, J)$ input is defined to be the feed pattern (positive or negative field), and Program 5338 forms the aperture illumination. Program 5345 amplitude $W(I, J)$ input is defined to be the aperture illumination (positive field only). With the final exception of an added case identification card in Program 5338, the programs are otherwise identical.

B. Applications

In addition to the prediction of far-field radiation patterns and gain loss due to phasing errors, the programs have provided a variety of other useful data. The blocking caused by quadripod structures has been input to the $W(I, J)$ array both as zero field intensity (Ref. 17) and as a fractional field intensity (Ref. 18). Quadripod transparency was evaluated by a comparison of measured and computed radiation patterns.

A 30-ft paraboloidal surface exhibiting moderate astigmatism (Ref. 19) was subsequently examined by civil engineering techniques; radiation patterns were computed with the surface data included (Ref. 20).

The same paraboloid was utilized in an experiment at extremely high frequency ($D/\lambda \approx 700$, Refs. 21 and 22). Measured and computed patterns disagreed; this fact led to an investigation of apex feedhorn physical placement. It was determined through manipulation of the feed phase error (H3) input that the experimental placement of the feedhorn was in error.

The program may also be used for unusual reflector shapes by appropriate adjustments in $W(I,J)$ and $H3(I,J)$ (Ref. 23).

Defocusing effects on gain and pointing may be investigated by the feed offset parameters in Program 5345.

C. Input

1. Program 5338

Card	Parameters	Format
1	*ICASE IMONTH IDAY IYEAR*	7I10
2	*TITLE*	12A6
3	*FK F FACT XMIN XMAX YMIN YMAX*	7F10.0
4	*LRSW LWSW LNBSW LH3SW LDZSW NR*	7I10
5	*R(1) R(2)* · · ·	7F10.0
.	*NB(1) NB(2)* · · ·	7I10
.	*W(1,1) W(1,2)* · · ·	7F10.0
.	*H3(1,1) H3(1,2)* · · ·	
	DZ(1,1) DZ(1,2) · · ·	7F10.0
N	*NPHI*	7I10
N+1	*PHI THETA1 THETA2 TTHETA*	7F10.0
N+NPHI	*PHI THETA1 THETA2 TTHETA*	7F10.0

ICASE = case number

IMONTH, IDAY, IYEAR = date

TITLE = any alphanumeric identification

FK = propagation constant $2\pi/\lambda$, in.$^{-1}$

F = focal length, in.

FACT = an addition factor for plot normalization, db

XMIN, XMAX, YMIN, YMAX = minimum and maximum values of antenna polar angle (in degrees) and amplitude (in decibels), respectively, to define the grid and range of output plots

LRSW = 1 to read in *R(I)* array
= 2 to read array to zero
= 3 to use values from previous case in core

LWSW = 1 to read in skeleton *W(I)* array; program forms rotationally symmetric *W(I,J)* array
= 2 read in *W(I,J)* array
= 3 use values from previous case

LNBSW = 1 read in *NB(I)* array
= 2 set array to zero
= 3 use values from previous case in core

LH3SW = 1 read in skeleton *H3(I)* array; program forms rotationally symmetric *H3(I,J)* array
= 2 set array to zero
= 3 read in *H3(I,J)*

LDZSW = 1 read in *DZ(I,J)*
= 2 set array to zero
= 3 use values from previous case in core

NR = the number of radius values (the range of *I* in the input arrays) ≤ 27

R(I) = radius values for input fields, etc., in.; omit for *LRSW* = 2 or 3

NB(I) = number of equal azimuthal increments for each radius value *R(I)* (range of *J* in input arrays); omit for *LNBSW* = 2 or 3, *NB(I)* ≤ 180

W(I,J) = reflector illumination at the point *I,J*, ± v; *W(I)* only for *LWSW* = 1; omit for *LWSW* = 3

H(I,J) = phase angle of reflector illumination, deg; *H(I)* only for *LH3SW* = 1; omit for *LH3SW* = 2

DZ(I,J) = full RF path length deflection of surface, from nominal paraboloid, at the point *I,J*, in., omit for *LDZSW* = 2 or 3

NPHI = number of azimuthal cuts (*PHI* values) for which output data is desired, ≤ 8

PHI = azimuthal angle of desired cut

THETA1 = initial value of polar angle (ρ) for computations and output data

THETA2 = last value of polar angle

TTHETA = number of polar angle increments, ≤ 150

All input data within a card group must appear as seven values per card. When the end of an array row is reached, proceed to the next card, first field.

2. Program 5345

Card	Parameters	Format
1	*ICASE IMONTH IDAY IYEAR*	4I10
2	*FK F FACT XMIN XMAX YMIN YMAX*	7F10.0
3	*DELTOL XOFF YOFF ZOFF*	4F10.0
4	*NOFRT NPHI LWSW LH3SW*	7I10
5	*NB(1) NB(2)* · · ·	7I10
	W(1,1) W(1,2) · · ·	7F10.0
	H3(1,1) H3(1,2) · · ·	
N		
N+1	*PHI THETA1 THETA2 TTHETA*	4F10.0
N+NPHI	*PHI THETA1 THETA2 TTHETA X Y U V W ID X Y U V W ID*	2F10.5, 10X3F10.5, 10XI10

Parameters are identical to those for Program 5338 except as follows:

W(I,J) = must include space loss

DELTOL = allowable tolerance for evaluating radius values; this, ensures that radius input values (*x,y*) are the correct numbers in proper order

XOFF, YOFF, ZOFF = constant factors added to all *U, V, W* deflections to effect an offset feed pattern

NOFRT = number of radius values; same as *NR* in Program 5338

x,y = Cartesian coordinates of data point

U, V, W = deflections from nominal paraboloid in *x, y,* and *z* directions, respectively. Z is directed along the axis of nominal paraboloid

ID = joint identification number

The last group of cards, containing the deflection data, must be arranged such that all of the cards of the same radius are together in the proper order, starting from the innermost radius. The maximum number of *x, y* values for any one radius cannot exceed 180.

All data must be consistent with every other data. If the *DZ(I, J)* or (*x, y, z*) points on the antenna are in a counterclockwise direction with reference axis on the horizontal as 0 deg, then both the *H3* and *W* array must also follow this same convention. The program does not know, or care, which system of reference is used; it is up to the user only to be consistent in using his reference plane. In order for the plots to come out so that they may be "butted" together, it is required that the reference axis be at 0° and in a counterclockwise direction.

Timing. Approximately 10 min are required for each ϕ value with 27 × 180 arrays; *TTHETA* = 100.

D. Output

These programs print out input data including internally generated arrays for some options. Computed data is normalized by a number representing the gain of the antenna if all of the field points radiated in phase. Thus, if the maximum value of the output is −1 db, this represents the loss due to an imperfect surface and/or the *H3* feed phase error. Note that this is not a measure of antenna efficiency, since the normalizing value has loss due to illumination efficiency. The amplitude (in decibels), normalized as discussed above, real and imaginary parts (in volts), un-normalized, and phase angle are output for the specified *THETA* values for each specified *PHI* cut. Photographic plots of the amplitude values (in decibels) are also output. The output of Program 5345 is identical to that of Program 5338 with the exception of the echoing of the input table. That is, x, y, z deflection data is printed out for Program 5345; $DZ(I, J)$ data is printed out for Program 5338.

E. Sample Case

The sample case for Program 5338 represents the Goldstone Venus Station 30-ft reflector with the original quadripod structure of 90-deg symmetry (Fig. 13 of Ref. 20). Frequency is 16.33 GHz; $NR = 27$, $NB = 112$. The array size was selected to provide a reasonable approximation to quadripod shadowing, which is taken as zero field. (Feed amplitude and phase data are shown in Figs. 14 and 15 of Ref. 24.) The reflector surface data represents deviations from a paraboloid, initially adjusted for a perfect surface at zenith pointing, and subsequently oriented for horizon pointing (Fig. 16 of Ref. 20). On-axis loss of 0.496 db is due to the feed phase and reflector surface losses. Note that, in Fig. 3, the main beam is on-axis with respect to the best-fitted surface. Total run time for the sample case: 25 min.

A sample case for Program 5345 is also included.

Sample input (program 5338)

```
          522       6         17        66
          SOFT REFLECTOR AAS SCALE HORT    DEFLECTED SURFACE BEST-FITTED
8.6930    150.000   0.00      0.00      1.50      -50.00    0.00
          1         2         1         1         1         27
0.0       7.0       14.0      21.0      28.0      35.0      42.0
49.0      56.0      63.0      70.0      77.0      84.0      91.0
98.0      105.0     112.0     119.0     126.0     133.0     140.0
147.0     154.0     161.0     168.0     175.0     180.0
          1         112       112       112       112       112       112
          112       112       112       112       112       112       112
          112       112       112       112       112       112       112
          112       112       112       112       112       112
0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000     0.000     0.000     0.000     0.000     0.000
0.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       0.0
0.0       0.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
0.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       0.0
0.0       0.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
0.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       0.0
0.0       0.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
0.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       0.0
0.0       0.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
0.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       0.0
0.0       0.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
0.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       0.0
0.0       0.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
0.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       0.0
0.0       0.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
1.0       1.0       1.0       1.0       1.0       1.0       1.0
```

Sample input (contd)

0.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	0.0
0.0	0.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
0.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	0.0
0.0	0.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
0.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	0.0
0.0	0.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
0.0	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.0
0.0	0.0	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.9955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.0	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.0
0.0	0.0	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.0	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.0
0.0	0.0	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.9955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.0	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.0
0.0	0.0	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.0	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.0
0.0	0.0	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.9955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.0	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.0
0.0	0.0	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.0	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.0
0.0	0.0	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.0	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.0
0.0	0.0	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.0	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.0
0.0	0.0	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.0	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.0
0.0	0.0	0.917	0.917	0.917	0.917	0.917

Sample input (contd)

0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.0	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.0
0.0	0.0	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.0	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.0
0.0	0.0	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.0	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.0
0.0	0.0	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.0	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.0
0.0	0.0	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.0	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.0
0.0	0.0	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.0	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.0
0.0	0.0	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.0	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.0
0.0	0.0	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.0	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.0
0.0	0.0	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.0	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.0
0.0	0.0	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.0	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.0
0.0	0.0	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.0	0.841	0.841	0.841	0.841	0.841	0.841
0.841	0.841	0.841	0.841	0.841	0.841	0.841
0.841	0.841	0.841	0.841	0.841	0.841	0.841
0.841	0.841	0.841	0.841	0.841	0.841	0.0
0.0	0.0	0.841	0.841	0.841	0.841	0.841
0.841	0.841	0.841	0.841	0.841	0.841	0.841
0.841	0.841	0.841	0.841	0.841	0.841	0.841
0.841	0.841	0.841	0.841	0.841	0.841	0.841
0.0	0.841	0.841	0.841	0.841	0.841	0.841
0.841	0.841	0.841	0.841	0.841	0.841	0.841
0.841	0.841	0.841	0.841	0.841	0.841	0.841
0.841	0.841	0.841	0.841	0.841	0.841	0.0
0.0	0.0	0.841	0.841	0.841	0.841	0.841
0.841	0.841	0.841	0.841	0.841	0.841	0.841
0.841	0.841	0.841	0.841	0.841	0.841	0.841
0.841	0.841	0.841	0.841	0.841	0.841	0.841
0.0	0.596	0.596	0.596	0.596	0.596	0.596
0.596	0.596	0.596	0.596	0.596	0.596	0.596

Sample input (contd)

0.596	0.596	0.596	0.596	0.596	0.596	0.596
0.596	0.596	0.596	0.596	0.596	0.596	0.0
0.0	0.0	0.596	0.596	0.596	0.596	0.596
0.596	0.596	0.596	0.596	0.596	0.596	0.596
0.596	0.596	0.596	0.596	0.596	0.596	0.596
0.596	0.596	0.596	0.596	0.596	0.596	0.596
0.0	0.596	0.596	0.596	0.596	0.596	0.596
0.596	0.596	0.596	0.596	0.596	0.596	0.596
0.596	0.596	0.596	0.596	0.596	0.596	0.596
0.596	0.596	0.596	0.596	0.596	0.596	0.0
0.0	0.0	0.596	0.596	0.596	0.596	0.596
0.596	0.596	0.596	0.596	0.596	0.596	0.596
0.596	0.596	0.596	0.596	0.596	0.596	0.596
0.596	0.596	0.596	0.596	0.596	0.596	0.596
0.0	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.0
0.0	0.0	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.0	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.0
0.0	0.0	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.0	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.0
0.0	0.0	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.0	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.0
0.0	0.0	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.0	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.0
0.0	0.0	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.0	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.0
0.0	0.0	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.0	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.0
0.0	0.0	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.0	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.0
0.0	0.0	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.562	0.562	0.562	0.562	0.562	0.562	0.562
0.0	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.0
0.0	0.0	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.0	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.0
0.0	0.0	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.0	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.0
0.0	0.0	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316

Sample input (contd)

0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.0	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.0
0.0	0.0	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.0	0.211	0.211	0.211	0.211	0.211	0.211
0.0	0.211	0.211	0.211	0.211	0.211	0.211
0.0	0.211	0.211	0.211	0.211	0.211	0.211
0.0	0.211	0.211	0.211	0.211	0.211	0.0
0.0	0.0	0.211	0.211	0.211	0.211	0.211
0.0	0.211	0.211	0.211	0.211	0.211	0.211
0.0	0.211	0.211	0.211	0.211	0.211	0.211
0.0	0.211	0.211	0.211	0.211	0.211	0.211
0.0	0.211	0.211	0.211	0.211	0.211	0.211
0.0	0.211	0.211	0.211	0.211	0.211	0.211
0.0	0.211	0.211	0.211	0.211	0.211	0.211
0.0	0.211	0.211	0.211	0.211	0.211	0.0
0.0	0.0	0.211	0.211	0.211	0.211	0.211
0.0	0.211	0.211	0.211	0.211	0.211	0.211
0.0	0.211	0.211	0.211	0.211	0.211	0.211
0.0	0.211	0.211	0.211	0.211	0.211	0.211
15.0	15.0	15.0	15.0	15.0	15.0	15.0
15.0	15.0	15.0	15.0	15.0	15.0	15.0
10.0	20.0	10.0	25.0	10.0	20.0	36.0
27.0	6.0	2.0	0.0	0.0	10.0	
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0						
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0						
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0						
-.029	-.019	-.010	-.001	-.063	-.055	-.046
-.037	-.028	-.019	-.010	-.020	-.016	-.012
-.008	-.004	0.000	0.004	-.027	-.023	-.018
-.013	-.008	-.004	0.000	0.000	-.003	-.006
-.009	-.012	-.015	-.018	-.012	-.014	-.016
-.017	-.018	-.020	-.022	0.036	0.028	0.020
0.013	0.006	-.002	-.010	0.011	0.006	0.001
-.004	-.009	-.013	-.017	-.018	-.019	-.020
-.021	-.022	-.023	-.025	-.036	-.036	-.036
-.036	-.037	-.037	-.037	-.053	-.051	-.049
-.046	-.044	-.042	-.040	-.040	-.043	-.046
-.049	-.052	-.055	-.057	-.047	-.048	-.049
-.050	-.051	-.053	-.055	-.035	-.039	-.044
-.049	-.053	-.058	-.062	-.062	-.060	-.058
-.057	-.053	-.050	-.052	-.047	-.052	-.057
-.060	-.062	-.067	-.072	-.057	-.048	-.039
-.029	-.019	-.010	-.001	-.063	-.055	-.046
-.037	-.028	-.019	-.010	-.020	-.016	-.012
-.008	-.004	0.000	0.004	-.027	-.023	-.018
-.013	-.008	-.004	0.000	0.000	-.003	-.006
-.009	-.012	-.015	-.018	-.012	-.014	-.016
-.017	-.018	-.020	-.022	0.036	0.028	0.020
0.013	0.006	-.002	-.010	0.011	0.006	0.001
-.004	-.009	-.013	-.017	-.018	-.019	-.020
-.021	-.022	-.023	-.025	-.036	-.036	-.036
-.036	-.037	-.037	-.037	-.053	-.051	-.049
-.046	-.044	-.042	-.040	-.040	-.043	-.046
-.049	-.052	-.055	-.057	-.047	-.048	-.049
-.050	-.051	-.053	-.055	-.035	-.039	-.044
-.049	-.053	-.058	-.062	-.062	-.060	-.058
-.057	-.053	-.050	-.052	-.047	-.052	-.057
-.060	-.062	-.067	-.072	-.057	-.048	-.039
-.030	-.022	-.013	-.004	-.057	-.050	-.041
-.033	-.024	-.016	-.008	-.014	-.010	-.005
0.000	0.000	0.006	0.009	-.020	-.016	-.010
-.006	-.002	0.002	0.006	0.003	0.000	-.003
-.004	-.006	-.008	-.010	-.005	-.007	-.007
-.010	-.013	-.014	-.015	0.036	0.028	0.020
0.008	0.004	-.001	0.000	0.000	0.003	0.002

Sample input (contd)

-.004	-.009	-.013	-.016	-.018	-.019	-.019
-.020	-.020	-.020	-.022	-.036	-.034	-.033
-.032	-.032	-.030	-.029	-.049	-.046	-.043
-.037	-.036	-.034	-.033	-.032	-.034	-.036
-.039	-.042	-.044	-.044	-.037	-.038	-.039
-.040	-.042	-.044	-.045	-.028	-.031	-.036
-.040	-.044	-.048	-.052	-.051	-.050	-.050
-.049	-.049	-.046	-.048	-.042	-.046	-.050
-.055	-.058	-.062	-.067	-.056	-.047	-.039
-.031	-.024	-.016	-.008	-.052	-.045	-.036
-.029	-.021	-.013	2.005	-.008	-.003	0.002
0.008	0.010	0.012	0.014	-.014	-.009	-.003
0.002	0.005	0.008	0.012	0.006	0.004	0.003
0.001	0.000	-.001	-.002	0.002	0.000	-.002
-.003	-.003	-.007	-.009	0.036	0.028	0.020
0.010	0.002	0.000	-.020	-.025	0.000	-.002
-.004	-.009	-.013	-.016	-.019	-.019	-.018
-.018	-.018	-.017	-.018	-.036	-.033	-.030
-.028	-.026	-.021	-.021	-.045	-.041	-.037
-.030	-.028	-.026	-.024	-.025	-.025	-.027
-.029	-.031	-.030	-.031	-.027	-.028	-.029
-.030	-.032	-.034	-.035	-.021	-.022	-.028
-.031	-.034	-.038	-.042	-.041	-.043	-.045
-.043	-.042	-.042	-.044	-.038	-.040	-.045
-.050	-.054	-.058	-.063	-.055	-.047	-.040
-.033	-.026	-.019	-.011	-.047	-.040	-.031
-.024	-.017	-.010	-.002	-.002	0.002	0.007
0.012	0.015	0.018	0.021	-.007	-.002	0.003
0.009	0.012	0.014	0.018	0.009	0.008	0.007
0.006	0.006	0.006	0.006	0.009	0.007	0.005
0.004	0.003	0.000	-.002	0.036	0.028	0.020
0.010	0.002	0.000	-.080	-.025	0.000	-.002
-.005	-.008	-.012	-.015	-.020	-.019	-.017
-.017	-.016	-.014	-.014	-.036	-.032	-.028
-.024	-.020	-.015	-.013	-.041	-.036	-.031
-.024	-.020	-.018	-.015	-.016	-.017	-.018
-.019	-.019	-.018	-.018	-.017	-.018	-.019
-.020	-.022	-.024	-.025	-.013	-.014	-.017
-.022	-.025	-.028	-.032	-.032	-.036	-.040
-.035	-.037	-.038	-.040	-.034	-.032	-.036
-.041	-.046	-.053	-.059	-.055	-.047	-.041
-.035	-.028	-.022	-.015	-.041	-.034	-.027
-.020	-.014	-.007	0.000	0.004	0.008	0.012
0.015	0.019	0.023	0.026	0.000	0.004	0.008
0.014	0.017	0.020	0.024	0.012	0.012	0.012
0.012	0.012	0.013	0.013	0.016	0.014	0.012
0.011	0.010	0.007	0.005	0.036	0.028	0.020
0.010	0.000	-.020	-.090	-.050	-.025	0.000
-.005	-.008	-.012	-.015	-.022	-.019	-.017
-.015	-.014	-.012	-.010	-.036	-.031	-.026
-.020	-.015	-.009	-.003	-.037	-.031	-.025
-.018	-.014	-.010	-.006	-.009	-.009	-.010
-.007	-.006	-.005	-.004	-.007	-.008	-.009
-.010	-.011	-.013	-.015	-.005	-.006	-.009
-.013	-.015	-.018	-.022	-.023	-.027	-.032
-.029	-.033	-.034	-.036	-.028	-.026	-.031
-.036	-.042	-.048	-.055	-.054	-.047	-.042
-.036	-.030	-.024	-.018	-.035	-.028	-.022
-.016	-.010	-.004	0.002	0.012	0.016	0.017
0.019	0.024	0.028	0.033	0.007	0.011	0.014
0.019	0.024	0.027	0.030	0.015	0.016	0.017
0.018	0.019	0.020	0.021	0.023	0.022	0.020
0.019	0.017	0.015	0.012	0.036	0.028	0.019
0.010	0.000	-.050	-.100	-.100	-.050	0.000
-.005	-.008	-.012	-.015	-.024	-.020	-.017
-.014	-.011	-.010	-.006	-.036	-.030	-.023
-.015	-.009	-.003	0.007	-.033	-.025	-.020
-.012	-.007	-.002	0.003	-.001	-.003	0.000
0.004	0.006	0.007	0.011	0.003	0.002	0.001
0.000	-.002	-.004	-.005	0.003	0.002	-.002
-.004	-.006	-.008	-.012	-.014	-.019	-.024
-.023	-.025	-.028	-.032	-.023	-.018	-.025
-.031	-.036	-.043	-.051	-.054	-.047	-.042
-.038	-.032	-.027	-.021	-.029	-.023	-.017
-.011	-.006	0.000	0.005	0.020	0.021	0.022
0.023	0.030	0.034	0.038	0.014	0.018	0.022
0.026	0.030	0.034	0.038	0.018	0.019	0.022
0.024	0.025	0.027	0.029	0.030	0.029	0.027
0.026	0.025	0.022	0.019	0.036	0.028	0.019
0.010	0.000	-.080	-.154	-.217	-.100	0.000
-.005	-.008	-.012	-.014	-.025	-.020	-.016
-.013	-.007	-.007	-.002	-.037	-.028	-.020
-.011	-.003	0.003	0.015	-.029	-.020	-.014
-.006	0.000	0.006	0.012	0.007	0.006	0.010
0.016	0.018	0.020	0.024	0.011	0.011	0.010
0.010	0.010	0.010	0.010	0.011	0.010	0.008
0.005	0.003	0.002	-.002	-.005	-.010	-.016
-.017	-.022	-.024	-.028	-.019	-.012	-.018
-.026	-.032	-.038	-.047	-.053	-.047	-.043
-.039	-.034	-.030	-.025	-.023	-.018	-.012
-.007	-.003	0.004	0.008	0.025	0.027	0.029
0.031	0.035	0.039	0.043	0.021	0.025	0.029
0.033	0.038	0.041	0.044	0.020	0.023	0.026
0.029	0.033	0.035	0.037	0.037	0.036	0.035
0.033	0.033	0.030	0.026	0.037	0.028	0.019
0.010	0.000	-.080	-.154	-.217	-.100	0.000
-.005	-.008	-.012	-.014	-.025	-.021	-.016
-.011	-.005	-.003	0.002	-.037	-.027	-.018
-.007	0.003	0.010	0.023	-.024	-.015	-.008
0.000	0.007	0.014	0.021	0.015	0.016	0.020
0.026	0.030	0.033	0.037	0.021	0.021	0.020
0.020	0.020	0.020	0.020	0.019	0.017	0.016

Sample input (contd)

0.014	0.013	0.012	0.011	0.004	-.002	-.008
-.011	-.015	-.020	-.025	-.015	-.006	-.012
-.021	-.027	-.034	-.043	-.053	-.047	-.043
-.040	-.036	-.032	-.028	-.017	-.012	-.008
-.003	0.003	0.007	0.011	0.030	0.033	0.036
0.039	0.041	0.044	0.048	0.030	0.034	0.036
0.040	0.044	0.046	0.050	0.023	0.027	0.031
0.034	0.037	0.041	0.045	0.045	0.044	0.042
0.040	0.039	0.037	0.035	0.037	0.028	0.018
0.009	0.000	-.080	-.154	-.217	-.100	0.000
-.003	-.006	-.009	-.013	-.026	-.021	-.016
-.010	-.004	0.001	0.006	-.037	-.026	-.015
-.003	0.009	0.020	0.031	-.019	-.010	-.002
0.006	0.014	0.022	0.030	0.022	0.026	0.030
0.036	0.042	0.046	0.050	0.031	0.030	0.030
0.030	0.030	0.030	0.031	0.027	0.025	0.024
0.023	0.022	0.021	0.019	0.013	0.007	0.001
-.005	-.011	-.017	-.023	-.010	-.001	-.008
-.016	-.021	-.030	-.039	-.052	-.048	-.044
-.043	-.040	-.038	-.035	-.026	-.019	-.013
-.006	0.000	0.007	0.013	0.027	0.031	0.034
0.037	0.040	0.044	0.047	0.031	0.033	0.035
0.038	0.040	0.043	0.046	0.030	0.033	0.037
0.041	0.044	0.048	0.052	0.052	0.047	0.045
0.044	0.041	0.039	0.037	0.025	0.018	0.013
0.006	0.000	-.050	-.100	-.100	-.050	0.000
-.003	-.006	-.009	-.009	-.030	-.024	-.019
-.013	-.006	-.002	0.004	-.037	-.027	-.016
-.005	0.007	0.017	0.027	-.017	-.008	0.000
0.009	0.017	0.024	0.034	0.025	0.029	0.032
0.037	0.042	0.046	0.050	0.035	0.035	0.034
0.035	0.035	0.038	0.038	0.028	0.026	0.025
0.026	0.024	0.024	0.023	0.013	0.007	0.001
-.005	-.011	-.017	-.023	-.016	-.009	-.016
-.023	-.029	-.037	-.045	-.052	-.049	-.046
-.046	-.044	-.044	-.042	-.035	-.027	-.018
-.010	-.002	0.008	0.016	0.023	0.027	0.031
0.035	0.039	0.043	0.046	0.032	0.033	0.034
0.036	0.038	0.040	0.041	0.037	0.043	0.047
0.048	0.050	0.055	0.045	0.059	0.055	0.053
0.048	0.044	0.043	0.039	0.012	0.008	0.008
0.004	0.000	-.020	-.060	-.050	-.025	0.000
-.002	-.003	-.004	-.006	-.033	-.027	-.022
-.016	-.008	-.004	0.002	-.037	-.028	-.018
-.007	0.005	0.014	0.024	-.015	-.006	0.003
0.017	0.020	0.028	0.038	0.028	0.031	0.034
0.038	0.043	0.046	0.049	0.040	0.040	0.038
0.045	0.045	0.045	0.045	0.029	0.027	0.027
0.028	0.028	0.028	0.027	0.012	0.006	0.000
-.005	-.011	-.017	-.023	-.022	-.018	-.024
-.030	-.038	-.044	-.051	-.051	-.050	-.048
-.050	-.048	-.050	-.049	-.044	-.034	-.023
-.013	-.003	0.008	0.020	0.020	0.024	0.028
0.033	0.037	0.041	0.045	0.032	0.032	0.033
0.034	0.035	0.036	0.036	0.045	0.053	0.054
0.055	0.055	0.060	0.054	0.067	0.055	0.050
0.052	0.048	0.045	0.041	0.000	-.002	0.003
0.002	0.001	0.000	-.020	-.025	0.000	0.001
0.000	-.001	-.002	-.004	-.036	-.030	-.025
-.020	-.010	-.006	0.000	-.038	-.029	-.020
-.009	0.003	0.011	0.020	-.014	-.004	0.005
0.015	0.023	0.033	0.042	0.031	0.033	0.036
0.040	0.043	0.046	0.049	0.044	0.045	0.042
0.049	0.050	0.050	0.051	0.029	0.028	0.029
0.032	0.032	0.032	0.031	0.012	0.006	0.000
-.005	-.010	-.016	-.023	-.028	-.027	-.032
-.037	-.047	-.051	-.057	-.051	-.050	-.050
-.053	-.052	-.055	-.056	-.053	-.041	-.028
-.017	-.004	0.008	0.023	0.017	0.017	0.023
0.031	0.035	0.040	0.044	0.033	0.032	0.032
0.032	0.032	0.033	0.032	0.052	0.053	0.063
0.063	0.063	0.070	0.073	0.068	0.060	0.055
0.056	0.050	0.046	0.043	-.012	-.010	-.002
0.002	0.005	0.010	0.000	0.000	0.003	0.003
0.002	0.001	0.000	-.002	-.039	-.034	-.028
-.023	-.013	-.008	-.002	-.038	-.030	-.022
-.011	0.000	0.007	0.016	-.013	-.003	0.007
0.018	0.026	0.036	0.046	0.034	0.036	0.038
0.041	0.044	0.046	0.048	0.049	0.050	0.048
0.054	0.055	0.055	0.057	0.030	0.030	0.031
0.034	0.034	0.035	0.035	0.011	0.005	0.000
-.005	-.010	-.016	-.023	-.034	-.035	-.040

Sample input (contd)

-.046	-.056	-.058	-.063	0.050	-.051	-.052
-.056	-.059	-.061	-.063	0.062	-.048	-.034
-.020	-.006	0.008	0.025	0.014	0.019	0.024
0.029	0.034	0.039	0.044	0.033	0.032	0.031
0.030	0.029	0.028	0.028	0.059	0.063	0.067
0.070	0.073	0.077	0.081	0.075	0.070	0.065
0.060	0.055	0.050	0.045	-.024	-.016	-.008
0.002	0.011	0.019	0.027	0.007	0.006	0.005
0.004	0.003	0.002	0.000	-.043	-.039	-.033
-.026	-.016	-.010	-.004	-.038	-.030	-.024
-.014	-.004	0.004	0.012	-.011	-.001	0.010
0.020	0.030	0.040	0.051	0.037	0.039	0.041
0.042	0.044	0.046	0.048	0.053	0.055	0.056
0.058	0.059	0.061	0.063	0.031	0.032	0.033
0.035	0.036	0.037	0.038	0.010	0.005	0.000
-.005	-.010	-.016	-.023	-.039	-.044	-.049
-.055	-.061	-.066	-.071	-.050	-.052	-.054
-.066	-.069	-.072	-.075	-.018	-.016	-.015
-.014	-.013	-.012	-.010	0.021	0.021	0.020
0.020	0.020	0.019	0.019	0.036	0.034	0.032
0.030	0.028	0.026	0.025	0.059	0.055	0.051
0.045	0.039	0.035	0.031	-.004	-.009	-.015
-.020	-.025	-.030	-.035	-.024	-.020	-.016
-.013	-.010	-.006	-.003	0.017	0.012	0.006
0.001	-.005	-.010	-.015	-.005	-.014	-.023
-.030	-.038	-.047	-.056	-.016	-.016	-.017
-.018	-.019	-.020	-.020	0.010	0.011	0.013
0.015	0.017	0.019	0.021	0.056	0.052	0.049
0.045	0.041	0.038	0.034	0.075	0.068	0.061
0.054	0.047	0.040	0.033	0.070	0.060	0.050
0.040	0.030	0.020	0.009	0.032	0.017	0.002
-.014	-.031	-.046	-.061	-.004	-.019	-.035
-.050	-.065	-.081	-.097	-.056	-.059	-.063
-.063	-.065	-.068	-.070	-.018	-.015	-.013
-.011	-.008	-.005	-.003	0.026	0.025	0.024
0.023	0.023	0.021	0.021	0.036	0.034	0.033
0.032	0.030	0.028	0.028	0.029	0.055	0.051
0.047	0.043	0.039	0.035	-.001	-.005	-.012
-.015	-.021	-.026	-.032	-.021	-.017	-.013
-.009	-.006	-.002	0.000	0.017	0.012	0.006
0.000	-.006	-.012	-.018	-.008	-.016	-.025
-.032	-.041	-.050	-.059	-.024	-.023	-.023
-.023	-.023	-.022	-.021	0.008	0.009	0.012
0.015	0.017	0.019	0.022	0.054	0.051	0.048
0.045	0.042	0.039	0.036	0.073	0.067	0.060
0.054	0.048	0.042	0.035	0.072	0.063	0.052
0.043	0.033	0.023	0.013	0.035	0.020	0.005
-.010	-.027	-.042	-.057	-.010	-.025	-.038
-.052	-.065	-.078	-.094	-.054	-.057	-.060
-.059	-.061	-.063	-.065	-.019	-.015	-.010
-.007	-.004	0.000	0.004	0.031	0.030	0.028
0.027	0.026	0.024	0.023	0.035	0.034	0.033
0.033	0.032	0.031	0.030	0.059	0.056	0.052
0.049	0.046	0.042	0.039	0.002	-.003	-.007
-.011	-.017	-.023	-.029	-.018	-.014	-.010
-.006	-.003	0.000	0.003	0.017	0.011	0.005
-.001	-.008	-.014	-.020	-.010	-.018	-.027
-.035	-.043	-.053	-.061	-.032	-.030	-.029
-.028	-.026	-.024	-.023	0.005	0.008	0.011
0.014	0.017	0.020	0.023	0.050	0.049	0.047
0.045	0.042	0.040	0.038	0.072	0.066	0.060
0.055	0.050	0.044	0.038	0.074	0.065	0.055
0.046	0.036	0.026	0.017	0.039	0.024	0.009
-.006	-.022	-.038	-.053	-.017	-.029	-.042
-.054	-.065	-.076	-.089	-.053	-.055	-.057
-.056	-.058	-.060	-.060	-.019	-.014	-.009
-.003	0.002	0.007	0.012	0.036	0.034	0.032
0.030	0.028	0.026	0.024	0.035	0.035	0.034
0.034	0.033	0.032	0.032	0.058	0.056	0.054
0.052	0.049	0.046	0.043	0.005	0.000	-.003
-.007	-.013	-.019	-.026	-.015	-.011	-.007
-.003	0.000	0.003	0.007	0.018	0.011	0.005
-.002	-.009	-.016	-.022	-.013	-.021	-.030
-.038	-.046	-.055	-.063	-.040	-.037	-.035
-.033	-.029	-.026	-.024	0.002	0.006	0.009
0.013	0.017	0.020	0.024	0.047	0.047	0.045
0.044	0.043	0.042	0.041	0.071	0.065	0.060
0.056	0.051	0.046	0.041	0.075	0.066	0.058
0.049	0.040	0.030	0.021	0.043	0.028	0.013
-.002	-.018	-.033	-.049	-.023	-.035	-.045
-.056	-.065	-.075	-.086	-.051	-.053	-.055
-.053	-.054	-.054	-.055	-.020	-.014	-.007
0.000	0.006	0.012	0.019	0.041	0.038	0.035
0.033	0.031	0.028	0.026	0.035	0.035	0.035
0.035	0.034	0.034	0.034	0.058	0.056	0.055
0.054	0.052	0.050	0.049	0.008	0.004	0.000
-.003	-.009	-.016	-.022	-.012	-.008	-.004
0.000	0.003	0.007	0.011	0.018	0.011	0.004
-.003	-.010	-.017	-.024	-.015	-.023	-.032
-.040	-.048	-.057	-.065	-.048	-.044	-.040
-.037	-.033	-.029	-.025	0.000	0.004	0.008
0.013	0.017	0.021	0.025	0.045	0.045	0.044

Sample input (contd)

0.044	0.044	0.043	0.043	0.069	0.064	0.060
0.056	0.052	0.048	0.043	0.076	0.068	0.060
C.052	0.043	0.034	0.025	0.048	0.032	0.017
0.002	-.013	-.029	-.045	-.030	-.039	-.048
-.057	-.066	-.076	-.085	-.050	-.051	-.052
-.049	-.050	-.050	-.050	-.020	-.013	-.005
0.003	0.010	0.018	0.026	0.046	0.043	0.040
0.036	0.034	0.031	0.028	0.035	0.035	0.035
0.036	0.036	0.036	0.037	0.058	0.057	0.055
0.056	0.055	0.054	0.054	0.011	0.008	0.005
0.001	-.005	-.011	-.017	-.008	-.004	0.000
0.003	0.006	0.010	0.015	0.018	0.011	0.004
-.003	-.011	-.019	-.027	-.017	-.025	-.035
-.043	-.050	-.060	-.068	-.056	-.052	-.046
-.041	-.036	-.031	-.026	-.002	0.002	0.007
0.013	0.017	0.022	0.026	0.043	0.043	0.043
0.044	0.044	0.045	0.045	0.068	0.064	0.060
0.056	0.053	0.049	0.045	0.077	0.070	0.062
0.055	0.046	0.038	0.029	0.053	0.037	0.022
0.006	-.009	-.026	-.041	-.036	-.045	-.052
-.058	-.067	-.075	-.084	-.049	-.049	-.049
-.046	-.046	-.045	-.045	-.020	-.013	-.003
0.006	0.015	0.023	0.033	0.051	0.048	0.044
0.040	0.036	0.033	0.030	0.035	0.035	0.036
0.037	0.037	0.038	0.039	0.057	0.057	0.057
0.058	0.058	0.058	0.058	0.014	0.012	0.009
0.006	0.000	-.006	-.012	-.004	0.000	0.003
0.006	0.010	0.014	0.018	0.019	0.011	0.004
-.004	-.012	-.020	-.029	-.020	-.028	-.037
-.045	-.053	-.062	-.070	-.064	-.059	-.052
-.045	-.039	-.033	-.027	-.005	-.001	0.006
0.012	0.017	0.023	0.027	0.040	0.042	0.043
0.044	0.045	0.047	0.048	0.066	0.063	0.060
0.057	0.055	0.052	0.048	0.078	0.071	0.064
0.057	0.049	0.041	0.033	0.057	0.042	0.026
0.010	-.006	-.022	-.038	-.043	-.050	-.055
-.060	-.066	-.073	-.081	-.047	-.047	-.046
-.043	-.043	-.042	-.040	-.021	-.010	0.000
0.009	0.020	0.030	0.040	0.056	0.052	0.047
0.043	0.040	0.036	0.032	0.034	0.035	0.036
0.038	0.038	0.040	0.041	0.057	0.058	0.058
C.059	0.060	0.062	0.062	0.017	0.015	0.013
0.010	0.004	-.002	-.008	0.000	0.003	0.005
0.009	0.013	0.018	0.022	0.019	0.011	0.003
-.005	-.013	-.022	-.031	-.023	-.031	-.040
-.048	-.055	-.064	-.072	-.072	-.065	-.058
-.050	-.044	-.035	-.028	-.008	-.001	0.005
0.011	0.015	0.022	0.028	0.037	0.040	0.042
0.044	0.046	0.048	0.050	0.064	0.062	0.060
0.058	0.056	0.054	0.051	0.080	0.073	0.066
0.059	0.052	0.044	0.037	0.061	0.046	0.030
0.014	-.002	-.018	-.034	-.049	-.055	-.059
-.062	-.067	-.073	-.078	-.046	-.045	-.044
-.040	-.039	-.037	-.035	-.021	-.010	0.002
0.013	0.024	0.036	0.048	0.061	0.056	0.052
0.047	0.043	0.039	0.034	0.034	0.035	0.037
0.039	0.040	0.041	0.043	0.057	0.058	0.060
0.061	0.063	0.065	0.066	0.020	0.019	0.017
0.015	0.009	0.003	-.003	0.001	0.005	0.009
0.013	0.017	0.022	0.026	0.020	0.011	0.002
-.006	-.015	-.024	-.033	-.026	-.034	-.042
-.050	-.058	-.066	-.074	-.080	-.072	-.064
-.055	-.046	-.037	-.029	-.009	-.002	0.004
0.010	0.016	0.022	0.029	0.035	0.038	0.041
0.044	0.047	0.050	0.053	0.063	0.061	0.059
0.058	0.057	0.055	0.053	0.082	0.075	0.068
0.061	0.054	0.047	0.041	0.065	0.049	0.033
0.017	0.002	-.014	-.030	-.056	-.059	-.062
-.065	-.068	-.072	-.075	-.044	-.043	-.042

	4		
0.0	0.	1.5	100.
90.0	0.	1.5	100.
180.0	0.	1.5	100.
270.0	0.	1.5	100.

-EOF

Sample input (program 5345)

85	6	4	66				
1.221	432.	0.	0.	2.0	-50.	0.	
2.0							
9	2	1	2				
1	24	24	24	24	24	24	
24	24						
0.	1.0	1.0	1.0	1.0	1.0	1.0	
1.0	1.0						
90.	0.	2.0	50.				
270.	0.	2.	50.				
0.							1
58.50	7.70		-.00134	.02254	.02141	3.72	10703
54.52	22.58		-.00175	.02225	.02411	3.72	10701
46.81	35.92		-.00325	.02086	.02621	3.72	10403
35.92	46.81		-.00293	.02026	.02973	3.72	10401
22.58	54.52		-.00136	.02141	.03275	3.72	10107
7.70	58.50		-.00047	.02122	.03278	3.72	10105
-7.70	58.50		.00047	.02122	.03278	3.72	20105
-22.58	54.52		.00136	.02141	.03275	3.72	20107
-35.92	46.81		.00293	.02026	.02973	3.72	20401
-46.81	35.92		.00325	.02086	.02621	3.72	20403
-54.81	22.58		.00175	.02225	.02411	3.72	20701
-58.50	7.70		.00134	.02254	.02141	3.72	20703
-58.50	-7.70		.00013	.02249	.01580	3.72	30705
-54.81	-22.58		-.00167	.02182	.01085	3.72	31101
-46.81	-35.92		-.00293	.02063	.00729	3.72	31103
-35.92	-46.81		-.00246	.02028	.00754	3.72	31401
-22.58	-54.52		-.00151	.02042	.00713	3.72	31403
-7.70	-58.50		-.00047	.02088	.00595	3.72	31405
7.70	-58.50		.00047	.02088	.00595	3.72	41405
22.58	-54.52		.00151	.02042	.00713	3.72	41403
35.92	-46.81		.00246	.02028	.00754	3.72	41401
46.81	-35.92		.00293	.02063	.00729	3.72	41103
54.81	-22.58		.00167	.02182	.01085	3.72	41101
58.50	-7.70		-.00013	.02249	.01580	3.72	40705
114.02	15.01		-.00121	.01578	.02364	17.65	10709
106.26	44.02		-.00032	.01659	.02859	17.65	10707
91.25	70.02		-.00311	.01565	.03778	17.65	10407
70.02	91.25		-.00269	.01671	.04446	17.65	10405
44.02	106.26		-.00057	.02083	.04722	17.65	10113
15.01	114.02		-.00012	.02168	.04666	17.65	10111
-15.01	114.02		.00012	.02168	.04666	17.65	20111
-44.02	106.26		.00057	.02083	.04722	17.65	20113
-70.02	91.25		.00269	.01671	.04446	17.65	20405
-91.25	70.02		.00311	.01565	.03778	17.65	20407
-106.26	44.02		.00032	.01659	.02859	17.65	20707
-114.02	15.01		.00121	.01578	.02364	17.65	20709
-114.02	-15.01		.00122	.01542	.01197	17.65	30711
-106.26	-44.02		-.00023	.01556	.00276	17.65	31105
-91.25	-70.02		-.00179	.01542	-.00232	17.65	31107
-70.02	-91.25		-.00138	.01655	-.00284	17.65	31409
-44.02	-106.26		-.00057	.01831	-.00350	17.65	31411
-15.01	-114.02		.00002	.02013	-.00826	17.65	31413
15.01	-114.02		-.00002	.02013	-.00826	17.65	41413
44.02	-106.26		.00057	.01831	-.00350	17.65	41411
70.02	-91.25		.00138	.01655	-.00284	17.65	41409
91.25	-70.02		.00179	.01542	-.00232	17.65	41107
106.26	-44.02		.00023	.01556	.00276	17.65	41105
114.02	-15.01		-.00122	.01542	.01197	17.65	40711
211.73	27.88		-.00146	.02044	.01728	34.69	10909
197.32	82.57		-.00116	.01990	.02956	34.69	10907
169.44	130.02		-.00768	.01596	.05965	34.69	10510
130.02	169.44		-.00663	.01655	.07050	34.69	10508
82.57	197.32		-.00164	.02314	.05997	34.69	10211
27.88	211.73		-.00061	.02238	.05848	34.69	10209
-27.88	211.73		.00061	.02238	.05848	34.69	20209
-82.57	197.32		.00164	.02314	.05997	34.69	20211
-130.02	169.44		.00663	.01655	.07050	34.69	20508
-169.44	130.02		.00768	.01596	.05965	34.69	20510
-197.32	82.57		.00116	.01990	.02956	34.69	20907
-211.73	27.88		.00146	.02044	.01728	34.69	20909
-211.73	-27.88		-.00070	.02052	.00116	34.69	30911
-197.32	-82.57		-.00260	.01964	-.00686	34.69	31208
-169.44	-130.02		-.00384	.01779	-.00893	34.69	31210
-130.02	-169.44		-.00281	.01665	-.01771	34.69	31511
-82.57	-197.32		-.00311	.01199	-.03931	34.69	31513
-27.88	-211.73		-.00069	.01496	-.04647	34.69	31515
27.88	-211.73		.00069	.01496	-.04647	34.69	41515
82.57	-197.32		.00311	.01199	-.03931	34.69	41513
130.02	-169.44		.00281	.01665	-.01771	34.69	41511
169.44	-130.02		.00384	.01779	-.00893	34.69	41210
197.32	-82.57		.00260	.01964	-.00686	34.69	41208
211.73	-27.88		.00070	.02052	.00116	34.69	40911
291.18	38.34		-.00170	.01913	.01124	17.27	10916
271.33	112.39		-.00038	.02099	.02544	17.27	10913
233.00	178.79		-.00142	.02133	.03938	17.27	10515
178.79	233.00		-.00137	.02144	.05004	17.27	10512
112.39	271.33		.00036	.02442	.05855	17.27	10218
38.34	291.18		-.00005	.02226	.06348	17.27	10215
-38.34	291.18		.00005	.02226	.06348	17.27	20215
-112.39	271.33		-.00036	.02442	.05855	17.27	20218
-178.79	233.00		.00137	.02144	.05004	17.27	20512
-233.00	178.79		.00142	.02133	.03938	17.27	20515
-271.33	112.39		.00038	.02099	.02544	17.27	20913
-291.18	38.34		.00170	.01913	.01124	17.27	20916
-291.18	-38.34		-.00145	.01720	-.00779	17.27	30919
-271.33	-112.39		-.00613	.01392	-.02992	17.27	31212
-233.00	-178.79		-.01023	.00962	-.04756	17.27	31215
-178.79	-233.00		-.00873	.00815	-.06339	17.27	31519
-112.39	-271.33		-.00750	.00577	-.08386	17.27	31522
-38.34	-291.18		-.00249	.01097	-.07376	17.27	31525

Sample input (contd)

38.34	-291.18	.00249	.01097	-.07376	17.27	41525
112.39	-271.33	.00750	.00577	-.08386	17.27	41522
178.79	-233.00	.00873	.00815	-.06339	17.27	41519
233.00	-178.79	.01023	.00962	-.04756	17.27	41215
271.33	-112.39	.00613	.01392	-.02992	17.27	41212
291.18	-38.34	.00145	.01720	-.00779	17.27	40919
345.60	45.50	-.00188	.01627	.00989	17.25	11005
322.10	133.40	.00099	.01962	.02185	17.25	11001
276.60	212.20	.00276	.02311	.02616	17.25	10605
212.20	276.60	.00395	.02311	.03714	17.25	10601
133.40	322.10	.00331	.02461	.05567	17.25	10307
45.50	345.60	.00060	.02155	.06543	17.25	10303
-45.50	345.60	-.00060	.02155	.06543	17.25	20303
-133.40	322.10	-.00331	.02461	.05567	17.25	20307
-212.20	276.60	-.00395	.02311	.03714	17.25	20601
-276.60	212.20	-.00276	.02311	.02616	17.25	20605
-322.10	133.40	-.00099	.01962	.02185	17.25	21001
-345.60	45.50	.00188	.01627	.00989	17.25	21005
-345.60	-45.50	-.00139	.01370	-.01230	17.25	31009
-322.10	-133.40	-.00862	.00901	-.04460	17.25	31301
-276.60	-212.20	-.01709	.00164	-.07655	17.25	31305
-212.20	-276.60	-.01074	.00262	-.08382	17.25	31601
-133.40	-322.10	-.00637	.00536	-.09127	17.25	31605
-45.50	-345.60	-.00226	.00949	-.08386	17.25	31609
45.50	-345.60	.00226	.00949	-.08386	17.25	41609
133.40	-322.10	.00637	.00536	-.09127	17.25	41605
212.20	-276.60	.01074	.00262	-.08382	17.25	41601
276.60	-212.20	.01709	.00164	-.07655	17.25	41305
322.10	-133.40	.00862	.00901	-.04460	17.25	41301
345.60	-45.50	.00139	.01370	-.01230	17.25	41009
399.20	52.60	-.00316	.01503	.01093	19.34	11017
372.00	154.10	.00014	.02095	.02063	19.34	11013
319.40	245.10	.00575	.02602	.01584	19.34	10614
245.10	319.40	.00744	.02597	.02671	19.34	10610
154.10	372.00	.00564	.02394	.05452	19.34	10317
52.60	399.20	.00156	.01984	.06863	19.34	10313
-52.60	399.20	-.00156	.01984	.06863	19.34	20313
-154.10	372.00	-.00564	.02394	.05452	19.34	20317
-245.10	319.40	-.00744	.02597	.02671	19.34	20610
-319.40	245.10	-.00575	.02602	.01584	19.34	20614
-372.00	154.10	-.00014	.02095	.02063	19.34	21013
-399.20	52.60	.00316	.01503	.01093	19.34	21017
-399.20	-52.60	-.00002	.00889	-.01346	19.34	31021
-372.00	-154.10	-.00915	.00074	-.05633	19.34	31310
-319.40	-245.10	-.02460	-.00814	-.10699	19.34	31314
-245.10	-319.40	-.01782	-.00034	-.10303	19.34	31613
-154.10	-372.00	-.00990	.00597	-.09791	19.34	31617
-52.60	-399.20	-.00334	.00897	-.08972	19.34	31621
52.60	-399.20	.00334	.00897	-.08972	19.34	41621
154.10	-372.00	.00990	.00597	-.09791	19.34	41617
245.10	-319.40	.01782	-.00034	-.10303	19.34	41613
319.40	-245.10	.02460	-.00814	-.10699	19.34	41314
372.00	-154.10	.00915	.00074	-.05633	19.34	41310
399.20	-52.60	.00002	.00889	-.01346	19.34	41021
450.60	59.30	-.00565	.01439	.01364	22.21	11028
419.90	173.90	-.00053	.01860	.02180	22.21	11025
360.60	276.70	.01008	.02744	.00605	22.21	10621
276.70	360.60	.00987	.03002	.01652	22.21	10618
173.90	419.90	.00419	.02376	.05517	22.21	10326
59.30	450.60	.00081	.01758	.07258	22.21	10323
-59.30	450.60	-.00081	.01758	.07258	22.21	20323
-173.90	419.90	-.00419	.02376	.05517	22.21	20326
-276.70	360.60	-.00987	.03002	.01652	22.21	20618
-360.60	276.70	-.01008	.02744	.00605	22.21	20621
-419.90	173.90	.00053	.01860	.02180	22.21	21025
-450.60	59.30	.00565	.01439	.01364	22.21	21028
-450.60	-59.30	.00191	.01132	-.01183	22.21	31031
-419.90	-173.90	-.01256	.00375	-.06361	22.21	31318
-360.60	-276.70	-.03225	-.01201	-.12715	22.21	31321
-276.70	-360.60	-.01967	-.00533	-.11719	22.21	31625
-173.90	-419.90	-.00816	.00567	-.10143	22.21	31628
-59.30	-450.60	-.00233	.01005	-.09185	22.21	31631
59.30	-450.60	.00233	.01005	-.09185	22.21	41631
173.90	-419.90	.00816	.00567	-.10143	22.21	41628
276.70	-360.60	.01967	-.00533	-.11719	22.21	41625
360.60	-276.70	.03225	-.01201	-.12715	22.21	41321
419.90	-173.90	.01256	.00375	-.06361	22.21	41318
450.60	-59.30	-.00191	.01132	-.01183	22.21	41031
505.60	66.60	-.01095	.01344	.02171	25.00	11036
471.20	195.20	-.00431	.01775	.02744	25.00	11034
404.60	310.50	.01262	.03002	-.00102	25.00	10626
310.50	404.60	.01302	.03309	.00832	25.00	10624
195.20	471.20	.00444	.02162	.05806	25.00	10332
66.60	505.60	.00076	.01394	.07860	25.00	10330
-66.60	505.60	-.00076	.01394	.07860	25.00	20330
-195.20	471.20	-.00444	.02162	.05806	25.00	20332
-310.50	404.60	-.01302	.03309	.00832	25.00	20624
-404.60	310.50	-.01262	.03002	-.00102	25.00	20626
-471.20	195.20	.00431	.01775	.02744	25.00	21034
-505.60	66.60	.01095	.01344	.02171	25.00	21036
-505.60	-66.60	.00742	.01068	-.00409	25.00	31038
-471.20	-195.20	-.01067	.00265	-.06329	25.00	31324
-404.60	-310.50	-.03710	-.01649	-.14097	25.00	31326
-310.50	-404.60	-.02133	-.00586	-.12220	25.00	31635
-195.20	-471.20	-.00760	.01027	-.09627	25.00	31637
-66.60	-505.60	-.00200	.01592	-.08429	25.00	31639
66.60	-505.60	.00200	.01592	-.08429	25.00	41639
195.20	-471.20	.00760	.01027	-.09627	25.00	41637
310.50	-404.60	.02133	-.00586	-.12220	25.00	41635
404.60	-310.50	.03710	-.01649	-.14097	25.00	41326
471.20	-195.20	.01067	.00265	-.06329	25.00	41324
505.60	-66.60	-.00742	.01068	-.00409	25.00	41038

Sample output (program 5338)

```
RADIATION PATTERN COMPUTATION        ENGINEER  PHIL POTTER         FORMULATION  CHUCK LAWSON

      CASE NUMBER  522
       30FT REFLECTOR AAS SCALE HORIZON DEFLECTED SURFACE BEST-FITTED

                INPUT VALUES

                       PROP. CONSTANT    FOCAL LENGTH      FACTOR          RADIUS       NO. OF BETA
                          1/INCHES          INCHES           DB            INCHES          VALUES
                           8.693           150.000           0.
                                                                            0.               1
                                                                            7.000          112
                                                                           14.000          112
                                                                           21.000          112
                                                                           28.000          112
                                                                           35.000          112
                                                                           42.000          112
                                                                           49.000          112
                                                                           56.000          112
                                                                           63.000          112
                                                                           70.000          112
                                                                           77.000          112
                                                                           84.000          112
                                                                           91.000          112
                                                                           98.000          112
                                                                          105.000          112
                                                                          112.000          112
                                                                          119.000          112
                                                                          126.000          112
                                                                          133.000          112
                                                                          140.000          112
                                                                          147.000          112
                                                                          154.000          112
                                                                          161.000          112
                                                                          168.000          112
                                                                          175.000          112
                                                                          180.000          112

RADIATION PATTERN COMPUTATION        ENGINEER  PHIL POTTER         FORMULATION  CHUCK LAWSON

      CASE NUMBER  522

                INPUT ARRAYS

                       W ARRAY       I,J
                                     1
                                               0.
                                     2
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                     3
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                               0.        0.        0.        0.        0.        0.        0.        0.
                                     4
                                               0.        1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               1.000     1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               1.000     1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               1.000     1.000     1.000     0.        0.        0.        1.000     1.000
                                               1.000     1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               1.000     1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               1.000     1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               0.        1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               1.000     1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               1.000     1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               1.000     1.000     1.000     0.        0.        0.        1.000     1.000
                                               1.000     1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               1.000     1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               1.000     1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                     5
                                               0.        1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               1.000     1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               1.000     1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               1.000     1.000     1.000     0.        0.        0.        1.000     1.000
                                               1.000     1.000     1.000     1.000     1.000     1.000     1.000     1.000
                                               1.000     1.000     1.000     1.000     1.000     1.000     1.000     1.000
```

Sample output (contd)

1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	0.	0.	0.	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

6

0.	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	0.	0.	0.	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	0.	0.	0.	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

7

0.	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	0.	0.	0.	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	0.	0.	0.	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

8

0.	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	0.	0.	0.	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	0.	0.	0.	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

9

0.	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.	0.	0.	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.995	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.	0.	0.	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955

10

0.	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.	0.	0.	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.995	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.	0.	0.	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955

11

0.	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.	0.	0.	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.995	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.	0.	0.	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955

Sample output (contd)

12

0.	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.	0.	0.	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.	0.	0.	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917

13

0.	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.	0.	0.	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.	0.	0.	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917

14

0.	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.	0.	0.	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.	0.	0.	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861

15

0.	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.	0.	0.	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.	0.	0.	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861

16

0.	0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.	0.	0.	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.	0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.	0.	0.	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776	0.776
0.776	0.776	0.776	0.776	0.776	0.776	0.776	0.776

17

0.	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.	0.	0.	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.	0.	0.	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861
0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861

18

0.	0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.	0.	0.	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.	0.668	0.668	0.668	0.668	0.668	0.668	0.668
0.668	0.668	0.668	0.668	0.668	0.668	0.668	0.668

Sample output (contd)

	0.668	0.668	0.668	0.668	0.668	0.668	0.668	0.668
	0.668	0.668	0.668	0.	0.	0.	0.668	0.668
	0.668	0.668	0.668	0.668	0.668	0.668	0.668	0.668
	0.668	0.668	0.668	0.668	0.668	0.668	0.668	0.668
	0.668	0.668	0.668	0.668	0.668	0.668	0.668	0.668
19								
	0.	0.841	0.841	0.841	0.841	0.841	0.841	0.841
	0.841	0.841	0.841	0.841	0.841	0.841	0.841	0.841
	0.841	0.841	0.841	0.841	0.841	0.841	0.841	0.841
	0.841	0.841	0.841	0.	0.	0.	0.841	0.841
	0.841	0.841	0.841	0.841	0.841	0.841	0.841	0.841
	0.841	0.841	0.841	0.841	0.841	0.841	0.841	0.841
	0.841	0.841	0.841	0.841	0.841	0.841	0.841	0.841
	0.	0.841	0.841	0.841	0.841	0.841	0.841	0.841
	0.841	0.841	0.841	0.841	0.841	0.841	0.841	0.841
	0.841	0.841	0.841	0.841	0.841	0.841	0.841	0.841
	0.841	0.841	0.841	0.	0.	0.	0.841	0.841
	0.841	0.841	0.841	0.841	0.841	0.841	0.841	0.841
	0.841	0.841	0.841	0.841	0.841	0.841	0.841	0.841
	0.841	0.841	0.841	0.841	0.841	0.841	0.841	0.841
20								
	0.	0.596	0.596	0.596	0.596	0.596	0.596	0.596
	0.596	0.596	0.596	0.596	0.596	0.596	0.596	0.596
	0.596	0.596	0.596	0.596	0.596	0.596	0.596	0.596
	0.596	0.596	0.596	0.	0.	0.	0.596	0.596
	0.596	0.596	0.596	0.596	0.596	0.596	0.596	0.596
	0.596	0.596	0.596	0.596	0.596	0.596	0.596	0.596
	0.596	0.596	0.596	0.596	0.596	0.596	0.596	0.596
	0.	0.596	0.596	0.596	0.596	0.596	0.596	0.596
	0.596	0.596	0.596	0.596	0.596	0.596	0.596	0.596
	0.596	0.596	0.596	0.596	0.596	0.596	0.596	0.596
	0.596	0.596	0.596	0.	0.	0.	0.596	0.596
	0.596	0.596	0.596	0.596	0.596	0.596	0.596	0.596
	0.596	0.596	0.596	0.596	0.596	0.596	0.596	0.596
	0.596	0.596	0.596	0.596	0.596	0.596	0.596	0.596
21								
	0.	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.	0.	0.	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.	0.	0.	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
22								
	0.	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.	0.	0.	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.	0.	0.	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
23								
	0.	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.	0.	0.	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.	0.	0.	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
24								
	0.	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.	0.	0.	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.	0.	0.	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562
	0.562	0.562	0.562	0.562	0.562	0.562	0.562	0.562

Sample output (contd)

25

0.	0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.	0.	0.	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.	0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.	0.	0.	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.473	0.473	0.473	0.473	0.473	0.473	0.473	0.473

26

0.	0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.	0.	0.	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.	0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.	0.	0.	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316
0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316

27

0.	0.211	0.211	0.211	0.211	0.211	0.211	0.
0.211	0.211	0.211	0.211	0.211	0.211	0.	0.211
0.211	0.211	0.211	0.211	0.211	0.	0.211	0.211
0.211	0.211	0.211	0.	0.	0.	0.211	0.211
0.211	0.211	0.211	0.	0.211	0.211	0.211	0.211
0.211	0.211	0.	0.211	0.211	0.211	0.211	0.211
0.211	0.	0.211	0.211	0.211	0.211	0.211	0.211
0.	0.211	0.211	0.211	0.211	0.211	0.211	0.
0.211	0.211	0.211	0.211	0.211	0.211	0.	0.211
0.211	0.211	0.211	0.211	0.211	0.	0.211	0.211
0.211	0.211	0.211	0.	0.	0.	0.211	0.211
0.211	0.211	0.211	0.	0.211	0.211	0.211	0.211
0.211	0.211	0.	0.211	0.211	0.211	0.211	0.211
0.211	0.	0.211	0.211	0.211	0.211	0.211	0.211

RADIATION PATTERN COMPUTATION   ENGINEER PHIL POTTER   FORMULATION CHUCK LAWSON

CASE NUMBER 522

INPUT ARRAYS

H3 ARRAY   I,J

1

15.000

2

15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000

3

15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000

Sample output (contd)

4

15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000

5

15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000

6

15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000

7

15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000

8

15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000

9

15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000

10

15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000

Sample output (contd)

	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
11								
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
12								
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
13								
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
14								
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
15								
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
16								
	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
17								
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000

Sample output (contd)

```
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
18
      25.000  25.000  25.000  25.000  25.000  25.000  25.000  25.000
      25.000  25.000  25.000  25.000  25.000  25.000  25.000  25.000
      25.000  25.000  25.000  25.000  25.000  25.000  25.000  25.000
      25.000  25.000  25.000  25.000  25.000  25.000  25.000  25.000
      25.000  25.000  25.000  25.000  25.000  25.000  25.000  25.000
      25.000  25.000  25.000  25.000  25.000  25.000  25.000  25.000
      25.000  25.000  25.000  25.000  25.000  25.000  25.000  25.000
      25.000  25.000  25.000  25.000  25.000  25.000  25.000  25.000
      25.000  25.000  25.000  25.000  25.000  25.000  25.000  25.000
      25.000  25.000  25.000  25.000  25.000  25.000  25.000  25.000
      25.000  25.000  25.000  25.000  25.000  25.000  25.000  25.000
      25.000  25.000  25.000  25.000  25.000  25.000  25.000  25.000
      25.000  25.000  25.000  25.000  25.000  25.000  25.000  25.000
      25.000  25.000  25.000  25.000  25.000  25.000  25.000  25.000
19
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
      10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
20
      20.000  20.000  20.000  20.000  20.000  20.000  20.000  20.000
      20.000  20.000  20.000  20.000  20.000  20.000  20.000  20.000
      20.000  20.000  20.000  20.000  20.000  20.000  20.000  20.000
      20.000  20.000  20.000  20.000  20.000  20.000  20.000  20.000
      20.000  20.000  20.000  20.000  20.000  20.000  20.000  20.000
      20.000  20.000  20.000  20.000  20.000  20.000  20.000  20.000
      20.000  20.000  20.000  20.000  20.000  20.000  20.000  20.000
      20.000  20.000  20.000  20.000  20.000  20.000  20.000  20.000
      20.000  20.000  20.000  20.000  20.000  20.000  20.000  20.000
      20.000  20.000  20.000  20.000  20.000  20.000  20.000  20.000
      20.000  20.000  20.000  20.000  20.000  20.000  20.000  20.000
      20.000  20.000  20.000  20.000  20.000  20.000  20.000  20.000
      20.000  20.000  20.000  20.000  20.000  20.000  20.000  20.000
      20.000  20.000  20.000  20.000  20.000  20.000  20.000  20.000
21
      36.000  36.000  36.000  36.000  36.000  36.000  36.000  36.000
      36.000  36.000  36.000  36.000  36.000  36.000  36.000  36.000
      36.000  36.000  36.000  36.000  36.000  36.000  36.000  36.000
      36.000  36.000  36.000  36.000  36.000  36.000  36.000  36.000
      36.000  36.000  36.000  36.000  36.000  36.000  36.000  36.000
      36.000  36.000  36.000  36.000  36.000  36.000  36.000  36.000
      36.000  36.000  36.000  36.000  36.000  36.000  36.000  36.000
      36.000  36.000  36.000  36.000  36.000  36.000  36.000  36.000
      36.000  36.000  36.000  36.000  36.000  36.000  36.000  36.000
      36.000  36.000  36.000  36.000  36.000  36.000  36.000  36.000
      36.000  36.000  36.000  36.000  36.000  36.000  36.000  36.000
      36.000  36.000  36.000  36.000  36.000  36.000  36.000  36.000
      36.000  36.000  36.000  36.000  36.000  36.000  36.000  36.000
      36.000  36.000  36.000  36.000  36.000  36.000  36.000  36.000
22
      27.000  27.000  27.000  27.000  27.000  27.000  27.000  27.000
      27.000  27.000  27.000  27.000  27.000  27.000  27.000  27.000
      27.000  27.000  27.000  27.000  27.000  27.000  27.000  27.000
      27.000  27.000  27.000  27.000  27.000  27.000  27.000  27.000
      27.000  27.000  27.000  27.000  27.000  27.000  27.000  27.000
      27.000  27.000  27.000  27.000  27.000  27.000  27.000  27.000
      27.000  27.000  27.000  27.000  27.000  27.000  27.000  27.000
      27.000  27.000  27.000  27.000  27.000  27.000  27.000  27.000
      27.000  27.000  27.000  27.000  27.000  27.000  27.000  27.000
      27.000  27.000  27.000  27.000  27.000  27.000  27.000  27.000
      27.000  27.000  27.000  27.000  27.000  27.000  27.000  27.000
      27.000  27.000  27.000  27.000  27.000  27.000  27.000  27.000
      27.000  27.000  27.000  27.000  27.000  27.000  27.000  27.000
      27.000  27.000  27.000  27.000  27.000  27.000  27.000  27.000
23
       6.000   6.000   6.000   6.000   6.000   6.000   6.000   6.000
       6.000   6.000   6.000   6.000   6.000   6.000   6.000   6.000
       6.000   6.000   6.000   6.000   6.000   6.000   6.000   6.000
       6.000   6.000   6.000   6.000   6.000   6.000   6.000   6.000
       6.000   6.000   6.000   6.000   6.000   6.000   6.000   6.000
       6.000   6.000   6.000   6.000   6.000   6.000   6.000   6.000
       6.000   6.000   6.000   6.000   6.000   6.000   6.000   6.000
       6.000   6.000   6.000   6.000   6.000   6.000   6.000   6.000
       6.000   6.000   6.000   6.000   6.000   6.000   6.000   6.000
       6.000   6.000   6.000   6.000   6.000   6.000   6.000   6.000
       6.000   6.000   6.000   6.000   6.000   6.000   6.000   6.000
       6.000   6.000   6.000   6.000   6.000   6.000   6.000   6.000
       6.000   6.000   6.000   6.000   6.000   6.000   6.000   6.000
       6.000   6.000   6.000   6.000   6.000   6.000   6.000   6.000
```

Sample output (contd)

24

2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000

25

0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.

26

0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.

27

10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000

RADIATION PATTERN COMPUTATION   ENGINEER PHIL POTTER   FORMULATION CHUCK LAWSON

CASE NUMBER 522

INPUT ARRAYS

DZ ARRAY   I,J

1

0.

2

0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.

3

0.	0.	0.	0.	0.	0.	0.	0.
-0.	-0.	-0.	-0.	-0.	-0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.

Sample output (contd)

	0.	0.	0.	0.	0.	0.	-0.	-0.
	-0.	-0.	-0.	-0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	-0.	-0.	-0.	-0.	-0.	-0.
4								
	-0.029	-0.019	-0.010	-0.001	-0.063	-0.055	-0.046	-0.037
	-0.028	-0.019	-0.010	-0.020	-0.016	-0.012	-0.008	-0.004
	0.	0.004	-0.027	-0.023	-0.018	-0.013	-0.008	-0.004
	0.	0.	-0.003	-0.006	-0.009	-0.012	-0.015	-0.018
	-0.012	-0.014	-0.016	-0.017	-0.018	-0.020	-0.022	0.036
	0.028	0.020	0.013	0.006	-0.002	-0.010	0.011	0.006
	0.001	-0.004	-0.009	-0.013	-0.017	-0.018	-0.019	-0.020
	-0.021	-0.022	-0.023	-0.025	-0.036	-0.036	-0.036	-0.036
	-0.037	-0.037	-0.037	-0.053	-0.051	-0.049	-0.046	-0.044
	-0.042	-0.040	-0.040	-0.043	-0.046	-0.049	-0.052	-0.055
	-0.057	-0.047	-0.048	-0.049	-0.050	-0.051	-0.053	-0.055
	-0.035	-0.039	-0.044	-0.049	-0.053	-0.058	-0.062	-0.062
	-0.060	-0.058	-0.057	-0.053	-0.050	-0.052	-0.047	-0.052
	-0.057	-0.060	-0.062	-0.067	-0.072	-0.057	-0.048	-0.039
5								
	-0.029	-0.019	-0.010	-0.001	-0.063	-0.055	-0.046	-0.037
	-0.028	-0.019	-0.010	-0.020	-0.016	-0.012	-0.008	-0.004
	0.	0.004	-0.027	-0.023	-0.018	-0.013	-0.008	-0.004
	0.	0.	-0.003	-0.006	-0.009	-0.012	-0.015	-0.018
	-0.012	-0.014	-0.016	-0.017	-0.018	-0.020	-0.022	0.036
	0.028	0.020	0.013	0.006	-0.002	-0.010	0.011	0.006
	0.001	-0.004	-0.009	-0.013	-0.017	-0.018	-0.019	-0.020
	-0.021	-0.022	-0.023	-0.025	-0.036	-0.036	-0.036	-0.036
	-0.037	-0.037	-0.037	-0.053	-0.051	-0.049	-0.046	-0.044
	-0.042	-0.040	-0.040	-0.043	-0.046	-0.049	-0.052	-0.055
	-0.057	-0.047	-0.048	-0.049	-0.050	-0.051	-0.053	-0.055
	-0.035	-0.039	-0.044	-0.049	-0.053	-0.058	-0.062	-0.062
	-0.060	-0.058	-0.057	-0.053	-0.050	-0.052	-0.047	-0.052
	-0.057	-0.060	-0.062	-0.067	-0.072	-0.057	-0.048	-0.039
6								
	-0.030	-0.022	-0.013	-0.004	-0.057	-0.050	-0.041	-0.033
	-0.024	-0.016	-0.008	-0.014	-0.010	-0.005	0.	0.
	0.006	0.009	-0.020	-0.016	-0.010	-0.006	-0.002	0.002
	0.006	0.003	0.	-0.003	-0.004	-0.006	-0.008	-0.010
	-0.005	-0.007	-0.007	-0.010	-0.013	-0.014	-0.015	0.036
	0.028	0.020	0.008	0.004	-0.001	0.	0.	0.003
	0.002	-0.004	-0.009	-0.013	-0.016	-0.018	-0.019	-0.019
	-0.020	-0.020	-0.020	-0.022	-0.036	-0.034	-0.033	-0.032
	-0.032	-0.030	-0.029	-0.049	-0.046	-0.043	-0.037	-0.036
	-0.034	-0.033	-0.032	-0.034	-0.036	-0.039	-0.042	-0.044
	-0.044	-0.037	-0.038	-0.039	-0.040	-0.042	-0.044	-0.045
	-0.028	-0.031	-0.036	-0.040	-0.044	-0.048	-0.052	-0.051
	-0.050	-0.050	-0.049	-0.049	-0.046	-0.048	-0.042	-0.046
	-0.050	-0.055	-0.058	-0.062	-0.067	-0.056	-0.047	-0.039
7								
	-0.031	-0.024	-0.016	-0.008	-0.052	-0.045	-0.036	-0.029
	-0.021	-0.013	2.005	-0.008	-0.003	0.002	0.008	0.010
	0.012	0.014	-0.014	-0.009	-0.003	0.002	0.005	0.008
	0.012	0.006	0.004	0.003	0.001	0.	-0.001	-0.002
	0.002	0.	-0.002	-0.003	-0.003	-0.007	-0.009	0.036
	0.028	0.020	0.010	0.002	0.	-0.020	-0.025	0.
	-0.002	-0.004	-0.009	-0.013	-0.016	-0.019	-0.019	-0.018
	-0.018	-0.018	-0.017	-0.018	-0.036	-0.033	-0.030	-0.028
	-0.026	-0.021	-0.021	-0.045	-0.041	-0.037	-0.030	-0.028
	-0.026	-0.024	-0.025	-0.025	-0.027	-0.029	-0.031	-0.030
	-0.031	-0.027	-0.028	-0.029	-0.030	-0.032	-0.034	-0.035
	-0.021	-0.022	-0.028	-0.031	-0.034	-0.038	-0.042	-0.041
	-0.043	-0.045	-0.043	-0.042	-0.042	-0.044	-0.038	-0.040
	-0.045	-0.050	-0.054	-0.058	-0.063	-0.055	-0.047	-0.040
8								
	-0.033	-0.026	-0.019	-0.011	-0.047	-0.040	-0.031	-0.024
	-0.017	-0.010	-0.002	-0.002	0.002	0.007	0.012	0.015
	0.018	0.021	-0.007	-0.002	0.003	0.009	0.012	0.014
	0.018	0.009	0.008	0.007	0.006	0.006	0.006	0.006
	0.009	0.007	0.005	0.004	0.003	0.	-0.002	0.036
	0.028	0.020	0.010	0.002	0.	-0.080	-0.025	0.
	-0.002	-0.005	-0.008	-0.012	-0.015	-0.020	-0.019	-0.017
	-0.017	-0.016	-0.014	-0.014	-0.036	-0.032	-0.028	-0.024
	-0.020	-0.015	-0.013	-0.041	-0.036	-0.031	-0.024	-0.020
	-0.018	-0.015	-0.016	-0.017	-0.018	-0.019	-0.019	-0.018
	-0.018	-0.017	-0.018	-0.019	-0.020	-0.022	-0.024	-0.025
	-0.013	-0.014	-0.017	-0.022	-0.025	-0.028	-0.032	-0.032
	-0.036	-0.040	-0.035	-0.037	-0.038	-0.040	-0.034	-0.032
	-0.036	-0.041	-0.046	-0.053	-0.059	-0.055	-0.047	-0.041
9								
	-0.035	-0.028	-0.022	-0.015	-0.041	-0.034	-0.027	-0.020
	-0.014	-0.007	0.	0.004	0.008	0.012	0.015	0.019
	0.023	0.026	0.	0.004	0.008	0.014	0.017	0.020
	0.024	0.012	0.012	0.012	0.012	0.012	0.013	0.013
	0.016	0.014	0.012	0.011	0.010	0.007	0.005	0.036
	0.028	0.020	0.010	0.	-0.020	-0.090	-0.050	-0.025
	0.	-0.005	-0.008	-0.012	-0.015	-0.022	-0.019	-0.017
	-0.015	-0.014	-0.012	-0.010	-0.036	-0.031	-0.026	-0.020
	-0.015	-0.009	-0.003	-0.037	-0.031	-0.025	-0.018	-0.014
	-0.010	-0.006	-0.009	-0.009	-0.010	-0.007	-0.006	-0.005
	-0.004	-0.007	-0.008	-0.009	-0.010	-0.011	-0.013	-0.015
	-0.005	-0.006	-0.009	-0.013	-0.015	-0.018	-0.022	-0.023
	-0.027	-0.032	-0.029	-0.033	-0.034	-0.036	-0.028	-0.026
	-0.031	-0.036	-0.042	-0.048	-0.055	-0.054	-0.047	-0.042
10								
	-0.036	-0.030	-0.024	-0.018	-0.035	-0.028	-0.022	-0.016
	-0.010	-0.004	0.002	0.012	0.016	0.017	0.019	0.024
	0.028	0.033	0.007	0.011	0.014	0.019	0.024	0.027
	0.030	0.015	0.016	0.017	0.018	0.019	0.020	0.021
	0.023	0.022	0.020	0.019	0.017	0.015	0.012	0.036

Sample output (contd)

	0.028	0.019	0.010	0.	-0.050	-0.100	-0.100	-0.050
	0.	-0.005	-0.008	-0.012	-0.015	-0.024	-0.020	-0.017
	-0.014	-0.011	-0.010	-0.006	-0.036	-0.030	-0.023	-0.015
	-0.009	-0.003	0.007	-0.033	-0.025	-0.020	-0.012	-0.007
	-0.002	0.003	-0.001	-0.003	0.	0.004	0.006	0.007
	0.011	0.003	0.002	0.001	0.	-0.002	-0.004	-0.005
	0.003	0.002	-0.002	-0.004	-0.006	-0.008	-0.012	-0.014
	-0.019	-0.024	-0.023	-0.025	-0.028	-0.032	-0.023	-0.018
	-0.025	-0.031	-0.036	-0.043	-0.051	-0.054	-0.047	-0.042
11								
	-0.038	-0.032	-0.027	-0.021	-0.029	-0.023	-0.017	-0.011
	-0.006	0.	0.005	0.020	0.021	0.022	0.023	0.030
	0.034	0.038	0.014	0.018	0.022	0.026	0.030	0.034
	0.038	0.018	0.019	0.022	0.024	0.025	0.027	0.029
	0.030	0.029	0.027	0.026	0.025	0.022	0.019	0.036
	0.028	0.019	0.010	0.	-0.080	-0.154	-0.217	-0.100
	0.	-0.005	-0.008	-0.012	-0.014	-0.025	-0.020	-0.016
	-0.013	-0.007	-0.007	-0.002	-0.037	-0.028	-0.020	-0.011
	-0.003	0.003	0.015	-0.029	-0.020	-0.014	-0.006	0.
	0.006	0.012	0.007	0.006	0.010	0.016	0.018	0.020
	0.024	0.011	0.011	0.010	0.010	0.010	0.010	0.010
	0.011	0.010	0.008	0.005	0.003	0.002	-0.002	-0.005
	-0.010	-0.016	-0.017	-0.022	-0.024	-0.028	-0.019	-0.012
	-0.018	-0.026	-0.032	-0.038	-0.047	-0.053	-0.047	-0.043
12								
	-0.039	-0.034	-0.030	-0.025	-0.023	-0.018	-0.012	-0.007
	-0.003	0.004	0.008	0.025	0.027	0.029	0.031	0.035
	0.039	0.043	0.021	0.025	0.029	0.033	0.038	0.041
	0.044	0.020	0.023	0.026	0.029	0.033	0.035	0.037
	0.037	0.036	0.035	0.033	0.033	0.030	0.026	0.037
	0.028	0.019	0.010	0.	-0.080	-0.154	-0.217	-0.100
	0.	-0.005	-0.008	-0.012	-0.014	-0.025	-0.021	-0.016
	-0.011	-0.005	-0.003	0.002	-0.037	-0.027	-0.018	-0.007
	0.003	0.010	0.023	-0.024	-0.015	-0.008	0.	0.007
	0.014	0.021	0.015	0.016	0.020	0.026	0.030	0.033
	0.037	0.021	0.021	0.020	0.020	0.020	0.020	0.020
	0.019	0.017	0.016	0.014	0.013	0.012	0.011	0.004
	-0.002	-0.008	-0.011	-0.015	-0.020	-0.025	-0.015	-0.006
	-0.012	-0.021	-0.027	-0.034	-0.043	-0.053	-0.047	-0.043
13								
	-0.040	-0.036	-0.032	-0.028	-0.017	-0.012	-0.008	-0.003
	0.003	0.007	0.011	0.030	0.033	0.036	0.039	0.041
	0.044	0.048	0.030	0.034	0.036	0.040	0.044	0.046
	0.050	0.023	0.027	0.031	0.034	0.037	0.041	0.045
	0.045	0.044	0.042	0.040	0.039	0.037	0.035	0.037
	0.028	0.018	0.009	0.	-0.080	-0.154	-0.217	-0.100
	0.	-0.003	-0.006	-0.009	-0.013	-0.026	-0.021	-0.016
	-0.010	-0.004	0.001	0.006	-0.037	-0.026	-0.015	-0.003
	0.009	0.020	0.031	-0.019	-0.010	-0.002	0.006	0.014
	0.022	0.030	0.022	0.026	0.030	0.036	0.042	0.046
	0.050	0.031	0.030	0.030	0.030	0.030	0.030	0.031
	0.027	0.025	0.024	0.023	0.022	0.021	0.019	0.013
	0.007	0.001	-0.005	-0.011	-0.017	-0.023	-0.010	-0.001
	-0.008	-0.016	-0.021	-0.030	-0.039	-0.052	-0.048	-0.044
14								
	-0.043	-0.040	-0.038	-0.035	-0.026	-0.019	-0.013	-0.006
	0.	0.007	0.013	0.027	0.031	0.034	0.037	0.040
	0.044	0.047	0.031	0.033	0.035	0.038	0.040	0.043
	0.046	0.030	0.033	0.037	0.041	0.044	0.048	0.052
	0.052	0.047	0.045	0.044	0.041	0.039	0.037	0.025
	0.018	0.013	0.006	0.	-0.050	-0.100	-0.100	-0.050
	0.	-0.003	-0.006	-0.009	-0.009	-0.030	-0.024	-0.019
	-0.013	-0.006	-0.002	0.004	-0.037	-0.027	-0.016	-0.005
	0.007	0.017	0.027	-0.017	-0.008	0.	0.009	0.017
	0.024	0.034	0.025	0.029	0.032	0.037	0.042	0.046
	0.050	0.035	0.035	0.034	0.035	0.035	0.038	0.038
	0.028	0.026	0.025	0.026	0.024	0.024	0.023	0.013
	0.007	0.001	-0.005	-0.011	-0.017	-0.023	-0.016	-0.009
	-0.016	-0.023	-0.029	-0.037	-0.045	-0.052	-0.049	-0.046
15								
	-0.046	-0.044	-0.044	-0.042	-0.035	-0.027	-0.018	-0.010
	-0.002	0.008	0.016	0.023	0.027	0.031	0.035	0.039
	0.043	0.046	0.032	0.033	0.034	0.036	0.038	0.040
	0.041	0.037	0.043	0.047	0.048	0.050	0.055	0.045
	0.059	0.055	0.053	0.048	0.044	0.043	0.039	0.012
	0.008	0.006	0.004	0.	-0.020	-0.060	-0.050	-0.025
	0.	-0.002	-0.003	-0.004	-0.006	-0.033	-0.027	-0.022
	-0.016	-0.008	-0.004	0.002	-0.037	-0.028	-0.018	-0.007
	0.005	0.014	0.024	-0.015	-0.006	0.003	0.012	0.020
	0.028	0.038	0.028	0.031	0.034	0.038	0.043	0.046
	0.049	0.040	0.040	0.038	0.045	0.045	0.045	0.045
	0.029	0.027	0.027	0.028	0.028	0.028	0.027	0.012
	0.006	0.	-0.005	-0.011	-0.017	-0.023	-0.022	-0.018
	-0.024	-0.030	-0.038	-0.044	-0.051	-0.051	-0.050	-0.048
16								
	-0.050	-0.048	-0.050	-0.049	-0.044	-0.034	-0.023	-0.013
	-0.003	0.008	0.020	0.020	0.024	0.028	0.033	0.037
	0.041	0.045	0.032	0.032	0.033	0.034	0.035	0.036
	0.036	0.045	0.053	0.054	0.055	0.055	0.060	0.054
	0.067	0.055	0.050	0.052	0.048	0.045	0.041	0.
	-0.002	0.003	0.002	0.001	0.	-0.020	-0.025	0.
	0.001	0.	-0.001	-0.002	-0.004	-0.036	-0.030	-0.025
	-0.020	-0.010	-0.006	0.	-0.038	-0.029	-0.020	-0.009
	0.003	0.011	0.020	-0.014	-0.004	0.005	0.015	0.023
	0.033	0.042	0.031	0.033	0.036	0.040	0.043	0.046
	0.049	0.044	0.045	0.042	0.049	0.050	0.050	0.051
	0.029	0.028	0.029	0.032	0.032	0.032	0.031	0.012
	0.006	0.	-0.005	-0.010	-0.016	-0.023	-0.028	-0.027
	-0.032	-0.037	-0.047	-0.051	-0.057	-0.051	-0.050	-0.050

Sample output (contd)

17								
	-0.053	-0.052	-0.055	-0.056	-0.053	-0.041	-0.028	-0.017
	-0.004	0.008	0.023	0.017	0.017	0.023	0.031	0.035
	0.040	0.044	0.033	0.032	0.032	0.032	0.032	0.033
	0.032	0.052	0.053	0.063	0.063	0.063	0.070	0.073
	0.068	0.060	0.055	0.056	0.050	0.046	0.043	-0.012
	-0.010	-0.002	0.002	0.005	0.010	0.	0.	0.003
	0.003	0.002	0.001	0.	-0.002	-0.039	-0.034	-0.028
	-0.023	-0.013	-0.008	-0.002	-0.038	-0.030	-0.022	-0.011
	0.	0.007	0.016	-0.013	-0.003	0.007	0.018	0.026
	0.036	0.046	0.034	0.036	0.038	0.041	0.044	0.046
	0.048	0.049	0.050	0.048	0.054	0.055	0.055	0.057
	0.030	0.030	0.031	0.034	0.034	0.035	0.035	0.011
	0.005	0.	-0.005	-0.010	-0.016	-0.023	-0.034	-0.035
	-0.040	-0.046	-0.056	-0.058	-0.063	-0.050	-0.051	-0.052
18								
	-0.056	-0.059	-0.061	-0.063	-0.062	-0.048	-0.034	-0.020
	-0.006	0.008	0.025	0.014	0.019	0.024	0.029	0.034
	0.039	0.044	0.033	0.032	0.031	0.030	0.029	0.028
	0.028	0.059	0.063	0.067	0.070	0.073	0.077	0.081
	0.075	0.070	0.065	0.060	0.055	0.050	0.045	-0.024
	-0.016	-0.008	0.002	0.011	0.019	0.027	0.007	0.006
	0.005	0.004	0.003	0.002	0.	-0.043	-0.039	-0.033
	-0.026	-0.016	-0.010	-0.004	-0.038	-0.030	-0.024	-0.014
	-0.004	0.004	0.012	-0.011	-0.001	0.010	0.020	0.030
	0.040	0.051	0.037	0.039	0.041	0.042	0.044	0.046
	0.048	0.053	0.055	0.056	0.058	0.059	0.061	0.063
	0.031	0.032	0.033	0.035	0.036	0.037	0.038	0.010
	0.005	0.	-0.005	-0.010	-0.016	-0.023	-0.039	-0.044
	-0.049	-0.055	-0.061	-0.066	-0.071	-0.050	-0.052	-0.054
19								
	-0.066	-0.069	-0.072	-0.075	-0.018	-0.016	-0.015	-0.014
	-0.013	-0.012	-0.010	0.021	0.021	0.020	0.020	0.020
	0.019	0.019	0.036	0.034	0.032	0.030	0.028	0.026
	0.025	0.059	0.055	0.051	0.045	0.039	0.035	0.031
	-0.004	-0.009	-0.015	-0.020	-0.025	-0.030	-0.035	-0.024
	-0.020	-0.016	-0.013	-0.010	-0.006	-0.003	0.017	0.012
	0.006	0.001	-0.005	-0.010	-0.015	-0.005	-0.014	-0.023
	-0.030	-0.038	-0.047	-0.056	-0.016	-0.016	-0.017	-0.018
	-0.019	-0.020	-0.020	0.010	0.011	0.013	0.015	0.017
	0.019	0.021	0.056	0.052	0.049	0.045	0.041	0.038
	0.034	0.075	0.068	0.061	0.054	0.047	0.040	0.033
	0.070	0.060	0.050	0.040	0.030	0.020	0.009	0.032
	0.017	0.002	-0.014	-0.031	-0.046	-0.061	-0.004	-0.019
	-0.035	-0.050	-0.065	-0.081	-0.097	-0.056	-0.059	-0.063
20								
	-0.063	-0.065	-0.068	-0.070	-0.018	-0.015	-0.013	-0.011
	-0.008	-0.005	-0.003	0.026	0.025	0.024	0.023	0.023
	0.021	0.021	0.036	0.034	0.033	0.032	0.030	0.028
	0.028	0.029	0.055	0.051	0.047	0.043	0.039	0.035
	-0.001	-0.005	-0.012	-0.015	-0.021	-0.026	-0.032	-0.021
	-0.017	-0.013	-0.009	-0.006	-0.002	0.	0.017	0.012
	0.006	0.	-0.006	-0.012	-0.018	-0.008	-0.016	-0.025
	-0.032	-0.041	-0.050	-0.059	-0.024	-0.023	-0.023	-0.023
	-0.023	-0.022	-0.021	0.008	0.009	0.012	0.015	0.017
	0.019	0.022	0.054	0.051	0.048	0.045	0.042	0.039
	0.036	0.073	0.067	0.060	0.054	0.048	0.042	0.035
	0.072	0.063	0.052	0.043	0.033	0.023	0.013	0.035
	0.020	0.005	-0.010	-0.027	-0.042	-0.057	-0.010	-0.025
	-0.038	-0.052	-0.065	-0.078	-0.094	-0.054	-0.057	-0.060
21								
	-0.059	-0.061	-0.063	-0.065	-0.019	-0.015	-0.010	-0.007
	-0.004	0.	0.004	0.031	0.030	0.028	0.027	0.026
	0.024	0.023	0.035	0.034	0.033	0.033	0.032	0.031
	0.030	0.059	0.056	0.052	0.049	0.046	0.042	0.039
	0.002	-0.003	-0.007	-0.011	-0.017	-0.023	-0.029	-0.018
	-0.014	-0.010	-0.006	-0.003	0.	0.003	0.017	0.011
	0.005	-0.001	-0.008	-0.014	-0.020	-0.010	-0.018	-0.027
	-0.035	-0.043	-0.053	-0.061	-0.032	-0.030	-0.029	-0.028
	-0.026	-0.024	-0.023	0.005	0.008	0.011	0.014	0.017
	0.020	0.023	0.050	0.049	0.047	0.045	0.042	0.040
	0.038	0.072	0.066	0.060	0.055	0.050	0.044	0.038
	0.074	0.065	0.055	0.046	0.036	0.026	0.017	0.039
	0.024	0.009	-0.006	-0.022	-0.038	-0.053	-0.017	-0.029
	-0.042	-0.054	-0.065	-0.076	-0.089	-0.053	-0.055	-0.057
22								
	-0.056	-0.058	-0.060	-0.060	-0.019	-0.014	-0.009	-0.003
	0.002	0.007	0.012	0.036	0.034	0.032	0.030	0.028
	0.026	0.024	0.035	0.035	0.034	0.034	0.033	0.032
	0.032	0.058	0.056	0.054	0.052	0.049	0.046	0.043
	0.005	0.	-0.003	-0.007	-0.013	-0.019	-0.026	-0.015
	-0.011	-0.007	-0.003	0.	0.003	0.007	0.018	0.011
	0.005	-0.002	-0.009	-0.016	-0.022	-0.013	-0.021	-0.030
	-0.038	-0.046	-0.055	-0.063	-0.040	-0.037	-0.035	-0.033
	-0.029	-0.026	-0.024	0.002	0.006	0.009	0.013	0.017
	0.020	0.024	0.047	0.047	0.045	0.044	0.043	0.042
	0.041	0.071	0.065	0.060	0.056	0.051	0.046	0.041
	0.075	0.066	0.058	0.049	0.040	0.030	0.021	0.043
	0.028	0.013	-0.002	-0.018	-0.033	-0.049	-0.023	-0.035
	-0.045	-0.056	-0.065	-0.075	-0.086	-0.051	-0.053	-0.055
23								
	-0.053	-0.054	-0.054	-0.055	-0.020	-0.014	-0.007	0.
	0.006	0.012	0.019	0.041	0.038	0.035	0.033	0.031
	0.028	0.026	0.035	0.035	0.035	0.035	0.034	0.034
	0.034	0.058	0.056	0.055	0.054	0.052	0.050	0.049
	0.008	0.004	0.	-0.003	-0.009	-0.016	-0.022	-0.012
	-0.008	-0.004	0.	0.003	0.007	0.011	0.018	0.011
	0.004	-0.003	-0.010	-0.017	-0.024	-0.015	-0.023	-0.032
	-0.040	-0.048	-0.057	-0.065	-0.048	-0.044	-0.040	-0.037
	-0.033	-0.029	-0.025	0.	0.004	0.008	0.013	0.017

Sample output (contd)

	0.021	0.025	0.045	0.045	0.044	0.044	0.044	0.043
	0.043	0.069	0.064	0.060	0.056	0.052	0.048	0.043
	0.076	0.068	0.060	0.052	0.043	0.034	0.025	0.048
	0.032	0.017	0.002	-0.013	-0.029	-0.045	-0.030	-0.039
	-0.048	-0.057	-0.066	-0.076	-0.085	-0.050	-0.051	-0.052
24								
	-0.049	-0.050	-0.050	-0.050	-0.020	-0.013	-0.005	0.003
	0.010	0.018	0.026	0.046	0.043	0.040	0.036	0.034
	0.031	0.028	0.035	0.035	0.035	0.036	0.036	0.036
	0.037	0.058	0.057	0.055	0.056	0.055	0.054	0.054
	0.011	0.008	0.005	0.001	-0.005	-0.011	-0.017	-0.008
	-0.004	0.	0.003	0.006	0.010	0.015	0.018	0.011
	0.004	-0.003	-0.011	-0.019	-0.027	-0.017	-0.025	-0.035
	-0.043	-0.050	-0.060	-0.068	-0.056	-0.052	-0.046	-0.041
	-0.036	-0.031	-0.026	-0.002	0.002	0.007	0.013	0.017
	0.022	0.026	0.043	0.043	0.043	0.044	0.044	0.045
	0.045	0.068	0.064	0.060	0.056	0.053	0.049	0.045
	0.077	0.070	0.062	0.055	0.046	0.038	0.029	0.053
	0.037	0.022	0.006	-0.009	-0.026	-0.041	-0.036	-0.045
	-0.052	-0.058	-0.067	-0.075	-0.084	-0.049	-0.049	-0.049
25								
	-0.046	-0.046	-0.045	-0.045	-0.020	-0.013	-0.003	0.006
	0.015	0.023	0.033	0.051	0.048	0.044	0.040	0.036
	0.033	0.030	0.035	0.035	0.036	0.037	0.037	0.038
	0.039	0.057	0.057	0.057	0.058	0.058	0.058	0.058
	0.014	0.012	0.009	0.006	0.	-0.006	-0.012	-0.004
	0.	0.003	0.006	0.010	0.014	0.018	0.019	0.011
	0.004	-0.004	-0.012	-0.020	-0.029	-0.020	-0.028	-0.037
	-0.045	-0.053	-0.062	-0.070	-0.064	-0.059	-0.052	-0.045
	-0.039	-0.033	-0.027	-0.005	-0.001	0.006	0.012	0.017
	0.023	0.027	0.040	0.042	0.043	0.044	0.045	0.047
	0.048	0.066	0.063	0.060	0.057	0.055	0.052	0.048
	0.078	0.071	0.064	0.057	0.049	0.041	0.033	0.057
	0.042	0.026	0.010	-0.006	-0.022	-0.038	-0.043	-0.050
	-0.055	-0.060	-0.066	-0.073	-0.081	-0.047	-0.047	-0.046
26								
	-0.043	-0.043	-0.042	-0.040	-0.021	-0.010	0.	0.009
	0.020	0.030	0.040	0.056	0.052	0.047	0.043	0.040
	0.036	0.032	0.034	0.035	0.036	0.038	0.038	0.040
	0.041	0.057	0.058	0.058	0.059	0.060	0.062	0.062
	0.017	0.015	0.013	0.010	0.004	-0.002	-0.008	0.
	0.003	0.005	0.009	0.013	0.018	0.022	0.019	0.011
	0.003	-0.005	-0.013	-0.022	-0.031	-0.023	-0.031	-0.040
	-0.048	-0.055	-0.064	-0.072	-0.072	-0.065	-0.058	-0.050
	-0.044	-0.035	-0.028	-0.008	-0.001	0.005	0.011	0.015
	0.022	0.028	0.037	0.040	0.042	0.044	0.046	0.048
	0.050	0.064	0.062	0.060	0.058	0.056	0.054	0.051
	0.080	0.073	0.066	0.059	0.052	0.044	0.037	0.061
	0.046	0.030	0.014	-0.002	-0.018	-0.034	-0.049	-0.055
	-0.059	-0.062	-0.067	-0.073	-0.078	-0.046	-0.045	-0.044
27								
	-0.040	-0.039	-0.037	-0.035	-0.021	-0.010	0.002	0.013
	0.024	0.036	0.048	0.061	0.056	0.052	0.047	0.043
	0.039	0.034	0.034	0.035	0.037	0.039	0.040	0.041
	0.043	0.057	0.058	0.060	0.061	0.063	0.065	0.066
	0.020	0.019	0.017	0.015	0.009	0.003	-0.003	0.001
	0.005	0.009	0.013	0.017	0.022	0.026	0.020	0.011
	0.002	-0.006	-0.015	-0.024	-0.033	-0.026	-0.034	-0.042
	-0.050	-0.058	-0.066	-0.074	-0.080	-0.072	-0.064	-0.055
	-0.046	-0.037	-0.029	-0.009	-0.002	0.004	0.010	0.016
	0.022	0.029	0.035	0.038	0.041	0.044	0.047	0.050
	0.053	0.063	0.061	0.059	0.058	0.057	0.055	0.053
	0.082	0.075	0.068	0.061	0.054	0.047	0.041	0.065
	0.049	0.033	0.017	0.002	-0.014	-0.030	-0.056	-0.059
	-0.062	-0.065	-0.068	-0.072	-0.075	-0.044	-0.043	-0.042

RADIATION PATTERN COMPUTATION ENGINEER PHIL POTTER FORMULATION CHUCK LAWSON

CASE NUMBER 522

COMPUTED RESULTS

PHI	THETA	GNORM	20*LOG10(GNORM)	PHASE ANGLE	GIMAG	GREAL
0.						
	0.	0.944	-0.496	14.663	8.015E 05	3.063E 06
	0.015	0.931	-0.623	14.738	7.939E 05	3.018E 06
	0.030	0.885	-1.059	15.142	7.752E 05	2.865E 06
	0.045	0.811	-1.819	15.917	7.456E 05	2.615E 06
	0.060	0.713	-2.934	17.152	7.052E 05	2.285E 06
	0.075	0.599	-4.451	19.019	6.544E 05	1.898E 06
	0.090	0.476	-6.451	21.851	5.937E 05	1.481E 06
	0.105	0.352	-9.066	26.362	5.242E 05	1.058E 06
	0.120	0.237	-12.519	34.339	4.474E 05	6.549E 05
	0.135	0.140	-17.084	51.216	3.656E 05	2.938E 05
	0.150	0.084	-21.519	91.910	2.813E 05	-9.380E 03
	0.165	0.094	-20.567	141.004	1.976E 05	-2.441E 05
	0.180	0.126	-17.977	163.827	1.179E 05	-4.064E 05
	0.195	0.149	-16.514	174.818	4.523E 04	-4.987E 05

Sample output (contd)

0.210	0.158	-16.040	181.888	-1.742E 04	-5.286E 05
0.225	0.153	-16.315	187.607	-6.783E 04	-5.079E 05
0.240	0.138	-17.202	193.066	-1.046E 05	-4.507E 05
0.255	0.117	-18.612	198.887	-1.273E 05	-3.721E 05
0.270	0.095	-20.474	205.501	-1.367E 05	-2.865E 05
0.285	0.073	-22.691	213.108	-1.343E 05	-2.060E 05
0.300	0.055	-25.115	221.321	-1.228E 05	-1.397E 05
0.315	0.042	-27.542	228.480	-1.053E 05	-9.325E 04
0.330	0.033	-29.731	231.194	-8.521E 04	-6.853E 04
0.345	0.027	-31.237	225.696	-6.580E 04	-6.422E 04
0.360	0.027	-31.292	213.185	-5.000E 04	-7.646E 04
0.375	0.032	-29.882	201.867	-4.002E 04	-9.973E 04
0.390	0.040	-28.020	196.201	-3.715E 04	-1.279E 05
0.405	0.048	-26.396	195.046	-4.167E 04	-1.550E 05
0.420	0.055	-25.203	196.689	-5.289E 04	-1.764E 05
0.435	0.060	-24.435	200.139	-6.927E 04	-1.889E 05
0.450	0.063	-24.033	204.881	-8.866E 04	-1.912E 05
0.465	0.064	-23.919	210.574	-1.086E 05	-1.838E 05
0.480	0.063	-24.015	216.849	-1.266E 05	-1.690E 05
0.495	0.061	-24.253	223.189	-1.406E 05	-1.498E 05
0.510	0.059	-24.588	228.896	-1.490E 05	-1.300E 05
0.525	0.056	-25.000	233.155	-1.509E 05	-1.130E 05
0.540	0.053	-25.482	235.128	-1.463E 05	-1.020E 05
0.555	0.050	-25.995	234.077	-1.361E 05	-9.863E 04
0.570	0.048	-26.429	229.585	-1.218E 05	-1.037E 05
0.585	0.047	-26.593	222.048	-1.051E 05	-1.165E 05
0.600	0.048	-26.333	213.085	-8.827E 04	-1.355E 05
0.615	0.052	-25.686	204.876	-7.328E 04	-1.580E 05
0.630	0.057	-24.859	198.829	-6.184E 04	-1.814E 05
0.645	0.063	-24.067	195.217	-5.509E 04	-2.025E 05
0.660	0.067	-23.440	193.728	-5.354E 04	-2.192E 05
0.675	0.071	-23.032	193.945	-5.698E 04	-2.295E 05
0.690	0.072	-22.850	195.511	-6.458E 04	-2.327E 05
0.705	0.072	-22.875	198.141	-7.497E 04	-2.288E 05
0.720	0.070	-23.073	201.564	-8.649E 04	-2.189E 05
0.735	0.068	-23.408	205.476	-9.740E 04	-2.044E 05

RADIATION PATTERN COMPUTATION ENGINEER PHIL POTTER FORMULATION CHUCK LAWSON

CASE NUMBER 522

COMPUTED RESULTS

PHI	THETA	GNORM	20*LOG10(GNORM)	PHASE ANGLE	GIMAG	GREAL
	0.750	0.064	-23.840	209.496	-1.061E 05	-1.875E 05
	0.765	0.061	-24.338	213.161	-1.113E 05	-1.703E 05
	0.780	0.057	-24.883	215.962	-1.122E 05	-1.547E 05
	0.795	0.053	-25.454	217.407	-1.087E 05	-1.421E 05
	0.810	0.050	-26.023	217.108	-1.011E 05	-1.336E 05
	0.825	0.047	-26.539	214.899	-9.035E 04	-1.295E 05
	0.840	0.045	-26.928	210.978	-7.771E 04	-1.294E 05
	0.855	0.044	-27.128	205.997	-6.468E 04	-1.326E 05
	0.870	0.044	-27.122	200.933	-5.276E 04	-1.379E 05
	0.885	0.045	-26.964	196.728	-4.328E 04	-1.440E 05
	0.900	0.046	-26.745	193.980	-3.726E 04	-1.496E 05
	0.915	0.047	-26.546	192.914	-3.526E 04	-1.538E 05
	0.930	0.048	-26.417	193.499	-3.738E 04	-1.557E 05
	0.945	0.048	-26.371	195.576	-4.323E 04	-1.551E 05
	0.960	0.048	-26.393	198.897	-5.201E 04	-1.519E 05
	0.975	0.048	-26.455	203.127	-6.263E 04	-1.466E 05
	0.990	0.047	-26.527	207.842	-7.385E 04	-1.398E 05
	1.005	0.047	-26.595	212.562	-8.444E 04	-1.322E 05
	1.020	0.046	-26.663	216.818	-9.329E 04	-1.246E 05
	1.035	0.046	-26.747	220.234	-9.958E 04	-1.177E 05
	1.050	0.045	-26.870	222.555	-1.028E 05	-1.120E 05
	1.065	0.044	-27.046	223.653	-1.028E 05	-1.078E 05
	1.080	0.043	-27.274	223.504	-9.989E 04	-1.052E 05
	1.095	0.042	-27.536	222.179	-9.452E 04	-1.043E 05
	1.110	0.041	-27.803	219.854	-8.748E 04	-1.048E 05
	1.125	0.040	-28.036	216.817	-7.964E 04	-1.064E 05
	1.140	0.039	-28.204	213.460	-7.188E 04	-1.088E 05
	1.155	0.039	-28.288	210.216	-6.498E 04	-1.116E 05
	1.170	0.039	-28.290	207.479	-5.956E 04	-1.145E 05
	1.185	0.039	-28.227	205.518	-5.601E 04	-1.173E 05
	1.200	0.039	-28.121	204.452	-5.448E 04	-1.198E 05
	1.215	0.040	-27.993	204.256	-5.487E 04	-1.218E 05
	1.230	0.040	-27.862	204.801	-5.688E 04	-1.231E 05
	1.245	0.041	-27.746	205.904	-6.003E 04	-1.236E 05
	1.260	0.041	-27.662	207.366	-6.378E 04	-1.232E 05
	1.275	0.042	-27.627	208.999	-6.754E 04	-1.218E 05
	1.290	0.041	-27.658	210.647	-7.076E 04	-1.194E 05
	1.305	0.041	-27.771	212.187	-7.299E 04	-1.160E 05
	1.320	0.040	-27.978	213.523	-7.389E 04	-1.115E 05
	1.335	0.039	-28.287	214.579	-7.328E 04	-1.063E 05
	1.350	0.037	-28.699	215.277	-7.112E 04	-1.005E 05
	1.365	0.035	-29.205	215.533	-6.752E 04	-9.454E 04
	1.380	0.032	-29.787	215.251	-6.270E 04	-8.872E 04
	1.395	0.030	-30.414	214.327	-5.700E 04	-8.348E 04
	1.410	0.028	-31.038	212.679	-5.079E 04	-7.918E 04
	1.425	0.026	-31.602	210.303	-4.448E 04	-7.611E 04
	1.440	0.025	-32.043	207.332	-3.847E 04	-7.444E 04
	1.455	0.024	-32.313	204.069	-3.313E 04	-7.416E 04
	1.470	0.024	-32.399	200.938	-2.874E 04	-7.512E 04
	1.485	0.024	-32.326	198.351	-2.554E 04	-7.698E 04

Sample output (contd)

RADIATION PATTERN COMPUTATION ENGINEER PHIL POTTER FORMULATION CHUCK LAWSON

CASE NUMBER 522

COMPUTED RESULTS

PHI	THETA	GNORM	20*LOG10(GNORM)	PHASE ANGLE	GIMAG	GREAL
	1.500	0.025	-32.150	196.591	-2.363E 04	-7.932E 04
90.000						
	0.	0.944	-0.496	14.663	8.015E 05	3.063E 06
	0.015	0.927	-0.655	14.549	7.810E 05	3.009E 06
	0.030	0.880	-1.106	14.054	7.167E 05	2.863E 06
	0.045	0.807	-1.867	13.107	6.132E 05	2.634E 06
	0.060	0.711	-2.964	11.564	4.777E 05	2.335E 06
	0.075	0.600	-4.440	9.158	3.200E 05	1.985E 06
	0.090	0.481	-6.354	5.377	1.511E 05	1.606E 06
	0.105	0.364	-8.784	359.185	-1.735E 04	1.219E 06
	0.120	0.258	-11.771	348.357	-1.745E 05	8.467E 05
	0.135	0.177	-15.024	328.493	-3.107E 05	5.068E 05
	0.150	0.140	-17.059	297.125	-4.186E 05	2.144E 05
	0.165	0.147	-16.634	267.608	-4.935E 05	-2.062E 04
	0.180	0.169	-15.425	250.046	-5.336E 05	-1.937E 05
	0.195	0.185	-14.653	240.495	-5.400E 05	-3.056E 05
	0.210	0.188	-14.519	235.001	-5.161E 05	-3.614E 05
	0.225	0.178	-14.996	231.640	-4.677E 05	-3.701E 05
	0.240	0.158	-16.051	229.476	-4.015E 05	-3.432E 05
	0.255	0.131	-17.685	227.970	-3.251E 05	-2.930E 05
	0.270	0.101	-19.935	226.678	-2.457E 05	-2.317E 05
	0.285	0.072	-22.885	224.965	-1.700E 05	-1.702E 05
	0.300	0.046	-26.663	221.404	-1.029E 05	-1.168E 05
	0.315	0.027	-31.319	212.020	-4.829E 04	-7.722E 04
	0.330	0.016	-35.732	188.156	-7.773E 03	-5.424E 04
	0.345	0.015	-36.320	158.870	1.846E 04	-4.776E 04
	0.360	0.019	-34.401	150.221	3.172E 04	-5.544E 04
	0.375	0.024	-32.340	154.854	3.441E 04	-7.330E 04
	0.390	0.030	-30.419	162.981	2.957E 04	-9.660E 04
	0.405	0.036	-28.762	170.369	2.045E 04	-1.205E 05
	0.420	0.042	-27.504	175.893	1.012E 04	-1.409E 05
	0.435	0.046	-26.709	179.590	1.108E 03	-1.548E 05
	0.450	0.048	-26.385	181.704	-4.780E 03	-1.607E 05
	0.465	0.047	-26.510	182.381	-6.582E 03	-1.583E 05
	0.480	0.044	-27.039	181.595	-4.149E 03	-1.490E 05
	0.495	0.040	-27.901	179.165	1.968E 03	-1.350E 05
	0.510	0.036	-28.965	174.857	1.070E 04	-1.189E 05
	0.525	0.032	-30.020	168.705	2.072E 04	-1.037E 05
	0.540	0.029	-30.797	161.555	3.060E 04	-9.175E 04
	0.555	0.028	-31.105	155.227	3.911E 04	-8.476E 04
	0.570	0.028	-30.949	151.525	4.531E 04	-8.354E 04
	0.585	0.030	-30.464	151.046	4.865E 04	-8.793E 04
	0.600	0.032	-29.792	153.165	4.901E 04	-9.688E 04
	0.615	0.035	-29.050	156.760	4.667E 04	-1.087E 05
	0.630	0.038	-28.339	160.814	4.218E 04	-1.212E 05
	0.645	0.041	-27.753	164.666	3.631E 04	-1.324E 05
	0.660	0.043	-27.364	167.993	2.987E 04	-1.405E 05
	0.675	0.044	-27.220	170.686	2.363E 04	-1.441E 05
	0.690	0.043	-27.351	172.737	1.818E 04	-1.427E 05
	0.705	0.041	-27.763	174.169	1.393E 04	-1.364E 05
	0.720	0.038	-28.448	175.000	1.105E 04	-1.263E 05

RADIATION PATTERN COMPUTATION ENGINEER PHIL POTTER FORMULATION CHUCK LAWSON

CASE NUMBER 522

COMPUTED RESULTS

PHI	THETA	GNORM	20*LOG10(GNORM)	PHASE ANGLE	GIMAG	GREAL
	0.735	0.034	-29.371	175.234	9.470E 03	-1.136E 05
	0.750	0.030	-30.465	174.877	8.972E 03	-1.001E 05
	0.765	0.026	-31.614	173.996	9.208E 03	-8.755E 04
	0.780	0.023	-32.645	172.808	9.788E 03	-7.756E 04
	0.795	0.021	-33.359	171.748	1.034E 04	-7.127E 04
	0.810	0.021	-33.596	171.340	1.055E 04	-6.927E 04
	0.825	0.022	-33.325	171.863	1.023E 04	-7.157E 04
	0.840	0.023	-32.653	173.163	9.297E 03	-7.755E 04
	0.855	0.026	-31.767	174.843	7.775E 03	-8.615E 04
	0.870	0.029	-30.848	176.552	5.783E 03	-9.598E 04
	0.885	0.032	-30.033	178.101	3.499E 03	-1.055E 05
	0.900	0.034	-29.410	179.431	1.128E 03	-1.135E 05
	0.915	0.035	-29.027	180.547	-1.132E 03	-1.186E 05
	0.930	0.036	-28.909	181.481	-3.106E 03	-1.202E 05
	0.945	0.035	-29.064	182.263	-4.663E 03	-1.180E 05
	0.960	0.034	-29.492	182.913	-5.713E 03	-1.123E 05
	0.975	0.031	-30.181	183.429	-6.209E 03	-1.036E 05
	0.990	0.028	-31.110	183.771	-6.135E 03	-9.309E 04
	1.005	0.024	-32.237	183.848	-5.498E 03	-8.175E 04
	1.020	0.021	-33.493	183.492	-4.319E 03	-7.078E 04
	1.035	0.018	-34.765	182.460	-2.629E 03	-6.120E 04
	1.050	0.016	-35.890	180.501	-4.704E 02	-5.381E 04
	1.065	0.015	-36.679	177.555	2.096E 03	-4.909E 04
	1.080	0.014	-36.981	173.967	4.987E 03	-4.719E 04
	1.095	0.014	-36.776	170.421	8.086E 03	-4.791E 04
	1.110	0.016	-36.182	167.522	1.124E 04	-5.080E 04

Sample output (contd)

1.125	0.017	-35.389	165.501	1.427E 04	-5.519E 04
1.140	0.019	-34.564	164.291	1.697E 04	-6.034E 04
1.155	0.020	-33.827	163.719	1.913E 04	-6.550E 04
1.170	0.022	-33.246	163.636	2.055E 04	-7.000E 04
1.185	0.023	-32.856	163.950	2.110E 04	-7.333E 04
1.200	0.023	-32.669	164.617	2.068E 04	-7.517E 04
1.215	0.023	-32.683	165.628	1.932E 04	-7.540E 04
1.230	0.023	-32.889	166.988	1.712E 04	-7.407E 04
1.245	0.022	-33.265	168.693	1.427E 04	-7.138E 04
1.260	0.020	-33.784	170.704	1.108E 04	-6.767E 04
1.275	0.019	-34.412	172.920	7.862E 03	-6.330E 04
1.290	0.018	-35.106	175.146	4.983E 03	-5.868E 04
1.305	0.016	-35.822	177.075	2.768E 03	-5.416E 04
1.320	0.015	-36.511	178.305	1.482E 03	-5.007E 04
1.335	0.014	-37.121	178.414	1.292E 03	-4.668E 04
1.350	0.013	-37.595	177.091	2.244E 03	-4.416E 04
1.365	0.013	-37.869	174.305	4.252E 03	-4.263E 04
1.380	0.013	-37.889	170.425	7.110E 03	-4.215E 04
1.395	0.013	-37.642	166.168	1.051E 04	-4.271E 04
1.410	0.014	-37.171	162.322	1.410E 04	-4.424E 04
1.425	0.015	-36.563	159.454	1.748E 04	-4.663E 04
1.440	0.016	-35.906	157.801	2.029E 04	-4.973E 04
1.455	0.017	-35.272	157.341	2.226E 04	-5.332E 04
1.470	0.018	-34.703	157.915	2.319E 04	-5.716E 04

RADIATION PATTERN COMPUTATION   ENGINEER PHIL POTTER   FORMULATION CHUCK LAWSON

CASE NUMBER 522

COMPUTED RESULTS

PHI	THETA	GNORM	20*LOG10(GNORM)	PHASE ANGLE	GIMAG	GREAL
	1.485	0.019	-34.222	159.305	2.304E 04	-6.099E 04
	1.500	0.020	-33.840	161.276	2.187E 04	-6.452E 04
180.000						
	0.	0.944	-0.496	14.663	8.015E 05	3.063E 06
	0.015	0.925	-0.673	14.904	7.979E 05	2.998E 06
	0.030	0.875	-1.160	15.480	7.829E 05	2.827E 06
	0.045	0.797	-1.970	16.442	7.563E 05	2.563E 06
	0.060	0.697	-3.133	17.890	7.179E 05	2.224E 06
	0.075	0.582	-4.695	20.006	6.680E 05	1.835E 06
	0.090	0.461	-6.729	23.137	6.071E 05	1.421E 06
	0.105	0.341	-9.355	28.006	5.361E 05	1.008E 06
	0.120	0.230	-12.765	36.341	4.569E 05	6.211E 05
	0.135	0.139	-17.148	53.013	3.719E 05	2.801E 05
	0.150	0.085	-21.446	90.056	2.838E 05	-2.782E 02
	0.165	0.086	-21.304	137.153	1.962E 05	-2.115E 05
	0.180	0.110	-19.157	162.251	1.126E 05	-3.518E 05
	0.195	0.127	-17.900	175.091	3.653E 04	-4.253E 05
	0.210	0.132	-17.590	183.748	-2.892E 04	-4.415E 05
	0.225	0.126	-18.016	191.133	-8.134E 04	-4.133E 05
	0.240	0.112	-19.020	198.528	-1.192E 05	-3.558E 05
	0.255	0.095	-20.461	206.582	-1.423E 05	-2.843E 05
	0.270	0.078	-22.175	215.392	-1.511E 05	-2.127E 05
	0.285	0.063	-23.968	224.098	-1.477E 05	-1.525E 05
	0.300	0.052	-25.655	230.447	-1.348E 05	-1.113E 05
	0.315	0.044	-27.069	231.118	-1.157E 05	-9.326E 04
	0.330	0.041	-27.834	223.666	-9.392E 04	-9.840E 04
	0.345	0.043	-27.363	218.606	-7.312E 04	-1.236E 05
	0.360	0.052	-25.761	199.017	-5.628E 04	-1.633E 05
	0.375	0.064	-23.845	192.245	-4.567E 04	-2.104E 05
	0.390	0.078	-22.167	189.384	-4.259E 04	-2.577E 05
	0.405	0.090	-20.898	188.999	-4.729E 04	-2.986E 05
	0.420	0.099	-20.054	190.194	-5.896E 04	-3.279E 05
	0.435	0.105	-19.603	192.500	-7.596E 04	-3.426E 05
	0.450	0.106	-19.500	195.683	-9.599E 04	-3.419E 05
	0.465	0.104	-19.697	199.604	-1.165E 05	-3.270E 05
	0.480	0.098	-20.140	204.129	-1.348E 05	-3.010E 05
	0.495	0.092	-20.771	209.044	-1.489E 05	-2.682E 05
	0.510	0.084	-21.528	213.979	-1.571E 05	-2.332E 05
	0.525	0.076	-22.354	218.375	-1.587E 05	-2.004E 05
	0.540	0.069	-23.198	221.508	-1.537E 05	-1.737E 05
	0.555	0.063	-24.007	222.620	-1.431E 05	-1.555E 05
	0.570	0.058	-24.699	221.163	-1.284E 05	-1.469E 05
	0.585	0.055	-25.160	217.154	-1.118E 05	-1.475E 05
	0.600	0.054	-25.282	211.479	-9.530E 04	-1.556E 05
	0.615	0.056	-25.058	205.669	-8.111E 04	-1.688E 05
	0.630	0.059	-24.615	201.089	-7.091E 04	-1.839E 05
	0.645	0.062	-24.122	198.394	-6.581E 04	-1.979E 05
	0.660	0.065	-23.715	197.636	-6.622E 04	-2.083E 05
	0.675	0.067	-23.465	198.613	-7.180E 04	-2.132E 05
	0.690	0.068	-23.393	201.067	-8.154E 04	-2.117E 05
	0.705	0.067	-23.484	204.733	-9.392E 04	-2.039E 05

Sample output (contd)

RADIATION PATTERN COMPUTATION   ENGINEER PHIL POTTER   FORMULATION CHUCK LAWSON

CASE NUMBER 522

COMPUTED RESULTS

PHI	THETA	GNORM	20*LOG10(GNORM)	PHASE ANGLE	GIMAG	GREAL
	0.720	0.065	-23.705	209.306	-1.071E 05	-1.908E 05
	0.735	0.063	-24.017	214.389	-1.192E 05	-1.742E 05
	0.750	0.060	-24.388	219.473	-1.286E 05	-1.561E 05
	0.765	0.058	-24.804	223.965	-1.339E 05	-1.388E 05
	0.780	0.055	-25.265	227.264	-1.343E 05	-1.241E 05
	0.795	0.051	-25.777	228.828	-1.298E 05	-1.135E 05
	0.810	0.048	-26.325	228.243	-1.207E 05	-1.078E 05
	0.825	0.045	-26.855	225.307	-1.082E 05	-1.071E 05
	0.840	0.043	-27.273	220.211	-9.369E 04	-1.108E 05
	0.855	0.042	-27.477	213.721	-7.869E 04	-1.179E 05
	0.870	0.042	-27.433	207.072	-6.484E 04	-1.269E 05
	0.885	0.044	-27.201	201.461	-5.353E 04	-1.362E 05
	0.900	0.045	-26.901	197.600	-4.580E 04	-1.444E 05
	0.915	0.047	-26.640	195.680	-4.218E 04	-1.503E 05
	0.930	0.047	-26.480	195.589	-4.273E 04	-1.531E 05
	0.945	0.048	-26.440	197.099	-4.696E 04	-1.527E 05
	0.960	0.047	-26.508	199.927	-5.401E 04	-1.490E 05
	0.975	0.046	-26.652	203.730	-6.272E 04	-1.427E 05
	0.990	0.046	-26.839	208.085	-7.182E 04	-1.346E 05
	1.005	0.044	-27.045	212.503	-8.005E 04	-1.256E 05
	1.020	0.043	-27.264	216.481	-8.637E 04	-1.168E 05
	1.035	0.042	-27.505	219.580	-9.002E 04	-1.089E 05
	1.050	0.041	-27.782	221.478	-9.064E 04	-1.025E 05
	1.065	0.039	-28.101	221.987	-8.825E 04	-9.806E 04
	1.080	0.038	-28.450	221.062	-8.324E 04	-9.555E 04
	1.095	0.036	-28.799	218.813	-7.630E 04	-9.485E 04
	1.110	0.035	-29.105	215.538	-6.830E 04	-9.562E 04
	1.125	0.034	-29.328	211.715	-6.021E 04	-9.743E 04
	1.140	0.034	-29.449	207.937	-5.292E 04	-9.979E 04
	1.155	0.034	-29.474	204.769	-4.719E 04	-1.023E 05
	1.170	0.034	-29.430	202.618	-4.354E 04	-1.045E 05
	1.185	0.034	-29.349	201.673	-4.220E 04	-1.062E 05
	1.200	0.034	-29.253	201.923	-4.313E 04	-1.072E 05
	1.215	0.035	-29.155	203.204	-4.604E 04	-1.074E 05
	1.230	0.035	-29.063	205.257	-5.039E 04	-1.068E 05
	1.245	0.036	-28.983	207.778	-5.554E 04	-1.054E 05
	1.260	0.036	-28.931	210.466	-6.079E 04	-1.033E 05
	1.275	0.036	-28.924	213.064	-6.547E 04	-1.006E 05
	1.290	0.036	-28.985	215.379	-6.899E 04	-9.715E 04
	1.305	0.035	-29.136	217.280	-7.093E 04	-9.317E 04
	1.320	0.034	-29.394	218.685	-7.105E 04	-8.873E 04
	1.335	0.032	-29.769	219.538	-6.930E 04	-8.396E 04
	1.350	0.031	-30.262	219.787	-6.582E 04	-7.904E 04
	1.365	0.029	-30.863	219.373	-6.089E 04	-7.420E 04
	1.380	0.026	-31.545	218.223	-5.490E 04	-6.971E 04
	1.395	0.024	-32.265	216.276	-4.833E 04	-6.585E 04
	1.410	0.022	-32.960	213.522	-4.164E 04	-6.286E 04
	1.425	0.021	-33.552	210.083	-3.530E 04	-6.094E 04
	1.440	0.020	-33.970	206.268	-2.970E 04	-6.019E 04
	1.455	0.020	-34.171	202.555	-2.516E 04	-6.057E 04

RADIATION PATTERN COMPUTATION   ENGINEER PHIL POTTER   FORMULATION CHUCK LAWSON

CASE NUMBER 522

COMPUTED RESULTS

PHI	THETA	GNORM	20*LOG10(GNORM)	PHASE ANGLE	GIMAG	GREAL
	1.470	0.020	-34.158	199.441	-2.186E 04	-6.193E 04
	1.485	0.020	-33.984	197.276	-1.990E 04	-6.399E 04
	1.500	0.021	-33.717	196.183	-1.926E 04	-6.636E 04
270.000						
	0.	0.944	-0.496	14.663	8.015E 05	3.063E 06
	0.015	0.931	-0.621	14.416	7.771E 05	3.023E 06
	0.030	0.888	-1.027	13.792	7.100E 05	2.893E 06
	0.045	0.820	-1.720	12.729	6.059E 05	2.682E 06
	0.060	0.732	-2.710	11.111	4.729E 05	2.408E 06
	0.075	0.630	-4.011	8.739	3.210E 05	2.088E 06
	0.090	0.522	-5.640	5.286	1.613E 05	1.744E 06
	0.105	0.416	-7.610	0.207	5.053E 03	1.396E 06
	0.120	0.320	-9.895	352.628	-1.377E 05	1.064E 06
	0.135	0.241	-12.368	341.328	-2.584E 05	7.647E 05
	0.150	0.185	-14.677	325.431	-3.511E 05	5.095E 05
	0.165	0.153	-16.301	306.550	-4.123E 05	3.057E 05
	0.180	0.140	-17.100	289.363	-4.416E 05	1.552E 05
	0.195	0.133	-17.548	277.166	-4.411E 05	5.546E 04
	0.210	0.124	-18.144	269.983	-4.151E 05	-1.233E 02
	0.225	0.110	-19.140	266.768	-3.695E 05	-2.087E 04
	0.240	0.093	-20.632	266.767	-3.112E 05	-1.758E 04
	0.255	0.074	-22.648	269.714	-2.471E 05	-1.235E 03
	0.270	0.055	-25.180	275.666	-1.837E 05	1.823E 04
	0.285	0.039	-28.191	284.574	-1.264E 05	3.285E 04
	0.300	0.026	-31.696	295.299	-7.884E 04	3.727E 04
	0.315	0.016	-36.162	303.728	-4.337E 04	2.895E 04

Sample output (contd)

0.330	0.007	-43.665	291.684	-2.043E 04	8.123E 03
0.345	0.007	-42.741	201.647	-9.020E 03	-2.273E 04
0.360	0.018	-34.961	186.707	-6.994E 03	-5.947E 04
0.375	0.029	-30.697	186.726	-1.146E 04	-9.717E 04
0.390	0.039	-28.077	188.366	-1.925E 04	-1.309E 05
0.405	0.047	-26.493	189.916	-2.734E 04	-1.564E 05
0.420	0.052	-25.697	191.012	-3.323E 04	-1.708E 05
0.435	0.053	-25.580	191.511	-3.519E 04	-1.728E 05
0.450	0.050	-26.101	191.242	-3.238E 04	-1.629E 05
0.465	0.043	-27.269	189.850	-2.484E 04	-1.430E 05
0.480	0.035	-29.130	186.565	-1.340E 04	-1.164E 05
0.495	0.026	-31.730	179.646	5.364E 02	-8.686E 04
0.510	0.018	-34.893	165.372	1.524E 04	-5.840E 04
0.525	0.013	-37.424	140.061	2.895E 04	-3.458E 04
0.540	0.013	-37.639	114.313	4.009E 04	-1.811E 04
0.555	0.015	-36.765	102.529	4.749E 04	-1.055E 04
0.570	0.015	-36.196	103.541	5.050E 04	-1.216E 04
0.585	0.016	-35.902	114.138	4.904E 04	-2.197E 04
0.600	0.017	-35.269	131.119	4.354E 04	-3.801E 04
0.615	0.020	-33.939	148.794	3.490E 04	-5.761E 04
0.630	0.024	-32.277	162.678	2.428E 04	-7.786E 04
0.645	0.029	-30.785	172.293	1.299E 04	-9.598E 04
0.660	0.033	-29.702	178.822	2.255E 03	-1.097E 05
0.675	0.035	-29.091	183.340	-6.858E 03	-1.175E 05
0.690	0.036	-28.951	186.524	-1.359E 04	-1.188E 05

RADIATION PATTERN COMPUTATION ENGINEER PHIL POTTER FORMULATION CHUCK LAWSON

CASE NUMBER 522

COMPUTED RESULTS

PHI	THETA	GNORM	20*LOG10(GNORM)	PHASE ANGLE	GIMAG	GREAL
	0.705	0.034	-29.263	188.741	-1.754E 04	-1.141E 05
	0.720	0.032	-30.002	190.133	-1.865E 04	-1.043E 05
	0.735	0.028	-31.133	190.649	-1.719E 04	-9.144E 04
	0.750	0.023	-32.592	190.034	-1.370E 04	-7.745E 04
	0.765	0.019	-34.239	187.827	-8.862E 03	-6.447E 04
	0.780	0.016	-35.795	183.593	-3.409E 03	-5.429E 04
	0.795	0.014	-36.833	177.691	1.945E 03	-4.824E 04
	0.810	0.014	-36.989	171.998	6.600E 03	-4.695E 04
	0.825	0.015	-36.285	168.655	1.011E 04	-5.041E 04
	0.840	0.018	-35.057	168.086	1.223E 04	-5.795E 04
	0.855	0.021	-33.655	169.354	1.286E 04	-6.840E 04
	0.870	0.024	-32.315	171.436	1.209E 04	-8.031E 04
	0.885	0.028	-31.169	173.719	1.014E 04	-9.211E 04
	0.900	0.031	-30.280	175.931	7.284E 03	-1.024E 05
	0.915	0.033	-29.670	177.987	3.867E 03	-1.100E 05
	0.930	0.034	-29.338	179.884	2.324E 02	-1.144E 05
	0.945	0.034	-29.267	181.636	-3.293E 03	-1.153E 05
	0.960	0.034	-29.430	183.250	-6.418E 03	-1.130E 05
	0.975	0.032	-29.788	184.697	-8.895E 03	-1.083E 05
	0.990	0.031	-30.290	185.893	-1.053E 04	-1.020E 05
	1.005	0.029	-30.870	186.684	-1.116E 04	-9.526E 04
	1.020	0.027	-31.445	186.855	-1.071E 04	-8.912E 04
	1.035	0.025	-31.927	186.178	-9.138E 03	-8.442E 04
	1.050	0.024	-32.231	184.517	-6.458E 03	-8.174E 04
	1.065	0.024	-32.297	181.946	-2.763E 03	-8.133E 04
	1.080	0.025	-32.116	178.769	1.785E 03	-8.307E 04
	1.095	0.026	-31.729	175.409	6.954E 03	-8.659E 04
	1.110	0.027	-31.221	172.234	1.245E 04	-9.127E 04
	1.125	0.029	-30.681	169.469	1.791E 04	-9.637E 04
	1.140	0.031	-30.190	167.196	2.298E 04	-1.011E 05
	1.155	0.032	-29.806	165.421	2.729E 04	-1.049E 05
	1.170	0.033	-29.567	164.120	3.049E 04	-1.072E 05
	1.185	0.034	-29.491	163.274	3.235E 04	-1.077E 05
	1.200	0.033	-29.588	162.881	3.272E 04	-1.062E 05
	1.215	0.032	-29.854	162.961	3.159E 04	-1.031E 05
	1.230	0.031	-30.278	163.543	2.909E 04	-9.846E 04
	1.245	0.029	-30.838	164.657	2.547E 04	-9.283E 04
	1.260	0.027	-31.502	166.306	2.111E 04	-8.665E 04
	1.275	0.024	-32.224	168.432	1.646E 04	-8.039E 04
	1.290	0.023	-32.953	170.876	1.196E 04	-7.450E 04
	1.305	0.021	-33.633	173.350	8.080E 03	-6.930E 04
	1.320	0.019	-34.216	175.462	5.162E 03	-6.504E 04
	1.335	0.018	-34.668	176.802	3.456E 03	-6.184E 04
	1.350	0.018	-34.970	177.070	3.058E 03	-5.974E 04
	1.365	0.018	-35.116	176.186	3.913E 03	-5.869E 04
	1.380	0.018	-35.110	174.326	5.820E 03	-5.858E 04
	1.395	0.018	-34.966	171.874	8.459E 03	-5.925E 04
	1.410	0.018	-34.717	169.297	1.144E 04	-6.052E 04
	1.425	0.019	-34.408	167.019	1.434E 04	-6.219E 04
	1.440	0.020	-34.088	165.338	1.676E 04	-6.406E 04

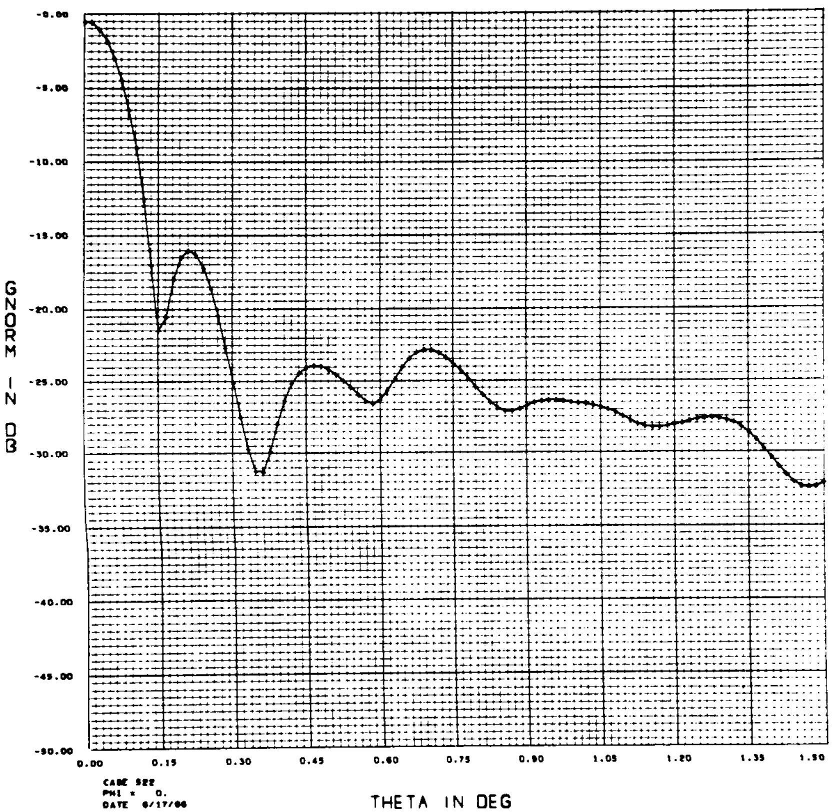
RADIATION PATTERN COMPUTATION ENGINEER PHIL POTTER FORMULATION CHUCK LAWSON

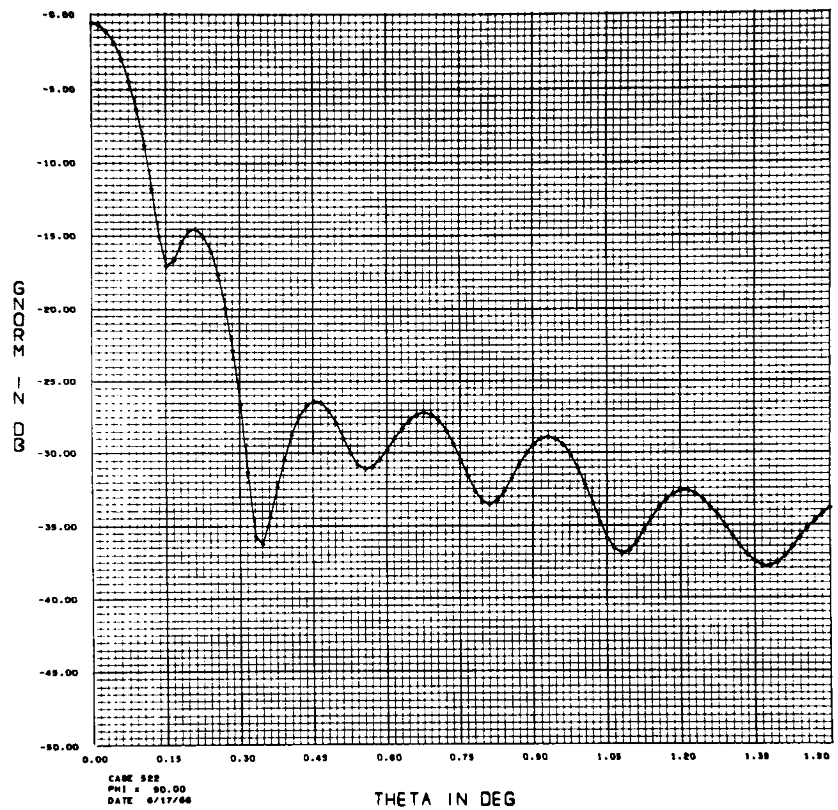
CASE NUMBER 522

COMPUTED RESULTS

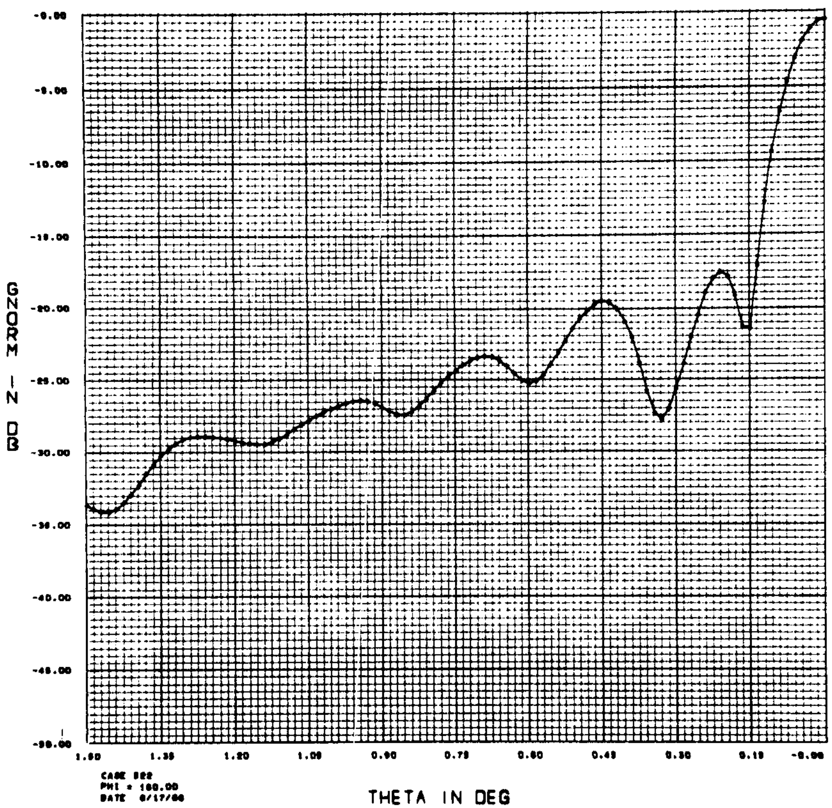
PHI	THETA	GNORM	20*LOG10(GNORM)	PHASE ANGLE	GIMAG	GREAL
	1.455	0.020	-33.803	164.407	1.839E 04	-6.590E 04
	1.470	0.021	-33.587	164.264	1.902E 04	-6.751E 04
	1.485	0.021	-33.463	164.864	1.858E 04	-6.868E 04
	1.500	0.021	-33.444	166.111	1.712E 04	-6.923E 04

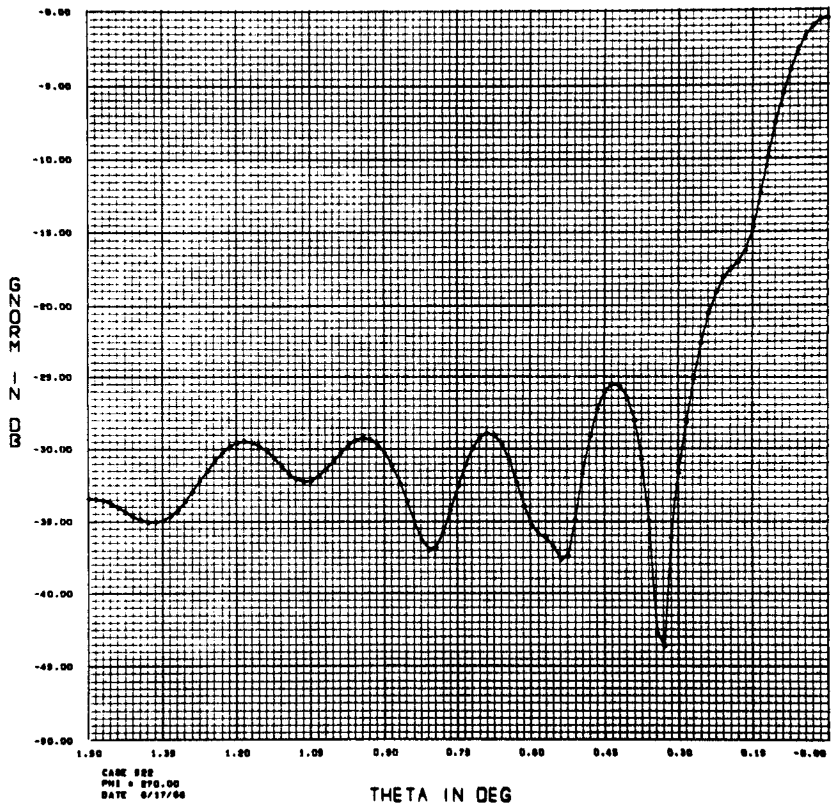
Sample output (plotted)





Sample output, plotted (contd)





XIV. ANTENNA NOISE TEMPERATURE PROGRAM

T. Y. Otoshi and C. T. Stelzried

Program: 5634000, binary in Jet Propulsion Laboratory Library

Engineers: T. Y. Otoshi and C. T. Stelzried

Programmer: Thelma Chapman

A. Program Description

This program computes the zenith antenna temperature from antenna radiation patterns and antenna environment brightness temperatures. The probable error of the antenna temperature is also computed from the probable errors of the input data.

The program is presently restricted to a special antenna case for which the following basic requirements must be fulfilled: (1) the antenna must have circular physical symmetry, (2) the antenna aperture is excited by only TE_{1n} and/or TM_{1n} cylindrical waveguide modes, and (3) the antenna is situated in an environment where the brightness temperature profile changes only with respect to the antenna polar angle variable θ. Although the last requirement would be difficult to fulfill in practice, the condition is nearly realized by a zenith-oriented antenna in a flat ground environment.

Derivation of the special case antenna temperature equation for this program is discussed in Ref. 25. The antenna temperature is calculated by subdividing the antenna environment into n number of subregions and then summing up the noise temperatures contributed by each subregion. Antenna polar angles $\theta = 0$ and $\theta = \pi$ define the upper and lower limits of integration. Using reciprocity, the noise temperature received from a subregion may be calculated by determining the fraction of total radiated power contained in the solid angle subregion, and then multiplying this fractional power by the average brightness temperature as seen by the antenna over the solid angle sector (Refs. 26 and 27).

Sky brightness temperature input data for this program may be obtained from the sky brightness temperature versus frequency curves published by D. C. Hogg (Ref. 28). These curves account for atmospheric absorption effects only. Ground brightness temperature is a function of the dielectric constant and electrical conductivity of the ground, frequency, polarization, angle of incidence, and also reflected sky temperature. A discussion of the equations used to compute brightness temperatures is presented in Ref. 29. A list of 2295-Mc brightness temperatures is shown in the sample printout pages. This list is applicable to a circularly polarized antenna (or an antenna with identical E- and H-plane patterns) in a desert ground environment at 290°K physical temperature.

The computer uses data from two antenna patterns to compute fractional power contained in a subregion. A. Ludwig[5] pointed out that the total power pattern of any antenna, whose aperture is circularly symmetric and excited by $m = 1$ modes, can be completely described in terms of two selected patterns. For a linearly polarized antenna, the two required patterns are the E- and H-plane patterns. For a right circular polarization (RCP) or left circular polarization (LCP) antenna, the two required patterns are the receive patterns taken with the illuminator, illuminating first in RCP and then in LCP.

In terms of the two selected pattern data, the antenna temperature equation, which is used by the computer, is given as

$$T_A \approx \left\{ \frac{\sum_{i=2}^{n-1} \left[T_{bi} (p_{1i} + p_{2i}) (\sin \theta_i) (\theta_{i+1} - \theta_{i-1}) \right]}{\sum_{i=2}^{n-1} \left[(p_{1i} + p_{2i}) (\sin \theta_i) (\theta_{i+1} - \theta_{i-1}) \right]} \right\} \quad (1)$$

where

T_{bi} = average brightness temperature of the ith annular solid angle segment, °K

θ_i = angle (in radians) corresponding to the ith subregion, while θ_{i+1} and θ_{i-1} are the angles corresponding to the $(i + 1)$th and $(i - 1)$th subregions, respectively

p_{1i}, p_{2i} = normalized powers for the ith subregion as determined from patterns 1 and 2, respectively, and are calculated from raw pattern data from the following equation

$$p_{1i} = 10^{[(F_{1i} - F_{M1})/10]} \quad (2)$$

and

$$p_{2i} = 10^{[(F_{2i} - F_{M1})/10]} \quad (3)$$

where

F_{1i} = value of the ith data point on pattern 1, as read relative to 0 db of the recording scale. The value of any F_{1i} point must be negative decibels, with the exception of any 0-db values

F_{2i} = value of the ith data point (in decibels) on pattern 2, as read relative to 0 db of the recording scale

F_{M1} = least negative data point value (in decibels) on pattern 1

A sample pattern recording showing F_{1i} and F_{M1} may be seen in Fig. 4. Pattern 1 can be either the E- or H-plane pattern for the linearly polarized antenna case. For an RCP antenna, pattern 1 is the pattern obtained when the illuminator is transmitting RCP. For a LCP antenna, pattern 1 is the pattern obtained when the illuminator is transmitting LCP.

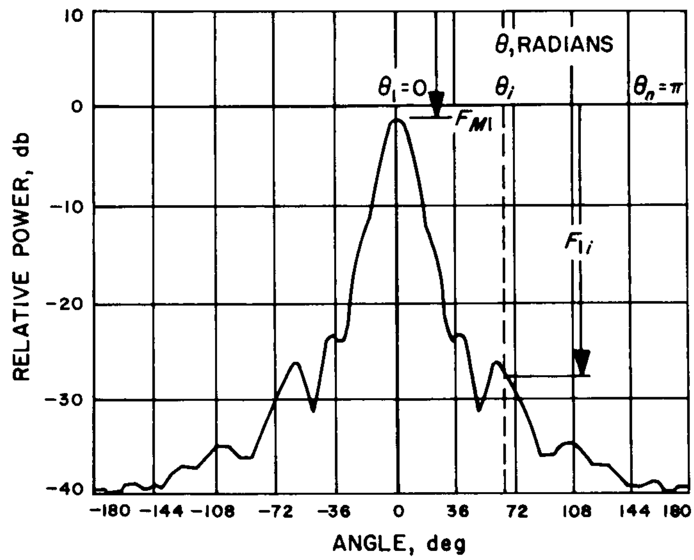


Fig. 4. Sample pattern recording for an antenna with circular symmetry

For the general case, the data on both patterns should be normalized by F_{M1}. However, for the case of the linearly polarized antenna, it is permissible to normalize data on pattern 2 by F_{M2} (least negative data point on pattern 2) so that

$$p_{2i} = 10^{[(F_{2i} - F_{M2})/10]} \quad (4)$$

This is done for this case so that any recording system drift occurring between the taking of the two patterns becomes noncritical. The computer will automatically select and use Eqs. (2) and (3) for circularly polarized antenna cases and Eqs. (2) and (4) for linearly polarized antenna cases. The computer finds values of F_{M1} and F_{M2} from the F_{1i} and F_{2i} input data.

[5] A. Ludwig, private communication, Jet Propulsion Laboratory, Pasadena, California, 1965.

For either linearly or circularly polarized antennas, the computer uses the following equation for maximum antenna gain calculation.

$$G_M = \frac{4(p_{1k} + p_{2k})}{\sum_{i=2}^{n-1} [(p_{1i} + p_{2i})(\sin\theta_i)(\theta_{i+1} - \theta_{i-1})]} \tag{5}$$

where

p_{1k} = maximum normalized power point in the pattern 1 input array. From Eq. (2), it may be seen that the value of p_{1k} will always be equal to unity. The k subscript refers to the $i = k$th subregion in which this maximum data point exists

p_{2k} = normalized power point in pattern 2 occurring in the $i = k$th subregion. For linearly polarized antenna cases, F_{2i} at $i = K$ will be equal to F_{M2}, and so, from Eq. (4), the value of p_{2k} is unity.

The total probable error of the calculated antenna temperature is a function of the probable errors of the input data. Using the analytical method given in Ref. 25, the equation for the total probable error of the calculated antenna temperature for the general polarization case is obtained as

$$PE_{T_A} = \frac{G_M}{4(p_{1k} + p_{2k})} \sqrt{\sum_{i=2}^{n-1} \left\{ \begin{aligned} &[PE^2_{T_{bi}}] [(p_{1i} + p_{2i})(\sin\theta_i)(\theta_{i+1} - \theta_{i-1})]^2 \\ &+ \left(\frac{\ln 10}{10}\right)^2 [PE^2_a + PE^2_{F_{M1}} + b^2F^2_{1i}] [(T_{bi} - T_A)(p_{1i}\sin\theta_i)(\theta_{i+1} - \theta_{i-1})]^2 \\ &+ \left(\frac{\ln 10}{10}\right)^2 [PE^2_a + PE^2_{F_{M2}} + b^2F^2_{2i}] [(T_{bi} - T_A)(p_{2i}\sin\theta_i)(\theta_{i+1} - \theta_{i-1})]^2 \\ &+ [PE^2_{\theta_i}] \begin{bmatrix} (T_{b(i-1)} - T_A)(p_{1(i-1)} + p_{2(i-1)})(\sin\theta_{i-1}) \\ + (T_{bi} - T_A)(p_{1i} + p_{2i})(\cos\theta_i)(\theta_{i+1} - \theta_{i-1}) \\ - (T_{b(i+1)} - T_A)(p_{1(i+1)} + p_{2(i+1)})(\sin\theta_{i+1}) \end{bmatrix}^2 \end{aligned} \right\}} \tag{6}$$

where

$PE_{T_{bi}}$ = probable error of ith value of brightness temperature, °K

PE_a = constant probable error in the pattern data due to recorder jitter and the accuracy with which pattern data can be digitized, db

b = pattern recording system nonlinearity error constant, db/db

$PE_{F_{M1}}$ = probable error of F_{M1}, db

$PE_{F_{M2}}$ = probable error of F_{M2}, db

PE_{θ_i} = probable error of ith value of θ, rad

Account has not been taken in the probable error expressions for errors caused by limited dynamic range of the patterns. The limits of this source of error are found by computing the antenna temperature in two ways. The antenna temperature is first solved by the computer with the given input pattern data and then all data points equal to or greater than −40 db replaced by −70 db.

B. Applications

This program can be used to compute zenith antenna temperature for any circularly symmetric antenna whose aperture is excited with TE_{1n} and/or TM_{1n} circular waveguide modes. Most circular feed horns and paraboloidal antennas presently being used in the Deep Space Instrumentation Facility and Jet Propulsion Laboratory spacecraft systems are applicable to this program. The program can also be used to compute antenna temperatures for the azimuth and elevation channels of a monopulse antenna.

C. Input

Card	Parameters	Format
1	*ICASE*	I3
2	*AZ*	12A6
3	*BZ*	2A6
4	*CZ*	2A6
5	*PEA, B, PETHET, PEF1, PEF2*	5F10.0
6	*M, N, IF2OPT*	3I3
7	*ALPHA(1), TB(1), PETB⁺(1), PETB⁻(1)*	4F10.0
.	. . .	.
.	. . .	.
.	. . .	.
$M+6$	*ALPHA(M), TB(M), PETB⁺(M), PETB⁻(M)*	.
$M+7$	*THETA(1), F1(1), PH1, F2(1), PH2*	5F10.0
.	. . . .	.
.	. . . .	.
.	. . . .	.
$M+N+6$	*THETA(N), F1(N), PH1, F2(N), PH2*	.

ICASE = number of complete sets of input data, usually 1

AZ = title for "antenna project," Columns 2 through 72

BZ = pattern numbers, Columns 2 through 6, and 7 through 12

CZ = date, Columns 2 through 12

PEA = constant probable error in the patterns (in decibels). This variable is the same as PE_a in Eq. (6)

B = pattern recording system nonlinearity error constant (in decibels/decibel). This variable is the same as b in Eq. (6)

PETHET = probable error of the ith value of θ (in radians). This variable is the same as PE_{θ_i} in Eq. (6)

PEF1 = probable error of F_{M1} (in decibels). This variable is the same as $PE_{F_{M1}}$ in Eq. (6)

PEF2 = probable error of F_{M2} (in decibels). This variable is the same as $PE_{F_{M2}}$ in Eq. (6)

M = number of brightness temperature input data cards ($M \leq 200$)

N = number of pattern input data cards ($N \leq 500$)

IF2OPT = 0 for circular polarization case

= 1 for linear polarization case

ALPHA(J) = polar antenna angle (in degrees) and corresponds to the jth subregion of the J data input array

TB(J) = brightness temperature corresponding to *ALPHA(J)*, °K

PETB⁺(J) = positive probable error of *TB(J)*, °K

PETB⁻(J) = negative probable error of *TB(J)*, °K

THETA(I) = polar antenna angle (in degrees) and corresponds to the ith subregion of the I data input array. The angle, when converted to radians by the program, is the same as θ_i in Eqs. (1) and (6)

F1(1) = pattern 1 data (in decibels) corresponding to *THETA(I)*. Same as variable F_{1i} in Eq. (2) and Fig. 4

PH1 = 0.0 or any value suitable for input format of F10.0

F2(1) = pattern 2 data (in decibels) corresponding to *THETA(I)*. This variable is the same as F_{2i} in Eq. (3).

PH2 = 0.0 or any value suitable for the input format of F10.0

The values *PH1* and *PH2* are not used in this computer program, but the pattern data card format is identical to that for Ludwig's Efficiency Program (IX). Therefore, the same pattern data cards can be used for either program.

As previously discussed, the *F1(I)* and *F2(I)* pattern data must be E- and H-plane pattern data for the linearly polarized antenna case, and RCP and LCP illuminated pattern data for circularly polarized antennas.

Consecutive cases may be run (the total number of cases is specified on the *ICASE* card). Each new subsequent case requires all the input data cards shown previously with the exception of the *ICASE* card.

The accuracy of the calculated antenna temperature increases as the total number of pattern data points used increases. In general, it has been found that pattern data input of 2° increments between 0° to 180° will result in sufficiently accurate calculated temperatures.

The brightness temperature input (*J*-array) does not have to have the same number of data points as the antenna pattern input (*I*-array) because the program will perform the necessary interpolations. It is not necessary that the pattern or brightness temperature data input be given in equal angular increments, but it is required that the initial and final data points for both input data arrays begin at 0° and end at 180°.

D. Output

On the first page of the sample case the program prints out a table of the brightness temperature input data, *ALPHA(J)*, *TB(J)*, $PETB^{+}(J)$ and $PETB^{-}(J)$. On the subsequent page(s), the computer prints out a table of the input data *THETA(I)*, *F1(I)*, *F2(I)*; interpolated brightness temperature data *TB(I)*, $PETB^{+}(I)$, $PETB^{-}(I)$; beam efficiency, subregional antenna temperature contributions, and the sum of antenna temperature contributions. At the end of the table, the computer prints out the input probable error data values, the antenna gain (in decibels), antenna gain probable error (in decibels), total antenna temperature, and ± antenna temperature probable error.

E. Sample Case

A sample output of a circularly polarized antenna case is shown in the following. The total 7094 machine time for this sample case was approximately 22 sec; the time between execution and completion was 7 sec. The input consisted of 99 brightness temperature cards and 91 pattern data cards.

Sample input

1				
AQUISITION AID ANTENNA		(SUM CHANNEL)		FREQ = 2295 MC
1 2				
6/16/66				
0.05	.005	.002	.05	.05
99 91 0				
0.000	2.450	.0980	-.0735	
2.000	2.450	.0980	-.0735	
4.000	2.450	.0980	-.0735	
6.000	2.450	.0980	-.0735	
8.000	2.455	.0982	-.0736	
10.000	2.460	.0984	-.0738	
12.000	2.465	.0986	-.0739	
14.000	2.470	.0988	-.0741	
16.000	2.475	.0990	-.0742	
18.000	2.480	.0992	-.0744	
20.000	2.490	.0996	-.0747	
22.000	2.500	.1000	-.0750	
24.000	2.515	.1006	-.0754	
26.000	2.530	.1012	-.0759	
28.000	2.565	.1026	-.0769	
30.000	2.600	.1040	-.0780	
32.000	2.660	.1064	-.0798	
34.000	2.720	.1088	-.0816	
36.000	2.810	.1124	-.0843	
38.000	2.900	.1160	-.0870	
40.000	3.000	.1200	-.0900	
42.000	3.100	.1240	-.0930	
44.000	3.225	.1290	-.0967	
46.000	3.350	.1340	-.1005	
48.000	3.490	.1396	-.1047	
50.000	3.630	.1452	-.1089	
52.000	3.800	.1520	-.1140	
54.000	3.970	.1588	-.1191	
56.000	4.135	.1654	-.1240	
58.000	4.300	.1720	-.1290	
60.000	4.500	.1800	-.1350	
62.000	4.700	.1880	-.1410	
64.000	4.930	.1972	-.1479	
66.000	5.160	.2064	-.1548	
68.000	5.540	.2216	-.1662	
70.000	5.800	.2320	-.1740	
72.000	6.300	.2520	-.1890	
74.000	6.800	.2720	-.2040	
76.000	7.550	.3020	-.2265	
78.000	8.300	.3320	-.2490	
80.000	9.570	.3828	-.2871	
82.000	12.500	.5000	-.3750	
84.000	17.500	.7000	-.5250	
85.000	20.000	.8000	-.6000	
86.000	27.000	1.0800	-.8100	
87.000	35.000	1.4000	-1.0500	
88.000	61.300	2.4520	-1.8390	
89.000	87.500	3.5000	-2.6250	
89.500	100.000	4.0000	-3.0000	
90.000	112.600	4.5040	-3.3780	
90.500	109.094	4.3637	-3.2728	
91.000	106.313	4.2525	-3.1894	
92.000	101.385	4.0554	-3.0415	
93.000	98.370	3.9348	-2.9511	
94.000	109.527	4.3811	-3.2858	
95.000	120.475	4.8190	-3.6142	
96.000	133.142	5.3257	-3.9942	
98.000	154.974	6.1989	-4.6492	
100.000	173.802	6.9521	-5.2140	
102.000	189.882	7.5952	-5.6964	
104.000	203.276	8.1310	-6.0982	
106.000	214.333	8.5733	-6.4300	
108.000	223.552	8.9420	-6.7065	
110.000	231.206	9.2482	-6.9362	
112.000	237.622	9.5048	-7.1286	
114.000	242.949	9.7179	-7.2884	
116.000	247.418	9.8967	-7.4225	
118.000	251.152	10.0460	-7.5345	
120.000	254.276	10.1710	-7.6282	
122.000	256.887	10.2755	-7.7066	
124.000	259.073	10.3629	-7.7722	
126.000	260.899	10.4359	-7.8269	
128.000	262.421	10.4968	-7.8726	
130.000	263.688	10.5475	-7.9106	
132.000	264.745	10.5898	-7.9423	
134.000	265.620	10.6248	-7.9686	
136.000	266.346	10.6538	-7.9903	
138.000	266.943	10.6777	-8.0083	
140.000	267.435	10.6974	-8.0230	
142.000	267.837	10.7134	-8.0351	
144.000	268.164	10.7265	-8.0449	
146.000	268.427	10.7371	-8.0528	
148.000	268.640	10.7456	-8.0592	
150.000	268.808	10.7523	-8.0642	
152.000	268.942	10.7577	-8.0682	
154.000	269.046	10.7618	-8.0714	
156.000	269.127	10.7651	-8.0738	
158.000	269.188	10.7675	-8.0756	
160.000	269.233	10.7693	-8.0770	
162.000	269.266	10.7706	-8.0779	
164.000	269.289	10.7715	-8.0786	
166.000	269.304	10.7721	-8.0791	
168.000	269.314	10.7725	-8.0794	
170.000	269.319	10.7727	-8.0795	
172.000	269.322	10.7729	-8.0796	

Sample input (contd)

174.000	269.323	10.7729	-8.0797	
176.000	269.324	10.7729	-8.0797	
178.000	269.324	10.7729	-8.0797	
180.000	269.324	10.7729	-8.0797	
0.000	-1.200	0.000	-36.000	0.000
2.000	-1.500	0.000	-37.500	0.000
4.000	-2.000	0.000	-34.000	0.000
6.000	-3.000	0.000	-26.900	0.000
8.000	-4.200	0.000	-21.800	0.000
10.000	-5.800	0.000	-18.500	0.000
12.000	-7.600	0.000	-16.600	0.000
14.000	-8.900	0.000	-15.600	0.000
16.000	-10.000	0.000	-15.400	0.000
18.000	-11.000	0.000	-15.800	0.000
20.000	-12.000	0.000	-16.600	0.000
22.000	-13.100	0.000	-18.600	0.000
24.000	-14.700	0.000	-20.900	0.000
26.000	-16.800	0.000	-24.200	0.000
28.000	-19.100	0.000	-27.200	0.000
30.000	-21.900	0.000	-27.200	0.000
32.000	-23.600	0.000	-25.300	0.000
34.000	-23.600	0.000	-24.000	0.000
36.000	-22.900	0.000	-23.800	0.000
38.000	-22.700	0.000	-24.100	0.000
40.000	-22.900	0.000	-25.100	0.000
42.000	-23.900	0.000	-26.900	0.000
44.000	-25.500	0.000	-29.700	0.000
46.000	-27.800	0.000	-33.500	0.000
48.000	-30.300	0.000	-35.700	0.000
50.000	-31.800	0.000	-33.000	0.000
52.000	-30.500	0.000	-30.000	0.000
54.000	-38.800	0.000	-28.200	0.000
56.000	-37.600	0.000	-27.600	0.000
58.000	-36.800	0.000	-27.400	0.000
60.000	-36.700	0.000	-27.200	0.000
62.000	-36.400	0.000	-27.200	0.000
64.000	-36.500	0.000	-27.400	0.000
66.000	-36.700	0.000	-28.000	0.000
68.000	-37.200	0.000	-29.100	0.000
70.000	-38.400	0.000	-30.900	0.000
72.000	-29.900	0.000	-32.100	0.000
74.000	-31.200	0.000	-33.200	0.000
76.000	-31.900	0.000	-33.800	0.000
78.000	-32.500	0.000	-34.100	0.000
80.000	-33.500	0.000	-35.000	0.000
82.000	-34.500	0.000	-36.200	0.000
84.000	-35.500	0.000	-37.500	0.000
86.000	-36.400	0.000	-38.400	0.000
88.000	-37.200	0.000	-38.500	0.000
90.000	-37.200	0.000	-37.800	0.000
92.000	-37.000	0.000	-37.500	0.000
94.000	-36.600	0.000	-37.600	0.000
96.000	-36.600	0.000	-37.900	0.000
98.000	-36.700	0.000	-38.000	0.000
100.000	-36.900	0.000	-38.200	0.000
102.000	-37.500	0.000	-37.900	0.000
104.000	-38.200	0.000	-36.600	0.000
106.000	-38.100	0.000	-36.400	0.000
108.000	-37.800	0.000	-37.400	0.000
110.000	-37.900	0.000	-38.000	0.000
112.000	-38.500	0.000	-38.900	0.000
114.000	-39.000	0.000	-39.600	0.000
116.000	-39.000	0.000	-39.900	0.000
118.000	-39.000	0.000	-39.900	0.000
120.000	-39.000	0.000	-39.100	0.000
122.000	-39.800	0.000	-39.000	0.000
124.000	-40.000	0.000	-39.000	0.000
126.000	-40.000	0.000	-40.000	0.000
128.000	-40.000	0.000	-40.000	0.000
130.000	-40.000	0.000	-39.900	0.000
132.000	-40.000	0.000	-40.000	0.000
134.000	-40.000	0.000	-40.000	0.000
136.000	-40.000	0.000	-40.000	0.000
138.000	-40.000	0.000	-40.000	0.000
140.000	-40.000	0.000	-40.000	0.000
142.000	-40.000	0.000	-40.000	0.000
144.000	-40.000	0.000	-39.900	0.000
146.000	-40.000	0.000	-39.900	0.000
148.000	-40.000	0.000	-40.000	0.000
150.000	-40.000	0.000	-40.000	0.000
152.000	-40.000	0.000	-40.000	0.000
154.000	-40.000	0.000	-40.000	0.000
156.000	-39.900	0.000	-40.000	0.000
158.000	-39.900	0.000	-40.000	0.000
160.000	-40.000	0.000	-40.000	0.000
162.000	-40.000	0.000	-40.000	0.000
164.000	-40.000	0.000	-40.000	0.000
166.000	-39.900	0.000	-40.000	0.000
168.000	-39.900	0.000	-40.000	0.000
170.000	-40.000	0.000	-40.000	0.000
172.000	-40.000	0.000	-40.000	0.000
174.000	-40.000	0.000	-40.000	0.000
176.000	-40.000	0.000	-39.900	0.000
178.000	-40.000	0.000	-38.400	0.000
180.000	-40.000	0.000	-39.900	0.000

Sample output

```
ANTENNA TEMPERATURE AND ERROR ANALYSIS PROGRAM

ANTENNA PROJECT AQUISITION AID ANTENNA  (SUM CHANNEL)      FREQ = 2295 MC

PATTERNS     1  AND    2

BRIGHTNESS TEMPERATURE INPUT DATA
99   91    0       0.05       0.01       0.00       0.05       0.05
```

0.00	2.45	0.10	-0.07
2.00	2.45	0.10	-0.07
4.00	2.45	0.10	-0.07
6.00	2.45	0.10	-0.07
8.00	2.46	0.10	-0.07
10.00	2.46	0.10	-0.07
12.00	2.47	0.10	-0.07
14.00	2.47	0.10	-0.07
16.00	2.47	0.10	-0.07
18.00	2.48	0.10	-0.07
20.00	2.49	0.10	-0.07
22.00	2.50	0.10	-0.08
24.00	2.51	0.10	-0.08
26.00	2.53	0.10	-0.08
28.00	2.56	0.10	-0.08
30.00	2.60	0.10	-0.08
32.00	2.66	0.11	-0.08
34.00	2.72	0.11	-0.08
36.00	2.81	0.11	-0.08
38.00	2.90	0.12	-0.09
40.00	3.00	0.12	-0.09
42.00	3.10	0.12	-0.09
44.00	3.22	0.13	-0.10
46.00	3.35	0.13	-0.10
48.00	3.49	0.14	-0.10
50.00	3.63	0.15	-0.11
52.00	3.80	0.15	-0.11
54.00	3.97	0.16	-0.12
56.00	4.13	0.17	-0.12
58.00	4.30	0.17	-0.13
60.00	4.50	0.18	-0.13
62.00	4.70	0.19	-0.14
64.00	4.93	0.20	-0.15
66.00	5.16	0.21	-0.15
68.00	5.54	0.22	-0.17
70.00	5.80	0.23	-0.17
72.00	6.30	0.25	-0.19
74.00	6.80	0.27	-0.20
76.00	7.55	0.30	-0.23
78.00	8.30	0.33	-0.25
80.00	9.57	0.38	-0.29
82.00	12.50	0.50	-0.38
84.00	17.50	0.70	-0.52
85.00	20.00	0.80	-0.60
86.00	27.00	1.08	-0.81
87.00	35.00	1.40	-1.05
88.00	61.30	2.45	-1.84
89.00	87.50	3.50	-2.63
89.50	100.00	4.00	-3.00
90.00	112.60	4.50	-3.38
90.50	109.09	4.36	-3.27
91.00	106.31	4.25	-3.19
92.00	101.39	4.06	-3.04
93.00	98.37	3.93	-2.95
94.00	109.53	4.38	-3.29
95.00	120.48	4.82	-3.61
96.00	133.14	5.33	-3.99
98.00	154.97	6.20	-4.65
100.00	173.80	6.95	-5.21
102.00	189.88	7.60	-5.70
104.00	203.28	8.13	-6.10
106.00	214.33	8.57	-6.43
108.00	223.55	8.94	-6.71
110.00	231.21	9.25	-6.94
112.00	237.62	9.50	-7.13
114.00	242.95	9.72	-7.29
116.00	247.42	9.90	-7.42
118.00	251.15	10.05	-7.53
120.00	254.28	10.17	-7.63
122.00	256.89	10.28	-7.71
124.00	259.07	10.36	-7.77
126.00	260.90	10.44	-7.83
128.00	262.42	10.50	-7.87
130.00	263.69	10.55	-7.91
132.00	264.74	10.59	-7.94
134.00	265.62	10.62	-7.97
136.00	266.35	10.65	-7.99
138.00	266.94	10.68	-8.01
140.00	267.44	10.70	-8.02
142.00	267.84	10.71	-8.04
144.00	268.16	10.73	-8.04
146.00	268.43	10.74	-8.05
148.00	268.64	10.75	-8.06
150.00	268.81	10.75	-8.06

Sample output (contd)

152.00	268.94	10.76	-8.07
154.00	269.05	10.76	-8.07
156.00	269.13	10.77	-8.07
158.00	269.19	10.77	-8.08
160.00	269.23	10.77	-8.08
162.00	269.27	10.77	-8.08
164.00	269.29	10.77	-8.08
166.00	269.30	10.77	-8.08
168.00	269.31	10.77	-8.06
170.00	269.32	10.77	-8.08
172.00	269.32	10.77	-8.08
174.00	269.32	10.77	-8.08
176.00	269.32	10.77	-8.08
178.00	269.32	10.77	-8.08
180.00	269.32	10.77	-8.08

0.00	-1.20	0.00	-36.00
2.00	-1.50	0.00	-37.50
4.00	-2.00	0.00	-34.00
6.00	-3.00	0.00	-26.90
8.00	-4.20	0.00	-21.80
10.00	-5.80	0.00	-18.50
12.00	-7.60	0.00	-16.60
14.00	-8.90	0.00	-15.60
16.00	-10.00	0.00	-15.40
18.00	-11.00	0.00	-15.80
20.00	-12.00	0.00	-16.60
22.00	-13.10	0.00	-18.60
24.00	-14.70	0.00	-20.90
26.00	-16.80	0.00	-24.20
28.00	-19.10	0.00	-27.20
30.00	-21.90	0.00	-27.20
32.00	-23.60	0.00	-25.30
34.00	-23.60	0.00	-24.00
36.00	-22.90	0.00	-23.80
38.00	-22.70	0.00	-24.10
40.00	-22.90	0.00	-25.10
42.00	-23.90	0.00	-26.90
44.00	-25.50	0.00	-29.70
46.00	-27.80	0.00	-33.50
48.00	-30.30	0.00	-35.70
50.00	-31.80	0.00	-33.00
52.00	-30.50	0.00	-30.00
54.00	-38.80	0.00	-28.20
56.00	-37.60	0.00	-27.60
58.00	-36.80	0.00	-27.40
60.00	-36.70	0.00	-27.20
62.00	-36.40	0.00	-27.20
64.00	-36.50	0.00	-27.40
66.00	-36.70	0.00	-28.00
68.00	-37.20	0.00	-29.10
70.00	-38.40	0.00	-30.90
72.00	-29.90	0.00	-32.10
74.00	-31.20	0.00	-33.20
76.00	-31.90	0.00	-33.80
78.00	-32.50	0.00	-34.10
80.00	-33.50	0.00	-35.00
82.00	-34.50	0.00	-36.20
84.00	-35.50	0.00	-37.50
86.00	-36.40	0.00	-38.40
88.00	-37.20	0.00	-38.50
90.00	-37.20	0.00	-37.80
92.00	-37.00	0.00	-37.50
94.00	-36.60	0.00	-37.60
96.00	-36.60	0.00	-37.90
98.00	-36.70	0.00	-38.00
100.00	-36.90	0.00	-38.20
102.00	-37.50	0.00	-37.90
104.00	-38.20	0.00	-36.60
106.00	-38.10	0.00	-36.40
108.00	-37.80	0.00	-37.40
110.00	-37.90	0.00	-38.00
112.00	-38.50	0.00	-38.90
114.00	-39.00	0.00	-39.60
116.00	-39.00	0.00	-39.90
118.00	-39.00	0.00	-39.90
120.00	-39.00	0.00	-39.10
122.00	-39.80	0.00	-39.00
124.00	-40.00	0.00	-39.00
126.00	-40.00	0.00	-40.00
128.00	-40.00	0.00	-40.00
130.00	-40.00	0.00	-39.90
132.00	-40.00	0.00	-40.00
134.00	-40.00	0.00	-40.00
136.00	-40.00	0.00	-40.00
138.00	-40.00	0.00	-40.00
140.00	-40.00	0.00	-40.00
142.00	-40.00	0.00	-40.00
144.00	-40.00	0.00	-39.90
146.00	-40.00	0.00	-39.90
148.00	-40.00	0.00	-40.00
150.00	-40.00	0.00	-40.00
152.00	-40.00	0.00	-40.00
154.00	-40.00	0.00	-40.00
156.00	-39.90	0.00	-40.00
158.00	-39.90	0.00	-40.00

Sample output (contd)

160.00	-40.00	0.00	-40.00
162.00	-40.00	0.00	-40.00
164.00	-40.00	0.00	-40.00
166.00	-39.90	0.00	-40.00
168.00	-39.90	0.00	-40.00
170.00	-40.00	0.00	-40.00
172.00	-40.00	0.00	-40.00
174.00	-40.00	0.00	-40.00
176.00	-40.00	0.00	-39.90
178.00	-40.00	0.00	-38.40
180.00	-40.00	0.00	-39.90

F2OPT	K	F1(K)	F2(K)	L	F2(L)	F2L	P2K
0	1	-1.2	-36.0	9	-15.4	-1.2	0.331131E-03

Sample output

ANTENNA TEMPERATURE AND ERROR ANALYSIS PROGRAM

ANTENNA PROJECT AQUISITION AID ANTENNA (SUM CHANNEL) FREQ = 2295 MC

PATTERNS 1 AND 2

BRIGHTNESS TEMPERATURE INPUT DATA

J	ALPHA(J) (DEG)	TB(J) (DEG K)	PETB(+) (DEG K)	PETB(-) (DEG K)
1	0.0	2.45	0.10	-0.07
2	2.0	2.45	0.10	-0.07
3	4.0	2.45	0.10	-0.07
4	6.0	2.45	0.10	-0.07
5	8.0	2.46	0.10	-0.07
6	10.0	2.46	0.10	-0.07
7	12.0	2.47	0.10	-0.07
8	14.0	2.47	0.10	-0.07
9	16.0	2.47	0.10	-0.07
10	18.0	2.48	0.10	-0.07
11	20.0	2.49	0.10	-0.07
12	22.0	2.50	0.10	-0.08
13	24.0	2.51	0.10	-0.08
14	26.0	2.53	0.10	-0.08
15	28.0	2.56	0.10	-0.08
16	30.0	2.60	0.10	-0.08
17	32.0	2.66	0.11	-0.08
18	34.0	2.72	0.11	-0.08
19	36.0	2.81	0.11	-0.08
20	38.0	2.90	0.12	-0.09
21	40.0	3.00	0.12	-0.09
22	42.0	3.10	0.12	-0.09
23	44.0	3.22	0.13	-0.10
24	46.0	3.35	0.13	-0.10
25	48.0	3.49	0.14	-0.10
26	50.0	3.63	0.15	-0.11
27	52.0	3.80	0.15	-0.11
28	54.0	3.97	0.16	-0.12
29	56.0	4.13	0.17	-0.12
30	58.0	4.30	0.17	-0.13
31	60.0	4.50	0.18	-0.13
32	62.0	4.70	0.19	-0.14
33	64.0	4.93	0.20	-0.15
34	66.0	5.16	0.21	-0.15
35	68.0	5.54	0.22	-0.17
36	70.0	5.80	0.23	-0.17
37	72.0	6.30	0.25	-0.19
38	74.0	6.80	0.27	-0.20
39	76.0	7.55	0.30	-0.23
40	78.0	8.30	0.33	-0.25
41	80.0	9.57	0.38	-0.29
42	82.0	12.50	0.50	-0.38
43	84.0	17.50	0.70	-0.52
44	85.0	20.00	0.80	-0.60
45	86.0	27.00	1.08	-0.81
46	87.0	35.00	1.40	-1.05
47	88.0	61.30	2.45	-1.84
48	89.0	87.50	3.50	-2.63
49	89.5	100.00	4.00	-3.00
50	90.0	112.60	4.50	-3.38
51	90.5	109.09	4.36	-3.27
52	91.0	106.31	4.25	-3.19
53	92.0	101.39	4.06	-3.04
54	93.0	98.37	3.93	-2.95
55	94.0	109.53	4.38	-3.29
56	95.0	120.48	4.82	-3.61
57	96.0	133.14	5.33	-3.99
58	98.0	154.97	6.20	-4.65
59	100.0	173.80	6.95	-5.21
60	102.0	189.88	7.60	-5.70
61	104.0	203.28	8.13	-6.10
62	106.0	214.33	8.57	-6.43
63	108.0	223.55	8.94	-6.71
64	110.0	231.21	9.25	-6.94
65	112.0	237.62	9.50	-7.13
66	114.0	242.95	9.72	-7.29
67	116.0	247.42	9.90	-7.42
68	118.0	251.15	10.05	-7.53
69	120.0	254.28	10.17	-7.63
70	122.0	256.89	10.28	-7.71
71	124.0	259.07	10.36	-7.77
72	126.0	260.90	10.44	-7.83
73	128.0	262.42	10.50	-7.87
74	130.0	263.69	10.55	-7.91
75	132.0	264.74	10.59	-7.94
76	134.0	265.62	10.62	-7.97
77	136.0	266.35	10.65	-7.99
78	138.0	266.94	10.68	-8.01
79	140.0	267.44	10.70	-8.02
80	142.0	267.84	10.71	-8.04
81	144.0	268.16	10.73	-8.04
82	146.0	268.43	10.74	-8.05
83	148.0	268.64	10.75	-8.06
84	150.0	268.81	10.75	-8.06
85	152.0	268.94	10.76	-8.07
86	154.0	269.05	10.76	-8.07
87	156.0	269.13	10.77	-8.07
88	158.0	269.19	10.77	-8.08
89	160.0	269.23	10.77	-8.08

Sample output (contd)

90	162.0	269.27	10.77	-8.08
91	164.0	269.29	10.77	-8.08
92	166.0	269.30	10.77	-8.08
93	168.0	269.31	10.77	-8.08
94	170.0	269.32	10.77	-8.08
95	172.0	269.32	10.77	-8.08
96	174.0	269.32	10.77	-8.08
97	176.0	269.32	10.77	-8.08
98	178.0	269.32	10.77	-8.08
99	180.0	269.32	10.77	-8.08

Sample output

ANTENNA PROJECT AQUISITION AID ANTENNA (SUM CHANNEL) FREQ = 2295 MC

CIRCULAR POLARIZATION PATTERNS

PATTERNS 1 AND 2 40 DB PATTERN CASE DATE 6/16/66

ANTENNA BEAM EFFICIENCY, TEMPERATURE, AND GAIN

I	THETA (DEG)	F1 (DB)	F2 (DB)	TB (DEG K)	PETB(+) (DEG K)	PETB(-) (DEG K)	SUM(ETA)	TA (DEG K)	SUM(TA) (DEG K)
1	0.0	-1.2	-36.0	2.45	0.10	-0.07	0.000000	-0.000000	0.000000
2	2.0	-1.5	-37.5	2.45	0.10	-0.07	0.046891	0.114882	0.114882
3	4.0	-2.0	-34.0	2.45	0.10	-0.07	0.130455	0.204731	0.319614
4	6.0	-3.0	-26.9	2.45	0.10	-0.07	0.230261	0.244526	0.564140
5	8.0	-4.2	-21.8	2.46	0.10	-0.07	0.332402	0.250754	0.814895
6	10.0	-5.8	-18.5	2.46	0.10	-0.07	0.423718	0.224638	1.039532
7	12.0	-7.6	-16.6	2.47	0.10	-0.07	0.500903	0.190262	1.229795
8	14.0	-8.9	-15.6	2.47	0.10	-0.07	0.572679	0.177287	1.407082
9	16.0	-10.0	-15.4	2.47	0.10	-0.07	0.640062	0.166773	1.573854
10	18.0	-11.0	-15.8	2.48	0.10	-0.07	0.702058	0.153750	1.727604
11	20.0	-12.0	-16.6	2.49	0.10	-0.07	0.757202	0.137307	1.864911
12	22.0	-13.1	-18.6	2.50	0.10	-0.08	0.801626	0.111560	1.976471
13	24.0	-14.7	-20.9	2.51	0.10	-0.08	0.834249	0.081544	2.058015
14	26.0	-16.8	-24.2	2.53	0.10	-0.08	0.854789	0.051967	2.109982
15	28.0	-19.1	-27.2	2.56	0.10	-0.08	0.867445	0.032463	2.142446
16	30.0	-21.9	-27.2	2.60	0.10	-0.08	0.875378	0.020626	2.163071
17	32.0	-23.6	-25.3	2.66	0.11	-0.08	0.882735	0.019568	2.182639
18	34.0	-23.6	-24.0	2.72	0.11	-0.08	0.891590	0.024087	2.206726
19	36.0	-22.9	-23.8	2.81	0.11	-0.08	0.901959	0.029137	2.235863
20	38.0	-22.7	-24.1	2.90	0.12	-0.09	0.912777	0.031372	2.267235
21	40.0	-22.9	-25.1	3.00	0.12	-0.09	0.922801	0.030072	2.297307
22	42.0	-23.9	-26.9	3.10	0.12	-0.09	0.930565	0.024069	2.321377
23	44.0	-25.5	-29.7	3.22	0.13	-0.10	0.935692	0.016535	2.337912
24	46.0	-27.8	-33.5	3.35	0.13	-0.10	0.938567	0.009631	2.347542
25	48.0	-30.3	-35.7	3.49	0.14	-0.10	0.940263	0.005917	2.353459
26	50.0	-31.8	-33.0	3.63	0.15	-0.11	0.941952	0.006130	2.359590
27	52.0	-30.5	-30.0	3.80	0.15	-0.11	0.944779	0.010745	2.370335
28	54.0	-38.8	-28.2	3.97	0.16	-0.12	0.947305	0.010027	2.380362
29	56.0	-37.6	-27.6	4.13	0.17	-0.12	0.950312	0.012434	2.392796
30	58.0	-36.8	-27.4	4.30	0.17	-0.13	0.953576	0.014036	2.406832
31	60.0	-36.7	-27.2	4.50	0.18	-0.13	0.957059	0.015671	2.422503
32	62.0	-36.4	-27.2	4.70	0.19	-0.14	0.960635	0.016807	2.439310
33	64.0	-36.5	-27.4	4.93	0.20	-0.15	0.964120	0.017181	2.456491
34	66.0	-36.7	-28.0	5.16	0.21	-0.15	0.967237	0.016088	2.472579
35	68.0	-37.2	-29.1	5.54	0.22	-0.17	0.969737	0.013848	2.486427
36	70.0	-38.4	-30.9	5.80	0.23	-0.17	0.971444	0.009900	2.496327
37	72.0	-29.9	-32.1	6.30	0.25	-0.19	0.974403	0.018643	2.514970
38	74.0	-31.2	-33.2	6.80	0.27	-0.20	0.976660	0.015344	2.530315
39	76.0	-31.9	-33.8	7.55	0.30	-0.23	0.978616	0.014769	2.545084
40	78.0	-32.5	-34.1	8.30	0.33	-0.25	0.980382	0.014655	2.559739
41	80.0	-33.5	-35.0	9.57	0.38	-0.29	0.981807	0.013643	2.573382
42	82.0	-34.5	-36.2	12.50	0.50	-0.38	0.982925	0.013967	2.587349
43	84.0	-35.5	-37.5	17.50	0.70	-0.52	0.983792	0.015179	2.602528
44	86.0	-36.4	-38.4	27.00	1.08	-0.81	0.984499	0.019094	2.621623
45	88.0	-37.2	-38.5	61.30	2.45	-1.84	0.985128	0.038568	2.660191
46	90.0	-37.2	-37.8	112.60	4.50	-3.38	0.985805	0.076166	2.736358
47	92.0	-37.0	-37.5	101.39	4.06	-3.04	0.986520	0.072547	2.808904
48	94.0	-36.6	-37.6	109.53	4.38	-3.29	0.987263	0.081381	2.890285
49	96.0	-36.6	-37.9	133.14	5.33	-3.99	0.987982	0.095712	2.985997
50	98.0	-36.7	-38.0	154.97	6.20	-4.65	0.988682	0.108404	3.094402
51	100.0	-36.9	-38.2	173.80	6.95	-5.21	0.989346	0.115463	3.209864
52	102.0	-37.5	-37.9	189.88	7.60	-5.70	0.989977	0.119822	3.329687
53	104.0	-38.2	-36.6	203.28	8.13	-6.10	0.990658	0.138518	3.468205
54	106.0	-38.1	-36.4	214.33	8.57	-6.43	0.991359	0.150102	3.618307
55	108.0	-37.8	-37.4	223.55	8.94	-6.71	0.991987	0.140357	3.758664
56	110.0	-37.9	-38.0	231.21	9.25	-6.94	0.992558	0.132191	3.890855
57	112.0	-38.5	-38.9	237.62	9.50	-7.13	0.993033	0.112902	4.003757
58	114.0	-39.0	-39.6	242.95	9.72	-7.29	0.993442	0.099191	4.102948
59	116.0	-39.0	-39.9	247.42	9.90	-7.42	0.993831	0.096296	4.199244
60	118.0	-39.0	-39.9	251.15	10.05	-7.53	0.994213	0.096026	4.295270
61	120.0	-39.0	-39.1	254.28	10.17	-7.63	0.994622	0.104005	4.399275
62	122.0	-39.8	-39.0	256.89	10.28	-7.71	0.994993	0.095322	4.494596
63	124.0	-40.0	-39.0	259.07	10.36	-7.77	0.995349	0.092057	4.586653
64	126.0	-40.0	-40.0	260.90	10.44	-7.83	0.995656	0.080098	4.666751
65	128.0	-40.0	-40.0	262.42	10.50	-7.87	0.995955	0.078473	4.745224
66	130.0	-40.0	-39.9	263.69	10.55	-7.91	0.996249	0.077547	4.822771
67	132.0	-40.0	-40.0	264.74	10.59	-7.94	0.996531	0.074660	4.897431
68	134.0	-40.0	-40.0	265.62	10.62	-7.97	0.996804	0.072508	4.969939
69	136.0	-40.0	-40.0	266.35	10.65	-7.99	0.997067	0.070211	5.040150
70	138.0	-40.0	-40.0	266.94	10.68	-8.01	0.997321	0.067783	5.107933
71	140.0	-40.0	-40.0	267.44	10.70	-8.02	0.997565	0.065234	5.173167
72	142.0	-40.0	-40.0	267.84	10.71	-8.04	0.997799	0.062575	5.235742
73	144.0	-40.0	-39.9	268.16	10.73	-8.04	0.998025	0.060511	5.296254
74	146.0	-40.0	-39.9	268.43	10.74	-8.05	0.998239	0.057624	5.353878
75	148.0	-40.0	-40.0	268.64	10.75	-8.06	0.998440	0.054022	5.407900
76	150.0	-40.0	-40.0	268.81	10.75	-8.06	0.998630	0.051004	5.458903
77	152.0	-40.0	-40.0	268.94	10.76	-8.07	0.998808	0.047913	5.506817
78	154.0	-40.0	-40.0	269.05	10.76	-8.07	0.998975	0.044757	5.551574
79	156.0	-39.9	-40.0	269.13	10.77	-8.07	0.999131	0.042023	5.593597
80	158.0	-39.9	-40.0	269.19	10.77	-8.08	0.999274	0.038712	5.632309
81	160.0	-40.0	-40.0	269.23	10.77	-8.08	0.999404	0.034944	5.667253
82	162.0	-40.0	-40.0	269.27	10.77	-8.08	0.999522	0.031576	5.698828
83	164.0	-40.0	-40.0	269.29	10.77	-8.08	0.999626	0.028167	5.726996
84	166.0	-39.9	-40.0	269.30	10.77	-8.08	0.999719	0.025011	5.752007
85	168.0	-39.9	-40.0	269.31	10.77	-8.08	0.999799	0.021496	5.773503
86	170.0	-40.0	-40.0	269.32	10.77	-8.08	0.999865	0.017747	5.791250
87	172.0	-40.0	-40.0	269.32	10.77	-8.08	0.999917	0.014224	5.805474
88	174.0	-40.0	-40.0	269.32	10.77	-8.08	0.999957	0.010683	5.816157
89	176.0	-40.0	-39.9	269.32	10.77	-8.08	0.999984	0.007212	5.823369

Sample output (contd)

90	178.0	-40.0	-38.4	269.32	10.77	-8.08	1.000000	0.004361	5.827730
91	180.0	-40.0	-39.9	269.32	10.77	-8.08	1.000000	-0.000000	5.827730

```
   PEA = 0.0500  DB                    GMDB =  19.1643  DB             TA(TOTAL)=  5.8277  DEG K
     B = 0.0050  DB PER DB           PEGMDB =   0.0251  DB              PETA(+)=  0.0423  DEG K
 PEF1M = 0.0500  DB                                                     PETA(-)=  0.0362  DEG K
 PEF2M = 0.0500  DB
  PETH = 0.0020  RADIAN
```

Sample output

ANTENNA PROJECT AQUISITION AID ANTENNA (SUM CHANNEL) FREQ = 2295 MC

CIRCULAR POLARIZATION PATTERNS

PATTERNS 1 AND 2 70 DB PATTERN CASE DATE 6/16/66

ANTENNA BEAM EFFICIENCY, TEMPERATURE, AND GAIN

I	THETA (DEG)	F1 (DB)	F2 (DB)	TB (DEG K)	PETB(+) (DEG K)	PETB(−) (DEG K)	SUM(ETA)	TA (DEG K)	SUM(TA) (DEG K)
1	0.0	-1.2	-36.0	2.45	0.10	-0.07	0.000000	-0.000000	0.000000
2	2.0	-1.5	-37.5	2.45	0.10	-0.07	0.047087	0.115364	0.115364
3	4.0	-2.0	-34.0	2.45	0.10	-0.07	0.131001	0.205589	0.320952
4	6.0	-3.0	-26.9	2.45	0.10	-0.07	0.231226	0.245551	0.566503
5	8.0	-4.2	-21.8	2.46	0.10	-0.07	0.333794	0.251805	0.818308
6	10.0	-5.8	-18.5	2.46	0.10	-0.07	0.425493	0.225579	1.043887
7	12.0	-7.6	-16.6	2.47	0.10	-0.07	0.503001	0.191059	1.234946
8	14.0	-8.9	-15.6	2.47	0.10	-0.07	0.575078	0.178030	1.412975
9	16.0	-10.0	-15.4	2.47	0.10	-0.07	0.642743	0.167471	1.580446
10	18.0	-11.0	-15.8	2.48	0.10	-0.07	0.704999	0.154394	1.734840
11	20.0	-12.0	-16.6	2.49	0.10	-0.07	0.760373	0.137882	1.872722
12	22.0	-13.1	-18.6	2.50	0.10	-0.08	0.805184	0.112027	1.984750
13	24.0	-14.7	-20.9	2.51	0.10	-0.08	0.837743	0.081885	2.066635
14	26.0	-16.8	-24.2	2.53	0.10	-0.08	0.858369	0.052185	2.118820
15	28.0	-19.1	-27.2	2.56	0.10	-0.08	0.871079	0.032599	2.151419
16	30.0	-21.9	-27.2	2.60	0.10	-0.08	0.879045	0.020712	2.172131
17	32.0	-23.6	-25.3	2.66	0.11	-0.08	0.886432	0.019650	2.191781
18	34.0	-23.6	-24.0	2.72	0.11	-0.08	0.895325	0.024188	2.215969
19	36.0	-22.9	-23.8	2.81	0.11	-0.08	0.905737	0.029259	2.245228
20	38.0	-22.7	-24.1	2.90	0.12	-0.09	0.916600	0.031504	2.276732
21	40.0	-22.9	-25.1	3.00	0.12	-0.09	0.926666	0.030198	2.306930
22	42.0	-23.9	-26.9	3.10	0.12	-0.09	0.934463	0.024170	2.331100
23	44.0	-25.5	-29.7	3.22	0.13	-0.10	0.939612	0.016604	2.347704
24	46.0	-27.8	-33.5	3.35	0.13	-0.10	0.942499	0.009671	2.357375
25	48.0	-30.3	-35.7	3.49	0.14	-0.10	0.944201	0.005942	2.363317
26	50.0	-31.8	-33.0	3.63	0.15	-0.11	0.945897	0.006156	2.369473
27	52.0	-30.5	-30.0	3.80	0.15	-0.11	0.948737	0.010790	2.380263
28	54.0	-38.8	-28.2	3.97	0.16	-0.12	0.951273	0.010069	2.390332
29	56.0	-37.6	-27.6	4.13	0.17	-0.12	0.954292	0.012486	2.402818
30	58.0	-36.8	-27.4	4.30	0.17	-0.13	0.957570	0.014095	2.416913
31	60.0	-36.7	-27.2	4.50	0.18	-0.13	0.961067	0.015736	2.432649
32	62.0	-36.4	-27.2	4.70	0.19	-0.14	0.964658	0.016878	2.449527
33	64.0	-36.5	-27.4	4.93	0.20	-0.15	0.968158	0.017253	2.466780
34	66.0	-36.7	-28.0	5.16	0.21	-0.15	0.971289	0.016155	2.482935
35	68.0	-37.2	-29.1	5.54	0.22	-0.17	0.973799	0.013906	2.496841
36	70.0	-38.4	-30.9	5.80	0.23	-0.17	0.975513	0.009942	2.506783
37	72.0	-29.9	-32.1	6.30	0.25	-0.19	0.978484	0.018721	2.525504
38	74.0	-31.2	-33.2	6.80	0.27	-0.20	0.980750	0.015409	2.540913
39	76.0	-31.9	-33.8	7.55	0.30	-0.23	0.982715	0.014831	2.555744
40	78.0	-32.5	-34.1	8.30	0.33	-0.25	0.984488	0.014717	2.570461
41	80.0	-33.5	-35.0	9.57	0.38	-0.29	0.985919	0.013700	2.584160
42	82.0	-34.5	-36.2	12.50	0.50	-0.38	0.987041	0.014026	2.598186
43	84.0	-35.5	-37.5	17.50	0.70	-0.52	0.987913	0.015243	2.613429
44	86.0	-36.4	-38.4	27.00	1.08	-0.81	0.988623	0.019174	2.632604
45	88.0	-37.2	-38.5	61.30	2.45	-1.84	0.989254	0.038730	2.671333
46	90.0	-37.2	-37.8	112.60	4.50	-3.38	0.989934	0.076485	2.747819
47	92.0	-37.0	-37.5	101.39	4.06	-3.04	0.990652	0.072851	2.820669
48	94.0	-36.6	-37.6	109.53	4.38	-3.29	0.991398	0.081722	2.902391
49	96.0	-36.6	-37.9	133.14	5.33	-3.99	0.992120	0.096113	2.998504
50	98.0	-36.7	-38.0	154.97	6.20	-4.65	0.992823	0.108859	3.107362
51	100.0	-36.9	-38.2	173.80	6.95	-5.21	0.993490	0.115946	3.223309
52	102.0	-37.5	-37.9	189.88	7.60	-5.70	0.994124	0.120324	3.343633
53	104.0	-38.2	-36.6	203.28	8.13	-6.10	0.994808	0.139098	3.482731
54	106.0	-38.1	-36.4	214.33	8.57	-6.43	0.995511	0.150730	3.633462
55	108.0	-37.8	-37.4	223.55	8.94	-6.71	0.996142	0.140945	3.774407
56	110.0	-37.9	-38.0	231.21	9.25	-6.94	0.996716	0.132745	3.907152
57	112.0	-38.5	-38.9	237.62	9.50	-7.13	0.997193	0.113375	4.020527
58	114.0	-39.0	-39.6	242.95	9.72	-7.29	0.997603	0.099606	4.120133
59	116.0	-39.0	-39.9	247.42	9.90	-7.42	0.997994	0.096699	4.216832
60	118.0	-39.0	-39.9	251.15	10.05	-7.53	0.998378	0.096428	4.313260
61	120.0	-39.0	-39.1	254.28	10.17	-7.63	0.998788	0.104441	4.417701
62	122.0	-39.8	-39.0	256.89	10.28	-7.71	0.999161	0.095721	4.513422
63	124.0	-70.0	-39.0	259.07	10.36	-7.77	0.999360	0.051560	4.564982
64	126.0	-70.0	-70.0	260.90	10.44	-7.83	0.999360	0.000080	4.565063
65	128.0	-70.0	-70.0	262.42	10.50	-7.87	0.999361	0.000079	4.565141
66	130.0	-70.0	-39.9	263.69	10.55	-7.91	0.999510	0.039422	4.604564
67	132.0	-70.0	-70.0	264.74	10.59	-7.94	0.999510	0.000075	4.604639
68	134.0	-70.0	-70.0	265.62	10.62	-7.97	0.999511	0.000073	4.604712
69	136.0	-70.0	-70.0	266.35	10.65	-7.99	0.999511	0.000071	4.604782
70	138.0	-70.0	-70.0	266.94	10.68	-8.01	0.999511	0.000068	4.604850
71	140.0	-70.0	-70.0	267.44	10.70	-8.02	0.999511	0.000066	4.604916
72	142.0	-70.0	-70.0	267.84	10.71	-8.04	0.999512	0.000063	4.604978
73	144.0	-70.0	-39.9	268.16	10.73	-8.04	0.999626	0.030762	4.635741
74	146.0	-70.0	-39.9	268.43	10.74	-8.05	0.999735	0.029295	4.665035
75	148.0	-70.0	-70.0	268.64	10.75	-8.06	0.999736	0.000054	4.665089
76	150.0	-70.0	-70.0	268.81	10.75	-8.06	0.999736	0.000051	4.665141
77	152.0	-70.0	-70.0	268.94	10.76	-8.07	0.999736	0.000048	4.665189
78	154.0	-70.0	-70.0	269.05	10.76	-8.07	0.999736	0.000045	4.665234
79	156.0	-39.9	-70.0	269.13	10.77	-8.07	0.999816	0.021363	4.686597
80	158.0	-39.9	-70.0	269.19	10.77	-8.08	0.999889	0.019680	4.706277
81	160.0	-70.0	-70.0	269.23	10.77	-8.08	0.999889	0.000035	4.706312
82	162.0	-70.0	-70.0	269.27	10.77	-8.08	0.999889	0.000032	4.706344
83	164.0	-70.0	-70.0	269.29	10.77	-8.08	0.999889	0.000028	4.706372
84	166.0	-39.9	-70.0	269.30	10.77	-8.08	0.999936	0.012715	4.719087
85	168.0	-39.9	-70.0	269.31	10.77	-8.08	0.999977	0.010928	4.730015
86	170.0	-70.0	-70.0	269.32	10.77	-8.08	0.999977	0.000018	4.730033
87	172.0	-70.0	-70.0	269.32	10.77	-8.08	0.999977	0.000014	4.730047
88	174.0	-70.0	-70.0	269.32	10.77	-8.08	0.999977	0.000011	4.730058
89	176.0	-70.0	-39.9	269.32	10.77	-8.08	0.999991	0.003667	4.733724

Sample output (contd)

90	178.0	-70.0	-38.4	269.32	10.77	-8.08	1.000000	0.002590	4.736314
91	180.0	-70.0	-39.9	269.32	10.77	-8.08	1.000000	-0.000000	4.736314

```
   PEA = 0.0500  DB                    GMDB =  19.1824  DB           TA(TOTAL)=  4.7363  DEG K
     B = 0.0050  DB PER DB           PEGMDB =   0.0252  DB            PETA(+)=   0.0377  DEG K
 PEF1M = 0.0500  DB                                                   PETA(-)=   0.0315  DEG K
 PEF2M = 0.0500  DB
  PETH = 0.0020  RADIAN
```

REFERENCES

1. Ludwig, A., "Radiation Pattern Synthesis for Circular Aperture Horn Antennas," *IEEE Transactions on Antennas and Propagation*, Vol. AP-14, No. 4, pp. 434–440, July 1966.

2. Ludwig, A., "Antenna Feed Research," *Space Programs Summary No. 37-33*, Vol. IV, pp. 261–266, Jet Propulsion Laboratory, Pasadena, Calif., June 30, 1965.

3. Ludwig, A., "Mode Generation in Cylindrical Waveguide," *Space Programs Summary No. 37-36*, Vol. IV, pp. 251–255, Jet Propulsion Laboratory, Pasadena, Calif., December 31, 1965.

4. Potter, P. D., "Antenna Feed Research: Spherical Wave Functions," *Space Programs Summary* No. *37-24*, Vol. IV, pp. 150–154 (review of basic spherical wave function theory), Jet Propulsion Laboratory, Pasadena, Calif., December 31, 1963.

5. Potter, P. D., "Antenna Feed Research: Spherical Wave Functions," *Space Programs Summary No. 37-26*, Vol. IV., pp. 197–200 (expansion of aperture illumination pattern in spherical modes), Jet Propulsion Laboratory, Pasadena, Calif., April 30, 1964.

6. Potter, P. D., "Antenna Feed Research: Spherical Wave Functions," *Space Programs Summary No. 37-27*, Vol. IV, pp. 155–159 (analytical formulation for Synthesis Program), Jet Propulsion Laboratory, Pasadena, Calif., June 30, 1964.

7. Potter, P. D., "Antenna Feed Research: Nonoptical Subreflector Synthesis by Use of Spherical Waves," *Space Programs Summary No. 37-31*, Vol. IV, pp. 285–286 (brief description of Synthesis Program), Jet Propulsion Laboratory, Pasadena, Calif., February 28, 1965.

8. Rusch, W. V. T., "Antenna Feed Research: Scattering of an Arbitrary Spherical Wave by an Arbitrary Surface of Revolution," *Space Programs Summary No. 37-31*, Vol. IV, pp. 286–287 (quantitative comparison between spherical mode theory and scattering theory; effect of subreflector truncation), Jet Propulsion Laboratory, Pasadena, Calif., February 28, 1965.

9. Ludwig, A., "Antenna Feed Research," *Space Programs Summary No. 37-33*, Vol. IV, pp. 261–266 (detailed discussion of feedhorn pattern synthesis), Jet Propulsion Laboratory, Pasadena, Calif., June 30, 1965.

10. Ludwig, A., "Shaped Reflector Cassegrainian Antennas," *Space Programs Summary No. 37-35*, Vol. IV, pp. 266–268 (discussion of an alternate technique for shaped subreflectors), Jet Propulsion Laboratory, Pasadena, Calif., October 31, 1965.

11. Rusch, W. V. T., "Scattering of a Spherical Wave by an Arbitrary Truncated Surface of Revolution," Technical Report No. 32-434, Jet Propulsion Laboratory, Pasadena, Calif., May 1963.

12. Rusch, W. V. T., "Phase Error and Associated Cross-Polarization Effects in Cassegrainian-Fed Microwave Antennas," *IEE Transactions on Antennas and Propagation*, Vol. AP-14, No. 3, pp. 266–275, May 1966.

References (contd)

13. Ludwig, A., "Antenna Feed Efficiency," *Space Programs Summary No. 37-26,* Vol. IV, pp. 200–208, Jet Propulsion Laboratory, Pasadena, Calif., April 30, 1964.

14. Utku, S., and Barondess, S. M., "Computation of Weighted Root Mean Square of Path Length Changes Caused by Deformations and Imperfections of Rotational Paraboloidal Antennas," Technical Memorandum No. 33-118, Jet Propulsion Laboratory, Pasadena, Calif., March 1963.

15. Christianson, H., "RMS-Paraboloid Fitting Program," Western Development Laboratories-Philco Corporation, Palo Alto, Calif., September 1964.

16. Silver, S., *Microwave Antenna Theory and Design,* Radiation Laboratory Series, Vol. 12, p. 173, McGraw-Hill Book Co., New York, N. Y., 1949.

17. "Radiation Pattern and Antenna Efficiency Computer Studies," *Space Programs Summary No. 37-23,* Vol. III, pp. 34–36, Jet Propulsion Laboratory, Pasadena, Calif., September 30, 1963.

18. "S-Band Antenna Gain and Pattern Calibrations," *Space Programs Summary No. 37-24,* Vol. III, pp. 24–27, Jet Propulsion Laboratory, Pasadena, Calif., November 30, 1963.

19. "1/7-Scale Model Feed," *Space Programs Summary No. 37-30,* Vol. III, pp. 110–115, Jet Propulsion Laboratory, Pasadena, Calif., November 30, 1964.

20. "Feed for the AAS," *Space Programs Summary No. 37-33,* Vol. III, pp. 14–18, Jet Propulsion Laboratory, Pasadena, Calif., May 31, 1965.

21. "Gain Calibration of 30-ft Antenna at 22 Gc," *Space Programs Summary No. 37-33,* Vol. III, pp. 69–81, Jet Propulsion Laboratory, Pasadena, Calif., May 31, 1965.

22. "22 Gc/sec Gain Calibration," *Space Programs Summary No. 37-35,* Vol. III, pp. 55–57, Jet Propulsion Laboratory, Pasadena, Calif., September 30, 1965.

23. Ludwig, A., "Antennas for Space Communications: Antenna Pattern Synthesis," *Space Programs Summary No. 37-39,* Vol. IV, pp. 198–200, Jet Propulsion Laboratory, Pasadena, Calif., June 30, 1966.

24. "Cassegrain Feed for the Advanced Antenna System," *Space Programs Summary No. 37-32,* Vol. III, pp. 74–80, Jet Propulsion Laboratory, Pasadena, Calif., March 31, 1965.

25. Otoshi, T., and Stelzried, C. T., "Antenna Temperature Analysis," *Space Programs Summary No. 37-36,* Vol. IV, pp. 262–267, Jet Propulsion Laboratory, Pasadena, Calif., December 31, 1965.

26. Hansen, R. C., "Low Noise Antennas," *Microwave Journal,* p. 21, June 1959.

27. Blake, L. V., "Low-Noise Receiving Antennas," *Microwaves,* p. 20, March 1966.

References (contd)

28. Hogg, D. C., "Effective Antenna Temperature Due to Oxygen and Water Vapor in the Atmosphere," *Journal of Applied Physics,* Vol. 30, No. 9, pp. 1417–1419, September 1959.

29. Otoshi, T., "Antenna Temperature Analysis," *Space Programs Summary No. 37-37,* Vol. IV, pp. 207–210, Jet Propulsion Laboratory, Pasadena, Calif., February 28, 1966.