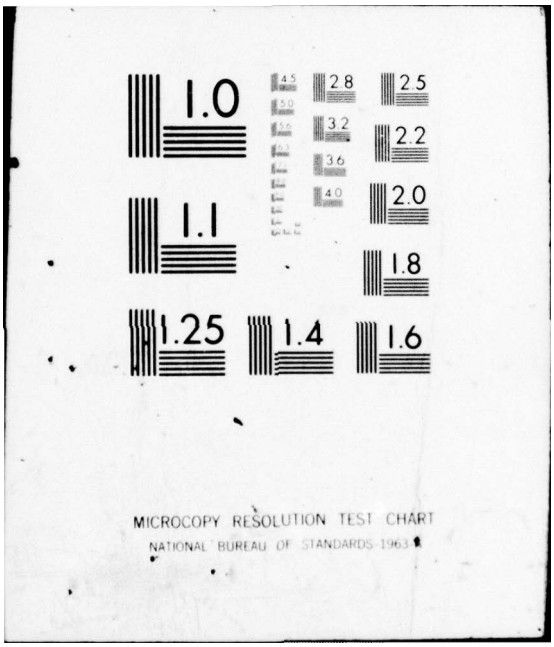
AD-A040 026 BDM CORP ALBUQUERQUE N MEX F/G 20/3
GENERAL ELECTROMAGNETIC MODEL FOR THE ANALYSIS OF COMPLEX SYSTE--ETC(U)
APR 77 R J BALESTRI, T R FERGUSON F30602-74-C-0182
UNCLASSIFIED RADC-TR-77-137-VOL-1 NL

1 OF 2
AD
A040026


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

ADA040026

12

RADC-TR-77-137, Volume I (of two)
Final Technical Report
April 1977

GENERAL ELECTROMAGNETIC MODEL FOR THE ANALYSIS OF COMPLEX SYSTEMS
User's Manual

The BDM Corporation

COPY AVAILABLE TO DDC DOES NOT
PERMIT FULLY LEGIBLE PRODUCTION

Approved for public release; distribution unlimited.

DDC
RECEIVED
MAY 31 1977
C

ROME AIR DEVELOPMENT CENTER
AIR FORCE SYSTEMS COMMAND
GRIFFISS AIR FORCE BASE, NEW YORK 13441

RJ NO.
DDC FILE COPY

This report contains a large percentage of machine-produced copy which is not of the highest printing quality but because of economical consideration, it was determined in the best interest of the government that they be used in this publication.

This report has been reviewed by the RADC Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be releasable to the general public, including foreign nations.

This report has been reviewed and approved for publication.

APPROVED: Kenneth R. Siarkiewicz

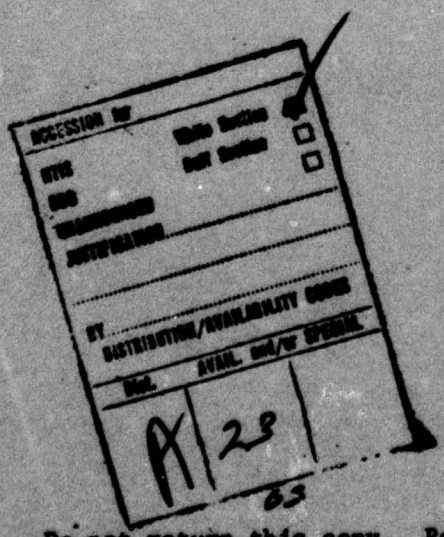
KENNETH R. SIARKIEWICZ
Project Engineer

APPROVED: Joseph J. Naresky

JOSEPH J. NARESKY
Chief, Reliability & Compatibility Division

FOR THE COMMANDER: John P. Huss

JOHN P. HUSS
Acting Chief, Plans Office



Do not return this copy. Retain or destroy.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: RADC-TR-77-137, Vol I (of two)

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle): GENERAL ELECTROMAGNETIC MODEL FOR THE ANALYSIS OF COMPLEX SYSTEMS, ~~User's Manual~~ Volume I. User's Manual.

5. TYPE OF REPORT & PERIOD COVERED: Final Technical Report. 2 Apr 74 – 30 Sep 76

6. PERFORMING ORG. REPORT NUMBER: N/A

7. AUTHOR(s): R. J. Balestri, T. R. Ferguson, E. R. Anderson

8. CONTRACT OR GRANT NUMBER(s): F30602-74-C-0182

9. PERFORMING ORGANIZATION NAME AND ADDRESS: The BDM Corporation, 2600 Yale Blvd, S.E., Albuquerque NM 87106

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 62702F, 45400133

11. CONTROLLING OFFICE NAME AND ADDRESS: Rome Air Development Center (RBCT), Griffiss AFB NY 13441

12. REPORT DATE: April 1977

13. NUMBER OF PAGES: 173

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): Same 182p.

15. SECURITY CLASS. (of this report): UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

16. DISTRIBUTION STATEMENT (of this Report): Approved for public release; distribution unlimited. 4540 01

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report): Same RADC TR-77-137-Vol-I

DDC RECEIVED MAY 31 1977 B

18. SUPPLEMENTARY NOTES: RADC Project Engineer: Kenneth R. Siarkiewicz (RBCT)

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Electromagnetic Compatibility
Method of Moments
Antenna Analysis
Matrix Equation Solution

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
Volume I of this report is the user's manual for the GEMACS code developed under this contract. GEMACS utilizes a MOM (Method of Moments) formalism with the EFIE (Electric Field Integral Equation) for the solution of electromagnetic radiation and scattering problems. The code employs both full matrix decomposition and Banded Matrix Iteration solution techniques and is expressly designed for large problems.

→ next page

(Continued)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

391884

cont →

Volume II of this report describes the engineering approximations, the theory and implementation of the Banded Matrix Iteration scheme, and the results of a wire grid modeling study that established consistent wire grid modeling requirements for large structures.

TABLE OF CONTENTS

		Page
A.	INTRODUCTION	1
B.	COMPUTATIONAL APPROACH	7
C.	GEMACS COMMAND AND GEOMETRY LANGUAGE	10
1.	GEMACS Command Language	12
	BACSUB	17
	BAND	18
	BMI	19
	CHKPNT	20
	CONJG	21
	DEBUG	22
	DMP	23
	EFIELD	25
	END	29
	ESRC	30
	GMDATA	32
	LOOP/LABEL	33
	LUD	34
	PLOT	35
	PRINT	36
	PURGE	37
	READ	38
	RSTART	39
	SET	40
	SOLVE	41
	SYMDEF	42
	TRANSP	43
	VSRC	44
	WIPOUT	45
	WRITE	46
	ZCODES	47
	ZGEN	49
	ZLOADS	50
2.	Geometry Input Language Processor	52
3.	Geometry Input Language Commands	55
	AT	57
	CE	58
	CP	59
	CS	61
	DE	62
	DF	63
	END	64
	MP	65
	PT	66

TABLE OF CONTENTS (Concluded)

		Page
	RA	67
	RF	68
	RN	71
	RT	72
	SC	75
	WR	76
	XL	77
D.	GEMACS APPLICATION	80
1.	Computer Requirements and Resources	80
2.	Structure Representation	83
3.	Electrical Environment	87
4.	Solution Technique	89
5.	Outputs	92
6.	Checkpoint Restart	95
7.	Debugging Capability	97
8.	Error Recovery	101
E.	COMPUTER REQUIREMENTS	170
1.	I/O Requirements	170
2.	Internal Storage Requirements	172
3.	System Library Routines	173

LIST OF ILLUSTRATIONS

Figure		Page
1	Illustration of BAND Operation	18
2a	Plot Axis for Spherical ϕ and Cylindrical θ Independent Coordinate	28
2b	Plot Axis for Spherical θ as Independent Coordinate	28
3	Excitation Coordinate System	31
4a	Original Points 1, 2, 3	74
4b	RT, MP, CP Operations Defining Basic Element of CONE	74
5	Wire Grid	79
6a	Location of Points	85
6b	Original Numbering Scheme	85
6c	Renumbered Segment Scheme	85

EVALUATION

This report documents the results of an effort to develop the engineering tools to support the electromagnetic (EM) fields analysis program for Air Force use during the design, development, fabrication, installation, maintenance and modification of electrically large systems. In terms of wavelengths, an electrically large system is one which has an area of at least 10 square wavelengths for a plane surface, or one which has a linear dimension of at least 200 wavelengths for a single dimension system.

The code that was developed uses the method of moments (MOM) technique to solve Maxwell's equations for an arbitrary geometry of radiators and scatterers. However, it has two major advantages over other MOM codes. First, it enables the user to specify a system with up to 2000 unknowns, instead of 200 to 300. Out-of-core manipulation and banded matrix iteration (BMI) are the major features of this code which make the solution of such large systems of equations practical.

Secondly, the input language for the code, as well as the architecture and structure of the code itself, are designed to permit an organized growth of the capability of the code. The basic function of the code is the storage and manipulation of large quantities of data. These capabilities have been utilized to solve the EM fields analysis equations in either of two ways. It is the intent of the code design to allow the incorporation of other solution techniques, such as Bodies of Revolution and the Geometrical Theory of Diffraction (GTD).

Therefore, the results of this effort have both short-range and long-term advantages for the Air Force. The Air Force now has the capability to

model and characterize large systems in terms of far-field radiation patterns and scattering cross-section, the coupling between large numbers of collocated antennas and the input impedance of antennas in large radiating systems. The long-term advantage is the inherent growth potential and Air Force wide commonality available to the users of this code.

The work accomplishes the objective of TPO-1, Command, Control, Communications Survivability in that it provides an interference analysis and prediction tool for the Air Force in Intrasystem Analysis Program (IAP).

Kenneth R. Siarkiewicz

KENNETH R. SIARKIEWICZ
Project Engineer

A. INTRODUCTION

This manual contains instructions for using the GEMACS (General Electromagnetic Model for the Analysis of Complex Systems) computer program. The program is a highly user-oriented general purpose code designed for gradual incorporation of a variety of techniques for electromagnetic analysis of complex systems. The user is assumed to be an experienced electromagnetics analyst with a fair understanding of applied linear algebra. The current version (release 1) of the code supports all of the functions necessary for using one thin-wire MOM (Method of Moments) formalism. The GEMACS code uses a high level language and provides flexibility of control over the computational sequence by the user. Error messages, debug and trace options, and other features are included to aid the user in identifying sources of fatal errors.

The MOM formalism used in the present code includes the thin-wire Pocklington integral equation, pulse plus sine plus cosine expansion functions, point matching, and a charge redistribution scheme at multiple wire junctions. This is the same formalism as used in the AMP (Antenna Modeling Program) code [1]. The GEMACS code includes most of the engineering features of the AMP code such as loading and ground plane effects. However, the range of applicability of the moments technique is extended to objects of larger electrical size in the GEMACS code by using a new solution method for linear simultaneous equations called BMI (Banded Matrix Iteration). The user must have a limited understanding of the solution method to insure convergence and reasonable efficiency. The method is documented in volume II of this report and in references noted therein.

The thin-wire MOM can be used to solve general physical problems involving actual wires, wire grid models of conducting surfaces, or a combination of these. Wire grid modeling is not yet a highly defined

---

[1]The Antenna Modeling Program is a general-purpose thin wire code developed and documented by MB Associates in "Antenna Modeling Program-Engineering Manual," July 1972, AD-A025890.

process. Modeling guidelines developed in recent studies are discussed in volume II. The user must reduce the physical problem to a thin wire model. The GEMACS code includes a highly flexible geometry processor to aid in this task. The user specifies the frequency, additional features such as loading or the presence of a ground plane, and the excitation. Excitation options currently include plane or spherical waves, voltage sources for antennas, or arbitrary excitations on specified individual wire segments. Load options currently include fixed (as a function of frequency) lumped loads, series or parallel RLC networks, and finite segment conductivity.

The code generates a set of linear simultaneous equations from the information provided. The user controls the process by which the equations are solved. If the total number of wire segments in the model is sufficiently small, standard solution methods are applicable. Solution by full matrix triangular decomposition is one of the least expensive general methods, and is supported by GEMACS. For large problems, this method is too expensive, and the BMI solution method should be specified by the user. This method is considerably less expensive provided the user carefully chooses the segment numbering and matrix bandwidth according to the guidelines discussed in volume II.

The user specifies other quantities to be computed from the wire currents, such as impedances, coupling parameters, near fields or far fields. These are computed from currents regardless of the solution process specified. Regardless of the solution technique exercised, it is emphasized that the user must be familiar with general results from the literature to insure that the computed solution using the model for the system is of sufficient accuracy for the purposes intended. For example, the far fields can be computed from approximate currents obtained by specifying a weak convergence criterion when using the BMI solution method. This will allow the reduction of the required computer resources when large systems are being analyzed.

The present code generates an interaction matrix from the thin-wire EFIE (Electric Field Integral Equation) discussed in the GEMACS Engineering Manual. The electric current is represented by a sine, cosine, and pulse expansion function with redistribution at junctions based on the

fractional length of each segment with respect to the total length of all segments connected at the junction. The interactions matrix may be modified by loading the individual wire segments of the model using resistance, capacitance, and inductance in parallel or series configurations.

Associated with the geometric structure and interaction matrix is an excitation matrix which contains the total tangential electric field present at the midpoint of each segment. The electric field may be caused by as many combinations of three types of sources as desired. These types are plane and spherical wave sources for scattering problems and voltage sources for antenna problems. In addition, the user may assign an arbitrary value to the excitation of any wire segment to force the desired boundary condition.

With the interaction matrix denoted by $\lfloor Z \rfloor$ and the excitation matrix denoted by $\lfloor E \rfloor$, the primary function of the code is to generate and solve the system of equations for the electric current $[I]$.

$$\lfloor Z \rfloor \quad \lfloor I \rfloor \quad = \quad \lfloor E \rfloor$$

This may be done using direct full matrix decomposition in which $\lfloor Z \rfloor$ is decomposed into lower and upper triangular matrices $\lfloor ZL \rfloor$ and $\lfloor ZU \rfloor$. Forward elimination and back substitution are then performed as indicated below.

$$\begin{aligned} [Z\ ] \quad [I\ ] &= [E\ ] \\ [ZL] \quad [ZU] \quad [I\ ] &= [E\ ] \\ [ZL] \quad [I'] &= [E\ ] \\ [ZU] \quad [I\ ] &= [I'] \end{aligned}$$

where, since $\lfloor ZL \rfloor$ and $\lfloor ZU \rfloor$ are triangular, the actual inverse is not required.

For very large problems, the direct solution method may be prohibitive due to the large amount of time required and the possible roundoff errors. In this case, the BMI (Banded Matrix Iteration) technique is available. In this method, $\lfloor Z \rfloor$ is partitioned (<u>not</u> decom-

posed) into lower and upper triangular matrices ($\left|LZ\right|$ and $\left|UZ\right|$) and a central or banded matrix [BZ]. This is illustrated graphically below.

$$\left|Z\right| = \left[\begin{array}{c} \diagdown\ \diagdown\ UZ' \\ \diagdown\ BZ'\ \diagdown \\ LZ'\ \diagdown\ \diagdown \end{array}\right]$$

$$\left|Z\right| = \left|LZ\right| + \left|BZ\right| + \left|UZ\right|$$

where LZ', BZ', UZ' are the nonzero elements of LZ, BZ, and UZ. In this notation, the problem to be solved becomes:

$$\left|Z\right]\left[I\right] = \left|LZ\right]\left[I\right] + \left|BZ\right]\left[I\right] + \left|UZ\right]\left[I\right] = \left[E\right]$$

or:

$$\left|BZ\right]\left[I\right] = \left[E\right] - \left(\left|LZ\right| + \left|UZ\right|\right)\left[I\right]$$

The banded portion of interaction matrix $\left|BZ\right|$ should contain the dominant interactions while those contained in $\left|LZ\right|$ and $\left|UZ\right|$ may be viewed as perturbations in a properly posed problem. In this case, the BMI technique involves appending subscripts to the [I] vector and only solving the banded portion of the interaction matrix.

$$\left|BZ\right]\left[I\right]_n = \left[RHS\right]_n$$

where the right-hand side at the n^{th} iteration $\left|RHS\right|_n$ is given by:

$$\left[RHS\right]_n = \left[E\right] - \left(\left|LZ\right| + \left|UZ\right|\right)\left[I\right]_{n-1}$$

The starting value for $\left|I\right|$ or $\left[I\right]_o$ is zero unless preset by the user. There is very little if any advantage to presetting $\left[I\right]$. Since $\left|BZ\right|$ is usually much smaller than $\left|Z\right|$, the time to perform lower/upper decomposition is reduced considerably and the system to be solved becomes:

$$\left|BZL\right]\left[BZU\right]\left[I\right]_n = \left[RHS\right]_n$$

where $[BZL]$ and $[BZU]$ are the lower and upper triangular matrices obtained by decomposing $[BZ]$. The solution for $[I]_n$ is obtained exactly as for the full matrix decomposition. When using BMI, the user must provide the convergence measure and value to be used to stop the iterative procedure. Three criteria or measures are available, the BCRE (Boundary Condition Relative Error), the IRE (Iterative Relative Error), and the PRE (Predicted Relative Error). The BCRE is a measure of how well the solution matches the boundary condition. Mathematically:

$$BCRE = \frac{|[E] - [Z][I]_n|}{|[E]|}$$

While this form has great engineering appeal, it is mathematically not recommended since the system of equations may be ill-conditioned near resonances, and there is, by definition, a large variance in the elements of $[I]$ which will result in a small BCRE.

The second criterion is the IRE. This is defined mathematically as:

$$IRE = \frac{|[I]_n - [I]_{n-1}|}{|[I]_n|}$$

and can be seen to be the relative change between successive approximations to the solution. For slowly converging problems, this criterion may cause premature termination of the iterative procedure.

Finally, the PRE may be used. This quantity is determined by using an exponential fit to the two previous values for the IRE and has been shown to be a good approximation to the ARE (Actual Relative Error) after four iterations. The ARE is defined as:

$$ARE = \frac{|[I]_n - [I]|}{|[I]|}$$

where $[I]$ is the exact solution. Since the exact solution is not available, the PRE is the recommended criterion. (See the GEMACS Engineering Manual, section C.3 for a discussion of the PRE.)

The value of the convergence criteria depends largely on the output desired. If input impedance or near field parameters are desired, a 1 percent value is not inappropriate; however, if normalized far-field patterns are desired, a 10 to 50 percent value may be sufficient.

Once the solution has been obtained, the input impedance of each voltage driven element (i.e., Antenna Feed Point) is output to the user. These are computed simply as $Z_a = \frac{V_a}{I_a}$ since a delta gap model is used for antenna sources. The currents may be used as inputs to the field computation routines to obtain the near- and/or far-electric field patterns, and the coupling between pairs of antennas.

There are inherent limitations to the solution techniques available. The user who is not familiar with these techniques is advised to consult the engineering manual and its references in order to not waste valuable time and computer resources working an ill-posed problem.

B. COMPUTATIONAL APPROACH

The basic approach in the design of the GEMACS code is to permit the user to generate or define data sets and then to perform operations on the data contained in the data sets. The data sets are identified using symbolic names of six ANSI FORTRAN characters or less. All names must start with an alphanumeric character. The result of this approach is a code which the user completely controls down to the functional or operational level. Associated with each symbol is a set of symbol characteristics referred to as attributes. These attributes are generated as the data associated with the symbol are generated or modified by an operation. The attributes are checked each time the data are used in an operation. This insures the integrity of the resulting data and the sanity of the operation. For example, if the user attempts to generate an impedance matrix using data which do not represent a geometrical structure, an error will occur since the operation is not defined. However, if an impedance matrix is generated for a properly defined geometry data set, it will have the attributes of a complex impedance matrix and will be identified as having been generated from the geometry data set specified. In this way, a symbol's lineage and the type of data (both physical and computational) are known. Likewise, the solution vector for a geometry data set is linked to the impedance matrix and thus to the geometry which was the parent data for all subsequent operations. Therefore, when field output is desired, the code will retrieve the correct electrical current data for use with the geometry data specified.

The primary function of GEMACS is to store and retrieve data in order that user specified operations may be performed. The result of these operations will be a solution or analysis of the system described to the code.

As more operations are added to the GEMACS code, it is necessary to define the attributes of the data necessary to assure correct program operation, modify the ILP (Input Language Processor) to recognize the

command and add the software to perform the operation. The data handling will be taken care of by the executive level programs in the GEMACS code.

As an example, a normal MOM scattering solution at a single frequency for which the far radiation field is desired could be done with the following input stream. The directives are discussed in the following section.

```
COMMAND
   1      GMDATA = GEOM1
   2      EINC = ESRC (GEOM1), FRQ = 180, SW = 1.,0.,THETA = 45.
   3      ZGEN GMDATA = GEOM1, SINCOS, ZMATRX = ZMAT1
   4      BNDZ1 = BAND (ZMAT1), BNDW = 50
   5      BNDZ1 = LUD (BNDZ1)
   6      BNDZ1 * CUR1 = EINC - ZMAT1 * CUR1, MAXITR = 10, CONVRG = 1,
           VALUE = 20
   7      EFIELD (CUR1), LOGPLR, P1 = 0.  P2 = 180.  DP = 10.  T1 = 90.
   8      END
               GEOMETRY DATA
          END
```

Card 1 directs the geometry processor to generate the data to be associated with symbol GEOM1. Card 2 directs data associated with symbol EINC to be generated by a spherical wave at 180 MHz incident on the geometry specified by GEOM1 at a spherical angle theta of 45°. Card 3 directs that data assocated with impedance matrix ZMAT1 be generated using the sine + cosine + pulse expansion function on the geometry associated with GEOM1. Card 4 causes extraction of the elements from ZMAT1 which are located within 50 elements of the diagonal elements and associates the data with symbol BNDZ1. Card 5 results in BNDZ1 being decomposed into upper and lower triangular matrices and the result restored in BNDZ1. Card 6 invokes the BMI solution technique to obtain the data for symbol CUR1. The procedure is limited to 10 iterations and the BCRE convergence criterion will be used. When the BCRE $\leq$ 20 percent, the procedure will

stop and return to execute the next directive. Card 7 directs the computation and output of the far-field of structure GEOM1. The field will be computed at 10° intervals from $\phi = 0$ to $\phi = 180$ for $\theta = 90°$. In addition to a tabular print, the $\log_{10}$ of the field will be plotted on a polar graph. Card 8 indicates the end of the directives and is followed by geometry data input which are also terminated by an END card. The input is completely free field and there are default values for most parameters. All of the directives are processed before any execution begins. This precludes wasting considerable computer resources in the event of an error in the command directives. A complete discussion of each directive and the geometry processor is presented in the following section.

C. GEMACS COMMAND AND GEOMETRY LANGUAGE

The GEMACS inputs are in two categories. The command language directs the program execution while the geometry language is used to describe the geometrical properties of the structure being analyzed.

The GEMACS command language is a free field, keyword oriented input stream. The order of the inputs is not important and the items on each card are delimited by a blank or a comma. An item is considered to be all of the input associated with a particular parameter such as THETA = 90. Note that an item may consist of several entries, each entry is referred to as a field. Blanks may be imbedded between fields of an item but not within a field. Thus, THETA = 90. is acceptable while THETA = 9 0. is incorrect and will be interpreted as 2 items (i.e., THETA = 9 and 0). The extraneous item would be detected by the code and execution would be inhibited.

In order to prevent wasting computer resources, all of the GEMACS commands are read prior to execution of the code. All errors in the user commands are identified; that is, one error does not preclude location of any other error during the same execution. This prevents the need for the user to make several submittals to debug the input.

The GEMACS geometry language is also a free-field language. However, the items must appear in the order specified or an error will occur which may not be detected. The reason for not using keyword-specified items on the geometry inputs is to decrease the effort required by the user since the geometry inputs are usually much larger than the command inputs.

For both inputs, there are several standard conventions. These relate to comment cards, comments on cards, and continuation cards. Comment cards are those cards which have a $ as the first non-blank character. Likewise, comments may be appended to command or geometry input by preceding the comment with a $. If the last character encountered before a $ or the end of a card is a comma or arithmetic operator (+, -,*,/),

the next card must be a continuation card. If a card has a continuation character in column 1, it is treated as a continuation of the previous card. All continuation cards must have a continuation character in column 1. This is the only format required. The continuation character may be installation dependent, it is an asterisk (*) in most versions. Other possible choices are the other arithmetic operators. The actual character is defined as variable NCONCH and is set in subroutine BLKDAT.

1. GEMACS Command Language

In describing the GEMACS command language items enclosed in brackets [ ] have default values and need not be specified if the default value is acceptable to the user. Items enclosed in braces { } indicate a multiple choice. The only restrictions on symbolic names provided by the user are that they be six characters or less, the first character be a member of the alphabet (A-Z), and only characters contained in the alphabet or the digits (0-9) be present. That is, the characters =, +, -, *, /, $, and comma are not allowed. In addition, the following reserved keywords may not be used for symbolic names.

ONE LETTER KEYWORDS

C	D	N	O	R	V	X	Z

TWO LETTER KEYWORDS

CW	C1	C2	DM	DP	DR	DT	DW	DX	DY	DZ
IS	LU	NP	NR	ON	P1	P2	R1	R2	SC	SW
T1	T2	VS	X1	X2	Y1	Y2	Z1	Z2		

THREE LETTER KEYWORDS

ABS	CDP	ECC	END	FRQ	ILP	INV	LUD	OFF	PHI	RDP
SEQ	SET									

FOUR LETTER KEYWORDS

AXIS	RAND	BNDW	COND	EPSR	ESRC
LOOP	PLOT	PRLC	READ	SCDP	SEGS
SIZE	SRDP	SRLC	TAGS	TIME	TYPE
VRSC	ZGEN	ZIMP			

FIVE LETTER KEYWORDS

CONJG	CPINC	CPNUM	DEBUG	LABEL	PARTN
PIVOT	PRINT	PULSE	PURGE	SOLVE	THETA
TRACE	VALUE	WRITE			

SIX LETTER KEYWORDS

BACSUB	CHKPNT	COLPSE	CONVRS	EFIELD	EXPAND
FILEID	GMDATA	LINLIN	LINLOG	LINPLR	LOGLIN
LOGLOG	LOGPLR	MAXITR	PCESIN	REDUCE	REFLCT
REPLACE	RSTART	SINCOS	SYMDEF	TRANSP	WIPOUT
ZCODES	ZLOADS	ZMATRX			

In addition to these names, one other case is to be avoided. If an out of core matrix is to be decomposed and is identified symbolically, as XXXXXX where the X's are legitimate characters, then the user must not define another data set with either XXXLWR, XXXUPR, or XXXPVT. These names will be internally generated to contain the lower triangular decomposed matrix, the upper triangular decomposed matrix, and the pivot vector as specified. These names may be referenced in output statements however in general, the user should simply ignore them. It is also correct to assume that a matrix which resides out of core is not destroyed when it is decomposed. However, unless a matrix is large, it will be difficult for the user to know a priori where it will be stored.

A list of commands is given in table 1 in which the following codes are used:

- S - Previously undefined symbol
- DS - Previously defined symbol
- SDS - Either S or DS
- N - Numeric value
- DSN - Either a DS or numeric value
- KW - Keyword
- A - Alphameric word starting with a character A-Z and containing only characters A-Z and 0-9

TABLE 1. LIST OF COMMANDS, FORMATS, AND MNEMONICS

COMMAND	FORMAT	MNEMONIC
FORWARD ELIMINATION/BACK SUBSTITUTION	BACSUB DS1*SDS = DS2	BACSUB
CONSTRUCT BANDED MATRIX	SDS = BAND (DS), BNDW = N	BAND
BMI SOLUTION PROCESS	DS1 * SDS1 = DS2 - DS3 * SDS2 [, CONVRG = {BCRE / IRE / PRE}] [,VALUE = N] , MAXITR = N	BMI
CHECKPOINT COMMAND	CHKPNT [LU = N,][FILEID = A] [,CPINC = N] [,NR]	CHKPNT
COMPLEX CONJUGATION (NOT AVAILABLE)	SDS = CONJG (DSN)	CONJG
DEBUG COMMAND	DEBUG {ON / OFF / TRACE} [,ILP]	DEBUG
ARITHMETIC OPERATION (SCALAR QUANTITIES ONLY)	SDS = DSN1 {+ / - / * / / / **} DSN2	DMP
ELECTRIC FIELD OUTPUT	[SDS=] EFIELD (DS) [, {LINLIN / LINLOG / LOGLIN / LOGLOG / LINPLR / LOGPLR}] [,U2=N] [,DU=N] [,V2=N] [,DV=N] [,W2=N] [,DW=N] [,U1=N] [,V1=N] [,W1=N]	EFIELD
END OF COMMANDS	END	END

TABLE 1. LIST OF COMMANDS, FORMATS, AND MNEMONICS (Continued)

COMMAND	FORMAT	MNEMONIC
ELECTRIC FIELD EXCITATION	SDS = ESRC [(DS)] [,FRQ = DSN] SW = DSN, DSN [,R = DSN] [,THETA = DSN] [,PHI = DSN] [,ECC = DSN]	ESRC
GENERATE A STRUCTURE GEOMETRY	GMDATA [= S] [,LU = N]	GMDATA
COMMAND REPETITION	LOOP {A / N} N LABEL {A / N}	LOOP/LABEL
MATRIX DECOMPOSITION	SDS = LUD (DS)	LUD
PLOT COMMAND (NOT AVAILABLE)	PLOT DS1, DS2, TYPE = {LINLIN / LINLOG / LOGLIN / LOGLOG / LINPLR / LOGPLR}	PLOT
PRINT DATA COMMAND	PRINT SDS, SDS, ... SDS	PRINT
PURGE DATA COMMAND	PURGE SDS, SDS, ... SDS	PURGE
DATA INPUT (NOT AVAILABLE)	READ SDS [,LU = N] [,TYPE = {R / C}] [,R1 = N] [,R2 = N] [,C1 = N] [,C2 = N] [,FILEID = A]	READ
CHECKPOINT RESTART	RSTART [LU = N] [,FILEID = A] ,CPNUM = N	RSTART
DATA INITIALIZATION AND MODIFICATION	SET SDS = N [,N] [,R1 = N] [,R2 = N] [,C1 = N] [,C2 = N]	SET

TABLE 1. LIST OF COMMANDS, FORMATS, AND MNEMONICS (Concluded)

COMMAND	FORMAT	MNEMONIC
SOLVE SYSTEM OF SIMULTANEOUS LINEAR EQUATIONS	SOLVE DS1* SDS = DS2	SOLVE
DEFINE SYMBOL NAME (NOT AVAILABLE)	SYMDEF S [TYPE = {R / C}] [,SEQ = {R / C}] [,R = N] [,C = N]	SYMDEF
MATRIX TRANSPOSITION (NOT AVAILABLE)	SDS1 = TRANSP (DS2)	TRANSP
VOLTAGE OR ANTENNA EXCITATION	SDS = VSRC [(DS)] [,FRQ = DSN] ,V = DSN, DSN, {TAGS / SEGS} = N, N, ..., N	VSRC
COMMAND STREAM MODIFICATION	WIPOUT N, N, N, ...N	WIPOUT
DATA OUTPUT COMMAND	WRITE DS [,LU = N] [,R1 = N] [,R2 = N] [,C1 = N] [,C2 = N] [,FILEID = A]	WRITE
USER SUBROUTINE CALLS (NOT AVAILABLE)	ZCODES N, SDS, SDS, ..., SDS	ZCODES
IMPEDANCE MATRIX GENERATION	ZGEN SINCOS [,GMDATA = DS] [,FRQ = DSN] ,ZMATRX = S [,ZLOAD = DS] [,COND = DSN] [, EPSR = DSN]	ZGEN
STRUCTURE LOADING	ZLOADS = SDS [,GMDATA = DS], {COND = DSN / ZIMP = DSN, DSN / {PRLC / SRLC} = DSN, DSN, DSN} {TAGS / 'SEGS} = N, N, ...N	ZLOADS

BACSUB

Forward Elimination/Back Substitution Command

BACSUB DS1*SDS = DS2

This command causes the solution for a previously decomposed matrix DS1 to be found for the right-hand side DS2 and stored as symbol SDS. For example, assume SRC1, SRC2, and SRC3 have been previously defined, then the solutions SOL1, SOL2, and SOL3 would be obtained by:

```
ZM = LUD(ZIJMAT)
BACSUB ZM*SOL1 = SRC1
BACSUB ZM*SOL2 = SRC2
BACSUB ZM*SOL3 = SRC3
```

This command permits the user to obtain several solutions with only one decomposition.

BAND

Construct Banded Matrix

SDS = BAND (DS), BNDW = N

This operation causes the data associated with the matrix DS which is within N elements of a diagonal element to be transferred to the symbol identified as SDS. Note that SDS and DS may not be the same symbolic name. This operation is typically used to construct the banded matrix for use in the BMI solution process. This operation is illustrated in figure 1.

Examples:

BNDZIJ = BAND (ZIJMAT), BNDW = 50

This operation will construct a banded matrix from the data associated with ZIJMAT

DIAG = BAND (ZIJMAT), BNDW = 0

This operation will extract the diagonal elements from ZIJMAT and store them as DIAG.

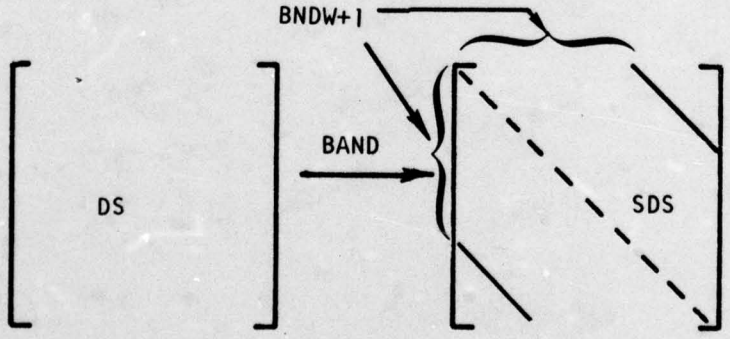


Figure 1. Illustration of BAND Operation

BMI

BMI Solution Process

$$DS1 * SDS1 = DS2 - DS3 * SDS2 \left[,CONVRG = \begin{Bmatrix} BCRE \\ IRE \\ PRE \end{Bmatrix}\right]$$

$$\left[,VALUE = N\right] , MAXITR = N$$

This command causes the BMI solution process to be executed. DS1 must be a banded decomposed matrix whose elements were originally contained in DS3. The solution will be stored in SDS1 upon completion. DS2 is the excitation or right-hand side of the original system of simultaneous equations and DS3 the original impedance matrix of coefficients. DS3 will still contain the elements which were used to generate the banded matrix; however, they will be ignored. The symbol SDS2 may be predefined and preloaded or it may be SDS1, in which case it will be initialized to zero. The convergence parameter to be used is contained in the CONVRG item. Their relative merits and definitions are described in Volume II, GEMACS Engineering Manual. Default convergence item is CONVRG = PRE. The value in percent which the convergence parameter must reach is contained in the VALUE item. The default item is VALUE = 1. The MAXITR parameter defines an upper bound on the number of iterations. There is no default value for this field.

Example:

```
LUDZIJ * CUR = VDRV - ZIJMAT * CUR, CONVRG = BCRE,
VALUE = 10, MAXITR = 5
```

CHKPNT

Checkpoint Command

CHKPNT [LU = N,] [FILEID = A] [,CPINC = N] [,NR]

This command designates the FORTRAN logical unit (LU) N in the LU = N item to be used to receive the checkpoint data. The default item is LU = 7 and if the user specifies a different logical unit, he must assure the availability of the unit to the GEMACS code. The first word written on the checkpoint file will be the value A specified in the FILEID = A item. A may be any string of the characters A-Z, 0-9. If the item is not specified, the default field CHKPNT is provided. Checkpoints will be taken at time increments of N CP minutes specified in the CPINC = N item. If the item is not specified, an immediate checkpoint is written when the command is encountered during execution. This type of command will not change the checkpoint increment specified on a previous command. Multiple CHKPNT commands may be used to vary the checkpoint increment and logical unit during execution.

Checkpoints are accomplished by writing all data contained in named commons and all data associated with symbolic names to the checkpoint file. For large problems, this can be a very large amount of data and it is advisable to avoid using magnetic tapes for the checkpoint file since multiple reels may be required. Also, a large CP increment is recommended unless large data blocks are PURGED when no longer needed.

A historical record of checkpoint information is kept if the NR parameter is specified; otherwise, the checkpoint file is rewound after each checkpoint and overwritten with subsequent checkpoints. Due to the large amount of data, use of the NR parameter is not recommended. If the NR parameter is used, checkpointing should be controlled directly from the command language by omission of the CPINC item. This is the only mode that restarting can be guaranteed with known data for multiple checkpoints on the same file in release 1 of GEMACS.

CONJG

Complex Conjugation (Not Available)

SDS = CONJG (DSN)

This operation will associate the complex conjugate of the data operand with the symbol SDS. Note that SDS may be the same symbol specified in DSN.

DEBUG

Debug Command

DEBUG { ON / OFF / TRACE } [,ILP]

This command is used to obtain diagnostic information during program execution. Specifying the ON parameter causes all available information associated with the subsequent tasks to be printed. When the TRACE parameter is specified, the printout will include subroutine entry and exit information to allow the user to follow the program flow. When OFF is specified, the program returns to the normal mode. The parameter ILP may be specified if the user needs to obtain diagnostic information during the execution of the Input Language Processor.

Examples:

1.
```
DEBUG ON
BACSUB Z * I = V
DEBUG OFF
```

This command stream will cause a detailed printout to occur during execution of the BACSUB command.

2.
```
DEBUG ON,ILP
BACSUB Z * I = V
DEBUG OFF
```

This will cause a detailed printout to occur during input processing of the BACSUB command.

3.
```
DEBUG ON,ILP
END
```

This will cause all of the input language processes and execution tables to be printed on termination of the ILP and before execution of the tasks specified by the user.

Arithmetic Operation (Scalar Quantities Only)

$$SDS = DSN1 \left\{ \begin{matrix} + \\ - \\ * \\ / \\ ** \end{matrix} \right\} DSN2$$

This command directs the arithmetic operation specified to be performed on the data associated with the symbolic name or the numeric value used. The legality of the operation is determined by the type of data. The valid operations are indicated below.

DSN1 / DSN2	SCALAR	MATRIX
SCALAR	(**) + - * /	* /
MATRIX	*	+ - *

Attempts to operate on improperly dimensioned matrices will result in an error. Note that the resultant symbol may be the same as an operand. Several global internal parameters may be defined by use of arithmetic operations. These are:

FRQ	(frequency in MHz)
TIME	(CP run time in minutes)
NUMFIL	(highest FORTRAN logical unit number available for use)
COND	(ground conductivity (in mhos/m)
EPSR	(relative dielectric constant for ground)

In release 1 of GEMACS, there is no hierarchy of operation and the user must use parentheses to denote order of operations. Operations are performed from right to left and from innermost to outermost parenthesis. Thus,

$$A = 3**2 + 6 \rightarrow 3^8$$

while

$$A = (3**2) + 6 \rightarrow 3^2 + 6$$

Examples;

```
FRQ = FRQ + 1.                $INCREMENT FREQUENCY
OMEGA = 6.28 * FRQ.           $CONVERT TO RADIAN
VOLTS = ZIJMAT * CURENT
TIME = 30                     $SET 30 MINUTE CP TIME LIMIT
```

EFIELD

Electric Field Output

$$[\text{SDS=}]\ \text{EFIELD}\ (\text{DS})\ \left[\left[,\begin{Bmatrix}\text{LINLIN}\\ \text{LINLOG}\\ \text{LOGLIN}\\ \text{LOGLOG}\\ \text{LINPLR}\\ \text{LOGPLR}\end{Bmatrix}\right]\right]$$

$$[,\text{U2=N}]\ [,\text{DU=N}]\ [,\text{V2=N}]\ [,\text{DV=N}]\ [,\text{W2=N}]$$
$$[,\text{DW=N}]\ [,\text{U1=N}]\ [,\text{V1=N}]\ [,\text{W1=N}]$$

This command will compute the electric field due to the currents identified as DS. If SDS is specified, the resultant data are associated with the symbol in the SDS field. If SDS is not specified, the data are not saved. The location of all points at which the field is to be computed may be specified in spherical, cylindrical, or Cartesian coordinates. If spherical parameters are specified and R is omitted, the far electric field will be computed. If R is specified, the near field will be computed. The order in which the parameters are specified will determine the order of the output. U, V, and W may be R1, T1, P1, X1, Y1, Z1, with U2, V2, and W2 being R2, T2, P2, X2, Y2, Z2, and DU, DV, and DW being DR, DT, DP, DX, DY, DZ. In this way, the user specifies the first point, the increment, and the last point for each coordinate axis. If U, W, V represent three coordinate specifications, then specifying U1 before W1 will cause the variation specified for W to be completed for each value of U. This is similar to nested FORTRAN DO loops. At the completion of each innermost variation, the electric field components will be printed and, if specified, plotted using the scales specified. The dependent axis will be the magnitude of the components of the electric field and the independent axis will be the geometric variables. Note that to specify a polar plot with either R, X, Y, or Z as the most rapidly varying coordinate is meaningless and will result in an error. However, requesting a linear or log independent axis for an angular coordinate is not meaningless and will be plotted. A combination R, T,

P will imply a spherical coordinate system while R, T, Z implies a cylindrical system and X, Y, Z implies a Cartesian system. These are the only combinations allowed and the meanings of the primary coordinate identified (R, T, P, X, Y, Z) are given in table 2.

The default values for U1, V1, W1, DU, DV, and DW are all zero. The coordinate specified will take all values from U1 to U2 in steps of DU. U2, V2, and W2 are defaulted to U1, V1, and W1.

Example:

EFIELD (CUR) LOGPLR R1 = 36 T1 = 0, DT = 10,
T2 = 90, P1 = 0., DP = 10, P2 = 360.

This will compute the near field at a distance of 36 meters in the upper hemisphere. Log polar plots of E_r, E_θ, and E_ϕ will be made for theta angles of 0° to 90° in increments of 10° with 37 points for each component per plot.

TABLE 2. KEYWORD DEFINITIONS FOR COORDINATE SYSTEMS

	SPHERICAL	CYLINDRICAL	CARTESIAN
R	Radius of Point from Origin	Radius in XY Plane	
T	Angle measured from Z axis	Angle measured from X axis counterclockwise	
P	Angle measured from X axis counterclockwise		
X			X Coordinate
Y			Y Coordinate
Z		Z Coordinate	Z Coordinate

The plot output associated with the electric field output is unlabeled in release 1 of GEMACS. The plots are intended to be used in a qualitative manner, and the data are listed prior to the plot. The abscissa (X) axis is printed across the page and the ordinate (Y) is printed down the page. In the event of a polar plot, the origin is at the center of the display region while for nonpolar plots, the origin is as indicated by the axis data listed.

All plots use the most rapidly varying geometric parameter as the independent variable (angle for polar plots, abscissa for nonpolar plots). The dependent variable is the ratio of the magnitude of the electric field at the observation point to the maximum electric field computed for all observation points. The LOG specification results in the value being modified to 20 $\log_{10}$ of the ratio (Field Strength/ Maximum Field Strength, power dB down from maximum). The dynamic range of the plots is 100 dB.

When the independent variable is an angular coordinate for a polar plot, the location of the reference depends on the coordinate and the coordinate system in use. For cylindrical coordinate, the θ angle is measured positive counterclockwise from the positive X axis. The same convention holds for the $\emptyset$ angle in spherical coordinates. This is illustrated in figure 2a. For the spherical θ angle, the measure is positive clockwise from the plot Y axis. In this case, the plane of the plot is the plane containing the vectors $\hat{r}$ and $\hat{Z}$, where $\hat{r}$ is in the direction of the observation point and $\hat{Z}$ is parallel to the Cartesian Z axis. This is illustrated in figure 2b.

Angular coordinates for nonpolar plots are treated the same as any other independent variable and plotted as the abscissa.

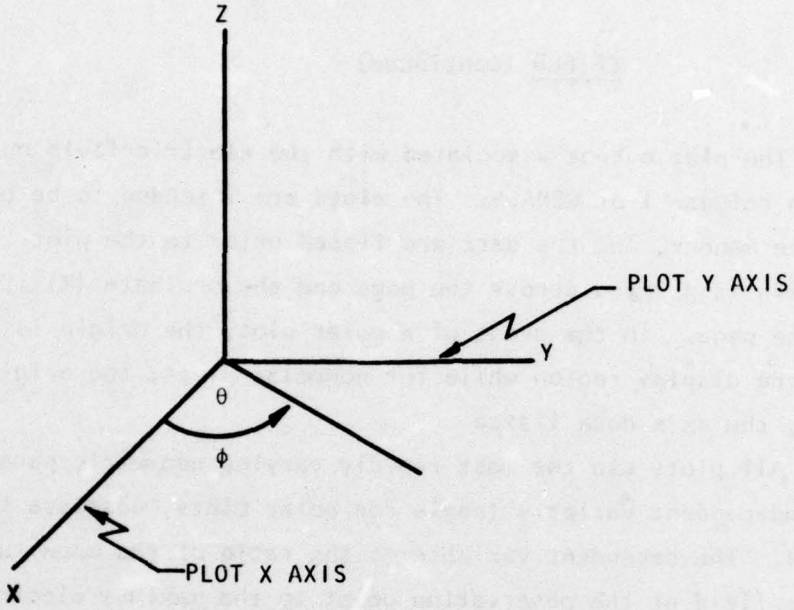


Figure 2a. Plot Axis for Spherical ϕ and Cylindrical θ Independent Coordinate

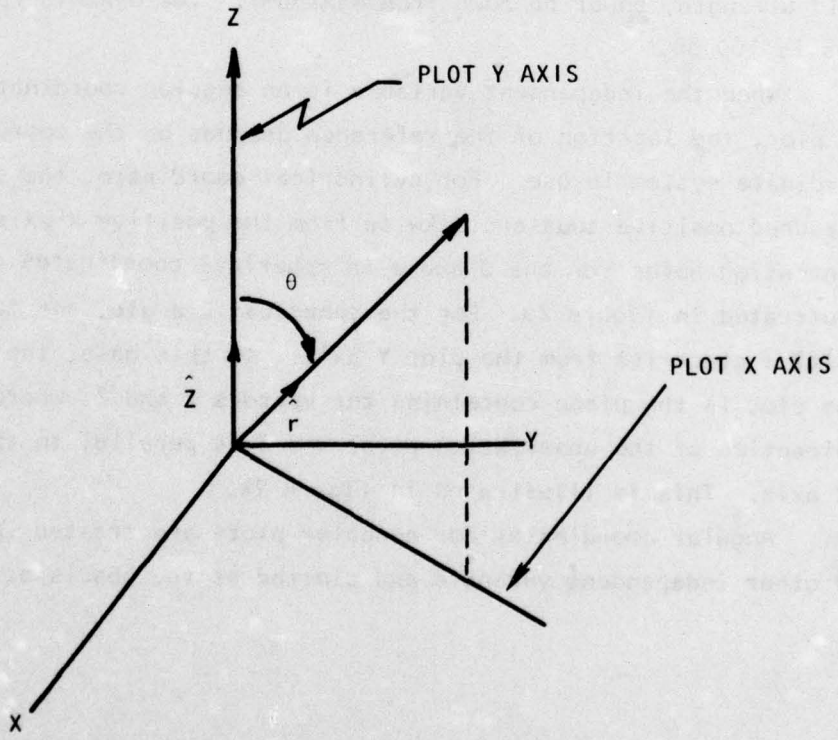


Figure 2b. Plot Axis for Spherical θ as Independent Coordinate

END

End of Commands

END

The END card is used to designate the end of a command input deck. Any text may be on the same card as long as it is separated from the END by at least one blank or comma. In addition, the END must be the first field encountered.

Examples:

END

END OF COMMANDS

END OF FCP747 ANALYSIS

ESRC

Electric Field Excitation

SDS = ESRC [(DS)] [,FRQ = DSN] SW = DSN, DSN
[,R = DSN] [,THETA = DSN] [,PHI = DSN]
[,ECC = DSN]

This command generates or modifies the excitation specified in SDS by driving the structure identified by DS with an incident electric field. The default structure identifier GEODAT is supplied if omitted. The frequency in MHz is specified in the FRQ item and, if omitted, the value used is the last value specified in a FRQ item of any command. If the frequency has changed since the last excitation (either ESRC or VSRC), the data are reinitialized to zero before the excitation is computed. Once computed, the excitation is superpositioned with previous excitation data. The angular coordinates of the source are illustrated in figure 3. THETA is measured in degrees from the Cartesian Z axis and PHI is measured in degrees counterclockwise from the Cartesian X axis. The default values are THETA = 90., PHI = 0. If the radial location specified in the R item is positive, a spherical incident wave from a source located at R, THETA, and PHI will be generated. If the radial location is omitted or negative, a plane wave incident from THETA and PHI will be generated. The default value is R = -1. The vector components of the source field are specified as the values in the SW field. The first value is the component of the field in the spherical $\hat{\theta}$ direction and the second value is the component in the spherical $\hat{\phi}$ direction. If the value item is SW = -1., 0. for example, it corresponds to a vertically polarized electric field with an intensity of 1 volt/m. If an elliptically polarized incident field is to be generated, the ratio of the minor to major axis is specified in the ECC field. The default value is ECC = 0, indicating a nonpolarized wave. Left or right polarization is denoted by the sign of this parameter. Left polarization is positive while right polarization is negative.

When a ground plane has been specified by a previous ZGEN command, the total excitation is the vector sum of the source field and the reflected field. The reflected field is calculated using the reflection coefficient method discussed in the GEMACS Engineering Manual.

Example:

VANT = ESRC SW = 0.,1., THETA = 45., ECC = 1

This will drive the default structure (GEODAT) with a left-hand circularly polarized plane wave incident from 45° in the XZ plane of the structure.

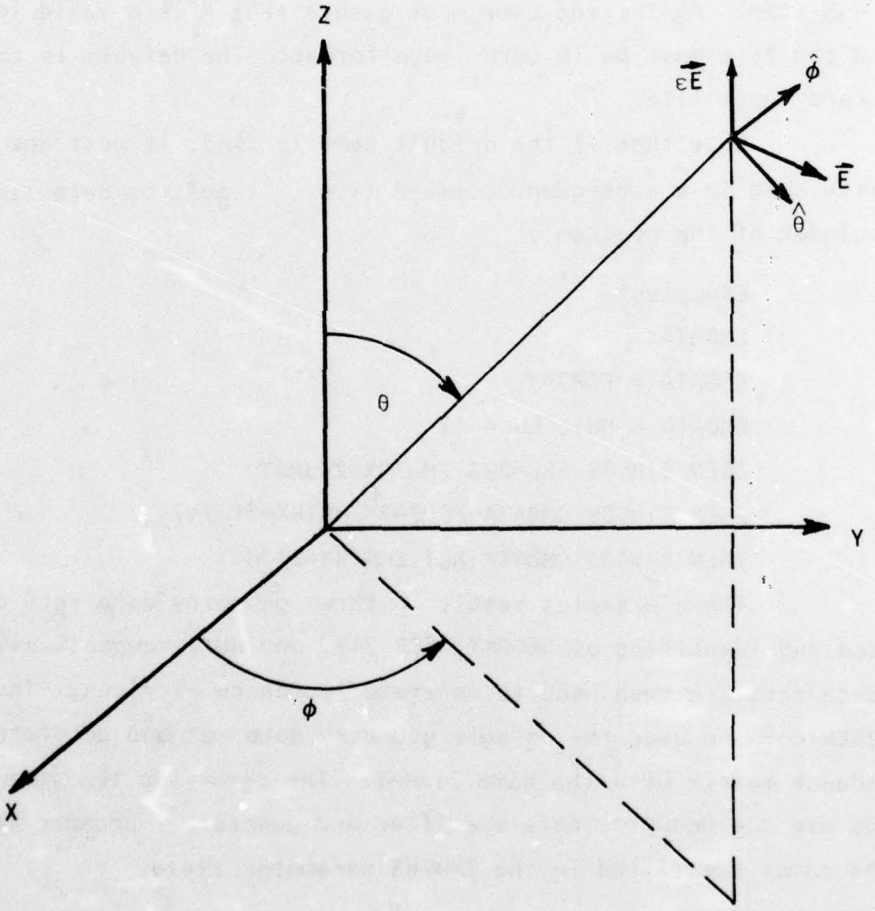


Figure 3. Excitation Coordinate System

GMDATA

Generate a Structure Geometry

GMDATA [= S] [,LU = N]

This command causes the geometry processor to be called to read the geometry data cards which follow the END card. Note that geometry data do not get read until after all commands are read. The default symbol name of the geometry data set S is GEODAT. The processor will read the data from the FORTRAN logical unit specified in the LU = N item. Again, the user must assure that N is a valid logical unit and the file must be in card image format. The default is the system card input file.

Note that if the default name is used, it must not be explicitly used in a subsequent command (i.e., it must be defaulted for the remainder of the program).

Examples:

```
GMDATA
GMDATA = FCP747
GMDATA = HUT, LU = 11
ZGEN SINCOS FRQ=295 ZMATRX=ZIJMAT
ZGEN SINCOS GMDATA=FCP747 ZMATRX=ZIJ747
ZGEN SINCOS GMDATA=HUT ZMATRX=ZIJHUT
```

These examples result in three geometry data sets being generated and identified as GEODAT, FCP 747, and HUT, respectively. These data sets are then used to generate impedance matrices. The first ZGEN command uses the default geometry data set and generates an impedance matrix with the name ZIJMAT. The remaining two ZGEN commands use the geometry data specified and generate impedance matrices with the names identified in the ZMATRX parameter field.

LOOP/LABEL

Command Repetition

LOOP $\left\{\begin{matrix}A\\N\end{matrix}\right\}$ N

LABEL $\left\{\begin{matrix}A\\N\end{matrix}\right\}$

These inputs cause the commands contained between them to be executed N times. Loops may be nested to any level as long as the total number of LOOP commands does not exceed 10. When using nested loops, the loops must be terminated from the innermost loop to the outermost loop. The $\left\{\begin{matrix}A\\N\end{matrix}\right\}$ field may be a six character alphabetical entry or an integer.

Example:

```
LOOP   1, 5          $ EXECUTE SUBSEQUENT COMMANDS 5 TIMES
  :
LABEL 1

LOOP  LOOP1, 5       $ EXECUTE SUBSEQUENT COMMANDS 5 TIMES
LOOP  LOOP2, 10      $ EXECUTE SUBSEQUENT COMMANDS 10 TIMES
  :                  $ COMMANDS EXECUTED 50 TIMES
LABEL  LOOP2         $ INNER LOOP TERMINATOR
  :
LABEL  LOOP1         $ OUTER LOOP TERMINATOR
```

LUD

Matrix Decomposition

SDS = LUD (DS)

This command results in the decomposition by rows of the matrix DS into a lower and upper triangular matrix identified by SDS. In most cases, the matrix DS will not reside in core memory, and subsequently, there will be two matrices generated. They will be internally identified as symbols where the rightmost three characters of the symbol specified for SDS are replaced with LWR and UPR for the lower and upper triangular matrices respectively. This will be transparent to the user since any reference to SDS will result in the retrieval of the lower and upper triangular matrices when necessary for the operation. However, the user may reference the data symbolically by using the original symbol with LWR and UPR replacing the last three characters of the name. If SDS has three or less characters, then the matrices are simply LWR and UPR. No pivoting will take place during decomposition. This is due to the fact that for EM problems, pivoting is usually of little value and can be quite time consuming for matrices not stored in core. Pivoting may be added in a subsequent version if a need is demonstrated.

Examples:

```
LUDZIJ   =   LUD (ZIJMAT)
ZIJMAT   =   LUD (ZIJMAT)
IM       =   LUD (ZIJMAT)
PRINT LUDLWR, LUDUPR
PRINT ZIJLWR, ZIJUPR
PRINT LWR, UPR
```

Note: When the matrix DS does not reside in core, it will still exist on the original file. The LWR and UPR matrices will reside on files other than the original. Therefore, purging DS will not affect the LWR and UPR matrices. Also, the user will retain DS if the LWR and/or UPR matrices are purged.

PLOT

Plot Command (Not Available)

PLOT DS1, DS2, TYPE = { LINLIN | LINLOG | LOGLIN | LOGLOG | LINPLR | LOGPLR }

This command will plot the data associated with DS1 on the y axis against the data associated with DS2 on the x axis. The type of plot is specified by the value in the TYPE item. The first three characters define the Y axis while the last three characters define the X axis. The symbolic names will be printed to identify the data to the user. If DS1 contains complex data, both magnitude and phase will be plotted. DS2 must contain only real data.

Example:

PLOT CURDAT, LDAT LOGLIN

PRINT

Print Data Command

PRINT SDS, SDS, ... SDS

This command allows the user to obtain the entire contents of each symbol specified. If the data are complex, the output will contain both the real and imaginary components as well as the magnitude and phase. For complex data, there will be 2 elements per line and for real data, there will be 10 elements per line. Printing out large complex arrays can consume a fair amount of paper and the user is encouraged to use the WRITE command when the entire contents are not required.

Example:

PRINT VSRC, CURRNT

This command will cause the data associated with symbols VSRC and CURRNT to be printed sequentially.

PURGE

Purge Data Command

PURGE SDS, SDS, ... SDS

This command will cause the internal core storage or FORTRAN logical unit associated with the specified symbols to be made available for other use. The data are not retrievable after a PURGE command. Due to the limited FORTRAN logical units, it is recommended that symbols be purged when no longer required. This will also make checkpoint files shorter. Purged symbols may be referenced if the actual data are not required. This could occur, for example, after a matrix has been decomposed and all that is required is the lower/upper triangular matrices.

Example:

```
GMDATA
ZGEN  SINCOS  FRQ = 123
ZIJMAT = LUD (ZIJMAT)
PURGE  ZIJMAT
VOLT = VSRC,  V = 1.,0. SEGS = 51-60
BACSUB  ZIJMAT * CUR = VOLT
PRINT  CUR, VOLT
END OF COMMANDS
GEOMETRY DATA
END OF DATA
```

READ

Data Input (Not Available)

$$\text{READ SDS } \left[\text{,LU = N}\right] \left[\text{,TYPE = } \left\{\begin{matrix}\text{R}\\\text{C}\end{matrix}\right\}\right] \left[\text{,R1 = N}\right] \left[\text{,R2 = N}\right]$$
$$\left[\text{,C1 = N}\right] \left[\text{,C2 = N}\right] \left[\text{,FILEID = A}\right]$$

This command will cause GEMACS to read card image data to be associated with the symbol SDS from the FORTRAN logical unit specified in the LU = N item. The default logical unit is the system card input file. The data must be in card image format and must be terminated with an END card. The TYPE = $\left\{\begin{matrix}\text{R}\\\text{C}\end{matrix}\right\}$ item identifies the type of data to be read. R identifies real data, C identifies complex data. The default type is R. The parameters R1, R2, C1, C2 designate the storage locations for the data. The default values are: R1 = 1, R2 = R1, C1 = 1, and C2 = C1. Matrix data are assumed to be ordered by columns on the input cards. The card data are free-field format and reading will continue until an END is encountered. Excess data will be ignored and a warning message issued while excess variables will be unaltered and a warning message issued. That is, if there are M data elements read from the input and $M < (|R2 - R1| \cdot |C2 - C1|)$, then $(|R2 - R1|) \cdot (|C2 - C1|) - M$ entries of SDS are unaltered. If the FILEID entry is present, the first word read must correspond to the FILEID field A. Default is no FILEID specified.

Again, if a logical unit other than the system card input is specified, the user must assure the unit is available to the GEMACS code. Note that continuation and comment card rules apply to the user's input.

Example:

```
READ VORV, TYPE = C, R2 = 100, FILEID = VI
```

RSTART

Checkpoint Restart

RSTART [LU = N] [,FILEID = A] ,CPNUM = N

This command is used to restart a job from checkpoint. The checkpoint file is to reside on the FORTRAN logical unit specified in the LU = N item. The default item is LU = 7 which is the same as the checkpoint default logical unit. If an alternate logical unit is specified, the user is responsible for assuring that GEMACS can access the unit. The FILEID item is used to assure that the correct checkpoint file is available. The default item is FILEID = CHKPNT which also corresponds to the default CHKPNT FILEID item. The checkpoint number to be recovered is specified in the CPNUM item and is not defaulted. The value N specifies the integer number of the checkpoint to be recovered. This is done to permit different operations to be performed on the data without being required to regenerate all the data. For instance, if a checkpoint was written after the impedance matrix was generated, the user could restart at that point and use a different solution procedure than on a previous run.

NOTE: RSTART should be the first command encountered for the restart run. If it is not, all previous commands in the restart input stream are ignored.

Example:

```
RSTART   FILEID = FCP747, CPNUM = 5
```

If a RSTART is executed from the same logical unit as the checkpoint was written to, the checkpoint file may be overwritten on subsequent checkpoints. If the user wishes to maintain the integrity of the original checkpoint tape, the restart should take place from a different logical unit.

SET

Data Initialization and Modification

SET SDS = N [,N] [,R1 = N] [,R2 = N] [,C1 = N] [,C2 = N]

This command may be used to initialize or change the value of data associated with SDS. If the data are complex, then SDS = N, N corresponding to the real and imaginary components is used. If the data are real, then SDS = N is the correct form. The parameters R1, R2, C1, and C2 specify the row and column limits of the data to be loaded with the value specified. The default value of R1 and C1 is 1 while R2 and C2 default to R1 and C1 respectively.

This command would allow the user to alter an excitation data set if he wished to force a boundary condition. If a structure has interior wires and is excited by an external field, the field on the internal wires could be reset to zero. Also, the initial solution for the BMI could be specified, as well as modifications to the impedance matrix.

Example:

```
SET   ZIJMAT = 0.,0.  R1 = 10, C2 = 100
SET   ZIJMAT = 0.,0.  R2 = 100, C1 = 10
SET   ZIJMAT = 1.,0.  R1 = 10, C1 = 10
SET   VDRV = 0.,0., R1 = 10
```

This sequence would load zeros into every element of the tenth row and tenth column of ZIJMAT and then reset the diagonal element to (1.,0). The 10th element of VDRV would be set to zero. This would have the effect of constraining the current in the 10th segment to be zero and not allowing any interaction between the 10th segment and the rest of the structure except for current continuity at junctions.

SOLVE

Solve System of Simultaneous Linear Equations

```
SOLVE   DS1* SDS  =  DS2
```

This command will solve for the solution vector SDS using lower/upper triangular decomposition on DS1 and back substitution using DS2. If DS1 is already decomposed, only the back substitution will be performed. SDS and DS2 may be the same symbol.

Example:

```
SOLVE   ZIJMAT * CUR  =  EINC
```

Will cause execution of the following equivalent input.

```
ZIJMAT = LUD (ZIJMAT)
BACSUB   ZIJMAT * CUR = EINC
```

SYMDEF

Define Symbol Name (Not Available)

$$\text{SYMDEF} \quad S\left[\text{TYPE} = \begin{Bmatrix} R \\ C \end{Bmatrix}\right] [,R = N][,C = N] \left[,\text{SEQ} = \begin{Bmatrix} R \\ C \end{Bmatrix}\right]$$

This command allows the user to define a data set for use by a ZCODES subroutine. The data type, real or complex, is specified by the R or C value in the TYPE item. Default type is real. The number of rows is specified by the integer N field of the R parameter, and the number of columns is specified by the integer N in the C item. Both R and C default to 1. The sequence of the data are specified by R or C in the SEQ item. SEQ = R specifies that the data are stored by rows. This implies a transposed matrix. SEQ = C implies the data are stored by columns and is the normal FORTRAN storage sequence, hence the default field is SEQ = C.

TRANSP

Matrix Transposition (Not Available)

SDS1 = TRANSP (DS2)

This command will transpose DS2 and associate the resultant data with SDS1. Note that SDS1 and DS2 may be the same symbol.

Example:

ZIJMAT = TRANSP (ZIJMAT)

VSRC

Voltage or Antenna Excitation

$$SDS = VSRC\ [(DS)]\ [,FRQ = DSN]\ \ ,V = DSN, DSN,$$

$$\left\{\begin{matrix}TAGS\\SEGS\end{matrix}\right\} = N, N, \ldots, N$$

This command will set up or add to the excitation specified by SDS on the structure DS. The default structure identified is GEODAT. The voltage source is applied as a delta-gap electric field at the midpoints of the specified segments in the geometry data. That is the tangential electric field at the midpoints of the segments specified is $-V/\ell$ where ℓ is the segment length in meters. The frequency in MHz is specified in the FRQ item and if the item is omitted, the last frequency specified in a FRQ item on any command is used. If the value of the frequency has changed since the last excitation (either VSRC or ESRC), the symbol will be reinitialized to zero before the source data are computed. If the frequency is unchanged, then the source data will be added to the existing data associated with SDS. This permits superpositioning of excitations. The real and imaginary components of the voltage source are specified by the V parameter. The values for this item may have been previously defined symbolically. The segment identification may have one of two forms. If TAGS is specified, then all segments which have tag numbers identified in the parameter list will be excited. If SEGS is specified, only those segment numbers listed will be excited. This list of numbers must be the last entry of the command and may contain a minus sign between successive entries. That is N_1, N_2 - N_3, N_4 is valid and will cause tags or segments N_1, N_2 through and including N_3, and N_4 to be excited.

Example:

```
VANT = VSRC    ,  FRQ = FRQMHZ
V  =  .707, - .707  TAGS = 1-4
```

WIPOUT

Command Stream Modification

WIPOUT N, N, N, ...N

This command will cause the commands identified by the sequence number N to be cancelled. The commands are sequenced in ascending order starting with 1. Note that the command sequence number is not necessarily the same as the card number containing the command since comment cards and continuation cards may be present. If one of the N is 99999, then the entire sequence from the previous command number specified up to and including the WIPOUT command are eliminated from the execution.

The WIPOUT command would normally be used after a RSTART command to change the command sequence. Additional commands may follow the WIPOUT command.

Example:

```
RSTART    CPNUM = 5
WIPOUT    5, 99999
:
```

This would eliminate all commands after the fourth command of the run which generated the checkpoint being restarted. Subsequent commands would be executed.

(Note: LOOP/LABEL commands may not be wiped out.)

WRITE

Data Output Command

WRITE DS [,LU = N] [,R1 = N] [,R2 = N] [,C1 = N]

[,C2 = N] [,FILEID = A]

Using this command, partial data associated with the symbol DS may be written to the file specified. If the logical unit item LU = N is not specified, the system printer is used and the FILEID item is ignored. If LU = N is specified, the field A in the FILEID item is written first and then the data specified. In this case, the output is in FORTRAN binary format and may be used as input to other programs. R1, R2, C1, and C2 define the row and column limits of the data. Default values for R1 and C1 are 1 while default values for R2 and C2 are dependent on whether R1 or C1 are specified. If R1 is specified R2 defaults to R1. If not, then R2 defaults to number of rows in the symbol DS. The same procedure applies to C2.

EXAMPLE:

WRITE ZIJMAT R1 = 10, C1 = 1, C2 = 5

This prints the first 5 elements in row 10 of ZIJMAT

WRITE ZIJMAT

This writes the entire matrix ZIJMAT.

ZCODES

User Subroutine Calls (Not Available)

ZCODES N, SDS, SDS, ..., SDS

When the user desires to perform some operation on the data associated with the symbols specified, he may do so using a ZCODEN subroutine. N is an integer 0-9 and thus provides 10 user subroutine interfaces. The user subroutine interface is:

```
SUBROUTINE  ZCODEN  (MSYMS, NSYMS)
DIMENSION   MSYMS (10, 3)
```

where NSYMS will contain the number of symbols specified on the command and MSYMS is an array which contains three entries for each symbol specified. For the i^{th} symbol, these are:

```
MSYMS (I, 1)  =  Symbol Name
MSYMS (I, 2)  =  Number of Rows
MSYMS (I, 3)  =  Number of Columns
```

The symbol name is stored in a GEMACS internal code and in order to write the name, it must first be converted to left justified, blank filled text using the following FORTRAN call to GEMACS subroutine CONVRT.

```
CALL  CONVRT  (MYSYMS (I, 1), NAME)
```

There are a maximum of 10 symbols which can be passed to a ZCODEN routine.

The data associated with a symbol are retrieved and stored by using the GEMACS subroutines GETSYM and PUTSYM. The FORTRAN calls are:

```
CALL   GETSYM  (NAME, ARRAY, REC1, REC2)
CALL   PUTSYM  (NAME, ARRAY, REC1, REC2)
```

where

```
NAME  =  Symbol name (MYSYMS (1,1)).
ARRAY =  A user provided storage array large enough
         for the data requested.
REC1  =  First record desired.
REC2  =  Last record desired.
```

ZCODES (Concluded)

Matrices are stored by columns and each column is a record. Therefore, REC1 and REC2 refer to the first and last column to be retrieved or stored.

The user must store data to be used later in the execution.

Example:

```
ZCODES   5, ZIJMAT, CUR1, VDRV
```

This command would call ZCODE5 with the information regarding the three symbols specified in the MSYMS array and NSYMS = 3.

ZGEN

Impedance Matrix Generation

ZGEN SINCOS [,GMDATA = DS] [,FRQ = DSN] ,ZMATRX = S
[,ZLOADS = DS] [,COND = DSN] [,EPSR = DSN]

This command causes an impedance matrix to be generated using the sine + cosine + pulse expansion and collocation on the structure specified in the GMDATA item. The default structure is GEODAT which is the default name for the GMDATA command. The frequency in MHz is specified by the value DSN of the FRQ item. The last FRQ parameter will be used if none is specified on the command. If the FRQ parameter has not been previously specified, a fatal error will occur. Note that the frequency may be specified symbolically or numerically. The resultant impedance matrix is identified by the parameter in the ZMATRX item. If the structure is to be loaded, the value in the ZLOADS item must be a symbol name of a data set generated by a ZLOADS command. The default is no loading or a null ZLOADS item. If a ground is to be used, the conductivity in mhos/meter must be specified in the COND item. COND = -1 implies a perfect ground, COND = 0 implies no ground. Default is COND = 0. If a nonperfect ground is specified, the relative dielectric constant ε_r may be specified in the EPSR item. The default item is EPSR = 1. For a perfect or no ground case, the contents of the EPSR item are ignored. When a ground is specified, it is assumed to be perpendicular to the structure Z axis.

Example:

```
ZGEN   SINCOS   FRQ = FRQMHZ, ZMATRX = ZIJ, COND = 80
```

ZLOADS

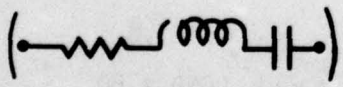
Structure Loading

$$\text{ZLOADS} = \text{SDS}\ [,\text{GMDATA} = \text{DS}]\ , \left\{\begin{array}{l}\text{COND} = \text{DSN} \\ \text{ZIMP} = \text{DSN, DSN} \\ \left\{\begin{array}{l}\text{PRLC} \\ \text{SRLC}\end{array}\right\} = \text{DSN, DSN, DSN}\end{array}\right\}$$

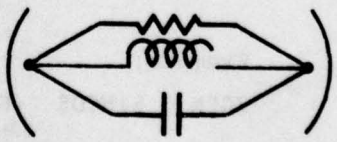
$$,\left\{\begin{array}{l}\text{TAGS} \\ \text{SEGS}\end{array}\right\} = \text{N, N, ... N}$$

This command allows a user to place electrical loads on the structure identified in the GMDATA item. The default structure (GEODAT) will be used if the GMDATA item is omitted. The load information data will be associated with the symbol SDS and will be a complex column vector with the same number of rows as wire segments in the structure.

The type of loading is specified by one of the parameters. COND, ZIMP, PRLC, or SRLC. COND is used to specify the segment conductivity in MHOS/METER. ZIMP is used to specify a lumped load resistance and reactance in ohms. The PRLC and SRLC parameters permit loading with parallel or series RLC circuits. The values of R, L, and C per meter are contained in the parameter list in that order. The units of R, L, and C for the PRLC and SRLC options are ohms, millihenries, and microfarads respectively. The equivalent circuits are illustrated below:



SRLC



PRLC

ZLOADS (Concluded)

The TAGS/SEGS item is used to identify those segments to be loaded. Use of the TAGS option results in all segments which have the tags specified being loaded. Use of the SEGS option limits the loading to only those segments specified. The integer list in the TAGS or SEGS item may contain consecutive integers separated by a minus sign. In this case, all elements from the first integer to the last are effectively specified.

Multiple ZLOADS commands are permitted. In order to be effective, the ZLOADS command must occur before the ZGEN command.

Example:

```
ZLOADS   FCPLOD   GMDATA = FCP747, PRLC = 5, 13, 21,
                  SEGS = 1, 5,  7-23, 47
```

This command causes the structure FCP747 to have a PRLC load applied to segments 1, 5, 7, 8, 9, ..., 21, 22, 23, and 47 with R = 5 ohms, L = 13 mH, and C = 21 μF.

Note: The ZLOADS card must precede the ZGEN card since this is a required item for input on the latter card.

2. Geometry Input Language Processor

The function of the GIP (Geometry Input Processor) is to translate the user's inputs related to structure geometry into a data set which may be operated on by an impedance matrix generator to provide the impedance matrix of the structure under analysis. The GIP is entered on encountering the GMDATA command in the command language input stream. It is a re-entrant processor in that it may be called several times, either to extend a previously generated geometry data set or to create a new geometry data set. The attributes of the geometry data set are assigned by the GIP. On completion of the geometry processing, all data are written out to a peripheral storage device.

The user inputs to GIP consist of BCD records (card images) in which the first non-blank field is an alphanumeric code designating the type of data contained in the record. The data following the type code must be separated by blanks or commas. Blanks embedded within fields are not allowed. A field is therefore defined as a contiguous group of characters which, when interpreted, correspond to a data requirement of the record being processed. Text following a $ is regarded as a comment and is ignored. There are a maximum of 256 fields per command. This does not include comment fields or commas since these are not processed. Continuation cards are indicated in the following ways. First, when a card ends in a comma, the next card is read as a continuation and must have a continuation character in column 1. Secondly, any card which has a continuation character in column 1 is assumed to be a continuation of the previous card. There is no limit on the number of continuation cards except that dictated by the limit of 256 fields. The continuation character and its definition are the same as described in section C.

The type codes and their meaning which are currently allowed are:

Type Code	Definition
AT	Attach
CE	Combine Elements
CP	Connect Point
CS	Coordinate System
DE	Define End
DF	Define
END	End
MP	Multiple Points
PT	Point
RA	Radii
RF	Reflect
RN	Re-number
RT	Rotate
SC	Scale
WR	Wire
XL	Translate

The input record image and use of each of these types is presented in the following section.

General guidelines for wire modeling include the following:

1. Segments must be short compared to one wavelength. Lengths of 0.1 λ should be adequate for most purposes. For wire grids with square mesh, good results have been obtained with lengths up to 0.14 λ. (See GEMACS Engineering Manual, volume II, section D.3.)

2. Actual wires should be modeled with the actual radius. Grid models should use a wire radius about one-fifth of the segment length in regions of square mesh. (See GEMACS Engineering Manual, volume II, section D.3, for more detailed comments.)

3. Grid mesh circumferences should not greatly exceed 0.5 λ. Larger circumferences lead to loop resonances and poor results.

4. Segments with lengths differing by more than a factor of two should not be joined. Small angles (less than about 20°) between joined

segments should be avoided. Unjoined segments should be separated by a segment length or more. The maximum number of segments commonly joined is limited to 50. Segments are considered to be joined when their end points are separated by ZERO, a parameter set in a data statement in subroutine BLKDAT. The value of ZERO should be set in the code by the user according to his needs and the limits of precision imposed by his machine. It is computed using the following formula:

$$ZERO = 1/2 \times 2^{-(m-1)}$$

where m is the number of bits in the mantissa of the computer system.

5. The maximum number of points, segments, defined elements, etc. that can presently be input for the geometry is discussed in section E.2 of this volume.

6. The renumbering command (RN) permits the user to specify the geometry in the most convenient manner available and to subsequently renumber the wire segments to locate the near-neighbor interactions close to the diagonal of the interaction matrix. The interaction terms between the i^{th} and j^{th} segments will be the (ij) and (ji) matrix elements. If the bandwidth chosen is m, then if $|i-j| > m$, the interaction of i^{th} and j^{th} segments will not be included in the band. Too many (an as yet unquantified number) large interactions omitted from the band will cause the BMI solution technique to fail to converge. Therefore, numbering the problem such that near neighbors have approximately equal numbers will cause large interactions to occur in the band. However, too many small coherent interactions outside the band may also cause the BMI solution technique to fail to converge.

3. Geometry Input Language Commands

The general form of the commands available to the user is:

TYPE P1, P2, P3, ...

where TYPE is one of the type codes listed in section 2. P1, P2, P3 are the ordered parameter fields required or used in the processing of the command specified. The parameters may be separated by a comma or a blank. The basic geometrical elements in the GIP are points and line segments. In addition, points and line segments may belong to larger groups. For points, the only larger group is referred to as a DF NAME (Defined Element) and reference to a DF will automatically reference all of the points within the element. Line segments may also belong to a group identified by a tag number in addition to a line segment number. The former method (DF) is preferred due to programming considerations. Thus, the user may reference points, line segments, or a group of points and/or line segments. At present, there is no way to reference individual line segments unless they are part of a group; however, they may be the only element of the group. Whenever an element is operated on to form a new element, the known attributes of the source element are automatically given to the new element with the exception of group membership. This attribute will also be associated if the group has not been closed by a DE (Define End) command. To the GIP, the attributes of points are:

1. Point number.
2. Point location.
3. Group membership.

The attributes of a line segment are:

1. Segment number.
2. Segment tag.
3. Location of end points.
4. Group membership.
5. Radius of wire segment.
6. Segment connection data.

In the discussion of the commands that follow, it must be remembered that the parameter fields are ordered. This is in contrast to the parameter fields of the ILP which were keyword indexed to achieve order independence. Keywords are not used in the GIP in order to achieve a more succinct input.

It should also be noted that some of the commands have parameter fields that may be defaulted. An example of this is the connect points (CP) command. In general, for a command of the form

TYPE P1, P2, P3, P4, P5

in which P3, P4, and P5 may be defaulted, it must be kept in mind that there is a difference between a zero field and a null field. Defaulted fields are indicated by a null field, and defaults can be achieved only from right to left. To default P5, both P3 and P4 must be specified. To default P4, only P3 must be specified, while P5 may be specified only if desired.

AT

Attach Operation

$$\text{AT} \begin{Bmatrix} \text{PT} \\ \text{TG} \\ \text{DF} \end{Bmatrix}, \begin{Bmatrix} \text{n} \\ \text{n} \\ \text{name} \end{Bmatrix}, \text{NCS}$$

Parameter		Definition
AT	-	Attach operation code.
$\begin{Bmatrix} \text{PT} \\ \text{TG} \\ \text{DF} \end{Bmatrix}$	-	Point, tag, or defined element to be operated on.
$\begin{Bmatrix} \text{n} \\ \text{n} \\ \text{name} \end{Bmatrix}$	-	An integer for points or tag elements; the element name for defined elements.
NCS	-	Integer identifier of previously defined coordinate system to which the element is to be attached.

This command results in a group of points and/or segments to be translated and rotated to origin of the coordinate system specified. No new elements will be generated. This allows the user to input elements in local systems and then relocate them to their actual position.

Examples:

AT PT 10 3

This would result in the coordinates of point 10 being changed to those it should have after being relocated to the coordinate system 3. If point 10 originally had x, y, z coordinates (0,0,0) and coordinate system 3 were located at (10,0,0) with regard to the global system, then point 10 would have (10,0,0) as its coordinates after the operation.

AT DF SPHERE 2

All elements of SPHERE would have their coordinates modified to those they would have if they had originally been defined in coordinate system 2.

CE

Combine Elements Operation

CE name1, name2, name3,...

Parameter		Definition
CE	-	Combine elements code.
name1	-	Name by which resultant group will be known.
name2 name3	-	Names of elements to be combined into element name. Note that these elements must have been generated by a Define Element operation and will not be available under their original names after this operation.

If the user has several elements that have been defined by a Define Element operation, he may combine them into one element with this operation. This is useful when a user has a collection of generic shapes and he puts them together to form another object. He may then combine all of the elements under one name for ease of future reference.

Example:

Assume all previous data are present.

```
AT  DF BOOM 3
AT  DF DISH 1
CE  SATLIT  CYLNDR  DISH  BOOM
AT  DF SATLIT 5
```

Coordinate systems 3 and 1 may have been defined such that the first two AT commands move elements BOOM and DISH to locations on element CYLNDR. Then CYLNDR, DISH, and BOOM were combined into element SATLIT and the resultant element positioned at coordinate system number 5. As seen, this has eased the input of geometry considerably when the relative locations of defined elements are known or easily calculated. If the user wanted to define the members of BOOM, DISH, and CYLNDR in coordinate system 5, a considerable amount of precomputation would have been required if the elements' dimensions were on separate drawings.

CP

Connect Points Operation

CP N1 N2 [NSEG][NTAG][NRAD]

Parameter		Definition
CP	-	Connect point code.
N1	-	Integer number of first point.
N2	-	Integer number of second point.
NSEG	-	Number of segments to be generated between N1 and N2. (Default=last NSEG parameter from any previous operation.)
NTAG	-	Tag number identifying all segments between N1 and N2. (Default=last NTAG parameter from any previous operation.)
NRAD	-	Integer index to radii table entry. (Default=last NRAD entry from any previous operation.)

After the user has defined the points N1 and N2, this operation will connect NSEG segments between these points. Each segment generated will have a TAG number specified by NTAG and a radius retrieved from the NRAD entry of radii table. The default values for NSEG, NTAG, and NRAD are those values left over from any previous operation for which whey were defined. This implies that they must be defined on the first operation which requires them. Note that a zero is different than a null field. Default values are implied by a null field. This implies that fields are only defaulted from right to left. That is, if you wish to change only the NRAD parameter, both NSEG and NTAG must be specified. However, if you wish to change the NTAG field, only NSEG must be specified.

CP (Concluded)

Examples:

```
CP  1 2 3 0 5
```

or

```
CP  1,2,3,0,5
```

This would result in generating 3 wire segments from point 1 to point 2. They would have a TAG of 0 and a radius extracted from the fifth radii entry.

```
CP 1 4, ,1,3
```

Assuming the first example preceded this operation, three more segments would be generated from point 1 to point 4 with a TAG of 1 and radius extracted from the third radii entry.

CS

Coordinate System Specification

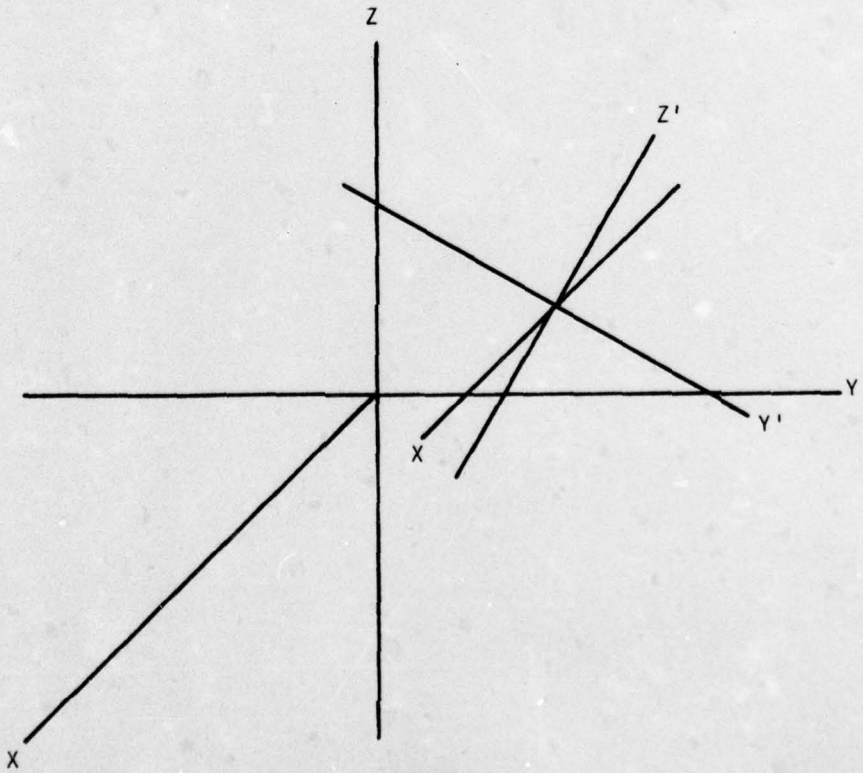
CS NCS XC , YC , ZC , RX , RY , RZ

Parameter		Definition
CS	-	Coordinate system code.
NCS	-	Unique integer identifier for this system.
{XC, YC, ZC}	-	(x,y,z) location of coordinate system origin.
{RX, RY, RZ}	-	Rotation angles in degrees about the x, y, and z axis of the global coordinate system.

This card permits the user to specify additional coordinate systems. The NCS field on other inputs reference the coordinate system identified by this number. When the NCS parameter is specified on other inputs, the transformation from or to this coordinate system will be made. This card must precede all cards referencing this NCS.

EXAMPLE:

CS 3 0.0 2.0 1.0 30.0



DE

Define End Operation

DE

Parameter		Definition
DE	-	Define end code.

This operation ends or closes the group identified in the current Define Element (DF) operation. The group may not be extended except by a CE operation. All points and wire segments generated since the last DF operation belong to the group identified by the DF name. Points in this group may be referenced without regard to group membership, however, the segment data may only be referenced by identifying the group. It is advisable not to generate points under a DF operation since the storage available for points is more restricted than that for segments and operations performed on the DF element will generate more points which are not usually required (see the example for the DF operation).

DF

Define Element Operation

DF name

Parameter		Definition
DF	-	Define element code.
name	-	A 6 character or less identifier, must begin with alpha character, but can include integers.

All points and segments generated between this input and the next DE input will belong to the group "name." Nested DF's are allowed. Note that while points may belong to a group, they may still be referenced individually.

Examples:

```
DF BOX
PT 1  1  0  0
PT 2  0  1  0
PT 3 -1  0  0
PT 4  0 -1  0
CP 1, 2, 1, 0, 1
CP 2, 3
CP 3, 4
CP 4, 1
DE
AT DF BOX 1
```

Points 1, 2, 3, and 4, and segments generated in connecting those points are identified as belonging to BOX. All of these segments are then moved to coordinate system 1. If an operation was performed on BOX which involved generation of additional elements, the points belonging to BOX would also be used as sources for additional points. For this reason, use of points in a defined element should be avoided whenever possible, since the storage available for points is more restricted than that for segments.

END

End of Geometry

END

Parameter		Definition
END	-	End of current geometry designator.

This card causes the GIP to stop reading input. It will then look for wire junctions, identify all multiple segments, print out the point table and segment data set, and write the segment data set to the user specified data set.

Multiple segments are defined as those segments lying on an axis of rotation or in a plane of reflection. They are identical segments with the same end points as the generating segment. The generated segments do not enter into the impedance matrix calculation, and they are identified in the segment data output by a zero in the ISEG column.

Multiple Point Connection Operation

MP NPTS, NP1, NP2, NP3, ..., NPNPTS, [NSEG,] [NTAG,] [NRAD]

Parameter		Definition
MP	-	Multiple point connect code.
NPTS	-	Integer value of the number of points connected.
NP1, NP2, ., ., ., NPNPTS	-	Integer identification of points to be connected. There must be NPTS of these values.
NSEG	-	Number of segments between each pair of points. There will be (NPTS-1)*NSEG segments generated. (Default NSEG=last NSEG value from any previous entry.)
NTAG	-	Integer tag number identifying all segments generated. (Default NTAG= last NTAG value from any previous entry.)
NRAD	-	Integer value of location of wire radius in radii table. (Default NRAD=last NRAD value from any previous entry.)

When the user has generated a set of points to be connected with an equal number of segments, this card permits that to be done. There is no restriction on the location of the points and NPTS must be greater than 1.

Examples:

MP 6 1 3 7 10 5 4 2 0 1

This card would connect points 1, 3, 7, 10, 5, and 4 with a wire whose radius is stored in the first entry of the radii table. There would be two segments between each pair of points and all segments would have a tag of zero.

PT

Point Specification

PT NPT X Y Z [NCS]

Parameter		Definition
PT	-	Point specification code.
NPT	-	Integer identifier of this point. This must be a unique number.
X, Y, Z	-	(x,y,z) location of point with regards to NCS.
NCS	-	Integer identification of coordinate system for (x,y,z). (Default NCS= last defined NCS entry.)

This input is used to specify points. The identifier NPT must be globally unique (not simply unique to coordinate system NCS). The point (x,y,z) will be transformed from coordinate system NCS before it is stored if NCS is non-zero.

Examples

PT 3 1. 1. 1. 10

This defines point number 3 as being at (1.,1.,1.) in coordinate system 10. The point will be transformed to the global coordinate system before being stored.

Radii Specifications

RA R1, R2, R3, ..., Rn

Parameter		Definition
RA	-	Radii table entry code.
R1 . . . Rn	-	Floating point values of the radii entries. The radii table will be loaded sequentially with these values.

Instead of the user appending the wire radius information to each input that generates a wire segment, he simply refers to an entry in the radii table. These entries are loaded sequentially from these RA inputs. Currently $n \leq 10$.

Examples:

RA .001 .125 .0067

RA .025 1.00 .0003

Load radii entries 1 through 6 with the encountered values.

Reflect Operation

$$RF \begin{Bmatrix} PT \\ TG \\ DF \end{Bmatrix}, \begin{Bmatrix} n \\ n \\ name \end{Bmatrix}, A1, A2, A3, [INCTAG,][NCS]$$

Parameter		Definition
RF	-	Reflection operation code.
$\begin{Bmatrix} PT \\ TG \\ DF \end{Bmatrix}$	-	Two letter code to indicate point, tag or defined element is to be operated on.
$\begin{Bmatrix} n \\ n \\ name \end{Bmatrix}$	-	For PT and TG, the integer identifier, for DF, the alphanumeric name of the defined element.
A1	-	Alpha designation (x,y, or z) of axis along which first reflection will occur.
A2	-	Alpha designation of axis along which second reflection will occur.
A3	-	Alpha designation of axis along which third reflection will occur.
INCTAG	-	Tag increment parameter. Segments generated by first reflection will have tags incremented by INCTAG. Segments generated by second reflection will have tags incremented by 2* (INCTAG) and segments generated by third reflection will have tags incremented by 4* (INCTAG) (Default INCTAG=0.)
NCS	-	Integer identifier of coordinate system in which reflection is to take place. (Default NCS=last NCS value.)

This card causes the symmetry operation of reflecting through the plane normal to the axis specified. Segments in the planes of reflection are allowed. They are identified as such and will not enter into the impedance matrix calculation. If the reflection operation takes place on an element currently being defined, all segments generated will be associated with the element being defined.

Examples:

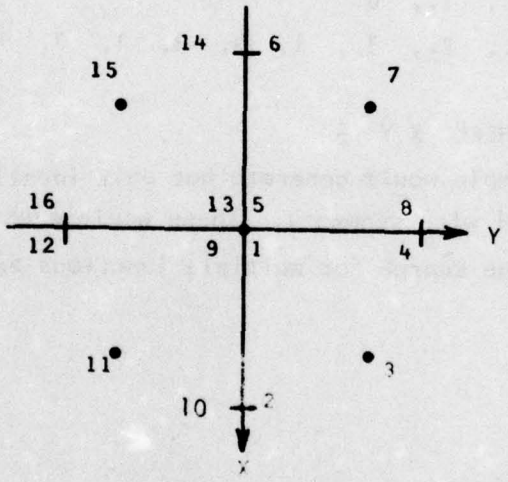
1. RF DF WHEEL X 10

This will cause all points and segments associated with WHEEL to be reflected through the YZ plane and the tags to be incremented by 10.

```
DF WHEEL
PT 1 0. 0. 0.
PT 2 1. 0. 0.
RT PT 2 2 90
DE
```

RF DF WHEEL X Y 10

This would generate the following points in the positions indicated. Note that points in the plane of symmetry are regenerated.



This is strictly for the user's convenience in keeping up with the point identifiers. NPTS will result in 2^n*NPTS points incremented sequentially where n is the number of planes of reflection. The additional commands:

```
MP  13,  1, 2, 3, 1, 4, 7, 1, 6, 15, 1, 16, 11
*1, 1, 0, 1
CP 11, 10, 1, 0, 1
CP  3, 4, 1, 0, 1
CP  7, 6, 1, 0, 1
CP  15, 16, 1, 0, 1
```

would generate the outline of a spoked wheel.

The user could have substituted 5, 9, or 13 for point 1, 10 for 2, 8 for 4, 14 for 6, and 12 for 16 with the same result.

2.
```
DF WHEEL
PT  1  0.,  0.,  0.
PT  2  1.,  0.,  0.
RT  PT  2  1  45.
PT  4  0.,  1.,  0.
MP  6  1.,  2.,  3.,  1,  4,  3,  1,  0,  1
DE
RF  DF WHEEL  X Y  5
```

This example would generate not only identical points, but identical wire segments. These would eventually be detected during the search for multiple junctions and flagged as null segments.

RN

Renumber Operation

RN i1, i2, i3, ..., -in, in+2, ..., i

Parameter		Definition
RN	-	Renumber operation code.
$\left\{\begin{matrix} i1 \\ . \\ . \\ . \\ i \end{matrix}\right\}$	-	Integer numbers to control the resequencing of wire segment numbers.

When using the banded matrix iteration technique, it may be important to have the wire segments numbered correctly in order for the system to converge. When an RN operation is encountered, the wire segments which have been generated since the last RN are renumbered according to the sequence specified by the integers on the RN input. The resequencing will start with the first segment generated since the last RN operation. The segment numbers are changed to correspond to the integers on the input directive. When a negative integer is encountered, the sequence number of the next wire segment will be the absolute value of the negative integer and the sequence numbers will be incremented by 1 until the number of segments identified by the next input field have been sequenced.

Examples:

Suppose the user has generated segments 1 through 10 and wishes to renumber the segments:

RN 2 4 -5 , 5 , 1 , 3 , 10

Old Segment Numbers	1	2	3	4	5	6	7	8	9	10
New Segment Numbers	2	4	5	6	7	8	9	1	3	10

RT

Rotation Operation

$$RT\begin{Bmatrix} PT \\ TG \\ DF \end{Bmatrix}, \begin{Bmatrix} n \\ n \\ name \end{Bmatrix}, IADD, RX, RY, RZ, [INCTAG,][NCS]$$

Parameter		Definition
RT	-	Rotation operation code.
$\begin{Bmatrix} PT \\ TG \\ DF \end{Bmatrix}$	-	Two letter code designating point, tag or, defined element to be rotated.
$\begin{Bmatrix} n \\ n \\ name \end{Bmatrix}$	-	For PT and TG, n is the integer identifier; for DF, "name" is the alphanumeric name of the defined element.
IADD	-	Integer indicating the number of additional elements to be generated.
$\begin{Bmatrix} RX \\ RY \\ RZ \end{Bmatrix}$	-	*Rotation angles in degress* about the x, y, and z axis in the coordinate system NCS. (positive counterclockwise)
INCTAG	-	Tag increment for each additional element. (Default=0.)
NCS	-	Coordinate system identifier (Default NCS = last NCS specified)

The rotation operation can be used to generate objects which have axes of revolution. If the segments to be rotated are members of a defined element, the segment numbers of the original segments increment by the number of segments in the original defined element for each additional element. If the DF operation is still in effect, all segments and points generated will be members of the element being defined.

Examples:

```
RA  .01
DF  CONE
PT  1  0., 0., 0.
PT  2  1., 0., 10.
FT  3  0., 0., 10.
```

```
RT  PT  2,  1,  0,  0,  45.  $ ROTATE PT2 45° AROUND Z AXIS GENERATE PT4
MP  3  3  2  4  1  0  1  $ CONNECT PTS, 3, 2, 4
CP  2  1  10  $ CONNECT PTS 1 and 2 WITH 10 SEG OF RADIUS .01
RT  DF  CONE  7  0,  0,  315,  $ ROTATE BASIC SEGMENT TO COMPLETE CONE
DE
```

The RA command establishes the radius of all the segments generated. This is followed by the define element command. All points and segments generated from here to the next define end card will belong to the structure called CONE. The next 3 cards define the basic points, the result of which is shown in figure 4a. Then point a is rotated around the Z-axis to generate point 4. The next 2 cards connected these four points to define the basic structure of the element CONE. This is shown in figure 4b. This basic element is then rotated around the Z-axis and regenerated seven more times to define a wire-gridded cone. The DE card then closes the generation cards for CONE.

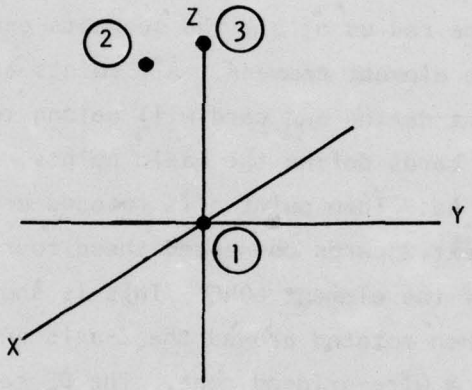


Figure 4a. Original Points 1, 2, 3

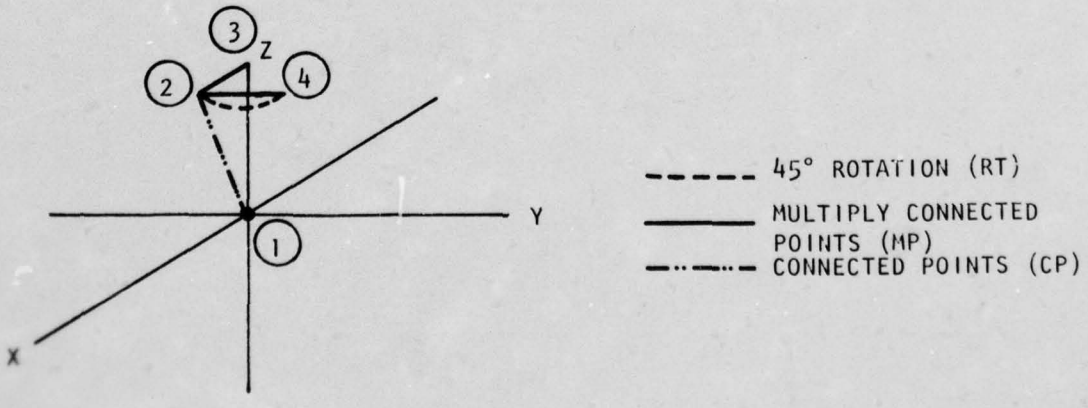
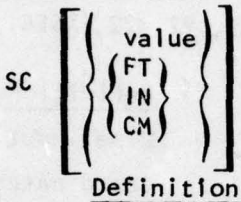


Figure 4b. RT, MP, CP Operations Defining Basic Element of CONE

SC

Scale Parameter



Parameter		Definition
SC	-	Scale specification code.
value FT IN CM	-	Value is the numeric value of the scale factor in meters/unit. FT, IN, CM are 2 letter codes that automatically scale the data from feet, inches, and centimeters to meters. (Default value=1)

The GEMACS code uses the MKS system of units. Unless specified otherwise, all geometry input is assumed to be in meters. When an SC input is read, all input until the next SC input is scaled to the new value.

Example:

SC FT

All subsequent data would be converted from feet to meters before being stored.

WR

Wire Input

WR X1, Y1, Z1, X2, Y2, Z2,[NSEG,][NTAG,][NRAD,][NCS]

Parameter		Definition
WR	-	Wire input designator.
{X1 Y1 Z1}	-	Coordinates of what will be considered the negative end of the wire segment.
{X2 Y2 Z2}	-	Coordinates of what will be considered the positive end of the wire segment.
NSEG	-	Number of segments the wire is to generate. (Default to previous NSEG entry of any operation.)
NTAG	-	Integer tag identifier of each segment. (Default to previous NTAG entry of any operation.)
NRAD	-	The location of the radius of each segment in the radii table. (Default to previous NRAD entry of any operation.)
NCS	-	Integer identifier of reference coordinate system. (Default to previous NCS entry of any operation.)

This is another method of inputting wire segment data into GEMACS. It will generate NSEG segments between (X1, Y1, Z1) and (X2, Y2, Z2) with tag identifiers of NTAG, of radius specified by NRAD, and if NCS is not equal to zero, (X1, Y1, Z1) and (X2, Y2, Z2) will be the end points in coordinate system NCS.

Example:

WR 1.63, 2.47, 3.67, 26.4, 16.3, 43., 10,,1,1

This would generate 10 segments with the default tag number and with the radius specified by the first radius entered previously. The end points would be transformed from coordinate system 1 before storing segment end points.

XL

Translation Operator

XL {PT / TG / DF}, {n / n / name}, IADD, DX, DY, DZ, [INCTAG,][NCS]

Parameter		Definition
XL	-	Translation operation code.
{PT / TG / DF}	-	Two letter code designating point, tag, or defined element to be translated.
{n / n / name}	-	For PT and TG, n is the integer identifier; for DF, "name" is the alphanumeric name of the defined element.
IADD	-	Integer indicating the number of additional elements to be generated.
{DX / DY / DZ}	-	Incremental translation vector.
INCTAG	-	Tag increment for each additional element. (Default=0.)
NCS	-	Coordinate system in which translation is to take place. (Default= last NCS value used.)

The translation operation will generate IADD additional segments identical to the segment specified. Each segment will be displaced from the original segment by (DX,DY,DZ) in the coordinate system indicated. If IADD is zero, the element is simply translated to a new location. The same function can be performed by defining a coordinate system at the new location and performing an AT (attach) operation.

Example:

```
RA  .01
PT   1 0. 0. 0
PT   2 0. 1. 0.
PT   3 0. 0. 1.
```

```
DF   GRID
MP   3  3  1  2  1  1
XL   DF   GRID   9 0. 1.
WR   0., 10., 0. , 0. , 10. , 1., 1
XL   DF  GRID  9  0. , 0. , 1. , 1.
WR   0., 0., 10. , 0., 10., 10., 10
DE
```

The MP input would create segments 1 and 2 illustrated in figure 5(a). The first XL operation would create segments 3 through 20 and the WR operation would result in segment 21 of figure 5(b). The second XL operation would generate segments 22 through 210 and the WR operation would close the grid with segments 211 through 220 as illustrated in figure 5(c). Future references to GRID would reference segments 1 through 220.

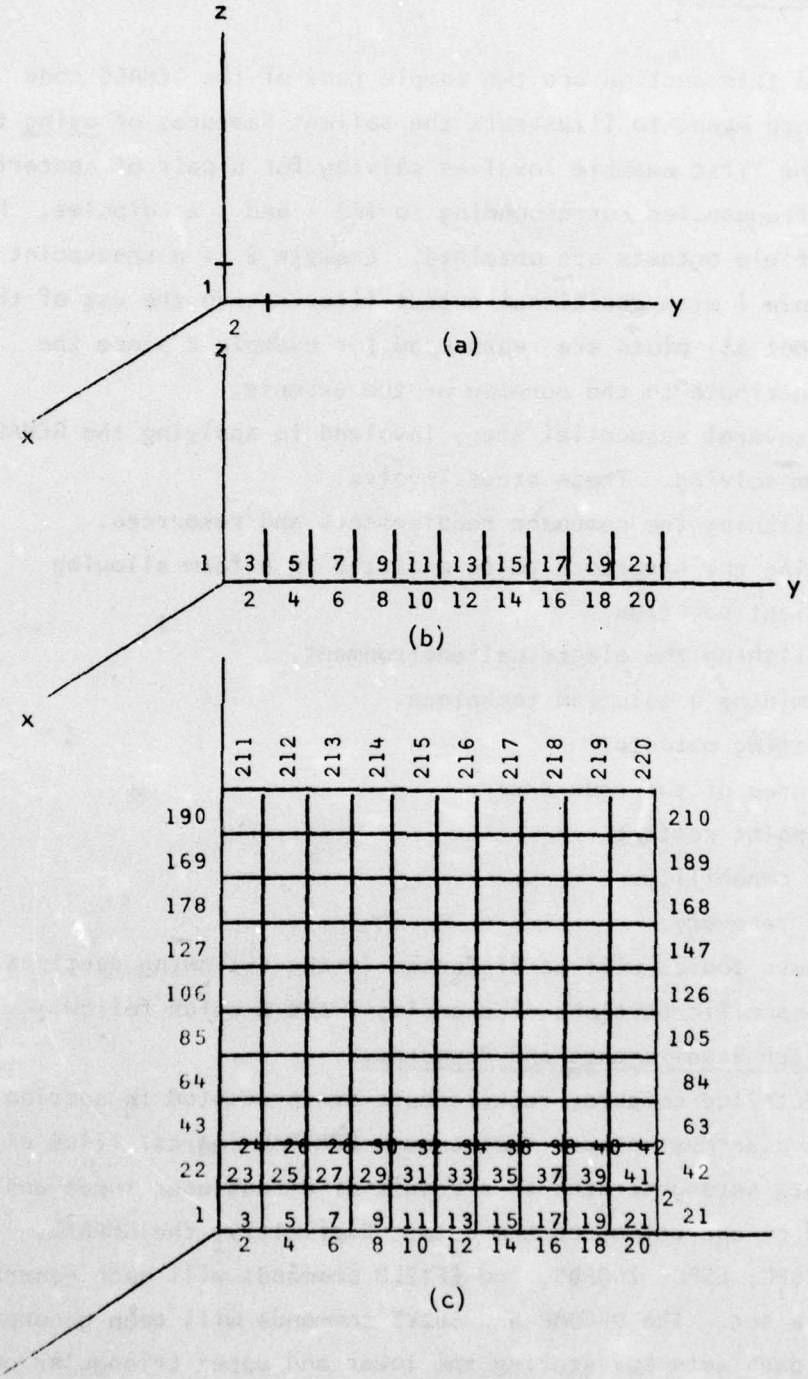


Figure 5. Wire Grid

D. GEMACS APPLICATION

Included in this section are two sample runs of the GEMACS code. These examples are meant to illustrate the salient features of using the GEMACS code. The first example involves solving for a pair of centerfed dipoles at two frequencies corresponding to 1/2 λ and 1 λ dipoles. Far field and near field outputs are obtained. Example 2 is a checkpoint restart of example 1 with additional output illustrating the use of the DEBUG option. Not all plots are reproduced for example 2 since the plots do not contribute to the purpose of the example.

There are several sequential steps involved in applying the GEMACS code for problem solving. These steps involve:

(1) Establishing the computer requirements and resources.
(2) Defining the structure to be analyzed in a form allowing efficient solution.
(3) Establishing the electrical environment.
(4) Determining a solution technique.
(5) Requesting outputs.

Additional features of the code are:

(1) Checkpoint restart.
(2) Debug capability.
(3) Error recovery.

Each of these topics will be discussed in the following sections and related to specific portions of examples 1 and 2 which follow.

1. Computer Requirements and Resources

The detailed computer requirements are presented in section E. In general, the user must assure that enough FORTRAN logical files exist to store the data sets generated as a result of direct user input and those generated by operations on the data. Explicitly, the GMDATA, BACSUB, ZGEN, VSRC, ESRC, ZLOADS, and EFIELD commands will each generate a resultant data set. The DECOMP and SOLVE commands will each generate two additional data sets for storing the lower and upper triangular components of the decomposed matrix. The user may minimize the peripheral file requirement by use of the PURGE operation on data sets no longer required. The data set may be regenerated at a later time; as in a

LOOP/LABEL set of instructions, and may be reassigned to another available logical unit. The number of logical units available is specified by use of the NUMFIL = n arithmetic operation. If no operation is specified, the installation default is assumed (i.e., the value of the variable NFILES in subroutine BLKDAT). This is further discussed in section E.1.

In order to make use of the checkpoint/restart and CPU time limit error recovery, the user must specify a time limit. This is done by use of the TIME = n arithmetic operation. This feature requires the presence of a FORTRAN library function to return the elapsed CPU time as discussed in section E.3. When this feature is available and the TIME = n statement has been used, GEMACS will automatically terminate when the specified time limit has been exceeded. The user should assure that the time limit specified to the GEMACS code is less than that requested by the job control cards. There is no way for GEMACS to know the actual time remaining. Since this is the case, GEMACS could, if TIME is set less than the value of the control card, call subroutine ERROR and write a checkpoint to save all the current data. If this is not done, when the time on the control card is reached, the computer system will terminate the uncompleted run and the user will need to start from the beginning on a subsequent run.

The final GEMACS resource required by the user is the presence of a checkpoint file. This is accomplished by use of the CHKPNT command. If a CHKPNT command is present in the input stream, the availability of the checkpoint file is established during execution. This allows a checkpoint to be written in the event of an internally detected fatal error or an attempt to exceed the specified CPU time limit. The error may occur in a command prior to the CHKPNT command, however, the availability of the checkpoint file is established before execution begins.

The computer resources and requirements are contained in cards 14, 15, and 52 in example 1. The last card establishes a checkpoint file, and the NR option will allow GEMACS to write a checkpoint if an internal fatal error is encountered.

Example 2 does not contain any resource cards, whose presence would update those data specified in example 1. Consequently, the time

BEST AVAILABLE COPY

statistics for the second example will be added to those of the first run. Therefore, both examples must be executed within the time limit specified on card 15 of example 1. If not, an internally generated fatal error will occur.

The computer resource data are output to the user at the beginning of the execution report. They are given in the following format:

```
GEMACS TASK EXECUTION STARTED ON  11/10/76  AT  12.06.50.

NUMBER OF PERIPHERAL FILES AVAILIBLE    16

RUN TIME SET TO     5.00     CPU MINUTES
```

It should be noted that the "number" specified for the number of peripheral files available is the integer of the highest-numbered contiguous unit, which may not be the same as a number count of files. This is due to the fact that units 3 and 4 are, in general, not required for the execution of GEMACS, as can be seen from table 3 in section E of this manual.

When it is time for a checkpoint, either as a result of a command-level CHKPNT or as a result of a specified elapsed time since the beginning of program execution, the following printout is generated.

```
CHECKPOINT NUMBER      2 STARTED AT TIME          .596
COMMON BLOCK ADDRUS WRITTEN OUT TO IOCKPT
COMMON BLOCK AMPZIJ WRITTEN OUT TO IOCKPT
COMMON BLOCK ARCOM WRITTEN OUT TO IOCKPT
COMMON BLOCK CSYSTM WRITTEN OUT TO IOCKPT
COMMON BLOCK DEFDAT WRITTEN OUT TO IOCKPT
COMMON BLOCK FLOGIC WRITTEN OUT TO IOCKPT
COMMON BLOCK GENDAT WRITTEN OUT TO IOCKPT
COMMON BLOCK IOFILS WRITTEN OUT TO IOCKPT
COMMON BLOCK JUMCOM WRITTEN OUT TO IOCKPT
COMMON BLOCK PARTAB WRITTEN OUT TO IOCKPT
COMMON BLOCK SCRPAD WRITTEN OUT TO IOCKPT
COMMON BLOCK SEGMNT WRITTEN OUT TO IOCKPT
COMMON BLOCK SYMSTR WRITTEN OUT TO IOCKPT
COMMON BLOCK SYSFIL WRITTEN OUT TO IOCKPT
COMMON BLOCK TEMP01 WRITTEN OUT TO IOCKPT
PERIPHERAL FILE      8   SYMBOL ADIROL NUMREC=   40
PERIPHERAL FILE      9   SYMBOL ZLJYDP NUMREC=   40
PERIPHERAL FILE     10   SYMBOL BADFIJ NUMREC=   40
PERIPHERAL FILE     11   SYMBOL ONESEC NUMREC=    1
PERIPHERAL FILE     15   SYMBOL        I NUMREC=    1
PERIPHERAL FILE     12   SYMBOL XERFLO NUMREC=    4
PERIPHERAL FILE     13   SYMBOL BADLAB NUMREC=   40
PERIPHERAL FILE     14   SYMBOL ENDLAB NUMREC=   10
CHECKPOINT COMPLETE AT          .598
ELAPSED TIME=          .011
NUMBER OF WORDS WRITTEN =     49715
```

This block of data specifies to the user the sequential number of the checkpoint, the time in minutes since beginning of execution at which the checkpoint is being taken, the common blocks and files written out to the checkpoint tape (along with the number of records for the latter), the time at which the checkpoint was written, the time it took to write the checkpoint, and the cumulative number of words written on the checkpoint tape for all checkpoints written since the last rewind command.

2. Structure Representation

GEMACS is a code designed primarily for the analysis of electrically large structures. Relatively small structures requiring approximately 100 unknowns will also be solved efficiently and standard modeling techniques may be used. However, the model representation of large structures requiring the use of the BMI solution technique imposes some restrictions. A detailed collection of experience gained during the development of BMI is presented in Volume II, GEMACS Engineering Manual. General guidelines are presented in section C.2. The renumbering command (RN) has been implemented to support those geometry modeling requirements peculiar to the use of the BMI solution technique. Geometry generation is initiated by the GMDATA command. Upon processing this command, the input stream following the first END card is read as geometry data and is expected to conform to the geometry command format presented in section C.3. The presence of any nongeometry input before the next END card will cause a fatal error and subsequent error action to occur. There are installation limits on the number of wire segments, points, defined elements, and coordinate systems available to model a structure. These are discussed in section E.2 of this manual. Requirements for expanding or contracting these parameters are also discussed in section E.2.

The geometry data set is the basic source of data for many other GEMACS commands. It must be available before an impedance, excitation, load, or output data set can be generated. Additionally, the accuracy of the results are extremely dependent on the applicability of the structure representation for the analysis being performed. Again, the reader is urged to be familiar with the results of developmental efforts presented in Volume II, GEMACS Engineering Manual.

Card 17 of example 1 will initiate the Geometry Input Processor. The geometry data are contained in cards 64 to 76. In general, the radius cards are input first listing the radii of the wires. Then, for this problem, a point is generated and translated to the location of an end point of wire 1. This point is then rotated around the origin to generate the end points for the second wire and the other end point for the first wire. The results of these operations are shown in figure 6a. The end points are then connected to the origin to generate the arms of the crossed dipoles, as shown in figure 6b. This figure also indicates the segment numbering on the arms.

Then the arms are renumbered to spiral outward from the intersection of the wires. This is done to increase the efficiency of the BMI solution process as discussed in section C.5 of volume II, the engineering manual. The renumbered geometry is indicated in figure 6c.

Once GEMACS has processed all of the geometry input, determined connections and junctions, and converted the data to center point and direction angle format, the contents of the segment table (SEGTBL) are printed out in the following format.

Reading the columns from left to right, the following information is available:

(1) The tag number for each segment.

(2) The X-coordinates for end 1, center point, and end 2 of the segment.

(3) The Y-coordinates for end 1, center point, and end 2 of the segment.

(4) The Z-coordinates for end 1, center point, and end 2 of the segment.

(5) The radius of each segment in meters.

(6) The length of each segment in meters.

(7) The lowest numbered segment connected to end 1 of the segment. The preceding negative sign would indicate end 1 of the segment making the connection, while no sign would indicate end 2 being connected to this segment.

(8) The segment number. A zero in this column would indicate that this segment is identical to a preceding segment in the list.

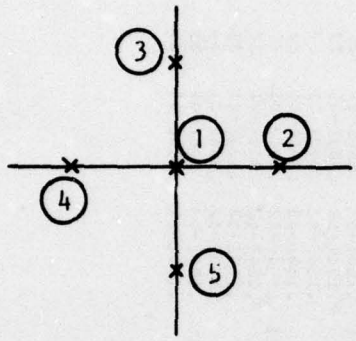


Figure 6a. Location of Points

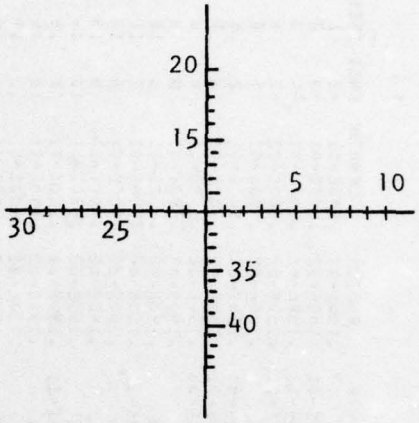


Figure 6b. Original Numbering Scheme

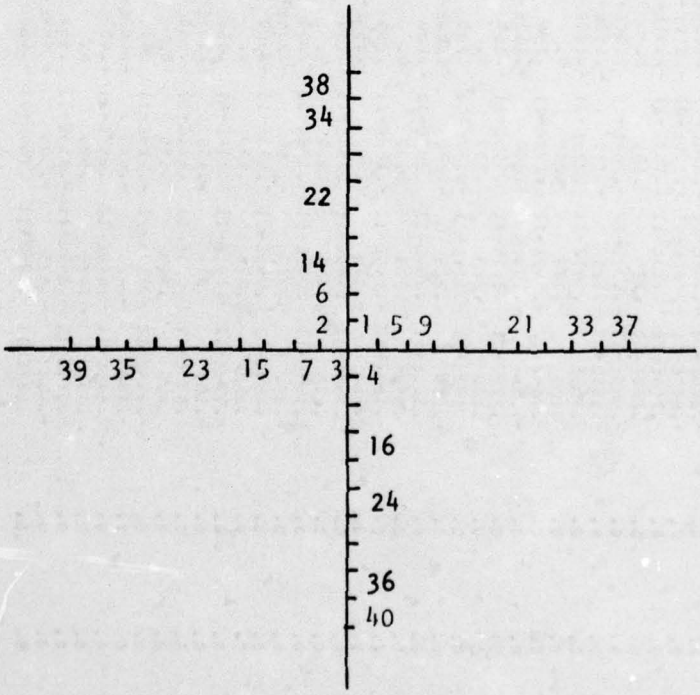


Figure 6c. Renumbered Segment Scheme

BEST AVAILABLE COPY

SEGMENT DATA

TAG	XN	XC	XP	YN	YC	YP	ZN	ZC	ZP	RADIUS	LENGTH	END1	ISEG	END2
1	0.	0.	0.	0.	.250E-01	.500E-01	0.	0.	0.	.150E-02	.500E-01	-2	1	-5
2	0.	0.	0.	0.	-.127E-12	-.255E-12	0.	.250E-01	.500E-01	.150E-02	.500E-01	-3	2	-6
3	0.	0.	0.	0.	-.250E-01	-.500E-01	0.	-.255E-12	-.510E-12	.150E-02	.500E-01	-4	3	-7
4	0.	0.	0.	0.	.382E-12	.764E-12	0.	-.250E-01	-.500E-01	.150E-02	.500E-01	-1	4	-8
1	0.	0.	0.	.500E-01	.750E-01	.100E+00	0.	0.	0.	.150E-02	.500E-01	1	5	-9
2	0.	0.	0.	-.255E-12	-.382E-12	-.510E-12	.500E-01	.750E-01	.100E+00	.150E-02	.500E-01	2	6	-10
3	0.	0.	0.	-.500E-01	-.750E-01	-.100E+00	-.510E-12	-.764E-12	-.102E-11	.150E-02	.500E-01	3	7	-11
4	0.	0.	0.	.764E-12	.115E-11	.153E-11	-.500E-01	-.750E-01	-.100E+00	.150E-02	.500E-01	4	8	-12
1	0.	0.	0.	.100E+00	.125	.150	0.	0.	0.	.150E-02	.500E-01	5	9	-13
2	0.	0.	0.	-.510E-12	-.637E-12	-.764E-12	.100E+00	.125	.150	.150E-02	.500E-01	6	10	-14
3	0.	0.	0.	-.100E+00	-.125	-.150	-.102E-11	-.127E-11	-.153E-11	.150E-02	.500E-01	7	11	-15
4	0.	0.	0.	.153E-11	.191E-11	.229E-11	-.100E+00	-.125	-.150	.150E-02	.500E-01	8	12	-16
1	0.	0.	0.	.150	.175	.200	0.	0.	0.	.150E-02	.500E-01	9	13	-17
2	0.	0.	0.	-.764E-12	-.892E-12	-.102E-11	.150	.175	.200	.150E-02	.500E-01	10	14	-18
3	0.	0.	0.	-.150	-.175	-.200	-.153E-11	-.178E-11	-.204E-11	.150E-02	.500E-01	11	15	-19
4	0.	0.	0.	.229E-11	.267E-11	.305E-11	-.150	-.175	-.200	.150E-02	.500E-01	12	16	-20
1	0.	0.	0.	.200	.225	.250	0.	0.	0.	.150E-02	.500E-01	13	17	-21
2	0.	0.	0.	-.102E-11	-.115E-11	-.127E-11	.200	.225	.250	.150E-02	.500E-01	14	18	-22
3	0.	0.	0.	-.200	-.225	-.250	-.204E-11	-.229E-11	-.255E-11	.150E-02	.500E-01	15	19	-23
4	0.	0.	0.	.305E-11	.344E-11	.382E-11	-.200	-.225	-.250	.150E-02	.500E-01	16	20	-24
1	0.	0.	0.	.250	.275	.300	0.	0.	0.	.150E-02	.500E-01	17	21	-25
2	0.	0.	0.	-.127E-11	-.140E-11	-.153E-11	.250	.275	.300	.150E-02	.500E-01	18	22	-26
3	0.	0.	0.	-.250	-.275	-.300	-.255E-11	-.280E-11	-.306E-11	.150E-02	.500E-01	19	23	-27
4	0.	0.	0.	.382E-11	.420E-11	.458E-11	-.250	-.275	-.300	.150E-02	.500E-01	20	24	-28
1	0.	0.	0.	.300	.325	.350	0.	0.	0.	.150E-02	.500E-01	21	25	-29
2	0.	0.	0.	-.153E-11	-.166E-11	-.178E-11	.300	.325	.350	.150E-02	.500E-01	22	26	-30
3	0.	0.	0.	-.300	-.325	-.350	-.306E-11	-.331E-11	-.357E-11	.150E-02	.500E-01	23	27	-31
4	0.	0.	0.	.458E-11	.496E-11	.535E-11	-.300	-.325	-.350	.150E-02	.500E-01	24	28	-32
1	0.	0.	0.	.350	.375	.400	0.	0.	0.	.150E-02	.500E-01	25	29	-33
2	0.	0.	0.	-.178E-11	-.191E-11	-.204E-11	.350	.375	.400	.150E-02	.500E-01	26	30	-34
3	0.	0.	0.	-.350	-.375	-.400	-.357E-11	-.382E-11	-.408E-11	.150E-02	.500E-01	27	31	-35
4	0.	0.	0.	.535E-11	.573E-11	.611E-11	-.350	-.375	-.400	.150E-02	.500E-01	28	32	-36
1	0.	0.	0.	.400	.425	.450	0.	0.	0.	.150E-02	.500E-01	29	33	-37
2	0.	0.	0.	-.204E-11	-.217E-11	-.229E-11	.400	.425	.450	.150E-02	.500E-01	30	34	-38
3	0.	0.	0.	-.400	-.425	-.450	-.408E-11	-.433E-11	-.459E-11	.150E-02	.500E-01	31	35	-39
4	0.	0.	0.	.611E-11	.649E-11	.687E-11	-.400	-.425	-.450	.150E-02	.500E-01	32	36	-40
1	0.	0.	0.	.450	.475	.500	0.	0.	0.	.150E-02	.500E-01	33	37	0
2	0.	0.	0.	-.229E-11	-.242E-11	-.255E-11	.450	.475	.500	.150E-02	.500E-01	34	38	0
3	0.	0.	0.	-.450	-.475	-.500	-.459E-11	-.484E-11	-.510E-11	.150E-02	.500E-01	35	39	0
4	0.	0.	0.	.687E-11	.725E-11	.764E-11	-.450	-.475	-.500	.150E-02	.500E-01	36	40	0

(9) The lowest numbered segment connected to end 2 of this segment. The same convention regarding the negative sign applies as for end 1 of this segment.

3. Electrical Environment

The electrical environment of the structure to be analyzed includes the effects of loads, external or incident fields, voltage driven or antenna source segments, and the ground parameters.

Once a structure has been defined geometrically, the electrical parameters affecting its response to an external field or voltage driven element may be specified. There are three user definable parameters. These are the frequency (FRQ), ground conductivity (COND), and relative dielectric constant of the ground (EPSR).

The frequency may be specified on a ZGEN, ZLOADS, ESRC, or VSRC command. Alternately, and perhaps more directly, it may be set by the arithmetic operation FRQ = MHz. All subsequent electrical functions will use the last value specified or calculated for the frequency. In order for GEMACS results to be meaningful, all sources must be at the same frequency.

The ground environment is specified by the COND and EPSR parameters which may be set directly in an arithmetic operation or specified on the ZGEN command entry. If no ground parameters are specified, a free space environment is assumed. The presence of a negative conductivity (COND) implies a perfect ground and the value of EPSR is ignored. The ground environment must be established prior to the generation of the impedance matrix and the specification of field sources. Failure to do so will result in the ground interactions and reflections being ignored.

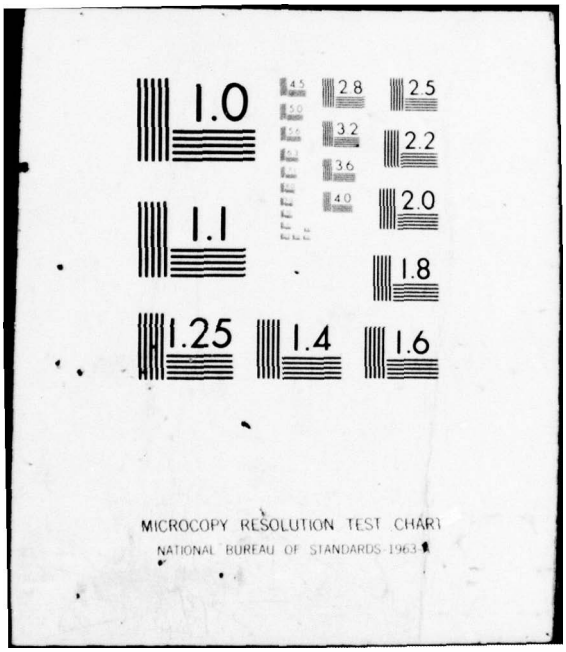
A detailed discussion of the ground representation and computational approximation may be found in section B.2 in Volume II, GEMACS Engineering Manual and its references. The primary restriction imposed by the ground model on the geometry model is that wire segments should not be at acute angles to the ground plane when their midpoints are less than a segment length from the ground plane. Antenna source segments connected to the ground plane are particularly sensitive to the ground model. Inadequacies of the geometry/ground model interaction will usually be indicated by a negative input impedance of antenna source segments in near electrical proximity to the ground plane.

AD-A040 026 BDM CORP ALBUQUERQUE N MEX F/G 20/3
GENERAL ELECTROMAGNETIC MODEL FOR THE ANALYSIS OF COMPLEX SYSTE--ETC(U)
APR 77 R J BALESTRI, T R FERGUSON F30602-74-C-0182
UNCLASSIFIED RADC-TR-77-137-VOL-1 NL

2 OF 2
AD
A040026

END

DATE
FILMED
6-77


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

GEMACS employs both external and internal excitation of structures. The external excitation includes both spherical and plane elliptically polarized waves. The internal excitation is specified as a voltage applied to a wire segment. This voltage is converted to an electric field at the segment midpoint using a delta gap excitation as discussed in volume II. All segments driven by a voltage source are considered as antenna sources and as such will have the power and impedance of the segment computed after the structure currents have been obtained. Multiple sources will be superimposed if they have the same frequency.

The structure may be loaded with series or parallel combinations of resistors, inductors, and capacitors. All ZLOADS commands are cumulative for the same resultant or load data sets for a given frequency. The power dissipated in all loads will be displayed after the structure currents have been obtained.

In example 1, the frequency is initially set at 300 MHz directly in an arithmetic operation by card 16. After the fields have been calculated at this frequency, the frequency is then doubled to 600 MHz at card 53 by another arithmetic operation. Note that since this card is within a LOOP/LABEL loop it is executed again after the fields have been computed, and the frequency at this time is now 1200 MHz.

Also note that the excitation cards 24 and 25 are located within this same loop. The first command places a voltage $V_1 = 0.5 + j0.0$ on segments 1 and 3 (figure 5c), and the second command excites segments 2 and 4 with $V_2 = 0.0 + j0.5$. All of these excitations are placed in the file ANTSRC. When executing the loop the second time the file ANTSRC is reinitialized to zero before the data are loaded since the frequency has changed from 300 to 600 MHz.

Due to the nature of the problem, no other electrical characteristics are required as input. However, it must be kept in mind that if the structure were loaded, the ZLOADS card must precede the ZGEN command.

In example 2 the excitation data are also recomputed. This is not strictly necessary since the field on the excited segment is computed using the physical length of the segment. However, recomputation is required if the driving function is an external field since this has a strong dependency on the frequency.

BEST AVAILABLE COPY

In the case in which both external and internal sources are present both must be recalculated since entering the excitation driver for the external source will zero out the previous excitation (due to the change in frequency) and therefore automatically wipe out the internal source.

GEMACS will list out the frequency at which the analysis is being performed as well as any ground parameters (none for this example), the excitation driving the structure, and the load if any is present. The format for this is:

```
FREQUENCY SET TO      300.      MEGAHERTZ
WAVLENGTH      .999      METERS


EXCITE GEOMETRY DATA XDIPOL
EXCITATION VOLTGE
EXCITATION DATA ANTSRC


REAL COMP      .500      IMAG COMP      0.
EXCITED   SEGS
   1     3
EXCITE GEOMETRY DATA XDIPOL
EXCITATION VOLTGE
EXCITATION DATA ANTSRC


REAL COMP      0.        IMAG COMP      .500
EXCITED   SEGS
   2     4
```

Once the electrical environment has been established, the solution for the electrical currents flowing on the structure at the frequency specified may be obtained.

4. Solution Technique

Once the impedance matrix [Z] has been generated in response to a ZGEN command and the structure excitation [E] is complete, the solution to the system of simultaneous linear equations represented in matrix form as:

$$[Z]\ [I] = [E]$$

may be obtained using either full matrix decomposition or by employing the BMI solution technique. The choice of the solution technique is

usually dictated by the size of the problem and the suitability of the geometry model. The code is capable of performing full matrix decomposition, as well as the BMI, to obtain the solution. The first method is preferred for smaller problems (less than 100 unknowns) or problems that are ill-posed for BMI to converge. This latter condition may occur when the geometry numbering scheme excludes a fair number of near-neighbor interactions from the band or when the structure has a high Q resonance near the specified frequency. Under these circumstances, the sensitive outputs (source impedance, power) may be considerably in error due to the poor condition of the impedance matrix. This will generally be indicated by a large pivot ratio (greater than 10^4) encountered during decomposition. The implications of those events is usually the failure of the iterative scheme to converge or to converge very slowly. In these cases, the SOLVE command or a combination of the LUD and BACSUB Commands is the only alternative to completely redefining the problem. However, it may occur that the full matrix solution will result in the detection of a singular matrix due to the lack of pivoting in the current release. When this occurs, the problem is not amenable to solution in the current electromagnetic environment with this release of GEMACS.

Prior to using the BMI technique, the impedance matrix must be banded by use of the BAND command and the user must direct the decomposition of the banded resultant matrix with the LUD command. The use of SOLVE does not require a previously decomposed matrix.

A detailed discussion of the knowledge gained during development of the BMI solution technique is presented in volume II, section C. Results are presented there and in its references showing the range of applicability of BMI, methods of numbering various shapes of geometry, and recommendations for determining the width of the band as a function of the object's dimensions.

In example 1 the ZGEN command is given in card 22, and it is located within the loop since a change in frequency requires the recomputation of the elements within the interaction matrix. Note that it may appear before or after the excitation commands, but must appear after the ZLOADS cards and all other cards providing electrical data.

Note that the ZGEN command must also be present in the input stream in example 2. This is due to the fact that the frequency has changed to 1200 MHz because of card 53 in example 1.

For the purposes of illustration, the examples use the BMI technique to obtain a solution. Since the structure is small, the full matrix decomposition could have been used just as efficiently. Note that in these examples the BAND command precedes, as it must, the LUD command which must, in turn, precede the BMI command. Therefore, at card 30 in example 1 and card 16 in example 2 the currents on the crossed dipoles are obtained.

GEMACS will output to the user the name of the impedance matrix, the basis function used, the name of the geometry data set as well as the name of the load data set, and the electrical parameters of the system. Then the printout will consist of informative messages relating to band dominance (showing the ratio of the norm of the numbers in a column within the band to the norm of the numbers in that column out of the band), the band norm, and the column norm. (The ratio of these last two norms yields the band dominance factor.) A history of the iterative process is also printed out showing the number of iterations predicted to be needed for convergence (0 for the first four iterations) and the values of the various convergence criteria. In this case the criterion chosen was a PRE value of 5 percent. The final values are shown once convergence has been achieved (PRE equal to 2.29 percent for this case). The output format is as follows:

```
FILL IMPEDANCE MATRIX ZIJXDP
USING BASIS FUNCTION  SINCOS
ON GEOMETRY DATA SET  XDIPOL
LOADS(IF SPECIFIED)IN
FREQUENCY(MEGAHERTZ)     300.00
GROUND COND (MHOS/M)     0.
RELATIVE PERMITTIVITY    1.0000


EXTRACT BNDZIJ FROM ZIJXDP BANDWIDTH    10

AT COLUMN     20 BAND NORM=     .3343E+05 COLUMN NORM=     .3343E+05
BAND DOMINANCE FACTOR=     .2331E+05
```

BEST AVAILABLE COPY

BEST AVAILABLE COPY

```
DECOMPOSE BNDZIJ STORE RESULT IN BNDZIJ PIVOT=      N

MAX DIAG =   47937.      MIN DIAG =   3952.9
PIVOT RATIO =      12.13

BMI SOLUTION TO- BNDZIJ*      I=ANTSRC-ZIJKDP*      I

MAXITR=  10 CONVRG ON PRE    AT   5.0 PERCENT

ITERATION     1 PRED CONV IN    0 ITERATIONS
PRE=   100.00 IRE=  100.00 BCRE=    15.94
ITERATION     2 PRED CONV IN    0 ITERATIONS
PRE=    52.46 IRE=   72.43 BCRE=     7.15
ITERATION     3 PRED CONV IN    0 ITERATIONS
PRE=    10.61 IRE=   27.99 BCRE=     3.07
ITERATION     4 PRED CONV IN    0 ITERATIONS
PRE=     5.75 IRE=   12.68 BCRE=     1.31

CONVERGENCE REACHED

FINAL VALUES-- PRE      2.29 IRE      5.36 BCRE       .57
```

5. Outputs

After the electrical currents have been obtained, the GEMACS code recovers the geometry, load, and source data associated with the currents. It will then compute the impedance, admittance, and power for all voltage driven (antenna source) and loaded elements. Unless specifically directed, no other output will occur. Additional output is obtained by using the PRINT, WRITE, and EFIELD commands.

The PRINT and WRITE commands may be used to obtain a list of the currents on the structure as well as the contents of any data set. The PRINT command lists the entire contents of a data set, while the WRITE command lists those data specifically requested by the user. The latter could be used to print out a limited set of elements of the interaction matrix if the currents look questionable to the user.

The EFIELD command will result in the computation of the near or far electric fields. The output will list the vector components of the field and optionally plot the magnitudes as directed. The near field will be determined for Cartesian, cylindrical, or spherical coordinates. The use of spherical coordinates with the radius parameter omitted will result in the far field being computed. This is the only mechanism to control near and far field output.

The following is the only data output by GEMACS without being specifically requested by the user.

ANTENNA/LOAD PARAMETERS

SEGMENT	IMP(MAG)	IMP(PHZ)	PWR INPUT	PWR LOAD
1	2164.976	-.009	.494E-04	0.
2	1067.138	-.021	.395E-04	0.
3	2121.987	-.009	.504E-04	0.
4	1071.208	-.021	.404E-04	0.

This gives the number of the segment either loaded or driven, the magnitude and phase of its input impedance, the power input to the driven element in watts, and the power into the load connected to the segment (none are present in this example).

The PRINT command results in the following data being printed for the source vector (ANTSRC) and the current vector (I).

SYMBOL I

LINEAGE- RNDZIJ-ZIJKDP-KDIPOL-
COMPLX DATA

	REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)		REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)
1	.1979E-03	.1194E-03	.2311E-03	31.11	2	-.4409E-03	.1594E-03	.4686E-03	160.1
3	.2019E-03	.1219E-03	.2358E-03	31.12	4	-.4382E-03	.1617E-03	.4671E-03	159.7
5	-.1459E-03	-.8652E-04	.1440E-03	-143.6	6	-.1544E-03	.5127E-03	.5355E-03	106.8
7	-.1121E-03	-.6294E-04	.1286E-03	-149.5	8	-.1515E-03	.5150E-03	.5369E-03	106.4
9	-.4916E-03	-.2248E-03	.4997E-03	-150.7	10	.8846E-04	.8163E-03	.8211E-03	83.74
11	-.3975E-03	-.2220E-03	.4554E-03	-150.6	12	.9233E-04	.8184E-03	.8234E-03	83.56
13	-.6242E-03	-.3044E-03	.7012E-03	-153.8	14	.2841E-03	.1034E-02	.1077E-02	74.70
15	-.6[illegible]E-03	-.3068E-03	.6974E-03	-153.9	16	.2854E-03	.1040E-02	.1078E-02	74.66
17	-.7819E-03	-.3488E-03	.8561E-03	-156.0	18	.[illegible]E-03	.1161E-02	.1238E-02	69.85
19	-.7796E-03	-.3459E-03	.8529E-03	-156.1	20	.3352E-03	.1183E-02	.1230E-02	69.57
21	-.8466E-03	-.3472E-03	.9146E-03	-157.7	22	.3062E-03	.1175E-02	.1214E-02	69.44
23	-.8444E-03	-.3446E-03	.9116E-03	-157.8	24	.3126E-03	.1179E-02	.1219E-02	69.68
25	-.8153E-03	-.3110E-03	.8726E-03	-159.1	26	.3038E-03	.1073E-02	.1115E-02	64.77
27	-.8138E-03	-.3086E-03	.8704E-03	-159.2	28	.3093E-03	.1074E-02	.1118E-02	64.74
29	-.8910E-03	-.2965E-03	.9394E-03	-160.4	30	.4419E-03	.9804E-03	.9973E-03	63.68
31	-.8903E-03	-.2947E-03	.9378E-03	-160.5	32	.4473E-03	.9813E-03	.9985E-03	63.65
33	-.4835E-03	-.1612E-03	.5097E-03	-161.6	34	.3218E-03	.6546E-03	.6[illegible]E-03	61.97
35	-.4[illegible]E-03	-.1601E-03	.5047E-03	-161.7	36	.3214E-03	.6508E-03	.6[illegible]E-03	61.85
37	-.1965E-03	-.6[illegible]E-04	.2069E-03	-162.7	38	.1[illegible]E-03	.2[illegible]E-03	.2[illegible]E-03	60.[illegible]
39	-.1983E-03	-.6086E-04	.2085E-03	-162.8	40	.1355E-03	.2363E-03	.2709E-03	60.42

BEST AVAILABLE COPY

```
**********
SYMBOL ANTS=C

 LINEAGE= XDIPOL=
COMPLX DATA

**********

COLUMN=  1
```

	REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)		REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)
1	-10.00	0.	10.00	180.0	2	0.	-10.00	10.00	-90.00
3	-10.00	0.	10.00	180.0	4	0.	-10.00	10.00	-90.00
5	0.	0.	0.	0.	6	0.	0.	0.	0.
7	0.	0.	0.	0.	8	0.	0.	0.	0.
9	0.	0.	0.	0.	10	0.	0.	0.	0.
11	0.	0.	0.	0.	12	0.	0.	0.	0.
13	0.	0.	0.	0.	14	0.	0.	0.	0.
15	0.	0.	0.	0.	16	0.	0.	0.	0.
17	0.	0.	0.	0.	18	0.	0.	0.	0.
19	0.	0.	0.	0.	20	0.	0.	0.	0.
21	0.	0.	0.	0.	22	0.	0.	0.	0.
23	0.	0.	0.	0.	24	0.	0.	0.	0.
25	0.	0.	0.	0.	26	0.	0.	0.	0.
27	0.	0.	0.	0.	28	0.	0.	0.	0.
29	0.	0.	0.	0.	30	0.	0.	0.	0.
31	0.	0.	0.	0.	32	0.	0.	0.	0.
33	0.	0.	0.	0.	34	0.	0.	0.	0.
35	0.	0.	0.	0.	36	0.	0.	0.	0.
37	0.	0.	0.	0.	38	0.	0.	0.	0.
39	0.	0.	0.	0.	40	0.	0.	0.	0.

The data are preceded by an informative message giving the symbol name, the links to other symbols, and the data type. Since these data are complex, the real, imaginary, magnitude, and phase are given for the current (amperes) and the excitation (volts/meter) on each segment. Had the data been real, the format would have called for ten values to be printed across the page.

The EFIELD command results in the printing of an initial heading of the following form:

```
E-FIELD MATRIX       I
SPHERICAL COORDINATE SYSTEM

FAR FIELD FOR        FIELD DATA=NOPCOD -CURRENT DATA=     I -GEOMETRY DATA=XDIPOL
NORMALIZATION FACTOR    .136     V/M
```

BEST AVAILABLE COPY

This states that the E-field data have been derived for the current stored in symbol I and that they are given in the spherical coordinate system. The far field is being output, and since no symbol for storage was specified on the command, the storage symbol is given as NOPCOD. Had a symbol been given and storage requested, then the symbol would have been listed here. This can be seen for the near field data, where the symbol is specified as NERFLD. Also listed are the symbols for the current data and the geometry data. This is followed by the normalization factor, which is applicable to all the field points computed, not just those for a particular ϕ and separation distance.

GEMACS then prints out the tabulated and graphical field data for each set of ϕ and distance as a function of theta. The tabulated data are the magnitude and phase of each component of the electric field as a function of theta. The normalized values are derived by finding the magnitude of the total field at a point, dividing by the normalization factor (0.136 v/m) in this case, and then finding 20 $\log_{10}$ of that ratio.

The plots provided with this release of GEMACS serve to show qualitatively the nature of the beam pattern. They can be useful for quickly detecting anomalies, deep nulls, or unexpected shifts in the direction of the main beam. As explained in the discussions of the EFIELD command, the axes are unlabeled and the references depend on the most rapidly varying coordinate and the coordinate system being utilized.

The user should also be aware that the coupling between pairs of antennas may be obtained from the data output by GEMACS. The coupling may be obtained by calculating:

$$10 \log_{10} \frac{\text{PWR LOAD}}{\text{PWR INPUT}}$$

6. Checkpoint Restart

GEMACS is structured to write a checkpoint at specified time intervals, on command, or on detection of a fatal error during execution of any command. In order to recover from a checkpoint, the RSTART command has been provided. The restart action is straightforward; on encountering the RSTART command in the input stream, all previous input is overwritten with the contents of the checkpoint file. After the

checkpoint file has been read, additional commands may be processed. These commands will be concatenated to the commands for the run which generated the checkpoint file. The END command present in the initial input stream is ignored. All original commands which were executed prior to the checkpoint will be ignored and processing will start at the instruction being executed when the checkpoint was written, unless the checkpoint was written in response to a CHKPNT command. In this case, processing will resume at the next command present in the current input stream. The current input stream will include all commands entered after the RSTART command. Those commands affected by a WIPOUT command will be omitted. This allows the user to completely replace the input stream following the command being executed when the checkpoint was written. The commands preceding this command may also be altered; however, this will have no effect on the subsequent execution. The RSTART use is illustrated in example 2. In this case, the last checkpoint written during execution of example 1 (card 52) will be read into GEMACS. Since the loop has already been executed twice, the commands following the RSTART command in example 2 will be executed immediately. Note that FRQ had already been doubled before the checkpoint was written, therefore it was not necessary in example 2 to redefine the frequency. The parameters TIME and NUMFIL will have the same values in example 2 as in example 1 since they were not redefined. Since TIME was not redefined in example 2, the time remaining to execute example 2 is the time remaining when example 1 finished.

The logical unit number for the checkpoint file is shown in section E.1, table 3, of this volume. The user is advised to always provide for a checkpoint file on any run by requesting an immediate checkpoint, using the NR option on the command. As a result of this command subroutine ERROR will generate a checkpoint tape whose contents will provide a data base from which the user may recover from a fatal error in a command. The subsequent restart run could then have a RSTART command which could be followed by a WIPOUT command eliminating all commands from the erroneous one to the end. A new run stream identical to the original from the fatal point on (with a corrected version of the

fatal command) can then follow the WIPOUT command. Execution time can thus be saved.

The output for a checkpoint is shown in section D.1. The output from GEMACS that is generated during the restart process is shown on the second through tenth pages of example 2. All of this output occurs only if the DEBUG command is executed during the ILP. The basic output consists of a record indicating what common blocks have been loaded and how many words have been loaded in each common block. Then, as each symbol is loaded back into its file, an informative message is printed out giving the symbol and the number of records loaded.

7. Debugging Capability

Example 2 illustrates two of the three debug modes available in GEMACS. In order to illustrate the use of the DEBUG command for the Input Language Processor, the ILP parameter is specified on card 1. As a result, a detailed printout of the input language processing and the restart process is provided. The Input Language Processor information appears under five headings during processing. A sample resulting from the command on card 16 of example 2 is shown below and will be discussed in detail.

```
   13  RNDZIJ=[illegible] WAKITR=10 CONVRG=1 VALUE=5

**********  PARSE CALLED  **********

 NTAB  NCODE          NVAL
    1      6  2343520350   (RNDZIJ)
    2      4             3   (=      )
    3      6             9   (     I)
    4      4             8   (=      )
    5      6    1313944707   (ZNTSHC)
    6      4             2   (-      )
    7      6  2607100284   (ZIJXDP)
    8      4             3   (*      )
    9      6             9   (     I)
   10      5            15   (WAKITR)
   11      4             6   (=      )
   12      7            10
   13      5            17   (CONVRG)
   14      4             8   (=      )
   15      7             1
   16      5            15   ( VALUE)
   17      4             8   (=      )
   18      7             5
   19      1  ***** END *****

NEW TASK ENTRY
 24                  160

NEW ARGUMENT LIST ENTRIES
160                   15
161                    3
162                    5
163                    4
164                    2
165                    5
166                   10
167                    1
168                    5
```

BEST AVAILABLE COPY

The command itself is first printed out exactly as it appears on the input card. The data following the "PARSE" CALLED" heading are NCODE and NVAL array entries specified by the NTAB index. To the right of the NVAL data, the card image of the field corresponding to coded data is printed.

The data under the heading NCODE identify the type of information, whether it is integer or a keyword, etc. For convenience, the more common codes and their meanings are listed below:

NCODE	MEANING
1.	End of Card
2.	Error on Card
3.	Task Field
4.	Symbol Field
5.	Keyword Field
6.	Alpha Field
7.	Integer Field
8.	Floating Point Field

These data are set in subroutine BLKDAT, and the definitions are found in the discussion of named common ADEBUG, both of which are found in the computer code documentation.

The data following "NEW TASK ENTRY" correspond to the entry code in the NTSKTB array at the location specified by the first number. The content, which points to the first entry in the NARGTB array for the command, is listed to the right. The data following "NEW ARGUMENT LIST ENTRIES" are the contents of the NARGTB array (printed in the second column) at the locations identified by the first column. These are the coded data to be interpreted by the individual processors which execute the commands. The first entry is the unique number of the task to be executed, in this case the BMI command. The remaining data are pointers to the symbol or literal tables (a positive integer pointing to the former and a negative integer pointing to the latter), and keyword NCODE array pointers, depending on the number in the NCODE column of the (PARSE CALL) printout.

The data listed under "NEW LITERAL TABLE ENTRIES" correspond to entries in the LITNUM array at the locations specified by the first column. The second column contains the code identifying the literal type (integer, floating point, alpha, etc.) and the value is printed in the third column.

This is illustrated below for the EFIELD command cards 25 to 29 of example 2.

```
NEW LITERAL TABLE ENTRIES
 15      8          .200000E+02
 16      8          .100000E+01
```

An additional heading "NEW SYMBOL TABLE ENTRIES" will be printed whenever a new entry is made in the NDATBL array. This is not illustrated in example 2 since all of the symbols had been previously defined by example 1. If it were present, it would contain eight columns of data listing from left to right the symbol name, its file location, the first and last words on the file, the bit set information giving the attributes of the symbol, the number of rows and colums of data, and the linkage of the symbol with other symbols in the table.

At the conclusion of input processing, the contents of NTSKTB and NARGTB are listed under the headings "TASK TABLE" and "ARGUMENT LIST TABLE". An excerpt from example 2 is shown below.

```
TASK TABLE          ARGUMENT LIST TABLE

 1                   1        DM
                              -1
                              -2
                              -3
 2                   5        DM
                              -4
                              -2
                              -5
 3                   9        DM
                              -6
                              -2
                              -7
 4                  13     GEOGEN
                              1
                          -999999
 5                  15      LOOP
                              1
 6                  18      ZGEN
                             101
                              1
                          -999999
                          -999999
                          -999999
                          -999999
                              2
```

BEST AVAILABLE COPY

The three columns list the task number, the location of the first entry in the NARGTB array for the task, and the arguments needed by the task processors for execution of the command. This is essentially a summary of the information contained under the "NEW TASK ENTRY" and "NEW ARGUMENT LIST ENTRIES" printed for each command. Two points should be noted. First, the entry -999999 indicates a default input by the user. Second, since this is a restart, the sequence of tasks follows the command sequence from example 1 followed by the command sequence of example 2.

The loop, symbol, and literal tables (reproduced here) follow these data. The first array contains the control information for the

LOOP TABLE

1	1290222466	6	2	1

SYMBOL TABLE

1	XDIPOL	5	1	0	8195	11	40	0
2	ZIJKOP	9	1	0	32792	40	40	1
3	BNDZIJ	10	1	0	33420	21	40	2
4	ANTSRC	11	1	0	16345	40	1	1
5	I	15	1	0	65548	40	1	3
6	NEWFLD	12	1	0	524292	228	4	5
7		0	1	0	1048580	152	2	5
8	BNDUPR	13	1	0	35468	11	40	3
9	BNDLWR	14	1	0	34444	11	40	3
10		0	1	0	1048580	152	2	5

LITERAL TABLE

1	5	NUMFIL
2	4	=
3	7	16
4	5	TIME
5	7	5
6	5	FRQ
7	8	.30000E+03
8	8	.50000E+00
9	8	0.
10	8	.36000E+03
11	8	.10000E+02
12	8	.90000E+02
13	7	2
14	4	*
15	8	.24000E+02
16	8	.10000E+01

BEST AVAILABLE COPY

LOOP/LABEL commands. Next, the NDATBL array is listed under the "SYMBOL TABLE" heading. This array contains the name and all known information for the symbols defined by the input stream of this and previous runs. The LITNUM array is then listed under the "LITERAL TABLE" heading. The type and value of each entry are printed. A detailed description of these arrays is presented in section I of the GEMACS computer code documentation.

Since example 2 was a restart, the debug information relating to restarting is printed on the second through tenth pages of example 2 output. This printout consists largely of documenting read and write activities. The output specifies the logical unit and the number of words involved. Additional output is primarily related to the retrieval and storage of FORTRAN common blocks and the data associated with the symbolic names generated during the run of example 1.

The execution debug mode is turned on by card 15 of example 2 to illustrate the level of output obtainable. This output again largely documents the I/O operations being performed during the BMI solution. In addition, the RHS and solution for each iteration is printed along with the current values of the PRE, BCRE, and IRE. Since the bulk of activity in GEMACS is concerned with moving data in and out of core, tracking this I/O is extremely important when trying to isolate errors leading to abnormal termination. When in the debug mode, each time a data set is stored, fetched, updated, or redefined, a message will be issued. An additional level of diagnostic output is obtained when the debug mode is entered with the TRACE option. In this case, a message is issued each time a subroutine is entered or exited which identifies the subroutine by name and the calling subroutine. An additional level of trace information to identify the FORTRAN calling statement is available and identified by an LSTAT number referencing a section of code within a subroutine, but it is not utilized extensively in this release of GEMACS.

8. Error Recovery

GEMACS has a large number of internal checks to maintain the integrity of the data. When an error is detected, a message is printed out to identify the nature and location of the error. A walkback feature is also incorporated which lists the subroutine calling sequence

from the subroutine which detected the error to the main routine within GEMACS. Additionally, a checkpoint will be attempted if:

(1) A checkpoint file is available.

(2) The error did not occur during a checkpoint.

(3) The NR parameter was specified on the last CHKPNT command.

The reason for not writing a checkpoint when the checkpoint file is rewound after each checkpoint is to avoid writing possibly invalid data over valid data.

In the event of a catastrophic error, such as divide fault or address out of range, there is no mechanism in GEMACS to interface with the operating system for recovery. In this event, the status of the peripheral files is strongly dependent on the local operating system capabilities and features.

EXAMPLE 1

BEST AVAILABLE COPY

GEMACS VERSION 01

USER INPUT STREAM

```
$*****************************************************************************
$*****************************************************************************
$
$         GEMACS EXAMPLE ONE
$         CROSSED DIPOLES CENTER FED 90 DEGREES OUT OF PHASE
$         FREQUENCIES OF 300 AND 600 MHZ
$         CHECKPOINT FOR EACH FREQUENCY
$         BMI SOLUTION TECHNIQUE
$         PRINT CURRENT AND SOURCE VECTOR
$         PLOT NEAR FIELD AND FAR FIELD IN XY AND YZ PLANE ON POLAR AXIS
$
$*****************************************************************************
$*****************************************************************************
NUMFIL=16          $ SET UPPER LIMIT TO TAPE FILES AVAILABLE
TIME=5             $ SET CP TIME LIMIT TO 5 MINUTES
FRQ=300.           $ INITIALIZE FREQUENCY TO 300 MHZ
GMDATA=XDIPOL      $ READ GEOMETRY AND STORE AS SYMBOL XDIPOL
$
$    LOOP TO LABEL LABEL1 TWICE
$
LOOP LABEL1 2
ZGEN SINCOS ZMATRX=ZIJXDP GMDATA=XDIPOL $GENERATE IMP MATRIX ZIJXDP
BNDZIJ=BAND(ZIJXDP) BNDW=10                $EXTRACT BNDZIJ FROM XIJXDP
ANTSRC=VSRC(XDIPOL) V=.5,.0 SEGS=1,3       $ EXCITE SEGMENTS 1 AND 3
ANTSRC=VSRC(XDIPOL) V=.0,.5 SEGS=2,4       $ EXCITE SEGMENTS 2 AND 4
BNDZIJ=LUD(BNDZIJ)                         $ DECOMPOSE BANDED MATRIX
$
$ DO BMI ON SYSTEM--STOP AT 10 ITERATION OR WHEN PRC .LE.5 PERCENT
$
BNDZIJ*I=ANTSRC-ZIJXDP*I MAXITR=10 CONVRG=1 VALUE=5
$
$  PRINT CURRENT VECTOR I  AND  SOURCE VECTOR  ANTSRC
$
PRINT I,ANTSRC
$
$  COMPUTE FARFLD AND PLOT ON LOG POLAR FORMAT FOR THETA INCREMENTS OF
$  10 DEGREES FROM 0(VERTICAL) TO 360( BACK TO VERTICAL) FOR PHI ANGLES
$  OF 0 AND 90 DEGREES...( FAR FIELD INDICATED BY SPHERICAL COORDINATES
$  AND MISSING  RADIAL COORDINATE  R  )
$
EFIELD(I) LOGPLR T2=360. DT=10. P2=90. DP=90. P1=0. T1=0.
$
$  COMPUTE NEAR FIELD IN SAME PLANES AND STORE AS SYMBOL NERFLD FOR
$  FUTURE USE IF NECESSARY
$
NERFLD=EFIELD(I) LOGPLR T2=360. DT=10. P2=90. DP=90. R1=10. P1=0. T1=0.
$
$  WRITE A CHECKPOINT AND INHIBIT AUTO REWIND WITH  NR  PARAMETER
$  NOTE-- THIS SHOULD ONLY BE DONE WHEN CHECKPOINT IS TAKEN IN COMMAND
$  STREAM
$
CHKPNT NR
FRQ=2*FRQ          $ DOUBLE FREQ TO 600MHZ
LABEL LABEL1       $ END OF DO LOOP ON LABEL LABEL1
$
END OF COMMANDS FOR EXAMPLE 1
```

BEST AVAILABLE COPY

```
57      $*********************************************************************
58      $*********************************************************************
59      $
60      $          CROSSED WIRES RENUMBERED CYCLICLY FROM INTERSECTION
61      $
62      $*********************************************************************
63      $*********************************************************************
64      PA .0015                  $ SET RADIUS ENTRY 1 TO .0015 METERS
65      PT 1 0. 0. 0.             $ DEFINE POINT 1 AT ORIGIN
66      XL PT 1 1 .0 .5 .0         $ GENERATE POINT 2 THE HARD WAY
67      RT PT 2 3 270. 0. 0.      $ ROTATE PT 2 TO GENERATE POINTS 3,4,5 ON(Z,-Y,-Z)
68      CP 1 2 10 1 1             $ GENERATE ARM 1 WITH 10 SEGMENTS AND TAG ID 1
69      CP 1 3 10 2 1             $ GENERATE ARM 2 WITH 10 SEGMENTS AND TAG ID 2
70      CP 1 4 10 3 1             $ GENERATE ARM 3 WITH 10 SEGMENTS AND TAG ID 3
71      CP 1 5 10 4 1             $ GENERATE ARM 4 WITH 10 SEGMENTS AND TAG ID 4
72      RN 1 5  9 13 17 21 25 29 33 37 $ RENUMBER ARM 1
73         2 6 10 14 18 22 26 30 34 38 $ RENUMBER ARM 2
74         3 7 11 15 19 23 27 31 35 39 $ RENUMBER ARM 3
75         4 8 12 16 20 24 28 32 36 40 $ RENUMBER ARM 4
76      END OF GEOMETRY FOR CROSSED WIRES
```

RESERVED KEYWORDS--MAY NOT BE USED FOR SYMBOL NAMES

	C	D	N	O	R	V	X	Z	CM
C1	C2	DM	DP	DR	DT	DW	DX	DY	DZ
IS	LU	NP	NR	OV	P1	P2	R1	R2	SC
SW	T1	T2	VS	X1	X2	Y1	Y2	Z1	Z2
ABS	COP	ECC	END	FRQ	ILP	INV	LOD	OFF	PHI
RDP	SEQ	SET	AXIS	BAND	BNDW	COND	EPSR	ESRC	LOOP
PLOT	PRLC	READ	SCDP	SEGS	SIZE	SRDP	SRLC	TAGS	TIME
TYPE	VSRC	ZGEN	ZIMP	CONJG	CPINC	CPNUM	DEBUG	LABEL	PARTN
PIVOT	PRINT	PULSE	PURGE	SOLVE	THETA	TRACE	VALUE	WRITE	BRCSJB
CHKPNT	COLPSE	CONVRG	EFIELD	EXPAND	FILEID	GMDATA	LINLIN	LINLOG	LINPLR
LOGLIN	LOGLOG	LOGPLR	MAXITR	NUMFIL	PCESIN	REDUCE	REFLCT	REPLAC	RSTART
SINCOS	SYMDEF	TRANSP	WIPOUT	ZCODES	ZLOADS	ZMATRX			

NEMACS INPUT LANGUAGE PROCESSOR CALLED ON 11/10/76 AT 12.06.52.

NEMACS CARD IMAGE PROCESSOR FOR RECORD 1

```
CARD          1111111111222222222233333333334444444444555555555566666666677777777778
     12345678901234567890123456789012345678901234567890123456789012345678901234567890

   1  $*********************************************************************
   2  $*********************************************************************
   3  $
   4  $          NEMACS EXAMPLE ONE
   5  $          CROSSED DIPOLES CENTER FED 90 DEGREES OUT OF PHASE
   6  $          FREQUENCIES OF 300 AND 600 MHZ
   7  $          CHECKPOINT FOR EACH FREQUENCY
   8  $          BXI SOLUTION TECHNIQUE
   9  $          PRINT CURRENT AND SOURCE VECTOR
  10  $          PLOT NEAR FIELD AND FAR FIELD IN XY AND YZ PLANE ON POLAR AXIS
  11  $
  12  $*********************************************************************
  13  $*********************************************************************
```

BEST AVAILABLE COPY

```
14  NUMFIL=16          $ SET UPPER LIMIT TO TAPE FILES AVAILABLE
15  TIME=5             $ SET CP TIME LIMIT TO 5 MINUTES
16  FRQ=300.           $ INITIALIZE FREQUENCY TO 300 MHZ
17  GMDATA=XDIPOL      $ READ GEOMETRY AND STORE AS SYMBOL XDIPOL
18  $
19  $     LOOP TO LABEL LABEL1 TWICE
20  $
21  LOOP LABEL1 2
22  ZGEN SINCOS ZMATRX=ZIJXDP GMDATA=XDIPOL $GENERATE IMP MATRIX ZIJXDP
23  BNDZIJ=BAND(ZIJXDP) BND#=10                $EXTRACT BNDZIJ FROM XIJXDP
24  ANTSRC=VSRC(X)IPOL) V=.5,.0 SEGS=1,3       $ EXCITE SEGMENTS 1 AND 3
25  ANTSRC=VSRC(X)IPOL) V=.0,.5 SEGS=2,4       $ EXCITE SEGMENTS 2 AND 4
26  BNDZIJ=LU)(BNDZIJ)                         $ DECOMPOSE BANDED MATRIX
27  $
28  $ DO BMI ON SYSTEM--STOP AT 10 ITERATION OR WHEN PRE .LE.5 PERCENT
29  $
30  BNDZIJ*I=ANTSRC-ZIJXDP*I MAXITR=10 CONVRG=1 VALUE=5
31  $
32  $  PRINT CURRENT VECTOR I  AND  SOURCE VECTOR  ANTSRC
33  $
34  PRINT I,ANTSRC
35  $
36  $  COMPUTE FARFLD AND PLOT ON LOG POLAR FORMAT FOR THETA INCREMENTS OF
37  $  10 DEGREES FROM 0(VERTICAL) TO 360( BACK TO VERTICAL) FOR PHI ANGLES
38  $  OF 0 AND 90 DEGREES...( FAR FIELD INDICATED BY SPHERICAL COORDINATES
39  $  AND MISSING  RADIAL COORDINATE  R  )
40  $
41  EFIELD(I) LOGPLR T2=360. DT=10. P2=90. DP=90. P1=0. T1=0.
42  $
43  $  COMPUTE NEAR FIELD IN SAME PLANES AND STORE AS SYMBOL NEARFLD FOR
44  $  FUTURE USE IF NECESSARY
45  $
46  NERFLD=EFIELD(I) LOGPLR T2=360. DT=10. P2=90. DP=90. R1=10. P1=0. T1=0.
47  $
48  $  WRITE A CHECKPOINT AND INHIBIT AUTO REWIND WITH  NR  PARAMETER
49  $  NOTE-- THIS SHOULD ONLY BE DONE WHEN CHECKPOINT IS TAKEN IN COMMAND
50  $  STREAM
51  $
52  CHKPNT NR
53  FRQ=2*FRQ          $ DOUBLE FREQ TO 600MHZ
54  LABEL LABEL1       $ END OF DO LOOP ON LABEL LABEL1
55  $
56  END OF COMMANDS FOR EXAMPLE 1


SEMACS TASK EXECUTION STARTED ON  11/10/76  AT  12.06.53.


NUMBER OF PERIPHERAL FILES AVAILIBLE    16


RUN TIME SET TO      5.00      CPU MINUTES


FREQUENCY SET TO      300.      MEGAHERTZ
WAVELENGTH      .999      METERS
```

BEST AVAILABLE COPY

```
GEMACS CARD IMAGE PROCESSOR FOR RECORD  2

 CARD          1111111111222222222233333333334444444444555555555566666666677777777776
      1234567890123456789012345678901234567890123456789012345678901234567890123456790

    1  $**********************************************************************
    2  $**********************************************************************
    3  $
    4  $          CROSSED WIRES RENUMBERED CYCLICLY FROM INTERSECTION
    5  $
    6  $**********************************************************************
    7  $**********************************************************************
    8  RA .0015                 $ SET RADIUS ENTRY 1 TO .0015 METERS
    9  PT 1 0. 0. 0.            $ DEFINE POINT 1 AT ORIGIN
   10  XL PT 1 1 .0 .5 .0        $ GENERATE POINT 2 THE HARD WAY
   11  RT PT 2 3 270. 0. 0.   $ ROTATE PT 2 TO GENERATE POINTS 3,4,5 ON(Z,-Y,-Z)
   12  CP 1 2 10 1 1            $ GENERATE ARM 1 WITH 10 SEGMENTS AND TAG ID 1
   13  CP 1 3 10 2 1            $ GENERATE ARM 2 WITH 10 SEGMENTS AND TAG ID 2
   14  CP 1 4 10 3 1            $ GENERATE ARM 3 WITH 10 SEGMENTS AND TAG ID 3
   15  CP 1 5 10 4 1            $ GENERATE ARM 4 WITH 10 SEGMENTS AND TAG ID 4
   16  RN 1 5  9 13 17 21 25 29 33 37 $ RENUMBER ARM 1
   17     2 6 10 14 18 22 26 30 34 38 $ RENUMBER ARM 2
   18     3 7 11 15 19 23 27 31 35 39 $ RENUMBER ARM 3
   19     4 8 12 16 20 24 28 32 36 40 $ RENUMBER ARM 4
   20  END OF GEOMETRY FOR CROSSED WIRES
```

SEGMENT DATA

TAG	XN	XC	XP	YN	YC	YP	ZN	ZC	ZP	RADIUS	LENGTH	END1	ISEG	END2
1	0.	0.	0.	0.	.250E-01	.500E-01	0.	0.	0.	.150E-02	.500E-01	-2	1	-5
2	0.	0.	0.	0.	-.127E-12	-.255E-12	0.	.250E-01	.500E-01	.150E-02	.500E-01	-3	2	-6
3	0.	0.	0.	0.	-.250E-01	-.500E-01	0.	-.255E-12	-.510E-12	.150E-02	.500E-01	-4	3	-7
4	0.	0.	0.	0.	.382E-12	.764E-12	0.	-.250E-01	-.500E-01	.150E-02	.500E-01	-1	4	-8
1	0.	0.	0.	.500E-01	.750E-01	.100E+00	0.	0.	0.	.150E-02	.500E-01	1	5	-9
2	0.	0.	0.	-.255E-12	-.382E-12	-.510E-12	.500E-01	.750E-01	.100E+00	.150E-02	.500E-01	2	6	-10
3	0.	0.	0.	-.500E-01	-.750E-01	-.100E+00	-.510E-12	-.764E-12	-.102E-11	.150E-02	.500E-01	3	7	-11
4	0.	0.	0.	.764E-12	.115E-11	.153E-11	-.500E-01	-.750E-01	-.100E+00	.150E-02	.500E-01	4	8	-12
1	0.	0.	0.	.100E+00	.125	.150	0.	0.	0.	.150E-02	.500E-01	5	9	-13
2	0.	0.	0.	-.510E-12	-.637E-12	-.764E-12	.100E+00	.125	.150	.150E-02	.500E-01	6	10	-14
3	0.	0.	0.	-.100E+00	-.125	-.150	-.102E-11	-.127E-11	-.153E-11	.150E-02	.500E-01	7	11	-15
4	0.	0.	0.	.153E-11	.191E-11	.229E-11	-.100E+00	-.125	-.150	.150E-02	.500E-01	8	12	-16
1	0.	0.	0.	.150	.175	.200	0.	0.	0.	.150E-02	.500E-01	9	13	-17
2	0.	0.	0.	-.764E-12	-.892E-12	-.102E-11	.150	.175	.200	.150E-02	.500E-01	10	14	-18
3	0.	0.	0.	-.150	-.175	-.200	-.153E-11	-.178E-11	-.204E-11	.150E-02	.500E-01	11	15	-19
4	0.	0.	0.	.229E-11	.267E-11	.305E-11	-.150	-.175	-.200	.150E-02	.500E-01	12	16	-20
1	0.	0.	0.	.200	.225	.250	0.	0.	0.	.150E-02	.500E-01	13	17	-21
2	0.	0.	0.	-.102E-11	-.115E-11	-.127E-11	.200	.225	.250	.150E-02	.500E-01	14	18	-22
3	0.	0.	0.	-.200	-.225	-.250	-.204E-11	-.229E-11	-.255E-11	.150E-02	.500E-01	15	19	-23
4	0.	0.	0.	.305E-11	.344E-11	.382E-11	-.200	-.225	-.250	.150E-02	.500E-01	16	20	-24
1	0.	0.	0.	.250	.275	.300	0.	0.	0.	.150E-02	.500E-01	17	21	-25
2	0.	0.	0.	-.127E-11	-.140E-11	-.153E-11	.250	.275	.300	.150E-02	.500E-01	18	22	-26
3	0.	0.	0.	-.250	-.275	-.300	-.255E-11	-.280E-11	-.306E-11	.150E-02	.500E-01	19	23	-27
4	0.	0.	0.	.382E-11	.420E-11	.458E-11	-.250	-.275	-.300	.150E-02	.500E-01	20	24	-28
1	0.	0.	0.	.300	.325	.350	0.	0.	0.	.150E-02	.500E-01	21	25	-29
2	0.	0.	0.	-.153E-11	-.166E-11	-.178E-11	.300	.325	.350	.150E-02	.500E-01	22	26	-30
3	0.	0.	0.	-.300	-.325	-.350	-.306E-11	-.331E-11	-.357E-11	.150E-02	.500E-01	23	27	-31
4	0.	0.	0.	.458E-11	.497E-11	.535E-11	-.300	-.325	-.350	.150E-02	.500E-01	24	28	-32
1	0.	0.	0.	.350	.375	.400	0.	0.	0.	.150E-02	.500E-01	25	29	-33
2	0.	0.	0.	-.178E-11	-.191E-11	-.204E-11	.350	.375	.400	.150E-02	.500E-01	26	30	-34
3	0.	0.	0.	-.350	-.375	-.400	-.357E-11	-.382E-11	-.408E-11	.150E-02	.500E-01	27	31	-35
4	0.	0.	0.	.535E-11	.573E-11	.611E-11	-.350	-.375	-.400	.150E-02	.500E-01	28	32	-36
1	0.	0.	0.	.400	.425	.450	0.	0.	0.	.150E-02	.500E-01	29	33	-37
2	0.	0.	0.	-.204E-11	-.217E-11	-.229E-11	.400	.425	.450	.150E-02	.500E-01	30	34	-38
3	0.	0.	0.	-.400	-.425	-.450	-.408E-11	-.433E-11	-.459E-11	.150E-02	.500E-01	31	35	-39
4	0.	0.	0.	.611E-11	.649E-11	.688E-11	-.400	-.425	-.450	.150E-02	.500E-01	32	36	-40
1	0.	0.	0.	.450	.475	.500	0.	0.	0.	.150E-02	.500E-01	33	37	0
2	0.	0.	0.	-.229E-11	-.242E-11	-.255E-11	.450	.475	.500	.150E-02	.500E-01	34	38	0
3	0.	0.	0.	-.450	-.475	-.500	-.459E-11	-.484E-11	-.510E-11	.150E-02	.500E-01	35	39	0
4	0.	0.	0.	.688E-11	.726E-11	.764E-11	-.450	-.475	-.500	.150E-02	.500E-01	36	40	0

FILL IMPEDANCE MATRIX ZIJXDP
USING BASIS FUNCTION SINCOS
ON GEOMETRY DATA SET XDIPOL
LOADS(IF SPECIFIED)IN
FREQUENCY(MEGAHERTZ) 300.00
GROUND COND (MHOS/M) 0.
RELATIVE PERMITIVITY 1.0000

EXTRACT BNDZIJ FROM ZIJXDP BANDWIDTH 10

AT COLUMN 20 BAND NORM= .3343E+05 COLUMN NORM= .3343E+05
BAND DOMINANCE FACTOR= .2331E+05

EXCITE GEOMETRY DATA XDIPOL
EXCITATION VOLTGE
EXCITATION DATA ANTSRC

BEST AVAILABLE COPY

```
REAL COMP      .500      IMAG COMP      0.
EXCITED   SEGS
   1     3
EXCITE GEOMETRY DATA XDIPOL
EXCITATION VOLTGE
EXCITATION DATA ANTSRC


REAL COMP      0.        IMAG COMP      .500
EXCITED   SEGS
   2     4


DECOMPOSE BNDZIJ STORE RESULT IN BNDZIJ PIVOT=       N

MAX DIAG =    .7937.      MIN DIAG =   3952.9
PIVOT RATIO =       12.13


BMI SOLUTION TO- BNDZIJ*      I=ANTSRC-ZIJXDP*      I

MAXITR=  10 CONVRG ON PRE     AT   5.0 PERCENT

ITERATION     1 PRED CONV IN    0 ITERATIONS
PRE=    100.00 IRE=  100.00 BCRE=    15.94
ITERATION     2 PRED CONV IN    0 ITERATIONS
PRE=     52.46 IRE=   72.43 BCRE=     7.15
ITERATION     3 PRED CONV IN    0 ITERATIONS
PRE=     10.81 IRE=   27.99 BCRE=     3.07
ITERATION     4 PRED CONV IN    0 ITERATIONS
PRE=      5.75 IRE=   12.68 BCRE=     1.31

CONVERGENCE REACHED

FINAL VALUES-- PRE      2.29 IRE      5.38 BCRE       .57


GEOMETRY DATA SET XDIPOL

*** NO LOAD FOR STRUCTURE ***


ANTENNA/LOAD PARAMETERS

  SEGMENT  IMP(MAG)   IMP(PHZ) PWR INPUT  PWR LOAD

        1  2104.975     -.009  .494E-04  0.
        2  1067.138     -.021  .395E-04  0.
        3  2121.967     -.009  .504E-04  0.
        4  1071.208     -.021  .404E-04  0.

**********
SYMBOL       I

 LINEAGE- BNDZIJ-ZIJXDP-XDIPOL-
COMPLX DATA

**********
```

COLUMN- 1

	REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)		REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)
1	.1979E-03	.1194E-03	.2311E-03	31.11	2	-.4409E-03	.1594E-03	.4689E-03	160.1
3	.2019E-03	.1219E-03	.2358E-03	31.12	4	-.4382E-03	.1617E-03	.4671E-03	159.7
5	-.1159E-03	-.8552E-04	.1440E-03	-143.6	6	-.1544E-03	.5127E-03	.5355E-03	106.8
7	-.1121E-03	-.8294E-04	.1394E-03	-143.5	8	-.1515E-03	.5150E-03	.5368E-03	106.4
9	-.4010E-03	-.2248E-03	.4597E-03	-150.7	10	.8945E-04	.8163E-03	.8212E-03	83.74
11	-.3976E-03	-.2220E-03	.4554E-03	-150.8	12	.9233E-04	.8184E-03	.8236E-03	83.56
13	-.6292E-03	-.3046E-03	.7012E-03	-153.8	14	.2341E-03	.1039E-02	.1077E-02	74.70
15	-.6285E-03	-.3065E-03	.6974E-03	-153.9	16	.2359E-03	.1040E-02	.1079E-02	74.56
17	-.7819E-03	-.3482E-03	.8561E-03	-156.0	18	.4238E-03	.1161E-02	.1236E-02	69.95
19	-.7796E-03	-.3455E-03	.8528E-03	-156.1	20	.4262E-03	.1163E-02	.1238E-02	69.87
21	-.8466E-03	-.3472E-03	.9145E-03	-157.7	22	.5002E-03	.1175E-02	.1277E-02	66.94
23	-.8440E-03	-.3445E-03	.9116E-03	-157.8	24	.5026E-03	.1176E-02	.1279E-02	66.88
25	-.8153E-03	-.3110E-03	.8726E-03	-159.1	26	.5080E-03	.1078E-02	.1192E-02	64.77
27	-.8138E-03	-.3086E-03	.8704E-03	-159.2	28	.5093E-03	.1079E-02	.1194E-02	64.74
29	-.6910E-03	-.2465E-03	.7336E-03	-160.4	30	.4459E-03	.8804E-03	.9873E-03	63.08
31	-.6905E-03	-.2447E-03	.7328E-03	-160.5	32	.4473E-03	.8812E-03	.9884E-03	63.06
33	-.4835E-03	-.1612E-03	.5097E-03	-161.6	34	.3210E-03	.5954E-03	.6764E-03	61.67
35	-.4826E-03	-.1601E-03	.5087E-03	-161.7	36	.3214E-03	.5960E-03	.6772E-03	61.66
37	-.1965E-03	-.5128E-04	.2059E-03	-162.7	38	.1334E-03	.2351E-03	.2703E-03	60.42
39	-.1963E-03	-.6085E-04	.2055E-03	-162.8	40	.1335E-03	.2353E-03	.2705E-03	60.42

SYMBOL ANTSHC

LINEAGE- XDIPOL-
COMPLX DATA

COLUMN- 1

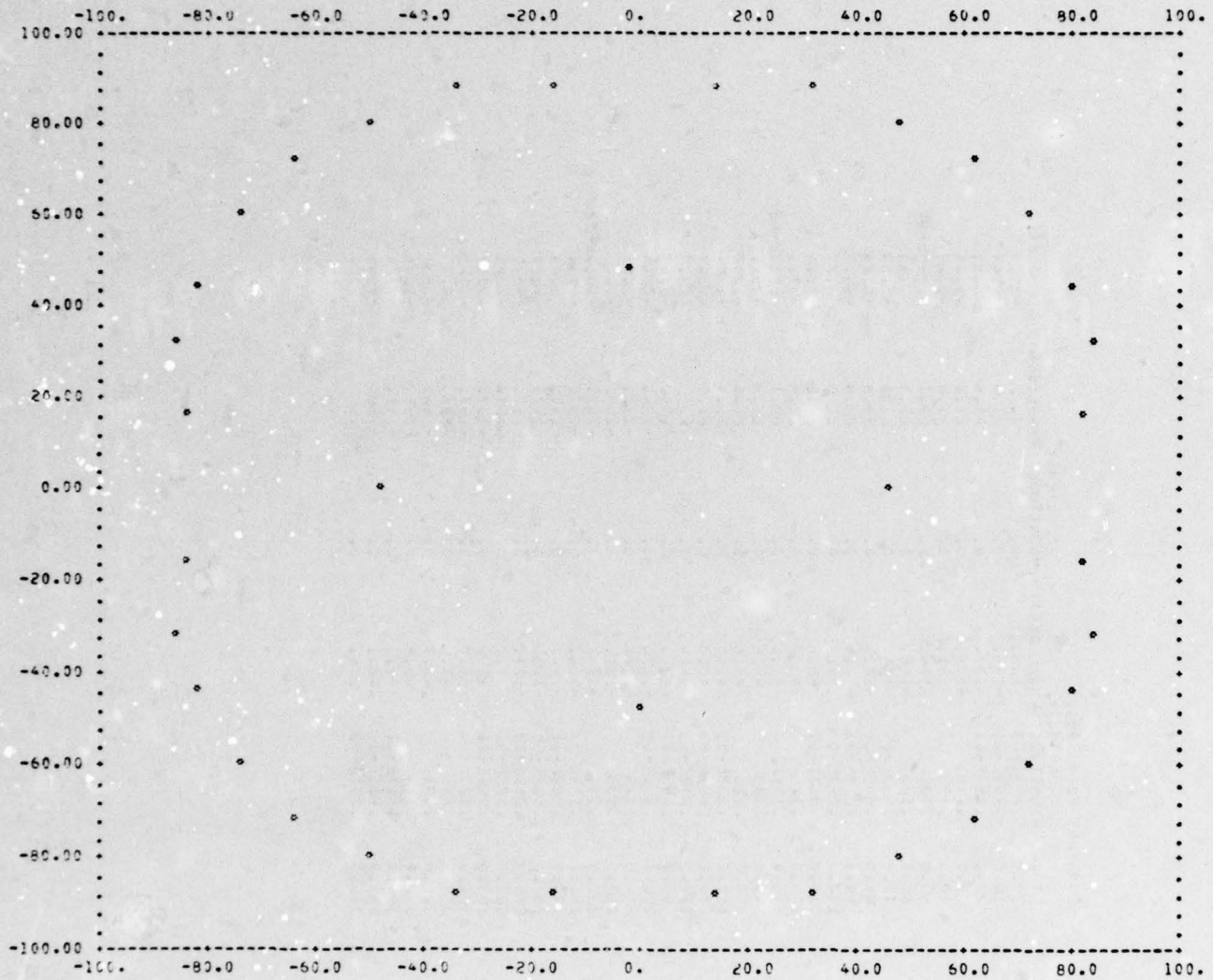
	REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)		REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)
1	-10.00	0.	10.00	180.0	2	0.	-10.00	10.00	-90.00
3	-10.00	0.	10.00	180.0	4	0.	-10.00	10.00	-90.00
5	0.	0.	0.	0.	6	0.	0.	0.	0.
7	0.	0.	0.	0.	8	0.	0.	0.	0.
9	0.	0.	0.	0.	10	0.	0.	0.	0.
11	0.	0.	0.	0.	12	0.	0.	0.	0.
13	0.	0.	0.	0.	14	0.	0.	0.	0.
15	0.	0.	0.	0.	16	0.	0.	0.	0.
17	0.	0.	0.	0.	18	0.	0.	0.	0.
19	0.	0.	0.	0.	20	0.	0.	0.	0.
21	0.	0.	0.	0.	22	0.	0.	0.	0.
23	0.	0.	0.	0.	24	0.	0.	0.	0.
25	0.	0.	0.	0.	26	0.	0.	0.	0.
27	0.	0.	0.	0.	28	0.	0.	0.	0.
29	0.	0.	0.	0.	30	0.	0.	0.	0.
31	0.	0.	0.	0.	32	0.	0.	0.	0.
33	0.	0.	0.	0.	34	0.	0.	0.	0.
35	0.	0.	0.	0.	36	0.	0.	0.	0.
37	0.	0.	0.	0.	38	0.	0.	0.	0.
39	0.	0.	0.	0.	40	0.	0.	0.	0.

E-FIELD MATRIX I
SPHERICAL COORDINATE SYSTEM

FAR FIELD FOR FIELD DATA=NOPCOD -CURRENT DATA= I -GEOMETRY DATA=XDIPOL
NORMALIZATION FACTOR .136 V/M

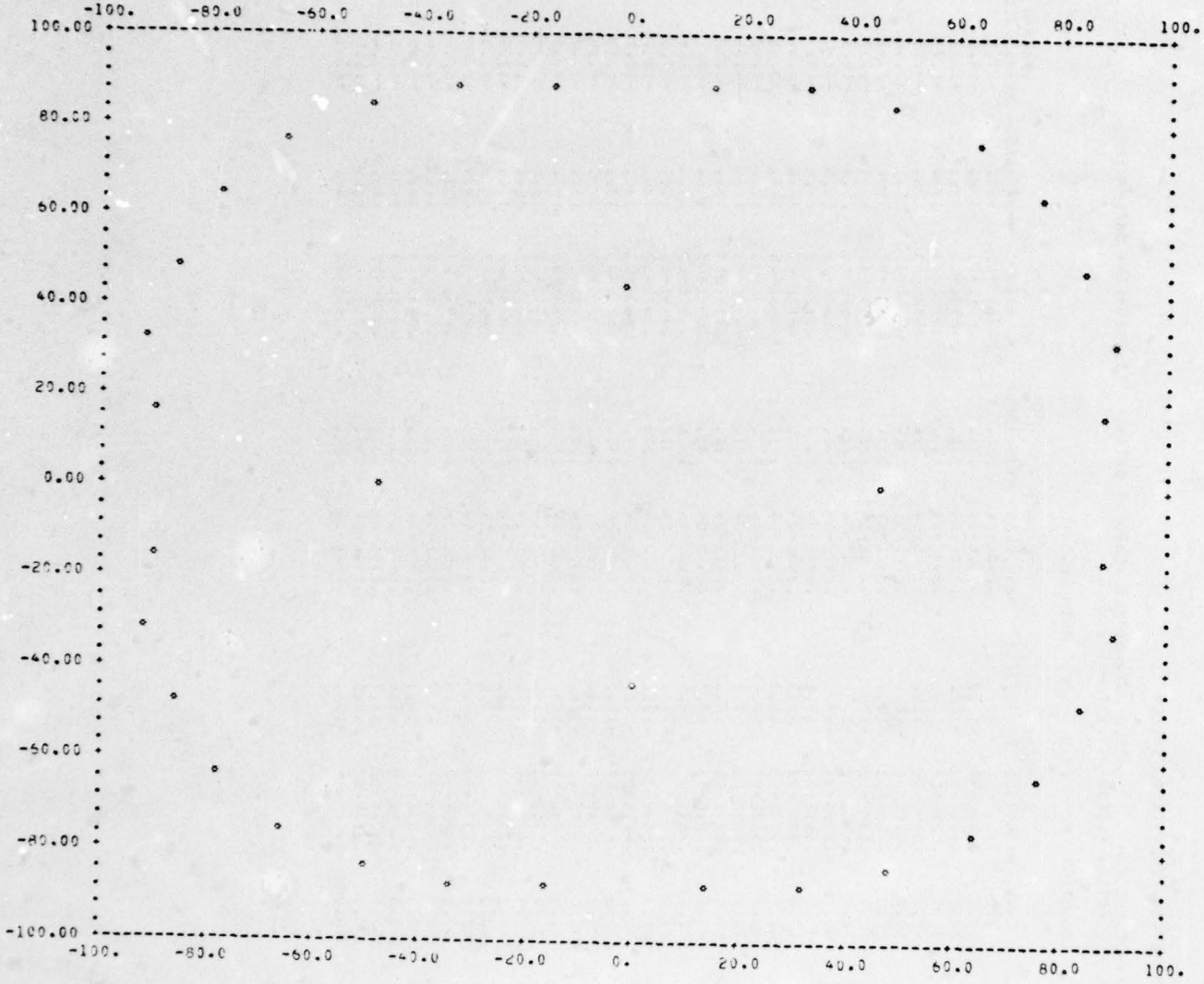
CONSTANT PHI= 0.

TH=	E(THETA) MAGNITUDE	E(THETA) PHASE(DEG)	E(PHI) MAGNITUDE	E(PHI) PHASE(DEG)	NORMALIZED
0.0	0.	0.	.290E-03	136.	-53.4
10.0	.208E-01	-109.	.290E-03	136.	-16.3
20.0	.419E-01	-109.	.290E-03	136.	-10.3
30.0	.627E-01	-110.	.290E-03	136.	-6.75
40.0	.807E-01	-111.	.290E-03	136.	-4.55
50.0	.916E-01	-111.	.290E-03	136.	-3.44
60.0	.908E-01	-112.	.290E-03	136.	-3.54
70.0	.740E-01	-112.	.290E-03	136.	-5.31
80.0	.419E-01	-112.	.290E-03	136.	-10.3
90.0	.215E-03	-52.8	.290E-03	136.	-51.5
100.0	.417E-01	67.5	.290E-03	136.	-10.3
110.0	.739E-01	67.8	.290E-03	136.	-5.33
120.0	.907E-01	68.2	.290E-03	136.	-3.55
130.0	.917E-01	68.8	.290E-03	136.	-3.45
140.0	.807E-01	69.4	.290E-03	136.	-4.57
150.0	.625E-01	70.0	.290E-03	136.	-6.75
160.0	.419E-01	70.6	.290E-03	136.	-10.3
170.0	.208E-01	71.0	.290E-03	136.	-16.3
180.0	0.	-109.	.290E-03	136.	-53.4
190.0	.208E-01	-109.	.290E-03	136.	-16.3
200.0	.419E-01	-109.	.290E-03	136.	-10.3
210.0	.626E-01	-110.	.290E-03	136.	-6.75
220.0	.807E-01	-111.	.290E-03	136.	-4.57
230.0	.917E-01	-111.	.290E-03	136.	-3.45
240.0	.907E-01	-112.	.290E-03	136.	-3.55
250.0	.739E-01	-112.	.290E-03	136.	-5.33
260.0	.417E-01	-113.	.290E-03	136.	-10.3
270.0	.215E-03	127.	.290E-03	136.	-51.5
280.0	.419E-01	68.0	.290E-03	136.	-10.3
290.0	.740E-01	68.1	.290E-03	136.	-5.31
300.0	.908E-01	68.4	.290E-03	136.	-3.54
310.0	.918E-01	68.9	.290E-03	136.	-3.44
320.0	.807E-01	69.4	.290E-03	136.	-4.55
330.0	.627E-01	70.1	.290E-03	136.	-6.75
340.0	.419E-01	70.6	.290E-03	136.	-10.3
350.0	.208E-01	71.0	.290E-03	136.	-16.3
360.0	0.	-109.	.290E-03	136.	-53.4


-100.
-80.0
-60.0
-40.0
-20.0
0.
20.0
40.0
60.0
80.0
100.
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
-100.00

CONSTANT PHI= 90.0

	E(THETA)		E(PHI)		
TH=	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	NORMALIZED
0.0	.290E-03	136.	0.	0.	-53.4
10.0	.459E-01	-139.	0.	21.0	-9.47
20.0	.857E-01	-137.	0.	21.4	-4.04
30.0	.115	-134.	0.	21.6	-1.45
40.0	.133	-131.	0.	21.8	-.242
50.0	.136	-129.	0.	22.1	-.303E-02
60.0	.125	-126.	0.	22.4	-.783
70.0	.963E-01	-124.	0.	22.6	-3.03
80.0	.528E-01	-123.	0.	22.8	-8.25
90.0	.215E-03	-52.8	0.	22.9	-56.0
100.0	.527E-01	56.6	0.	22.8	-8.27
110.0	.962E-01	55.6	0.	22.6	-3.04
120.0	.125	53.9	0.	22.4	-.789
130.0	.136	51.4	0.	22.1	-.688E-02
140.0	.133	48.5	0.	21.8	-.244
150.0	.115	45.6	0.	21.6	-1.45
160.0	.857E-01	43.1	0.	21.4	-4.04
170.0	.459E-01	41.3	0.	21.0	-9.47
180.0	.290E-03	-44.4	0.	0.	-53.4
190.0	.459E-01	-138.	0.	-159.	-9.47
200.0	.857E-01	-137.	0.	-159.	-4.04
210.0	.115	-134.	0.	-158.	-1.45
220.0	.133	-131.	0.	-158.	-.242
230.0	.136	-129.	0.	-158.	-.382E-02
240.0	.125	-126.	0.	-157.	-.785
250.0	.962E-01	-124.	0.	-157.	-3.03
260.0	.527E-01	-123.	0.	-157.	-8.27
270.0	.215E-03	127.	0.	-157.	-56.0
280.0	.528E-01	57.1	0.	-157.	-8.24
290.0	.964E-01	55.9	0.	-157.	-3.02
300.0	.125	54.0	0.	-157.	-.780
310.0	.136	51.6	0.	-158.	0.
320.0	.133	48.7	0.	-158.	-.239
330.0	.115	45.8	0.	-158.	-1.45
340.0	.857E-01	43.4	0.	-158.	-4.04
350.0	.459E-01	42.1	0.	-158.	-9.47
360.0	.290E-03	136.	0.	0.	-53.4

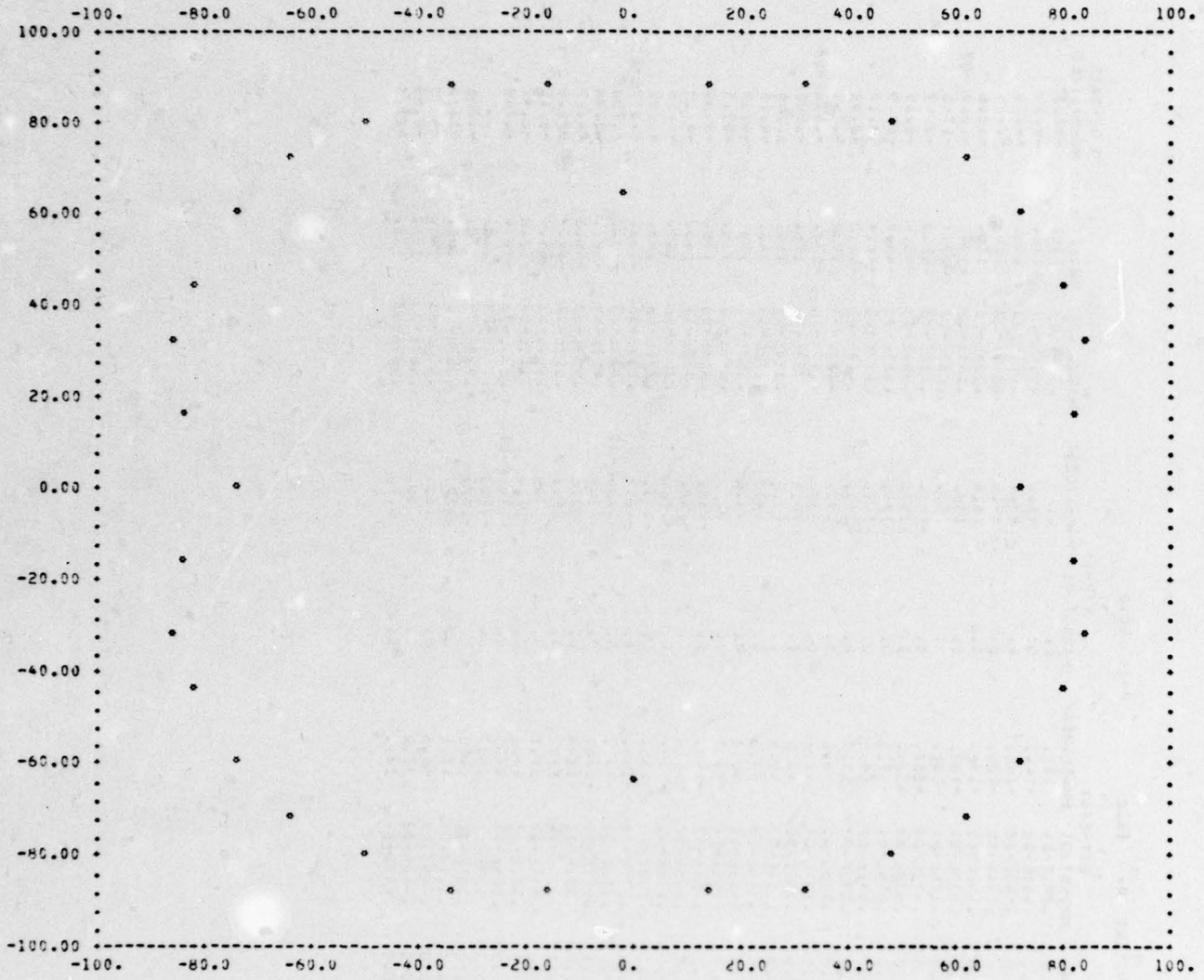

-100.
-80.0
-60.0
-40.0
-20.0
0.
20.0
40.0
60.0
80.0
100.
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
-100.00

E-FIELD MATRIX I
SPHERICAL COORDINATE SYSTEM

NEAR FIELD FOR FIELD DATA=NERFLD -CURRENT DATA= I -GEOMETRY DATA=XDIPOL
NORMALIZATION FACTOR .137E-01 V/M

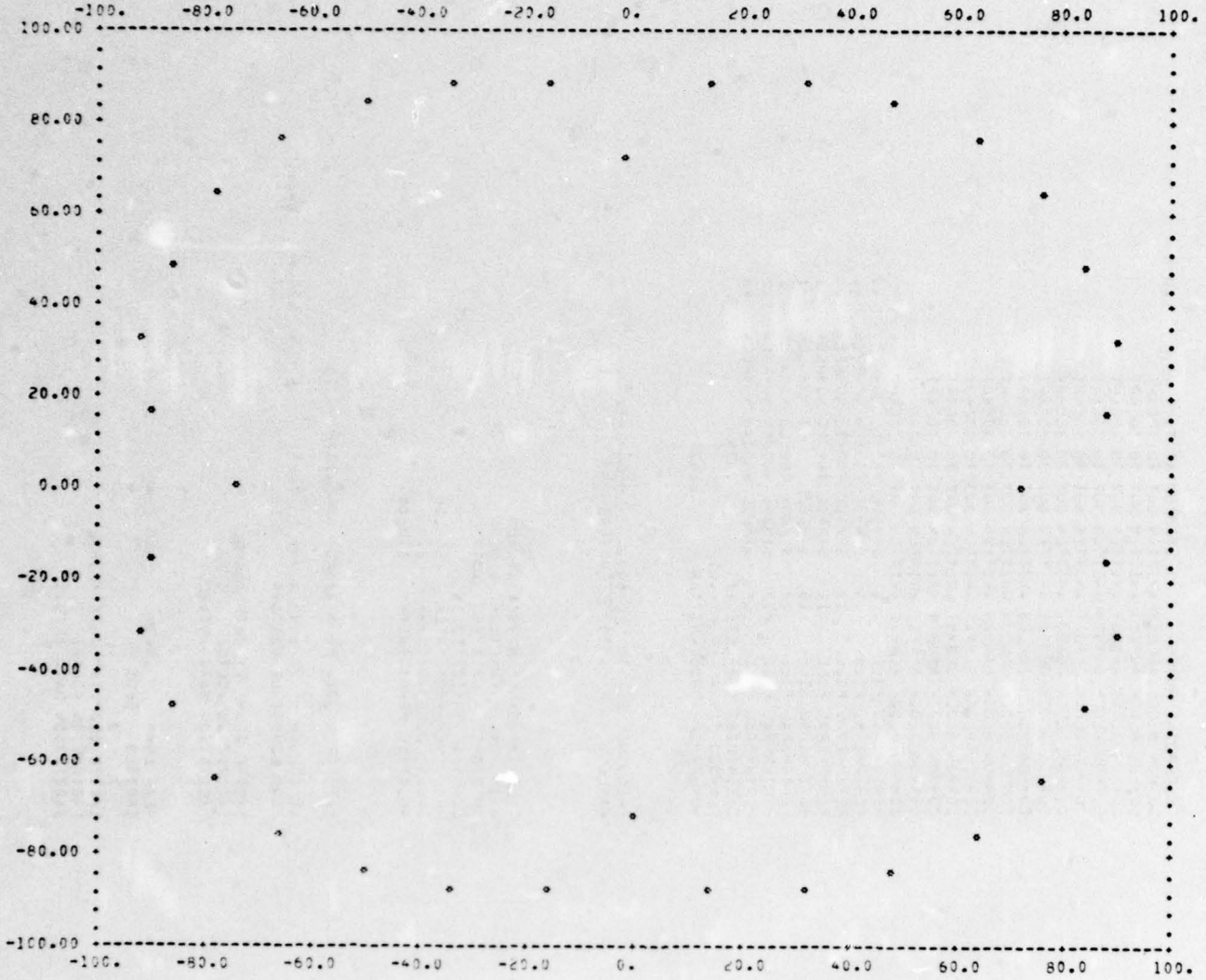
CONSTANT R= 10.0 PHI= 0.

	E(THETA)		E(PHI)		E(RAD)		DB-GAIN
TH=	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	NORMALIZED
0.0	0.	0.	.290E-04	131.	.569E-03	136.	-27.3
10.0	.210E-02	-111.	.290E-04	131.	.591E-03	136.	-16.0
20.0	.422E-02	-112.	.290E-04	131.	.592E-03	135.	-10.1
30.0	.629E-02	-113.	.290E-04	131.	.575E-03	133.	-6.71
40.0	.809E-02	-115.	.290E-04	131.	.526E-03	128.	-4.55
50.0	.918E-02	-116.	.290E-04	131.	.425E-03	121.	-3.46
60.0	.905E-02	-118.	.290E-04	131.	.296E-03	103.	-3.58
70.0	.737E-02	-118.	.290E-04	131.	.214E-03	62.9	-5.37
80.0	.417E-02	-119.	.290E-04	131.	.251E-03	25.8	-10.3
90.0	.215E-04	-57.1	.290E-04	131.	.285E-03	15.6	-33.5
100.0	.415E-02	60.5	.290E-04	131.	.251E-03	25.8	-10.4
110.0	.735E-02	61.3	.290E-04	131.	.215E-03	62.8	-5.39
120.0	.904E-02	62.3	.290E-04	131.	.296E-03	103.	-3.60
130.0	.917E-02	63.6	.290E-04	131.	.425E-03	120.	-3.47
140.0	.809E-02	65.0	.290E-04	131.	.525E-03	128.	-4.56
150.0	.629E-02	66.5	.290E-04	131.	.575E-03	132.	-6.72
160.0	.421E-02	67.7	.290E-04	131.	.592E-03	135.	-10.1
170.0	.209E-02	68.5	.290E-04	131.	.591E-03	136.	-16.0
180.0	0.	-106.	.290E-04	131.	.569E-03	136.	-27.3
190.0	.209E-02	-111.	.290E-04	131.	.591E-03	136.	-16.0
200.0	.421E-02	-112.	.290E-04	131.	.592E-03	135.	-10.1
210.0	.629E-02	-114.	.290E-04	131.	.575E-03	132.	-6.72
220.0	.808E-02	-115.	.290E-04	131.	.526E-03	128.	-4.56
230.0	.917E-02	-116.	.290E-04	131.	.425E-03	120.	-3.47
240.0	.904E-02	-118.	.290E-04	131.	.296E-03	103.	-3.60
250.0	.735E-02	-119.	.290E-04	131.	.215E-03	62.8	-5.39
260.0	.415E-02	-119.	.290E-04	131.	.251E-03	25.8	-10.4
270.0	.215E-04	123.	.290E-04	131.	.285E-03	15.6	-33.5
280.0	.417E-02	61.0	.290E-04	131.	.251E-03	25.8	-10.3
290.0	.737E-02	61.5	.290E-04	131.	.214E-03	62.9	-5.37
300.0	.905E-02	62.5	.290E-04	131.	.296E-03	103.	-3.58
310.0	.918E-02	63.7	.290E-04	131.	.425E-03	121.	-3.46
320.0	.809E-02	65.1	.290E-04	131.	.526E-03	128.	-4.55
330.0	.629E-02	66.5	.290E-04	131.	.575E-03	133.	-6.71
340.0	.422E-02	67.7	.290E-04	131.	.592E-03	135.	-10.1
350.0	.210E-02	68.6	.290E-04	131.	.591E-03	136.	-16.0
360.0	0.	-106.	.290E-04	131.	.569E-03	136.	-27.3


-100.
-80.0
-60.0
-40.0
-20.0
0.
20.0
40.0
60.0
80.0
100.
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
-100.00

CONSTANT R= 10.0 PHI= 90.0

	E(THETA)		E(PHI)		E(RAD)		DB-GAIN
TH=	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	NORMALIZED
0.0	.290E-04	131.	0.	0.	.589E-03	136.	-27.3
10.0	.451E-02	-144.	0.	43.6	.557E-03	138.	-9.59
20.0	.845E-02	-142.	0.	48.4	.473E-03	145.	-4.18
30.0	.114E-01	-139.	0.	57.8	.359E-03	156.	-1.56
40.0	.132E-01	-136.	0.	79.9	.233E-03	176.	-.268
50.0	.137E-01	-133.	0.	138.	.141E-03	-132.	-.219E-02
60.0	.126E-01	-131.	0.	180.	.233E-03	-70.7	-.750
70.0	.971E-02	-130.	0.	-159.	.412E-03	-52.3	-2.97
80.0	.533E-02	-129.	0.	-157.	.559E-03	-46.4	-8.15
90.0	.215E-04	-57.1	0.	175.	.615E-03	-45.0	-26.9
100.0	.532E-02	50.6	0.	-157.	.559E-03	-46.4	-8.17
110.0	.970E-02	50.0	0.	-159.	.412E-03	-52.2	-2.98
120.0	.125E-01	48.6	0.	180.	.233E-03	-70.4	-.755
130.0	.137E-01	46.5	0.	138.	.140E-03	-132.	-.534E-02
140.0	.132E-01	43.8	0.	79.8	.232E-03	176.	-.290
150.0	.114E-01	40.9	0.	57.7	.359E-03	156.	-1.56
160.0	.845E-02	38.2	0.	48.3	.472E-03	145.	-4.18
170.0	.451E-02	36.2	0.	43.6	.557E-03	138.	-9.59
180.0	.290E-04	-48.7	0.	0.	.589E-03	136.	-27.3
190.0	.450E-02	-143.	0.	-136.	.557E-03	138.	-9.59
200.0	.845E-02	-141.	0.	-132.	.472E-03	145.	-4.18
210.0	.114E-01	-139.	0.	-122.	.359E-03	156.	-1.56
220.0	.132E-01	-136.	0.	-100.	.231E-03	176.	-.268
230.0	.137E-01	-133.	0.	-42.3	.139E-03	-132.	-.317E-02
240.0	.126E-01	-131.	0.	.420E-01	.233E-03	-70.2	-.753
250.0	.971E-02	-130.	0.	11.5	.412E-03	-52.1	-2.98
260.0	.532E-02	-129.	0.	13.6	.559E-03	-46.3	-8.17
270.0	.215E-04	123.	0.	20.3	.615E-03	-44.9	-26.9
280.0	.533E-02	51.1	0.	13.6	.559E-03	-46.4	-8.15
290.0	.972E-02	50.2	0.	11.4	.412E-03	-52.2	-2.97
300.0	.126E-01	48.8	0.	-.246E-01	.233E-03	-70.4	-.748
310.0	.137E-01	46.7	0.	-42.3	.140E-03	-132.	0.
320.0	.132E-01	44.0	0.	-100.	.232E-03	176.	-.286
330.0	.114E-01	41.1	0.	-122.	.359E-03	156.	-1.56
340.0	.845E-02	38.5	0.	-131.	.472E-03	145.	-4.18
350.0	.450E-02	37.0	0.	-136.	.557E-03	138.	-9.59
360.0	.290E-04	131.	0.	0.	.589E-03	136.	-27.3


-100.
-80.0
-60.0
-40.0
-20.0
0.
20.0
40.0
60.0
80.0
100.
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
-100.00

```
CHECKPOINT NUMBER      1 STARTED AT TIME          .295
COMMON BLOCK ADEBUG WRITTEN OUT TO IOCKPT
COMMON BLOCK AMPZIJ WRITTEN OUT TO IOCKPT
COMMON BLOCK ARGCOM WRITTEN OUT TO IOCKPT
COMMON BLOCK CSYSTM WRITTEN OUT TO IOCKPT
COMMON BLOCK DEFDAT WRITTEN OUT TO IOCKPT
COMMON BLOCK FLDCOM WRITTEN OUT TO IOCKPT
COMMON BLOCK GEODAT WRITTEN OUT TO IOCKPT
COMMON BLOCK IOFLES WRITTEN OUT TO IOCKPT
COMMON BLOCK JUNCOM WRITTEN OUT TO IOCKPT
COMMON BLOCK PARTAB WRITTEN OUT TO IOCKPT
COMMON BLOCK SCNPAR WRITTEN OUT TO IOCKPT
COMMON BLOCK SEGMNT WRITTEN OUT TO IOCKPT
COMMON BLOCK SYMSTR WRITTEN OUT TO IOCKPT
COMMON BLOCK SYSFIL WRITTEN OUT TO IOCKPT
COMMON BLOCK TEMP01 WRITTEN OUT TO IOCKPT
PERIPHERAL FILE      8    SYMBOL XDIPOL NUMREC=    40
PERIPHERAL FILE      9    SYMBOL ZIJXDP NUMREC=    40
PERIPHERAL FILE     10    SYMBOL BNDZIJ NUMREC=    40
PERIPHERAL FILE     11    SYMBOL ANTSRC NUMREC=     1
PERIPHERAL FILE     15    SYMBOL        I NUMREC=     1
PERIPHERAL FILE     12    SYMBOL NERFLD NUMREC=     2
PERIPHERAL FILE     13    SYMBOL BNDJPR NUMREC=    40
PERIPHERAL FILE     14    SYMBOL BNDLNR NUMREC=    40
CHECKPOINT COMPLETE AT          .305
ELAPSED TIME=          .012
NUMBER OF WORDS WRITTEN =      24630


FREQUENCY SET TO      600.      MEGAHERTZ
WAVLENGTH      .500      METERS



FILL IMPEDANCE MATRIX ZIJXDP
USING BASIS FUNCTION  SINCOS
ON GEOMETRY DATA SET  XDIPOL
LOADS(IF SPECIFIED)IN
FREQUENCY(MEGAHERTZ)     600.00
GROUND COND (MHOS/M)     0.
RELATIVE PERMITIVITY     1.0000



EXTRACT BNDZIJ FROM ZIJXDP BANDWIDTH     10

AT COLUMN     20 BAND NORM=     7923.      COLUMN NORM=     7924.
BAND DOMINANCE FACTOR=     7600.

EXCITE GEOMETRY DATA XDIPOL
EXCITATION VOLTGE
EXCITATION DATA ANTSRC


REAL COMP      .500      IMAG COMP      0.
EXCITED   SEGS
    1     3
EXCITE GEOMETRY DATA XDIPOL
EXCITATION VOLTGE
EXCITATION DATA ANTSRC
```

```
REAL COMP      0.        IMAG COMP      .500
EXCITED   SEGS
   2    4


DECOMPOSE BNDZIJ STORE RESULT IN BNDZIJ PIVOT=       N

MAX DIAG =   17375.      MIN DIAG =   1327.9
PIVOT RATIO =       13.08


BMI SOLUTION TO- BNDZIJ*      I=ANTSRC-ZIJXDP*      I

MAXITR=  10 CONVRG ON PRE    AT   5.0 PERCENT

ITERATION    1 PRED CONV IN   0 ITERATIONS
PRE=   100.00 IRE=  100.00 BCRE=     9.21


CONVERGENCE REACHED


FINAL VALUES-- PRE      4.41 IRE     21.00 BCRE      1.77


GEOMETRY DATA SET XDIPOL

*** NO LOAD FOR STRUCTURE ***


ANTENNA/LOAD PARAMETERS

  SEGMENT  IMP(MAG)   IMP(PHZ) PWR INPUT  PWR LOAD

        1  2446.251     -.023  .115E-04  0.
        2   746.314     -.012  .129E-03  0.
        3  2460.582     -.024  .103E-04  0.
        4   750.035     -.012  .128E-03  0.

**********
SYMBOL       I

 LINEAGE- BNDZIJ-ZIJXDP-XDIPOL-
COMPLX DATA

**********
```

COLUMN- 1

	REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)		REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)
1	.4134E-04	.3985E-03	.4091E-03	77.03	2	-.8544E-03	.1033E-02	.1341E-02	129.6
3	.8713E-04	.3972E-03	.4067E-03	77.63	4	-.8524E-03	.1026E-02	.1334E-02	129.7
5	-.7915E-03	-.2036E-04	.7915E-03	-178.5	6	.6113E-03	.2603E-02	.2674E-02	76.78
7	-.7948E-03	-.1963E-04	.7948E-03	-178.6	8	.6101E-03	.2604E-02	.2675E-02	76.69
9	-.1242E-02	-.1658E-03	.1253E-02	-172.4	10	.1564E-02	.3243E-02	.3603E-02	65.67
11	-.1244E-02	-.1604E-03	.1255E-02	-172.7	12	.1532E-02	.3290E-02	.3573E-02	63.61
13	-.1110E-02	-.1127E-03	.1116E-02	-174.2	14	.1353E-02	.2766E-02	.3331E-02	56.20
15	-.1111E-02	-.1024E-03	.1115E-02	-174.7	16	.1382E-02	.2775E-02	.3342E-02	56.15
17	-.4624E-03	.5775E-04	.4660E-03	172.9	18	.1263E-02	.1221E-02	.1757E-02	44.03
19	-.4639E-03	.5441E-04	.4588E-03	172.1	20	.1272E-02	.1229E-02	.1766E-02	43.92
21	.4431E-03	.2891E-03	.5161E-03	69.74	22	.1190E-03	-.7942E-03	.8030E-03	-81.48
23	.4432E-03	.2873E-03	.5124E-03	30.14	24	.1227E-03	-.7975E-03	.8065E-03	-81.25
25	.1268E-02	.4012E-03	.1330E-02	17.55	26	-.1102E-02	-.2527E-02	.2757E-02	-113.6
27	.1261E-02	.3970E-03	.1322E-02	17.48	28	-.1105E-02	-.2534E-02	.2765E-02	-113.6
29	.1671E-02	.4959E-03	.1726E-02	14.62	30	-.1877E-02	-.3320E-02	.3814E-02	-119.5
31	.1662E-02	.4278E-03	.1716E-02	14.44	32	-.1868E-02	-.3327E-02	.3825E-02	-119.5
33	.1467E-02	.3413E-03	.1506E-02	13.10	34	-.1837E-02	-.2861E-02	.3400E-02	-122.7
35	.1454E-02	.3335E-03	.1497E-02	12.87	36	-.1849E-02	-.2869E-02	.3409E-02	-122.8
37	.6615E-03	.1403E-03	.6762E-03	11.97	38	-.8836E-03	-.1255E-02	.1535E-02	-125.1
39	.6577E-03	.1359E-03	.6718E-03	11.75	40	-.8873E-03	-.1257E-02	.1536E-02	-125.2

****

SYMBOL ANTSRC

LINEAGE- ADIPOL-
COMPLX DATA

****

COLUMN- 1

	REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)		REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)
1	-10.00	0.	10.00	180.0	2	0.	-10.00	10.00	-90.00
3	-10.00	0.	10.00	180.0	4	0.	-10.00	10.00	-90.00
5	0.	0.	0.	0.	6	0.	0.	0.	0.
7	0.	0.	0.	0.	8	0.	0.	0.	0.
9	0.	0.	0.	0.	10	0.	0.	0.	0.
11	0.	0.	0.	0.	12	0.	0.	0.	0.
13	0.	0.	0.	0.	14	0.	0.	0.	0.
15	0.	0.	0.	0.	16	0.	0.	0.	0.
17	0.	0.	0.	0.	18	0.	0.	0.	0.
19	0.	0.	0.	0.	20	0.	0.	0.	0.
21	0.	0.	0.	0.	22	0.	0.	0.	0.
23	0.	0.	0.	0.	24	0.	0.	0.	0.
25	0.	0.	0.	0.	26	0.	0.	0.	0.
27	0.	0.	0.	0.	28	0.	0.	0.	0.
29	0.	0.	0.	0.	30	0.	0.	0.	0.
31	0.	0.	0.	0.	32	0.	0.	0.	0.

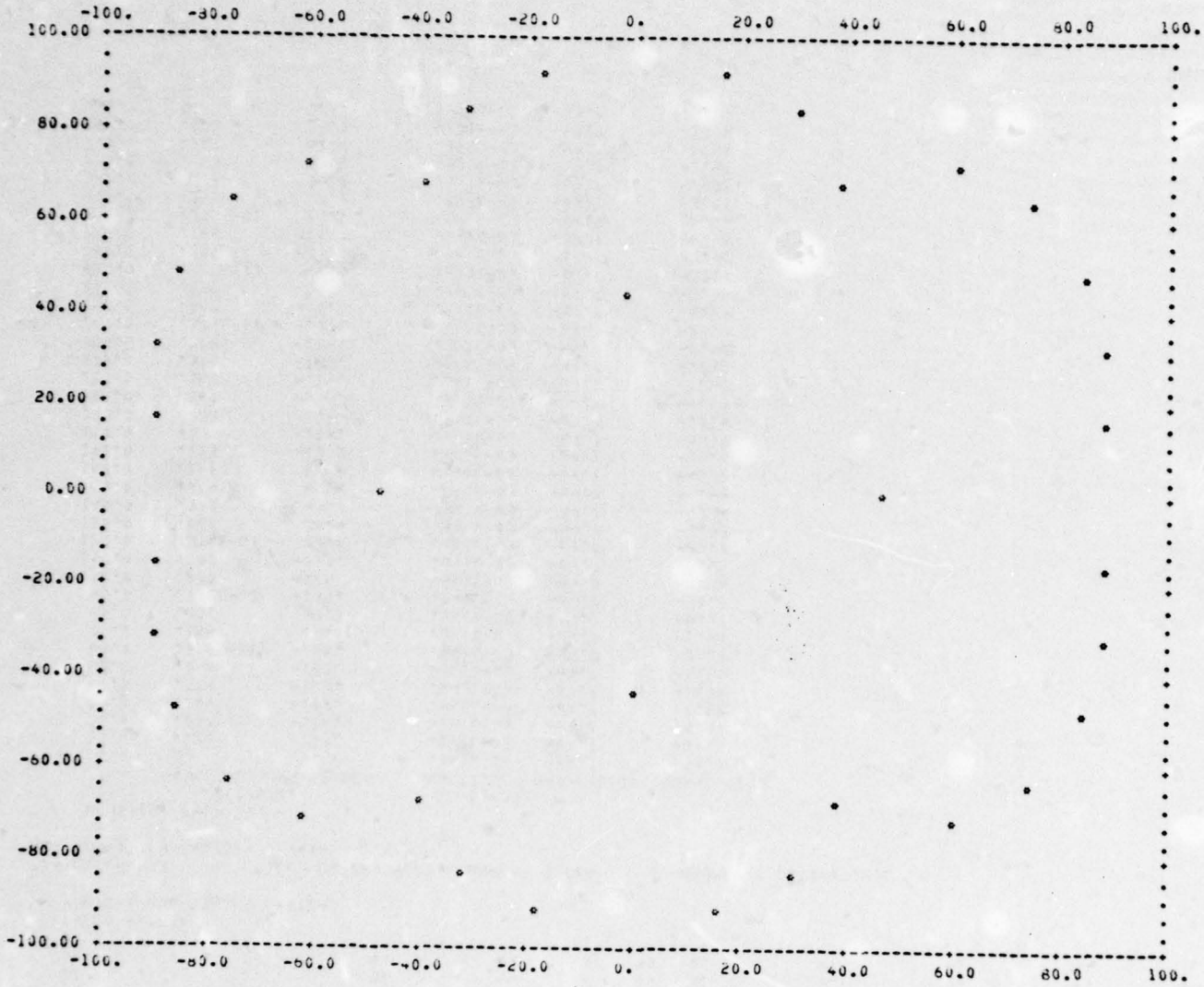
35	0.	0.	0.	0.	36	0.	0.	0.	0.
37	0.	0.	0.	0.	38	0.	0.	0.	0.
39	0.	0.	0.	0.	40	0.	0.	0.	0.

E-FIELD MATRIX I
SPHERICAL COORDINATE SYSTEM

FAR FIELD FOR FIELD DATA=NOPCOD -CURRENT DATA= I -GEOMETRY DATA=ADIPOL
NORMALIZATION FACTOR .416 V/M

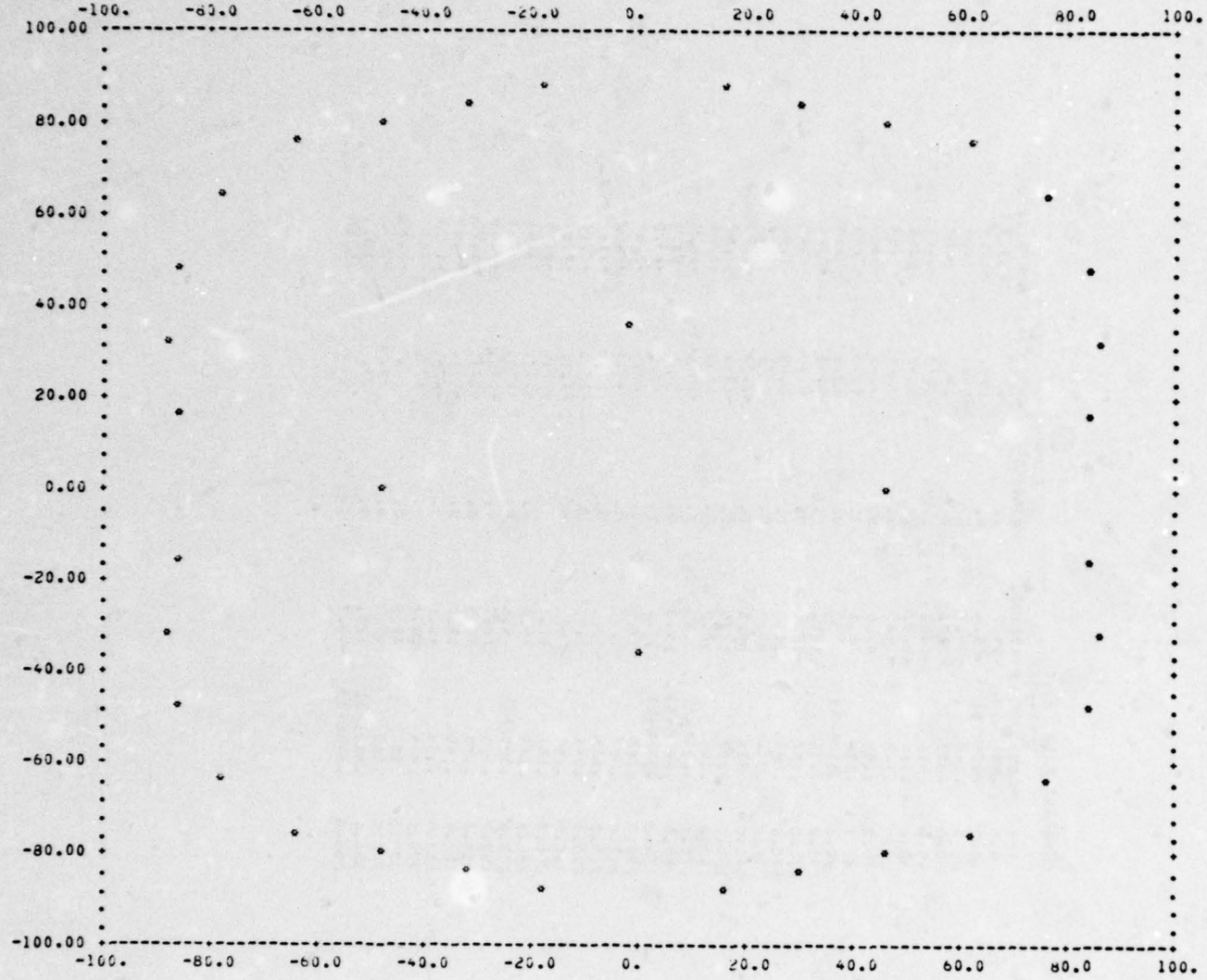
CONSTANT PHI= 0.

	E(THETA)		E(PHI)		
THE=	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	NORMALIZED
0.0	0.	0.	.841E-03	-89.7	-53.9
10.0	.123	-117.	.841E-03	-89.7	-10.5
20.0	.247	-118.	.841E-03	-89.7	-4.54
30.0	.349	-119.	.841E-03	-89.7	-1.52
40.0	.375	-120.	.841E-03	-89.7	-.899
50.0	.265	-123.	.841E-03	-89.7	-3.41
60.0	.373E-01	-155.	.841E-03	-89.7	-20.9
70.0	.186	56.3	.841E-03	-89.7	-6.94
80.0	.200	53.5	.841E-03	-89.7	-6.37
90.0	.320E-03	-135.	.841E-03	-89.7	-53.3
100.0	.200	-116.	.841E-03	-89.7	-6.34
110.0	.187	-113.	.841E-03	-89.7	-6.94
120.0	.374E-01	23.1	.841E-03	-89.7	-20.9
130.0	.265	56.9	.841E-03	-89.7	-3.92
140.0	.375	59.7	.841E-03	-89.7	-.899
150.0	.349	61.2	.841E-03	-89.7	-1.52
160.0	.247	62.4	.841E-03	-89.7	-4.53
170.0	.123	63.3	.841E-03	-89.7	-10.5
180.0	0.	-116.	.841E-03	-89.7	-53.9
190.0	.123	-117.	.841E-03	-89.7	-10.5
200.0	.247	-118.	.841E-03	-89.7	-4.53
210.0	.349	-119.	.841E-03	-89.7	-1.52
220.0	.375	-120.	.841E-03	-89.7	-.899
230.0	.265	-123.	.841E-03	-89.7	-3.92
240.0	.374E-01	-157.	.841E-03	-89.7	-20.9
250.0	.187	56.5	.841E-03	-89.7	-6.94
260.0	.200	53.5	.841E-03	-89.7	-6.34
270.0	.320E-03	44.5	.841E-03	-89.7	-53.3
280.0	.200	-117.	.841E-03	-89.7	-6.37
290.0	.186	-114.	.841E-03	-89.7	-6.98
300.0	.373E-01	25.1	.841E-03	-89.7	-20.9
310.0	.265	57.1	.841E-03	-89.7	-3.91
320.0	.375	59.7	.841E-03	-89.7	-.895
330.0	.349	61.2	.841E-03	-89.7	-1.52
340.0	.247	62.4	.841E-03	-89.7	-4.54
350.0	.123	63.3	.841E-03	-89.7	-10.5
360.0	0.	-1.6.	.841E-03	-89.7	-53.9


-100.
-80.0
-60.0
-40.0
-20.0
0.
20.0
40.0
60.0
80.0
100.
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
-100.00

CONSTANT PHI= 90.0

	E(THETA)		E(PHI)		
TH=	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	NORMALIZED
0.0	.841E-03	-89.7	0.	0.	-53.9
10.0	.878E-01	-54.0	0.	-160.	-13.5
20.0	.168	-89.7	0.	-156.	-7.88
30.0	.307	-117.	0.	-129.	-2.62
40.0	.415	-130.	0.	-3.73	-.424E-03
50.0	.364	-140.	0.	6.00	-1.15
60.0	.168	-168.	0.	9.48	-7.89
70.0	.155	97.0	0.	9.49	-8.52
80.0	.175	76.1	0.	9.93	-7.48
90.0	.320E-03	-135.	0.	10.1	-62.3
100.0	.175	-104.	0.	9.93	-7.45
110.0	.157	-82.9	0.	9.49	-8.45
120.0	.169	11.7	0.	8.48	-7.88
130.0	.364	40.3	0.	6.00	-1.15
140.0	.415	50.0	0.	-3.73	-.223E-02
150.0	.307	52.6	0.	-129.	-2.62
160.0	.168	90.3	0.	-156.	-7.87
170.0	.879E-01	126.	0.	-159.	-13.5
180.0	.841E-03	90.3	0.	0.	-53.9
190.0	.870E-01	-53.4	0.	20.5	-13.5
200.0	.168	-89.5	0.	23.9	-7.89
210.0	.307	-117.	0.	44.7	-2.62
220.0	.415	-130.	0.	177.	-.187E-02
230.0	.364	-140.	0.	-174.	-1.15
240.0	.169	-168.	0.	-171.	-7.87
250.0	.157	97.1	0.	-171.	-8.45
260.0	.175	75.2	0.	-170.	-7.45
270.0	.320E-03	44.5	0.	-170.	-62.3
280.0	.175	-104.	0.	-170.	-7.49
290.0	.155	-82.9	0.	-171.	-8.52
300.0	.168	12.2	0.	-171.	-7.89
310.0	.364	40.5	0.	-174.	-1.15
320.0	.415	50.2	0.	177.	0.
330.0	.307	52.8	0.	44.7	-2.62
340.0	.167	90.5	0.	23.9	-7.90
350.0	.869E-01	127.	0.	20.5	-13.5
360.0	.841E-03	-89.7	0.	0.	-53.9

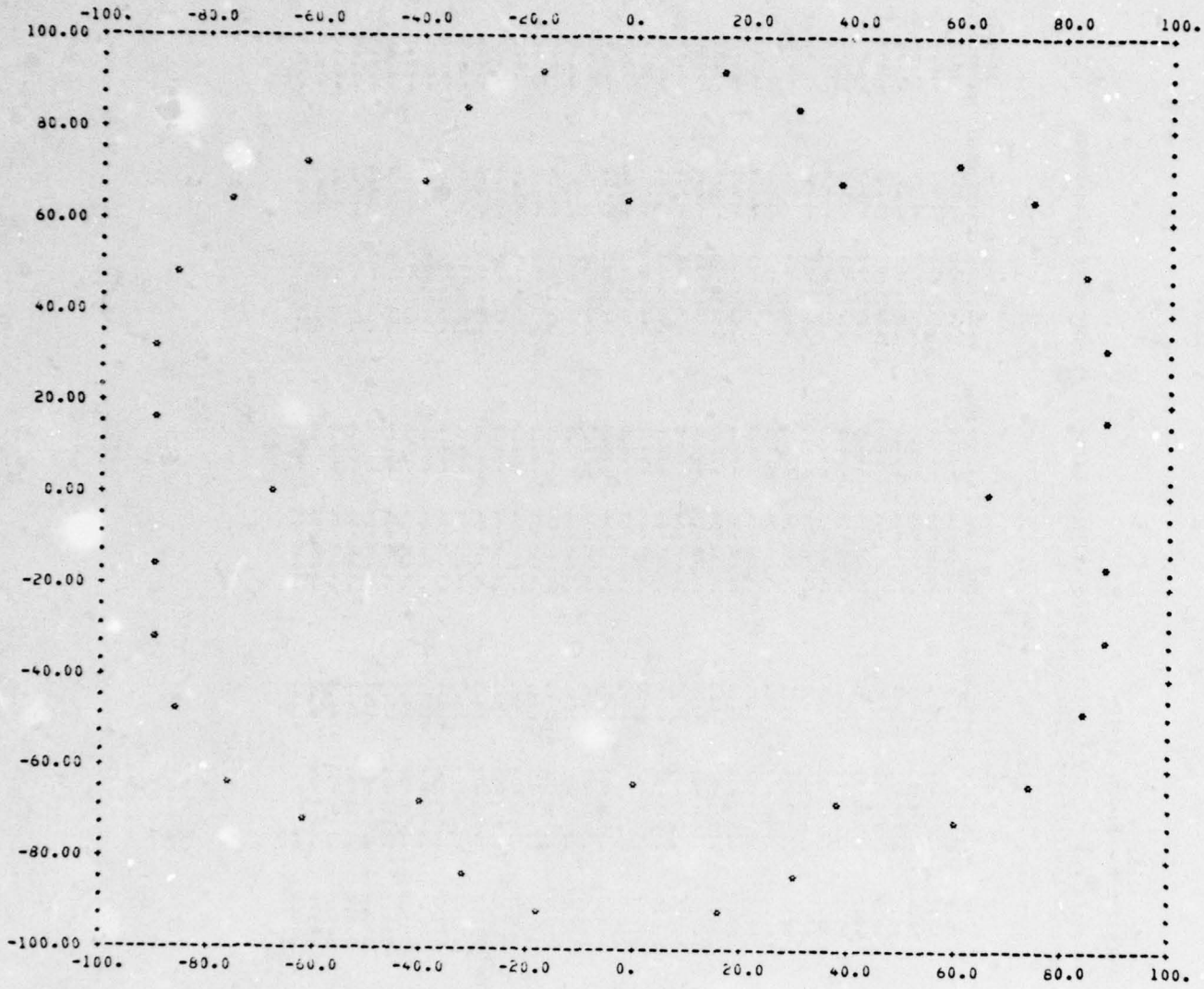

-100.
-80.0
-60.0
-40.0
-20.0
0.
20.0
40.0
60.0
80.0
100.
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
-100.00

E-FIELD MATRIX I
SPHERICAL COORDINATE SYSTEM

NEAR FIELD FOR FIELD DATA=NEARFLD -CURRENT DATA= I -GEOMETRY DATA=XDIPOL
NORMALIZATION FACTOR .207E-01 V/M

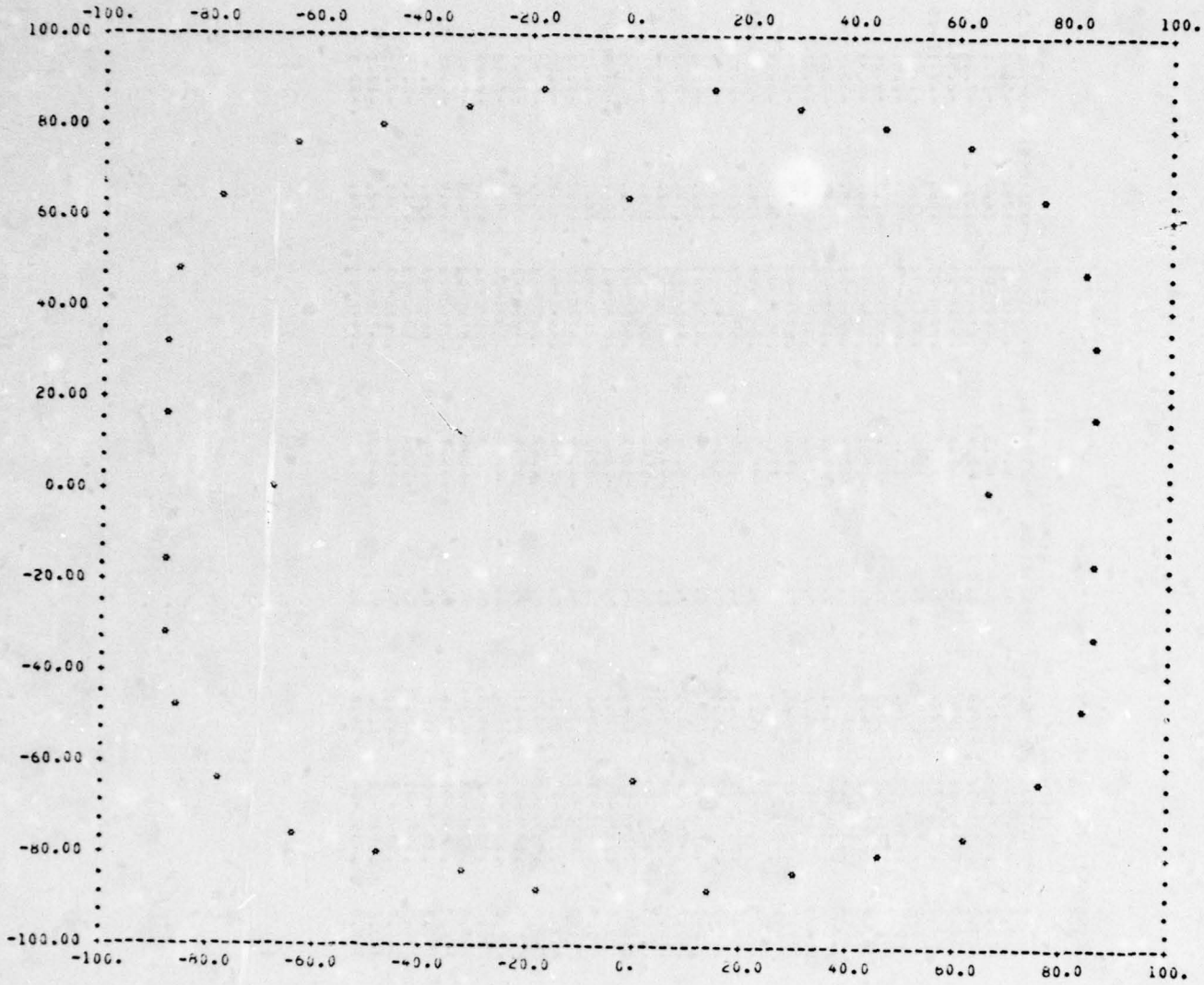
CONSTANT R= 10.0 PHI= 0.

	E(THETA)		E(PHI)		E(RAD)		DB-GAIN
TH=	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	NORMALIZED
0.0	0.	0.	.435E-04	-99.0	.447E-03	-178.	-33.3
10.0	.620E-02	-122.	.435E-04	-99.0	.444E-03	-180.	-10.4
20.0	.124E-01	-123.	.435E-04	-99.0	.409E-03	178.	-4.44
30.0	.175E-01	-126.	.435E-04	-99.0	.280E-03	-173.	-1.45
40.0	.189E-01	-129.	.435E-04	-99.0	.205E-03	-92.6	-.846
50.0	.132E-01	-133.	.435E-04	-99.0	.581E-03	-56.9	-3.85
60.0	.183E-02	-164.	.435E-04	-99.0	.831E-03	-55.1	-20.3
70.0	.921E-02	52.6	.435E-04	-99.0	.612E-03	-63.8	-7.01
80.0	.989E-02	49.2	.435E-04	-99.0	.222E-03	-135.	-6.41
90.0	.137E-04	-140.	.435E-04	-99.0	.389E-03	179.	-34.5
100.0	.992E-02	-131.	.435E-04	-99.0	.223E-03	-135.	-5.38
110.0	.925E-02	-127.	.435E-04	-99.0	.612E-03	-63.9	-6.97
120.0	.183E-02	14.0	.435E-04	-99.0	.831E-03	-55.1	-20.2
130.0	.132E-01	46.8	.435E-04	-99.0	.562E-03	-56.8	-3.88
140.0	.189E-01	51.1	.435E-04	-99.0	.205E-03	-92.6	-.846
150.0	.175E-01	54.1	.435E-04	-99.0	.280E-03	-173.	-1.45
160.0	.124E-01	56.6	.435E-04	-99.0	.409E-03	178.	-4.44
170.0	.620E-02	58.3	.435E-04	-99.0	.444E-03	-180.	-10.4
180.0	0.	-114.	.435E-04	-99.0	.443E-03	-178.	-33.3
190.0	.620E-02	-122.	.435E-04	-99.0	.444E-03	-180.	-10.4
200.0	.124E-01	-123.	.435E-04	-99.0	.409E-03	178.	-4.44
210.0	.175E-01	-126.	.435E-04	-99.0	.280E-03	-173.	-1.45
220.0	.189E-01	-129.	.435E-04	-99.0	.205E-03	-92.6	-.846
230.0	.132E-01	-133.	.435E-04	-99.0	.582E-03	-56.8	-3.88
240.0	.183E-02	-166.	.435E-04	-99.0	.831E-03	-55.1	-20.2
250.0	.925E-02	52.9	.435E-04	-99.0	.612E-03	-63.9	-6.97
260.0	.992E-02	49.3	.435E-04	-99.0	.223E-03	-135.	-5.38
270.0	.137E-04	39.7	.435E-04	-99.0	.389E-03	179.	-34.5
280.0	.989E-02	-131.	.435E-04	-99.0	.222E-03	-135.	-6.41
290.0	.921E-02	-127.	.435E-04	-99.0	.612E-03	-63.8	-7.01
300.0	.183E-02	15.0	.435E-04	-99.0	.831E-03	-55.1	-20.3
310.0	.132E-01	47.0	.435E-04	-99.0	.581E-03	-56.9	-3.86
320.0	.189E-01	51.1	.435E-04	-99.0	.205E-03	-93.0	-.843
330.0	.175E-01	54.2	.435E-04	-99.0	.280E-03	-173.	-1.45
340.0	.124E-01	56.5	.435E-04	-99.0	.409E-03	178.	-4.44
350.0	.620E-02	58.3	.435E-04	-99.0	.444E-03	-180.	-10.4
360.0	0.	-114.	.435E-04	-99.0	.447E-03	-178.	-33.3


-100.
-80.0
-60.0
-40.0
-20.0
0.
20.0
40.0
60.0
80.0
100.
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
-100.00

CONSTANT R= 10.0 PHI= 40.0

	E(THETA)		E(PHI)		E(RAD)		DB-GAIN
TH=	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	NORMALIZED
0.0	.435E-04	-99.0	0.	0.	.447E-03	-178.	-33.3
10.0	.513E-02	-53.1	0.	80.6	.469E-03	162.	-12.1
20.0	.907E-02	-34.9	0.	62.4	.614E-03	133.	-7.14
30.0	.154E-01	-124.	0.	51.6	.631E-03	121.	-2.55
40.0	.207E-01	-139.	0.	54.8	.289E-03	106.	-.211E-03
50.0	.183E-01	-149.	0.	114.	.314E-03	-37.1	-1.07
60.0	.834E-02	-176.	0.	175.	.675E-03	-50.8	-7.81
70.0	.708E-02	83.3	0.	-178.	.512E-03	-61.7	-9.29
80.0	.835E-02	50.8	0.	-175.	.188E-03	-158.	-7.88
90.0	.137E-04	-140.	0.	-180.	.426E-03	159.	-33.7
100.0	.838E-02	-119.	0.	-175.	.189E-03	-158.	-7.85
110.0	.714E-02	-96.6	0.	-178.	.512E-03	-61.9	-9.22
120.0	.841E-02	3.79	0.	175.	.677E-03	-50.8	-7.79
130.0	.183E-01	30.4	0.	114.	.315E-03	-36.9	-1.07
140.0	.207E-01	40.8	0.	54.7	.289E-03	106.	-.895E-03
150.0	.154E-01	55.5	0.	51.6	.631E-03	121.	-2.55
160.0	.907E-02	85.1	0.	62.4	.619E-03	133.	-7.14
170.0	.514E-02	117.	0.	80.7	.470E-03	162.	-12.1
180.0	.435E-04	81.0	0.	0.	.449E-03	-178.	-33.3
190.0	.509E-02	-62.6	0.	-99.3	.472E-03	162.	-12.1
200.0	.905E-02	-94.7	0.	-118.	.620E-03	134.	-7.15
210.0	.154E-01	-124.	0.	-128.	.632E-03	121.	-2.55
220.0	.207E-01	-139.	0.	-125.	.289E-03	106.	-.694E-03
230.0	.183E-01	-150.	0.	-65.1	.315E-03	-36.7	-1.07
240.0	.841E-02	-176.	0.	-4.89	.677E-03	-50.7	-7.79
250.0	.714E-02	83.5	0.	1.89	.513E-03	-61.8	-9.22
260.0	.834E-02	50.9	0.	4.61	.190E-03	-158.	-7.83
270.0	.137E-04	39.7	0.	17.6	.426E-03	159.	-33.7
280.0	.835E-02	-119.	0.	4.61	.188E-03	-158.	-7.88
290.0	.708E-02	-96.6	0.	1.79	.512E-03	-61.7	-9.29
300.0	.839E-02	4.26	0.	-4.96	.675E-03	-50.8	-7.81
310.0	.183E-01	30.6	0.	-66.2	.314E-03	-36.9	-1.07
320.0	.207E-01	41.0	0.	-125.	.289E-03	106.	0.
330.0	.154E-01	55.7	0.	-128.	.632E-03	121.	-2.56
340.0	.905E-02	85.3	0.	-118.	.620E-03	134.	-7.15
350.0	.509E-02	117.	0.	-99.3	.471E-03	162.	-12.2
360.0	.435E-04	-99.0	0.	0.	.447E-03	-178.	-33.3


-100.
-80.0
-60.0
-40.0
-20.0
0.
20.0
40.0
60.0
80.0
100.
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
-100.00

```
CHECKPOINT NUMBER     2 STARTED AT TIME          .596
COMMON BLOCK ADEBUG #RITTEN OUT TO IOCKPT
COMMON BLOCK AMPZIJ #RITTEN OUT TO IOCKPT
COMMON BLOCK ARGCOM #RITTEN OUT TO IOCKPT
COMMON BLOCK CSYSTM #RITTEN OUT TO IOCKPT
COMMON BLOCK DEFDAT #RITTEN OUT TO IOCKPT
COMMON BLOCK FLDCOM #RITTEN OUT TO IOCKPT
COMMON BLOCK GEODAT #RITTEN OUT TO IOCKPT
COMMON BLOCK IOFLES #RITTEN OUT TO IOCKPT
COMMON BLOCK JUNCOM #RITTEN OUT TO IOCKPT
COMMON BLOCK PARTAB #RITTEN OUT TO IOCKPT
COMMON BLOCK SCNPAR #RITTEN OUT TO IOCKPT
COMMON BLOCK SEGMNT #RITTEN OUT TO IOCKPT
COMMON BLOCK SYMSTR #RITTEN OUT TO IOCKPT
COMMON BLOCK SYSFIL #RITTEN OUT TO IOCKPT
COMMON BLOCK TEMP01 #RITTEN OUT TO IOCKPT
PERIPHERAL FILE     8   SYMBOL #DIPOL NUMREC=    40
PERIPHERAL FILE     9   SYMBOL ZIJKOP NUMREC=    40
PERIPHERAL FILE    10   SYMBOL BNDZIJ NUMREC=    40
PERIPHERAL FILE    11   SYMBOL ANTSRC NUMREC=     1
PERIPHERAL FILE    15   SYMBOL      I NUMREC=     1
PERIPHERAL FILE    12   SYMBOL NERFLD NUMREC=     4
PERIPHERAL FILE    13   SYMBOL BNDJPR NUMREC=    40
PERIPHERAL FILE    14   SYMBOL BNDLMR NUMREC=    40
CHECKPOINT COMPLETE AT          .594
ELAPSED TIME=          .011
NUMBER OF WORDS #RITTEN =      49715


FREQUENCY SET TO      .120E+04 MEGAHERTZ
#AVLENGTH     .250      METERS


GEMACS EXECUTION COMPLETED ON  11/10/75  AT  12.07.53.


GEMACS SUBROUTINE TIMING STATISTICS (IN SECONDS)

                TIMES      TOTAL TIME      PER CENT OF
 ROUTINE       CALLED     IN ROUTINE       EMCAP TIME

  ROMBNT         9120           7.61           20.794
  TNEFLD         9120           6.73           18.377
  PASPLT            4           2.50            6.861
  PAGPLT            4           2.30            6.343
  #DEFIL         2130           1.74            4.598
  #RTFIL         1335           1.44            3.928
  ZIJSET            1           1.32            3.598
  ZIJSET            1           1.24            3.382
  NERFLD           74           1.11            3.021
  NERFLD           74           1.07            2.912
  NTHPLT         1600            .85            2.311
  NTHPLT         1600            .83            2.261
  SEJCOM         3440            .72            1.955
  FARFLD           74            .66            1.817
  FARFLD           74            .65            1.778
  JNCSUM         3040            .54            1.584
  JNCSUM         3040            .55            1.519
  GETSYM          168            .52            1.423
  RWCOMS            2            .39            1.061
  FLDOUT            2            .32             .874
  FLDOUT            2            .31             .855
  PUTSYM          129            .30             .830
  SCAN             28            .30             .824
  IBITCK         1174            .23             .647
```

MOVFIL	141	.19	.505
DECOMP	1	.12	.336
GEODRV	1	.12	.322
FABL04	48	.12	.322
OPNFIL	29	.12	.317
DECOMP	1	.11	.294
FABL04	48	.11	.293
FLDDRV	2	.10	.265
FLDDRV	2	.09	.249
TSKXQT	1	.09	.235
JCTION	1	.09	.235
SOLVOC	10	.08	.229
#RTCHK	2	.08	.227
SYMDEF	22	.06	.172
GETK#D	70	.05	.134
SOLDRV	1	.05	.134
BMIRHS	6	.05	.131
LNKJCT	1	.04	.117
SOLVOC	4	.04	.098
SYSCHK	99	.04	.098
CABC	2	.03	.093
ENDARG	73	.03	.085
PARSE	18	.03	.085
SOLDRV	1	.03	.082
CABC	2	.03	.079
PRTSYM	1	.03	.071
BMIRHS	3	.02	.066
BACSUB	5	.02	.066
BANDIT	1	.02	.057
BANDIT	1	.02	.052
EXCDRV	2	.02	.046
EXCDRV	2	.02	.044
PRTSYM	1	.02	.044
#YRDRV	1	.01	.041
GETARG	70	.01	.036
PUTSEG	40	.01	.033
BUBBLE	1	.01	.027
SYMUPD	20	.01	.027
ZIJDRV	1	.01	.022
LUDDRV	1	.01	.019
BACSUB	2	.01	.019
PUTK#V	3	.01	.016
ZIJDRV	1	.01	.016
FLDDRV	2	.01	.016
LITSCH	31	.01	.016
LUDDRV	1	.01	.014
INPDRV	1	.00	.014
SYMSCH	21	.00	.014
POSTPR	18	.00	.011
SCALE2	8	.00	.008
PUTK#V	1	.00	.008
SCALE2	8	.00	.008
PUTK#V	1	.00	.005
CNVAMP	1	.00	.005
DMPDRV	3	.00	.005
CNVAMP	1	.00	.005
SYMLIT	13	.00	.005
DMPDRV	4	.00	.003
PREPAR	18	.00	.003
EXCDRV	2	.00	.003
SOLDRV	1	.00	.003
DMPDRV	1	.00	.003
COORDS	4	.00	.003
PLIST	3	.00	.003
DMPDRV	1	.00	.003
PUTPNT	5	.00	.003
PRTSYM	1	0.00	0.003
ZIJDRV	1	0.00	0.000
GETK#V	1	0.00	0.000
PRESCN	1	0.00	0.000
SYSHTN	4	0.00	0.000
GEODRV	1	0.00	0.000
GETPNT	6	0.00	0.000
BANDIT	1	0.00	0.000
POSTIP	1	0.00	0.000
GETK#V	1	0.00	0.000
LUDDRV	1	0.00	0.000

TOTAL ACCOUNTED TIME(SECONDS)= 36.61

EXAMPLE 2

```
                                                                GEMACS VERSION 01

USER INPUT STREAM

        1     DEBUG ON,ILP
        2     RSTART CPNUM=2
        3     $
        4     $   PERFORM SAME OPERATIONS AT 1200 MHZ AND TURN ON DEBUG FOR DEMONSTRAT
        5     $  ION DURING RMI
        6     $
        7     ZGEN SINCOS ZMATRX=ZIJKDP BWDATA=ADIPOL  $ RE GENERATE IMPEDANCE MATRIX
        8     BNDZIJ=BAND(ZIJKDP) BNDW=10              $ EXTRACT BAND
        9     ANTSRC=VSRC(XDIPOL) V=.5,.0 SEGS=1,3     $ EXCITE SEGMENTS 1 AND 3
       10     ANTSRC=VSRC(ADIPOL) V=.0,.5 SEGS=2,4     $ EXCITE SEGMENTS 2 AND 4
       11     BNDZIJ=LUD(BNDZIJ)                       $ DECOMPOSE BANDED MATRIX
       12     $
       13     $ TURN DEBUG ON DURING RMI
       14     $
       15     DEBUG ON
       16     BNDZIJRI=ANTSRC-ZIJKDP,I MAXITR=10 CONVRG=1 VALUE=5
       17     $
       18     $ TURN DEBUG OFF
       19     $
       20     DEBUG OFF
       21     PRINT I,ANTSRC
       22     $
       23     $  PLOT NEAR FIELD IN CONICAL CUTS (CYLINDRICAL COORDINATES)
       24     $
       25     EFIELD(I) LOGPLR
       26      T2=360. DT=10.
       27      R2=10. DR=0.
       28      Z2=20. DZ=1.
       29      P1=10. Z1=0. T1=0.
       30     END

RESERVED KEYWORDS--MAY NOT BE USED FOR SYMBOL NAMES

            C       D       N       O       R       V       X       Z       C*
      C1    C2      DM      DP      DR      DT      D*      DX      DY      DZ
      IS    LU      NP      NR      ON      P1      P2      R1      R2      SC
      SW    T1      T2      VS      X1      X2      Y1      Y2      Z1      Z2
     ABS    COP     ECO     END     FRQ     ILP     INV     LUD     OFF     PRI
     ROP    SEQ     SET     AXIS    BAND    BNDA    COND    LPSR    ESRC    LOOP
    PLOT    PRLC    READ    SCOP    SEGS    SIZE    SRCP    SRLC    TAGS    TIME
    TYPE    VSRC    ZGEN    ZIMP    CONJG   CPINC   CPNUM   DEBUG   LABEL   PARIN
   PIVOT    PRINT   PULSE   PURGE   SOLVE   THETA   TRACE   VALUE   WRITE   BACSUB
  CURRNT COLPSE CONVRG EFIELD EXPAND FILEID GWDATA LINLIN LINLOG LINPLR
  LOGLIN LOGLOG LOGPLR MAXITR NUMPIL PCESIN REDUCE REFLCT REPLAC RSTART
  SINCOS SYMDEF TRANSP WIPOUT ZCODES ZLOADS ZMATRX

GEMACS INPUT LANGUAGE PROCESSOR CALLED ON  11/15/78  AT  23.49.45.


GEMACS CARD IMAGE PROCESSOR FOR RECORD  1

 CARD          1111111111222222222233333333344444444445555555556666666667777777778
       1234567890123456789012345678901234567890123456789012345678901234567890

    1  DEBUG ON,ILP

NEW TASK ENTRY
  1                1
```

```
NEW ARGUMENT LIST ENTRIES
  1                 8
  2                64
  3                 0
    2  RSTART CPNUM=2

**********  PARSE CALLED  **********

  NTAB  NCODE            NVAL
    1      5              32   (RSTART)
    2      5              45   ( CPNUM)
    3      4               8   (=      )
    4      7               2
    5      1  ***** END *****

NEW TASK ENTRY
  2                 4

NEW ARGUMENT LIST ENTRIES
  4                29
  5           -999999
  6           -999999
  7                 2

     EXECUTING THE RESTART COMMAND
       FROM FILE CHKPNT, ON LOGICAL UNIT   7, CHECK POINT NUMBER   2
READ FILE      7 NUMBER OF WORDS=          1
READ FILE      7 NUMBER OF WORDS=          1
READ FILE      7 NUMBER OF WORDS=          1
     COMMON ADEBUG READ WITH   1106 WORDS
READ FILE      7 NUMBER OF WORDS=       1106
     COMMON AMPZIO READ WITH     43 WORDS
     COMMON ARGCOM READ WITH    104 WORDS
     COMMON CSYSTM READ WITH     72 WORDS
     COMMON DEFDAT READ WITH    505 WORDS
     COMMON FLDCOM READ WITH      7 WORDS
     COMMON GEODAT READ WITH    119 WORDS
     COMMON IOFLES READ WITH    200 WORDS
     COMMON JUNCOM READ WITH    205 WORDS
     COMMON PARTAB READ WITH   3338 WORDS
     COMMON SCNPAR READ WITH    755 WORDS
     COMMON SEGMNT READ WITH   5525 WORDS
     COMMON SYMSTR READ WITH    107 WORDS
     COMMON SYSFIL READ WITH     32 WORDS
     COMMON TEMP01 READ WITH   5002 WORDS
READ FILE      7 NUMBER OF WORDS=          1

GETSYM CALLED FOR RECORDS     1 TO     40 FOR XDIPOL     7 =FILEID     1 =FIRST WORD ON FILE
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
READ FILE      7 NUMBER OF WORDS=         11
     READING DATA SET XDIPOL RECORDS=     40
READ FILE      7 NUMBER OF WORDS=          1
```

```
GETSYM CALLED FOR RECORDS     1 TO     40 FOR ZIUADP     7 =FILEID     1 =FIRST WORD ON FILE
READ FILE      7 NUMBER OF WORDS=          80
READ FILE      7 NUMBER OF WORDS=          80
READ FILE      7 NUMBER OF WORDS=          80
```

```
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
     READING DATA SET BNDZIJ RECORDS=        40
READ FILE      7 NUMBER OF WORDS=           1

SETSYM CALLED FOR RECORDS    1 TO     1 FOR ANTSRC     7 =FILEID     1 =FIRST WORD ON FILE
READ FILE      7 NUMBER OF WORDS=          60
     READING DATA SET ANTSRC RECORDS=         1
READ FILE      7 NUMBER OF WORDS=           1

SETSYM CALLED FOR RECORDS    1 TO     1 FOR       I     7 =FILEID     1 =FIRST WORD ON FILE
READ FILE      7 NUMBER OF WORDS=          60
     READING DATA SET       I RECORDS=         1
READ FILE      7 NUMBER OF WORDS=           1

SETSYM CALLED FOR RECORDS    1 TO     2 FOR NERFLD     7 =FILEID     1 =FIRST WORD ON FILE
READ FILE      7 NUMBER OF WORDS=         228
READ FILE      7 NUMBER OF WORDS=         228
     READING DATA SET NERFLD RECORDS=         2
READ FILE      7 NUMBER OF WORDS=           1

SETSYM CALLED FOR RECORDS    1 TO    40 FOR BNDUPR     7 =FILEID     1 =FIRST WORD ON FILE
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          20
READ FILE      7 NUMBER OF WORDS=          18
READ FILE      7 NUMBER OF WORDS=          16
READ FILE      7 NUMBER OF WORDS=          14
READ FILE      7 NUMBER OF WORDS=          12
READ FILE      7 NUMBER OF WORDS=          10
READ FILE      7 NUMBER OF WORDS=           8
READ FILE      7 NUMBER OF WORDS=           6
READ FILE      7 NUMBER OF WORDS=           4
READ FILE      7 NUMBER OF WORDS=           2
     READING DATA SET BNDUPR RECORDS=        40
READ FILE      7 NUMBER OF WORDS=           1

SETSYM CALLED FOR RECORDS    1 TO    40 FOR BNDLWR     7 =FILEID     1 =FIRST WORD ON FILE
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
```

```
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          20
READ FILE      7 NUMBER OF WORDS=          18
READ FILE      7 NUMBER OF WORDS=          16
READ FILE      7 NUMBER OF WORDS=          14
READ FILE      7 NUMBER OF WORDS=          12
READ FILE      7 NUMBER OF WORDS=          10
READ FILE      7 NUMBER OF WORDS=           8
READ FILE      7 NUMBER OF WORDS=           6
READ FILE      7 NUMBER OF WORDS=           4
READ FILE      7 NUMBER OF WORDS=           2
     READING DATA SET AMDLAR RECORDS=      40
READ FILE      7 NUMBER OF WORDS=           1
READ FILE      7 NUMBER OF WORDS=           1
     COMMON ADERUS READ WITH    1105 WORDS
READ FILE      7 NUMBER OF WORDS=        1106
     COMMON AMPZIJ READ WITH      43 WORDS
     COMMON ARGCOM READ WITH     104 WORDS
     COMMON CSYSTM READ WITH      72 WORDS
     COMMON DEFDAT READ WITH     505 WORDS
     COMMON FLDCOM READ WITH       7 WORDS
     COMMON GEODAT READ WITH     114 WORDS
     COMMON ICFLES READ WITH     200 WORDS
     COMMON JUNCOM READ WITH     205 WORDS
     COMMON PARTAB READ WITH    3338 WORDS
     COMMON SCNPAR READ WITH     755 WORDS
     COMMON SEGMNT READ WITH    5525 WORDS
     COMMON SYSTM READ WITH      107 WORDS
     COMMON SYSFIL READ WITH      32 WORDS
     COMMON TEMP01 READ WITH    5002 WORDS
READ FILE      7 NUMBER OF WORDS=           1

GETSYM CALLED FOR RECORDS     1 TO     40 FOR ASIMOL     7 =FILEID     1 =FIRST WORD ON FILE
READ FILE      7 NUMBER OF WORDS=          11
READ FILE      7 NUMBER OF WORDS=          11
READ FILE      7 NUMBER OF WORDS=          11
```

```
READ FILE      7 NUMBER OF WORDS=          11
READ FILE      7 NUMBER OF WORDS=          11
READ FILE      7 NUMBER OF WORDS=          11
READ FILE      7 NUMBER OF WORDS=          11
READ FILE      7 NUMBER OF WORDS=          11
READ FILE      7 NUMBER OF WORDS=          11
READ FILE      7 NUMBER OF WORDS=          11
READ FILE      7 NUMBER OF WORDS=          11
READ FILE      7 NUMBER OF WORDS=          11
READ FILE      7 NUMBER OF WORDS=          11
READ FILE      7 NUMBER OF WORDS=          11
PUTSYM CALLED TO STORE RECORDS     1 TO    40 FOR XDIPOL     8 =FILEID      1 =FIRST WORD ON FILE
WRITE     11 WORDS TO FILE  8
WRITE     11 WORDS TO FILE  8
WRITE     11 WORDS TO FILE  8
```

```
READ FILE      7 NUMBER OF WORDS=          80
READ FILE      7 NUMBER OF WORDS=          80
READ FILE      7 NUMBER OF WORDS=          80
READ FILE      7 NUMBER OF WORDS=          80
READ FILE      7 NUMBER OF WORDS=          80
READ FILE      7 NUMBER OF WORDS=          80
READ FILE      7 NUMBER OF WORDS=          80
READ FILE      7 NUMBER OF WORDS=          80
READ FILE      7 NUMBER OF WORDS=          80
READ FILE      7 NUMBER OF WORDS=          80
READ FILE      7 NUMBER OF WORDS=          80
READ FILE      7 NUMBER OF WORDS=          80
READ FILE      7 NUMBER OF WORDS=          80
PUTSYM CALLED TO STORE RECORDS     1 TO    40 FOR ZIJADP     9 =FILEID      1 =FIRST WORD ON FILE
WRITE     80 WORDS TO FILE  9
WRITE     80 WORDS TO FILE  9
WRITE     80 WORDS TO FILE  9
```

```
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
READ FILE      7 NUMBER OF WORDS=          42
PUTSYM CALLED TO STORE RECORDS     1 TO    40 FOR BNDZIJ    10 =FILEID      1 =FIRST WORD ON FILE
WRITE     42 WORDS TO FILE 10
WRITE     42 WORDS TO FILE 10
WRITE     42 WORDS TO FILE 10
```

```
GETSYM CALLED FOR RECORDS     1 TO      4 FOR NERFLD     7 =FILEID      1 =FIRST WORD ON FILE
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
PUTSYM CALLED TO STORE RECORDS     1 TO      4 FOR NERFLD    12 =FILEID      1 =FIRST WORD ON FILE
WRITE    22 WORDS TO FILE 12
WRITE    22 WORDS TO FILE 12
WRITE    22 WORDS TO FILE 12
WRITE    22 WORDS TO FILE 12
     READING DATA SET NERFLD RECORDS=          4
READ FILE      7 NUMBER OF WORDS=           1

GETSYM CALLED FOR RECORDS     1 TO     40 FOR ENDUPR     7 =FILEID      1 =FIRST WORD ON FILE
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
READ FILE      7 NUMBER OF WORDS=          22
```

```
WRITE     22 WORDS TO FILE 13
WRITE     20 WORDS TO FILE 13
WRITE     18 WORDS TO FILE 13
WRITE     16 WORDS TO FILE 13
WRITE     14 WORDS TO FILE 13
WRITE     12 WORDS TO FILE 13
WRITE     10 WORDS TO FILE 13
WRITE      8 WORDS TO FILE 13
WRITE      6 WORDS TO FILE 13
WRITE      4 WORDS TO FILE 13
WRITE      2 WORDS TO FILE 13
     READING DATA SET BNDUPR RECORDS=       40
READ FILE      7 NUMBER OF WORDS=          1

GETSYM CALLED FOR RECORDS     1 TO     40 FOR BNDLWR     7 =FILEID      1 =FIRST WORD ON FILE
READ FILE      7 NUMBER OF WORDS=         22
READ FILE      7 NUMBER OF WORDS=         22
READ FILE      7 NUMBER OF WORDS=         22
```

```
WRITE     22 WORDS TO FILE 14
WRITE     22 WORDS TO FILE 14
WRITE     20 WORDS TO FILE 14
WRITE     18 WORDS TO FILE 14
WRITE     16 WORDS TO FILE 14
WRITE     14 WORDS TO FILE 14
WRITE     12 WORDS TO FILE 14
WRITE     10 WORDS TO FILE 14
WRITE      8 WORDS TO FILE 14
WRITE      6 WORDS TO FILE 14
WRITE      4 WORDS TO FILE 14
WRITE      2 WORDS TO FILE 14
     READING DATA SET BNDLAR RECORDS=       40
     CHECK POINT   2 LOADING COMPLETE
    0  $
    1  $   PERFORM SAME OPERATIONS AT 1200 MHZ AND TURN ON DEBUG FOR DEMONSTRAT
    2  $  ION DURING RMI
    3  $
    4  ZGEN SINCOS ZMATRX=ZIJXDP GMDATA=XDIPOL  $ RE GENERATE IMPEDANCE MATRIX

**********************  PARSE CALLED  **********************

  NTAB  NCODE             NVAL
     1      5               39   (  ZGEN)
     2      5              101   (SINCOS)
     3      5              107   (ZMATRX)
     4      4                8   (=      )
     5      6      28071002384   (ZIJXDP)
     6      5               14   (GMDATA)
     7      4                8   (=      )
     8      6      25839338444   (XDIPOL)
     9      1  ***** END *****

NEW TASK ENTRY
 18               123

NEW ARGUMENT LIST ENTRIES
123                39
124               101
125                 1
126          -999999
127          -999999
128          -999999
129          -999999
130                 2
    5  RNDZIJ=BAND(ZIJXDP) RNDW=10              $ EXTRACT BAND

**********************  PARSE CALLED  **********************

  NTAB  NCODE             NVAL
     1      6       2383520330   (RNDZIJ)
     2      4                8   (=      )
     3      5                2   (  BAND)
     4      4                5   ((      )
     5      6      28071002384   (ZIJXDP)
     6      4                5   ()      )
     7      5               41   (  RNDW)
     8      4                4   (=      )
     9      7               10
    10      1  ***** END *****

NEW TASK ENTRY
 19               131

NEW ARGUMENT LIST ENTRIES
131                 3
132                 3
133                 2
134                10
    6  ANTSRC=VSRC(XDIPOL) V=.5,,0 SEGS=1,3     $ EXCITE SEGMENTS 1 AND 3

**********************  PARSE CALLED  **********************

  NTAB  NCODE             NVAL
     1      6       1313944707   (ANTSRC)
     2      4                8   (=      )
     3      5               10   (  VSRC)
     4      4                5   ((      )
     5      6      25839338444   (XDIPOL)
     6      4                6   ()      )
     7      5               88   (     V)
     8      4                8   (=      )
     9      8        .50000E+00
```

```
   10       6       0.
   11       5                  76    (  SEGS)
   12       4                   8    (=      )
   13       7                   1
   14       7                   3
   15       1  ***** END *****

NEW TASK ENTRY
 20                 135

NEW ARGUMENT LIST ENTRIES
135                  45
136                   4
137                   1
138              -999999
139                  -8
140                  -9
141                  75
142                   1
143                   3
    7  ANTSRC=VSRC(XDIPOL) V=.0,.5 SEGS=2,4      $ EXCITE SEGMENTS 2 AND 4

***************  PARSE CALLED  ***************

  NTAB  NCODE             NVAL
    1       6       1313944737    (ANTSRC)
    2       4                8    (=      )
    3       5                10   (  VSRC)
    4       4                5    ((      )
    5       6       25839338444   (XDIPOL)
    6       4                6    ()      )
    7       5                88   (     V)
    8       4                8    (=      )
    9       8       0.
   10       8        .50000E+00
   11       5                76   (  SEGS)
   12       4                8    (=      )
   13       7                2
   14       7                4
   15       1  ***** END *****

NEW TASK ENTRY
 21                 144

NEW ARGUMENT LIST ENTRIES
144                  45
145                   4
146                   1
147              -999999
148                  -9
149                  -8
150                  75
151                   2
152                   4
    8  BNDZIJ=LUD(BNDZIJ)                        $ DECOMPOSE BANDED MATRIX

***************  PARSE CALLED  ***************

  NTAB  NCODE             NVAL
    1       6       2353520330    (BNDZIJ)
    2       4                8    (=      )
    3       5                8    (  LUD)
    4       4                5    ((      )
    5       6       2353520330    (BNDZIJ)
    6       4                5    ()      )
    7       1  ***** END *****

NEW TASK ENTRY
 22                 153

NEW ARGUMENT LIST ENTRIES
153                   9
154                   3
155                   5
156              -999999
    9  $
   10  $ TURN DEBUG ON DURING BMI
   11  $
   12  DEBUG ON
```

```
**********  PARSE CALLED  **********

  NTAB  NCODE            NVAL
    1       5               7   ( DEBUG)
    2       5              64   (    ON)
    3       1  ***** END *****

NEW TASK ENTRY
 23                157

NEW ARGUMENT LIST ENTRIES
157                 5
158                64
159           -999999
   13  RNDZIJ=I=ANTSRC-ZIJXDP=I MAXITR=10 CONVRG=1 VALUE=5

**********  PARSE CALLED  **********

  NTAB  NCODE            NVAL
    1       6      2383520330   (RNDZIJ)
    2       4               3   (=     )
    3       6               9   (     I)
    4       4               8   (=     )
    5       6      1313944707   (ANTSRC)
    6       4               2   (-     )
    7       6      2807100238   (ZIJXDP)
    8       4               3   (=     )
    9       6               9   (     I)
   10       5              19   (MAXITR)
   11       4               8   (=     )
   12       7              10
   13       5              17   (CONVRG)
   14       4               8   (=     )
   15       7               1
   16       5              18   ( VALUE)
   17       4               8   (=     )
   18       7               5
   19       1  ***** END *****

NEW TASK ENTRY
 24                160

NEW ARGUMENT LIST ENTRIES
160                15
161                 3
162                 5
163                 4
164                 2
165                 5
166                10
167                 1
168                 5
   14  $
   15  $ TURN DEBUG OFF
   16  $
   17  DEBUG OFF

**********  PARSE CALLED  **********

  NTAB  NCODE            NVAL
    1       5               7   ( DEBUG)
    2       5              63   (   OFF)
    3       1  ***** END *****

NEW TASK ENTRY
 25                169

NEW ARGUMENT LIST ENTRIES
169                 5
170                63
171           -999999
   18  PRINT I+ANTSRC
```

```
**********  PARSE CALLED  **********

  NTAB  NCODE          NVAL
    1      5            27   ( PRINT)
    2      6             9   (     I)
    3      6    1313944707   (ANTSRC)
    4      1   ***** END *****

NEW TASK ENTRY
 26              172

NEW ARGUMENT LIST ENTRIES
172               24
173                5
174                4
   19  $
   20  $  PLOT NEAR FIELD IN CONICAL CUTS (CYLINDRICAL COORDINATES)
   21  $
   22  EFIELD(I) LOGPLR
   23   T2=360. DT=10.
   24   R2=10. DR=0.
   25   Z2=20. DZ=1.
   26   R1=10. Z1=0. T1=0.

**********  PARSE CALLED  **********

  NTAB  NCODE          NVAL
    1      5            13   (EFIELD)
    2      4             5   ((    )
    3      6             9   (     I)
    4      4             6   ()    )
    5      5            59   (LOGPLR)
    6      5            87   (    T2)
    7      4             8   (=    )
    8      8     .36000E+03
    9      5           112   (    DT)
   10      4             8   (=    )
   11      8     .10000E+02
   12      5            73   (    R2)
   13      4             8   (=    )
   14      8     .10000E+02
   15      5           110   (    DR)
   16      4             8   (=    )
   17      8     0.
   18      5            98   (    Z2)
   19      4             8   (=    )
   20      8     .20000E+02
   21      5           115   (    DZ)
   22      4             8   (=    )
   23      8     .10000E+01
   24      5            72   (    R1)
   25      4             8   (=    )
   26      8     .10000E+02
   27      5            97   (    Z1)
   28      4             8   (=    )
   29      8     0.
   30      5            86   (    T1)
   31      4             8   (=    )
   32      8     0.
   33      1   ***** END *****

NEW TASK ENTRY
 27              175

NEW ARGUMENT LIST ENTRIES
175               43
176                5
177          -999999
178          -999999
179               59
180               87
181              -10
182              112
183              -11
184               73
185              -11
186              110
187               -4
```

```
188                 98
189                -15
190                115
191                -15
192                 72
193                -11
194                 97
195                 -9
196                 85
197                 -9

NEW LITERAL TABLE ENTRIES
 15      8          .20000E+02
 16      8          .10000E+01
   27  END

**********************  PARSE CALLED  **********************

  NTAB  NCODE              NVAL
    1      5                 9    (   END)
    2      1  ***** END *****

NEW TASK ENTRY
 28                 198

TASK TABLE              ARGUMENT LIST TABLE

 1                   1        DM
                             -1
                             -2
                             -3
 2                   5        DM
                             -4
                             -2
                             -5
 3                   9        DM
                             -6
                             -2
                             -7
 4                  13    GEOGEN
                              1
                         -999999
 5                  15      LOOP
                              1
 6                  18      ZGEN
                            101
                              1
                         -999999
                         -999999
                         -999999
                         -999999
                              2
 7                  25    BANDIT
                              3
                              2
                             10
 8                  30      VSRC
                              4
                              1
                         -999999
                             -8
                             -9
                             76
                              1
                              3
 9                  34      VSRC
                              4
                              1
                         -999999
                             -9
                             -8
                             76
                              2
                              4
10                  48    DECOY9
                              3
                              3
                         -999999
```

```
11              52   ITRATE
                        3
                        5
                        4
                        2
                        5
                       10
                        1
                        5
12              61    PRINT
                        5
                        4
13              64   EFIELD
                        5
                   -999999
                   -999999
                       59
                       87
                      -10
                      112
                      -11
                       69
                      -12
                      114
                      -12
                       68
                       -9
                       86
                       -9
                   -999999
                   -999999
                   -999999
                   -999999
                   -999999
                   -999999
14              87   EFIELD
                        6
                        5
                   -999999
                       59
                       87
                      -10
                      112
                      -11
                       69
                      -12
                      114
                      -12
                       72
                      -11
                       68
                       -9
                       86
                       -9
                   -999999
                   -999999
                   -999999
                   -999999
                   -999999
15              110  CHKPNT
                   -999999
                   -999999
                   -999999
                      117
16              115     DM
                       -6
                       -2
                      -13
                      -14
                       -6
17              121   LABEL
                        1
18              123    ZGEN
                      101
                        1
                   -999999
                   -999999
                   -999999
                   -999999
                        2
```

```
19              131   BANDIT
                        3
                        2
                       10
20              135     VSRC
                        4
                        1
                  -999999
                       -6
                       -9
                       76
                        1
                        3
21              144     VSRC
                        4
                        1
                  -999999
                       -9
                       -8
                       76
                        2
                        4
22              153   DECOMP
                        3
                        3
                  -999999
23              157    DEBUG
                       64
                  -999999
24              160   ITRATE
                        3
                        5
                        4
                        2
                        5
                       10
                        1
                        5
25              169    DEBUG
                       63
                  -999999
26              172    PRINT
                        5
                        4
27              175   EFIELD
                        5
                  -999999
                  -999999
                       59
                       87
                      -10
                      112
                      -11
                       73
                      -11
                      110
                       -9
                       96
                      -15
                      115
                      -16
                       72
                      -11
                       97
                       -9
                       66
                       -9
28              195      END
                  -999999

LOOP TABLE

 1          12902224666          6          2          1
```

```
SYMBOL TABLE

  1   XDIPOL    5       1       0                8195      11      40      0
  2   ZIJXDP    9       1       0               33292      40      40      1
  3   BNDZIJ   10       1       0               33420      21      40      2
  4   ANTSRC   11       1       0               16395      40       1      1
  5        I   15       1       0               55548      40       1      3
  6   NEWFLD   12       1       0              524292     228       4      5
  7            0       1       0             1048580     152       2      5
  8   BNDUPR   13       1       0               35468      11      40      3
  9   BNDLWR   14       1       0               34444      11      40      3
 10            0       1       0             1048580     152       2      5

LITERAL TABLE

  1     5              NUMFIL
  2     4              =
  3     7                 15
  4     5               TIME
  5     7                  5
  6     5               FRQ
  7     8         .30000E+03
  8     8         .50000E+00
  9     8         0.
 10     8         .36000E+03
 11     8         .10000E+02
 12     8         .90000E+02
 13     7                  2
 14     4              *
 15     8         .20000E+02
 15     8         .10000E+01

GEMACS TASK EXECUTION STARTED ON  11/15/76  AT  23.49.54.


RESTART AT TASK    15


FREQUENCY SET TO      .120E+04 MEGAHERTZ
WAVLENGTH     .250     METERS


FILL IMPEDANCE MATRIX ZIJXDP
USING BASIS FUNCTION  SINCOS
ON GEOMETRY DATA SET  XDIPOL
LOADS(IF SPECIFIED)IN
FREQUENCY(MEGAHERTZ)     1200.0
GROUND COND (MHOS/M)     0.
RELATIVE PERMITIVITY     1.0000


EXTRACT BNDZIJ FROM ZIJXDP BANDWIDTH     10

AT COLUMN     20 BAND NORM=     1702.      COLUMN NORM=     1703.
BAND DOMINANCE FACTOR=     1281.

EXCITE GEOMETRY DATA XDIPOL
EXCITATION VOLTGE
EXCITATION DATA ANTSRC


REAL COMP      .500      IMAG COMP      0.
EXCITED   SEGS
   1    3
EXCITE GEOMETRY DATA XDIPOL
EXCITATION VOLTGE
EXCITATION DATA ANTSRC


REAL COMP      0.        IMAG COMP      .500
EXCITED   SEGS
   2    4
```

```
DECOMPOSE BNDZIJ STORE RESULT IN BNDZIJ PIVOT=       N

MAX DIAG =   5693.2      MIN DIAG =   277.18
PIVOT RATIO =      20.54

FILE      1 OPENED
FILE      2 OPENED

BMI SOLUTION TO- BNDZIJ*      I=ANTSRC-ZIJADP*      I

MAXITR=  10 CONVRG ON PRE    AT   5.0 PERCENT


*ARNING--SYMBOL TABLE DATA FOR SYMBOL       1 BEING UPDATED


SYMBOL       1 NROWS=   40 NCOLS=     1
ENTERED IN SYMBOL TABLE LOCATION     5 STORED ON FILE 15

FILE     15 OPENED
UPDATE SYMBOL       1 COLUMN    8 NEW DATA     3
PUTSYM CALLED TO STORE RECORDS     1 TO     1 FOR       1   15 =FILEID      1 =FIRST WORD ON FILE
WRITE     80 WORDS TO FILE 15

GETSYM CALLED FOR RECORDS     1 TO      1 FOR       1   15 =FILEID      1 =FIRST WORD ON FILE
MOVE FILE 15 ,    -80 WORDS,CURRENT LENGTH     80
READ FILE     15 NUMBER OF WORDS=           80
MOVE FILE  2 ,      0 WORDS,CURRENT LENGTH      0
WRITE     80 WORDS TO FILE  2

GETSYM CALLED FOR RECORDS     1 TO      1 FOR ANTSRC   11 =FILEID      1 =FIRST WORD ON FILE
MOVE FILE 11 ,    -80 WORDS,CURRENT LENGTH     80
READ FILE     11 NUMBER OF WORDS=           80
MOVE FILE  2 ,    -80 WORDS,CURRENT LENGTH     80
READ FILE      2 NUMBER OF WORDS=           80

GETSYM CALLED FOR RECORDS     1 TO     40 FOR ZIJADP     9 =FILEID      1 =FIRST WORD ON FILE
MOVE FILE  9 , -3200 WORDS,CURRENT LENGTH  3200
READ FILE      9 NUMBER OF WORDS=           80
READ FILE      9 NUMBER OF WORDS=           80
READ FILE      9 NUMBER OF WORDS=           80
```

```
RHS FOR ITERATION  0
  -10.00          0.          0.        -10.00        -10.00          0.          0.        -10.00          0.          0.
    0.            0.          0.          0.            0.            0.          0.          0.            0.          0.
    0.            0.          0.          0.            0.            0.          0.          0.            0.          0.
    0.            0.          0.          0.            0.            0.          0.          0.            0.          0.
    0.            0.          0.          0.            0.            0.          0.          0.            0.          0.
    0.            0.          0.          0.            0.            0.          0.          0.            0.          0.
    0.            0.          0.          0.            0.            0.          0.          0.            0.          0.
    0.            0.          0.          0.            0.            0.          0.          0.            0.          0.

MOVE FILE  1 .     0 #ORDS.CURRENT LENGTH     0
#RITE    80 #ORDS TO FILE  1

BACSUB ON MATRIX BNDZIJ


UPPER MATRIX-BNDUPR _OWER MATRIX-BNDLWR


SETSYM CALLED FOR RECORDS    1 TO    40 FOR BNDUPR   13 =FILEID     1 =FIRST #ORD ON FILE
MOVE FILE 13 .  -770 #ORDS.CURRENT LENGTH    770
READ FILE    13 NUMBER OF #ORDS=          22
READ FILE    13 NUMBER OF #ORDS=          22
READ FILE    13 NUMBER OF #ORDS=          22
```

```
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          22
READ FILE    14 NUMBER OF WORDS=          20
READ FILE    14 NUMBER OF WORDS=          18
READ FILE    14 NUMBER OF WORDS=          16
READ FILE    14 NUMBER OF WORDS=          14
READ FILE    14 NUMBER OF WORDS=          12
READ FILE    14 NUMBER OF WORDS=          10
READ FILE    14 NUMBER OF WORDS=           8
READ FILE    14 NUMBER OF WORDS=           6
READ FILE    14 NUMBER OF WORDS=           4
READ FILE    14 NUMBER OF WORDS=           2

SOL FOR ITERATION  0
  -.7288E-04   -.7757E-03   -.2333E-02    .7380E-02   -.9355E-04   -.7603E-03   -.2337E-02    .7383E-02   -.2002E-02   -.8840E-04
   .4446E-02    .8149E-02   -.2021E-02   -.1332E-03    .4510E-02    .8293E-02   -.3265E-03    .1142E-02    .4510E-02   -.9165E-03
  -.6687E-03    .1191E-02    .4492E-02   -.5763E-03    .2984E-02    .1083E-02   -.1330E-02   -.4380E-02    .2112E-02    .1146E-02
  -.1574E-02   -.4470E-02    .2006E-02   -.2761E-03   -.4653E-02   -.4626E-02    .1477E-02   -.2340E-03   -.4700E-02   -.4814E-02
  -.5782E-03   -.9573E-03   -.4794E-03    .5489E-02   -.4976E-03   -.9021E-03   -.9777E-03    .5047E-02   -.1970E-02   -.5543E-03
   .3486E-02    .7531E-02   -.1442E-02   -.5001E-03    .3544E-02    .7433E-02   -.5345E-03    .2223E-03    .2332E-02    .6734E-03
  -.5049E-03    .6395E-03    .2332E-02    .2747E-03    .1684E-02    .6095E-03    .2031E-02   -.7281E-02    .1707E-02    .3394E-03
  -.2073E-02   -.7295E-02    .1367E-02    .7809E-04   -.2457E-02   -.5027E-02    .1350E-02    .9998E-04   -.2491E-02   -.5026E-02

MOVE FILE  2 ,   -50 WORDS,CURRENT LENGTH     80
READ FILE     2 NUMBER OF WORDS=            80
MOVE FILE  2 ,   -50 WORDS,CURRENT LENGTH     80
WRITE     80 WORDS TO FILE  2

GETSYM CALLED FOR RECORDS     1 TO      1 FOR WNTSRC   11 =FILEID      1 =FIRST WORD IN FILE
MOVE FILE 11 ,   -80 WORDS,CURRENT LENGTH     80
READ FILE    11 NUMBER OF WORDS=            80
MOVE FILE  2 ,   -80 WORDS,CURRENT LENGTH     80
READ FILE     2 NUMBER OF WORDS=            80

GETSYM CALLED FOR RECORDS     1 TO     40 FOR ZIJADP     9 =FILEID      1 =FIRST WORD IN FILE
MOVE FILE  9 , -3200 WORDS,CURRENT LENGTH   3200
READ FILE     9 NUMBER OF WORDS=            80
READ FILE     9 NUMBER OF WORDS=            80
READ FILE     9 NUMBER OF WORDS=            80
READ FILE     9 NUMBER OF WORDS=            80
READ FILE     9 NUMBER OF WORDS=            80
READ FILE     9 NUMBER OF WORDS=            80
READ FILE     9 NUMBER OF WORDS=            80
READ FILE     9 NUMBER OF WORDS=            80
READ FILE     9 NUMBER OF WORDS=            80
READ FILE     9 NUMBER OF WORDS=            80
READ FILE     9 NUMBER OF WORDS=            80
READ FILE     9 NUMBER OF WORDS=            80
READ FILE     9 NUMBER OF WORDS=            80
```

```
READ FILE     9 NUMBER OF #ORDS=          80
READ FILE     9 NUMBER OF #ORDS=          80
READ FILE     9 NUMBER OF #ORDS=          80
```

```
READ FILE     13 NUMBER OF WORDS=          22
READ FILE     13 NUMBER OF WORDS=          22
READ FILE     13 NUMBER OF WORDS=          22
READ FILE     13 NUMBER OF WORDS=          22
READ FILE     13 NUMBER OF WORDS=          22
READ FILE     13 NUMBER OF WORDS=          22
READ FILE     13 NUMBER OF WORDS=          22
READ FILE     13 NUMBER OF WORDS=          22
READ FILE     13 NUMBER OF WORDS=          22
READ FILE     13 NUMBER OF WORDS=          22
READ FILE     13 NUMBER OF WORDS=          22
READ FILE     13 NUMBER OF WORDS=          22
READ FILE     13 NUMBER OF WORDS=          20
READ FILE     13 NUMBER OF WORDS=          18
READ FILE     13 NUMBER OF WORDS=          16
READ FILE     13 NUMBER OF WORDS=          14
READ FILE     13 NUMBER OF WORDS=          12
READ FILE     13 NUMBER OF WORDS=          10
READ FILE     13 NUMBER OF WORDS=           8
READ FILE     13 NUMBER OF WORDS=           6
READ FILE     13 NUMBER OF WORDS=           4
READ FILE     13 NUMBER OF WORDS=           2

GETSYM CALLED FOR RECORDS     1 TO    40 FOR BNDLAM   14 =FILEID     1 =FIRST WORD ON FILE
MOVE FILE 14 ,  -770 WORDS.CURRENT LENGTH   770
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          22
READ FILE     14 NUMBER OF WORDS=          20
READ FILE     14 NUMBER OF WORDS=          18
READ FILE     14 NUMBER OF WORDS=          16
READ FILE     14 NUMBER OF WORDS=          14
READ FILE     14 NUMBER OF WORDS=          12
READ FILE     14 NUMBER OF WORDS=          10
READ FILE     14 NUMBER OF WORDS=           8
READ FILE     14 NUMBER OF WORDS=           6
READ FILE     14 NUMBER OF WORDS=           4
READ FILE     14 NUMBER OF WORDS=           2
```

```
SOL FOR ITERATION  1
  -.1237E-02    .1044E-02   -.1201E-02    .7066E-02   -.1254E-02    .1052E-02   -.1206E-02    .7067E-02   -.2261E-02    .1995E-02
   .4524E-02    .9749E-02   -.2265E-02    .2040E-02    .4632E-02    .9744E-02    .3396E-03    .1399E-02    .3365E-02    .2244E-03
   .3435E-03    .1437E-02    .3410E-02    .2243E-03    .2952E-02   -.4514E-03   -.2548E-02   -.4155E-02    .2984E-02   -.4526E-03
  -.2601E-02   -.9201E-02    .2054E-02   -.1266E-02   -.4684E-02   -.5941E-02    .2053E-02   -.1247E-02   -.4732E-02   -.5943E-02
  -.1156E-02   -.1566E-03   -.5740E-04    .5524E-02   -.1147E-02   -.1454E-03   -.5515E-04    .5534E-02   -.2501E-02    .9944E-03
   .4534E-02    .9556E-02   -.2463E-02    .1005E-02    .4552E-02    .9545E-02   -.3066E-03    .4566E-03    .2472E-02    .5541E-03
  -.2846E-03    .4592E-03    .2465E-02    .5476E-03    .2381E-02   -.9606E-03   -.3033E-02   -.9409E-02    .2369E-02   -.9787E-03
  -.3049E-02   -.9427E-02    .1765E-02   -.9752E-03   -.3385E-02   -.6770E-02    .1782E-02   -.9801E-03   -.3398E-02   -.6761E-02

MOVE FILE  2 ,   -80 WORDS,CURRENT LENGTH     80
READ FILE     2 NUMBER OF WORDS=          80
MOVE FILE  2 ,   -80 WORDS,CURRENT LENGTH     80
WRITE    80 WORDS TO FILE  2

GETSYM CALLED FOR RECORDS     1 TO      1 FOR ANTSRC    11 =FILEID      1 =FIRST WORD ON FILE
MOVE FILE 11 ,   -80 WORDS,CURRENT LENGTH     80
READ FILE    11 NUMBER OF WORDS=          80
MOVE FILE  2 ,   -80 WORDS,CURRENT LENGTH     80
READ FILE     2 NUMBER OF WORDS=          80

GETSYM CALLED FOR RECORDS     1 TO     40 FOR ZIJXJP     9 =FILEID      1 =FIRST WORD ON FILE
MOVE FILE  9 , -3200 WORDS,CURRENT LENGTH   3200
READ FILE     9 NUMBER OF WORDS=          80
READ FILE     9 NUMBER OF WORDS=          80
READ FILE     9 NUMBER OF WORDS=          80
```

```
RHS FOR ITERATION  2
  -9.735          .4129E-02   -.4426        -10.25        -9.725        -.1632E-01   -.5547        -10.13        .5213         -.3344E-02
  -.3864         -.1533        .3749        -.8670E-01    -.3504        -.2054        .3823         .8494E-01    .2347         .7635E-02
   .3467          .2075        .2935         .2248E-01     .3256         .4205E-01    .7171         .4277        .2442        -.7746E-01
   .5666          .3591       -.1424E-01    -.1956E-01     .4670         .6520       -.1484         .2017        .5424         .2502
   .2725         -.5853E-01   -.1395        -.3376         .3258        -.8446E-01   -.1537        -.3539        .1204        -.3384
  -.7195         -.4524        .2615E-01    -.2103        -.7591        -.4848       -.1274E-01   -.9213E-01   -.5572        .2214
   .9256E-01     -.5325E-01   -.6492         .2312        -.3859E-01    -.7927E-02    .1471         .5545       -.4250E-01    .6437E-02
   .1171          .5573        .3396E-01     .1857         .7300         .1717        .1040         .2335        .7471         .1765

MOVE FILE  1 ,   -80 WORDS,CURRENT LENGTH     80
READ FILE      1 NUMBER OF WORDS=           80
MOVE FILE  1 ,   -80 WORDS,CURRENT LENGTH     80
WRITE     80 WORDS TO FILE  1
ITERATION    2 PRED CONV IN   0 ITERATIONS
PRE=     6.78 IRE=   26.04 HCRE=    3.55

BACSUB ON MATRIX BNDZIJ


GETSYM CALLED FOR RECORDS     1 TO     40 FOR BNDUPR    13 =FILEID      1 =FIRST WORD ON FILE
MOVE FILE 13 ,  -770 WORDS,CURRENT LENGTH    770
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           22
READ FILE     13 NUMBER OF WORDS=           20
READ FILE     13 NUMBER OF WORDS=           18
READ FILE     13 NUMBER OF WORDS=           16
READ FILE     13 NUMBER OF WORDS=           14
READ FILE     13 NUMBER OF WORDS=           12
READ FILE     13 NUMBER OF WORDS=           10
READ FILE     13 NUMBER OF WORDS=            8
```

```
READ FILE    13 NUMBER OF WORDS=          6
READ FILE    13 NUMBER OF WORDS=          4
READ FILE    13 NUMBER OF WORDS=          2

GETSYM CALLED FOR RECORDS     1 TO    40 FOR BADLAR    14 =FILEID     1 =FIRST WORD ON FILE
MOVE FILE 14 ,  -770 WORDS,CURRENT LENGTH    770
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         22
READ FILE    14 NUMBER OF WORDS=         20
READ FILE    14 NUMBER OF WORDS=         18
READ FILE    14 NUMBER OF WORDS=         16
READ FILE    14 NUMBER OF WORDS=         14
READ FILE    14 NUMBER OF WORDS=         12
READ FILE    14 NUMBER OF WORDS=         10
READ FILE    14 NUMBER OF WORDS=          8
READ FILE    14 NUMBER OF WORDS=          6
READ FILE    14 NUMBER OF WORDS=          4
READ FILE    14 NUMBER OF WORDS=          2

SOL FOR ITERATION  2
  -.1154E-02    .1517E-02   -.1286E-02    .7117E-02   -.1156E-02    .1020E-02   -.1281E-02    .7114E-02   -.2214E-02    .2[illegible]E-02
   .4607E-02    .1044E-01   -.2209E-02    .2856E-02    .4602E-02    .1045E-01    .2840E-03    .1581E-02    .3481E-02    .8[illegible]E-03
   .2863E-03    .1571E-02    .3452E-02    .8563E-03    .2855E-02   -.1064E-02   -.2546E-02   -.9435E-02    .2[illegible]E-02   -.1084E-02
  -.2554E-02   -.9443E-02    .2008E-02   -.1742E-02   -.4644E-02   -.6376E-02    .2003E-02   -.1734E-02   -.4702E-02   -.6371E-02
  -.1100E-02    .2150E-03   -.8003E-04    .5534E-02   -.1096E-02    .2245E-03   -.7455E-04    .5542E-02   -.2345E-02    .[illegible]E-02
   .4523E-02    .9934E-02   -.2334E-02    .1774E-02    .4533E-02    .9943E-02   -.2010E-03    .5702E-03    .2514E-02    .6491E-03
  -.1984E-03    .5710E-03    .2824E-02    .6999E-03    .2304E-02   -.1742E-02   -.2990E-02   -.7[illegible]E-02    .2301E-02   -.1[illegible]E-02
  -.2999E-02   -.9791E-02    .1670E-02   -.1590E-02   -.3381E-02   -.7103E-02    .1666E-02   -.1594E-02   -.3384E-02   -.7105E-02

MOVE FILE  2 ,   -80 WORDS,CURRENT LENGTH     80
READ FILE     2 NUMBER OF WORDS=          80
MOVE FILE  2 ,   -80 WORDS,CURRENT LENGTH     80
WRITE    80 WORDS TO FILE  2


CONVERGENCE REACHED
```

```
SETSYM CALLED FOR RECORDS     1 TO      1 FOR ANTS+C    11 =FILEID      1 =FIRST WORD ON FILE
MOVE FILE 11 +    -80 WORDS+CURRENT LENGTH     80
READ FILE     11 NUMBER OF WORDS=          80
MOVE FILE  2 +    -80 WORDS+CURRENT LENGTH     80
READ FILE      2 NUMBER OF WORDS=          80

SETSYM CALLED FOR RECORDS     1 TO     40 FOR ZIGZAG     9 =FILEID      1 =FIRST WORD ON FILE
MOVE FILE  9 + -3200 WORDS+CURRENT LENGTH  3200
READ FILE      9 NUMBER OF WORDS=          80
READ FILE      9 NUMBER OF WORDS=          80
READ FILE      9 NUMBER OF WORDS=          80
```

```
MOVE FILE  1 ,   -80 WORDS,CURRENT LENGTH     80
READ FILE     1 NUMBER OF WORDS=          80
MOVE FILE  1 ,   -80 WORDS,CURRENT LENGTH     80
WRITE    80 WORDS TO FILE  1
FINAL VALUES-- PRE      2.53 IME      8.12 MORE      1.09

PUTSYM CALLED TO STORE RECORDS    1 TO    1 FOR       I   15 =FILEID      1 =FIRST WORD ON FILE
MOVE FILE 15 ,   -80 WORDS,CURRENT LENGTH     80
WRITE    80 WORDS TO FILE 15

GEOMETRY DATA SET XDIPOL
FILE      1 OPENED
WRITE   440 WORDS TO FILE  1

GETSYM CALLED FOR RECORDS    1 TO    40 FOR XDIPOL     8 =FILEID      1 =FIRST WORD ON FILE
MOVE FILE  8 ,  -440 WORDS,CURRENT LENGTH    440
READ FILE     6 NUMBER OF WORDS=          11
READ FILE     8 NUMBER OF WORDS=          11
READ FILE     8 NUMBER OF WORDS=          11
READ FILE     8
```

ANTENNA/LOAD PARAMETERS

SEGMENT	IMP(MAG)	IMP(PHZ)	PWR INPUT	PWR LOAD

SEG 1 STATUS 1 ZR 0. ZI 0. ETR,ETI -10.0 0. CURR,CURI -.115E-02 .162E-02 .050
1 1007.422 -.038 -.721E-04 0.
SEG 2 STATUS 1 ZR 0. ZI 0. ETR,ETI 0. -10.0 CURR,CURI -.124E-02 .712E-02 .050
2 276.743 -.003 .444E-03 0.
SEG 3 STATUS 1 ZR 0. ZI 0. ETR,ETI -10.0 0. CURR,CURI -.116E-02 .162E-02 .050
3 1005.751 -.036 -.722E-04 0.
SEG 4 STATUS 1 ZR 0. ZI 0. ETR,ETI 0. -10.0 CURR,CURI -.128E-02 .711E-02 .050
4 276.874 -.003 .444E-03 0.
MOVE FILE 1 , -440 WORDS,CURRENT LENGTH 440
READ FILE 1 NUMBER OF WORDS= 440

****

SYMBOL I

LINEAGE- BNDZIJ-ZIJKDP-XDIPOL-
COMPLX DATA

****

COLUMN- 1

	REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)		REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)
1	-.1154E-02	.1617E-02	.1987E-02	125.5	2	-.1265E-02	.7117E-02	.7234E-02	100.2
3	-.1156E-02	.1620E-02	.1990E-02	125.5	4	-.1281E-02	.7114E-02	.7234E-02	100.2
5	-.2219E-02	.2846E-02	.3608E-02	127.9	6	.4507E-02	.1044E-01	.1141E-01	66.19
7	-.2209E-02	.2858E-02	.3611E-02	127.7	8	.4502E-02	.1045E-01	.1141E-01	66.22
9	.2840E-03	.1588E-02	.1591E-02	79.72	10	.3401E-02	.6802E-03	.3467E-02	11.16
11	.2863E-03	.1571E-02	.1597E-02	79.67	12	.3422E-02	.6863E-03	.3490E-02	11.24
13	.2655E-02	-.1068E-02	.3044E-02	-20.51	14	-.2590E-02	-.4435E-02	.4777E-02	-120.1
15	.2650E-02	-.1069E-02	.3044E-02	-20.57	16	-.2597E-02	-.4440E-02	.4781E-02	-120.2
17	.2008E-02	-.1742E-02	.2658E-02	-40.94	18	-.4594E-02	-.6837E-02	.7419E-02	-124.1
19	.2003E-02	-.1734E-02	.2653E-02	-40.96	20	-.4706E-02	-.6871E-02	.7421E-02	-124.3
21	-.1100E-02	.2150E-03	.1121E-02	168.9	22	-.8003E-04	.5534E-02	.5534E-02	90.83
23	-.1096E-02	.2243E-03	.1119E-02	168.4	24	-.7435E-04	.5542E-02	.5543E-02	90.77
25	-.2345E-02	.1784E-02	.2949E-02	142.7	26	.4523E-02	.9434E-02	.1047E-01	65.92
27	-.2334E-02	.1794E-02	.2944E-02	142.5	28	.4533E-02	.9443E-02	.1048E-01	65.94
29	-.2018E-03	.5702E-03	.6049E-03	109.5	30	.2518E-02	.6981E-03	.2613E-02	15.50
31	-.1984E-03	.5710E-03	.6046E-03	109.2	32	.2504E-02	.6944E-03	.2601E-02	15.50
33	.2304E-02	-.1742E-02	.2888E-02	-37.09	34	-.2394E-02	-.4788E-02	.1072E-01	-117.0
35	.2301E-02	-.1746E-02	.2889E-02	-37.22	36	-.2399E-02	-.4791E-02	.1074E-01	-117.0
37	.1670E-02	-.1590E-02	.2306E-02	-43.60	38	-.3381E-02	-.7103E-02	.7866E-02	-115.5
39	.1666E-02	-.1594E-02	.2305E-02	-43.73	40	-.3384E-02	-.7106E-02	.7872E-02	-115.5

****

SYMBOL ANTSMC

LINEAGE- XDIPOL-
COMPLX DATA

****

****

COLUMN- 1

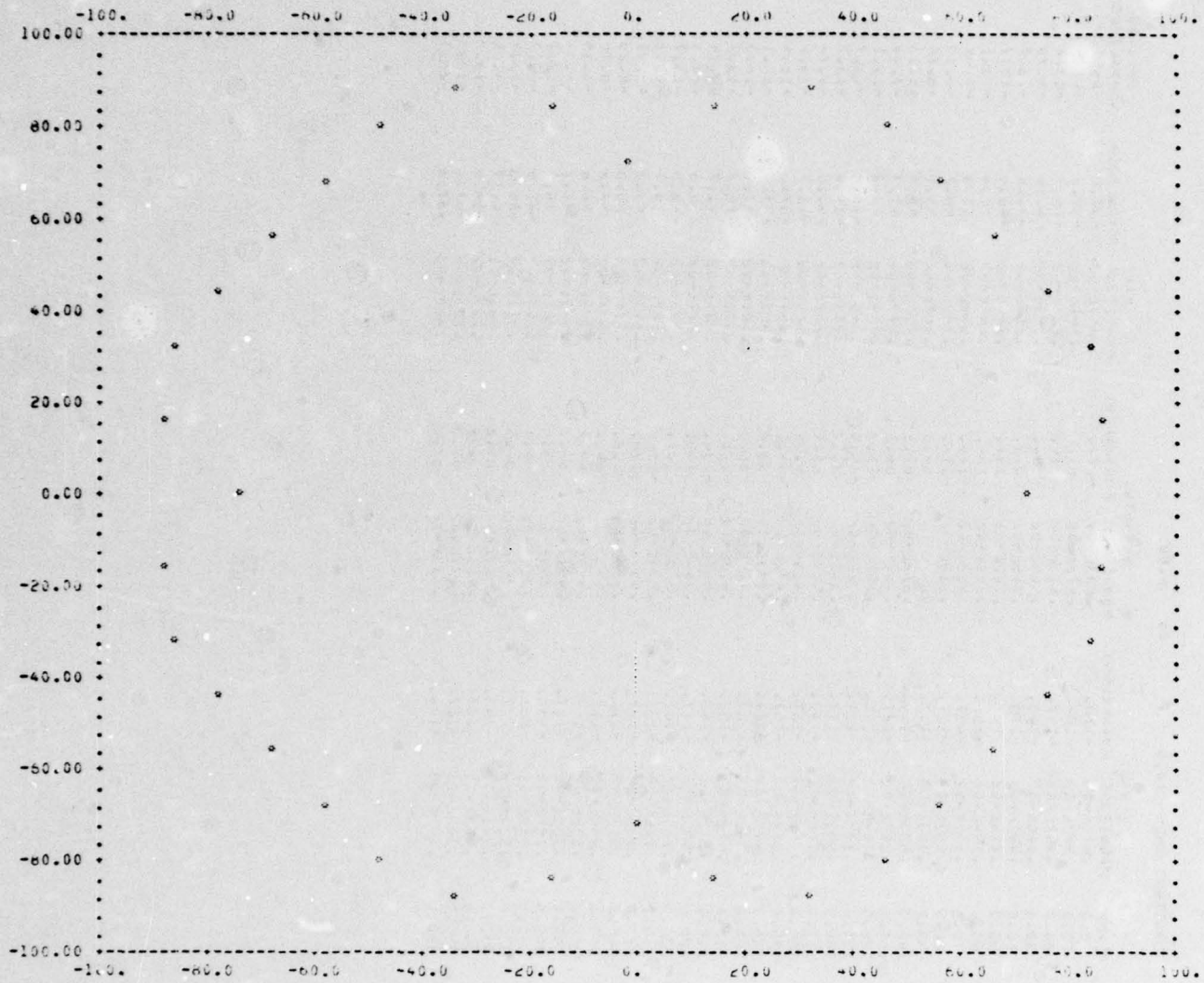
	REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)		REAL	IMAGINARY	MAGNITUDE	PHASE(DEG)
1	-10.00	0.	10.00	180.0	2	0.	-10.00	10.00	-90.00
3	-10.00	0.	10.00	180.0	4	0.	-10.00	10.00	-90.00
5	0.	0.	0.	0.	6	0.	0.	0.	0.
7	0.	0.	0.	0.	8	0.	0.	0.	0.
9	0.	0.	0.	0.	10	0.	0.	0.	0.
11	0.	0.	0.	0.	12	0.	0.	0.	0.
13	0.	0.	0.	0.	14	0.	0.	0.	0.
15	0.	0.	0.	0.	16	0.	0.	0.	0.
17	0.	0.	0.	0.	18	0.	0.	0.	0.
19	0.	0.	0.	0.	20	0.	0.	0.	0.
21	0.	0.	0.	0.	22	0.	0.	0.	0.
23	0.	0.	0.	0.	24	0.	0.	0.	0.
25	0.	0.	0.	0.	26	0.	0.	0.	0.
27	0.	0.	0.	0.	28	0.	0.	0.	0.
29	0.	0.	0.	0.	30	0.	0.	0.	0.
31	0.	0.	0.	0.	32	0.	0.	0.	0.
33	0.	0.	0.	0.	34	0.	0.	0.	0.
35	0.	0.	0.	0.	36	0.	0.	0.	0.
37	0.	0.	0.	0.	38	0.	0.	0.	0.
39	0.	0.	0.	0.	40	0.	0.	0.	0.

E-FIELD MATRIX I
CYLINDRICAL COORDINATE SYSTEM

NEAR FIELD FOR FIELD DATA=NOPCOD -CURRENT DATA= I -GEOMETRY DATA=XDIPOL
NORMALIZATION FACTOR .202E-01 V/M

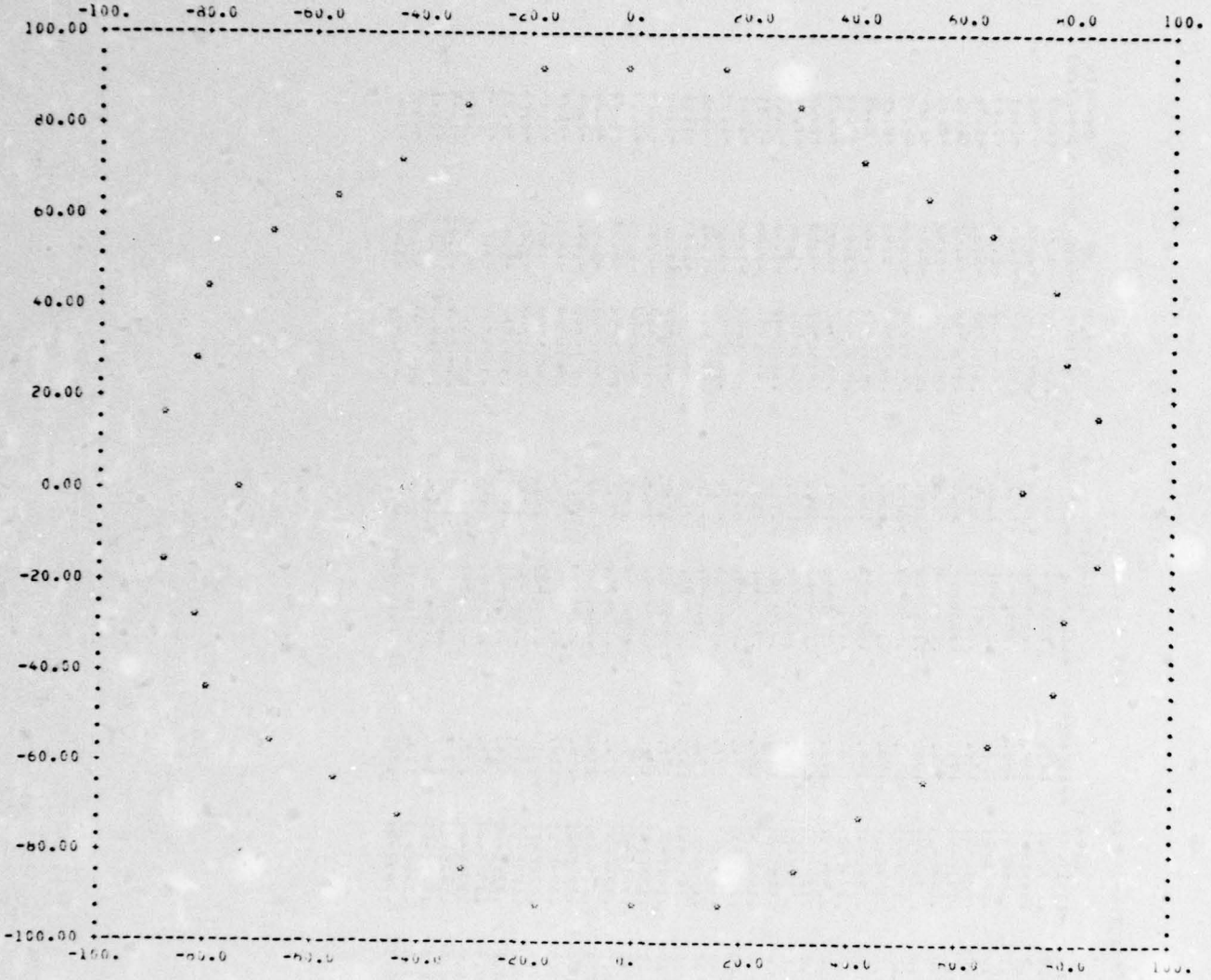
CONSTANT RHO= 10.0 Z= 0.

	E(RHO)		E(THETA)		E(Z)		DB-GAIN
TH=	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	NORMALIZED
0.0	.695E-03	15-.	.272E-04	148.	.311E-04	-140.	-27.1
10.0	.710E-03	127.	.495E-02	-35.4	.311E-04	-140.	-16.1
20.0	.760E-03	124.	.702E-02	79.6	.311E-04	-140.	-9.12
30.0	.913E-03	149.	.509E-02	54.1	.311E-04	-140.	-11.8
40.0	.817E-03	132.	.444E-02	1.31	.311E-04	-140.	-12.9
50.0	.835E-03	122.	.522E-02	95.5	.311E-04	-140.	-10.1
60.0	.867E-03	138.	.122E-01	114.	.311E-04	-140.	-4.32
70.0	.892E-03	150.	.107E-01	127.	.311E-04	-140.	-5.45
80.0	.878E-03	153.	.551E-02	130.	.311E-04	-140.	-11.2
90.0	.695E-03	153.	0.	0.	.311E-04	-140.	-27.3
100.0	.878E-03	153.	.551E-02	-49.8	.311E-04	-140.	-11.2
110.0	.892E-03	150.	.107E-01	-53.5	.311E-04	-140.	-5.45
120.0	.867E-03	138.	.122E-01	-60.7	.311E-04	-140.	-4.32
130.0	.835E-03	122.	.522E-02	-84.5	.311E-04	-140.	-10.1
140.0	.817E-03	132.	.444E-02	-179.	.311E-04	-140.	-12.9
150.0	.913E-03	149.	.509E-02	-122.	.311E-04	-140.	-11.8
160.0	.760E-03	128.	.702E-02	-101.	.311E-04	-140.	-9.12
170.0	.710E-03	127.	.495E-02	145.	.311E-04	-140.	-12.1
180.0	.895E-03	154.	.272E-04	-32.2	.311E-04	-140.	-27.1
190.0	.710E-03	127.	.503E-02	-35.3	.311E-04	-140.	-12.0
200.0	.760E-03	127.	.703E-02	79.5	.311E-04	-140.	-9.11
210.0	.913E-03	149.	.509E-02	54.4	.311E-04	-140.	-11.8
220.0	.817E-03	132.	.444E-02	1.08	.311E-04	-140.	-12.9
230.0	.835E-03	122.	.514E-02	95.4	.311E-04	-140.	-10.2
240.0	.868E-03	138.	.122E-01	114.	.311E-04	-140.	-4.34
250.0	.892E-03	150.	.107E-01	126.	.311E-04	-140.	-5.45
260.0	.878E-03	153.	.551E-02	130.	.311E-04	-140.	-11.2
270.0	.867E-03	153.	0.	-38.8	.311E-04	-140.	-27.3
280.0	.878E-03	153.	.551E-02	-49.8	.311E-04	-140.	-11.2
290.0	.892E-03	150.	.107E-01	-53.5	.311E-04	-140.	-5.45
300.0	.868E-03	138.	.122E-01	-60.7	.311E-04	-140.	-4.34
310.0	.835E-03	122.	.514E-02	-84.5	.311E-04	-140.	-10.2
320.0	.817E-03	132.	.444E-02	-179.	.311E-04	-140.	-12.9
330.0	.913E-03	149.	.509E-02	-122.	.311E-04	-140.	-11.8
340.0	.760E-03	127.	.703E-02	-102.	.311E-04	-140.	-9.11
350.0	.710E-03	127.	.503E-02	145.	.311E-04	-140.	-12.0
360.0	.895E-03	154.	.272E-04	148.	.311E-04	-140.	-27.1


-100.
-80.0
-60.0
-40.0
-20.0
0.
20.0
40.0
60.0
80.0
100.
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
-100.00

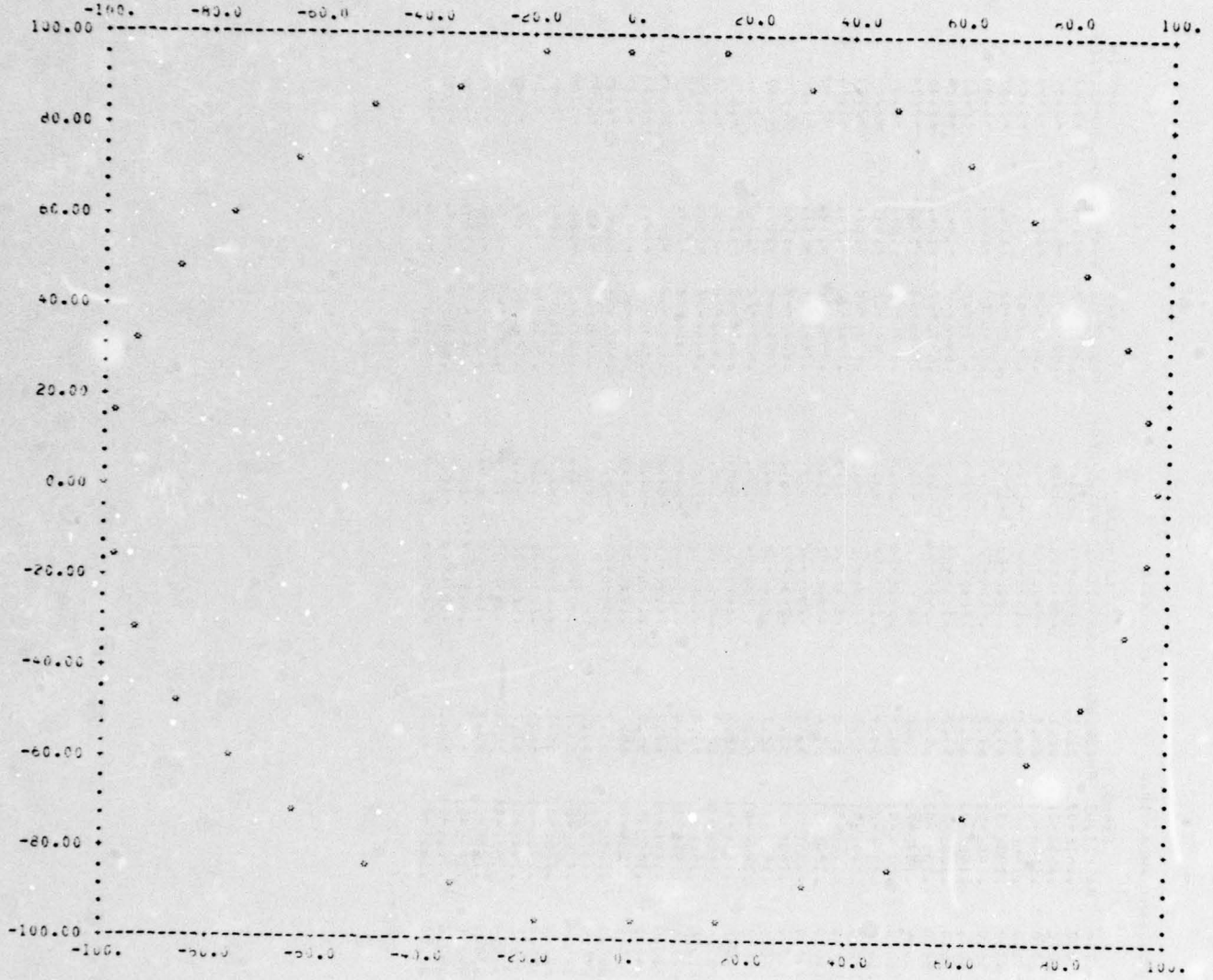
CONSTANT RHO= 10.0 Z= 0.00

	E(RHO)		E(THETA)		E(Z)		DB-GAIN
TH=	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	MAGNITUDE	PHASE(DEG)	NORMALIZED
0.0	.479E-03	-114.	.233E-04	-87.0	.8R0E-03	-37.8	-26.1
10.0	.382E-03	-162.	.472E-02	84.9	.101E-02	-57.0	-12.4
20.0	.952E-03	-157.	.413E-02	-171.	.123E-02	-16.7	-13.2
30.0	.140E-02	-143.	.505E-02	-154.	.202E-02	4.10	-9.79
40.0	.931E-03	-177.	.349E-02	149.	.212E-02	-34.4	-13.7
50.0	.115E-02	161.	.320E-02	131.	.243E-02	-46.8	-13.7
60.0	.199E-02	-151.	.301E-02	-154.	.204E-02	10.9	-13.1
70.0	.387E-02	-127.	.452E-02	-125.	.542E-02	47.3	-7.45
80.0	.533E-02	-119.	.315E-02	-118.	.749E-02	56.7	-6.13
90.0	.583E-02	-117.	0.	84.0	.8R2E-02	58.9	-5.75
100.0	.533E-02	-119.	.314E-02	62.3	.749E-02	56.7	-6.13
110.0	.387E-02	-127.	.452E-02	55.1	.542E-02	47.3	-7.45
120.0	.199E-02	-151.	.301E-02	25.7	.204E-02	10.9	-13.1
130.0	.115E-02	161.	.320E-02	-49.4	.243E-02	-46.8	-13.7
140.0	.931E-03	-177.	.349E-02	-30.7	.212E-02	-34.4	-13.7
150.0	.140E-02	-143.	.505E-02	25.1	.202E-02	4.10	-9.79
160.0	.952E-03	-157.	.413E-02	9.38	.123E-02	-16.7	-13.2
170.0	.382E-03	-162.	.472E-02	-95.1	.101E-02	-57.0	-12.4
180.0	.479E-03	-114.	.233E-04	93.0	.8R0E-03	-37.8	-26.1
190.0	.382E-03	-162.	.477E-02	85.0	.101E-02	-57.1	-12.3
200.0	.953E-03	-157.	.413E-02	-171.	.123E-02	-16.9	-13.2
210.0	.141E-02	-143.	.507E-02	-154.	.203E-02	4.17	-9.78
220.0	.930E-03	-177.	.344E-02	149.	.211E-02	-34.3	-13.7
230.0	.115E-02	161.	.320E-02	131.	.243E-02	-47.0	-13.7
240.0	.199E-02	-151.	.299E-02	-154.	.202E-02	10.7	-13.1
250.0	.388E-02	-127.	.451E-02	-125.	.540E-02	47.2	-8.01
260.0	.532E-02	-119.	.314E-02	-118.	.774E-02	56.8	-6.15
270.0	.581E-02	-117.	0.	84.0	.868E-02	58.9	-5.74
280.0	.532E-02	-119.	.313E-02	62.2	.773E-02	56.8	-6.15
290.0	.385E-02	-127.	.451E-02	55.1	.540E-02	47.2	-8.01
300.0	.196E-02	-151.	.299E-02	25.5	.202E-02	10.7	-13.1
310.0	.115E-02	161.	.320E-02	-49.1	.243E-02	-47.0	-13.7
320.0	.930E-03	-177.	.344E-02	-30.5	.211E-02	-34.3	-13.7
330.0	.141E-02	-143.	.507E-02	25.2	.203E-02	4.17	-9.78
340.0	.953E-03	-157.	.413E-02	9.04	.123E-02	-16.9	-13.2
350.0	.382E-03	-162.	.477E-02	-95.0	.101E-02	-57.1	-12.3
360.0	.479E-03	-114.	.233E-04	-87.0	.8R0E-03	-37.8	-26.1


-100.
-80.0
-60.0
-40.0
-20.0
0.
20.0
40.0
60.0
80.0
100.
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
-100.00

CONSTANT RHO= 10.0 /= 15.0

TH=	E(RHO) MAGNITUDE	E(RHO) PHASE(DEG)	E(THETA) MAGNITUDE	E(THETA) PHASE(DEG)	E(Z) MAGNITUDE	E(Z) PHASE(DEG)	DB-GAIN NORMALIZED
0.0	.149E-01	177.	.151E-04	94.9	.993E-02	-3.22	-1.07
10.0	.149E-01	179.	.288E-02	-90.8	.992E-02	-1.92	-.958
20.0	.145E-01	180.	.255E-02	-71.2	.993E-02	-1.05	-1.11
30.0	.140E-01	177.	.205E-02	7.00	.995E-02	-3.95	-1.49
40.0	.134E-01	172.	.324E-02	35.5	.993E-02	-6.37	-1.76
50.0	.131E-01	171.	.285E-02	35.5	.975E-02	-9.63	-2.03
60.0	.129E-01	174.	.174E-02	20.3	.981E-02	-6.93	-2.23
70.0	.129E-01	178.	.104E-02	-3.54	.989E-02	-3.09	-2.29
80.0	.129E-01	-180.	.323E-03	-20.5	.981E-02	-.422	-2.29
90.0	.129E-01	-179.	0.	154.	.982E-02	.453	-2.28
100.0	.129E-01	-180.	.323E-03	180.	.981E-02	-.422	-2.29
110.0	.129E-01	178.	.104E-02	175.	.989E-02	-3.08	-2.29
120.0	.129E-01	174.	.174E-02	-160.	.981E-02	-6.93	-2.23
130.0	.131E-01	171.	.285E-02	-144.	.975E-02	-9.63	-2.03
140.0	.134E-01	172.	.324E-02	-143.	.993E-02	-6.37	-1.76
150.0	.140E-01	177.	.205E-02	-173.	.994E-02	-3.93	-1.49
160.0	.145E-01	180.	.255E-02	109.	.995E-02	-1.05	-1.11
170.0	.145E-01	179.	.288E-02	89.2	.992E-02	-1.92	-.958
180.0	.149E-01	177.	.151E-04	-80.1	.993E-02	-3.22	-1.07
190.0	.149E-01	179.	.291E-02	-90.0	.992E-02	-1.91	-.950
200.0	.145E-01	180.	.257E-02	-71.2	.994E-02	-1.03	-1.11
210.0	.140E-01	177.	.208E-02	8.02	.997E-02	-3.93	-1.49
220.0	.134E-01	172.	.323E-02	35.5	.993E-02	-6.37	-1.76
230.0	.131E-01	171.	.285E-02	35.6	.975E-02	-9.65	-2.03
240.0	.129E-01	174.	.174E-02	20.5	.981E-02	-6.97	-2.23
250.0	.129E-01	178.	.109E-02	-3.31	.989E-02	-3.12	-2.29
260.0	.129E-01	-180.	.323E-03	-20.3	.981E-02	-.454	-2.28
270.0	.129E-01	-179.	0.	155.	.982E-02	.423	-2.28
280.0	.129E-01	-180.	.323E-03	150.	.981E-02	-.454	-2.29
290.0	.129E-01	178.	.109E-02	177.	.989E-02	-3.12	-2.29
300.0	.129E-01	174.	.174E-02	-150.	.981E-02	-6.97	-2.23
310.0	.131E-01	171.	.285E-02	-144.	.975E-02	-9.65	-2.03
320.0	.134E-01	172.	.323E-02	-144.	.993E-02	-6.37	-1.76
330.0	.140E-01	177.	.208E-02	-173.	.997E-02	-3.93	-1.49
340.0	.145E-01	180.	.257E-02	109.	.994E-02	-1.03	-1.11
350.0	.145E-01	179.	.291E-02	89.4	.992E-02	-1.91	-.950
360.0	.149E-01	177.	.151E-04	94.9	.993E-02	-3.22	-1.07


-100.
-80.0
-60.0
-40.0
-20.0
0.
20.0
40.0
60.0
80.0
100.
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
-100.00

CONSTANT RHO= 10.0 Z= 20.0

TH=	E(RHO) MAGNITUDE	E(RHO) PHASE(DEG)	E(THETA) MAGNITUDE	E(THETA) PHASE(DEG)	E(Z) MAGNITUDE	E(Z) PHASE(DEG)	DB-GAIN NORMALIZED
0.0	.161E-01	61.1	.122E-04	-23.9	.803E-02	-116.	-1.02
10.0	.161E-01	62.1	.204E-02	146.	.803E-02	-117.	-.951
20.0	.160E-01	63.7	.243E-02	155.	.804E-02	-116.	-.939
30.0	.156E-01	63.2	.152E-02	-17C.	.783E-02	-117.	-1.02
40.0	.150E-01	60.4	.100E-02	-109.	.755E-02	-114.	-1.07
50.0	.144E-01	57.2	.204E-02	-85.1	.724E-02	-122.	-1.09
60.0	.140E-01	55.3	.182E-02	-84.8	.703E-02	-124.	-2.13
70.0	.138E-01	55.2	.163E-02	-85.9	.692E-02	-124.	-2.09
80.0	.138E-01	55.7	.591E-03	-90.2	.687E-02	-124.	-2.08
90.0	.137E-01	56.0	0.	88.2	.686E-02	-123.	-2.08
100.0	.138E-01	55.7	.591E-03	89.8	.687E-02	-124.	-2.08
110.0	.138E-01	55.2	.163E-02	93.1	.692E-02	-124.	-2.09
120.0	.140E-01	55.3	.182E-02	95.2	.703E-02	-124.	-2.13
130.0	.144E-01	57.2	.204E-02	91.9	.724E-02	-122.	-1.09
140.0	.150E-01	60.4	.100E-02	71.2	.755E-02	-119.	-1.07
150.0	.156E-01	63.2	.152E-02	8.27	.783E-02	-117.	-1.02
160.0	.160E-01	63.7	.243E-02	-25.2	.804E-02	-116.	-.939
170.0	.161E-01	62.1	.204E-02	-34.1	.803E-02	-117.	-.951
180.0	.161E-01	61.1	.122E-04	156.	.803E-02	-116.	-1.02
190.0	.161E-01	62.1	.204E-02	146.	.803E-02	-117.	-.950
200.0	.160E-01	63.7	.243E-02	155.	.804E-02	-116.	-.939
210.0	.156E-01	63.2	.152E-02	-17C.	.783E-02	-116.	-1.02
220.0	.150E-01	60.4	.100E-02	-109.	.755E-02	-114.	-1.07
230.0	.144E-01	57.2	.204E-02	-85.2	.724E-02	-122.	-1.09
240.0	.140E-01	55.3	.182E-02	-84.8	.703E-02	-124.	-2.13
250.0	.138E-01	55.1	.163E-02	-85.8	.692E-02	-124.	-2.09
260.0	.138E-01	55.7	.592E-03	-90.1	.687E-02	-124.	-2.08
270.0	.137E-01	56.0	0.	88.3	.686E-02	-123.	-2.08
280.0	.138E-01	55.7	.592E-03	89.9	.687E-02	-124.	-2.08
290.0	.138E-01	55.1	.163E-02	93.2	.692E-02	-124.	-2.09
300.0	.140E-01	55.3	.182E-02	95.2	.703E-02	-124.	-2.13
310.0	.144E-01	57.2	.204E-02	91.8	.724E-02	-122.	-1.09
320.0	.150E-01	60.4	.100E-02	70.9	.755E-02	-119.	-1.07
330.0	.156E-01	63.2	.152E-02	8.01	.783E-02	-117.	-1.02
340.0	.160E-01	63.7	.243E-02	-25.1	.804E-02	-116.	-.938
350.0	.161E-01	62.1	.207E-02	-34.0	.803E-02	-117.	-.950
360.0	.161E-01	61.1	.122E-04	-23.9	.803E-02	-116.	-1.02

100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
-100.00
-100.
-80.0
-60.0
-40.0
-20.0
0.
20.0
40.0
60.0
80.0
100.

GEMACS EXECUTION COMPLETED ON 11/16/75 AT 19.14.0M.

GEMACS SUBROUTINE TIMING STATISTICS (IN SECONDS)

ROUTINE	TIMES CALLED	TOTAL TIME IN ROUTINE	PER CENT OF GEMCAP TIME
ROMRNT	32681	26.10	21.793
TNEFLD	32681	23.85	19.913
NEWFLD	9897	18.56	15.499
PAGPLT	3051	13.52	11.286
FLDOUT	9121	9.47	7.908
PAGPLT	4	2.50	2.088
PAGPLT	4	2.39	2.000
PRTSYM	1925	1.65	1.374
FABL04	49	1.43	1.194
SYMSCH	1690	1.35	1.126
ZIJSET	9	1.35	1.125
ZIJSET	1	1.24	1.034
DECOMP	1050	1.23	1.027
FLDDRV	3441	1.19	.991
NEWFLD	74	1.11	.924
NEWFLD	74	1.07	.890
CABC	1601	.86	.719
NTHPLT	1640	.84	.706
NTHPLT	1600	.83	.697
FARFLD	74	.66	.555
FARFLD	74	.65	.544
WRTFIL	697	.62	.519
UNOSUM	3041	.60	.504
UNOSUM	3040	.54	.484
PLIST	3	.57	.478
BACSUB	152	.49	.412
SCAN	37	.41	.346
SEJCON	1684	.33	.275
FLDOUT	2	.32	.267
FLDOUT	2	.30	.255
EXCDRV	122	.29	.242
POSTIP	99	.26	.220
TSKXQT	82	.23	.194
SOLVOC	139	.23	.190
LODDRV	1039	.22	.181
RWCOMS	2	.20	.164
SYMDEF	11	.14	.118
DECOMP	1	.12	.103
OPNFIL	37	.12	.102
SYMLPD	37	.12	.102
FABL04	48	.12	.099
DECOMP	1	.11	.091
FABL04	48	.11	.090
PRESCN	536	.10	.083
FLDDRV	2	.10	.081
FLDDRV	2	.09	.076
MOVFIL	51	.09	.073
SOLVOC	10	.08	.070
GETKWD	117	.08	.066
SOLDRV	2	.05	.044
PARSE	27	.05	.043
SOLDRV	1	.05	.041
BMIRMS	6	.05	.040
WRTCHK	2	.04	.035
POSTPR	18	.04	.031
SOLVOC	4	.04	.030
CABC	2	.03	.026
FNDARG	94	.03	.025
BMIRMS	5	.03	.027

SCALE2	43	.03	.027
BANDIT	21	.03	.026
SOLDRV	1	.03	.025
CABC	2	.03	.024
PRTSYM	1	.03	.022
BMIRRS	3	.02	.020
BACSUB	5	.02	.020
TSKXQT	2	.02	.019
SYMLIT	51	.02	.017
BANDIT	1	.02	.016
SYSCHK	52	.02	.015
EXCDRV	2	.02	.014
EXCDRV	2	.02	.013
ZIJDRV	4	.02	.013
PRTSYM	1	.02	.013
CNVANP	2	.02	.013
POSTIP	71	.01	.012
INPDRV	1	.01	.008
LITSCH	40	.01	.007
BACSUB	2	.01	.006
LODDRV	1	.01	.006
ZIJDRV	1	.01	.005
GETKWV	3	.01	.005
LODDRV	1	.01	.004
SYMSCH	21	.01	.004
PUTKWV	5	.00	.003
LITSCH	14	.00	.003
SCALE2	8	.00	.003
SYMLIT	5	.00	.003
SCALE2	8	.00	.003
PUTKWV	1	.00	.002
PREPAR	27	.00	.002
CNVANP	1	.00	.002
PRESCN	3	.00	.001
DMPDRV	2	.00	.001
DMPDRV	1	.00	.001
SYSRTN	5	0.00	0.000
GETKWV	1	0.00	0.000
PLIST	4	0.00	0.000

TOTAL ACCOUNTED TIME(SECONDS)= 119.75

E. COMPUTER REQUIREMENTS

GEMACS is written in American Standard FORTRAN, X 3.9-1966. It is capable of executing with no library subroutines other than those required by the ANSI standard. The code requires approximately 70K decimal core locations (depending on machine and load method utilized) and may be segmented or overlayed. As released, neither of these features is utilized due to incompatibility with various machines.

1. I/O Requirements

GEMACS makes extensive use of peripheral file storage and must have several FORTRAN logical units available. These are listed below with the internal variable name, the logical unit number, and the file usage given. Data are stored starting on logical unit IOSYMB up to and including the logical unit number specified on the NUMFIL input. The user is responsible for assuring that GEMACS can access these files. If more files are required than made available, a fatal error will occur and an attempt will be made to write a checkpoint.

TABLE 3. GEMACS LOGICAL UNITS

INTERNAL DESIGNATOR	LOGICAL UNIT NUMBER	USE
IOSCR1	1	Scratch File
IOSCR2	2	Scratch File
LUTASK	5	Card Image Input
LUPRNT	6	Formatted Output
IOCKPT	7	Checkpoint File (Binary)
IOSYMB	8	Data Storage (Binary)
LUNIT	9	Data Storage (Binary)
LUNIT	10	Data Storage (Binary)
	.	
	.	
	.	
	.	
LUNIT	NUMFIL	Data Storage (Binary)

If a logical unit designator is used on any command, it should be units 3 or 4, or greater than that specified on the NUMFIL entry. This will insure that the unit is not in use when required. As a practical consideration, the following types of data sets will require the specified number of units.

TABLE 4. DATA SET LOGICAL UNIT REQUIREMENTS

DATA SET TYPE	NUMBER OF UNITS
GEOMETRY	1
EXCITATION	1
IMPEDANCE	1
BANDED	1
DECOMPOSED	2
FIELD	1

Execution of a PURGE command releases the logical unit used for the specified data set for other use.

2. Internal Storage Requirements

There are five primary arrays used by GEMACS for problem execution. All arrays are stored in common blocks and have internal variables specifying their size.

Geometry data are affected by the SEGTBL, PTTBLE, IDEFIN, and CVAL arrays.

SEGTBL is used to store the segment data and must be dimensioned as an NPRSEG by MAXSEG array, where MAXSEG is the maximum largest numbered segment. As presently dimensional, GEMACS can accommodate up to 500 segments.

PTTBLE is used to store point data and must be dimensioned as an MAXPTS by NPRPT array. MAXPTS is the maximum number of points to be stored, which is presently dimensioned for 100 points.

IDEFIN is used to store the data for defined elements and must be dimensioned as an MAXDEF by NPRDEF array. MAXDEF is the maximum number of defined elements allowed, which is presently 100 elements.

CVAL is used to store coordinate system data and must be dimensioned as an MAXCSY by 6 array. MAXCSY is the maximum number of coordinate systems allowed, now set to 10. CVAL is equivalent to CX in the CSYSTM common block.

The array TEMP is stored in common TEMP01 and must be of dimension NTEMPS, presently set to 5000. This array is used throughout the code for internal computation and intermediate storage. At present, TEMP must be capable of containing at least three columns of the impedance matrix. As this implies, NTEMPS $\geq$ 6 X MAXSEG since the matrix is complex.

All array parameters are stored in the same common block as the array and are preset in block data subroutine BLKDAT.

3. System Library Routines

No system library routines are required; however, some are desirable. The most important is a routine to return the elapsed CP time in minutes. This routine is called from subroutine TICHEK and must be available for using the CHKPNT command with the CPINC parameter.

Auxiliary routines to return the date and time are called by subroutine SYSRTN. In the absence of these routines, zeros should be returned to the calling routine.

The file status function routine LUSTAT is called after each read to detect an end of file. If a library function is available to determine this information, it should be called from this routine. If none is available, simply return a zero value for the function.

METRIC SYSTEM

BASE UNITS:

Quantity	Unit	SI Symbol	Formula
length	metre	m	...
mass	kilogram	kg	...
time	second	s	...
electric current	ampere	A	...
thermodynamic temperature	kelvin	K	...
amount of substance	mole	mol	...
luminous intensity	candela	cd	...

SUPPLEMENTARY UNITS:

plane angle	radian	rad	...
solid angle	steradian	sr	...

DERIVED UNITS:

Acceleration	metre per second squared	...	m/s
activity (of a radioactive source)	disintegration per second	...	(disintegration)/s
angular acceleration	radian per second squared	...	rad/s
angular velocity	radian per second	...	rad/s
area	square metre	...	m
density	kilogram per cubic metre	...	kg/m
electric capacitance	farad	F	A·s/V
electrical conductance	siemens	S	A/V
electric field strength	volt per metre	...	V/m
electric inductance	henry	H	V·s/A
electric potential difference	volt	V	W/A
electric resistance	ohm		V/A
electromotive force	volt	V	W/A
energy	joule	J	N·m
entropy	joule per kelvin	...	J/K
force	newton	N	kg·m/s
frequency	hertz	Hz	(cycle)/s
illuminance	lux	lx	lm/m
luminance	candela per square metre	...	cd/m
luminous flux	lumen	lm	cd·sr
magnetic field strength	ampere per metre	...	A/m
magnetic flux	weber	Wb	V·s
magnetic flux density	tesla	T	Wb/m
magnetomotive force	ampere	A	...
power	watt	W	J/s
pressure	pascal	Pa	N/m
quantity of electricity	coulomb	C	A·s
quantity of heat	joule	J	N·m
radiant intensity	watt per steradian	...	W/sr
specific heat	joule per kilogram-kelvin	...	J/kg·K
stress	pascal	Pa	N/m
thermal conductivity	watt per metre-kelvin	...	W/m·K
velocity	metre per second	...	m/s
viscosity, dynamic	pascal-second	...	Pa·s
viscosity, kinematic	square metre per second	...	m/s
voltage	volt	V	W/A
volume	cubic metre	...	m
wavenumber	reciprocal metre	...	(wave)/m
work	joule	J	N·m

SI PREFIXES:

Multiplication Factors	Prefix	SI Symbol
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
1 000 000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	k
100 = 10^{2}	hecto*	h
10 = 10^{1}	deka*	da
0.1 = 10^{-1}	deci*	d
0.01 = 10^{-2}	centi*	c
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
0.000 000 000 000 001 = 10^{-15}	femto	f
0.000 000 000 000 000 001 = 10^{-18}	atto	a

* To be avoided where possible.

MISSION
of
Rome Air Development Center

RADC plans and conducts research, exploratory and advanced development programs in command, control, and communications (C^3) activities, and in the C^3 areas of information sciences and intelligence. The principal technical mission areas are communications, electromagnetic guidance and control, surveillance of ground and aerospace objects, intelligence data collection and handling, information system technology, ionospheric propagation, solid state sciences, microwave physics and electronic reliability, maintainability and compatibility.