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PROGRAM NUMBER

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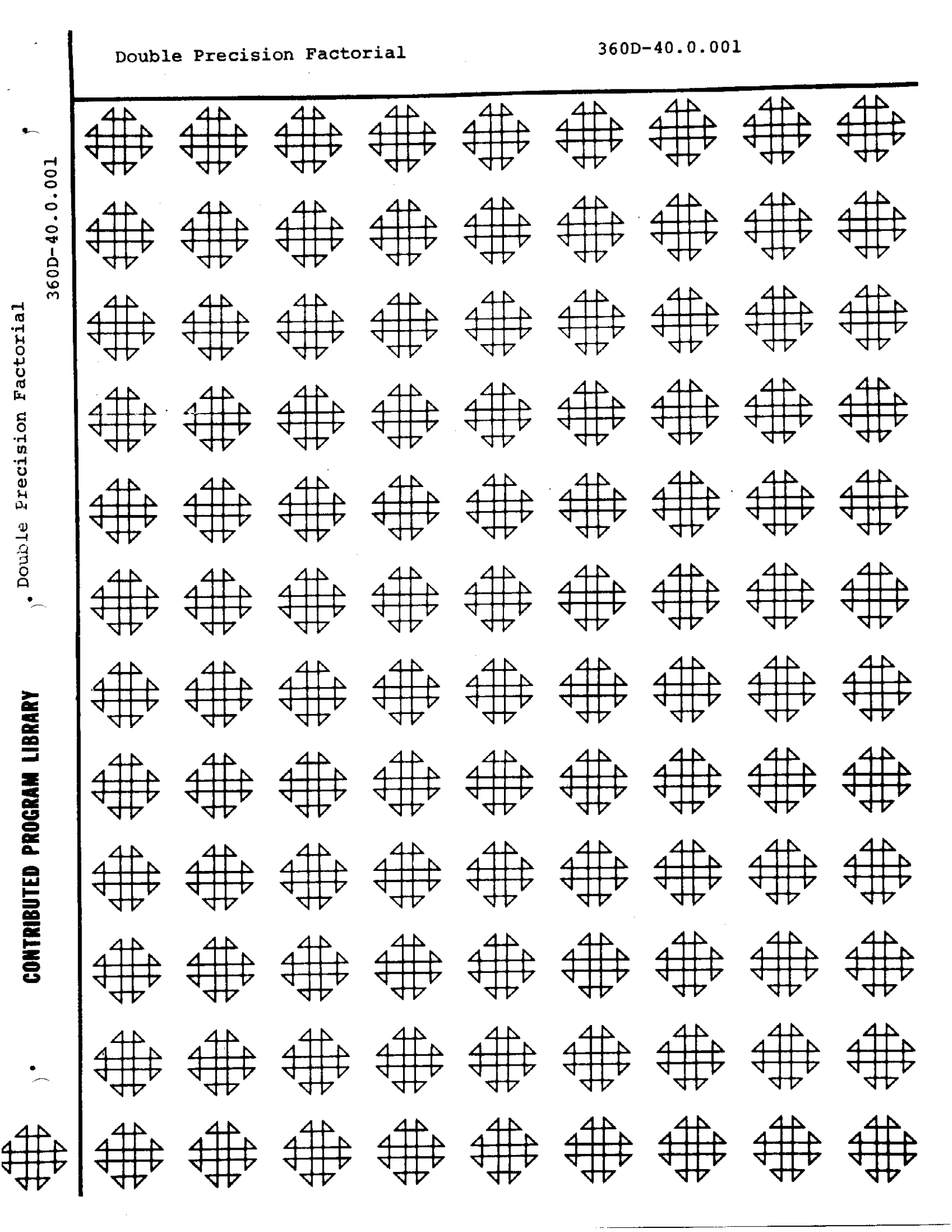
360D-40.0.001 Double Precision Factorial



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(for IBM S/360, 1130 and 1800)

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Attention: Program Control Desk

This form should be completed and submitted with the program package to PID at the address shown above. Standards and instructions for submitting programs are in your *User Group Reference Manual* or the *Contributed Program Submittal Standards Manual* available from PID.

(1) **Program Order Number** *(to be filled in by PID)* 360D 40.0.001

(2) **System Type** *(machine)* S/360

(3) **Search Key** . . . . . /DOUBLE/ /PRECISION/FACTORIAL/N/

(4) **Name of Author** *(if different than submitter's)* . . . . .

(5) **Submitter's Name** *(direct technical inquiries to)* . . . . Henry E. Schaffer

(6) **Submitter's Address** . . . . . Dept. of Genetics
N. C. State University
Raleigh, N. C., 27607

(7) **Title of Program** . . . . DFACT Double Precision Factorial

(8) **Submitter's User Group Affiliation Code and Installation Code** . . . . . S NCS

(9) **Submitter's Own Program Identification and Suffix** *(optional)* . . . . .

(10) **Primary Subject Code** 4.0.0

(11) **Secondary Subject Codes** . . . . . 13.0 41.0 . . .

(12) **Operating or Monitor System Required** . . . . . OS 360 FORT IV

(13) **New or Revision Code** *(if revision, show prior Program Order Number in item 1)* . . . . . N

(14) **Year Completed** 68

(15) **Date of Submittal** 03.08.68

(16) **Documentation** *(number of original pages submitted)* 6

(17) **Abstract** *(should contain sufficient information for a reader to determine the value of the program). Listed on the reverse side of this form are subjects which may serve as a guide for a descriptive abstract.*

CONTRIBUTED PROGRAM LIBRARY SUBMITTAL FORM

Subject Guide

a. Purpose
b. Programming Language used
c. Version and modification level or release number of IBM Programming System used, or program order number for non-IBM authored program used
d. Field of application
e. Type of routine (main program, subroutine, etc.)
f. Specific description of machine requirements
g. Engineering Changes (EC) level of equipment (if pertinent)

ABSTRACT

This subroutine returns the double precision value of factorial n. For negative n, the absolute value of n is used and an error indication is returned. For n greater than 56 the maximum floating point value is returned and an error indication is returned. (Factorial 56 is the largest factorial value which can be represented in a floating point word.)

This subroutine is very fast since the factorial values are found by a table look up. The tabular values were generated exactly in hexadecimal arithetic and rounded to double precision length. The accuracy of these hexadecimal tabular values is thus the maximum possible in a double precision word, and is not affected by any inaccuracy in the conversion of decimal constants to hexadecimal. This subroutine is written in FORTRAN IV. It should compile and run on any S/360 with FORTRAN IV (G or H level), and uses approximately 1,000 bytes of core at object time.

(Please attach additional pages if necessary) . . . . . **Total pages attached** 5

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(18) **Signature of Submitter and Date** Henry E Schaffer March 8, 1968

(19) **Signature of Installation Addressee** K R Hamilton

T4SF

ACKNOWLEDGMENT

I would like to acknowledge the assistance of Mrs. Dianne G. Cuthbertson. This subroutine was developed in the course of research supported by grant GM-11546 of the National Institutes of Health. Computing time was provided under Grant FR-00011 of the National Institutes of Health.

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CARD DECK KEY SHEET

Source Deck, sequence Ø1 through 38 in cc 79-8Ø; 38 cards.

PROGRAM WRITE-UP

This subroutine does a table look up to find factorial n. The tabular values were computed exactly in hexadecimal arithmetic and rounded to give double precision values.

This subrountine is invoked by the following statement:

CALL DFACT(N, DFACTN, I)

The arguments are:

Name	Type	Meaning
N	Integer*4	The integer whose factorial is to be returned.
DFACTN	Real*8	The double precision value of the factorial. The factorial of the absolute value of N is returned if N is negative. If N is greater than 56, the maximum floating point value is returned.
I	Integer*4	This is normally returned with a value of 1. It is returned as a zero if N is negative or greater than 56.

```
0001            SUBROUTINE DFACT (N, DFACTN, I)
                C   RETURNS DFACTN, THE DOUBLE PRECISION VALUE OF N FACTORIAL
                C   FOR N = 0,1,...,56. FOR NEGATIVE N THE ABSOLUTE VALUE OF N IS
                C   USED. FOR N.GT.56 THE MAXIMUM REAL NUMBER IS RETURNED. IN
                C   BOTH CASES I IS RETURNED AS 0. OTHERWISE I IS RETURNED AS 1.
0002            REAL*8 T(56)/Z4110C0000000000C,Z4120000000000000,
               1Z4160C00000000000,Z42180C0000C00000,Z4278000000000000,
               2Z432D000000000000,Z4413800000C00000,Z449D800000000000,
               3Z4558980000000000,Z46375F0000000000,Z4726115000000000,
               4Z481C8CFC00000000,Z4917328CC0000000,Z4A144C3B28000000,
               5Z4B1307777580000C,Z4C1307777580000C,Z4D1437EEECD80000,
               6Z4E16BEECCA730000,Z4F1802B9306890C0,Z5021C3677C82B400,
               7Z512C50770369BC40,Z523CEEA4C2B3E0D8,Z5357970CD7E29337,
               8Z548362934 3D30CD2,Z55CD4A0619FB0908,Z5714D9849EA37EEB,
               9Z58232F0FCBB3E62C,Z5930925BA47AD2CD,Z5A6F99461A1E9E14,
               AZ5BC13F637CF96866,Z5D1956AD0AAE33A4,Z5E32AD5A155C6749,
               BZ5F688589CCCE9506,Z60DE1BC4D19EFCAD,Z621E5DCBE8A88C8C,
               CZ6344530ACB78A83A,Z649E0008F68DF506,Z661774015499125F,
               DZ67392AC33E351CC7,Z688EEAE81B84C7F2,Z6A16E39F2C684406,
               EZ6B3C1581D491828F,Z6CA179CCEB478FE1,Z6E1BC0EF38704C8B,
               FZ6F4E0EADCEB8D7CD,Z70E06A0E525C0C6E,Z72293378A11EE648,
               GZ73789A69E35CB2D8,Z7517A89E4484BF3B,Z7649EEBC961ED27A,
               HZ77EBA8F91E823EE4,Z792FDE529A3274C6,Z7A9E90719EC72201,
               IZ7C217277F77E0158,Z7D72F97C62C1249F,Z7F192693359A4003/
0003             REAL*8 Z/Z7FFFFFFFFFFFFFFF/, DFACTN
0004             I=1
0005             IF (N)80,90,100
0006          90 DFACTN = 1.0000000
0007             RETURN
0008          80 I = 0
0009             N = -N
0010         100 IF (N.LT.57) GO TO 110
0011             I = 0
0012             DFACTN = Z
0013             RETURN
0014         110 DFACTN = T(N)
0015             RETURN
0016             END
```

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(1) **Program Order Number** *(to be filled in by PID)* 360D-42.2.001

(2) **System Type** *(machine)* S/360

(3) **Search Key** . . . . . ROOTS / OF / POLYNOMIALS

(4) **Name of Author** *(if different than submitter's)* . . . . . Irene Gargantini
Willy Munzner

(5) **Submitter's Name** *(direct technical inquiries to)* . Irene Gargantini

(6) **Submitter's Address** . . . . . Department of Computer Science
— Univ. of Western Ontario
— London N6A3K7
— Ontario, Canada

(7) **Title of Program** . . . . Experimental Program for Determining Polynomial Zeros

(8) **Submitter's User Group Affiliation Code and Installation Code** . . . . . S PK

(9) **Submitter's Own Program Identification and Suffix** *(optional)* . . . . . POGA

(10) **Primary Subject Code** 4.2.2

(11) **Secondary Subject Codes** . . . . . .

(12) **Operating or Monitor System Required** . . . . . OS/DOS

(13) **New or Revision Code** *(if revision, show prior Program Order Number in item 1)* . . . . . N

(14) **Year Completed** 68

(15) **Date of Submittal** 12.01.68

(16) **Documentation** *(number of original pages submitted)* 79

(17) **Abstract** *(should contain sufficient information for a reader to determine the value of the program). Listed on the reverse side of this form are subjects which may serve as a guide for a descriptive abstract.*

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Subject Guide

a. Purpose
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d. Field of application
e. Type of routine (main program, subroutine, etc.)
f. Specific description of machine requirements
g. Engineering Changes (EC) level of equipment (if pertinent)

ABSTRACT

The program determines simultaneously all the zeros of a polynomial together with error bounds. It is possible for the user to follow how the procedure works throughout the entire program by removing the C for comment in the write statements and in the two subprograms PRINTS and PRINTD. This program is not intended to be optimal, neither with regard to programming nor to computing time. It is the first digital technique for searching all the zeros that does not use deflation and gives approximations to the zeros with a predictable degree of accuracy. The program consists of FORTRAN IV subroutines. It runs on a System/360 with at least 128K core storage.

(Please attach additional pages if necessary) . . . . . **Total pages attached** _____

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(18) **Signature of Submitter and Date** Irene Gargantini 12-20-68

(19) **Signature of Installation Addressee** Carol E. Sharesy 1-10-69

T4SF

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1. DECK KEY

The first card deck consists of 14 subroutines, identified as follows:

Subprogram Name	Identification Cols. 77-80	No. of Cards	Sequence Nos. Cols. 73-76
POGA	POGA	472	0001-0472
PRINTS (comments)	PR S	8	0001-0008
PRINTD (comments)	PR D	9	0001-0009
SUSPES	SU S	42	0001-0042
SUSPED	SU D	26	0001-0026
TINAS	TI S	218	0001-0218
TINAD	TI D	53	0001-0053
QCVAL	QCVA	21	0001-0021
PCVAL	PCVA	21	0001-0021
FASES	FA S	55	0001-0055
FASED	FA D	55	0001-0055
ARCC	ARCC	30	0001-0030
R	R	13	0001-0013
T	T	14	0001-0014

The second card deck is the sample program, 16 cards, numbered 0001-0016 in columns 73-76 and identified ' y SAMP in columns 77-80.

2. PROGRAM DESCRIPTION

a. Purpose

This program computes the zeros of a polynomial.

b. The Method

By means of a transformation the given polynomial is reduced to a polynomial with leading coefficient 1 and with all the roots inside the unit disk. Let this polynomial be:

$$P(z) = z^N + a_{N-1}z^{N-1} + \ldots + a_0 .$$

Subdivide the unit square Q_0 successively by 2. At the h-th subdivision ($h = 1, 2, 3, \ldots$) consider the square Q_h of center a_h and semidiagonal $r_h = 2^{1/2 - h}$. Taking the expression $N(1+\sqrt{2})^{N-1}$, as upper bound for $|P'(z)|$ $z \xi Q_0$, the following assertions can be proved:

Square Q_h will not contain zeros if any of the following conditions hold:

(1) $|P(a_h)| > N(1+\sqrt{2})^{N-1} r_h$ (test T_1)

(2) $|P(a_h)| > \sum_{k=1}^{N} \frac{|P^{(k)}(a_h)|}{k!} r_h^k$ (test T_2)

(3) $|P(a_{h+s})| > \sum_{k=1}^{N} \frac{|P^{(k)}(a_h)|}{k!} r_{h+s}^k$ (test T_3)

$s = 1, 2, 3, \ldots$

(4) $c_0^{(0)} \neq 0 \; ; \; c_0^{(j)} > 0, \; j = 1,2,\ldots,N$ (test T_4)

where

$$\begin{cases} c^{(j+1)} = \bar{c}_0^{(j)} c_n^{(j)} - c_{N-j}^{(j)} \bar{c}_{N-j-n}^{(j)} \\ n = 0, 1, \ldots, N-j-1; \; j = 0, 1, \ldots, N-1 \end{cases}$$

$$c_n^{(0)} = \frac{P^{(n)}(a_h)}{n!} r_h^n, \quad n = 0, 1, \ldots, N.$$

We call a square "suspect of zeros" according to T_i $(i = 1, 2, 3, 4)$, if Q_h does not satisfy test T_i. It is possible to prove that for any h, all the squares "suspect of zeros" by T_1, T_2, and T_3 can be grouped in N rectangles with the properties: (1) They have no points in common; (2) at least one segment of the boundary belongs to a suspect square; (3) on the boundary the Argument Principle is applicable. This last affirmation not only means that on the contour $P(z) \neq 0$, but that this contour can be decomposed into segments between the extremes of which the variation of the argument of P(z) is inferior to π. So no uncertainty exists in establishing the number of zeros inside each rectangle.

The method in practice proceeds as follows. As input data we fix the minimum degree of refinement of Q_0, hmin. At any step h we exclude squares that do not contain zeros by using one of the test T_1 and we store the remaining ones. When hmin is reached, test T_2 is applied and suspect squares are grouped in nonconnected rectangles. The center of a rectangle gives the zero, its semidiagonal a bound for the error, the Argument

Principle determines the p-multiplicity of the zero. A p-multiple zero is repeated p-times.

A transformation brings back the results to the original polynomial.

The method was programmed for its generality and accuracy.

c. Range and Precision

NA< 50, HLE≥ 2^{-20}. The final accuracy depends on the required accuracy, HMIN. We used HMIN = 2^{-24}.

The coefficients of the polynomial have to be stored in long precision in order to obtain the coefficients of P(z) with the same accuracy as the original coefficients. After this transformation, the facility is given to the user to carry out all the computations in short or long precision, according to parameter IT. For tests T_1, T_2 and T_3, wrong decisions due to rounding-errors in evaluating P(z) and its successive derivatives are avoided by multiplying the right sides of (1), (2), and (3) by the factor VAZP = 1.001.

For test T_4 wrong decisions are avoided by enlarging the semi-diagonal of Q_h, $r_h = 2^{1/2-h}$ to $r_h = 1.5 \times 2^{-h}$.

d. System Requirements

This program has been compiled under both the FORTRAN E-level and H-level compilers running under OS/360. It requires approximately 70,000 bytes of memory.

3. INPUT/OUTPUT

Input parameters are as follows:

A - vector containing the real parts of the coefficents of the polynomial, ordered from the smallest to the largest power (long precision).

B - vector containing the imaginary parts.

NA - degree of the polynomial.

KSTART - initial subdivision of the unit square Q_0.
KSTART = 1 subdivides Q_0 into 4 parts (h = 1).

IT - if IT = 0 computations are carried out in short precision (23 binary positions).

- if IT = 1 computations are carried out in long precision (55 binary positions).

HMIN - degree of refinement of Q_0. Computation is stopped when the side length of a square Q_h is $< 2 \cdot$ HMIN.

NDE - if NDE = 1 no information exists about the location of the zeros.

if NDE = 2 the roots are known to lie inside a circle centered at the origin and of radius RMAX < 1.

LDS - switching parameter. The program switches from test T_1 or test T_3 to test T_2 if the number of "suspect" squares is $\geq 1000/\text{LDS}$ for h ≤ 20, and $\geq 500/\text{LDS}$ for h > 20.

HLE - Schur-Cohn criterion is used if the side length of a square Q_h is $\geq 2 \cdot$ HLE.

RMAX - if NDE = 2, the value of RMAX must be supplied.

Output parameters are:

XA - vector containing the real parts of the zeros (long precision).

XB - vector containing the imaginary parts.

ERROR - vector containing an upper bound for the absolute error of the zeros. The i-th component contains the error of the i-th zero.

The calling sequence to POGA is:

CALL POGA (A,B,NA,XA,XB,KSTART,IT,HMIN,ERROR, NDE,LDS,HLE,RMAX). The variables NA,KSTART,IT, NDE and LDS are integer variables. A,B,HMIN,HLE, RMAX,XA,XB and ERROR are floating point variables.

Under normal conditions POGA does not produce any printed output. However, there are a number of WRITE statements included in the program with "C" in column 1 to nullify them. The user can remove the "C" to assist in debugging his use of the program. Output from these statements is written on FORTRAN logical unit 3.

4. SAMPLE PROBLEM

The following sample problem, which computes the zeros of Z^4-1:

```
C                SAMPLE PROBLEM      ZEROS OF P(Z) = Z**4-1
      DIMENSION A(50),B(50),XA(50),XB(50),ERROR(50)
      DOUBLE PRECISION A,B,XA,XB,RMAX
      DO 1 I=1,5
      A(I)=0.
    1 B(I)=0.
      A(1)=-1.
      A(5)=1.
      J=4
      CALL POGA(A,B,4,XA,XB,1,0,1.E-07,ERROR,1,4,5.E-02,RMAX)
      WRITE(3,76)
      WRITE(3,71) (XA(I),XB(I),ERROR(I),I = 1,J)
   71 FORMAT (1H0, 2E30.16,E30.8)
   76 FORMAT (1H1,32X,5HZEROS,39X,14HABSOLUTE ERROR//////)
      STOP
      END
```

produced the following output:

ZEROS				ABSOLUTE ERROR
0.9999999999999980D	00	0.0		0.33717475E-06
-0.9999999999999980D	00	0.0		0.33717475E-06
0.0		0.9999999999999980D	00	0.33717475E-06
0.0		-0.9999999999999980D	00	0.33717475E-06

5. TESTING

The program ran about one hundred times before submission in the case of real and complex coefficients, in the case of clustering of zeros, and in the case of multiplicity. Random complex coefficients were also tried.

6. SYSTEMS MATERIAL

a. Label Table

The major variables in the program have the following functions:

XSA, YSA : contain the coordinates of the centers of squares Q_h (short precision).

XDA, YDA : as XSA, YSA, but in long precision.

CCSA : contains an upper bound for $|P'(z)|$, $z \in Q_h$ (short precision).

XSB, YSB : contain the coordinates of the centers of suspect squares obtained from the partition of Q_h into 4 subsquares Q_{h+1} (short precision).

XDB, YDB : as XSB, YSB, but in long precision.

CCSB : contains an upper bound for $|P'(z)|$, $z \in Q_{h+s}$, $s = 0,1,2,\ldots$

H : semilength of a square $Q_{h'}$, $H = 2^{-h}$, $h = 1,2,\ldots$

The program switches from XSA to XDA, from XSB to XDB when h is so high that $1-2^{-h}=1$ for the computer in short precision.

b. Program Composition

Program POGA consists basically of twelve subprograms:

POGA, SUSPES, SUSPED, TINAS, TINAD, QCVAL, PCVAL, FASES, FASED, ARCC, R, T. Two other subprograms, PRINTS and PRINTD, are provided for additional output. Only subroutine POGA must be called by the main program, all the others being required by POGA.

The functions of these other subroutines are as follows:

SUSPES : contains test T_1 or T_3. Coordinates of center of Q_h are in short precision.

SUSPED : as SUSPES, with coordinates in long precision.

TINAS : contains test T_2 and T_4. Choice between the two tests is made according to HLE. Coordinates of centers of Q_h are in short precision.

TINAD : contains test T_2; coordinates of Q_h are in long precision.

QCVAL : evaluation of P(z), z in short precision.

PCVAL : evaluation of P(z), z in long precision.

FASES : computes the variation of the argument of P(z), z in short precision.

FASED : as FASES, z in long precision.

ARCC : computes arctg (s) with the condition $|\text{arctg}(s)|<\pi$

R(A,B) : if the exponents of A and B are such that their sum is out of range of the machine, 0 replaces the product A x B (short precision).

T(A,B) : as R(A,B) in long precision.

c. Program Listing

The attached listing is the output of a run compiling the sample problem and the POGA subroutines and executing the sample problem.

```
IEF285I   SYS1.LIN                                        KEPT
IEF285I   VOL SER NOS= 222222.
IEF285I   SYS1.LIN                                        KEPT
IEF285I   VOL SER NOS= 222222.
IEF285I   SYSOUT                                          SYSOUT
IEF285I   VOL SER NOS=        .
                                                  *** STEP = SETUP     TERMINATED AT  18H 53M 22.235

//  EXEC FORTRANH
//SOURCE EXEC  PGM=IEKAA00                                        00000000
//SYSPRINT DD  SYSOUT=A                                           00000010
//SYSPUNCH DD  UNIT=SYSCP                                         00000020
//SYSLIN DD DSNAME=SYS1.LIN,DISP=(MOD,PASS),DCB=(RECFM=FB,LRECL=80, *00000030
//             BLKSIZE=3200)                                      00000031
//SYSUT2 DD DSNAME=SYS1.UTIL2,DISP=OLD                            00000040
//SYSIN DD *
IEF236I ALLOC. FOR PCGA     SOURCE
IEF237I SYSPUNCH ON 032
IEF237I SYSLIN   ON 370
IEF237I SYSUT2   ON 370
IEF237I SYSIN    ON 031
```

10

```
LEVEL 15 ( 1 JAN 68)                 OS/360  FORTRAN H                      DATE  68.364/18.53.23

         COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=53,SOURCE,BCD,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
                C       SAMPLE PROBLEM, ZEROS OF F(Z)=Z**4-1
    ISN 0002            DIMENSION A(50),B(50),XA(50),XB(50),ERROR(50)
    ISN 0003            DOUBLE PRECISION A,B,XA,XB,RMAX
    ISN 0004            DO 1 I=1,5
    ISN 0005            A(I)=0.
    ISN 0006          1 B(I)=0.
    ISN 0007            A(1)=-1.
    ISN 0008            A(5)=1.
    ISN 0009            J=4
    ISN 0010            CALL PCGA(A,B,J,XA,XB,1.0,1.E-07,ERROR,1.4,5.E-02,RMAX)
    ISN 0011            WRITE(3,76)
    ISN 0012            WRITE(3,71) (XA(I),XB(I),ERROR(I),I=1,J)
    ISN 0013         71 FORMAT(1H0,2E30.16,E30.8)
    ISN 0014         76 FORMAT(1H1,32X,5HZEROS,39X,14HABSOLUTE ERROR//////)
    ISN 0015            STOP
    ISN 0016            END
```

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
A	SFA	R*8	0CC1D8	B	SFA	R*8	000768	I	SF	I*4	0000EC	J	SFA	I*4	000100
XA	SFA	R*8	0004F8	XB	SFA	R*8	CCC688	PDGA	SF XF	P*4	000000	RMAX	SFA	R*8	000108
ERROR	SFA	R*4	CCC11C	IBCCP#	F XF	R*4	000000								

12

LABEL	ADDR	LABEL	ADDR	LABEL	ADDR	LABEL	ADDR	PAGE 003
I	CCCE0C							

****** END OF COMPILATION FLP*****

```
COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=53,SOURCE,BCD,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
              C                          SUBROUTINE  POGA
ISN 0002            SUBROUTINE POGA(A,B,NA,XA,XB,KSTART,IT,HMIN,ERROR,NDE,LOS,HLE,
                   1RMAX)
ISN 0003            DIMENSION A(50),B(50), ERROR(50),                          XA(50),XB(50
                   1),XSA(1000),XSB(1000),YSA(1000), YSB(1000),XDA(500),
                   2XDB(500),YDA(500),YDB(500)
ISN 0004            DIMENSION CCSA(1000),CCSB(1000)
ISN 0005            COMMON ZA(50),ZB(50),ZAS(50),ZBS(50),H,H8,N,ISW,NN,VAZP,VZS,ROUE
ISN 0006            DOUBLE PRECISION A,B,ZA,ZB,XDA,XDB,YDA,YDB,AQ,AT, RMAX,R
ISN 0007            DOUBLE PRECISION XA,XB,XL,XH,YL,YH,XHH,YHH,XLL,YLL
ISN 0008            EQUIVALENCE  (XDA(1),XSA(1)),(XDB(1),XSP(1)),(YDA(1),YSA(1)),(YDB
                   1(1),YSB(1))
ISN 0009            VAZP=1.001
ISN 0010            VZS=HLE
ISN 0011            IDAM=1000
ISN 0012            IDDIM=IDAM/2
ISN 0013            IOUD=IDAM/LOS
ISN 0014            IOUDD=IOUD/2
ISN 0015            IOMF=IDAM-4
ISN 0016            IODMF=IDDIM-4
ISN 0017            N=NA
ISN 0018            ISW=IT
ISN 0019            NN=N+1
ISN 0020            ROLE=SQRT(2.)
              C
              C     WRITE(3,79) N
ISN 0021            GO TO (15,16),NDE
ISN 0022         15 CONTINUE
              C     WRITE (3,75)
              C     WRITE (3,72) (A(K),B(K),K=1,NN)
ISN 0023            AQ=DSQRT(A(NN)**2+B(NN)**2)
ISN 0024            RMAX=0.
ISN 0025            DO 3 K=1,N
ISN 0026            AT=DSQRT(A(K)**2+B(K)**2)
ISN 0027            J=NN-K
ISN 0028            WJ=J
ISN 0029            R=(AT/AQ)**(1./WJ)
ISN 0030            IF(RMAX-R) 12,13,13
ISN 0031         12 RMAX=R
ISN 0032         13 CONTINUE
ISN 0033          3 CONTINUE
ISN 0034            RMAX=2.*RMAX
              C
              C     ALL THE ZEROS OF THE GIVEN POLYNOMIAL ARE INSIDE THE CIRCLE
              C     CENTERED AT THE ORIGIN AND RADIUS  RMAX
ISN 0035         16 CONTINUE
              C
ISN 0036            DO 14 K=1,N
ISN 0037            J=NN-K
```

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ISN 0038            AQ=A(NN)*RMAX**J
ISN 0039            AT=B(NN)*RMAX**J
ISN 0040            R=AQ**2+AT**2
ISN 0041            ZA(K)=(A(K)*AQ +B(K)*AT)/R
ISN 0042         14 ZB(K)=(-A(K)*AT+B(K)*AQ)/R
ISN 0043            ZA(NN)=1.
ISN 0044            ZB(NN)=0.
ISN 0045            DO 4 K=1,NN
ISN 0046            ZAS(K)=ZA(K)
ISN 0047          4 ZBS(K)=ZB(K)
              C     WRITE(3,73) RMAX
              C     WRITE (3,74)
              C     WRITE(3,78) (ZAS(K),ZBS(K),K=1,NN)
              C     WRITE (3,80)
              C     WRITE (3,77)
              C
              C     ALL THE ZEROS OF THE TRANSFORMED POLYNOMIAL ARE INSIDE THE
              C     UNIT CIRCLE
              C
ISN 0048            KEFF=KSTART-1
ISN 0049            KPOT=2**KEFF
ISN 0050            H=1./KPOT
ISN 0051            KEND=KPOT*2+1
              C
              C
              C              CALCULATION  OF THE START CONFIGURATION
              C
ISN 0052            I=1
ISN 0053            KST1=1
ISN 0054        200 XSA(I) =1.-KST1*H
ISN 0055            KST2=1
ISN 0056        205 YSA(I)=1.-KST2*H
ISN 0057            I=I+1
ISN 0058            KST2=KST2+2
ISN 0059            IF(KST2-KEND) 210,215,215
ISN 0060        210 XSA(I)=XSA(I-1)
ISN 0061            GO TO 205
ISN 0062        215 KST1 =KST1+2
ISN 0063            IF(KST1-KEND) 200,220,220
ISN 0064        220 IMAX=I-1
ISN 0065            IC=0
              C
ISN 0066            CCSA(1)=ROUE    *N*(1.+ROUE    )**(N-1)
              C
              C
              C  IN THE FOLLOWING  THE SQUARE  QH IS DEFINED 'SUSPECT OF ZEROS' USING
              C  TEST T1
              C  CCSA(1) CONTAINS ABS(P'(Z))*SQRT(2.)
              C
              C
ISN 0067            DO 225 I=1,IMAX
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ISN 0068          CCSA(I)=CCSA(I)                                          0101P0GA
ISN 0069        220 CONTINUE                                               0102P0GA
ISN 0070            H=H/2.                                                 0103P0GA
ISN 0071            GO TO 250                                              0104P0GA
ISN 0072        230 H=H/2.                                                 0105P0GA
ISN 0073            IF(1.+H-1.) 300,300,240                                0106P0GA
                C                                                          0107P0GA
                C              THE INDEPENDENT VARIABLE IS STORED IN SHORT PRECISION       0108P0GA
                C                                                          0109P0GA
ISN 0074        240 DO 245 I=1,IMAX                                        0110P0GA
ISN 0075            XSA(I) =XSP(I)                                         0111P0GA
ISN 0076            YSA(I)=YSP(I)                                          0112P0GA
ISN 0077            CCSA(I)=CCSP(I)                                        0113P0GA
ISN 0078        245 CONTINUE                                               0114P0GA
ISN 0079        250 IF(H-VZS) 260,260,255                                  0115P0GA
ISN 0080        255 CONTINUE                                               0116P0GA
ISN 0081            HR=H*1.5                                               0117P0GA
ISN 0082            GO TO 420                                              0118P0GA
ISN 0083        260 IF(IMAX-IOLD) 251,251,400                              0119P0GA
ISN 0084        251 IF(H-HMIN) 400,400,252                                 0120P0GA
                C                                                          0121P0GA
                C                                                          0122P0GA
                C  QH IS DEFINED *SUSPECT OF ZEROS* USING TEST   T1 OR T3  0123P0GA
                C                                                          0124P0GA
                C                                                          0125P0GA
ISN 0085        252 IN=1                                                   0126P0GA
ISN 0086            DO 280 I=1,IMAX                                        0127P0GA
ISN 0087               XSP(IN) =XSA(I)+H                                   0128P0GA
ISN 0088               YSP(IN) =YSA(I)+H                                   0129P0GA
ISN 0089               CCSP(IN)=CCSA(I)                                    0130P0GA
ISN 0090            CALL SUSPES(XSP(IN),YSP(IN),CCSP(IN),MARK)             0131P0GA
ISN 0091            IM=IN+MARK                                             0132P0GA
ISN 0092               XSP(IM)=XSP(IN)                                     0133P0GA
ISN 0093               YSP(IM)=YSA(I)-H                                    0134P0GA
ISN 0094               CCSP(IM) =CCSA(I)                                   0135P0GA
ISN 0095            CALL SUSPES(XSP(IM),YSP(IM),CCSP(IM),MARK)             0136P0GA
ISN 0096            IN=IM+MARK                                             0137P0GA
ISN 0097             XSP(IN)=XSA(I)-H                                      0138P0GA
ISN 0098             YSP(IN)=YSP(IM)                                       0139P0GA
ISN 0099             CCSP(IN)=CCSA(I)                                      0140P0GA
ISN 0100            CALL SUSPES(XSP(IN),YSP(IN),CCSP(IN),MARK)             0141P0GA
ISN 0101            IM=IN+MARK                                             0142P0GA
ISN 0102               XSP(IM)=XSP(IN)                                     0143P0GA
ISN 0103               YSP(IM)=YSA(I)+H                                    0144P0GA
ISN 0104               CCSP(IM)=CCSA(I)                                    0145P0GA
ISN 0105            CALL SUSPES(XSP(IM),YSP(IM),CCSP(IM),MARK)             0146P0GA
ISN 0106            IN=IM+MARK                                             0147P0GA
ISN 0107            IF(IN-IOMF) 280,400,400                                0148P0GA
ISN 0108        280 CONTINUE                                               0149P0GA
ISN 0109            IC=0                                                   0150P0GA
ISN 0110        281 IMAX=IN-1                                              0151P0GA
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                C     CALL PRINTS(XSP,YSP,IMAX,H,IC)                       0152P0GA
ISN 0111            IF(H-HMIN)  1, 1,230                                   0153P0GA
                C                                                          0154P0GA
                C              THE INDEPENDENT VARIABLE IS STORED IN LONG  PRECISION       0155P0GA
                C                                                          0156P0GA
ISN 0112        300 IF(IMAX-ICCIN) 305,500,500                             0157P0GA
ISN 0113        305 DO 310 I=1,IMAX                                        0158P0GA
ISN 0114               XDA(I) =XSP(I)                                      0159P0GA
ISN 0115               YDA(I)=YSP(I)                                       0160P0GA
ISN 0116               CCSA(I) =CCSP(I)                                    0161P0GA
ISN 0117        310 CONTINUE                                               0162P0GA
ISN 0118            GO TO 350                                              0163P0GA
ISN 0119        330 H=H/2.                                                 0164P0GA
ISN 0120            DO 340 I=1,IMAX                                        0165P0GA
ISN 0121               XDA(I) =XDB(I)                                      0166P0GA
ISN 0122               YDA(I)=YDB(I)                                       0167P0GA
ISN 0123               CCSA(I) =CCSB(I)                                    0168P0GA
ISN 0124        340 CONTINUE                                               0169P0GA
ISN 0125        350 IF(IMAX-ICLCC) 351,351,600                             0170P0GA
ISN 0126        351 IF(H-HMIN) 600,600,352                                 0171P0GA
                C                                                          0172P0GA
                C                                                          0173P0GA
                C  QH IS DEFINED *SUSPECT OF ZEROS* USING TEST   T1 OR T3  0174P0GA
                C                                                          0175P0GA
                C                                                          0176P0GA
ISN 0127        352 IN=1                                                   0177P0GA
ISN 0128            DO 380 I=1,IMAX                                        0178P0GA
ISN 0129               XDB(IN) =XDA(I)+H                                   0179P0GA
ISN 0130               YDB(IN) =YDA(I)+H                                   0180P0GA
ISN 0131               CCSB(IN)=CCSA(I)                                    0181P0GA
ISN 0132            CALL SUSPEC(XDB(IN),YDB(IN),CCSB(IN),MARK)             0182P0GA
ISN 0133            IM=IN+MARK                                             0183P0GA
ISN 0134               XDB(IM)=XDB(IN)                                     0184P0GA
ISN 0135               YDB(IM)=YDA(I)-H                                    0185P0GA
ISN 0136               CCSB(IM)=CCSA(I)                                    0186P0GA
ISN 0137            CALL SUSPEC(XDB(IM),YDB(IM),CCSB(IM),MARK)             0187P0GA
ISN 0138            IN=IM+MARK                                             0188P0GA
ISN 0139               XDB(IN) =XDA(I)-H                                   0189P0GA
ISN 0140               YDB(IN)=YDB(IM)                                     0190P0GA
ISN 0141               CCSB(IN)=CCSA(I)                                    0191P0GA
ISN 0142            CALL SUSPEC(XDB(IN),YDB(IN),CCSB(IN),MARK)             0192P0GA
ISN 0143            IM=IN+MARK                                             0193P0GA
ISN 0144               XDB(IM)=XDB(IN)                                     0194P0GA
ISN 0145               YDB(IM)=YDA(I)+H                                    0195P0GA
ISN 0146               CCSB(IM)=CCSA(I)                                    0196P0GA
ISN 0147            CALL SUSPEC(XDB(IM),YDB(IM),CCSB(IM),MARK)             0197P0GA
ISN 0148            IN=IM+MARK                                             0198P0GA
ISN 0149            IF(IN-IOOIM) 380,600,600                               0199P0GA
ISN 0150        380 CONTINUE                                               0200P0GA
ISN 0151            IC=0                                                   0201P0GA
ISN 0152        381 IMAX=IN-1                                              0202P0GA
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C      CALL PRINTC(XCB,YCB,IMAX,H,IC)                                   0203P0GA
ISN C152      IF(H-HMIN) 11,11,330                                      0204P0GA
C                                                                       0205P0GA
C                                                                       0206P0GA
C  QH IS DEFINED 'SUSPECT OF ZEROS' BY MEANS OF  TEST -2                0207P0GA
C  THE INDEPENDENT VARIABLE IS STORED IN SHORT PRECISION                0208P0GA
C                                                                       0209P0GA
ISN C154    4CC CONTINUE                                                0210P0GA
ISN C155        HR=H*RDUE                                               0211P0GA
ISN C156    42C CONTINUE                                                0212P0GA
ISN C157        IN=1                                                    0213P0GA
ISN C158         IC=1                                                   0214P0GA
ISN C159         DC 45C I=1,IMAX                                        0215P0GA
ISN C160           XSB(IN)=XSA(I)+H                                     0216P0GA
ISN C161           YSB(IN)=YSA(I)+H                                     0217P0GA
ISN C162                 CALL TINAS (XSB(IN),YSB(IN),CCSB(IN),MARK)     0218P0GA
ISN C163                 IM=IN+MARK                                     0219P0GA
ISN C164                 XSB(IM)=XSB(IN)                                0220P0GA
ISN C165                 YSB(IM)=YSA(I)-H                               0221P0GA
ISN C166                 CALL TINAS (XSB(IM),YSB(IM),CCSB(IM),MARK)     0222P0GA
ISN C167        IN=IM+MARK                                              0223P0GA
ISN C168        XSB(IN)=XSA(I)-H                                        0224P0GA
ISN C169        YSB(IN)=YSB(IM)                                         0225P0GA
ISN C170                 CALL TINAS (XSB(IN),YSB(IN),CCSB(IN),MARK)     0226P0GA
ISN C171                 IM=IN+MARK                                     0227P0GA
ISN C172                 XSB(IM)=XSB(IN)                                0228P0GA
ISN C173                 YSB(IM)=YSA(I)+H                               0229P0GA
ISN C174                 CALL TINAS (XSB(IM),YSB(IM),CCSB(IM),MARK)     0230P0GA
ISN C175        IN=IM+MARK                                              0231P0GA
ISN C176        IF(IN-ICMF) 45C,46C,46C                                 0232P0GA
ISN C177    45C CONTINUE                                                0233P0GA
ISN C178        GO TO 281                                               0234P0GA
C                                                                       0235P0GA
C                                                                       0236P0GA
C  QH IS DEFINED 'SUSPECT OF ZEROS' BY MEANS OF  TEST -2                0237P0GA
C  THE INDEPENDENT VARIABLE IS STORED IN LONG  PRECISION                0238P0GA
C                                                                       0239P0GA
ISN C179    60C IN=1                                                    0240P0GA
ISN C180        IC=1                                                    0241P0GA
ISN C181        HR=H*RDUE                                               0242P0GA
ISN C182        DO 65C I=1,IMAX                                         0243P0GA
ISN C183        XDB(IN)=XDA(I)+H                                        0244P0GA
ISN C184        YDB(IN)=YDA(I)+H                                        0245P0GA
ISN C185                 CALL TINAD (XDB(IN),YDB(IN),CCSB(IN),MARK)     0246P0GA
ISN C186                 IM=IN+MARK                                     0247P0GA
ISN C187                 XDB(IM)=XDB(IN)                                0248P0GA
ISN C188                 YDB(IM)=YDA(I)-H                               0249P0GA
ISN C189                 CALL TINAC (XDB(IM),YDB(IM),CCSB(IM),MARK)     0250P0GA
ISN C190        IN=IM+MARK                                              0251P0GA
ISN C191        XDB(IN)=XDA(I)-H                                        0252P0GA
ISN C192        YDB(IN)=YDB(IM)                                         0253P0GA
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ISN 0193                 CALL TINAD (XDB(IN),YDB(IN),CCSB(IN),MARK)     0254P0GA
ISN C194                 IM=IN+MARK                                     0255P0GA
ISN C195                 XDB(IM)=XDB(IN)                                0256P0GA
ISN C196                 YDB(IM)=YDA(I)+H                               0257P0GA
ISN C197                 CALL TINAC (XDB(IM),YDB(IM),CCSB(IM),MARK)     0258P0GA
ISN C198        IN=IM+MARK                                              0259P0GA
ISN 0199        IF(IN-IDOMF) 65C,66C,66C                                0260P0GA
ISN 0200    65C CONTINUE                                                0261P0GA
ISN 02C1        GO TO 381                                               0262P0GA
C                                                                       0263P0GA
C                                                                       0264P0GA
C                                                                       0265P0GA
ISN 0202    500 H=H*2.                                                  0266P0GA
ISN C2C3       ,IF(IC) 560,400,56C                                      0267P0GA
ISN 0204    56C CONTINUE                                                0268P0GA
C       CALL PRINTS(XSB,YSB,IMAX,H,IC)                                  0269P0GA
ISN C205        WRITE (3,7C1)                                           0270P0GA
ISN 0206        GO TO 1                                                 0271P0GA
ISN 0207    660 CONTINUE                                                0272P0GA
ISN 0208        H=2.*H                                                  0273P0GA
ISN 0209        WRITE (3,701)                                           0274P0GA
ISN 021C        DO 661 I=1,IMAX                                         0275P0GA
ISN C211        XDB(I)=XDA(I)                                           0276P0GA
ISN 0212    661 YDB(I)=YDA(I)                                           0277P0GA
ISN C213        GO TO 11                                                0278P0GA
ISN 0214    46C CONTINUE                                                0279P0GA
ISN 0215        H=2.*H                                                  0280P0GA
ISN 0216    7CC WRITE (3,7C1)                                           0281P0GA
ISN 0217        DO 461 I=1,IMAX                                         0282P0GA
ISN C218        XSB(I)=XSA(I)                                           0283P0GA
ISN C219    461 YSB(I)=YSA(I)                                           0284P0GA
C                                                                       0285P0GA
C                                                                       0286P0GA
C           CONSTRUCTION  OF NONCONNECTED RECTANGLES                    0287P0GA
C           SHORT PRECISION                                             0288P0GA
C                                                                       0289P0GA
C                                                                       0290P0GA
ISN 0220      1 CONTINUE                                                0291P0GA
C       WRITE(3,77)                                                     0292P0GA
ISN 0221        K=IMAX                                                  0293P0GA
ISN C222        KS=K                                                    0294P0GA
ISN 0223        L=C                                                     0295P0GA
ISN 0224    4000 FL=XSB(1)-2.*H                                         0296P0GA
ISN 0225         FH=XSB(1)+2.*H                                         0297P0GA
ISN 0226         GL=YSB(1)-2.*H                                         0298P0GA
ISN 0227         GH=YSB(1)+2.*H                                         0299P0GA
ISN C228         IF(KS-1) 4CC5,4CC5,4010                                0300P0GA
ISN 0229    4CC5 K=C                                                    0301P0GA
ISN C23C         KS=0                                                   0302P0GA
ISN 0231         GO TO 4CC0                                             0303P0GA
ISN 0232    4010 I=1                                                    0304P0GA
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```
      K=KS
 4100         IF(XSB(I)-PL) 4500,4160,4110
 4110         IF(XSB(I)-PH) 4120,4140,4500
 4120         IF(YSB(I)-QL) 4500,4250,4130
 4130         IF(YSB(I)-QH) 4200,4300,4500
 4140         IF(YSB(I)-QL) 4500,4500,4150
 4150         IF(YSB(I)-QH) 4350,4500,4500
 4160         IF(YSB(I)-QL) 4500,4500,4170
 4170         IF(YSB(I)-QH) 4400,4500,4500
 4200         XSB(I)=XSB(KS)
              YSB(I)=YSB(KS)
      KS=KS-1
              IF(K) 4600,4600,4500
 4250    QL=YSB(I) -2.*H
         GO TO 4450
 4300    QH=YSB(I)+2.*H
         GO TO 4450
 4350    PH=XSB(I)+2.*H
         GO TO 4450
 4400    PL=XSB(I)-2.*H
 4450 CONTINUE
      IF(I-K) 4460,4470,4470
 4460     XSB(I)=XSB(KS)
          YSB(I)=YSB(KS)
      KS=KS-1
      GO TO 4480
 4470 CONTINUE
      XSB(I)=XSB(KS)
      YSB(I)=YSB(KS)
      KS=KS-1
 4480 CONTINUE
          IF(K) 4600,4600,4010
 4500 I=I+1
      IF(I-K) 4100,4100,4600
 4600 CONTINUE
      K=KS
C
      PHH=PH-H
      QHH=QH-H
      PLL=PL+H
      QLL=QL+H
C     WRITE(3,72) PHH,QHH,PLL,QLL
      SV= (PHH+PLL)*0.5
      ST= (QHH+QLL)*0.5
      SV=SV*RMAX
      ST=ST*RMAX
C
      CALL FASES(PHH,QHH,PLL,QLL,MARK)
      IF (MARK) 5000,5001,5000
 5000 CONTINUE
C
```

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C             STORAGE OF THE ZEROS  (SHORT  PRECISION)
C
      DO 5002 IS=1,MARK
      LL=L+IS
      XA(LL)= (PH-PL)*0.5-H
      XB(LL)= (QH-QL)*0.5-H
      ERROR(LL   )=DSQRT(XA(LL   )**2+XB(LL   )**2)*RMAX
      XA(LL )=SV
      XB(LL )=ST
 5002 CONTINUE
      L=LL
 5001 CONTINUE
C
      IF (K) 2000,2000,4000
C
C
C             CONSTRUCTION  OF NONCONNECTED RECTANGLES
C             LONG PRECISION
C
C
   11 CONTINUE
C     WRITE(3,77)
      K=IMAX
      KS=K
      L=0
 1000 XL=XOB(1)-2.*H
      XH=XOB(1)+2.*H
      YL=YOB(1)-2.*H
      YH=YOB(1)+2.*H
      IF(KS-1) 1005,1005,1010
 1005 K=0
      KS=0
      GO TO 1600
 1010 I=1
      K=KS
 1100         IF(XOB(I)-XL) 1500,1160,1110
 1110         IF(XOB(I)-XH) 1120,1140,1500
 1120         IF(YOB(I)-YL) 1500,1250,1130
 1130         IF(YOB(I)-YH) 1200,1300,1500
 1140         IF(YOB(I)-YL) 1500,1500,1150
 1150         IF(YOB(I)-YH) 1350,1500,1500
 1160         IF(YOB(I)-YL) 1500,1500,1170
 1170         IF(YOB(I)-YH) 1400,1500,1500
 1200         XOB(I)=XOB(KS)
              YOB(I)=YOB(KS)
      KS=KS-1
              IF(K) 1600,1600,1500
 1250    YL=YOB(I) -2.*H
         GO TO 1450
 1300    YH=YOB(I)+2.*H
         GO TO 1450
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ISN 0321      1390      XH=XCR(I)+2.*H                                        0407P0GA
ISN 0322                GO TO 1450                                            0408P0GA
ISN 0323      1400      XL=XCR(I)-2.*H                                        0409P0GA
ISN 0324      1450 CONTINUE                                                   0410P0GA
ISN 0325                IF(I-K) 1460,1470,1470                                0411P0GA
ISN 0326      1460        XCR(I)=XCR(KS)                                      0412P0GA
ISN 0327                  YCR(I)=YCR(KS)                                      0413P0GA
ISN 0328                KS=KS-1                                               0414P0GA
ISN 0329                GO TO 1480                                            0415P0GA
ISN 0330      1470 CONTINUE                                                   0416P0GA
ISN 0331                XCR(1) =XCR(KS)                                       0417P0GA
ISN 0332                YCR(1)=YCR(KS)                                        0418P0GA
ISN 0333                KS=KS-1                                               0419P0GA
ISN 0334      1480 CONTINUE                                                   0420P0GA
ISN 0335                IF(K) 1600,1600,1010                                  0421P0GA
ISN 0336      1500 I=I+1                                                      0422P0GA
ISN 0337                IF(I-K) 1100,1100,1600                                0423P0GA
ISN 0338      1600 CONTINUE                                                   0424P0GA
ISN 0339                K=KS                                                  0425P0GA
              C                                                               0426P0GA
ISN 0340                XHH=XH+H                                              0427P0GA
ISN 0341                YHH=YH+H                                              0428P0GA
ISN 0342                XLL=XL+H                                              0429P0GA
ISN 0343                YLL=YL+H                                              0430P0GA
              C         WRITE (3,72) XHH,YHH,XLL,YLL                          0431P0GA
ISN 0344                AC= (XHH+XLL)*0.5                                     0432P0GA
ISN 0345                AT= (YHH+YLL)*0.5                                     0433P0GA
ISN 0346                AC=AC**8X                                             0434P0GA
ISN 0347                AT=AT**8X                                             0435P0GA
              C                                                               0436P0GA
ISN 0348                CALL BASED(XHH,YHH,XLL,YLL,MARK)                      0437P0GA
ISN 0349                IF (MARK) 3000,3001,3000                              0438P0GA
              C                                                               0439P0GA
              C           STORAGE OF THE ZEROS  (LONG   PRECISION)            0440P0GA
              C                                                               0441P0GA
ISN 0350      3000 CONTINUE                                                   0442P0GA
ISN 0351                DO 3002 IS=1,MARK                                     0443P0GA
ISN 0352                LL=L+IS                                               0444P0GA
ISN 0353                XA(LL)= (XH-XL)*0.5-H                                 0445P0GA
ISN 0354                XB(LL)= (YH-YL)*0.5-H                                 0446P0GA
ISN 0355                ERRCP(LL  )=DSQRT(XA(LL  )**2+XB(LL  )**2)*RMAX       0447P0GA
ISN 0356                XA(LL )=AC                                            0448P0GA
ISN 0357                XB(LL )=AT                                            0449P0GA
ISN 0358      3002 CONTINUE                                                   0450P0GA
ISN 0359                L=LL                                                  0451P0GA
ISN 0360      3001 CONTINUE                                                   0452P0GA
              C                                                               0453P0GA
ISN 0361                IF (K) 2000,2000,1000                                 0454P0GA
ISN 0362      2000 CONTINUE                                                   0455P0GA
              C         WRITE (3,76)                                          0456P0GA
              C         WRITE (3,71) (XA(I),XB(I),ERRCP(I),I=1,LL)            0457P0GA
```



```
              C     WRITE(3,77)                                               0458P0GA
              C  71 FORMAT (1H0, 2E30.16,E30.8)                               0459P0GA
              C  72 FORMAT(1HC,2E25.16,8X,2E25.16)                            0460P0GA
              C  73 FORMAT(1H0, 67HTHE ZEROS LIE INSIDE THE CIRCLE CENTERED AT THE ORI0461P0GA
              C    1GIN AND RADIUS =1PE10.3)                                  0462P0GA
              C  74 FORMAT(1H1,58X,16HREAL COEFFICIENTS//)                    0463P0GA
              C  75 FORMAT(1H0,57X,12HCOEFFICIENTS///)                        0464P0GA
              C  76 FORMAT(1H1,32X,5HZEROS,30X,14HABSOLUTE ERROR///////)      0465P0GA
              C  77 FORMAT(1H1)                                               0466P0GA
              C  78 FORMAT(1H0,2E25.8,8X,E25.8)                               0467P0GA
              C  79 FORMAT(1H1,46X,26HDEGREE OF THE POLYNOMIAL =I3//)         0468P0GA
              C  80 FORMAT(1HC,45X,26HTHE ZEROS LIE INSIDE THE UNIT CIRCLE//) 0469P0GA
ISN 0363        701 FORMAT (1H0, 19HCIMPASICAS EXCEEDED)                      0470P0GA
ISN 0364            RETURN                                                    0471P0GA
ISN 0365            END                                                       0472P0GA
```

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
A	FA XR	R*8	000000	B	FA XR	R*8	000000	H	SF C	R*4	000480	I	SF	I*4	000168
J	SF	I*4	00016C	K	SFA	I*4	000170	L	SF	I*4	000174	N	SF C	I*4	000488
R	SF	R*8	000210	AC	SF	R*8	000218	AT	SF	R*8	000220	HR	S C	R*4	000484
IC	S	I*4	000178	IM	SFA	I*4	00017C	IN	SFA	I*4	000180	IS	SF	I*4	000184
IT	F	I*4	000188	KS	SF	I*4	00018C	LL	SFA	I*4	000190	NA	F	I*4	000194
NN	SFA C	I*4	0004C0	PH	SF	R*4	00015C	PL	SF	R*4	00019C	OH	SF	R*4	0001A0
CL	SF	R*4	0001A4	ST	SF	R*4	0001A8	SV	SF	R*4	0001AC	WJ	SF	R*4	0001B0
XA	SFA XR	R*8	000000	XB	SFA XR	R*8	000000	XH	SF	R*8	000228	XL	SF	R*8	000230
YH	SF	R*8	000238	YL	SF	R*8	000240	ZA	SF C	R*8	000000	ZB	SF C	R*8	000190
HLF	F	R*4	0001B4	ISH	S C	I*4	0004BC	LCS	F	I*4	0001B8	NOF	F	I*4	0001BC
PHH	SFA	R*4	0001C0	PLL	SFA	R*4	0001C4	CHH	SFA	R*4	0001C8	CLL	SFA	R*4	0001CC
VZS	S C	R*4	0004C8	XDA	SF E	R*8	0021A8	XDB	SFA E	R*8	0031A8	XHH	SFA	R*8	000248
XLL	SFA	R*8	000250	XSA	SF E	R*4	0021B8	XSB	SFA E	R*4	0031A8	YDA	SF E	R*8	0041D8
YDB	SFA E	R*8	005D80	YHH	SFA	R*8	000258	YLL	SFA	R*8	000260	YSA	SF E	R*4	004108
YSB	SFA E	R*4	005080	ZAS	S C	R*4	000320	ZBS	S C	R*4	0003E8	CCSA	SF	R*4	000270
CCSB	SFA	R*4	001214	HMIN		R*4	0001D0	IDAY	SF	I*4	0001D4	IDME	S	I*4	0001D8
IMAX	SF	I*4	0001DC	IOUT	SF	I*4	0001E0	KEEP	SF	I*4	0001E4	KEND	S	I*4	0001E8
KPRT	SF	I*4	0001EC	KST1	SF	I*4	0001F0	KST2	SF	I*4	0001F4	MARK	SFA	I*4	0001F8
PDGA		R*4	0001FC	ROUF	SF C	R*4	0004CC	RMAX	SF	R*8	000268	VAZP	S C	R*4	0004C4
ERROR	S XR	R*4	000000	FASED	SF XF	R*4	000000	FASES	SF XF	R*4	000000	ICNTM	SF	I*4	000200
IOCME	S	I*4	000204	ICURC	S	I*4	000208	TINAC	SF XF	R*4	000000	TINAS	SF XF	R*4	000000
FRXPI#	XF	R*4	000000	FIXPI#	XF	I*4	000000	FDXPI#	XF	R*8	000000	FDXPD#	XF	R*8	000000
DSQRT	XF	R*8	000000	SQRT	XF	R*4	000000	IBCOM#	F XF	I*4	000000	KSTART	F	I*4	00020C
SLSPEC	SF XF	R*4	000000	SLSPES	SF XF	R*4	000000								

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * * SIZE OF BLOCK 0004D0 HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
ZA	R*8	000000	ZB	R*8	00015C	ZAS	R*4	000320	ZBS	R*4	0003E8
H	R*4	000480	HR	R*4	000484	N	I*4	000488	ISH	I*4	0004BC
NN	I*4	0004C0	VAZP	R*4	0004C4	VZS	R*4	0004C8	ROUF	R*4	0004CC

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LABEL	ADDR	LABEL	ADDR	LABEL	ADDR	LABEL	ADDR
15	0061FC	12	0062E2	13	0062FA	3	0062FA
16	0063C8	14	0063BF	4	006410	200	0064A4
205	0064F4	210	00653C	215	006548	220	006560
225	0065FF	230	0065DC	240	006626	245	00665F
250	006662	265	006676	260	00668A	251	006652
252	00669F	280	006E16	281	006832	300	00694E
305	00685A	310	00688E	330	0068BE	340	00690E
350	006914	351	006928	352	006938	380	006AE4
381	006E1A	400	006B36	420	006B46	450	006CAB
600	006CCC	650	006F5A	500	006F72	560	006FBA
660	006EA4	661	006EF4	460	006FCB	451	006F58
1	006F64	4000	006F84	4005	006FC6	4010	006FD2
4100	00701C	4110	00702E	4120	007030	4130	00703E
4140	00705C	4150	00705A	4160	00706E	4170	007072
4200	0070BC	4250	0070A6	4300	0070C6	4350	0070E4
4400	00710E	4450	007122	4460	00712E	4470	00715E
4480	007182	4500	007194	4600	0071A8	5000	00723C
5002	0072FA	5001	007312	11	007324	1000	007344
1005	00738C	1010	00735E	1100	0073D6	1110	0073F6
1120	0073E6	1130	007404	1140	007416	1150	007420
1160	00742E	1170	007438	1200	007444	1250	00746C
1300	0074BC	1350	00748C	1400	0074CC	1450	0074E8
1460	0074F4	1470	007524	1480	007548	1500	00755A
1600	00756F	3000	0075F2	3002	007692	3001	0076AA
2000	0076F4						

****** END OF COMPILATION PDGA***

```
COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=53,SOURCE,BCD,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
          C                                                                    0001PR S
          C       SUBROUTINE PRINTS(X,Y,I,H,IC)                                0002PR S
          C       DIMENSION X(1000),Y(1000)                                    0003PR S
          C       WRITE(3,200)H,IC,I                                           0004PR S
          C 200 FORMAT(1H0,20X,3HH =E16.8,5X,4HIC =I2,5X,27HNUMBER OF SUSPECT SQUA0005PR S
          C      1RES =I6)                                                     0006PR S
          C       RETURN                                                       0007PR S
          C       END                                                          0008PR S
          C                                                                    0001PR D
          C       SUBROUTINE PRINTD(X,Y,I,H,IC)                                0002PR D
          C       DIMENSION X(500),Y(500)                                      0003PR D
          C       DOUBLE PRECISION X,Y                                         0004PR D
          C       WRITE(3,200)H,IC,I                                           0005PR D
          C 200 FORMAT(1H0,20X,3HH =E16.8,5X,4HIC =I2,5X,27HNUMBER OF SUSPECT SQUA0006PR D
          C      1RES =I6)                                                     0007PR D
          C     1 RETURN                                                       0008PR D
          C       END                                                          0009PR D
          C                           SUBROUTINE   SUSPES                      0001SU S
ISN 0002          SUBROUTINE SUSPES(A,B,COS,M)                                 0002SU S
ISN 0003          COMMON ZA(50),ZB(50),ZAS(50),ZBS(50),H,HR,N,ISW,NN,VAZP,VZS,ROUE  0003SU S
ISN 0004          DOUBLE PRECISION ZA,ZB,VA,VB,VAA                             0004SU S
          C                                                                    0005SU S
          C            THE COORDINATES OF THE CENTER OF THE SQUARE ARE IN SHORT  0006SU S
          C            PRECISION                                               0007SU S
          C                                                                    0008SU S
ISN 0005          IF(ISW) 1,1,2                                                0009SU S
          C              EVALUATION OF THE POLYNOMIAL    SHORT  PRECISION     0010SU S
ISN 0006        1 SA=1.                                                        0011SU S
ISN 0007          SB=0.                                                        0012SU S
ISN 0008          JN=N                                                         0013SU S
ISN 0009        8 IF (JN) 6,6,7                                                0014SU S
ISN 0010        7 SAA=SA                                                       0015SU S
ISN 0011          SA=SA*A-SB*B+ZAS(JN)                                         0016SU S
ISN 0012          SB=SAA*B+SB*A+ZBS(JN)                                        0017SU S
ISN 0013          JN=JN-1                                                      0018SU S
ISN 0014          GO TO 8                                                      0019SU S
ISN 0015        6 CONTINUE                                                     0020SU S
ISN 0016          SAA=SQRT(SA**2+SB**2)                                        0021SU S
ISN 0017          IF(SAA-H*COS*VAZP    ) 3,3,4                                 0022SU S
ISN 0018        3 M=1                                                          0023SU S
ISN 0019          GO TO 5                                                      0024SU S
ISN 0020        4 M=0                                                          0025SU S
ISN 0021          GO TO 5                                                      0026SU S
          C                                                                    0027SU S
          C              EVALUATION OF THE POLYNOMIAL    LONG   PRECISION     0028SU S
          C                                                                    0029SU S
ISN 0022        2 VA=1.                                                        0030SU S
ISN 0023          VB=0.                                                        0031SU S
ISN 0024          JN=N                                                         0032SU S
```



```
ISN 0025       18 IF(JN) 16,16,17                                              0033SU S
ISN 0026       17 VAA=VA                                                       0034SU S
ISN 0027          VA=VA*A-VB*B+ZA(JN)                                          0035SU S
ISN 0028          VB=VAA*B+VB*A+ZB(JN)                                         0036SU S
ISN 0029          JN=JN-1                                                      0037SU S
ISN 0030          GO TO 18                                                     0038SU S
ISN 0031       16 VAA=DSQRT(VA**2+VB**2)                                       0039SU S
ISN 0032          IF(VAA-H*COS*VAZP    ) 3,3,4                                 0040SU S
ISN 0033        5 RETURN                                                       0041SU S
ISN 0034          END                                                          0042SU S
```

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
A	F	R*4	000080	B	F	R*4	000084	F	C	R*4	000490	M S		I*4	000048
N	F C	I*4	000488	HR	C	R*4	N.R.	JA	SF	I*4	000040	NN	C	I*4	N.R.
SA	SFA	R*4	000090	SB	SFA	R*4	000004	VA	SFA	R*8	000008	VB	SFA	R*8	000000
ZA	F C	R*8	000000	ZB	F C	R*8	000100	CCS		R*4	000088	ISW	C	I*4	000480
SAA	SF	R*4	000098	VAA	SF	R*8	000008	VZS	C	R*4	N.R.	ZAS	F C	R*4	000320
ZBS	F C	R*4	0003E8	RDUE	C	R*4	N.R.	VAZP	C	R*4	000404	DSORT	XF	R*8	000000
SQRT	XF	R*4	000000	SLSPES		R*4	000000								

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * * SIZE OF BLOCK 000480 HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
ZA	R*8	000000	ZB	R*8	000150	ZAS	R*4	000320	ZBS	R*4	0003E8
F	R*4	000480	HR	R*4	N.R.	N	I*4	000488	ISW	I*4	000480
NN	I*4	N.R.	VAZP	R*4	000404	VZS	R*4	N.R.	RDUE	R*4	N.R.

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LABEL	ADDR	LABEL	ADDR	LABEL	ADDR	LABEL	ADDR
1	000142	8	000164	7	000168	6	0001A6
3	0001EC	4	0001EF	2	0001F0	18	000226
17	000220	16	000268	5	0002AC		

***** END OF COMPILATION FOR***

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LEVEL 19 ( 1 JAN 68)                    OS/360  FORTRAN H                              DATE  68.364/18.53.44

      COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SOURCE,NOD,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
C                              SUBROUTINE  SUSPEC                                    0001SU 0
ISN 0002           SUBROUTINE SUSPEC(A,B,CCS,N)                                     0002SU 0
ISN 0003           COMMON ZA(50),ZE(50),ZAS(50),ZES(50),F,HP,N,ISN,NN,VAZP,VZS,RDUE 0003SU 0
ISN 0004           DOUBLE PRECISION ZA,ZP,VA,VB,VAA ,A,P                            0004SU 0
                                                                                    0005SU 0
C                                                                                   0006SU 0
C          THE COORDINATES OF THE CENTER OF THE SQUARE ARE IN LONG                  0007SU 0
C          PRECISION                                                                0008SU 0
C                                                                                   0009SU 0
C            EVALUATION OF THE POLYNOMIAL          LONG PRECISION                   0010SU 0
ISN 0005           VA=1.                                                            0011SU 0
ISN 0006           VB=0.                                                            0012SU 0
ISN 0007           JN=N                                                             0013SU 0
ISN 0008         8 IF (JN) 6,6,7                                                    0014SU 0
ISN 0009         7 VAA=VA                                                           0015SU 0
ISN 0010           VA=VA*A-VB*B+ZA(JN)                                              0016SU 0
ISN 0011           VB=VAA*B+VB*A+ZB(JN)                                             0017SU 0
ISN 0012           JN=JN-1                                                          0018SU 0
ISN 0013            GO TO 8                                                         0019SU 0
ISN 0014         6 CONTINUE                                                         0020SU 0
ISN 0015           VZA=DSQRT(VA**2+VB**2)                                           0021SU 0
ISN 0016           IF(VAA-P**CCS*VAZP    ) 3,3,4                                    0022SU 0
ISN 0017         3 M=1                                                              0023SU 0
ISN 0018           GO TO 5                                                          0024SU 0
ISN 0019         4 M=0                                                              0025SU 0
ISN 0020         5 RETURN                                                           0026SU 0
ISN 0021           END
```



```
                                        /  SUSPEC /     SIZE OF PROGRAM 000208 HEXADECIMAL BYTES PAGE 002

NAME     TAG   TYPE  ADD.      NAME     TAG   TYPE  ADD.      NAME     TAG   TYPE  ADD.      NAME     TAG   TYPE  ADD.
   A   F       R*8  0000A8        B   F       R*8  000080        P       C  R*4  0004B0        M  S        I*4  000098
   N   F   C   I*4  0004BB       HP       C  R*4    N.R.       JN  SF       I*4  00009C       NN       C  I*4    N.R.
  VA  SFA      R*8  0000B8       VB  SFA      R*8  0000C0       ZA   F   C  R*8  0000D0       ZB   F   C  R*8  000190
 CCS           R*4  0000A0      ISN       C  I*4    N.R.      VAA  SF       R*8  0000C8      VZS       C  R*4    N.R.
 ZAS       C   R*8    N.R.      ZES       C  R*4    N.R.     RDUE       C  R*4    N.R.     VAZP       C  R*4  0004C4
DSQRT      XF  R*8  000000    SLSPEC           R*4  000084

                                        *****  COMMON INFORMATION  *****

   NAME OF COMMON BLOCK  *       *   SIZE OF BLOCK     0004D0 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
      ZA   R*8  000000            ZB   R*8  0001C0            ZAS   R*4    N.R.            ZBS   R*4    N.R.
       P   R*4  0004B0            HP   P*4    N.R.              N   I*4  0004BB            ISN   I*4    N.R.
      NN   I*4    N.R.          VAZP   R*4  0004C4            VZS   R*4    N.R.          RDUE   R*4    N.R.
```

LABEL	ADDR	LABEL	ADDR	LABEL	ADDR	LABEL	ADDR
9	00012A	7	00012C	6	0001AB	3	0001AB
4	0001B0	5	0001B4				

****** END OF COMPILATION FUR***


```
COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=53,SOURCE,BCD,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
              C                         SUBROUTINE  TINAS
    ISN 0002          SUBROUTINE TINAS (A,B,COS,N)
    ISN 0003          DIMENSION XR(50),XI(50),PR(50),PI(50)
    ISN 0004          DIMENSION VR(50),VI(50),AR(50),AI(50)
    ISN 0005          COMMON ZA(50),ZB(50),ZAS(50),ZBS(50),H,HR,N,ISW,NN,VAZP,VZS,RDUS
    ISN 0006          DOUBLE PRECISION VR,VI,AR,AI,COD,SMD,DH
    ISN 0007          DOUBLE PRECISION ZA,ZB
              C
    ISN 0008             IF(ISW) 100,100,101
              C
              C
              C                            SHORT PRECISION
              C
              C
              C             COMPLETE HORNER SCHEME
    ISN 0009        100     CONTINUE
    ISN 0010          XR(1)=1.
    ISN 0011          XI(1)=0.
    ISN 0012          DO 1 J=2,NN
    ISN 0013          NJ=N-J+2
    ISN 0014          XR(J) = A*XR(J-1)-B*XI(J-1)+ZAS(NJ)
    ISN 0015        1 XI(J) = A*XI(J-1)+B*XR(J-1)+ZBS(NJ)
    ISN 0016          DO 2 J=1,N
    ISN 0017          PR(J)=XR(J)
    ISN 0018        2 PI(J)=XI(J)
              C
    ISN 0019          DO 4 K=2,N
    ISN 0020          NK=N+2-K
    ISN 0021          XR(1)=PR(1)
    ISN 0022          XI(1)=PI(1)
    ISN 0023             DO 3 J=2,NK
    ISN 0024            XR(J)=A*XR(J-1)-B*XI(J-1)+PR(J)
    ISN 0025        3   XI(J)=A*XI(J-1)+B*XR(J-1)+PI(J)
    ISN 0026          NK1=NK-1
              C
    ISN 0027          DO 5 J=1,NK1
    ISN 0028          PR(J)=XR(J)
    ISN 0029        5 PI(J)=XI(J)
    ISN 0030        4 CONTINUE
              C
              C  COMPUTATION OF AN UPPER BOUND FOR THE ABSOLUTE VALUE OF THE FIRST
              C  DERIVATIVE
              C
    ISN 0031          DO 30 L=1,N
    ISN 0032       30 PR(L)=SQRT(XR(L)**2+XI(L)**2)
              C
    ISN 0033          COS=N*PR(1)
    ISN 0034          DO 14 J=2,N
    ISN 0035       14 COS=COS*H*RDUS+(N-J+1)*PR(J)
```

```
ISN 0036          CCS=RDUE*CCS
ISN 0037          IF(H-VZS) 1000,1050,1050
ISN 0038     1000 SMOD=SQRT(XR(NN)*XR(NN)+XI(NN)*XI(NN))
ISN 0039          CX=PR(1)
ISN 0040          DO 13 J=2,N
ISN 0041       13 CX=CX*HR+PR(J)
ISN 0042          IF(SMOD-HR*CX*VAZP)  402,402,404
           C
           C
           C  THE CIRCLE CENTERED AT (A,B) AND RADIUS HR IS TRANSFORMED IN TO
           C  THE UNIT CIRCLE
           C
ISN 0043     1050 CONTINUE
ISN 0044          PH=1.
ISN 0045          DO 200 J=2,NN
ISN 0046          PH=PH*HR
ISN 0047          K=N-J+2
ISN 0048          PR(J)=R(XR(K),PH)
ISN 0049          PI(J)=R(XI(K),PH)
ISN 0050      200 CONTINUE
ISN 0051          PR(1)=XR(NN)
ISN 0052          PI(1)=XI(NN)
           C
           C         SCHUR COHN  CRITERION
           C
ISN 0053          J=0
ISN 0054          NJ=NN
ISN 0055          DO 601 K=1,NN
ISN 0056          XR(K)=PR(K)
ISN 0057      601 XI(K)=PI(K)
ISN 0058          PR(1)= R(XR(1),XR(1))+R(XI(1) ,XI(1))-R(XR(NJ),XR(NJ))
ISN 0059          PI(1)=0.
ISN 0060          IF(PR(1)) 402,402,603
ISN 0061      603 IF(N-1) 404,404,605
ISN 0062      605 CONTINUE
ISN 0063          DO 606 K=2,N
ISN 0064          KS=NN-K+1
ISN 0065          PR(K)=R(XR(1),XR(K))+R(XI(1),XI(K))-R(XR(NJ),XR(KS))
ISN 0066          PI(K)=R(XR(1),XI(K))-R(XI(1),XR(K))+R(XR(NJ) ,XI(KS))
ISN 0067      606 CONTINUE
           C
ISN 0068          J=1
ISN 0069      250 NJ=NN-J
ISN 0070          DO 201 K=1,NJ
ISN 0071          XR(K) =PR(K)/PR(1)
ISN 0072      201 XI(K)=PI(K)/PR(1)
ISN 0073          PR(1)= R(XR(1),XR(1))                    -R(XR(NJ),XR(NJ))-R(XI(NJ),X
                 1I(NJ))
ISN 0074          IF(PR(1)) 402,402,203
ISN 0075      203 IF(NJ-2) 404,404,205
ISN 0076      205 CONTINUE
```



```
ISN 0077          NS=N-J
ISN 0078          DO 206 K=2,NS
ISN 0079          KS=NJ-K+1
ISN 0080          PR(K)=R(XR(1),XR(K))                     -R(XR(NJ),XR(KS))-R(XI(NJ),XI(
                 1KS))
ISN 0081          PI(K)=R(XR(1),XI(K))                     +R(XR(NJ) ,XI(KS))-R(XI(NJ),XR(
                 1KS))
ISN 0082      206 CONTINUE
ISN 0083          J=J+1
ISN 0084          GO TO 250
           C
           C
           C
           C                         LONG  PRECISION
           C
           C
           C      COMPLETE HORNER SCHEME
ISN 0085      101 CONTINUE
ISN 0086          VR(1)=1.
ISN 0087          VI(1)=0.
ISN 0088          DO 51 J=2,NN
ISN 0089          NJ=N-J+2
ISN 0090          VR(J) = A*VR(J-1)-B*VI(J-1)+ZR (NJ)
ISN 0091       51 VI(J) = A*VI(J-1)+B*VR(J-1)+ZR (NJ)
ISN 0092          DO 52 J=1,N
ISN 0093          AR(J)=VR(J)
ISN 0094       52 AI(J)=VI(J)
           C
ISN 0095          DO 54 K=2,N
ISN 0096          NK=N+2-K
ISN 0097          VR(1)=AR(1)
ISN 0098          VI(1)=AI(1)
ISN 0099          DO 53 J=2,NK
ISN 0100             VR(J)=A*VR(J-1)-B*VI(J-1)+AR(J)
ISN 0101       53    VI(J)=A*VI(J-1)+B*VR(J-1)+AI(J)
ISN 0102          NK1=NK-1
           C
ISN 0103          DO 55 J=1,NK1
ISN 0104          AR(J)=VR(J)
ISN 0105       55 AI(J)=VI(J)
ISN 0106       54 CONTINUE
           C
           C  COMPUTATION OF UPPER BOUND FOR THE ABSOLUTE VALUE OF THE FIRST
           C  DERIVATIVE
           C
ISN 0107          DO 60 L=1,N
ISN 0108       60 AR(L)=DSQRT(VR(L)**2+VI(L)**2)
           C
ISN 0109          CCD=N*AR(1)
ISN 0110          DO 64 J=2,N
ISN 0111       64 CCD=CCD*H*RDUE+(N-J+1)*AR(J)
```

```
      CCS=RCUF*CCD
      IF(N-V7S) 1200,1250,1250
 1200 SMD= DSQRT(VR(NN)*VR(NN)+VI(NN)*VI(NN))
      CCD=AR(1)
      DO 63 J=2,N
   63 CCD=CCD*HR+AR(J)
      IF(SMD-HR*(CC*V0ZR)) 402,402,404
C
C
C  THE CIRCLE CENTERED AT (A,B) AND RADIUS HR IS TRANSFORMED IN TO
C  THE UNIT CIRCLE
C
 1250 CONTINUE
      CH=1.
      DO 400 J=2,NN
      CH=T(CH,HR)
      K=N-J+2
      AR(J)=T(VR(K),CH)
      AI(J)=T(VI(K),CH)
  400 CONTINUE
      AR(1)=VR(NN)
      AI(1)=VI(NN)
C
C         SCHUR CHCK  CRITERION
C
      J=0
      NJ=NN
      DO 801 K=1,NN
      VR(K)=AR(K)
  801 VI(K)=AI(K)
      AR(1)= T(VR(1),VR(1))+T(VI(1) ,VI(1))-T(VR(NJ),VR(NJ))
      AI(1)=0.
      IF(AR(1)) 402,402,803
  803 IF(N-1) 404,404,805
  805 CONTINUE
      DO 806 K=2,N
      KS=NN-K+1
      AR(K)=T(VR(1),VR(K))+T(VI(1),VI(K))-T(VR(NJ),VR(KS))
      AI(K)=T(VR(1),VI(K))-T(VI(1),VR(K))+T(VR(NJ) ,VI(KS))
  806 CONTINUE
C
      J=1
  450 NJ=NN-J
      DO 401 K=1,NJ
      VR(K) =AR(K)/AR(1)
  401 VI(K)=AI(K)/AR(1)
      AR(1)= T(VR(1),VR(1))                       -T(VR(NJ),VR(NJ))-T(VI(NJ),VI
     1(NJ))
      IF(AR(1)) 402,402,403
  403 IF(NJ-2)  404,404,405
  405 CONTINUE
```



```
      NS=N-J
      DO 406 K=2,NS
      KS=NJ-K+1
      AR(K)=T(VR(1),VR(K))                 -T(VR(NJ),VR(KS))-T(VI(NJ),VI(
     1KS))
      AI(K)=T(VR(1),VI(K))                 +T(VR(NJ) ,VI(KS))-T(VI(NJ),VR(
     1KS))
  406 CONTINUE
      J=J+1
      GO TO 450
  402 M=1
      GO TO 500
  404 M=0
  500 CONTINUE
      RETURN
      END
```

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
A	F	R*4	000000	P	F	R*4	0000D4	H	F C	R*4	000480	J	SF	I*4	000008
K	SFA	I*4	000008	L	SFA	I*4	0000E0	M	S	I*4	0000E4	N	F C	I*4	000488
P	F XF	R*4	0000C0	T	F XF	R*4	000000	AI	SF	R*8	000468	AR	SF	R*8	0005D8
BI	SF	R*4	000128	BR	SF	R*4	0001F0	CK	SF	R*4	0000F8	HR	FA C	R*4	000484
KS	SFA	I*4	0000EC	NJ	SFA	I*4	0000F0	NK	SF	I*4	0000E4	NN	FA C	I*4	0004C0
NS	SF	I*4	0000F8	OH	SFA	R*4	0000FC	OK	SFA	F*8	000110	VT	SFA	R*8	000768
VR	SFA	R*8	0003F8	XI	SFA	R*4	0002B8	XR	SFA	R*4	000388	ZA	F C	R*8	000000
ZB	F C	R*8	000198	CCC	SF	R*8	000118	CCS	SF	R*4	000100	TSW	C	I*4	0004BC
NKI	SF	I*4	000104	SMC	S	R*8	000120	VZS	C	R*4	0004C8	ZAS	F C	R*4	000320
ZRS	F C	R*4	0003E8	RCUE	F C	R*4	0004CC	SMOD	S	R*4	000108	VAZP	C	R*4	0004C4
TINAS		R*4	000100	DSQRT	XF	R*8	000000	SQRT	XF	R*4	000000				

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * * SIZE OF BLOCK 0004DC HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
ZA	R*8	000000	ZB	R*8	000198	ZAS	R*4	000320	ZRS	R*4	0003E8
I	R*4	0004B0	FR	R*4	0004B4	N	I*4	0004B8	ISW	I*4	0004BC
NK	I*4	0004C0	VAZP	R*4	0004C4	VZS	R*4	0004C8	RCUE	R*4	0004CC

LABEL	ADDR	LABEL	ADDR	LABEL	ADDR	LABEL	ADDR
1CC	CCCF46	1	000BA6	2	000BE6	3	000C5E
5	CCCC9C	4	000C5C	30	000CB0	14	000D42
100C	000C84	13	000DE2	1050	000E22	200	000FC8
6C1	CCCEE2	603	000FB6	6C5	000F9A	606	0010CA
2EC	001CE2	2C1	CC1112	2C3	0011A8	205	0011B4
2C6	0012EC	1C1	CC12FA	51	0013EE	52	0013AE
53	CC142E	55	CC1460	54	CC144C	60	0014BC
64	001526	1200	0015EE	63	0015DE	1250	001612
4CC	CC169A	A01	0016E2	A03	CC179A	BC5	0017AC
5C6	CC18DC	450	CC18F4	4C1	001924	403	001900
405	0019CC	406	001A1C	4C2	CC181E	404	001A2E
5CC	CC183A						

****** END OF COMPILATION FUP***

```
      COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=53,SOURCE,BCD,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
            C                        SUBROUTINE  TIAAD
ISN 0002          SUBROUTINE TIAAD (A,B,CC ,M)
ISN 0003          DIMENSION XR(50),XI(50),BR(50),BI(50)
ISN 0004          COMMON ZA(50),ZB(50),ZAS(50),ZBS(50),H,HR,N,ISW,NN,VAZP,VZS,RDUE
ISN 0005          DOUBLE PRECISION ZA,ZB  ,A,B,XR,XI,BR,BI,CCS,SMOD,RH
            C
            C          COMPLETE HORNER SCHEME
            C          TEST  T2
            C          LONG PRECISION
ISN 0006          XR(1)=1.
ISN 0007          XI(1)=0.
ISN 0008          DO 1 J=2,NN
ISN 0009          NJ=N-J+2
ISN 0010          XR(J) = A*XR(J-1)-B*XI(J-1)+ZA (NJ)
ISN 0011        1 XI(J) = A*XI(J-1)+B*XR(J-1)+ZB (NJ)
ISN 0012          DO 2 J=1,N
ISN 0013          BR(J)=XR(J)
ISN 0014        2 BI(J)=XI(J)
            C
ISN 0015          DO 4 K=2,N
ISN 0016          NK=N+2-K
ISN 0017          XR(1)=BR(1)
ISN 0018          XI(1)=BI(1)
ISN 0019             DO 3 J=2,NK
ISN 0020             XR(J)=A*XR(J-1)-B*XI(J-1)+BR(J)
ISN 0021        3    XI(J)=A*XI(J-1)+B*XR(J-1)+BI(J)
ISN 0022          NK1=NK-1
            C
ISN 0023          DO 5 J=1,NK1
ISN 0024          BR(J)=XR(J)
ISN 0025        5 BI(J)=XI(J)
ISN 0026        4 CONTINUE
            C
            C
ISN 0027          SMOD=DSQRT(XR(NN)**2+XI(NN)**2)
ISN 0028          DO 30 L=1,N
ISN 0029       30 BR(L)=DSQRT(XR(L)**2+XI(L)**2)
            C
ISN 0030          CCS=BR(1)
ISN 0031          DO 13 J=2,N
ISN 0032       13 CCS=CCS*HR+BR(J)
ISN 0033          IF(SMOD-HR*CCS*VAZP) 7,7,8
ISN 0034        7 M=1
ISN 0035          GO TO 9
ISN 0036        8 M=0
ISN 0037        9 CONTINUE
ISN 0038          CCS=N*BR(1)
ISN 0039          DO 14 J=2,N
ISN 0040       14 CCS=CCS*HR+(N-J+1)*BR(J)
```

40


```
ISN 0041          CC=RELE*CCS
            C
ISN 0042          RETURN
ISN 0043          END
```

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
A	E	R*8	0000C8	B	E	R*8	000000	H	C	R*4	N.R.	J	SF	I*4	0000A0
K	SF	I*4	0000A4	L	SFA	I*4	0000AB	M	S	I*4	0000AC	N	E C	I*4	0004BB
R1	SF	R*8	0000E8	RR	SF	R*8	000278	CC	S	R*4	0000BC	HR	E C	R*4	0004B4
NJ	SF	I*4	0000R4	NK	SF	I*4	0000C8	AN	EA C	I*4	0004C0	PH		R*8	N.R.
XI	SFA	R*8	000428	XE	SFA	R*8	0000EE	ZA	E C	R*8	000000	ZB	E C	R*8	000190
EGS	SF	R*8	0000D8	ISN	C	I*4	N.R.	NK1	SF	I*4	0000BC	VZS	C	R*4	N.R.
Z8S	C	R*4	N.R.	ZBS	C	R*4	N.R.	RDLE	E C	R*4	0004CC	SMOB	S	R*8	0000E0
VAZB	C	R*4	0004C4	TINAD		R*4	000000	DSORT	XE	R*8	000000				

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * * SIZE OF BLOCK 0004DC HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
ZZ	R*8	000000	ZB	R*8	000150	Z8S	R*4	N.R.	Z8S	R*4	N.R.
H	R*4	N.R.	HR	R*4	0004B4	N	I*4	0004BB	ISN	I*4	N.R.
AA	I*4	0004C0	VAZB	R*4	0004C4	VZS	R*4	N.R.	RDUE	R*4	0004CC

LABEL	ADDR	LABEL	ADDR	LABEL	ADDR	LABEL	ADDR
1	0007F4	2	000824	3	000850	5	000BCE
4	000BD8	30	000928	13	000984	7	000984
8	000ECC	9	000ECE	14	000A18		

****** END OF COMPILATION FOR***

```
LEVEL 19.1 JAN 81                    OS/360  FORTRAN H                    DATE  80.344/18.54.01

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=52,SOURCE,NOD,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
                C                          SUBROUTINE  CCVAL                                          0001CCVA
ISN 0002              SUBROUTINE CCVALID(F,FF,FI)                                                    0002CCVA
ISN 0003              COMMON  A(62), B(50),ZAS(50),ZRS(50),H,HP,A,ISW,AA,VAZP,VZS,RDUE               0003CCVA
ISN 0004              DOUBLE PRECISION A,P,F,S,C                                                     0004CCVA
                C                                                                                    0005CCVA
                C           EVALUATION OF THE POLYNOMIAL   COMPLEX CASE                              0006CCVA
                C           THE INDEPENDENT VARIABLE IS STORED IN SHORT PRECISION                    0007CCVA
                C           LONG PRECISION                                                           0008CCVA
ISN 0005              E=1.                                                                           0009CCVA
ISN 0006              F=0.                                                                           0010CCVA
ISN 0007              J=N                                                                            0011CCVA
ISN 0008            1 IF (J) 3,3,2                                                                   0012CCVA
ISN 0009            2 CONTINUE                                                                       0013CCVA
ISN 0010              C=F                                                                            0014CCVA
ISN 0011              E=E*FP-F*FI+A(J)                                                               0015CCVA
ISN 0012              F=C*FI+F*FR+B(J)                                                               0016CCVA
ISN 0013              J=J-1                                                                          0017CCVA
ISN 0014              GO TO 1                                                                        0018CCVA
ISN 0015            3 CONTINUE                                                                       0019CCVA
ISN 0016              RETURN                                                                         0020CCVA
ISN 0017              END                                                                            0021CCVA
```



```
                                        /   CCVAL /     SIZE OF PROGRAM 000190 HEXADECIMAL BYTES PAGE 002

NAME     TAG   TYPE  ADD.      NAME     TAG   TYPE  ADD.      NAME     TAG   TYPE  ADD.      NAME     TAG   TYPE  ADD.
   A  F    C  R*8   CCCCC0        B  F    C  R*8   000190        E  SF       R*8   CCCCA8        F  SF       R*8   000080
   H       C  R*4    N.R.        J  SF      I*4   CCCCC4        N  F    C  I*4   0004B8        O  SF       R*8   0000B8
  HP       C  R*4    N.R.       NN       C  I*4    N.R.       PI  F       R*4   0000C8       PR  F        R*4   0000C0
 ISW       C  I*4    N.R.      VZS       C  R*4    N.R.      ZAS       C  R*4    N.R.      ZBS       C  R*4    N.R.
RDUE       C  R*4    N.R.     VAZP       C  R*4    N.R.     CCVAL          R*4   000040

                                    *****  COMMON INFORMATION  *****

   NAME OF COMMON BLOCK  *        *   SIZE OF BLOCK    000400 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
        A  R*8   CCCCC0             B  R*8   000190             ZAS  R*4    N.R.             ZRS  R*4    N.R.
        H  R*4    N.R.             HP  R*4    N.R.               A  I*4   0004B8             ISW  I*4    N.R.
       NN  I*4    N.R.           VAZP  R*4    N.R.             VZS  R*4    N.R.            RDUE  R*4    N.R.
```

```
   LABEL    ADDR           LABEL    ADDR           LABEL    ADDR           LABEL    ADDR                              PAGE 003

       1  00012E               2  000134               3  000170

****** END OF COMPILATION PC***
```



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LEVEL 15 ( 1 JAN 66)                          OS/360  FORTRAN H                                    DATE  68.364/18.54.03

        COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=53,SOURCE,BCD,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
             C                        SUBROUTINE  PCVAL                                            0001PCVA
   ISN 0002         SUBROUTINE PCVAL(E,F,PR,PI)                                                    0002PCVA
   ISN 0003         COMMON  A(50), B(50),ZAS(50),ZBS(50),E,ER,N,ISW,NN,VAZP,VZS,ROUF              0003PCVA
   ISN 0004         DOUBLE PRECISION A,B,E,F,PR,PI,C                                               0004PCVA
             C                                                                                     0005PCVA
             C             EVALUATION OF THE POLYNOMIAL      COMPLEX CASE                          0006PCVA
             C             LONG PRECISION                                                          0007PCVA
             C             THE INDEPENDENT VARIABLE IS STORED IN LONG PRECISION                    0008PCVA
   ISN 0005         E=1.                                                                           0009PCVA
   ISN 0006         F=0.                                                                           0010PCVA
   ISN 0007         J=N                                                                            0011PCVA
   ISN 0008       1 IF (J) 3,3,2                                                                   0012PCVA
   ISN 0009       2 CONTINUE                                                                       0013PCVA
   ISN 0010         C=E                                                                            0014PCVA
   ISN 0011         E=E*PR-F*PI+A(J)                                                               0015PCVA
   ISN 0012         F=C*PI+F*PR+B(J)                                                               0016PCVA
   ISN 0013         J=J-1                                                                          0017PCVA
   ISN 0014         GO TO 1                                                                        0018PCVA
   ISN 0015       3 CONTINUE                                                                       0019PCVA
   ISN 0016         RETURN                                                                         0020PCVA
   ISN 0017         END                                                                            0021PCVA
```

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
A	F C	R*8	000000	B	F C	R*8	000100	E	SF	R*8	000068	F	SF	R*8	000068
H	C	R*4	N.R.	J	SF	I*4	0F0054	N	F C	I*4	000488	O	SF	R*8	000080
HR	C	R*4	N.R.	NN	C	I*4	N.R.	PI	F	R*8	000088	RR	F	R*8	000000
ISW	C	I*4	N.R.	VZS	C	R*4	N.R.	ZBS	C	R*4	N.R.	ZRS	C	R*4	N.R.
RDUF	C	R*4	N.R.	VAZE	C	R*4	N.R.	PCVAL		R*4	000058				

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * * SIZE OF BLOCK 0004B0 HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
A	R*8	000000	B	R*8	000100	ZBS	R*4	N.R.	ZRS	R*4	N.R.
H	R*4	N.R.	HR	R*4	N.R.	N	I*4	000488	ISW	I*4	N.R.
NN	I*4	N.R.	VAZE	R*4	N.R.	VZS	R*4	N.R.	RDUF	R*4	N.R.

LABEL	ADDR	LABEL	ADDR	LABEL	ADDR	LABEL	ADDR
1	000108	2	000114	3	000150		

****** END OF COMPILATION FLE***

```
COMPILER OPTIONS - NAME= MAIN,OPT=02,LINECNT=53,SOURCE,REO,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
                C                         SUBROUTINE  FASES                                          0001FA S
                C                                                                                      0002FA S
ISN 0002              SUBROUTINE FASES(A,B,C,D,L)                                                    0003FA S
ISN 0003              COMMON ZA(15C),ZP(50),ZAS(501,ZPS(501,H,HP,N,ISW,NN,VAZP,VZS,RDUE              0004FA S
ISN 0004              EOUBLE PRECISION ZA,ZP,            F,F,FA,FA,T,TE                              0005FA S
                C                                                                                      0006FA S
                C           APPLICATION OF THE PRINCIPLE OF THE ARGUMENT                               0007FA S
                C           THE CONTOUR MUST BE A RECTANGLE OR A SQUARE                                0008FA S
                C           SHORT PRECISION                                                            0009FA S
                C                                                                                      0010FA S
ISN 0005              HS=H*2.                                                                        0011FA S
ISN 0006              T=C.                                                                           0012FA S
ISN 0007              CALL CCVAL(E,F,A,B)                                                            0013FA S
ISN 0008              X=A                                                                            0014FA S
ISN 0009            1 X=X-HS                                                                         0015FA S
ISN 0010              CALL QCVAL(EA,FA,X,B)                                                          0016FA S
ISN 0011              CALL ARGCIE,EA,F,FA,TE)                                                        0017FA S
ISN 0012              T=T+TE                                                                         0018FA S
ISN 0013              E=EA                                                                           0019FA S
ISN 0014              F=FA                                                                           0020FA S
ISN 0015              IF(X-C) 2,2,1                                                                  0021FA S
ISN 0016            2 CONTINUE                                                                       0022FA S
                C                                                                                      0023FA S
ISN 0017              Y=B                                                                            0024FA S
ISN 0018            3 Y=Y-HS                                                                         0025FA S
ISN 0019              CALL CCVAL(EA,FA,C,Y)                                                          0026FA S
ISN 0020              CALL ARGC(E,EA,F,FA,TE)                                                        0027FA S
ISN 0021              T=T+TE                                                                         0028FA S
ISN 0022              E=EA                                                                           0029FA S
ISN 0023              F=FA                                                                           0030FA S
ISN 0024              IF(Y-D) 4,4,3                                                                  0031FA S
ISN 0025            4 CONTINUE                                                                       0032FA S
                C                                                                                      0033FA S
ISN 0026              X=C                                                                            0034FA S
ISN 0027            5 X=X+HS                                                                         0035FA S
ISN 0028              CALL CCVAL(EA,FA,X,D)                                                          0036FA S
ISN 0029              CALL ARGC(E,EA,F,FA,TE)                                                        0037FA S
ISN 0030              T=T+TE                                                                         0038FA S
ISN 0031              E=EA                                                                           0039FA S
ISN 0032              F=FA                                                                           0040FA S
ISN 0033              IF(X-A) 5,6,6                                                                  0041FA S
ISN 0034            6 CONTINUE                                                                       0042FA S
                C                                                                                      0043FA S
ISN 0035              Y=D                                                                            0044FA S
ISN 0036            7 Y=Y+HS                                                                         0045FA S
ISN 0037              CALL CCVAL(EA,FA,A,Y)                                                          0046FA S
ISN 0038              CALL ARGC(E,EA,F,FA,TE)                                                        0047FA S
ISN 0039              T=T+TE                                                                         0048FA S
ISN 0040              E=EA                                                                           0049FA S
```

50


```
ISN 0042              IF(Y-B) 7,8,8                                                                  0050FA S
ISN 0043            8 CONTINUE                                                                       0051FA S
                C                                                                                      0052FA S
ISN 0044              L=T/6.2E +0.5                                                                  0053FA S
ISN 0045              RETURN                                                                         0054FA S
ISN 0046              END                                                                            0055FA S
```

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
A	SEA	R*4	000110	D	SEA	R*4	000114	C	SEA	R*4	000118	B	SEA	R*4	00011C
E	SEA	R*8	000138	F	SEA	R*8	000140	H	F C	R*4	000148	I	S	I*4	000120
N	C	I*4	N.R.	T	SF	R*8	000148	X	SEA	R*4	000124	Y	SEA	R*4	000128
EE	SEA	R*8	000150	FA	SEA	R*8	000158	MR	C	R*4	N.R.	MS	SF	R*4	000120
NN	C	I*4	N.R.	TF	SEA	R*8	000160	ZA	C	R*8	N.R.	ZB	C	R*8	N.R.
ISW	C	I*4	N.R.	VZS	C	R*4	N.R.	ZBS	C	R*4	N.R.	ZPS	C	R*4	N.R.
ABCC	SF	XF	R*4	000000	RDUF	C	R*4	N.R.	VAZP	C	R*4	N.R.	FASES		R*4	000130
CCVAL	SF	XF	R*4	000000												

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * * SIZE OF BLOCK 0004DC HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
ZA	R*8	N.R.	ZB	R*8	N.R.	ZBS	R*4	N.R.	ZPS	R*4	N.R.
H	R*4	0004A0	M	R*4	N.R.	N	I*4	N.R.	ISW	I*4	N.R.
NN	I*4	N.R.	VAZP	R*4	N.R.	VZS	R*4	N.R.	RDUF	R*4	N.R.

LABEL	ADDR	LABEL	ADDR	LABEL	ADDR	LABEL	ADDR
1	000158	2	0001E6	3	000188	4	000236
5	000238	6	0002B6	7	0002BE	8	0002D6

****** END OF COMPILATION FOR***

```
        COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=58,SOURCE,BCD,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
                C                          SUBROUTINE  FASED                                     0001FA D
  ISN 0002            SUBROUTINE FASED(A,B,C,D,L)                                                0002FA D
  ISN 0003            COMMON ZA(50),ZB(50),ZAS(50),ZBS(50),H,HR,N,ISN,NN,VAZP,VZS,REUE          0003FA D
  ISN 0004            DOUBLE PRECISION ZA,ZB,A,B,C,D,X,Y,E,F,EA,FA,T,TF                          0004FA D
                C                                                                                 0005FA D
                C              APPLICATION OF THE PRINCIPLE OF THE ARGUMENT                      0006FA D
                C              THE CONTOUR MUST BE A RECTANGLE OR A SQUARE                       0007FA D
                C              LONG PRECISION                                                    0008FA D
                C                                                                                 0009FA D
  ISN 0005            HS=H*2.                                                                    0010FA D
  ISN 0006            T=0.                                                                       0011FA D
  ISN 0007            CALL PCVAL(E,F,A,B)                                                        0012FA D
  ISN 0008            X=A                                                                        0013FA D
  ISN 0009          1 X=X-HS                                                                     0014FA D
  ISN 0010            CALL PCVAL(EA,FA,X,B)                                                      0015FA D
  ISN 0011            CALL ARCC(E,EA,F,FA,TF)                                                    0016FA D
  ISN 0012            T=T+TF                                                                     0017FA D
  ISN 0013            E=EA                                                                       0018FA D
  ISN 0014            F=FA                                                                       0019FA D
  ISN 0015            IF(X-C) 2,2,1                                                              0020FA D
  ISN 0016          2 CONTINUE                                                                   0021FA D
                C                                                                                 0022FA D
  ISN 0017            Y=B                                                                        0023FA D
  ISN 0018          3 Y=Y-HS                                                                     0024FA D
  ISN 0019            CALL PCVAL(EA,FA,C,Y)                                                      0025FA D
  ISN 0020            CALL ARCC(E,EA,F,FA,TF)                                                    0026FA D
  ISN 0021            T=T+TF                                                                     0027FA D
  ISN 0022            E=EA                                                                       0028FA D
  ISN 0023            F=FA                                                                       0029FA D
  ISN 0024            IF(Y-D) 4,4,3                                                              0030FA D
  ISN 0025          4 CONTINUE                                                                   0031FA D
                C                                                                                 0032FA D
  ISN 0026            X=C                                                                        0033FA D
  ISN 0027          5 X=X+HS                                                                     0034FA D
  ISN 0028            CALL PCVAL(EA,FA,X,D)                                                      0035FA D
  ISN 0029            CALL ARCC(E,EA,F,FA,TF)                                                    0036FA D
  ISN 0030            T=T+TF                                                                     0037FA D
  ISN 0031            E=EA                                                                       0038FA D
  ISN 0032            F=FA                                                                       0039FA D
  ISN 0033            IF(X-A) 5,6,6                                                              0040FA D
  ISN 0034          6 CONTINUE                                                                   0041FA D
                C                                                                                 0042FA D
  ISN 0035            Y=D                                                                        0043FA D
  ISN 0036          7 Y=Y+HS                                                                     0044FA D
  ISN 0037            CALL PCVAL(EA,FA,A,Y)                                                      0045FA D
  ISN 0038            CALL ARCC(E,EA,F,FA,TF)                                                    0046FA D
  ISN 0039            T=T+TF                                                                     0047FA D
  ISN 0040            E=EA                                                                       0048FA D
  ISN 0041            F=FA                                                                       0049FA D
```

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```
  ISN 0042            IF(Y-B) 7,8,8                                                              0050FA D
  ISN 0043          8 CONTINUE                                                                   0051FA D
                C                                                                                 0052FA D
  ISN 0044            L=T/6.28 +0.5                                                              0053FA D
  ISN 0045            RETURN                                                                     0054FA D
  ISN 0046            END                                                                        0055FA D
```

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
A	SEA	R*8	000120	P	SEA	R*8	000128	C	SEA	R*8	000130	O	SEA	R*8	000138
F	SEA	R*8	000140	E	SEA	R*8	000148	H	E C	R*4	000A8E	I	S	I*4	000110
N	C	I*4	N.R.	T	SE	R*8	000150	X	SEA	R*4	000158	V	SEA	R*8	000160
EA	SEA	R*8	000168	FA	SEA	R*8	000170	HR	C	R*4	N.R.	HS	SE	R*4	000114
NN	C	I*4	N.R.	TE	SEA	R*8	000178	ZA	C	R*8	N.R.	ZR	C	R*8	N.R.
ISW	C	I*4	N.R.	VZS	C	R*4	N.R.	ZAS	C	R*4	N.R.	ZRS	C	R*4	N.R.
ARGC	SE	XF	R*4	000000	RDUF	C	R*4	N.R.	VAZR	C	R*4	N.R.	EASED		R*4	000118
REVAL	SE	XF	R*4	CCCCCC												

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * A SIZE OF BLOCK 000400 HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
ZB	R*8	N.R.	ZP	R*8	N.R.	ZAS	R*4	N.R.	ZRS	R*4	N.R.
F	R*4	000A80	EE	R*4	N.R.	N	I*4	N.R.	ISW	I*4	N.R.
NN	I*4	N.R.	VAZR	R*4	N.R.	VZS	R*4	N.R.	RDUF	R*4	N.R.

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LABEL	ADDR	LABEL	ADDR	LABEL	ADDR	LABEL	ADDR
1	000108	2	000220	3	000228	4	000270
5	000200	6	000208	7	000210	R	000320

****** END OF COMPILATION FOR***

```
LEVEL 15 ( 1 JAN 68)                         OS/360  FORTRAN H                                  DATE  68.366/19.54.10

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=53,SOURCE,BCD,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
                C                    SUBROUTINE  ARCC                                                      0001ARCC
   ISN 0002           SUBROUTINE ARCC(E,EA,F,FA,T)                                                         0002ARCC
   ISN 0003           DOUBLE PRECISION E,EA,F,FA, T, PIGR,G,H                                              0003ARCC
   ISN 0004           DOUBLE PRECISION X,Y                                                                 0004ARCC
                C                                                                                          0005ARCC
                C        LONG  PRECISION                                                                   0006ARCC
                C                                                                                          0007ARCC
   ISN 0005           PIGR=3.14159265D+00                                                                  0008ARCC
   ISN 0006           X=E*FA+F*FA                                                                          0009ARCC
   ISN 0007           Y=FA*E-F*FA                                                                          0010ARCC
                C                                                                                          0011ARCC
                C     COMPUTATION OF THE ARGUMENT   T  OF THE COMPLEX NUMBER  (X,Y) WITHOUT                0012ARCC
                C     THE CONDITION  ABSOLUTE VALUE OF  T   LESS THAN 3.15159.....                         0013ARCC
                C                                                                                          0014ARCC
   ISN 0008           T=DABS(Y/X)                                                                          0015ARCC
   ISN 0009           T=DATAN(T)                                                                           0016ARCC
                C     IN THE FOLLOWING THE TEST  IF(Y*X)   IS AVOIDED   IT CAN GIVE                        0017ARCC
                C     UNDERFLOW                                                                            0018ARCC
   ISN 0010           IF(Y) 2,2,3                                                                          0019ARCC
   ISN 0011         3 IF(X) 9,6,6                                                                          0020ARCC
   ISN 0012         6 CONTINUE                                                                             0021ARCC
   ISN 0013           RETURN                                                                               0022ARCC
   ISN 0014         9 T=PIGR-T                                                                             0023ARCC
   ISN 0015           GO TO 6                                                                              0024ARCC
   ISN 0016         2 IF(X) 4,10,10                                                                        0025ARCC
   ISN 0017         4 T=T-PIGR                                                                             0026ARCC
   ISN 0018           GO TO 6                                                                              0027ARCC
   ISN 0019        10 T=-T                                                                                 0028ARCC
   ISN 0020           GO TO 6                                                                              0029ARCC
   ISN 0021           END                                                                                  0030ARCC
```

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```
                                         /    ARCC /     SIZE OF PROGRAM 0001C0 HEXADECIMAL BYTES PAGE 002

   NAME    TAG   TYPE  ADD.        NAME    TAG   TYPE  ADD.        NAME    TAG   TYPE  ADD.        NAME    TAG   TYPE  ADD.
     E  F        R*8  0000B8          F  F       R*8  000090          G          R*8    N.R.          H          R*8    N.R.
     T SFA       R*8  000098          X SFA      R*8  0000A0          Y SFA      R*8  0000A8         FA  F       R*8  0000B0
    EA  F        R*8  000088       ARCC          R*4  000080       PIGR SF       R*8  0000C0       DATAN     XF  R*8  000000
```

```
LABEL    ADDR          LABEL    ADDR          LABEL    ADDR          LABEL    ADDR

    7  000138              6  00014P              9  000150              2  0001AC
    4  0001AA             10  00017A

****** END OF COMPILATION FUP***
```



```
LEVEL 15 ( 1 JAN 68 )                    OS/360  FORTRAN H                        DATE  68.364/18.54.12

         COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=53,SOURCE,BCD,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
                C                       FUNCTION  9                                     0001R
   ISN 0002              FUNCTION R(A,B)                                                0002R
   ISN 0003              EQUIVALENCE (I,C) ,(J,D)                                       0003R
   ISN 0004              C= ABS(A)                                                      0004R
   ISN 0005              D= ABS(B)                                                      0005R
   ISN 0006              I=I/16777216                                                   0006R
   ISN 0007              J=J/16777216                                                   0007R
   ISN 0008              IF(I+J-65) 1,1,2                                               0008R
   ISN 0009            1 R=0.                                                           0009R
   ISN 0010              RETURN                                                         0010R
   ISN 0011            2 R=A*B                                                          0011R
   ISN 0012              RETURN                                                         0012R
   ISN 0013              END                                                            0013R
```

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
A	FE	R*4	0000P4	B	FA	R*4	CCCCP8	C	S F	R*4	000098	D	S F	R*4	0000A0
I	SF F	I*4	000098	J	SF F	I*4	CCCCAC	R	S	R*4	0000BC				

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LABEL	ADDR	LABEL	ADDR	LABEL	ADDR	LABEL	ADDR	PAGE 003
1	CCCFEC	2	000FFC					

****** END OF COMPILATION FL0***

```
        COMPILER OPTIONS - NAME= MAIN,OPT=02,LINECNT=53,SOURCE,BCD,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,NOXREF
              C                    FUNCTION T                                   0001T
  ISN 0002          DOUBLE PRECISION FUNCTION T(A,B)                            0002T
  ISN 0003          DOUBLE PRECISION A,B                                        0003T
  ISN 0004          EQUIVALENCE (I,C) ,(J,D)                                    0004T
  ISN 0005          C=SNGL(DABS(A))                                             0005T
  ISN 0006          D=SNGL(DABS(B))                                             0006T
  ISN 0007          I=I/16777216                                                0007T
  ISN 0008          J=J/16777216                                                0008T
  ISN 0009          IF(I+J-65) 1,1,2                                            0009T
  ISN 0010        1 T=0.                                                        0010T
  ISN 0011          RETURN                                                      0011T
  ISN 0012        2 T=A*B                                                       0012T
  ISN 0013          RETURN                                                      0013T
  ISN 0014          END                                                         0014T
```

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```
                              /        T /      SIZE OF PROGRAM 000174 HEXADECIMAL BYTES PAGE 002

 NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.
    A  F A    R*8  000090        B  F A    R*8  000098        C  S   E  R*4  0000B0        D  S   E  R*4  0000B8
    I  SF  E  I*4  0000B0        J  SF  E  I*4  0000B8        T  S      R*8  0000A0
```

```
LABEL    ADDR          LABEL    ADDR          LABEL    ADDR          LABEL    ADDR

    1  000104              2  000114

****** END OF COMPILATION FLP***
```

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```
IEF285I   SYSOUT                                         SYSOUT
IEF285I   VOL SER NOS=       .
IEF285I   SYS1.LIN                                       PASSED
IEF285I   VOL SER NOS= 222222.
IEF285I   SYS1.UTIL2                                     KEPT
IEF285I   VOL SER NOS= 222222.
                                                   *** STEP = SOURCE    TERMINATED AT  18H 54M 17.83S

//LINK EXEC LINKMOD
//LINK EXEC PGM=IEWL,PARM='XREF,LIST'                                     00000000
//SYSLIB   DD  DSNAME=SYS1.FORTLIB,DISP=OLD                                00000010
//           DD  DSNAME=SYS1.SSPLIB,DISP=OLD                               00000020
//           DD  DSNAME=SYS1.FILLIB,DISP=OLD                               00000030
//           DD  DSNAME=SYS1.ALGLIB,DISP=OLD                               00000040
//           DD  DSNAME=SYS1.COBLIB,DISP=OLD                               00000050
//SYSUT1 DD DSNAME=SYS1.UTIL1,DISP=OLD                                     00000060
//SYSLIN DD DSNAME=SYS1.LIN,DISP=OLD                                       00000070
//     DD     DDNAME=SYSIN                                                  00000080
//SYSLMOD DD DSNAME=&&GOSET(MAIN),DISP=(,PASS),SPACE=(CYL,(2,,1)),         *00000090
//                 UNIT=2314     NON-SPECIFIC REQUEST FOR 2314 SYSTEM       00000100
//SYSPRINT DD  SYSOUT=A                                                     00000110
IEF236I ALLOC. FOR PCGA     LINK     LINK
IEF237I SYSLIB   ON 370
IEF237I          ON 370
IEF237I          ON 370
IEF237I          ON 370
IEF237I          ON 370
IEF237I SYSUT1   ON 100
IEF237I SYSLIN   ON 370
IEF237I SYSLMOD  ON 371
```

F128-LEVEL LINKAGE EDITOR OPTIONS SPECIFIED XREF,LIST
VARIABLE OPTIONS USED - SIZE=(121072,286721)   DEFAULT OPTION(S) USED
****MAIN   DOES NOT EXIST BUT HAS BEEN ADDED TO DATA SET

CROSS REFERENCE TABLE

CONTROL SECTION			ENTRY							
NAME	ORIGIN	LENGTH	NAME	LOCATION	NAME	LOCATION	NAME	LOCATION	NAME	LOCATION
MAIN	CC	538								
PDGA	57F	778A								
SUSPES	8CE8	300								
SUSPED	8368	2C8								
TINAS	85EC	185F								
TINAD	A190	8CC								
OCVAL	AC6C	1CC								
RCVAL	AE3C	1BC								
FASES	AFEC	388								
FASED	B368	3C2								
ARCC	B740	1CC								
R	B920	15C								
T	BAFC	174								
IHCLATN2*	BFFB	1F4	DATAN2	BFFB	DATAN	BC14				
IHCLSQRT*	BDEC	56	DSQRT	BDEC						
IHCFDXPD*	BE68	C0	FDXPD#	BE88						
IHCFDXPI*	BF58	9C	FDXPI#	BF58						
IHCFIXPI*	BFF8	A8	FIXPI#	BFF8						
IHCFRXPI*	CCAC	54	FRXPI#	CCAC						
IHCFCOMH*	C138	F00	IBCOM#	C138	FDIOCS#	C1F4	INTSW	CF24		
IHCSSQRT*	C038	AC	SQRT	C038						
IHCFCVTH*	D0E8	1C45	ADCON#	D0E8	FCVZO	D234	FCVAO	D2DA	FCVLO	D36A
			FCVIO	D680	FCVEO	DBA2	FCVCO	DDBC	INTASW	E178
IHCFINTH*	E190	3A6	ARITH#	E190	ADJSW	E455				
IHCLEXP *	E538	100	DEXP	E538						
IHCLLOG *	E7C8	178	DLOG10	E7C8	DLOG	E724				
IHCFIOSH*	E880	DAA	FIOCS#	E880						
IHCUOPT *	F630	6								
IHCTRCH *	F638	2C8								
IHCUATBL*	F9CC	188								

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NAME	ORIGIN	LENGTH	NAME	LOCATION	NAME	LOCATION	NAME	LOCATION	NAME	LOCATION
$BLANKCOM	FAE8	400								

LOCATION	REFERS TO SYMBOL	IN CONTROL SECTION	LOCATION	REFERS TO SYMBOL	IN CONTROL SECTION
820	PDGA	PDGA	824	IBCOM#	IHCFCOMH
659C			65C8	FASED	FASED
65CC	FASES	FASES	65D0	TINAD	TINAD
65D4	TINAS	TINAS	65D8	FRXPI#	IHCFRXPI
65DC	FIXPI#	IHCFIXPI	65EC	FDXPI#	IHCFDXPI
65E4	FDXPD#	IHCFDXPD	65E8	DSQRT	IHCLSQRT
65FC	SQRT	IHCSSQRT	65F0	IBCOM#	IHCFCOMH
65F4	SUSPED	SUSPED	65F8	SUSPES	SUSPES
81C8			81CC	DSQRT	IHCLSQRT
81DC	SQRT	IHCSSQRT	E4B8		
84BC	DSQRT	IHCLSQRT	9978		
9C7C	R	R	9C80	T	T
9CB4	DSQRT	IHCLSQRT	9CE8	SQRT	IHCSSQRT
E688			A8A8		
A8BC	DSQRT	IHCLSQRT	AC28		
AF00			8148		
B14C	ARCC	ARCC	B150	OCVAL	OCVAL
B4E8			B4FC	ARCC	ARCC
B4FC	RCVAL	RCVAL	B8C8	DATAN	IHCLATN2
BDE8	IBCOM#	IHCFCOMH	BE78	IBCOM#	IHCFCOMH
BE54	IBCOM#	IHCFCOMH	BE4C	DLOG	IHCLLOG
BF5C	DEXP	IHCLEXP	BEF0	IBCOM#	IHCFCOMH
CC9C	IBCOM#	IHCFCOMH	C130	IBCOM#	IHCFCOMH
CE1C	ADCON#	IHCFCVTH	CE14	FIOCS#	IHCFIOSH
CE2C	ARITH#	IHCFINTH	CE40	ADJSW	IHCFINTH
CE3C	IHCUOPT	IHCUOPT	CE24	FCVEO	IHCFCVTH
CE28	FCVLO	IHCFCVTH	CE2C	FCVIO	IHCFCVTH
CE30	FCVCO	IHCFCVTH	CE34	FCVAO	IHCFCVTH
CE38	FCVZO	IHCFCVTH	CE10	IHCTRCH	IHCTRCH
DCBC	IBCOM#	IHCFCOMH	EC4C	IBCOM#	IHCFCOMH
E494	IBCOM#	IHCFCOMH	E498	INTSW	IHCFCOMH
E450	INTSW	IHCFCVTH	E44C	IHCUOPT	IHCUOPT
E4AC	ADCON#	IHCFCVTH	E49C	FIOCS#	IHCFIOSH
E628	IBCOM#	IHCFCOMH	EE7C	IBCOM#	IHCFCOMH
E9A8	IHCUATBL	IHCUATBL	E5B4	IBCOM#	IHCFCOMH
F7F4	IBCOM#	IHCFCOMH	F7F8	ADCON#	IHCFCVTH
F7FC	FIOCS#	IHCFIOSH			

ENTRY ADDRESS 00
TOTAL LENGTH FEE8

```
IEF285I   SYS1.FORTLIB                                    KEPT
IEF285I   VOL SER NOS= 222222.
IEF285I   SYS1.SSPLIB                                     KEPT
IEF285I   VOL SER NOS= 222222.
IEF285I   SYS1.F111LIB                                    KEPT
IEF285I   VOL SER NOS= 222222.
IEF285I   SYS1.ALCLIB                                     KEPT
IEF285I   VOL SER NOS= 222222.
IEF285I   SYS1.COBLIB                                     KEPT
IEF285I   VOL SER NOS= 222222.
IEF285I   SYS1.UTIL1                                      KEPT
IEF285I   VOL SER NOS= DRUM01.
IEF285I   SYS1.LIN                                        KEPT
IEF285I   VOL SER NOS= 222222.
IEF285I   SYS65007.T0A2546.RP0C2.PCGA.GOSET               PASSED
IEF285I   VOL SER NOS= 333333.
IEF285I   SYSOUT                                          SYSOUT
IEF285I   VOL SER NOS=          .
                                                          *** STEP = LINK       TERMINATED AT  1PH 54M 30.50S
// EXEC RUN
//RUN   PROC   PROGM=*.LINK.LINK.SYSLMOD                          00000000
//DATA   EXEC   PGM=PROGM                                         00000010
//SYSPRINT  DD  SYSOUT=A                                          00000020
//FT01F001 DD DSNAME=SYS1.UTIL1,DISP=OLD                          00000030
//FT02F001 DD DSNAME=SYS1.UTIL2,DISP=OLD                          00000040
//FT03F001 DD SYSOUT=A
X/FT03F001 DD DSNAME=SYS1.UTIL3,DISP=OLD                          00000050
IEF655I DSNAME INVALID WHEN SYSOUT SPECIFIED
//FT05F001 DD DDNAME=FORTIN                                       00000060
//FT06F001 DD SYSOUT=A                                            00000070
//FT07F001 DD UNIT=SYSCP                                          00000080
//
IEF236I ALLOC. FOR PCGA      DATA
IEF237I PGM=*.DD ON 371
IEF237I FT01F001 ON 190
IEF237I FT02F001 ON 370
IEF237I FT07F001 ON 032
```

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ZEROS		ABSOLUTE ERROR
0.99999999999999980D 00	0.0	0.33717475E-06
-0.99999999999999980D 00	0.0	0.33717475E-06
0.0	-0.99999999999999980D 00	0.33717475E-06
0.0	0.99999999999999980D 00	0.33717475E-06