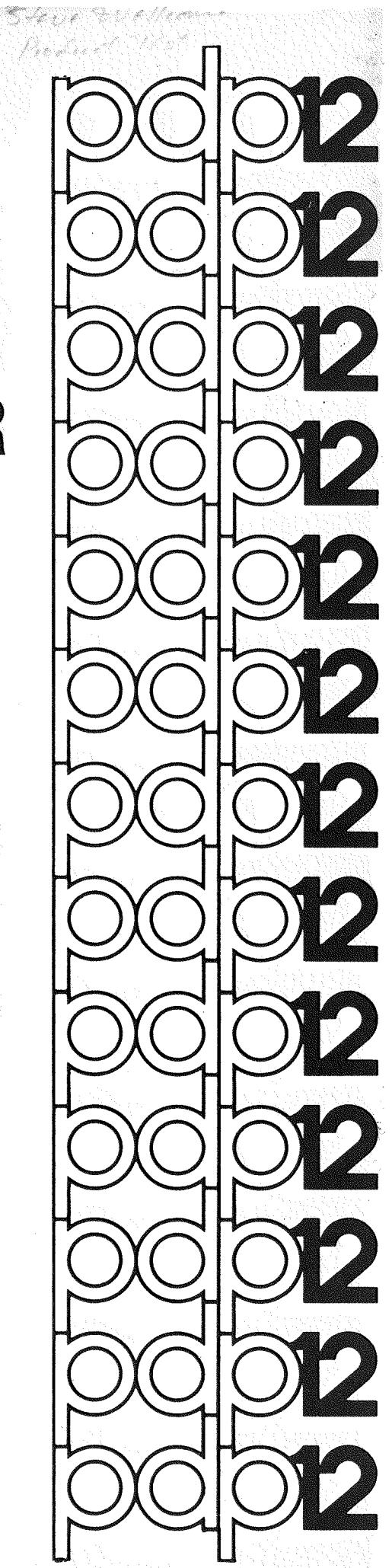
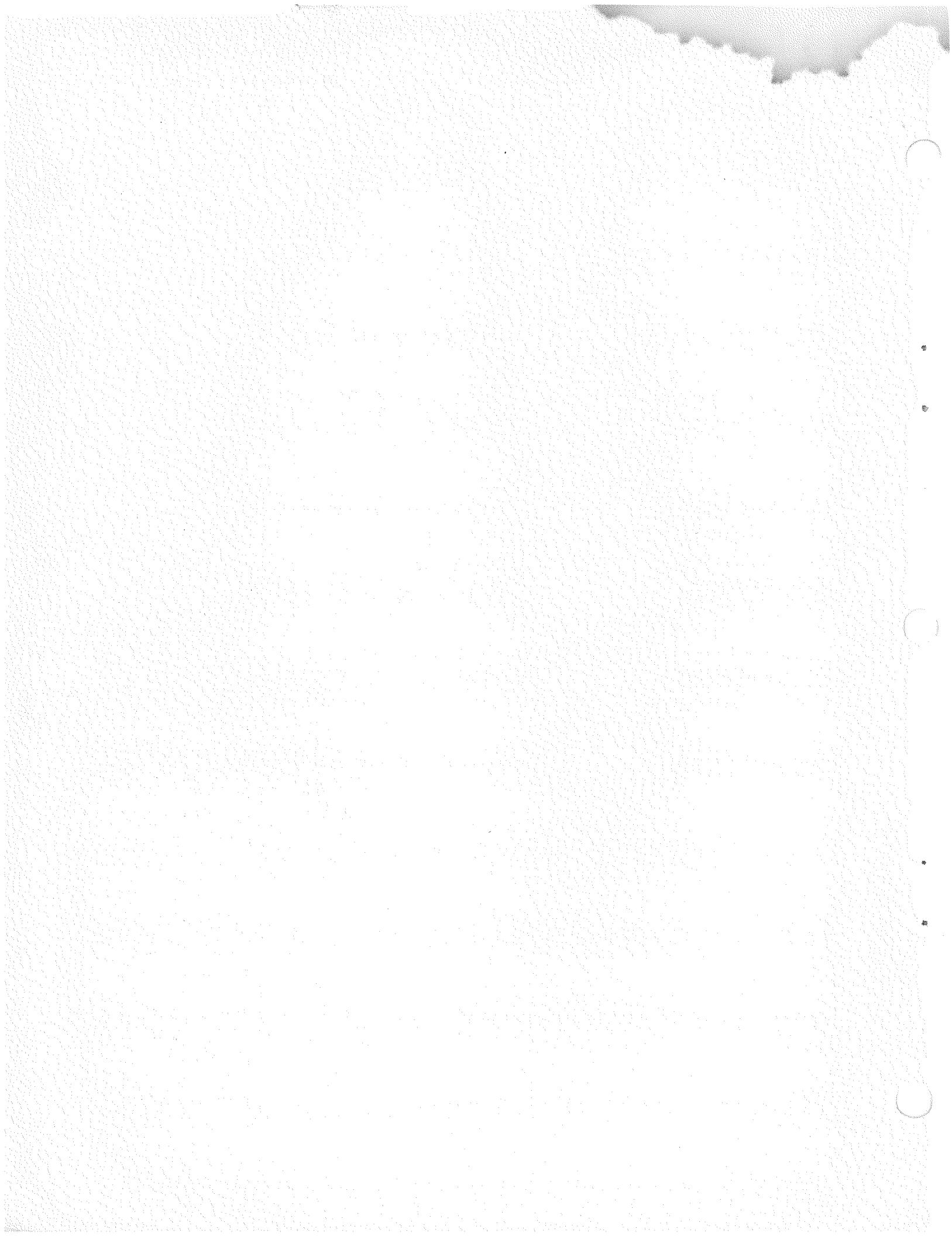


digital

FAST FOURIER TRANSFORM AND DISPLAY





DEC-12-FQEA-D

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ACKNOWLEDGMENT

The PDP-12 Fast Fourier Transform + Display program is an adaptation of a program written by James Rothman, of Digital Equipment Corporation. The algorithm is described briefly in Section 7.0 of this manual and in detail in DECUSCOPE, Volume 72, Number 3, available from DECUS Library, Digital Equipment Corporation, Maynard, Massachusetts.

1.0 INTRODUCTION

The FFTD (Fast Fourier Transform + Display) program can perform a Fast Fourier Transform or Inverse Fast Fourier Transform on 4 to 1024 real or complex points which have been stored on a LAP6-DIAL¹ or data LINC-tape or disk. The real and imaginary parts of the input or output data and the magnitude of the output data may be displayed on the scope via a moving window. Transformed data may also be stored on a DIAL or data LINCtape or disk. In addition, the scale of the displayed data can be user-modified over twelve different ranges.

2.0 MINIMUM HARDWARE REQUIREMENTS

8K PDP-12B with EAE.

3.0 OPERATING PROCEDURE

3.1 Loading FFTD

FFTD is a "load and go" program and is called from tape or disk by the DIAL command:

→LO FFTD, n)

where n is the tape (0-7) or disk (10-17) containing the program. A DIAL system tape must be on unit 0. (If a non-existent unit is addressed, NO is displayed on the scope. Press RETURN and issue the proper command.)

At any time during program operation, FFTD may be restarted by pressing the console keys: LINC mode, I/O PRESET, and START 20.

3.2 FFTD Displays

The first display is:

DISPLAY 1 SINGLE PRECISION FFT
INPUT ON DIAL UNIT? Y/N _____

¹LAP6-DIAL is hereafter referred to as DIAL.

Type Y if the data file is on a tape or disk containing DIAL; type N if the file is on a data tape or disk. (A file copied from paper tape via PIP must be referenced as a data tape or disk.)

The final user replies to all the scope displays are terminated by pressing LINE FEED.

If the input is on a DIAL tape or disk, the second display is:

DISPLAY 2 UNIT NUMBER__
 FILE NAME-----

Specify the unit number, 0 to 7 for tape, and 10 to 17 for disk, where the file is located and press RETURN. Then type the file name, which may be 1 to 8 characters long and must begin with a non-numeric character and not contain a ?, /, \, or >. After typing the file name, press LINE FEED. Note that a file addressed by name on a DIAL tape or disk can not have a header block and must have been placed on the device only by the FFTD program. If a non-existent unit is requested, NO is displayed. To restart the program from LINCTape, press STOP, I/O PRESET, and START 20. The program must be reloaded from an RK8 or RF08 disk.

The user is told if the file is not on the specified unit:

DISPLAY 3 CANNOT FIND
 HIT RETURN TO CONT

Press RETURN to bring back display 2

If the input is on a data tape or disk, the second display is:

DISPLAY 4 UNIT NUMBER__
 BLOCK NUMBER___

The unit may be any number from 0 to 7 for tape and 10 to 17 for disk. The block number must be an octal number from 0 to 777. If a data file with a header block is on a DIAL device, it may be accessed by this sequence (instead of the DIAL message). The correct block number is the value in the DIAL index plus one. After the file has been located, the calculation must be specified.

DISPLAY 5 HOW MANY PTS ---
 (4-1024 BY POWERS OF 2)
REAL OR
COMPLEX? R/C_

Powers of 2, from 2 to 10, are acceptable, permitting 4 to 1024 points. Type R if the data is real; type C if it is complex. (Refer to Section 4.0 for a description of data storage format.) If there is not enough room between the starting block number and the end of tape to hold the number of points specified, display 5 will reappear.

The calculation is further specified:

DISPLAY 6 FFT OR DISPLAY? F/D_
TRANSFORM OR
INVERSE? T/I_

If the data is just to be displayed, type D and press RETURN. Then type T if the data has most recently been transformed or I if it has not been manipulated at all or has been inversely transformed. Continue at display 7.

The next display is:

DISPLAY 7 OUTPUT ON DIAL UNIT? Y/N_

Type Y if output is to a DIAL tape or disk; type N if output is to a data tape or disk.

A reply of Y to display 7 (DIAL tape or disk) causes the display:

DISPLAY 8 UNIT NUMBER --
FILE NAME -----

These answers have the same restrictions as the input display, display 2. If there is not enough space on the DIAL tape/disk to hold the output data, the next display is:

DISPLAY 9 NO SPACE
HIT RETURN TO CONT

Press RETURN to bring back display 7.

If a file already exists with the specified name, the next display is:

DISPLAY 10 REPLACE? Y/N

Type Y or N to replace or not to replace the file. A reply of N will cause display 8 to reappear. If the file is to be replaced, but the new file is larger than the old file, display 9 will reappear.

If output is to a data tape or disk, the next display is:

DISPLAY 11 UNIT NUMBER --
 BLK NUMBER ---

The answers have the same restrictions as the input display, display 4. If there is not enough space from the starting block number to the end of the tape to hold the output data, display 9 will reappear.

The program will now read in the data, perform a Fast Fourier Transform or Inverse Fast Fourier Transform, and write the results as complex data pairs onto the specified tape or disk.

When the transform is completed or if just displays are desired, the following message is displayed:

DISPLAY 12 WHICH DISPLAY?
 R(EAL)
 I(MAGINARY)
 M(AGNITUDE)
 S(CALE FACTOR)
 LINE FEED (RESTART)

Type R, I, M, or S and LINE FEED to obtain the desired display. The scale factor is displayed as a decimal number (0-12). (Refer to Section 6.0, Data Scaling, for an explanation of the scale factor.) (The magnitude, M, for $a+b$ is $M = \sqrt{a^2+b^2}$.)

If the display is less than 512 points, it will be stationary and centered on the scope. If it contains 512 or more points, the display can be moved in either direction using A/D knob Ø.

A cursor which can be moved by rotating A/D knob 1 will ride along the curve. Associated with the cursor are four octal words displayed in the top left corner of the scope, one beneath the other. The first two words are the absolute 15-bit core address of the cursor point. The third word is the contents of the displayed core address, i.e., the actual 12-bit value in the data buffer of the data word that corresponds

to the cursor point. The fourth word is the scope Y coordinate of the cursor point. The fourth word is a relative value and depends upon the Y scale factor and Y offset. Because the data is scaled to nine bits prior to display, the fourth word or Y coordinate will range from $\theta\theta\theta 1$ to $1\theta\theta\theta_8$, where $\theta\theta\theta 1$ corresponds to the bottom of the scope and $1\theta\theta\theta$ to the top.

The curve can be expanded in the Y direction by typing a 1 or decreased by typing Q. Twelve different ranges are possible. As the display is enlarged, no check is made against losing significant digits of large values because the user may wish to expand small features of the display. Therefore, as the display is enlarged, large values may suddenly decrease in size as significant digits are lost.

The magnitude display is shown at half scale initially. If the values allow, the number 1 can be typed once to show the display at full scale.

Pressing RETURN will cause display 12 to reappear. As many displays as desired may be requested. Subsequent displays will be initially shown at the same range as the preceding display. Pressing LINE FEED without entering a character will cause display 1 to reappear.

4.0 EXAMPLE

This section provides examples of the displays which result from a transform performed on a square wave of 512 points and from an inverse transform performed on the resulting coefficients.

4.1 Input Display

Consider a square wave¹ of 512 real points which has the following format on tape or disk:

Address	Value
0	$2\theta\theta\theta$
77	$1\theta\theta\theta$
1\theta\theta	$\theta\theta\theta\theta$
177	$1\theta\theta\theta$

77 points
77 points

¹The displays shown on the following pages are adaptations and are for demonstration purposes only.

Address	Value	
277	2000	77 points
277	1000	
300	0000	77 points
377	1000	
400	2000	77 points
477	1000	
500	0000	77 points
577	1000	
600	2000	77 points
677	1000	
700	0000	77 points
777	1000	

If the input is displayed, there will only be a REAL display. It will look as follows, assuming the cursor is to the extreme left and the display is not moving.

```
0001
0000
2000
0601
_____
```

.

The first two values in the upper left hand corner are the address of the point on which the cursor is resting. When the cursor is at the extreme left, it indicates location 0000 of field 1. The third value is the contents of that memory location, in this case, 2000. The fourth value is the position of the cursor with respect to the bottom of the screen. [1 = bottom, 401 = X axis (middle), 1000 = top.]

4.2 Transform Displays

4.2.1 Real Display

```
0001
2000
0000
0401
_____
```

.

Moving the cursor to the highest point in the display will change the value display to:

ØØØ1
24ØØ
ØØØØ
Ø6Ø1

This is the DC component of the wave.

4.2.2 Imaginary Display

ØØØ1
2ØØØ
ØØØØ
Ø4Ø1

Moving the cursor to the lowest point produces the values:

ØØØ1
2374
6567
Ø257

Moving the cursor to the highest point displays:

ØØØ1
24Ø4
1214
Ø522

4.2.3 Magnitude Display

ØØØ1
2ØØØ
ØØØØ
Ø4Ø1

Moving the cursor to the highest point gives the following display:

ØØØ1
24ØØ
1ØØØ
Ø5Ø1

Because the magnitude of maximum values causes overflow, a factor of 2 is removed during computation. Therefore, the values displayed are half scale; type the key "l" once to display the magnitude at full scale.

4.2.4 Scale Factor Display

The scale factor has a value of 1. To obtain the actual coefficients, rest the cursor on the desired point and shift right the third value of the corner display the number of bits equal to the scale factor. In this example, the highest value of the real display is 2000_8 . Shifting it right by the scale factor (=1) yields 1000_8 , the actual value of the DC component, which in binary is 001 000 000 000. Because the binary point is to the right of the sign bit, the actual value is $+.01_2$.

4.3 Inverse Transform Displays

The output of the transfer was 512 complex points. The inverse yields the following displays:

4.3.1 Real Display

0001
 0000
 0764
 0477

.

The third value, 0764 , is a deviation from 1000_8 , the exact value. At this time there are 2 scale factors involved. The relationship between the computed results and the original data is:

$$\text{results} = [(\text{original data}) * 2^{\text{sum of scale factors}}] / \# \text{ of points}$$

Reducing the equation for the first point yields:

$$\begin{aligned} 1000_8 &= [(2000_8) * 2^8] / 1000_8 \\ 2^9 &= 2^{10} * 2^8 / 2^9 \\ &= 2^9 \end{aligned}$$

4.3.2 Imaginary Display

0001
1000
0007
0401

The values are very small and are the result of imprecision in the computations.

4.3.3 Magnitude Display

0001
2000
0372
0440

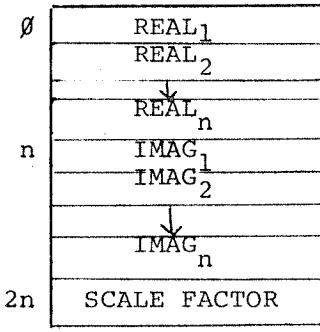
As in the magnitude display of the transform, the values displayed are half scale. Because the imaginary components are essentially zero, the magnitude, when doubled, equals the real values.

4.3.4 Scale Factor Display

The scale factor has a value of 7.

5.0 DATA STORAGE

The data must be stored sequentially on tape or disk in a binary file starting at the beginning of a block. If the data is complex, the real parts are grouped together followed by the imaginary parts, if any. If there are none, the program will create imaginary parts of value zero. The input and output data are in the form of binary fractions. For output data, the location following the last imaginary part contains the scale factor (refer to Data Scaling, Section 6.0). A file of complex values are stored in the following format:



-only present if file is generated by the FFTD program.

6.0 DATA SCALING

All calculations in FFTD are done with single precision fixed point signed binary fractions. The binary point is located between bit \emptyset and bit 1, leaving an 11 bit signed mantissa. Bit \emptyset is used as a sign bit. Negative numbers are formed by taking the two's complement of the positive binary fraction, so all inputs must be scaled in magnitude to less than one. The outputs are also formatted as above.

In order to preserve precision, it is sometimes necessary to divide by 2 in a computation. As a result, a pseudo floating point format has been adopted in which a variable scale factor (or exponent) is imposed on all the Fourier coefficients. This scale factor or pseudo exponent is found in item SCAL after each transform has been completed. It is also stored after the last imaginary part on tape or disk. The values stored on tape or disk are the Fourier coefficients multiplied by 2^{SCAL} . Because in binary notation shifting a number right one bit is equivalent to dividing by two, to retrieve the coefficients themselves, shift each number right by the number of bits equal to the value of the scale factor. In the case of the inverse transform, the time samples are the values in memory multiplied by 2^{-SCAL} . If, however, the inverse transform was performed on normalized transform data, the results are equal to $((original\ data) * 2^n) / no.\ of\ points$ where n equals the sum of both scale factors. To retrieve the time samples, shift left each number by the value of the scale factor.

7.0 SUBROUTINES USED

Manipulation of the DIAL and data LINCtapes and disk is done using the program MILDRED (DEC-12-FZDA). The question and answer displays are handled by QANDA (DEC-12-FISA). The data displays are handled by DISPLAY

(DEC-12-FLSA). A modification of FFTS-C (DECUS #8-144) is used to perform the Fourier Transforms.

8.0 ALGORITHM DESCRIPTION

The Fast Fourier Transformation enables computation of the power spectrum of a time series in a minimum of time. Specifically, it permits the discrete Fourier transformation

$$S_j = \frac{1}{N} \left[\sum_{k=0}^{N-1} x_k e^{-2\pi i j k / N} \right] \quad j = 0, \dots, N-1 \\ i = \sqrt{-1}$$

of a series on N equally spaced time samples (where N is a power of 2). The time required is proportional to $N_2 \log_2 N$, whereas previous methods required times proportional to N. This gives a reduction in computation time of $1 - \log_2 N / N$ or over 99 percent for $N=1024$. The algorithm makes use of the fact that

$$w^k = w^{(k \bmod N)} \text{ (where } w = e^{-2\pi i / N})$$

to reduce the number of manipulations necessary for a transformation.

9.0 CORE CHART

Field 0

SEGMENT 0
PAGE 0 - IFFT
*400 - FFT
*1400 - DISPLAY
SEGMENT 1 - MILDRED
SEGMENT 2 - MONITOR
QANDA
SEGMENT 3 - Data display code
FDV table
RWPARM table
Questions
Sine Table

Field 1

0 - Buffer - real parts
2000 - Buffer - imaginary parts

10.0 PROGRAM REGION DESCRIPTION

10.1 Routines

- IFFT - Take the Inverse Fourier Transformation of the data in field 1. The results are in bit inverted order (refer to the SORTX routine).
- FFT - Take the Fourier Transformation of the data in field 1. The results are in bit inverted order (refer to the SORTX routine).
- SORTX - Sort the data from bit inverted order to sequential order. Bit inversion means simply the process of re-ordering the bits in a binary number. For instance, the binary number 001 bit inverted is just $1\theta\theta$ (=4). For example, to locate S_5 in memory for a 16 point transformation ($N=16$, $n=4$), write 5 as a binary number of $n=4$ bits, $5_{10}=\theta1\theta1_2$. Then reverse the order of these bits to $1\theta1\theta_2$. This means S_5 is stored in position 1θ . Physically, then, S_5 of the real parts is to be found in location XRTAB+9.
- MULTIP - Perform a rounded single precision signed multiply using EAE. The CAL+1 contains the address of the multiplicand. The AC contains the multiplier. Exit with the product in the AC.
- INVRT - Reverse the bits of the number contained in the AC.
- TRIGET - Fetch sine and cosine values. Specifically, if the AC=K on entry, the values of $\sin(2\pi K/N)$ and $\cos(2\pi K/N)$ are fetched from an internal trig table. K must be $\geq N/2$. A register COSINE contains the cosine value and the AC contains the sine value on exit.
- ADDR - Perform a single precision add with rounding.

- IDORA - This subroutine generates a moving window display with a cursor riding on the curve. For more information refer to the DISPLAY document, DEC-12-FLSA-D.
- IFDIAL - Display the question: FROM DIAL UNIT? Y/N_ If the answer is Y, jump to UNTFIL; if N, jump to DATTAP; if neither, redisplay the question.
- UNTFIL - Jump to the subroutine ASK2 to display:
- UNIT NUMBER__
FILE NAME_____
- If the unit number is illegal, jump to ASK2 again to redisplay the question. If legal, jump to LOOKUP with the address of the File Description Vector (hereafter referred to as FDV) parameter list in the AC. If the file cannot be found, display the message:
- CANNOT FIND
HIT RETURN TO CONT
- When RETURN is hit, jump back to UNTFIL. If the file is found, jump to MOVINP.
- DATTAP - Jump to the subroutine ASK3 to display:
- UNIT NUMBER__
BLK NUMBER___
- If an illegal value is entered, jump back to DATTAP. If all the input is legal, fall through to MOVINP.
- MOVINP - Jump to FDV2RW to move the input information from the FDV to the read/write parameter list. Fall through to PTS.
- PTS - Display: NUMBER OF PTS
(4-1024 BY POWERS OF 2)
REAL OR
COMPLEX? R/C_

Set B1 to the address of the answer buffer, MPLIER to 12 and UPLEGL to -71 (-9) because the number of points is entered as a decimal value. Set the AC to the largest legal value, 2000, and jump to CONV. If the answer is an illegal value jump back to PTS; store the value in N and store its 1's complement in TEMP1. Since the number of points must be an integral power of 2, only one bit in TEMP1 may be set. Bit 11 is the exception to one bit being a power of 2. Check bit 11 first, then rotate the value adding up the number of bits set. If the total is not 1, jump back to PTS. Otherwise fall through to ROT1.

- ROT1 - Compute the power of 2 by rotating right the value in TEMP1 and stepping B2 until the bit that is set is encountered in bit 11. Fall through to STAMU.
- STAMU - Store the power of 2 in NU. If the power is less than 2, jump back to PTS. Otherwise load the AC with the number of points*2 and jump to NUMBKS to compute the number of blocks needed to hold the output. Store the value in FDV+7. Store it also in RWPARM+3 since, for complex data, the input and output data consist of the same number of blocks. If the answer to the second question is not R, jump to IFCOM. If it is R, the input consists of half as many words as the output. Load the AC with the value of N and jump to NUMBKS to compute the number of input blocks. Store the value in RWPARM+3. Set REALFG and jump to CKEND.
- IFCOM - If the answer is C, clear REALFG and fall through to CKEND. Otherwise jump back to PTS to redisplay the question.
- CKEND - If there is not enough room between the starting block number and the end of tape to hold the number of points specified, jump back to PTS. If

the number of output words is 4000 or greater, another block will be needed to hold the scale factor. Increment FDV+7. Fall through to IFFFT.

IFFFT - Display: FFT OR DISPLAY? F/D_
TRANSFORM OR
INVERSE? T/I_

If the answer to the first question is D, set DISFLG to indicate that the data will only be displayed. If F, clear DISFLG to indicate that a Transform or Inverse Transform will be performed. If the answer to the second question is T, clear FTFLG; if I, set it. If DISFLG is set, jump to DISPLAY to display the data. Otherwise, jump to OUTQES.

OUTQES - Display the question: OUTPUT ON DIAL UNIT? Y/N_
If the answer is Y jump to OUTUNT; if N jump to ONDAT; otherwise redisplay the question.

OUTUNT - Jump to the subroutine ASK2 to display:

UNIT NUMBER--
FILE NAME -----

If an illegal value is input, redisplay the question. Otherwise jump to ENTER with the address of the parameter list in the AC. If a file with the specified name already exists, jump to SAMNAM. If there is not enough space to hold the output data, jump to NOSPAC. If it is a new file and there is enough space to hold it, fall through to RDDATA.

RDDATA - Clear 4000 words of field 1 and read in the input data. If REALFG is 0, the data is complex - move the imaginary parts to start at location 2000. If it is non-zero, the data is real and nothing need be done. Jump to PROC.

PROC - If IFTFLG is 0, jump to FT to do a Transform. Otherwise, fall through to do an Inverse Transform.

- IFT - Jump to the subroutine IFFT to do an Inverse Transform on the input data. Then jump to the subroutine SORTX to sort the coefficients into sequential order from bit inverted order. Jump to STSCAL to store the scale factor which is equal to NU-SCAL. The data should be shifted by this value.
- FT - Jump to the subroutine FFT to transform the input data. Then jump to the subroutine SORTX to sort the coefficients into sequential order from bit inverted order. The scale factor is the value in SCAL and equals the number of bits by which the data should be shifted right. Fall through to STSCAL.
- STSCAL - Store the scale factor in the word following the last imaginary part. Move the imaginary parts from ~~2000~~ to immediately behind the real parts.
- NOWSTR - Jump to the subroutine FDV2RW to move the output parameters from the FDV to the read/write parameter list. Write the data onto the output tape and jump to DISPLAY.
- NOSPAC - Jump to the subroutine ASK to display the message:
- NO SPACE
HIT RETURN TO CONT
- When RETURN is hit, jump to OUTQES.
- SAMNAM - Jump to the subroutine ASK to display:
- ALREADY EXISTS
REPLACE? Y/N_
- If the answer is Y, jump to REPL; if it is N, jump to OUTUNT. If it is neither, redisplay the question.

REPL - Try to replace the existing file with the new file. If the new file is longer, jump to NOSPAC. If the replacement is successful, jump to RDDATA.

ONDAT - Jump to the subroutine ASK3 to display:

UNIT NUMBER__
BLK NUMBER__

If an illegal value is entered, redisplay the question. If there is not enough space between the specified block number and the end of tape to hold the output data, jump to NOSPAC. Otherwise, jump to RDDATA.

10.2 Subroutines

FDV2RW - Transfer the unit number, starting block number, and number of blocks from the FDV parameter list to the READ/WRITE parameter list.

NUMBKS - Enter with the number of words in the AC. Convert this value to blocks by counting the number of times 400 can be subtracted from it before the value becomes negative. Return with the number of blocks in the AC.

ASK2 - Jump to OCTL to set MPLIER to 10 and UPLEG to -67(-7) because the unit number is input as an octal number.

Display: UNIT NUMBER__
FILE NAME -----

by jumping to the subroutine ASK with the address of QUES2 in the AC. Set B1 to the address of the answer buffer and jump to the subroutine CONV with the largest legal unit number, 17, in the AC. If the value is illegal, return to CALL+1. If legal, store it and the file name in the FDV parameter list. Fill the file name out to 8 characters with 77's. Return to CALL+2.

ASK3 - Display: UNIT NUMBER __
BLK NUMBER -----

by jumping to the subroutine ASK with the address of QUES3 in the AC. Set B1 to the address of the answer buffer and jump to OCTL to set MPLIER to 10 and UPLEGL to -67(7) because the unit and block numbers are input in octal. Jump to subroutine CONV with the largest legal unit number, 17, in the AC. If the value is illegal, return to CALL+1. Otherwise, store it in word 0 of the FDV parameter list. B1 is now pointing to the block number. Jump to CONV with the largest legal block number, 777, in the AC. If the value is illegal, return to CALL+1. If legal, store it in word 6 of the FDV parameter list. Return to CALL+2.

- CONV - CONV is entered with the largest legal value in the AC and B1 pointing to the address - (1 half word) of the first character to be converted. Store the 1's complement of the largest legal value in TEMP2 and clear TEMP1. UPLEGL contains a -71(-9) or -67(-7) and MPLIER contains a 10 or 12 depending on whether the number to be converted is in decimal or octal. Extract a character and compare it against an ASCII 0 and the contents of UPLEGL. If it is a legal value, jump to MULPLY which will multiply the value in TEMP1 by the contents of MPLIER and add the digit being converted to it. Repeat the procedure until a character is found which is not between 0 and UPLEGL. If it is not a 34, 74, or 0, it is an illegal character: return to CALL+1. A 34 or 74 indicates the end of the input field; a 0 indicates the end of the input. Compare the converted value in TEMP1 against the maximum legal value in TEMP2. If the value is legal return to CALL+2; otherwise return to CALL+1.
- OCTL - OCTL sets MPLIER to 10 and UPLEGL to -67(-7) so that CONV will convert an octal number.

ASK - ASK is entered with the address of the display in the AC. Store it in the parameter list and jump to QAINIT to display the message. Refresh the display until the answer is input. Return to the calling routine.

DISPLAY - This region is entered either after the Transform or Inverse Transform is completed or in response to a D in answer to the display: FFT OR DISPLAY? F/D_. Since the data is manipulated in preparation for each display it must be read in before each display. After reading in the data, display:

```
WHICH DISPLAY?  
R(EAL)  
I(MAGINARY)  
M(AGNITUDE)  
S(CALE FACTOR)  
LINE FEED (RESTART)
```

If the answer buffer contained \emptyset , just LINE FEED was hit: jump to IFDIAL to restart the program. Otherwise jump to WCHDIS.

WCHDIS - Jump to DPIMAG, DPMAG, DPREAL, or DPSCAL if the answer was I, M, R, or S, respectively. Otherwise redisplay the question.

DPIMAG - If REALFG is non-zero, the input is real and no Transform was performed. Therefore, there are no imaginary parts to display; redisplay the question. If REALFG is zero, check IFTFLG. If it equals zero, either an Inverse Transform was performed or the original data is just being displayed. In either case the data is in the right order. If IFTFLG is non-zero, a transform was performed. The positive half of the curve is first followed by the negative half and the signs are reversed. Swap the halves and reverse signs before jumping to PREPAR.

DPREAL - Check IFTFLG for the same reason as in DPIMAG. The only difference is that the signs of the real parts are not reversed.

- PREPAR - If less than 1000 points are to be displayed, the display will not move and the points displayed will be centered on the scope. To achieve this, LEFTX is set to the 1's complement of $-1000 + (1000 = \# \text{ of points}) / 2$, MINPTS to the 2's complement of the number of points, and MVDIS to the instruction CLR. Jump to SHOWIT.
- GQ1000 - If 1000 or more points are to be displayed, the display will fill the scope and will move. To achieve this, LEFTX is set to the 1's complement of 1000, MINPTS to the 2's complement of 1000 and MVDIS to the instruction SCR 4. Fall through to SHOWIT.
- SHOWIT - Jump to the subroutine IDORA to display the data. The six parameters following the call to IDORA are in order: the memory field of the lower address, the lower address, the memory field of the higher address, the higher address, the Y offset of the display and the scale factor of the data. Both fields are always 1, the lower address is always Ø. The higher address is set in the region DISPLAY. The Y offset is always Ø; therefore the baseline is half way up the scope. The scale factor is the instruction SCR plus the number of bits to scale the data right before displaying it. Since IDORA displays only the right nine bits, if the left three bits are significant, the data must be scaled right three before displaying it.
- RFRSH - Jump to RDORA to refresh repeatedly the display until a key on the teletype is hit. If the RETURN is hit, jump to REDPLY which jumps to DISPLAY to redisplay the question: WHICH DISPLAY? If a 1 is entered, jump to LARGER to blow up the display. If a Q is hit, jump to SMALLR to decrease its size. If anything else is entered, ignore it.
- SMALLR - If the instruction at SIZE contains a shift of 11 bits, a bigger shift would be meaningless. Jump back to RFRSH. Otherwise, increment the value of the shift and jump to SHOWIT.

- LARGER - If the instruction at SIZE contains a shift of \emptyset bits, jump back to RFRSH. Otherwise decrement the value of the shift and jump to SHOWIT.
- DPSCAL - If REALFG is non-zero, only real parts are present, meaning this program did not create the file and therefore there is no scale factor. Return to DISPLAY to redisplay the question. If REALFG is \emptyset , the scale factor is stored after the last imaginary part. Convert it to ASCII decimal and display it.
- DPMAG - If REALFG is non-zero, the input data is real and no transform was performed; therefore the magnitude is the same as the real points. Redisplay the question: WHICH DISPLAY? Otherwise move the imaginary parts to location 2000. Set RELPTR and IMGPTR, which contain the effective address of the multipliers, to 6000 since the data begins at location \emptyset of their respective segments and is fractional. Fall through to NXTMAG.
- NXTMAG - Square a real part and store it. Square the imaginary part, add the square of the real part to it, jump to the subroutine SQRT to get the square root of the sum and store it in place of the real part. Repeat the process for each point. Then jump to SHOWIT to display the magnitude.
- MOVPTS - The subroutine MOVPTS moves values from one buffer (address -1 in l0) in field l to another (address -1 in l1). If CMPFLG equals 1, the values are complemented as they are moved. TEMPR contains the 2's complement of the number of values to move.
- MVRLMG - The subroutine MVRLMG is used to swap the first and second halves of the real or magnitude values. In the process they are moved from the buffer starting at location \emptyset to the one starting at 2000.
- FDV - The File Descriptor Vector parameter list is used by the LOOKUP, ENTER, and REPLACE sections of MILDRED. Word \emptyset contains the unit number, words 1-4 contain

the file name, word 5 contains a 2 indicating the file is binary, word 6 is the starting block number, and word 7 is the number of blocks. Word 6 is filled by LOOKUP, ENTER and REPLACE. Word 7 is filled by LOOKUP but must be supplied for ENTER and REPLACE.

- RWPARM - The Read/Write parameter list is used by the READ and WRITE sections of MILDRED. Bits 0-2 of word 0 contain the field, bits 9-11 contain the unit. Word 0 contains the starting address, word 1 the starting tape block number and word 2 the number of blocks.
- SQRT - The subroutine SQRT is entered with a value in the double precision location DPSQ. It returns with the square root in the AC.

10.3 Symbols

N	Number of words in computation
NU	Power of 2 of value of N
L	Index to show what array is being constructed
S	Gives spacing between node pairs in the Lth array
NOVER4	Storage for N/4
MAXNU	Power of 2 of largest table size (13)
MNOVR2	Storage for N/2
QR	Pointer to real part of X(Q)
QI	Pointer to imaginary part of X(Q)
PR	Pointer to real part of X(P)
PI	Pointer to imaginary part of X(P)
Q	Numerical index Q ($=\emptyset, 1, \dots, N-1$)
P	Numerical index P ($=\emptyset, \dots, N-1$)
K	Number in the node being operated on
C	Interrupts computation of Lth array every S passes.
ADD2	Used by subroutine ADDR as data (addend)
	Used by monitor as a temporary location
TEMPLR	Temporary storage register for real parts
	Used by monitor as a temporary location
SINE	Temporary storage for sin ($S * PI * K / N$)
	Used by monitor as a temporary location
COSINE	Temporary storage for cos ($2 * PI * K / N$)
	Used by monitor as a temporary location
GR	Real part of product ($W^k * X(P)$) - temporary storage
	Used by monitor as a temporary location
GI	Imaginary part of product ($W^k * X(P)$) - temporary storage
SCAL	Pseudo exponent of Fourier coefficients
SHFLAG	If =1, add with shift; if $\neq \emptyset$, add without shift
SHFCHK	Indicates if all X's in an iteration are <.5
DISFLG	If $\neq \emptyset$, the data will just be displayed
IIFTFLG	If $\neq \emptyset$, an Inverse Transform was performed
REALFG	If $\neq \emptyset$, the data does not contain imaginary parts
DPSQ	Used to save the double precision squares of the real and imaginary parts during calculation of the magnitude.
CMPFLG	If =1, the subroutine MOVPTS will complement the values as it moves them

10.4 Beta Registers

Beta registers 1, 2, and 3 are used by the monitor in ASK2 and ASK3 as temporary pointers and counters. QANDA and MILDRED make more extensive use of the Beta registers.

11.0 ASSEMBLY INSTRUCTIONS

The FFTD program is assembled in three sections by assembling and saving each, then adding them together. The entire command sequence is:

```
→AS MILQAN,n  
→SB MILQAN,n  
→AS SIN256,n  
→SB SIN256,n  
→AS FFTC-1  
→SB FFTC-1  
→ZE  
→AB MILQAN,n  
→AB SIN256,n  
→AB FFTC-1,n  
→SB FFTD,n,L
```

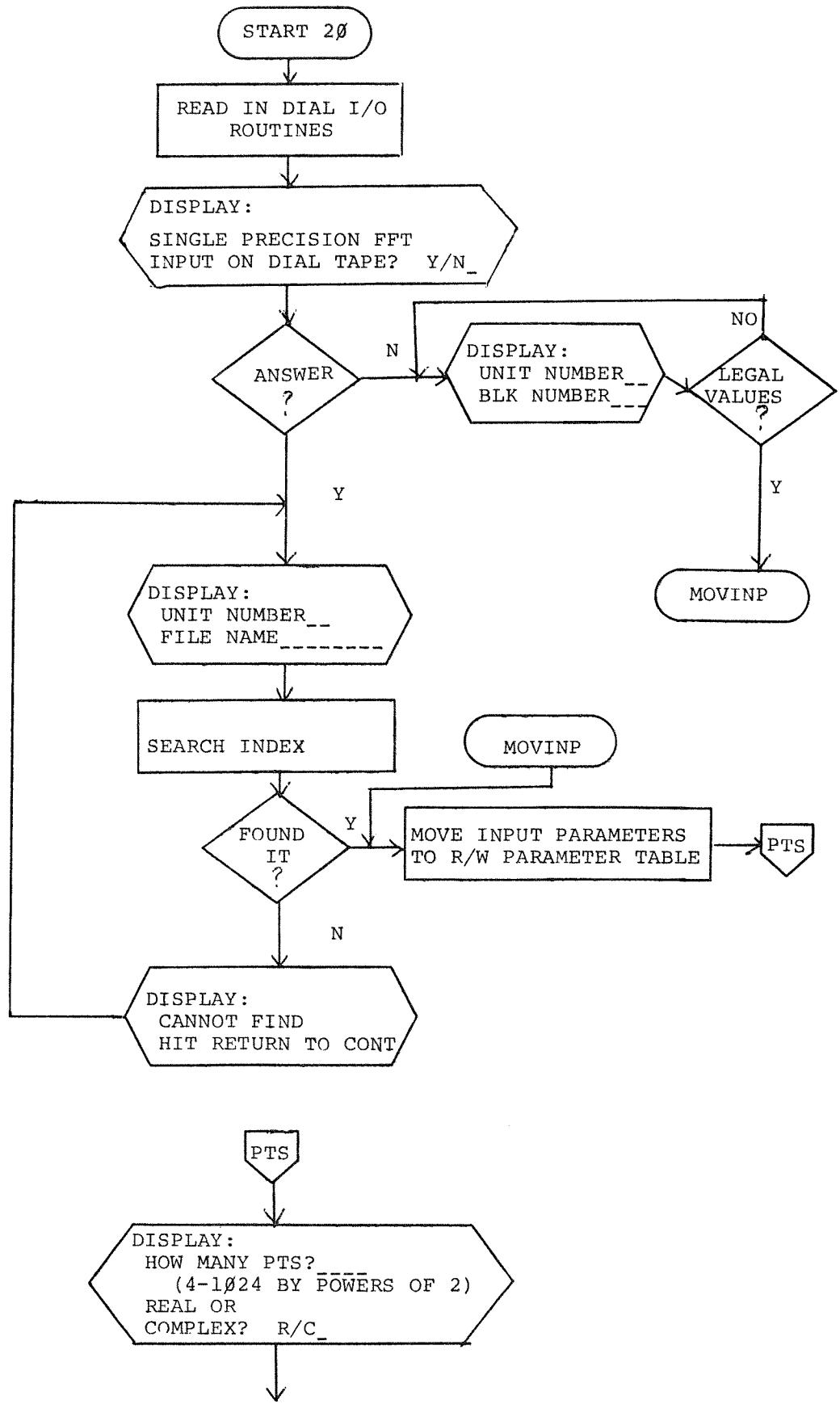
where n is the unit containing the program
(FFTC-1 chains to FFTC-2)
(saves the whole program)

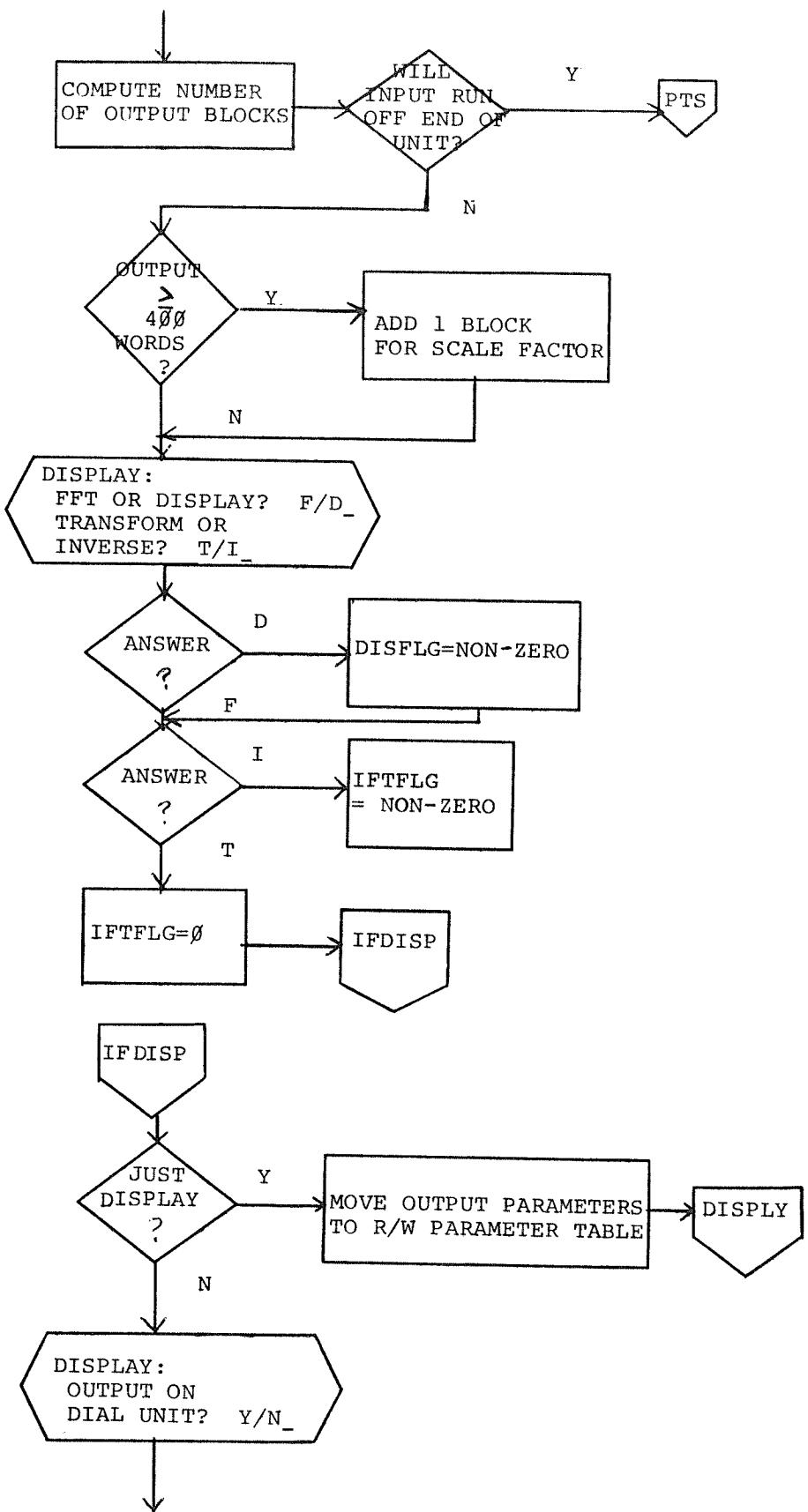
12.0 SYSTEM FLOWCHARTS

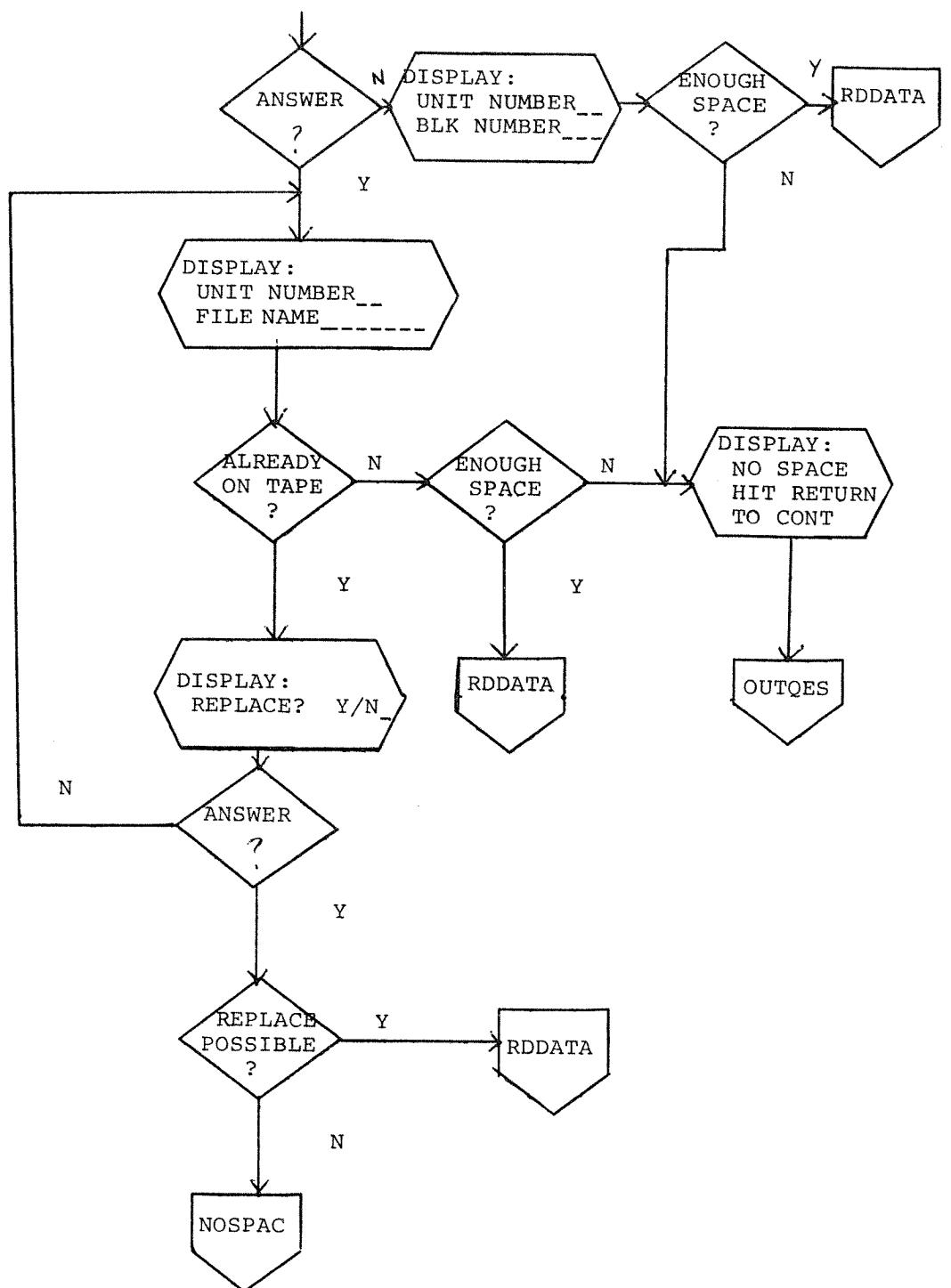
(Attached)

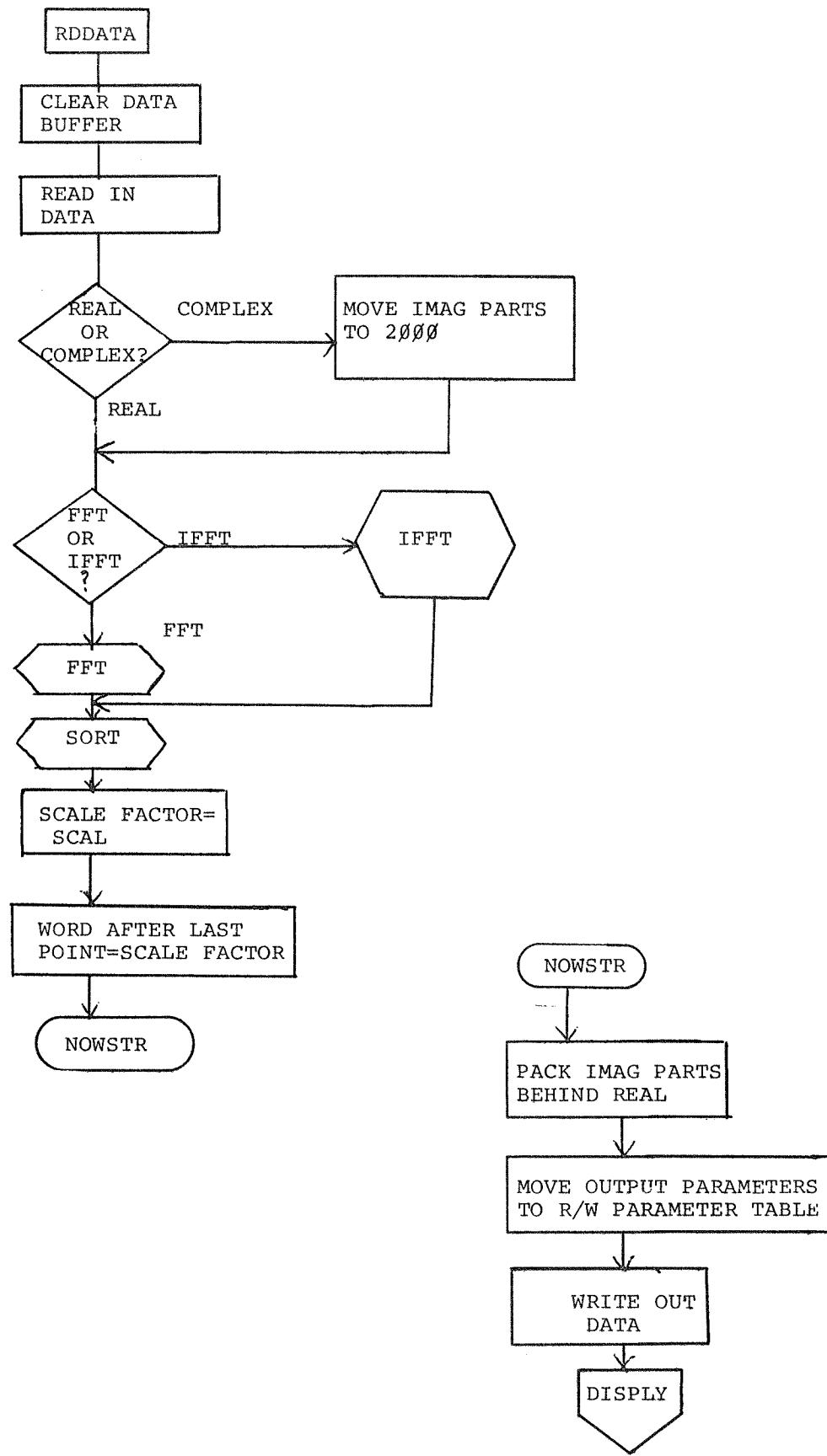
13.0 PROGRAM LISTING

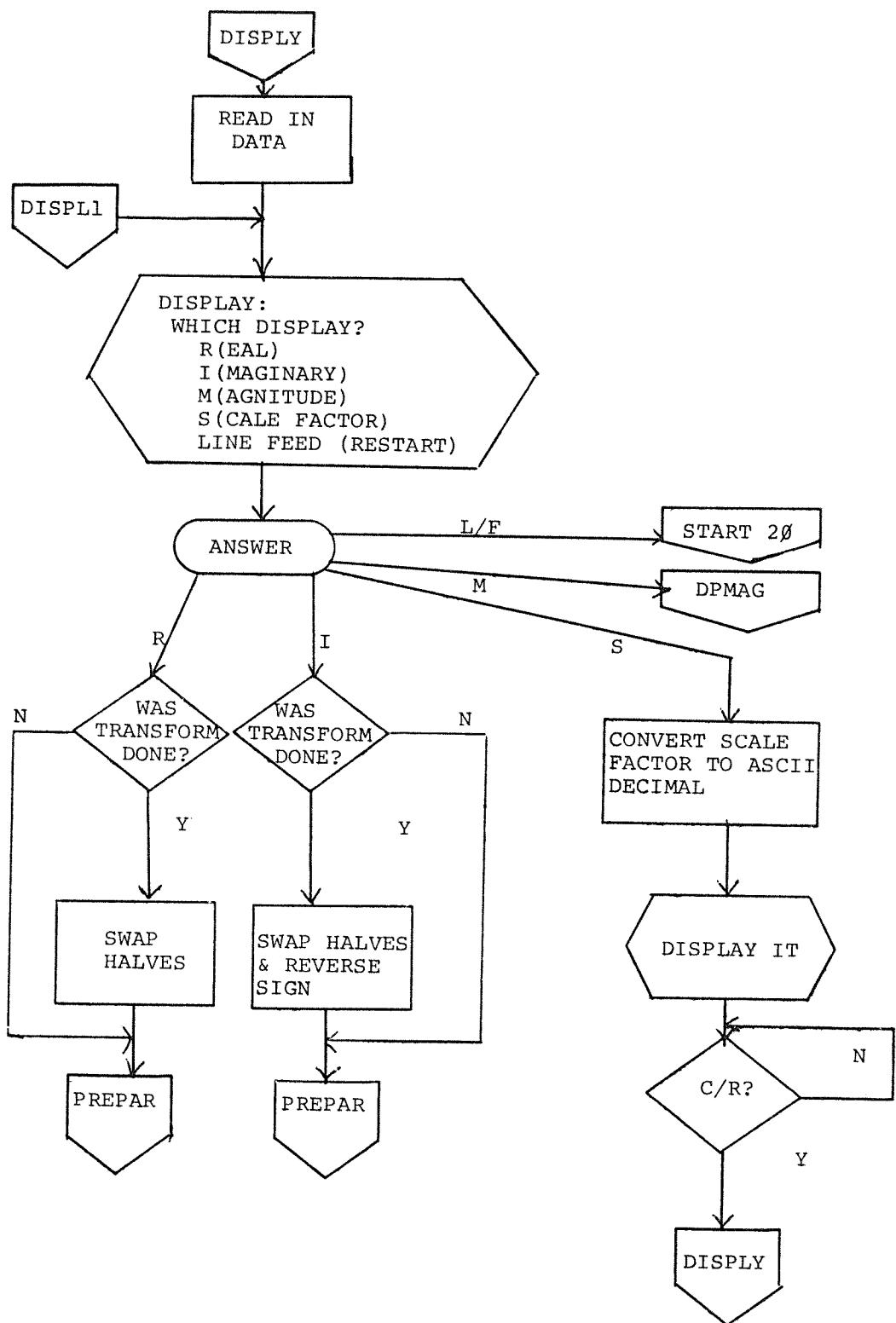
(Attached)

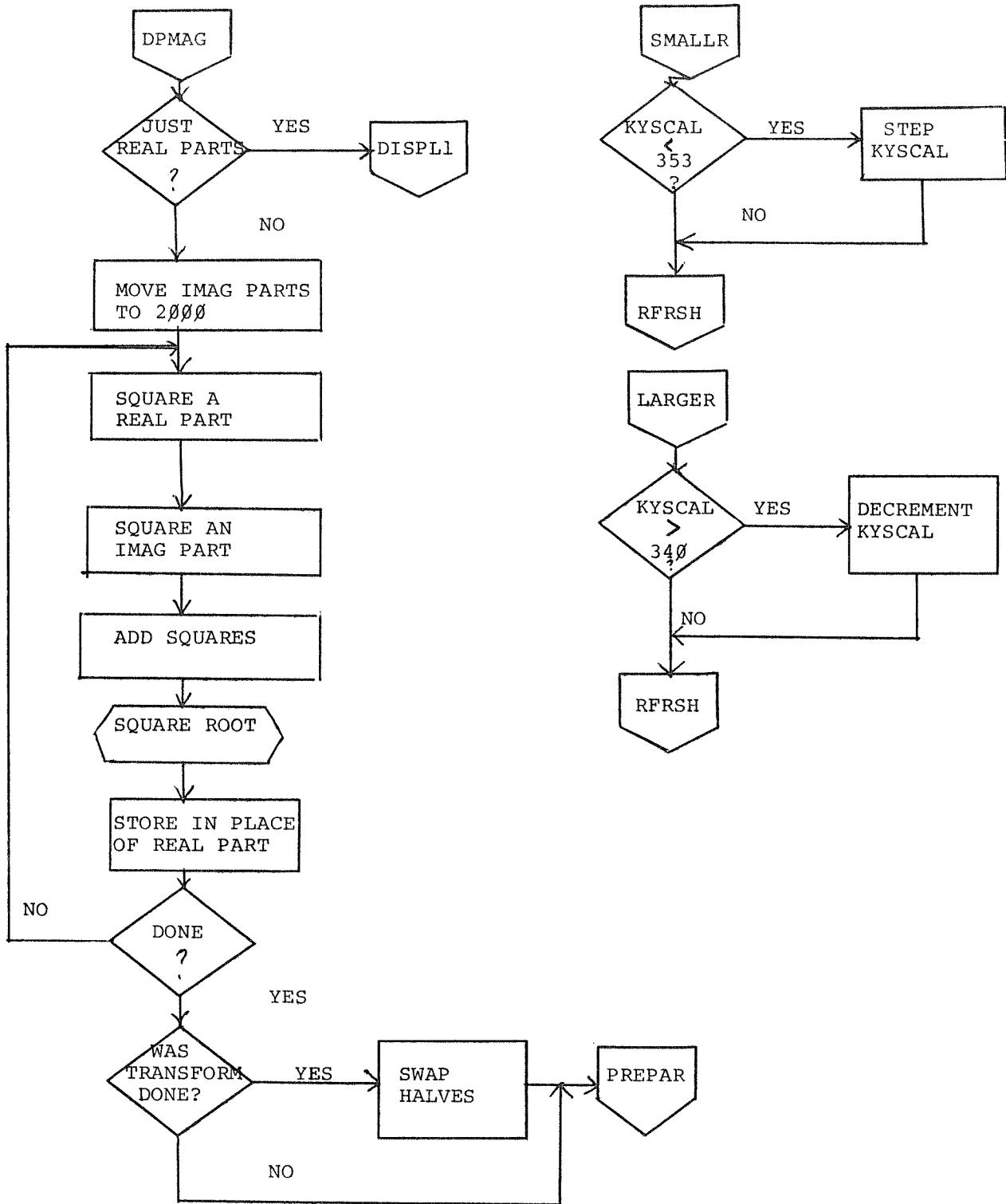


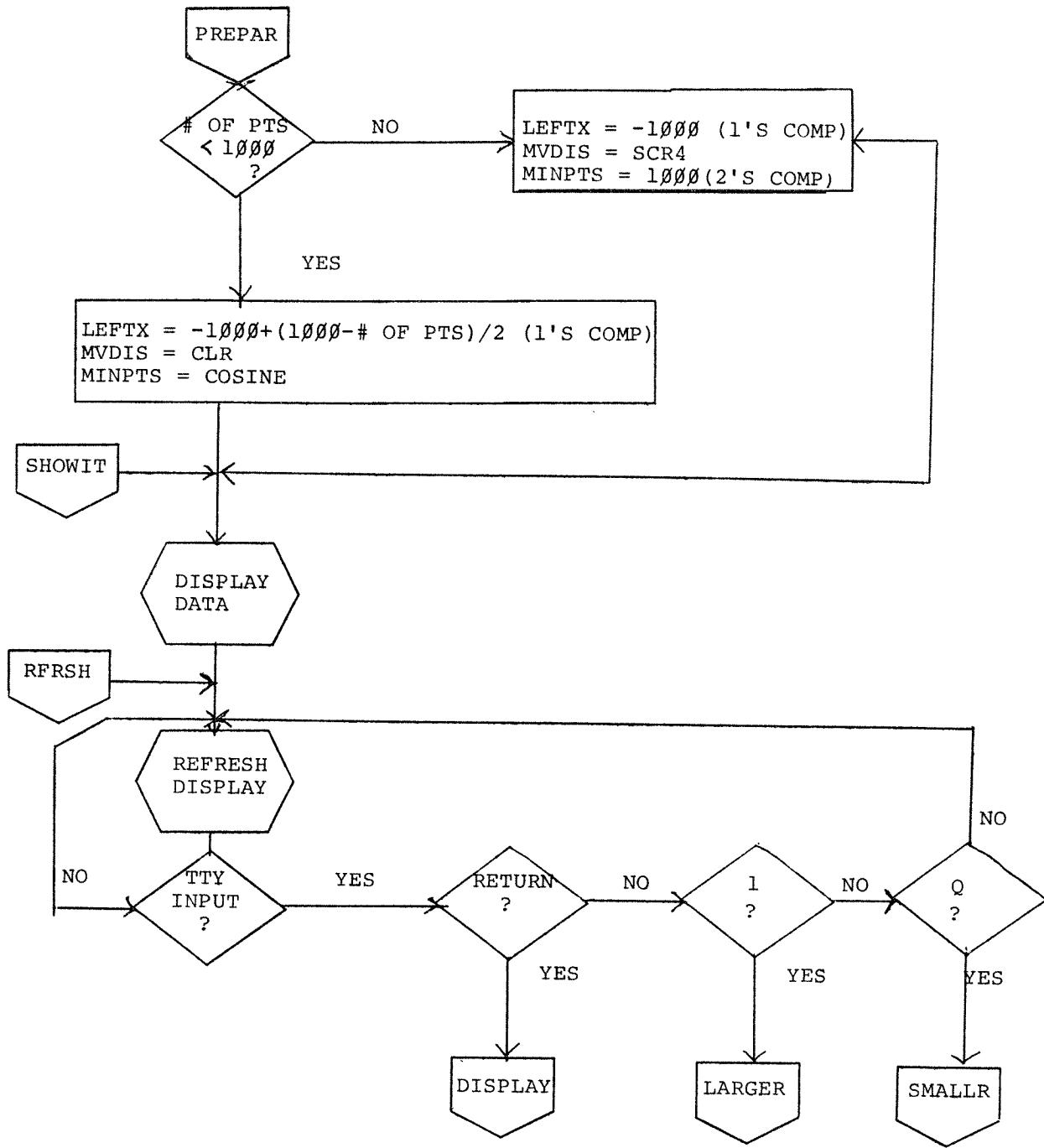












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```

*20
0000 /FFTS=REAL
0001 /THIS IS A PROGRAM FOR CALCULATING THE
0002 /FAST FOURIER TRANSFORMATION OF N REAL
0003 /TIME SAMPLES WHICH ARE STORED ON DIAL
0004 /OR DATA TAPE OR DISK
0005 /TO BE RUN ON A PDP-12 COMPUTER EQUIPPED/WITH THE FOLLOWING MINIMUM HARDWARE:
0006 / 1) ASR 33 OR ASR 35 TELETYPE
0007 / 2) 8 K OF CORE MEMORY
0008 / 3) VR12 CRT DISPLAY
0009 /
0010 /
0011 /
0012 /
0013 /COPYRIGHT 1970, DIGITAL EQUIPMENT CORPORATION
0014 / MAYNARD, MASS., 01754
0015 /TRANSFORM ALGORITHM
0016 /WRITTEN BY JAMES ROTHMAN -- AUGUST, 1968
0017 QARFSH=1053
0018 QAINIT=1000
0019 XRTAB=0
0020 XITAB=2000
0021 SINTAB=7347
0022 CDF1=6211
0023 CDF0=6201
0024 PMODE
0025
0026
0027 /PAGE ZERO
0028 *3
0029 /TABLE PARAMETERS
0030
0031 0003 0000 N, 0
0032 0004 0000 NU, 0
0033 0005 0000 L, 0
0034 0006 0000 S, 0
0035 0007 0000 F, 0
0036
0037
0038
0039
0040
0041 0020 0000 NOVER4, 0
0042 0021 0012 MAXNU, B1GSNU
0043 0022 0000 MNQR2, 0
0044 /INDEXING VARIABLES
0045 0023 0000 QR, 0
0046 0024 0000 QI, 0
0047 0025 0000 PR, 0
0048 0026 0000 PI, 0
0049 0027 0000 Q, 0
0050 0028 0000 P, 0
0051 0029 0000 K, 0
0052 0030 0000 GI, 0
0053 0031 0000 C, 0
0054 /LOOP DELIMITERS
0055 0032 0000 ADDER, ADDR
0056 /DATA VARIABLES
0057 0033 0000 ADD2, 0
0058 0034 0000 TMR, 0
0059 0035 0000 SINE, 0
0060 0036 0000 COSINE, 0
0061 0037 0000 GR, 0
0062 0038 0000 GI, 0
0063 0039 0000 C, 0
0064 0040 0000
0065 /SUBROUTINE CALL LIST
0066 0041 1135 ADDER, ADDR
0067 0042 0701 SORT, X
0068 0043 1040 INVERT, INVR
0069 0044 1040 MULT, MULTIP
0070 0045 1040 GETRIG, TRIGET
0071 0046 0400 DOFFT, FFT
0072 0047 0400
0073 0048 0400
0074 0049 0400
0075 0050 0400
0076 0051 0400
0077 0052 0400
0078 0053 0400
0079 0054 0400
0080 0055 0400
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0752 0727 0400
0753 0728 0400
0754 0729 0400
0755 0730 0400
0756 0731 0400
0757 0732 0400
0758 0733 0400
0
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0174 0143 00000
0175 0144 0644 LM00E
0176 0145 0344 LDF4,
0177 0146 0011 SCR4,
0200 CCLR,
0201 CLR
0202 PMODE
0203 EJECT

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0223
0224 //THIS SUBROUTINE TAKES THE INVERSE FFT (IFFT) OF THE DATA IN THE BUFFER,
0225 //IT IS ASSUMED THAT THIS DATA IS STORED SEQUENTIAL ORDER.
0226 //THE RESULTS ARE STORED IN BIT INVERTED ORDER.
0227 //THE ALGORITHM USED IS AS FOLLOWS:
0228 // THE NORMAL TRANSFORM IS PERFORMED, EXCEPT:
0229 // ON FETCHING THE VALUE FOR IM[W^K], WHICH IS
0230 // THE SIN(2*PI*K/N), THIS SIN VALUE IS NEGATED,
0231 //
0232 //THE REASONING FOR THIS IS AS FOLLOWS:
0233 // A WEIGHTING FACTOR OF W^(-K) IS USED IN THE IFFT
0234 // AND SINCE W^K AND W^(-K) ARE THE SAME EXCEPT THAT
0235 // THEIR IMAGINARY PARTS HAVE OPPOSITE SIGNS, IT FOLLOWS
0236 // THAT IM[JW^K] SHOULD BE REPLACED BY -IM[W^K].
0237
0238 IFFT,
0239     0000    7300    CLA    CLL    /NEGATE IM[W^K], GET CIA INSTRUCTION
0240     J151    1152    TAD    CCIA    /AND PUT AT LOCATION ADJSN
0241     3152    3561    DCA    1      SGNAJ    /DU FFT
0242     4123    4445    JMS    1      DOFFT   /DU FFT
0243     4134    6211    CDF0
0244     0125    1163    TAD    CNOP    /RE-INSTATE NOP AT ADJSN FOR FFT.
0245     0156    3561    DCA    1      SGNAJ
0246     0157    6211    CDF1
0247     0160    5547    JMP    1      IFFT    /EXIT
0248     0161    0570    SGNAJ, ADJSN    /POINTER TO SIGN ADJUST INSTRUCTION
0249     0162    7041    CCIA, CIA, NOP, EJECT
0250     0163    7000
0251

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*400

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*COMPUTATION OF FIRST COMPLEX ARRAY   IM INPUT DATA
/NUMBER OF INPUT POINTS IN "N" .LOG -. (N)IN"NU", FOR DETAILS OF ALGORITHM, SEE FLOWCHART
0236
0237
0240 0000 0401 7301 CLA IAC CLL
0242 0401 7301 DCA L
0243 0402 3005 DCA SCAL
0244 0403 3053 DCA
0245 0434 7001 IAC
0246 0405 3054 SHFLAG
0247 0406 3055 SHFCHK
0250 0407 1003 TAD N
0251 0410 7112 CLL RTR
0252 0411 3020 DCA NOVER4
0253 0412 1004 TAD NU
0254 0413 7041 CIA
0255 0414 1021 TAD MAXNU
0256 0415 3456 DCA I SHIFT1
0257 0416 1456 TAD I SHIFT1
0260 0417 3457 DCA I SHIFT2
0261 0420 1457 TAD I SHIFT2
0262 0421 3460 DCA I SHIFT3
0263 0422 1003 TAD N
0264 0423 7110 CLL RAR S
0265 0424 3006 DCA
0266 0425 1006 TAD S
0267 0426 7041 CIA
0270 0427 3022 DCA
0271 0430 7042 CMA
0272 0431 1006 TAD
0273 0432 1051 TAD
0274 0433 3023 XRLOC
0275 0434 1004 DCA QR
0276 0435 7041 TAD NU
0277 0436 7001 CIA
0278 0437 3007 DCA F
0279 0440 1023 TAD QR
0280 0441 1006 S
0281 0442 3025 DCA PR
0282 0443 1023 TAD QR
0283 0444 1052 TAD XLOCDF
0284 0445 3024 DCA QI
0285 0446 1025 TAD PR
0286 0447 1052 TAD XLOCDF
0287 0450 3026 DCA P1
0288 0451 6211 CDF1
0289 0452 1424 TAD 1 QI
0290 0453 3033 DCA ADD2
0291 0454 1426 TAD 1 PI
0292 0455 4441 JMS 1 ADDER
0293 0456 3034 DCA TEMP
0294 0457 1424 TAD 1 QI
0295 0460 3033 DCA ADD2
0296 0461 1426 TAD 1 PI
0297 0462 7041 CIA
0298 0463 4441 JMS 1 ADDER
0299 0464 3426 DCA I
0300 0465 1034 TAD TEMP
0301 0466 3424 DCA I
0302 0467 1423 TAD 1 QR
0303 0470 3033 DCA ADD2
0304 0471 1425 TAD 1 PR
0305 0472 4441 JMS 1 ADDER
0306 0473 3034 DCA I
0307 0474 1424 TAD 1 QI
0308 0475 3033 DCA ADD2
0309 0476 1426 TAD 1 PI
0310 0477 7041 CIA
0311 0478 4441 JMS 1 ADDER
0312 0479 6211 DCA I
0313 0480 1424 TAD 1 QI
0314 0481 3033 DCA ADD2
0315 0482 1426 TAD 1 PI
0316 0483 4441 JMS 1 ADDER
0317 0484 3034 DCA TEMP
0318 0485 1424 TAD 1 QI
0319 0486 3033 DCA ADD2
0320 0487 7041 CIA
0321 0488 4441 JMS 1 ADDER
0322 0489 1426 TAD 1 PI
0323 0490 7042 CIA
0324 0491 4441 JMS 1 ADDER
0325 0492 3426 DCA I
0326 0493 1034 TAD TEMP
0327 0494 3424 DCA I
0328 0495 1423 TAD 1 QR
0329 0496 3033 DCA ADD2
0330 0497 1425 TAD 1 PR
0331 0498 4441 JMS 1 ADDER
0332 0499 3034 DCA I
0333 0500 1424 TAD 1 PI
0334 0501 7041 CIA
0335 0502 4441 JMS 1 ADDER
0336 0503 3034 DCA TEMP
0337 0504 1424 TAD 1 QI
0338 0505 3033 DCA ADD2
0339 0506 1426 TAD 1 PI
0340 0507 7041 CIA
0341 0508 4441 JMS 1 ADDER
0342 0509 3034 DCA I
0343 0510 1424 TAD 1 QI
0344 0511 3033 DCA ADD2
0345 0512 7041 CIA
0346 0513 4441 JMS 1 ADDER
0347 0514 3034 DCA TEMP
0348 0515 1424 TAD 1 QI
0349 0516 3033 DCA ADD2
0350 0517 1426 TAD 1 PI
0351 0518 7041 CIA
0352 0519 4441 JMS 1 ADDER
0353 0520 3034 DCA I
0354 0521 1424 TAD 1 QI
0355 0522 3033 DCA ADD2
0356 0523 7041 CIA
0357 0524 4441 JMS 1 ADDER
0358 0525 3034 DCA TEMP
0359 0526 1424 TAD 1 QI
0360 0527 3033 DCA ADD2
0361 0528 1426 TAD 1 PI
0362 0529 7041 CIA
0363 0530 4441 JMS 1 ADDER
0364 0531 3034 DCA I
0365 0532 1424 TAD 1 QI
0366 0533 3033 DCA ADD2
0367 0534 7041 CIA
0368 0535 4441 JMS 1 ADDER
0369 0536 3034 DCA TEMP
0370 0537 1424 TAD 1 QI
0371 0538 3033 DCA ADD2
0372 0539 1426 TAD 1 PI
0373 0540 7041 CIA
0374 0541 4441 JMS 1 ADDER
0375 0542 3034 DCA I
0376 0543 1424 TAD 1 QI
0377 0544 3033 DCA ADD2
0378 0545 7041 CIA
0379 0546 4441 JMS 1 ADDER
0380 0547 3034 DCA TEMP
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0382 0549 3033 DCA ADD2
0383 0550 1426 TAD 1 PI
0384 0551 7041 CIA
0385 0552 4441 JMS 1 ADDER
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0388 0555 3033 DCA ADD2
0389 0556 7041 CIA
0390 0557 4441 JMS 1 ADDER
0391 0558 3034 DCA TEMP
0392 0559 1424 TAD 1 QI
0393 0560 3033 DCA ADD2
0394 0561 1426 TAD 1 PI
0395 0562 7041 CIA
0396 0563 4441 JMS 1 ADDER
0397 0564 3034 DCA I
0398 0565 1034 TAD TEMP
0399 0566 3424 DCA I
0400 0567 1423 TAD 1 QR
0401 0568 3033 DCA ADD2
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0403 0570 4441 JMS 1 ADDER
0404 0571 3034 DCA I
0405 0572 1424 TAD 1 PI
0406 0573 3033 DCA ADD2
0407 0574 7041 CIA
0408 0575 4441 JMS 1 ADDER
0409 0576 3034 DCA TEMP
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0412 0579 1426 TAD 1 PI
0413 0580 7041 CIA
0414 0581 4441 JMS 1 ADDER
0415 0582 3034 DCA I
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0417 0584 3033 DCA ADD2
0418 0585 7041 CIA
0419 0586 4441 JMS 1 ADDER
0420 0587 3034 DCA TEMP
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0422 0589 3033 DCA ADD2
0423 0590 1426 TAD 1 PI
0424 0591 7041 CIA
0425 0592 4441 JMS 1 ADDER
0426 0593 3034 DCA I
0427 0594 1424 TAD 1 QI
0428 0595 3033 DCA ADD2
0429 0596 7041 CIA
0430 0597 4441 JMS 1 ADDER
0431 0598 3034 DCA TEMP
0432 0599 1424 TAD 1 QI
0433 0600 3033 DCA ADD2
0434 0601 1426 TAD 1 PI
0435 0602 7041 CIA
0436 0603 4441 JMS 1 ADDER
0437 0604 3034 DCA I
0438 0605 1424 TAD 1 QI
0439 0606 3033 DCA ADD2
0440 0607 7041 CIA
0441 0608 4441 JMS 1 ADDER
0442 0609 3034 DCA TEMP
0443 0610 1424 TAD 1 QI
0444 0611 3033 DCA ADD2
0445 0612 1426 TAD 1 PI
0446 0613 7041 CIA
0447 0614 4441 JMS 1 ADDER
0448 0615 3034 DCA I
0449 0616 1424 TAD 1 QI
0450 0617 3033 DCA ADD2
0451 0618 7041 CIA
0452 0619 4441 JMS 1 ADDER
0453 0620 3034 DCA TEMP
0454 0621 1424 TAD 1 QI
0455 0622 3033 DCA ADD2
0456 0623 7041 CIA
0457 0624 4441 JMS 1 ADDER
0458 0625 3034 DCA TEMP
0459 0626 1424 TAD 1 QI
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0461 0628 7041 CIA
0462 0629 4441 JMS 1 ADDER
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0465 0632 3033 DCA ADD2
0466 0633 7041 CIA
0467 0634 4441 JMS 1 ADDER
0468 0635 3034 DCA TEMP
0469 0636 1424 TAD 1 QI
0470 0637 3033 DCA ADD2
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0472 0639 4441 JMS 1 ADDER
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0475 0642 3033 DCA ADD2
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0477 0644 4441 JMS 1 ADDER
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0480 0647 3033 DCA ADD2
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0482 0649 4441 JMS 1 ADDER
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0485 0652 3033 DCA ADD2
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0487 0654 4441 JMS 1 ADDER
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0795 0962 3033 DCA ADD2
0796 0963 7041 CIA
0797 0964 4441 JMS 1 ADDER
0798 0965 3034 DCA TEMP
0799 0966 1424 TAD 1 QI
0800 0967 3033 DCA ADD2
0801 0968 7041 CIA
0802 0969 4441 JMS 1 ADDER
0803 0970 3034 DCA TEMP
0804 0971 1424 TAD 1 QI
0805 0972 3033 DCA ADD2
0806 0973 7041 CIA
0807 0974 4441 JMS 1 ADDER
0808 0975 3034 DCA TEMP
0809 0976 1424 TAD 1 QI
0810 0977 3033 DCA ADD2
0811 0978 7041 CIA
0812 0979 4441 JMS 1 ADDER
0813 0980 3034 DCA TEMP
0814 0981 1424 TAD 1 QI
0815 0982 3033 DCA ADD2
0816 0983 7041 CIA
0817 0984 4441 JMS 1 ADDER
0818 0985 3034 DCA TEMP
0819 0986 1424 TAD 1 QI
0820 0987 3033 DCA ADD2
0821 0988 7041 CIA
0822 0989 4441 JMS 1 ADDER
0823 0990 3034 DCA TEMP
0824 0991 1424 TAD 1 QI
0825 0992 3033 DCA ADD2
0826 0993 7041 CIA
0827 0994 4441 JMS 1 ADDER
0828 0995 3034 DCA TEMP
0829 0996 1424 TAD 1 QI
0830 0997 3033 DCA ADD2
0831 0998 7041 CIA
0832 0999 4441 JMS 1 ADDER
0833 0999 3034 DCA TEMP
0834 0999 1424 TAD 1 QI
0835 0999 3033 DCA ADD2
0836 0999 7041 CIA
0837 0999 4441 JMS 1 ADDER
0838 0999 3034 DCA TEMP
0839 0999 1424 TAD 1 QI
0840 0999 30
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04 52 TAD I QR           /GET REC[X(Q)] 
04 75 30 33 ADD2      /RE=REAL PART
04 76 14 25 PR
04 77 70 41 CIA
05 41 44 41 JMS I ADDER
05 22 34 25 DCA I PR
05 21 10 34 TAD TEMPR
05 02 34 23 DCA I QR
05 03 10 51 TAD XRLOC
05 04 70 41 CIA
05 05 25 TAD QR           /AC IS Q
05 06 10 23 SPA SNA CLA /IS Q>0? (IE THE WHOLE ARRAY HAS NOT BEEN COVERED)
05 07 77 50 JMP CHKPT   /NO, Q=0, DONE WITH FIRST ARRAY, MOVE ON TO OTHERS
05 10 53 10 PR
05 11 70 40 CMA
05 12 10 23 TAD QR           /YES, Q<=0-1, MOVE UP THIS ARRAY
05 13 30 23 DCA QR           /OR EQUIVALENTLY, QR<=QR-1
05 14 52 40 JMP LOOP1    /DO NEXT NODE PAIR
05 15 10 05 TAD L           /L GIVES THE NUMBER OF THE VERTICAL ARRAY JUST BUILT
05 16 70 41 CIA
05 17 10 04 TAD NU           /IS L=NU? (IE HAS THE LAST ARRAY BEEN COMPUTED?)
05 20 76 50 SNA CLA
05 21 56 00 JMP FFT        /YES, DONE, RESULTS STORED IN BIT REVERSED ORDER
05 22 10 55 TAD SHFCHK   /GET SCALE FACTOR AND ADJUST FOR PROPER
05 23 30 54 DCA SHFLAG    /ADDITION ON NEXT ITERATION
05 24 10 55 TAD SHFCHK
05 25 76 50 SNA CLA
05 26 20 53 ISZ SCAL
05 27 30 55 DCA SHFCHK
05 30 20 05 ISZ L           /L<=L+1, MOVE ON TO NEXT ARRAY
05 31 10 06 TAD S           /S GIVES SPACING BETWEEN NODE PAIRS, WHICH IS N/2*L
05 32 71 10 CLL RAR        /DIVIDE BY 2 AND PUT BACK, SO THAT ON THE LTH PASS THROUGH
05 33 30 06 DCA S           /S WILL=N/2*L, THE SPACING,
05 34 20 07 ISZ F           /F<=F+1, ON LTH PASS, F WILL BE F=L-NU, THE SCALE FACTOR FOR K.
05 35 70 00 NOP
05 36 70 40 CMA
05 37 10 03 TAD N           /NOP FOR WHEN F=-1 TO PREVENT ERROR DUE TO SKIP
05 38 20 53 TAD XRLOC
05 39 30 55 PR           /P<=N-1, PR POINTS TO REC[X(P=N-1)]
05 40 10 51 DCA IAC
05 41 30 25 DCA C           /C<=1, C BREAKS BUILD LOOP EVERY S ITERATIONS
05 42 04 40 SETC, DCA PR           /SO AS TO AVOID RECOMPUTATION
05 43 72 01 BUILD, TAD XLDCDF
05 44 30 32 DCA PI           /PR=XRLOC+P
05 45 10 25 TAD
05 46 10 52 DCA
05 47 30 26 TAD
05 48 10 51 CIA
05 49 70 41 TAD
05 50 04 11 CIA
05 51 10 25 TAD
05 52 30 30 DCA P           /ACTUAL INDEX IS P:(0,1,...,N-1)
05 53 10 07 TAD F           /BUILD ARRAY, F=L-NU, SHIFT "P"-F PLACES RIGHT (#NU-L)
05 54 74 50 SNA
05 55 53 64 JMP NOROT
05 56 70 40 CMA
05 57 33 62 DCA SHIFT
05 58 10 30 TAD P           /GET NODE INDEX
05 59 74 17 LSR
05 60 04 21 TAD /SHIFT P RIGHT SHIFTCT+1=-F-1+1=-F=NU-L PLACES
05 61 74 17 SHIFCT, HL T /STORAGE FOR SHIFT COUNT
05 62 74 02 NOROT, TAD /ACK=INTEGER PART [P*2+F]
05 63 10 30 SKP /NO ROTATION, JUST GET P=P*2+F
05 64 74 17 TAD /INVERT BIT ORDER AND PUT IN K (NUMBER IN PTH NODE)
05 65 44 43 MN0VR2 /SUBTRACT N/2 TO GET NUMBER IN Q (=K) (PS NODE PAIR.)
05 66 10 22 JMS I GETRIG
05 67 44 45 CMA
05 68 04 20 DCA /SET CIA FOR DOING FFT, NOT FOR FFT
05 69 70 00 ADJSGN, NOP /SIN((K/N))=IMCW+KJ, COS IN REGISTER COSINE
05 70 30 35 DCA
05 71 14 25 TAD I /FORM ((W*K)*X(P))=A COMPLEX MULTIPLICATION

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0434      JMS I      MULT          /DO THE FIRST RE[X(P)]*COSINE+IM[X(P)]*SINE
0573      4444      COSINE        /AC= (P)*COSINE=RE[X(P)]*RE[W^K]
0574      0036      DCA ADD2       /SAVE FOR ADDITION LATER
0575      3033      TAD I         /GET IM[X(P)]
0435      0576      1426          /AC=IM[X(P)]*SINE=-IM[W^K]*IM[X(P)]
0436      0577      4444          /AC=RE[W^K]*RE[X(P)]-IM[W^K]*IM[X(P)]=RE[X(P)=W^K]
0437      0578      0035          /AC=IM[X(P)]*SINE=IM[W^K]*IM[X(P)]
0440      0600      0033          /AC=RE[W^K]*RE[X(P)]-IM[W^K]*IM[X(P)]=RE[X(P)=W^K]
0441      0601      1033          /AC=IM[X(P)]*SINE=-IM[W^K]*IM[X(P)]
0442      0602      3037          /AC=RE[W^K]*RE[X(P)]-IM[W^K]*IM[X(P)]=RE[X(P)=W^K]
0443      0603      1426          /DO IMAG, PART NEXT=IM[X(P)]*COSINE=IM[X(P)]*RE[W^K]
0444      0604      4444          /AC=IM[X(P)]*COSINE=IM[X(P)]*RE[W^K]
0445      0605      0036          /AC=IM[X(P)]*COSINE=IM[X(P)]*RE[W^K]
0446      0606      3033          /AC=RE[X(P)]*COSINE=IM[X(P)]*RE[W^K]
0450      0607      1425          /AC=RE[X(P)]*COSINE=IM[X(P)]*RE[W^K]
0451      0610      4444          /AC=RE[X(P)]*COSINE=IM[X(P)]*RE[W^K]
0452      0611      0035          /AC=RE[X(P)]*COSINE=IM[X(P)]*RE[W^K]
0453      0612      7041          /AC=RE[X(P)]*IM[W^K]
0454      0613      1033          /AC=IM[X(P)]*RE[W^K]+RE[X(P)]*IM[X(P)*W^K]
0455      0614      3040          /STORE AT GI, SO GI=IM[X(P)*W^K] AND GR=RE[X(P)*W^K] G=GR+I*GI
0456      0615      1006          /LOCATE P NODE PAIR Q, LOCATED S=N/(2*L) UP ARRAY
0457      0616      0035          /S0 SET Q=P-S INDEX OF NODE PAIR
0460      0617      1025          /LOCATE X(Q) IN MEMORY BY FIXING POINTERS QR AND QI
0461      0618      3023          /TO QS REAL AND IMAG PARTS RESPECTIVELY
0462      0620      3023          /AC=RE[X(P)]*IM[W^K]
0463      0621      1023          /AC=RE[X(P)]*IM[W^K]
0464      0622      1052          /AC=RE[X(P)]*IM[W^K]
0465      0623      3024          /AC=RE[X(P)]*IM[W^K]
0466      0624      1423          /FIRST DO REAL PART OF X(P), GET RE[X(Q)] AND STORE
0467      0625      3033          /GET RE[G]
0470      0626      1037          /DO THE COMPLEX OPERATIONS! X(P)<=X(Q)-G/X(Q)<=X(Q)+G
0471      0627      7041          /SUBTRACT THEM,
0472      0630      4444          /RE[X(P)]<=RE[X(Q)]-RE[G]
0473      0631      3425          /COMPUTE IMAG, PART OF X(P), GET IM[X(Q)]
0474      0632      1424          /AND STORE
0475      0633      3033          /GET RE[G]
0476      0634      1040          /GET IMEG
0477      0635      7041          /AND SUBTRACT THEM,
0500      0636      4444          /IM[X(P)]<=IM[X(Q)]-IM[G], X(P) IS NOW DONE.
0501      0637      3426          /NEXT COMPUTE X(Q), FIRST REAL PART
0502      0640      1423          /GET RE[G] AND STORE
0503      0641      3033          /GET RE[G] AND STORE
0504      0642      1037          /GET RE[G] AND ADD TO FORM
0505      0643      4444          /RE[X(Q)]+RE[G].
0506      0644      3423          /NOW COMPUTE IMAG PART OF X(Q), GET IM[X(Q)]
0507      0645      1424          /IM[X(Q)]+IM[G]
0510      0646      3033          /IM[X(Q)]+IM[G]
0511      0647      1040          /MOVE UP ARRAY TO NEXT NODE, SET AC=-1
0512      0648      4444          /TO FORM -1
0513      0651      3424          /P<=P-1
0514      0652      7040          /P
0515      0653      1030          /DCA
0516      0654      3030          /CMA
0517      0655      7040          /PR
0520      0656      1025          /DO THE SAME FOR POINTER PR
0521      0657      3025          /CHECK ON SPACING, IS A NODE WHICH HAS ALREADY BEEN COMPUTED
0522      0660      1032          /ABOUT TO BE RE-DONE, OR EQUIVALLY.
0523      0661      7041          /IS C=S?
0524      0662      1006          /YES.
0525      0663      7640          /NO, DO NEXT NODE PAIR
0526      0664      5277          /YES, BUT ARE WE AT THE TOP OF THE ARRAY?
0527      0665      1030          /OR, IS S=P+1? (P COMPLEMENTED=-P-1--(P+1)
0530      0666      7040          /AC=RE[X(P)]*IM[W^K]

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0533      0671    RECHK   JMP I
0534      1026    TAD     S
0535      0673    CIA     PR
0536      0674    1025    TAD     PR
0537      0675    3025    DCA     PR
0540      0676    5465    C      RESETC
0541      0677    2032    CNOTS,
0542      0700    5464    SORT X,   C      ISZ
0543      0701    0000    0      RBUILD
0544      0702    7040    CMA     PR
0545      0703    1003    TAD     /REINITIALIZE C TO 1 SINCE AN UNUSED AREA HAS BEEN ENTERED.
0546      0704    3027    REVERS,  /C <= C+1, ANOTHER NODE PAIR HAS BEEN HANDLED.
0547      0705    2705    TAD     /DO NEXT NODE PAIR IN THIS AREA.
0550      0706    4443    JMS     /SUBROUTINE THAT
0551      0707    3030    INVERT  /SORTS OUT TRANSFORMS BY
0552      0710    1030    DCA     /BIT INVERSION OF ADDRESSES,
0553      0711    7041    CIA     /Q <= N-1, START FROM BOTTOM OF BUFFER
0554      0712    1027    TAD     /P <= BIT INVERTED Q
0555      0713    7750    SPA     /BIT INVERSION ROUTINE
0556      0714    5345    SWAPD  /FORM Q-P
0557      0715    1030    TAD     /IS P<Q?
0560      0716    1051    TAD     /NO, HAVE ALREADY DONE THIS PAIR
0561      0717    3025    DCA     /YES, SWAP ORDER
0562      0720    1051    TAD     /FIRST SET UP SUBSCRIPT POINTERS FOR X(P) AND X(Q),
0563      0721    3023    DCA     /FOR Q=P
0564      0722    3023    TAD     /EXCHANGE: X(P)<=X(Q) AND X(Q)<=X(P)
0565      0723    1025    DCA     /EXCHANGE REAL PARTS, GET RECX(P)
0566      0724    1052    TAD     /STORE IT.
0567      0725    3026    DCA     /GET RECX(Q)
0570      0726    1023    TAD     /MAKE IT RECX(Q)
0571      0727    1052    TAD     /EXCHANGE IMAGINARY PARTS, GET IMCX(P)
0572      0730    3024    DCA     /STORE IT.
0573      0731    1425    TAD     /GET IMCX(Q)
0574      0732    3034    DCA     /MAKE IT RECX(P)
0575      0733    1423    TAD     /GET RECX(Q)
0576      0734    3425    DCA     /MOVE IT RECX(P)
0577      0735    1034    TAD     /GET RECX(P)
0600      0736    3423    DCA     /MAKE IT RECX(Q)
0601      0737    1426    TAD     /EXCHANGE IMAGINARY PARTS, GET IMCX(P)
0602      0740    3034    DCA     /STORE IT.
0603      0741    1424    TAD     /GET IMCX(Q)
0604      0742    3426    DCA     /MAKE IT IMCX(P)
0605      0743    1034    TAD     /GET IMCX(P)
0606      0744    3424    DCA     /MAKE IT IMCX(Q)
0607      0745    1027    SWAPD,  /IS Q=0?, IE; ARE WE AT THE TOP OF THE ARRAY
0610      0746    7640    TAD     /NO, Q<=Q-1, IE; MOVE UP THE ARRAY
0611      0747    5352    SZA     /YES, DONE EXIT
0612      0750    6201    CDF0   /GO BACK AND CONTINUE
0613      0751    5701    SORTX
0614      0752    7040    CMA
0615      0753    1027    TAD
0616      0754    3027    DCA     EJECT
0617      0755    5305    Q      REVERS
0620      -       -       -

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*1000
/SIGNED S.P. MULTIPLY, USING THE EAE
/ENTRY: AC=MULTIPLIER, C(CALL+1)=ADDR OF MULTICAND, EXIT*AC=PRODUCT,
/AN 11 BIT SIGNED BINARY FRAC
MULTIP, 0
/AC=ARG1 (MULTIPLIER)
/ARG1>0?
CLL
SPA
CML IAC
/MQ
/LOAD INTO MQ
NO-MAKE POS-SET L=1 TO SHOW IT WAS NEG
/NO, MAKE POSITIVE, CHANGE LINK, SINCE -1+1=1 AND -1+1=-1
/STORE
/AND RETRIEVE MULTPLICAND ITSELF,
((FOR EXIT AT CALL+2))

/ARG2>0?
/GET ADDR OF MULTPLICAND
/PUT AWAY AT ARG2
/NO, MAKE POSITIVE, CHANGE LINK, SINCE -1+1=1 AND -1+1=-1
/DO MULTIPLICATION
/ARGUMENT 2 (MULTPLICAND)
/NORMALIZE BINARY POINT,
/SAVE HIGH ORDER, NOW ROUND OFF,
/SET AC11=MQ0, AC0-10=0
/NO, NEGATE
/POSITIVE SIGN?
/NO, NEGATE
/EXIT, SIGNED RESULT IN AC,
/NU CONTAINS THE NAME OF BITS IN THE WORD
INVRT, 0
/GET WORD TO BE INVERTED
/ZERO OBJECT REGISTER
/GET NUMBER OF BITS TO BE
/INVERTED AND USE TO LIMIT THE
/EXTENT OF LOOP
/PULL OUT RIGHTMOST BIT OF WORD
/PUT BACK SO A NEW BIT IS OPERATED ON EACH TIME)
/AND PUSH INTO WORDP FROM LEFT
WORDP
FLIPCT
/RT MOST BIT NOW IN AC
WORD
WORDP
RAL
DCA
WORDP
TAD
WORDP
TAD
WORDP
ISZ
FLIPCT
/NO, DO NEXT BIT
/YES, PICK UP RESULT
/AND EXIT
EJECT

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0713 /THIS SUBROUTINE FETCHES THE VALUES OF SIN(2*PI*C(AC)/N)
0714 /AND OF COS(2*PI*C(AC)/N) FOR C(AC) < N/2+1
0715 /ENTRY: AC=INDEX OF LOOP UP
0716 /EXIT : COS(2*PI*C(AC)/N) STORED AT "COSINE" AND
0717 / AC=VALUE OF SIN(2*PI*C(AC)/N),
0720 TRIGET, 0
0721 1060 CDF0
0722 1061 DCA K /STORE C(AC) AT K.
0723 1062 MQL /CLEAR MQ
0724 1063 TAD /FORM N/4-K,
0725 1064 1031 CIA
0726 1065 7141 NOVER4
0727 1066 10220 NO4MIK
0728 1067 3333 DCA
0729 1070 7432 SZL /IS N/4-K<0?
0730 1071 5310 JMP QUAD1 /NO, FIRST QUADRANT ANGLE.
0731 1072 1333 TAD /2ND QUADRANT, GET -COS AT K-N/4.
0732 1073 7041 CIA
0733 1074 7417 LSR /MAKE CORRECTIVE RIGHT SHIFT ON INDEX.
0734 1075 0000 SHL /FIND ON SINE TABLE FOR 2*MAXNU BY MULTIPLYING
0735 1076 7413 INDEX BY 2*(MAXNU-NU), WHICH IS STORED HERE.
0736 1077 74022 TAD /LOCATE IT IN MEMORY.
0737 1100 10500 CIA
0738 1101 3334 SINLOC /2ND QUADRANT COS IS NEGATIVE.
0739 1102 1734 INDEX
0740 1103 7041 CIA
0741 1104 3036 DCA COSINE
0742 1105 13333 TAD NO4MIK
0743 1106 10200 TAD NOVER4
0744 1107 5322 SINRET
0745 1110 13333 TAD NO4MIK
0746 1111 7417 LSR /GET SIN AT N/2-K
0747 1112 00000 0 /GET COS AT N/4-K,
0748 1113 7413 SHL
0749 1114 74022 HLT /GET SIN AT K.
0750 1115 10500 TAD SINLOC
0751 1116 5334 INDEX
0752 1117 1734 TAD I INDEX
0753 1118 5036 DCA COSINE
0754 1119 74022 SINRET, TAD K
0755 1115 10500 TAD SINLOC
0756 1116 5334 INDEX
0757 1117 1734 TAD I INDEX
0758 1118 5036 DCA COSINE
0759 1119 1031 TAD K
0760 1120 10500 TAD SINLOC
0761 1121 5036 INDEX
0762 1122 7417 SINRET, TAD I
0763 1123 00000 0 /STORAGE FOR N/4-K
0764 1124 7413 SHL /POINTER TO SINE TABLE
0765 1125 74022 SHFT3, HLT /THIS ROUTINE PERFORMS A SINGLE PRECISION ADD WITH ROUNDING EACH ARGUMENT IS
0766 1126 10500 TAD /SHIFTED RIGHT ONCE TO PREVENT OVERFLOW OF BINARY POINT (IF NECESSARY)
0767 1127 3334 DCA /AND THEN CHECKED TO SEE IF IT CAN BE NORMALIZED AFTER ADDITION
0768 1128 1734 TAD I
0769 1129 6211 CDF1 /ENTRY: AC=ADDEND,C(ADD2)=AUGEND
0770 1130 1734 TAD /AC=RESULT, DIVIDED BY TWO IF NECESSARY.
0771 1131 6211 CDF1
0772 1132 5660 JMP I TRIGET
0773 1133 00000 NO4MIK, 0 /SHOULD ADD BE DONE WITH SHIFT?
0774 1134 0000 INDEX, 0 /THIS ROUTINE ADDS WITH OUT SHIFT
0775 1135 3334 ADD1 /NO, ~ ADD WITH OUT SHIFT
0776 1136 7417 SNA CLA /YES, ^ ADDEND
0777 1137 1054 JNP ADDWOS /DO ^ SIGNED RIGHT SHIFT
0778 1138 7650 TAD ASR
0779 1139 5357 ADD1
0780 1140 1334 TAD
0781 1141 1337 JNP ADD1
0782 1142 1337 TAD
0783 1143 7415 ASR
0784 1144 1334 ADD1
0785 1145 7415 SNA CLA
0786 1146 1337 JNP ADD1
0787 1147 1337 TAD
0788 1148 1337 ASR
0789 1149 1337 ADD1
0790 1150 1337 SNA CLA
0791 1151 1337 JNP ADD1
0792 1152 1337 TAD
0793 1153 1337 ASR
0794 1154 1337 ADD1
0795 1155 1337 SNA CLA
0796 1156 1337 JNP ADD1
0797 1157 1337 TAD
0798 1158 1337 ASR
0799 1159 1337 ADD1
0800 1160 1337 SNA CLA
0801 1161 1337 JNP ADD1
0802 1162 1337 TAD
0803 1163 1337 ASR
0804 1164 1337 ADD1
0805 1165 1337 SNA CLA
0806 1166 1337 JNP ADD1
0807 1167 1337 TAD
0808 1168 1337 ASR
0809 1169 1337 ADD1
0810 1170 1337 SNA CLA
0811 1171 1337 JNP ADD1
0812 1172 1337 TAD
0813 1173 1337 ASR
0814 1174 1337 ADD1
0815 1175 1337 SNA CLA
0816 1176 1337 JNP ADD1
0817 1177 1337 TAD
0818 1178 1337 ASR
0819 1179 1337 ADD1
0820 1180 1337 SNA CLA
0821 1181 1337 JNP ADD1
0822 1182 1337 TAD
0823 1183 1337 ASR
0824 1184 1337 ADD1
0825 1185 1337 SNA CLA
0826 1186 1337 JNP ADD1
0827 1187 1337 TAD
0828 1188 1337 ASR
0829 1189 1337 ADD1
0830 1190 1337 SNA CLA
0831 1191 1337 JNP ADD1
0832 1192 1337 TAD
0833 1193 1337 ASR
0834 1194 1337 ADD1
0835 1195 1337 SNA CLA
0836 1196 1337 JNP ADD1
0837 1197 1337 TAD
0838 1198 1337 ASR
0839 1199 1337 ADD1
0840 1200 1337 SNA CLA
0841 1201 1337 JNP ADD1
0842 1202 1337 TAD
0843 1203 1337 ASR
0844 1204 1337 ADD1
0845 1205 1337 SNA CLA
0846 1206 1337 JNP ADD1
0847 1207 1337 TAD
0848 1208 1337 ASR
0849 1209 1337 ADD1
0850 1210 1337 SNA CLA
0851 1211 1337 JNP ADD1
0852 1212 1337 TAD
0853 1213 1337 ASR
0854 1214 1337 ADD1
0855 1215 1337 SNA CLA
0856 1216 1337 JNP ADD1
0857 1217 1337 TAD
0858 1218 1337 ASR
0859 1219 1337 ADD1
0860 1220 1337 SNA CLA
0861 1221 1337 JNP ADD1
0862 1222 1337 TAD
0863 1223 1337 ASR
0864 1224 1337 ADD1
0865 1225 1337 SNA CLA
0866 1226 1337 JNP ADD1
0867 1227 1337 TAD
0868 1228 1337 ASR
0869 1229 1337 ADD1
0870 1230 1337 SNA CLA
0871 1231 1337 JNP ADD1
0872 1232 1337 TAD
0873 1233 1337 ASR
0874 1234 1337 ADD1
0875 1235 1337 SNA CLA
0876 1236 1337 JNP ADD1
0877 1237 1337 TAD
0878 1238 1337 ASR
0879 1239 1337 ADD1
0880 1240 1337 SNA CLA
0881 1241 1337 JNP ADD1
0882 1242 1337 TAD
0883 1243 1337 ASR
0884 1244 1337 ADD1
0885 1245 1337 SNA CLA
0886 1246 1337 JNP ADD1
0887 1247 1337 TAD
0888 1248 1337 ASR
0889 1249 1337 ADD1
0890 1250 1337 SNA CLA
0891 1251 1337 JNP ADD1
0892 1252 1337 TAD
0893 1253 1337 ASR
0894 1254 1337 ADD1
0895 1255 1337 SNA CLA
0896 1256 1337 JNP ADD1
0897 1257 1337 TAD
0898 1258 1337 ASR
0899 1259 1337 ADD1
0900 1260 1337 SNA CLA
0901 1261 1337 JNP ADD1
0902 1262 1337 TAD
0903 1263 1337 ASR
0904 1264 1337 ADD1
0905 1265 1337 SNA CLA
0906 1266 1337 JNP ADD1
0907 1267 1337 TAD
0908 1268 1337 ASR
0909 1269 1337 ADD1
0910 1270 1337 SNA CLA
0911 1271 1337 JNP ADD1
0912 1272 1337 TAD
0913 1273 1337 ASR
0914 1274 1337 ADD1
0915 1275 1337 SNA CLA
0916 1276 1337 JNP ADD1
0917 1277 1337 TAD
0918 1278 1337 ASR
0919 1279 1337 ADD1
0920 1280 1337 SNA CLA
0921 1281 1337 JNP ADD1
0922 1282 1337 TAD
0923 1283 1337 ASR
0924 1284 1337 ADD1
0925 1285 1337 SNA CLA
0926 1286 1337 JNP ADD1
0927 1287 1337 TAD
0928 1288 1337 ASR
0929 1289 1337 ADD1
0930 1290 1337 SNA CLA
0931 1291 1337 JNP ADD1
0932 1292 1337 TAD
0933 1293 1337 ASR
0934 1294 1337 ADD1
0935 1295 1337 SNA CLA
0936 1296 1337 JNP ADD1
0937 1297 1337 TAD
0938 1298 1337 ASR
0939 1299 1337 ADD1
0940 1300 1337 SNA CLA
0941 1301 1337 JNP ADD1
0942 1302 1337 TAD
0943 1303 1337 ASR
0944 1304 1337 ADD1
0945 1305 1337 SNA CLA
0946 1306 1337 JNP ADD1
0947 1307 1337 TAD
0948 1308 1337 ASR
0949 1309 1337 ADD1
0950 1310 1337 SNA CLA
0951 1311 1337 JNP ADD1
0952 1312 1337 TAD
0953 1313 1337 ASR
0954 1314 1337 ADD1
0955 1315 1337 SNA CLA
0956 1316 1337 JNP ADD1
0957 1317 1337 TAD
0958 1318 1337 ASR
0959 1319 1337 ADD1
0960 1320 1337 SNA CLA
0961 1321 1337 JNP ADD1
0962 1322 1337 TAD
0963 1323 1337 ASR
0964 1324 1337 ADD1
0965 1325 1337 SNA CLA
0966 1326 1337 JNP ADD1
0967 1327 1337 TAD
0968 1328 1337 ASR
0969 1329 1337 ADD1
0970 1330 1337 SNA CLA
0971 1331 1337 JNP ADD1
0972 1332 1337 TAD
0973 1333 1337 ASR
0974 1334 1337 ADD1
0975 1335 1337 SNA CLA
0976 1336 1337 JNP ADD1
0977 1337 1337 TAD
0978 1338 1337 ASR
0979 1339 1337 ADD1
0980 1340 1337 SNA CLA
0981 1341 1337 JNP ADD1
0982 1342 1337 TAD
0983 1343 1337 ASR
0984 1344 1337 ADD1
0985 1345 1337 SNA CLA
0986 1346 1337 JNP ADD1
0987 1347 1337 TAD
0988 1348 1337 ASR
0989 1349 1337 ADD1
0990 1350 1337 SNA CLA
0991 1351 1337 JNP ADD1
0992 1352 1337 TAD
0993 1353 1337 ASR
0994 1354 1337 ADD1
0995 1355 1337 SNA CLA
0996 1356 1337 JNP ADD1
0997 1357 1337 TAD
0998 1358 1337 ASR
0999 1359 1337 ADD1
1000 1360 1337 SNA CLA

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1012    1145    3374    DCA      ADD1
1013    1146    1033    TAD      ADD2
1014    1147    7415    ASR      0
1015    1150    0020    DCA      ADD2
1016    1151    3033    MQA      RAL
1017    1152    7501    CMA      CML
1020    1153    7004    CML
1021    1154    7060
1022
1023    1155    7720    SMA      SNL   CLA
1024    1156    7001    IAC      ADD1
1025    1157    1374    ADDOS , TAD      ADD2
1026    1160    1033    TAD      ADD2
1027    1161    3375    DCA      XSUM
1030    1162    1375    TAD      XSUM
1031    1163    7510    SPA
1032    1164    7041    CIA
1033    1165    7004    RAL
1034    1166    7720    SMA      CLA
1035    1167    5372    JMP      NOTNOR
1036    1170    7001    IAC
1037    1171    3055    DCA      SHFCHK
1040    1172    1375    NO TN OR, TAD
1041    1173    5735    JMP      1      ADDR
1042    1174    0000    ADD1,
1043    1175    0000    0      XSUM,
1044

```

/IF BOTH WERE=1 (NEITHER=0), INTRODUCE A CARRY.

/DO THE ADDITION,

/STORE THE RESULT

/CHECK TO SEE IF ALREADY NORMALIZED,

/IS IT POSITIVE?

/MAKE IT POSITIVE,

/GET BIT 1, WAS NORMALIZED IF #1

/NOT NORMALIZED, LEAVE SHFCHK ALONE,

/SET SHFCHK#1

/ADDEND STORAGE

/TEMP STORAGE FOR SUM

EJECT

1245
1246 /DEFINITIONS FOR EAE
1247 DV1=7407
1248 NM1=7411
1249 SHL=7413
1250 ASR=7415
1251 LSR=7417
1252 MQL=7421
1253 MUY=7405
1254 MQA=7501
1255 CAM=7621
1256 SCA=7441
1257 SCL=7403
1258 /ASSEMBLY PARAMETERS
1259 BIGNU=12 /LARGEST TRANSFORMATION HAS DIMENSION 2*10.
1260 EJECT
1261 -

/MOVING WINDOW DISPLAY SUBROUTINE

```

1065 PMODE PAGE
1066 1240 0000 IDORA, 0 /GET BOUNDS
1067 1231 7300 CLA CLL
1068 1232 6201 CDF@, CDF @
1069 1233 1600 TAD I IDORA /DATA BUFFER
1070 1234 3635 DCA I KMNFLD /15 BIT
1071 1235 2200 ISZ IDORA /LOWER BOUND
1072 1236 1600 TAD I IDORA /AT P+1, P+2
1073 1237 3636 DCA I KMNA DR /MINFLD, MINADR
1074 1238 2200 ISZ IDORA /UPPER BOUND
1075 1239 1600 TAD I IDORA /AT P+3, P+4
1076 1240 3637 DCA I KM XFLD
1077 1241 2200 ISZ IDORA
1078 1242 7001 IAC /RDORA USES
1079 1243 1600 TAD I IDORA /MAX+1
1080 1244 3640 DCA I KM XADR
1081 1245 7004 RAL
1082 1246 1637 TAD I KM XFLD
1083 1247 3637 DCA I KM XFLD
1084 1248 2200 ISZ IDORA
1085 1249 1600 TAD I IDORA /Y SHIFT
1086 1250 1221 2200 ISZ IDORA
1087 1251 1222 2200 ISZ IDORA
1088 1252 1223 2200 ISZ IDORA
1089 1253 1224 2200 ISZ IDORA
1090 1254 1225 2200 ISZ IDORA
1091 1255 1226 2200 ISZ IDORA /Y SCALE
1092 1256 1227 3536 DCA I KYSCAL
1093 1257 1228 3536 TAD I KMNFLD /INITIALIZE
1094 1258 1229 3536 DCA I KBUFFI /WINDOW
1095 1259 1230 3536 TAD I KMNA DR /STARTING ADDR
1096 1260 1231 3536 DCA I KBUFFL /RTN TO SCR N
1097 1261 1232 3536 JMP I IDORA /RTN TO SCR N
1098 1262 1233 3536 MINFLD,
1099 1263 1234 3536 KMNFLD, MINADR
1100 1264 1235 3536 KMNA DR, MINADR
1101 1265 1236 3536 KMNFLD, MAXFLD
1102 1266 1237 3536 KMNA DR, MAXADR
1103 1267 1238 3536 KBUFFL, BUFFH
1104 1268 1239 3536 KBUFFL, BUFFL
1105 1269 1240 3536 P401, 401
1106 1270 1241 3536 DSCLOC, TAD P401, /DSC X,Y COORD
1107 1271 1242 3536 DCA VCOORD /FIELD
1108 1272 1243 3536 TAD XCURLO /ADDRESS
1109 1273 1244 3536 JMS DSCWD /FIELD
1110 1274 1245 3536 TAD XCURHI /CONTENTS OF
1111 1275 1246 3536 JMS DSCWD /CURSR CORE LOC
1112 1276 1247 3536 TAD CORVAL /CURSOR POINT
1113 1277 1248 3536 JMS DSCWD /Y COORD OF
1114 1278 1249 3536 TAD YCUR /RESTORE USER
1115 1279 1250 3536 TAD P401 /DATA FLD
1116 1280 1251 3536 JMS DSCWD /RTN
1117 1281 1252 3536 DSCWD, 0 /DSC C(AC)
1118 1282 1253 3536 LINC /SAVE VALUE
1119 1283 1254 3536 LMODE /CHAN 1
1120 1284 1255 3536 STC TEMP /VC FOR FULL
1121 1285 1256 3536 SFA /SIZE IS -40
1122 1286 1257 3536 ROL 1 5 /-20 FOR HALF
1123 1287 1258 3536 LDA 1 /-20 FOR HALF
1124 1288 1259 3536
1125 1289 1260 3536
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1614 174
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    VCOORD,      ADM 1
    /UPDATE VC

    DSCLOP,      0
    LDA 1
    TEMP,       2
    ROL 3
    STA 1
    TEMP
    BCLL 1
    7770
    ROL 1
    ADA 1
    TAB&1777
    STC 2
    ADD VCOORD
    DSC 2
    DSC 1 2
    XSK 1 1
    XSK 1 1
    SRO 1
    3567
    JMP DSCLOP
    PDP
    PMODE
    CLA CLL
    JMP I DSCWD
    /RTN
    4536 /60,0
    3651
    2101 /61,1
    0177
    4523 /62,2
    2151
    4122 /63,3
    2651
    2651
    2414 /64,4
    0477
    5172 /65,5
    0651
    1506 /66,6
    4225
    4225
    4443 /67,7
    6050
    CLA CLL
    RDF
    TAD ACDF0
    DCA RTNCDF
    LINC
    LMODE
    CURSAM
    SCR 1
    PDP
    PMODE
    TAD P401
    CIA CLL
    LINC
    LMODE
    STC CURCNT&1777
    WNSAM, WNSAM
    MOVDIS, 0
    SET I XCORD
    LEFTXn
    JMP CONT&1777
    /WINDOW
    /SCR 4 OR CLR
    /LEFT COORD
    ISPLAY

```

1263	0105	FREESAM	SCR 1
1264	0341	SCR 1	PDP
1265	0202	P MODE	DCA YCUR
1266		TAD YCUR	LINC
1267	1370	5115	6000
1268	1371	1115	PAGE
1269	1372	6141	/JMP 0
1270	1373	6000	
1271			
1272			
1273	1400	0002	CONT,
1274	1401	6201	CCDF 0,
1275	1402	3547	CDF 0
1276	1403	3547	/PUT KNOB VAL
1277	1404	1347	/IN DAC
1300	1404	7710	/PROPAGATE SIGN
1301	1405	7040	/BIT HI ORD
1302	1406	3541	DCA DBLHI
1303	1407	4304	JMS DADD
1304	1410	1347	TAD DBLLO
1305	1411	3575	DCA BUFLO
1306	1412	1541	TAD DBLHI
1307	1413	3374	DCA BUFHI
1310			/MUST CHK
1311			/WINDOW SA
1312			/WITH BOUNDS
1313			/TO MAINTAIN
1314			/BUFFER RING
1315	1414	4316	JMS BOUND
1316	1415	0001	MINFLD, 1
1317	1416	0000	MINADR, 0
1320	1417	7700	SMA CLA
1321	1420	5273	JMP CHKHI
1322	1420	5273	TAD MAXFLD
1323	1421	1274	DCA BUFHI
1324	1422	3374	TAD MAXADR
1325	1423	1275	DCA BUFLO
1326	1424	3375	JMS DADD
1327	1425	4304	TAD DBLLO
1330	1426	1347	DCA BUFLO
1331	1427	3375	DCA BUFLO
1332	1430	1341	TAD DBLHI
1333	1431	3374	DCA BUFHI
1334	1432	1375	TAD BUFLD
1335	1433	3304	JMS SETDISPLAY
1336	1434	1131	DCA BUFPTR
1337	1435	3116	TAD MINPTS
1340	1436	1374	DCA COUNT
1341	1437	3316	TAD BUFHI
1342	1440	4341	DCA BOUND
1343	1441	1704	JMS SETDF
1344	1442	1111	TAD I BUFPTR
1345	1443	6141	TAD YSHFT
1346			LINC
1347	1444	0341	LMODE
1350	1445	0161	SCAL, SCR 1
1351	1446	0002	DIS 1 XCORD
1352			P MODE
1353	1447	2373	ISZ CURCNT
1354			/READY TO DIS
1355	1450	7610	/CURSOR ?
1356	1451	5351	/NO
1357	1452	2376	/CHK FOR HI
1358	1453	5262	/ENDL

1455 5263 JMP OKEND /RESET TO
 1456 1216 TAD MINADR /LOWER BOUND
 1363 1457 DCA BUPTR
 1364 1460 1215 TAD MINFLD
 1365 1461 3316 DCA BOUND
 1366 1462 5266 JMP NXTDF
 1367 1463 2304 OKEND, ISZ BUPTR /CHK FOR FIELD
 1370 1464 5267 JMP OKFLD /BOUNDARY
 1371 1465 2316 ISZ BOUND /ITS OK
 1372 1466 4341 NXTDF, JMS SETDF /SET NXT FLD
 1373 1467 2116 ISZ COUNT /512 PNTS ?
 1374 1468 OKFLD, JMP NXTPNT /NO
 1375 1469 5241 JMP I .+1 /DSC READ OUT
 1376 1470 5672 DSCL OC /UPR BOUND
 1377 1471 1244 JMS BOUND /CHK UPR BOUND
 1402 1472 1244 MAXFLD, 2
 1401 1473 4316 CHKH1, JMS BOUND /CHK UPR BOUND
 1402 1474 0002 MAXFLD, 2
 1403 1475 0000 MA XADR, 0 SPA CLA /HI WRAP ?
 1404 1476 7710 M70, SPA CLA /HI WRAP ?
 1405 1477 5232 JMP SETFLD /YES
 1406 1500 1215 TAD MINFLD /RESET TO
 1407 1501 3374 DCA BUFHI /LOWER BOUND
 1410 1502 1216 TAD MINADR /WRAP
 1411 1503 5224 JMP WRAP /DOUBLE PRECISION ADD
 1412 /DBLHI,DBLLO)+(BUFHI,BUFLO)
 1413 /RESULT IN (DBLHI,DBLLO)
 1414 /BUFHI,BUFLO)=INITIAL SCOPE ADDRESS
 1415
 1416 1504 DADD, 0
 1417 1505 0000 DADD, 0
 1420 1506 7300 CLA CLL
 1421 1507 1347 TAD DBLLO
 1422 1508 1375 TAD BUFLO
 1423 1510 3347 DCA DBLLO
 1424 1511 7004 RAL
 1425 1512 1341 TAD DBLHI
 1426 1513 1374 TAD BUFHI
 1427 1514 3341 DCA DBLHI
 1430 1515 5704 JMP I DADD
 1431
 1432 /ADD -UPPER OR -LOWER BOUND
 1433 /TO (BUFHI,BUFLO)
 1434 /BOUND IS AT P+1,P+2 OF CALL
 1435
 1436 1516 0000 BOUND, 0 TAD I BOUND /2\$ COM OF ARG
 1437 1517 1716 NOP /TO DAC
 1440 1520 7140 CMA CLL /TO DAC
 1441 1521 3341 DCA DBLHI
 1442 1522 2316 ISZ BOUND
 1443 1523 1716 TAD I BOUND
 1444 1524 7041 CIA
 1445 1525 7430 SZL
 1446 1526 2341 ISZ DBLHI
 1447 1527 7000 M1000, NOP
 1450 1530 3347 DCA DBLLO /DAC HOLDS -NUM
 1451 1531 4304 JMS DADD /TO END OF BUF
 1452 1532 1341 TAD DBLHI /NO MATTER FOR
 1453 1533 3377 DCA ENDHI /LOW END WRA
 1454 1534 1347 TAD DBLLO /TO CHK FOR
 1455 1535 3376 DCA ENDLO /UPON RTN
 1456 1536 1341 TAD DBLHI
 1460 2316 ISZ BOUND

```

1461      5716    JMP 1 BOUND
1462      0000    SETDF,   0
1463      1316    TAD BOUND
1464      1243    CLL RTL
1465      1544    7004    RAL
1466      1545    1201    TAD CCDF0
1467      1546    3347    DCA .+1
1470      1547    0000    DBLL0,
1471      1550    5741    I SETDF
1472      1551    3115    CURDIS,  DCA YCUR
1473      1552    1316    TAD BOUND
1474      1553    3112    DCA XCURHI
1475      1554    1304    TAD BUFTR
1476      1555    3113    DCA XCURL0
1477      1556    1704    TAD I BUFTR
1500      1557    3114    DCA CORVAL
1501      1560    1276    TAD M70
1502      1561    3347    DCA DBLLO
1503      1562    1115    TAD YCUR
1504      1563    6141    CURLOP, LINC
1505      1564    24465   SNS I 5
1507      1565    7365    JMP FREE
1510      1566    0141    DIS XCORD
1511      1567    2002    POP
1512      1570    2347    PMODE
1514      1571    5363    ISZ DBLLO
1515      1572    5250    JMP CURLOP
1516      1573    0000    CURNT, 0
1517      1574    0001    JMP CURRTN
1520      1575    0000    DBLHI=SETDF
1521      1576    0000    BUFTR=DADD
1522      1577    0000    XCORD=1
1523      1577    0000    LMODE
1524      1577    0001    CURSAM=SAM 1
1525      1577    0001    WINSAM=SAM 0
1526      1577    0001    FRESAM=SAM 5
1527      1577    0001    SCALE=SCR SC12BU=SCR 3
1530      1577    0001    /CURSOR KNOB
1531      1577    0001    /WINDOW KNOB
1532      1577    0001    /FREE CURSOR
1533      1577    0001    /SCALE FACTOR
1534      1577    0001    /12 BIT UNSIGNED
1535      1577    0001    /Y OFFSET FOR
1536      1577    0001    /12 BIT UNSIGNED
1537      1577    0001    CHAIN "FFTC-2"

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*20

0037
2001

EJECT


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0114 0000 TEMP1, 0
0115 0456 SKP
0116 6064 JMP PTS
0117 0062 SET 1 2
0118 -13
0119 7764 SR0
0120 1500 ROTAT, TEMP1,
0121 1500 TEMP1, JMP i*3
0122 0114 SR0
0123 6126 /COUNT NO OF BITS SET
0124 1120 ADA i
0125 0001 1
0126 0222 XSK I 2
0127 6121 JMP ROTAT
0128 1120 ADA i
0129 7776 -1
0130 0017 COM
0131 0133 AZE
0132 00450 JMP PTS
0133 0134 4002 //>1-NOT POWER OF 2
0134 0135 STC 2
0135 1500 SRO
0136 0114 /CLEAR
0137 0114 /DETERMINE POWER OF 2
0138 0140 TEMP1,
0139 0456 SKP
0140 0141 6144 JMP STAMU
0141 0142 0222 XSK I 2
0142 0143 6136 JMP ROTAT
0143 0144 1000 LDA
0144 0145 0002 2
0145 0146 0640 LDF 0
0146 0147 1040 STA
0147 0150 2004 NU+20000
0148 0151 1120 ADA i
0149 0152 7776 -1
0150 0153 0451 APO
0151 0154 6064 JMP PTS
0152 0155 1000 /POWER<2 /COMPUTE NO OF OUTPUT BLKS
0153 0156 2003 N+2000 /NO OF PTS
0154 0157 0241 ROL 1 /*2
0155 0158 6503 JMP NUMBKS
0156 0159 1040 STA
0157 0160 1040 FDV+2007 /NO OF BLKS FOR REAL & IMAG
0158 0161 2404 STA
0159 0162 1040 RWPARM+2003
0160 0163 2410 LDH
0161 0164 1300 ANSWER+2003
0162 0165 3046 REALFG+2000
0163 0166 0167 1460 SAE 1
0164 0168 0170 0022 22
0165 0169 0171 6203 JMP IFCOM
0166 0172 1040 STA
0167 0173 2053 REALFG+2000
0168 0174 0640 LDF 0
0169 0175 1000 LOA
0170 0176 2003 N+2000 /COMPUTE INPUT BLKS
0171 0177 6503 JMP NUMBKS
0172 0178 0179 1040 STA
0173 0180 0202 RWPARM+2003
0174 0181 2410 JMP CKEND
0175 0182 6211 IFCOM, SAE 1
0176 0183 1460 3 JMP PTS /ERROR
0177 0184 0204 0003 CLR /COMPLEX-CLEAR FLAG
0178 0185 0205 STA /WILL INPUT RUN OFF END OF TAPE
0179 0186 0206 LDA
0180 0187 0207 1040
0181 0188 0208 2053
0182 0189 0209 CKEND
0183 0190 0210 1000
0184 0191 0211 2053

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02000 2407 RWPARM+20002
02001 0213 1100 ADA
02002 0214 2410 RWPARM+2003
02003 0215 1120 ADA I
02004 0216 6777 -1000
02005 0217 0471 APO I
02006 0220 6064 PTS /YES
02007 0221 0002 POP
02010 0222 PMODE
0211 4222 7200 CLA
0212 4223 1003 TAD N /ADD 1 BLK FOR SCALE FACTOR IF 400 WORDS OR MORE
0213 4224 7104 CLL RAL /NO OF OUTPUT WRDS = NO OF PTS*2
0214 4225 1107 TAD M400
0215 4226 7700 SMA CLA
0216 4227 2523 ISZ I PFDV7
0217 4230 6141 LINC
02200 0231 1020 LMODE
02211 0232 2625 LDA I /DO FFT OR JUST DISPLAY?
02222 0233 6720 QUES11+2000
0223 0234 1300 JMP ASK
0224 0235 7043 LDH
0225 0236 1460 ANSWER+6000
0226 0237 0004 SAE I
0227 0240 6244 STA I /NOT=0 JUST DISPLAY
0228 0241 1060 4
0229 0242 0000 DISFLG, /FIF
0230 0243 6251 CLR
0231 0244 1460 SAE I
0232 0245 0006 STC
0233 0246 6231 DISFLG /#=0 WILL DO TRANSFORM OR INVERSE
0234 0247 0011 LDH
0235 0248 4242 ANSWER+6001
0236 0249 0006 /ERROR
0237 0250 4242 CLR
0238 0251 1300 F1F,
0239 0252 7044 JMP IFFFFT
0240 0253 1460 SAE I
0241 0254 0024 24
0242 0255 6261 JMP IFI
0243 0256 0011 CLR
0244 0257 4356 STC IFFTFLG
0245 0258 0260 6265 JMF IDISP
0246 0259 0261 1460 SAE I
0247 0262 0011 11
0248 0263 6231 JMP IFFFFT
0249 0264 4356 STC IFFTFLG /DO IFFT
0250 0265 2242 IFDISP, ADD DISFLG
0251 0266 0470 AZE I
0252 0267 6273 OUTQES
0253 0268 0270 6466 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0254 0269 0271 0603 LIF 3 /JUST DISPLAY
0255 0272 0601 JMP DISPLAY
0256 0273 /GET OUTPUT INFO
0257 0274 OUTQES, LDA I
0258 0275 QUES5+2000
0259 0276 1300 OUTQES
0260 0277 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0261 0278 0603 LIF 3 /JUST DISPLAY
0262 0279 0601 JMP DISPLAY
0263 0280 /GET OUTPUT INFO
0264 0281 OUTQES, LDA I
0265 0282 2571 QUES5+2000
0266 0283 6720 JMP ASK
0267 0284 1300 OUTQES
0268 0285 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0269 0286 0603 LIF 3 /JUST DISPLAY
0270 0287 0601 JMP DISPLAY
0271 0288 0273 /GET OUTPUT INFO
0272 0289 0603 OUTQES
0273 0290 0601 QUES5+2000
0274 0291 6720 JMP ASK
0275 0292 1300 OUTQES
0276 0293 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0277 0294 0603 LIF 3 /JUST DISPLAY
0278 0295 0601 JMP DISPLAY
0279 0296 0273 /GET OUTPUT INFO
0280 0297 0603 OUTQES
0281 0298 0601 QUES5+2000
0282 0299 6720 JMP ASK
0283 0300 1300 OUTQES
0284 0301 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0285 0302 0603 LIF 3 /JUST DISPLAY
0286 0303 0601 JMP DISPLAY
0287 0304 0273 /GET OUTPUT INFO
0288 0305 0603 OUTQES
0289 0306 0601 QUES5+2000
0290 0307 6720 JMP ASK
0291 0308 1300 OUTQES
0292 0309 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0293 0310 0603 LIF 3 /JUST DISPLAY
0294 0311 0601 JMP DISPLAY
0295 0312 0273 /GET OUTPUT INFO
0296 0313 0603 OUTQES
0297 0314 0601 QUES5+2000
0298 0315 6720 JMP ASK
0299 0316 1300 OUTQES
0300 0317 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0301 0318 0603 LIF 3 /JUST DISPLAY
0302 0319 0601 JMP DISPLAY
0303 0320 0273 /GET OUTPUT INFO
0304 0321 0603 OUTQES
0305 0322 0601 QUES5+2000
0306 0323 6720 JMP ASK
0307 0324 1300 OUTQES
0308 0325 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0309 0326 0603 LIF 3 /JUST DISPLAY
0310 0327 0601 JMP DISPLAY
0311 0328 0273 /GET OUTPUT INFO
0312 0329 0603 OUTQES
0313 0330 0601 QUES5+2000
0314 0331 6720 JMP ASK
0315 0332 1300 OUTQES
0316 0333 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0317 0334 0603 LIF 3 /JUST DISPLAY
0318 0335 0601 JMP DISPLAY
0319 0336 0273 /GET OUTPUT INFO
0320 0337 0603 OUTQES
0321 0338 0601 QUES5+2000
0322 0339 6720 JMP ASK
0323 0340 1300 OUTQES
0324 0341 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0325 0342 0603 LIF 3 /JUST DISPLAY
0326 0343 0601 JMP DISPLAY
0327 0344 0273 /GET OUTPUT INFO
0328 0345 0603 OUTQES
0329 0346 0601 QUES5+2000
0330 0347 6720 JMP ASK
0331 0348 1300 OUTQES
0332 0349 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0333 0350 0603 LIF 3 /JUST DISPLAY
0334 0351 0601 JMP DISPLAY
0335 0352 0273 /GET OUTPUT INFO
0336 0353 0603 OUTQES
0337 0354 0601 QUES5+2000
0338 0355 6720 JMP ASK
0339 0356 1300 OUTQES
0340 0357 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0341 0358 0603 LIF 3 /JUST DISPLAY
0342 0359 0601 JMP DISPLAY
0343 0360 0273 /GET OUTPUT INFO
0344 0361 0603 OUTQES
0345 0362 0601 QUES5+2000
0346 0363 6720 JMP ASK
0347 0364 1300 OUTQES
0348 0365 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0349 0366 0603 LIF 3 /JUST DISPLAY
0350 0367 0601 JMP DISPLAY
0351 0368 0273 /GET OUTPUT INFO
0352 0369 0603 OUTQES
0353 0370 0601 QUES5+2000
0354 0371 6720 JMP ASK
0355 0372 1300 OUTQES
0356 0373 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0357 0374 0603 LIF 3 /JUST DISPLAY
0358 0375 0601 JMP DISPLAY
0359 0376 0273 /GET OUTPUT INFO
0360 0377 0603 OUTQES
0361 0378 0601 QUES5+2000
0362 0379 6720 JMP ASK
0363 0380 1300 OUTQES
0364 0381 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0365 0382 0603 LIF 3 /JUST DISPLAY
0366 0383 0601 JMP DISPLAY
0367 0384 0273 /GET OUTPUT INFO
0368 0385 0603 OUTQES
0369 0386 0601 QUES5+2000
0370 0387 6720 JMP ASK
0371 0388 1300 OUTQES
0372 0389 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0373 0390 0603 LIF 3 /JUST DISPLAY
0374 0391 0601 JMP DISPLAY
0375 0392 0273 /GET OUTPUT INFO
0376 0393 0603 OUTQES
0377 0394 0601 QUES5+2000
0378 0395 6720 JMP ASK
0379 0396 1300 OUTQES
0380 0397 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0381 0398 0603 LIF 3 /JUST DISPLAY
0382 0399 0601 JMP DISPLAY
0383 0400 0273 /GET OUTPUT INFO
0384 0401 0603 OUTQES
0385 0402 0601 QUES5+2000
0386 0403 6720 JMP ASK
0387 0404 1300 OUTQES
0388 0405 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0389 0406 0603 LIF 3 /JUST DISPLAY
0390 0407 0601 JMP DISPLAY
0391 0408 0273 /GET OUTPUT INFO
0392 0409 0603 OUTQES
0393 0410 0601 QUES5+2000
0394 0411 6720 JMP ASK
0395 0412 1300 OUTQES
0396 0413 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0397 0414 0603 LIF 3 /JUST DISPLAY
0398 0415 0601 JMP DISPLAY
0399 0416 0273 /GET OUTPUT INFO
0400 0417 0603 OUTQES
0401 0418 0601 QUES5+2000
0402 0419 6720 JMP ASK
0403 0420 1300 OUTQES
0404 0421 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0405 0422 0603 LIF 3 /JUST DISPLAY
0406 0423 0601 JMP DISPLAY
0407 0424 0273 /GET OUTPUT INFO
0408 0425 0603 OUTQES
0409 0426 0601 QUES5+2000
0410 0427 6720 JMP ASK
0411 0428 1300 OUTQES
0412 0429 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0413 0430 0603 LIF 3 /JUST DISPLAY
0414 0431 0601 JMP DISPLAY
0415 0432 0273 /GET OUTPUT INFO
0416 0433 0603 OUTQES
0417 0434 0601 QUES5+2000
0418 0435 6720 JMP ASK
0419 0436 1300 OUTQES
0420 0437 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0421 0438 0603 LIF 3 /JUST DISPLAY
0422 0439 0601 JMP DISPLAY
0423 0440 0273 /GET OUTPUT INFO
0424 0441 0603 OUTQES
0425 0442 0601 QUES5+2000
0426 0443 6720 JMP ASK
0427 0444 1300 OUTQES
0428 0445 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0429 0446 0603 LIF 3 /JUST DISPLAY
0430 0447 0601 JMP DISPLAY
0431 0448 0273 /GET OUTPUT INFO
0432 0449 0603 OUTQES
0433 0450 0601 QUES5+2000
0434 0451 6720 JMP ASK
0435 0452 1300 OUTQES
0436 0453 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0437 0454 0603 LIF 3 /JUST DISPLAY
0438 0455 0601 JMP DISPLAY
0439 0456 0273 /GET OUTPUT INFO
0440 0457 0603 OUTQES
0441 0458 0601 QUES5+2000
0442 0459 6720 JMP ASK
0443 0460 1300 OUTQES
0444 0461 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0445 0462 0603 LIF 3 /JUST DISPLAY
0446 0463 0601 JMP DISPLAY
0447 0464 0273 /GET OUTPUT INFO
0448 0465 0603 OUTQES
0449 0466 0601 QUES5+2000
0450 0467 6720 JMP ASK
0451 0468 1300 OUTQES
0452 0469 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0453 0470 0603 LIF 3 /JUST DISPLAY
0454 0471 0601 JMP DISPLAY
0455 0472 0273 /GET OUTPUT INFO
0456 0473 0603 OUTQES
0457 0474 0601 QUES5+2000
0458 0475 6720 JMP ASK
0459 0476 1300 OUTQES
0460 0477 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0461 0478 0603 LIF 3 /JUST DISPLAY
0462 0479 0601 JMP DISPLAY
0463 0480 0273 /GET OUTPUT INFO
0464 0481 0603 OUTQES
0465 0482 0601 QUES5+2000
0466 0483 6720 JMP ASK
0467 0484 1300 OUTQES
0468 0485 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0469 0486 0603 LIF 3 /JUST DISPLAY
0470 0487 0601 JMP DISPLAY
0471 0488 0273 /GET OUTPUT INFO
0472 0489 0603 OUTQES
0473 0490 0601 QUES5+2000
0474 0491 6720 JMP ASK
0475 0492 1300 OUTQES
0476 0493 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0477 0494 0603 LIF 3 /JUST DISPLAY
0478 0495 0601 JMP DISPLAY
0479 0496 0273 /GET OUTPUT INFO
0480 0497 0603 OUTQES
0481 0498 0601 QUES5+2000
0482 0499 6720 JMP ASK
0483 0500 1300 OUTQES
0484 0501 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0485 0502 0603 LIF 3 /JUST DISPLAY
0486 0503 0601 JMP DISPLAY
0487 0504 0273 /GET OUTPUT INFO
0488 0505 0603 OUTQES
0489 0506 0601 QUES5+2000
0490 0507 6720 JMP ASK
0491 0508 1300 OUTQES
0492 0509 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0493 0510 0603 LIF 3 /JUST DISPLAY
0494 0511 0601 JMP DISPLAY
0495 0512 0273 /GET OUTPUT INFO
0496 0513 0603 OUTQES
0497 0514 0601 QUES5+2000
0498 0515 6720 JMP ASK
0499 0516 1300 OUTQES
0500 0517 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0501 0518 0603 LIF 3 /JUST DISPLAY
0502 0519 0601 JMP DISPLAY
0503 0520 0273 /GET OUTPUT INFO
0504 0521 0603 OUTQES
0505 0522 0601 QUES5+2000
0506 0523 6720 JMP ASK
0507 0524 1300 OUTQES
0508 0525 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0509 0526 0603 LIF 3 /JUST DISPLAY
0510 0527 0601 JMP DISPLAY
0511 0528 0273 /GET OUTPUT INFO
0512 0529 0603 OUTQES
0513 0530 0601 QUES5+2000
0514 0531 6720 JMP ASK
0515 0532 1300 OUTQES
0516 0533 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0517 0534 0603 LIF 3 /JUST DISPLAY
0518 0535 0601 JMP DISPLAY
0519 0536 0273 /GET OUTPUT INFO
0520 0537 0603 OUTQES
0521 0538 0601 QUES5+2000
0522 0539 6720 JMP ASK
0523 0540 1300 OUTQES
0524 0541 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0525 0542 0603 LIF 3 /JUST DISPLAY
0526 0543 0601 JMP DISPLAY
0527 0544 0273 /GET OUTPUT INFO
0528 0545 0603 OUTQES
0529 0546 0601 QUES5+2000
0530 0547 6720 JMP ASK
0531 0548 1300 OUTQES
0532 0549 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0533 0550 0603 LIF 3 /JUST DISPLAY
0534 0551 0601 JMP DISPLAY
0535 0552 0273 /GET OUTPUT INFO
0536 0553 0603 OUTQES
0537 0554 0601 QUES5+2000
0538 0555 6720 JMP ASK
0539 0556 1300 OUTQES
0540 0557 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0541 0558 0603 LIF 3 /JUST DISPLAY
0542 0559 0601 JMP DISPLAY
0543 0560 0273 /GET OUTPUT INFO
0544 0561 0603 OUTQES
0545 0562 0601 QUES5+2000
0546 0563 6720 JMP ASK
0547 0564 1300 OUTQES
0548 0565 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0549 0566 0603 LIF 3 /JUST DISPLAY
0550 0567 0601 JMP DISPLAY
0551 0568 0273 /GET OUTPUT INFO
0552 0569 0603 OUTQES
0553 0570 0601 QUES5+2000
0554 0571 6720 JMP ASK
0555 0572 1300 OUTQES
0556 0573 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0557 0574 0603 LIF 3 /JUST DISPLAY
0558 0575 0601 JMP DISPLAY
0559 0576 0273 /GET OUTPUT INFO
0560 0577 0603 OUTQES
0561 0578 0601 QUES5+2000
0562 0579 6720 JMP ASK
0563 0580 1300 OUTQES
0564 0581 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0565 0582 0603 LIF 3 /JUST DISPLAY
0566 0583 0601 JMP DISPLAY
0567 0584 0273 /GET OUTPUT INFO
0568 0585 0603 OUTQES
0569 0586 0601 QUES5+2000
0570 0587 6720 JMP ASK
0571 0588 1300 OUTQES
0572 0589 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0573 0590 0603 LIF 3 /JUST DISPLAY
0574 0591 0601 JMP DISPLAY
0575 0592 0273 /GET OUTPUT INFO
0576 0593 0603 OUTQES
0577 0594 0601 QUES5+2000
0578 0595 6720 JMP ASK
0579 0596 1300 OUTQES
0580 0597 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0581 0598 0603 LIF 3 /JUST DISPLAY
0582 0599 0601 JMP DISPLAY
0583 0600 0273 /GET OUTPUT INFO
0584 0601 0603 OUTQES
0585 0602 0601 QUES5+2000
0586 0603 6720 JMP ASK
0587 0604 1300 OUTQES
0588 0605 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0589 0606 0603 LIF 3 /JUST DISPLAY
0590 0607 0601 JMP DISPLAY
0591 0608 0273 /GET OUTPUT INFO
0592 0609 0603 OUTQES
0593 0610 0601 QUES5+2000
0594 0611 6720 JMP ASK
0595 0612 1300 OUTQES
0596 0613 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0597 0614 0603 LIF 3 /JUST DISPLAY
0598 0615 0601 JMP DISPLAY
0599 0616 0273 /GET OUTPUT INFO
0600 0617 0603 OUTQES
0601 0618 0601 QUES5+2000
0602 0619 6720 JMP ASK
0603 0620 1300 OUTQES
0604 0621 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0605 0622 0603 LIF 3 /JUST DISPLAY
0606 0623 0601 JMP DISPLAY
0607 0624 0273 /GET OUTPUT INFO
0608 0625 0603 OUTQES
0609 0626 0601 QUES5+2000
0610 0627 6720 JMP ASK
0611 0628 1300 OUTQES
0612 0629 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0613 0630 0603 LIF 3 /JUST DISPLAY
0614 0631 0601 JMP DISPLAY
0615 0632 0273 /GET OUTPUT INFO
0616 0633 0603 OUTQES
0617 0634 0601 QUES5+2000
0618 0635 6720 JMP ASK
0619 0636 1300 OUTQES
0620 0637 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0621 0638 0603 LIF 3 /JUST DISPLAY
0622 0639 0601 JMP DISPLAY
0623 0640 0273 /GET OUTPUT INFO
0624 0641 0603 OUTQES
0625 0642 0601 QUES5+2000
0626 0643 6720 JMP ASK
0627 0644 1300 OUTQES
0628 0645 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0629 0646 0603 LIF 3 /JUST DISPLAY
0630 0647 0601 JMP DISPLAY
0631 0648 0273 /GET OUTPUT INFO
0632 0649 0603 OUTQES
0633 0650 0601 QUES5+2000
0634 0651 6720 JMP ASK
0635 0652 1300 OUTQES
0636 0653 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0637 0654 0603 LIF 3 /JUST DISPLAY
0638 0655 0601 JMP DISPLAY
0639 0656 0273 /GET OUTPUT INFO
0640 0657 0603 OUTQES
0641 0658 0601 QUES5+2000
0642 0659 6720 JMP ASK
0643 0660 1300 OUTQES
0644 0661 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0645 0662 0603 LIF 3 /JUST DISPLAY
0646 0663 0601 JMP DISPLAY
0647 0664 0273 /GET OUTPUT INFO
0648 0665 0603 OUTQES
0649 0666 0601 QUES5+2000
0650 0667 6720 JMP ASK
0651 0668 1300 OUTQES
0652 0669 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0653 0670 0603 LIF 3 /JUST DISPLAY
0654 0671 0601 JMP DISPLAY
0655 0672 0273 /GET OUTPUT INFO
0656 0673 0603 OUTQES
0657 0674 0601 QUES5+2000
0658 0675 6720 JMP ASK
0659 0676 1300 OUTQES
0660 0677 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0661 0678 0603 LIF 3 /JUST DISPLAY
0662 0679 0601 JMP DISPLAY
0663 0680 0273 /GET OUTPUT INFO
0664 0681 0603 OUTQES
0665 0682 0601 QUES5+2000
0666 0683 6720 JMP ASK
0667 0684 1300 OUTQES
0668 0685 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0669 0686 0603 LIF 3 /JUST DISPLAY
0670 0687 0601 JMP DISPLAY
0671 0688 0273 /GET OUTPUT INFO
0672 0689 0603 OUTQES
0673 0690 0601 QUES5+2000
0674 0691 6720 JMP ASK
0675 0692 1300 OUTQES
0676 0693 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0677 0694 0603 LIF 3 /JUST DISPLAY
0678 0695 0601 JMP DISPLAY
0679 0696 0273 /GET OUTPUT INFO
0680 0697 0603 OUTQES
0681 0698 0601 QUES5+2000
0682 0699 6720 JMP ASK
0683 0700 1300 OUTQES
0684 0701 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0685 0702 0603 LIF 3 /JUST DISPLAY
0686 0703 0601 JMP DISPLAY
0687 0704 0273 /GET OUTPUT INFO
0688 0705 0603 OUTQES
0689 0706 0601 QUES5+2000
0690 0707 6720 JMP ASK
0691 0708 1300 OUTQES
0692 0709 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0693 0710 0603 LIF 3 /JUST DISPLAY
0694 0711 0601 JMP DISPLAY
0695 0712 0273 /GET OUTPUT INFO
0696 0713 0603 OUTQES
0697 0714 0601 QUES5+2000
0698 0715 6720 JMP ASK
0699 0716 1300 OUTQES
0700 0717 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0701 0718 0603 LIF 3 /JUST DISPLAY
0702 0719 0601 JMP DISPLAY
0703 0720 0273 /GET OUTPUT INFO
0704 0721 0603 OUTQES
0705 0722 0601 QUES5+2000
0706 0723 6720 JMP ASK
0707 0724 1300 OUTQES
0708 0725 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0709 0726 0603 LIF 3 /JUST DISPLAY
0710 0727 0601 JMP DISPLAY
0711 0728 0273 /GET OUTPUT INFO
0712 0729 0603 OUTQES
0713 0730 0601 QUES5+2000
0714 0731 6720 JMP ASK
0715 0732 1300 OUTQES
0716 0733 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0717 0734 0603 LIF 3 /JUST DISPLAY
0718 0735 0601 JMP DISPLAY
0719 0736 0273 /GET OUTPUT INFO
0720 0737 0603 OUTQES
0721 0738 0601 QUES5+2000
0722 0739 6720 JMP ASK
0723 0740 1300 OUTQES
0724 0741 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0725 0742 0603 LIF 3 /JUST DISPLAY
0726 0743 0601 JMP DISPLAY
0727 0744 0273 /GET OUTPUT INFO
0728 0745 0603 OUTQES
0729 0746 0601 QUES5+2000
0730 0747 6720 JMP ASK
0731 0748 1300 OUTQES
0732 0749 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0733 0750 0603 LIF 3 /JUST DISPLAY
0734 0751 0601 JMP DISPLAY
0735 0752 0273 /GET OUTPUT INFO
0736 0753 0603 OUTQES
0737 0754 0601 QUES5+2000
0738 0755 6720 JMP ASK
0739 0756 1300 OUTQES
0740 0757 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0741 0758 0603 LIF 3 /JUST DISPLAY
0742 0759 0601 JMP DISPLAY
0743 0760 0273 /GET OUTPUT INFO
0744 0761 0603 OUTQES
0745 0762 0601 QUES5+2000
0746 0763 6720 JMP ASK
0747 0764 1300 OUTQES
0748 0765 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0749 0766 0603 LIF 3 /JUST DISPLAY
0750 0767 0601 JMP DISPLAY
0751 0768 0273 /GET OUTPUT INFO
0752 0769 0603 OUTQES
0753 0770 0601 QUES5+2000
0754 0771 6720 JMP ASK
0755 0772 1300 OUTQES
0756 0773 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0757 0774 0603 LIF 3 /JUST DISPLAY
0758 0775 0601 JMP DISPLAY
0759 0776 0273 /GET OUTPUT INFO
0760 0777 0603 OUTQES
0761 0778 0601 QUES5+2000
0762 0779 6720 JMP ASK
0763 0780 1300 OUTQES
0764 0781 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0765 0782 0603 LIF 3 /JUST DISPLAY
0766 0783 0601 JMP DISPLAY
0767 0784 0273 /GET OUTPUT INFO
0768 0785 0603 OUTQES
0769 0786 0601 QUES5+2000
0770 0787 6720 JMP ASK
0771 0788 1300 OUTQES
0772 0789 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0773 0790 0603 LIF 3 /JUST DISPLAY
0774 0791 0601 JMP DISPLAY
0775 0792 0273 /GET OUTPUT INFO
0776 0793 0603 OUTQES
0777 0794 0601 QUES5+2000
0778 0795 6720 JMP ASK
0779 0796 1300 OUTQES
0780 0797 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0781 0798 0603 LIF 3 /JUST DISPLAY
0782 0799 0601 JMP DISPLAY
0783 0800 0273 /GET OUTPUT INFO
0784 0801 0603 OUTQES
0785 0802 0601 QUES5+2000
0786 0803 6720 JMP ASK
0787 0804 1300 OUTQES
0788 0805 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0789 0806 0603 LIF 3 /JUST DISPLAY
0790 0807 0601 JMP DISPLAY
0791 0808 0273 /GET OUTPUT INFO
0792 0809 0603 OUTQES
0793 0810 0601 QUES5+2000
0794 0811 6720 JMP ASK
0795 0812 1300 OUTQES
0796 0813 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0797 0814 0603 LIF 3 /JUST DISPLAY
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0805 0822 0603 LIF 3 /JUST DISPLAY
0806 0823 0601 JMP DISPLAY
0807 0824 0273 /GET OUTPUT INFO
0808 0825 0603 OUTQES
0809 0826 0601 QUES5+2000
0810 0827 6720 JMP ASK
0811 0828 1300 OUTQES
0812 0829 7043 FDV2RW /MOVE OUTPUT PARAMETERS TO R/W
0813 0830 0603 LIF 3 /JUST DISPLAY
0814 0831 0601 JMP DISPLAY
0815 0832 0273 /GET OUTPUT INFO
0816 0833 0603 OUTQES
0817 0834 0601 QUES5+2000
081
```

0277 /
 0300 6273 OUTQES /NO
 0307 6452 ONDAT /ASK FOR UNIT NO & FILE NAME
 0301 6523 OUTUNT, ASK2 /ERROR
 0312 6310 OUTUNT LIF 1 /ENTER IN INDEX
 0302 0512 0601 LDA I 1
 0303 0313 1020 FDX+2000 22
 0304 0314 2375 JMP SAMNAM /NAME ALREADY USED
 0305 2315 0022 JMP NOSPAC /NO SPACE
 0306 2316 6430 RDDATA, PDP /CLEAR DATA BUFFER
 0307 0317 6423 PMODE CLA CMA
 0310 0320 0002 TAD XRLOC
 0311 4321 7240 DCA 10
 0312 2313 4322 1051 TAD M4000
 0314 4323 3010 DCA 11
 0315 4324 1067 DCA 11
 0316 4325 3011 CDF1
 0317 4326 6211 DCA 110
 0320 4327 3410 ISZ 11
 0321 4330 2011 TAD M4000
 0322 4331 5327 JMP .-2
 0323 4332 6201 CDF0
 0324 4333 6212 CIF 10 /READ IN DATA
 0325 4334 4534 JMS 1 PREAD
 0326 4335 6405 RWPARM
 0327 4336 6201 CDF0
 0330 4337 7200 CLA I PRELFG /REAL OR COMPLEX
 0331 4338 4340 1532 TAD SZA CLA
 0332 4341 7640 JMP PROC /REAL
 0333 4342 5357 CMA /MOVE IMAG PARTS TO 2000
 0334 4343 7040 TAD N /OLD ADDR = NO OF PTS
 0335 4344 1003 DCA 10
 0336 4345 3010 TAD C1777 /NEW ADDR = 2000
 0337 4345 3010 DCA 11
 0340 4346 1110 TAD N
 0341 4347 3011 DCA 11
 0342 4350 1003 TAD N
 0343 4351 7041 CIA
 0344 4352 3034 DCA TEMP
 0345 4353 3130 CMPFLG /DONT COMPLEMENT
 0346 4354 4527 JMS 1 PMVPTS /MOVE THEM
 0347 4355 5357 JMP
 0350 4356 0000 IFFTFLG, 2 /FFT NON0=IFFT
 0352 4357 3532 PROC, DCA I PRELFG /OUTPUT WILL BE COMPLEX REGARDLESS OF INPUT
 0354 4360 1356 TAD IFFTFLG /DO IFFT?
 0355 4361 7650 SNA CLA
 0356 4362 5365 JMP FT /NO
 0357 4363 4447 IFT, JMS I DOIFFT
 0360 4364 7410 SKP
 0361 4365 4446 FT, JMS I DOFFT
 0362 4366 4442 JMS I SORT /PUT IN SEQUENTIAL ORDER
 0363 4367 1053 STSCAL, TAD SCAL
 0364 4370 6211 CDF1
 0365 4371 3034 DCA TEMP /SAVE
 0366 4372 1003 TAD N
 0367 4373 7104 CLL RAL
 0370 4374 3236 DCA COSINE /NO OF PTS*2
 0371 4375 1034 TAD TEMP
 0372 4376 5436 DCA I COSINE /STORE SCALE FACTOR AFTER DATA
 0373 4377 6201 NO WSTR, CDF0
 0374 4400 1110 TAD C1777 /OLD ADDR = 10
 0375 4401 3010 DCA

0376 4402 7040 /NEW ADDR = OF PTS
 0377 4403 1003
 0400 4404 3011
 0401 4405 1003
 0402 4406 7041
 0403 4407 3034
 0404 4410 3130
 0405 4411 4527
 0406 4412 6141
 0407 0410 0413 6466
 0411 0414 0002
 0412 0413 4415 6212
 0414 4416 4535
 0415 4417 6405
 0416 4420 6141
 0417 0421 0603
 0420 0422 6001
 0421 0423 0602
 0422 0424 1020
 0423 0425 3013
 0424 0426 6720
 0425 0427 6273
 0426 0430 0602
 0427 0431 1020
 0430 0431 0432
 0431 0432 2612
 0432 0433 6720
 0434 0434 1300
 0435 0435 7043
 0436 0436 1460
 0437 0437 0031
 0440 0440 0456
 0441 0441 6446
 0442 0442 1460
 0443 0443 0016
 0444 0444 6430
 0445 0445 6310
 0446 0446 0601
 0447 0447 6024
 0448 0448 6423
 0449 0449 0451
 0450 0450 0452
 0451 0451 0452
 0452 0452 0602
 0453 0453 6572
 0454 0454 6452
 0455 0455 1000
 0456 0456 0450
 0457 0457 0457
 0460 0460 0460
 0461 0461 1120
 0462 0462 0462
 0463 0463 0471
 0464 0464 0464
 0465 0465 0465
 0466 0466 1000
 0467 0467 0467
 0470 0470 2575
 0471 0471 1040
 0472 0472 2425
 0473 0473 1000
 CIA TAD N
 DCA TAD N
 DCA TAD N
 DCA TEMP
 DCA CMPLG
 JMS I PMVPTS
 LINC LINC
 LINC LMODE
 PDP JMP FDV2RW
 PMODE CIF 10
 JMS I PWRITE /WRITE OUT DATA
 RWPARM LMODE
 LINC LIF 3
 LIF 2
 LDA 1
 MSG2+2000
 ASK
 OUTQES
 JMP LIF 2
 LDA 1
 QUES6+2000
 /ASK OUTPUT QUESTIONS AGAIN
 /NAME ALREADY EXISTS
 /REPLACE WITH NEW FILE?
 LDH ANSWER+6000
 SAE 1
 31
 SKP
 JMP REPL
 SAE 1
 16
 JMP SAMNAM
 OUTUNT /NO=ASK FOR NAME AGAIN
 JMP LIF 1
 JMP 24
 JMP NOSPAC
 RDDATA
 ONDAT, LIF 2
 JMP ASK3
 ONDAT
 JMP LDA
 FDV+2006 /BLK NO
 ADA
 FDV+2007 /NO OF BLKS
 ADA 1
 -1000
 APO I
 JMP NOSPAC
 RDDATA
 /MOVE FDV PARAMETERS TO R-W LIST
 LDA FDV2RW,
 FDV+2000
 STA RWPARM+2000
 1040

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        RWPARM+20002
0475 2407
0476 1000
0477 2404
0501 0500 2412
0502 6000 2412
0504 2503 4114 /CONVERT WORDS TO BLOCKS
0504 0504 2110 NUMBKX, STC TEMP1
0504 0504 4122 ADD 0
0504 0504 2114 NUMBKX
0504 0504 2643 ADD TEMP1
0504 0504 0061 LDF 3
0504 0504 0001 SET I 1
0504 0504 0011 1
0504 0504 1120 ADA 1
0504 0504 7377 -400
0510 0510 0451 APO
0510 0510 6515 JMP +3
0510 0510 0221 XSK 1 1
0510 0510 6512 JMP -5
0510 0510 1120 ADA 1
0510 0510 7377 -400
0515 0515 0451 APO
0515 0515 6515 JMP +3
0515 0515 0221 XSK 1 1
0515 0515 6512 JMP -5
0515 0515 1120 ADA 1
0515 0515 7377 -400
0523 0523 0001 NUMBKX, 0 /ASK FOR UNIT NUMBER & FILE NAME
0523 0523 0000 /CONV & STORE UNIT NUMBER
0523 0523 0000 /MOVE FILE NAME TO ENTER, LOOKUP PARAMETER LIST
0523 0523 0000 /STORE UNIT THRU B3
0531 0523 1000 ASK2, LDA
0532 0524 0000 ASK2X
0533 0525 4571 STC
0534 0526 0602 LIF 2 /CHANGE PARAMETERS TO HANDLE OCTAL NUMBERS
0535 0527 6711 JMP OCTL
0536 0530 1020 LOA I
0537 0531 2453 QUES2+2000
0540 0532 6720 JMP ASK
0541 0533 0061 SET I 1 /PT TO UNIT NO-1H
0542 0534 3043 ANSWER+2000
0543 0535 1020 LDA I /MAX VALUE
0543 0535 3017 17
0545 0537 6627 JMP CONV
0545 0542 6571 ASK2X /ERROR
0547 0541 1040 STA /STORE UNIT
0553 0542 2375 FDV+2000
0551 0061 /MOVE FILE NAME FROM ANSWER BUFFER TO LOOKUP, ENTER PARAMETER LIST
0552 0543 SET I 1 ANSWER+6001
0553 0544 7044 SET I 2
0554 0545 0062 FDV+6000
0555 0546 6375 SET I 3 /LEFT HALF 1ST OF FDV+1
0556 0547 0063 -10 /8 CHARS
0557 0550 7767 LDH 1 1 /IF 1ST CHAR OF NAME
0560 0551 1321 AZE 1 1 /=00, NO NAME WAS
0561 0552 0470 JMP ASK2X /ENTERED-ERROR
0562 0553 6571 SKP
0563 0554 0456 INFIL, LDH 1 1
0564 0555 1321 AZE 1 1 /FILL TO 8 CHARS WITH 77
0565 0556 0450 JMP +3
0566 0557 6562 LOH 1
0567 0560 1320
0570 0561 7700
0571 0562 1362
0572 0563 0223 STH 1 2
0573 0564 6555 XSK 1 3
0573 0564 6555 JMP INFIL

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0565    LDA 1          /RETURN CALL+2
0566    0021          1
0567    *ADM
0568    1140
0569    0571          .+1
0570    ASK2X,        0
0571    0000          /ASK FOR UNIT NUMBER + BLK NO AND CONVERT
0572    /STORE UNIT THRU B7
0573    /* BLK NO " B10
0574    ASK3,         LDA
0575    0000          0
0576    STC           ASK3X
0577    0575          2
0578    LIF           2
0579    LDA 1          LDA
0580    0576          1020
0581    0577          2475
0582    0578          QUES3+2000
0583    0579          JMP  ASK
0584    0601          LDA 1          /ADDR-1H OF 1ST CHAR - UNIT
0585    0602          0061
0586    0603          3043
0587    0604          6711
0588    0605          1020
0589    0606          0017
0590    0607          0017
0591    0608          3043
0592    0609          6627
0593    0610          6627
0594    0611          6627
0595    0612          6627
0596    0613          6627
0597    0614          6627
0598    0615          6627
0599    0616          6627
0600    0617          6627
0601    0618          6627
0602    0619          6627
0603    0620          6627
0604    0621          6627
0605    0622          6627
0606    0623          6627
0607    0624          6627
0608    0625          6627
0609    0626          6627
0610    0627          6627
0611    0628          6627
0612    0629          6627
0613    0630          6627
0614    0631          6627
0615    0632          6627
0616    0633          6627
0617    0634          6627
0618    0635          6627
0619    0636          6627
0620    0637          6627
0621    0638          6627
0622    0639          6627
0623    0640          6627
0624    0641          6627
0625    0642          6627
0626    0643          6627
0627    0644          6627
0628    0645          6627
0629    0646          6627
0630    0647          6627
0631    0648          6627
0632    0649          6627
0633    0650          6627
0634    0651          6627
0635    0652          6627
0636    0653          6627
0637    0654          6627
0638    0655          6627
0639    0656          6627
0640    0657          6627
0641    0660          6627
0642    0661          6627
0643    0662          6627
0644    0663          6627
0645    0664          6627
0646    0665          6627
0647    0666          6627
0648    0667          6627
0649    0668          6627
0650    0669          6627
0651    0670          6627
0652    0671          6627
0653    0672          6627
0654    0673          6627
0655    0674          6627
0656    0675          6627
0657    0676          6627
0658    0677          6627
0659    0678          6627
0660    0679          6627
0661    0680          6627
0662    0681          6627
0663    0682          6627
0664    0683          6627
0665    0684          6627
0666    0685          6627
0667    0686          6627
0668    0687          6627
0669    0688          6627
0670    0689          6627
0671    0690          6627
0672    0691          6627
0673    0692          6627
0674    0693          6627
0675    0694          6627
0676    0695          6627
0677    0696          6627
0678    0697          6627
0679    0698          6627
0680    0699          6627
0681    0600          6627
0682    0601          6627
0683    0602          6627
0684    0603          6627
0685    0604          6627
0686    0605          6627
0687    0606          6627
0688    0607          6627
0689    0608          6627
0690    0609          6627
0691    060A          6627
0692    060B          6627
0693    060C          6627
0694    060D          6627
0695    060E          6627
0696    060F          6627
0697    0600          6627
0698    0601          6627
0699    0602          6627
0700    0603          6627
0701    0604          6627
0702    0605          6627
0703    0606          6627
0704    0607          6627
0705    0608          6627
0706    0609          6627
0707    060A          6627
0708    060B          6627
0709    060C          6627
0710    060D          6627
0711    060E          6627
0712    060F          6627
0713    0600          6627
0714    0601          6627
0715    0602          6627
0716    0603          6627
0717    0604          6627
0718    0605          6627
0719    0606          6627
0720    0607          6627
0721    0608          6627
0722    0609          6627
0723    060A          6627
0724    060B          6627
0725    060C          6627
0726    060D          6627
0727    060E          6627
0728    060F          6627
0729    0600          6627
0730    0601          6627
0731    0602          6627
0732    0603          6627
0733    0604          6627
0734    0605          6627
0735    0606          6627
0736    0607          6627
0737    0608          6627
0738    0609          6627
0739    060A          6627
0740    060B          6627
0741    060C          6627
0742    060D          6627
0743    060E          6627
0744    060F          6627
0745    0600          6627
0746    0601          6627
0747    0602          6627
0748    0603          6627
0749    0604          6627
0750    0605          6627
0751    0606          6627
0752    0607          6627
0753    0608          6627
0754    0609          6627
0755    060A          6627
0756    060B          6627
0757    060C          6627
0758    060D          6627
0759    060E          6627
0760    060F          6627
0761    0600          6627
0762    0601          6627
0763    0602          6627
0764    0603          6627
0765    0604          6627
0766    0605          6627
0767    0606          6627
0768    0607          6627
0769    0608          6627
0770    0609          6627
0771    060A          6627
0772    060B          6627
0773    060C          6627
0774    060D          6627
0775    060E          6627
0776    060F          6627
0777    0600          6627
0778    0601          6627
0779    0602          6627
0780    0603          6627
0781    0604          6627
0782    0605          6627
0783    0606          6627
0784    0607          6627
0785    0608          6627
0786    0609          6627
0787    060A          6627
0788    060B          6627
0789    060C          6627
0790    060D          6627
0791    060E          6627
0792    060F          6627
0793    0600          6627
0794    0601          6627
0795    0602          6627
0796    0603          6627
0797    0604          6627
0798    0605          6627
0799    0606          6627
0800    0607          6627
0801    0608          6627
0802    0609          6627
0803    060A          6627
0804    060B          6627
0805    060C          6627
0806    060D          6627
0807    060E          6627
0808    060F          6627
0809    0600          6627
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0821    060C          6627
0822    060D          6627
0823    060E          6627
0824    060F          6627
0825    0600          6627
0826    0601          6627
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0828    0603          6627
0829    0604          6627
0830    0605          6627
0831    0606          6627
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0834    0609          6627
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0839    060E          6627
0840    060F          6627
0841    0600          6627
0842    0601          6627
0843    0602          6627
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0845    0604          6627
0846    0605          6627
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0849    0608          6627
0850    0609          6627
0851    060A          6627
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0853    060C          6627
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0855    060E          6627
0856    060F          6627
0857    0600          6627
0858    0601          6627
0859    0602          6627
0860    0603          6627
0861    0604          6627
0862    0605          6627
0863    0606          6627
0864    0607          6627
0865    0608          6627
0866    0609          6627
0867    060A          6627
0868    060B          6627
0869    060C          6627
0870    060D          6627
0871    060E          6627
0872    060F          6627
0873    0600          6627
0874    0601          6627
0875    0602          6627
0876    0603          6627
0877    0604          6627
0878    0605          6627
0879    0606          6627
0880    0607          6627
0881    0608          6627
0882    0609          6627
0883    060A          6627
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0885    060C          6627
0886    060D          6627
0887    060E          6627
0888    060F          6627
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0891    0602          6627
0892    0603          6627
0893    0604          6627
0894    0605          6627
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0898    0609          6627
0899    060A          6627
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0901    060C          6627
0902    060D          6627
0903    060E          6627
0904    060F          6627
0905    0600          6627
0906    0601          6627
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0914    0609          6627
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0916    060B          6627
0917    060C          6627
0918    060D          6627
0919    060E          6627
0920    060F          6627
0921    0600          6627
0922    0601          6627
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0935    060E          6627
0936    060F          6627
0937    0600          6627
0938    0601          6627
0939    0602          6627
0940    0603          6627
0941    0604          6627
0942    0605          6627
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0944    0607          6627
0945    0608          6627
0946    0609          6627
0947    060A          6627
0948    060B          6627
0949    060C          6627
0950    060D          6627
0951    060E          6627
0952    060F          6627
0953    0600          6627
0954    0601          6627
0955    0602          6627
0956    0603          6627
0957    0604          6627
0958    0605          6627
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0968    060F          6627
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0970    0601          6627
0971    0602          6627
0972    0603          6627
0973    0604          6627
0974    0605          6627
0975    0606          6627
0976    0607          6627
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0982    060D          6627
0983    060E          6627
0984    060F          6627
0985    0600          6627
0986    0601          6627
0987    0602          6627
0988    0603          6627
0989    0604          6627
0990    0605          6627
0991    0606          6627
0992    0607          6627
0993    0608          6627
0994    0609          6627
0995    060A          6627
0996    060B          6627
0997    060C          6627
0998    060D          6627
0999    060E          6627
1000    060F          6627

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0655 1460 SAE I
 0673 0074 CONVER 74 /ILLEGAL CHAR
 0674 0056 ERRCHK , JMP /=34 OR 74 - NUMBER COMPLETED
 0675 0657 0000 LDA TEMP1
 0676 0660 0114 TEMP1
 0677 0661 0114 ADA
 0700 0662 1100 TEMP2
 0701 0663 0675 ADA
 0702 0664 0471 APO I
 0703 0665 0674 LDA I
 0704 0666 1020 TEMP1
 0705 0667 0001 ADM
 0706 0670 1140 /TOO LARGE
 0707 0671 0674 /OK STEP EXIT
 0710 0672 1000 LDA
 0711 0673 0114 TEMP1
 0712 0674 0000 CONVER, 0
 0713 0675 0000 TEMP2, 0
 0714 /MULPLY, LDA /VALUE SO FAR
 0715 0676 1000 TEMP1
 0716 0677 0114 MUL I
 0717 0700 1260 MUL I
 0720 0701 0010 MPLIER, 10
 0721 0702 4114 STC TEMP1
 0722 0703 1301 LDH 1 /* THIS VALUE
 0723 0704 1560 BCL 1
 0724 0705 7760 7760
 0725 0706 1140 ADM
 0726 0707 0114 TEMP1
 0727 0710 6634 JMP NXTCHR
 0730 /CHANGE PARAMETERS SO CONV & MULPLY WILL HANDLE OCTAL NUMBERS
 0731 0711 1020 OCTL, LDA I
 0732 0712 0010 10
 0733 0713 4701 STC MPLIER
 0734 0713 4701 LDA I
 0735 0714 1020 -67
 0736 0715 7710 STC UPLEGL
 0737 0716 4645 JMP
 0740 0717 6000
 0741 /DISPLAY QUESTIONS /ADDR OF TEXT
 0742 0720 4734 ASK, STC QUESNO
 0743 0721 2000 ADD 0
 0744 0722 4740 STC ASKX
 0745 0723 0500 IOB
 0746 0723 PMODE
 0747 RIB
 0750 4724 6234 LMODE
 0751 0725 0343 SCR 3
 0752 0726 1560 BCL 1
 0753 0727 7740 7740
 0754 0727 7740 ADA 1
 0755 0730 1120 LIF 0
 0756 0731 0600 STC ASKX-1
 0757 0732 4737 JMP QA INIT
 0760 0733 7000 QUESNO, 0 ANSWER+20000
 0761 0734 0000 JMP QARFSH
 0762 0735 3043 /DISPLAY
 0763 0736 7053 /WAIT FOR ANSWERS
 0764 0737 0000
 0765 0740 ASKX, 0
 0766 EJECT

SEGMENT 3
 LMODE *1, PDP
 077.0001 0002 DISPLAY, PMODE
 077.0002 7200 CLA
 077.0003 1003 TAD N
 077.0004 7110 CLL RAR GR /NO OF PTS/2
 077.0005 3037 DCA
 077.0006 1037 TAD GR
 077.0007 7041 CIA
 077.0008 3033 DCA ADD2 /-NO OF PTS/2
 077.0009 1140 TAD C2000
 077.0010 3364 DCA LOAD ADDR /LOWER ADDR OF DISPLAY
 077.0011 1110 TAD C1777
 077.0012 1003 TAD N
 077.0013 3366 DCA UP ADDR /UPPER ADDR OF DISPLAY
 077.0014 6212 CIF 10 PREAD
 077.0015 4534 JMS 1
 077.0016 6405 RWPARM
 077.0017 6141 LINC
 077.0018 LMODE
 077.0019 1020 LD A 1 /WHICH DISPLAY
 077.0020 2665 QUES13+2000
 077.0021 0024 0602 LIF 2
 077.0022 0025 6720 JMP ASK
 077.0023 0026 1300 LDH
 077.0024 0027 7043 ANSWER+6000
 077.0025 0030 0450 AZE
 077.0026 0031 6034 JMP *+3
 077.0027 0032 0602 LIF 2
 077.0028 0033 6026 JMP IFDIAL /LINE FEED
 077.0029 0034 0002 PDP
 077.0030 0035 1077 PMODE
 077.0031 0036 7450 WCHDIS, TAD M1.1
 077.0032 0037 5255 SNA
 077.0033 0040 1075 JMP DPIMAG /IMAG
 077.0034 0041 7450 TAD M4
 077.0035 0042 1100 SNA
 077.0036 0043 5317 JMP I PDPMAG /MAGNITUDE
 077.0037 0044 7450 TAD M5
 077.0038 0045 6245 SNA
 077.0039 0046 1070 JMP DPREAL /REAL
 077.0040 0047 7650 TAD M1
 077.0041 0048 5650 SNA CLA
 077.0042 0049 6051 DISPER, LINC PDPSCALE /SCALE FACTOR
 077.0043 0050 6052 0022 LMODE
 077.0044 0051 0053 0000 REALFG, 0 JMP DISPLAY1
 077.0045 0052 0054 02226 PDPSCALE, TAD REALFG
 077.0046 0055 6055 1253 SZA CLA /NO IMAG PARTS TO DISPLAY
 077.0047 0056 6056 7640 JMP DISPER
 077.0048 0057 6057 5251 TAD I PIFFTFC /IF TRANSFORM WAS DONE, SWAP HALVES
 077.0049 0058 6058 1533 SZA CLA
 077.0050 0059 6059 6061 7640 JMP NOINVPPI /INVERSE WAS DONE
 077.0051 0060 6060 6062 5310 TAD N
 077.0052 0061 6061 6063 7040 DCA 10 /OLD LOW ADDR OF 1ST 1/2 = NO OF PTS
 077.0053 0062 6062 6064 1003 TAD GR ---- /NEW LOW ADDR OF 1ST 1/2 = 2000 * NO OF PTS /2
 077.0054 0063 6063 6065 3010
 077.0055 0064 6064 6066 1037
 077.0056 0065 6065 6066 1111

10010
 1272 60113 1033 ADD2
 1271 6071 1033 TAD
 1272 6072 3034 DCA /MOVE 1/2 OF PTS
 1073 6073 7201 CLA IAC
 6074 3133 DCA CMPLG /COMPLEMENT VALUES
 6075 4527 JMS 1 PMVPTS /MOVE THEM
 6076 7040 CMA /OLD ADDR OF 2ND 1/2 = 3/2 NO OF PTS
 6077 1037 TAD GR
 6100 103 N
 6101 3010 TAD C1777 /NEW ADDR OF 2ND 1/2 = 2000
 6102 6103 3011 DCA 11 ADD2
 6103 6104 1033 DCA TEMP /1/2 OF PTS
 6104 6105 3034 DCA PMVPTS /MOVE THEM - 1ST 1/2 IS NOW 2ND 1/2; 2ND 1/2 IS NOW 1ST 1/2
 6105 6106 4527 JMS 1 PREPAR
 6107 6107 3330 JMP N
 6110 6110 1003 NSWPPI, TAD N
 6111 6111 3364 DCA LOADDR /LOW ADDR OF IMAGE = NO OF PTS
 6112 6112 7040 CMA LOADDR /HIGH ADDR = 2*NO OF PTS-1
 6113 6113 1003 TAD N
 6114 6114 1003 TAD N
 6115 6115 3366 DCA UPADDR
 6116 6116 5330 PREPAR
 6117 6117 1533 DPREAL, TAD I PIITFG /IF TRANSFORM WAS DONE, SWAP HALVES
 6120 6120 7640 SZA CLA
 6121 6121 5324 JMP NO SWPR
 6122 6122 4526 JMS 1 PMRLMG /SWAP
 6123 6123 5330 SPA SNA
 6124 6124 3364 JMP PREPAR
 6125 6125 7040 DCA LOADDR /LOW ADDR OF REAL
 6126 6126 1003 TAD N
 6127 6127 3366 DCA UPADDR /HIGH ADDR = NO OF PTS-1
 6130 6130 PREPAR, TAD ADD2 /NO OF PTS <1000?
 6131 6131 7104 CLL RAL
 6132 6132 1137 TAD C1000
 6133 6133 7550 SPA SNA
 6134 6134 5347 JMP GQ1000
 6135 6135 7110 CLL RAR
 6136 6136 7001 IAC /YES
 6137 6137 1141 TAD MIK /CENTER DISPLAY
 6140 6140 3525 DCA I PLEFTX /1000-(1000-NO OF PTS/2) 1,S COMP
 6141 6141 1146 TAD CCLR
 6142 6142 3524 DCA I PMVDIS
 6143 6143 1033 TAD ADD2 /WIDTH OF DISPLAY
 6144 6144 7124 CLL RAL /NO OF PTS
 6145 6145 3131 DCA MINPTS
 6146 6146 5362 JMP SHOWIT
 6147 6147 7200 GQ1000, CLA
 6150 6150 1141 TAD MIK /LEFT JUSTIFY DISPLAY
 6151 6151 3525 DCA I PLEFTX /-1000 1,S COMP
 6152 6152 1525 TAD I PLEFTX /WIDTH OF DISPLAY
 6153 6153 7001 IAC
 6154 6154 3131 DCA MINPTS
 6155 6155 1145 TAD SCR4 /MOVE DISPLAY
 6156 6156 3524 DCA I PMVDIS
 6157 6157 3362 JMP SHOWIT
 6160 6141 /DISPLAY DATA
 6161 6001 REPLY, LINC
 6162 6163 LMODE
 6164 6165 JMP DISPLAY
 6165 6166 PMODE

1166
 1167 6162 4517 SHOWIT, JMS I KIDORA 1 /LOW ADDR FILE
 1168 6163 0001 LOADDR, 0 "/"
 1169 6164 0000 LOADDR, 0 "/"
 1170 6165 0001 UPADDR, 0 "/"
 1171 6166 0000 UPADDR, 0 "/"
 1172 6167 0000 LMODE 0 "/Y OFFSET
 1173 6175 0170 0343 SIZE , SCR 3 /SCALE
 1174 6176 6171 4520 RFRSH, JMS I KRDORA /REFRESH UNTIL LF IS HIT
 1175 6172 6031 KSF /SCALE
 1200 6173 5571 JMP , -2
 1201 6174 6036 KRB
 1202 6175 1102 TAD M215
 1203 6176 7650 SNA CLA
 1204 6177 5360 JMP REDPLY
 1205 6200 6036 KRB
 1206 6201 1106 TAD M261
 1207 6202 7650 SNA CLA
 1208 6203 5216 JMP LARGER
 1209 6204 6036 KRB
 1210 6205 1103 TAD M321
 1211 6206 7650 SNA CLA
 1212 6207 5211 JMP SMALLR
 1213 6210 5522 JMP I PRFRSH
 1214 6211 1536 TAD I KYSCAL
 1215 6212 1104 TAD M353
 1216 6213 7710 SPA CLA
 1217 6214 2536 ISZ I KYSCAL
 1218 6215 5522 JMP I PRFRSH
 1219 6216 1536 TAD I KYSCAL
 1220 6217 1105 TAD M340
 1221 6218 7750 SPA SNA CLA
 1222 6219 5522 JMP I PRFRSH
 1223 6220 7040 CMA
 1224 6221 5522 TAD I KYSCAL
 1225 6222 7040 DCA I KYSCAL
 1226 6223 1536 TAD I KYSCAL
 1227 6224 3536 DCA I KYSCAL
 1228 6225 5522 JMP I PRFRSH
 1229 6226 1532 DPSCAL , TAD I PRELFG
 1230 6227 7640 SZA CLA /JUST REAL MEANS I DIDNT MAKE FILE = NO SCALE FACTOR
 1231 6228 5772 JMP I PDSPER
 1232 6229 1003 TAD N
 1233 6230 6231 1003 CLL RAL /ADDR = NO OF PTS**2
 1234 6231 7104 DCA TEMP
 1235 6232 3034 CDF1 /DISPLAY SCALE FACTOR
 1236 6233 3034 TAD I TEMP
 1237 6234 6211 SMA SZA /ADD R = NO OF PTS**2
 1238 6235 1434 TAD I TEMP
 1239 6236 1077 TAD M11
 1240 6237 7740 SMA SZA /DISPLAY SCALE FACTOR
 1241 6238 6211 TAD I TEMP
 1242 6239 5244 TAD LESS10 /SPACE + ASCII SCALE FACTOR
 1243 6240 5244 TAD I TEMP
 1244 6241 1074 TAD GR9 />9
 1245 6242 1434 TAD I SHOSCL
 1246 6243 5247 TAD M12
 1247 6244 1071 GR9, TAD I TEMP
 1248 6245 1434 TAD GRET10 /10+SCALE FACTOR-10
 1249 6246 1073 TAD CDF0
 1250 6247 6201 SHOSCL, DCMAG-2 /STORE IN DISPLAY PARAMETERS
 1251 6248 3266 DCA LINE
 1252 6249 3267 DCA
 1253 6250 3268 DCA
 1254 6251 3269 DCA
 1255 6252 3270 DCA
 1256 6253 3271 DCA
 1257 6254 3272 DCA
 1258 6255 3273 DCA
 1259 6256 3274 DCA
 1260 6257 3275 DCA
 1261 6258 3276 DCA
 1262 6259 3277 DCA
 1263 6260 3278 DCA

12252 1020 LDA 1
 12253 2257 SCLFAC+20000
 12254 2254 LIF 2
 12255 0602 JMP ASK /DISPLAY IT
 12256 0255 6001 SCLFAC, TEXT Z
 12257 4347 F \Z
 12258 2262 4043
 12259 2261 4043
 12260 2262 2640
 12261 0263 4040
 12262 2264 4040
 12263 2265 4040
 12264 0266 4040
 12265 2267 3400
 12266 2268 4043
 12267 2269 4043
 12268 2270 1532 /COMPUTE MAGNITUDE
 12269 2271 7640 DPMAG, TAD I PRELFG
 12270 2272 5772 SZA CLA
 12271 2273 7040 JMP I PDSPER
 12272 2274 1003 CMA
 12273 2275 3010 TAD N
 12274 2276 1110 DCA 10 /LOW ADDR OF IMAG = NO OF PTS
 12275 2277 3011 TAD C1777
 12276 2278 1002 /MOVE TO 2000
 12277 2279 1003 DCA 11
 12278 2280 1004 TAD N
 12279 2281 7041 CIA
 12280 2282 3034 DCA TE MPR
 12281 2283 3130 CMPFLG /DONT COMPLEMENT VALUES
 12282 2284 4527 JMS I PMVPTS /MOVE IMAG TO 2000
 12283 2285 3036 DCA COSINE /ADDR OF 1ST REAL
 12284 2286 1110 TAD C1777 /ADDR-1 OF IMAG PARTS
 12285 2287 3011 DCA 11
 12286 2288 1101 TAD C6000 /FRAC MULT
 12287 2289 3324 RELPTR
 12288 2290 1101 DC A
 12289 2291 3334 C6000
 12290 2292 1102 TAD
 12291 2293 3335 IMGPTR
 12292 2294 1033 ADD2
 12293 2295 7104 CLL RAL
 12294 2296 3034 DCA TEMP R /-NO OF PTS
 12295 2297 6211 CDF1
 12296 2298 6314 TAD I COSINE /REAL PART
 12297 2299 6315 1033
 12298 2300 6316 7104 LING
 12299 2301 6317 6211 LMODE
 12300 2302 6318 6314 LOF 4 /FIELD OF REAL
 12301 2303 6319 6211 MUL /MULT BY ITSELF
 12302 2304 6320 1436 NXTMAG, TAD I
 12303 2305 6321 6141 SCR 1 3 /1 BECAUSE PROD IS SHIFTED LEFT 1, 2 BECAUSE MAX VALUE WILL OVERFLOW - TAKE OUT 2
 12304 2306 0002 PD P
 12305 2307 0644 PMODE
 12306 2308 0323 1240 DCA
 12307 2309 0324 0000 MUL
 12308 2310 0325 0363 RELPTR, 0
 12309 2311 0326 SQUARED SCR 1
 12310 2312 0002 PD P
 12311 2313 6327 3143 DPA
 12312 2314 6330 7501 MQA
 12313 2315 6331 3142 DCA
 12314 2316 6332 1411 TAD I
 12315 2317 6333 6141 LINC
 12316 2318 0645 LMODE
 12317 2319 0646 /FIELD OF REAL
 12318 2320 0647 /MULT BY ITSELF
 12319 2321 0648 DPA
 12320 2322 0649 DPSQ
 12321 2323 0650 11 /IMAG PART
 12322 2324 0651 /FIELD OF REAL
 12323 2325 0652 /MULT BY ITSELF
 12324 2326 0653 DPA
 12325 2327 0654 DPSQ
 12326 2328 0655 11 /IMAG PART
 12327 2329 0656 /FIELD OF REAL
 12328 2330 0657 /MULT BY ITSELF
 12329 2331 0658 DPA
 12330 2332 0659 DPSQ
 12331 2333 0660 11 /IMAG PART
 12332 2334 0661 /FIELD OF REAL
 12333 2335 0662 /MULT BY ITSELF
 12334 2336 0663 DPA
 12335 2337 0664 DPSQ
 12336 2338 0665 11 /IMAG PART
 12337 2339 0666 /FIELD OF REAL
 12338 2340 0667 /MULT BY ITSELF
 12339 2341 0668 DPA
 12340 2342 0669 DPSQ
 12341 2343 0670 11 /IMAG PART
 12342 2344 0671 /FIELD OF REAL
 12343 2345 0672 /MULT BY ITSELF
 12344 2346 0673 DPA
 12345 2347 0674 DPSQ
 12346 2348 0675 11 /IMAG PART
 12347 2349 0676 /FIELD OF REAL
 12348 2350 0677 /MULT BY ITSELF
 12349 2351 0678 DPA
 12350 2352 0679 DPSQ
 12351 2353 0680 11 /IMAG PART
 12352 2354 0681 /FIELD OF REAL
 12353 2355 0682 /MULT BY ITSELF
 12354 2356 0683 DPA
 12355 2357 0684 DPSQ
 12356 2358 0685 11 /IMAG PART
 12357 2359 0686 /FIELD OF REAL
 12358 2360 0687 /MULT BY ITSELF
 12359 2361 0688 DPA
 12360 2362 0689 DPSQ
 12361 2363 0690 11 /IMAG PART
 12362 2364 0691 /FIELD OF REAL
 12363 2365 0692 /MULT BY ITSELF
 12364 2366 0693 DPA
 12365 2367 0694 DPSQ
 12366 2368 0695 11 /IMAG PART
 12367 2369 0696 /FIELD OF REAL
 12368 2370 0697 /MULT BY ITSELF
 12369 2371 0698 DPA
 12370 2372 0699 DPSQ
 12371 2373 0700 11 /IMAG PART
 12372 2374 0701 /FIELD OF REAL
 12373 2375 0702 /MULT BY ITSELF
 12374 2376 0703 DPA
 12375 2377 0704 DPSQ
 12376 2378 0705 11 /IMAG PART
 12377 2379 0706 /FIELD OF REAL
 12378 2380 0707 /MULT BY ITSELF
 12379 2381 0708 DPA
 12380 2382 0709 DPSQ
 12381 2383 0710 11 /IMAG PART
 12382 2384 0711 /FIELD OF REAL
 12383 2385 0712 /MULT BY ITSELF
 12384 2386 0713 DPA
 12385 2387 0714 DPSQ
 12386 2388 0715 11 /IMAG PART
 12387 2389 0716 /FIELD OF REAL
 12388 2390 0717 /MULT BY ITSELF
 12389 2391 0718 DPA
 12390 2392 0719 DPSQ
 12391 2393 0720 11 /IMAG PART
 12392 2394 0721 /FIELD OF REAL
 12393 2395 0722 /MULT BY ITSELF
 12394 2396 0723 DPA
 12395 2397 0724 DPSQ
 12396 2398 0725 11 /IMAG PART
 12397 2399 0726 /FIELD OF REAL
 12398 2400 0727 /MULT BY ITSELF
 12399 2401 0728 DPA
 12400 2402 0729 DPSQ
 12401 2403 0730 11 /IMAG PART
 12402 2404 0731 /FIELD OF REAL
 12403 2405 0732 /MULT BY ITSELF
 12404 2406 0733 DPA
 12405 2407 0734 DPSQ
 12406 2408 0735 11 /IMAG PART
 12407 2409 0736 /FIELD OF REAL
 12408 2410 0737 /MULT BY ITSELF
 12409 2411 0738 DPA
 12410 2412 0739 DPSQ
 12411 2413 0740 11 /IMAG PART
 12412 2414 0741 /FIELD OF REAL
 12413 2415 0742 /MULT BY ITSELF
 12414 2416 0743 DPA
 12415 2417 0744 DPSQ
 12416 2418 0745 11 /IMAG PART
 12417 2419 0746 /FIELD OF REAL
 12418 2420 0747 /MULT BY ITSELF
 12419 2421 0748 DPA
 12420 2422 0749 DPSQ
 12421 2423 0750 11 /IMAG PART
 12422 2424 0751 /FIELD OF REAL
 12423 2425 0752 /MULT BY ITSELF
 12424 2426 0753 DPA
 12425 2427 0754 DPSQ
 12426 2428 0755 11 /IMAG PART
 12427 2429 0756 /FIELD OF REAL
 12428 2430 0757 /MULT BY ITSELF
 12429 2431 0758 DPA
 12430 2432 0759 DPSQ
 12431 2433 0760 11 /IMAG PART
 12432 2434 0761 /FIELD OF REAL
 12433 2435 0762 /MULT BY ITSELF
 12434 2436 0763 DPA
 12435 2437 0764 DPSQ
 12436 2438 0765 11 /IMAG PART
 12437 2439 0766 /FIELD OF REAL
 12438 2440 0767 /MULT BY ITSELF
 12439 2441 0768 DPA
 12440 2442 0769 DPSQ
 12441 2443 0770 11 /IMAG PART
 12442 2444 0771 /FIELD OF REAL
 12443 2445 0772 /MULT BY ITSELF
 12444 2446 0773 DPA
 12445 2447 0774 DPSQ
 12446 2448 0775 11 /IMAG PART
 12447 2449 0776 /FIELD OF REAL
 12448 2450 0777 /MULT BY ITSELF
 12449 2451 0778 DPA
 12450 2452 0779 DPSQ
 12451 2453 0780 11 /IMAG PART
 12452 2454 0781 /FIELD OF REAL
 12453 2455 0782 /MULT BY ITSELF
 12454 2456 0783 DPA
 12455 2457 0784 DPSQ
 12456 2458 0785 11 /IMAG PART
 12457 2459 0786 /FIELD OF REAL
 12458 2460 0787 /MULT BY ITSELF
 12459 2461 0788 DPA
 12460 2462 0789 DPSQ
 12461 2463 0790 11 /IMAG PART
 12462 2464 0791 /FIELD OF REAL
 12463 2465 0792 /MULT BY ITSELF
 12464 2466 0793 DPA
 12465 2467 0794 DPSQ
 12466 2468 0795 11 /IMAG PART
 12467 2469 0796 /FIELD OF REAL
 12468 2470 0797 /MULT BY ITSELF
 12469 2471 0798 DPA
 12470 2472 0799 DPSQ
 12471 2473 0800 11 /IMAG PART
 12472 2474 0801 /FIELD OF REAL
 12473 2475 0802 /MULT BY ITSELF
 12474 2476 0803 DPA
 12475 2477 0804 DPSQ
 12476 2478 0805 11 /IMAG PART
 12477 2479 0806 /FIELD OF REAL
 12478 2480 0807 /MULT BY ITSELF
 12479 2481 0808 DPA
 12480 2482 0809 DPSQ
 12481 2483 0810 11 /IMAG PART
 12482 2484 0811 /FIELD OF REAL
 12483 2485 0812 /MULT BY ITSELF
 12484 2486 0813 DPA
 12485 2487 0814 DPSQ
 12486 2488 0815 11 /IMAG PART
 12487 2489 0816 /FIELD OF REAL
 12488 2490 0817 /MULT BY ITSELF
 12489 2491 0818 DPA
 12490 2492 0819 DPSQ
 12491 2493 0820 11 /IMAG PART
 12492 2494 0821 /FIELD OF REAL
 12493 2495 0822 /MULT BY ITSELF
 12494 2496 0823 DPA
 12495 2497 0824 DPSQ
 12496 2498 0825 11 /IMAG PART
 12497 2499 0826 /FIELD OF REAL
 12498 2500 0827 /MULT BY ITSELF
 12499 2501 0828 DPA
 12500 2502 0829 DPSQ
 12501 2503 0830 11 /IMAG PART
 12502 2504 0831 /FIELD OF REAL
 12503 2505 0832 /MULT BY ITSELF
 12504 2506 0833 DPA
 12505 2507 0834 DPSQ
 12506 2508 0835 11 /IMAG PART
 12507 2509 0836 /FIELD OF REAL
 12508 2510 0837 /MULT BY ITSELF
 12509 2511 0838 DPA
 12510 2512 0839 DPSQ
 12511 2513 0840 11 /IMAG PART
 12512 2514 0841 /FIELD OF REAL
 12513 2515 0842 /MULT BY ITSELF
 12514 2516 0843 DPA
 12515 2517 0844 DPSQ
 12516 2518 0845 11 /IMAG PART
 12517 2519 0846 /FIELD OF REAL
 12518 2520 0847 /MULT BY ITSELF
 12519 2521 0848 DPA
 12520 2522 0849 DPSQ
 12521 2523 0850 11 /IMAG PART
 12522 2524 0851 /FIELD OF REAL
 12523 2525 0852 /MULT BY ITSELF
 12524 2526 0853 DPA
 12525 2527 0854 DPSQ
 12526 2528 0855 11 /IMAG PART
 12527 2529 0856 /FIELD OF REAL
 12528 2530 0857 /MULT BY ITSELF
 12529 2531 0858 DPA
 12530 2532 0859 DPSQ
 12531 2533 0860 11 /IMAG PART
 12532 2534 0861 /FIELD OF REAL
 12533 2535 0862 /MULT BY ITSELF
 12534 2536 0863 DPA
 12535 2537 0864 DPSQ
 12536 2538 0865 11 /IMAG PART
 12537 2539 0866 /FIELD OF REAL
 12538 2540 0867 /MULT BY ITSELF
 12539 2541 0868 DPA
 12540 2542 0869 DPSQ
 12541 2543 0870 11 /IMAG PART
 12542 2544 0871 /FIELD OF REAL
 12543 2545 0872 /MULT BY ITSELF
 12544 2546 0873 DPA
 12545 2547 0874 DPSQ
 12546 2548 0875 11 /IMAG PART
 12547 2549 0876 /FIELD OF REAL
 12548 2550 0877 /MULT BY ITSELF
 12549 2551 0878 DPA
 12550 2552 0879 DPSQ
 12551 2553 0880 11 /IMAG PART
 12552 2554 0881 /FIELD OF REAL
 12553 2555 0882 /MULT BY ITSELF
 12554 2556 0883 DPA
 12555 2557 0884 DPSQ
 12556 2558 0885 11 /IMAG PART
 12557 2559 0886 /FIELD OF REAL
 12558 2560 0887 /MULT BY ITSELF
 12559 2561 0888 DPA
 12560 2562 0889 DPSQ
 12561 2563 0890 11 /IMAG PART
 12562 2564 0891 /FIELD OF REAL
 12563 2565 0892 /MULT BY ITSELF
 12564 2566 0893 DPA
 12565 2567 0894 DPSQ
 12566 2568 0895 11 /IMAG PART
 12567 2569 0896 /FIELD OF REAL
 12568 2570 0897 /MULT BY ITSELF
 12569 2571 0898 DPA
 12570 2572 0899 DPSQ
 12571 2573 0900 11 /IMAG PART
 12572 2574 0901 /FIELD OF REAL
 12573 2575 0902 /MULT BY ITSELF
 12574 2576 0903 DPA
 12575 2577 0904 DPSQ
 12576 2578 0905 11 /IMAG PART
 12577 2579 0906 /FIELD OF REAL
 12578 2580 0907 /MULT BY ITSELF
 12579 2581 0908 DPA
 12580 2582 0909 DPSQ
 12581 2583 0910 11 /IMAG PART
 12582 2584 0911 /FIELD OF REAL
 12583 2585 0912 /MULT BY ITSELF
 12584 2586 0913 DPA
 12585 2587 0914 DPSQ
 12586 2588 0915 11 /IMAG PART
 12587 2589 0916 /FIELD OF REAL
 12588 2590 0917 /MULT BY ITSELF
 12589 2591 0918 DPA
 12590 2592 0919 DPSQ
 12591 2593 0920 11 /IMAG PART
 12592 2594 0921 /FIELD OF REAL
 12593 2595 0922 /MULT BY ITSELF
 12594 2596 0923 DPA
 12595 2597 0924 DPSQ
 12596 2598 0925 11 /IMAG PART
 12597 2599 0926 /FIELD OF REAL
 12598 2600 0927 /MULT BY ITSELF
 12599 2601 0928 DPA
 12600 2602 0929 DPSQ
 12601 2603 0930 11 /IMAG PART
 12602 2604 0931 /FIELD OF REAL
 12603 2605 0932 /MULT BY ITSELF
 12604 2606 0933 DPA
 12605 2607 0934 DPSQ
 12606 2608 0935 11 /IMAG PART
 12607 2609 0936 /FIELD OF REAL
 12608 2610 0937 /MULT BY ITSELF
 12609 2611 0938 DPA
 12610 2612 0939 DPSQ
 12611 2613 0940 11 /IMAG PART
 12612 2614 0941 /FIELD OF REAL
 12613 2615 0942 /MULT BY ITSELF
 12614 2616 0943 DPA
 12615 2617 0944 DPSQ
 12616 2618 0945 11 /IMAG PART
 12617 2619 0946 /FIELD OF REAL
 12618 2620 0947 /MULT BY ITSELF
 12619 2621 0948 DPA
 12620 2622 0949 DPSQ
 12621 2623 0950 11 /IMAG PART
 12622 2624 0951 /FIELD OF REAL
 12623 2625 0952 /MULT BY ITSELF
 12624 2626 0953 DPA
 12625 2627 0954 DPSQ
 12626 2628 0955 11 /IMAG PART
 12627 2629 0956 /FIELD OF REAL
 12628 2630 0957 /MULT BY ITSELF
 12629 2631 0958 DPA
 12630 2632 0959 DPSQ
 12631 2633 0960 11 /IMAG PART
 12632 2634 0961 /FIELD OF REAL
 12633 2635 0962 /MULT BY ITSELF
 12634 2636 0963 DPA
 12635 2637 0964 DPSQ
 12636 2638 0965 11 /IMAG PART
 12637 2639 0966 /FIELD OF REAL
 12638 2640 0967 /MULT BY ITSELF
 12639 2641 0968 DPA
 12640 2642 0969 DPSQ
 12641 2643 0970 11 /IMAG PART
 12642 2644 0971 /FIELD OF REAL
 12643 2645 0972 /MULT BY ITSELF
 12644 2646 0973 DPA
 12645 2647 0974 DPSQ
 12646 2648 0975 11 /IMAG PART
 12647 2649 0976 /FIELD OF REAL
 12648 2650 0977 /MULT BY ITSELF
 12649 2651 0978 DPA
 12650 2652 0979 DPSQ
 12651 2653 0980 11 /IMAG PART
 12652 2654 0981 /FIELD OF REAL
 12653 2655 0982 /MULT BY ITSELF
 12654 2656 0983 DPA
 12655 2657 0984 DPSQ
 12656 2658 0985 11 /IMAG PART
 12657 2659 0986 /FIELD OF REAL
 12658 2660 0987 /MULT BY ITSELF
 12659 2661 0988 DPA
 12660 2662 0989 DPSQ
 12661 2663 0990 11 /IMAG PART
 12662 2664 0991 /FIELD OF REAL
 12663 2665 0992 /MULT BY ITSELF
 12664 2666 0993 DPA
 12665 2667 0994 DPSQ
 12666 2668 0995 11 /IMAG PART
 12667 2669 0996 /FIELD OF REAL
 12668 2670 0997 /MULT BY ITSELF
 12669 2671 0998 DPA
 12670 2672 0999 DPSQ
 12671 2673 1000 11 /IMAG PART

1352	1240	MUL	IMGPTR, \emptyset	3	/SAME REASON AS REAL
1353	0036	0000	SCR 1		
1354	0337	0363	PDP		
1355	0340	0200	PMODE		
1356	0202	DCA	SINE		/SAVE H.O.
1357	6341	3035	CLL		/L.O. OF IMAG
1360	6342	7100	MQA		/L.O. OF REAL
1361	6343	7501	DCA		/OVERFLOW IF ANY
1362	6344	1142	TAD		/H.O. OF IMAG
1363	6345	5142	DCA		/H.O. OF REAL
1364	6346	7004	RAL		/TAKE SQ RT
1365	6347	1035	TAD		/STORE IN PLACE OF REAL
1366	6350	1143	DPSQ		COSINE
1367	6351	3143	DPSQ+1		COSINE
1370	6352	4773	JMS 1		/STEP REAL PTR
1371	6353	3436	DCA 1		IMGPTR /" IMAG ADDR - ON LAST PT OF 1024 PTS WILL SKIP
1372	6354	2036	ISZ		RELPTR /STEP REAL ADDR
1373	6355	2336	ISZ		TEMPR /STEP CTR
1374	6356	2324	ISZ		NXTMAG
1375	6357	2034	ISZ		LINC
1376	6360	5320	JMP		LMODE
1377	6361	6141	LDF	3	PDTFC
1400	02362	0643	PDP		/IF TRANSFORM WAS DONE, SWAP HALVES
1401	0363	0002	PMODE		SZA CLA
1402	0363	0002	TAD 1		JMP I
1403	0363	0002	PDP		PNSNPR
1404	6364	1533	PMODE		JMS I
1405	6365	7640	TAD 1		PMRLMG
1406	6366	5774	SZA CLA		JMP I
1407	6367	4526	PDTFC		PPREPR
1410	6370	5771	/		/DISPLAY MAG
1411	6371	6130	PPREPR		
1412	6372	6051	PDSPER		
1413	6373	7052	DISPER		
1414	6373	6124	PSQRT		
1415	6374	6124	PNSWPR		
1416	-	-	EJECT		

1417
 1422 LMODE /LOOKUP, ENTER PARAMETER LIST
 1421 FDV, 0 /UNIT 0
 2375 0000 /FILE NAME - 8 CHAR
 1422 0376 0000 0
 1423 0377 0000 0
 1424 0400 0000 0
 1425 0401 0000 0
 1426 0402 0000 0
 1427 0403 0000 0
 1430 0404 0000 0
 1431 0425 RWPARM, 0000 /
 1432 0406 0020 /UNIT
 1433 0407 0000 /BUFFER ADDR
 1434 0410 0000 0 /BLK NO
 1435 0410 0000 0 /NO OF BLKS
 1436 0411 0044 /
 1437 0412 0044 LMODE
 1440 0413 0023 /QUESTIONS
 1441 0414 0044
 1441 0415 0044
 1441 0416 0044
 1441 0417 0022
 1441 0420 0033
 1441 0421 0022
 1441 0422 0022
 1441 0423 0023
 1441 0424 0024
 1441 0425 0025
 1442 0426 0026
 1442 0427 0027
 1443 0428 0028
 1443 0429 0029
 1444 0430 0030
 1444 0431 0040
 1444 0432 0011
 1444 0433 0020
 1444 0434 0024
 1444 0435 0017
 1444 0436 0033 F INPUT ON
 1445 0437 0043
 1446 0440 0306
 1446 0441 0040
 1446 0442 0011
 1446 0443 0114
 1446 0444 0025
 1446 0445 0011
 1446 0446 0046
 1446 0447 0031
 1446 0450 0016
 1446 0451 0016
 1446 0452 0002
 1447 F DIAL UNIT? Y/N<1\Z
 1447 QUES2, TEXT Z
 1450 0453 0043
 1450 0454 0025
 1450 0455 0011

1450	0457	1625					
1450	0460	1502					
1450	0461	0522	FUNIT NUMBER<2				
1450	0462	7462					
1451	0463	4347					
1451	0464	4043					
1452	0465	0606					
1452	0466	1114					
1452	0467	0540					
1452	0470	1601					
1452	0471	1505					
1452	0472	4040					
1452	0473	7470					
1452	0474	3400	FILE NAME <8\Z QUEST, TEXT Z				
1453	0475	4043					
1454	0476	0640					
1454	0477	4025					
1454	0500	1611					
1454	0501	2440					
1454	0502	1625					
1454	0503	1502					
1454	0504	0522	F UNIT NUMBER<2				
1455	0505	7462					
1455	0506	4347					
1455	0507	4043					
1456	0510	0640					
1456	0511	4002					
1456	0512	1413					
1456	0513	4016					
1456	0514	2515					
1456	0515	0205					
1456	0516	2240					
1456	0517	7463					
1456	0520	3400	BLK NUMBER <3\Z QUEST, TEXT Z				
1457	0521	4043					
1460	0522	0610					
1460	0523	1727					
1460	0524	4015					
1460	0525	0116					
1460	0526	3140					
1460	0527	2024					
1460	0530	2377	HOW MANY PTS? <4				
1461	0531	7464					
1461	0532	4347					
1461	0533	4043					
1462	0534	4740					
1462	0535	5064					
1462	0536	5561					
1462	0537	6062					
1462	0540	6440					
1462	0541	0231					

1462 0545 2340
 1462 0546 1706
 1462 0547 4062
 1462 0550 5143 (4=1024 BY POWERS OF 2)
 1463 0551 4740
 1464 0552 4306
 1464 0553 2205
 1464 0554 0114
 1464 0555 4017 FREAL OR
 1465 0556 2243
 1465 0557 4740
 1466 0560 4306
 1466 0561 0317
 1466 0562 1520
 1466 0563 1405
 1466 0564 3077
 1466 0565 4022
 1466 0566 5703
 1466 0567 7461
 1466 0570 3400
 1466 FCOMPLEX? R/C<1\Z
 1467 QUES5, TEXT Z
 1470 0571 4306
 1470 0572 4040
 1470 0573 1725
 1470 0574 2420
 1470 0575 2524
 1470 0576 4017 F OUTPUT ON
 1471 0577 1643
 1471 0600 0640
 1471 0601 4004
 1471 0602 1101
 1471 0603 1440
 1471 0604 2516
 1471 0605 1124
 1471 0606 7740
 1471 0607 3157
 1471 0610 1674
 1471 0611 6134 F DIAL UNIT? Y/N<1\Z
 1471 0612 4043
 1473 QUES6, TEXT Z
 1473 0612 4043
 1474 0613 4740
 1474 0614 4306
 1474 0615 4022
 1474 0616 0520
 1474 0617 1401
 1474 0620 0305
 1474 0621 7740
 1474 0622 3157
 1474 0623 1674
 1474 0624 6134 F REPLACE? Y/N<1\Z
 1475 QUES11, TEXT Z
 1476 0625 4306
 1476 0626 2606

1476 0627 2440
147 0630 1722
147 0631 4004
1476 0632 1123
1476 0633 2014
1476 0634 0131
1476 0635 7740
1476 0656 0657
1476 2637 0474 FFT OR DISPLAY? F/D<1
1477 0640 6143
1477 1500 0641 4740
1500 0642 4347
1500 0643 4043
1501 0644 0624
1501 0645 2201
1501 0646 1623
1501 0647 0617
1501 0650 2215
1501 0651 4017 FTRANSFORM OR
1501 0652 2243
1502 0653 4740
1503 0654 4306
1503 0655 1116
1503 0656 2605
1503 0657 2223
1503 0660 0577
1503 0661 4024
1503 0662 5711
1503 0663 7461
1503 0664 3400 FINVERSE? T/I<1\Z
1504 0665 4306 QUEST13, TEXT Z
1505 0666 2710
1505 0667 1103
1505 0670 1040
1505 0671 0411
1505 0672 2320
1505 0673 1401
1505 0674 3177 FWHICH DISPLAY?<1
1506 0675 7461 R(EAL)
1506 2676 4347
1507 0677 4043
1507 0700 4740
1507 0701 4040
1507 0702 4040
1507 0703 2250
1507 0704 0501
1507 0705 1451
1510 0706 4347
1510 0707 4040
1510 0710 4040
1510 0711 4011
1510 0712 5012

1521

1002 1124
1003 4022
1521 1004 0524
1521 1005 2522
1521 1006 1640
1521 1007 2417
1521 1010 4003
1521 1011 1716
1521 1012 2434

HIT RETURN TO CONT\Z

1523 1013 4347

MSG2 , TEXT Z

1523

1014 4043
1015 0640
1016 4040
1017 4016
1020 1740
1021 2320
1022 0103 F NO SPACE

1525 1023 0543

1024 4740
1025 4347
1026 4040
1027 4040
1030 4040
1031 4010
1032 1124
1033 4022
1034 0524
1035 2522
1036 1640
1037 2417
1040 4003
1041 1716
1042 2434

1526

1043 0000 / ANSWER, 0 *.*6
1527 1530 1532 1533 - EJECT

HIT RETURN TO CONT\Z

		PMODE	ROOT	
1534		/SQUARE	0	
1535	7052	0000	DCA	ROOT /CLR ROOT
1536	7053	3273	TAD	/IF SQ IS 0, EXIT
1537	7054	1142	SZA CLA	DPSQ
1538	7055	7640	JMP NOT0	
1539	7056	5262	TAD DPSQ+1	
1540	7057	1143	SNA CLA	
1541	7058	7650	JMP I	SQRT
1542	7059	5652	TAD DPSQ+1	
1543	7060	7652	SNA CLA	
1544	7061	5652	JMP I	SQRT
1545	7062	1143	TAD DPSQ+1	/1ST APPROX OF ROOT
1546	7063	7110	CLL RAR	/DIVIDE BY 2
1547	7064	1140	TAD C2000	/+1/2
1548	7065	3273	DCA ROOT	
1549				
1550	7066	1142	SQRT2,	DPSQ /SUM OF SQUARES
1551	7067	7421	MOL	
1552	7068	1143	TAD DPSQ+1	
1553	7069	7100	CLL	
1554	7070	7100	DV1	/DIVIDE BY ROOT APPROX
1555	7071	7100	DZL	
1556	7072	7407	SQRT1	/OVERFLOW
1557	7073	0000	CLA	
1558	7074	7430	JMP MQA	/QUOTIENT TO AC
1559	7075	5314	TAD ROOT	/ADD APPROX TO QUOTIENT
1560	7076	7200	IAC	
1561	7077	7501	CLL RAR	/DIVIDE BY 2
1562	7078	5314	DCA SINE	/SAVE
1563	7079	7200	TAD ROOT	/SUBTRACT OLD ROOT FROM NEW ONE
1564	7080	7501	CIA SINE	
1565	7100	1273	DZL	
1566	7101	7001	SNA CLA	
1567	7102	7110	JMP SQRT1	/=0
1568	7103	3035	TAD SINE	
1569	7104	1273	DCA ROOT	/NEW ROOT
1570	7105	7041	JMP SQRT2	
1571	7106	1035	TAD SINE	
1572	7107	7650	SNA CLA	
1573	7108	1035	JMP SQRT1	
1574	7109	5314	TAD SINE	
1575	7110	5314	DCA ROOT	
1576	7111	1035	JMP SQRT2	
1577	7112	3273	TAD SINE	
1600	7113	5266	DCA ROOT	
1601	7114	1273	JMP I	EJECT
1602	7115	5652	TAD ROOT	
1603			SQRT	
1604				
1605				

1607
 1610
 1611 /MOVE PTS FROM ONE AREA TO ANOTHER
 1612 /10 = OLD BUFFER
 1613 /11 = NEW "
 1614 /IF CMPFLG=1, COMPLEMENT VALUE
 1615 MOVPTS, 0
 1616 7115 7122 6211 CDF1
 1617 7123 1132 TAD CMPFLG
 1618 NXTPTR, CLL RAR /TO LK
 1619 7121 7113 TAD 1 10
 1620 7122 1410 S2L
 1621 7123 7430
 1622 7124 7041 CIA
 1623 7125 3411 DCA 1 11
 1624 7126 2034 ISZ TEMP
 1625 7127 5320 JMP NXTPTR
 1626 7130 6201 CDF0
 1627 7131 5716 JMP 1 MOVPTS
 1630
 1631 /MOVE REAL OR MAGNITUDE VALUES
 1632 /FROM 0 TO 2000
 1633 /AND SWAP HALVES
 1634 /DO NOT COMPLEMENT
 1635 7132 0000 MVRLMG, 0
 1636 7133 7040 CMA
 1637 7134 3010 DCA 10
 1640 7135 1037 TAD GR
 1641 7136 1110 TAD C1777
 1642 7137 3011 DCA 11
 1643 7140 1033 TAD ADD2
 1644 7141 3034 DCA TEMP
 1645 7142 3130 DCA CMPFLG
 1646 7143 4527 JMS 1 /DONT COMPLEMENT
 1647 7144 7040 CMA /MOVE THEM
 1650 7145 1037 TAD GR
 1651 7146 3010 DCA 10
 1652 7147 1110 TAD C1777 /MOVE THEM
 1653 7150 3011 DCA 11
 1654 7151 1033 TAD ADD2
 1655 7152 3034 DCA TEMP
 1656 7153 4527 JMS 1 /1/2 NO OF PTS
 1657 7154 5732 JMP 1 MVRLMG
 1660
 1661

EJECT

ACDF0 1202
F-R 0041
ALWOS 1157
ADD1 1174
ADD2 0033
ADJSGN 0570
ANSWER 7043
ARG2 1020
ASK 4720
ASKX 4740
ASK2 4523
ASK2 X 4571
ASK3 4572
ASK3 X 4626
ASR 7415
BIGSNU 0012
BOUND 1516
BUFH1 1574
BUFL0 1575
BUFPT 1504
BUILD 0544
C 0032
CAM 7621
CCDF0 1401
CCIA 0162
CCLR 0146
CDF0 6201
CDF1 6211
CHKEND 4650
CHKK1 1473
CHKPT 0515
CKEND 4211
CMPFLG 0130
CNOP 0163
CNOTS 0677
CONT 1400
CONV 4627
CONVER 4674
CORVAL 0114
COSINE 0036
COUNT 0116
CSAM 1351
CURCNT 1573
CURDIS 1551
CURLOP 1563
CURRTN 1450
CURSAM 0101
C1000 0137
C1777 0110
C2000 0140
C6000 0101
DADD 1504
DATTAP 4061
DBLH1 1541
DBLLO 1547
DISFLG 4242
DISPER 6051
DISPLAY 6001
DISPL1 6022

DOIFFT 0047
DPIIMAG 6055
DPIMAG 6270
DPREAL 6117
DPSCAL 6226
DPSQ 0142
DSCLOC 1244
DSCLOP 1275
DS CWD 1261
DVI 7407
ENDHI 1577
ENDLO 1576
ERRCHK 4660
F 0007
FDV 6375
FDV2RW 4466
FFT 0400
FIF 4251
FLIP 1046
FLIPCT 0063
FREE 1365
FRESAM 0105
FT 4365
GETRIG 0045
GI 0040
GQ1000 6147
GR 0037
GRET10 0073
GR9 6244
IDORA 1200
IFCOM 4203
IFDIAL 4026
IFDISP 4265
IFFFT 4231
IFFT 0147
IF1 4261
IFT 4363
IFTFLG 4356
IMGPTR 6336
INDEX 1134
INFILE 4555
INVERT 0043
INVRT 1040
K 0031
KBUFH1 1241
KBUFFL0 1242
KIDORA 0117
KMNADR 1236
KMNFLD 1235
KMXADR 1240
KMXFLD 1237
KRDDRA 0120
KYSCAL 0136
L 0005
LARGER 6216
LDF4 0144
LEFTX 1363
LESS10 0074
LO 6164
LO 0440
LSR 7417
LVAND 4475

MAXFLU 1474
MAXNU 0021
MINTS R 1416
MINTS D 1415
MINPTS 0131
MN0VR2 0022
MOVDIS 1361
MOVINP 4263
MOVPTS 7116
MPLIER 4701
MGA 7521
MGL 7421
MSG1 6760
MSG2 7013
MULTPLY 4676
MULT 0044
MULTIP 1000
MUY 7405
MVRLMG 7132
M1 0070
M1K 0141
M10 0072
M1000 1527
M11 0077
M12 0071
M215 0102
M261 0106
M321 0103
M340 0105
M353 0104
M4 0075
M400 0107
M4000 0067
M5 0100
M70 1476
N 0003
NM1 7411
NOROT 0564
NSPAC 4423
NSWP1 6110
NSWPR 6124
NOTNOR 1172
NOTD 7062
NOVER4 0020
NOWSTR 4377
NO4MIK 1133
NU 0004
NUMBK5 4503
NUMBKX 4522
NXTCCHR 4634
NXTDF 1466
NXTMAG 6320
NXTPNT 1441
NXTPT 7120
OCTL 4711
OF12BU 4000
OKEND 1463
OKFLD 1467
ONDAT 4452
OUTQES 4273
OUTUNT 4310
P 0030

PDSPER 6372
PFDV7 0123
PI 0026
PIFTFG 0133
PLEFTX 0125
PMRLMG 0126
PMVDIS 0124
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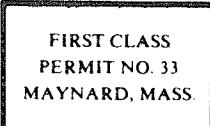
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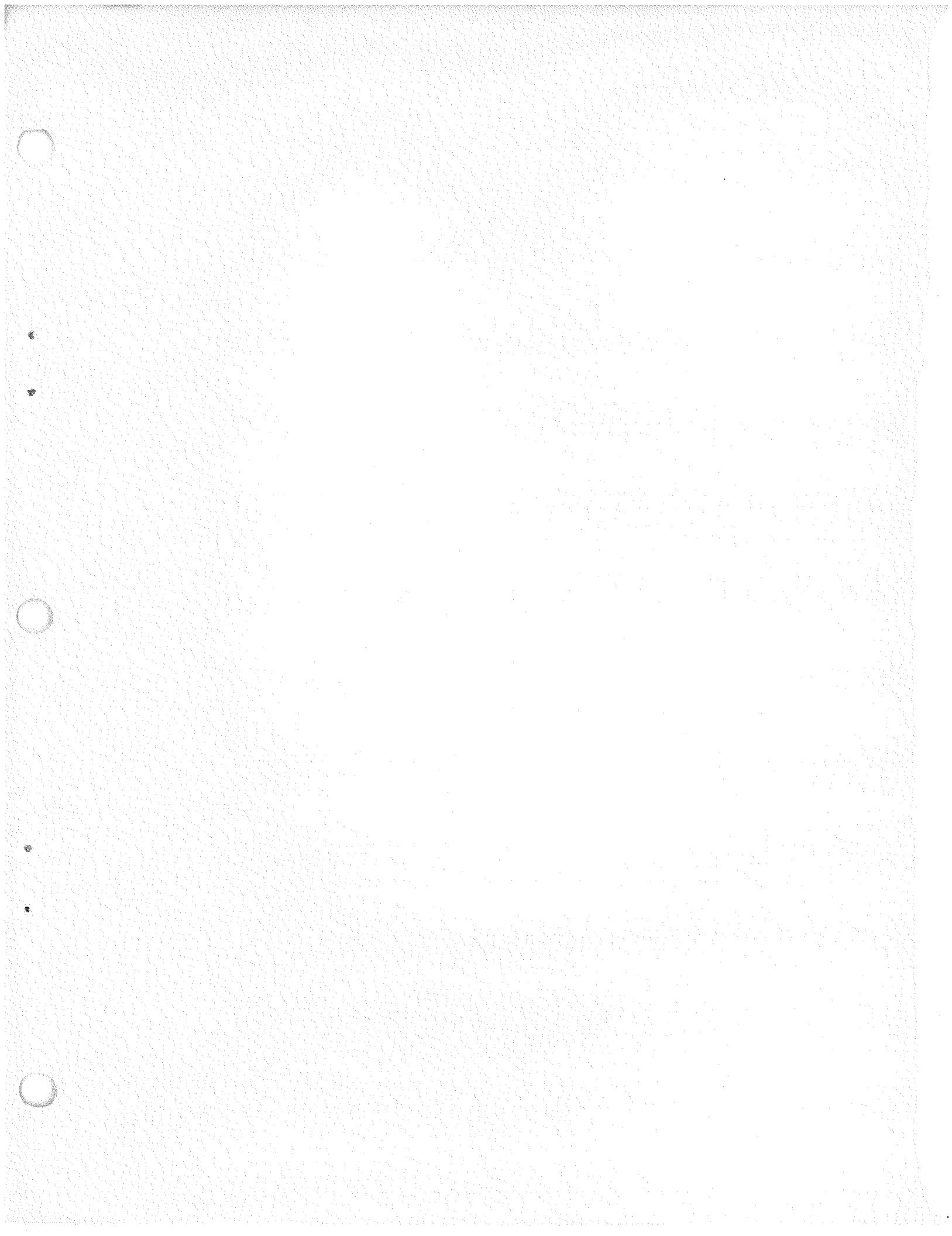


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