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REPORT

**DUAL ONE-DIMENSIONAL ANALYSIS
AND DISPLAY PROGRAM**

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DUAL ONE DIMENSIONAL ANALYSIS AND DISPLAY PROGRAM

By

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TABLE OF CONTENTS

INTRODUCTION	1
OPERATION	1
COMMANDS	2
CLOCK	5
PROGRAM DESCRIPTION	5
Page Zero Routines	7
Page One Routines	8
Page Two Routines	9
Page Three Routines	10
Page Four Routines	11
Page Five Routines	12
Page Six Routines	13
Page Seven Routines	14
DUAL ONE DIMENSIONAL ANALYSIS AND DISPLAY PROGRAM LISTING	15
EXAMPLE	33
SUMMARY OF COMMANDS	35

DUAL ONE DIMENSIONAL AND DISPLAY PROGRAM

INTRODUCTION

This program was written for use with the combination of a PDP-8 and a modified ND-160F analog to digital converter. The Digital Equipment Corporation's one dimensional display and analysis program was used as a guide; however, this program contains several additional features. The most important additional features are faster data input through the data break, and the facility to analyze two independent inputs simultaneously.

The PDP-8's memory is divided into four quadrants, the first of which (0-1777₈)* contains the program. The other three quadrants (2000₈ - 3777₈, 4000₈ - 5777₈, and 6000₈ - 7777₈) are used as three 1024 channel memories for data storage. The program has been written in modular form to facilitate its alteration to meet specific future needs. A complete program listing and a detailed description of the modular units are included.

OPERATION

The purpose of the dual one-dimensional analysis and display (DODAD) program is to simultaneously analyze two independent signals in two 1024 channel analyzers. It receives and executes commands from the keyboard and receives data through data break facilities; the commands independently control data taking and display. They choose the input side, either F or M; the data region, either 1, 2, or 3; and the precision of data taking and writing, either single (S) or double (D). Selection switches, independent of program control, determine the region where the data are stored.

* Subscript 8 denotes octal numbers.

COMMANDS

There are fourteen legal commands. The three commands, ENABLE, DISABLE, and CLOCK, must be followed by a letter to identify the appropriate input. The DISPLAY command has three options and is executed only after the receipt of a carriage return (↵). Three commands, LOWER and UPPER markers and OVERLAP, must be followed by a single digit, either to specify the amount of change in the marker or to specify the data region to be overlapped. WRITE must be followed by a letter to specify the precision of the printout; SUBTRACT must be followed by two digits to specify the regions to be subtracted. PRECISION must be followed by two letters, one to specify the side and the other to specify the precision of data taking. All commands may be aborted by typing the rub-out key, which causes the program to ignore anything previously typed on that line. After a bell, a carriage return and a line feed, control is returned to the main program. Since the interrupt is off during teleprinter operation, care should be taken when using the write or punch commands.

All illegal commands are ignored and control is returned to the main program. After completion of a legal command, control is returned to the main program. The legal commands are:

Xa	ENABLE the data taking on the side specified by the letter a. (a = F or M)
Na	DISABLE the data taking on the side specified by the letter a. (a = F or M)
Ca	Reset the CLOCK on the side as specified by the letter a. (a = F or M)
Dd,	DISPLAY the data region specified by the digit d, (d = 1, 2, or 3) with markers at

channels 0000 and 1023.

All 1024 channels are displayed with a four-fold interleave to reduce flicker. The switch register (SR) controls the counts per full scale.

For a SR = 1, full scale = 512 counts;

For a SR = 2, full scale = 1024 counts;

For a SR = 4, full scale = 2048 counts;

For a SR = 10_8 , full scale = 4096 counts.

Dd xxxx ↵

Same as Dd ↵ but the lower marker is specified by the 4-digit decimal number typed. The upper marker is 1023.

Note: The format of this command must be as specified.

Dd xxxx xxxx ↵

Same as Dd xxxx ↵ but the upper marker is specified by the second 4-digit decimal number typed.

Note: The format of this command must be as specified.

Od

OVERLAP the currently displayed data region with the region specified by the digit d. (d = 1, 2, or 3)

Ux

Decrease the UPPER marker by a single decimal number x.

Print the new value, expand, and print the new expansion factor.

Lx

Increase the LOWER marker by the single decimal number x.

Print the new value, expand, and print the new expansion factor.

- E EXPAND the display between the markers to the maximum area of the display. Print the factor of expansion.
Note: The expanded display is not interleaved so that for expansion factors of less than four, the display will flicker.
- I INTEGRATE the curve between the markers (includes the channel numbers represented by the markers) and print the result (in decimal).
- Z) ZERO the data between the markers.
- P) PUNCH the data (in BIN format) in the channels between the markers.
- Wb WRITE the data as specified by the letter b, (b = S or D) in single or double precision, from the channels between the markers. The left hand number of the printout is the channel number, while the numbers to the right are the counts in that channel and in succeeding channels.
- Sd₁d₂ SUBTRACT data region d₁ from the data region d₂ and leave the result in data region d₂. Negative numbers are stored as zeros. (d₁ and d₂ = 1, 2, or 3).
- Rab PRECISION. The side specified by the letter a, (a = F or M) is set to take data in the mode specified by the letter b, (b = S or D). In single precision (S) the overflow channels are typed out, identifying the side, the region, and the channel number. In double

precision (D), the maximum number of channels available is 400. The overflow channels are transferred to the upper 400 channels of the overflowing region.

CLOCK

The data taking routine for each input is disabled independently upon receipt of the keyboard command, Na, or by its clock overflowing. When a clock has received the maximum of counts, the message "a CLOCK FULL" is typed. Each clock is a double precision counter receiving 8192 counts/min or 819 counts/min from the analog to digital converter. They are reset by the clock overflowing or by the command Ca to the value found in the registers whose tags are CLKCa1 and CLKCa2. The absolute addresses for CLKCF1, CLKCF2, CLKCM1 and CLKCM2 are 173, 174, 175 and 176, respectively. These registers may be changed by the operator of the program to give different counting times. The contents of the registers CLKCa1 and CLKCa2 are the double precision 2's compliment of the number of clock pulses to be received. They are nominally set to accept 8192 pulses, i.e., the registers are set at 7776 and 0000. The clock receives pulses into its least significant register, the zeroth channel in the data region, through data break.

PROGRAM DESCRIPTION

This program is written in a somewhat modular form. The routines that handle the commands are fairly isolated so that they may be removed or altered. However, many of the routines use subroutines such as ORIGIN or PRINT1. These should not be removed unless all of the routines that they service are suitably altered. To conserve storage space several of the routines use the same register. For example, both of the routines SWEEP1 and

INPUT4 use the register PRODUCT; therefore, some care must be exercised when trying to change parts of the program.

There are two methods of storing information into the memory of the computer. The data break facility is used to transfer data from the ADC's to the appropriate memory location. Two external switches select the data region for each input. Data break does not disturb program control. The program interrupt transfers program control from the main program to a routine that determines which external device (teleprinter or F or M overflow) caused the interrupt. The program cannot be interrupted while in the interrupt state.

PAGE 0 ROUTINES

INTER: Chooses which device caused the interrupt and services that device.

CONTIN: Resets the teleprinter, restores the contents of the accumulator, turns the program interrupt on, and returns to the main program.

READ: Reads one character form the keyboard and prints the same character. It clears the keyboard and teleprinter flags and the accumulator. The rubout character (377) will cause the program to return to the main program through ERROR.

PRINT1: Prints the contents of the accumulator. It clears the teleprinter flag and the accumulator.

CRLF: Resets the teleprinter by executing a carriage return and line feed combination.

CLKCad: Clock constants 1 and 2 for the M and F sides. They are set to the double precision 2's compliment of the number of clock pulses to be accepted. Nominally set to accept 8192 pulses.

PAGE 1 ROUTINES

BEGIN: Resets all flags, rings the bell and waits for a command.

CMMAND: Looks for and interprets commands from the program. This is accomplished by using two tables, one of the commands the other the addresses of the commands. If no legal command is found, control returns to the main program through ERROR.

TABLE2: Table of legal commands.

TABLE1: Table of addresses of legal commands.

CLDATA: Clears the registers between the markers as specified by display routine.

ENABLE: Enables either the F or M data taking facilities. Uses SIDE.

ORIGIN: Looks for the data region digit d and sets SETTNG to 2000_8 , 4000_8 , or 6000_8 for regions 1, 2 and 3, respectively.

PRECS: Looks for the precision (S or D) and sets either the F or M side to take data in either single or double precision. Uses SIDE.

SIDE: Looks for the side (F or M) and sets the link = 1 for the M side and the link = 0 for the F side.

PAGE 2 ROUTINES

CLOCK: Resets the clock registers, SETTING and CLKCa2. Uses SIDE.

CLKSa: Increments the most significant clock register of side a. If not full, control returns to the program. If full, data taking is disabled, the clock registers are reset, and control is transferred to CKFULL.

CKFULL: Prints out the side and the statement CLOCK FULL.

OVERSa: If the overflow is from the clock, it transfers control to CLKSa. If it isn't, it transfers control to either OVERS or OVERD, depending upon program control.

OVERS: Prints out the side, region, and channel number of the overflow.

OVERD: Increments the proper channel in the upper half of the data region.
Note: The conversion gain switch must NOT be set to 1024 channels per full scale. The maximum number of double precision channels is 400.

ERRORS: Clears the keyboard and teleprinter flags and rings the bell. Control is returned to the main program.

PAGE 3 ROUTINES

SWEEP1: Reads the switch register and sets up proper scaling factor for display.

SWEEP2: Sets up parameter for interleaving display.

SWEEP3: Displays data.

SCALE: Puts scale markers on the display.

MARK: Puts vertical markers on the display.

LOWER: Looks for a number, x, adds it to the present value of the lower marker, and goes to PMARK.

UPPER: Looks for a number, x, subtracts it from the present value of the upper marker and goes to PMARK.

PMARK: Prints the current value of the marker and goes to EXPAND.

PAGE 4 ROUTINES

PNTDEC: Converts binary numbers to decimal and prints the results.

ADD: A double precision add routine used by PNTDEC.

SBTRCT: Looks for the regions, subtracts the data region d_1 from data region d_2 , and stores the results in d_2 ($d_2 - d_1 \rightarrow d_2$).

INTEG: Adds the contents of the registers between the markers and prints the result in double precision.

DISABLE: Disables either the F or M data taking facilities. Uses SIDE.

PAGE 5 ROUTINES

DISPLAY: Main display routine. It first sets the markers at 0000 and 1023; then it looks for and accepts the origin setting from ORIGIN. If the next character is $\backslash$, control proceeds; if not, control transfers to INPUT4 which reads in a 4-digit decimal number and stores it in LOMARK.

If the next character is $\backslash$ control proceeds; if not, the next 4-digit number is read in by INPUT4 and is stored in HIMARK. Control then proceeds to set up the parameters for SWEEP1. They are the interleaving factors (INLEV, XCONST, YCONST, COUNT8), the marker and scale factors, (MASKX, PSPLCE, MINLO, MINHI) and the address of the first point to be displayed (YORG).

INPUT4: Looks for 4 decimal digits and converts them to a binary word which is left in the accumulator.

LEADIN: Punches leader-trailer code for PUNCH.

PUNCH: Punches a tape in binary format of the contents of the channels between the markers. Uses BINCH to punch the 12-bit word.

BINCH: Punches the 12-bit word in the AC in binary format, and calls subroutine CHECK.

CHECK: Computes the check sum, which is the last thing punched on the tape before the trailer code is punched.

PAGE 6 ROUTINES

EXPAND: Expands the display. It operates by taking the difference between the markers and multiplying by 2 until the number of points is greater than 1024. The routine then expands the distance between the scale markers, recenters the display, displaces the markers if necessary, sets all of the operating parameters of DISPLAY, prints the expansion factor and transfer control to DISPLAY.

SHIFT: Changes the parameters in SWEEP1. Used by EXPAND.

STOP: Sets up the parameters for the display calls PNTDEC to print the expansion factor and transfer control to SWEEP1. Used by EXPAND.

PAGE 7 ROUTINES

OV LAP: Looks for the region to be overlapped with the current region, sets up parameters for OVLAPT. Uses ORIGIN.

OVLAPT: Tests which region is to be displayed next, sets up parameters in SWEEP2 and transfer control to SWEEP1.

WRITE: Looks for the precision (S or D) and sets up the parameters for using PNTDEC in single precision.

CHAN: Prints the address of the next channel that is to be outputted, control is then transferred to SGO (single precision) or to DGO (double precision).

DGO: Prints the contents of 5 channels in double precision (8 digits) before returning control to CHAN. If all channels have been printed control returns to the main program.

SGO: Prints the contents of 10 channels in single precision (4 digits) before returning control to CHAN. If all channels have been printed control returns to the main program.

/PROGRAM LISTING

/DEFINITIONS

FCA=6304 /CLEAR ADC F
MCA=6334 /CLEAR ADC M
FCE=6322 /CLEAR ENABLE ADC F
MCE=6324 /CLEAR ENABLE ADE M
FCO=6302 /CLEAR F OVERFLOW
MCO=6332 /CLEAR M OVERFLOW
FSE=6312 /SET ENABLE ADC F
MSE=6314 /SET ENABLE ADC M
FSC=6311 /SKIP IF NOT CLOCK F
MSC=6321 /SKIP IF NOT CLOCK M
FSO=6301 /SKIP IF F OVERFLOW
MSO=6331 /SKIP IF M OVERFLOW
FRA=6351 /READ ADC F
MRA=6352 /READ ADC M
DXL=6053 /CLEAR AND LOAD X BUFFER SCOPE
DYS=6067 /CLEAR AND LOAD Y BUFFER AND INTENSIFY SCOPE
DMF=5353 /JMP OVERD
NOF=5200 /JMP SWEEP1

```

                                /PROGRAM
*1
0001 6031 INTER, KSF /IS IT THE KEYBOARD?
0002 5004 JMP .+2 /NO
0003 5565 JMP I CMAND /YES
0004 6331 MSO /IS IT M OVERFLOW?
0005 5007 JMP .+2 /NO
0006 5555 JMP I OVERM /YES
0007 6301 FSO /IS IT F OVERFLOW?
0010 5560 JMP I ERROR /NO
0011 5554 JMP I OVERF /YES
0012 0000 INDEX1, 0
0013 0000 INDEX2, 0
0014 0000 INDEX3, 0

*20
0020 4050 CONTIN, JMS CRLF
0021 1151 TAD SAVEAC /RESTORE CONTENTS OF AC
0022 6001 ION /ENABLE MACHINE PI
0023 5400 JMP I INTER-1 /EXIT
0024 0000 READ, 0 /READ SUBROUTINE WITHOUT
0025 7200 CLA / INTERRUPT
0026 6031 KSF
0027 5026 JMP .-1
0030 6036 KRB
0031 3122 DCA HOLD1
0032 1122 TAD HOLD1
0033 4041 JMS PRINT1 /ECHO CHARACTER
0034 1122 TAD HOLD1
0035 1105 TAD MRBOUT /RUBOUT
0036 7650 SNA CLA
0037 5560 JMP I ERROR
0040 5424 JMP I READ / EXIT
0041 0000 PRINT1, 0 /PRINT SUBROUTINE WITHOUT
0042 6046 TLS / INTERRUPT
0043 6041 TSF
0044 5043 JMP .-1
0045 6042 TCF
0046 7200 CLA
0047 5441 JMP I PRINT1
0050 0000 CRLF, 0
0051 7200 CLA
0052 1071 TAD CARRTN
0053 4041 JMS PRINT1
0054 1070 TAD LNFEED
0055 4041 JMS PRINT1
0056 5450 JMP I CRLF
0057 7770 MIN10, 7770 /CONSTANTS
0060 7760 MIN20, 7760
0061 7776 CLKF2, 7776
0062 7776 CLKM2, 7776
0063 0275 EQUAL, 0275
0064 0260 ZERO, 0260
0065 0240 SPACE, 0240
0066 0306 FSIDE, 0306
0067 0315 MSIDE, 0315
0070 0212 LNFEED, 0212
0071 0215 CARRTN, 0215
0072 0200 COD200, 0200
0073 0305 PE, 0305
0074 7410 SKIP, 7410
0075 7400 M4HUN, 7400
0076 7000 M1THOU, 7000
0077 6000 M2THOU, 6000

```

0100	1160	P1160,	1160
0101	1000	P1THOU,	1000
0102	2000	P2THOU,	2000
0103	3000	P3THOU,	3000
0104	7774	MINUS4,	7774
0105	7401	MRBOUT,	7401
0106	7563	MINCR,	7563
0107	0004	PLUS4,	0004
0110	0017	MASK15,	0017
0111	0077	MASK63,	0077
0112	0177	MASK7,	0177
0113	1777	MASK10,	1777
0114	0003	MASK2,	0003
0115	0000	MASKX,	0
0116	0000	MINHI,	0
0117	0000	MINLO,	0
0120	0000	LOMARK,	0
0121	0000	HIMARK,	0
0122	0000	HOLD1,	0
0123	0000	HOLD2,	0
0124	0000	HIGH,	0
0125	0000	LOW,	0
0126	0000	COUNT1,	0
0127	0000	COUNT2,	0
0130	0000	COUNT3,	0
0131	0000	COUNT4,	0
0132	0000	COUNT5,	0
0133	0000	COUNT6,	0
0134	0000	COUNT7,	0
0135	0000	COUNT8,	0
0136	0000	SETTING,	0
0137	0000	CONST6,	0
0140	0000	CONST7,	0
0141	0000	CONST8,	0
0142	0000	INLEAV,	0
0143	0000	PRODCI,	0
0144	0000	YCONST,	0
0145	0000	YORG,	0
0146	0000	XCONST,	0
0147	0000	XAXIS,	0
0150	0000	DSPLCE,	0
0151	0000	SAVEAC,	0
0152	0417	CLKF,	CLKSF
0153	0433	CLKM,	CLKSM
0154	0500	OVERF,	OVERSF
0155	0535	OVERM,	OVERSM
0156	1065	ADRSC6,	TABLE3+7
0157	1055	ADRSC7,	TABLE3-1
0160	0571	ERROR,	ERRORS
0161	1400	EXPPT,	EXPAND
0162	1000	OUTPUT,	PNTDEC
0163	0323	ORGPT,	ORIGIN
0164	0202	RETURN,	CMMAND-6
0165	0210	CMAND,	CMMAND
0166	0365	SIDES,	SIDE
0167	0714	OVT,	SKIP3-1
0170	1647	OLT,	OVLAPT
0171	5353	DMF,	DMF
0172	5200	NOV,	NOF
0173	0000	CLKCF1,	0000
0174	7776	CLKCF2,	7776
0175	0000	CLKCM1,	0000
0176	7776	CLKCM2,	7776

```

*200
0200 6032 BEGIN, KCC /CLEAR FLAGS
0201 6042 TCF
0202 6306 FCA FCO
0203 6336 MCA MCO
0204 6326 FCE MCE
0205 1234 TAD BELL /RING BELL
0206 4041 JMS PRINT1
0207 4050 JMS CRLF
0210 3151 CMMAND, DCA SAVEAC /SAVE THE CONTENTS OF AC
0211 6042 TCF
0212 4024 JMS READ /READ COMMAND
0213 1235 TAD ADRSC3
0214 3014 DCA INDEX3
0215 1244 TAD TABLE2+6
0216 3126 DCA COUNT1
0217 1254 TAD ADRSC1
0220 3123 DCA HOLD2
0221 1122 TAD HOLD1
0222 1414 TAD I INDEX3 /DECODE COMMAND
0223 7450 SNA
0224 5231 JMP .+5
0225 2123 ISZ HOLD2
0226 2126 ISZ COUNT1
0227 5222 JMP .-5
0230 5560 JMP I ERROR /IGNORE ILLEGAL COMMAND
0231 1523 TAD I HOLD2
0232 3123 DCA HOLD2
0233 5523 JMP I HOLD2 /GO TO PROPER ROUTINE
0234 0207 BELL, 0207
0235 0235 ADRSC3, TABLE2-1
0236 7474 TABLE2, 7474 /D
0237 7766 7766 /N
0240 7764 7764 /Z
0241 0003 0003 /W
0242 0007 0007 /P
0243 0013 0013 /E
0244 7762 7762 /S
0245 0012 0012 /I
0246 7761 7761 /X
0247 0003 0003 /U
0250 0003 0003 /R
0251 0003 0003 /O
0252 0003 0003 /L
0253 0011 0011 /C
0254 0255 ADRSC1, TABLE1
0255 1200 TABLE1, DISPLAY
0256 1156 DSABLE
0257 0273 CLDATA
0260 1676 WRITE
0261 1311 PUNCH
0262 1400 EXPAND
0263 1076 SBTRCT
0264 1125 INTEG
0265 0311 ENABLE
0266 0747 UPPER
0267 0333 PRECS
0270 1600 OVLAP
0271 0740 LOWER
0272 0400 CLOCK
0273 4024 CLDATA, JMS READ /READ CR
0274 7040 CMA
0275 1136 TAD SETNG
0276 1120 TAD LOMARK
0277 3012 DCA INDEX1

```


0300	1121		TAD HIMARK	
0301	7040		CMA	
0302	1120		TAD LOMARK	
0303	3310		DCA COUNT9	
0304	3412		DCA I INDEX1	/ZERO DATA BETWEEN MARKERS
0305	2310		ISZ COUNT9	
0306	5304		JMP .-2	
0307	5020		JMP CONTIN	
0310	0000	COUNT9,	0	
0311	4566	ENABLE,	JMS I SIDES	
0312	7200		CLA	
0313	7430		SZL	
0314	5320		JMP .+4	
0315	6304		FCA	
0316	6312		FSE	/ENABLE F SIDE
0317	5020		JMP CONTIN	
0320	6334		MCA	
0321	6314		MSE	/ENABLE M SIDE
0322	5020		JMP CONTIN	
0323	0000	ORIGIN,	0	
0324	4024		JMS READ	
0325	1122		TAD HOLD1	
0326	0110		AND MASK15	
0327	7110		CLL RAR	
0330	7012		RTR	
0331	3136		DCA SETTING	
0332	5723		JMP I ORIGIN	
0333	4566	PRECS,	JMS I SIDES	/F HAS A ZERO LINK
0334	4024		JMS READ	
0335	1122		TAD HOLD1	
0336	0114		AND MASK2	/D HAS A ZERO AC
0337	7440		SZA	
0340	5351		JMP .+9	
0341	7430		SZL	/DOUBLE PRECISION
0342	5346		JMP .+4	
0343	1171		TAD DFM	/ F SIDE
0344	3761		DCA I CANF	
0345	5020		JMP CONTIN	
0346	1171		TAD DFM	/ M SIDE
0347	3762		DCA I CANM	
0350	5020		JMP CONTIN	
0351	7630		SZL CLA	/SINGLE PRECISION
0352	5356		JMP .+4	
0353	1363		TAD SF	/ F SIDE
0354	3761		DCA I CANF	
0355	5020		JMP CONTIN	
0356	1364		TAD SM	/ M SIDE
0357	3762		DCA I CANM	
0360	5020		JMP CONTIN	
0361	0510	CANF,	CHANGF	
0362	0545	CANM,	CHANGM	
0363	1066	SF,	TAD FSIDE	
0364	1067	SM,	TAD MSIDE	
0365	0000	SIDE,	0	
0366	4024		JMS READ	/READ EITHER AN F OR M
0367	1122		TAD HOLD1	
0370	7110		CLL RAR	
0371	7200		CLA	/F HAS A ZERO LINK
0372	5765		JMP I SIDE	

```

*400
0400 4566 CLOCK, JMS I SIDES
0401 7430 SZL
0402 5211 JMP .+7
0403 6322 FCE /RESET F CLOCK
0404 1173 TAD CLKCF1
0405 3536 DCA I SETTING
0406 1174 TAD CLKCF2
0407 3061 DCA CLKF2
0410 5020 JMP CONTIN
0411 6324 MCE /RESET M CLOCK
0412 1175 TAD CLKCM1
0413 3536 DCA I SETTING
0414 1176 TAD CLKCM2
0415 3062 DCA CLKM2
0416 5020 JMP CONTIN
0417 2061 CLKSF, ISZ CLKF2
0420 5021 JMP CONTIN+1
0421 6322 FCE /CLOCK FULL DISABLE F SIDE
0422 1123 TAD HOLD2 /AND RESET F CLOCK
0423 0077 AND M2THOU
0424 3123 DCA HOLD2
0425 1173 TAD CLKCF1
0426 3523 DCA I HOLD2
0427 1174 TAD CLKCF2
0430 3061 DCA CLKF2
0431 1066 TAD FSIDE
0432 5247 JMP CKFULL
0433 2062 CLKSM, ISZ CLKM2
0434 5021 JMP CONTIN+1
0435 6324 MCE /CLOCK FULL DISABLE M SIDE
0436 1123 TAD HOLD2 /AND RESET M CLOCK
0437 0077 AND M2THOU
0440 3123 DCA HOLD2
0441 1175 TAD CLKCM1
0442 3523 DCA I HOLD2
0443 1176 TAD CLKCM2
0444 3062 DCA CLKM2
0445 1067 TAD MSIDE
0446 5247 JMP CKFULL
0447 4041 CKFULL, JMS PRINT1
0450 1276 TAD ADRSC5
0451 3013 DCA INDEX2
0452 1413 TAD I INDEX2
0453 7450 SNA
0454 5257 JMP .+3
0455 4041 JMS PRINT1
0456 5252 JMP .-4
0457 5021 JMP CONTIN+1
0460 0240 TABLE6, 0240 / CLOCK FULL
0461 0303 0303
0462 0314 0314
0463 0317 0317
0464 0303 0303
0465 0313 0313
0466 0240 0240
0467 0306 0306
0470 0325 0325
0471 0314 0314
0472 0314 0314
0473 0215 0215
0474 0212 0212
0475 0000 0000
0476 0457 ADRSC5, TABLE6-1
0477 0465 ADRSC4, TABLE6+5

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0500	3151	OVERSF,	DCA SAVEAC	/F OVERFLOW
0501	6351		FRA	
0502	3123		DCA HOLD2	
0503	6306		FCA FCO	
0504	1123		TAD HOLD2	
0505	0113		AND MASK10	
0506	7650		SNA CLA	/IS IT THE F CLOCK?
0507	5217		JMP CLKSF	/YES
0510	1066	CHANGF,	TAD FSIDE	/NO
0511	5312		JMP OVERS	
0512	4041	OVERS,	JMS PRINT1	/SINGLE PRECISION OVERFLOW
0513	1123		TAD HOLD2	/PRINT OUT THE SIDE, THE
0514	0077		AND M2THOU	/REGION, AND THE CHANNEL
0515	7104		CLL RAL	/NUMBER.
0516	7006		RTL	
0517	1064		TAD ZERO	
0520	4041		JMS PRINT1	
0521	1065		TAD SPACE	
0522	4041		JMS PRINT1	
0523	1123		TAD HOLD2	
0524	0113		AND MASK10	
0525	3125		DCA LOW	
0526	3124		DCA HIGH	
0527	1104		TAD MINUS4	
0530	3137		DCA CONST6	
0531	1156		TAD ADRSC6	
0532	3140		DCA CONST7	
0533	4562		JMS I OUTPUT	
0534	5020		JMP CONTIN	
0535	3151	OVERSM,	DCA SAVEAC	/M OVERFLOW
0536	6352		MRA	
0537	3123		DCA HOLD2	
0540	6336		MCA MCO	
0541	1123		TAD HOLD2	
0542	0113		AND MASK10	
0543	7650		SNA CLA	/IS IT THE M CLOCK?
0544	5233		JMP CLKSM	/YES
0545	1067	CHANGM,	TAD MSIDE	/NO
0546	5312		JMP OVERS	
		*553		
0553	7100	OVERD,	CLL	/DOUBLE PRECISION OVERFLOW
0554	1123		TAD HOLD2	
0555	1100		TAD P1160	
0556	3370		DCA HOLD3	
0557	1136		TAD SETTING	
0560	1113		TAD MASK10	
0561	7040		CMA	
0562	1370		TAD HOLD3	
0563	7630		SZL CLA	/REJECT OVERFLOW IF PULSE
0564	5021		JMP CONTIN+1	/HEIGHT IS GREATER THAN
0565	2770		ISZ I HOLD3	/400 CHANNELS.
0566	7000		NOP	
0567	5021		JMP CONTIN+1	
0570	0000	HOLD3,	0	
0571	6032	ERRORS,	KCC	
0572	6042		TCF	
0573	7200		CLA	
0574	1377		TAD BELLS	
0575	4041		JMS PRINT1	
0576	5020		JMP CONTIN	
0577	0207	BELLS,	0207	

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*600
0600 1074 SWEEP1, TAD SKIP /SET UP SCALING
0601 3273 DCA SWIT5
0602 6001 ION /ENABLE INTERRUPT
0603 1315 TAD SKIP3
0604 3275 DCA SWIT6
0605 1076 TAD MITHOU /NOP=7000
0606 3271 DCA SWIT3
0607 7604 CLA OSR /READ SWITCHES
0610 7112 CLL RTR /SET PROPER SCALING
0611 7420 SNL
0612 5217 JMP .+5
0613 7200 CLA
0614 1074 TAD SKIP
0615 3271 DCA SWIT3
0616 5233 JMP .+15
0617 7010 RAR
0620 7420 SNL
0621 5226 JMP .+5
0622 7200 CLA
0623 1076 TAD MITHOU
0624 3273 DCA SWIT5
0625 5233 JMP .+6
0626 7010 RAR
0627 7620 SNL CLA
0630 5233 JMP .+3
0631 1076 TAD MITHOU
0632 3275 DCA SWIT6
0633 3130 DCA COUNT3 /INTERLEAVE AT X=0,4,...
0634 1141 TAD CONST8 /CHANGED BY EXPAND
0635 3126 DCA COUNT1
0636 1142 SWEEP2, TAD INLEAV
0637 3127 DCA COUNT2
0640 1145 TAD YORG
0641 1130 TAD COUNT3
0642 3143 DCA PRODC T /XAXIS IN MEMORY
0643 1130 TAD COUNT3
0644 3147 DCA XAXIS /XAXIS ON SCOPE
0645 1147 SWEEP3, TAD XAXIS /LOAD X
0646 6053 DXL
0647 1150 TAD DSPLCE /DURING EXPAND, MARKERS
0650 0115 AND MASKX /SHIFT
0651 7650 SNA CLA
0652 5316 JMP SCALE /PUT UP SCALE MARKERS
0653 1147 TAD XAXIS
0654 1117 TAD MINLO /VERTICAL MARKER?
0655 7450 SNA
0656 5325 JMP MARK-3 /YES
0657 1116 TAD MINHI
0660 7650 SNA CLA
0661 5325 JMP MARK-3 /YES
0662 1074 TAD SKIP /NO
0663 3301 DCA SWIT4
0664 7000 NOP /TO INTENSIFY Y=0 USE DYS
0665 1147 TAD XAXIS
0666 1146 TAD XCONST
0667 3147 DCA XAXIS /UPDATE X ON SCOPE
0670 1543 TAD I PRODC T /GET Y
0671 7000 SWIT3, NOP
0672 7104 CLL RAL /SCALE IT
0673 7410 SWIT5, SKP
0674 7112 CLL RTR
0675 5300 SWIT6, JMP .+3
0676 7010 RAR
0677 7112 CLL RTR

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0700	6067		DYS	
0701	7410	SWIT4,	SKP	/MARK?
0702	5330		JMP MARK	/YES
0703	7200		CLA	/NO
0704	1143		TAD PRODC	/UPDATE XAXIS IN CORE
0705	1144		TAD YCONST	
0706	3143		DCA PRODC	
0707	2127		ISZ COUNT2	/FIRST INTERLEAVE DONE?
0710	5245		JMP SWEEP3	/NO
0711	2130		ISZ COUNT3	/YES-UPDATE POINTER
0712	2126		ISZ COUNT1	/ALL DONE?
0713	5236		JMP SWEEP2	/NO
0714	5200		JMP SWEEP1	/YES:START OVER
0715	5300	SKIP3,	JMP SWIT4-1	
0716	7101	SCALE,	CLL IAC	/PUT UP SCALE MARKERS
0717	7006		RTL	
0720	6067		DYS	
0721	7006		RTL	
0722	6067		DYS	
0723	7200		CLA	
0724	5253		JMP SWEEP3+6	
0725	1076		TAD MITHOU	
0726	3301		DCA SWIT4	
0727	5264		JMP SWIT3-5	
0730	7200	MARK,	CLA	/DRAW VERTICAL LINE
0731	1102		TAD P2THOU	
0732	7100		CLL	
0733	1060		TAD MIN20	
0734	7420		SNL	
0735	5303		JMP SWIT4+2	
0736	6067		DYS	
0737	5332		JMP --5	
0740	4024	LOWER,	JMS READ	/INCREMENT LOWER MARKER
0741	1122		TAD HOLD1	
0742	0110		AND MASK15	
0743	1120		TAD LOMARK	
0744	3120		DCA LOMARK	
0745	1120		TAD LOMARK	
0746	5356		JMP PMARK	
0747	4024	UPPER,	JMS READ	/DECREMENT UPPER MARKER
0750	1122		TAD HOLD1	
0751	0110		AND MASK15	
0752	7041		CMA IAC	
0753	1121		TAD HIMARK	
0754	3121		DCA HIMARK	
0755	1121		TAD HIMARK	
0756	3125	PMARK,	DCA LOW	/PRINT OUT NEW VALUE
0757	3124		DCA HIGH	
0760	1104		TAD MINUS4	
0761	3137		DCA CONST6	
0762	1156		TAD ADRSC6	
0763	3140		DCA CONST7	
0764	1063		TAD EQUAL	
0765	4041		JMS PRINT1	
0766	4562		JMS I OUTPUT	
0767	1071		TAD CARRTN	
0770	4041		JMS PRINT1	
0771	1070		TAD LNFEED	
0772	4041		JMS PRINT1	
0773	1073		TAD PE	
0774	4041		JMS PRINT1	
0775	5561		JMP I EXPPT	

1000	0000	*1000		
		PNTDEC,	0	/PRINT DECIMAL
1001	1137		TAD CONST6	
1002	3135		DCA COUNT8	
1003	1140		TAD CONST7	
1004	3013		DCA INDEX2	
1005	1413		TAD I INDEX2	
1006	3252		DCA HSUB	
1007	1413		TAD I INDEX2	
1010	3253		DCA LSUB	
1011	3255		DCA CHRCTR	
1012	4231		JMS ADD	
1013	1255		TAD CHRCTR	
1014	1064		TAD ZERO	
1015	4041		JMS PRINT1	
1016	2135		ISZ COUNT8	
1017	5205		JMP *-12	
1020	1104		TAD MINUS4	
1021	7001		IAC	
1022	3135		DCA COUNT8	
1023	2135		ISZ COUNT8	
1024	7410		SKP	
1025	5600		JMP I PNTDEC	
1026	1065		TAD SPACE	
1027	4041		JMS PRINT1	
1030	5223		JMP *-5	
1031	0000	ADD,	0	/DOUBLE PRECISION ADD
1032	7100		CLL	
1033	1125		TAD LOW	
1034	1253		TAD LSUB	
1035	3254		DCA TEMPL	
1036	7004		RAL	
1037	1124		TAD HIGH	
1040	1252		TAD HSUB	
1041	7420		SNL	
1042	5250		JMP *+6	
1043	3124		DCA HIGH	
1044	1254		TAD TEMPL	
1045	3125		DCA LOW	
1046	2255		ISZ CHRCTR	
1047	5232		JMP ADD+1	
1050	7200		CLA	
1051	5631		JMP I ADD	
1052	0000	HSUB,	0	
1053	0000	LSUB,	0	
1054	0000	TEMPL,	0	
1055	0000	CHRCTR,	0	
1056	3166	TABLE3,	3166	/CONVERSION TABLE
1057	4600		4600	
1060	7413		7413	
1061	6700		6700	
1062	7747		7747	
1063	4540		4540	
1064	7775		7775	
1065	4360		4360	
1066	7777		7777	
1067	6030		6030	
1070	7777		7777	
1071	7634		7634	
1072	7777		7777	
1073	7766		7766	
1074	7777		7777	
1075	7777		7777	
1076	4563	SBTRCT,	JMS I ORGPT	/SUBTRAHEND REGION
1077	7040		CMA	

1100	1136	TAD SETTING	
1101	3014	DCA INDEX3	
1102	4563	JMS I ORGPT	/MINUEND REGION
1103	7040	CMA	
1104	1136	TAD SETTING	
1105	3013	DCA INDEX2	
1106	7040	CMA	
1107	1136	TAD SETTING	
1110	3012	DCA INDEX1	
1111	1077	TAD M2THOU	
1112	3355	DCA COUN10	
1113	7100	CLL	
1114	1414	TAD I INDEX3	
1115	7041	CIA	
1116	1413	TAD I INDEX2	
1117	7420	SNL	
1120	7200	CLA	
1121	3412	DCA I INDEX1	
1122	2355	ISZ COUN10	
1123	5313	JMP *-10	
1124	5020	JMP CONTIN	
1125	7040	CMA	/INTEGRATION
1126	1136	TAD SETTING	
1127	1120	TAD LOMARK	
1130	3013	DCA INDEX2	
1131	3124	DCA HIGH	
1132	1063	TAD EQUAL	
1133	4041	JMS PRINT1	
1134	1121	TAD HIMARK	
1135	7040	CMA	
1136	1120	TAD LOMARK	
1137	3135	DCA COUNT8	
1140	7100	CLL	
1141	1413	TAD I INDEX2	
1142	7430	SZL	
1143	2124	ISZ HIGH	
1144	2135	ISZ COUNT8	
1145	5340	JMP *-5	
1146	3125	DCA LOW	
1147	1057	TAD MIN10	
1150	3137	DCA CONST6	
1151	1157	TAD ADRSC7	
1152	3140	DCA CONST7	
1153	4200	JMS PNTDEC	
1154	5020	JMP CONTIN	
1155	0000	0	
1156	4566	JMS I SIDES	
1157	7430	SZL	
1160	5364	JMP *+4	
1161	6322	FCE	/DISABLE F
1162	6306	FCA FCO	
1163	5020	JMP CONTIN	
1164	6324	MCE	/DISABLE M
1165	6336	MCA MCO	
1166	5020	JMP CONTIN	

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*1200
DSPLAY,      TAD NOV                      /SET PARAMETERS FOR DISPLAY
1201 3567      DCA I OVT
1202 1254      TAD ADRSC2
1203 3127      DCA COUNT2
1204 3527      DCA I COUNT2
1205 2127      ISZ COUNT2
1206 1077      TAD M2THOU
1207 7040      CMA
1210 3527      DCA I COUNT2
1211 1254      TAD ADRSC2
1212 3127      DCA COUNT2
1213 4563      JMS I ORGPT
1214 4024      JMS READ
1215 1122      TAD HOLD1
1216 1106      TAD MINCR
1217 7650      SNA CLA
1220 5225      JMP .+5
1221 4256      JMS INPUT4
1222 3527      DCA I COUNT2
1223 2127      ISZ COUNT2
1224 5214      JMP .-10
1225 1070      TAD LNFEED
1226 4041      JMS PRINT1
1227 1107      TAD PLUS4
1230 3146      DCA XCONST
1231 1136      TAD SETTNG
1232 3145      DCA YORG
1233 1107      TAD PLUS4
1234 3144      DCA YCONST
1235 1120      TAD LOMARK
1236 7041      CMA IAC
1237 3117      DCA MINLO
1240 1121      TAD HIMARK
1241 7041      CMA IAC
1242 1120      TAD LOMARK
1243 3116      DCA MINHI
1244 1075      TAD M4HUN
1245 3142      DCA INLEAV
1246 1104      TAD MINUS4
1247 3141      DCA CONST8
1250 1111      TAD MASK63
1251 3115      DCA MASKX
1252 3150      DCA DSPLCE
1253 5655      JMP I DSPLPT
1254 0120      ADRSC2, LOMARK
1255 0600      DSPLPT, SWEEP1
1256 0000      INPUT4, 0                      /INPUT 4 DECIMAL
                                           /CHARACTERS
1257 1104      TAD MINUS4
1260 3126      DCA COUNT1
1261 3143      DCA PRODC2
1262 4024      JMS READ
1263 1122      TAD HOLD1
1264 0110      AND MASK15
1265 1143      TAD PRODC2
1266 2126      ISZ COUNT1
1267 7410      SKP
1270 5656      JMP I INPUT4
1271 7104      CLL RAL
1272 3143      DCA PRODC2
1273 1143      TAD PRODC2
1274 7006      RTL
1275 1143      TAD PRODC2
1276 3143      DCA PRODC2
1277 5262      JMP INPUT4+4

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1300	0000	LEADIN,	0
1301	1072		TAD COD200
1302	7041		CIA
1303	3133		DCA COUNT6
1304	1072		TAD COD200
1305	4041		JMS PRINT1
1306	2133		ISZ COUNT6
1307	5304		JMP .-3
1310	5700		JMP I LEADIN
1311	4024	PUNCH,	JMS READ
1312	1070		TAD LNFEED
1313	4041		JMS PRINT1
1314	4300		JMS LEADIN
1315	1120		TAD LOMARK
1316	1136		TAD SETTING
1317	3132		DCA COUNT5
1320	1121		TAD HIMARK
1321	1136		TAD SETTING
1322	7041		CMA IAC
1323	3133		DCA COUNT6
1324	3125		DCA LOW
1325	1132		TAD COUNT5
1326	7120		CLL CML
1327	4351		JMS BINPCH
1330	6031		KSF
1331	5333		JMP .+2
1332	5560		JMP I ERROR
1333	1532		TAD I COUNT5
1334	7100		CLL
1335	4351		JMS BINPCH
1336	1132		TAD COUNT5
1337	1133		TAD COUNT6
1340	7650		SNA CLA
1341	5344		JMP .+3
1342	2132		ISZ COUNT5
1343	5330		JMP .-13
1344	7100		CLL
1345	1125		TAD LOW
1346	4351		JMS BINPCH
1347	4300		JMS LEADIN
1350	5020		JMP CONTIN
1351	0000	BINPCH,	0
1352	3135		DCA COUNT8
1353	1135		TAD COUNT8
1354	7012		RTR
1355	7012		RTR
1356	7012		RTR
1357	0112		AND MASK7
1360	4367		JMS CHECK
1361	4041		JMS PRINT1
1362	1135		TAD COUNT8
1363	0111		AND MASK63
1364	4367		JMS CHECK
1365	4041		JMS PRINT1
1366	5751		JMP I BINPCH
1367	0000	CHECK,	0
1370	3134		DCA COUNT7
1371	1134		TAD COUNT7
1372	1125		TAD LOW
1373	3125		DCA LOW
1374	1134		TAD COUNT7
1375	5767		JMP I CHECK

1400	1111	*1400	TAD MASK63	/EXPANSION ROUTINE
1401	3115	EXPAND,	DCA MASKX	/SET UP PARAMTERS
1402	1077		TAD M2THOU	/FOR SWEEP
1403	3142		DCA INLEAV	
1404	7201		CLA IAC	
1405	3146		DCA XCONST	
1406	1120		TAD LOMARK	
1407	7041		CMA IAC	
1410	1121		TAD HIMARK	
1411	7500		SMA	
1412	5223		JMP .+11	
1413	7200		CLA	
1414	1120		TAD LOMARK	
1415	3122		DCA HOLD1	
1416	1121		TAD HIMARK	
1417	3120		DCA LOMARK	
1420	1122		TAD HOLD1	
1421	3121		DCA HIMARK	
1422	5206		JMP .-14	
1423	3116		DCA MINHI	
1424	1115		TAD MASKX	
1425	7040		CMA	
1426	3150		DCA DSPLCE	
1427	1120		TAD LOMARK	
1430	7450		SNA	
1431	5236		JMP .+5	
1432	1150		TAD DSPLCE	
1433	7500		SMA	
1434	5232		JMP .-2	
1435	7041		CMA IAC	
1436	3150		DCA DSPLCE	
1437	1116		TAD MINHI	
1440	7001		IAC	
1441	7110		CLL RAR	
1442	7430		SZL	
1443	7001		IAC	
1444	7104		CLL RAL	
1445	3122		DCA HOLD1	
1446	1122		TAD HOLD1	
1447	3144		DCA YCONST	
1450	1144	SHIFT,	TAD YCONST	
1451	7104		CLL RAL	
1452	3343		DCA TEMP	
1453	1343		TAD TEMP	
1454	1077		TAD M2THOU	
1455	7700		SMA CLA	
1456	5303		JMP STOP	
1457	1343		TAD TEMP	
1460	3144		DCA YCONST	
1461	1146		TAD XCONST	
1462	7104		CLL RAL	
1463	3146		DCA XCONST	
1464	1115		TAD MASKX	
1465	7120		CLL CML	
1466	7004		RAL	
1467	3115		DCA MASKX	
1470	1142		TAD INLEAV	
1471	7120		CLL CML	
1472	7010		RAR	
1473	3142		DCA INLEAV	
1474	1116		TAD MINHI	
1475	7104		CLL RAL	
1476	3116		DCA MINHI	
1477	1150		TAD DSPLCE	

1500	7104		CLL RAL
1501	3150		DCA DSPLCE
1502	5250		JMP SHIFT
1503	7040	STOP,	CMA
1504	3141		DCA CONST8
1505	1142		TAD INLEAV
1506	1122		TAD HOLD1
1507	7120		CLL CML
1510	7010		RAR
1511	1120		TAD LOMARK
1512	1136		TAD SETTING
1513	3145		DCA YORG
1514	1077		TAD M2THOU
1515	1144		TAD YCONST
1516	7120		CLL CML
1517	7010		RAR
1520	3117		DCA MINLO
1521	1116		TAD MINHI
1522	7041		CMA IAC
1523	3116		DCA MINHI
1524	1150		TAD DSPLCE
1525	7041		CMA IAC
1526	1117		TAD MINLO
1527	3150		DCA DSPLCE
1530	7001		IAC
1531	3144		DCA YCONST
1532	1104		TAD MINUS4
1533	3137		DCA CONST6
1534	1156		TAD ADRSC6
1535	3140		DCA CONST7
1536	1146		TAD XCONST
1537	3125		DCA LOW
1540	3124		DCA HIGH
1541	4562		JMS I OUTPUT
1542	5020		JMP CONTIN
1543	0000	TEMP,	0

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*1600
1600 1266 OVLAP, TAD OVLT /OVERLAP REGIONS
1601 3567 DCA I OVT
1602 4563 JMS I ORGPT /CHOOSE SECOND REGION
1603 1136 TAD SETNG
1604 7004 RAL
1605 7006 RTL
1606 3271 DCA HOLD4 /SECOND REGION
1607 4050 JMS CRLF
1610 3272 DCA HOLDS
1611 1145 TAD YORG
1612 7100 CLL
1613 1113 TAD MASK10
1614 1102 TAD P2THOU
1615 2272 ISZ HOLDS
1616 7420 SNL
1617 5214 JMP .-3
1620 7200 CLA
1621 1272 TAD HOLDS /FIRST REGION
1622 1104 TAD MINUS4
1623 1271 TAD HOLD4
1624 7430 SZL
1625 5236 JMP .+9
1626 7012 RTR /POSITIVE DIFFERENCE
1627 7010 RAR
1630 3271 DCA HOLD4
1631 1271 TAD HOLD4
1632 7041 CIA
1633 3272 DCA HOLDS
1634 3270 DCA TEST
1635 5247 JMP OVLAFT
1636 7041 CIA /NEGATIVE DIFFERENCE
1637 7110 CLL RAR
1640 7012 RTR
1641 3272 DCA HOLDS
1642 1272 TAD HOLDS
1643 7041 CIA
1644 3271 DCA HOLD4
1645 3270 DCA TEST
1646 5247 JMP OVLAFT
1647 1270 OVLAFT, TAD TEST
1650 7440 SZA
1651 5260 JMP .+7
1652 1102 TAD P2THOU /SECOND REGION
1653 3270 DCA TEST
1654 1145 TAD YORG
1655 1271 TAD HOLD4
1656 3145 DCA YORG
1657 5667 JMP I SWEP /RETURN TO SWEEP1
1660 7200 CLA /FIRST REGION
1661 3270 DCA TEST
1662 1145 TAD YORG
1663 1272 TAD HOLDS
1664 3145 DCA YORG
1665 5667 JMP I SWEP /RETURN TO SWEEP1
1666 5570 OVLT, JMP I OLT
1667 0600 SWEP, SWEEP1
1670 0000 TEST, 0
1671 0000 HOLD4, 0
1672 0000 HOLDS, 0
1673 0000 HOLD6, 0
1674 7773 MIND5, 7773
1675 7766 MIND10, 7766
1676 4024 WRITE, JMS READ /READ S OR D
1677 1122 TAD HOLD1

```

1700	0114	AND MASK2	
1701	3273	DCA HOLD6	
1702	1120	TAD LOMARK	
1703	3132	DCA COUNT5	
1704	1121	TAD HIMARK	
1705	7041	CIA	
1706	3133	DCA COUNT6	
1707	6031	CHAN, KSF	/CHANNEL NUMBER IN
1710	5312	JMP .+2	/SINGLE PRECISION
1711	5560	JMP I ERROR	
1712	1104	TAD MINUS4	
1713	3137	DCA CONST6	
1714	1156	TAD ADRSC6	
1715	3140	DCA CONST7	
1716	3124	DCA HIGH	
1717	4050	JMS CRLF	
1720	1132	TAD COUNT5	
1721	3125	DCA LOW	
1722	4562	JMS I OUTPUT	
1723	1273	TAD HOLD6	
1724	7640	SZA CLA	
1725	5360	JMP SGO	
1726	1057	TAD MIN10	/DOUBLE PRECISION CONSTANTS
1727	3137	DCA CONST6	
1730	1157	TAD ADRSC7	
1731	3140	DCA CONST7	
1732	1274	TAD MIND5	
1733	3134	DCA COUNT7	
1734	1132	DGO, TAD COUNT5	
1735	1136	TAD SETTING	
1736	3125	DCA LOW	
1737	1525	TAD I LOW	
1740	3125	DCA LOW	/LEAST SIGNIFICANT HALF
1741	1132	TAD COUNT5	
1742	1136	TAD SETTING	
1743	1100	TAD P1160	
1744	3124	DCA HIGH	
1745	1524	TAD I HIGH	
1746	3124	DCA HIGH	/MOST SIGNIFICANT HALF
1747	4562	JMS I OUTPUT	/OUTPUT THIS NUMBER
1750	1133	TAD COUNT6	
1751	1132	TAD COUNT5	
1752	7650	SNA CLA	/DONE?
1753	5020	JMP CONTIN	/YES
1754	2132	ISZ COUNT5	/NO
1755	2134	ISZ COUNT7	/OUTPUT FIVE NUMBERS?
1756	5334	JMP DGO	/NO
1757	5307	JMP CHAN	/YES-GO TYPE CHANNEL NUMBER
1760	1275	SGO, TAD MIND10	/SINGLE PRECISION
1761	3134	DCA COUNT7	
1762	1132	TAD COUNT5	
1763	1136	TAD SETTING	
1764	3125	DCA LOW	
1765	1525	TAD I LOW	
1766	3125	DCA LOW	
1767	4562	JMS I OUTPUT	/OUTPUT THIS NUMBER
1770	1133	TAD COUNT6	
1771	1132	TAD COUNT5	
1772	7650	SNA CLA	/DONE?
1773	5020	JMP CONTIN	/YES
1774	2132	ISZ COUNT5	/NO
1775	2134	ISZ COUNT7	/OUTPUT 10 NUMBERS?
1776	5362	JMP SGO+2	/NO
1777	5307	JMP CHAN	/YES-GO TYPE CHANNEL NUMBER

ADD	1031	ERRORS	0571	ORGPT	0163
ADRSC1	0254	EXPAND	1400	ORIGIN	0323
ADRSC2	1254	EXPPT	0161	OUTPUT	0162
ADRSC3	0235	FCA	6304	OVERD	0553
ADRSC4	0477	FCE	6322	OVERF	0154
ADRSC5	0476	FCO	6302	OVERM	0155
ADRSC6	0156	FRA	6351	OVERS	0512
ADRSC7	0157	FSC	6311	OVERSF	0500
BEGIN	0200	FSE	6312	OVERSM	0535
BELL	0234	FSIDE	0066	OVLAP	1600
BELLS	0577	FSO	6301	OVLAPT	1647
BINPCH	1351	HIGH	0124	OVL T	1666
CANF	0361	HIMARK	0121	OVT	0167
CANM	0362	HOLD1	0122	PE	0073
CARRTN	0071	HOLD2	0123	PLUS4	0107
CHAN	1707	HOLD3	0570	PMARK	0756
CHANGF	0510	HOLD4	1671	PNTDEC	1000
CHANGM	0545	HOLD5	1672	PRECS	0333
CHECK	1367	HOLD6	1673	PRINT1	0041
CHRCR	1055	HSUB	1052	PRODC T	0143
CKFULL	0447	INDEX1	0012	PUNCH	1311
CLDATA	0273	INDEX2	0013	P1THOU	0101
CLKCF1	0173	INDEX3	0014	P1160	0100
CLKCF2	0174	INLEAV	0142	P2THOU	0102
CLKCM1	0175	INPUT4	1256	P3THOU	0103
CLKCM2	0176	INTEG	1125	READ	0024
CLKF	0152	INTER	0001	RETURN	0164
CLKF2	0061	LEADIN	1300	SAVEAC	0151
CLKM	0153	LNFEED	0070	S8TRCT	1076
CLKM2	0062	LOMARK	0120	SCALE	0716
CLKSF	0417	LOW	0125	SETNG	0136
CLKSM	0433	LOWER	0740	SF	0363
CLOCK	0400	LSUB	1053	SGO	1760
CMAND	0165	MARK	0730	SHIFT	1450
CMMAND	0210	MASKX	0115	SIDE	0365
COD200	0072	MASK10	0113	SIDES	0166
CONST6	0137	MASK15	0110	SKIP	0074
CONST7	0140	MASK2	0114	SKIP3	0715
CONST8	0141	MASK63	0111	SM	0364
CONTIN	0020	MASK7	0112	SPACE	0065
COUNT1	0126	MCA	6334	STOP	1503
COUNT2	0127	MCE	6324	SWEEP1	0600
COUNT3	0130	MCO	6332	SWEEP2	0636
COUNT4	0131	MINCR	0106	SWEEP3	0645
COUNT5	0132	MIND10	1675	SWEP	1667
COUNT6	0133	MIND5	1674	SWIT3	0671
COUNT7	0134	MINHI	0116	SWIT4	0701
COUNT8	0135	MINLO	0117	SWIT5	0673
COUNT9	0310	MINUS4	0104	SWIT6	0675
COUN10	1155	MIN10	0057	TABLE1	0255
CRLF	0050	MIN20	0060	TABLE2	0236
DFM	0171	MRA	6352	TABLE3	1056
DGO	1734	MRBOUT	0105	TABLE6	0460
DMF	5353	MSC	6321	TEMP	1543
DSABLE	1156	MSE	6314	TEMPL	1054
DSPLAY	1200	MSIDE	0067	TEST	1670
DSPLCE	0150	MSO	6331	UPPER	0747
DSPLPT	1255	M1THOU	0076	WRITE	1676
DXL	6053	M2THOU	0077	XAXIS	0147
DYS	6067	M4HUN	0075	XCONST	0146
ENABLE	0311	NOF	5200	YCONST	0144
EQUAL	0063	NOV	0172	YORG	0145
ERROR	0160	OLT	0170	ZERO	0064

EXAMPLE:

The following is given as a cookbook recipe to those users who do not want to delve into the workings of the program. To set up to take data in region one on the M side do the following:

- Step 1: After the binary loader has been placed into memory, load the DODAD program (a binary tape). When loaded, turn the reader off and remove the tape.
- Step 2: Set the switch register (SR) to 200_8 , press load address then start. The program will ring the bell, and reset the teleprinter.
- Step 3: Set the data region switches located on the interface panel on the ADC M side to "off" for DATA ADD 0, and to "on" for DATA ADD 1.
- Step 4: Display data region one by typing the keyboard keys "D" "1" and "RETURN". Set the SR at 10_8 for 4096 counts per full scale.
- Step 5: Zero this region by typing "Z" and "RETURN".
- Step 6: Turn the clock switch located on the ADC to either minutes or tens of minutes for a 1 min or 10 min count. To change the live time to other values, consult the explanation given in CLOCK. The M clock may be reset during a time interval by typing "C" and "M".
- Step 7: Enable the data taking by typing "X" and "M".
- Step 8: Disable data taking by typing "N" and "M", or by waiting for the clock to disable the data taking.

The following steps may be performed as desired:

- Step 9: Expand the display to look at only the first 200 channels by typing "D" "1" "space", 4 "Ø's", "space", "Ø", "2", "Ø", "Ø", and "return". This will set the marker at 0000 and 0200. Then by typing "E" the display will be expanded.
- Step 10: Increase the lower marker by 5 by typing "L" and "5" and decrease the upper marker by 8 by typing "U" and "8". This will set the markers at 0005 and 0192.
- Step 11: Integrate between the markers by typing "I".
- Step 12: Write out the data in single precision by typing "W" and "S".

To use the other commands see the detailed explanation given in the COMMAND section.

These steps are intended as a guide only and can be altered to fit the needs of individual experiments.

SUMMARY OF COMMANDS

CLOCK	Ca	Xa	ENABLE
DISABLE	Na	Na	DISABLE
DISPLAY	Dd ↵	Ca	CLOCK
	Dd xxxx ↵	Dd ↵	DISPLAY
	Dd xxxx xxxx ↵	Dd xxxx ↵	
ENABLE	Xa	Dd xxxx xxxx ↵	
EXPAND	E	Od	OVERLAP
INTEGRATE	I	Lx	LOWER
LOWER	Lx	Ux	UPPER
OVERLAP	Od	E	ENABLE
PRECISION	Rab	I	INTEGRATE
PUNCH	P ↵	Z ↵	ZERO
SUBTRACT	Sd ₁ d ₂	P ↵	PUNCH
UPPER	Ux	Wb	WRITE
WRITE	Wb	Sd ₁ d ₂	SUBTRACT
ZERO	Z ↵	Rab	PRECISION

where:

a = F or M

b = S or D

d = 1, 2, or 3

x = any digit

↵ = carriage return

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