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OFF-LINE PROCESSING PROGRAM FOR MULTIPARAMETER SPECTRA DATA STORED IN DECTAPE

by

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FOR

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Abstract

A program for the off-line analysis of multiparameter spectra data stored into a DEC tape is described. The analysis is done by the PDP-8 computer. A two-dimensional correlation between any pair of pulse heights for desired events can be obtained. In addition, they are further discriminated by a requirement on the other pulse heights. Two different pulse-height scales are available. The program is written by Program Assembly Language, and its complete listing is presented.

1 Introduction

The purpose of this program is to analyze multiparameter pulse-height spectra data which were stored into DEC microtapes on line with DEC PDP-8 computer. The program is written by the Program Assembly Language (PAL)[1]. The program described herein was prepared for a particular experiment[2], and was not written in modular form. However, its alteration enables a simple off-line analysis in the other experiment.

The raw data for each event were recorded into 8 words by the on-line data taking program KRUN3[2]. The content of each word is listed in Table 1. In addition to run parameters, four kinds of pulse-height information are available for each event along with a fast logic code, which consists of the information on various coincidence logics among many counters.

The program KPHA2 is intended to obtain a two-dimensional correlation between any pair of pulse heights for a particular kind of events, which can be picked out of the raw data looking at their fast logic codes. In addition, the events are further discriminated by a requirement on the other pulse heights. The correlation can be summarized as a matrix with a pulse-height scale reduced by a factor of two or the one in a given range with a normal scale. In any case, the result is printed as a 50-channel x 40-channel matrix.

The program communicates with an operator through a keyboard. The computer receives commands to be executed and parameters to specify a given data. It waits for a command when encountered with an event having unexpected identification parameters.

TABLE 1

Computer words	Contents
1-st word	target "full" or "empty".
	name of up Λ°-telescope.
	run sequence number. (12 bits)
2-nd word	event sequence number. (12 bits)
3-rd word	magnet current. (12 bits)
4-th word	fast coincidence signals. (10 bits)
5-th word	pulse height, TOF (7 bits)
6-th word	pulse height, dE/dx 1 (7 bits)
7-th word	pulse height, dE/dx 2 (7 bits)
8-th word	pulse height, dE/dx 3 (7 bits)

Every 3 blocks of data (600_8 words) are read out of the DEC tape into a computer memory (locations 7000 to 7577 in octal). The pulse-height correlation is stored into locations 1600 to 6577, while the program occupies 0001 to 1577 and 7600 to 7661 . It should be noted that the program destroys a part of the BIN LOADER.

§2 Program Description

Commands

The program has four legal commands which are informed to the computer by the keyboard. All commands are terminated by typing a carriage return (↵). All illegal commands including a rubout cause the program to ignore anything preciously typed, and the program waits for a correct command. The legal commands are:

S↵ Start the data processing.

Contents of count registers and matrix locations are reset for a new data storage. The computer requires a designation of the pulse-height combination and the event code.

A↵ Add the data.

Only the parameters specifying the run are required to undergo a change. All the data previously stored into the count registers and matrix locations are added to the new ones.

E↵ End the data processing.

The run parameters and the number of events, which have been processed, are printed out. The program returns to a waiting loop to accept a command.

T↵ Print out the results.

The two-dimensional pulse-height correlation is printed out, along with the parameters of the processed runs and the number of events.

Since the program interrupt is disenabled except during the data transfer from the DEC tape, the computer accepts the command only in the waiting loop. The bell rings at the entrance to the waiting loop.

Program Sequence

The program sequence is illustrated by the flow diagram shown in Fig. 1. In the followings, characters enclosed by " " mean a requirement from the computer, and xxxx is an octal number to be typed on the keyboard.

1) Designate the pulse-height scale by a content of the 1-st bit of a switch register (SR), on starting the program.

SR0 = 0 ; the pulse height is reduced by a factor of tow.

SR0 = 1 ; not reduced, but biased at given pulse heights.

In the latter case, the lower limits are typed in;

"CUT =" xxxx , xxxx ↵

a lower limit 1 and a lower limit 2.

2) Specify a pair of pulse heights.

"CH =" 0 ↵ ; ADC1 and ADC2.

(TOF and dE/dx-1 in the present case.)

2 ↵ ; ADC3 and ADC4.

(dE/dx-3 and dE/dx-4 in the present case.)

In the latter case, a requirement on the TOF can be made;

"TOF =" xxxx, xxxx ↵

a lower and an upper limits.

Otherwise, the above sequence is bypassed.

3) Specify a particular kind of events by typing the corresponding logic codes.

"CODE =" xxxx, xxxx ↵

a mask code and an event code.

Four kinds of them can be specified by repeating this operation. They must be terminated by 0↵ upon requesting the next step.

4) Specify run parameters of the data to be processed.

i) "RUN NO =" xxxx ↵

a sequence number of the run.

ii) "BLOCK =" xx...x , xxxx ↵

block numbers of the top and the end of the run, specifying a data region of the DEC tape.

iii) "EVENT =" xxxx ↵

the number of the first event of the run.

iv) "MAG =" xxxx , xxxx ↵

a lower and an upper limits of the magnet current.

5) Read three blocks of raw data from the DEC tape.

6) Pick up one event and check run parameters associated with it. If an anomalous parameter is found, the 8 words of the event are printed out, waiting for a judgement of the operator. The event is discarded when the magnet current is out of the specified range.

7) Check the fast logic code. When the event does not satisfy the required coincidence logic, it is discarded.

8) Check the pulse height of the TOF in the case of the dE/dx-dE/dx combination.

9) When the event does not satisfy the requirement set at the step 2), it is discarded.

9) Generate an address (x, y) with the pulse heights x and y;

$$(x, y) = (y + 100) + (x) + SA$$

where SA is a starting address of the matrix.

10) Check the address whether it is in the matrix region or not.

11) Add one to the content of the address (x, y) and check the overflow.

12) Repeat the above procedure starting at 6).
New data are read out of the tape after the processing of the old data transferred to the computer memory is completed.

13) Print out the run parameters and wait for a command when all the events of the specified run is processed.

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References

1) PDP-8 Programming Manual.

2) S. Iwata, INS-J-115('70).

S. Iwata, INS-J-118('70).

Appendix

Program Listing

For

Off-Line Processing Program

KPHA2

```
/OFF-LINE PROGRAM FOR MULTIPARAMETER ANALYSIS
            /XPHA



*0
/CONSTANTS,POINTERS,AND SUBROUTINES
       0
       JMP I 2
       INTR
   DIS,BACK
 DTERR,ERROR
  MCOM,0
  FBLK,0
  LBLK,0
   IR1,0
   IR2,0
   IR3,0
  C212,212
  C215,215
  C240,240
  C260,260
     W,0          /TYPE ONE CHARACTER
       TLS
       TSF
       JMP .-1
       TCF
       CLA
       JMP I W
  CRLF,0          /CARRIAGE-RETURN AND LINE-FEED
       TAD C215
       JMS W
       TAD C212
       JMS W
       JMP I CRLF
  SPC1,0          /TYPE ONE SPACE
       TAD C240
       JMS W
       JMP I SPC1
  SPC2,0          /TYPE DOUBLE SPACE
       JMS SPC1
       JMS SPC1
       JMP I SPC2
  MASK,177
         7
        77
  PLS2,2
  PLS3,3
  PLS4,4
  PLS5,5
  MIN2,-2
  MIN3,-3
  MIN4,-4
  MIN5,-5
  MIN6,-6
  MIN8,-10
   M10,-12
   M20,-20
   M40,-40
```

```
 CONT1,0
 CONT2,0
 CONT3,0
   REG,0
  TEMP,0
  ADRS,0
  CHAR,0
  WRD1,0
  WRD2,0
   RUN,0
 EVCNT,0
CHANEL,0
   IW4,OCTL        /POINTERS
  CMND,COMAND
LISTEN,TYPEIN
LETTER,MESAGE
 IR12R,R12R
 UPRNT,UDPRNT
 IOCPT,DCPT
 READY,NEXT
 HEADR,RUNNO
 HEADB,BLOCK
 HEADE,EVENT
 PHCHK,SPH
    SA,1600
SCALER,.
  ENO1,0
  ENO2,0
 GOOD1,0
 GOOD2,0
   OUT,0
  OVER,0
 MADDR,.
  MAGU,0
  MAGL,0
DIGITS,.
       0
       0
       0
       0
       0
 ECODE,.
       0          /MEMORY OF EVENT CODE
       0
       0
       0
       0
    DY,100
SETTOF,0          /SET TOF LEVELS,LOWER AND UPPER
       JMS I LETTER
       2417
       0675
       0000
       JMS I LISTEN
       DCA TOFL
       JMS I LISTEN
       DCA TOFU
       JMP I SETTOF
 PHTOF,.
  TOFL,0
  TOFU,0
```

```
TLEVEL,0          /CHECK TOF
       TAD CHANEL
       SNA CLA
       JMP OK
       TAD PHTOF
       DCA IR2
       TAD REG
       IAC
       DCA ADRS
       TAD I ADRS
       JMS I PHCHK
       JMP I TLEVEL
    OK,ISZ TLEVEL
       JMP I TLEVEL
 BUFF,0
```

```
*200
/DATA CONTROL NO.1
  INIT,JMP I BIT1
  BIT1,BIT
 START,JMS I LETTER/SELECT PULSE-HEIGHT COMBINATION
       4543
       0310
       7500
       JMS I LISTEN
       DCA CHANEL
       JMS CRLF
       TAD CHANEL
       SZA CLA
       JMS SETTOF
       TAD DIGITS
       DCA IR1
       TAD ECODE
       DCA IR3
       JMS I LETTER
       4543
       0317
       0405
       7500
   ESET,JMS I LISTEN/SET EVENT CODE
       SNA
       JMP MCLEAR
       DCA I IR1
       JMS I LISTEN
       DCA I IR3
       JMS CRLF
       JMP ESET
MCLEAR,CLA CMA        /CLEAR MEMORIES
       TAD SA
       DCA IR1
       TAD PHACH
       JMS RESET
       TAD SCALER
       DCA IR1
       TAD MING
       JMS RESET
    ADD,
    SET,JMS I HEADR    /SET RUN PARAMETERS
       JMS I LISTEN
       DCA RUN
       JMS I HEADB
       JMS I LISTEN
       DCA FBLK
       JMS I LISTEN
       DCA LBLK
       JMS I HEADE
       JMS I LISTEN
       DCA EVCNT
```

```
 LEVEL,JMS I LETTER
       4543
       1501
       0775
       0000
       JMS I LISTEN/SET RANGE OF MAGNET EXCITATION
       DCA MAGL
       JMS I LISTEN
       DCA MAGU
ENDCHK,CMA
       JMS COMPAR
       TAD MIN3
       SPA
       JMP NEXT-3
       CLA
       TAD MIN3
DPOSIT,DCA READIN+3
       TAD FBLK
       DCA READIN+4

READIN,JMS I IR128 /READ BLOCKS OF DATA
       DATA
       7000
       0
       0
       JMS I WAIT
       IOF
       TAD BANK
       DCA REG
       JMP NPAGE
       TAD PLS3
       CIA
       JMP DPOSIT

  NEXT,ISZ CONT3    /PICK UP ONE EVENT
       JMP ECHK-3
       JMS COMPAR
       ISZ FBLK
       CLA
       TAD REG
       TAD EOM
       SNA CLA
       JMP ENDCHK
 NPAGE,TAD M20
       DCA CONT3
       TAD REG
       DCA IR3
       JMP I ECHK
  ECHK,CHECK

COMPAR,0            /END OF RUN?
       TAD FBLK
       CIA
       TAD LBLK
       SPA SNA
       JMP I RUNEND
       JMP I COMPAR
```

```
RESET,0             /CLEAR MEMORIES
       DCA CONTI
       DCA I IR1
       ISZ CONTI
       JMP .-2
       JMP I RESET
RUNEND,END
   EOM,-7577
 PHACH,-5100
  WAIT,DWAIT
  OVFL,ISZ OVER
       NOP
       JMP .+3
       ISZ OUT
       NOP
       CLA CLL
       TAD CHANEL
       SZA CLA
       JMP NEXT
       TAD PLS2
       TAD REG
       DCA REG
       JMP NEXT
  BANK,DATA-1
```

```
*400
/DATA CONTROL NO.2
CHECK,TAD RUN       /CHECK RUN NO. AND EVENT NO.
      ISZ REG
      CIA
      TAD I REG
      AND RMASK
      SZA CLA
      JMS LOOK
      TAD EVCNT
      ISZ REG
      CIA
      TAD I REG
      SZA CLA
      JMS LOOK
      ISZ EVCNT
      NOP
MAGNET,ISZ REG      /CHECK MAGNET SETTING
      TAD MADDR
      DCA IR2
      TAD I REG
      JMS SPH
      JMP DISCARD
      TAD REG
      TAD PLS3
      DCA ADRS
      TAD I ADRS
      TAD MIN8
TAD MIN4
      SPA CLA
      JMP DISCARD
      ISZ REG
      ISZ ENO2
      SKP
      ISZ ENO1
      JMP I CLASS
DISCARD,TAD PLS5    /DISCARD THIS EVENT
      TAD REG
      DCA REG
      JMP I READY
RMASK,777
CLASS,SELECT
 LOOK,0             /TYPE OUT DOUBTFUL EVENT
      JMS I HEADB
      TAD FBLK
      JMS I IW4
      TAD MIN3
      DCA CONT1
      TAD MIN8
      DCA CONT2
      JMS CRLF
      JMS SPC2
      TAD I IR3
      JMS I IW4
      ISZ CONT2
      JMP .-4
      ISZ CONT1
      JMP LOOK+6
      HLT           /INDICATE HOW TO DEAL WITH THE EVENT
      LAS
      SMA
      JMP .+3
      CLA
      JMP I LOOK    /SR0=1,CONTINUE THE ANALYSIS
      RTL
      SZL CLA
      JMP LOOK+4    /SR1=1,CHECK SUCCEEDING 3 EVENTS
      JMP I CMND    /SR1=0,WAIT FOR COMMAND
```

```
TYPEIN,0            /TYPE IN PARAMETERS
        CLA
        DCA  NUMBER
        JMS  TAKE
        TAD  UP
        SMA  CLA
        JMP  I CMND
        TAD  TEMP
        TAD  M260
        SMA
        JMP  .+4
        CLA
        TAD  NUMBER
        JMP  I TYPEIN
        DCA  TEMP
        TAD  NUMBER
        RTL  CLL
        RAL
        TAD  TEMP
        DCA  NUMBER
        JMP  TYPEIN+3
NUMBER,0
  TAKE,0            /READ IN ONE CHARACTER
        KSF
        JMP  .-1
        KRB
        DCA  TEMP
        TAD  TEMP
        JMS  W
        TAD  TEMP
        TAD  RUBOUT
        SNA  CLA
        JMP  I CMND
        TAD  TEMP
        JMP  I TAKE
    UP,-270
RUBOUT,-377
  M260,-260
   SPH,0            /SKIP IF PULSE-HEIGHT REQUIREMENT IS SATISFIED
        CIA
        DCA  CHAR
        TAD  CHAR
        TAD  I IR2
        SPA  CLA
        JMP  I SPH
        TAD  I IR2
        TAD  CHAR
        SPA  CLA
        ISZ  SPH
        JMP  I SPH
```

```
*600
/DATA CONTROL NO.3
COMAND,CLA          /READ COMMAND CHARACTERS
       TAD RING
       JMS W
       JMS I KB
       DCA BUFF
       JMS I KB
       TAD BUFF
       DCA BUFF
       TAD CMCODE
       DCA IR1
       TAD PATH
       DCA ADRS
       TAD MIN4
       DCA CONT1
POINTR,TAD BUFF
       TAD I IR1
       SNA CLA
       JMP .+5
       ISZ ADRS
       ISZ CONT1
       JMP POINTR
       JMP COMAND
       TAD I ADRS
       DCA ADRS
       JMP I ADRS
CMCODE,.
       -516
       -540
       -541
       -522
  PATH,.+1
       ADD
       START
       TABLE
       END
    KB,TAKE
  RING,207
   END,CLA
       JMS I HEADR
       TAD RUN
       JMS I IW4
       JMS I HEADB
       TAD FBLK
       JMS I IW4
       JMS I HEADE
       JMS I DPRNT
       ENO1
       JMS SPC2
       TAD EVCNT
       JMS OCTL
       JMP COMAND
```

```
 INTR,DCA AC            /PROGRAM INTERRUPT CONTROL
      RAL
      DCA LINK
      DTSF
      SKP
      JMP I MCOM
      TAD UNKNOW
      JMS W
      JMS FLAG
 BACK,CLA               /GO BACK TO INTERRUPTED PROGRAM
      TAD LINK
      RAR CLL
      TAD AC
      ION
      JMP I 0
UNKNOW,277
   AC,0
 LINK,0
ERROR,DCA TEMP          /DECTAPE ERROR
      JMS I LETTER
      4543
      0522
      2200
      TAD TEMP
      HLT
      LAS
      SMA CLA
      JMP COMAND
      JMP I .+1         /READ AGAIN
      READIN
 FLAG,0                 /CLEAR FLAGS
      IOF
      KCC
      TCF
      RFC
      DTXA
      JMP I FLAG
 RUNNO,0                /HEADINGS
      JMS I LETTER
      4543
      2225
      1640
      1617
      7500
      JMP I RUNNO
BLOCK,0
      JMS I LETTER
      4543
      0214
      1703
      1340
      7500
      JMP I BLOCK
```

```
EVENT,0
      JMS I LETTER
      4543
      4526
      0516
      2423
      7500
      JMP I EVENT
 OCTL,0              /OCTAL PRINT
      DCA TEMP
      TAD MIN4
      DCA BUFF
      TAD TEMP
      RAL CLL
      RTL
      DCA TEMP
      TAD TEMP
      RAL
      AND MASK+1
      TAD C260
      JMS W
      ISZ BUFF
      JMP OCTL+4
      JMP I OCTL
```

```
*1000
/SUBROUTINES
UDPRNT,0            /DOUBLE PRECISION DECIMAL PRINT
       CLA CLL      /6 DIGITS
       DCA DBOX
       TAD I UDPRNT
       DCA CHAR
       TAD I CHAR
       DCA WRD1
       ISZ CHAR
       TAD I CHAR
       DCA WRD2
       TAD MIN6
       DCA CNTE
       TAD DADDR
       DCA DLOC
       ISZ UDPRNT
DARND, TAD I DLOC
       ISZ DLOC
       DCA HSUB
       TAD I DLOC
       ISZ DLOC
       DCA LSUB
  DDO, CLL
       TAD LSUB
       TAD WRD2
       DCA TEMP
       RAL
       TAD HSUB
       TAD WRD1
       SNL
       JMP DOUT
       ISZ DBOX
       DCA WRD1
       TAD TEMP
       DCA WRD2
       JMP DDO
 DOUT, CLA
       TAD DBOX
       TAD C260
       JMS W
       CLL
       DCA DBOX
       ISZ CNTE
       JMP DARND
       JMP I UDPRNT
DADDR, DCON1
 CNTE, 0
 HSUB, 0
 LSUB, 0
 DBOX, 0
 DLOC, 0
```

```
DCON1,7747          /POWERS OF TEN
      4540
      7775
      4360
      7777
      6430
      7777
      7634
      7777
      7766
      7777
      7777

MESAGE,0            /TYPE OUT SERIES OF CHARACTERS
      CLA CMA
      TAD MESAGE
      DCA IR2
      TAD I IR2
      DCA CHAR
      TAD CHAR
      RTR
      RTR
      RTR
      JMS TYPECH
      TAD CHAR
      JMS TYPECH
      JMP MESAGE+4
TYPECH,0
      AND MASK+2
      SNA
      JMP I IR2
      TAD M40
      SMA
      JMP .+3
      TAD C340
      JMP MTP
      TAD MIN3
      SZA
      JMP .+3
      TAD C212
      JMP MTP
      TAD MIN2
      SZA
      JMP .+3
      TAD C215
      JMP MTP
      TAD C245
  MTP,JMS W
      JMP I TYPECH
 C245,245
 C340,340
```

```
DCPT,0          /SINGLE PRECISION DECIMAL PRINT
      DCA TEMP
      TAD MIN4
      DCA CNTE
      TAD ACODE
      DCA DLOC
      DCA DBOX
  D1,TAD TEMP
      CLL
      TAD I DLOC
      SNL
      JMP .+4
      DCA TEMP
      ISZ DBOX
      JMP D1
      CLA
      TAD DBOX
      TAD C260
      JMS W
      ISZ DLOC
      ISZ CNTE
      JMP D1-1
      JMP I DCPT
ACODE,.+1
      6030
      7634
      7766
      7777
```

```
/TC01 TAPE ROUTINES

*1200
/TC01 IOT DEFINITIONS

DTXA=6764    /XOR AC TO STATUS A
DTRB=6772    /READ STATUS B
DTCA=6762    /CLEAR STATUS A
DTRA=6761    /READ STATUS A
DTLA=6766    /LOAD STATUS A (CLEAR AND XOR)
DTLB=6774    /LOAD STATUS B
DTSF=6771    /SKIP ON TC01 FLAGS

R128,       0            /READ 128 WORDS
     JMS DWAIT   /WAIT IF MOTION IS ON
     TAD R128
     DCA W128
     CLA IAC             /SET TO WRITE
     JMP DGR-2

W128,       0
     JMS DWAIT   /WAIT IF MOTION IS ON
     TAD DR128C
     DCA DRET    /READ WRITE RETURN AFTER SEARCH
DGR, CLA CMA             /FIRST
     JMS DGET    /CORE LOC       -
     DCA R128
     JMS DGET
     DCA DUF             /UNIT AND FIELD
     JMS DGET
     DCA DNCB
     TAD DCRET
     DCA DSERH
     DCA DSTOP   /DON'T STOP TRANSPORT AFTER SEARCH
     JMS DGET    /GET BLOCK NUMBER
     JMP DTS1-1  /INITIATE SEARCH
DRET,       0
DUF, 0
     JMP I W128


DTEMP,
DTEMX,
DGET,       0            /PICK UP ARGUEMENTS
     TAD I W128
     ISZ W128
     JMP I DGET
DCRET,      DRET

DR128,      TAD D20              /WRITE
     TAD D30     /READ
     DTXA        /SET FUNCTION
     TAD R128
     DCA I DCAA  /ADRESS OF DATA
     ISZ WCOM    /POINT INT TO DATA
DR127,      DTXA                 /SEND A READ OR WRITE
     TAD D7600   /SET WORD COUNT FOR 128(10)WORDS
     DCA I DWC
     JMP I DIS   /EXIT
```

```
     JMP DIS3A
DINT,       DTRB                    /READ STATUS B
     SPA CLA
     JMP DER             /ERROR FLAG
     ISZ DNCB    /COUNT BLOCKS
     JMP DR127   /CONTINUE OPERATION
DTURNX,     TAD D200    /COMPLEMENT MOTION AND DIRECTION
     TAD D400
     JMP DR127
DR12RC,     DR12R
DCAA,       7755                    /POINTER TO CURRENT ADDRESS
DWC, 7754       /POINTER TO WORD COUNT
DNCB,       0
D30, 30
DCINT,      DINT-1
D24, 24
DTEM,       0
DBLK,       DTBLK
D400,       400
D614,       614
DTBLK,      0
D200,       200

DSERR,      0
     DCA R12R   /STORE BLOCK NUMBER
     JMS DWAIT
     TAD DTURNX
     DCA DSTOP
     TAD R12R
     DCA DTEM
DIS1,       TAD DBLK
     DCA I DCAA
     TAD DCINT
     DCA MCOM   /INTERRUPT RETURN
DIS2,       CLA IAC
     TAD DSERR
     DCA DTEMP
     TAD I DTEMP
     AND D7000  /PICK UP UNIT NUMBER
     TAD D614   /SET TO SEARCH,NORMAL,REVERSE
     DTLA       /LOAD STATUS A
DTLB        /FIELD 0
     ISZ DTEMP
     ION        /ENABLE INTERRUPT
     JMP I DTEMP        /RETURN TO USER

DIS3A,      DTRB                    /LOOK FOR END ZONE
     RTL
     SPA CLA
     JMP DTURNX /IN END ZONE; TURN AROUND
     DTRB
     SPA CLA
     JMP DER            /ERROR FLAG
     DTRA
```

```
D7000,      RTL
     RTL
D7600,      7600                    /OPERATE 2 CLA
     TAD DTBLK
     CMA IAC
     TAD DTEM
     SNA
     JMP DTFIND /FOUND BLOCK CHECK DIR
     CMA IAC
     SNL
     IAC
     SNL CLA
DTURN,      TAD D400     /TURN IF HERE
     JMP DR127  /XOR TO A STATUS AND DISMIS
DER, DTRA
     AND D200   /STOP TAPE IF RUNNING
     TAD D2     /DON'T CLEAR ERRORS
     DTXA
     DTRB       /ERROR STATUS B
     JMP I DTERR
DTFIND,     SNL CLA                 /TEST MOTION
     JMP DR127  /DON'T TURN YET
     TAD I DSERH          /GET COMPLETION RETURN
     DCA DSERH
DSTOP,      0    /EITHER A 0 OR TAD D200 (STOP)
     DTXA       /CLEAR FLAG
     TAD DUF
     DTLB       /SET MEM FIELD
     JMP I DSERH          /EXIT TO COMPLETION RETURN
D2, 2


DWAIT,      0               /WAIT FOR NO MOTION
     DTRA
     AND D230
     SZA CLA
     JMP .-3
 JMP I DWAIT
```

```
*1400
/PULSE HEIGHT ANALYSIS
SELECT,
 BDPHA,TAD DIGITS
       DCA IR1
       TAD ECODE
       DCA IR2
       TAD MIN5
       DCA CONTI
FLOGIC,TAD I IR1    /PICK UP REQUIRED EVENT
       SNA
       JMP GONEXT
       DCA TEMP
       TAD I REG
       AND TEMP
       CIA
       TAD I IR2
       SNA CLA
       JMP MATRIX
       ISZ CONTI
       JMP FLOGIC
GONEXT,TAD PLS4     /NOT REQUIRED

       TAD REG
       DCA REG
       JMP I READY
MATRIX,JMS TLEVEL
       JMP GONEXT
       ISZ GOOD2
       SKP
       ISZ GOOD1
       TAD REG
       TAD CHANEL
       DCA REG
       JMP PATH1
       JMP I ISCALE
ISCALE,SCALE
 PATH3,JMP PATH1
 PATH1,JMS I COND
       DCA WRD1

 PATH2,RTL CLL
       RTL
       RTL
       TAD WRD1
       TAD SA
       SZL
       JMP I OOR
       DCA ADRS
       TAD ADRS
       TAD LIMIT
       SZL
  HIGH,JMP I OOR
       ISZ I ADRS
       SKP
       SKP
       JMP I RTRN
       JMP I FLOW
 LIMIT,-6677
  COND,CONDNS
  FLOW,OVFL
  RTRN,OVFL+5
   OOR,OVFL+3
```

```
TABLE,JMS CRLF      /TYPE OUT MATRIX
      JMS I DPRNT
      GOOD1
      JMS CRLF
      TAD OVER
      JMS I IDCPT
      TAD DY
      CIA
      TAD SA
      DCA YAXIS     /YAXIS=SA-DY
      CMA
      DCA REG
      TAD MIN4
      DCA CONT3
AGAIN,TAD MIN5      /INITIALIZATION FOR NEW MATRIX
      DCA CONT2
      JMS CRLF
      ISZ CONT2
      JMP .-2
      TAD M10
      DCA CONT1
      JMS SPC2
      JMS SPC2
      JMS SPC1
  YCH,JMS SPC1
      ISZ REG
      NOP
      TAD REG
      JMS I IDCPT
      ISZ CONT1
      JMP YCH
CONINT,TAD FULL
      DCA XCNT
      CMA
      DCA XAXIS
 LINE,JMS CRLF
      TAD M10
      DCA CONT1
      ISZ XAXIS
      TAD XAXIS
      JMS I IDCPT /TYPE OUT X-CHANNEL
      JMS SPC1
      TAD XAXIS
      TAD YAXIS
      DCA ADRS    /ADRS=XAXIS+YAXIS
 MELM,TAD DY
      TAD ADRS
      DCA ADRS
      JMS SPC1
      TAD I ADRS
      JMS I IDCPT /TYPE OUT CONTENT AT (X,Y)
      ISZ CONT1
      JMP MELM
      ISZ XCNT
      JMP LINE
      ISZ CONT3
      SKP
      JMP I CMND
      TAD STEP
      TAD YAXIS
      DCA YAXIS
      JMP AGAIN
```

```
XAXIS,0
YAXIS,0
 XCNT,0
 FULL,-62
 STEP,1200



*7000
  DATA,0
```

```
*7600
   BIT,JMS I FCLEAR/SET SCALE OF PULSE HEIGHT
       LAS
       RAL
       SZL
       JMP SETJMP+2
       CLA
       TAD I BYPASS+1
SETJMP,DCA I BRANCH
       JMP I CMND
       JMS I LETTER
       4543
       0325
       2475
       0000
       JMS I LISTEN
       DCA CUT1
       JMS I LISTEN
       DCA CUT2
       TAD BYPASS
       JMP SETJMP
FCLEAR,FLAG
BYPASS,7000
       PATH3
BRANCH,PATH3-3
 SCALE,ISZ REG
       TAD I REG
       TAD CUT1
       SPA
       JMP LOW
       AND MASK+2
       DCA WRD1
       ISZ REG
       TAD I REG
       TAD CUT2
       SPA
       JMP LOW+1
       AND MASK+2
       JMP I .+1
       PATH2
   LOW,ISZ REG
       JMP I .+1
       HIGH
  CUT1,0            /LOWER LEVEL 1
  CUT2,0            /LOWER LEVEL 2
CONDNS,0            /SCALE DOWN CHANNEL NO,
       ISZ REG
       TAD I REG
       AND MASK
       RAR CLL
       JMP I CONDNS
$
```

OFF-LINE PROGRAM (KPHA2)