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REAL-TIME SOLAR MAGNETOGRAPH OPERATION SYSTEM SOFTWARE DESIGN AND USER'S GUIDE

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Science and Engineering Directorate

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16. ABSTRACT

This document presents the Real-Time Solar Magnetograph (RTSM) Operation system software design on PDP11/23+ and the User's Guide.

RTSM operation software is for Real-Time Instrumentation Control, data collection and data management.

The data will be used for vector analysis, plotting or graphics display. The processed data can then be easily compared with solar data from other sources, such as the Solar Maximum Mission (SMM).

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I wish to thank a number of people who helped me get the Real-Time Solar Magnetograph (RTSM) operation system software on the PDP 11/23+ successfully operational. In particular, Steve Purinton developed the I/O driver which provides the primary data flow path from the Solar Magnetograph camera into the PDP 11/23+ and also wrote the Chapter IV for describing the device driver interface. Dr. Mona Hagyard, Ed West, Nes Cumings and Steve Purinton provided very helpful suggestion and support during the software designing and development.

I also wish to thank our secretary, Leila Reed, for her support in typing this.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Concluded)

TECHNICAL MEMORANDUM

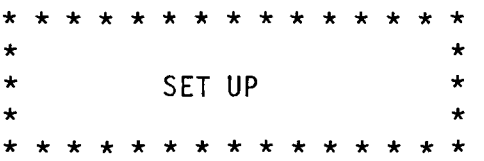
REAL-TIME SOLAR MAGNETOGRAPH OPERATION SYSTEM SOFTWARE DESIGN AND USER'S GUIDE

I. INTRODUCTION

One of the design goals of the new Marshall Space Flight Center vector magnetograph was to add flexibility so that the system could be configured to optimize hardware capabilities for specific scientific goals. In the design that was approved, a PDP 11/23 minicomputer is used as the host computer to control the data storage, the real time analysis and the operation of the vector magnetograph. A discrete I/O board and a DMA (Direct Memory Access) board connect the PDP 11/23 minicomputer to an Intel microprocessor which controls the hardware functions of magnetograph. The PDP 11/23 sets up the magnetograph operation by sending commands to the Intel microprocessor through the discrete I/O. After the hardware has been configured, the 11/23 then tells the Intel processor to acquire a data set. The Intel processor then controls the timing for the solid state camera (CCD) system, the polarizing optics and the data transfer from the sensor through the hardware adders (which will produce an enhanced or integrated image) to the temporary memory. When the integration has been completed, the data is transferred through the DMA to the 11/23. The communication times between the PDP 11/23 and the Intel microprocessor are usually small compared to the integration times for the data acquisition. This operation frees the 11/23 CPU to do real time data analysis so that the operators of the magnetograph can adjust the observational programs to fit solar activity.

The purpose of this report is to describe the Real Time Solar Magnetograph (RTSM) operation system software which includes the software design and user's guide. The observers or software engineers can use it as a reference manual.

II. RTSM OPERATION PROGRAM

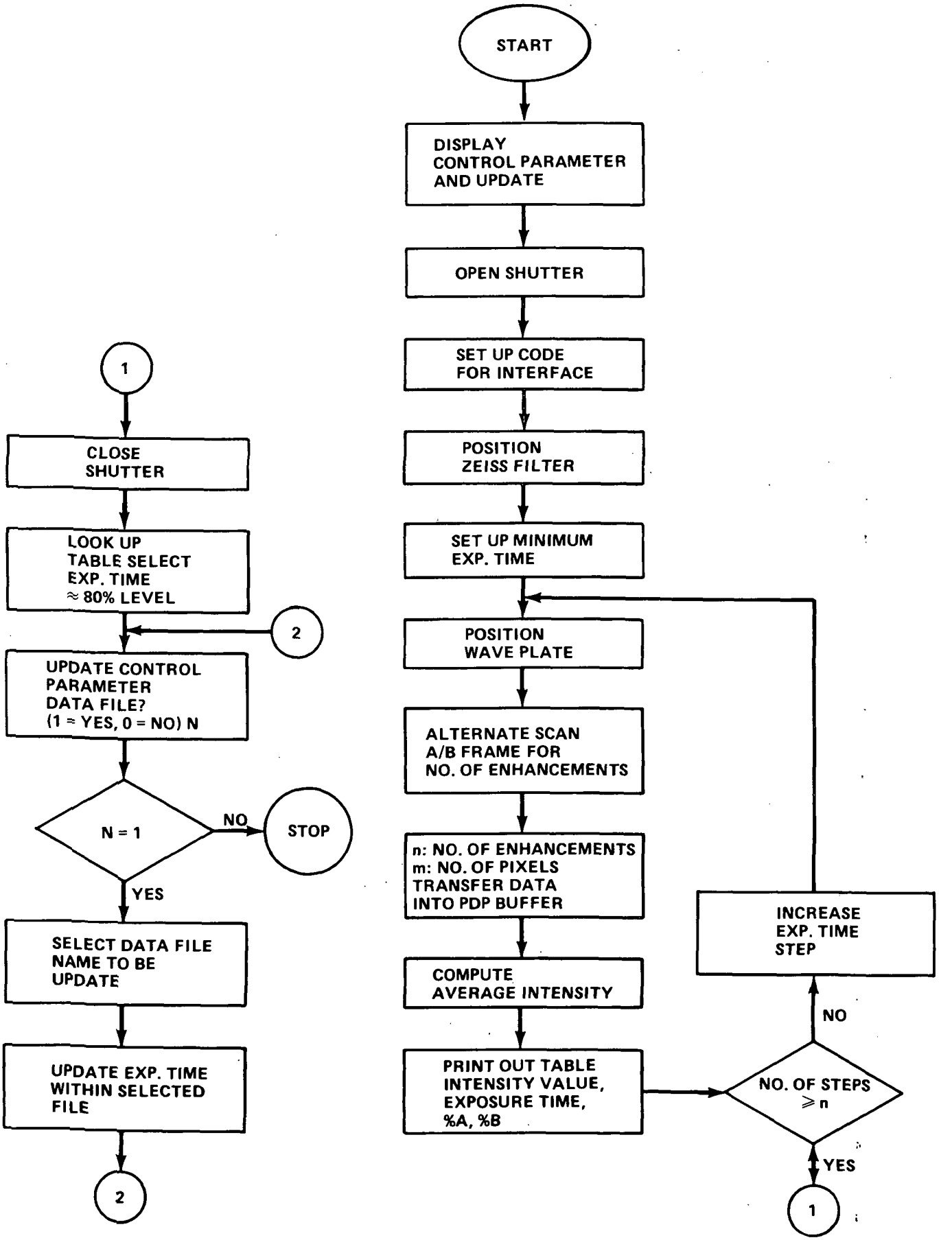


PROGRAM NAME: CE

PURPOSE: THIS IS A SET UP PROGRAM TO LOOK FOR CAMERA EXPOSURE TIME
WITH 80% SIGNAL LEVEL

PROGRAM AND SUBROUTINES LAYOUT: (*FOR SYSTEM ROUTINE)

```
CE
  STCTL
        CDDRW
             *GETADR
             *Q10
              ERRC
             *WAITFR

        UPD

  ZF2

        *GETADR
        *WTQ10
         ERRC
         BCDXA

CEMOD
      CDDRW

ACQTRA
      CDDRW
     *Q10
      TRANS1
      WAITFR

DISPLY
      CDDRW

UPDPAR
      *SPAWN
      *WAITFR
```


START
DISPLAY CONTROL PARAMETER AND UPDATE
OPEN SHUTTER
SET UP CODE FOR INTERFACE
POSITION ZEISS FILTER
SET UP MINIMUM EXP. TIME
POSITION WAVE PLATE
ALTERNATE SCAN A/B FRAME FOR NO. OF ENHANCEMENTS
n: NO. OF ENHANCEMENTS
m: NO. OF PIXELS
TRANSFER DATA INTO PDP BUFFER
COMPUTE AVERAGE INTENSITY
PRINT OUT TABLE INTENSITY VALUE, EXPOSURE TIME, %A, %B
NO. OF STEPS ⩾ n
NO
INCREASE EXP. TIME STEP
YES
1
1
CLOSE SHUTTER
LOOK UP TABLE SELECT EXP. TIME ≈ 80% LEVEL
2
UPDATE CONTROL PARAMETER DATA FILE? (1 = YES, 0 = NO) N
N = 1
NO
STOP
YES
SELECT DATA FILE NAME TO BE UPDATE
UPDATE EXP. TIME WITHIN SELECTED FILE
2

```
PROGRAM NAME : CE
PROGRAM DESCRIPTION : CAMERA EXPOSURE
1. MODE:1. 1A1B 2. 2A2B 3. 3A3B 4. (2AB,3AB) 5. ALL      1
2. NO. OF ENHANCEMENTS                                   16
3. STARTING PIXEL NO.                                    40
4. STARTING LINE NO.                                     40
5. NO OF PIXELS                                          32
6. NO OF LINES                                           32
7. BEGINNING EXP TIME                                   100
8. EXPOSURE TIME STEP I                                  10
9. NO. OF STEPS FOR STEP I                               10
10. EXPOSURE TIME STEP II                                 0
11. NO. OF STEPS FOR STEP II                              0
12. CENTER FILTER POSITION                              519
13. FILTER POSITION                                     527
14. BINNING IN X AXIS                                     2
15. BINNING IN Y AXIS                                     2

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2

INPUT PARAMETER NO.=
7,8,9

7. BEGINNING EXP TIME    = 25
8. EXPOSURE TIME STEP I =  5
9. NO. OF STEPS FOR STEPI=15

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
4

SIGNAL=1859.19  EXP. TIME= 25   %A= 45.53       %B= 45.23
.
.
.
SIGNAL=4095.00  EXP. TIME= 95   %A=100.00       %B=100.00

OPTION :
1. UPDATE NEW EXP TIME IN PARAMETER DATA FILE
2. STOP
1
INPUT PARAMETER DATA FILE NAME=
CE.DAT : CAMERA EXPOSURE
```

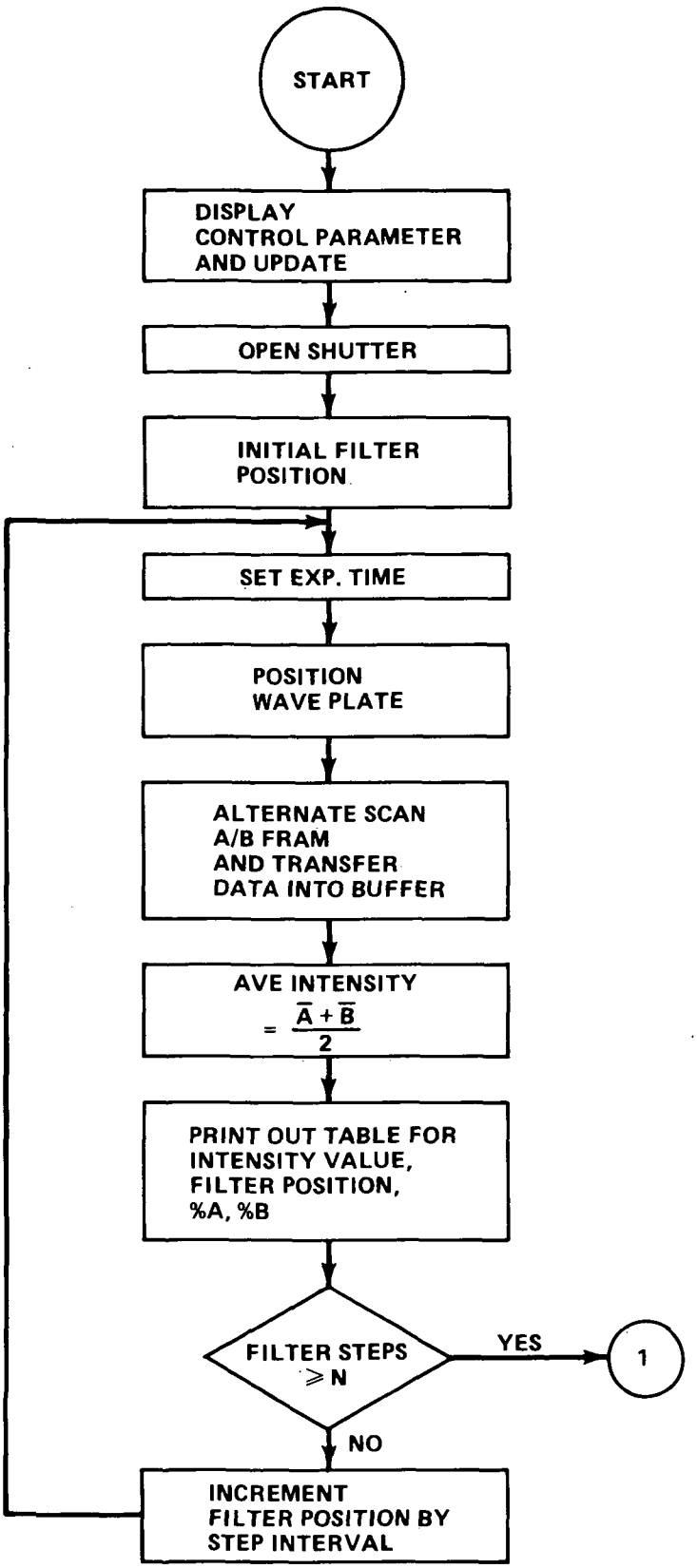
```
CF.DAT : CENTER FILTER
GC.DAT : GUIDER COORDINATE
IP.DAT : INSTRUMENTAL POLARIZATION
PC.DAT : POLARIZATION CALIBRATION
PH.DAT : PHOTO CALIBRATION
SMD.DAT: SOLAR MAGNETOGRAPH
AM.DAT : AUTO MODE
FS.DAT : FILTER STEP
CR.DAT : CROSS TALK
SN1.DAT: SIGNAL TO NOISE ONE
SN2.DAT: SIGNAL TO NOISE TWO

CE.DAT
SELECT UPDATE EXP. TIME = 45

OPTION:
1. UPDATE NEW EXP TIME IN PARAMETER DATA FILE
2. STOP
2
--STOP
```

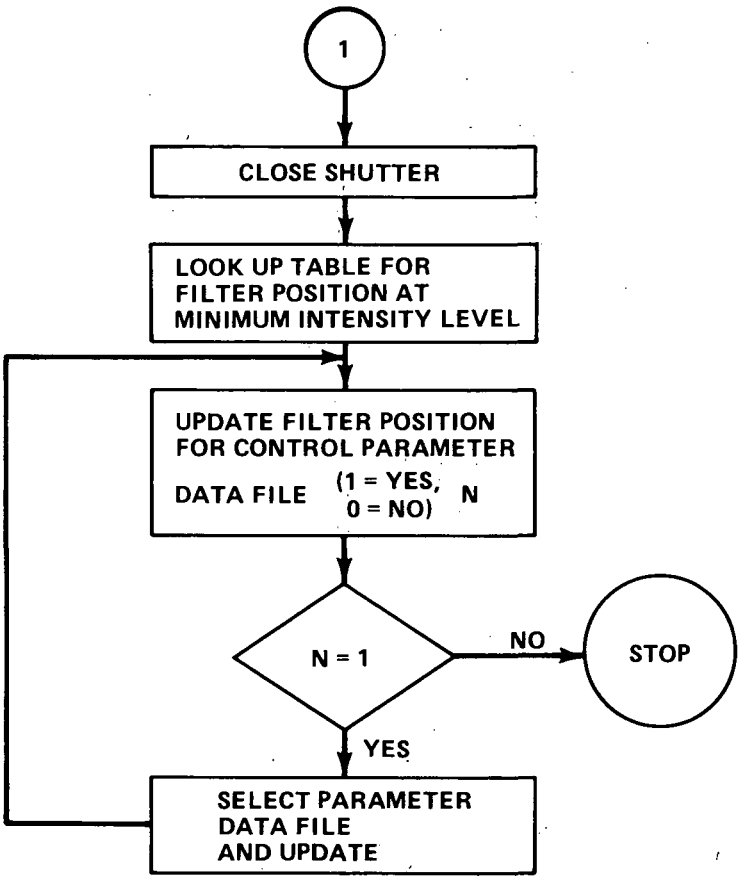
PROGRAM NAME: CF

PURPOSE: LOOK FOR FILTER POSITION AT MINIMUM SIGNAL LEVEL

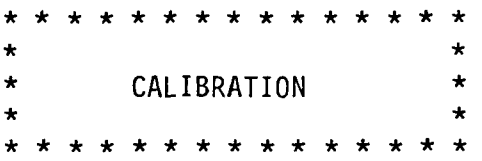
PROGRAM AND SUBROUTINES LAYOUT: (* FOR SYSTEM ROUTINE)

```
CF
  STCTL
       CDDRW
            *GETADR
            *Q10
             ERRC
            *WAITFR

       UPD

  CDDRW
  ZF2
     *GETADR
     *WTQ10
      ERRC
      BCDXA

  CEMOD
       CDDRW
      *Q10
       TRANS1
       WAITFR

  DISPLY
       CDDRW

  UPDPAR
       *SPAWN
       *WAITFR
```


START
DISPLAY CONTROL PARAMETER AND UPDATE
OPEN SHUTTER
INITIAL FILTER POSITION
SET EXP. TIME
POSITION WAVE PLATE
ALTERNATE SCAN A/B FRAM AND TRANSFER DATA INTO BUFFER
AVE INTENSITY = $\frac{\bar{A}+\bar{B}}{2}$
PRINT OUT TABLE FOR INTENSITY VALUE, FILTER POSITION, %A, %B
FILTER STEPS ⩾ N
YES
1
NO
INCREMENT FILTER POSITION BY STEP INTERVAL


1
CLOSE SHUTTER
LOOK UP TABLE FOR FILTER POSITION AT MINIMUM INTENSITY LEVEL
UPDATE FILTER POSITION FOR CONTROL PARAMETER DATA FILE (1 = YES, 0 = NO) N
N = 1
NO
STOP
YES
SELECT PARAMETER DATA FILE AND UPDATE

```
PROGRAM NAME : CF
PROGRAM DESCRIPTION : CENTER FILTER
1. MODE:1. 1A1B 2. 2A2B 3. 3A3B 4. (2AB,3AB) 5. ALL      1
2. NO. OF ENHANCEMENTS                                   16
3. STARTING PIXEL NO.                                    48
4. STARTING LINE NO.                                     48
5. NO OF PIXELS                                          32
6. NO OF LINES                                           32
7. BEGINNING EXP TIME                                   100
8. BEGINNING FILTER POSITION                            519
9. ENDING FILTER POSITION                               527
10. FILTER POSITION STEP                                  1
11. CENTER FILTER POSITION                                0
12. BINNING IN X AXIS                                     2
13. BINNING IN Y AXIS                                     2

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2

INPUT PARAMETER NO.=
7,8

7. EXPOSURE TIME        = 45
8. BEGINNING FILTER POSITION=511

OPTION:
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
4

SIGNAL= 3439.38 FILTER POS.=    511     %A 84.10        %B 83.88
.
.
.
SIGNAL= 3395.38 FILTER POS.=    526     %A 82.96        %B 82.87

OPTION :
1. UPDATE NEW EXP TIME IN PARAMETER DATA FILE
2. STOP
2
--STOP
```



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PROGRAM NAME: GC

PURPOSE: LOOK FOR THE EAST, WEST, NORTH, SOUTH EDGE OF THE SUN

1. Compute the Calibration Coefficient

2. Position Camera to the EAST,, WEST, NORTH, SOUTH, and Look for the Edge Pixel for Each Side

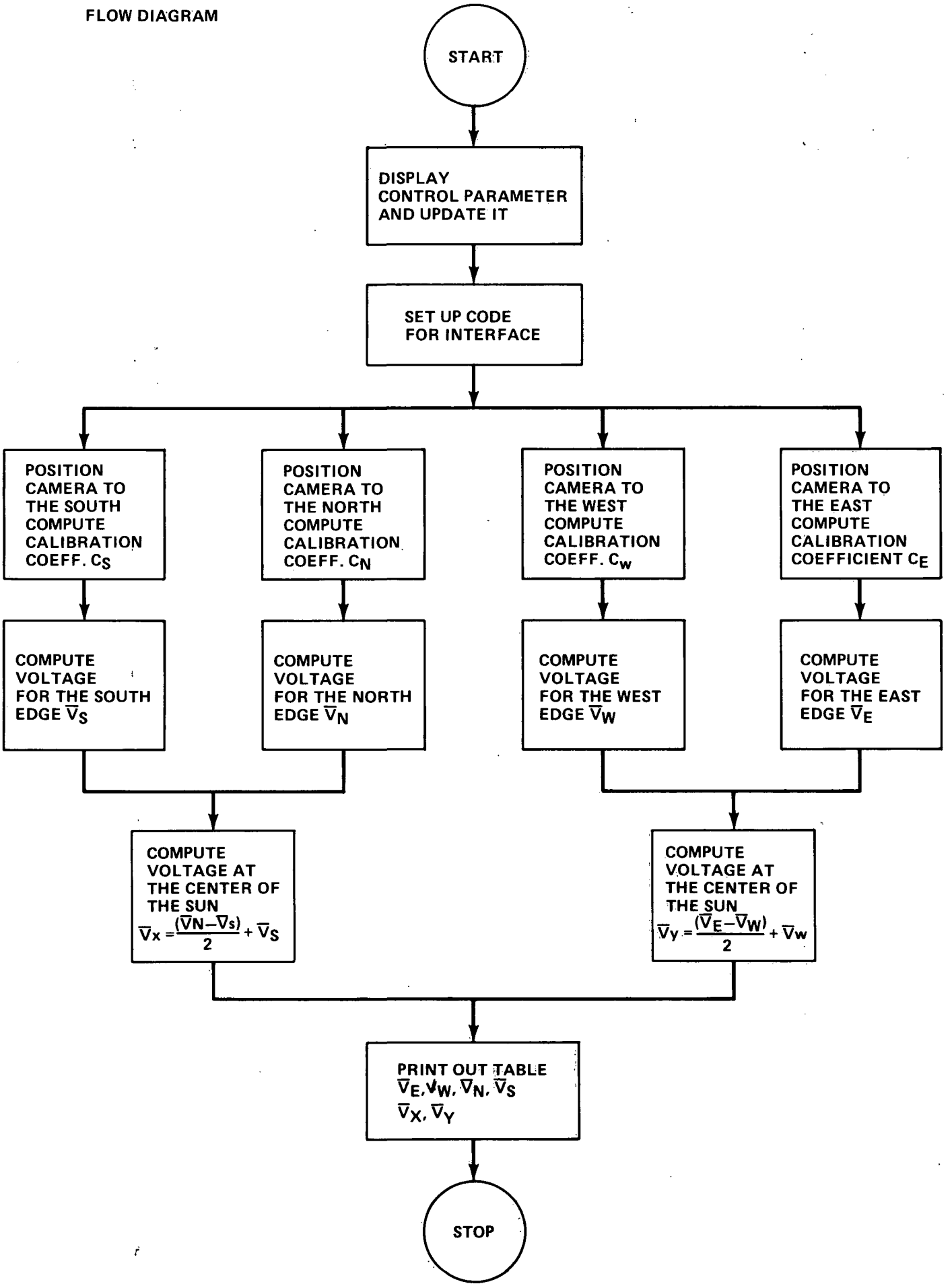
3. Compute the Voltage for Edge Pixels

PROGRAM AND SUBROUTINE LAYOUT:

```
GC
  STCTL
       CDDRW
            *GETADR
            *Q10
             ERRC
            *WAITFR

       UPD

 GCCB
     ZFT2
     EDGE
     HOUS

EDGE
     CDDRW
     MOD
     GCACQ
          XDISK
               SMNAM
               POPEN
               ERRC
              *GETADR
              *WTQ10
               ERRC
               PBLOCK
               PCLOSE
         CDDRW
        *Q10
         WAITFR

HOUS
    *GETADR
     BCDXA
    *WTQ10
```

```
ERRC
NBIT
SUB
ZF1
     CDDRW
     BCDXA
```

FLOW DIAGRAM



```
PROGRAM NAME : GC
PROGRAM DESCRIPTION : GUIDER COORDINATES


OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2

INPUT PARAMETER NO. =
DISPLAY PARAMETER DESCRIPTION AND INPUT VALUE TO BE CHANGED

OPTION:
1. POSITION CAMERA AT EAST
2. POSITION CAMERA AT WEST
3. POSITION CAMERA AT NORTH
4. POSITION CAMERA AT SOUTH
5. STOP

1
PAUSE : POSITION CAMERA ON THE EDGE OF THE SUN

"KEY IN RES WHEN FINISHED"

2
PAUSE : POSITION CAMERA ON THE EDGE OF THE SUN

"KEY IN RES WHEN FINISHED"

3

.
.
.
OPTION :
1. OPTION CAMERA AT EAST
2. OPTION CAMERA AT WEST
3. OPTION CAMERA AT NORTH
4. OPTION CAMERA AT SOUTH
5. STOP

5

PRINT OUT VOLTAGE FOR EAST,WEST,NORTH AND SOUTH
VE=        VW=        VN=        VS=

--STOP
```

PROGRAM NAME: IP

PURPOSE: "INSTRUMENTAL POLARIZATION"
LOOK FOR CIRCULARLY OR LINEARLY POLARIZED LIGHT TO THE ACTUAL INTENSITY LIGHT

COMPUTE THE MEAN:

$$\overline{P} = \Sigma \frac{A-B}{A+B} \; /N$$

DEVIATION:

$$Pij = Pij - \overline{P}$$

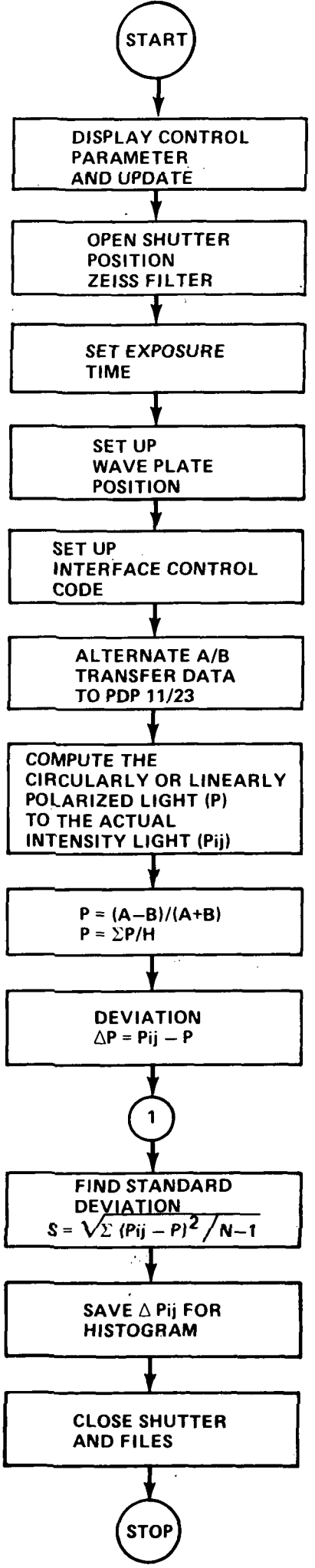
GROUP STANDARD DEVIATION:

$$S = \sqrt{\frac{\Sigma P^2}{N-1}}$$

SAVE DEVIATION ΔP FOR HISTOGRAM

PROGRAM AND SUBROUTINE LAYOUT:

```
IP
  STCTL
       CDDRW
            *GETADR
            *Q10
             ERRC
            *WAITFR

       UPD

  CDDRW
       *GETADR
       *Q10
        ERRC
       *WAITFR

  ZFT2
      *GETADR
      *WTQ10
       ERRC
       BCOXA

  MOD
     CDDRW

  ACQSAV
       CDDRW
      *Q10
      *WAITFR
       XDISK
           SMNAM
           POPEN
           ERRC
          *GETADR
          *WTQ10
           PBLOCK
           PCLOSE

 DISPLY
       *SPAWN
       *WATFR

 RMSQ
```


START
DISPLAY CONTROL PARAMETER AND UPDATE
OPEN SHUTTER POSITION ZEISS FILTER
SET EXPOSURE TIME
SET UP WAVE PLATE POSITION
SET UP INTERFACE CONTROL CODE
ALTERNATE A/B TRANSFER DATA TO PDP 11/23
COMPUTE THE CIRCULARLY OR LINEARLY POLARIZED LIGHT (P) TO THE ACTUAL INTENSITY LIGHT (Pij)
P = (A−B)/(A+B)
P = ΣP/H
DEVIATION
ΔP = Pij − P
1
FIND STANDARD DEVIATION
S = √Σ (Pij − P)² / N−1
SAVE Δ Pij FOR HISTOGRAM
CLOSE SHUTTER AND FILES
STOP

```
PROGRAM NAME : IP
PROGRAM DESCRIPTION : INSTRUMENTAL POLARIZATION
1. MODE:1. 1A1B 2. 2A2B 3. 3A3B 4. (2AB,3AB) 5. ALL      5
2. NO. OF ENHANCEMENTS                                  128
3. STARTING PIXEL NO.                                     1
4. STARTING LINE NO.                                      1
5. NO OF PIXELS                                         128
6. NO OF LINES                                          128
7. BEGINNING EXP TIME                                   100
8. CENTER FILTER POSITION                               519
9. FILTER POSITION                                      527
10. BINNING IN X AXIS                                     2
11. BINNING IN Y AXIS                                     2

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2


OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2

INPUT PARAMETER NO.=

DISPLAY PARAMETER DESCRIPTION AND INPUT VALUE TO BE CHANGED

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
4

SAVE  Pij FOR HISTOGRAM
FILE NAME : DELTP.DAT
PRINT OUT STANDARD DEVIATION

--STOP
```

PROGRAM NAME: PC

PURPOSE: "POLARIZATION CALIBRATION"
THE POLARIZING OPTICS OF THE RTSM CONSISTS OF LINEAR POLARIZER, $\lambda/4$ PLATE (ANALIZER), KD*P CRYSTAL. THIS PROGRAM IS TO ADJUST THE ANGLE θ IN BETWEEN THE LINEAR POLARIZER AND THE $\lambda/4$ PLATE (ANALIZER) AND COMPARE THE RESULT OF THE VECTOR COMPONENTS U, Q, V IN MATHEMATICAL FORM WITH THE REAL TIME DATA

MATH FORMAT	$\lambda/4$ IN	$\lambda/4$ OUT
U =	C	SIN(2θ)
Q =	COS(2θ)	COS(2θ)
V =	SIN(2θ)	C

REAL TIME DATA

U = 1A1B
Q = 2A2B
V = 3A3B

DESCRIPTION: U: Linearly Polarization at an Angle

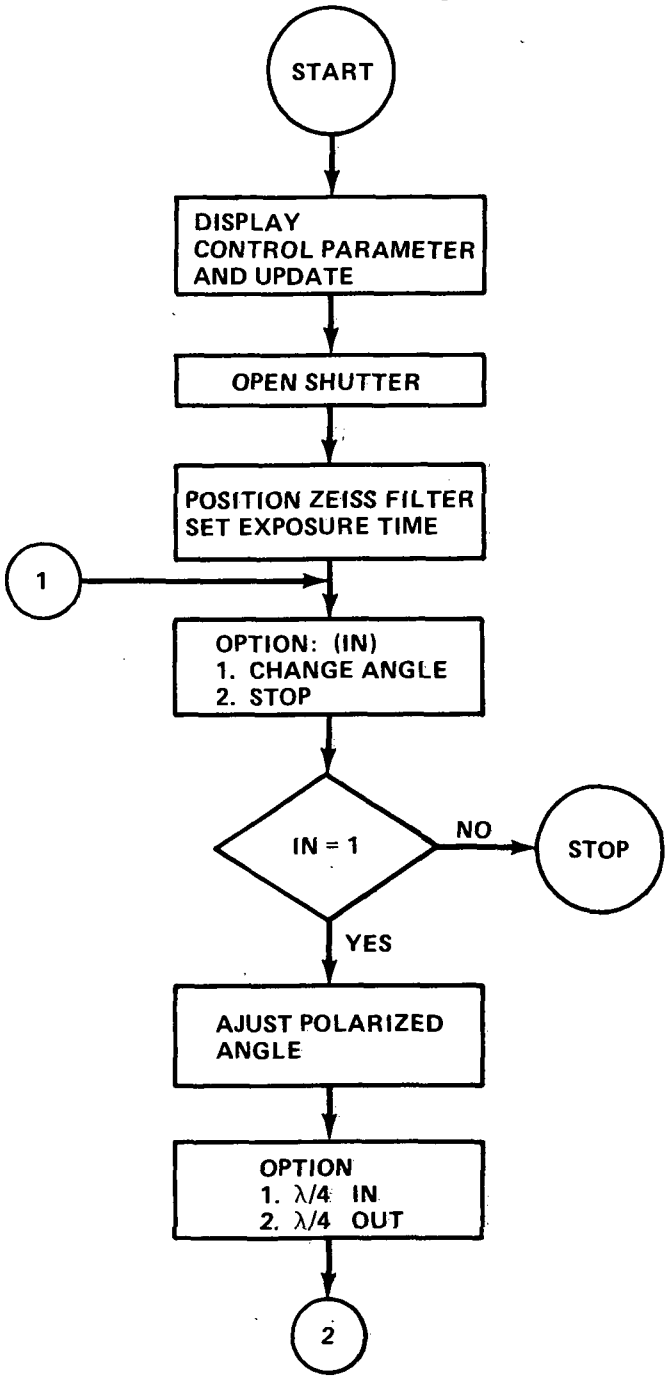
Q: Intensity Which is Linearly Polarized Parallel to Some Fixed Direction $\vec{i}$ in the Plane Perpendicular to the Direction of Propagation of the Light

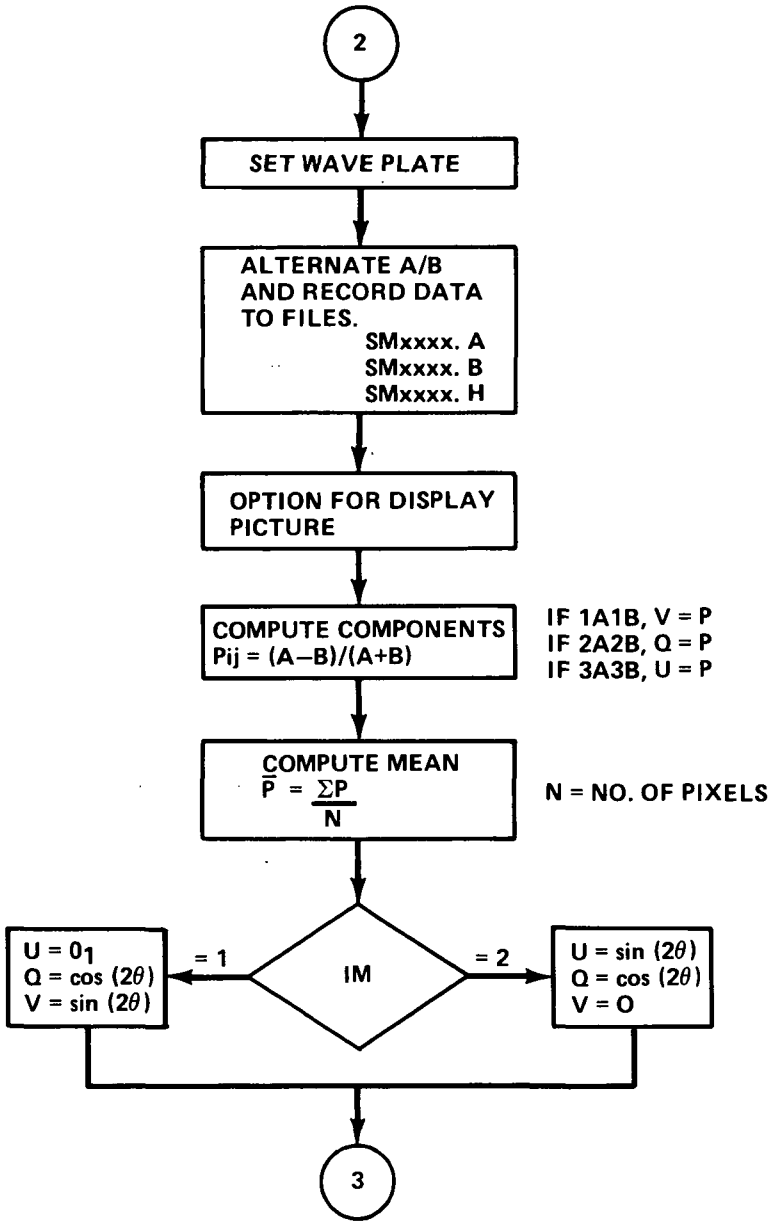
V: Circularly Polarized Light

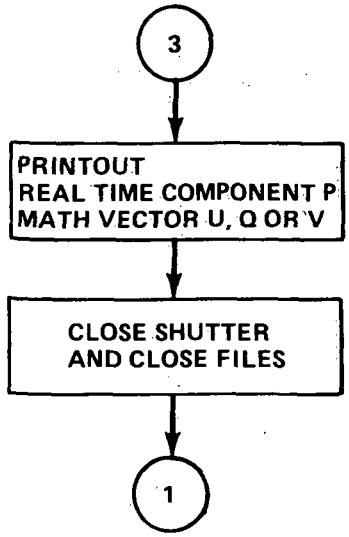
PROGRAM AND SUBROUTINE LAYOUT:

```
PC
  STCTL
       CDDRW
            *GETADR
            *Q10
             ERRC
            *WAITFR

       UPD

  CDDRW

  ZFT2
     CDDRW
     BCDXA

 MOD
    CDDRW

 ACQSAV
      CDDRW
     *Q10
      WAITFR
      XDISK
           SMNAM
           POPEN
           ERRC
          *GETADR
          *WTQ10
           ERRC
           PBLOCK
           PCLOSE

DISPLY
      *SPAWN
      *WAITFR

ANALY
     HOUS
         *GETADR
          BCDXA
         *WTQ10
          ERRC
          NBIT
          SUB
          ZF1
             CDDRW
             BCDXA

HKEEP
```

FLOW DIAGRAM




2
SET WAVE PLATE
ALTERNATE A/B
AND RECORD DATA
TO FILES.
SMxxxx. A
SMxxxx. B
SMxxxx. H
OPTION FOR DISPLAY
PICTURE
COMPUTE COMPONENTS
Pij = (A−B)/(A+B)
IF 1A1B, V = P
IF 2A2B, Q = P
IF 3A3B, U = P
COMPUTE MEAN
$\overline{P} = \frac{\Sigma P}{N}$
N = NO. OF PIXELS
IM
= 1
= 2
U = 0₁
Q = cos (2θ)
V = sin (2θ)
U = sin (2θ)
Q = cos (2θ)
V = O
3


3
PRINTOUT
REAL TIME COMPONENT P
MATH VECTOR U, Q OR V
CLOSE SHUTTER
AND CLOSE FILES
1

```
PROGRAM NAME : PC
PROGRAM DESCRIPTION : POLARIZATION CALIBRATION
1. MODE:1. 1A1B 2. 2A2B 3. 3A3B 4. (2AB,3AB) 5. ALL      5
2. NO. OF ENHANCEMENTS                                   16
3. STARTING PIXEL NO.                                     1
4. STARTING LINE NO.                                      1
5. NO OF PIXELS                                         128
6. NO OF LINES                                          128
7. BEGINNING EXP TIME                                   100
8. CENTER FILTER POSITION                               519
9. FILTER POSITION                                      527
10. BINNING IN X AXIS                                     2
11. BINNING IN Y AXIS                                     2

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2


OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2
INPUT PARAMETER NO. =7,8
7. EXPOSURE TIME=100
8. CENTER FILTER POSITION = 518

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED

4

OPTION :
1. CHANGE ANGLE
2. STOP
1

INPUT ANGLE IN DEGREES = 22.50

OPTION :
1. W/4 IN
2. W/4 OUT
```

```
(ADJUST ANGLE)
2

PRINT OUT
REAL PT=              ,THEORETICAL PT=           ,THETA ANGLE=

SM0693.A
SM0693.B

DO YOU WANT TO DISPLAY PICTURES
(YES=1,NO=0)

INPUT COMMENTS=
(KEY IN ** FOR TERMINATION)
**
SM0694.A
SM0694.B

DO YOU WANT TO DISPLAY PICTURES
(YES=1,NO=0)

0

.
.
.
OPTION :
1. CHANGE ANGLE
2. STOP
2
--STOP
```

PROGRAM NAME: PH

PURPOSE: "PHOTO CALIBRATION"
TAKING DATA FOR SIX STEPS OF FILTER POSITION,

1. Center Filter -6
2. Center Filter +0
3. Center Filter +2
4. Center Filter +3
5. Center Filter +4
6. Center Filter +5

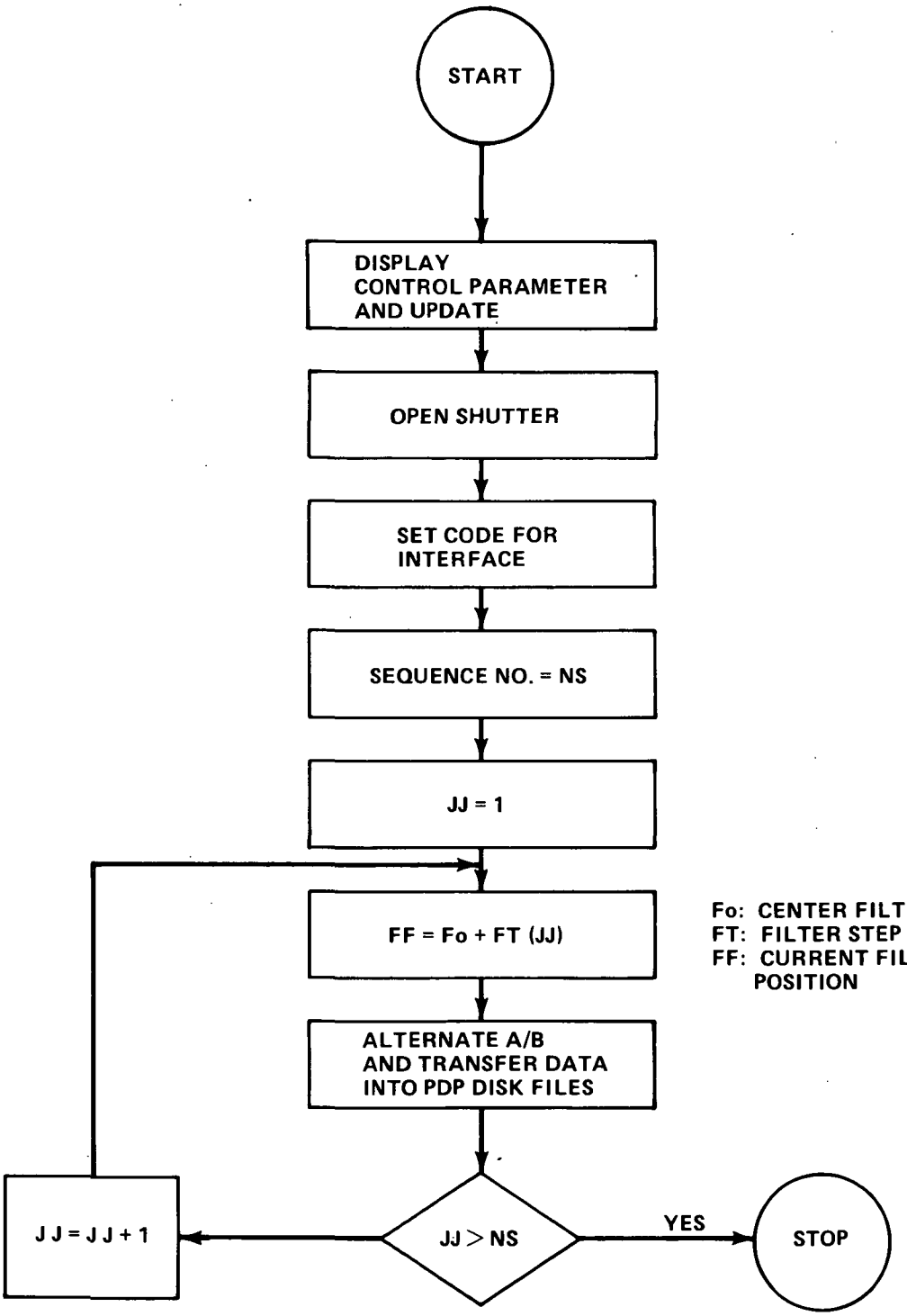
AND ONE ZERO-ILLUMINATION SET. SAVE THESE DATA INTO SMXXXX. FILES FOR FUTURE DATA ANALYSIS PROGRAMS TO NORMALIZE THE ABSOLUTE INTENSITY FROM THE BACKGROUND NOISE.

PROGRAM LAYOUT:

```
PH
  STCTL
       CDDRW
            *GETADR
            *Q10
             ERRC
            *WAITFR


       UPD

  CDDRW
  ZFT2
       *GETADR
       *WTQ10
        ERRC
        BCDXA

      MOD

         CDDRW

      ACQSAV
            CDDRW
           *Q10
            TRANS1
            WAITFR

     DISPLY
           *SPAWN
           *WAITFR

    ZERO
```

```
CDDRW
MOD
ACQSAV
DISPLY
```

FLOW DIAGRAM

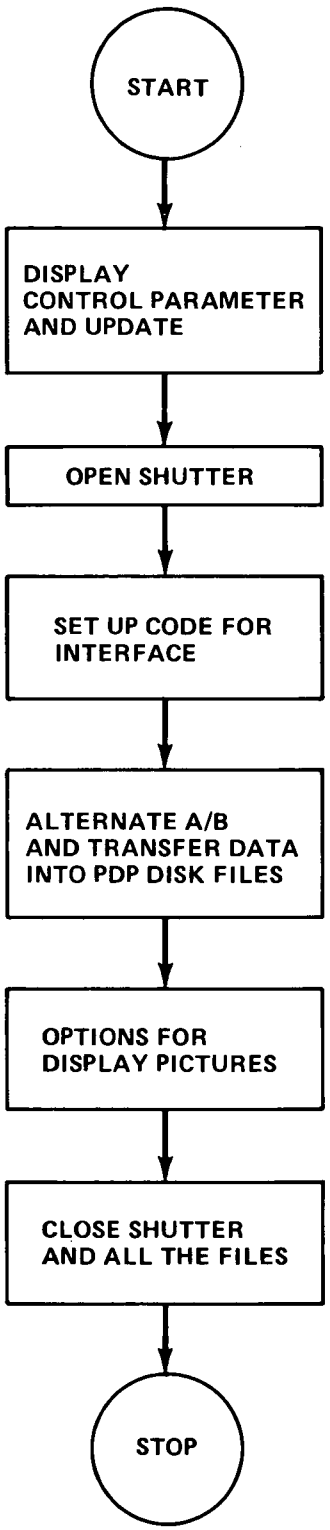


```
PROGRAM NAME : PH
PROGRAM DESCRIPTION : PHOTO CALIBRATION
1. MODE:1. 1A1B 2. 2A2B 3. 3A3B 4. (2AB,3AB) 5. ALL     1
2. NO. OF ENHANCEMENTS                                 128
3. STARTING PIXEL NO.                                    1
4. STARTING LINE NO.                                     1
5. NO OF PIXELS                                        128
6. NO OF LINES                                         128
7. BEGINNING EXP TIME                                  100
8. CENTER FILTER POSITION                              519
9. FILTER POSITION                                     527
10. BINNING IN X AXIS                                    2
11. BINNING IN Y AXIS                                    2

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2


OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
4

SAVE TRANSFER DATA
SMXXXX.A
SMXXXX.B

CONTINUE NEXT STEP OF FILTER POSITION AND TRANSFER DATA UNTIL
FINISHED SIX STEPS OF FILTER POSITION

DISPLAY IMAGE

--STOP
```

```
* * * * * * * * * * * * * * * *
*                             *
*   MAGNETOGRAPH MODE         *
*                             *
* * * * * * * * * * * * * * * *
```

```
PROGRAM NAME:  SM

PURPOSE:  "SOLAR MAGNETOGRAPH"
          A STRAIGHT THROUGH DATA TAKEN PROGRAM WITH OPTIONS OF
          DISPLAYING THE PICTURE.

          SAVED FILES:   SMXXXX.A
                         SMXXXX.B
                         SMXXXX.H       HOUSEKEEPING

PROGRAM AND SUBROUTINE LAYOUT:

     SM
       STCTL
           CDDRW
               *GETADR
               *Q10
                ERRC
               *WAITFR

          UPD

       CDDRW
       ZFT2

            CDDRW
            BCDXA

       MOD
             CDDRW

       ACQSAV
              CDDRW
             *Q10
              WAITFR
              XDISK
                  SMNAM
                  POPEN
                  ERRC
                 *GETADR
                 *WTQ10
                  ERRC
                  PBLOCK
                  PCLOSE

     HSAV
        HOUS
        HKEEP

     DISPLAY
           CDDRW
```

FLOW DIAGRAM



```
PROGRAM NAME :SM
PROGRAM DESCRIPTION : SOLAR MAGNETOGRAPH
1. MODE:1. 1A1B 2. 2A2B 3. 3A3B 4. (2AB,3AB) 5. ALL      1
2. NO. OF ENHANCEMENTS                                  256
3. STARTING PIXEL NO.                                     1
4. STARTING LINE NO.                                      1
5. NO OF PIXELS                                         128
6. NO OF LINES                                          128
7. BEGINNING EXP TIME                                   100
8. CENTER FILTER POSITION                               519
9. FILTER POSITION                                      527
10. BINNING IN X AXIS                                     2
11. BINNING IN Y AXIS                                     2

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2


OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2

INPUT PARAMETER NO.=
1,2
1. MODE: 1.1A1B 2. 2A2B 3. 3A3B 4. (2AB,3AB) 5. ALL =1
2. NO. OF ENHANCEMENTS = 1

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED

4

SMXXXX.A
SMXXXX.B

DO YOU WANT TO DISPLAY PICTURES
(YES=1,NO=0)
0
--STOP
```

PROGRAM NAME: AM

PURPOSE: "AUTO MODE"
THIS PROGRAM IS LIKE SM PROGRAM, EXCEPT IT CONTINUES TO REPEAT THE SAME PROCEDURE WITH DIFFERENT FILTER STEPS UNTIL THE SEQUENCE IS COMPLETED OR TERMINATED BY KEYING IN CONTROL C, ACD, AND ABO.

PROGRAM AND SUBROUTTINE LAYOUT:

```
AM
  STCTL
      CDDRW
          *GETADR
          *Q10
           ERRC
          *WAITFR

  CDDRW
  ZFT2
     CDDRW
     BCDXA

  HSAV
     HOUS
     HKEEP

 ACQSAV
     CDDRW
     WAITFR
     XDISK
         SMNAM
         POPEN
         ERRC
        *GETADR
        *WTQ10
         PBLOCK
         PCLOSE
```

```
PROGRAM NAME : AM
PROGRAM DESCRIPTION : AUTO MODE
1. MODE:1. 1A1B 2. 2A2B 3. 3A3B 4. (2AB,3AB) 5. ALL     5
2. NO. OF ENHANCEMENTS                                  256
3. STARTING PIXEL NO.                                     1
4. STARTING LINE NO.                                      1
5. NO OF PIXELS                                         128
6. NO OF LINES                                          128
7. BEGINNING EXP TIME                                    85
8. CENTER FILTER POSITION                               528
9. TIME DELAY                                             0
10. NO. OF SEQUENCE REPEAT                                1
11. BINNING IN X AXIS                                     2
12. BINNING IN Y AXIS                                     2
13. FILTER SEQUENCE                                       6

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2


OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
4

REPEAT THE SAME PROCEDURE WITH DIFFERENT FILTER STEPS UNTIL
THE SEQUENCE IS COMPLETED OR TERMINATED BY "KEY IN CNTL/C AND
ACD , AND ABO"

SMXXXX.A
SMXXXX.B
SMXXXX.A
SMXXXX.B
.
.
.
CNTL/C
ACD
ABO
--STOP
```

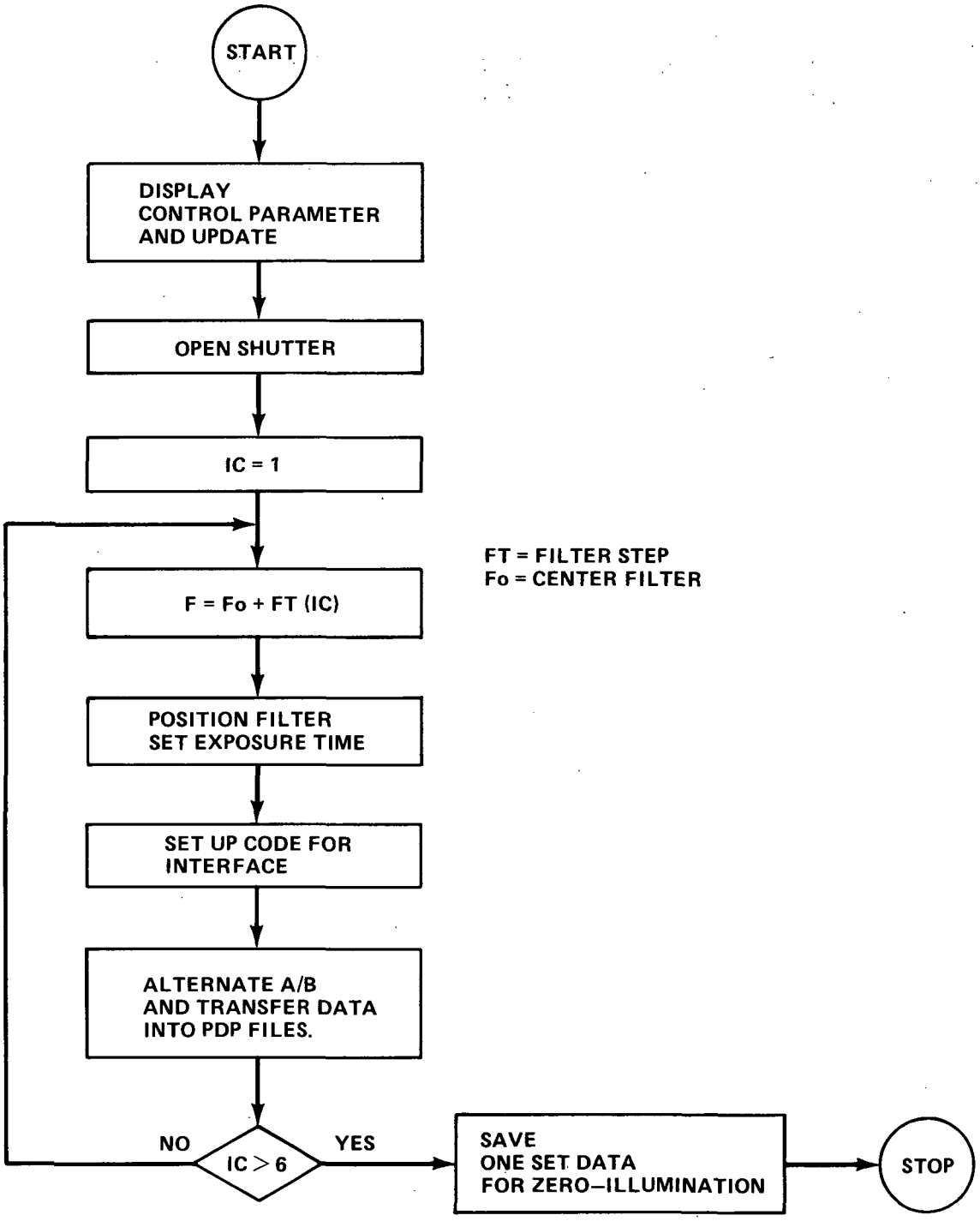
PROGRAM NAME: FS

PURPOSE: "FILTER SCAN"
THIS PROGRAM OPERATES THE SAME AS AM EXCEPT THE INTERVAL IN BETWEEN FILTER STEPS ARE THE SAME.

PROGRAM AND SUBROUTINE LAYOUT:

FS
- CDDRW
- STCTL
- ZFT2
- MOD
- ACQSAV
- DISPLY
- SAVH
- AVE
- LOCAT

FLOW DIAGRAM



```
PROGRAM NAME : FS
PROGRAM DESCRIPTION : FILTER SCAN
1. MODE:1. 1A1B 2. 2A2B 3. 3A3B 4. (2AB,3AB) 5. ALL      1
2. NO. OF ENHANCEMENTS                                   16
3. STARTING PIXEL NO.                                     1
4. STARTING LINE NO.                                      1
5. NO OF PIXELS                                         128
6. NO OF LINES                                          128
7. BEGINNING EXP TIME                                   100
8. EXPOSURE TIME STEP I                                  50
9. NO. OF STEPS FOR STEP I                               10
10. EXPOSURE TIME STEP II                                10
11. NO. OF STEPS FOR STEP II                             20
12. BEGINNING FILTER POSITION                           519
13. ENDING FILTER POSITION                              527
14. FILTER POSITION STEP                                  1
13. CENTER FILTER POSITION                              519
16. BINNING IN X AXIS                                     2
17. BINNING IN Y AXIS                                     2

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2

OPTION :
1. GO
2. STOP
1

INPUT SIGNAL RANGE IN PERCENTAGE (REAL NO.)=

SET UP CONTROL TABLE


OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED

4

SAVE DATA SET
SMXXXX.A
SMXXXX.B

PV=              ,FILTER POSITION =
```

```
LOCATE PIXEL POSITION WITH THE SELECTED SIGNAL LEVEL

(Xi,Yi)=    ,
.
.
.


OPTION :
1. GO
2. STOP
2

--STOP
```

DIAGNOSTICS

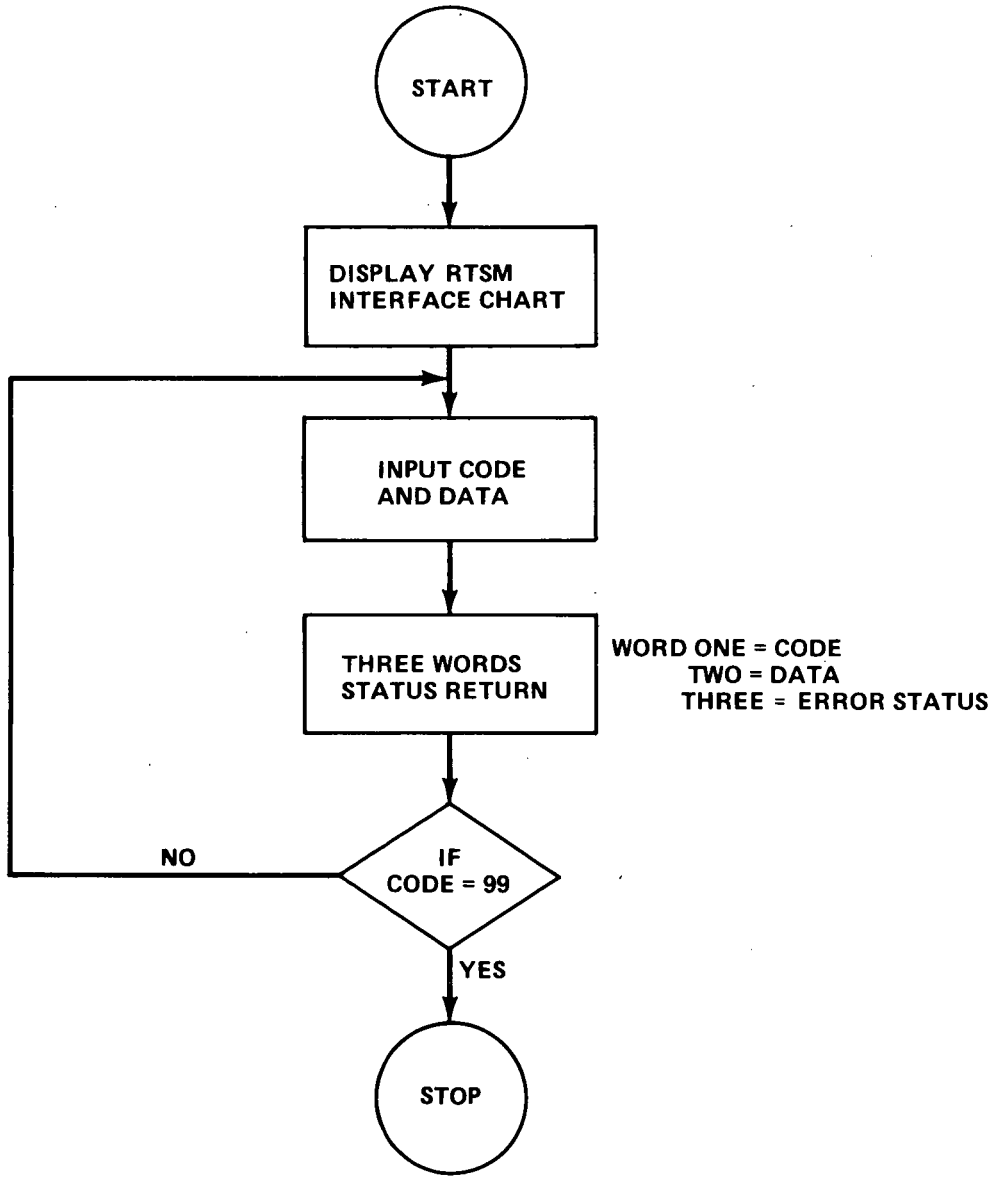
PROGRAM NAME: SOLAR

PURPOSE: THIS IS A TESTING PROGRAM. IT ALLOWS THE OPERATOR TO ENTER ANY INTERFACE CODE AND CHECK OUT THE PROBLEMS INDIVIDUALLY.

PROGRAM AND SUBROUTINE LAYOUT:

```
SOLAR
    CDDRW
    SOLZF
      SOLSUB
            *GETADR
            *WTQ10
             ERRC
            *WAITFR

  SOLCLK
      NBIT

 SOLSW
      CDDRW
      SUB

SOLXDK
    POPEN
     ERRC
    *GETADR
    *WTQ10
     ERRC
     PBLOCK
     PCLOSE

HOUS
   *GETADR
    BCDXA
   *WTQ10
    ERRC
    NBIT
    SUB
    ZF1
       CDDRW
       BCDXA

HKEEP
```

FLOW DIAGRAM



MARSHALL SPACE FLIGHT CENTER VECTOR MAGNETORGRAPH

OPERATION

CODE	FUNCTION
35	PDP CONTROL
37	TERMINAL INPUT
28 –	ALTERNATE A/B
31	CHANGE FILTER
25	DMA XFER
45	SHUTTER VOLTAGES
46	POLAR. VOLTAGES
02	COD INPUT
24	FILM CAMERA
53	MEMORY PATTERN
54	CLEAR
55	TEST PATTERN
56	DISPLAY STORAGE

INPUT CODE = 28
RETURN 3 WORD IN DEC = 1

STATUS

CODE	FUNCTION		
41	A RELAY		1
42	B RELAY		2
43	WAVEPLATE POS.		1
32	FILTER POS		522
21	ENHANCEMENTS		256
51	EXP. TIME		70
23	VIDEO DISPLAY		
15	R–T CLOCK	221: 16: 41: 14	
11	DVM # 1		0.163
12	DVM # 2		–9.827
14	A/D CHANNELS:	# 1 185	# 2 185
	# 3 167	# 4 209	# 5
	# 6	# 7	# 8
16	STATUS SWITCHES		

INPUT DATA = _
209 0

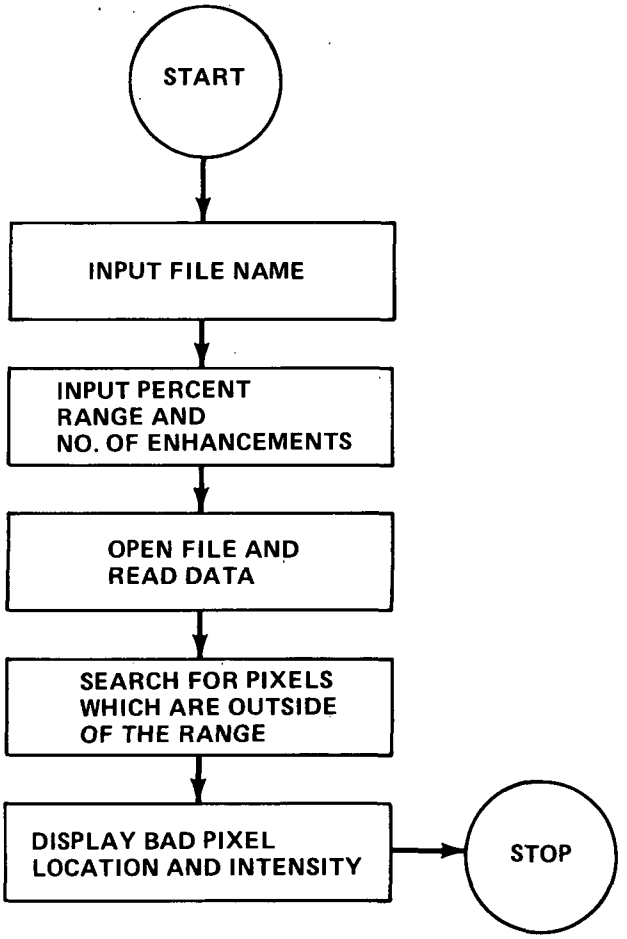
PROGRAM NAME: BADPX

PURPOSE: LOOK FOR BAD PIXELS. DISPLAY THE BAD PIXEL LOCATION AND INTENSITY.

PROGRAM AND SUBROUTINE:

BADPX
NBIT

FLOW DIAGRAM:


START
INPUT FILE NAME
INPUT PERCENT
RANGE AND
NO. OF ENHANCEMENTS
OPEN FILE AND
READ DATA
SEARCH FOR PIXELS
WHICH ARE OUTSIDE
OF THE RANGE
DISPLAY BAD PIXEL
LOCATION AND INTENSITY
STOP

```
PROGRAM NAME : BADPX
PROGRAM DESCRIPTION : BAD PIXEL

INPUT FILENAME =
SMXXXX.A

INPUT PERCENT RANGE (REAL NO.)= XXXX.XX,XXXX.XX

STARTING AND ENDING LINE NO.=
STARTING AND ENDING PIXEL NO.=

PRINT OUT ALL THE PIXEL POSITION AND INTENSITY FOR
THE PIXEL OUTSIDE OF THE RANGE

--STOP
```

PROGRAM NAME: FIXPX

PURPOSE: THIS PROGRAM IS TO REPLACE A BAD PIXEL WITH THE INTENISTY VALUE EQUIVALENT TO THE PREVIOUS PIXEL.

```
PROGRAM NAME : FIXPX
PROGRAM DESCRIPTION : FIX THE BAD PIXEL

INPUT FILE NAME =
SMXXXX.A

OUTPUT FILE NAME =
SMXXXX.A

INPUT NO. OF BAD PIXELS =
n

PIXEL LOCATION =
X1,Y1 =    ,
.
.
.
Xn,Yn =    ,

IF THE BADPIXEL IS AT LOCATION (1,1)
THEN INPUT PERCENTAGE FOR THAT PIXEL (REAL NO.)

--STOP
```

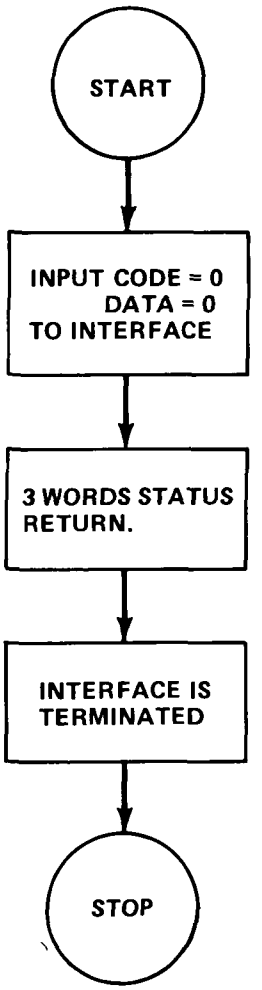
PROGRAM NAME: ACD

PURPOSE : THIS PROGRAM IS TO TERMINATE THE INTERFACE.

PROGRAM AND SUBROUTINE LAYOUT:

```
    ACD
      CDDRW
          *GETADR
          *Q10
           ERRC
          WAITFER
```

FLOW DIAGRAM:



ANALYSIS

Preceding Page Blank

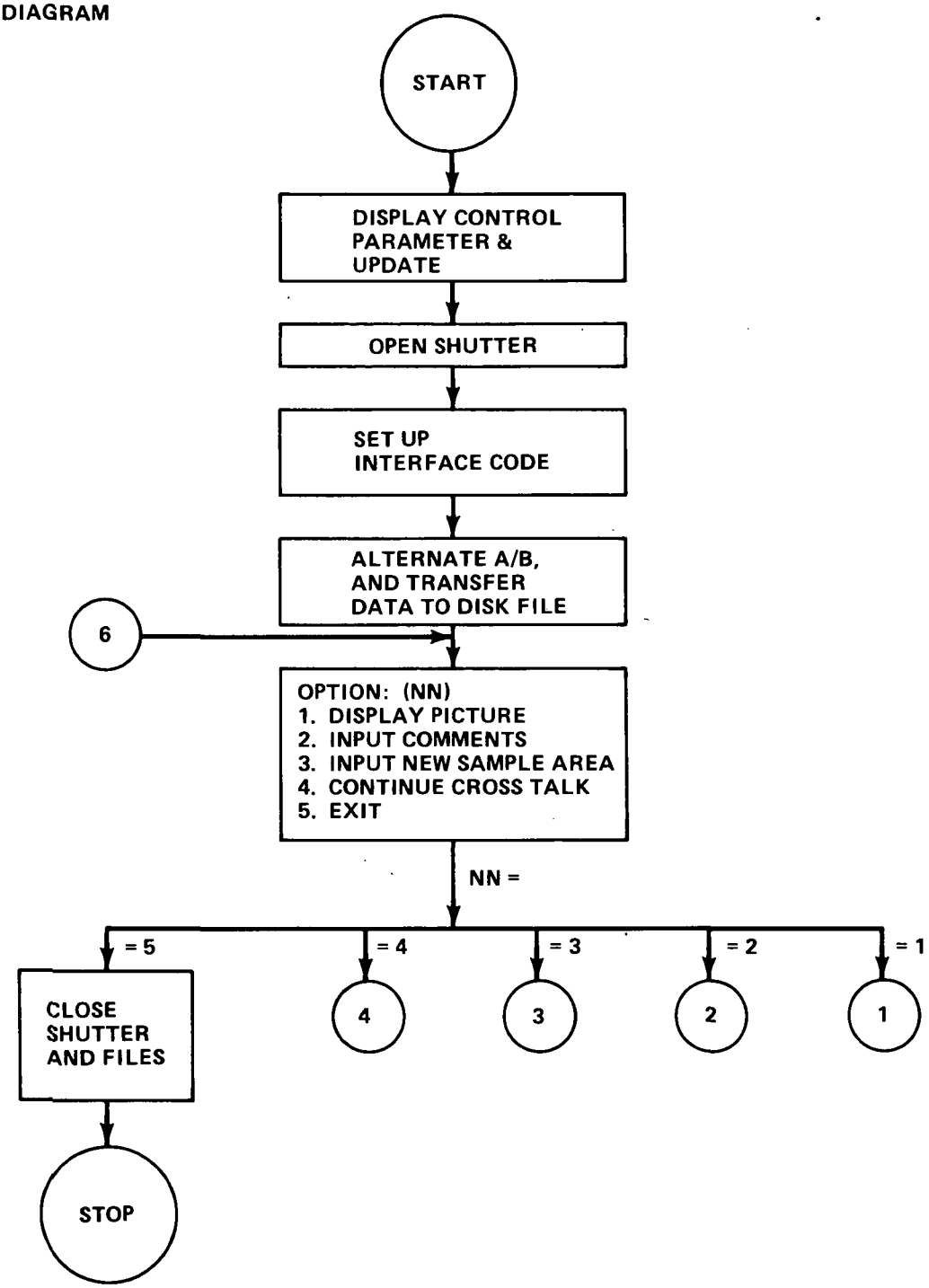
PROGRAM NAME: CR

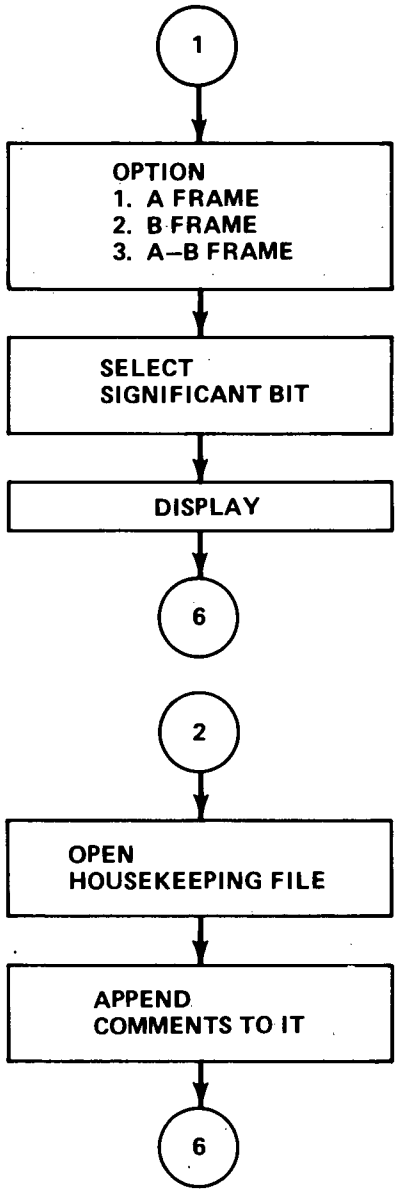
PURPOSE: "CROSS TALK"
THIS PROGRAM IS TO COMPARE DATA A 5 POINT (4 CORNER AREAS
AND 1 CENTER AREA)

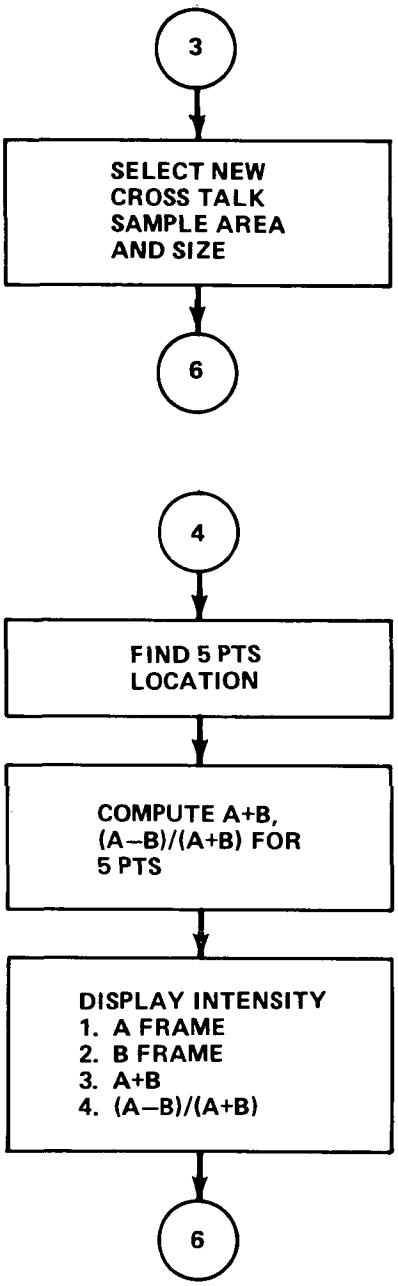
PROGRAM AND SUBROUTINE LAYOUT:

```
CR
  STCTL
      CDDRW
          *GETADR
          *Q10
           ERRC
          *WAITFR

    UPD

 CDDRW
 ZFT2
     *GETADR
     *WTQ10
      ERRC
      BCDXA

MOD
   CDDRW

ACQTRA
     CDDRW
    *Q10
     TRANS1
     WAITFR

DISPLY
     *SPAWN
     *WAITFR

CRSUB
     HOUS
        *GETADR
        BCDXA
        *WTQ10
         ERRC
         NBIT
        SUB
        ZF1
            CDDRW
```

FLOW DIAGRAM




1
OPTION
1. A FRAME
2. B FRAME
3. A–B FRAME
SELECT
SIGNIFICANT BIT
DISPLAY
6
2
OPEN
HOUSEKEEPING FILE
APPEND
COMMENTS TO IT
6


3
SELECT NEW CROSS TALK SAMPLE AREA AND SIZE
6
4
FIND 5 PTS LOCATION
COMPUTE A+B, (A–B)/(A+B) FOR 5 PTS
DISPLAY INTENSITY
1. A FRAME
2. B FRAME
3. A+B
4. (A–B)/(A+B)
6

```
PROGRAM NAME : CR
PROGRAM DESCRIPTION : CROSS TALK
1. MODE:1. 1A1B 2. 2A2B 3. 3A3B 4. (2AB,3AB) 5. ALL      1
2. NO. OF ENHANCEMENTS                                    8
3. STARTING PIXEL NO.                                     1
4. STARTING LINE NO.                                      1
5. NO OF PIXELS                                         128
6. NO OF LINES                                          128
7. BEGINNING EXP TIME                                   300
8. CENTER FILTER POSITION                               519
9. FILTER POSITION                                      519
10. BINNING IN X AXIS                                     2
15. BINNING IN Y AXIS                                     2

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2


OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED

4
OPTION:
1. GO
2. SOTP
1

SMXXXX.A
SMXXXX.B

DEFAULT SAMPLE AREA
STARTING PIXEL AND LINE NO. = 20,20
SIZE (X,Y)=10,10
OPTION :
1. DISPLAY PICTURE
2. INPUT COMMENTS
3. INPUT NEW SAMPLE AREA SIZE
4. CONTINUE CROSS TALK
5. EXIT

4

DISPLAY 5 POINTS FOR A,B FRAME , (A-B)/(A+B), (A+B)
```

```
A =
B =
CR=(A-B)/(A+B)
INT=(A+B)

OPTION :
1. GO
2. STOP
2

--STOP
```

PROGRAM NAME: SN1

PURPOSE: "SIGNAL TO NOISE ANALYSIS"

SAVE 4 SETS OF DATA

1. (L) images with light (LL)
2. (L) images without light (LZ)
3. (1) image with light (ZL)
4. (1) unage without light (ZZ)

USE THESE DATA TO CALCULATE THE RANDOM AND FIXED NOISE THROUGH THE FOLLOWING THREE EQUATIONS:

$$(Sij)_1 = (S)_1 + (\ ij)_1 + (\ ij)_1$$

$$(Sij)_L = (S)_L + (\ ij)_L$$

$$\frac{(\Delta ij)_L}{(\bar{S})_L} = \frac{(\Delta ij)_1}{(\bar{S})_1}$$

$(Sij)_1$: Single Pixel Intensity for (ZL-ZZ)

$(Sij)_L$: Single Pixel Intensity for (LL-LZ)

$(S)_1$: $(\Sigma Sij)_1/N$

N. No of pixels

$(S)_L$: $(\Sigma Sij)_L/N$

$(\ ij)_1$: Random Noise

$(\ ij)_1$: Fixed Noise

Random Noise:

$$Tij = (sij)_1 - \frac{(\bar{S})_1}{(\bar{S})_L} - (Sij)_L$$

Fixed Noise:

$$\Delta ij = (\overline{S})_1 \left[\frac{(Sij)_L}{(\overline{S})_L} - 1 \right]$$

Standard Deviation:

$$T = \sqrt{\frac{\Sigma (\Delta ij)^2}{N}}$$

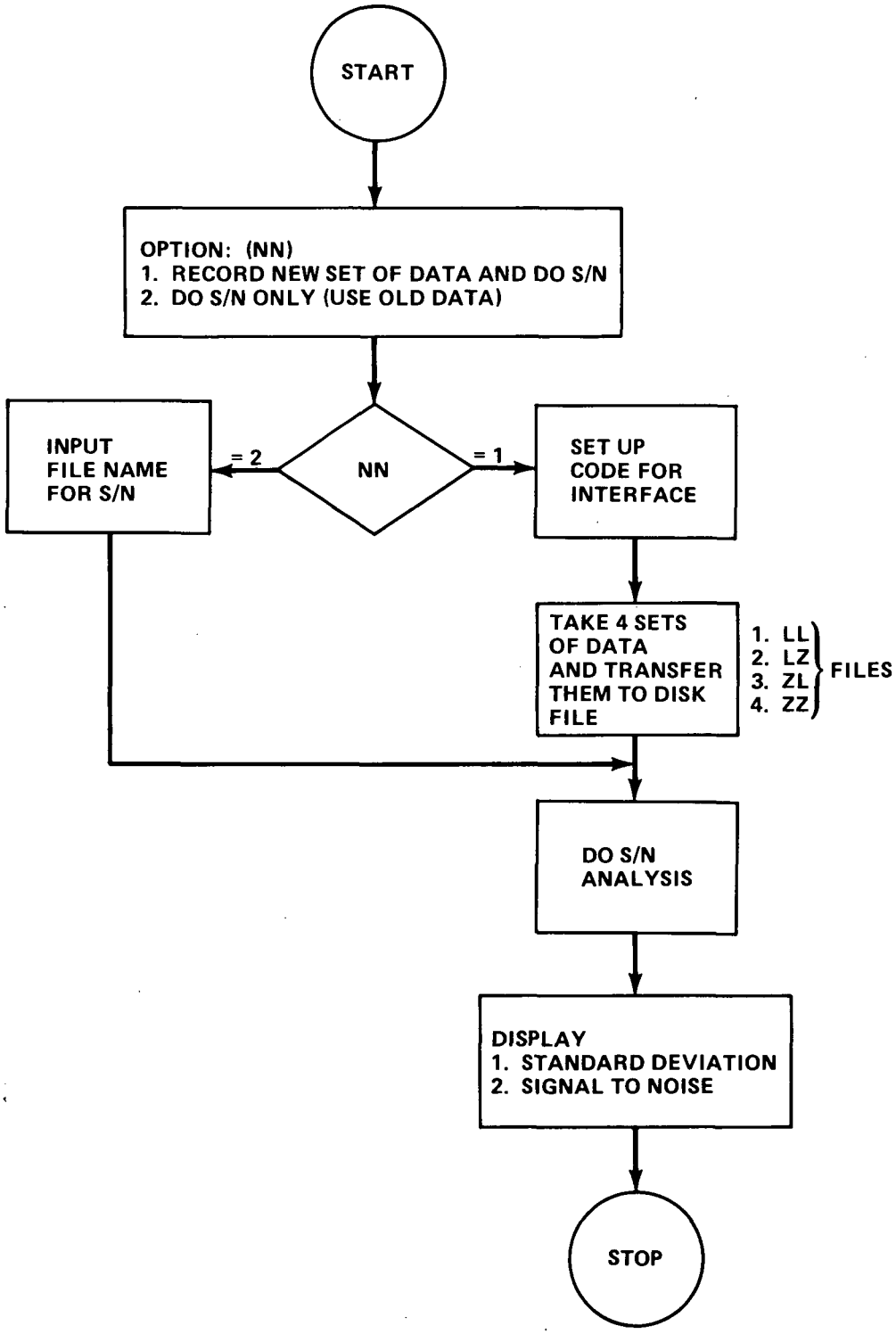
Signal to Noise:

$$S/N = (\overline{S})_1 / T$$

PROGRAM AND SUBROUTINE LAYOUT:

```
SN1
  UPD
  CDDRW
  MOD
     CDDRW
  SNCTL
     CDDRW
        *GETADR
        *Q10
         ERRC
        *WAITFR

ACQSAV
    CDDRW
   *Q10
    WAITFR
    XDISK
        SMNAM
        POPEN
        ERRC
       *GETADR
       *WTQ10
       PBLOCK
       PCLOSE

AVE
   HKEEP

SNN1
```

FLOW DIAGRAM



```
PROGRAM NAME : SN1
PROGRAM DESCRIPTION : SIGNAL TO NOISE ANALYSIS
1. MODE:1. 1A1B 2. 2A2B 3. 3A3B 4. (2AB,3AB) 5. ALL      1
2. NO. OF ENHANCEMENTS                                   16
3. STARTING PIXEL NO.                                     1
4. STARTING LINE NO.                                      1
5. NO OF PIXELS                                         128
6. NO OF LINES                                          128
7. BEGINNING EXP TIME                                   100
8. CENTER FILTER POSITION                               519
9. FILTER POSITION                                      527
10. BINNING IN X AXIS                                     2
11. BINNING IN Y AXIS                                     2

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2

OPTION :
1. RECORD NEW SET OF DATA AND DO S/N
2. DO S/N ONLY(USE OLD DATA)

IF SELECT OPTION 1
TAKE 4 SETS OF DATA WITH DIFFERENT EXPOSURE TIME AND NO. OF
ENHANCEMENTS ,RUNNING PROCEDURE LIKE SM PROGRAM

1. (L) IMAGE WITH LIGHT (LL)
2. (L) IMAGE WITHOUT LIGHT (LZ)
3. (1) IMAGE WITH LIGHT (ZL)
4. (1) IMAGE WITHOUT LIGHT (ZZ)

IF SELECT OPTION 2
INPUT 4 DATA SETS NAMES

DO S/N ANALYSIS

INPUT RANGE
STARTING AND ENDING LINE NO.= XXXXX,XXXXX
STARTING AND ENDING PIXEL NO.=XXXXX,XXXXX

PRINT OUT
AVERAGE INTENSITY FOR L ENHANCEMENTS=
AVERAGE INTENSITY FOR 1 ENHANCEMENTS=

STANDARD DEVIATION =
S/N =
SIGNAL TO NOISE (XXXXXXXXXX: 1)
```

PROGRAM NAME: SN2

PURPOSE: "SIGNAL TO NOISE 2"
THIS PROGRAM USES TWO IDENTICAL DATA SETS (A1, A2) AND ONE ZERO-ILLUMINATION DATA SET TO DO THE SIGNAL TO NOISE ANALYSIS.

CALCULATION PROCEDURE:

1. Take Away the Background Noise

$A1 - Z = Sij^{(1)}$

$A2 - Z = Sij^{(2)}$

2. Calculate Image

$$(sij)^C = \left[Sij^{(1)} * \frac{\langle Sij \rangle^{(2)}}{(Sij)^{(2)}} \right]$$

< > means average

3. Find Average $\langle Sij \rangle^C$

4. Calculate Deviation

$\Delta Sij = (Sij)^C - \langle Sij \rangle^C$

5. Calculate Variance

$$\mu_L = \frac{\Sigma \Delta S_U^L}{M}$$

M. No of pixels
L. 2,3,4

6. Calculate Skewness

$$\beta_1 = \mu_3^2/\mu_2^2 \quad , \beta_2 = \mu_4^2/\mu_2^2$$

$$skw = \sqrt{\beta_1} \cdot (\beta_2+3)/_2 \cdot (5\beta_2 - 6\beta_1 - 9)$$

7. Calculate Standard Deviation

$T = \sqrt{\mu_2}$

8. Calculate Signal to Noise

$S/N = (\langle sij \rangle^C/T) * \sqrt{2}$

OUTPUT FILE FOR MATRIX (Sij^C) is [SIJC.DAT]

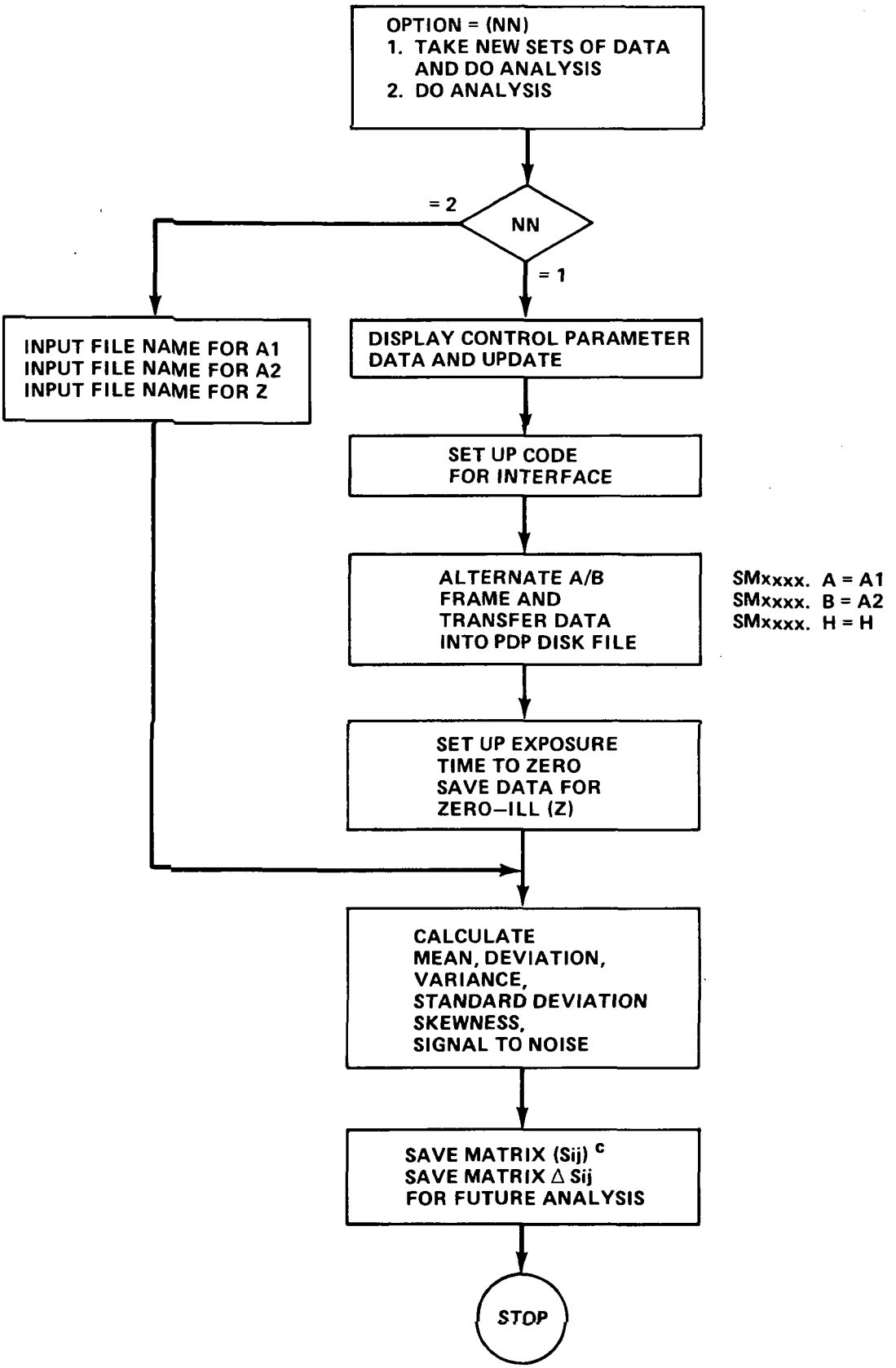
OUTPUT FILE FOR MATRIX ΔSij is [DESL.DAT]

HISTOGRAM PROGRAM IS AVAILABLE FOR THESE TWO OUTPUT FILES.

PROGRAM AND SUBROUTINE LAYOUT:

```
SN2
   UPD
   CDDRW
        *GETADR
        *Q10
         ERRC
        *WAITFR

  MOD
      CDDRW

 SNCTL
     CDDRW
         *GETADR
         *Q10
          ERRC
         *WAITFR

 ACQSAV
      CDDRW
     *Q10
      TRANS1
      WAITFR

SNN2
```

FLOW DIAGRAM



```
PROGRAM NAME : SN2
PROGRAM DESCRIPTION :SIGNAL TO NOISE 2
1. MODE:1. 1A1B 2. 2A2B 3. 3A3B 4. (2AB,3AB) 5. ALL      1
2. NO. OF ENHANCEMENTS                                   16
3. STARTING PIXEL NO.                                     1
4. STARTING LINE NO.                                      1
5. NO OF PIXELS                                         128
6. NO OF LINES                                          128
7. BEGINNING EXP TIME                                   100
8. CENTER FILTER POSITION                               519
9. FILTER POSITION                                      527
10. BINNING IN X AXIS                                     2
11. BINNING IN Y AXIS                                     2

OPTION :
1. CHANGE ALL
2. SELECTED
3. DISPLAY
4. COMPLETED
2

OPTION :
1. RECORD NEW SET OF DATA AND DO S/N
2. DO S/N ANALYSIS ONLY

IF SELECT OPTION 1
TAKE 3 SETS OF DATA , USE PROCEDURE LIKE SM PROGRAM ,SET UP
EXPOSURE TIME AND NO. OF ENHANCEMENTS
TWO IDENTICAL DATA SETS (A1,A2)
ONE ZERO-ILL DATA SET (Z) WITH ZERO EXP.

IF SELECT OPTION 2
ANSWER QUESTION FOR 3 DATA SET NAME

INPUT PIXEL RANGE
STARTING AND ENDING LINE NO.=
STARTING AND ENDING PIXEL NO.=
                              C
PRINT OUT AVERAGE FOR (Sij)
PRINT OUT THE VARIANCE UL
PRINT OUT THE STANDARD DEVIATION
S/N=

--STOP
```

PROGRAM NAME: HISTG, HISTGR, HIST

PURPOSE: THESE PROGRAMS ARE FOR HISTOGRAM ANALYSIS

THE DIFFERENCE BETWEEN THESE PROGRAMS ARE THE FORMAT FOR INPUT FILES.

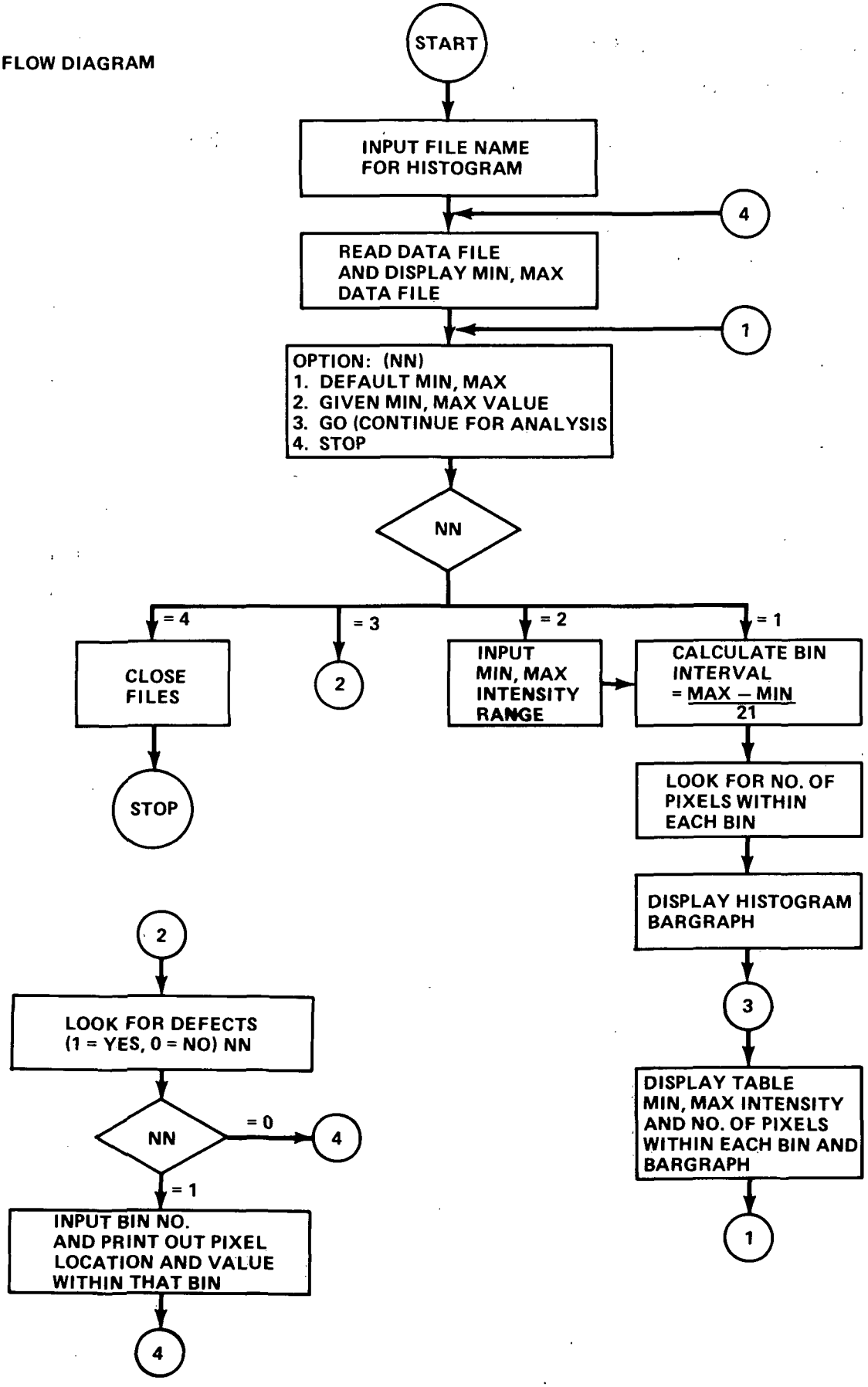
1. HISTG - Sequential, Formatted File
   Record size = 1024 bytes
   FORMAT (4 (32F8,21)

2. HISTGR - Raw Mag. Data
   Sequential, Formatted File
   Record Size = 512
   FORMAT (128A4)

3. HIST - Unformated Sequential File
   Record Size = 512

THIS PROGRAM READS THE ENTIRE DATA AND DIVIDES THE DATA INTO 20 BINS WITH SAME INCREMENTS OF INTENSITY VALUE AND PRINT OUT BARGRAPH.

FLOW DIAGRAM



```
PROGRAM NAME : HIST,HISTG,HISTR
PROGRAM DESCRIPTION : HISTOGRAM


INPUT FILE NAME=
MIN INTENSITY =XXXXX.XX
MAX INTENSITY =XXXXX.XX

OPTION :
1. DEFAULT
2. INPUT MIN AND MAX INTENSITY
3. GO
4. STOP

IF SELECT OPTION 2
INPUT MIN,MAX INTENSITY
PRINT OUT BIN INCREMENTS=XXXXXXX.X
MAX NO. OF PIXEL IN BIN= XXXXX    EACH *=XXX PIXELS
PRINT GRAPH
1. **
2. ****
3. ******
.

.
10.*****************************************
.
.
.
20.**

PRINT OUT MIN AND MAX INTENSITY FOR EACH BIN
BIN(nn) MIN,MAX NO OF PIXEL =XXXXX

LOOK FOR DEFECTS (YES=1,NO=0)
IF YES
SELECT BIN NO. =
n
PRINT OUT PIXEL LOCATION IN THAT BIN
PIXEL LOCATION =XXXX,XXXX  INTENSITY =XXXXXXX.XX


--STOP
```

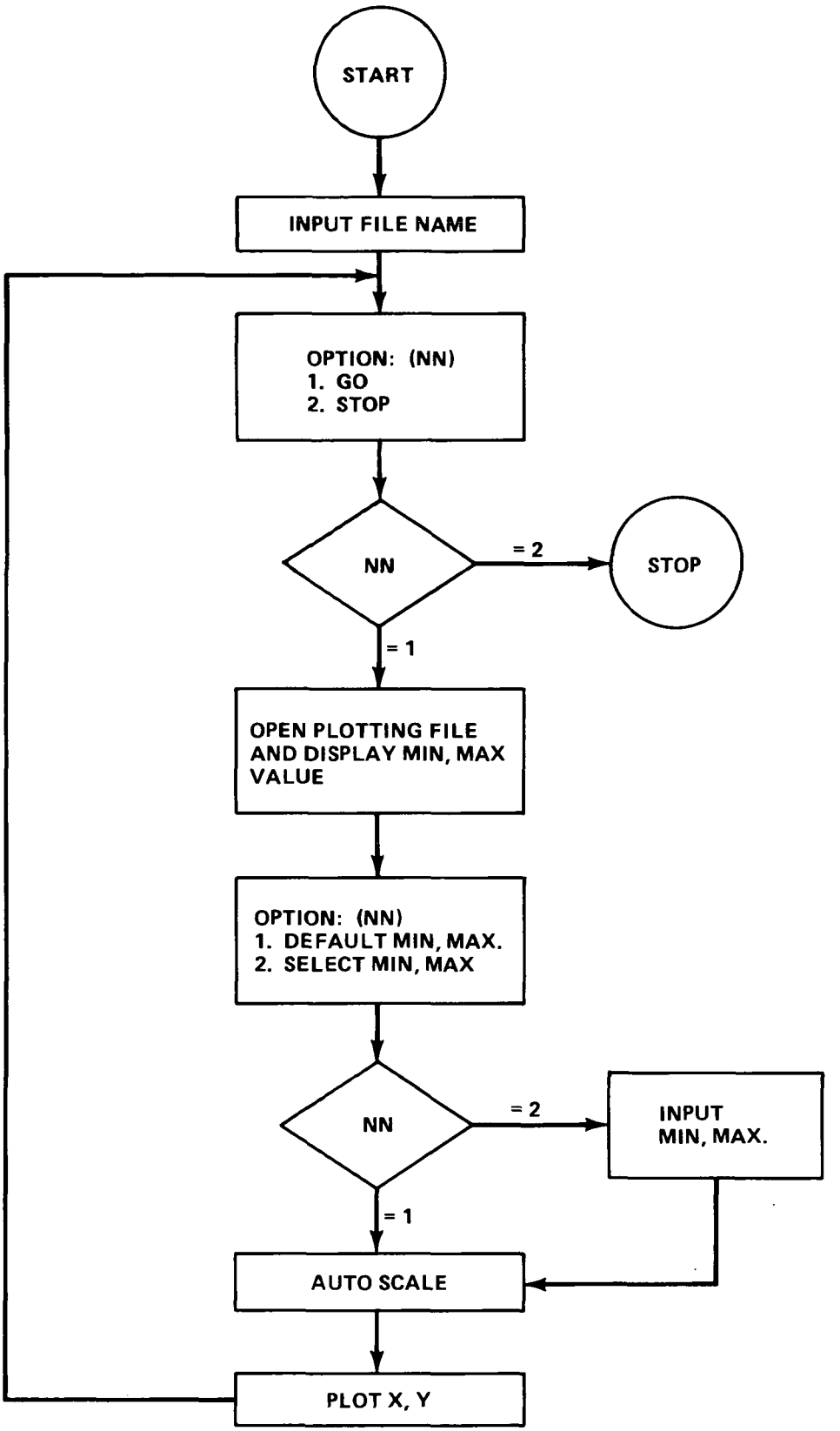
PROGRAM NAME: TKPLOT

PURPOSE: THIS IS A GENERAL PLOTTING PROGRAM. IT READS FORMATTED
SEQUENTIAL FILE AND AUTO SCALING.

PROGRAM AND SUBROUTINE LAYOUT:

```
TKLPOT
    PLOT
       *INITT
       *ERASE
       *DWINDO
       *TWINDO
       *MOVEA
       *MOVABS
       *ANMODE
       *ERASE
       *FINITT
```

FLOW DIAGRAM



```
PROGRAM NAME : TKPLOT
PROGRAM DESCRIPTION : INTENSITY PLOT

OPTION :
1. RAW DATA (SMXXXX.A)
2. UNFORMATTED SEQUENTIAL DATA (BXXXXF.02)
1
INPUT FILE NAME=
SMXXXX.A
INPUT BEGINNING AND ENDING PIXEL NO=
INPUT BEGINNING AND ENDING LINE NO=

PLOT

OPTION :
DO YOU WANT TO DISPLAY DATA
(YES=1,NO=0)
1
.................
.................
.................

--STOP
```

FILE MANAGEMENT

```
PROGRAM NAME : SMSAV,NVSAV
PROGRAM DESCRIPTION : SMSAV (SAVE SM DATA TO SAVE TAPE)
                      NVSAV (SAVE NV DATA TO SAVE TAPE)
ALLOCATE TAPE
INIT TAPE
MOU TAPE
THEN RUN SMSAV PROGRAM

INPUT SM OR NV FILE NO. IN RANGE =XXXX,XXXX

DISPLAY ALL FILE IN SEQUENCE SMXXXX.A,SMXXXX.B,SMXXXX.H
                             NVXXXX.A,NVXXXX.B,NVXXXX.H

COPY FILES FROM DISK FILE TO MSO: TAPE
MOVE DISK FILE TO DATA BANK ALSO

--STOP
```

MANGETOGRAPH LIBRARY SUBROUTINES

SUBROUTINE NAME: ACQSAV

PURPOSE: SET UP INTERFACE FOR ENHANCEMENTS, ALTERNATE A/B, TRANSFER DATA TO PDP BUFFER AND CALL "XDISK" TO SAVE DATA INTO DISK

SUBROUTINE NAME: ACQTRA (AVES, AVEB, PERA, PERB)

PURPOSE: SET UP INTERFACE, TRANSFER DATA TO PDP BUFFER WITH ARRAY LESS OR EQUAL TO (64 X 64). NO SAVE FILES. CALCULATE MEAN VALUE FOR A, B FRAMES AND ALSO THE PERCENTAGE FOR A AND B.

INPUT: COMMON BLOCK /INP/, WITH ALL SET UP CODE VALUE

OUTPUT: AVEA - MEAN VALUE FOR A FRAME
AVEB - MEAN VALUE FOR B FRAME
PERA - PERCENTAGE FOR A
FULL INTENSITY = 4095

$$PERA\% = \overline{A}/4095 \quad *100\%$$

PERB - PERCENTAGE FOR B

SUBROUTINE NAME: ANALY (MOD, IM THE)

PURPOSE: THIS ROUTINE US FOR POLARIZATION CALIBRATION.

READ A, B FRAME. CALCULATE

$$P = \Sigma \frac{A-B}{A+B} \quad /\text{NO. OF PIXELS}$$

	THEORETICAL REAL POINT	
if 1A1B $\lambda/4$ in	Sin(2θ)	$\overline{P}$
if 2A2B $\lambda/4$ in	Cos(2θ)	$\overline{P}$
if 3A3B $\lambda/4$ in	0	$\overline{P}$
if 1A1B $\lambda/4$ out	0	$\overline{P}$
if 2A2B $\lambda/4$ out	Cos(2θ)	$\overline{P}$
if 3A3B $\lambda/4$ out	Sin(2θ)	$\overline{P}$

INPUT: MOD - MODE

IM - OPTION FOR $\lambda/4$
IM = 1, $\lambda/4$ in
IM = 2, $\lambda/4$ out

THE - Polarized Angle

OUTPUT: The theoretical pt. and the mathematical pt.
Printout table

SUBROUTINE NAME: AVE

PURPOSE: $\frac{A+B}{2}$, AVERAGE A,B.

FILES AND STORES IT INTO FILE NAME SMXXXX.C.

INPUT: A,B Files

OUTPUT: C Files

SUBROUTINE NAME: CDDRW (DATA, 1 DATA)

PURPOSE: READ FROM OR WRITE TO
THE INTEL SYSTEM

INPUT: DATA 2 INTEGER WORDS
(CODE AND DATA)

OUTPUT: 1 DATA 3 INTEGER WORDS
(CODE, DATA, STATUS)

SUBROUTINE NAME: CEMOD (IR1, IR2, W)

PURPOSE: SET UP RELAY AND WAVEPLATE POSITION FOR THE SPECIFIED MODE.

INPUT: if 1A1B IR1 = 1
IR2 = 2
W = 1 REV
W = 257 FWD

2A2B IR1 = 4
IR2 = 8
W = 2 REV
W = 258 FWD

3A3B IR1 = 4
IR2 = 8
W = 3 REV
W = FWD

OUTPUT: SET UP WAVEPLATE POSITION

SUBROUTINE NAME: DISPLY

PURPOSE: DISPLY REALTIME IMAGE ON MONITOR

IBIT = NO. OF SIGNIFICANT BITS
A FRAME DATA = 1×2^8 + IBIT
B FRAME DATA = 2×2^8 + IBIT
(A-B) CONTOUR DATA = 4×2^8 + IBIT
(A-B) BOUNDARY DATA = 5×2^8 + IBIT

SUBROUTINE NAME: ERRC (LUN, STAT, MESS)

PURPOSE: IF ERROR DURING READ OR WRITE, PRINTS OUT THE STATUS.

LUN - UNIT NUMBER

STAT - STATUS WORD (2 WORDS)

MESS - READ OR WRITE

INPUT: LUN, MESS

OUTPUT: STAT

SBUROUTINE NAME: FSPV (PV, NAM3)

PURPOSE: THIS ROUTINE IS FOR FILTER SCAN.

INPUT: A,B FRAME

OUTPUT: PV = (A-B)/(A+B)

SMMXXXX.C FOR A,B AVERAGE

SUBROUTINE NAME: GCCB (CP)

PURPOSE: CALIBRATION FOR GUIDE COORDINATES

INPUT: COMMON BLOCK/INP/,
PARAMETER DATA

OUTPUT: (CP) - CALIBRATION COEFFICIENT

SUBROUTINE NAME: HKEEP (IPR, IUN)

PURPOSE: SAVE HOUSEKEEPING INTO SMMXXXX.H FILE

INPUT: COMMON BLOCK /ZNP/ WITH ALL PARAMETER DATA

OUTPUT: WRITE HOUSEKEEPING TO SMXXXX.H FILE

SUBROUTINE NAME: HOUS

PURPOSE: READ THE CLOCK, VOLTAGE SENSOR SWITCHES, A/D CHANNEL AND CONVERT THEM INTO INTEGER, ASCZZ FORMAT.

SUBROUTINE NAME: HSAV (IPT)

PURPOSE: OPEN HOUSEKEEPING FILE AND CALL HKEEP.

INPUT: IPR - PROGRAM NAME FOR HOUSEKEEPING HEADER INFORMATION.

SUBROUTINE NAME: LOCAT (NAM, RS, RE)

PURPOSE: LOCATE PIXEL LOCATION WITH THE SELECTED SIGNAL LEVEL

INPUT: NAM - FILE NAME

RS, RE - PERCENT RANGE
STARTING AND ENDING

OUTPUT: PIXEL LOCATION WITHIN THE GIVEN RANGE

SUBROUTINE NAME: LREDGE (LX, LY)

PURPPOSE: FOR GUIDER COORDINATES. THIS PROGRAM LOOKS FOR LEFT AND RIGHT EDGE OF THE SUN.

LX - PIXEL NO.
LY - LINE NO.

SUBROUTINE NAME: MOD (IR1, IR2, W)

SAME AS CEMOD, EXCEPT THIS PROGRAM IS CALLED "HOUS"

SUBROUTINE NAME: NBIT (IDATA, BS, BE, ODATA)

PURPOSE: DECODE DATA BITS INTO INTEGER WORD.

IDATA - INPUT 2 BYTES WORD

BS - STARTING BIT

BE - ENDING BIT

ODATA - OUT INTEGER WORD

SUBROUTINE NAME: POPEN (CMD, NC, BUFF, IOER)

PURPOSE: GET ADDRESS FOR A CONTIGUOUS DISK SPACE AND TRANSFER DATA FAST SPEED FROM PDP DISK BUFFER TO DISK FILE.

CMD - FILE NAME

NC - NO. OF CHARACTERS FOR FILE NAME

BUFF - FILE ATRIBUTES

IOER - ERR STATUS

SUBROUTINE NAME: PBLOCK (DATA, 1E)

PURPOSE: TO PERFORM A HIGH SPEED. LOW OVERHEAD WRITE TO THE DISK FILE OPENED VIA POPEN.

DATA - DATA BUFFER OF 2048 BYTES

1E - ERR STATUS

SUBROUTINE NAME: RMSQ

PURPOSE: DATA ANALYSIS FOR INSTRUMENTATION POLARIZATION

$$\overline{P} = \Sigma \left(\frac{A-B}{A+B}\right) \quad / \quad \text{NO. OF PIXELS}$$

$$P = P - \overline{P}$$

$$\text{RMS} = \sqrt{\frac{(\Delta P)^2}{(N\ (-1)}}$$

SUBROUTINE NAME: SMNAM

PURPOSE: GENERATE A NEW FILE NAME FOR SM DATA FILE

SUBROUTINE NAME: SNCTL

PURPOSE: SET AND EXECUTE CAMERA CONTROL TABLE

SUBROUTINE NAME: SNN1 (NENHSN)

PURPOSE: SIGNAL TO NOISE 1 ANALYSIS

NENHSN - NO. OF ENHANCEMENTS

SUBROUTINE NAME: SNN2

PURPOSE: SIGNAL TO NOISE 2 ANALYSIS

SUBROUTINE NAME: SOLCLK (DATA, JDATA, DT)

PURPOSE: READ CLOCK

DATA - INPUT CODE AND DATA FOR CLOCK

JDATA - OUTPUT DATA AND STATUS

DT - SEC, MIN, HR, DAY

SUBROUTINE NAME: SOLSUB (DATA, JDATA)

PURPOSE: FOR INTERFACE INPUT AND OUTPUT

SUBROUTINE NAME: SOLSW (DATA, JDATA, IA)

PURPOSE: DECODE SAMPLE
SWITCH

DATA - INTERFACE INPUT

JDATA - INTERFACE OUTPUT

IA - 16 WORDS ARRAY
IA (9-16) FOR 8 SAMPLE SWITCHES

SUBROUTINE: SOLVD (DATA, JDATA, X)

PURPOSE: READ VOLTAGE

X - VOLTAGE OUTPUT

SUBROUTINE NAME: SOLXDK

PURPOSE: SAVE DATA FILE

SUBROUTINE NAME: SOLZF (FF)

PURPOSE: SELECT FILTER POSITION

FRF - CURRENT FILTER POSITION
(INTEGER)

SUBROUTINE NAME: SOLZF1 (JDATA,JDATAO,IZEISS)

PURPOSE: READ CURRENT FILTER POSITION

SUBROUTINE NAME: STCTL

PURPOSE: RESET CONTROL TABLE, UPDATE PARAMETER DATA FILE

SUBROUTINE NAME: SUB (DATA, IA)

PURPOSE: DISPLAY BITS

DATA - INPUT 2 BYTES WORD

IA - ARRAY 16
BINARY OUTPUT

SUBROUTINE NAME: TRANS1 (MM, IFRM, TOTAL)

PURPOSE: TRANSFER DATA FROM C.D BOX TO PDP-11 DATA BUFFER

MM - NO. OF PIXELS

IFRM - 1 FOR A FRAME
2 FOR B FRAME

TOTAL - TOTAL INTENSITY FOR THE WHOLE FRAME

SUBROUTINE NAME: TBEDGE

PURPOSE: FOR GUIDER COORDINATES
FIND TOP OR BOTTOM EDGE

SUBROUTINE: UPD

PURPOSE: UPDATE PARAMETERS
OUTPUT PARAMETER TO COMMON BLOCK /INP/

SUBROUTINE: UPDPAR (NPAR,T)

PURPOSE: CHANGE EXPOSURE TIME FOR PARAMETER DATA FILES

SUBROUTINE: XDISK

PURPOSE: TRANSFER DATA FROM PDP BUFFER TO DISK FILE

SUBROUTINE NAME: ZERO (ZR1, IR2, W)

PURPOSE: FOR ZERO ILLUMINATION

INPUT:
IR1: RELAY 1
IR2: RELAY 2
W : WAVE PLATE POSITION

OUTPUT: DATA SET SMxxxx.A
SMxxxx.B
SMxxxx.H

SUBROUTINE NAME: ZF1

PURPOSE: READ CURRENT ZEISS FILTER POSITION

INPUT: CODE 32

OUTPUT: CURRENT FILTER POSITION

SUBROUTINE NAME: ZFT2

PURPOSE: SELECT ZEISS FILTER POSITION

INPUT: CODE 31,
DATA FILTER POSITION

OUTPUT: FILTER POSITION

IV. HOST SYSTEM

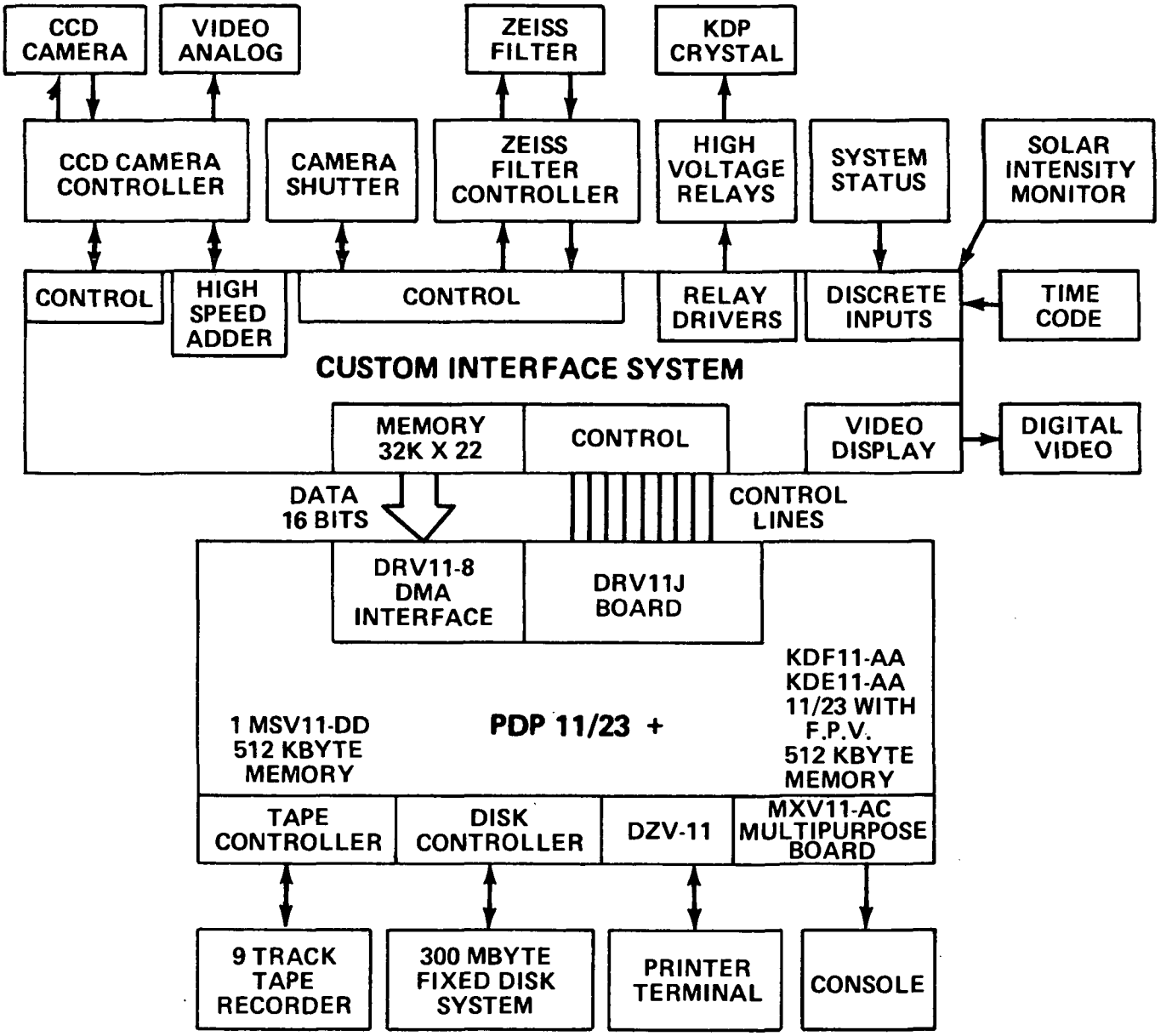
```
* * * * * * * * * * * *
*                       *
*      HARDWARE         *
*                       *
* * * * * * * * * * * * *
```

The Solar Magnetograph sysem consists of the following elements

a. Telescope
b. Camera
C. Camera controller
d. Camera Interface - Intel 8080
e. Host coumputer

The Host computer consists to the following items

a. PDP 11/23+
b. 512K bytes memory
c. KEF11 floating point unit
d. MXV11 2 serial ports
e. DZV11 8 serial ports
f. Dilog tape controller emulating MSV11 with
    1. Cipher Tape Drive
g. Dilog disc controller emulating RM03 and RM05 discs
    1. 300Mbyte drive
    2. 160Mbyte drive
h. Intecolor terminal
i. Ramtek 6400 terminal
j. LA100 terminal
k. VT125 terminal
l. Tecktronix 4010 terminal with hardcopy
m. DRV11-B interface
n. DRV11-J interface



SOLAR MAGNETOGRAPH SYSTEM

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SOFTWARE

RSX11m Configuration

RSX11m was generated in a configuration to optimize the performance of the Solar Magnetograph system. The system was built as a 20K RSX without executive common. This allows sufficient room for system pool and keeps low overhead on all system calls. The round robin scheduler frequency was lowered because with a few users this saves system overhead at no apparent loss (or even a savings) in performance. The largest disc interface task was selected to maximize disc performance. Loadable and user drivers were needed to allow the special drivers for the camera interface to be incorporated into the system. Other options were selected for convenience and program development or for system diagnostic purposes.

The Interface to the Solar Magnetograph by the PDP 11/23 computer was accomplished with two standard DEC inferface boards. Control was passed through a DRV11-J and data was collected from a DRV11-B interface. I/O drivers for the two interfaces are loaded in the Startup command file for RSX. The command file is named 'DRIVER' and loads the I/O drivers into a partition called DRIVER. The partition was generated during the VMR stage of building a system.

After the drivers are loaded, a task is run to initialize the driver for the DRV11-B. This task (CDINIT) passes the location of the partition CD0000 to the I/O driver. The partition was allocated during the VMR stage of sysgen and is 32KW in size. By allocating the partition in this manner it lays within the address space of the DRV11-B which is restricted to the first 128KW. The data from the Magnetograph is transfered via DMA into this partition and then moved into the application program in manageable blocks. This technique removes any address restrictions from the application program.

The two special I/O driver descriptions follow.

CDDRV

This I/O driver provides the primary data flow path from the Solar Magnetograph camera into the PDP 11/23. The interface is a DEC DRV11-B.

The driver has basically two modes of operation. Mode 1 is a standard read function where the data from the camera is read directly into a buffer in the program (see figure 1). This mode is usefull for small to medium sized transfers of data and is relatively straight forward to use. Mode 2 is mutually exclusive of mode 1 and is implemented to allow large data transfers to memory. In the PDP 11/23 addressing is limited to 32kw for any single program without overlays. This restriction would prohibit the use of a 32k word data buffer within the program. Mode 2 allows the data to be transfered from the camera into a large memory buffer external to the program. When the transfer is complete the data is moved in small blocks into the program or onto a disc file. Figure 2 illustrates the data flow.

The driver code is stored in uic [5,106] and the task can be built by setting the uic and using @CDDRV.

FUNCTIONS SUPPORTED BY THIS DRIVER

FUNCTION	CODE	USAGE
IO.KIL	000000	CANCEL I/O REQUEST
IO.RLB	001000	READ A BLOCK
IO.ATT	001400	ATTACH DEVICE
IO.DET	002000	DETACH DEVICE
IO.BUF	007401	CONNECT A BUFFER AREA TO DRIVER
IO.INI	014400	INITIALIZE READ INTO THE BUFFER AREA
IO.HIS	015000	MOVE DATA FROM BUFFER TO USER AREA
IO.SIH	015100	MOVE DATA FROM USER AREA TO BUFFER
IO.CON	015400	CONNECT A BUFFER AREA TO DRIVER
IO.DIS	016000	DISCONNECT A BUFFER AREA

FUNCTION	PARAMETERS
IO.KIL	No Parameters
IO.RLB	1. Buffer Address 2. Byte Count 3. Function Bits (3 BITS IN CSR) - optional
IO.ATT	No Parameters

IO.DET	No Parameters
IO.BUF	1. Physical Block Address of Region or Partition 2. Block Length of Region or Partition
IO.INI	1. Byte Count for Read into Region - optional 2. Function Bits (3 BITS IN CSR) - optional
IO.HIS	1. Buffer Address 2. Byte Count of Transfer 3. Index into Region or Partition
IO.SIH	1. Buffer Address 2. Byte Count of Transfer 3. Index into Region or Partition
IO.CON	1. Physical Block Address of Region or Partition 2. Block Length of Region or Partition
IO.DIS	No Parameters

Note on error codes. The standard error codes are used and have the defined meanings. A bad parameter is probably a byte count of zero, a bad buffer address, or too large of a byte count. A device not ready indicates one of the following conditions, the DMA is not ready, a special buffer is connected and you are trying to read, or a special buffer is not connected and you are trying to use it.

DIDRV

This interface is a DEC DRV11-J standard interface which the I/O driver address as four separate 16 bit parallel read/write ports. This driver is designed to communicate with the camera contoller interface to exercise control of the camera, camera controller, and interface. The interface is designed to provide a flow of control information and return of status at a low volume. Because the status is returned on a different port, the status can be read with the NO-WAIT qio and then a control function initiated. This technique eliminates the chance of missing status, but the time-out in the driver must be of adequate length to achieve the longest function. To acheive this, the retry count must be high enough to cover the maximum time by retry*10 = time span. The fundamental time out is 10 seconds. The basic data is transfered via another interface.

The driver is stored in uic [5,106] and can be built by the indirect command @DIDRV.

FUNCTIONS SUPPORTED BY THIS DRIVER

FUNCTION	CODE	USAGE
IO.KIL	000000	CANCEL I/O REQUEST
IO.WLB	000400	WRITE A BLOCK
IO.RLB	001000	READ A BLOCK
IO.ATT	001400	ATTACH DEVICE
IO.DET	002000	DETACH DEVICE

FUNCTION	PARAMETERS
IO.KIL	No Parameters
IO.WLB	1. Buffer Address 2. Byte count (modulus 4) 3. Retry count (optional)
IO.RLB	1. Buffer Address 2. Byte Count (modulus 4) 3. Retry count (optional)
IO.ATT	No Parameters
IO.DET	No Parameters

Note on error codes. The standard error codes are used and have the defined meanings. A bad parameter is probably a byte count of zero, a bad buffer address, or too large of a byte count. A device not ready indicates the interface is not ready.

V. APPENDIX

APPENDIX A

CAMERA CABLE REMARKS

OUT DRV11B J1 B	IN J2	CAMERA CABLE REMARKS	CAMERA OUTPUT	CANNON 25 PIN CONTROL CONNECTOR	
		THROUGH 1-SHOUT	14		
J	F,J,T	+5 VIA PULLUPS			
	N	CO			
		GND			
	D	ATTN			
	V	FNCT1H XST		16	
L		STATUS A STA - ON LINE		2	
R		STATUS B NOT RDY		14	
T		STATUS C NO TASK IN PROG		1	
	R	FNCT2H XRS		17	
UU		0 OUT F0		21	0
SS		1 F1		22	1
PP		2 F2		20	2
MM		3 F3		24	3
DD		8 DO		13	8
FF		9 D1		11	9
JJ		10 D2		25	10
LL		11 D3		12	11
NN		12 D4		10	12
RR		13 D5		23	13
JJ		14 D6		9	14
VV		15 D7		7	15

UU	0IN	CDO	5
SS	1	1	17
PP	2	2	4
MM	3	3	3
KK	4	4	16
HH	5	5	2
EE	6	6	15
CC	7	7	1
DD	8	8	20
FF	9	9	8
JJ	10	10	21
LL	11	11	9
NN	12	12	18
RR	13	13	6
TT	14	14	19
VV	15	15	7

A,C,E	GROUND	13
H,M,P		
S,U,W		
X,Y,Z		
AA,BB		

SAME GROUNDS FOR BOTH J1 AND J2 OF DRV11B

APPENDIX B

INTERFACE FUNCTION CODE

FUNCTION	CODE	DATA	RETURN 0	1	2-5
CAMERA ST TH	1	CONTL	+-1	1	CONTL,0
CAMERA CTL TB	2	CONTL	+-1	2	CONTL,0
EXECUTE CTL TB	3	0	+-1	3	0,0
RESET CTL TB	4	0	+-1	4	0,0
	5				
SET UP OMA	6	B COUNT	+-1	6	BYTE COUNT,0
	7				
	8				
	9				
	10				
READ DVM1	11	0	+-1	11	DVM,0
READ DVM2	12	0	+-1	12	DVM,0
TEMP ALARM	13	3	+-1	13	3,0
READ A/D1	14	0	+-1	14	A/D 1,0
READ CLOCK	15	0	+-1	15	CLOCK
	16				
SUN SENSOR	17	126	+-1	17	126,0
	18				
	19				
	20				
ENHANCEMENT	21	N	+-1	21	N,0
SAMPLE MICR SW	22	0	+-1	22	0,0
DISPLAY					
1. A FRAME	23	OP	+-1	23	$1X2^8$ +IBIT,0
2. B FRAME		OP	+-1	23	$2X2^8$ +IBIT,0
3. (A-B) CONTOUR		OP	+-1	23	$4X2^8$ +IBIT,0
4. (A-B) BOUNDARY		OP	+-1	23	$5X2^8$ +IBIT,0
FILM CAMERA	24	0	+-1	24	0,0
DMA TRANS	25	1,2	+-1	25	0,0
READ A FRAME	26	0	+-1	26	0,0
READ B FRAME	27	0	+-1	27	0,0
READ (A,B) FRAME	28	0	+-1	28	0,0
	29				
	30				
SELECT FILT POS	31	POS	+-1	31	POS,0
READ ZEISS FILT	32	0	+-1	32	CURR POS,0
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				
A FRAME (RELAY)	41	OP(1,2,4,8)	+-1	41	OP,0
B FRAME	42	OP(1,2,4,8)	+-1	42	OP,0
WAVEPLATE POS	43	OP REV(1,2,3) OP FWD(257,258,259)	+-1	43	OP,0
	44				

	45				
	46				
	47				
	48				
	49				
	50				
SHUTTER TIME	51	1-1000 MILI SEC	+-1	51	TIME,0
	52				
WRITE TO MEM	53	INTEGER	+-1	53	INTEGER,0
ALL ZEROS IN MEM	54	0	+-1	54	0,0
COUNTER IN MEM	55	0	+-1	55	0,0
DISPLAY	56	0	+-1	56	0,0
	57				
	58				

CAMERA CONTROL TABLE

FUNCTION CODE	WORD
	ISP
	ISL
	IX
	IY
	EXP
	IBNX
	IBNY

DATA = FUN $*2^8$ + WORD

APPENDIX C

PARAMETER DATA FILES

NAME / CODE	CE	CF	GC	IP	PC	PH	SMD	AM	FS	CR	SN1	SN2
1 MODE	1	1	1	5	5	1	5	5	1	5	5	1
2 NENH	16	4	256	128	16	128	256	128	16	128	256	256
3 ISP	40	48	1	1	1	1	1	1	1	1	1	1
4 ISL	40	48	1	1	1	1	1	1	1	1	1	1
5 IX	32	32	128	128	128	128	128	128	128	128	128	128
6 IY	32	32	128	128	128	128	128	128	128	128	128	128
7 EXP		80	80	80	80	80	80	80	80	80	80	80
8 BT	500											
9 ET	525											
10 DT1	2											
11 N1	13											
12 DT2												
13 N2												
14 BF		510							510			
15 EF		530							530			
16 DF		1							1			
17 CF	519	519	519	519	519	519	519	519	519	519	519	519
18 FF	527	527	527	527	527		527	527	527	527	527	527
19 TDLY								0				
20 NREP								2				
21 IBNX	2	2	2	2	2	2	2	2	2	2	2	2
22 IBNY	2	2	2	2	2	2	2	2	2	2	2	2
23 FT						6		6				

	CODE	DESCRIPTION
1.	MODE	MODE: 1.(1A1B) 2.(2A2B) 3.(3A3B) 4.(2AB,3AB) 5.ALL
2.	NENH	NO. OF ENHANCEMENTS
3.	USP	STARTING PIXEL NO.
4.	ISL	STARTING LINE NO.
5.	IX	NO. OF PIXELS
6.	IY	NO. OF LINES
7.	EXP	EXPOSURE TIME
8.	BT	BEGINNING EXP TIME
9.	ET	ENDING EXP TIME
10.	DT1	EXPOSURE TIME STEP I
11.	N1	NO. OF STEPS FOR STEP I
12.	DT2	EXPOSURE TIME STEP II
13.	N2	NO. OF STEPS FOR STEP II
14.	BF	BEGINNING FILTER POSITION
15.	EF	ENDING FILTER POSITION
16.	DF	FILTER POSITION
17.	CF	CENTER FILTER POSITION
18.	FF	FILTER POSITION
19.	TDLY	TIME DELAY
20.	NREP	NO. OF SEQUENCE REPEAT
21.	IBNX	BINNING IN X AXIS
22.	IBNY	BINNING IN Y AXIS
23.	FT	FILTER SEQUENCE

APPENDIX D

DISK FILE UNIT

UNIT NO.	DESCRIPTIONS
1	NC DRIVE, PDP 11/23 BUFFER
2	PARAMETER DATA DISK FILE
3	OUTPUT TABLE DISK FILE
4	TRANSFER FILE
5	TERMINAL DISPLAY
7	SAVED FILE FOR EXECUTION
10	
11	DI1 DRIVE, WRITE FROM PDP TO C.D. SYS.
12	DI0 READ FROM C.D. TO PDP
20, 21, 22, 23	SIGNAL TO NOISE DATA FILES
24, 25, 30, 31	TEMPORARY FILE

APPROVAL

REAL-TIME SOLAR MAGNETOGRAPH OPERATION SYSTEM SOFTWARE DESIGN AND USER'S GUIDE

By Caroline Wang

The information in this report has been reviewed for technical content. Review of any information concerning Department of Defense or nuclear energy activities or programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

E. Tandberg-Hanssen

A. J. DESSLER
Director, Space Science Laboratory

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