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SOFTWARE INSTRUCTION MANUAL ND4410 SINGLE PARAMETER PHYSICS ANALYZER

INTRODUCTION

This instruction manual describes the basic data acquisition and display for the ND4410 Single Parameter Data Acquisition and Display System. Each program is covered under a separate chapter with each chapter sub-divided into eight sections. The following programs are covered in this manual.

CHAPTER	PROGRAM
I	ND4410 Basic Physics Analyzer (41-1060)
II	ND812 Integer Interpreter (41-0017)

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SECTION I
INTRODUCTION

1-1. PROGRAM SUMMARY

1-2. The ND4410. Basic Physics Analyzer Program (41-1060) defines the basic pushbutton and keyboard entry commands for the ND4410 Single Parameter Data Acquisition and Display System. The program is an independent program containing routines for the following data acquisition and display functions:

a. Initiation/termination of data acquisition in the Accumulator Mode.

b. Selection of preset analysis times.

c. Selection of memory groups for data storage and display.

d. Selection of memory group widths.

e. Full scale horizontal and vertical display expansion.

f. Marker display and expansion of marker defined area to horizontal full scale.

g. Selection of live or static linear display or logarithmic display.

h. Selection of the following parameters for display.

(1) Center pointer channel/content and marker channels (left-right)

(2) Current group/total groups, current group width and counts full scale value

(3) Elapsed and preset analysis time

(4) Off (no parameters displayed)

i. X-Y plot of the current status display and the current group.

1-3. Data Acquisition in the List Mode and additional operational commands are provided through the use of overlay programs.

1-4. PROGRAM AREA

1-5. The program occupies memory core location Ø,ØØØØ$_8$ through Ø,3ØØØ$_8$.

1-6. STARTING ADDRESS

1-7. The starting address of the program is Ø2ØØ$_8$. If the auto restart option is provided, the program will automatically restart at ØØ4Ø$_8$.

1-8. EQUIPMENT CONFIGURATION

1-9. MINIMUM EQUIPMENT

1-10. The minimum equipment required for proper operation of this system is:

a. An ADC

b. The ND4410 Function Control Module

c. A 33ASR Teletype

d. A display oscilloscope

e. The 4K, ND812 Computer

1-11. The program will operate with either a 4K, 8K, 12K or 16K ND812 memory configuration, providing maximum data storage configuration of 1K, 3K, 5K or 7K (24 bits), respectively.

1-12. OPTIONAL EQUIPMENT

1-13. An optional unit controlled by this program is an X-Y plotter.

SECTION II
PROGRAM DESCRIPTION

2-1. INTRODUCTION

2-2. This section is intended to be read in conjunction with the flow charts outlined in Section VII.

2-3. The ND4410 Basic Physics Analyzer Program provides the basic function of analysis. It controls display, the clock, data acquisition, 12 of the 16 pushbuttons, and the erase pushbuttons. The program is divided into three sections (Figure 7-1): the background display section, the pushbutton and keyboard section and the ADC and low power section. The three sections are separated by interrupt levels. The background display program has all interrupts enabled. The pushbutton and keyboard routines have only the high level interrupts enabled (ADC, clock and low power). The ADC, clock and low power routines have no interrupts enabled. Thus, ADC data can be stored at any time, and the pushbutton calculations have precedent over background display.

2-4. MAIN ROUTINES

2-5. BACKGROUND DISPLAY ROUTINE

2-6. The background display routine (Figure 7-2) provides passive display of predetermined data. It is divided into three parts; the display of the data points, the display of the three markers, and the display of the status parameters.

2-7. The data may be displayed in either the live or static mode. In live mode, the last ADC point acquired is displayed. In static mode, the program sets the starting address and the number of points to be displayed, and displays them. The X-axis is adjusted such that the points to be displayed are evenly spaced over the entire horizontal face of the CRT.

2-8. The markers are displayed as vertical lines if they are within the limits of display. The two movable markers (left and right) may have any position in the display (or may be absent). They cannot cross, but they can be super-imposed. The third marker is always in the center of the display (or 1/2 point to left of center).

2-9. Status may be any one of three parameters: current group number/total groups, group width and counts full scale value; clock values; and center marker location/value and left-right marker locations.

2-10. The number of groups is equal to the memory size divided by the specified group width. Any remaining channels are assigned to group 1. Thus with the 4K ND812, the group width may vary from 1 to 1024. With each additional 4K of memory, 2048 channels are added to the memory size.

2-11. The counts full scale value may be from 1 to 2^{24}-1 in binary increments. The displayed value of 2^{24}-1 is -1 since the number system is 23 bits plus sign (see Chapter II). If these limits are exceeded, the program automatically switches to logarithmic display. The counts full scale value for logarithmic display will be displayed as zero.

NOTE

> An automatic calculation of memory size is made during initialization and set into the program for future reference.

2-12. The clock values are the initial time over the remaining time of acquisition. The initial clock time may be varied in integer centiseconds (0.01 second). The time may be set to zero if infinity is desired. The remaining time, also in centiseconds, is displayed in increasing values from minus to zero for preset time, and from zero on up for infinity.

2-13. The center marker is displayed as a maximum four digit channel address followed by the value of the channel at that location. These numbers will vary as the display changes. The value is continually updated by the display program. The left and right marker locations are displayed as maximum four digit channel addresses separated by a dash (-).

2-14. The background display program continues the cycle of data display, marker display, and status display until an external device interrupts the cycle. After the interrupt, control is transferred back to the background program and the display cycle is continued.

2-15. ADC, CLOCK AND LOW POWER ROUTINES

2-16. The ADC, clock, and low power routines (Figures 7-3, 7-6, and 7-4 respectively) are on the high level interrupt. They can interrupt any other program (except one another) for minimum processing time. The low power routine stops the computer. If the auto restart option is provided, the program is automatically started at 0040_8, which is equivalent to manual starting at 0200_8. The ADC routine reads and processes ADC data. It routes the data to the specified data storage group and increments that memory location. It also ensures that data storage is not within the program portion of the memory.

2-17. The clock routine operates on interrupts from a 100 KHz clock. Time is measured in centiseconds (0.01 seconds). At each interrupt, the clock routine is entered. If acquisition is off, no action is taken except to clear the clock flag. If acquisition is on, the clock buffer is incremented by one and a test is made for completion. If the acquisition is complete, then acquisition is turned off. At this time the clock status display buffer will indicate zero centiseconds.

2-18. PUSHBUTTON AND KEYBOARD ROUTINES

2-19. The middle level of interrupts are the pushbuttons, the erase buttons, the teletype (input and output) and the high speed reader and punch (Figure 7-5). Only one of these may be processed at a time, but they can be sequential. Thus, if a teletype character and erase occur at the same time, the teletype will be handled first, then the display will be erased. From the operator viewpoint both occur simultaneously.

2-20. I/O DEVICE ROUTINE

2-21. The teletype and high speed paper tape routines allow program continuation without waiting for the external device (Figure 7-8). Only the TTY input/output routines are used in this program. The others are provided for use by overlays.

2-22. In one of the foreground routines, the command for print is given and control is returned to the background program. When the teletype is finished printing the character, an interrupt is generated. Through polling, it is found that the TTY print flag is set. This flag is then cleared and control is returned to the program that generated the print command. This allows other operations while the teletype is printing.

2-23. The TTY read routine, reads a key from the keyboard and transfers control to either the keyboard routine or the calling foreground routine. In the keyboard routine, the key is compared in a table and if the overlay routine exists, control is transferred to that routine. Otherwise the message ERROR will be typed and control will return to the background program.

2-24. 1-16, ERASE PUSHBUTTON ROUTINES

2-25. There are 16 front panel pushbuttons (Figure 7-7). In this program only 12 are used. The other four (pushbuttons 8, 14, 15 and 16) are for overlay programs and future expansion. In Section IV, each pushbutton is explained in detail, and in Section VI they are summarized.

2-26. In general, if a pushbutton is depressed, it sends an interrupt signal to the processor. If the program is in the background section it is trapped to location one and proceeds to the pushbutton decode section. A table in the program listing lists the routines and where they are located in memory. The particular routine is performed, then control is returned to the background program.

2-27. SUBROUTINES

2-28. The motion width and left and right marker subroutines have special hardware variable re-entry control. Thus, while the other pushbuttons act only once each time they are depressed, the motion, width, and left and right markers cause interrupts of variable speeds when they are held depressed.

2-29. MOTION AND WIDTH SUBROUTINES

2-30. The motion subroutine (Figure 7-9) increases or decreases the starting and ending addresses for display. This subroutine sets the expand flag. (Refer to description of groups routine, paragraph 2-44).

2-31. The width subroutine increases or decreases the number of channels displayed. This expansion (or contraction) is fixed to the center marker such that the display acts like a "zoom" lens on a camera. This routine sets the expand flag. (Refer to description of groups routine, paragraph 2-44).

2-32. LEFT AND RIGHT MARKER SUBROUTINES

2-33. The left and right markers (Figure 7-10) may be moved from the left marker at the current group starting channel to the right marker at the current group ending channel.

2-34. The right marker may be moved from the left marker to current group ending channel.

2-35. CFS SUBROUTINE

2-36. The display CFS subroutine (Figure 7-11) increases or decreases the counts full scale value by a factor of two until a maximum value of $2^{24}-1$ (0r -1) or a minimum value of 1 is reached. A further increase or decrease after the maximum or minimum value is reached causes a switch to logarithmic display.

2-37. PLOT SUBROUTINE

2-38. The plot subroutine (Figure 7-12) plots the current status selected display parameter and the content of the channels displayed in the current group at the XY plotter.

2-39. STATUS SUBROUTINE

2-40. The status subroutine (Figure 7-13) changes the data displayed in the background section. It sets up the status for counts full scale, group width and groups, the clock, or the markers.

2-41. DISPLAY SUBROUTINE

2-42. The display subroutine (Figure 7-14) either turns on the live display or the static display.

2-43. GROUPS SUBROUTINE

2-44. The groups subroutine (Figure 7-15) cycles through the possible groups and sets the starting address and width so that the next (or first) group is displayed. If the expand flag is set, no advance in the group number is made and the full "current" group is displayed.

NOTE

The group width may be varied by the Group Set Command.

2-45. EXPAND SUBROUTINE

2-46. The expand subroutine (Figure 7-16) sets the expand flag, the value of the left marker into display start, and the left and right marker difference into display width.

2-47. ACQUIRE SUBROUTINE

2-48. The acquire subroutine (Figure 7-17) turns acquisition on and off. It also resets the time for data acquisition to the predetermined value.

NOTE

The predetermined value can be varied by the Clock Set Command.

2-49. RETURN SUBROUTINE

2-50. The return subroutine (Figure 7-18) stops all input/output operations (teletype, plotter, cassette, etc.) except acquire, and returns control to the background display program.

2-51. ERASE SUBROUTINE

2-52. The erase pushbuttons (Figure 7-19) are similar to the other pushbuttons, but they serve a special function. Both must be pressed simultaneously to cause a program interrupt. When the erase flag is set, the program will go to the erase routine. This subroutine erases the group being displayed and then returns to the background display routine.

SECTION III
OPERATIONAL PROCEDURE

3-1. INITIALIZATION PROCEDURE

3-2. The following is a step-by-step procedure for loading and initializing the ND4410 Basic Physics Analyzer Program (41-1060):

a. Depress the STOP key at the ND812 Computer.

b. Place the START/FREE/STOP switch at the teletype in the FREE position.

c. Load the ND4410 Basic Physics Analyzer Program (41-1060) tape into the teletype reader with the leader (8-level punches) over the read head.

d. Set the START/FREE/STOP switch at START.

e. Simultaneously depress the LOAD AR and NEXT WORD keys at the computer. The teletype reader will now step through the leader and read the program into the ND812 memory. Upon completion of read-in, the reader will stop automatically. When the reader stops, check J Register for zero. If non-zero, reload.

NOTE

> Refer to the ND812 Binary Paper Tape and Cassette Loader Program (41-0005) for loading procedures using a high speed paper tape reader or magnetic tape cassette.

f. Set the SWITCH REGISTER Switches at starting address (Ø,Ø2ØØ$_8$) and depress the LOAD AR Key.

g. Depress the START key. The program will cause the teletype to print ND4410, perform a carriage return and line feed, print PLOTTER? and wait for entry of an N or Y to indicate whether or not an X-Y plotter is to be used.

h. If an X-Y plotter is not used, type N. When N is typed, the program echoes NO, performs a carriage return and line feed, and types an asterisk (*).

i. If an X-Y plotter is used, type Y. When Y is typed, the program will echo YES and supply a (Ø,Ø) calibration voltage to the X-Y plotter.

j. Adjust the plotter Zero controls to place the pen at the desired (Ø,Ø) point.

k. Depress the SPACE bar at the teletype. This supplies a full scale X-Y calibration voltage to the X-Y plotter.

l. Adjust the plotter Vernier controls to place the pen at the desired full scale X-Y point.

m. Depress the SPACE bar at the teletype again. This returns the calibration voltage to the (Ø,Ø) point. Readjust the plotter Zero controls to place the pen at the desired (Ø,Ø) point.

n. Depress the SPACE bar at the teletype again. This returns the calibration voltage to the full scale X-Y point. Readjust the plotter Vernier controls to place the pen at the desired full scale X-Y point.

o. Repeat Step m and n as often as necessary to attain satisfactory calibration. When satisfactory calibration is obtained, depress the RETURN key at the teletype. When the RETURN key is depressed, the program performs a carriage return and line feed, and types an asterisk (*).

p. When an asterisk (*) is typed either after Step h or after Step o, call up the desired routine from the monitor mode by depressing the appropriate pushbutton on the ND4410 Function Control Module or by typing the appropriate single letter mnemonic at the teletype keyboard.

NOTE

For those routines requiring stipulation of direction, position the Direction (<—>) Switch accordingly.

3-3. X-Y PLOTTER RECALIBRATION

3-4. The X-Y plotter can be recalibrated without re-initializing the entire ND4410 System. This is accomplished by loading a short overlay program (41-1059) tape following the loading procedure outlined in steps a through e (use 41-1059 tape in step c) of the initialization procedure (paragraph 3-1) and then performing the initialization and X-Y plotter calibration procedures outlined in steps f, g, and i through p. Repeat this procedure each time recalibration of the X-Y plotter is desired.

NOTE

To avoid destruction of data stored in the first 31 channels (memory core locations $4ØØØ_8$ - $4Ø62_8$) of the data storage area (41-1059 is loaded into these locations), select a group width such that group 1 (which contains the odd number of channels remaining) will be at least 31 channels wide and refrain from using groups 1 for data storage. A program listing for 41-1059 is provided on pages 8-60 through 8-63.

3-5. RESTART PROCEDURE

3-6. If it is necessary to restart the program, perform the following procedure.

a. Depress the STOP key at the ND812 Computer.

b. Set the SWITCH REGISTER switches at starting address (Ø,Ø2ØØ$_8$) and depress the LOAD AR key.

c. Depress the START key. On restart, the program will cause the teletype to perform a carriage return and line feed and type an asterisk (*).

3-7. ACQUISITION MODE SELECTION

3-8. The ND4410 Basic Physics Analyzer Program (41-1060) permits the ADC service routine to monitor data acquisition in three different modes: Accumulator, DMA Increment and DMA List. The three different modes are selected by changing the content of a location in memory. The content of a location is changed as follows:

a. Depress the STOP key at the ND812 Computer.

b. Set the SWITCH REGISTER switches to the octal memory location whose content is to be changed and depress the LOAD AR key.

c. Set the SWITCH REGISTER switches to the octal number of the change and lift the LOAD MR key. This changes the content of the memory location specified in step b.

d. Restart the program as described for the Restart Procedure (paragraph 3-5).

3-9. ACCUMULATOR MODE

3-10. The ND4410 Basic Physics Analyzer Program (41-1060) is initialized to the accumulator mode of acquisition, i.e. the accumulator mode is the mode of acquisition selected when 41-1060 is loaded into the ND812 Computer. This mode of acquisition is completely under software control. When the ADC interrupts the computer, indicating that the ADC has an event for processing, all other interrupts are disabled and the program reads the channel number for the event. The program then checks the boundaries of the group in which the ADC is acquiring. If the event is outside the current group width (which can happen when the ADC conversion gain is larger than the group size), the event is ignored, the ADC is reset and all interrupts are again enabled. If the event is within the boundaries of the current group, the program increments the 24-bit channel specified by the ADC, resets the ADC, and re-enables all interrupts.

3-11. The time required to process an event in the Accumulator Mode is approximately 90 microseconds. The main advantage of this mode is that the user has complete control over how many data channels there are in the groups and where in memory the data will be stored. To select the Accumulator mode with acquisition in group 1 starting at location 4ØØØ$_8$, field Ø, the contents of locations Ø,2Ø71$_8$ and Ø,2Ø72$_8$ are set to ØØ2Ø$_8$ and ØØØØ$_8$ respectively, upon loading of the program. The content of locations Ø,2Ø71$_8$ (ØØ2Ø$_8$) sets the mode of acquisition to the Accumulator mode and the content of location Ø,2Ø72$_8$ (ØØØØ$_8$) specifies data field Ø.

3-12. DMA INCREMENT MODE

3-13. The DMA Increment Mode of acquisition is completely under hardware control with the exception that the memory field in which data is to be stored can be specified. When the ADC cycle steals with an event, the hardware increments the 24-bit channel specified by the ADC. For this mode, the number of channels in the group is controlled by the hardware and the ADC conversion gain switch. The standard starting channel for DMA Increment is location 4ØØØ$_8$ in memory field Ø. Therefore, if the conversion gain is larger than 1024, the data acquired in channels above 1024 will wrap around and be added to the lower channels. This will cause errors in the data acquired.

NOTE

> Although the DMA Increment acquisition starting data channel is at location 4ØØØ$_8$ in memory field Ø, it can be changed to any memory location with a wiring change. (Refer to the ND4410 Data Acquisition and Display System Hardware Instruction Manual (IM88-0428, Addendum 1)).

3-14. The main advantage of the DMA Increment Mode is acquisition time. The time to process an event in this mode is approximately 6 microseconds. The DMA Increment Mode can be enabled by changing the content of memory location Ø,2Ø71$_8$ to ØØ4Ø$_8$. If the starting data channel is to be location 4ØØØ$_8$ of field 1 rather than field Ø, change the content of location Ø,2Ø72$_8$ to 2ØØØ$_8$ (4ØØØ$_8$ for field 2, or 6ØØØ$_8$ for field 3). The content of location Ø,2Ø72$_8$ is initially set to ØØØØ$_8$ to select memory field Ø upon loading of the program.

3-15. DMA LIST MODE

3-16. The DMA List Mode, like the DMA Increment Mode is under hardware control. When the ADC cycle steals with an event, the hardware accepts the event's channel number and the ADC's tagword, and stores the data sequentially in memory. The number of events listed and the starting location of the list (from the end of the selected memory field) is determined by the content of memory location Ø,2Ø73$_8$. For example, if a list count of 1$_8$ is selected, the event would be stored in the last channel of the selected memory field. If 1ØØØ$_8$ is selected as the list count, the list will start 512 (1ØØØ$_8$) channels from the end of the selected memory field.

3-17. When the last event's data is stored and the list is full, an interrupt is generated. To service the list interrupt and output the list to an I/O device, the user must provide appropriate routines. At this time, Nuclear Data does not provide any software to support handling of the list mode as each individual system requires different processing of the list. The DMA List Mode can be enabled by changing the content of location Ø,2Ø72$_8$ to ØØ6Ø$_8$. If the memory field for storage of the list is to be memory field 1 rather than field Ø, change the content of location Ø,2Ø72$_8$ to 2ØØØ$_8$ (4ØØØ$_8$ for field 2 or 6ØØØ$_8$ for field 3). The content of location Ø,2Ø72$_8$ is initially set to ØØØØ$_8$ to select memory field Ø upon loading of the program. If the size of the list is to be other than 1ØØØ$_8$ (as it is initially set), change the content of location Ø,2Ø73$_8$ to the desired octal number.

SECTION IV
OPERATOR OR USER CONTROL

4-1. GENERAL INFORMATION

4-2. The pushbutton selected (hardware entry) commands of the ND4410 Basic Physics Analyzer Program (41-1060) are executed by depressing the appropriate pushbutton at the ND4410 Function Control Module. The keyboard entry commands are executed by entering the appropriate single letter mnemonic at the teletype after an asterisk (*) has been typed by the program. For those commands which require stipulation of direction, the Direction (◀—▶) Switch is used. In the following description, the portion of the command to be typed at the teletype keyboard is underlined. All other information is provided by the program.

4-3. HARDWARE ENTRY COMMANDS

4-4. DIRECTION (◀—▶) SWITCH

4-5. Determines the direction in which the display limit, marker, counts full scale or group will move when the selected pushbutton is depressed.

4-6. MOTION PUSHBUTTON

4-7. Holding the MOTION pushbutton depressed causes the display to move horizontally in the direction selected by the Direction (◀—▶) Switch. The rate of movement is a function of the length of time the MOTION pushbutton is held depressed. However, a momentary depression will only move the display one channel.

4-8. WIDTH PUSHBUTTON

4-9. Holding the WIDTH pushbutton depressed, horizontally expands the display when the Direction switch is in the Left (◀—) position or horizontally contracts the display when the Direction switch is in the Right (—▶) position. Horizontal expansion increases the spacing between channels, causing the number of channels displayed to decrease, while horizontal contraction decreases the spacing between channels, causing the number of channels displayed to increase. The rate of expansion or contraction is a function of the length of time the WIDTH pushbutton is depressed. However, a momentary depression will only expand or contract the display by one channel.

4-10. MARK POS PUSHBUTTON

4-11. Holding the MARK POS pushbutton depressed, causes the left and right markers (full scale vertical lines imposed upon the spectrum) to move in the direction specified by the Direction (↔) Switch. The rate of movement is a function of the length of time the MARK POS pushbutton is held depressed. However, a momentary depression will only move the markers one channel.

4-12. MARK SPAN PUSHBUTTON

4-13. Holding the MARK SPAN pushbutton depressed, causes the right marker (a full scale vertical line imposed upon the spectrum) to move in the direction specified by the Direction (↔) Switch increasing or decreasing the number of channels between the markers. The rate of movement is a function of the length of time the MARK SPAN pushbutton is held depressed. However, a momentary depression will only move the right marker one channel.

4-14. CFS PUSHBUTTON

4-15. Depressing the CFS pushbutton increases the counts full scale value by a factor of two when the Direction Switch is in the Right (→) position or decreases the counts full scale value by a factor of two when the Direction Switch is in the Left (←) position. Each time the CFS pushbutton is depressed, the counts full scale value will be increased or decreased by a factor of two until it becomes zero. The range of counts full scale values is from 1 to 2^{24}-1 in binary increments. Logarithmic display is selected by depressing the CFS pushbutton after the minimum counts full scale value (1) is reached with the Direction Switch in the Left (←) position or after the maximum counts full scale value (2^{24}-1) is reached with the Direction Switch in the Right (→) position. Display of the counts full scale value when selected by the STATUS pushbutton will appear as follows: Ø,1,3. . .83886Ø7,-1,Ø. The counts full scale value displayed for 2^{24}-1 is -1. The counts full scale value displayed for logarithmic display is zero (Ø).

4-16. PLOT PUSHBUTTON

4-17. Depressing the PLOT pushbutton plots the current display (including the current STATUS selected display parameters and the content of the channels in the current group) at the X-Y Plotter. The X-Y plot operation can be terminated at any time by depressing the RETURN pushbutton. An asterisk (*) is typed at the teletype to indicate initiation and termination of the X-Y plot operation.

NOTE

> Calibration of the X-Y plotter is described in Section 3 of this manual under OPERATIONAL PROCEDURE. When an X-Y plotter is not used, depressing the PLOT pushbutton causes an asterisk (*) to be typed.

4-18. STATUS PUSHBUTTON

4-19. Depressing the STATUS pushbutton sequentially displays the following parameters: (1) Center pointer channel/content and left marker channel-right marker channel, with the channels relative to the currently displayed group; (2) Current group number/total groups, current group width and counts full scale; (3) Remaining/elapsed and preset analysis time in centiseconds or (4) Off (no parameters displayed). After the last parameter, display reverts back to the first parameter.

NOTE

> If a preset time other than zero (Ø) is entered using the Clock Set Command, remaining time is displayed in increasing values from minus (-) the preset time to zero (Ø). If zero (Ø) is entered for the preset time, then elapsed time is displayed in increasing values from zero (Ø) to the maximum preset analysis time (8,388,607).

4-20. DISPLAY PUSHBUTTON

4-21. Depressing the DISPLAY pushbutton alternately selects live or static display. Static display presents the data to the display oscilloscope continually while live display presents the data to the display oscilloscope only when the corresponding channel has been addressed by the ADC.

4-22. GROUPS PUSHBUTTON

4-23. Depressing the GROUPS pushbutton sequentially selects the groups for data storage and display. The direction of selection is determined by the Direction (⟷) Switch. In the left (⟵) position, the next lower group is selected. After the first group, selection reverts to the last group. In the right (⟶) position, the next higher group is selected. After the last group, selection reverts back to the first group. Display of the current group, total groups and current group width can be selected using the STATUS pushbutton.

4-24. EXPAND PUSHBUTTON

4-25. Depressing the EXPAND pushbutton expands the display between the left and right markers to horizontal full scale. The display can be returned to normal by depressing the GROUPS pushbutton.

4-26. ACQUIRE PUSHBUTTON

4-27. Depressing the ACQUIRE pushbutton alternately starts or stops data acquisition. Data acquisition stops automatically after the preset analysis time. The preset analysis time is entered using the Clock Set Command. If data acquisition is stopped prior to completion of the preset analysis time, it can be re-started to continue for the remaining time by first re-setting the preset time to the time remaining using the Clock Set Command and then re-starting data acquisition using the ACQUIRE pushbutton. The preset and remaining/elapsed analysis time can be displayed using the STATUS pushbutton.

NOTE

> Since data storage occurs in the group displayed at the start of analysis, the GROUPS Pushbutton should be used to display the desired storage group prior to starting analysis.

4-28. RETURN PUSHBUTTON

4-29. Depressing the RETURN pushbutton re-initializes the program and returns to display.

4-30. ERASE PUSHBUTTONS

4-31. Simultaneously depressing the ERASE pushbuttons, clears the currently displayed group to zero.

4-32. KEYBOARD ENTRY COMMANDS

4-33. CLOCK SET COMMAND

4-34. The following operation sets the preset analysis time at 1000 centiseconds (0.01 seconds).

```
*CLOCK TIME:  1000 (SPACE) CENTISEC
```

4-35. The Clock Set Command permits entering a preset analysis time in centiseconds (0.01 second). Maximum preset analysis time is 2^{23} - 1 centiseconds (83,886.07 seconds). Entering 0 selects the maximum preset analysis time. Control of analysis on a live or clock time basis is selected by the LIVE TIME/CLOCK TIME switch on the ADC. The preset and remaining/elapsed analysis time in centiseconds can be displayed using the STATUS pushbutton.

4-36. The Clock Set Command is specified by typing C after an asterisk (*) is typed. After C is typed, the routine prints CLOCK TIME: and waits for an input number. Depressing the ALT MODE key causes the routine to echo the last time value entered. Otherwise a number from 0 to 2^{23} - 1 (8,388,607) centiseconds may be entered. Entry of a number must be terminated by depressing the SPACE bar.

4-37. GROUP SET COMMAND

4-38. The following operation sets the group width at 256 channels.

```
*GROUP WIDTH:  256 (SPACE)
```

4-39. The Group Set Command enables entering the number of channels to be contained in each group. The group width can be any number from 1 to the maximum number of channels allocated for data storage (1024, 3072, 5120, or 7168 channels for ND812 memory sizes of 4K, 8K, 12K or 16K respectively). If the group width selected is a number not equally divisable into the total number of channels allocated for data storage, the group width of the first group will be equal to the remainder and the remaining group widths will be equal in size. For example: If 333 is selected as the group width with 1024 channels allocated for data storage, the first group would contain 25 channels (1024 - 3 x 333 = 25) and the remaining 3 groups would each contain 333 channels.

4-40. The Group Set Command is specified by typing G after an asterisk (*) is typed. After G is typed, the routine prints GROUP WIDTH: and waits for entry of an input number. Depressing the ALT MODE key causes the routine to echo the last group width entered. Otherwise, any number from 1 to the maximum number of channels allocated for data storage, may be entered. Entry of the group width must be terminated by depressing the SPACE bar.

SECTION V
ERROR DIAGNOSTICS

5-1. ERROR INDICATION

5-2. Execution of an illegal operation will result in an error message being typed at the teletype. Table 5-1 lists the error messages and their causes.

Table 5-1. Error Indications

ERROR MESSAGE	CAUSE
ERROR: 99XXXX	Depressing an unassigned pushbutton.
ERROR: 62XXXX	Depressing an unassigned teletype key.
ERROR: 47XXXXX	Entering a clock time greater than seven digits.
ERROR: 40XXXXX	Entering a group width greater than the number of channel allocated for data storage.

NOTE

The least significant digits indicated by X's in Table 5-1 for the ERROR message may change depending upon what illegal operation was performed. However, the two most significant digits will be the same for the same type of error.

SECTION VI
COMMAND SUMMARY

6-1. HARDWARE ENTRY COMMANDS

6-2. The following summarizes the hardware entry commands described in Section IV.

a. DIRECTION (◀▶) SWITCH

Stipulates direction of display, marker, counts full scale or group movement.

b. MOTION PUSHBUTTON

Moves display horizontally in direction specified.

c. WIDTH PUSHBUTTON

Horizontally expands/contracts display.

d. MARK POS PUSHBUTTON

Moves markers in direction specified.

e. MARK SPAN PUSHBUTTON

Moves right marker in direction specified, increasing or decreasing the number of channels between the markers.

f. CFS PUSHBUTTON

Increases/decreases the counts full scale value in binary increments. Selects logarithmic display after reaching the maximum/minimum counts full scale value.

g. PLOT PUSHBUTTON

Plots the current display parameters and group at the X-Y plotter.

h. STATUS PUSHBUTTON

Sequentially displays: (1) center pointer channel/content and left-right marker channels; (2) current group number/total groups, current group width and counts full scale value; (3) remaining/elapsed and preset analysis time; or (4) Off (no parameters displayed).

i. DISPLAY PUSHBUTTON

Alternately selects live or static display.

j. GROUPS PUSHBUTTON

Sequentially selects groups for data storage and display in direction specified.

k. EXPAND PUSHBUTTON

Expands the marker defined display to horizontal full scale.

l. ACQUIRE PUSHBUTTON

Alternately starts or stops data acquisition.

m. RETURN PUSHBUTTON

Re-initializes the program and returns to display.

n. ERASE PUSHBUTTONS

Clears currently displayed group to zero.

6-3. KEYBOARD ENTRY COMMANDS

6-4. The following summarizes the keyboard entry commands depicted in Section IV.

a. CLOCK SET COMMAND

Permits entering a preset analysis time in centiseconds (0.01 second). Maximum analysis time is $2^{23}-1$ centiseconds (83,886.07 seconds). Entering 0 selects the maximum analysis time.

b. GROUP SET COMMAND

Permits entering the number of channels per group. Group width can be any number from 1 to the maximum number of channels allocated for data storage.

SECTION VII
FLOW CHARTS

7-1. MAIN ROUTINE FLOW CHARTS

7-2. Figures 7-1 through 7-8 depict the flow of the main program.

7-3. SUBROUTINE FLOW CHARTS

7-4. Figures 7-9 through 7-22 depict the flow of the individual subroutines.

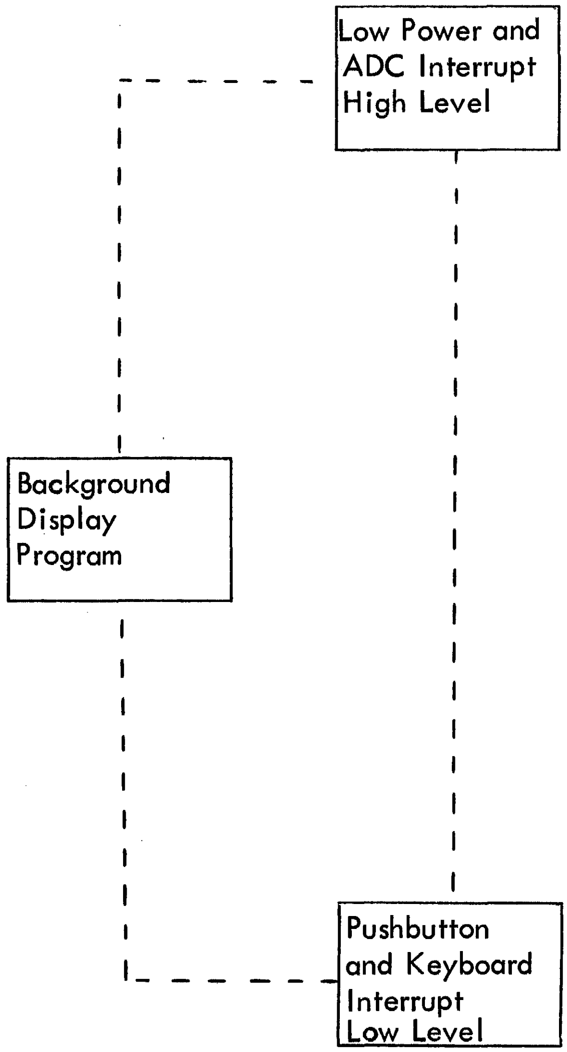

Low Power and ADC Interrupt High Level
Background Display Program
Pushbutton and Keyboard Interrupt Low Level

Figure 7-1. Basic Physics Analyzer Program

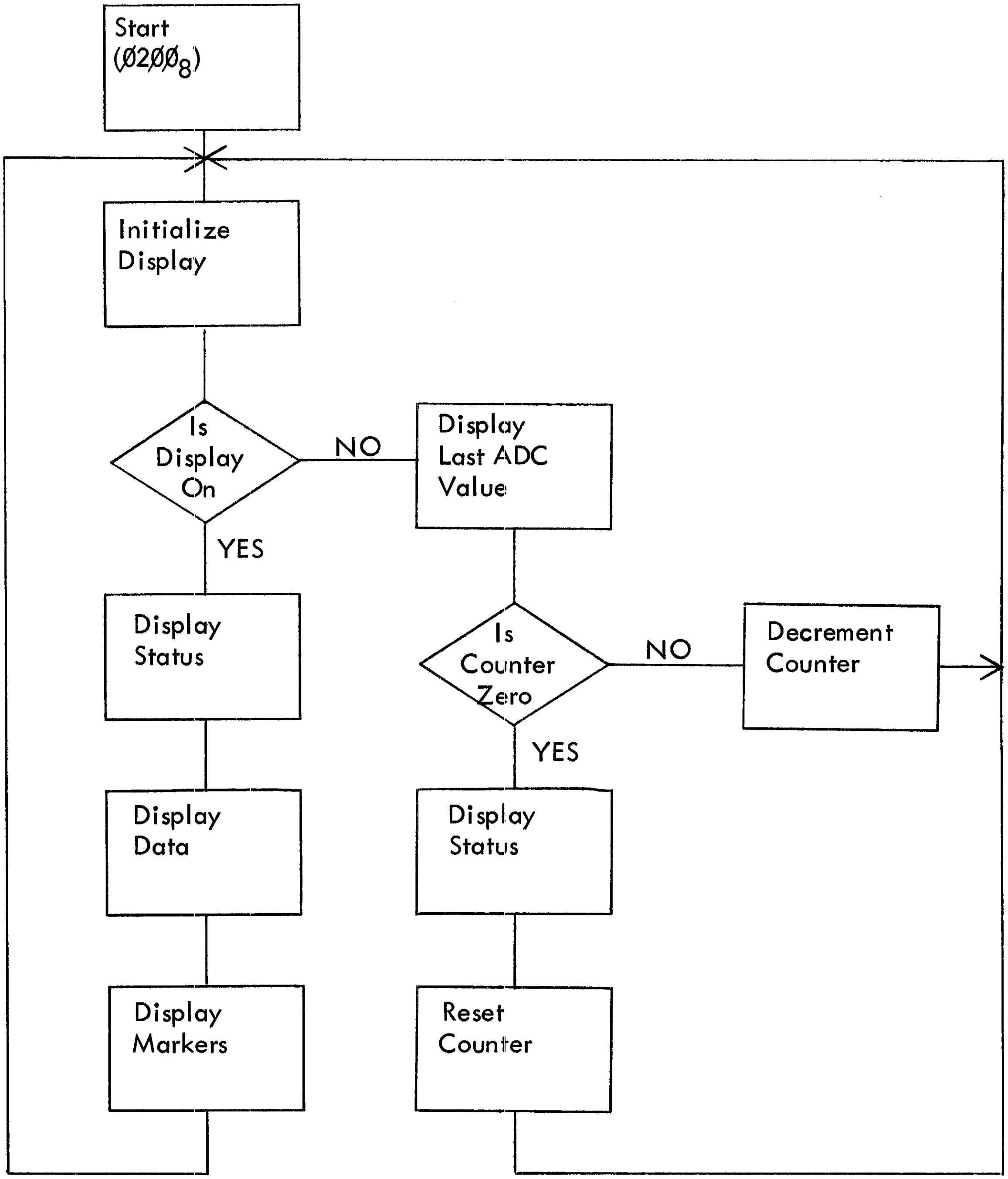


Figure 7-2. Background Display Routine

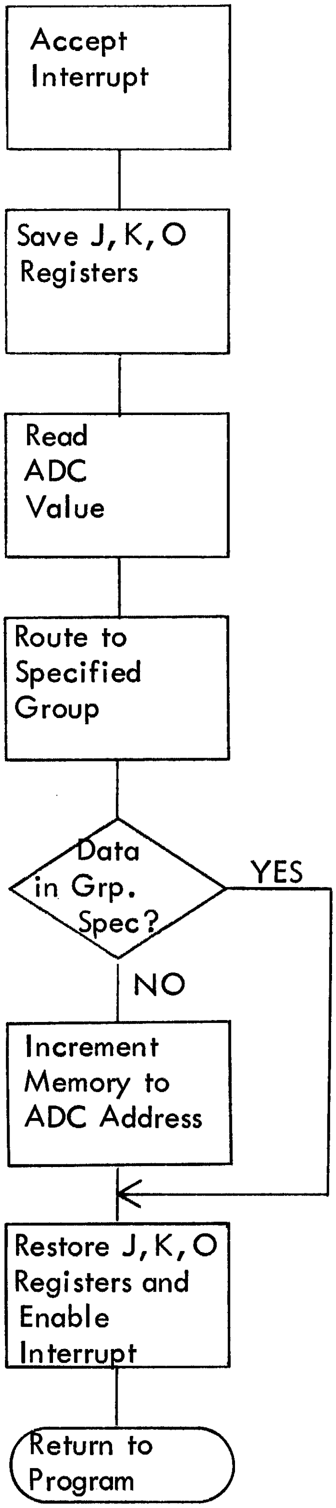


Figure 7-3. ADC Routine

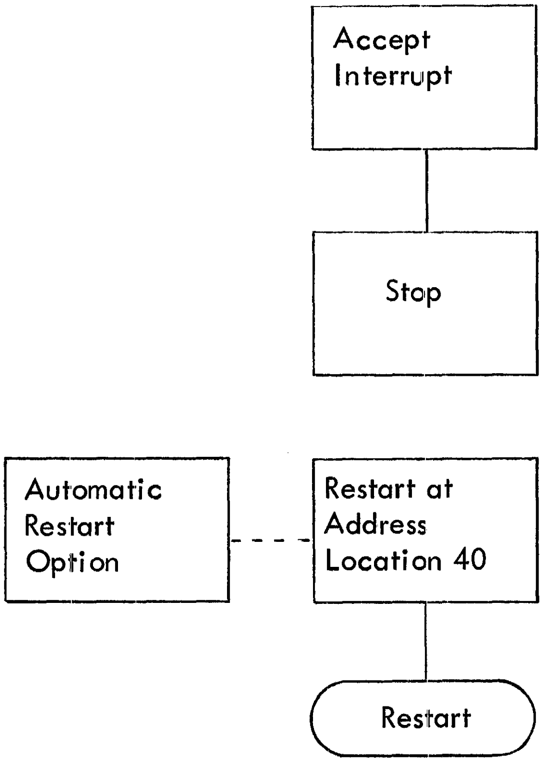


Figure 7-4. Low Power Routine

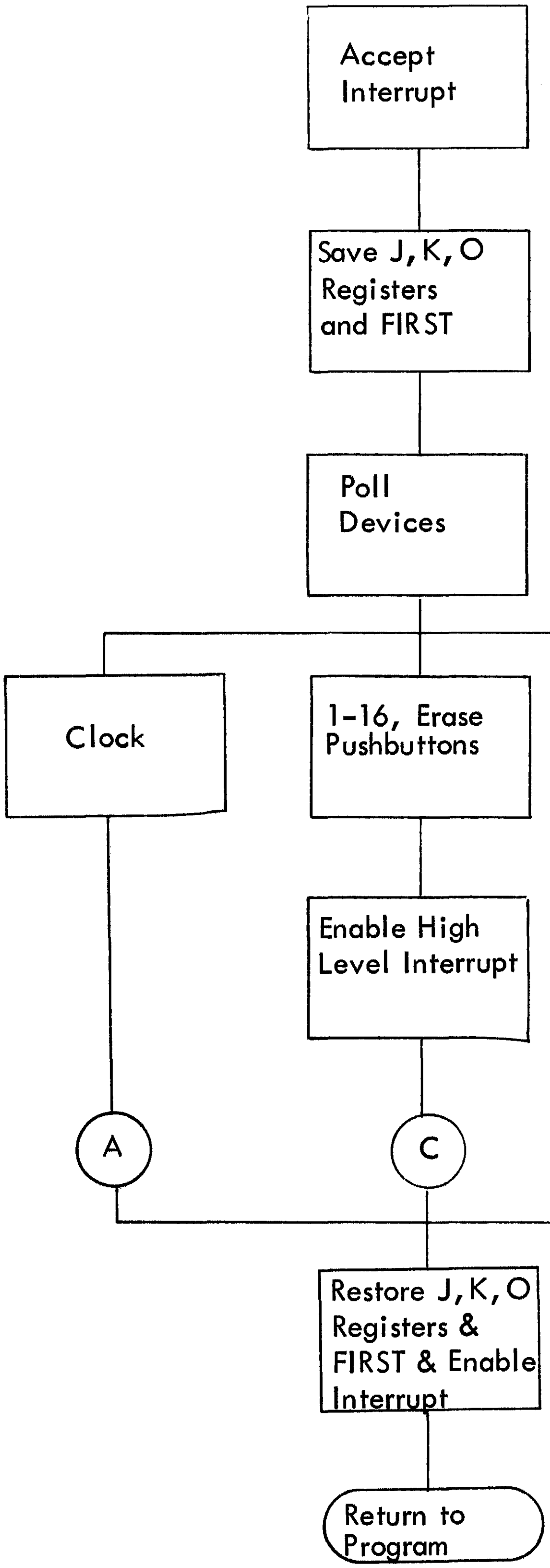

Accept Interrupt
Save J, K, O Registers and FIRST
Poll Devices
Clock
1-16, Erase Pushbuttons
I/O Device
Enable High Level Interrupt
A
C
D
Restore J, K, O Registers & FIRST & Enable Interrupt
Return to Program

Figure 7-5. Pushbutton and Keyboard Routine

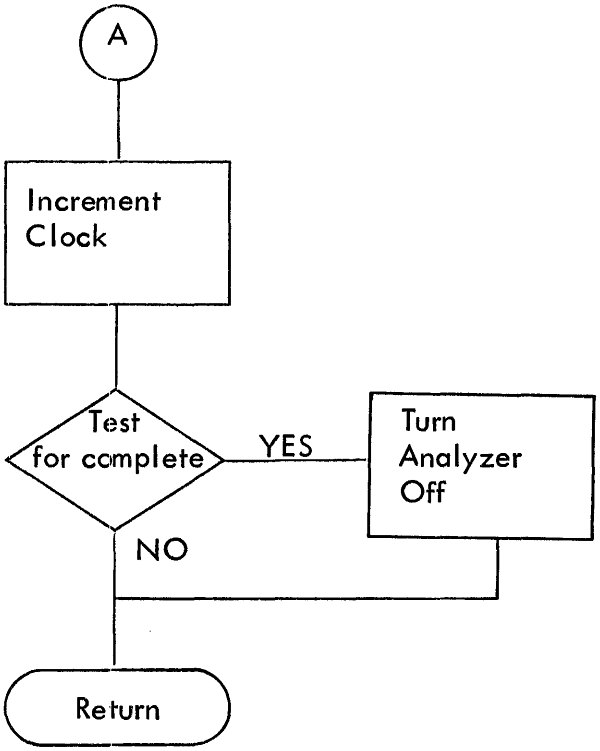
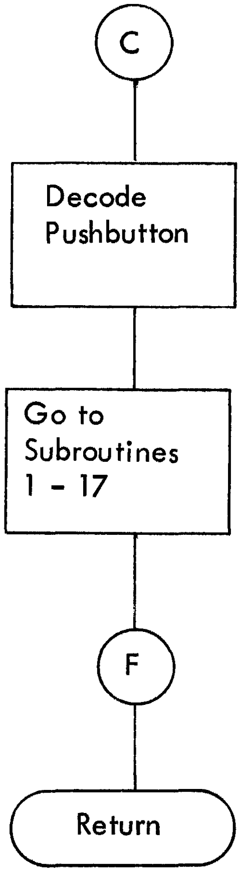


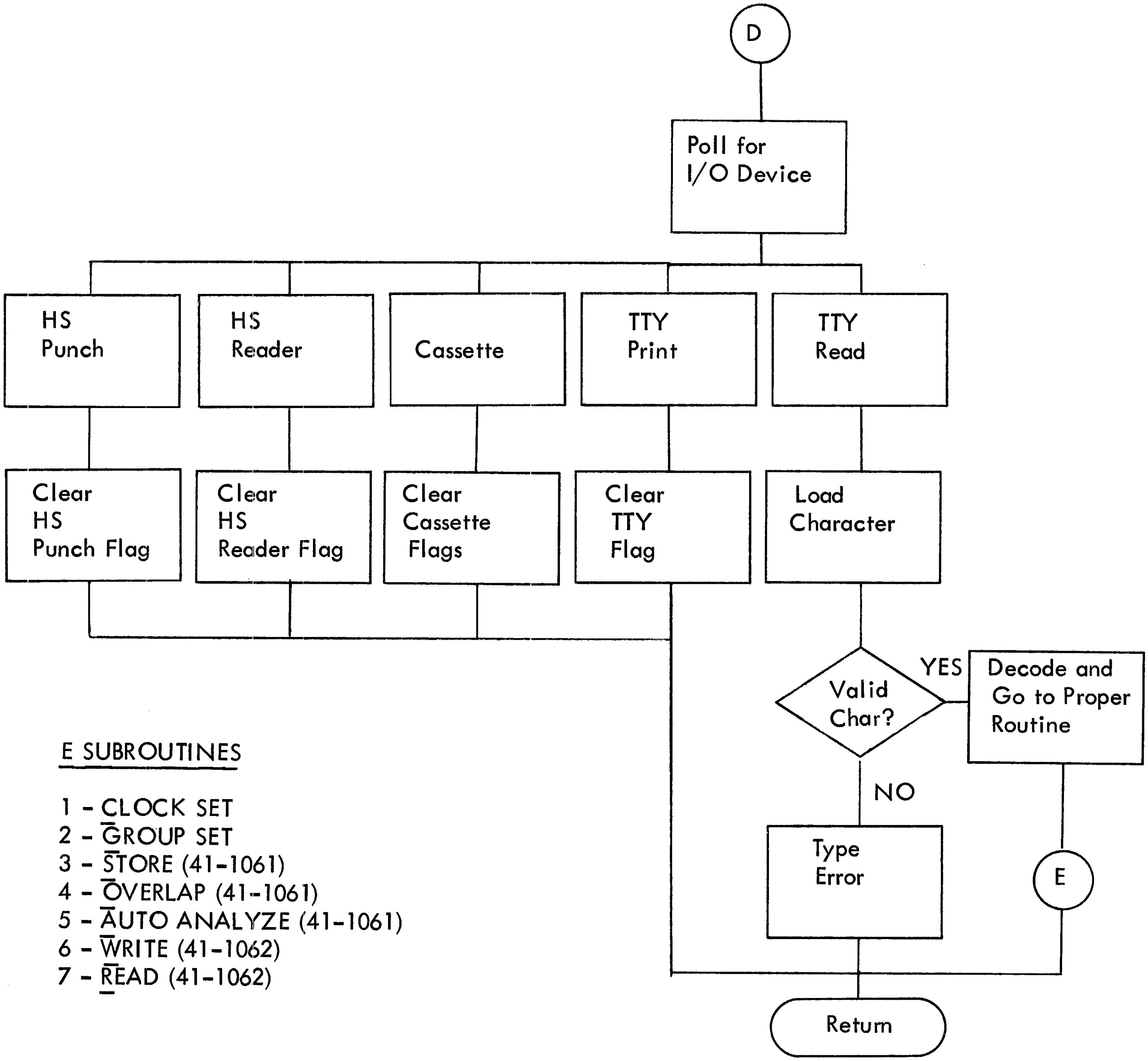
Figure 7-6. Clock Routine



F SUBROUTINE

1	-	MOTION
2	-	WIDTH
3	-	MARK POS
4	-	MARK SPAN
5	-	CFS
6	-	PLOT
7	-	STATUS
8	-	TOTAL (41-1061)
9	-	DISPLAY
10	-	GROUPS
11	-	EXPAND
12	-	ACQUIRE
13	-	RETURN
14	-	PRINT (41-1061)
15	-	INTEG/DIFF (41-1061)
16	-	SPARE
17	-	ERASE

Figure 7-7. 1-16, Erase Pushbuttons Routine



E SUBROUTINES

1 - CLOCK SET
2 - G̅ROUP SET
3 - S̅TORE (41-1061)
4 - O̅VERLAP (41-1061)
5 - A̅UTO ANALYZE (41-1061)
6 - W̅RITE (41-1062)
7 - R̅EAD (41-1062)

Figure 7-8. I/O Device Routine

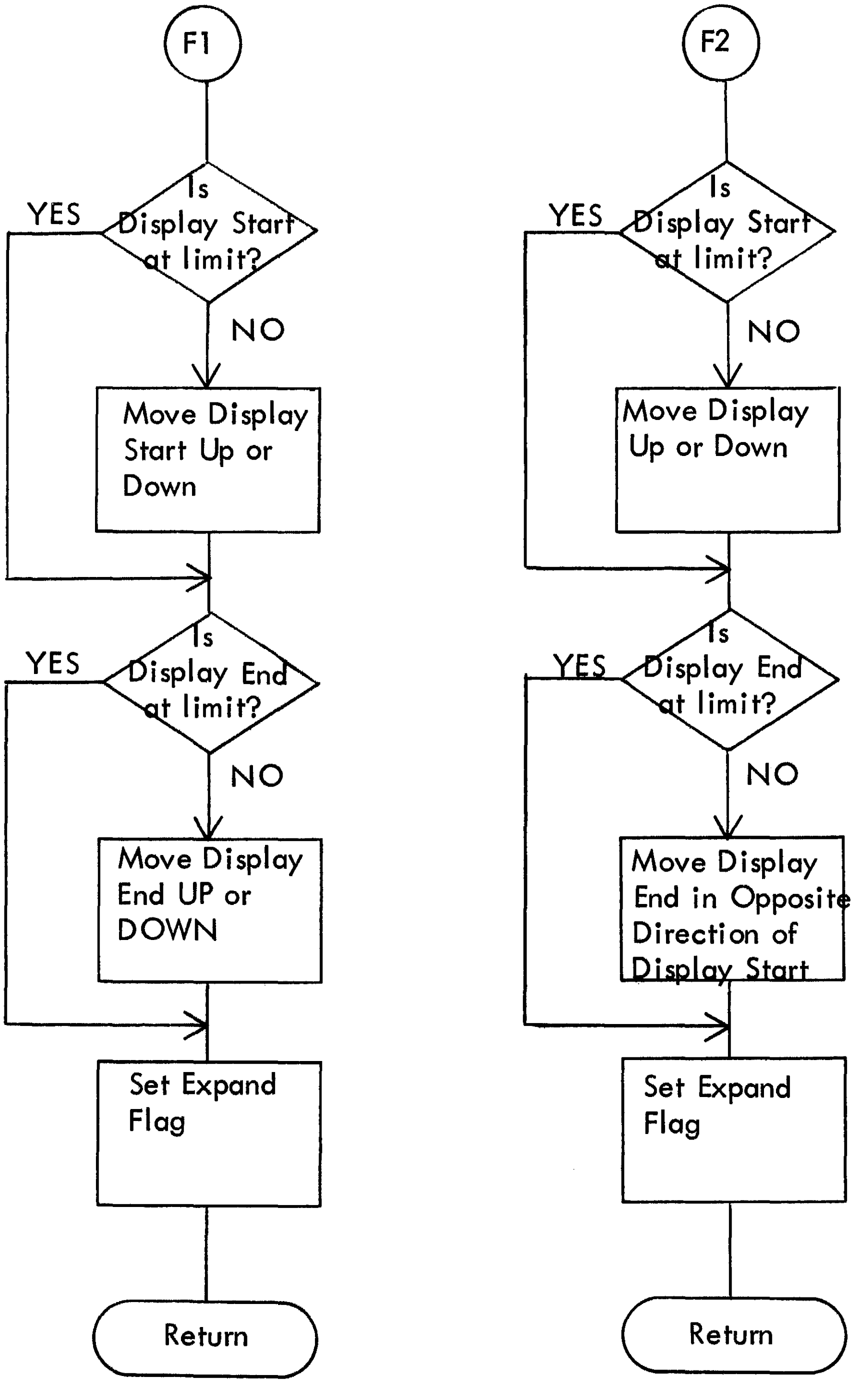

F1
Is Display Start at limit?
YES
NO
Move Display Start Up or Down
Is Display End at limit?
YES
NO
Move Display End UP or DOWN
Set Expand Flag
Return
F2
Is Display Start at limit?
YES
NO
Move Display Up or Down
Is Display End at limit?
YES
NO
Move Display End in Opposite Direction of Display Start
Set Expand Flag
Return

Figure 7-9. Motion and Width Subroutines

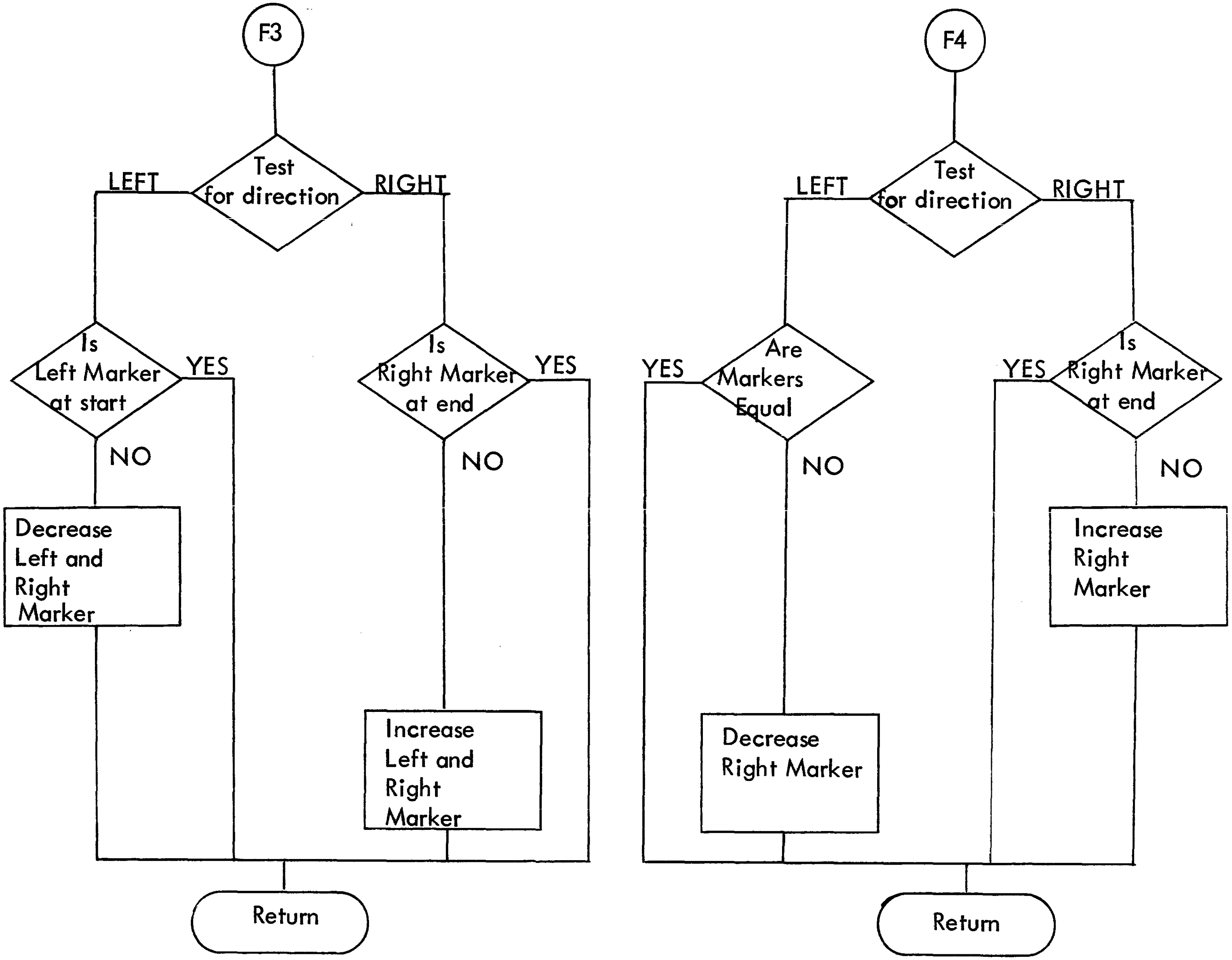


Figure 7-10. Left and Right Marker Subroutines

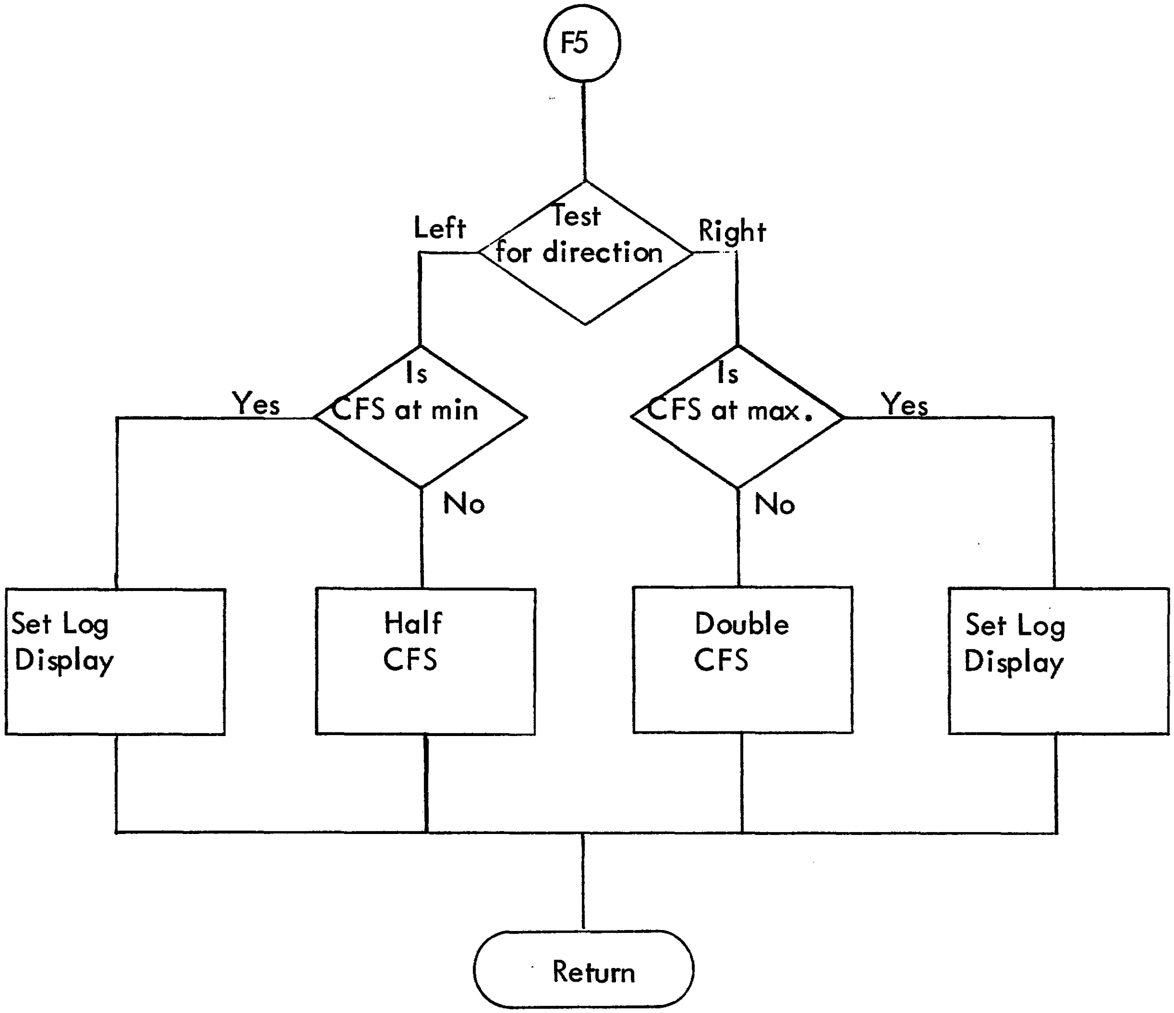


Figure 7-11. CFS Subroutine

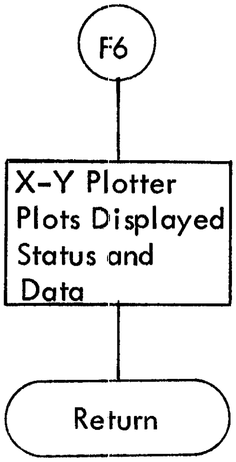


Figure 7-12. Plot Subroutine

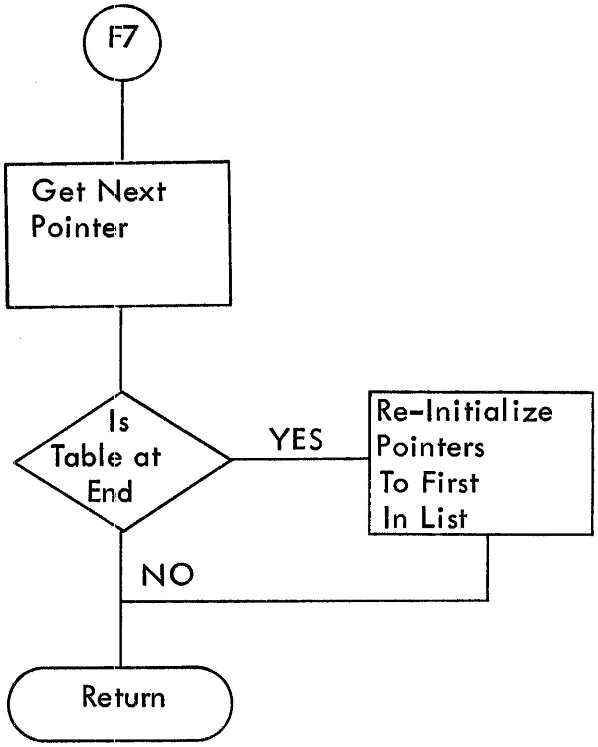


Figure 7-13. Status Subroutine

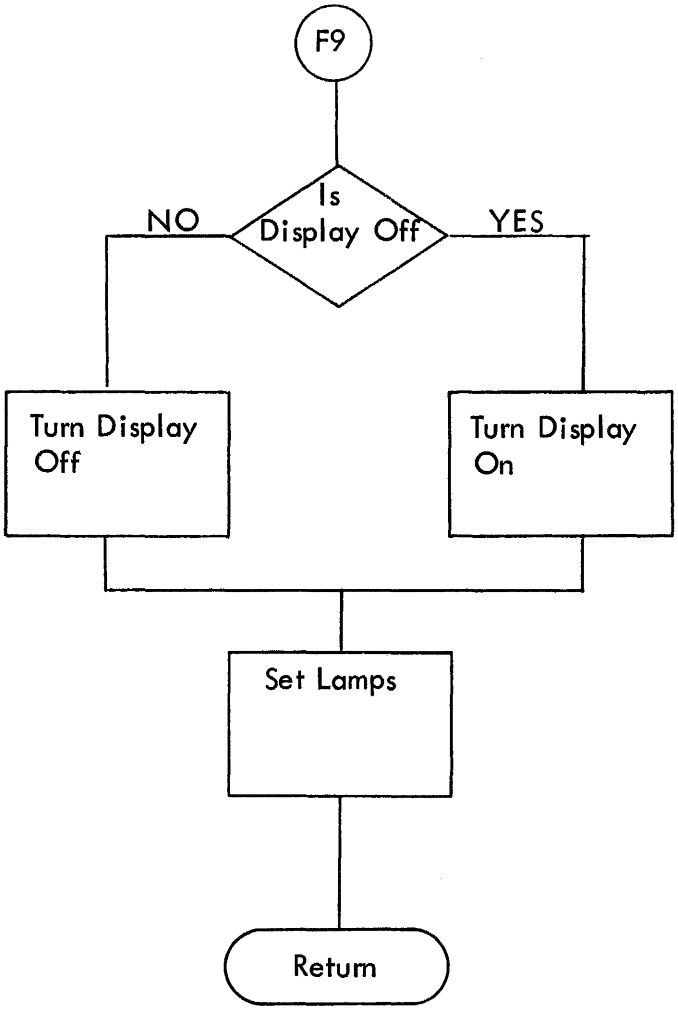


Figure 7-14. Display Subroutine

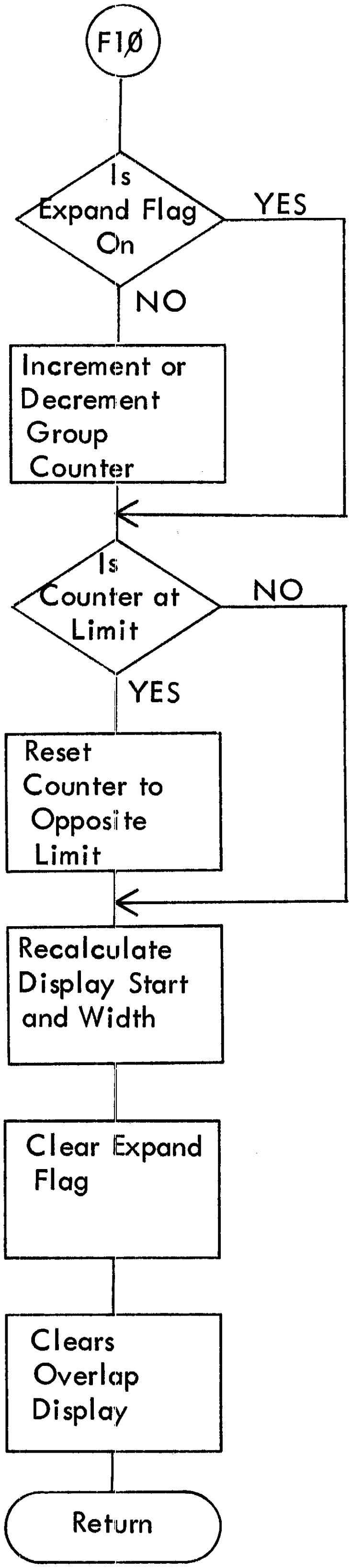

F1Ø
Is Expand Flag On
YES
NO
Increment or Decrement Group Counter
Is Counter at Limit
NO
YES
Reset Counter to Opposite Limit
Recalculate Display Start and Width
Clear Expand Flag
Clears Overlap Display
Return

Figure 7-15. Groups Subroutine

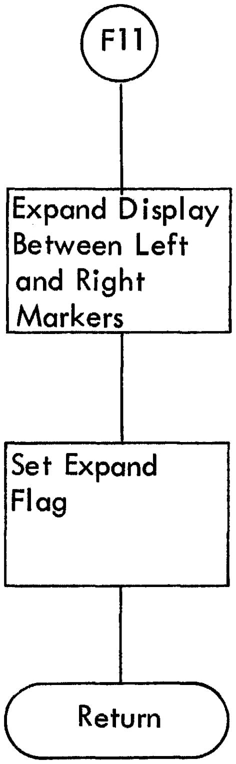


Figure 7-16. Expand Subroutine

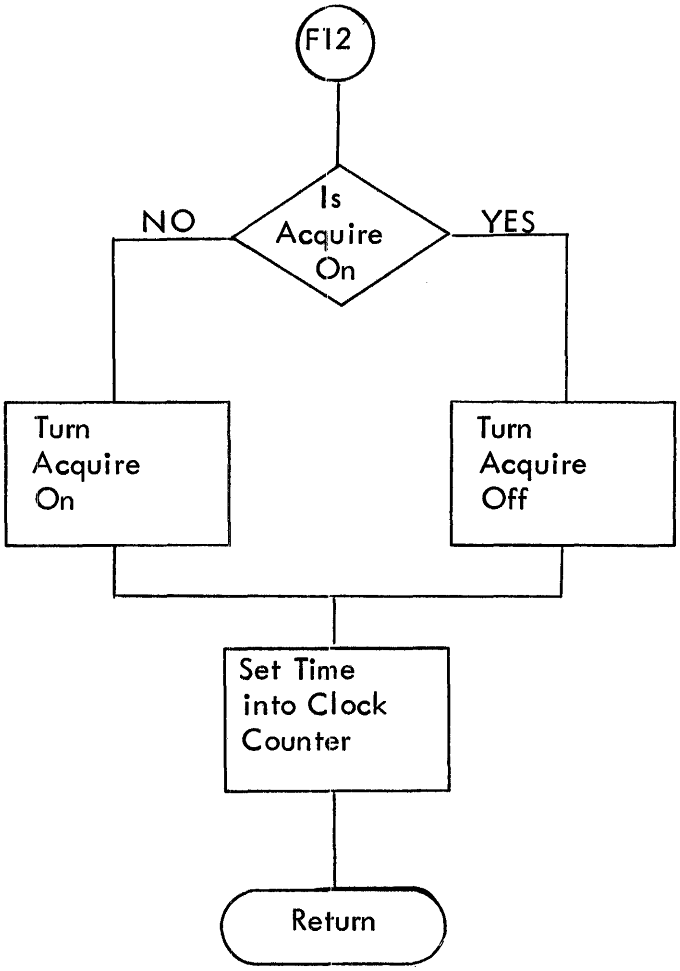


Figure 7-17. Acquire Subroutine

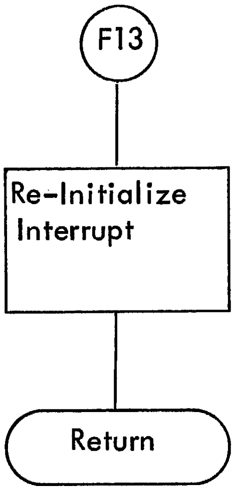


Figure 7-18. Return Subroutine

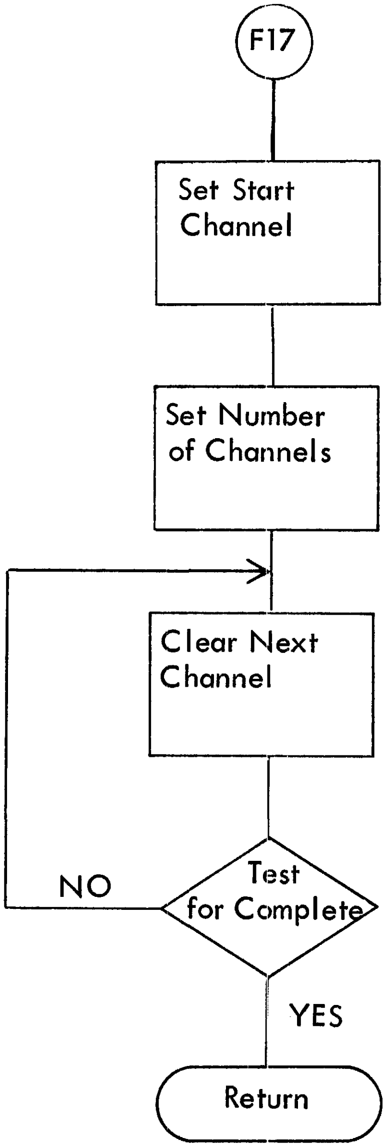


Figure 7-19. Erase Subroutine

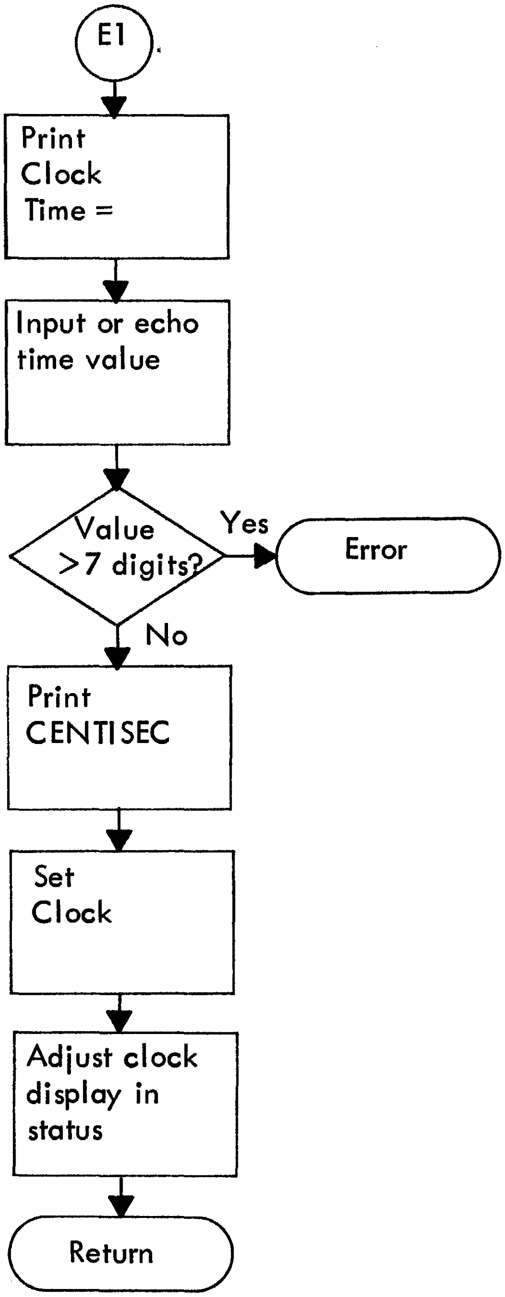


Figure 7-20。 Clock Set Subroutine

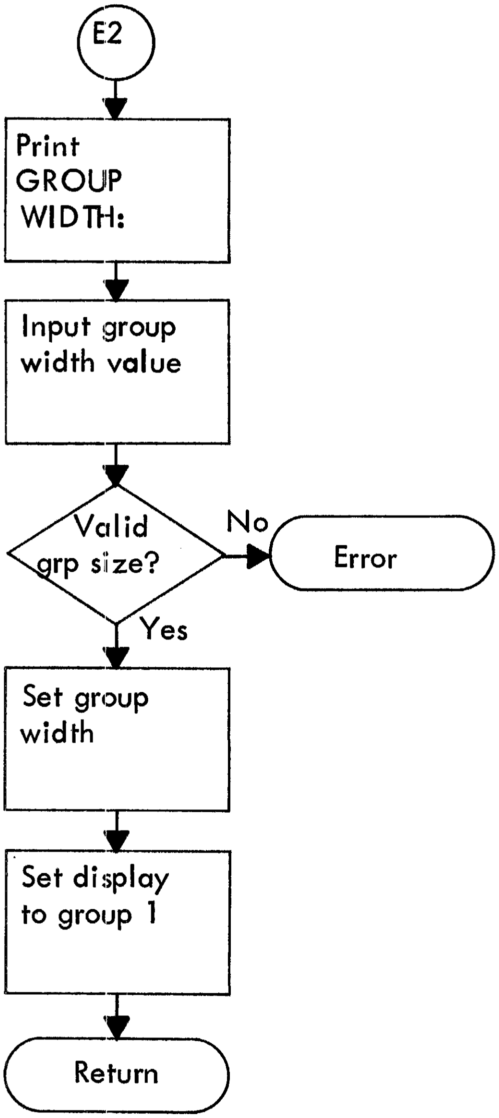


Figure 7-21. Group Set Subroutine

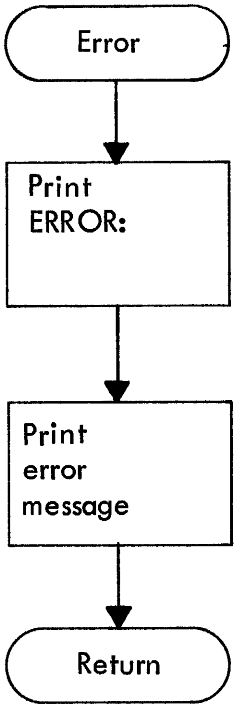


Figure 7-22. Error Subroutine

SECTION VIII
PROGRAM LISTING

8-1. A listing of the ND4410 Basic Physics Analyzer Program (41-1060) as produced by Pass 3 of the ND812 BASC-12 General Assembler Program (41-0001) is provided on the following pages.

```
/ND41-1Ø6Ø-Ø1           ØØØØ-2777       SA = Ø,Ø2ØØ
/ND-441Ø BASIC SINGLE PARAMETER ANALYZER SYSTEM
/VERSION A

/ 2(53)                 Ø8/14/72
/     DF/MG


/DEFINITIONS

               RDSTAT  =  Ø6Ø6         /READ DOUBLE STATUS WORD
               CLRCLK  =  Ø612         /CLEAR CLOCK FLAG
               SETACQ  =  2Ø26         /TRANSFER ADC CONTROL WORD
               READCW  =  7527         /READ DOUBLE ADC WORD
               CLRADC  =  7521         /CLEAR SPECIFIED ADC
               DISRDY  =  7514         /SKIP IF DISPLAY READY
               LDLIST  =  Ø632         /LOAD LIST REGISTER
               LDSPLY  =  75Ø6         /DISPLAY X AND Y COORDINATES
               DSMARK  =  75Ø7         /DISPLAY MARKER
               DISPOF  =  75ØØ         /TURN OFF DISPLAY (ACC)
               DMDSOF  =  2221         /TURN OFF DISPLAY (DMA)
               DMDSON  =  223Ø         /TURN ON  DISPLAY (DMA)
               DMWCSA  =  Ø626         /LOAD DMA WORD COUNT AND START
               CSWTCH  =  Ø611         /CLEAR SWITCH FLAG
               STLAMP  =  Ø614         /SET LAMP REGISTER
               SKPL    =  144Ø         /SKIP ON POWER LOW
               PION    =  15ØØ         /POWER INTERRUPT ON
               PLOTXY  =  7511         /PLOT XY, SET DSRDY FLAG WHEN DONE

/INTEGER PACKAGE DEFINITIONS

               IEXT    =  ØØØØ         /EXIT
               IOUT    =  34ØØ         /OUTPUT
               ISUB    =  4ØØØ         /SUBTRACTION
               IADD    =  44ØØ         /ADDITION
               ILOD    =  5ØØØ         /LOAD
               ISTR    =  54ØØ         /STORE
               INEG    =  6ØØØ         /NEGATE INTEGER AC
               IDIV    =  64ØØ         /DIVISION
               IMUL    =  7ØØØ         /MULTIPLICATION
               INOP    =  74ØØ         /NO OPERATION
               IM      =  DUBINT       /INTEGER PACKAGE ENTRY
```

```
/INTERRUPT ROUTINES FOR
/ LOW POWER (HIGH)
/ TTY (LOW)
/ HSR-HSP (LOW)
/ STATUS (B) TO J REGISTER
/       TIME OUT ON EXTERNAL CLOCK
/       CLOCK AT 100 HZ (HIGH)
/       PUSH BUTTONS (INCLUDING ERASE)
/       ERASE
/       DIRECTION: 1=LEFT; 0=RIGHT
/       2 EXTRA BITS
/       4 BITS FOR BUTTON DECODE (NOT ERASE)

                [FIELD 0
                [FIELD 0


                *0001

/NON-VECTORED INTERRUPT LOCATION

 0 0001  0760  LOWIPR, STATS              /PC STORAGE ON INTERRUPT
 0 0002  6272          JMP@ LPC           /INTERRUPT SERVICE ROUTINE

/TTY CHARACTER INPUT BUFFER

 0 0003  1300  TTY,    1300               /TTY BUFFER
 0 0004  0000          0000
 0 0005  0000          0000
 0 0006  0000          0000
 0 0007  7575          7575

/TTY MESSAGES

 0 0010  5457  CLSM,   5457               /(C)LOCK TIME
 0 0011  4353          4353
 0 0012  0064  TIM,    0064               /TIME
 0 0013  5155          5155
 0 0014  4575          4575

 0 0015  0043  CSEC,   0043               /CENTISEC
 0 0016  4556          4556
 0 0017  6451          6451
 0 0020  6345          6345
 0 0021  4375          4375


 0 0022  6257  GPW,    6257               /(G)ROUP
 0 0023  6560          6560
 0 0024  0075          0075
 Ø ØØ25  6751  WID,     6751             /WIDTH
 Ø ØØ26  4464           4464
 Ø ØØ27  5Ø75           5Ø75

 Ø ØØ3Ø  ØØ45  ERRORX,  ØØ45             /ERROR
 Ø ØØ31  6262           6262
 Ø ØØ32  5762           5762
 Ø ØØ33  32ØØ  EQ,      32ØØ             /COLON
 Ø ØØ34  7575           7575

 Ø ØØ35  7777  PCRLF,   7777             /CR-LF, CR-LF *
 Ø ØØ36  12ØØ           12ØØ
 Ø ØØ37  7575           7575

/E1951
```

```
/AUTO RESTART VECTOR

 0 0040  6236          JMP@ HP0        /REINITIALIZE

/SPACE USED  BY OVERLAYS


/SPACE RESERVED        FOR CASSETTE AND DISC TRAP INTERRUPTS

               *0061

/CASSETTE TRAP ROUTINE

 0 0061  0000  CTRAP,  0
 0 0062  0740          TWIO            /CLEAR ALL CASSETTE FLAGS
 0 0063  0141          CCLF
 0 0064  7061          XCT  IONX       /ENABLE INTERRUPTS
 0 0065  6304          JMP@ CTRAP      /IGNORE INTERRUPT

               *0071

/DISK TRAP ROUTINE

 0 0071  0000  ADCST,  0               /DISK TRAP AND ADC STATUS SAVE AREA
 0 0072  7053          XCT  IONX       /ENABLE INTERRUPTS
 0 0073  6302          JMP@ ADCST      /RETURN

 0 0074  0300  LPC,    LOWPC   /POINTER TO INTERRUPT PROCESS ROUTINE
 0 0075  0362  MOREF,  RETRN   /POINTER TO ADDITIONAL SKIP CHAIN ON LOW LEVEL
 0 0076  0200  HP0,    COMRET  /POINTER TO INITIALIZATION ROUTINE
 0 0077  0000  ADCJ,   0       /J REG STORAGE ON ADC INTERRUPT
 0 0100  0000  ADCK,   0       /K REG STORAGE ON ADC INTERRUPT


               *101

/ADC INTERRUPT PROCSS ROUTINE (HIGH)

 0 0101  0000  ADC0,   0               /91 MICRO SECOND STORE
 0 0102  5503          STJ ADCJ        /STORE J
 0 0103  0550          TWSTK           /STORE K
 0 0104  0100          ADCK
 0 0105  1011          LJST            /STORE STATUS
 0 0106  5515          STJ ADCST
 0 0107  1450          CLR O
 0 0110  7527          READCW          /READ ADC WORD
 0 0111  1602          SIP K
 0 0112  6026          JMP ADC1        /ALT SET - EVENT NO GOOD -IGNORE
 0 0113  1341          SFTZ JK 1       /FORM INC INST FOR ADC VALUE
 0 0114  4442          ADJ  GROUPZ
```

```
Ø Ø115   5415            STJ ADDRS        /ADDRESS PORTION
Ø Ø116   1455            SIZ  O CLR O     /FIELD CHANGE?
Ø Ø117   16Ø4            INC  K           /YES
Ø Ø12Ø   4Ø4Ø            SBJ  MEMZC
Ø Ø121   1374            ROTD JK 14
Ø Ø122   4435            ADJ  GROUPZ+1
Ø Ø123   54Ø6            STJ  X11         /INSTRUCTION + FIELD
Ø Ø124   1455            SIZ  O CLR O
Ø Ø125   23Ø1            SUBL 1
Ø Ø126   4Ø33            SBJ  MEMZC+1
Ø Ø127   1451            SNZ  O CLR O     /GROUP OVERFLOW?
Ø Ø13Ø   6Ø1Ø            JMP  ADC1        /YES, DONT STORE
Ø Ø131   Ø344   X11,     TWISZ FØ         /INCREMENT PROPER CHANNEL-(MODIFIED)
Ø Ø132   4ØØØ   ADDRS,   4ØØØ             /(MODIFIED)
Ø Ø133   6ØØ5            JMP ADC1         /NO OVERFLOW
Ø Ø134   35Ø2            ISZ ADDRS        /INC HIGH ORDER -  LOW OVERFLOWED
Ø Ø135   71Ø4            XCT X11
Ø Ø136   31Ø4            DSZ  ADDRS
Ø Ø137   14ØØ            IDLE
Ø Ø14Ø   Ø51Ø   ADC1,    TWLDK            /RESTORE K
Ø Ø141   Ø1ØØ            ADCK
Ø Ø142   5151            LDJ ADCST        /RESTORE STATUS
Ø Ø143   1ØØ2            RFOV
Ø Ø144   5145            LDJ ADCJ         /RESTORE J
Ø Ø145   1ØØ7   IONX,    IONN             /(MODIFIED) IONN OR IØNH
Ø Ø146   6345            JMP@ ADCØ

/HIGH SPEED READER INTERRUPT TEST

Ø Ø147   7424   HREADT,  HIS              /HS READ FLAG?
Ø Ø15Ø   6353            JMP@ MOREF       /NO, GO TEST OVERLAY INTERRUPTS
Ø Ø151   7422            HIR              /YES, CLEAR FLAG, READ CHAR
Ø Ø152   Ø6ØØ            TWJMP
Ø Ø153   Ø362   HREAD,   RETRN
Ø Ø154   7423            HRF              /CLEAR FLAG, READCHAR, FETCH CHAR
Ø Ø155   6213            JMP@ INICOM      /RETURN FROM INTERRUPT


Ø Ø156   4ØØØ   GROUPZ,  4ØØØ             /INC INST FOR FIRST CHANNEL
Ø Ø157   Ø344            TWISZ FØ         /IN CURRENT GROUP
Ø Ø16Ø   7776   MEMZC,   7776             /INC INST FOR LAST CHANNEL+1
Ø Ø161   Ø344            TWISZ FØ         /IN CURRENT GROUP
Ø Ø162   23Ø3   CONTL2,  TAB1-1           /PTR,TO VALID KYBD COMMAND CHARS
Ø Ø163   Ø76Ø   IDIS,    STATS            /PTR,TO INITAL RTN TO BACKGROUND
Ø Ø164   Ø433   IPRC,    SAVEL+7          /INITAL PTR TO PC IN STACK
Ø Ø165   Ø434   INITL,   SAVEL+1Ø         /INITAL VALUE FOR STACK PTR
Ø Ø166   Ø212   INITO,   NOOLAY           /USED BY OVERLAY FOR INITALIZATION
Ø Ø167   2422   IPSUPF,  PSUPPF           /PTR,TO PRINT SUPPRESS INDICATOR
Ø Ø17Ø   Ø362   INICOM,  RETRN            /PTR,TO INTERRUPT RETURN ROUTINE
```

```
/HIGH SPEED PUNCH INTERRUPT TEST

 Ø Ø171  7434  HIPUNT, HOS            /HSPUNCH FLAG?
 Ø Ø172  6123          JMP  HREADT    /NO, GO TRY HS READER
 Ø Ø173  7432          HOL            /YES, CLEAR FLAG, LOAD BUFFER
 Ø Ø174  Ø6ØØ          TWJMP
 Ø Ø175  Ø362  HIPUN,  RETRN
 Ø Ø176  7433          HLP            /CLEAR FLAG, LOAD BUFFER,  PUNCH  CHAR
 Ø Ø177  63Ø7          JMP@ INICOM    /RETURN FROM INTERRUPT

/E2415
```

```
            *Ø2ØØ

/INITIALIZATION ROUTINE

 Ø Ø2ØØ  6642  COMRET, JPS@ LOPRNT     /INITIALIZE-(IOFF) AFTER 1ST EXECUTION
 Ø Ø2Ø1  5114          LDJ  INITL      /INITIALIZE STACK POINTER
 Ø Ø2Ø2  Ø54Ø          TWSTJ
 Ø Ø2Ø3  Ø413          SAVEP
 Ø Ø2Ø4  5121          LDJ  IDIS       /SET INTERRUPT RTN TO B/G STATUS
 Ø Ø2Ø5  5721          STJ@ IPRC
 Ø Ø2Ø6  151Ø          CLR  J
 Ø Ø2Ø7  572Ø          STJ@ IPSUPF     /CLEAR PRINT SUPPRESS INDICATOR
 Ø Ø21Ø  5624          STJ@ IECHOF     /CLEAR ECHO OLD VALUE INDICATOR
 Ø Ø211  6323          JMP@ INITO      /INITIALIZE OVERLAY( ) OR NOOP(NOOLAY)
 Ø Ø212  15ØØ  NOOLAY, PION            /INITIALIZE POWER LOW INTERRUPT
 Ø Ø213  Ø64Ø          TWJPS           /PRINT CR/LF *
 Ø Ø214  24Ø3          UNPACK
 Ø Ø215  ØØ35          PCRLF
 Ø Ø216  6427          JPS  FCHAR      /GO WAIT FOR COMMAND CHAR
 Ø Ø217  26ØØ          SMJ@ FIRST      /GOT IT, SEARCH COMMAND DIRECTORY
 Ø Ø22Ø  6ØØ2          JMP  .+2
 Ø Ø221  61Ø2          JMP  .-2
 Ø Ø222  5ØØØ          LDJ  FIRST      /MATCH,FETCH POINTER
 Ø Ø223  2215          ADDL 15         /MOVE IT TO ROUTINE ADDRESS
 Ø Ø224  54Ø3          STJ  DECODE     /LAY IT IN THE ROAD
 Ø Ø225  175Ø          CLR  JK O
 Ø Ø226  Ø66Ø          TWJPS@          /RUN OVER IT!
 Ø Ø227  ØØØØ  DECODE, Ø               /(MODIFIED) POINTER TO COMMAND ROUTINE
 Ø Ø23Ø  5Ø42          LDJ  DINST2     /DISABLE PLOTTER
 Ø Ø231  Ø54Ø  DMOD,   TWSTJ
 Ø Ø232  Ø572          DINST
 Ø Ø233  6133          JMP  COMRET     /REINITIALIZE

 Ø Ø234  21Ø6  IECHOF, ECHOF           /FLAG INDICATING INEC FORCED TO ECHO

/TTY PRINTER INTERRUPT ROUTINE

 Ø Ø235  1ØØ4  TYPET,  IONH            /ENABLE HIGH INTERRUPT
 Ø Ø236  7414          TOS             /PRINT FLAG?
 Ø Ø237  6146          JMP  HIPUNT     /NO, GO TRY HIGH SPEED PUNCH
 Ø Ø24Ø  7411          TOC             /YES, CLEAR FLAG
 Ø Ø241  Ø6ØØ          TWJMP           / RETURN TO CALL
 Ø Ø242  4ØØØ  LOPRNT, MEMZØ           /RTN ADDRESS,ROUTINE FOR TTY
 Ø Ø243  7413          TCP             /CLEAR FLAG - TYPE CHAR
 Ø Ø244  6354          JMP@ INICOM     /RETURN FROM INTERRUPT

/FETCH CHAR  ROUTINE
/RETURN WITH 7 BIT STRIPPED KEYBOARD COMMAND CHAR

 Ø Ø245  ØØØØ  FCHAR,  Ø
 0 0246  6416          JPS  LOREAD     /RETURN AFTER CHAR RECEIVED
 0 0247  1145          SFTZ J 5        /STIP OFF PARITY BIT
 0 0250  1167          ROTD J 7
 0 0251  0540          TWSTJ           /SAVE CHAR
 0 0252  2320  CHARXP, CHARX
 0 0253  6511          JPS  LOPRNT     /ECHO CHARACTER BACK
 0 0254  5172          LDJ  CONTL2     /PTR TO VALID KEYBOARD COMMAND CHARS
 0 0255  5400          STJ  FIRST
 0 0256  5304          LDJ@ CHARXP     /7 BIT CONTROL CHAR
 0 0257  6312          JMP@ FCHAR      /EXIT

/KEYBOARD INTERRUPT TEST

 0 0260  7404  KYBDT,  TIS             /KEYBOARD FLAG?
 0 0261  6124          JMP  TYPET      /NO, GO TRY PRINTER FLAG
 0 0262  7402          TIR             /YES, READ CHAR, CLEAR FLAG
 0 0263  0600          TWJMP           /RETURN TO CALL
 0 0264  0362  LOREAD, RETRN           /RETURN ADDRESS OF ROUTINE WANTING TTY
 0 0265 <6375          JMP@ INICOM     /RETURN FROM INTERRUPT

/PLOT PUSHBUTTON ROUTINE

 0 0266  0000  PLOT,   0               /SET FOR PLOT NEXT DISPLAY PASS
 0 0267  5010          LDJ  JPSD       /SET UP PLOT NOT DISPLAY
 0 0270  6137          JMP  DMOD

/PLOT JK ROUTINE

 0 0271  0000  WAITP,  0
 0 0272  7506  DINST2, LDSPLY
 0 0273  7511  PINST,  PLOTXY          /(MODIFIED) IDLE IF NO PLOTTER
 0 0274  7514          DISRDY          /WAIT UNTIL DONE
 0 0275  6101          JMP  .-1
 0 0276  6305          JMP@ WAITP      /EXIT

 0 0277  6746  JPSD,   JPS@ .+PWAITP-DINST     /PLOT (NO DISPLAY) INSTRUCTION

/E2060
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/INTERRUPT PROCESS ROUTINE

 Ø Ø3ØØ  7514  LOWPC,  DISRDY           /MARKER RUNNING?
 Ø Ø3Ø1  1442          SKIP
 Ø Ø3Ø2  75ØØ          DISPOF           /NO, BLANK SCOPE
 Ø Ø3Ø3 >6476          JPS  SAVE        /SAVE THE FOLLOWING: J
 Ø Ø3Ø4  1374          ROTD JK 14       /K
 Ø Ø3Ø5  13Ø2          LJKFRS           /R
 Ø Ø3Ø6  1374          ROTD JK 14       /S
 Ø Ø3Ø7  1Ø11          LJST             /STATUS
 Ø Ø31Ø >5277          LDJ@ IONXP       /OLD INTERRUPT STATE
 Ø Ø311  5ØØØ          LDJ  FIRST       /FIRST
 Ø Ø312  5266          LDJ@ LIPR        /PROGRAM COUNTER
 Ø Ø313  6ØØ1          JMP  .+1         /EXIT FROM SAVE
 Ø Ø314  5Ø25          LDJ  IONHP       /PREP FOR ADC INT TO DO IONH NOT IONN
 Ø Ø315  7Ø53          XCT  X16         /STJ @ IONXP
 Ø Ø316  144Ø          SKPL             /POWER FAIL?
 Ø Ø317  1442          SKIP
 Ø Ø32Ø  ØØØØ          STOP             /YES
 Ø Ø321  14ØØ  MOREH,  IDLE             /OVERLAYS CAN USE AS TWJMP TO TEST FOR
 Ø Ø322  14ØØ          IDLE             /MORE HIGH LEVEL INTERRUPTS-MUST RESTORE
 Ø Ø323  Ø74Ø  HRTN,   TWIO             /TAGGED FOR OVERLAY RETURN
 Ø Ø324  Ø6Ø6          RDSTAT           /FETCH 441Ø STATUS
 Ø Ø325  16Ø2          SIP  K           /LIST MODE OVERFLOW?
 Ø Ø326  6262          JMP@ LOFLO       /YES, TURN OFF ACQUIRE
 Ø Ø327  12Ø4          LKFJ             /SAVE 44ØØ STATUS IN K
 Ø Ø33Ø  2Ø64          ANDF P34ØØ       /LOOK AT INTERRUPT FLAGS
 Ø Ø331  15Ø1          SNZ  J           /44ØØ INTERRUPT?
 Ø Ø332  6152          JMP  KYBDT       /NO, GO TRY KYBD/RDER FLAG
 Ø Ø333  1141          SFTZ J 1         /YES,NOW EVALUATE THEM
 Ø Ø334  15Ø2          SIP  J           /CTB INTERRUPT ?
 Ø Ø335  6254          JMP@ ITMOUT      /YES
 Ø Ø336  1141  NOCTB,  SFTZ J 1         /NO
 Ø Ø337  15Ø2          SIP  J           /44ØØ CLOCK INTERRUPT?
 Ø Ø34Ø  6252          JMP@ ICLOCK      /YES
 Ø Ø341  1ØØ4  IONHP,  IONH             /NO, ENABLE INTERRUPT HIGH
 Ø Ø342  Ø74Ø          TWIO
 Ø Ø343  Ø611          CSWTCH           /CLEAR SWITCH FLAG
 Ø Ø344  1344          SFTZ JK 4        /MUST BE PUSHBUTTONS
 Ø Ø345  1361          ROTD JK 1        /MOVE ERASE BIT INTO J
 Ø Ø346  15Ø5          SIZ  J           /ERASE?
 Ø Ø347  161Ø          CLR  K           /YES, CLR PUSHBUTTON CODE
 Ø Ø35Ø  141Ø          CLR  FLAG
 Ø Ø351  16Ø2          SIP  K           /L/R BIT LEFT?
 Ø Ø352  143Ø          SET  FLAG        /YES - FLAG IS DIRECTION INDICATOR
 Ø Ø353  1243          SFTZ K 3         /NOW GET PUSHBUTTON CODE
 Ø Ø354  1364          ROTD JK 4        /IF ERASE J NOW = 2Ø
 Ø Ø355  444Ø          ADJ  POINTR      /BUILD POINTER TO PUSHBUTTON ROUTINE POI
 Ø Ø356  54Ø3          STJ  .+3
 Ø Ø357  175Ø          CLR  JK 0
 0 0360  0660          TWJPS@              /GO TO PUSHBUTTON ROUTINE
 0 0361  0000          0                   /(MODIFIED) POINTER TO PUSHBUTTON ROUTI

/INTERRUPT RETURN ROUTINE

 0 0362  1003  RETRN,  IOFF
 0 0363  1410          CLR   FLAG          /PRIME FLAG FOR RESTORATION
 0 0364  1450          CLR   O             /PRIME OVERFLOW FOR RESTORATION
 0 0365  6431          JPS   RSTR          /RESTORE THE FOLLOWING:
 0 0366  5612          STJ@ LIPR           /PROGRAM COUNTER
 0 0367  5400          STJ   FIRST         /FIRST
 0 0370  5617  X16,    STJ@ IONXP          /OLD INTERRUPT STATE
 0 0371  1002          RFOV                /STATUS
 0 0372  1204          LKFJ                /S
 0 0373  1301          LRSFJK              /R
 0 0374  1204          LKFJ                /K
 0 0375  6001          JMP   .+1           /EXIT FROM RESTORE ROUTINE- J RESTORED
 0 0376  7211          XCT@ IONXP          /TURN ON INTERRUPT
 0 0377  0620          TWJMP@              /RETURN TO BACKGROUND
 0 0400  0001  LIPR,   LOWIPR

/SAVE REGISTERS ROUTINE

 0 0401  0000  SAVE,   0
 0 0402  5611          STJ@ SAVEP          /PUSH J REG IN STACK
 0 0403  3410          ISZ   SAVEP         /BUMP STACK POINTER
 0 0404  7303          XCT@ SAVE           /GET NEXT REG TO SAVE OR EXIT
 0 0405  3504          ISZ   SAVE          /UPDATE POINTER TO NEXT REG
 0 0406  6104          JMP   .-4

 0 0407  0145  IONXP,  IONX                /PTR,TO INTERRUPT RTN CMD
 0 0410  2025  LOFLO,  AQOFF               /PRT,TO ACQUIRE OFF ROUTINE
 0 0411  0336  ITMOUT, NOCTB               /ADC TIME OUT
 0 0412  2011  ICLOCK, CLOCK               /PTR, TO LIVE TIME CLOCK SERVICE
 0 0413  0434  SAVEP,  SAVEL+10            /STACK POINTER
 0 0414  3400  P3400,  3400
 0 0415  2336  POINTR, TABLE               /PTR,TO PUSHBUTTON TABLE

/RESTORE REGISTERS ROUTINE

 0 0416  0000  RSTR,   0
 0 0417  3104          DSZ   SAVEP         /DECREMENT STACK POINTER
 0 0420  5305          LDJ@ SAVEP          /POP STACK TO J REG
 0 0421  7303          XCT@ RSTR           /MOVE J REG TO PROPER REG OR EXIT
 0 0422  3504          ISZ   RSTR          /UPDATE POINTER TO NEXT REG
 0 0423  6104          JMP   .-4

/INTERRUPT REGISTER STACK FOR LOW LEVEL

 0 0424  0000  SAVEL,  0                   /J
 Ø Ø425  ØØØØ         Ø                  /K
 Ø Ø426  ØØØØ         Ø                  /R
 Ø Ø427  ØØØØ         Ø                  /S
 Ø Ø43Ø  ØØØØ         Ø                  /STATUS
 Ø Ø431  1ØØ7         IONN               /IONX
 Ø Ø432  ØØØØ         Ø                  /FIRST
 Ø Ø433  Ø76Ø         STATS              /PC

/INTERRUPT REGISTER STACK FOR HIGH LEVEL

 Ø Ø434  ØØØØ         Ø                  /J
 Ø Ø435  ØØØØ         Ø                  /K
 Ø Ø436  ØØØØ         Ø                  /R
 Ø Ø437  ØØØØ         Ø                  /S
 Ø Ø44Ø  ØØØØ         Ø                  /STATUS
 Ø Ø441  ØØØØ         Ø                  /IONX
 Ø Ø442  ØØØØ         Ø                  /FIRST
 Ø Ø443  ØØØØ         Ø                  /PC

/E27Ø2
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/LOAD DOUBLE INTEGER INTO J + K REGISTER ROUTINE
/J POINTS TO INTEGER ON CALL

 Ø Ø444  ØØØØ  GETW,   Ø
 Ø Ø445  54Ø4          STJ  GETP
 Ø Ø446  52Ø3          LDJ@ GETP
 Ø Ø447  34Ø2          ISZ  GETP
 Ø Ø45Ø  Ø51Ø          TWLDK
 Ø Ø451  ØØØØ  GETP,   Ø
 Ø Ø452  63Ø6          JMP@ GETW

/DOUBLE INT ADD OR SUBTRACT ROUTINE
/IF OVERFLOW = Ø ADD
/IF OVERFLOW = 1 SUBTRACT
/KJ + OR - @(CALL+1)
/RETURN TO CALL+2
/RESULT IN KJ

 Ø Ø453  ØØØØ  ASTW,   Ø
 Ø Ø454  13Ø1          LRSFJK             /SAVE KJ
 Ø Ø455  53Ø2          LDJ@ ASTW          /FETCH CALL+1
 Ø Ø456  35Ø3          ISZ  ASTW
 Ø Ø457  6513          JPS  GETW          /FETCH C(CALL@)
 Ø Ø46Ø  1451          SNZ  CLR O         /SUTRACT?
 Ø Ø461  6ØØ5          JMP  ADTW          /NO, DO AD
 Ø Ø462  172Ø          CMP  JK            /YES,NEGATE KJ
 Ø Ø463  15Ø4          INC  J
 Ø Ø464  1455          SIZ  CLR O         /BORROW?
 Ø Ø465  16Ø4          INC  K             /YES
 Ø Ø466  1122  ADTW,   ADR  J             /ADD LEAST
 Ø Ø467  1455          SIZ  CLR O         /CARRY?
 Ø Ø47Ø  16Ø4          INC  K             /YES
 Ø Ø471  1224          ADS  K             /ADD MOST
 Ø Ø472  6317          JMP@ ASTW

 Ø Ø473  ØØØØ  LOG,    Ø                  /LOG 2 CONVERSION
 Ø Ø474  16Ø5          SIZ  K             /MOST = Ø?
 Ø Ø475  6ØØ7          JMP  LOGD1         /NO, DO ALL
 Ø Ø476  15Ø1          SNZ  J             /LEAST = Ø?
 Ø Ø477  63Ø4          JMP@ LOG           /EXIT, DATA = Ø
 Ø Ø5ØØ  12Ø4          LKFJ               /DO LEAST
 Ø Ø5Ø1  5Ø17          LDJ  LOGTWO
 Ø Ø5Ø2  2314          SUBL 14
 Ø Ø5Ø3  5415          STJ  LOGTWO
 Ø Ø5Ø4  16Ø2  LOGD1,  SIP  K             /DONE?
 Ø Ø5Ø5  6ØØ4          JMP  LOGD2         /YES
 Ø Ø5Ø6  3Ø12          DSZ  LOGTWO
 Ø Ø5Ø7  1341          SFTZ JK 1
 Ø Ø51Ø  61Ø4          JMP  LOGD1
 Ø Ø511  1341  LOGD2,  SFTZ JK 1
 Ø Ø512  5ØØ6              LDJ  LOGTWO
 Ø Ø513  1367              ROTD JK 7
 Ø Ø514  1354              SFTZ JK 14
 Ø Ø515  223Ø              ADDL 3Ø
 Ø Ø516  54Ø2              STJ  LOGTWO
 Ø Ø517  6324              JMP@ LOG        /EXIT, K = LOG JK

 Ø Ø52Ø  ØØ3Ø     LOGTWO, 3Ø
 Ø Ø521  Ø133     TWK5,   133
 Ø Ø522  Ø131     X11I,   X11     /POINTER TO TWISZ INSTRUCTION TO LAST CHANNEL
 Ø Ø523  ØØØØ     DISCON, Ø       /DISPLAY TYPE, =Ø LIVE, OTHERWISE STATIC
 Ø Ø524  Ø271     PWAITP, WAITP   /POINTER TO PLOT ROUTINE

/LIVE DISPLAY ROUTINE

 Ø Ø525  5Ø52     TWINKT, LDJ  TEX2        /MODIFY DISPLAY ROUTINE - SO ONLY 1 POIN
 Ø Ø526  545Ø             STJ  TEX1
 Ø Ø527  51Ø5             LDJ  X11I
 Ø Ø53Ø  6564     X9,     JPS  GETW        /FETCH ADC DATA CHANNEL ADDRESS
 Ø Ø531  1374             ROTD JK 14
 Ø Ø532  147Ø             SET  0           /SET SUBTRACT INDICATOR FOR ASTW
 Ø Ø533  656Ø             JPS  ASTW        /SUB ADDRESS OF 1ST CHANNEL IN GROUP
 Ø Ø534  Ø156             GROUPZ
 Ø Ø535  136Ø     TWINK1, ROTD JK Ø        /(MODIFIED) CFS
 Ø Ø536  1361             ROTD JK 1        /(MODIFIED)
 Ø Ø537  13Ø3             EXJRKS           /R=X AXIS, KJ=ADDRESS
 Ø Ø54Ø  64Ø7             JPS  DSPLY       /DISPLAY POINT
 Ø Ø541  312Ø             DSZ  TWK5        /4ØØ POINTS?
 Ø Ø542  6Ø53             JMP  LDSCON
 Ø Ø543  5121             LDJ  X11I        /YES, DO STATUS
 Ø Ø544  5523             STJ  TWK5
 Ø Ø545  Ø6ØØ             TWJMP
 Ø Ø546  Ø76Ø             STATS

/DISPLAY ALL DATA POINTS 1 TIME ROUTINE
/J-K REGS HAVE POINTER TO 1ST CHANNEL TO DISPLAY

 Ø Ø547  ØØØØ     DSPLY,  Ø
 Ø Ø55Ø  54Ø7             STJ  DISP52      /ADDRESS OF 1ST CHANNEL TO DISPLAY
 Ø Ø551  1374             ROTD JK 14       /ISOLATE FIELD OF 1ST CHANNEL
 Ø Ø552  21Ø3             ANDL 3
 Ø Ø553  4464             ADJ  DNORM       /FORM TWLDK INSTRUCTION
 Ø Ø554  54Ø2             STJ  DISP51
 Ø Ø555  175Ø             CLR  JK 0
 Ø Ø556  Ø514     DISP51, TWLDK FØ         /(MODIFIED) - LOAD CHANNEL LOW
 Ø Ø557  4ØØØ     DISP52, 4ØØØ             /(MODIFIED)
 Ø Ø56Ø  35Ø1             ISZ  DISP52      /STEP TO CHANNEL HIGH
 Ø Ø561  1374             ROTD JK 14       /J = DATA LEAST
 Ø Ø562  12Ø1             LSFK             /S = CURRENT DELTA X
 Ø Ø563  71Ø5             XCT  DISP51      /K = DATA MOST
 Ø Ø564  1357  SFTZ1,   SFTZ JK 17       /(MODIFIED) (MAY BE JPS LOG)
 Ø Ø565  134Ø  SFTZ2,   SFTZ JK Ø        /(MODIFIED) ADJUST FOR COUNTS FULL SCAL
 Ø Ø566  155Ø           CLR  J O
 Ø Ø567  1124           ADS  J
 Ø Ø57Ø  4415           ADJ  DELTA
 Ø Ø571  11Ø3  TEX,     EXJR
 Ø Ø572  75Ø6  DINST,   LDSPLY           /(MODIFIED)DISPLAY POINT (JPS@ FWAITP)
 Ø Ø573  1455           SIZ  CLR O       /UPDATE DELTA X
 Ø Ø574  15Ø4           INC  J
 Ø Ø575  4411           ADJ  DELTA+1
 Ø Ø576  11Ø3  TEX1,    EXJR             /(MODIFIED BY TWINKT), R=NEXT X ORIGIN
 Ø Ø577  1455  TEX2,    SIZ  CLR O       /X OVERFLOW?
 Ø Ø6ØØ  6331           JMP@ DSPLY       /YES - EXIT
 Ø Ø6Ø1  3522           ISZ  DISP52      /NO - STEP TO NEXT CHANNEL
 Ø Ø6Ø2  6124           JMP  DISP51
 Ø Ø6Ø3  3525           ISZ  DISP51
 Ø Ø6Ø4  6126           JMP  DISP51

 Ø Ø6Ø5  ØØØØ  DELTA,   Ø         /DELTA VALUE FOR X ORIGIN FOR DATA-SUPER LOW
 Ø Ø6Ø6  ØØØ4           4         /LOW
 Ø Ø6Ø7  1512  MGCP, MGCLP-1      /POINTER TO LEFT, RIGHT, CENTER MARKER POINTERS
 Ø Ø61Ø  ØØØ3  MARKN,   3         /NUMBER OF MARKERS
 Ø Ø611  ØØØØ  MDATA,   Ø         /CENTER MARKER DATA VALUE
 Ø Ø612  ØØØØ           Ø
 Ø Ø613  1533  DSPP,    DSC       /POINTER TO DISPLAY STARTING CHANNEL
 Ø Ø614  ØØØØ  PMTWO,   Ø         /OVERLAP INDICATOR

/DATA DISPLAY - (BACKGROUND)

 Ø Ø615  5124  LDSCON, LDJ  TEX          /RESTORE DISPLAY ROUTINE
 Ø Ø616  552Ø           STJ  TEX1
 Ø Ø617 <5174           LDJ  DISCON
 Ø Ø62Ø  1511           SNZ  CLR J       /STATIC DISPLAY?
 Ø Ø621 <6174           JMP  TWINKT      /NO, LIVE DISPLAY
 Ø Ø622  11Ø1           LRFJ             /SET X AXIS = Ø IN R REG
 Ø Ø623  51Ø7           LDJ  PMTWO       /SET OLAP OR NORMAL GROUP START CHNL
 Ø Ø624  1524           CMP  INC J
 Ø Ø625  5511           STJ  PMTWO
 Ø Ø626  4513           ADJ  DSPP        /DISPLAY STARTING CHANNEL
 Ø Ø627 <7177  X1Ø,     XCT  X9          /JPS GETW - GET DOUBLE INTEGER
 Ø Ø63Ø  1361           ROTD JK 1        /KJ = ABSOLUTE STARTING ADDRESS
 Ø Ø631  6562           JPS  DSPLY       /NOW DISPLAY DATA
 Ø Ø632  5Ø16           LDJ  MARKD       /DISABLE PLOTTER - ENABLE DISPLAY
 Ø Ø633  23Ø1           SUBL 1
 Ø Ø634  5542           STJ  DINST

/E32Ø4
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/MARKER         CALCULATION AND DISPLAY

 Ø Ø635   5126              LDJ  MGCP        /POINTER TO LEFT, RIGHT, CENTER MARKER P
 Ø Ø636   54ØØ              STJ  FIRST
 Ø Ø637   Ø514   DNORM,     TWLDK FØ         /GET  CENTER MARKER DATA VALUE
 Ø Ø64Ø   Ø612              MDATA+1
 Ø Ø641   513Ø              LDJ  MDATA
 Ø Ø642   7156              XCT  SFTZ1       /ADJUST FO COUNTS FULL SCALE
 Ø Ø643   7156              XCT  SFTZ2       /VALUE IN K REG
 Ø Ø644   5134              LDJ  MARKN       /SET COUNT OF MARKERS TO OUTPUT
 Ø Ø645   5472              STJ  MARKC
 Ø Ø646  >5Ø76   MARKS,     LDJ  DELTM
 Ø Ø647   15Ø5              SIZ  J           /MARKER OUTSIDE DISPLAY?
 Ø Ø65Ø   75Ø7   MARKD,     DSMARK           /NO, DISPLAY MARKER
 Ø Ø651   7514              DISRDY           /WAIT FOR LAST MARKER
 Ø Ø652   61Ø1              JMP  .-1
 Ø Ø653   52ØØ              LDJ@ FIRST       /J = MGC POINTER
 Ø Ø654   54Ø3              STJ  .+3         /FETCH MARKER CHANNEL NUMBER POINTER
 Ø Ø655   173Ø              SET  JK          /MARKER CHANNEL NUMBER -1
 Ø Ø656   7Ø33              XCT  X13         /TWJPS ASTW
 Ø Ø657   ØØØØ              Ø
 Ø Ø66Ø   145Ø              CLR  O           /MARKER CHANNEL NUMBER -1
 Ø Ø661   7Ø3Ø              XCT  X13         /TWJPS ASTW
 Ø Ø662   164Ø              GSC
 Ø Ø663   Ø55Ø   X12,       TWSTK            /SAVE ABSOLUTE MARKER CHANNEL ADDRESS
 Ø Ø664   Ø742              MCHAN+1
 Ø Ø665   5454              STJ  MCHAN
 Ø Ø666   3Ø51              DSZ MARKC
 Ø Ø667   6Ø2Ø              JMP  MRK1        /NO, BYPASS DATA FETCH
 Ø Ø67Ø   1361              ROTD JK 1        /YES,SET UP DATA FETCH
 Ø Ø671   54Ø5              STJ  CM2
 Ø Ø672   5133              LDJ  DNORM
 Ø Ø673   112Ø              AJK  J
 Ø Ø674   54Ø1              STJ  CM1
 Ø Ø675   Ø514   CM1,       TWLDK FØ         /FETCH DATA
 Ø Ø676   ØØØØ   CM2,       Ø
 Ø Ø677   1374              ROTD JK 14
 Ø Ø7ØØ   5567              STJ  MDATA       /AND SAVE IT
 Ø Ø7Ø1   35Ø3              ISZ  CM2
 Ø Ø7Ø2   71Ø5              XCT  CM1
 Ø Ø7Ø3   Ø55Ø              TWSTK
 Ø Ø7Ø4   Ø612              MDATA+1
 Ø Ø7Ø5   5Ø33              LDJ  MCHANP
 Ø Ø7Ø6   7157              XCT  X1Ø         /FETCH ABS MARKER CHNL JPS GETW
 Ø Ø7Ø7   343Ø   MRK1,      ISZ  MARKC       /RESTORE REMAINING MARKERS COUNT
 Ø Ø71Ø   147Ø              SET  O
 Ø Ø711   Ø64Ø   X13,       TWJPS            /SUBTRACT DISPLAY STARTING CHANNEL
 Ø Ø712   Ø453              ASTW
 Ø Ø713   1533   DSCI,      DSC
 Ø Ø714   5425              STJ  MCHAN
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Ø Ø715  7132            XCT  X12          /MCHAN = MARKER DISPLAY CHANNEL
Ø Ø716  16Ø2            SIP  K            /MARKER INSIDE DISPLAY AREA?
Ø Ø717  6Ø11            JMP  MRK5         /NO, KILL MARKER
Ø Ø72Ø  Ø51Ø   X8,      TWLDK             /MCHAN * DELTA X
Ø Ø721  Ø6Ø5            DELTA
Ø Ø722  1ØØØ            MPY               /MCHAN * DELTA
Ø Ø723  13Ø3            EXJRKS
Ø Ø724  Ø55Ø            TWSTK
Ø Ø725  Ø744            DELTM
Ø Ø726  Ø514   DNORM1,  TWLDK FØ
Ø Ø727  Ø6Ø6            DELTA+1
Ø Ø73Ø  5Ø12   MRK5,    LDJ  MCHAN+1
Ø Ø731  16Ø1            SNZ  K            /DELTA > 4Ø96?
Ø Ø732  6Ø13            JMP  MRK2         /NO
Ø Ø733  1515            SIZ  CLR J        /MCHAN > 4Ø96?
Ø Ø734  6Ø2Ø            JMP  MRK4         /YES, OUTSIDE DISPLAY
Ø Ø735  5ØØ4            LDJ  MCHAN
Ø Ø736  6Ø1Ø            JMP  MRK3

Ø Ø737  ØØØØ   MARKC,   Ø        /POINTER TO NUMBER TO BE DISPLAYED
Ø Ø74Ø  Ø741   MCHANP,  MCHAN
Ø Ø741  ØØØØ   MCHAN,   Ø        /HIGH ORDER HALF OF NUMBER TO BE DISPLAYED
Ø Ø742  ØØØØ            Ø
Ø Ø743  Ø646   MARKSP,  MARKS    /POINTER TO MARKER PROCESSING LOOP
Ø Ø744  ØØØØ   DELTM,   Ø        /X AXIS LOCATION OF MARKER

Ø Ø745  7125   MRK2,    XCT  X8           /LDK  DELTA
Ø Ø746  1ØØØ   MRK3,    MPY               /MCHAN * DELTA+1) OR (DELTA * MCHAN+1)
Ø Ø747  13Ø3            EXJRKS
Ø Ø75Ø  45Ø4            ADJ  DELTM
Ø Ø751  15Ø1            SNZ  J            /MARKER DELTA = Ø?
Ø Ø752  15Ø4            INC  J            /YES,INC FOR DISPLAY
Ø Ø753  1655            SIZ  CLR K O      /OUTSIDE DISPLAY?
Ø Ø754  175Ø   MRK4,    CLR  JK O         /YES, KILL MARKER
Ø Ø755  5511            STJ  DELTM
Ø Ø756  3117            DSZ  MARKC        /3 DELTAS DONE?
Ø Ø757  6314            JMP@ MARKSP       /NO, DO ANOTHER

/E196Ø
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/STATUS          CALCULATION AND DISPLAY ROUTINE - (BACKGROUND)

 Ø Ø76Ø  5Ø61  STATS,  LDJ  STATX      /INITIALIZE STATUS SETUP
 Ø Ø761  15Ø1          SNZ  J          /BLANK?
 Ø Ø762  6256          JMP@ STATO      /YES, SKIP THE STATUS DISPLAY
 Ø Ø763  54ØØ          STJ  FIRST
 Ø Ø764  143Ø          SET             /IND FOR 1ST WORD OF CHAR MATRIX
 Ø Ø765  153Ø          SET  J          /INITIALIZE Y ORIGIN - 7777
 Ø Ø766  5454          STJ  YORIG
 Ø Ø767  157Ø  SCOPCR, SET  J O        /DO A SCOPE CR LF
 Ø Ø77Ø  4Ø54          SBJ  C240
 Ø Ø771  5454          STJ  XORIG      /SET X ORIGIN = 754Ø
 Ø Ø772  445Ø          ADJ  YORIG      /SET Y ORIGIN AT 337 LESS THAN OLD
 Ø Ø773 >2377          SUBL 77
 Ø Ø774  5446          STJ  YORIG
 Ø Ø775  151Ø  STATLP, CLR  K
 Ø Ø776  52ØØ          LDJ@ FIRST      /FETCH POINTER TO NUMBER
 Ø Ø777  554Ø          STJ  MARKC
 Ø 1ØØØ  5341          LDJ@ MARKC      /FETCH HIGH HALF OF NUMBER
 Ø 1ØØ1  554Ø          STJ  MCHAN
 Ø 1ØØ2  15Ø2          SIP  J          /AND NEGATE IF NEGATIVE
 Ø 1ØØ3  156Ø          CMP  J O
 Ø 1ØØ4  5412          STJ  STADH      /STORE HIGH HALF
 Ø 1ØØ5  3146          DSZ  MARKC      /FETCH LOW HALF OF NUMBER
 Ø 1ØØ6  5347          LDJ@ MARKC
 Ø 1ØØ7  1455          SIZ  CLR O      /NEGATE IF NEGATIVE
 Ø 1Ø1Ø  1524          CMP  INC J
 Ø 1Ø11  54Ø7          STJ  STADL      /STORE LOW HALF
 Ø 1Ø12  1455          SIZ  CLR O
 Ø 1Ø13  34Ø3          ISZ  STADH      /ACCOUNT FOR OVERFLOW FROM LOW
 Ø 1Ø14  75ØØ  CONVLP, DISPOF
 Ø 1Ø15  6431          JPS  DVBY1Ø     /DIVIDE HIGH ORDER       BY 1Ø
 Ø 1Ø16  ØØØØ  STADH,  Ø
 Ø 1Ø17  6427          JPS  DVBY1Ø     /DIVIDE LOW ORDER        + REMAINDER
 Ø 1Ø2Ø  ØØØØ  STADL,  Ø
 Ø 1Ø21  1374          ROTD JK 14
 Ø 1Ø22  6435          JPS  STAOUT     /DISPLAY NEXT LOW ORDER DIGIT(REMAINDER
 Ø 1Ø23  Ø51Ø          TWLDK
 Ø 1Ø24  1Ø2Ø          STADL
 Ø 1Ø25  51Ø7          LDJ  STADH
 Ø 1Ø26  1715          SIZ  CLR JK     /CONVERSION DONE?
 Ø 1Ø27  6113          JMP  CONVLP     /NO - GET NEXT LOWEST DIGIT
 Ø 1Ø3Ø  5167          LDJ  MCHAN      /YES, NOW INSERT SIGN
 Ø 1Ø31  1516          SIN  CLR J      /NEGATIVE?
 Ø 1Ø32  6ØØ3          JMP  .+3        /NO,FORGET IT
 Ø 1Ø33  23Ø3          SUBL 3          /YES, INSERT MINUS
 Ø 1Ø34  6423          JPS  STAOUT     /DISPLAY MINUS SIGN
 Ø 1Ø35  52ØØ          LDJ@ FIRST      /GET SEPARATOR CHAR
 Ø 1Ø36  6421          JPS  STAOUT     /DISPLAY CHAR
 Ø 1Ø37  6142          JMP  STATLP
 Ø 1Ø4Ø  Ø615  STATO,  LDSCON  /POINTER TO DISPLAY DATA ROUTINE
 Ø 1Ø41  2257  STATX,  MR-1    /POINTER TO STATUS GROUP TO BE DISPLAYED
 Ø 1Ø42  7777  YORIG,  7777    /Y ORIGIN FOR DISPLAY
 Ø 1Ø43  ØØ77  C77,    77
 Ø 1Ø44  Ø24Ø  C24Ø,   24Ø
 Ø 1Ø45  ØØØØ  XORIG,  Ø       /X ORIGIN FOR DISPLAY

/DIVIDE BY 1Ø ROUTINE
/DIVIDE CALL+1 BY DECIMAL 1Ø
/RESULT PUT  IN CALL+1
/RETURN TO CALL+2
/K HAS HIGH  ORDER ON ENTRY

 Ø 1Ø46  ØØØØ  DVBY1Ø, Ø
 Ø 1Ø47  155Ø         CLR  J O
 Ø 1Ø5Ø  2212         ADDL 12
 Ø 1Ø51  11Ø1         LRFJ
 Ø 1Ø52  53Ø4         LDJ@ DVBY1Ø
 Ø 1Ø53  1ØØ1         DIV
 Ø 1Ø54  57Ø6         STJ@ DVBY1Ø
 Ø 1Ø55  35Ø7         ISZ  DVBY1Ø
 Ø 1Ø56  631Ø         JMP@ DVBY1Ø

/DISPLAY CHAR IN J REGISTER ROUTINE

 Ø 1Ø57  ØØØØ  STAOUT, Ø
 Ø 1Ø6Ø  75ØØ         DISPOF
 Ø 1Ø61  222Ø         ADDL 2Ø         /TERMINATOR?
 Ø 1Ø62  15Ø1         SNZ  J
 Ø 1Ø63  6323         JMP@ STATO      /YES - EXIT STATUS ROUTINE
 Ø 1Ø64 >2177         ANDL 77
 Ø 1Ø65  2522.        SMJ  C77        /END LINE?
 Ø 1Ø66 <6177         JMP  SCOPCR     /YES, ADJUST XY ORIGINS
 Ø 1Ø67  1141         SFTZ Ø1 J       /NO - BUILD LDJ INST TO GET CHAR
 Ø 1Ø7Ø  4461         ADJ  CTABLE
 Ø 1Ø71  5414         STJ  GWRD
 Ø 1Ø72  5Ø54         LDJ  P5         /5 BITS PER ROW ALONG X AXIS
 Ø 1Ø73  5455         STJ  POINTC
 Ø 1Ø74  2233         ADDL 33         /4Ø= OFFSET ON Y AXIS
 Ø 1Ø75  12Ø4         LKFJ
 Ø 1Ø76  12Ø1         LSFK            /OFFSET ON Y AXIS IN S REG
 Ø 1Ø77  Ø51Ø         TWLDK
 Ø 11ØØ  1Ø42         YORIG
 Ø 11Ø1  5134         LDJ  XORIG
 Ø 11Ø2  11Ø3         EXJR            /X ORIGIN IN R REG
 Ø 11Ø3  5Ø44  NXTWRD, LDJ  P14       /14 BITS IN EACH OF 2 WORDS OF MATRIX
 Ø 11Ø4  544Ø         STJ  BITCNT
 Ø 11Ø5  5Ø13  GWRD,   LDJ  TABL-32   /FETCH MATRIX WORD (MODIFIED)
 Ø 11Ø6  35Ø1         ISZ  .-1        /STEP TO 2ND MATRIX WORD
 0 1107  1161  NXTPNZ, ROTD J 1        /GET NEXT MATRIX POINT
 0 1110  4435          ADJ  P4000
 0 1111  1103          EXJR            /MATRIX IN R REG, X ORIGIN IN J REG
 0 1112  7500          DISPOF
 0 1113  1455          SIZ  CLR O      /DISPLAY POINT IF SET
 0 1114  7226          XCT@ DINSTP     /LDSPLY - DISPLAY POINT
 0 1115  2230          ADDL 30         /BIAS X ORIGIN FOR NEXT POINT
 0 1116  3032          DSZ  POINTC     /ROW COMPLETE?
 0 1117  6005          JMP  CONT       /NO
 0 1120  5026          LDJ  P5         /YES- RESTORE FOR 5 MORE POINTS
 0 1121  5427          STJ  POINTC
 0 1122  5155          LDJ  XORIG      /RESTORE X ORIGIN
 0 1123  1235          NSBS K          /BIAS Y ORIGIN FOR NEXT ROW
 0 1124  1103  CONT,   EXJR            /X ORIGIN IN R REG, MATRIX IN J REG
 0 1125  3017          DSZ  BITCNT     /WORD DEPLETED?
 0 1126  6117          JMP  NXTPNZ     /NO- PROCESS NEXT POINT
 0 1127  1425          SIZ  CMP        /ANOTHER WORD LEFT IN MATRIX?
 0 1130  6125          JMP  NXTWRD     /YES
 0 1131  2412          SMJ  DTWO       /WAS IT A 2?
 0 1132  1442          SKIP
 0 1133  6003          JMP  ADVANC     /NO
 0 1134  1103          EXJR            /YES, FORCE LAST POINT
 0 1135  7205          XCT@ DINSTP     /LDSPLY - DISPLAY POINT
 0 1136  5171  ADVANC, LDJ  XORIG      /REORIGIN X ORIGIN
 0 1137  4173          SBJ  C240
 0 1140  5573          STJ  XORIG
 0 1141  6362          JMP@ STAOUT     /EXIT - AFTER 1 CHAR

 0 1142  0572  DINSTP, DINST   /POINTER TO DISPLAY POINT INSTRUCTION
 0 1143  0570  DTWO,   570     /2 WORD COMPLEMENTED MATRIX WORD FOR A 2
 0 1144  0000  BITCNT, 0       /BIT COUNT IN CHAR MATRIX PER WORD
 0 1145  4000  P4000,  4000
 0 1146  0005  P5,     5
 0 1147  0014  P14,    14
 0 1150  0005  POINTC, 5       /BIT COUNT IN CHAR MATRIX ON X AXIS
 0 1151  5013  CTABLE, LDJ  .+13       /SKELETON FOR LDJ INST TO GET DISPLAY MA
                       /MATRIX FOR CHAR

/DISPLAY CHAR IMAGES
/ROTATE EACH WORD 1 LEFT
/THEN EACH 5 BITS ACROSS X AXIS
/AND LAST(5TH) ROW HAS ONLY 4 BITS
/2 IS SPECIAL AND NEEDS BIT SET IN
/MISSING BIT IN 5TH ROW

 0 1152  4001  TABL,   4001     1-
 0 1153  3400          3400
 0 1154  0000          0        /.
 0 1155  0002          2
 0 1156  0104          104      //
```

```
0 1157  2104            2104
0 1160  1643            1643    /0
0 1161  4613            4613
0 1162  0430            430     /1
0 1163  6043            6043
0 1164  7602            7602    /2
0 1165  7207            7207
0 1166  7602            7602    /3
0 1167  7017            7017
0 1170  4214            4214    /4
0 1171  5370            5370
0 1172  7641            7641    /5
0 1173  7017            7017
0 1174  5641            5641    /6
0 1175  7213            7213
0 1176  3704            3704    /7
0 1177  2102            2102
0 1200  5642            5642    /8
0 1201  7213            7213
0 1202  5642            5642    /9
0 1203  7413            7413

/E3692
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```
/DISPLAY PUSHBUTTON ROUTINE

 Ø 12Ø4  ØØ2Ø  DISPLY, Ø
 Ø 12Ø5  5243          LDJ@ DISCN       /REVERSE DISPLAY TYPE INDICATOR
 Ø 12Ø6  152Ø          CMP  J
 Ø 12Ø7  21Ø1          ANDL 1
 Ø 121Ø  564Ø          STJ@ DISCN
 Ø 1211  1356          SFTZ JK 16       /MOVE TO STATIC IND BIT TO KREG BIT NO 9
 Ø 1212  153Ø          SET  J
 Ø 1213  5463          STJ  ZSET
 Ø 1214  5Ø35          LDJ  LAMP        /UPDATE LAMP BITS TO REFLECT DISPLAY
 Ø 1215  2173          ANDL    73
 Ø 1216  112Ø          AJK  J           /ADD IN STATIC LAMP BIT
 Ø 1217  5432          STJ  LAMP
 Ø 122Ø  074Ø          TWIO             /SET LAMPS ON OR OFF
 Ø 1221  Ø614          STLAMP
 Ø 1222  Ø5ØØ          TWLDJ            /SET UP LIVE DISPLAY
 Ø 1223  1664          GROUPW
 Ø 1224  Ø51Ø          TWLDK
 Ø 1225  1665          GROUPW+1
 Ø 1226  16Ø5          SIZ  K           /LOG CONV DONE?
 Ø 1227  6ØØ5          JMP  LDONE
 Ø 123Ø  1341          SFTZ JK 1        /NO
 Ø 1231  3445          ISZ  ZSET
 Ø 1232  61Ø4          JMP  .-4
 Ø 1233  61Ø5          JMP  .-5
 Ø 1234  1515  LDONE,  SIZ  CLR J      /REMAINDER?
 Ø 1235  3Ø41          DSZ  ZSET       /YES, ROUND UP
 Ø 1236  5Ø4Ø          LDJ  ZSET
 Ø 1237  15Ø3          SIP  SNZ J      />2K GROUP?
 Ø 124Ø  2214          ADDL 14          /YES
 Ø 1241  442Ø          ADJ  ROTT        /BUILD ROTATION INST.
 Ø 1242  Ø54Ø          TWSTJ
 Ø 1243  Ø535          TWINK1
 Ø 1244  4Ø32          SBJ  ZSET
 Ø 1245  Ø54Ø          TWSTJ
 Ø 1246  Ø536          TWINK1+1
 Ø 1247  6343          JMP@ DISPLY

 Ø 125Ø  Ø523  DISCN,  DISCON  /POINTER TO DISPLAY TYPE INDICATOR
 Ø 1251  ØØØ7  LAMP,   7       /LAMPS TO BE SET ON
 Ø 1252  1255  CFSP,   CFS     /POINTER TO COUNTS FULL SCALE
 Ø 1253  ØØØ1          1       /CFS MINIMUM
 Ø 1254  ØØØØ          Ø
 Ø 1255  ØØ12  CFS,    12      /COUNTS FULL SCALE
 Ø 1256  ØØØØ          Ø
 Ø 1257  ØØ3Ø          3Ø      /CFS MAXIMUM
 Ø 126Ø  ØØØØ          Ø
 Ø 1261  136Ø  ROTT,   ROTD JK Ø               /SKELETON FOR ROTD JK INST
 Ø 1262  134Ø  SFTT,   SFTZ JK Ø               /SKELETON FOR SFTZ JK INST
 Ø 1263  6571  JPSLOG, JPS  .+LOG-SFTZ1        /(JPS  LOG)
 Ø 1264  ØØØ1  MMIN,   1       /MINIMUM RANGE OF LEFT MARKER
 Ø 1265  ØØØØ          Ø
 Ø 1266  ØØØ1  MGCL,   1       /LEFT MARKER CHANNEL NUMBER
 Ø 1267  ØØØØ          Ø
 Ø 127Ø  2ØØØ  MGCR,   2ØØØ    /RIGHT MARKER CHANNEL NUMBER
 Ø 1271  ØØØØ          Ø
 Ø 1272  2ØØØ  MMAX,   2ØØØ    /MAXIMUM RANGE OF RIGHT MARKER
 Ø 1273  ØØØØ          Ø
 Ø 1274  3777  ZFULL,  3777    /COUNTS FULL SCALE
 Ø 1275  ØØØØ          Ø

/CSF PUSHBUTTON ROUTINE
/SET COUNTS FULL SCALE OR LOG DISPLAY

 Ø 1276  ØØØØ  ZSET,   Ø
 Ø 1277  5125          LDJ  CFSP
 Ø 13ØØ  6457          JPS  UPDWN        /Ø < CFS < 25
 Ø 13Ø1  16Ø5          SIZ  K            /AT LIMIT?
 Ø 13Ø2  6Ø31          JMP  ZLOG         /YES, SET LOG DISPLAY
 Ø 13Ø3  5126          LDJ  CFS          /NO, SET UP DISPLAY SHIFTS
 Ø 13Ø4  55Ø7          STJ  ZFULL+1
 Ø 13Ø5  233Ø          SUBL 3Ø
 Ø 13Ø6  1524          CMP  INC J
 Ø 13Ø7  2314          SUBL 14
 Ø 131Ø  15Ø6          SIN  J
 Ø 1311  1354          SFTZ JK 14
 Ø 1312  2214          ADDL 14
 Ø 1313  4531          ADJ  SFTT
 Ø 1314  Ø54Ø  X21,    TWSTJ             /STORE DISPLAY SHIFT NUMBER 2
 Ø 1315  Ø565          SFTZ2
 Ø 1316  1374          ROTD JK 14
 Ø 1317  4535          ADJ  SFTT
 Ø 132Ø  Ø54Ø  X22,    TWSTJ             /STORE DISPLAY SHIFT NUMBER 1
 Ø 1321  Ø564          SFTZ1
 Ø 1322  171Ø          CLR  JK           /NOW SET COUNTS FULL SCALE
 Ø 1323  1341          SFTZ JK 1
 Ø 1324  15Ø4          INC  J
 Ø 1325  313Ø          DSZ  ZFULL+1
 Ø 1326  61Ø3          JMP  .-3
 Ø 1327  5533  ZMERG,  STJ  ZFULL
 Ø 133Ø  Ø55Ø          TWSTK
 Ø 1331  1275          ZFULL+1
 Ø 1332  6334          JMP@ ZSET         /EXIT

 Ø 1333  5151  ZLOG,   LDJ  SFTT         /PLACE JMP LOG IN DISPLAY ROUTINE
 Ø 1334  712Ø          XCT  X21          /TWSTJ SFTZ2 - NOOP SHIFT NUMBER 2
 Ø 1335  5152          LDJ  JPSLOG       /JPS LOG INSTRUCTION
 Ø 1336  7116          XCT  X22          /TWSTJ SFTZ1 - MODIFY SHIFT NUMBER 1
 Ø 1337  171Ø          CLR  JK
 Ø 1340  6111            JMP  ZMERG

/E19Ø8
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/MOVE LEFT AND RIGHT MARKERS UP OR DOWN ROUTINE

 Ø 1341  ØØØØ  MOVEIT, Ø
 Ø 1342  5544          STJ  ZSET
 Ø 1343  14Ø1          SNZ                 /COUNT DOWN?
 Ø 1344  22Ø2          ADDL 2              /NO, MOVE RIGHT ONE FIRST
 Ø 1345  6412          JPS  UPDWN          /YES, MOVE LEFT ONE
 Ø 1346  515Ø          LDJ  ZSET
 Ø 1347  14Ø5          SIZ                 /COUNT DOWN?
 Ø 135Ø  22Ø2          ADDL 2              /YES, MOVE RIGHT ONE
 Ø 1351  147Ø          SET  O              /SECOND PASS FLAG
 Ø 1352  64Ø5          JPS  UPDWN
 Ø 1353  6312          JMP@ MOVEIT

 Ø 1354  1521  DCHI,   DCHANS
 Ø 1355  ØØØØ  STIMES, Ø
 Ø 1356  ØØ1Ø  PCONST, 1Ø                  /TIMER CONTROL CONSTANT

/STEP UP OR  DOWN BY 1 TO 8 ROUTINE
/UP/DOWN BASED ON FLAG

 Ø 1357  ØØØØ  UPDWN,  Ø
 Ø 136Ø  5421          STJ  NUM            /POINTER TO NUMBER
 Ø 1361  14Ø5          SIZ
 Ø 1362  23Ø4          SUBL 4              /FLAG SET- GOING DOWN
 Ø 1363  22Ø2          ADDL 2              /FLAG CLEAR- GOING UP
 Ø 1364  5422          STJ  LIMIT          /POINTER TO LIMIT
 Ø 1365  5252          LDJ@ PTIMEI
 Ø 1366  1455          SIZ  CLR O          /SECOND PASS?
 Ø 1367  5112          LDJ  STIMES         /YES, USE OLD TEST
 Ø 137Ø  5513          STJ  STIMES
 Ø 1371  1515          SIZ  CLR J          /PUSHBUTTON SINGLE STEP?
 Ø 1372  6ØØ4          JMP  .+4            /YES, BYPASS MULTIPLE UPDWNS
 Ø 1373  5317          LDJ@ DCHI           /N TIMES A FUNCTION OF DISPLY WIDTH
 Ø 1374  1163          ROTD J 3
 Ø 1375  21Ø7          ANDL 7              /BUT NO MORE THAN 8
 Ø 1376  15Ø4          INC  J
 Ø 1377 >5476          STJ  EXPAND         /SET PASS COUNTER
 Ø 14ØØ  Ø51Ø          TWLDK               /GET NUMBER - LOW
 Ø 14Ø1  ØØØØ  NUM,    Ø
 Ø 14Ø2  35Ø1          ISZ  NUM            /STEP TO HIGH HALF
 Ø 14Ø3  53Ø2          LDJ@ NUM            /GET NUMBER - HIGH
 Ø 14Ø4  13Ø1          LRSFJK              /SAVE NUMBER IN RS
 Ø 14Ø5  Ø41Ø          TWSBK               /START LIMIT TEST
 Ø 14Ø6  ØØØØ  LIMIT,  Ø
 Ø 14Ø7  35Ø1          ISZ  LIMIT
 Ø 141Ø  43Ø2          SBJ@ LIMIT
 Ø 1411  31Ø3          DSZ  LIMIT          /RESTORE LIMIT POINTER
 Ø 1412  1735             SIZ  SET JK      /AT LIMIT?
 Ø 1413  1756             SIN  CLR JK 0    /NO, CLR & SKIP UNCONDITIONALLY
 Ø 1414  6335             JMP@ UPDOWN      /YES, EXIT JK SET
 Ø 1415  16Ø4             INC  K           /SET KJ = + 1
 Ø 1416  14Ø5             SIZ              /COUNT DOWN?
 Ø 1417  173Ø             SET  JK          /YES, KJ = -1
 Ø 142Ø  1224             ADS K            /ADD LOW
 Ø 1421  1455             SIZ  CLR 0       /CARRY?
 Ø 1422  15Ø4             INC  J           /YES
 Ø 1423  1122             ADR  J           /ADD MOST
 Ø 1424  5723             STJ@ NUM         /AND STORE IT
 Ø 1425  1374             ROTD JK 14
 Ø 1426  3125             DSZ  NUM         /FETCH LEAST
 Ø 1427  5726             STJ@ NUM         /AND STORE IT
 Ø 143Ø  3045             DSZ  EXPAND      /LAST PASS?
 Ø 1431  6131             JMP  NUM-1       /NO, DO ANOTHER
 Ø 1432  5154             LDJ  PCONST      /SET UP TIMER FOR CLOCK
 Ø 1433  Ø54Ø             TWSTJ
 Ø 1434  2102             PTIME2
 Ø 1435  175Ø             CLR  JK 0
 Ø 1436  Ø54Ø             TWSTJ
 Ø 1437  2103   PTIMEI,   PTIME
 Ø 144Ø  6351             JMP@ UPDOWN      /EXIT JK = Ø

/MARKER SPAN PUSHBUTTON ROUTINE

 Ø 1441  ØØØØ   MWIDTH,   Ø
 Ø 1442  5052             LDJ  MGCRP       /MOVE RIGHT MARKER UP OR DOWN
 Ø 1443  6564             JPS  UPDOWN
 Ø 1444  63Ø3             JMP@ MWIDTH      /EXIT

/DISPLAY SPAN PUSHBUTTON ROUTINE

 Ø 1445  ØØØØ   DWIDTH,   Ø
 Ø 1446 >5075             LDJ  DSCP        /MOVE DISPLAY START CHANNEL UP
 Ø 1447  657Ø             JPS  UPDOWN
 Ø 145Ø  142Ø             CMP              /REVERSE DIRECTIONS
 Ø 1451  147Ø             SET  0           /SET SECOND PASS FLAG
 Ø 1452  5044             LDJ  DECP        /MOVE DISPLAY END CHANNEL DOWN
 Ø 1453 <6574             JPS  UPDOWN
 Ø 1454  6471             JPS  DISSET      /SET DISPLAY PARAMETERS
 Ø 1455  3467             ISZ  GROUPF      /SET EXPAND FLAG
 Ø 1456  6311             JMP@ DWIDTH      /EXIT
 Ø 1457  6102             JMP  .-2         /OOPS, GROUPF OVERFLOW

/MARKER POS  PUSHBUTTON ROUTINE

 Ø 146Ø  ØØØØ   MMOVE,    Ø
 Ø 1461  5Ø32             LDJ  MGCLP       /MOVE LEFT + RIGHT MARKERS UP OR DOWN
 Ø 1462  Ø64Ø   X57,      TWJPS
 Ø 1463  1341             MOVEIT
 Ø 1464  63Ø4             JMP@ MMOVE

/DISPLAY POS PUSHBUTTON ROUTINE

 Ø 1465  ØØØØ  DMOVE,     Ø                 /CHANGE DISPLAY STARTING CHANNEL
 Ø 1466  142Ø             CMP               /REVERSE NORMAL FUNCTION OF UPDWN
 Ø 1467  5Ø54             LDJ  DSCP         /MOVE START AND END DISPLAY CHANNELS
 Ø 147Ø  71Ø6             XCT X57           /JPS MOVEIT
 Ø 1471  6454             JPS  DISSET       /SET UP NEW DISPLAY PARAMETERS
 Ø 1472  3452             ISZ  GROUPF       /SET EXPAND FLAG
 Ø 1473  63Ø6             JMP@ DMOVE        /EXIT
 Ø 1474  61Ø2             JMP  .-2          /OOPS, GROUPF OVERFLOW

/EXPAND PUSHBUTTON ROUTINE

 Ø 1475  ØØØØ  EXPAND,    Ø
 Ø 1476  7Ø5Ø             XCT  X51          /JPS IM
 Ø 1477  5214             ILOD@ MGCLP       /LEFT MARKER CHANNEL NUMBER
 Ø 15ØØ  462Ø             IADD@ GSCP        /ADD/2 OF 1ST CHANNEL IN CURRENT GROUP
 Ø 15Ø1  4Ø4Ø             ISUB IN1
 Ø 15Ø2  5431             ISTR DSC          /NEW DISPLAY STARTING CHANNEL ADD/2
 Ø 15Ø3  5211             ILOD@ MGCRP       /RIGHT CHANNEL MARKER NUMBER
 Ø 15Ø4  4614             IADD@ GSCP        /ADD/2 OF 1ST CHANNEL IN CURRENT GROUP
 Ø 15Ø5  4Ø34             ISUB IN1
 Ø 15Ø6  5427             ISTR DEC          /NEW DISPLAY ENDING CHANNEL ADD/2
 Ø 15Ø7  ØØØØ             IEXT
 Ø 151Ø  6435             JPS  DISSET       /SET DISPLAY PARAMETERS
 Ø 1511  3433             ISZ  GROUPF       /SET EXPAND FLAG
 Ø 1512  6315             JMP@ EXPAND       /EXIT

 Ø 1513  1266  MGCLP,     MGCL      /POINTER TO LEFT MARKER CHANNEL NUMBER
 Ø 1514  127Ø  MGCRP,     MGCR      /POINTER TO RIGHT MARKER CHANNEL NUMBER
 Ø 1515  1525  MGCCP,     MGCC      /POINTER TO CENTER MARKER CHANNEL NUMBER
 Ø 1516  1535  DECP,      DEC       /POINTER TO DISPLAY ENDING CHANNEL
 Ø 1517  Ø6Ø5  DELTAP,    DELTA     /X AXIS DELTA VALUE
 Ø 152Ø  164Ø  GSCP,      GSC       /POINTER TO ADDRESS/2 OF 1ST CHANNEL IN
 Ø 1521  1777  DCHANS,    1777      /NUMBER OF CHANNELS TO DISPLAY -1
 Ø 1522  ØØØØ             Ø
 Ø 1523  ØØØØ  DPNTS,     Ø         //FUDGE TO GET X AXIS DELTA FOR DATA
 Ø 1524  3776             3776
 Ø 1525  1ØØØ  MGCC,      1ØØØ      /CENTER MARKER CHANNEL NUMBER
 Ø 1526  ØØØØ             Ø
 Ø 1527  2ØØØ  OLSC,      2ØØØ      /OVERLAY INDICATOR
 Ø 153Ø  ØØØØ             Ø
 Ø 1531  2ØØØ  DMIN,      2ØØØ      /ADDRESS/2 OF 1ST CHANNEL IN CURRENT GROUP
 Ø 1532  ØØØØ             Ø
 Ø 1533  2ØØØ  DSC,       2ØØØ      /DISPLAY STARTING CHANNEL ADDRESS/2
 Ø 1534  ØØØØ             Ø
 Ø 1535  3777  DEC,       3777      /DISPLAY ENDING CHANNEL ADDRESS/2
 Ø 1536  ØØØØ           Ø
 Ø 1537  3777  DMAX,    3777      /ADDRESS/2 OF LAST CHANNEL IN CURRENT GROUP
 Ø 154Ø  ØØØØ           Ø
 Ø 1541  ØØØ1  IN1,     1         /INTEGER 1
 Ø 1542  ØØØØ           Ø
 Ø 1543  1533  DSCP,    DSC       /POINTER TO DISPLAY STARTING CHANNEL
 Ø 1544  ØØØØ  GROUPF,  Ø         /EXPAND FLAG

/SET UP DISPLAY PARAMETERS ROUTINE

 Ø 1545  ØØØØ  DISSET,  Ø
 Ø 1546  Ø64Ø  X51,     TWJPS
 Ø 1547  2441           IM
 Ø 155Ø  5113           ILOD DEC
 Ø 1551  4116           ISUB DSC
 Ø 1552  5531           ISTR DCHANS     /NUMBER OF DISPLAY CHANNELS -1
 Ø 1553  4467           IADD IN2
 Ø 1554  6466           IDIV IN2
 Ø 1555  4522           IADD DSC
 Ø 1556  4Ø62           ISUB GSC
 Ø 1557  5532           ISTR MGCC       /CENTER MARKER GROUP CHNL
 Ø 156Ø  5135           ILOD DPNTS
 Ø 1561  654Ø           IDIV DCHANS
 Ø 1562  7Ø6Ø           IMUL IN2
 Ø 1563  5744           ISTR@ DELTAP    /DELTA X FOR DISPLAY
 Ø 1564  ØØØØ           IEXT
 Ø 1565  632Ø           JMP@ DISSET     /EXIT

/E3921
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```
/GROUP SET PUSHBUTTON ROUTINE

 Ø 1566  ØØØØ  GROUP,   Ø
 Ø 1567  5123           LDJ  GROUPF       /SET EXPAND FLAG
 Ø 157Ø  1354           SFTZ JK 14        /SAVE EXPAND FLAG IN K, CLR J
 Ø 1571  5525           STJ  GROUPF       /CLEAR EXPAND FLAG
 Ø 1572  5456           STJ  GROUPD+1
 Ø 1573  1615           SIZ  CLR K        /WAS EXPAND ON?
 Ø 1574  6Ø2Ø           JMP  RELD         /YES, GO RESTORE DISPLAY
 Ø 1575  5Ø56           LDJ  GROPSP       /NO, SET+/- ONE GROUP
 Ø 1576  Ø64Ø           TWJPS
 Ø 1577  1357           UPDWN
 Ø 16ØØ  5Ø6Ø           LDJ  GROUPS       /PICK UP NEW GROUP
 Ø 16Ø1  1631           SNZ  SET K        /UPDWN HIT A LIMIT?
 Ø 16Ø2  6ØØ5           JMP  GRCONT
 Ø 16Ø3  1514           CLR  INC J        /YES, SET TO GROUP1
 Ø 16Ø4  14Ø5           SIZ               /WAS IT COUNT UP?
 Ø 16Ø5  5Ø55           LDJ  GROUPN       /YES SET TO LAST GROUP
 Ø 16Ø6  5452           STJ  GROUPS       /SET NEW GROUP
 Ø 16Ø7  544Ø  GRCONT,  STJ  GROUPD       /GROUPD = GROUPS - 1
 Ø 161Ø  5Ø41           LDJ  GRP1WP       /FETCH POINTER TO GROUP 1 WIDTH
 Ø 1611  3Ø36           DSZ  GROUPD       /GROUP 1?
 Ø 1612  22Ø2           ADDL 2            /SET POINTER TO NORMAL WIDTH
 Ø 1613  5437           STJ  GRPWP
 Ø 1614  7146  RELD,    XCT  X51          /JPS IM
 Ø 1615  5235           ILOD@ GRPWP       /GET CURRENT GROUP WIDTH
 Ø 1616  5446           ISTR GROUPW       /SET GROUP WIDTH
 Ø 1617  5636           ISTR@ MMAXI       /SET LIMIT ON MARKER
 Ø 162Ø  7Ø27           IMUL GROUPD       /CURRENT GROUP NUMBER -1
 Ø 1621  4Ø43           ISUB GROUPW       /ADJUST FOR WIERD 1ST GROUP SIZE
 Ø 1622  4444           IADD GROP1W
 Ø 1623  4421           IADD IN2ØØØ       /STEP PAST 441Ø INSTRUCTIONS
 Ø 1624  5414           ISTR GSC          /SET UP GROUP START CHANNEL
 Ø 1625 <5574           ISTR DMIN         /SET UP LOWER BOUNDS FOR CHANNEL
 Ø 1626  5573           ISTR DSC          /SET DISPLAY START CHANNEL
 Ø 1627  4435           IADD GROUPW
 Ø 163Ø  4167           ISUB IN1
 Ø 1631 <5574           ISTR DEC          /SET DISPLAY END CHANNEL
 Ø 1632  5573           ISTR DMAX         /SET UP UPPER BOUNDS FOR CHANNEL
 Ø 1633  517Ø           ILOD DSCP
 Ø 1634  5612           ISTR@ DISPI       /CLEAR OVERLAP OFFSET
 Ø 1635  ØØØØ           IEXT
 Ø 1636  6571           JPS  DISSET       /SET UP DISPLAY PARAMETERS
 Ø 1637  6351           JMP@ GROUP        /EXIT

 Ø 164Ø  2ØØØ  GSC,     2ØØØ    /ADDRESS/2 OF 1ST CHANNEL IN CURRENT GROUP
 Ø 1641  ØØØØ           Ø
 Ø 1642  ØØØ2  IN2,     2       /INTEGER 2
 Ø 1643  ØØØØ           Ø
 Ø 1644  2ØØØ  IN2ØØØ,  2ØØØ    /INTEGER 2ØØØ
```

```
0 1645  0000            0
0 1646  0513  DISPI,    DSPP
0 1647  0000  GROUPD,   0          /CURRENT GROUP NUMBER -1
0 1650  0000            0
0 1651  1666  GRP1WP,   GROP1W     /POINTER TO GROUP 1 WIDTH
0 1652  1666  GRPWP,    GROP1W     /POINTER TO CURRENT GROUP WIDTH
0 1653  1660  GROPSP,   GROUPS     /POINTER TO CURRENT GROUP NUMBER
0 1654  1670  GROPWP,   GROPNW     /POINTER TO NORMAL GROUP WIDTH
0 1655  1272  MMAXI,    MMAX       /POINTER TO MAXIMUM RANGE OF MARKERS
0 1656  0001  II1,      1          /INTEGER 1
0 1657  0000            0
0 1660  0001  GROUPS,   1          /CURRENT GROUP NUMBER
0 1661  0000            0
0 1662  0001  GROUPN,   1          /NUMBER OF GROUPS
0 1663  0000            0
0 1664  2000  GROUPW,   2000       /CURRENT GROUP WIDTH
0 1665  0000            0
0 1666  2000  GROP1W,   2000       /GROUP 1 WIDTH
0 1667  0000            0
0 1670  2000  GROPNW,   2000       /NORMAL GROUP WIDTH (2 - N)
0 1671  0000            0
0 1672  0000  GROUPT,   0          /GROUP SIZE ENTERED ON GROUP SET COMMAND
0 1673  0000            0
0 1674  0000  STF,      0          /SKELETON FOR TWSTJ INSTRUCTION
0 1675  0544            TWSTJ F0

/GROUP SET COMMAND ROUTINE

0 1676  0000  GWSET,    0
0 1677  0540            TWSTJ              /CLEAR EXPAND FLAG
0 1700  1544            GROUPF
0 1701  0640  X56,      TWJPS              /PRINT GROUP
0 1702  2403            UNPACK
0 1703  0022            GPW
0 1704  7103            XCT  X56           /JPS UNPACK - PRINT WIDTH
0 1705  0025            WID
0 1706  0640            TWJPS              /INPUT OR ECHO GROUP WIDTH
0 1707  2140            INEC
0 1710  1672            GROUPT
0 1711 <7175  X54,      XCT  RELD          /JPS IM
0 1712  5034            ILOD MEMSIZ
0 1713  6521            IDIV GROUPT
0 1714  0000            IEXT               /EXIT WITH N GROUPS IN J
0 1715  1601            SNZ  K             /GROUP WIDTH TOO SMALL?
0 1716  1501            SNZ  J             /GROUP WIDTH TOO LARGE?
0 1717  6631            JPS@ GERR          /ERROR, ONE OF THE ABOVE
0 1720  5536            STJ  GROUPN        /STORE NUMBER OF GROUPS
0 1721  7110            XCT  X54           /JPS IM
0 1722  5130            ILOD GROUPT        /LOAD NORMAL GROUP WIDTH
0 1723  5533            ISTR GROPNW        /STORE NORMAL GROUP WIDTH
```

```
0 1724  5536            ISTR GROP1W      /STORE GROUP1 WIDTH - JUST IN CASE SAME
0 1725  7143            IMUL GROUPN      /MULT BY NO. OF GROUPS
0 1726  5557            ISTR GROUPD      /TEMP STORE
0 1727  5017            ILOD MEMSIZ      /GET SIZE OF GROUP 1
0 1730  4161            ISUB GROUPD
0 1731  0000            IEXT
0 1732  1501            SNZ  J           /CHANNELS REMAINING?
0 1733  6005            JMP  WEXIT       /NO
0 1734  3552            ISZ  GROUPN      /YES, 1 MORE GROUP IN TOTAL
0 1735  5547            STJ  GROP1W      /STORE GROUP 1 SIZE
0 1736  0550            TWSTK
0 1737  1667            GROP1W+1
0 1740  5156    WEXIT,  LDJ  GROUPN      /FORCE UPPER LIMIT IN GROUPS
0 1741  5561            STJ  GROUPS
0 1742  1410            CLR  FLAG
0 1743  0640            TWJPS            /STEP TO 1ST GROUP + INITIALIZE GROUP I
0 1744  1566            GROUP
0 1745  6347            JMP@ GWSET       /EXIT

0 1746  0000    MEMSIZ, 0        /2000,6000,12000,16000 - NUMBER OF DOUBLE INTS
0 1747  0000            0
0 1750  2120    GERR,   UNUSED   /POINTER TO ERROR MESSAGE ROUTINE
0 1751  1664    GROPWI, GROUPW   /POINTER TO CURRENT GROUP WIDTH
0 1752  0000    ERASEC, 0        /COUNT OF NUMBER OF CHANNELS TO ERASE
0 1753  0000            0
0 1754  0000    TWIZ,   0        /SKELETON FOR TWISZ INSTRUCTION
0 1755  0344            TWISZ F0

/ERASE PUSHBUTTON ROUTINE

0 1756  0000    ERASER, 0
0 1757  7146    X55,    XCT  X54         /JPS IM
0 1760  5307            ILOD@ GROPWI     /COUNT OF CHANNELS TO ERASE
0 1761  6000            INEG
0 1762  5510            ISTR ERASEC
0 1763  5224            ILOD@ GSCI       /ADDRESS OF 1ST CHANNEL TO ERASE
0 1764  7224            IMUL@ IN2I
0 1765  4571            IADD STF         /BUILD TWSTJ INST
0 1766  0000            IEXT
0 1767  5405            STJ  ERASE1+1
0 1770  0550            TWSTK
0 1771  1773            ERASE1
0 1772  1510            CLR J
0 1773  0544    ERASE1, TWSTJ F0         /(MODIFIED) ERASE CHANNEL - LOW
0 1774  4000            4000
0 1775  3501            ISZ ERASE1+1
0 1776  7103            XCT ERASE1       /ERASE CHANNEL - HIGH
0 1777  3503            ISZ ERASE1+1     /STEP TO NEXT CHANNEL
0 2000  1442            SKIP
0 2001  3506            ISZ ERASE1
```

```
Ø 2ØØ2  353Ø          ISZ ERASEC       /MORE CHANNELS LEFT TO ERASE?
Ø 2ØØ3  611Ø          JMP ERASE1       /YES
Ø 2ØØ4  3531          ISZ ERASEC+1
Ø 2ØØ5  6112          JMP ERASE1       /YES
Ø 2ØØ6  633Ø          JMP@ ERASER      /NO - EXIT
```

/E3682

```
/
Ø 2ØØ7  164Ø  GSCI,   GSC        /POINTER TO ADDRESS/2 OF 1ST CHANNEL
Ø 2Ø1Ø  1642  IN2I,   IN2        /POINTER TO INTEGER 2

Ø 2Ø11  Ø74Ø  CLOCK,  TWIO                 /CLEAR CLOCK FLAG
Ø 2Ø12  Ø612          CLRCLK
Ø 2Ø13  3Ø67          DSZ  PTIME2          /PUSHBUTTON/PLOTTER TIMER
Ø 2Ø14  6ØØ3          JMP  .+3
Ø 2Ø15  3Ø66          DSZ  PTIME
Ø 2Ø16  14ØØ          IDLE
Ø 2Ø17  5Ø56          LDJ  ACQCOM
Ø 2Ø2Ø  1515          SIZ  CLR J           /AQUIRING?
Ø 2Ø21  3457          ISZ  CLOCK1          /YES, INC CLOCK
Ø 2Ø22  6263          JMP@ IRTRN
Ø 2Ø23  3456          ISZ  CLOCK1+1
Ø 2Ø24  6261          JMP@ IRTRN
Ø 2Ø25  151Ø  AQOFF,  CLR  J               /ALSO LIST OVERFLOW SERV-STOP ACQUIRE
Ø 2Ø26  5447          STJ  ACQCOM
Ø 2Ø27  6Ø32          JMP  AQEXIT          /SET ACQUIRE ON OR OFF

/ACQUIRE PUSHBUTTON ROUTINE

Ø 2Ø3Ø  ØØØØ  AQUIRE, Ø
Ø 2Ø31  5Ø44          LDJ ACQCOM           /REVERSE ACQUIRE INDICATOR
Ø 2Ø32  152Ø          CMP J
Ø 2Ø33  2Ø36          ANDF AQMODE          /INT MODE=2Ø, INC=4Ø, DMA LIST=6Ø
Ø 2Ø34  5441          STJ ACQCOM
Ø 2Ø35  15Ø1          SNZ  J               /AQUIRE OFF?
Ø 2Ø36  6Ø23          JMP  AQEXIT          /YES, BYPASS SET UP
Ø 2Ø37  4433          ADJ  AQFLD           /NO, MERGE DMA FIELD FOR ADC COMMAND
Ø 2Ø4Ø  5435          STJ  ACQCOM
Ø 2Ø41  7162  X53,    XCT  X55             /JPS IM
Ø 2Ø42  5Ø34          ILOD TIME            /SET UP PRESET TIME
Ø 2Ø43  6ØØØ          INEG
Ø 2Ø44  5434          ISTR CLOCK1
Ø 2Ø45  5336          ILOD@ GSCI           /SET UP ADC SERVICE
Ø 2Ø46  7336          IMUL@ IN2I
Ø 2Ø47  4573          IADD TWIZ
Ø 2Ø5Ø  5634          ISTR@ GROPZK         /STORE TWISZ FOR 1ST CHANNEL IN
Ø 2Ø51  5216          ILOD@ DMAXI
Ø 2Ø52  7342          IMUL@ IN2I
Ø 2Ø53 <4577          IADD TWIZ
Ø 2Ø54  5614          ISTR@ MEMZCI         /STORE TWISZ FOR LAST CHANNEL
Ø 2Ø55  ØØØØ          IEXT
Ø 2Ø56  5Ø15          LDJ  LISTC
Ø 2Ø57  Ø74Ø          TWIO                 /SET UP LIST MODE CHAN CNT.
Ø 2Ø6Ø  Ø632          LDLIST
Ø 2Ø61  6213  AQEXIT, JMP@ OLYEXT          /PROVISION FOR OVERLAY SERVICE
Ø 2Ø62  5Ø13          LDJ  ACQCOM
Ø 2Ø63  1354          SFTZ JK 14
Ø 2Ø64  Ø74Ø          TWIO                 /TURN AQUIRE ON/OFF
```

```
Ø 2Ø65  2Ø26            SETACQ
Ø 2Ø66  6336            JMP@ AQUIRE      /EXIT

Ø 2Ø67  1537  DMAXI,    DMAX      /POINTER TO ADDRESS/2 OF LAST CHANNEL
Ø 2Ø7Ø  Ø16Ø  MEMZCI,   MEMZC     /POINTER TO TWISZ FOR LAST CHANNEL
Ø 2Ø71  ØØ2Ø  AQMODE,   ØØ2Ø      /MODE OF ADC ACQUIRE 2Ø=INT, 4Ø=INC, 6Ø=LIST
Ø 2Ø72  ØØØØ  AQFLD,    Ø         /FIELD OF ADC ACQUIRING
Ø 2Ø73  1ØØØ  LISTC,    1ØØØ      /LIST MODE DUMMY COUNT
Ø 2Ø74  2Ø62  OLYEXT,   AQEXIT+1          /OVERLAY INDICATOR OF SOME TYPE
Ø 2Ø75  ØØØØ  ACQCOM,   Ø         /ACQUIRING INDICATOR
Ø 2Ø76  ØØØØ  TIME,     Ø         /PRESET TIME TO ACQUIRE FOR
Ø 2Ø77  ØØØØ            Ø
Ø 21ØØ  ØØØØ  CLOCK1,   Ø         /NEGATIVE NUMBER OF TICKS TO ACQUIRE FOR
Ø 21Ø1  ØØØØ            Ø
Ø 21Ø2  Ø1ØØ  PTIME2,   1ØØ
Ø 21Ø3  ØØØØ  PTIME,    Ø
Ø 21Ø4  Ø156  GROPZK,   GROUPZ    /POINTER TO TWISZ FOR 1ST CHANNEL
Ø 21Ø5  Ø362  IRTRN,    RETRN
Ø 21Ø6  ØØØØ  ECHOF,    Ø         /ECHO OLD VALUE INDICATOR

/E1629
```

```
/CLOCK SET COMMAND ROUTINE

 Ø 2107  ØØØØ  CLSET,  Ø
 Ø 2110  7Ø4Ø          XCT  X9Ø        /JPS UNPACK - TYPE CLOCK TIME
 Ø 2111  ØØ1Ø          CLSM
 Ø 2112  6426          JPS  INEC       /INPUT OR ECHO LAST TIME
 Ø 2113  2Ø76          TIME
 Ø 2114  7Ø34          XCT  X9Ø        /JPS UNPACK - TYPE CENISEC
 Ø 2115  ØØ15          CSEC
 Ø 2116  63Ø7          JMP@ CLSET      /EXIT

/ERROR MESSAGE ROUTINE

 Ø 2117  ØØØØ  NUSED1, Ø       /DOUBLE INT INPUT FROM TTY
 Ø 212Ø  ØØØØ  UNUSED, Ø
 Ø 2121  7Ø27          XCT  X9Ø        /JPS UNPACK - PRINT ERROR:
 Ø 2122  ØØ3Ø          ERRORX
 Ø 2123  3515          ISZ  ECHOF
 Ø 2124  6414          JPS  INEC       /ECHO ERROR NUMBER
 Ø 2125  2117          NUSED1
 Ø 2126  Ø64Ø          TWJPS           /RESTART
 Ø 2127  Ø227  DECODP, DECODE

/PRINT OLD NUMBER

 Ø 213Ø  7167  ALTM,   XCT  X53        /JPS IM
 Ø 2131  5273          ILOD@INEC1      /FETCH OLD NUMBER
 Ø 2132  34ØØ          IOUT            /CONVERT TO OUTPUT FORMAT
 Ø 2133  ØØØØ          IEXT
 Ø 2134  7Ø14          XCT  X9Ø        /TWJPS UNPACK - PRINT NUMBER
 Ø 2135  ØØØ3          TTY
 Ø 2136  553Ø          STJ  ECHOF      /CLEAR ECHO OLD VALUE INDICATOR
 Ø 2137  62Ø1          JMP@ INEC

/INPUT VALUE POINTED TO BY CALL+1 OR ECHO OLD VALUE IF ALTMODE ENTERED
/RETURN TO CALL+2

 Ø 214Ø  ØØØØ  INEC,   Ø
 Ø 2141  53Ø1          LDJ@ INEC
 Ø 2142  5462          STJ  INEC1      /POINTER TO INPUT VARIABLE LOCATION
 Ø 2143  35Ø3          ISZ  INEC       /STEP TO RETURN ADDRESS
 Ø 2144  151Ø  INECR,  CLR  J          /ECHO OLD VALUE
 Ø 2145  2537          SMJ  ECHOF
 Ø 2146  1442          SKIP            /NO
 Ø 2147  6117          JMP  ALTM       /YES
 Ø 215Ø  Ø64Ø  X9Ø,    TWJPS           /TYPE COLON
 Ø 2151  24Ø3          UNPACK
 Ø 2152  ØØ33          EQ
 Ø 2153  5534          STJ  NUSED1     /CLEAR STORAGE FOR INPUT NUMBER
 Ø 2154  5534          STJ  UNUSED
```

```
Ø 2155  5452            STJ  SIGN1       /CLEAR SIGN OF INPUT NUMBER
Ø 2156  221Ø            ADDL 1Ø          /SEVEN DIGITS MAX
Ø 2157  5451            STJ  CNTR
Ø 216Ø  3447            ISZ  SIGN1       /1 IF POS, 2 IF NEG
Ø 2161  Ø64Ø  X91,      TWJPS            /FETCH CHAR
Ø 2162  Ø245            FCHAR
Ø 2163  2453            SMJ  MINUS       /MINUS CHAR?
Ø 2164  61Ø4            JMP  .-4         /YES- INCREMENT SIGN1
Ø 2165  1442            SKIP             /NO
Ø 2166  71Ø5  LOOP2,    XCT  X91         /JPS FCHAR
Ø 2167  145Ø            CLR  O           /START TEST FOR NUMERIC CHAR- NUMERIC?
Ø 217Ø  2372            SUBL 72
Ø 2171  1441            SNZ  O
Ø 2172  6Ø16            JMP  TSTC        /NO - TEST FOR SPECIAL CHARACTER
Ø 2173  2212            ADDL 12
Ø 2174  1455            SIZ  CLR O
Ø 2175  6Ø13            JMP  TSTC        /NO, GO TEST FOR SPECIAL CHARS
Ø 2176  5427            STJ  TEMP3       /YES, CONVERT DIGIT
Ø 2177  7147  X72,      XCT  ALTM        /JPS IM
Ø 22ØØ  5161            ILOD NUSED1      /MULT OLD BY 1Ø
Ø 22Ø1  7Ø3Ø            IMUL C1Ø
Ø 22Ø2  4423            IADD TEMP3       /AND ADD NEW
Ø 22Ø3  5564            ISTR NUSED1      /TEMPORARY TOTAL NUMBER
Ø 22Ø4  ØØØØ            IEXT
Ø 22Ø5  3Ø23            DSZ  CNTR        /SEVEN DIGITS DONE?
Ø 22Ø6  612Ø            JMP  LOOP2       /NO, GO DO ANOTHER
Ø 22Ø7  6567            JPS  UNUSED
Ø 221Ø  2425  TSTC,     SMJ  RUBOUT      /RUBOUT CHAR?
Ø 2211  6145            JMP  INECR       /YES,RESTART FORMING NUMBER
Ø 2212  2422            SMJ  ESC         /ESCAPE OR ALTMODE?
Ø 2213  6163            JMP  ALTM        /YES, GO ECHO OLD NUMBER
Ø 2214  2417            SMJ  ALT
Ø 2215  6165            JMP  ALTM        /YES, GO ECHO OLD NUMBER
Ø 2216  3Ø11            DSZ  SIGN1       /NO,SIGN NEGATIVE?
Ø 2217  662Ø            JPS@ NEGACI      /NEGATE INTEGER AC
Ø 222Ø  7121            XCT  X72         /JPS IM
Ø 2221  56Ø3            ISTR@ INEC1      /STORE NEW NUMBER
Ø 2222  ØØØØ            IEXT             /J,K HAVE INPUT NUMBER
Ø 2223  6363            JMP@ INEC

Ø 2224  ØØØØ  INEC1,    Ø        /POINTER TO VARIABLE TO BE INPUT
Ø 2225  ØØØØ  TEMP3,    Ø        /TEMP STORAGE FOR LAST DECIMAL DIGIT ENTERED
Ø 2226  ØØØØ            Ø
Ø 2227  ØØØØ  SIGN1,    Ø        /SIGN OF INPUT NUMBER, 1 IF POSITIVE, 2 IF NEGAT
Ø 223Ø  ØØØØ  CNTR,     Ø        /DIGIT COUNTER FOR TTY NUMBER INPUT
Ø 2231  ØØ12  C1Ø,      12       /DOUBLE INTEGER DECIMAL 1Ø
Ø 2232  ØØØØ            Ø
Ø 2233  Ø1Ø3  ALT,      1Ø3      /ALTMODE MASK, 175-72
Ø 2234  7753  ESC,      7753     /ESCAPE MASK, 33-6Ø
Ø 2235  Ø1Ø5  RUBOUT,   1Ø5      /RUBOUT MASK, 177-72
```

```
 0 2236  0055  MINUS,  55       /7 BIT ASCII FOR MINUS SIGN
 0 2237  2550  NEGACI, NEGAC    /POINTER TO NEGATE INTEGER ACCUMULATOR ROUTINE

/STATUS PUSHBUTTON ROUTINE

 0 2240  0000  STATUS, 0
 0 2241  3401          ISZ STATU1         /STEP TO NEXT STATUS GROUP POINTER
 0 2242  5011  STATU1, LDJ .+11           /STORE NEW STATUS GROUP POINTER
 0 2243  0540          TWSTJ
 0 2244  1041          STATX
 0 2245  1505          SIZ  J             /LIST END?
 0 2246  6306          JMP@ STATUS        /NO - EXIT
 0 2247  5003          LDJ  LDF           /YES, RESET TO BEGINNING OF LIST
 0 2250  5506          STJ  STATU1
 0 2251  6311          JMP@ STATUS        /EXIT

/LIST OF POINTERS TO STATUS GROUPS

 0 2252  5010  LDF,    LDJ  .+10
 0 2253  2257          MR-1
 0 2254  2267          ZFLL-1
 0 2255  2277          CLOK-1
 0 2256  0000          0                  /PROVISION FOR OVERLAY STATUS
 0 2257  0000          0                  /ZERO TERMINATOR TO STACK


/STATUS GROUPS - 20 ADDED TO ASCII CHARACTERS

 0 2260  0612  MR,     MDATA+1            /CENTER MARKER DATA
 0 2261  0077          77                 /  /
 0 2262  1526          MGCC+1             /CENTER MARKER CHNL
 0 2263  0057          57                 /CR-LF
 0 2264  1271          MGCR+1             /RIGHT MARKER CHNL
 0 2265  0075          75                 / -
 0 2266  1267          MGCL+1             /LEFT MARKER CHNL
 0 2267  7760          7760               /TERMINATOR

 0 2270  1663  ZFLL,   GROUPN+1           /NO OF GROUPS
 0 2271  0077          77                 /  /
 0 2272  1661          GROUPS+1           /CURRENT GROUP
 0 2273  0057          57                 /CR-LF
 0 2274  1665          GROUPW+1           /GROUP WIDTH
 0 2275  0057          57                 /CR-LF
 0 2276  1275          ZFULL+1            /COUNTS FULL SCALE
 0 2277  7760          7760               /TERMINATOR

 0 2300  2101  CLOK,   CLOCK1+1           /ELAPSED TIME
 0 2301  0057          57                 /CR-LF
 0 2302  2077          TIME+1             /PRESET TIME
 0 2303  7760          7760               /TERMINATOR
```

/E3259

```
/KEYBOARD COMMAND DIRECTORY

 Ø 23Ø4  Ø1Ø3  TAB1,   1Ø3      /CLOCK SET
 Ø 23Ø5  Ø1Ø7          1Ø7      /GROUP SET
 Ø 23Ø6  ØØØØ          Ø        /STORE (1Ø61)
 Ø 23Ø7  ØØØØ          Ø        /PRINT (1Ø61)
 Ø 231Ø  ØØØØ          Ø        /EXTRA
 Ø 2311  ØØØØ          Ø        /INTEGRATE (1Ø61)
 Ø 2312  ØØØØ          Ø        /DIFFERENTIATE (1Ø61)
 Ø 2313  ØØØØ          Ø        /EXTRA
 Ø 2314  ØØØØ          Ø        /EXTRA
 Ø 2315  ØØØØ          Ø        /EXTRA
 Ø 2316  ØØØØ          Ø        /EXTRA
 Ø 2317  ØØØØ          Ø        /EXTRA
 Ø 232Ø  ØØØØ  CHARX,  Ø        /END OF TABLE - CHARACTER INPUT

/KEYBOARD ROUTINE DIRECTORY

 Ø 2321  21Ø7          CLSET    /CLOCK SET COMMAND ROUTINE
 Ø 2322  1676          GWSET    /GROUP SET COMMAND ROUTINE
 Ø 2323  212Ø          UNUSED
 Ø 2324  212Ø          UNUSED
 Ø 2325  212Ø          UNUSED
 Ø 2326  212Ø          UNUSED
 Ø 2327  212Ø          UNUSED
 Ø 233Ø  212Ø          UNUSED
 Ø 2331  212Ø          UNUSED
 Ø 2332  212Ø          UNUSED
 Ø 2333  212Ø          UNUSED
 Ø 2334  212Ø          UNUSED
 Ø 2335  212Ø          UNUSED  /CAN NOT BE CHANGED - TAKEN IF CHARACTER
                       /NOT FOUND


/PUSHBUTTON ROUTINE TABLE

 Ø 2336  1465  TABLE,  DMOVE    / Ø
 Ø 2337  1445          DWIDTH   / 1
 Ø 234Ø  146Ø          MMOVE    / 2
 Ø 2341  1441          MWIDTH   / 3
 Ø 2342  1276          ZSET     / 4
 Ø 2343  Ø266          PLOT     / 5
 Ø 2344  224Ø          STATUS   / 6
 Ø 2345  212Ø          UNUSED   / 7
 Ø 2346  12Ø4          DISPLY   / 8
 Ø 2347  1566          GROUP    / 9
 Ø 235Ø  1475          EXPAND   /1Ø
 Ø 2351  2Ø3Ø          AQUIRE   /11
 Ø 2352  Ø227          DECODE   /12
 Ø 2353  212Ø          UNUSED   /13
```

```
  FRONT PANEL
  PUSHBUTTONS

 Ø    1    2    3

 4    5    6    7

 8    9    1Ø   11

12   13    14   15

     16    16
```

```
0 2354  2120          UNUSED  /14
0 2355  2120          UNUSED  /15
0 2356  1756          ERASER  /16
```

```
 Ø 2357  ØØØØ  PKTEMP, Ø                   /TEMPORY CHAR STORAGE BEFORE PRINT
 Ø 2360  ØØØØ  POINT,  Ø                   /MESSAGE POINTER FOR TTY OUTPUT

/PRINT 1 CHARACTER ROUTINE

 Ø 2361  ØØØØ  CHROUT, Ø
 Ø 2362 >2177          ANDL 77             /ISOLATE CHARACTER
 Ø 2363  2443          SMJ  P75            /TERMINATOR ?
 Ø 2364  6ØØ5          JMP  CLRJ           /YES
 Ø 2365  2442          SMJ  P77            /END LINE ?
 Ø 2366  6ØØ5          JMP  CRLOUT         /YES - OUTPUT CR-LF
 Ø 2367  4436          ADJ  P24Ø           /CONVERT TO ASCII
 Ø 237Ø  6Ø1Ø          JMP  XOUT           /PRINT CHARACTER
 Ø 2371  151Ø  CLRJ,   CLR  J              /INITIALIZE J REG J= Ø ON RETURN
 Ø 2372  6211          JMP@ UNPACK         /EXIT - END OF MESSAGE

/PRINT CR-CR-LF ROUTINE

 Ø 2373  5Ø31  CRLOUT, LDJ  P215           /CR
 Ø 2374  7ØØ4          XCT  XOUT           /TWJPS LOPRNT
 Ø 2375  5Ø27          LDJ  P215           /CR
 Ø 2376  7ØØ2          XCT  XOUT           /TWJPS LOPRNT
 Ø 2377  5Ø24          LDJ  P212           /LF
 Ø 24ØØ  Ø64Ø  XOUT,   TWJPS               /PRINT CHARACTER
 Ø 24Ø1  Ø242          LOPRNT
 Ø 24Ø2  6321          JMP@ CHROUT         /RETURN FOR NEXT CHARACTER

/  PRINT MESSAGE UNTIL TERMINATOR (75) ON TTY ROUTINE
/CALL + 1 IS POINTER TO MESSAGE
/RETURN TO CALL + 2 WITH J=Ø

 Ø 24Ø3  ØØØØ  UNPACK, Ø
 Ø 24Ø4  53Ø1          LDJ@ UNPACK         /LOCATION OF MESSAGE
 Ø 24Ø5  5525          STJ  POINT          /TO POINTER
 Ø 24Ø6  35Ø3          ISZ  UNPACK
 Ø 24Ø7  1514          CLR  INC J
 Ø 241Ø  2412          SMJ  PSUPPF         /PRINT SUPPRESS?
 Ø 2411  612Ø          JMP CLRJ            /YES, CLEAR J AND EXIT
 Ø 2412  5332  NXTPNT, LDJ@ POINT          /GET 2 CHARACTERS
 Ø 2413  5534          STJ  PKTEMP         /STORE 2ND CHARACTER
 Ø 2414  3534          ISZ  POINT          /STEP TO NEXT 2 CHARACTERS
 Ø 2415  1166          ROTD Ø6 J           /POSITION 1ST CHARACTER
 Ø 2416  6535          JPS  CHROUT         /OUTPUT 1ST CHARACTER
 Ø 2417  514Ø          LDJ  PKTEMP         /GET 2ND CHARACTER
 Ø 242Ø  6537          JPS  CHROUT         /OUTPUT 2ND CHARACTER
 Ø 2421  61Ø7          JMP  NXTPNT         /PROCESS NEXT 2 CHARACTERS
 Ø 2422  ØØØØ  PSUPPF, Ø                    /PRINT SUPPRESS IF =1
 Ø 2423  Ø212  P212,   212                  /LF
 Ø 2424  Ø215  P215,   215                  /CR
 Ø 2425  Ø240  P240,   240                  /SPACE
 Ø 2426  ØØ75  P75,    75                   /TERMINATOR
 Ø 2427  ØØ77  P77,    77                   /CR-LF INDICATOR

/E2136
```

```
/DOUBLE INTEGER PACKAGE - DUBINT OR IM

 Ø 243Ø  2442           NOPX             /74ØØ
 Ø 2431  2577           DLMLT            /7ØØØ
 Ø 2432  2632           DLDIV            /64ØØ
 Ø 2433  25Ø7           ACNEG            /6ØØØ
 Ø 2434  2516           DLSTOR           /54ØØ
 Ø 2435  2511           DLLOAD           /5ØØØ
 Ø 2436  2523           FLADD            /44ØØ
 Ø 2437  2535           FLSUB            /4ØØØ
 Ø 244Ø  27Ø7           SDPRNT           /34ØØ

 Ø 2441  ØØØØ  DUBINT,  Ø                /INTEGER PACKAGE
 Ø 2442  53Ø1  NOPX,    LDJ@ DUBINT
 Ø 2443  1164           ROTD J 4         /FETCH INST
 Ø 2444  12Ø4           LKFJ             /SAVE EVERYTHING
 Ø 2445  2117           ANDL 17          /RETAIN INST CODE
 Ø 2446  15Ø5           SIZ  J           /IEXT?
 Ø 2447  23Ø6           SUBL 6           /NO
 Ø 245Ø  4432           ADJ  TABLEX      /BUILD GO TO POINTER
 Ø 2451  543Ø           STJ  TEMPX
 Ø 2452  1374           EXJK             /RESTORE EVERYTHING
 Ø 2453  165Ø           CLR  K O
 Ø 2454  1361           ROTD JK 1        /MOVE INDIRECT BIT TO K
 Ø 2455  15Ø2           SIP  J           /RELATIVE BIT MINUS?
 Ø 2456  147Ø           SET  O           /YES, O REMEMBERS
 Ø 2457  1167           ROTD J 7         /NOW MOVE IN RELATIVE ADDRESS
 Ø 246Ø >2177           ANDL 77
 Ø 2461  1455           SIZ  CLR O       /RELATIVE MINUS?
 Ø 2462  1524           CMP  INC J       /YES, NEGATE RELATIVE ADDRESS
 Ø 2463  4522           ADJ  DUBINT      /COMPUTE ABS ADDRESS
 Ø 2464  5433           STJ  ADRS
 Ø 2465  5232           LDJ@ ADRS        /NOW FETCH OPERAND
 Ø 2466  1615           SIZ  CLR K       /INDIRECT?
 Ø 2467  61Ø3           JMP  .-3         /YES, GO FETCH REAL OPERAND
 Ø 247Ø  5413           STJ  LORD1
 Ø 2471  3426           ISZ  ADRS
 Ø 2472  5225           LDJ@ ADRS
 Ø 2473  5411           STJ  HORD1
 Ø 2474  3533           ISZ  DUBINT
 Ø 2475  Ø51Ø           TWLDK
 Ø 2476  25Ø6           HORD
 Ø 2477  5ØØ6           LDJ  LORD
 Ø 25ØØ  141Ø           CLR  FLAG
 Ø 25Ø1  634Ø  TEMPX,   JMP@ DUBINT

 Ø 25Ø2  634Ø  TABLEX,  JMP@ DUBINT+1    /USED TO BUILD POINTER TO OPERATION ROUT
```

```
Ø 25Ø3  ØØØØ  LORD1,  Ø
Ø 25Ø4  ØØØØ  HORD1,  Ø
Ø 25Ø5  ØØØØ  LORD,   Ø
Ø 25Ø6  ØØØØ  HORD,   Ø

Ø 25Ø7  6441  ACNEG,  JPS  NEGAC
Ø 251Ø  6146          JMP  DUBINT+1

Ø 2511  51Ø6  DLLOAD, LDJ  LORD1
Ø 2512  55Ø5          STJ  LORD
Ø 2513  51Ø7          LDJ  HORD1
Ø 2514  55Ø6          STJ  HORD
Ø 2515  6153          JMP  DUBINT+1

Ø 2516  Ø55Ø  DLSTOR, TWSTK
Ø 2517  ØØØØ  ADRS,   Ø
Ø 252Ø  31Ø1          DSZ  ADRS
Ø 2521  57Ø2          STJ@ ADRS
Ø 2522  616Ø          JMP  DUBINT+1

Ø 2523  145Ø  FLADD,  CLR  O
Ø 2524  5117          LDJ  LORD
Ø 2525  4522          ADJ  LORD1
Ø 2526  5521          STJ  LORD
Ø 2527  5121          LDJ  HORD
Ø 253Ø  1455          SIZ  O CLR O
Ø 2531  15Ø4          INC  J
Ø 2532  4526          ADJ  HORD1
Ø 2533  5525  X2,     STJ  HORD
Ø 2534  6172  X14,    JMP  DUBINT+1

Ø 2535  64Ø2  FLSUB,  JPS  NEGOP
Ø 2536  6113          JMP  FLADD

Ø 2537  ØØØØ  NEGOP,  Ø
Ø 254Ø  155Ø          CLR  J O
Ø 2541  4136          SBJ LORD1
Ø 2542  5537          STJ  LORD1
Ø 2543  1515          SIZ  CLR J
Ø 2544  23Ø1          SUBL 1
Ø 2545  4141          SBJ  HORD1
Ø 2546  5542          STJ  HORD1
Ø 2547  631Ø          JMP@ NEGOP

Ø 255Ø  ØØØØ  NEGAC,  Ø
Ø 2551  155Ø          CLR  J O
Ø 2552  4145          SBJ LORD
Ø 2553  5546          STJ  LORD
Ø 2554  1515          SIZ  CLR J
Ø 2555  23Ø1          SUBL 1
```

```
Ø 2556  415Ø           SBJ  HORD
Ø 2557  5551           STJ  HORD
Ø 256Ø  631Ø           JMP@ NEGAC

Ø 2561  ØØØØ  SIGN,    Ø
Ø 2562  151Ø           CLR  J
Ø 2563  5446           STJ  SIGNSW
Ø 2564  5265           LDJ@ HORDB1
Ø 2565  15Ø6           SIN J
Ø 2566  6ØØ3           JMP .+3
Ø 2567  653Ø  X1,      JPS NEGOP
Ø 257Ø  3441           ISZ  SIGNSW
Ø 2571  527Ø           LDJ@ HORDA1
Ø 2572  15Ø6           SIN J
Ø 2573  6ØØ3           JMP .+3
Ø 2574  6524           JPS NEGAC
Ø 2575  3434           ISZ  SIGNSW
Ø 2576  6315           JMP@ SIGN

Ø 2577  6516  DLMLT,   JPS  SIGN
Ø 26ØØ  52Ø7           LDJ@ LORDA1
Ø 26Ø1  7Ø16           XCT  X3Ø         /LDK LORD
Ø 26Ø2  1ØØØ           MPY
Ø 26Ø3  13Ø2           LJKFRS
Ø 26Ø4  Ø55Ø           TWSTK
Ø 26Ø5  2561           SIGN             /TEMPORARY
Ø 26Ø6  Ø51Ø           TWLDK
Ø 26Ø7  25Ø5  LORDA1,  LORD
Ø 261Ø  57Ø1           STJ@ LORDA1
Ø 2611  524Ø           LDJ@ HORDB1
Ø 2612  1ØØØ           MPY
Ø 2613  13Ø2           LJKFRS
Ø 2614  4533           ADJ  SIGN
Ø 2615  5534           STJ  SIGN
Ø 2616  5243           LDJ@ HORDA1
Ø 2617  Ø51Ø  X3Ø,     TWLDK
Ø 262Ø  25Ø3  LORDB1,  LORD1
Ø 2621  1ØØØ           MPY
Ø 2622  13Ø2           LJKFRS
Ø 2623  4542           ADJ  SIGN
Ø 2624  5635           STJ@ HORDA1
Ø 2625  3ØØ4  MDEXIT,  DSZ  SIGNSW
Ø 2626  7172           XCT  X14         /JMP DUBINT+1
Ø 2627  6557  X4,      JPS NEGAC
Ø 263Ø <7174  X7,      XCT  X14         /JMP DUBINT+1

Ø 2631  ØØØØ  SIGNSW,  Ø

Ø 2632  175Ø  DLDIV,   CLR  JK O
Ø 2633  13Ø1           LRSFJK
```

```
Ø 2634  5451            STJ  ERROR1
Ø 2635  2331            SUBL 31
Ø 2636  5450            STJ  DIVCTR
Ø 2637  5556            JPS SIGN
Ø 2640  7151            XCT X1             /JPS NEGOP
Ø 2641  7122            XCT  X3Ø           /LDK LORD1
Ø 2642  1715            SIZ  CLR JK
Ø 2643  1552            SIP  CLR J O
Ø 2644  6Ø37            JMP  ERROR
Ø 2645  4725  DIVLP,    ADJ@ LORDB1
Ø 2646  1455            SIZ  O CLR O
Ø 2647  16Ø4            INC  K
Ø 265Ø  Ø45Ø            TWADK
Ø 2651  25Ø4  HORDB1,   HORD1
Ø 2652  145Ø            CLR O
Ø 2653  16Ø2            SIP K
Ø 2654  6ØØ3            JMP .+3
Ø 2655  147Ø            CLR CMP O
Ø 2656  13Ø1            LRSFJK
Ø 2657  535Ø  X6,       LDJ@ LORDA1
Ø 266Ø  Ø51Ø            TWLDK
Ø 2661  25Ø6  HORDA1,   HORD
Ø 2662  16Ø2            SIP K
Ø 2663  142Ø            CMP FLAG
Ø 2664  1341            SFTZ JK 1
Ø 2665  1455            SIZ  O CLR O
Ø 2666  15Ø4            INC  J
Ø 2667  576Ø            STJ@ LORDA1
Ø 267Ø  Ø55Ø            TWSTK
Ø 2671  25Ø6            HORD
Ø 2672  13Ø2            LJKFRS
Ø 2673  3413            ISZ  DIVCTR
Ø 2674  6ØØ2            JMP  .+2
Ø 2675  615Ø            JMP  MDEXIT        /FINISHED SO EXIT
Ø 2676  1341            SFTZ JK 1
Ø 2677  1415            SIZ CLR FLAG
Ø 27ØØ  15Ø4            INC  J
Ø 27Ø1  13Ø1            LRSFJK
Ø 27Ø2  6135            JMP DIVLP

Ø 27Ø3  34Ø2  ERROR,    ISZ  ERROR1
Ø 27Ø4  7154  X5,       XCT  X7            /JMP DUBINT+1

Ø 27Ø5  ØØØØ  ERROR1,   Ø
Ø 27Ø6  ØØØØ  DIVCTR,   Ø

/E2524
```

```
/INTEGER PACKAGE OUTPUT

 0 2707  5065  SDPRNT, LDJ   TTYP
 0 2710  5461          STJ   TEMP1
 0 2711  5330          LDJ@  HORD41
 0 2712  5505          STJ   ERROR1      /REMEMBER SIGN
 0 2713  1502          SIP   J           /SIGN NEGATIVE?
 0 2714  7165          XCT   X4          /JPS NEGAC
 0 2715  5407          STJ   SDH         /J = HORD
 0 2716  7137          XCT   X6          /LDJ LORD
 0 2717  5407          STJ   SDL
 0 2720  1710          CLR   JK
 0 2721  2307          SUBL  7           /SET UP FOR 7 DIGITS
 0 2722  5514          STJ   DIVCTR
 0 2723  6414  SDLP,   JPS   BY10DV      /DIVIDE H ORDER BY 10
 0 2724  0000  SDH,    0
 0 2725  6412          JPS   BY10DV      /DIVIDE L ORDER BY 10
 0 2726  0000  SDL,    0
 0 2727  1374          ROTD  JK 14
 0 2730  6417          JPS   SDOUT       /REMAINDER TO STATUS BUFFER
 0 2731  5105          LDJ   SDH
 0 2732  1715          SIZ   CLR JK      /CONVERSION DONE?
 0 2733  6110          JMP   SDLP
 0 2734  5037          LDJ   N20         /YES, FILL REMAINDER WITH BLANKS
 0 2735  6412          JPS   SDOUT
 0 2736  6102          JMP   .-2

 0 2737  0000  BY10DV, 0                 /DIVIDE CALL+1 BY 10
 0 2740  5032          LDJ   P12
 0 2741  1101          LRFJ
 0 2742  5303          LDJ@  BY10DV
 0 2743  1001          DIV
 0 2744  5705          STJ@  BY10DV
 0 2745  3506          ISZ   BY10DV
 0 2746  6307          JMP@  BY10DV

 0 2747  0000  SDOUT,  0                 /STORE J IN TTY BUFFER
 0 2750  2220          ADDL  20
 0 2751  1101          LRFJ
 0 2752  4617          ADJ@  TEMP1
 0 2753  1425          SIZ   CMP
 0 2754  6003          JMP   .+3
 0 2755  1103          EXJR
 0 2756  3013          DSZ   TEMP1
 0 2757  1166          ROTD  J 6
 0 2760  5611          STJ@  TEMP1
 0 2761  3553          ISZ   DIVCTR      /BUFFER FULL?
 0 2762  6313          JMP@  SDOUT       /NO, PROCEED WITH CONVERSION
 0 2763  5156          LDJ   ERROR1      /BUFFER FULL, NOW INSERT SIGN
 0 2764  1516          SIN   CLR J       /SIGN NEGATIVE?
```

```
Ø 2765  2315            SUBL 15         /NO, INSERT BLANK
Ø 2766  23Ø3            SUBL 3
Ø 2767  652Ø            JPS  SDOUT
Ø 277Ø  7164            XCT  X5         /JMP DUBINT+1

Ø 2771  ØØØØ  TEMP1,    Ø
Ø 2772  ØØ12  P12,      12
Ø 2773  776Ø  N2Ø,      -2Ø
Ø 2774  ØØØ7  TTYP,     TTY+4           /LAST LOCATION POINTER FIXED!

/E1Ø19
```

```
                    *4000
/INITIALIZE  ROUTINE - ONCE ONLY CODE
/AREA BECOMES PART OF DATA BUFFER AFTER EXIT
/TYPES INITIAL MESSAGE ND4410
/DETERMINES  MEMORY SIZE

 0 4000  0000  MEMZ0,  0
 0 4001  0640          TWJPS             /TYPE ND4410*
 0 4002  2403          UNPACK
 0 4003  4077          BGNING
 0 4004  5072          LDJ IDL           /REPLACE CALL TO THIS ROUTINE WITH IOFF
 0 4005  0540          TWSTJ
 0 4006  0200          COMRET
 0 4007  5063          LDJ P1            /LOAD LAST LOCATION OF 4 FIELDS
 0 4010  0544          TWSTJ F0
 0 4011  7777          7777
 0 4012  5061          LDJ P2
 0 4013  0545          TWSTJ F1
 0 4014  7777          7777
 0 4015  5057          LDJ P3
 0 4016  0546          TWSTJ F2
 0 4017  7777          7777
 0 4020  5055          LDJ P4
 0 4021  0547          TWSTJ F3
 0 4022  7777          7777
 0 4023  1610          CLR K             /TEST LAST LOCATION OF 4 FIELDS
 0 4024  0504          TWLDJ F0
 0 4025  7777          7777
 0 4026  2444          SMJ P1
 0 4027  1604          INC K
 0 4030  0505          TWLDJ F1
 0 4031  7777          7777
 0 4032  2441          SMJ P2
 0 4033  1604          INC K
 0 4034  0506          TWLDJ F2
 0 4035  7777          7777
 0 4036  2436          SMJ P3
 0 4037  1604          INC K
 0 4040  0507          TWLDJ F3
 0 4041  7777          7777
 0 4042  2433          SMJ P4
 0 4043  1604          INC K
 0 4044  1374          ROTD JK 14        /MOVE COUNT OF FIELDS TO J REGISTER
 0 4045  2301          SUBL 1            /FIELD COUNT = 0,1,2,3
 0 4046  1141          SFTZ J 1          /NO. BLOCKS OF 1 K CHNLS=(NO. FIELDSX2+
 0 4047  2201          ADDL 1            /FOR ALL FIELDS FOR PROGRAM MAKE IDLE
 0 4050  0540          TWSTJ             /AND CHANGE IN2000 TO IN4000 VALUE
 0 4051  1662          GROUPN            /NUMBER OF 1K DOUBLEINT BLOCKS
 0 4052  1610          CLR  K
 0 4053  0550          TWSTK
 0 4054  1663           GROUPN+1
 0 4055  0550           TWSTK
 0 4056  1650           GROUPD+1
 0 4057  1372           ROTD JK 12
 0 4060  0550           TWSTK           /2000-6000-12000-16000
 0 4061  1747           MEMSIZ+1
 0 4062  0540           TWSTJ
 0 4063  1746           MEMSIZ
 0 4064  1510           CLR J
 0 4065  0540           TWSTJ
 0 4066  1647           GROUPD
 0 4067  0640           TWJPS           /INITIALIZE DISPLAY PARAMETERS
 0 4070  1204           DISPLY
 0 4071  6014           JMP  PLT        /INITIALIZE PLOTTER

 0 4072  0001  P1,      1
 0 4073  0002  P2,      2
 0 4074  0003  P3,      3
 0 4075  0004  P4,      4
 0 4076  1003  IDL,     IOFF

/TTY OUTPUT  MESSAGE

 0 4077  7777  BGNING, 7777
 0 4100  5644           5644
 0 4101  0024           0024
 0 4102  2421           2421
 0 4103  2077           2077
 0 4104  7775           7775

/INITIALIZE  PLOTTER ROUTINE

 0 4105  0640  PLT,     TWJPS           /TYPE PLOTTER?
 0 4106  2403           UNPACK
 0 4107  4145           PLTR
 0 4110  0640           TWJPS           /GET OPERATOR RESPONSE
 0 4111  0245           FCHAR
 0 4112  2445           SMJ  PN         /N?
 0 4113  6024           JMP  NOPL       /YES
 0 4114  2444           SMJ  PY         /Y?
 0 4115  6002           JMP  PLT1       /YES
 0 4116  6111           JMP  PLT        /NOT Y OR N SO AGAIN
 0 4117  7112  PLT1,    XCT  PLT        /TYPE YES
 0 4120  4152           ES
 0 4121  1730           CLR  CMP JK
 0 4122  1442           SKIP
 0 4123  1302  PLOOP,   LJKFRS          /PLOT ALTERNATE MAXS AND MINS
 0 4124  1720           CMP  JK
 0 4125  1301           LRSFJK
 0 4126  0640           TWJPS
```

```
Ø 4127  Ø271          WAITP               /PLOT + DISPLAY
Ø 4130  74Ø4          TIS                 /WAIT FOR TTY INPUT CHAR
Ø 4131  61Ø1          JMP  .-1
Ø 4132  74Ø3          TRF                 /REQUEST ANOTHER CHAR
Ø 4133  2426          SMJ  SP             /SPACE TYPED?
Ø 4134  6111          JMP  PLOOP          /YES - PLOT AGAIN
Ø 4135  Ø64Ø  MEMRET, TWJPS               /NO - REINITIALIZE
Ø 4136  Ø227          DECODE
Ø 4137  7132  NOPL,   XCT  PLT            /JPS UNPACK
Ø 4140  4154          PNO
Ø 4141  5Ø15          LDJ  IDLEP
Ø 4142  Ø54Ø          TWSTJ
Ø 4143  Ø273          PINST
Ø 4144  61Ø7          JMP  MEMRET         /EXIT

Ø 4145  6Ø54  PLTR,   6Ø54                /PLOTTER?
Ø 4146  5764          5764
Ø 4147  6445          6445
Ø 415Ø  6237          6237
Ø 4151  ØØ75          ØØ75

Ø 4152  4563  ES,     4563                /(Y)ES
Ø 4153  7775          7775
Ø 4154  5777  PNO,    5777                /(N)O
Ø 4155  7575          7575

Ø 4156  14ØØ  IDLEP,  IDLE        /IDLE INSTRUCTION FOR MODIFICATION
Ø 4157  Ø116  PN,     116         /ASCII N
Ø 416Ø  Ø131  PY,     131         /ASCII Y
Ø 4161  Ø24Ø  SP,     24Ø         /ASCII SPACE

/E1915
```

```
SE 4164
ACNEG   = 25Ø7
ACQCOM  = 2Ø75
ADCØ    = Ø1Ø1
ADC1    = Ø14Ø
ADCJ    = ØØ77
ADCK    = Ø1ØØ
ADCST   = ØØ71
ADDRS   = Ø132
ADRS    = 2517
ADTW    = Ø466
ADVANC  = 1136
ALT     = 2233
ALTM    = 213Ø
AQEXIT  = 2Ø61
AQFLD   = 2Ø72
AQMODE  = 2Ø71
AQOFF   = 2Ø25
AQUIRE  = 2Ø3Ø
ASTW    = Ø453
BGNING  = 4Ø77
BITCNT  = 1144
BY1ØDV  = 2737
C1Ø     = 2231
C24Ø    = 1Ø44
C77     = 1Ø43
CFS     = 1255
CFSP    = 1252
CHARX   = 232Ø
CHARXP  = Ø252
CHROUT  = 2361
CLOCK   = 2Ø11
CLOCK1  = 21ØØ
CLOK    = 23ØØ
CLRADC  = 7521
CLRCLK  = Ø612
CLRJ    = 2371
CLSET   = 21Ø7
CLSM    = ØØ1Ø
CM1     = Ø675
CM2     = Ø676
CNTR    = 223Ø
COMRET  = Ø2ØØ
CONT    = 1124
CONTL2  = Ø162
CONVLP  = 1Ø14
CRLOUT  = 2373
CSEC    = ØØ15
CSWTCH  = Ø611
```

```
CTABLE   =  1151
CTRAP    =  0061
DCHANS   =  1521
DCHI     =  1354
DEC      =  1535
DECODE   =  0227
DECODP   =  2127
DECP     =  1516
DELTA    =  0605
DELTAP   =  1517
DELTM    =  0744
DINST    =  0572
DINST2   =  0272
DINSTP   =  1142
DISCN    =  1250
DISCON   =  0523
DISP51   =  0556
DISP52   =  0557
DISPI    =  1646
DISPLY   =  1204
DISPOF   =  7500
DISRDY   =  7514
DISSET   =  1545
DIVCTR   =  2706
DIVLP    =  2645
DLDIV    =  2632
DLLOAD   =  2511
DLMLT    =  2577
DLSTOR   =  2516
DMAX     =  1537
DMAXI    =  2067
DMDSOF   =  2221
DMDSON   =  2230
DMIN     =  1531
DMOD     =  0231
DMOVE    =  1465
DMWCSA   =  0626
DNORM    =  0637
DNORM1   =  0726
DPNTS    =  1523
DSC      =  1533
DSCI     =  0713
DSCP     =  1543
DSMARK   =  7507
DSPLY    =  0547
DSPP     =  0613
DTWO     =  1143
DUBINT   =  2441
DVBY10   =  1046
DWIDTH   =  1445
```

```
ECHOF    =  21Ø6
EQ       =  ØØ33
ERASE1   =  1773
ERASEC   =  1752
ERASEF   =  1756
ERPOR    =  27Ø3
ERROR1   =  27Ø5
ERRORX   =  ØØ3Ø
ES       =  4152
ESC      =  2234
EXPAND   =  1475
FCHAR    =  Ø245
FLADD    =  2523
FLSUB    =  2535
GERR     =  175Ø
GETP     =  Ø451
GETW     =  Ø444
GPW      =  ØØ22
GRCONT   =  16Ø7
GROP1W   =  1666
GROPNW   =  167Ø
GROPSP   =  1653
GROPWI   =  1751
GROPWP   =  1654
GROPZK   =  21Ø4
GROUP    =  15Ø6
GROUPD   =  1647
GROUPF   =  1544
GROUPN   =  1662
GROUPS   =  166Ø
GROUPT   =  1672
GROUPW   =  1664
GROUPZ   =  Ø156
GRP1WP   =  1651
GRPWP    =  1652
GSC      =  164Ø
GSCI     =  2ØØ7
GSCP     =  152Ø
GWRD     =  11Ø5
GWSET    =  1676
HIPUN    =  Ø175
HIPUNT   =  Ø171
HORD     =  25Ø6
HORD1    =  25Ø4
HORDA1   =  2661
HORDB1   =  2651
HPØ      =  ØØ76
HREAD    =  Ø153
HREADT   =  Ø147
HRTN     =  Ø323
```

```
IADD     =  4400
ICLOCK   =  0412
IDIS     =  0163
IDIV     =  6400
IDL      =  4076
IDLEP    =  4156
IECHOF   =  0234
IEXT     =  0000
II1      =  1656
ILOD     =  5000
IM       =  DUBINT
IMUL     =  7000
IN1      =  1541
IN2      =  1642
IN2000   =  1644
IN2I     =  2010
INEC     =  2140
INEC1    =  2224
INECR    =  2144
INEG     =  6000
INICOM   =  0170
INITL    =  0165
INITO    =  0166
INOP     =  7400
IONHP    =  0341
IONX     =  0145
IONXP    =  0407
IOUT     =  3400
IPRC     =  0164
IPSUPF   =  0167
IRTRN    =  2105
ISTR     =  5400
ISUB     =  4000
ITMOUT   =  0411
JPSD     =  0277
JPSLOG   =  1263
KYBDT    =  0260
LAMP     =  1251
LDF      =  2252
LDLIST   =  0632
LDONE    =  1234
LDSCON   =  0615
LDSPLY   =  7506
LIMIT    =  1406
LIPR     =  0400
LISTC    =  2073
LOFLO    =  3410
LOG      =  0473
LOGD1    =  0504
LOGD2    =  0511
```

```
LOGTWO  = Ø52Ø
LOOP2   = 2166
LOPRNT  = Ø242
LORD    = 25Ø5
LORD1   = 25Ø3
LORDA1  = 26Ø7
LORDB1  = 262Ø
LOREAD  = Ø264
LOWIPR  = ØØØ1
LOWPC   = Ø3ØØ
LPC     = ØØ74
MARKC   = Ø737
MARKD   = Ø65Ø
MARKN   = Ø61Ø
MARKS   = Ø646
MARKSP  = Ø743
MCHAN   = Ø741
MCHANP  = Ø74Ø
MDATA   = Ø611
MDEXIT  = 2625
MEMRET  = 4135
MEMSIZ  = 1746
MEMZØ   = 4ØØØ
MEMZC   = Ø16Ø
MEMZCI  = 2Ø7Ø
MGCC    = 1525
MGCCP   = 1515
MGCL    = 1266
MGCLP   = 1513
MGCP    = Ø6Ø7
MGCR    = 127Ø
MGCRP   = 1514
MINUS   = 2236
MMAX    = 1272
MMAXI   = 1655
MMIN    = 1264
MMOVE   = 146Ø
MOREF   = ØØ75
MOREH   = Ø321
MOVEIT  = 1341
MR      = 226Ø
MRK1    = Ø7Ø7
MRK2    = Ø745
MRK3    = Ø746
MRK4    = Ø754
MRK5    = Ø73Ø
MWIDTH  = 1441
N2Ø     = 2773
NEGAC   = 255Ø
NEGACI  = 2237
```

```
NEGOP    = 2537
NOCTB    = 0336
NOOLAY   = 0212
NOPL     = 4137
NOPX     = 2442
NUM      = 1401
NUSED1   = 2117
NXTPNT   = 2412
NXTPNZ   = 1107
NXTWRD   = 1103
OLSC     = 1527
OLYEXT   = 2074
P1       = 4072
P12      = 2772
P14      = 1147
P2       = 4073
P212     = 2423
P215     = 2424
P240     = 2425
P3       = 4074
P3400    = 0414
P4       = 4075
P4000    = 1145
P5       = 1146
P75      = 2426
P77      = 2427
PCONST   = 1356
PCRLF    = 0035
PINST    = 0273
PION     = 1500
PKTEMP   = 2357
PLOOP    = 4123
PLOT     = 0266
PLOTXY   = 7511
PLT      = 4105
PLT1     = 4117
PLTR     = 4145
PMTWO    = 0614
PN       = 4157
PNO      = 4154
POINT    = 2360
POINTC   = 1150
POINTR   = 0415
PSUPPF   = 2422
PTIME    = 2103
PTIME2   = 2102
PTIMEI   = 1437
PWAITP   = 0524
PY       = 4160
RDSTAT   = 0606
```

```
READCW  = 7527
RELD    = 1614
RETRN   = Ø362
ROTT    = 1261
RSTR    = Ø416
RUBOUT  = 2235
SAVE    = Ø4Ø1
SAVEL   = Ø424
SAVEP   = Ø413
SCOPCR  = Ø767
SDH     = 2724
SDL     = 2726
SDLP    = 2723
SDOUT   = 2747
SDPRNT  = 27Ø7
SETACQ  = 2Ø26
SFTT    = 1262
SFTZ1   = Ø564
SFTZ2   = Ø565
SIGN    = 2561
SIGN1   = 2227
SIGNSW  = 2631
SKPL    = 144Ø
SP      = 4161
STADH   = 1Ø16
STADL   = 1Ø2Ø
STAOUT  = 1Ø57
STATLP  = Ø775
STATO   = 1Ø4Ø
STATS   = Ø76Ø
STATU1  = 2242
STATUS  = 224Ø
STATX   = 1Ø41
STF     = 1674
STIMES  = 1355
STLAMP  = Ø614
TAB1    = 23Ø4
TABL    = 1152
TABLE   = 2336
TABLEX  = 25Ø2
TEMP1   = 2771
TEMP3   = 2225
TEMPX   = 25Ø1
TEX     = Ø571
TEX1    = Ø576
TEX2    = Ø577
TIM     = ØØ12
TIME    = 2Ø76
TSTC    = 221Ø
TTY     = ØØØ3
```

```
TTYP     = 2774
TWINK1   = Ø535
TWINKT   = Ø525
TWIZ     = 1754
TWK5     = Ø521
TYPET    = Ø235
UNPACK   = 24Ø3
UNUSED   = 212Ø
UPDWN    = 1357
WAITP    = Ø271
WEXIT    = 174Ø
WID      = ØØ25
X1       = 2567
X1Ø      = Ø627
X11      = Ø131
X11I     = Ø522
X12      = Ø663
X13      = Ø711
X14      = 2534
X16      = Ø37Ø
X2       = 2533
X21      = 1314
X22      = 132Ø
X3Ø      = 2617
X4       = 2627
X5       = 27Ø4
X51      = 1546
X53      = 2Ø41
X54      = 1711
X55      = 1757
X56      = 17Ø1
X57      = 1462
X6       = 2657
X7       = 263Ø
X72      = 2177
X8       = Ø72Ø
X9       = Ø53Ø
X9Ø      = 215Ø
X91      = 2161
XORIG    = 1Ø45
XOUT     = 24ØØ
YORIG    = 1Ø42
ZFLL     = 227Ø
ZFULL    = 1274
ZLOG     = 1333
ZMERG    = 1327
ZSET     = 1276
ER ØØØØ
```

```
/ND41-1059-00                    S.A. = N.A.      4000-4062
/OVERLAY FOR ND41-1060-00 ALLOWS PLOTTER RECALIBRATION (X-Y plotter)
/VERSION A

/2  6/7/72

/MG

            *200

0200  6642           JPS@ LOPRNT              /FIRST TIME SENDS TO CALIB. ROUT.

            *LOPRNT

0242  4000           MEMZ0            /SETS UP ADDRESS FOR FIRST TIME JPS

            *SAVEP

0413  0434           SAVEL+10         /RESTORES STACK POINTER

            *SAVEL

0424  0000           0                /REINITIALIZES STACK
0425  0000           0
0426  0000           0
0427  0000           0
0430  0000           0
0431  1007           IONN
0432  0000           0
0433  0760           STATS

0434  0000           0
0435  0000           0
0436  0000           0
0437  0000           0
0440  0000           0
0441  0000           0
0442  0000           0
0443  0000           0


            *4000
/NOTE *** USES GROUP 1 CHNLS 1-32 FOR CALIBRATE ROUTINE
/INITIALIZE  ROUTINE - ONCE ONLY CODE
/AREA BECOMES PART OF DATA BUFFER AFTER EXIT


4000  0000  MEMZ0Z, 0
4001  5061           LDJ IDLZ         /REPLACE CALL TO THIS ROUTINE WITH IOFF
4002  0540           TWSTJ
```

```
4003  0200          COMRET
4004  0640  PLTZ,   TWJPS           /TYPE PLOTTER?
4005  2403          UNPACK
4006  4044          PLTRZ
4007  0640          TWJPS           /GET OPERATOR REPONSE
4010  0245          FCHAR
4011  2446          SMJ  PNZ                /N?
4012  6024          JMP  NOPLZ      /YES
4013  2445          SMJ  PYZ                /Y?
4014  6002          JMP  PLT1Z      /YES
4015  6111          JMP  PLTZ       /NOT Y OR N SO REASK
4016  7112  PLT1Z,  XCT  PLTZ       /TYPE YES
4017  4052          ESZ
4020  1730          CLR  CMP JK
4021  1442          SKIP
4022  1302  PLOOPZ, LJKFRS          /PLOT ALTERNATE MAXS AND MINS
4023  1720          CMP  JK
4024  1301          LRSFJK
4025  0640          TWJPS
4026  0271          WAITP           /PLOT + DISPLAY
4027  7404          TIS             /WAIT FOR TTY INPUT CHAR
4030  6101          JMP  .-1
4031  7403          TRF             /REQUEST ANOTHER CHAR
4032  2427          SMJ  SPZ                /SPACE TYPED?
4033  6111          JMP  PLOOPZ     /YES - PLOT AGAIN
4034  0640  MEMREZ, TWJPS           /NO - REINITIALIZE
4035  0227          DECODE
4036  7132  NOPLZ,  XCT  PLTZ       /JPS UNPACK
4037  4054          PNOZ
4040  5016          LDJ  IDLEPZ
4041  0540          TWSTJ
4042  0273          PINST
4043  6107          JMP  MEMREZ

4044  7777  PLTRZ,  7777            /PLOTTER?
4045  6054          6054
4046  5764          5764
4047  6445          6445
4050  6237          6237
4051  0075          0075

4052  4563  ESZ,    4563            /(Y)ES
4053  7775          7775
4054  5777  PNOZ,   5777            /(N)O
4055  7575          7575

4056  1400  IDLEPZ, IDLE    /IDLE INSTRUCTION FOR MODIFICATION
4057  0116  PNZ,    116     /ASCII N
4060  0131  PYZ,    131     /ASCII Y
4061  0240  SPZ,    240     /ASCII SPACE
```

```
4Ø62  1ØØ3  IDLZ,   IOFF


/E1413
```

```
SE 426Ø
ESZ      = 4Ø52
IDLEPZ   = 4Ø56
IDLZ     = 4Ø62
MEMREZ   = 4Ø34
MEMZØZ   = 4ØØØ
NOPLZ    = 4Ø36
PLOOPZ   = 4Ø22
PLT1Z    = 4Ø16
PLTRZ    = 4Ø44
PLTZ     = 4ØØ4
PNOZ     = 4Ø54
PNZ      = 4Ø57
PYZ      = 4Ø6Ø
SPZ      = 4Ø61
ER ØØØØ
```

SECTION I
INTRODUCTION

1-1. PROGRAM SUMMARY

1-2. The Integer Interpreter Program (41-0017) is an integral part of ND4410 Basic Physics Analyzer Program (41-1060). It contains programmable subroutines that provide fast double precision addition, subtraction, multiplication, division, and I/O routines.

1-3. PROGRAM AREA

1-4. Not applicable.

1-5. STARTING ADDRESS

1-6. The subroutines are called by software commands from the Basic Physics Analyzer Program (41-1060).

1-7. EQUIPMENT CONFIGURATION

1-8. Refer to Chapter 1, Paragraph 1-8, equipment configuration.

SECTION II
PROGRAM DESCRIPTION

2-1. INTRODUCTION

2-2. This section is intended to be read in conjunction with the flow charts outlined in Section VII.

2-3. This program contains a two-word (24 bit) integer accumulator and a two-word operand holding register that make up an intricate section of the instruction interpreter. The interpreter uses a format modeled after the standard MRI's i.e., a 4-bit instruction code, an indirect bit, a direction bit, and 6 address bits.

2-4. INTEGER INTERPRETER

2-5. The interpreter (Figure 7-1) is entered by a JPS IM. The effective address is determined and the operand is deposited in the operand holding register. Note that a zero instruction will exit the interpreter. The instruction code is then decoded and the program will branch to the indicated routine. A load or store routine is basically a utility in that they load the integer accumulator with a 5000 instruction or store the contents of the integer accumulator with a 5400 instruction.

2-6. ADDITION ROUTINE, SUBTRACTION ROUTINE, AND MULTIPLICATION ROUTINE

2-7. The add routine (Figure 7-3) performs a double precision addition of the operand to the integer accumulator with the results left in the integer accumulator. The subtraction routine (Figure 7-4) is accomplished by negating the operand and adding the negative operand to the integer accumulator. The multiplication routine (Figure 7-5) checks the sign of the operand and integer accumulator to ascertain that it is positive, and multiplies the high order 12 bits of the operand by the low order 12 bits of the integer accumulator (hardware multiply). Next the high order 12 bits of the integer accumulator are multiplied by the low order 12 bits of the operand. Finally the high order 12 bits of the integer accumulator are multiplied by the low order 12 bits of the operand. The sign of the product is corrected and the product is left in the integer accumulator. Note that only the low order 24 bits are generated (23 data bits and 1 sign bit).

2-8. DIVISION ROUTINE

2-9. The division routine (Figure 7-6) is a process of 23 subtractions and integer accumulator left shifts. The operand is the divisor, the integer accumulator the integer dividend, and the quotient is shifted into the integer accumulator from the right. Only integer numbers are considered in the quotient. Division by zero causes the division routine to be bypassed.

SECTION III
OPERATIONAL PROCEDURE

3-1. NOT APPLICABLE

SECTION IV
OPERATOR OR USER CONTROL

4-1. GENERAL INFORMATION

4-2. In the following sample program the interpreter is entered with a two-word JPS, A is loaded into the integer accumulator, B added to it, multiplied by C and stored in D. The interpreter is then exited and the program stops. Table 4-1 lists the status of HORD and LORD (the integer accumulator) for each routine in the sample routine.

NOTE

The minus (-) key must be depressed when inputting a negative number.

```
4ØØØ          Ø64Ø        TWJPS
4ØØ1          Ø4ØØ        IM
4ØØ2          5ØØ6        ILOD       A      (1)
4ØØ3          44Ø7        IADD       B      (2)
4ØØ4          7Ø1Ø        IMLT       C      (3)
4ØØ5          5411        ISTR       D      (4)
4ØØ6          ØØØØ        IEXT
4ØØ7          ØØØØ        STOP
4Ø1Ø          ØØØØ        A, Ø
4Ø11          ØØØ2           2
4Ø12          ØØØØ        B, Ø
4Ø13          ØØØ4           4
4Ø14          ØØØØ        C, Ø
4Ø15          ØØØ6           6
4Ø16          ØØØØ        D, Ø
4Ø17          ØØØØ           Ø
```

Table 4-1. HORD and LORD Status

STEP	1	2	3	4
HORD	Ø	Ø	Ø	Ø
LORD	2	6	44	44

SECTION V
ERROR DIAGNOSTICS

5-1. ERROR INDICATION

5-2. A division by zero causes the contents of location ERROR1 to be incremented by one (initially set to Ø) and the division routine is bypassed.

SECTION VI
COMMAND SUMMARY

6-1. Table 6-1 describes the instructions of the Integer Interpreter.

Table 6-1. Integer Interpreter Instructions

INSTRUCTION CODE	INSTRUCTION	DESCRIPTION
0000	IEXT	This instruction exits the interpreter mode.
3400	IOUT	This instruction causes a JPS to the output routine. It converts the number in the integer accumulator, the form is a sign and seven digits. The contents of the integer accumulator are destroyed. This number can range from -8388608 to +8388607. The converted number is stored in the output buffer starting at location TTY.
4000	ISUB	This instruction causes a double precision subtraction of the operand from the integer accumulator. The results are left in the integer accumulator.
4400	IADD	This instruction causes a double precision addition of the operand to the integer accumulator. The results are left in the integer accumulator.
5000	ILOD	This instruction loads the operand into the integer accumulator.

Table 6-1. Integer Interpreter Instructions (Cont'd)

INSTRUCTION CODE	INSTRUCTION	DESCRIPTION
5400	ISTR	This instruction stores the integer accumulator in the effective address. The contents of the integer accumulator are left intact.
6000	INEG	Negates integer accumulator.
6400	IDIV	This instruction causes the integer accumulator to be divided by the contents of the effective address. The quotient is left in the integer accumulator. The remainder is in core locations 743 and 744. Division by zero causes location 745 to be set ≠ 0 and the division is bypassed.
7000	IMUL	This instruction causes the integer accumulator to be multiplied by the contents of the effective address. Note that only the low order 24 bits are generated.
7400	INOP	Dummy routine.

SECTION VII
FLOW CHARTS

7-1. Figures 7-1 through 7-8 depict the flow of the integer package routines.

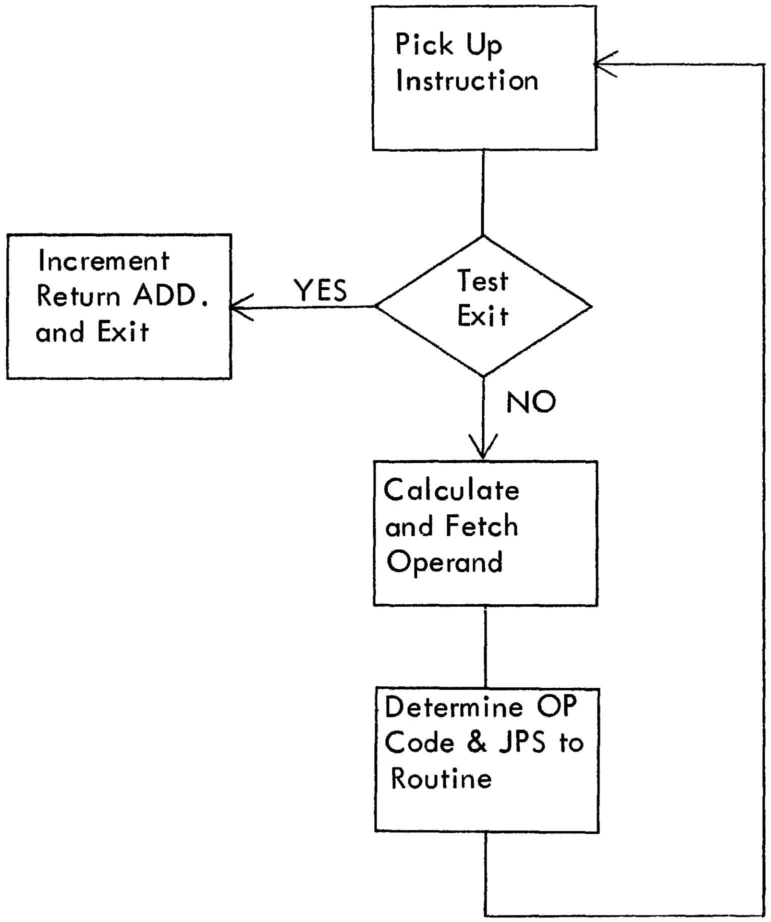
Pick Up Instruction
Increment Return ADD. and Exit
YES
Test Exit
NO
Calculate and Fetch Operand
Determine OP Code & JPS to Routine

Figure 7-1. Integer Interpreter

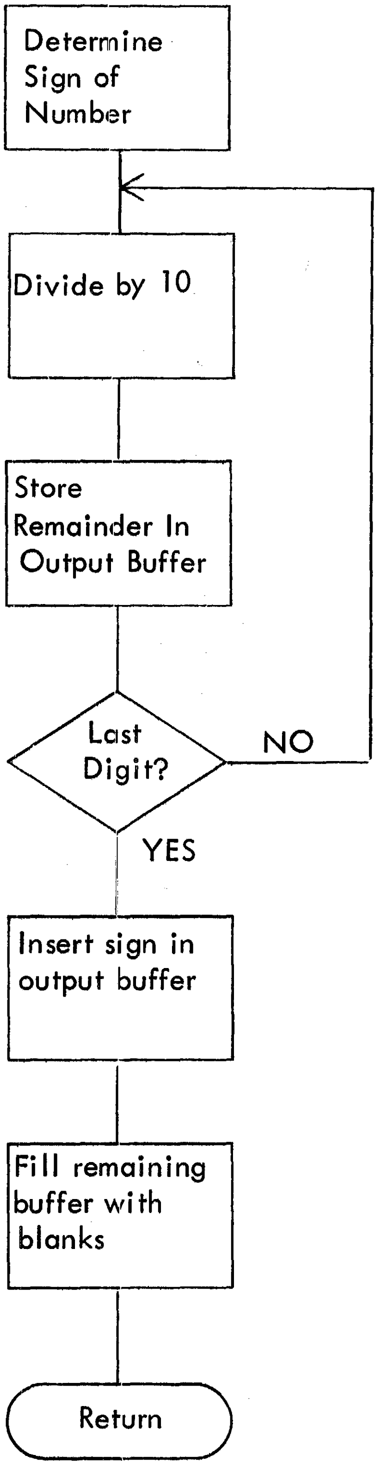
Determine Sign of Number
Divide by 10
Store Remainder In Output Buffer
Last Digit?
NO
YES
Insert sign in output buffer
Fill remaining buffer with blanks
Return

Figure 7-2. Output Routine

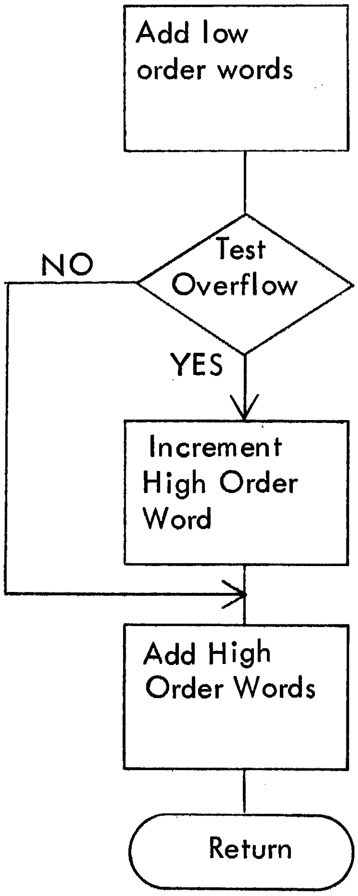

Figure 7-3. Addition Routine

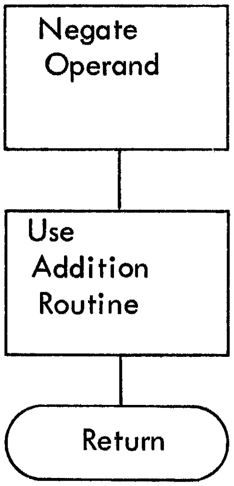

Figure 7-4. Subtraction Routine

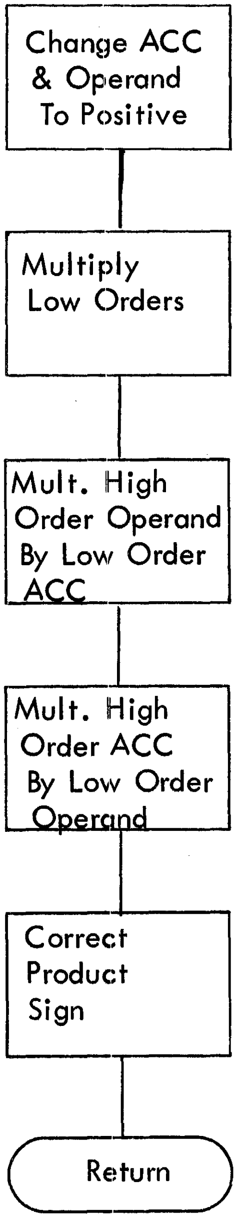
Change ACC & Operand To Positive
Multiply Low Orders
Mult. High Order Operand By Low Order ACC
Mult. High Order ACC By Low Order Operand
Correct Product Sign
Return

Figure 7-5. Multiplication Routine

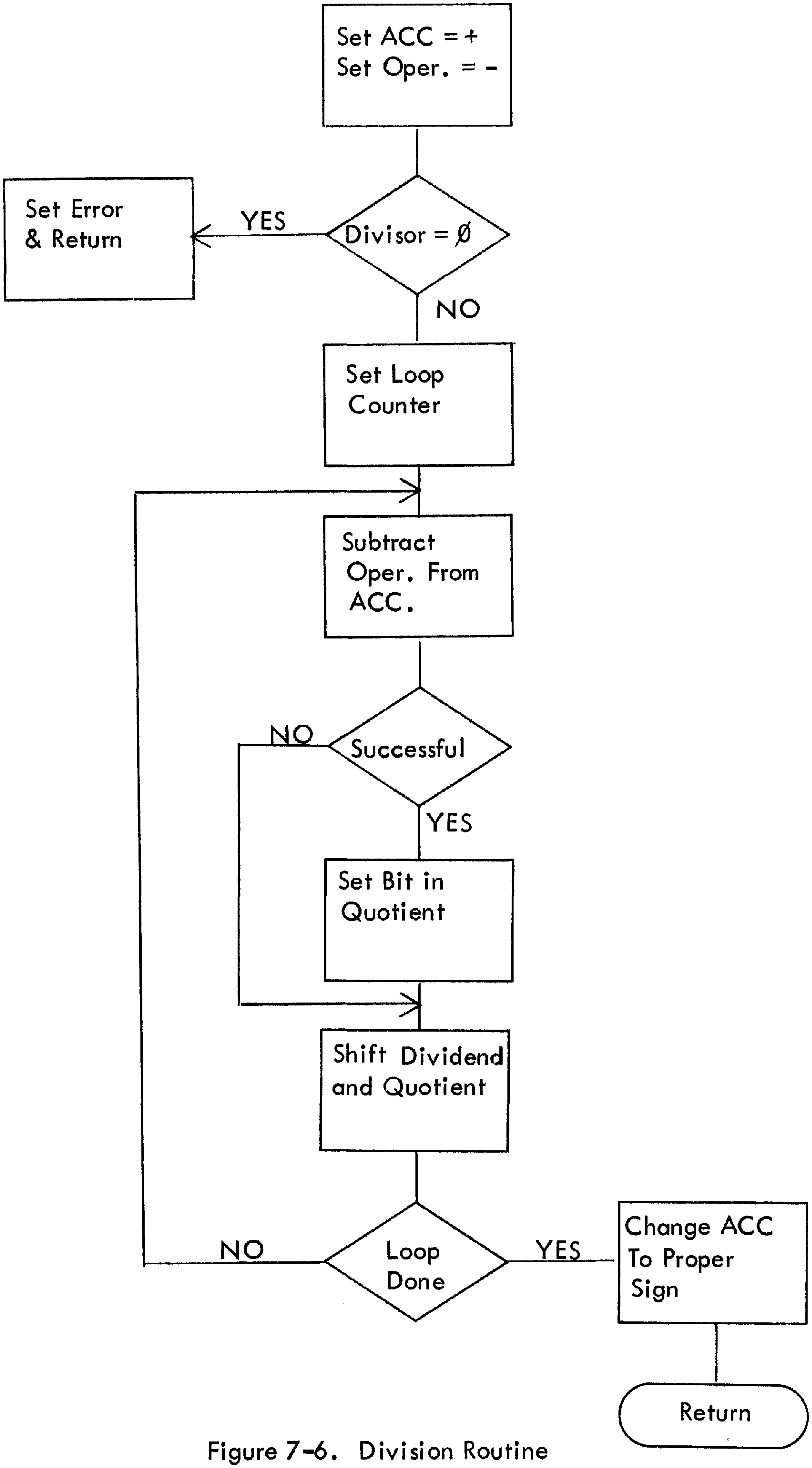

Figure 7-6. Division Routine

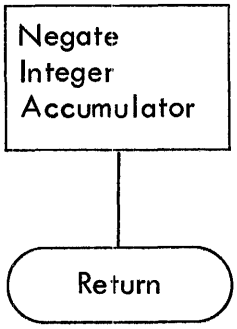

Figure 7-8. Dummy Routine

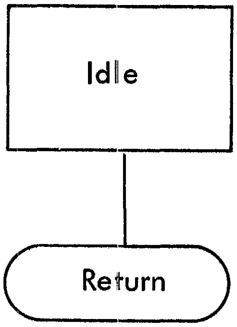

Figure 7-7. Negate Routine

SECTION VIII
PROGRAM LISTING

8-1. Refer to Chapter 1, Section VIII (41-1060 listing).

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