General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.

- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.

- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.

- This document is paginated as submitted by the original source.

- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

Produced by the NASA Center for Aerospace Information (CASI)

NASA CONTRACTOR
REPORT

NASA CR-144167

(NASA-CR-144167) ARTWORK INTERACTIVE DESIGN SYSTEM (AIDS) PROGRAM DESCRIPTION (M&S Computing, Inc.) 95 p HC $5.00 CSCL 09C

N76-17297

Unclas
G3/33 14207

ARTWORK INTERACTIVE DESIGN SYSTEM - AIDS PROGRAM DESCRIPTION

By B. T. Johnson and J. F. Taylor
M&S Computing, Inc.
Huntsville, Alabama 35805

February 1976

Prepared for

NASA - GEORGE C. MARSHALL SPACE FLIGHT CENTER
Marshall Space Flight Center, Alabama 35812

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
NASA CR-144167		

4. TITLE AND SUBTITLE	5. REPORT DATE
ARTWORK INTERACTIVE DESIGN SYSTEM -AIDS- PROGRAM DESCRIPTION	September 12, 1975
	6. PERFORMING ORGANIZATION CODE EC45
7. AUTHOR(S) B. T. Johnson and J. F. Taylor	8. PERFORMING ORGANIZATION REPORT # 73-0002, Rev. 1
9. PERFORMING ORGANIZATION NAME AND ADDRESS M&S Computing, Inc. P. O. Box 5183 Huntsville, Alabama 35805	10. WORK UNIT NO.
	11. CONTRACT OR GRANT NO. NAS8-25621
12. SPONSORING AGENCY NAME AND ADDRESS National Aeronautics and Space Administration George C. Marshall Space Flight Center Huntsville, Alabama 35812	13. TYPE OF REPORT & PERIOD COVERED Contractor Report
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Electronics and Control Laboratory, Electronics Development Division
Design Techniques Branch

16. ABSTRACT
This document describes an Artwork Interactive Design System (AIDS) implemented at the Marshall Space Flight Center to provide the microelectronic circuit designer/engineer a tool to perform circuit design, automatic layout modification, standard cell design, and artwork verification at a graphics computer terminal using a graphics tablet at the designer/computer interface.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
	Unclassified-Unlimited COR: John T. Gould EC01 Director, E&C Lab

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
		94	

For sale by National Technical Information Service, Springfield, Virginia 22151

PREFACE

Under the direction of Nasa Contract NAS8-25621, M&S Computing, Inc. has implemented an Artwork Interactive Design System (AIDS) to allow the designer/engineer to perform circuit design at the graphics terminal. This software was implemented on the Astrionics Laboratory Technology Division's Computer Facility which consists of a XDS Sigma 2 Computer and a Computek Display Terminal.

This document is intended to serve as a User's Manual as well as a Program Description Manual for the AIDS software. All program options are explained and a detail description of the internal logic and flow of the program are included in this document.

Prepared by:

B. T. Johnston
J. F. Taylor

Approved by:

J. W. Meadlock

TABLE OF CONTENTS

Section			Page
1.	INTRODUCTION		1
2.	AIDS DESIGN DISPLAYS		3
	2.1	Display Interpretation	3
		2.1.1 Control Display	4
		2.1.2 Design Display	6
	2.2	Basic Display Package	8
3.	DESIGN CONTROL PARAMETERS		25
	3.1	Interconnect Display Symbology	25
	3.2	Component Display Symbology	25
	3.3	Grid Display Symbology	26
	3.4	Negative Masks Definition	26
	3.5	Display Resolution	26
	3.6	Interconnect Control	27
4.	AIDS DESIGN COMMANDS		29
	4.1	Display Commands	29
		4.1.1 Display/Blank Current Level	29
		4.1.2 Display/Blank Grid	29
		4.1.3 Update Command, Delay Update	29
		4.1.4 Multi-Screen Display Option	30
		4.1.5 Display Grid Structure	30
		4.1.6 Display Cell Library Table of Contents	31
		4.1.7 Display/Blank Character Components	31
		4.1.8 Interconnect Display Symbology	31
		4.1.9 Component Display Symbology	31
	4.2	Move/Modify Commands	32

TABLE OF CONTENTS
(continued)

Section		Page
	4.2.1 Move Block, Shape, Line, Cell, Character	34
	4.2.2 Move Unit Area	34
	4.2.3 Copy Unit Area	34
	4.2.4 Modify Block Edge	34
	4.2.5 Modify Shape Edge	34
	4.2.6 Modify Line Node	35
	4.2.7 Modify Cell Edge	35
	4.2.8 Modify Unit Area Edge	35
	4.2.9 Rotate	35
	4.2.10 Select Current Orientation	37
	4.2.11 Move File	37
4.3	Placement Commands	37
	4.3.1 Place Block	37
	4.3.2 Place Shape	37
	4.3.3 Place Line	39
	4.3.4 Place Character	39
	4.3.5 Place Cell	39
	4.3.6 Place Unit Area	39
4.4	Delete Commands	40
	4.4.1 Delete Block, Shape, Line, Cell, Character	40
	4.4.2 Delete Unit Area	40
	4.4.3 Point Reset	40
	4.4.4 Swap Command	40
4.5	Select Commands	40
	4.5.1 Select Level	40
	4.5.2 Select Cell	41
	4.5.3 Select Line Width	41
4.6	Number Commands	41
	4.6.1 Topo	41
	4.6.2 One Through Sixteen (1-16)	41
	4.6.3 Fifty and One Hundred	41

TABLE OF CONTENTS
(continued)

Section		Page
4.7	Window Commands	41
	4.7.1 Fit Window	41
	4.7.2 Area Window	42
	4.7.3 Center Window	42
	4.7.4 Increase/Decrease Window	42
	4.7.5 Save, Recall Window	42
4.8	Miscellaneous Commands	42
	4.8.1 Drop Cell	42
	4.8.2 Drop Active Cell	42
	4.8.3 Any Angle	43
	4.8.4 Levels Off/Save Levels/Restore Levels	43
	4.8.5 File Circuit	43
	4.8.6 Start Mosaic/Continue Mosaic/Stop Mosaic	43
	4.8.7 Expand Cell	44
	4.8.8 Add Cell to Library	44
	4.8.9 Delete Cell	44
	4.8.10 Delete Active Cell	44a
4.9	Command Interrupt	44a
4.10	File Separation and Concatenation Commands	44a
	4.10.1 SEP-F Command	44a
	4.10.2 SEP-O Command	44b
	4.10.3 DSP-B Command	44b
	4.10.4 SWTCH Command	44b
	4.10.5 MERGE Command	44b
4.11	Header Updates	44b
	4.11.1 Screen Origin Update	44c
	4.11.2 Active Cell Update	44c
	4.11.3 Line Width Update	44c
	4.11.4 Number Update	44d

TABLE OF CONTENTS
(continued)

Section			Page
5.	AIDS SOFTWARE DESCRIPTION		45
	5.1	System Organization	45
	5.2	AIDS Executive	45
	5.3	AIDS Data Structures	50
		5.3.1 Display Symbology Table	50
		5.3.2 Display Parameter Table	50
		5.3.3 Buffer Pool	52
		5.3.4 Disk Working File	52
		5.3.5 Cell Library Table	52
		5.3.6 Active Cell Table	56
		5.3.7 Independent Component Table	60
	5.4	General Support Routines	60
APPENDIX			A-1

1. INTRODUCTION

This program document describes the Artwork Interactive Design System, AIDS, developed by M&S Computing, Inc. for the Astrionics Laboratory Technology Division's computer facility. This facility consists of an XDS Sigma 2 computer and a Computek Series 400 CRT Display System.

Since the primary user of this facility will be an engineer rather than a computer specialist, the Computek Display provides an ideal method for efficient user oriented, two-way communication between the engineer and the system. This communication is achieved through the use of the graphic display software implemented under a parallel effort of this contract. This general purpose display support software provides the interface between the AIDS Program operating in the SIGMA 2 computer and the Computek display unit through which the user communicates with the system. Figure 1-1 presents a general flow of communication between the AIDS software, the graphic display software component (the Display Controller), and the user at the display.

The display unit is not only used for designing circuits but is also used for user tutoring and program control option selection. The set of AIDS design displays leads the designer through the entire sequence of initializing the design programs, selecting the proper design control parameters, performing the actual design operations, and producing the design output. Sufficient text information is provided within the displays to adequately explain each step to the designer as he progresses from one phase of operation to the next.

The AIDS system provides total design control via the graphics display terminal. Sixteen levels of mask plus a topographical or composite level are available to the designer. An open-ended data structure accommodates designs of virtually any size. To eliminate redundant designing and minimize the design task, a library of standard cells may be generated interactively and maintained by the system. A file capability allows the designer to save his intermediate or final design and later recall the design for subsequent design work, modification or editing. Having perfected his design, the user may request the AIDS system to convert the design to an input format acceptable to the Banning Artwork Program.

Section 2 of this document presents the entire set of AIDS design displays. Sections 3 and 4 describe in detail the specific design displays and the special capabilities provided by the various design commands. The AIDS software is defined in Section 5 with detail program flowcharts included in the Appendix to further clarify the software functions.

COMMUNICATION FLOW

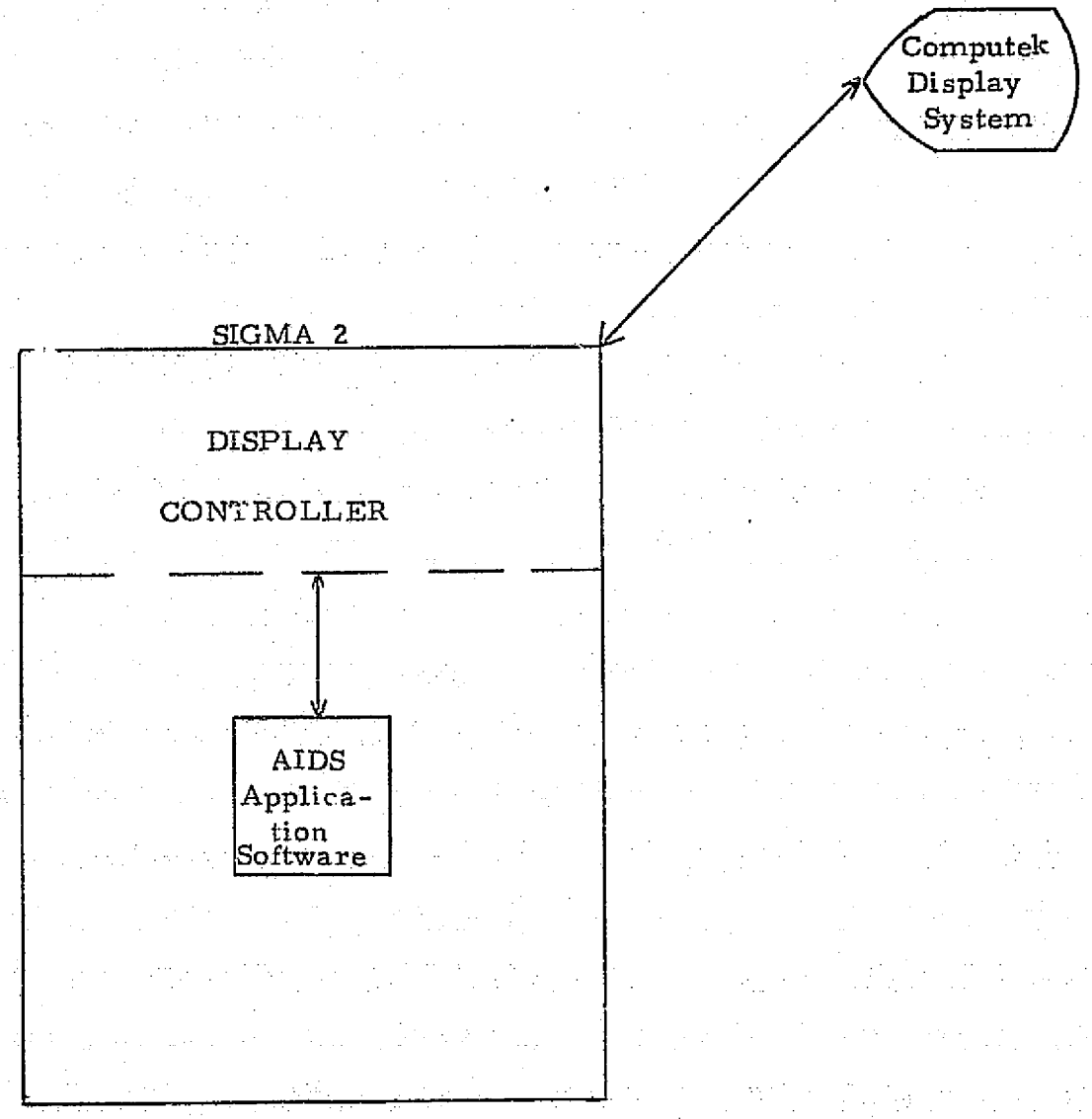


Figure 1-1

2. AIDS DESIGN DISPLAYS

The displays, found in Section 2.2, provide the user with an easy-to-use method of dynamically selecting the mode or sub-modes of operation of a given design operation. The entire set of design displays was preformatted by an off-line display librarian in order to minimize the on-line core memory and time requirements necessary to create each individual display. The Display Librarian is a display support program implemented during the initial phase of the current contract that accepts card images of the text and control information defining each display and creates a "book" of displays. The display book will reside on disk so that the Display Control Program can quickly switch from one display to another in response to the user's tablet pen or keyboard action.

When the AIDS Program is loaded, the first display presented to the user is Display 0100. This display allows the user to select one of two design modes:

1. Initiate New Design

2. Recall Previous Design

The next display to appear in response to an "Initiate New Design" selection is Display 0101. At this point the user may specify a library of standard cells to be used during his subsequent design effort.

On selecting the "Recall Previous Design" option, Display 0102 is displayed requesting the user to identify the file on which the previous design resides. This design is input and becomes the starting point for the current design session.

Having performed the required processing peculiar to the selected design mode of operation, the design flow converges at Display 0104. The design sequence then evolves into selecting the proper design control parameters, performing the actual design operations and producing the design output.

2.1 Display Interpretation

The display, as it resides on disk, contains the information that is to be displayed to the user. This information consists of embedded graphic orders, character control orders and alphanumeric data.

Certain symbols have special meaning within a display. The "#"

symbol generated on the printed display but displayed as a blank indicates input locations where the AIDS Program may fill in alphanumeric information and thus communicate to the user. Display 0105, for example, uses the special symbol "#" to display the current interconnect display symbology for each level. When Display 0105 is first presented, the fields represented by "#" will be filled-in with the appropriate information.

The "|" symbol defines compose areas where information from the keyboard can be entered. On the printed display the compose areas are depicted by "|" symbols, however, on the display picture these areas are represented by underline characters "_". In actual use, a symbol called the cursor is shown on the face of the CRT to identify the position at which the next character from the keyboard will be displayed. The position of the cursor is controlled by the user through the use of the cursor keys provided on the Computek keyboard. Display 0101 contains one compose field consisting of 2 sub-fields. The first sub-field allows the user to enter the alphanumeric name of the file on which his library resides and the second sub-field is used to specify the area on disk in which this file is located.

The symbols "<" and ">" define an area on the display that may be selected with the tablet pen. The "<" and ">" symbols will appear on the printed display but on the display picture only the characters within these symbols will be displayed. The pen option areas may be used to cycle from one display to another and to select various design options.

The AIDS display package contains two types of displays:

- o Control
- o Design

2.1.1 Control Display

The typical control display can be divided into a text area and a message area. These areas are illustrated by the typical control display format presented in Figure 2-1. The function of each area is described below:

Text Area

The text area contains the option descriptions, and other information explaining or controlling the use of the display.

CONTROL DISPLAY FORMAT

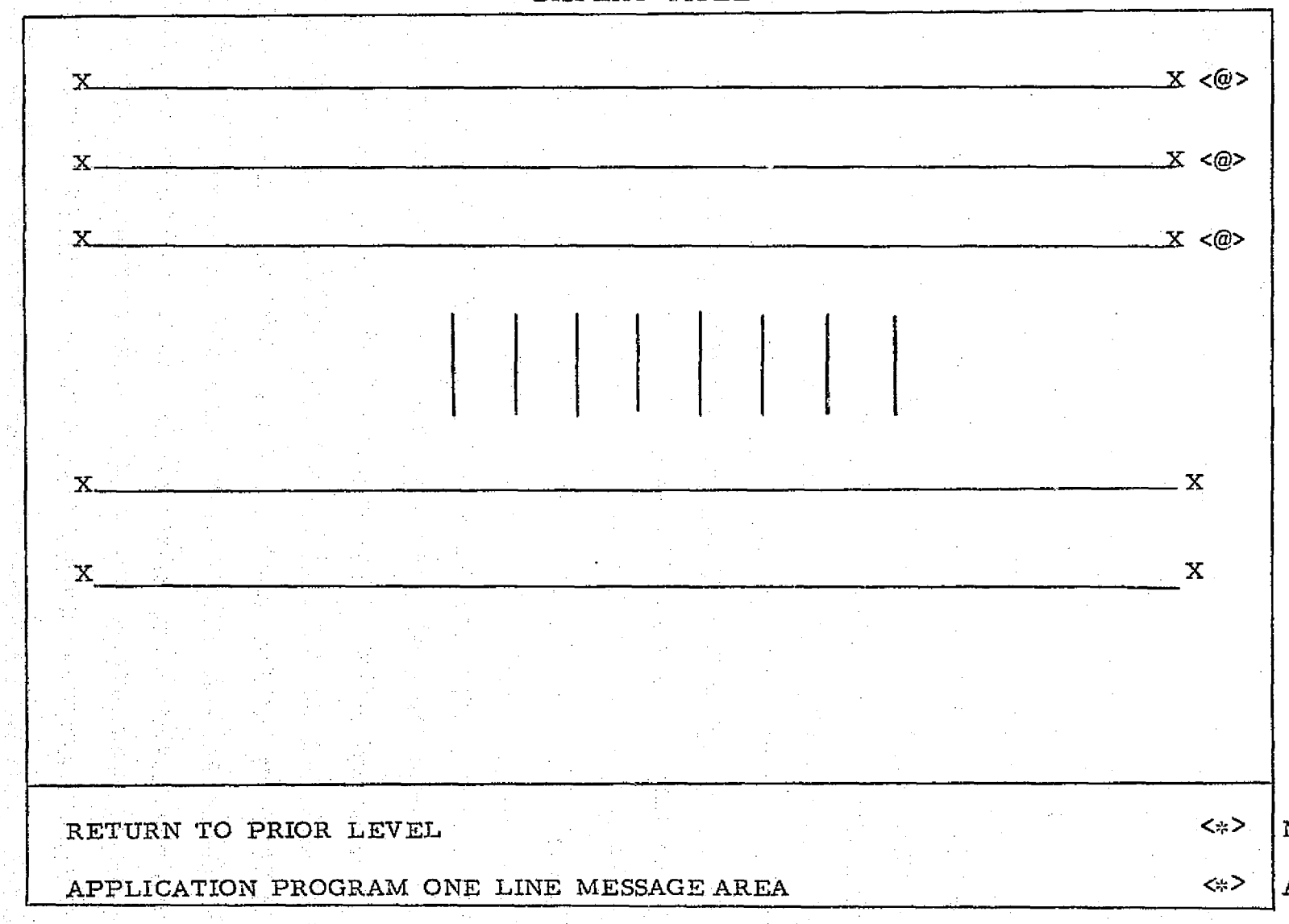


Figure 2-1

Message Area

The display message area consists of two lines at the bottom of the display. The first line is a "return to prior level" option which allows the operator to sequence back to the display used to arrive at the current display. The second line is a one line message area. This area is used by the Display Controller and the AIDS Program as an error or message indicator. Any misuse of the options provided on the display that result in an abnormal condition will be identified through a one line error message.

2.1.2 Design Display

The design display as illustrated in Figure 2-2 consists of two displays: the command menu display and the drawing display. The command menu display, Display 0110, in actual use will be superimposed on the graphic tablet leaving the total display screen area available for designing.

Command Menu

The command menu serves the user in much the same way as the text area of the basic control display. This area contains all of the design options available to the designer. In order to conserve space, text information describing each option has been omitted and control commands have been abbreviated. The commands are explained in detail in Section 4 of this document.

Drawing Display

The designer's work area on the display includes the entire display screen which is 8.25 x 6.4 inches. This area is used by the designer for placing and manipulating components under the control of the graphics tablet pen. As the designer uses the pen to identify positions of components, the AIDS Program will in turn display the components as specified. The designer sees immediately the layout of his design and can proceed to modify the design, shift the position of the design or add additional components.

Two message areas on the screen are supported by the AIDS Program on the drawing display to provide the user with information concerning the current status of the design control parameters and to provide prompting and error messages throughout the design process. These areas are within the designer's work area and do not subtract from his total designing area. The message area at the top of the screen reflects the current status of the design parameters. The message area

DRAWING DISPLAY FORMAT

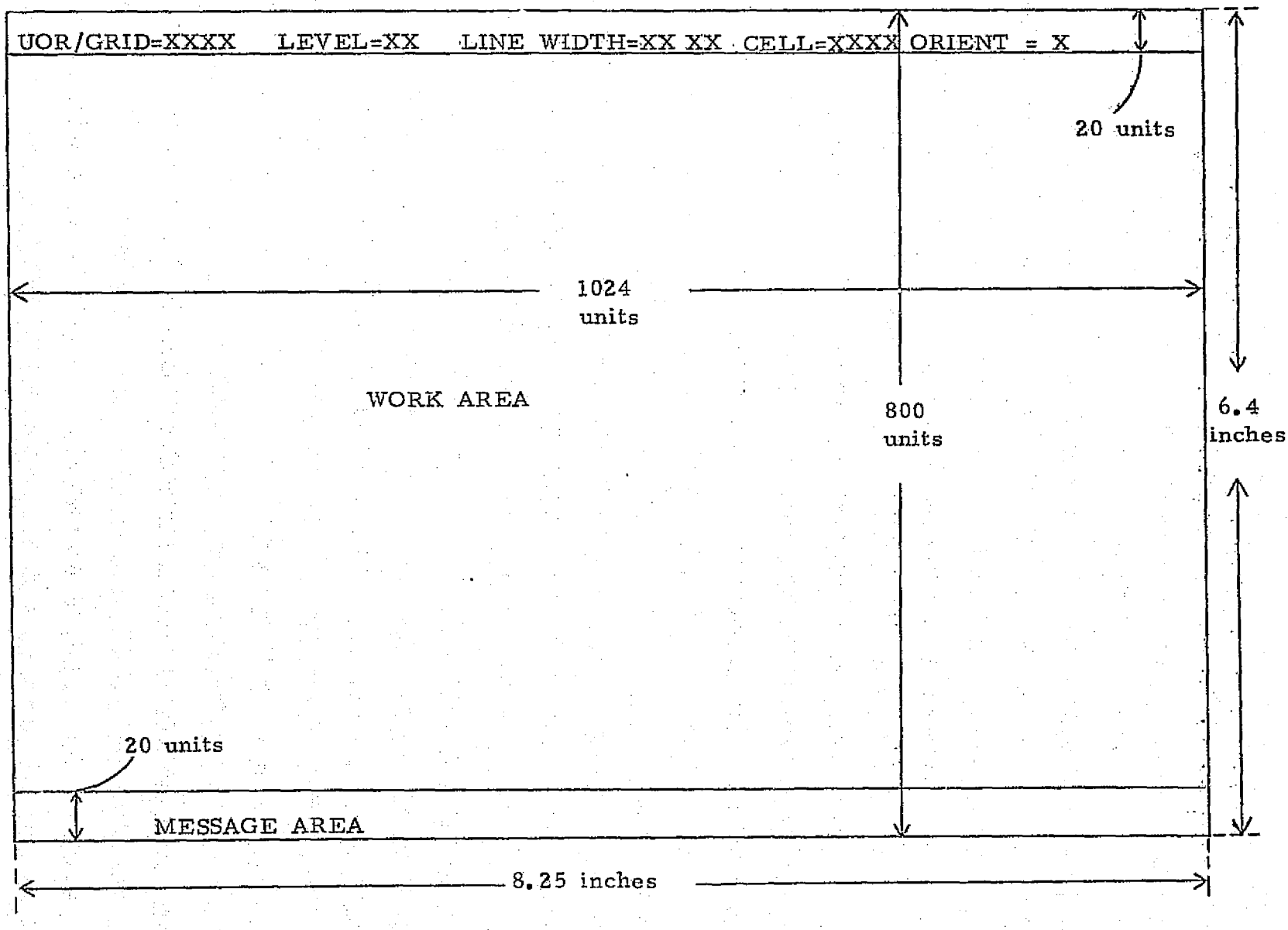


Figure 2-2

at the bottom of the screen is used for prompting messages and error indications.

2.2 Basic Display Package

This section contains the set of displays designed to support the current capabilities of the AIDS Program. Figure 2-3 is a "display tree" which shows the interrelationship of the displays and the contents of each display.

Pages 10 through 24b depict the entire set of AIDS design displays. The area within the display outline is what will appear within the window of the display screen. The column to the right, labeled "NEXT DISP", contains the name of the display next accessed by the Display Controller for each selected option. The name of each display is found at the top of the page. Four character sizes are supported by the display software and are represented on the display print out as follows:

1. Character size 1 - 1 column x 1 row
2. Character size 2 - 2 columns x 2 rows
3. Character size 3 - 3 columns x 3 rows
4. Character size 4 - 4 columns x 4 rows

The displays in this section will be clarified and discussed in a later section of this document.

AIDS DISPLAY TREE

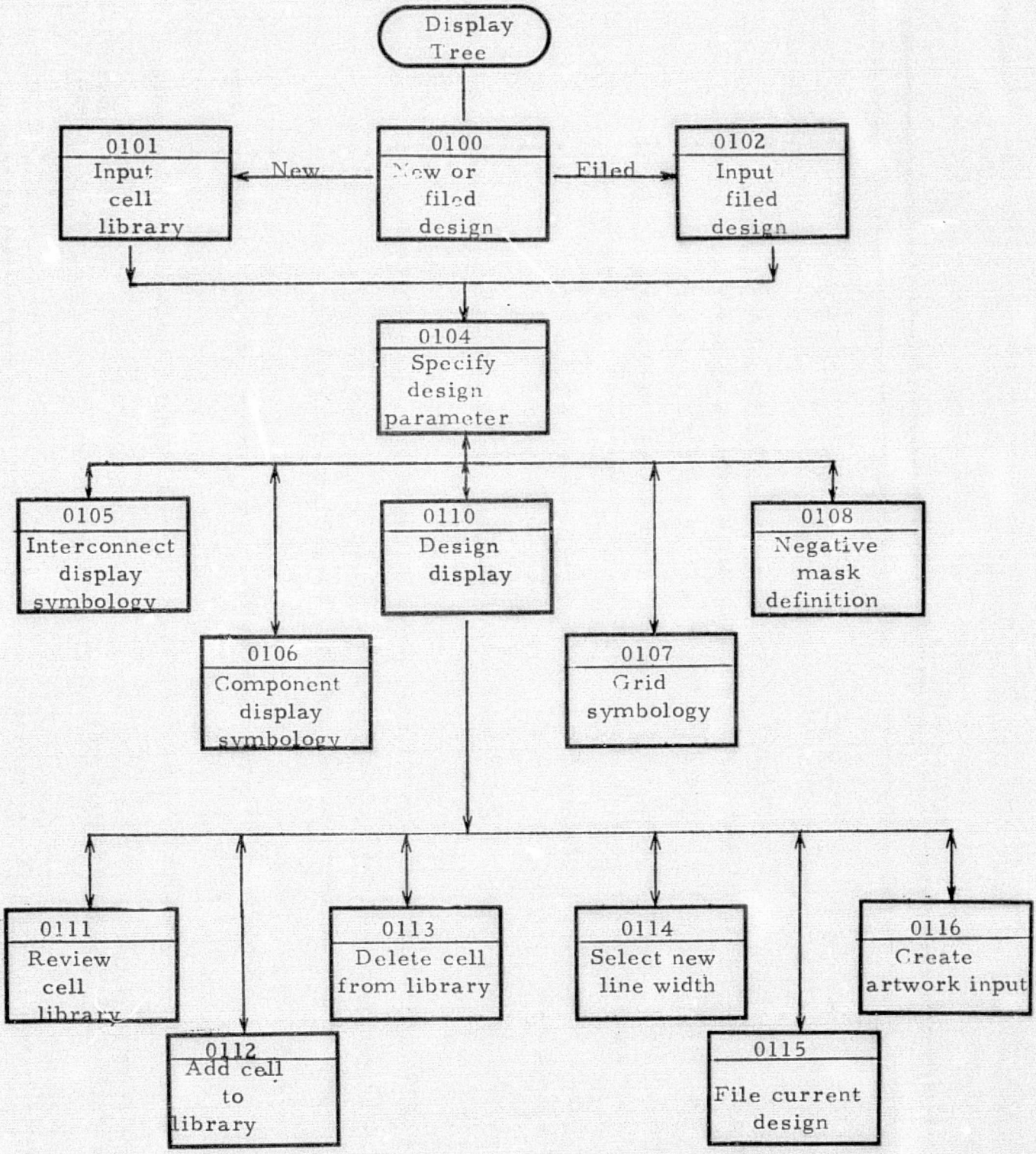


Figure 2-3

ORIGINAL PAGE IS OF POOR QUALITY

DISPLAY 0100

```
*****************************************************************************************-------NEXT DISPL
*                                                                                       *
*                                                                                       *
*                                                                                       *
*                                                                                       *
*          A R T W O R K   I N T E R A C T I V E   D E S I G N   S Y S T E M            *
*                                                                                       *
*                                                                                       *
*   T H E   A I D S   P R O G R A M   P R O V I D E S   T O T A L   D E S I G N         *
*                                                                                       *
*   C O N T R O L   V I A   T H E   G R A P H I C S   T E R M I N A L .   L A Y O U T S *
*                                                                                       *
*   C A N   B E   C O N S T R U C T E D   A N D   M A N I P U L A T E D   I N T E R -   *
*                                                                                       *
*   A C T I V E L Y .   I N T E R M E D I A T E   A N D   F I N A L   D E S I G N S     *
*                                                                                       *
*   M A Y   B E   S T O R E D   A N D   R E T R I E V E D   F O R   V I E W I N G ,     *
*                                                                                       *
*   M O D I F I C A T I O N   A N D   A D D I T I O N A L   D E S I G N I N G .   A     *
*                                                                                       *
*   S T A N D A R D   L I B R A R Y   M A Y   B E   G E N E R A T E D   A N D           *
*                                                                                       *
*   M A I N T A I N E D   T O   E L I M I N A T E   R E D U N D A N T   D E S I G N .   *
*                                                                                       *
*                                                                                       *
*                                                                                       *
*                                                                                       *
*    A I D S   M A Y   B E   I N I T I A L I Z E D   T O   B E G I N   A   N E W        *
*                                                                                       *
*   D E S I G N   O R   R E C A L L   A   P R E V I O U S   D E S I G N   F O R         *
*                                                                                       *
*   A D D I T I O N A L   W O R K .   S E L E C T   T H E   M O D E   B E L O W :       *
*                                                                                       *
*                                                                                       *
*                                                                                       *
*                 I N I T I A T E   N E W   D E S I G N   - - - - - -   < 0 >           *   0101
*                                                                                       *
*                                                                                       *
*                                                                                       *
*                 R E C A L L   P R E V I O U S   D E S I G N   - - -   < 0 >           *   0102
*                                                                                       *
*                                                                                       *
*  RETURN TO PRIOR LEVEL                                                          <*>   *  PREV
*  APPLICATION PROGRAM ONE LINE MESSAGE AREA                                      <*>   *  PREV
*                                                                                       *
*                                                                                       *
*                                                                                       *
*****************************************************************************************
```

DISPLAY 0101

NEXT DISP

INITIATE NEW DESIGN

TO BEGIN THE DESIGN OF A NEW CIRCUIT, THE USER MAY ENTER THE NAME OF THE DISK FILE THAT CONTAINS THE GRAPHICAL DESCRIPTION OF ANY STANDARD CELLS TO BE USED DURING THE DESIGN. THE RAD AREA THAT CONTAINS THE FILE MUST ALSO BE ENTERED.

NO LIBRARY REQUIRED - - - - - < 0 > 0104

LIBRARY FILE NAME | | | | | | | |

RAD AREA | | 0104

RETURN TO PRIOR LEVEL <+> PREV
APPLICATION PROGRAM ONE LINE MESSAGE AREA <*> PREV

ORIGINAL PAGE IS
OF POOR QUALITY

DISPLAY 0102

NEXT DISPL

RECALL A PREVIOUS DESIGN

WHEN THE ORIGINAL DESIGN WAS FILED, THE NAME OF THE CIRCUIT WAS ASSIGNED TO THE FILE FOR IDENTIFICATION.

TO RECALL THE FILED DESIGN, ENTER THE FILE NAME AND RAD AREA BELOW:

CIRCUIT FILE NAME I I I I I I I I

RAD AREA I I 0104

RETURN TO PRIOR LEVEL <*> PREV
APPLICATION PROGRAM ONE LINE MESSAGE AREA <*> PREV

ORIGINAL PAGE IS
OF POOR QUALITY

DISPLAY 0104

NEXT DISP

SPECIFICATION OF DESIGN PARAMETERS

AIDS ALLOWS THE USER TO CONTROL THE VARIOUS DESIGN PARAMETERS. STANDARD VALUES HAVE BEEN DEFINED FOR EACH PARAMETER. THE USER MAY ALTER ANY OF THESE PARAMETERS BEFORE BEGINNING HIS DESIGN OR REDEFINE THEM AT ANY TIME DURING THE DESIGN.

DEFINE INTERCONNECT DISPLAY SYMBOLOGY	< @ >	0105
DEFINE COMPONENT DISPLAY SYMBOLOGY	< @ >	0106
DEFINE GRID SYMBOLOGY	< @ >	0107
DEFINE NEGATIVE MASKS	< @ >	0108
BEGIN DESIGN	< @ >	0110
RETURN TO PRIOR LEVEL	<«>	PREV
APPLICATION PROGRAM ONE LINE MESSAGE AREA	<«>	PREV

DISPLAY 0105

NEXT DISP

INTERCONNECT DISPLAY SYMBOLOGY

A LINE IS REPRESENTED ON ITS MASK LEVEL AS A RECTANGLE WITH THE DIMENSIONS: LINE WIDTH X LINE LENGTH. HOWEVER, VARIOUS METHODS OF REPRESENTING LINES ON THE TOPO-GRAPHICAL LEVEL ARE PROVIDED TO AID IN INTERPRETING THE DESIGN.

THE FOLLOWING LINE TYPES ARE SUPPORTED:

1 = SOLID, 2 = DOT, 3 = DASH, 4 = DASH-DOT

LEVEL	CURRENT SYMBOLOGY	REDEFINE	LEVEL	CURRENT SYMBOLOGY	REDEFINE	
1	#	|	2	#	|	SAME,SAME
3	#	|	4	#	|	SAME,SAME
5	#	|	6	#	|	SAME,SAME
7	#	|	8	#	|	SAME,SAME
9	#	|	10	#	|	SAME,SAME
11	#	|	12	#	|	SAME,SAME
13	#	|	14	#	|	SAME,SAME
15	#	|	16	#	|	SAME,SAME
TOPO	#	|				SAME

DEFINITION COMPLETE ---- < 0 > 0104

RETURN TO PRIOR LEVEL <*> PREV

APPLICATION PROGRAM ONE LINE MESSAGE AREA <*> PREV

DISPLAY 0106

```
*****************************************************************************************-------NEXT DISPI
*                                                                                      *
*                                                                                      *
*                                                                                      *
*                                                                                      *
*                C O M P O N E N T   D I S P L A Y   S Y M B O L O G Y                 *
*                                                                                      *
*   V A R I O U S   M E T H O D S   O F   R E P R E S E N T I N G   C O M P O N E N T S *
*                                                                                      *
*   O N   T H E   D I S P L A Y   A R E   P R O V I D E D   T O   A I D   T H E   D E - *
*                                                                                      *
*   S I G N E R   I N   I N T E R P R E T I N G   T H E   D E S I G N .                 *
*                                                                                      *
*                                                                                      *
*                                                                                      *
*   T H E   A V A I L A B L E   D I S P L A Y   S Y M B O L O G I E S   A R E :         *
*                                                                                      *
*   1   =   O U T L I N E                                                              *
*                                                                                      *
*   2   =   O U T L I N E ,   + 4 5   D E G R E E   C R O S S - H A T C H               *
*                                                                                      *
*   3   =   O U T L I N E ,   - 4 5   D E G R E E   C R O S S - H A T C H               *
*                                                                                      *
*   4   =   O U T L I N E ,   1 8 0   D E G R E E   C R O S S - H A T C H               *
*                                                                                      *
*   5   =   O U T L I N E ,     9 0   D E G R E E   C R O S S - H A T C H               *
*                                                                                      *
*                                                                                      *
*   LEVEL     CURRENT SYMBOLOGY     REDEFINE    LEVEL     CURRENT SYMBOLOGY     REDEFINE *
*                                                                                      *
*     1             #                 |          2             #                 |      *   SAME,SAME
*     3             #                 |          4             #                 |      *   SAME,SAME
*     5             #                 |          6             #                 |      *   SAME,SAME
*     7             #                 |          8             #                 |      *   SAME,SAME
*     9             #                 |         10             #                 |      *   SAME,SAME
*    11             #                 |         12             #                 |      *   SAME,SAME
*    13             #                 |         14             #                 |      *   SAME,SAME
*    15             #                 |         16             #                 |      *   SAME,SAME
*    TOPO           #                 |                                                *   SAME
*                                                                                      *
*                                                                                      *
*                       D E F I N I T I O N   C O M P L E T E   - - - -   < @ >        *   0104
*   RETURN TO PRIOR LEVEL                                                      <*>     *   PREV
*   APPLICATION PROGRAM ONE LINE MESSAGE AREA                                  <*>     *   PREV
*                                                                                      *
*                                                                                      *
*                                                                                      *
*****************************************************************************************
```

ORIGINAL PAGE IS
OF POOR QUALITY

DISPLAY 0107

NEXT DISP

GRID SYMBOLOGY

THE GRID MATRIX MAY BE REPRESENTED AS A DOT-GRID OR AS A LINE-GRID. ON THE DOT-GRID MATRIX EVERY TENTH GRID WILL BE DENOTED BY A '+'.

THE CURRENT GRID SYMBOLOGY IS DENOTED BY AN X. SELECT THE SYMBOLOGY YOU DESIRE.

\# DOT-GRID - - - - - - - - - < > 0104

\# LINE-GRID - - - - - - - - - < > 0104

RETURN TO PRIOR LEVEL <*> PREV

APPLICATION PROGRAM ONE LINE MESSAGE AREA <*> PREV

DISPLAY 0108

```
*****************************************************************************************-------NEXT DISP
*                                                                                       *
*                                                                                       *
*                                                                                       *
*                                                                                       *
*                  N E G A T I V E   M A S K S   D E F I N I T I O N                    *
*                                                                                       *
*   I N   S U P P O R T   O F   P R O C E S S E S   R E Q U I R I N G   T H E   U S E   *
*                                                                                       *
*                                                                                       *
*   O F   R E V E R S E   O R   N E G A T I V E   M A S K S ,   A I D S                 *
*                                                                                       *
*   A L L O W S   T H E   U S E R   T O   D E S I G N   W I T H   R E S P E C T   T O   *
*                                                                                       *
*   A   P O S I T I V E   I M A G E   A N D   H A V E   T H E   S Y S T E M   A U T O -   *
*                                                                                       *
*   M A T I C A L L Y   G E N E R A T E   T H E   N E G A T I V E   E Q U I V A L E N T   *
*                                                                                       *
*   .   D U R I N G   A R T W O R K   G E N E R A T I O N   T H E   M A S K               *
*                                                                                       *
*   S P E C I F I E D   B Y   T H E   U S E R   A S   T H E   P O S I T I V E   M A S K   *
*                                                                                       *
*   W I L L   B E   S U B T R A C T E D   F R O M   I T S E L F   A N D   T H E   R E -   *
*                                                                                       *
*   S U L T S   A D D E D   T O   T H E   C O R R E S P O N D I N G   N E G A T I V E   *
*                                                                                       *
*   M A S K   O F   T H E   P O S I T I V E - N E G A T I V E   P A I R .                 *
*                                                                                       *
*                                                                                       *
*                                                                                       *
*   K E Y   I N   T H E   M A S K   P A I R   B E L O W :                                 *
*                                                                                       *
*                                                                                       *
*                                                                                       *
*         N E G A T I V E   M A S K   N U M B E R        | |                            *
*                                                                                       *
*                                                                                       *
*                                                                                       *
*         P O S I T I V E   M A S K   N U M B E R        | |                            *   0104
*                                                                                       *
*                                                                                       *
*                                                                                       *
*  RETURN TO PRIOR LEVEL                                                          <*>   *  PREV
*  APPLICATION PROGRAM ONE LINE MESSAGE AREA                                      <*>   *  PREV
*                                                                                       *
*                                                                                       *
*                                                                                       *
*****************************************************************************************
```

ORIGINAL PAGE IS
OF POOR QUALITY

DISPLAY 0110

DISPLAY	MOVE/MODIFY		PLACE	DELETE	SELECT	NUMBER	
LEVEL ON-OFF	BLOCK	EDGE	BLOCK	BLOCK	LEVEL	50	100
	SHAPE	EDGE	SHAPE	SHAPE	CELL	TDPO	
GRID ON-OFF	LINE	NODE	LINE	LINE	LINE WIDTH	1	2
	CELL	EDGE	CELL	CELL			
UPDATE COMMAND	CHAR		CHAR	CHAR	SEP-F		
	UNIA	EDGE	UNIT	UNIA	SEP-O	3	4
DELAY UPDATE	FILE		AREA	SWAP	DSP-B		
	COPY UNIA			POINT	SWITCH	5	6
SCREEN 1 - 2	COMMAND RESET				MERGE		
	ROTATE		MISCELLANEOUS			7	8
MINGRID	R_2	R_2	DRP CELL | DRP AC		WINDOW		
MAXGRID			ANY ANG LINE		FIT	9	10
REVIEW LIBRARY	R_4	R_3	L OF | SAVE L | RES L		AREA		
			FILE CIRCUIT		CENTER	11	12
CHAR ON-OFF	R_5	R_6	MOS | CONT | SKP | STP		INCREASE		
			EXPAND CELL		DECREASE	13	14
LINE-SY	R_8	R_7	ADD CELL TO LIB		SAVE		
COMP-SY			DEL CELL | DEL AC		RECALL	15	16

DISPLAY 0111

NEXT DISP

REVIEW CELL LIBRARY

NAME	DESCRIPTION	NAME	DESCRIPTION
####	##########	####	##########
####	##########	####	##########
####	##########	####	##########
####	##########	####	##########
####	##########	####	##########
####	##########	####	##########

TURN PAGE ---- <0> 0111

SELECT NEW CURRENT CELL NAME |||| SAME

SELECTION COMPLETE ---- <0> 0110

RETURN TO PRIOR LEVEL <*> PREV

APPLICATION PROGRAM ONE LINE MESSAGE AREA <*> PREV

ORIGINAL PAGE IS
OF POOR QUALITY

DISPLAY 0112

NEXT DISP

ADD CELL TO LIBRARY

THE CELL YOU HAVE DEFINED MAY NOW BE
CATALOGUED IN THE CELL LIBRARY AND
MAINTAINED FOR SUBSEQUENT RECALL.

TO FURTHER DEFINE THIS CELL ENTER
THE NUMBER OF INTERCONNECTS II,
THE CELL NAME IIII AND THE CELL
DESCRIPTION IIIIIIIIIII. SAME

THE USER MAY WISH TO CREATE A NEW
CELL LIBRARY MASTER THAT INCLUDES THE
NEW CELL. TO DO SO ENTER THE FILE NAME
FOR THE LIBRARY IIIIIIIII.AND THE RAD
AREA II. SAME

DEFINITION COMPLETE ---- <0> 0110

RETURN TO PRIOR LEVEL <*> PREV
APPLICATION PROGRAM ONE LINE MESSAGE AREA <*> PREV

ORIGINAL PAGE IS
OF POOR QUALITY

DISPLAY 0113

NEXT DISP

DELETE CELL FROM LIBRARY

THE USER MAY DESIRE TO DELETE A CELL FROM THE LIBRARY. TO DO SO ENTER THE CELL NAME IIII. SAME

THE USER MAY ALSO WISH TO CREATE A NEW CELL LIBRARY MASTER THAT DOES NOT INCLUDE THE DELETED CELL. TO DO SO ENTER THE FILE NAME IIIIIIII AND THE RAD AREA II. SAME

DEFINITION COMPLETE ---- <0> 0110

RETURN TO PRIOR LEVEL <#> PREV
APPLICATION PROGRAM ONE LINE MESSAGE AREA <*> PREV

DISPLAY 0114

NEXT DISP

SELECT NEW LINE WIDTH

LINE WIDTH IS DEFINED IN TERMS OF
UNITS OF RESOLUTION (UOR).

KEY-IN LINE WIDTH ||.|| UOR(S) SAME

SELECTION COMPLETE ---- <0> 0110

RETURN TO PRIOR LEVEL <*> PREV
APPLICATION PROGRAM ONE LINE MESSAGE AREA <*> PREV

ORIGINAL PAGE IS
OF POOR QUALITY

DISPLAY 0115

NEXT DISP

FILE CURRENT DESIGN

THE FILE CAPABILITY ALLOWS THE DESIGNER TO SAVE HIS FINAL OR ANY INTERMEDIATE DESIGN. THE FILED DESIGN MAY THEN BE RECALLED FOR VIEWING, MODIFICATION, OR ARTWORK CREATION.

THE DESIGNER MAY NOW ENTER THE DISK FILE NAME ON WHICH THE DESIGN WILL BE FILED AND THE RAD AREA FOR THIS FILE

FILE NAME IIIIIIII

RAD AREA II

SAME

OUTPUT COMPLETE ------- <@>

0100

RETURN TO PRIOR LEVEL <*> PREV

APPLICATION PROGRAM ONE LINE MESSAGE AREA <s> PREV

DISPLAY 0116

NEXT DISP

GENERATE INPUT TO ARTWORK

TO CREATE THE ARTWORK MASKS REQUIRED TO PRODUCE THE USER'S CURRENT DESIGN, THE DESIGN MUST BE CONVERTED TO AN INPUT FORMAT ACCEPTABLE TO THE ARTWORK PROGRAM.

THE USER MUST ENTER A SCALE FACTOR TO CONVERT THE DESIGN FROM UNITS OF RESOLUTION (UOR) TO INCHES AND THE FILE NAME ON WHICH THE ARTWORK INPUT IS TO BE RECORDED.

SCALE FACTOR: UOR = I I I I I I I I I INCHES

FILE NAME = I I I I I I I I I PAD AREA I I. SAME

OUTPUT COMPLETE - - - - - - - < 0 > 0100

RETURN TO PRIOR LEVEL <*> PREV

APPLICATION PROGRAM ONE LINE MESSAGE AREA <*> PREV

DISPLAY 0118

DELETE ACTIVE CELL

THE USER MAY WISH TO DELETE ALL CELLS OF A PARTICULAR TYPE FROM THE CURRENT DESIGN.

TO DO THIS, TYPE THE CELL NAME FOR WHICH ALL ACTIVE PLACEMENTS ARE TO BE DELETED.

CELL NAME = //// SAME

DEFINITION COMPLETE _ _ _ _ <@> 0110

RETURN TO PRIOR LEVEL <@> PREV

APPLICATION PROGRAM ONE-LINE MESSAGE AREA <@> PREV

DISPLAY 0119

DROP ACTIVE CELLS

THE USER MAY WISH TO DROP THE CELL STATUS FOR EVERY CELL OF A PARTICULAR TYPE FROM THE CURRENT DESIGN.

TO DO THIS, TYPE THE CELL NAME

CELL NAME = //// SAME

DEFINITION COMPLETE ____ <@> 0110

RETURN TO PRIOR LEVEL <@> PREV

APPLICATION PROGRAM ONE-LINE MESSAGE AREA <@> PREV

3. DESIGN CONTROL PARAMETERS

AIDS allows the user to control the various design parameters thus providing complete design flexibility. The following paragraphs describe the use of each design control parameter.

3.1 Interconnect Display Symbology

Four types of interconnect level differentiation are provided to support meaningful composite displays on the topographical level. These are:

1. solid line
2. dotted line
3. dashed line
4. dashed-dotted line

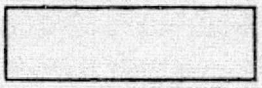
A line is represented on its mask level as a rectangle with the dimensions:

Line Length + Line Width x Line Width.

However, on the topographical level, lines are represented by one of the four line types specified above. Control over how each level line will be represented on the topographical level is provided by Display 0105.

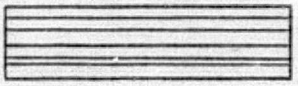
3.2 Component Display Symbology

Five types of component level differentiation are provided to aid the designer in interpreting his design. All polygons within the design will be displayed with one of these types. The available display symbologies are:

1. Outline only 

2. Outline, +45 degree cross-hatch

3. Outline, -45 degree cross-hatch

4. Outline, horizontal cross-hatch 

5. Outline, vertical cross-hatch

The user may select the symbology for each level of mask via Display 0106.

3.3 Grid Display Symbology

The grid matrix may be represented in either of two types: dot-grid or line-grid. The dot-grid will have every tenth grid location denoted by a plus "+". The user may select either symbology via Display 0107.

3.4 Negative Masks Definition

In support of production processes requiring the use of reverse or negative masks, AIDS allows the user to design with respect to a positive image and have the negative equivalent generated by the AIDS software. During Artwork generation the mask specified will be subtracted from itself and the results added to the corresponding negative mask of the positive-negative pair. Display 0108 allows the user to specify the positive-negative mask pairs.

3.5 Display Resolution

Although the working area of the display screen, as illustrated in Figure 2-2, is only 8.25 x 6.4 inches, it may represent a layout as large as 32,768 x 32,768 units or, on the other extreme, provide a display resolution great enough to adequately place and manipulate components with the graphic tablet pen. To support both the viewing and construction of complex layouts, the AIDS Program employs the grid and window control features.

The size of the grid is directly related to an integral number of units of resolution (UOR). The UOR is the basic position increment within the design system and controls the accuracy of the design.

All entities within the design are defined in terms of UOR. The correspondence between a grid and the number of UOR it represents is established by the user via the "WINDOW INCREASE" and "WINDOW DECREASE" control commands and is adjustable at any time during the design process. Thus the user may select as coarse or as fine a resolution as he desires. The size of the grid, number of UOR/GRID, is always displayed within the display status header line at the top of the display window.

In addition, two grid architectures are available to the user as a supplementary design tool. Either architecture may be represented by a dot-grid or a line-grid as depicted in Figure 3-1. The minimum grid is spaced at 2/10 of an inch intervals and the maximum grid at 1/10 of an inch intervals.

3.6 Interconnect Control

The AIDS system supports any angle lines and variable line widths. The permissable angles are pre-deiined to the system according to customer specification. When lines are defined on the drawing area, they are constrained to the nearest permissable angle.

The line width is a parameter that is established by the user and adjustable at any time during the design process. Line width is defined in terms of units of resolution (UOR) but is not restricted to an integral number of UOR's. This provides for the definition of lines of virtually any width. The current width parameter is always displayed within the design status header line at the top of the display picture.

GRID STRUCTURES

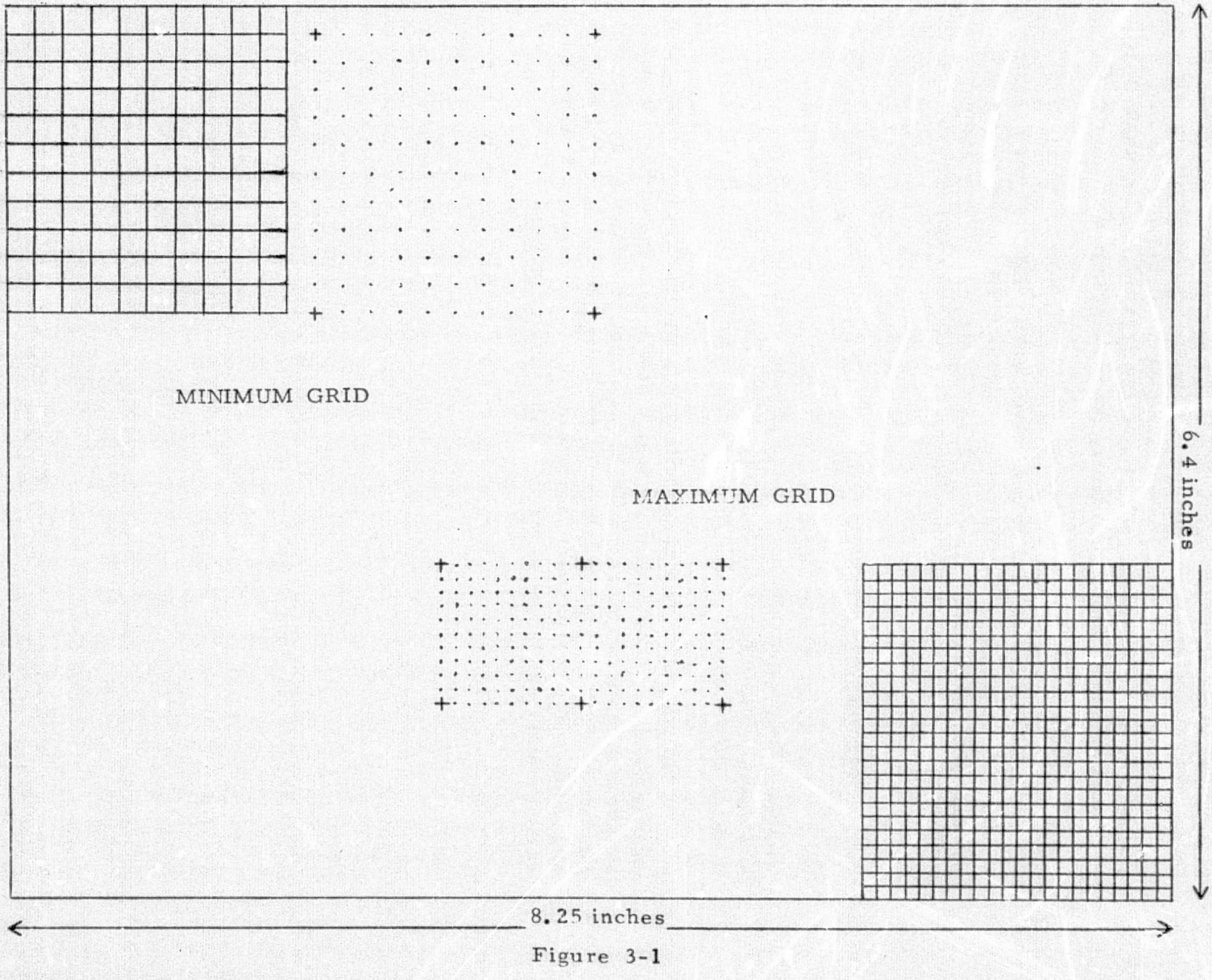


Figure 3-1

4. AIDS DESIGN COMMANDS

The design command menu of Display 0110 provides the designer with the necessary tools for drafting a multi-level design. Each command on the menu is described in detail in this section with respect to how it is used and its purpose.

4.1 Display Commands

The display/blank commands are a means of selectively presenting and removing entities from the display picture on a temporary basis. The user is able to reduce the complexity of his picture by making specific levels of his composite blank while working on other levels.

4.1.1 Display/Blank Current Level

This command permits the displaying/blanking of components by level association. All levels or selected levels may be displayed or blanked. The status of each level, displayed/blanked, is maintained by the system and governs the construction of the display picture.

The level last selected via the "SELECT LEVEL" command becomes the current level within the design. When a level is selected, its level state is set to active or displayable and all of the components on this level are displayed along with all the components on the previously selected active levels. The current level number within the design is always displayed within the status header line at the top of the display window.

On selecting the "DISPLAY LEVEL ON/OFF" command, the current level's state is inverted and the level is displayed/blanked depending on its new level state. If the new level state is OFF, the level's components are removed from the display picture. If the level state is ON or active, the components on this level are displayed.

4.1.2 Display/Blank Grid

The grid may be blanked or displayed at the discretion of the user any time during the design process.

4.1.3 Update Command, Delay Update

The "UPDATE COMMAND" option is used in conjunction with the "DELAY UPDATE" option to minimize the number of

times the display picture must be erased and redisplayed. The user may, in effect, stack commands that do not require immediate action and not incur the delay required to refresh the display after each command.

In the "UPDATE COMMAND" mode, the display picture is updated to its current status after each command is executed. In the "DELAY UPDATE" mode, commands are processed but are not reflected on the display picture until the "UPDATE COMMAND" option is selected.

To illustrate the usefulness of this feature, take the case of the designer who desires to delete several components from his layout but is not interested in seeing the intermediate results effected by each individual delete operation. To accomplish this he would perform the following sequence of steps:

1. Select the "DELAY UPDATE" command.

2. Indicate the components to be deleted via the respective "DELETE" commands.

3. Select the "UPDATE COMMAND

4.1.4 Multi-Screen Display Option

The AIDS system supports a multi-screen capability for the viewing and designing of layouts. Different portions of the design can be displayed concurrently facilitating the construction of complex circuits. For example, one screen could depict the entire layout indicating the areas available for further design logic while another screen could be used for designing the additional logic.

Currently the AIDS software supports two output screens in the design mode. This capability can readily be expanded to support any number of screens. The "SCREEN 1-2" command selects the opposite screen from the screen currently active and directs all future display requests to the newly selected screen.

4.1.5 Display Grid Structure

Two grid structures are available to the designer to provide further flexibility in the design of his layout. The minimum grid structure separates the grid positions by approximately 2/10 of an inch; whereas, the maximum grid structure is spaced at intervals of 1/10 of an inch.

Using either grid structure at a high resolution enables the user to accurately position and manipulate components with the graphic tablet pen. At a low resolution the user can view a large portion of his circuit or the entire circuit.

The two grid structures are depicted in Figure 3-1 and controlled via the "MINGRID" and "MAXGRID" options.

4.1.6 Display Cell Library Table of Contents

A library of standard cells may be created interactively via the display terminal and cataloged for future design work. This eliminates redundant designing and minimizes the designing task.

The definition of a cell in the library includes an all name or number and a description of the cell. With the "REVIEW LIBRARY" option, a listing of each cell in the library by name and description is presented to the user in the format defined in Display 0111.

4.1.7 Display/Blank Character Components

A method of labeling cells and different portions of the layout is provided via the character components to augment design interpretation. Any character supported by the display keyboard is acceptable. Normally, characters would be defined for the topographical level, however, they are supported for all levels.

The "CHAR ON-OFF" command allows the user to selectively display/blank all characters on the active levels.

4.1.8 Interconnect Display Symbology

A line is represented on its mask levels as a rectangle with the dimensions line width and line length. However, lines on the topographical level may be represented by solid, dotted, dashed, or dash-dot lines.

With the "LINE-SY" options, a listing of each mask level and its current topographical representation is presented to the user. The topographical representation for each level may then be redefined by the user.

4.1.9 Component Display Symbology

Various methods for representing components are provided to the user. With the "COM-SY" option, a listing of each mask level and its current "COMP-SY" component symbology is presented to the user, who may then redefine this representation.

4.2 Move/Modify Commands

The move and modify commands provide an easy-to-use method of editing a layout. Components may be moved individually or collectively; individual component sizes may be modified, and component cells may be rotated about their origins in one of eight orientations.

A move can be accomplished in one of two ways. The first method is a low resolution move and enables the user to move an entity to any location on the screen with the accuracy provided by the graphic tablet pen. The second type of move is a restrictive or high resolution move in that the direction of the move is either horizontal or vertical and the magnitude of the move is a specified number of units of resolution.

The sequence of operations required by each type of move is defined below.

Type 1 Move

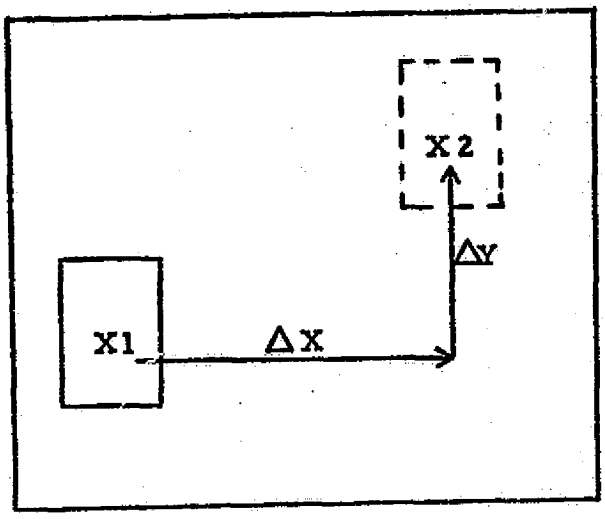
- Select the appropriate move command.
- Identify the component to move with the tablet pen.
- Define the direction and magnitude of the move with the tablet pen relative to the location of the previous tablet pen input.

Type 2 Move

- Select the appropriate move command.
- Select the number of units of resolution to move via the number matrix on the command menu.
- Identify the component to move with the tablet pen.
- Indicate the direction of the move with the tablet pen as it relates to the location of the previous tablet pen input.

Subsequent tablet pen inputs without an intervening command selection are interpreted and processed as the tablet pen associated with the final step of the respective move method. The two types of moves are illustrated in Figure 4-1.

TYPE 1 MOVE

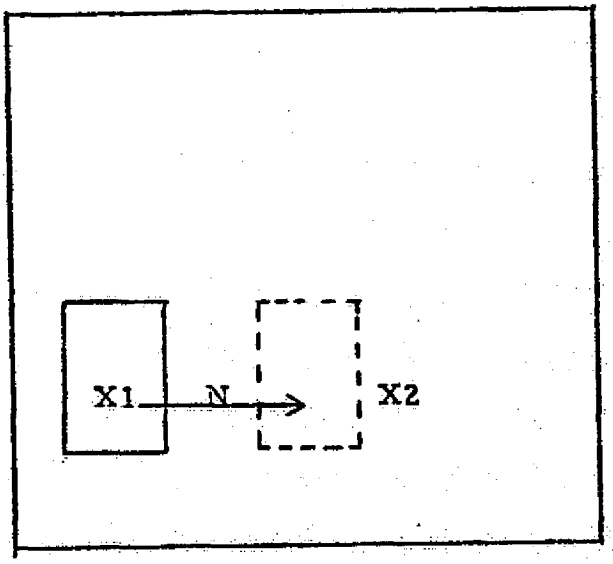


X1 = tablet pen identifying component to move

X2 = tablet pen identifying direction and magnitude to move

ΔX,ΔY = amount component was moved based on X1 and X2

TYPE 2 MOVE



N = number of UORS selected to move

X1 = tablet pen identifying component to move

X2 = tablet pen indicating direction to move

Figure 4-1

4.2.1 Move Block, Shape, Line, Cell, Character

These commands allow the user to move selected components as previously described. The component definition will be updated to reflect the new position and the component will be relocated within the display window.

4.2.2 Move Unit Area

The Unit Area concept has been incorporated into the design system as a means of identifying a group of components as an entity. A Unit Area is defined via the "PLACE UNIT AREA" option as an n-sided polygon with no level association. This enables the designer to identify a group of components with one operation rather than requiring him to individually select each component within a group resulting in many operations.

When the "MOVE UNIT AREA" command is selected, all of the components entirely within the unit area as well as the unit area symbolic representation are moved.

4.2.3 Copy Unit Area

A duplicated copy of the unit area and its components is defined in response to this command. The position of the duplicate is determined by the same methods as the move. The original unit area is undisturbed.

4.2.4 Modify Block Edge

The sides or edge of a block may be modified in a horizontal or vertical direction. The high resolution or type 2 move operation should be utilized when modifying a block's sides; however, if the type 1 operation is chosen, the AIDS software will attempt to identify the user's intent and perform the move.

The edge of the block to modify is identified as the edge nearest the tablet pen that identifies the block. The new coordinates of the block are calculated based on the direction and magnitude of the move and the component definition is updated to reflect the new block size.

4.2.5 Modify Shape Edge

The edge of a shape may be modified if caution is observed when modifying non-orthogonal sides of a shape. The modification of a non-orthogonal side may result in the elimination or addition of a side and should be avoided. As with a block, only horizontal and vertical modifications are supported and the type 2 operation should be used. The edge of the shape to be modified is identified as the edge nearest the tablet pen that identifies the shape.

4.2.6 Modify Line Node

The capability to extend or shorten an existing line is provided with this command. The first tablet pen identifies the line to be modified. The node or end point of the line to be modified is determined by the end point nearest the tablet pen location. This end point is moved the direction and amount specified and then readjusted with respect to the other end point to the nearest allowable angle of a line.

4.2.7 Modify Cell Edge

This command enables the designer to define a long or wide version of a cell without defining a new cell in the library. When the cell was created and placed in the library, an origin was defined to be used in adjusting the basic cell for long and wide specifications. This origin, as depicted in Figure 4-2, becomes the stretch point of the cell.

Cell modification is restricted to the horizontal or vertical direction and the type 2 or high resolution move method should be employed. The cell's definition is updated to reflect the modification factor and each component within the cell is adjusted accordingly when the cell is displayed.

4.2.8 Modify Unit Area Edge

The edge of the unit area may be modified in the same manner as a shape.

4.2.9 Rotate

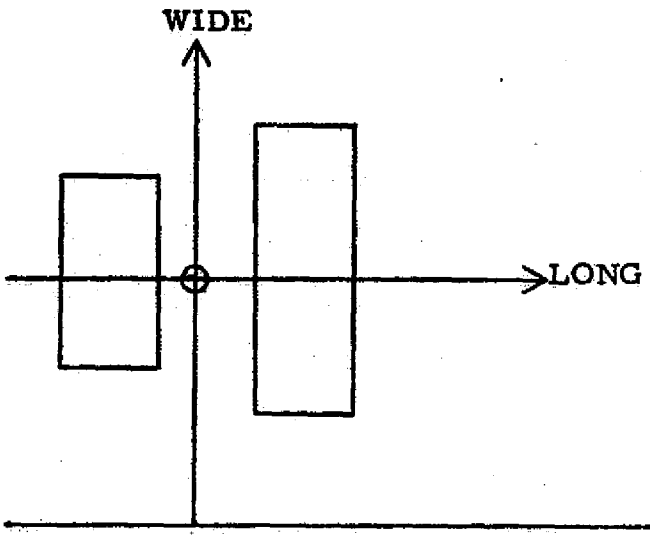
When a cell is placed via the "PLACE CELL" command, the cell is oriented about its origin to the currently active orientation in the system and displayed at this orientation. The current orientation in the system is controlled by the set of commands defined in Section 4.2.10. The cell may then be re-oriented with the "ROTATE" command.

The steps to re-orienting a cell are as follows:

- Select the desired orientation via the command set of Section 4.2.10. This becomes the current orientation in the system.
- Select the "ROTATE" command on the command menu.
- Select the cell(s) to re-orient with the tablet pen.

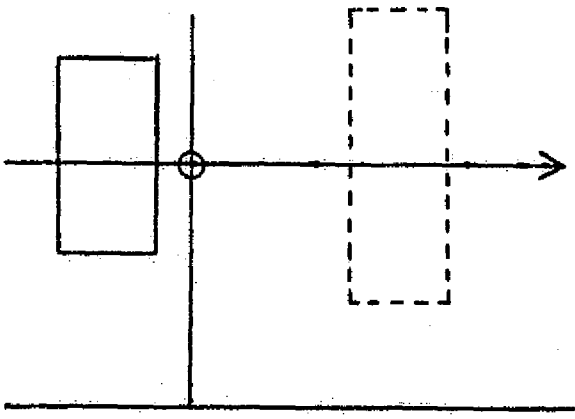
LONG AND WIDE SPECIFICATION OF CELL

BASIC CELL



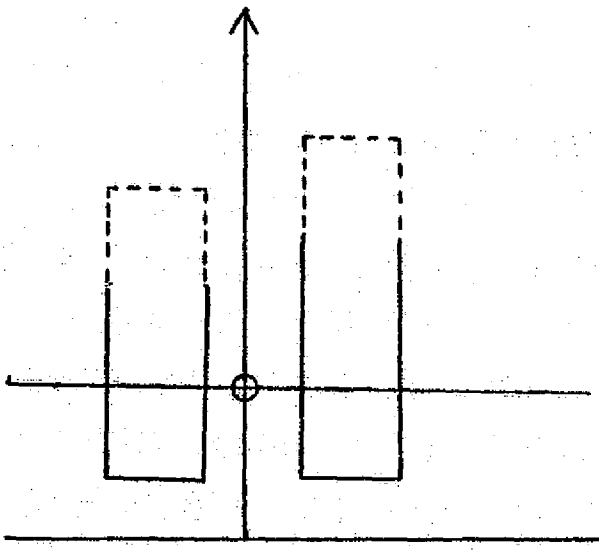
O = cell's origin

LONG SPECIFICATION



Everything to the right of the origin, 'O', is SHIFTED; everything to the left of 'O' remains stationary.

WIDE SPECIFICATION



Everything above the orgin, 'O', is shifted; everything below the origin, 'O', remains stationary.

Figure 4-2

There are eight orientations available to the user for placing cells as depicted in Figure 4-3. A cell is always defined within the library at the standard orientation, orientation 1 or "R," but may be placed at any one of the eight orientations. The orientation of the cell is a parameter within the cell's definition in the active cell table. When the cell is reoriented, the new orientation of the cell is computed with respect to the cell's current orientation and orientation requested. For example, if the current orientation of the cell is orientation 2 (⌑) and the requested orientation is orientation 4 (⌑), the new orientation of the cell becomes orientation 1 (R).

4.2.10 Select Current Orientation

Eight orientations are supported by the AID and illustrated in Figure 4-3. The character 'R' is used on the command menu to depict the various orientations. The user selects the current orientation in the system by selecting one of the figures. The number corresponding to the figure is always displayed to the user within the display status header at the top of the display window.

4.2.11 Move File

This command allows the user to bias all untagged points (Section 4.10) within a design file by a delta X and Y value. The user may execute this command by either the Type 1 or Type 2 move method. However, the first tablet pen position need not fall within the range of a particular design component, but serves as the starting position from which the delta X and Y are calculated.

4.3 Placement Commands

These commands allow the user to define and place various components on the display at the currently active level.

4.3.1 Place Block

This command specifies that the next two tablet inputs are to be interpreted as the diagonal of a rectangle to be placed on the currently active mask level. A component block entry will be added to the independent component table in the system reflecting the block's location, size, and level. The block is then displayed with the display symbology associated with the level.

4.3.2 Place Shape

This command specifies that the following tablet inputs are to be interpreted as the vertices of a polygon to be constructed on the current mask level. The first and last points must be the same to close the shape. As each input is received it is adjusted to the previous point at one of the allowable line angles.

8 POSSIBLE CELL ORIENTATIONS

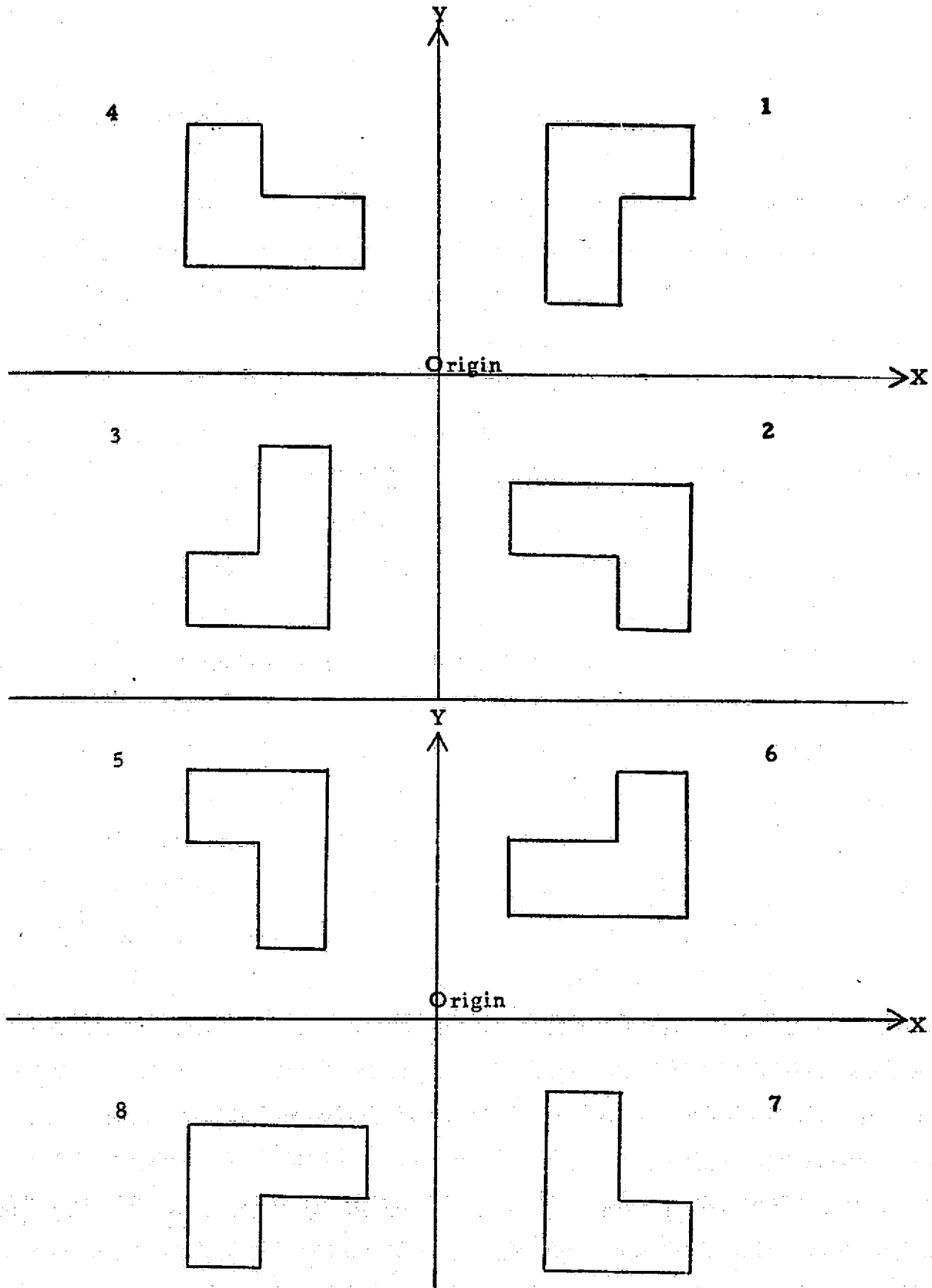


Figure 4-3

The component shape entry is added to the independent component table and displayed with the display symbology associated with the current level.

4.3.3 Place Line

When this command is selected, the subsequent tablet inputs are interpreted as the beginning/bending/ending points of a line on the current selected level. As each input is received it is "fixed" in relationship to the previous input at the nearest allowable angle for a line. The current input and previous input define a component line entry whose width is determined by the currently active level width parameter in effect. This entry is added to the independent component table and displayed on its mask level as a rectangle with the dimensions:

Line Length + Line Width x Line Width.

On the topographical level, the line is displayed as a unit line according to the interconnect display symbology associated with the line's level.

4.3.4 Place Character

This command is used to define characters to be placed or the layout for purposes of labeling cells and portions of the layout. When this command is selected, the next tablet input is interpreted as the location to place the character. The user must then enter from the keyboard the desired character. A component character entry will be added to the independent component table and the character displayed. Normally, character components will be defined on the topographical level; however, they are supported for all levels.

4.3.5 Place Cell

The cell to place is the currently active cell in the system chosen via the "SELECT CELL" command. Tablet inputs received after the "PLACE CELL" command are processed as the origins of this cell. A cell entry is constructed for each input defining the cell's origin. Each entry is added to the cell table. All levels within the cell that are currently in the active state are displayed at the current orientation in the system.

4.3.6 Place Unit Area

A unit area is defined in the same manner as a shape is defined. If a previous unit area is active, the new unit area will replace it. The unit area has no level association and is displayed whenever active.

4.4 Delete Commands

4.4.1 Delete Block, Shape, Line, Cell, Character

The delete commands are used to delete components permanently from the layout. After selecting the appropriate "DELETE" command, the subsequent tablet inputs are interpreted as selection commands for components to be deleted. Each tablet input selects a component. The corresponding tables and the display picture are updated to reflect the deleted components.

4.4.2 Delete Unit Area

The unit area definition is deleted from the system.

4.4.3 Point Reset

This command enables the user who has just placed a line, block, or shape side to strike the "DELETE POINT" command, and then reissue the point whereupon the figure will be drawn from the previous point to this new point and the point immediately preceding this new point will be nullified.

4.4.4 Swap Command

This command allows the user to replace a line containing a tagged point (Section 4.10) with another line provided the lines share a common vertex which is tagged in the line to be removed. The point in the replacing line is tagged and the swapped line is removed from the design file. To execute this command, the user first selects the "SWAP" command from the menu. Next, he identifies the line which is to replace the tagged line, followed by the line to be replaced. AIDS then verifies the validity of the operations and performs the swap. However, if there is an error, AIDS responds with a message noting the problem and the operation is canceled with both lines remaining active in the design file.

4.5 Select Commands

4.5.1 Select Level

This command specifies that the next number command selected is to be interpreted as the current selected level in the system. This level will be set active and displayed along with any other active levels.

4.5.2 Select Cell

Display 0111 is presented when this command is selected listing the cell library table of contents. The user may then select the cell name from the list that is to be the new current cell within the system. The software adds this cell to the active cell table and saves pointers to this cell to allow immediate access. After selecting the cell, the user may return to the design display and proceed to place the cell at various locations and orientations. The current cell name is always displayed within the display status header of the design display.

4.5.3 Select Line Width

This command enables the user to define a new line width parameter at any time during the designer process. Display 0114 is presented to the user requesting him to enter the new line width. On return to the designing display, the new line width is displayed within the display status header at the top of the window.

4.6 Number Commands

4.6.1 Topo

"TOPO" is an abbreviation for topographical level and is used to select the topographical level as the currently active level of the design.

4.6.2 One Through Sixteen (1-16)

These numbers are used to select a current level number, specify a move magnitude, and to specify the number of units of resolution/grid to increase/decrease the window magnification.

4.6.3 Fifty and One Hundred

These numbers may be used to specify the number of units of resolution/grid to increase/decrease the window magnification.

4.7 Window Commands

The area of the picture being displayed can be modified using the following commands.

4.7.1 Fit Window

This command indicates that the window center and magnification are to be adjusted in such a manner that all drawings on the display are visible

within the display window. The display screen is erased and redisplayed at this new scale.

4.7.2 Area Window

The next two tablet inputs are interpreted as the diagonal of a rectangle defining an area to be displayed within the window. The center and magnification of the window are adjusted so that all the drawings within this area are visible within the window. The screen is erased and the area is displayed.

4.7.3 Center Window

This command enables the user to specify a new center for the display window. The window is adjusted so that its center is located at the position defined by the next tablet input. The window magnification is unchanged and the screen is erased and redisplayed.

4.7.4 Increase/Decrease Window

An extensive scale capability is provided by the "WINDOW INCREASE" and "WINDOW DECREASE" commands. The window scale magnification corresponds to the number of units of resolution (UOR) per grid position. Initially, the scale is set to the minimum, one UOR/GRID. The window magnification may then be varied by selecting one of these commands followed by a number command that represents the number of UOR/GRID to increase/decrease the scale. The number of UOR/GRID is displayed within the header line at the top of the display window.

4.7.5 Save, Recall Window

With these commands, the user may save the current window center and magnification and later restore it.

4.8 Miscellaneous Commands

4.8.1 Drop Cell

This option specifies that the cell identified by the next tablet pen input is to be removed from the table of active cells and its components added to the independent component table. With this feature, a cell may be updated without redefining its entire inner logic.

4.8.2 Drop Active Cell

Display 0119 is presented to the user in response to selection of this option. The display requests the user to input a cell name. Upon receiving

the cell name all cells with this name will be dropped from the table of active cells, and the components of these cells will be added to the independent component table.

4.8.3 Any Angle

With this option the user may place lines on the design at angles other than 0, 45, 90, or 180 degrees, however, the lines will continue to be forced to the closest grid point.

4.8.4 Levels Off/Save Levels/Restore Levels

The levels off option allows the user to turn all mask levels off with one command.

The save and restore levels options may be used to save the status of the levels being displayed and later recall these same displayed levels.

4.8.5 File Circuit

The file capability allows the user to save his final or intermediate design for future design work, modification, or editing. When the file option is selected, Display 0115 is presented requesting the user to enter the file name on which to record the design. All of the information required to redisplay the current design will be written to this file.

With the file capability, the user can spend an indefinite amount of time perfecting his design. At the end of each design session, the current status of the design can be saved and then recalled at the starting point of the next session. Completed keyouts can also be saved permanently in this form so that the user can review his layout before creating the input to the Banning Artwork Program.

4.8.6 Start Mosaic/Continue Mosaic/Stop Mosaic

This option allows the user at any point during the design session to produce a hard copy of the entire design at the current magnification of the display window.

When the start mosaic option is selected, the lower left corner of the design is displayed at the current window magnification. Each time the Continue Mosaic option is selected, the next successive frame of the design is displayed until the entire design has been displayed. If the user wishes

to position the mosaic to the next higher row of frames he may do this by selecting the "SKP" command. This enables the user to view upper portions of the design without having to ramp through every frame in every row of the mosaic. The Stop Mosaic option removes the program from the Mosaic mode.

The mosaic feature also allows the user a systematic method for inspection and modification of an entire design at any level of magnification.

4.8.7 Expand Cell

In constructing a cell to be added to the cell library, the user must define specific attributes of the cell. This option is used to define the origin of the cell about which the cell can be expanded or stretched if a long or wide version of the cell is permissible. A tablet input defines this origin. If the cell is not expandable, the software defines the cell's origin to be the lowest X and Y location within the cell.

4.8.8 Add Cell to Library

The "UNIT AREA" defines the boundaries of the cell being constructed. All components entirely within the unit area are considered to be a part of the cell. Display 0112 is presented to the user in response to this selection and requests that the user define the number of cell interconnects required, the cell name, and a 10-character cell description. Upon receiving this information, the software determines all the components within the unit area, the cell's origin and extends. The cell definition is then added to the cell library. A cell may be comprised of other cells; however, the new cell definition will reflect only the components of the member cells and not the fact that these components were previously a part of another cell. This forces each cell to be a complete and independent entity.

Before returning to the design display, the user may desire to catalog this new cell permanently in the master cell library. To do so, he must enter the file name on which the master cell library resides.

4.8.9 Delete Cell

This option allows the user to delete a cell from the cell library by entering the cell name. The master cell library may also be updated to reflect the deleted cell.

4.8.10 Delete Active Cell

Display 0118 is presented to the user in response to selection of this option. This display requests the user to input a cell name. Upon receiving the cell name all cells with this name will be deleted from the table of active cells, and will no longer appear on the current design.

4.9 Command Interrupt

This capability allows the user to interrupt, place, move, or modify commands for window and scaling changes. The user will select the "COMMAND RESET" option from the menu after these scaling and/or window changes have been completed and then continue with the original place, move, or modify.

4.10 File Separation and Concatenation Commands

This set of commands provides the user with the capability to divide a design file into two distinct files on which he can operate separately. This feature provides for much more rapid display update rates when working with a large data base. This is done by separating the smaller area which needs modification from the total design. The user may then edit the smaller data base after which he merges the two files back together. Once a file has been separated, it cannot be separated again until it has been merged into the original file.

The unit area is used as the mechanism for separating the file. Independent components which fall totally or partially within the unit area are placed in the file which is called the fenced file. Components which fall totally outside the fence are placed in the other file. As stated above, components lying partially within the unit area are placed in the fenced file, however, those vertices not within the unit area are tagged. This means that as long as the design is separated into two files, these points may not be modified or deleted. When the design is merged back into a single file the tagged points are untagged and no longer carry any additional significance. Cell placements are included in the fenced file as long as any portion of the cell's range lies within unit area, however, there is no tagging of cell placements.

4.10.1 SEP-F Command

This command when selected by the user causes the current design file to be separated into two files. Before executing this command, the user must define a unit area to the system. When the files are separated, the screen is updated with a display of the fenced file. The window center and

magnification remain whatever they were when the file separate command was selected. The user can now modify the fenced file which has been made active by the system.

4.10.2 SEP-O Command

This command works like the above with the exception that the file outside the unit area is displayed and made the active file rather than the fenced file.

4.10.3 DSP-B Command

With this command, the user may call for a composite drawing of both files when he is operating in the split file mode. Either the fenced or the non-fenced file may be active when this command is executed. When the command is issued, both files will be displayed on the screen at the current window position and magnification. After the command has completed execution, the file which was active previously to selection of the command remains active.

4.10.4 SWTCH Command

While operating in the split file mode this command allows the user to switch from one file being active for modification to the other. When the user selects this command, the active file is saved in its current condition and the other file is activated and displayed using its last previously active window and magnification parameters.

4.10.5 MERGE Command

When the user is satisfied that all editing needed to be done in the split file mode is complete, he may select this command which causes the two files to be merged back into a single design file. During execution of this command, all tagged points within the fenced file are untagged as the files are merged. If during the split mode of operation a cell library was modified in one of the two files, this file should be made active prior to execution of the "MERGE" command. This is due to the fact that when the files are merged the cell library of the currently active files becomes the cell library file of the merged files.

4.11 Header Updates

This capability allows the user to update header information which is displayed at the top of the drawing display (Section 2.1.2). To update these parameters, the user types the appropriate information into the keyboard

followed by the RETURN key. If a key is incorrectly typed the user may strike the backspace key and then retype the proper key. The format required to update the different header parameters is described below.

4.11.1 Screen Origin Update

This update allows the user to display any portion of the design file by setting the X, Y origin of the drawing display. When this update is entered, the drawing screen will be erased and redrawn with the origin set equal to the user's input values. The required format for this input is as follows:

OG = XXXXX, YYYYY

The format for this command is fixed which means that all five locations must be typed for X and Y and a comma must be typed separating the two values. Also, there are no embedded blanks typed within the message.

4.11.2 Active Cell Update

This capability allows the user to change the current active cell without leaving the drawing display and without updating the screen. When the cell name is input, the system responds with a message noting that the information was accepted or was invalid, however, the screen is not updated to reflect the new active cell until some other command is executed which requires a screen update. The format of this update is as follows:

AC = NNNN

The cell name represented by the letters N may be from 1 to 4 characters long and only the actual number of characters should be typed with no embedded blanks unless the cell name contains blanks.

4.11.3 Line Width Update

This update allows the user to define a new line width parameter to the system without having to leave or update the drawing display. When the data is input, the system responds with a message denoting either acceptance or rejection of the data and, like the active cell update, the new line width is not reflected in the header until a command is executed which requires a screen update. The format of this update is:

LW = II.FF

The II represents the integer portion of the line width and the FF represents the fractional portion. If there is a fractional portion input, the format shown

must be followed with the decimal point separating the two parts and typed as the sixth character; if, however, there is only an integer portion that is all that need be typed.

4.11.4 Number Update

The Number Update option may be used in conjunction with several menu commands which cause different actions. It can be used with window commands to change, increase, or decrease the area of the design file which is being displayed. It can also be used with high resolution move or modify commands described in Section 4.2. To use the Number Updates, the appropriate command is selected from the command menu using the tablet pen. The user then using the keyboard types the needed number into the system. If a high resolution move command is being executed the user then continues the command as described in Section 4.2. If, however, the command being executed is a window increase or decrease the system will immediately update the screen using the amount specified in the number update. The format of this update is:

NO = IIIII.

where the I's represent the integer value which may be from one to five digits long. There should be no embedded blanks and only the desired number of digits need be typed.

5. AIDS SOFTWARE DESCRIPTION

The AIDS software developed to support the various design system processes is described in this section and supplemented by the detail program flow charts included in the Appendix. The software is designed to effectively and efficiently utilize the display console as an interactive man/computer communication device and to allow the operator maximum flexibility and control over the program execution.

5.1 System Organization

Figure 5-1 presents a functional organization block diagram of the total Sigma 2 Display System software and hardware. The display support package, the Display Controller, performs display system housekeeping functions, passes control and data to appropriate application software routines as a result of user activity, and processes application program requests to display tabular data, graphical data, and messages.

The AIDS Application Program is a non-resident program loaded in real time by the Display Controller at the request of the user at the display terminal. To minimize core, it is structured into overlay segments as depicted in Figure 5-2. Communication with the Display Controller is established through the AIDS executive which resides within the next segment of the program.

5.2 AIDS Executive

The AIDS Executive, ROOTEX, provides the communication link to the Display Controller and is a general package that can be adapted to interface with any application program.

When ROOTEX is called by the Display Controller an array is passed in the format defined in Table 5-1. ROOTEX searches the Program Name Table, Table 5-2, for the program requested. The overlay segment the program resides in is loaded, the data is placed in predefined locations in COMMON, and the program is called. When the program returns, ROOTEX returns control to the Display Controller.

On output requests from the AIDS Programs, ROOTEX sets up the linkage to the output processor, DISPIO, within the Display Controller and passes the requests to the Display Controller which processes them and transmits them to the display.

AIDS FUNCTIONAL OPERATION

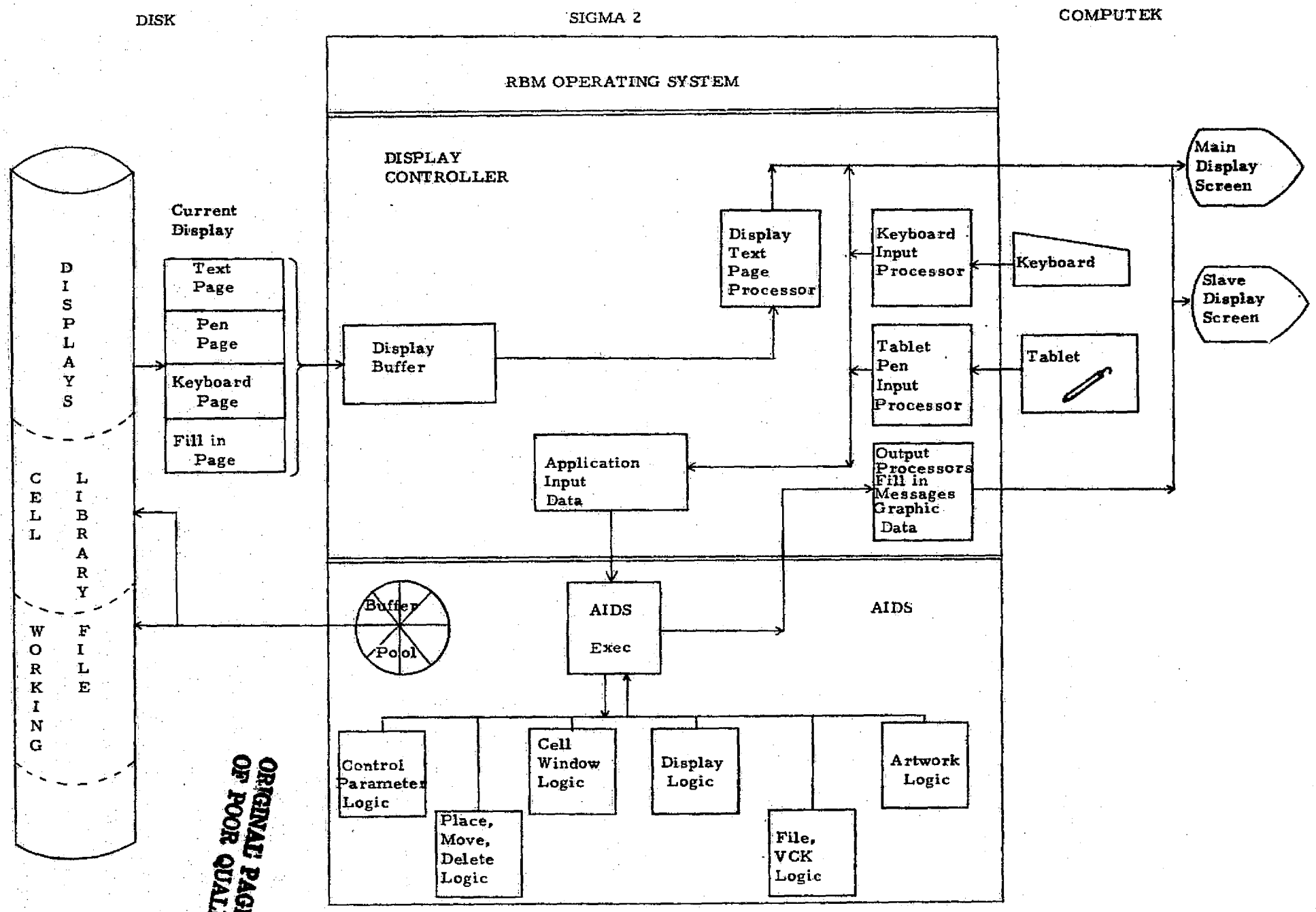


Figure 5-1

ORIGINAL PAGE IS OF POOR QUALITY

AIDS OVERLAY STRUCTURE

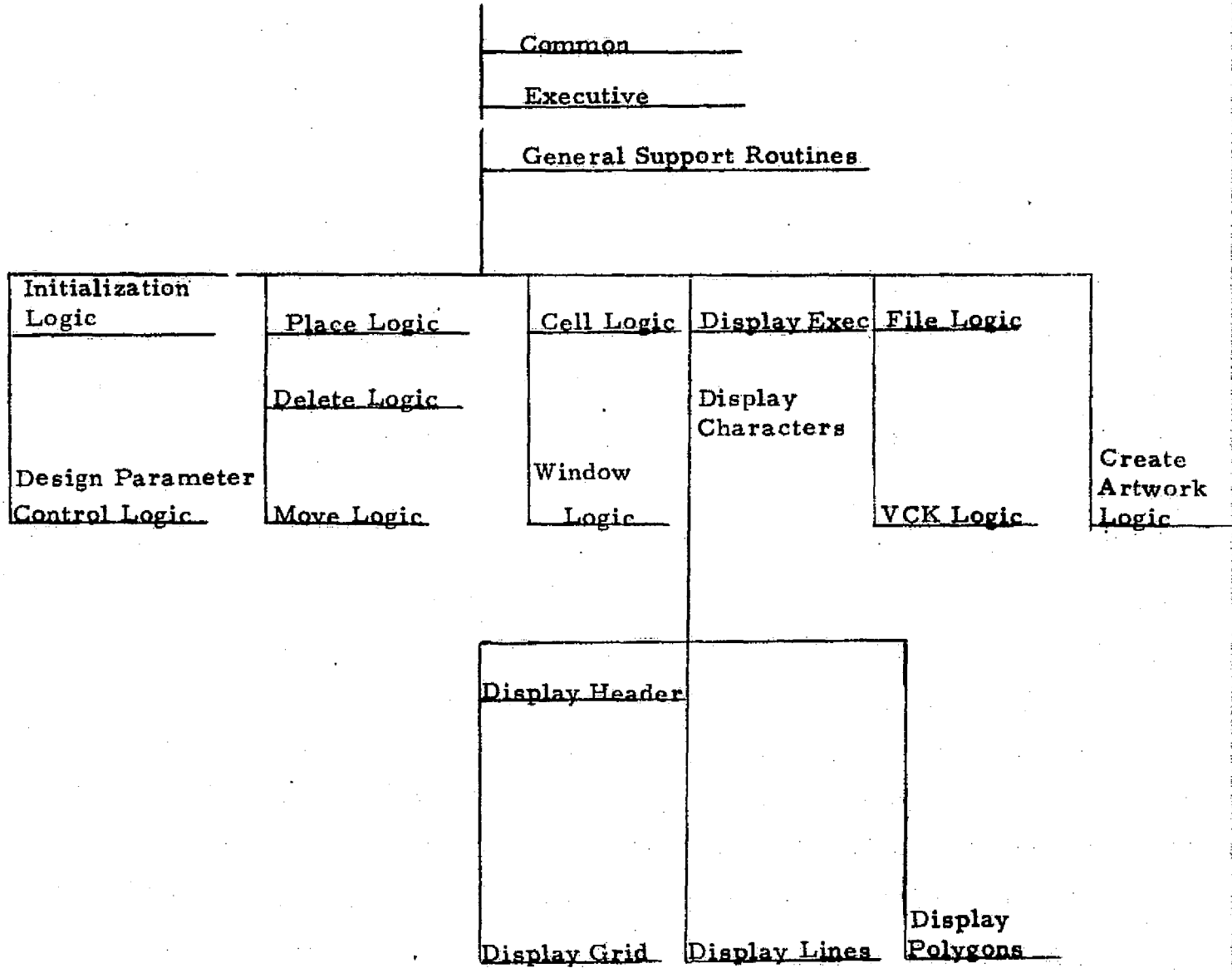


Figure 5-2

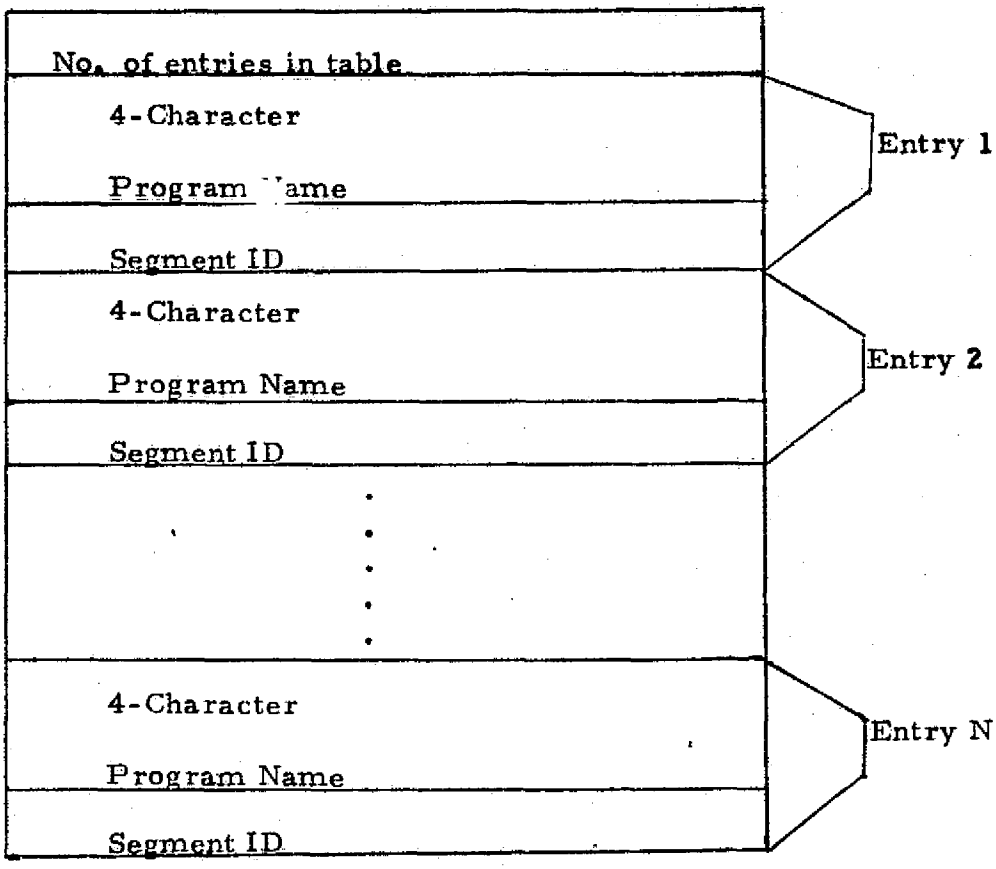
DISPLAY CONTROLLER PARAMETER TABLE

WORD	
1	TERMINAL ID
2	NEXT PROGRAM
3	NAME
4	CURRENT DISPLAY TAG
5	OPTION NO.
6	DATA LENGTH IN CHARACTERS
7	DATA TYPE: 1, 2, 3
8	DATA
.	.
.	.
N	.

TERMINAL ID:	ID of the terminal request was initiated from
NEXT PROGRAM NAME:	4-Character program name that must correspond to program in Program Name Table.
CURRENT DISPLAY TAG:	Display that is currently being viewed
OPTION NUMBER:	Option No. selected by the user at display
DATA LENGTH:	Number of characters in Words 8-N of this array
DATA TYPE:	1 = compose data, (alphanumeric characters) 2 = tablet data, (X, Y coordinate) 3 = keyboard character (alphanumeric character)
DATA:	Data entered from the terminal

Table 5-1

PROGRAM NAME TABLE



The segment ID is the number assigned to the segment when the overlay was constructed. If the program resides in the root segment, the segment ID is zero.

Table 5-2

5.3 AIDS Data Structures

The data structures defined in support of the AIDS software are open-ended and can accommodate layouts of virtually any size. These structures were designed to be readily adaptable to interfacing future application.

The smaller tables are core-resident while the larger tables are segmented and maintained on disk. Disk management routines were incorporated into the software to perform the spooling and chaining of the segmented tables on disk. These routines access the tables randomly to minimize disk access time.

The tables required to support the various design processes are defined below.

5.3.1 Display Symbology Table

The Display Symbology Table is a core-resident table within COMMON. It defines the symbology used to display lines on the topographical level and components on the various mask levels as well as the topographical level. The symbologies are user controlled and may be re-defined at any time during the design process via Displays 0106 and 0107. The format of the table is defined in Table 5-3.

5.3.2 Display Parameter Table

The Display Parameter Table reflects the current status of each display screen. It is core-resident and resides in COMMON. Currently the table is set up for two screens but can easily be extended to include more.

The current status includes the following:

- current screen
- current level
- current grid structure (maximum/minimum)
- current grid type (dot/line)
- grid state (on/off)
- current state of all 16 levels and the topographical level (on/off)

DISPLAY SYMBOLOGY TABLE

LEVEL	LINE TYPE	COMPONENT TYPE
1	1-4	1-5
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
TOPO		

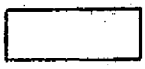
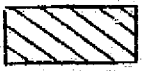
LINE TYPE	COMPONENT TYPE	
1 = Solid Line	1 =	
2 = Dotted Line	2 =	
3 = Dashed Line	3 =	
4 = Dash-Dot Line	4 =	
	5 =	

Table 5-3

- o character state (on/off)
- o window center
- o window scale

The table format is depicted in Table 5-4.

5.3.3 Buffer Pool

The buffer pool resides in COMMON and is divided into eight 90-word buffers. Each time a process needs a buffer, a buffer is allocated from the buffer pool and assigned to this process. When the buffer is no longer needed, it is returned to the buffer pool. The status of each buffer is maintained in a 2-word cell called "BUFMAP".

5.3.4 Disk Working File

A working file is maintained throughout the design process for the disk-resident tables and scratch areas. This file is predefined to the system via the Sigma 2 RBM RADEDIT processor. The file is accessed randomly by sector numbers. A sector map is maintained in COMMON that indicates the status of each sector within the file. The sectors that comprise a particular data table are chained together by current and forward pointers in words one and two of each sector. Word one is the current sector number and word two is the next sector number.

When a new sector is required, the sector map is accessed to find an available sector and the sector is set unavailable. When a sector is no longer required, it is returned to the available status. For processes that require temporary disk space, this file management technique is extremely useful. Sectors can be allocated for the duration of the process and then freed requiring no additional overhead.

The sector map and sector format are defined in Table 5-5 and Table 5-6.

5.3.5 Cell Library Table

The cell library table within the working file may be input from a master cell library or constructed during the design process or both. After defining a cell, the designer may instruct the software to generate a new master cell library. The format of a library

DISPLAY PARAMETER TABLE

Word																
1	Current Screen No.													No. of Screens		
2	A	B	C	D	E									Current Level No.		
3	No. of Display Units/Grid															
4	X-offset from center															
5	Y-offset from center															
6	No. of UORS/GRID															
7	16	15	Active Level Indicator											2	1	
8	A	B	C	D	E									Current Level No.		
9	No. of Display Units/Grid															
10	X-offset															
11	Y-offset															
12	No. of UORS/GRID															
13	Level Indicator															

Screen 1's Status

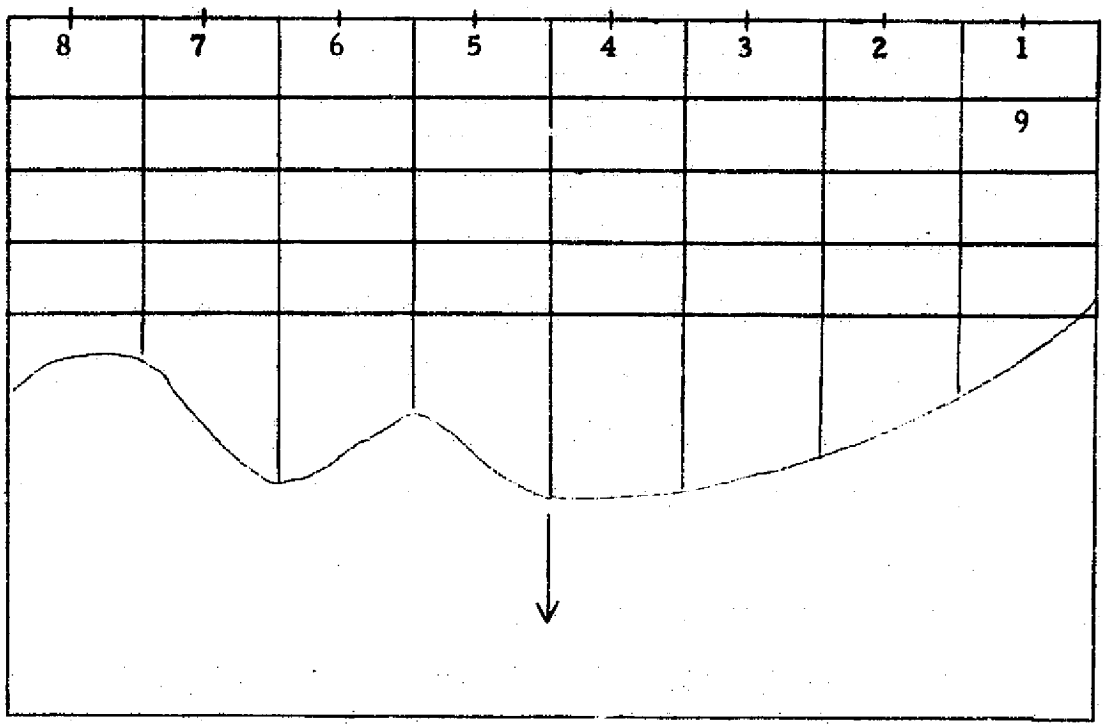
Screen 2's Status

Word 2; A-Bit - 0 = grid off; 1 = grid on
B-Bit - 0 = Dot grid; 1 = Line grid
C-Bit - 0 = Minimum grid; 1 = Maximum grid
D-Bit - 0 = TOPO Level active; 1 = inactive
E-Bit - 0 = Character state blank; 1 = Display Characters

Word 7 and 13: There is one bit per level to indicate the status of the associated level. A zero means the level is inactive or blank; a one means the level is active and is to be displayed.

Table 5-4

SECTOR MAP



The sector status is indicated by two bits:

00 = sector available

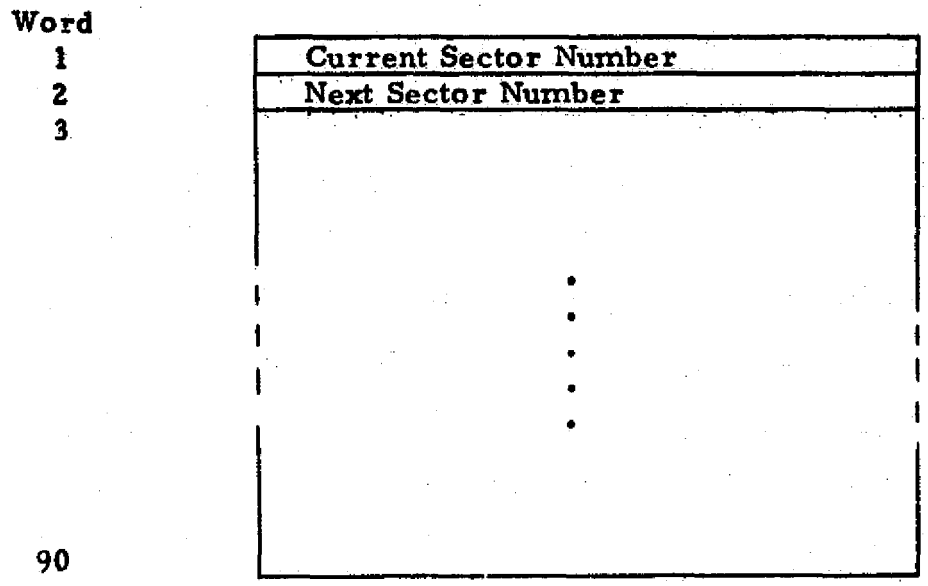
01 = beginning of cell library entry

10 = continuation of cell library entry

11 = other

Table 5-5

SECTOR FORMAT



If the "next sector number" is zero, the current sector is the last sector of the table. A word of all ones indicates the end of significant data within the sector.

Table 5-6

entry is the same for the master and working library and is depicted in Table 5-7.

When a cell is defined, it is added to the working library with all the information required to re-display this cell. When a user selects a cell for the current design process, the cell library is searched and the cell's definition is added to the list of active cells within the Active Cell Table.

A cell library entry always starts on a sector boundary but may be comprised of n sectors. The signal to change sectors when processing an entry is indicated by a word of all ones. The next sector accessed is indicated by word 2 of the current sector.

All component definitions are relative to 0,0 which is equivalent to the cell's origin. The E-bit of word 11, if one, signifies that the cell may be expanded into a long or wide version of the cell. The level indicator, word 16, signifies all the active levels within the cell. For example, a one-bit in the right-most bit of word 16 would indicate that the cell has components on level 1.

5.3.6 Active Cell Table

The Active Cell Table defines each of the cells currently active within the layout and the locations where each cell is placed. One cell may have been placed at various locations. If this is the case, the cell's description is within the cell table followed by the location (origin) and orientation of each placement.

When a cell is selected as the current cell, the Active Cell Table is first searched to determine if this cell was previously selected. If so, pointers are set to indicate the sector number and word number of the cell's description within the cell table. When a new cell is selected, the cell library is searched for the cell name. The pertinent cell library information is extracted and a new cell description is constructed and added to the cell table. Again pointers are set to the sector number and word number of the cell description within the cell table to provide immediate access to this cell when it is subsequently placed.

The Active Cell Table resides on disk and is chained together by the sector format previously mentioned. The format of this table is illustrated in Table 5-8.

CELL LIBRARY TABLE FORMAT

Word		
1	Current Sector Number	
2	Next Sector Number	
3	4-Character	
4	Cell Name	
5	10-Character	
6		
7	Cell	
8		
9	Description	
10	No. of Cell Interconnects	
11	Reserved	E
12	X_{Lo}	Extent of Cell
13	Y_{Lo}	Relative to 0, 0
14	X_{Hi}	Origin
15	Y_{Hi}	
16	Level Indicator	
17	No. of Topographical Components	
	Topo Component Definitions	
	No. of Level Components	
	Level Component Definitions	

Cell Library Entry

Table 5-7

ACTIVE CELL TABLE

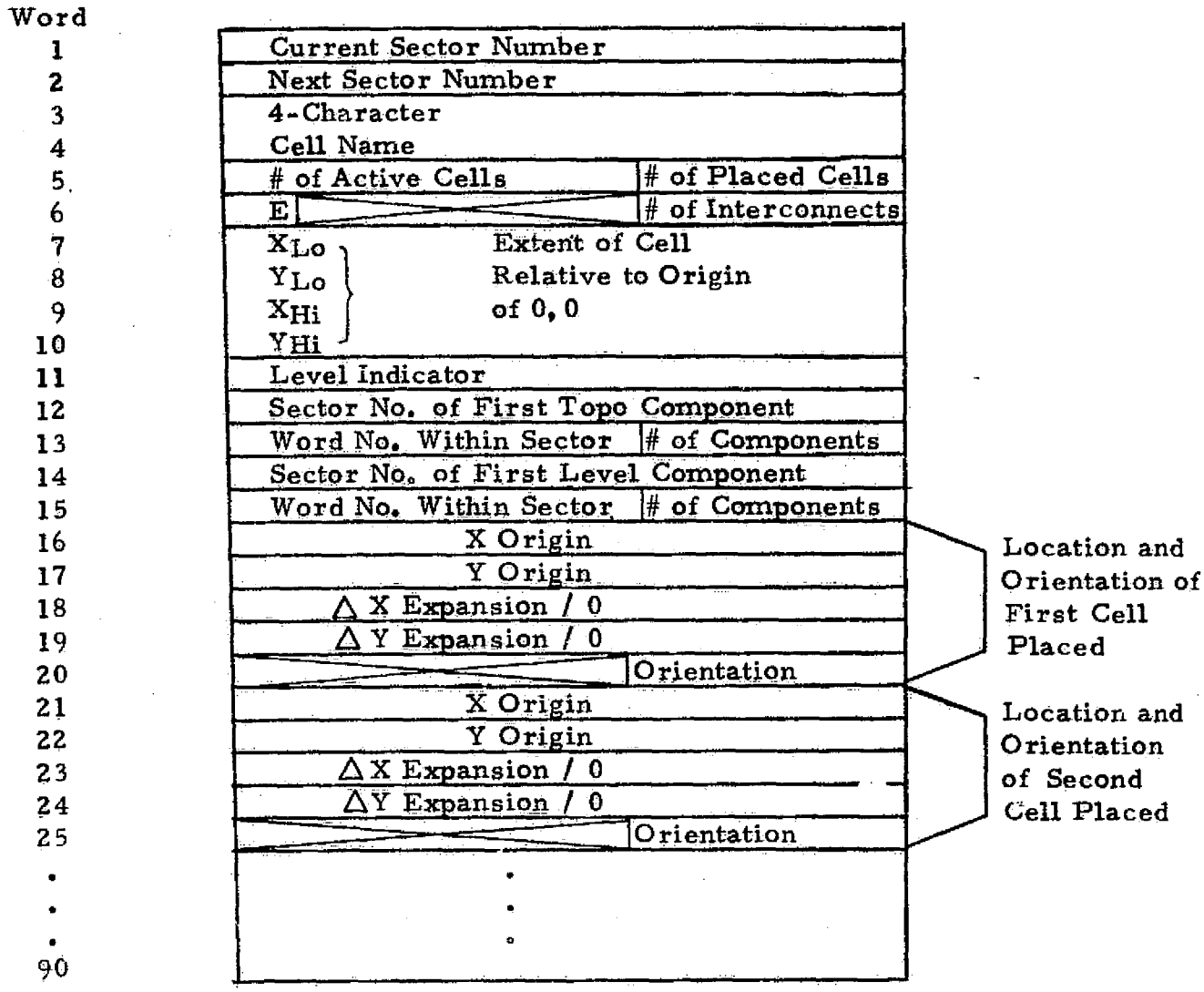


Table 5-8

ACTIVE CELL TABLE
(continued)

Word 5 - # of active cells. This entry reflects the number of cells of this type that are currently active, i.e., have not been deleted.

# of placed cells. This entry denotes the number of cells placed including the deleted ones. When a cell is deleted its orientation entry is set to 0 and the number of active cells is decreased by one. This slot may then be reused for subsequent cells of this type that are defined.

Word 6 - E. If the E-bit equals one, the cell is expandable.

Words 7-10 - Extent. The extent or range of a cell is determined by adding the extents to the origin. This is used in determining which cell was selected and the cells within the window or unit area.

Word 11 - Level Indicator. One bit/level indicating which levels are active within the cell.

Word 12 - Sector No. of First TOPO Component. This is the sector number of the first topographical component defined in the cell library.

Word 13 - Word No. Word number within the cell library sector of the first topo component.

# of components. Number of topographical components within the cell.

Words 14&15- Same as words 12 and 13 except that they denote the position within the cell library of the cell's level components.

Words 16-20- Cell Table placement entry. This entry defines the origin of the cell placed and the orientation. If the cell has been expanded, the ΔX and ΔY expansion factors reflect the expansion. Each of the components within the cell is defined in respect to the cell origin.

Table 5-8
(continued)

5.3.7 Independent Component Table

The Independent Component Table reflects all of the components within the layout that are not a part of a cell. This table includes blocks, lines, shapes, and characters. Each component is distinguished by a type flag in the component definition.

When a component is defined and placed on the layout, it is entered in the Independent Component Table. At a future time, these components can be collectively grouped under a cell definition and added to the cell library.

The Independent Component Table is disk-resident and is depicted in Table 5-9 with each component type illustrated.

5.4 General Support Routines

The AIDS software is modular and lends itself readily to modification and expansion. Functions common to two or more operations are isolated into subroutines to eliminate redundant coding and reduce the core requirements. The common subroutines that support the construction and manipulation of the various data tables were designed to facilitate the interfacing of other programs with the AIDS system. These routines along with a brief description of each are defined in Table 5-10.

INDEPENDENT COMPONENT TABLE

Word			
1	Current Sector No.		
2	Next Sector No.		
3	Type = 1	Level No.	Block Component Entry where X, Y and X_D Y_D define the diagonal of the block
4		# of Coordinates	
5	X_1		
6	Y_1		
7	X_D		
8	Y_D		
	Type = 2	Level No.	Shape Component where X_1 Y_1 define the vertices of the shape.
		# of Coordinates	
	X_1		
	Y_1		
	.		
	.		
	X_N		
	Y_N		
	Type = 3	Level No.	Line Component where X_1 Y_1 and X_2 Y_2 define the begin and end part of a line.
	Line Width in II. FF UORS		
	X_1		
	Y_1		
	X_2		
	Y_2		
	Type = 4	Level No.	Character Component where 'Character' defines the character to be placed at X_1 Y_1
	Character	# of Coordinates	
	X_1		
	Y_1		

Table 5-9

AIDS SUPPORT SUBROUTINES

NAME	ARGUMENTS	DESCRIPTION
PUTICP	Length of entry, Component Entry	Add component to Independent Component Table.
PUTCEL	Cell Origin, Orient. Entry, Index to Cell Description, index to Location Cell Entry was placed	Add cell to Active Cell Table. Return location of where cell was placed in table.
GETICP	Index to Component	Get next component from Independent Component Table and return index to component.
GETCMP	Index to Component Type requested (Topo or Level)	Get current cell's next component based on Type and return Index to it.
GETCEL	Index to Cell's Description, Index to Cell's Origin	Get next cell from Active Cell Table and return Indices to its description and origin.
GETCLB	Cell Number, Index	Get cell N from Cell Library and return Index to cell.

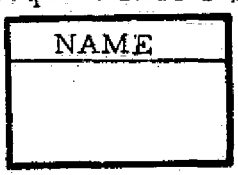
Table 5-10

APPENDIX

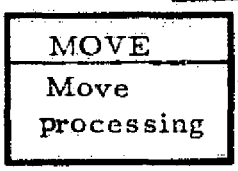
ARTWORK INTERACTIVE DESIGN SYSTEM PROGRAM FLOWCHARTS

This Appendix presents the detail flowcharts of the Artwork Interactive Design System (AIDS). The flowcharts should provide sufficient explanation of the AIDS source listing.

The "Picture on a Page" technique has been utilized, which allows the reader to study the flowcharts to the depth he desires. Each page is a complete representation of the area presented. Those functions that are expanded in more depth on subsequent sheets are identified with subroutine nomenclature blocks



For example, on page A-11, the block



indicates that the activity defined by the block is discussed in more detail on a separate sheet with the entry MOVE (See page A-11).

Table A1 is an index to the flowcharts. Table A2 describes the flowchart symbol convention adhered to by these flowcharts.

PRECEDING PAGE BLANK NOT FILMED

ARTWORK INTERACTIVE DESIGN SYSTEM

FLOWCHART INDEX

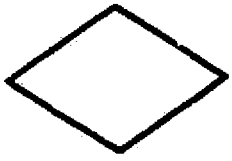
	Page
AIDS Executive	A-4
AIDS Initialization	A-5
Input Cell Library	A-6
Input Previous Design	A-7
Design Parameter Display Logic	A-8
Design Parameter Update Logic	A-9
Initialize Design Display	A-10
Command Menu Executive	A-11
Image Design Executive	A-12
Display Commands	A-13
Move Processing	A-14
Place Processing	A-15
Delete Processing	A-16
Level and Number Commands	A-17
Window Commands	A-18
Window Processing	A-19
Display Executive	A-20
Message Executive	A-21
Select Cell and Drop Cell Commands	A-22
Cell Library Commands	A-23
Verification Check	A-24
File Current Design	A-25
Create Artwork Input	A-26

Table A1

FLOWCHART SYMBOL CONVENTION

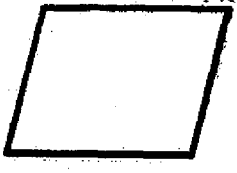
Subroutine Terminal Points

Process

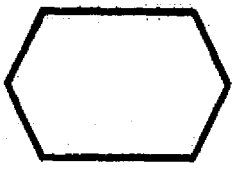


Decision

Subroutine Call



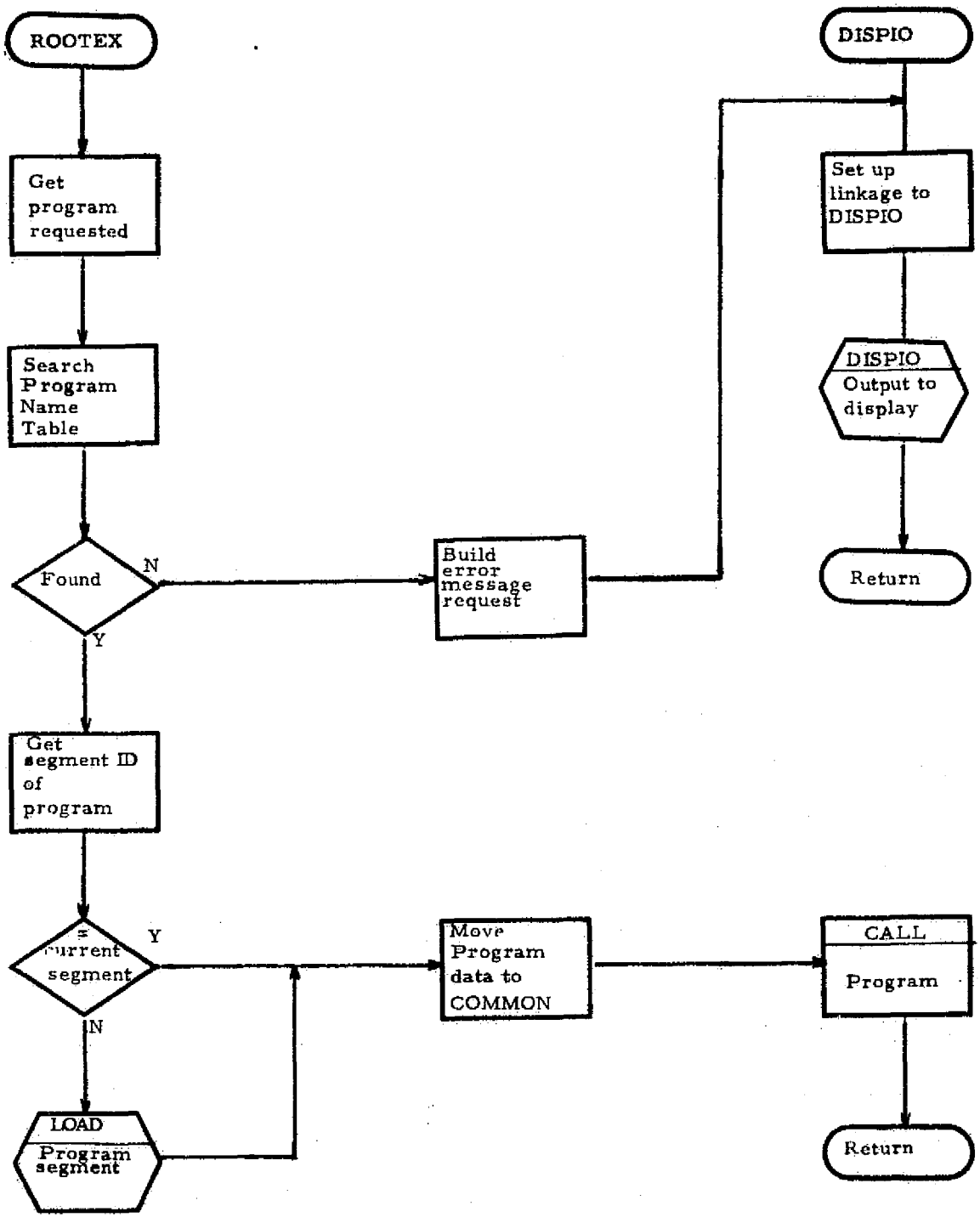
I/O Operation



Process Defined External to the Program

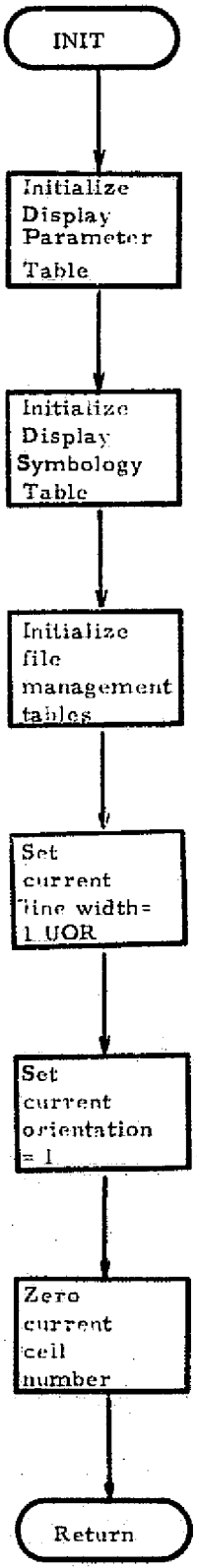
On Page Connector

Table A2



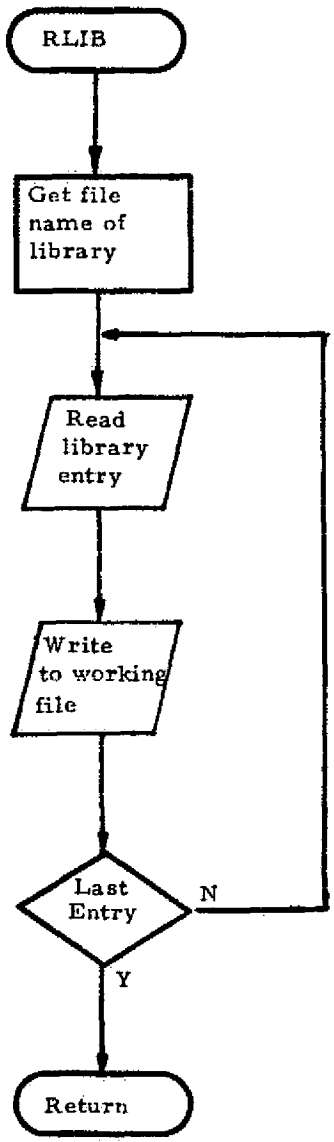
ORIGINAL PAGE IS
OF POOR QUALITY

AIDS INITIALIZATION

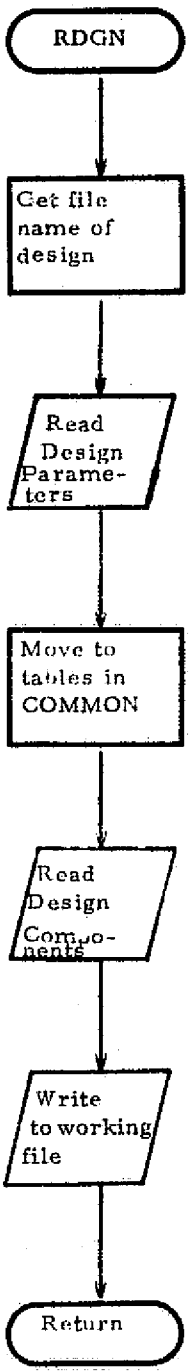


ORIGINAL PAGE IS
OF POOR QUALITY

INPUT CELL LIBRARY

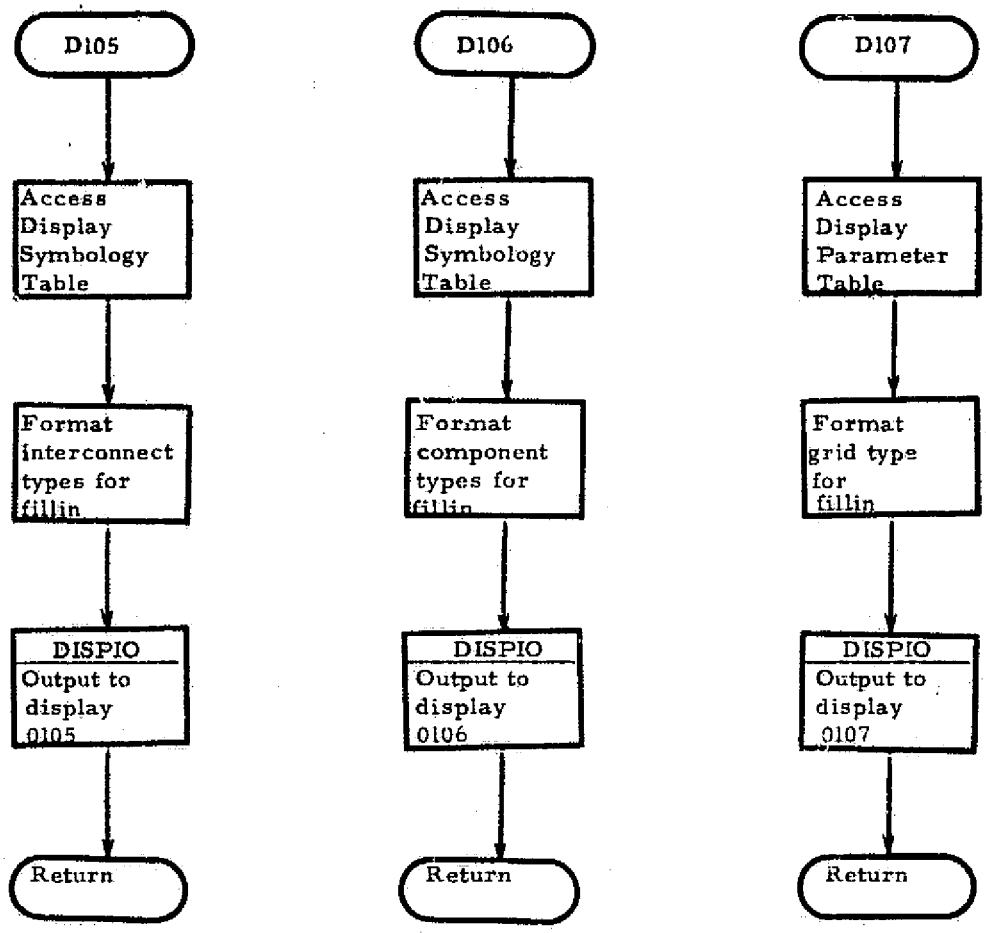


INPUT PREVIOUS DESIGN

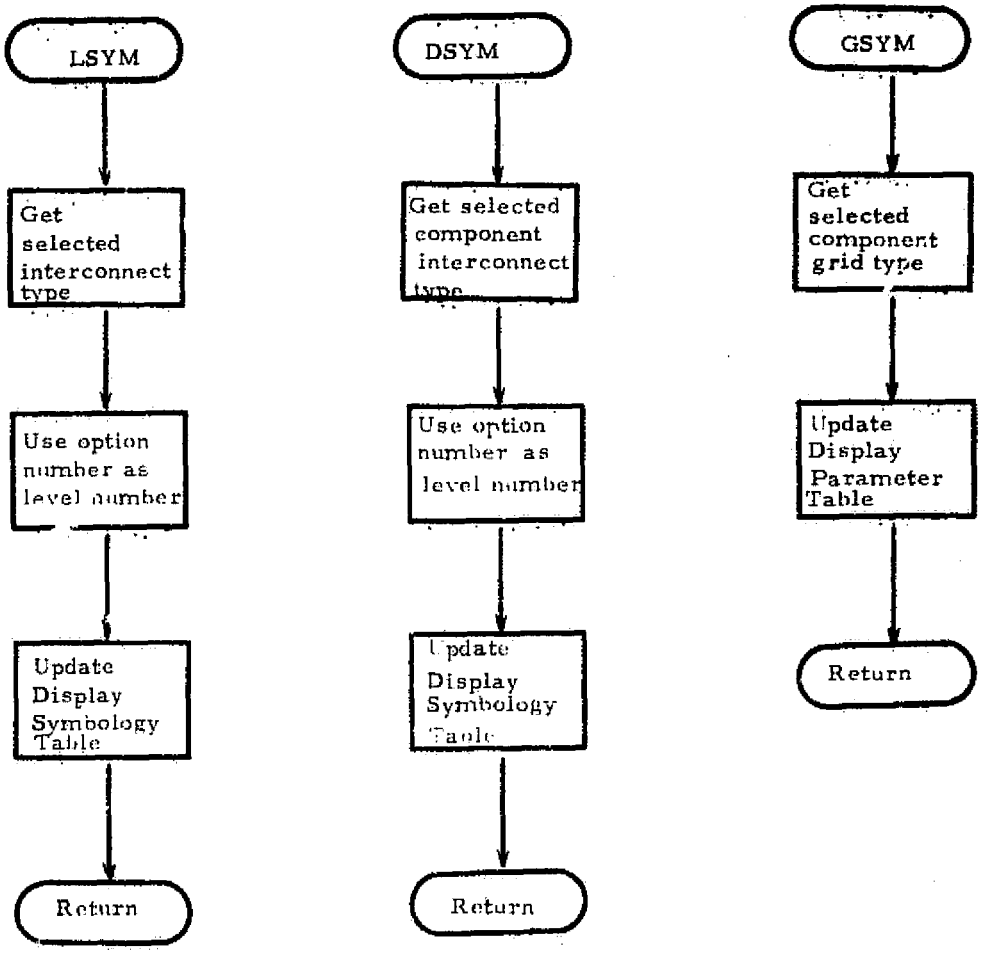


ORIGINAL PAGE IS
OF POOR QUALITY

DESIGN PARAMETER DISPLAY LOGIC

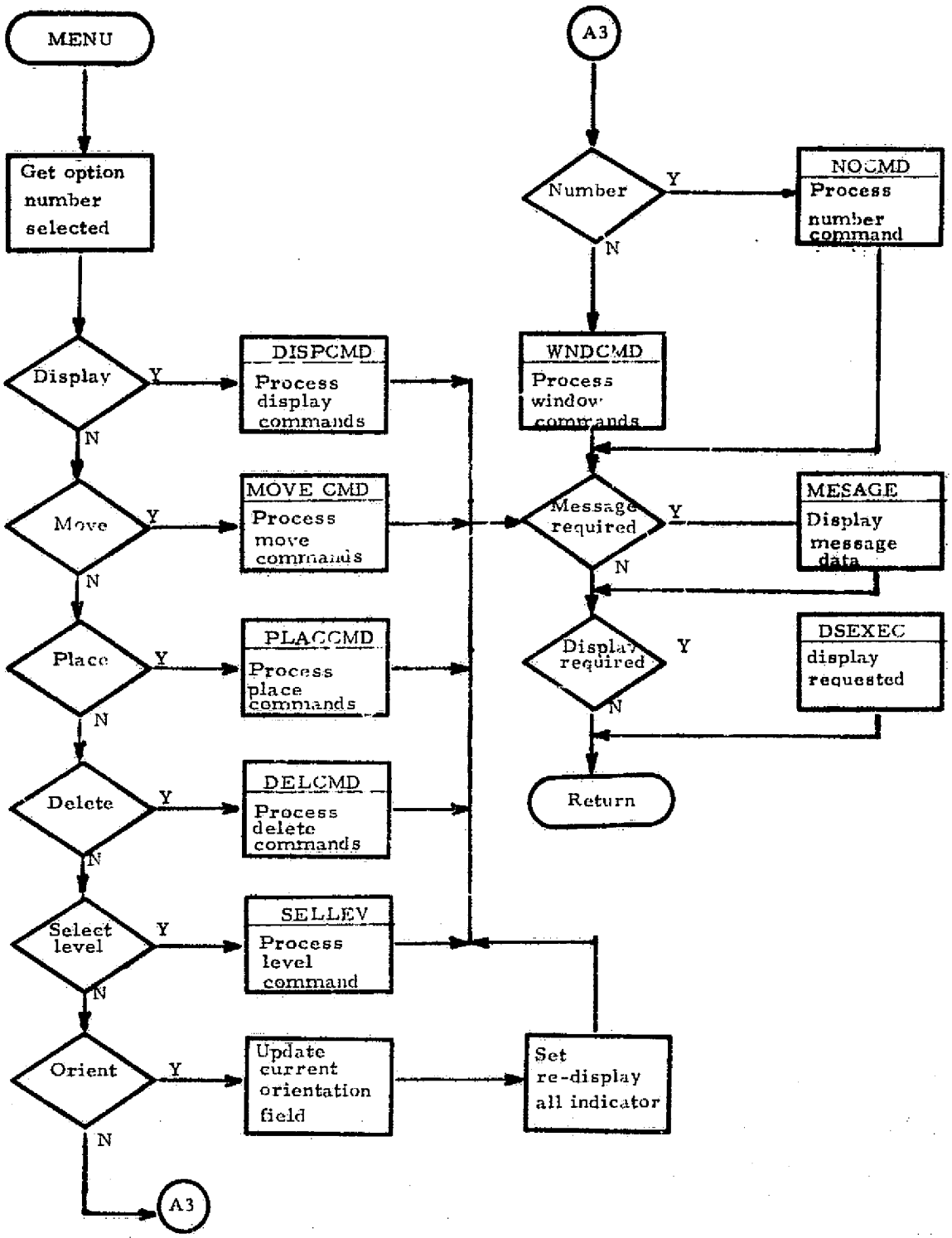


DESIGN PARAMETER UPDATE LOGIC

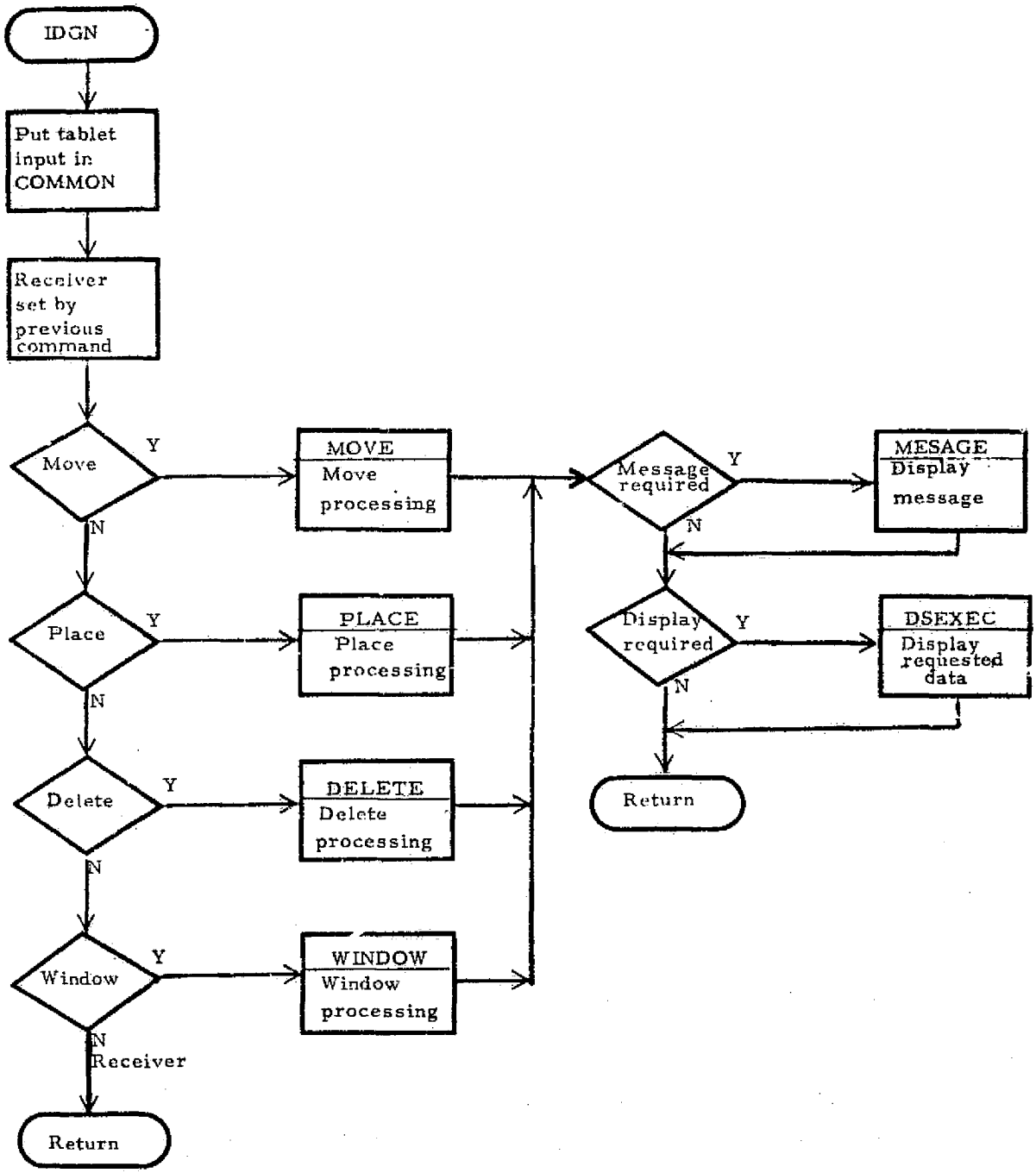


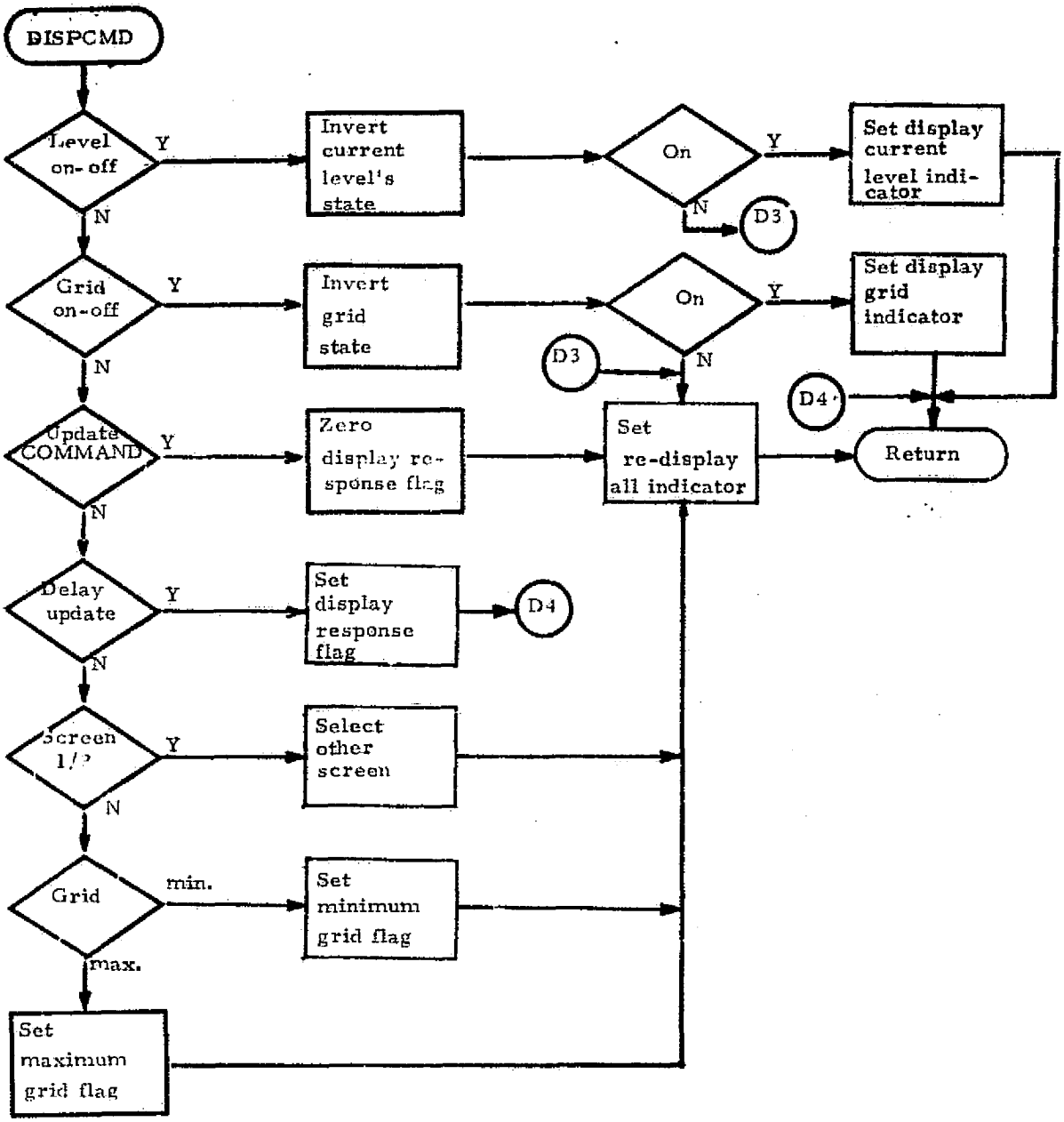
ORIGINAL PAGE IS
OF POOR QUALITY

INITIALIZE DESIGN DISPLAY



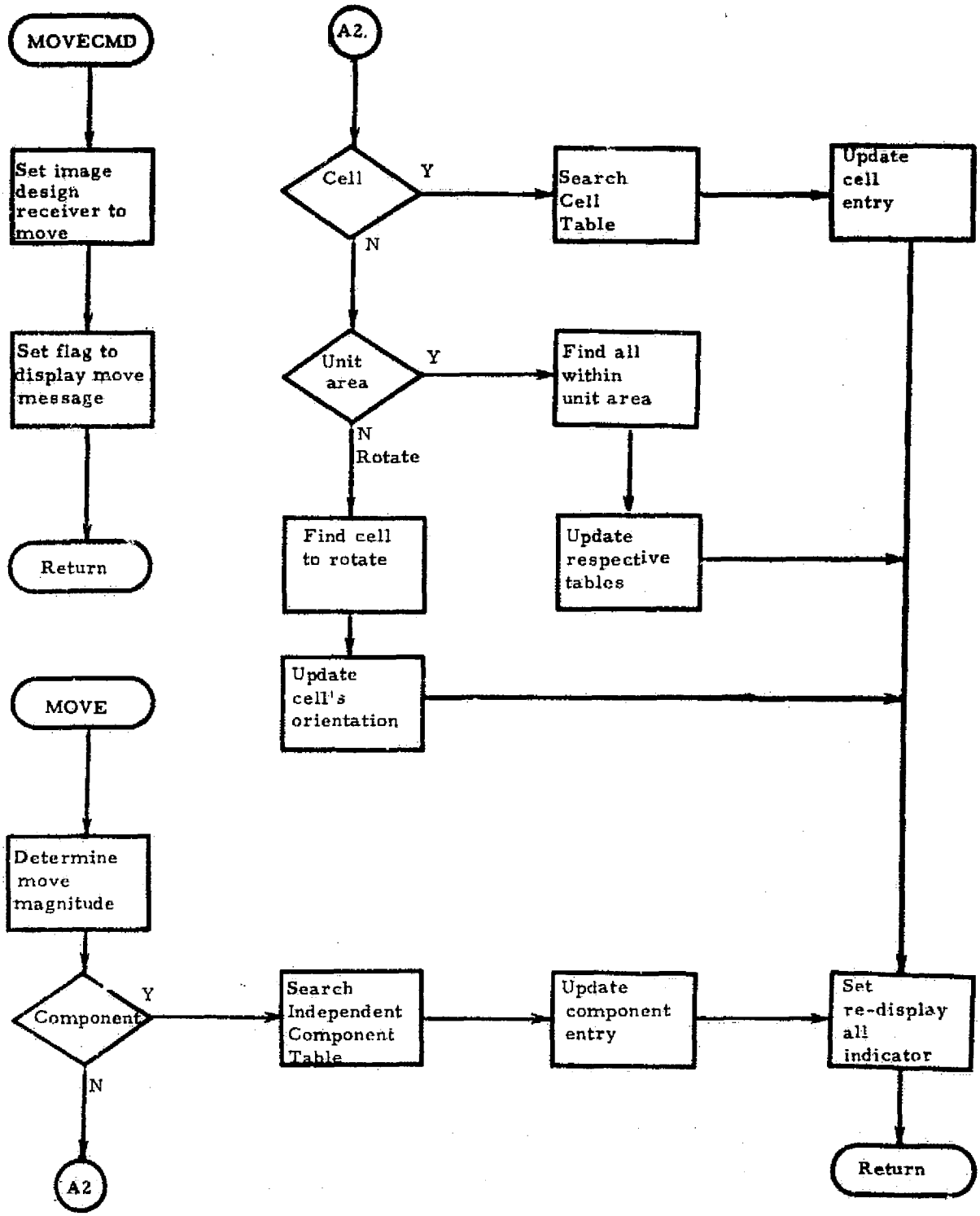
ORIGINAL PAGE IS
OF POOR QUALITY


IDGN
Put tablet input in COMMON
Receiver set by previous command
Move
Y
N
MOVE
Move processing
Place
Y
N
PLACE
Place processing
Delete
Y
N
DELETE
Delete processing
Window
Y
N
WINDOW
Window processing
Receiver
Return
Message required
Y
N
MESAGE
Display message
Display required
Y
N
DSEXEC
Display requested data
Return

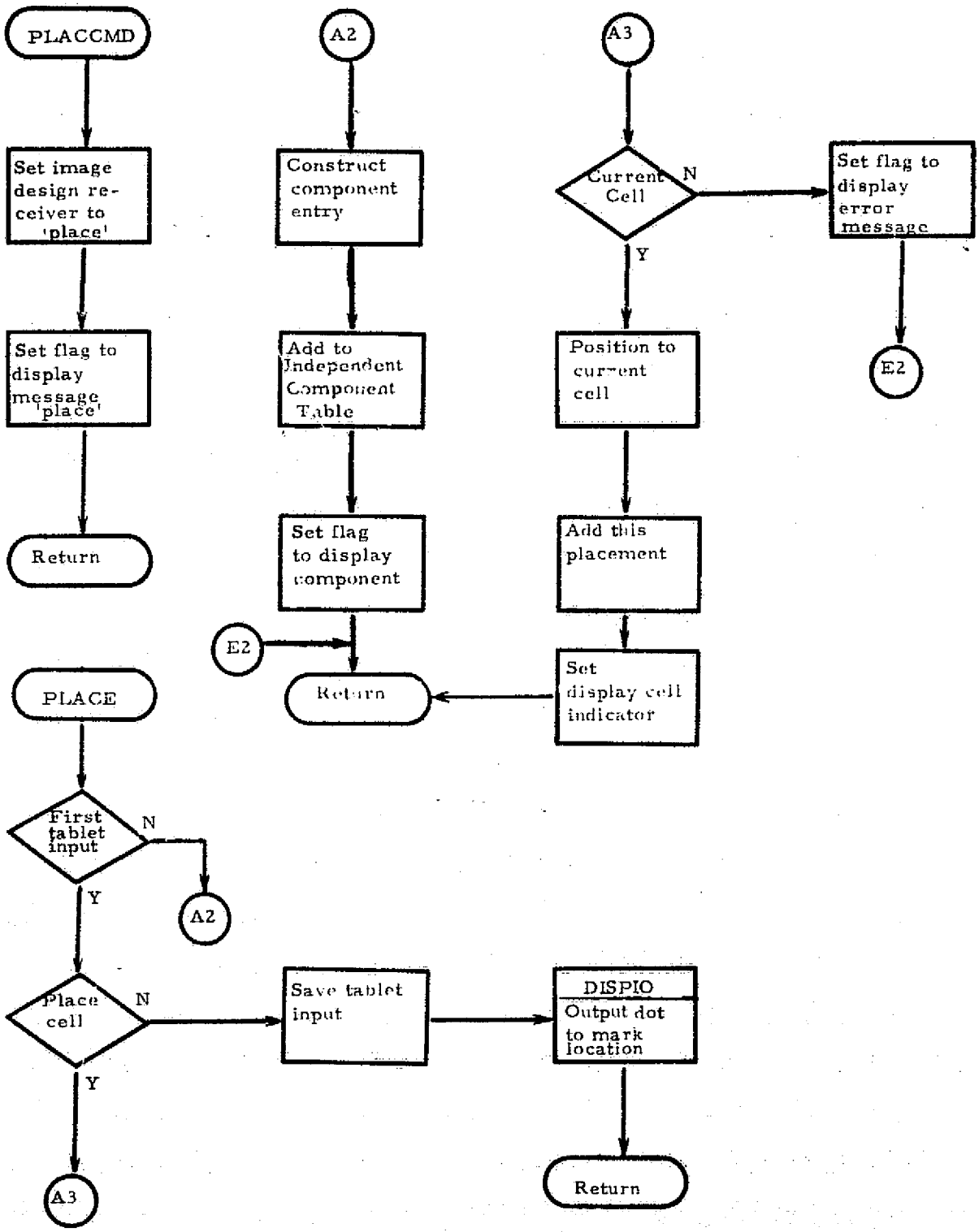


ORIGINAL PAGE IS
OF POOR QUALITY

MOVE PROCESSING

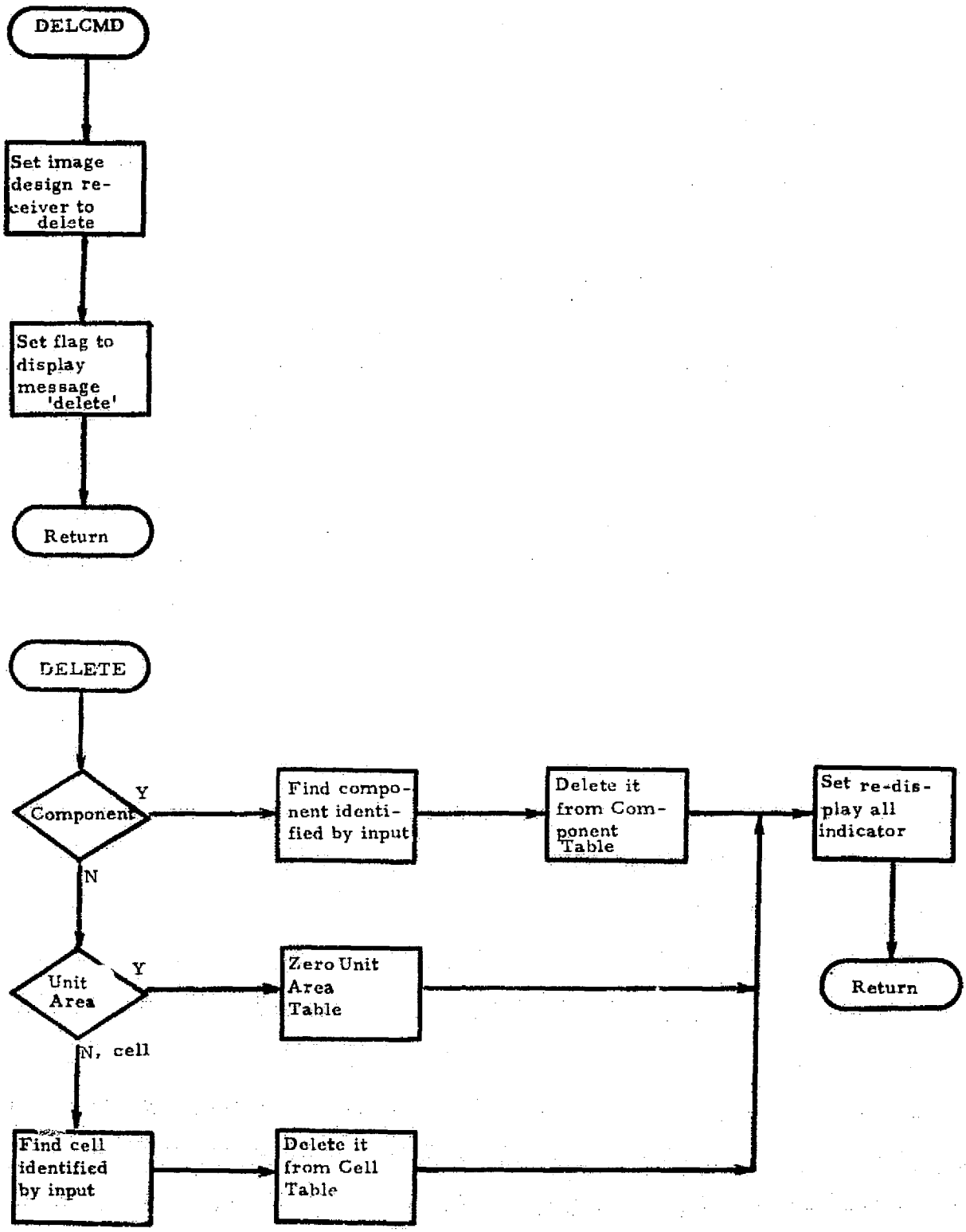


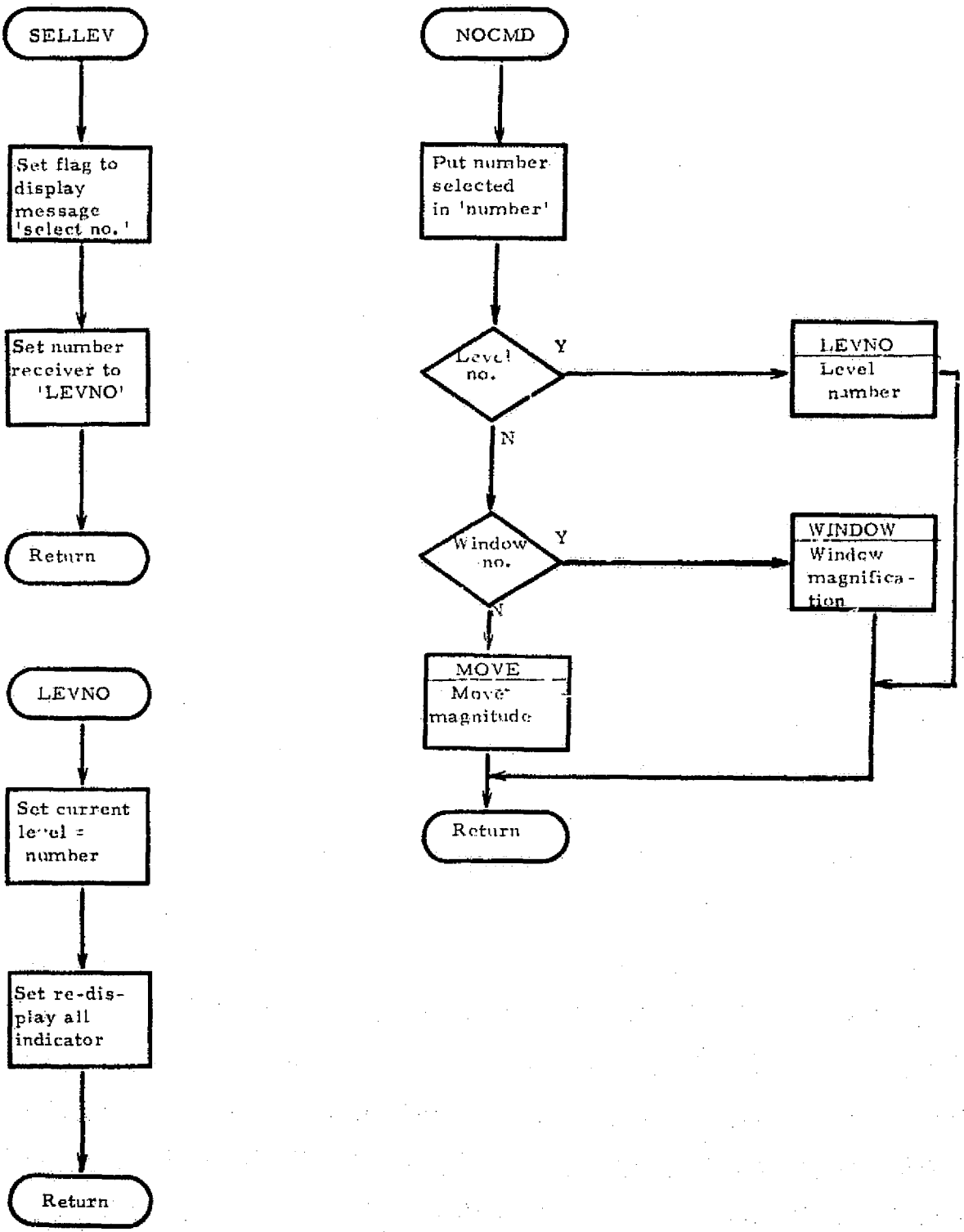
PLACE PROCESSING

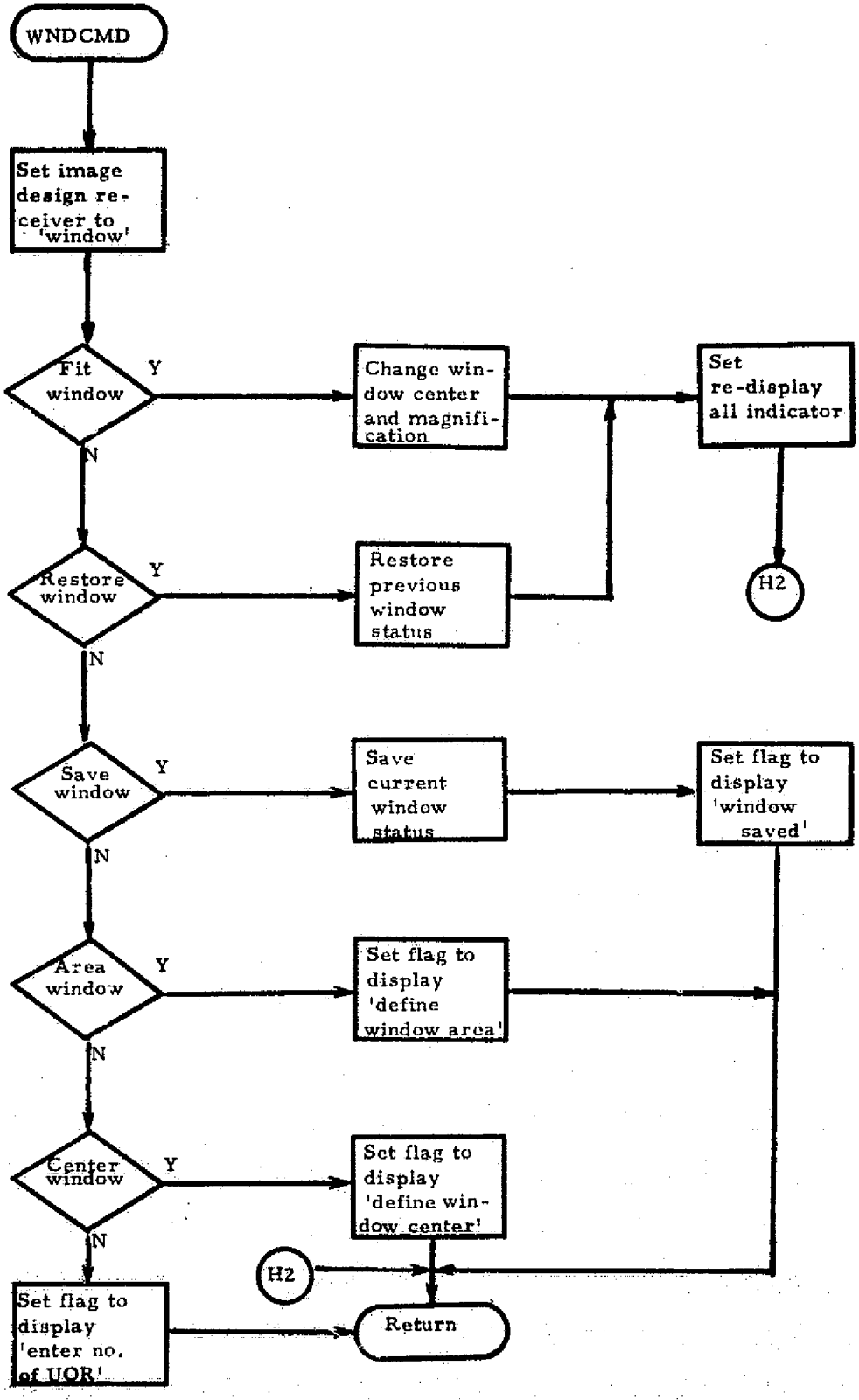


ORIGINAL PAGE IS
OF POOR QUALITY

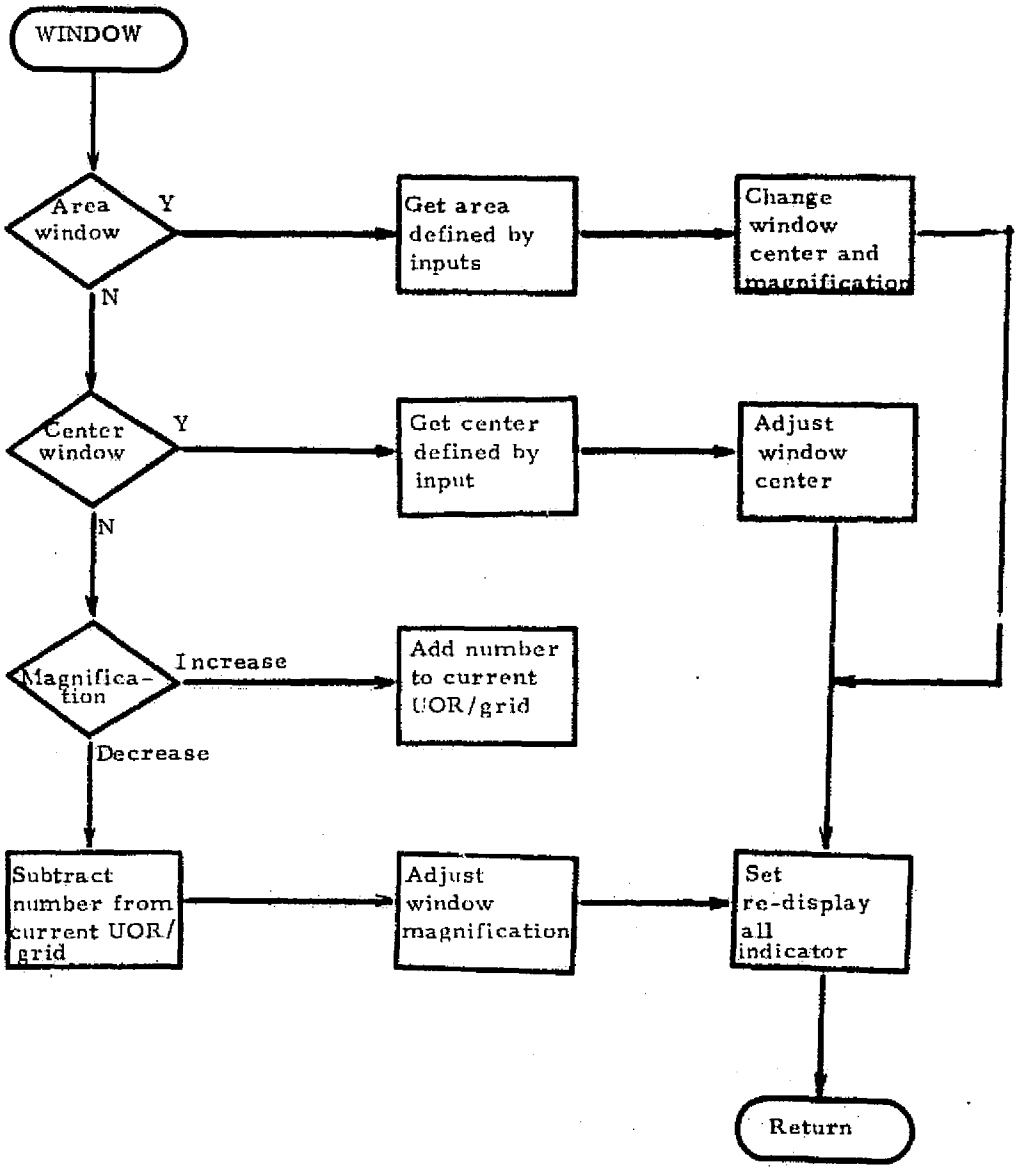
DELETE PROCESSING



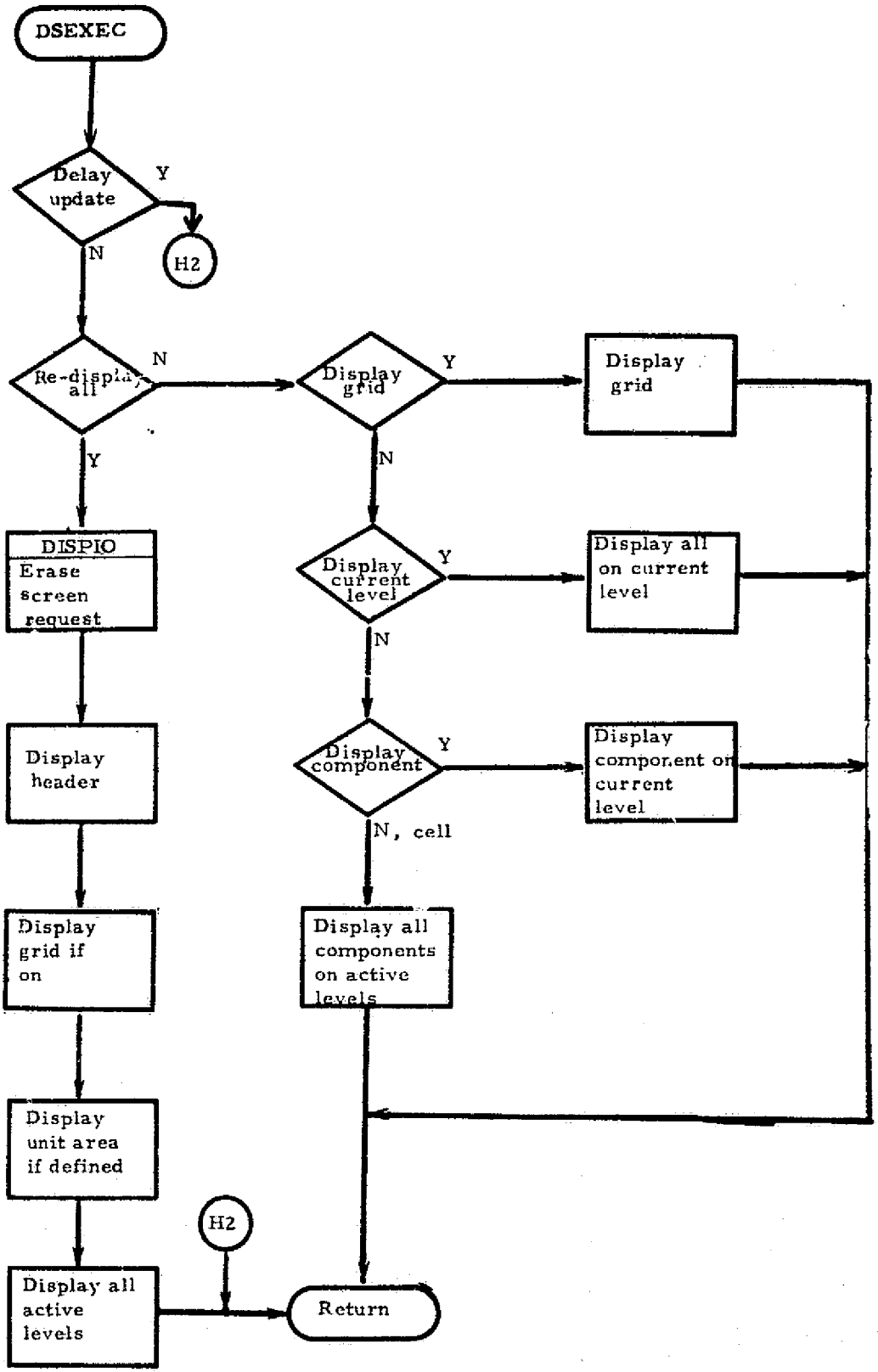

SELLEV
Set flag to display message 'select no.'
Set number receiver to 'LEVNO'
Return
LEVNO
Set current level = number
Set re-display all indicator
Return
NOCMD
Put number selected in 'number'
Level no.
Y
N
LEVNO
Level number
Window no.
Y
N
WINDOW
Window magnification
MOVE
Move magnitude
Return

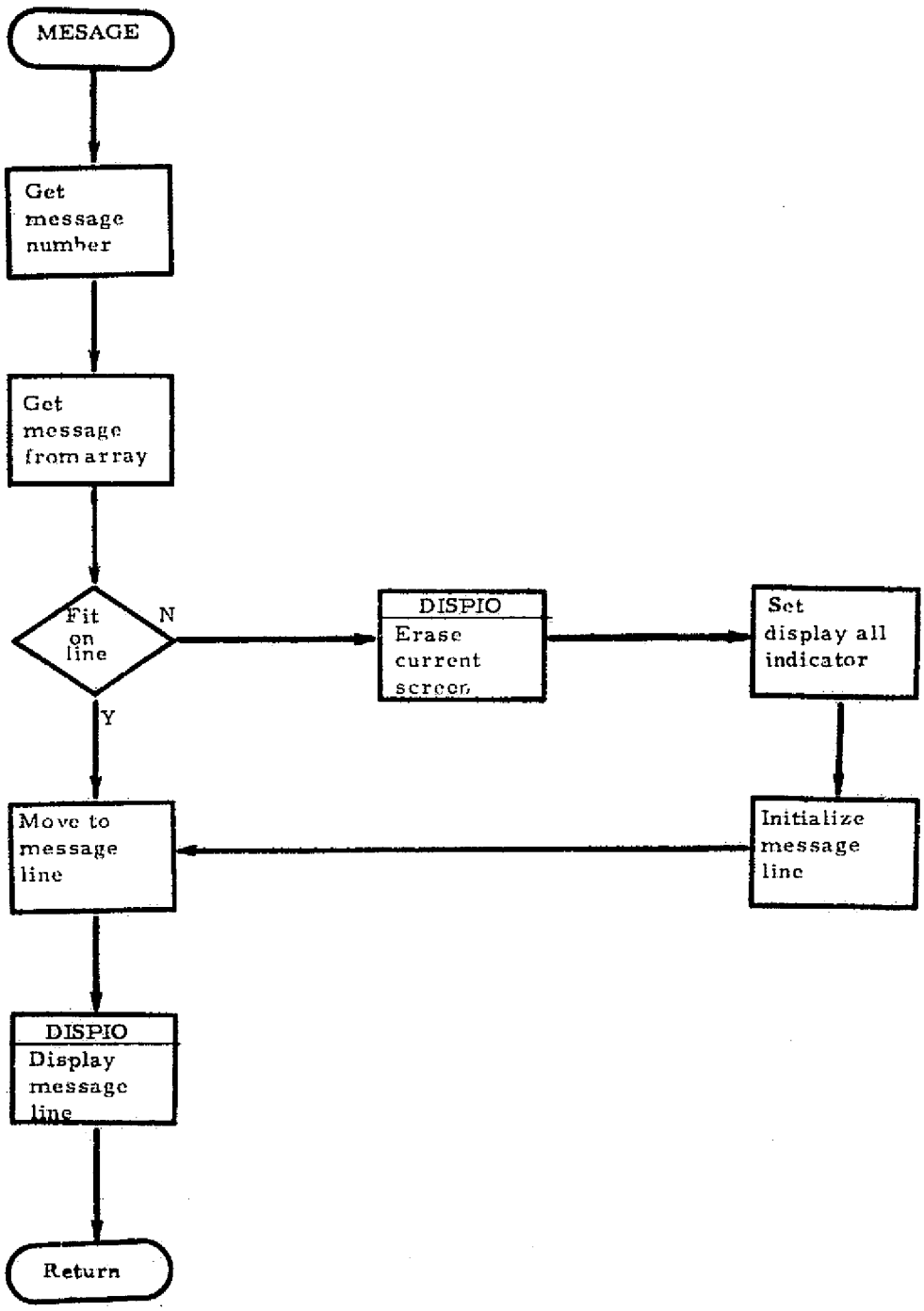

WNDCMD
Set image design receiver to 'window'
Fit window
Y
N
Change window center and magnification
Set re-display all indicator
H2
Restore window
Y
N
Restore previous window status
Save window
Y
N
Save current window status
Set flag to display 'window saved'
Area window
Y
N
Set flag to display 'define window area'
Center window
Y
N
Set flag to display 'define window center'
H2
Set flag to display 'enter no. of UOR'
Return

WINDOW PROCESSING

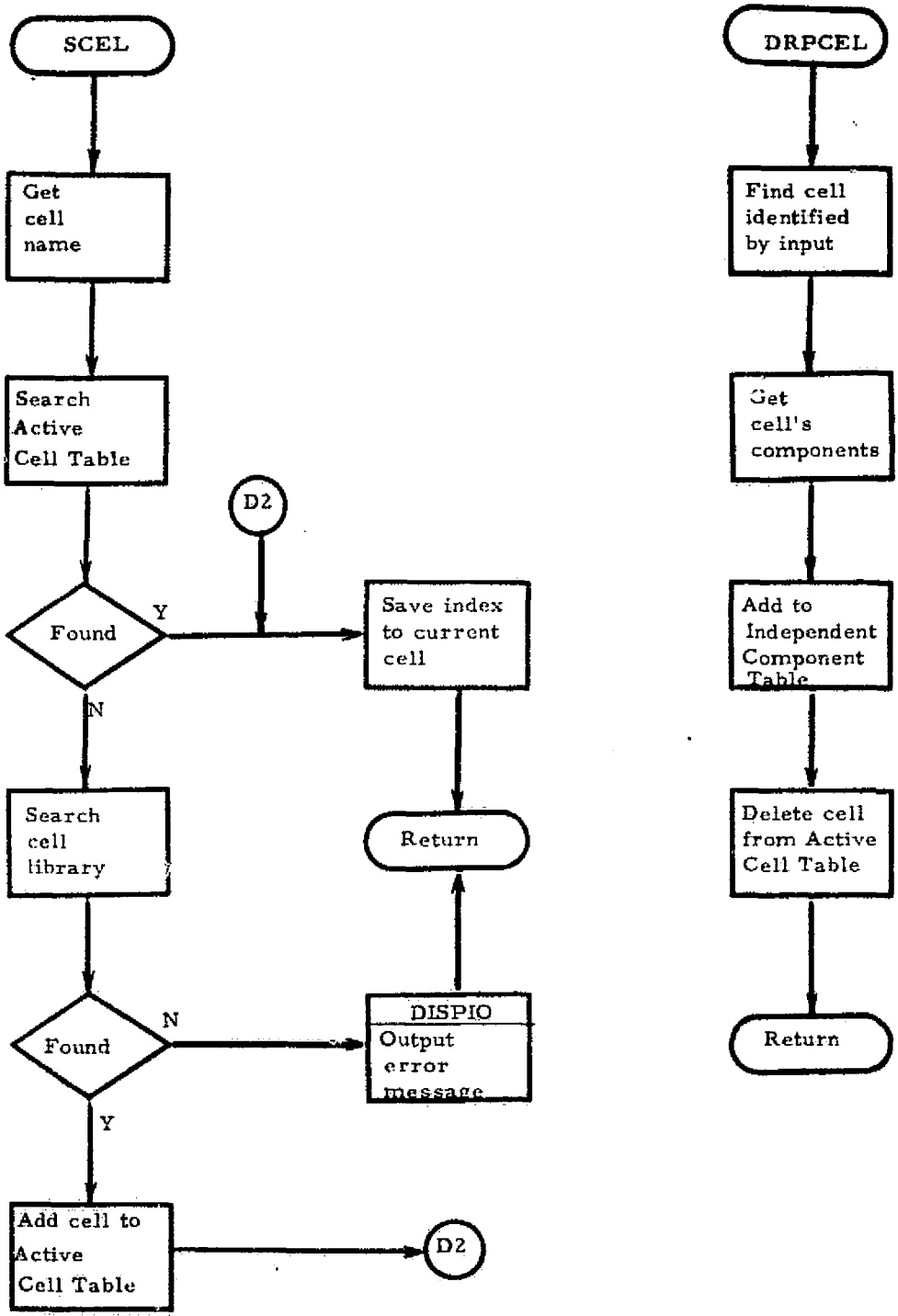


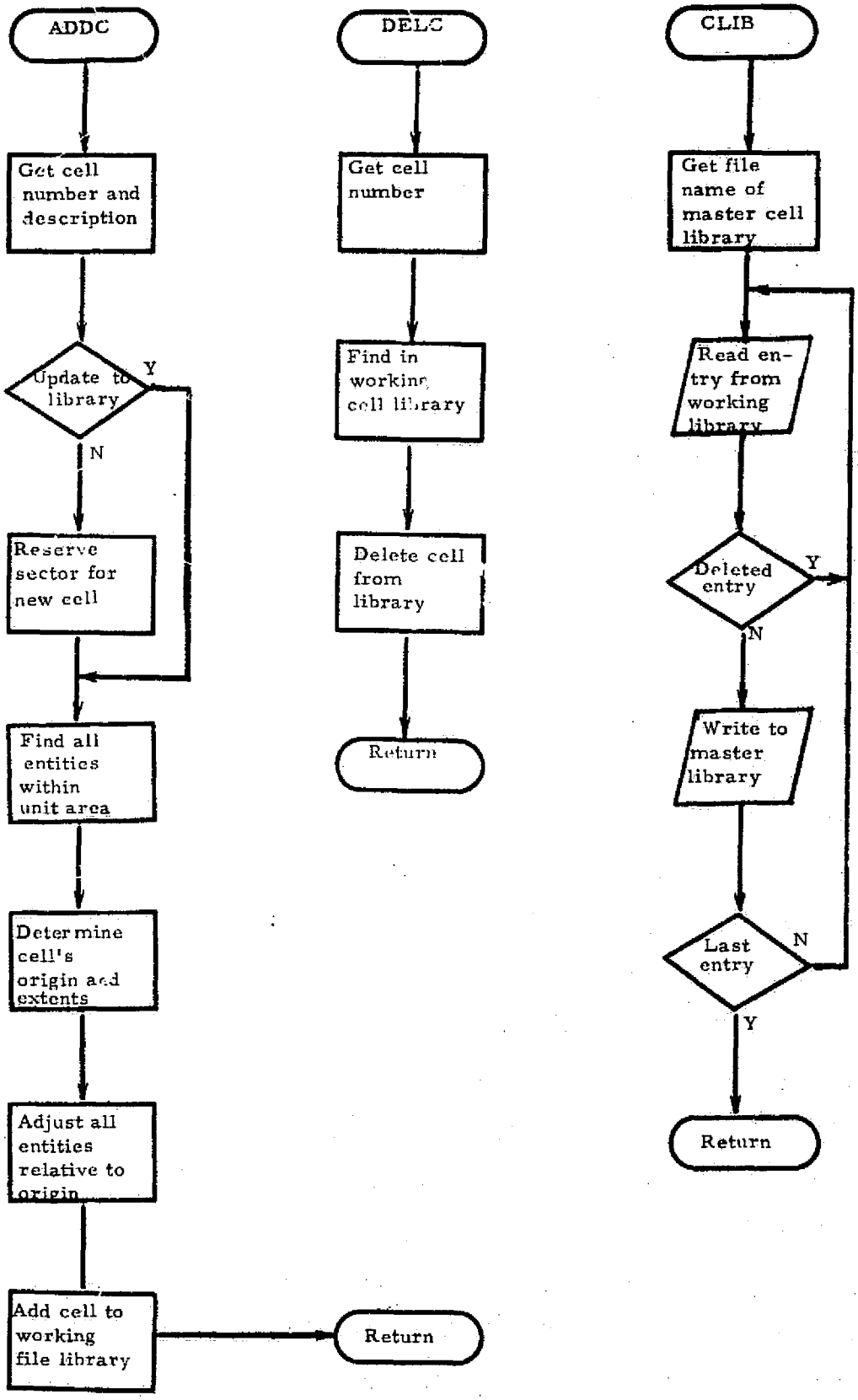
DISPLAY EXECUTIVE



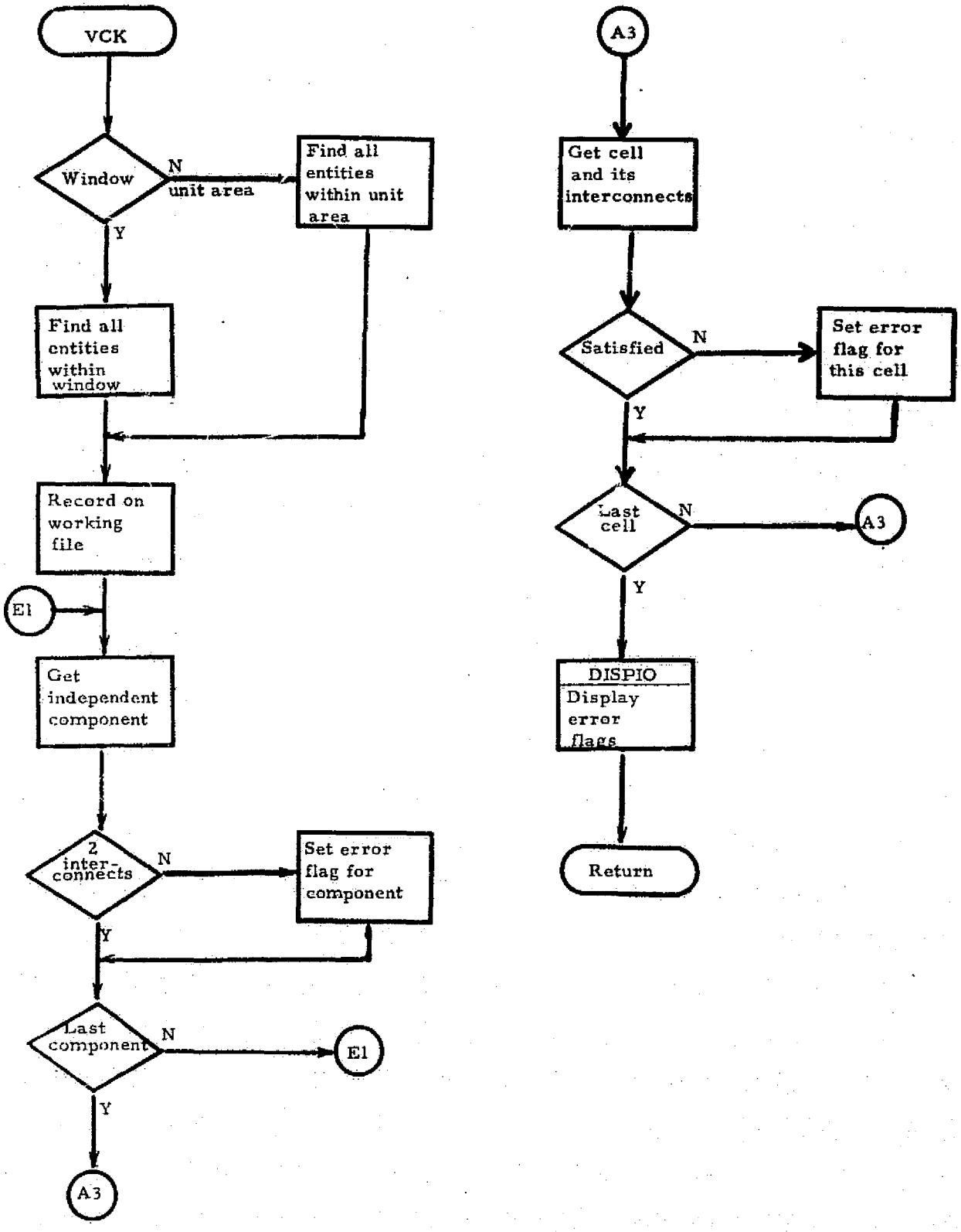

MESAGE
Get message number
Get message from array
Fit on line
N
Y
DISPIO
Erase current screen
Set display all indicator
Move to message line
Initialize message line
DISPIO
Display message line
Return

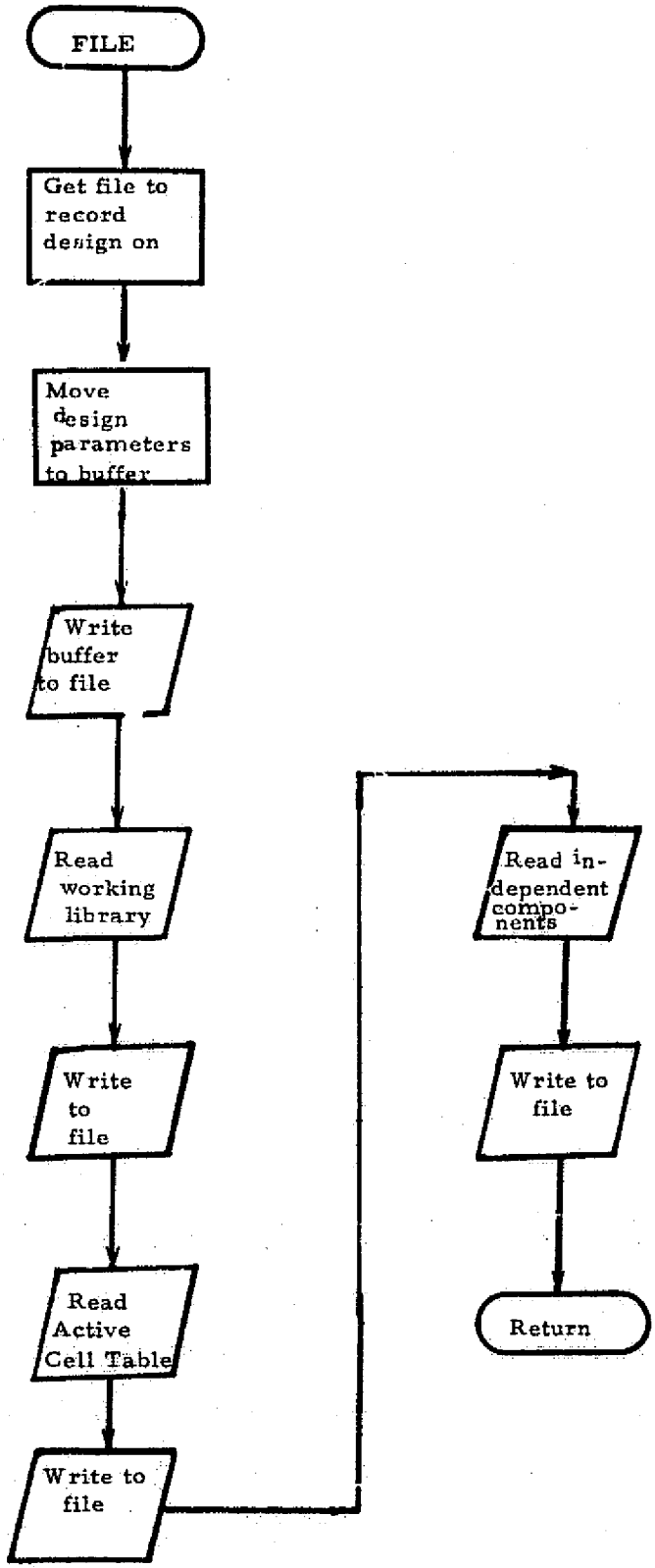
SELECT CELL AND DROP CELL COMMANDS

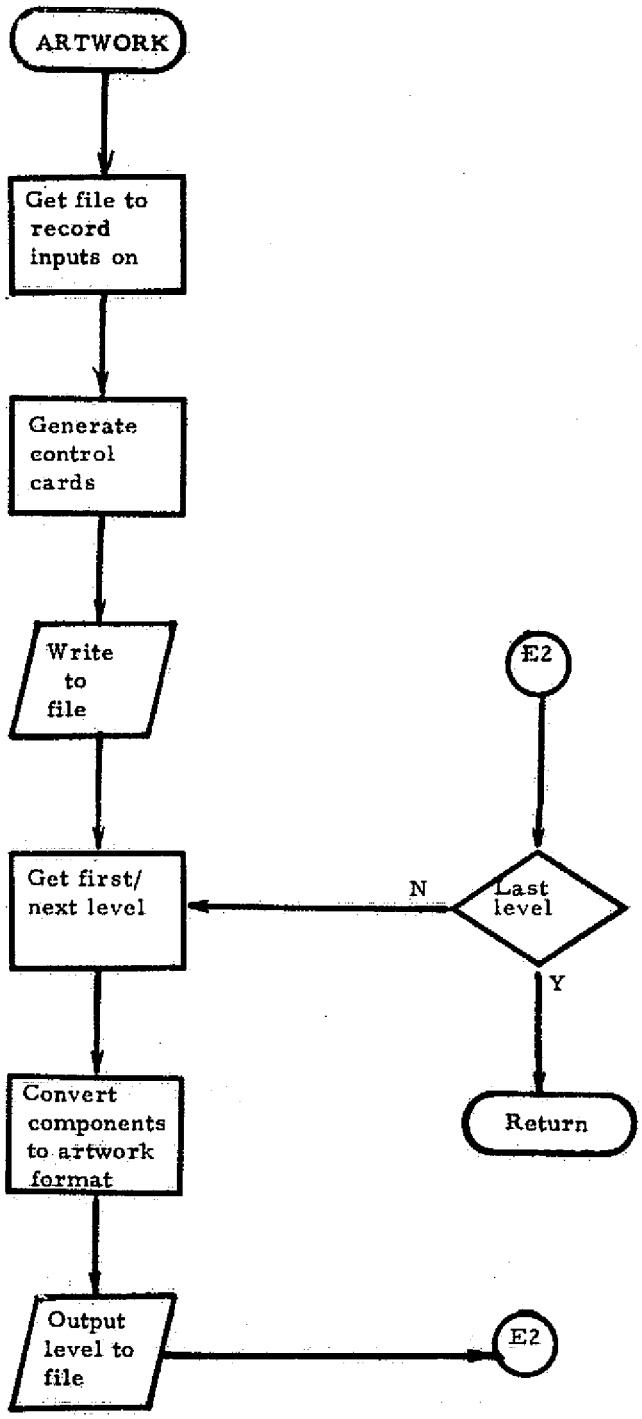




ORIGINAL PAGE IS
OF POOR QUALITY


VCK
Window
N
unit area
Find all entities within unit area
Y
Find all entities within window
Record on working file
E1
Get independent component
2 inter-connects
N
Set error flag for component
Y
Last component
N
E1
Y
A3
A3
Get cell and its interconnects
Satisfied
N
Set error flag for this cell
Y
Last cell
N
A3
Y
DISPIO
Display error flags
Return



ORIGINAL PAGE IS
OF POOR QUALITY

CREATE ARTWORK INPUT