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Geological Survey

Research on Uranium Resource Models, A Progress Report: Part IV, Logic--A Computer Graphics Program to Construct Integrated Logic Circuits for Genetic-Geologic Models

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INTRODUCTION

Integrated logic circuits were described by Finch and others (1980) as a means of formally representing genetic-geologic models for estimating undiscovered uranium resources. The logic circuits are logical combinations of selected geologic characteristics judged to be associated with particular types of uranium deposits. Each combination takes on a value which corresponds to the combined presence, absence, or "don't know" states of the selected characteristic within a specified geographic cell. Within each cell, the output of the logic circuit is taken as a measure of the favorability of occurrence of an undiscovered deposit of the type being considered. In this way, geological, geochemical, and geophysical data are incorporated explicitly into potential uranium resource estimates. Such an approach tends to reduce the subjectivity of estimates based on geologic analogy. Details of this method of estimation, called Geologic Decision Analysis, were given by McCammon (1980). The present report describes how integrated logic circuits are constructed by use of a computer graphics program.

Logic Elements

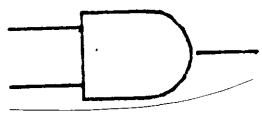
The question, "Is a geologic attribute or characteristic present?" is answered by "yes", "no", or "don't know". In a logic circuit, these answers are given the numerical values of +1, -1, or $\emptyset$, respectively, and are combined according to the envisioned logical relationships summarized by a genetic-geologic model defined for a particular type of uranium deposit. Logic symbols are used to express these relationships as follows:

Or

Or

A single "yes" answer is sufficient to pass a +1 value through an "Or" logic symbol (or gate). For example, if any one of a combined set of questions connected in an "Or" relationship can be answered "yes," this is sufficient to give a +1 value to the output. "No" answers for all questions are necessary to pass a -1 value. A Ø value is passed if one or more answers are "don't know," and none is "yes."

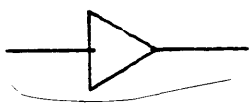
And



And

All answers must be "yes" to pass a +1 value through an "And" logic symbol (or gate). A single "no" answer is sufficient to pass a -1 value. A Ø value is passed if one or more answers are "don't know," and none is "no."

Not



Not

The "Not" symbol (or gate) is given a +1 value only if the question is answered negatively. Conversely, a positive answer passes a -1 value.

Weight

W_i

Weight

Weights are calculated as statistical correlations among a set of geographically defined cells within a control area.

STATEMENT OF THE PROBLEM

The integrated logic circuit devised for tabular humate uranium deposits represented more than 100 geologic characteristics combined within a complex logical framework (Granger and others, 1980). In the development of this circuit, numerous trial arrangements of the characteristics were considered before the final one was accepted. For each trial, it was extremely helpful to have the current version of the circuit displayed in graphic form. The problem was to display a circuit quickly and easily. The problem was resolved by using a computer program that was available on the Tektronix 4081 Graphics System.

TEKTRONIX SYSTEM

The Tektronix 4081 Graphics System used consists of:

1. A CRT (cathode-ray-tube) display screen and keyboard with joyswitch for data entry.
2. A 64k-word minicomputer with tape cassette unit for Initial Program Load (IPL).
3. Two floppy disc drives.
4. Two hard disc drives.
5. Two digitizer tablets (large and small) with cursor.
6. One 4663 plotter for generating plots from plot files.
7. One hard-copy unit to copy image from display screen.

The minimum components needed for operating the program are the CRT display, minicomputer, a disc drive, a plotter (Tektronix 4662 or 4663), and a digitizing tablet with cursor.

USERS' GUIDE

The sections which follow describe how integrated logic circuits are generated on the Tektronix 4081 Graphics System from circuits drawn by hand. It can be assumed that the hardware configuration has been installed on a permanent basis and, therefore, that a user need be familiar only with the power up procedure. It is further assumed that the appropriate IPL tape is available.

System Power Up Procedure

The user must first turn on the main power switch at the left side of the console (above the recorder). Next, the hard-disc unit(s) are turned on by the following steps:

(a) press power switch "On"

(b) wait for "Load" light

(c) press Load/Run button to "Run"

(d) wait for "Ready" light

IMPORTANT - When all work is completed and before turning main power switch off, the user must turn off power to the hard disc(s) by following the above steps in reverse order with reverse settings. Failure to follow these steps observe the above may result in serious disc-drive damage.

System Load Procedure

1. Insert the "USGS GOS IPL 4 hard disc" cassette.
2. Press the "IPL" button on the front of the cassette drive.
   After the tape has been read in, a response of - "GOS Version 4 Level Ø2" will appear on the screen. (A different Level number may appear if the system is updated.)

At this time, all necessary peripheral control programs have been called that allow communication between the user and the computer.

Prompts, which appear on the screen for user input at the keyboard, are listed below with their meanings.

#	This character will appear on the left side of screen when the system is at command level.
$	When the system is at command level and a request is entered without designating a file or default device, this character will appear as a prompt, to request a filename.
*	This character will appear at the lower left corner of screen while the user is in the Graphic Function Manager (GFM) mode to prompt the user for a GFM entry using the keyboard or cursor. Any responses from GFM will also appear on this line.

During a session, the user will occasionally need to enter an input filename or identify a unique name as an output file. In this report, parentheses ( ) are used to contain these names, but should not be entered by the user. Brackets [ ] contain optional standard filename extensions and also should not be entered by the user.

Each input line from the user should be followed by pressing the carriage return (CR) button.

By pressing the "reset page" button, the user can erase the screen contents. This is helpful just before a picture is displayed or if the screen fills up with computer/operator responses.

The example session that follows illustrates the dialogue between the GFM/Logic program and the user, who responds either by keyboard or cursor control. Under the user's one-line input is a brief description of what the command does.

If the user enters an unacceptable command, the computer will respond with "filename.OBJ not found!" and allow another entry.

Program Load Procedure

screen: GOS Version 4 Level Ø2

#

user: ipl gfmdk[.sav]

Loads the gfm routines from user-defined default hard disc.

screen: GOS Version 4 Level ØØ (GFMdk)

#

user: gfm

Calls the Graphic Function Manager package.

screen: Plot 8Ø/GFM Version 4 Level Ø2

*

User may now enter GFM commands or do the following steps for calling the Logic routines. If Logic is loaded, GFM commands may still be entered at the keyboard.

Logic Menu Load Procedure

user: workspace load logic

This loads the logic circuit elements, as well as the logic menu for selecting them, into the workspace.

A crosshair now appears on the screen. This crosshair indicates the position of the cursor on the tablet and is controlled by gentle movement of the cursor over the tablet. The crosshair position is recorded whenever the cursor is firmly pressed. If this position corresponds

to a menu box, the contents of that box are executed if an instruction, or selected if a symbol.

Place printed copy of menu on the tablet surface.

screen: *

user: menushift

An image of the menu boxes now appears on the CRT screen (which also replicates the tablet surface).

Because the screen image is unlikely to be aligned with with respect to the tablet menu, the following commands are issued to cause them to coincide.

Logic Menu Alignment

screen: * Locate menu corner

user:
1. Move crosshair to lower left corner of lower left box on screen (by using cursor on tablet).
2. Press cursor to record point.

screen: * Locate opposite corner

user:
1. Move crosshair towards upper right of screen to enclose the menu boxes just within the crosshair lines (point may be off screen at top).
2. Press cursor to record point.

screen: * Locate new minimum menu.

user: On hard-copy menu, press cursor at lower left corner of lower left box.

screen: * Position menu

user: On hard-copy menu, press cursor at upper right corner of upper right box.

User is now ready to begin or edit a drawing.

Figure 1 is the menu used for constructing integrated logic circuits.

If this menu is not available, see "Plotting the Logic Menu" in this paper.

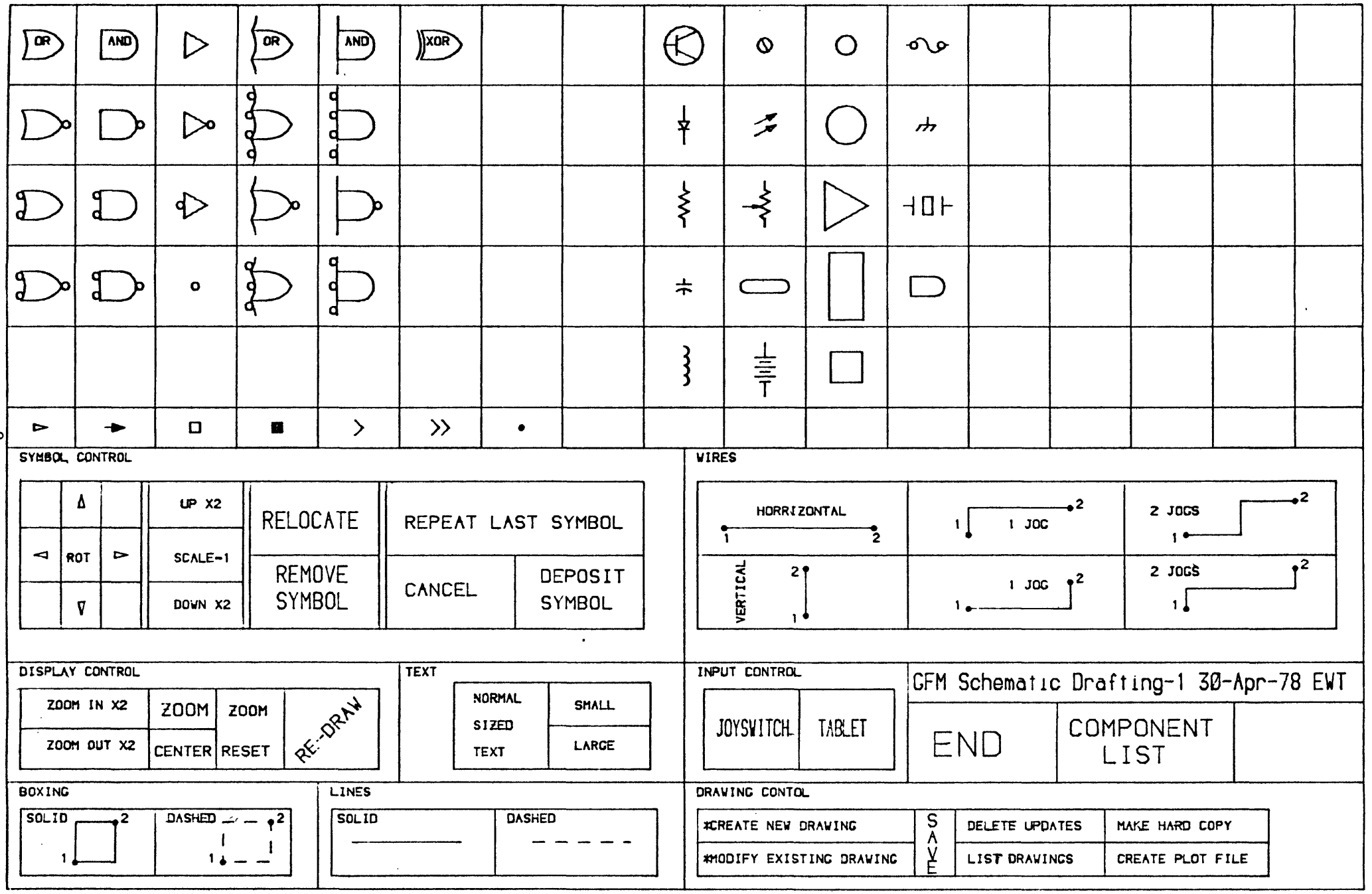


Figure 1.--Menu used for constructing integrated logic circuits.

Creating or Updating a Picture

Creating a New Drawing

user: Using the cursor, the user should first select the "create new drawing" box.

screen: new

user: (unique file name)
Following the "new" prompt, the user should enter a unique file name to identify the drawing.

screen: A drawing border will appear, as a guide to the user.

user: The user should select the "save" box.
This command will store the file on disc.

screen: Done

To construct an appropriate logic circuit, the user selects Or-gate, And-gate, or Not symbols from the logic menu and positions them on the screen by using the tablet and cursor.

Updating an Existing Drawing

user: display (file)[.pdb]
Displays the latest update of the drawing for modification.
The user may now begin to add symbols.
Symbol selection is a two-step procedure.

1. Using the tablet, press cursor within the box containing the needed symbol.
2. While viewing the screen, slightly touch the cursor on the tablet and move the selected symbol to the proper position; then press cursor.

Remember to select the "save" box occasionally. You must select it as the last response before ending, so updates are stored.

Via the menu and keyboard, the lines and text are inserted in place and any other desired elements are created and added to complete the drawing. Logic stores a set of these drawings in a library file called drawin.lib, and the user can display and edit these without extracting them from the library.

Figure 2 is an example of a picture data-base file when completed.

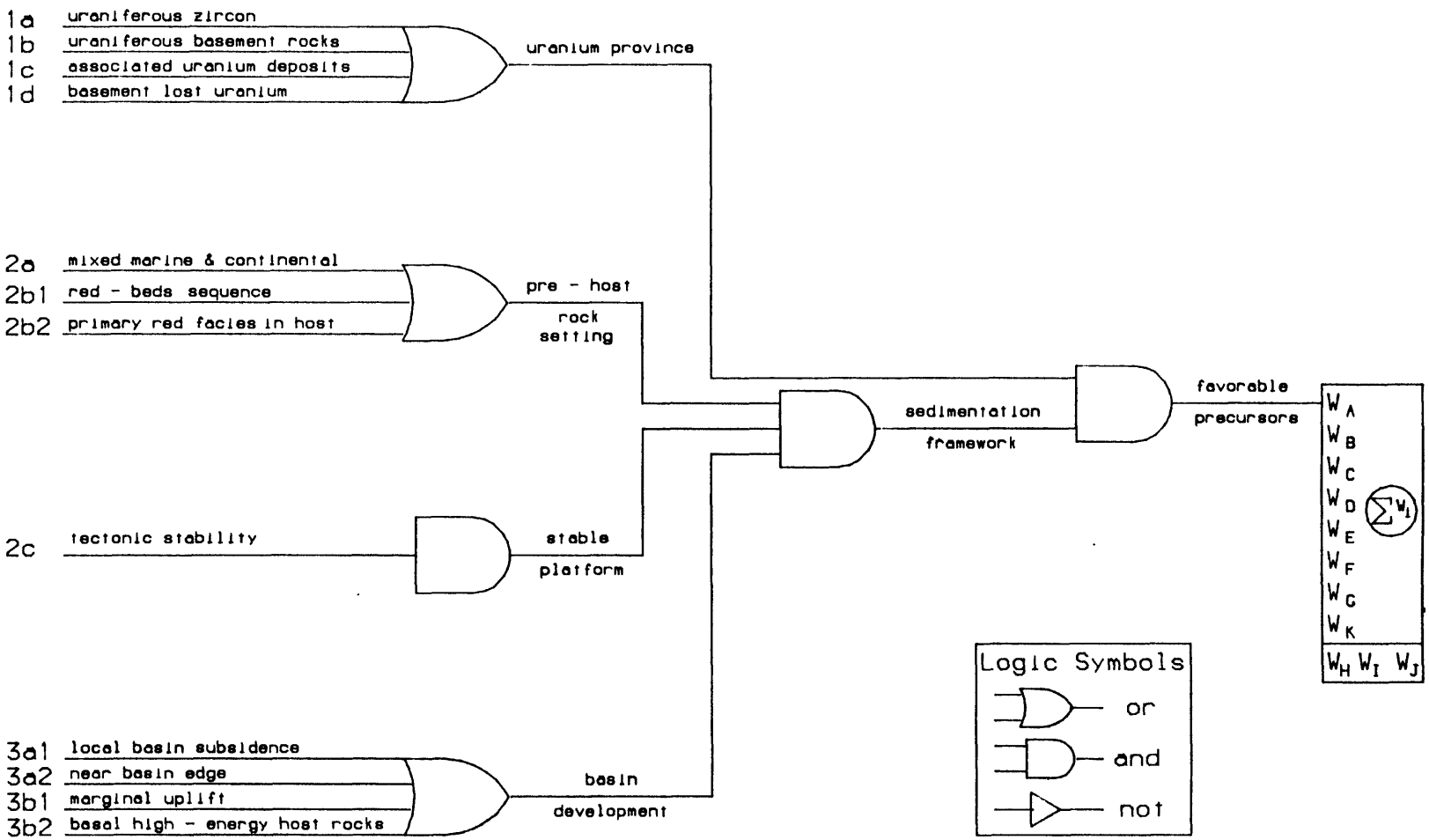


Figure 2.-- An example of an integrated logic circuit

Converting Picture Files To Plot Files

To convert one or more drawings from the picture data-base (.pdb) file to a plot (.plt) file, the following commands are entered while in the GFM routine:

screen: *

user: use display (filename).plt

This command creates a plot file on the default user disc (DK1). The filename should be the same as the .pdb file to eliminate confusion, but the .plt extension must be added.

screen: *

user: display (filename)[.pdb]

Converts the .pdb file to a plot .plt file.

screen: *

IMPORTANT - At this time, the user must enter only one of the following two commands.

user: use display dc:

Closes previously displayed file so user can go to display level and create a plot file of next picture. This step is recommended if many plot files need to be created; otherwise, a separate entry into GFM is required for each drawing.

(or enter)

user: end

This command ends session.

Failure to do either command before displaying the next file will combine the two files and create a bad file.

Plotting a [.plt] File

(system commands)

Before the user issues the "plot (file).plt" command, the plotter must be readied to draw the plot (see "Using the Tektronix 4663 Plotter" below).

```
screen:         #
user:           ipl sys:gfmgos [.sav]
                Loads plot routines.
screen:         GOS Version 4 Level Ø2 (gfmgos)
                #
user:           plot (file)[.plt]
                Plots the .plt file
                Repeat the "plot" command for remaining files.
```

USING THE TEKTRONIX 4663 PLOTTER

The 4663 plotter connects directly to the 4081 and draws plots under its control. Pen types (fiber, liquid ink, liquid ball), pressure, and plot speeds are selectable. Many other parameters (media, formats, etc.) are selectable by a programmable card on the device. Maximum sheet size is 17" x 24".

For the circuit diagrams, it is recommended that plots be made with liquid ink on white paper at a data-transmission rate of 1200 baud.

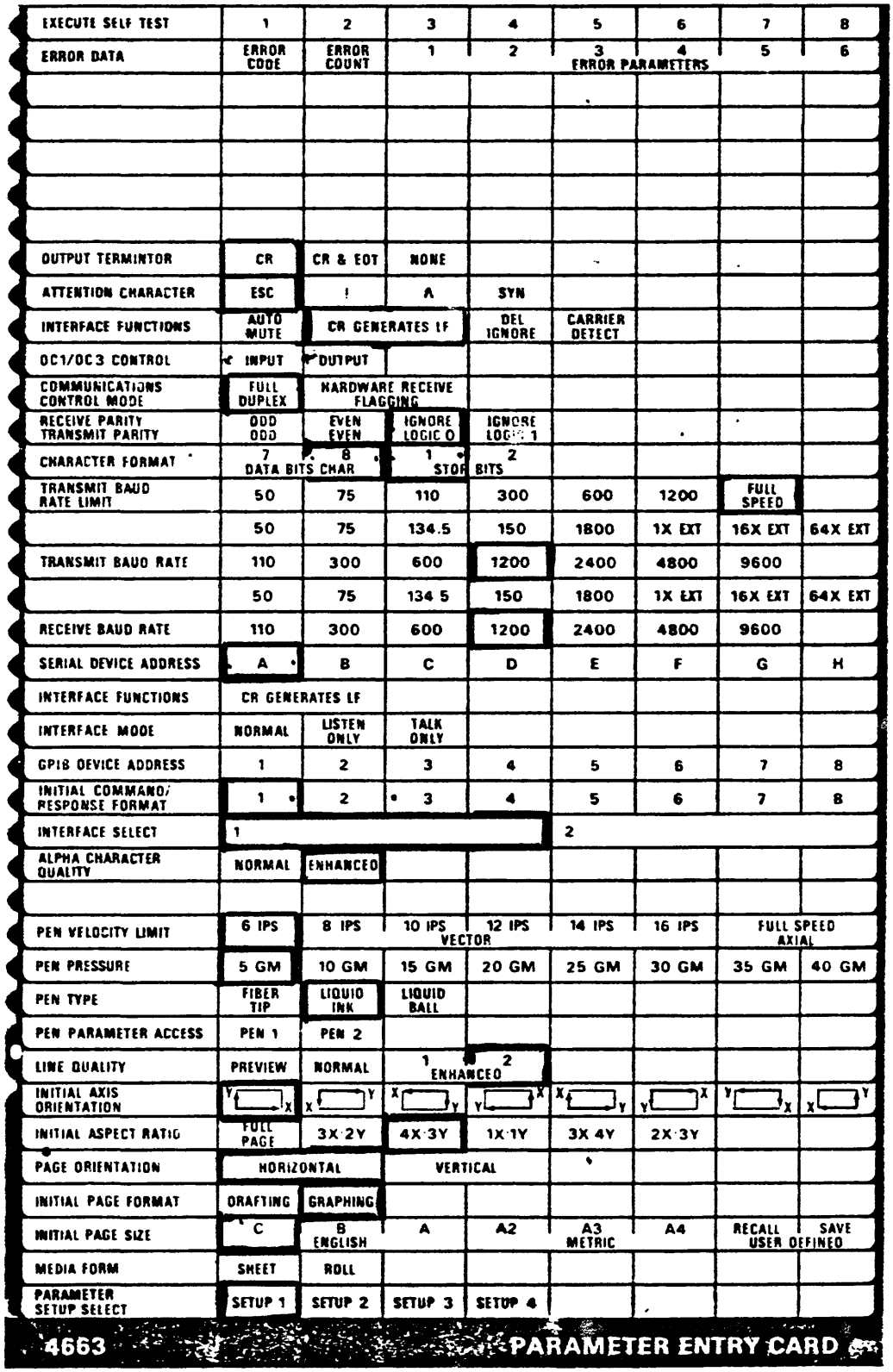
Plot Procedure

The plotter is controlled by front panel switches (which light when "on") and by an insertable program card for input/output and plotting parameters. As the card is moved in or out to each parameter position, the indicators light to show the current setting; to change the setting, push the proper indicators. When all parameters are set, push the card fully in to load them. (Figure 3 shows the parameter entry card on which appropriate settings are marked).

To ready plotter for a plot:

1. Turn front panel power switch to "On."
2. Set program card (as described above).
3. Set front panel interface switches to "On Line" and "Remote."
4. Press "Media Change" button and place paper in position on plotting surface. Press button back off when paper is ready.
5. Insert pen in holder.
6. Press "Initialize" to ready plotter for plot.
7. Type plot commands to make plot.
8. At finish of plot, repeat steps 4, 6, and 7 to make additional plots.

When finished plotting, remove pen and turn plotter power switch to "Off."



EXECUTE SELF TEST	1	2	3	4	5	6	7	8
ERROR DATA	ERROR CODE	ERROR COUNT	1	2	3 ERROR PARAMETERS	4	5	6
OUTPUT TERMINTOR	CR	CR & EOT	NONE					
ATTENTION CHARACTER	ESC	!	A	SYN				
INTERFACE FUNCTIONS	AUTO MUTE	CR GENERATES LF		DEL IGNORE	CARRIER DETECT			
OC1/OC3 CONTROL	INPUT	OUTPUT						
COMMUNICATIONS CONTROL MODE	FULL DUPLEX	HARDWARE RECEIVE FLAGGING						
RECEIVE PARITY TRANSMIT PARITY	ODD ODD	EVEN EVEN	IGNORE LOGIC 0	IGNORE LOGIC 1				
CHARACTER FORMAT	7 DATA BITS	8 CHAR	1 STOP	2 BITS				
TRANSMIT BAUD RATE LIMIT	50	75	110	300	600	1200	FULL SPEED	
	50	75	134.5	150	1800	1X EXT	16X EXT	64X EXT
TRANSMIT BAUD RATE	110	300	600	1200	2400	4800	9600	
	50	75	134 5	150	1800	1X EXT	16X EXT	64X EXT
RECEIVE BAUD RATE	110	300	600	1200	2400	4800	9600	
SERIAL DEVICE ADDRESS	A	B	C	D	E	F	G	H
INTERFACE FUNCTIONS	CR GENERATES LF							
INTERFACE MODE	NORMAL	LISTEN ONLY	TALK ONLY					
GPIB DEVICE ADDRESS	1	2	3	4	5	6	7	8
INITIAL COMMAND/ RESPONSE FORMAT	1	2	3	4	5	6	7	8
INTERFACE SELECT	1				2			
ALPHA CHARACTER QUALITY	NORMAL	ENHANCED						
PEN VELOCITY LIMIT	6 IPS	8 IPS	10 IPS VECTOR	12 IPS	14 IPS	16 IPS	FULL SPEED AXIAL	
PEN PRESSURE	5 GM	10 GM	15 GM	20 GM	25 GM	30 GM	35 GM	40 GM
PEN TYPE	FIBER TIP	LIQUID INK	LIQUID BALL					
PEN PARAMETER ACCESS	PEN 1	PEN 2						
LINE QUALITY	PREVIEW	NORMAL	1 2 ENHANCED					
INITIAL AXIS ORIENTATION	Y X	X Y	X Y	Y X	X Y	Y X	Y X	X Y
INITIAL ASPECT RATIO	FULL PAGE	3X·2Y	4X·3Y	1X·1Y	3X 4Y	2X·3Y		
PAGE ORIENTATION	HORIZONTAL		VERTICAL					
INITIAL PAGE FORMAT	DRAFTING	GRAPHING						
INITIAL PAGE SIZE	C	B ENGLISH	A	A2	A3 METRIC	A4	RECALL USER DEFINED	SAVE
MEDIA FORM	SHEET	ROLL						
PARAMETER SETUP SELECT	SETUP 1	SETUP 2	SETUP 3	SETUP 4				

4663 PARAMETER ENTRY CARD

Figure 3.--Parameter entry card on which appropriate settings are marked.

Plotting the Logic Menu

If the menu for constructing logic circuits is not available, it can be easily plotted, by use of the two plot files (menu.plt and logicl.plt) on the default (DK1) hard disc. The user should first prepare the plotter by following the steps under "Plot Procedure."

Then enter:

```
# plot menu
```

When this plot is completed, leave the paper in position and enter:

```
# plot logicl
```

CREATING A CIRCUIT COMPOSITE

The large circuit diagrams for an entire deposit are formed by combining modules, each consisting of a separate plot file of a smaller circuit element, such as "source of material," "transport conditions," or titles and legends.

Plotting

Each module is plotted separately. This allows for plotting at maximum size to obtain clear lettering and fine detail, as well as for any size or scale adjustment necessary.

Xerox Reduction

Each module plot is reduction copied (on a Xerox 2080) to the proper size for the composite. These copies are examined for legibility and quality.

Paste-Up

The reduced plots are mounted on a background sheet in the desired arrangement and any connecting lines or other features are drafted in.

Final Copy

The finished paste-up is used to make photocopies for distribution, or is used to make a film positive for ozalid reproduction. An example of a final copy of an integrated logic circuit is shown in Plate I of Granger and others (1980).

REFERENCES CITED

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