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JKDIGIT, A Program to Control a  
Digitizing Board for Geologists,  
Written in BASIC for an  
IBM Personal Computer

U.S. GEOLOGICAL SURVEY BULLETIN 1616





# JKDIGIT, A Program to Control a Digitizing Board for Geologists, Written in BASIC for an IBM Personal Computer

By John O. Kork

*A computer program enabling geologists to  
transfer information from maps to computer  
files using only a microcomputer*

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# JKDIGIT, a Program to Control a Digitizing Board for Geologists, Written in BASIC for an IBM Personal Computer

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## Abstract

JKDIGIT is a computer program that enables geologists to transfer information from maps to computer files using only a microcomputer to control the digitizing board. Data can be digitized directly into Cartesian or geodetic coordinates, and a variety of types of identification can be associated with the digitized location. The program is written in BASIC for an IBM Personal Computer, but the code is well documented and modular so that it can be modified by a programmer for different microcomputers. Complete documentation also makes the program easy for nonprogrammers to use. Digitized locations are written to a disk file in standard ASCII format and can be transferred to another computer or used for input to another program.

## INTRODUCTION

The program described in this report was written so that geologists would be able to transfer information from maps to computer files using only a microcomputer to control the digitizing board. Geologists often need to record digitized data in geodetic coordinates (latitude and longitude) so that maps can be drawn automatically using different map projections and scales. The programs supplied with the Houston Series 7000 digitizing board<sup>1</sup> allowed scaling only for Cartesian coordinates. Furthermore, those programs were written in FORTRAN for a PDP 11 computer, whereas this program was written in BASIC, a simpler language that can be used with most microcomputers. In this program, point identification labels of any length can be stored with the location coordinates, and lines as well as points can be digitized quickly and easily. The digitized coordinates along with an optional label are stored onto a computer disk file in

standard ASCII format and can be transferred to another computer or used for input to other programs.

The program was written in advanced BASIC for an IBM Personal Computer (PC) and can be executed with the interpreter or compiled. The hardware used includes the IBM PC with 128K RAM and an asynchronous communications port, with capability of executing programs in advanced BASIC. The operating system used to develop this program was PC-DOS, Version 1.1. The digitizer board must be equipped with a cursor capable of transmitting a different character for each of the 10 decimal digits and also for two additional characters (# and \*). No proprietary code is included, even in the compiled version, and hence a prospective user need not buy the BASIC compiler. At a slight cost in efficiency the program was written in highly modular form so that it could be modified for use on other microcomputer systems. Copious documentation is included with each subroutine to aid programmers trying to adapt the program to other systems; but because the program, including comments, is 102K bytes long, the comments must be removed before the program is loaded for interpreter execution. A loading routine which automatically removes the comments is part of the program.

This report includes the program documentation, which is presented in the text, and the complete source code and cross reference lists, which are presented in the appendixes. The documentation includes a brief description of how to merge the program modules for execution, a program description and user guide, and descriptions of program structure and subroutines. Users with access to an IBM PC and the required communications package will need to read only the first two sections. Users who want to modify the program to run on other microcomputers will find the descriptions of program structure and subroutines in the latter two sections useful.

The source code is given in Appendix 1, but is more readily available on diskette from the author. Appendixes 2-6 give various cross-reference lists that are of value to programmers.

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<sup>1</sup>Any use of trade names in this report is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.

## MERGING THE PROGRAM MODULES FOR EXECUTION

The program modules consist of a loading/merging driver program (JKMERGE), the main driver program (JKDIGDRV), and 18 subroutines; initially each of the modules is stored in a separate file on disk. Because the program modules contain extensive documentation, the result of merging them is a program that is too large to fit into the 64K bytes available to the BASIC interpreter. Hence as the modules are merged for execution, the comments must be removed. This merging and removal of comments need only be done once if the uncommented program is then saved in a disk file.

To load and merge the program, the user first loads the advanced BASIC interpreter, reserving 2048 bytes for an input buffer, by entering BASICA/C:2048 via the keyboard. Entering LOAD "JKMERGE" loads the merging program, and entering RUN begins execution. Merging the program modules and deleting comments takes about 10 minutes, and then the digitizer program starts. If the user saves the merged, uncommented program by entering SAVE "filename" after terminating the digitizing session, the program can be executed again just by entering BASICA/C:2048 filename.

The BASIC compiler will not compile a source program saved in binary form, and hence the user should save the merged program in ASCII form by entering SAVE "filename",A via the keyboard. Compiler switches used are /X, /D, /S, /O, and /C:4096; after linking the object module and IBMCOM.OBJ with the BASIC library, the program can be executed by entering the name of the execution module via the keyboard.

## PROGRAM DESCRIPTION AND USER GUIDE

The program is menu driven in the sense that all choices available to the user are listed in menus which are printed on the CRT screen at the appropriate time and the user is forced to choose digitizing parameters in the proper order. Each user response is checked at the time of entry to ensure that the selected parameter value is compatible with previously chosen parameter values. Each subordinate menu includes the option of returning to the main menu without making any parameter choice so that the user can always exit from the program without problems.

The first action taken by the program is to send to the digitizing board a signal for a two-second beep. This beep indicates that the board is turned on and connected properly. If the beep fails to sound, the user can correct the problem and send another beep request to ensure that the problem has been removed.

The main menu for selection of digitizing parameters and control information next appears on the CRT screen. Present status of the main menu options is indicated on the right in square brackets:

### MAIN MENU

- 1 Select Coordinate Type [NOT SELECTED]
- 2 Get Scaling Matrix [NOT SELECTED]
- 3 Select ID Type [NOT SELECTED]
- 4 Select Output File Name [NOT SELECTED]
- 5 Get Template Location Parameters [NOT LOCATED]
- 6 Select Roundoff Values [DEFAULT - .0000001, .0000001]
- 7 Validate Scaling [NOT VALIDATED]
- 8 Save Coordinate Scaling Parameters [NOT SAVED]
- 9 Save Template Scaling Parameters [NOT SAVED]
- 10 Select Beep Option [BEEP]
- 11 Select Printer Option [NO LPRINT]
- 12 Select Switch Stream Increment [DEFAULT .10]
- 13 Start Point Mode Digitizing [NOT DIGITIZING]
- 14 Start Switch Stream Mode Digitizing [NOT DIGITIZING]
- 15 Quit

Some of these choices must be made in a specific order, and others may be meaningless in the context of previous parameter choices. For example, scaling (option 2) cannot be accomplished until the coordinate type (option 1) has been chosen, and the scaling parameters cannot be saved in a file (option 8) until the scaling computations have been performed (option 2). Acceptable option choices are indicated by highlighting the options on the CRT screen. The main menu options are discussed in detail in the following sections, which are numbered to correspond to the numbers in the MAIN MENU.

#### 1. Select Coordinate Type

The six menu selections for coordinate type choices are:

- 1) real x-y scaled Cartesian coordinates
- 2) integer x-y scaled Cartesian coordinates
- 3) latitude and longitude in decimal degrees
- 4) latitude and longitude in degrees, minutes, and seconds
- 5) integer board coordinates (0.001-inch units)
- 6) return to main menu

Cartesian coordinates can include the decimal fraction or be rounded to integer values and are calculated and recorded in double precision. Geographic coordinates



can be saved in decimal degrees or in degrees, minutes, and seconds. Coordinate information is sent from the digitizing board to the microcomputer as integer values representing x-y displacement from the lower left corner of the board in units of 0.001 inches, and option 5 causes these values to be written to the output file with no scaling performed.

## 2. Get Scaling Matrix

The seven choices for scaling parameter options are:

- 1) enter parameters from the keyboard
- 2) read parameters from a previously saved file
- 3) digitize control points and calculate new parameters
- 4) register 7.5-minute quadrangle map
- 5) register 15-minute quadrangle map
- 6) register 2-degree sheet
- 7) return to main menu

If the user knows the numerical values of all the scaling parameters, option 1 allows them to be entered via the keyboard. This situation might occur if the user had saved the parameters on a disk file, recorded the values, and then deleted the file. The second choice, option 2, would be of value if the digitizing process had to be interrupted before completing all work on a map, and the map had not been moved before continuation of digitizing. A possible cause of this situation might be a power failure. The user is instructed to enter the name of the file in which the parameters are to be saved. This name is checked to ensure that it is of a form acceptable to the computer operating system, and then the extension ".DIG" is appended to the name. If a file with this name does not exist or if the file is not a coordinate-scaling parameter file, the user is so informed and can then try another name or return to the main menu by inserting a null file name (a carriage return alone). The parameters are read from the file, and the program returns to the main menu if no errors are detected.

Options 3, 4, 5, and 6 are for use whenever a new map is being digitized or when a previously scaled map has been moved on the digitizing board. Options 4, 5, and 6 can only be selected if the previously made coordinate type choice (main menu option 1) specified geographic coordinates. When using these options the user must digitize registration points with known user coordinates, and this information is used to calculate the scaling parameters. Using option 3 the operator can choose to have the scaling accomplished by least squares regression fitting of bilinear, biquadratic, or bicubic polynomials to the registration point data. A separate polynomial is fitted for the horizontal and the vertical coordinates. The form of the bicubic equations is:

$$\begin{aligned} X' &= A + BX + CY + DX^2 + EXY + FY^2 \\ &\quad + GX^3 + HX^2Y + IXY^2 + JY^3 \\ Y' &= K + LX + MY + NX^2 + OXY + PY^2 \\ &\quad + QX^3 + RX^2Y + SXY^2 + TY^3 \end{aligned} \quad (1)$$

where  $X'$  and  $Y'$  are in user coordinates and  $X$  and  $Y$  are raw board coordinates. The constants  $A-T$  are calculated using standard regression methods. The bilinear fit uses only the first three terms and the biquadratic fit uses only the first six terms of the equations (1). Bicubic polynomial fitting is automatically specified whenever options 4, 5, or 6 are chosen.

After selecting (if necessary) the degree of the polynomials to be fitted to the registration points, the user is instructed to digitize the registration points. The minimum number of points allowed for registration is 3 for bilinear, 6 for biquadratic, and 10 for bicubic fit. However, because the fitted polynomials, although they are reasonably regular functions, can have large variations, the use of as many registration points as possible is strongly suggested. This is particularly true when the bicubic polynomial fit is used. When using options 4, 5, or 6 (special map registration) the user is forced to use all the tick marks on the maps as registration points—16 points for 7.5- and 15-minute quadrangles and 25 points for 2-degree sheets. The advantage of choosing one of these three options is that the user coordinates of only the lower left hand corner of the map need be entered, and the user coordinates of the rest of the points can be calculated by the program. Of course, the user must then digitize the registration points from the map in a specified order—from lower left to upper right by rows as shown. The order of digitizing the points for 7.5- and 15-minute quadrangle maps is indicated by the numbers shown in the following diagram:

```

13--14--15--16
 9--10--11--12
 5-- 6-- 7-- 8
 1-- 2-- 3-- 4

```

The order of digitizing registration points for a 2-degree sheet is similar, but 25 rather than 16 points must be used.

Some general guidelines for choosing the registration points when option 3 has been chosen are:

- a. At least one-half of the registration points should be on or very near the boundary of the map or region to be digitized, spread as evenly as possible along this boundary.
- b. The remaining points (about 1/4 to 1/2 of the points) should be distributed as evenly as possible in the interior of the map.
- c. The nearest neighbor distances between control points (that is, the distance from a given point to the nearest other point) should be as uniform as possible.

- d. The first time a configuration of control points is used, there should be extensive use of the scaling validation option (main menu option 7).

The user indicates that all control points have been digitized by placing the cursor anywhere on the digitizing board and pressing the “\*” cursor button. User coordinates for the control points must then be entered via the keyboard in the same order that the control points were digitized. The program then displays the user coordinates and allows for correction of errors. After the necessary corrections have been made, the program calculates the scaling parameters and returns to the main menu. If the program is being executed through the interpreter, the regression calculations may take up to one minute for each coordinate.

When the program is executed for the first time after the digitizing board power is turned on, the input buffer from the board sometimes contains extraneous signals which will cause the program to indicate an error when the first point is digitized (usually this will occur when the first registration point is digitized). The program will stop and print the error message “Trouble in JKDIGBRD.” The only remedy is to start the program over by entering RUN via the keyboard. This problem has never occurred after the program has been restarted.

### 3. Select ID Type

The selections for ID type are:

- 1) keyboard input
- 2) cursor button input
- 3) constant ID—one push per point
- 4) cursor alphanumeric input
- 5) return to main menu

The ID associated with a location can consist of numbers (and possibly alphanumerics for options 1 and 4), preceded optionally by a fixed alphanumeric sequence that is the same for each location. The capability of including a fixed sequence of numbers and (or) letters was included because a geologist might want to be able to identify all points digitized from a given map after the coordinates from many maps have been merged into one file.

If the variable part of the ID is always to be numeric, option 2 can be used. The operator must place the cursor over the location to be digitized and press the cursor button for the leftmost digit of the variable part of the ID. The remaining digits are entered by placing the cursor anywhere on the map and pressing the proper cursor buttons in sequence. The location of the point is specified by the location of the cursor when the first digit is sent to the computer program. Pressing the “#” signals the program that the whole ID has been entered, at which time the user coordinates are calculated and displayed. The user can instruct the program to reject the point and not save the coordinates by pressing any cursor button

other than “0”. If the “0” button is pressed, the point is stored in the output file, and the program waits for the location and first ID digit of the next point to be digitized. The user can return to the main menu (for example to change the constant portion of the ID, to change the output file, or to terminate the digitizing session) by pressing the “\*” cursor button.

Option 1, keyboard input, operates in about the same manner as option 2. The location of the point being digitized is specified by pressing any cursor button other than “\*”, but only the location of the point is recorded. The variable part of the ID is entered via the keyboard and hence can include letters as well as numbers. Signals to end ID input and to accept or reject a point are also entered via the keyboard, and entering “\*” on the keyboard causes a return to the main menu. This method allows for character ID values but usually requires two operators—one at the digitizing board and one at the keyboard.

Option 3 specifies that only the constant part of the ID is to be recorded for each point, and the location is recorded without user verification of the calculated coordinates. This option is useful for digitizing lines by moving the cursor along the line in discrete steps and pressing any cursor button other than “\*” to have the point digitized. Pressing the “\*” button causes a return to the main menu.

Option 4, cursor alphanumeric input, allows the same freedom of choice for ID characters as option 1, but the letters and numbers in the variable part of the ID are entered by placing the cursor on the appropriate symbol on a template placed anywhere on the digitizing board and pressing any cursor button other than “\*” or “#”. The required configuration for the cursor template is shown in figure 1. The size and shape of the template shown in figure 1 can be changed as long as the relative positions of the characters remain the same and the outside boundary of the template is a rectangle. A copy of this template can be placed in any position on the board not covered by the map being digitized; the location is registered using main menu option 5. If ID type option 4 is selected, then option 5 (registration of the template) must be performed before digitizing can commence.

Even in the stream digitizing mode (main menu option 14) an ID type selection must be made. This choice is necessary so that the user can specify the constant portion of the ID.

### 4. Select Output File Name

This option is used to specify the file to which the digitized locations are to be stored and to open that file for output. If an output file has previously been selected (and thus opened), it is closed. The user is instructed to enter the file name for the digitized data. This file name is checked to ensure that it contains no more than eight

0	1	2	3	4	5	6	7	8	9
A	B	C	D	E	F	G	H	I	J
K	L	M	N	O	P	Q	R	S	T
U	V	W	X	Y	Z	-	+	#	*

**Figure 1.** Template layout showing order for digitizing registration points.

characters and has no file extension; the extension “.DIG” is appended to the name automatically. If the file name is acceptable but a file with that name already exists, the user is given the choice of appending data to the existing file, overwriting the file, or trying another file name. After all checks have been satisfied, the file is opened for output, and the program returns to the main menu. If a null file name (a carriage return alone) is inserted, the program returns to the main menu with the file status the same as it was when this option was selected.

#### 5. Get Template Location Parameters

If the selection of ID type (main menu option 3) is to insert the variable part of the ID via the cursor alphanumeric template, it is necessary to perform this option before proceeding to main menu options 6–14. The character template (fig. 1) must be fastened to the digitizing board, and the scaling menu discussed in section 2 is presented on the CRT screen with the map scaling options (options 4, 5, and 6) disabled. The user can insert the menu scaling parameters via the keyboard (selection 1), read the parameters from a previously saved file (selection 2), or digitize registration points and calculate the new parameter values (selection 3). If option value 2 is selected, the user is asked to insert the file name, and the program proceeds as described in section 2, except that the file must be a template-scaling parameter file instead of a coordinate-scaling parameter file. If the program finds that the specified file is not of the correct type, it closes the file and returns to the step of asking the user to insert a file name.

If the cursor template has been moved since the previous use or has never been mounted on the digitizing board, the user must select option value 3. The user is instructed to digitize in order the lower left, lower right, and upper left corners of the cursor template as shown by the digits outside the rectangle in figure 1. Any cursor button other than “\*” or “#” can be used to digitize

these points. After the third registration point is digitized, the program calculates the parameter values and returns to the main menu. A faulty template registration would be indicated by erroneous letters or numbers appearing in the variable portion of the ID after the point digitizing started (main menu option 13), at which time the user could exit from digitizing mode and register the menu again.

#### 6. Select Roundoff Values

Roundoff values are automatically set to 0.0000001 for both horizontal and vertical user coordinates when the program is first executed, but if the coordinate type selection (main menu option 1) is for integer x-y Cartesian coordinates or raw board coordinates, these values have no effect. For the other coordinate type choices, the real user coordinates are rounded to the precision specified. If the user selects this main menu option, the program requests that a horizontal and a vertical roundoff value be inserted via the keyboard. The program then returns to the main menu, and the real user coordinates of all subsequently digitized points will use these roundoff values. If the user coordinate scaling parameters are saved in a file for later use, the roundoff values are stored in that same file, so that when the scaling parameters are read back from the file, the roundoff values are reset to what they had been when the parameters were saved.

#### 7. Validate Scaling

The selections for scaling validation are:

- 1) try another validation point
- 2) scaling validation OK—return to main menu
- 3) scaling validation failed—return to main menu.

The user should select option value 1 as many times as necessary to ensure that the coordinate scaling parameters presently in effect cause the user coordinates to be calculated correctly for any point within the digitizing area. When option 1 is selected, the program requests that the user digitize a point with known user coordinates. The program then calculates the user coordinates and displays them on the CRT screen along with the three validation choices shown at the beginning of this section. The user can then select option 1 again or return to the main menu by selecting option 2 or 3. If the validation failed, the user can then return to main menu option 2 and get another set of scaling parameters.

#### 8. Save Coordinate Scaling Parameters

The user can save the coordinate scaling parameters in a file using this option. The file is an ASCII file and can thus be printed on a line printer for safekeeping. The user is instructed to insert a file name of eight characters or less with no file extension. The extension “.DIG” is appended to the name, and the program checks to see if a file with this name already exists. If no such file exists, the parameters are written to the file, and the program

returns to the main menu. If a file with this name already exists, the user can choose to append the parameters to the existing file, overwrite the file, or select another file name. A null file name (a carriage return alone) causes a return to the main menu.

#### 9. Save Template Scaling Parameters

The operation of this option is the same as that for main menu option 8 except that the template scaling parameters are written to the specified file.

#### 10. Select Beep Option

The IBM Personal Computer has the capability of sounding a short beep, and the digitizing program causes a beep to sound each time a cursor button is pressed. This option allows the user to choose not to have the beep sound; or, if the beep has been turned off, to turn it on again.

#### 11. Select Printer Option

If the computer configuration includes a printer, the user might want to obtain a hard copy of the digitized locations as the digitizing progresses. The default choice is not to have simultaneous printing, but the user can change from printing to non-printing or the reverse at any time using this option. If the user attempts to exercise the printer option for a configuration without a printer, or if the printer is not turned on, the program informs the user of printer troubles.

#### 12. Select Switch Stream Increment

This option has no effect until the switch stream incremental mode (main menu option 14) of digitizing has been selected. When operating in switch stream incremental mode, the digitizing board causes a new point to be digitized when any cursor button is moved from the open position to the depressed position, or when the button is held down and the cursor is moved a set distance on the board. The distance, in inches of board movement, that the cursor must be moved to cause transmission of the next point is called the switch stream increment. The default value for this increment is 0.10 inches, but the user can set it to 0.005, 0.01, 0.10, 0.20, 0.30, or 0.315 inches using option 12.

#### 13. Start Point Mode Digitizing

Selection of this option starts the actual digitizing operation. A digitizer action table (fig. 2) showing the current state of the digitizing process and the operation control signals available to the operator is placed on the CRT screen. This table shows the user coordinates and ID presently being processed and displays the action the user can take to control the process. The signal to exit from this mode is always the transmission of a "\*" to the computer via the keyboard, cursor button, or cursor alphanumeric template; however, not all three of these

DIG MODE: ID CONST:	ID MODE: NO PNTS:
X: Y: ID:	
GET NEW LOCATION crsr button crsr move	HALT DIGITIZING kybd * crsr * tmpl *
NEXT ID CHARACTER kybd (not CR) crsr (not #,*) tmpl (not #,*)	END ID INPUT kybd CR crsr # tmpl #
ACCEPT POINT kybd Y crsr 0 tmpl 0	REJECT POINT kybd N crsr (not 0,*) tmpl (not 0,*)

**Figure 2.** Layout of digitizer action table as it appears on CRT screen. Abbreviations: crsr, cursor entry; kybd, keyboard entry; tmpl, template entry.

devices can be exercised at all times. The available methods for transmission of the "\*" depend on the selected parameters, and the user is shown which methods are available by the appropriate selections being highlighted in the table. Exiting from this mode causes a return to the main menu.

When the program is being executed using the interpreter, it is possible that points could be transmitted to the computer faster than they can be processed. An input buffer of 2K bytes is assigned when the program is loaded properly, but the buffer still might get full. The user is informed of a pending buffer overflow by the computer playing "The Volga Boatman" through its speaker. When this tune is played, the user should stop digitizing and wait until the computer plays "When the Saints Go Marching In," indicating that the buffer has been cleared. The problem of buffer overflow has never occurred with the compiled version of the program.

#### 14. Start Switch Stream Mode Digitizing

In switch stream mode, new location information is digitized as discussed in section 12. Exit from this mode causes a return to the main menu.

#### 15. Quit

The choice of the option causes the program to close all files and end the digitizing session.

## PROGRAM STRUCTURE

The digitizing program consists of a main driver, JKDIGDRV, a loading program, JKMERGE, and 18 subroutine modules. The loading program loads the driver and subroutines in order, deleting the comments of a subroutine as the next subroutine is being merged. In this way the program, although 102K bytes long with comments, can be executed within the 64K byte limitation of the BASIC interpreter. The loading program also deletes from itself the commands that load the subroutines so that if the merged program (without comments) is saved on a disk file, it can be loaded and executed without the delay of the merging procedure. Program listing and documentation is given in Appendix 1. Appendix 2 lists a short macro program which uses the system COPY command to concatenate the subroutines, including comments, into a single file for listing the program. Documentation in the driver program includes the starting line number of each of the subroutines.

Control of the subroutine calling sequence is accomplished in lines 285 through 320 of the driver program. These lines form a "DO-WHILE" loop that cycles through the main menu selections, allowing the user to exercise control only with the proper sequence of operations. The present status, which determines which of the main menu selections are available, is stored in an integer variable, ST%. The actual specification of which main menu options can be selected is stored in a character array, ST\$, indexed by ST%.

As is usual in BASIC programs, all variables are defined globally—a situation which causes complications when setting values for control parameters for subroutines called from many different places in the program. For this reason a software stack was implemented so that as control is passed to a subroutine, the control parameters are stored in an integer stack array variable, VSTK%. Input values of these parameters are placed into an array, PRM%, immediately before the subroutine is called. The number of parameters is stored in PRM%(0), and the values are stored in PRM%(1), PRM%(2), ..., PRM%(PRM%(0)). The first statement in the called subroutine places these values into VSTK% and updates the stack pointer, ISTK%. These values are available within the subroutine using a user-defined function, FNSTK%, defined by

$$\text{FNSTK\%(I)} = \text{PRM\%(I)}, \text{ for } I = 1, 2, \dots, \text{PRM\%(0)}.$$

The parameter passing array, PRM%, can then be used to set parameter values for calling another subroutine before returning to the higher level program.

## SUBROUTINES

Documentation within each subroutine specifies the purpose of the routine, the meaning of input variables and returned variables, and internal variable names used. This documentation is included in the program listing in Appendix 1. Appendix 2 contains a system macro program to concatenate the program modules into the form shown in Appendix 1, and Appendices 3–6 contain cross reference information for programmers who want to modify the program. The 18 subroutines are discussed in the order in which they appear in the program listing.

1. JKNUMINP, beginning line number 1000, sets the parameters used by subroutine JKNUMENU, which actually prints the menu and checks the numerical response.

2. JKMNMENU, beginning line number 3000, sets parameters for the main menu. This subroutine is separate from JKNUMINP because the main menu is somewhat more complicated than the rest of the menus.

3. JKNUMENU, beginning line number 5000, displays a menu with acceptable responses highlighted and checks to ensure that the response is within the allowable range of values.

4. JKDIGUTL, beginning line number 7000, sets parameters for the menus and responses for the beep and printer options.

5. JKYESNO, beginning line number 9000, displays a question and requires a Y(es) or N(o) response.

6. JKVALSCL, beginning line number 11000, controls scaling validation. It displays the validation menu and calls subroutines to accept a digitized location from the board, calculate the user coordinates, and receive the user's response.

7. JKGETRND, beginning line number 13000, controls input of the roundoff factors.

8. JKFILPRM, beginning line number 15000, controls the input and output of both coordinate- and template-scaling parameters.

9. JKDIGFIL, beginning line number 17000, is used whenever a file name must be entered. It checks that the name is acceptable to the operating system, appends the extension ".DIG", and checks whether a file with that name already exists. If the file is to be used for output and a file with that name exists, the user can choose to append data to the file, overwrite the file, or try another file name. If the file is to be used as input but no file with that name exists, the user must try another file name. If no such file exists, the user is informed that a new file name must be chosen for input. Unless the file name entered is a null file name (a carriage return alone), the file is opened in this subroutine.

10. JKDIGDBL, beginning line number 19000, causes board coordinates to be accepted from the digitizing board and calculates the user coordinates using the appropriate scaling matrix. If coordinate scaling is specified, the returned values are in the form selected from the main menu option 1. For template scaling, the returned values are x-y coordinates between 0 and 1 representing the relative location of the cursor within the template rectangle. Internal subroutines perform round-off and ensure that the coordinates will not be printed in exponential format by the BASIC interpreter.

11. JKDIGBRD, beginning line number 21000, is the interface to the digitizing board. It returns raw board coordinates and a single character value representing the cursor button pressed. The only other program lines concerned with the digitizer board interface directly are line 24460 and lines 23200 through 23210 of JKGETPNT and lines 25750 through 25760 of JKINTVAR. The subroutine expects two numbers and a single character, separated by commas, to be sent from the board in ASCII form.

12. JKGETPNT, beginning line number 23000, is the main control routine for the actual digitizing process for both point and switch stream incremental modes. When main menu options 13 or 14 are selected, control is transferred to this subroutine, returning to the driver program only upon receipt of a "\*" cursor control signal from the digitizer board. An internal subroutine draws the digitizer action table and is probably the most machine-specific part of the digitizing program.

13. JKINTVAR, beginning line number 25000, initializes values of the variables, including the main menu option displays, but arrays are dimensioned and user

functions are defined in the driver program to satisfy BASIC compiler requirements. In this subroutine the signal requesting a two-second beep from the digitizing board is sent. Program lines 25750 and 25760 use the specific digitizer control codes.

14. JKSCCLCTL, beginning line number 27000, controls the scaling for both coordinate and template scaling.

15. JKREGRES, beginning line number 28000, performs least squares regression to calculate the scaling matrices for both coordinate and template scaling.

16. JKSCLCRD, beginning line number 29000, acquires both the board and user coordinate values used to calculate the scaling matrix.

17. JKSCCLKEY, beginning line number 31000, receives the scaling parameters when the keyboard input option is selected.

18. JKSTACK, beginning line number 35000, controls the software stack.

## CONCLUSION

This program was designed to provide geologists with an easily transportable program to control a digitizing board using a microcomputer. The BASIC programming language was selected because most microcomputers can execute programs in BASIC. Care was taken to include complete documentation and make the program easy for a nonprogrammer to use, and modular design techniques were used to make the program relatively easy for a programmer to understand.

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## APPENDIXES 1-6

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# Appendix 1. Commented listing of all modules in JKDIGIT.BAS

```

1 REM *****
3 REM &&& PROGRAM JKMERGE ***
5 REM *** LOADS DIGITIZING PROGRAM DRIVER AND SUBROUTINES, DELETING ***
7 REM *** COMMENTS IN PREVIOUSLY MERGED SUBROUTINES AS LATER ROUTINES ***
9 REM *** ARE BEING MERGED ***
11 REM *****
13 REM *** DATED: AUGUST 16, 1983 ***
15 REM *****
17 KEY OFF:WIDTH 40:FOR I%=1 TO 5:PRINT:NEXT I%
19 PRINT "          DIGITIZING PROGRAM"
21 PRINT "  FOR CARTESIAN OR GEODETIC COORDINATES"
23 PRINT:PRINT "          BY"
25 PRINT:PRINT "          JOHN O. KORK"
27 PRINT "          U.S. GEOLOGICAL SURVEY"
29 PRINT "          P.O. BOX 25046, DFC, MS 937"
31 PRINT "          DENVER, COLORADO 80225"
33 PRINT "-----"
35 PRINT "DELETING COMMENTS BEFORE INITIALIZATION"
37 PRINT "PLEASE WAIT FOR A COUNT OF 21.":I%=1
39 GOSUB 87:CHAIN MERGE "JKDIGDRV",41,ALL
41 GOSUB 87:CHAIN MERGE "JKNUMINP",43,ALL,DELETE 110-375
43 GOSUB 87:CHAIN MERGE "JKMMMENU",45,ALL,DELETE 1010-1210
45 GOSUB 87:CHAIN MERGE "JKNUMENU",47,ALL,DELETE 3020-3380
47 GOSUB 87:CHAIN MERGE "JKDIGUTL",49,ALL,DELETE 5020-5260
49 GOSUB 87:CHAIN MERGE "JKYESNO",51,ALL,DELETE 7020-7220
51 GOSUB 87:CHAIN MERGE "JKVALSCL",53,ALL,DELETE 9020-9130
53 GOSUB 87:CHAIN MERGE "JKGETRND",55,ALL,DELETE 11020-11270
55 GOSUB 87:CHAIN MERGE "JKFILPRM",57,ALL,DELETE 13020-13040
57 GOSUB 87:CHAIN MERGE "JKDIGFIL",59,ALL,DELETE 15020-15440
59 GOSUB 87:CHAIN MERGE "JKDIGDBL",61,ALL,DELETE 17020-17370
61 GOSUB 87:CHAIN MERGE "JKDIGBRD",63,ALL,DELETE 19020-19630
63 GOSUB 87:CHAIN MERGE "JKGETPNT",65,ALL,DELETE 21020-21080
65 GOSUB 87:CHAIN MERGE "JKINTVAR",67,ALL,DELETE 23010-23285
67 GOSUB 87:CHAIN MERGE "JKSCLCTL",69,ALL,DELETE 25020-25440
69 GOSUB 87:CHAIN MERGE "JKREGRES",71,ALL,DELETE 27010-27255
71 GOSUB 87:CHAIN MERGE "JKSCLCRD",73,ALL,DELETE 28020-28260
73 GOSUB 87:CHAIN MERGE "JKSCLKEY",75,ALL,DELETE 29020-29450
75 GOSUB 87:CHAIN MERGE "JKSTACK",77,ALL,DELETE 31020-31260
77 GOSUB 87:CHAIN MERGE "NUL",79,ALL,DELETE 35020-35150
79 GOSUB 87:CHAIN MERGE "NUL",81,ALL,DELETE 24005-24080
81 WIDTH 80
82 PRINT "MERGE COMPLETE - SUGGEST SAVING MERGED PROGRAM FOR FURTHER USE"
83 CHAIN MERGE "NUL",85,ALL,DELETE 1-15
85 CHAIN MERGE "NUL",89,ALL,DELETE 35-87

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

87 LOCATE 19,1:PRINT "***** ";I%;" *****";:I%=I%+1:RETURN
89 PRINT:PRINT "PRESS ANY KEY TO START PROGRAM"
91 A$=INKEY$:IF A$="" GOTO 91
100 REM *****
105 REM &&& PROGRAM JKDIGDRV ***
110 REM *** DRIVER FOR DIGITIZER PROGRAM ***
115 REM *****
120 REM *** DATED: AUGUST 10, 1983 ***
85 CHAIN MERGE "NUL",89,ALL,DELETE 35-87
85 CHAIN MERGE "NUL",89,ALL,DELETE 35-87
110 REM *** DRIVER FOR DIGITIZER PROGRAM ***
115 REM *****
120 REM *** DATED: AUGUST 10, 1983 ***
125 REM *****
130 REM *** PROGRAMMED BY: ***
135 REM *** JOHN O. KORK ***
140 REM *** BRANCH OF RESOURCE ANALYSIS ***
145 REM *** U. S. GEOLOGICAL SURVEY ***
150 REM *** MAIL STOP 937, DENVER FEDERAL CENTER ***
155 REM *** DENVER, CO 80225 ***
160 REM *****
165 REM *** VARIABLE LIST ***
170 REM *** I%,J% LOOP INDICES ***
175 REM *** FLMOD% FILE OPENING MODE ***
180 REM *** IRET%,IRET1% : RETURNED VALUES FROM SUBROUTINES ***
185 REM *** MSG$(*) ARRAY FOR MESSAGES ***
190 REM *** PRM1$,PRM2$ : VARIABLES FOR PASSING CHARACTER ***
195 REM *** PARAMETERS TO SUBROUTINES ***
200 REM *** IDCHR$ CONSTANT PORTION OF PRESENT ID ***
205 REM *** SEE SUBROUTINE JKINTVAR FOR ***
210 REM *** BPON,CLD%(),CLO%(),CLR%(),DAT$(),DATX%(),DATY%(),FALSE, ***
215 REM *** INCR$(),INCR%(),INCS$(),LPON,M1$(),MDF%(),MKR$(), ***
220 REM *** MSEL%(),RNUM%(),ST$(),ST%,TRUE ***
225 REM *** SEE SUBROUTINE JKSCCLCTL FOR ***
230 REM *** A#(),AX#(),CDEG%(),CX#(),CY#(),MFIL$,SFIL$,TX#(),TY#(), ***
235 REM *** XBOFF,XROUND#,XUOFF#,YBOFF,YROUND#,YUOFF# ***
240 REM *** SEE SUBROUTINE JKSTACK FOR ***
245 REM *** FNRET%(),FNSTK%(),ISTK%,NTSK%,PRM%(),VSTK% ***
250 REM *** SEE SUBROUTINE JKGETPNT FOR ***
255 REM *** LA(),LO(),NPTS%,OFIL$ ***
260 REM *** SEE SUBROUTINE JKNUMENU FOR ***
265 REM *** M$(),MSGB$(),MSGT$() ***
270 REM *** SEE SUBROUTINE JKREGRES FOR P%() ***
275 GOTO 380
280 REM *** SUBROUTINES CALLED ***
285 GOTO 780 'subroutine jknuminp ***
290 GOTO 3000 'subroutine jkmmenu ***

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

295 GOTO 5000      'subroutine jknumenu      ***
300 GOTO 7000      'subroutine jkdigutl      ***
305 GOTO 9000      'subroutine jkyesno      ***
310 GOTO 11000     'subroutine jkvalsc1      ***
315 GOTO 13000     'subroutine jkgetrnd      ***
320 GOTO 15000     'subroutine jkfilprm      ***
325 GOTO 17000     'subroutine jkdigfil      ***
330 GOTO 19000     'subroutine jkdigdbl      ***
335 GOTO 21000     'subroutine jkdigbrd      ***
340 GOTO 23000     'subroutine jkgetpnt      ***
345 GOTO 25000     'subroutine jkintvar      ***
350 GOTO 27000     'subroutine jksc1ctl      ***
355 GOTO 28000     'subroutine jkregres      ***
360 GOTO 29000     'subroutine jksc1crd      ***
365 GOTO 31000     'subroutine jksc1key      ***
370 GOTO 35000     'subroutine jkstack      ***
375 REM *****
380 CLS:WIDTH 80:PRINT "INITIALIZING - - WAIT"
385 DIM M1$(15),M$(15),MSEL%(14),MDF%(14),MKR$(14,6),A#(11,11),AX#(25,11)
390 DIM CX#(9,1),CY#(9,1),TX#(25),TY#(25),MSG$(10),MSGT$(10),MSGB$(10)
395 DIM RNUM%(3),LA(25,3),LO(25,3),XBOFF(1),YBOFF(1),XUOFF#(1),YUOFF#(1)
400 DIM VSTK%(20),INCS$(8),INCR$(8),CDEG%(2),P%(11),PRM%(10)
405 DIM DAT$(3,2,3),CLR%(3,2,3),DATX%(3,2,3),DATY%(3,2,3)
410 DIM CLD%(3,2,3),CLO%(3,2,3),ST$(6)
415 DEF FNSTK%(I%)=VSTK%(ISTK%-VSTK%(ISTK%)+I%-1)
420 DEF FNRET%(I%)=ISTK%-VSTK%(ISTK%)+I%-1
425 GOSUB 25000      'gosub jkintvar
430 IF IRET%=3 THEN PRINT "ABNORMAL TERMINATION":GOTO 875
435 WHILE TRUE
440 ST%=1
445 IF MSEL%(1) < MDF%(1) THEN ST%=2
450 IF ST% = 2 AND MSEL%(2)<MDF%(2) THEN ST%=3
455 IF ST%=3 AND MSEL%(3)<MDF%(3) AND MSEL%(4)<MDF%(4) THEN ST%=4
460 IF ST%=4 AND (MSEL%(3) <> 4 OR CDEG%(0)<>0) THEN ST%=5
465 GOSUB 3000      'gosub jknummenu
470 ON IRET% GOSUB 480,525,565,590,615,645,660,675,690,705,725,745,760,780,815
475 WEND
480 'get coordinate type selection
485 PRM%(0)=1:PRM%(1)=MSEL%(1):GOSUB 35000      'gosub jkstack
490 PRM%(0)=1:PRM%(1)=1:GOSUB 1000      'gosub jknuminp
495 IF IRET%=6 GOTO 520
500 MSEL%(1)=IRET%:I%=FNSTK%(1):J%=IRET%
505 IF I%<=2 AND J%<=2 GOTO 520
510 IF (I%=3 OR I%=4) AND (J%=3 OR J%=4) GOTO 520
515 MSEL%(2)=MDF%(2):MSEL%(7)=MDF%(7):SFIL$="":MSEL%(8)=MDF%(8)
520 NSTK%=NSTK%-1:ISTK%=FNSTK%(0):RETURN
525 'get coordinate scaling parameters

```

**Appendix 1.** Commented listing of all modules in JKDIGIT.BAS—Continued

```

530 PRM%(0)=1:PRM%(1)=MSEL%(1):GOSUB 27000 'gosub jksclctl
535 IF IRET%=5 THEN RETURN
540 MSEL%(7)=MDF%(7):IF IRET% <= 2 GOTO 555
545 MSEL%(2)=MDF%(2):IF IRET%=3 THEN RETURN
550 XROUND#=0:YROUND#=0:MSEL%(6)=MDF%(6):SFIL$="":MSEL%(8)=MDF%(8):RETURN
555 MSEL%(2)=1:IF IRET%=1 THEN SFIL$="":MSEL%(8)=MDF%(8):RETURN
560 MSEL%(6)=1:MSEL%(8)=1:RETURN
565 'get ID type choice
570 PRM%(0)=1:PRM%(1)=3:GOSUB 1000:MSEL%(3)=IRET% 'gosub jknuminp
575 CLS:PRINT:PRINT "THE ID CAN HAVE CONSTANT CHARACTERS AT THE BEGINNING."
580 PRINT:PRINT "INSERT CONSTANT CHARACTERS (OR JUST CR TO RETURN): ";
585 INPUT IDCHR$:RETURN
590 'get output file name and open
595 PRM%(0)=2:PRM%(1)=1:PRM%(2)=2:PRM1$="OUTPUT FILE NAME"
600 GOSUB 17000 'gosub jkdigfil
605 IF IRET%=1 THEN NPTS%=0
610 MSEL%(4)=IRET%:OFIL$=PRM2$:FLMOD%=IRET1%:RETURN
615 'get template location parameters
620 PRM%(0)=1:PRM%(1)=0:GOSUB 27000 'gosub jksclctl
625 IF IRET%=5 THEN RETURN
630 IF IRET%=1 THEN MSEL%(5)=1:MFIL$="":MSEL%(9)=MDF%(9):RETURN
635 IF IRET%=2 THEN MSEL%(5)=1:MSEL%(9)=1:MFIL$=PRM2$:RETURN
640 MSEL%(5)=MDF%(5):CDEG%(0)=0:RETURN
645 'get roundoff parameters
650 GOSUB 13000 'gosub jkgetrnd
655 MSEL%(6)=1:RETURN
660 'validate coordinate scaling parameters
665 PRM%(0)=1:PRM%(1)=MSEL%(1):GOSUB 11000 'gosub jkvalsc1
670 MSEL%(7)=IRET%:RETURN
675 'save coordinate scaling parameters in file
680 PRM%(0)=3:PRM%(1)=1:PRM%(2)=2:PRM%(3)=MSEL%(1):GOSUB 15000 'gosub jkfilprm
685 SFIL$=PRM2$:MSEL%(8)=IRET%:RETURN
690 'save menu placement parameters in file
695 PRM%(0)=3:PRM%(1)=1:PRM%(2)=1:PRM%(3)=MSEL%(1):GOSUB 15000 'gosub jkfilprm
700 MFIL$=PRM2$:MSEL%(9)=IRET%:RETURN
705 'select beep option
710 BPON=FALSE:PRM%(0)=1:PRM%(1)=1:GOSUB 7000 'gosub jkdigut1
715 MSEL%(10)=IRET%:IF IRET%=2 THEN BPON = TRUE
720 RETURN
725 'select line printer option
730 LPON=FALSE:PRM%(0)=1:PRM%(1)=2:GOSUB 7000 'gosub jkdigut1
735 MSEL%(11)=IRET%:IF IRET%=1 THEN LPON = TRUE
740 RETURN
745 'select switch stream increment value
750 PRM%(0)=1:PRM%(1)=8:GOSUB 1000 'gosub jknuminp
755 INCR%=IRET%:MSEL%(12)=1:RETURN
760 'start digitizing in point mode

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

765 PRM%(0)=3:PRM%(1)=MSEL%(1):PRM%(2)=MSEL%(3):PRM%(3)=2
770 GOSUB 23000 'gosub jkgetpnt
775 MSEL%(13)=1:MSEL%(14)=MDF%(14):RETURN
780 'start digitizing in switch stream mode
785 PRM%(0)=3:PRM%(1)=MSEL%(1):PRM%(2)=MSEL%(3):PRM%(3)=1:PRM1$=INCS$(INCR%)
790 GOSUB 23000 'gosub jsgetpnt
795 MSEL%(14)=1:MSEL%(13)=MDF%(13):RETURN
800 LPON=FALSE:PRM%(0)=1:PRM%(1)=2:GOSUB 7000 'gosub jkdigut1, printer option
805 MSEL%(11)=IRET%:IF IRET%=1 THEN LPON=TRUE
810 RETURN
815 'terminate digitizing program
820 CLS:PRINT "DIGITIZING PROGRAM TERMINATION"
825 PRINT:IF MSEL%(4)=1 THEN PRINT "LAST OUTPUT FILE WAS ";OFIL$
830 IF LEN(SFIL$) > 0 THEN PRINT "SCALE PARAMETERS SAVED IN ";SFIL$
835 IF LEN(MFIL$) > 0 THEN PRINT "TEMPLATE PARAMETERS SAVED IN ";MFIL$
840 PRINT:PRINT "NUMBER OF NEW POINTS IN OUTPUT FILE: ";NPTS%
845 IF NOT LPON GOTO 870
850 IF MSEL%(4)=1 THEN LPRINT:LPRINT "LAST OUTPUT FILE WAS ";OFIL$
855 IF LEN(SFIL$)>0 THEN LPRINT "SCALE PARAMETERS SAVED IN ";SFIL$
860 IF LEN(MFIL$)>0 THEN LPRINT "TEMPLATE PARAMETERS SAVED IN ";MFIL$
865 LPRINT "NUMBER OF NEW POINTS IN OUTPUT FILE: ";NPTS%
870 CLOSE
875 END
1000 REM *****
1005 REM &&& SUBROUTINE JKNUMINP ***
1010 REM *** FOR GETTING NUMERICAL KEYBOARD INPUT FROM MENU CHOICES ***
1015 REM *** FOR DIGITIZER PROGRAMS ***
1020 REM *****
1025 REM *** DATED: AUGUST 8, 1983 ***
1030 REM *****
1035 REM *** INPUT VARIABLES ***
1040 REM *** PRM%(0) NUMBER OF OTHER PARAMETERS ***
1045 REM *** PRM%(1) SPECIFIES WHICH MENU TO PRINT ***
1050 REM *** 1) COORDINATE TYPE SELECTION (1<=IRET%<=6) ***
1055 REM *** 2) SCALING PARAMETER INPUT TYPE (1<=IRET%<=7) ***
1060 REM *** 3) ID INPUT METHOD (1<=IRET%<=5) ***
1065 REM *** 4) SCALING VALIDATION CHOICE (1<=IRET%<=3) ***
1070 REM *** 5) FILE OPENING DECISION (1<=IRET%<=4) ***
1075 REM *** 6) DIGITIZER INITIALIZATION CHECK (1<=IRET%<=3) ***
1080 REM *** 7) DEGREE FOR REGRESSION SCALING (1<=IRET%<=4) ***
1085 REM *** 8) STREAM MODE DIGITIZING CHOICE (1<=IRET%<=8) ***
1090 REM *** INCR$(*) ARRAY OF STREAM DIGITIZING INCREMENTS ***
1095 REM *** MSK$ MASK SPECIFYING HIGHLIGHTING OF OPTIONS ***
1100 REM *** MSGT$(*) ARRAY OF TOP LINES ON MENU ***
1105 REM *** MSGT% NUMBER OF TOP LINES IN MENU ***
1110 REM *** PRM2$ FILE NAME FOR I/O MENU ***
1115 REM *** RETURNED VARIABLES ***

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

1120 REM ***      IRET%      RETURNED INTEGER FROM KEYBOARD INPUT      ***
1125 REM *** OTHER VARIABLES AND FUNCTIONS ***
1130 REM ***      BAS$      DESCRIPTION OF MENU CHOICE TYPE ***
1135 REM ***      FNRET%()  STACK RESETING FUNCTION ***
1140 REM ***      FNSTK%()  FUNCTION RETURNS INPUT PARAMETER VALUE ***
1145 REM ***      HIGH     COLOR VALUE FOR HIGHLIGHTING ***
1150 REM ***      I%       INDEX VARIABLE ***
1155 REM ***      ISTK%    STACK POINTER ***
1160 REM ***      LOW      COLOR VALUE FOR NON-HIGHLIGHTED OPTIONS ***
1165 REM ***      M$(*)    ARRAY OF MENU CHOICES ***
1170 REM ***      MAX%     LARGEST ALLOWABLE RETURN VALUE ***
1175 REM ***      MSGB%    NUMBER OF LOWER BASE LINES ON MENU ***
1180 REM ***      NSTK%    STACK LEVEL ***
1185 REM ***      TOP$     LINES TO BE PRINTED ABOVE MENU ***
1190 REM *** SUBROUTINES CALLED ***
1195 GOTO 1215
1200 GOTO 5000      'subroutine jknumenu ***
1205 GOTO 35000     'subroutine jkstack ***
1210 REM *****
1215 IF PRM%(0) <> 1 THEN PRINT "FATAL PARAMETER ERROR":STOP
1220 GOSUB 35000                                         'gosub jkstack
1225 WIDTH 80:MSGB%=0:HIGH=15:LOW=7
1230 ON FNSTK%(1) GOTO 1245,1300,1360,1405,1445,1495,1545,1590
1235 PRINT "PROGRAMING ERROR, NO MENU FOR PRM1% = ";FNSTK%(1):IRET%=0:GOTO 1620
1240 'menu for coordinate type selection *****
1245 MAX%=6:MSK$="111111":MSGT%=0
1250 M$(1)="REAL X-Y SCALED CARTESIAN COORDINATES"
1255 M$(2)="INTEGER X-Y SCALED CARTESIAN COORDINATES"
1260 M$(3)="LATITUDE AND LONGITUDE IN DECIMAL DEGREES"
1265 M$(4)="LATITUDE AND LONGITUDE IN DEG, MIN AND SEC (REAL)"
1270 M$(5)="INTEGER BOARD COORDINATES IN .001 IN. UNITS"
1275 M$(6)="RETURN TO MAIN MENU"
1280 TOP$="COORDINATE TYPE SELECTION MENU"
1285 BAS$="a highlighted coordinate type"
1290 GOSUB 5000:GOTO 1620                                'gosub jknumenu
1295 'menu for scaling parameter input*****
1300 MAX%=7:MSGT%=0
1305 M$(1)="ENTER PARAMETERS FROM KEYBOARD"
1310 M$(2)="READ PARAMETERS FROM A PREVIOUSLY SAVED FILE"
1315 M$(3)="DIGITIZE CONTROL POINTS AND CALCULATE NEW PARAMETERS"
1320 M$(4)="REGISTER 7.5 MIN QUAD"
1325 M$(5)="REGISTER 15 MIN QUAD"
1330 M$(6)="REGISTER 2 DEG SHEET"
1335 M$(7)="RETURN TO MAIN MENU"
1340 TOP$="SCALING SELECTION MENU"
1345 BAS$="a scaling option"
1350 GOSUB 5000:GOTO 1620                                'gosub jknumenu

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

1355 'menu for id input method*****
1360 MAX%=5:MSK$="1111":MSGT%=0
1365 M$(1)="KEYBOARD INPUT"
1370 M$(2)="CURSOR BUTTON INPUT"
1375 M$(3)="CONSTANT ID - 1 PUSH PER POINT"
1380 M$(4)="CURSOR ALPHANUMERIC INPUT"
1385 M$(5)="RETURN TO MAIN MENU"
1390 TOP$="MENU FOR ID INPUT METHOD"
1395 BAS$="an ID input option"
1400 GOSUB 5000:GOTO 1620                                'gosub jknumenu
1405 'menu for scaling validation*****
1410 MAX%=3:MSK$="111"
1415 M$(1)="TRY ANOTHER VALIDATION POINT?"
1420 M$(2)="SCALING VALIDATION OK - RETURN TO MAIN MENU"
1425 M$(3)="SCALING VALIDATION FAILED - RETURN TO MAIN MENU"
1430 TOP$="SCALING VALIDATION MENU"
1435 BAS$="a scaling validation option"
1440 GOSUB 5000:GOTO 1620                                'gosub jknumenu
1445 'menu for file opening choice*****
1450 MAX%=4:MSK$="1111":MSGT%=1
1455 MSGT$(1)="FILE "+PRM2$+" ALREADY EXISTS."
1460 M$(1)="CHOOSE A DIFFERENT FILE NAME"
1465 M$(2)="APPEND OUTPUT TO THIS FILE"
1470 M$(3)="OVERWRITE THIS FILE"
1475 M$(4)="RETURN TO MAIN MENU"
1480 TOP$="FILE EXISTENCE MENU"
1485 BAS$="a file overwrite/append option"
1490 GOSUB 5000:GOTO 1620                                'gosub jknumenu
1495 'menu for digitizer opening check*****
1500 MAX%=3:MSK$="111":MSGT%=2
1505 MSGT$(1)="The digitizer horn should have just give a 2 second beep."
1510 MSGT$(2)="If it did not beep there is trouble with the connection."
1515 M$(1)="DIGITIZER BEEPED - CONTINUE"
1520 M$(2)="NO BEEP - TROUBLE CORRECTED - TRY AGAIN"
1525 M$(3)="NO BEEP - EXIT FROM DIGITIZER PROGRAM"
1530 TOP$="DIGITIZER CONNECTION CHECK MENU"
1535 BAS$="the desired action"
1540 GOSUB 5000:GOTO 1620                                'gosub jknumenu
1545 'menu for geographic coordinate scaling regression degree*****
1550 MAX%=4:MSK$="1111":MSGT%=0
1555 M$(1)="LINEAR -      3 or more points"
1560 M$(2)="QUADRATIC -   6 or more points"
1565 M$(3)="CUBIC -      10 or more points"
1570 M$(4)="RETURN TO MAIN MENU"
1575 TOP$="GEOGRAPHIC SCALING REGRESSION MODEL MENU"
1580 BAS$="the degree of the regression model"
1585 GOSUB 5000:GOTO 1620                                'gosub jknumenu

```



Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

1590 'menu for selection of increment for stream digitizing*****
1595 MAX%=8:MSK$="1111111":MSGT%=0
1600 FOR I%=1 TO 8:MS(I%)=INCR$(I%):NEXT I%
1605 TOP$="STREAM INCREMENT SELECTION MENU"
1610 BAS$="an increment"
1615 GOSUB 5000:GOTO 1620                                     'gosub jknumenu
1620 NSTK%=NSTK%-1:ISTK%=FNRET%(0):RETURN
3000 REM *****
3010 REM &&& SUBROUTINE JKMNMENU                                     ***
3020 REM *** CONSTRUCTS MAIN MENU                                     ***
3030 REM *****
3040 REM *** DATED: AUGUST 8, 1983                                     ***
3050 REM *****
3060 REM *** INPUT VARIABLES                                     ***
3070 REM ***      CDEG(*)   ARRAY OF REGRESSION MODEL DEGREES       ***
3080 REM ***      IDCHR$    CONSTANT PORTION OF PRESENT ID         ***
3090 REM ***      INCR$(*)  ARRAY OF STREAM INCREMENT CHOICES FOR MENU ***
3100 REM ***      INCR%    PRESENT STREAM INCREMENT CHOICE        ***
3110 REM ***      M1$(*)   ARRAY OF MAIN MENU CHOICES             ***
3120 REM ***      M1%      NUMBER OF MAIN MENU OPTIONS            ***
3130 REM ***      MFIL$    ID MENU SCALING PARAMETER SAVE FILE NAME ***
3140 REM ***      MKR$(*)  ARRAY OF PRESENT CHOICE SYMBOLS FOR MENU ***
3150 REM ***      MSEL$(*) PRESENT MAIN MENU SELECTIONS           ***
3160 REM ***      OFIL$    PRESENT OUTPUT FILE NAME               ***
3170 REM ***      SFIL$    COORDINATE SCALING PARAMETER SAVE FILE NAME ***
3180 REM ***      ST$(*)   ARRAY OF PRESENT STATUS MASKS         ***
3190 REM ***      ST%      PRESENT STATUS INDEX                   ***
3200 REM ***      XROUND#   PRESENT X-ROUNDOFF VALUE              ***
3210 REM ***      YROUND#   PRESENT Y-ROUNDOFF VALUE              ***
3220 REM *** OUTPUT VARIABLE                                     ***
3230 REM ***      IRET%     KEYBOARD CHOICE                        ***
3240 REM *** OTHER VARIABLES                                     ***
3250 REM ***      BAS$     DESCRIPTION OF MENU CHOICE TYPE        ***
3260 REM ***      HIGH     COLOR VALUE FOR HIGHLIGHTING           ***
3270 REM ***      I%       INDEX VARIABLE                          ***
3280 REM ***      LOW      COLOR VALUE FOR NON-HIGHLIGHTED OPTIONS ***
3290 REM ***      MS$(*)   ARRAY OF MENU CHOICES SENT TO JKNUMENU ***
3300 REM ***      MAX%     MAXIMUM ALLOWABLE MENU CHOICE          ***
3310 REM ***      MSGB%    NUMBER OF BASE LINES IN MENU           ***
3320 REM ***      MSGT%    NUMBER OF TOP LINES IN MENU            ***
3330 REM ***      MSK$     MASK VARIABLE FOR HIGHLIGHTING         ***
3340 REM ***      TOP$     LINE TO BE PRINTED AT TOP OF MENU      ***
3350 REM *** SUBROUTINES CALLED                                     ***
3360 GOTO 3390
3370 GOTO 5000 'subroutine jknumenu                                     ***
3380 REM *****
3390 FOR I%=1 TO M1%-1

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

3400 M$(I%)=M1$(I%)+ " ["+MKR$(I%,MSEL%(I%))
3410 IF I%=3 AND IDCHR$<> "" THEN M$(I%)=M$(I%)+ "- INITIAL: "+IDCHR$
3420 IF I%=4 AND MSEL%(I%)=1 THEN M$(I%)=M$(I%)+OFIL$
3430 IF I%=6 THEN M$(I%)=M$(I%)+ " - "+STR$(XROUND#)+ " , "+STR$(YROUND#)
3440 IF I%=8 AND MSEL%(I%)=1 THEN M$(I%)=M$(I%)+SFIL$
3450 IF I%=9 AND MSEL%(I%)=1 THEN M$(I%)=M$(I%)+MFIL$
3460 IF I%=12 THEN M$(I%)=M$(I%)+ " "+INCR$(INCR%)
3470 M$(I%)=M$(I%)+ "]"
3480 NEXT I%
3490 M$(M1%)=M1$(I%)
3500 MAX%=M1%:MSK$=ST$(ST%):MSGT%=0:MSGB%=0
3510 IF CDEG%(0) <> 0 THEN MID$(MSK$,9,1)="1" ELSE MID$(MSK$,9,1)="0"
3520 TOP$="MAIN MENU":BAS$="a highlighted option"
3530 HIGH=15:LOW=7:GOSUB 5000 'gosub jknumenu to get menu selection ***
3540 RETURN
5000 REM *****
5010 REM &&& SUBROUTINE JKNUMENU.BAS ***
5020 REM *** PRINTS MENU AND CHECKS FOR PROPER NUMERICAL INPUT ***
5030 REM *****
5040 REM *** DATED: AUGUST 8, 1983 ***
5050 REM *****
5060 REM *** INPUT VARIABLES ***
5070 REM *** BAS$ MENU CHOICE TYPE ***
5080 REM *** HIGH COLOR VALUE FOR HIGHLIGHTED OPTIONS ***
5090 REM *** LOW COLOR VALUE FOR NON-HIGHLIGHTED OPTIONS ***
5100 REM *** MAX% NUMBER OF MENU CHOICES ***
5110 REM *** M$(*) ARRAY OF MENU CHOICES ***
5120 REM *** MSK$ MASK SHOWING ACCEPTABLE CHOICES ***
5130 REM *** MSGT% NUMBER OF MESSAGE LINES TO BE PRINTED AT TOP ***
5140 REM *** MSGB% NUMBER OF MESSAGE LINES TO BE PRINTED AT BASE ***
5150 REM *** MSGT$(*) ARRAY OF MESSAGE LINES AT TOP ***
5160 REM *** MSGB$(*) ARRAY OF MESSAGE LINES AT BASE ***
5170 REM *** TOP$ MENU TITLE LINE ***
5180 REM *** RETURNED VARIABLES ***
5190 REM *** IRET% NUMERICAL RETURN ***
5200 REM *** INTERNAL VARIABLES ***
5210 REM *** A$ CHARACTER FOR INPUT ***
5220 REM *** XTMP REAL FOR CHECKING FOR INTEGER INPUT ***
5230 REM *** I% LOOP INDEX ***
5240 REM *** ITMP% SAVE INPUT VALUE OF MSGB% ***
5250 REM *** STAR(1,2)$ LINES OF STARS AND MESSAGE FOR HEADER ***
5260 REM *****
5270 ITMP%=MSGB%:STAR1$=STRING$(79,"*"):STAR2$=STAR1$:WIDTH 80
5280 MID$(STAR2$,39-INT(LEN(TOP$)/2),LEN(TOP$))=TOP$
5290 CLS:COLOR HIGH:PRINT STAR1$:PRINT STAR2$:PRINT STAR1$
5300 IF MSGT%>0 THEN PRINT:FOR I%=1 TO MSGT%:PRINT MSGT$(I%):NEXT I%
5310 PRINT:COLOR LOW:FOR I%=1 TO MAX%

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

5320 IF MID$(MSK$,I%,1)="1" THEN COLOR HIGH
5330 PRINT USING "##";I%;
5340 PRINT " "+M$(I%):COLOR LOW
5350 NEXT I%
5360 PRINT
5370 IF MSGB%>0 THEN COLOR HIGH:FOR I%=1 TO MSGB%:PRINT MSGB$(I%):NEXT I%
5380 MSGB%=ITMP%
5390 PRINT:COLOR HIGH+16:PRINT "Choose ";BAS$;": ";:COLOR LOW:INPUT A$
5400 XTMP=VAL(A$)
5410 IF XTMP = 0 GOTO 5450
5420 IRET%=INT(XTMP)
5430 IF IRET% = XTMP THEN GOTO 5440
5440 IF IRET% >= 1 AND IRET% <= MAX% GOTO 5480
5450 MSGB%=MSGB%+2
5460 MSGB$(MSGB%-1)="Please insert an integer between 1 and "+STR$(MAX%)
5470 MSGB$(MSGB%)="You inserted ("+A$+)"":GOTO 5290
5480 IF MID$(MSK$,IRET%,1) = "1" THEN MSGT%=0:MSGB%=0:RETURN
5490 MSGB%=MSGB%+1
5500 MSGB$(MSGB%)="Please select a highlighted option. You selected "+A$
5510 GOTO 5290
7000 REM *****
7010 REM &&& SUBROUTINE JKDIGUTL ***
7020 REM *** CHOICE OF GOODIES FOR DIGITIZER PROGRAM ***
7030 REM *****
7040 REM *** DATED: AUGUST 10, 1983 ***
7050 REM *****
7060 REM *** INPUT VARIABLES ***
7070 REM *** PRM%(0) NUMBER OF OTHER PARAMETERS ***
7080 REM *** PRM%(1) SPECIFIES WHICH GOODIE ***
7090 REM *** 1 = BEEP CHOICE ***
7100 REM *** 2 = LINE PRINTER OPTION ***
7110 REM *** RETURNED VARIABLES ***
7120 REM *** IRET% GOODIE CHOICE ***
7130 REM *** OTHER VARIABLES AND FUNCTIONS ***
7140 REM *** INPUT VALUES FOR SUBROUTINE JKNUMENU ***
7150 REM *** BAS$,M$(*),MAX%,MSGB%,MSGB$(*),MSGT%,MSGT$(*),TOP$ ***
7160 REM *** STACK VARIABLES AND FUNCTIONS ***
7170 REM *** FNRET%(),FNSTK%(),ISTK%,NSTK% ***
7180 REM *** SUBROUTINES CALLED ***
7190 GOTO 7230
7200 GOTO 5000 'subroutine jknumenu ***
7210 GOTO 35000 'subroutine jkstack ***
7220 REM *****
7230 IF PRM%(0) <> 1 THEN PRINT "FATAL PARAMETER ERROR":STOP
7240 GOSUB 35000 'gosub jkstack
7250 ON FNSTK%(1) GOTO 7270,7330
7260 IRET%=3:RETURN

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

7270 MAX%=2:MSGT%=0:MSGB%=0
7280 M$(1)="no beep"
7290 M$(2)="beep enabled"
7300 TOP$="BEEP OPTION MENU"
7310 BAS$="a beep option"
7320 GOSUB 5000:GOTO 7390                                'gosub jknumenu
7330 MAX%=2:MSGT%=0:MSGB%=0
7340 M$(1)="line printing enabled"
7350 M$(2)="line printing disabled"
7360 TOP$="LINE PRINTING OPTION MENU"
7370 BAS$="a line printing option"
7380 GOSUB 5000                                          'gosub jknumenu
7390 NSTK%=NSTK%-1:ISTK%=FNRET%(0):RETURN
9000 REM *****
9010 REM &&& SUBROUTINE JKYESNO                                ***
9020 REM *** PRINTS QUERY AND REQUIRES A "Y" OR "N" RESPONSE ***
9030 REM *****
9040 REM *** DATED: AUGUST 10, 1983                        ***
9050 REM *****
9060 REM *** INPUT VARIABLES                                ***
9070 REM *** PRM1$ CHARACTER PROMPT TO BE PRINTED          ***
9080 REM *** RETURNED VARIABLES                            ***
9090 REM *** IRET% = 1 IF ANSWER WAS YES                   ***
9100 REM *** = 2 IF ANSWER WAS NO                         ***
9110 REM *** INTERNAL VARIABLES                            ***
9120 REM *** A$ CHARACTER HOLDING KEYBOARD RESPONSE        ***
9130 REM *****
9140 PRINT:PRINT PRM1$;:INPUT A$
9150 IF A$ = "Y" OR A$ = "y" THEN IRET% = 1: RETURN
9160 IF A$ = "N" OR A$ = "n" THEN IRET% = 2: RETURN
9170 PRINT
9180 IF LEN(A$) = 0 THEN PRINT "YOU INSERTED A BLANK. ";:GOTO 9200
9190 PRINT "YOU INSERTED "A$". ";
9200 PRINT "PLEASE INSERT Y OR N.":GOTO 9140
11000 REM *****
11010 REM &&& SUBROUTINE JKVALSCL                                ***
11020 REM *** CHECKS SCALING WITH VALIDATION CHECK POINTS ***
11030 REM *****
11040 REM *** DATED: AUGUST 10, 1983                        ***
11050 REM *****
11060 REM *** INPUT VARIABLES                                ***
11070 REM *** PRM%(0) NUMBER OF OTHER PARAMETERS           ***
11080 REM *** PRM%(1) COORDINATE TYPE CHOICE               ***
11090 REM *** BPON BEEP ON/OFF FLAG                       ***
11100 REM *** LA(*) GEOGRAPHIC USER COORDINATE LATITUDE ARRAY ***
11110 REM *** LO(*) GEOGRAPHIC USER COORDINATE LONGITUDE ARRAY ***
11120 REM *** XDB#,YDB# CARTESIAN USER COORDINATES        ***

```

# Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

11130 REM *** RETURNED VARIABLES ***
11140 REM ***      IRET%      1=SUCCESS, 2=FAILURE ***
11150 REM *** OTHER VARIABLES ***
11160 REM ***      INPUT VARIABLES FOR CALL TO SUBROUTINE JKNUMINP ***
11170 REM ***      MSGB%,MSGT%,MSGT$(*) ***
11180 REM ***      STACK VARIABLES AND FUNCTIONS ***
11190 REM ***      FNRET%(),FNSTK%(),ISTK%,NSTK% ***
11200 REM ***      NOTE THAT ALL SCALING PARAMETERS ARE USED IN THE ***
11210 REM ***      CALL TO SUBROUTINE JKDIGDBL ***
11220 REM *** SUBROUTINES CALLED ***
11230 GOTO 11280
11240 GOTO 1000      'subroutine jknuminp ***
11250 GOTO 19000     'subroutine jkdigdbl ***
11260 GOTO 35000     'subroutine jkstack ***
11270 REM *****
11280 IF PRM%(0) <> 1 THEN PRINT "FATAL PARAMETER ERROR.":STOP
11290 GOSUB 35000      'gosub jkstack
11300 MSGT%=0:MSGB%=0
11310 PRM%(0)=1:PRM%(1)=4:GOSUB 1000      'gosub jknuminp
11320 ON IRET% GOTO 11330,11490,11500
11330 CLS:PRINT "DIGITIZE A KNOWN CHECK POINT"
11340 PRM%(0)=1:PRM%(1)=FNSTK%(1):GOSUB 19000 'gosub jkdigdbl, user coordinates
11350 IF BPON THEN BEEP
11360 MSGT%=2:MSGB%=0
11370 ON FNSTK%(1) GOTO 11460,11460,11380,11410,11460
11380 MSGT$(1)="LATITUDE: "+STR$(LA(1,3))+ " deg"
11390 MSGT$(2)="LONGITUDE: "+STR$(LO(1,3))+ " deg"
11400 GOTO 11310
11410 MSGT$(1)="LATITUDE: "+STR$(LA(1,1))+ " deg "+STR$(LA(1,2))+ " min "
11420 MSGT$(1)=MSGT$(1)+STR$(LA(1,3))+ " sec"
11430 MSGT$(2)="LONGITUDE: "+STR$(LO(1,1))+ " deg "+STR$(LO(1,2))+ " min "
11440 MSGT$(2)=MSGT$(2)+STR$(LO(1,3))+ " sec"
11450 GOTO 11310
11460 MSGT$(1)="X COORDINATE IS: "+STR$(XDB#)
11470 MSGT$(2)="Y COORDINATE IS: "+STR$(YDB#)
11480 GOTO 11310
11490 IRET%=1:GOTO 11510
11500 IRET%=2
11510 NSTK%=NSTK%-1:ISTK%=FNRET%(0):RETURN
13000 REM *****
13010 REM &&& SUBROUTINE JKGETRND ***
13020 REM *** GETS USER UNIT ROUND OFF VALUES ***
13030 REM *** DATED: APRIL 12, 1983 ***
13040 REM *****
13050 CLS:PRINT "THE PRESENT ROUND OFF FACTORS ARE:"
13060 PRINT:PRINT "XROUND# : ";XROUND#
13070 PRINT "YROUND# : ";YROUND#

```

# Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

13080 COLOR 31:PRINT:INPUT "INSERT NEW XROUND#: ";XROUND#
13090 IF XROUND#<.0000001 OR XROUND#>1 THEN TMP#=XROUND#:CLS:GOSUB 13130:GOTO 13080
13100 COLOR 31:PRINT:INPUT "INSERT NEW YROUND#: ";YROUND#
13110 IF YROUND#<.0000001 OR YROUND#>1 THEN TMP#=YROUND#:CLS:GOSUB 13130:GOTO 13100
13120 COLOR 7:RETURN
13130 COLOR 15:PRINT:PRINT "ROUND OFF FACTORS MUST BE BETWEEN .0000001 AND 1."
13140 PRINT "YOU INSERTED ";TMP#:RETURN
15000 REM *****
15010 REM &&& SUBROUTINE JKFILPRM ***
15020 REM *** WRITES OR READS A FILE OF SCALING PARAMETERS ***
15030 REM *****
15040 REM *** DATED: AUGUST 10, 1983 ***
15050 REM *****
15060 REM *** INPUT VARIABLES ***
15070 REM *** PRM%(0) NUMBER OF OTHER PARAMETERS ***
15080 REM *** PRM%(1) READ OR WRITE PARAMETER ***
15090 REM *** 1 = WRITE, 2 = READ ***
15100 REM *** PRM%(2) TYPE OF SCALE PARAMETER FILE ***
15110 REM *** 1=TEMPLATE ***
15120 REM *** 2=USER COORDINATE SCALING ***
15130 REM *** PRM%(3) COORDINATE TYPE SELECTION ***
15140 REM *** SCALING PARAMETERS ***
15150 REM *** CDEG%(*) DEGREE OF SCALING REGRESSION ***
15160 REM *** CX#(*) SCALING MATRIX FOR HORIZONTAL COORDINATE ***
15170 REM *** CY#(*) SCALING MATRIX FOR VERTICAL COORDINATE ***
15180 REM *** RNUM%(*) ARRAY HOLDING THE NUMBER OF TERMS IN ***
15190 REM *** THE REGRESSION MODEL FOR SCALING ***
15200 REM *** XBOFF(*) BOARD COORDINATE OFFSET ***
15210 REM *** YBOFF(*) BOARD COORDINATE OFFSET ***
15220 REM *** XUOFF#(*) USER COORDINATE OFFSET ***
15230 REM *** YUOFF#(*) USER COORDINATE OFFSET ***
15240 REM *** (OFFSETS ARE SET TO BE THE COORDINATES OF ***
15250 REM *** THE FIRST REGISTRATION POINT DIGITIZED) ***
15260 REM *** XROUND# HORIZONTAL COORDINATE ROUND OFF FACTOR ***
15270 REM *** YROUND# VERTICAL COORDINATE ROUND OFF FACTOR ***
15280 REM *** OUTPUT VARIABLES ***
15290 REM *** IRET% STATUS VARIABLE ***
15300 REM *** 1 = READ OR WRITE ACCOMPLISHED ***
15310 REM *** 2 = READ OR WRITE FAILED ***
15320 REM *** PRM1$ FILE OPERATED ON ***
15330 REM *** OTHER VARIABLES ***
15340 REM *** A$ CHARACTER ANSWER VARIABLE ***
15350 REM *** K% INDEX SPECIFYING MENU OR COORDINATE PARMS ***
15360 REM *** (0 IS MENU, 1 IS COORDINATE) ***
15370 REM *** TMP3$ FIRST LINE OF PARM SAVE FILE ***
15380 REM *** STACK VARIABLES AND FUNCTIONS ***
15390 REM *** FNRET%(),FNSTK%(),ISTK%,NSTK% ***

```

Appendix 1. Commented listing of all modules in JKDIGIN.BAS—Continued

```

15400 GOTO 15460
15410 REM *** SUBROUTINES CALLED ***
15420 GOTO 17000      'subroutine jkdigfil
15430 GOTO 35000      'subroutine jkstack
15440 REM *****
15450 IF PRM%(0) <> 3 THEN PRINT "FATAL PARAMETER ERROR":STOP
15460 GOSUB 35000:PRM1$=""      'gosub jkstack
15470 ON FNSTK%(2) GOTO 15480,15490
15480 TMP3$="TEMPLATE PARAMETER FILE":GOTO 15520
15490 ON FNSTK%(3) GOTO 15500,15500,15510,15510,15500
15500 TMP3$="CARTESIAN PARAMETER FILE":GOTO 15520
15510 TMP3$="GEOGRAPHIC PARAMETER FILE"
15520 ON FNSTK%(1) GOTO 15550,15760
15530 CLS:PRINT "PROGRAMMING ERROR, PRM1% CANNOT BE ";FNSTK%(1)
15540 IRET% = 2: GOTO 16040
15550 WIDTH 80
15560 'get file name and write parameters
15570 PRM%(0)=2:PRM%(1)=1:PRM%(2)=3:GOSUB 17000      'gosub jkdigfil
15580 IF IRET%=2 GOTO 15950
15590 ON ERROR GOTO 15970
15600 PRINT #3,TMP3$
15610 PRINT #3,"SAVED ON "+DATE$
15620 IF FNSTK%(2)=1 THEN K%=0 ELSE K%=1
15630 PRINT #3,XBOFF(K%)
15640 PRINT #3,YBOFF(K%)
15650 PRINT #3,XUOFF#(K%)
15660 PRINT #3,YUOFF#(K%)
15670 PRINT #3,CDEG%(K%):ITMP%=RNUM%(CDEG%(K%))
15680 FOR I%=1 TO ITMP%:PRINT #3,CX#(I%-1,K%):NEXT I%
15690 FOR I%=1 TO ITMP%:PRINT #3,CY#(I%-1,K%):NEXT I%
15700 IF K%=0 GOTO 15730
15710 PRINT #3,XROUND#
15720 PRINT #3,YROUND#
15730 CLOSE #3
15740 IRET% = 1
15750 GOTO 16060
15760 'get filename and read parameters
15770 PRM%(0)=2:PRM%(1)=3:PRM%(2)=3:GOSUB 17000      'gosub jkdigfil
15780 ON IRET% GOTO 15790,15990
15790 ON ERROR GOTO 16000
15800 LINE INPUT #3,A$
15810 IF A$ <> TMP3$ GOTO 16020
15820 LINE INPUT #3,A$
15830 IF FNSTK%(2) = 1 THEN K%=0 ELSE K%=1
15840 INPUT #3,XBOFF(K%)
15850 INPUT #3,YBOFF(K%)
15860 INPUT #3,XUOFF#(K%)

```



Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

15870 INPUT #3,YUOFF#(K%)
15880 INPUT #3,CDEG%(K%):ITMP%=RNUM%(CDEG%(K%))
15890 FOR I%=1 TO ITMP%:INPUT #3,CX#(I%-1,K%):NEXT I%
15900 FOR I%=1 TO ITMP%:INPUT #3,CY#(I%-1,K%):NEXT I%
15910 IF K%=0 GOTO 15940
15920 INPUT #3,XROUND#
15930 INPUT #3,YROUND#
15940 CLOSE #3:IRET%=1:ON ERROR GOTO 0:GOTO 16060
15950 PRINT "Output file not open - parameters not saved.":GOTO 16040
15960 PRINT "No coordinate type selected yet.":GOTO 16040
15970 CLOSE #3:ON ERROR GOTO 0
15980 PRINT "Error writing parameter file - parameters not saved.":GOTO 16040
15990 PRINT "Input file not open - parameters not read.":GOTO 16040
16000 CLOSE #3:ON ERROR GOTO 0
16010 PRINT "Error reading parameter file - parameters not read.":GOTO 16040
16020 CLOSE #3
16030 PRINT "Selected file is not ";TMP3$
16040 IRET%=2:PRINT "PRESS ANY KEY TO RETURN TO MAIN MENU."
16050 A$=INKEY$:IF A$="" THEN 16050
16060 NSTK%=NSTK%-1:ISTK%=FNRET%(0):RETURN
17000 REM *****
17010 REM &&& SUBROUTINE JKDIGFIL ***
17020 REM *** GETS FILENAME, CHECKS FOR GROSS ERRORS, AND OPENS IT ***
17030 REM *** FILE HAS EXTENSION (.DIG) ***
17040 REM *****
17050 REM *** DATED AUGUST 10, 1983 ***
17060 REM *****
17070 REM *** INPUT VARIABLES ***
17080 REM *** PRM%(0) NUMBER OF OTHER PARAMTERS ***
17090 REM *** PRM%(1) SPECIFIES WHICH TYPE OF OPEN ***
17100 REM *** 1) OPEN NEW FILE FOR OUTPUT ***
17110 REM *** 2) OPEN OLD FILE FOR APPEND OUTPUT ***
17120 REM *** 3) OPEN OLD FILE FOR INPUT ***
17130 REM *** PRM%(2) NUMBER OF FILE TO OPEN ***
17140 REM *** PRM1$ INPUT FILE USE MESSAGE ***
17150 REM *** VARIABLES RETURNED ***
17160 REM *** PRM2$ NAME OF FILE OPERATED ON ***
17170 REM *** IRET% INTEGER STATUS VARIABLE ***
17180 REM *** 1 = FILE OPENED ***
17190 REM *** 2 = FAILED TO OPEN FILE ***
17200 REM *** IRET1% RETURNED TO BE FLMOD%, TYPE OF WRITE CHOSEN ***
17210 REM *** 1 = WRITING NEW FILE ***
17220 REM *** 2 = APPENDING TO OLD FILE ***
17230 REM *** 3 = OVERWRITING OLD FILE ***
17240 REM *** 4 = RETURNED - NO FILE OPEN ***
17250 REM *** INTERNAL VARIABLES ***
17260 REM *** A$ TEMPORARY FILENAME VARIABLE ***

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

17270 REM ***      I%,J%      LOOP INDEX VARIABLES      ***
17280 REM ***      TMP%      TEMP STORAGE FOR ASCII CHAR REPRESENTATION      ***
17290 REM ***      TMP1$      TEMP STORAGE FOR PRM1$      ***
17300 REM ***      STACK VARIABLES AND FUNCTIONS      ***
17310 REM ***      FNRET%(),FNSTK%(),ISTK%,NSTK%      ***
17320 REM *** SUBROUTINES CALLED      ***
17330 GOTO 17380
17340 GOTO 1000      'subroutine jknuminp      ***
17350 GOTO 9000      'subroutine jkyesno      ***
17360 GOTO 35000      'subroutine jkstack      ***
17370 REM *****
17380 IF PRM%(0) <> 2 THEN PRINT "FATAL PARAMETER ERROR":STOP
17390 GOSUB 35000      'gosub jkstack
17400 PRM2$="":IRET%=2:TMP1$=PRM1$:IRET1%=1
17410 CLS:WIDTH 80
17420 ON ERROR GOTO 17450
17430 CLOSE #FNSTK%(2)
17440 GOTO 17460
17450 ON ERROR GOTO 0: RESUME 17460
17460 PRINT "FILE OPENING SUBROUTINE"
17470 PRINT:PRINT "INSERT FILE NAME "TMP1$" (OR JUST CR TO RETURN): ";:INPUT A$
17480 PRM2$=A$
17490 REM *** TRANSFER IF LENGTH OK
17500 IF LEN(PRM2$) > 0 AND LEN(PRM2$) < 9 GOTO 17600
17510 REM *** RETURN AND ABORT TRY IF LENGTH IS ZERO
17520 IF LEN(PRM2$) <> 0 GOTO 17570
17530 CLS
17540 PRM1$="BLANK INPUT. DO YOU WANT TO RETURN TO MAIN MENU":GOSUB 9000
17550 ON IRET% GOTO 17560,17470      'gosub jkyesno
17560 IRET%=2:GOTO 18040
17570 CLS:PRINT "FILE NAME TOO LONG. USE 8 OR FEWER CHARACTER. TRY AGAIN."
17580 GOTO 17470
17590 REM *** CHECK EACH CHARACTER POSITION FOR NON-LETTER OR NON-NUMBER
17600 FOR I%=1 TO LEN(PRM2$)
17610 TMP% = ASC(MID$(PRM2$,I%,1))
17620 FOR J%=65 TO 90
17630 IF TMP%=J% GOTO 17720
17640 NEXT J%
17650 FOR J% = 48 TO 57
17660 IF TMP% = J% GOTO 17720
17670 NEXT J%
17680 FOR J% = 97 TO 122
17690 IF TMP% = J% GOTO 17720
17700 NEXT J%
17710 PRINT:PRINT "FILENAME CAN HAVE ONLY LETTERS OR NUMBERS IN IT.":GOTO 17470
17720 NEXT I%
17730 REM *** CHARACTERS IN NAME OK - APPEND .DIG

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

17740 PRM2$=PRM2$+".DIG"
17750 ON FNSTK%(1) GOTO 17760,17920,17970
17760 REM *** CASE FOR OPENING NEW FILE FOR OUTPUT
17770 REM *** TRY TO OPEN FOR INPUT. IF ERROR, THEN NO FILE YET EXISTS. OPEN IT
17780 REM *** IF NO ERROR, THEN FILE DOES EXIST
17790 ON ERROR GOTO 17850
17800 OPEN "I",#FNSTK%(2),PRM2$
17810 CLOSE #FNSTK%(2)
17820 ON ERROR GOTO 0
17830 PRM%(0)=1:PRM%(1)=5:GOSUB 1000:IRET1%=IRET%           'gosub jknuminp
17840 ON IRET% GOTO 17470,17920,17880,17960
17850 RESUME 17860
17860 ON ERROR GOTO 0
17870 CLOSE #FNSTK%(2)
17880 OPEN "O",#FNSTK%(2),PRM2$
17890 IRET%=1
17900 PRINT "FILE "PRM2$" OPENED FOR OUTPUT."
17910 GOTO 18040
17920 OPEN "A",#FNSTK%(2),PRM2$
17930 PRINT "FILE "PRM2$" OPENED IN OUTPUT APPEND MODE."
17940 IRET% = 1
17950 GOTO 18040
17960 IRET%=2:GOTO 18040
17970 REM *** CASE FOR OPENING FOR INPUT
17980 ON ERROR GOTO 18010
17990 OPEN "I",#FNSTK%(2),PRM2$
18000 ON ERROR GOTO 0:IRET%=1:PRINT "FILE "A$" OPENED FOR INPUT.":GOTO 18040
18010 PRINT "FILE "PRM2$" DOES NOT EXIST. TRY AGAIN."
18020 RESUME 18030
18030 ON ERROR GOTO 0:GOTO 17460
18040 NSTK%=NSTK%-1:ISTK%=FNRET%(0):RETURN
19000 REM *****
19010 REM &&& SUBROUTINE JKDIGDBL                                     ***
19020 REM *** RETURNS USER COORDINATES SCALED                                     ***
19030 REM *****
19040 REM *** DATED: AUGUST 10, 1983                                     ***
19050 REM *****
19060 REM *** INPUT VARIABLES                                     ***
19070 REM ***          PRM%(0)    NUMBER OF OTHER PARAMETERS                                     ***
19080 REM ***          PRM%(1)    COORDINATE TYPE CHOICE                                     ***
19090 REM ***          (0 = MENU)                                     ***
19100 REM ***          SCALING PARAMETERS                                     ***
19110 REM ***          CDEG%(*)    DEGREE OF SCALING REGRESSION                                     ***
19120 REM ***          CX#(*)     SCALING MATRIX FOR HORIZONTAL COORDINATES                                     ***
19130 REM ***          CY#(*)     SCALING MATRIX FOR VERTICAL COORDINATES                                     ***
19140 REM ***          RNUM%(*)   ARRAY HOLDING THE NUMBER OF TERMS IN                                     ***
19150 REM ***          THE REGRESSION MODEL FOR SCALING                                     ***

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

19160 REM ***      XBOFF(*) BOARD COORDINATE OFFSET      ***
19170 REM ***      YBOFF(*) BOARD COORDINATE OFFSET      ***
19180 REM ***      XUOFF#(*) USER COORDINATE OFFSET      ***
19190 REM ***      YUOFF#(*) USER COORDINATE OFFSET      ***
19200 REM ***      (OFFSETS ARE SET TO BE COORDINATES OF  ***
19210 REM ***      THE FIRST REGISTRATION POINT DIGITIZED ***
19220 REM ***      XROUND# HORIZONTAL COORDINATE ROUNDOFF FACTOR ***
19230 REM ***      YROUND# VERTICAL COORDINATE ROUNDOFF FACTOR ***
19240 REM *** VARIABLES RETURNED ***
19250 REM ***      XDB#,YDB# X,Y USER COORDINATES ***
19260 REM *** (OR) LA(*) USER GEOGRAPHIC COORDINATES ***
19270 REM ***      LO(*) USER GEOGRAPHIC COORDINATES ***
19280 REM ***      CBTN$ CURSOR ENTRY CHARACTER ***
19290 REM ***      IRET% ERROR RETURN VARIABLE ***
19300 REM ***      0 = NO ERROR RETURN ***
19310 REM ***      1 = ERROR-ABORT ***
19320 REM *** OTHER VARIABLES ***
19330 REM ***      AX#(.,.) HOLDS VALUES FOR DEPENDENT VARIABLES FOR ***
19331 REM ***      REGRESSION ***
19340 REM ***      A$,B$,C$ TEMPORARY CHARACTER VARIABLES HOLDING ***
19350 REM ***      DOUBLE PRECISION VALUES ***
19360 REM ***      B#,C#,D# NUMBERS USED IN ROUNDING DOUBLE PRECISION ***
19370 REM ***      COORDINATES ***
19380 REM ***      B%,TMP% INTEGER VARIABLES USED REMOVING EXPONENT ***
19390 REM ***      C%,C INTEGER AND SINGLE PRECISION VERSIONS OF C# ***
19400 REM ***      I%,J% LOOP INDEX VARIABLES ***
19410 REM ***      K% SPECIFIES TEMPLATE OR COORDINATE SCALING ***
19420 REM ***      (0 = TEMPLATE, 1 = COORDINATE) ***
19430 REM ***      S% SIGN HOLDING VARIABLE ***
19440 REM ***      TROUND# TEMPORARY ROUNDING FACTOR IN SUBROUTINE ***
19450 REM ***      XI,YI RETURNED RAW BOARD COORDINATES ***
19460 REM ***      XT#,YT# BOARD COORDINATES WITH BOARD OFFSET REMOVED ***
19470 REM ***      USED FOR CALCULATING AX#() ARRAYS ***
19480 REM ***      STACK VARIABLES AND FUNCTIONS ***
19490 REM ***      FNRET%(),FNSTK%(),ISTK%,NSTK% ***
19500 REM *** SUBROUTINES CALLED ***
19510 GOTO 19640
19520 GOTO 21000 'subroutine jkdigbrd ***
19530 GOTO 20050 'subroutine dblrnd (internal) ***
19540 GOTO 20150 'subroutine grdrnd (internal) ***
19550 GOTO 20270 'subroutine rmvexp (internal) ***
19560 GOTO 35000 'subroutine jkstack ***
19570 REM *** NOTE: THE DOUBLE PRECISION EXPONENTIAL FORMAT IS REMOVED ***
19580 REM *** IN THIS PROGRAM BY DECREASING THE NUMBER OF SIGNIFICANT ***
19590 REM *** DIGITS BY THE EXPONENT VALUE. THIS IS DONE SO THAT THE ***
19600 REM *** RETURNED VALUE IS ALWAYS IN INTEGER OR REAL FORMAT. IN ***
19610 REM *** THE UNLIKELY EVENT THAT THIS CAUSES ACCURACY PROBLEMS ***

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

19620 REM ***          NOTIFY THE AUTHOR.          ***
19630 REM *****
19640 IF PRM%(0) <> 1 THEN PRINT "FATAL PARAMETER ERROR":STOP
19650 GOSUB 35000      'gosub jkstack
19660 IRET%=0:IF FNSTK%(1)=0 THEN K%=0 ELSE K%=1
19670 'get raw board coordinates
19680 GOSUB 21000      'subroutine jkdighrd
19690 IF CBTN$="" THEN GOTO 20040
19700 XT#=CDBL(XI-XBOFF(K%)):YT#=CDBL(YI-YBOFF(K%))
19710 'scale coordinates
19720 'calculate dependent variable values for regression
19730 AX#(1,1)=XT#:AX#(1,2)=YT#:IF CDEG%(K%)=1 GOTO 19790
19740 AX#(1,3)=XT#*XT#:AX#(1,4)=XT#*YT#:AX#(1,5)=YT#*YT#
19750 IF CDEG%(K%)=2 GOTO 19790
19760 AX#(1,6)=XT#*AX#(1,3):AX#(1,7)=XT#*AX#(1,7):AX#(1,8)=XT#*AX#(1,5)
19770 AX#(1,9)=YT#*AX#(1,5)
19780 'calculate user coordinates
19790 XDB#=CX#(0,K%)+XUOFF#(K%):YDB#=CY#(0,K%)+YUOFF#(K%)
19800 FOR J%=1 TO RNUM%(CDEG%(K%))-1
19810 XDB#=XDB#+CX#(J%,K%)*AX#(1,J%)
19820 YDB#=YDB#+CY#(J%,K%)*AX#(1,J%)
19830 NEXT J%
19840 ON FNSTK%(1) GOTO 19900,19900,19900,19860,19900
19850 GOTO 20040
19860 FOR I%=1 TO 2
19870 LA(1,I%)=FIX(CSNG(YDB#)):YDB#=(YDB#-LA(1,I%))*60
19880 LO(1,I%)=FIX(CSNG(XDB#)):XDB#=(XDB#-LO(1,I%))*60
19890 NEXT I%
19900 'remove exponential format
19910 B#=XDB#:GOSUB 20270:XDB#=C#
19920 B#=YDB#:GOSUB 20270:YDB#=C#
19930 IF FNSTK%(1) <> 2 GOTO 19960
19940 B#=XDB#:GOSUB 20050:XDB#=C#
19950 B#=YDB#:GOSUB 20050:YDB#=C#:GOTO 20040
19960 TROUND#=XROUND#:B#=XDB#:GOSUB 20150:XDB#=C#
19970 TROUND#=YROUND#:B#=YDB#:GOSUB 20150:YDB#=C#
19980 ON FNSTK%(1) GOTO 20040,20040,20000,20000,20040
19990 GOTO 20040
20000 LA(1,3)=CSNG(YDB#):LO(1,3)=CSNG(XDB#)
20010 IF FNSTK%(1)=3 GOTO 20040
20020 IF LA(1,3)>=60 THEN LA(1,2)=LA(1,2)+1:LA(1,3)=LA(1,3)-60
20030 IF LO(1,3)>=60 THEN LO(1,2)=LO(1,2)+1:LO(1,3)=LO(1,3)-60
20040 NSTK%=NSTK%-1:ISTK%=FNRET%(0):RETURN
20050 REM *** INTERNAL SUBROUTINE DBLRND
20060 REM *** INPUT VARIABLE: B#
20070 REM *** RETURNED VARIABLE: C# (ROUNDED TO INTEGER VALUE)
20080 A$=STR$(B#):B$=""

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

20090 FOR I% = 1 TO LEN(A$)
20100 IF MID$(A$,I%,1) = "." GOTO 20130
20110 B$=B$+MID$(A$,I%,1)
20120 NEXT I%
20130 D#=VAL(B$):C=CSNG(B#-D#):C%=CINT(C):C#=D#+CDBL(C%)
20140 RETURN
20150 REM *** INTERNAL SUBROUTINE GRDRND
20160 REM *** INPUT B#
20170 REM *** OUTPUT C# (ROUNDED)
20180 A$=STR$(B#):B$=""
20190 FOR I%=1 TO LEN(A$)
20200 IF MID$(A$,I%,1) = "." GOTO 20230
20210 B$=B$+MID$(A$,I%,1)
20220 NEXT I%
20230 D#=VAL(B$):C=CSNG(B#-D#):S%=+1
20240 IF C < 0! THEN S%=-1:C=-C
20250 C#=D#+CDBL(S%*(INT((C/TROUND#)+.5))*TROUND#)
20260 RETURN
20270 REM *** INTERNAL SUBROUTINE RMVEXP
20280 REM *** REMOVES EXPONENTIAL FORMAT OF DOUBLE PRECISION NUMBER
20290 C#=B#:A$=STR$(B#):TMP%=INSTR(A$,"D"):IF TMP%=0 THEN RETURN
20300 B$=MID$(A$,TMP%+2,2):B%=VAL(B$):IF B%>=TMP%-1 THEN C#=0:RETURN
20310 C$=MID$(A$,1,TMP%-B%-1)+MID$(A$,TMP%,4)
20320 C#=VAL(C$)
20330 RETURN
21000 REM *****
21010 REM &&& SUBROUTINE JKDIGBRD *****
21020 REM *** RETURNS BOARD COORDINATES OF SINGLE POINT, AND CURSOR BOTTON ***
21030 REM *****
21040 REM *** DATED AUGUST 10, 1983 *****
21050 REM *****
21060 REM *** RETURNED VARIABLES *****
21070 REM ***      XI,YI      :DIGITIZER COORDINATES (.001 ") *****
21080 REM ***      CBTN$     :CURSOR BOTTON CHARACTER *****
21090 REM *****
21100 ON ERROR GOTO 21150
21110 INPUT #1,XI,YI,CBTN$
21120 CBTN$=MID$(CBTN$,1,1)
21130 ON ERROR GOTO 0
21140 RETURN
21150 WIDTH 80:PRINT "COMMUNICATIONS TROUBLE IN JKDIGBRD?"
21160 PRINT "ERR: ",ERR,"ERL: ",ERL
21170 PRINT:PRINT "RESTART THE PROGRAM - ERROR SHOULD NOT OCCUR AGAIN."
21180 CLOSE:STOP
23000 REM *****
23005 REM &&& SUBROUTINE JKGETPNT *****
23010 REM *** TO READ POINT LOCATIONS FROM THE DIGITIZER BOARD, SCALE THEM ***

```

# Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

23015 REM *** AND WRITE THE COORDINATES TO A FILE ***
23020 REM ****
23025 REM *** DATED: AUGUST 10, 1983 ***
23030 REM ****
23035 REM *** INPUT VARIABLES ***
23040 REM *** PRM%(0) NUMBER OF OTHER PARAMETERS ***
23045 REM *** PRM%(1) COORDINATE TYPE SELECTION ***
23050 REM *** PRM%(2) ID TYPE SELECTION ***
23055 REM *** PRM%(3) DIGITIZING MODE ***
23060 REM *** (1=STREAM, 2=POINT) ***
23065 REM *** BPON BEEP CHOICE INDICATOR ***
23070 REM *** CLR%(*) HIGHLIGHTING COLOR NUMBERS FOR ACTION TABLE ***
23075 REM *** (I,J,K):I=ROW,J=COL,K=ENTRY NUMBER ***
23080 REM *** ALSO HOLDS NEW COLORS FOR ACTION TABLE UPDATE ***
23085 REM *** DAT$(*) ACTION TABLE PRINT ENTRIES ***
23090 REM *** DATX$(*) LABEL POSITIONS FOR ACTION TABLE ***
23095 REM *** DATY$(*) LABEL POSITIONS FOR ACTION TABLE ***
23100 REM *** IDCHR$ CONSTANT PORTION OF ID ***
23105 REM *** LPON LINE PRINTER OPTION CHOICE ***
23110 REM *** MKR$(*) MENU STATUS LABEL-USED FOR ID TYPE CHOICE ***
23115 REM *** NPTS% NUMBER OF PTS DIGITIZED IN THIS RUN ***
23120 REM *** OFIL$ OUTPUT FILE NAME ***
23125 REM *** PRM1$ CONTROL CHARACTER FOR DIGITIZING MODE ***
23130 REM *** ALSO HOLDS PRINT LINE FOR CALL TO JKYESNO ***
23135 REM *** TNE$ MUSIC SHOWING EMPTY BUFFER (SAINTS) ***
23140 REM *** TNF$ MUSIC SHOWING FULL BUFFER (VOLGA BOATMAN) ***
23145 REM *** FLMOD% OUTPUT FILE OPENING MODE ***
23150 REM *** OTHER VARIABLES ***
23155 REM *** A$ CHARACTER ANSWER VARIABLE, ALSO VERTICAL ***
23160 REM *** LINE CHARACTER FOR ACTION TABLE ***
23165 REM *** B$ HORIZONTAL LINE CHARACTER FOR ACTION TABLE ***
23170 REM *** BPBF LOGICAL COMBINATION OF BPON AND NOT MBUF ***
23175 REM *** CLO%(*) COLOR INDICATOR FOR TABLE ENTRIES (SEE CLR%(*)) ***
23180 REM *** I%,J%,K% LOOP INDICES ***
23185 REM *** IDTOP$ SHORTENED FORM OF IDCHR$ FOR TABLE ***
23190 REM *** IDWRT$ ID ACCUMULATOR FOR PRINTING LABEL ***
23195 REM *** IFRST FIRST POINT DIGITIZED FLAG (FOR FILE HEADER) ***
23200 REM *** IRET% ERROR RETURN VARIABLE FROM VARIOUS SUBROUTINES ***
23205 REM *** LA(),LO() LATITUDE AND LONGITUDE COORDINATES ***
23210 REM *** MBUF BUFFER NEAR FULL INDICATOR ***
23215 REM *** TMP1$ TEMPORARY STORAGE FOR PRM1$ ***
23220 REM *** XDB#,YDB# USER CARTESIAN COORDINATES ***
23225 REM *** X#,Y# TEMPORARY STORAGE FOR HOLDING USER COORDINATES ***
23230 REM *** WHILE ENTERING REST OF ID ***
23235 REM *** XMEN%,YMEN% : RELATIVE LOCATION COORDINATES WITHIN ***
23240 REM *** MENU BOX ***
23245 REM *** STACK VARIABLES AND FUNCTIONS ***

```



Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

23250 REM ***          FNRET%(),FNSTK%(),ISTK%,NSTK%          ***
23255 REM *** SUBROUTINES CALLED          ***
23260 GOTO 23290
23265 GOTO 19000          'subroutine jkdigdb1          ***
23270 GOTO 23850          'subroutine jkmenhit (internal)  ***
23275 GOTO 24000          'subroutine jkaction (internal)  ***
23280 GOTO 35000          'subroutine jkstack          ***
23285 REM *****
23290 IF PRM%(0) <> 3 THEN PRINT "FATAL PARAMETER ERROR":STOP
23295 GOSUB 35000:TMP1$=PRM1$:IFRST=TRUE          'gosub jkstack
23300 WIDTH 40:MBUF=FALSE:PRINT "STARTING DIGITIZING OF POINTS"
23305 IDWRT$=IDCHR$:ON FLMOD% GOTO 23310,23315,23310
23310 PRINT #2,"DIGITIZED ON "DATE$:FLMOD%=2
23315 IF NOT LPON GOTO 23370
23320 'error trap for printer troubles
23325 ON ERROR GOTO 23350
23330 LPRINT "DIGITIZER OUTPUT PRINTOUT."
23335 LPRINT "STORED IN FILE "OFIL$
23340 LPRINT "DATED: "DATE$
23345 GOTO 23395
23350 ON ERROR GOTO 0
23355 PRINT:PRINT "CHECK YOUR PRINTER - POWER, ETC.":RESUME 23360
23360 PRM1$="WANT TO TRY PRINTER AGAIN":GOSUB 9000          'gosub jkyesno
23365 ON IRET% GOTO 23320,23370
23370 ON FNSTK%(3) GOTO 23375,23395
23375 PRINT #1,"#]K"          'set digitizer to switch stream mode
23380 PRINT #1,"#]M"          'set digitizer to incremental mode
23385 PRINT #1,"#]'" ;TMP1$          'send increment character
23390 'initialize action table
23395 PRM%(1)=1:GOSUB 24000          'gosub jkaction
23400 'refresh action table before next point
23405 IF FNSTK%(3)=1 THEN CLR%(1,1,2)=15 ELSE CLR%(1,1,1)=15
23410 CLR%(1,2,2)=15
23415 PRM%(1)=2:IDWRT$=IDCHR$:GOSUB 24000          'gosub jkaction
23420 'check for full i/o buffer
23425 IF LOF(1) >= 1500 GOTO 23435
23430 IF NOT MBUF THEN MBUF=TRUE:PLAY TNF$:GOTO 23445
23435 IF LOC(1) <= 32 AND MBUF THEN MBUF=FALSE ELSE GOTO 23450
23440 PLAY TNE$:LOCATE 25,10:COLOR 7:PRINT SPC(20):LOCATE 1,1,0:GOTO 23450
23445 LOCATE 25,10:COLOR 31:PRINT "BUFFER FULL - WAIT";:LOCATE 1,1,0
23450 BPBF=BPON AND NOT MBUF
23455 'get next location - or symbol to halt
23460 PRM%(0)=1:PRM%(1)=FNSTK%(1):GOSUB 19000          'gosub jkdigdb1
23465 IF BPBF THEN BEEP
23470 IF CBTN$=":" OR CBTN$="J" OR CBTN$="Z" GOTO 24440
23475 'save location coordinates
23480 ON FNSTK%(1) GOTO 23485,23485,23495,23490,23485

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

23485 X#=XDB#:Y#=YDB#:GOTO 23505
23490 LA(2,1)=LA(1,1):LA(2,2)=LA(1,2):LO(2,1)=LO(1,1):LO(2,2)=LO(1,2)
23495 LA(2,3)=LA(1,3):LO(2,3)=LO(1,3)
23500 'get id if applicable mode
23505 ON FNSTK%(3) GOTO 23745,23510
23510 ON FNSTK%(2) GOTO 23515,23550,23745,23585
23515 'gosub jkaction
23520 CLR%(1,2,1)=15:CLR%(2,1,1)=15:CLR%(2,2,1)=15:PRM%(1)=3:GOSUB 24000
23525 A$=INKEY$:IF A$="" GOTO 23525
23530 IF A$="*" GOTO 24435
23535 IF ASC(A$)=13 GOTO 23640
23540 IDWRT$=IDWRT$+A$:PRM%(1)=4:GOSUB 24000
23545 GOTO 23525
23550 IDWRT$=IDCHR$+CBTN$ 'v gosub jkaction
23555 CLR%(1,2,2)=15:CLR%(2,1,2)=15:CLR%(2,2,2)=15:PRM%(1)=3:GOSUB 24000
23560 PRM%(0)=1:PRM%(1)=FNSTK%(1):GOSUB 19000:IF BPBF THEN BEEP 'gosub jkdigdbl
23565 IF CBTN$=":" GOTO 24440
23570 IF CBTN$=";" GOTO 23640
23575 IDWRT$=IDWRT$+CBTN$:PRM%(1)=5:GOSUB 24000 'gosub jkaction
23580 GOTO 23560
23585 'template input
23590 CLR%(1,2,3)=15:CLR%(2,1,3)=15:CLR%(2,2,3)=15
23595 PRM%(1)=3:GOSUB 24000 'gosub jkaction
23600 PRM%(0)=1:PRM%(1)=0:GOSUB 19000:IF BPBF THEN BEEP 'gosub jkdigbrd
23605 IF CBTN$=":" GOTO 24440
23610 PRM%(1)=1:GOSUB 23850:IF IRET% <> 1 GOTO 23600
23615 IF CBTN$="#" GOTO 23640
23620 IF CBTN$="*" THEN GOTO 24440
23625 IDWRT$=IDWRT$+CBTN$:PRM%(1)=5:GOSUB 24000 'gosub jkaction
23630 GOTO 23600
23635 'verification screen printing
23640 ON FNSTK%(2) GOTO 23645,23685,23770,23715
23645 CLR%(3,1,1)=15:CLR%(3,2,1)=15:PRM%(1)=6:GOSUB 24000 'gosub jkaction
23650 PRM%(1)=5:GOSUB 24000 'gosub jkaction
23655 A$=INKEY$:IF A$="" GOTO 23655
23660 LOCATE 25,10:COLOR 7:PRINT SPC(20);:LOCATE 1,1,0
23665 IF A$="Y" OR A$="y" GOTO 23770
23670 IF A$="N" OR A$="n" GOTO 23845
23675 LOCATE 25,10:COLOR 31:PRINT "PLEASE INSERT Y OR N";:LOCATE 1,1,0
23680 GOTO 23650
23685 CLR%(1,2,2)=15:CLR%(3,1,2)=15:CLR%(3,2,2)=15
23690 PRM%(1)=6:GOSUB 24000 'gosub jkaction
23695 PRM%(0)=1:PRM%(1)=FNSTK%(1):GOSUB 19000 'gosub jkdigdbl
23700 IF BPBF THEN BEEP
23705 IF CBTN$=":" GOTO 24440
23710 IF CBTN$ <> "0" GOTO 23845 ELSE GOTO 23770
23715 CLR%(3,1,2)=15:CLR%(3,1,3)=15:CLR%(3,2,3)=15

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

23720 PRM%(1)=6:GOSUB 24000                                'gosub jkaction
23725 PRM%(0)=1:PRM%(1)=0:GOSUB 19000:IF BPBF THEN BEEP    'gosub jkdigdb1
23730 IF CBTN$="0" GOTO 23770
23735 PRM%(1)=2:GOSUB 23850
23740 IF IRET%<> 1 OR CBTN$ <> "0" GOTO 23845 ELSE GOTO 23770
23745 'update only coords in action table
23750 LOCATE 6,11:PRINT SPC(32);
23755 LOCATE 7,11:PRINT SPC(32);
23760 PRM%(1)=4:GOSUB 24000                                'gosub jkaction
23765 'write output to file and printer
23770 ON FNSTK%(1) GOTO 23775,23775,23790,23805,23775
23775 PRINT #2,X#,Y#,IDWRT$
23780 IF LPON THEN LPRINT X#,Y#,IDWRT$
23785 GOTO 23840
23790 PRINT #2,LA(2,3),LO(2,3),IDWRT$
23795 IF LPON THEN LPRINT LA(2,3),LO(2,3),IDWRT$
23800 GOTO 23840
23805 FOR I%=1 TO 3:PRINT #2,LA(2,I%);TAB(10*(I%)):NEXT I%
23810 FOR I%=1 TO 3:PRINT #2,LO(2,I%);TAB(10*(I%+3)):NEXT I%
23815 PRINT #2,IDWRT$
23820 IF NOT LPON GOTO 23840
23825 FOR I%=1 TO 3:LPRINT LA(2,I%);TAB(10*(I%)):NEXT I%
23830 FOR I%=1 TO 3:LPRINT LO(2,I%);TAB(10*(I%+3)):NEXT I%
23835 LPRINT IDWRT$
23840 NPTS%=NPTS%+1
23845 IF FNSTK%(2)=3 OR FNSTK%(3)=1 THEN GOTO 23425 ELSE GOTO 23405
23850 'internal subroutine menhit to return character from template
23855 LOCATE 25,1:PRINT SPC(39);
23860 IF XDB#<0 OR YDB#<0 GOTO 23935 'not in template
23865 XMEN%=1:FOR I%=1 TO 10:IF XDB#<=.1*I% GOTO 23880
23870 XMEN%=XMEN%+1:NEXT I%
23875 GOTO 23935 'not in template
23880 YMEN%=1:FOR I%=1 TO 4:IF YDB#<=.25*I% GOTO 23895
23885 YMEN%=YMEN%+1:NEXT I%
23890 GOTO 23935 'not in template
23895 IF YMEN%=4 THEN CBTN$=CHR$(47+XMEN%):GOTO 23960
23900 IF YMEN%>=2 THEN CBTN$=CHR$(64+10*(3-ymen%)+xmEN%):GOTO 23960
23905 IF XMEN%<=6 THEN CBTN$=CHR$(84+XMEN%):GOTO 23960
23910 ON (11-XMEN%) GOTO 23915,23920,23925,23930
23915 CBTN$=CHR$(42):GOTO 23960
23920 CBTN$=CHR$(35):GOTO 23960
23925 CBTN$=CHR$(43):GOTO 23960
23930 CBTN$=CHR$(45):GOTO 23960
23935 'error - not in template
23940 IF PRM%(1)=2 GOTO 23955
23945 LOCATE 25,1:COLOR 31
23950 PRINT "CURSOR NOT PLACED ON TEMPLATE. TRY AGAIN.";:COLOR 7

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

23955 IRET%=2:GOTO 23965
23960 IRET%=1
23965 RETURN
24000 'subroutine to draw and update digitizer action table
24005 ' prn%(1)=entry point
24010 ' fnstk%(1)=coord type selection
24015 '=====
24020 '               action table list
24025 '=====
24030 'initialize      |  xx  |  --  |  --  |  --  |  --  |  --  |
24035 'new id          |  xx  |  xx  |  --  |  --  |  --  |  --  |
24040 'clear coords    |  --  |  xx  |  xx  |  --  |  --  |  --  |
24045 'update npts     |  --  |  xx  |  --  |  xx  |  --  |  --  |
24050 'update choices  |  --  |  xx  |  xx  |  --  |  --  |  xx  |
24055 'update coords  |  --  |  --  |  xx  |  xx  |  --  |  --  |
24060 'update id       |  --  |  --  |  xx  |  xx  |  xx  |  xx  |
24065 '=====
24070 'status          |  init | before | after | 1-push | id  | verify |
24075 '               |      |   loc  |   loc  |  stream | loop |        |
24080 '=====
24085 COLOR 15
24090 ON PRN%(1) GOTO 24100,24260,24305,24270,24420,24305
24095 'initialize
24100 A$=CHR$(196):B$=CHR$(179):WIDTH 40:CLS
24105 'draw form
24110 LOCATE 1,5:PRINT "*** DIGITIZING ACTION TABLE ***";
24115 LOCATE 2,1:PRINT STRING$(39,A$);
24120 LOCATE 3,1:PRINT "DIG MODE:";:LOCATE 3,23:PRINT "ID MODE:";
24125 LOCATE 4,1:PRINT "ID CONST:";:LOCATE 4,23:PRINT "NO PNTS:";
24130 LOCATE 5,1:PRINT STRING$(39,A$);
24135 LOCATE 10,1:PRINT STRING$(39,A$);
24140 LOCATE 11,1:PRINT"GET NEW LOCATION"SPC(6)"HALT DIGITIZING";
24145 LOCATE 15,1:PRINT STRING$(39,A$);
24150 LOCATE 16,1:PRINT "NEXT ID CHARACTER"SPC(5)"END ID INPUT";
24155 LOCATE 20,1:PRINT STRING$(39,A$);
24160 LOCATE 21,1:PRINT "ACCEPT POINT"SPC(10)"REJECT POINT";
24165 FOR I%=11 TO 24:LOCATE I%,19:PRINT CHR$(179);:NEXT I%
24170 'initialize header
24175 IF LEN(IDCHR$)>10 THEN IDTOP$=MID$(IDCHR$,1,8)+"?" ELSE IDTOP$=IDCHR$
24180 LOCATE 3,11:IF FNSTK%(3)=1 THEN PRINT "stream"; ELSE PRINT "point ";
24185 LOCATE 3,32:PRINT MKR$(3,FNSTK%(2));
24190 LOCATE 4,11:PRINT SPC(10);:LOCATE 4,11:PRINT IDTOP$;
24195 ON FNSTK%(1) GOTO 24200,24200,24215,24215,24200
24200 LOCATE 6,1:PRINT "   X: ";
24205 LOCATE 7,1:PRINT "   Y: ";
24210 GOTO 24225
24215 LOCATE 6,1:PRINT "  LAT: ";

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```
24220 LOCATE 7,1:PRINT " LON: ";
24225 LOCATE 8,1:PRINT " ID: ";
24230 'initialize choices
24235 COLOR 7
24240 FOR I%=1 TO 3:FOR J%=1 TO 2:FOR K%=1 TO 3
24245 LOCATE DATX%(I%,J%,K%),DATY%(I%,J%,K%):PRINT DAT$(I%,J%,K%);
24250 NEXT K%:NEXT J%:NEXT I%
24255 GOTO 24430
24260 'insert initial id in present id loc
24265 COLOR 15:LOCATE 8,11:PRINT SPC(10);:LOCATE 4,11:PRINT IDTOP$;
24270 'clear coordinate locations
24275 LOCATE 6,8:PRINT SPC(32);
24280 LOCATE 7,8:PRINT SPC(32);
24285 LOCATE 8,8:PRINT SPC(32);
24290 'update npts
24295 LOCATE 4,32:PRINT NPTS%;
24300 IF PRM%(1)=4 GOTO 24360
24305 'update choices
24310 FOR I%=1 TO 3:FOR J%=1 TO 2:FOR K%=1 TO 3
24315 IF CLR%(I%,J%,K%)=15 GOTO 24325
24320 IF CLO%(I%,J%,K%)=CLR%(I%,J%,K%) GOTO 24340
24325 COLOR CLR%(I%,J%,K%):LOCATE DATX%(I%,J%,K%),DATY%(I%,J%,K%)
24330 PRINT DAT$(I%,J%,K%);
24335 CLO%(I%,J%,K%)=CLR%(I%,J%,K%)
24340 CLR%(I%,J%,K%)=7
24345 NEXT K%:NEXT J%:NEXT I%
24350 IF PRM%(1)=2 GOTO 24430
24355 IF PRM%(1)=4 GOTO 24425
24360 'update coordinates
24365 COLOR 15
24370 IF PRM%(1)=6 GOTO 24420
24375 ON FNSTK%(1) GOTO 24380,24380,24395,24410,24380
24380 LOCATE 6,8:PRINT X#;
24385 LOCATE 7,8:PRINT Y#;
24390 GOTO 24420
24395 LOCATE 6,8:PRINT LA(2,3);" deg";
24400 LOCATE 7,8:PRINT LO(2,3);" deg";
24405 GOTO 24420
24410 LOCATE 6,8:PRINT LA(2,1);" deg ";LA(2,2);" min ";LA(2,3);" sec";
24415 LOCATE 7,8:PRINT LO(2,1);" deg ";LO(2,2);" min ";LO(2,3);" sec";
24420 'update present id
24425 LOCATE 8,8:PRINT IDWRT$;
24430 LOCATE 1,1,0:COLOR 7:RETURN
24435 'digitizing halted - return to main driver
24440 CLS:PRINT "DIGITIZING HALTED."
24445 PRINT "PRESS ANY KEY TO RETURN TO MAIN MENU."
24450 A$=INKEY$:IF A$="" THEN 24450
```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

24455 WIDTH 80
24460 PRINT #1,"#]I" 'return digitizer to point mode
24465 NSTK%=NSTK%-1:ISTK%=FNRET%(0):RETURN
25000 REM *****
25010 REM &&& SUBROUTINE JKINTVAR ***
25020 REM *** INITIALIZES VARIABLES AND ARRAYS FOR DIGITIZER PROGRAM ***
25030 REM *****
25040 REM *** DATED: AUGUST 10, 1983 ***
25050 REM *****
25060 REM *** RETURNED VARIABLES ***
25070 REM *** IRET% DIGITIZER CONNECTION CHECK ACTION ***
25080 REM *** 1=OK,2=RETRY,3=EXIT FROM PROGRAM ***
25090 REM *** OTHER VARIABLES ***
25100 REM *** A$ KEYBOARD RESPONSE VARIABLE ***
25110 REM *** BPON BEEP CHOICE INDICATOR ***
25120 REM *** CDEG(*) DEGREE OF REGRESSION MODELS ***
25130 REM *** CLD(*) COLORS INITIALIZED FOR ACTION TABLE ENTRIES ***
25140 REM *** CLO(*) COLORS FOR ACTION TABLE ENTRIES ***
25150 REM *** CLR(*) COLORS FOR ACTION TABLE ENTRIES ***
25160 REM *** DAT(*) ENTRIES FOR ACTION TABLE LAYOUT ***
25170 REM *** DATX(*) LOCATIONS FOR ACTION TABLE ENTRIES ***
25180 REM *** DATY(*) LOCATIONS FOR ACTION TABLE ENTRIES ***
25190 REM *** FALSE LOGICAL VALUE ***
25200 REM *** I%,J%,K% LOOP INDICES ***
25210 REM *** INCR$(*) INCREMENTS FOR MAIN MENU DISPLAY ***
25220 REM *** INCR% PRESENT INCREMENT CHOICE ***
25230 REM *** INCS$(*) INCREMENT CODES FOR SENDING TO DIGITIZER ***
25240 REM *** LPON LINE PRINTER OPTION INDICATOR ***
25250 REM *** M1$(*) MAIN MENU CHOICE ARRAY ***
25260 REM *** M1% NUMBER OF MAIN MENU CHOICES AVAILABLE ***
25270 REM *** MDF(*) DEFAULT CHOICES FOR MAIN MENU OPTIONS ***
25280 REM *** MKR$(*) MARKERS SHOWING PRESENT MAIN MENU CHOICES ***
25290 REM *** MPRM% NUMBER OF MAIN MENU CHOICES (EXCEPT QUIT) ***
25300 REM *** MSEL(*) PRESENT MAIN MENU SELECTIONS ***
25310 REM *** PRM(*) PARAMETER PASSING ARRAY ***
25320 REM *** RNUM(*) NUMBER OF TERMS IN REGRESSION MODELS ***
25330 REM *** ST$(*) ARRAY OF PRESENT STATUS MASKS ***
25340 REM *** TNE$ BUFFER EMPTY TUNE (SAINTS GO MARCHING IN) ***
25350 REM *** TNF$ BUFFER FULL TUNE (VOLGA BOATMAN) ***
25360 REM *** TRUE LOGICAL VALUE ***
25370 REM *** XROUND# X ROUND OFF FACTOR ***
25380 REM *** YROUND# Y ROUND OFF FACTOR ***
25390 REM *** STACK VARIABLES AND FUNCTIONS ***
25400 REM *** FNRET%(),FNSTK%(),ISTK%,NSTK% ***
25410 REM *** SUBROUTINES CALLED ***
25420 GOTO 25450
25430 GOTO 1000 'subroutine jknuminp ***

```

### Appendix 1. Commented listing of all modules in IKDIGIT.BAS—Continued

```

25440 REM *****
25450 'initialize MDF% to default main menu parameter values
25460 MPRM%=14:M1%=MPRM%+1:KEY OFF
25470 DATA 6,2,5,2,2,2,2,2,2,2,2,2,2
25480 'selection symbols
25490 DATA "XY REAL","XY INT","DECDEG","DEGMS","BOARD","NOT SELECTED"
25500 DATA "SCALED","NOT SCALED"
25510 DATA "KEYBOARD","BUTTON","1 PUSH","TEMPLATE","NOT SELECTED"
25520 DATA "FILE OPEN-","NOT SELECTED","LOCATED","NOT LOCATED"
25530 DATA "SELECTED","DEFAULT","VALIDATED","NOT VALIDATED"
25540 DATA "SAVED IN-","NOT SAVED"
25550 DATA "SAVED IN-","NOT SAVED","NO BEEP","BEEP","LPRINT","NO LPRINT"
25560 DATA "SELECTED","DEFAULT","DIGITIZING","NOT DIGITIZING"
25570 DATA "DIGITIZING","NOT DIGITIZING"
25580 DATA "01","02","0","14","28","32","3<","3?"
25590 DATA ".005",".01",".05",".10",".20",".25",".30",".315"
25600 DATA "crsr button","crsr move","","kybd *","crsr *","template *"
25610 DATA "kybd (not CR)","crsr (not #,*)","template (not #,*)"
25620 DATA "kybd CR","crsr #","template #","kybd Y","crsr 0","template 0"
25630 DATA "kybd N","crsr (not 0,*)","template (not 0,*)"
25640 DATA 7,7,7,7,7,7,7,7,7,7,7,7,7,7,7,7
25650 DATA 12,13,14,12,13,14,17,18,19,17,18,19,22,23,24,22,23,24
25660 DATA 4,4,4,26,26,26,4,4,4,26,26,26,4,4,4,26,26,26
25670 TSTK%=20:ISTK%=0:NSTK%=0
25680 TRUE=-1:FALSE=NOT TRUE
25690 FOR I%=1 TO MPRM%
25700 READ MDF%(I%)
25710 MSEL%(I%)=MDF%(I%)
25720 NEXT I%
25730 FOR I%=1 TO MPRM%
25740 FOR J%=1 TO MDF%(I%)
25750 READ MKR$(I%,J%)
25760 NEXT J%
25770 NEXT I%
25780 FOR I%=1 TO 8:READ INCSS$(I%):NEXT I%
25790 FOR I%=1 TO 8:READ INCR$(I%):NEXT I%
25800 FOR I%=1 TO 3:FOR J%=1 TO 2:FOR K%=1 TO 3
25810 READ DAT$(I%,J%,K%):NEXT K%:NEXT J%:NEXT I%
25820 FOR I%=1 TO 3:FOR J%=1 TO 2:FOR K%=1 TO 3
25830 READ CLD%(I%,J%,K%):CLO%(I%,J%,K%)=CLD%(I%,J%,K%)
25840 CLR%(I%,J%,K%)=CLD%(I%,J%,K%):NEXT K%:NEXT J%:NEXT I%
25850 FOR I%=1 TO 3:FOR J%=1 TO 2:FOR K%=1 TO 3
25860 READ DATX%(I%,J%,K%):NEXT K%:NEXT J%:NEXT I%
25870 FOR I%=1 TO 3:FOR J%=1 TO 2:FOR K%=1 TO 3
25880 READ DATY%(I%,J%,K%):NEXT K%:NEXT J%:NEXT I%
25890 M1$(1)="Select Coordinate Type"
25900 M1$(2)="Get Scaling Matrix"

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

25910 M1$(3)="Select ID Type"
25920 M1$(4)="Select Output File Name"
25930 M1$(5)="Get Template Location Parameters"
25940 M1$(6)="Select Roundoff Values"
25950 M1$(7)="Validate Scaling"
25960 M1$(8)="Save Coordinate Scaling Parameters"
25970 M1$(9)="Save Template Scaling Parameters"
25980 M1$(10)="Select Beep Option"
25990 M1$(11)="Select Printer Option"
26000 M1$(12)="Select Switch Stream Increment"
26010 M1$(13)="Start Point Mode Digitizing"
26020 M1$(14)="Start Switch Stream Mode Digitizing"
26030 M1$(15)="Quit"
26040 ST$(1)="1000000000000001":ST$(2)="1100000000000001"
26050 ST$(3)="1111000000000001":ST$(4)="1111100000000001"
26060 ST$(5)="1111111111111111"
26070 RNUM%(1)=3:RNUM%(2)=6:RNUM%(3)=10
26080 XROUND#=.0000001#:YROUND#=.0000001#:CDEG%(0)=0:INCR%=4
26090 OPEN "COM1:9600,N,8,2,RS,CS,DS" AS 1
26100 PRINT #1,"#]b" 'send beep request
26110 PRINT #1,"#]I" 'go to point mode
26120 PRM%(0)=1:PRM%(1)=6:GOSUB 1000 'gosub jknuminp
26130 ON IRET% GOTO 26140,26100,26240
26140 ON ERROR GOTO 26250 'device error retry
26150 WHILE NOT EOF(1)
26160 A$=INPUT$(LOC(1),#1)
26170 WEND
26180 ON ERROR GOTO 0
26190 A$="FDMLGMNGMLDDMND"
26200 TNF$="MF01"+A$+"E"+A$
26210 A$="MSCEFMLGGGGMNG"
26220 TNE$="MFL803"+A$+A$
26230 BPON=TRUE:LPON=FALSE
26240 RETURN
26250 RESUME 'device error retry
27000 REM *****
27005 REM &&& SUBROUTINE JKSCCLCTL ***
27010 REM *** CONTROL FOR SCALING FOR DIGITIZER PROGRAM ***
27015 REM *****
27020 REM *** DATED: AUGUST 10, 1983 ***
27025 REM *****
27030 REM *** INPUT VARIABLES ***
27035 REM *** PRM%(0) NUMBER OF OTHER PARAMETERS ***
27040 REM *** PRM%(1) COORDINATE TYPE CHOICE ***
27045 REM *** (0 FOR TEMPLATE SCALING) ***
27050 REM *** RETURNED VARIABLES ***
27055 REM *** IRET% COMPLETION VARIABLES ***

```



Appendix 1. Commented listing of all modules in JKDIT.BAS—Continued

```

27060 REM ***          1=COMPLETED, NOT READ FROM FILE          ***
27065 REM ***          2=COMPLETED, READ FROM FILE              ***
27070 REM ***          3=FAILED, ERROR OTHER THAN FILE READ      ***
27075 REM ***          4=FAILED, ERROR IN FILE READ              ***
27080 REM ***          5=NO CHANGE                                ***
27085 REM ***          SCALING FACTORS (TEMPLATE=0,COORDINATE=1) ***
27090 REM ***          CDEG%(.)          DEGREE OF REGRESSION MODEL ***
27095 REM ***          XBOFF(.),YBOFF(.)  BOARD COORDINATE OFFSET ***
27100 REM ***          XUOFF#(.),YUOFF#(.) USER COORDINATE OFFSET ***
27105 REM ***          CX#(I,.),CY#(I,.), REGRESSION COEFFICIENTS ***
27110 REM ***          SFIL$          COORDINATE SCALING PARAMETER SAVE FILE NAME ***
27115 REM ***          MFIL$          TEMPLATE SCALING PARAMETER SAVE FILE NAME ***
27120 REM *** OTHER VARIABLES ***
27125 REM ***          A#(*)          ARRAY OF REGRESSION COEFFICIENTS RETURNED ***
27130 REM ***          FROM SUBROUTINE JKREGRES ***
27135 REM ***          AS          KEYBOARD INPUT CHARACTER ***
27140 REM ***          AX#(*)          ARRAY OF BOARD COORDINATES SENT TO ***
27145 REM ***          REGRESSION SUBROUTINE ***
27150 REM ***          I%,J%          LOOP INDEX VARIABLES ***
27155 REM ***          ITRM%          TEMP NUMBER OF TERMS IN REGRESSION ***
27160 REM ***          MPTS%          NUMBER OF REGISTRATION POINTS ***
27165 REM ***          MSGT$(*)       LINES FOR TOP OF MENU ***
27170 REM ***          MSGT%          NUMBER OF LINES FOR TOP OF MENU ***
27175 REM ***          MSK$          MASK FOR HIGHLIGHTING MENU OPTIONS ***
27180 REM ***          PRM2$          FILE NAME RETURNED FROM SUBROUTINE JKFILPRM ***
27185 REM ***          RNUM%(*)       NUMBER OF TERMS IN REGRESSION MODEL ***
27190 REM ***          TDEG%          TEMP STORAGE FOR DEGREE OF REGRESSION MODEL ***
27195 REM ***          TX#(*)          BOARD COORDINATES OF REGISTRATION POINTS ***
27200 REM ***          TY#(*)          BOARD COORDINATES OF REGISTRATION POINTS ***
27205 REM ***          STACK VARIABLES AND FUNCTIONS ***
27210 REM ***          FNRET%(),FNSTK%(),ISTK%,NSTK% ***
27215 REM *** SUBROUTINES CALLED ***
27220 GOTO 27260
27225 GOSUB 1000          'subroutine jknuminp ***
27230 GOSUB 15000        'subroutine jkfilprm ***
27235 GOSUB 28000        'subroutine jkregres ***
27240 GOSUB 29000        'subroutine jkscldrd ***
27245 GOSUB 31000        'subroutine jkscldkey ***
27250 GOSUB 35000        'subroutine jkstack ***
27255 REM *****
27260 GOSUB 35000          'gosub jkstack
27265 IF FNSTK%(1) <> 5 GOTO 27290
27270 'case for raw board coordinates
27275 CDEG%(1)=1:XBOFF(1)=0:YBOFF(1)=0:XUOFF#(1)=0:YUOFF#(1)=0
27280 FOR I%=0 TO 9: CX#(I%,1)=0:CY#(I%,1)=0:NEXT I%
27285 CX#(1,1)=1:CY#(2,1)=1:GOTO 27490
27290 'get scaling type

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

27295 MSK$="1110001"
27300 IF FNSTK%(1)=0 THEN MSGT$(1)="TEMPLATE PLACEMENT SCALING":GOTO 27315
27305 MSGT$(1)="COORDINATE SCALING"
27310 IF FNSTK%(1)=3 OR FNSTK%(1)=4 THEN MSK$="1111111"
27315 MSGT%=1
27320 PRM%(0)=1:PRM%(1)=2:GOSUB 1000 'gosub jknuminp
27325 IF IRET%=7 THEN IRET%=5:GOTO 27520
27330 ON IRET% GOTO 27335,27340,27365,27365,27365,27365
27335 PRM%(0)=1:PRM%(1)=FNSTK%(1):GOSUB 31000:GOTO 27490 'gosub jksc1key
27340 IF FNSTK%(1)=0 THEN PRM%(2)=1 ELSE PRM%(2)=2
27345 PRM%(0)=3:PRM%(1)=2:PRM%(3)=FNSTK%(1):GOSUB 15000 'gosub jkfilprm
27350 IF IRET%=2 THEN IRET%=4:GOTO 27520
27355 IF FNSTK%(1) <> 0 THEN SFIL$=PRM2$ ELSE MFIL$=PRM2$
27360 IRET%=2:GOTO 27520
27365 'get degree of regression model and prepare for coordinate entry
27370 IF IRET%>3 THEN TDEG%=3:CDEG%(1)=3:ITRM%=10:PRM%(2)=IRET%-3:GOTO 27405
27375 IF FNSTK%(1) <> 0 GOTO 27385
27380 TDEG%=1:CDEG%(0)=TDEG%:ITRM%=3:GOTO 27405 'case for template scaling
27385 PRM%(0)=1:PRM%(1)=7:GOSUB 1000 'coordinate scaling
27390 IF IRET%=4 THEN IRET%=5:GOTO 27520
27395 TDEG%=IRET%:CDEG%(1)=TDEG%:ITRM%=RNUM%(TDEG%):PRM%(2)=0
27400 'gosub jksclcrd to get coordinates for registration
27405 PRM%(0)=2:PRM%(1)=FNSTK%(1):GOSUB 29000 'gosub jksclcrd
27410 IF IRET%=2 GOTO 27365
27415 'calculate regression coefficients
27420 PRINT:PRINT "CALCULATING X-REGRESSION COEFFICIENTS-WAIT(up to 1 minute)."

```

Appendix 1. Commented listing of all modules in JKDIGIN.BAS—Continued

```

28010 REM &&& SUBROUTINE JKREGRES ***
28020 REM *** CALCULATES REGRESSION COEFFICIENTS-USES BEATON SWEEP ***
28030 REM *****
28040 REM *** DATED AUGUST 10, 1983 ***
28050 REM *****
28060 REM *** INPUT VARIABLES ***
28070 REM *** PRM%(0) NUMBER OF OTHER PARAMETERS ***
28080 REM *** PRM%(1) NUMBER OF DATA POINTS ***
28090 REM *** PRM%(2) NUMBER OF TERMS IN REGRESSION MODEL ***
28100 REM *** AX#(.) ARRAY-AUGMENTED DATA MATRIX (NPTS x ITRM%+1) ***
28110 REM *** RETURNED VARIABLES ***
28120 REM *** IRET% STATUS VARIABLE (1=NO ERROR, 2=ERROR) ***
28130 REM *** A#(.,.) SWEPT COVARIANCE MATRIX ***
28140 REM *** OTHER VARIABLES ***
28150 REM *** I%,J%,K%,L% : LOOP INDEX VARIABLES ***
28160 REM *** N% NUMBER OF PIVOTS ***
28170 REM *** NDIM% DIMENSION OF AUGMENTED COVARIANCE MATRIX ***
28180 REM *** P%(*) ARRAY OF INDICES FOR FINDING LARGEST PIVOT ***
28190 REM *** VMAX LARGEST REMAINING PIVOT VALUE ***
28200 REM *** STACK VARIABLES AND FUNCTIONS ***
28210 REM *** FNRET%(),FNSTK%(),ISTK%,NSTK% ***
28220 REM SUBROUTINES CALLED ***
28230 GOTO 28270
28240 GOSUB 28480 'subroutine jksweep - internal ***
28250 GOSUB 35000 'subroutine jkstack ***
28260 REM *****
28270 IF PRM%(0) <> 2 THEN PRINT "FATAL PARAMETER ERROR":STOP
28280 GOSUB 35000:IRET%=1 'gosub jkstack
28290 NDIM%=FNSTK%(2)+1:N%=FNSTK%(1)
28300 'calculate augmented raw product matrix
28310 FOR I%=1 TO NDIM%:FOR J%=1 TO NDIM%:A#(I%,J%)=0!
28320 FOR K%=1 TO N%
28330 A#(I%,J%)=A#(I%,J%)+AX#(K%,I%)*AX#(K%,J%)
28340 NEXT K%:NEXT J%:NEXT I%
28350 'sweep last row/col to calculate augmented covariance matrix
28360 K%=NDIM%:GOSUB 28480:IF IRET% <> 1 GOTO 28470 'gosub jksweep
28370 'sweep to calculate regression coefficients - choosing largest pivots
28380 N%=FNSTK%(2)-1:FOR I%=1 TO N%:P%(I%)=I%:NEXT I%
28390 VMAX=ABS(A#(P%(1),P%(1))):K%=P%(1):L%=1:IF N%=1 GOTO 28430
28400 FOR I%=2 TO N%:IF ABS(A#(P%(I%),P%(I%))) <= VMAX GOTO 28420
28410 VMAX=ABS(A#(P%(I%),P%(I%))):K%=P%(I%):L%=I%
28420 NEXT I%
28430 GOSUB 28480:IF IRET% <> 1 GOTO 28470 'gosub jksweep
28440 N%=N%-1:IF N%=0 THEN GOTO 28470
28450 IF L%=N%+1 GOTO 28390
28460 FOR I%=L% TO N%:P%(I%)=P%(I%+1):NEXT I%:GOTO 28390
28470 NSTK%=NSTK%-1:ISTK%=FNRET%(0):RETURN

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

28480 'internal subroutine jksweep to sweep matrix a#(.,.) by row/col k%
28490 ON ERROR GOTO 28630
28500 A#(K%,K%)=-1!/A#(K%,K%)
28510 FOR I%=1 TO NDIM%:IF I%=K% GOTO 28530
28520 A#(I%,K%)=-A#(I%,K%)*A#(K%,K%)
28530 NEXT I%
28540 FOR I%=1 TO NDIM%:FOR J%=1 TO NDIM%:IF I%=K% OR J%=K% GOTO 28560
28550 A#(I%,J%)=A#(I%,J%)-A#(I%,K%)*A#(K%,J%)
28560 NEXT J%:NEXT I%
28570 FOR J% = 1 TO NDIM%
28580 IF J% = K% GOTO 28600
28590 A#(K%,J%)=-A#(K%,J%)*A#(K%,K%)
28600 NEXT J%
28610 IRET%=1:GOTO 28640
28620 'signal error for return
28630 IRET%=2:ON ERROR GOTO 0:RESUME 28640
28640 RETURN
29000 REM *****
29010 REM &&& SUBROUTINE JKSCLCRD ***
29020 REM *** GETS BOARD AND USER COORDINATES FOR REGISTRATION POINTS ***
29030 REM *****
29040 REM *** DATED: AUGUST 10, 1983 ***
29050 REM *****
29060 REM *** INPUT VARIABLES ***
29070 REM *** PRM%(0) NUMBER OF OTHER PARAMETERS ***
29080 REM *** PRM%(1) COORDINATE TYPE CHOICE ***
29090 REM *** (0 FOR TEMPLATE SCALING) ***
29100 REM *** PRM%(2) QUAD REGISTRATION SELECTION INDICATOR ***
29110 REM *** 0 = NO QUAD - MUST INPUT ALL USER COORDS ***
29120 REM *** 1=7.5 MIN QUAD, 2=15 MIN QUAD, 3=2 DEG SHEET ***
29130 REM *** TDEG% DEGREE OF REGRESSION MODEL ***
29140 REM *** ITRM% NO OF TERMS IN REGRESSION MODEL ***
29150 REM *** RETURNED VARIABLES ***
29160 REM *** IRET% COMPLETION VARIABLES ***
29170 REM *** (1=COMPLETED, 2=NOT COMPLETED) ***
29180 REM *** AX#(.,.) COORDINATE MATRIX FOR DEPENDENT VARIABLES ***
29190 REM *** TX#(),TY#() DEPENDENT VARIABLES FOR REGRESSION ***
29200 REM *** SCALING FACTORS (0 FOR TEMPLATE, 1 FOR COORDINATE) ***
29210 REM *** CDEG%(.) DEGREE OF REGRESSION MODEL ***
29220 REM *** XBOFF(.),YBOFF(.) BOARD COORDINATE OFFSET ***
29230 REM *** XUOFF#(.),YUOFF#(.) USER COORDINATE OFFSET ***
29240 REM *** OTHER VARIABLES ***
29250 REM *** A$ KEYBOARD INPUT VARIABLE ***
29260 REM *** CBTN$ RETURNED CURSOR BUTTON CHARACTER ***
29270 REM *** I%,J%,K%,L% : LOOP INDEX VARIABLES ***
29280 REM *** LA(*) LATITUDE ARRAY ***
29290 REM *** LO(*) LONGITUDE ARRAY ***

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

29300 REM ***      MPTS%  NUMBER OF REGISTRATION POINTS      ***
29310 REM ***      MSGB$(*): MESSAGE LINES FOR BOTTOM OF MENU ***
29320 REM ***      MSGT$(*): MESSAGE LINES FOR TOP OF MENU   ***
29330 REM ***      NMAX%  MAX ALLOWABLE NUMBER OF REGISTRATION POINTS ***
29340 REM ***      TMP    FACTOR FOR CALCULATING GEOGRAPHIC COORDINATES ***
29350 REM ***      TMP1   FACTOR FOR CALCULATING GEOGRAPHIC COORDINATES ***
29360 REM ***      XI,YI  RAW BOARD COORDINATES RETURNED     ***
29370 REM ***      STACK VARIABLES AND FUNCTIONS             ***
29380 REM ***      FNRET%(),FNSTK%(),ISTK%,NSTK%              ***
29390 REM *** SUBROUTINES CALLED                               ***
29400 GOTO 29460
29410 GOSUB 21000      'subroutine jkdigbrd                    ***
29420 GOSUB 30070      'subroutine getxy - internal            ***
29430 GOSUB 30590      'subroutine getgeo - internal           ***
29440 GOSUB 35000      'subroutine jkstack                     ***
29450 REM *****
29460 IF PRM%(0) <> 2 THEN PRINT "FATAL PARAMETER ERROR":STOP
29470 GOSUB 35000:IRET%=2                                     'gosub jkstack
29480 IF FNSTK%(1) <> 0 GOTO 29620
29490 'case for menu scaling
29500 MSGT$(1)=" LOWER LEFT ":MSGT$(2)=" LOWER RIGHT ":MSGT$(3)=" UPPER LEFT "
29510 CLS:PRINT "***** DIGITIZING TEMPLATE SCALING BOARD COORDINATES *****"
29511 PRINT
29520 FOR I%=1 TO 3:PRINT "DIGITIZE";MSGT$(I%);"TEMPLATE CORNER"
29530 GOSUB 21000:BEEP                                         'gosub jkdigbrd
29540 IF I% <> 1 GOTO 29560
29550 XBOFF(0)=XI:YBOFF(0)=YI:AX#(I%,1)=0:AX#(I%,2)=0:GOTO 29570
29560 AX#(I%,1)=XI-XBOFF(0):AX#(I%,2)=YI-YBOFF(0)
29570 AX#(I%,4)=1:NEXT I%
29580 MPTS%=3
29590 XUOFF#(0)=0:YUOFF#(0)=0
29600 TX#(1)=0:TY#(1)=0:TX#(2)=1:TY#(2)=0:TX#(3)=0:TY#(3)=1
29610 GOTO 30710
29620 'case for coordinate scaling
29630 'get registration board coordinates
29640 CLS:PRINT "***** DIGITIZING REGISTRATION POINT BOARD COORDINATES *****"
29650 NMAX%=25:IF FNSTK%(2)=0 GOTO 29730
29660 IF FNSTK%(2)=1 OR FNSTK%(2)=2 THEN NMAX%=16
29670 PRINT:PRINT"***** SPECIAL REGISTRATION - 2 DEG SHEET OR 7.5,15 MIN QUAD"
29680 PRINT:PRINT "YOU MUST DIGITIZE ALL THE TICK MARKS IN ORDER:"
29690 PRINT "BY ROWS FROM LOWER LEFT TO UPPER RIGHT ON THE MAP."
29700 PRINT "16 POINTS FOR 7.5 OR 15 MIN QUAD, 25 POINTS FOR 2 DEG SHEET"
29710 PRINT "FOR 2 DEG SHEET, DELTA=30 MIN HORIZ: 15 MIN VERT"
29720 PRINT
29730 I%=0
29740 WHILE I% < NMAX%
29750 I%=I%+1:PRINT USING "&##";"DIGITIZE REGISTRATION POINT NUMBER: ";I%

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

29760 GOSUB 21000:BEEP                                     'gosub jkdigbrd
29770 IF CBTN$ = ":" GOTO 29870
29780 IF I% <> 1 GOTO 29800
29790 XBOFF(1)=XI:YBOFF(1)=YI
29800 AX#(I%,1)=XI-XBOFF(1):AX#(I%,2)=YI-YBOFF(1):IF TDEG% = 1 GOTO 29850
29810 AX#(I%,3)=AX#(I%,1)*AX#(I%,1):AX#(I%,4)=AX#(I%,1)*AX#(I%,2)
29820 AX#(I%,5)=AX#(I%,2)*AX#(I%,2):IF TDEG% = 2 GOTO 29850
29830 AX#(I%,6)=AX#(I%,1)*AX#(I%,3):AX#(I%,7)=AX#(I%,1)*AX#(I%,4)
29840 AX#(I%,8)=AX#(I%,1)*AX#(I%,5):AX#(I%,9)=AX#(I%,2)*AX#(I%,5)
29850 AX#(I%,ITRM%+1)=1
29860 WEND
29870 IF CBTN$=":" THEN MPTS%=I%-1 ELSE MPTS%=I%
29880 IF MPTS% >= ITRM% GOTO 29930
29890 PRINT "NO. OF REGISTRATION POINTS IS ";MPTS%
29900 PRINT:PRINT "NOT ENOUGH FOR REGRESSION DEGREE ";ITRM%
29910 PRINT:PRINT "PRESS ANY KEY TO RETURN TO REGRESSION MODEL MENU."
29920 A$=INKEY$:IF A$="" GOTO 29920 ELSE GOTO 30720
29930 'get user coordinates of registration points
29940 'case for x-y coordinates
29950 ON FNSTK%(1) GOTO 29960,29960,30110,30110
29960 FOR I%=1 TO MPTS%:PRINT:GOSUB 30070:NEXT I%           'gosub getxy
29970 CLS:PRINT "*** VERIFICATION OF USER COORDINATES FOR REGISTRATION ***"
29980 PRINT " number";TAB(20);" x-horizontal";TAB(40);" y-vertical":PRINT
29990 FOR I%=1 TO MPTS%:PRINT I%;TAB(20);TX#(I%);TAB(40);TY#(I%)
30000 NEXT I%
30010 PRINT:PRINT "INSERT POINT NUMBER OF ANY CORRECTION NEEDED."
30020 PRINT "INSERT 0 IF ALL ARE OK.":INPUT I%
30030 IF I% >= 0 AND I% <= MPTS% GOTO 30050
30040 PRINT:PRINT "PLEASE INSERT AN INTEGER BETWEEN 0 AND ";MPTS%:GOTO 30010
30050 IF I%=0 GOTO 30670
30060 GOSUB 30070:GOTO 29970
30070 'internal subroutine to get user x,y for i-th point
30080 PRINT "INSERT X-HORIZONTAL COORDINATE FOR POINT NO ";I%;:INPUT TX#(I%)
30090 PRINT "INSERT Y-VERTICAL COORDINATE FOR POINT NO ";I%;:INPUT TY#(I%)
30100 RETURN
30110 'get geographic user coordinates of registration points
30120 IF FNSTK%(1)=4 GOTO 30140
30130 NMAX%=1:MSGT$(1)= "(decimal degrees): ":GOTO 30160
30140 NMAX%=3:MSGT$(1)= "(integer degrees): ":MSGT$(2)= " (integer minutes): "
30150 MSGT$(3)= " (real seconds): "
30160 CLS: IF FNSTK%(2)=0 GOTO 30280
30170 I%=1:PRINT "INSERT COORDINATES FOR LOWER LEFT (SW) CORNER OF MAP."
30180 PRINT:GOSUB 30590           'gosub getgeo - internal
30190 L%=4:TMP=.0416667:TMP1=TMP
30200 IF FNSTK%(2)=3 THEN L%=5:TMP=.166667:TMP1=TMP/2
30210 FOR I%=0 TO L%-1:FOR J%=1 TO L%
30220 K%=I%*L%+J%

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

30230 LA(K%,1)=LA(1,1)+TMP1*FNSTK%(2)*I%
30240 LA(K%,2)=LA(1,2):LA(K%,3)=LA(1,3)
30250 LO(K%,1)=LO(1,1)-TMP*FNSTK%(2)*(J%-1)
30260 LO(K%,2)=LO(1,2):LO(K%,3)=LO(1,3)
30270 NEXT J%:NEXT I%:GOTO 30520
30280 FOR I%=1 TO MPTS%
30290 GOSUB 30590 'gosub getgeo - internal subroutine
30300 NEXT I%
30310 'verify user coords are ok
30320 CLS:PRINT "*** VERIFICATION OF USER COORDINATES FOR REGISTRATION ***"
30330 MSGB$(1)=" number":MSGB$(2)=" lat deg":MSGB$(3)=" lat min"
30340 MSGB$(4)=" lat sec":MSGB$(5)=" lon deg":MSGB$(6)=" lon min"
30350 MSGB$(7)=" lon sec"
30360 IF FNSTK%(1)=3 GOTO 30400
30370 K%=1:FOR I%=1 TO 7
30380 PRINT MSGB$(I%);TAB(10*I%):NEXT I%
30390 PRINT:GOTO 30410
30400 K%=2:PRINT MSGB$(1);TAB(20);MSGB$(2);TAB(40);MSGB$(5)
30410 FOR I%=1 TO MPTS%
30420 PRINT I%;TAB(K%*10)
30430 FOR J%=1 TO NMAX%:PRINT LA(I%,J%);TAB(10*K%*(J%+1)):NEXT J%
30440 FOR J%=1 TO NMAX%:PRINT LO(I%,J%);TAB(10*K%*(J%+1+NMAX%)):NEXT J%
30450 PRINT:NEXT I%
30460 PRINT:PRINT "INSERT THE POINT NUMBER OF ANY CORRECTION NEEDED."
30470 PRINT "INSERT 0 IF ALL ARE OK."
30480 INPUT I%:IF I%>=0 AND I%<=MPTS% GOTO 30500
30490 PRINT "PLEASE INSERT AN INTEGER BETWEEN 0 AND ";MPTS%:GOTO 30480
30500 IF I% = 0 GOTO 30520
30510 CLS:GOSUB 30590:GOTO 30310 'gosub jkgetgeo - internal subroutine
30520 FOR I%=1 TO MPTS%:TX#(I%)=0:TY#(I%)=0
30530 FOR J%=1 TO NMAX%
30540 TY#(I%)=TY#(I%)+LA(I%,J%)/(60*(J%-1))
30550 TX#(I%)=TX#(I%)+LO(I%,J%)/(60*(J%-1))
30560 NEXT J%
30570 NEXT I%
30580 GOTO 30670
30590 'internal subroutine to get user lat/lon for point i
30600 FOR J%=1 TO NMAX%
30610 PRINT "INSERT LATITUDE";MSGT$(J%);"FOR REGISTRATION POINT NUMBER ";I%
30620 INPUT LA(I%,J%):NEXT J%
30630 FOR J%=1 TO NMAX%
30640 PRINT "INSERT LONGITUDE";MSGT$(J%);"FOR REGISTRATION POINT NUMBER ";I%
30650 INPUT LO(I%,J%):NEXT J%
30660 RETURN
30670 'set offsets and shift coordinates
30680 XUOFF#(1)=TX#(1):YUOFF#(1)=TY#(1)
30690 FOR I%=1 TO MPTS%

```

Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

30700 TX#(I%)=TX#(I%)-XUOFF#(1):TY#(I%)=TY#(I%)-YUOFF#(1):NEXT I%
30710 IRET%=1
30720 NSTK%=NSTK%-1:ISTK%=FNRET%(0):RETURN
31000 REM *****
31010 REM &&& SUBROUTINE JKSCLEKEY ***
31020 REM *** GETS SCALING FACTORS FROM KEYBOARD ***
31030 REM *****
31040 REM *** DATED: AUGUST 10, 1983 ***
31050 REM *****
31060 REM *** INPUT VARIABLES ***
31070 REM *** PRM%(0) NUMBER OF INPUT OTHER PARAMETERS ***
31080 REM *** PRM%(1) COORDINATE TYPE CHOICE ***
31090 REM *** OUTPUT VARIABLES ***
31100 REM *** CDEG%(*) DEGREE OF REGRESSION MODEL ***
31110 REM *** CX#(*) REGRESSION COEFFICIENTS FOR HORIZONTAL COORDS ***
31120 REM *** CY#(*) REGRESSION COEFFICIENTS FOR VERTICAL COORDS ***
31130 REM *** XBOFF(*) BOARD COORDINATE OFFSET ***
31140 REM *** YBOFF(*) BOARD COORDINATE OFFSET ***
31150 REM *** XUOFF#(*) USER COORDINATE OFFSET ***
31160 REM *** YUOFF#(*) USER COORDINATE OFFSET ***
31170 REM *** XROUND# X-ROUNDOFF FACTOR ***
31180 REM *** YROUND# Y-ROUNDOFF FACTOR ***
31190 REM *** IRET% ERROR RETURN (NOT CHECKED NOW) ***
31200 REM *** OTHER VARIABLES ***
31210 REM *** I%,J%,K%: LOOP INDEX VARIABLES ***
31220 REM *** RNUM%(*) NUMBER OF TERMS IN REGRESSION MODEL ***
31230 REM *** SUBROUTINES CALLED ***
31240 GOTO 31270
31250 GOSUB 35000 'subroutine jkstack
31260 REM *****
31270 IF PRM%(0) <> 1 THEN PRINT "FATAL PARAMETER ERROR":STOP
31280 GOSUB 35000 'gosub jkstack
31290 IRET%=2
31300 CLS
31310 PRINT "***** KEYBOARD SCALE FACTOR INPUT *****"
31320 ON FNSTK%(1) GOTO 31340,31340,31390,31390
31330 PRINT "*** MENU SCALING KEYBOARD INPUT ***":K%=0:GOTO 31350
31340 PRINT "*** COORDINATE SCALING KEYBOARD INPUT ***":K%=1
31350 PRINT:INPUT "INSERT XBOFF : ";XBOFF(K%)
31360 INPUT "INSERT YBOFF : ";YBOFF(K%)
31370 INPUT "INSERT XUOFF# : ";XUOFF#(K%)
31380 INPUT "INSERT YUOFF# : ";YUOFF#(K%)
31390 INPUT "INSERT CDEG%: ";CDEG%(K%)
31400 PRINT
31410 FOR I%=1 TO RNUM%(CDEG%(K%))
31420 J%=I%-1
31430 PRINT "INSERT CX#("+STR$(J%)+") : ":INPUT CX#(J%,K%)

```



## Appendix 1. Commented listing of all modules in JKDIGIT.BAS—Continued

```

31440 NEXT I%
31450 PRINT
31460 FOR I%=1 TO RNUM%(CDEG%(K%))
31470 J%=I%-1
31480 PRINT "INSERT CY#("+STR$(J%)+")": ":INPUT CY#(J%,K%)
31490 NEXT I%
31500 NSTK%=NSTK%-1:ISTK%=FNRET%(0):RETURN
35000 REM *****
35010 REM &&& SUBROUTINE JKSTACK ***
35020 REM *** BUILDS STACK OF INTEGER PARAMETERS PASSED TO SUBROUTINES***
35030 REM *****
35040 REM *** DATED: AUGUST 10, 1983 ***
35050 REM *****
35060 REM *** GLOBAL STACK VARIABLES ***
35070 REM *** NSTK% STACK LEVEL (SUBROUTINE NEST COUNT) ***
35080 REM *** ISTK% PRESENT STACK COUNT ***
35090 REM *** VSTK%( ) ARRAY OF STACKED VALUES ***
35100 REM *** TSTK% MAX STACK COUNT (DIMENSION LIMITATION) ***
35110 REM *** JSTK% TEMPORARY INDEX VARIABLE ***
35120 REM *** KSTK% TEMPORARY VARIABLE ***
35130 REM *** prm%(0) as input is the number of other integer parameters
35140 REM *** passed to the subroutine being entered as prm%(1-prm%(0)).
35150 REM *****
35160 KSTK%=ISTK%:ISTK%=ISTK%+PRM%(0)+1:IF ISTK% <= TSTK% GOTO 35190
35170 CLS:WIDTH 40:COLOR 15
35180 PRINT "FATAL ERROR - STACK SIZE EXCEEDED ";ISTK%:STOP
35190 FOR JSTK%=1 TO PRM%(0):KSTK%=KSTK%+1
35200 VSTK%(KSTK%)=PRM%(JSTK%):NEXT JSTK%
35210 VSTK%(ISTK%)=PRM%(0)
35220 NSTK%=NSTK%+1:RETURN

```

## Appendix 2. System macro to concatenate programs and subroutines, with comments for listing

```

COPY JKMERGE.BAS+JKDIGDRV.BAS+JKNUMINP.BAS+JKMNMENU.BAS TMP.TMP
COPY TMP.TMP+JKNUMENU.BAS+JKDIGUTL.BAS TMP.TMP
COPY TMP.TMP+JKYESNO.BAS+JKVALSCL.BAS+JKGETRND.BAS TMP.TMP
COPY TMP.TMP+JKFILPRM.BAS+JKDIGFIL.BAS+JKDIGDBL.BAS TMP.TMP
COPY TMP.TMP+JKDIGBRD.BAS+JKGETPNT.BAS+JKINTVAR.BAS TMP.TMP
COPY TMP.TMP+JKSCLCTL.BAS+JKREGRES.BAS+JKSCLCRD.BAS TMP.TMP
COPY TMP.TMP+JKSCLKEY.BAS+JKSTACK.BAS JKDIGLST.BAS
ERASE TMP.TMP

```

### Appendix 3. Cross-reference list of subroutine calls, by calling program

#### PROGRAM JKDIGDRV

#### CALLS SUBROUTINES

25000	AT	425,	3000	AT	465,	480	AT	470,
35000	AT	485,	1000	AT	490,	27000	AT	530,
1000	AT	570,	17000	AT	600,	27000	AT	620,
13000	AT	650,	11000	AT	665,	15000	AT	680,
15000	AT	695,	7000	AT	710,	7000	AT	730,
1000	AT	750,	23000	AT	770,	23000	AT	790,
7000	AT	800						

#### SUBROUTINE JKNUMINP

#### CALLS SUBROUTINES

35000	AT	1220,	5000	AT	1290,	5000	AT	1350,
5000	AT	1400,	5000	AT	1440,	5000	AT	1490,
5000	AT	1540,	5000	AT	1585,	5000	AT	1615

#### SUBROUTINE JKMMMENU

#### CALLS SUBROUTINES

5000 AT 3530

#### SUBROUTINE JKDIGUTL

#### CALLS SUBROUTINES

35000	AT	7240,	5000	AT	7320,	5000	AT	7380
-------	----	-------	------	----	-------	------	----	------

#### SUBROUTINE JKVALSCL

#### CALLS SUBROUTINES

35000	AT	11290,	1000	AT	11310,	19000	AT	11340
-------	----	--------	------	----	--------	-------	----	-------

#### SUBROUTINE JKGETRND

#### CALLS SUBROUTINES

13130	AT	13090,	13130	AT	13110
-------	----	--------	-------	----	-------

#### SUBROUTINE JKFILPRM

#### CALLS SUBROUTINES

35000	AT	15460,	17000	AT	15570,	17000	AT	15770
-------	----	--------	-------	----	--------	-------	----	-------

#### SUBROUTINE JKDIGFIL

#### CALLS SUBROUTINES

35000	AT	17390,	9000	AT	17540,	1000	AT	17830
-------	----	--------	------	----	--------	------	----	-------

#### SUBROUTINE JKDIGDBL

#### CALLS SUBROUTINES

35000	AT	19650,	21000	AT	19680,	20270	AT	19910,
20270	AT	19920,	20050	AT	19940,	20050	AT	19950,
20150	AT	19960,	20150	AT	19970			

**Appendix 3.** Cross-reference list of subroutine calls, by calling program—Continued

SUBROUTINE JKGETPNT      CALLS SUBROUTINES

35000	AT	23295,	9000	AT	23360,	24000	AT	23395,
24000	AT	23415,	19000	AT	23460,	24000	AT	23520,
24000	AT	23540,	24000	AT	23555,	19000	AT	23560
24000	AT	23575,	24000	AT	23595,	19000	AT	23600,
23850	AT	23610,	24000	AT	23625,	24000	AT	23645,
24000	AT	23650,	24000	AT	23690,	19000	AT	23695,
24000	AT	23720,	19000	AT	23725,	23850	AT	23735,
24000	AT	23760						

SUBROUTINE JKINTVAR      CALLS SUBROUTINES

1000      AT    26120

SUBROUTINE JKSCCLCTL      CALLS SUBROUTINES

35000	AT	27260,	1000	AT	27320,	31000	AT	27335,
15000	AT	27345,	1000	AT	27385,	29000	AT	27405,
28000	AT	27430,	28000	AT	27465			

SUBROUTINE JKREGRES      CALLS SUBROUTINES

35000	AT	28280,	28480	AT	28360,	28480	AT	28430
-------	----	--------	-------	----	--------	-------	----	-------

SUBROUTINE JKSCCLCRD      CALLS SUBROUTINES

35000	AT	29470,	21000	AT	29530,	21000	AT	29760,
30070	AT	29960,	30070	AT	30060,	30590	AT	30180,
30590	AT	30290,	30590	AT	30510			

SUBROUTINE JKSCCLKEY      CALLS SUBROUTINES

35000      AT    31280

**Appendix 4.** Cross-reference list of subroutine calls, by called program

SUBROUTINE 480 CALLED FROM			
PROGRAM JKDIGDRV	AT	470	
SUBROUTINE 1000 CALLED FROM			
PROGRAM JKDIGDRV	AT	490,	PROGRAM JKDIGDRV AT 570,
PROGRAM JKDIGDRV	AT	750,	SUBROUTINE JKVALSCL AT 11310,
SUBROUTINE JKDIGFIL	AT	17830,	SUBROUTINE JKINTVAR AT 26120,
SUBROUTINE JKSCSCTL	AT	27320,	SUBROUTINE JKSCSCTL AT 27385
SUBROUTINE 3000 CALLED FROM			
PROGRAM JKDIGDRV	AT	465	
SUBROUTINE 5000 CALLED FROM			
SUBROUTINE JKNUMINP	AT	1290,	SUBROUTINE JKNUMINP AT 1350,
SUBROUTINE JKNUMINP	AT	1400,	SUBROUTINE JKNUMINP AT 1440,
SUBROUTINE JKNUMINP	AT	1490,	SUBROUTINE JKNUMINP AT 1540,
SUBROUTINE JKNUMINP	AT	1585,	SUBROUTINE JKNUMINP AT 1615,
SUBROUTINE JKMMENU	AT	3530,	SUBROUTINE JKDIGUTL AT 7320,
SUBROUTINE JKDIGUTL	AT	7380	
SUBROUTINE 7000 CALLED FROM			
PROGRAM JKDIGDRV	AT	710,	PROGRAM JKDIGDRV AT 730,
PROGRAM JKDIGDRV	AT	800	
SUBROUTINE 9000 CALLED FROM			
SUBROUTINE JKDIGFIL	AT	17540,	SUBROUTINE JKGETPNT AT 23360
SUBROUTINE 11000 CALLED FROM			
PROGRAM JKDIGDRV	AT	665	
SUBROUTINE 13000 CALLED FROM			
PROGRAM JKDIGDRV	AT	650	
SUBROUTINE 13130 CALLED FROM			
SUBROUTINE JKGETRND	AT	13090,	SUBROUTINE JKGETRND AT 13110
SUBROUTINE 15000 CALLED FROM			
PROGRAM JKDIGDRV	AT	680,	PROGRAM JKDIGDRV AT 695,
SUBROUTINE JKSCSCTL	AT	27345	
SUBROUTINE 17000 CALLED FROM			
PROGRAM JKDIGDRV	AT	600,	SUBROUTINE JKFILPRM AT 15570,
SUBROUTINE JKFILPRM	AT	15770	

**Appendix 4.** Cross-reference list of subroutine calls, by called program—Continued

SUBROUTINE 19000 CALLED FROM			
SUBROUTINE JKVALSCL	AT 11340,	SUBROUTINE JKGETPNT	AT 23460,
SUBROUTINE JKGETPNT	AT 23560,	SUBROUTINE JKGETPNT	AT 23600,
SUBROUTINE JKGETPNT	AT 23695,	SUBROUTINE JKGETPNT	AT 23725
SUBROUTINE 20050 CALLED FROM			
SUBROUTINE JKDIGDBL	AT 19940,	SUBROUTINE JKDIGDBL	AT 19950
SUBROUTINE 20150 CALLED FROM			
SUBROUTINE JKDIGDBL	AT 19960,	SUBROUTINE JKDIGDBL	AT 19970
SUBROUTINE 20270 CALLED FROM			
SUBROUTINE JKDIGDBL	AT 19910,	SUBROUTINE JKDIGDBL	AT 19920
SUBROUTINE 21000 CALLED FROM			
SUBROUTINE JKDIGDBL	AT 19680,	SUBROUTINE JKSCLCRD	AT 29530,
SUBROUTINE JKSCLCRD	AT 29760		
SUBROUTINE 23000 CALLED FROM			
PROGRAM JKDIGDRV	AT 770,	PROGRAM JKDIGDRV	AT 790
SUBROUTINE 23850 CALLED FROM			
SUBROUTINE JKGETPNT	AT 23610,	SUBROUTINE JKGETPNT	AT 23735
SUBROUTINE 24000 CALLED FROM			
SUBROUTINE JKGETPNT	AT 23395,	SUBROUTINE JKGETPNT	AT 23415,
SUBROUTINE JKGETPNT	AT 23520,	SUBROUTINE JKGETPNT	AT 23540,
SUBROUTINE JKGETPNT	AT 23555,	SUBROUTINE JKGETPNT	AT 23575,
SUBROUTINE JKGETPNT	AT 23595,	SUBROUTINE JKGETPNT	AT 23625,
SUBROUTINE JKGETPNT	AT 23645,	SUBROUTINE JKGETPNT	AT 23650,
SUBROUTINE JKGETPNT	AT 23690,	SUBROUTINE JKGETPNT	AT 23720,
SUBROUTINE JKGETPNT	AT 23760		
SUBROUTINE 25000 CALLED FROM			
PROGRAM JKDIGDRV	AT 425		
SUBROUTINE 27000 CALLED FROM			
PROGRAM JKDIGDRV	AT 530,	PROGRAM JKDIGDRV	AT 620
SUBROUTINE 28000 CALLED FROM			
SUBROUTINE JKSCLCCTL	AT 27430,	SUBROUTINE JKSCLCCTL	AT 27465
SUBROUTINE 28480 CALLED FROM			
SUBROUTINE JKREGRES	AT 28360,	SUBROUTINE JKREGRES	AT 28430
SUBROUTINE 29000 CALLED FROM			
SUBROUTINE JKSCLCCTL	AT 27405		

Appendix 4. Cross-reference list of subroutine calls, by called program—Continued

SUBROUTINE 30070 CALLED FROM		
SUBROUTINE JKSLCRD AT 29960,	SUBROUTINE JKSLCRD	AT 30060
SUBROUTINE 30590 CALLED FROM		
SUBROUTINE JKSLCRD AT 30180,	SUBROUTINE JKSLCRD	AT 30290
SUBROUTINE JKSLCRD AT 30510		
SUBROUTINE 31000 CALLED FROM		
SUBROUTINE JKSLCTL AT 27335		
SUBROUTINE 35000 CALLED FROM		
PROGRAM JKDIGDRV AT 485,	SUBROUTINE JKNUMINP	AT 1220,
SUBROUTINE JKDIGUTL AT 7240,	SUBROUTINE JKVALSCL	AT 11290,
SUBROUTINE JKFILPRM AT 15460,	SUBROUTINE JKDIGFIL	AT 17390,
SUBROUTINE JKDIGDBL AT 19650,	SUBROUTINE JKGETPNT	AT 23295,
SUBROUTINE JKSLCTL AT 27260,	SUBROUTINE JKREGRES	AT 28280,
SUBROUTINE JKSLCRD AT 29470,	SUBROUTINE JKSLKEY	AT 31280

**Appendix 5.** Complete variable list with reference lines

SYMBOL	REFERENCE LINE						
A#(	385	27445	27450	27480	27485	28310	28330
	28390	28400	28410	28500	28520	28550	28590
A\$	91	5390	5400	5470	5500	9140	9150
	9160	9180	9190	15800	15810	15820	16050
	17470	17480	18000	20080	20090	20100	20110
	20180	20190	20200	20210	20290	20300	20310
	23525	23530	23535	23540	23655	23665	23670
	24100	24115	24130	24135	24145	24155	24450
	26160	26190	26200	26210	26220	27510	29920
ALL	39	41	43	45	47	49	51
	53	55	57	59	61	63	65
	67	69	71	73	75	77	79
	83	85					
AX#(	385	19730	19740	19760	19770	19810	19820
	27425	27460	28330	29550	29560	29570	29800
	29810	29820	29830	29840	29850		
B#	19910	19920	19940	19950	19960	19970	20080
	20130	20180	20230	20290			
B\$	20080	20110	20130	20180	20210	20230	20300
	24100						
B%	20300	20310					
BAS\$	1285	1345	1395	1435	1485	1535	1580
	1610	3520	5390	7310	7370		
BPBF	23450	23465	23560	23600	23700	23725	
BPON	710	715	11350	23450	26230		
C	20130	20230	20240	20250			
C#	19910	19920	19940	19950	19960	19970	20130
	20250	20290	20300	20320			
C\$	20310	20320					
C%	20130						
CBTN\$	19690	21110	21120	23470	23550	23565	23570
	23575	23605	23615	23620	23625	23705	23710
	23730	23740	23895	23900	23905	23915	23920
	23925	23930	29770	29870			
CDEG%(	400	460	640	3510	15670	15880	19730
	19750	19800	26080	27275	27370	27380	27395
	31390	31410	31460				
CLD%(	410	25830	25840				
CLO%(	410	24320	24335	25830			

Appendix 5. Complete variable list with reference lines—Continued

SYMBOL	REFERENCE LINE						
CLR%(	405 23685 25840	23405 23715	23410 24315	23520 24320	23555 24325	23590 24335	23645 24340
CX#(	390 27445	15680 27450	15890 31430	19790	19810	27280	27285
CY#(	390 27480	15690 27485	15900 31480	19790	19820	27280	27285
D#	20130	20230	20250				
DAT\$(	405	24245	24330	25810			
DATX%(	405	24245	24325	25860			
DATY%(	405	24245	24325	25880			
ERROR	15590 17790 21130	15790 17820 23325	15940 17860 23350	15970 17980 26140	16000 18000 26180	17420 18030 28490	17450 21100 28630
FALSE	710	730	800	23300	23435	25680	26230
FLMOD%	610	23305	23310				
FNRET%(	420 24465	1620 27520	7390 28470	11510 30720	16060 31500	18040	20040
FNSTK%(	415 11370 17430 17990 23405 23695 27265 27375 29650 30250	500 15470 17750 19660 23460 23770 27300 27405 29660 30360	520 15490 17800 19840 23480 23845 27310 27440 29950 31320	1230 15520 17810 19930 23505 24180 27335 27475 30120	1235 15530 17870 19980 23510 24185 27340 28290 30160	7250 15620 17880 20010 23560 24195 27345 28380 30200	11340 15830 17920 23370 23640 24375 27355 29480 30230
HIGH	1225	3530	5290	5320	5370	5390	
I%	17 510 3440 5310 15690 19870 20190 23830 24245 24335	37 1600 3450 5320 15890 19880 20200 23865 24250 24340	87 3390 3460 5330 15900 19890 20210 23870 24310 24345	415 3400 3470 5340 17600 20090 20220 23880 24315 25690	420 3410 3480 5350 17610 20100 23805 23885 24320 25700	500 3420 3490 5370 17720 20110 23810 24165 24325 25710	505 3430 5300 15680 19860 20120 23825 24240 24330 25720



Appendix 5. Complete variable list with reference lines—Continued

SYMBOL	REFERENCE LINE						
I%(continued)	25730	25740	25750	25770	25780	25790	25800
	25810	25820	25830	25840	25850	25860	25870
	25880	27280	27425	27445	27460	27480	28310
	28330	28340	28380	28400	28410	28420	28460
	28510	28520	28530	28540	28550	28560	29520
	29540	29550	29560	29570	29730	29740	29750
	29780	29800	29810	29820	29830	29840	29850
	29870	29960	29990	30000	30020	30030	30050
	30080	30090	30170	30210	30220	30230	30270
	30280	30300	30370	30380	30410	30420	30430
	30440	30450	30480	30500	30520	30540	30550
	30570	30610	30620	30640	30650	30690	30700
	31410	31420	31440	31460	31470	31490	
IDCHRS	585	3410	23305	23415	23550	24175	
IDTOP\$	24175	24190	24265				
IDWRT\$	23305	23415	23540	23550	23575	23625	23775
	23780	23790	23795	23815	23835	24425	
IFRST	23295						
INCR\$(	400	1600	3460	25790			
INCR%	755	785	3460	26080			
INCS\$(	400	785	25780				
INPUT	585	5390	9140	13080	13100	15800	15820
	15840	15850	15860	15870	15880	15890	15900
	15920	15930	17470	21110	30020	30080	30090
	30480	30620	30650	31350	31360	31370	31380
	31390	31430	31480				
INPUT\$(	26160						
IRET%	430	470	495	500	535	540	545
	555	570	605	610	625	630	635
	670	685	700	715	735	755	805
	1235	5420	5430	5440	5480	7260	9150
	9160	11320	11490	11500	15540	15580	15740
	15780	15940	16040	17400	17550	17560	17830
	17840	17890	17940	17960	18000	19660	23365
	23610	23740	23955	23960	26130	27325	27330
	27350	27360	27370	27390	27395	27410	27435
	27470	27490	28280	28360	28430	28610	28630
	29470	30710	31290				
IRET1%	610	17400	17830				

Appendix 5. Complete variable list with reference lines—Continued

SYMBOL	REFERENCE LINE						
ISTK%	415	420	520	1620	7390	11510	16060
	18040	20040	24465	25670	27520	28470	30720
	31500	35160	35180	35210			
ITMP%	5270	5380	15670	15680	15690	15880	15890
	15900						
ITRM%	27370	27380	27395	27425	27430	27445	27450
	27460	27465	27480	27485	29850	29880	29900
J%	500	505	510	17620	17630	17640	17650
	17660	17670	17680	17690	17700	19800	19810
	19820	19830	24240	24245	24250	24310	24315
	24320	24325	24330	24335	24340	24345	25740
	25750	25760	25800	25810	25820	25830	25840
	25850	25860	25870	25880	27440	27445	27450
	27475	27480	27485	28310	28330	28340	28540
	28550	28560	28570	28580	28590	28600	30210
	30220	30250	30270	30430	30440	30530	30540
	30550	30560	30600	30610	30620	30630	30640
	30650	31420	31430	31470	31480		
JSTK%	35190	35200					
K%	15620	15630	15640	15650	15660	15670	15680
	15690	15700	15830	15840	15850	15860	15870
	15880	15890	15900	15910	19660	19700	19730
	19750	19790	19800	19810	19820	24240	24245
	24250	24310	24315	24320	24325	24330	24335
	24340	24345	25800	25810	25820	25830	25840
	25850	25860	25870	25880	28320	28330	28340
	28360	28390	28410	28500	28510	28520	28540
	28550	28580	28590	30220	30230	30240	30250
	30260	30370	30400	30420	30430	30440	31330
	31340	31350	31360	31370	31380	31390	31410
	31430	31460	31480				
KSTK%	35160	35190	35200				
L%	28390	28410	28450	28460	30190	30200	30210
	30220						
LA(	395	11380	11410	11420	19870	20000	20020
	23490	23495	23790	23795	23805	23825	24395
	24410	30230	30240	30430	30540	30620	
LO(	395	11390	11430	11440	19880	20000	20030
	23490	23495	23790	23795	23810	23830	24400
	24415	30250	30260	30440	30550	30650	

Appendix 5. Complete variable list with reference lines—Continued

SYMBOL	REFERENCE LINE						
LOCATE	87	23440	23445	23660	23675	23750	23755
	23855	23945	24110	24115	24120	24125	24130
	24135	24140	24145	24150	24155	24160	24165
	24180	24185	24190	24200	24205	24215	24220
	24225	24245	24265	24275	24280	24285	24295
	24325	24380	24385	24395	24400	24410	24415
	24425	24430					
	1225	3530	5310	5340	5390		
LOW	730	735	800	805	845	23315	23780
LPON	23795	23820	26230				
M\$(	385	1250	1255	1260	1265	1270	1275
	1305	1310	1315	1320	1325	1330	1335
	1365	1370	1375	1380	1385	1415	1420
	1425	1460	1465	1470	1475	1515	1520
	1525	1555	1560	1565	1570	1600	3400
	3410	3420	3430	3440	3450	3460	3470
	3490	5340	7280	7290	7340	7350	
	385	3400	3490	25890	25900	25910	25920
M1\$(	25930	25940	25950	25960	25970	25980	25990
	26000	26010	26020	26030			
M1%	3390	3490	3500	25460			
MAX%	1245	1300	1360	1410	1450	1500	1550
	1595	3500	5310	5440	5460	7270	7330
MBUF	23300	23430	23435	23450			
MDF%(	385	445	450	455	515	540	545
	550	555	630	640	775	795	25700
	25710	25740					
MFIL\$	630	635	700	835	860	3450	27355
MKR\$(	385	3400	24185	25750			
MPRM%	25460	25690	25730				
MPTS%	27425	27430	27460	27465	29580	29870	29880
	29890	29960	29990	30030	30040	30280	30410
	30480	30490	30520	30690			
MSEL%(	385	445	450	455	460	485	500
	515	530	540	545	550	555	560
	570	610	630	635	640	655	665
	670	680	685	695	700	715	735
	755	765	775	785	795	805	825
	850	3400	3420	3440	3450	25710	

Appendix 5. Complete variable list with reference lines—Continued

SYMBOL	REFERENCE LINE						
MSG\$(	390						
MSGB\$(	390	5370	5460	5470	5500	30330	30340
	30350	30380	30400				
MSGB%	1225	3500	5270	5370	5380	5450	5460
	5470	5480	5490	5500	7270	7330	11300
	11360						
MSGT\$(	390	1455	1505	1510	5300	11380	11390
	11410	11420	11430	11440	11460	11470	27300
	27305	29500	29520	30130	30140	30150	30610
	30640						
MSGT%	1245	1300	1360	1450	1500	1550	1595
	3500	5300	5480	7270	7330	11300	11360
	27315						
MSK\$	1245	1360	1410	1450	1500	1550	1595
	3500	3510	5320	5480	27295	27310	
N%	28290	28320	28380	28390	28400	28440	28450
	28460						
NDIM%	28290	28310	28360	28510	28540	28570	
NMAX%	29650	29660	29740	30130	30140	30430	30440
	30530	30600	30630				
NPTS%	605	840	865	23840	24295		
NSTK%	520	1620	7390	11510	16060	18040	20040
	24465	25670	27520	28470	30720	31500	35220
OFIL\$	610	825	850	3420	23335		
P%(	400	28380	28390	28400	28410	28460	
PRM%(	400	485	490	530	570	595	620
	665	680	695	710	730	750	765
	785	800	1215	7230	11280	11310	11340
	15450	15570	15770	17380	17830	19640	23290
	23395	23415	23460	23520	23540	23555	23560
	23575	23595	23600	23610	23625	23645	23650
	23690	23695	23720	23725	23735	23760	23940
	24090	24300	24350	24355	24370	26120	27320
	27335	27340	27345	27370	27385	27395	27405
	27430	27465	28270	29460	31270	35160	35190
	35200	35210					
PRM1\$	595	785	9140	15460	17400	17540	23295
	23360						
PRM2\$	610	635	685	700	1455	17400	17480
	17500	17520	17600	17610	17740	17800	17880
	17900	17920	17930	17990	18010	27355	

Appendix 5. Complete variable list with reference lines—Continued

SYMBOL	REFERENCE LINE						
RNUM%(	395 31460	15670	15880	19800	26070	27395	31410
S%	20230	20240	20250				
SFIL\$	515 27355	550	555	685	830	855	3440
SPC(	23440 24160	23660 24190	23750 24265	23755 24275	23855 24280	24140 24285	24150
ST\$(	410	3500	26040	26050	26060		
ST%	440	445	450	455	460	3500	
STAR1\$	5270	5290					
STAR2\$	5270	5280	5290				
TAB(	23805 30400	23810 30420	23825 30430	23830 30440	29980	29990	30380
TDEG%	27370	27380	27395	29800	29820		
TMP	30190	30200	30250				
TMP#	13090	13110	13140				
TMP%	17610	17630	17660	17690	20290	20300	20310
TMP1	30190	30200	30230				
TMP1\$	17400	17470	23295	23385			
TMP3\$	15480	15500	15510	15600	15810	16030	
TNE\$	23440	26220					
TNF\$	23430	26200					
TOP\$	1280 1605	1340 3520	1390 5280	1430 7300	1480 7360	1530	1575
TROUND#	19960	19970	20250				
TRUE	435 26230	715	735	805	23295	23430	25680
TSTK%	25670	35160					
TX#(	390 30680	27425 30700	29600	29990	30080	30520	30550
TY#(	390 30680	27460 30700	29600	29990	30090	30520	30540
VMAX	28390	28400	28410				
VSTK%(	400	415	420	35200	35210		
X#	23485	23775	23780	24380			

Appendix 5. Complete variable list with reference lines—Continued

SYMBOL	REFERENCE LINE						
XBOFF(	395	15630	15840	19700	27275	29550	29560
	29790	29800	31350				
XDB#	11460	19790	19810	19880	19910	19940	19960
	20000	23485	23860	23865			
XI	19700	21110	29550	29560	29790	29800	
XMEN%	23865	23870	23895	23900	23905	23910	
XROUND#	550	3430	13060	13080	13090	15710	15920
	19960	26080					
XT#	19700	19730	19740	19760			
XTMP	5400	5410	5420	5430			
XUOFF#(	395	15650	15860	19790	27275	29590	30680
	30700	31370					
Y#	23485	23775	23780	24385			
YBOFF(	395	15640	15850	19700	27275	29550	29560
	29790	29800	31360				
YDB#	11470	19790	19820	19870	19920	19950	19970
	20000	23485	23860	23880			
YI	19700	21110	29550	29560	29790	29800	
YMEN%	23880	23885	23895	23900			
YROUND#	550	3430	13070	13100	13110	15720	15930
	19970	26080					
YT#	19700	19730	19740	19770			
YUOFF#(	395	15660	15870	19790	27275	29590	30680
	30700	31380					
=====							
LINES: 1760	BYTES: 99333	SYMBOLS: 382	REFERENCES: 2154				

**Appendix 6.** Transfer statement cross-reference list

SYMBOL	REFERENCE LINE						
0	15940	15970	16000	17450	17820	17860	18000
	18030	21130	23350	26180	28630		
87	39	41	43	45	47	49	51
	53	55	57	59	61	63	65
	67	69	71	73	75	77	79
91	91						
380	275						
480	470						
520	495	505	510				
525	470						
555	540						
565	470						
590	470						
615	470						
645	470						
660	470						
675	470						
690	470						
705	470						
725	470						
745	470						
760	470						
780	285	470					
815	470						
870	845						
875	430						
1000	490	570	750	11240	11310	17340	17830
	25430	26120	27225	27320	27385		
1215	1195						
1245	1230						
1300	1230						

Appendix 6. Transfer statement cross-reference list—Continued

SYMBOL	REFERENCE LINE						
1360	1230						
1405	1230						
1445	1230						
1495	1230						
1545	1230						
1590	1230						
1620	1235	1290	1350	1400	1440	1490	1540
	1585	1615					
3000	290	465					
3390	3360						
5000	295	1200	1290	1350	1400	1440	1490
	1540	1585	1615	3370	3530	7200	7320
	7380						
5290	5470	5510					
5440	5430						
5450	5410						
5480	5440						
7000	300	710	730	800			
7230	7190						
7270	7250						
7330	7250						
7390	7320						
9000	305	17350	17540	23360			
9140	9200						
9200	9180						
11000	310	665					
11280	11230						
11310	11400	11450	11480				
11330	11320						
11380	11370						
11410	11370						
11460	11370						
11490	11320						



**Appendix 6.** Transfer statement cross-reference list—Continued

SYMBOL	REFERENCE LINE					
11500	11320					
11510	11490					
13000	315	650				
13080	13090					
13100	13110					
13130	13090	13110				
15000	320	680	695	27230	27345	
15460	15400					
15480	15470					
15490	15470					
15500	15490					
15510	15490					
15520	15480	15500				
15550	15520					
15730	15700					
15760	15520					
15790	15780					
15940	15910					
15950	15580					
15970	15590					
15990	15780					
16000	15790					
16020	15810					
16040	15540	15950	15960	15980	15990	16010
16050	16050					
16060	15750	15940				
17000	325	600	15420	15570	15770	
17380	17330					
17450	17420					
17460	17440	17450	18030			
17470	17550	17580	17710	17840		
17560	17550					
17570	17520					

Appendix 6. Transfer statement cross-reference list—Continued

SYMBOL	REFERENCE LINE						
17600	17500						
17720	17630	17660	17690				
17760	17750						
17850	17790						
17860	17850						
17880	17840						
17920	17750	17840					
17960	17840						
17970	17750						
18010	17980						
18030	18020						
18040	17560	17910	17950	17960	18000		
19000	330	11250	11340	23265	23460	23560	23600
	23695	23725					
19640	19510						
19790	19730	19750					
19860	19840						
19900	19840						
19960	19930						
20000	19980						
20040	19690	19850	19950	19980	19990	20010	
20050	19530	19940	19950				
20130	20100						
20150	19540	19960	19970				
20230	20200						
20270	19550	19910	19920				
21000	335	19520	19680	29410	29530	29760	
21150	21100						
23000	340	770	790				
23290	23260						
23310	23305						
23315	23305						
23320	23365						
23350	23325						

Appendix 6. Transfer statement cross-reference list—Continued

SYMBOL	REFERENCE LINE					
23360	23355					
23370	23315	23365				
23375	23370					
23395	23345	23370				
23405	23845					
23425	23845					
23435	23425					
23445	23430					
23450	23435	23440				
23485	23480					
23490	23480					
23495	23480					
23505	23485					
23510	23505					
23515	23510					
23525	23525	23545				
23550	23510					
23560	23580					
23585	23510					
23600	23610	23630				
23640	23535	23570	23615			
23645	23640					
23650	23680					
23655	23655					
23685	23640					
23715	23640					
23745	23505	23510				
23770	23640	23665	23710	23730	23740	
23775	23770					
23790	23770					
23805	23770					
23840	23785	23800	23820			
23845	23670	23710	23740			

Appendix 6. Transfer statement cross-reference list—Continued

SYMBOL	REFERENCE LINE						
23850	23270	23610	23735				
23880	23865						
23895	23880						
23915	23910						
23920	23910						
23925	23910						
23930	23910						
23935	23860	23875	23890				
23955	23940						
23960	23895	23900	23905	23915	23920	23925	23930
23965	23955						
24000	23275	23395	23415	23520	23540	23555	23575
	23595	23625	23645	23650	23690	23720	23760
24100	24090						
24200	24195						
24215	24195						
24225	24210						
24260	24090						
24270	24090						
24305	24090						
24325	24315						
24340	24320						
24360	24300						
24380	24375						
24395	24375						
24410	24375						
24420	24090	24370	24390	24405			
24425	24355						
24430	24255	24350					
24435	23530						
24440	23470	23565	23605	23620	23705		
24450	24450						
25000	345	425					
25450	25420						

Appendix 6. Transfer statement cross-reference list—Continued

SYMBOL	REFERENCE LINE				
26100	26130				
26140	26130				
26240	26130				
26250	26140				
27000	350	530	620		
27260	27220				
27265	27515				
27290	27265				
27315	27300				
27335	27330				
27340	27330				
27365	27330	27410			
27385	27375				
27405	27370	27380			
27490	27285	27335			
27500	27435	27470			
27510	27510				
27520	27325	27350	27360	27390	27490
28000	355	27235	27430	27465	
28270	28230				
28390	28450	28460			
28420	28400				
28430	28390				
28470	28360	28430	28440		
28480	28240	28360	28430		
28530	28510				
28560	28540				
28600	28580				
28630	28490				
28640	28610	28630			
29000	360	27240	27405		
29460	29400				
29560	29540				

Appendix 6. Transfer statement cross-reference list—Continued

SYMBOL	REFERENCE LINE			
29570	29550			
29620	29480			
29730	29650			
29800	29780			
29850	29800	29820		
29870	29770			
29920	29920			
29930	29880			
29960	29950			
29970	30060			
30010	30040			
30050	30030			
30070	29420	29960	30060	
30110	29950			
30140	30120			
30160	30130			
30280	30160			
30310	30510			
30400	30360			
30410	30390			
30480	30490			
30500	30480			
30520	30270	30500		
30590	29430	30180	30290	30510
30670	30050	30580		
30710	29610			
30720	29920			
31000	365	27245	27335	
31270	31240			
31340	31320			

**Appendix 6.** Transfer statement cross-reference list—Continued

SYMBOL	REFERENCE LINE						
31350	31330						
31390	31320						
35000	370	485	1205	1220	7210	7240	11260
	11290	15430	15460	17360	17390	19560	19650
	23280	23295	27250	27260	28250	28280	29440
	29470	31250	31280				
35190	35150						











