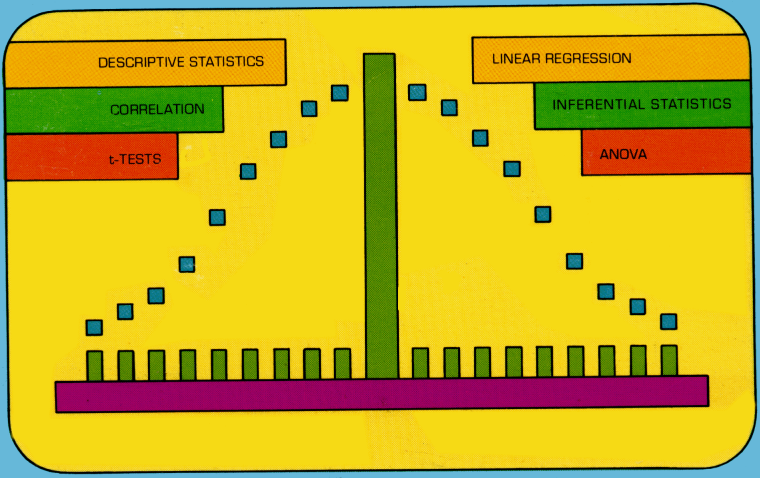
Texas Instruments Home Computer

Statistics

SOLID STATE SOFTWARE™ **COMMAND MODULE**

Performs a variety of statistical calculations for you with computer speed and accuracy. Leaves you more time to analyze the results and apply them to your particular situation.



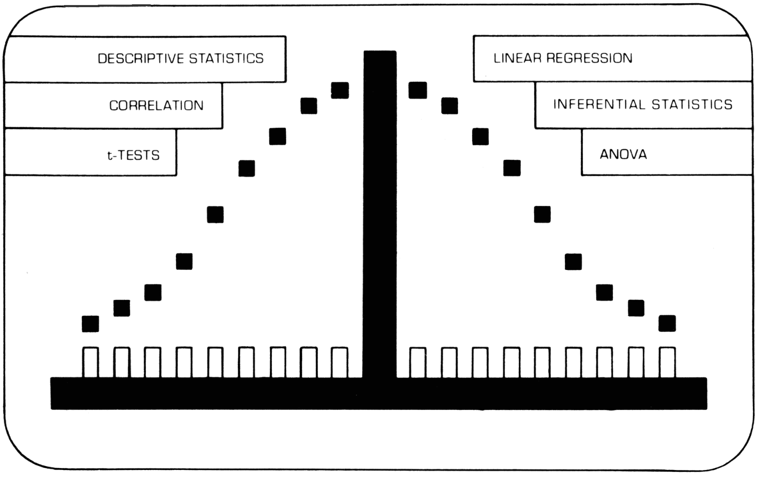
Quick Reference Guide

Note that the key sequences required to access special functions depend on the type of computer console you have. Important keystroke sequences are summarized here for your "quick reference."

TI-99/4	*TI-99/4A*	
ENTER	**ENTER**	Tells the computer to process the information you've typed.
SHIFT E (UP ↑) **SHIFT X (DOWN ↓)**	**FCTN E (UP ↑)** **FCTN X (DOWN ↓)**	If the results of a calculation are displayed on more than one screen, press **E** to view the following screens or **X** to view the preceding screens.
SHIFT Z (BACK)	**FCTN 9 (BACK)**	Returns to previous selection list or index.
SHIFT S (LEFT ←) **SHIFT D (RIGHT →)**	**FCTN S (LEFT ←)** **FCTN D (RIGHT →)**	Moves the cursor one space to the left or right without erasing or changing the data on the screen.
SHIFT F (DEL)	**FCTN 1 (DEL)**	Deletes the character under the cursor. The rest of the line is shifted left.
SHIFT G (INS)	**FCTN 2 (INS)**	This key sequence allows you to insert one or more characters in front of the character under the cursor. The rest of the line is shifted right.
SHIFT C (CLEAR)	**FCTN 4 (CLEAR)**	Erases an entry that has been typed only if **ENTER** has not been pressed.
SHIFT Q (QUIT)	**FCTN = (QUIT)**	Returns the computer to the master title screen. *Note:* All data you have entered will be lost.

TEXAS INSTRUMENTS
HOME COMPUTER

Statistics



This *Solid State Software*™ Command Module is designed to be used with the Texas Instruments Home Computer. Its preprogrammed solid-state memory expands the power, versatility, and capability of your Home Computer.

TABLE OF CONTENTS

INTRODUCTION

The statistics branch of mathematics has become increasingly important in many aspects of our daily life. Scientists, government leaders, educators, and pollsters — among others — regularly apply statistical methods to analyze large amounts of data. The results often influence critical and far-reaching decisions. Whether your field is science, business, or education, you probably find yourself devoting valuable time to lengthy and difficult statistical computations.

With the Statistics *Solid State Software*™ Command Module plugged in, the Home Computer can perform statistical calculations for you with speed and accuracy, leaving you with more time to concentrate on analyzing the results.

The module is designed to be easy to use. Without programming experience or special computer training, you can perform calculations in the following statistical categories:

- Descriptive statistics, including mean, standard deviation, and frequency tables
- Correlation
- Linear regression
- Inferential statistics, including t-tests and analysis of variance
- Significance level calculator for z, Student's t, r, F, and χ^2

The Statistics module program guides you in entering the data set. First, to help you set up the file structure, the computer prompts you to enter the category names and the type of data they will contain. Then you are ready to enter the values for each category as prompted on the screen. When your data file is complete, you simply select the analysis you want performed and type the names of the categories to be analyzed. The module then performs all of the calculations and displays the results for you!

The Statistics module uses terminology familiar to most statisticians. A *data file* is the organized collection of numerical facts which you want to analyze, such as test scores in an English class. The *data file* contains two basic categories of information — *variables* and *observations*. The *variables* are the separate categories of information included in the file, such as NAME, TEST1, TEST2, and FINAL EXAM. An *observation* is the set of variables relating to a particular element in a file, such as all of the test scores for Mary Smith.

For future analysis of a data file, the file contents must be stored on a mass storage device, such as a cassette tape or disk. Stored files are easily reloaded into the computer for further analysis. (See "Saving and Loading a Data File" on page 34.)

You can transmit data files to another Home Computer via the Texas Instruments RS232 Interface and the Texas Instruments Telephone Coupler (Modem). With the optional Texas Instruments Solid State Thermal Printer (or another printer connected via the RS232 Interface) attached to the Home Computer, you can make printed copies of displayed results.

In addition, the file structures of the Statistics Command Module and the Personal Record Keeping Command Module are designed to be compatible. Applying the capabilities of one of these modules to data generated from the other can increase the usefulness of both by accomplishing tasks which are not possible with either module used alone. See the "Personal Record Keeping Module Compatibility" section of this manual for additional details. You may also wish to ask your retailer to let you review the owner's manual for the Personal Record Keeping Command Module.

USING THIS MANUAL

This manual is designed to demonstrate the development of a data file and the statistical procedures available in the Statistics module. First, there is a brief review of the "Special Keys and Features" of the module, followed by the directions for installing the module. The next section explains in detail how to set up and enter a data file.

Correctly structuring the data file is essential, since it is the basis upon which all of the statistical analyses (except the Significance Level Calculator) are performed. For demonstration purposes, we have chosen a data set relating to the effects of heat on the life spans of electrical components. The data set may seem rather large for a demonstration, but its size makes it possible to apply all of the statistical routines. Thus, you can explore the capabilities of the module without entering or reviewing a unique data set for each separate application.

You probably won't want to enter the whole example into the computer. To help you familiarize yourself with the operation of the module, we recommend the following procedure:

1. Study the sample data set to see how it has been organized.
2. Enter and define the eight categories (*variables*) that make up the structure of the file. Observe the way the module program "prompts" you for each entry or selection.
3. Enter several lines of data (*observations*) for practice.
4. Follow the examples given for reviewing, correcting, and changing data *after* entry. Remember, correct data entry is essential in any statistical calculation.

5. Read the remaining sections of the manual, and try out the examples whenever possible. Even though you haven't entered the whole data set and the results of the operations may therefore be invalid, you can observe the organization of the module and familiarize yourself with the options it offers.

Each statistical analysis is discussed and demonstrated in terms of the sample data file. The major goal of these examples is to show you how the module program operates — and how you interact with it. You'll find very little theory in these discussions; we assume that you are familiar with the statistical tests and calculations available in the module and that you understand when and how to apply them to a particular data set. For your convenience, the formulas used by the program are included in an appendix at the end of the manual.

You may also want to practice *saving* and *loading* data by means of a mass storage device. Other sections of the book discuss these procedures, as well as transmitting data from one computer to another and obtaining printed copies of your data file and results.

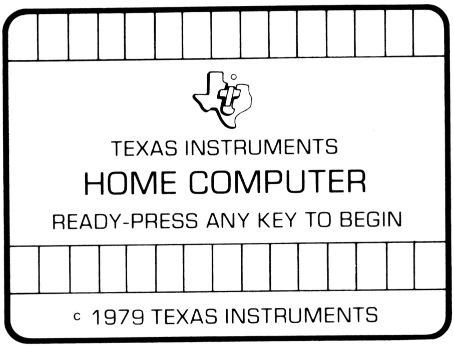
SPECIAL KEYS AND FEATURES

▯	The screen shows a flashing symbol (cursor) or character to tell you when and where to type information for the computer.
ENTER	Pressing the **ENTER** key tells the computer to process the information you've typed. Also, when a calculation produces more than one display of results, pressing **ENTER** displays more information.
SHIFT (UP) ↑ **SHIFT (DOWN)** ↓	Sometimes the results of a calculation require more than one display. Press **SHIFT** ↑ (UP) to view preceding screens or **SHIFT** ↓ (DOWN) to view following screens.
P	If a printer is attached to the Home Computer, pressing **P** produces a printed copy of the results displayed on the screen.
SHIFT Z (BACK)	When an analysis is completed, pressing **SHIFT Z** returns the computer to the previous selection list or index.
SHIFT (LEFT) ← **SHIFT (RIGHT)** →	To move the cursor one space to the left or right without erasing or changing data on the screen, press **SHIFT** ← (LEFT) or **SHIFT** → (RIGHT).
SHIFT F (DEL)	Holding down the **SHIFT** key and pressing **F** deletes the character under the cursor. The remainder of the line is shifted left.
SHIFT G (INS)	Pressing **SHIFT G** (INS) lets you insert a new character(s) in front of the character under the cursor. The rest of the line is shifted right.
SHIFT C (CLEAR)	To erase the entry you are typing, press **SHIFT C** (CLEAR) before pressing **ENTER**.
SHIFT Q (QUIT)	This key sequence returns the computer to the master title screen. *Note*: All data you have entered will be erased.

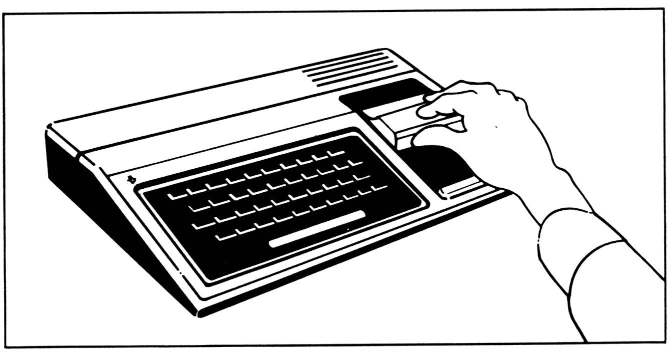
USING THE *SOLID STATE SOFTWARE*™ COMMAND MODULE

An automatic reset feature is built into the computer. When a module is plugged into the console, the computer returns to the master title screen. All data and program material you have entered will be erased.

Note: Be sure the module is free of static electricity before inserting it into the computer (see page 45).



1. Turn the computer ON, and wait for the master title screen to appear. Then slide the module into the slot on the console.



2. Press any key to make the master selection list appear. The title of the module will be on the list. To select the module, press the key for the number next to STATISTICS.

Note: To remove the module, *first* return the computer to the master title screen by pressing **SHIFT Q**. *Then* remove the module from the slot. If you have any problem inserting the module, or if it is accidentally removed from the slot while in use, please see "In Case of Difficulty" on page 46.

DEMONSTRATION — ENTERING A SAMPLE DATA FILE

When you choose Statistics, the module's title screen appears, automatically followed by the message "ONE MOMENT PLEASE..." The Statistics selection list then appears.

```
PRESS
  1    TO CREATE A NEW FILE
  2       LOAD AN EXISTING FILE
  3       USE SIGNIFICANCE
          LEVEL CALCULATOR
  4       QUIT
```

The first option allows you to set up a new file for statistical analyses. Option 2 loads a data file which was previously saved on a mass storage device. With option 3 you can compute the significance level of a known statistic. Select option 4 to leave the Statistics module if you have completed your analyses.

Naming the File

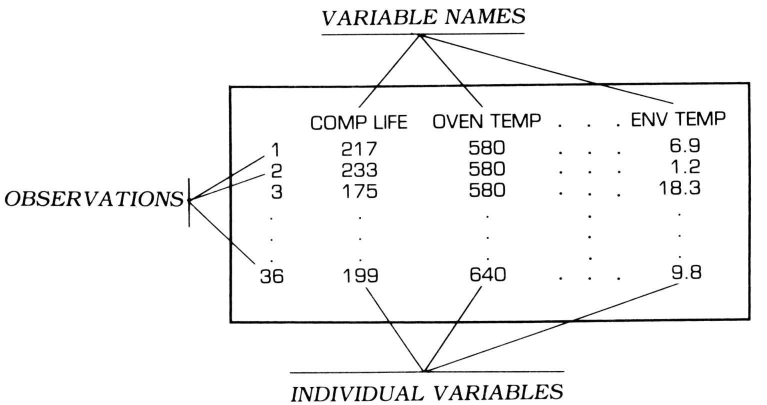
For this demonstration, press **1** to *Create a New File.* The computer then prompts you for the file name. Type DEMO1 and press the **ENTER** key.

Now you are ready to set up a data file and perform the various statistical analyses in the module.

A Sample Data File

The first step in creating any data file is deciding how the data should be organized, the major categories that should be included, and the amount of space available for the file.

The Statistics module organizes information into groups called *observations*. Each observation contains a set of categories, called *variables*.



Each observation is one full set of variable categories in your file. For example, all of the information relating to the life span of one specific electrical component makes up one observation in the Demonstration data file. The number of observations available for a file is determined by the number of variables, the length of each variable entry, and the amount of memory in the computer.

The demonstration data included here has been selected to illustrate the options available with the Statistics Command Module, from the simplest to the most complex. Thus, some variables serve multiple roles, and the data file may appear to be unrealistic.

The observations concern the lifetimes of 36 randomly selected electrical components which were baked at four oven temperatures and three baking times. These components were then tracked over their lifetimes, and the following data file recorded.

Life of the Electrical Component (100 Hours)	*Oven Temperature (F°)*	*Baking Time (Hours)*	*Replication*	*Expensive Test (C°)*	*Cheaper Test (C°)*	*Intervals of Lifetimes*	*Environmental Temperature (C°)*
217	580	5	1	29.2	24.7	7	6.9
233	580	10	1	28.0	23.2	8	1.2
175	580	15	1	22.6	23.1	4	18.3
158	600	5	1	19.9	26.4	3	21.7
138	600	10	1	19.5	24.4	2	25.9
152	600	15	1	20.7	14.9	3	23.3
229	620	5	1	31.1	33.9	8	2.2
186	620	10	1	26.0	23.7	5	13.9
155	620	15	1	17.9	27.2	3	22.0
223	640	5	1	26.0	24.2	8	2.6
227	640	10	1	27.0	31.4	8	0.3
156	640	15	1	20.6	20.7	3	23.3
188	580	5	2	26.1	28.2	5	14.0
201	580	10	2	25.3	22.1	6	11.9
195	580	15	2	24.7	30.9	6	9.3
126	600	5	2	16.4	12.8	1	30.0
130	600	10	2	16.0	19.7	1	28.1
147	600	15	2	18.6	14.2	2	27.6
160	620	5	2	22.3	26.6	3	22.8
170	620	10	2	24.4	19.2	4	19.2
161	620	15	2	22.5	16.7	3	23.4
201	640	5	2	25.6	25.5	6	8.1
181	640	10	2	24.6	25.0	5	13.3
172	640	15	2	25.1	19.6	4	16.2
162	580	5	3	21.9	26.1	3	22.2
170	580	10	3	22.7	17.2	4	17.9
213	580	15	3	28.8	21.7	7	7.7
122	600	5	3	16.4	18.1	1	31.5
185	600	10	3	20.4	21.6	5	14.8
180	600	15	3	21.8	29.7	5	14.5
167	620	5	3	20.1	17.2	4	19.7
181	620	10	3	21.9	25.1	5	12.0
182	620	15	3	21.9	23.0	5	13.4
182	640	5	3	22.5	20.2	5	14.5
201	640	10	3	21.8	22.1	6	9.1
199	640	15	3	21.5	22.2	6	9.8

An example analysis from a study by Charles R. Hicks served as the basis for developing this sample data set.* In the data set, the life span of the electrical component is expressed in hundreds of hours, the oven temperature in degrees Fahrenheit, and the length of the baking time in hours. The replication number identifies the experimental run in which the component was fired. After it was fired, two procedures were used to measure the component's internal operating temperature (C°). The cheaper test could be performed directly on the component, while the expensive test required assembly of the entire system. The "Intervals of Lifetimes" column is included only to illustrate a frequency table for component life. The environmental temperature (C°) is an estimate of the average operating temperature of the room that housed the system which used the component. The system ran continually except for preventive maintenance.

Naming and Defining Variables

As you set up a file, each variable must be given a name for identification. For instance, the variable name for the life span of an electrical component could be COMPONENT LIFE. Since variable names can be a maximum of nine characters long, this can be abbreviated to COMP LIFE.

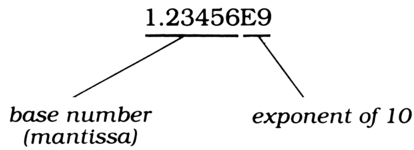
In addition to being "named," each variable must also be "defined" by its type and length. The computer prompts you, one at a time, for the variable name, the variable type, and the variable length.

Variable Name — When the prompt VARIABLE NAME? is on the screen, type the name for the variable and press **ENTER**. Variable names can be up to nine characters long.

*Charles R. Hicks, *Fundamental Concepts in the Design of Experiments* (New York: Holt, Rinehart, and Winston, Inc., 1973), pp. 215-219.

Variable Type — Next, the computer prompts for Variable Type, displaying a list of the four available types. Indicate the kind of data you'll be entering by pressing **1**, **2**, **3**, or **4**.

1. CHARACTERS — These are alphanumeric entries such as names and addresses. Any numbers entered in this category cannot be used in mathematical operations.
2. INTEGERS — These entries are whole numbers with no decimal point. (*Note*: If you have defined an item as an integer, the computer will not accept a zero as the first digit.)
3. DECIMALS — These entries are numbers with a decimal point, such as dollars and cents.
4. SCIENTIFIC NOTATION — Scientific notation is used for the entry of very large or very small numbers (entries that exceed the maximum number of digits allowed in the other two number fields). For example, the number 1,234,560,000 would be entered in scientific notation as:



See the sections on scientific notation in *Beginner's BASIC* and the *User's Reference Guide* for a more complete discussion.

Note: The only variable types that can be used in mathematical operations are Integers, Decimals, and Scientific Notation.

Variable Length — The prompt, MAX#CHARACTERS (or DIGITS), asks you to define the number of characters or digits for each variable. The length you specify for each variable is determined by the longest entry you expect to have for that variable. To save memory space, specify only the length that is actually needed. The following chart lists the maximum lengths that are available for use:

FILE ELEMENT	*MAXIMUM LENGTH*
FILE NAME	9
VARIABLE NAME	9
CHARACTER	15
INTEGER	10
DECIMAL	11 (including decimal point)
SCIENTIFIC NOTATION	5 (decimal places; total length, 13 characters)

Setting Up the File Structure

The computer prompts you through the process, beginning with VARIABLE NAME. These prompts continue until all of the variable names are specified. The following chart shows the on-screen prompts and the inputs that set up the DEMO1 file structure. Since it's important to the entire data file that the structure be entirely accurate, check each input before you press **ENTER** . To correct an input use the editing keys as explained in "Special Keys and Features" on page 5. When the input is correct, press **ENTER** to go on to the next prompt.

Variable Number	*Prompts*	*Input*
1	VARIABLE NAME	COMP LIFE
	TYPE	2
	MAX# OF DIGITS	3
2	VARIABLE NAME	OVEN TEMP
	TYPE	2
	MAX# OF DIGITS	3
3	VARIABLE NAME	BAKE TIME
	TYPE	2
	MAX# OF DIGITS	2
4	VARIABLE NAME	REP
	TYPE	2
	MAX# OF DIGITS	1
5	VARIABLE NAME	EXP TEST
	TYPE	3
	MAX# OF DIGITS, INCLUDING DECIMAL POINT	4
	NO. OF DECIMAL PLACES	1
6	VARIABLE NAME	CHP TEST
	TYPE	3
	MAX# OF DIGITS, INCLUDING DECIMAL POINT	4
	NO. OF DECIMAL PLACES	1
7	VARIABLE NAME	INTERVALS
	TYPE	2
	MAX# OF DIGITS	1
8	VARIABLE NAME	ENV TEMP
	TYPE	3
	MAX# OF DIGITS, INCLUDING DECIMAL POINT	4
	NO. OF DECIMAL PLACES	1

Your file structure is set up now, and you're ready to enter the observations. To continue, hold down the **SHIFT** key and press **Z** (BACK). The display then asks if you are going to use a printing device. For this example, press **2** since no printing will be done. (Obtaining printed copy is discussed on page 36.)

Checking the File Structure

After you answer the question(s) relating to the printer, the computer displays the MAIN INDEX.

```
              MAIN INDEX

    PRESS
      1    TO SEE FILE DEFINITION
      2       ENTER OBSERVATIONS
      3       CHANGE OBSERVATIONS
      4       ANALYZE DATA FILE
      5       SAVE DATA FILE
      6       QUIT
```

The MAIN INDEX is a summary of the six general options available with the Statistics Module. Press **1** to *See File Definition* to review the data file structure you have just set up. Check the variable names and specifications for accuracy. To correct mistakes, press **SHIFT Q** to return to the master title screen (all data you have entered will be erased). Then select the module again. When the Statistics selection list is displayed, select *Create a New File* again, and reenter all of the data in the file structure from the beginning.

The top of the File Definition display tells you the maximum number of observations you can enter, determined by the number and length of the variables and the amount of available computer memory. Once you begin entering data, no corrections can be made to the variable names or parameters.

When you have reviewed the file structure, press **SHIFT Z** (BACK) to return to the MAIN INDEX.

Entering Observations

Now, begin entering the demonstration data for each observation (in this case, the information pertaining to each component life span). Press **2** to select *Enter Observations*. The next display shows OBSERVATION 1 and prompts you to enter your data by displaying the variable names one at a time. The following chart shows the information you enter for the first observation.

Prompt	*Input*
COMP LIFE	217
OVEN TEMP	580
BAKE TIME	5
REP	1
EXP TEST	29.2
CHP TEST	24.7
INTERVALS	7
ENV TEMP	6.9

Next, the module program requests the information for Observation 2. Refer to the chart on page 9, and enter the data for the other observations. When you have entered all the data, press **SHIFT Z** (BACK) to return to the MAIN INDEX.

Changing Observations

Since accurate data entry is crucial to statistical validity, the module lets you check each observation to make sure the data was entered correctly. When the MAIN INDEX appears on the screen, press **3** to *Change Observations*. The display now asks WHAT OBSERVATION? To check all of the data, press **1** and then **ENTER**.

The program displays the data you entered for the first observation. The cursor flashes over the first number of 217. If 217 is correct, press the **ENTER** key. If not, correct it using one of these two procedures:

1) Retype the number and then press **ENTER**.
2) Press **SHIFT C** to erase the incorrect value, type it correctly, and press **ENTER**.

The cursor then moves to the next variable. Press **ENTER** if it's correct, or change it if it's not. Each time you press **ENTER**, the cursor moves to the next variable.

If you don't need to make any corrections, press **SHIFT Z** (BACK) when the cursor is flashing over the first entry. The display again asks WHAT OBSERVATION? This time, press **2** and **ENTER** to check the second observation. Continue the procedure until you have checked the entire data file and have made any necessary changes.

When you press **SHIFT Z** (BACK) after checking the final observation, you are again prompted for the observation number. Press **SHIFT Z** (BACK) a second time to return to the MAIN INDEX.

At this time, you may wish to save your data file on a mass storage device. If so, press **5** for *Save Data File*. The computer then gives you directions for saving the file. For more information, see "Saving a File" on page 34.

ANALYZING THE DATA FILE

To begin analyzing the data, press **4** for *Analyze Data File* while the MAIN INDEX is displayed. This selection list appears.

```
         ANALYZE DATA FILE

PRESS
  1    FOR DESCRIPTIVE
           STATISTICS
  2        CORRELATION
  3        LINEAR REGRESSION
           ANALYSIS
  4        INFERENTIAL
           STATISTICS
  5    TO  EXIT THIS SECTION
```

Now you're ready to examine the various statistical analyses available with the module.

Descriptive Statistics

Descriptive statistics involves collecting, grouping, and presenting large sets of data in ways that can be easily understood or assimilated. When working with an entire population, we generally assume that descriptive statistics describe the characteristics of the population. To analyze a statistical sample, we usually apply inferential statistics. These statistics allow us to draw conclusions about the population based upon a sample while realizing there is some risk of drawing incorrect conclusions. When analyzing a sample with descriptive statistics, we must understand that the characteristics described apply only to the sample and not to the population. The descriptive statistics of a sample, however, play an important role in inferential statistics.

Begin these analyses by pressing **1** for *Descriptive Statistics*. At this point, you can choose: (1) Mean, Standard Deviation, Etc., (2) Frequency Tables, or (3) Return to Analyze Data File.

Mean, Standard Deviation, Etc.

This analysis computes eighteen descriptive measures for a variable in a data file. Some of the measures included are mean, standard deviation, standard error, variance, skewness, kurtosis, and the minimum and maximum values of the variable.

For our example, we'll obtain a summary of the Component Life values in our DEMO1 data file.

To access this option, press **1** for *Mean, Standard Deviation, Etc.* The following display asks for an input.

Prompt	*Input*
WHICH VARIABLE?	COMP LIFE

The next display shows the message CALCULATING — PLEASE WAIT. The number at the bottom of the display indicates how many observations remain before the calculations are complete. A tone sounds and these results are then shown.

MEAN, ETC. FOR COMP LIFE	
N (NON-MISSING)	36
MISSING VALUES	0
MEAN	178.4722222
STD DEV	28.94870943
STD ERR	4.824784905
VARIANCE	814.7492284
MINIMUM	122
MAXIMUM	233
RANGE	111
SUM X	6425
SUM X^2	1176015
SUM X^3	220390259
SUM X^4	4.22129E+10
COEFF VAR.	16.2202885
SKEWNESS	.03975599451
KURTOSIS	-.7070045671
t (HO: MU=0)	36.991
PR (t)	.001

After you have finished viewing the data, press **SHIFT Z** (BACK) to return to the ANALYZE DATA FILE selection list. To complete the Descriptive Statistics analyses, press **1** again.

Frequency Tables

We used the Standard Deviation and Mean values from the previous example to create the variable "Intervals of Lifetimes." With the frequency table option we can see how the lifetimes of the 36 components are distributed *in the sample.*

Select option 2, *Frequency Tables*, when the computer displays the ANALYZE DATA FILE selection list. Then enter the variable name to be analyzed.

Prompt	*Input*
WHICH VARIABLE?	INTERVALS

While the computer calculates the values for the table, the display shows the message CALCULATING — PLEASE WAIT. The results are displayed as shown here.

FREQUENCIES FOR INTERVALS

VALUE	FREQ	PCT	ACCUM PCT
1	3	8.3	8.3
2	2	5.6	13.9
3	7	19.4	33.3
4	5	13.9	47.2
5	8	22.2	69.4
6	5	13.9	83.3
7	2	5.6	88.9
8	4	11.1	100
TOTAL FREQUENCY			36

The table of results makes it easy to see that, based on the interval size selected, the lifetimes are neither evenly distributed in the sample nor tightly bunched in the middle of the sample. When you're ready to examine the next option on the ANALYZE DATA FILE selection list, press **SHIFT Z** (BACK) to return to this list.

Pearson's P-M Correlation

The correlation coefficient measures the degree of linear association between two random variables. To perform this analysis, the module uses Pearson's product-moment correlation coefficient. This statistical procedure assumes that we have a random sample from a bivariate (involving two variables) population, where one random variable has a normal distribution, and the true correlation is zero. (*Note*: This method cannot be applied to nonrandom variables.)

Assume that you want to determine the correlation between the Expensive Test and the Cheaper Test. If a strong relationship exists, you might consider eliminating the more costly test.

When the display shows the ANALYZE DATA FILE selection list, press **2** for *Correlation*. Then enter the variable names as prompted by the computer.

Prompt	*Input*
WHICH VARIABLE?	EXP TEST
WITH	
WHICH VARIABLE?	CHP TEST

After the calculations are complete, the display shows these results.

```
PEARSON'S P-M CORRELATION
EXP TEST WITH CHP TEST
NUMBER OF PAIRS          36
CORRELATION            .508
SIGNIFICANCE LEVEL     .002
PRESS P TO PRINT
PRESS BACK WHEN FINISHED
```

With a previously selected significance level of .05, we would conclude that, in this case, a nonzero correlation exists between the two procedures (significance level = .002 ≤ .05). Further testing is necessary before a final decision can be made about eliminating the expensive test. When you are finished viewing the results, press **SHIFT Z** (BACK) to return to the ANALYZE DATA FILE selection list.

Linear Regression Analysis

The linear regression analysis in the module can be applied, under certain conditions, to two variables, such as Component Life and the Cheaper Test in this example. In general, this program may be applied to the two general categories of the simple linear model and the simple linear regression model. The primary difference in the categories is in the interpretation of the results; the secondary difference occurs in the probability of a type-two error and in confidence-interval widths. For a complete discussion of linear regression, see Chapter 5 of *An Introduction to Linear Statistical Models* by Franklin A. Graybill.

To determine the simple linear regression of Component Life on the Cheaper Test, press **3** for *Linear Regression*. The computer then prompts you as follows:

Prompt	*Input*
DEPENDENT VARIABLE [Y]?	COMP LIFE
INDEPENDENT VARIABLE [X]?	CHP TEST

After the calculations are completed, the display shows the following information.

```
                LINEAR REGRESSION
                    Y=A*X+B
                  Y=COMP LIFE
                  X=CHP TEST
A=                                  3.230576078
STD ERR                             .8557139553
B=                                  104.6625327
STD ERR                             19.99784632
N                                   36
CORRELATION                         .543
SIGNIFICANCE LEVEL                  .001
STD ERR ESTIMATE                    24.6548064
```

If you had previously chosen a significance level of .05, this analysis tells you that there is a nonzero simple linear regression of Component Life on the Cheaper Test (significance level = .001≤.05). Press **SHIFT Z** (BACK) to return to the ANALYZE DATA FILE selection list.

Inferential Statistics

The final option for performing statistical analyses is called *Inferential Statistics*. Although correlation and linear regression analysis are also inferential statistical procedures, the analyses included under this option are generally associated with design experiments which test for differences among experimental treatments. For example, we might want to find out whether baking temperature affects component life.

When the ANALYZE DATA FILE selection list appears on the screen, press **4** to display the INFERENTIAL STATISTICS selection list.

```
            INFERENTIAL STATISTICS

PRESS
  1    FOR t TESTS
  2        ANALYSIS OF VARIANCE
  3        SIGNIFICANCE LEVEL
           CALCULATOR (FOR z,
           t, F, r, OR X²)
  4    TO  EXIT THIS SECTION
```

The t-Tests compare the means of two variables from the data file to determine whether the difference between the two means is large enough for the variables to be considered significantly different from one another. The Analysis of Variance (ANOVA) model simultaneously compares two or more means to determine whether the variables from the data sets differ significantly. The Significance Level Calculator computes the significance level of a statistic when you provide an assumed or calculated value for the statistic.

t-Test for Independent Groups

This t-Test allows you to compare the means of two independently sampled populations, given that the samples are randomly selected.

For example, assume that we want to determine whether the 580° and 640° baking temperatures affect component life differently. The two populations to be compared consist of all components baked at 580° or 640°. (Note that we are assuming that baking procedures do not affect component life.) From each population, we independently select a random sample of nine components.

When the INFERENTIAL STATISTICS selection list appears on the screen, press **1** for *t-Tests*. Then press **2** for *Independent Groups*. These prompts are displayed.

Prompt	*Input*
INDEPENDENT VARIABLE?	OVEN TEMP
WHAT VALUE IDENTIFIES GROUP 1?	580
WHAT VALUE IDENTIFIES GROUP 2?	640
DEPENDENT VARIABLE?	COMP LIFE

After the calculations are complete, the display shows these results of the comparison.

```
            t TEST
     FOR INDEPENDENT GROUPS
     GRP 1          GRP 2
N    9              9
M    194.8888889    193.5555556
SD   23.58730826    23.16306927
t VALUE                        .121
DEGREES OF FREEDOM               16
SIGNIFICANCE LEVEL             .905
STRENGTH OF ASSOC.              .03
PRESS P TO PRINT
PRESS BACK WHEN FINISHED
```

If you had previously chosen a significance level of .05, this analysis tells you that, based upon the amount of data analyzed, the results are inconclusive (significance level = .905 > .05). To return to the ANALYZE DATA FILE selection list, press **SHIFT Z** (BACK).

Analysis of Variance, One-Way Design

This analysis of variance (ANOVA) method may be appropriate when the response variable in the data file is either obtained from a completely randomized design or measured on the basis of independent random samples from each of several populations of interest. The second case is similiar to the t-test for two independent groups, except that the ANOVA method can be applied to more than two groups.

Assume that we want to know whether Oven Temperature affects Component Life. We begin by randomly selecting 36 electrical components and randomly assigning them to four oven temperatures, making sure that nine components are assigned to each temperature. Then, each component is selected at random and baked at its assigned temperature. This procedure continues until all 36 components have been baked. Finally, the components are put through a life test, and their lifetimes are recorded.

To select this analysis, press **4** for *Inferential Statistics* when the display shows the ANALYZE DATA FILE selection list. Next, press **2** for *Analysis of Variance* and press **1** for *One-Way ANOVA*. The computer then prompts you as follows.

Prompt	*Input*
HOW MANY LEVELS? (in the independent variable)	4
INDEPENDENT VARIABLE?	OVEN TEMP
WHAT VALUE IDENTIFIES LEVEL 1?	580
WHAT VALUE IDENTIFIES LEVEL 2?	600
WHAT VALUE IDENTIFIES LEVEL 3?	620
WHAT VALUE IDENTIFIES LEVEL 4?	640
DEPENDENT VARIABLE?	COMP LIFE

The computer first displays the means table. To see the source table, press **ENTER**. These results are shown.

ANALYSIS OF VARIANCE RESULTS
SOURCE TABLE

SOURCE	DF	SS	MS	F	PR(F)
BETWEEN	3	12494.30556	4164.768581	7.91561626	.001
ERROR	32	16836.66667	526.1458333		
TOTAL	35	29330.97222	838.0277778		

If the significance level selected before the test was run was .05, these results indicate that the oven temperature does affect the components' life spans (PR(F) = .001 ≤ .05). When you have reviewed the results, press **SHIFT Z** (BACK) to return to the ANALYZE DATA FILE selection list.

Analysis of Variance, Two-Factor Factorial Design

This analysis of variance method may be appropriate for analyzing the effects of two factors when the response variable in the data file is obtained from a completely randomized design.

For example, we can examine the effects of both oven temperature and baking time on component life. As in the previous example, 36 electrical components are selected. Next, we randomly assign four components to each of the twelve combinations of oven temperature and baking time. Then we randomly select a component and bake it at its assigned time and temperature. Finally, the lifetimes of the components are recorded.

To perform this analysis, press **4** for *Inferential Statistics* when the ANALYZE DATA FILE selection list is on the screen. Next, press **2** for *Analysis of Variance*, and **3** for *Factorial ANOVA, Two Factors*. These inputs would be appropriate for the prompts displayed.

Prompt	*Input*
INDEPENDENT VARIABLE 1?	OVEN TEMP
NUMBER OF LEVELS?	4
WHAT VALUE IDENTIFIES LEVEL 1?	580
WHAT VALUE IDENTIFIES LEVEL 2?	600
WHAT VALUE IDENTIFIES LEVEL 3?	620
WHAT VALUE IDENTIFIES LEVEL 4?	640
INDEPENDENT VARIABLE 2?	BAKE TIME
NUMBER OF LEVELS?	3
WHAT VALUE IDENTIFIES LEVEL 1?	5
WHAT VALUE IDENTIFIES LEVEL 2?	10
WHAT VALUE IDENTIFIES LEVEL 3?	15
DEPENDENT VARIABLE?	COMP LIFE

Press **ENTER** when the means table is displayed, and the computer shows the following source table on two screens.

ANALYSIS OF VARIANCE RESULTS
SOURCE TABLE

SOURCE	DF	SS	MS	F	PR[F]
OVEN TEMP[A]	3	12494.30556	4164.768518	7.31195643	.001
BAKE TIME[B]	2	566.222222	283.111111	.497049499	.614
A*B	6	2600.444445	433.4074075	.760920101	.607
ERROR	24	13670	569.5833333		
TOTAL	35	29330.97222	838.0277778		

With a previously selected significance level of .05, the results indicate that (1) the effects of the interaction of oven temperature and baking time on component life are inconclusive (PR(F) = .607 > .05), (2) the effects of baking time on component life are inconclusive (PR(F) = .614 > .05), and (3) oven temperature does affect component life (PR(F) = .001 ≤ .05). After you review the results, press **SHIFT Z** (BACK) to return to the ANALYZE DATA FILE selection list.

REORGANIZING A DATA FILE

All of the Inferential Statistics analyses in the module calculate the effect of one or more independent variables on a dependent one. If you choose any of the analyses discussed previously (t-Test for Independent Groups, One-Way ANOVA, and Factorial ANOVA with Two Factors), the computer prompts you to input both the independent and dependent variables. However, with the other analyses (t-Test for Matched Groups, Two-Way ANOVA, and Split Plot ANOVA), the computer only requests the independent variable(s). To obtain a proper result with these analyses, the data file must be organized on the basis of a dependent variable.

The analysis methods in this section usually have some kind of blocking factor in common. To reorganize your file to perform the remaining analyses, choose one variable as the treatment variable, one as the blocking factor, and one as the response. The blocking factor is associated with the rows, and the values of the blocking factor appear in the first column. To complete the file organization, enter the treatment variables as the headings for the remaining columns and the measurement of the response in the appropriate row-column positions.

For example, if we choose Oven Temperature as the blocking factor, Baking Time as the treatment variable, and Component Life as the response variable, the reorganized file looks like this:

TEMP	TIME5	TIME10	TIME15
580	217	233	175
600	158	138	152
620	229	186	155
640	223	227	156
580	188	201	195
600	126	130	147
620	160	170	161
640	201	181	172
580	162	170	213
600	122	185	180
620	167	181	182
640	182	201	199

Press **SHIFT Q** to return to the master title screen (all data not saved on a mass storage device will be lost). Enter the new file, called DEMO2, in the same way as explained on pages 7-16 for DEMO1.

After you have entered and reviewed the data file, select option 4, *Analyze Data File*, when the MAIN INDEX is displayed. Then press **4** for *Inferential Statistics*.

Additional Inferential Statistics

The Inferential Statistical analyses included are the t-Test for Matched Groups, Two-Way Analysis of Variance without interaction (also called the one-factor randomized complete block design), and the Split Plot Analysis of Variance. Begin by pressing **1** for *t-Tests*. Press **1** again for *Matched Groups*.

t-Test for Matched Groups

This t-test, also known as the paired t-test, may be appropriate for response variables that are collected in pairs to minimize uncontrolled or uncontrollable factors.

For example, suppose you are interested in the possible effects of baking time on component life. Ideally, you would bake each component separately; however the plant manager tells you that, because of time and cost constraints, you must bake two components in the oven at the same time. (Assume that, in this experiment, the oven temperature is not considered and is set at 580°F.) First, you randomly select and pair 24 unbaked electrical components. Next, you randomly assign the twelve pairs to a baking order. Then the pairs are baked in the specified order. For each pair, you select and remove one component at random after five hours; the other component is removed after ten hours. Finally, their lifetimes are recorded. This method allows you to determine the effects, if any, of baking time on the life of the component with less concern for possible changes or fluctuation in the oven temperature.

You are prompted for this analysis as follows.

Prompt	*Input*
MEASURE 1?	TIME5
MEASURE 2?	TIME10

After the computer completes the calculations for all 12 observations, these results are displayed.

```
        t TEST FOR MATCHED GROUPS
     TIME 5              TIME 10
N    12                  12
M    177.9166667         183.5833333
SD   35.33336907         30.55980228
t VALUE                         -.756
DEGREES OF FREEDOM                 11
SIGNIFICANCE LEVEL               .465
STRENGTH OF ASSOC.               .222
PRESS P TO PRINT
PRESS BACK WHEN FINISHED
```

With a previously selected significance level of .05, the results of the analyses are inconclusive concerning the effects of baking time on component life (significance level = .465 > .05). To return to the ANALYZE DATA FILE selection list, press **SHIFT Z** (BACK).

Analysis of Variance, Two-Way Design

The method may be appropriate for a two-factor, completely randomized design with *a priori* evidence of no interaction effect or for the randomized complete block design (also called a one-factor randomized complete block design), which is an extension of the t-test for matched groups.

For example, we can extend the previous application for this analysis. Assume that we are interested in the effects of the three baking times on component life and that we are going to simultaneously bake three components in the oven. After we make the appropriate changes to the random selection procedure, we can perform the experiment. In this case, we randomly remove one component after five hours, a second after ten hours, and the third after fifteen hours.

When you select this test, the computer requests information on the number of comparisons to be made.

Prompt	*Input*
HOW MANY TREATMENTS?	3
VARIABLE WHICH CONTAINS MEASURE FOR TREATMENT 1?	TIME5
VARIABLE WHICH CONTAINS MEASURE FOR TREATMENT 2?	TIME10
VARIABLE WHICH CONTAINS MEASURE FOR TREATMENT 3?	TIME15

After the calculations are complete, the computer displays the means table. When you press **ENTER**, the following source table is shown on two screens.

ANALYSIS OF VARIANCE RESULTS
SOURCE TABLE

SOURCE	DF	SS	MS	F	PR[F]
COLUMNS	2	566.222222	283.111111	.496932732	.615
ROWS	11	16230.97222	1475.542929	2.58995691	.028
RESIDUAL	22	12533.77778	569.7171717		
TOTAL	35	29330.97222	838.0277778		

With a previously selected significance level of .05, the results are again inconclusive concerning the effect of various lengths of baking time on component life (PR(F) = .615 > .05).

When you have examined the results, press **SHIFT Z** (BACK). The computer then returns to the ANALYZE DATA FILE selection list.

Analysis of Variance, Split Plot, 1B/1W

The split plot analysis is used to determine the effects and interaction of two independent variables on a dependent variable. The resulting analysis provides more precise information about the values of the independent variable assigned at random to the split (sub) plots within each whole plot than it does about the independent variable assigned at random to the whole (main) plots.

Assume that you want to analyze the effects of oven temperature and baking time on component life, and have selected the sample with the appropriate randomization procedure. The normal procedure would be to randomly select both the temperature and time. However, in this situation, it's more practical and economical to bake the components for different lengths of time at the same oven temperature. Three components are placed in the oven set at a randomly selected temperature. One component, selected at random, is removed after five hours of baking. Another is selected at random and removed after ten hours. The last one is removed after fifteen hours.

This test can be performed on four consecutive days each week at oven temperatures of 580°, 600°, 620°, and 640°, for three weeks, resulting in a replication (duplication of the experiment) of 1 for the first week, 2 for the second, and 3 for the third.

The whole plot in this analysis is the combination of the oven temperature and the replication. The split plot is the random assignment of baking times to the three components in the oven.

Since the oven temperatures are confounded (confused) with the whole plot, any differences among the whole plots show up as differences among temperatures. As a result, this analysis gives more precise information about the variable in the split plot than the variable in the whole plot.

To perform this analysis, type in your inputs as prompted by the computer.

Prompt	*Input*
BETWEEN GROUPS INDEPENDENT VARIABLE?	TEMP
HOW MANY LEVELS?	4
WHAT VALUE IDENTIFIES LEVEL 1?	580
WHAT VALUE IDENTIFIES LEVEL 2?	600
WHAT VALUE IDENTIFIES LEVEL 3?	620
WHAT VALUE IDENTIFIES LEVEL 4?	640
NUMBER OF LEVELS FOR WITHIN-GROUPS INDEPENDENT VARIABLE?	3
LEVEL 1 VARIABLE?	TIME5
LEVEL 2 VARIABLE?	TIME10
LEVEL 3 VARIABLE?	TIME15

After the calculations are completed and the means table is shown, press **ENTER**. These results are then displayed on two screens.

ANALYSIS OF VARIANCE RESULTS
SOURCE TABLE

SOURCE	DF	SS	MS	F	PR[F]
BETWEEN	11	16230.97222			
TEMP[A]	3	12494.30556	4164.768518	8.91654276	.006
SUB W/G	8	3736.666667	467.0833334		
WITHIN	24	13100			
WITHIN[B]	2	566.222222	283.111111	.456017896	.642
A*B	6	2600.444445	433.4074075	.698105891	.655
B*SUB W/G	16	9933.333333	620.8333333		
TOTAL	35	29330.97222			

With a previously chosen significance level of .05, the results indicate that (1) the effect of the interaction of baking time and oven temperature on component life is inconclusive (PR(F) = .655 > .05), (2) the effect of baking time on component life is inconclusive (PR(F) = .642 > .05), and (3) the oven temperature (or uncontrolled factors, such as a systematic drift in the oven temperature regulator) does affect component life (PR(F) = .006 ≤ .05).

Note: The module program combines the degrees of freedom and sums of squares of the replication effect with the interaction of replication and temperature to give the SUB W/G results. The degrees of freedom and sums of squares of the interaction of replication and baking time are combined with the interaction of replication, baking time, and temperature to give the B*SUB W/G results.

You have now examined all of the analyses available with the Statistics module except the Significance Level Calculator. Press **SHIFT Z** (BACK) to return to the ANALYZE DATA FILE selection list.

SIGNIFICANCE LEVEL CALCULATOR

To compute the signficance level of various values of a statistic, select option 3 from the STATISTICS selection list or option 3 from the INFERENTIAL STATISTICS selection list. These choices are available.

SIGNIFICANCE LEVEL
CALCULATOR

PRESS

1	FOR	z
2		STUDENT'S t
3		r (CORRELATION)
4		F
5		X^2 (CHI SQUARE)
6	TO	EXIT THIS SECTION

For each statistic, enter a value and the degrees of freedom. You can either select your inputs at random or choose them from related tables of values.

z-Value

This example gives the significance level of the value 1.645 for a statistic with a standard normal distribution.

Prompt	*Input*
VALUE?	1.645

The significance level is .1.

Student's t

This calculation finds the significance level of a statistic with a Student's t distribution. For example, the result of the value 2.015 with 5 degrees of freedom is illustrated.

Prompt	*Input*
VALUE?	2.015
DEGREES OF FREEDOM?	5

The significance level is .1.

r (Correlation)

This example shows the significance level of the value 0.632 with 8 degrees of freedom for Pearson's product-moment sample correlation statistic when the true correlation is zero.

Prompt	*Input*
VALUE?	0.632
DEGREES OF FREEDOM?	8

The significance level is .05.

F Ratio

Finding the significance level of the value of 4.77 with 9 and 5 degrees of freedom of a statistic with an F distribution is illustrated.

Prompt	*Input*
VALUE?	4.77
DEGREES OF FREEDOM?	9
?	5

The significance level is .05.

χ^2 (Chi Square)

You can use the this option to find the significance level of a value such as 1.1 with 5 degrees of freedom for a statistic with a χ^2 distribution.

Prompt	*Input*
VALUE?	1.1
DEGREES OF FREEDOM?	5

The significance level is .954.

SAVING AND LOADING A DATA FILE

If you expect to use a data set more than once, you can save the file on a mass storage device, such as a cassette tape or disk. Then, when you're ready to use the file again, you can easily load the data into the computer's memory instead of beginning over with "Create a New File."

Note: Any data file in the computer's memory that is not saved on a mass storage device is erased when you return to the STATISTICS selection list, the master selection list, or the master title screen.

Saving a File

Select option 5 (*Save Data File*) when the MAIN INDEX is displayed. (If the computer currently displays the ANALYZE DATA FILE selection list, press **5** to exit this section and return to the MAIN INDEX. Then press **5** again.) The next display gives you these options for a mass storage device.

```
SAVE DATA FILE

PRESS   TO SAVE ONTO
  1     CASSETTE CS1
  2     CASSETTE CS2
  3     ANOTHER DEVICE
```

CASSETTE CS1 and CS2 refer to audio cassette recorders attached to the console via the Cassette Interface Cable. To store data on a cassette tape, follow the directions in the *User's Reference Guide* to connect the cassette recorder to the computer console. Then press **1** for *Cassette CS1* or **2** for *Cassette CS2* and follow the procedure that appears on the display. After the data is properly recorded on cassette tape, remove the tape from the cassette recorder and label it for identification.

Option 3, *Another Device*, refers to a TI Disk Memory Drive or any future mass storage device. If you select this option, the computer prompts you to enter the name of the device. Follow the directions in the appropriate owner's manual for the proper device name format and saving procedure.

Loading a File

To load a data file which was previously saved, plug in the Statistics module, attach the device to the computer, and select option 2, *To Load an Existing File*, from the STATISTICS selection list. When you are prompted by the computer, enter the device name as specified in the appropriate owner's manual. The computer then gives you instructions for loading the file into the computer's memory.

After the data file is properly loaded, you are ready to select the analyses you require.

OBTAINING PRINTED COPY

To obtain printed copies of a display, a printer must be attached to the Home Computer. The TI Solid State Thermal Printer can produce an exact copy of a displayed results screen, including all special graphics characters. (Refer to the owner's manual for further instructions.)

An RS232C compatible printer can also reproduce the results displayed on any given screen. Such printers must be connected to the Home Computer via the TI RS232 Interface (see the RS232 owner's manual for complete directions). These printers usually output information in a variety of formats and cannot reproduce special graphics characters.

After you set up a file structure or load previously saved data from a mass storage device, the display asks if you wish to use a printer during the current session. If a printer is attached, press **1**.

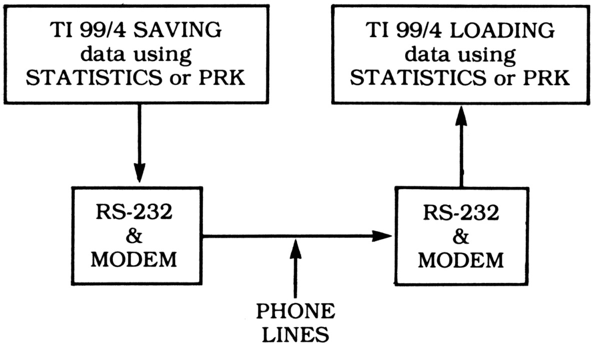
The display then prompts you to enter the name of the printing device. If the TI Solid State Thermal Printer is attached, the device name is TP. If some other printer is attached via the TI RS232 Interface, the device name is RS232/1 or RS232/2, depending on which RS232 port is used.

Each time the module displays the results of a calculation, one of the lines at the bottom of the display says PRESS P TO PRINT. If you press **P**, the printer reproduces the information on the screen.

Note: Mass storage devices, such as cassette tape decks, can save your data file but cannot save results. If you do not have a printer attached to your Home Computer, you will need to write down your results in order to have a permanent record of them.

TRANSMITTING A DATA FILE

Data files can be transmitted from one Home Computer to another via the Texas Instruments RS232 Interface and the Texas Instruments Telephone Coupler (Modem). Both computers must have Statistics (or Personal Record Keeping) modules plugged into the console. The following arrangement is necessary for transmission:



Then follow this procedure to transmit the file in your computer's memory:

1. From the MAIN INDEX screen, press **5** (*Save Data File*). The display shows these choices for saving data:

    1 CASSETTE CS1
    2 CASSETTE CS2
    3 ANOTHER DEVICE

   Press **3** (*Another Device*).
2. When you are asked "DEVICE NAME," type RS232. DO NOT PRESS **ENTER**.
3. Call the other user. (See the modem manual for specific instructions.) The other user plugs in the Statistics or Personal Record Keeping module and selects "*Load A File*," designating RS232 as the device. (DO NOT PRESS **ENTER**.)
4. Both parties correctly place the telephone receivers on the modems, and both press **ENTER**.

5. The number 255 then appears at the top center of each screen. Once the link is established, this value is replaced by the remaining number of 256-character records to be exchanged. The value decreases as each record is transferred. When it reaches zero, the complete file has been transmitted.
6. Do not remove the telephone receivers from the modems until the computer sending (saving) the file displays the MAIN INDEX (or "LABEL" with Personal Record Keeping) and the computer receiving (loading) the data displays "FILE LOADED."
7. For more details, see the TI RS232 Interface owner's manual.

MODULE ORGANIZATION

The following chart outlines the basic organization of the module. The first column gives the title of the screen, and the other column shows the choices given on that screen. If you want to select a specific analysis, you can use this chart to know which options to choose.

TITLE	*SELECTIONS*
(Statistics selection list)	1 CREATE A DATA FILE 2 LOAD AN EXISTING FILE 3 SIGNIFICANCE LEVEL CALCULATOR 4 QUIT
MAIN INDEX	1 SEE FILE DEFINITION 2 ENTER OBSERVATIONS 3 CHANGE OBSERVATIONS 4 ANALYZE DATA FILE 5 SAVE DATA FILE 6 QUIT
ANALYZE DATA FILE	1 DESCRIPTIVE STATISTICS 2 CORRELATION 3 LINEAR REGRESSION ANALYSIS 4 INFERENTIAL STATISTICS 5 EXIT THIS SECTION
SAVE DATA FILE	1 CASSETTE CS1 2 CASSETTE CS2 3 ANOTHER DEVICE

TITLE	*SELECTIONS*
DESCRIPTIVE STATISTICS	1 MEAN., STD. DEV., ETC. 2 FREQUENCY TABLES 3 EXIT THIS SECTION
INFERENTIAL STATISTICS	1 t-TESTS 2 ANALYSIS OF VARIANCE 3 SIGNIFICANCE LEVEL CALCULATOR (FOR z, t, F, r, OR χ^2) 4 EXIT THIS SECTION
t-TESTS	1 MATCHED GROUPS 2 INDEPENDENT GROUPS
ANALYSIS OF VARIANCE	1 ONE-WAY ANOVA 2 TWO-WAY ANOVA 3 FACTORIAL ANOVA, TWO FACTORS 4 SPLIT PLOT, 1BTWN, 1WTHN 5 EXIT THIS SECTION
SIGNIFICANCE LEVEL CALCULATOR	1 z 2 STUDENT'S t 3 r CORRELATION 4 F 5 χ^2 (CHI SQUARE) 6 EXIT THIS SECTION

FILE STRUCTURE AND MEMORY

The number of observations in a data file is limited by the number of variables, the length of each variable, and the amount of available memory. Before setting up your file, analyze your data to determine the variable name, the variable type, and the variable length of each data category. Try to structure the file so that you do not exceed the memory capacity of your computer.

After you set up the file structure, select the option *File Definition*. The display then tells you the maximum number of observations that can be entered.

PERSONAL RECORD KEEPING COMMAND MODULE COMPATIBILITY

Another module manufactured by Texas Instruments can expand the usefulness of the Statistics Command Module. The Personal Record Keeping Command Module can organize and reorder data files set up with the Statistics module. The file structures of these modules are compatible so that data entered and recorded by one module can be loaded and used by the other. For example, two capabilities available when you apply the Personal Record Keeping Module to a data file originally entered with the Statistics Module are:

- Data files generated by the Statistics Command Module can be alphabetized by the Personal Record Keeping Command Module.
- The Personal Record Keeping Module can be used to print summary reports of all observations. The Statistics Module can only print one observation at a time.

In transferring data from one module to the other, there are some differences you should keep in mind. The Statistics module permits up to 99 variables for each observation, while the Personal Record Keeping module allows only 15 items (variables) per page (observation). Also you can enter identical item names with Personal Record Keeping, but each variable name in Statistics must be different.

Although the two modules are compatible, the terminology used in these packages varies due to differences in subject matter. The basic terminology correspondence is:

PERSONAL RECORDS TERM	*MEANS THE SAME AS*	*STATISTICS TERM*
item	=	variable
page	=	observation
report	=	table

Appendix
Formulas Used

This appendix lists the formulas used in the module for statistical calculations which can be performed in more than one way. Any formulas for the module analyses not included here are standardized computations which can be found in most statistical methods books.

GENERAL NOTATION

- Σ: summation sign
- X: variable (independent)
- Y: variable (dependent)
- $\overline{X}$: mean
- S: sample standard deviation
- S^2: sample variance
- $S_{\overline{X}}$: standard error of estimate
- ν: degrees of freedom
- r: correlation coefficient
- ΣX: the sum of all X variables
- ΣX^2: the sum of the squares of all X variables
- ΣXY: the sum of all products of X and Y

DESCRIPTIVE STATISTICS

N: The number of non-missing values of the specified variable.

MISSING VALUES: The number of observations in which no data was entered.

MEAN: $\overline{X} = \dfrac{\Sigma X}{N}$

STD DEV: (standard deviation) $S = \left(\dfrac{\Sigma X^2 - (\Sigma X)^2/N}{N-1}\right)^{1/2}$

STD ERR: (standard error of estimate) The standard deviation divided by the square root of N,

$$S_{\overline{X}} = \frac{S}{\sqrt{N}}$$

VARIANCE: The square of the standard deviation multiplied by (N − 1)/N gives

$$SS = \frac{\Sigma X^2}{N} - \left(\frac{\Sigma X}{N}\right)^2$$

SKEWNESS: $\dfrac{M_3}{(M_2)^{3/2}}$

$$M_2 = \frac{\Sigma X^2}{N} - \frac{(\Sigma X)^2}{N^2} = SS \qquad M_3 = \frac{\Sigma X^3}{N} - \frac{3\Sigma X \; \Sigma X^2}{N^2} + \frac{2(\Sigma X)^3}{N^3}$$

KURTOSIS: $\frac{M_4}{(M_2)^2}$

$$M_4 = \frac{\Sigma X^4}{N} - \frac{4\Sigma X \ \Sigma X^3}{N^2} + \frac{6(\Sigma X)^2(\Sigma X^2)}{N^3} - \frac{3(\Sigma X)^4}{N^4}$$

MINIMUM: Smallest non-missing number (N)

MAXIMUM: Largest non-missing number (N)

RANGE: MAXIMUM — MINIMUM

T: MEAN/STD ERR If standard error of estimate is zero, this value is blank. This value tests if the population mean is zero.

PR(T): Significance level of the value of T using N — 1 degrees of freedom.

CORRELATION

NUMBER OF PAIRS: The number of pairs with non-missing values (N).

CORRELATION: (correlation coefficient)

$$r = \frac{N\Sigma XY - (\Sigma X)(\Sigma Y)}{[N\Sigma X^2 - (\Sigma X)^2]^{1/2} \, [N\Sigma Y^2 - (\Sigma Y)^2]^{1/2}}$$

where X and Y are the values of the variables specified.

LINEAR REGRESSION

Y = AX+B: General equation for a line

Y: Dependent variable

X: Independent variable

A: Slope of the regression line

STD ERR of A: $\left[\frac{S_E^2}{\Sigma(X_i - \overline{X})^2}\right]^{1/2}$ where $S_E^2 = \frac{\Sigma(Y - \hat{Y})^2}{N - 2}$

B: Y-intercept of the regression line

STD ERR of B: $\left\{S_E^2\left[\frac{1}{N} + \frac{\overline{X}^2}{\Sigma(X_i - \overline{X})^2}\right]\right\}^{1/2}$

N: Number of pairs with non-missing values.

CORRELATION: Pearson's Product-Moment Correlation between the dependent and independent variables.

SIGNIFICANCE LEVEL: The probability of mistakenly claiming that a relationship exists when no such relationship does exist.

STD ERR ESTIMATE: (Standard error of deviation from regression) A measure of the extent of spread or scatter of points expressed in units of the dependent variable (Y).

$$S_E = \left[\frac{\Sigma(Y - \hat{Y})^2}{N - 2}\right]^{1/2}$$

where

Y = Actual value of dependent variable

$\hat{Y}$ = Computed value of dependent variable using the equation for the regression line.

NOTES

CARING FOR THE MODULE

Command modules are durable devices, but they should be handled with the same care you would give any other electronic equipment. Keep the module and its recessed contacts clean and dry.

> CAUTION:
> The contents of a module can be damaged by static electricity discharges.

Static electricity build-ups are more likely to occur when the natural humidity of the air is low (during winter, for example, or in very dry climates). To avoid possible damage to the Command Module, touch any metal object (a doorknob, a desklamp, etc.) before handling the module. Always use this method to ensure that both you and the module are free of static electricity before you install the module on the console.

If static electricity is a problem in your area, you may want to purchase a special carpet treatment that reduces static electricity build-up. These commercial preparations are usually available from local hardware and office supply stores.

IN CASE OF DIFFICULTY

If the module activities do not appear to be operating properly, return to the master title screen by pressing **SHIFT Q**. Withdraw the module, align it with the module opening, and reinsert it carefully. Then press any key to make the master selection list appear. Repeat the selection process. (*Note*: In some instances, it may be necessary to turn the computer off, wait several seconds, and then turn it on again.)

If the module is accidentally removed from the slot while the module contents are being used, the computer may behave erratically. To restore the computer to normal operation, turn the computer console off, wait a few seconds, reinsert the module, and turn it on again.

If you have any difficulty with your computer or the Statistics Module, please contact the dealer from whom you purchased the unit and/or module for service directions.

Additional information concerning use and service can be found in your *User's Reference Guide*.

THREE-MONTH LIMITED WARRANTY
HOME COMPUTER SOFTWARE MODULE

Texas Instruments Incorporated extends this consumer warranty only to the original consumer purchaser.

WARRANTY COVERAGE

This warranty covers the electronic and case components of the software module. These components include all semiconductor chips and devices, plastics, boards, wiring and all other hardware contained in this module ("the Hardware"). This limited warranty does not extend to the programs contained in the software module and in the accompanying book materials ("the Programs").

The Hardware is warranted against malfunction due to defective materials or construction. **THIS WARRANTY IS VOID IF THE HARDWARE HAS BEEN DAMAGED BY ACCIDENT OR UNREASONABLE USE, NEGLECT, IMPROPER SERVICE OR OTHER CAUSES NOT ARISING OUT OF DEFECTS IN MATERIAL OR CONSTRUCTION.**

WARRANTY DURATION

The Hardware is warranted for a period of three months from the date of the original purchase by the consumer.

WARRANTY DISCLAIMERS

ANY IMPLIED WARRANTIES ARISING OUT OF THIS SALE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE ABOVE THREE MONTH PERIOD. TEXAS INSTRUMENTS SHALL NOT BE LIABLE FOR LOSS OF USE OF THE HARDWARE OR OTHER INCIDENTAL OR CONSEQUENTIAL COSTS, EXPENSES, OR DAMAGES INCURRED BY THE CONSUMER OR ANY OTHER USER.

Some states do not allow the exclusion or limitation of implied warranties or consequential damages, so the above limitations or exclusions may not apply to you in those states.

LEGAL REMEDIES

This warranty gives you specific legal rights, and you may also have other rights that vary from state to state.

PERFORMANCE BY TI UNDER WARRANTY

During the three month warranty period, defective Hardware will be replaced when it is returned postage prepaid to a Texas Instruments Service Facility listed below. The replacement Hardware will be warranted for a period of three months from date of replacement. Other than the postage requirement, no charge will be made for replacement.

TI strongly recommends that you insure the Hardware for value prior to mailing.

TEXAS INSTRUMENTS CONSUMER SERVICE FACILITIES

Texas Instruments Service Facility
P.O. Box 2500
Lubbock, Texas 79408

Geophysical Services Incorporated
41 Shelley Road
Richmond Hill, Ontario, Canada L4C5G4

Consumers in California and Oregon may contact the following Texas Instruments offices for additional assistance or information.

Texas Instruments Consumer Service
831 South Douglas Street
El Segundo, California 90245
(213)973-1803

Texas Instruments Consumer Service
10700 Southwest Beaverton Highway
Park Plaza West
Beaverton, Oregon 97005
(503)643-6758

IMPORTANT NOTICE OF DISCLAIMER REGARDING THE PROGRAMS

The following should be read and understood *before* purchasing and/or using the software module.

TI does not warrant the Programs will be free from error or will meet the specific requirements of the consumer. The consumer assumes complete responsibility for any decisions made or actions taken based on information obtained using the Programs. Any statements made concerning the utility of the Programs are not to be construed as express or implied warranties.

TEXAS INSTRUMENTS MAKES NO WARRANTY, EITHER EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, REGARDING THE PROGRAMS AND MAKES ALL PROGRAMS AVAILABLE SOLELY ON AN "AS IS" BASIS.

IN NO EVENT SHALL TEXAS INSTRUMENTS BE LIABLE TO ANYONE FOR SPECIAL, COLLATERAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH OR ARISING OUT OF THE PURCHASE OR USE OF THE PROGRAMS AND THE SOLE AND EXCLUSIVE LIABILITY OF TEXAS INSTRUMENTS, REGARDLESS OF THE FORM OF ACTION, SHALL NOT EXCEED THE PURCHASE PRICE OF THE SOFTWARE MODULE. MOREOVER, TEXAS INSTRUMENTS SHALL NOT BE LIABLE FOR ANY CLAIM OF ANY KIND WHATSOEVER BY ANY OTHER PARTY AGAINST THE USER OF THE PROGRAMS.

Some states do not allow the exclusion or limitation of implied warranties or consequential damages, so the above limitations or exclusions may not apply to you in those states.

In many areas of study, such as psychology, education, science, or business, statistical methods involving lengthy and difficult computations are necessary for analyzing large amounts of data. With the Statistics Command Module, you only need to enter your data set as prompted by the computer and select the desired analysis. The Home Computer then quickly and accurately computes the answer for you, leaving you more time to analyze the results.

Statistics module features perform calculations in these categories:

- Descriptive statistics, including mean, standard deviation, and frequency tables
- Correlation
- Linear regression
- Inferential statistics, including t-tests and analysis of variance
- Significance level calculator for z, Student's t, r, F, χ^2

Adds 30K bytes of active memory with stored program to your TI Home Computer.

TEXAS INSTRUMENTS
INCORPORATED

Printed in U.S.A.

1037109-14