STUDIECENTRUM VOOR ECONOMISCH EN SOCIAAL ONDERZOEK

TSAF Program Library
- no 1 -

TSERS
User's Manual

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Rapport 86/188
March 1986

Deze software is tot stand gekomen mede dank zij de steun van de Christelijke Centrale van Houtbewerkers en Bouwvakarbeiders.

We thank Mr. H. Pauwels. Without his help this conversion would never have been a success.

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D/1986/1169/06

Abstract

The TSERS system is designed to perform BOX-JENKINS type analyses for univariate stochastic models. The system is both versatile and easy to use. Input to the program is accomplished via a sequence of simple commands, only a small number of which are needed for standard analyses.

The input data file for TSERS can also be used for the ARSTU, PACK (PACK 1, PACK 2 & Pack 3), MULTISTOCH and MULTITRAN programs.

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1. INTRODUCTION TO TSERS

1.1. General Description

The TSERS system is designed to perform BOX-JENKINS type analyses for univariate stochastic models. An effort has been made to keep this system both versatile and easy to use. Input to the program is accomplished via a sequence of simple commands, only a small number of which are needed for standard analyses. However, there are a large number of additional commands that can be used to modify standard assumptions, invoke special options and, in general, give the user the ability to control system operation.

1.2. Special Features of the TSERS system

Some of the special features and important outputs provided by TSERS are:

1. Information necessary for identification of ARIMA time series models.
2. Preliminary estimates of model parameters.
3. Least squares (i.e., approximate maximum likelihood) estimation of model parameters, employing back forecasting and the Marquardt non linear least squares algorithm.
4. Information concerning the estimated parameters.
5. Extensive outputs useful in diagnostic checking of the fitted model through analysis of the residuals.
6. Forecasting of the time series, including computation of standard errors of prediction and prediction limits. Forecasts can be computed for several specified origins, if desired.
7. Ability to perform standard analyses through the use of only a few commands and the ability to request special non standard options with relative ease.
8. Input to the system is accomplished through easy to remember commands and free field input of numeric information. This reduces the frequency of input errors.
9. Ability to transform and/or difference the inputted time series.
10. Ability to output into a file the transformed and/or differenced time series or the residuals from the fitted model. These can then be used in subsequent analyses.

11. There is no limit on the number of tasks which can be performed in one program run.
12. Voluminous, unnecessary, or redundant outputs are easy to suppress.
13. An extensive error checking facility has been built into the system. Minor error conditions are generaly self correcting.

2. TSERS COMMANDS

Input to the TSERS system is accomplished through a sequence of simple four-letter-commands. These commands can be devided, by function, into 7 groups.

1. Commands to input time series data to the system.
2. Commands to transform and/or difference the time series data.
3. Commands to specify a model.
4. Commands to control the amount and type of system output.
5. Commands for system control.
6. Commands to specify the type of run.
7. Commands for other miscellaneous options.
8. Special, infrequently used commands.

In the following sections a detailed description of each of these commands will be given. Each command begins with a four-letter key word. Numerical arguments (if any) can appear anywhere in the command, separated by spaces or commas. Any other letters or special characters (other than negative signs or decimal points) have no effect on the system but can and should be used as comments to document the commands. In the description of the commands, "k" represents an argument which must be a nonnegative integer. Other arguments are represented by a "u". Arguments shown in brackets are optional, other are mandatory. If two arguments appear within the same set of brackets, either both or neither should be included in the command.

NOTE: A command can only be entered if the message

NEW INPUT

is displayed on the screen.

3. COMMAND FOR INPUT OF TIME SERIES DATA

In order to adapt the program for the HP-1000 computer only one command for input of the time series data has been retained.

<u>DATA</u> k_1, {k_2,{k_3}}

This command instructs the system to read time series data.

k_1 : length of the time series
Restriction: $k_1 \leq 300$

k_2 : if k_2 appears, one of the following options is requested
= 0 the input data are not to be printed
= 1 the input data are to be printed (default option)

The time series data should immediately follow the DATA command in the input stream and can be entered via the terminal keyboard in FREE FORMAT.

If k_3 appears, the argument must always be "1". In this case the data are to be read from a datafile. The name of this datafile must be entered after the message

ENTER: NAME OF DATAFILE

is displayed on the screen (See appendix I for details about the preparation of this datafile.). In order to specify k_3=1, k_2 must also be specified.

4. COMMANDS FOR TRANSFORMATION AND DIFFERENCING

4.1. TRAN u_1, u_2

This command allows one to transform the inputted time series. The transformed series is

$\ln (Z(t) - u_2)$	$(u_1 = 0)$
$(Z(t) - u_2) ** u_1$	$(u_1 \neq 0)$

Default values are $u_1 = 1$ and $u_2 = 0$. An attempt to raise a negative number to a noninteger power or to take the ln of a nonpositive number will result in a fatal error.

4.2. NRDF k_1

This command requests that k_1 regular differences be performed.
Restriction: $0 \leq k_1 \leq 4$

4.3. NSDF k_1, k_2

This command requests that k_1 seasonal differences of order k_2 be performed.
Restriction: $0 \leq k_1 \leq 3$ and $1 < k_2 \leq 100$

4.4. SCAL u_1

This command will cause the raw time series, as inputted with the DATA command, to be divided by the scale factor $u_1 \neq o$. Use of the REST command will NOT restore the original series; this could be effected by using another SCAL command with specified scale factor $1/u_1$.

5. COMMANDS FOR INPUT OF AN ARMA MODEL

5.1. RART k_1, $\{u_1\}$

This command requests that a regular autoregressive term of order k_1 be included in the model. Optionally, an initial assumed parameter value can also be specified by including u_1 in the command.
Restriction: $1 \leq k_1 \leq 100$ and $-10.0 \leq u_1 \leq 10.0$
Default : $u_1 = 0.10$

5.2. SART k_1, $\{u_1\}$

Similar to RART, this command is used to request a seasonal autoregressive term of order k_1.
Restriction: $1 \leq k_1 \leq 100$ and $-10.0 \leq u_1 \leq 10.0$
Default : $u_1 = 0.10$

5.3. RMAT k_1, $\{u_1\}$

Similar to RART, this command is used to request a regular moving average term of order k_1.
Restriction: $1 \leq k_1 \leq 100$ and $-10.0 \leq u_1 \leq 10.0$
Default : $u_1 = 0.10$

5.4. SMAT k_1, $\{u_1\}$

Similar to RART, this command is used to request a seasonal moving average term of order k_1.
Restriction: $1 \leq k_1 \leq 100$ and $-10.0 \leq u_1 \leq 10.0$
Default : $u_1 = 0.10$

5.5. MEAN $\{k_1$, $\{u_1\}\}$

This command allows the user to request special options for estimation of the mean of the working series and for inclusion of a constant term in the time series model. The first argument in the command, k_1, (if it is used) specifies the desired option. If u_1 appears in the command, it specifies an initial estimate for the mean of the working series which can be used with option 3 or 4, if desired. Otherwise, the sample mean of the working series is used.

The available options are:

$k_1 = 0$ The working series is not to be centered. That is, the mean is assumed to be 0.

$k_1 = 1$ The working series is to be centered. No constant term is to be included in the model. This assumes that any nonstationary (e.g., trend when differencing is of first order) is stochastic.

$k_1 = 2$ The working series is to be centered and a constant term is to be included in the model. If the series has been differenced, this assumes that any nonstationary (e.g., trend when differencing is of first order) is deterministic. Some physical justification for this assumption should be available. If no differencing has been performed, this option implies that the time series has a constant nonzero mean.

$k_1 = 3$ Same as option 1, except that the mean of the working series is estimated along with the other model parameters instead of using the sample mean as an estimate.

$k_1 = 4$ Same as option 2,except that the mean of the working series is estimated along with the other model parameters instead of using the sample mean .

Default options are option k_1 if any differencing has been performed and option k_2 otherwise.

6. COMMANDS FOR CONTROL AND MODIFICATION OF SYSTEM OUTPUT

6.1. PRIN $\{k_1\}$, $\{k_2\}$,..., $\{k_{10}\}$

6.2. EPRI $\{k_1\}$, $\{k_2\}$,..., $\{k_{10}\}$

These commands are used to control printing of optional system outputs. If the PRIN command is used, the outputs specified by the integers in the command, corresponding to the numbered outputs shown below, are provided. If the EPRI command is used, all outputs *except* those specified by the integers appearing in the command are provided. If neither of these commands is used, it is assumed that all printed output is desired.

The optional printed outputs and their corresponding numbers are:

1. Original time series
2. Transformed time series
3. Differenced time series
4. Autocorrelations
5. Partial autocorrelations

*6. Cross correlations between the working series and the residuals from the fitted model

*7. Final back forecasts of the working series and the corresponding residuals

*8. Residuals from the fitted model

*9. Chi-square goodness of fit test for normality of the residuals

10. As a check, print auxiliary output which has been requested with a PUNC command.

Unmarked outputs are available in all four run types. Optional outputs market by "*" are available only for the ESTI and the OUTP run.

6.3. PLOT $\{k_1\}$, $\{k_2\}$,..., $\{k_{10}\}$

6.4. EPLO $\{k_1\}$, $\{k_2\}$,..., $\{k_{10}\}$

These commands are used, in a manner similar to the PRIN and EPRI commands, to control the optional plotted outputs.

The optional plotted outputs and their corresponding numbers are:

1. Original time series
2. Transformed time series
3. Differenced time series
4. Autocorrelations
5. Partial autocorrelations
*6. Cross correlations between the working series and the residuals from the fitted model
*7. Forecasts
*8. Residuals from the fitted model
*9. Normal probability plot of the residuals
*10. Cumulative periodogram of the residuals and the associated Kolmogorov-Smirnov test

Unmarked outputs are available for all four run types. Optional outputs marked by "*" are available only for the ESTI and the OUTP run.

6.5. CLPA u_1

This command allows one to change the confidence level for outputted confidence intervals for the estimated parameters to u_1 %.
Restriction: $10.0 \leq u_1 \leq 99.99$
Default : $u_1 = 95.0$

6.7. NACR k_1

This command specifies that k_1 autocorrelations are to be printed.
Restriction: $0 < k_1 \leq 99$
Default : $k_1 = 24$

6.8. NPAC k_1

This command specifies that k_1 partial autocorrelations are to be printed.
Restriction: $0 < k_1 \leq 36$
Default : $k_1 = 24$

6.9. NCRO k_1, k_2

This command allows one to change the number of requested negative (k_1) and positive (k_2) lags to be computed for the estimated cross correlation function between the working series and the residuals of the fitted model.

Restrictions: $0 < k_1 \leq 99$ and $0 < k_2 \leq 99$

Default : $k_1 = 15$ and $k_2 = 15$

6.10. BOXP k_1, k_2

This command, when it precedes the IDEN command, requests the plotting of Multiple Notched Boxplots.

If the input stream , preceding the IDEN command does not contain a TRAN command, the BOXP command will only result in the plotting of Boxplots for the untransformed (undifferenced) time series. If also a TRAN command is included in the input stream, the BOXP command will result in the plotting of BOXplots as well for the untransformed (undifferenced) time series as for the transformed (undifferenced) time series.

Two methods are available:

- Method 1: Subset method

  $k_1 = 1$

  k_2 = length of subseries

  Restriction: $4 \leq k_2 \leq$ data length (NPOINT)

  Default : $k_2 = 12$

- Method 2: Sampling method

  $k_1 = 2$

  k_2 = Sampling interval

  Restriction: $4 \leq k_2 \leq 12$

  Default : $k_2 = 12$

The BOXP command is automatically removed after execution. This is in contrast with the commands used to specify a particular type of model. These commands remain valid until they are removed by the NEWM command.

6.11. SPEC k_1

This command, when it precedes the ESTI command, requests the plotting of the power spectrum of the specified subset of the inputted series and of the residuals from the fitted model.
If the input stream, preceding the ESTI command, contains a TRAN and/or a NRDF or NSDF command, the SPEC command will also result in the plotting of the power spectrum of the transformed and/or differenced series.
The parameter k_1 specifies the number of autocovariances that will be used in computing the weighted autocovariance estimator.
Restriction: $4 \leq k_1 \leq 99$
Default : k_1 = one third of data length (NPOINT/3)

The SPEC command is automatically removed after execution. This is in contrast with the commands used to specify a particular type of model. These commands remain valid until they are removed by the NEWM command.

6.12. PUNC

In order to adapt the programs for the HP-1000 computer this command had to be changed.
This command, when it precedes an OUTP or an ESTI command, requests writing of the residuals from the fitted model on a datafile. When the command precedes an IDEN command, the uncentered working series is written on a datafile. When the command precedes a PEST command, the centered working series is written on a datafile, unless MEAN option 0 has been specified, in which case the uncentered working series is provided.

The requested output, i.e. residuals and/or (un)centered working series, will be written on a datafile in the right FORMAT so that it can be used for further analysis and/or future runs. (See Appendix I.) The parameters for the datafile have to be inputted after the message

ENTER: NAME OF DATAFILE

is displayed on the screen. These parameters have to be inputted as:

NAME: SECURITY CODE: 7:3:10

6.13. FORE k_1

This command requests forecasting of the time series for k_1 future periods. Forecasting is only performed when the FORE command is included in an input stream preceding an ESTI or an OUTP command.
Forecasts are provided with the specified or implied last value of the time series as the forecast origin.
Additional origins can be specified by using the ORIG command.
Restriction: $k_1 \leq 100$

6.14. ORIG $\{k_1\}$, $\{k_2\}$,..., $\{k_{15}\}$

When forecasting is requested, the assumed forecast origin is the last observation used in the preceding analysis of the time series. Additional origins, each of which must of course precede the last observation used in the analysis, can be specified by this command.
If no numbers appear in the command, only the one origin is used.
The ORIG command has to be accompanied by a FORE command and both commands have to be included in an input stream preceding an ESTI or an OUTP command.
Restriction: max 15 additional origins.

7. COMMANDS FOR SYSTEM CONTROL

7.1. NEWM

This command removes all specified terms from the model without affecting any of the other program options which have been previously requested.
Use of this command will also reset the mean estimation option to the default option. Previously requested differencing of the time series will not be affected.

7.2. REST

This command restarts the program by resetting all program assumptions and options to their initial values. It also removes all previously specified terms from the model. The current time series remains until another DATA command is encountered.

7.3. CHAN {k_1, u_1}

This command allows one to modify the "current parameter values". If k_1 and u_1 does not appear in the command, preliminary estimates obtained after the following PEST command will replace the current parameter values.
Alternatively, if k_1 and u_1 appear in the command, the value u_1 is substituted for the current value of parameter number k_1.
The command is especially useful for modification of the starting values for the estimation procedure and for use with the GRID command.
See Section 12 for information concerning numbering of parameters and modification of "current parameter values".

7.4. STOP

This command terminates the TSERS run.

8. COMMANDS REQUESTING A PARTICULAR TYPE OF RUN

8.1. IDEN $\{k_1, k_2\}$

This command requests output which is useful for identification of an ARIMA model. In particular, it provides

- simple statistics pertaining to the time series (sample mean, standard deviation)
- autocorrelation function
- partial autocorrelation function
- multiple notched Boxplots (BOXP command)

These outputs can be obtained for a time series which has been differenced (NRDF and NSDF command), and/or transformed (TRAN command) by including the appropriate commands before the IDEN command. If the analysis is desired for only a subset of the inputted series (e.g., the first half), two integers, k_1 and k_2, should appear in the command to indicate which observations are to be used.

The resulting output for the IDEN command is described in more detail in Section 11.2.

8.2. PEST $\{k_1, k_2\}$

This command provides the same output as the IDEN command.

In addition, if a model has been specified, preliminary estimates of its parameters are computed. If requested (by using the CHAN command), the preliminary estimates can be used as starting values for a subsequent estimation run. If for some reason the estimates are not obtained, a warning is printed, arbitrary values of 0.1 are substituted, and execution continues. As with the IDEN command, a subset of the series can be used for the computations.

The output requested by the PEST command is described in Section 11.3.

8.3. ESTI $\{k_1, k_2\}$

This command requests nonlinear least squares estimation of the specified ARMA model. In addition to outputs pertaining to estimation of the parameters, various outputs for residual analysis and diagnostic checking of the model are provided. Additional output can be requested by the SPEC command. Forecasting is performed if requested with a FORE (and an ORIG) command preceding the ESTI command. As with the IDEN command, a subset of the series can be used for the computations. See Section 11.4. for a detailed describtion of the output.

8.4. OUTP $\{k_1,k_2\}$

This command provides the same output as the ESTI command, except that the parameters are not estimated. Instead, the initially inputted or previously estimated values of the parameters are used to compute all requested outputs.

8.5. GRID k_1, u_1, k_2, u_2

This command is used to compute and print the sum of squares functions over a grid of two incremented parameters, k_1 and k_2. Other parameters in the model, if any, are held constant. The parameters specified by k_1 and k_2 are incremented by amounts u_1 and u_2 respectively, the grid being centered on the "current parameter values". The CHAN command can be used to change the "current parameter values". The option of using the GRID command with a subset of the original series is not available.
See Section 12 for information concerning numbering of parameters and modifications of "current parameter values".
See Section 11.6 for a describtion of the output.

9. COMMANDS FOR OTHER MISCELLANEOUS OPTIONS

9.1. HEAD {Heading or running title}

This command can be used to specify a heading or a running title to be printed at various points among the system outputs. This heading can be up to 76 characters.

9.2. C {Any comment}

This command allows one to insert comments among the other comments. Such commands may not occur among the time series data unless these comments contain no numeric characters.

10. SPECIAL, INFREQUENTLY USED COMMANDS

<u>OPTI</u> k_1, {u_1 or k_2}

This command can be used to request special options which are not used very often. The first argument, k_1, specifies the requested option. The available options are listed below. The second argument (either k_2 or u_1) must appear on commands market with a "*". For such commands, the meaning of the second argument is shown together with the initially assumed value.

k_1 Option and meaning of the second argument

0. Reset all Marquardt algorithm estimation control options to their intially assumed values

*1. k_2 = New output unit number
Initial value is k_2 = 6 (printer)
To use the display as output unit number k_2 = 1.

*2. k_2 - New input unit number
This option cannot be used on the HP-1000 computer

*3. u_1 = Starting value for the lambda parameter in the Marquardt algorithm.
Initial value is u_1 = 0.0001

*4. u_1 = Maximum allowable relative change termination criterion for the Marquardt algorithm
Initial value is u_1 = 0.0001

*5. k_2 = Maximum number of iterations for the Marquardt algorithm.
Initial value is k_2 = 25

*6. k_2 = Level of output to be provided during the estimation procedure.
The available output levels are:
k_2 = 0 None
k_2 = 1 Summary at each iteration

$k_2 = 2$ Information at each function evaluation

$k_2 = 3$ Output for $k_2 = 2$ plus the computed Hessian at each iteration (used in debugging)

$k_2 = 4$ Output for $k_2 = 3$ plus, for each pair of parameters, a grid of sums of squares values at the termination of the estimation procedure. Because the resulting output can be very expensive to produce, this options should be used judiciously.

Default value: $k_2 = 1$

*7. k_2 = Change factor nu for the Marquardt algorithm.
Initial value is $k_2 = 10$.

8. Control of certain output which is useful for system debugging. If the option is off, this command will turn it on. If the option is on, this command will turn it off.
Initially, the option is off.

9. Control printing of elapsed CPU and real time at the end of each task during system execution.
This option is not maintained in TSERS.

11. DESCRIPTION OF SYSTEM OUTPUT

This section describes the outputs provided by TSERS. For information on the proper use and interpretation of these outputs, the user is referred to the appropriate section(s) in Box and Jenkins /2/. All of the system outputs will be described here. In many situations, it will be advantageous to suppress outputs which are redundant, unnecessary, expensive to produce, and/or particularly voluminous. This is done readily with PRIN, EPRIN, PLOT or EPLO commands. For example, it would not be necessary to plot the original time series during a sequence of runs using the same data. Also, computation of the cumulative periodogram is quite costly for a long time series and might be postponed if multiple exploratory runs are anticipated.

The outputs are described for each run type. Given first is a brief explanation of some checks on the TSERS commands and a description of output which is common to all run types.

11.1. General output

The TSERS system reads commands one at a time. Each command is printed (or displayed) as it is read. A recognized command is preceded by a ">", e.g.

> REST

If an unrecognized command is read, it is immediately identified as such and execution continues.

When time series data are being read (from keybord or datafile) the 80 column card images are printed as they are read, each row preceded by a "<" to distinguish it from a regular command. If a regular command, when printed, is preceded by a "<", instead of a ">", it is an indication that less than the specified number of observations followed the DATA command or that not enough data could be found on the datafile specified: the system is looking for more observations.

TSERS detects many abnormal conditions and input errors as soon as they occur, in which case an error or warning message is printed. A detailed description of the error checking facility is contained in Appendix II.

TSERS reads and interprets commands sequentially until a "type of run" command is encountered. Then the system provides all requested output, after which it resumes reading commands.
The following outputs, most of which can be selectively supressed if desired, are provided in response to all "type of runs" commands (except the GRID command for which lengthly outputs are always suppressed).

1. A list of some of the input data and certain requested options
2. A table and a plot of the original time series
3. A table and a plot of the transformed time series (if it was transformed)
4. A table and a plot of the differenced time series (if it was differenced)
5. The number of observations in the working series and the the number of observations lost through differencing
6. The sample mean and sample standard deviation of the working series.

11.2. IDEN Run Output

In addition to the output described above, the IDEN command provides the following output:

1. The sample autocorrelations function of the working series
2. The sample partial autocorrelation function of the working series
3. The chi-square statistic associated with the "portmanteau test" for the sample autocorrelations.

For a detailed explanation of how to interpret these outputs, see Chapter 6 and Section 9.2.3 of /2/.

If a BOXP command is included in the input stream preceding an IDEN command the requested additional output will consist of the Multiple Notched Boxplots for the untransformed (undifferenced) time series. If requested (by a TRAN command) the Boxplots will also be given for the transformed (undifferenced) time series. For a detailed explanation of how to interpret these Boxplots, see /8, pp.65-92/.

11.3. PEST Run Output

In addition to the IDEN output, this command provides preliminary estimates for a specified ARMA model. If a multiplicative model has been specified, estimates are computed for only the non-multiplicative coefficients. For most problems, these preliminary estimates will provide reasonably good starting values for the non-linear least squares estimation procedure. Section 6.3.4. of /2/ gives more information on these preliminary estimates.

11.4. ESTI Run Output

In addition to the common output described in Section 11.1, the ESTI command provides:

1. The specified model, including current options regarding estimation of the mean
2. Information pertaining to the estimation procedure and estimated parameters, including:
   - Output showing the progress during the estimation procedure. The amount of such output is controlled with the OPTI command.
   - The final estimated lag coefficients (including any multiplicative coefficients) for the working series.
   - Back forecasts of the working series and the corresponding residuals.
   - A table giving information on each of the estimated parameters, including the mean of the series if it was estimated. This table contains the estimates, the estimated standard errors of the estimates, the t-values, and upper and lower confidence limits.
3. Outputs pertaining to the residuals from the fitted model. These are useful for diagnostic checking. Information on how these outputs are used and interpreted is contained in Chapter 8 of /2/. The outputs are:
   - A Table and a plot of the residuals
   - Summary statistics computed from the residuals
   - A normal probability plot of the residuals
   - A chi-square test for normality of the residuals.
   - The empirical cumulative periodogram and the corresponding

lower and upper 80 % Kolmogorov-Smirnov limits and the p-value for the associated significance test (if $0.01 \leq p \leq 0.25$)

- The cross correlation function between the residuals and the working series.
- The autocorrelation function of the residuals and the associated chi-square statistic.
- The partial autocorrelation function of the residuals.

4. The estimated "expanded model" lag coefficients. That is, the estimated ARIMA model parameters for the undifferenced time series. If a MEAN option other than 0 is in effect, the estimated mean of the working series is given. If MEAN option 2 or 4 has been used, the implied constant term for the model is given as well.

5. If a SPEC command was included in the input stream preceding the ESTI command the output will consist of the plotting of the power spectrum of the specified subset of the inputted series and of the residuals from the fitted model.
If also TRAN and/or a NRDF or NSDF command was included the SPEC command will also result in the plotting of the power spectrum of the transformed and/or differenced series.
Apart from the plotting of the spectrum the output will also consist of the amplitude and period for each of the peak frequencies.

6. Forecasts for the time series are computed if they were previously requested with a FORE command.
Additional forecast origins can be specified by using the ORIG command.
Forecasts are given first in terms of the transformed time series (if the time series was transformed). The variance and standard error of prediction are given along with prediction limits. Following this, the forecasts and the associated prediction limits are given in terms of the untransformed series. A plot of the forecasts is also provided.

11.5. OUTP Run Output

An OUTP run provides the same output as an ESTI run except that the parameters are not estimated: rather, the initially inputted or previously estimated parameters values are used for all computations.

11.6. GRID Run Output

This command provides a grid of sum of squares values computed for specified incremental changes in a selected pair of model parameters.

12. CONVENTIONS AND TERMINOLOGY

This section explains some of the conventions and the corresponding terminology used in this manual.

The "working series" is the time series resulting from any transformation and/or differencing performed on the inputted (raw) time series data. Even though most of the internal computations are done in terms of this series, the final model is always given in terms of the undifferenced series (this is termed the "expanded model"). Forecasts, when requested, are given in terms of the transformed time series as well as the untransformed series.

If many runs are contemplated for a particular working series, it may be more efficient to output the working series (by inserting a PUNC command before an IDEN command) and then use it for preliminary analyses. The original series can be used for a final run to obtain forecasts etc.

In order to use some of the special commands, it is necessary to understand the numbering scheme used for the model parameters. The parameters are numbered from 1 up to the number of parameters in the model. Parameters corresponding to regular autoregressive terms (RART) have the smallest numbers, followed by seasonal autoregressive terms (SART), regular moving average terms (RMAT) and seasonal moving average terms (SMAT). Last is the mean of the series (if it is to be estimated via the nonlinear least squares procedure). Within each term type, numbers are assigned according to the order of the term. For example, the following commands request model terms which are assigned the numbers shown, regardless, of the particular order in which the commands appear

Term #	Command	Order
1	RART	1
2	RART	2
3	SART	12
4	RMAT	1
5	SMAT	12
6	MEAN	-

The parameter values used in computations for OUTP or GRID runs and for starting values for ESTI runs, are called the "current parameter values" and can be changed or specified in several different ways:

1. Initial values can be specified in the command requesting a particular model term. If no initial value is specified, a default value of 0.1 is assumed. Even if any modifications are made to these values in the ways specified below, these initial values are restored (i.e. if any one of the following commands appear: RART, SART, RMAT, SMAT, MEAN, NRDF or NSDF).

2. After an ESTI run, the new current parameter values are the estimates found by the nonlinear least squares procedure.

3. If a CHAN command containing no numbers immediately precedes a PEST command, the preliminary estimates become the current parameter values.

4. The CHAN command can also be used to modify the current value of a specific parameter, as explained in Section 5.3.

It should be remembered that if one purposely changes any of the current parameter values using methods 2, 3 or 4 (usually in preparation for a GRID, OUTP or ESTI run), then no commands requesting a change in the model should appear between the requested changes in the parameters and where the new values are to be used.

13.COMPUTATIONAL ASPECTS OF THE SYSTEM

For the most part, the computations in TSERS follow the outline given by BOX and JENKINS /2/. This section will discuss some of the details and other information about methodological and computational aspects.

1. Most of the program has been written in single precision. However, in certain parts, double precision is used for accumulation of sums, notably in the computation of the sums of squares of the residuals, in accumulation of the X'X (Hessian) matrix of the linearized model and in computation of the gradient vector, all of which are used with the Marquardt nonlinear least squares algorithm.

2. Back forecasts are computed at each function evaluation. Only one iteration of back forecasting is performed. The back forecasts are deemed to have died out when the last computed value is less than a threshold of 0.0005. A maximum of 100-M (where M is the largest model lag) back forecasts are computed. If this upper limit is reached any time during execuation, a warning message is printed.

3. The Marquardt nonlinear least squares algorithm follows the outline given in /6/ rather than that given in /2/.

4. Standard errors of the sample autocorrelations are computed from equation 6.2.2 of /2/.

5. Standard errors for the sample partial autocorrelation are computed from equation 6.2.3 of /2/.

6. Standard errors of the sample cross correlations between the working series and the residuals are computed from equation 11.1.11 of /2/.

7. The sum of squares of the back forecasted observations are used in the estimation of the model parameters but are not used in computing the estimate of the process variance.

8. The KOLMOGOROV-SMIRNOV limits and p-value for the corresponding hypothesis test are based on the asymptotic distribution of the K-S statistic, the approximation being quite good for a sample size of 50 or more.

9. The plotting of Multiple Notched Boxplots can be found and is described in /8, pp.65-92/.

10. To estimate the power spectrum a weighted autocovariance estimator is used. It is computed by the GOERTZEL method (Fourier Transform) for a trigonometric window of the BLACKMAN-TUKEY type.
    This part of the TSERS system is based on the programs 72.1.1 (AUTOCOR) and 72.2.1 (AUSPEC) of the TIMSAC program package. These programs were originally published in /1/.
    In order to perform the printer plots of the spectrum use has been made of the program ARSPLT which was used and referred to in /4/.

14.CONVERGENCE PROBLEMS AND CHECKING

In most of the estimation problems which have been run with TSERS, the Marquardt algorithm, even with arbitrary starting values, has performed quite well. However, sometimes difficulties arise. The sum of squares function may be badly behaved, exhibiting multiple minima and/or an irregular (i.e. nonquadratic) shape. Some possible causes are:

1. Attempting to fit model with too few observations.
2. Attempting to fit a model with unnecessary or redundant model terms.
3. Parameter values of autoregressive terms which start or stray outside of the stationary region. Further differencing may be required.
4. Parameter values of moving average terms which start or stray outside of the invertibility region. This can be the result of excessive differencing.

Box and Jenkins (see Section 7.1.6 of /2/) strongly recommend that one investigate the sum of squares function (numerically or graphically) in all new situations. The <u>GRID</u> command allows such studies to be performed quite easily. When more than two parameters are beging estimated, the <u>GRID</u> command can be used with specified pairs of parameters.

Use of GRID commands can serve several purposes.

1. Rather coarse grids can be used to examine the overall shape of the sum of squares function and to suggest starting values for estimation.

2. After the estimation procedure is complete, examination of the sum of squares surface will indicate whether or not a minimum was indeed found and allow the user to assess the general shape of the function.

The Marquardt algorithm will terminate with one of three possible messages:

1. "RELATIVE CHANGE IN EACH PARAMETER VALUE LESS THAN ..." This is a normal termination message. However, it could occur at a point other than at the minimum if the surface has an irregular shape.

2. "UNABLE TO REDUCE SUM OF SQUARES ANY FURTHER. MAXIMUM CHANGE IS ... FOR PARAMETER..." This message indicates that no reduction in the sum of squares was obtained in the direction chosen by the algorithm. Two possible causes for this condition are:
   - A point very close to the minimum was found during the preceding iteration.
   - A badly behaved sum of squares function or numerical problems have caused a poor direction to be chosen.

   In either case, the sum of squares function should be investigated.

3. "CONVERGENCE CRITERION NOT MET AFTER ... ITERATIONS. MAXIMUM CHANGE IS ... FOR PARAMETER ..." Any of the irregular conditons mentioned above could also cause this condition. Again, the sum of squares function should be investigated.

15. WARNING AND ERROR MESSAGES

An extensive error checking facility has been written into TSERS. Two types of errors might be countered: fatal errors, and less severe errors for which only a warning is given. A fatal error occurs when a detected abnormal condition is serious enough that it is very unlikely that continuing the run would produce useable results. An example of such an error would be attempting to fit a model before time series data have been inputted. For less serious errors, a warning message is printed and, in some cases, a correction is effected to rectify the abnormal condition before execution continues. An example of such an error would be incorrect specification of a confidence level. Several error messages are given explicitly.

1. Unrecognized commands (usually caused by a typing error) are flagged and ignored, after which execution continues.

2. If an unexpected noninteger or negative number is detected in a command, a warning is given, the integer part and/or the absolute value is substituted and execution continues.

3. If the back forecasts of the working series do not die out rapidly when computing the sum of squares of the residuals, a warning is given. The warning is given only once for a given sequence of evaluations and the back forecasts of the working series and the corresponding residuals are automatically printed. This condition is usually caused by a combination of autoregressive parameter values which is near the nonstationary region. This condition can be self-correcting during the estimation process. This is easily checked by examination of the printed back forecasts and the general shape of the sum of squares function.

In an effort to reduce computer storage requirements and because most error conditions should occur infrequently, other abnormal conditions which are detected by the system are followed by a printed message and an error number. A detailed explanation of the condition which caused a particular error can be found in the list to follow (see Appendix II). In the case of non fatal warnings, the system's standard correction (if any) is also given. In the list, a "#" before an error number indicates a fatal error.

The introduction of two new commands (BOXP and SPEC) also leaded to the introduction of a few new error codes. These new error messages are marked with a "X" sign.

Some error conditions will not be detected by TSERS but will generate errors which are detected by the operating systems of the computer. Examples are reading an end of file or requesting an inexisting datafile. In most cases, the remedy for such problems is obvious.

In the explanation of the causes of the errors, several FORTRAN variable names are referred to. These variables and their meanings are:

NACORR	Number of autocorrelations to be computed
MAXTER	Maximum number of model terms that can be estimated
MAXPON	Maximum number of observations allowed in the time series
NRPOIN	Number of observations on the working series.

See Appendix II for a complete list of the error numbers.

16. OUTPUT EXAMPLE: IDEN

16.1. Example 1

Input stream:

```
HEAD  &USTRB
DATA 156 1 1
(&USTRB)
BOXP  1 12
EPLO  1
EPRI  1 4 5
IDEN
```

Resulting output: See pp. 33-35.

16.2. Example 2

If the BOXP command is replaced by

```
BOXP 2 12
```

the resulting output will be the same as in the example above except for the output of the Boxplots; the output on p.35 will be replaced by that given on p.36.

16.3. Example 3

Input stream:

```
HEAD &USTRB
DATA 156 1 1
(&USTRB)
NRDF 1
EPLO 1 3
EPRI 1 3 4 5
IDEN
```

Resulting output: See pp.37-38.

INPUT DATA:

ORIGINAL NUMBER OF OBSERVATIONS 156
NUMBER OF REGULAR DIFFERENCES 0
NUMBER OF SEASONAL DIFFERENCES 0
SEASONAL PERIOD 12
CALCULATE 24 AUTOCORRELATIONS
CALCULATE 24 PARTIAL AUTOCORRELATIONS

TIME SERIES NOT TRANSFORMED

TIME SERIES NOT DIFFERENCED

DIFFERENCED (WORKING) SERIES $W(T)=(1-B^{12})^{0}(1-B)^{0}Z(T)$

0 OBSERVATIONS LOST IN DIFFERENCING
156 OBSERVATIONS IN THE WORKING SERIES

MEAN AND STANDARD DEVIATION OF THE WORKING SERIES &USTRB
MEAN= .3422E+01
STANDARD DEVIATION= .1037E+01

AUTOCORRELATION FUNCTION OF THE WORKING SERIES &USTRB

	VALUE	S.E.	T VALUE	-1.0 0.0 1.0
1	.954	.080	11.916	************************
2	.895	.134	6.655	***********************
3	.828	.168	4.916	*********************
4	.761	.193	3.947	********************
5	.694	.211	3.289	******************
6	.627	.225	2.783	****************
7	.567	.236	2.400	***************
8	.521	.245	2.129	**************
9	.489	.252	1.941	*************
10	.464	.258	1.799	************
11	.441	.263	1.677	************
12	.418	.268	1.562	***********
13	.392	.272	1.441	**********
14	.367	.275	1.332	**********
15	.345	.279	1.238	*********
16	.325	.281	1.155	*********
17	.312	.284	1.099	********
18	.307	.286	1.073	********
19	.323	.288	1.122	*********
20	.346	.290	1.191	*********
21	.370	.293	1.263	**********
22	.392	.296	1.324	**********
23	.415	.299	1.388	***********
24	.434	.303	1.433	***********

BOX-PIERCE TEST CHISQUARE STATISTIC WITH 20 DEGREES OF FREEDOM = 966.048

PARTIAL AUTOCORRELATION FUNCTION OF THE WORKING SERIES &USTRB

	VALUE	S.E.	T VALUE	-1.0 0.0 1.0
1	.954	.080	11.916	************************
2	-.171	.080	-2.133	*****
3	-.102	.080	-1.277	***
4	-.014	.080	-.173	*
5	-.029	.080	-.366	*
6	-.052	.080	-.655	**
7	.043	.080	.537	**
8	.111	.080	1.382	***
9	.072	.080	.897	**
10	.011	.080	.133	*
11	-.022	.080	-.277	*
12	-.039	.080	-.482	*
13	-.062	.080	-.776	**
14	.019	.080	.243	*
15	.039	.080	.482	**
16	.028	.080	.352	*
17	.083	.080	1.035	***
18	.075	.080	.933	**
19	.213	.080	2.658	******
20	.006	.080	.070	*
21	-.018	.080	-.227	*
22	-.012	.080	-.149	*
23	.058	.080	.723	**
24	-.023	.080	-.286	*

BOX-PLOTS

```
LENGTH OF  SERIES =  156
 LENGTH SUB SERIES =   12
NUMBER OF  PLOTS  =   13
 POINTS PER PLOT   =   12

TRANSFORM. LAMBDA =.10000E+01
           MTRAN  =.00000E+00


    1 )                      --------
                            -(   +  )I-----
                             --------
    2 )                                 ----
                                      -(+ )I--
                                        ----
    3 )    ------------------------
        (-I       +          )    I--
          ------------------------
    4 )                                 ------------------
                                  (--I    +       )   I-------
                                    ------------------
    5 )                          ----------------
                         ( --I  +      )     I--------------
                             ----------------
    6 )                     --
                           -(+- *
                            --
    7 )                                --
                                 -+)--
                                   --
    8 )                                  --------
                                     (I + ) I-
                                     --------
    9 )                                      --
                                             +)-  0
                                             --
   10 )                                          ---
                                                 -(+)-   *
                                                  ---
   11 )                                                       ---------
                                                            (-I +   ) I---
                                                              ---------
   12 )                                                   ----------
                                             --------I(  +   )I-----
                                                      ----------
   13 )                                                                 -------
                                                                   --I( + )-----
                                                                     -------
```

```
BOX-PLOTS

LENGTH OF  SERIES =  156
 SAMPLING INTERVAL =   12
NUMBER OF  PLOTS  =   12
 POINTS PER PLOT   =   13

TRANSFORM. LAMBDA =.10000E+01
           MTRAN  =.00000E+00
```

```
    1 )                          -------------------------
                           --(---I       +         )     I-----------
                                 -------------------------
    2 )                           -----------------
                ---------------(-I     +       )  I---------------
                                 -----------------
    3 )                          -----------------
             -------------------(-I     +      )   I-----------------
                                 -----------------
    4 )                          -----------------
          ---------------------(-I    +      )   I----------------------
                                 -----------------
    5 )                         ---------------
         *                 ----(I    +     )  I--------------             *
                                ---------------
    6 )                         -------------
       *                    ----I  (    +   I-)-------------             *
                                -------------
    7 )                     ----------------------
        --------------------I (        +        )I----------------------
                            ----------------------
    8 )                        -------------------
                  -------------I  (       +      I)-----------------
                               -------------------
    9 )                           ------------------
                           -------I  (      +      I)------------------
                                  ------------------
   10 )                           --------------------
                           -------I  (       +       )------------------
                                  --------------------
   11 )                           ---------------------
                            ------I(        +        )I------------------
                                  ---------------------
   12 )                            -------------------------
                          --------(I        +          )   I-------------------
                                   -------------------------
```

&USTRB

INPUT DATA:

ORIGINAL NUMBER OF OBSERVATIONS 156
NUMBER OF REGULAR DIFFERENCES 1
NUMBER OF SEASONAL DIFFERENCES 0
SEASONAL PERIOD 12
CALCULATE 24 AUTOCORRELATIONS
CALCULATE 24 PARTIAL AUTOCORRELATIONS

TIME SERIES NOT TRANSFORMED

DIFFERENCED (WORKING) SERIES $W(T)=(1-B^{12})^{0}(1-B)^{1}Z(T)$

1 OBSERVATIONS LOST IN DIFFERENCING
155 OBSERVATIONS IN THE WORKING SERIES

MEAN AND STANDARD DEVIATION OF THE WORKING SERIES &USTRB
MEAN= .2232E-01
STANDARD DEVIATION= .2292E+00

AUTOCORRELATION FUNCTION OF THE WORKING SERIES &USTRB

	VALUE	S.E.	T VALUE	-1.0 0.0 1.0
1	.384	.080	4.784	**********
2	.197	.091	2.159	******
3	.066	.094	.702	**
4	.019	.094	.204	*
5	-.095	.094	-1.010	***
6	-.229	.095	-2.409	******
7	-.297	.099	-3.016	********
8	-.172	.104	-1.648	*****
9	-.081	.106	-.760	***
10	.003	.106	.026	*
11	-.002	.106	-.019	*
12	.083	.106	.778	***
13	.031	.107	.291	*
14	-.007	.107	-.062	*
15	-.008	.107	-.071	*
16	-.104	.107	-.969	***
17	-.147	.108	-1.365	****
18	-.209	.109	-1.919	******
19	-.149	.111	-1.334	****
20	-.075	.113	-.665	**
21	-.090	.113	-.796	***
22	-.155	.113	-1.364	****
23	.000	.115	.004	*
24	.163	.115	1.421	*****

BOX-PIERCE TEST CHISQUARE STATISTIC WITH 20 DEGREES OF FREEDOM = 75.759

PARTIAL AUTOCORRELATION FUNCTION OF THE WORKING SERIES &USTRB

	VALUE	S.E.	T VALUE	-1.0 0.0 1.0
1	.384	.080	4.784	**********
2	.058	.080	.726	**
3	-.033	.080	-.408	*
4	-.007	.080	-.089	*
5	-.116	.080	-1.443	***
6	-.187	.080	-2.329	*****
7	-.165	.080	-2.056	*****
8	.031	.080	.390	*
9	.034	.080	.418	*
10	.052	.080	.650	**
11	-.031	.080	-.390	*
12	.038	.080	.470	*
13	-.108	.080	-1.344	***
14	-.094	.080	-1.174	***
15	.003	.080	.040	*
16	-.108	.080	-1.346	***
17	-.078	.080	-.966	**
18	-.130	.080	-1.613	****
19	-.020	.080	-.248	*
20	-.015	.080	-.185	*
21	-.105	.080	-1.302	***
22	-.196	.080	-2.442	*****
23	.027	.080	.339	*
24	.103	.080	1.283	***

17. OUTPUT EXAMPLE: PEST

Input stream:

```
HEAD &USTRB
DATA 156 1 1
(&USTRB)
NRDF 1
MEAN 0
RART 1
RART 2
PLOT
PRIN
CHAN
PEST
```

Resulting output: See p.40.

INPUT DATA:

ORIGINAL NUMBER OF OBSERVATIONS 156
NUMBER OF REGULAR DIFFERENCES 1
NUMBER OF SEASONAL DIFFERENCES 0
SEASONAL PERIOD 12
CALCULATE 24 AUTOCORRELATIONS
CALCULATE 24 PARTIAL AUTOCORRELATIONS

TIME SERIES NOT TRANSFORMED

DIFFERENCED (WORKING) SERIES $W(T)=(1-B^{12})^{0}(1-B)^{1}Z(T)$

1 OBSERVATIONS LOST IN DIFFERENCING
155 OBSERVATIONS IN THE WORKING SERIES

MEAN AND STANDARD DEVIATION OF THE WORKING SERIES &USTRB
MEAN= .2232E-01
STANDARD DEVIATION= .2292E+00

&USTRB

TERMS IN THE ASSUMED STATIONARY (DIFFERENCED) MODEL
2 REGULAR AUTOREGRESSIVE TERM(S)
0 SEASONAL AUTOREGRESSIVE TERM(S)
0 REGULAR MOVING AVERAGE TERM(S)
0 SEASONAL MOVING AVERAGE TERM(S)

THE WORKING SERIES IS NOT TO BE CENTERED--MEAN ASSUMED EQUAL TO 0.

MAX BACKORDER= 2

PRELIMINARY PARAMETER ESTIMATES

AUTOREGRESSIVE TERMS

1	2
.3619	.0583

CONSTANT TERM= .0094
ESTIMATED VARIANCE= .0446

18. OUTPUT EXAMPLE: ESTI

Input stream:

```
HEAD &USTRB
DATA 156 1 1
(&USTRB)
NRDF 1
MEAN 0
RART 1
RART 2
SPEC 24
ORIG 144 150
FORE 24
EPLO 1
EPRI 4 5 6
ESTI
```

Resulting output: See p.42-56.

&USTRB

INPUT DATA:

ORIGINAL NUMBER OF OBSERVATIONS 156
NUMBER OF REGULAR DIFFERENCES 1
NUMBER OF SEASONAL DIFFERENCES 0
SEASONAL PERIOD 12
CALCULATE 24 AUTOCORRELATIONS
CALCULATE 24 PARTIAL AUTOCORRELATIONS

ORIGINAL TIME SERIES &USTRB

LAG 1 - 12	2.456	2.372	2.310	2.613	2.650	2.527	2.334	2.606	2.850	2.961	3.000	3.230
LAG 13 - 24	3.210	3.165	3.140	3.113	3.042	3.316	3.165	3.404	3.578	3.591	3.337	3.102
LAG 25 - 36	2.598	1.562	1.354	1.126	1.046	.881	.962	1.686	2.484	2.793	2.756	2.814
LAG 37 - 48	2.837	2.712	2.852	2.960	2.851	3.247	3.243	3.358	3.998	4.117	4.209	4.572
LAG 49 - 60	4.436	3.954	3.439	3.244	3.392	2.641	2.396	2.286	2.489	2.426	2.384	2.272
LAG 61 - 72	2.302	2.408	2.420	2.327	2.288	2.359	2.268	2.402	2.304	2.350	2.458	2.617
LAG 73 - 84	2.746	2.752	2.719	2.735	2.694	2.719	2.945	2.837	2.792	2.751	2.803	2.856
LAG 85 - 96	2.914	2.916	2.897	2.909	2.920	2.995	3.143	3.320	3.379	3.453	3.522	3.523
LAG 97 - 108	3.529	3.532	3.553	3.484	3.482	3.478	3.479	3.506	3.527	3.575	3.624	3.856
LAG 109 - 120	3.828	3.929	3.942	3.932	3.895	3.810	3.831	3.836	3.912	4.032	4.082	4.362
LAG 121 - 132	4.596	4.670	4.626	4.611	4.642	4.539	4.855	4.932	5.356	5.387	5.344	5.007
LAG 133 - 144	4.759	4.554	4.288	3.852	3.640	3.480	4.308	4.275	4.451	4.588	4.762	5.012
LAG 145 - 156	5.081	4.969	5.144	5.365	5.621	5.544	5.382	5.095	5.202	5.334	5.492	5.916

TIME SERIES NOT TRANSFORMED

DIFFERENCED (WORKING) SERIES $W(T)=(1-B^{12})^{0}(1-B)^{1}Z(T)$

DIFFERENCED SERIES &USTRB

LAG 2 - 13	-.084	-.062	.303	.037	-.123	-.193	.272	.244	.111	.039	.230	-.020
LAG 14 - 25	-.045	-.025	-.027	-.071	.274	-.151	.239	.174	.013	-.254	-.235	-.504
LAG 26 - 37	-1.036	-.208	-.228	-.080	-.165	.081	.724	.798	.309	-.037	.058	.023
LAG 38 - 49	-.125	.140	.108	-.109	.396	-.004	.115	.640	.119	.092	.363	-.136
LAG 50 - 61	-.482	-.515	-.195	.148	-.751	-.245	-.110	.203	-.063	-.042	-.112	.030
LAG 62 - 73	.106	.012	-.093	-.039	.071	-.091	.134	-.098	.046	.108	.159	.129
LAG 74 - 85	.006	-.033	.016	-.041	.025	.226	-.108	-.045	-.041	.052	.053	.058
LAG 86 - 97	.002	-.019	.012	.011	.075	.148	.177	.059	.074	.069	.001	.006
LAG 98 - 109	.003	.021	-.069	-.002	-.004	.001	.027	.021	.048	.049	.232	-.028
LAG 110 - 121	.101	.013	-.010	-.037	-.085	.021	.005	.076	.120	.050	.280	.234
LAG 122 - 133	.074	-.044	-.015	.031	-.103	.316	.077	.424	.031	-.043	-.337	-.248
LAG 134 - 145	-.205	-.266	-.436	-.212	-.160	.828	-.033	.176	.137	.174	.250	.069
LAG 146 - 156	-.112	.175	.221	.256	-.077	-.162	-.287	.107	.132	.158	.424	

		0.000
2	-.084	***
3	-.062	**
4	.303	********
5	.037	*
6	-.123	***
7	-.193	*****
8	.272	*******
9	.244	*******
10	.111	***
11	.039	*
12	.230	******
13	-.020	*
14	-.045	**
15	-.025	*
16	-.027	*
17	-.071	**
18	.274	*******
19	-.151	****
20	.239	******
21	.174	*****
22	.013	*
23	-.254	*******
24	-.235	******
25	-.504	*************
26	-1.036	*************************
27	-.208	******
28	-.228	******
29	-.080	**
30	-.165	****
31	.081	***
32	.724	*******************
33	.798	*********************
34	.309	********
35	-.037	*
36	.058	**
37	.023	*
38	-.125	****
39	.140	****
40	.108	***
41	-.109	***
42	.396	**********
43	-.004	*
44	.115	***
45	.640	******************
46	.119	***
47	.092	***
48	.363	**********
49	-.136	****
50	-.482	*************
51	-.515	**************
52	-.195	*****
53	.148	****
54	-.751	********************
55	-.245	******
56	-.110	***
57	.203	******
58	-.063	**
59	-.042	**
60	-.112	***
61	.030	*
62	.106	***
63	.012	*
64	-.093	***
65	-.039	*
66	.071	**
67	-.091	***
68	.134	****
69	-.098	***
70	.046	**
71	.108	***
72	.159	****
73	.129	****
74	.006	*
75	-.033	*
76	.016	*
77	-.041	*
78	.025	*
79	.226	******
80	-.108	***
81	-.045	**
82	-.041	*
83	.052	**
84	.053	**

```
  1 OBSERVATIONS LOST IN DIFFERENCING
155 OBSERVATIONS IN THE WORKING SERIES

MEAN AND STANDARD DEVIATION OF THE WORKING SERIES      &USTRB
MEAN=     .2232E-01
STANDARD DEVIATION=     .2292E+00


      &USTRB


TERMS IN THE ASSUMED STATIONARY (DIFFERENCED) MODEL
  2 REGULAR AUTOREGRESSIVE TERM(S)
  0 SEASONAL AUTOREGRESSIVE TERM(S)
  0 REGULAR MOVING AVERAGE TERM(S)
  0 SEASONAL MOVING AVERAGE TERM(S)

THE WORKING SERIES IS NOT TO BE CENTERED--MEAN ASSUMED EQUAL TO 0.

NO CONSTANT TERM IN THE MODEL

MAX BACKORDER=   2


 BEGINING ESTIMATION

ITERATION   SUM OF SQUARES     PARAMETER VALUES
    0        .6890283D+01    .329245    .100000
    1        .6874011D+01    .373562    .063559
    2        .6874011D+01    .373651    .063477
    3        .6874011D+01    .373651    .063477

RELATIVE CHANGE IN EACH ESTIMATE LESS THAN    .1000E-03

ESTIMATION COMPLETED


ESTIMATED LAG COEFFICIENTS FOR THE WORKING SERIES

AUTOREGRESSIVE TERMS
       1          2
    .3737      .0635


      &USTRB

                                                                 95% LIMITS
TERM#   TYPE   ORDER        ESTIMATE   STD. ERROR   T VALUE     LOWER      UPPER
--------------------------------------------------------------------------------
  1    REG. AR   1            .3737      .0815      4.5871      .2140      .5333
  2    REG. AR   2            .0635      .0816       .7781    -.0965      .2234
```

COVARIANCE MATRIX OF THE ESTIMATED PARAMETERS &USTRB

	1	2
1	.664E-02	-.260E-02
2	-.260E-02	.666E-02

CORRELATION MATRIX OF THE ESTIMATED PARAMETERS &USTRB

	1	2
1	.100E+01	-.391E+00
2	-.391E+00	.100E+01

STATISTICS COMPUTED FROM THE RESIDUALS &USTRB

RESIDUAL MEAN= .0139
RESIDUAL VARIANCE= .0449
RESIDUAL STD. DEV.= .2119
MINIMUM RESIDUAL= -.8328
MAXIMUM RESIDUAL= .9012
RANGE= 1.7340
S.E. OF THE RESIDUAL MEAN= .0170
RESIDUAL MEAN/S.E.= .8184
R SQUARE (WITH RESPECT TO THE WORKING SERIES)= .1505
R SQUARE (OVERALL)= .9587
DURBIN WATSON STAT= 1.9776
NUMBER OF NEGATIVE RESIDUALS= 73
NUMBER OF POSITIVE RESIDUALS= 82
NUMBER OF RUNS= 70
Z STATISTIC FOR THE RUNS TEST= -1.3323

ESTIMATED EXPANDED MODEL LAG COEFFICIENTS &USTRB

AUTOREGRESSIVE TERMS

1	2	3
1.3737	-.3102	-.0635

MOVING AVERAGE TERMS

NONE

BACK FORECASTS OF THE WORKING SERIES

LAG -6 - 0	-.001	-.001	-.002	-.005	-.009	-.019	-.035

BACK FORECASTS OF THE RESIDUALS

LAG -6 - 0	-.001	-.001	-.002	-.004	-.007	-.015	-.028

lESIDUALS &USTRB

LAG	2 -	13	-.070	-.028	.331	-.072	-.156	-.149	.352	.155	.003	-.018	.208	-.108
LAG	14 -	25	-.052	-.007	-.015	-.059	.302	-.249	.278	.094	-.067	-.270	-.141	-.400
LAG	26 -	37	-.833	.211	-.085	.018	-.121	.148	.704	.522	-.035	-.203	.052	.004
LAG	38 -	49	-.137	.185	.064	-.158	.430	-.145	.091	.597	-.127	.007	.321	-.277
LAG	50 -	61	-.454	-.326	.028	.254	-.794	.026	.029	.260	-.132	-.031	-.092	.075
LAG	62 -	73	.102	-.030	-.104	-.005	.091	-.115	.163	-.142	.074	.097	.116	.063
LAG	74 -	85	-.052	-.043	.028	-.045	.039	.219	-.194	-.019	-.017	.070	.036	.035
LAG	86 -	97	-.023	-.023	.019	.008	.070	.119	.117	-.017	.041	.038	-.029	.001
LAG	98 -	109	.001	.019	-.077	.022	.001	.003	.027	.011	.038	.030	.211	-.118
LAG	110 -	121	.097	-.023	-.021	-.034	-.071	.055	.003	.073	.091	.000	.254	.126
LAG	122 -	133	-.031	-.087	-.003	.039	-.114	.353	-.035	.375	-.132	-.081	-.323	-.119
LAG	134 -	145	-.091	-.174	-.324	-.032	-.053	.901	-.332	.136	.073	.112	.176	-.035
LAG	146 -	156	-.154	.212	.163	.162	-.187	-.149	-.222	.225	.110	.102	.357	

```
       VALUE  S.E.  T VALUE
                            +----------------------------------------------------+
  2    -.070   .212   -.329 I                        **                          I
  3    -.028   .212   -.134 I                         *                          I
  4     .331   .212   1.564 I                         **********                 I
  5    -.072   .212   -.341 I                       ***                          I
  6    -.156   .212   -.736 I                     *****                          I
  7    -.149   .212   -.705 I                     *****                          I
  8     .352   .212   1.660 I                         ***********                I
  9     .155   .212    .730 I                         *****                      I
 10     .003   .212    .012 I                         *                          I
 11    -.018   .212   -.085 I                         *                          I
 12     .208   .212    .983 I                         *******                    I
 13    -.108   .212   -.512 I                      ****                          I
 14    -.052   .212   -.246 I                        **                          I
 15    -.007   .212   -.033 I                         *                          I
 16    -.015   .212   -.070 I                         *                          I
 17    -.059   .212   -.280 I                        **                          I
 18     .302   .212   1.426 I                         *********                  I
 19    -.249   .212  -1.174 I                   *******                          I
 20     .278   .212   1.312 I                         *********                  I
 21     .094   .212    .445 I                         ***                        I
 22    -.067   .212   -.317 I                        **                          I
 23    -.270   .212  -1.273 I                  ********                          I
 24    -.141   .212   -.665 I                      ****                          I
 25    -.400   .212  -1.888 I              ************                          I
 26    -.833   .212  -3.929 I  ************************                          I
 27     .211   .212    .996 I                         *******                    I
 28    -.085   .212   -.399 I                       ***                          I
 29     .018   .212    .087 I                         *                          I
 30    -.121   .212   -.569 I                      ****                          I
 31     .148   .212    .697 I                         *****                      I
 32     .704   .212   3.323 I                         *********************      I
 33     .522   .212   2.464 I                         ****************           I
 34    -.035   .212   -.166 I                         *                          I
 35    -.203   .212   -.958 I                    ******                          I
 36     .052   .212    .246 I                         **                         I
 37     .004   .212    .017 I                         *                          I
 38    -.137   .212   -.648 I                      ****                          I
 39     .185   .212    .874 I                         ******                     I
 40     .064   .212    .300 I                         **                         I
 41    -.158   .212   -.747 I                     *****                          I
 42     .430   .212   2.028 I                         *************              I
 43    -.145   .212   -.684 I                     *****                          I
 44     .091   .212    .431 I                         ***                        I
 45     .597   .212   2.818 I                         ******************         I
 46    -.127   .212   -.601 I                      ****                          I
 47     .007   .212    .033 I                         *                          I
 48     .321   .212   1.515 I                         **********                 I
 49    -.277   .212  -1.309 I                  ********                          I
 50    -.454   .212  -2.143 I             *************                          I
 51    -.326   .212  -1.539 I                **********                          I
 52     .028   .212    .132 I                         *                          I
 53     .254   .212   1.196 I                         ********                   I
 54    -.794   .212  -3.746 I   ***********************                          I
 55     .026   .212    .124 I                         *                          I
 56     .029   .212    .138 I                         *                          I
 57     .260   .212   1.225 I                         ********                   I
 58    -.132   .212   -.622 I                      ****                          I
 59    -.031   .212   -.148 I                         *                          I
 60    -.092   .212   -.436 I                       ***                          I
 61     .075   .212    .352 I                         ***                        I
 62     .102   .212    .481 I                         ***                        I
 63    -.030   .212   -.139 I                         *                          I
```

CROSS CORRELATION FUNCTION OF THE WORKING SERIES W(T) AND THE RESIDUALS A(T+K)

	VALUE	S.E.	T VALUE	-1.0 0.0 1.0
-15	-.005	.085	-.054	*
-14	-.021	.084	-.253	*
-13	.006	.084	.066	*
-12	.091	.084	1.092	***
-11	.000	.083	.000	*
-10	.052	.083	.622	**
-9	.008	.083	.094	*
-8	-.045	.082	-.551	**
-7	-.226	.082	-2.754	******
-6	-.217	.082	-2.643	******
-5	-.122	.082	-1.498	****
-4	-.017	.081	-.211	*
-3	-.032	.081	-.394	*
-2	-.006	.081	-.076	*
-1	-.006	.081	-.079	*
0	.917	.080	11.419	************************
1	.333	.081	4.132	*********
2	.187	.081	2.318	*****
3	.071	.081	.870	**
4	.075	.081	.921	**
5	.009	.082	.114	*
6	-.115	.082	-1.410	***
7	-.247	.082	-3.007	*******
8	-.154	.082	-1.865	****
9	-.088	.083	-1.068	***
10	-.001	.083	-.015	*
11	-.038	.083	-.457	*
12	.078	.084	.929	***
13	.037	.084	.440	*
14	.003	.084	.035	*
15	.044	.085	.519	**

STANDARD ERRORS ASSUME THE SERIES ARE NOT CROSS CORRELATED AND THAT AT LEAST ONE IS WHITE NOISE

AUTOCORRELATION FUNCTION OF THE RESIDUALS &USTRB

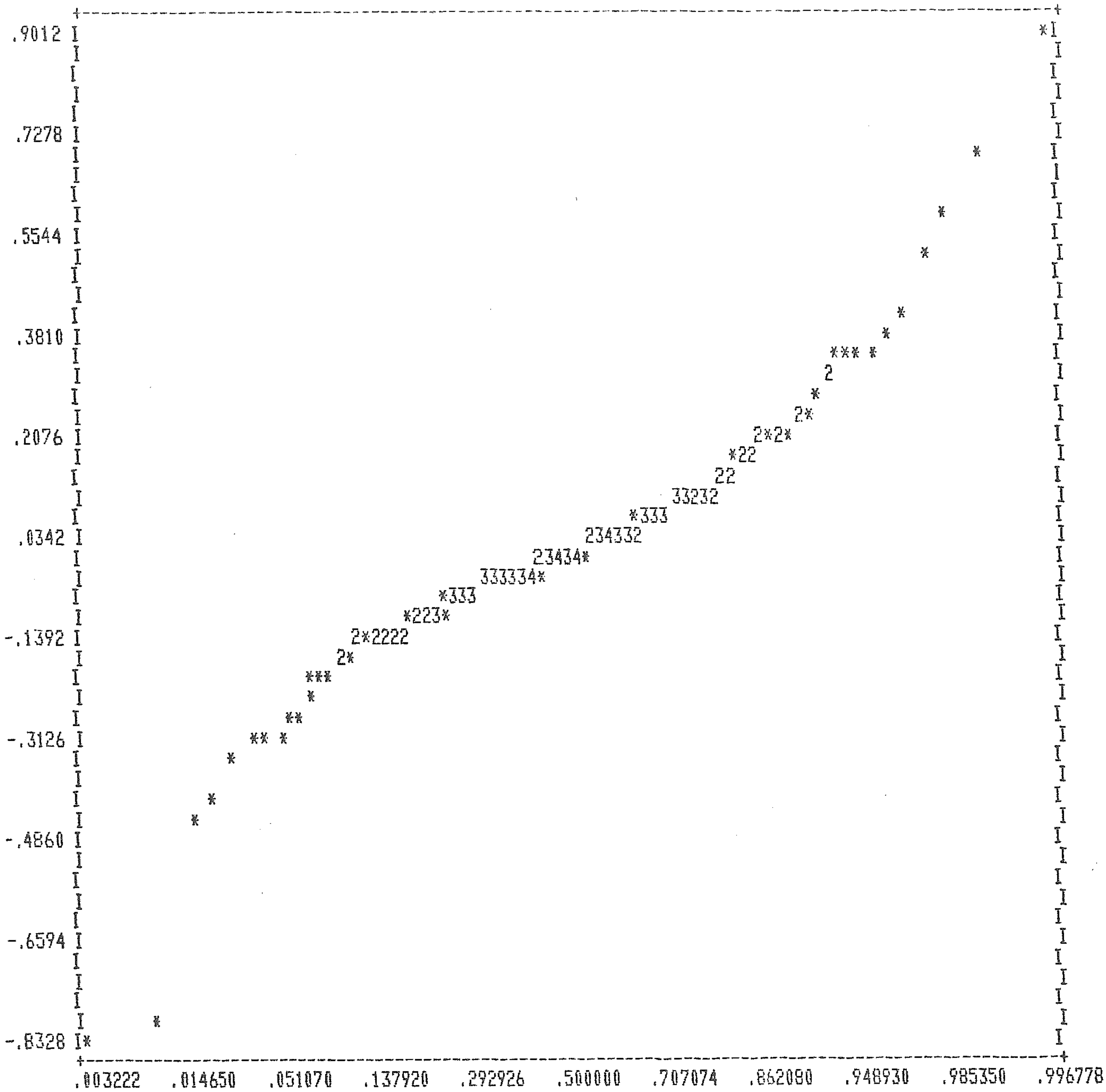
	VALUE	S.E.	T VALUE	-1.0 0.0 1.0
1	-.002	.080	-.028	*
2	.009	.080	.107	*
3	-.020	.080	-.245	*
4	.045	.080	.563	**
5	-.030	.081	-.370	*
6	-.139	.081	-1.726	****
7	-.228	.082	-2.772	******
8	-.056	.086	-.652	**
9	-.012	.086	-.144	*
10	.050	.086	.585	**
11	-.038	.087	-.437	*
12	.098	.087	1.135	***
13	.015	.087	.171	*
14	-.014	.087	-.162	*
15	.046	.087	.524	**
16	-.056	.088	-.638	**
17	-.066	.088	-.749	**
18	-.126	.088	-1.432	****
19	-.063	.089	-.711	**
20	.023	.090	.259	*
21	-.024	.090	-.270	*
22	-.185	.090	-2.064	*****
23	-.009	.092	-.100	*
24	.173	.092	1.876	*****

BOX-PIERCE TEST CHISQUARE STATISTIC WITH 20 DEGREES OF FREEDOM = 24.303

PARTIAL AUTOCORRELATION FUNCTION OF THE RESIDUALS &USTRB

	VALUE	S.E.	T VALUE	-1.0 0.0 1.0
1	-.002	.080	-.028	*
2	.009	.080	.107	*
3	-.020	.080	-.245	*
4	.045	.080	.562	**
5	-.029	.080	-.366	*
6	-.141	.080	-1.752	****
7	-.231	.080	-2.880	******
8	-.071	.080	-.882	**
9	-.018	.080	-.221	*
10	.058	.080	.724	**
11	-.024	.080	-.297	*
12	.074	.080	.925	**
13	-.047	.080	-.585	**
14	-.101	.080	-1.257	***
15	.015	.080	.191	*
16	-.064	.080	-.802	**
17	-.057	.080	-.714	**
18	-.123	.080	-1.533	****
19	-.057	.080	-.715	**
20	.007	.080	.085	*
21	-.040	.080	-.499	**
22	-.227	.080	-2.832	******
23	-.087	.080	-1.088	***
24	.095	.080	1.184	***

NORMAL PROBABILITY PLOT OF THE RESIDUALS &USTRB



&USTRB

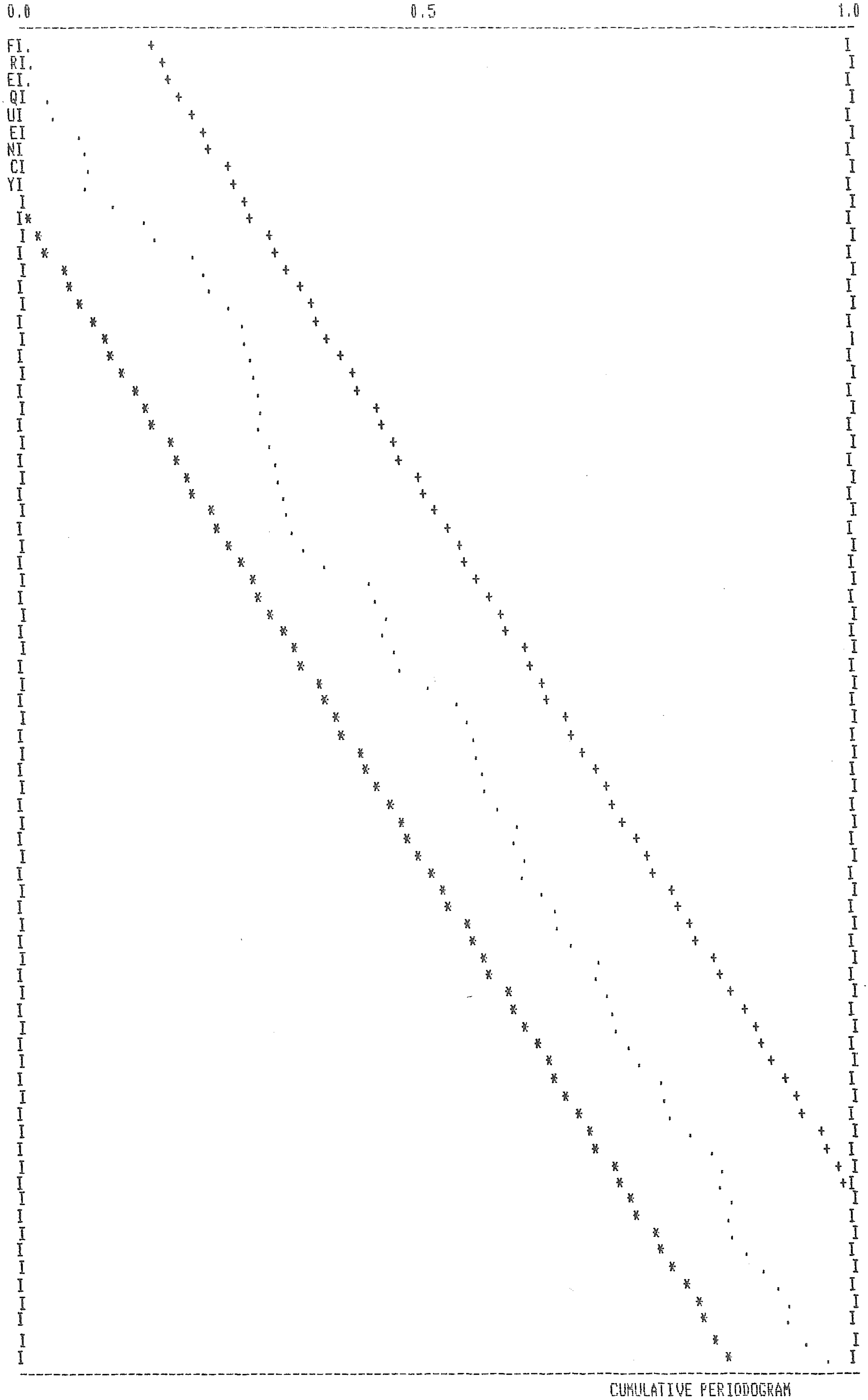
CHI-SQUARED GOODNESS OF FIT TEST FOR NORMALITY

INTERVAL		EXPECTED	OBSERVED	(O-E)**2/E
-	-.23	19.38	11.00	3.620
-.23	-.13	19.38	16.00	.588
-.13	-.05	19.38	22.00	.356
-.05	.01	19.38	35.00	12.601
.01	.08	19.38	27.00	3.001
.08	.16	19.38	17.00	.291
.16	.26	19.38	13.00	2.098
.26	-	19.38	14.00	1.491
				24.045

CHI-SQUARED STATISTIC WITH 5 DEGREES OF FREEDOM 24.045

CUMULATIVE NORMALIZED PERIODOGRAM OF THE RESIDUALS   L AND U ARE 80% LOWER AND UPPER K-S LIMITS

FREQ	E(CP)	CP
.0065	.0130	.0025
.0129	.0260	.0035
.0194	.0390	.0068
.0258	.0519	.0301
.0323	.0649	.0399
.0387	.0779	.0648
.0452	.0909	.0722
.0516	.1039	.0738
.0581	.1169	.0775
.0645	.1299	.1102
.0710	.1429	.1453
.0774	.1558	.1578
.0839	.1688	.2079
.0903	.1818	.2218
.0968	.1948	.2262
.1032	.2078	.2504
.1097	.2208	.2701
.1161	.2338	.2715
.1226	.2468	.2746
.1290	.2597	.2804
.1355	.2727	.2830
.1419	.2857	.2841
.1484	.2987	.2895
.1548	.3117	.2952
.1613	.3247	.3038
.1677	.3377	.3067
.1742	.3506	.3139
.1806	.3636	.3228
.1871	.3766	.3319
.1935	.3896	.3357
.2000	.4026	.3657
.2065	.4156	.4226
.2129	.4286	.4257
.2194	.4416	.4369
.2258	.4545	.4391
.2323	.4675	.4518
.2387	.4805	.4605
.2452	.4935	.4912
.2516	.5065	.5348
.2581	.5195	.5450
.2645	.5325	.5464
.2710	.5455	.5510
.2774	.5584	.5561
.2839	.5714	.5575
.2903	.5844	.5805
.2968	.5974	.5983
.3032	.6104	.6016
.3097	.6234	.6123
.3161	.6364	.6151
.3226	.6494	.6341
.3290	.6623	.6470
.3355	.6753	.6495
.3419	.6883	.6767
.3484	.7013	.7024
.3548	.7143	.7043
.3613	.7273	.7159
.3677	.7403	.7205
.3742	.7532	.7216
.3806	.7662	.7414
.3871	.7792	.7526
.3935	.7922	.7821
.4000	.8052	.7854
.4065	.8182	.7919
.4129	.8312	.8171
.4194	.8442	.8446
.4258	.8571	.8491
.4323	.8701	.8582
.4387	.8831	.8621
.4452	.8961	.8635
.4516	.9091	.8672
.4581	.9221	.8838
.4645	.9351	.9083
.4710	.9481	.9192
.4774	.9610	.9296
.4839	.9740	.9323
.4903	.9870	.9585
.4968	1.0000	.9828



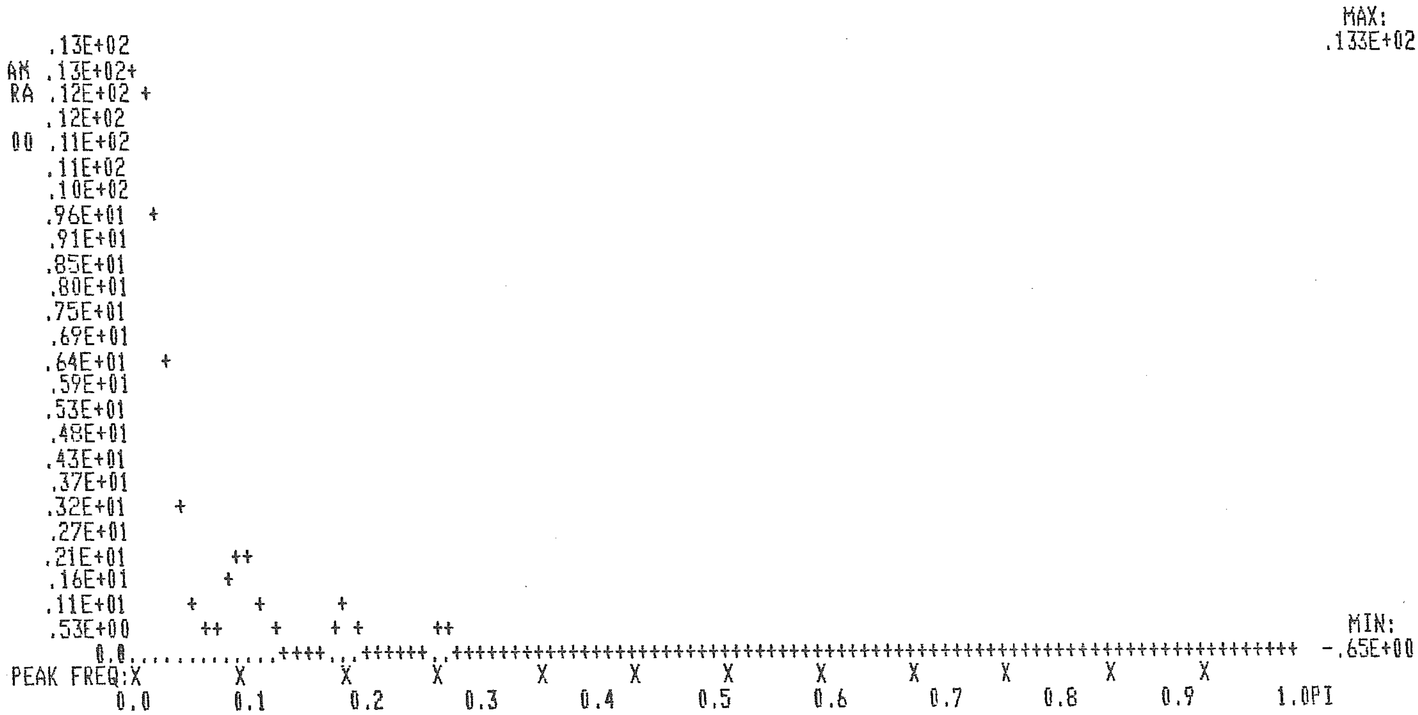
MAXIMUM DEVIATION IS .0539 AT FREQUENCY .1935
FOR THE KOLMOGOROV-SMIRNOV TEST, THIS IS NOT SIGNIFICANT AT THE 25% LEVEL

SIGNIFICANCE LEVEL	.250	.200	.150	.100	.050	.010
K-S CRITICAL LIMIT	.116	.122	.130	.139	.155	.186

SPECTRAL DENSITIES - NONPARAMETRIC METHOD

SUBSET OF ORIG. SERIES

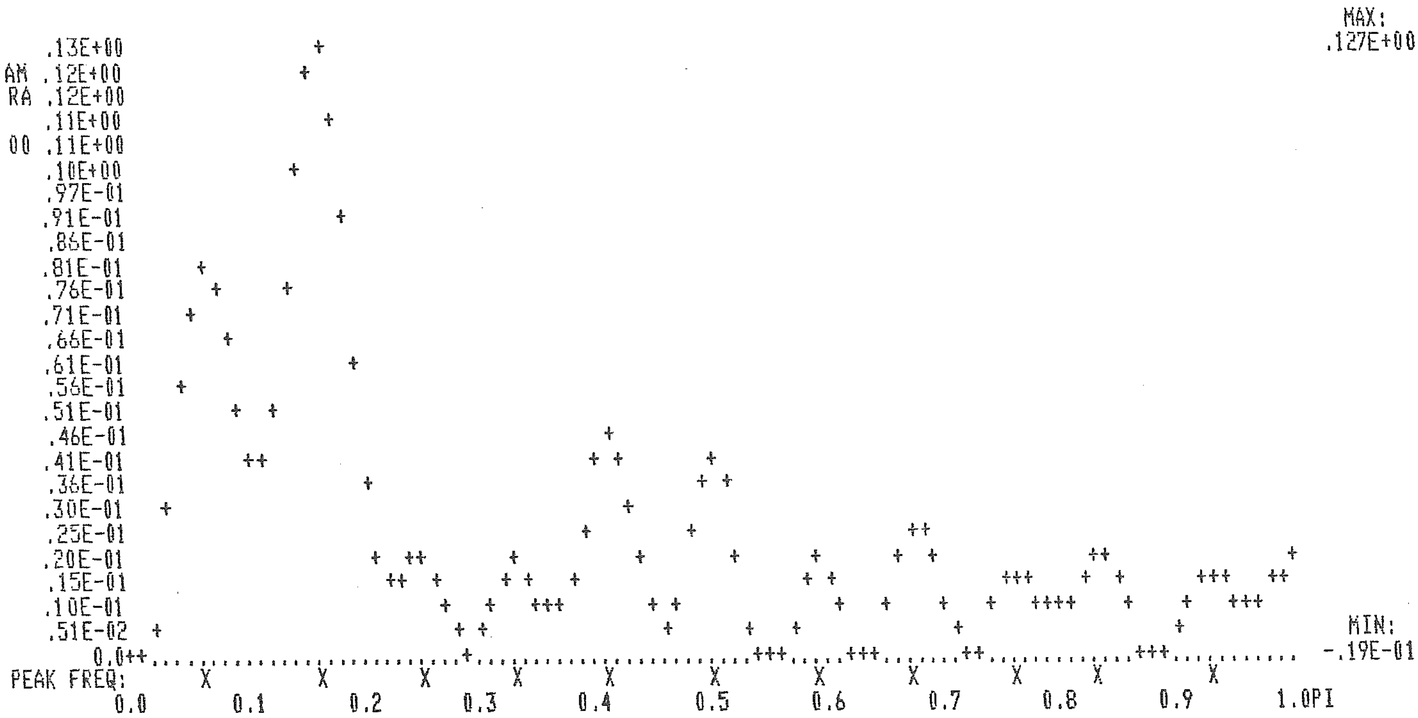
NPOINT	=	156
KUS	=	156
KLS	=	1
NCPOIN	=	156
LAGHO	=	24



THE AMPLITUDE AT FREQUENCY 0.00PI IS .133E+02
THE AMPLITUDE AT THE PEAK AT FREQUENCY .090PI WITH PERIOD .222E+02 IS .231E+01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .180PI WITH PERIOD .111E+02 IS .122E+01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .260PI WITH PERIOD .769E+01 IS .615E+00
THE AMPLITUDE AT THE PEAK AT FREQUENCY .350PI WITH PERIOD .571E+01 IS .484E+00
THE AMPLITUDE AT THE PEAK AT FREQUENCY .430PI WITH PERIOD .465E+01 IS .403E+00
THE AMPLITUDE AT THE PEAK AT FREQUENCY .510PI WITH PERIOD .392E+01 IS .357E+00
THE AMPLITUDE AT THE PEAK AT FREQUENCY .590PI WITH PERIOD .339E+01 IS .309E+00
THE AMPLITUDE AT THE PEAK AT FREQUENCY .670PI WITH PERIOD .299E+01 IS .275E+00
THE AMPLITUDE AT THE PEAK AT FREQUENCY .750PI WITH PERIOD .267E+01 IS .247E+00
THE AMPLITUDE AT THE PEAK AT FREQUENCY .840PI WITH PERIOD .238E+01 IS .251E+00
THE AMPLITUDE AT THE PEAK AT FREQUENCY .920PI WITH PERIOD .217E+01 IS .246E+00
THE AMPLITUDE AT FREQUENCY 1.00PI IS .242E+00

DIFF. (& TRANSF.) SERIES

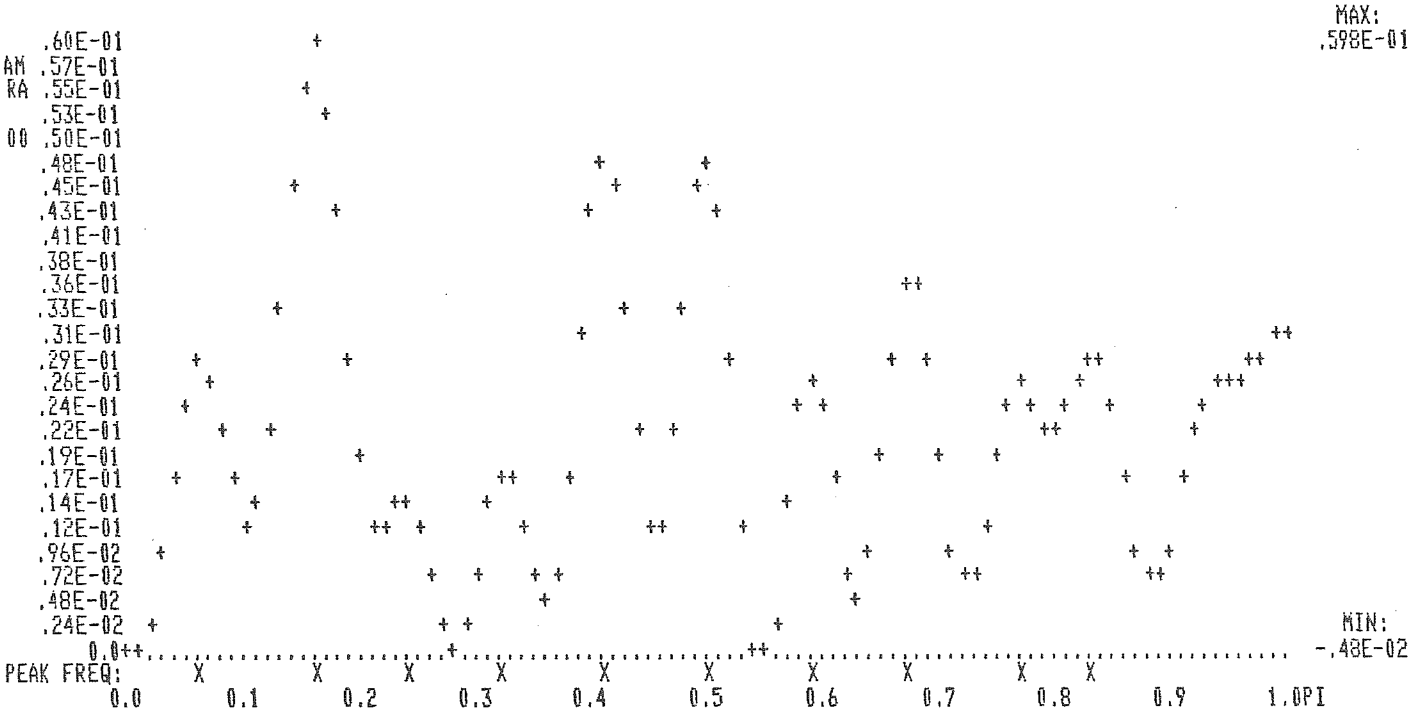
NRPOIN = 155
NRDIFF = 1
NSDIFF = 0
LAGHO = 24



THE AMPLITUDE AT FREQUENCY 0.00PI IS -.19E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .060PI WITH PERIOD .333E+02 IS .835E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .160PI WITH PERIOD .125E+02 IS .127E+00
THE AMPLITUDE AT THE PEAK AT FREQUENCY .250PI WITH PERIOD .800E+01 IS .222E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .330PI WITH PERIOD .606E+01 IS .227E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .410PI WITH PERIOD .488E+01 IS .470E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .500PI WITH PERIOD .400E+01 IS .425E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .590PI WITH PERIOD .339E+01 IS .233E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .670PI WITH PERIOD .299E+01 IS .264E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .760PI WITH PERIOD .263E+01 IS .179E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .830PI WITH PERIOD .241E+01 IS .213E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .930PI WITH PERIOD .215E+01 IS .176E-01
THE AMPLITUDE AT FREQUENCY 1.00PI IS .210E-01

RESIDUALS

NRPOIN = 155
LAGHO = 24



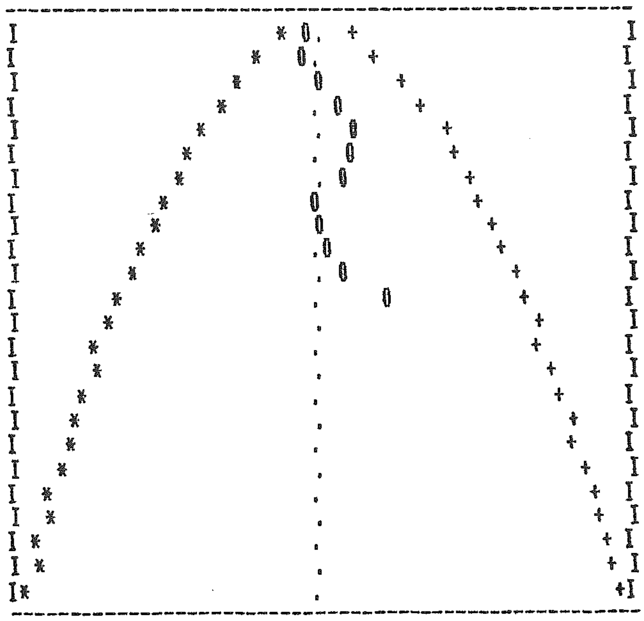
THE AMPLITUDE AT FREQUENCY 0.00PI IS -.48E-02
THE AMPLITUDE AT THE PEAK AT FREQUENCY .060PI WITH PERIOD .333E+02 IS .288E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .160PI WITH PERIOD .125E+02 IS .598E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .240PI WITH PERIOD .833E+01 IS .157E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .320PI WITH PERIOD .625E+01 IS .190E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .410PI WITH PERIOD .488E+01 IS .500E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .500PI WITH PERIOD .400E+01 IS .500E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .590PI WITH PERIOD .339E+01 IS .282E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .670PI WITH PERIOD .299E+01 IS .368E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .770PI WITH PERIOD .260E+01 IS .266E-01
THE AMPLITUDE AT THE PEAK AT FREQUENCY .830PI WITH PERIOD .241E+01 IS .300E-01
THE AMPLITUDE AT FREQUENCY 1.00PI IS .333E-01

FORECASTS FROM PERIOD 144

PERIOD	FORECAST	PSI	VAR	SD	95 PERCENT LIMITS LOWER	UPPER	ACTUAL
145	5.116	1.374	.045	.212	4.701	5.532	5.081
146	5.171	1.577	.130	.360	4.465	5.877	4.969
147	5.199	1.676	.241	.491	4.235	6.162	5.144
148	5.212	1.726	.368	.606	4.024	6.401	5.365
149	5.219	1.752	.501	.708	3.831	6.607	5.621
150	5.222	1.764	.639	.800	3.655	6.790	5.544
151	5.224	1.770	.779	.883	3.494	6.954	5.382
152	5.225	1.773	.920	.959	3.345	7.105	5.095
153	5.225	1.775	1.061	1.030	3.206	7.245	5.202
154	5.226	1.776	1.203	1.097	3.076	7.375	5.334
155	5.226	1.776	1.344	1.159	2.953	7.499	5.492
156	5.226	1.776	1.486	1.219	2.836	7.616	5.916
157	5.226	1.777	1.628	1.276	2.725	7.727	
158	5.226	1.777	1.770	1.330	2.618	7.834	
159	5.226	1.777	1.911	1.383	2.515	7.936	
160	5.226	1.777	2.053	1.433	2.417	8.035	
161	5.226	1.777	2.195	1.482	2.321	8.130	
162	5.226	1.777	2.337	1.529	2.229	8.223	
163	5.226	1.777	2.479	1.574	2.139	8.312	
164	5.226	1.777	2.620	1.619	2.052	8.399	
165	5.226	1.777	2.762	1.662	1.968	8.484	
166	5.226	1.777	2.904	1.704	1.885	8.566	
167	5.226	1.777	3.046	1.745	1.805	8.647	
168	5.226	1.777	3.187	1.785	1.726	8.726	

FORECASTS IN TERMS OF THE ORIGINAL SERIES

PERIOD	FORECAST	95 PERCENT LIMITS LOWER	UPPER	ACTUAL
145	5.116	4.701	5.532	5.081
146	5.171	4.465	5.877	4.969
147	5.199	4.235	6.162	5.144
148	5.212	4.024	6.401	5.365
149	5.219	3.831	6.607	5.621
150	5.222	3.655	6.790	5.544
151	5.224	3.494	6.954	5.382
152	5.225	3.345	7.105	5.095
153	5.225	3.206	7.245	5.202
154	5.226	3.076	7.375	5.334
155	5.226	2.953	7.499	5.492
156	5.226	2.836	7.616	5.916
157	5.226	2.725	7.727	
158	5.226	2.618	7.834	
159	5.226	2.515	7.936	
160	5.226	2.417	8.035	
161	5.226	2.321	8.130	
162	5.226	2.229	8.223	
163	5.226	2.139	8.312	
164	5.226	2.052	8.399	
165	5.226	1.968	8.484	
166	5.226	1.885	8.566	
167	5.226	1.805	8.647	
168	5.226	1.726	8.726	



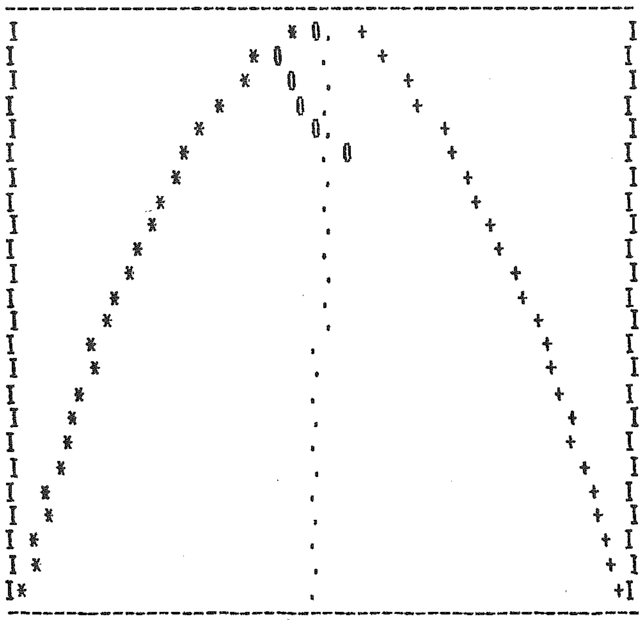
FORECASTS FROM PERIOD 150

95 PERCENT LIMITS

PERIOD	FORECAST	PSI	VAR	SD	LOWER	UPPER	ACTUAL
151	5.531	1.374	.045	.212	5.116	5.947	5.382
152	5.522	1.577	.130	.360	4.816	6.228	5.095
153	5.518	1.676	.241	.491	4.554	6.481	5.202
154	5.515	1.726	.368	.606	4.327	6.704	5.334
155	5.514	1.752	.501	.708	4.126	6.902	5.492
156	5.514	1.764	.639	.800	3.946	7.081	5.916
157	5.513	1.770	.779	.883	3.783	7.244	
158	5.513	1.773	.920	.959	3.633	7.393	
159	5.513	1.775	1.061	1.030	3.494	7.533	
160	5.513	1.776	1.203	1.097	3.363	7.663	
161	5.513	1.776	1.344	1.159	3.240	7.786	
162	5.513	1.776	1.486	1.219	3.123	7.903	
163	5.513	1.777	1.628	1.276	3.012	8.014	
164	5.513	1.777	1.770	1.330	2.905	8.121	
165	5.513	1.777	1.911	1.383	2.803	8.223	
166	5.513	1.777	2.053	1.433	2.704	8.322	
167	5.513	1.777	2.195	1.482	2.609	8.417	
168	5.513	1.777	2.337	1.529	2.516	8.510	
169	5.513	1.777	2.479	1.574	2.427	8.599	
170	5.513	1.777	2.620	1.619	2.340	8.686	
171	5.513	1.777	2.762	1.662	2.255	8.771	
172	5.513	1.777	2.904	1.704	2.172	8.854	
173	5.513	1.777	3.046	1.745	2.092	8.934	
174	5.513	1.777	3.187	1.785	2.013	9.013	

FORECASTS IN TERMS OF THE ORIGINAL SERIES

PERIOD	FORECAST	95 PERCENT LIMITS LOWER	UPPER	ACTUAL
151	5.531	5.116	5.947	5.382
152	5.522	4.816	6.228	5.095
153	5.518	4.554	6.481	5.202
154	5.515	4.327	6.704	5.334
155	5.514	4.126	6.902	5.492
156	5.514	3.946	7.081	5.916
157	5.513	3.783	7.244	
158	5.513	3.633	7.393	
159	5.513	3.494	7.533	
160	5.513	3.363	7.663	
161	5.513	3.240	7.786	
162	5.513	3.123	7.903	
163	5.513	3.012	8.014	
164	5.513	2.905	8.121	
165	5.513	2.803	8.223	
166	5.513	2.704	8.322	
167	5.513	2.609	8.417	
168	5.513	2.516	8.510	
169	5.513	2.427	8.599	
170	5.513	2.340	8.686	
171	5.513	2.255	8.771	
172	5.513	2.172	8.854	
173	5.513	2.092	8.934	
174	5.513	2.013	9.013	

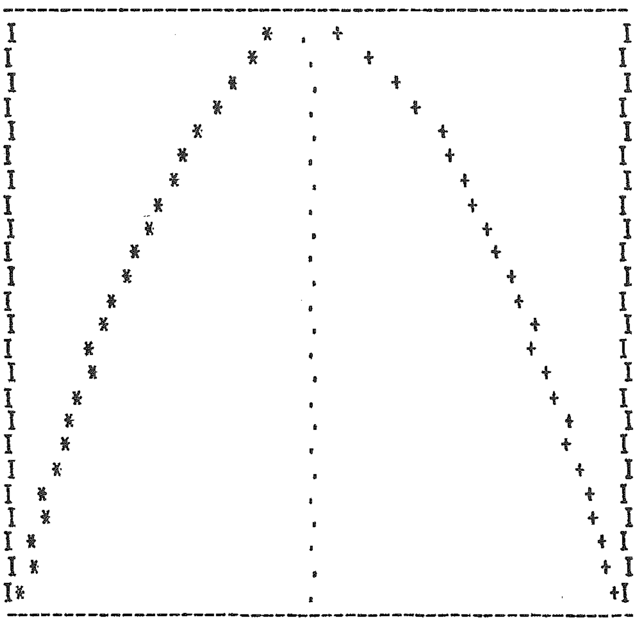


FORECASTS FROM PERIOD 156

PERIOD	FORECAST	PSI	VAR	SD	95 PERCENT LIMITS LOWER	UPPER	ACTUAL
157	6.084	1.374	.045	.212	5.669	6.500	
158	6.174	1.577	.130	.360	5.468	6.880	
159	6.219	1.676	.241	.491	5.255	7.182	
160	6.241	1.726	.368	.606	5.052	7.429	
161	6.252	1.752	.501	.708	4.864	7.640	
162	6.258	1.764	.639	.800	4.690	7.825	
163	6.260	1.770	.779	.883	4.530	7.991	
164	6.262	1.773	.920	.959	4.381	8.142	
165	6.262	1.775	1.061	1.030	4.243	8.282	
166	6.263	1.776	1.203	1.097	4.113	8.413	
167	6.263	1.776	1.344	1.159	3.990	8.536	
168	6.263	1.776	1.486	1.219	3.873	8.653	
169	6.263	1.777	1.628	1.276	3.762	8.764	
170	6.263	1.777	1.770	1.330	3.655	8.871	
171	6.263	1.777	1.911	1.383	3.553	8.973	
172	6.263	1.777	2.053	1.433	3.454	9.072	
173	6.263	1.777	2.195	1.482	3.359	9.167	
174	6.263	1.777	2.337	1.529	3.266	9.260	
175	6.263	1.777	2.479	1.574	3.177	9.349	
176	6.263	1.777	2.620	1.619	3.090	9.436	
177	6.263	1.777	2.762	1.662	3.005	9.521	
178	6.263	1.777	2.904	1.704	2.922	9.604	
179	6.263	1.777	3.046	1.745	2.842	9.684	
180	6.263	1.777	3.187	1.785	2.763	9.763	

FORECASTS IN TERMS OF THE ORIGINAL SERIES

PERIOD	FORECAST	95 PERCENT LIMITS LOWER	UPPER	ACTUAL
157	6.084	5.669	6.500	
158	6.174	5.468	6.880	
159	6.219	5.255	7.182	
160	6.241	5.052	7.429	
161	6.252	4.864	7.640	
162	6.258	4.690	7.825	
163	6.260	4.530	7.991	
164	6.262	4.381	8.142	
165	6.262	4.243	8.282	
166	6.263	4.113	8.413	
167	6.263	3.990	8.536	
168	6.263	3.873	8.653	
169	6.263	3.762	8.764	
170	6.263	3.655	8.871	
171	6.263	3.553	8.973	
172	6.263	3.454	9.072	
173	6.263	3.359	9.167	
174	6.263	3.266	9.260	
175	6.263	3.177	9.349	
176	6.263	3.090	9.436	
177	6.263	3.005	9.521	
178	6.263	2.922	9.604	
179	6.263	2.842	9.684	
180	6.263	2.763	9.763	



19. OUTPUT EXAMPLE: GRID

Input stream:

```
GRID   1   0.05    2   0.05
GRID   1   0.025   2   0.025
GRID   1   0.01    2   0.01
```

Resulting output: See pp.58-60.

&USTRB

TIME SERIES NOT TRANSFORMED

DIFFERENCED (WORKING) SERIES $W(T)=(1-B^{12})^{0}(1-B)^{1}Z(T)$

&USTRB

TERMS IN THE ASSUMED STATIONARY (DIFFERENCED) MODEL
2 REGULAR AUTOREGRESSIVE TERM(S)
0 SEASONAL AUTOREGRESSIVE TERM(S)
0 REGULAR MOVING AVERAGE TERM(S)
0 SEASONAL MOVING AVERAGE TERM(S)

THE WORKING SERIES IS NOT TO BE CENTERED--MEAN ASSUMED EQUAL TO 0.

NO CONSTANT TERM IN THE MODEL

MAX BACKORDER= 2

PARAMETER VALUES
1 .373653E+00
2 .634751E-01

FACTOR = .1000D-06

	PARAMETER # 1										
PARAM # 2	.1237	.1737	.2237	.2737	.3237	.3737	.4237	.4737	.5237	.5737	.6237
-.1865	.8258D+08	.8001D+08	.7784D+08	.7606D+08	.7469D+08	.7371D+08	.7313D+08	.7295D+08	.7318D+08	.7380D+08	.7481D+08
-.1365	.8002D+08	.7760D+08	.7558D+08	.7396D+08	.7274D+08	.7192D+08	.7150D+08	.7148D+08	.7185D+08	.7263D+08	.7380D+08
-.0865	.7785D+08	.7559D+08	.7372D+08	.7226D+08	.7119D+08	.7053D+08	.7026D+08	.7040D+08	.7093D+08	.7186D+08	.7319D+08
-.0365	.7608D+08	.7397D+08	.7226D+08	.7095D+08	.7005D+08	.6954D+08	.6942D+08	.6971D+08	.7040D+08	.7148D+08	.7297D+08
.0135	.7470D+08	.7275D+08	.7120D+08	.7005D+08	.6929D+08	.6894D+08	.6898D+08	.6943D+08	.7027D+08	.7151D+08	.7315D+08
.0635	.7373D+08	.7193D+08	.7054D+08	.6954D+08	.6894D+08	.6874D+08	.6894D+08	.6954D+08	.7054D+08	.7193D+08	.7373D+08
.1135	.7315D+08	.7151D+08	.7027D+08	.6943D+08	.6898D+08	.6894D+08	.6929D+08	.7005D+08	.7120D+08	.7275D+08	.7470D+08
.1635	.7297D+08	.7148D+08	.7040D+08	.6971D+08	.6942D+08	.6954D+08	.7005D+08	.7095D+08	.7226D+08	.7397D+08	.7608D+08
.2135	.7319D+08	.7186D+08	.7093D+08	.7040D+08	.7026D+08	.7053D+08	.7120D+08	.7226D+08	.7372D+08	.7559D+08	.7785D+08
.2635	.7380D+08	.7263D+08	.7185D+08	.7148D+08	.7150D+08	.7192D+08	.7274D+08	.7396D+08	.7558D+08	.7760D+08	.8002D+08
.3135	.7481D+08	.7380D+08	.7318D+08	.7295D+08	.7313D+08	.7371D+08	.7469D+08	.7606D+08	.7784D+08	.8001D+08	.8258D+08

&USTRB

TIME SERIES NOT TRANSFORMED

DIFFERENCED (WORKING) SERIES $W(T)=(1-B^{12})^{0}(1-B)^{1}Z(T)$

&USTRB

TERMS IN THE ASSUMED STATIONARY (DIFFERENCED) MODEL
  2 REGULAR AUTOREGRESSIVE TERM(S)
  0 SEASONAL AUTOREGRESSIVE TERM(S)
  0 REGULAR MOVING AVERAGE TERM(S)
  0 SEASONAL MOVING AVERAGE TERM(S)

THE WORKING SERIES IS NOT TO BE CENTERED--MEAN ASSUMED EQUAL TO 0.

NO CONSTANT TERM IN THE MODEL

MAX BACKORDER= 2

PARAMETER VALUES
 1 .373653E+00
 2 .634751E-01

FACTOR = .1000D-06

	PARAMETER # 1										
PARAM # 2	.2487	.2737	.2987	.3237	.3487	.3737	.3987	.4237	.4487	.4737	.4987
-.0615	.7220D+08	.7156D+08	.7101D+08	.7057D+08	.7023D+08	.6998D+08	.6984D+08	.6979D+08	.6985D+08	.7000D+08	.7026D+08
-.0365	.7156D+08	.7095D+08	.7045D+08	.7005D+08	.6974D+08	.6954D+08	.6943D+08	.6942D+08	.6952D+08	.6971D+08	.7001D+08
-.0115	.7102D+08	.7045D+08	.6999D+08	.6962D+08	.6935D+08	.6919D+08	.6912D+08	.6915D+08	.6929D+08	.6952D+08	.6985D+08
.0135	.7057D+08	.7005D+08	.6962D+08	.6929D+08	.6907D+08	.6894D+08	.6891D+08	.6898D+08	.6915D+08	.6943D+08	.6980D+08
.0385	.7023D+08	.6974D+08	.6936D+08	.6907D+08	.6888D+08	.6879D+08	.6880D+08	.6891D+08	.6912D+08	.6943D+08	.6984D+08
.0635	.6999D+08	.6954D+08	.6919D+08	.6894D+08	.6879D+08	.6874D+08	.6879D+08	.6894D+08	.6919D+08	.6954D+08	.6999D+08
.0885	.6984D+08	.6943D+08	.6912D+08	.6891D+08	.6880D+08	.6879D+08	.6888D+08	.6907D+08	.6936D+08	.6974D+08	.7023D+08
.1135	.6980D+08	.6943D+08	.6915D+08	.6898D+08	.6891D+08	.6894D+08	.6907D+08	.6929D+08	.6962D+08	.7005D+08	.7057D+08
.1385	.6985D+08	.6952D+08	.6929D+08	.6915D+08	.6912D+08	.6919D+08	.6935D+08	.6962D+08	.6999D+08	.7045D+08	.7102D+08
.1635	.7001D+08	.6971D+08	.6952D+08	.6942D+08	.6943D+08	.6954D+08	.6974D+08	.7005D+08	.7045D+08	.7095D+08	.7156D+08
.1885	.7026D+08	.7000D+08	.6985D+08	.6979D+08	.6984D+08	.6998D+08	.7023D+08	.7057D+08	.7101D+08	.7156D+08	.7220D+08

&USTRB

TIME SERIES NOT TRANSFORMED

DIFFERENCED (WORKING) SERIES $W(T)=(1-B^{12})^{0}(1-B)^{1}Z(T)$

&USTRB

TERMS IN THE ASSUMED STATIONARY (DIFFERENCED) MODEL
2 REGULAR AUTOREGRESSIVE TERM(S)
0 SEASONAL AUTOREGRESSIVE TERM(S)
0 REGULAR MOVING AVERAGE TERM(S)
0 SEASONAL MOVING AVERAGE TERM(S)

THE WORKING SERIES IS NOT TO BE CENTERED--MEAN ASSUMED EQUAL TO 0.

NO CONSTANT TERM IN THE MODEL

MAX BACKORDER= 2

PARAMETER VALUES
1 .373653E+00
2 .634751E-01

FACTOR = .1000D-06

	PARAMETER # 1										
PARAM # 2	.3237	.3337	.3437	.3537	.3637	.3737	.3837	.3937	.4037	.4137	.4237
.0135	.6929D+08	.6919D+08	.6910D+08	.6903D+08	.6898D+08	.6894D+08	.6892D+08	.6891D+08	.6892D+08	.6894D+08	.6898D+08
.0235	.6919D+08	.6909D+08	.6901D+08	.6895D+08	.6890D+08	.6887D+08	.6885D+08	.6885D+08	.6886D+08	.6890D+08	.6894D+08
.0335	.6910D+08	.6901D+08	.6894D+08	.6888D+08	.6884D+08	.6881D+08	.6880D+08	.6881D+08	.6883D+08	.6886D+08	.6892D+08
.0435	.6903D+08	.6895D+08	.6888D+08	.6883D+08	.6879D+08	.6877D+08	.6877D+08	.6878D+08	.6881D+08	.6885D+08	.6891D+08
.0535	.6898D+08	.6890D+08	.6884D+08	.6879D+08	.6876D+08	.6875D+08	.6875D+08	.6877D+08	.6880D+08	.6885D+08	.6892D+08
.0635	.6894D+08	.6887D+08	.6881D+08	.6877D+08	.6875D+08	.6874D+08	.6875D+08	.6877D+08	.6881D+08	.6887D+08	.6894D+08
.0735	.6892D+08	.6885D+08	.6880D+08	.6877D+08	.6875D+08	.6875D+08	.6876D+08	.6879D+08	.6884D+08	.6890D+08	.6898D+08
.0835	.6891D+08	.6885D+08	.6881D+08	.6878D+08	.6877D+08	.6877D+08	.6879D+08	.6883D+08	.6888D+08	.6895D+08	.6903D+08
.0935	.6892D+08	.6886D+08	.6883D+08	.6881D+08	.6880D+08	.6881D+08	.6884D+08	.6888D+08	.6894D+08	.6901D+08	.6910D+08
.1035	.6894D+08	.6890D+08	.6886D+08	.6885D+08	.6885D+08	.6887D+08	.6890D+08	.6895D+08	.6901D+08	.6909D+08	.6919D+08
.1135	.6898D+08	.6894D+08	.6892D+08	.6891D+08	.6892D+08	.6894D+08	.6898D+08	.6903D+08	.6910D+08	.6919D+08	.6929D+08

APPENDIX I - INPUT DATAFILE

1. The datafile is entered, CReated or REplaced by the EDITR. Each line (record), consisting of 70 characters, must contain 7 observations. Each observation, entered in free format, is separated from the other by at least one blank.

   For an example see the input datafile EXF1 on p. 62.

2. If the input datafile is entered such that
   - each line (record) is equally divided into 8 fields, each field consisting of 10 characters,
   - the first 7 of these fields are used for time series observations,
   - each observation is separated from the other by at least one blank,
   - the 8th field, i.e. the last 10 characters of the record, is used for the Identification and Sequencing of the data record

   this same input datafile can also be used for the MULTISTOCH and MULTITRAN programs.

   For an example see the input datafile EXF2 on p.62.

3. Apart from the Identification and the Sequencing the input datafile, resulting from a TSERS' PUNC command, is MULTISTOCH and MULTITRAN compatible. The FORMAT used is (7 (G 9.5, 1X)).

```
EXF1   T=00004 IS ON CR00007 USING 00003 BLKS R=0000

               1         2         3         4         5         6         7         8
      12345678901234567890123456789012345678901234567890123456789012345678901234567890

      2.456 2.372 2.310 2.613 2.650 2.527 2.334
      2.606 2.850 2.961 3.000 3.230 3.210 3.165
      3.140 3.113 3.042 3.316 3.165 3.404 3.578
      3.591 3.337 3.102 2.598 1.562 1.354 1.126
      1.046 0.881 0.962 1.686 2.484 2.793 2.756
```

```
EXF2   T=00004 IS ON CR00007 USING 00004 BLKS R=0000

               1         2         3         4         5         6         7         8
      12345678901234567890123456789012345678901234567890123456789012345678901234567890

      2.456     2.372     2.310     2.613     2.650     2.527     2.334     USTRB    01
      2.606     2.850     2.961     3.000     3.230     3.210     3.165     USTRB    02
      3.140     3.113     3.042     3.316     3.165     3.404     3.578     USTRB    03
      3.591     3.337     3.102     2.598     1.562     1.354     1.126     USTRB    04
      1.046     0.881     0.962     1.686     2.484     2.793     2.756     USTRB    05
```

APPENDIX II - List of Error Numbers

Error numbers marked with a "*" sign indicate a fatal error. The error numbers refering to the new commands (BOXP and SPEC) are market with a "x" sign.

x 81 An illegal number of arguments appears in a SPEC command. Only one argument should appear. Execution continues under the assumption that one argument appears in the command.

x 82 An illegal argument appears in a SPEC command. This argument (number of auto-covariances) must be between 4 and 99. Execution continues with a default value for the number of autocovariances of one third of the data length.

*1001 An illegal lower limit for a subset series has been requested on an IDEN, PEST, ESTI, or OUTP command.

*1002 An illegal upper limit for a subest series has been requested on an IDEN, PEST, ESTI, or OUTP command.

*1008 An illegal time series length has been specified in a DATA command. The length must be between 10 and MAXPON.

1062 A (nearly) singular information matrix has been encountered. This is an indication that the specified model cannot be estimated with the available data. This condition has also been encountered when a combination of moving average parameters is very close to the noninvertable region. Execution continues; however, variances and standard errors printed subsequently will have no meaning.

*1077 An insufficient number of observations has been provided to perform the requested differencing.

1700 Preliminary estimation has been requested before a model has been specified. Execution continues.

1800 An illegal origin for forecasting has been requested; such origins must be within the series specified for analysis; the requested origin is ignored.

*2001 An illegal number of arguments appears on an RART command. There must be either one or two arguments.

*2011 An illegal lag has been specified as the first argument on an RART command. Requested lags must be between 1 and 100.

2021 An illegal initial parameter value specified on an RART command. Such values, if specified, must lie between -10 and 10. The default value of 0.1 is assumed.

*2031 The number of RART commands exceeds the maximum of 5.

*2002
*2012 Same as 2001, 2011, 2021, and 2031 for SART commands.
2022
*2032

*2003
*2013 Same as 2001, 2011, 2021, and 2031 for RMAT commands.
2023
*2033

*2004
*2014 Same as 2001,2011,2021, and 2031 for SMAT commands.
2024
*2034

2244 The computed value of R-square with respect to the working series is less than 0, indicating that the model has been grossly misfit.

2245 The computed value of R-square with respect to the undifferenced series is less than 0, indicating that the model has been grossly misfit.

*3200 The number of seasonal differences specified on an NSDF command is not within the allowable range of 0 to 3.

*3225 The number of observations remaining after the series has been differenced is not sufficient to estimate the model parameters.

3500 An illegal number of forecasts has been requested. The number requested must be between 1 and 100; 20 is assumed.

4062 An argument which is out of range appears on the preceeding command. This argument is ignored.

*4117 An illegal number of arguments appears in a DATA command. There must be between 1 and 3 arguments.

4124 An illegal forecast inverse transformation has been requested. This is probably due to some other error.

4198 An illegal number of arguments appears for the requested OPTI option. Only one argument should appear. The command is ignored.

4199 An illegal number of arguments appears for the requested OPTI option. A total of two arguments should appear. The command is ignored.

4200 An illegal OPTI option has been requested. Option numbers range between 0 and 9.

4201 An illegal output unit has been specified with an OPTI 1 command. The unit number must be between 1 and 32 and must be properly assigned to the operating system of the user's computer. Unit 6 is assumed.

4202 Same as 4201 for the input unit on an OPTI 2 command. Unit 5 is assumed.

4203 An illegal starting lambda parameter has been requested for the Marquardt algorithm with an OPTI 3 command. The value must lie between 10.0E-07 and 10.0E-03; the assumed value is 10.0E-05.

4204 An illegal maximum relative change parameter (epsilon) has been requested for the Marquardt algorithm with an OPTI 4 command. The value must lie between 10.0E-07 and 10.0E-03. The assumed value is 10.0E-05.

4205 An illegal maximum number of iterations for the Marquardt algorithm has been specified in an OPTI 5 command. The number should be between 10 and 75. A maximum of 25 is assumed.

2406 Illegal print level option for the Marquardt algorithm has been requested with an OPTI 6 command. The print level should be between 0 and 4. Level 1 is assumed.

4207 Illegal change factor nu has been requested for the Marquardt algorithm with an OPTI 7 command. The value must lie between 1.5 and 25.0. A value of 10.0 is assumed.

4802 An illegal term number appears on a CHAN command. The command is ignored.

*5001 The number of observations remaining after differencing is too small to give any meaningful results.

5003 The number of autocorrelations requested (either implicitly or through the use of an NACR command) was larger than the differenced series. The minimum of (24,NACORR) is assumed.

5004 An illegal number of partial autocorrelations has been requested (either implicitly or through the use of an NPAC command). The minimum of (24, NACORR) is assumed.

*5006 Maximum lag for the ARMA model for the working series is larger than 100.

*5020 Too many model terms have been requested. The number must lie between 0 and MAXTER.

*5021 Two requests for the same model term have been detected.

6001 An illegal confidence level has been requested on a CLPA command. The value must lie between 10% and 99.99%; 95% is assumed.

6002 Same as 6001 for a prediction level with a CLFC command. Again, 95% is assumed.

*6050 An illegal maximum lag appears in the unscrambled ARIMA model. The maximum allowable lag is 150.

6230 Divergence has occured in the Newton-Raphson iterations for preliminary estimation of MA parameters; if they were to be used as starting values for the Marquardt algorithm, arbitrary values of 0.1 will be substituted.

6250 Singular matrix encountered in the the preliminary estimation procedure for the AR terms. Same fix-up as 6230.

6260 Same as 6250 for preliminary estimation of the MA terms.

6350 An illegal unit has been specified on a PUNC command. The value must lie between 1 and 32. The current output unit for printing is assumed.

6665 Either a 0 or no argument appears on a SCAL command; the command is ignored.

6710 An illegal number of negative lags for compuation of cross correlations has been requested with an NCRO command. The value must be between 0 and 50; 15 is assumed.

6711 Same as 6710 for positive lags.

6712 An illegal number of arguments appears in an NCRO command. The command is ignored.

*7001 An illegal number of arguments appears in an NRDF command. The command must contain one number indicating the number of regular differences to be performed.

*7002 An illegal number of regular differences has been requested with an NRDF command. The argument must be between 0 and 4.

*7003 An illegal number of arguments appears in an NSDF command. The command must contain two arguments indicating the number of seasonal differences and the order of the differencing respectively.

*7004 An illegal number of seasonal differences has been requested as the first argument in an NSDF command. The number of seasonal differences must be between 0 and 3.

*7005 An illegal order of seasonal differencing has been requested as the second argument in an NSDF command. The order must be between 1 and 100.

x7006 A number other than 2 arguments appears in a BOXP command. A total of two arguments should appear. Execution continues under the assumption that the first method (subset method) was requested with a default value for the subset length of 12.

x7007 An illegal number for the requested method appears in a BOXP command. This number must be 1 or 2. Execution continues with a default value of 1, i.e. the subset method.

x7008 An illegal second argument appears in a BOXP command requesting the subset method. This second argument (length of the subset) must be between 4 and the length of the undifferenced series. Execution continues and the default value for the length of the subset is assumed to be 12.

x7009 An illegal second argument appears in a BOXP command requesting the sampling method. This second argument (sampling interval) must be between 4 and 12. Execution continues and the default value for the sampling interval is assumed to be 12.

7100 An incorrect option has been requested in a MEAN command. MEAN option arguments must be between 0 and 4 (or blank for the default option). The default option is assumed.

7111 A (nearly) singular matrix was detected during execution of the Marquardt nonlinear least squares algorithm. An internal fix-up is invoked.

7113 A number other than 4 arguments appears on a GRID command. The command is ignored.

7189 A GRID command appears before a model has been specified. The command is ignored.

7522 An illegal parameter has been specified as the first argument in a GRID command; 1 is assumed.

7523 Same as 7522, for the second argument; 2 is assumed.

7890 An illegal input number has been specified as the third argument on a DATA command. The unit number must lie between 1 and 32. The current input number is assumed.

*9001 A request for estimation of the mean exceeds the maximum number of allowable model terms.

*9040 Illegal transformation. An attempt has been made to raise a negative number to a noninteger power.

*9050 Illegal transformation. An attempt has been made to take the log of a nonpositive number.

APPENDIX III - List of Commands

This appendix contains a list of the TSERS commands, organized into groups according to function.

1. Commands for Input of Time Series Data

DATA	Input time series data

2. Commands for Transformation and Differencing

TRAN	Transformation of time series
NRDF	Regular differencing
NSDF	Seasonal differencing
SCAL	Divide the raw time series by a scale factor

3. Commands for Input of an ARMA Model

RART	Regular autoregressive term
SART	Seasonal autoregressive term
RMAT	Regular moving average term
SMAT	Seasonal moving average term
MEAN	Estimation of the mean and/or inclusion of a constant term

4. Commands for Control and Modification of System Output

PRIN	Inclusive print
EPRI	Exclusive print
PLOT	Inclusive plot
EPLO	Exclusive plot
CLPA	Parameter confidence intervals
CLFC	Level for prediction intervals
NACR	Number of autocorrelations
NPAC	Number of partial autocorrelations
NCRO	Number of cross correlations
BOXP	Multiple notched Boxplots
SPEC	Power spectrum
PUNC	Output on datafile
FORE	Forecasting
ORIG	Additional forecast origins

5. Commands for System Control

NEWM	Remove model terms
REST	Reset all system options
CHAN	Change of parameter values
STOP	Terminate TSERS run

6. Commands Requesting a Particular Type of Run

IDEN	Identification
PEST	Preliminary estimation
ESTI	Estimation and forecasting
OUTP	Same as ESTI but without estimation
GRID	Grid of sum of squares values

7. Commands for other Miscellaneous Options

HEAD	Heading or title
C	Comment

8. Special, Infrequently used Commands

OPTI	Algorithm control, debugging output, etc.

APPENDIX IV - USER-LEVEL FLOW CHART

```
FLOW   T=00004 IS ON CR00007 USING 00018 BLKS R=0000

                            +-------+
 +------------------------->| READ  |
 |                          |COMMAND|
 |                          +-------+
 |                              |
 |                              |
 |                              V
 |       +-------+   OTHER  +-------+  STOP     +-------+
 |<------| TASK  |<---------| TYPE? |---------->| STOP  |
 |       +-------+          +-------+           +-------+
 |                              |
 |                              |  TYPE OF RUN
 |                              V
 |                          +-------+
 |                          | TRAN  |
 |                          | DIFF. |
 |                          +-------+
 |                              |
 |                              |
 |                              V
 |                          +-------+
 |                          | PRIN  |
 |                          | PLOT  |
 |                          +-------+
 |                              |
 |                              |
 |                              V
 |       +-------+   ESTI   +-------+  IDEN     +-------+
 |       | ESTI  |<---------| TYPE? |---------->| IDEN  |
 |       +-------+          +-------+           +-------+
 |           |                  |                   |
 |           |                  |  OUTP             |
 |           V                  |                   V
 |       +-------+  NO          |               +-------+  YES  +-------+
 |       | SPEC? |------------->|               | BOXP? |------>| BOXP  |
 |       +-------+              |               +-------+       +-------+
 |           |                  |                   |               |
 |           |  YES             |                   |  NO           |
 |           V                  |                   V               |
 |       +-------+              |               +-------+  NO       |
 |       | SPEC  |              |               | PEST? |---------->|
 |       +-------+              |               +-------+           |
 |           |                  |                   |               |
 |           |                  |                   |  YES          |
 |           |                  V                   V               |
 |           V              +-------+           +-------+           |
 |           +------------->| OUTP  |           | PEST  |           |
 |                          +-------+           +-------+           |
 |                              |                   |               |
 |                              |                   |               |
 |                              V                   |               |
 |                     NO   +-------+               |               |
 |<-------------------------| FORE? |               |               |
 |                          +-------+               |               |
 |                              |                   |               |
 |                              |  YES              |               |
 |                              V                   |               |
 |                          +-------+               |               |
 |                          | FORE  |               |               |
 |                          +-------+               |               |
 |                              |                   |               |
 |                              |                   |               |
 |                              V                   V               V
 +------------------------------+-------------------+---------------+
```

APPENDIX V - TSERIES versus TSERS

TSERIES is a user-oriented computer program for identifying, fitting and forecasting ARIMA time series model. It was originally written by /7/

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and implemented on the HP-1000 computer as TSERS.

Apart from the internal structure, the following modifications were made to the program:

1. The REWI command is omitted, i.e. time series data cannot be inputted via magnetic tape.
2. As the HP-1000 computer has no punched card facilities,the DATA command had to be changed. It follows that time series data can only be inputted in two ways:
   - terminal keyboard
   - datafile on disk
3. Since the input of time series data is always in free format (via keyboard or datafile) the FREE and FORM commands are omitted.
4. For the same reason also the PUNC command had to be changed. The "working series" and the residuals can only be saved on a datafile on disk.
5. The OPTI 9 option, i.e. the printing of elapsed CPU and real time, was not retained in TSERS.
6. Two new commands have been added: BOXP and SPEC.
7. Some minor changes have been made to the layout of the output:
   - symbols used for the plotting of the confidence intervals of the cummulated periodogram
   - symbols used for the plotting of the forecasts

The following additions are planned for the (near) future:

1. Range/Mean or Deviation/Mean plot /5, pp.45-46/
2. Seasonal Subseries plot /3/
3. Factorization of the final estimated model
4. Parametric method for the estimation of the spectrum of the AR-part and the MA-part of the ARMA model as well as of the combined effect of the AR- and MA-part.
5. ARIMA model expressed as a weighted sum of the past plus a random shock (PI weights)
6. Aggregate forecasts and aggregate uncertainty from any given time origin.

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