STUDIECENTRUM VOOR ECONOMISCH EN SOCIAAL ONDERZOEK

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PACK 2
User's Manual

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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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Abstract

The PACK system is designed to perform BOX-JENKINS type analyses for both univariate stochastic models and univariate transfer function models.

PACK 2 performs the estimation stage of the iterative model building process. In its present form PACK 2 is a (passive) interactive program, i.e. the appropriate input is supplied directly to the program by answering the displayed questions.

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

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INTRODUCTION

This user's manual describes a computer program for the analysis of time series models using the BOX-JENKINS philosophy.

Two basically different types of models may be analyzed. These models are briefly summarized as follows:

1. Univariate Stochastic Model (Single Output Model)
   - model based on a single time series
   - describes the present value of this series as a function of the past values of this same series and a random error.

2. Univariate Transfer Function Model (Single Output-Multiple Input Model)
   - model based on two or more series
   - describes the present value of one series, called the "output" series, as a function of the past values of this same series, the past and present values of the other "input" series, and a "noise". This noise may have a structure described by a univariate stochastic model, called "noise model", reducing the noise to a random error.
   - It is important to note that the transfer function models with more than one input series are analyzed with an implicit assumption that the input series are independent of each other. The interrelationships between the inputs are ignored.

The iterative model building process at the foundation of the BOX-JENKINS approach must be part of the background of anyone attempting to make use of this manual. This document does not explain the process, only the computer program.

PACK 2 is an ESTIMATION program. It is an adaption for the HP-1000 computer of SUBROUTINE TRFEST, which forms the main part of the "MAIN ESTIMATION & FORECASTING" program of the PACK SYSTEM [5,7] . The latter was written in early 1977 at the Ohio State University by D. PACK and is distributed on a commercial basis by

Automatic Forecasting Systems, Inc.
P.O. Box 563
HATBORO
Pennsylvania 19040

This PACK program was an extension of a December 1974 program [4] , which was in turn an extension of two previous publicly available programs [6,3].

Since the originally PACK program was a batch processing program, based on a card input, the input part of the program had to be changed.

In its present form PACK 2 is a (passive) interactive program, i.e. the appropriate input is supplied directly to the program by answering the displayed questions.

In a later stage (next release?) this input part could be modified into an independent (passive) interactive input program which generates images of the input cards on an output file. This output file could then be used as an input file for further batch processing.

I - UNIVARIATE STOCHASTIC MODEL

1 - MODEL STRUCTURE

The Univariate Stochastic Model (Single Output Model or Multiplicative ARIMA Model) can be written in its most general form as

$$\prod_{i=1}^{NAR} \phi_i(B) w_t = \theta_0 + \prod_{j=1}^{NMA} \theta_j(B) a_t$$

The model consists of

1. NAR autoregressive factors, the i^{th} factor given by a polynomial of degree p_i in the backward shift operator B, i.e.

   $$\phi_i(B) = (1 - \phi_{i1}B - \phi_{i2}B^2 - \ldots - \phi_{iP_i}B^{P_i})$$

   and containing one or more autoregressive parameters ϕ_{im}.

2. NMA moving average factors, the j^{th} factor given by a polynomial of degree q_j in the backward shift operator B, i.e.

   $$\theta_j(B) = (1 - \theta_{j1}B - \theta_{j2}B^2 - \ldots - \theta_{jq_j}B^{q_j})$$

   and containing one or more moving average parameters θ_{jm}.

3. a variable w_t, defined as the appropriately differenced and transformed series

$$w_t = \begin{cases} \prod_{k=1}^{ND} (1-b^{S_k})^{d_k} Z_t^{(\lambda)} & (ND \neq 0) \\ Z_t^{(\lambda)} - \bar{Z}^{(\lambda)} & (ND = 0) \end{cases}$$

   where

$$Z_t^{(\lambda)} = \begin{cases} (Z_t + \text{scaling constant})^{\lambda} & (\lambda \neq 0) \\ \ln_e (Z_t + \text{scaling constant}) & (\lambda = 0) \end{cases}$$

$\bar{Z}^{(\lambda)}$ is the mean of $Z_t^{(\lambda)}$

and

ND is the number of differencing factors

S_k is the order of the k^{th} differencing

d_k is the number of differences of order S_k

4. a constant θ_0 which measures
   - the mean value of w_t when ND $\neq$ 0 (representing the possible presence of a deterministic trend)
   - the correction to the sample mean $\bar{Z}^{(\lambda)}$ to estimate the population mean when ND = 0

5. an error term a_t which must be "white noise".

2. PROGRAM INPUT STRUCTURE

For each input the original input number is mentioned. Additional inputs can easily be recognized since they all have been given the same number "00".

A "# " sign means that on displaying that particular input question this "# " sign will be replaced by a sequence number (number of time series, factor, parameter, ...).

A vertical accolade means that the indicated inputs form a sequence. If the necessary condition is satisfied this sequence will be repeated as many times as indicated.

2.1. Displayed Questions

GENERAL SPECIFICATION

INPUT 00
ENTER IPROG : General Program Parameter.
= 0 STOP
= 1 Univariate Stochastic Model (USES-USFO)
= 2 Mult.Input Trans.Model (MUTE-MUTF)

INPUT 00
ENTER IOUT : Logical Unit Number Output Device.
= 1 Display
= 6 Printer

INPUT 00
ENTER LISIN : Listing of Input Parameters.
= 0 No
= 1 Yes

INPUT 00
ENTER NMODEL : Number of Models to be Estimated and/or Forecast.

INPUT 02
ENTER NOB : Number of Observations (NOB.LE.300).

INPUT 05
ENTER RNAM : Title of Time Series # (Max.48 Characters).

ENTER NAME of Datafile.

INPUT 00
ENTER FOB : First Obs.of Time Series #.

INPUT 40
ENTER ILDEST : Listing of Time Series #.
= 0 No
= 1 Yes

INPUT 41
ENTER IPDEST : Plotting of Time Series #.
= 0 No
= 1 Yes

SPECIFICATION FOR THE OUTPUT SERIES

INPUT 06
ENTER NLAM : Data Transformation for the Output Series.
= 0 Analysis only for Original Output Series
= X Number of Values for Lambda

INPUT 07
ENTER TM : Mean Correction before Transformation.

INPUT 07
ENTER PLAM : Lambda for Transformation #.

INPUT 12
ENTER AVEPA : Final Estimate of the Mean.

SPECIFICATION OF THE NOISE MODEL

INPUT 08
ENTER MFAC2 : Number of Differencing Factors (MFAC2.LE.3).

INPUT 09
ENTER ND : Number of Differences of Factor #.

INPUT 09
ENTER IOD : Order of Differences of Factor #.

INPUT 08
ENTER MFAC1 : Number of AR-Factors (MFAC1.LE.(6-MFAC3)).

INPUT 13
ENTER INC : Number of Parameters in AR-Factor #.

INPUT 14
ENTER IOPA : Order of Parameter # in AR-Factor #.

INPUT 15
ENTER UPA : Estimate of Param.# in AR-Factor #.

INPUT 08
ENTER MFAC3 : Number of MA-Factors (MFAC3.LE.(6-MFAC1)).

INPUT 13
ENTER INC : Number of Parameters in MA-Factor #.

INPUT 14
ENTER IOPA : Order of Parameter # in MA-Factor #.

INPUT 15
ENTER UPA : Estimate of Param.# in MA-Factor #.

SPECIFICATION FOR THE TREND

INPUT 16
ENTER ITREND : Trend Parameter.
= 0 Model does not Contain a Trend
= 1 Model contains a Trend

INPUT 17
ENTER TREPA : Estimate of the Trend Parameter.

SPECIFICATION FOR THE ESTIMATION PROCESS

INPUT 37
ENTER IWBF : Backforecasting Procedure.
= 0 No
= 1 Yes

INPUT 38
ENTER EPS1 : Relative Change in Residual Sum of Squares.

INPUT 38
ENTER EPS2 : Relative Change in each Individual Parameter.

INPUT 39
ENTER MIT : Maximum Number of Iterations.

SPECIFICATION FOR THE RESIDUALS

INPUT 39
ENTER IPRES : Plotting of the Residuals.
= 0 No
= 1 Yes

SPECIFICATION FOR THE AUTO CORR.FUNC. OF THE RESIDUALS

INPUT 42
ENTER NAC : Lag for Auto Corr.Function (NAC.LE.100).

INPUT 42
ENTER NPAC : Lag for Part.Auto Corr.Func.(NPAC.LE.NAC).

INPUT 42
ENTER NCHI : Chi-Square Statistic for Auto Corr.Function.
= 0 Suppress Statistic
= X Number of Terms to be Used (NCHI.LE.NAC)

INPUT 42
ENTER MCSE : Standard Errors of Individual Auto Correlations.
= 0 No
= 1 Yes

INPUT 42
ENTER NAPL : Number of Auto Corr.per Line (NAPL.LE.12).

INPUT 42
ENTER IWTPA : Plotting of Auto Correlations.
= 0 No
= 1 Yes

2.2. Conditions, Restrictions and Comments

00-IOUT : The program output can be displayed (IOUT = 1) or printed (IOUT = 6).

00-LISIN : Even when the program output is displayed (IOUT = 1) the inputted parameters can be printed (LISIN = 1).

00-NMODEL : Whatever the value of NMODEL may be only one model can be estimated or forecasted at a time. Restriction: NMODEL = 1.

02-NOB : The analysis will be based on NOB observations.
Restriction: NOB $\leq$ 300 .

05-RNAM : The heading or running title may consist of any character; numerical, alphanumerical or special.
Restriction: Maximum number of Characters is 48.

NAME : The only way to input time series data is through a datafile. The name of this datafile must be entered immediately after the message is displayed on the screen. See Appendix I for details about the preparation of this datafile.

00-FOB : First observation of the datafile to take account of. The total number of observations on the datafile must be at least: FOB + NOB - 1.

06-NLAM : Number of values of the time series data transformation parameter lambda to be considered.
For each of these NLAM lambda values the parameters of the specified model will be estimated and the sum of squared residuals calculated.
These sum of squares, expressed in the same metric, are then compared. The program continues with that value for lambda for which the sum of squared residuals is minimum.
Restriction: 0 $\leq$ NLAM $\leq$ 7.

07-TM : Number to be added to each time series observation prior to any data transformation.

07-PLAM : As many times as indicated by NLAM.
Value of transformation parameter lambda.
PLAM = 1.0 means no real transformation.
PLAM = 0.0 means natural log transformation.

12-AVEPA : Mean value of the time series.
If the output is a stationary series, the mean of the output series is one of the estimated parameters. If this is the case the mean value of the time series is a good initial estimate or starting value for the estimation process.

08-MFAC2 : Number of differencing factors.
Restriction: $0 \leq MFAC2 \leq 3$.

09-ND
09-IOD
] Only if MFAC2 $\neq 0$.
As many times as indicated by MFAC2.

08-MFAC1 : Number of AR-factors.
Restriction: The total number of AR- and/or MA-factors must be less than or equal to six, i.e. $0 \leq MFAC1 + MFAC3 \leq 6$.

13-INC
14-IOPA
15-UPA
] INC times] MFAC1 times

15-UPA : Initial value or starting value for AR-parameter.

08-MFAC3 : Number of MA-factors.
Restriction: The total number of MA- and/or AR-factors must be less than or equal to six, i.e. $0 \leq MFAC1 + MFAC3 \leq 6$.

13-INC
14-IOPA
15-UPA
] INC times] MFAC3 times

15-UPA : Initial value or starting value for MA-parameter.

17-TREPA : Only if ITREND = 1.
Initial value or starting value for the trend parameter.

37-IWBF : The use of the backforecasting procedure in the estimation of the time series model parameters can be suppressed by entering IWBF = 0.
For the backforecasting procedure see [1], pp.215-220.

38-EPS1 : If the relative change in the residual sum of squares is less than EPS1, the iterative change in parameter values stops at the presumed optimum.

38-EPS2 : If the relative change in each individual parameter is less than EPS2, the iterative change in parameter values stops at the presumed optimum.

39-MIT : Whatever the values of EPS1 and EPS2 may be the maximum number of iterations to be allowed for the parameter estimation process is determined by MIT.

42-NAC : Restriction: $NAC \leq 100$.
42-NPAC : Restriction: $NPAC \leq NAC$.
42-NCHI : Restriction: $NCHI \leq NAC$.
42-NAPL : Restriction: $1 \leq NAPL \leq 12$.

3 - EXAMPLE : UNIVARIATE STOCHASTIC MODEL

00	GENERAL PROGRAM PARAMETER	IPROG =	1
00	ESTIMATION-CHECKING STAGE	IEYON =	1
00	FORECASTING STAGE	IFYON =	0
00	LOGICAL UNIT NUMBER OUTPUT DEVICE	IOUT =	6
00	LISTING OF INPUT PARAMETERS	LISIN =	1
00	NUMBER OF MODELS	NMODEL =	1
01	NUMBER OF TIME SERIES	NSERIE =	1
02	NUMBER OF OBSERVATIONS	NOB =	296

05 TIME SERIES 1 CODED TS017

00	TIME SERIES 1 FIRST OBSERVATION	FOR =	1
40	TIME SERIES 1 LISTING	ILDEST =	1
41	PLOTTING	IPDEST =	1

SPECIFICATION FOR MODEL 1

SPECIFICATION FOR THE OUTPUT SERIES

06 NUMBER OF VALUES FOR LAMBDA	NLAM	=	0
12 FINAL ESTIMATE OF THE MEAN	AVEPA	=	-.100000E+00

SPECIFICATION OF THE NOISE MODEL

08 NUMBER OF DIFFERENCING FACTORS	MFAC2	=	0
08 NUMBER OF AR-FACTORS	MFAC1	=	1
13 NUMBER OF PARAM. IN AR-FACTOR 1	INC	=	3
14 ORDER OF PAR. 1 AR-FACT. 1	IOPA	=	1
15 ESTI. OF PAR. 1 AR-FACT. 1	UPA	=	.100000E+01
14 ORDER OF PAR. 2 AR-FACT. 1	IOPA	=	2
15 ESTI. OF PAR. 2 AR-FACT. 1	UPA	=	-.100000E+01
14 ORDER OF PAR. 3 AR-FACT. 1	IOPA	=	3
15 ESTI. OF PAR. 3 AR-FACT. 1	UPA	=	.500000E+00
08 NUMBER OF MA-FACTORS	MFAC3	=	0

SPECIFICATION OF THE TREND

16 TREND PARAMETER	ITREND	=	0

SPECIFICATION FOR THE ESTIMATION PROCESS

37 BACKFORECASTING PROCEDURE	IWBF	=	1
38 REL. CHANGE IN RES. SUM OF SQUARES	EPS1	=	.000000E+00
38 REL. CHANGE IN EACH INDIVIDUAL PAR.	EPS2	=	.100000E-03
39 MAXIMUM NUMBER OF ITERATIONS	MIT	=	20

SPECIFICATION FOR THE RESIDUALS

39 PLOTTING OF THE RESIDUALS	IPRES	=	1

SPECIFICATION FOR ACF RESIDUALS

42 MAX. LAG IN CALC. AUTO CORR.	NAC	=	24
42 MAX. LAG IN CALC. PART. AUTO CORR.	NPAC	=	24
42 NUMBER OF AUTO CORR. CHI-SQ. STAT.	NCHI	=	24
42 STANDARD ERRORS FOR AUTO CORR.	MCSE	=	1
42 NUMBER OF AUTO CORR. PER LINE	NAPL	=	8
42 PLOTTING OF AUTO CORR.	IWTPA	=	1

CODED TS017

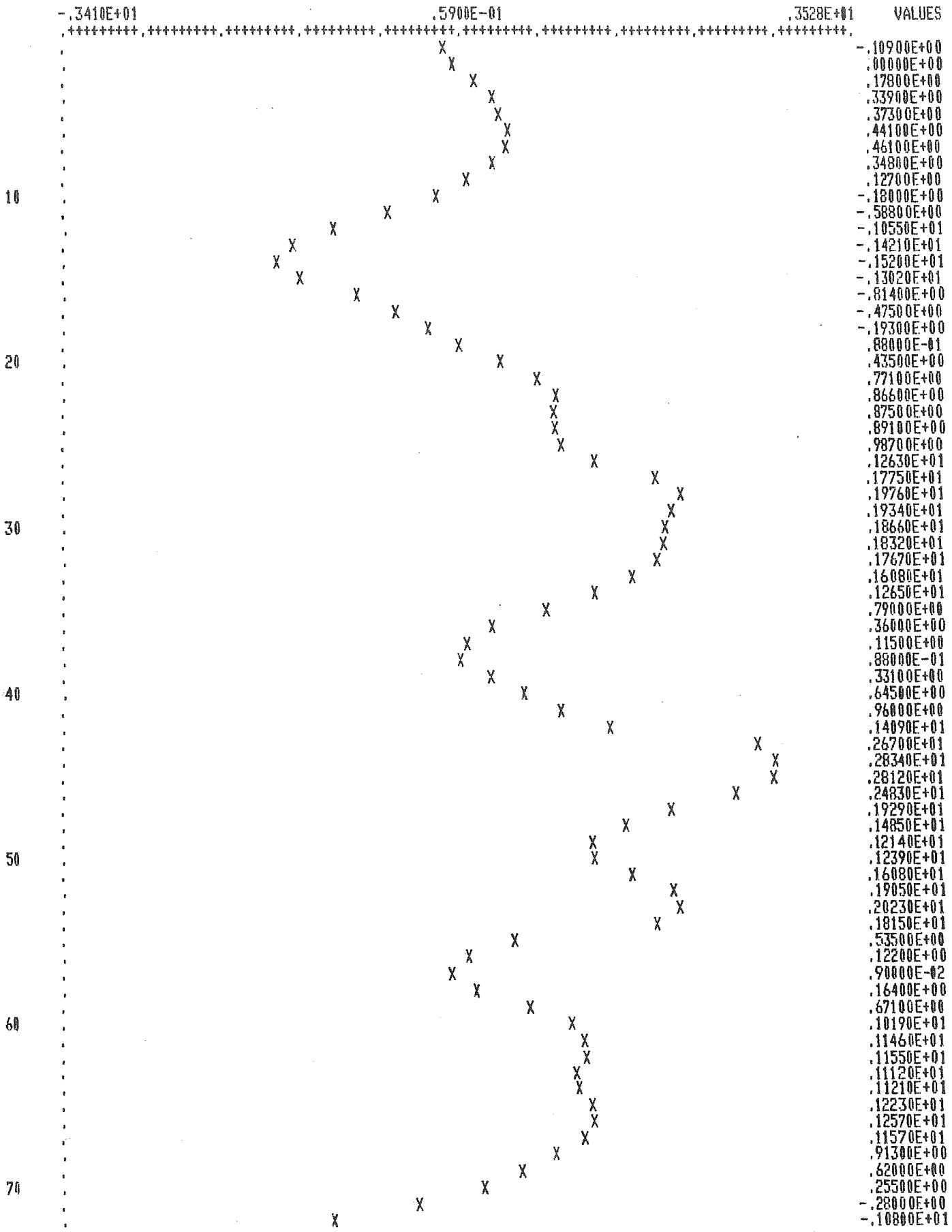
LISTING OF OBSERVED SERIES

1- 8	-.109000E+00	.000000E+00	.178000E+00	.339000E+00	.373000E+00	.441000E+00	.461000E+00	.348000E+00
9- 16	.127000E+00	-.180000E+00	-.588000E+00	-.105500E+01	-.142100E+01	-.152000E+01	-.130200E+01	-.814000E+00
17- 24	-.475000E+00	-.193000E+00	.880000E-01	.435000E+00	.771000E+00	.866000E+00	.875000E+00	.891000E+00
25- 32	.987000E+00	.126300E+01	.177500E+01	.197600E+01	.193400E+01	.186600E+01	.183200E+01	.176700E+01
33- 40	.160800E+01	.126500E+01	.790000E+00	.360000E+00	.115000E+00	.880000E-01	.331000E+00	.645000E+00
41- 48	.960000E+00	.140900E+01	.267000E+01	.283400E+01	.281200E+01	.248300E+01	.192900E+01	.148500E+01
49- 56	.121400E+01	.123900E+01	.160800E+01	.190500E+01	.202300E+01	.181500E+01	.535000E+00	.122000E+00
57- 64	.900000E-02	.164000E+00	.671000E+00	.101900E+01	.114600E+01	.115500E+01	.111200E+01	.112100E+01
65- 72	.122300E+01	.125700E+01	.115700E+01	.913000E+00	.620000E+00	.255000E+00	-.280000E+00	-.108000E+01
73- 80	-.155100E+01	-.179900E+01	-.182500E+01	-.145600E+01	-.944000E+00	-.570000E+00	-.431000E+00	-.577000E+00
81- 88	-.960000E+00	-.161600E+01	-.187500E+01	-.189100E+01	-.174600E+01	-.147400E+01	-.120100E+01	-.927000E+00
89- 96	-.524000E+00	.400000E-01	.788000E+00	.943000E+00	.930000E+00	.100600E+01	.113700E+01	.119800E+01
97- 104	.105400E+01	.595000E+00	-.800000E-01	-.314000E+00	-.288000E+00	-.153000E+00	-.109000E+00	-.187000E+00
105- 112	-.255000E+00	-.229000E+00	-.700000E-02	.254000E+00	.330000E+00	.102000E+00	-.423000E+00	-.113900E+01
113- 120	-.227500E+01	-.259400E+01	-.271600E+01	-.251000E+01	-.179000E+01	-.134600E+01	-.108100E+01	-.910000E+00
121- 128	-.876000E+00	-.885000E+00	-.800000E+00	-.544000E+00	-.416000E+00	-.271000E+00	.000000E+00	.403000E+00
129- 136	.841000E+00	.128500E+01	.160700E+01	.174600E+01	.168300E+01	.148500E+01	.993000E+00	.648000E+00
137- 144	.577000E+00	.577000E+00	.632000E+00	.747000E+00	.900000E+00	.993000E+00	.968000E+00	.790000E+00
145- 152	.399000E+00	-.161000E+00	-.553000E+00	-.603000E+00	-.424000E+00	-.194000E+00	-.490000E-01	.600000E-01
153- 160	.161000E+00	.301000E+00	.517000E+00	.566000E+00	.560000E+00	.573000E+00	.592000E+00	.671000E+00
161- 168	.933000E+00	.133700E+01	.146000E+01	.135300E+01	.772000E+00	.218000E+00	-.237000E+00	-.714000E+00
169- 176	-.109900E+01	-.126900E+01	-.117500E+01	-.676000E+00	.330000E-01	.556000E+00	.643000E+00	.484000E+00
177- 184	.109000E+00	-.310000E+00	-.697000E+00	-.104700E+01	-.121800E+01	-.118300E+01	-.873000E+00	-.336000E+00
185- 192	.630000E-01	.840000E-01	.000000E+00	.100000E-02	.209000E+00	.556000E+00	.782000E+00	.858000E+00
193- 200	.918000E+00	.862000E+00	.416000E+00	-.336000E+00	-.959000E+00	-.181300E+01	-.237800E+01	-.249900E+01
201- 208	-.247300E+01	-.233000E+01	-.205300E+01	-.173900E+01	-.126100E+01	-.569000E+00	-.137000E+00	-.240000E-01
209- 216	-.500000E-01	-.135000E+00	-.276000E+00	-.534000E+00	-.871600E+00	-.124300E+01	-.143900E+01	-.142200E+01
217- 224	-.117500E+01	-.813000E+00	-.634000E+00	-.582000E+00	-.625000E+00	-.713000E+00	-.848000E+00	-.103900E+01
225- 232	-.134600E+01	-.162800E+01	-.161900E+01	-.114900E+01	-.488000E+00	-.160000E+00	-.700000E-02	-.920000E-01
233- 240	-.620000E+00	-.108600E+01	-.152500E+01	-.185800E+01	-.202900E+01	-.202400E+01	-.196100E+01	-.195200E+01
241- 248	-.179400E+01	-.130200E+01	-.103000E+01	-.918000E+00	-.798000E+00	-.867000E+00	-.104700E+01	-.112300E+01
249- 256	-.876000E+00	-.395000E+00	.185000E+00	.662000E+00	.709000E+00	.605000E+00	.501000E+00	.603000E+00
257- 264	.943000E+00	.122300E+01	.124900E+01	.824000E+00	.102000E+00	.250000E-01	.382000E+00	.922000E+00
265- 272	.103200E+01	.866000E+00	.527000E+00	.930000E-01	-.458000E+00	-.748000E+00	-.947000E+00	-.102900E+01
273- 280	-.928000E+00	-.645000E+00	-.424000E+00	-.276000E+00	-.158000E+00	-.330000E-01	.102000E+00	.251000E+00
281- 288	.280000E+00	.000000E+00	-.493000E+00	-.759000E+00	-.824000E+00	-.740000E+00	-.528000E+00	-.204000E+00
289- 296	.340000E-01	.204000E+00	.253000E+00	.195000E+00	.131000E+00	.170000E-01	-.182000E+00	-.262000E+00

CODED TS017

GRAPH OF OBSERVED SERIES

GRAPH INTERVAL IS .6938E-01



TIME SERIERS PARAMETER ESTIMATION FOR MODEL 1

****

DATA - Z = CODED TS017 296 OBSERVATIONS

DIFFERENCING ON Z - NONE

TRANSFORMATIONS EXAMINED - NONE

****

UNIVARIATE MODEL PARAMETERS

****

PARAMETER NUMBER	PARAMETER TYPE	PARAMETER ORDER	BEGINNING VALUE
1	MEAN		-.10000E+00
2	AUTOREGRESSIVE 1	1	.10000E+01
3	AUTOREGRESSIVE 1	2	-.10000E+01
4	AUTOREGRESSIVE 1	3	.50000E+00

****

INITIAL SUM OF SQUARES = .1047E+03

ITERATION NO. 1

TEST POINT PARAMETER VALUES

-.9393E-01 .1783E+01 -.1069E+01 .2152E+00

TEST POINT SUM OF SQUARES = .1091E+02

PARAMETER VALUES VIA REGRESSION

1	2	3	4
-.9393E-01	.1783E+01	-.1069E+01	.2152E+00

SUM OF SQUARES AFTER REGRESSION = .1090585E+02

TEST POINT PARAMETER VALUES

-.5962E-01 .1976E+01 -.1374E+01 .3428E+00

TEST POINT SUM OF SQUARES = .1045E+02

PARAMETER VALUES VIA REGRESSION

1	2	3	4
-.5962E-01	.1976E+01	-.1374E+01	.3428E+00

SUM OF SQUARES AFTER REGRESSION = .1044644E+02

ITERATION STOPS - RELATIVE CHANGE IN EACH PARAMETER LESS THAN .1000E-03

SUMMARY OF MODEL 1

DATA - Z = CODED TS017 296 OBSERVATIONS

DIFFERENCING ON Z - NONE

UNIVARIATE MODEL PARAMETERS

PARAMETER NUMBER	PARAMETER TYPE	PARAMETER ORDER	ESTIMATED VALUE	95 PER CENT LOWER LIMIT	95 PER CENT UPPER LIMIT
1	MEAN		-.59624E-01	-.45354E+00	.33429E+00
2	AUTOREGRESSIVE 1	1	.19757E+01	.18657E+01	.20856E+01
3	AUTOREGRESSIVE 1	2	-.13743E+01	-.15736E+01	-.11750E+01
4	AUTOREGRESSIVE 1	3	.34282E+00	.23279E+00	.45285E+00

OTHER INFORMATION AND RESULTS

RESIDUAL SUM OF SQUARES	.10446E+02 292 D.F.	RESIDUAL MEAN SQUARE	.35775E-01
NUMBER OF RESIDUALS	296	RESIDUAL STANDARD ERROR	.18914E+00

CORRELATION MATRIX OF THE PARAMETERS

	1	2	3	4
1	1.0000			
2	.0012	1.0000		
3	-.0018	-.9409	1.0000	
4	.0018	.7899	-.9410	1.0000

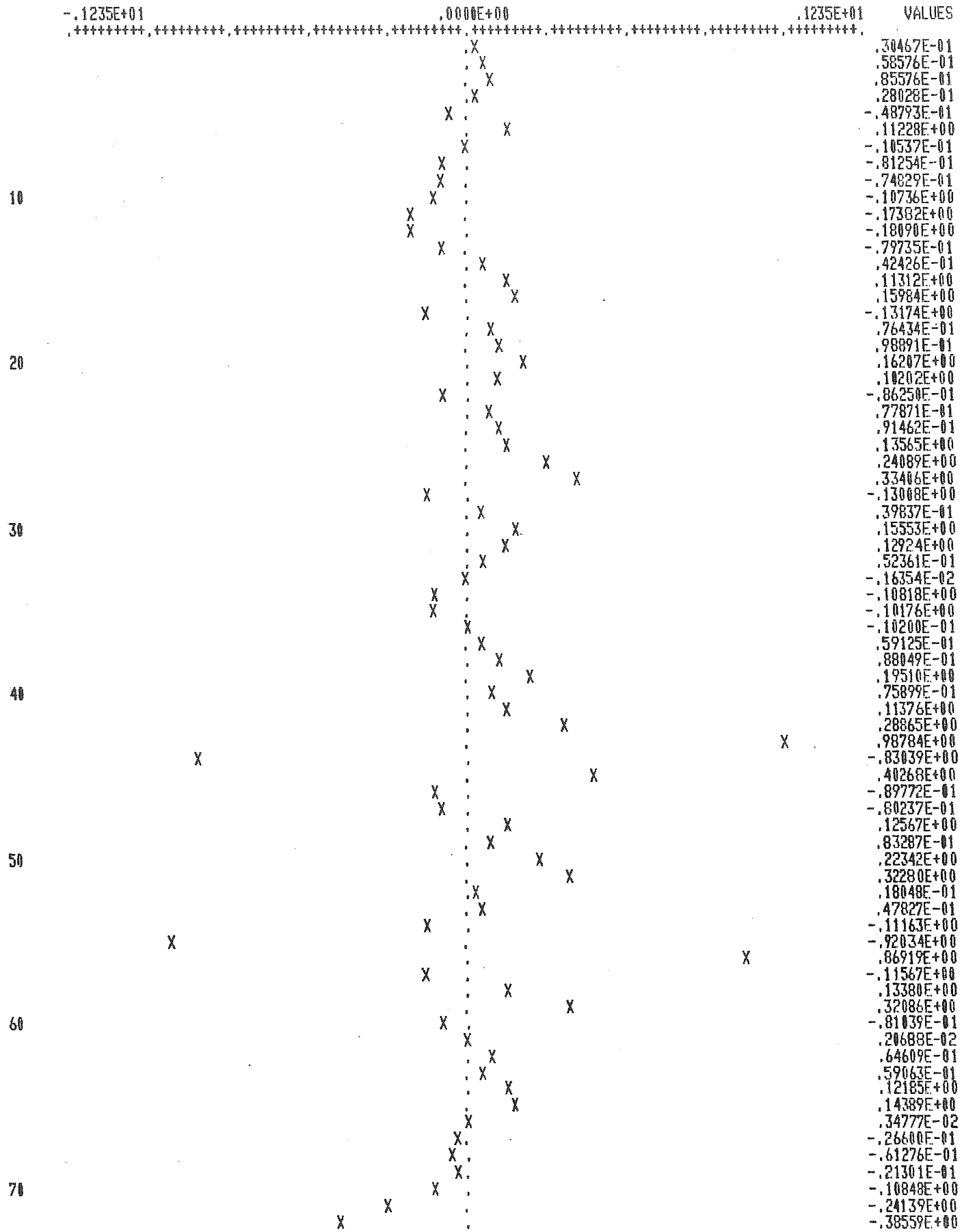
END OF ESTIMATION FOR MODEL 1

T	FITTED VALUE	RESIDUAL	DATA VALUE
1	-.1395E+00	.3047E-01	-.1090E+00
2	-.5858E-01	.5858E-01	.0000E+00
3	.9242E-01	.8558E-01	.1780E+00
4	.3110E+00	.2803E-01	.3390E+00
5	.4218E+00	-.4879E-01	.3730E+00
6	.3287E+00	.1123E+00	.4410E+00
7	.4715E+00	-.1054E-01	.4610E+00
8	.4293E+00	-.8125E-01	.3480E+00
9	.2018E+00	-.7483E-01	.1270E+00
10	-.7264E-01	-.1074E+00	-.1800E+00
11	-.4142E+00	-.1738E+00	-.5880E+00
12	-.8741E+00	-.1809E+00	-.1055E+01
13	-.1341E+01	-.7973E-01	-.1421E+01
14	-.1562E+01	.4243E-01	-.1520E+01
15	-.1415E+01	.1131E+00	-.1302E+01
16	-.9738E+00	.1598E+00	-.8140E+00
17	-.3433E+00	-.1317E+00	-.4750E+00
18	-.2694E+00	.7643E-01	-.1930E+00
19	-.1089E-01	.9889E-01	.8800E-01
20	.2729E+00	.1621E+00	.4350E+00
21	.6690E+00	.1020E+00	.7710E+00
22	.9523E+00	-.8625E-01	.8660E+00
23	.7971E+00	.7787E-01	.8750E+00
24	.7995E+00	.9146E-01	.8910E+00
25	.8513E+00	.1357E+00	.9870E+00
26	.1022E+01	.2409E+00	.1263E+01
27	.1441E+01	.3341E+00	.1775E+01
28	.2106E+01	-.1301E+00	.1976E+01
29	.1894E+01	.3984E-01	.1934E+01
30	.1710E+01	.1555E+00	.1866E+01
31	.1703E+01	.1292E+00	.1832E+01
32	.1715E+01	.5236E-01	.1767E+01
33	.1610E+01	-.1635E-02	.1608E+01
34	.1373E+01	-.1082E+00	.1265E+01
35	.8918E+00	-.1018E+00	.7900E+00
36	.3702E+00	-.1020E-01	.3600E+00
37	.5588E-01	.5912E-01	.1150E+00
38	-.4929E-04	.8805E-01	.8800E-01
39	.1359E+00	.1951E+00	.3310E+00
40	.5691E+00	.7590E-01	.6450E+00
41	.8462E+00	.1138E+00	.9600E+00
42	.1120E+01	.2886E+00	.1409E+01
43	.1682E+01	.9878E+00	.2670E+01
44	.3664E+01	-.8304E+00	.2834E+01
45	.2409E+01	.4027E+00	.2812E+01
46	.2573E+01	-.8977E-01	.2483E+01
47	.2009E+01	-.8024E-01	.1929E+01
48	.1359E+01	.1257E+00	.1485E+01
49	.1131E+01	.8329E-01	.1214E+01
50	.1016E+01	.2234E+00	.1239E+01
51	.1285E+01	.3228E+00	.1608E+01
52	.1887E+01	.1805E-01	.1905E+01
53	.1975E+01	.4783E-01	.2023E+01
54	.1927E+01	-.1116E+00	.1815E+01
55	.1455E+01	-.9203E+00	.5350E+00
56	-.7472E+00	.8692E+00	.1220E+00
57	.1247E+00	-.1157E+00	.9000E-02
58	.3020E-01	.1338E+00	.1640E+00
59	.3501E+00	.3209E+00	.6710E+00
60	.1100E+01	-.8104E-01	.1019E+01
61	.1144E+01	.2069E-02	.1146E+01
62	.1090E+01	.6461E-01	.1155E+01
63	.1053E+01	.5906E-01	.1112E+01
64	.9992E+00	.1218E+00	.1121E+01
65	.1079E+01	.1439E+00	.1223E+01
66	.1254E+01	.3478E-02	.1257E+01
67	.1184E+01	-.2660E-01	.1157E+01
68	.9743E+00	-.6128E-01	.9130E+00
69	.6413E+00	-.2130E-01	.6200E+00
70	.3635E+00	-.1085E+00	.2550E+00
71	-.3861E-01	-.2414E+00	-.2800E+00
72	-.6944E+00	-.3856E+00	-.1080E+01
73	-.1665E+01	.1138E+00	-.1551E+01
74	-.1679E+01	-.1197E+00	-.1799E+01
75	-.1796E+01	-.2876E-01	-.1825E+01
76	-.1668E+01	.2122E+00	-.1456E+01
77	-.9885E+00	.4451E-01	-.9440E+00

CODED TS017

GRAPH OF RESIDUALS FROM MODEL 1

GRAPH INTERVAL IS .2470E-01



AUTOCORRELATION FUNCTION

DATA - THE ESTIMATED RESIDUALS - MODEL 1 296 OBSERVATIONS

ORIGINAL SERIES
MEAN OF THE SERIES = .75621E-04
ST. DEV. OF SERIES = .18786E+00
NUMBER OF OBSERVATIONS = 296

1- 8	-.04	.07	.06	-.15	-.01	.06	.01	.00
ST.E.	.06	.06	.06	.06	.06	.06	.06	.06
9- 16	-.06	.04	.14	-.08	.10	.04	-.08	.02
ST.E.	.06	.06	.06	.06	.06	.06	.06	.06
17- 24	.07	-.05	-.08	.02	.01	.03	.04	.00
ST.E.	.06	.06	.06	.06	.06	.06	.06	.06

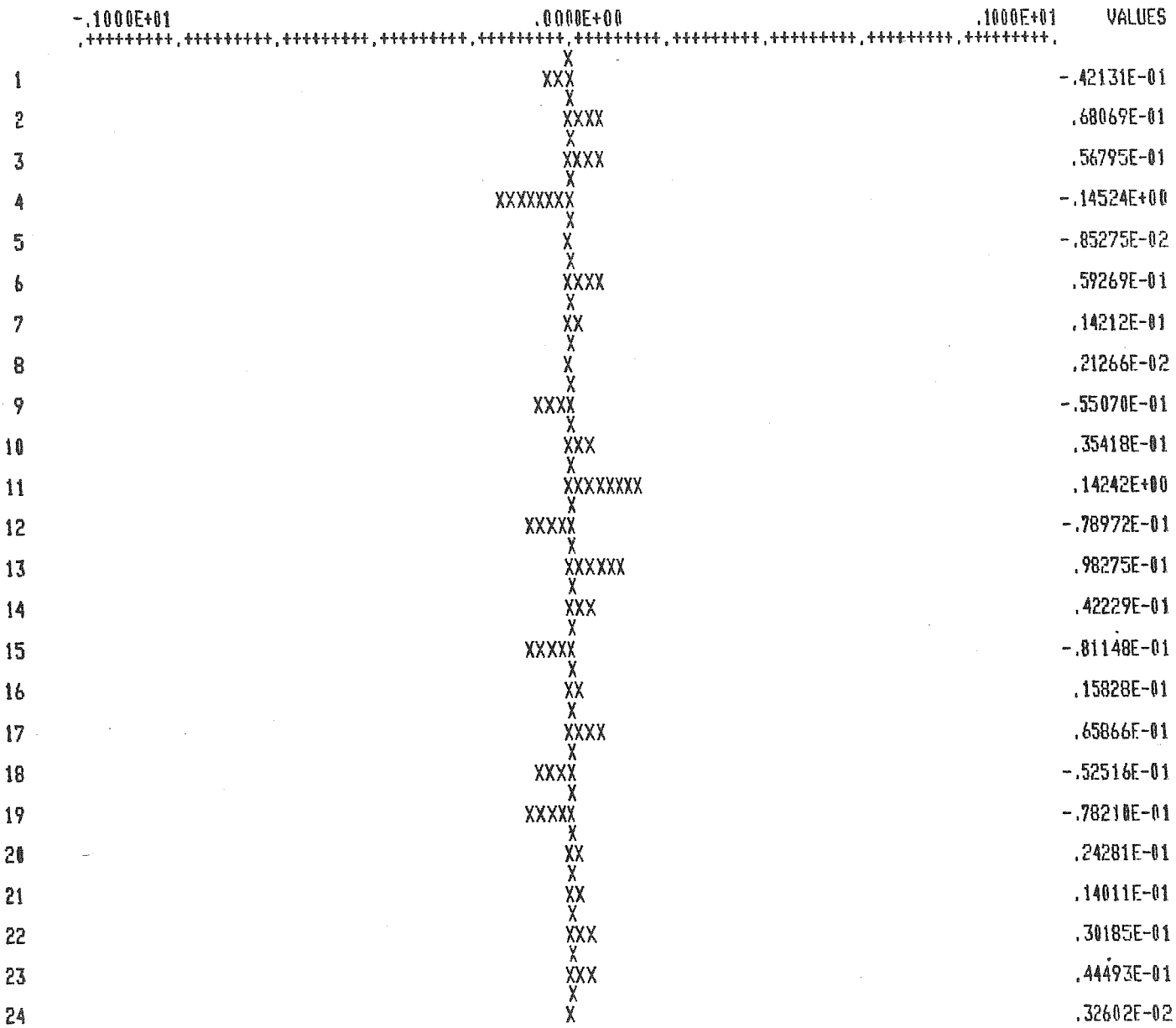
MEAN DIVIDED BY ST. ERROR = .69255E-02

TO TEST WHETHER THIS SERIES IS WHITE NOISE, THE VALUE .31048E+02
SHOULD BE COMPARED WITH A CHI-SQUARE VARIABLE WITH 20 DEGREES OF FREEDOM

THE ESTIMATED RESIDUALS - MODEL 1

GRAPH OF OBSERVED SERIES ACF

GRAPH INTERVAL IS .2000E-01



PARTIAL AUTOCORRELATIONS

DATA - THE ESTIMATED RESIDUALS - MODEL 1 296 OBSERVATIONS

ORIGINAL SERIES
MEAN OF THE SERIES = .75621E-04
ST. DEV. OF SERIES = .18786E+00
NUMBER OF OBSERVATIONS = 296

1- 8	-.04	.07	.06	-.15	-.03	.08	.04	-.03
9- 16	-.08	.05	.18	-.08	.03	.06	-.02	-.03
17- 24	.06	-.02	-.11	.02	.05	.03	.01	-.04

THE ESTIMATED RESIDUALS - MODEL 1

GRAPH OF OBSERVED SERIES PACF

GRAPH INTERVAL IS .2000E-01

```
                -.1000E+01                                  .0000E+00                                  .1000E+01     VALUES
                .+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.
 1                                                         XXX                                                  -.42131E-01
 2                                                          XXXX                                                 .66412E-01
 3                                                          XXXX                                                 .62658E-01
 4                                                       XXXXXXXX                                                -.14629E+00
 5                                                          XX                                                   -.28896E-01
 6                                                          XXXXX                                                .78647E-01
 7                                                          XXX                                                  .40321E-01
 8                                                          XX                                                   -.28141E-01
 9                                                       XXXXX                                                   -.76939E-01
10                                                          XXXX                                                 .52659E-01
11                                                          XXXXXXXXXX                                           .17888E+00
12                                                       XXXXX                                                   -.81517E-01
13                                                          XXX                                                  .31681E-01
14                                                          XXXX                                                 .62904E-01
15                                                          XX                                                   -.20209E-01
16                                                          XX                                                   -.29313E-01
17                                                          XXXX                                                 .63136E-01
18                                                          XX                                                   -.22853E-01
19                                                       XXXXXXX                                                 -.11166E+00
20                                                          XX                                                   .16836E-01
21                                                          XXXX                                                 .54028E-01
22                                                          XXX                                                  .30335E-01
23                                                          XX                                                   .10582E-01
24                                                          XXX                                                  -.43916E-01
```

II - UNIVARIATE TRANSFER FUNCTION MODEL

1 - MODEL STRUCTURE

The Univariate Transfer Function Model (Single Output - Single Input Model) can be written in its most general form as

$$y_t = \theta_0 + \prod_{i=1}^{NOL} \delta_i^{-1}(B) \prod_{j=1}^{NIL} \omega_j(B) x_{t-b} + N_t$$

The model consists of

1. a stationary output variable y_t, i.e. an appropriately transformed and differenced continuously fluctuating variable defined as

$$y_t = \begin{cases} \prod_{k=1}^{NDY} (1-B^{SY_k})^{dY_k} Y_t^{(\lambda Y)} & (NDY \neq 0) \\ Y_t^{(\lambda Y)} - \bar{Y}^{(\lambda Y)} & (NDY = 0) \end{cases}$$

where

$$Y_t^{(\lambda Y)} = \begin{cases} (Y_t + \text{scaling constant})^{\lambda Y} & (\lambda Y \neq 0) \\ \ln_e (Y_t + \text{scaling constant}) & (\lambda Y = 0) \end{cases}$$

$\bar{Y}^{(\lambda Y)}$ is the mean of $Y_t^{(\lambda Y)}$

and

NDY is the number of differencing factors for Y

SY_k is the order of the k^{th} differencing

dY_k is the number of differences of order SY_k

2. a single parameter θ_0 representing the possible presence of a deterministic trend over time

3. one or more input variables x_t. The Single Input Model can easily be generalized to a Multiple Input Model by adding one or more input variables to the general specification. Each of these inputs may be a continuously fluctuating variable or an intervention variable consisting of a sequence of steps or pulses. If the input is of the continuous type it can be defined as

$$x_t = \begin{cases} \prod_{l=1}^{NDX} (1-B)^{SX_l)^{dX_l}} X_t^{(\lambda X)} & (NDX \neq 0) \\ X_t^{(\lambda X)} - \bar{X}^{(\lambda X)} & (NDX = 0) \end{cases}$$

where

$$X_t^{(\lambda X)} = \begin{cases} (X_t + \text{scaling constant})^{\lambda X} & (\lambda X \neq 0) \\ \ln_e (X_t + \text{scaling constant}) & (\lambda X = 0) \end{cases}$$

$\bar{X}^{(\lambda X)}$ is the mean of $X_t^{(\lambda X)}$

and

NDX is the number of differencing factors for X

SX_l is the order of the l^{th} differencing

dX_l is the number of differences of order SX_l

4. a noise parameter N_t, which is not a random shock in the system but a modelable noise component that may be reduced to a random series or "white noise" by, apart from the transformation, a Univariate Stochastic Model.

The influence of each of the input variables on the output variable y_t is captured by

1. NOL autoregressive transfer function operators or output lag factors, the i^{th} factor given by a polynomial of degree R_i in the backward shift operator B, i.e.

   $$\delta_i(B) = (1-\delta_{i1}B - \delta_{i2}B^2 - \ldots - \delta_{iR_i}B^{R_i})$$

   and containing one or more autoregressive transfer function parameters δ_{im}.
   The output lag factor is so named because it can be seen as multiplying the output y_t.

2. NIL moving average transfer function operators or input lag factors, the j^{th} factor given by a polynomial of degree S_j in the backward shift operator B, i.e.

   $$\omega_j(B) = (\omega_{j0}-\omega_{j1}B-\omega_{j2}B^2 - \ldots - \omega_{jS_j}B^{S_j})$$

   and containing one or more moving average transfer function parameters ω_{jm}.
   The input lag factor is so named because it multiplies the input x_{t-b}.
   It should be noted that for $j > 1$, $\omega_{j0} = 1$ by definition.

3. a delay parameter b measuring the delay before a change in the input x begins to have an effect on the output y_t.

2 - PROGRAM INPUT STRUCTURE

For each input the original input number is mentioned. Additional inputs can easily be recognized since they all have been given the same number "00".

A "# " sign means that on displaying that particular input question this "# " sign will be replaced by a sequence number (number of time series, factor, parameter, ...).

A vertical accolade means that the indicated inputs form a sequence. If the necessary condition is satisfied this sequence will be repeated as many times as indicated.

2.1. Displayed Questions

GENERAL SPECIFICATION

```
INPUT 00
ENTER IPROG    : General Program Parameter.
                 = 0 STOP
                 = 1 Univariate Stochastic Model (USES-USFO)
                 = 2 Mult.Input Trans.Func.Model (MUTE-MUTF)

INPUT 00
ENTER IOUT     : Logical Unit Number Output Device.
                 = 1 Display
                 = 6 Printer

INPUT 00
ENTER LISIN    : Listing of Input Parameters.
                 = 0 No
                 = 1 Yes

INPUT 00
ENTER NMODEL   : Number of Models to be Estimated and/or Forecast.
```

INPUT 01
ENTER NSERIE : Number of Separate Time Series (NSERIE.LE.6).

INPUT 02
ENTER NOB : Number of Observations (NOB.LE.300).

INPUT 05
ENTER RNAM : Title of Time Series # (Max.48 Characters).

ENTER NAME of Datafile.

INPUT 00
ENTER FOB : First Obs.of time Series #.

INPUT 40
ENTER ILDEST : Listing of Time Series #.
= 0 No
= 1 Yes

INPUT 41
ENTER IPDEST : Plotting of Time Series #.
= 0 No
= 1 Yes

SPECIFICATION FOR THE OUTPUT SERIES

INPUT 06
ENTER NLAM : Data Transformation for the Output Series.
= 0 Analysis only for Original Output Series
= X Number of Values for Lambda

INPUT 07
ENTER TM : Mean Correction before Transformation.

INPUT 07
ENTER PLAM : Lambda for Transformation #.

INPUT 10
ENTER NDIFY : Number of Differencing Factors (NDIFY.LE.3).

INPUT 11
ENTER NDY : Number of Differences of Factor #.

INPUT 11
ENTER IODY : Order of Differences of Factor #.

INPUT 12
ENTER AVEPA : Final Estimate of the Mean.

SPECIFICATION OF THE NOISE MODEL

INPUT 08
ENTER MFAC2 : Number of Differencing Factors (MFAC2.LE.3).

INPUT 09
ENTER ND : Number of Differences of Factor #.

INPUT 09
ENTER IOD : Order of Differences of Factor #.

INPUT 08
ENTER MFAC1 : Number of AR-Factors (MFAC1.LE.(6-MFAC3)).

INPUT 13
ENTER INC : Number of Parameters in AR-Factor #.

INPUT 14
ENTER IOPA : Order of Param.# in AR-Factor #.

INPUT 15
ENTER UPA : Estimate of Param.# in AR-Factor #.

INPUT 08
ENTER MFAC3 : Number of MA-Factors (MFAC.3.LE.(6-MFAC1)).

INPUT 13
ENTER INC : Number of Parameters in MA-Factor #.

INPUT 14
ENTER IOPA : Order of Parameter # in MA-Factor #.

INPUT 15
ENTER UPA : Estimate of Param.# in MA-Factor #.

SPECIFICATION FOR THE TREND

INPUT 16
ENTER ITREND : Trend Parameter.
= 0 Model does not Contain a Trend
= 1 Model Contains a Trend

INPUT 17
ENTER TREPA : Estimate of the Trend Parameter.

SPECIFICATION OF TRANSF.FUNCTION #

INPUT 18
ENTER MFACT2 : Number of Differencing Factors (MFACT2.LE.3).

INPUT 19
ENTER NDX : Number of Differences of Factor #.

INPUT 19
ENTER IODX : Order of Differences of Factor #.

INPUT 18
ENTER MFACT1 : Number of Output Lag Factors (MFACT1.LE.(6-MFACT3)).

INPUT 20
ENTER JNC : Number of Param.in Output Factor #.

INPUT 21
ENTER JOPA : Order of Par.# in Output Factor #.

INPUT 22
ENTER TFPA : Esti.of Par.# in Output Factor #.

INPUT 18
ENTER MFACT3 : Number of Input Lag Factors (MFACT3.LE.(6-MFACT1)).

INPUT 20
ENTER JNC : Number of Param.in Input Factor #.

INPUT 21
ENTER JOPA : Order of Par.# in Input Factor #.

INPUT 22
ENTER TFPA : Esti.of Par.# in Input Factor #.

INPUT 23
ENTER IB : Time Lag of Input Series #.

PREWHITENING MODEL FOR INPUT SERIES #

INPUT 24
ENTER ISERCB : Specification of Input Series #.
= 0 Continuous Type
= 1 Binary Type (Denominator Differencing)
= 2 Binary Type (Numerator Differencing)

INPUT 25
ENTER TLAM : Exponent of Power Transformation (Lambda).
= 0.0 Natural Log Transformation
= 1.0 No Data Transformation
= X.X Exponent of Transformation

```
INPUT 25
ENTER TM      : Mean Correction before Transformation.
                = 0.0 No Correction of the Mean
                = X.X Amount Added to Series before Transform.

INPUT 26
ENTER MFAC2   : Number of Dif.Factors (MFAC2.LE.3).
                = 0 No Differencing
                = X Number of Differencing Types

INPUT 28
ENTER ND      : Number of Differences of Factor #.

INPUT 28
ENTER IOD     : Order of Differences of Factor #.

INPUT 27
ENTER AVEPA   : Final Estimate of the Mean.

INPUT 26
ENTER MFAC1   : Number of AR-Factors (MFAC1.LE.(6-MFAC3)).

INPUT 29
ENTER INC     : Number of Parameters in AR-Factor #.

INPUT 30
ENTER IOPA    : Order of Parameter  #  in AR-Factor #.

INPUT 31
ENTER UPA     : Estimate of Param.#  in AR-Factor #.

INPUT 26
ENTER MFAC3   : Number of MA-Factors (MFAC3.LE.(6-MFAC1)).
```

INPUT 29
ENTER INC : Number of Parameters in MA-Factor #.

INPUT 30
ENTER IOPA : Order of Parameter # in MA-Factor #.

INPUT 31
ENTER UPA : Estimate of Param.# in MA-Factor #.

INPUT 32
ENTER ITREND : Trend Parameter.
= 0 No
= 1 Yes

INPUT 33
ENTER TREPA : Estimate of Trend Parameter.

SPECIFICATION FOR PAR.TREATED AS CONSTANT MULTIPLE

INPUT 34
ENTER NMUPAR : Total Number of Parameters (NMUPAR.LE.10).

IDEN.OF REFERENCE PARAMETER #

INPUT 35
ENTER MUPAR1 : Input Number.

INPUT 35
ENTER MUPAR2 : Factor Number.

INPUT 35
ENTER MUPAR3 : Param.Number.

IDEN.OF PARAM. TO BE MULTIPLIED #

INPUT 35
ENTER MUPAR4 : Input Number.

INPUT 35
ENTER MUPAR5 : Factor Number.

INPUT 35
ENTER MUPAR6 : Param.Number.

INPUT 36
ENTER CONPAR : Constant Multiple.

SPECIFICATION FOR THE ESTIMATION PROCESS

INPUT 37
ENTER IWBF : Backforecasting Procedure.
= 0 No
= 1 Yes

INPUT 38
ENTER EPS1 : Relative Change in Residual Sum of Squares.

INPUT 38
ENTER EPS2 : Relative Change in each Individual Parameter.

INPUT 39
ENTER MIT : Maximum Number of Iterations.

SPECIFICATIONS FOR THE RESIDUALS

INPUT 39
ENTER IPRES : Plotting of the Residuals.
= 0 No
= 1 Yes

SPECIFICATION FOR THE AUTO CORR.FUNC.OF THE RESIDUALS

INPUT 42
ENTER NAC : Lag for Auto Corr.Function (NAC.LE.100).

INPUT 42
ENTER NPAC : Lag for Part.Auto Corr.Func.(NPAC.LE.NAC).

INPUT 42
ENTER NCHI : Chi-Square Statistic for Auto Corr.Function.
= 0 Suppress Statistic
= X Number of Terms to be Used (NCHI.LE.NAC)

INPUT42
ENTER MCSE : Standard Errors of Individual Auto Correlations.
= 0 No
= 1 Yes

INPUT 42
ENTER NAPL : Number of Auto Corr.per Line (NAPL.LE.12).

INPUT 42
ENTER IWTPA : Plotting of Auto Correlations.
= 0 No
= 1 Yes

SPECIFICATION FOR THE PREWH.CROSS CORR.FUNCTION

INPUT 43
ENTER NCC : Cross Corr.between Prewh.Input and Residuals.
= 0 No
= X Max.Lag (NCC.LE.54)

2.2. Conditions, Restrictions and Comments

00-IOUT : The program output can be displayed (IOUT = 1) or printed (IOUT = 6).

00-LISIN : Even when the program output is displayed (IOUT = 1) the inputted parameters can be printed (LISIN = 1).

00-NMODEL : Whatever the value of NMODEL may be, only one model can be estimated or forecasted at a time.
Restriction: NMODEL = 1.

01-NSERIE : Total number of variables, i.e. number of input series plus one. The variable on the last place will be considered as the output variable.
Restriction: $1 < NSERIE \leq 6$.

02-NOB : The analysis will be based on NOB observations.
Restriction: $NOB \leq 300$.

05-RNAM : The heading or running title may consist of any character; numerical, alphanumerical or special.
Restriction: Maximum number of characters is 48.

NAME : The only way to input time series data is through a datafile. The name of this datafile must be entered immediately after the message is displayed on the screen.
See Appendix I for details about the preparation of this datafile.

00-FOB : First observation of the datafile to take account of. The total number of observations on the datafile must be at least: FOB + NOB - 1.

05-RNAM
NAME
00-FOB
40-ILDEST
41-IPDEST

As many times as indicated by NSERIE
The input for the output variable comes on the last place.

06-NLAM : Number of values of the time series data transformation parameter lambda to be considered. For each of these NLAM lambda values the parameters of the specified model will be estimated and the sum of squared residuals calculated. These sum of squares, expressed in the same metric,are then compared. The program continues with that value for lambda for which the sum of squared residuals is minimum.
Restriction: $0 \leq NLAM \leq 7$.

07-TM : Number to be added to each time series observation prior to any data transformation.

07-PLAM : As many times as indicated by NLAM.
Value of transformation parameter lambda.
PLAM = 1.0 means no real transformation.
PLAM = 0.0 means natural log transformation.

10-NDIFY : Number of differencing factors.
Restriction: $0 \leq NDIFY \leq 3$.

11-NDY
11-IODY

Only if NDIFY $\neq 0$.
As many times as indicated by NDIFY.

12-AVEPA : Mean value of the time series.
If the output is a stationary series, the mean of the output series is one of the estimated parameters. If this is the case the mean value of the time series is a good initial estimate or starting value for the estimation process.

08-MFAC2 : Number of differencing factors.
In an intervention model one may wish to express the model in a form where the noise model contains differencing factors. See [2] for an illustration of this case.
The PACK2 computer program allows this option.
This computer program also allows this option in the transfer function environment, although historically, differencing in the noise model has not been used in this environment.
Restriction: $0 \leq MFAC2 \leq 3$.

09-ND
09-IOD
] Only if MFAC2 ≠ 0
As many times as indicated by MFAC2.

08-MFAC1 : Number of AR-factors.
Restriction: The total number of AR-and/or MA-factors must be less than or equal to six, i.e. $0 \leq MFAC1 + MFAC3 \leq 6$.

13-INC
14-IOPA
15-UPA
INC times
MFAC1 times

15-UPA : Initial value or starting value for AR-parameter.

08-MFAC3 : Number of MA-factors.
Restriction: The total number of MA- and/or AR-factors must be less than or equal to six, i.e. $0 \leq MFAC1 + MFAC3 \leq 6$

13-INC
14-IOPA
15-UPA
INC times
MFAC3 times

15-UPA : Initial value or starting value for MA-parameter.

17-TREPA : Only if ITREND = 1.
Initial value or starting value for the trend parameter.

18-MFACT2 : Number of differencing factors.
If the input series is a "regular" time series, i.e. a continuous fluctuating series, these differencing factors will be used to difference this input variable.
If the input series is an intervention variable , these differencing factors can be used
- to operate on the input series, i.e. they are considered to be in the numerator of the transfer function.
- to operate on the output lag factors (if any), i.e. they are considered to be in the denumerator of the transfer function. (See [2] for examples of this kind of structures).

See also INPUT 24 : ISERCB.
Restriction: $0 \leq$ MFACT2 ≤ 3.

19-NDX
19-IODX
] Only if MFACT2 $\neq 0$.
As many times as indicated by MFACT2.

18-MFACT1 : Number of output lag factors, i.e. number of factors in the AR-part of the transfer function.
Restriction: The total number of AR- and/or MA-factors in the transfer function must be less than or equal to six, i.e. $1 \leq$ MFACT1 + MFACT3 ≤ 6.

20-JNC
21-JOPA
22-TFPA
] JNC times
MFACT1 times.

22-TFPA : Initial value or starting value for output lag factor parameter.

18-MFACT3 : Number of input lag factors, i.e. number of factors in the MA-part of the transfer function.
Restriction: The total number of MA- and/or AR-factors in the transfer function must be less than or equal to six and
$1 \leq$ MFACT3, i.e. $1 \leq$ MFACT1 + MFACT3 ≤ 6.

20-JNC

21-JOPA] JNC times [MFACT3 times
22-TFPA

22-TFPA : Initial value or starting value for input lag factor parameter.

24-ISERCB : ISERCB = 0: The input series is a "regular" time series. The differencing factors (if any), entered by MFACT2 (see INPUT 18), will be used to difference the input variable.
ISERCB = 1 : The input series is an "intervention" variable. The differencing factors (if any), entered by MFACT2 (see INPUT 18), will be used to operate on the output lag factors.
ISERCB = 2 : The input series is an "intervention" variable. The differencing factors (if any), entered by MFACT2 (see INPUT 18), will be used to operate on the input series.
See also INPUT 18 : MFACT2.

26-MFAC2 : Number of differencing factors.
Restriction: $0 \leq$ MFAC2 ≤ 3.

28-ND] Only if MFAC2 $\neq 0$.
28-IOD] As many times as indicated by MFAC2.

27-AVEPA : Mean value of the input series.
If the input series is a stationary series the mean of the series is one of the parameters estimated by a USES program.

26-MFAC1 : Number of AR-factors.
Restriction: The total number of AR- and/or MA-factors must be less than or equal to six, i.e. $0 \leq MFAC1 + MFAC3 \leq 6$.

29-INC

30-IOPA] INC times
31-UPA]

] MFAC1 times

31-UPA : Estimated AR-parameter

26-MFAC3 : Number of MA-factors.
Restriction: The total number of MA- and/or AR-factors must be less than or equal to six, i.e. $0 \leq MFAC1 + MFAC3 \leq 6$.

29-INC

30-IOPA] INC times
31-UPA]

] MFAC3 times

31-UPA : Estimated MA-parameter.

33-TREPA : Only if ITREND = 1.
Estimate of trend parameter.

34-NMUPAR : If there is at least one intervention variable in the model, one may wish to specify that a parameter in one term is a constant multiple of the value of another parameter in the same term or another term.
NMUPAR indicates the number of times this can be done, i.e. the number of individual transfer function parameters (all inputs and both input and output lag factors considered) that will be treated as constant multiples of other transfer function parameters.
For each of these NMUPAR times one has to specify the two parameters involved (term or input numbers MUPAR1 and MUPAR4, factor numbers within the terms MUPAR2 and MUPAR5, parameter numbers within the factors MUPAR3 and MUPAR6) and the constant multiple CONPAR.
Output lag factors are considered to come before input lag factors.
Restriction: $0 \leq NMUPAR \leq 10$.

37-IWBF : The use of the backforecasting procedure in the estimation of the time series model parameters can be suppressed by entering IWBF = 0.
For the backforecasting procedure see [1],pp.215-220.

38-EPS1 : If the relative change in the residual sum of squares is less than EPS1, the iterative change in parameter values stops at the presumed optimum.

38-EPS2 : If the relative change in each individual parameter is less than EPS2, the iterative change in parameter values stops at the presumed optimum.

39-MIT : Whatever the values of EPS1 and EPS2 may be the maximum number of iterations to be allowed for the parameter estimation process is determined by MIT.

42-NAC : Restriction: NAC $\leq$ 100.
42-NPAC : Restriction: NPAC $\leq$ NAC.
42-NCHI : Restriction: NCHI $\leq$ NAC.
42-NAPL : Restriction: 1 $\leq$ NAPL $\leq$ 12.

43-NCC : Restriction: NCC $\leq$ 54.

3 - EXAMPLE 1 : CONTINUOUS INPUT

MULTIPLE INPUT TRANSFER FUNCTION ESTIMATION (MUTE)

```
00 GENERAL PROGRAM PARAMETER                IPROG  =        2
00 ESTIMATION-CHECKING STAGE                IEYON  =        1
00 FORECASTING STAGE                        IFYON  =        0

00 LOGICAL UNIT NUMBER OUTPUT DEVICE        IOUT   =        6
00 LISTING OF INPUT PARAMETERS              LISIN  =        1

00 NUMBER OF MODELS                         NMODEL =        1
01 NUMBER OF TIME SERIES                    NSERIE =        2
02 NUMBER OF OBSERVATIONS                   NOB    =      296


05 TIME SERIES 1 CODED   TS017

00 TIME SERIES 1 FIRST OBSERVATION          FOB    =        1

40 TIME SERIES 1 LISTING                    ILDEST =        0
41               PLOTTING                   IPDEST =        0

05 TIME SERIES 2 CO2CO   TS018

00 TIME SERIES 2 FIRST OBSERVATION          FOB    =        1

40 TIME SERIES 2 LISTING                    ILDEST =        0
41               PLOTTING                   IPDEST =        0
```

SPECIFICATION FOR MODEL 1

SPECIFICATION FOR THE OUTPUT SERIES

06 NUMBER OF VALUES FOR LAMBDA	NLAM	=	0
10 NUMBER OF DIFFERENCING FACTORS	NDIFY	=	0
12 FINAL ESTIMATE OF THE MEAN	AVEPA	=	.535100E+02

SPECIFICATION OF THE NOISE MODEL

08 NUMBER OF DIFFERENCING FACTORS	MFAC2	=	0
08 NUMBER OF AR-FACTORS	MFAC1	=	1
13 NUMBER OF PARAM. IN AR-FACTOR 1	INC	=	2
14 ORDER OF PAR. 1 AR-FACT. 1	IOPA	=	1
15 ESTI. OF PAR. 1 AR-FACT. 1	UPA	=	.100000E+01
14 ORDER OF PAR. 2 AR-FACT. 1	IOPA	=	2
15 ESTI. OF PAR. 2 AR-FACT. 1	UPA	=	-.500000E+00
08 NUMBER OF MA-FACTORS	MFAC3	=	0

SPECIFICATION OF THE TREND

16 TREND PARAMETER	ITREND	=	0

SPECIFICATION OF TRANSF. FUNCTION 1

18 NUMBER OF DIFFERENCING FACTORS	MFACT2	=	0
18 NUMBER OF OUTPUT LAG FACTORS	MFACT1	=	1
20 NUMBER OF PAR. IN OUTPUT FACTOR 1	JNC	=	1
21 ORDER OF PAR. 1 OUTP.FACT. 1	JOPA	=	1
22 ESTI. OF PAR. 1 OUTP.FACT. 1	TFPA	=	.500000E+00
18 NUMBER OF INPUT LAG FACTORS	MFACT3	=	1
20 NUMBER OF PAR. IN INPUT FACTOR 1	JNC	=	3
21 ORDER OF PAR. 1 INP. FACT. 1	JOPA	=	0
22 ESTI. OF PAR. 1 INP. FACT. 1	TFPA	=	-.500000E+00
21 ORDER OF PAR. 2 INP. FACT. 1	JOPA	=	1
22 ESTI. OF PAR. 2 INP. FACT. 1	TFPA	=	.500000E+00
21 ORDER OF PAR. 3 INP. FACT. 1	JOPA	=	2
22 ESTI. OF PAR. 3 INP. FACT. 1	TFPA	=	.500000E+00
23 TIME LAG OF INPUT SERIES 1	IB	=	3

PREWHITENING MODEL FOR INPUT SERIES 1

24 SPECIFICATION OF INPUT SERIES 1	ISERCB	=	0
25 TRANSFORMATION	TLAM	=	.100000E+01
25	TM	=	.000000E+00
26 NUMBER OF DIFFERENCING FACTORS	MFAC2	=	0
27 FINAL ESTIMATE OF THE MEAN	AVEPA	=	-.568300E-01
26 NUMBER OF AR-FACTORS	MFAC1	=	1
29 NUMBER OF PARAM. IN AR-FACTOR 1	INC	=	3
30 ORDER OF PAR. 1 AR-FACT. 1	IOPA	=	1
31 ESTI. OF PAR. 1 AR-FACT. 1	UPA	=	.197000E+01
30 ORDER OF PAR. 2 AR-FACT. 1	IOPA	=	2
31 ESTI. OF PAR. 2 AR-FACT. 1	UPA	=	-.137000E+01
30 ORDER OF PAR. 3 AR-FACT. 1	IOPA	=	3
31 ESTI. OF PAR. 3 AR-FACT. 1	UPA	=	.340000E+00
26 NUMBER OF MA-FACTORS	MFAC3	=	0
32 TREND PARAMETER	ITREND	=	0

SPECIFICATION FOR THE ESTIMATION PROCESS

37 BACKFORECASTING PROCEDURE	IWBF	=	1
38 REL. CHANGE IN RES. SUM OF SQUARES	EPS1	=	.000000E+00
38 REL. CHANGE IN EACH INDIVIDUAL PAR.	EPS2	=	.100000E-03
39 MAXIMUM NUMBER OF ITERATIONS	MIT	=	20

SPECIFICATION FOR THE RESIDUALS

39 PLOTTING OF THE RESIDUALS	IPRES	=	0

SPECIFICATION FOR ACF RESIDUALS

42 MAX. LAG IN CALC. AUTO CORR.	NAC	=	24
42 MAX. LAG IN CALC. PART. AUTO CORR.	NPAC	=	24
42 NUMBER OF AUTO CORR. CHI-SQ. STAT.	NCHI	=	24
42 STANDARD ERRORS FOR AUTO CORR.	NCSE	=	1
42 NUMBER OF AUTO CORR. PER LINE	NAPL	=	8
42 PLOTTING OF AUTO CORR.	IWTPA	=	1

SPECIFICATION FOR PREWH. CCF

43 MAX. LAG IN CALC. PREWH. CROSS CORR.	NCC	=	24

TIME SERIERS PARAMETER ESTIMATION FOR MODEL 1

****

DATA - Y = CO2CO TS018 296 OBSERVATIONS

DIFFERENCING ON Y - NONE

TRANSFORMATIONS EXAMINED - NONE

****

****

NOISE SERIES

DIFFERENCING ON NOISE - NONE

****

NOISE MODEL PARAMETERS

****

PARAMETER NUMBER	PARAMETER TYPE	PARAMETER ORDER	BEGINNING VALUE
1	MEAN		.53510E+02
2	AUTOREGRESSIVE 1	1	.10000E+01
3	AUTOREGRESSIVE 1	2	-.50000E+00

****

****

INPUT SERIES 1

DATA - X1 = CODED TS017

DIFFERENCING ON X1 - NONE (ASSUMED MEAN OF SERIES = -.56830E-01)

VALUE OF LAG PARAMETER IS 3

****

TRANSFER FUNCTION PARAMETERS

****

4	OUTPUT LAG 1	1	.50000E+00
5	INPUT LAG 1	0	-.50000E+00
6	INPUT LAG 1	1	.50000E+00
7	INPUT LAG 1	2	.50000E+00

****

INITIAL SUM OF SQUARES = .5172E+02

ITERATION NO. 1

TEST POINT PARAMETER VALUES

.5352E+02 .1485E+01 -.5855E+00 .5042E+00 -.5008E+00 .4585E+00 .5515E+00

TEST POINT SUM OF SQUARES = .1678E+02

PARAMETER VALUES VIA REGRESSION

1	2	3	4	5	6	7
.5352E+02	.1485E+01	-.5855E+00	.5042E+00	-.5008E+00	.4585E+00	.5515E+00

SUM OF SQUARES AFTER REGRESSION = .1677681E+02

TEST POINT PARAMETER VALUES

.5354E+02 .1533E+01 -.6336E+00 .5493E+00 -.5308E+00 .3798E+00 .5181E+00

TEST POINT SUM OF SQUARES = .1661E+02

PARAMETER VALUES VIA REGRESSION

1	2	3	4	5	6	7
.5354E+02	.1533E+01	-.6336E+00	.5493E+00	-.5308E+00	.3798E+00	.5181E+00

SUM OF SQUARES AFTER REGRESSION = .1661162E+02

ITERATION STOPS - RELATIVE CHANGE IN EACH PARAMETER LESS THAN .1000E-03

SUMMARY OF MODEL 1

DATA - Y = CO2CO TS018 296 OBSERVATIONS

DIFFERENCING ON Y - NONE

NOISE SERIES

DIFFERENCING ON NOISE - NONE

NOISE MODEL PARAMETERS

PARAMETER NUMBER	PARAMETER TYPE	PARAMETER ORDER	ESTIMATED VALUE	95 PER CENT LOWER LIMIT	95 PER CENT UPPER LIMIT
1	MEAN		.53539E+02	.53257E+02	.53821E+02
2	AUTOREGRESSIVE 1	1	.15327E+01	.14380E+01	.16275E+01
3	AUTOREGRESSIVE 1	2	-.63362E+00	-.73337E+00	-.53386E+00

INPUT SERIES 1

DATA - X1 = CODED TS017

DIFFERENCING ON X1 - NONE (ASSUMED MEAN OF SERIES = -.56830E-01)

VALUE OF LAG PARAMETER IS 3

TRANSFER FUNCTION PARAMETERS

4	OUTPUT LAG 1	1	.54926E+00	.47443E+00	.62408E+00
5	INPUT LAG 1	0	-.53077E+00	-.68010E+00	-.38145E+00
6	INPUT LAG 1	1	.37983E+00	.17456E+00	.58510E+00
7	INPUT LAG 1	2	.51814E+00	.30394E+00	.73234E+00

OTHER INFORMATION AND RESULTS

RESIDUAL SUM OF SQUARES	.16612E+02 284 D.F.	RESIDUAL MEAN SQUARE	.58492E-01
NUMBER OF RESIDUALS	291	RESIDUAL STANDARD ERROR	.24185E+00

CORRELATION MATRIX OF THE PARAMETERS

	1	2	3	4	5	6	7
1	1.0000						
2	-.0402	1.0000					
3	.0661	-.9267	1.0000				
4	-.0035	.0181	-.0247	1.0000			
5	.0036	-.0031	.0221	-.0092	1.0000		
6	.0004	.0048	-.0034	-.0339	.7129	1.0000	
7	.0015	-.0028	.0052	-.7177	-.1804	-.4724	1.0000

END OF ESTIMATION FOR MODEL 1.

T	FITTED VALUE	RESIDUAL	DATA VALUE
6	.5318E+02	-.7951E-01	.5310E+02
7	.5280E+02	-.1044E+00	.5270E+02
8	.5234E+02	.6394E-01	.5240E+02
9	.5214E+02	.5662E-01	.5220E+02
10	.5207E+02	-.7472E-01	.5200E+02
11	.5194E+02	.6273E-01	.5200E+02
12	.5218E+02	.2234E+00	.5240E+02
13	.5294E+02	.6186E-01	.5300E+02
14	.5376E+02	.2397E+00	.5400E+02
15	.5507E+02	-.1679E+00	.5490E+02
16	.5590E+02	.9574E-01	.5600E+02
17	.5697E+02	-.1657E+00	.5680E+02
18	.5728E+02	-.4815E+00	.5680E+02
19	.5647E+02	-.7062E-01	.5640E+02
20	.5573E+02	-.2827E-01	.5570E+02
21	.5486E+02	.1445E+00	.5500E+02
22	.5428E+02	.2381E-01	.5430E+02
23	.5356E+02	-.3627E+00	.5320E+02
24	.5221E+02	.8560E-01	.5230E+02
25	.5154E+02	.6237E-01	.5160E+02
26	.5108E+02	.1172E+00	.5120E+02
27	.5098E+02	-.1812E+00	.5080E+02
28	.5055E+02	-.5462E-01	.5050E+02
29	.5018E+02	-.1761E+00	.5000E+02
30	.4933E+02	-.1330E+00	.4920E+02
31	.4837E+02	.3490E-01	.4840E+02
32	.4771E+02	.1950E+00	.4790E+02
33	.4763E+02	-.3400E-01	.4760E+02
34	.4754E+02	-.3764E-01	.4750E+02
35	.4755E+02	-.4912E-01	.4750E+02
36	.4764E+02	-.4017E-01	.4760E+02
37	.4794E+02	.1570E+00	.4810E+02
38	.4885E+02	.1501E+00	.4900E+02
39	.5007E+02	-.7354E-01	.5000E+02
40	.5106E+02	.4035E-01	.5110E+02
41	.5200E+02	-.1998E+00	.5180E+02
42	.5216E+02	-.2581E+00	.5190E+02
43	.5170E+02	.3538E-04	.5170E+02
44	.5121E+02	-.6150E-02	.5120E+02
45	.5045E+02	-.4546E+00	.5000E+02
46	.4840E+02	-.1044E+00	.4830E+02
47	.4668E+02	.3219E+00	.4700E+02
48	.4571E+02	.8741E-01	.4580E+02
49	.4534E+02	.2595E+00	.4560E+02
50	.4598E+02	.1811E-01	.4600E+02
51	.4684E+02	.5632E-01	.4690E+02
52	.4796E+02	-.1639E+00	.4780E+02
53	.4856E+02	-.3614E+00	.4820E+02
54	.4831E+02	-.1285E-01	.4830E+02
55	.4804E+02	-.1440E+00	.4790E+02
56	.4734E+02	-.1434E+00	.4720E+02
57	.4679E+02	.4126E+00	.4720E+02
58	.4798E+02	.1240E+00	.4810E+02
59	.4945E+02	-.5317E-01	.4940E+02
60	.5100E+02	-.4046E+00	.5060E+02
61	.5143E+02	.6788E-01	.5150E+02
62	.5175E+02	-.1488E+00	.5160E+02
63	.5123E+02	-.3165E-01	.5120E+02
64	.5057E+02	-.6856E-01	.5050E+02
65	.4994E+02	.1582E+00	.5010E+02
66	.4990E+02	-.9630E-01	.4980E+02
67	.4969E+02	-.8829E-01	.4960E+02
68	.4950E+02	-.9567E-01	.4940E+02
69	.4927E+02	.2900E-01	.4930E+02
70	.4928E+02	-.7899E-01	.4920E+02
71	.4934E+02	-.3840E-01	.4930E+02
72	.4970E+02	.6530E-03	.4970E+02
73	.5039E+02	-.9487E-01	.5030E+02
74	.5124E+02	.5560E-01	.5130E+02
75	.5271E+02	.9247E-01	.5280E+02
76	.5449E+02	-.8646E-01	.5440E+02
77	.5602E+02	-.1960E-01	.5600E+02
78	.5724E+02	-.3426E+00	.5690E+02
79	.5735E+02	.1478E+00	.5750E+02
80	.5747E+02	-.1737E+00	.5730E+02
81	.5665E+02	-.5192E-01	.5660E+02
82	.5579E+02	.2067E+00	.5600E+02

AUTOCORRELATION FUNCTION

DATA - THE ESTIMATED RESIDUALS - MODEL 1 291 OBSERVATIONS

ORIGINAL SERIES
MEAN OF THE SERIES = .49831E-03
ST. DEV. OF SERIES = .23892E+00
NUMBER OF OBSERVATIONS = 291

1- 8	.02	.06	-.07	-.05	-.06	.12	.03	.03
ST.E.	.06	.06	.06	.06	.06	.06	.06	.06
9- 16	-.08	.05	.02	.10	-.04	.05	-.09	-.01
ST.E.	.06	.06	.06	.06	.06	.06	.06	.06
17- 24	-.08	-.00	-.12	.00	-.01	.08	.02	-.01
ST.E.	.06	.06	.06	.06	.06	.06	.06	.06

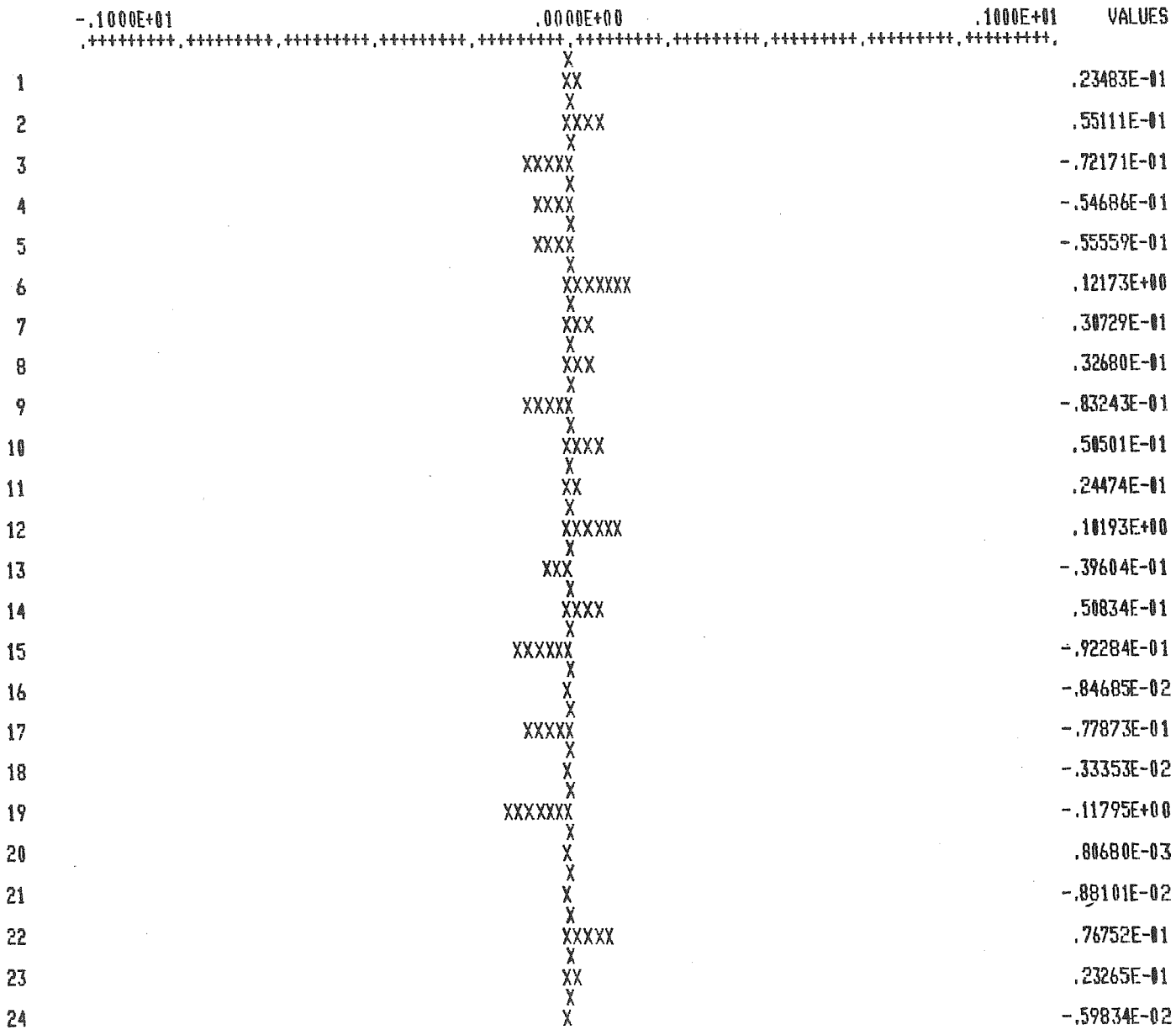
MEAN DIVIDED BY ST. ERROR = .35578E-01

TO TEST WHETHER THIS SERIES IS WHITE NOISE, THE VALUE .27930E+02
SHOULD BE COMPARED WITH A CHI-SQUARE VARIABLE WITH 21 DEGREES OF FREEDOM

THE ESTIMATED RESIDUALS - MODEL 1

GRAPH OF OBSERVED SERIES ACF

GRAPH INTERVAL IS .2000E-01



PARTIAL AUTOCORRELATIONS

DATA - THE ESTIMATED RESIDUALS - MODEL 1 291 OBSERVATIONS

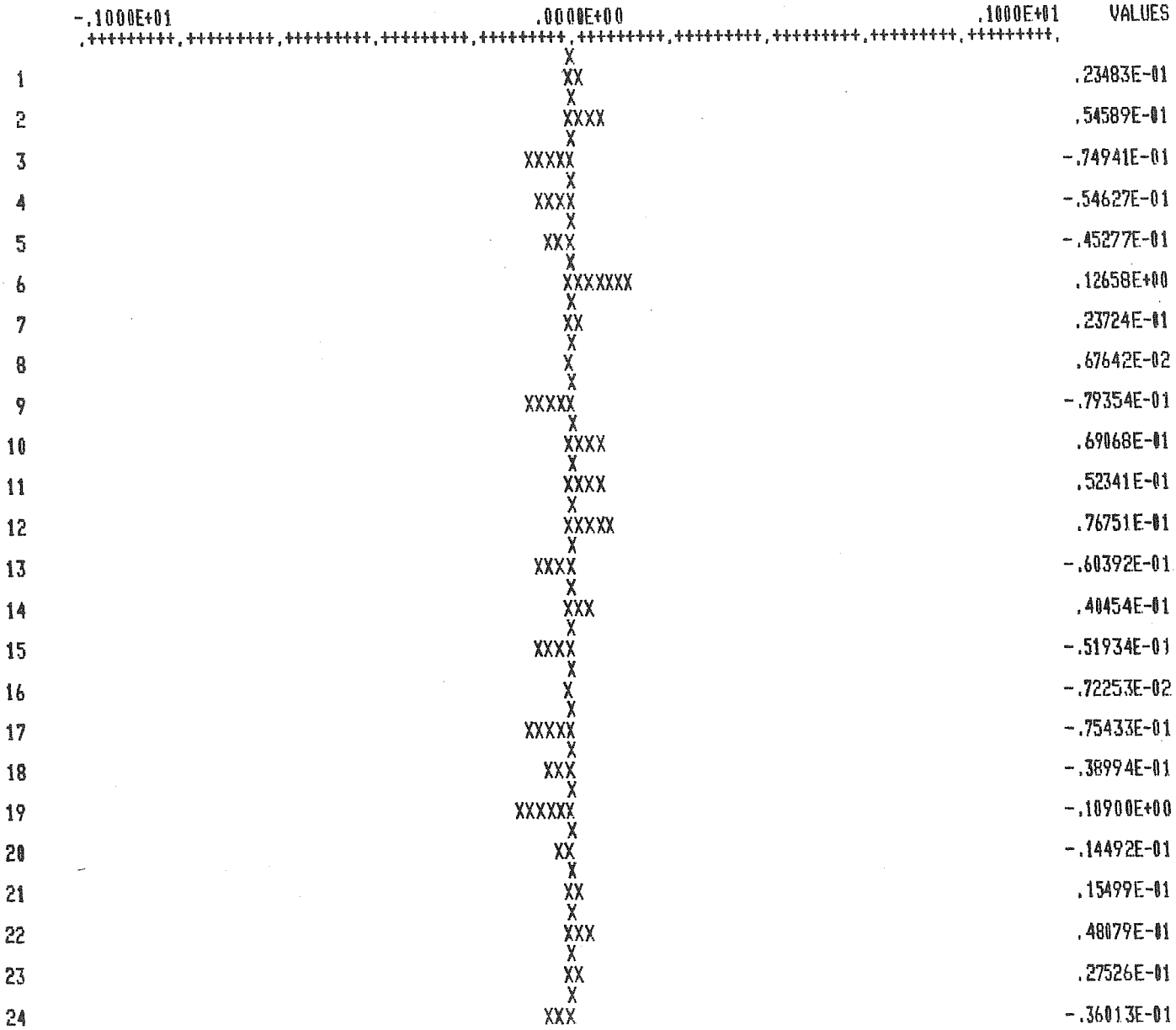
ORIGINAL SERIES
MEAN OF THE SERIES = .49831E-03
ST. DEV. OF SERIES = .23892E+00
NUMBER OF OBSERVATIONS = 291

1- 8	.02	.05	-.07	-.05	-.05	.13	.02	.01
9- 16	-.08	.07	.05	.08	-.06	.04	-.05	-.01
17- 24	-.08	-.04	-.11	-.01	.02	.05	.03	-.04

THE ESTIMATED RESIDUALS - MODEL 1

GRAPH OF OBSERVED SERIES PACF

GRAPH INTERVAL IS .2000E-01



CROSS CORRELATIONS

SERIES 1 - THE ESTIMATED RESIDUALS - MODEL
SERIES 2 - THE ESTIMATED RESIDUALS - MODEL

MEAN OF SERIES 1 = -.61508E-03
ST. DEV. OF SERIES 1 = .18938E+00
MEAN OF SERIES 2 = .16912E-02
ST. DEV. OF SERIES 2 = .25851E+00

NUMBER OF LAGS ON SERIES 1	CROSS CORRELATION	NUMBER OF LAGS ON SERIES 2	CROSS CORRELATION
0	-.034	0	-.034
1	.045	1	-.059
2	-.028	2	.048
3	.008	3	-.038
4	.002	4	-.014
5	.008	5	.038
6	.005	6	-.090
7	-.042	7	.031
8	.048	8	-.043
9	.056	9	.022
10	-.052	10	.047
11	-.003	11	.003
12	-.016	12	-.019
13	-.091	13	.004
14	.051	14	-.015
15	.028	15	.012
16	.012	16	-.037
17	-.005	17	-.030
18	.009	18	-.017
19	-.133	19	.091
20	.033	20	-.069
21	-.065	21	.053
22	-.049	22	-.045
23	.045	23	-.043
24	-.033	24	-.060

CROSS CORRELATIONS

SERIES 1 - PREWHITENED CODED TS017
SERIES 2 - THE ESTIMATED RESIDUALS - MODEL

MEAN OF SERIES 1 = -.61508E-03
ST. DEV. OF SERIES 1 = .18938E+00
MEAN OF SERIES 2 = .49831E-03
ST. DEV. OF SERIES 2 = .23892E+00

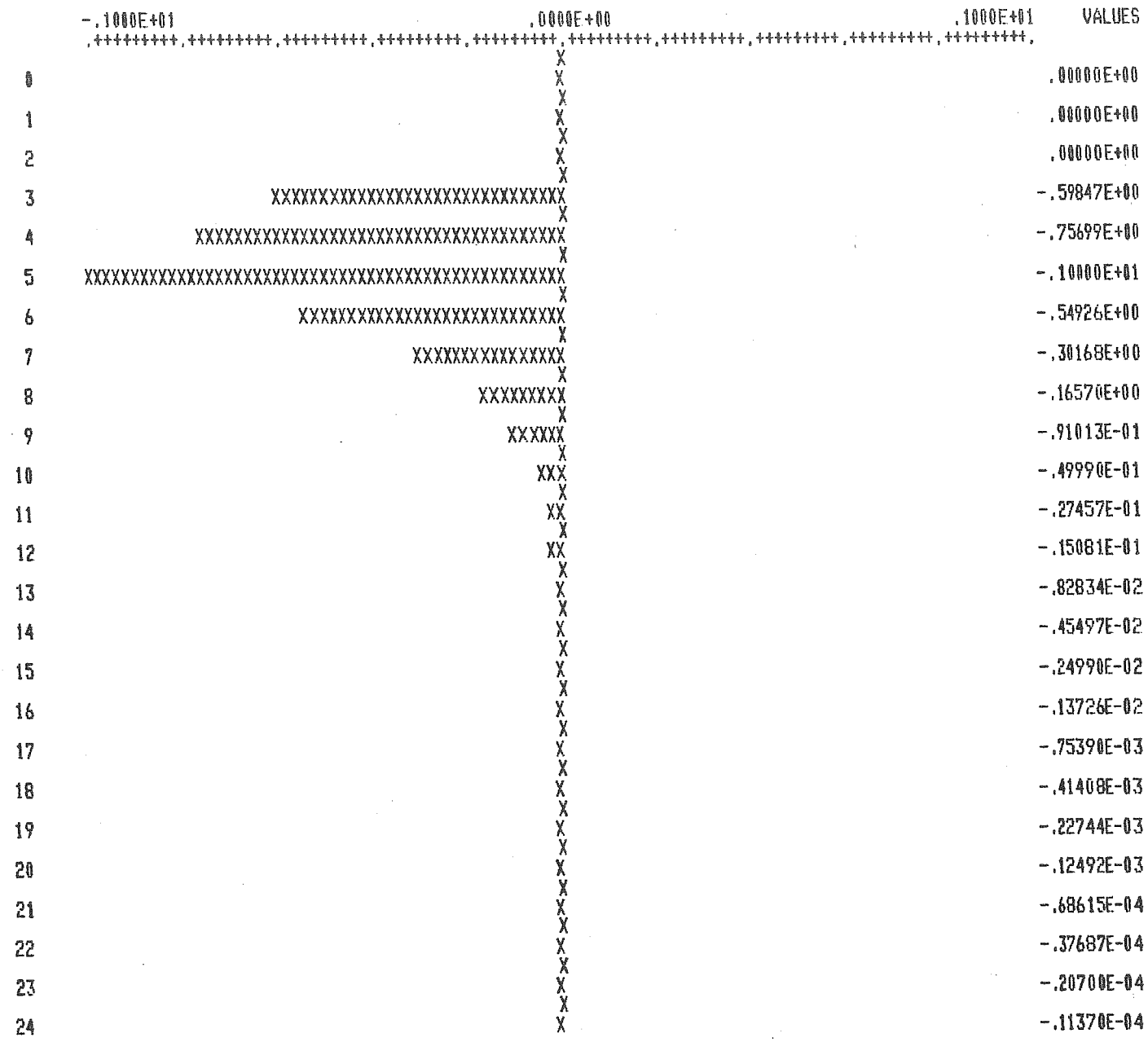
NUMBER OF LAGS ON SERIES 1	CROSS CORRELATION	NUMBER OF LAGS ON SERIES 2	CROSS CORRELATION
0	-.057	0	-.057
1	.024	1	-.044
2	-.014	2	.036
3	.003	3	-.042
4	.003	4	-.011
5	.009	5	-.001
6	.008	6	-.093
7	-.045	7	.014
8	.030	8	-.032
9	.074	9	.045
10	-.026	10	.049
11	-.020	11	-.005
12	-.028	12	-.020
13	-.112	13	-.003
14	.010	14	-.021
15	.047	15	-.014
16	.039	16	-.056
17	.011	17	-.026
18	.011	18	.021
19	-.142	19	.078
20	-.029	20	-.054
21	-.075	21	.028
22	-.078	22	-.080
23	.021	23	-.076
24	-.018	24	-.056

INPUT SERIES 1
****

LAG	MODEL IMPLIED IMPULSE RESPONSE WEIGHTS	ESTIMATED CORRECT IMPULSE RESPONSE WEIGHTS	DIFFERENCE
0	.000000E+00	-.250987E-01	-.250987E-01
1	.000000E+00	.329034E-01	.329034E-01
2	.000000E+00	-.202686E-01	-.202686E-01
3	-.530775E+00	-.524769E+00	.600568E-02
4	-.671364E+00	-.669805E+00	.155877E-02
5	-.886889E+00	-.881006E+00	.588303E-02
6	-.487130E+00	-.483612E+00	.351852E-02
7	-.267560E+00	-.298291E+00	-.307310E-01
8	-.146959E+00	-.112159E+00	.348003E-01
9	-.807185E-01	-.396194E-01	.410992E-01
10	-.443353E-01	-.821471E-01	-.378118E-01
11	-.243515E-01	-.262287E-01	-.187721E-02
12	-.133752E-01	-.248654E-01	-.114902E-01
13	-.734645E-02	-.743379E-01	-.669914E-01
14	-.403509E-02	.331355E-01	.371705E-01
15	-.221630E-02	.185688E-01	.207851E-01
16	-.121732E-02	.759796E-02	.881528E-02
17	-.668623E-03	-.403043E-02	-.336181E-02
18	-.367246E-03	.643425E-02	.680149E-02
19	-.201713E-03	-.973116E-01	-.971099E-01
20	-.110792E-03	.242020E-01	.243128E-01
21	-.608535E-04	-.473576E-01	-.472968E-01
22	-.334242E-04	-.360589E-01	-.360255E-01
23	-.183585E-04	.329089E-01	.329273E-01
24	-.100835E-04	-.240307E-01	-.240206E-01

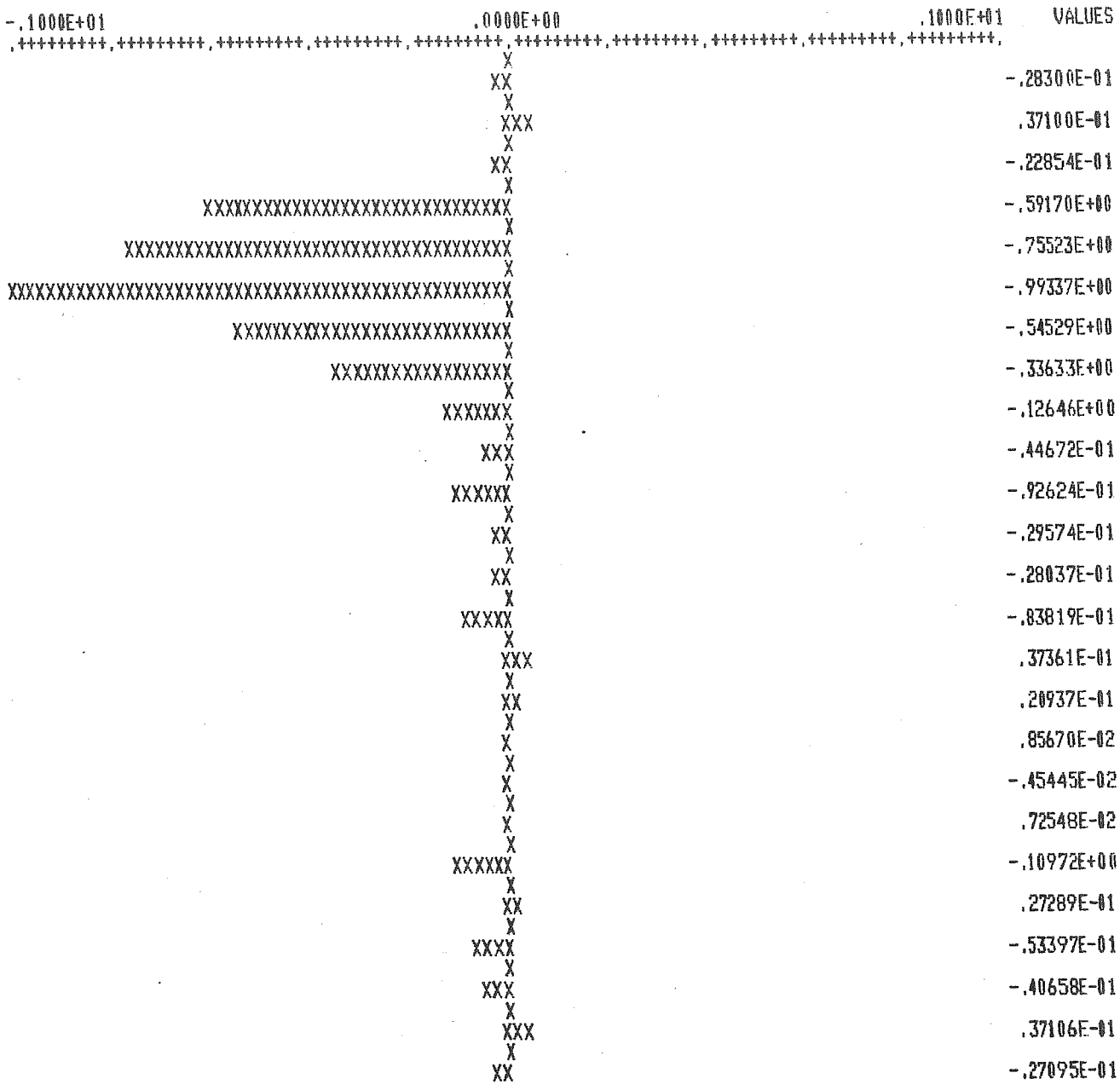
GRAPH OF MODEL IMPLIED WEIGHTS

GRAPH INTERVAL IS .2000E-01



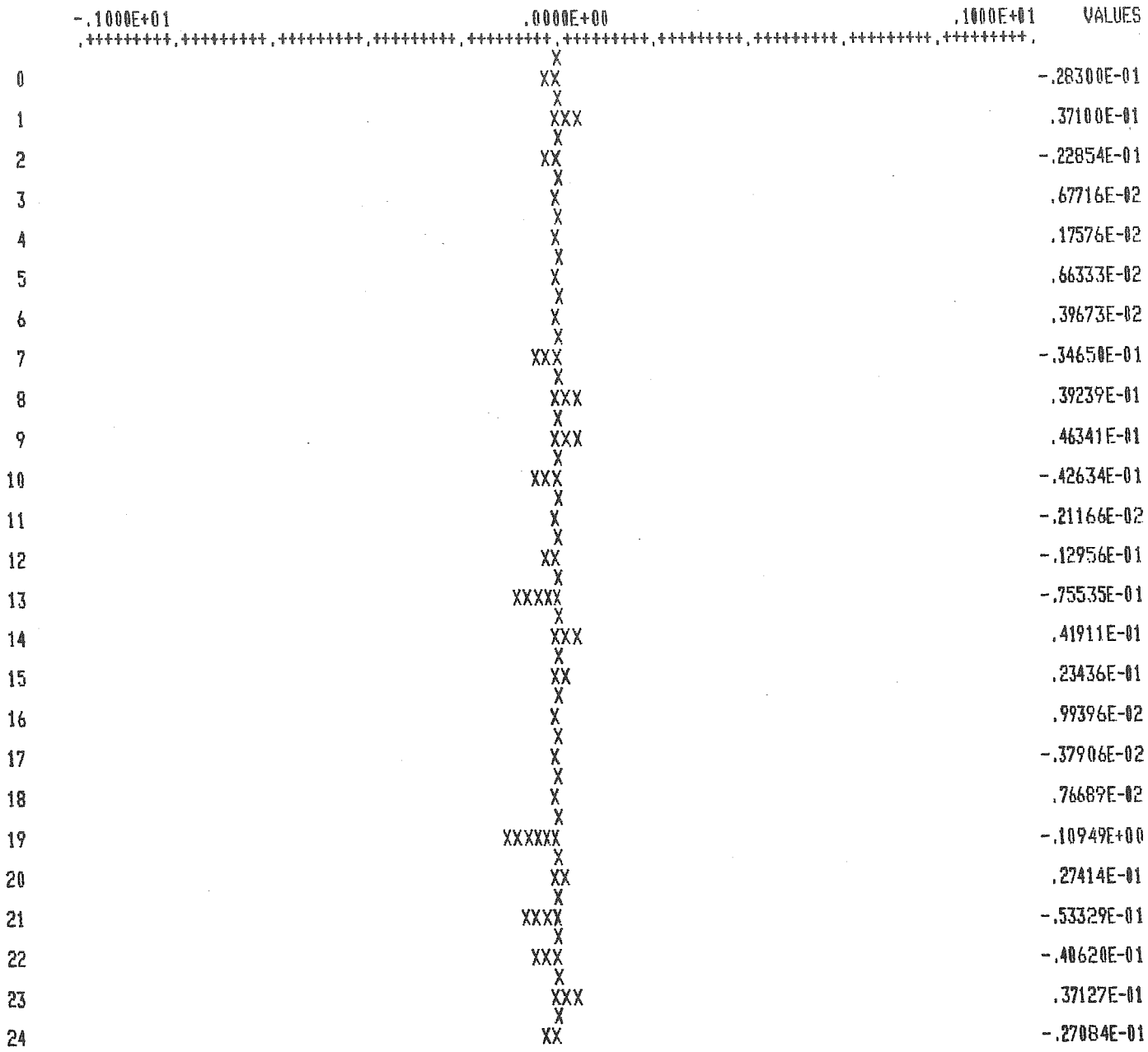
GRAPH OF ESTIMATED CORRECT WGHTS.

GRAPH INTERVAL IS .2000E-01



GRAPH OF WEIGHT DIFFERENCE

GRAPH INTERVAL IS .2000E-01



4 - EXAMPLE 2 : INTERVENTION ANALYSIS & CONSTRAINED ESTIMATION

MULTIPLE INPUT TRANSFER FUNCTION ESTIMATION (MUTE)

00	GENERAL PROGRAM PARAMETER	IPROG =	2
00	ESTIMATION-CHECKING STAGE	IEYON =	1
00	FORECASTING STAGE	IFYON =	0
00	LOGICAL UNIT NUMBER OUTPUT DEVICE	IOUT =	6
00	LISTING OF INPUT PARAMETERS	LISIN =	1
00	NUMBER OF MODELS	NMODEL =	1
01	NUMBER OF TIME SERIES	NSERIE =	3
02	NUMBER OF OBSERVATIONS	NOB =	36

05 TIME SERIES 1 OWN PROM. (DMBA4)

00	TIME SERIES 1 FIRST OBSERVATION	FOB =	1
40	TIME SERIES 1 LISTING	ILDEST =	1
41	PLOTTING	IPDEST =	1

05 TIME SERIES 2 COMP. PROM. (DMBA5)

00	TIME SERIES 2 FIRST OBSERVATION	FOB =	1
40	TIME SERIES 2 LISTING	ILDEST =	1
41	PLOTTING	IPDEST =	1

05 TIME SERIES 3 PLANTA SALES (DMBA1)

00	TIME SERIES 3 FIRST OBSERVATION	FOB =	1
40	TIME SERIES 3 LISTING	ILDEST =	1
41	PLOTTING	IPDEST =	1

SPECIFICATION FOR MODEL 1

SPECIFICATION FOR THE OUTPUT SERIES

06 NUMBER OF VALUES FOR LAMBDA	NLAM	=	0
10 NUMBER OF DIFFERENCING FACTORS	NDIFY	=	0
12 FINAL ESTIMATE OF THE MEAN	AVEPA	=	.559440E+01

SPECIFICATION OF THE NOISE MODEL

08 NUMBER OF DIFFERENCING FACTORS	MFAC2	=	2
09 NUMBER OF DIFFERENCES OF FACTOR 1	ND	=	1
09 ORDER OF DIFFERENCES OF FACTOR 1	IOD	=	1
09 NUMBER OF DIFFERENCES OF FACTOR 2	ND	=	1
09 ORDER OF DIFFERENCES OF FACTOR 2	IOD	=	12
08 NUMBER OF AR-FACTORS	MFAC1	=	1
13 NUMBER OF PARAM. IN AR-FACTOR 1	INC	=	2
14 ORDER OF PAR. 1 AR-FACT. 1	IOPA	=	1
15 ESTI. OF PAR. 1 AR-FACT. 1	UPA	=	-.300000E+00
14 ORDER OF PAR. 2 AR-FACT. 1	IOPA	=	2
15 ESTI. OF PAR. 2 AR-FACT. 1	UPA	=	-.300000E+00
08 NUMBER OF MA-FACTORS	MFAC3	=	1
13 NUMBER OF PARAM. IN MA-FACTOR 1	INC	=	1
14 ORDER OF PAR. 1 MA-FACT. 1	IOPA	=	12
15 ESTI. OF PAR. 1 MA-FACT. 1	UPA	=	.300000E+00

SPECIFICATION OF THE TREND

16 TREND PARAMETER	ITREND	=	0

SPECIFICATION OF TRANSF. FUNCTION 1

18 NUMBER OF DIFFERENCING FACTORS	MFACT2 =	0
18 NUMBER OF OUTPUT LAG FACTORS	MFACT1 =	0
18 NUMBER OF INPUT LAG FACTORS	MFACT3 =	1
20 NUMBER OF PAR. IN INPUT FACTOR 1	JNC =	2
21 ORDER OF PAR. 1 INP. FACT. 1	JOPA =	0
22 ESTI. OF PAR. 1 INP. FACT. 1	TFPA =	.300000E+00
21 ORDER OF PAR. 2 INP. FACT. 1	JOPA =	1
22 ESTI. OF PAR. 2 INP. FACT. 1	TFPA =	-.300000E+00
23 TIME LAG OF INPUT SERIES 1	IB =	0

SPECIFICATION OF TRANSF. FUNCTION 2

18 NUMBER OF DIFFERENCING FACTORS	MFACT2 =	0
18 NUMBER OF OUTPUT LAG FACTORS	MFACT1 =	0
18 NUMBER OF INPUT LAG FACTORS	MFACT3 =	1
20 NUMBER OF PAR. IN INPUT FACTOR 1	JNC =	1
21 ORDER OF PAR. 1 INP. FACT. 1	JOPA =	0
22 ESTI. OF PAR. 1 INP. FACT. 1	TFPA =	-.300000E+00
23 TIME LAG OF INPUT SERIES 2	IB =	0

PREWHITENING MODEL FOR INPUT SERIES 1

24 SPECIFICATION OF INPUT SERIES 1	ISERCB =	1

PREWHITENING MODEL FOR INPUT SERIES 2

24 SPECIFICATION OF INPUT SERIES 2	ISERCB =	1

SPECIFICATION FOR PAR. TREATED AS CONST. MULT.

34 TOTAL NUMBER OF PARAMETERS	NMUPAR =	1

IDENTIFICATION OF PAR. TO BE MULT. 1

35 INPUT NUMBER	MUPAR1 =	1
35 FACTOR NUMBER	MUPAR2 =	1
35 PARAM. NUMBER	MUPAR3 =	1

IDENTIFICATION OF REFERENCE PARAM. 1

35 INPUT NUMBER	MUPAR4 =	2
35 FACTOR NUMBER	MUPAR5 =	1
35 PARAM. NUMBER	MUPAR6 =	1
36 CONSTANT MULTIPLE	CONPAR =	-.100000E+01

SPECIFICATION FOR THE ESTIMATION PROCESS

37 BACKFORECASTING PROCEDURE	IWBF	=	1
38 REL. CHANGE IN RES. SUM OF SQUARES	EPS1	=	.000000E+00
38 REL. CHANGE IN EACH INDIVIDUAL PAR.	EPS2	=	.100000E-03
39 MAXIMUM NUMBER OF ITERATIONS	MIT	=	20

SPECIFICATION FOR THE RESIDUALS

39 PLOTTING OF THE RESIDUALS	IPRES	=	1

SPECIFICATION FOR ACF RESIDUALS

42 MAX. LAG IN CALC. AUTO CORR.	NAC	=	18
42 MAX. LAG IN CALC. PART. AUTO CORR.	NPAC	=	18
42 NUMBER OF AUTO CORR. CHI-SQ. STAT.	NCHI	=	18
42 STANDARD ERRORS FOR AUTO CORR.	MCSE	=	1
42 NUMBER OF AUTO CORR. PER LINE	NAPL	=	12
42 PLOTTING OF AUTO CORR.	IWTPA	=	1

OWN PROM. (DMBA4)

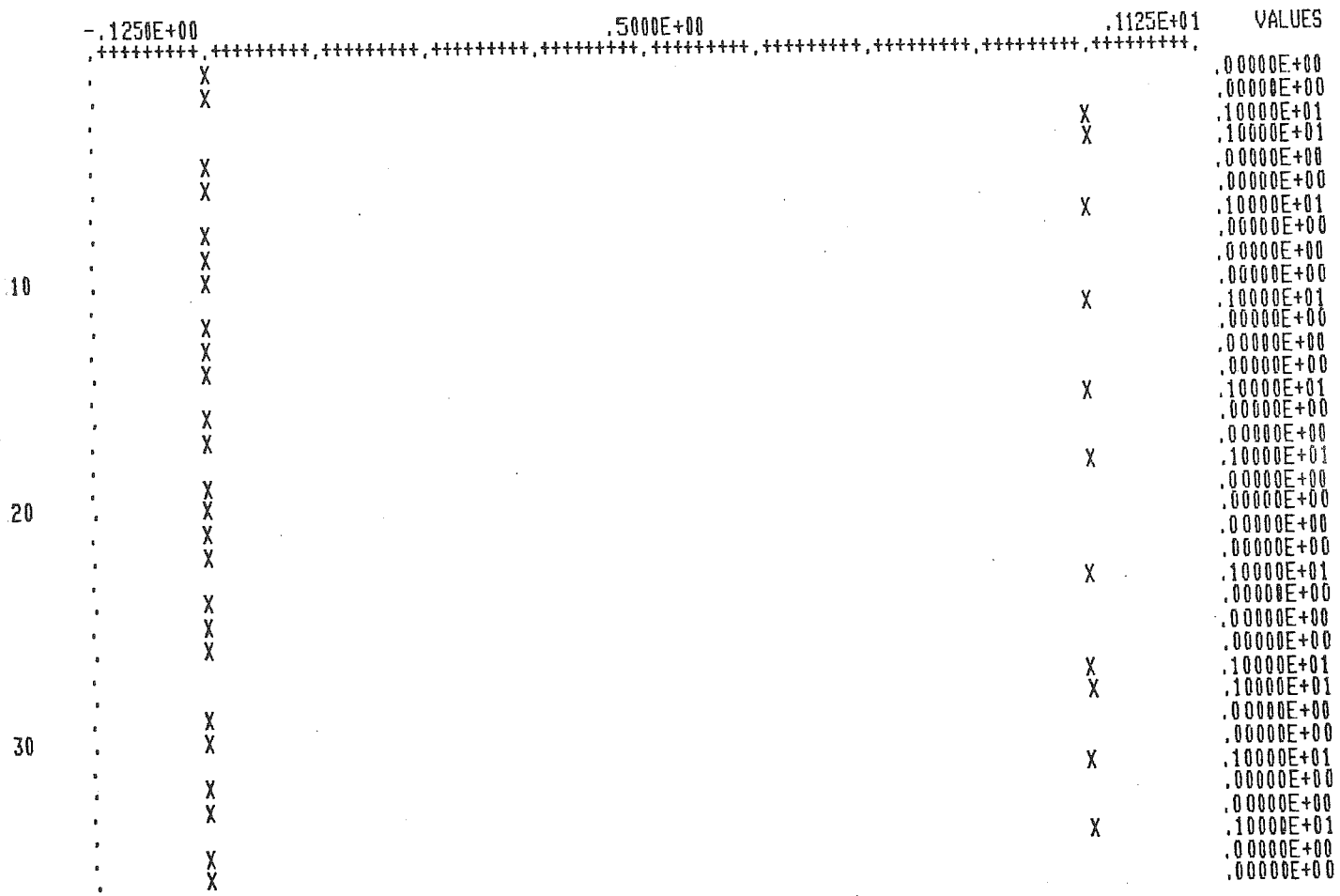
LISTING OF OBSERVED SERIES

1-	8	.000000E+00	.000000E+00	.100000E+01	.100000E+01	.000000E+00	.000000E+00	.100000E+01	.000000E+00
9-	16	.000000E+00	.000000E+00	.100000E+01	.000000E+00	.000000E+00	.000000E+00	.100000E+01	.000000E+00
17-	24	.000000E+00	.100000E+01	.000000E+00	.000000E+00	.000000E+00	.000000E+00	.100000E+01	.000000E+00
25-	32	.000000E+00	.000000E+00	.100000E+01	.100000E+01	.000000E+00	.000000E+00	.100000E+01	.000000E+00
33-	36	.000000E+00	.100000E+01	.000000E+00	.000000E+00				

OWN PROM. (DMBA4)

GRAPH OF OBSERVED SERIES

GRAPH INTERVAL IS .1250E-01



COMP. PROM. (DMBA5)

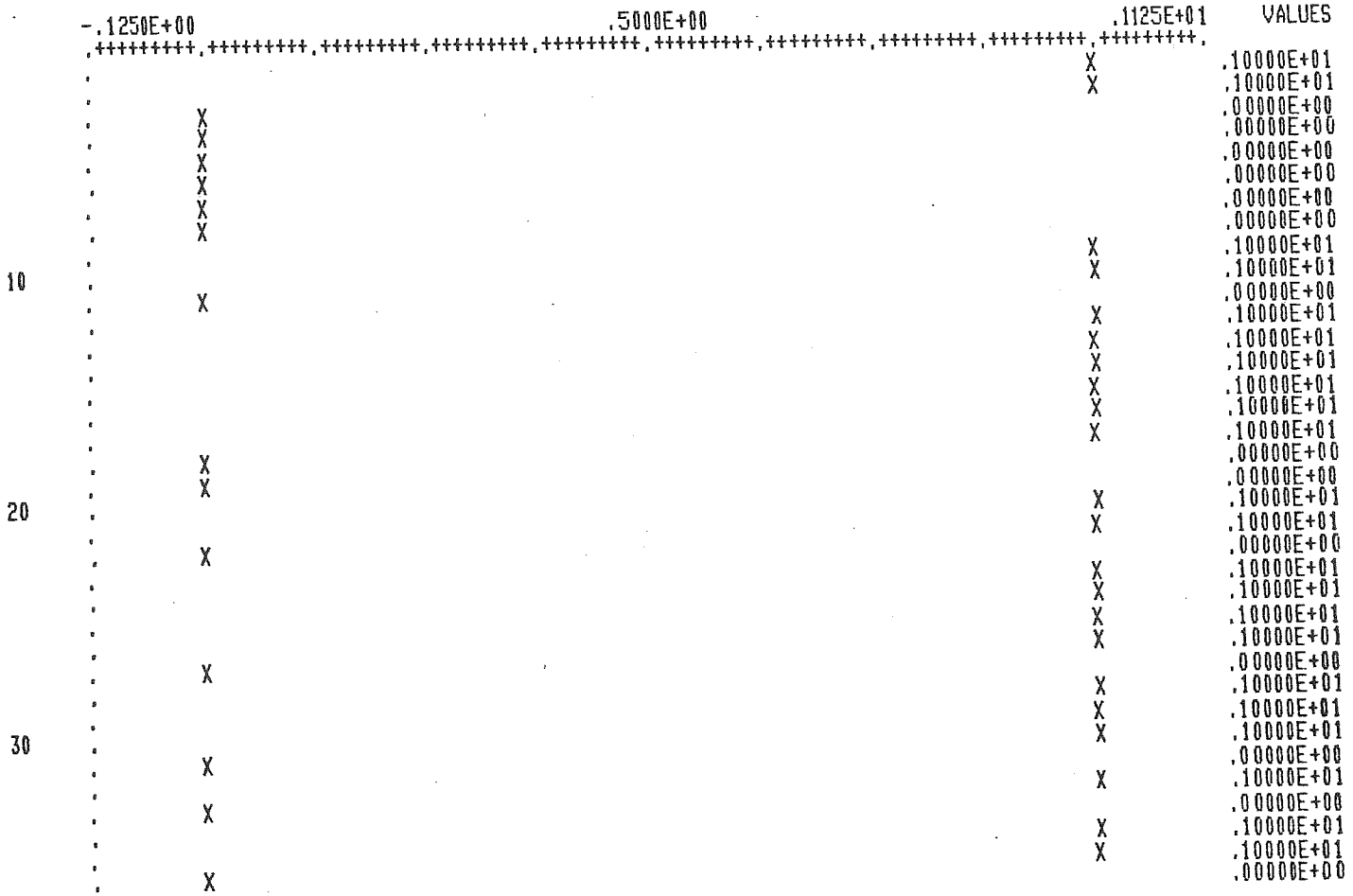
LISTING OF OBSERVED SERIES

1- 8	.100000E+01	.100000E+01	.000000E+00	.000000E+00	.000000E+00	.000000E+00	.000000E+00	.000000E+00
9- 16	.100000E+01	.100000E+01	.000000E+00	.100000E+01	.100000E+01	.100000E+01	.100000E+01	.100000E+01
17- 24	.100000E+01	.000000E+00	.000000E+00	.100000E+01	.100000E+01	.000000E+00	.100000E+01	.100000E+01
25- 32	.100000E+01	.100000E+01	.000000E+00	.100000E+01	.100000E+01	.100000E+01	.000000E+00	.100000E+01
33- 36	.000000E+00	.100000E+01	.100000E+01	.000000E+00				

COMP. PROM. (DMBA5)

GRAPH OF OBSERVED SERIES

GRAPH INTERVAL IS .1250E-01



PLANTA SALES (DMBA1)

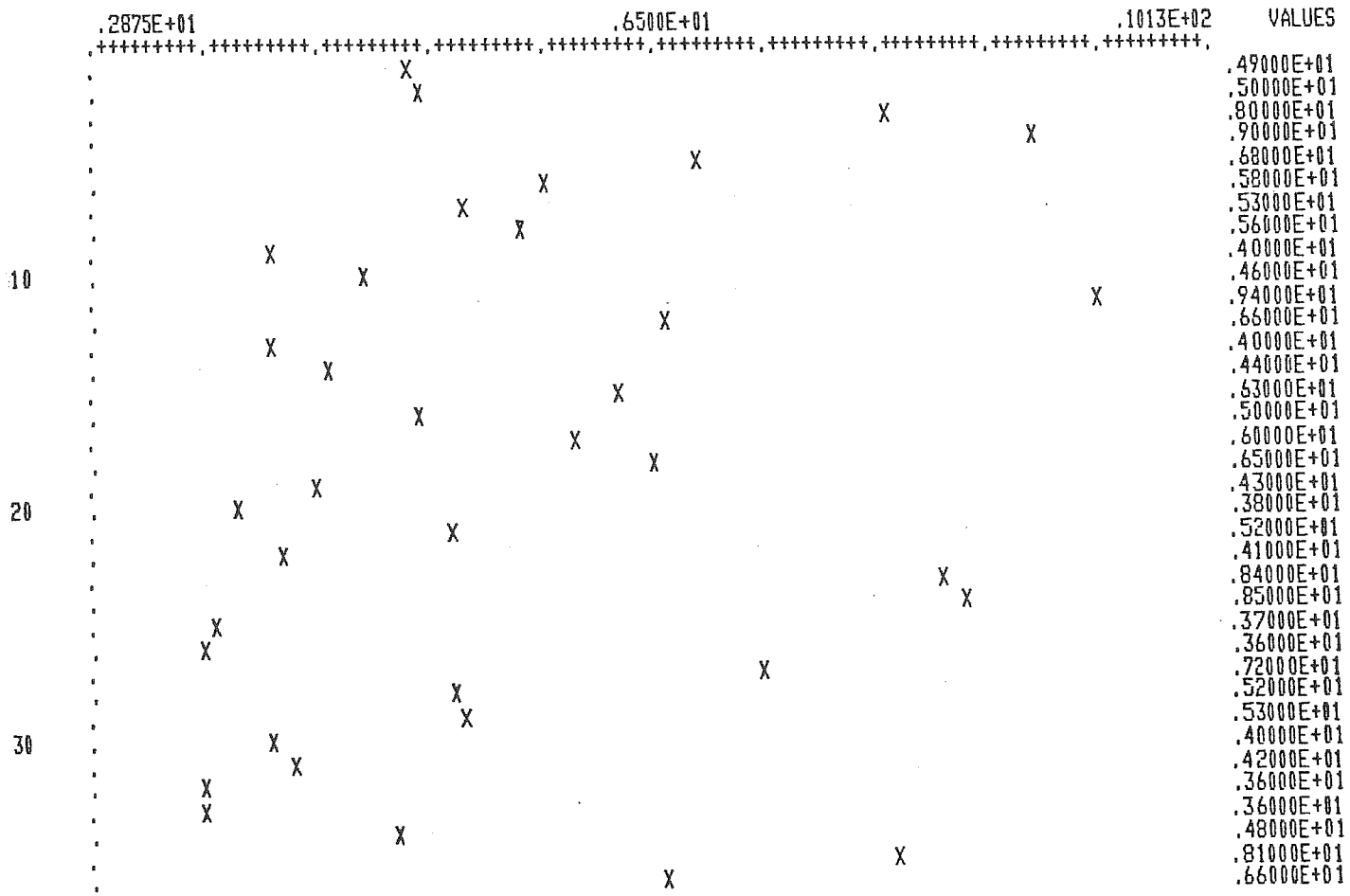
LISTING OF OBSERVED SERIES

1-	8	.490000E+01	.500000E+01	.800000E+01	.900000E+01	.680000E+01	.580000E+01	.530000E+01	.560000E+01
9-	16	.400000E+01	.460000E+01	.940000E+01	.660000E+01	.400000E+01	.440000E+01	.630000E+01	.500000E+01
17-	24	.600000E+01	.650000E+01	.430000E+01	.380000E+01	.520000E+01	.410000E+01	.840000E+01	.850000E+01
25-	32	.370000E+01	.360000E+01	.720000E+01	.520000E+01	.530000E+01	.400000E+01	.420000E+01	.360000E+01
33-	36	.360000E+01	.480000E+01	.810000E+01	.660000E+01				

PLANTA SALES (DMBA1)

GRAPH OF OBSERVED SERIES

GRAPH INTERVAL IS .7250E-01



TIME SERIERS PARAMETER ESTIMATION FOR MODEL 1

****

DATA - Y = PLANTA SALES (DMBA1) 36 OBSERVATIONS

DIFFERENCING ON Y - NONE

TRANSFORMATIONS EXAMINED - NONE

****

****

NOISE SERIES

DIFFERENCING ON NOISE - 1) 1 OF ORDER 1 2) 1 OF ORDER 12

****

NOISE MODEL PARAMETERS

****

PARAMETER NUMBER	PARAMETER TYPE	PARAMETER ORDER	BEGINNING VALUE
1	AUTOREGRESSIVE 1	1	-.30000E+00
2	AUTOREGRESSIVE 1	2	-.30000E+00
3	MOVING AVERAGE 1	12	.30000E+00

****

****

INTERVENTION 1

DATA - X1 = OWN PROM. (DMBA4)

DIFFERENCING IN DENOMINATOR OF TRANSFER FUNCTION - NONE

VALUE OF LAG PARAMETER IS 0

****

TRANSFER FUNCTION PARAMETERS

****

4	INPUT LAG 1	0	.30000E+00	FIXED RATIO TO PARAMETER 6 = -1.0000
5	INPUT LAG 1	1	-.30000E+00	

****

****

INTERVENTION 2

DATA - X2 = COMP. PROM. (DMBA5)

DIFFERENCING IN DENOMINATOR OF TRANSFER FUNCTION - NONE

VALUE OF LAG PARAMETER IS 0

****

TRANSFER FUNCTION PARAMETERS

****

6	INPUT LAG 1	0	-.30000E+00

****

INITIAL SUM OF SQUARES = .2872E+02

ITERATION NO. 1

TEST POINT PARAMETER VALUES

-.8156E+00 -.6052E+00 .5134E+00 -.1007E+01 -.7943E+00

TEST POINT SUM OF SQUARES = .1439E+02

PARAMETER VALUES VIA REGRESSION

1	2	3	4	5
-.8156E+00	-.6052E+00	.5134E+00	-.1007E+01	-.7943E+00

SUM OF SQUARES AFTER REGRESSION = .1439398E+02

TEST POINT PARAMETER VALUES

-.7885E+00 -.8336E+00 .8664E+00 -.7417E+00 -.6112E+00

TEST POINT SUM OF SQUARES = .8707E+01

PARAMETER VALUES VIA REGRESSION

1	2	3	4	5
-.7885E+00	-.8336E+00	.8664E+00	-.7417E+00	-.6112E+00

SUM OF SQUARES AFTER REGRESSION = .8706501E+01

ITERATION STOPS - RELATIVE CHANGE IN EACH PARAMETER LESS THAN .1000E-03

SUMMARY OF MODEL 1

DATA - Y = PLANTA SALES (DMBA1) 36 OBSERVATIONS

DIFFERENCING ON Y - NONE

NOISE SERIES

DIFFERENCING ON NOISE - 1) 1 OF ORDER 1 2) 1 OF ORDER 12

NOISE MODEL PARAMETERS

PARAMETER NUMBER	PARAMETER TYPE	PARAMETER ORDER	ESTIMATED VALUE	95 PER CENT LOWER LIMIT	95 PER CENT UPPER LIMIT
1	AUTOREGRESSIVE 1	1	-.78848E+00	-.10273E+01	-.54966E+00
2	AUTOREGRESSIVE 1	2	-.83364E+00	-.10829E+01	-.58441E+00
3	MOVING AVERAGE 1	12	.86642E+00	.70813E+00	.10247E+01

INTERVENTION 1

DATA - X1 = OWN PROM. (DMBA4)

DIFFERENCING IN DENOMINATOR OF TRANSFER FUNCTION - NONE

VALUE OF LAG PARAMETER IS 0

TRANSFER FUNCTION PARAMETERS

4	INPUT LAG 1	0	.61123E+00	FIXED RATIO TO PARAMETER 6 =	-1.0000
5	INPUT LAG 1	1	-.74166E+00	-.14634E+01	-.19976E-01

INTERVENTION 2

DATA - X2 = COMP. PROM. (DMBA5)

DIFFERENCING IN DENOMINATOR OF TRANSFER FUNCTION - NONE

VALUE OF LAG PARAMETER IS 0

TRANSFER FUNCTION PARAMETERS

6	INPUT LAG 1	0	-.61123E+00	-.98143E+00	-.24102E+00

OTHER INFORMATION AND RESULTS

RESIDUAL SUM OF SQUARES	.87065E+01 17 D.F.	RESIDUAL MEAN SQUARE	.51215E+00
NUMBER OF RESIDUALS	35	RESIDUAL STANDARD ERROR	.71564E+00

CORRELATION MATRIX OF THE PARAMETERS

	1	2	3	4	5
1	1.0000				
2	.4112	1.0000			
3	-.3775	-.0542	1.0000		
4	-.0055	.0559	.0414	1.0000	
5	.1009	.1394	-.0041	.2539	1.0000

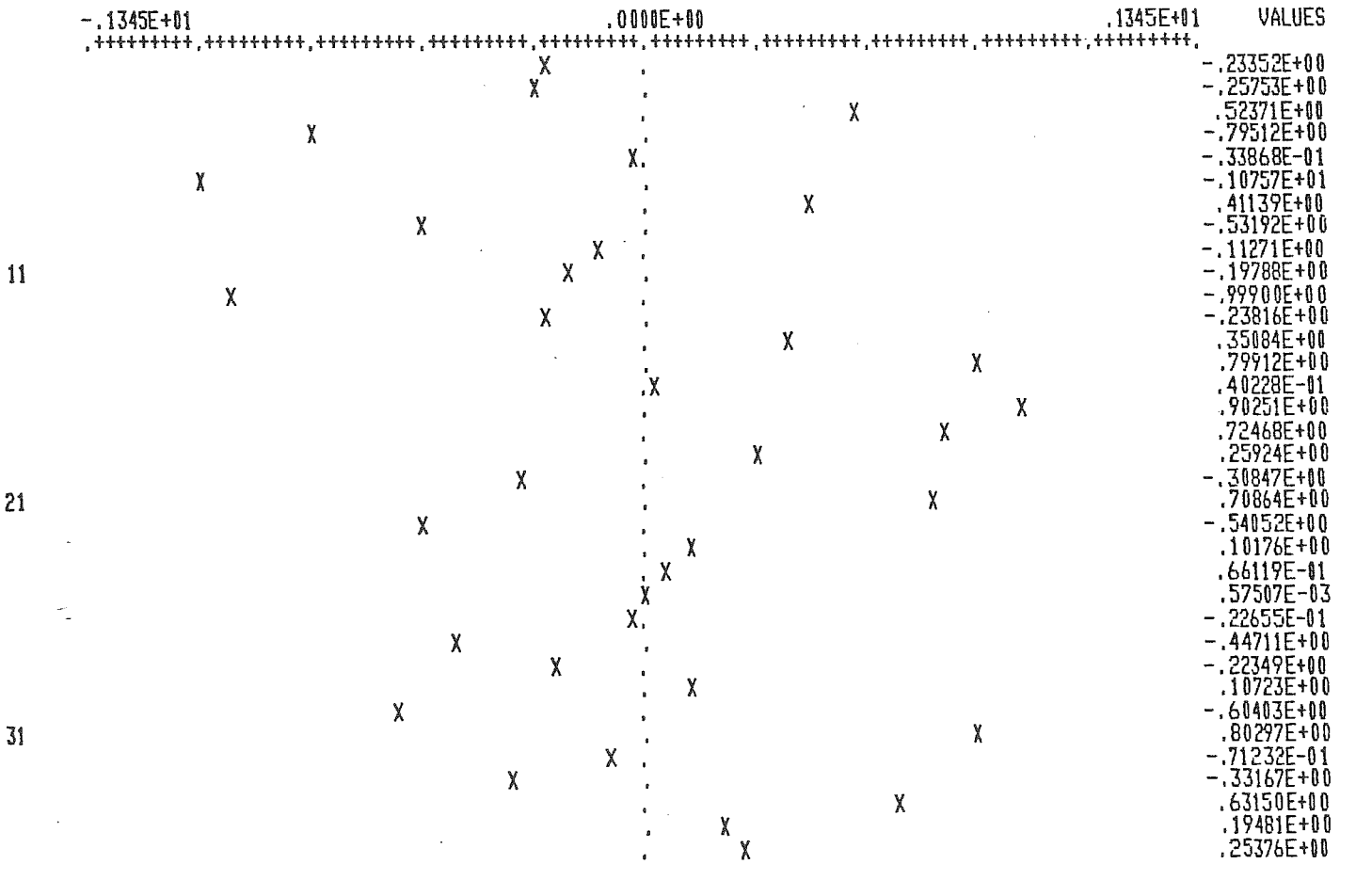
END OF ESTIMATION FOR MODEL 1

T	FITTED VALUE	RESIDUAL	DATA VALUE
2	.5234E+01	-.2335E+00	.5000E+01
3	.8258E+01	-.2575E+00	.8000E+01
4	.8476E+01	.5237E+00	.9000E+01
5	.7595E+01	-.7951E+00	.6800E+01
6	.5834E+01	-.3387E-01	.5800E+01
7	.6376E+01	-.1076E+01	.5300E+01
8	.5189E+01	.4114E+00	.5600E+01
9	.4532E+01	-.5319E+00	.4000E+01
10	.4713E+01	-.1127E+00	.4600E+01
11	.9598E+01	-.1979E+00	.9400E+01
12	.7599E+01	-.9990E+00	.6600E+01
13	.4238E+01	-.2382E+00	.4000E+01
14	.4049E+01	.3508E+00	.4400E+01
15	.5501E+01	.7991E+00	.6300E+01
16	.4960E+01	.4023E-01	.5000E+01
17	.5097E+01	.9025E+00	.6000E+01
18	.5775E+01	.7247E+00	.6500E+01
19	.4041E+01	.2592E+00	.4300E+01
20	.4108E+01	-.3085E+00	.3800E+01
21	.4491E+01	.7086E+00	.5200E+01
22	.4641E+01	-.5405E+00	.4100E+01
23	.8298E+01	.1018E+00	.8400E+01
24	.8434E+01	.6612E-01	.8500E+01
25	.3699E+01	.5751E-03	.3700E+01
26	.3623E+01	-.2265E-01	.3600E+01
27	.7647E+01	-.4471E+00	.7200E+01
28	.5423E+01	-.2235E+00	.5200E+01
29	.5193E+01	.1072E+00	.5300E+01
30	.4604E+01	-.6040E+00	.4000E+01
31	.3397E+01	.8030E+00	.4200E+01
32	.3671E+01	-.7123E-01	.3600E+01
33	.3932E+01	-.3317E+00	.3600E+01
34	.4168E+01	.6315E+00	.4800E+01
35	.7905E+01	.1948E+00	.8100E+01
36	.6346E+01	.2538E+00	.6600E+01

PLANTA SALES (DMBA1)

GRAPH OF RESIDUALS FROM MODEL 1

GRAPH INTERVAL IS .2689E-01



AUTOCORRELATION FUNCTION

DATA - THE ESTIMATED RESIDUALS - MODEL 1

35 OBSERVATIONS

ORIGINAL SERIES
MEAN OF THE SERIES =-.41573E-02
ST. DEV. OF SERIES = .49874E+00
NUMBER OF OBSERVATIONS = 35

1- 12	-.08	.27	.08	.05	-.06	-.07	-.02	-.16	-.24	-.03	-.07	-.32
ST.E.	.17	.17	.18	.18	.18	.18	.18	.18	.19	.20	.20	.20
13- 18	.09	-.07	.07	-.02	.22	.03						
ST.E.	.21	.21	.21	.21	.22	.22						

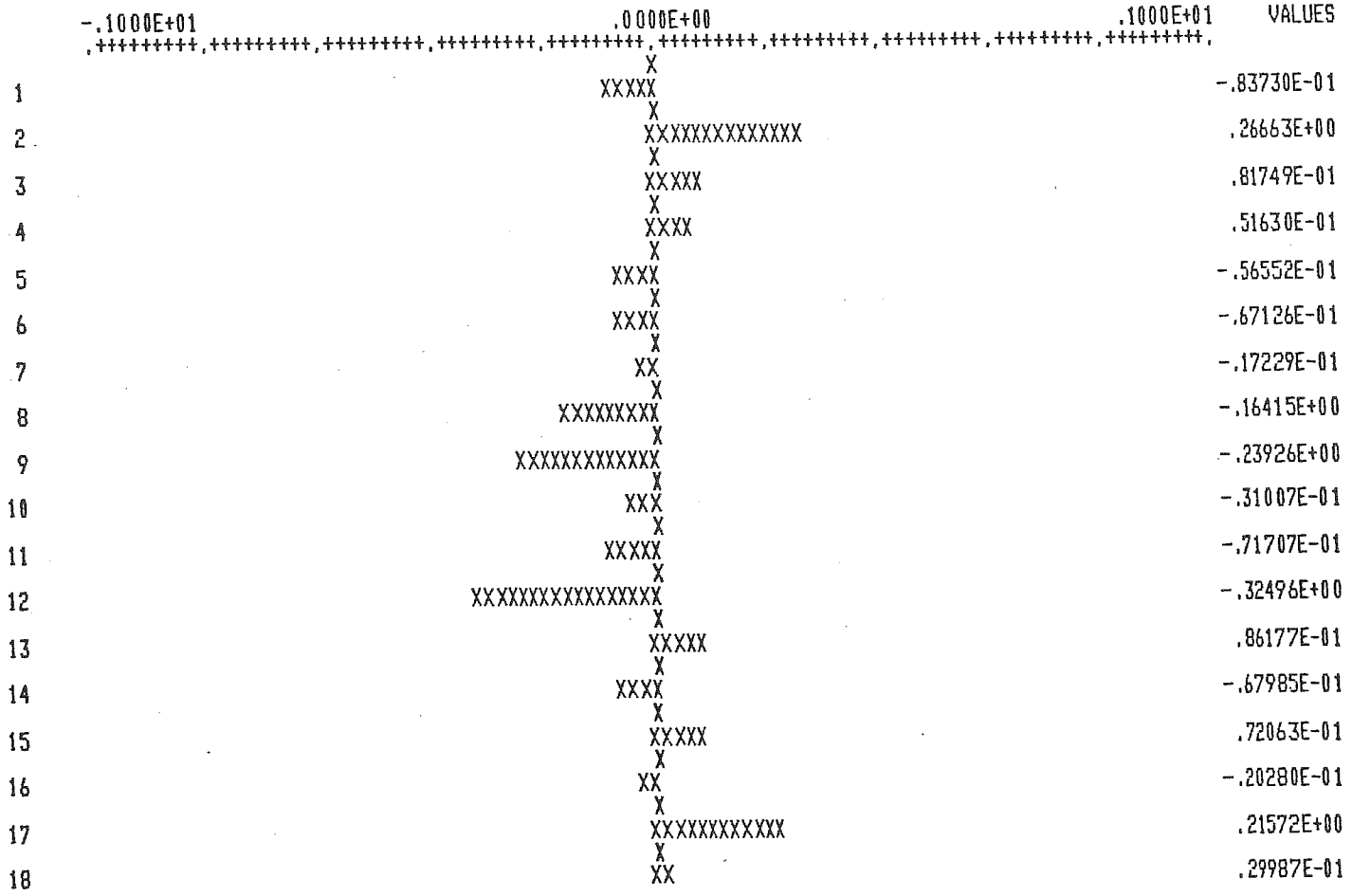
MEAN DIVIDED BY ST. ERROR = .49314E-01

TO TEST WHETHER THIS SERIES IS WHITE NOISE, THE VALUE .18711E+02
SHOULD BE COMPARED WITH A CHI-SQUARE VARIABLE WITH 15 DEGREES OF FREEDOM

THE ESTIMATED RESIDUALS - MODEL 1

GRAPH OF OBSERVED SERIES ACF

GRAPH INTERVAL IS .2000E-01



PARTIAL AUTOCORRELATIONS

DATA - THE ESTIMATED RESIDUALS - MODEL 1 35 OBSERVATIONS

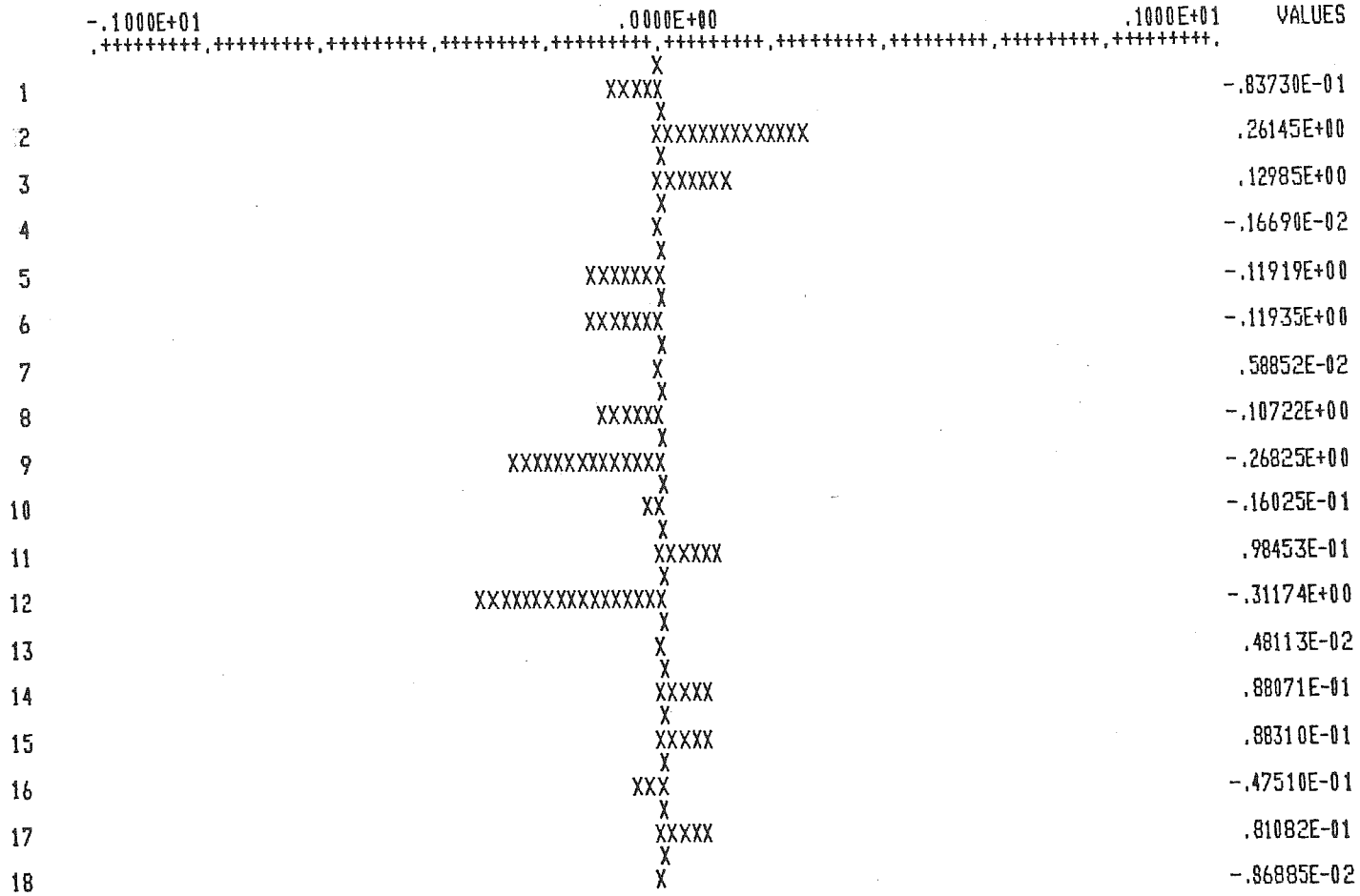
ORIGINAL SERIES
MEAN OF THE SERIES =-.41573E-02
ST. DEV. OF SERIES = .49874E+00
NUMBER OF OBSERVATIONS = 35

1- 12	-.08	.26	.13	-.00	-.12	-.12	.01	-.11	-.27	-.02	.10	-.31
13- 18	.00	.09	.09	-.05	.08	-.01						

THE ESTIMATED RESIDUALS - MODEL 1

GRAPH OF OBSERVED SERIES PACF

GRAPH INTERVAL IS .2000E-01



LAG	MODEL IMPLIED IMPULSE RESPONSE WEIGHTS
0	.611228E+00
1	.741663E+00
2	.000000E+00
3	.000000E+00
4	.000000E+00
5	.000000E+00
6	.000000E+00
7	.000000E+00
8	.000000E+00
9	.000000E+00
10	.000000E+00
11	.000000E+00
12	.000000E+00
13	.000000E+00
14	.000000E+00
15	.000000E+00
16	.000000E+00
17	.000000E+00
18	.000000E+00
19	.000000E+00
20	.000000E+00
21	.000000E+00
22	.000000E+00
23	.000000E+00
24	.000000E+00
25	.000000E+00
26	.000000E+00
27	.000000E+00
28	.000000E+00
29	.000000E+00
30	.000000E+00
31	.000000E+00
32	.000000E+00
33	.000000E+00
34	.000000E+00
35	.000000E+00
36	.000000E+00

GRAPH OF MODEL IMPLIED WEIGHTS

GRAPH INTERVAL IS .2000E-01

```
    -.1000E+01                          .0000E+00                          .1000E+01     VALUES
    .+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.
                                        X
0                                       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX          .82413E+00
                                        X
1                                       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX .10000E+01
                                        X
2                                       X                                                   .00000E+00
                                        X
3                                       X                                                   .00000E+00
                                        X
4                                       X                                                   .00000E+00
                                        X
5                                       X                                                   .00000E+00
                                        X
6                                       X                                                   .00000E+00
                                        X
7                                       X                                                   .00000E+00
                                        X
8                                       X                                                   .00000E+00
                                        X
9                                       X                                                   .00000E+00
                                        X
10                                      X                                                   .00000E+00
                                        X
11                                      X                                                   .00000E+00
                                        X
12                                      X                                                   .00000E+00
```

LAG	MODEL IMPLIED IMPULSE RESPONSE WEIGHTS
0	-.611228E+00
1	.000000E+00
2	.000000E+00
3	.000000E+00
4	.000000E+00
5	.000000E+00
6	.000000E+00
7	.000000E+00
8	.000000E+00
9	.000000E+00
10	.000000E+00
11	.000000E+00
12	.000000E+00
13	.000000E+00
14	.000000E+00
15	.000000E+00
16	.000000E+00
17	.000000E+00
18	.000000E+00
19	.000000E+00
20	.000000E+00
21	.000000E+00
22	.000000E+00
23	.000000E+00
24	.000000E+00
25	.000000E+00
26	.000000E+00
27	.000000E+00
28	.000000E+00
29	.000000E+00
30	.000000E+00
31	.000000E+00
32	.000000E+00
33	.000000E+00
34	.000000E+00
35	.000000E+00
36	.000000E+00

GRAPH OF MODEL IMPLIED WEIGHTS

GRAPH INTERVAL IS .2000E-01

```
          -.1000E+01                              .0000E+00                              .1000E+01     VALUES
          .+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.+++++++++.
                                                  X
0         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX                          -.10000E+01
                                                  X
1                                                 X                                          .00000E+00
                                                  X
2                                                 X                                          .00000E+00
                                                  X
3                                                 X                                          .00000E+00
                                                  X
4                                                 X                                          .00000E+00
                                                  X
5                                                 X                                          .00000E+00
                                                  X
6                                                 X                                          .00000E+00
                                                  X
7                                                 X                                          .00000E+00
                                                  X
8                                                 X                                          .00000E+00
                                                  X
9                                                 X                                          .00000E+00
                                                  X
10                                                X                                          .00000E+00
                                                  X
11                                                X                                          .00000E+00
                                                  X
12                                                X                                          .00000E+00
```

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.82 .

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. 82.

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

0001          1         2         3         4         5         6         7         8
0002 12345678901234567890123456789012345678901234567890123456789012345678901234567890
0003
0004  2.456 2.372 2.310 2.613 2.650 2.527 2.334
0005  2.606 2.850 2.961 3.000 3.230 3.210 3.165
0006  3.140 3.113 3.042 3.316 3.165 3.404 3.578
0007  3.591 3.337 3.102 2.598 1.562 1.354 1.126
0008  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

0001          1         2         3         4         5         6         7         8
0002 12345678901234567890123456789012345678901234567890123456789012345678901234567890
0003
0004  2.456     2.372     2.310     2.613     2.650     2.527     2.334     USTRB  01
0005  2.606     2.850     2.961     3.000     3.230     3.210     3.165     USTRB  02
0006  3.140     3.113     3.042     3.316     3.165     3.404     3.578     USTRB  03
0007  3.591     3.337     3.102     2.598     1.562     1.354     1.126     USTRB  04
0008  1.046     0.881     0.962     1.686     2.484     2.793     2.756     USTRB  05
```

REFERENCES

[1] Box, G.E.P. & JENKINS, G.M.
Time Series Analysis: Forecasting and Control
Holden-Day, San Francisco, 1976

[2] BOX,G.E.P. & TIAO, G.C.
Intervention Analysis with Applications to Economic and Environmental Problems
Journal of the American Statistical Association, 70, no.349, March 1975, pp.70-79

[3] PACK, D.J.
Computer Programs for the Analysis of Single Input Transfer Function Models Using the Methods of Box and Jenkins
The Data Center, College of Administrative Science, Ohio State University, February 1974

[4] PACK, D.J.
Computer Programs for the Analysis of Univariate Time Series Models and Single Input Transfer Function Models Using the Methods of Box and Jenkins
The Data Center, College of Administrative Science, Ohio State University, December 1974

[5] PACK, D.J.
Documentation for "A Computer Program for the Analysis of Time Series Models Using the Box-Jenkins Philosophy"
Automatic Forecasting Systems, Inc., Hatboro, 1979

[6] PACK, D.J., GOODMAN, M.L. & MILLER, R.B.
Computer Programs for the Analysis of Univariate Time Series Using the Methods of Box and Jenkins
Technical Report # 296, Department of Statistics, University of Wisconsin, Madison, April 1972

[7] THE PACK SYSTEM - USER'S GUIDE
Automatic Forecasting Systems, Inc., Hatboro, 1983