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STATISTICAL SOFTWARE – SPC

User's Guide

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INTRODUCTION

The STATISTICAL software (see NOTE I) allows to use the measurements of a workpiece, previously done and saved on Hard Disk, for statistical computations. Therefore in the operative sequence is distinguished the following phases:

1. MEASURING AND SAVING OF MEASUREMENTS DATA

The measurement could be saved by mean of :

- a) CMM (Co-ordinates Measuring Machines) CATRIM, IGROB, GANTRY (of MDM production), through the **M/7** mode (Execution of MIX for SPC; see NOTE II).
- b) TLC measurement device (Tube Laser Control produced by MDM) using its software.
- c) Discrete systems of measurement, whose results are sent, through a dedicated net, to a Personal Computer, and using a software developed by MDM MetroSoft.

This User Guide contains a description of the only point a) ; points b) and c) are described in the dedicated User’s Guide.

2. STATISTICAL COMPUTATION OF SAVED MEASUREMENTS DATA

The computation will be done through the **M/6** option (SPC Analysis; see NOTE II) .

The argument has been developed in conformance with the **UNI Standards : 4723, 4724 -66, 4725, 4726 - 66, 4728 - 66** for the terminology and the calculations.

In the explanation of the various topics, the description of the functioning modes will followed by a practical example, with graphic representation of the Windows that will be displayed on the monitor in the different phases.

NOTE

- I. STATISTICAL software is similar in presentation and utilisation to MIX. We suggest the Operator to read these arguments in “Application Manager User’s Guide” and in “MIX User’s Guide”.
- II. For both selections, **M/7** and **M/6**, it is necessary to do operations on Files described in “Application Manager User’s Guide” at pages N. 7, 15, 16, 17.

1. MEASURING AND SAVING OF MEASUREMENTS

Select the **M/7** mode (Execution of MIX for SPC).

The selection can be done in 2 different ways, as indicated in Figure N. 1 and N. 2.

Figure N. 1

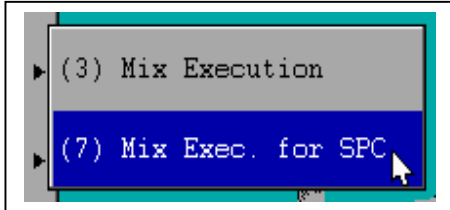
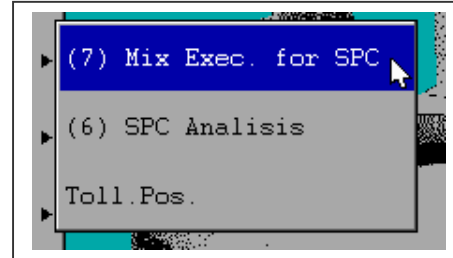


Figure N. 2



1.1. SELECTION OF THE MEASUREMENT SEQUENCE

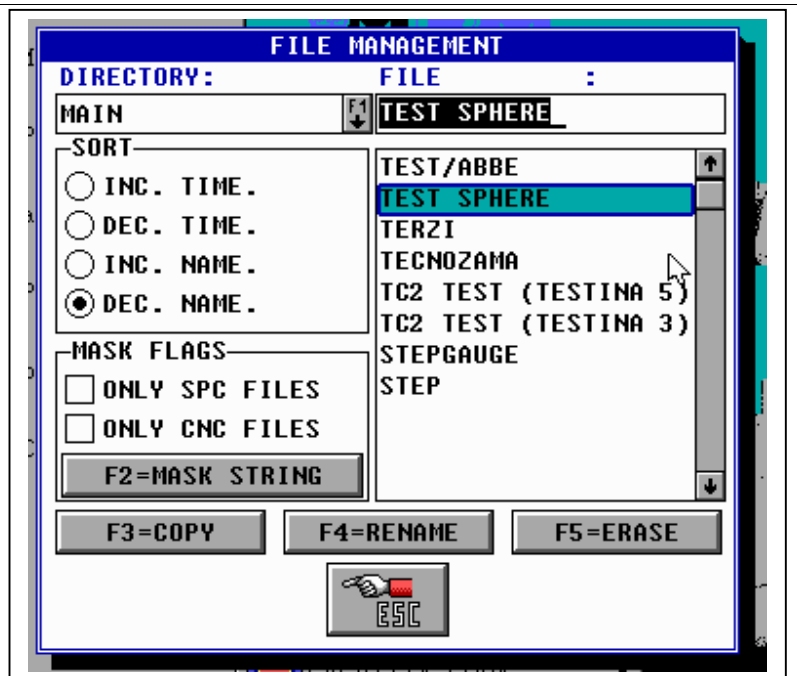
It will be displayed Figure N. 3, through which can be selected the labels of the Files in which have been previously saved :

- for all the types of CMM the File of the sequence of the measurements.
- for the CNC machines, as for the **M/3** option, also the File of Path sequence (see CNC CATRIM User's Guide).

Figure N. 3

If the Path sequence has not been saved, as for the **M/3** option with the first manual Path sequence, the File can be saved in "auto-learning".

In Figure N.3 it is supposed to select the File with label **TEST SPHERE**.



After this selection will be displayed the same questions and the same windows of the **M/3** mode (see MIX User's Guide) for both CMM (manual and CNC).

1.2. SELECTION OF STATISTICAL MODE OF SAVING

Measurements data are saved in conformance with the Statistical necessities.

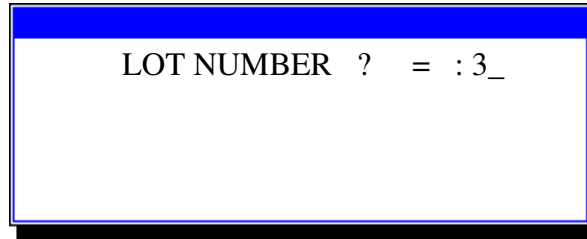
We will call in future ‘Measurements data’ simply ‘Data’.

It will be necessary to assign two parameters :

L = Lot Number and **E_S** = Number of Element For Sample .

With Figure N.4 will be requested the number **L**.

Figure N. 4



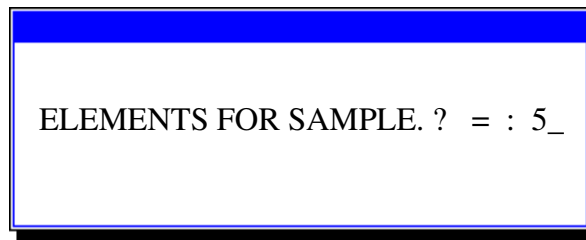
A screenshot of a software dialog box with a blue title bar. The text inside the dialog box reads: "LOT NUMBER ? = : 3_". The text is centered and appears to be a prompt for user input.

Then are possible two cases :

2.2.1. In the Lot **L** assigned **it has been previously** assigned the number **E_S**.
It is not necessary, therefore, to assign anything else.

2.2.2. In the Lot **L** assigned **it has not been previously assigned** the number **E_S**.
With Figure N. 5 it will be requested, therefore, to assign the number **E_S**.

Figure N. 5



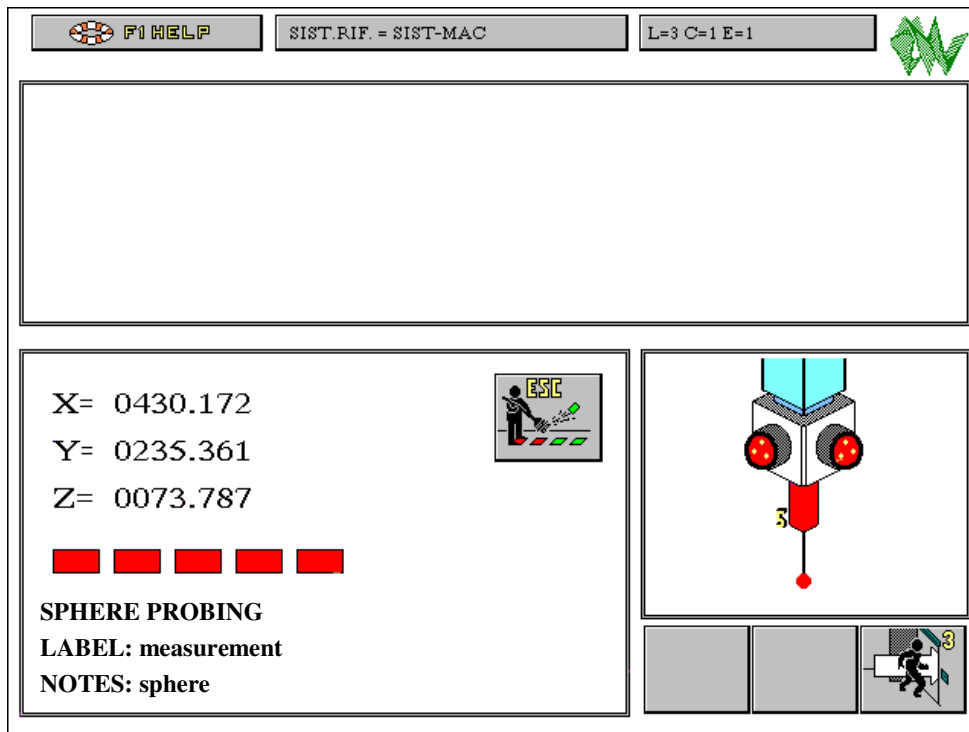
A screenshot of a software dialog box with a blue title bar. The text inside the dialog box reads: "ELEMENTS FOR SAMPLE. ? = : 5_". The text is centered and appears to be a prompt for user input.

1.3. MEASUREMENT EXECUTION

After selection of statistical parameters, will begin measurements phase.

Will be displayed Figure N. 6.

Figure N. 6



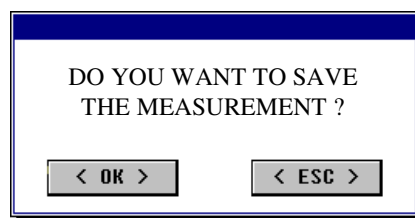
On the top of the Window, at right hand, is displayed a label with three numbers :

- L = Number of the selected Lot
- C = Number of the Sample on measurement
- E = Number of the Element of the Sample that is under measurement.

1.4. SAVING DATA

At the end of measurements will be displayed Figure N. 7, with which operator will be requested if he wants save or not to save Data (measurements could not be satisfying).

Figure N. 7



In case of positive answer, measurement will be saved, and another one will be proposed, with the same number **L** of Lot.

- if $E < E_S$, then $E = E + 1$.
- if $E = E_S$, then $C = C + 1$ and $E = 1$.

It is suggested to measure completely a Sample **C** ($E = E_S$) because STATISTICAL Software, in accordance with Statistical Process Control, allows only computation of complete Samples.

It is suggested, in the use of STATISTICAL software, to limit if not absolutely exclude, the printing of the measurements results : it could be necessary a considerable quantity of paper for printing results of measurements that, in any case, will be saved, and can be displayed on monitor on paper when desired.

In consideration of the fact that statistical computation of a measurement could require the knowledge of the tolerances, and that these tolerances can be assigned with the Window of printing (See MIX User's Guide), it is suggested to assign tolerances, and to forbid printing with the character "!".

2. STATISTICAL COMPUTATION

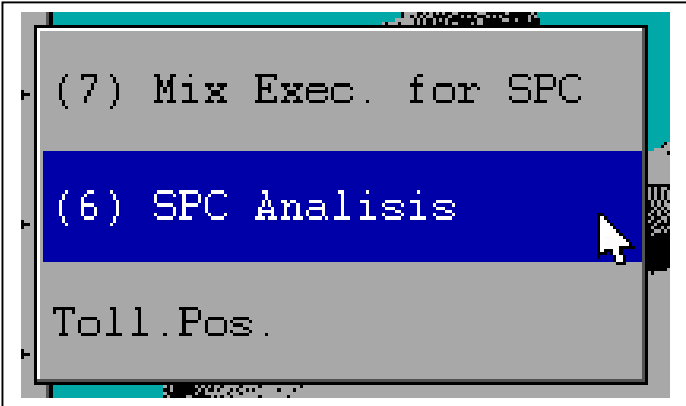
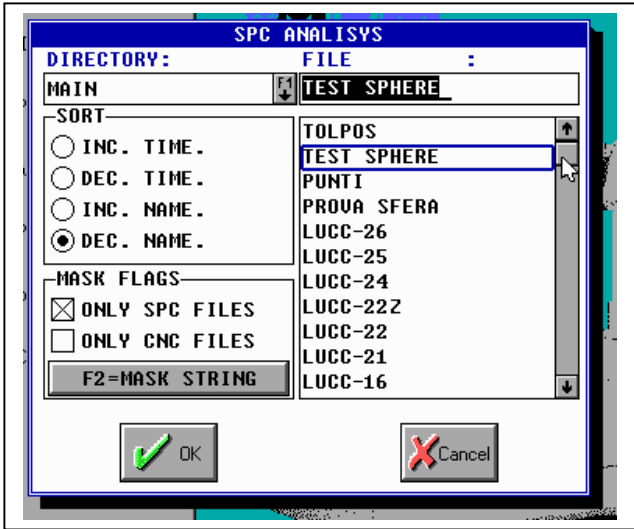
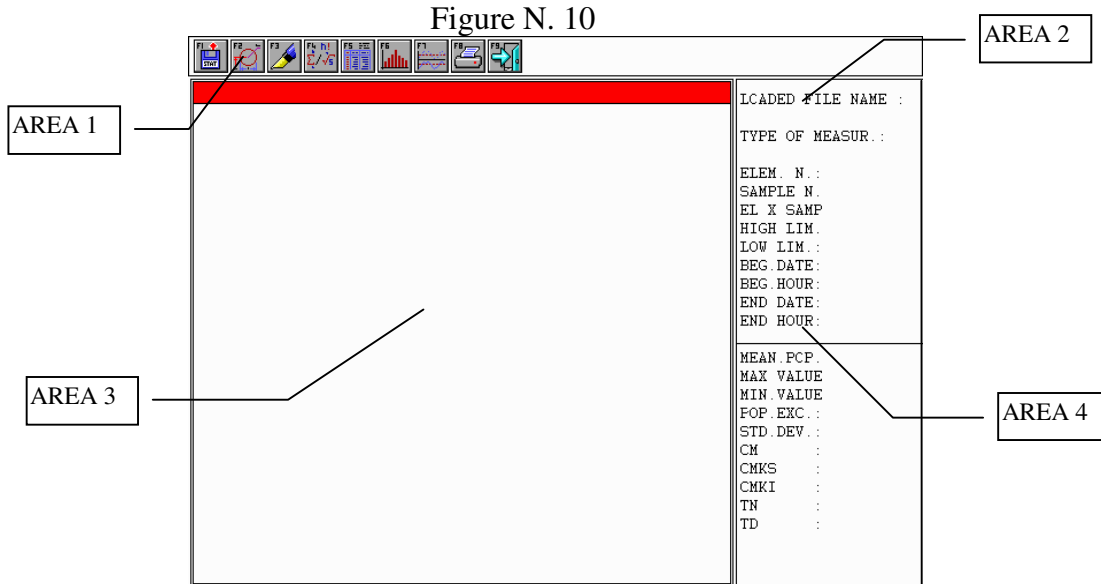
Figure N. 8	
<p>We want, at this moment, to make Statistical computations of Measurements Data previously saved through the M/7 mode.</p> <p>The selection of this software is done through option M/6 (see MIX User's Guide).</p> <p>It will be displayed Figure N. 9.</p>	

Figure N. 9	
<p>Will be displayed, of default, the list of the only one files containing the Measurements Data previously saved .</p> <p>Using utilities of Application manager it has been selected the file: “TEST SPHERE” on which statistical computations will be done.</p> <p>After this selection it will be loaded the Statistical Software, whose presentation is displayed in the next page.</p>	

2.1. DISPLAY PRESENTATION

In Figure N. 10 is given an indication of the 4 different AREAS in which the window of the Statistical Computation Software is divided.



The AREAS are reserved respectively to:

- AREA 1 : Main Menu, structured by icon.
- AREA 2 : Various uses in the different phases of the program.
- AREA 3 : Visualization and choice of functioning modes.
- AREA 4 : Reading elaborate data.

2.2. DATA SELECTION FOR SPC

In the Figure N. 11 is displayed an example. The selected Datum is, in this case, the DIAMETER.

<p>In the Figure N. 11 is displayed an example of presentation of the archive in this phase. The selected Datum is, in this case, the DIAMETER. If desired, with commands Pg-Dn is possible, for example, choose XC, or YC, etc. , end at the end confirm it with F1 key.</p>	<p style="text-align: center;">Figure N. 11</p>
---	---

All the measurements previously saved for the ‘DIAMETER’ in conformance with statistic necessities are the population of the DIAMETER.

It will be possible to use all the population, or a part of it to do statistic computation of the DIAMETER. This selection is done through the menu schematized in Figure N.12 activated :

- with the Mouse "clicking" in correspondence of the arrow at right of the writing "SELECT".
- by Keyboard pressing the keys ALT + DOWN ARROW.

Figure 12

OPTION	MEANING OF DATA SELECTION FOR STATISTICAL COMPUTATION
<i>SELECT</i>	Selects a generic lot or sample of the population
<i>UNSELECT</i>	Unselects a generic lot or sample of the population
<i>ALL</i>	Selects all the population.
Lot 1	Selects or UnSelects (depending to the disposition) the lot 1 of the population
Lot 2	Selects or UnSelects (depending to the disposition) the lot 2 of the population
.....
Lot T - 1	Selects or UnSelects (depending to the disposition) the lot T-1 of the population
Lot T	Selects or UnSelects (depending to the disposition) the lot T of the population

2.3. REQUIREMENTS TO FOLLOW FOR THE SELECTION

a) Select full samples; each sample, must be constituted by all its elements. If not, a WINDOW of ERROR will be displayed with the message :

**NOT ALL SAMPLES CONSIST
OF SAME NUMBER OF ELEMENTS**

b) The selection must include at least a sample, obviously full. If not, a WINDOW of ERROR will be displayed with the message:

WHOLE DATUMS TOO LITTLE

c) It is impossible to do statistical computations on samples with different values of E (N. of element for sample); this could happen in case of samples of different lots.

If not, a WINDOW of ERROR will be displayed with the message:

**NOT ALL SAMPLES HAVE THE
SAME NUMBER OF ELEMENTS**

2.4. OPTIONS OF SELECTION MENU

In consideration of the requirements of paragraph 2.3., SELECTION can be done :

d) FOR ADDITION

Single samples, or lots, are clicked in ‘SELECTION mode’.

Full samples must be clicked and, if samples belong to different lots, the number of elements for all the samples must be the same.

e) FOR SUBTRACTION

“ALL” option is clicked in “SELECTION mode”.

Single samples or lots are clicked in “DESELECTION mode” (obviously the number of elements for all the samples remaining must be the same).

In both the cases, in the Figure 11, on the right of the writing "SELECTION SET" will appear the **P** and **S** numbers, with a bar in the middle, that will denote:

- **P** = Population number (total number of the measurements).
- **S** = Selected number (number of the selected measurements) .

2.5. CONFIRMATION OF THE SELECTION

To confirm the selection key F1 must be pushed. All the statistical computations will the be done automatically, with results in graphic, or numerical form.

If selection is not confirmed ESC key must de pushed.

2.6. VISUALIZATION AND SELECTION OF DATA SET

In Figure 13 is displayed the selection of :

- File : TEST SPHERE
- Datum : DIAMETER

<p>In the columns it is possible to read respectively</p> <p>1° column = Number of Lot 2° column = Number of Sample 3° column = Number of Element 4° column = Date of measurement 5° column = Hour of measurement</p> <p>In this represented case is selected the entire Lot N. 1, composed by a population of 20 elements.</p> <p>Activating this selection with the command F1, will be available the statistical results, provided also in graphics form that in numerical form.</p>	<p style="text-align: center;">Figure N. 13</p>
---	---

2.7. RESULTS IN GRAPHIC FORM

After the F1 key has been pushed (see Figure 13), in the Area 2 will be available the graphic.

In head to the graph is displayed the name of Datum, followed by the :

PRESENTATION GRAPHICS TABLE

In the Area 3 will be displayed a COMBO BOX MENU, activable:

- with the Mouse "clicking" in correspondence of the arrow on the right of the written "FREQ. ABSOL. ."
- by Keyboard pressing the keys ALT and DOWN ARROW at the same time.

This menu contains what it is in the column "reticulated" of the table, and allows to represent the following graphic:

Figure 14

GRAPHICS PRESENTATION TABLE		
OPTION	TITLE	RAPPRESENTED GRAPHIC TYPE
FREQ. ABSOL.	ABSOLUTE FREQUENCY	HISTOGRAM OF THE FREQUENCIES Number of elements included in a class
FREQ.CUMUL.	CUMULATIVE FREQUENCY	HISTOGRAM OF THE CUMULATIVE FREQUENCIES Addition of the frequencies correspondents to all the included classes between an extreme of the distribution and a defined limit of class.
GAUSSIAN	GAUSSIAN DISTRIBUTION	GAUSSIAN OR NORMAL DISTRIBUTION Distribution of theoretical frequency to which usually tends a quantity when is influenced from a great number of random causes of variation, everyone of which operates independently from the others, and with a very small effect in comparison with the addition of all the effects.

The graphic is displayed, by default, with the histogram ABSOLUTE FREQUENCY.

In the high zone of the Area 2 in a small window it is possible to read the number of the classes (by default 13) with which are displayed the histograms.

With a COMBO BOX MENU activated :

- by Mouse "clicking" in correspondence of the arrow at right of the label "13 CLASSES".
- by Keyboard pressing the key F10.

It is possible to show the histograms with the number of classes : 7, 9, 11, 13, 15

In the histogram will be displayed the following data:

- on the left the values of the centre of the class.
- on the right, in correspondence of each class, the number of the measurements included in the class.

In the Figures N. 15, N. 16, N, 17 are represented the histograms achievable with the 3 options of the “GRAPHICS PRESENTATION TABLE”.

Figure N. 15

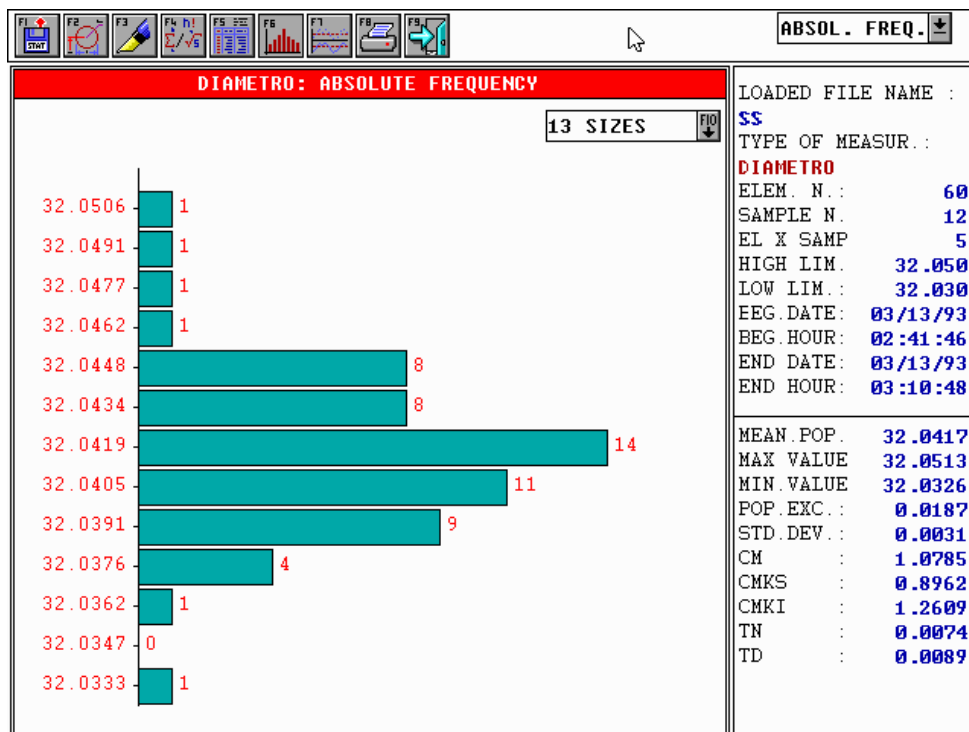


Figure N. 16

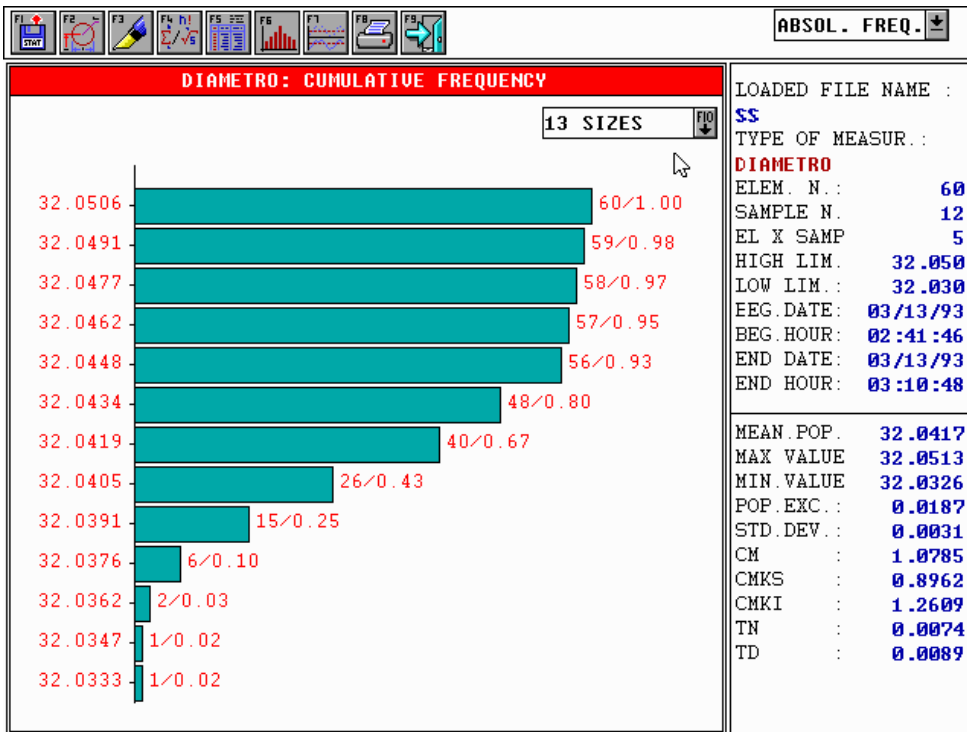
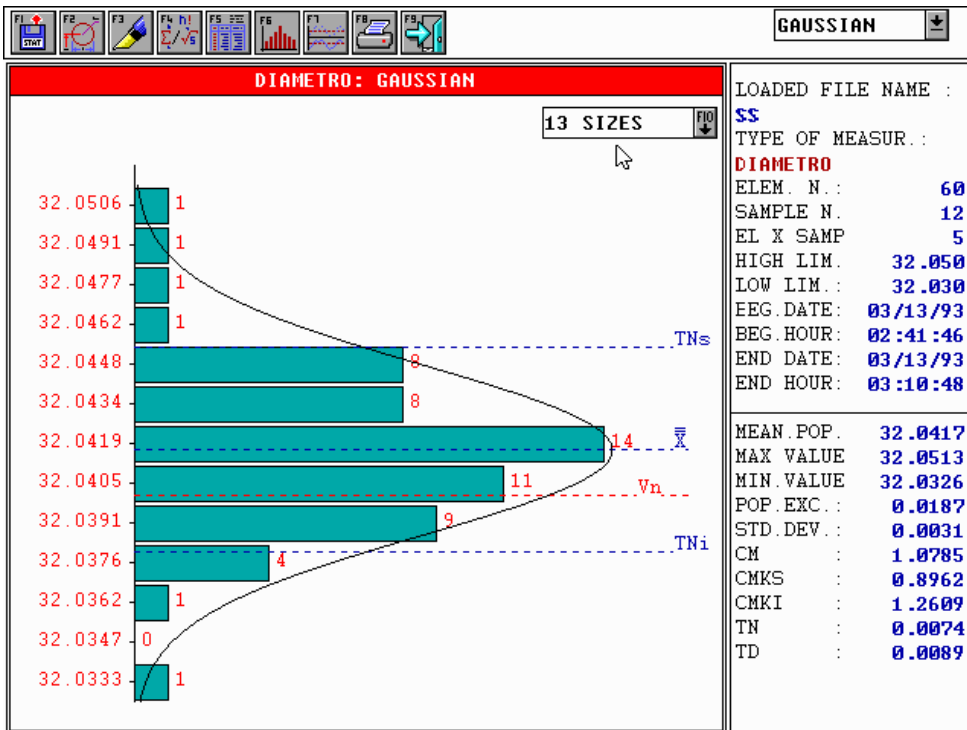


Figure N. 17

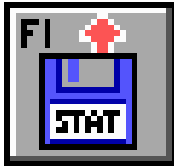


2.8. MAIN MENU

Is a menu of the type “Tool bar”, displayed in the Area 1, and contains 9 options in sequence, from F1 to F9.

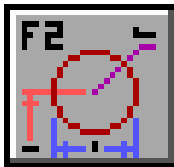
We will examine the different options.

2.8.1. OPTIONS OF MAIN MENU



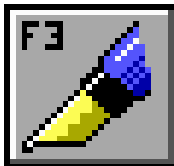
F1 WHOLE SELECTION

Enables the selection of point 2. 6.



F2 DATUM SELECTION

Enables the selection of point 2. 2.



F3 NOMINAL TOLERANCES

For what concerns the tolerances of a certain Datum, at the moment of measurement these are the possibilities :

- a) have been assigned and have been saved (see point 2. 2 .) .
- b) have not been assigned and, obviously, have not been saved.

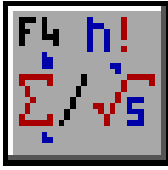
The option F3 allows to assign the tolerances temporarily :

- c) eventually modified in case a).
- d) “ex novo” in case b).

In both c) and d) cases these tolerances are not saved, but held in memory provisionally, to use them in the statistical computation.

It is also possible, in cases a), c), d), using the key F1, to operate in the following modes:

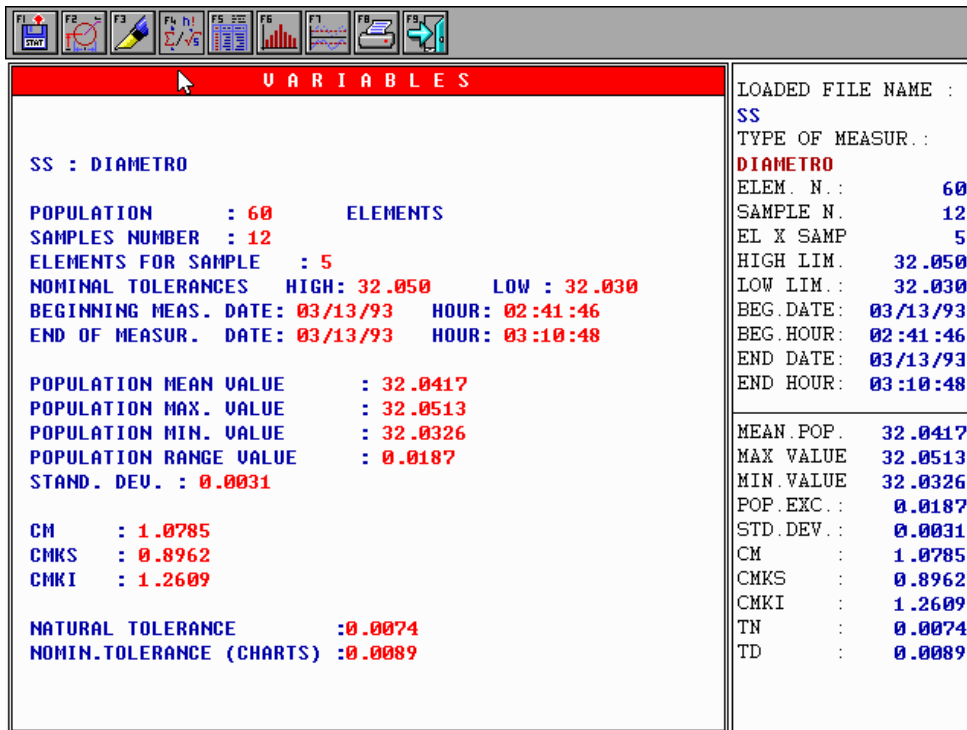
- e) Apply these tolerances in the statistical computations (put a cross in the square box on the right of F1).
- f) Not to apply these tolerances in the statistical computations (on the right of F1 empty), to operate as in case b).



F4 DISPLAY OF STATISTICAL DATA IN NUMERICAL FORM

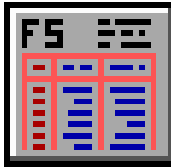
With this option is possible have statistical data in numerical form, as displayed in Figure N. 18, that contains statistical results processed on the same measurements of the Figures N. 15, N. 16, N. 17.

Figure N. 18



It will be possible, as we will see later, to print these data with the option F8 of the MAIN MENU.

We want now specify that, if b) or f) conditions described in the preceding page are verified, with the option F3 will not be displayed neither the values of the tolerances of the drawing, nor values of Cp, Cpk, Cpk_i and of the Natural Tolerance; all these parameters cannot be computed under these conditions.



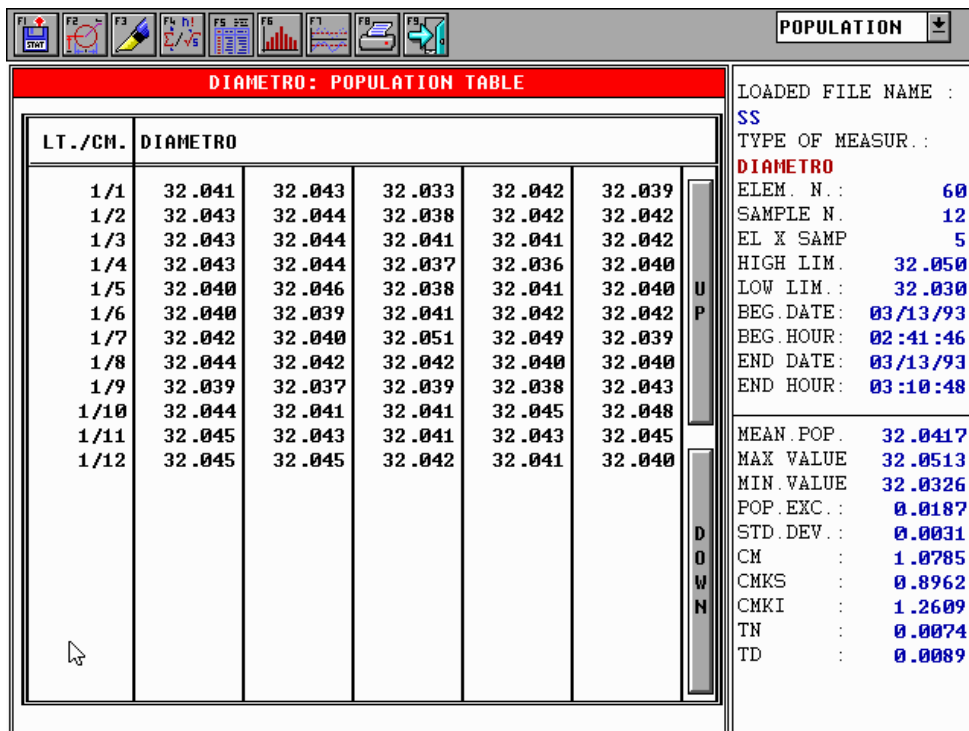
F5 POPULATION DATA VISUALIZATION

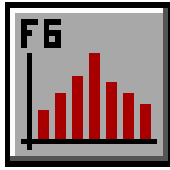
This option allows the complete visualization, for the selected population, of the results of the measurement of the Datum, detailed for the generic sample (Cm), of the generic Lot (Lt).

In every column will be point out the value of the generic element of each sample. The table provides 5 columns for the elements; if the number of the elements should be higher, would be hold the columns of the following row, until the number of the elements is exhausted.

In the Figure N. 19, shown below, is displayed the data of the population regarding always the same set of measurements and same selection for which we have previously showed results in Figures N. 15, N. 16, N. 17, N. 18.

Figure N. 19

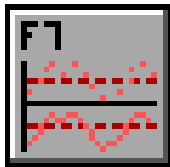




F6 PRESENTATION OF THE RESULTS BY GRAPHICS FORM

This option allows to display what, in the sequence previously provided, is visualized when the F1 key is pressed (see option 2. 5. "CONFIRMATION OF THE SELECTION ") at the end of the sequence for the selection of the Data.

The possibilities offered are described in paragraph 2. 7. .



F7 CHARTS PRESENTATION

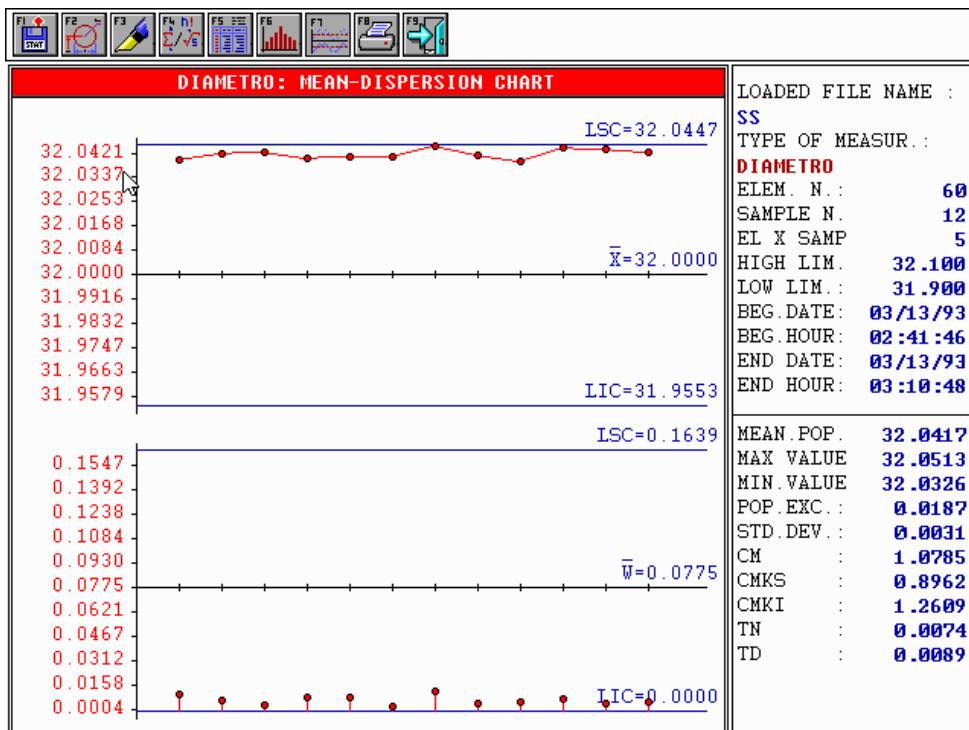
Selecting this option in the Area 2 will appear a Window with title:

MEANS DISPERSIONS CHART

where are showed the charts (X, W) or (X, S).

The Figure N. 20 contains the relative chart of the preceding example.

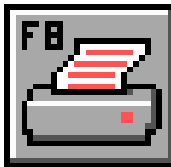
Figure N. 20



The charts contain all the informations to verify if a process is " in control."

Results shown in graphic form can indicate the situation of the process examining the color of the area inside the circle, and exactly:

- All the green areas denote : **PROCESS IN CONTROL**
- A single red area denote : **PROCESS OUT OF CONTROL**



F8 PRINT OUTPUT

This option allows to print what displayed on the video after the selection of any of the options F4, F5, F6, F7.



F9 EXIT

This option allows of exit from the program.

This necessity could be verified, obviously for leaving the program of Statistic, but also for statistical computations of data recorded on different File from that previously selected.

2.8.2. DATA THAT APPEAR IN THE AREA

Using the options F4, F5, F6, F7, F8, will always be displayed not only the graphic and numerical results in the Area 2 previously described, but also a series of data shown in numerical form in correspondence of the Area 4.

These data, divided in two groups, are in practice the same that appear in the Area 2 selecting the option with the key F4 .

The meaning of these data is described in Figures N. 21 and N. 22 .

Figure N. 21

UPPER ZONE

DATA DESCRIPTION	DATA MEANING
LOADED FILE NAME	Name of the file loaded at the beginning
MEASUREMENT TYPE	The assigned name will appear initially to the selected type of measurement
N. Elem.	Total number of the selected elements
N. Samp.	Number of the selected samples
El. for Sample	Number of the elements for sample
Upp. Lim.	Upper limit, if assigned (*). On the contrary a row of asterisks will appear.
Low. Lim.	Lower limit, if assigned (*). On the contrary a row of asterisks will appear.
Date Beg.	Date of execution and saving of the first measurement for that File.
Hour Beg.	Hour of execution and saving of the first measurement for that File.
Date End.	Date of execution and saving of the last measurement for that File.
Hour End.	Hour of execution and saving of the last measurement for that File.

Figure N. 22

LOWER ZONE

ELABORATED DATA	ELABORATED DATA MEANING
Mean Popul.	Average value between values selected for Datum.
Max. Value	Maximum value between values selected for Datum
Min. Value.	Minimum value between values selected for Datum
Range Value.	Difference between maximum value and minimum value
Stand. Dev.	Standard deviations
Cm	Capability. It can be computed and displayed only if have been assigned the Upper and the Lower limit (*).
Cm ks	Capability . It can be computed and displayed only if has been assigned the Upper limit (*).
Cm ki	Capability . It can be computed and displayed only if has been assigned the Lower limit (*).
Nat. Tol.	Natural Tolerance
Nominal Tol.	Nominal Tolerance . It can be computed and displayed only if have been assigned the Upper and the Lower limit (*).

(*) The values of the Upper and Lower limit could be present because assigned temporarily with the option F3.

2.8.3. FURTHER CONSIDERATIONS ON THE PRESENTATION OF THE STATISTICAL COMPUTATIONS RESULTS

As denoted in correspondence of the description of the option F3, the limits of the tolerances could be changed in accordance with the modalities a), b), c), d).

In the Windows of the Figures previously showed it has been represented always, in practice, the case a).

Possible changes could determine the following variations:

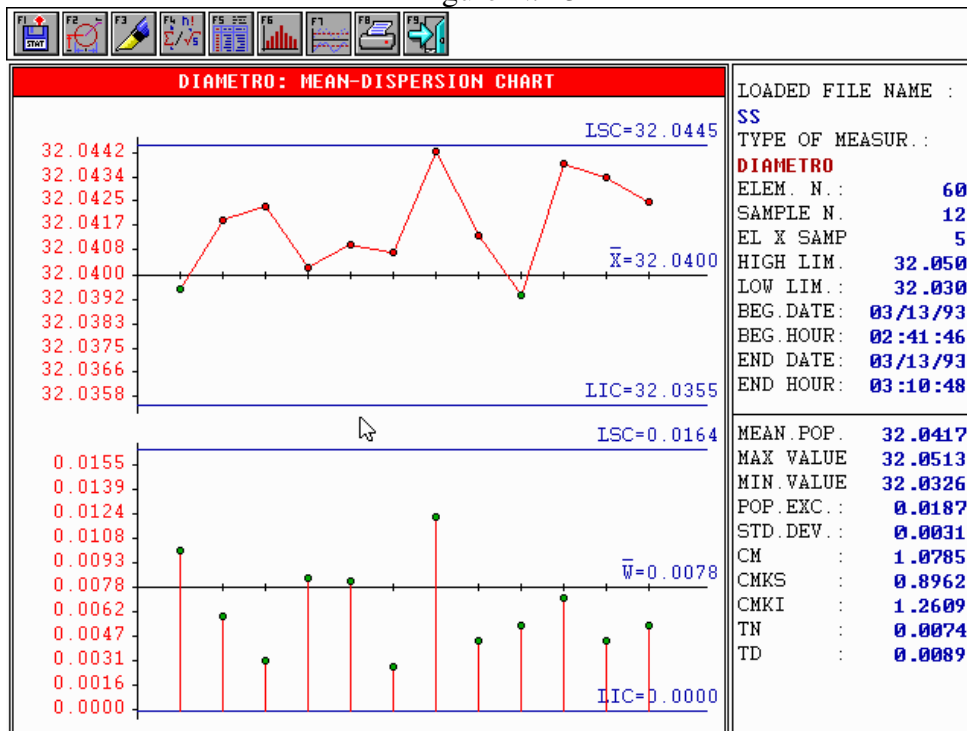
- in the data displayed in the Area 4 in all the Windows.
- in the statistical data in numerical form of the Figure N. 18 (option F4).
- in the statistical data in graphic form of the Figure N. 20 (option F7).

Case 1) : Modified Limit

The variation regards only the changes of the Upper and Lower Limits, and the results of the consequent computation of C_m , C_{mks} , C_{mki} and TD.

In the Figure N. 23 are displayed both the variations.

Figure N. 23



Case 2) : Limits not assigned or excluded

In case the Limits have not been assigned, in correspondence of Upper Limit, Lower Limit, Cm, Cm ks, Cm ki will be displayed some asterisks.

The variation involves that the zone of acceptance has located in operation to the natural tolerances, not of those to design.

In the Figure N. 24 are displayed the variations.

Figure N. 24

