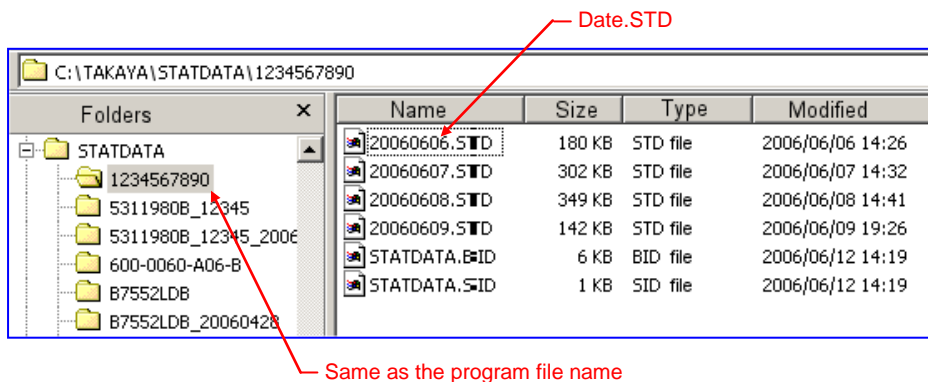


## Statistic function

The Statistic function, available in the software Ver1.0-9 or later of the Takaya APT-9411 series, enables to analyze the test results to quantify and/or graph average value, variation, stability and process capability index (Cp/Cpk) based on the measured value at each step.

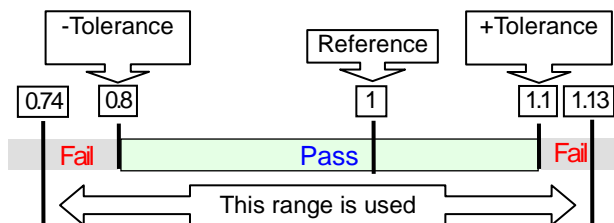
### 1. General specifications

- (1) The test result data obtained under test is analyzed to make it available for the process management and/or the reexamination of test programs.
- (2) All the output available as statistical data are "Score", "Sigma/Deviation", "Cp", "Cpk", "Accuracy", "Min", "Max", and "Avg". These values could be recalculated by changing the reference value and/or the tolerance.
- (3) The test result data is always managed by date when it was obtained and is saved with an extension "STD" automatically at the same time as the test program is saved. In addition, the destination of the test result data file to save is "STATDATA" folder which is automatically created inside the folder specified in Master mode:



Basic things to know is, when a test program file is moved to another PC, it is necessary to copy the test result data inside the STATDATA folder at the destination as well.

- (4) It is not until the same test program is tested more than three (3) times that the Statistic function becomes effective. In addition, the more the test result is, the more the statistical data is reliable. Usually, the APT software acquires the test result data only based on following conditions.
  - 1) Test program excluding the test results of "SHORT" and "OPEN"
  - 2) The test result data should be in the range where is divided into 10 equal parts between the reference value and the tolerance and is added by 3 equal parts from the tolerance.  
(Ex.) Reference: 1KO, +Tolerance: 10%, -Tolerance: 20%



In the case below, the APT software doesn't acquire the test result data for the Statistic function;

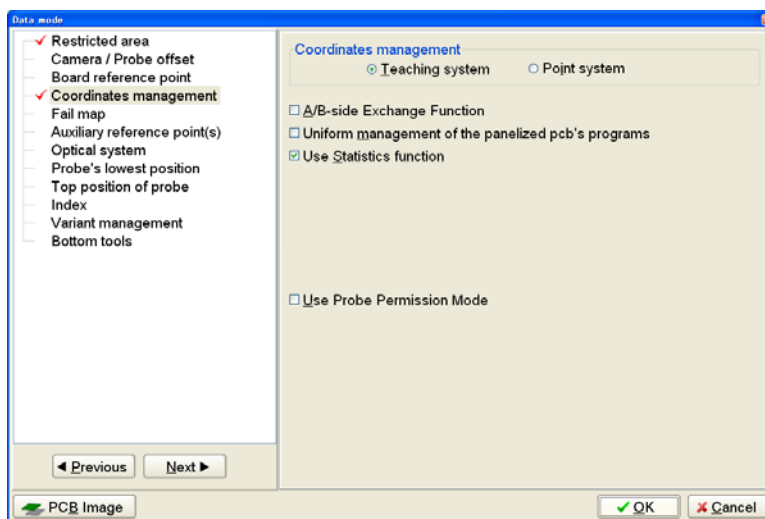
- ✓ Region test function (Test menu > [I] key)
- ✓ Fail retest function (Test menu)

In addition, the APT software doesn't acquire the test result data from the step that corresponds to any of the following;

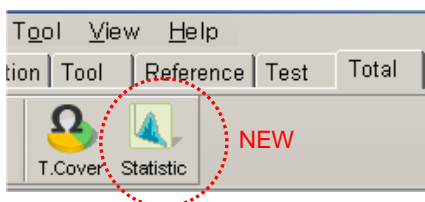
- Step without reference value
- Step which upper/lower tolerance ([+%) and [-%]) is "0"[%]
- Optical step which lower concordance rate is less "30"[%]
- Step for external equipments (BST step, DDE step, PS-ZD step, IO/G step)
- IO step (IO/O, IO/I, IO/T, IO/M, IO/V, IO/P, IO/C, IO/U, IO/W, IO/X)
- JP step
- Special JP step
- SH step
- OP step
- AJ step
- WA step (Normal test step, Optical test step)
- D judge step
- E judge step
- F judge step
- SS step

## 2. Activate Statistic function

- 1) Check the box "Use Statistic function" in Data mode, and the test result will be accumulated in the manner mentioned above.

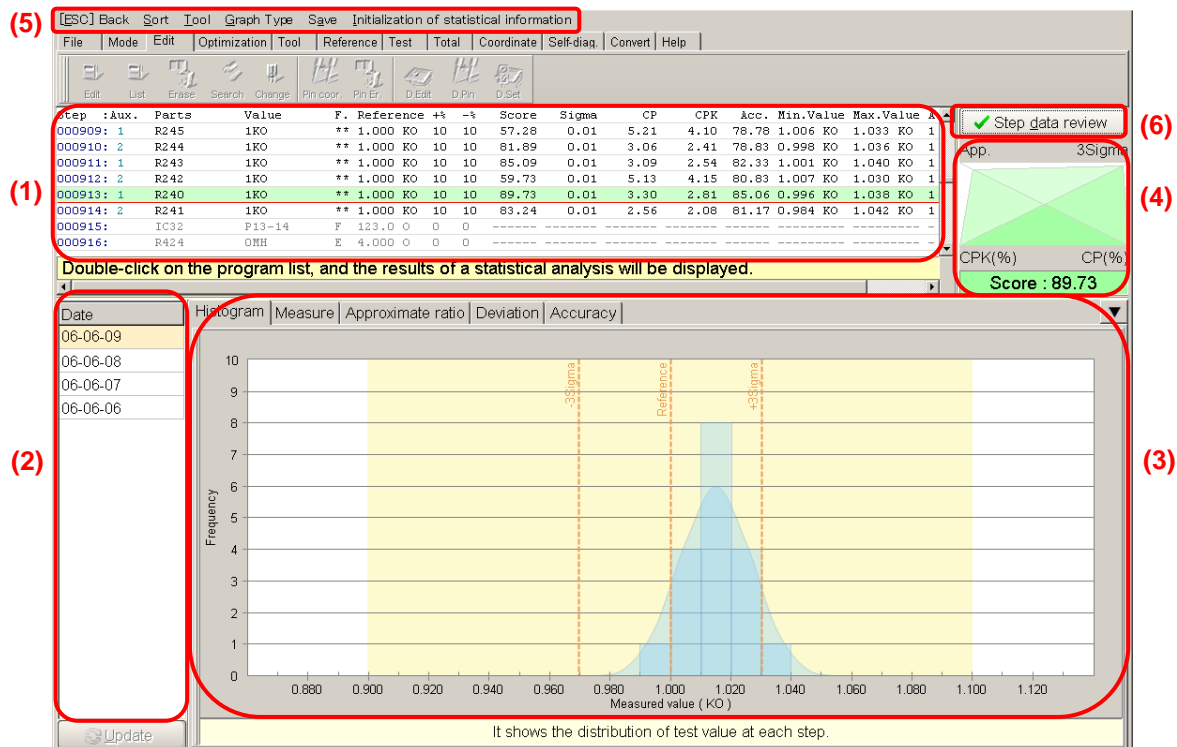


- 2) Use the mouse to click "Statistic" icon on the Tool bar (or select Test > Total > Statistic function), and the APT software pops up the Statistic function menu to show the updated analysis.



### 3. Explanation of Statistic function menu

The Statistic function menu analyzes the test result data specified by date to graph and list. In addition, it shows the results of a comprehensive analysis at “Score” column to get a rough idea whether the test program needs further examination or not.



Statistic function menu

#### (1) List display

A list of the analysis of the test result data. It's possible to directly correct the reference value and the tolerance based on the analysis.

- The steps displayed in light green are currently shown on the graph and the Score field.

```
000001: R1 1.5KO ** 1.500 KO 10 10 39.18 0.04 1.21 0.56 46.44
```

- The steps displayed in blue indicate that the test result data obtained under test is less 3. In this case, no analysis is displayed.

```
000003: R3 1.8KO ** 1.800 KO 10 10 -----
```

- The steps displayed in gray indicate that they are not supported by the Statistic function or have got no reference value yet.

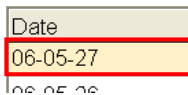
```
000006: C3 133 JP 13.00 nF 30 30 -----
```

- If you want to display another analysis on the menu, use the mouse to double click on the step. In addition, you just have to press [+] key (or [-] key) when you want to choose the next step (or the previous step).

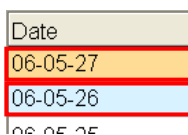
## (2) Date

This field displays the date when the test result data was obtained. The analysis specified by date is displayed on the menu.

- Use the mouse to click the date and Update button, and the specified analysis is displayed on the menu.
- It allows multiple selection of the date. In addition, if pressing Ctrl+A key while any date is selected, all date will be selected.
- The date field is displayed as follows.
  - The date displayed in light orange shows that the analysis is currently displayed on the menu.

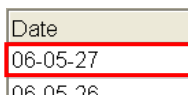


- If the date that the analysis is currently displayed on the menu is selected by the mouse, it changes to orange.



- ← In case that the analysis is already displayed on the menu
- ← In case of other date not display the analysis

- The date not display the analysis or not selected by the mouse is white.

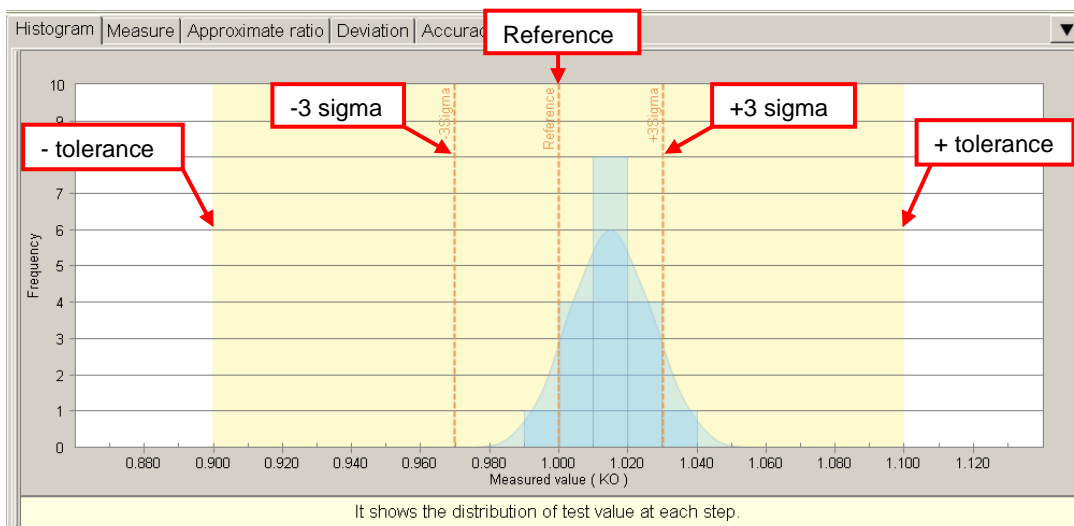


## (3) Graph display of analysis

The analysis is displayed on 5 different graphs.

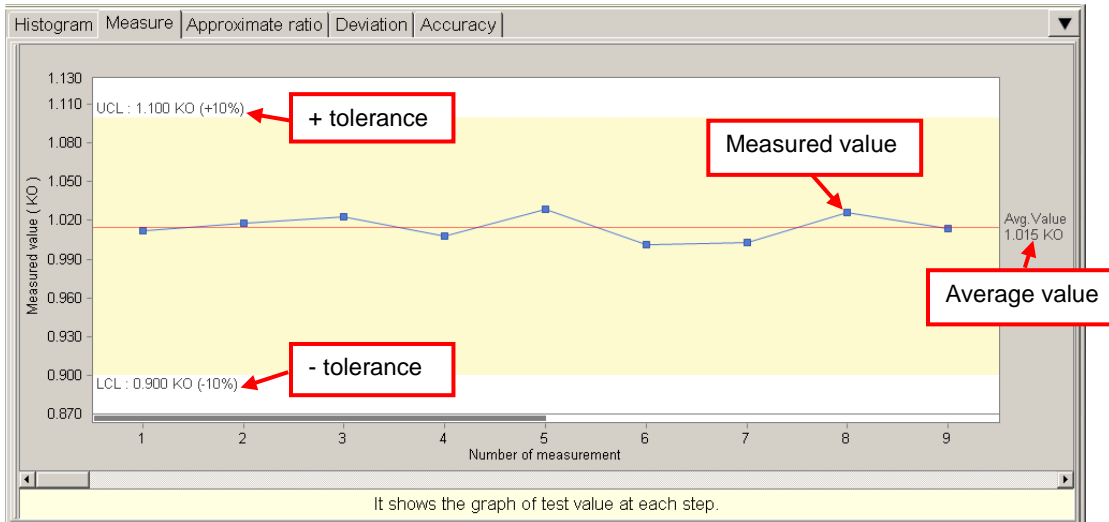
### 1) Histogram

The measured value counted in each range where is divided into 10 equal parts between the reference value and the +/- tolerance is displayed on a bar graph. This will enable you to understand aggregated distribution of the measured value against the reference value and the +/- tolerance.



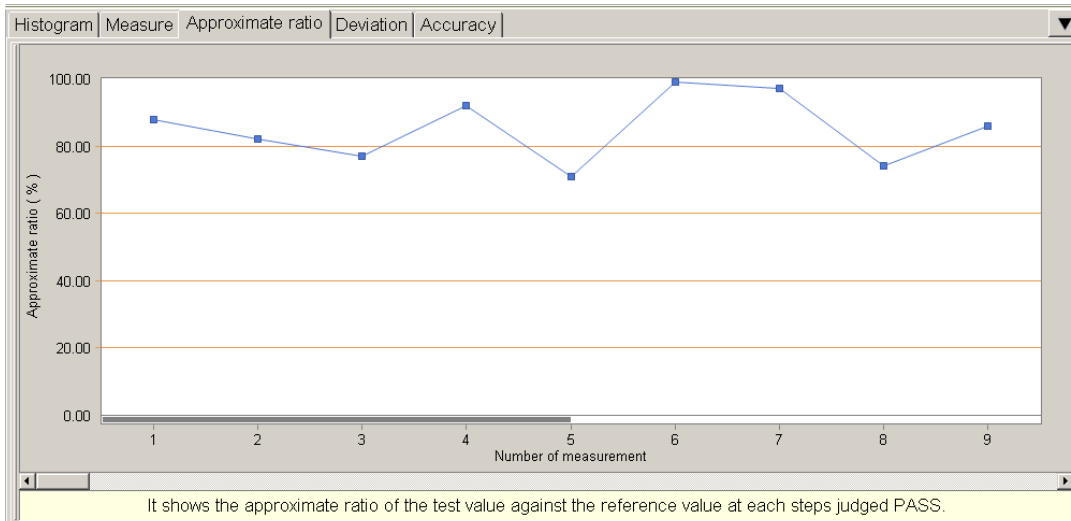
### 2) Measure

The measured value obtained under each test is displayed on a graph. This will enable you to understand data spread of the measured value and the average value at each test. In the case of multiple selection of the date, the graph is displayed on date to date basis.



### 3) Approximate ratio

It is displayed on a graph how the measured value is close to the reference value while comparing them at each test. In the case of constant state of low measurement, it will be necessary to reexamine the test steps.



The Approximate ratio is calculated based on Upper tolerance value (UCL), Measured value ( $x$ ) and Reference value ( $X$ ).

i) In case of  $x > X$

$$a \quad p = \frac{U - Cx}{U - CL} \times 100 [\%]$$

ii) In case of  $x < X$

$$a \quad p = \frac{x - L}{X - L} \times \frac{C}{L} \times 100 [\%]$$

iii) In case of  $x = UCL, x = LCL$

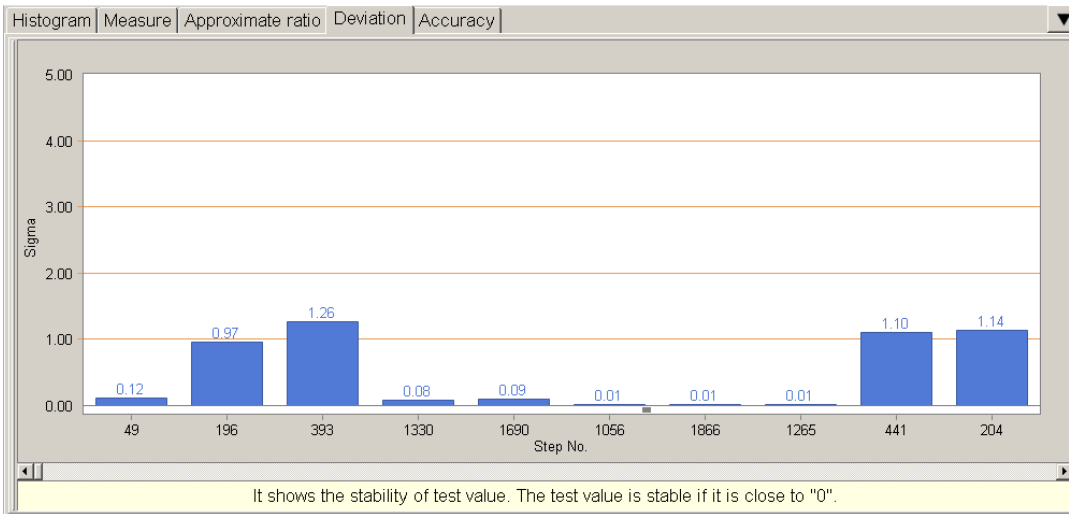
$$app = 0 [\%]$$

iv) In case of  $x = X$

$$app = 100 [\%]$$

#### 4) Deviation

This quantifies the measurement stability at each test step and display on a graph. The more you measure unstably, the bigger Sigma becomes. The reverse is also taking place. In the case of higher value, it will be necessary to reexamine the test steps.

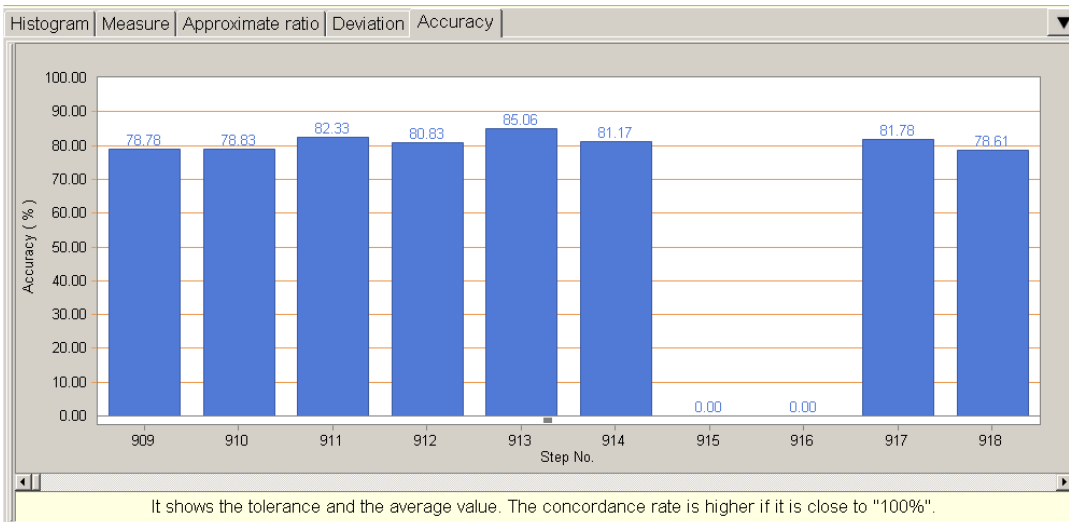


The Sigma ( $\sigma$ ) is calculated based on Measured value ( $x$ ), Average value ( $\mu$ ) and the numbers of test result data used for statistics ( $n$ ).

$$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \mu)^2}{n}}$$

#### 5) Accuracy

The concordance rate is displayed on a graph while comparing the average value to the center value of +/- tolerance. This will enable you to understand whether the +/- tolerance is appropriate. In the case of lower value, it will be necessary to reexamine the test steps.



The Accuracy is calculated based on Upper tolerance value (UCL), Lower tolerance value (LCL) and Average value ( $\mu$ ).

i) In case of  $\mu < \frac{UCL + LCL}{2}$  ( $UCL \neq LCL$ )

$$Accuracy = \left| \frac{\mu - LCL}{\frac{UCL - LCL}{2}} \right| \times 100 \quad [\%]$$

ii) In case of  $\mu > \frac{UCL + LCL}{2}$  ( $UCL \neq LCL$ )

$$Accuracy = \left| \frac{\mu - UCL}{\frac{UCL + LCL}{2}} \right| \times \frac{L}{C} \quad [\%]$$

iii) In case of  $\mu = UCL$  ( $UCL \neq LCL$ )

$$Accuracy = 0 \quad [\%]$$

iv) In case of  $\mu \neq UCL$  ( $UCL = LCL$ )

$$Accuracy = 0 \quad [\%]$$

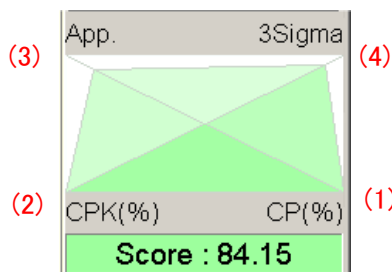
**6) Others**

It displays following screen when the test result data obtained under test is less than three (3) times or when the step is not supported by the Statistic function.



**(4) Score**

Overall judgment is made by 4 analyses and displayed on the Score field. The bigger the green area, the higher the overall judgment is judged. In the case of low Score, it will be necessary to reexamine the test steps.



The Score is calculated based on an area of square that is configured by CP, CPK, App and 3Sigma.

$$Score = \frac{Area\ of\ inner\ square}{Area\ of\ outer\ square} \times 100$$

In addition, the Score has different display colors as follows.

- Less than 50: red
- 50-70: blue
- 70-100: green

1) Cp

The Cp value indicates degree of data spread in the measurement. The big Cp value is regarded as having small data spread in the measurement or unnecessarily wide tolerance. On the other hand, the small Cp value is regarded as having wide data spread in the measurement. In general, the Cp value should be in the range of 1.33 ~ 1.67 for stable measurement.

2) Cpk

The Cpk value adds the difference between the average value and the center value of +/- tolerance to the Cp value. In general, the Cpk value should be in the range of 1.33 ~ 1.67 for stable measurement.

Both the Cp value and the Cpk value are calculated based on Upper tolerance value (UCL), Lower tolerance value (LCL), Deviation value ( $\sigma$ ) and Average value ( $\mu$ ).

$$C_p = \frac{UCL - LCL}{6\sigma}$$

$$C_{pk} = C_p(1 - k)$$

$$k = \frac{\left| \mu - \frac{UCL + LCL}{2} \right|}{\frac{UCL - LCL}{2}}$$

<b>Cpk(Cp) &lt; 0.67</b>	The tolerance is too narrow or the measurement varies widely and is unstable.
<b>0.67 ≤ Cpk(Cp) &lt; 1.00</b>	The tolerance is slightly narrow or the measurement has slight variation.
<b>1.00 ≤ Cpk(Cp) &lt; 1.33</b>	The tolerance is generally appropriate or the measurement doesn't have much variation.
<b>1.33 ≤ Cpk(Cp) &lt; 1.67</b>	The tolerance is appropriate or the measurement has only a few variations and is stable.
<b>1.67 ≤ Cpk(Cp)</b>	The tolerance is too wide or the measurement has very few variations and is stable.

3) App

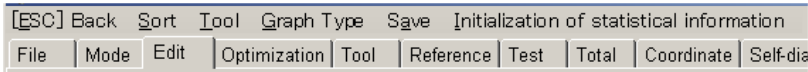
This indicates the average value of approximation rate at each test. When the reference value becomes far removed from the average value, the approximation rate is lower.

4) 3 sigma

This indicates the ratio of Area inside ±3 sigma to Area inside a spline curve of the histogram.

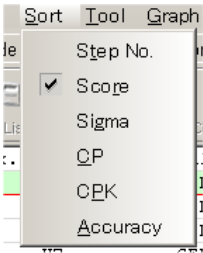


### (5) Menu bar



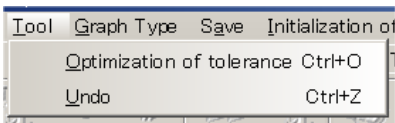
#### 1) Sort

This enables to sort the list in a predefined order.



Step No.	Sort in numeric order of steps
Score	Sort in ascending order of Score
Sigma	Sort in descending order of Sigma
CP	Sort in ascending order of Cp value
CPK	Sort in ascending order of Cpk value
Accuracy	Sort in ascending order of Accuracy

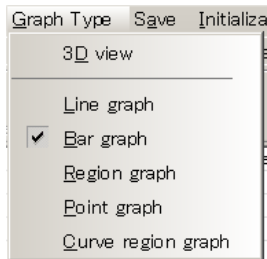
#### 2) Tool



Optimization of tolerance	Auto-configure the tolerance so as the Cp value and the Cpk value at the step which result of analysis is displayed come close to 1.495. If no appropriate tolerance was set, the reference value will be changed.
Undo	Undo the measuring conditions changed at Optimization of tolerance.

#### 3) Graph Type

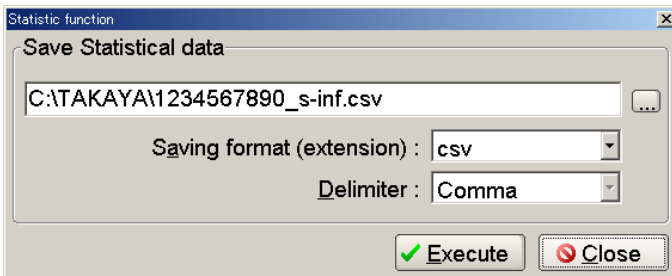
This enables to set graph type that you want.



3D view	Displayed in a 3D graph
Line graph	Displayed in a line graph
Bar graph	Displayed in a bar graph
Region graph	Displayed in a region graph
Point graph	Displayed in a point graph
Curve region graph	Displayed in a curve region graph

#### 4) Save

This enables to output the list to the file.

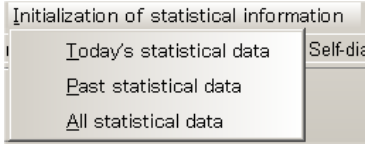


After specified the destination to save and the file name, press the Execute button so that the file is output.

Saving format (extension)	Choose the format in which to save the file. (CSV or TXT)
Delimiter	Choose the delimiter. CSV format → Comma only TXT format → Space, Comma, Semicolon, Tab

5) Initialization of statistical information

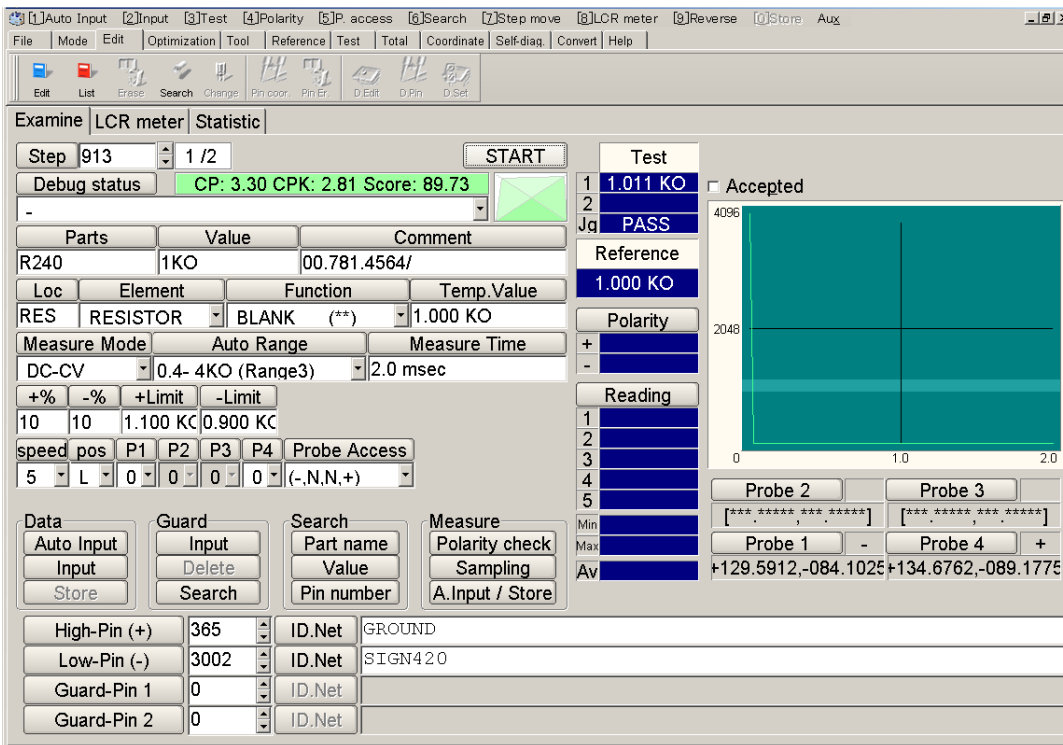
This enables to initialize the acquired statistic data.



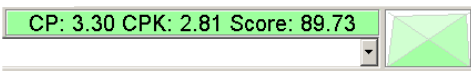
Today's statistical data	Initialize all the data of today.
Past statistical data	Initialize all the data obtained in the past (exclude today)
All statistical data	Initialize all the data obtained in the past (include today)

(6) Step data review button

Pressing "Step data review" button, it moves to the Step data review menu.



1) The Step data review menu shows CP, CPK and Score. Once if either the reference value or the tolerance was changed, these values will be recalculated.



If another measuring condition was changed on the Step data review menu, the statistic data will be initialized. In this case, CP, CPK and Score will be also initialized at the same time.

2) You can move to Examine, LCR meter or Statistic function menu by clicking the Tab title.

