GausSPC

v. 2.1

Statistical Process Control Software

User Guide

RLS d.o.o.
September 2005

INDEX

1 MEASURING INTERFACES

Measuring interfaces are devices used to connect gauges to the PC. The following measuring interfaces are supported by GausSPC 2.1:

Measuring interface	Manufacturer	Gauge type	Notes
MBox – 1	Bobe	4 x Digimatic	
MBox – 2	Bobe	8 x Digimatic	
MBox – 15	Bobe	6 x Opto RS232	
MBox – 16	Bobe	4 x Digimatic 3 x Opto RS232	
MBox – 22	Bobe	6 x Digimatic 2 x Opto RS232	
MBox – 26	Bobe	2 x Digimatic 5 x Opto RS232	
SBox – 9	Bobe	1 x Digimatic	
SBox – 25	Bobe	2 x Digimatic	
HF – MS	Bobe	8 x Digimatic / Mahr / Tesa	1)
Opto RS232	Tesa, Helios, Mahr	1 x Opto RS232	2)
DMX – 1	Mitutoyo	1 x Digimatic	
MUX – 10	Mitutoyo	3 x Digimatic	
MUX – 50	Mitutoyo	8 x Digimatic	
mc4	IBRit	8 x Digimatic	
Other	Various manufacturers	Various gauges	3)

All measuring interfaces are connected to the PC through COM ports (or through the USB port using a RS232-to-USB adapter).

Notes
1) Wireless connection between gauges and the measuring interface
2) Connect the gauge with Opto RS232 output directly to the COM port of the computer
3) Interfaces which emulate a keyboard (e.g. Digi-USB1, DMX-3T, TBox-206). Measurements are entered as if they were entered manually.

1.1 WAYS TO TRIGGER MEASUREMENTS USING DIFFERENT MEASURING INTERFACES

Measuring Interface	Measurement Trigger
MBox – 1	Footswitch (external trigger)
MBox – 2	Footswitch (external trigger)
MBox – 15	Footswitch (external trigger)
MBox – 16	Footswitch (external trigger)
MBox – 22	Footswitch (external trigger)
MBox – 26	Footswitch (external trigger)
SBox – 9	Footswitch (external trigger), button on gauge
SBox – 25	Button on gauge, footswitch (with FS/25 adapter)
HF – MS	Button on gauge
Opto RS232	Button on gauge
DMX – 1	Footswitch (external trigger), button on gauge
MUX – 10	Footswitch (external trigger), button on gauge
MUX – 50	Footswitch (external trigger), button on gauge
mc4	Footswitch (external trigger), button on gauge

1.2 INSTALLATION OF MEASURING INTERFACES AND GAUGES

- **MBox -1, MBox-2, MBox-15, MBox-16, MBox-22, MBox-26**
  - The measuring interface is connected to the computer by a cable with 9- pin D connectors at both ends. Plug the cable into the socket labelled RS232C at the rear side of the measuring interface and plug the other end of the cable into a PC COM port.
  - The footswitch is plugged into the Fusstaster socket (15-pin D connector) at the rear side of the measuring interface.
  - Connect the gauges (using data cables) to the sockets labelled 1 to 6/8, (these are also channel numbers) at the rear of the measuring interface.
  - Finally, connect the measuring interface to the power supply and switch on.

- **SBox-9, SBox-25**
  - Connect the measuring interface to a free COM port on the computer
  - Connect the footswitch to the measuring interface (3.5mm round connector).
  - To connect a footswitch to SBox-25 you will also need an FS/25 adapter.

- **Opto RS232**
  - With Opto RS232 you do not need an interface as you can connect a gauge featuring the Opto RS232 output directly to the computer COM port.

- **DMX-1**
  - Connect the measuring interface to the computer COM port.
  - Connect the Digimatic gauge and the footswitch.

- **mc4**
  - Connect the measuring interface to the computer using a cable with 9-pin connectors at both ends.
  - Connect the footswitch to the trigger socket (9-pin D connector) at the front of the measuring interface.
  - Use data cables to connect the gauges to the sockets labelled 1 to 8 (these are also channel numbers) on the front of the measuring interface.
  - Connect the measuring interface to the power supply and switch on.

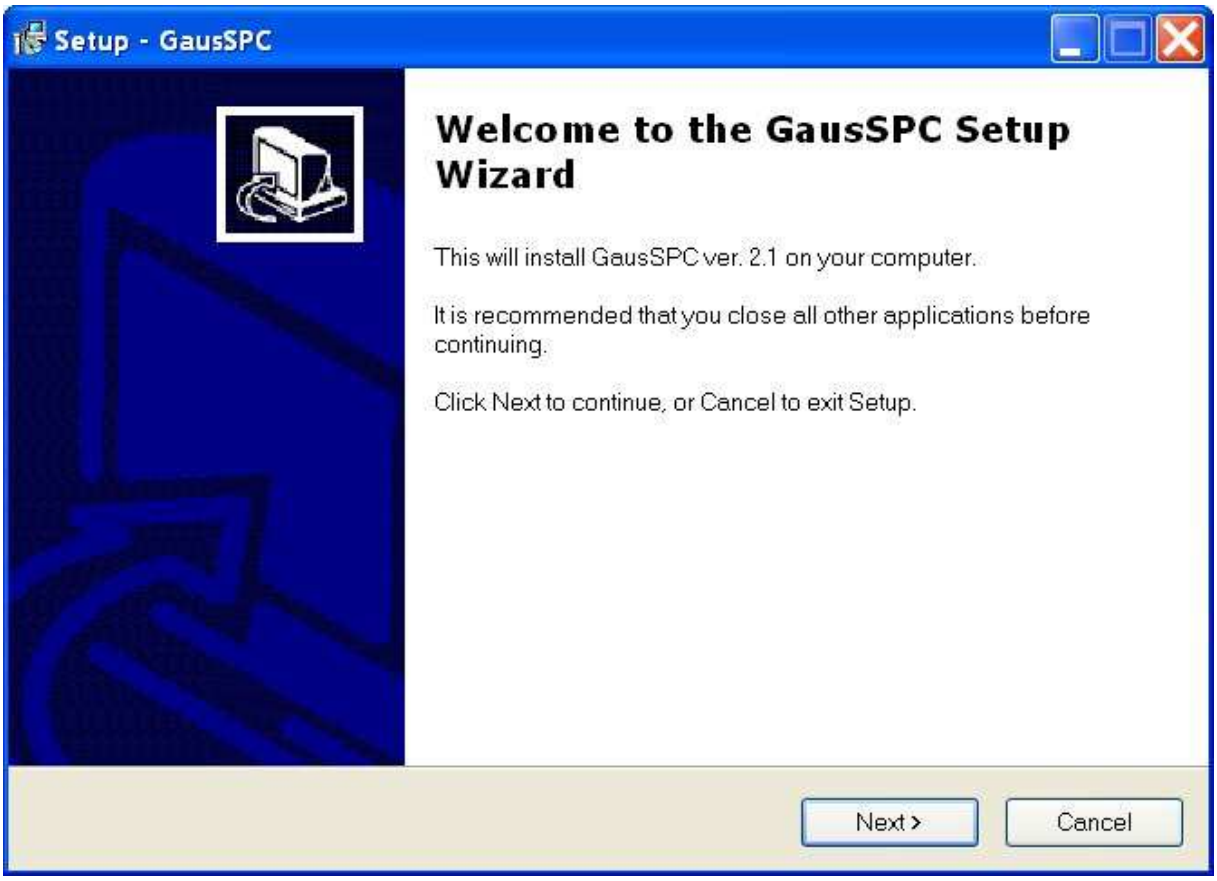
1.3 MANUAL ENTRY OF MEASUREMENTS

It is also possible to enter measurements manually. Administrator and Controller user groups (see Section 3) can enter measurements without limitations, while the Operator user can only enter measurements for characteristics for which manual entry has been explicitly permitted. GausSPC allows you to choose the direction in which the cursor moves after each measurement is entered.

2 SOFTWARE INSTALLATION AND ACTIVATION

Run the “setup.exe” file you have downloaded from the www.gausspc.com website.

The Setup Wizard will guide through the installation process.



Click the “Next >” button and select whether you accept the license agreement. If you do not accept the license agreement the installation process will be terminated and GausSPC will not be installed. If you accept the license agreement, select the “I accept the agreement” and click the “Next >” button.

In the next screen you can change the folder to which GausSPC should be installed. Change the folder if you want to, and than click the “Next >” button.

In the next screen, check the installation settings and click the “Install” button to install GausSPC.

Click the “Finish” button.

2.1 BUYING AND ACTIVATING GausSPC

After you have installed GausSPC, it will run for 30 days in the trial mode to enable you to test its full functionality. After 30 days it will switch to demo mode with limited functionality.

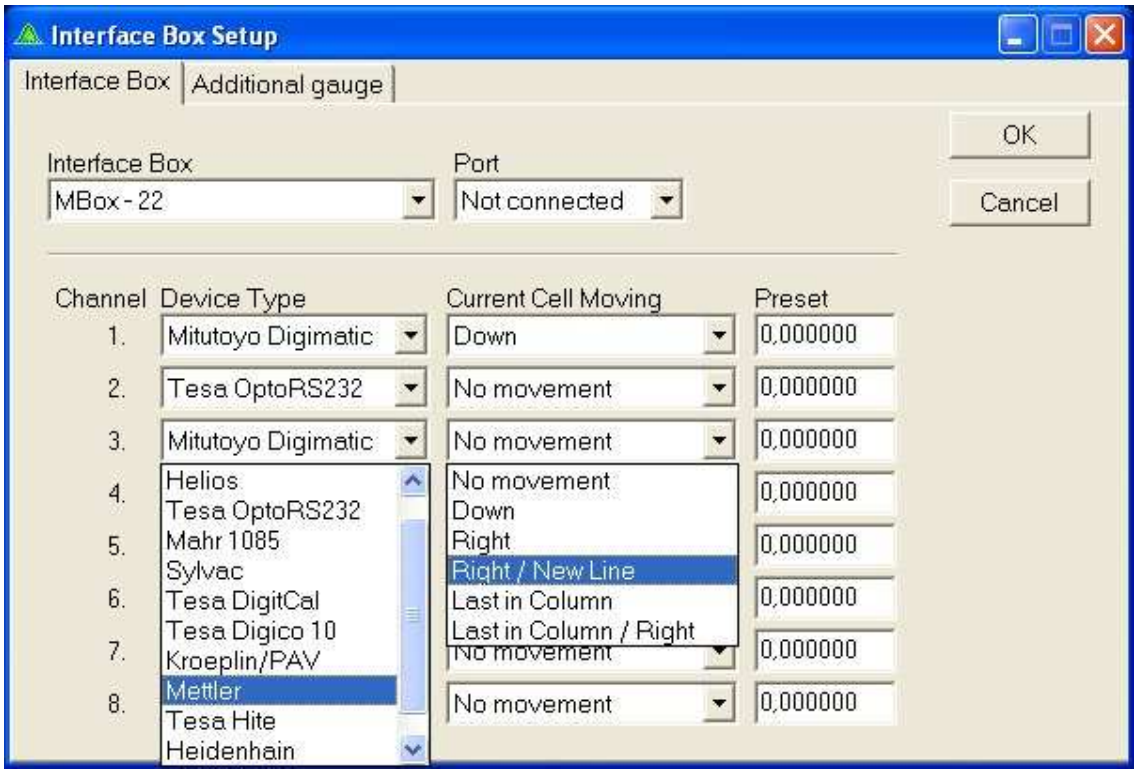
To activate full functionality, you can buy a GausSPC license by selecting Help / Buy GausSPC from the main menu in GausSPC. You will be then taken to the website which will guide you through the purchasing process.

After purchasing the license, select Help / Activate GausSPC from the main menu. Click the Help button in the dialog box that appears and follow the simple instructions.

3 RUNNING GausSPC FOR THE FIRST TIME

Double-click the GausSPC icon on the Desktop to start.

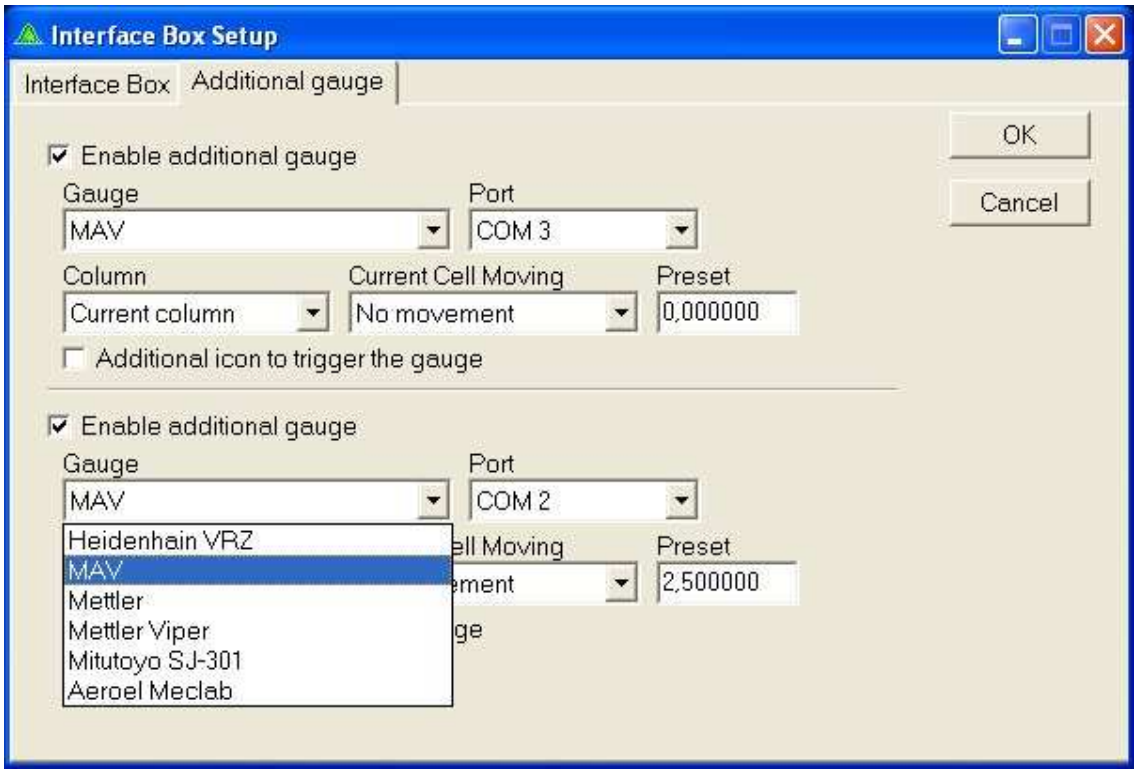
A dialog box appears in which you will choose the measuring interface and the computer port to which it is connected. If you are not using a measuring interface, select “not connected” in the computer port field. Otherwise, for each channel of the measuring interface, set the type of gauge, the cursor movement after measurement entry and any values to be added to each measured value (Preset – this value will usually be 0). Measurements are triggered by pressing the footswitch or the button on the gauge (please see the table in Section 1.1).



GausSPC also supports measurement entry from some other gauges, not only those which are connected through a measuring interface. Click the ‘Additional Gauge’ tab and select the type of gauge, the computer port, column for entry, cursor movement after entry and any addition to the measured value (Preset).

Trigger the transfer of data by pressing the button on the gauge (e.g. Print button) or by clicking the additional button (icon) in the GausSPC toolbar.

Currently supported are MAV force measurement devices, Mettler Viper scale, Heidenhein VRZ counter, Meclab laser profile measuring device.



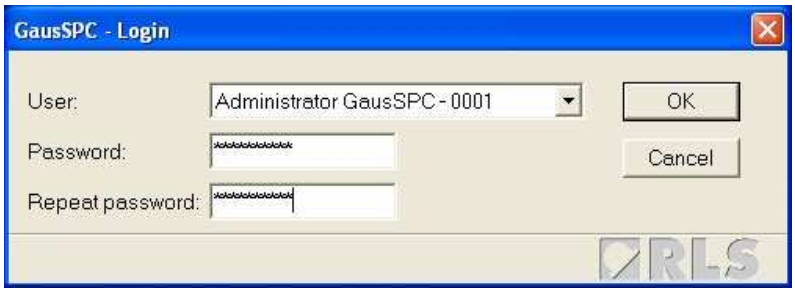
Click the OK button.

If the message below appears, it can either mean:

- The measuring interface is not connected to the computer
- The measuring interface is connected to the computer but not through the specified COM port.
- The measuring interface is not switched on.
- The correct measuring interface was not selected.

If the error message repeats even though you have checked the above criteria, click the Ignore button, continue with log-in and then in the main window repeat the selection by selecting Interface Box/Setup.

User Log-In follows

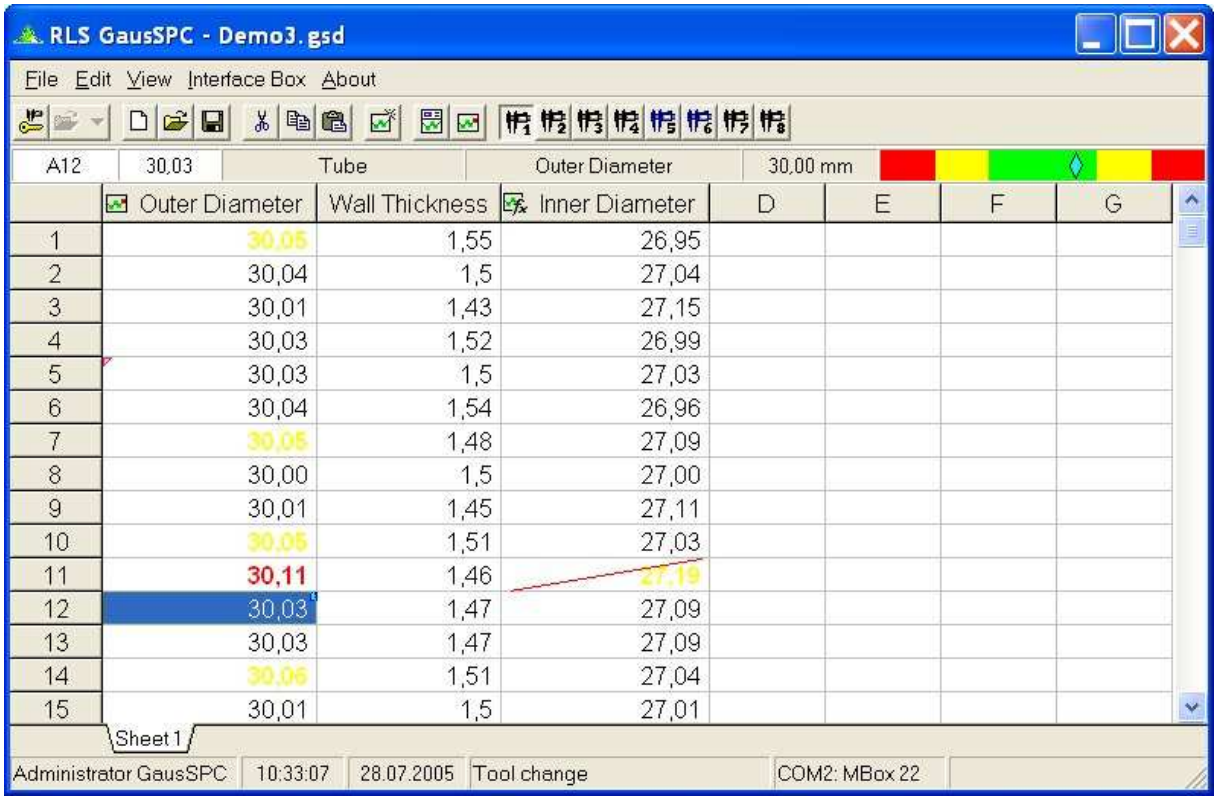


If you are running GausSPC in the 30-day trial mode, you do not need to enter the password.

Select your user name from the drop-down list (sorted alphabetically), and type in your password. If the user is typing in their password for the first time, they will be asked to confirm it. Click OK. See Section 8 - Managing Users for further details.

Users are categorised into three groups: Operator, Controller and Administrator. Administrators have access to all software settings, Controllers have the same rights as Administrators – their only limitation is that they cannot access the User List. The Operator is the user with the least rights and can only enter measurements.

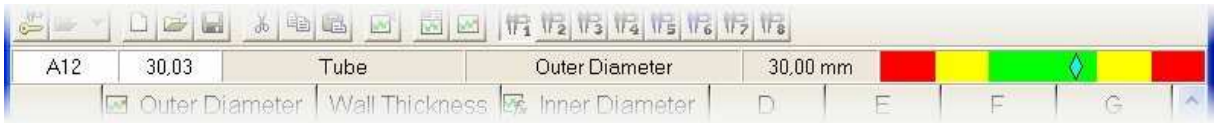
3.1 ADMINISTRATOR LOG-IN AND THE GausSPC MAIN WINDOW



Above is a typical GausSPC main window with a worksheet containing measurements, the menu, toolbar and two status bars. The cursor (the blue coloured active cell) is moved through the sheet using the arrow keys, PgUp, PgDn, Home and End keys. The screen view can also be moved by using the scroll bar on the right of the screen.

Measurements are entered into the cells on the worksheet. GausSPC is designed such that each worksheet relates to one product and each column on that worksheet relates to one characteristic of that product.

The buttons on the toolbar from left to right are: User Log-Off, New Worksheet, Open File with Measurements, Save File. The next group of three buttons are used to Cut, Copy and Paste measurements. The New Chart button follows, which puts a new chart into your report. The next two buttons are Show Report and Show Quick Chart. The last group of icons represent gauges connected to the measuring interface.



The upper status bar gives information on cell location, value, product part number/name and nominal value of the characteristic. For double-sided tolerances, the relative position of the measurement in relation to the tolerance field is graphically presented.

A chart symbol next to the name of the characteristic in the column's title bar means that this characteristic has a Quick Chart assigned to it, which will be displayed after each entry or change of measurement. The chart symbol with letters 'fx' shows that the characteristic is being calculated from values from other columns.

Where a measurement is coloured yellow, this means that it is outside reduced tolerances or outside the middle-half of the tolerance field. The red coloured measurement warns of measurements outside of predefined tolerance limits. A blue square in the right corner of a cell means that there is a note attached to that measurement. A violet triangle in the left corner of a cell means that the previous value of the cell was overwritten. A measurement with a red strike through will not be included in any statistical calculations and will not be displayed in charts or reports.

In the lower status bar you can see the name of the Operator and the time the measurement was taken. If the cell is empty, the current time will be displayed. To the right you can see which measuring interface is connected and to which port.

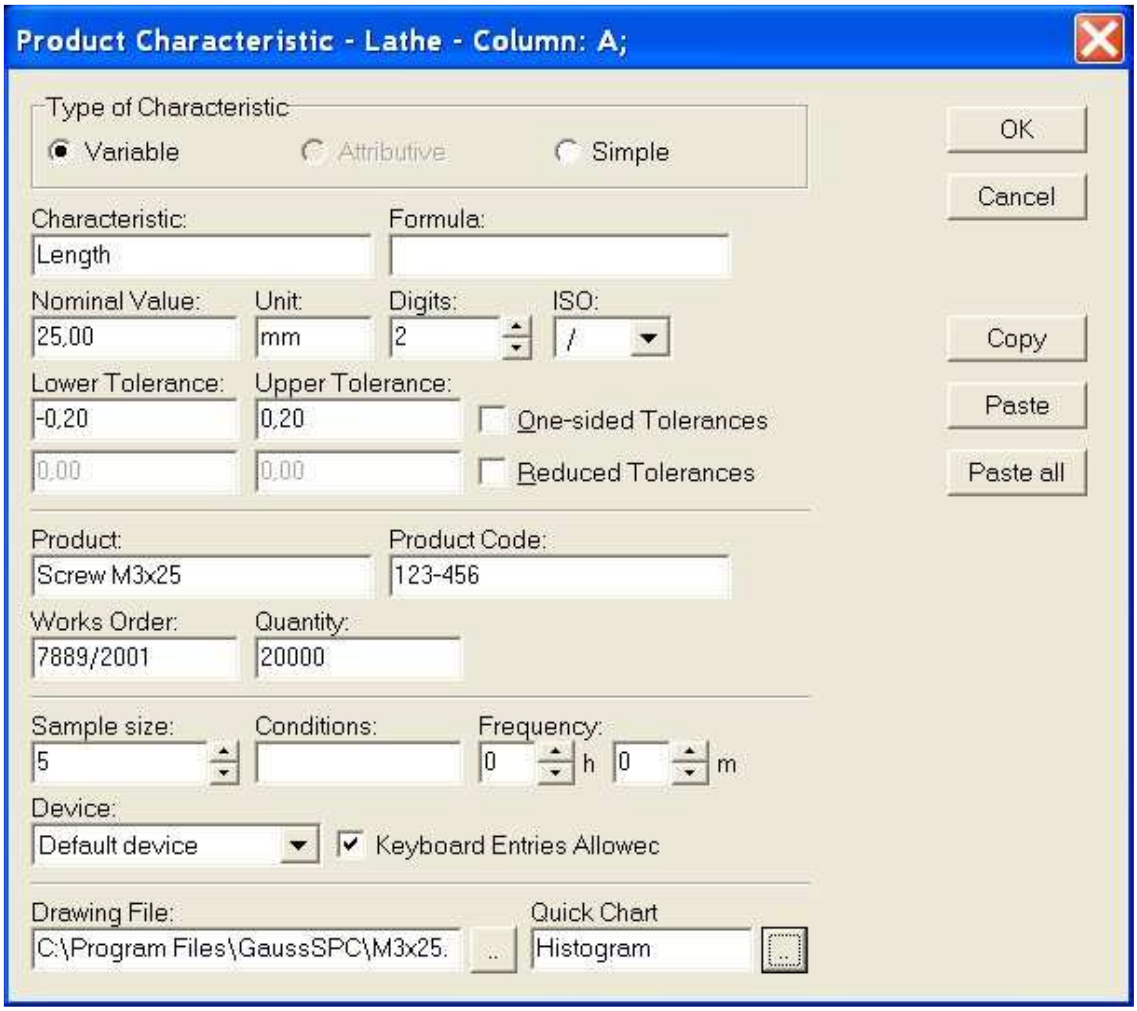
GausSPC can work on multiple worksheets simultaneously. All of the worksheets are saved in a single file.

3.2 EDITING THE WORKSHEET

An empty worksheet consists of 8 columns and 8191 rows by default. You can add up to 255 columns to each worksheet. Each file can contain up to 16 worksheets.

3.3 COLUMN PROPERTIES – SETTING A CHARACTERISTIC OF A PRODUCT

Right click the title row of the column or click Edit / Column Properties on the menu to complete the fields of the dialog box which define a single characteristic of a product.



First choose the type of characteristic:

- 'Variable' is the most common – choose this option for characteristics for which values are changing from measurement to measurement and which have a defined tolerance field
- 'Attributive' should be selected when you only type in the Go / No Go status.
- 'Simple' – values for a single characteristic vary from measurement to measurement like the variable characteristic but they do not have a defined tolerance field. Choose this type when you do not intend to monitor the measurements through control charts or reports.

3.3.1 Variable Characteristics:

- Type the name of the characteristic into the 'Characteristic' field, e.g. 'Length'
- If the value of the characteristic is calculated from values from other columns, enter the formula for the calculation in the 'Expression' field.

Example: For the product Tube you are monitoring three characteristics - outer diameter (Column A), inner diameter (Column B) and wall thickness (Column C). It is not necessary to measure the thickness of the wall of the tube because you can calculate this from the difference between the outer diameter and the inner diameter. Enter '(A-B)/2' into the 'Expression' field. Each time you enter measurements into Column A and B, GausSPC will perform this calculation and enter the result into Column C.

Manual entry of values is not permitted into columns which contain calculations.

See Appendix A for further examples and descriptions of possible formulas.

- Enter the nominal value of the characteristic e.g 25.5
- Enter the unit e.g. mm
- If you select an ISO tolerance from the drop-down list, GausSPC will automatically enter the lower and upper tolerance.
- Select the number of decimal places shown for measurements, usually 2 or 3.
- Enter the lower and upper tolerance e.g. -0.3 and +0.5. The upper tolerance must be greater than the lower tolerance.
- If the characteristic is limited in one direction only (one-sided tolerance), you must select the 'One-Sided Tolerances' checkbox and enter only the upper tolerance or only the lower tolerance e.g. 25.3.
- You can also enter reduced tolerances.
- Now enter the product name, product code, work order, quantity of products per order, measuring conditions and sample size.
- Enter the frequency of measurement. You can opt for GausSPC to warn you when more time than defined has elapsed since the last measurement. If this is not required, set the frequency to '0'.
- In the 'Device' field, select to which channel your gauge (with which you will measure this characteristic) is connected. If you select 'Default' the gauge which is currently active will be used.
- Check the field 'Allow manual entry' if the Operator will enter measurements manually. If this field is not checked, the Operator will not be able to enter measurements via the keyboard.
- To each of the characteristics you can also assign an image file, which would then be displayed during measurements by pressing the F4 key e.g. an additional instruction for the Operator or a product image. The file can be selected from a list by clicking on the Browse button to the right of the entry field. GausSPC recognises .BMP, .ICO, .JPG and .WMF file types.
- By clicking on the button next to the Quick Chart field, you select the chart which will be displayed after entry of each new measurement or change to an existing entry. See Section 6 for further details regarding Quick Charts.

Usually the contents of the Product Name, Product Code, Work Order and Quantity fields are the same for all characteristics. Click Copy to copy the contents of these fields. Click OK.

In the title row of the column the name of the characteristic appears and in the upper status bar you can also see the Product Name, Nominal Value of the characteristic and its tolerances.

When defining the properties of the next column, click Paste or Paste All. The Product Name, Product Code, Quantity, etc, are entered for you.

3.3.2 Attributive Characteristics

Enter the name of the characteristic, the Product Name, Product Code, Work Order, Quantity, measuring Conditions, set the frequency of measurement and select the image file for the characteristic.

When you enter a value into the cell on the worksheet, type 1 for Go and 0 for No Go. At each entry of No Go GausSPC requires a Remark to be entered.

3.3.3 Simple Characteristics

It is sufficient just to enter the name of the characteristic. Measurements for simple characteristics can also be entered through a measuring interface.

3.4 INSERTING COLUMNS

To insert a new column select a cell, click Edit / Insert Column on the menu. The new column will be inserted to the left of the selected cell.

3.5 ADDING COLUMNS

A new column can be added by choosing Edit / Add New Column. The new column will be added at the far right of the worksheet.

3.6 DELETING COLUMN VALUES

You can delete column values by selecting Edit / Delete Values from the menu. You will be prompted for confirmation that you wish to proceed with this action.

3.7 ERASING COLUMNS

By selecting Edit / Erase Column, the properties for the product characteristics and any values entered will be erased. You will be prompted for confirmation.

3.8 DELETING (REMOVING) COLUMNS

By selecting Edit / Delete Column from the menu, the selected columns will be completely removed. You will be prompted for confirmation.

3.9 RENAMING WORKSHEETS

The sheet is renamed by right-clicking on the tab at the bottom of the worksheet or by choosing Edit / Rename Sheet on the menu. You can then insert the new name in the dialog box.

3.10 ADDING NEW WORKSHEETS

Click Edit / Add New Worksheet on the menu.

3.11 ADDING A DUPLICATE WORKSHEET

Click Edit / Add Duplicate Worksheet. The new worksheet will have the same name and the same characteristic properties as the current worksheet, but will not contain any values.

3.12 DELETING WORKSHEETS

Remove a worksheet by selecting Edit / Delete Sheet. You will be prompted for confirmation.

3.13 IMPORTING/EXPORTING DATA

Measurements can be exchanged with other applications e.g. MS Excel through the clipboard using the Edit / Cut / Copy / Paste commands. In GausSPC these commands are available from the menu, the toolbar and the popup menus. Only the values of measurements will be exported from GausSPC. Use Copy Special from the menu/popup menu to also copy other information about each cell e.g. time/ Operator/Remarks.

See Section 5 - Importing Data for further details.

When copying from the clipboard to GausSPC, the time of measurement displayed will be the current time (as opposed to the time the measurement was taken).

3.14 SHORTCUT KEYS

F2	select a job (only valid for users with Operator status)
F3	display measuring instructions
F4	show the image file assigned to the characteristic
F5	log-off
F9	recalculate characteristics which contain formula
F11	show / hide Quick Chart
F12	show / hide Report Window

3.15 OPERATOR LOG-IN

The Operator user must enter their username and password, they must then select a Template and Work Order.

In the Product Template drop-down list, templates stored in the Template folder are shown. These templates can only be prepared by the Administrator or the Controller. The Template folder is set through the File / Template folder on the menu.

The list of Work Orders can only be prepared by an Administrator. This procedure is described in Section 8 – Managing Users. Click OK.

GausSPC creates the filename by combining the Product Template name with the Work Order number (e.g. if the product template name is Demo1.gst and the work order number is May05, then the filename will be Demo1_May05.gsd). If the file already exists in the Data Folder, it is opened and the Operator can continue entering values into this file.

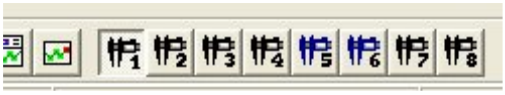
The data folder can only be set by the Administrator or the Controller through the File / Data Folder menu option. Each template can be assigned its own data folder.

4 MEASUREMENTS

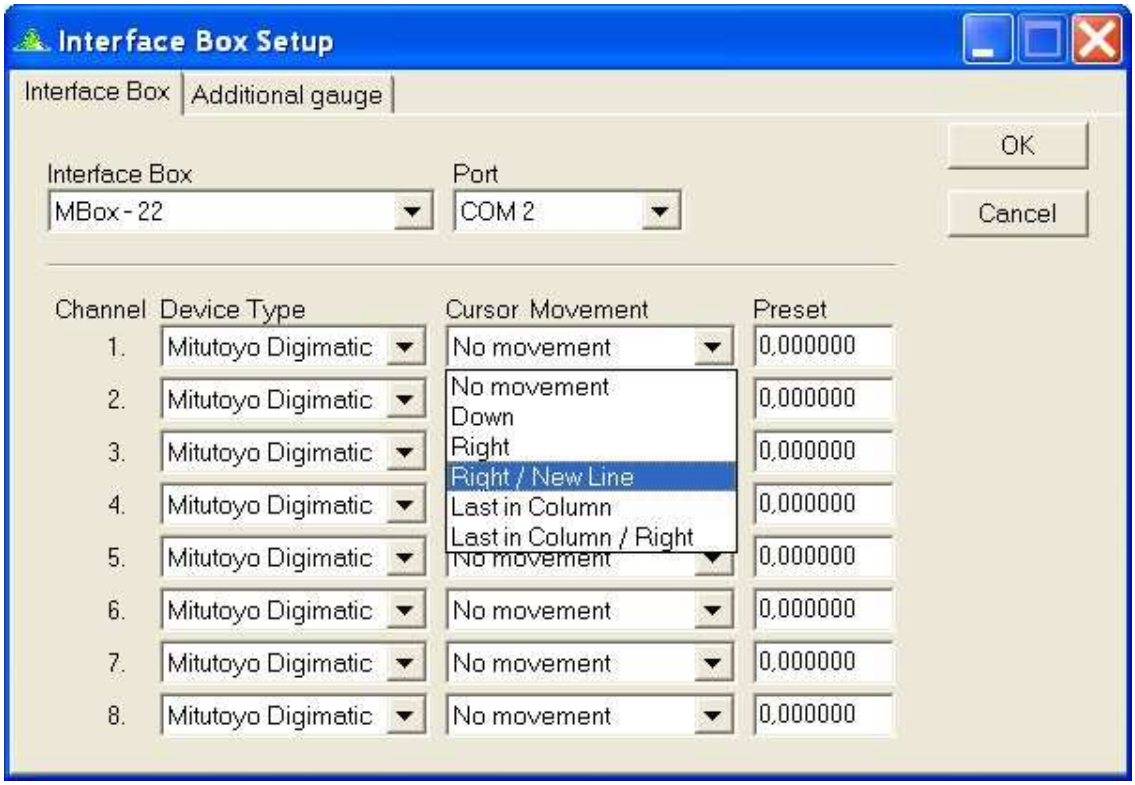
4.1 ENTERING MEASUREMENTS

Measurements are entered into the cells of a worksheet either manually or through a measuring interface. Cells on the worksheet can only contain numbers. For each entry the time, date and user are also recorded. The user, the time of entry and any remarks are shown in the lower status bar. If the cell is empty the current user and the current time are displayed. If a measurement is outside of tolerance it is coloured red.

If you are using a measuring interface, all you have to do is press the trigger to record a value. However you must first select the gauge. To do this, click on the button in the toolbar which represents the channel to which the gauge is connected.



Select Interface Box / Setup from the menu. Here you can choose where the cursor moves after each measurement has been entered.



The position of the cursor (the active cell) can be changed to any of the following:

- No Movement: The cursor stays in the current cell
- Down: The cursor moves down
- Right: The cursor moves to the right
- Right / New Line: Move to the right until last column containing product characteristic, then jump to new line in first column

- Last in Column: Measurement is always recorded as the last measurement of the current column
- Last in Column / Right: Measurement is recorded as the last measurement of the current column, after the entry the cursor moves to the right

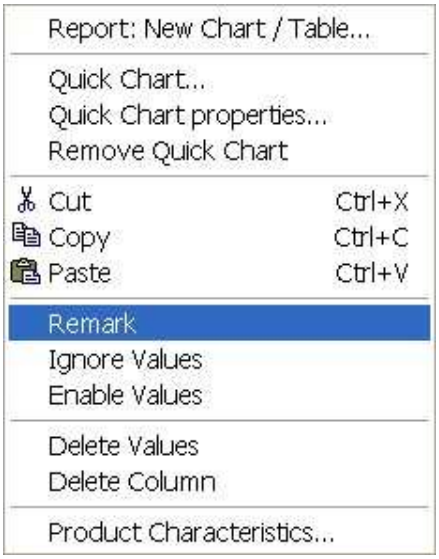
The cursor movement should be set according to your measurement process. For example, if you want to measure the same characteristic for all samples, then select 'Move Down', but if you want to measure all characteristics for each sample, then it would be best to choose 'Right / New Line'.

From the Interface Box submenu, it is possible to set a sound signal:

- Beep: Every Value - for each entry of data (the system sound for the Asterisk event is used)
- Beep: Out of Tolerance – alerts you when the measurement is outside of tolerance (the system sound for the Question event is used).

4.2 REMARKS

Right-click the cell to which you want to assign a remark and select Remark from the popup menu.



Enter the remark into the dialog box. Click OK.

Cells with remarks entered are flagged with a small blue square in the upper right corner. The remark is shown in the lower status bar.

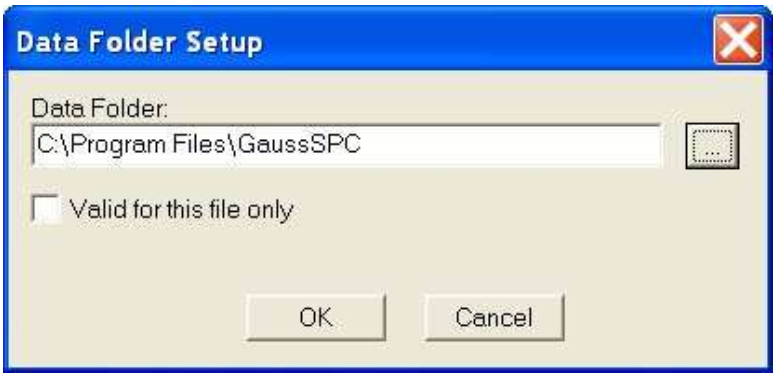
4.3 SAVING MEASUREMENTS

You can save measurements by clicking File / Save on the menu, or by clicking the Save icon on the toolbar. The default folder for saving is the folder in which GaussSPC is installed. The file ending for files containing values is .gsd. If you want to save measurements to a file with a new name, select File / Save As from the menu.

If you want to save the worksheet as a template, select GaussSPC Templates from the 'Save as type' drop-down list. The file ending for templates is .gst.

4.4 SAVING MEASUREMENTS TO A DATA FOLDER

Measurements can also be saved to a preset folder, which you can define by selecting File / Data Folder from the menu.



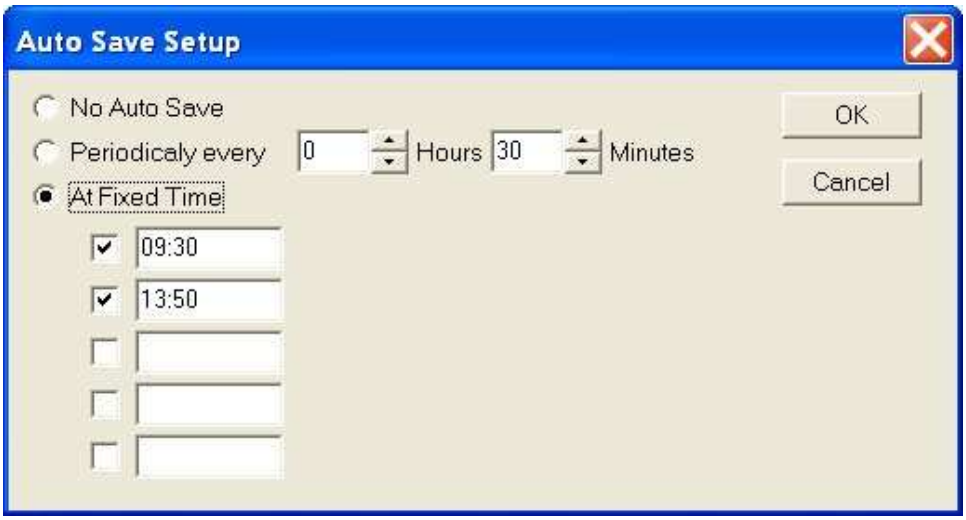
Click on the Browse button to the right of the Data Folder field to select a folder. You can either select a local folder or one within your network.

If you do not want to set the default Data Folder, but only the folder for the current file, tick the 'Valid for this file only' checkbox.

In the same way you can preset the folder from which the Product Template drop-down list for the Operator user is created. To do this select File / Template from the menu.

4.5 AUTO SAVE

To ensure measurements are saved at certain intervals, you can instruct GausSPC to save measurements automatically. Select File / Auto Save from the menu and set the auto save options.



GausSPC can either save measurements periodically after a defined interval or at certain times e.g. at the end of a shift. The shortest save interval is ten minutes.

When Auto Save is enabled, a disk icon showing the time of the next save will be shown on the lower status bar.

4.6 OPENING EXISTING FILES

Select File / Open and search for the file. The browser will open the Data Folder if set, otherwise it will open in the Program Files / GaussSPC folder. Double-click the file you need to open.

To open a file used recently, select it from the bottom of the File menu.

4.7 LOGGING-OFF

To log-off either click the Log-Out button (on the left of the tool bar) or select File / Log Off.

If the user is an Operator, measurements will be saved automatically.

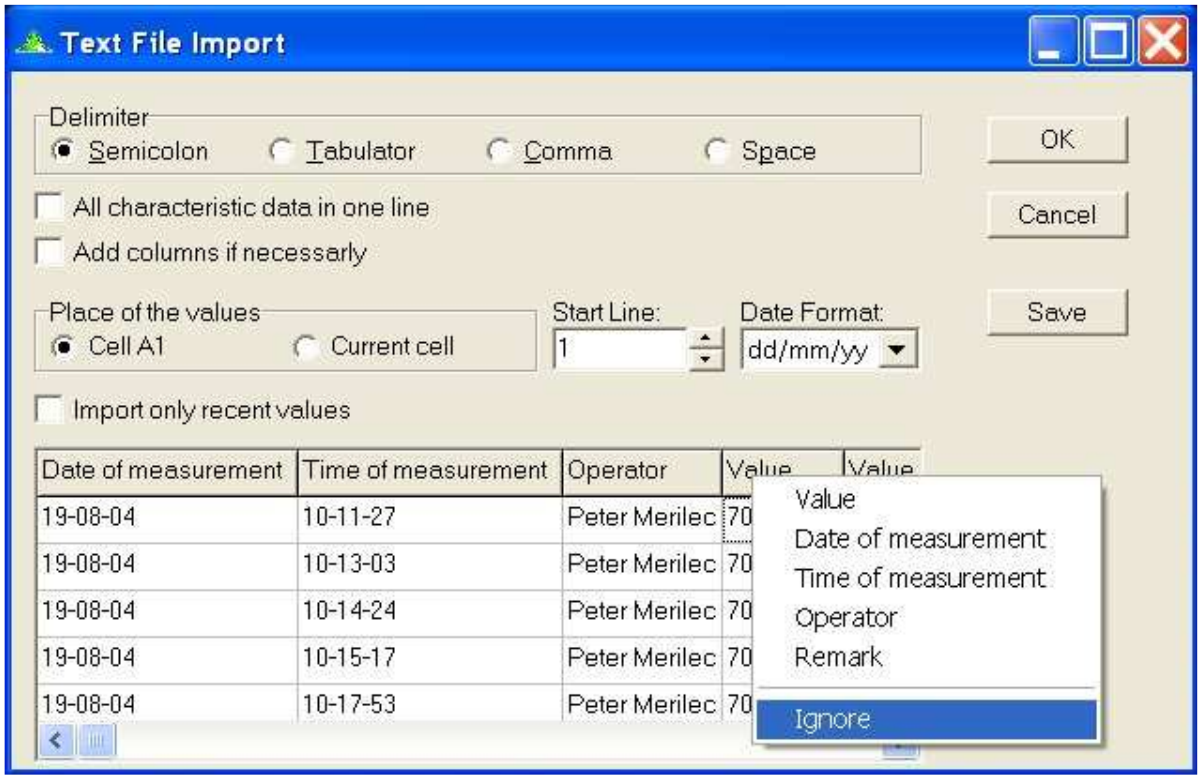
After log-off, the log-in screen appears.

5 IMPORTING DATA

You can import measurements to GausSPC from a number of sources including those from a custom measuring device, a co-ordinate measuring machine (CMM) or measurements saved in an external file.

5.1 IMPORTING DATA FROM A TEXT FILE

Select File / Import Values / Text Files and select the text file containing data.

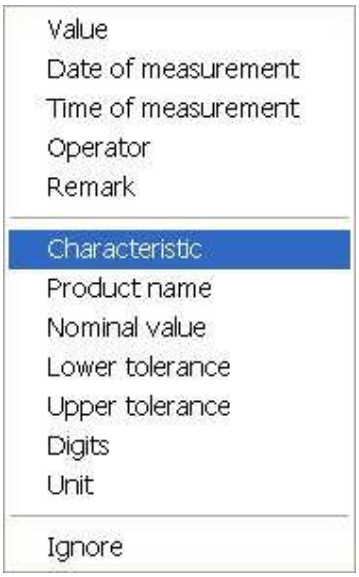


In the dialog box select the Delimiter which separates data in the text file.

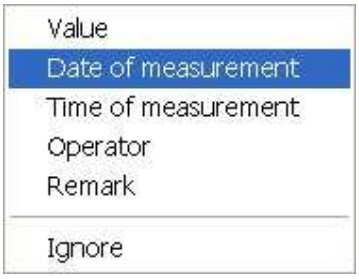
Tick the 'All Characteristic Data in one line' checkbox if there is only one measurement per line.

Tick the 'Add Columns if necessary' checkbox if there are more columns of data in the text file than currently defined in the GausSPC file.

Right-click on each column header to select the type of information contained in each column from the popup menu. If there is only one measurement per line (with 'All Characteristic Data in one line' selected) you can choose one of the thirteen predefined types of information.



If a single line contains measurements for more than one characteristic (with 'All Characteristic Data in one line' unchecked) you will have a shorter list of available information types.



You can also set the Date Format, the Start Line and the Position where the data is to be inserted.

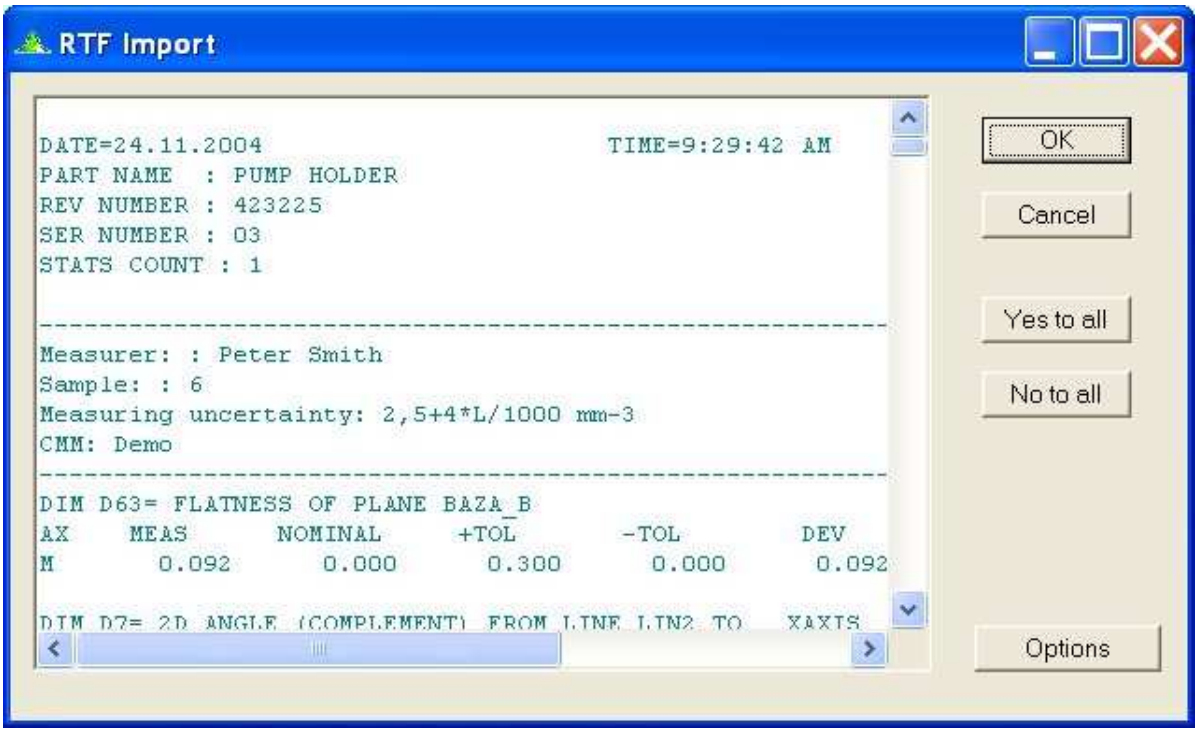
If there is a date of measurement amongst the information you are importing, you can also tick the 'Import only recent values' checkbox. In this case GausSPC checks whether data is newer than existing data in the worksheet and will add only newer data.

Click the Save button if you want to save all the settings within this dialog box for future use. Click OK. GausSPC will tell you how many characteristics were added and how many values have been imported.

If a warning appears saying GausSPC does not recognise the date or the time format, click Cancel. GausSPC will still import the measurements but the time of measurements will be the current computer time. Check the date/time format.

5.2 IMPORTING DATA FROM .RTF FILES (RICH TEXT FORMAT FILES) CREATED BY PC-DMIS SOFTWARE

Select File / Import Data / PC DMIS Rtf files and choose one or more rtf files.



The 'Yes to all' and 'No to all' buttons are only visible when you have chosen more than one .rtf file.

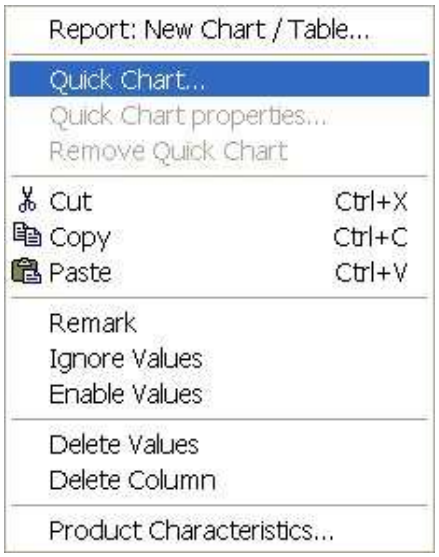
GausSPC reads and imports to a worksheet all the names of characteristics, their nominal values, tolerance limits and measurement values. For each of the characteristics GausSPC checks whether the worksheet already contains a characteristic with the same properties. If this is the case it adds the measurement values into an existing column, otherwise it first adds a new characteristic and then the measured values.

Please see Appendix C for additional settings available for importing .rtf files. Appendix C contains a detailed description of Gauss.ini file fields.

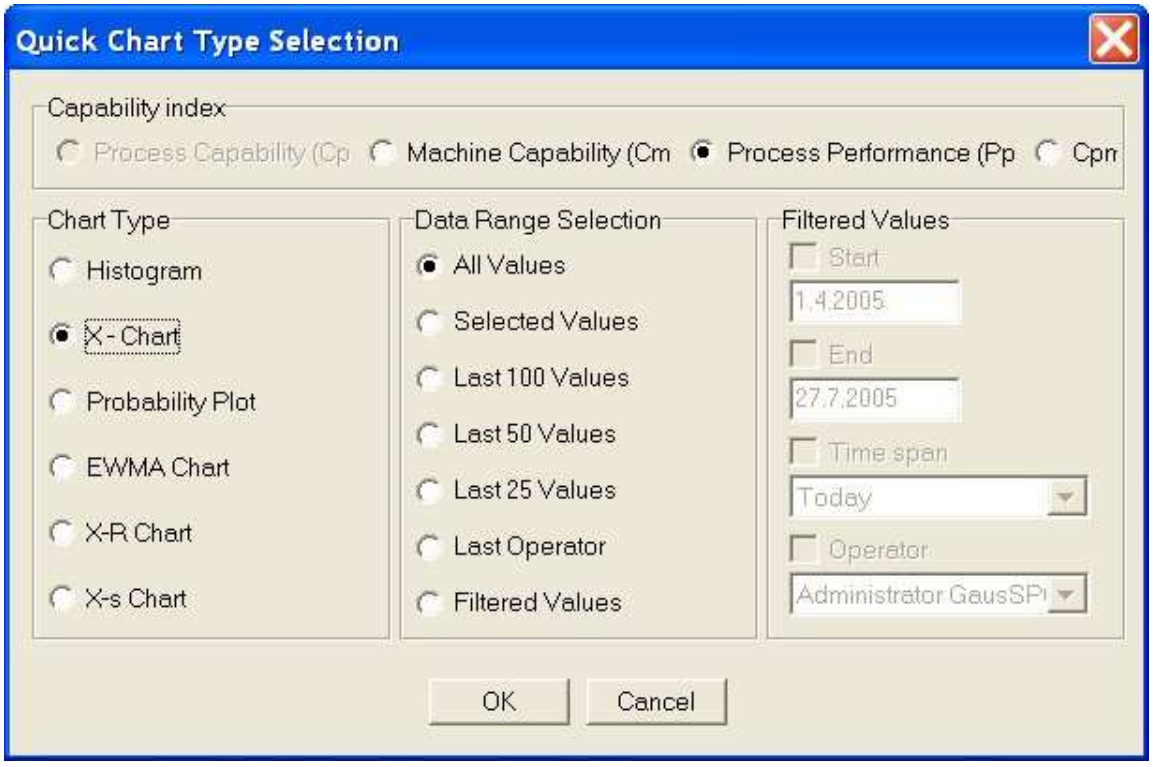
6 QUICK CHART

Quick Chart is a chart (graph) which you can assign to a variable characteristic to display after each change of values in the column. In this way you can monitor the performance of characteristics in real time and/or control the stability of the process.

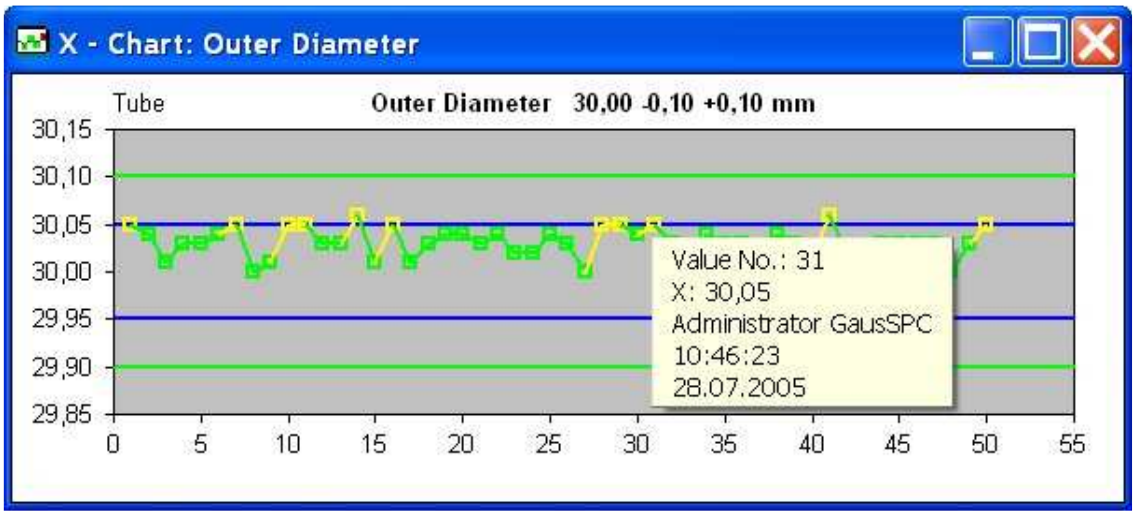
You can assign a Quick Chart to a characteristic by right-clicking in a cell and selecting Quick Chart from the popup menu. Alternatively you can assign a Quick Chart through the Product Characteristics dialog box. The advantage of the first option is that you can assign a Quick Chart to all of the selected columns at once.



Now select the type of Quick Chart, the appropriate Capability Index and the Data Range to be shown.



In the title of the column a Quick Chart icon appears next to the name of the characteristic. You can display the Quick Chart by clicking the Quick Chart button in the toolbar, by double-clicking a value or by pressing F11. The F11 key shows/hides the Quick Chart.



You can change the width of the Quick Chart and properties, depending on the type of chart selected. Right-click on the graph to display the dialog box which will allow you to edit the Chart Properties.

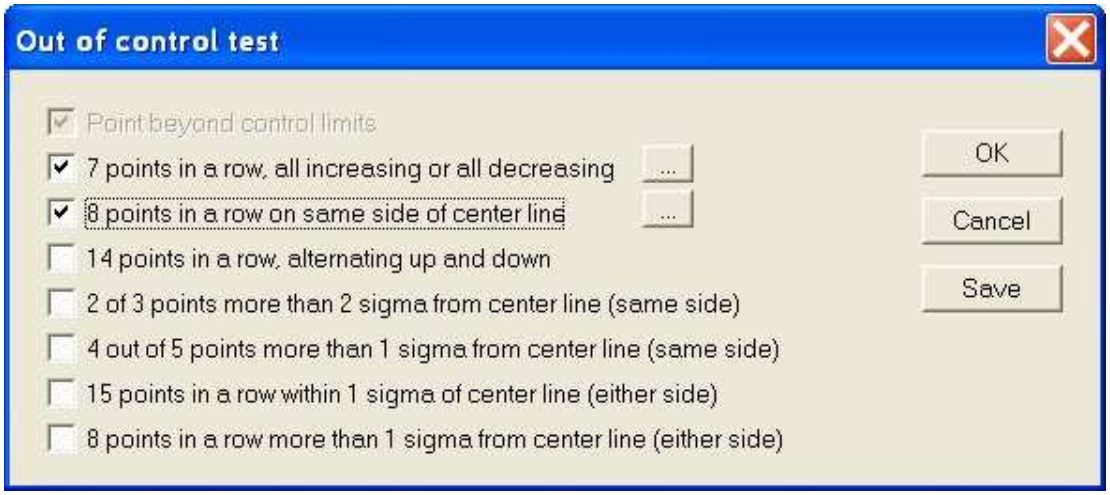
For the X-chart, X-R chart or X-s chart options, additional information about each point on the graph will be displayed when you hold the mouse pointer over points on the graph.

6.1 SHORTCUT KEYS

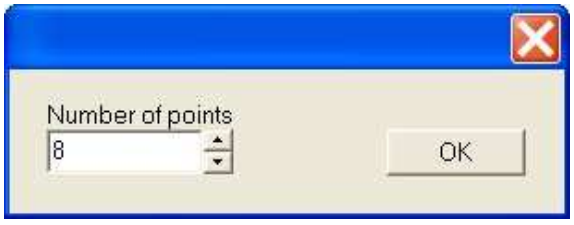
'+' on the numeric keypad zooms in on X, EWMA, X-R and X-s charts
'-' on the numeric keypad zooms out on X, EWMA, X-R and X-s charts
'CTRL C' copies the Quick Chart to the clipboard.

6.2 QUICK CHART AND PROCESS STABILITY TEST

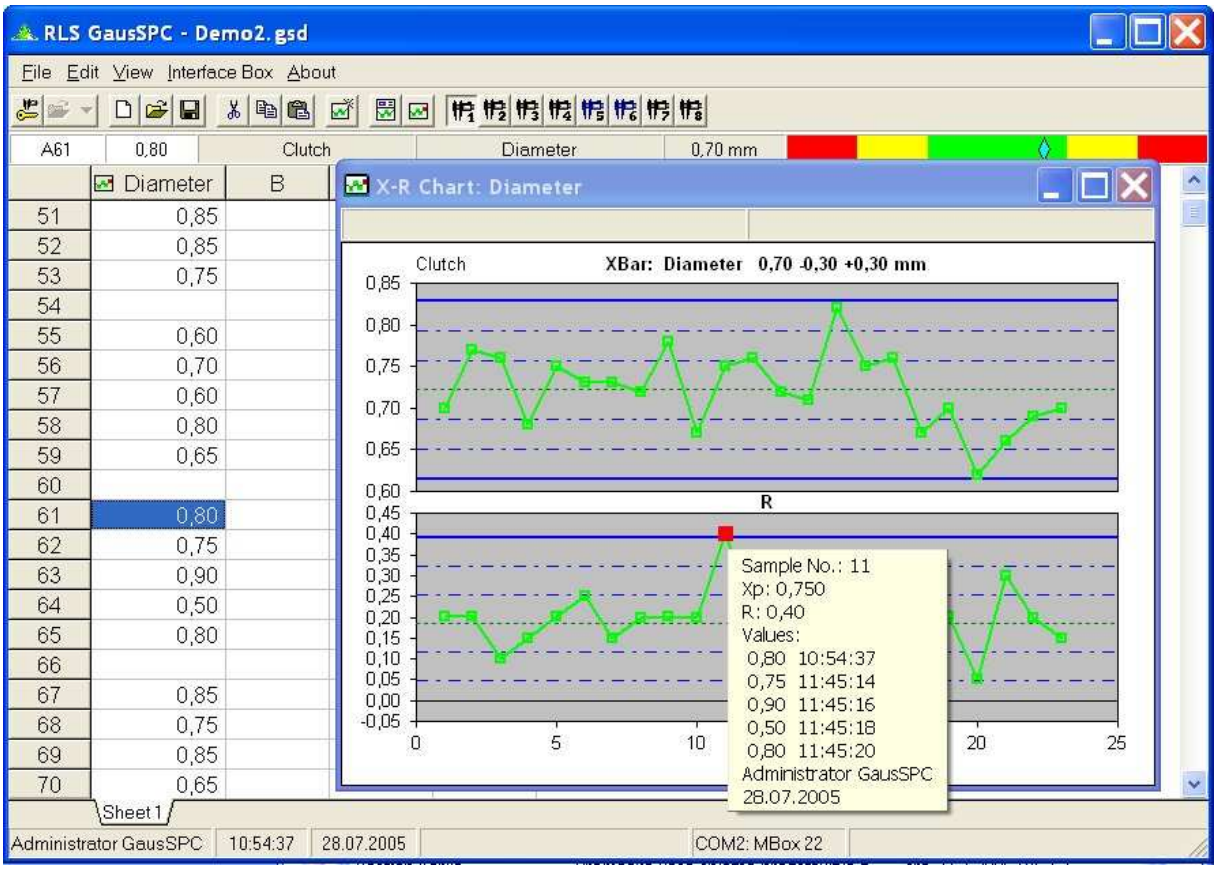
With X-R or X-s Quick Charts you can also monitor the stability of the process. First right-click on the Quick Chart, tick the 'Out of control test' option and click on the Browse button next to this. Here you can set the test to be executed after each new measurement.



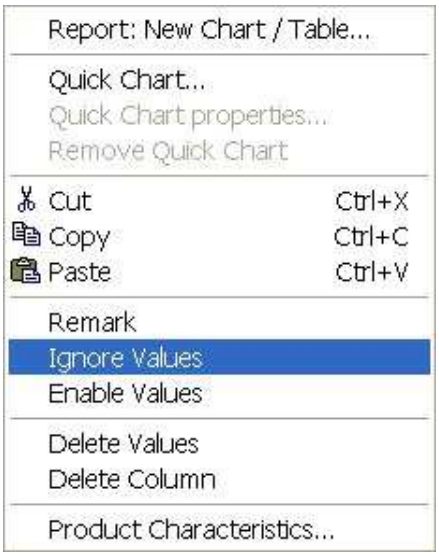
Click on the Browse button next to the 'x points in a row, all increasing or decreasing' and the 'x points in a row on same side of centre line' in order to amend the number of points which should be taken into account.

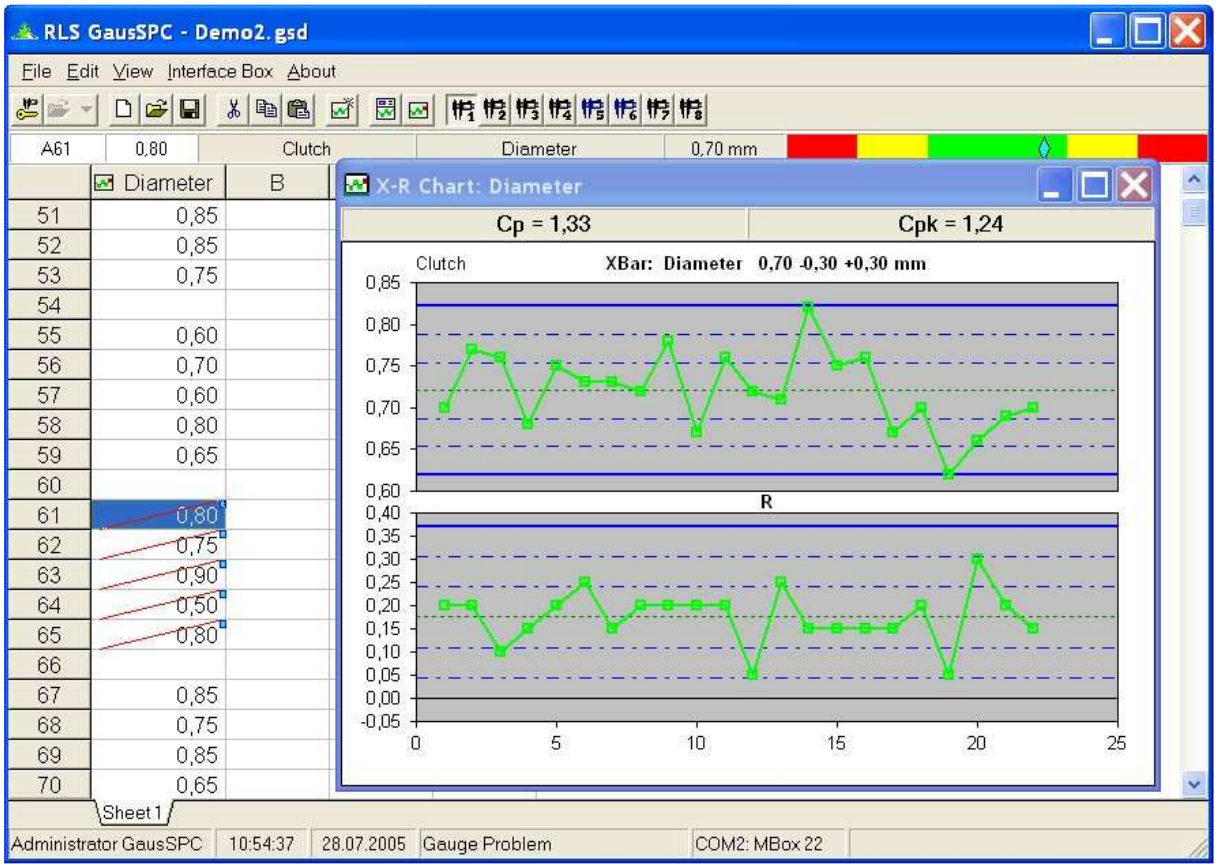


GausSPC executes the selected tests and it highlights the points in red to indicate that the process may be out of control.



The range in sample 11 is greater than the upper control limit for the range. Analysis of this sample shows the problem was incorrect use of the gauge. Select all five values in sample 11, right-click and select 'Ignore Values' from the popup menu.





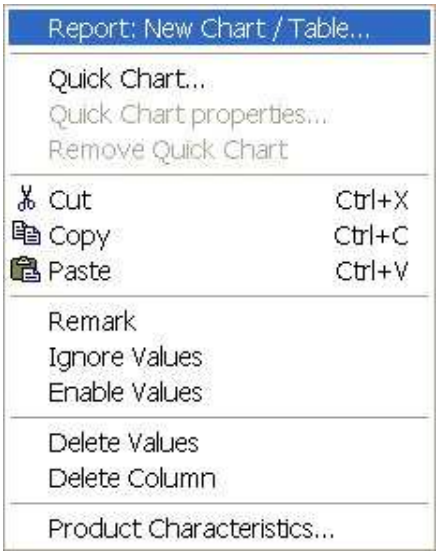
The values for sample 11 are still present in the worksheet but are not taken into account for statistical analysis. You can also add notes to these values.

The process is now again under control. Therefore the index of process capability and the critical index of process capability are displayed.

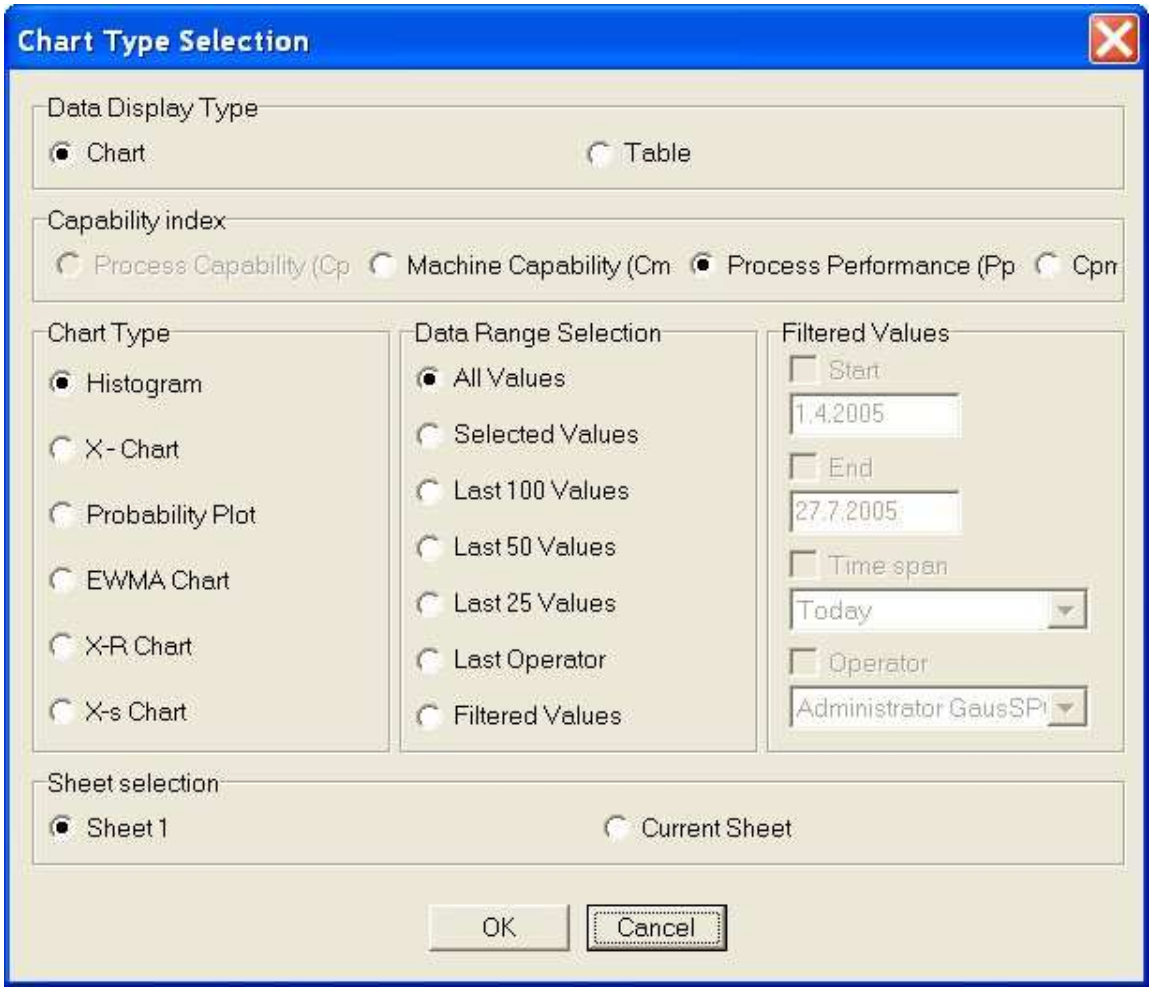
If the process is out of control, these two parameters are not shown even though the chart is set to display these.

7 SETTING THE CONTROL CHARTS – SETTING THE REPORT

Right-click a cell and select Report: New Chart/Table from the popup menu.



In the dialog box select the form and range of data which are to be displayed.

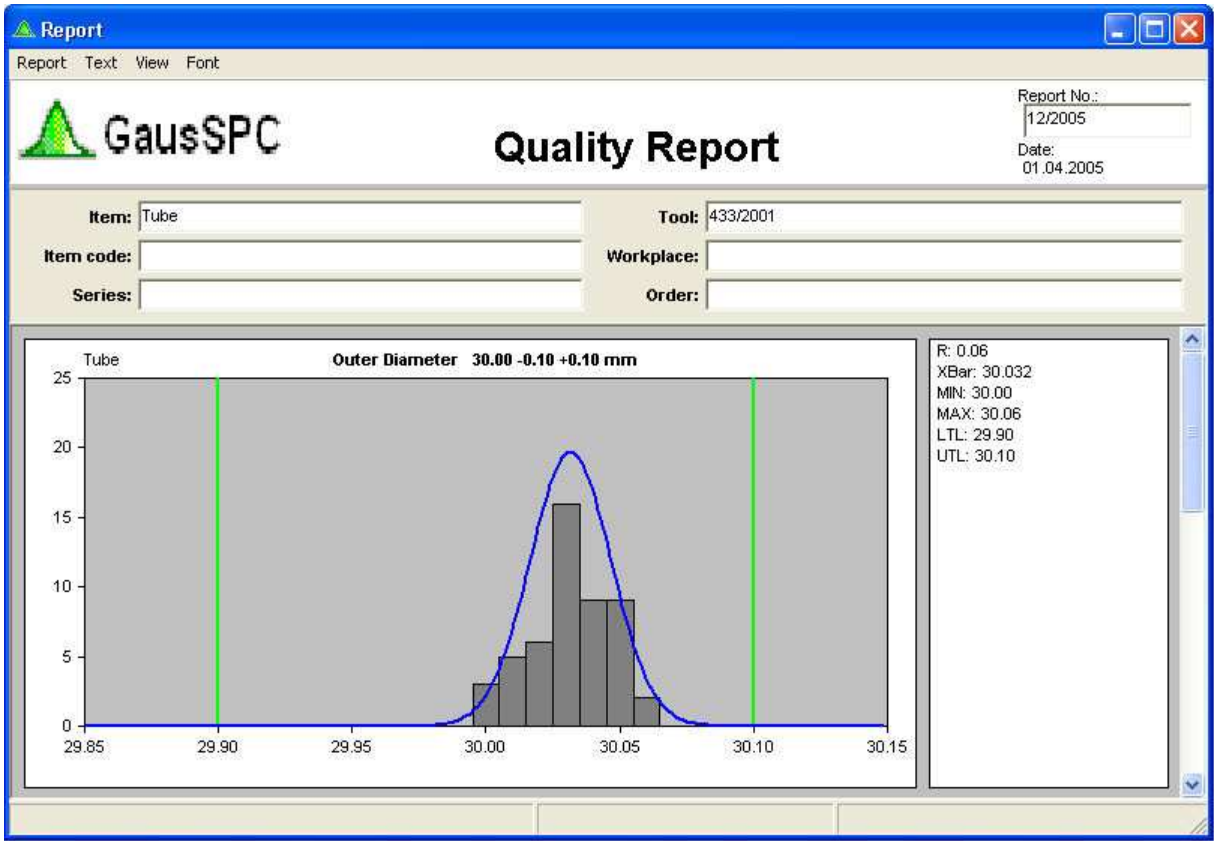


First choose either the chart or table Data Display Type.

Next select the Chart Type. A description of the different chart types can be found in section 7.4.

Then select the Capability Index to be calculated. The available options here depend on the selected Chart Type. The process capability index (Cp, Cpk) can be chosen only for EWMA, X-R and X-s charts. The machine capability index (Cm, Cmk), process performance (Pp, Ppk) and modified process capability index (Cpm) can be chosen for histogram, X-chart and probability distribution charts. Formulas to calculate these indexes are listed in Appendix B.

Now select the range of data, this can also be filtered by time or Operator.



At the top of the report there is a header with title, logo, report number and the date. Below these are Header Lines where you can put other information such as product codes, tools used, order number, etc.

Under the header there are charts (e.g. our example above shows a histogram with a list of statistical parameters to the right). The list depends on the chart type and it contains basic statistical parameters for the range of data shown.

At the bottom of the report there is a field with the name of the Operator and a field for their signature.

7.1 FORMATTING THE REPORT HEADER

7.1.1 LOGO

Should you wish to personalise the report by adding your own logo, you can do so by selecting Report / Report Layout from the Report Window menu. Click the Browse button next to the Logo file box to choose your own logo.

You can resize the logo by clicking on it and dragging its handles. You can also change its position by dragging it with the mouse pointer.

7.1.2 TITLE

The title of the report can be moved in the same way as the logo. By right-clicking on the title you can set the font properties. You can also change the font properties for all the report elements in this way. The only exceptions are the notes under charts and the contents of Header Lines for which you set the font by selecting 'Font' from the menu.

Section 7.2 shows you how to change the title.

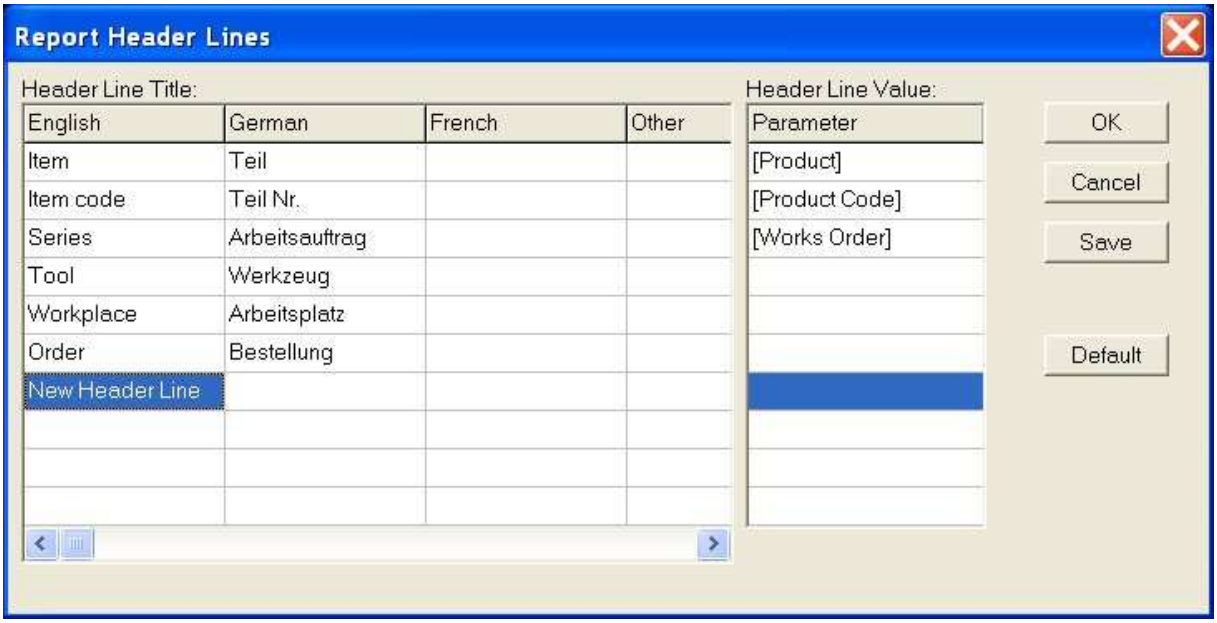
7.1.3 DATE

GausSPC displays the current date.

7.1.4 REPORT NUMBER

GausSPC allows you to insert your own report number. Type this into the Report No field.

7.1.5 FORMATTING HEADER LINES



To display the Header Lines dialog box, double-click in the Header Lines area on the report or select Text / Header Lines from the menu.

The header titles can be entered in four languages.

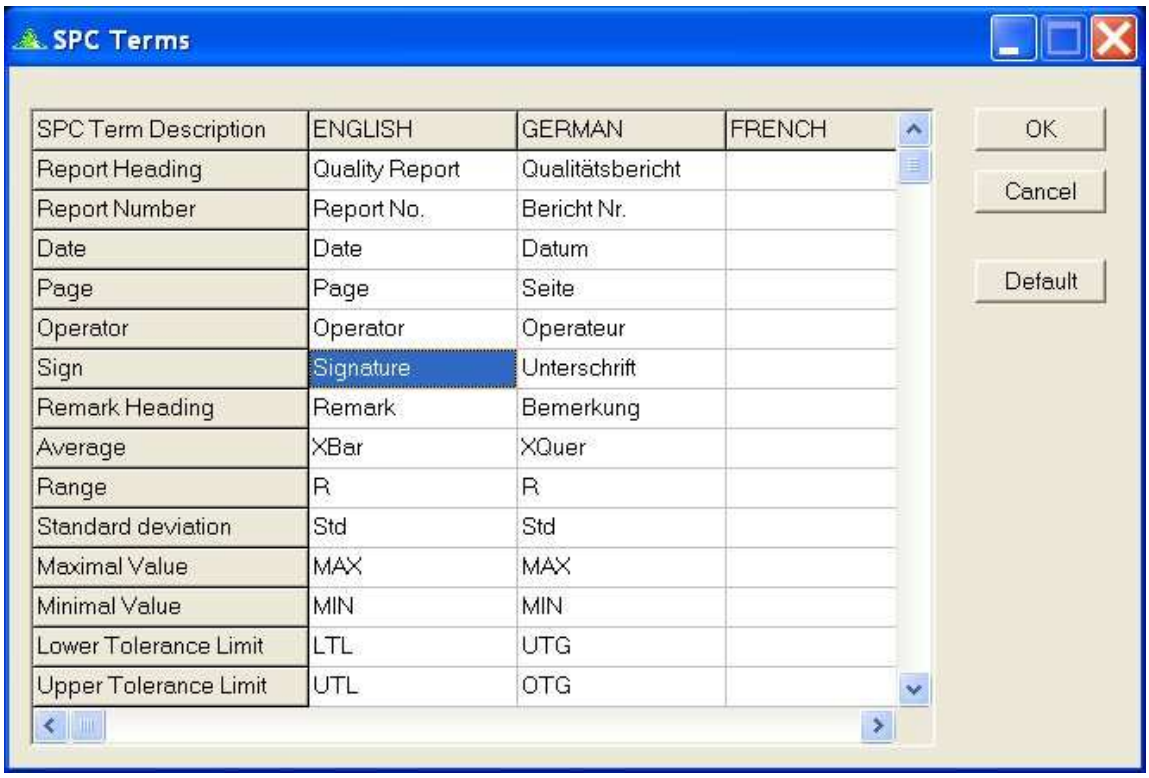
You can also define which parameters are going to be automatically filled in from the Product Characteristic settings. Right-click on the relevant cell in the Parameter column to select the parameter which should be automatically entered into this line.

The automatically entered parameters will be drawn from the settings of the characteristic which are shown in the first chart/table on the report.

By clicking the Save button you will save the header titles as default values into the Gauss.ini file. By clicking on the Default button you will retrieve the header titles from the Gauss.ini file.

7.2 SETTING THE SPC TERMS

As with the Header Titles, you can set other terms used in the report header or in the list of statistical parameters (and also in four languages). Select Text / Edit SPC Terms from the menu.



SPC Term Description	ENGLISH	GERMAN	FRENCH
Report Heading	Quality Report	Qualitätsbericht	
Report Number	Report No.	Bericht Nr.	
Date	Date	Datum	
Page	Page	Seite	
Operator	Operator	Operateur	
Sign	Signature	Unterschrift	
Remark Heading	Remark	Bemerkung	
Average	XBar	XQuer	
Range	R	R	
Standard deviation	Std	Std	
Maximal Value	MAX	MAX	
Minimal Value	MIN	MIN	
Lower Tolerance Limit	LTL	UTG	
Upper Tolerance Limit	UTL	OTG	

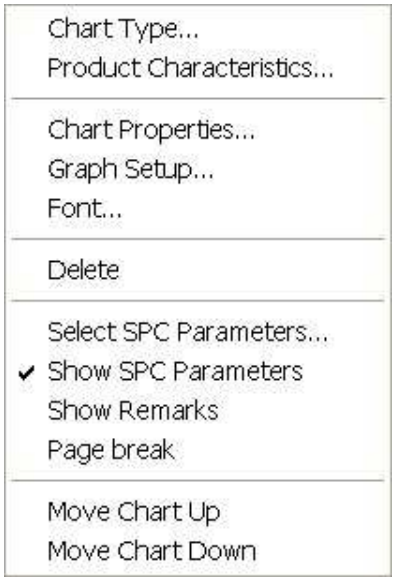
The default terms are saved in the Gauss.ini file and you can retrieve the default settings by clicking on the Default button.

7.3 SELECTING THE LANGUAGE OF THE REPORT

Select the language of the report by selecting Text / Language from the menu.

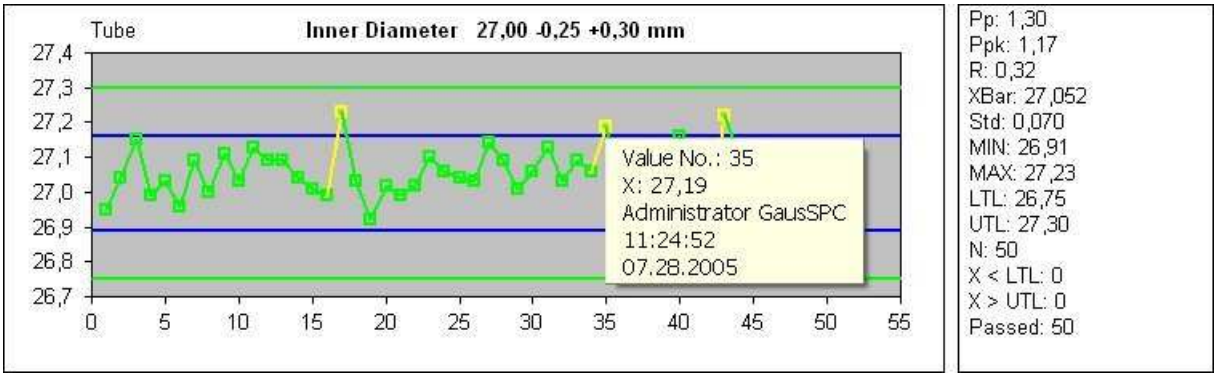
7.4 CONTROL CHARTS

You can change the properties for each control chart or table. Right-click on the chart/table to see the popup menu, the options are as follows:



- Change the Chart Type or the range of data
- Display the Product Characteristics dialog box
- Define the chart properties
- Change general graph settings
- Change font
- Delete chart
- Select statistical parameters to be displayed to the right of the chart
- Show/hide SPC parameters
- Show/hide notes under the chart
- Insert page break (the chart will be moved to the beginning of a new page)
- Change the position of the chart

7.4.1 X-CHART OR PRE-CONTROL CHART



The X or pre-control chart displays single measurements in the order they were recorded. For each measurement there is one point on the graph.

If you hold the mouse pointer over one of the points, additional information about that point will appear. The number of measurements, the value, the time, the Operator and any remarks will be shown.

Two green horizontal lines limit the tolerance field of the characteristic. Two blue lines define the control field. The width of the control field is either one half of the tolerance field or it equals the reduced tolerance field (if reduced tolerances have been set).

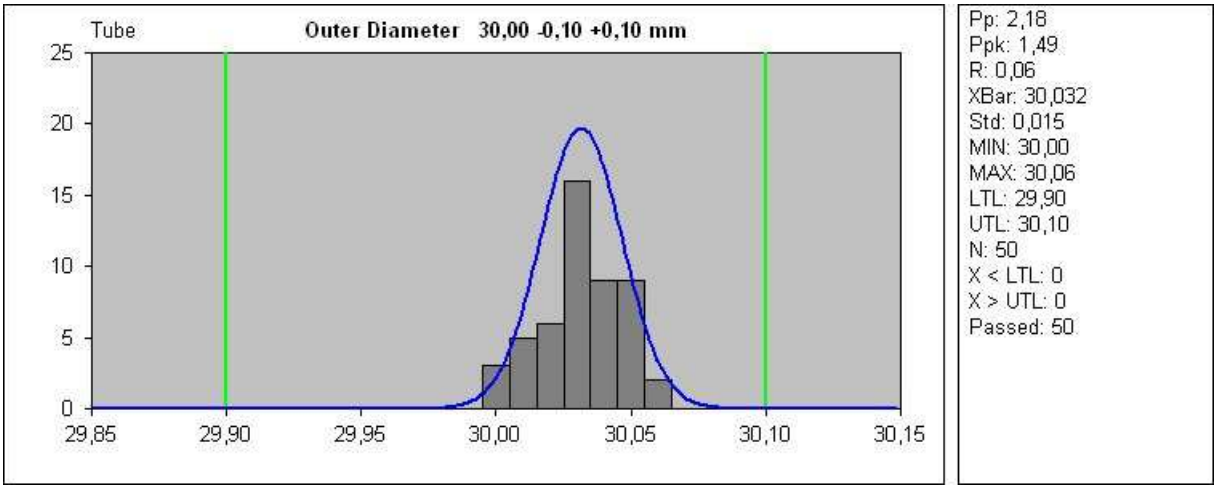
Displayed to the right of the chart are:

- process performance index (Pp),
- process performance critical index (Ppk),
- range of measurements (R),
- average value (XBar),
- standard deviation (Std),
- minimum value (MIN),
- maximum value (MAX),
- lower tolerance limit (LTL),
- upper tolerance limit (UTL),
- number of measurements (N),
- number of measurements below the lower tolerance limit (X < LTL),
- number of measurements above the upper tolerance limit (X > UTL),
- number of measurements within tolerance limits (Passed).

In the Chart Properties dialog box, you can set how you want to display graph points and whether you want to display control limits and/or the trend line.


Chart Properties
X Chart
Control Limits
Trend Line
Color Lines
Color Markers
Lines
Markers
Lines and Markers
OK
Cancel

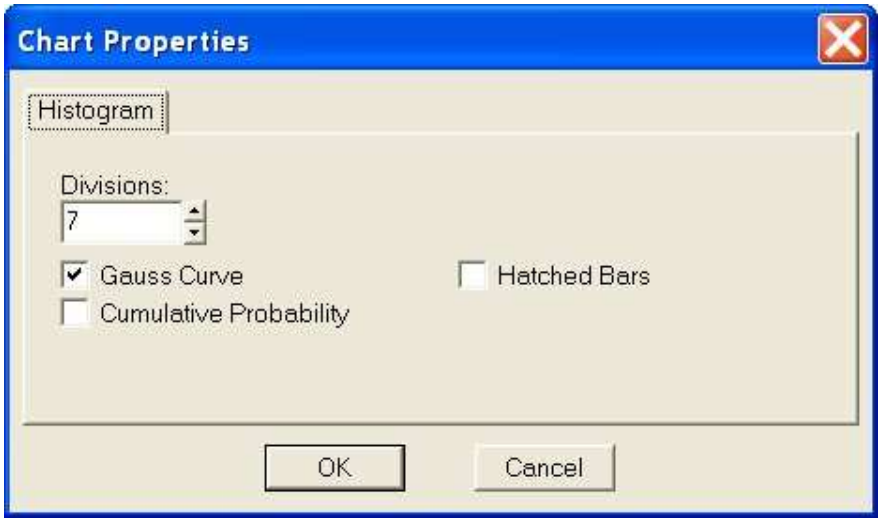
7.4.2 HISTOGRAM



GausSPC groups single measurements into divisions. The default number of divisions is a rounded square of the number of selected measurements.

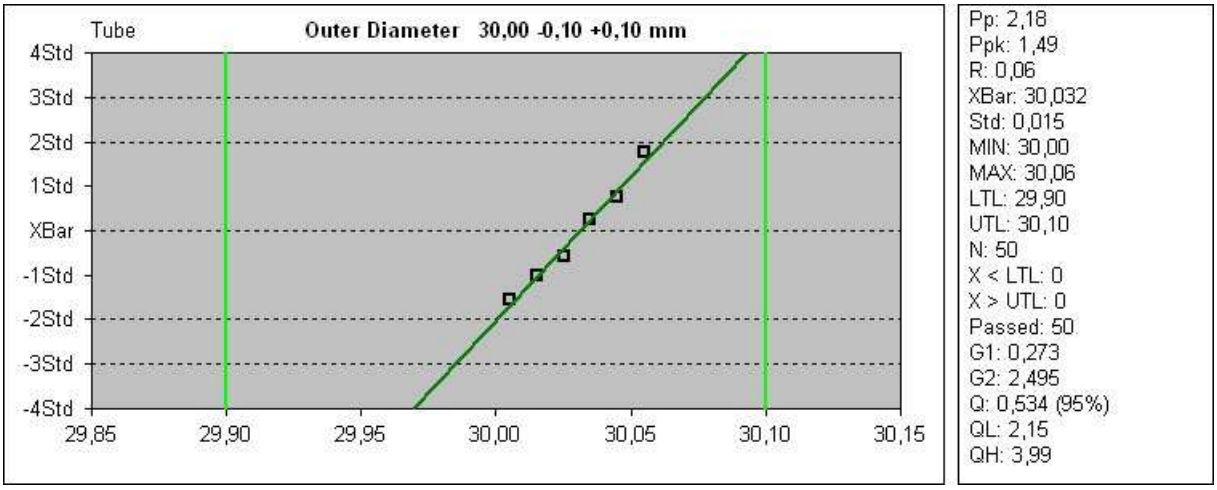
The two vertical green lines depict the upper and lower tolerance limits. The blue curve is the Gauss curve with the same average and same standard deviation as the measurements.

The parameters to the right of the histogram are the same as for the X-chart (see Section 7.4.1).



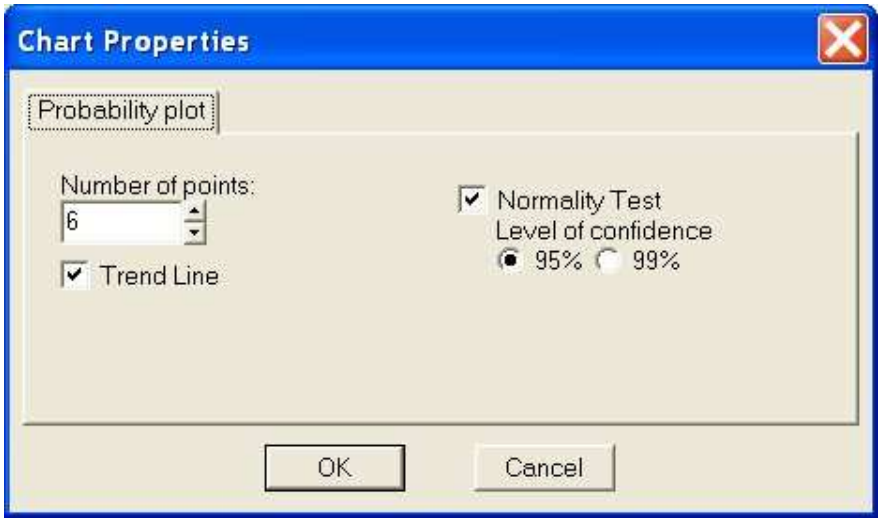
You can set the number of divisions, display of the Gauss curve and the Cumulative curve. The bars can either be coloured or hatched. For details of how to set colours, please see Section 7.5.

7.4.3 PROBABILITY PLOT



The probability plot is different from the histogram in that instead of number of meawsurements in a single division on the vertical axis, there is a cumulative frequency by divisions expressed in terms of standard deviation. From this chart it is possible to quickly see the average value and ratio between the range and the tolerance field.

Among the statistical parameters on the right, which are the same for X-chart and histogram, you can also add the results of the normality test. Please see Appendix B for an explanation of these results.

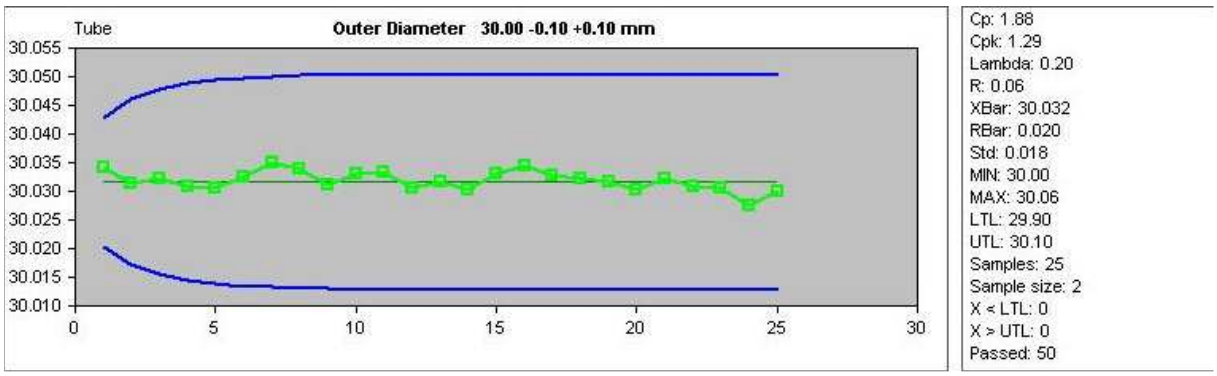


You can also change the number of points on the graph and show/hide the trend line.

7.4.4 EWMA CHART

Use the EWMA (Exponentially Weighted Moving Average) chart when you need to quickly detect smaller shifts in the process. The position of the point for a single sample depends also on the values of previous samples whereby a larger weight is given to the more recent samples. The weight of previous samples is defined by the value of the Lambda parameter (e.g. Lambda=0.2 means that the current sample contributes 20% to the current point, while the contribution of all previous samples amounts to 80%). The usual choice of Lambda parameter is between 0.1 and 0.3. A process is out of control when a point is outside of the control limits.

If you hold the mouse pointer over one of the points on the graph, additional information about that point will appear.

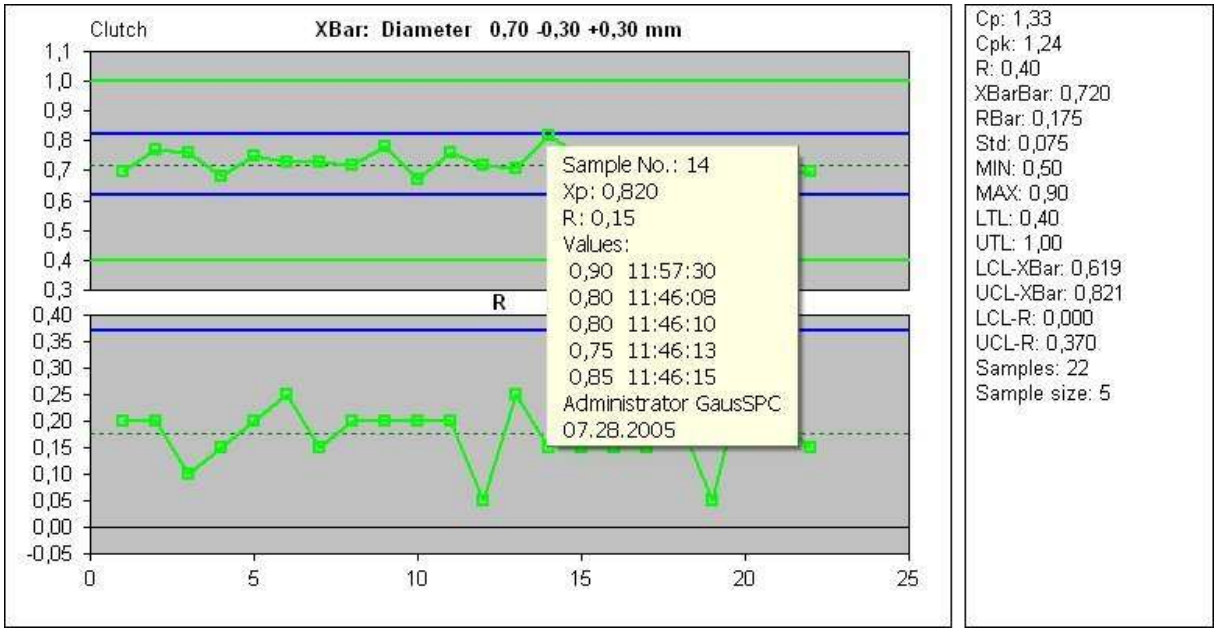


In addition to the statistical parameters already described for X-chart and histogram, the Lambda parameter, sample size and number of samples are also added to the list of statistical parameters.

In the chart properties dialog box you can also set the Lambda parameter.

7.4.5 X-R CHART

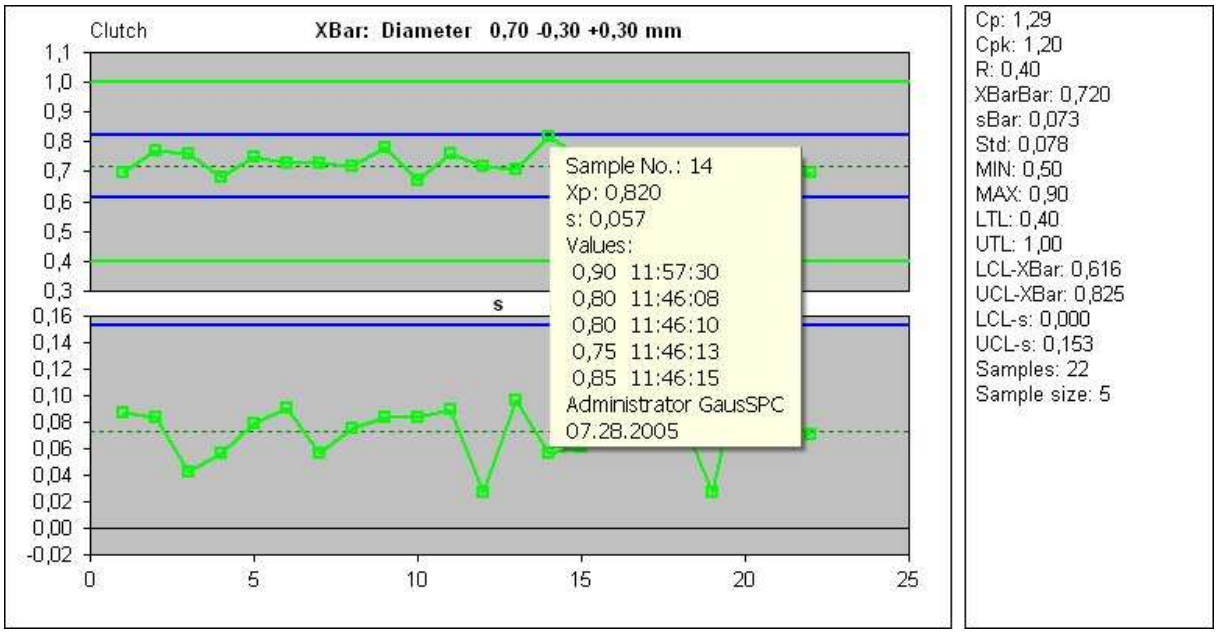
The X-R chart consists of two graphs. *In the upper graph a point corresponds to the average value of the sample and in the lower graph a point corresponds to the range of values in the sample. Each sample is represented by one point on each of the graphs.* Control limits are calculated based on the measurements and the sample size. Values for control limits for XBar and R are also now included in the list of statistical parameters.



If you hold the mouse pointer over one of the points, additional information about that point will appear.

7.4.6 X-s CHART

The X-s chart is similar to the X-R chart except that instead of the range of values there is a standard deviation of a sample shown in the lower graph.



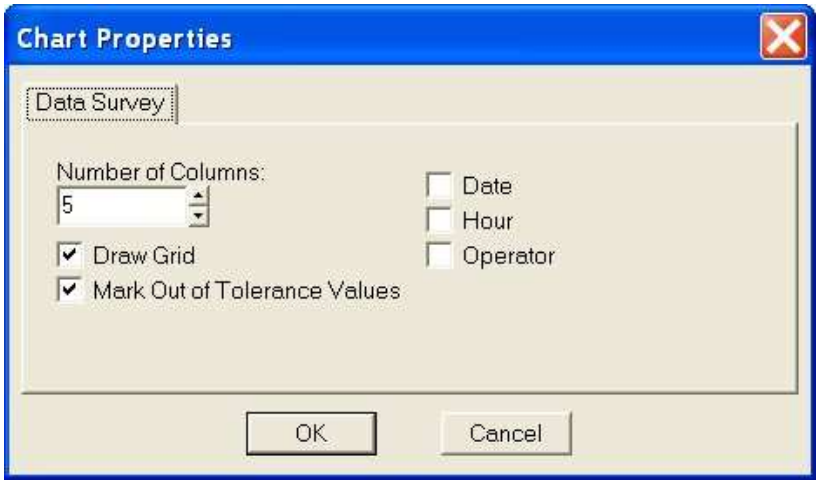
7.4.7 TABLE

If you select Table as the Data Display Type in the Chart Type Selection dialog box, measurements will be shown in the form of a table.

The table below is an example of a table where the Chart Type is X-chart, histogram or probability plot.

Length 25,00 -0,20 +0,20 mm					
Nr.	1	2	3	4	5
1 - 5	25,02	25,00	24,98	24,96	25,03
6 - 10	25,04	24,97	25,00	24,96	25,01
11 - 15	25,01	25,03	25,00	24,99	24,96
16 - 20	25,04	25,01	24,97	24,99	25,00
21 - 25	25,02	25,00	24,98	24,96	24,99
26 - 30	24,96	25,00	24,99	24,96	25,04
31 - 35	24,96	25,00	24,99	24,96	25,04
36 - 40	24,99	25,00	25,02	25,04	25,00
41 - 45	24,97	24,98	24,96	25,04	24,97
46 - 50	25,02	25,00	25,03	25,00	24,99

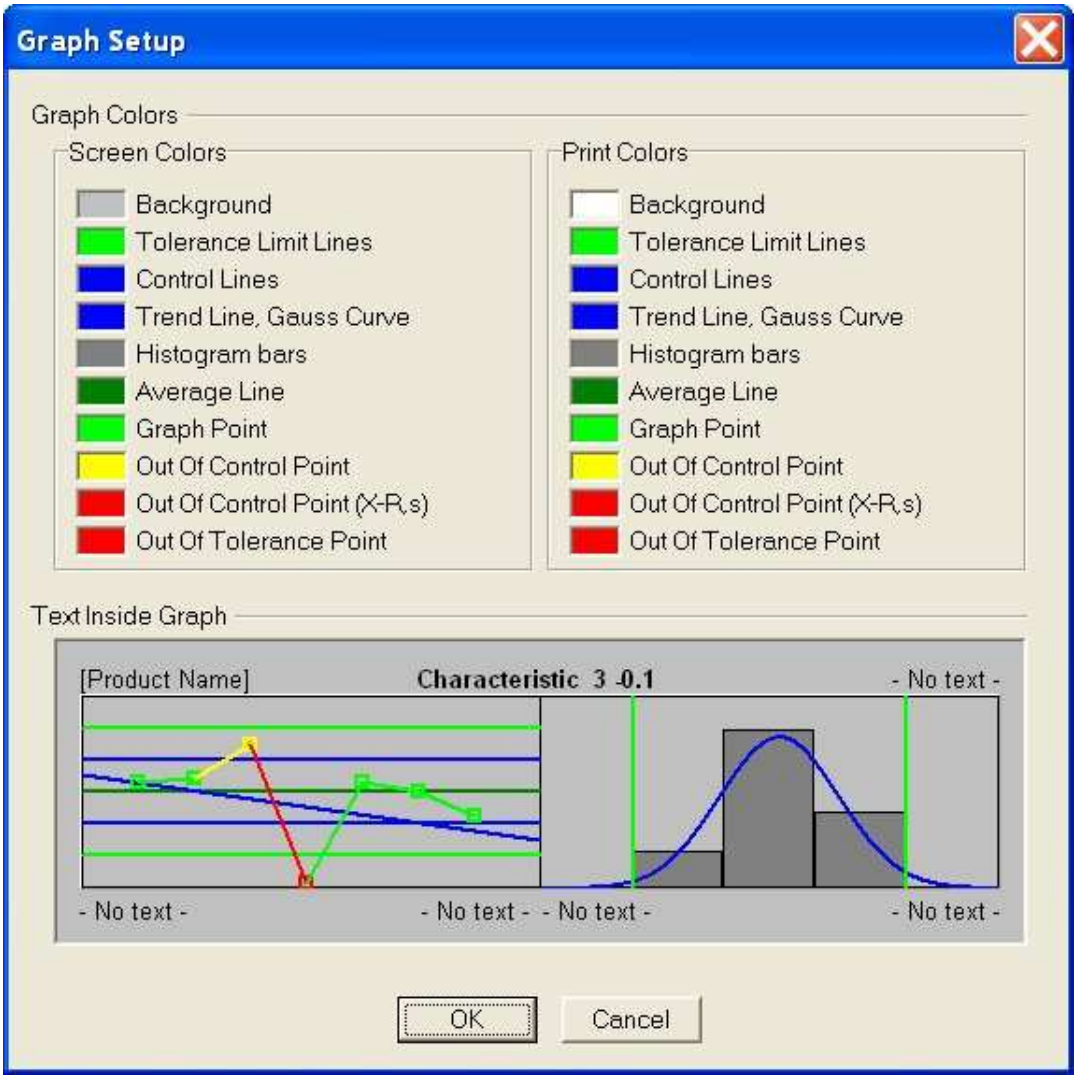
In the Chart Properties dialog box you can now set the number of columns, show/hide gridlines and select whether you want to mark the measurements which are outside tolerance limits. You can also select whether to show the date and time of the measurements and the Operator who entered them.



For X-R, X-s and EWMA charts measurements are grouped by samples. Two columns are also added which display the average value and range.

Length 25,00 -0,20 +0,20 mm							
Number	1	2	3	4	5	XBar	R
1	25,02	25,00	24,98	24,96	25,03	24,998	0,07
2	25,04	24,97	25,00	24,96	25,01	24,996	0,08
3	25,01	25,03	25,00	24,99	24,96	24,998	0,07
4	25,04	25,01	24,97	24,99	25,00	25,002	0,07
5	25,02	25,00	24,98	24,96	24,99	24,990	0,06
6	24,96	25,00	24,99	24,96	25,04	24,990	0,08
7	24,96	25,00	24,99	24,96	25,04	24,990	0,08
8	24,99	25,00	25,02	25,04	25,00	25,010	0,05
9	24,97	24,98	24,96	25,04	24,97	24,984	0,08
10	25,02	25,00	25,03	25,00	24,99	25,008	0,04

7.5 GRAPH SETUP



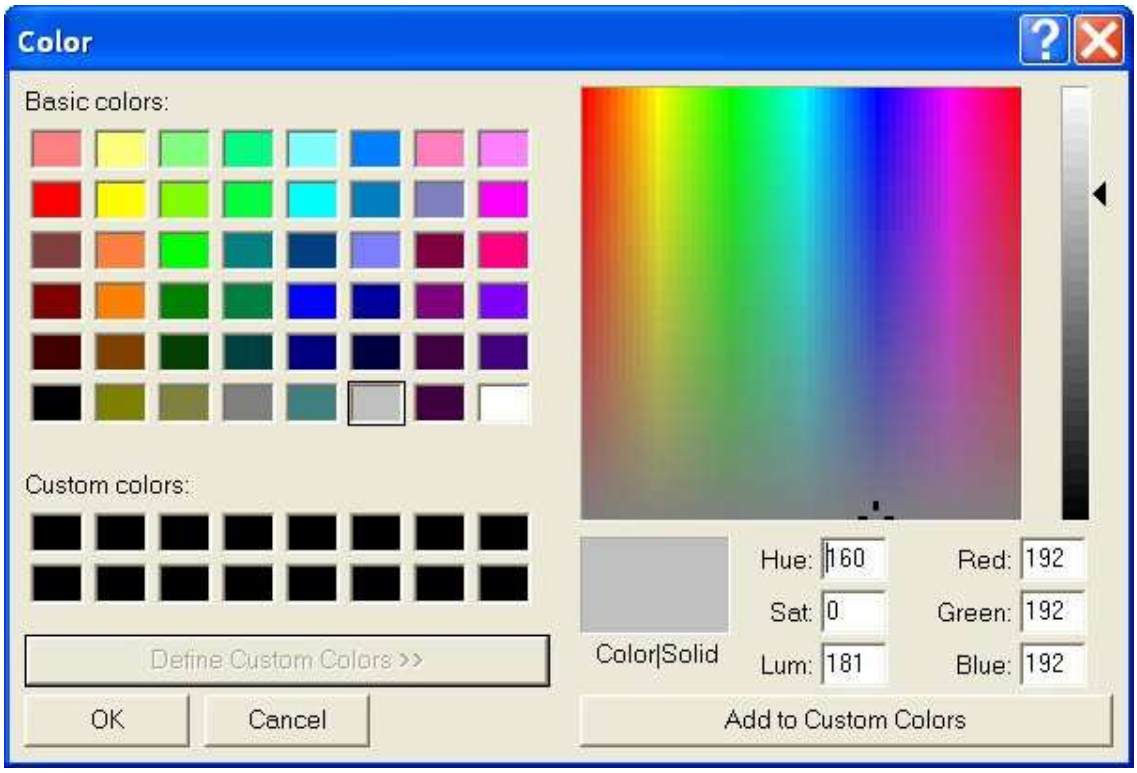
Set the graph properties common to all charts by selecting Report / Graph Setup from the menu or by right-clicking on the graph and selecting Graph Setup from the popup menu.

7.5.1 GRAPH COLOURS

You can set the colour of the background, different lines and also different colours for points on graphs depending on whether they are inside or outside the control or tolerance limits.

You can set different colours to be displayed on the screen than would be printed on paper. Usually the only difference is in the background colour i.e. the background colour for the printer would normally be white, but on the screen it is grey.

Double-click the coloured square to select a new colour from the Colour Palette shown.

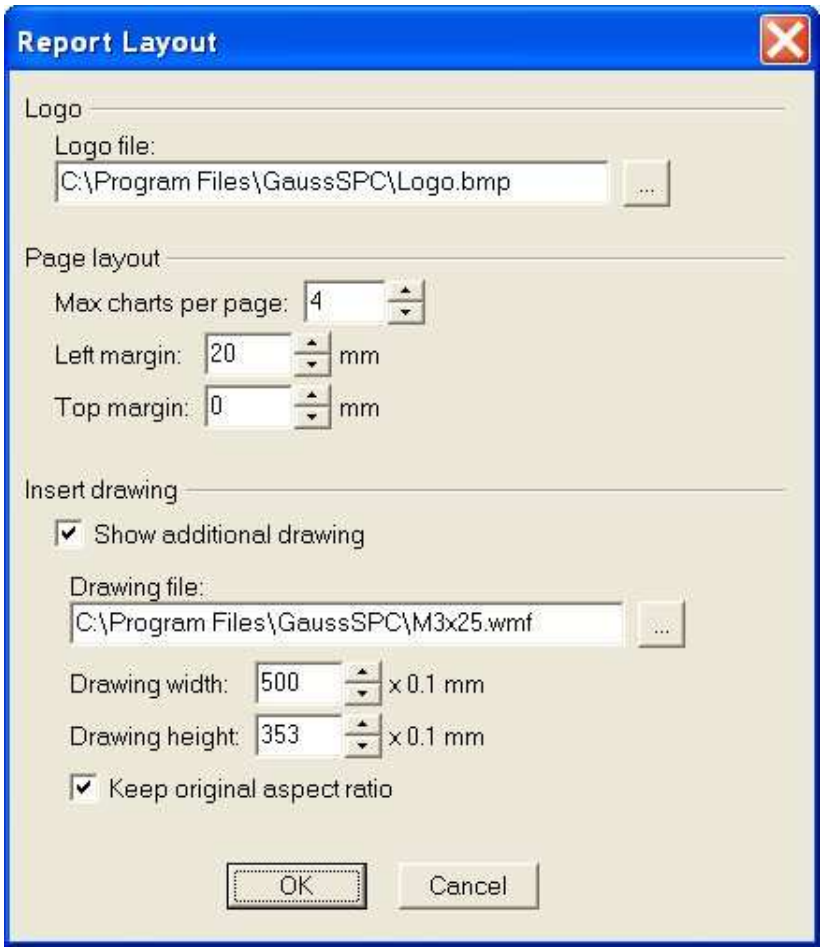


7.5.2 GRAPH LABELS

Each chart has a title showing the characteristic name, the nominal value and tolerance. You can also add labels at the bottom and at the four corners of the chart by right-clicking on the empty labels on the graph in the Graph Setup dialog box.

7.5.3 REPORT LAYOUT

Select Report / Report Layout from the menu to set the report layout. Here you can determine the size of chart, the left and the upper margins and other layout properties.



Add your own logo to the report by clicking the Browse button next to the Logo File field and then selecting the image. The image must be in .BMP, .JPG, .ICO, .WMF or .EMF format.

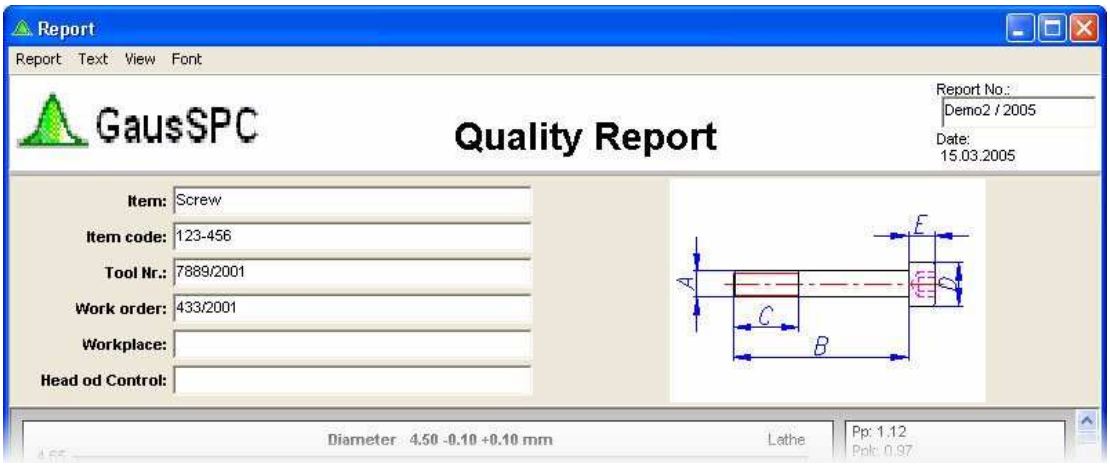
The 'Max charts per page' parameter defines an approximate size of chart. Please note the actual number of charts per page may vary according to available space. For example, on the first page space may be limited if you have numerous header lines and also note that X-R / X-s charts will take double the space of other graphs. A histogram will also take more space than an X-chart.

To preview the report, select Report / Preview from the menu.

You can add an image to the head of the report showing e.g. the product characteristic or measurement procedure by ticking the 'Show additional drawing' checkbox, then click the Browse button to select the image. The image must be in .BMP, .JPG, .ICO, .WMF or .EMF format.

You can also set the height and width of the drawing. You also have the option of maintaining the original ratio of the drawing.

The image is inserted to the right of the header lines which will now be formatted into a single column. The image size on the screen is adapted to the available space and does not correlate to the actual size on the printed report. To preview the report, select Report / Preview from the menu.

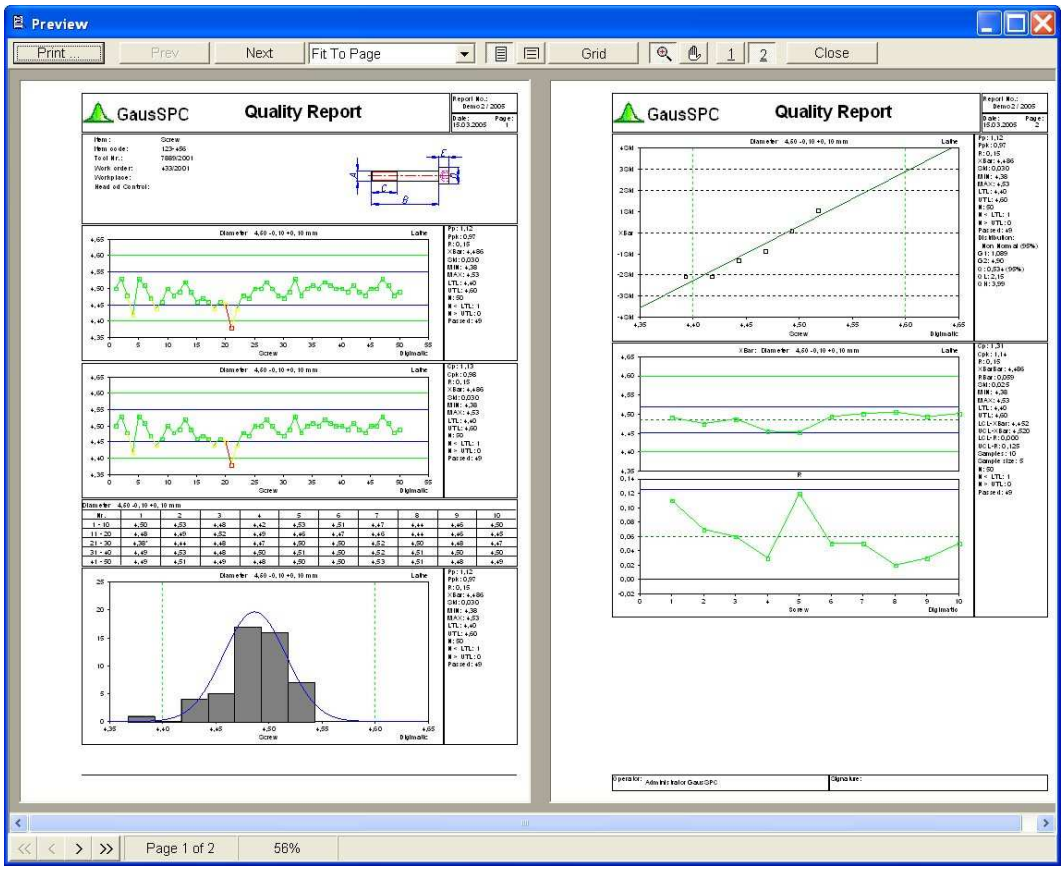


7.6 REPORT PREVIEW

To preview the report, select Report / Preview from the menu.

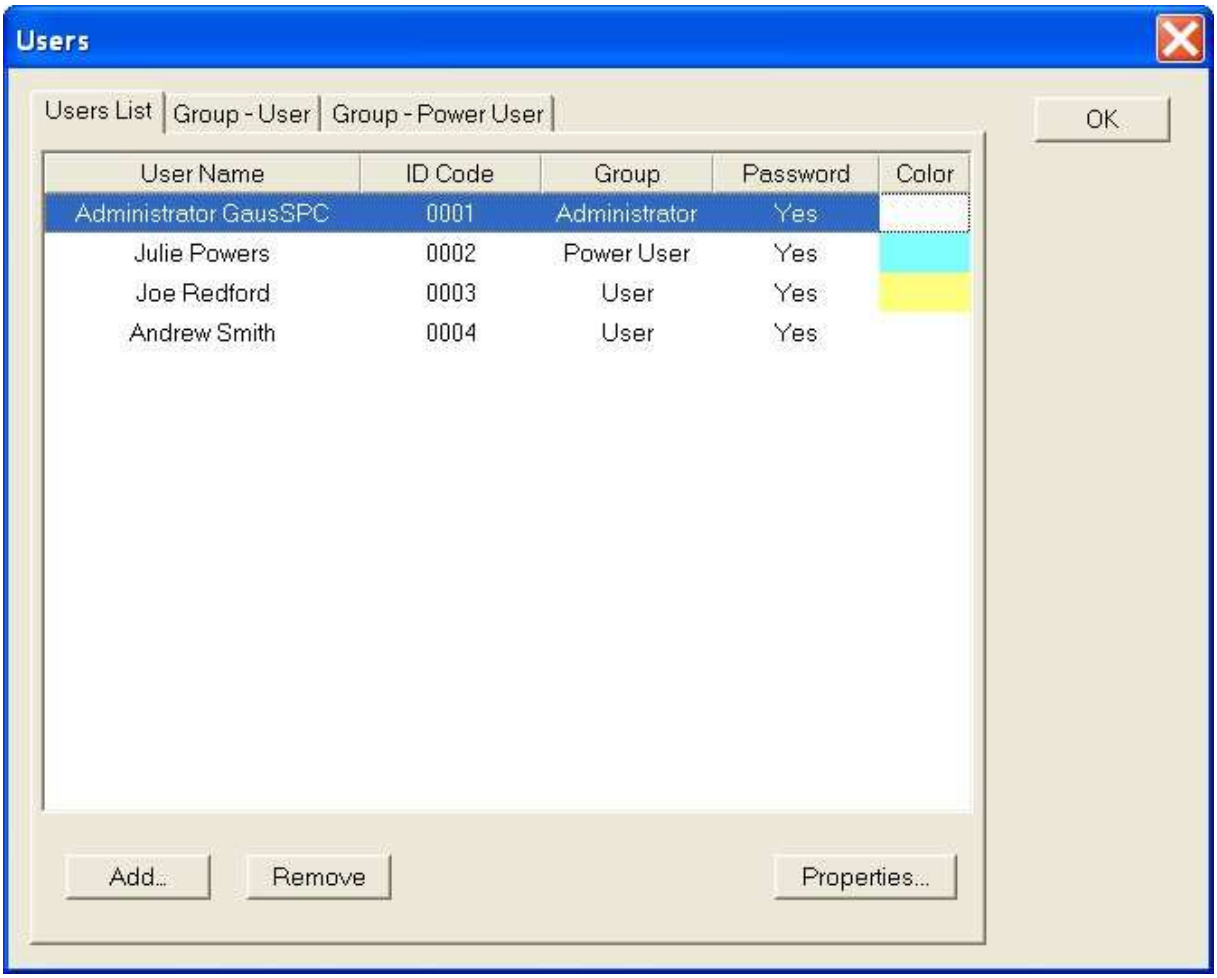
You can choose whether to preview one or two pages of the report. You can also select the level of zoom. Click on the magnifying glass icon to enable the zoom tool. To zoom in left-click on the report and right-click to zoom out. Click on the hand icon to reactivate the pointer tool. Click Print to print the report.

Please note that if prior to printing you change the selected printer, it is possible that the properties of the new printer (resolution, paper orientation and paper size) will be different from the originally selected printer for which the preview was done. It is therefore possible that the print on the paper will differ from the preview.



8 MANAGING USERS

Select File / Users List from the menu to setup GausSPC users and their privileges. (You can only do this if you are logged in as a user with Administrator group access).



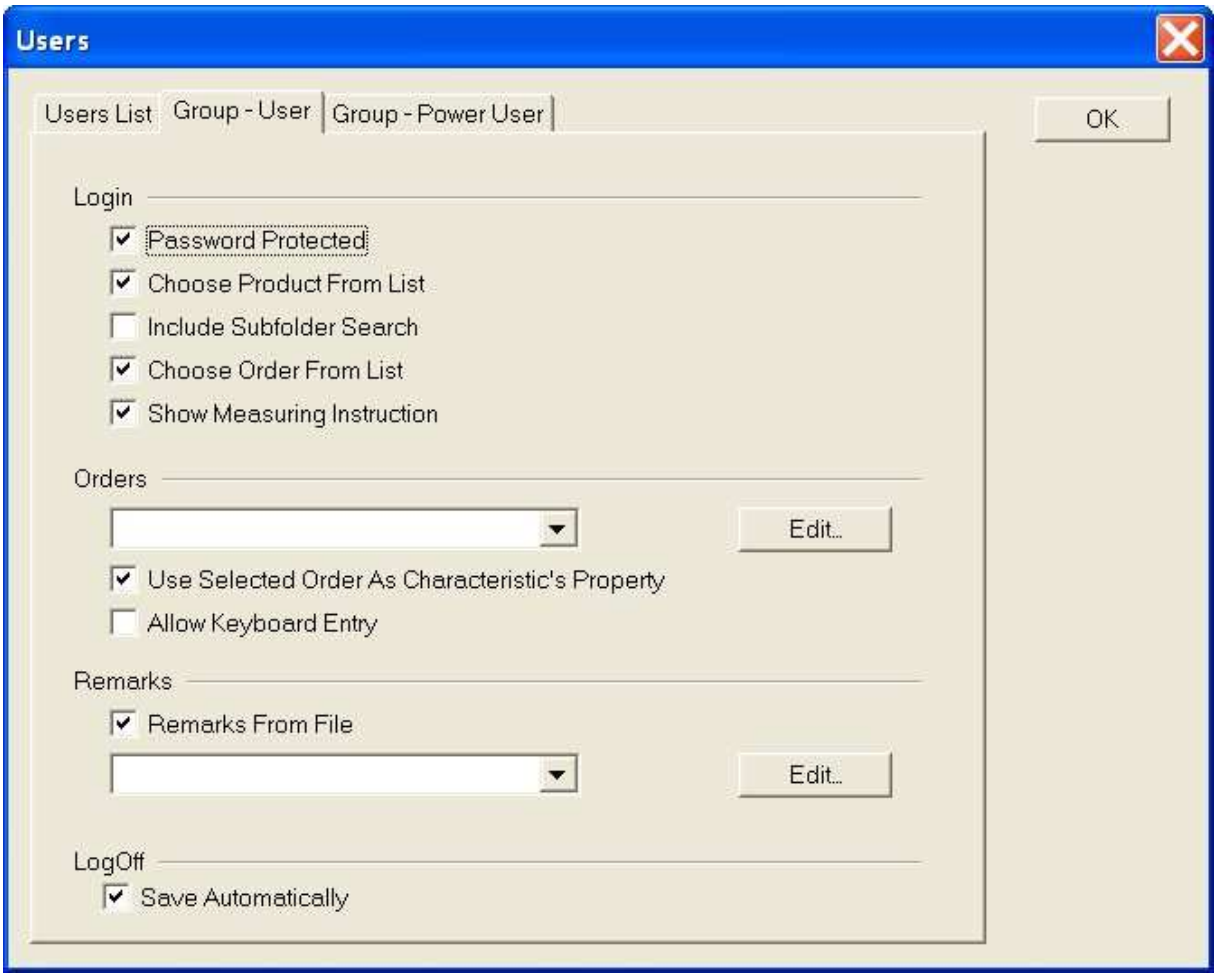
A list of all users appears. New users can be added by clicking the Add button and they can be deleted by clicking the Remove button. Edit the profiles of existing users by clicking on the Properties button. Here you can amend the user's name, surname, level of access and delete his/her password. You can also select a colour to be used as a background for all measurements entered by this user. Set the colour by double-clicking the colour box.

You can not set the password for a user, you can only remove it. The user must set his/her password at the next log-in.

You can also set properties for the User and Power User access groups.

For the Power User access group (which only differs from the Administrator access group in that it does not have access to the Users List) you can only set whether they need to insert a password at log-in.

For the User access group, you can set whether users must type in a password at log-in, whether they must select a template at log-in and whether they are allowed to search for templates outside of the default Data Folder. You can also set whether they must choose a work order at log-in and whether measuring instructions are shown at log-in.


Users
Users List
Group - User
Group - Power User
OK
Login
Password Protected
Choose Product From List
Include Subfolder Search
Choose Order From List
Show Measuring Instruction
Orders
Edit...
Use Selected Order As Characteristic's Property
Allow Keyboard Entry
Remarks
Remarks From File
Edit...
LogOff
Save Automatically


Users
Users List
Group - User
Group - Power User
OK
Login
Password Protected

9 ABOUT GausSPC

Select About / About GausSPC from the menu to see the GausSPC version number, copyright notices, information regarding the hardware protection key, the measuring interface and the amount of memory available.

APPENDIX A – AVAILABLE OPERANDS, FUNCTIONS AND EXAMPLES OF FORMULAE

Available operands:

()	brackets,
+	addition,
-	subtraction,
*	multiplication,
/	division,
^	exponent (raising to a power)

Available functions:

Sin	sine,
Cos	cosine (angle in radians),
Tan	tangens,
Ctg	cotangens
Arcsin	arc sine,
Arcos	arc cosine,
Arctan	arc tangens,
Arcctg	arc cotangens,
Sinh	hyperbolic sine
Cosh	hyperbolic cosine
Tanh	hyperbolic tangens
Ctgh	hyperbolic cotangens
Sqrt	square root
Abs	absolute value
In	natural logarithm
Exp	natural exponent

Available Constant:

Pi	the ratio between the circumference and the diameter of a circle

Examples of Formulas:

(A-B)/2	half the difference between columns A and B
Tan(C)	tangens of the value in column C (C in radians)
Sin(C*Pi/180)	sine of the value in column C (C in degrees)

2*ARCTAN((D-B)/2/(C-A))*180/Pi

in column A is the height at which we measure the first diameter of a cone. In column B is the diameter of the cone at this height. Column C is the height at which we measure the second diameter of the cone. Column D is the diameter of the cone at the height of the column C value. The result is the angle of the cone expressed in degrees.

GausSPC does not differentiate between lower and upper case characters.

APPENDIX B – FORMULAS USED

X-chart, histogram and probability plot

Cm – machine capability index

The average: $$X_p = \frac{1}{N}\sum_{i=1}^{N} X_i$$

Where X_i is the i-th measurement and N is the total number of measurements

Standard deviation (N <= 50): $$\sigma_m = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(X_i - X_p)^2}$$

Machine capability index: $$C_m = \frac{UTL - LTL}{6\sigma_m}$$

Critical machine capability index – two-sided tolerances:

$$C_{ml} = \frac{X_p - LTL}{3\sigma_m}, \qquad C_{mu} = \frac{UTL - X_p}{3\sigma_m}$$

$$C_{mk} = MIN(C_{ml}, C_{mu})$$

Critical machine capability index – one-sided tolerance:

- Lower tolerance: $$C_{mk} = \frac{X_p - LTL}{3\sigma_m}$$
- Upper tolerance: $$C_{mk} = \frac{UTL - X_p}{3\sigma_m}$$

Pp – process performance index (short-term process capability index)

The average: $$X_p = \frac{1}{N}\sum_{i=1}^{N} X_i$$

Where X_i is the i-th measurement and N is the total number of measurements.

Standard deviation: $$\sigma_{Pp} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(X_i - X_p)^2}$$

Process performance index: $$P_p = \frac{UTL - LTL}{6\sigma_{Pp}}$$

Where UTL is the upper and LTL is the lower tolerance limit.

Critical process performance index - two-sided tolerances:

$$P_{pl} = \frac{X_p - LTL}{3\sigma_{Pp}}, \quad P_{pu} = \frac{UTL - X_p}{3\sigma_{Pp}}$$

$$P_{pk} = MIN(P_{pl}, P_{pu})$$

Critical process performance index: - one-sided tolerance

- Lower tolerance: $$P_{pk} = \frac{X_p - LTL}{3\sigma_{Pp}}$$
- Upper tolerance: $$P_{pk} = \frac{UTL - X_p}{3\sigma_{Pp}}$$

Cpm – modified process capability index:

$$C_{pm} = \frac{UTL - LTL}{6\sigma_{Cpm}}$$

$$\sigma_{Cpm} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(X_i - T)^2}$$

Where X_i is the i-th measurement, N is the total number of measurements, T is the nominal value, UTL is the upper and LTL is the lower tolerance limit.

Probability Plots – Test of normality of distribution

G1 (skewness):

$$G1 = \frac{\sum_{i=1}^{N}(X_i - X_p)^3}{(\sum_{i=1}^{N}(X_i - X_p)^2)^{2/3}}\sqrt{N}$$

Where X_i is the i-th measurement, X_p the average and N the total number of measurements. For a normal distribution, G1=0.

G2 (kurtosis):

$$G2 = N\frac{\sum_{i=1}^{N}(X_i - X_p)^4}{(\sum_{i=1}^{N}(X_i - X_p)^2)^2}$$

Where X_i is the i-th measurement, X_p the average and N the total number of measurements. For normal distribution G2=3.

The absolute value of G1 and G2 is compared to critical values (see table below) for the given total number of measurements (N) and selected level of confidence (95% or 99%) Based on the comparison at the selected level of confidence we can either state that the distribution is not normal at this confidence level, or we cannot state this.

Examples:

1 N=40, G1=1.40, G2=4.23. The critical values for the confidence level of 95% at N=40 are Q=0.587, QL=2.07 and QH=4.06. G1 is greater than the critical value of Q and G2 is greater than the critical value of QH. Therefore we can state that distribution is not normal with the confidence level of 95% (i.e. with 5% risk).

2 N=50, G1=0.47, G2=2.48. The critical values for the confidence level of 95% at N=50 are Q=0.534, QL=2.15 and QH=3.99. We cannot make the statement that the distribution is not normal with the 95% confidence level because G1 and G2 are smaller than the critical values.

N	Critical values					
	G1 (skewness)		G2 (kurtosis)			
	Q		QL		QH	
	95%	99%	1%	5%	95%	99%
7	1.008	1.432	1,25	1,41	3,55	4,23
10	0.950	1.397	1,39	1,56	3,95	5.00
15	0.862	1.275	1,55	1,72	4,13	5.30
20	0.777	1.152	1,65	1,82	4,17	5,36
25	0.714	1.073	1,72	1,91	4,16	5.30
30	0.664	0.985	1,79	1,98	4,11	5,21
35	0.624	0.932	1,84	2,03	4.10	5,13
40	0.587	0.870	1,89	2,07	4,06	5,04
45	0.558	0.825	1,93	2,11	4.00	4,94
50	0.534	0.787	1,95	2,15	3,99	4,88
70	0.459	0.673	2,08	2,25	3,88	4,61
100	0.389	0.567	2,18	2,35	3,77	4,39
125	0.350	0.508	2,24	2.40	3,71	4,24
150	0.321	0.464	2,29	2,45	3,65	4,13
175	0.298	0.430	2,33	2,48	3,61	4,05
200	0.280	0.403	2,37	2,51	3,57	3,98
250	0.251	0.360	2,42	2,55	3,52	3,87
300	0.230	0.329	2,46	2,59	3,47	3,79
400	0.200	0.285	2,52	2,64	3,41	3,67
500	0.179	0.255	2,57	2,67	3,37	3.60
700	0.151	0.215	2,62	2,72	3,31	3.50
1000	0.127	0.180	2,68	2,76	3,26	3,41
2000		0.127	2,77	2,83	3,18	3,28

EWMA Charts

Cp – Process capability index (long-term process capability index)

The sample average: $$X_p = \frac{1}{N}\sum_{i=1}^{N} X_i$$

Where X_i is the i-th measurement and N is the sample size.

The average of samples: $$X_{Pp} = \frac{1}{M}\sum_{i=1}^{M} X_{pi}$$

Where X_{pi} is the sample average of the i-th sample and M is the total number of samples.

Range of i-th sample: $$R_i = MAX_i - MIN_i$$

Average range: $$R_p = \frac{1}{M}\sum_{i=1}^{M} R_i$$

Standard deviation of process: $$\sigma_{EWMA} = \frac{R_p}{C_2}$$

Graph point: $$\hat{X}_i = \lambda \cdot X_{pi} + (1-\lambda)\cdot \hat{X}_{i-1} \ , \ 0 < \lambda < 1$$

Where X_{pi} is the sample average for the i-th sample.

Starting point in graph: $$\hat{X}_0 = X_{pp}$$

Lower control limit: $$LCL_i = X_{pp} - 3\frac{\sigma_{EWMA}}{\sqrt{N}}\sqrt{\frac{\lambda}{1-\lambda}(1-(1-\lambda)^{2i})}$$

Upper control limit: $$UCL_i = X_{pp} + 3\frac{\sigma_{EWMA}}{\sqrt{N}}\sqrt{\frac{\lambda}{1-\lambda}(1-(1-\lambda)^{2i})}$$

Process capability index: $$C_p = \frac{UCL - LCL}{6\sigma_{EWMA}}$$

Critical process capability index – two-sided tolerances:

$$C_{pl} = \frac{X_p - LTL}{3\sigma_{EWMA}}, \quad C_{pu} = \frac{UTL - X_p}{3\sigma_{EWMA}}$$

$$C_{pk} = MIN(C_{pl,} C_{pu})$$

Critical process capability index – one-sided tolerances:

- Lower tolerance: $C_{pk} = \frac{X_p - LTL}{3\sigma_{EWMA}}$

- Upper tolerance: $C_{pk} = \frac{UTL - X_p}{3\sigma_{EWMA}}$

The value of factor C_2 depends on the sample size and is given in the table at the end of Appendix B.

X-R Charts

Cp – Process capability index (long-term process capability index)

The sample average: $$X_p = \frac{1}{N}\sum_{i=1}^{N} X_i$$

Where X_i is the i-th measurement and N is the sample size.

The average of samples: $$X_{pp} = \frac{1}{M}\sum_{i=1}^{M} X_{pi}$$

Where X_{pi} is the sample average of the i-th sample and M is the total number of samples.

Range of i-th sample: $$R_i = MAX_i - MIN_i$$

Average range: $$R_p = \frac{1}{M}\sum_{i=1}^{M} R_i$$

Standard deviation of process: $$\sigma_R = \frac{R_p}{C_2}$$

Process capability index: $$C_p = \frac{UTL - LTL}{6\sigma_R}$$

Critical process capability index – two-sided tolerances:

$$C_{pl} = \frac{X_p - LTL}{3\sigma_R}, \quad C_{pu} = \frac{UTL - X_p}{3\sigma_R}$$

$$C_{pk} = MIN(C_{pl}, C_{pu})$$

Critical process capability index – one-sided tolerances:

- Lower tolerance: $$C_{pk} = \frac{X_p - LTL}{3\sigma_R}$$
- Upper tolerance: $$C_{pk} = \frac{UTL - X_p}{3\sigma_R}$$

Calculation of process capability index is only useful when the process is stable.

Lower control limit for X_p: $$LCL_{Xp} = X_{pp} - A_2 R_p$$

Upper control limit for X_p: $$UCL_{Xp} = X_{pp} + A_2 R_p$$

Lower control limit for R_p: $$LCL_{Rp} = D_3 R_p$$

Upper control limit for R_p: $$UCL_{Rp} = D_4 R_p$$

Values for parameters A_2, D_3, D_4 and C_2 depend on the sample size and are given in the table at the end of Appendix B.

X-s Charts

Cp – Process capability index (long-term process capability index)

The sample average: $$X_p = \frac{1}{N}\sum_{i=1}^{N} X_i$$

Where X_i is the i-th measurement and N is the sample size.

The average of samples: $$X_{pp} = \frac{1}{M}\sum_{i=1}^{M} X_{pi}$$

Where X_{pi} is the sample average of the i-th sample and M is the total number of samples.

Standard deviation of the i-th sample: $$s_i = \sqrt{\frac{1}{N-1}\sum_{j=1}^{N}(X_j - X_p)^2}$$

Average standard deviation of samples: $$s_p = \frac{1}{M}\sum_{i=1}^{M} s_i$$

Standard deviation of the process: $$\sigma_s = \frac{s_p}{C_4}$$

Process capability index: $$C_p = \frac{UTL - LTL}{6\sigma_s}$$

Critical process capability index – two-sided tolerances:

$$C_{pl} = \frac{X_p - LTL}{3\sigma_s}, \quad C_{pu} = \frac{UTL - X_p}{3\sigma_s}$$

$$C_{pk} = MIN(C_{pl}, C_{pu})$$

Critical process capability index – one-sided tolerances:

- Lower tolerance: $$C_{pk} = \frac{X_p - LTL}{3\sigma_s}$$
- Upper tolerance: $$C_{pk} = \frac{UTL - X_p}{3\sigma_s}$$

NB. Calculation of process capability index is only useful when the process is stable.

Lower control limit for X_p: $$LCL_{Xp} = X_{pp} - A_3 s_p$$

Upper control limit for X_p: $$UCL_{Xp} = X_{pp} + A_3 sR_p$$

Lower control limit for s_p: $$LCL_{sp} = B_3 s_p$$

Upper control limit for s_p: $$UCL_{sp} = B_4 s_p$$

Values for parameters A_3, B_3, B_4 and C_4 depend on the sample size and are given in the table at the end of Appendix B.

Table of parameters for X-R, X-s and EWMA control charts

Sample size	X – R, EWMA				X – s			
N	A_2	C_2	D_3	D_4	A_3	C_4	B_3	B_4
2	1.880	1.128	0.000	3.267	2.659	0.7979	0.000	3.267
3	1.023	1.693	0.000	2.574	1.954	0.8862	0.000	2.568
4	0.729	2.059	0.000	2.282	1.628	0.9213	0.000	2.266
5	0.577	2.326	0.000	2.114	1.427	0.9400	0.000	2.089
6	0.483	2.534	0.000	2.004	1.287	0.9515	0.030	1.970
7	0.419	2.704	0.076	1.924	1.182	0.9594	0.118	1.882
8	0.373	2.847	0.136	1.864	1.099	0.9650	0.185	1.815
9	0.337	2.970	0.184	1.816	1.032	0.9693	0.239	1.761
10	0.308	3.078	0.223	1.777	0.975	0.9727	0.284	1.716
11	0.285	3.173	0.256	1.744	0.927	0.9754	0.321	1.679
12	0.266	3.258	0.283	1.717	0.886	0.9776	0.354	1.646
13	0.249	3.336	0.307	1.693	0.850	0.9794	0.382	1.618
14	0.235	3.407	0.328	1.672	0.817	0.9810	0.406	1.594
15	0.223	3.472	0.347	1.653	0.789	0.9823	0.428	1.572
16	0.212	3.532	0.363	1.637	0.763	0.9835	0.448	1.552
17	0.203	3.588	0.378	1.622	0.739	0.9845	0.466	1.534
18	0.194	3.640	0.391	1.608	0.718	0.9854	0.482	1.518
19	0.187	3.689	0.403	1.597	0.698	0.9862	0.497	1.503
20	0.180	3.735	0.415	1.585	0.680	0.9869	0.510	1.490
21	0.173	3.778	0.425	1.575	0.663	0.9876	0.523	1.477
22	0.167	3.819	0.435	1.566	0.647	0.9882	0.534	1.466
23	0.162	3.858	0.443	1.557	0.633	0.9887	0.545	1.455
24	0.157	3.895	0.451	1.548	0.619	0.9892	0.555	1.445
25	0.153	3.931	0.459	1.541	0.606	0.9896	0.565	1.435

APPENDIX C – THE GAUSS.INI FILE

```
[Language]
Language=english
;Language=german
```

The [Language] section of the Gauss.ini file is used to set the language version. In the GausSPC program folder, a language file must exist (e.g. german.lng), from which translations will be read for all texts used in GausSPC.

```
[Additional Product Parameters]
ParameterDescription0=
ParameterDescription1=
ParameterDescription2=
ParameterDescription3=
```

Use the [Additional Product Parameters] section to add up to four additional parameters to the Product Characteristic dialog box.

```
[Report]
ReportTitle_Str=Report|Bericht||
ReportNr_Str=Report No.|Bericht Nr.||
Date_Str=Date|Datum||
Page_Str=Page|Seite||
Operator_Str=Operator|Operateur||
Sign_Str=Signature|Unterschrift||
Remark_Str=Remark|Bemerkung||
Average_Str=XBar|XQuer||
Range_Str=R|R||
StdDeviation_Str=Std|Std||
MaxValue_Str=MAX|MAX||
MinValue_Str=MIN|MIN||
LowerTolLimit_Str=LTL|UTG||
UpperTolLimit_Str=UTL|OTG||
LowerControlLimit_Str=LCL|UKG||
UpperControlLimit_Str=UCL|OKG||
Passed_Str=Passed|Gut||
SampleSize_Str=Sample size|Muster||
SamplesCount_Str=Number|Anzahl||
SampleAverage_Str=XBarBar|XQuerQuer||
RangeAverage_Str=RBar|RQuer||
SigmaAverage_Str=sBar|sQuer||
Measurement_Str=Nr.|Nr.||
Sample_Str=Samples|Musteranzahl||
SampleNr_Str=Sample Nr.|Muster Nr.||
AllErrors_Str=Errors|Fehlers||
ErrorsCount_Str=Errors|Fehlers||
CumulativeFrequency_Str=Cumulative
Frequency|Summenhaeufigkeit||
Frequency_Str=Error Frequency|Fehlerhaeufigkeit||
Error_Str=Error type|Fehler typ||
```

```
HeaderLine1=Item|Teil||
HeaderLine2=Item code|Teil Nr.||
HeaderLine3=Series|Serie||
HeaderLine4=Tool|Werkzeug||
HeaderLine5=Work place|Arbeitstelle||
HeaderLine6=Order|Bestellung||
HeaderLine7=|||
HeaderLine8=|||
HeaderLine9=|||
HeaderLine10=|||
Link1=0
Link2=0
Link3=0
Link4=0
Link5=0
Link6=0
Link7=0
Link8=0
Link9=0
Link10=0
```

Use the [Report] section to edit text strings to be included in the report in four languages. Note that you can also change these through the GausSPC interface.

```
MaxReportCharts=128
```

Use the 'MaxReportCharts' parameter under the [Report] section to set the maximum number of charts permitted per report. The default value is 64 and the highest possible value is 255. Higher values can cause unstable behaviour of Windows 95/98 operating systems due to limited resources. This limitation does not exist for Windows 2000/XP.

```
[FileImport]
SkipLines=0
Delimiter=59
Columns=6
Type_Column0=1
Type_Column1=2
Type_Column2=3
Type_Column3=0
Type_Column4=0
Type_Column5=0
Type_Column6=0
Type_Column7=2
Type_Column8=8
DateFormat=0
Type_Column9=9
Type_Column10=10
Type_Column11=5
Type_Column12=5
Type_Column13=5
```

```
Type_Column14=5
Type_Column15=5
NewEntriesOnly=0
OneValuePerLine=0
Type_Column16=5
Type_Column17=5
Type_Column18=5
Type_Column19=5
Type_Column20=5
AddColumns=0
```

The [FileImport] section contains the settings for importing text files.

```
[SBox25]
Delay=1000
```

Use the [SBox25] section to set the minimum delay between two consecutive inputs from SBox25 or SBox9 measuring interfaces which will otherwise keep sending the data until the trigger is released. The delay is in miliseconds.

```
[Grid]
Columns=16
Sheets=1
MaxRows=8024
```

The [Grid] section defines the default size of the worksheet when a new file is opened.

```
[RTF]
Measurer=Measurer
Prefix=
```

Use the [RTF] section to set the parameters for importing PC-DMIS .rtf files. The 'Prefix' parameter defines the string which is omitted from the name of the characteristic when imported. For example characteristics 'D12', 'D13' and 'D14' will be displayed as '12', '13' and '14' when Prefix=D. The 'Measurer' parameter defines the string for which GausSPC must search to find the name of the Operator who entered the measurements.

```
[OutOfControlTest]
NumIncreasing=7
NumSameSide=7
TestsCode=1
```

The [OutOfControlTest] section contains the settings for the out of control test.