



Real-Time Data Collection and Analysis

**QC-CALC[®] Real-Time
Training
Manual & Workbook**

Version 3.4.1

Notices

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1. The Goal

Prolink's goal is to produce information out of large amounts of data with as little work as possible. In other words, save you time!

- Provide Easy to Use Data Collection Software that:
 1. Automatically Collects data on up to 3000 features per part while
 2. Switching Automatically to any Part Program and
 3. Displaying Up to 500 Live Plots and
 4. Operates without Humans needing to be Present therefore,
 5. Never Asks Questions and
 6. Adapts Under All Conditions with
 7. Total Error Recovery.
- Provide Tools to Reduce Data into Information by:
 1. Identifying Bad Features and Parts and/or
 2. Filter Parts Made by Cavities, Machines, etc while
 3. Showing Trending Features therefore
 4. Automatically Alert You by
 5. Printing Reports to Paper or
 6. Printing Reports to File and optionally
 7. Emailing these Files to Alert Management.
- Provide Data Export to Database & Spreadsheets
- Provide Data Export to other SPC Formats

2. What's New in QC-CALC 3.4

Our previous version of QC-CALC Real-Time was 3.3 was this 3.4 version of based. For those who used 3.3 you'll find the following changes in 3.4:

- New Reporting and Exporting screens have a consistent look and feel
- Manual Input screen was removed from the Automatic Reporting area and given its own trigger and setup
- You can now add a picture to each feature in Real-Time
- All reporting templates are updated to version 16
- The Administrative password has a one-use recovery password in case you forget it. This password is generated by Prolink personnel.
- Control Limits are now available for Non-Toleranced Features
- New built-in record filter called Last_N_Records for quick access
- Many other updates for consistency

3. Welcome to QC-CALC Training

QC-CALC[®] is a comprehensive data collection and statistical process control program designed to manage, analyze and report inspection data. Inspection data may be collected automatically from inspection devices or entered manually.

Most of QC-CALC's operation is automatic and requires very little knowledge to operate. This tutorial and training manual was designed for those who wish to learn the full power of QC-CALC to optimize data collection and automate many of the daily repetitive tasks.

3.1 Course Prerequisites

To ensure your success with this training, we recommend that you do the following **before** you come to class:

- Install QC-CALC on your inspection equipment
- Read the special section (first set of gray pages of the QC-CALC manual) discussing how to generate inspection results from your inspection equipment
- Run several parts and obtain live QC-CALC graphs
- Print a few reports
- Review this manual – this assumes you purchased before attending

You should have a working knowledge of the following topics, which are **not** covered in this training:

- Limited knowledge of some SPC terms
- A working knowledge of Windows operating system

3.2 Course Objectives

The objective of this training is to familiarize the student with the operation of QC-CALC's automatic data collection and analysis program known as QC-CALC Real-Time. After the basic overview of the program and its operation, you can skip sections that are not relevant to your operation and concentrate on sections you'll need.

Many customers require basic operating knowledge of the software while others require advanced detail to maximize QC-CALC's ability to reduce large amounts of data into useful information. Therefore, this course is divided into basic and advanced sessions. The basic user will learn the general operation, how to collect data, how to interpret the plots, how to print reports, and how to export data.

Advanced users will learn more data collection methods, printing automatic reports, setup trend detection and actions, print and saving reports to files, and email reports as necessary.

After completing this course, you will be able to:

- Change the look and feel of QC-CALC
- Output inspection results to QC-CALC and display each feature as a plot
- Create inspection reports
- Export results to various database formats
- Create and modify QC-CALC databases
- Generate reports indicating in-tolerance and out-of-tolerance conditions
- Use the on-line Help to find desired information

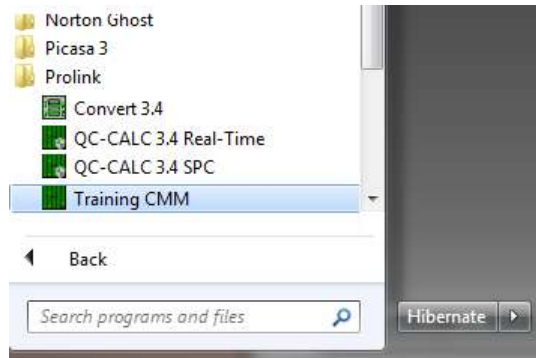
4. Training CMM Software Tool

4.1 Introduction

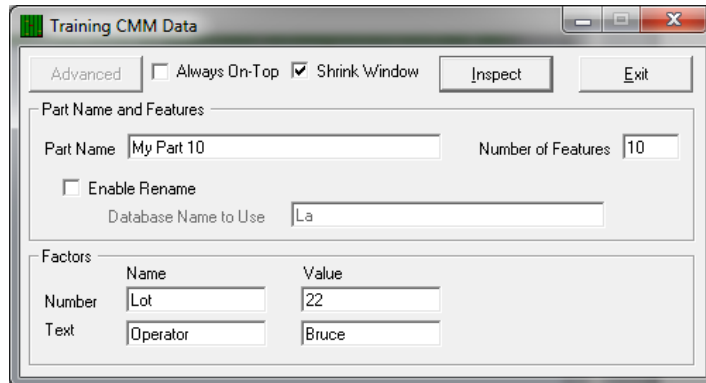
During normal operation, QC-CALC reads and displays the measurement result files created by your CMM, video CMM or Gages. During this training we simulate the CMM by using a small program called **Training CMM.EXE**. This is a small program used to generate random numbers providing a method to show you QC-CALC Real-Time in action.

4.2 Starting the Training CMM

Now start the **Training CMM** program by selecting it from the Windows **START** button. Choose **All Programs – Prolink – Training CMM ...**



... and **Training CMM** launches looking similar to the diagram below.



4.3 Using the Training CMM

4.3.1 Part Name

Enter a name in the **Part Name** text-box that represents one of the parts you might inspect on your CMM. When you run a part program on a real CMM this is the CMM part program name. Use any name you like (no slashes etc). In this example, we used MyPart 10.

4.3.2 Number of Features

Number of Features represents how many features are inspected on each part. This also represents how many plots you will see in the Real-Time screen since QC-CALC creates one plot per feature. You can change this number at any time but you should follow the exercise instructions in this document to become familiar with its operation. The default value is 10 and you should stay below 500.

4.3.3 Name & Value

The first **Name** and **Value** represent extra numeric Trace fields sent with each inspected part. The default value is Cavity with a value of 0 and is limited to numbers only.

The second row of **Name** and **Value** is the second Trace field but this text-box allows text to be sent with each part. You can add anything you want such as Operator, Lot, etc. and QC-CALC saves and displays value with your part data. The default value is Operator with a value of Not Used.

4.3.4 Creating Simulated Parts

The **Inspect** button is used to create the simulated data that QC-CALC reads. Each time you click the **Inspect** button a file is created containing the number of features you entered in the **Number of Features** box. This file is read by QC-CALC and one record is added to the database. You can inspect simulated parts very quickly by clicking the button many times. We use and reference this program throughout the manual and any live training you may attend.

5. Layout Orientation

5.1 Start QC-CALC Real-Time



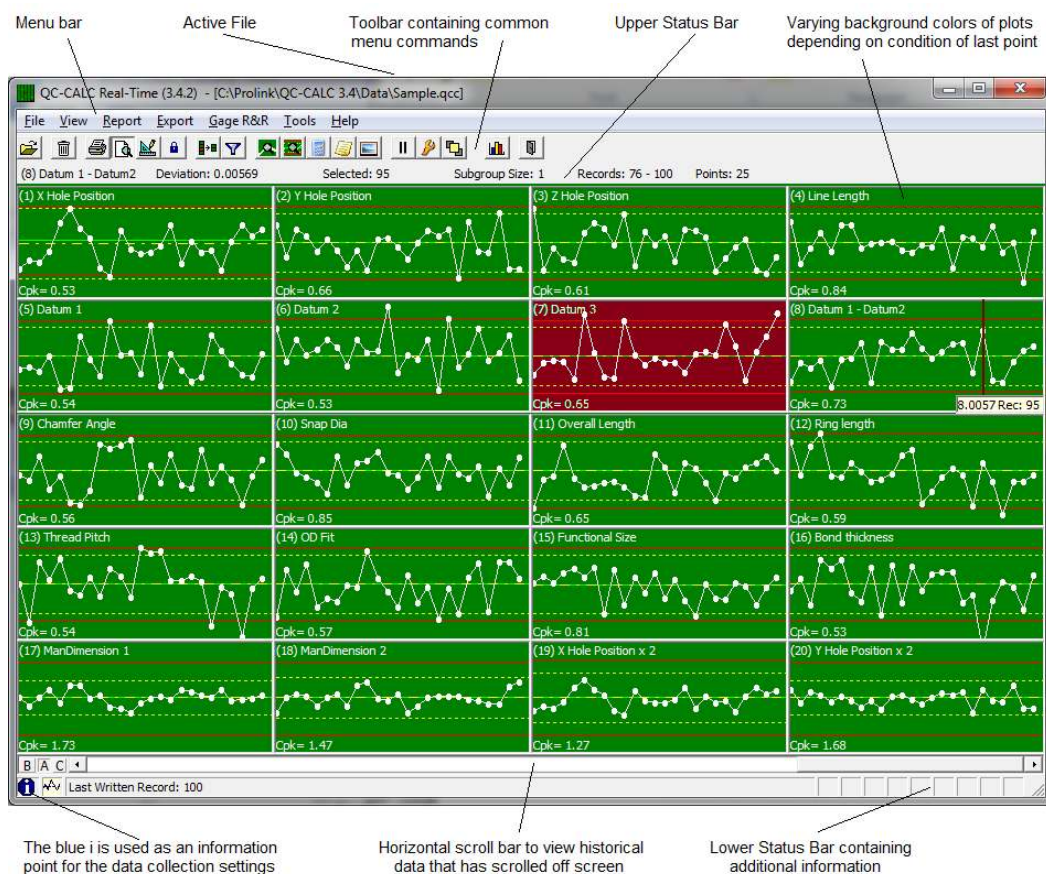
Simply double click the green icon on your desktop or select the Windows **START** button and choose **All Programs – Prolink – QC-CALC Real-Time**.

5.2 Overview of Screen

The diagram below is the QC-CALC Real-Time Plots Screen. Various areas of this screen are discussed here and these important parts of QC-CALC are referenced throughout this course.

All data collection occurs when this screen is present and many other options are available during data collection. The important items to point out are:

- Header
- Menu Bar
- Toolbar
- Top Status Bar Display
- Plots
- Background Color of Plots
- Plot Types
- Right Clicking a Plot
- Scroll Bar
- Bottom Status Bar Display
- Part Information
- Part Rate
- Record Number
- Zooming in on Plots
- Un-Zooming a Plot



5.3 Menu

The QC-CALC Real-Time menu bar controls the overall operation of the software including all of the reporting, exporting, and display settings for the plots.

5.4 Toolbar Buttons


The QC-CALC Real-Time Toolbar provides you with convenient shortcuts to frequently used menu items. These shortcuts are easily identifiable by their icons. Hover the mouse over an icon to activate a tool-tip that will identify the shortcut.

5.5 Top Status Bar

The Upper Status Bar shows Dimension Name, Deviation, Selected Point, Subgroup Size, Record Range and Points.

5.6 Bottom Status Bar

5.6.1 Part Information

The white  inside of the blue circle is an information icon. When you place the mouse cursor over it a tool-tip window pops up with information about the current inspection machine and the active file. The Part Name contains up to 32 characters of text describing the current part routine.

```
Model Name: CALY
Source file name: C:\zeiss\calypso\home\om\workarea\results\*_chr.txt
Source Type: FILE
PartName: Sample
Filter Group: C:\Prolink\QC-CALC 3.3\Filters\Default.qcf
```

The part information PopUp informs you of QC-CALC's current data collection status.

The **Source file name** is usually received from the inspection machine but can be changed by selecting **Tools – Options – Data Collection – Data Source Information**. Also included are the Model Name, Source File Name, Source Type, Part Name and Filter Group, which specifies what type of file is being received, and where it is coming from.

5.6.2 Last Record Number

The next section of the tray is used to display information that does not require a response. Normally, you will see the last written record counting. Use this as a reference. Other colored messages may appear and are self-explanatory. They are usually exceptions or reports of abnormal situations.

5.6.3 Status Area

The right side of the tray displays the current status of QC-CALC's automatic features. Automatic exporting, reporting, and metafile creation can be enabled independently, and can trigger on different schedules. This area tells you the status of each of these features. Click on this area to see the path and name of the files being used in your automatic operations.

5.6.4 The Scroll Bar

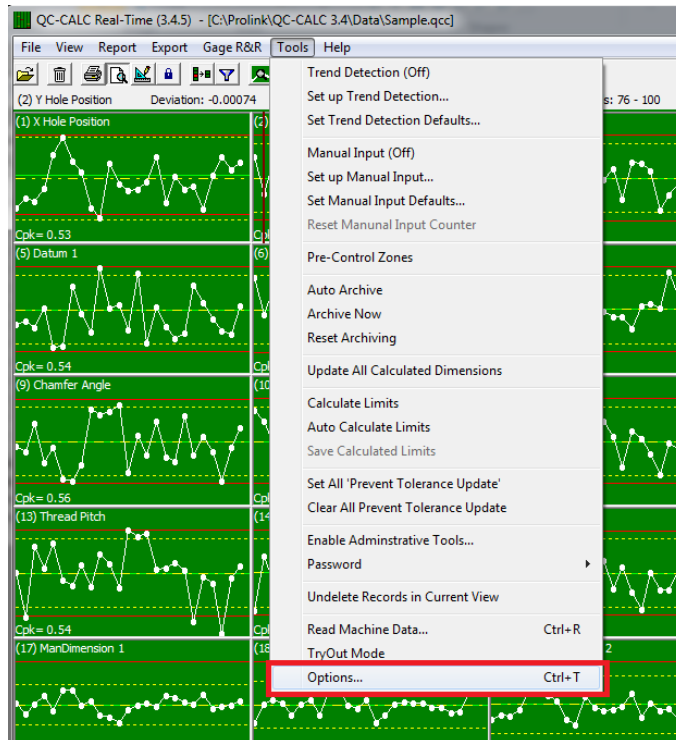
The scrolling area located below the plots is used to control the view (Basic, Advanced, or Custom) you are using, to scroll to older data in the plots, or to move through the dimension being displayed if you are zoomed in on a single dimension.



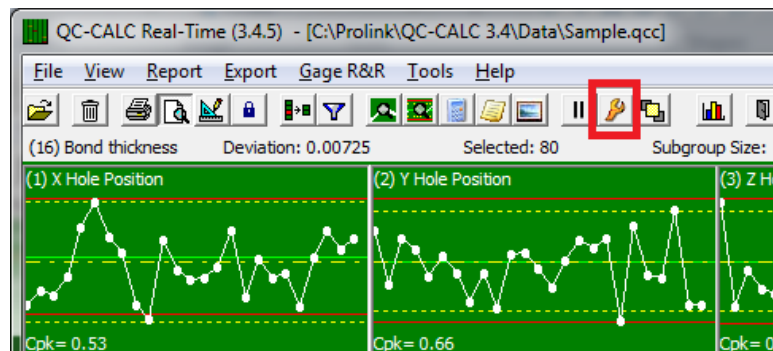
6. QC-CALC Conventions

6.1 Introduction

Like most Windows programs, QC-CALC's operation follows a convention that requires discussion. ALL settings are changed using the **Tools – Options** menu. Some of the settings you change may not “take affect” until you turn the feature on or off from another menu. As an example, you can set the trends you want to monitor but until you “turn on” the **Trend Detection** menu the settings are saved but not activated. Trends are seen when the menu is enabled.

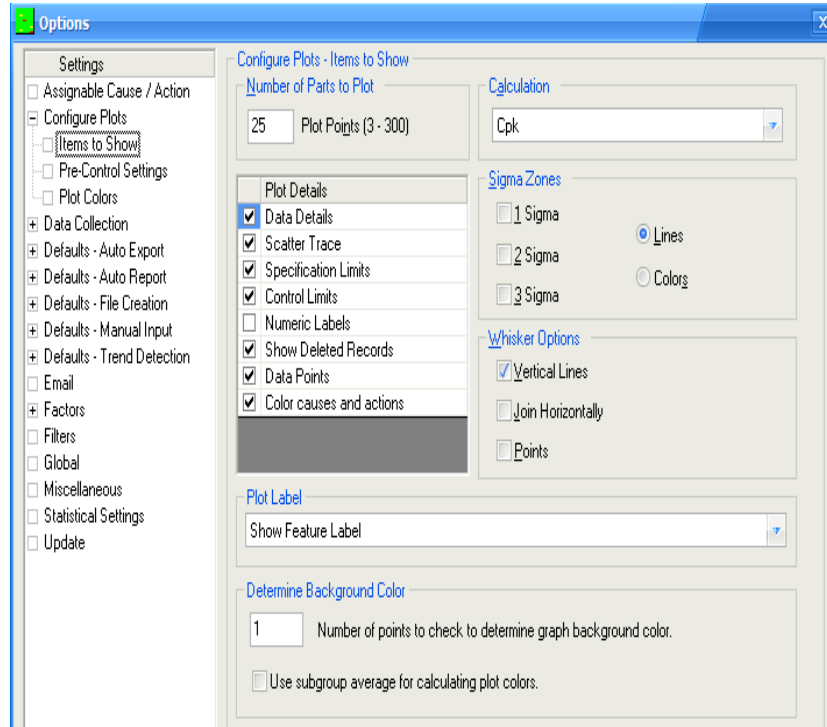


The **Tools – Options** shortcut button is the orange wrench found in the Toolbar. We will refer to this menu option many times throughout this manual.



6.2 Tools – Options – Settings

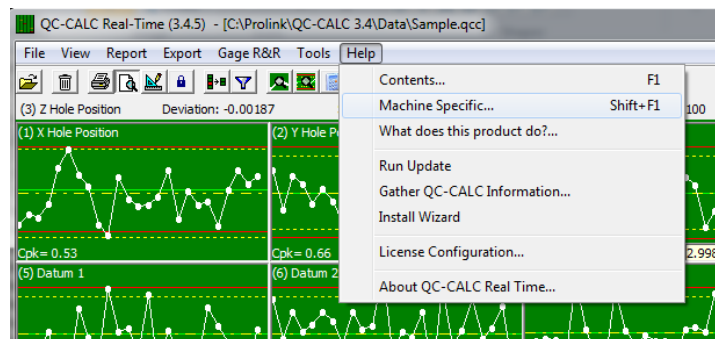
When **Tools – Options** is selected, you see the **Settings** window. You can change QC-CALC’s operation from this multi-purpose window. When you click on the menus located on the left side of this window, the right side changes showing the available options. You select and change the option that best suits your needs. This is an important screen in QC-CALC and you will use it often during this training.



6.3 Help System

6.3.1 F1 Key is Context Sensitive

All Windows programs use the F1 key to initiate the Help system. QC-CALC is no different so whenever you need help, simply press the F1 key. The menu option shows the contents of the QC-CALC help file. Jump text is available to get to specific help topics.



6.3.2 SHIFT + F1 – Machine Help

This menu option shows the help file section containing interface notes for the specific type of inspection machine interface currently running. This is particularly helpful if you forget how to output CMM inspection results to QC-CALC. Simply hold the SHIFT key down and press F1.

6.3.3 Run Update

This menu option allows you to locate and run the update patch required to update your current version of QC-CALC Real-Time when a newer version is available. This feature requires the QC-CALC PC to be connected to your local area network and possibly the Internet. For details about updating see the [Update](#) section on page [222](#).

6.3.4 Gather QC-CALC Information

If there is a problem with your software that cannot be solved by using the help system or your manual, you can call Prolink for technical support. We may ask you to choose this menu option which will automatically collect all of the information about your settings that we will need to assess the problem. You will need to either email or Fax the information to us after QC-CALC stores it in a file. A short wizard will guide you through the steps.

6.3.5 Install Wizard

Advanced users use this menu item in an attempt to automatically configure QC-CALC to collect data. This is the same Window that was displayed the first time you ran QC-CALC. You can return to the “first run” screen by selecting this menu. See the [Install Wizard](#) section on page [202](#) for details.

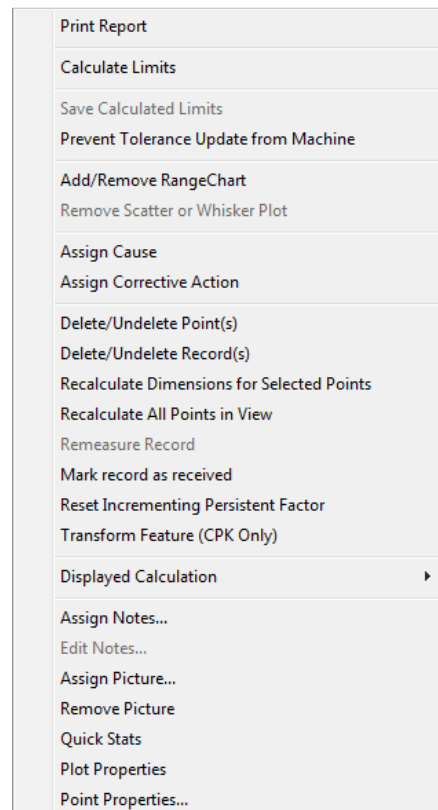
6.3.6 Help About

Use this menu to determine which version of QC-CALC you are running. There is other important information that our support team may request.

6.4 PopUp Menu

6.4.1 The Right Mouse

As with most Windows programs, the right mouse button usually has hidden options. If you Right click any plot on the QC-CALC Real-Time screen, a special menu pops up with a variety of options. This type of interface allows you to select the plot before the menu is activated. Keep this in mind as various topics are discussed throughout this training. For more details about this menu see the [PopUp Menu \(Right Click on Any Plot\)](#) section on page [203](#).



7. Data Layout

7.1 Introduction

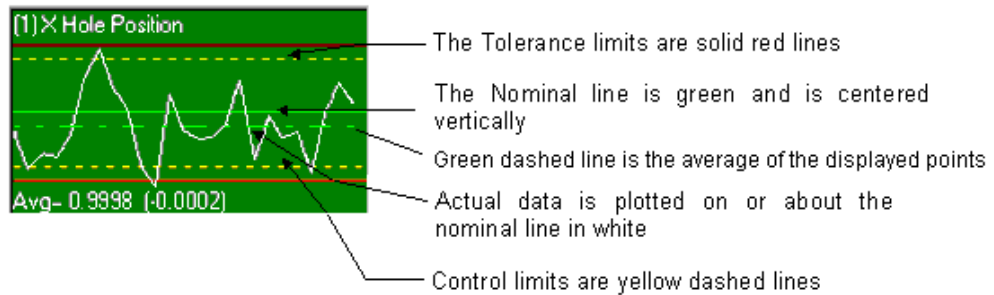
A QC-CALC database is simply a way of dividing a large body of information into smaller, logical pieces. Each database contains information on the part being measured. The database is made up of individual records (rows) holding the measurement results of one part. Each column represents one feature over many parts. Select **File – Show QC-CALC SPC** to see the Edit Data window. Many other data items are stored with the data as shown in the figure below. Please read the **QC-CALC SPC Training Manual** for more details.

Record	(1) X Hole Position	(2) Y Hole Position	(3) Z Hole Position	(4) Line Length	(5) Datum 1	(6) Datum 2	(7) Datum 3	(8) Datum 1 - Datum 2	(9) Chamfer Angle	(10) Snap Dia	(11) Cavity
1	1.0009	1.9991	2.9990	4.0004	4.9884	5.9989	7.0008	7.9959	9.0032	9.9959	1
2	1.0000	2.0008	2.9986	4.0025	4.9866	6.0027	7.0007	7.9993	9.0046	10.0016	2
3	1.0002	1.9999	3.0011	3.9986	4.9984	5.9985	6.9989	8.0088	8.9993	10.0085	3
4	1.0004	2.0009	3.0026	4.0008	4.9885	5.9989	7.0052	8.0040	9.0055	9.9986	4
5	0.9999	1.9992	3.0004	4.0027	4.9971	6.0029	7.0010	8.0039	8.9953	10.0175	5
6	1.0000	1.9993	2.9996	4.0032	5.0018	5.9978	6.9987	7.9933	8.9926	10.0049	6
7	0.9996	2.0013	2.9976	3.9993	5.0012	5.9991	6.9942	8.0035	9.0085	9.9987	7
8	1.0003	2.0014	2.9993	3.9990	5.0017	5.9937	6.9998	8.0017	8.9944	10.0006	8
9	0.9993	1.9984	3.0009	3.9980	5.0020	6.0008	7.0055	8.0063	8.9984	9.9976	9
10	1.0005	1.9991	2.9987	3.9987	5.0016	5.9984	7.0013	7.9969	9.0060	9.9971	10
11	0.9998	2.0018	2.9987	3.9998	5.0003	6.0022	7.0049	7.9997	9.0056	9.9987	11
12	1.0009	2.0004	2.9974	4.0015	4.9974	6.0025	6.9954	7.9951	8.9990	9.9955	12
13	1.0003	2.0008	2.9990	3.9955	5.0002	5.9945	6.9958	8.0015	9.0073	9.9992	13
14	0.9999	1.9997	3.0001	4.0028	4.9987	5.9996	6.9988	7.9936	8.9963	9.9919	14
15	0.9999	1.9988	2.9999	3.9994	5.0011	6.0006	6.9997	8.0063	8.9939	10.0027	15
16	0.9998	1.9992	2.9988	4.0007	5.0011	5.9932	7.0034	7.9982	9.0053	10.0041	16
17	0.9997	1.9997	2.9999	3.9990	5.0022	5.9971	7.0007	8.0014	9.0070	10.0064	1
18	1.0004	2.0000	3.0015	3.9971	5.0059	6.0007	7.0010	7.9988	9.0077	9.9985	2
19	1.0004	2.0002	2.9972	4.0009	5.0041	5.9987	7.0029	8.0029	8.9945	9.9990	3
20	1.0000	2.0002	3.0014	4.0030	5.0029	5.9987	7.0024	8.0018	9.0036	10.0047	4
21	1.0002	1.9995	2.9992	4.0024	5.0030	5.9993	6.9973	8.0088	8.9956	10.0033	5
22	0.9992	2.0000	2.9985	3.9984	4.9995	6.0054	6.9990	8.0039	8.9902	9.9916	6
23	0.9995	2.0013	2.9972	4.0003	5.0006	5.9976	7.0047	7.9971	8.9987	10.0010	7
24	0.9996	2.0014	3.0002	3.9986	5.0015	6.0001	6.9978	7.9973	9.0023	10.0096	8
25	0.9996	2.0003	3.0001	3.9988	5.0036	6.0024	6.9967	7.9973	9.0008	9.9955	9
26	0.9995	2.0008	2.9989	4.0012	4.9993	6.0016	7.0013	7.9997	9.0037	9.9992	10
27	0.9993	2.0019	3.0000	4.0009	5.0011	5.9989	7.0029	7.9959	8.9911	10.0012	11
28	1.0006	2.0024	2.9996	4.0018	5.0003	5.9961	6.9931	7.9977	8.9999	10.0017	12
29	1.0000	1.9996	2.9992	3.9979	4.9990	5.9959	6.9961	7.9932	8.9956	9.9985	13
30	1.0001	2.0008	3.0004	3.9997	5.0016	5.9986	6.9981	7.9994	9.0011	9.9965	14
31	1.0007	1.9998	3.0007	4.0006	5.0017	6.0006	7.0014	8.0001	9.0007	10.0000	15

8. The Plots

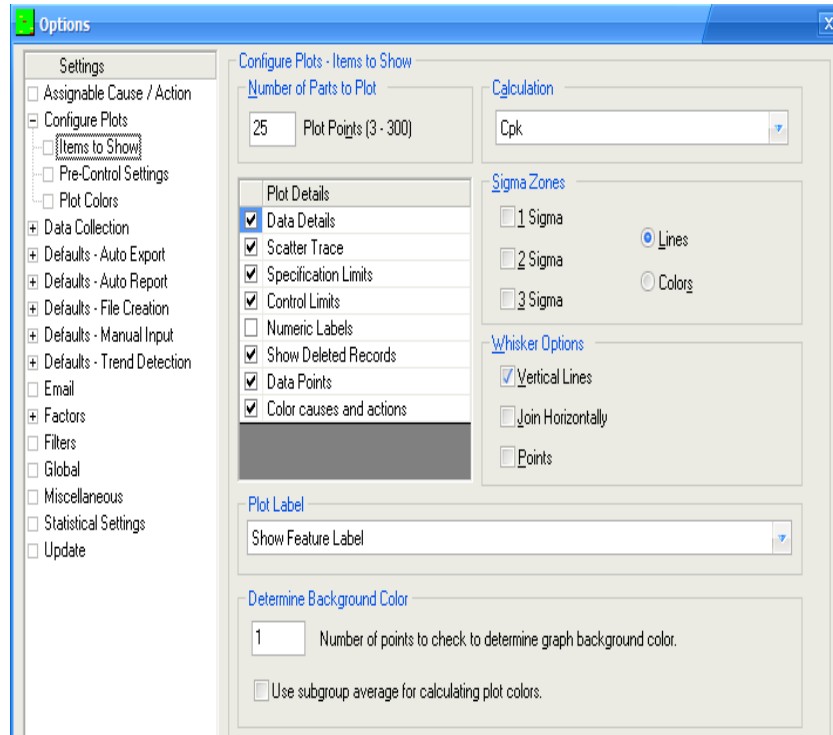
8.1 The Plot Details

Your inspection results are displayed in run chart format as either Raw Data plots or Xbar Charts depending on the Subgroup Size. With a Raw Data plot each point represents the actual data that was received from the inspection machine, but with the Xbar Chart each point represents the average of that subgroup of data points received. The plot history is scrolled left and latest values are added to the right. This type of plot lets you see how your process varies over time.



8.2 Configuring the Plots

The Real-Time plot screen has many options you can adjust. For example, you may want to change the color of the plots, the displayed calculation, the number of points within a plot, etc. All of the available plot configurations are found in the **Tools – Options – Configure Plot Settings** menu. The **Items to Show** menu changes what is displayed on the plots and the **Plot Colors** menu relates to the available colors of each item.



8.2.1 Number of Parts to Plot

This is the maximum number of actual data point values displayed within each plot. QC-CALC attempts to read this number of values from the file. Data is read from newest to oldest and plots are viewed with oldest data on the left side of the

plot with newest on the right. If a database filter is active you may see less points if some of the points do not match the filter criteria.

When the subgroup size is set to a number greater than 1 the **Number of Parts to Plot** is multiplied by the subgroup. This means if the subgroup size is 5 and the **Number of Parts to Plot** is set to 100 a total of 500 parts is included in each plot.

8.2.2 Calculation

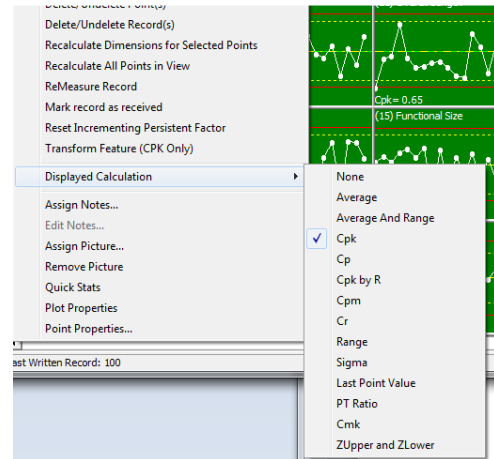
The lower left corner of each plot contains a calculated result. This number gives you immediate feedback of each feature's current situation. The calculation is not displayed on Scatter plots. You can display one of the following calculations:

Calculation	Description
None	No calculations are displayed on the plots.
Average	Shows the average value of all displayed data points.
Avg & Range	Shows both the average and the range values of all displayed data points.
Cpk	<p>QC-CALC calculates Cpk on all displayed numbers using the lesser of:</p> <p>Cpk_u based on upper tolerance = (USL - Mean) / 3σ Cpk_L based on lower tolerance = (Mean - LSL) / 3σ</p> <p>where: USL is Upper Spec Limit LSL is Lower Spec Limit σ is standard deviation</p> <p>If the feature has a single-sided tolerance, the Cpk for that particular side is displayed.</p>
Cp	<p>If you choose Cp to be displayed in the live plots, QC-CALC calculates Cp on all displayed numbers using the following equation:</p> $Cp = (USL - LSL) / 6\sigma$ <p>where: USL is Upper Spec Limit LSL is Lower Spec Limit σ is standard deviation</p>
Cr	<p>Computed by dividing 1 by the Cp value.</p> $Cr = 1 / Cp$ <p>This value is printed in the same place as the Cp value.</p>
Cpk by R	Cpk except σ _{by R} is used instead of σ.
Cpm	$= \frac{(USL - LSL)}{6\sqrt{(\sigma^2 + (\bar{X} - Nom)^2)}}$
Range	Shows the range of all displayed data points.
Sigma	Shows the sigma value for all displayed data points.
Last Point Value	The last data point in the plot is displayed. This is useful for quickly seeing all values of the most recent part without having to float the mouse over each point.
P/T Ratio	This is the same calculation of Cr but convenient for

	displaying the repeatability value when measuring one part over and over again in a Gage R type of test. For more details see the section on Gage R & R.
Cmk	This is the same calculation of Cpk but it is used when your data is measuring the capability of a machine instead of the process.
Zupper and Zlower	Indicates the number of sigmas a point is from the upper or lower spec limit. Please see a full explanation of Zupper & Zlower on page 176.

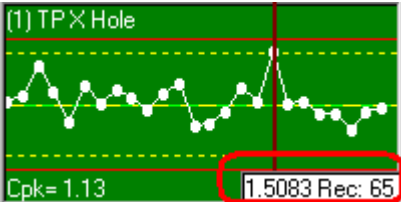
8.2.3 Short-Cut

You can quickly change the displayed calculation by using the right mouse button PopUp menu. Right click on any plot and select **Display Calculation** then pick the new calculation. This was added to make it quicker to change the calculation.



8.2.4 Plot Details

Each plot can contain tolerance lines, control lines, etc. You can control what is shown on the plots by checking the appropriate item. Each item is now discussed.

Data Details	<p>Because each plot has many data points it is impractical to display the value of each point on the screen. Data Details is used to display both the point's value and its record number. Float the mouse pointer close to the point of interest and the value is displayed.</p>  <p>This figure shows the mouse pointer over record 65 with a value of 1.5083 for the point. Note how the red (vertical) line is used to show you the closest point to the mouse.</p>
Scatter Trace	<p>The scatter plot is used to plot data in an X vs. Y type chart. Because scatter plots are X vs. Y all time reference is lost. Checking Scatter Trace causes the last 6 points to be connected with a line to show the most recent part history. More than 6 points clutter the plot so you cannot change the number of points connected, it is always the last 6. Refer to Scatter Plots on page 163 for more information.</p>
Specification Limits	<p>The tolerance lines (solid red lines) are displayed on all plots. You might want these lines turned off if the Real-Time subgroup size is greater than 1.</p>
Control Limits	<p>The control lines (yellow dashed lines) are displayed on all plots. The value of these lines is set at 80% of tolerance during file creation. Please see Calculate Limits on page 76 for</p>

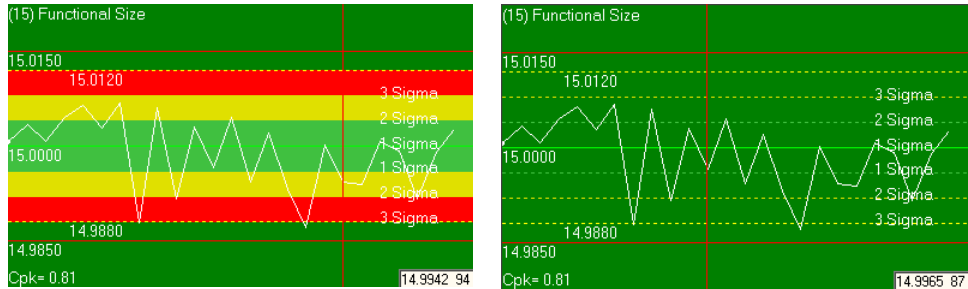
	adjusting these values.
Numeric Labels	These are values of the Upper and Lower Specifications limits for each plot and were obtained from your part program. These numbers are normally turned off since they crowd the plots. Zooming in on a plot yields their value also.
Show Deleted Records	This option allows you to view any records that you may have deleted. The delete point is connected with gold dashed lines in the active plots display.
Data Points	This option displays a dot where each point occurs on the data line making it easier to see the data point. These dots disappear if the plots become too crowded.
Mark Records with Causes	This option displays points that have an Assignable Cause or Corrective Action assigned to it. A different color is used for clarity.

8.2.5 Sigma Zones

QC-CALC can display sigma lines on the plots. The calculation of the sigma value is based on the points currently displayed in the plots only. There are two ways of showing the sigma values: Lines or Colors.

Sigma Zone Values

When QC-CALC creates a new file it calculates and sets the **Control Limits** to 80% of the given tolerance. QC-CALC also calculates the sigma zone to be 1/3 of this value. Each line is drawn on the plot as 1 x Sigma, 2 x Sigma, and 3 x Sigma creating the plots below. Once you have enough valid data to calculate the correct sigma zones use, QC-CALC's **Calculate Limits** menu to set the sigma zones as needed. See [Calculate Limits](#) on page 76 for more details.



You choose the specific sigma zones to show on the plot by selecting the appropriate check boxes in the **Sigma Zone** area.

8.3 Plot Colors

Each plot containing the data changes color depending on the value of the current raw data point received from the inspection machine. The current point is added to the right side of the plot, and all other points are shifted left.

If the current point (latest) is...

- ...within specification, the background is **green**
- ...exceeds the control limits, the background color is **yellow**
- ...exceeds the specification limits, the background color is **red**
- ...breaks a specified Trend, the background color is **purple**

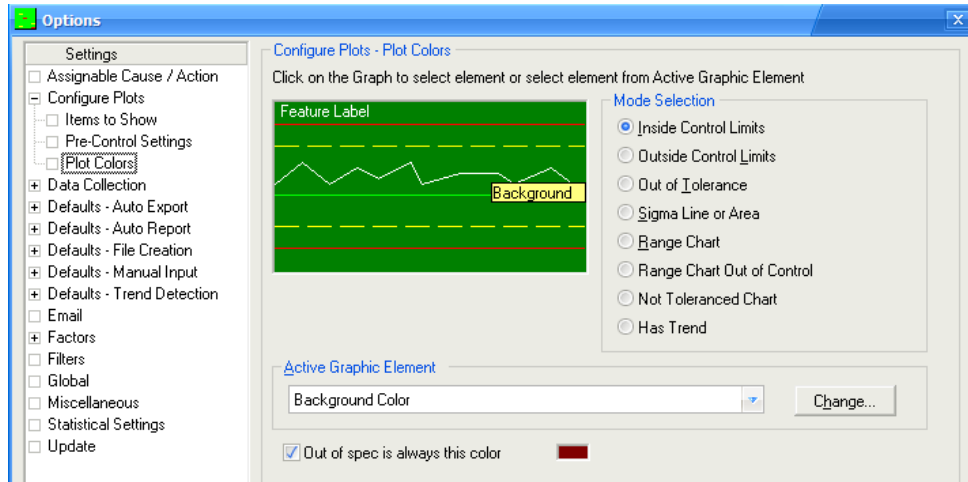
Use **Tools – Options – Configure Plots – Plot Colors** from QC-CALC Real-Time to change the background color of the plots.

NOTE: To make the background color based on the last 5 parts, select **Tools – Options – Configure Plots – Items to Show** to change **The Number of Points**

to Check to Determine the Background Color. Enter a 5 and any point out of spec in the last 5 will cause the background to be red.

8.3.1 Configure Plots - Plot Colors

The color of each element of the plots is selectable. The default colors are shown below.



Raw Data or Xbar colors

	Out of Spec	Out of Control	In-control
Plot Background	Red	Yellow	Green
Specification Lines	Bright Red	Bright Red	Bright Red
Control Lines	Bright Yellow	Dark Blue	Bright Yellow
Nominal Line	Bright Green	Bright Green	Bright Green
Data Line	White	White	White
Feature Label	White	Black	White
1 Sigma Line or Area	Green	Green	Green
2 Sigma Line or Area	Yellow	Yellow	Yellow
3 Sigma Line or Area	Red	Red	Red
Non-Toleranced	Green	Green*	Green

Range Chart Colors

	Out of Spec	Out of Control	In-control
Plot Background	N/a	Red	White
Control Lines	N/a	Compliment	Compliment

* **Non-Toleranced** dimensions always appear green unless the **Enable Control Limits for Non-Toleranced Dimensions** option is checked on the **Tools – Options – Global** screen. If that option is checked and the latest point received is out of control, the background of that graph will change to the color specified as the background color for Out of Control.

In addition to these you can also choose the colors to represent the three separate Sigma lines or areas. These default colors were chosen for their contrast but can be changed using the Color Editor.

Dimension that **have Trends** when Trend Analysis is being used will always show with a purple background color. The remaining colors follow the In-control settings.

8.4 Plot Type

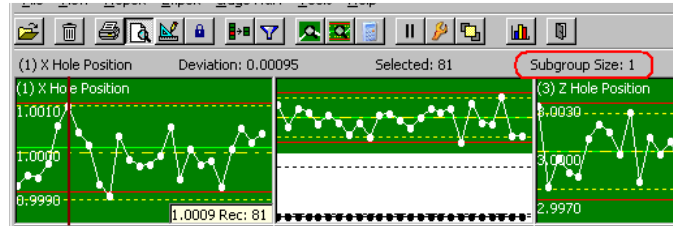
8.4.1 Range Plot

The default plot type is raw data or Xbar as just discussed, but you can add a Range Chart to each plot also. You do this by selecting the **View – Add Range Charts** menu. If your plots are raw data, Subgroup Size = 1, the Range charts will contain all 0.0000s since you need a minimum subgroup size of 2.

Viewing the Range Chart

To view the Range Charts, select the **View – Add Range Charts** menu. To remove the Range charts, select the **View – Remove Range Charts** menu.

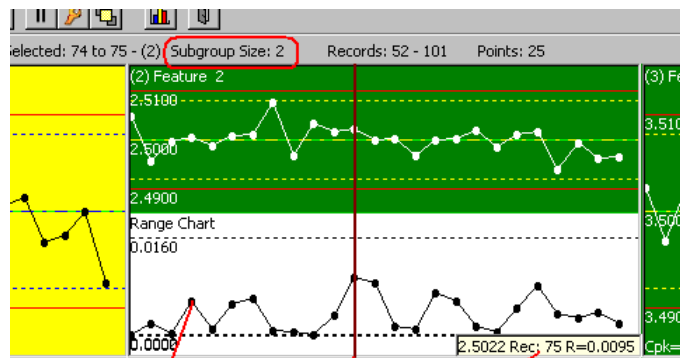
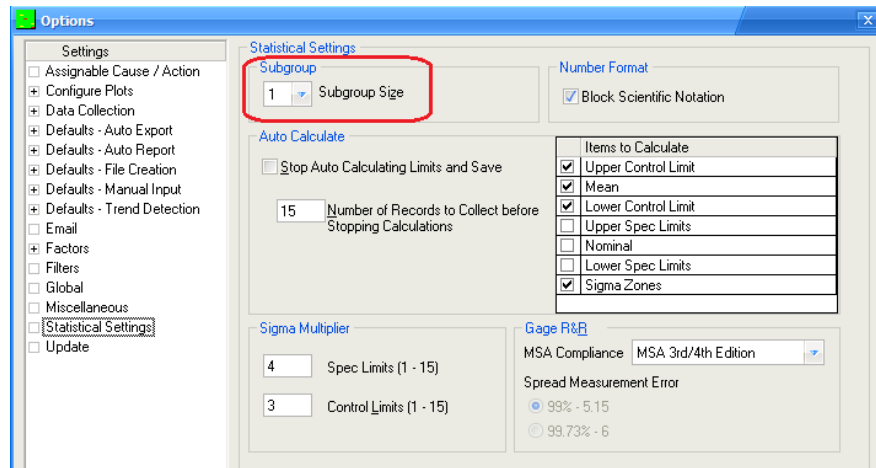
To add one Range Chart to one plot right click the plot of interest and select menu option **Add/Remove Range Chart**



The Range chart shows all zeros since the Subgroup size = 1

Subgroup Size

To change the **Subgroup Size** select the **Tools – Options – Statistical Settings** menu and choose 2 from the list. The picture below shows a **Subgroup Size** of 1.



With a subgroup size of 2 the range chart appears to look normal.

Note how the red cursor identifies the average and the range values.

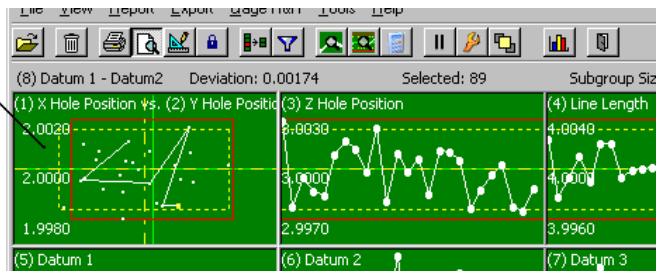
Control Limit Calculation

The tolerance and control lines shown in this plot are set by QC-CALC during file creation. An entire session is dedicated to discussing the details of how these limits can be calculated and changed. See [Calculate Limits](#) on page [76](#) for the full detail.

8.4.2 Scatter Plot

The scatter plot is used to plot one Feature against another. For example, you may want to see where a hole is located in 2 dimensional space. To create this plot you use menus **View – Create Scatter** and select the two features to join. In some cases, QC-CALC automatically joins these X & Y values for you during file creation if the CMM has well defined characteristics. This plot type is fairly common and the details for creating it are found in the [Scatter Plots](#) section on page [163](#).

Here we dragged and dropped Y Hole Position onto X Hole Position and the plot changed into a Scatter plot. This is useful for "seeing" an X vs. Y hole position.



8.4.3 Whisker Plot

Besides the standard raw data run-chart and the scatter plot just discussed, a third plot type called a **Whisker Plot** is available. Since Whisker plots are considered an advanced feature, the entire subject was moved to the Appendix labeled [Whisker Plots](#) on page [164](#). Please refer to that section if this subject is relevant to you.

8.4.4 Not Toleranced Plots

When QC-CALC receives dimensions from your part program that contain no upper or lower tolerance, it labels the feature as “not toleranced”. You will see a similar looking plot but without tolerance or control lines. These dimensions are plotted like other dimensions, but the backgrounds are always green and they will not trigger error reports, etc. All reports show a blank for the tolerances and any status of the feature is left blank. QC-CALC holds these features as raw data only. You can change the background color and special dimension filters are provided to remove all non-toleranced features with one click. See [Dimensions to Plot](#) on page [69](#) for more details.

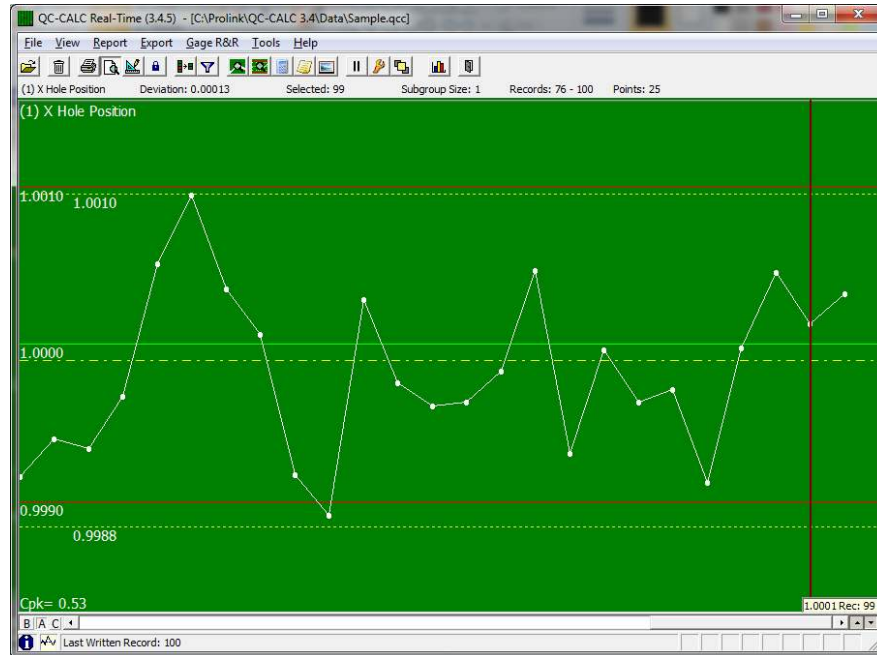
8.4.5 True Position Plots

QC-CALC Real-Time has a special plot type called True Position. The goal of True Position MMC is to relax the positional tolerance of a feature by adding unused size tolerance (bonus) to the position tolerance. Although this method cleverly saves parts from the scrap heap when the position of a hole is “out of spec” in X or Y, it has added a great deal of confusion. When SPC is applied to a many true position measurements even more confusion results. We address this issue based on the research and techniques available at this writing and will continue to add more calculation methods as this important topic evolves.

Since True Position plots are considered an advanced feature, the entire subject was moved to the Appendix labeled [True Position Plots](#) on page [167](#). Please refer to that section if this subject is relevant to you.

8.5 Zooming-In on Plots

Since the size of each plot becomes increasingly smaller with greater numbers of plots, QC-CALC can zoom in on any particular plot. Just double click the plot you wish to view more closely. The selected plot is enlarged (zoomed) to fill the window and offers increased plot details.



8.5.1 Extra Detail

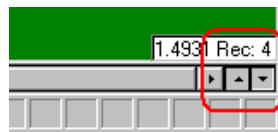
Sometimes there is not enough room on each plot to show all the details so the Zoom plot was created. Details include the nominal, tolerances, and control limits values on each line. All of the items are shown if the Zoom plot is large enough. It is possible to reduce the size of the window enough so some of the details are not shown, even in a zoom.

8.5.2 UnZooming a Plot

Double clicking on the zoom plot with the left mouse button reduces the plot to normal size.

8.5.3 Zoom Next Plot

You can move to the next dimension (plot) during Zoom by clicking the mouse on the down arrow button found at the lower right side of the horizontal scroll bar.



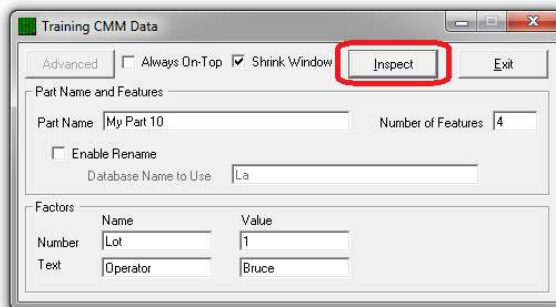
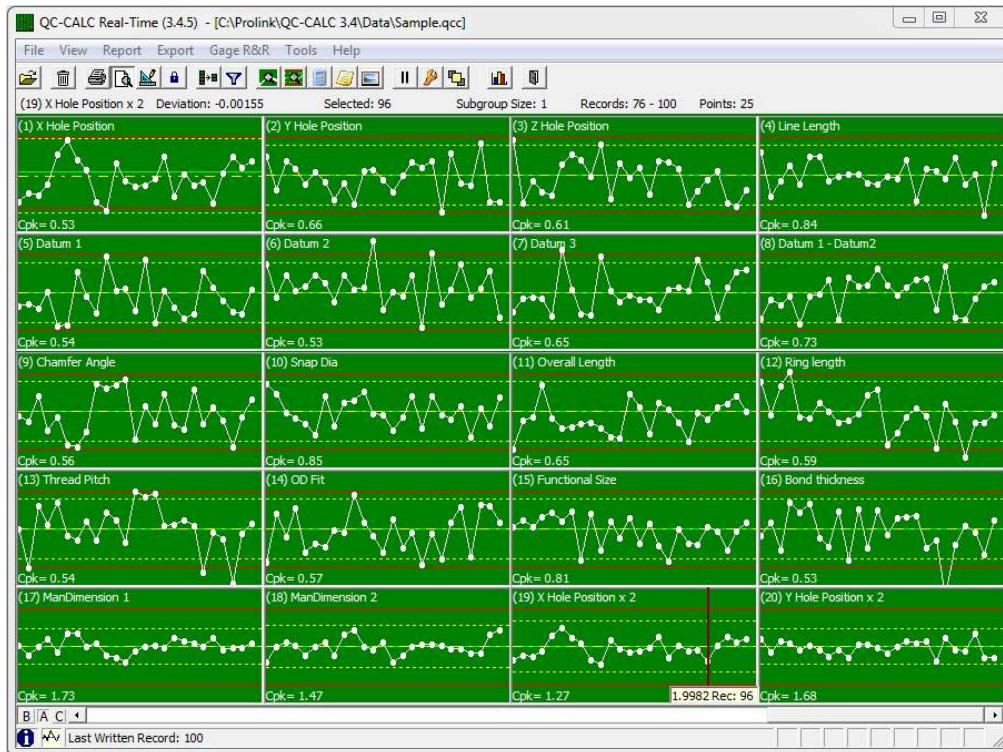
Exercises

Complete the following exercises to become familiar with inspecting a part with 10 features and have QC-CALC read and display the results. You use the **Training CMM** software to generate the inspection results that QC-CALC reads.

1. Start **QC-CALC**, start **Training CMM**, enter a **Part Name** of MyPart 10, enter 10 for The **Number of Features**, and press the **Inspect** button.
2. Zoom in on each plot
3. On the **Training CMM** add an extra trace field called Lot and add a value of 22. Now press the **Inspect** button.
4. On the **Training CMM** add an extra trace field called Operator and add a value of your name. Now press the **Inspect** button.

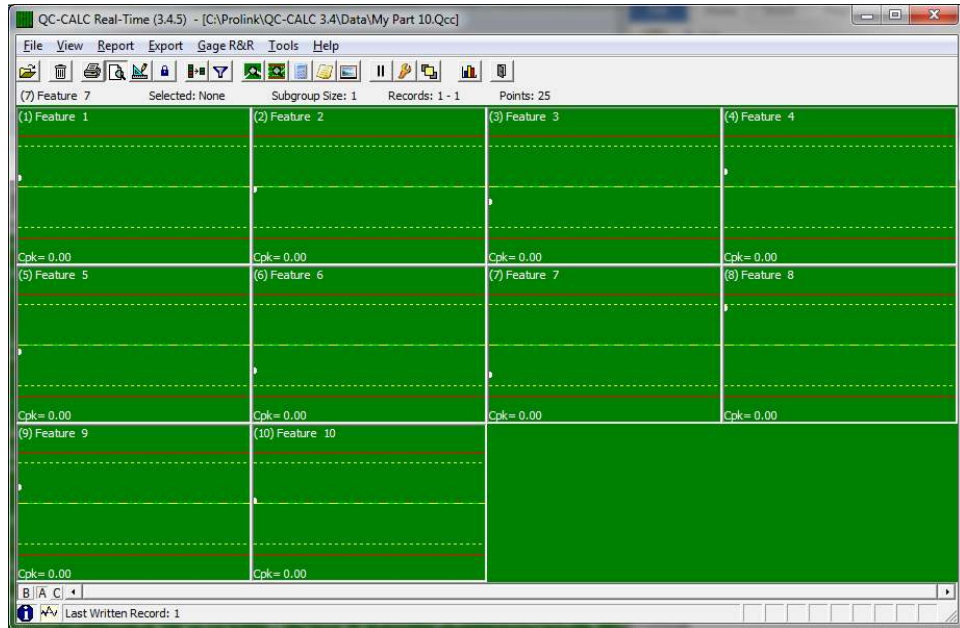
Exercise 1 – Inspecting the First Part Details

1. Here we see QC-CALC displaying SAMPLE.QCC (the default file included with QC-CALC) and the **Training CMM** program at the bottom.
2. Start QC-CALC by using the Windows **START– All Programs – Prolink – QC-CALC Real-Time** menu (or double click the desktop icon)
3. Start **Training CMM** by selecting **START– All Programs – Prolink – Training CMM**



Now click the **Training CMM Inspect** Button to create some simulated data. QC-CALC finds and reads this new simulated part generated by **Training CMM**.

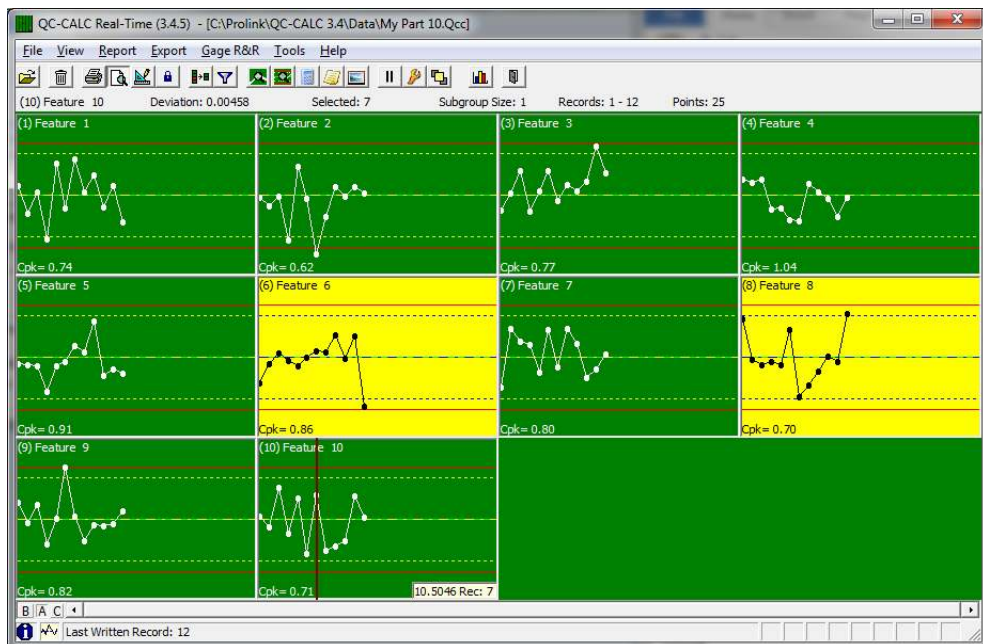
The screen clears (SAMPLE.QCC is closed) and 10 new plots appear with only 1 white dot on the extreme left edge of each plot.



Each plot has a label of Feature 1 thru 10. These are simulated labels and normally show the labels obtained from your part program. Each plot is automatically scaled according to your feature's nominal and tolerance values.

In the Training CMM, enter a **Name of Lot** and a value of **22**.

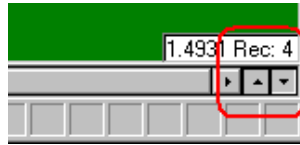
Press the **Inspect** button 11 more times to obtain some data. Random numbers are generated very quickly using the **Training CMM** software. Each person's screen will vary.



As we use the simulated data generator (**Training CMM**) keep in mind this is only for training purposes and the data is purely random in nature.

Exercise 2 – Zoom in on each Plot

1. Using the left mouse button, double click the first plot labeled **Feature 1** and it is instantly enlarged to fill the entire QC-CALC window. Note the extra detail such as nominal and tolerance values.
2. Now click the Down Arrow located at the bottom right of the horizontal scroll bar to move to the next plot.



Exercise 3 – Add Extra Trace Fields

1. Select our **Training CMM** program and enter **Lot** for the **Label** and **22** for the **Value**.
2. Now press **Inspect** button to create another part result file for QC-CALC to read. The Lot values are now saved with the inspection data. We will view this information shortly.

Exercise 4 – Add Extra Trace Fields

1. Select our **Training CMM** program and enter **Operator** for the **Label** and **Your Name** for the **Value**.
2. Now press **Inspect** button to create another part result file for QC-CALC to read. These values are saved with the data. We will view this information shortly.

9. Information Panels

9.1 Introduction

The Real-Time screen has special information windows you can display on the left-side of the plot screen. These windows contain several categories of information. For example, you might want to know information about each point within a plot such as its value, the time & date, etc. This window is known as the **Point Properties**. Or, you might want to know details about each plot such as nominals, tolerances, control limits, etc. This window is known as the **Plot Properties**. Others might want to see statistical calculations of the displayed data known as the Quick Stats window.

The **View** menu contains all of these windows and more. The collection of 6 separate panels that can be hidden or shown is referred to as the **Information Panel**.

- [Dimensions to Plot](#) pg. [69](#)
- [Record Filters](#) pg. [73](#)
- [Point Properties](#)  pg. [22](#)
- [Plot Properties](#)  pg. [23](#)
- [Quick Stats](#)  pg. [23](#)
- [Data Notes](#)  pg. [24](#)
- [Dimension Pictures](#)  pg. [25](#)

9.2 Point Properties

Each point in each plot has specific properties you may need to investigate. For example, you may want to see the actual value of the point or a calculation result.

There are 3 methods of displaying the **Point Properties** window:

- **View – Point Properties** menu (locked from editing)
- Toolbar icon for **Point Properties** (locked from editing)
- **Right Click** menu - **Point Properties** (unlocked for editing of data)

Normally, Point Properties are **Locked** meaning the **Point Properties** window updates as you float the mouse over different points in each plot. This is useful for rapid investigation of each point. When you right click a specific point in a specific plot and choose **Point Properties**, QC-CALC deliberately stops the updating (**unLocks**) so you can focus on changing the details of that specific point.

You may edit some of the values within the **Point Properties** window. Press the **F6** key to lock and unlock editing.

9.2.1 Individual Values Change

When the **Point Properties** Window is displayed, you can see the values change as you move the mouse around the screen.

Point Properties (Editing Locked) ? x	
Record	3
Dimension Label	Feature 1
Date	2/5/2013
Time	10:27:10 AM
Value	1.5007
Deviation	0.00069
Lot	22
Operator	Bruce
Assignable Cause1	None
Assignable Cause2	None
Corrective Action1	None
Corrective Action2	None
Fails	0

9.3 Plot Properties

The **Plot Properties** window can be displayed with or without the **Point Properties** window. Each plot has properties that you may wish to see by floating the mouse over each point.

As you move the mouse over each point, the plot properties does not change. This is due to the fact that all points within each plot have common properties such as Label, USL, Nominal, etc. So to see the **Plot Properties** change you must move the mouse over a different plot.

You may edit some of the values within the **Plot Properties** window. Press the **F7** key to lock and unlock editing. The USL and LSL are calculations and are not editable. The Calculation is only editable when the plot is a calculated plot.

Label	Feature 4
Dimension Informat...	
Dimension Source	
USL	4.5100
Plus Tol	0.0100
UCL	4.5080
Nominal	4.5000
LCL	4.4920
Minus Tol	-0.0100
LSL	4.4900
Precision	4
Calculation	None
Tolerance Type	Bilateral

9.4 Quick Stats

The **Quick Stats** window can be displayed with or without the **Point Properties** and the **Plot Properties** window. Each plot has calculation that you may wish to investigate by floating the mouse over each point within a plot. These are simple stat calculations used for quick, no-print reports. Remember, any points or records shown as deleted are not involved in the display calculations.

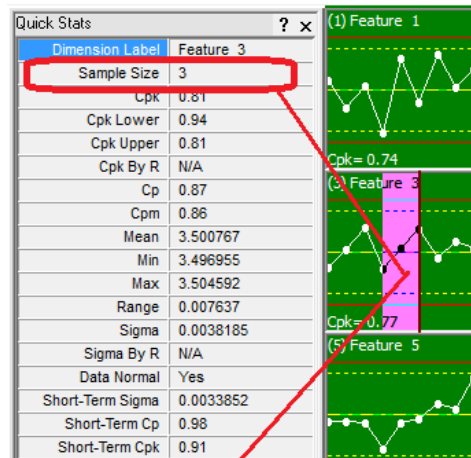
As you move the mouse over each point, the stat calculations no not change. This is due to the fact that all points within each plot are involved in the calculation. So to see the **Stats Calculations** change you must move the mouse over a different plot.

There is nothing editable in this window since every item is the result of a calculation. However, if you change a Point or Plot Property the calculations in this window are updated to reflect your change.

Dimension Label	Feature 5
Sample Size	15
Cpk	0.87
Cpk Lower	1.16
Cpk Upper	0.87
Cpk By R	N/A
Cp	1.01
Cpm	0.93
Mean	5.501447
Min	5.496788
Max	5.506691
Range	0.009903
Sigma	0.0032865
Sigma By R	N/A
Data Normal	Yes
Short-Term Sigma	0.003317
Short-Term Cp	1.0
Short-Term Cpk	0.86

9.4.1 Selecting Points with the Mouse

You can select a reduced number of points on each plot by holding the left mouse button down and then dragging across the points of interest. QC-CALC highlights these points in a complimentary color. Looking closely at the plot, we see 6 points are highlighted. It may be easier to view the second line in the **Plot Properties** since it tells us how many are highlighted. Remember, all calculations are now being made on the highlighted values only.



The screenshot shows the Quick Stats window for Feature 3. The 'Sample Size' is highlighted with a red box and shows a value of 3. To the right, a plot for Feature 3 shows three points highlighted in pink. A red arrow points from the highlighted 'Sample Size' value to the highlighted points in the plot.

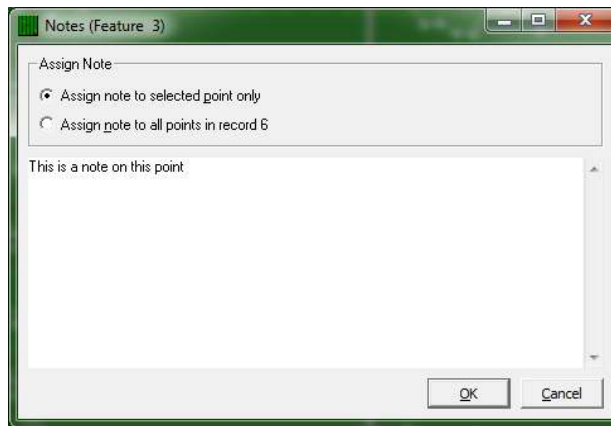
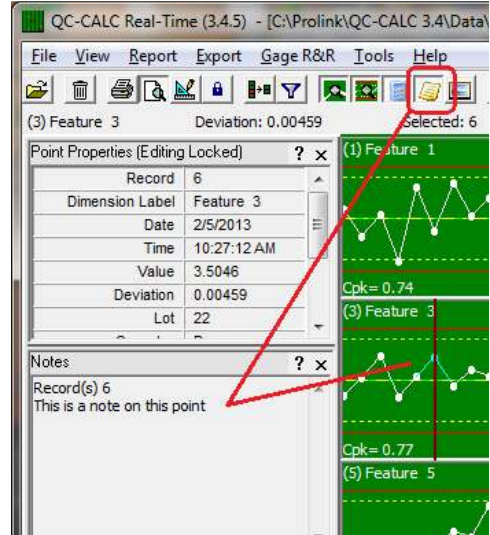
There are 3 points highlighted giving you Quick Stats on just the 3 points.

9.5 Data Notes

There are times you need to add notes to an individual point or even an entire plot. The **Data Notes** panel is used to display the text associated with a note you or another person has assigned.

You can display the Notes panel by selecting the **View – Data Notes** menu or click the yellow button in the toolbar shown on the right. Floating the mouse over a blue colored point displays the text in the panel. Using panels to display the text saves space on the graph and reduces the plot clutter.

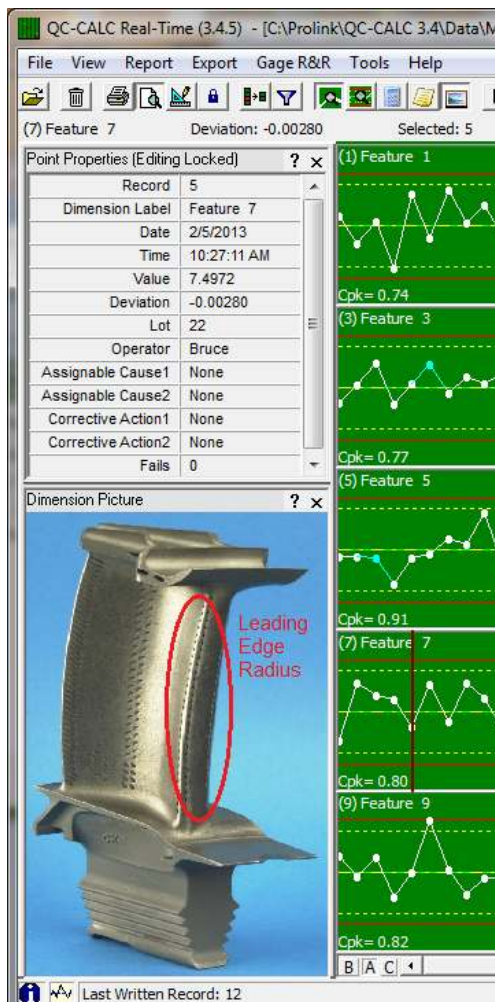
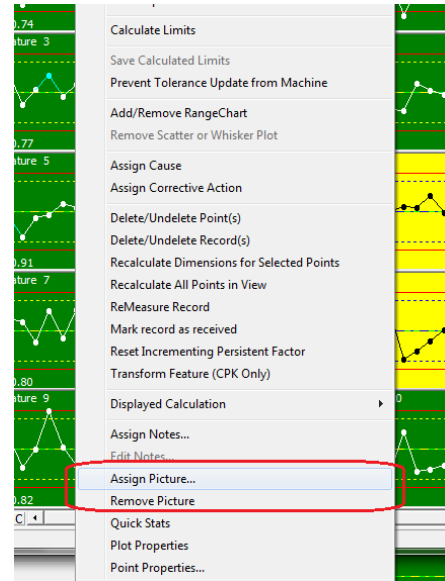
You Assign a note by right clicking on the point of interest and choosing the **Assign Note** menu. Enter your text in the window that appears (shown below) and choose to assign that note to the point or the entire part.



9.6 Dimension Pictures

You might want to add a picture to a plot to help the understanding of where this particular feature is located on the part. In this example we added a red circle and the text “Leading Edge Radius” to help the operator know what this plot (Feature 7) is showing him.

You Assign a picture by right clicking on the point of interest then selecting the **Assign Picture** menu. Now navigate to your picture file. The maximum picture size is 100K bytes and BMP, JPG, and GIF files are allowed.



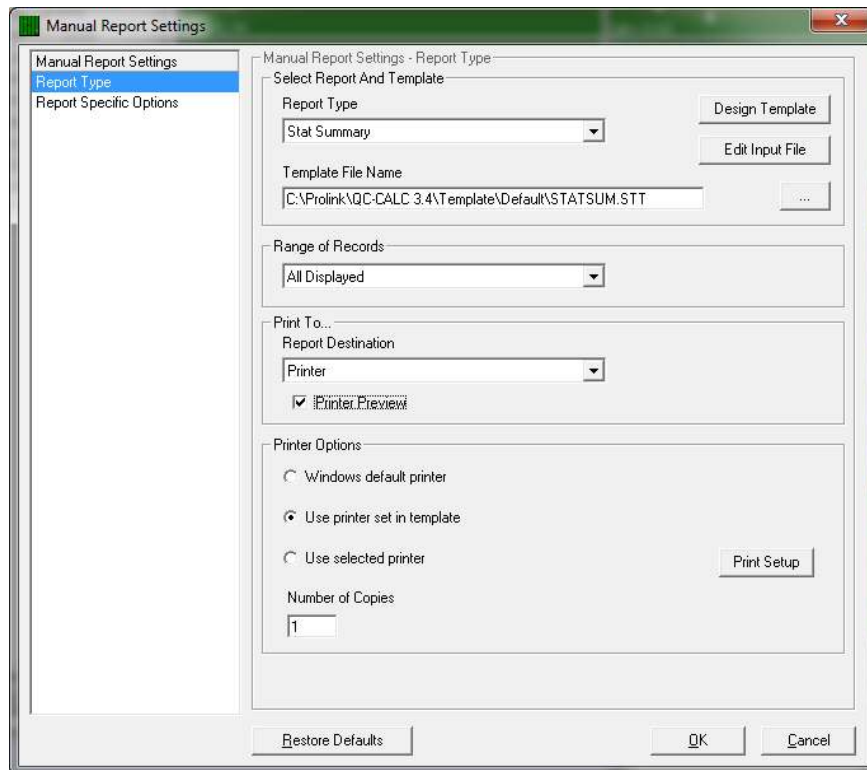
10. Reporting

10.1 Introduction

You can create a variety of reports directly from QC-CALC Real-Time. When you choose the **Report – Print Report** menu a list of report types is shown along with other options. This print dialog screen is designed to ask:

- **What** type of report to print?
- **Which** template to use?
- **How** much data to include?
- **Where** to print it?

When you select the **Report – Print Report** menu a print dialog box is displayed requesting information.



10.2 Report Types

QC-CALC Real-Time has the following report types and each report is driven by a template. If you need more SPC reports than shown here, use QC-CALC SPC.

Report Type	Page	Template Ext.
First Article – 1 Part Report	30	*.FST
First Article-Multi Parts	31	*.FPF
Raw Data	32	*.RAW
Stat Summary	33	*.STT
Visual Part Report	34	*.VPR
Plot Report	35	*.RTX
Single-P/T Ratio (Gage) Reports	36	*.GR1
Multi-P/T Ratio (Gage) Reports	36	*.GRM
Gage R&R Report Tabular Form	40	*.GRT
Gage R&R Report	41	*.GRR
CFR Part 11 Audit Report	285	*.A11
Notes Input Report	42	*.NIR

10.2.1 Report Templates

All QC-CALC reports use templates to create the final report. Each Report Type uses a different template type as shown in the table above. For example, if you select a First Article Report, QC-CALC only shows the .FST templates. The file extension is the difference between report templates.

Report templates are editable so you can change the report's look and content. The report designer is another subject covered later. For now, pick the template of interest when requested by QC-CALC.

10.2.2 Left Menu Panel

The Print Dialog box has a left panel showing two choices: The **Report Type** tab is the main tab which contains the majority of the settings and the [Report Specific Options](#) area discussed on page 45 contains items less often used.

10.2.3 Select Report & Template

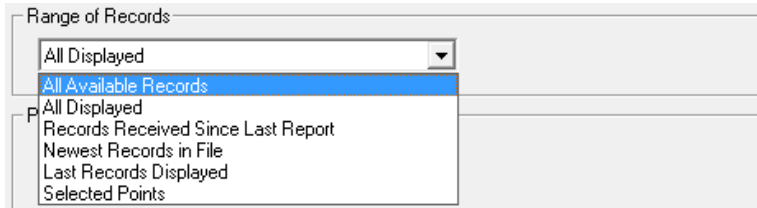
Report Type

Select one of the report types listed above from the list and answer the simple questions.

Template File Name

Since the contents of each report are different, the reports are template driven. Some reports have many templates so press the browse button to select the template of choice. This list of templates grows as you create your own custom report templates.

10.2.4 Range of Records



All Available Records

This option reports on all records that are currently in the file. It excludes all deleted and filtered out records.

All Displayed

The **Number of Parts to Plot** is set in **Tools - Options – Configure Plot Settings – Items to Show**. This option allows you to plot 3 – 100 points live points. It is this value that is used to determine how many points are displayed and how many records to Print in the reports. The exact range of records currently shown is written at the top of the Real-Time screen just below the icons labeled **Points**.

Records Received Since Last Report

QC-CALC Real-Time remembers the last record included in any of the reports you print. If you wish to print a report on all newly added parts choose this record range option.

Newest Records in File

This option starts at the newest record in the database (Last Written Record) and counts backward until the **x**th record is found. Any deleted records are skipped.

Last Records Displayed

This option starts at the newest point on the screen (extreme right side) which may or may not be the newest record in the file (you scrolled the screen), and counts backward until the **x**th record is found. Any deleted records are skipped.

Selected Points

This option prints a report using the records that are highlighted in the plots. If you did not highlight any points, the report is printed with no data.

If you need to generate a report for data collected two days ago, scroll the plots back in time until the last point that you want is on the right most edge of the plot. Then choose **Report – Print Report**. Select the **Range of Records** and choose **Last Records Displayed** and type the number of records that you want to report in the text-box. Starting with the record that is represented by the right-most edge of the plot, QC-CALC will count backwards (to the left) to include the number of records that you specified in the report. A better choice is to create a filter with the dates of interest which is discussed later.

10.2.5 Print To

Although printing to a **Printer**, **Print Preview** or **Print to File** is obvious, more detail is found in the [Printing To](#) section on page [44](#).

10.2.6 Printer Options

Please see the [Print to Printer](#) section on page [45](#) for a full explanation for the print options.

10.2.7 Printing a Report

1. Find the **Print Preview** button in the toolbar and be sure it is pressed and held down.
2. The first step in printing a report is to select the **Report – Print Report** menu.
3. Next, select the **Report Type** from the list.
4. When the Report Type is selected, QC-CALC pops up the file dialog box asking you to select a specific template that matches the type of report you just requested. You can use the **Browse** button to display the file dialog box, which allows you to select a different report template. **Note:** Be sure to match the template type (file extension) with the correct report type. If you are not sure which file types match which report types, use the down arrow to the right of the **Files name** box and all known report types are displayed.
5. Click the **Open** button to select your template.
6. Select the **Range of Records** and press the **Print** button.



Note: Pressing the **Close** button cancels the print but saves your print selection settings.



Tip: When you select **Report – Print Report** and setup a report to print, QC-CALC remembers your settings. If you click the **Printer** button in the Toolbar, it is the remembered report with the record range that is printed. The print setup screen is not displayed.

Exercises

Complete the following exercises to become familiar with printing

1. Print a **Stat Summary** report of the 12 parts you inspected in the previous section. Be sure to use **Print Preview**.
2. Now print a Stat Summary of the last 5 parts inspected using 2 methods:
 - Select **Newest Records in File** and enter a 5
 - Highlight the newest 5 points on screen using the left mouse button and select **Selected Points**.
3. Print a **Plot Report** of all records displayed – use the 2 x 5 template

10.3 Report Types

10.3.1 Introduction

The next few pages show examples of actual reports available in QC-CALC Real-Time. These are only examples and many more formats are possible.

10.3.2 First Article – 1 Part Report

This is an example of a First Article Report. The USL, LSL and Status are left blank for all not toleranced features. This is one example:

First Article Report							
							February 11, 2013 10:14:42 AM
Prolink							
Sample.qcc		Cavity		12			
Sample		Machine		1			
		Line		NORTH			
Date of Inspection		December 12, 1994		Supplier		HP	
Time of Inspection		12:00:00 PM		Machine Type		CMM	
Record Number		76		Fixture		14R	
				Operator		Laura	
Dim	Dimension Label	Nominal	USL	LSL	Actual	Deviation	Status
1	X Hole Position	1.0000	1.0010	0.9990	0.9992	-0.0008	|*|
2	Y Hole Position	2.0000	2.0020	1.9980	2.0010	0.0010	|*|
3	Z Hole Position	3.0000	3.0030	2.9970	3.0029	0.0029	|*|
4	Line Length	4.0000	4.0040	3.9960	4.0024	0.0024	|*|
5	Datum 1	5.0000			4.9983	-0.0017	
6	Datum 2	6.0000			6.0046	0.0046	
7	Datum 3	7.0000			6.9965	-0.0035	
8	Datum 1 - Datum2	8.0000			7.9946	-0.0054	
9	Chamfer Angle	9.0000	9.0090	8.9910	8.9989	-0.0011	|*|
10	Snap Dia	10.0000	10.0100	9.9900	10.0073	0.0073	|*|
11	Overall Length	11.0000	11.0110	10.9890	10.9889	-0.0111	OUT -0.00014
12	Ring length	12.0000	12.0120	11.9880	12.0095	0.0095	|*|
13	Thread Pitch	13.0000	13.0130	12.9870	13.0001	0.0001	|*|
14	OD Fit	14.0000	14.0140	13.9860	13.9875	-0.0125	|*|
15	Functional Size	15.0000	15.0150	14.9850	15.0008	0.0008	|*|
16	Bond thickness	16.0000	16.0160	15.9840	15.9972	-0.0028	|*|
17	ManDimension 1	1.5216	2.8147	0.2285	1.5600	0.0384	|*|
18	ManDimension 2	2.5351	3.5078	1.5624	2.1300	-0.4051	|*|
19	X Hole Position x 2	1.9998	2.0039	1.9957	1.9983	-0.0015	|*|
20	Y Hole Position x 2	4.0000	4.0097	3.9903	4.0020	0.0021	|*|

Page 1 of 1

10.3.3 First Article-Multi Parts

QC-CALC ships with 3 different Multi-Piece report templates so try each report by selecting a different template. This is one example:

Five Piece (1-5 Piece)											
Dim	Dimension Label	Nominal	USL	LSL	Part 1 Rec. 96	Part 2 Rec. 97	Part 3 Rec. 98	Part 4 Rec. 99	Part 5 Rec. 100	Rej	
1	X Hole Position	1.0000	1.0010	0.9990	0.9991	1.0000	1.0005	1.0001	1.0003		
2	Y Hole Position	2.0000	2.0020	1.9980	1.9996	1.9995	2.0017	1.9986	1.9986		
3	Z Hole Position	3.0000	3.0030	2.9970	2.9997	3.0003	2.9978	2.9975	2.9989		
4	Line Length	4.0000	4.0040	3.9960	4.0018	3.9990	4.0001	** 3.9957	4.0013	1	
5	Datum 1	5.0000			5.0008	4.9990	4.9974	4.9971	5.0004		
6	Datum 2	6.0000			6.0046	5.9993	6.0006	6.0036	5.9960		
7	Datum 3	7.0000			7.0021	6.9954	7.0010	7.0039	7.0043		
8	Datum 1 - Datum2	8.0000			7.9949	7.9943	7.9989	8.0014	8.0023		
9	Chamfer Angle	9.0000	9.0090	8.9910	9.0011	8.9978	8.9916	8.9987	9.0029		
10	Snap Dia	10.0000	10.0100	9.9900	10.0014	9.9931	10.0007	9.9962	10.0039		
11	Overall Length	11.0000	11.0110	10.9890	10.9978	11.0012	11.0024	11.0046	11.0001		
12	Ring length	12.0000	12.0120	11.9880	11.9967	** 11.9856	11.9965	11.9965	11.9989	1	
13	Thread Pitch	13.0000	13.0130	12.9870	12.9990	12.9967	** 12.9814	12.9986	13.0020	1	
14	OD Fit	14.0000	14.0140	13.9860	14.0084	13.9897	14.0089	14.0085	14.0024		
15	Functional Size	15.0000	15.0150	14.9850	15.0008	14.9993	14.9917	14.9991	15.0027		
16	Bond thickness	16.0000	16.0160	15.9840	15.9932	16.0014	15.9986	15.9991	16.0040		
17	ManDimension 1	1.5216	2.8147	0.2285	1.8300	1.4200	1.4800	1.4900	1.6300		
18	ManDimension 2	2.5351	3.5078	1.5624	2.4700	2.3600	2.3700	2.8500	2.9500		
19	X Hole Position x 2	1.9998	2.0039	1.9957	1.9982	2.0000	2.0009	2.0003	2.0006		
20	Y Hole Position x 2	4.0000	4.0097	3.9903	3.9991	3.9989	4.0034	3.9972	3.9971		

February 11, 2013
10:17:29 AM

Prolink

Sample.qcc
Sample
Date of Inspection December 12, 1994
Time of Inspection 12:00:00 PM
Records 96 - 100

10.3.4 Raw Data

QC-CALC ships with 2 different Raw Data report templates so try each report by selecting a different template. This is one example:

Raw Data Report

February 11, 2013
10:21:21 AM

Prolink
Sample.qcc
 Sample
 Sample Size 30
 Record Range 71 - 100

Rec Num	X Hole Position	Y Hole Position	Z Hole Position	Line Length	Datum 1	Datum 2	Datum 3	Datum 1 - Datum2	Chamfer Angle	Snap Dia	Date	Time
Nominal	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000	9.0000	10.0000		
USL	1.0010	2.0020	3.0030	4.0040	N/A	N/A	N/A	N/A	N/A	9.0090		
LSL	0.9990	1.9980	2.9970	3.9960	N/A	N/A	N/A	N/A	N/A	9.9910		
71	1.0006	1.9981	3.0004	** 4.0043	5.0016	5.9989	6.9997	8.0071	8.9991	10.0024	12/12/94	12:00:00 PM
72	0.9997	1.9993	3.0021	** 3.9945	5.0015	6.0012	6.9985	7.9956	9.0020	10.0040	12/12/94	12:00:00 PM
73	0.9995	1.9993	2.9991	3.9988	4.9957	6.0014	7.0029	** 8.0122	9.0037	10.0000	12/12/94	12:00:00 PM
74	1.0005	1.9988	3.0010	3.9985	4.9998	** 5.9930	7.0001	7.9996	9.0044	10.0008	12/12/94	12:00:00 PM
75	0.9997	2.0008	2.9972	3.9998	5.0019	** 5.9927	7.0038	7.9975	9.0037	10.0041	12/12/94	12:00:00 PM
76	0.9992	2.0010	3.0029	4.0024	4.9983	6.0046	6.9965	7.9946	8.9989	10.0073	12/12/94	12:00:00 PM
77	0.9994	1.9993	2.9978	3.9978	4.9986	5.9993	6.9989	7.9987	8.9977	10.0048	12/12/94	12:00:00 PM
78	0.9993	2.0007	2.9996	3.9994	4.9979	6.0028	6.9993	7.9975	9.0037	9.9996	12/12/94	12:00:00 PM
79	0.9997	2.0004	2.9987	4.0011	5.0001	6.0003	6.9990	7.9992	8.9956	9.9983	12/12/94	12:00:00 PM
80	1.0005	1.9995	2.9984	3.9991	4.9956	6.0011	6.9957	7.9934	8.9987	9.9969	12/12/94	12:00:00 PM
81	1.0009	2.0002	3.0009	4.0020	4.9957	6.0029	** 7.0081	7.9993	8.9921	9.9939	12/12/94	12:00:00 PM
82	1.0004	1.9996	3.0017	4.0020	5.0028	6.0016	7.0007	7.9997	8.9916	10.0041	12/12/94	12:00:00 PM
83	1.0001	1.9987	3.0012	3.9994	4.9996	5.9985	6.9961	8.0029	8.9951	9.9961	12/12/94	12:00:00 PM
84	0.9992	1.9996	2.9999	3.9999	4.9973	6.0029	6.9960	7.9942	9.0067	10.0022	12/12/94	12:00:00 PM
85	** 0.9989	1.9985	3.0024	4.0001	5.0049	6.0006	7.0068	8.0033	9.0056	10.0029	12/12/94	12:00:00 PM
86	1.0003	2.0002	2.9981	4.0002	5.0003	6.0009	7.0004	8.0015	9.0064	10.0052	12/12/94	12:00:00 PM
87	0.9998	2.0003	3.0009	3.9992	5.0006	** 6.0083	6.9984	8.0016	9.0077	9.9996	12/12/94	12:00:00 PM
88	0.9996	1.9998	2.9999	3.9990	4.9977	5.9974	6.9997	8.0051	8.9935	9.9990	12/12/94	12:00:00 PM
89	0.9996	1.9991	3.0006	3.9998	5.0043	6.0002	6.9989	8.0017	9.0014	9.9949	12/12/94	12:00:00 PM
90	0.9998	2.0000	2.9985	3.9996	4.9960	5.9995	6.9988	7.9996	8.9970	9.9984	12/12/94	12:00:00 PM
91	1.0005	2.0007	3.0011	4.0017	5.0003	6.0029	6.9968	8.0011	9.0043	10.0040	12/12/94	12:00:00 PM
92	0.9993	2.0004	3.0010	3.9973	4.9981	5.9945	7.0006	8.0029	8.9967	9.9955	12/12/94	12:00:00 PM
93	1.0000	2.0008	3.0005	4.0007	4.9996	** 6.0063	7.0009	8.0030	8.9956	10.0042	12/12/94	12:00:00 PM
94	0.9996	1.9981	2.9977	4.0005	4.9972	5.9983	7.0003	7.9966	9.0053	9.9992	12/12/94	12:00:00 PM
95	0.9997	2.0012	2.9988	3.9996	5.0029	6.0004	7.0063	8.0057	8.9972	9.9980	12/12/94	12:00:00 PM
96	0.9991	1.9996	2.9997	4.0018	5.0008	6.0046	7.0021	7.9949	9.0011	10.0014	12/12/94	12:00:00 PM

10.3.5 Stat Summary

QC-CALC ships with 1 Statistical Summary report template as shown on this page. You can edit this template to change what you see. This is one example:

Statistic Report

February 11, 2013
11:05:49 AM

ProLink Start Date: December 12, 1994 12:00:00 PM
 Sample.qcc End Date: December 12, 1994 12:00:00 PM
 Num. of Features 20 Range of Records: 71 - 100
 Num. of Parts 30
 Subgroup Size 1
 Cavity 7
 Line SOUTH

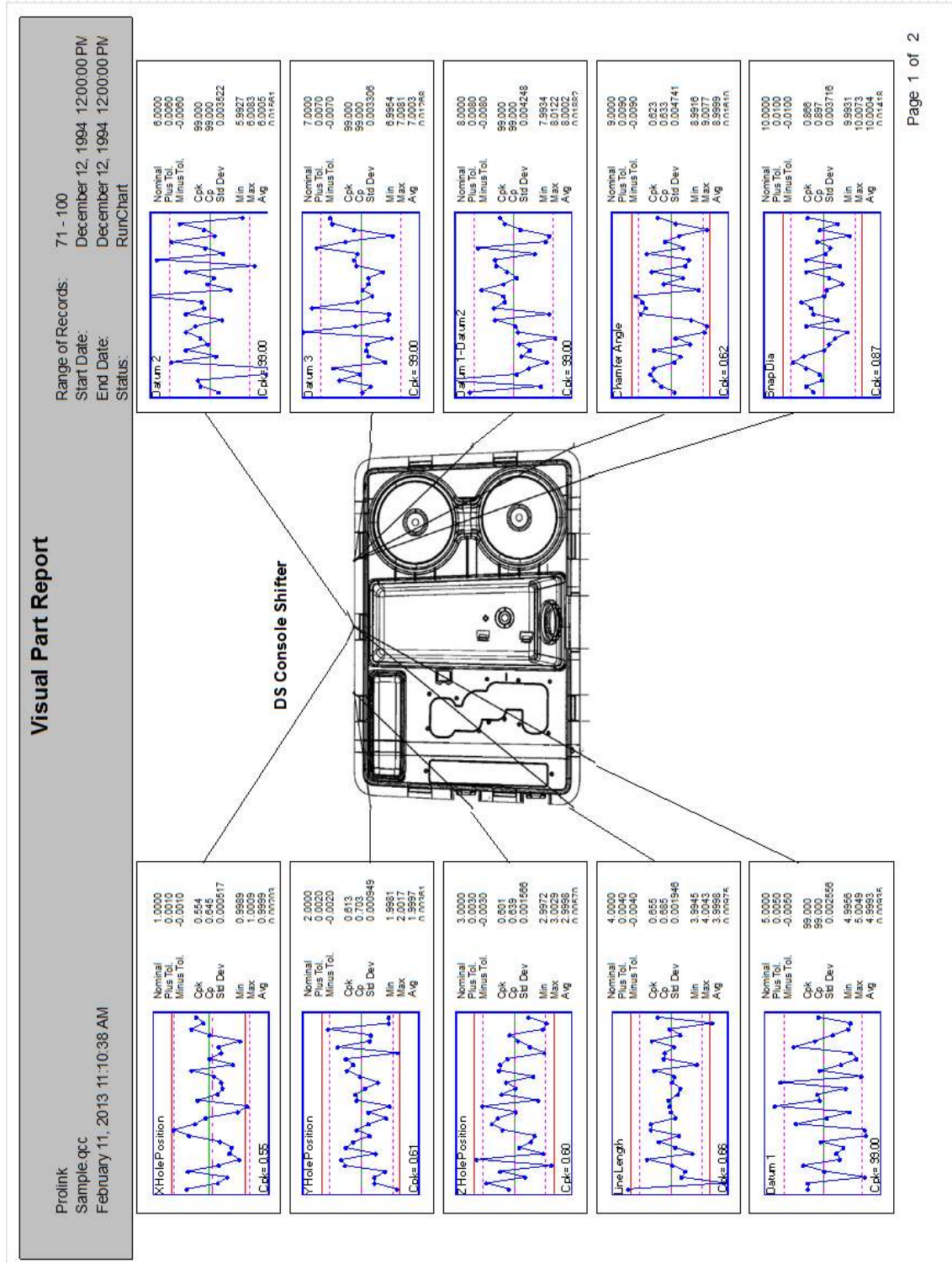
Supplier: HP
 Machine Type: CMM
 Fixture: 14R
 Operator: Laura

Dim	Dimension Label	Nom	+ Tol	- Tol	Average	Range	Max	Min	Sigma	Cp	Cpk	Sigma R	Cp R	Cpk R
1	X Hole Position	1.0000	0.0010	-0.0010	0.9999	0.0020	1.0009	0.9989	0.000517	0.64	0.55	0.000517	0.64	0.55
2	Y Hole Position	2.0000	0.0020	-0.0020	1.9997	0.0036	2.0017	1.9981	0.000949	0.70	0.61	0.000949	0.70	0.61
3	Z Hole Position	3.0000	0.0030	-0.0030	2.9998	0.0057	3.0029	2.9972	0.001566	0.64	0.60	0.001566	0.64	0.60
4	Line Length	4.0000	0.0040	-0.0040	3.9998	0.0097	4.0043	3.9945	0.001946	0.69	0.66	0.001946	0.69	0.66
5	Datum 1	Non-Toleranced			4.9993	0.0093	5.0049	4.9956	0.002556			0.002556		
6	Datum 2	Non-Toleranced			6.0005	0.0156	6.0083	5.9927	0.003522			0.003522		
7	Datum 3	Non-Toleranced			7.0003	0.0127	7.0081	6.9954	0.003306			0.003306		
8	Datum 1 - Datum2	Non-Toleranced			8.0002	0.0188	8.0122	7.9934	0.004248			0.004248		
9	Chamfer Angle	9.0000	0.0090	-0.0090	8.9999	0.0161	9.0077	8.9916	0.004741	0.63	0.62	0.004741	0.63	0.62
10	Snap Dia	10.0000	0.0100	-0.0100	10.0004	0.0142	10.0073	9.9931	0.003716	0.90	0.87	0.003716	0.90	0.87
11	Overall Length	11.0000	0.0110	-0.0110	10.9984	0.0190	11.0079	10.9889	0.004625	0.79	0.68	0.004625	0.79	0.68
12	Ring Length	12.0000	0.0120	-0.0120	11.9991	0.0270	12.0126	11.9856	0.006352	0.63	0.58	0.006352	0.63	0.58
13	Thread Pitch	13.0000	0.0130	-0.0130	13.0006	0.0320	13.0134	12.9814	0.007948	0.55	0.52	0.007948	0.55	0.52
14	OD Fit	14.0000	0.0140	-0.0140	13.9993	0.0262	14.0129	13.9867	0.007196	0.65	0.61	0.007196	0.65	0.61
15	Functional Size	15.0000	0.0150	-0.0150	14.9992	0.0201	15.0072	14.9871	0.005659	0.88	0.84	0.005659	0.88	0.84
16	Bond thickness	16.0000	0.0160	-0.0160	15.9989	0.0399	16.0111	15.9712	0.008590	0.62	0.58	0.008590	0.62	0.58
17	ManDimension 1	1.5216	1.2931	-1.2931	1.4847	1.0000	1.9800	0.9800	0.262544	1.64	1.59	0.262544	1.64	1.59
18	ManDimension 2	2.5351	0.9727	-0.9727	2.5593	0.8300	2.9600	2.1300	0.222911	1.45	1.42	0.222911	1.45	1.42
19	X Hole Position x 2	1.9998	0.0041	-0.0041	1.9997	0.0041	2.0019	1.9978	0.001034	1.33	1.30	0.001034	1.33	1.30
20	Y Hole Position x 2	4.0000	0.0097	-0.0097	3.9995	0.0072	4.0034	3.9962	0.001897	1.71	1.62	0.001897	1.71	1.62

Page 1 of 1

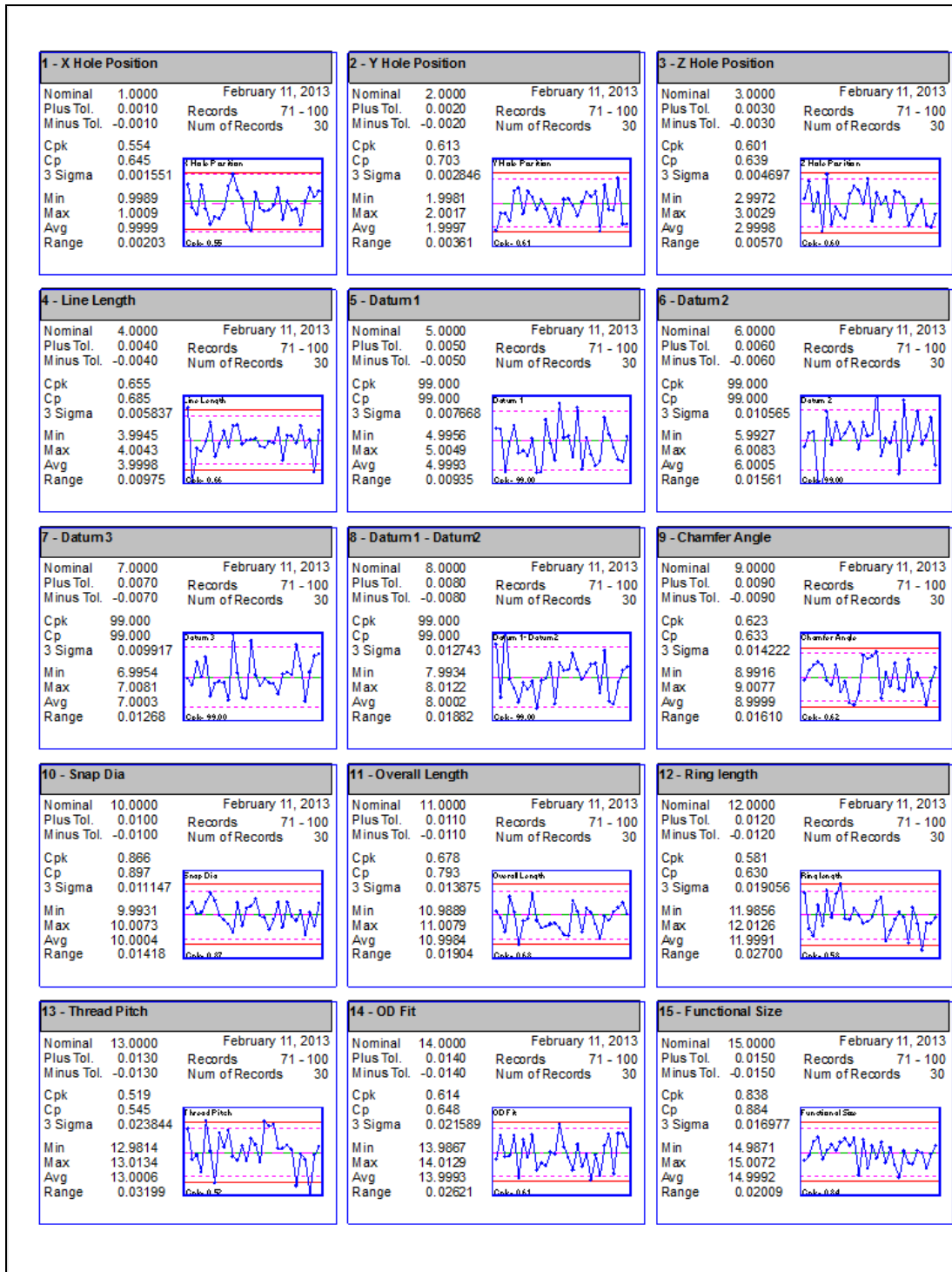
10.3.6 Visual Part Report

QC-CALC ships with 1 Visual Part Report template as shown on this page. If you have the need to display a picture of your part with QC-CALC's plots this might be the report for you. You can draw leader lines from each plot to the part feature aiding in your understanding. You can edit this template to change what you see. This is just one example:



10.3.7 Plot Report

QC-CALC ships with many different Plot Report templates so try several templates by selecting a different one. The template names start with **RTPlot** and have **1x2**, **1x3**, **1x4**, etc. added to indicate how many rows and columns exist in each template. This example used the **RTPlot 3x5**:



10.3.8 P/T Ratio (Gage) Reports

The precision and repeatability of a gage is very important when measuring parts. A general rule of thumb is to purchase a gage that is calibrated in units 1/10 as large as required in the final product you are measuring. The gage adds measurement error but it is acceptable when the gage error is 1/10 (or less) of the overall measurement error. The gage must measure accurately and repeatedly.

Traditional handheld gages have an additional problem since, by design, humans must use and interpret the results. This adds more opportunity for error, including the repeatability of each individual and the reproducibility between different humans. To separate and assign the error a Gage Repeatability & Reproducibility (GR&R) has been in use for many years. By measuring the same parts many times with many humans, we can use simple math to sort the results and assign the error.

Automated Measurement

Automated inspection equipment falls into a different category. Although full GR&R studies are still required we see much less of the measurement error assigned to the person running the CMM (probe, video, laser, etc). The 'automated system' uses its sensors to measure and interrupt the results in an unbiased way. Therefore, it seems appropriate to use an automated study to report the repeatability of a CMM measuring your parts. This report saves time and can find inaccurate equipment in minimal time.

The traditional method is to measure a single part 10 or 20 times and view the range of the measurements. If the range is small, you purchase the equipment. You can use QC-CALC's P/T Ratio Report to initially test the CMM. Also, you should use this report whenever you write a new part program to test the repeatability since choosing the wrong measurement sensor could cause erratic inspection results.

QC-CALC Real-Time has 2 special reports designed to indicate the repeatability of automated inspection equipment. These reports are based on the variation of repeated measurements of the same parts.

- Single-Part Gage Report (P/T Ratio) (uses *.GR1 templates)
- Multi-Part Gage Report (P/T Ratio) (uses *.GRM templates)

Single-Part Gage Report (P/T Ratio)

QC-CALC ships with 2 different PT Ratio report templates so try each report by selecting a different template. When performing a Single Part Report you simply measure one part as many times as you wish and print the report. The goal of the report is to show gage variation while measuring one part many times. It is assumed the part does not change size over the course of the testing period and therefore all variation (Sigma) is assigned to the gage. This is one example:

Multi-Part Gage Repeat using P/T Ratio February 11, 2013
11:21:03 AM

Prolink

Sample.qcc

Trials 10
 Unique Parts 2
 Total Parts Measured 20
 Record Range 81 - 100

This report is designed to show gage variation based upon repeated measurement of a group of similar parts such as 20 parts measured 2 times. Gage variation is calculated from the range of values between the trials (number of times the parts were measured). This report shows fixture and gage errors if the parts are removed and reinstalled on the gage. This test is better than the Single-Part Gage Repeat Report because it tests the gage's performance over a range of values. However, more work is required to measure each part several times. It is assumed the parts do not change size over the course of the testing period.

The *P/T Ratio* is the ratio between the gage variation and the specification range of each feature. See footer for equation.

A gage should not contribute more than 10% to the measurement error. Any value less than or equal to 10% is considered good. The P/T% column is the P/T Ratio multiplied by 100 with an added percent sign. This report does not replace the more exhaustive testing of a complete Gage R & R study. Instead, it is a first check to determine whether the gage is suitable to measure the parts within their part tolerance.

	Dimension	Nominal	USL	LSL	Sigma Gage	Sigma Parts	P/T Ratio	P/T%
1	X Hole Position	1.0000	1.0010	0.9990	0.000542	0.000000	1.6258	162.6%
2	Y Hole Position	2.0000	2.0020	1.9980	0.001151	0.000000	1.7267	172.7%
3	Z Hole Position	3.0000	3.0030	2.9970	0.001346	0.000528	1.3458	134.6%
4	Line Length	4.0000	4.0040	3.9960	0.001431	0.000599	1.0729	107.3%
5	Datum 1	5.0000			0.002521	0.001023		
6	Datum 2	6.0000			0.003751	0.000000		
7	Datum 3	7.0000			0.003344	0.001387		
8	Datum 1 - Datum2	8.0000			0.002925	0.001615		
9	Chamfer Angle	9.0000	9.0090	8.9910	0.004712	0.002623	1.5707	157.1%
10	Snap Dia	10.0000	10.0100	9.9900	0.004733	0.000000	1.4198	142.0%
11	Overall Length	11.0000	11.0110	10.9890	0.004453	0.000000	1.2144	121.4%
12	Ring length	12.0000	12.0120	11.9880	0.005491	0.000000	1.3728	137.3%
13	Thread Pitch	13.0000	13.0130	12.9870	0.008345	0.000000	1.9258	192.6%
14	OD Fit	14.0000	14.0140	13.9860	0.006909	0.002445	1.4804	148.0%
15	Functional Size	15.0000	15.0150	14.9850	0.007049	0.000000	1.4097	141.0%
16	Bond thickness	16.0000	16.0160	15.9840	0.007625	0.005797	1.4297	143.0%
17	ManDimension 1	1.5216	2.8147	0.2285	0.226950	0.120887	0.5265	52.7%
18	ManDimension 2	2.5351	3.5078	1.5624	0.257092	0.000000	0.7929	79.3%
19	X Hole Position x 2	1.9998	2.0039	1.9957	0.001084	0.000000	0.7906	79.1%
20	Y Hole Position x 2	4.0000	4.0097	3.9903	0.002302	0.000000	0.7109	71.1%
Sigma Gage = (RBar / d2)		and		P/T Ratio = (6 * Sigma Gage) / (USL - L SL)				

Multi-Part Gage Report (P/T Ratio)

QC-CALC ships with 2 different PT Ratio for multi-part reports so try each template by selecting a different template. This is one example:

Multi-Part Gage Repeat using P/T Ratio							February 11, 2013 11:21:03 AM
Prolink							
Sample.qcc							
Trials	10						
Unique Parts	2						
Total Parts Measured	20						
Record Range	81 - 100						
<p>This report is designed to show gage variation based upon repeated measurement of a group of similar parts such as 20 parts measured 2 times. Gage variation is calculated from the range of values between the trials (number of times the parts were measured). This report shows fixture and gage errors if the parts are removed and reinstalled on the gage. This test is better than the <u>Single-Part Gage Repeat Report</u> because it tests the gage's performance over a range of values. However, more work is required to measure each part several times. It is assumed the parts do not change size over the course of the testing period.</p> <p>The <i>P/T Ratio</i> is the ratio between the gage variation and the specification range of each feature. See footer for equation.</p> <p>A gage should not contribute more than 10% to the measurement error. Any value less than or equal to 10% is considered good. The P/T% column is the P/T Ratio multiplied by 100 with an added percent sign. This report does not replace the more exhaustive testing of a complete Gage R & R study. Instead, it is a first check to determine whether the gage is suitable to measure the parts within their part tolerance.</p>							
Dimension	Nominal	USL	LSL	Sigma Gage	Sigma Parts	P/T Ratio	P/T%
1 X Hole Position	1.0000	1.0010	0.9990	0.000542	0.000000	1.6258	162.6%
2 Y Hole Position	2.0000	2.0020	1.9980	0.001151	0.000000	1.7267	172.7%
3 Z Hole Position	3.0000	3.0030	2.9970	0.001346	0.000528	1.3458	134.6%
4 Line Length	4.0000	4.0040	3.9960	0.001431	0.000599	1.0729	107.3%
5 Datum 1	5.0000			0.002521	0.001023		
6 Datum 2	6.0000			0.003751	0.000000		
7 Datum 3	7.0000			0.003344	0.001387		
8 Datum 1 - Datum2	8.0000			0.002925	0.001615		
9 Chamfer Angle	9.0000	9.0090	8.9910	0.004712	0.002623	1.5707	157.1%
10 Snap Dia	10.0000	10.0100	9.9900	0.004733	0.000000	1.4198	142.0%
11 Overall Length	11.0000	11.0110	10.9890	0.004453	0.000000	1.2144	121.4%
12 Ring length	12.0000	12.0120	11.9880	0.005491	0.000000	1.3728	137.3%
13 Thread Pitch	13.0000	13.0130	12.9870	0.008345	0.000000	1.9258	192.6%
14 OD Fit	14.0000	14.0140	13.9860	0.006909	0.002445	1.4804	148.0%
15 Functional Size	15.0000	15.0150	14.9850	0.007049	0.000000	1.4097	141.0%
16 Bond thickness	16.0000	16.0160	15.9840	0.007625	0.005797	1.4297	143.0%
17 ManDimension 1	1.5216	2.8147	0.2285	0.226950	0.120887	0.5265	52.7%
18 ManDimension 2	2.5351	3.5078	1.5624	0.257092	0.000000	0.7929	79.3%
19 X Hole Position x 2	1.9998	2.0039	1.9957	0.001084	0.000000	0.7906	79.1%
20 Y Hole Position x 2	4.0000	4.0097	3.9903	0.002302	0.000000	0.7109	71.1%
Sigma Gage = (RBar / d2) and P/T Ratio = (6 * Sigma Gage) / (USL - LSL)							

Page 1 of 1

When performing the **Multi-Part Gage Report (P/T Ratio)** QC-CALC reads your measurement results in a very defined way. Trial #1 for each part must occur before Trial #2 begins. Therefore you must inspect parts 1, 2, 3, ... etc and then start over for trial 2. Continue this pattern for each trial in your study. For example, if you have 3 different parts and you plan to inspect each part 5 times (trials), you **must** inspect the parts in the order shown in the Table.

When you setup the **Print Report** configuration under **File – Print Report**, select **Multi-Part Gage Report (P/T Ratio)** and answer the **Number of Parts Used in the Study** with:

Number of Trials = 5
 Number of Unique Parts = 3

This information tells QC-CALC to read the data and calculate the Average and Range between records 1, 4, 7, 10, & 13. Notice these records contain part #1 information only. This sequence of inspection is critical.

The Multi-Part Gage Report is designed to show gage variation based on repeated measurement of a group of similar parts such as 10 parts measured 2 times. Gage variation is calculated from the range of values between the trials (number of times the parts were measured). This report shows fixture and gage errors if the parts are removed and reinstalled on the gage. This test is better than the **Single-Part Sigma Report** because it tests the gage's performance over a range of different parts, but more work is required to measure each part several times. It is assumed the parts do not change size over the course of the testing period.

Record	Part	Trial
1	1	1
2	2	1
3	3	1
4	1	2
5	2	2
6	3	2
7	1	3
8	2	3
9	3	3
10	1	4
11	2	4
12	3	4
13	1	5
14	2	5
15	3	5
16		

Unique Part count and **Total Parts Measured** were added to the **Trial** count so you can understand the conditions of the gage study. The **Single-Part Gage Report** only requires the Trial count.

Repeatability Minimum

A gage should not contribute more than 10% to the measurement error. Any value less than or equal to 10% is considered good. The P/T% column is the P/T Ratio multiplied by 100 with an added percent sign. This report does not replace the more exhaustive testing of a complete Gage Repeatability & Reproducibility study. Instead, it is a first check to determine whether the gage is suitable for measuring the part features within their tolerances.

With highly precise parts, it is possible that no gage can meet the 10% requirement and you may have to accept a gage only capable of 15%, 20%, or even 25%.

10.3.9 Gage R&R Report Tabular Form

QC-CALC ships with multiple Gage R&R Short Form templates covering the Range or ANOVA method of calculating the numbers along with basing the numbers on the Percent of Specification vs. Percent of Total Variation. You can only print this report if the QC-CALC file was created for Gage R&R.

February 19, 2013
 8:40:37 AM

Gage R&R Anova using Percent of Spec Limits

My Part 100_GRR_Qcc

Gage Type: CMM
 Gage Size: 12x24x36
 Gage Number: 23

Performed by: Bruce & Todd
 Record Range: 1 - 20

Parts: 5
 Trials: 2
 Operators: 2

Part Variation (PV)

Part Variation is a measure of how much the process is actually varying, if an infinite number of parts made by this process were measured using an Ideal Gage, 99.0% (5.15 sigma) of the parts would be within an interval Part Variation wide. This is, of course, only an estimate.

Repeatability (EV)

Equipment Variation is a measure of how much the gage readings vary when the same operator measures the same part several times. A large value might indicate gage wear, improper measurement policy (but all operators are making the same "mistake", it is not a matter of individual operator skill), or a gage without sufficient resolution or with a defect. This number is best used by comparing it with Reproducibility.

Reproducibility (AV)

Appraiser Variation is a measure of operator difference. The most common cause of a poor (large) Reproducibility is insufficient operator training. A gage that is sensitive to different techniques or is difficult to use would also cause a large Reproducibility. We believe using a CMM or Vision inspection system eliminates most of the human error. Fixturing should be checked if this value is high.

Gage R&R

Gage R&R is a measure of the combine variation of Repeatability and Reproducibility caused by the gaging system as opposed to the manufacturing process. This number, expressed as a percentage of tolerance, is the most important "warning flag". If R&R is a large percentage of total variation but not a large percentage of tolerance, both the gage and the process are good and the process standard deviation is even smaller than it appears (meaning the process spread is smaller and Cpk larger than reported). This also means a more precise gage would allow tighter control limits for earlier detection of loss of control. The following table shows typical interpretation.

% Of Tol.
 0 - 10% Gage is suitable
 10 - 30% May be acceptable based on importance of the measured part, cost of gage repair, etc. look at R and R separately
 Over 30% Gage system needs improvement

Dimension	Nominal	USL	LSL	Part Average	UCL	LCL	Parts	Part Variation (PV)	Repeatability (EV)	Reproducibility (AV)	Gage R&R
1 Feature 1	1.5000	1.5100	1.4900	1.50021	0.014017	0.000000	5	0.00%	20.34%	0.00%	20.34%
2 Feature 2	2.5000	2.5100	2.4900	2.49980	0.027564	0.000000	5	0.00%	31.54%	0.00%	31.54%
3 Feature 3	3.5000	3.5100	3.4900	3.50196	0.007603	0.000000	5	12.03%	11.59%	0.00%	11.59%
4 Feature 4	4.5000	4.5100	4.4900	4.50110	0.011650	0.000000	5	10.13%	21.05%	0.00%	21.05%
5 Feature 5	5.5000	5.5100	5.4900	5.50098	0.012950	0.000000	5	0.00%	16.59%	0.00%	16.59%
6 Feature 6	6.5000	6.5100	6.4900	6.50126	0.010673	0.000000	5	8.29%	15.15%	0.00%	15.15%
7 Feature 7	7.5000	7.5100	7.4900	7.50101	0.012687	0.000000	5	0.00%	15.43%	0.00%	15.43%
8 Feature 8	8.5000	8.5100	8.4900	8.50037	0.014758	0.000000	5	0.00%	22.61%	0.00%	22.61%

MSA Calculations Used in this Report

10.3.10 Gage R&R Report

QC-CALC ships with 2 Gage R&R Long Form templates with calculations based on the Range of the data or based on ANOVA. You can only print this report if the QC-CALC file was created for Gage R&R. The report will have 1 page for each plot shown on the screen, so be aware of how many plots you have showing.

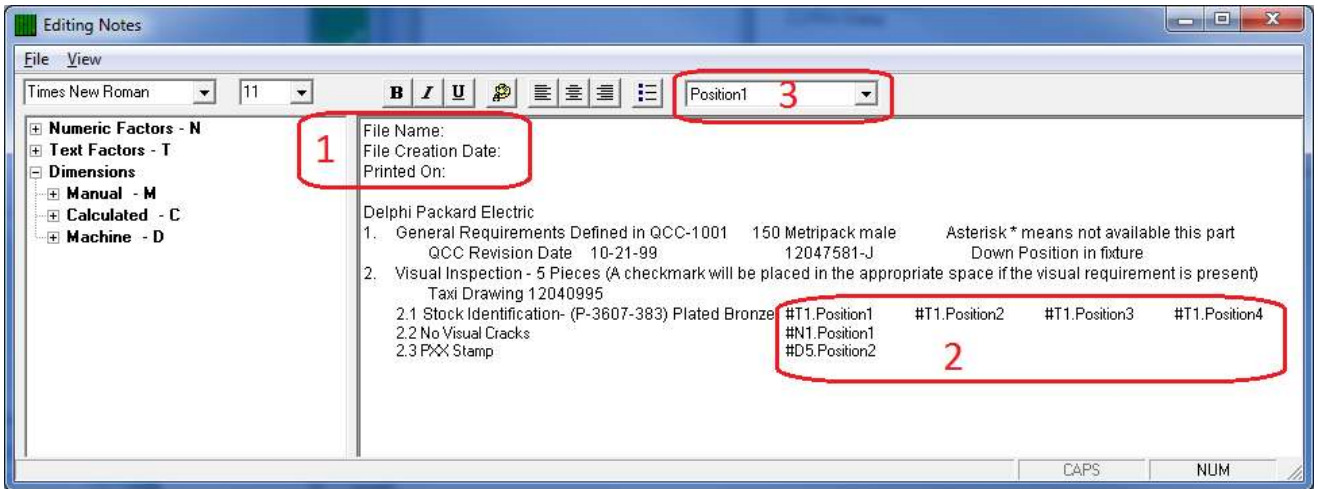
Gage R & R (Range) Report			February 11, 2013										
Prolink													
Part No. & Name: Sample Gage R&R_GRR.QCC		Gage Type: Junker Gage											
Characteristics: Circle diameter		Gage Number: 12345											
Nominal: 1.000000		Gage Size: Large											
USL: 1.001000		Study Date: 2/11/2013											
LSL: 0.999000													
Measurement Unit Analysis		% Total Variation (TV)											
Repeatability - Equipment Variation (EV) $EV = \bar{R} \times K_1$ $= 0.00010116$		$\%EV = 100[EV / TV]$ $= 92.33\%$ $= 5.06\% \text{ of Spec}$											
<table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <thead> <tr> <th style="padding: 2px;">Trials</th> <th style="padding: 2px;">K₁</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; padding: 2px;">1</td> <td style="text-align: center; padding: 2px;">4.5641</td> </tr> <tr> <td style="text-align: center; padding: 2px;">2</td> <td style="text-align: center; padding: 2px;">3.0427</td> </tr> </tbody> </table>		Trials	K ₁	1	4.5641	2	3.0427						
Trials	K ₁												
1	4.5641												
2	3.0427												
Reproducibility - Appraiser Variation (AV) $AV = \sqrt{(\bar{X}_{DIFF} \times K_2)^2 - (EV^2 / (nr))}$ $= 0.00002286$		$\%AV = 100[AV / TV]$ $= 20.86\%$ $= 1.14\% \text{ of Spec}$											
<table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <thead> <tr> <th style="padding: 2px;">Appraisers</th> <th style="padding: 2px;">2</th> <th style="padding: 2px;">3</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; padding: 2px;">K₂</td> <td style="text-align: center; padding: 2px;">3.6416</td> <td style="text-align: center; padding: 2px;">2.6941</td> </tr> </tbody> </table>		Appraisers	2	3	K ₂	3.6416	2.6941						
Appraisers	2	3											
K ₂	3.6416	2.6941											
Repeatability & Reproducibility (GRR) $GRR = \sqrt{EV^2 + AV^2}$ $= 0.00010371$		$\%GRR = 100[GRR / TV]$ $= 94.66\%$ $= 5.19\% \text{ of Spec}$											
Part Variation (PV) $PV = R_p \times K_3$ $= 0.00003532$		$\%PV = 100[PV / TV]$ $= 32.24\%$ $= 1.77\% \text{ of Spec}$											
<table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <thead> <tr> <th style="padding: 2px;">Parts</th> <th style="padding: 2px;">K₃</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; padding: 2px;">2</td> <td style="text-align: center; padding: 2px;">3.6416</td> </tr> <tr> <td style="text-align: center; padding: 2px;">3</td> <td style="text-align: center; padding: 2px;">2.6941</td> </tr> <tr> <td style="text-align: center; padding: 2px;">4</td> <td style="text-align: center; padding: 2px;">2.3003</td> </tr> <tr> <td style="text-align: center; padding: 2px;">5</td> <td style="text-align: center; padding: 2px;">2.0756</td> </tr> </tbody> </table>		Parts	K ₃	2	3.6416	3	2.6941	4	2.3003	5	2.0756		
Parts	K ₃												
2	3.6416												
3	2.6941												
4	2.3003												
5	2.0756												
Total Variation $TV = \sqrt{GRR^2 + PV^2}$ $= 0.00010956$		$ndc = 1.41 \left(\frac{PV}{GRR} \right)$ $= 0.48014490$											
<table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <tbody> <tr> <td style="text-align: center; padding: 2px;">6</td> <td style="text-align: center; padding: 2px;">1.9270</td> </tr> <tr> <td style="text-align: center; padding: 2px;">7</td> <td style="text-align: center; padding: 2px;">1.8199</td> </tr> <tr> <td style="text-align: center; padding: 2px;">8</td> <td style="text-align: center; padding: 2px;">1.7382</td> </tr> <tr> <td style="text-align: center; padding: 2px;">9</td> <td style="text-align: center; padding: 2px;">1.6732</td> </tr> <tr> <td style="text-align: center; padding: 2px;">10</td> <td style="text-align: center; padding: 2px;">1.6200</td> </tr> </tbody> </table>		6	1.9270	7	1.8199	8	1.7382	9	1.6732	10	1.6200		
6	1.9270												
7	1.8199												
8	1.7382												
9	1.6732												
10	1.6200												
For information on the theory and constants used in this form see <i>MSA Reference Manual</i> , Third Edition													
Page 1 of 8													

10.3.11 Notes Input Report

The **Notes Input** is a template you can use to send .rtf (pre-formatted) values to a template. You can design the entire report from the .rtf editor or just send 1 block of formatted text and choose the regular template variables to display anything else you wish to see. You are limited to the last 10 records when this report runs. The **Edit Input File** button on the **Report Type** screen brings up the **RTF Editor** and is used to edit the corresponding .rtf file.

RTF Editor

The RTF Editor is used to create or edit the .rtf file that will be used in your Notes Input report. In general it is easier to use Microsoft Word as your editor, then paste the rtf text into the RTF Editor in order to save the information where QC-CALC needs it to be saved. The variables that are replaced at run time can be typed into Word if you know what the correct variable would be.



The important items of the RTF Editor are numbered above and described below:

1. RTF Editor menus:

File – Save: This menu is used to save the contents displayed in the RTF Editor into an .rtf file associated with the currently open .qcc file.

File – Exit: This menu closes the RTF Editor and returns you to the Reporting screen.

View – Toolbar: This menu controls the visibility of the toolbar containing the buttons for controlling the font and paragraph properties and the Position choice.

View – Database Values: This controls the visibility of the left panel which contains the interface to all of the items in the database that are available to be inserted into the RTF file.

2. This area shows the database items you can use in the report. Double clicking one of these values inserts that item, along with the setting in the Position area, into the text on the right where ever the cursor is currently located. The variable inserted into the report will be an abbreviation for the dimension or factor, plus the Position displayed. For example, **#T1.Position1** will use the latest value from Text Factor 1 when the report runs. The abbreviations used are “Tn” for Text Factor n, “Nn” for Numeric Factor n, “Mn” for Manual Dimension n, “Cn” for Calculated Dimension n, and “Dn” for Machine Dimension n.

You have access to all dimensions and factors from the .qcc file, but you are limited in the number of readings (records) you can use to the last 10 readings. When the report is run that variable that was inserted will be

replaced with the corresponding value for that reading of the specified dimension or factor.

3. The Position is the reading for the current subgroup of data that you want to appear in that slot.



Note: The Positions appear to be backwards from what you would expect. Position 1 is the very last reading received (Value 5 in the **Manual Input Entry** form). Choose the Position number from the list at the top of the editor, then double click an item in the **Database Values** list on the left and that Position will be used for the variable inserted into the text on the right.

4. There are two ways to get heading type information into the report. The way shown in the picture is typing the values into the preformatted text before the report runs. The other option is to set up a heading area within the actual NotesInput.nir template within the Report Designer. You can setup the header area to print the values like File Name and current date using the variables sent directory to the Report Designer.
5. This area shows what is inserted when you double click an item in the left panel. When the report actually runs, the variables here will be replaced



Tip: The easiest way to line up the columns is to get everything the way you want it to look in Microsoft Word using the ruler and tabs, click the **File – Save As** menu, and choose .rtf as your format, then paste it into the RTF Editor. All of the tab stops that were setup in Word will be carried over, but you will not be able to edit them in the **Editing Notes** screen.

10.4 Printing To

10.4.1 Introduction

You can print to a printer, the screen (preview), or a file. The Printer and Print Preview are discussed in more detail in the [Print to Printer](#) section on page 45 but printing to a file is discussed here.

10.4.2 Print to File

There are times you want to print your reports to a file. This is useful when you need to electronically save the reports for future printing or send them electronically to a customer. When this option is selected, the **File Format**, **File Path**, and **File Name** and the **Browse** button become visible. Use the **File Type** pull-down list to select different output formats. Clicking the **Browse** button allows you to select the file location and name.

The screenshot shows a dialog box titled "File Type". It has three main input areas: "File Format" with a dropdown menu showing "ADOBE PDF Format"; "File Path" with a text box containing "C:\Prolink\QC-CALC 3.4\data\" and a "..." browse button; and "File Name" with a text box containing "report.pdf". Below these are three checkboxes: "Use part name, date, and time" (unchecked), "Send in Email (Sample@sample.xyz)" (unchecked), and "Open in Default Application" (unchecked). A "Configure" button is located to the right of the "Send in Email" checkbox.

Send in Email

This checkbox attaches the report file to an email. A built-in email dialog box is displayed allowing you to address the email, provide a subject, and write an email letter to the recipient. You can edit this information by pressing the **Configure** button at any time. QC-CALC has a built-in email system or acts as an email program such as Outlook, Lotus Notes, etc. Therefore it works on all systems. See the [Email Setup](#) section on page 151 for details.

Open in Default Application

This checkable option forces the report file to be displayed by the default application assigned to the file extension (i.e. PDF files are opened in Adobe Acrobat; HTML may use Internet Explorer, etc).

Use Part Name, Date, and Time

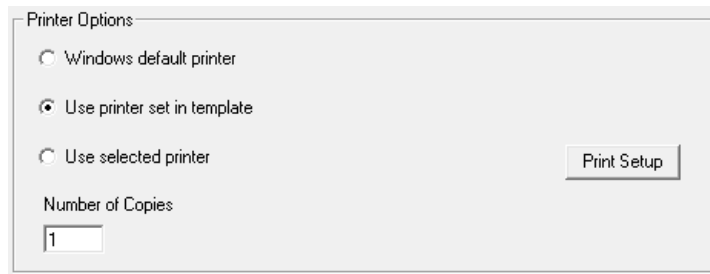
This checkable option creates unique file names for each report printed. If you do not use this option, the next report automatically overwrites the previous report file thereby losing previous results. Appending to an existing report file is not supported in this release of the software. Using **Use Part Name, Date, and Time** creates a new file name by using the name of the Part followed by the date (yyyy-mm-dd) and time (hh-mm-ss). Below is an example of a PDF file name for the part **Sample** that was created on January 5th, 2013 at 1:47:43 pm:

Sample 2013-01-05 13-47-43.pdf

The format of the date and time added to the file name are not editable. To ensure unique and sortable names, the 24-hour clock is used.

10.4.3 Print to Printer

The **Printer Options** in the **Report Type** dialog box direct the location to print your report and the number of copies to print.



Windows default printer

This is most commonly used printer to use since you probably have your favorite printer selected all of the time. However, there are times when you want to use another printer so choose a different option.

Use Printer set in Template

Each report template can be designed to specify a printer. If you added a printer option in the template, use this print option.

Use selected printer

You can quickly choose a different printer at any time by simply clicking the Print Setup button and choosing a printer. This does not change your default printer.

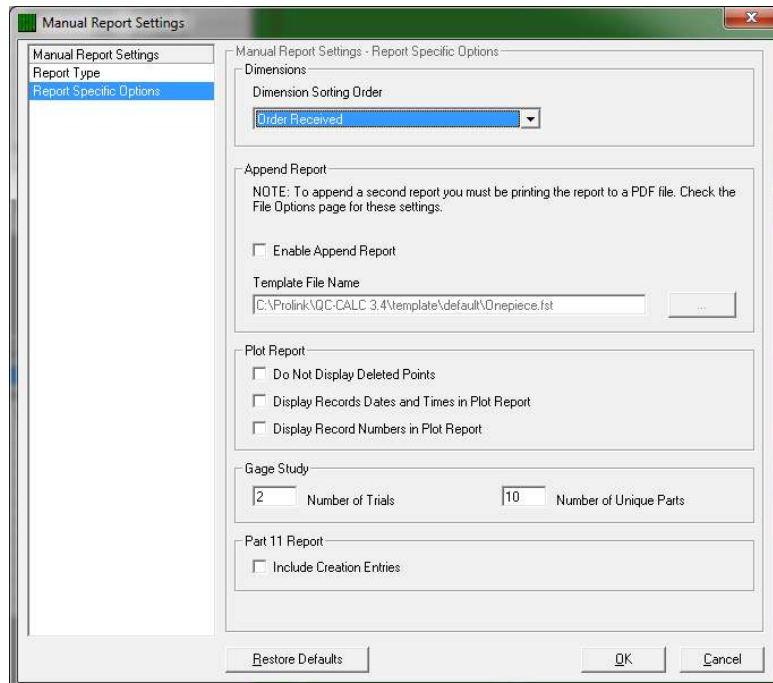
Number of Copies

When the report is sent to a printer you can request QC-CALC to print multiple copies.

10.5 Report Specific Options

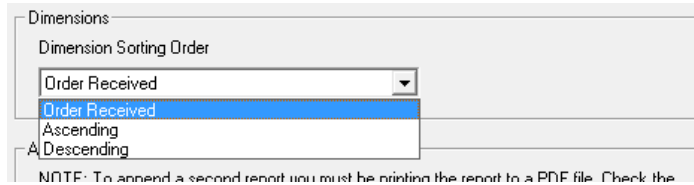
10.5.1 Introduction

This area provides several options to control your printing. We will briefly discuss each option so you can see how to modify your reports at the last minute.



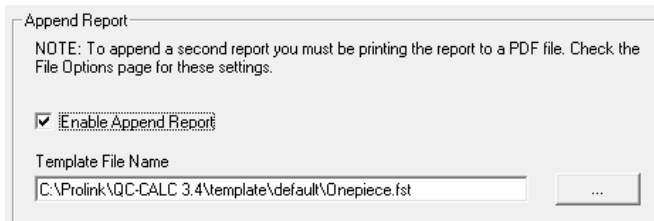
10.5.2 Dimension Sorting

You can have the Dimension Labels in your report sorted by **Order Received** (default) or **Ascending** or **Descending** alphabetical order. Choose the order you prefer from the list provided.



10.5.3 Append Report

When printing reports to PDF files, you can add a second report to the one you are printing by checking the **Enable Append Report** option and selecting a second report template. QC-CALC will print your chosen report and then it will add this one to the end of the PDF file. Currently, only two reports can be combined. This option will not work if you are not printing to a PDF file!



10.5.4 Plot Report

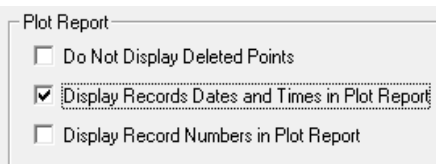
Do Not Display Deleted Points

Check this option to stop the deleted (gold dots) from appearing in the printout.

Display Records, Dates and Times in Plot Report and Metafiles

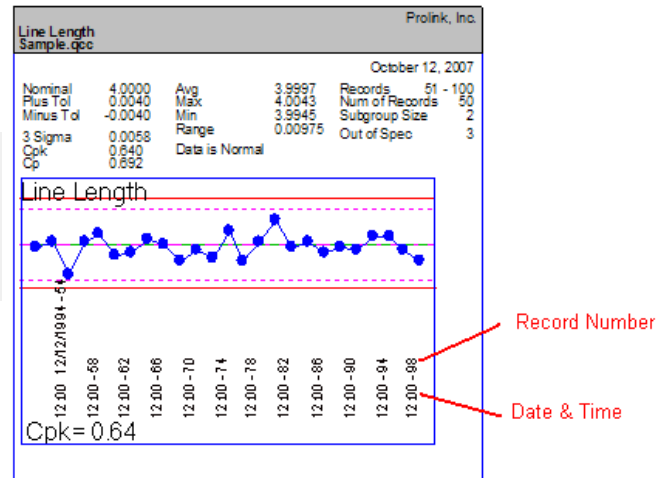
Check this option to include the date and time for each record on each point in the Plot Report. The time is shown on each point but the date is only added when it changes.

This was done to reduce clutter. The plot size is reduced to fit the date and time on the x-axis.



Display Records in Plots

Check this option to add a record number to date and time on each point in the Plot. Both Date & Time along with Record numbers are shown.



10.5.5 Gage Study

Single Part Gage Report

The Single Part P/T Ratio report requires no setup and assumes all data came from one part. Simply measure 1 part 10 times and run the report. The goal of the report is to show gage variation while measuring one part many times. It is assumed the part does not change size over the course of the testing period and therefore all variation (Sigma) is assigned to the gage.

Multi-Part Gage Report

The Multi-Part Gage Report requires multiple trials and multiple parts. The problem is determining which part and trial you have in the database. When performing the **Multi-Part Gage Report (P/T Ratio)** QC-CALC reads your measurement results in a very defined way. Trial #1 for each part must occur before Trial #2 begins. Therefore you must inspect parts 1, 2, 3, ... etc and then start over for trial 2. Continue this pattern for each trial in your study. For example, if you have 3 different parts and you plan to inspect each part 5 times (trials), you **must** inspect the parts in the order shown in the Table.

When you setup the **Print Report** configuration under **File – Print Report**, select Multi-Part Gage Report (P/T Ratio) and answer the **Number of Parts Used in the Study** with:

Number of Trials = 5
 Number of Unique Parts = 3

This information tells QC-CALC to read the data and calculate the Average and Range between records 1, 4, 7, 10, & 13. Notice these records contain part #1 information only. This sequence of inspection is critical.

The Multi-Part Gage Report is designed to show gage variation based on repeated measurement of a group of similar parts such as 2 parts measured 10 times. Gage variation is calculated from the range of values between the trials (number of times the parts were measured). This report shows fixture and gage errors if the parts are removed and reinstalled on the gage. This test is better than the **Single-Part Sigma Report** because it tests the gage's performance over a range of different parts, but more work is required to measure each part several times. It is assumed the parts do not change size over the course of the testing period.

Record	Part	Trial
1	1	1
2	2	1
3	3	1
4	1	2
5	2	2
6	3	2
7	1	3
8	2	3
9	3	3
10	1	4
11	2	4
12	3	4
13	1	5
14	2	5
15	3	5
16		

10.5.6 Part 11 Report

Part 11 Report

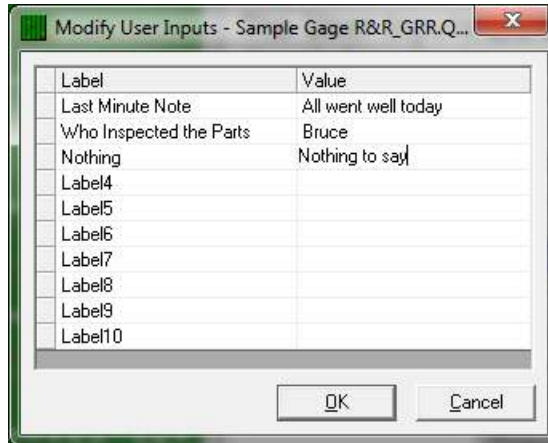
Include Creation Entries

You have an option to include the creation entries in the report by checking this option. When collecting data manually via QC-Gage, QC-CALC Real-Time creates a Part 11 entry for every record as it is created. This is because the record is being entered manually by a person unlike normal data collection within QC-CALC Real-Time where the data is being generated by automated inspection equipment. Because there is a Part 11 record generated for each new record in the QCC file, it can create a lengthy report when printed. This option allows you to either include or exclude these records in your Part 11 report. If you choose to exclude them (unchecked), the report will show only changes to existing records. If you are not operating under 21 CFR Part 11 mode, you can ignore this option.

10.6 Adding Notes to Reports

10.6.1 Modify User Inputs

The **User Inputs** are used to add information to the report that is not entered directly from the inspection machine. You decide which lines you want to show in the report. The Real-Time report templates shipped with your software have the variables USERINPUT1 through USERINPUT10 added to the top of page 1. This means any last minute text you type in these text-boxes is shown in the reports. To add user inputs on your report click **Report – Modify user Inputs**.



The **User Inputs** are associated with the specific part being measured so each part routine can have different **User Inputs** values. Any changes you make here will only affect the **User Inputs** for the specific part routine seen in the title bar of the **Modify User Inputs** window.

Here we see the three **User Inputs** above being displayed automatically in the partial First Article report. This last minute text addition is very useful to convey unavailable information just before the report is printed.

First Article Report				
Prolink				
C:\Prolink\QC-CALC 3.3\Data\MyPart 10.Qcc			Lot	
MyPart 10			NumFactor 2	
Date of Inspection	August 28, 2005		Operator	
Time of Inspection	3:00:36 PM		TxtFactor2	
Record Number	283		TxtFactor3	
All went well today			TxtFactor4	
Bruce			TxtFactor5	
Nothing to say				
Dim	Dimension Label	Nominal	USL	LSL
1	Feature 1	1.5000	1.5100	1.4900
2	Feature 2	0.5000	0.5100	0.4900

Exercises

Complete the following exercises to become familiar with printing reports. We will print most reports to the Print Preview screen.

1. Print a **Stat Summary Report** to include all visible parts in the plots.
2. Print a **Raw Data Report** with statistics using the newest 10 parts in the file.
3. Now print the same **Raw Data Report** to a PDF file called MyLatestTenParts.PDF and saved on your desktop.
4. Use the **Print Preview** screen to create the PDF file called Preview from the **Preview screen**.
5. Print a **Stat Summary** of 8 highlighted data points.

Exercise 1: Print a Stat Summary

Print a Stat Summary report to include all visible data. This report should include all parts displayed.

1. Ensure your **Print Preview** is enabled
2. Select **Report – Print Report**
 - a. Select a **Report Type** of **Stat Summary**
 - b. Select the **Report Template Name** of STATSUM.STT
 - c. Select **All Records Displayed as Range of Records to Report**
3. Click **Print**
4. Your report is printed to the print preview screen

Exercise 2: Print a Raw Data Report with Statistics

Print a **Raw Data Report** with statistics using the newest 10 parts in the file.

1. Ensure your **Print Preview** is enabled
2. Select **Report – Print Report**
 - a. Select a **Report Type** of **Raw Data**
 - b. Select the **Report Template Name** of RAWSTAT.RAW
3. Enter 10 in the Newest Records in File text-box
4. Click **Print**
5. Your report is printed to the print preview screen

Exercise 3: Print a Raw Data Report with Statistics to a PDF file

Now print the same **Raw Data Report** to a PDF file called MyLatestTenParts.PDF and saved on your desktop.

1. Select **Report – Print Reporting**
 - a. Select a **Report Type** of **Raw Data**
 - b. Select the **Report Template Name** of RAWSTAT.RAW
 - c. Select **10** as **Range of Records to Report**
 - d. Click the **Advance** button
 - e. Select **File** in the **Print To** area
 - f. Choose **Adobe PDF Format** in the **File Type** Drop-down. If File Type is not enabled, be sure to uncheck the **Enable** checkbox found in the **Append Report** below.
 - g. Click the **Browse** button under the **File Name**
 - h. Click the **Desktop** Button
 - i. Enter a **File name** of **MyLatestTenParts.PDF**
 - j. Click **Save**
2. Click **Print**
3. Your report is printed to the file.
4. Verify the file is on your desktop and if Adobe Reader is installed, open it

Exercise 4: Print a Raw Data Report with Statistics to a PDF file using Print Preview

Print a **Raw Data Report** with statistics using the newest 10 parts in the file.

1. Ensure your **Print Preview** is enabled
2. Select **Report – Print Report**
 - a. Select a Report Type of **Raw Data**
 - b. Select the **Report Template Name** of RAWSTAT.RAW
 - c. Enter **10** in the **Newest Records in File** text-box
3. Click **Print**
4. Your report is printed to the print preview screen
5. On the top of the Print Preview window, click the disk icon
6. Click the **Save in** Drop-down list and pick your desktop as the folder
7. Ensure the **File name** is **preview**
8. Select **PDF Document** in the **Save as** type Drop-down
9. Click **Save**
10. Verify the file is on your desktop and if Adobe Reader is installed, open it

Exercise 5: Print a Stat Summary

Print a **Stat Summary** of 8 highlighted data points.

1. Ensure your **Print Preview** is enabled
2. On the Real-Time Plot screen, click and drag the left mouse button over the last 8 data points displayed. Hint: it might be easier to start at the right side and drag left.
3. With the highlighted points shown, select **Report – Print Report**
 - a. Select a **Report Type** of **Stat Summary**
 - b. Select the **Report Template Name** of STATSUM.STT
 - c. Select **Selected Points** as **Range of Records to Report**. This selection is not available unless you highlight the data points on-screen
4. Click **Print**
5. Your report is printed to the print preview screen

11. Reporting (Automatic)

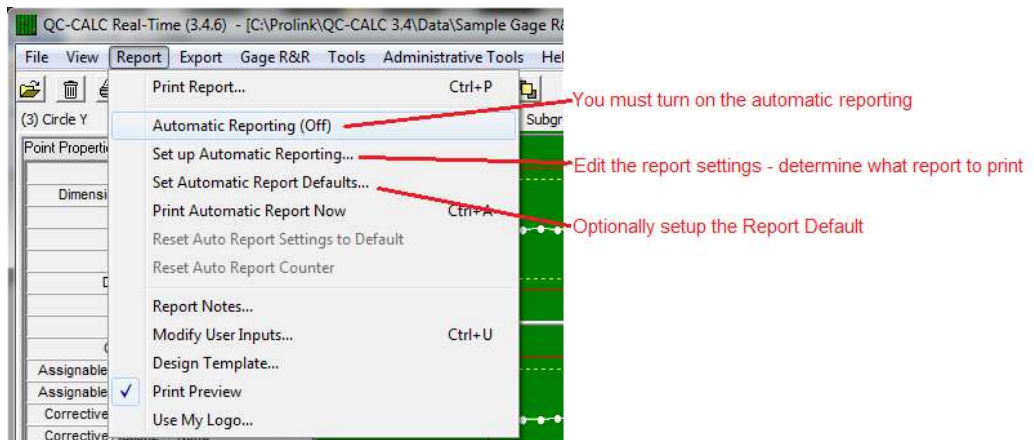
11.1 Introduction

Besides manually printing reports discussed in the previous section, QC-CALC can print reports automatically. With automatic printing you setup what and when to print and then turn-on the print facility. Everything you learned in [Report Types](#) on page 26 applies in this section so we will skip the first menu of Automatic Reports only discuss the frequency portion or “when-to-print”. The automatic print option is made up of several separate functions which include:

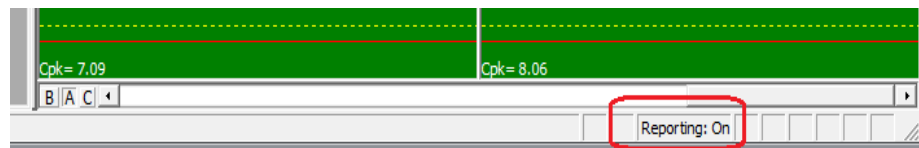
Function	Action	Discussed
What	type of report to print?	Report Types pg. 30
Which	template to use?	Report Types pg. 30
How	much data to include?	Range of Records pg. 27
Where	to print the report?	Printing To pg. 44
When	to trigger the report?	here
Options	special options	here
Defaults	apply to all parts	here

11.2 Automatic Printing (On)

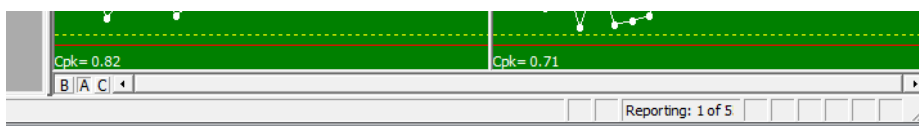
The first thing to do is turn-on the automatic printing by selecting **Report – Automatic Reporting (Off)** menu and its caption switches to **(On)**. This menu item enables or disables the **Automatic Reports**. Once you select this menu it becomes “checked” showing you that automatic reports are enabled. Selecting this menu again turns Automatic Reports off and the check disappears.



When the Automatic Reporting is ON (checked), QC-CALC obeys the schedule you setup in **Set up Automatic Reporting...** For example, if you setup a raw data report to print every 5 parts, the Lower Tray indicates you have enable the automatic reporting system with the words **Reporting: On**.



After the first part is received, you see the message change to **Reporting: 1 of 5** and the counter displays your current count in the sequence.



When enough parts have been received and the counter reads (5 of 5), the report is printed and the next received part starts the count over to 1 of 5.

11.3 Set Up Automatic Report

11.3.1 Report Type Menu

When you decide to use Automatic Reports for a part you are inspecting, you must setup or edit the configuration screen to tell QC-CALC what to do. To begin, select the **Report – Set up Automatic Reporting** menu. We already discussed the [Report Types](#) area on page [26](#) and now we cover the **Frequency** option.

Use Default Report Settings

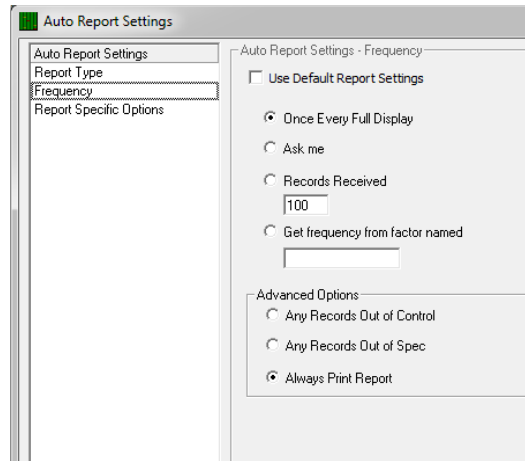
This option will “gray out” the rest of this form and will use the setting you established in the **Tools – Options – Defaults – Automatic Reports** section of the software. For now, we will use specific settings for this part.

11.3.2 Frequency of Reporting

Clicking on the **Frequency** option on the left displays the available options for how often your report is printed on the right.

Once Every Full Display

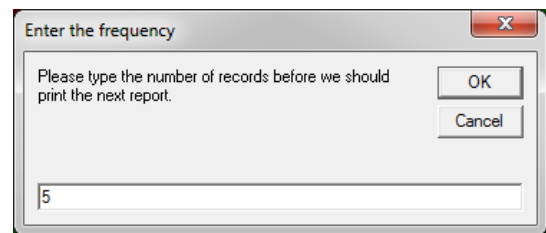
The **Number Of Parts to Plot** is set in **Tools – Options – Configure Plot – Items to Show**, allows you to plot 3 – 100 points. It is this value that is used to determine how often to print the report. You set the number of points to be displayed which becomes the number of points to print in the reports.



If the Real-Time subgroup size is set to 1 then one point equals one part. However, if the Real-Time subgroup size is set to 2 and you are showing 10 points then 20 parts must be received before the report is printed.

Ask Me

When the first part is received after turning on the **Automatic Reports**, QC-CALC displays a message asking for the number of Records (parts) before printing the next report. If you choose 1, the report will contain the part just received. if you choose 5, the report is printed after 4 more parts are received. If you select Cancel, the automatic report is skipped.



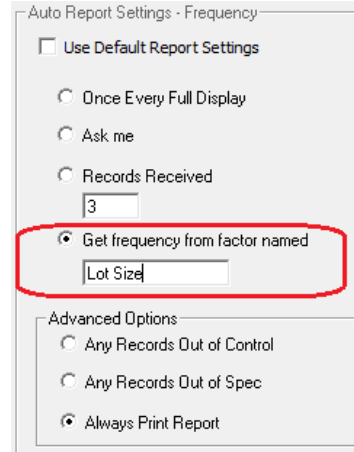
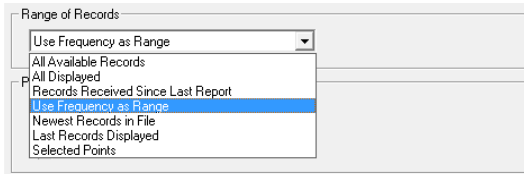
Records Received

This option is simply used to trigger a report after the entered number of parts are received. The subgroup size has no effect on this option.

Get Frequency from Factor Name

This option allows you to use the contents of a Factor value as your frequency. In our example we are saving a **Lot** number and an **Operator** with each part as trackable values.

However, what if you are saving a Factor called **Lot Size**? Then, each time you start a new lot you ask the operator to enter the lot size number. The gage reports the measurements and the Lot Size to QC-CALC. Using this option now creates a report after the lot is completed. Be sure to change the **Range of Records** to **Use Frequency as Range** under the **Report Type** menu.



11.3.3 Advanced Options

Any Records Out of Control

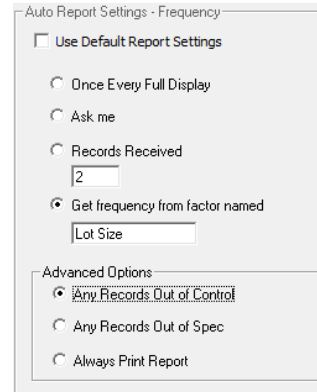
The report is printed only if a value was Out of Control among the records being used for the report. If subgroups are used, the average of the subgroup is tested to determine if the report is triggered.

Any Records Out of Spec

The report is printed only if a value was Out of Specification among the records being used for the report. If subgroups are used, the average of the subgroup is tested to determine if the report is triggered.

Always Print Report

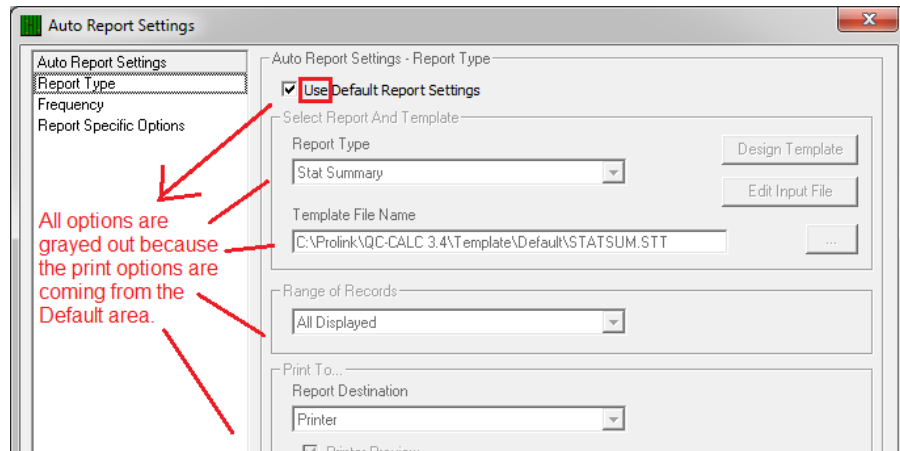
This is the default option and when this is chosen the report will print if an exception happened or if the data was fine.



11.4 Set Automatic Report Defaults

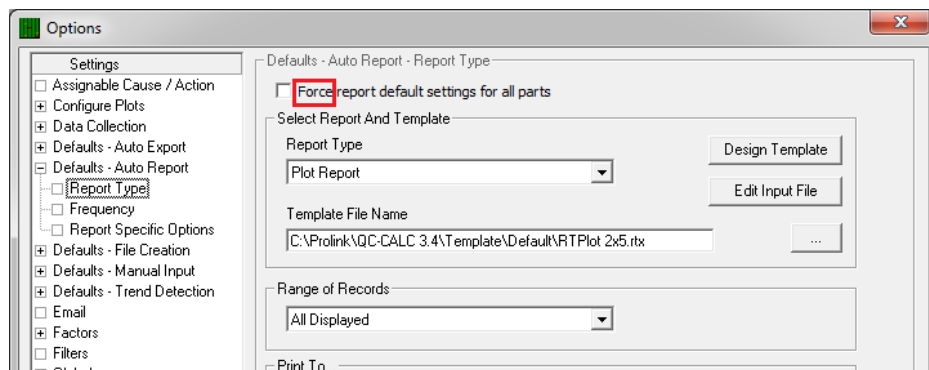
11.4.1 Introduction

When you decide to use **Automatic Reports** for a particular part you are inspecting, you must setup or edit the configuration screen and tell QC-CALC what & how to report. Each part program you write has its own report schedule saved in the QC-CALC. This means you can have a different report for every part. Although the report schedule setup is easy, you may want the same report regardless of the part being inspected. When you check the **Use Default Report Settings** checkbox all setting are read from the default area and then grayed out.



11.4.2 Set up Automatic Reports Default

You can establish one report setting for all parts by selecting **Report – Set up Automatic Reports Default** which brings you to the **Tools – Options – Defaults – Automatic Reports** area of QC-CALC. Whatever you choose in this default area is saved for use with any part you wish. Any time you want to use your standard report on any part simply check the checkbox shown above.



Note: Please note the **Force report default setting for all parts** checkbox in the above picture. This checkbox will override all automatic settings for all parts. This creates 1 global report for all parts.

11.5 Print Automatic Report Now

After you have established a report schedule and parts are being received, you may want to print the report early. For example, if you setup a report schedule to print a Stat Summary Report every 10 parts using the default report template and want to print the report after receiving only 7 parts, simply choose this menu option. If you need to generate a report on older data, use the method discussed earlier in this section.

11.6 Reset Auto Report Counter

This feature allows you to reset the count of your Automatic Reporting. This means the report will not be printed until the full count is repeated. For example, let's assume you setup a report schedule to print after 5 parts are received. After collecting two parts with Automatic Reporting turned on, you chose to reset the counter, the count would be cleared and start over. In this example it would take 7 parts to be received before a report is printed.

Exercises

Complete the following exercises to become familiar with advanced, automatic printing:

1. Setup an Automatic Report to print a Stat Summary report every 5 parts. This report should include all parts displayed.
2. Setup an Automatic Report to print a First Article – Multi-Piece every 5 parts received. The live plot screen should contain 25 points but the report should contain only the latest 5 parts received.
3. Setup an Automatic Report to print a Plot Report when a Control Limit is exceeded. The report must be printed to a PDF file called BadControlLimit.PDF and saved on your desktop.

Exercise 1: Automatic Report to Print a Stat Summary

Setup an Automatic Report to print a Stat Summary report every 5 parts. This report should include all parts displayed.

1. Ensure your **Print Preview** is enabled
2. Select **Tools – Options – Configure Plot Settings – Items to Show** and set the **Number Of Parts to Plot** to 25.
3. Select **Report – Automatic Reporting (Off)** to turn the system (on). Look for a checkmark on the menu indicating the report is on.
4. Select **Use Same Report Settings for All Parts** (if not already on)
5. Select **Report – Setup Automatic Reporting...** to see the Print Setup Screen.
 - a. Select a **Report Type** of **Stat Summary**
 - b. Select the **Report Template Name** of **STATSUM.STT**
 - c. Select **All Records Displayed** as **Range of Records to Report**
 - d. Enter **5** for the **New Records Received** text-box under **Frequency of Reporting**.
 - e. Click **OK**
6. Using your **Training CMM** program Inspect 5 parts slowly. Note the lower tray depicting the number of parts received. It should be counting from 1 of 5 to 5 of 5.
7. When QC-CALC receives 5 parts ensure the report is printed to screen.

Exercise 2: Automatic Report to Print a First Article – Multi-Piece

Setup an Automatic Report to print a First Article – Multi-Piece every 5 parts received. The live plot screen should contain 25 points but the report should contain only the 5 parts just received.

1. Ensure your **Print Preview** is enabled
2. Select **Report – Setup Automatic Reporting...** to see the Print Setup Screen.
 - a. Select a **Report Type** of **First Article – Multi-Piece**
 - b. Select the **Report Template Name** of **FIVESTAT.FPF**
 - c. Enter **5** for the **Newest Records in File** text-box
 - d. Enter **5** for the **New Records Received** text-box
 - e. Click **OK**
3. Using your **Training CMM** program Inspect 5 parts slowly. Note the lower tray depicting the number of parts received.

4. When QC-CALC receives 5 parts ensure the report is printed to screen.

Exercise 3: Automatic Report to print a Plot Report when a Control Limit is Exceeded

Setup an Automatic Report to print a Plot Report when a Control Limit is exceeded. The report must be printed to a PDF file and saved on your desktop with a file name of BadControlLimit.PDF.

1. Select **Report – Setup Automatic Reporting...** to see the Print Setup Screen.
 - a. Select a **Report Type** of **Plot Reports**
 - b. Select the **Report Template Name** of **Real-Time Plot 3x5**
 - c. Select the **Print On Exception** radio button
 - d. Select the **Outside Control Limits** radio button
 - e. Click the **Advance** button
 - f. Select **File** in the **Print To** area
 - g. Choose **Adobe PDF Format** in the **File Type** Drop-down. If File Type is not enabled, be sure to uncheck the **Enable** checkbox found in the **Append Report** below.
 - h. Click the **Browse** button under the **File Name**. If the **Browse** button does not allow you to enter a file name, it means the **Use Part Name, Date, and Time** is checked. Uncheck it for this exercise.
 - i. Click the **Desktop** Button
 - j. Enter a **File name** of **BadControlLimit.PDF**
 - k. Click **SAVE**
2. Using your **Training CMM** program press the **Inspect** button slowly until one of the plots turns gray or red.
3. Stop inspecting parts when you see that a control limit has been exceeded and view your desktop
4. Find the PDF file QC-CALC created and open it. If you do not have Adobe Reader on your computer you cannot open it so just verify its existence.

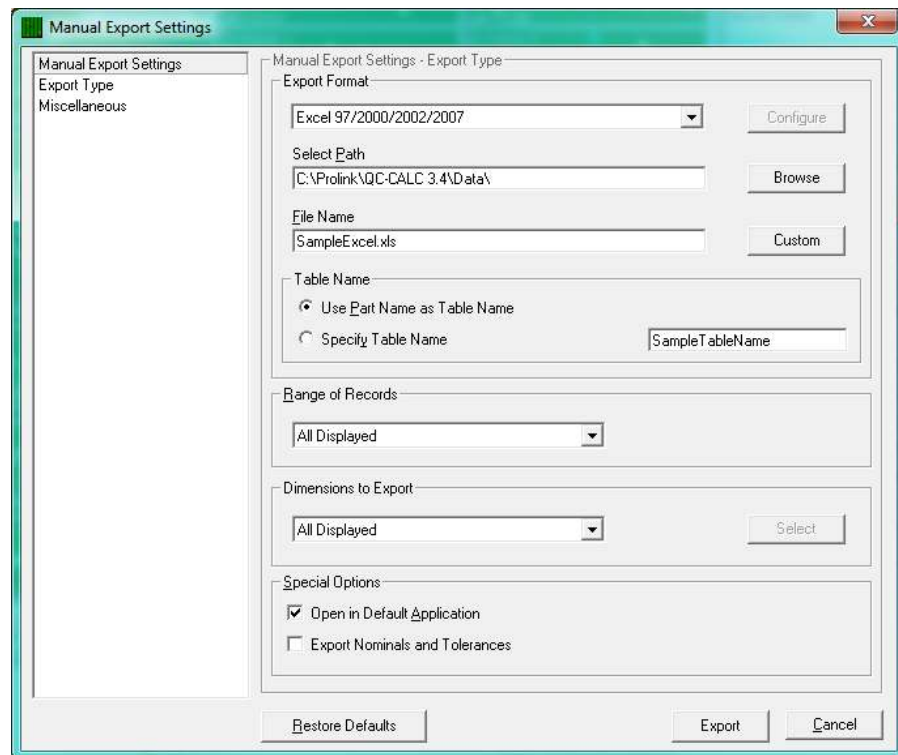
12. Exporting

12.1 Introduction

This option allows you to immediately export any range of data to a variety of file formats. It is a simple process to send data to Excel, Access, or other programs including other statistical packages. In this way, you can use QC-CALC Real-Time as a translator between all inspection equipment and all other formats.

You choose menu **Export – Export Data** and a dialog box asks:

- **What** type of export to do?
- **Where** and what file name to use?
- **How** much data to export?



Now let's discuss each item seen in the Export Dialog box.

12.2 Export Types

QC-CALC Real-Time has many output formats and the list continues to grow. As of this writing the supported formats are:

Access (all versions)	* ASCII Text File (pg. 223)
* ASCII User Defined Template (pg. 226)	* Becker Quality Solutions (pg. 230)
DataPage	Excel (all versions)
* InfinityQS Proficient (pg. 233)	* IQS Export (pg. 236)
JMP (pg. 238)	Lighthouse SPC (pg. 239)
Lotus 1-2-3	* Minitab (pg. 240)
Mitutoyo Measurlink (pg. 241)	* Net-Inspect Web Export (pg. 244)
Northwest Analytical	* OleDB Export (pg. 249)
* ODBC – Open Database Connectivity (pg. 246)	
* Proficiency Shop Floor (Visual SPC) (pg. 250)	* Prolink XML
* Q-DAS Format ASCII Output (pg. 254)	QMC CM4D (PC-DMIS)
QMD XML Class 1 - 3 (Ver 1)	Rektron SQC

* SPC Office Buddy (pg. 261)	* SQL Server Export (pg. 263)
* Stat Summary File (pg. 265)	StatGraphics Centurion XV
* WinSPC (pg. 268)	* Zontec Synergy 2000

You select the output file format by clicking on the list box labeled **Export Type**.

12.2.1 Configure Button

You can configure some of the export file formats. As you choose the output format the **Configure** button may become enabled. This means you have choices and can control what to output. The table above has * next to the formats with instructions included for the configuration choices.

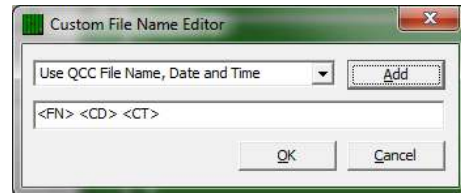
12.2.2 Select Path and File Name

A complete file path and name must be provided in the **Select Path** and **File Name** text box to specify where to save the exported data. The **Browse** button has been added to make this task easier by using a dialog box to choose the exact file instead of typing.

Custom File name Button

Pressing this button allows you to create a dynamic file name from the Factor Values, Part Name, the Date Time the part was inspected, or combinations of all of those options.

- Use Part Name, Date, and Time
- Date of Inspection
- Time of Inspection
- Part Name
- Any Text Factor value
- Any Numeric Factor value



During normal export, you specify the output file name using the File Location textbox. There are times when you may want the exported file name to be variable based on a Factor Value, the Date and Time, or typed in text. This option allows you to select what the final file name will be at export time.

If you know what you want for a file name, you can manually edit the text into the lower textbox. At Export time, this name is used for the export file name. Using the list, select the item(s) you want and click the **Add** button. Continue adding until you have the name you need. Remember, you can type in the list of variables too!

12.2.3 Table Name

If the chosen export output format is Access, Access 2000, or any of the Excel versions, then this area becomes active. You have the opportunity to choose the name of the table of an Access database or the sheet name of an Excel spreadsheet. The choices for naming are:

Use Part Name as Table Name

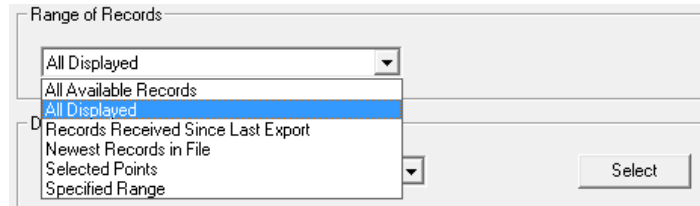
QC-CALC will use the name of your part as the table name.

Specify table name

Type a specific name of your choice. Some characters are not allowed in Access or Excel, and they will be automatically replaced with the underscore character. This will not interfere with your exporting in any way, just keep this in mind if your file name is different from what you typed.

12.2.4 Range of Records to Export

You can adjust the amount of data to export using four different options. Controlling the amount of data is important so read these options carefully.



All Available Records

Every record for the active part is sent to Excel. This can be a very large amount and may exceed the capabilities of Excel so do not choose this option with large amounts of data.

All Displayed

In this case, the number of points in each plot determines how much data is exported. This is controlled by **Number of Parts to Plot** which is set in **Tools – Options – Configure Plots – Items to Show**, and allowing 3 to 100 points to be plotted.

If the Real-Time **Subgroup Size** is set to 1 then one point equals one part. However, if the Real-Time Subgroup Size is set to 2 and you are showing 10 points, then all 20 parts currently being displayed are exported. Deleted records are not displayed, and will therefore not affect the exported range.

Records Received Since Last Export

When you manually export data, QC-CALC saves the last record number exported. When this export option is used, QC-CALC uses this saved value to mark the beginning of the next export. All records received since this mark will be exported. This can be useful if something goes wrong during an export. The missed records will be picked up on the next successful export. Any deleted records will be ignored.

Newest Records in File

This option starts at the newest record (last written record) and counts backward until the Xth value is found. This is the set of record numbers that are exported.

Selected Points

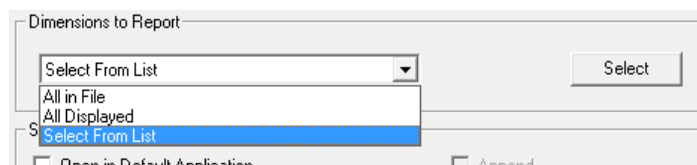
(Manual Export only) - When you highlight points within a plot using the mouse (left click drag) QC-CALC remembers which points you chose and uses these records as it's range to export.

Specified Range

(Manual Export only) - This option allows any range of records to be exported by entering the beginning record number in the first box and the ending record number in the second box. All non-deleted records between these two numbers are exported with all deleted ones being ignored.

12.2.5 Dimensions to Export

You can adjust which features in the file to export thereby skipping selected dimensions. Controlling which dimensions is done in three ways.



All in File

Every dimension in the active part is exported.

All Displayed

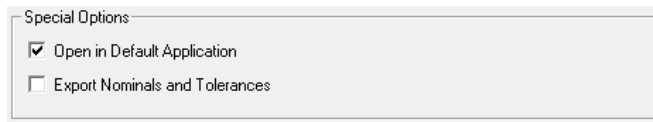
The **View – Dimension Filter** controls number of plots on the screen. When you reduce the plot number to the desired amount you will find only those dimensions in your exported file.

Select from List

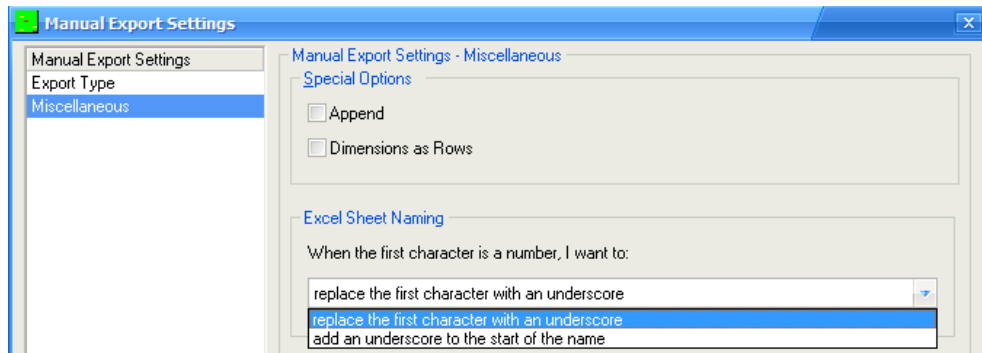
The **Select** button provides a simple method of reducing the number of dimensions exported.

12.2.6 Special Options**Open in Default Application**

When this option is enabled not only will QC-CALC export the file to your desired location, but it will also launch the application needed to run the file type that you specified.

**Export Nominals and Tolerances**

This option is available only for Excel and Access export types. It causes the first three rows of a new table to be filled with the Nominal, Plus Tolerance, and Minus Tolerance of each dimension.

12.3 Miscellaneous**12.3.1 Special Options****Append**

The **Append** check box is available only when ASCII text file is selected as the **Export Format**. When checked, all data is exported to your chosen file and is added to the end of the existing file (appended).

Note: If this option is not selected and an export occurs, the existing data in the output file is overwritten.

Dimensions as Rows

The check box labeled **Dimensions as Rows** applies only to Microsoft Access or Excel export formats and will be ignored if any other export formats are selected. This is an option to export the data sideways, with record numbers as the columns and dimensions as the rows. This was created for files containing more than 255 dimensions which is the column limit in an Excel spreadsheet or Access table.

12.3.2 Excel Sheet Naming

Excel is very particular about the names given to Sheets when they are being automatically created. For example Sheet names cannot start with a number. Previously QC-CALC handled this by replacing the first character (if it was a number) with an underscore (_). You now have the choice of continuing to replace the first character with an underscore, or you can have an underscore added before that first character instead. Using the 2nd option leaves your original name intact, but for backwards compatibility replacing the first character is the default value for this option.

Exercises

Complete the following exercises to become familiar with Exporting:

Exercise 1 – Export all of the parts and all of the dimensions in MyPart 10 to Excel

1. Select **Export – Export Data**
2. Select an **Export Type** of **Excel 97/2000/2002**
3. Press the **Browse** button and select your Desktop and enter a file name of **Junk.xls**
4. Pick **Last Records in File** and enter 12 for the value
5. Press the **Export** button
6. Now open the Excel file to see your data

Exercise 2 – Export the last 5 parts and first 5 dimensions to Excel

1. Select **View – Dimensions Filter**
2. Click on **(Choose from list...)**
3. Select the first 5 features
4. Press **OK**
5. Select **Export – Export Data**
6. Select an **Export Type** of **Excel 97/2000/2002**
7. Press the **Browse** button and select your Desktop and enter a file name of **Junk2.xls**
8. Pick **Last Records in File** and enter 5 for the value
9. Press the **Export** button
10. Now open the Excel file to see your data

Exercise 3 – Export the last 5 parts and all dimensions to Excel but change the Table name to My Table, and export the nominal and tolerances

1. Select **Export – Export Data**
2. Select an **Export Type** of **Excel 97/2000/2002**
3. Press the **Browse** button and select your Desktop and enter a file name of **Junk3.xls**
4. Pick **Last Records in File** and enter 5 for the value
5. Press the **Advanced** button
 - a. Select **Specify Table Name** and enter **My Table**
 - b. In the **Dimensions to Export** frame choose **All in File**
 - c. In the **Special Options** select **Export Nominals and Tolerances**
6. Press the **Export** button
7. Now open the Excel file to see your data

Exercises

Complete the following exercises to become familiar with Advanced Exporting.

Exercise 1

Export all of the parts and all of the dimensions in MyPart 10 to an Excel called Junk.xls but this time change the sheet name to **All Data** and include the Nominals and Tolerances.

1. Select **Export – Export Data**
2. Select an **Export Type** of **Excel 97/2000/2002**
3. Press the **Browse** button and select your Desktop and enter a file name of **Junk.xls**
4. Pick **Last Records in File** and enter 12 for the value
5. Press the **Advanced** button
6. Click **Specify table name** and type **All Data**
7. Select the **Export Nominals & Tolerances** checkbox
8. Press the **Export** button
9. Now open the Excel file to find your data

Exercise 2

In this exercise use the special **Records Received Since Last Export** for the range of data to export. Export the data to a file called **Every Five Parts**. Each time we export data, only the data since last export is sent to the Excel file. The new data is appended to the old. Using this method ensures you don't export the same data twice and you don't forget to export certain parts.

1. Select **Export – Export Data**
2. Select an **Export Type** of **Excel 97/2000/2002**
3. Press the **Browse** button and select your Desktop and enter a file name of **Every Five Parts.xls**
4. Pick **Records Received Since Last Export**
5. Press the **Advanced** button
6. Click **Specify table name** and type **Raw Data**
7. Select the **Export Nominals & Tolerances** checkbox
8. Press the **Export** button
9. Now open the Excel file to find your data

Exercise 3

Continue exercise 2 by using the Training CMM to inspect 3 more parts and export the new data to the same file.

1. Select menu **Export – Export Data**
2. Press the **Export** button
3. Now open the Excel file and verify the amount of data in the table was increased by 3 records.

13. Exporting (Automatic)

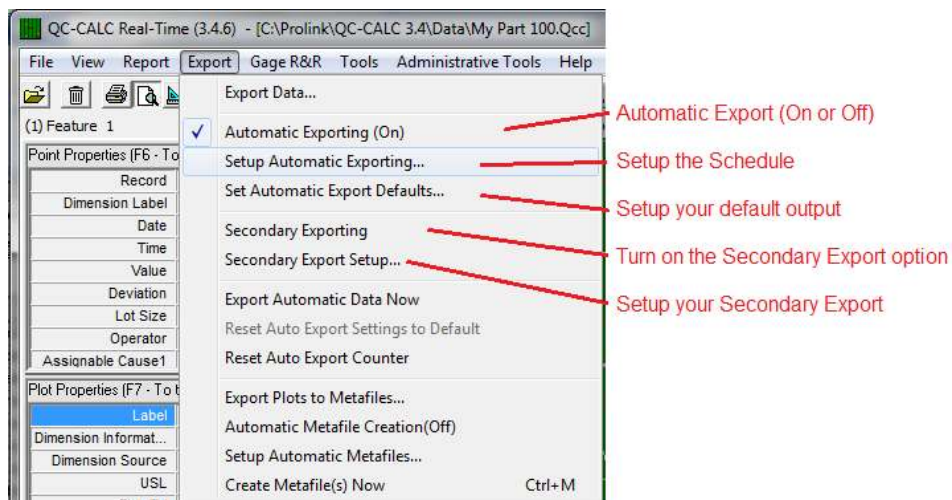
13.1 Introduction

Besides manually exporting data discussed in the previous section, QC-CALC can export data automatically. With automatic exporting you setup what and when to export and then turn-on the automatic facility. Everything you learned in the previous section on exporting apply in this section so we only discuss the automatic portion of the “when-to-export”. The automatic export option is made up of four separate functions which include:

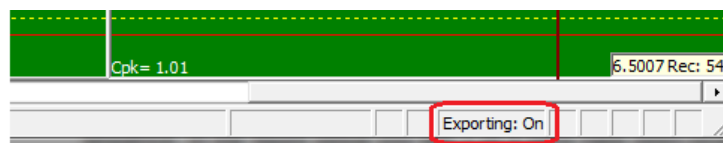
Function	Action	Discussed
What	export Types	Export Types pg. 57
Which	file to output to	Select Path and File Name pg. 58
How	much data to include?	Range of Records to Export pg. 59
When	to trigger the export?	here
Options	special options	here
Defaults	apply to all parts	here

13.2 Automatic Exporting (On)

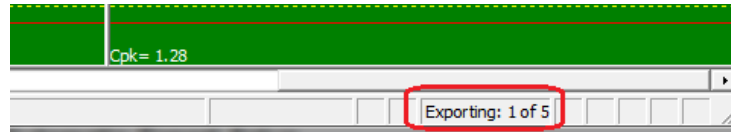
The first thing to do is turn on the automatic exporting by selecting the **Export – Automatic Exporting (Off)** menu. Its caption switches from **(Off)** to **(On)**. This menu item enables or disables the **Automatic Exports**. Once you select this menu item it becomes “checked” showing you that automatic export is enabled. Selecting this menu again turns Automatic Exports off and the check disappears.



When the Automatic Exporting is ON (checked), QC-CALC obeys the schedule you setup in **Setup Automatic Exporting...** For example, if you setup an export to Excel every 5 parts a counter is displayed in the lower tray indicating you have enable the automatic exporting system and a count begins to show your current status.



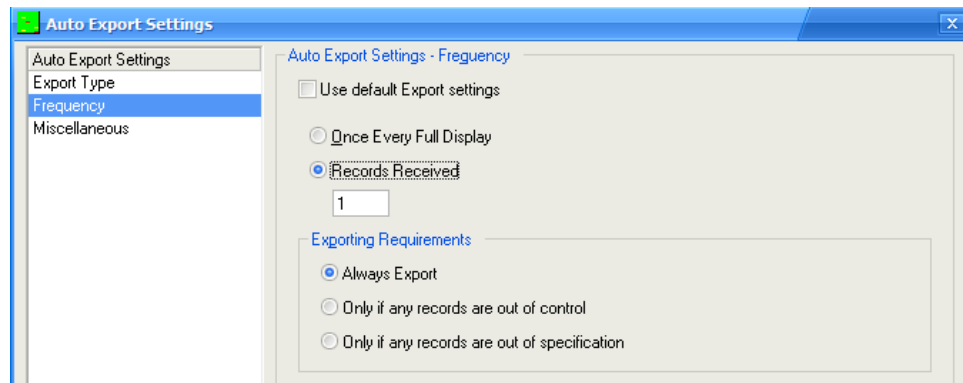
After the first part is received, you see the message change from **Exporting: On** to **Exporting: 1 of 5** and the counter displays your current count in the sequence. In the figure below you see 1 of 5 parts have been received and QC-CALC needs four more parts before the export occurs.



When enough parts have been received and the counter reads (5 of 5) the export has occurred and is completed.

13.3 Setup Automatic Export

When you decide to use **Automatic Exports** for a part you are inspecting, you must setup or edit a configuration screen to tell QC-CALC what to do. You do this by choosing **Export – Setup Automatic Exporting...** and the configuration screen appears asking you to setup the schedule. The **Frequency** menu is discussed here, but you can see the [Export Types](#) information on page 57.



13.3.1 Frequency of Exporting

The **Frequency** page deals with how often an export occurs.

Once Every Full Display

The **Number Of Parts to Plot** is set in **Tools – Options – Configure Plot Settings – Items to Show**, which allows you to plot 3 – 100 points. It is this value that is used to determine how often to export. You set the number of points to be displayed and how many points to export in the output file.

If the Real-Time Subgroup Size is set to 1 then one point equals one part. However, if the Real-Time Subgroup Size is set to 2 and you are showing 10 points then 20 parts must be received before the export occurs.

Records Received

This option is simply used to trigger an export after every X number of parts are received. The Subgroup Size has no effect on this option.

Export Requirements

This option allows you to **Always Export** the data or only if a problem occurs. For example, if you want to export the data to Excel when a Control Limit is exceeded choose the **Only if any records are out of control** option. If you want to export if a Tolerance Limit is exceeded, choose **Only if any records are out of specification**.

When the export is triggered, QC-CALC will check to see if an exception occurred. The export will only happen if an exception occurred among the X New Records received.

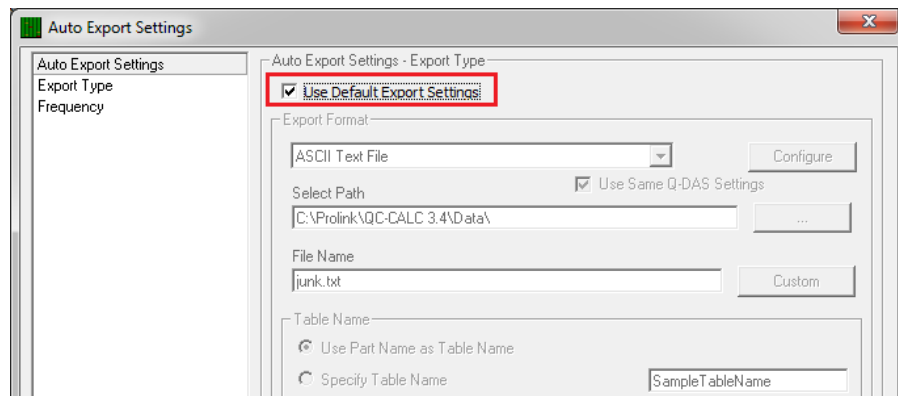
13.4 Secondary Exporting

There are times when you need your inspection data exported to multiple formats. The secondary exporting is setup the same as the primary export but they both share the same trigger. This means the secondary export will occur based at the same frequency you set for the primary export. You will note the **Frequency of Exporting** is missing because it is not used.

13.5 Set Automatic Export Defaults

13.5.1 Introduction

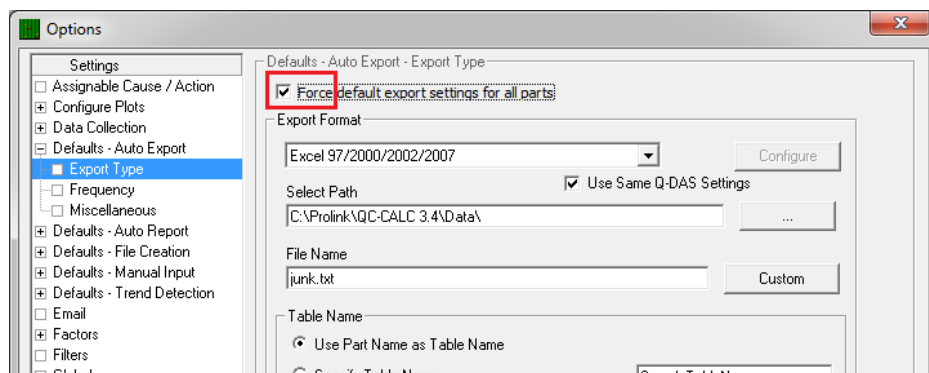
When a new .qcc file is created, the settings in the **Export – Set up Automatic Exports Defaults** area are used until changes are made. When changing the Auto Export Settings for a new .qcc file the **Use Default Export Settings** option will be checked. If this option is unchecked the default values for all setting will be shown and those settings can be changed to whatever is required for that specific .qcc file. These settings will be for the currently open .qcc file only. This will not change the default values in any way.



Full descriptions of the settings in the **Export – Set up Automatic Exports Defaults** area can be found in the [Exporting](#) section on page 57 and the [Setup Automatic Export](#) section on page 64.



Note: The **Force Export default setting for all parts** checkbox in the **Export – Set up Automatic Exports Defaults** area overrides all automatic settings for all parts. This creates 1 global export for all parts.



13.6 Export Data Now

After you have established an export schedule and parts are being received, you may want to export the data early. For example, if you setup an export schedule to export an Excel output every 10 parts and want to export the data after receiving only 7 parts, simply choose this menu option. If you need to generate an export on older data, use the method discussed earlier in this section.

13.7 Reset Auto Export Counter

This feature allows you to reset the count of your Automatic Exporting. This means the export will not occur until the full count is repeated. For example, let's assume you setup a schedule to export after 5 parts are received. After collecting two parts with Automatic Exporting turned on, you chose to reset the counter, the count would be cleared and start over. In this example it would take 7 parts to be received before an export occurs.

Exercises

Complete the following exercise to become familiar with Advanced Automatic Export.

Exercise 1

In this exercise use the special **Records Received Since Last Export** for the range of data to export. Export the data to a file called **Every Five Parts** and add **Use Part Name, Date and Time** to the file name for each export. Each time the automatic export occurs, a new file is created with the date and time added to the name.

1. Select menu **Export – Export Data**
2. Select an **Export Type** of **Excel 97/2000/2002**
3. Press the **Browse** button and select your Desktop and enter a file name of **My Five Parts.xls**
4. Pick **Records Received Since Last Export**
5. Select **New Records Received** for the Frequency and enter 3
6. Press the **Advanced** button
7. Press the **OK** button
8. Inspect 3 parts with your Training CMM and open the new Excel file to find your data. The file name should include the date and time.

14. Filtering Data

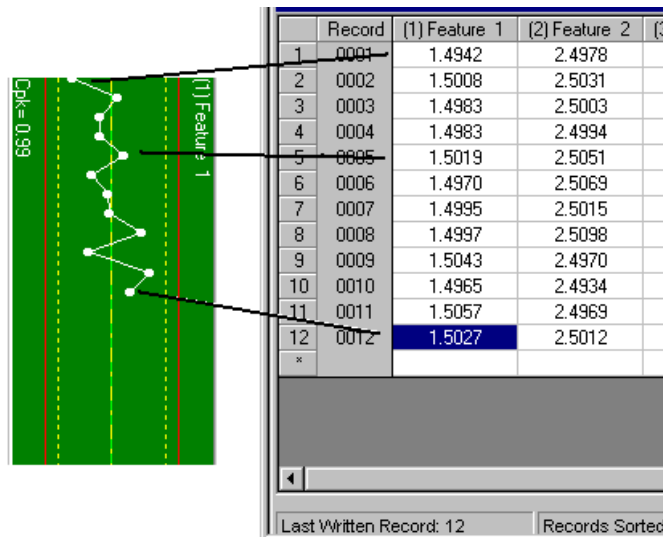
14.1 Introduction

QC-CALC can reduce the amount of data you see by removing records (parts) or removing plots (features) or both. Collectively this is known as filtering data. Reducing the number of plots is useful to show only the critical or important features thereby creating less confusion for you. By reducing the number of records (parts) you can separate parts made by the same machine, cavity number, operator, etc. This session discusses the manual and automatic methods of reducing data so you can quickly identify problems.

- Dimension Filter use to reduce the number of plots
- Record Filter use to reduce the number of records within the plots

14.2 The Data Layout

QC-CALC uses an easy to understand method of storing your inspection results. The database looks similar to a spreadsheet where each row is a part made up of many columns of features. Using the data we just created, picture in your mind the Real-Time plot data as a grid. The data would be displayed as 12 rows (parts) of 10 columns (dimensions). Each real-time plot is a column so QC-CALC calculates and displays everything within a column since this is the same feature across many parts. Here we rotated the Real-Time Plot clockwise and placed it next to the column of data to show you how the data is stored and plotted.




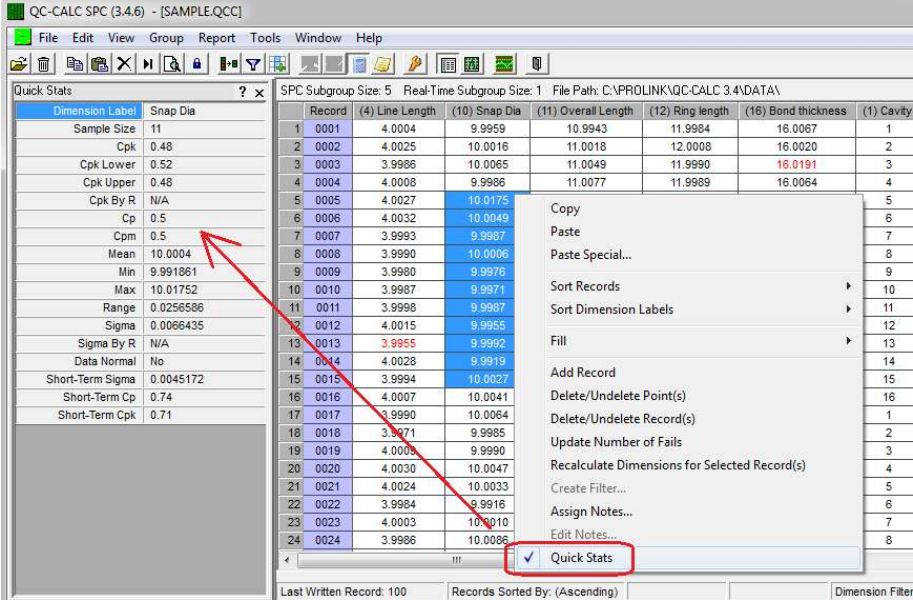
In this session we discuss how to filter data manually but remember QC-CALC can automatically filter data for you to help identify problems. For example, you might want QC-CALC to show all plots (features) having a Cpk of less than 1.33. Or you might want QC-CALC to show you which cavity or machine number is causing this low value. This is considered an advanced topic and is discussed in the [Record Filters - Details](#) on page [157](#).

14.3 Viewing the Data Grid

You can see this data layout by starting **QC-CALC SPC**. QC-CALC SPC is the second half of QC-CALC and you may not have purchased the SPC license. However, we'll digress for a moment to display QC-CALC SPC to you.

Exercise

1. Select the **File – Show QC-CALC SPC** menu or the  button and the other half of QC-CALC is launched.
2. Notice the data layout shows each feature in a separate column.
3. Using the mouse left click and drag down column 1 (Feature 1) highlighting the data
4. Right click the mouse and select **Quick Stats**
5. The **Quick Stats** window is displayed on left side in the information section



The screenshot shows the QC-CALC SPC (3.4.6) software interface. The main window displays a data grid with the following columns: Record, (4) Line Length, (10) Snap Dia, (11) Overall Length, (12) Ring length, (16) Bond thickness, and (1) Cavity. The data grid contains 24 records. A context menu is open over the data grid, with 'Quick Stats' highlighted. A red arrow points from the 'Quick Stats' menu item to the 'Quick Stats' window on the left side of the interface.

Record	(4) Line Length	(10) Snap Dia	(11) Overall Length	(12) Ring length	(16) Bond thickness	(1) Cavity	
1	0001	4.0004	9.9959	10.9943	11.9984	16.0067	1
2	0002	4.0025	10.0016	11.0018	12.0008	16.0020	2
3	0003	3.9986	10.0065	11.0049	11.9990	16.0191	3
4	0004	4.0008	9.9996	11.0077	11.9989	16.0064	4
5	0005	4.0027	10.0175				5
6	0006	4.0032	10.0049				6
7	0007	3.9993	9.9987				7
8	0008	3.9990	10.0006				8
9	0009	3.9980	9.9976				9
10	0010	3.9987	9.9971				10
11	0011	3.9998	9.9987				11
12	0012	4.0015	9.9955				12
13	0013	3.9955	9.9992				13
14	0014	4.0028	9.9919				14
15	0015	3.9994	10.0027				15
16	0016	4.0007	10.0041				16
17	0017	3.9990	10.0064				1
18	0018	3.9971	9.9985				2
19	0019	4.0000	9.9990				3
20	0020	4.0030	10.0047				4
21	0021	4.0024	10.0033				5
22	0022	3.9984	9.9916				6
23	0023	4.0003	10.0010				7
24	0024	3.9986	10.0086				8

6. Select **File – Exit** to shutdown QC-CALC SPC

14.4 Conclusion

The purpose of this exercise is to familiarize you with the format of your stored data. By using the Quick Stats window we show how QC-CALC uses all numbers in a column.

The data layout is important to understand. Many customers have hundreds of features per part and thousands of parts. The goal of filtering data is to reduce the number of rows (parts) and the number of columns (features) to a manageable number. Most people must identify problems as quickly as possible and filtering does this for you. The next two sections discuss the two filter methods. We will now return to QC-CALC Real-Time.


14.5 Dimensions to Plot

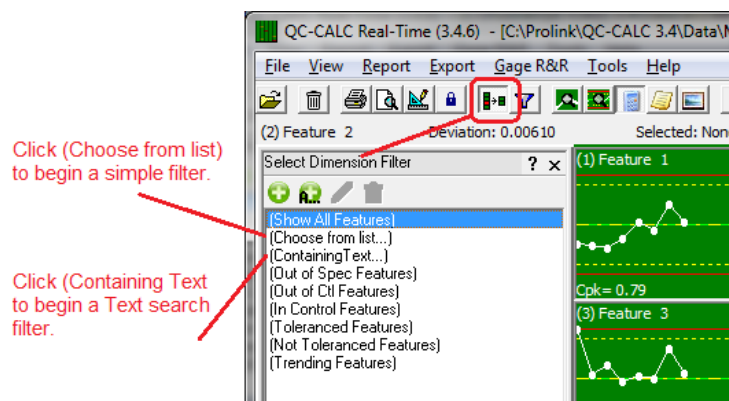
14.5.1 Introduction (Static List)

To reduce the number of plots displayed (dimensions) QC-CALC uses the concept of a dimension filter. This is a manual operation where you choose the dimensions you wish to display from a list. The list of dimensions was generated from your part program. You highlight the ones you want to see and click OK.

When you are inspecting parts on your CMM, QC-CALC Real-Time automatically saves your data assuming you want to see all dimensions. Therefore, all dimensions are selected by default. Clicking on a filter name in the list activates the highlighted filter and changes what plots you see to the right side because the filter is instantly applied.

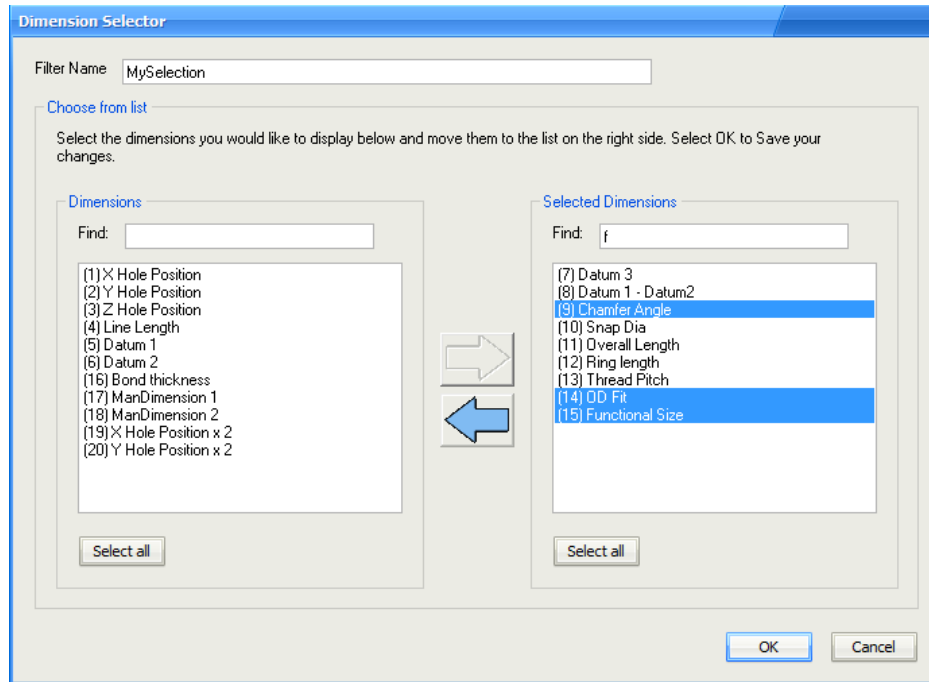
14.5.2 Display the Filter

To view the dimension filter, choose menu **View – Dimension Filter** or click the  button. The Dimension Filter panel is displayed in the **Information Panel** area and the plots are pushed to the right. You can add, change, and delete your own filters but there are permanent filters you cannot remove. When you create a new filter, you give it a name and it is added to the bottom of the list. Your custom filters are editable by clicking on the pencil and are deleted using the trash can.



Choose from List

The **(Choose from List...)** filter is a static list of dimensions that you select with the mouse. The **Dimension Selector** is displayed showing all the feature names in the file and the features are easily chosen using a combination of the CTRL and SHIFT keys with the mouse. Click **OK** to display only the highlighted dimensions and automatically save the Dimension Filter using the name shown in the **Selection Name** area. **Note:** Data is still collected for the dimensions that are not displayed.



The **Find** boxes at the top of each column aid the selection process when a large number of dimensions exist. Selecting dimensions becomes difficult when your part program has more than 100 dimensions. Consider how difficult it would be to pick and choose 3000 dimensions from the list.

The **Find** boxes provide a label search capability that helps speed up the selection process. All dimensions that you move to the right panel will be displayed. By default QC-CALC selects all features to display so you will see all dimensions in the right panel when this selector is first displayed.

For example, suppose you have 200 dimensions in a QC-CALC file and you want to quickly find and remove all dimensions containing the letter **F** in the label. Type the “f” in the right **Find** box and instantly all labels containing an F are highlighted as shown above. The large left arrow becomes enabled allowing you to remove the highlighted dimensions from the **Selected Dimensions** list and put them back into the column on the left.

You can type as many letters as needed to reduce the selection. You can move features back and forth to get just the right selection. Click **OK** when you have finished and the **Filter Name** shown at the top of the screen will be used to save your selections.


TIP: You can move dimensions back and forth by highlighting items in both sides and clicking the appropriate arrow. You can press and hold the CTRL key to highlight / un-highlight selected dimensions by clicking the mouse on the dimensions of interest. If your list is long you may not see all of the selected dimensions but understand they are selected even when out of sight.

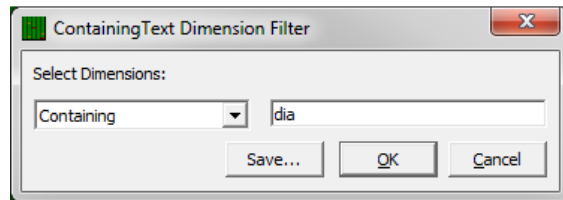
14.5.3 Introduction (Dynamic List)

(Containing Text)

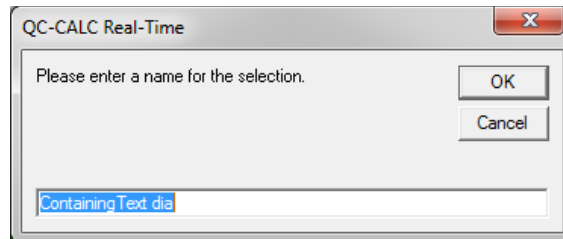
When you use **Choose from List** you are choosing a static list of dimension numbers that do not change across part files. The **Containing Text** filter is dynamic and is re-applied when you open another QC-CALC file. In other words, if you want QC-CALC to display all dimension labels that contain the letters TP no matter where they are positioned in the list, use the **Containing Text** filter.

For example, let's assume your dimension labels for all **true position** dimensions always end with the letters "TP" or maybe you use "PC" for all **process critical** dimensions. If this is the case, you can quickly create a dimension filter for your file by using the **Containing Text** option.

Click on the words **(Containing Text)** or click the  button and you are asked to enter the search characters. **Dia** was entered into the text box to be used as a filter. If you press the **OK** button your filter is used.



Click **Save...** and enter a filter name to add this to the list of Dimension Filters available to use.



(Out of Spec)

This built-in dimension filter (dynamic) shows the dimensions that are out of specification (the Red plots). As inspection occurs, this filter will continue to change the display since the next part may or may not have any features out of specification.

(Out of Control)

This built-in dimension filter shows the dimensions that are out of control and out of specification (the Yellow and Red plots). During Real-Time data collection the number of plots will change depending on their condition.

(In Control)

This built-in dimension filter shows the dimensions that are in control (the Green plots). To see all plots containing only in-control plots, click on the **In Control** filter. This hides any and all out of control and out of spec dimensions.

(Not Toleranced)

This filter shows only the plots that do not contain tolerance values. If your part program contains non-toleranced features, QC-CALC plots the raw data but does not show any tolerance or control lines. If you have a large amount of plots and wish to hide the non-toleranced features you can click on the dimension filter labeled **Toleranced Features Only**. The non-toleranced plots are removed from the screen and all data is collected.



Note: Just because the filtered plots are not shown does not mean data collection has halted for these invisible plots. All data collection continues for all dimensions, we have only reduced what you see.

(Toleranced)

This filter shows the plots having tolerance information and therefore has red and yellow lines representing the values. These are the normal plots you would expect to see.

(Trending)


QC-CALC can show you only dimensions that contain a trend, but **Trend Detection** must be enabled. If you enabled the Real-Time trend detection and want to see just the dimensions containing the trends you requested, click on the **Trend** label. Trend detection is discussed later in this manual.

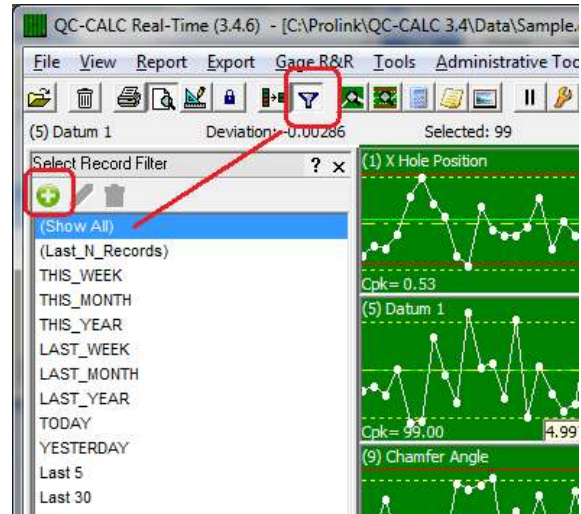
14.6 Record Filters

14.6.1 Introduction

The record filter is used to reduce the number of parts shown in the plots. By reducing the number of records you can group parts made within a week, by machine number, cavity number, operator, etc. This session discusses the manual and automatic methods of reducing data helping you quickly identify problems.

14.6.2 Display the Record Filter

The record filter is displayed by selecting the **View – Record Filter** menu or clicking the  button. The top of the list may contain predefined filters denoted in parentheses and are not editable. The **Show All** is one such filter and selecting it removes any active filter.




14.6.3 Use the Record Filter

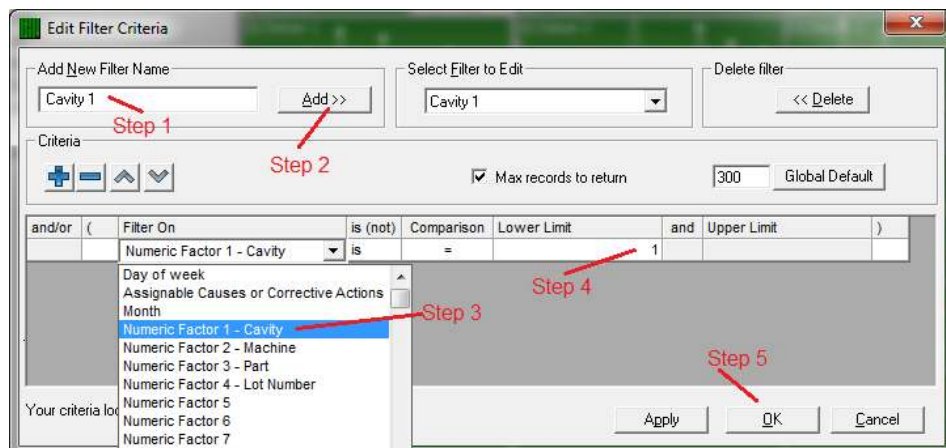
Several date oriented filters are provided to help you quickly reduce the viewed data to THIS_WEEK or LAST_WEEK. Using these built-in filters reduces the time spent creating filter of exact dates.

In other words, the result of these filters changes each week since our calendar is constantly changing. Clicking on any filter name instantly activates that particular filter.

14.6.4 Creating a Record Filter

You can create your own record filter by clicking on the  button. The filter editor is displayed. You can display the same filter by choosing **Tools – Options – Filter Settings** and click the **Edit File** button. Click **OK** to save your filter. Here are the steps to create a filter to show all parts made in Cavity 1.

1. Enter **Cavity 1** in the **Add New Filter Name**
2. Click **Add >>** button
3. In the **Filter On** textbox select Cavity
4. In the **Lower Limit** type 1



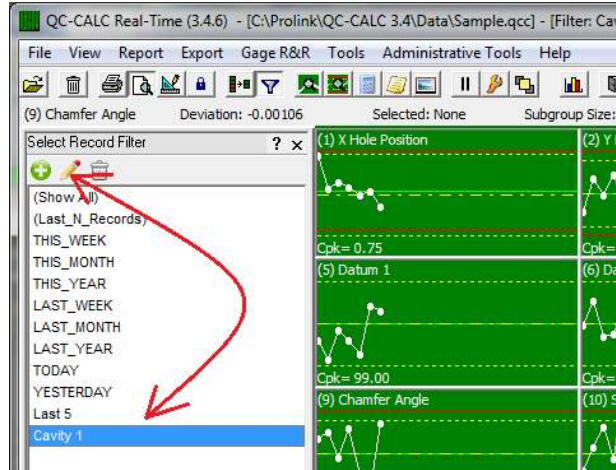
Press the **OK** button to return to the QC-CALC Real-Time screen and your new **Cavity 1** filter is displayed at the bottom of the list.

14.6.5 Edit the Record Filter

The pencil icon is now enabled and is used to edit filters. By clicking on the pencil the record filter editor is displayed again and you can change what you need in the same way you created the filter.

14.6.6 Delete Record Filters

Likewise, the trash can is also enabled and clicking it will delete the currently selected filter. Be careful since there is no confirmation on this action.



Note: When using filters, if no data matches your selected filter criteria all the plots will disappear and you'll see a message stating, **"No records passed the record filter criteria"**. In our example, clicking on **THIS_WEEK**, **THIS_MONTH**, or **THIS_YEAR** should not change the display since all displayed data passes these filters. However, if you select **LAST_WEEK**, **LAST_MONTH**, or **LAST_YEAR** no records are seen.



You should use very clear names on all filters since these names appear in the printed reports making it easy to identify the conditions when the report was created. You can use any characters in your filter name.

14.7 Molds and Cavities

A special section found in the appendix is dedicated to setting up and dealing with inspection data related to the molding industry. The lessons learned in this special section can be applied to any industry and most readers will understand how to translate the concept from cavities to their particular industry.

Complete the following exercises to become familiar with the record filter. You will use the **Training CMM** software to generate the results

Exercises


Exercise 1

Using the **Training CMM**, change the Lot number to 23 and add 5 data records to your QC-CALC file by clicking the **Inspect** button.

1. Find the **Training CMM** and change the Lot number to 23.
2. Now click the **Inspect** button 5 times.
3. Your plots are updated automatically with the new data.

Exercise 2

Create a new record filter for all parts made with **Lot = 23**

1. Be sure the record filter is displayed by clicking the **Filter**  button
2. Select no filter by choosing **(Show All)** found at the top of the filter list.
3. Click the **Add** filter button  found at the top of the record filter list.
4. The record filter editor is displayed.
5. Enter a label of **Lot 23** and click the **Add** button.

6. Click the mouse in the **Filter On** column and select Numeric Factor 1 – Lot.
7. Now enter a value of **23** in the Lower Limit.
8. Press **OK**.
9. Your new filter (Lot 23) is displayed in the filter list.
10. Click on this filter and watch the data be reduced to the last 5 records.



Exercise 3

Using the Training CMM:

1. Add **Operator** as the second Factor with a value of **Joe**.
2. Change **Lot** to **22**.
3. Add 5 data records to your QC-CALC file by clicking **Inspect**.

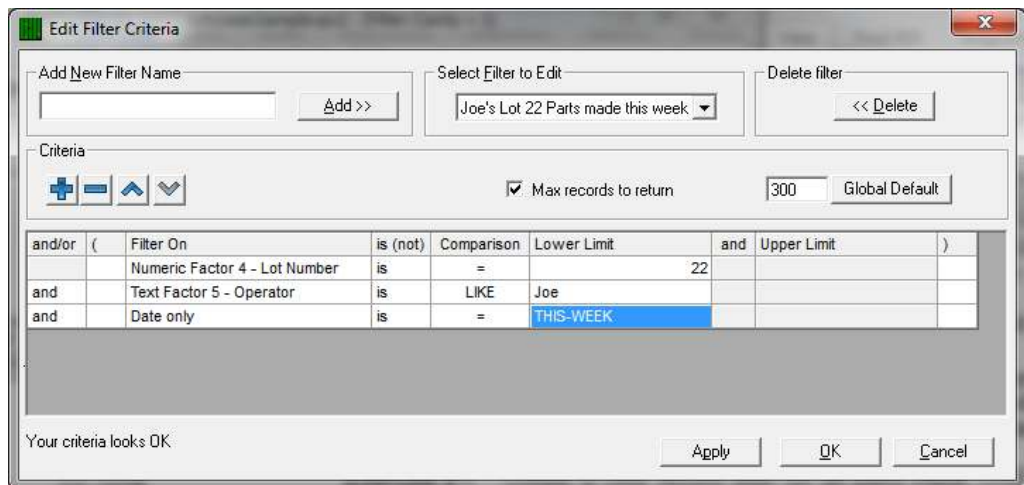
Exercise 4

Create a new record filter for all parts made with Lot = 22 and Operator = Joe.

1. Be sure the record filter is displayed by clicking the **Filter**  button.
2. Select no filter by choosing **(Show All)**.
3. **Click** the **Add** filter button  found at the top of the record filter list.
4. The record editor is displayed.
5. Enter a label of **Joe's Lot 22 Data** and click the **Add** button.
6. Click the mouse in the **Filter On** column and select Numeric Factor 1 – Lot.
7. Now enter a value of **22** in the Lower Limit.
8. Press **Append** which adds another line to the filter.
9. Click the mouse in the **Filter On** column and select Text Factor 1 – Operator.
10. Now enter a value of **Joe** in the Lower Limit.
11. Click **OK**.
12. Your new filter (Joe's Lot 22 Data) is displayed in the filter list.
13. Click on this filter and watch the data be reduced to the last 5 records.
14. Try clicking on other filters to see the live data change.

Exercise 5

Create a new record filter for all parts made THIS-WEEK, with Lot = 22 and Operator = Joe. Call the filter **Joe's Lot 22 Parts made This Week**. Here is a picture of your filter. Use the **Append** button to add more criteria.



For a more in-depth discussion of record filters, please see [Record Filters - Details](#) on page [157](#).

15. Calculate Limits

15.1 Introduction

There are several locations where QC-CALC calculates the control limits as well as other limits. Each area is summarized in this section to help you identify the best method of achieving the limits you expect under the conditions you want. QC-CALC can make these calculations for you either manually or automatically and on one dimension or on all dimensions.

We have concentrated a great deal of effort in the Real-Time data collection portion of QC-CALC to provide a fully automatic system for you. As such, many options have been added to provide flexibility for every situation. If you are monitoring 20 or more part features you begin to appreciate the power of QC-CALC's ability to calculate and save hundreds and thousands of control limits in an instant.

15.2 How are the Limits Calculated?

Sigma is the basis of all limits. When the subgroup size is set to 1, QC-CALC cannot calculate sigma using the Rbar / d2 equation since the Rbar is zero. If the Real-Time subgroup size is set to 1 (raw data) the sigma calculation is different from all other subgroup sizes (2 – 25) and is based on the following calculations:

Equation for Subgroup = 1

$$\sigma = \sqrt{\left(\frac{1}{n-1}\right) \sum_{i=1}^n (X_i - \bar{X})^2}$$

Equation for Subgroup > 1

$$\sigma = \frac{\bar{R}}{d_2}$$

After calculating sigma, the control limits are then calculated as usual and are listed here for completeness:

$$UCL = \bar{X} + 3\sigma$$

$$LCL = \bar{X} - 3\sigma$$

Note: The sigma multiplier is assumed to be 3. See next section discussing what the multiplier is.

15.3 Sigma Multiplier

15.3.1 Control Limits

You enter a scaling multiplier for calculating new control limits based on this number multiplied by the standard deviation (sigma) of the visible data. When calculating control limits this multiplier is normally set to 3. However, QC-CALC gives you the ability to enter different values for the multiplier. This multiplier is found in **Tools – Options – Statistical Settings – Sigma Multiplier – Control Limits**.

15.3.2 Tolerance Limits

Normally, you know the tolerance values for any given feature. If you would like to calculate what the tolerance values need to be to obtain a 6 sigma spread, enter a 6 for the multiplier. When you select **Calculated Limits**, QC-CALC calculates the standard deviation of the data, multiplies this result by **Sigma Multiplier for Tolerances**, and uses this value to draw the red specification limits. The top and bottom of each plot is scaled to 150% of these two new specification numbers.

15.4 What Limits are Calculated?

Before continuing we must establish what we mean by Calculate Limits. QC-CALC can calculate more than Control Limits. Select menus **Tools – Options –**

Statistical Settings and you see what limits are available for re-calculation in the upper right corner of the screen. By default QC-CALC selects the Upper and Lower Control Limits, Mean, and Sigma zones to be calculated. Whenever you request QC-CALC to calculate limits, all limits checked in this list are calculated.

Items to Calculate	
<input checked="" type="checkbox"/>	Upper Control Limit
<input checked="" type="checkbox"/>	Mean
<input checked="" type="checkbox"/>	Lower Control Limit
<input type="checkbox"/>	Upper Spec Limits
<input type="checkbox"/>	Nominal
<input type="checkbox"/>	Lower Spec Limits
<input checked="" type="checkbox"/>	Sigma Zones

15.5 Calculating vs. Saving Limits

We divide the process of calculating and saving limits into two separate actions. QC-CALC calculates and displays new limits in the live plots but this action does not overwrite the previously saved limits unless you choose to save the new values. The saved limits are usually the values written to the database for each feature when the file is created. As time goes by and many parts are saved in the database you may wish to calculate and save new Control Limits, Mean, Sigma Zones, etc.

15.6 How to Calculate Limits

There are 3 different methods you can choose to calculate the limits in QC-CALC Real-Time. You can:

1. **Manually** Calculate Limits on **One Plot** (right click on a plot)
2. **Manually** Calculate Limits on **All Plots** (menu selection)
3. **Automatically** Calculate Limits on **All Plots** (menu selection)

There are 2 different methods to save the calculated values.

1. **Save** Calculate Limits on **One Plot** (right click on a plot)
2. **Save** Calculate Limits on **All Plots** (menu selection)

15.6.1 Manually Calculate Limits on One Plot

The Real-Time Plot screen can contains 1 – 1200 live plots. Right click the mouse on any plot and choose the **Calculate Limits** menu. The Limits are calculated and the plot lines are redrawn. These new lines represent the new limits of the visible data in the plot you just clicked. If you want to save these limits you can right-click the same plot again and choose **Save Calculated Limits**. You are prompted with an **Are You Sure?** dialog box since the database values will be overwritten with these new values. If you do not save these new limits you can restore your previous values by right-clicking on the plot, select **Calculate Limits** and your original values reappear. If you saved new limits, both calculated and saved limits are the same at this moment in time.



Note: If this menu is grayed out it means the **Tools – Calculate Limits** is already turned on for all plots. Turn it off to activate this menu.

15.6.2 Calculate Limits for All Plots

When you select **Tools – Options – Calculate Limits** every visible plot is suddenly updated with new limits and the menu becomes “checked”. The limits you selected in the Settings window shown above are the limits you will see change. These new limits are temporarily frozen and do not update. They are not saved in the database unless you select **Tools – Save Calculated Limits**. Keep

in mind the calculated limits are temporarily kept in the computer's memory for display and limit testing (background color change, etc.) If you leave QC-CALC without saving the limits they are discarded and your old values are preserved.

If you leave the **Calculate Limits** menu "checked" these static values update if you make a change to the sigma multiplier. QC-CALC recognizes the **Calculate Limits** menu is on and recalculates all items using your new sigma multiplier.

To set the limits back to where they were before calculation, select menus **Options – Calculate Limits** and the menu becomes unchecked. You see your original limits return.

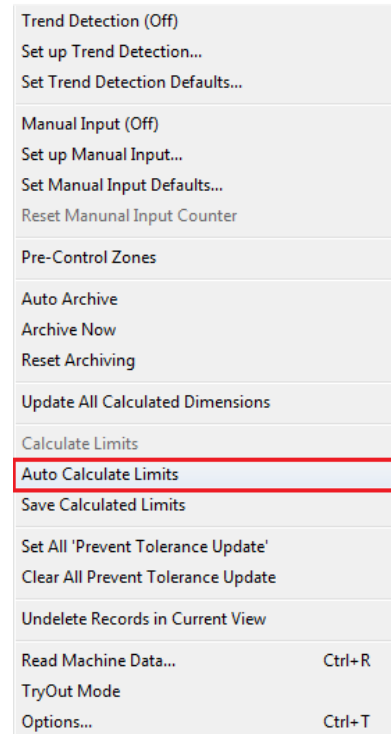


Note: You cannot save calculated limits until you calculate them! Remember, this is a two-step process.

15.6.3 Automatically Calculate Limits on All Plots

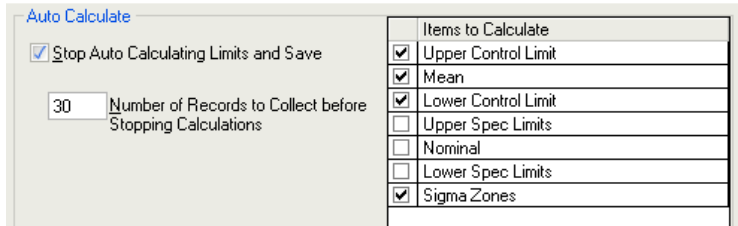
This option differs from manually calculating limits in that the limits dynamically change as new data arrives or as you scroll the plots. When the menu **Tools – Auto Calculate Limits** is on (checked), each time the screen is scrolled using the horizontal scroll bar or a new part is received, QC-CALC recalculates the limits using the visible data. The limit lines move around endlessly as each new data is added to the database.

When you use **Auto Calculate Limits** all changes take effect immediately. Remember, **Calculate Limits** is used to calculate "static" values that are "fixed" at the time you selected the option. **Automatic Calculate Limits** are dynamic and re-calculate if anything changes. Automatically switching to a new part program shuts off the Auto Calculate Limits and no values are saved.



Stop Auto Calculating Limits

The **Auto Calculate Limits** can be set to turn off automatically after a preset number of new parts have been saved to the database. This prevents the process from running forever and locks



the limits to a desired value at a desired time. Locking the Control Limits is good for comparing all new data with limits set at a time you knew the process was in-control. As shown in the figure, we set QC-CALC to stop calculating after an additional 30 parts are inspected. When 30 new parts arrive, the limits are locked and the menu for **Auto Calculate Limits** is turned off. You can scroll the plots horizontally without affecting this count. Restarting QC-CALC loses the count and it starts over when restarted. Automatically switching to a new part program shuts off the **Auto Calculate Limits** and no values are saved.

Range Control Limits

The range limits for any Real-Time plot are not valid until you calculate and optionally save them. Whether you have the range charts showing or not, when you calculate the control limits for the Real-Time plots, QC-CALC calculates the range control limits as well. If you save the limits to the database, the range limits are also saved even though they are not shown in the figure above.

Saving the Calculated Limits

QC-CALC can be set to save the limits once the automatic calculation has completed. This overwrites the values in the database with new values. Simply check the **Stop Auto Calculating Limits and Save** option to have your limits saved. This feature is particularly handy when you make a process change and want to establish new limits and not forget to save them.

15.7 Calculating Tolerance Limits

You may choose any of the limits listed to calculate but be careful not to overwrite tolerance limits that are specified by a blueprint. Calculating tolerance limits was added for customers who do not have known limits and wish QC-CALC to establish these limits by basing them on the average and standard deviation. The Sigma multiplier (for tolerance) is used to determine the new tolerance lines. For example, if QC-CALC calculates the Mean, Upper Tolerance, and Lower Tolerance, it will multiply the value of Sigma by the number shown and adds it to the Mean to determine the new Upper Tolerance.

Another nice use of this tool is for calculating “what if” tolerance values. If you are asked “What value would we need to achieve 6-sigma on this feature?” simply set the multiplier to 6 and right click and calculate the limits. If you zoom in on the plot, the new tolerances are displayed on the lines.



Note: Trend analysis is a tool used to monitor, analyze, and bring the production process to a state of control. In the formulation of trend analysis, calculated limits and sigma zones are used. The usage of the sigma lines is explained in the **Trend Detection** session that follows this session.

Exercises

Exercise 1

Set the control limit sigma multiplier to 3-sigma and calculate new control limits for 1 of your plots by using the right mouse click.

1. Check to be sure the **Tools – Calculate Limits** menu is not “checked”. If it is select, it to turn it off.
2. Select **Tools – Options** and **Statistical Settings** and set the Subgroup size to 1.
3. Change the **Sigma multiplier for Control limits** to 3.
4. Be sure only the following **Items to Calculate** are checked.
 - Upper Control Limit
 - Mean
 - Sigma Zones
 - Lower Control Limit
5. Click **OK**.
6. Now right click on Feature 1 and select **Calculate limits**. The menu becomes “checked” and the limit lines change.
7. Now right click on Feature 1 again and select **Calculate limits**. The menu becomes “unchecked” and the limit lines return to their original position.

Exercise 2

Calculate the limits again but this time save these new limits to the database.

1. Right click on the plot and select **Calculate Limits**.
2. Right click on the same plot and select **Save Calculated Limits**. Remember, this menu is not enabled if **Calculate Limits** is not checked.
3. Answer YES to the **Are you sure you want to save new limits?** question. Note how the **Calculate Limits** menu is automatically turned off and the **Save Calculate Limits** is disabled.

Exercise 3

Turn on the **Automatic Calculate Limits**. Using the **Training CMM** inspect some parts and watch the lines move as they are recalculated. This process continues endlessly. Nothing is saved to disk.

1. Select menu items **Tools – Automatic Calculate Limits**.
2. Using the **Training CMM** inspect parts and watch the lines recalculate.

Exercise 4

Turn on the **Automatic Calculate Limits** but this time set a stop point of 5 new parts. Using the **Training CMM** inspect 6 new parts and watch the lines recalculate and suddenly stop at the 5th part.

1. Select menu items **Tools – Automatic Calculate Limits**
2. **Select Tools – Options – Statistical Settings** and check **Stop Auto Calculating Limits**. Enter a 5 for **Number of Records to Collect before Stopping Calculation**.
3. Using the **Training CMM** inspect 10 parts and watch the lines recalculate up to the 5th part and then the limits lock.

Exercise 5

Set the subgroup size to 2 and calculate new control limits for all plots. Turn on the Range plots and save the limits.

1. Select **Tools – Options** and **Statistical Settings** and set the **Subgroup size** to **2**.
2. Select **View – Add Range Charts**.
3. Select menu items **Tools – Calculate Limits**.
4. Select menu items **Tools – Save Calculate Limits**.
4. Answer **YES** to the questions about **Are you sure want to save new limits?**

Exercise 6

Determine the upper and lower tolerance value to obtain a 6-sigma spread for Feature 1.

1. Select **Tools – Options** and **Statistical Settings** and set the **Subgroup size** to **1**.
2. Set the **Sigma Multiplier** for **Tolerance Limits** to **6**.
3. Right click on plot 1 (Feature 1) and select **Calculate Limits**.
4. Zoom in on Feature 1 and read the new values.

16. Trend Detection

16.1 Introduction

The trend analysis tool is used to monitor and analyze the received data for a pattern ultimately bringing the production process to a state of control. In a natural pattern, all data points are random and fall within control limits. This indicates that no abnormal, extraneous causes are working in the process and that it is in statistical control. Another characteristic of a natural pattern is fluctuations of the data points that are unsystematic and unpredictable.

QC-CALC focuses effort at detecting problems as soon as they occur which explains why the trend detection is part of the Real-Time data collection portion of the program. Realizing that many people use QC-CALC unattended, it is important to add this extra capability to ensure a trend does not go undetected. Once QC-CALC has detected a trend, the optional actions involve alerting you that a potential problem exists. These actions are consistent with QC-CALC's unattended operation mode and include:

- Highlight the trend on the plots and include text
- Print a report to paper
- Print a report to file
- Print a report to file and email it to yourself or others
- Require the operator to assign a cause and corrective action

16.2 Background of Zones

The chart below is the definition of the Zones used in trend testing. All tests work more accurately if the control limits on your graphs have a 3 Sigma range. QC-CALC gives you the ability to perform trend tests even if your control limits are not 3 Sigma but we highly recommend setting it to the standard of 3.

Since the control limits are 3 Sigma limits, each of the zones is one sigma in width. For this reason the zones are sometimes referred to as the "1 Sigma Zone" (Zone C), the "2 Sigma Zone" (Zone B), etc.

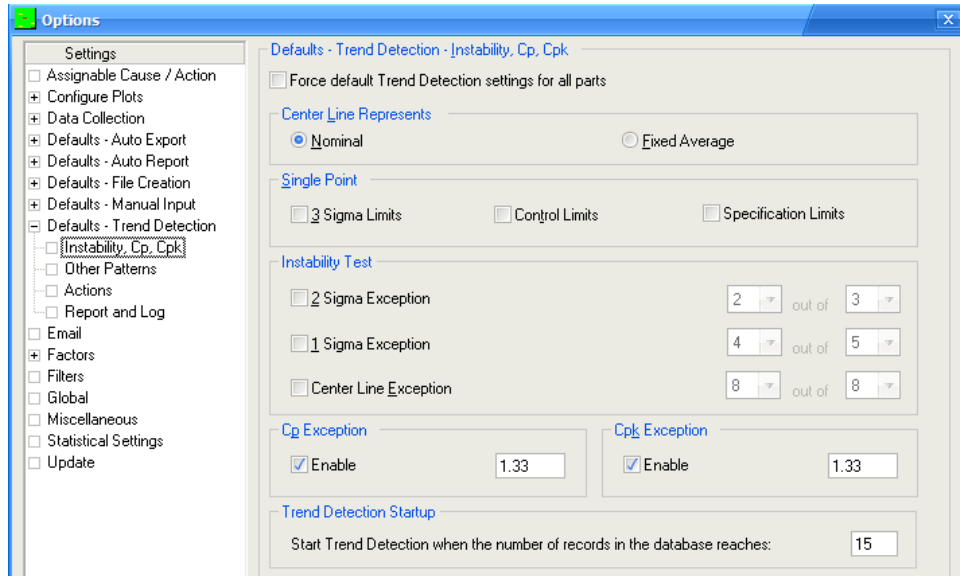
	<i>Upper Half</i>	<i>Lower Half</i>
	Single point out	
A	2 out of 3 in Zone A or above	
B	4 out of 5 in Zone B or above	
C	8 in row in Zone C or above	
		C 8 in row in Zone C or below
		B 4 out of 5 in Zone B or below
		A 2 out of 3 in Zone A or below
		Single point out

16.3 Display Sigma Zones

To view the sigma lines on the Real-Time plots select menus **Tools – Options – Configure Plots Settings – Items to Show** – and check the 3 options labeled **Sigma Zones**. Use Lines or colors. To ensure the lines are calculated to 1, 2, & 3-sigma, select **Tools – Options – Calculate Limits**. QC-CALC will calculate, display, and lock the sigma lines on each plot.

16.4 Selecting Trends

Menu **Tools – Options – Defaults - Trend Detection** contains the selection screen. You select the trend you want QC-CALC to watch and the action to take if a trend is detected. The **Trend** menu on the left side of the window has 4 sub-menus to view. Each menu is discussed in order.



16.4.1 Trend Detection – Instability, Cp, Cpk

The instability tests performed by QC-CALC are:

- Single Point outside the 3 Sigma, Control, or Specification limit
- 2 Sigma Exception
- 1 Sigma Exception
- Center Line Exception

Center Line Represents

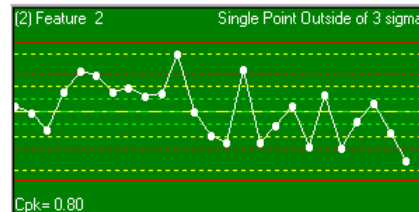
You have the option of specifying exactly what the Center Line represents. The two choices are either the **Nominal** or a **Fixed Average**. This choice does not affect the appearance of your graphs. It is used solely in the computation of Trend Detection. The Center Line tells QC-CALC where to begin the Sigma Zones.

Single Point

3 Sigma Limits – A single point falls outside the 3-sigma limit (beyond zone A).

Control Limits – A single point falls outside the Control Limits.

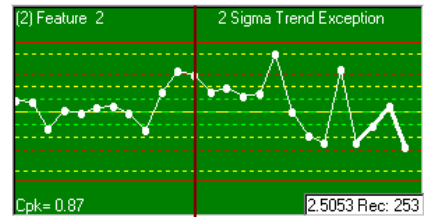
Spec Limits - A single point falls outside the Specification Limits.



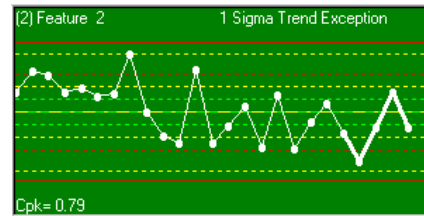
This example shows the latest point exceeding a 3-sigma limit.

2 Sigma Exception

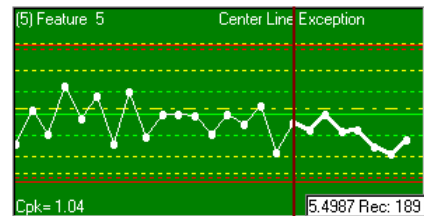
Two out of three successive points fall in Zone A or beyond. A single point can be anywhere, but only two points count.

**1 Sigma Exception**

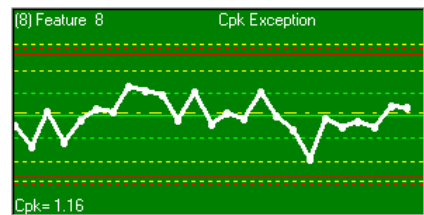
Four out of five successive points fall in Zone B or beyond. A single point within the five may be in Zone C, but four points are located at least in Zone B.

**Center Line Exception**

Eight successive points fall in Zone C or beyond and all on one side of the centerline. This is sometimes expressed as eight points in a row on one side of the centerline.

**Cp / Cpk Exception**

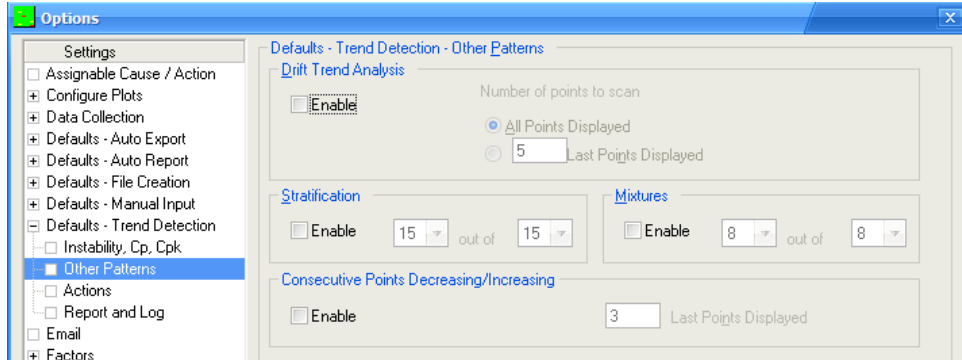
Calculated Cp and Cpk are compared to the entered Cp and Cpk values. When the actual Cp or Cpk is less than the value of Cp or Cpk entered in the text-box QC-CALC will trigger a Cp or Cpk Exception.

**Trend Detection Startup**

With this option you can control when new .qcc file will start to be monitored for Trends. Some trends would be detected early because there isn't enough data to accurately calculate the values being monitored. This option gives you the flexibility to start watching for trends after enough data has been collected for your specific values to make sense.

16.4.2 Trend Detection – Other Patterns

The patterns on this tab should be watched in addition to the patterns of instability. The ability to recognize these patterns can greatly increase the usefulness of the control chart by permitting a fuller interpretation of its meaning. These patterns are different from the patterns of instability in that both halves of the control chart are considered together in looking for the patterns.

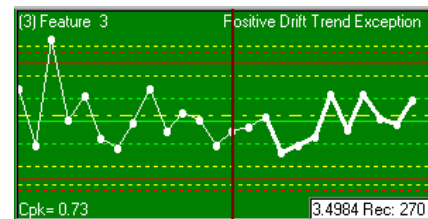


Drift Trend Analysis

Trends may be indicated by a series of consecutive points without a change in direction. It is a continuous movement up or down.

Number of Points to Scan

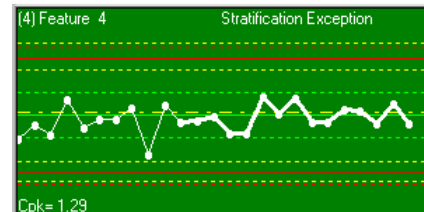
Specifies the number of plot points that are used to determine if a drift trend exists.



Note: Some of the most frequent causes of trends are Tool wear; wear of threads, holding devices or gages, deterioration of plating or etching solution; aging, inadequate maintenance on test set, seasonal effect, including temperature and humidity, human variables (These may be affected by the amount of supervisory attention, etc), operator fatigue, increases or decreases in production schedules, and gradual change in standards.

Stratification

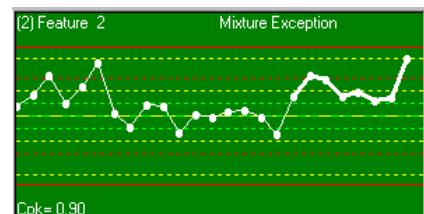
At least fifteen consecutive points fall in Zone C. If the up-and-down variations are very small in comparison with the width of the control limits, the control chart indicates stratification. This means the sampling is being done systematically in such a way that two or more different distributions are represented.



Anything that is capable of causing mixture may also produce stratification. However, stratification shows up less readily on the Xbar chart. Stratified patterns are frequently the result of incorrect calculations of the control limits or the misplacing of a decimal point.

Mixtures

Consider that the mixture exists when eight consecutive points are on both sides of the centerline with none of the points falling in Zone C. Another explanation of mixtures is if the pattern shows a tendency to avoid the centerline with too many points near the control limits.

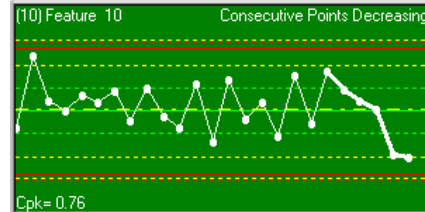


Distribution changing due to differences in material, operators, test sets, etc, breakdown in facilities or automatic controls, over adjustment of the process,

effect of experimental or development work, carelessness in setting temperature control, timing device, etc, wrong sampling procedures, change in the method of measurement, errors in plotting, incomplete operation, setup parts.

Consecutive Points Decreasing / Increasing

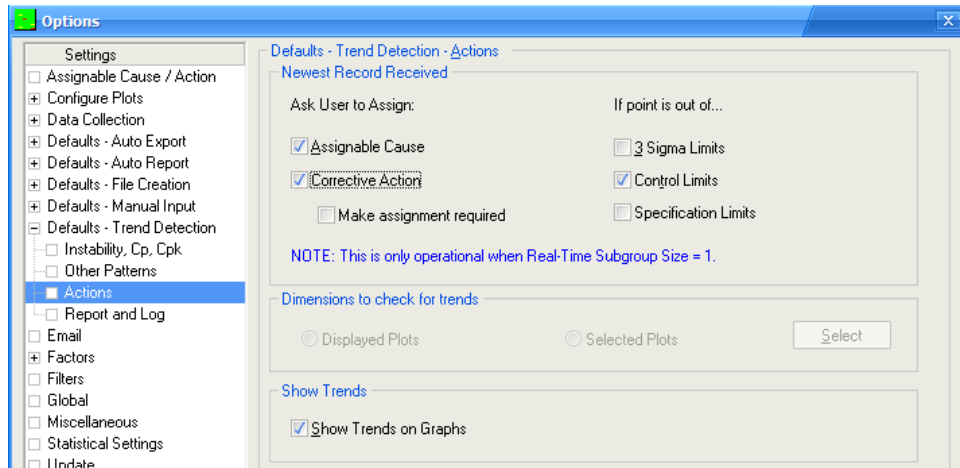
A number of points in a row are either all decreasing or all increasing. For example if you enter 5, the five points on the right side of the graph will be checked. If they are all increasing or all decreasing then a trend will be triggered. To check points that are not at the right edge of the graph, simply scroll the QC-CALC Real-Time screen backwards to view previous records and check them for trends. That number is determined by what you type in the box labeled **Last Points Displayed**.



16.4.3 Trend Detection – Actions

Require User to Assign Cause

When trends do occur, you can have QC-CALC take some action such as assign a cause or corrective action. A window will pop up and ask you to assign a **Cause** before continuing to collect data from your CMM.



This option checks each new record that is received to see if it meets the criteria that you set. If the point is outside the **3 Sigma Limits**, **Control Limits**, or **Specification Limits** you can require your operators to set an assignable cause and/or a corrective action for that record.

Dimensions to check for trends

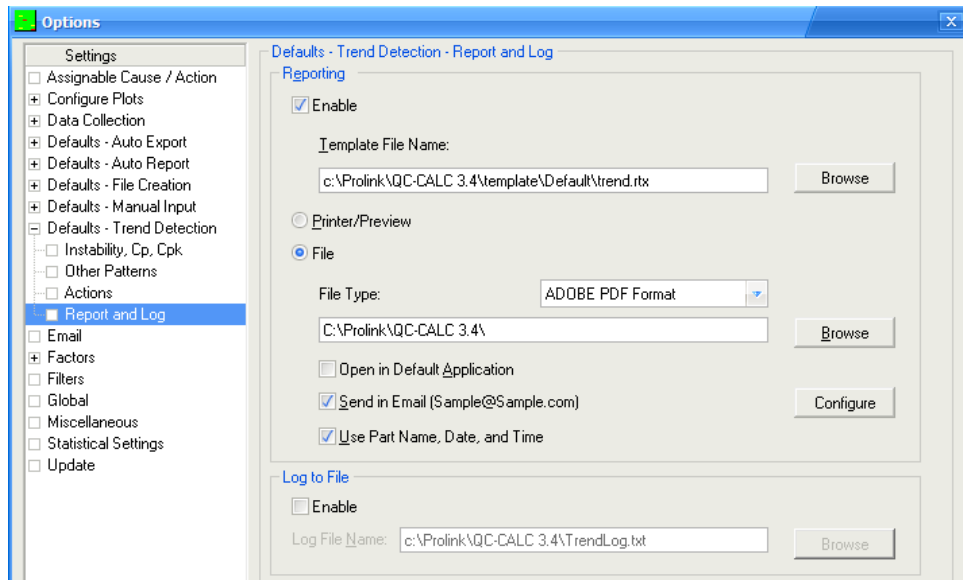
With this you have the option of monitoring all displayed dimensions for the trends you have chosen, or choosing specific dimensions to monitor instead.

Show Trends on Graphs

This option must be checked if you want the trends to be displayed on the plots. The trends are displayed as thick data lines.

16.4.4 Trend Detection – Report and Log

Checking the **Reporting – Enable** box tells QC-CALC to print a report every time a trend is detected in the data received during the collection process.



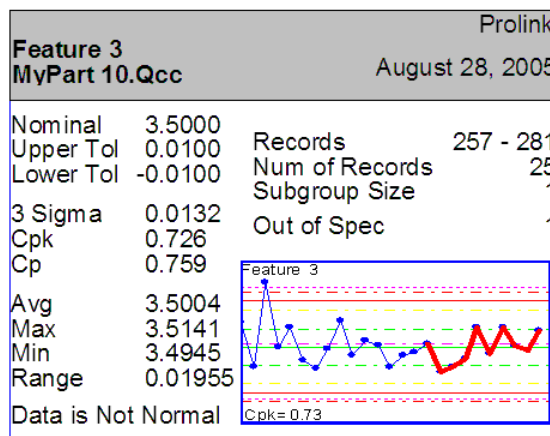
You can choose the template to use for the report by clicking the **Browse** button and selecting the template file name with “.rtx” extension. Other types of templates will not show the trends so they are not available at this time.

Print to Printer

The reporting is the same as discussed in the Reporting section. You must select a template to use during printing and your report is sent to the printer should a trend occur.

Print to File

Using **Print To File** is the same as the Reporting section – select the template, the File Type, and File Location. When the trend occurs, the report is printed and sent to the file of choice. Notice how the trend is highlighted in red to help you identify the problem.



Print to File and Email

Using the email capability allows you to print to file on a trend exception and attach the report to your email. This gives you unattended use of QC-CALC knowing that no events are missed because you weren't at the printer when the trend occurred.

Log to File

When the **Log to File** option is **Enabled** (checked), QC-CALC writes a trend description to the trend log file. Type the file name in the box provided, or click the **Browse** button and choose the file name using the dialog box that appears.

```
TrendLog.txt - Notepad
File Edit Format View Help

The following trend was encountered on dimension number 2 - Cp
Record Range: 61 - 85 07:40:48 02/18/2013
File Name: C:\Prolink\QC-CALC 3.4\Data\My Part 100.Qcc Part
Control Cpk: 1.33, Actual Cpk: 0.9111812

The following trend was encountered on dimension number 2 - Cp
Record Range: 61 - 85 07:40:48 02/18/2013
File Name: C:\Prolink\QC-CALC 3.4\Data\My Part 100.Qcc Part
Control Cp: 1.33, Actual Cp: 0.9449528

The following trend was encountered on dimension number 3 - Cp
Record Range: 61 - 85 07:40:48 02/18/2013
File Name: C:\Prolink\QC-CALC 3.4\Data\My Part 100.Qcc Part
```

The log file includes:

- Name of the trend, dimension number
- Record range, time and date
- File Name, part name
- Trend configuration

Exercise

Complete the following exercises to become familiar with the Trend system. You will use the **Training CMM** software to generate inspection results

1. Using the Trend System - select a Cpk trend, turn on the Trend system, and inspect parts until a trend occurs.
2. Select a report to print preview when a Cpk trend occurs and inspect parts until a trend occurs and a report is printed.
3. Select a report to print to File when a Cpk trend occurs. Inspect parts until you see the report created.
4. Now send the exception report via email.

Exercise 1 – Use the Trend System

1. Select menus **Tools – Options – Trend Detection**. Check the **Cpk** option and enter a value of **0.8**.
2. Select the **Action** tab and ensure **Show Trends on Graphs** is checked.
3. Select menu **Tools – Trend Detection** (this menu turns on & off the system so be sure the menu is checked).
4. Using the **Training CMM**, start adding records to your QC-CALC file by slowly clicking the **Inspect** button.
5. Add new parts until a Cpk trend occurs. If you go past the trend, use the horizontal scroll bar to go back until you see the trend. The entire plot is highlighted when the trend occurs.

Exercise 2 – Select a Report to Print Preview

1. Keeping the setting from the previous exercise select **Tools – Options – Trend Detection – Report and Log**.
2. Now check the **Enable** checkbox and the reporting is enabled.
3. Select the Trend.rtx template (if not already selected).
4. Be sure **Printer / Print Preview** is selected.
5. Click **Ok**.
6. Add new parts until a Cpk trend occurs.
7. A report is printed to your screen showing you the trends.

Exercise 3 – Select a Report to Print to File

1. Extending the previous exercise select **Tools – Options – Trend Detection – Report and Log**.
2. Be sure **File** is selected.
3. Select a **File Type of Adobe PDF Format**.
4. Click the **Browse** button and enter a file name of CpkTrend and place the file on your desktop.
5. Click **Ok**.
6. Add new parts until a Cpk trend occurs.
7. A report is printed to your desktop.
8. Open and verify the file if you have Adobe Acrobat Reader.

Exercise 4 – Send the Report via Email

1. Extending the previous exercise select **Tools – Options – Trend Detection – Report and Log**.
2. Be sure **File** is selected.
3. Select a **File Type of Adobe PDF Format**.
4. Click the **Browse** button and enter a file name of CpkTrend and place the file on your desktop.
5. Click the **Send in Email** checkbox.
6. Fill-in the email address with your email, a subject, and a body of text and Click **Ok**.
7. Click **Ok**.
Note: if your PC is not connected to the internet, you can stop here!
8. Add new parts until a Cpk trend occurs.
9. A report is printed to your desktop and an email is sent with this report attached.
10. Check your email and verify you received the note with the attached file.

Exercise 5 – Reset your Setting to turn off the trend reporting system

1. Select menu **Tools – Trend Detection** and be sure the menu is unchecked.
2. Be sure to turn off the Print to File and email options.

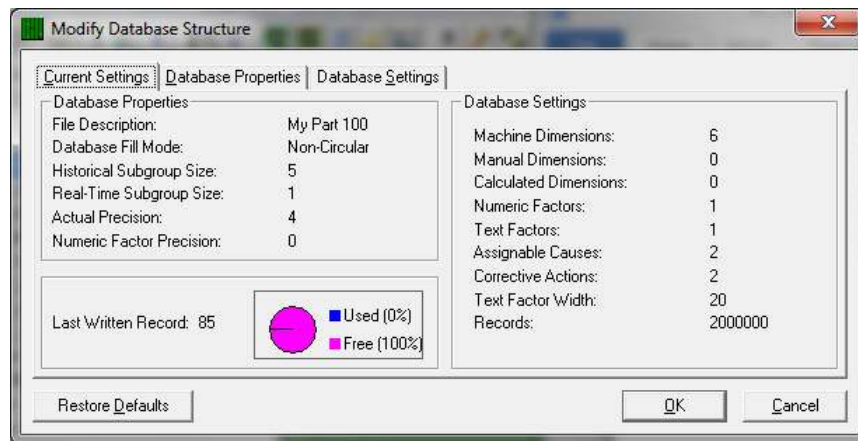
17. Modify Database Structure

17.1 Introduction

QC-CALC automatically builds its database when it reads a never before seen “results file” from your CMM. Since QC-CALC has a policy of not asking questions, it must obtain reasonable answers from somewhere. QC-CALC uses a **File Creation Default** area for these answers that was setup during installation. The file creation default area contains the answers to any questions that would normally have been asked of you. You can change these answers but they may have been incorrect for some situations. Therefore, we provide a tool to change the structure and content of any database previously created. This section of the training gives you an understanding what QC-CALC saves and how to change the settings.

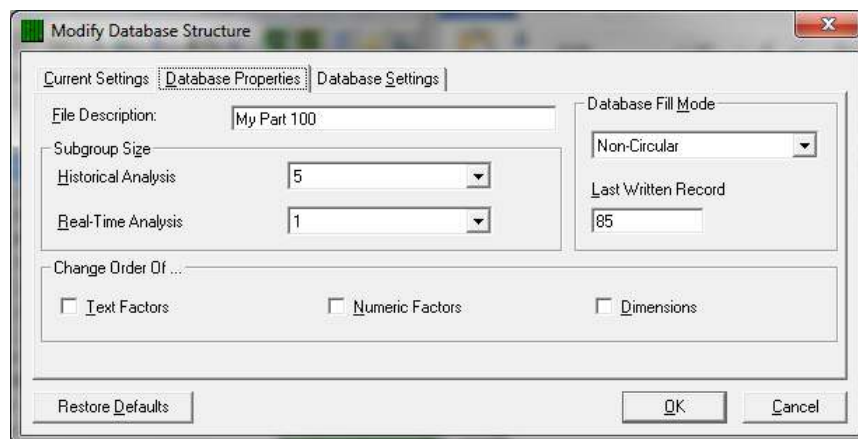
17.2 Current Settings

Select menu **File – Modify Database Structure** and the following window is displayed. This tab summarizes all the information about the currently open database file on one screen. You can change these values from the **Database Properties** and **Database Settings** tabs.



17.3 Database Properties

The tab contains the basic organization of the database file. You can modify these values to adjust how QC-CALC displays your data.



17.3.1 File Description

This is a description of the currently open file that may be used to give additional information about the file. If a specific value was not entered the .qcc file name will be save into this area.

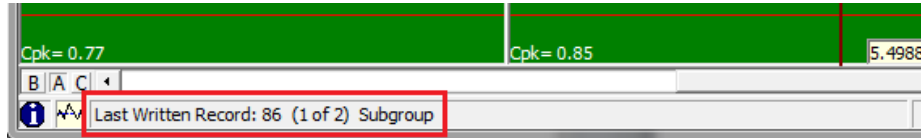
17.3.2 Subgroup Size

Historical Analysis

This controls the number of data points that make up a subgroup on the control charts in the statistical menu. The minimum subgroup size is 2 and the maximum is 25.

Real-Time Analysis

This controls the number of data points that make up a subgroup (or points) on the graphs in QC-CALC Real-Time. A subgroup size of 1 is the minimum size where each inspected part is displayed immediately as raw data. If you set the subgroup size to 2, no visible point is displayed until two parts are received. QC-CALC displays the current point within the subgroup in the lower status bar.



17.3.3 Database Fill Mode

This option only applies to Real-Time and tells QC-CALC what to do when the data file becomes full. The maximum parts store in each database is 2,000,000. If the file is circular, QC-CALC automatically wraps around from 2,000,000 back to the first record and begins writing over the old data. If you do not want the old data to be erased, archive the data file to another disk or select non-circular.

17.3.4 Last Written Record

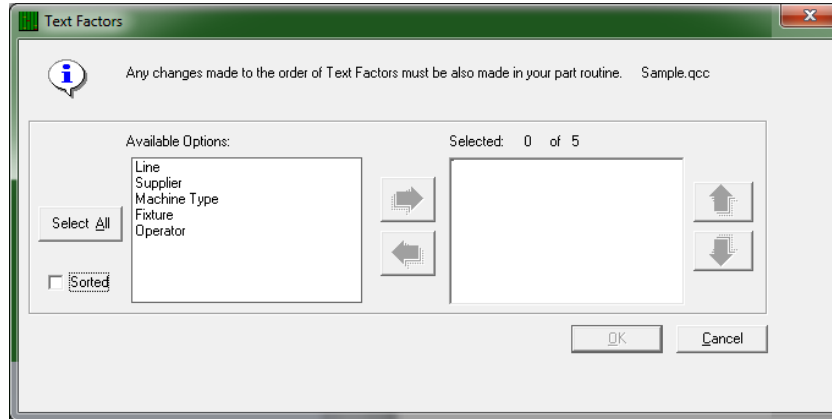
This is the number of the last record that was inspected. The number tells you where new data will be added when data collection or data entry resumes. Changing this number to a lower number will effectively erase the records located beyond that number. For example, if 42 were the last written record, changing this to 40 would cause records 41 and 42 to be overwritten when data is again received from the inspection equipment. If you move it back to 42 before any data is saved, your records are returned.

17.3.5 Change Order Of ...

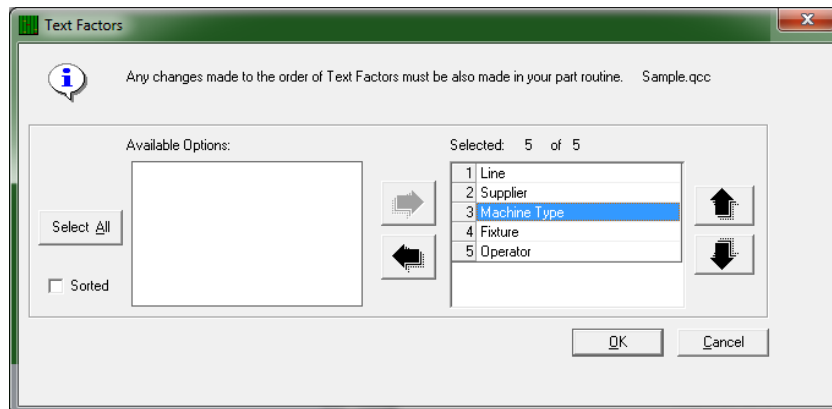
This frame contains three check boxes that allow you to change the column order in which your data is placed in the database. For example, you can swap the position of Dimension 1 with Dimension 2 or Text Factor 2 with Text Factor 3, etc. It is rare that you would need this type of maintenance but it is included should you change your part program and need to change the QC-CALC database to match.

Text Factors

These columns are used to record information specific to a part such as operator name, work order numbers, machine names, etc. In this example we swap Text Factor 3 (labeled Fixture) with Text Factor 4 (labeled Operator).



We start with the screen above and move all five Text Factors to the right panel using the right arrow and then using the vertical upper and down arrow keys, adjust their final position to look like the screen below. Pressing the **OK** button causes QC-CALC to move all text Factors to the newly selected order.



Numeric Factors

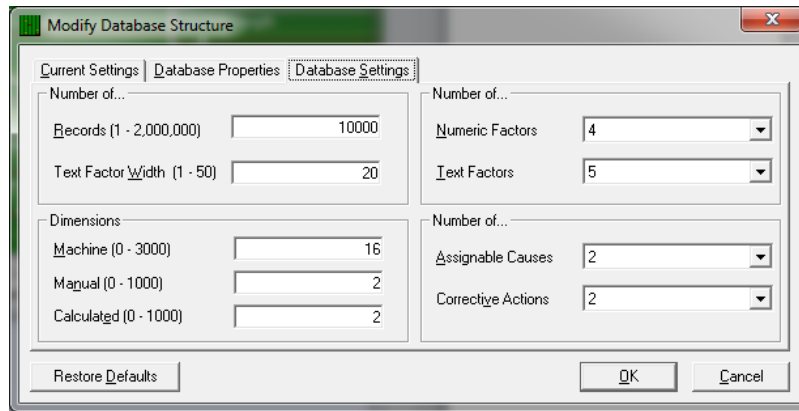
Numeric Factor operate the same but only numbers can be entered in these columns, which are mainly used to record information specific to each part stored in the database as well as to help you filter the data to create a more specific analysis.

Dimensions

The measured values operate the same but only numbers are allowed. These columns contain measurement results for each dimension in the database. A total of 3000 dimensions per part and up to 2,000,000 parts can be stored in one database. You can move or remove any of these columns of numbers to match your latest part program configuration.

17.4 Database Settings

The database settings tab contains items that change the size of the database. You can add or remove records, dimensions, Factors, assignable causes, etc. If you choose a value less than the value shown (existing), you are warned that information will be lost. When you finish and click **OK**, you see a screen of the selected items to keep and items to discard. You can change the order of each item as well. Each item is briefly discussed.



17.4.1 Number of...

Records (1 – 2,000,000)

This is the number of records (parts) stored in this database. If the number you enter is small than the current amount of records QC-CALC takes the number of records you specify from the newest data and discards the oldest.

Text Factor Width (1 – 50)

This is the width of each label stored in the Text Factor columns of your data file. You may choose any width up to a maximum of 50 characters.

17.4.2 Number of...

Numeric Factors

This refers to the number of columns of Numeric Factors you would like in your database. This number can be larger or smaller than the current value. You will be warned if you enter a value smaller than the present value.

Text Factors

This refers to the number of columns of Text Factors you wish to have converted. You can add, subtract, or move the order of these values.

17.4.3 Dimensions

This is the number of dimensions to convert. QC-CALC has three types of dimensions:

Machine

Dimensions created automatically by receiving data from an inspection machine.

Manual

Extra dimensions not received from an inspection machine and are entered by hand using QC-CALC's **View – Manual Dimensions**. See [Manual Dimensions](#) on page 99 for more details.

Calculated

You can add Dimensions that are made up of calculations. These are useful for creating features that are not available from the gage. For example, if a plot contains a measure value for one side of a panel and a second value for the

other side, you can calculate thickness by subtracting the two dimensions. See the [Calculated Dimensions](#) section on page [94](#) for more details.

17.4.4 Number of...

Assignable Causes

The purpose of an Assignable Cause file is to store your company's entire standard Causes that occur during the manufacturing process used to trace special events that occurred to a part. This selection lets you decide how many **Assignable Causes** you want to include. The range is 0 to 3 causes per part.

Corrective Actions

The associated **Corrective Actions** explains what you did to fix the Cause, however, the number of **Assignable Causes** do not have to match the amount of **Corrective Actions** and vice versa. Therefore you may select as many **Corrective Actions** as you have or desire but limited to 3.

18. Calculated Dimensions

18.1 Introduction

You can add Dimensions that are made up of calculations. These are useful for creating features that are not available from the gage. For example, if a plot contains a measured value for one side of a panel and a second value for the other side, you can calculate thickness by subtracting the two dimensions. Or you may wish to add a bias to the nominal of a number that is zeroed out on a gage block.

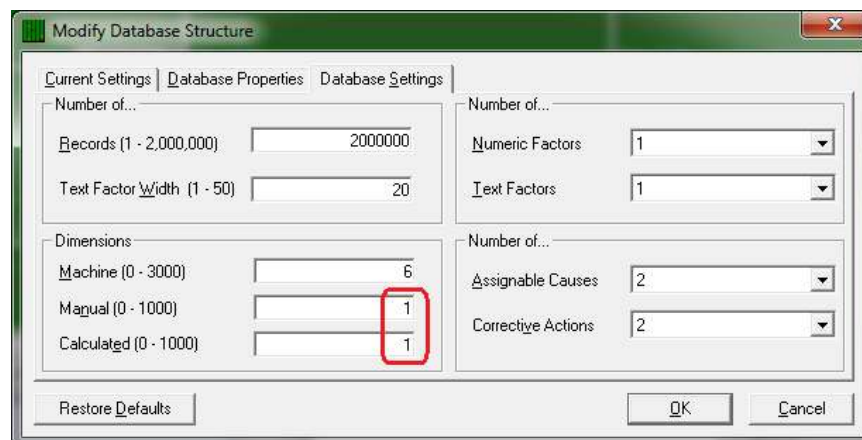
QC-CALC can also include dimensions where you manually enter the values into the QC-CALC Real-Time or QC-CALC SPC screens. These manual dimensions are discussed in the section labeled [Manual Dimensions](#) on page 99. This means QC-CALC has a total of 3 different measurement types it can plot in Real-Time.

- Machine Dimension Received from your CMM part program
- **Calculated Dimension** Extra dimension calculated by QC-CALC
- Manual Dimension Extra dimension typed by you

This unique capability means you can add separate features to your existing QC-CALC file that cannot be measured on your CMM. This section focuses on how to extend QC-CALC's capability.

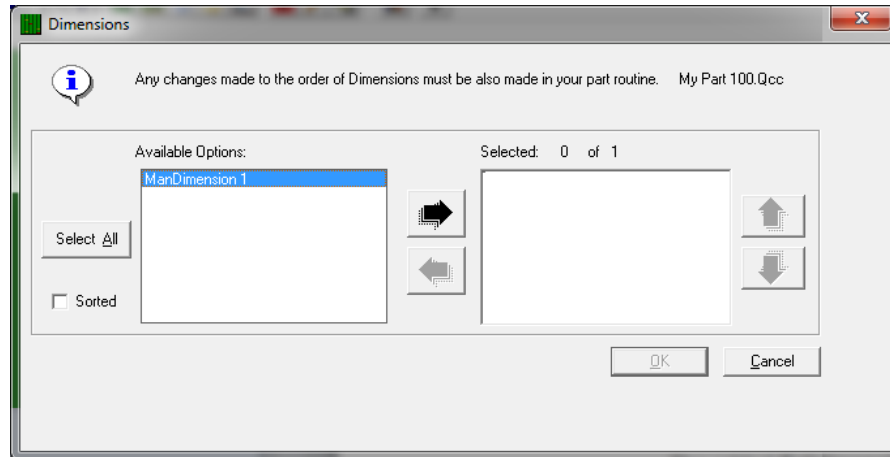
18.2 Adding the Extra Features

When we discussed [Modify Database Structure](#) on page 89 we briefly touched on the subject of Calculated Dimensions. We will now add a Calculated Dimension by using the Modify Database Structure options. Select **File – Modify Database Structure** and then select the **Database Settings** tab. Here we changed the Manual and Calculated Dimensions from 0 to 1 meaning we are adding 2 new dimensions to the database.

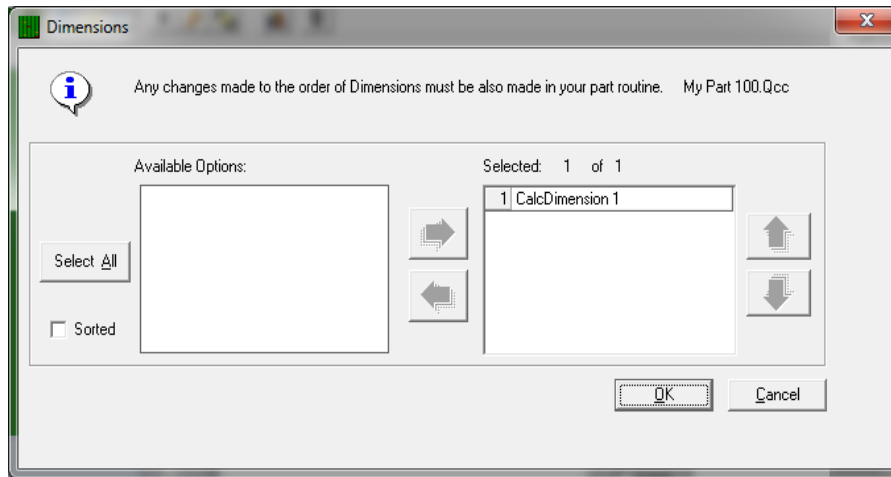


Note the Machine Dimensions is set to 16. This is automatically set when QC-CALC reads your CMM data results and creates the database automatically. Click **OK**.

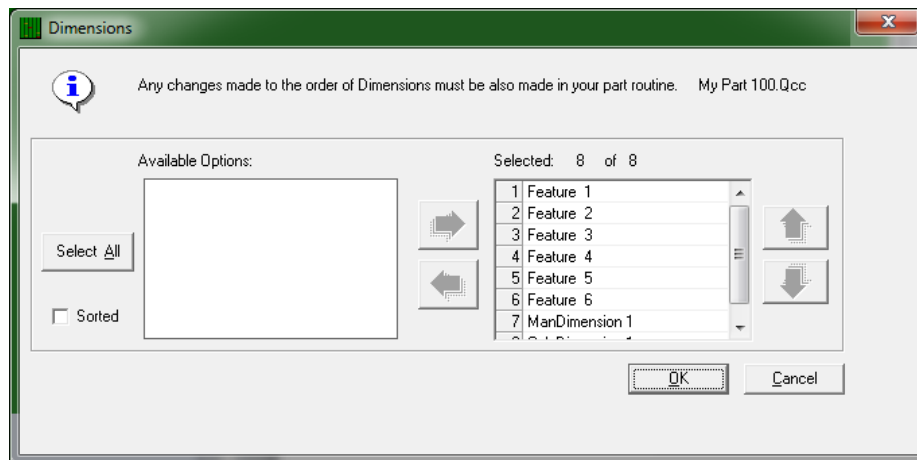
Select the ManDimension 1 (meaning **Manual Dimension**) and click the **Right Arrow** to move it to the right side and click **OK**.



The added **Calculated Dimension** is displayed next. Now select and click the **Right Arrow** button to move it to the right side. Click **OK**

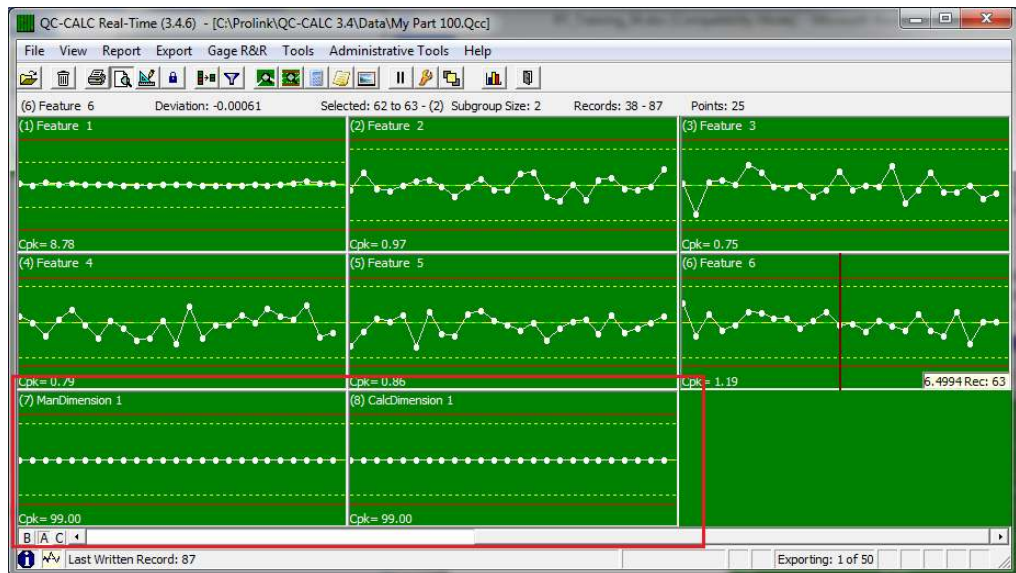


Lastly, you are prompted to move all of your machine, manual, and calculated dimensions. This last step allows you to rearrange the order each feature is displayed in the Real-Time plots. In this example, click **Select All** and then click **OK**. This moves everything from the left side to the right side.



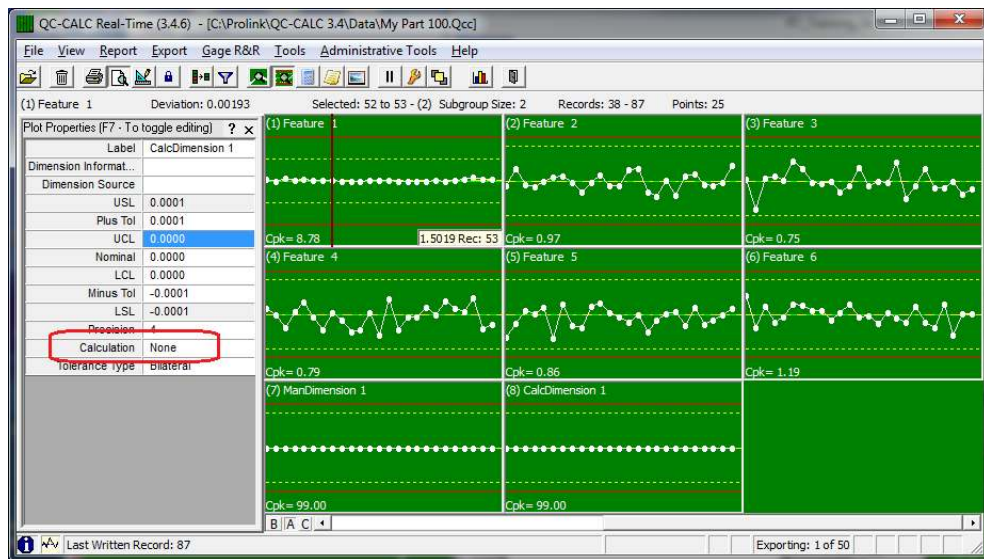
18.3 View the Extra Dimensions

The QC-CALC Real-Time screen now shows the two extra plots we added. Note the data line is flat since we had collected parts before adding these extra two dimensions. QC-CALC back fills the new dimensions with nominal values.



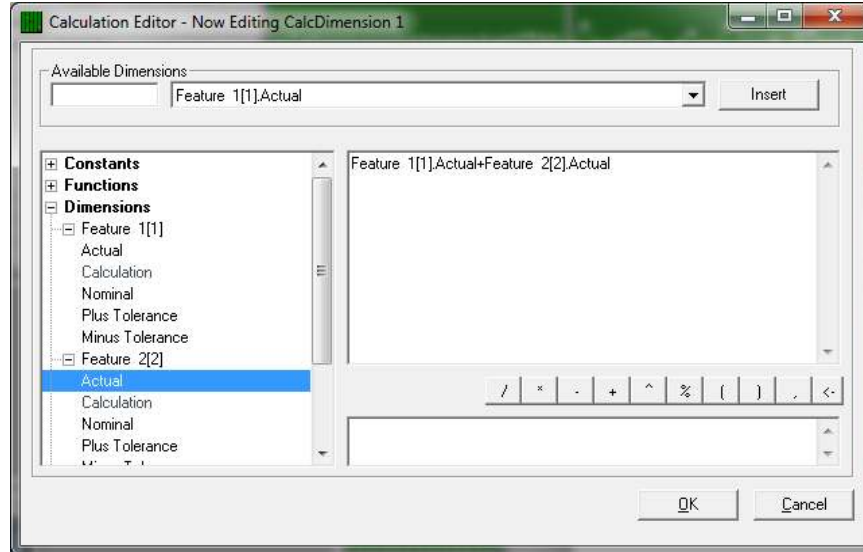
18.4 Display the Equation

Next, right click the calculated dimension and select the **Plot Properties** menu. The plot sizes are adjusted and the **Plot Properties** are shown on the left side. This Calculation field is editable only because it is a calculated dimension. This field is not available on any other type of dimension except a calculated dimension.

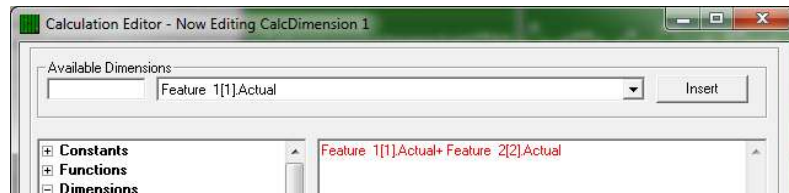


18.5 Edit the Equation

By clicking the white area of the Calculation property, an equation editor is displayed. Here we selected **Feature 1 Actual**, added a plus sign, and selected **Feature 2 Actual** from the list as our simple calculation. Click **OK** and the calculated dimension attempts to update the plot. However, the plot is not scaled correctly so we'll enter the nominal and tolerance numbers next.

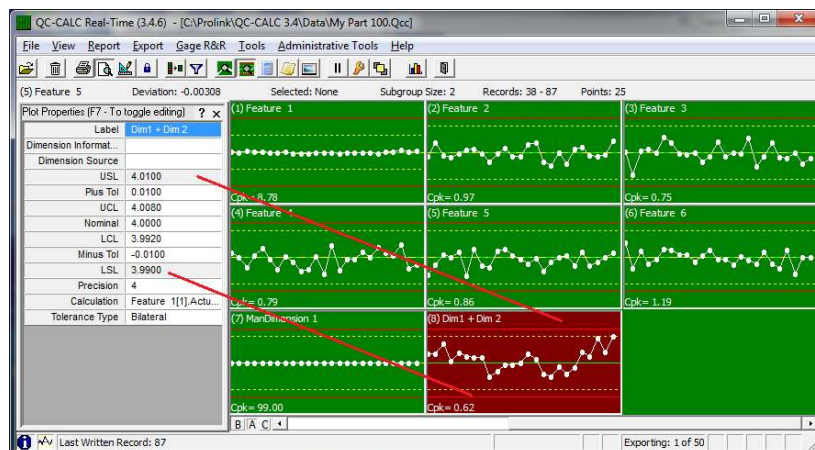


Tip: You **cannot** enter <spaces> in your equation. If you do, the equation is displayed in **red** letters and you cannot save it.



18.6 Scale the Plot

Knowing **Feature 1** has a nominal of 1.5000 and **Feature 2** has a nominal of 2.5000 we entered 4.0000 for nominal value. Also knowing the upper and lower tolerance to be +/- 0.01 we entered the same values for the tolerance of the calculated dimension. The control limits were entered as 80% of the upper and lower specification limit or 4.008 and 3.9920. The plot is now scaled properly. Press the F7 key to stop editing the **Plot Properties** and your plot is now ready.



18.7 Update Calculations

From this point forward QC-CALC automatically calculates and saves the calculated dimension along with the new CMM data as it arrives. You can control this **Update** action occurs by setting the **Data Collection – Actions**. If the **Update Calculated Dimensions** is set to **Every New Record**, QC-CALC recalculates your plots in real-time. Otherwise, a zero is saved for this calculated feature.

You update all calculations from the **Tools – Update Calculated Dimensions** menu to force a complete update of all records. You might need this option if you change some saved values and require QC-CALC to refresh all calculations. Remember, QC-CALC stores the calculated results in the database not the equation so you can treat the Calculated dimension the same as any other dimension.

19. Manual Dimensions

19.1 Introduction

Besides the CMM (machine) dimensions and the calculated dimensions discussed in the previous section, you can add what are known as Manual Dimensions. They are called manual dimensions because you must enter these values manually. Most times these values are collected using a hand-held gage and you want them stored with your CMM data to complete the part. Manual Dimensions are useful for adding features that are not available from a CMM and are measured using another such as a hardness value, a chemical reading, or color value, etc.

QC-CALC can also include dimensions that are calculated as described in the [Calculated Dimensions](#) section on page 94. This means QC-CALC has a total of 3 different measurement types plotted in Real-Time.

- Machine Dimension Received from your CMM part program
- Calculated Dimension Extra dimension calculated by QC-CALC
- **Manual Dimension** Extra dimension typed by you

This unique capability means you can add separate features to your existing QC-CALC file that cannot be measured on your CMM.

There are actually a couple of ways to add manual dimensions while you are inspecting your parts. These are listed below in order of recommended use. The most recommended is first.

- **QC-Gage via MultiSource** – This is the best way to enter manual measurements because it allows you the most flexibility when it comes to validation of the measurements taken. It also allows for a level of automation since QC-Gage can collect data from small measurement devices and specialized machines (such as hardness, roundness, surface finish gages, etc) via RS-232, TCP/IP, and file based outputs. As of QC-CALC 3.3, there is a new feature called MultiSource which allows your QCC files to literally have multiple sources. For instance, a QCC file with 10 dimensions could have 3 coming from a CMM, 5 coming from a video measurement system and the last 2 coming from QC-Gage (via manually entered values or a wireless micrometer). For more information on this, please consult ProLink for a demo.
- **Manual Input Screen** – This screen is great for entering trace fields (factors) for your parts when your inspection equipment does not have the ability to provide them. For instance, your inspection equipment can output the measurements directly into QC-CALC, but does not have the ability to allow your inspectors to enter the lot number, fixture, machine or other traceability info. It is also good for quickly entering manual dimensions when you don't want to use QC-Gage. It also allows you to validate manual dimensions as a percentage to help prevent mistyped values, combine trace fields and manual dimensions into the same screen, choose values from a list for better consistency, and it can be launched at regular measurement intervals (such as every 5 parts).
- **Manual Dimension Values Screen** – This screen is the original way of entering manual data and is the simplest of the manual data entry options. It simply gives you a column of cells for each manual dimension. You can then type the values directly into the cells. There is no validation

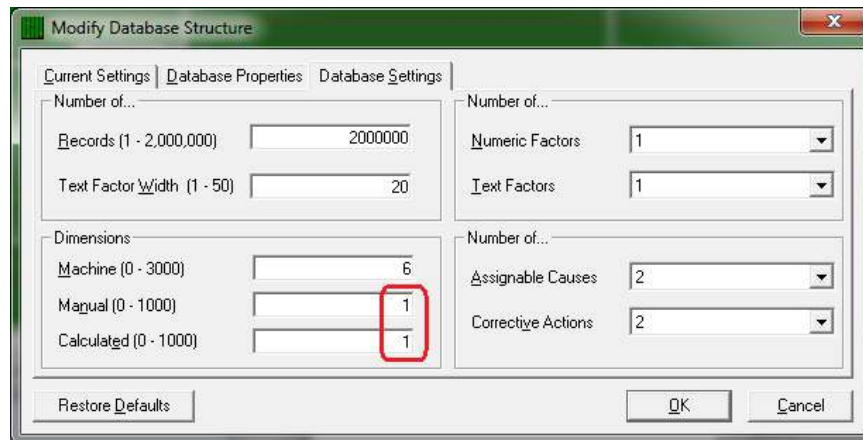
on the data and the values are plotted immediately upon pressing the Enter key on your keyboard.

In this section, the first of the manual options will not be discussed since it involves QC-Gage as an outside product.

Whether you decide to use the Manual Input screen or the Manual Dimension Values screen, the first thing you need to do is modify the database and create the dimensions that will be manually entered and ready them for the data to come. The next three sections cover this task and are followed by the two options so you can make an accurate choice based on your needs.

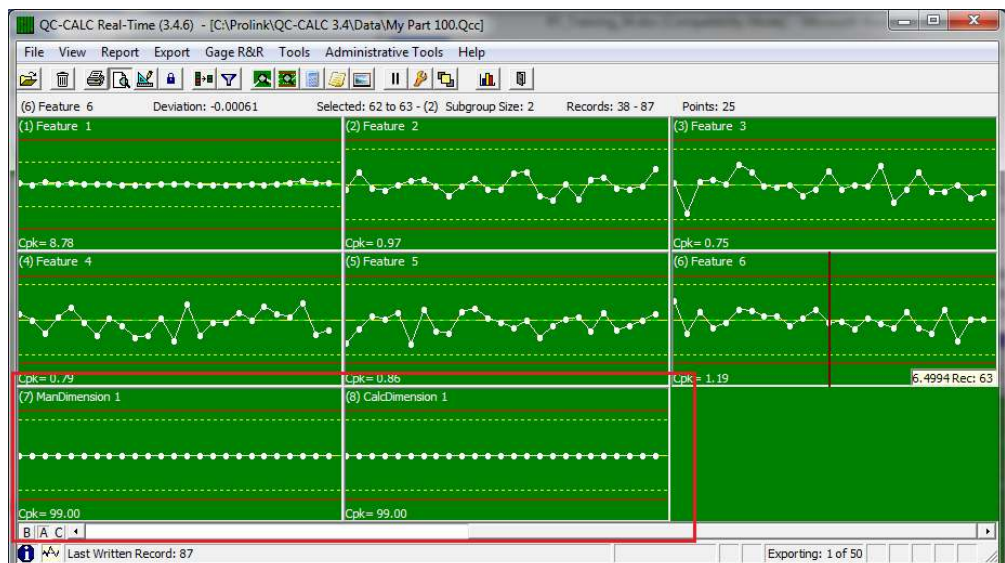
19.2 Adding the Extra Features

When we discussed adding an extra dimension in the [Calculated Dimensions](#) section on page 94, we added 1 Manual dimension and did not discuss anything further about it. Briefly, to add a Manual dimension, select **File – Modify Database Structure** and then select the **Database Settings** tab. Change the **Manual Dimensions 1** to add one new dimension to the database. Again, review the Calculated section for more details.



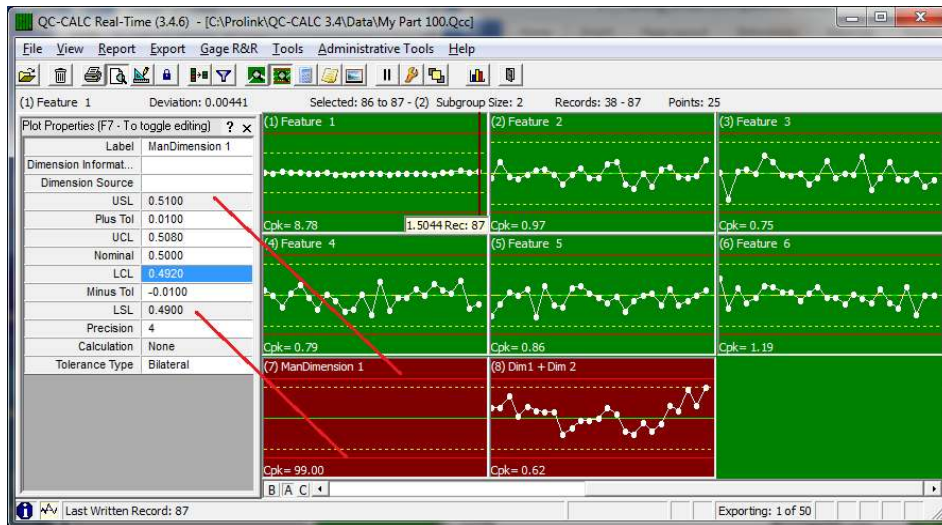
19.3 View the Extra Dimension

The Real-Time Plots screen now shows the two extra plots we added. Note the data line is flat since we had collected 11 parts before adding these extra two dimensions. QC-CALC back fills the new dimensions with nominal values.



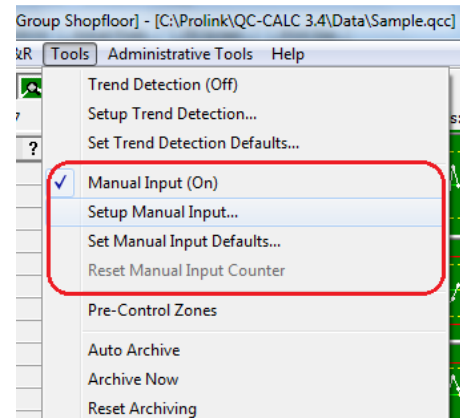
19.4 Scale the Plot

Right click on the Manual dimension and select **Plot Properties**. Assuming this new dimension has a nominal of 0.5000 and the upper and lower tolerance to be +/- 0.01 we entered these values into the Point Property screen. The control limits were entered at 80% of the upper and lower specification limit or 0.508 and 0.492. The plot is red because all values are set to zero and must be updated. Press the F7 key to stop editing the **Plot Properties** and your plot is now ready.



19.5 Entering Data via Manual Input Screen

The Manual Input screen (MIS) gives you an interface to enter extra data into a file that already contains the data from the CMM machine. Normally a CMM machine automatically measures a part and sends the data over to QC-Calc to be analyzed and displayed. For this process everything is done automatically. Now, what if, in addition to automatic part checks, you have to check parts with a different machine or by hand (Ex. microscope) where no automatic output feature exists? The Manual Input screen gives you the ability to enter these values into the same file as the CMM data. This needs to be set up so it launches at the right time and for the right number of parts.

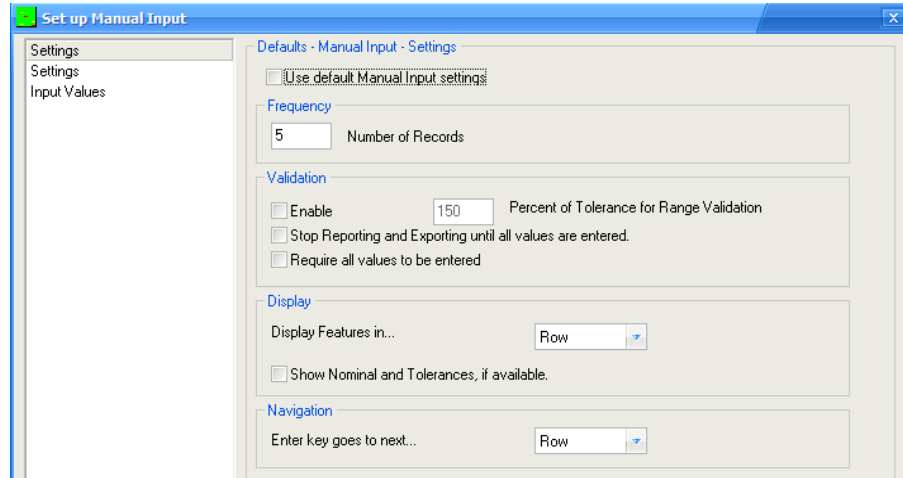


19.5.1 Setup Manual Input

To set up the Manual Input screen, choose **Tools – Set up Manual Input** and the setup screen will launch. There are two sections to this screen; **Settings** and **Input Values**.

Settings

The **Settings** screen allows you to set up the frequency of the screen as well as how it will behave to different keyboard strokes to make data entry easier for the user.



At the top of the screen, a checkbox labeled **Use default Manual Input settings** allows you to either use the defaults set in the **Tools – Options** area or override the settings for this specific QCC file.

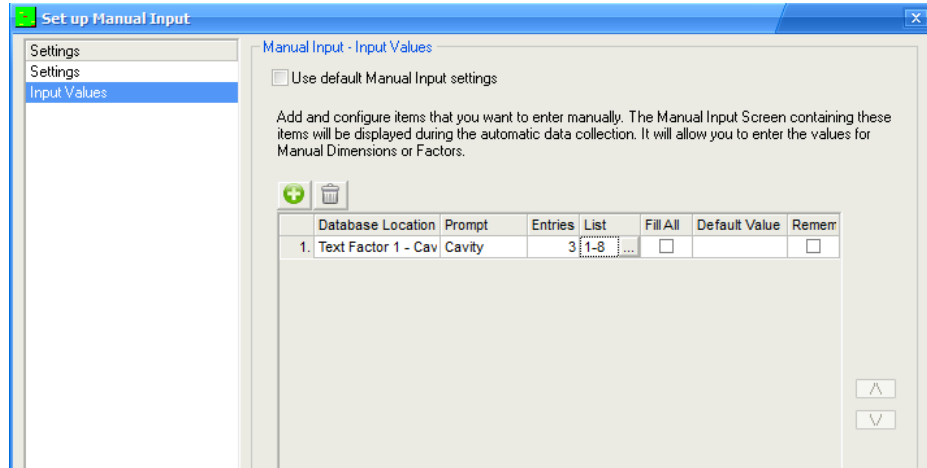
Start by setting the frequency. This will tell QC-CALC how often to launch the screen. In the picture above, this has been set to 5. This means the screen will launch every 5 parts to ask for manual values to be entered. It is important to understand that it will launch at the beginning of each group of 5 parts. When the data is entered, the values will then be applied to the next 5 parts as they arrive. If you shut down QC-CALC or change QCC files by inspecting different parts, it will not remember the manual values entered so it is important to enter the data and measure the parts together before switching parts.

Just below the frequency is a **Validation** section where you can choose if you want QC-CALC to validate the dimensions you're entering. This is set as a percent of tolerance. Therefore, if you set it at 150%, then it will warn you if a number that is typed is outside 150% on either side of tolerance. This is meant to prevent wildly out of tolerance values such as a misplaced decimal point (typing 11 instead of 1.1). You can also **Require all values to be entered** and **Stop Auto Reporting/Exporting until all values are entered** using the checkboxes.

The **Display** and **Navigation** sections control how the screen behaves when asking for values and what the user will see on the screen.

Input Values

The **Input Values** screen is where you set up the actual data points (dimensions and factors) that will be manually entered. To add entries, click the green plus icon and fill in the fields from left to right. These fields are defined as follows:



Database Location

This is the location where the entered data will be placed. It can either be a Factor or a Manual Dimension.

Prompt

This is the message the user will see. Enter something friendly like “Please type the serial number of the part” or “Please bar code scan your badge” to lead the operator through the process.

Entries

This is the number of entries (records) that will be required on the screen and may be less than the frequency. For instance, you may want to launch the screen every 5 parts, but only want to manually fill in the data for the first 3 of those parts. In this case, the **Frequency** on the **Settings** tab would be 5 and the **Entries** would be 3. If you want to have the operator fill in data for all parts, make sure the **Entries** number matches the **Frequency**. The entries are always at the beginning of the sample set. Therefore, if the frequency is 5 and a dimension has the Entries set as 3, it is always the first three parts that will have a value for the dimension and the remaining 2 will not be used (Null for Text Factors, 0 for Numeric Factors, or set to Nominal and Marked as Deleted for Manual Dimensions).



Note: Each different type of data entry point can have its own value for Entries. This allows you to set up some of your factors for all parts, but other dimensions for only some of your parts.

List

This option allows you to force the operator to choose the value from a list. This is useful for repeating values such as operator names or machine numbers where there is a finite list of items from which to choose. It helps to provide consistency in your data making filtering easier later.



Note: It is always recommended that you use lists when possible, especially for typed values such as names. Often operators will spell their names differently depending on mood or time of day (initials, first name, etc). By forcing a list, it ensures the data will be entered the same every time.

Fill All

This option allows you to fill remaining values with the last value entered. This is often used with the **Entries** option set to 1. Using the previous example of a frequency of 5 parts, it is likely the same operator will be measuring all 5 parts. Rather than making the operator enter their name 5 times, you can set the **Entries** to 1 and check the **Fill All** box. This way, the operator enters his name in the first box and it is copied across to the remaining 4 parts.

Default Value

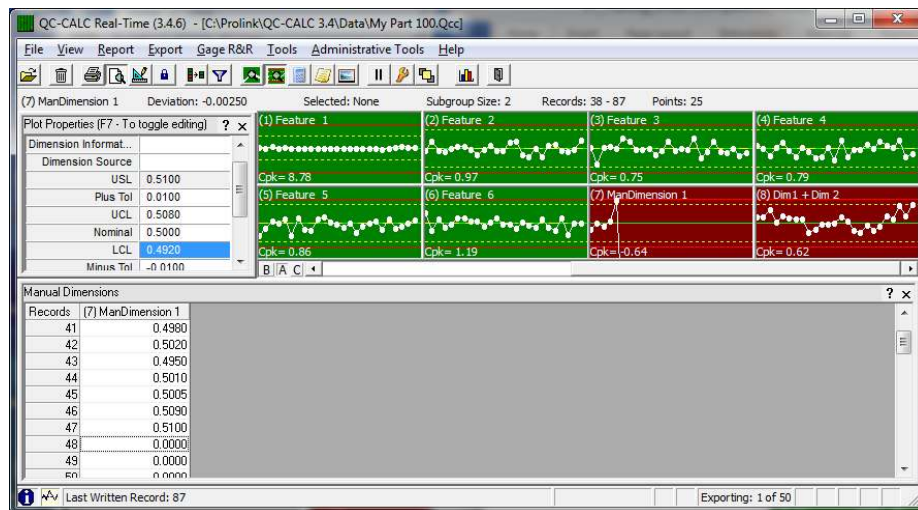
This is simply the default value of the factor or dimension. When the screen launches, cells with default values are pre-populated allowing the operator to enter the data only if it changes.

19.5.2 Turning Manual Input On/Off

The Manual Input functionality is turned on and off via the **Tools – Manual Input** menu. Simply click it in the **Tools** menu to activate or deactivate the MIS.

19.6 Entering Data via Manual Dimension Values Screen

To add data into this Manual dimension, select **Manual Dimension Values** from the **View** menu and a spreadsheet “like” grid is displayed. The grid contains the same number of values as displayed points. As you type the number into the grid, you will see the plot updating. Should you make a mistake, move up in the grid and change your entry.



Remember, QC-CALC stores the manually entered results in the database so you can treat the manual dimension the same as any other dimension.

20. File Creation Defaults

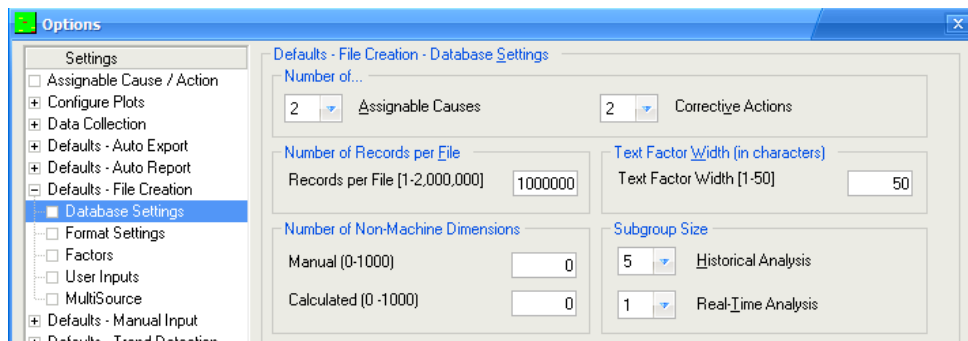
20.1 Introduction

QC-CALC automatically builds its database when it reads a never before seen “results file” from your CMM or gage. Since QC-CALC has a policy of not asking questions, it must obtain reasonable answers from somewhere. QC-CALC uses a concept of **File Creation Default** values for answers to questions during the creation of a new file. You can change the default answers. This section of the training gives you an understanding of what QC-CALC saves and how to change the settings.

Modify Database Structure follows this section and talks about how to change database settings once a database has been established. This means you can override the values after the file is created. Selecting **Tools – Options – File Creation Defaults** displays the following screen.

20.2 Database Settings

With each inspected part, QC-CALC saves the time, date, and Factor values. You can use these Factors to track additional pertinent information about each* part. For example, you can use Numeric Factor 1 to store the MACHINE number. Each time a part is inspected on an automatic measuring machine, the Factor information is saved with it. In later analysis you can plot all data values using the Factor as a criterion, thereby extracting a subset of the database. QC-CALC stores two different types of Factors: Numeric Factors and Text Factors.



20.2.1 Assignable Causes

The purpose of an Assignable Cause is to mark a specific part with an explanation as to why it may be Out of Control or tolerance. You can assign up to 3 of these special events that occur to a single part. The number of different Causes is unlimited. This selection lets you decide the maximum number of assignable causes you want to allow to mark a specific record.

20.2.2 Corrective Actions

The associated Corrective Actions explain what you did to fix the Assignable Cause. However, the number of assignable causes does not have to match the number of corrective actions and vice versa. This selection lets you decide the maximum number of Corrective Actions (up to 3) you want to allow to mark a specific record.

20.2.3 Number of Records per File

Enter the number of parts to be stored in the database. The range is 1 to 100,000. Many companies select a value that is equivalent to a day, a week, or a month's worth of work. This value is variable and can be changed at any time.

20.2.4 Text Factor Width (in characters)

This is the maximum number of characters used in the Text Factors values.

20.2.5 Number of Non Machine Dimensions – Manual

This sets the default number of manually entered dimensions. The default number of **Manual Dimensions** is 0. See [Manual Dimensions](#) on page 99 for more details. The range of manual dimensions is 1 – 100. If you enter an invalid number the entry will change colors to show the error. This value is variable and can be changed at any time.

20.2.6 Number of Non Machine Dimensions – Calculated

This sets the default number of Calculated Dimensions. The default number of calculated dimensions during the creation of a database is 0. This option will not let you exceed the maximum number allowed of 100.

20.2.7 Subgroup Size – Historical Analysis

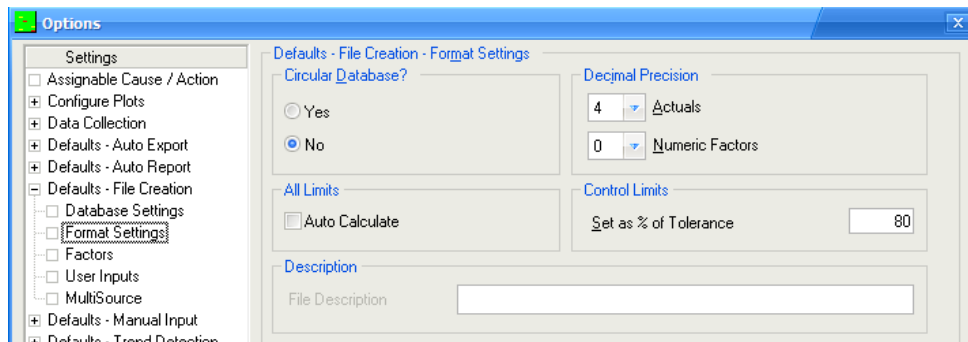
This controls the default number of data points contained within a subgroup. The subgroup only affects the control charts in QC-CALC SPC. The minimum subgroup size is 2 and the maximum is 25.

20.2.8 Subgroup Size – Real-Time Analysis

This controls the number of data points that make up a subgroup (or points) on the QC-CALC Real-Time run plots. The minimum value allowed in the Real-Time plots is 1 (raw data) and the maximum is 25.

20.3 Format Settings

The settings on this Tab affect how the data is presented in QC-CALC Real-Time and QC-CALC SPC.



20.3.1 Circular Database

This tells QC-CALC what to do when the data file becomes full and only applies to Real-Time data collection. If the file is circular, QC-CALC automatically wraps around from the last record back to the first record and begins writing over the old data. If you do not want the old data to be erased, select **No** or archive the data file to another disk.

20.3.2 Decimal Precision of Actuals

QC-CALC holds a total of 7 significant digits per reading. Enter the number of places needed to the right of the decimal point. If you enter a four (4), your format will be **nnn.nnnn**. If you enter a three (3), your format will be **nnnn.nnn**. The Decimal Precision set here will be used as the default precision for all data in your dimensions.

20.3.3 Decimal Precision of Numeric Factors

The Decimal Precision set here will be used as the default precision for all Numeric Factors. This should be set to 0 to ensure items like Lot Number are printed as 123 instead of 123.00

20.3.4 Auto Calculate

The option forces the **Auto Calculate** limits on when a new file is created. The limits will continue to calculate until the specified “Stop Count” is reached. Normally, this option is turned off and the control limits are set to 80% of tolerance. This feature is useful for obtaining control limits without any operator intervention. For more details see [Automatically Calculate Limits on All Plots](#) on page 78.

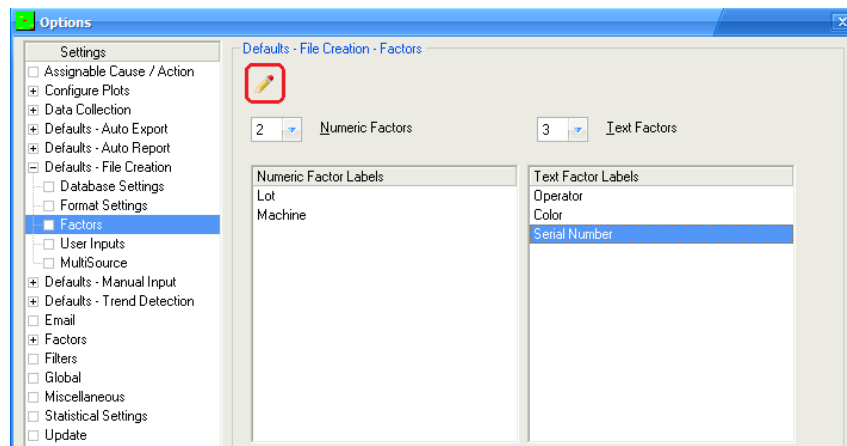
20.3.5 Control Limits as % of Tolerance

The Real-Time Xbar charts are displayed in green rectangles with the center based on the feature’s nominal value. Setting the Control Limits as a percent of tolerance gives you an approximate location to place the yellow dashed control lines based on the nominal and tolerance values. A good value to enter is 80. This moves your control lines to something less than your specification limits. Once you have a reasonable amount of inspection data you can have QC-CALC calculate and save the more accurate control limits. For details, see [Calculate Limits](#) on page 76.

20.4 Factors Settings

The main purpose of this screen is to reserve certain factor locations for named factors that you specify. For instance, if you want the first numeric factor to be Machine Number, you can add one numeric factor to this screen and call it “Machine Number”. Whenever a QCC file is created, the first numeric factor will be reserved for Machine Number. During data collection, if a factor is found in the incoming data by the same name, it will automatically be placed into this first numeric field regardless of its position in the machine output.

This is a very convenient feature for keeping your QCC files standardized and consistent as it both guarantees standardization of factor names and positions. It also allows you to re-use record filters across QCC files since you can rely on the position of the Machine Number (in my example) to be the same.



To use this screen, set the number of **Numeric** and **Text Factors** you want each new .qcc file to contain and then use the **Pencil** button to change the default names of those Factors to names that describe the data they will contain.

It is usually recommended that you set this screen up with a few standard factors you want included in all inspection routines as early in the process as possible. For instance, if you know all parts have a Machine, Serial Number, and Lot Number, it can be helpful to enter them here so all new QCC files have the same factors and positions. Furthermore, since this screen is in the Options area, it is also automatically included in the Administrative Tools. This means you can set these standardized factors at the Admin Group level allowing you to standardize the settings across all copies of QC-CALC in your shop from one location.



Note: Because it is part of the File Creation Defaults, it will only apply to new QCC files that are created. Existing files will not be affected.

20.4.1 Number of Numeric Factors

The Numeric Factors are used to store numbers only. The list allows from 0 to 30 numeric Factors. Don't forget to change each name in the list shown at the bottom of the screen.

20.4.2 Number of Text Factors

The Text Factors are used to store numbers or characters. The list allows from 0 to 30 numeric Factors. If you are unsure whether a Factor may or may not contain text, use the Text Factors and don't forget to change each name in the area below.

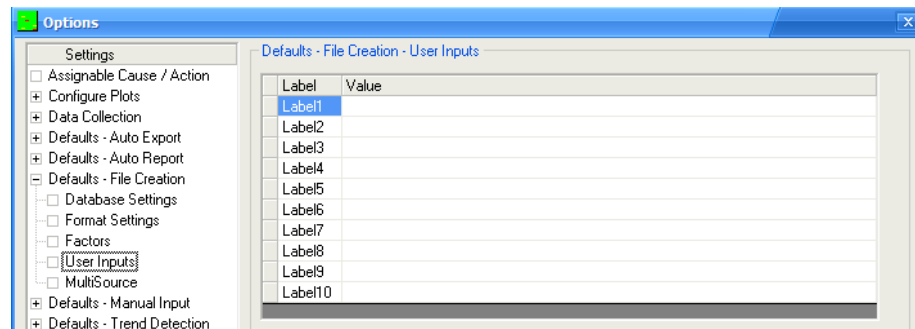
20.5 User Input Defaults

20.5.1 Introduction

User Inputs are used to send extra, last minute text to your reports. This information must be hand typed by someone and entered into 1 to 10 different text-boxes known as **User Inputs**. These **User Inputs** are sent to each report giving you an opportunity of adding "last minute" text to your report. You can edit the values by selecting **Report – Modify User Inputs** as discussed in the Report section of this training manual. Further, you can modify each report template to decide which **User Inputs** are used and where they are displayed. The **Report Designer** is used to modify reports.

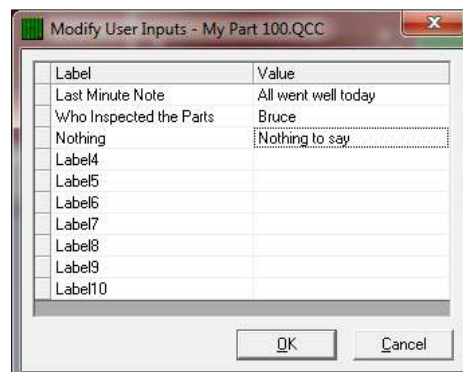
20.5.2 Edit User Input Defaults

The **User Input Defaults** are used to automatically set default information for reports when a new file is created. By adding default **Label** and default **Value** information here, each time a new QC-CALC file is created, you ensure the **User Input** area is "filled in" the same each time.



20.5.3 Modifying User Inputs Before Print

Assuming the labels were added above and MyPart 100.QCC was created some time later, you see the **Modify User Input** screen providing a consistent label for you to identify what **User Input 1** is asking you to "fill in" at the last minute. The labels provide clear direction for the text added in the **Value** column.



21. Data Collection

21.1 How QC-CALC Reads Data

QC-CALC[®] automatically collects and analyzes inspection data generated by all CMMs, Vision CMMs, and hand gages. The direct interface between the CMM and QC-CALC eliminates the need for you to create the SPC database and enter inspection results. Each part program run on the CMM generates important information used by QC-CALC to automate the creation of SPC files. All nominal, tolerance, and related labels needed for real-time data collection and display are passed to QC-CALC via a file transfer. When you run QC-CALC for the first time, you are asked to select the CMM you will be using. QC-CALC normally recommends the CMM since it has searched your computer and knows if it was just installed in one of many machines.

When the machine type is known, QC-CALC continuously looks for inspection result files (every 2 seconds) containing important inspection information. If the inspection output from your part program always produces the same amount of data, data collection is very easy and automatic. However, if you are changing your part programs to include more or less data, QC-CALC must adjust its database. This section helps you understand how to deal with these changes and how automatic data collection can have problems.

21.2 Data Collection Issues

Automatic data collection is easily accomplished when no errors or exceptions occur. However, there are situations where it is difficult to know what to do when the automatic inspection equipment produces unexpected results. For example, assume your part program was written to inspect and report 10 features and QC-CALC reads this file creating a database for each feature. Your part program may have successfully inspected hundreds of parts when suddenly an error occurs and only eight features are reported. Or worse, you edited the part program and add two extra features thereby confusing QC-CALC. Why are inspected dimensions missing or what causes extra dimensions to suddenly appear in the inspection file? What should QC-CALC do when either too few or too many features are found in your results file?

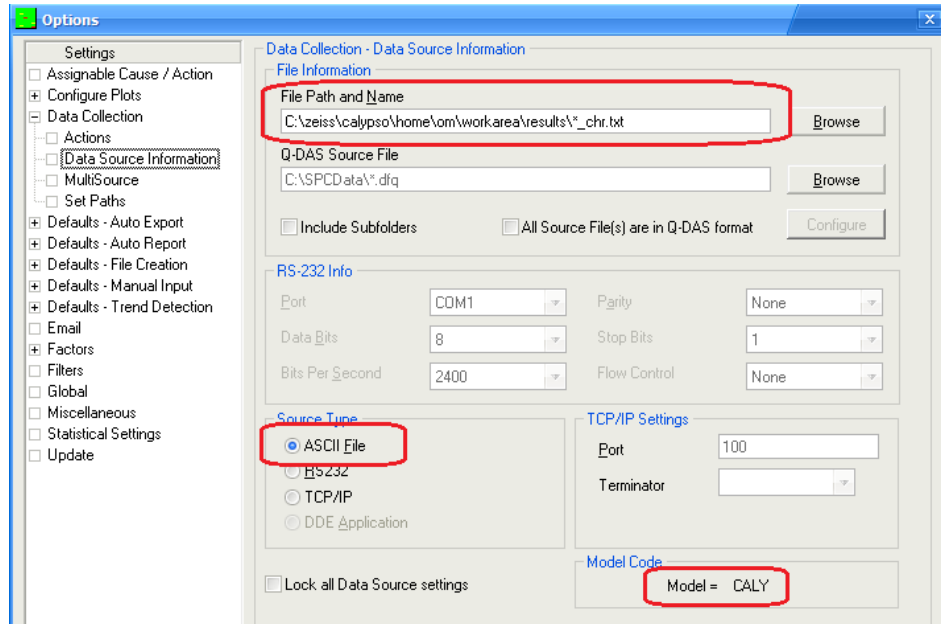
These questions are answered in this section and you should choose the option that best fits your needs. Remember, you may know what to do when errors occur but many times the CMM operator will become confused when error messages are displayed. It is important to set the QC-CALC **Data Collection Actions** to deal with these errors assuming the operator will not understand any of this discussion.

21.3 How Data is Collected

All inspection machines report the part measurement results to a file or possibly to a serial data stream known as RS232. QC-CALC has been programmed to know the details about each machine and therefore knows how and where to expect the results. The most common method of reading data is from a file. This simply means QC-CALC finds and reads your measurement results file. This direct interface between the machines and QC-CALC means you do not have to create SPC databases or manually enter inspection results. Each running part program generates important information used by QC-CALC to automate the creation of SPC files. All nominal, tolerance, control, and related labels needed for real-time data collection and display are passed to QC-CALC via a file.

21.4 Data Collection Settings

Before discussing what to do when things go wrong, we first discuss the settings needed to make things go right. When you select menu **Tools – Options – Data Collection**, you see the **Data Source Information** window. The 3 important areas are the data **Source Type**, the **Model Code**, and the **File Path and Name**. These three items control how QC-CALC automates data collection.

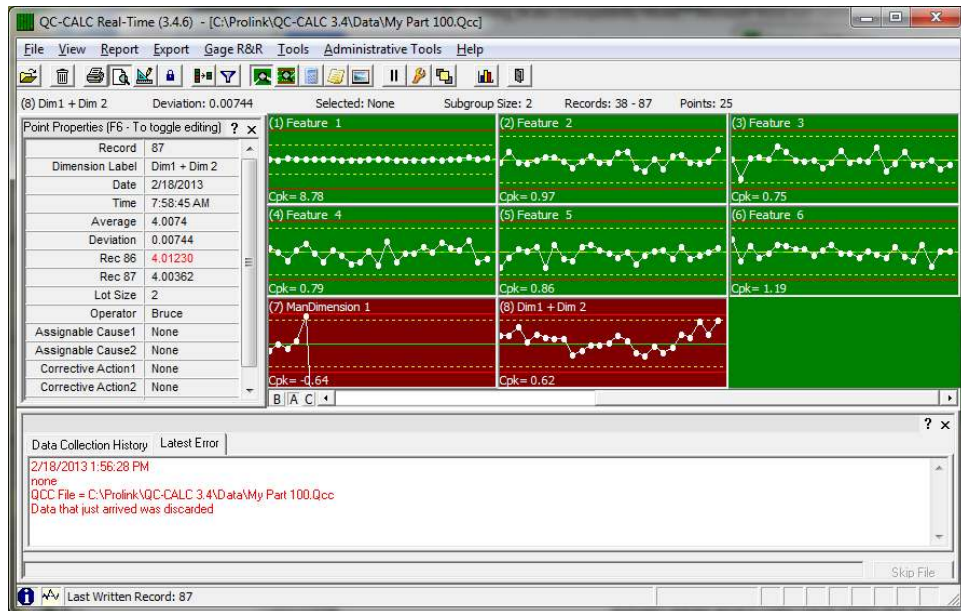


Since 99% of all machines report the results to a file, the source type is usually set to **ASCII File**. Each CMM manufacturer creates different file formats and the **Model** code tells QC-CALC how to read the file. The figure above shows a model code of CALY which is used with Zeiss Calypso machines. You cannot directly change this code since QC-CALC sets it automatically based on the machine type. The **File Path and Name** is the location QC-CALC looks for the results file. Although this is an editable path, you should let QC-CALC adjust this automatically.

For more information about the remainder of the settings see the [Data Source Information](#) section on page 195.

21.5 Data Collection Problems

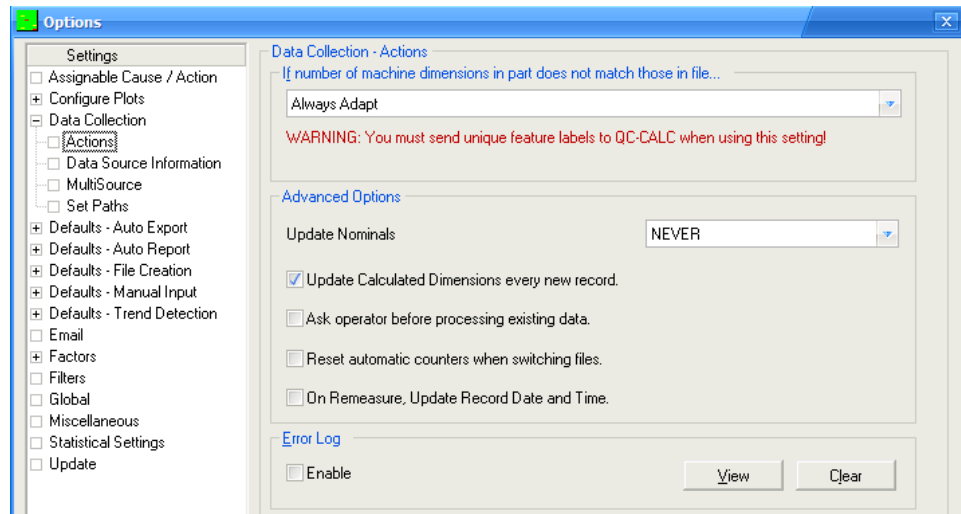
This next diagram shows QC-CALC's Real-Time plots with 8 dimensions (plots) and an error message indicating received data was discarded. When a mismatch of data occurs QC-CALC does not know how to handle the situation so it displays its status window and it reports the error.



This may be an unacceptable action since all of the inspection results were thrown away which may have been the wrong solution to the problem. The rest of this section discusses what the data collection problems are and how to recover from them.

21.6 Data Collection Settings Explained

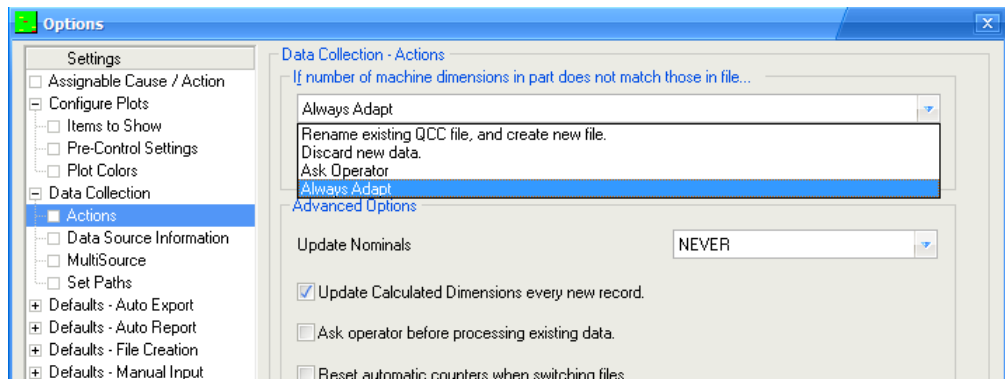
All of the data collection settings are found in the **Tools – Options – Data Collection – Actions** area in QC-CALC Real-Time. The **Data Collection Actions** are shown in a list at the top of this window.



By clicking the mouse on the list, the available actions are displayed as shown next. The description of each action follows this diagram. Remember, the selected action tells QC-CALC what to do when a dimension count from the CMM does not match the existing QCC file.

21.6.1 If Number of Machine Dimensions in Part Does not Match those in File...

These options offer you a preset course of action should your inspection machine save a data file with the same file name but different dimensions.



The list at the top lists the possible actions QC-CALC takes when abnormal data collection occurs. Actions include:

- Rename Existing QCC File, and Create New File
- Discard New Data
- Ask Operator
- Adapt to the New File Format

Rename Existing QCC File, and Create New File

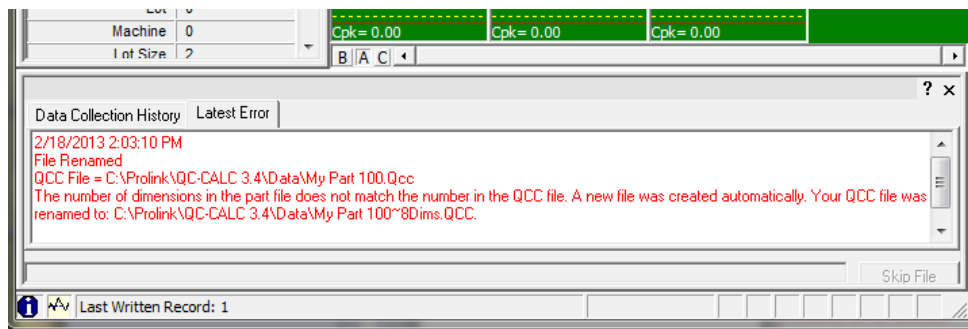
In this case, the name of the active file is changed and a new file is created to store the different sized data - no data is lost. For example, if you were saving 10 dimensions to a file called **MyPart.QCC** and a part is inspected with only 8 dimensions, QC-CALC would rename your active file to **MyPart~10.QCC** and create a new file called **MyPart.QCC** containing only 8 dimensions. The database name was changed from **MyPart.QCC** to **MyPart~10.QCC** where the **~10** tells QC-CALC there are 10 features in the file.

Usually, when QC-CALC receives data from an inspection machine with fewer than expected dimensions it means the part program was aborted early due to an error or possibly the CMM programmer deliberately reduced the number of features being reported. In either case, QC-CALC will adapt the database size and retain your old data in a file with the dimension count as part of the name. Remember, the **~10** tells QC-CALC there are 10 features in the file.

If the reduced number of features was due to a single part inspection error this partial part (8 dimensions in our example) is saved in a file called **MyPart.QCC**. Let's assume the very next part inspection produces the correct number of dimensions - 10 in this case - and QC-CALC attempts to save the data in the newly created file containing only 1 part of 8 dimensions. Clearly another error occurs and QC-CALC performs the following automatic recovery:

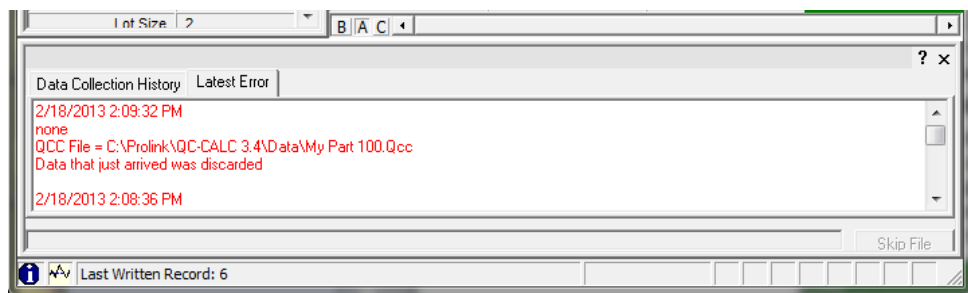
- QC-CALC renames **MyPart.QCC** to **MyPart~8.QCC**
- QC-CALC looks for **MyPart~10.QCC** and when found, renames it back to **MyPart.QCC**
- QC-CALC appends the new data and a full recovery is made.

This type of file creation and switching happens automatically to ensure the operator is not involved with the details and no data is lost. However, the PopUp status screen is displayed indicating something went wrong. The message is displayed until the operator clicks the **X** in the upper right corner of the window.



Discard New Data

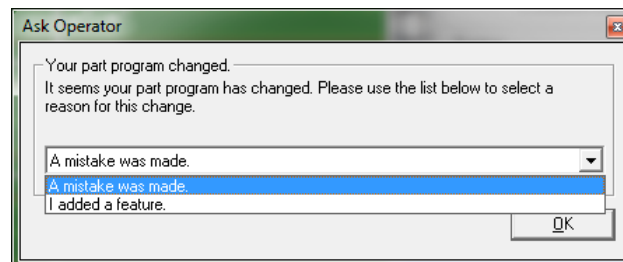
Any time an inspection results file is received and does not match the QC-CALC file it is simply thrown away. Although this seems harsh, many part programmers know that partially inspected parts contain unwanted data so they command QC-CALC to simply ignore the data. You are warned of this event but the inspection results file is lost and no action is required by the operator.



Ask Operator

The operator is prompted by the following screen and may choose one of 2 choices listed below. This option is not recommend since the operator may become confused by this popup screen. This option is available for those programmers or inspectors who do know what to do. The available options are:

- A mistake was made (results are discarded)
- I added a feature (database size is increased)

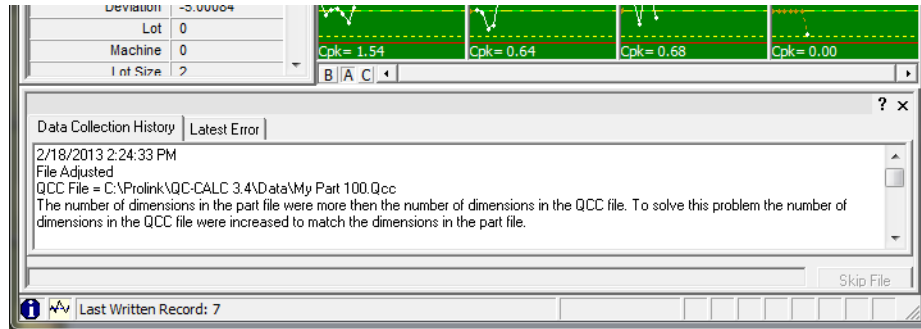


Always Adapt

The last option for mismatched data is the most comprehensive and should be considered the best method in most cases. Using this error recovery method offers the best of each technique discussed so far. When the number of features in the inspection file does not match the number of features in the QCC file, QC-CALC attempts to match-up each label found in the incoming inspection file with each label in the QCC file. This way if new features are added, QC-CALC can determine where to insert the new features. Similarly, if old features are missing from the inspection file, QC-CALC can determine where the missing values are located and then mark the point as deleted. When missing data is found, QC-CALC saves its nominal value and marks the point as deleted.

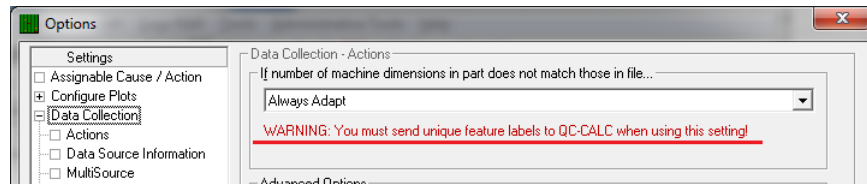
Inspection File Contains More Dimensions

If the incoming inspection file is larger than the QCC file, QC-CALC adds extra dimensions for the extra values received. All previous records for these new dimensions are filled with nominal values and marked as deleted. Marking the missing points as deleted removes their value from any statistical calculation thereby giving you a quick recovery. The deleted points are gold in color and connected with gold dashed lines. The following status message is shown in the Real-Time Data Collection screen when this occurs.



Inspection File Contains Less Dimensions

If the incoming inspection file contains fewer features than the matching QCC file, QC-CALC scans all labels and attempts to match-up the features in the inspection file with the features in the QCC file. All matching data is saved in the QCC file and newly found features are added for all unknown labels. Any missing data is filled with nominal values and marked as a missing point. The missing or deleted points are gold in color and connected with gold dashed lines. No status message is displayed in the Real-Time Data Collection screen.



Special Note

Most inspection equipment allows you to program a feature with the same label but some do not. This can be a problem for QC-CALC since it attempts to find the correct feature by searching the list of feature labels in its database. If more than one identical label exists and QC-CALC is faced with inserting a new feature into an existing database, it become ambiguous.

Unambiguous Labels

Column 2 of the following table shows a QC-CALC file with 6 dimensions all with unique labels. Column 3 shows the same part being inspected but an extra dimension (**Line 1**) has been inserted. Let's assume the part programmer added this extra feature called Line 1.

Since all labels are unique, QC-CALC has no problem inserting an additional feature in the correct location and therefore successfully adapting to this change.

<i>Dim No</i>	<i>Labels in QCC File</i>	<i>Labels in Results File</i>
1	Circle1 X	Circle1 X
2	Circle1 Y	Circle1 Y
3	Circle1 Dia	Circle1 Dia
4	Circle2 X	Line 1

5	Circle2 Y	Circle2 X
6	Circle2 Dia	Circle2 Y Circle2 Dia

Ambiguous Labels

Column 2 of the following table shows a QC-CALC file with 6 dimensions but some labels are repeated. Column 3 shows the same part being inspected with an extra **Circle X**. Let's assume the part programmer added this extra Circle X expecting QC-CALC to adapt to the new situation. Since all labels are not unique, QC-CALC cannot safely insert the additional feature and therefore might add it to the wrong location.

<i>Dim No</i>	<i>Labels in QCC File</i>	<i>Labels in Results File</i>
1	Circle X	Circle X
2	Circle X	Circle X
3	Circle X	Circle X
4	Circle X	Circle X
5	Circle Y	Circle X
6	Circle Dia	Circle Y Circle Dia

Be sure you create unique labels in your part program to ensure QC-CALC can adapt to changes without you having to modify the database by hand.

21.6.2 Update Nominals

The nominal and tolerance information extracted from your inspection routine can be updated in the QC-CALC database during inspection. This is useful when you change the values in your part routine and you want to balance the QC-CALC database nominals and tolerances.

The default setting for **Update Nominals** is NEVER. If you create a QC-CALC file and continue to change the nominals and tolerances, you might decide to change the **Update Nominals** to ALWAYS until the final version of the part routine is saved. This way, your changes are reflected on-screen as you go. The tolerance lines and the size of the plotting window for each graph will dynamically change. When viewing the **Edit - Nominals and Tolerances** screen of each QC-CALC feature, you see 14 editable fields. Of these, 7 change when updating is enabled. The control limits were purposely left out in the event you change the limits manually and don't want QC-CALC writing over your values. The fields that update are:

1. Label
2. Nominal
3. Upper & Lower Tolerances
4. Decimal places
5. Upper & Lower R & Sigma limits

21.6.3 Prevent Tolerance Update from Machine

A special feature of QC-CALC is its ability to block or prevent some nominals from being updated even though **Update Nominals** is set to **ALWAYS**. This option allows you to get very specific as to how and what is synchronized in the database with your part program.

Let's say your part program is changing due to engineering changes so you set the **Update Nominals** to **ALWAYS** to stay synchronized. However, you do not want one of the features you're inspecting updated and you want to block this feature from any change. You can right click on the plot and select **Prevent Tolerance Update from Machine** and all features are updated except the plot you blocked.

21.6.4 Set All “Prevent Tolerance Update”

Of course QC-CALC deals with hundreds or thousands of features on a given part so we added a special feature for setting all **Prevent Tolerance Updates** at one time. This option is found in the **Tools – Options – Set All ‘Prevent Tolerance Update’** menu. It was added in case many of the features you’re plotting (more than 50%) need to be blocked. You can set them all and then go back and turn off the ones you want to update.



Note: QC-CALC SPC has a more convenient method of setting a mix of **Prevent Tolerance Update** settings. This is discussed in the QC-CALC SPC training but for reference you can select **File – Show QC-CALC SPC** and the QC-CALC SPC begins to run. Choose **Edit – Nominals and Tolerances** to show the edit nominals screen. Click the **Prevent Tolerance Update** checkbox, highlight the dimensions (features) you want set, and click **Apply Changes to Selection**.

21.6.5 Clear All “Prevent Tolerance Update”

This is the opposite of **Set All “Prevent Tolerance Update”** and is used to quickly find and clear all occurrences of the option. Please see the two paragraphs above for operational details.

21.6.6 Update Calculated Dimensions

QC-CALC has calculated features you can manually add to your CMM data. As data is received from your inspection equipment, this option automatically performs the calculations of these special plots and updates each calculated plot. This option should be on but if it is accidentally shut off, you can update by choosing **Tools – Options – Update Calculated Dimensions**.

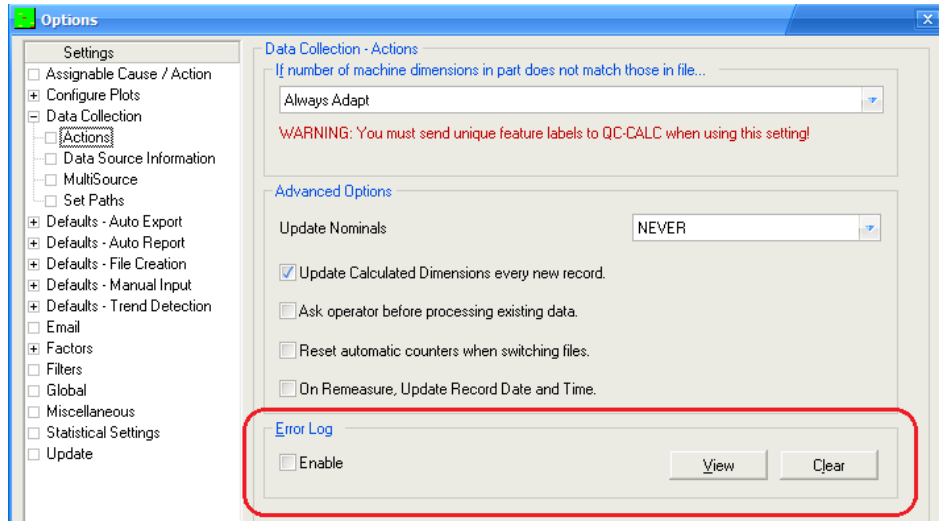
21.6.7 On New File... Reset Auto Counters

Using this option will cause all the automatic counters to be reset to 0 when changing between parts. This means if you are running part ABC and the counter for Reporting is at 4 of 8, then when part DEF comes in the counter will start over at 0. Switching back to part ABC would reset the counter again to 0.

Not having this option checked means that when you switch back to part ABC the counter will go back to where it was the last time the part ran. In this case the Report counter would end up at 5 of 8 (a part was received in order to switch back to part ABC).

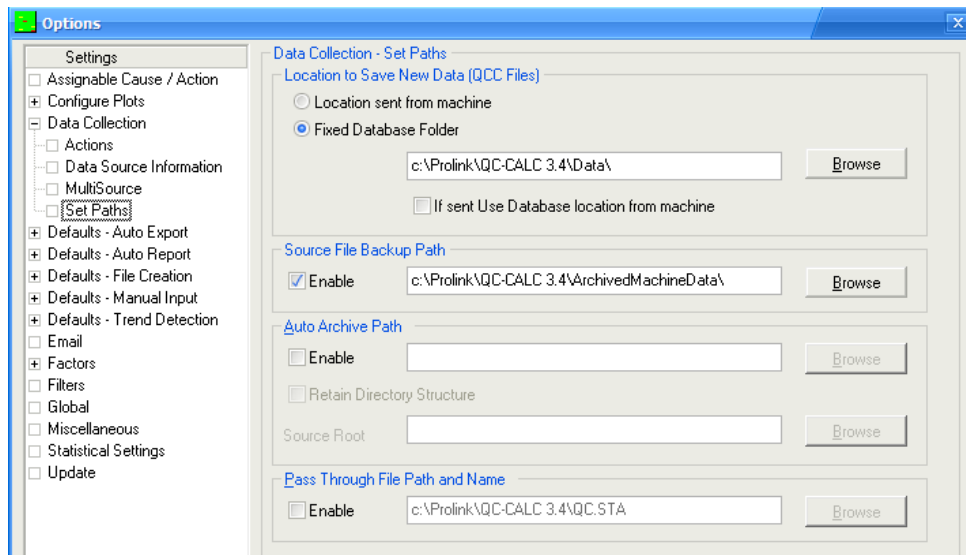
21.6.8 Error Log

When enabled, QC-CALC's error logging will record any errors that occur in a text file called ErrorLog.txt. This recording of errors will not interfere in any way with your data collection. When you wish to view the file of accumulated errors, simply click the **View** button and the file will open in Notepad. The file will be emptied whenever you click the **Clear** button, or when the file reaches a size of 32 Kb.



21.7 Set Paths

Selecting menus **Tools – Options – Data Collection – Set Path** displays the window shown below. Each option is discussed below. Most paths that QC-CALC Real-Time needs to have set are shown here. The functionality of each of these paths is described in the following pages.



21.7.1 Location to Save new QCC Files

Location Sent from Machine

QC-CALC normally stores data in the folder of the currently open .QCC file. **Note:** The default location is C:\Prolink\QC-CALC 3.4\Data\. To save data in a different folder, you must open any QCC file in the folder of choice making this new folder the default or active folder (path). This can be annoying when you open a file in another location and forget to return to the default location. For this reason we added a file path where QC-CALC must save its data.

Fixed Database Folder

Path to Save new QCC Files overrides the QC-CALC default folder location by providing an absolute file folder. Activating this option forces QC-CALC to save all .QCC files to the specified location regardless of where the currently open data file is located. You can set the folder for QC-CALC to save all .QCC files by clicking the **Enable** checkbox, press the **Browse** button, navigate to the desired folder, and click **OK**.

21.7.2 Source File Backup Path

Normally, QC-CALC reads your inspection result file and then deletes it. There are times you may want to keep a permanent record and have QC-CALC send the source file to another location. Use this path to save your data elsewhere. To avoid file overwrites, QC-CALC adds the date and time plus an index number to the file name to guarantee this does not happen. We use the tilde character to separate the date ~ time ~ index.

i.e. **MyPart.TXT** - was saved as - **MyPart~10-12-2007~65812~1.TXT**

In this example, MyPart.TXT was inspected on Oct 12, 2007 65912 seconds after midnight. The ~1, ~2, ~3, etc is added to the name in the event

21.7.3 Auto Archive Path

This option forces QC-CALC to create a 2nd copy of your active .QCC file in a different location. Although you can choose the same folder location as your active data file, the path should be on a network drive where the data is backed up daily. QC-CALC adds “**_Archive**” to your active file name to distinguish the difference between the two files

MyPart.QCC → MyPart_**Archive**.QCC

You can set the folder for QC-CALC to Archive all .QCC files by clicking the **Enable** checkbox, press the **Browse** button, navigate to the desired folder, and click **OK**. If this folder becomes unavailable due to network or computer server problems, QC-CALC keeps track of the last known “good archive”. When the network is restored, all “unarchived” records are sent at one time. There are no settings for this feature and QC-CALC takes care of all details fully automatically.

Archive Concept

QC-CALC has two interrelated concepts for archiving data. First, QC-CALC Real-Time can have a Circular database. This simply means you set the size of the database to a maximum number of parts (records) and when it becomes full, it wraps around to record 1 and begins overwriting old data. If losing old data is undesirable, do not make the database Circular or make it circular but Auto Archive the data to another drive.

As an example, let's say you want QC-CALC Real-Time to maintain 1 month of data which you determine is approximately 900 parts. You set the file size to 1000 and make it Circular. As parts are inspected QC-CALC Real-Time shows the newest value as usual, but quietly wraps around to record 1 when 1000 records have been filled. This circular method continues endlessly allowing you to scroll back and forth throughout a little more than a month's worth of parts.

If you turn on the Archive system and select a network drive, the inspection data is quietly copied to a second location thereby not requiring any human intervention or knowledge. The archive file is much larger and basically endless, so QC-CALC Real-Time has the latest history while QC-CALC SPC can open the archive file and show all data.



Note: Only the inspection data is saved to the archive file. If any values are changed/deleted or additional values are entered manually, those changes will NOT be saved into the archive file. We recommend using the EDL program to keep a complete copy of your data in a SQL database instead of relying on the archiving functionality within QC-CALC Real-Time.

When Auto-Archiving is turned on a new archive file with the “_Archive.qcc” suffix is created with a default database size of 2,000,000 records. When the archive file becomes full it is copied to FileName_Archive~#.qcc (starting with 0) and a new archive file is created with the 2,000,000 record size with same “_Archive.qcc” suffix. As each fills up the # is incremented by 1.

QC-CALC File Name	Contents
MyPart .qcc	the active QC-CALC file
MyPart_Archive.qcc	contains a copy of the first 2,000,000 records.
MyPart_Archive~0.qcc	contains a copy of the next 2,000,000 records.
MyPart_Archive~1.qcc	contains a copy of the next 2,000,000 records.
MyPart_Archive~2.qcc	contains a copy of the next 2,000,000 records.
etc.	

Retain Directory Structure

This option is necessary if different .qcc files are being saved into separate folders (based on your customer names for example). Enabling this option and setting the **Source Root** folder enables QC-CALC to mimic the same folder structure for the Archive files that it uses for the regular data files.

21.7.4 Pass Through File Path and Name

This option is used to pass a copy of the part data just received from the inspection machine to a second copy of QC-CALC using your internal network. It is only relevant to customers using networked computers.

If you have several inspection machines inspecting the same part it is possible to make one file containing the data from the multiple inspection machines. The inspection machines must be using the same part programs with the same name so that all measured features are saved to the same summary file. This process is done automatically if all inspecting QC-CALC's pass the data to the same PC running the central data collection.



Note: The value for **Pass Through File Path and Name** cannot be the same as the value for **Data Source Information – File Path and Name**.

22. MultiSource

22.1 Introduction

The MultiSource option allows you to collect data from multiple sources into one QCC file. This is a major improvement over past versions of QC-CALC where you may have had multiple QCC files representing the same part if you measured it on more than one inspection machine. You then had to group them in order to run reports on your parts. While that was an acceptable work around, having all the data for a part in the same QCC file is certainly more preferable.

MultiSource actually encompasses two different types of scenarios. To illustrate, we'll use a common example. Let's say you have a part and on that part you would like to measure 10 features. The first 8 are on your CMM. Then you take the part off the machine and measure the last two features with a handheld caliper. In the past, you would have a copy of QC-CALC Real-Time running on your CMM and it would create a QCC file for the 8 features. Then you would have a spec plan running in QC-Gage for your caliper. This would submit the data to a different copy of QC-CALC Real-Time on a different workstation and would create a different QCC file with 2 features. In order to run a first article for your part, you would need to launch QC-CALC SPC, create a group with the two files, and then run your first article report. The group would line the two files up side by side allowing you to report across both of them. The problem is that the data is still broken up between the two files.

MultiSource data is all being saved into the same QCC file regardless of the number or types of sources. If you are familiar with **Always Adapt** mode in QC-CALC, then this is basically an extension of this functionality. QC-CALC allows you to automatically merge parts from different measurement tools into the same database making the data storage simpler. This eliminates the need to create groups and allows you to run automatic reports and exports on the parts as they are collected. In the example above, the first 8 features from the CMM would be added to a QCC file. The gage station running QC-Gage would then add the last 2 features to the same QCC file.

22.2 Setting Up MultiSource

There are a couple rules to making the MultiSource functionality work. The rules are bulleted here and explained in greater detail in the following paragraphs.

1. You must have the **Data Collection Actions** set to **Always Adapt**.
2. You must have the MultiSource parameters set to one of the options below either in the **File Creation Defaults** (recommended) or at the individual QCC file level once the file has been created.
3. All of your sources must output files that have the same QCC file name. If you have inspection routines of different names, you can use the DBSwitch command to override the name so it matches the other sources to your MultiSource QCC file.
4. All of your feature names must be unique since QC-CALC always matches up features by name when **Always Adapt** is set.

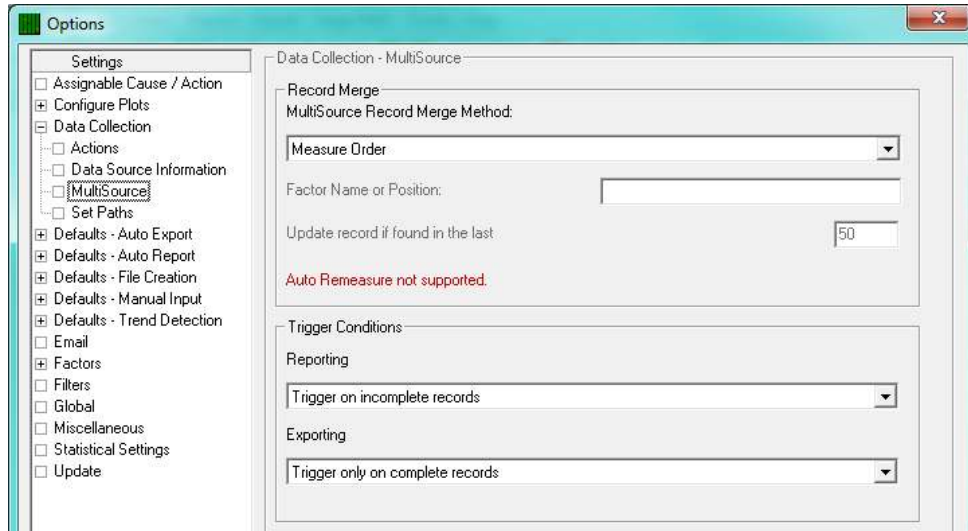
22.2.1 Setting Always Adapt

MultiSource is built around the **Always Adapt** option in QC-CALC and this must be set in order for the MultiSource functionality to work correctly. To set this option, perform the following 3 steps:

1. Go to **Tools – Options – Data Collection – Actions**.
2. Choose **Always Adapt** from the **If the number of machine dimensions in part does not match those in file...** list at the top of the screen.
3. Click **OK**.

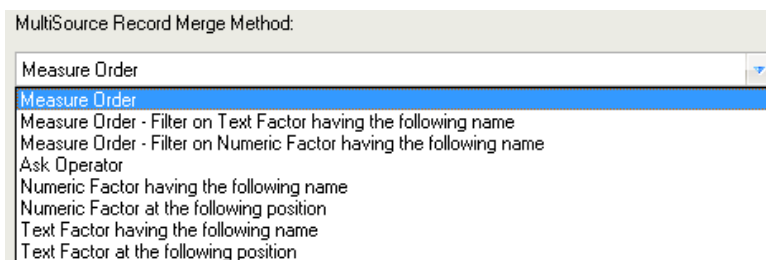
22.2.2 Setting MultiSource Parameters in File Creation Defaults

You can either set up individual QCC files to allow MultiSource, or in the **File Creation Defaults** of QC-CALC Real-Time you can set standard settings across all QCC files. **File Creation Defaults** are default settings that are added to a new QCC file when it is created (i.e. the first time you measure that particular type of part). Once the QCC file has been created, you can always go back and change the settings since they are only defaulted from the File Creation Defaults. It is recommended that you set up MultiSource in the File Creation Defaults to save yourself time and confusion later.



When setting up MultiSource, you can choose between many different modes in order to merge the records from your multiple sources. To set the options, perform the following steps:

1. Go to **Tools – Options – Defaults – File Creation – MultiSource**.
2. Choose one of the **MultiSource Record Merge Method** modes from the list at the top of the screen.
3. Set the options below based on the option chosen.
4. Click **OK**.



To explain the modes, we'll use the example above where you are measuring 8 features on your CMM and 2 features in QC-Gage. Let's assume you have 5 parts each with two factors; Serial Number (1-5) and Operator (The operator is the same for all parts. In this case, we'll call him "Jason").

Measure Order

This is the simplest method of merging records from multiple sources because there is no unique identifier between the sources. This method is recommended if you have equipment that is not capable of sending unique identifiers. In this mode, QC-CALC simply adds records as they arrive in the order they arrived. Making the data all fit together correctly depends more heavily on measuring the parts in the same order for all sources. If you measure the parts out of order or skip a part, the records will be out of sequence in the QCC file.

For our example, if your CMM measures your 5 parts in order by serial number (1-5) QC-CALC will create a QCC file with 5 parts and 8 features each. If you then measure the parts using QC-Gage, you will see QC-CALC suddenly add the extra two dimensions. You'll also see the first part filled in with the new values. The other 4 parts will be gold indicating there is no data for them yet. As you measure each part, the 2nd, 3rd, 4th and 5th the values fill in for each part. As long as you measure the parts in the same order in QC-Gage as you did on the CMM, the data will match up. Measuring in the same order is recommended anyway for good SPC practices.

Continuing with our example above, if you skipped part 3 in QC-Gage and continued measuring parts 4 and 5, you would quickly notice that parts 4 and 5 are offset by one. This is because there is no identifier to tell QC-CALC that part 4 needs to match up with part 4 in the database, etc. To get around this issue, there is a menu item on the popup menu called Mark Record as Received. If you know you are going to skip a part and want to make sure the subsequent parts are not offset, simply right click on the part and choose **Mark Record As Received**. In our example, if we marked part 3 as received then parts 4 and 5 would be placed in their correct spots when they arrived from QC-Gage.

Measure Order – Filter on Text Factor having the following name

Same as the Numeric Factor described below but text factors are used instead.

Measure Order – Filter on Numeric Factor having the following name

This method is required when you want part data merged between two gages in the order they are measured but you need to filter the parts by a unique factor first. Let's say you have 2 CMMs inspecting the same part type. CMM1 is inspecting parts made from Lot 1 and CMM2 is inspecting parts made from Lot 2. Both machines are running at the same time so the data in the QC-CALC file is mixed as desired and as shown in the table below.

Time	CMM 1 measures	CMM 2 measures	QC-CALC database
9:00	Part 1 – Lot 1	..	Record 1 – Lot 1
9:01	..	Part 1 – Lot 2	Record 2 – Lot 2
9:02	..	Part 2 – Lot 2	Record 3 – Lot 2
9:03	Part 2 – Lot 1	..	Record 4 – Lot 1
9:04	Part 3 – Lot 1	..	Record 5 – Lot 1
9:05	Part 4 – Lot 1	..	Record 6 – Lot 1
9:06	Part 5 – Lot 1	..	Record 7 – Lot 1
9:07	..	Part 3 – Lot 2	Record 8 – Lot 2
9:08	..	Part 4 – Lot 2	Record 9 – Lot 2
9:09	..	Part 5 – Lot 2	Record 10 – Lot 2

At 9:10 inspector 1 brings his basket of 5 parts to a hardness tester for the final measured feature (hardness). The hardness tester requests the Lot number and he enters a 1 and measures the hardness value. Knowing that QC-CALC has parts made from both Lots, you want the data filtered on Lot 1 before the merge occurs. This filter allows the hardness value to be saved with Lot 1 parts in standard measure order, beginning with Record 1. His second part is saved with the 4th record and so on. Focus on the time in the left column to understand how this sequence occurs.

Time	QC-CALC database	Hardness value
9:10	Record 1 – Lot 1	From Lot 1
	Record 2 – Lot 2	
	Record 3 – Lot 2	
9:11	Record 4 – Lot 1	From Lot 1
9:12	Record 5 – Lot 1	From Lot 1
9:13	Record 6 – Lot 1	From Lot 1
9:14	Record 7 – Lot 1	From Lot 1
	Record 8 – Lot 2	
	Record 9 – Lot 2	
	Record 10 – Lot 2	

At 9:15 inspector 2 arrives at the hardness tester with his basket of 5 parts. As he measures this hardness value he enters a Lot of 2 and QC-CALC filters the data and starts writing the values into the correct locations.

Time	QC-CALC database	Hardness value
9:15	Record 1 – Lot 1	From Lot 2
	Record 2 – Lot 2	
	Record 3 – Lot 2	
9:16	Record 4 – Lot 1	From Lot 2
	Record 5 – Lot 1	
	Record 6 – Lot 1	
	Record 7 – Lot 1	
9:17	Record 8 – Lot 2	From Lot 2
9:18	Record 9 – Lot 2	From Lot 2
9:19	Record 10 – Lot 2	From Lot 2

Ask Operator

With this option, the operator will be asked to specify the Unique Factor to use for the MultiSource merging.

Numeric Factor having the following name

This is the most recommended method since the parts are matched up based on a unique identifier in the numeric factor. If you have a trace field such as Serial Number, then this is a great way of ensuring all of your parts will be matched up across sources regardless as to whether or not you measure them in the same order. If you choose this mode, specify the name of the factor in the **Factor Name** field just below the list. As long as your two inspection routines output a field that matches this name exactly, all parts will automatically match up. If there is no factor with the matching factor name specified, QC-CALC will revert back to Measure Order mode.

Using the above example, if you measured the parts in order from 1-5 on your CMM and then measured Serial Number 2 in QC-Gage, the 2nd record will automatically populate the last two dimensions. The 1st, 3rd, 4th, and 5th records will be gold as they have not yet arrived. You can then measure the parts in any order and they will all match up correctly since the database is matching on unique serial numbers. You can also remeasure any of the parts as many times as necessary. Each time you remeasure a part of the same serial number, QC-CALC will automatically replace the value that arrived from that part for the source you sent.

Numeric Factor at the following position

This is a good method for matching up on a unique identifier if the factor names do not match, but it depends on the ordinal position of the factor in order to match up its values. If you choose this mode, specify the numeric ordinal position of the factor in the **Factor Position** field just below the list. As long as your two

inspection routines output a unique value in the same position, all parts will automatically match up.

Using the above example, if you set the Factor Position to 1 and the serial number of your CMM and Gage are both in position 1, the parts will all match up correctly since the database is matching on unique numbers in the first position. This is regardless as to the actual name of the first numeric factor in each device. For instance, maybe your CMM calls it "Serial Number" and your Gage Spec Plan calls it "Part Num". It will still work since QC-CALC is searching based on ordinal position rather than Factor name. You can also remeasure any of the parts as many times as necessary. Each time you remeasure a part of the same serial number, QC-CALC will automatically replace the dimensions that arrived from that part for the source you sent (in this case the CMM or QC-Gage).

Text Factor having the following name

This is the same as **Numeric Factor Having the Following Name** above. The only difference is that QC-CALC is matching on a text factor name rather than a numeric factor name. This is useful when your part numbers or unique identifier contain alpha numeric characters. Examples include ("123-56a", "123-456", etc). Since they aren't truly numeric, you must treat them as text fields.

Text Factor at the following position

This is the same as **Numeric Factor at the Following Position** above. The only difference is that QC-CALC is matching on a text factor position rather than a numeric factor position.

22.2.3 Searching for Unique Matches

When using any mode other than Measure Order, QC-CALC will look for a record with matching factor value based on the unique identifier specified. If such a record is found, then it will update the values of the features for that source for that record. If it is not found, QC-CALC will assume this is a new part and create a new record in the QCC file. Since it is searching the QCC file for a matching value, QC-CALC starts from the end and starts looking back over the records in the QCC file to find a match.

To control how many records it searches, you can set the value on the MultiSource setting screen to the desired amount. The setting is labeled, "Update record if found in the last" 50 "records". The default value is 50 meaning QC-CALC will start from the last record received from all sources and search back 50 parts for a matching factor value. As explained above, if not found a new record will be created.

This setting is meant to govern the amount of searching necessary especially with larger files. You can imagine a file with 100,000 records. When a new part is measured, QC-CALC would have to search back through every record looking for matches. This would get worse and worse as the file became larger. It has been added as a setting because there are times when customers have large fixtures that can hold up to 125 parts at a time. In this case, you might want to set the value to 125 to ensure you match up the parts correctly. Otherwise, 50 is typically an acceptable setting for most applications.

22.2.4 Automatic Re-measuring

If you are using any mode other than **Measure Order**, you can automatically re-measure any part from any source. When a record arrives with the same unique identifier multiple times, the record is updated (re-measured) rather than a new record being added to the end of the QCC file. Only when the unique identifier is not found is a new record added to the QCC file. The right click menu still contains the **Remeasure** option, but this option is no longer necessary if you are using a MultiSource mode other than **Measure Order**. Simply measure the same

part with the same unique identifier and the values measured will replace those in the QCC file.

22.2.5 Automatic Report/Export Triggering

When dealing with multisource QCC files, report and export triggering become a little more complex because it isn't always clear when you want to trigger a report. Should it be done when the record is partially full or only after the record has been completely loaded? To assist with this, Prolink adopted the following philosophies when dealing with both reporting/exporting and triggering each in a multisource environment.

1. Reporting is generally used for telling a user about something either in real-time or in a batch mode (every x parts). As such, it is more likely that a partial record will be used in reporting.
2. Exporting is generally used for synchronization of multiple systems. As such, it is more likely that only complete records should be sent to a downstream system.
3. A record is considered complete when all sources of the record have submitted at least one feature value. This is different than requiring a value for every feature. There are times when an extra feature is measured for 1 part and either never again or not for a long time. In this scenario, requiring all features to be considered "complete" would cause most parts to never actually acquire this status. Instead, as long as all the sources have checked in on a particular record, we will consider it "complete".

22.2.6 Options

Like the other MultiSource options, report and export triggering can be set either in the **File Creation Defaults** or at the individual QCC file level. To set it at the individual level, go to **Tools – Options – Data Collection – MultiSource**. To set it in the File Creation Defaults, go to **Tools – Options – Defaults – File Creation MultiSource**. In both cases, there are two lists at the bottom where you can choose the triggering options for both reporting and exporting. Both have the same options, but behave slightly differently due to the concepts above. The options are to "Trigger on incomplete records" or to "Trigger only on complete records".

22.3 Triggering for Automatic Reporting

When triggering for automatic reporting, triggering will only occur once for each source of the record. For example, let's say you have a QCC file with 10 features (2 sources of 5 features each). If the first source sends its 5 features, a possible report trigger will happen. If the second source sends its first feature, another possible report trigger will happen. If the second source then sends its remaining 4 features a trigger will not happen. This is because the trigger only happens once for each source per record. This is by design to avoid multiple reports from being triggered over and over again as the data trickles in or is re-measured.

If the trigger setting is set to "Trigger on incomplete records," a report will trigger as soon as the condition of the automatic report is met (regardless as to whether or not the record is complete). This is typically used when you want to trigger a report when a part goes out of control or out of spec. You will want to know about this immediately so waiting for the record to be completed is not an option.

If the trigger setting is set to "Trigger only on complete records," a report will trigger only if the condition of the automatic report is met and the record is considered "complete". See above for the definition of a complete record. Given this scenario, if there are multiple copies of QC-CALC contributing to the same QCC file and you want to trigger only on complete records, make sure the last QC-CALC has auto-reporting turned on. If the first source of the record has

automatic reporting turned on, you will never get a report. This is because the first source will never see completed records.

22.4 Triggering for Exporting

When triggering for automatic exporting, triggering will occur once for each source of the record and for re-measurements. For example, let's say you have a QCC file with 10 features (2 sources of 5 features each). If the first source sends its 5 features, a possible export trigger will happen. If the second source sends its first feature, another possible export trigger will happen. If the second source then sends its remaining 4 features, a third possible export trigger will happen. This is by design. Taking into account the philosophy that exporting is typically used for synchronization with a downstream system, it is typically desired that any updates are transmitted to that system to keep everything up to date.

If the trigger setting is set to "Trigger on incomplete records," an export will trigger as soon as the condition of the automatic export is met (regardless as to whether or not the record is complete). This is not used often and is not recommended unless you are sure your downstream system can handle repeated partial measurements of the same record.

If the trigger setting is set to "Trigger only on complete records," an export will trigger only if the condition of the automatic export is met and the record is considered "complete". See above for the definition of a complete record. Given this scenario, if there are multiple copies of QC-CALC contributing to the same QCC file and you want to trigger only on complete records, make sure the last QC-CALC has auto-exporting turned on. If the first source of the record has automatic exporting turned on, you will never get an export. This is because the first source will never see completed records.

23. Factor Settings

23.1 Introduction

With each inspected part, QC-CALC saves the date, time, and up to 30 items known as Factors. You may hear Factors referred to as Trace Fields, protocols, or some other or non-measurement data type. They all mean the same thing and they are referred to as Factors throughout QC-CALC.

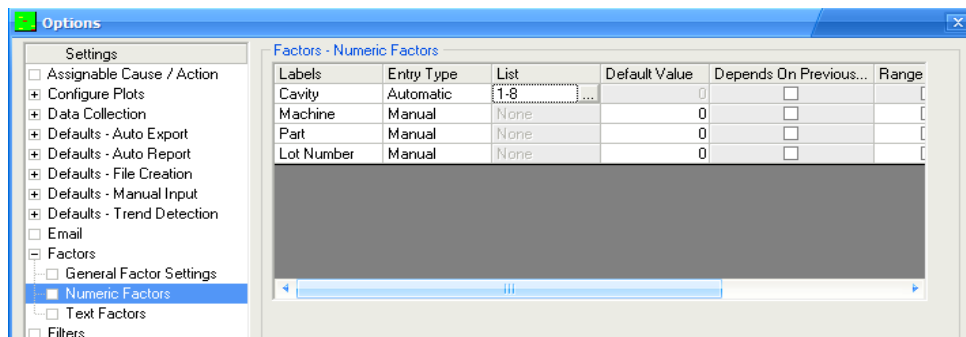
You use Factors to track additional pertinent information about each part. For example, you can edit Numeric Factor 1's label to read **Lot**. This will help identify the origin of the stored data. Each time a part is inspected on the measuring machine, the Factor information is saved with the part. In later analysis, you can plot all data values using the Factor as a filter criterion thereby extracting a subset of the database. For example, you can analyze all parts made in **Lot 6** or all parts made in **Lot 6** by **Operator John**.

Some inspection equipment can send this extra non-measurement information to be saved in the QC-CALC Factors but others cannot. Please refer to the special "gray pages" that are normally included in the front of the QC-CALC manual. Prolink has written a special interface manual for each machine interfaced to QC-CALC. You can also download any of these 5-30 page manuals from our website or use the **Help – Machine Specific** menu to read the same content.

This section discusses how QC-CALC generates, saves, and uses these values as filters during analysis.

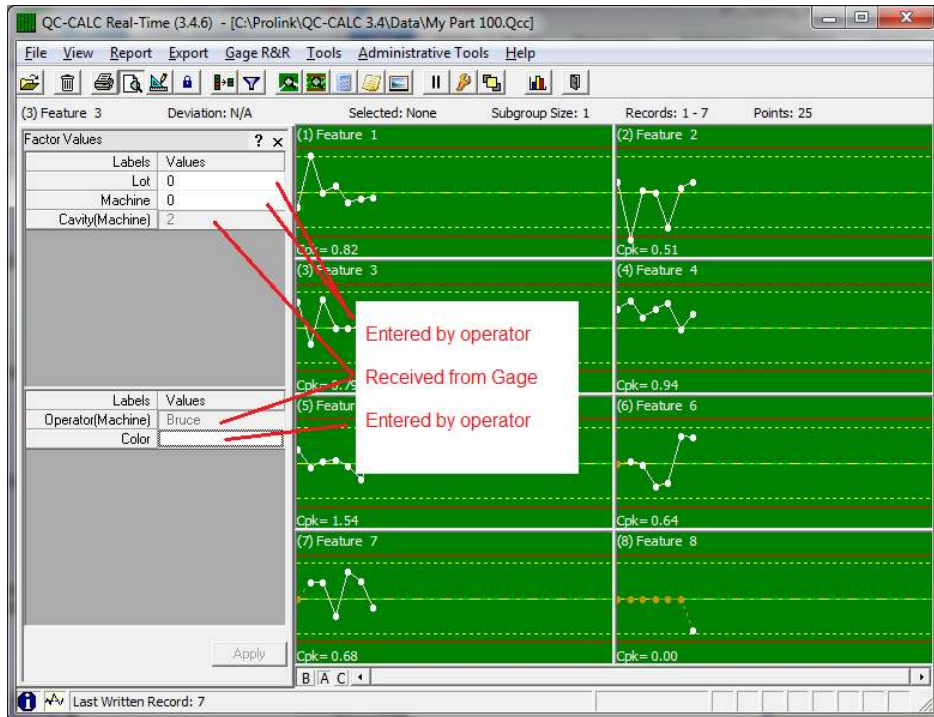
23.2 Factor Screen – Setup

This screen is used to create and add Factor values from within QC-CALC Real-Time and save them with the incoming parts. To do this you must setup QC-CALC so it knows what to add to incoming parts. To see the Factor setup screen select **Tools – Options – Factors** and a similar screen to the one in the figure below is displayed.



23.3 Factor Value Screen

After setting up the Factor values to be added to your incoming data you must display the values to the operator. To see your Factor values select **View – Factors Values** and QC-CALC displays them at the left side of the screen.



You can see the Factor values during data collection by viewing the **Point Properties** but the **Factor Value** screen allows for easy editing. Certain values are grayed out and un-editable. A grayed out Factor means the source of the value is automatic or coming from the inspection machine. These two types of Factor sources cannot be overwritten because they have a higher priority than hand entered values.

A close-up of the Factor Value screen shows the Factor labeled **Cavity (Machine)**, and is grayed out and not editable. The word (Machine) indicates the value 2 was received from the CMM Machine and cannot be overwritten. Similarly, the Factor labeled **Operator/(Machine)** is grayed out.

Because QC-CALC has 3 different sources of Factor values, all of which could occur simultaneously, a priority system is needed where you tell QC-CALC which Factor source you consider the highest priority. This priority system is discussed in detail in the **General Factor Settings** section below.

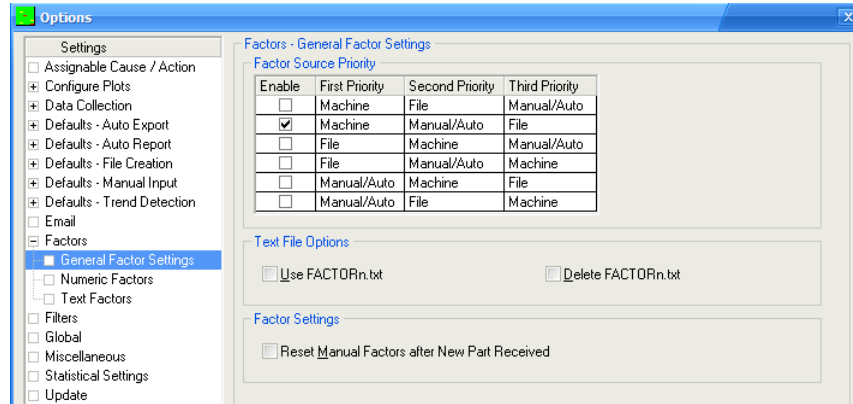
23.4 General Factor Settings

23.4.1 Introduction

QC-CALC allows for 3 different sources of Factor values, all of which could occur simultaneously. For this reason, a priority system was created so you can tell QC-CALC which Factor is the most important and which Factor should be ignored. The three sources of Factors are:

- Manual / Auto (built-in to QC-CALC)
- Machine (from your CMM)
- File (external text file)

This section of the manual has been devoted to discussing the **Manual / Automatic** method of generating Factors from within QC-CALC. Factors sent from your CMM **Machine** are discussed in the special manual written for the particular CMM you are using. These short machine interface manuals are printed on gray paper and included as the first pages of the QC-CALC manual. They are also available from within QC-CALC by using the **Help – Machine Specific** menu. The **File** method of passing Factors to QC-CALC has not been discussed previously but is detailed below.



The First Priority should be any Factors included with the inspection data (**Machine**). If the machine cannot produce this data the next best method of receiving Factor information is the built-in **Manual / Automatic** which is set as the second priority. The third and last priority is the little known **File** mechanism.

23.4.2 File Option

Introduction

A special file-read function was added to QC-CALC Real-Time for the purpose of merging external information into your inspection record. This need occurs when production line systems are not tightly integrated but must pass important information to save with your data. Let's assume you have an inspection machine that measures your parts but prior to the inspection a barcode reader reads a serial off the part. You want the serial number to be added to the inspection results and everything read into QC-CALC as a package. This scenario is possible through the use of a QC-CALC built-in function called FACTORN.TXT

QC-CALC can be set to read Factor information from an external text file. When QC-CALC receives inspection data from your CMM it optionally looks for the existence of 1 to 30 files named FACTORN1.TXT, FACTORN2.TXT, FACTORN3.TXT, ... and FACTORN30.TXT in the same folder QC-CALC was installed. If any of these files exist, QC-CALC reads them and writes their contents in the corresponding **Numeric FACTOR**. The number found in the file's name is used as the Factor number within QC-CALC.

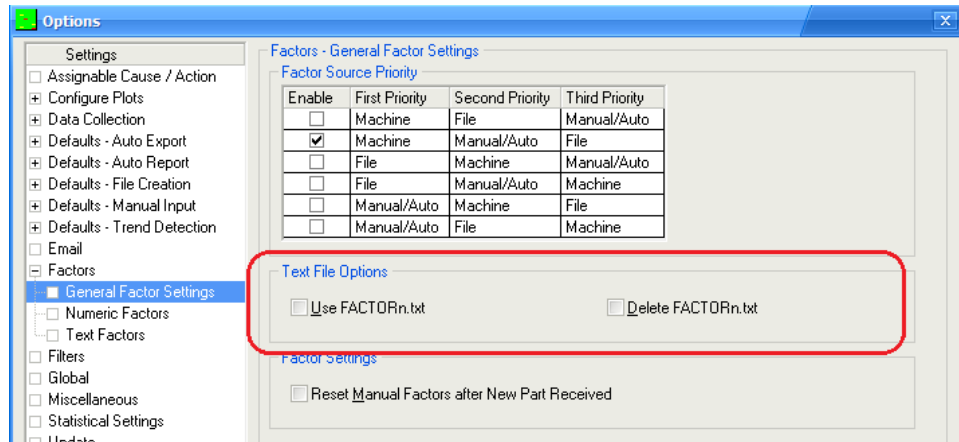
Similarly, QC-CALC looks for the existence of another 30 files named FACTORT1.TXT, FACTORT2.TXT, FACTORT3.TXT, ... and FACTORT30.TXT in the folder QC-CALC was installed. If any of these files exist, QC-CALC reads them and writes the contents in the corresponding **Text FACTOR**. The files must be ASCII and can have 1 of 2 formats. The two formats are:

Label, Value
or
Value

i.e.
Lot number,123

Operator, Bruce
Blue

To use this special feature, select **Tools – Options – Factors – General Factor Settings** and turn on **Use FACTORn.txt** and **Delete FACTORn.txt**.



Use FACTORn.txt

To turn-on this feature you must check the **Use FACTORn.txt** checkbox. QC-CALC will read files FACTORT1.TXT, FACTORT2.TXT, etc. from the QC-CALC directory after each part is inspected and add the contents to the Factors. If no label is in the file, QC-CALC generates a label of "FACTOR *n*" where *n* is the appropriate number.

Delete FACTORn.txt

If this option is checked the FACTOR?*n*.txt file is deleted after it has been used. The purpose of this option is to ensure the file is only read once. For example, if you have an application that writes this file for QC-CALC to add to its Factors, you might want to ensure it only happens once.

Reset Manual Factors after New Part Received

If this option is checked a value of 0 or blank is saved if QC-CALC does not find a new FactorN.txt file. This prevents QC-CALC from re-using the last known value from the previous file.

23.4.3 Multiple Files

Introduction

To make this file reading a little more complicated, let's assume you have an inspection machine that measures your parts but prior to the inspection a barcode reader reads a serial number off the part. Because of the method used to load and scan the parts, you want to queue more than one serial number before any inspection can be completed. You want the serial number to be added to the inspected parts in the order read using the next queued serial number.

This queued serial number scenario works with QC-CALC using the following method. Let's assume you are using Numeric Factor 1 to store bar coded serial numbers.

1. Barcode Reader reads Serial Number 1 and writes it into FactorN1.txt
2. Barcode Reader reads Serial Number 2 and writes it into FactorN1.tx1
3. Barcode Reader reads Serial Number 3 and writes it into FactorN1.tx2
4. Inspection begins on part 1, serial number 1
5. Inspection is complete
6. QC-CALC reads the results and adds the contents of FactorN1.txt to data
7. QC-CALC deletes FactorN1.txt

8. QC-CALC renames FactorN1.tx1 to FactorN1.txt
9. QC-CALC renames FactorN2.tx2 to FactorN1.tx1
10. The process is goes on endlessly.

Your barcode reader software must change the output name based on the files that currently exist. In our example above, the next barcode read should be written into FactorN1.tx2 since that file no longer exists.

23.5 Factor Setup – Numeric

23.5.1 Column Headings Definition

The next few paragraphs describe the columns in the setup area and their usage for automatic or manual Factors.

Labels	Entry Type	List	Default Value	Depends On Previous...	Range
Lot	Manual	None	3	<input type="checkbox"/>	
Machine	Manual	None	3	<input type="checkbox"/>	
Cavity	Automatic	1-9	0	<input type="checkbox"/>	
Required	Off	None	0	<input type="checkbox"/>	
NumFactor 5	Manual	None	0	<input type="checkbox"/>	

23.5.2 Labels

Enter a descriptive label from 1 to 32 characters describing the Numeric Factor. The label is entered by clicking in the area provided. Replace the initial value of "NumFactor 1" with your new label.

23.5.3 Entry Type

There are 4-different methods of setting up QC-CALC's automatic Numeric Factors. Once you understand these methods we'll discuss the options associated with each.

None This is the default setting and simply means no **Numeric Factor** information is added to your incoming inspection data.

Manual As the name implies, you manually enter the data in the **Factor Value** screen and the value is added to your inspection results as parts arrive. This process continues until you turn off the Factor or change the value. It is simple to use but the disadvantage is it is easily forgotten and may add old settings to new data. This entry method appears on the Real-Time Factor screen as an editable box where the value can be changed at any time.

Required When a **Required** method is used, QC-CALC automatically displays the Factor entry screen (if not already displayed) when a part arrives requiring you to enter a Factor value. This method ensures the operator does not forget to insert or add the value before continuing. Data collection is paused until the value is entered. Again, this entry method appears on the Real-Time Factor screen as an editable text-box that can be changed at any time.

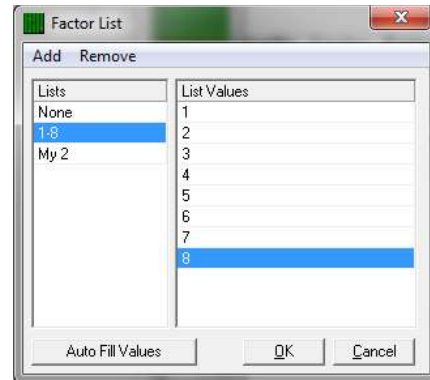
Automatic This method of entering Factors allows you to build a list of values to be used one after another as data is received from the CMM. This is the only entry method requiring that you create or select a list of items; therefore, the **List** column is enabled when you select this method. This entry method appears on the Real-Time Factor screen but is NOT editable.

Special Note If the Factor values on the Factor Value screen are grayed out

and not editable it means the values are being sent from the CMM or another source and you cannot override them. The priority of Factors is discussed in the [General Factor Settings](#) section on page [128](#).

23.5.4 List

The **Automatic Factor Entry Type** just discussed requires you to select a list of values to use as inspection data is received. Click the **List** column with your mouse and a small gray square becomes available. Click on the gray square to see all available lists.



Add The **Add** menu brings you to the **Add List** or **Add Values**

Add – List Choosing this adds a new list name to the **Lists** column and waits for you to name it. It has also added an item in the list. The new list values can be changed by clicking on them and typing in the appropriate box.

Add – Value Adds another entry in the **List Values** column of the currently selected list.

Remove The **Remove** menu shows you the **List** or **Value**.

Remove List This is a quick way to delete the selected list.

Remove Value Will remove the currently selected value in the **List Values** column. There must be more than two values in the list for this operation to be available.

Auto Fill Values This button gives you a quick method of entering a range of numbers without having to type them. Just enter the starting and ending values for your range of numbers and QC-CALC will create the list for you. Be sure to use the **Replace** option to create a new list or the **Append** option to add to an existing list.

23.5.5 Default Value

If you enter nothing this value is used by default.

23.5.6 Depends on Previous

You check this option if you want the incrementing of one Factor to depend on another. The second Factor will not increment until the first Factor exceeds its maximum value. This acts much like the odometer in a car. This checkbox is only used with Automatic Entry Types.

23.5.7 Range Check

When entering a numeric value you can check to make sure the value is in the appropriate range. This reduces the likelihood of an operator error during data entry. When you enable this option, the **Range From** and **Range To** become enabled and you enter the low and high values to check.

23.5.8 Range From

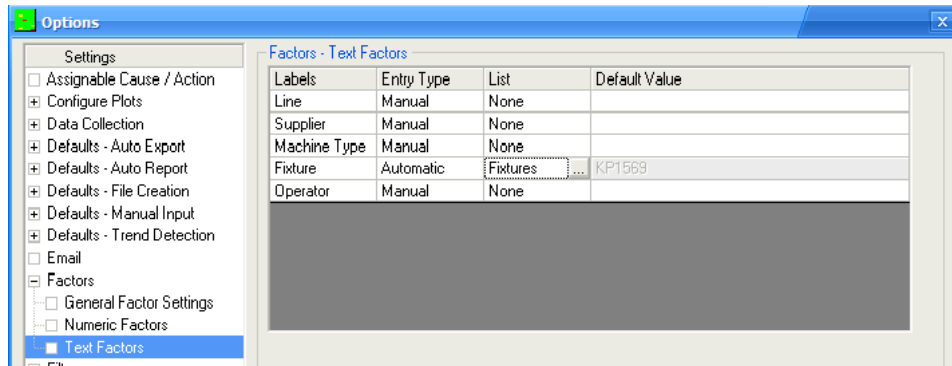
This is the lowest acceptable value you will allow the operator to enter for this Factor. If a value is entered lower than this setting, QC-CALC warns you that the value is out of range and displays the acceptable values.

23.5.9 Range To

This is the highest acceptable value you will allow the operator to enter for this Factor. If a value is entered larger than this setting, QC-CALC warns you that the value is out of range and displays the acceptable values.

23.6 Factor Setup – Text Factor

The Text Factors are similar to **Numeric Factors** but they can contain numbers and text. Text Factors cannot be incremented but you can build lists of names to be added to incoming inspected parts.



23.6.1 Labels

You enter a descriptive label from 1 to 32 characters describing the Text Factor. The label is entered by clicking in the area provided. Initially the label contains "TextFactor 1" so you should replace this value with your own label.

23.6.2 Entry Type

There are 4 different methods of setting up QC-CALC's Text Factors:

- None** This is the default setting and simply means no Text Factor information is added to your incoming inspection data.
- Manual** As the name implies, you manually enter the data in the Factor Values screen and the value is added to your inspection results as parts arrive. This process continues until you turn off the Factor or change the value. It is simple to use but the disadvantage is it is easily forgotten and may be adding old settings to new data. This entry method appears on the Real-Time Factor screen as an editable text-box that can be changed at any time.
- Required** When a Required method is used, QC-CALC automatically displays the Factor entry screen (if not already displayed) when a part arrives requiring a Factor value.
- Automatic** This method of entering Factor allows you to build a list of values to be used one after another as data is received from the CMM. This is the only entry method requiring that you to create or select a list of items; therefore, the List column is enabled when you select this method. This entry method appears on the Real-Time Factor screen but is NOT editable.

23.6.3 List

Creating a **List of Text Factor** values is the same as creating Numeric Factors so please review the Numeric Factors Lists above. The **Auto Fill Values** button is not available in this screen.

23.6.4 Default Value

This is the starting value passed to QC-CALC and you may enter a value manually. This value continues to be used unless you change it in the Real-Time screen.

Exercises

The Factor screen is a bit complicated to use because it is very flexible. The basic idea is to add Factor values to parts for traceability when the inspection machine cannot generate them for you. If possible, it is best to program your CMM to send the trace fields to QC-CALC to avoid missing this valuable information. To help your understanding of the Factor screen please complete the following exercises.

Exercise 1 – Using Single Values:

Let's assume you are inspecting 5 parts made on a particular machine. You want to "tag" each of these parts with a Numeric Factor of the machine they were made on (6 for this example). The CMM cannot send the Machine number to QC-CALC so you decide to use QC-CALC's built-in Factors. Do the following.

Select **Tools – Options – Factors – Numeric Factors** to display the Factor screen.

- Click the mouse in the **Labels** column for **Factor 2** and enter **Machine**.
- Click the mouse in the **Default Value** for **Factor 2** and type **6**.
- Click **OK**.
- Select **Window – Factor Values** to view the Factors during data collection.
- Using your Training CMM inspect 1 part.
- Select **Point Properties** and verify your value was saved with the part data.

Once this Factor is setup, each time QC-CALC receives a part from the CMM it adds "6" to the part. The disadvantage of this method is you may forget to change the machine number to another value when appropriate. There are fewer things to remember if the CMM asks you for the machine number when the part program starts.

Exercise 2 – Using Automatic Lists

This next example uses a list of numbers instead of the one machine value in example #1. Let's assume you are making plastic injection molded parts and want to track the parts made by each cavity. Your mold contains 9 cavities and you want the cavity number to be saved with each part.

- Select **Tools – Options – Factors – Numeric Factors** and the Factor screen is displayed.
- Click the mouse in the **Labels** column for **Factor 3** and enter **Cavity**.
- Click the mouse in the **Entry Type** and pick **Automatic**.
- Click the mouse in the **List** column and click the gray square.
- Select **Add – List** from the menu.
- Label the list **1-9**.
- Click the **Auto Fill Values** button and enter 1 to 9 for the **Range**
- Click **OK**.

- Select **Replace** for the **Fill Method** and your list is created.
- Click **OK**.

Now as parts are inspected, QC-CALC adds the cavity number for you but this time the values are taken from a list. This adds more flexibility to your database saving techniques.

Exercise #3 – Using Automatic Text Lists

Let's assume you have 2 parts made as a matched pair of left and right parts called 985-1R and 985-1L. You inspect both parts on the CMM as a pair and want QC-CALC to add these values to Text Factor 2 using a list.

- Select **Tools – Options – Factors – Text Factors**.
- Click the mouse in the **Labels** column for **Factor 2** and enter **Model**.
- Click the mouse in the **Entry Type** and pick **Automatic**.
- Click the mouse in the **List** column and click the gray square.
- Select **Add – List** from the menu.
- Label the list **R & L Brackets**.
- Click in the **List Values** column on the **Value0** and change it to **985-1R**.
- Select **Add – Value** from the menu.
- Click in the **List Values** column on the **Value1** and change it to **985-1L**.
- Click **OK**.
- Select **Window – Factor Values** to view the Factors during data collection.
- Using your Training CMM inspect 2 parts.
- Select **Point Properties** and verify your values are saved with the part data.

24. Gage R&R Wizard

24.1 Introduction

QC-CALC offers a built-in Gage Repeatability and Reproducibility (GR&R) feature to assist you through the somewhat time consuming task of conducting and reporting a study. It guides you through the process of setting up, saving, and reusing many different GR&R configurations. It steps you through the sequence of conducting a GR&R study while predicting the outcome during the test. This means if the test results are failing, you can shut down the study, fix the problem, and begin another study saving you time and money.

24.2 Definition

A Gage Repeatability and Reproducibility Study (GR&R) is a method of determining the suitability of a gage or gauging system for measuring a particular process. Every measurement taken has some error associated with it, and if this error is large compared to the allowable range of values (the tolerance band), the measuring device will frequently accept bad parts and reject good ones.

A Gage Repeatability and Reproducibility Study convey 6 basic pieces of information. They are:

- Part Variation
- Repeatability
- Reproducibility
- Repeatability and Reproducibility (R&R)
- Percent of Total Variation
- Percent of Tolerance

24.3 File Names

GR&R study data is not the same as SPC production data and therefore you do not want to mix gage study data with process data. Therefore, QC-CALC's Real-Time screen acts differently during the collecting of GR&R data and many of QC-CALC's features are disabled to reduce confusion.

When running a GR&R study one significant difference is the file naming QC-CALC uses. For example, if your part program is called **MyPart10** and you inspect parts with it, QC-CALC saves your process data in a file called **MyPart10.QCC**. If you begin a GR&R study with this same part program QC-CALC creates a separate file called **MyPart10_GRR.QCC**. The data is stored in two separate files thereby preserving the integrity of your process inspection data and your GR&R data.

24.4 Steps to Conduct a Study

You can start a study at any time by following these basic steps:

- Setup a study using the GR&R Wizard
- Begin the study
- Inspect parts
- Print the report

We will lead you through these steps and conclude with the final report.

24.4.1 Setup a Study

Start the GR&R Wizard by choosing menu **Gage R&R – Begin New Study** and the Welcome Screen of the Gage R&R Wizard is displayed. The list in the left panel is used to show where you are in the setup process. Here we show the "Welcome Screen" item by highlighting it in bold text. The right panel of the

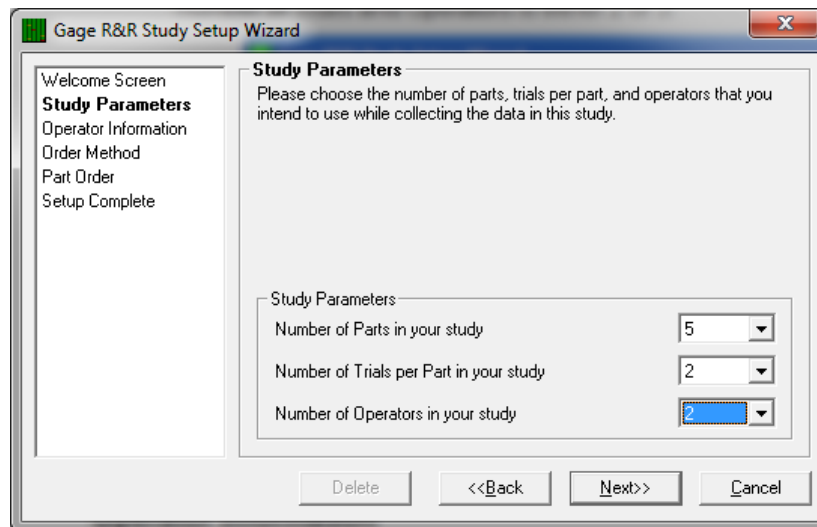
wizard changes as we move through the 6-step setup procedure. The buttons at the bottom of the panel navigate the wizard, begin the study, delete previously saved studies, or cancel from the wizard.



On this screen, you have two choices available from the list. You can either add a new study, or you can use one of the previously saved studies, which are listed alphabetically. If you choose a previously saved study, the **Delete** button becomes enabled allowing you to delete this study. The **Begin Study** button also appears at the far-left corner allowing for quick starts of known setups.

24.4.2 Study Parameters

There are three parameters for you to choose in each study; the number of **Parts**, the number of **Trials**, and the number of **Operators** measuring the parts. The current range for the number of parts in a study is 2 to 20 inclusive. The number of Trials and Operators is either 2 or 3.



24.4.3 Operator Information

You can enter real names for each operator. The purpose of these labels is to reduce operator confusion since they may forget which one of them is operator 2, and which one is operator 1. This would destroy the statistical value of the study. The name of the operator is displayed next to the Operator Number during the study.

The screenshot shows the 'Operator Information' step of the 'Gage R&R Study Setup Wizard'. The left sidebar lists the steps: Welcome Screen, Study Parameters, Operator Information (highlighted), Order Method, Part Order, and Setup Complete. The main area contains the following text: 'Please enter the names of each of the operators in the study. Their assigned number is on the left.' Below this, there are two input fields: 'Operator 1' with the text 'Bruce' and 'Operator 2' with the text 'Todd'. At the bottom, there are four buttons: 'Delete', '<<Back', 'Next>>', and 'Cancel'.

24.4.4 Order Method

There are four different methods that you can choose when deciding in what order to measure the parts of the study.

Run parts in random order

This is the most statistically accurate method of conducting a Gage R&R study. If you have 10 parts, 3 operators, and 3 trials in your study, there are 9 sets of parts. In each set, the operator and trial numbers are fixed and all 10 parts are measured in random order. The order of the sets themselves is also random.

Manually Set Order of Parts

If you have a specific order you wish to measure the parts you can type the numbers into the screen presented when you click the **Next>>** button. The Wizard will check your entries to make sure you do not enter any illegal Part, Trial, Operator combinations or reuse any legal ones.

Choose Preset Order

The wizard can fill-in the GR&R test order for you by incrementing the part, trial, and operator.

The screenshot shows the 'Order Method' step of the 'Gage R&R Study Setup Wizard'. The left sidebar lists the steps: Welcome Screen, Study Parameters, Operator Information, Order Method (highlighted), Part Order, and Setup Complete. The main area contains the following text: 'Please choose how you want to arrange the order of the parts in this study. A random ordering of parts and operators will give you the most statistically unbiased results.' Below this, there are three radio button options: 'Run parts in random order', 'Manually set order of parts', and 'Choose preset order' (which is selected and circled in red). Below the radio buttons is a dropdown menu with 'Part, Trial, Operator' selected and the text 'To preview order, click Next'. At the bottom, there are four buttons: 'Delete', '<<Back', 'Next>>', and 'Cancel'.

This time-saving features has 6 combinations of increments listed. They are:

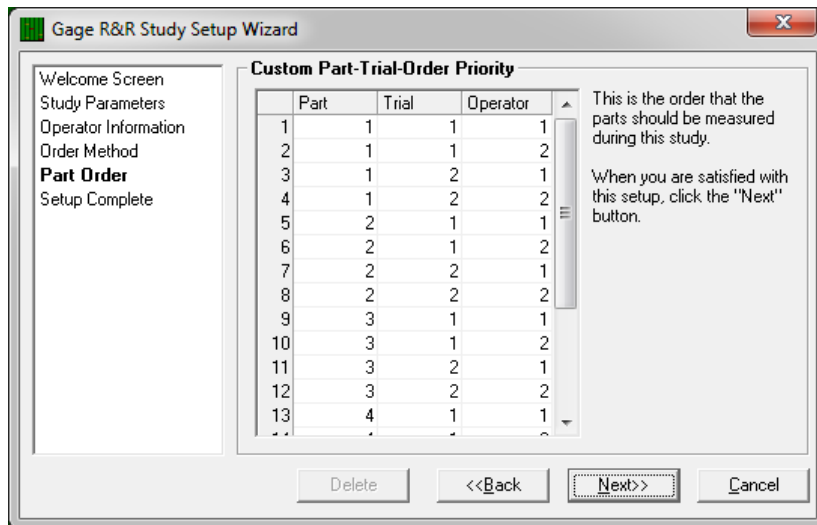
	Increment 3 rd	Increment 2 nd	Increment 1 st
1	Part	Trial	Operator
2	Part	Operator	Trial
3	Trial	Operator	Part
4	Trial	Part	Operator
5	Operator	Part	Trial
6	Operator	Trial	Part

To understand how the list is generated, the increment sequence mimics the odometer in your car. The least significant word in the list (right side) is incremented first, then the next, and finally the 3rd. The generated sequence can be seen by choosing one of these six preset orders and clicking the **Next>>** button. If you pick an order you do not want, select the **<<Back** button and try again. Click the **Next>>** button to see the next order you chose.

24.4.5 Part Order

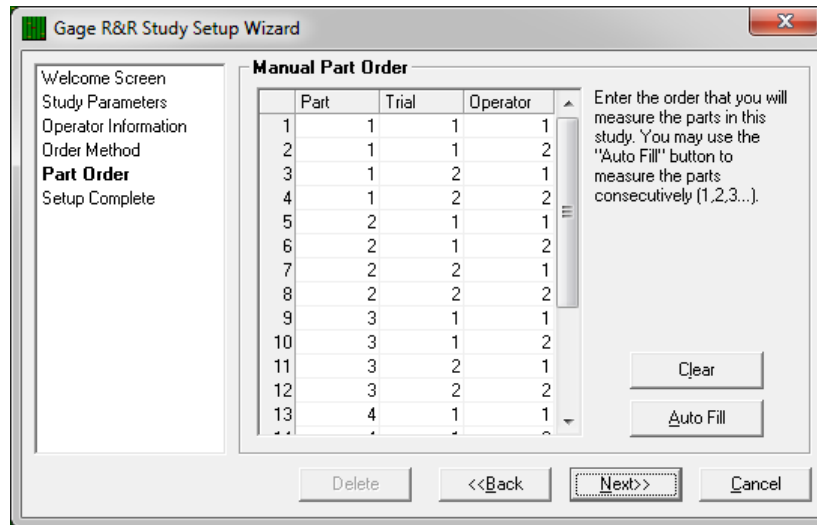
Automatic

This screen displays the order the study is conducted. It gives you a chance to see the entire study laid out ahead of time. If you do not like the order you can click the **<<Back** button and create another random order for all of the parts.



Manual

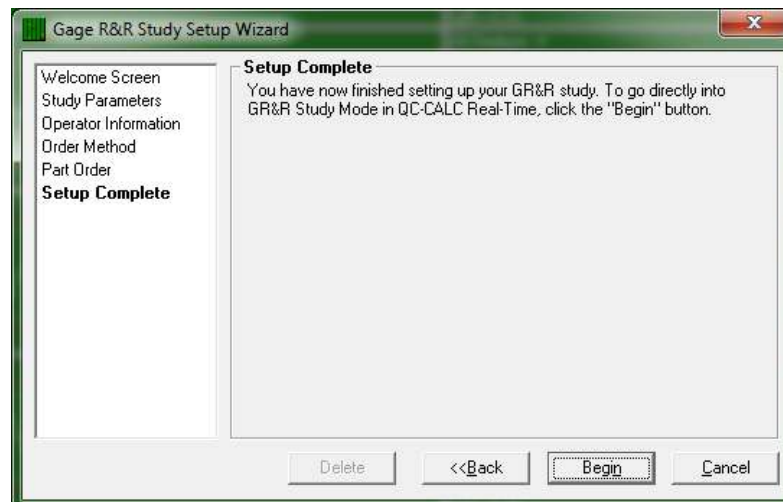
If you choose to specify the order of the parts manually, the Part Order screen is slightly different and the grid is editable. By default the grid is filled in similar to the **Sequential with same operator** choice but you may fill the grid any way you choose.



Also, there are two buttons that show up only with Manual Part Order. The **Clear** button clears the grid and fills it with zeros to show which areas have not been entered. The **Auto Fill** button fills the grid the same as **Sequential Same Operator**. This screen also checks for a correctly entered list of numbers to ensure the Gage R&R study is valid. This means that each operator must measure each part the appropriate number of times.

24.4.6 Setup Complete

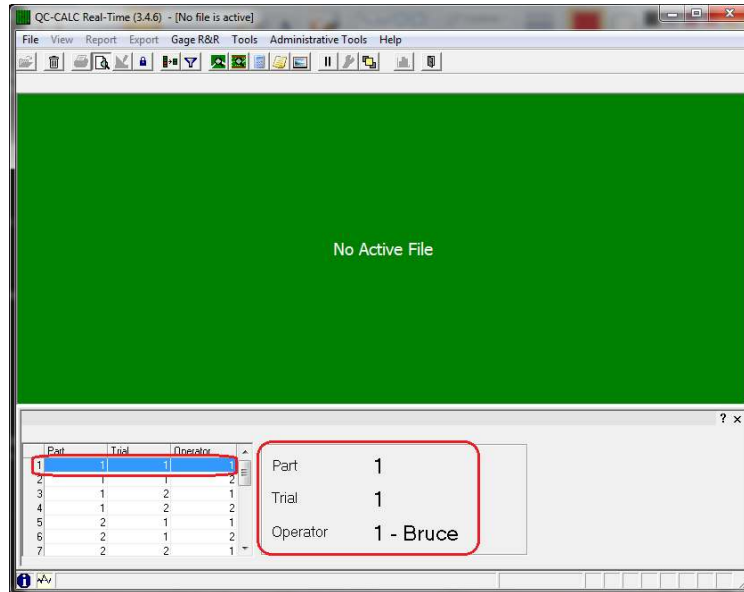
This screen tells you the setup process is complete. The **Next>** button has been replaced by a **Begin** button and when you click it, the Wizard asks for the name of the study so this same setup can be used in the future.



If you are editing a previously saved study, then the name of the study is already placed in the name box by default. You can change the name to a completely different study.

24.4.7 The GR&R Screen

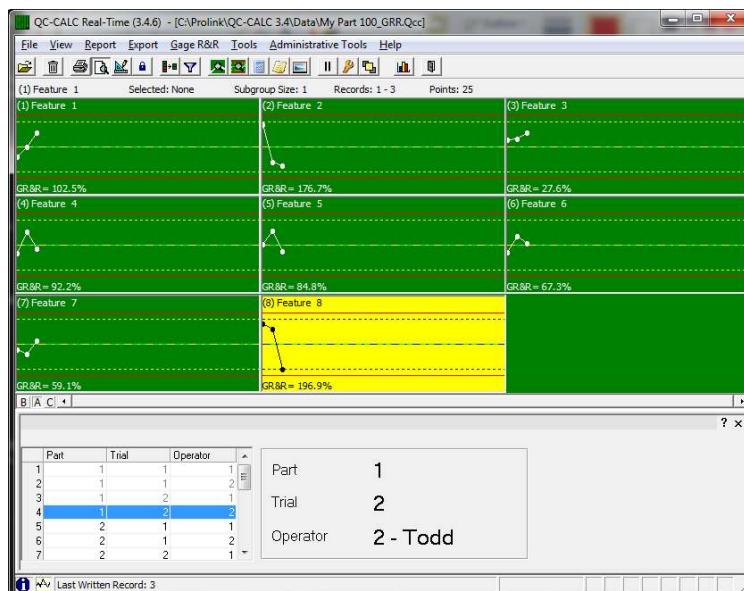
Once the setup file is saved, QC-CALC closes any active file, clears the plots, and adjusts itself to begin the GR&R study. The **Part – Trial – Operator** list is displayed on the lower left side of the screen so you can see which tests are complete and which tests are next. The completed tests are shown in gray letters while the incomplete tests are displayed in black.



The current part to be measured is highlighted in the grid. To the right of the grid are the same Part, Trial, and Operator numbers of the current part, along with the operator's name written in larger letters. These large numbers provide an “easy-to-see” display from across the room so you know which part to place on the CMM next.

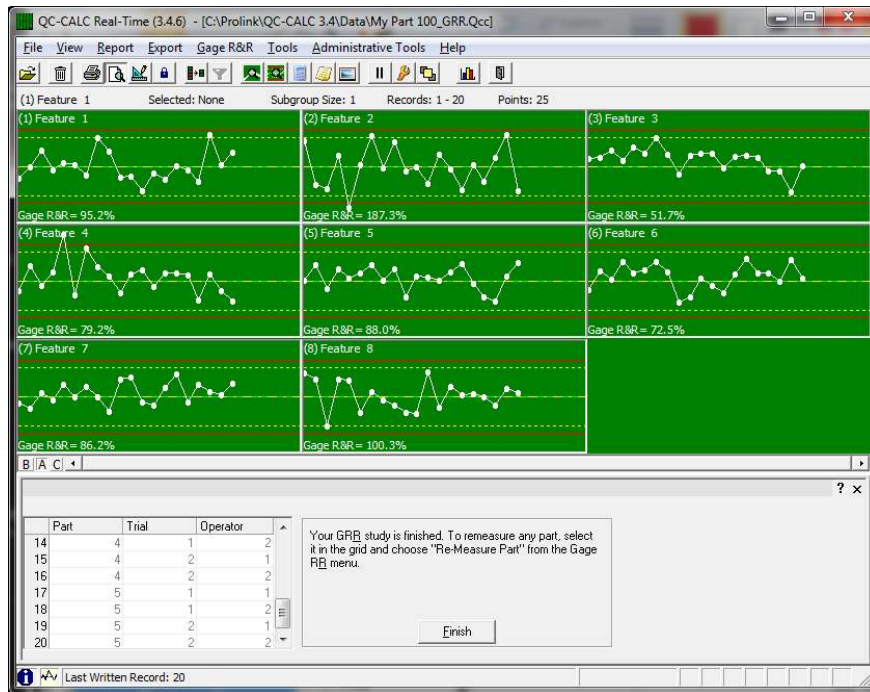
24.4.8 Three Parts Complete

As you run your CMM you see each measured part as a white dot in each feature. Here we see 6 features on three parts. Notice the GR&R calculation in the lower left corner of each plot. This is an estimate of the final GR&R test for each feature. This aids you in determining whether you should continue the study or whether you should stop and fix a fixture.



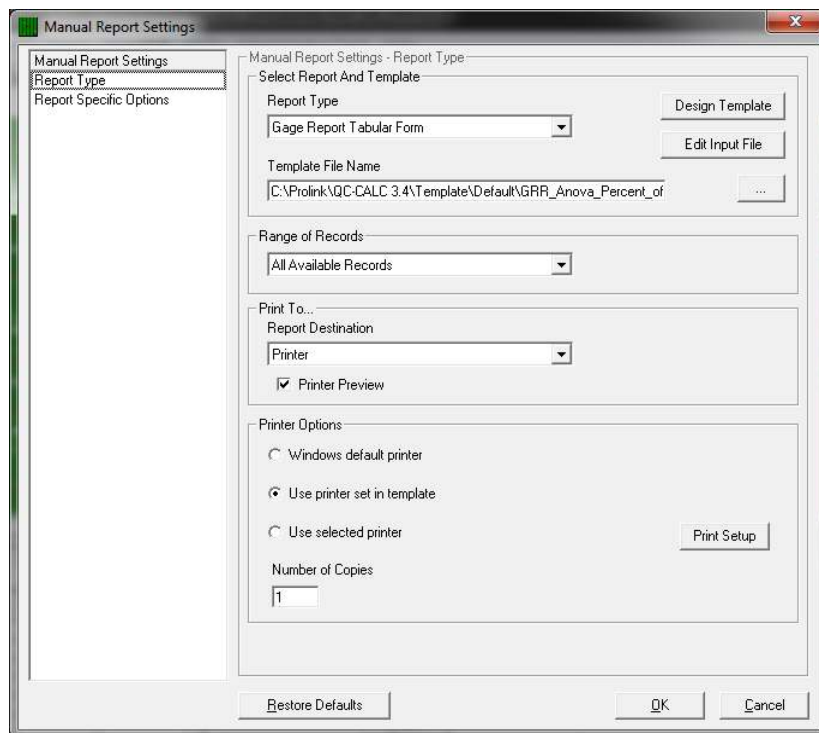
24.4.9 All Parts Complete

This is the final screen after all parts have been measured 2 times by 2 operators.



24.4.10 Print the Report

To print the GR&R report, select **Report – Print Report – Gage Report Tabular Form**. Next, select the **GRR Report.GRT** template and select **All Available Records** and click **Print**.



You can add some last minute descriptive text to Gage R&R report by filling in a few words on this next screen. It is useful for distinguishing one report from another.



If you choose to **Allow Outlier delete** any measurements above the 3-sigma limit are discarded and the report is based on a smaller set of parts. This is done on a feature-by-feature basis. See the column labeled **Parts** in the report on the next page. If the column contains a smaller than expected number of parts, it means an outlier was present.



24.4.11 Example GR & R Report

Your GR&R report is displayed with all details. If any dimension shows 4 parts instead of 5 it means a part was removed because we chose to **Allow Outlier Delete** and the part exceeded the 3-sigma limit.

February 19, 2013
8:40:37 AM

Gage R&R Anova using Percent of Spec Limits

My Part 100_GRR_Qcc

Gage Type: CMM
Gage Size: 12x24x36
Gage Number: 23

Part Variation (PV)
Part Variation is a measure of how much the process is actually varying. If an infinite number of parts made by this process were measured using an ideal Gage, 99.0% (5.15 sigma) of the parts would be within an interval Part Variation wide. This is, of course, only an estimate.

Repeatability (EV)
Equipment Variation is a measure of how much the gage readings vary when the same operator measures the same part several times. A large value might indicate gage wear, improper measurement policy (but all operators are making the same "mistake", it is not a matter of individual operator skill), or a gage without sufficient resolution or with a defect. This number is best used by comparing it with reproducibility.

Reproducibility (AV)
Appraiser Variation is a measure of operator difference. The most common cause of a poor (large) Reproducibility is insufficient operator training. A gage that is sensitive to different techniques or is difficult to use would also cause a large Reproducibility. We believe using a CMM or Vision inspection system eliminates most of the human error. Fixturing should be checked if this value is high.

Performed by: Bruce & Todd
Record Range: 1 - 20

Parts: 5
Trials: 2
Operators: 2

Gage R&R
Gage R&R is a measure of the combine variation of Repeatability and Reproducibility caused by the gaging system, as opposed to the manufacturing process. This number, expressed as a percentage of tolerance, is the most important "warning flag". If R&R is a large percentage of total variation but not a large percentage of tolerance, both the gage and the process are good and the process standard deviation is even smaller than it appears (meaning the process spread is smaller and Cpk larger than reported). This also means a more precise gage would allow tighter control limits for earlier detection of loss of control. The following table shows typical interpretation.

% Of Tol.
0 - 10% Gage is suitable
10 - 30% May be acceptable based on importance of the measured part, cost of gage repair, etc. look at R and R separately
Over 30% G-gage system needs improvement

Dimension	Nominal	USL	LSL	Part Average	UCL	LCL	Parts	Part Variation (PV)	Repeatability (EV)	Reproducibility (AV)	Gage R&R
1 Feature 1	1.5000	1.5100	1.4900	1.50021	0.014017	0.000000	5	0.00%	20.34%	0.00%	20.34%
2 Feature 2	2.5000	2.5100	2.4900	2.49980	0.027564	0.000000	5	0.00%	31.54%	0.00%	31.54%
3 Feature 3	3.5000	3.5100	3.4900	3.50196	0.007603	0.000000	5	12.03%	11.59%	0.00%	11.59%
4 Feature 4	4.5000	4.5100	4.4900	4.50110	0.011650	0.000000	5	10.13%	21.05%	0.00%	21.05%
5 Feature 5	5.5000	5.5100	5.4900	5.50098	0.012950	0.000000	5	0.00%	16.59%	0.00%	16.59%
6 Feature 6	6.5000	6.5100	6.4900	6.50126	0.010673	0.000000	5	8.29%	15.15%	0.00%	15.15%
7 Feature 7	7.5000	7.5100	7.4900	7.50101	0.012687	0.000000	5	0.00%	15.43%	0.00%	15.43%
8 Feature 8	8.5000	8.5100	8.4900	8.50037	0.014758	0.000000	5	0.00%	22.61%	0.00%	22.61%

MSA Calculations Used in this Report

Page 1 of 1

24.5 Optional Features of GR&R

24.5.1 Open Existing Study

This menu option lets you open an existing QC-CALC gage study. Once opened you can resume a study that was interrupted at a previous time or you can revisit a completed study, and possibly edit it.

24.5.2 Re-Measure Part

At any time during the study or after it is completed you can re-measure any part in the study. The part must first be selected in the grid on the Gage R&R Mode Display, and then you simply choose **Re-Measure Part** from the **Gage R&R** menu. At this point you are asked to verify that you want to re-measure the part since the selected part is deleted.

When you choose **Yes**, the part that was chosen in the grid turns black indicating that it has not yet been measured. The frame on the right of the grid updates to reflect the correct part that should now be measured. After this part has been measured, the grid moves back to where it was prior to the remeasure and the study resumes in normal order.

24.5.3 Pause Study

This option simply allows you to stop a study and return to it at a later time using the **Open Existing Study** menu. This is useful when the CMM is required by another user to do production work. Pausing the study for a long period of time is not recommended as the gage condition will change over time and may result in poorer calculations.

24.5.4 Gage R&R Estimate

During a Gage R&R study QC-CALC estimates the end result of your Gage R&R by looking at the data collected thus far. The estimate is displayed in the lower left-hand corner of each plot. Whenever possible the Sigma Estimate is used. If the order of the parts does not make this practical, then a Range Estimate is used. Remember, the quickest method of obtaining an estimate is to run the test in **Sequential – Same Part**. Once any part is measured twice, we can begin to estimate the GR&R.

Sigma Estimate

The Sigma Estimate used to approximate the final Gage R&R values is computed using the following formula.

$$GRR_{est} = \frac{6\sigma}{(USL - LSL)}$$

Range Estimate

To calculate the Range Estimate, the parts in the study are looked at one at a time. The range is found for all of the measurements that have been taken thus far for part 1. This number is multiplied by a constant equal to 2.7, and divided by the (Upper Tolerance – Lower Tolerance).

$$GRR_{est} = \frac{2.7 * Range}{(USL - LSL)}$$

We do the same for each of the other parts. The estimate that is displayed is the average of all of these estimates. This method always calculates the Gage R&R estimate a little too high because all variation in a part is assumed to be part variation, rather than operator variation.

25. Assignable Cause & Corrective Action

25.1 Introduction

The QC-CALC database saves all the part data in one record and it includes other data such as the time & date, Factor values, and **Assignable Cause** and **Corrective Action** codes. These assignable causes are used to trace special events that occur to a part. The associated Corrective Actions explain what you did to fix the Cause. To create, select, or edit the Assignable Cause File, you select **Tools – Options – Assignable Cause / Action** menu.

Similar to the Assignable Cause, the **Corrective Action** allows you to say what you did to fix a problem. The QC-CALC database reserves space for tagging each part with 1 to 3 Corrective Actions. Use this option when a feature has been corrected with a known or identified Corrective Action. By assigning a Corrective Action to the part, you can track what was done to fix Assignable Causes.

You can add new Actions and modify old ones. The purpose of predefining Actions is to force consistent text when identifying corrections. For example you could say “Replaced Tool” or “Tool Replaced”. Once the Action is added you simply pick the Action from a list.

Note: Everything discussed in this section describes the Assignable Causes. Since the Corrective Actions operate the same we only discuss Assignable Causes. Please apply the same understanding to Corrective Actions.

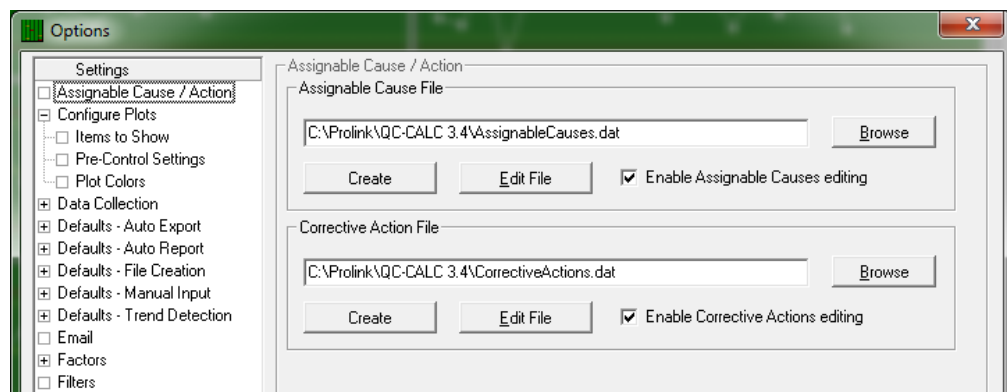
25.2 Set Assignable Cause File

25.2.1 Browse to File

QC-CALC uses two external text files to store your Assignable Cause and Corrective Action codes. These two files should be saved on a network server enabling all QC-CALC's to display a standard list of Causes. You choose the Assignable Cause file by clicking the **Browse** button.

25.2.2 Create New File

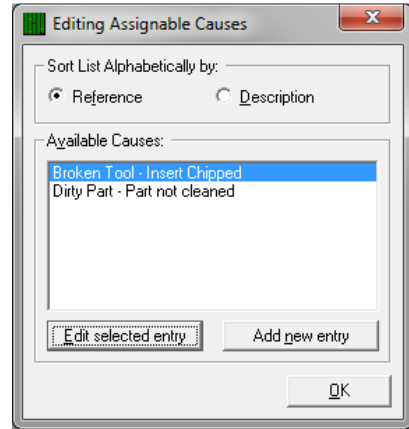
You can create a new file on your server by pressing the **Create** button to see a file dialog box appear. Here you select the folder location and enter your file name. Again, consider using a common name and location to ensure a consistent list of Causes for all inspectors pick from. **AssignableCauses.dat** is the default file, which is located in the QC-CALC install directory.



25.2.3 Edit Assignable Cause File

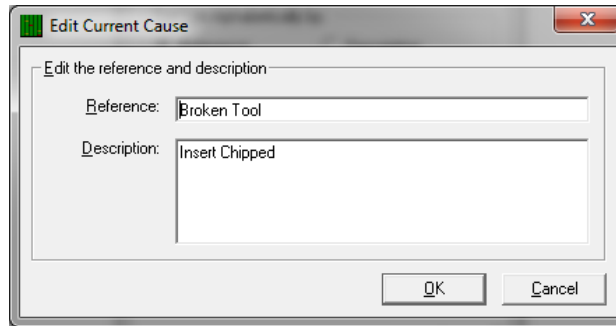
These files are empty when you install QC-CALC but you begin adding and building your list of standard codes by clicking the **Add New Entry** window.

To edit the Assignable Causes simply click the **Edit File** button and the existing codes are displayed allowing you to edit an old one or add a new one. The reference name or number is limited to 16 characters, and many times this is all that is needed. However, you can add up to 256 characters in the description. Only the Reference text is displayed in QC-CALC Real-Time.



25.2.4 Add New Assignable Cause

When you click **Add New Entry** or **Edit selected entry**, another window is displayed where you make your changes or add a completely new Cause.

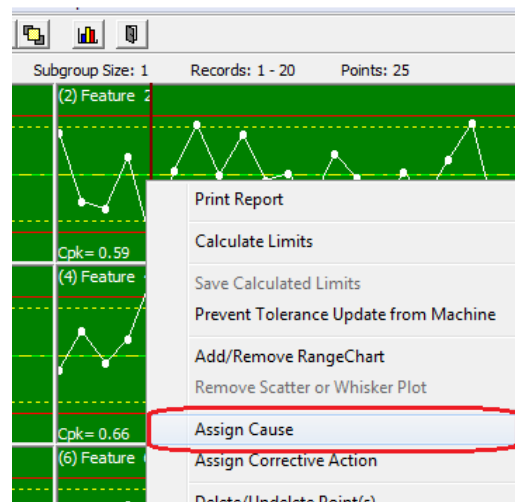


Click **OK** to save your changes.

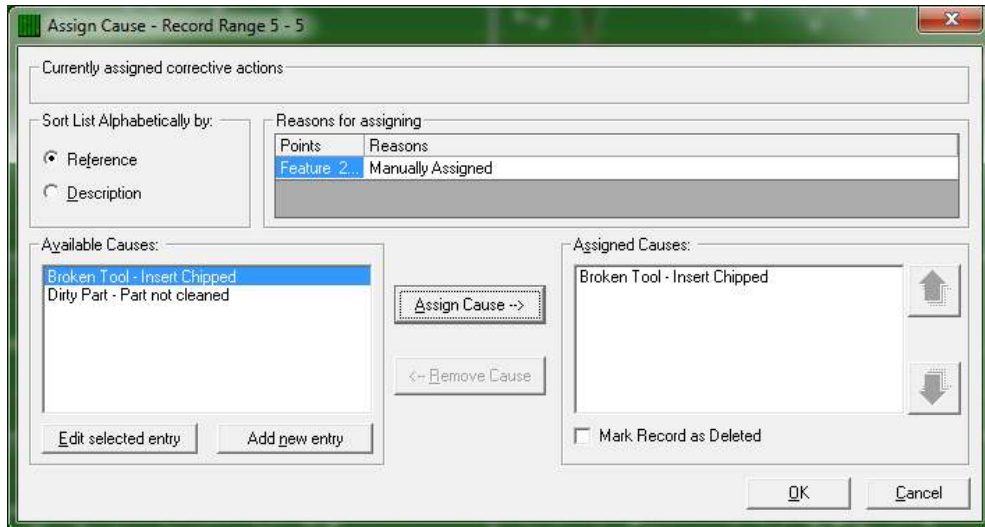
25.3 Assign a Cause

The QC-CALC database reserves space for tagging each part with 1 to 3 Assignable Causes. Use this PopUp menu when a feature has a known or identified problem. While viewing the Real-Time Plots float the mouse over the point of interest and right-click the mouse. A PopUp menu appears allowing you to pick a predefined Cause.

The screen below is displayed and you select one of the predefined Causes from the list. Now click the **Assign Cause** button to add the Cause to the part and click **OK**. Whenever the mouse floats over this point again, the tool-tip pops up the text describing the Cause.



Note: you can add new Causes to the list much like the discussion on the previous page. There is a button to **Edit** or **Add New** Causes.



Tip: Each Cause you add to the file has an internal number from 1 to xxx. Only the number is saved in your .QCC file. This means you cannot delete an entry since the numbers representing each Cause would be incorrect. However, you can edit the Cause text.

26. Security Passwords

26.1 Introduction

Password protection is provided to limit the functionality of QC-CALC to unauthorized employees. If you want to limit access to specific areas of QC-CALC simply lock the menu choice for each item. When a menu is locked, it appears “grayed out” in the menu list. To limit the functionality of QC-CALC Real-Time select the **Tools – Password**. The **Tools** menu and the **Password** menu within the **Tools** menu cannot be locked. This is to ensure access to the password protection at all times.

26.2 Establishing your Initial Password

When QC-CALC is first installed, **Change Password** is the only menu option available. The first time this menu option is selected a dialog box appears asking for a password. Enter the first 4 or 5 digits of the PSN (Prolink Serial Number) for the copy of QC-CALC you are running. This number can be found by selecting the **Help – About** menu. Once you successfully enter the serial number you must establish your own password by following the normal change password procedure. Once a password is established the serial number no longer applies to any of the requests for a password. This procedure prevents inadvertent setting of the initial password by unauthorized personnel.

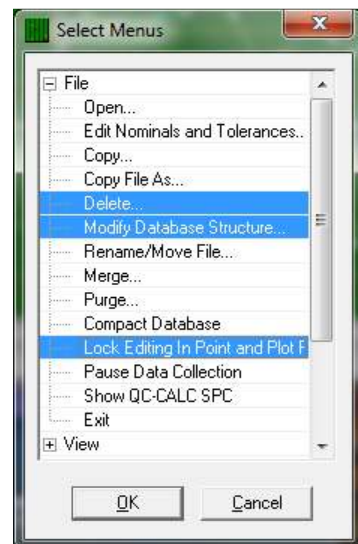
26.3 Lock/Unlock Menus

The **Tools – Password – Lock Menus** option toggles between “Lock Menus” and “Unlock Menus.” When this option is selected a dialog box appears asking for the password. Enter your password in the space provided and click **OK**. A message appears indicating the appropriate action happened. When you choose to **Lock Menus**, all menus you chose to lock out in the **Configure Menus to Lock** area still appear but are grayed out so they cannot be accessed. When you choose **Unlock Menus**, the entire QC-CALC program is available to all users no matter which menus were locked. It should be noted that if you activate the **Lock Menus** option and do not select individual menus to lock out, the entire program is still completely open.

26.4 Configure Menus to Lock

This menu option is used to establish which menu you want disabled when the **Lock Menus** option is chosen. In this example, the **Modify Database**, **Delete File**, and **Lock Editing** are locked.

This option is not available while the menus are locked. When you select **Configure Menus to Lock** a dialog box appears prompting you for a password. Enter the password and click the **OK** button. Next, a dialog box appears with a list of menus available to lock. Use the mouse to select the items you wish to be disabled by clicking on the items in the list. Multiple items are selected by holding down the control or shift keys while clicking. Once all the menus are selected click the **OK** button to commit your selection. Clicking the **Cancel** button will retain the previous selection.



One thing to remember when locking menus involves the **Exit** menu in both QC-CALC Real-Time and QC-CALC SPC. The **File – Exit** menu may be disabled to prevent an inadvertent exit, but the Windows Control Menu (The “x” in the upper

right hand corner of the form) is still available. You will be prompted for the password to allow you to exit the program if you click the "X" button when the **Exit** menu is disabled.

26.5 Change Password

When this menu item is selected a dialog box appears prompting you for the existing password. Enter your password in the space provided and click the **OK** button. A second dialog box appears to confirm your new password. Enter your new password in both places and click the **OK** button. A message appears indicating you successfully changed your password. Clicking the **Cancel** button at any point in the procedure brings you back to the main QC-CALC screen and the old password remains in effect.

26.6 Logout

To avoid being asked for the password multiple times as you move from the various password options, you have the ability to choose the **Keep me logged in** option. When this option is checked you will no longer be asked to enter your password each time you use one of the items in the Password area. Your Password will be remembered until you choose the **Tools – Options – Password – Logout** menu. It is critical to remember to use the **Logout** menu when you have finished, otherwise anyone will be able to control the Password Protection area.

27. Email Setup

27.1 Introduction

When using QC-CALC to email a report to yourself or others, QC-CALC has three different methods of sending your note.

- Use Your Email Account (Outlook, Lotus Notes, etc)
- Use an SMTP Server – Prolink
- Use an SMTP Server – Your company's SMTP server

QC-CALC can act as an independent email program and therefore does not require an interface with your company's internal system such as Outlook or Lotus Notes. However, all 3 methods are available.

27.2 Using Prolink Mail Server

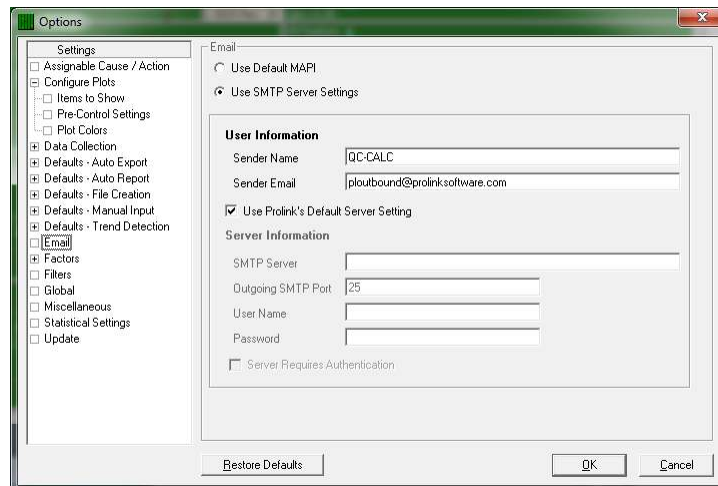
The default setting uses a special account setup on the Prolink website which means no other settings are required. However, you should change this setting to match your company's mail system. Select **Tools – Options – Email** and the following setup screen is shown.

27.2.1 Sender Name

Change **Sender Name** to a name that represents the equipment on which QC-CALC is running. This tells you which machine sent you the email.

27.2.2 Sender E-Mail

This default address must be **ploutbound@prolinksoftware.com** if you use our server. If you use your server, change the default address to your email address since it appears in the FROM address of the sent email. This is the address where all Replies are sent.



27.3 Using Outlook or Other Email Account

Choose the **Use Default MAPI** option to have QC-CALC use the default email found in the PC. All other options are disabled. You will find a copy of the email in the SENT folder of this email account. This method is not recommended since the latest versions of Outlook tend to block it.



27.3.1 Using Your Mail Server

Start by asking your IT Department for the correct **SMTP Server** settings. Choose the **Use SMTP Server Settings** option and un-check **Use Prolink's Default Server Settings**. Then enter the settings as shown below. The answers will vary depending on your company.

The screenshot shows the 'Options' dialog box with the 'Email' tab selected. The 'Server Information' section is highlighted with a red box. The settings are as follows:

Section	Field	Value
User Information	Sender Name	QC-CALC
	Sender Email	ploutbound@prolinksoftware.com
Server Information	SMTP Server	mail>YourServer.com
	Outgoing SMTP Port	2525
	User Name	La@YourServer.com
	Password	xxxxxxxxxx

Additional options shown in the dialog:

- Use Default MAPI
- Use SMTP Server Settings
- Use Prolink's Default Server Setting
- Server Requires Authentication

Buttons at the bottom: Restore Defaults, OK, Cancel.

28. License Configuration

28.1 Introduction

All copies of QC-CALC are installed as evaluation copies whether you purchased it or not. When you run QC-CALC for the first time you see a “splash” screen indicating the software has 30 Run Days Remaining. You may select the **Help – About** menu to see this screen.

An evaluation period of 30 run days means you can run the software for 30 non-consecutive days. This means if you use it today and don't use it for a week, when you return, you still have 29 days remaining. You can visit our website to extend your evaluation period without calling our office.



All users of QC-CALC must activate it by one of several methods. This section of the manual discusses the various activation options.

28.2 The Purchase Cycle

The internet provides an excellent method of purchasing and distributing software so Prolink added a method of purchasing QC-CALC. You may still order QC-CALC through our sales agents or your local equipment distributors and we encourage you to do so. However, you should visit our website to become familiar with the options the site offers. If you purchase QC-CALC via the internet the basic purchase cycle is:

1. Download an evaluation copy of QC-CALC from our website.
2. Install and tryout the software for up to 30 days.
3. Purchase the software via charge card, purchase order, or Paypal.
4. Activate software by visiting our website and obtain the Activation Code.

If you purchased the software from a sales agent or equipment manufacturer the process is a little different.

1. Purchase the software via sales agent.
2. Install software from the CD and use for up to 30 days.
3. Activate software by visiting our website and obtain the Activation Code.

In either case, your free updates and notifications are present on our website so you should visit it to see “what's new”.

28.3 License Activation Details

All software is activated through our website, www.ProlinkSoftware.com but more traditional methods still are available. When you purchase, install, and are ready to activate our software you must visit our **website** and log in to **My Account** to obtain and Activation Code.

28.3.1 License Activation on Web

After you purchase your software and are ready to activate it, go to our website, click on **My Account** and login. This is your "**My Account**" screen. You see:

The area in the center of the screen is labeled **My Software**. In this box click the **Activate** link next to the product you wish to activate. You are presented with the following window asking you for a **Friendly Name** and your **Computer ID**.

Product Name: QC-CALC SPC

PSN: 14622

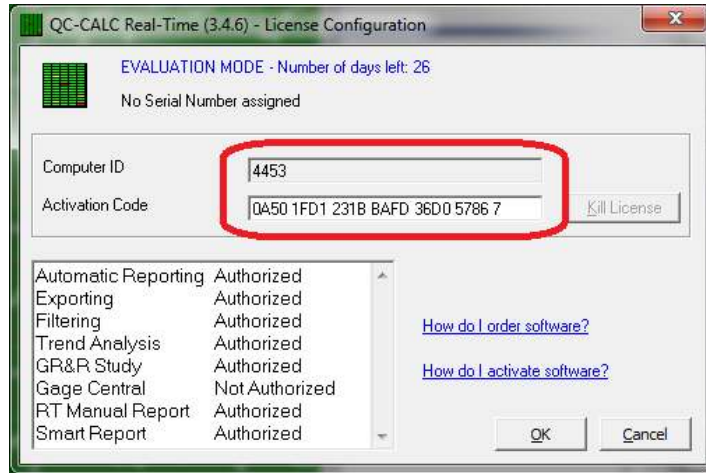
Computer ID: 

Machine Description: John's Blue CMM

Activation Code: 2763 2D92 4232 FA16 D0D2 97D3 6

Remember to use the correct **Computer ID** for the machine you are activating. The **Computer ID** is found in the **Help – License Configuration** menu of the software you have already installed. Once you have entered the **Computer ID**, click the **Get Authorization Code** button and the **Activation Code** is displayed in blue letters. It is this number you enter into the QC-CALC **License Configuration** screen. The **Friendly Name** is intended to be a name that helps you identify the machine you are activating. Remember, if you have 3 CMMs and they are very similar it might be hard to remember which machine you're viewing when you come to the website so use something that identifies that particular machine. You might use a machine serial number or other identifiable name.

Back in QC-CALC enter the **Activation Code** that was provided into the **Help – License Configuration** screen and click the **OK** button. Your software is now activated.



28.4 License Activation (manually)

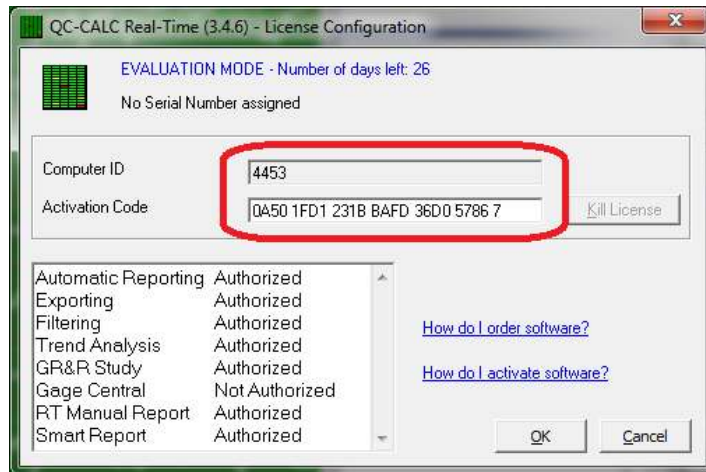
Each copy of QC-CALC is installed on an individual PC Personal Computer and must be activated using the license screen. Select the **Help – License Configuration...** menu to access the license screen. The basic concept of activating your purchased software is:

1. Select the **Help – License Configuration...** menu and a **Computer ID** number is generated by QC-CALC. You cannot change this number.
2. Supply the **Computer ID** to Prolink
3. Prolink generates and provides you with the **Activation Code**.
4. Enter the **Activation Code** into the box provided and click the **OK** button.

28.5 License Screen Details

28.5.1 Introduction

Most of this window is self-explanatory but various aspects are detailed here.



28.5.2 Top of Window

The top of the license screen displays the status of your license. If you are running an evaluation copy it tells you how many days are left until the evaluation

period expires. If it is a full purchased copy that has been activated it reads, "SOFTWARE ACTIVATED".

Your serial number is printed on the second line. From time to time you will supply the serial number to Prolink during phone support or identifying your software on the website. This serial number is available by choosing **Help – About QC-CALC Real-Time**.

28.5.3 Computer ID

The number that appears in this area is generated by QC-CALC and is considered your PC's identification number. This helps you identify which copy of QC-CALC you are working with and it is the origin of the **Activation Code**. If you have purchased multiple copies of QC-CALC, it makes it easier to identify which copy you are discussing with our support staff or the website.

28.5.4 Activation Code

If the **Activation Code** is blank it means you have not activated the software and you are still running an evaluation copy. Your **Activation Code** is issued by our website or by Prolink personnel. The **Activation Code** contains 6 groups of 4 and 1 single character at the end which totals to a 25 character code. This code consists of numbers 0 - 9 and letters A – F. (i.e. 0103 EEF4 ADDD 603B AB2A 9CE9 4). After entering an **Activation Code** and clicking the **OK** button, the **Activation Code** disappears and is replaced by "NO KEY NECESSARY" in order to avoid any confusion. The current software status is displayed at the top of the window.

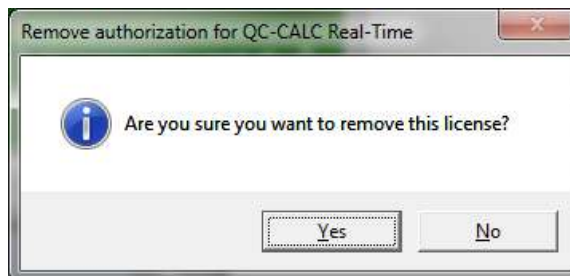
28.5.5 Options

The **Options** area displays the options activated by the **Activation Code** you entered. Most of the options are included with the standard software but some options may be turned off in the future to reduce the software cost. They include:

Automatic Reporting	Authorized
Exporting	Authorized
Filtering	Authorized
Trend Analysis	Authorized
GR&R Study	Authorized
Gage Central	Not Authorized
RT Manual Report	Authorized
SmartReport	Not Authorized

28.5.6 Kill License

This option is used to remove the QC-CALC license on a particular machine. We use this option to transfer a license from one computer to another. You are asked if you are sure before the license is removed. When successful a dialog box is displayed verifying your action.



You will read this number to a Prolink support staff member to allow you to move the license to a different machine. But in most case this is not required.

29. Record Filters - Details

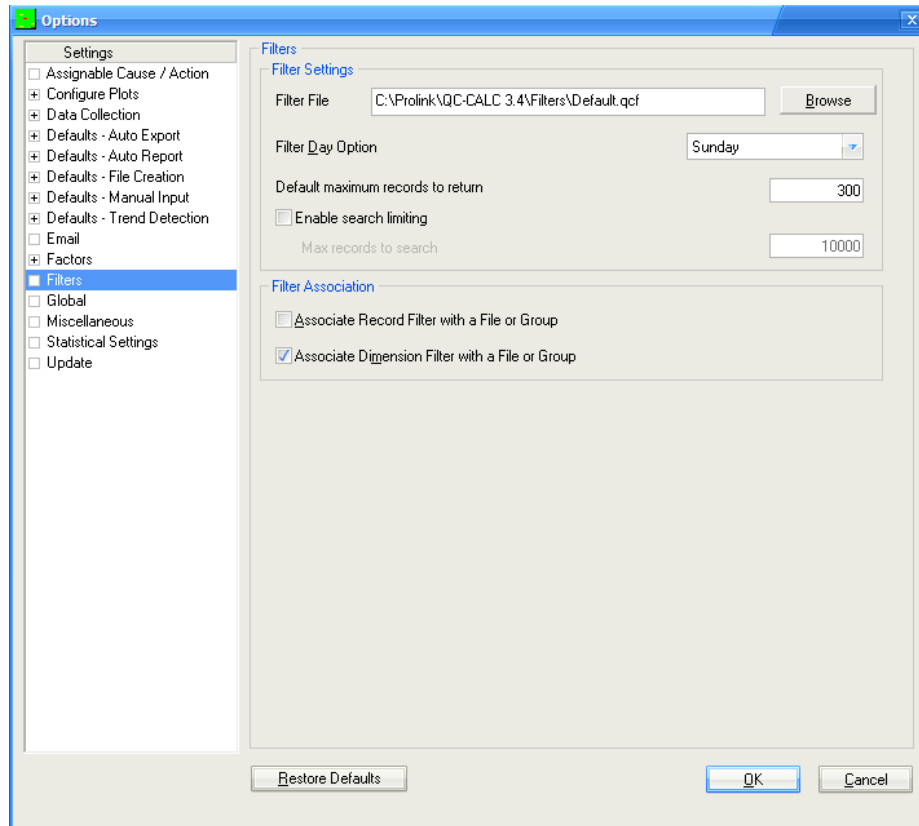
29.1 Introduction

This section contains the details of the **Record Filter** system used throughout QC-CALC. There are many options available and this expanded section was added to improve your understanding of this important subject. We create new filter files, add new filter criteria to existing files, and provide examples.

29.2 Creating a New Filter File

Select **Tools – Options – Filter Settings** to display the Filter file area. All filters are saved in files and QC-CALC's default filter file is DEFAULT.QCF which is the active filter when you start. You can create a new file by clicking the **Create Filter File** button. Enter a name in the file dialog box and you have a new – empty filter file. A filter file is where your filter criteria are stored for future retrieval.

One reason for creating multiple filter files would be to categorize filters for certain applications. For example, let's assume you have a 64-cavity mold and you want to create and save filters called Cavity 1, Cavity 2, through Cavity 64. You decide to save this set of filters on your local server in a file called Cavities. This organizes your filters and makes them available to all QC-CALC's within your facility. You can continue to make many filter files for every application.



29.2.1 Filter Day Option

QC-CALC has built-in filters such as TODAY, THIS-WEEK, LAST-WEEK, LAST-YEAR, etc. to help you with date related filters. This type of filter returns the correct date without having to know the exact dates for the week, month, or year. These filters produce variable results allowing you to reuse a filter without having to edit it. Since the first weekday can be defined differently, you have the option of choosing which day of the week begins the week.

29.2.2 Default maximum record to return

This option controls the total number of records returned from any filter. This value cannot be larger than the maximum number of records allowed in the database (2,000,000). This is just a default value. Each record filter has separate settings to control the amount of data returned for that specific filter.

29.2.3 Enable search limiting

Once this option is enabled you can limit how many records will be searched for results that match the filter criteria by entering the **Max records to search** in the box. If this setting is not used then all records in the .qcc file will be searched regardless of how long this search may take.

29.2.4 Global Filters

As you create and use filters you may find you want your filters to be available for all parts you inspect. This global concept is useful because you only have to create one filter and it is useful for all parts. However, the number of filters shown in the filter selector may become overwhelming and you may want to reduce this list. You can associate each filter with an individual part or associate it with all QC-CALC files. Click the **Associate Record Filter with a File or Group** to reduce the filter's range of use to the currently active QCC file. Uncheck this checkbox to make the filter available for all QCC files. This concept can be applied to dimension filters which are located under the record filter.

29.3 Create a New Filter

29.3.1 Introduction

When you click the **Edit a Filter** button the filter editor is displayed. To create a new filter, enter a name below the **Add New Filter Name** caption as shown in the top left hand corner. Choose a name for the filter and click **Add>>**.

and/or	(	Filter On	is (not)	Comparison	Lower Limit	and	Upper Limit)
		Date only	is	=	THIS-WEEK			

To edit an existing filter, select the filter's name from the **Select Filter to Edit** list, then edit the filter contents in the **Criteria** frame. Once you have modified your filter, click **OK** and your changes are saved.

29.3.2 Deleting a Filter

Just to the right of the **Select Filter to Edit** list is the **Delete Filter** button. Clicking this button removes the currently selected filter from the list. A dialog box is displayed asking you to verify your choice.

29.3.3 Max Records to Return

The Max records to return checkbox allows you to stop running the filter after a maximum set of results has been found. As your QCC files grow, filters will slow down since they have to search through more and more records. This feature allows you to set a governor on the number of results so the filter stops running

after x number of records have been returned. The default value for this is set in **Tools – Options – Filters**. In this screen, you can choose to not govern the query at all, set your own value, or leave it as the default value.

29.3.4 Entering Criteria

In the middle of the filter editor is the **Criteria** frame where your filter is created and edited. The choices you make for the items in this frame affect the data you see and any reports you run. The **Filter On** list contains all the possible types of information QC-CALC uses as a filter.

From the **Select Filter to Edit** list pick the filter name you wish to begin editing. Clicking the **Append** button adds new criteria to the end of the filter. Clicking the **Remove** button removes the currently selected criteria record. You can use the **^** and **V** buttons to move criteria up and down respectively to change the selection process of the filter.

29.3.5 Filter Criteria

The design of the filter criteria is setup to create a “man readable” sentence as the filter. As you select the fields in this row think about what the sentence is saying and the filter technique should be clear. For example, it should be obvious what you are trying to obtain when the filter reads **Lot is between 22 and 23** or maybe **Date only is = THIS WEEK**.

A combined example might be:

Lot is between 22 and 23
and **Date only is = THIS WEEK**

29.3.6 Criteria Field Explained

- And/or** When you enter more than one criteria (line) you can specify how the given criteria is combined with those before it. **AND** means both criteria have to be satisfied for a record to be included. **OR** means if either of the criteria are satisfied the record will be included. Use parenthesis for grouping criteria when using complex filters to ensure criteria is combined in a manner you'd expect. When you have two or more record criteria in the filter you can switch between **And** and **Or** by clicking on the word and a Drop-down list provides your choice.
- (&)** Parentheses are used to specify the beginning or end of a criteria group. Grouped criteria are first evaluated together before it's combined with other criteria. The examples at the end of this appendix should clarify the use of parentheses.
- Filter On** This is the list of items QC-CALC provides to build your filters. You select the **Filter On** item and add the range of acceptable values. A full definition of each item follows this section.
- is (not)** This option allows you to specify whether you want to include records that match this criteria or exclude them. e.g. **Lot is = 22** versus **Lot is not = 22**.
- Comparison** This portion of the criteria specifies how the data in the searched record will be compared to your criteria. “=”, “>”, “>=”, “<”, and “<=” have the standard meaning, “BETWEEN” lets you specify an inclusive range in which the data must fall to satisfy this criteria. “LIKE” lets you use wildcards to do pattern matching against your data: “*” matches zero or more characters, “?” matches a single character, and “#” matches a single digit. e.g.

Record number is LIKE 5 returns record 5 only

Record number is LIKE *5 returns all records ending with 5
 Record number is LIKE *5* returns all records containing a 5
 Operator is LIKE Laura returns all cases of LAURA
 Lot is LIKE 2# returns any Lot in the range of 20 – 29
 Lot is LIKE ?5? returns Lots with a 5 in the tens column

Lower Limit This is where you specify the lowest acceptable value of the searched record. It can be the only portion of the filter if you are searching for a single item such as **Lot is = 22**. This field can also contain special keywords selected from its own Drop-down list.

And This is an un-editable field and its only purpose is to make the criteria easier to read. The word “and” is displayed if you select **BETWEEN** as the comparison type.

Upper Limit This field specifies the upper limit for the range if you select **BETWEEN** as the comparison type. It is un-editable otherwise.

29.3.7 Filter On Explained

The **Filter On** column is a list containing several possible values. Each of these keywords is detailed here. Keep in mind the **Filter On** items also have special keywords you can use instead of filtering on just a number or text. These values are summarized in the table below with details following:

Filter On	Enter	or Special Key Words
Record Number	number	LAST N RECORDS
Date Only	number	TODAY, LAST_WEEK, etc.
Time Only	number	
Date & Time	number	
Number of Fails	number	
Day of the Week		MONDAY, TUESDAY, etc.
Assignable Cause or Corrective Action		TRUE or FALSE only
Numeric Factors	number	TRUE or FALSE only
Text Factors	number/text	LATEST_VALUE or ASK_VALUE
Features	number	LATEST_VALUE or ASK_VALUE

Filter On Details

Record Number Using this keyword lets you filter based on the QC-CALC record numbers. You can specify the range of records by entering a Lower and Upper Limit. You can also select the **LAST-N-RECS** in the Lower Limit column where this word has been added by QC-CALC. Use this keyword as a variable whenever you wish the newest X records to always be returned from the end of the database. You will be prompted for the value of N.

Date Only Using this keyword allows you to ignore the time portion associated with a date. It also lets you specify special keywords such as TODAY, YESTERDAY, THIS-WEEK, THIS-MONTH, THIS-YEAR, LAST-WEEK, LAST-MONTH, and LAST-YEAR. These special keywords let you create a filter that is timeless so when you create your reports for last week’s work you can always use the same filter without having to know the actual dates of that week.

Time Only Using this keyword lets you specify the time of day the part was received. There are no keywords associated with time.

Date and Time This keyword lets you specify both the date and the time the part was received.

Number of Fails	Each part stored in the QC-CALC database has a fail count saved with it. This keyword allows you to filter on the number of failed features within a part. For example, you can build a filter that only reports the parts containing bad features. The filter would read: Number of Fails is > 0
Day of Week	This keyword allows you to specify the day of the week the part was received. The possible values are SUNDAY – SATURDAY. These values are supplied in the Drop-down list and cannot be entered by you.
Assignable Cause or Corrective Action	This keyword allows you to specify whether the part has an Assignable Cause or a Corrective Action associated with it. The only possible values are TRUE or FALSE. You can filter all parts that have Causes or Actions assigned to them.
Numeric Factor	<p>Each part saved in the database has Factors saved with it. This keyword lets you specify the value a Numeric Factor equals to satisfy the criteria. There are two special keywords to discuss for the Numeric Factor and they are:</p> <p>LATEST-VALUE – Only parts having the same Numeric Factor as the most recently received part satisfy this criteria. This filter keyword is very important since it allows for dynamic filtering. For example, let's say you are inspecting plastic parts made in a 16 cavity mold and you want to filter on the part just inspected. Normally you would create 16 different filters labeled Cavity 1 through Cavity 16. To filter on each cavity you would click on each filter and instantly see the parts made in Cavity 1. This can be tedious because it is a manual task that humans must perform.</p> <p>The LATEST-VALUE keyword allows QC-CALC to filter on the part just received from the inspection equipment. What this means is you can request QC-CALC to automatically filter on the current cavity without touching the filters. This is a very useful tool when full automation is in use. When a problem occurs you know immediately which cavity caused the issue.</p> <p>ASK-VALUE – This keyword is preloaded into the Lower Limit field to assist you with quick lookups. When you click a filter containing this keyword, QC-CALC asks you to supply the filter value. For example, let's say you have a 64-cavity mold and you do not want to create 64 separate filters. You can create a filter containing a value of ASK-VALUE. The filter might read:</p> <p>Cavity is = ASK-VALUE</p> <p>To activate the filter, click on the name and a dialog box asks for the Cavity number and your data is filtered using that value.</p>
Text Factor	The Text Factors are the same as the Numeric Factors but they allow you to enter text as a value. Please read the definition on Numeric Factors to gain an understanding of Text Factor Filter use.
Feature	You can specify the value of any feature in the database by selecting the feature number. You then specify the allowable range for the feature. You might use this to find all parts within the last 100 inspected parts with a feature exceeding a particular value.

29.3.8 Filter Examples:

The following set of examples is supplied to increase your understanding of the QC-CALC filter use.

Example #1

Show only the last 20 records:

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Record Number	is	=	LAST-20-RECS			

Example #2

Show only records received yesterday:

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Date only	is	=	YESTERDAY			

Example #3

Assuming Text Factor 5 holds the operator's name, show parts measured by all operators whose names are between "B" and "G" alphabetically:

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Text Factor 5 - Operator	is	BETWEEN	B	and	G	

Example #4

Show only records with odd record numbers (ending in 1, 3, 5, 7, or 9):

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Record Number	is	LIKE	*1			
or		Record Number	is	LIKE	*3			
or		Record Number	is	LIKE	*5			
or		Record Number	is	LIKE	*7			
or		Record Number	is	LIKE	*9			

Example #5

Assuming you have multiple machines collecting data to the same file and storing the machine ID in Numeric Factor 2, show only parts collected from the machine that sent the last part.

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Numeric Factor 2 - Machine	is	=	LATEST-VALUE			

Example #6

Show parts from this week that had at least one feature out of spec.

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Date only	is	=	THIS-WEEK			
and		Number of fails	is	>=	1			

Example #7

Assuming Text Factor 5 contains the operator's name and Numeric Factor 2 contains Machine, show parts measured last month, on the 2nd shift (between 3pm and 10pm), on machines 1 or 3, measured by Bob or John.

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Date only	is	=	LAST-MONTH			
and		Time only	is	BETWEEN	03:00:00 PM	and	10:00:00 PM	
and	(	Numeric Factor 2 - Machine	is	=		1		
or		Numeric Factor 2 - Machine	is	=		3		
and	(	Text Factor 5 - Operator	is	=	BOB			
or		Text Factor 5 - Operator	is	=	JOHN			

Example #8

Assuming Text Factor 5 holds the operator's name, show parts measured by operators other than Bob, which had at least 1 feature out of spec and did not have an Assignable Cause or Corrective Action assigned to them:

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Assignable Causes or Corrective Ac	is	=	FALSE			
and		Number of fails	is	>=	1			
and		Text Factor 5 - Operator	is not	=	BOB			

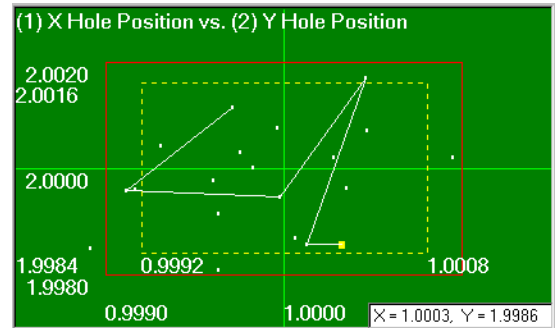
30. Scatter Plots

30.1 Introduction

Scatter Plots are used to plot two features against one another in an XY fashion. You use this to compare positional information such as XY, XZ, YZ on one plot. If you have this type of data you can use a scatter plot to display and compare your data in another view. The nominals and tolerances of the two features do not have to be of the same magnitude. The plot is scaled according to values of each axis.

30.1.1 Scatter Plots

Scatter plots provide a better view of two related features such as a hole position but lack the time orientation of Raw Data plots. Each pair of inspection data points is plotted as a “dot” instead of the familiar “dot and line” style of a typical time oriented Raw Data plot. The combined data is displayed as a scattering of points within a rectangle that is bounded by the Tolerances of the two dimensions.



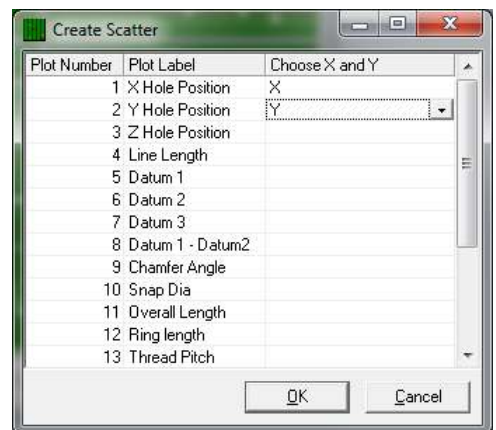
30.1.2 Scatter Trace

The Scatter Trace displays the last 6 points connected with a line to show the most recent part history. Connecting more than 6 points begins to clutter the plot. You cannot change the number of points connected, it is always the last 6 parts starting with the newest data (yellow dot) going backward to -5 parts.

If you make any process changes related to a positional feature the trace gives you immediate feedback of your change. For example, if the scatter plot shows your process is centered in the upper right quadrant of the plot and you made a change to center it on nominal you will see the trace move to the new location helping you to find the center

30.2 Create Scatter Plot

Select menu **View – Create Scatter** to create a scatter plot. A list of the part features is displayed in a table. Choose the features that will become the X-axis and the feature to be the Y-axis from the list in the right column. When you click **OK** the X & Y plots disappear and the scatter representing both plots appears.



30.3 Create Scatter Plot with Mouse

A shortcut to creating scatter plots is through the use of the keyboard and mouse drag and drop method. Do the following to create a scatter plot.

1. Hold the SHIFT key down.
2. Click and hold the left mouse button on the plot you want as the Y-axis.
3. Drag the Y-axis plot and drop it onto the plot that you want on the X-axis.

The destination plot (X-axis) turns into a Scatter Plot and the dimension you were dragging disappears.

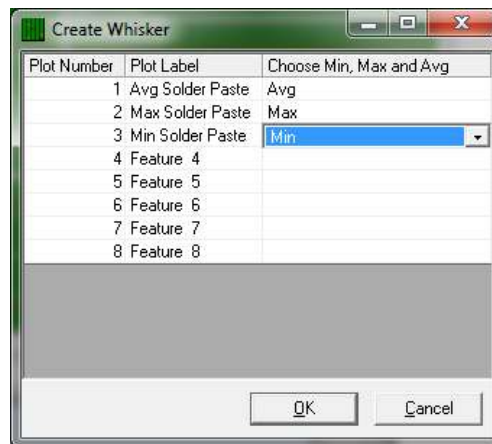
31. Whisker Plots

31.1 Introduction

Whisker Plots are used to plot multiple features on a raw data plot. You use this to compare similar features by overlaying the data onto one plot. The primary use is to plot an Average - Max - Min on one chart. If you have this type of data you can use a whisker plot to display and compare your data. As you might expect, the nominals and tolerances of three features overlaid on top of one another should be the same.

31.2 Create Whisker Plot

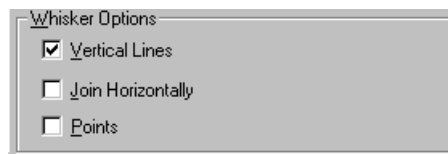
Select menu **View – Create Whisker** to create a Whisker chart. A list of the part features is displayed in a table. Choose the features that will become the Min, Max, and Avg from the list in the right column. When you click **OK** the **Min** and **Max** plots disappear and the **Avg** plot contains vertical lines showing you the extent of your process.



Each whisker plot is plotted with the base feature looking like a raw data plot and two optional plots for Max and Min calculations. You can use all three of the options below at once, but at least one of the options must be turned on in order to see the Whisker Plots at all. Try several combinations until you find one you like. The three possible options to identify the two extra features are as follows:

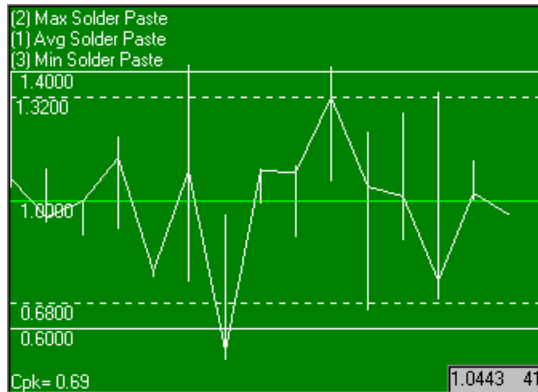
31.2.1 Changing the Options

Each whisker setting is changed in the **Tools – Options – Configure Plots Settings – Items to Show** menu. You see the choice of adding Vertical, Horizontal, and Points to your plot. These choices are additive allowing you to create unique combinations.

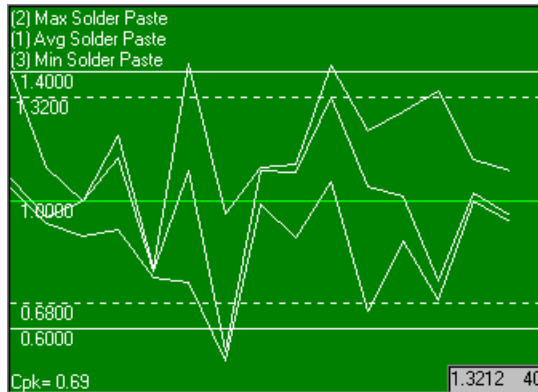


Vertical Lines

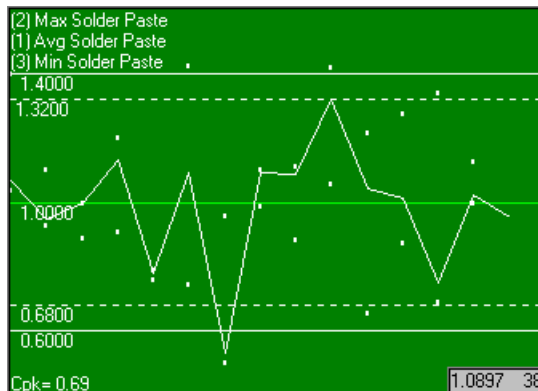
Join all data points of the base plot with the Max and/or Min plots with a vertical line. It is this option that makes the chart look like a whisker plot.

**Join Horizontally**

If you wish to join the Min/Max data points horizontally, like a raw data plot, use this option. This option connects all of the Max points to each other and all of the Min points together.

**Points**

If the vertical lines create a plot that is too “busy”, try using Points at the Min and Max points. You can have both vertical and points turned on at the same time.



If you accidentally create a whisker plot where the base plot has a nominal of 1.000 +/- 0.005 and the max plot has a nominal of 2.000 +/- 0.005 the vertical lines will be scaled off the plot making it difficult to read. Simply remove the whisker plot as described next.

31.2.2 Remove Scatter or Whisker Plot

When you right mouse click on a live plot that is either a Scatter or Whisker plot, this menu choice is enabled. When you select this choice, the dependent plots used to generate the complex plot are removed, and all plots revert to a raw data plot.

1. Right click on the Whisker plot.
2. Select **Remove Scatter or Whisker Plot** menu choice.
3. All three plots return to their normal **Raw Data** plots.

31.3 Create Whisker Plot with Mouse

A shortcut to creating whisker plots is through the use of the keyboard and mouse drag and drop method. Do the following to create whisker plots.

1. Hold the CTRL key down.
2. Click on the plot you wish to have as the Max value.
3. Drag and drop Max onto the plot you wish to have as the Avg value.
4. Hold the ALT key down.
5. Click on the plot you wish to have as the Min value.
6. Drag and drop it onto the plot you wish to have as the Avg value. The original plot will have extra whiskers added.

Be sure the nominal and tolerance values for each plot are the same otherwise your added lines may not be viewable.

32. True Position Plots

32.1 Introduction

QC-CALC Real-Time has a special plot type called True Position. The goal of True Position MMC is to relax the positional tolerance of a feature by adding unused size tolerance (bonus) to the position tolerance. Although this method cleverly saves parts from the scrap heap when the position of a hole is “out of spec” in X or Y, it has added a great deal of confusion. When SPC is applied to many true position measurements even more confusion results. We address these issues based on the research and techniques used at this writing and will continue to add more calculation methods as this important topic evolves.

32.1.1 The Purpose

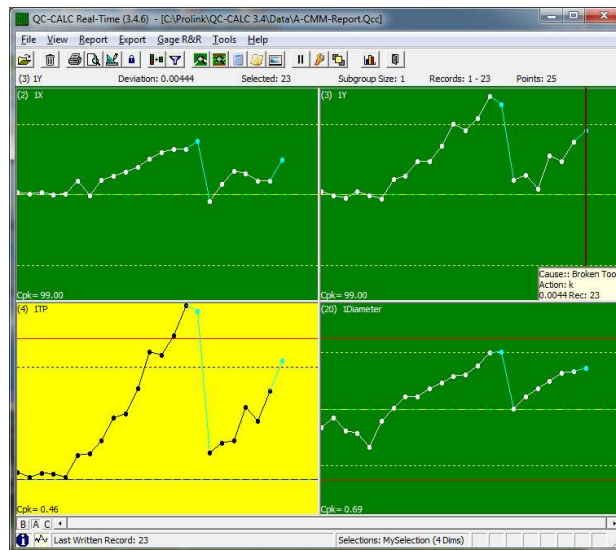
This section explains what true position is and how SPC calculations deal with many moving targets. Remember, we are adding individual bonus values to each TP reading making SPC analysis seemingly impossible. Further, it should be obvious as you apply unused size tolerance to positional tolerance the Cpk for TP usually improves. However, more bonus tolerance is given only because the feature size is getting further from nominal yielding a worse Cpk for size. So you gain process capability in position but you lose capability in size.

32.1.2 The Premise

The basic idea is to normalize each measurement to the same tolerance by adding (Upper Tol + Bonus) and equating it to 100% of available tolerance. Using the total available tolerance you convert each positional value to a percent of this total tolerance. Each point in the data set has a slightly different tolerance but it doesn't matter since each value is scaled to 100% of available tolerance for that point.

32.2 True Position Example

Let's start with a True Position example where QC-CALC Real-Time has read data from a CMM program while measuring a hole feature labeled **1 TP** on 12 parts. The 4 plots below show the X, Y, TP, and Dia values. These numbers are the source of this discussion and we include QC-CALC's operation to clarify the subject.



The Excel spreadsheet below shows four related dimensions of 12 parts in rows 6-17. These same numbers are shown in four QC-CALC's Real-Time plots above

to better depict how each dimension is changing (12 dots). Reviewing the basic calculations for TP we have:

$$TP_{RFS} = 2 * \sqrt{(x^2 + y^2)} \quad Bonus_{Hole} = Dia_{actual} - LSL \quad Bonus_{Pin} = USL - Dia_{actual}$$

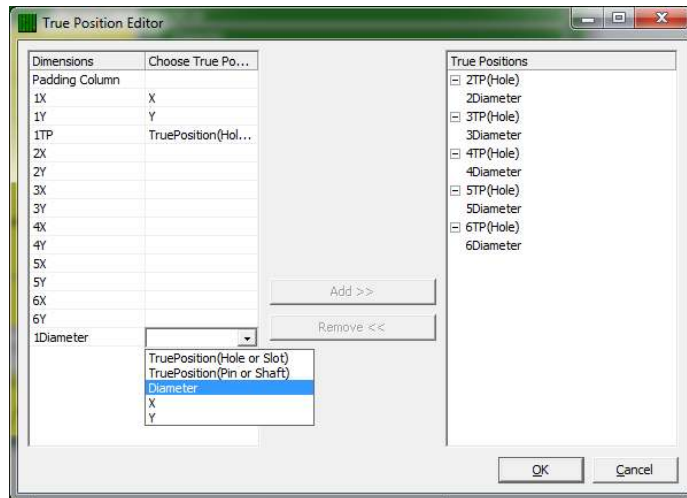
Most modern gages and CMMs calculate these values for you but we present them here as a refresher and for completeness.

	A	B	C	D	E	F	G	H
1		1X	1Y	1TP	1Diameter			
2	Nominal	4.00000	0.00000	0.00000	0.75000			
3	Upper tol	0.00600	0.00600	0.01200	0.00100			
4	Lower tol	-0.00600	-0.00600	0.00000	-0.00100	TP RFS	Bonus Hole	Bonus Pin
5								
6		3.999309	0.000383	0.001580	0.750016	0.000765	0.001016	0.000984
7		4.000855	0.000459	0.001941	0.750130	0.001941	0.001130	0.000870
8		4.000956	0.001014	0.002786	0.750196	0.002787	0.001196	0.000804
9		4.000515	0.002764	0.005623	0.750332	0.005623	0.001332	0.000668
10		4.001257	0.003236	0.006943	0.750374	0.006943	0.001374	0.000626
11		4.002034	0.003876	0.008754	0.750381	0.008754	0.001381	0.000619
12		4.002420	0.004699	0.010572	0.750415	0.010572	0.001415	0.000585
13		4.001575	0.005131	0.010735	0.750574	0.010735	0.001574	0.000426
14		4.001850	0.004708	0.010117	0.750607	0.010117	0.001607	0.000393
15		4.003561	0.004961	0.012213	0.750721	0.012213	0.001721	0.000279
16		4.004162	0.006356	0.015194	0.750892	0.015194	0.001892	0.000108
17		4.003217	0.007493	0.016308	0.750904	0.016308	0.001904	0.000096

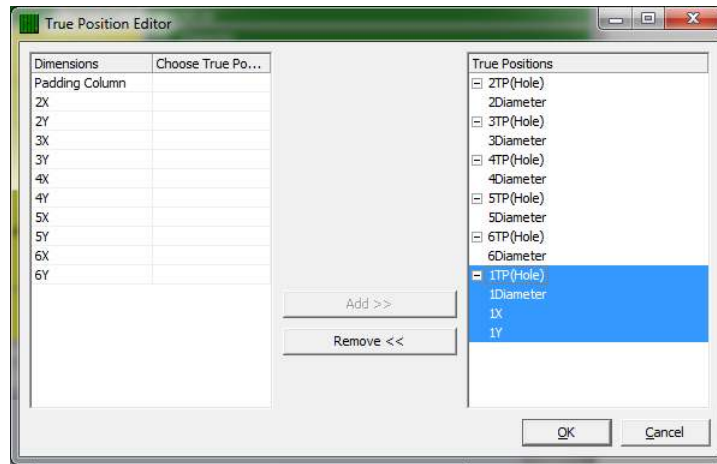
QC-CALC has the ability to join the four plots together and calculate all of the necessary TP values without the need of the CMM or gage to report the bonus. QC-CALC does not store the bonus values but instead dynamically recalculates everything needed in real-time. This includes the bonus, the percent of tolerance used, the magnitude of the point, the angle of each point and the Cpk. QC-CALC maintains the scaling of its charts in engineering units not percent of tolerance used. Only the Cpk calculation is based on the 100% of tolerance used.

32.2.1 Join the Plots

First, let's join these four plots together to graphically show the TP relationships. In QC-CALC's Real-Time menu select **View – Configure True Position**. In this example there are 6 holes being measured but we only join hole 1 by selecting the dimensions that contain the X, Y, TP, and Dia as shown.

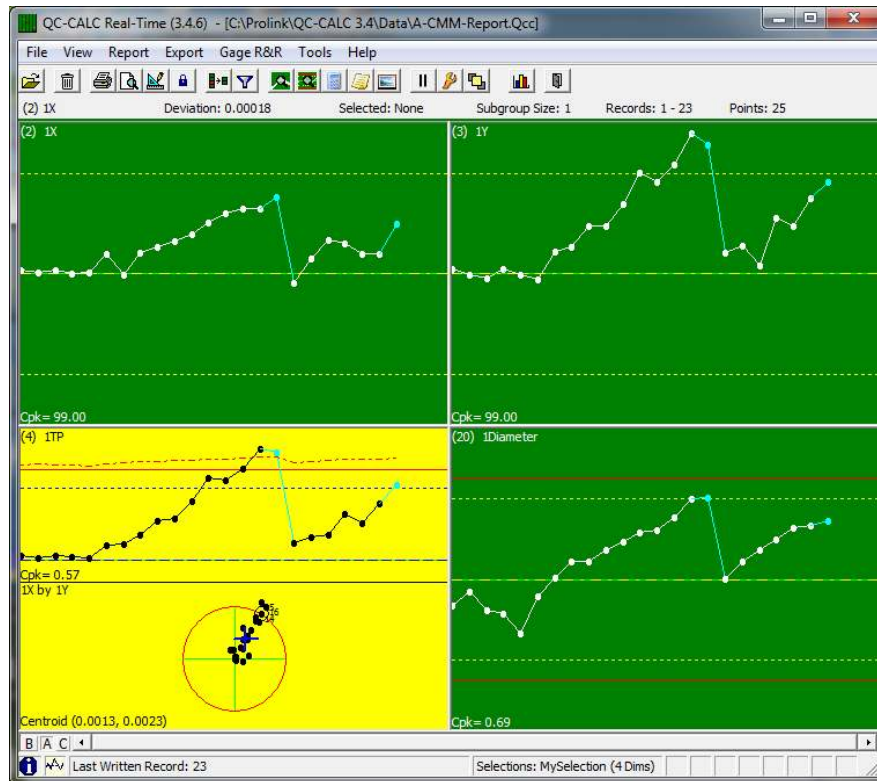


After all four dimensions are selected click the **Add >>** button to move this relationship to the right panel and click **OK**. You can create as many TP plots as desired but for simplicity we use just one.



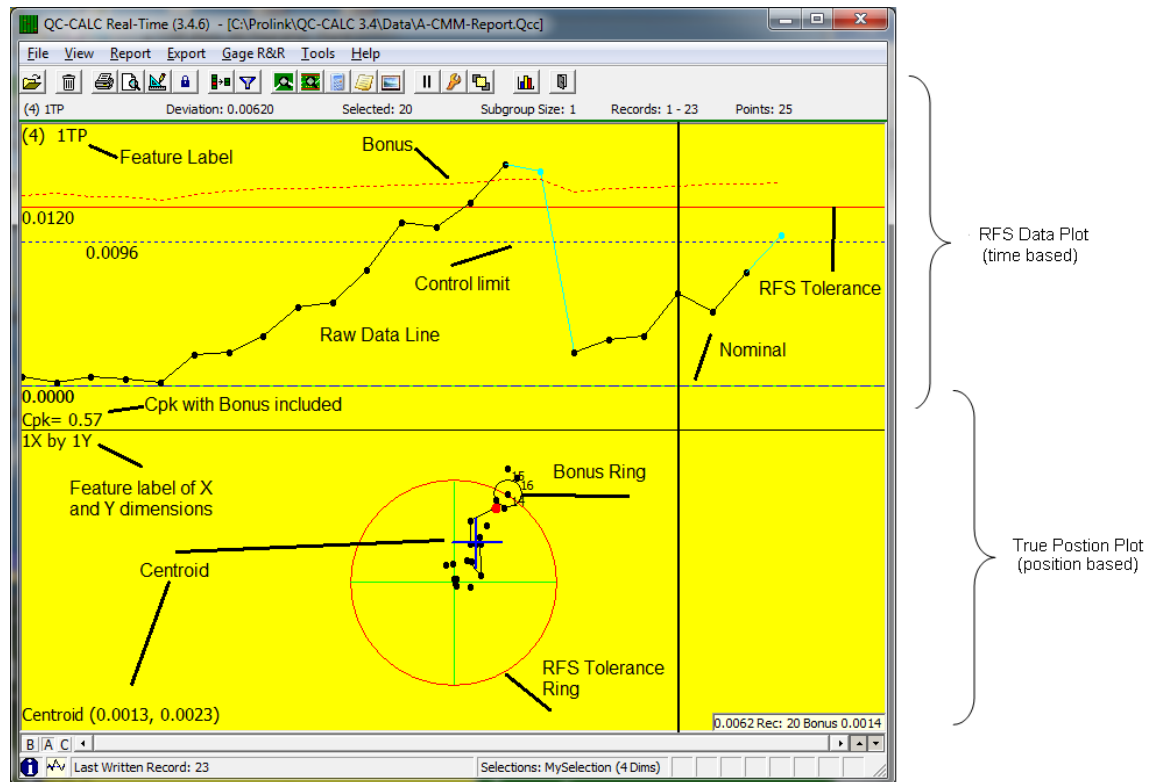
32.2.2 Composite TP Plot

The QC-CALC TP plot (bottom left) becomes a composite of the original four plots with an added bonus line and scatter plot. The bonus line is a red dashed line above the solid red RFS tolerance labeled 0.0120. Floating the mouse over each point yields the value of the point and the value of the bonus (lower right corner). This particular data shows a steadily increasing bonus line which is not typical but good for discussion purposes. Note the clustering of the TP dots mostly lie in the upper right quadrant of the plot.



32.3 Details of the Plot

Let's take a closer look at the composite TP plot by double clicking the red plot shown above. This is the normal method of zooming in on any of QC-CALC's dimensions. We've added extra descriptive text pointing out the details of the charts. This comprehensive, two plot diagram, yields a great deal of useful information. Let's not forget the original goal is to provide a method of incorporating the unused size tolerance (bonus) in the Cpk calculation of position.



32.3.1 Plot Details

The top chart is time based (chronological) showing you how the TP varies as parts are inspected. You see the bonus tolerance moving up and down as the related hole size varies. The RFS tolerance is the solid red line (0.0120) while the bonus is a red dashed line above it.

The lower TP plot shows you where the holes are physically positioned (white dots) with a centroid calculation (Avg x and Avg y). With very little knowledge, an operator could use the centroid values to center the process by dialing in an offset of X= -0.0018 and Y= -0.0038.

Any point that can be "bought" using the extra bonus tolerance is shown with a white bonus ring around it. By design, the bonus ring will always intersect the solid red RFS ring. If the point does not need the bonus to be considered a good part we do not add the ring. Likewise, if the point cannot be bought with the bonus, no ring is added since it is assumed to be a bad part. In an effort to reduce the screen clutter, we only show the bonus ring when the part is considered good because the added bonus made it so.

32.4 How is Bonus used in Cpk Calculation?

Before we can compare true position values, each with different tolerances, we normalize the numbers to a common base. One method is to add the Upper Tolerance + Bonus to create "100% of available tolerance" for each point. This

True Position Plots

total is different for each part (see column I below) but it represents 100% for each individual part. Now calculate the percent of available tolerance used by each point (see column J). The percent used is the basis of the Cpk calculation.

$$\text{Percent of tolerance used by point} = \frac{TP_{\text{point}}}{\text{UpperTol} + \text{Bonus}}$$

$$\text{Total Available tolerance} = \text{UpperTol} + \text{Bonus}$$

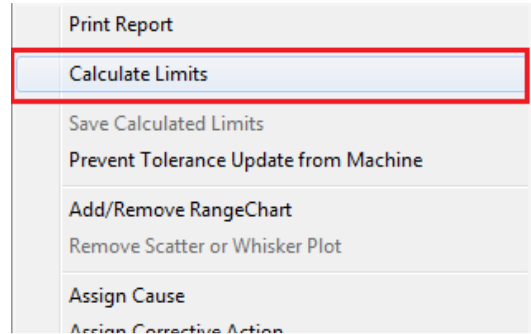
	A	B	C	D	E	F	G	H	I	J	
1		1X	1Y	1TP	1Diameter						
2		4.00000	0.00000	0.00000	0.75000						
3		0.00600	0.00600	0.01200	0.00100						
4		-0.00600	-0.00600	0.00000	-0.00100	TP RFS	Bonus Hole	Bonus Pin	Total Tol Hole	Percent Used	
5											
6		3.999309	0.000383	0.001580	0.750016	0.000765	0.001016	0.000984	0.013016	0.0588	
7		4.000855	0.000459	0.001941	0.750130	0.001941	0.001130	0.000870	0.013130	0.1478	
8		4.000956	0.001014	0.002786	0.750196	0.002787	0.001196	0.000804	0.013196	0.2112	
9		4.000515	0.002764	0.005623	0.750332	0.005623	0.001332	0.000668	0.013332	0.4217	
10		4.001257	0.003236	0.006943	0.750374	0.006943	0.001374	0.000626	0.013374	0.5191	
11		4.002034	0.003876	0.008754	0.750381	0.008754	0.001381	0.000619	0.013381	0.6542	
12		4.002420	0.004699	0.010572	0.750415	0.010572	0.001415	0.000585	0.013415	0.7881	
13		4.001575	0.005131	0.010735	0.750574	0.010735	0.001574	0.000426	0.013574	0.7908	
14		4.001850	0.004708	0.010117	0.750607	0.010117	0.001607	0.000393	0.013607	0.7435	
15		4.003561	0.004961	0.012213	0.750721	0.012213	0.001721	0.000279	0.013721	0.8901	
16		4.004162	0.006356	0.015194	0.750892	0.015194	0.001892	0.000108	0.013892	1.0938	
17		4.003217	0.007493	0.016308	0.750904	0.016308	0.001904	0.000096	0.013904	1.1729	
18	Centroid	0.00181	0.00376							Sigma	0.3607
19										Average	0.6243
20										Cpk	0.35

The average and sigma values are calculated based on the values in column J, which are the normalized values of percent of tolerance used. Because we use 100% as our new USL we substitute 1.0 for the USL in the equations below. You can verify these calculations by clicking QC-CALC's **View – Quick Stats** menu.

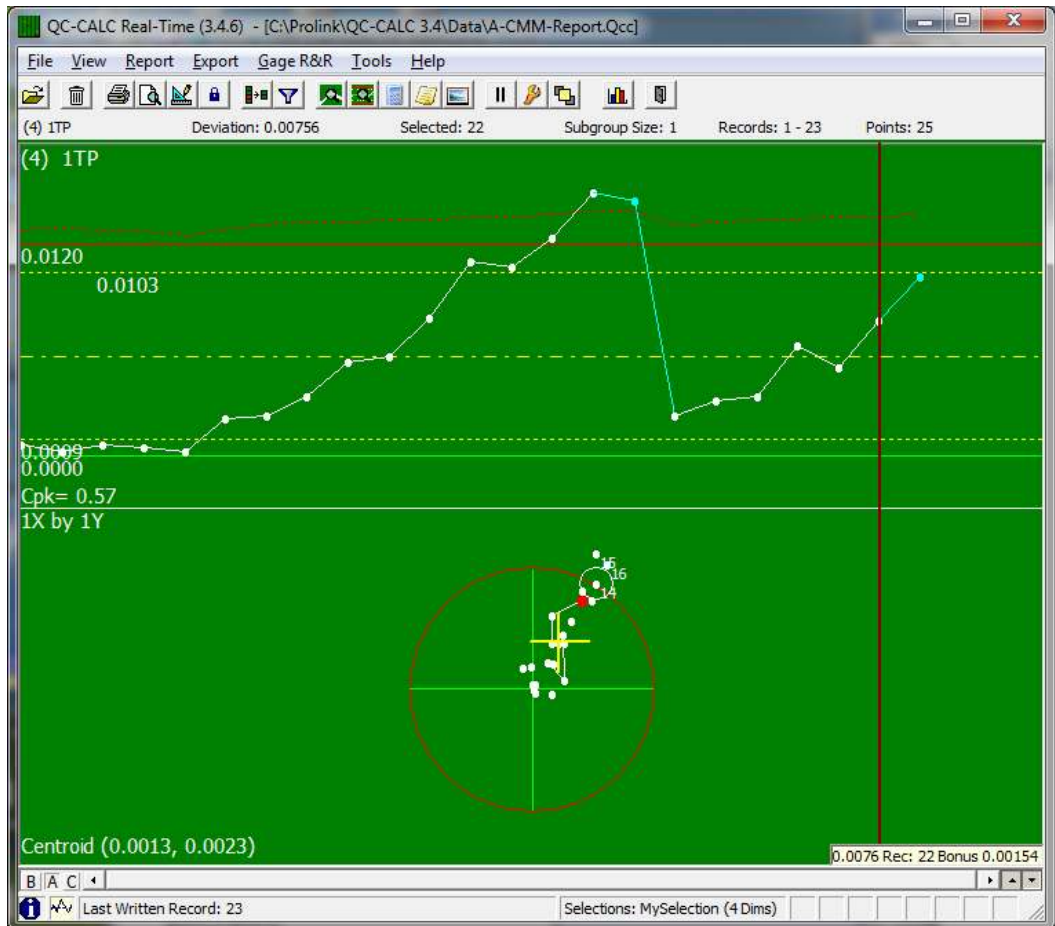
$$Cpk_{Hole} = \frac{USL - Xbar}{3 * Sigma} \rightarrow Cpk_{Hole} = \frac{1 - 0.6243}{3 * 0.3607} \rightarrow Cpk_{Hole} = 0.35$$

32.5 How are the control limits calculated?

The traditional control limit calculation is used on the TP plots. QC-CALC assumes that if the X and Y axis are individually in-control then the TP is in control. By right clicking anywhere on the plot you see a popup menu appear. Choose the **Calculate Limits** menu and the TP plot suddenly changes.



The control limit is drawn on the top chart as the usual horizontal control line. The graph is rescaled to fit the largest of the control or spec limit line. This is the same chart as before but with the control limits calculated to fit the data.



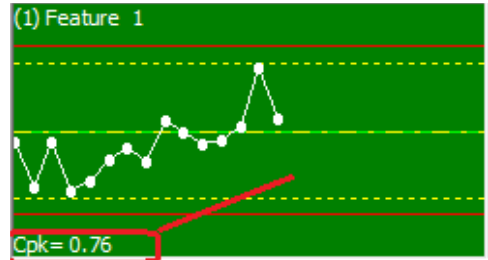
33. Sigma Calculations

33.1 Introduction

QC-CALC Real-Time calculates and displays several statistical calculations in the lower left corner of each plot. In addition, you'll find calculations in the Point Properties panel when it is chosen to be displayed on the left side of the screen. The third location for calculations is on the dash lines found in the plots themselves. This section of the manual provides insight as to how QC-CALC arrives at all of these values and why. Sigma is the source of most calculations.

33.2 Display Calculations

Each plot has an optional calculation displayed in the lower left corner of each plot. These calculations include **Cpk**, **Cpk_R**, **Cp**, **Cm**, **Cr**, **Avg**, **Range**, **PT Ratio**, **Zupper & Zlower**. All calculations shown here are dynamic and are calculated based on what data is displayed in the plot (visible data). These values update as new data is received or the data is changed using the horizontal scroll bar. Any display movement affects the calculations you see. This includes any live filters that may change the visible data set.



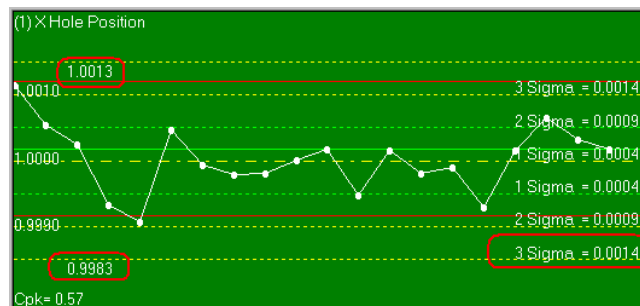
33.3 Quick Stats Calculations

The Quick Stats area of the Real-Time screen always agrees with the on-screen calculations (Lower Left Corner of the Plot) regardless of subgroup size. The purpose of this panel is to display many more calculations than are possible in the limited space of the plots. In other words, QC-CALC Real-Time displays all of the calculations at once providing a stat summary area without the need of printing paper report.

Quick Stats	
Dimension Label	Feature 5
Sample Size	15
Cpk	0.87
Cpk Lower	1.16
Cpk Upper	0.87
Cpk By R	N/A
Cp	1.01
Cpm	0.93
Mean	5.501447
Min	5.496788
Max	5.506691
Range	0.009903
Sigma	0.0032865
Sigma By R	N/A
Data Normal	Yes
Short-Term Sigma	0.003317
Short-Term Cp	1.0
Short-Term Cpk	0.86

33.4 Line Calculations

Each plot contains many possible lines to include: UCL, LCL, USL, LSL, Saved Mean, Calculated Mean, Nominal, & Sigma Zones. Choose **Tools – Options – Configure Plots – Items to Show** and items are seen. This plot shows many of the optional lines displayed and their corresponding calculations near the lines.



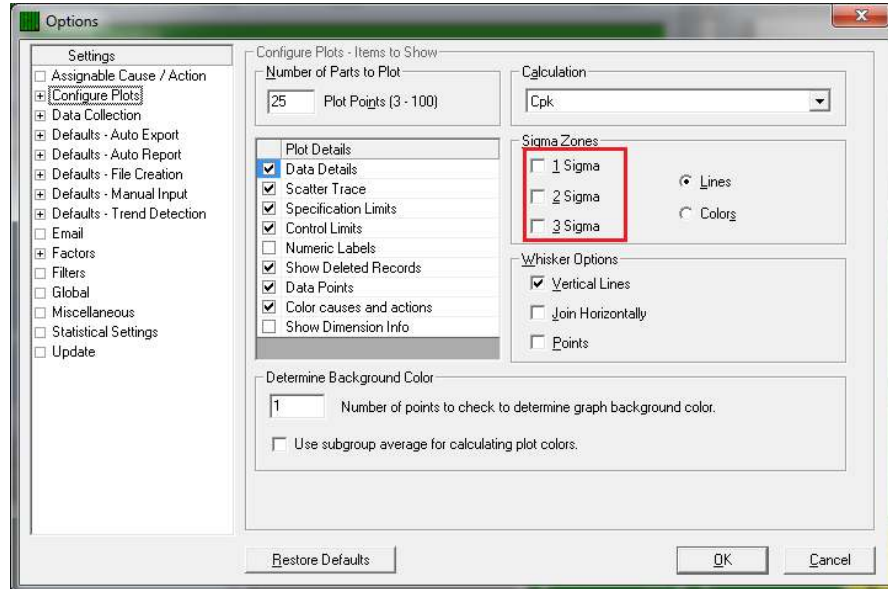
33.4.1 Items to Calculate vs. Items to Show

We now know the graphical lines in the Real-Time plots can not only be displayed but can also be calculated. You decide which lines you want displayed

and possibly which to calculate. This section makes a distinction between these two important concepts.

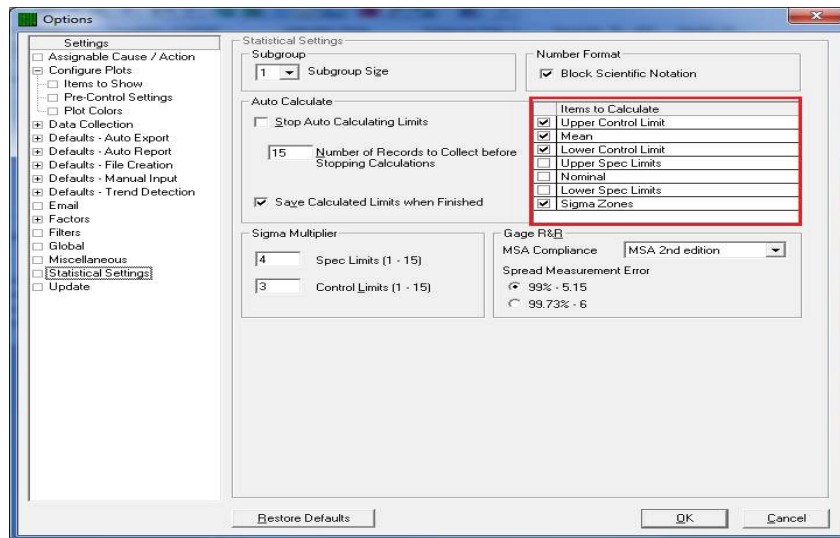
33.4.2 Items To Show

The **Tools – Options – Configure Plots Settings – Items to Show** menu is where the various options are selected for on-screen display. These items were discussed earlier but shown here for reference.



33.4.3 Items to Calculate

All of the lines displayed can be calculated for you based on the data you are viewing. You choose which to calculate by selecting menu **Tools – Options – Statistical Settings – Items to Calculate**.



All of these Limits can be manually calculated or dynamically calculated

- Calculate Single Plot
- Calculate Entire Screen
- Auto Calculate Entire Screen

When you choose one of these calculations all “checked” limits are updated and the value on each line is based on the variation of the data displayed.

33.5 How are the Limits Calculated?

Sigma is the basis of all limits calculations. When the Real-Time subgroup size is set to 1, QC-CALC cannot calculate sigma using the Rbar / d2 equation since the Rbar is zero. If the Real-Time subgroup size is set to 1 (raw data) the sigma calculation is different from all other subgroup sizes (2 – 25) and is based on the following calculations:

Subgroup = 1

$$\sigma_{Series} = \sqrt{\frac{\sum_{i=1}^n (X_i - \bar{X})^2}{(n-1)}}$$

If the Real-Time subgroup size = 1 all calculations involving sigma use σ_{Series} . This is without exception since the Rbar is not possible.

Subgroup > 1

$$\sigma_R = \frac{\bar{R}}{d_2}$$

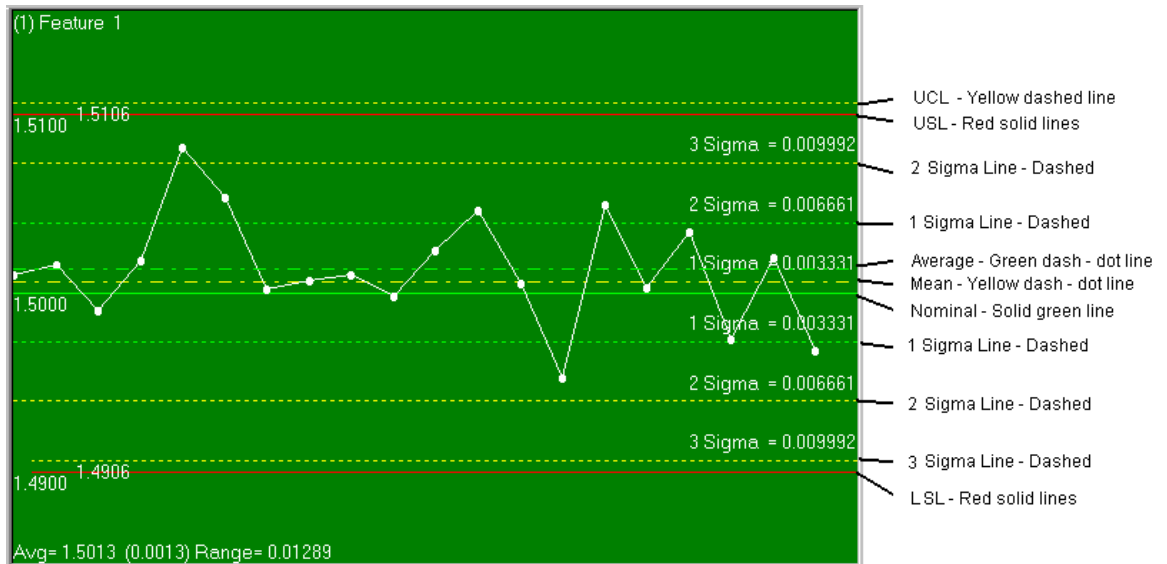
If the Real-Time subgroup size > 1 the Upper & Lower Control Limit and Sigma lines use σ_R . σ_{Series} is used in all other calculations.

If you choose not to calculate the Mean, the UCL and LCL limits may disagree with the 3 sigma lines. This is because the sigma lines are added to the calculated average while the UCL & LCL are added to the saved limit. Control limits are calculated as usual and are listed here for completeness:

$$UCL = \bar{X} + 3\sigma$$

$$LCL = \bar{X} - 3\sigma$$

Note: The sigma multiplier is assumed to be 3. See next section discussing what the multiplier is.



This plot shows all of the possible plot lines turned on for explanation purposes. Some details that might not be obvious include:

- When the lower left calculation is set to Average an additional green dash-dot line is displayed. This line represents the average or mean of the visible data. It is always a live calculation of the visible data.
- The Yellow dash-dot line is the saved mean value of the data. During file creation QC-CALC stores the nominal value as a starting point. When you calculate the limits and press Save Calculated Limits, the current average or mean is saved. This line does not update as data arrives during data collection.

- The 1, 2, & 3 Sigma lines are calculated as described above. Only one value of sigma is saved in the database but it is used by multiplying it by 2 and 3 and then added and subtracted from mean. Since the 3 Sigma line aligns with the upper and lower control limits, they will overlap each other when both are displayed.

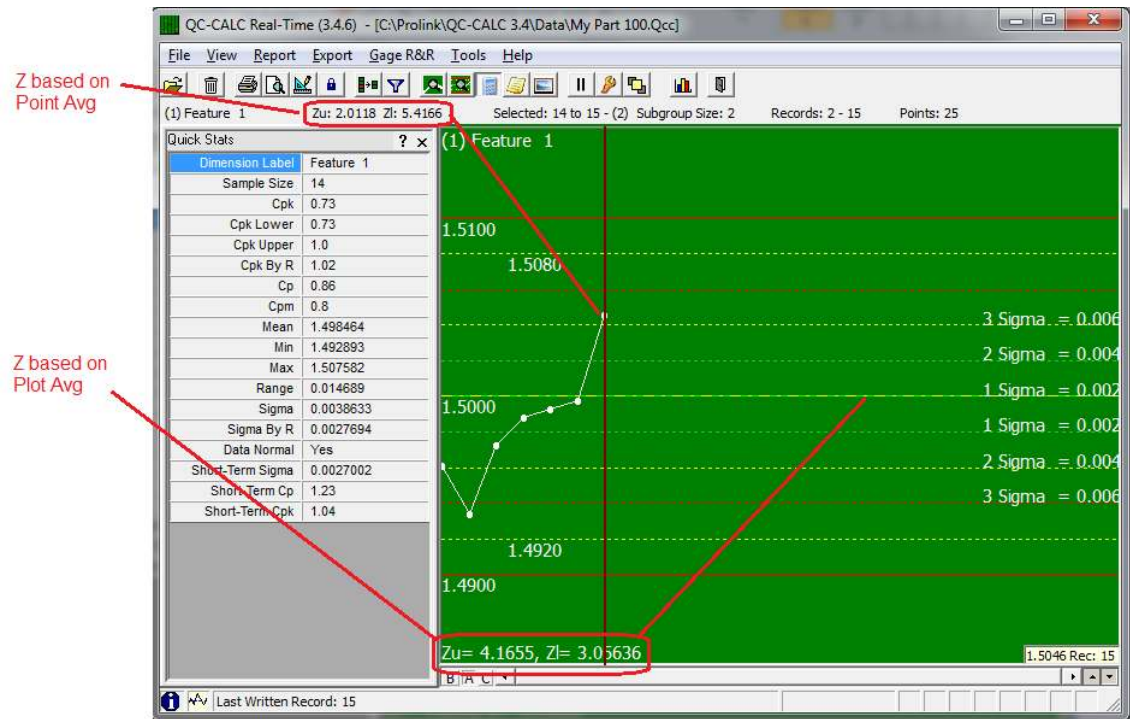
33.6 Zupper & Zlower

When the calculation for Zupper & Zlower is chosen for on-screen display, the calculated values are shown in the lower left corner of each plot. The values of Zu & Zl are based on the plot's X Double bar value. This tells you the number of "sigma's" your process is running from the upper or lower spec limits using these equations:

$$Z_{Upper} = \frac{USL - \bar{X}}{\sigma} \quad \text{and} \quad Z_{Lower} = \frac{\bar{X} - LSL}{\sigma}$$

In the top status bar **Deviation** is normally displayed but when Z is chosen the deviation is replaced with Zu & Zl. The calculations for Zu & Zl are based on the Xbar value of the point the mouse is floating over. These calculations indicate the distance (in "sigmas") a single point is from the upper and lower spec limits.

$$Z_{Upper} = \frac{USL - \bar{X}}{\sigma} \quad \text{and} \quad Z_{Lower} = \frac{\bar{X} - LSL}{\sigma}$$



You can see the Z value for points out-of-control as well as Z's for all points as you move the mouse over each point. The calculations work even if your subgroup size is set to one.

34. File Menu

34.1 Open

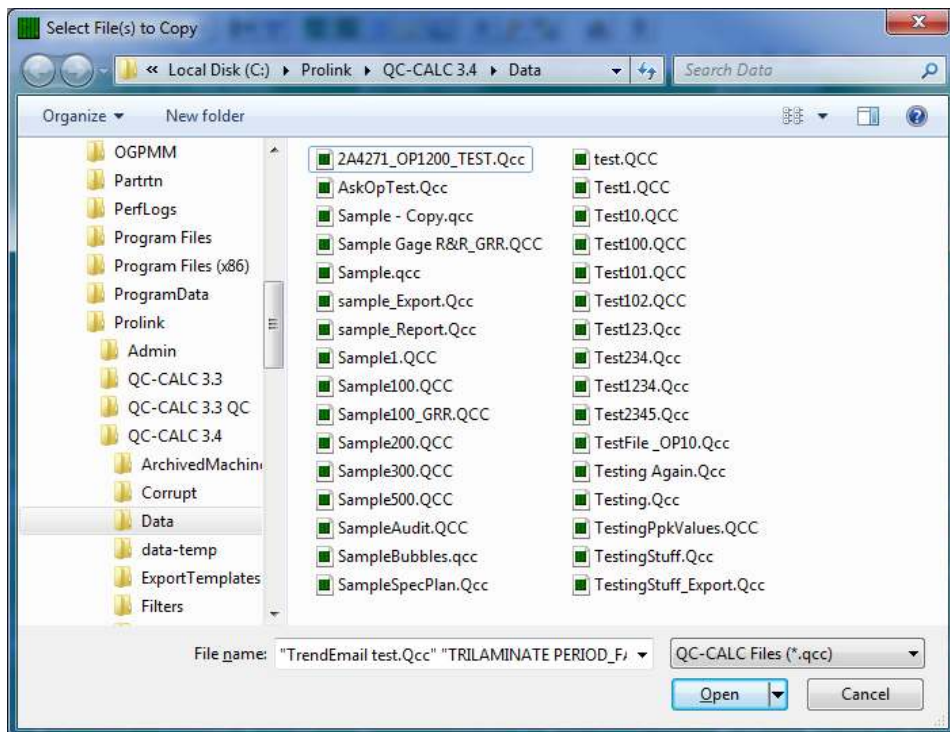
Although QC-CALC automatically “switches” to the active part program running in your inspection machine, this menu allows you to force the file you wish to view in QC-CALC Real-Time.

34.2 Edit Nominals and Tolerances

See the [Edit Nominals and Tolerances](#) section on page [207](#) for details.

34.3 Copy

You use this option to copy one or more QC-CALC files to other directories or disks. A list of QC-CALC files is displayed in the file dialog box. As with most Windows programs, point and click the file(s) you wish to select then click **OK**. If you want to select more than 1 file, use the Multiple File Selection.



Select all of the files you wish to copy to another folder. Click **OK** when your selection is complete.

Next, another file dialog box is displayed but no file names are presented. QC-CALC is requesting that you select the destination folder location. Click **OK** after making your selection.

34.4 Copy File As

You use this option to make a copy of the active file. The active file becomes inactive and the new copy with the new name becomes the active file.

34.5 Delete

This menu item provides a convenient method of removing unwanted QC-CALC files. A dialog box is displayed, you pick all .QCC files you want deleted, and click the **Open** button. You are asked “Are you sure you want to delete this file?” If you select **Yes**, the files are removed.

34.6 Modify Database Structure

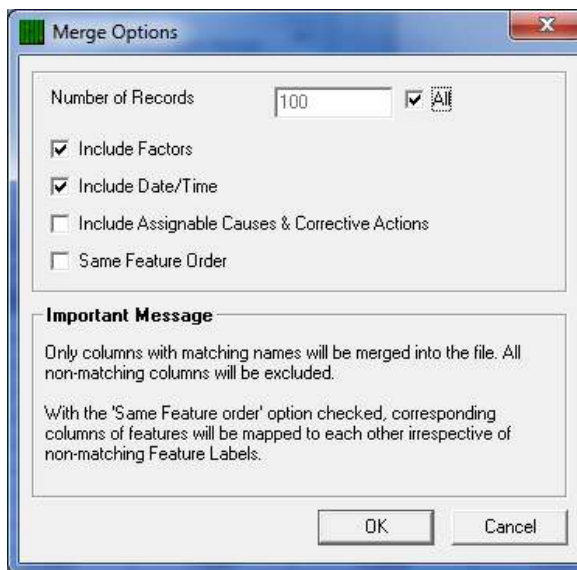
This menu allows you to change the settings of the structure of the currently open data file. See the [Modify Database Structure](#) section on page 89 for details.

34.7 Rename/Move File

This menu is used to rename your .qcc files and/or move them to another folder. There are many support files that are used in conjunction with your .qcc file and using this menu will rename and move those files along with your .qcc file.

34.8 Merge

The merge function is found by clicking on the **Tools – Merge** menu. The merge tool allows you to import a selected number of records, from a database of your choosing, into the database that you have open. After you have chosen the source file, there are several options available that are explained below.



34.8.1 Number of Records

The records chosen to merge in are always the most recent records from the source database. You have two options here. You can either choose to specify the number of records to merge, or else check the **All** checkbox. This will give you the maximum number of records available to merge. If you do not specify the number of records, QC-CALC will automatically calculate the maximum number of records available in the source file or the number of records there is space for in the destination file.

34.8.2 Include Factors

Checking this box will import the Factor values for each record from the file that is being merged with the active file.

34.8.3 Include Date/Time

Checking this box will import the Date and Time values for each record from the file that is being merged with the active file.

34.8.4 Include Assignable Causes & Corrective Actions

Checking this box will import the Assignable Causes and Corrective Actions for each record from the file that is being merged with the active file.

34.8.5 Same Feature Order

When checked, QC-CALC will assume that the dimensions from the source file are in the same order as the dimensions in the active file. It will therefore match the first dimension from the source file with the first dimension in the active file, the second with the second in the active file, and so on.

When unchecked, QC-CALC will assume that the order of the dimensions has been changed. For example: This will be true if the second dimension is missing, thus changing the position of all other dimensions after it. QC-CALC will therefore try to match up the dimension labels between the two files. They must match exactly or they will not be imported.

34.9 Purge

This option removes all records from the currently active database, but the nominals, tolerances, and labels keep the values they previously had.

34.10 Compact Database

This option allows you to reorder the file and remove any records marked for deletion from the file. If the file is circular and has been previously filled, the file is reordered putting the oldest record at record 1 and the newest record at the maximum number of records, if there are no records marked for deletion. While compacting, any record marked with a different color (deleted) is removed from the file and the records will be renumbered to cover the holes left by the removed records. This operation can only be done if the file is not currently open by another copy of QC-CALC.

34.11 Lock Editing in Point and Plot Properties

This menu item is available to prevent you from typing or overwriting data in the **Point Properties** window (QC-CALC Real-Time) or the Edit Data grid (QC-CALC SPC). In addition, once this item is checked, a supervisor can lock down this menu item by using the **Tools – Password – Lock Menu** option and ensure that no data values can be changed once the data has been collected.

34.12 Pause / Resume Data Collection

This option allows you to Pause or Resume data collection. When data collection is paused this menu will read **Resume Data Collection** and when data collection is running it will read **Pause Data Collection**. All new data that arrives while data collection is paused is ignored by QC-CALC and as soon as data collection is resumed all the accumulated data is collected. You can Pause data collection and use the **Tools – Options – Data Collection – Actions – Ask Operator Before processing accumulated data** option to discard any data that arrives while data collection is paused. Please see [Ask operator before processing existing data](#) on page 194 for more details.

34.13 Show QC-CALC SPC

This option is used to open QC-CALC SPC.

34.14 Exit

This option exits the program.

35. View Menu

The purpose of the **View** menu is to customize which items are displayed on the screen.

35.1 View Items

35.1.1 Toolbar

This menu turns on and off the display of the Toolbar.

35.1.2 Top Status Bar

See the [Top Status Bar](#) section on page 6 for details.

35.1.3 Bottom Status Bar

See the [Bottom Status Bar](#) section on page 6 for details.

35.2 Panels

The Real-Time screen has special docked information panels you can display on the left-side of the plot screen. These windows contain several categories of information. For example, you might want to know information about each point within a plot such as its value, the date and time, etc. This window is known as the **Point Properties**. Or, you might want to know details about each plot such as nominals, tolerances, control limits, etc. This window is known as the **Plot Properties**. Others might want to see statistical calculations of the displayed data known as the **Quick Stats** window.

The **View** menu contains all of these panels and more. The collection of 10 separate panels is referred to as the **Information Panel**.

35.2.1 Dimension Filter

See the [Dimensions to Plot](#) section on page 69 for details.

35.2.2 Record Filter

See the [Record Filters](#) section on page 73 for details.

35.2.3 Point Properties

See the [Point Properties](#)  section on page 22 for details.

35.2.4 Plot Properties

See the [Plot Properties](#)  section on page 23 for details.

35.2.5 Quick Stats

See the [Quick Stats](#)  section on page 23 for details.

35.2.6 Data Notes

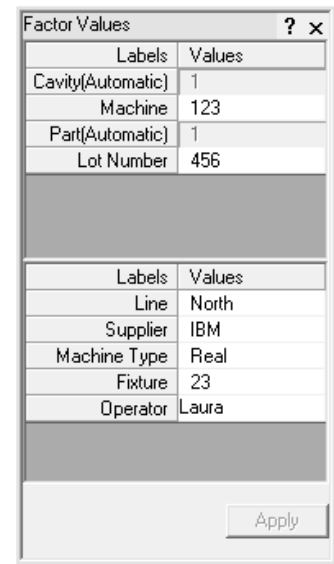
See the [Data Notes](#)  section on page 24 for details.

35.2.7 Dimension Picture

See the [Dimension Pictures](#)  section on page 25 for details.

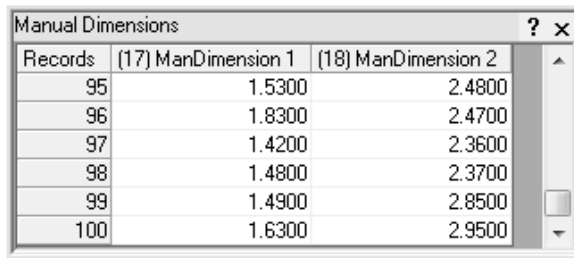
35.2.8 Factor Values

This menu displays the window used to enter Numeric or Text Factors. Any automatic factors will be labeled as such and data entry will not be allowed in those areas. Any Required factors will also be labeled and a message will appear if you attempt to leave this screen without entering a Required factor.



35.2.9 Manual Dimension Values

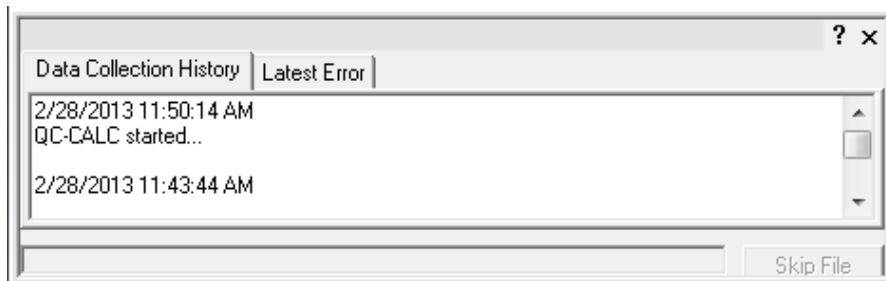
Manual Dimensions are values that you want to have plotted, but are not collected by the inspection machine. Most times these values are collected using a hand-held gage, but they need to be stored with the rest of the data for that part.



To add data into this Manual dimension, select **Manual Dimension Values** from the **View** menu and a spreadsheet “like” grid is displayed. The grid contains the same number of values as displayed points. As you type the number into the grid, you will see the plot updating. Should you make a mistake, move up in the grid and change your entry.

35.2.10 Status Screen

This screen shows the file that has just received a part, along with the date and time. If there were any problems, such as a dimension count mismatch, they will be listed here also. When an error occurs this screen will automatically appear to let you know the current status. Any errors will be on the **Latest Error** tab and the error messages will be written in **Red**.



35.3 View Graph Types

35.3.1 Add Range Charts

This option shows a graph displaying the Range values for each subgroup just below the Average chart in QC-CALC Real-Time. This is only available with a Subgroup Size greater than 1. See the [Range Plot](#) section on page 16 for more details.

35.3.2 Remove Range Charts

This option removes the Range charts turned on in the menu above.

35.3.3 Configure True Position

For in depth information on True Position please see the [True Position Plots](#) section on page [167](#).

35.3.4 Create Scatter Plot

See the [Scatter Plots](#) section on page [163](#) for details.

35.3.5 Create Whisker Plot

See the [Whisker Plots](#) section on page [164](#) for details.

35.4 Plots Always-on-Top

When you first launch QC-CALC Real-Time the window appears on top of other windows. At that point, if you select another window, QC-CALC Real-Time will be covered up. You can choose to keep the QC-CALC Real-Time window on top of all other windows even when you switch to other applications by clicking this menu. This option may be necessary if the inspection equipment software covers QC-CALC Real-Time, but you still want to see your results.

35.5 Refresh

This menu option will reread the .qcc file and redraw all plots using the data retrieved from the file.

36. Report Menu

Any reporting functionality within QC-CALC Real-Time is listed within this menu.

36.1 Print Report

You can create a variety of reports directly from QC-CALC Real-Time. For more information on this menu see the [Reporting](#) section on page [26](#).

36.2 Automatic Reporting

For more information see the [Reporting \(Automatic\)](#) section on page [51](#).

36.3 Setup Automatic Reporting

For more information see the [Set Up Automatic Report](#) section on page [52](#).

36.4 Setup Automatic Reporting Defaults

For more information see the [Set Automatic Report Defaults](#) section on page [54](#).

36.5 Print Automatic Report Now

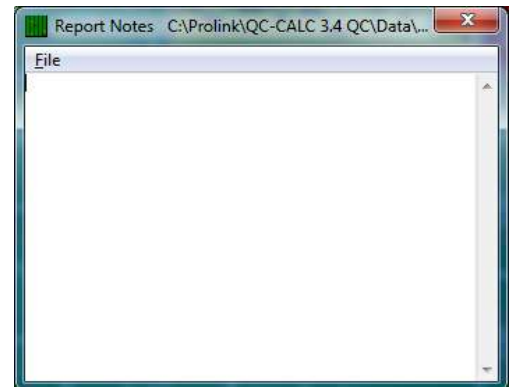
For more information see the [Print Automatic Report Now](#) section on page [54](#).

36.6 Reset Auto Report Counter

For more information see the [Reset Auto Report Counter](#) section on page [55](#).

36.7 Report Notes

The Report Notes are similar to User Inputs because they are values sent to the reports, but not sent from the inspection machine. The difference between Report Notes and User Inputs is the Report Notes hold a lot more text, which is sent across in one value. You can enter multiple paragraphs of information into the Report Notes and the exact formatting you used to enter the text will be shown in the report. With User Inputs you can only enter a single line for each User Input.

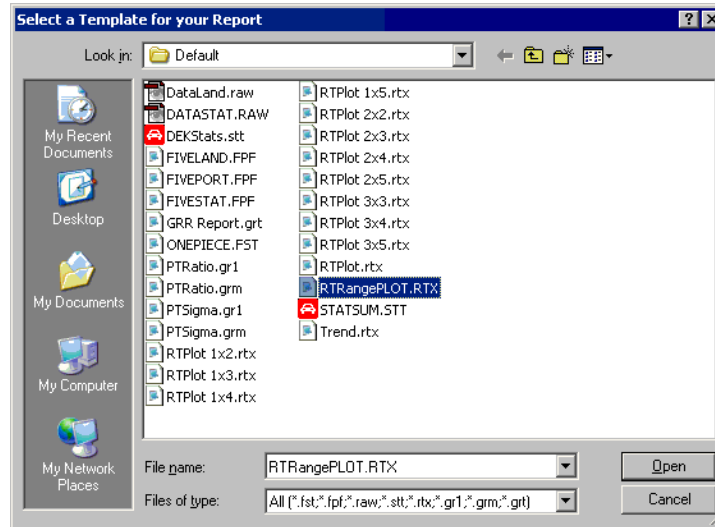


36.8 Modify User Inputs

For more information see the [Modify User Inputs](#) section on page [48](#).

36.9 Design Template

Select any template and the Report Designer appears with that template selected. For more information on the Report Designer see help within the Report Designer.



36.10 Print Preview

This is a “checkable” menu option that sends all reports to the computer screen for review before sending it to the printer. The toolbar **Print Preview** button will depress when this option is selected. Likewise, the button interacts with the checkable menu by **checking** or **unchecking** the menu depending whether it is **depressed** or **not**, acting as a shortcut. QC-CALC will not process any more reports or export until the Print Preview screen is closed by exiting the screen.

36.11 Use My Logo

Would you like to see your company logo in the reports you generate? All default templates are setup to use a bitmap from the same directory the template is in. This bitmap file must be called “Logo.bmp” and be in the specified directory, so this menu provides an easy way to choose your own logo to use in the report. This menu will make a copy of the bitmap logo you choose, rename it to “logo.bmp” and save that new file into the template directory.

37. Export Menu

Any exporting functionality within QC-CALC Real-Time is listed within this menu.

37.1 Export Data

For more information on this menu see the [Exporting](#) section on page [57](#).

37.2 Automatic Exporting

For more information see the [Exporting \(Automatic\)](#) section on page [63](#).

37.3 Setup Automatic Exporting

For more information see the [Setup Automatic Export](#) section on page [64](#).

37.4 Setup Automatic Export Defaults

For more information see the [Set Automatic Export Defaults](#) section on page [65](#).

37.5 Secondary Exporting

For more information see the [Secondary Exporting](#) section on page [65](#).

37.6 Secondary Export Setup

For more information see the [Setup Automatic Export](#) section on page [64](#).

37.7 Export Data Now

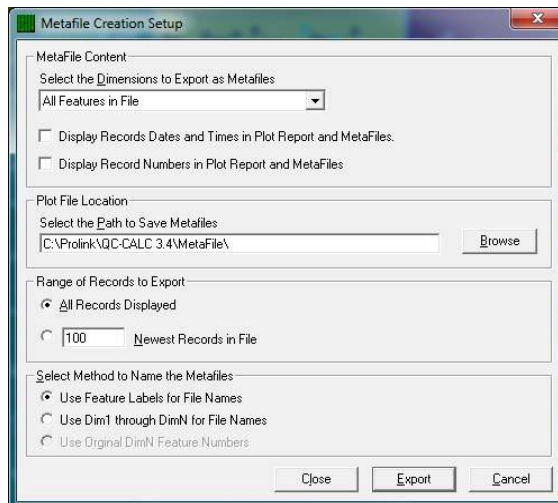
For more information see the [Export Data Now](#) section on page [65](#).

37.8 Reset Auto Export Counter

For more information see the [Reset Auto Export Counter](#) section on page [66](#).

37.9 Export Plots to Metafiles

The live QC-CALC plots can be saved as separate files in a metafile format. A Windows metafile or .WMF is a standard format that is useable in other Windows programs including Microsoft Word. This version of QC-CALC does not use .WMF but instead uses the **Extend MetaFile** or .EMF file, which has become a more universally accepted standard. If you have a reporting program as part of your CMM software you can export the QC-CALC plots to be included with your other reports including Microsoft Word, Excel, or PowerPoint.



37.9.1 Select the Dimensions to Export as Metafiles

You can either create metafiles for just the Displayed Features in QC-CALC Real-Time or you can create metafiles for All Features In File. This is needed

when the maximum of 100 plots is exceeded. In either case, please review how the file names are created for each feature (dimension) in the section below.

37.9.2 Display Records Dates and Times in Plot Report and MetaFiles

This option will print the Date and Time of each point on the metafiles that are created.

37.9.3 Plot File Location

You provide a file path (folder) in the **Select the Path to Save Metafiles** text box either by typing the path or using the **Browse** button.

37.9.4 Range of Records to Export

All records Displayed

The **Number Of Plot Points** is set in **Tools – Options – Plot Settings** and allows you to plot 3 – 100 points. It is this value that is used to determine how many points are displayed and how many points to write to the metafiles. If the Real-Time subgroup size is set to 1 then one point equals one record. However, if the Real-Time subgroup size is set to 3 and you are showing 30 points in a plot then 90 records are represented in the metafile. **Note:** Deleted records are not displayed and are not exported.

X Newest Records in File

This option starts at the newest point in the file (Last Written Record) and counts backward until the xth point is found. Deleted records will be ignored, so the X records that you ask for may not be concurrent.

Example: 3,4,5,7,8.

37.9.5 Select Method to Name the Metafiles

Use Feature Labels for File Names

The Feature Label for each feature becomes the name of the metafile. This is not recommended if you have dimensions with identical feature names in the same file. Multiple dimensions with the same feature label cause the new metafile to overwrite the previous metafile of the same name.

Use Dim1 through DimN for File Names

The file names Dim1.EMF through DimN.EMF are used consecutively for all features. This means if you choose to create metafiles for Displayed Features and some features are not showing in QC-CALC Real-Time, the file names are Dim1 through DimN consecutively for just the plots shown.

Use OriginalDimN Feature Numbers

The original database dimension numbers are used skipping any dimension numbers not shown in QC-CALC Real-Time.

An example for each of the **Metafile Naming Methods** assuming a file contains **6 dimensions** and you have **Dim1, Dim3, Dim4, and Dim6** showing in QC-CALC Real-Time the following file names are created:

Displayed No.	Use Feature Labels	Use Consecutive Dimension Numbers	Use Original Dimension Numbers
1	MyLabelX.EMF	Dim1.EMF	Dim1.EMF
3	MyLabelY.EMF	Dim2.EMF	Dim3.EMF
4	MyLabel Dia.EMF	Dim3.EMF	Dim4.EMF
6	MyLabelZ.EMF	Dim4.EMF	Dim6.EMF

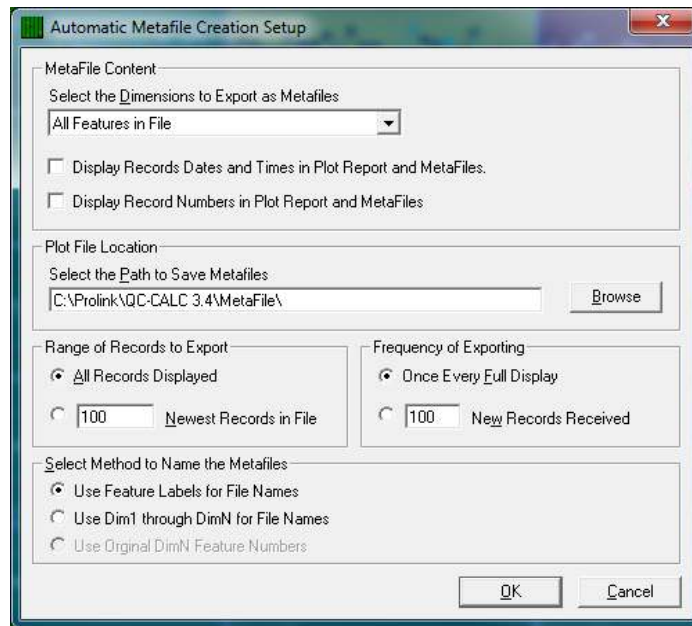
37.10 Automatic Metafile Creation

The live QC-CALC plots can be sent to separate plot files in a metafile format. An **Extended Windows Metafile** or .EMF file is a standard format that is compatible with other Windows programs including Microsoft Word, Excel, and PowerPoint. If you have a reporting package as part of your CMM software you can export the QC-CALC plots to have them included with your other reports.

The Automatic creation of Metafiles works the same as the manual metafile creation found in **Export – Export Plots to Metafiles** except that you must specify an export schedule.

37.11 Setup Automatic Metafiles

When you decide to use Automatic Export Metafiles for a particular part you are inspecting, you must setup or edit a configuration screen to tell QC-CALC how and when to export. Each part program that you write has its own export schedule saved in its QC-CALC file, allowing different export configurations for each part.



When you click this menu option, the configuration screen appears allowing you to setup the schedule. For a complete explanation refer to the [Export Plots to Metafiles](#) section on page [186](#).

37.11.1 Frequency of Exporting

One Every Full Screen

The **Number of Parts to Plot**, set in **Tools – Options – Configure Plots – Items to Show**, allows you to plot 3 – 100 points per graph. This value determines how often to create the metafiles. You set the number of points to be displayed and the same number of points is shown in the metafiles created.

If the Real-Time subgroup size is set to 1 then one point equals one part. However, if the Real-Time subgroup size is set to 2 and you are showing 10 points then 20 parts must be received before the metafiles are created.

X New Records Received

This option is used to trigger a metafile creation every X number of parts that are received. In this option, the subgroup size has no effect.

37.12 Create Metafile(s) Now

After you have established a metafile output schedule and parts are being received, you may want to export the metafiles early. For example, if you setup a metafile output schedule to create the metafiles every 10 parts and want to create the metafiles after receiving only 7 parts simply choose this menu option.

38. Gage R&R Menu

Gage R&R Mode was created to help guide you through the process of conducting a Gage Repeatability and Reproducibility study. It allows you to setup the study how they wish and to save that setup for future use. While the study is actually being conducted, a window displays for the user the exact point where they should be in the study to avoid improper results and wasted time.

While performing a Gage R&R study, you can rely on the window provided at the bottom of the Real-Time screen to guide them. There will be a grid showing all of the Part, Trial, Operator combinations that are used in the study. It will indicate the parts that have already been measured by writing them in grey, and the parts that have not yet been measured by writing them in black. The current part that should be measured will be highlighted in the grid. To the right of the grid will be the Part, Trial, and Operator numbers of that part, along with the operator name, written in larger letters. This will allow you to quickly glance at the screen and know immediately which part to measure.

	Part	Trial	Operator	
4	1	2	2	
5	2	1	1	
6	2	2	1	
7	2	1	2	
8	2	2	2	
9	3	1	1	
10	3	2	1	

Part	2
Trial	1
Operator	2 - Operator 2

38.1 Begin New Study

For more information on the Gage R&R Wizard see the [Steps to Conduct a Study](#) section on page [136](#).

38.2 Open Existing Study

For more information see the [Open Existing Study](#) section on page [145](#).

38.3 Re-Measure Part

For more information see the [Re-Measure Part](#) section on page [145](#).

38.4 Pause Study

For more information see the [Pause Study](#) section on page [145](#).

39. Tools Menu

You use this option to perform tasks not directly related to statistics and are considered add-on tools expanding QC-CALC Real-Time's capabilities.

39.1 Trend Detection

For more information see the [Selecting Trends](#) section on page [82](#).

39.2 Set Up Trend Detection

For more information on these screens see [Trend Detection – Instability, Cp, Cpk](#) section on page [82](#) through [Trend Detection – Report and Log](#) on page [86](#).

39.3 Set Trend Detection Defaults

For more information on these screens see [Trend Detection – Instability, Cp, Cpk](#) section on page [82](#) through [Trend Detection – Report and Log](#) on page [86](#).

39.4 Manual Input

The Manual Input screen (MIS) gives you an interface to enter extra data into a file that already contains the data from the CMM machine. Normally a CMM machine automatically measures a part and sends the data over to QC-Calc to be analyzed and displayed. For this process everything is done automatically. Now, what if, in addition to automatic part checks, you have to check parts with a different machine or by hand (Ex. microscope) where no automatic output feature exists? The Manual Input screen gives you the ability to enter these values into the same file as the CMM data.

39.5 Set Up Manual Input

This menu launches the MIS setup screen allowing you to set up your manual dimensions and factors. See the [Entering Data via Manual Input Screen](#) section on page [101](#) for details.

39.6 Set Manual Input Defaults

This menu allows you to set the default settings for the Manual Input screen. Defaults allow you to set it up once with a common set of settings for most QCC files, but then override it for those QCC files that are exception cases. All default settings have been moved to the **Tools – Options** area. By doing this, the defaults can now be set at the Administrative group level giving you more control and flexibility over multiple copies of QC-CALC on the shop floor. See the section on the [Administrative Tool & Part 11](#) section on page [269](#) for more information on this.

39.7 Reset Manual Input Counter

This allows you to reset the counter for the Manual Input screen in the middle of your data collection sequence. For instance, if you tell the MIS to launch every 5 parts and then you decide not to measure all 5 in a particular set (let's say you only measure 3 because the sample set was incomplete), you can tell it to reset the number to 0 so the next part will cause a new prompt for a new set of 5 parts. Otherwise, the sets would be offset. In this case, the remaining two values in that set would be discarded.

39.8 Pre-Control Zones

Pre-control is a technique that is used to detect shifts or upsets in the process that may result in the production of nonconforming units. The three pre-control zones are set at fixed percentages of the Tolerance. The green zone makes up 50% of the tolerance spread, and it is located from halfway between the nominal and the Upper Specification Limit to halfway between the nominal and the Lower Specification Limit. The yellow zones consist of the remaining 50% of the

tolerance spread between the upper and lower bounds of the green zone and the Upper and Lower Specification Limits, respectively. The red zone is the area outside of the Specification Limits.

39.9 SmartReport

SmartReport Mode is designed to do three main tasks:

- Collect, analyze, and report inspection results without operator intervention.
- Provide formatted reports based upon the inspection results of one or more parts.
- Collect data from your measurement software and save it in a variety of database formats.

This option is only available with specific inspection machines. Currently only QVI machines have conformed to our standards. Please see the **Help – Machine Specific** menu for details on each interface.

39.9.1 Dimension Names

QC-CALC is reading 1, 2, or 3 inspection result files that are generated by your QVI inspection software. With SmartReport Mode and the [MultiSource](#) capability (page 120), QC-CALC Real-Time will collect data for the typical Stats output along with the Report and Export output files and all features will be saved into a single .qcc file. It is possible for features to have the same names from all 3 sources so QC-CALC can automatically add “-RE” to the Feature Labels of features from the report.sta file and “-EX” to features from the export.sta file during the file creation process. This will help to differentiate one source from another on screen and in reports and will be used to create special dimension filters automatically.

39.10 Update All Calculated Dimensions

For more information see the [Update Calculated Dimensions](#) section on page 116.

39.11 Calculate Limits

For more information see the [Calculate Limits for All Plots](#) section on page 77.

39.12 Auto Calculate Limits

For more information see the [Automatically Calculate Limits on All Plots](#) section on page 78.

39.13 Save Calculated Limits

This overwrites the values in the database with new limits. Simply choose this menu to have the limits saved for all dimensions in your file.

39.14 Enable Administrative Tools

For more information see the [Enable Administrative Tools](#) section on page 212.

39.15 Password

For more information see the [Security Passwords](#) section on page 149. **Note:** This menu will not be visible if the **Administrative Tools** functionality is in use.

39.16 Undelete Records in Current View

This menu option will check all records displayed within the graphs on screen for any **points** that are marked as deleted and will remove the deleted flag on those points only.

39.17 Read Machine Data

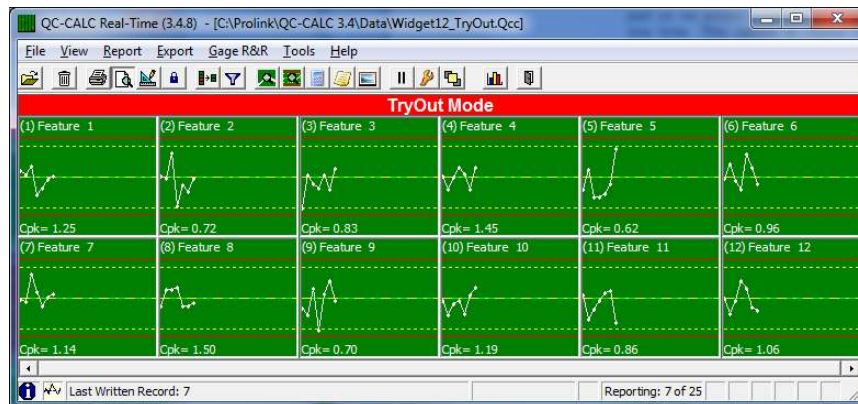
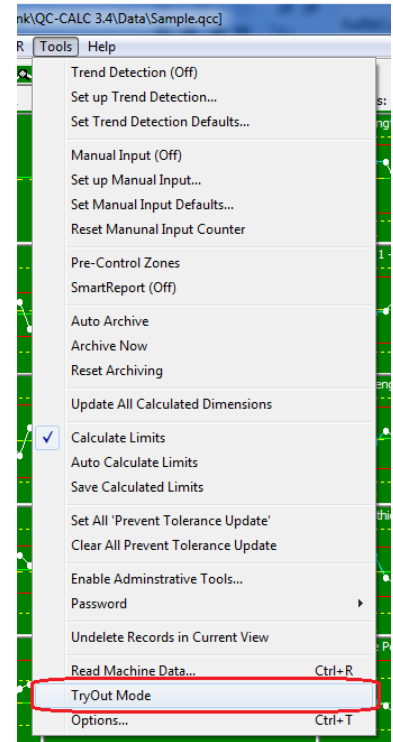
This menu option allows you to select a specific machine data file to be collected by QC-CALC Real-Time without the graphs updating with each new record received. This makes the data collection process much faster than having the graphs continually update with each new record, so it is a good option to use if a large data file needs to be brought into QC-CALC Real-Time. You are given an option to delete the data file when the process has finished.

39.18 TryOut Mode

Customers often ask us how they can measure test parts during a machine setup without mixing their test data with their production data. The answer to this is to run QC-CALC in **TryOut Mode**.

TryOut Mode is a simple menu option that allows you to create a separate QCC file that contains junk or test data. When in TryOut mode, the same QCC files are generated as normal, but with "_TryOut" appended to the name of the QCC file. Therefore, "widget12.qcc" becomes "widget12_TryOut.qcc" when TryOut mode is on. All functionality within QC-CALC is the same, but the data is automatically separated simply because the filename of the QCC file is different.

When you need to test parts, turn on the TryOut Mode by selecting the **Tools – TryOut Mode** menu whenever you want this feature enabled. When you're ready to run production parts, simply turn it back to normal by unchecking the TryOut menu and measure parts. The bright red bar at the top of the plots contains the words **TryOut** to remind you that you are saving non-production data.



The Tryout files should be considered non-production data and therefore are not audited.

40. Tools – Options

When **Tools – Options** is selected, you see the **Options** window. You can change QC-CALC's operation from this multi-purpose window. When you click on the menus located on the left side of this window, the right side changes showing the available options. You select and change the option that best suits your needs. This is an important screen in QC-CALC Real-Time.

40.1 Assignable Cause / Action

For more information see the [Assignable Cause & Corrective Action](#) section on page [146](#).

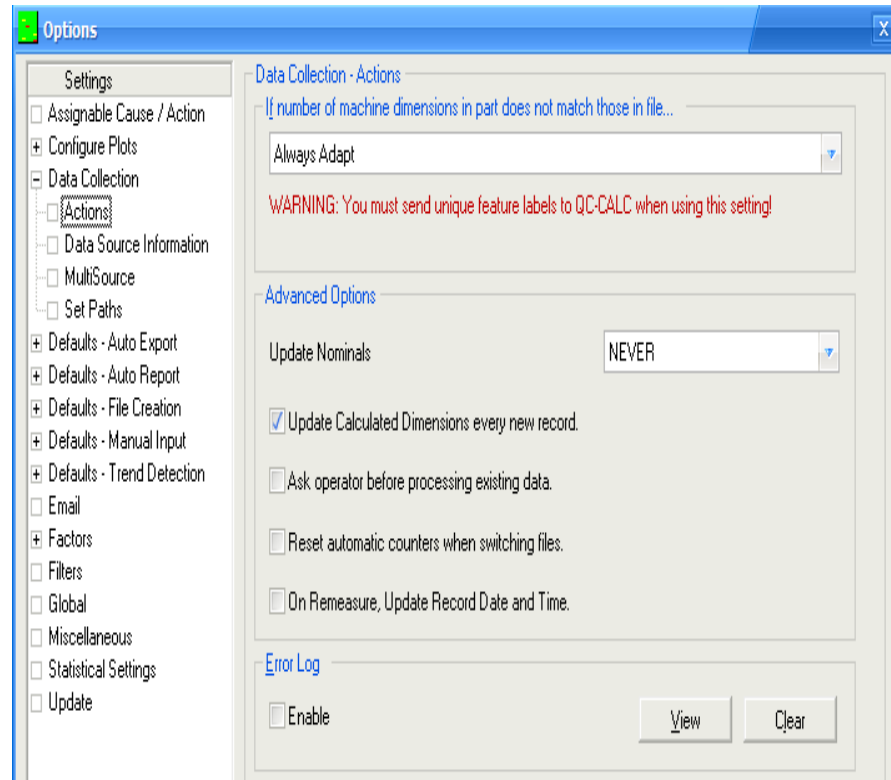
40.2 Configure Plots

For more information see the [Configure Plots](#) section on page [215](#).

40.3 Data Collection

All settings pertaining to collecting data are located in this area.

40.3.1 Actions



If number of machine dimensions...

For details see the [If Number of Machine Dimensions in Part Does not Match those in File...](#) section on page [112](#).

Update Nominals

For details see the [Update Nominals](#) section on page [115](#).

Update Calculated Dimensions every new record

For details see the [Update Calculated Dimensions](#) section on page [116](#).

Ask operator before processing existing data

When this option is enabled QC-CALC Real-Time will ask if you would like to collect the data that was inspected while QC-CALC Real-Time was not running

or **Paused**. You can choose to discard the inspection results that were run while QC-CALC Real-Time was not processing data or you can choose to process that data in QC-CALC Real-Time.

Reset automatic counters when switching files

Using this option will cause all the automatic counters to be reset to 0 when changing between parts. This means if you are running part ABC and the counter for Reporting is at 4 of 8, then part DEF comes in the counter will start over at 0. Switching back to part ABC would reset the counter again to 0.

Not having this option checked means that when you switch back to part ABC the counter will go back to where it was the last time the part ran. In this case the Report counter would end up at 5 of 8 (a part was received in order to switch back to part ABC).

On Remeasure, Update Record Date and Time

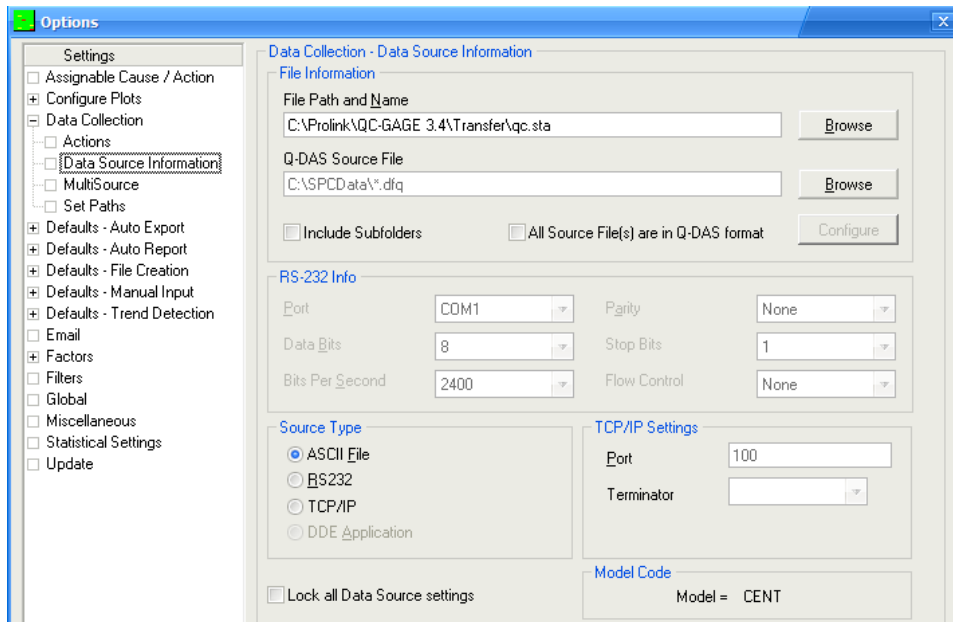
This option controls what happens to the date and time value of a record that is remeasured. When this is checked the date and time of the record will be updated to the value received with the remeasure data. When this is not checked the original date and time will remain on the record.

Error Log

For details see the [Error Log](#) section on page [117](#).

40.3.2 Data Source Information

The **Data Source Information** area contains the settings that tell QC-CALC where and how to collect of all inspection data. If you are not sure of the correct data source see the machine specific help located in the **Help** menu for your specific machine. The 3 important areas are the data **Source Type**, the **Model** Code, and the **File Path and Name**. These three items control how QC-CALC automates the data collection.



Since 99% of all machines report the results to a file, the source type is usually set to **ASCII File**. Each CMM manufacturer creates different file formats and the **Model** code tells QC-CALC how to read the file. The figure above shows a model code of CENC which is used to collect data from QC-Gage. You cannot directly change this code since QC-CALC sets it automatically based on the machine type set from the **Help – Install Wizard** menu. The **File Path and Name** is the

location QC-CALC looks for the results file. Although this is an editable path, you should let QC-CALC adjust this automatically.

File Information

File Path and Name

Because QC-CALC is obtaining the inspection results through the use of a file transfer from most machines, QC-CALC needs to know where you configured your inspection software to save your data. See the **Help – Machine Specific** menu for the recommended setting for your particular inspection machine.

Q-DAS Source File

QC-CALC can both read and write Q-DAS data. If you have a gage that is outputting into a Q-DAS format, you must check the **All Source File(s) are in Q-DAS format** box. If you do not check this box Real-Time will be expecting one format and you will be sending a different one and your data will not be collected.

Include Subfolders

This option is used for machines that save the output files to multiple locations, all located under 1 common folder. Do not use this option if you are unsure of its use!

All Source File(s) are in Q-DAS format

If you are outputting data in Q-DAS format you must check this box. As explained above, if you do not check this box and establish where QC-CALC Real-Time is looking for the Q-DAS formatted files your data will not be collected.

Source Type

- | | |
|-------------------|---|
| ASCII File | QC-CALC reads data from a file that the inspection machine previously saved. The ASCII file name and location must be specified in the File Information - File Path and Name section of the Select Data Source screen. Because QC-CALC is obtaining the inspection results through the use of a file transfer from the inspection machine, QC-CALC needs to know where you configured the machine to save your data. The file name can be any name you choose. In fact, you can use a different name for every part routine you write. Refer to the machine specific section located in the front of this manual for the standard file name to use with your inspection machine. |
| RS232 | Some inspection machines use an RS232 cable to receive and save inspection results. The settings for this method must be the same within the RS-232 Info area of QC-CALC Real-Time as they are on the inspection machine. Refer to the Help - Machine Specific area for information on your inspection machine's data source. |
| TCP/IP | Some inspection machines use the network to receive and save inspection results. The settings for this method must be made within the TCP/IP Settings area. Refer to the Help - Machine Specific area for information on your inspection machine's data source. |
| DDE | Some inspection machines use this communication technique to receive and save inspection results. This communication technique is fully automatic and requires no user input. See the machine specific section in the front of this user manual for information on your inspection machine's data source. |

RS232 Information

The **RS232 Information** area allows you to view and update how your RS232 equipment is connected to your system. All of these settings should be correct by default, but the interface is available if necessary.

TCP/IP Settings

The **TCP/IP Settings** area allows you to set the **Port** and **Terminator** for your specific inspection machine.

Model Code

This describes the specific type of inspection machine that you are using. This is a 4 character code that is set based on the choice made in the **Help – Install Wizard** menu.

Lock all Data Source settings

This option is used mainly for the **Administrative Tools** area. With this option you can set the **Data Source** settings, check this box, and lock it so no one can make changes to the settings when running as part of that **User Group**.

40.3.3 MultiSource

The **MultiSource** settings in the **Data Collection** area apply to the currently open .qcc file only. The same settings in the **Defaults – File Creation** area will apply to all new .qcc files that are created. For more information about these settings see the [Setting MultiSource Parameters in File Creation Defaults](#) section on page [121](#).

40.3.4 Set Paths

For more information see the [Set Paths](#) section on page [117](#).

40.4 Defaults – Auto Export

For more information see the [Set Automatic Export Defaults](#) section on page [65](#).

40.4.1 Export Type

For more information see the [Export Types](#) section on page [57](#).

40.4.2 Frequency

For more information see the [Setup Automatic Export](#) section on page [64](#).

40.5 Defaults – Auto Report

For more information see the [Set up Automatic Reports Default](#) section on page [54](#).

40.5.1 Report Type

For more information see the [Report Types](#) section on page [26](#) and continued in the [Printing To](#) section on page [44](#).

40.5.2 Frequency

For more information see the [Frequency of Reporting](#) section on page [52](#).

40.5.3 Report specific Options

For more information see the [Report Specific Options](#) section on page [45](#).

40.6 Defaults – File Creation

For more information see the [File Creation Defaults](#) section on page [105](#).

40.6.1 Database Settings

For more information see the [Database Settings](#) section on page [105](#).

40.6.2 Format Settings

For more information see the [Format Settings](#) section on page [106](#).

40.6.3 Factors

For more information see the [Factors Settings](#) section on page [107](#).

40.6.4 User Inputs

For more information see the [User Input Defaults](#) section on page [108](#).

40.6.5 MultiSource

For more information see the [Setting MultiSource Parameters in File Creation Defaults](#) section on page [121](#).

40.7 Defaults – Manual Input

For more information see the [Entering Data via Manual Input Screen](#) section on page [101](#).

40.7.1 Settings

For more information see the [Settings](#) section on page [102](#).

40.7.2 Input Values

For more information see the [Input Values](#) section on page [103](#).

40.8 Defaults – Trend Detection

For more information see the [Selecting Trends](#) section on page [82](#).

40.8.1 Instability, Cp, Cpk

For more information see the [Trend Detection – Instability, Cp, Cpk](#) section on page [82](#).

40.8.2 Other Patterns

For more information see the [Trend Detection – Other Patterns](#) section on page [84](#).

40.8.3 Actions

For more information see the [Trend Detection – Actions](#) section on page [85](#).

40.8.4 Report and Log

For more information see the [Trend Detection – Report and Log](#) section on page [86](#).

40.9 Email

For more information see the [Email Setup](#) section on page [151](#).

40.10 Factors

For more information see the [Factor Settings](#) section on page [127](#).

40.10.1 General Factor Settings

For more information see the [General Factor Settings](#) section on page [128](#).

40.10.2 Numeric Factors

For more information see the [Factor Setup – Numeric](#) section on page [131](#).

40.10.3 Text Factors

For more information see the [Factor Setup – Text Factor](#) section on page [133](#).

40.11 Filters

For more information see the [Creating a New Filter File](#) section on page [157](#).

40.12 Global

For more information see the [Global](#) section on page [217](#).

40.13 Miscellaneous

For more information see the [Miscellaneous](#) section on page [219](#).

40.14 Statistical Settings

For more information see the [Statistical Settings](#) section on page [220](#).

40.15 Update

For more information see the [Update](#) section on page [222](#).

41. Administrative Tools Menu

Historically, QC-CALC Real-Time has been used within an individual inspection machine as a single copy of software. Each person controlled and adjusted QC-CALC's operation individually. As networks became more prevalent, the inspection devices were connected to the network making data movement easier. This created the need to control the individual copies of QC-CALC running throughout the shop from a central location.

As of QC-CALC version 3.2, an **Administrative Tool** was added to help the Quality Department set up and control every copy of QC-CALC within the entire company. This tool can be activated and used from any of the QC-CALC copies on the network.

In addition, the medical supply companies must satisfy FDA title 21 Code of Federal Regulations (CFR21 Part 11) Electronic Records; Electronic Signatures, as it applies in a medical manufacturing environment. A special section has been added to this document which describes how QC-CALC can be configured to help you meet the requirements of Part 11.

If you are not seeing this menu, you will need to reinstall and follow the directions for setting up the Administrative Tool in the [Setup and Installation Instructions](#) section on page [270](#).

41.1 Set Current User Group

Once the User Groups are created and the options are set for each group, you activate the group by choosing **Administrative Tools – Set Current User Group** menu. This should be a one-time change and QC-CALC will remain in this configuration until further notice.

41.2 Manage User Groups

This menu is used to configure the User Groups. For details see the [Manage Options](#) section on page [274](#).

41.3 Change Password

This menu is used to change the Admin Password. You will be asked to enter the current password before you are allowed to enter a new password.

41.4 Logout

When you enter your password to modify anything in the **Administrative Tools**, there is a checkbox saying **Keep me logged in**. Once you check this you can modify multiple settings without re-typing your password each time. The Logout feature is used to cancel the edit feature. Closing QC-CALC and re-starting it cancels the login as well.

41.5 Disconnect from Admin Path

In the Administrative Tools menu, there is the **Disconnect from Admin Path** option which will allow you to leave the Administrative settings you're currently connected to.

41.6 Edit Application Defaults

The **Edit Application Defaults** selection gives the administrator the ability to modify the default values for QC-CALC Real-Time. Normally, these values do not need to be modified but they can be under certain conditions. The most commonly changed default values are surrounded with red. For more details see the [Edit Application Defaults](#) section on page [276](#).

42. Help Menu

42.1 Contents

This menu option shows the Contents of the QC-CALC help file. Jump text is available to get to specific help topics.

42.2 Machine Specific

This menu options shows the help file section containing interface notes for the specific type of inspection machine interface currently running.

42.3 What does this product do?

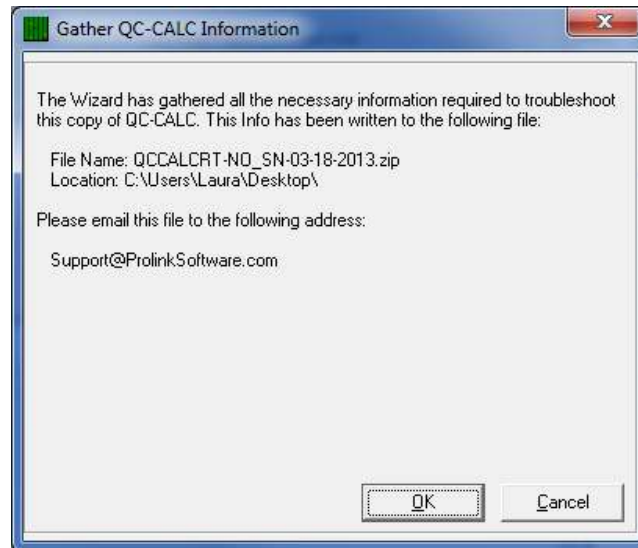
This menu launches the PowerPoint presentation that explains the differences between QC-CALC Enterprise, QC-CALC Real-Time, and QC-CALC SPC. This is the same presentation that runs after you install the program.

42.4 Run Update

This menu option will locate and run the update patch required to update QC-CALC Real-Time and/or QC-CALC SPC, if a newer version is available. See the [Update](#) section on page [222](#) for a description of the settings.

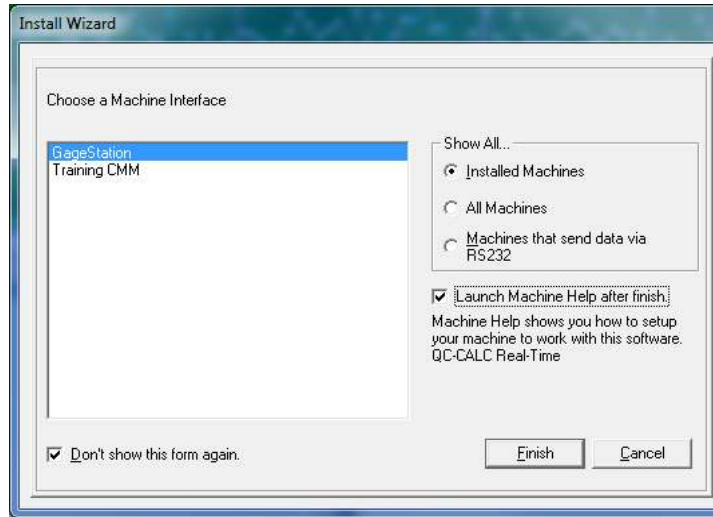
42.5 Gather QC-CALC Information

If there is a problem with your software that cannot be solved by the help file or your manual, you can contact Prolink for technical support for free via the website. We may ask you to choose this menu option, which will automatically collect all of the information about your settings that we will need to assess the problem. You will need to email the resulting file to us after QC-CALC finishes creating it. A short wizard will guide you through the steps.



42.6 Install Wizard

The first time you run QC-CALC Real-Time the Install Wizard is shown in order to let you choose which type of inspection machine you will be using. The **Help – Install Wizard** menu is also available so you can change this setting after you run the first time, or so you can get back to default settings for your particular machine type.



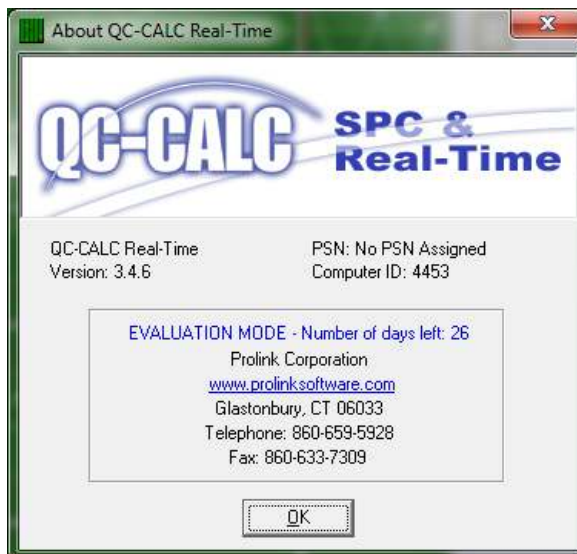
A list of inspection machines that were detected on your computer will be shown so you can choose the machine you will be collecting data from. The **Launch Machine Help after Finish** option will automatically show the Machines Help file for the machine type you chose after you click the **Finish** button and the **Don't show this form again** option keeps the form from being displayed each time QC-CALC Real-Time starts.

42.7 License Configuration

For details see the [License Screen Details](#) section on page [155](#).

42.8 About QC-CALC Real-Time

This is the screen that appears when you start the application. It contains information about this particular QC-CALC application. The serial number, version number, status of the license, and information on how to contact Prolink, Inc. are all included.



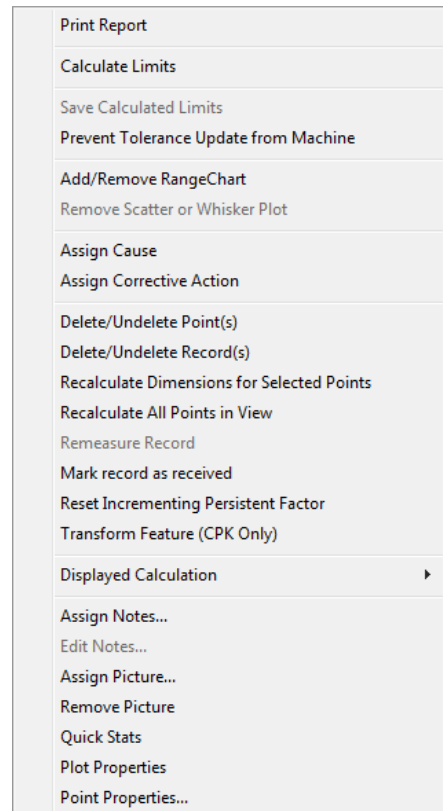
43. PopUp Menu (Right Click on Any Plot)

As with most Windows programs, the right mouse button usually has hidden options. If you Right click any plot on the QC-CALC Real-Time screen, a special menu pops up with a variety of options. This type of interface allows you to select the plot before the menu is activated.

43.1 Print Report

When a report is printed using the **Report – Print Report** menu, the details of that session are saved on your computer. When you pick this right-mouse click menu option the saved configuration is read and the report is printed again. The difference between the old and new report is the data points that are actually printed. For example, if you chose to print the last 5 parts using the Five Piece First Article Report, every time you click this menu, you'll get the last 5 parts printed. This may make more sense when you consider the QC-CALC live plots are constantly having new data added to them. In other words, the last 5 parts is not going to produce the same report since the data is changing through time.

Several of the reports can be printed from the current cursor position. For example, the First Article Reports are based from the current position. This means if you want to print a First Article Report for data collected days ago, simply scroll the live plots back to the data of interest, right click the point, and select **Print Report**.



43.2 Calculate Limits

When this menu is checked QC-Calc will recalculate new control and tolerance limits based on the data shown on the plot. The items to calculate are set in **Tools – Options – Statistical Settings – Items to Calculate** area and include the Control Limits, Specification Limits, Mean, Sigma Zones, and Nominal. See the [Calculate Limits](#) section on page [76](#) for more details.

43.3 Save Calculated Limits

If you want to save the limits that were calculated by clicking the Calculate Limits menu you can right-click the same plot again and choose **Save Calculated Limits**. You are prompted with an **Are You Sure?** dialog box since the database values will be overwritten with these new values. If you do **not** save these new limits you can restore your previous values by right-clicking on the plot, select **Calculate Limits** and your original values reappear.

43.4 Prevent Tolerance Update from Machine

See the [Prevent Tolerance Update from Machine](#) section on page [115](#) for details.

43.5 Add/Remove Range Chart

This option will add a range chart to the selected dimension only or remove the range chart if there is already one present. Use the **View – Add / Remove Range Charts** menus to apply the range charts to all dimensions. See the [Range Plot](#) section on page [16](#) for more details.

43.6 Remove Scatter or Whisker Plot

When you right mouse click on a graph that is either a Scatter or Whisker plot, this menu choice is enabled. When you select this choice, the dependent characteristics used to generate the complex plot are removed, and the plot reverts to a Raw Data plot. For more information see the [Scatter Plots](#) section on page 163 and the [Whisker Plots](#) section on page 164.

43.7 Assign Cause

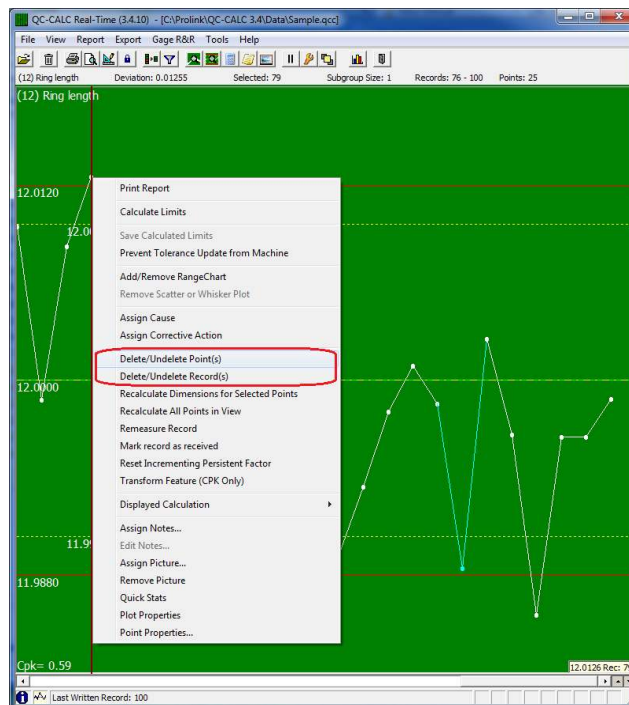
The QC-CALC database reserves space for tagging each part with 1 to 3 Assignable Causes. Use this menu item when a feature has a known or identified problem. By assigning a Cause to the part, you can track what caused the point to be out of control or out of tolerance. For details see the [Assign a Cause](#) section on page 147.

43.8 Assign Corrective Action

Similar to the Assignable Cause, the Assign Corrective Action allows you to say what you did to fix a problem. The QC-CALC database reserves space for tagging each part with 1 to 3 Corrective Actions. Use this menu item when a feature has been corrected with a known or identified Corrective Action. By assigning a Corrective Action to the part, you can track what was done to fix Assignable Causes. For details see the [Assign a Cause](#) section on page 147.

43.9 Delete/Undelete Point(s) / Record(s)

There are times during inspection when a bad part is entered accidentally and you need to remove it immediately. For convenience, we have added the ability to delete parts via the live graphic screen. For best results, zoom in on the plot showing the bad point. The plot is enlarged and **ToolTips** displays details about the data point you are hovering over. This is the best method of identifying the correct part (record) to delete. As you move the mouse over the plot and locate the bad part, note the value and record number being displayed. If it is the correct one, right click the mouse and a PopUp menu appears. Select **Delete/Undelete Point(s)** or **Delete/Undelete Record(s)** and either the point or the record is then marked as deleted (shown as a gold dot or hidden based on your settings) and the plots are updated.



In the picture shown above, note that the top left corner of the menu is exactly where the mouse cursor was when the right mouse button was clicked. It is easy to see that the alignment is correct because ToolTips is reading 12.0126 and record 79. The upper specification limit (red line) is reading 12.0120 and from this reading you can be sure you are at the correct point. If you need more details about the point you are looking to remove, use the **View – Point Properties** menu.

To undelete the data points simply click on **Delete/Undelete Point(s) / Record(s)** again and the data will reappear.

43.10 Recalculate Dimensions for Selected Points

If calculated dimensions are being used in the active database this menu will re-apply the calculations for the selected points only. You need this option if you change some saved values and require QC-CALC to refresh the calculated dimensions.

43.11 Recalculate All Points in View

This menu is only available when you right click on a Calculated Dimension and it will re-apply the calculation for that specific calculated dimension to the visible data points. Only the records visible on the screen will be updated, so if you would like to update all records you should use the **Tools – Update All Calculated Dimensions** menu instead. For more information see the [Update Calculated Dimensions](#) section on page [116](#).

43.12 Remeasure Record

This menu is used to choose a single record from the existing data and tell QC-CALC that the next part received will replace the data for that record. Once you choose this menu a message will appear telling you to run that part and the next data that is received will completely replace the point that was under the mouse when the right-mouse click occurred.

43.13 Mark record as received

When using the Measure Order option for a MultiSource file you may want to tell QC-CALC Real-Time to stop searching for available records at a certain location. For instance if the data file you're using has been collecting data for a long time

43.14 Reset Incrementing Persistent Factor

This menu is used when you are sending Incrementing Persistent Factors from the inspection machine, but somehow the counter is off. This can happen if a part is skipped in the fixture or an error occurred. In this case you would probably want to start measuring the entire fixture over, but you need to tell the Persistent Factor to start counting from the beginning again. This menu is used to tell QC-CALC to restart that counting.

43.15 Transform Feature (CPK Only)

This menu attempts to run a Johnson Transformation on non-normal data in order to normalize the data and get a valid Cp and Cpk. When data is not considered to be normally distributed (as is often the case with single sided tolerances), the Cp and Cpk values cannot be calculated accurately. To get a valid Cp and Cpk, one method is to transform the data using different algorithms in an attempt to normalize it. The Johnson Transform is one of the most reliable ways of transforming the data because it is actually a basket of algorithms for transforming the data that attempts multiple different options before arriving at the best option.

If your data is not normal, simply right click on the plot and choose **Transform Feature**. This will do two things: First QC-CALC will attempt to determine the

best algorithm to normalize your data using the 25 visible points on screen. Assuming this works, it will memorize the algorithm it used and save this for later. It will also transform the visible data and calculate a Cp and Cpk for display in the **Quick Stats** window and on reports. Once this has occurred, the labeling for all Cp and Cpk related fields in the **Quick Stats** window will appear as Cpk (JT) indicating the calculation is the result of a transformed set of values. The transformed values are never shown on screen as they are meaningless. They are only used for calculating certain statistics. The engineering units will always be displayed.



Note: Your collected data is never changed or lost as a result of the transform. It is transformed in a separate space only for the purpose of statistical calculations and is never written back to the QCC file.



Note: QC-CALC will do its best to normalize the data, but not all data can be normalized. If it cannot be normalized, a message will appear telling you it was not possible to properly normalize the data using the Johnson Transform.

43.16 Displayed Calculation

This menu provides a quick interface to the **Tools – Options – Configure Plot Settings – Items to Show – Calculation** area. All of the calculations available in that area are also available from the right-mouse click menu. See the [Calculation](#) section on page [12](#) for more details about these calculations.

43.17 Assign Notes

For details see the [Data Notes](#)  section on page [24](#).

43.18 Edit Notes

After assigning a note to a point, you can right-click on the same point and use the **Edit Notes** menu to edit the note previously entered.


43.19 Assign Picture

See the [Dimension Pictures](#)  section on page [25](#) for details.


43.20 Remove Picture

Right-clicking on a dimension and choosing the **Remove Picture** menu will un-assign the picture that was assigned to that specific Dimension.


43.21 Quick Stats

Using this menu is the same as using the **View – Quick Stats** menu. See [Quick Stats](#)  on page [23](#) for more details about this area.

43.22 Plot Properties

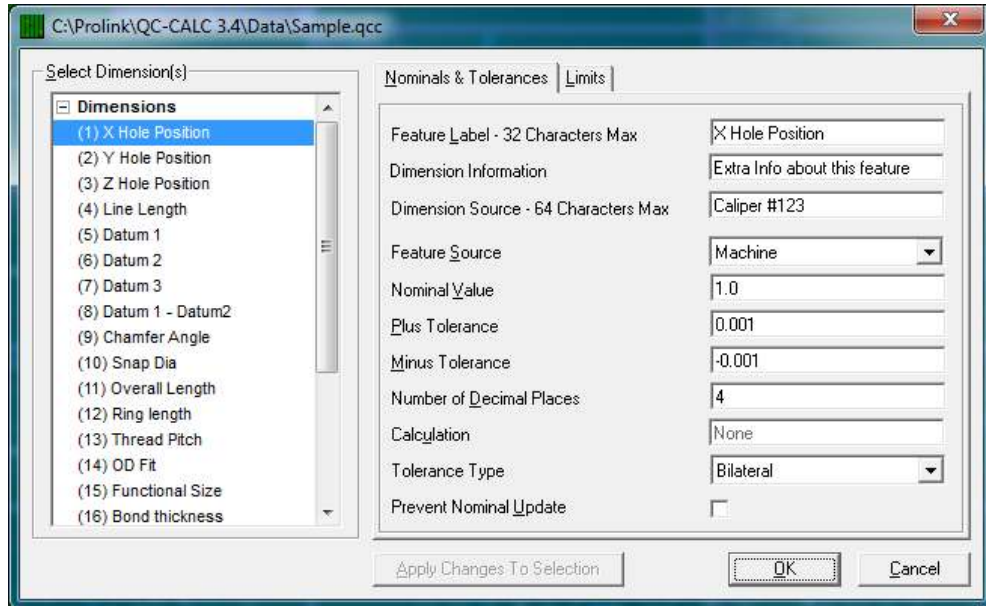
Using this menu is the same as using the **View – Plot Properties** menu except the Plot Properties window will be in editing mode when it appears and the dimension the mouse was over during the right-click will be the dimension available for editing. See [Plot Properties](#)  on page [23](#) for more details about this area.

43.23 Point Properties

Using this menu is the same as using the **View – Point Properties** menu except the Point Properties window will be in editing mode when it appears and the point the mouse was over during the right-click will be the value available for editing. See [Point Properties](#)  on page [22](#) for more details about this area.

44. Edit Nominals and Tolerances

The **File - Edit Nominals and Tolerances** menu is used to adjust any feature information for your file. You can see each feature in the list on the left and additional parameters stored with each dimension can be accessed and edited using this option.



To edit each feature click on the label in the left window and all of its settings are displayed on the right side. We will describe these settings next. If you have common values on some features, highlight as many features as you want, edit the common values and press the **Apply Changes To Selected** button. For example, if all of your tolerances are 0.005 highlight everything and enter the number once and press the **Apply Changes to Selection** button.

44.1 Nominals & Tolerances

44.1.1 Feature Label

Use this label to describe the dimension so you'll recognize each feature in your SPC reports. Up to 32 alphanumeric characters can be used. The default label is ManualDim1 but we edited this example to **MyCircle**.

44.1.2 Dimension Information

This is an area that is available to store additional information about this feature. You might want to describe how this feature is measured for example. This area holds up to 255 characters.

44.1.3 Dimension Source

This area is used to store the information about the machine that created this feature. You can store up to 64 characters describing the Dimension Source.

44.1.4 Feature Source

The term "source" describes where the data is coming from. There are 3 sources of data in QC-CALC and they are:

- Machine** Data is received from an inspection machine automatically.
- Manual** Data is entered manually (by you) which is the purpose of this section of the manual.

Calculated Data is calculated based on mathematical equations. See [Calculated Dimensions](#) on page 94 for details.

44.1.5 Nominal Value

This is the target value of the dimension. In our example, we entered a decimal value of 1.0000.

44.1.6 Plus Tolerance

This value, when added to the Nominal creates the **Upper Specification Limit** (USL) used throughout the program. All values that exceed the USL are considered “out of spec”. In our example, we entered 0.05 for both the plus and minus tol.

44.1.7 Minus Tolerance

This value, when added to the Nominal creates the **Lower Specification Limit** (LSL) used throughout the program. All values smaller than the LSL are considered “out of spec”. Normally, this number has a minus sign in front of it.



Note: If both tolerance values are on one side of the nominal, both may be positive or both may be negative. See the example below.

NOMINAL	LOWER TOL	UPPER TOL
1.00	+ .001	+ .005
1.00	- .005	- .001

If you forget to enter the tolerance values on a feature, QC-CALC will enter +/- 0.000050. In all cases, the Minus Tolerance is always added to nominal to create the Lower Specification Limit. If a zero is entered here, the feature is considered single sided.

44.1.8 Number of Decimal Places

Enter the number of decimal places (to the right of the decimal) to display for this dimension. QC-CALC uses this parameter when outputting and displaying data and analysis results for this dimension. Each dimension has its own value for the number of decimal places used to format displayed results. QC-CALC holds 7 significant digits of accuracy so if you have 4 digits on the right side of the decimal point, you'll have 3 digits on the left side.

44.1.9 Calculation

This option is only available for Dimensions with a **Feature Source** of **Calculated**. When you click in this area the Calculation Editor window appears to assist you with creating the equation used to calculate the value of each point. See [Calculated Dimensions](#) on page 94 for details.

44.1.10 Tolerance Type

There are 4 types of tolerance used throughout QC-CALC. They are:

Bilateral

A bilateral tolerance type meaning the Nominal is located between the Upper and Lower Specification Limits.

Single Sided Upper

A Single Sided Upper Tolerance Type means the Nominal and the Lower Specification Limit are the same (usually both zero).

Single Sided Lower

A single sided lower tolerance type meaning the Nominal and the Upper Specification Limit are the same (usually both zero).

Not Toleranced

Meaning the feature was received without tolerances specified. You will see a similar looking plot but without tolerance lines. You can plot this type of feature in Control Charts, Raw Data Charts, Correlation Plots, and Probability Plots. Any plot requiring tolerances such as Process Capability cannot be created with non-toleranced features and will be ignored.

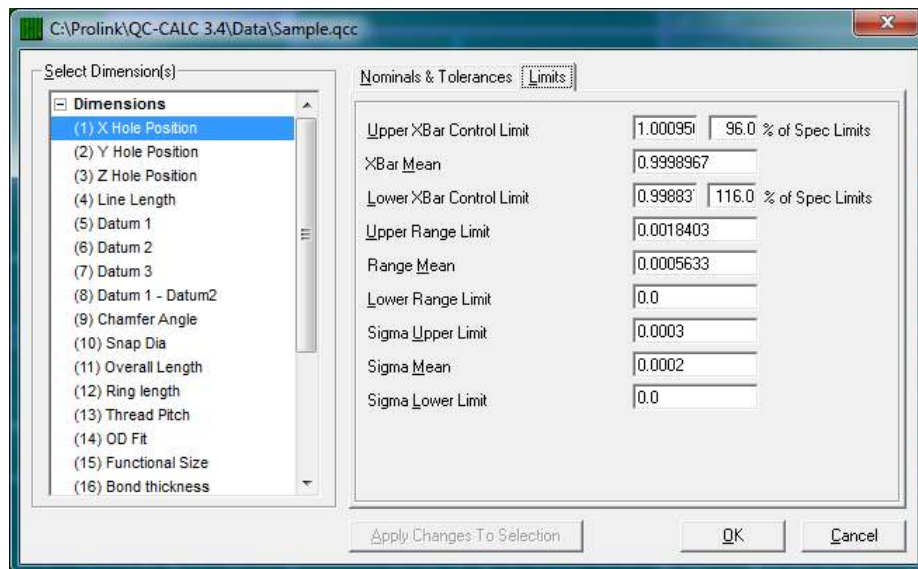
This type of tolerance type cannot trigger failure status such as trend detection and out-of-control reports. You will see blanks in reports where tolerances or upper spec limits are normally printed.

44.1.11 Prevent Nominal Update

This checkbox is used to prevent QC-CALC from updating the labels, nominals and tolerances of a dimension during Real-Time Inspection mode. QC-CALC has a special feature to Update Nominals to synchronize the QC-CALC database with your CMM part program. This subject is not discussed here but you can read about this automatic feature in the QC-CALC Real-Time section. The idea of this option is to stop the automatic update for the chosen feature you are editing. The nominal and tolerances will not be updated even if **Update Nominals** (in QC-CALC Real-Time) is set to **Always**. See the **Tools – Options – Data Collection – Actions** window in QC-CALC Real-Time.

44.2 Limits

The **Limits Tab** contains additional information about each feature in your data base. You see the following window when you click on this Tab.



44.2.1 Upper XBar Limit

This is a user-defined upper control limit for each XBar chart. If you know the value you want you can enter it here for each dimension. However, we recommend you let QC-CALC calculate and save the value for you so you don't have to type.

During analysis of Xbar Control charts QC-CALC can calculate the control limits based on the data you are analyzing or you can use these saved limits. The **Use Saved Control Limits** check box is found in **Tools – Options – Statistical Settings** area.

44.2.2 Percent of Spec Limits

You may type a percent value in this field and QC-CALC will calculate the control limit for you. The calculation = NOMINAL + (xx% of TOLERANCE). To enter the

value as a percent, type the percent value such as 80. The calculation occurs as you type.

i.e. If the nominal is 1.000 and the tolerance is +/- 0.05 and you choose 85%, The Upper XBar Limit is computed as:

$$\text{Upper XBar Limit} = 1.000 + (.85 \times 0.05) = 1.0425$$

This value is also used in the Real-Time data collection portion of QC-CALC. If you are using this program with automated inspection equipment, the yellow dashed line is placed on the plot using this technique to obtain a reasonable limit. However, once you have sufficient data to calculate the limits, we highly recommend you do so.

44.2.3 XBar Mean

This is the average of the subgroups in the XBar charts. You can assign a previously obtained value. This value may be used in place of QC-CALC calculated XBar mean when control charts are generated for this dimension. Should you have QC-CALC calculate and save the Mean value, it is stored in this location for each feature in the database.

44.2.4 Lower XBar Limit

This is a user-defined lower control limit constant for XBar charts. You can assign a unique, lower XBar control limit for each dimension. This limit may be used in place of QC-CALC calculated lower control limits when control charts are generated for this dimension. You can use the user-defined limits, the QC-CALC calculated limits or a one-time, manually inputted limit when the control chart is run for this dimension.

44.2.5 Percent of Tolerance

You may type a percent value in this field and QC-CALC will calculate the value for you. The calculation = NOMINAL – (xx% of TOLERANCE). To enter the value as a percent, type the percent value followed by a percent sign (%) i.e. 80%.

i.e. If the nominal is 1.000 and the tolerance is +/- 0.05 and you choose 85%, the Lower XBar Limit is computed as:

$$\text{Lower XBar Limit} = 1.000 - (.85 \times 0.05) = 0.9575$$

44.2.6 Upper Range Limit

This is a user-defined upper-control limit value for the range charts. You can assign a unique, upper Range control limit for each dimension. This limit may be used in place of QC-CALC calculated upper control limits when control charts are generated for this dimension. You can use the user-defined limits (by checking the **Use Saved Control Limits** check box) or the QC-CALC calculated limits.

44.2.7 Range Mean

This is the average of the ranges in the Range charts. You can assign a previously obtained value. This value may be used in place of QC-CALC calculated range mean when control charts are generated for this dimension.

44.2.8 Lower Range Limit

This is a user-defined lower-control limit constant for range charts. You can assign a unique, Lower Range control limit for each dimension. This limit may be used in place of QC-CALC calculated lower control limits when control charts are generated for this dimension. You can use the user-defined limits or the QC-CALC calculated limits for this dimension.

44.2.9 Sigma Upper Limit

This is a user-defined upper-control limit value for sigma charts. You can assign a unique upper Sigma control limit for each dimension. This limit may be used in place of QC-CALC calculated upper control limits when control charts are generated for this dimension. You can use the user-defined limits, the QC-CALC calculated limits or a one-time, manually inputted limit when the control chart is run for this dimension.

44.2.10 Sigma Mean

This is the average of the subgroups in the sigma charts. You can assign a previously obtained value. This value may be used in place of QC-CALC calculated sigma mean when control charts are generated for this dimension.

44.2.11 Sigma Lower Limit

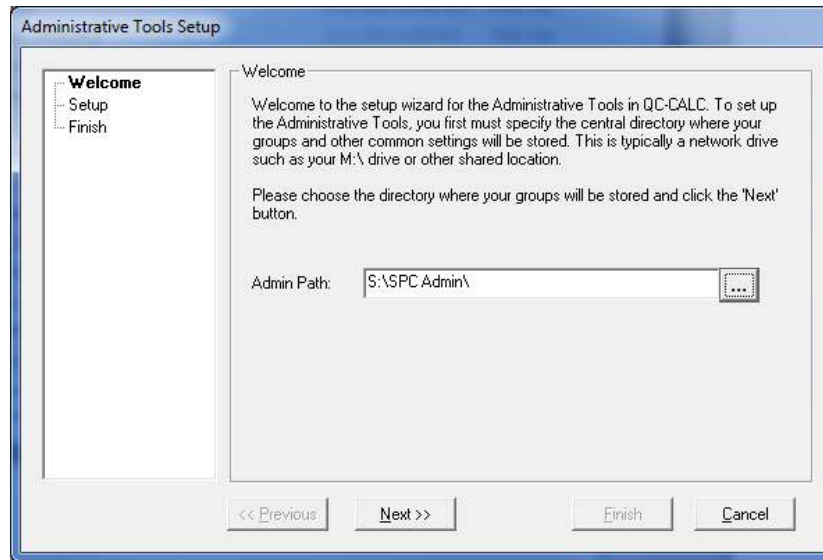
This is a user-defined lower-control limit value for sigma charts. You can assign a unique, Lower Sigma control limit for each dimension. This limit may be used in place of QC-CALC calculated lower control limits when control charts are generated for this dimension. You can use the user-defined limits or the QC-CALC calculated limits for this dimension. Click **OK** when you have finished entering the nominals and tolerances.

45. Enable Administrative Tools

Using this menu allows already installed copies of QC-CALC to use the Admin Tools area without having to reinstall. Once you choose this option a wizard will walk you through connecting to an Admin group. The steps below are for creating an entirely new Admin group, but the directions for joining an existing Admin group will follow this section.

45.1 Starting a New Admin Group

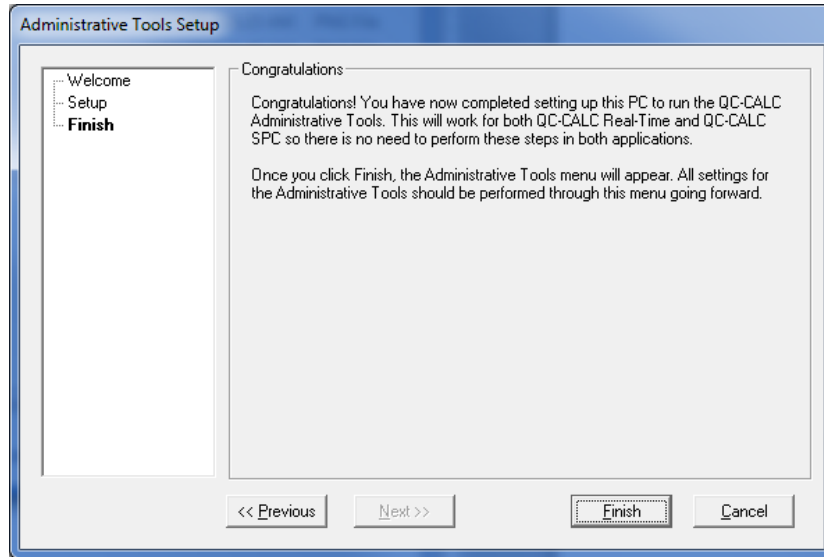
The first screen that is shown when you are creating a new Admin group asks you to choose the storage location of the Admin files. When you are starting a new Admin group choose the location where you plan to store the settings and as you start the setup process the files will appear there. This location should be on a server that all copies of QC-CALC will have access to.



On the second screen you are prompted to enter the password for your Admin group. This is a password you do not want others to learn, since it would enable them to change all of the settings you lock later.

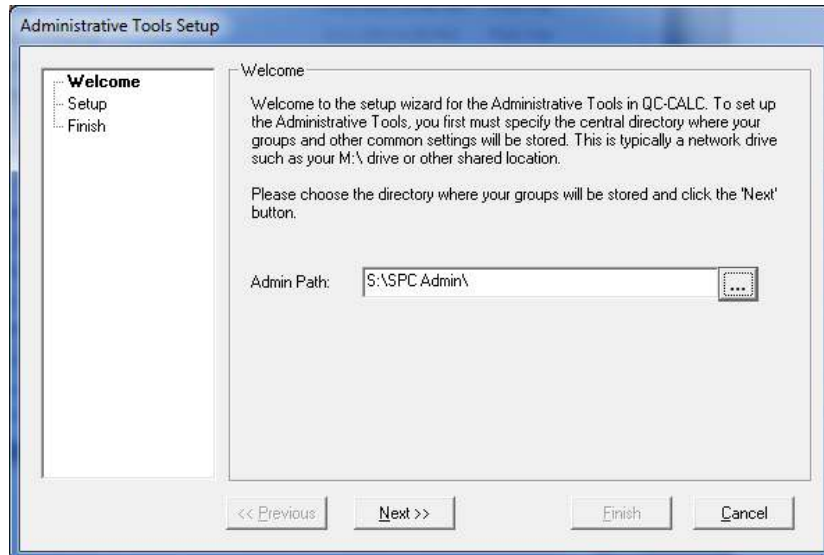


The final screen of this Wizard tells you the creation of the Admin group location was successful.

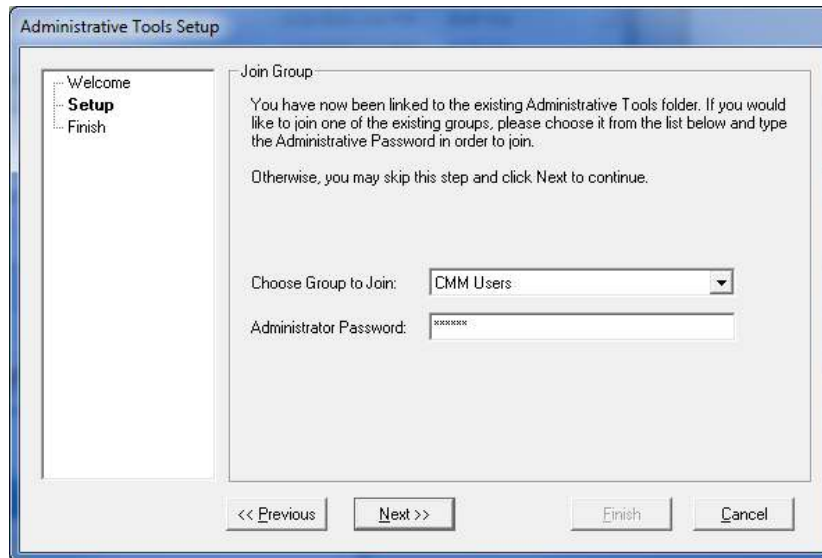


45.2 Joining an Existing Admin Group

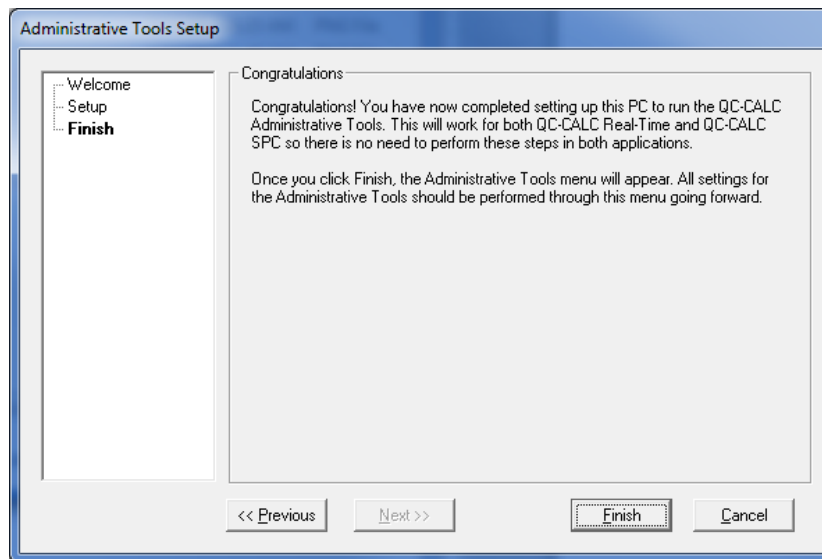
The first screen that is shown when you are creating a new Admin group asks you to choose the storage location of the Admin files. This location should be on a server that all copies of QC-CALC will have access to and should already have existing settings in that location.



Since the Admin group already exists the list of **User Groups** setup for that Admin group will be shown on the next screen. Choose the **User Group** this copy of QC-CALC should join and enter the **Admin Password**.



The final screen of this Wizard tells you that you successfully joined the Admin group.

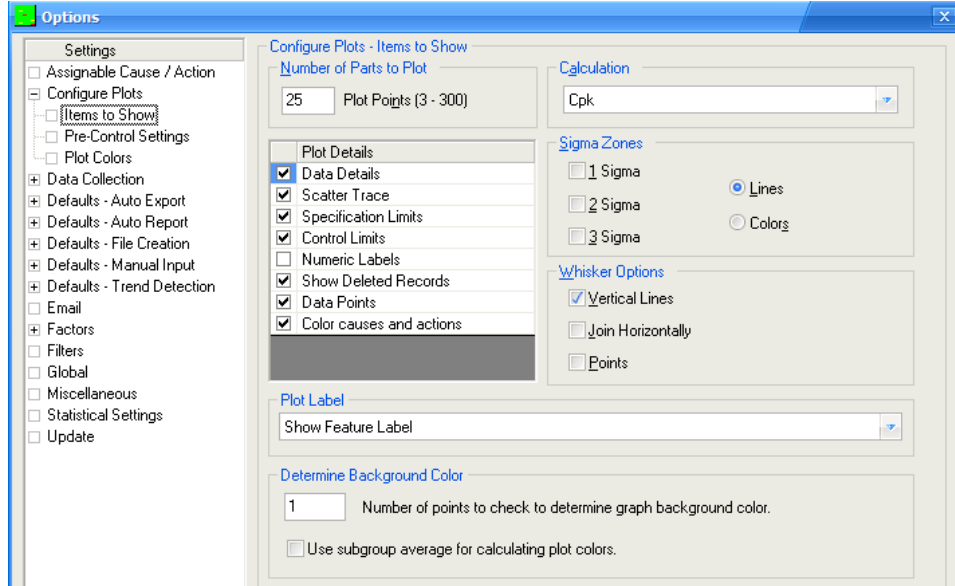


For more information see the [Administrative Tool & Part 11](#) section on page 269. **Note:** This menu will not be visible once the **Administrative Tools** functionality is in use.

46. Configure Plots

This menu item allows you to change what is seen on each plot. You can adjust the number of items seen on each plot, on-screen calculations, subgroup size, number of points in each plot, etc.

46.1 Items to Show



46.1.1 Number of Part to Plot

For details see the [Number of Parts to Plot](#) section on page [11](#).

46.1.2 Calculation

For details see the [Calculation](#) section on page [12](#).

46.1.3 Plot Details

For details see the [Plot Details](#) section on page [13](#).

46.1.4 Sigma Zones

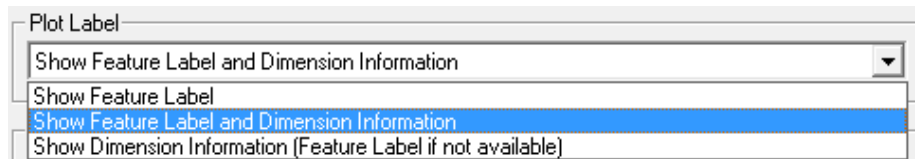
For details see the [Sigma Zones](#) section on page [14](#).

46.1.5 Whisker Options

For details see the [Changing the Options](#) section on page [164](#).

46.1.6 Plot Label

The label to describe each plot is controlled by this choice. There are 3 options here:



- **Show Feature Label** is the default choice and the standard way QC-CALC runs.
- **Show Feature Label and Dimension Information** will show the typical Feature Label and also have the value from the Dimension Information field shown directly below the Feature Label.

- **Show Dimension Information** will only show the Dimension Information value unless there isn't one available. At that point the regular Feature Label will be displayed.

46.1.7 Determine Background Color

The background color of the graph always depends on whether or not a measured value is in control, out of control, or out of tolerance. This number tells QC-CALC how many of the most recent points to look back. For example if the value is "3", then if any of the last 3 values are out of tolerance, then the background of the graph will be red.

Use subgroup average for calculating plot colors

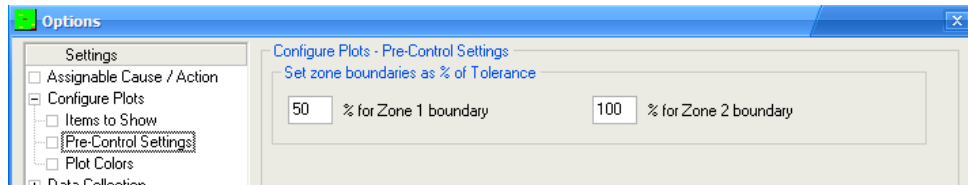
With this option checked the background color for each graph will be chosen based on the value of the average of the last displayed subgroup instead of the value of the last point received within the subgroup.

46.2 Pre-Control Settings

Pre-control is a technique that is used to detect shifts or upsets in the process that may result in the production of nonconforming units. The three pre-control zones are set at fixed percentages of the Tolerance. The green zone makes up 50% of the tolerance spread, and it is located from halfway between the nominal and the Upper Specification Limit to halfway between the nominal and the Lower Specification Limit. The yellow zones consist of the remaining 50% of the tolerance spread between the upper and lower bounds of the green zone and the Upper and Lower Specification Limits, respectively. The red zone is the area outside of the Specification Limits.

46.2.1 Set Boundary as % of Tolerance

This option gives you the ability to set where the Pre-Control Zones fall based on a percentage of the Tolerance Limits. The Default values for these are the first zone ending at the 50% of the tolerance available and the second zone ending at the Tolerance Limit.

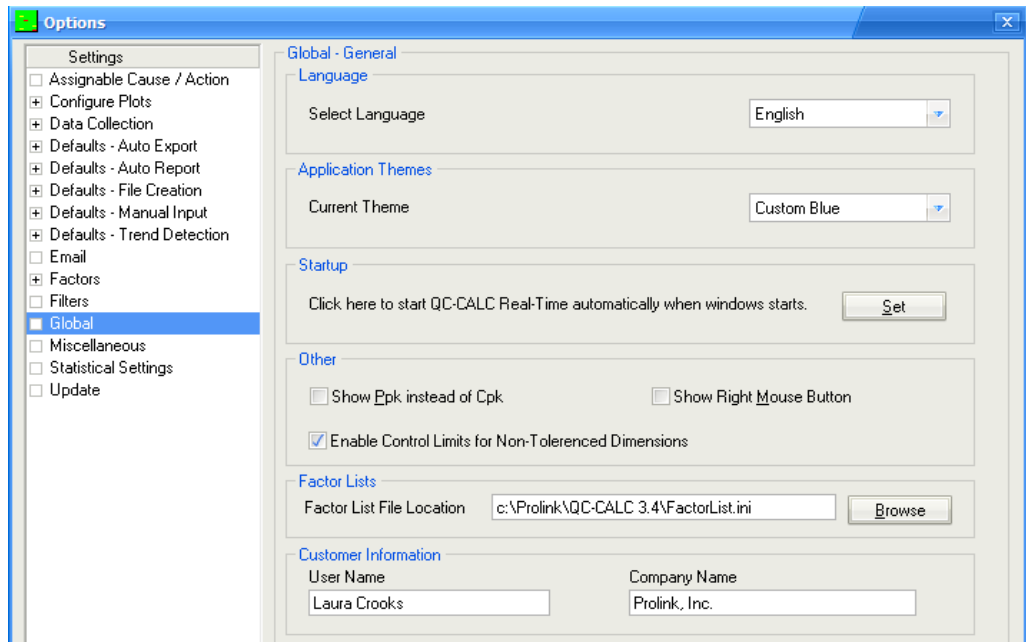


46.3 Plot Colors

For more information see the [Plot Colors](#) section on page [14](#).

47. Global Settings

The settings in this area are used in both QC-CALC Real-Time and QC-CALC SPC. Any changes made to the settings here in QC-CALC Real-Time will also apply to the QC-CALC SPC software running on the same computer.



47.1 Language

This allows you to change the language file that controls all of the captions and messages in QC-CALC. The languages that are currently supported are: Chinese, English, French, German, Italian, Spanish, and Swedish. Choose the language from the list and click **OK**. You must re-start QC-CALC for the new language to be shown.

47.2 Application Themes

You can change the look and feel of the screens within SPC Office Buddy with this option. Choosing “None” will remove any theme and the current Windows style will be used.

47.3 Startup


The **Set** button will place a shortcut to QC-CALC Real-Time in the startup folder so that QC-CALC Real-Time will be run every time the computer is started.

47.4 Other

47.4.1 Show Ppk instead of Cpk

For anyone following the AIAG standards, this option changes the **Cpk** (or **Cp**) labels through-out the program and reports to **Ppk** (or **Pp**).

47.4.2 Show Right Mouse Button

This option is designed for users utilizing a touch-screen monitor or who otherwise only have a single mouse button. Checking this option adds the  button to the toolbar on your screen. Click on the icon and then click on the plot point you would like to access; and the right-mouse click pop-up window appears. For more information on right-mouse click options, please refer to the [PopUp Menu \(Right Click on Any Plot\)](#) section on page [203](#).

47.4.3 Enable Control Limits for Non-Toleranced Dimensions

There are times you have dimensions that do not have tolerances associated, but you still want to watch to see how that feature is doing or run a report if a point goes out of Control. Enabling this feature gives you the ability to use any of the Out of Control options within the program.

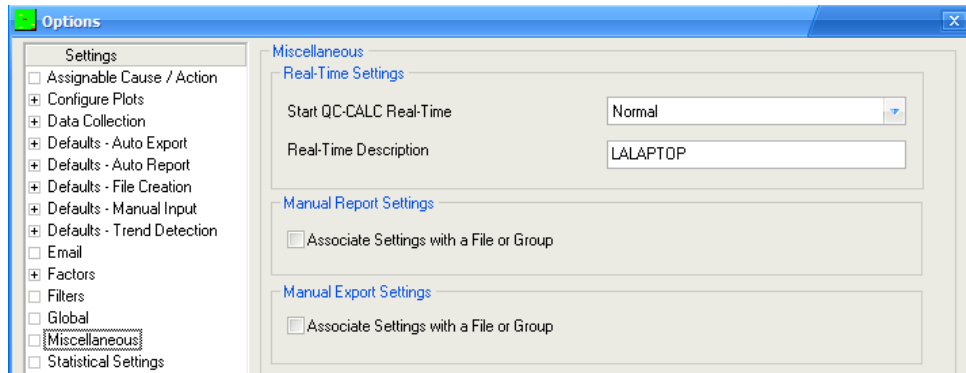
47.5 Factor Lists

This setting is used to control the location of the file the Factor Lists are saved to. You can choose a file name and location on the network and share the Factor Lists with QC-Gage. Once a different file name/location is chosen QC-CALC Real-Time will need to be restarted before that file will be used.

47.6 Customer Information

The information in this area is typically entered during the install process, but you can make changes to the User and Company Names from this area instead of having to reinstall when things change. The Company Name is used in most reports, so it is necessary to fix this when your company name changes.

48. Miscellaneous



48.1 Real-Time Settings

This area is used to control how QC-CALC Real-Time appears when it starts and the name used to describe this particular copy for the Monitoring in QC-CALC SPC.

48.1.1 Start QC-CALC Real-Time

This option will let you change how the QC-CALC Real-Time window is displayed when starting. You can choose to have it start up Maximized (full screen), Minimized (in the tray), or Normal.

48.1.2 Real-Time Description

This setting is used to describe this copy of QC-CALC when using the Monitoring option in QC-CALC SPC. You can monitor a copy of QC-CALC and this name will be displayed in the list of available QC-CALCs to make it easier to tell one copy of QC-CALC from another.

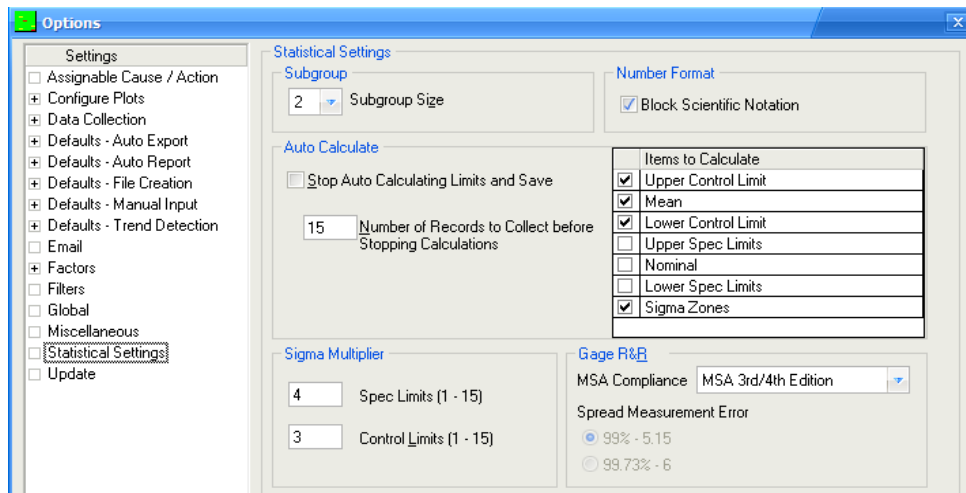
48.2 Manual Report Settings

Using the **Associate Settings with a File or Group** option will use your **Report – Print Report** settings separately for each different .qcc file instead of the same settings being used for all .qcc files.

48.3 Manual Export Settings

Using the **Associate Settings with a File or Group** option will use your **Export – Export Data** settings separately for each different .qcc file instead of the same settings being used for all .qcc files.

49. Statistical Settings



49.1 Subgroup Size

The subgroup size is the number of data points that will be included in each point on the chart or in your Analyses. For example, when your Subgroup Size is set to 2 one dot on the graph is actually the average of 2 data points. You have the choice to keep your existing values, or you can select a different value to be used with your Real-Time Analyses.

49.2 Number Format

49.2.1 Block Scientific Notation

When QC-CALC calculates and prints statistical results in the on-screen or printed report, the numbers may “snap” into scientific notation if their magnitude is very large or very small. Many people are unfamiliar with numbers displayed in scientific notation such as 1.23456E-9. This check box allows you to block this action.

49.3 Auto Calculate

This entire section is discussed in detail in the [Calculate Limits](#) section starting on page [76](#).

49.4 Sigma Multiplier

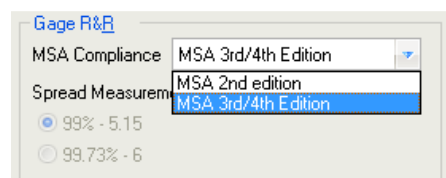
This entire section is discussed in detail in the [Calculate Limits](#) section starting on page [76](#).

49.5 Gage R&R

Gage R&R testing is a simple Design of Experiments in an attempt to determine the suitability of a gage to measure a part repeatability and accurately. The process of performing a GR&R can be very time consuming. Of course there are many methods and theories to achieve this end goal. QC-CALC supports the majority of them. The Gage R&R options are described here.

49.5.1 MSA Compliance

As the MSA Gage R&R standard evolves, QC-CALC has attempted to satisfy both the standard as well as our customers. The first supported standard was MSA 2nd Edition with an option to change from a Sigma multiplier of 5.15 or 6.00. When the 3rd Edition was released we adapted to the new standards but left the old method intact.



This yields you a choice of 4-combinations as shown in the diagram below.

In addition to these four options, QC-CALC is supplied with 4 report templates that are designed for you with preset calculations in them. The two basic calculation methods of variation are Range and Anova. Within these two categories you can choose between comparing the variation against the specification limits or compare the variation against the total variation.

Just before you print our Gage R&R report you are presented with the 4 templates with names that should make it clear as to what you should expect. They are:

GRR_Anova_Percent_of_Spec.grt
GRR_Anova_Percent_of_Total_Var.grt

GRR_Range_Percent_of_Spec.grt
GRR_Range_Percent_of_Total_Var.grt

This may be confusing but we feel it is important to provide a flexible choice of reports. Typically, you will obtain the best GR&R results by using:

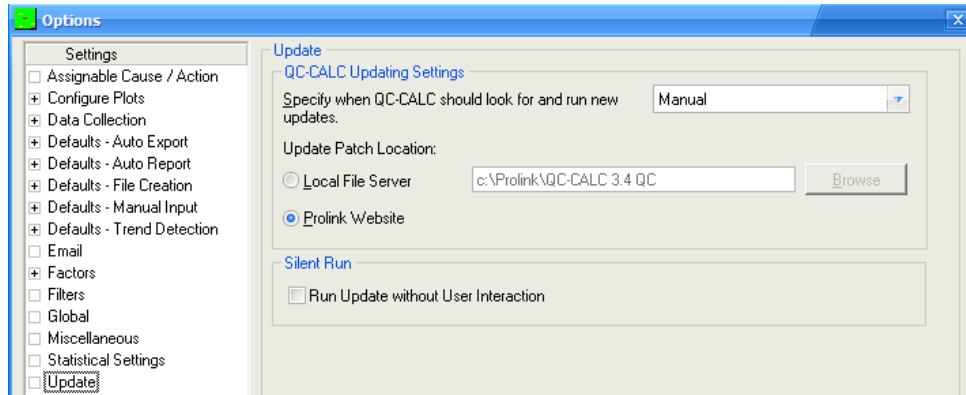
- MSA 2nd Edition
- Sigma of 5.15
- GRR_Range_Percent_of_Spec.grt template.

And you will receive the worse results using:

- MSA 3rd/4th Edition
- Sigma of 6.00
- GRR_Anova_Percent_of_Total_Var.grt.

50. Update

QC-CALC has the ability to automatically check for updates to the latest version. There are two ways of getting an update: from the **Prolink Website** (www.ProlinkSoftware.com) or from a **Local File Server**.



50.1 Specify when QC-CALC should look for...

You have the option of having QC-CALC automatically check to see if updates are available. If you do not want QC-CALC to check for updates automatically, then set the frequency to **Manual**. With the setting at **Manual**, the **Help – Run Update** menu will be the only way to perform the update operation. The choices to check for updates are:

- Manual
- Every Time QC-CALC Starts
- Once Every Day
- Once Every Week
- Once Every Month.

50.2 Update Patch Location

QC-CALC can be configured to look in 1 of 2 locations for the update patch. By default QC-CALC will look at the Prolink website to see if a new patch is available, but you can also choose a location on your local network if that is preferable.

If you want to update individual copies using a central location (meaning you control when the updates are downloaded and installed), then you need to visit the Prolink website to download the update to a location where it will be accessible to everyone. After the update has been downloaded, configure all QC-CALCs to check for available updates from that location by setting the **Update Patch Location** to the path where the update has been stored.

50.3 Run Update without User Interaction

Using the **Silent Run** option along with the automatic updating will keep QC-CALC up to date without the operators having to do anything at all. If a needed update was detected when the program started, the update will be downloaded and installed, then the program will start automatically when the updating process is finished.

51. Export Formats

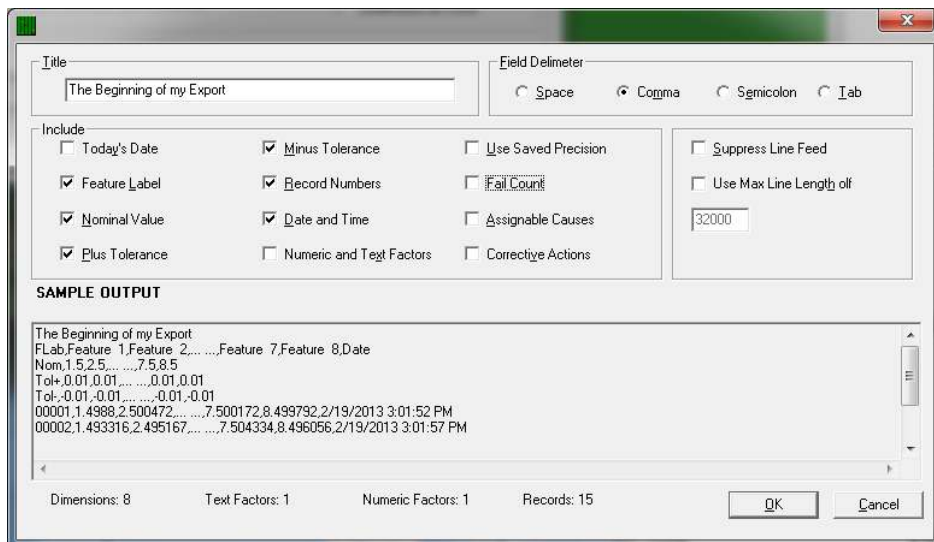
A few of the Exporting formats are described in this area.

- [ASCII Text File](#) pg. [223](#)
- [ASCII User Defined Template](#) pg. [226](#)
- [Becker Quality Solutions](#) pg. [230](#)
- [InfinityQS Proficient](#) pg. [233](#)
- [IQS Export](#) pg. [236](#)
- [JMP](#) pg. [238](#)
- [Lighthouse SPC](#) pg. [239](#)
- [Minitab](#) pg. [240](#)
- [Mitutoyo Measurlink](#) pg. [241](#)
- [Net-Inspect Web Export](#) pg. [244](#)
- [ODBC – Open Database Connectivity](#) pg. [246](#)
- [OleDB Export](#) pg. [249](#)
- [Proficiency Shop Floor \(Visual SPC\)](#) pg. [250](#)
- [Q-DAS Format ASCII Output](#) pg. [254](#)
- [SPC Office Buddy](#) pg. [261](#)
- [SQL Server Export](#) pg. [263](#)
- [Stat Summary File](#) pg. [265](#)
- [WinSPC](#) pg. [268](#)

51.1 ASCII Text File

51.1.1 Introduction

The purpose of this option is to create an ASCII file from the QC-CALC database file. This format is different than the template driven output discussed in Appendix B in that each record contains 1 complete part. You can add many items to the output file and each of those are discussed in this section. When you export data and choose an **Export Type** of **ASCII Text File** the **Configure** button is enabled. Clicking the **Configure** button brings you here.



51.1.2 Specify the Output File Name

When you select the **Export – Export Data** menu and you choose an **Export Type** of **ASCII Text File**, you choose the output file name in the **File Location** frame. A file dialog is displayed where you select the file name and location. You can choose any file extensions but the recommended extensions are **“.txt”**, **“.asc”**, or **“.csv”**. If you wish to create a file to import into Microsoft Excel, use a

file extension of .CSV for comma separated values. Be sure to use a comma for the field separator.

51.1.3 Dimensions To Export

When you choose to export your QC-CALC data to this ASCII format the currently selected Real-Time plots are the only dimensions used in the export. If you want all inspected features to be written to the ASCII file, they must be visible in the Real-Time screen.

Next, you have to specify the format of the ASCII file. The Sample Output display area shows a preview of the file you are creating. It is used only for previewing purposes not for editing. When you are satisfied with the file format click OK to continue or Cancel to abort.

51.1.4 Data to Export

Much of this screen is used to select the individual attributes to include with each inspected part such as Factors, Date & Time, etc. Some of your choices involve the overall file content related to the file you create. Each is now explained.

Title (Optional)

You can type any string here to help identify the output file contents. It is written to record 1 of the file.

Field Separator

Choose either a space (), comma (,), semicolon (;), or ^t (TAB). QC-CALC will use this separator as a marker to determine the beginning and the end of each data field. If the space character is chosen as a separator, QC-CALC will change all spaces found in any of your titles & labels to underscores (_). This is required since it is assumed the program reading the file will confuse these extra space characters as field separators.

Include Today's Date

Checking this box causes the current date to be recorded at the top of the data file. The data associated with each data record is unaffected either way.

Include Feature Label

Checking this box inserts the feature labels found in your part program to appear at the top of each column of numbers. Having this label makes it easy to identify your feature data.

Include Nominal Value

When this box is checked the Nominal values for each selected feature appear under the labels or on top of each column of numbers. This reminds you of target or expected value and may be useful with other programs.

Include Plus Tolerance

When this box is checked, the plus tolerance value for each selected feature appears under the nominal in your output file.

Include Minus Tolerance

When this box is checked, the minus tolerance value for each selected feature appears under the Plus Tol in your output file.

Include Record Numbers

Checking this box causes the record numbers to output on the left side of each record. You may want this reference number to determine where you are in the list at any time. It is inserted in the left most column.

Include Date & Time

Checking this box causes the date & time for each record to be passed to the output file. If present, it is inserted in the right-most column.

Include Numeric and Text Factors

Checking this box inserts all of the Numeric and Text Factors into the output file. Each QC-CALC file can contain different numbers of Factors.

Use Saved Precision

This option formats the output data according to the number of digits to the right of the decimal point as specified in the Nominal section. An unchecked box produces raw, unformatted numbers. Since round off occurs with formatted numbers, you might consider leaving this box empty. However, when formatted numbers are used, the column of numbers will line up uniformly.

Include Fail Count

When this box is checked, the count for the number of fails for each record appears at the end of each row of data values. It reflects the number of features in the record exceeded a tolerance limit.

Include Assignable Causes

When this box is checked, a reference number is exported which is a code for the description of the assignable cause in the default assignable cause file in your system.

Include Corrective Actions

When this box is checked, a reference number is exported which is a code for the description of the corrective action in the default corrective action file in your system.

Suppress Line Feed

Checking this box causes each record to terminate with a Carriage Return (CR) as opposed to Carriage Return/Line Feed (CRLF).

Use Max Line Length of

Type the maximum length of the records in your file. The maximum length allowed by QC-CALC is 32000 characters. If this file is to be printed on a printer, reduce this number to ensure the printer won't wrap.

51.1.5 ASCII Output Example

This file was created with the choices shown in the figure above. Note record 1 contains the title entered, records 2, 3, & 4 contain the nominal, plus tolerance, and minus tolerance, and the data follows. The four columns of data indicate only four plots were displayed at the time of export. The record numbers at the left of the data indicate only ten parts were selected to be exported (records 51 – 60).

```
The Beginning of My Export
FLab,X Hole Position,Y Hole Pos,Z Hole Position,Line Length,Date
Nom,1,2,3,4
Tol+,0.001,0.002,0.003,0.004
Tol-,-0.001,-0.002,-0.003,-0.004
0051,1.000148, 1.999153,2.999017,3.998912,12/12/1994 12:00:00 PM
0052,0.9999322,2.000062,2.998226,4.000368,12/12/1994 12:00:00 PM
0053,0.9998261,1.999914,3.001115,3.999953,12/12/1994 12:00:00 PM
0054,1.000802, 1.999343,3.000155,4.000306,12/12/1994 12:00:00 PM
0055,0.9996726,1.999477,2.998902,3.998077,12/12/1994 12:00:00 PM
0056,0.9998124,1.999915,3.001704,3.996612,12/12/1994 12:00:00 PM
0057,0.9999475,2.001485,2.999864,3.997249,12/12/1994 12:00:00 PM
0058,0.999037, 2.000962,2.999075,4.003339,12/12/1994 12:00:00 PM
0059,1.00008, 2.000618,3.000319,4.000885,12/12/1994 12:00:00 PM
0060,1.001135, 2.001485,2.998279,4.000936,12/12/1994 12:00:00 PM
```

51.2 ASCII User Defined Template

51.2.1 Introduction

The purpose of the Template Driven Output is to provide a method of designing your own custom file output. You may wish to export the QC-CALC data to another SPC program or a database that QC-CALC does not support. The combination of the straightforward interface and this tutorial should make it easy for you to export the data from QC-CALC to any application requiring the data. The created output is based on writing one dimension per record as opposed to one part per record as in ASCII Text Format in Appendix C. This user defined template output writes each feature to your output file one at a time before moving to the next part. This is similar to the way a CMM inspects parts. When you export data and choose an **Export Type of ASCII User Defined Template** the **Configure** button is enabled. Clicking the **Configure** button brings you here.

51.2.2 Special Characters

There are five output templates available to control the form and content of the result file. Each character entered into a template is saved in the output file “literally” with the exception of two special characters followed by one or two letters (@ and ^). The “at sign” (@) and the carat (^) character tell QC-CALC you want to write something other than literal text and are called variables. These two special characters are used together with letters to specify an action.

@ followed by two letters is a command to output a specific piece of data from the file.

^ followed by a letter outputs a control character such as carriage return or Tab.

These two special template characters are followed by 1 or 2 letter commands that are replaced with their data value when the file is created. If you enter any text, such as the word **START** or characters like an asterisks (*) or a space in the Part Header template, each character is output to the file just as you typed it (literally).

51.2.3 Special Character Commands

The combination of the @ and the ^ followed by one or two letters gives you the maximum flexibility. This list summarizes the available variables QC-CALC understands that you can add into your templates.

@AC Actual Value	@NM Nominal
@AL Assignable Cause Label	@PN Part Name
@AN Assignable Cause Number	@PR Precision
@AV Assignable Cause Value	@RN Routine Path Name
@CL Corrective Action Label	@QC Serial Number QC-CALC
@CN Corrective Action Number	@SN Serial Number Machine
@CV Corrective Action Value	@TC Time Current
@DL Date Current Long Date	@TI Time Inspection
@DR Delimiter	@TM Tolerance Minus
@DS Date Current Short Date	@TP Tolerance Plus
@DV Deviation	@TT Tolerance Type
@FB Factor Label	
@FL Feature Label	^M Carriage Return
@FN Factor Number	^J Line Feed
@FT Factor Type	^T Tab
@FV Factor Value	^H Hex Char
@IL Date Inspection Long Date	@@ At Symbol
@IS Date Inspection Short Date	^^ Carat Symbol

e.g. If your part program name is **MyPartName** and you create a template containing:

```
START @PN
```

At export time the @PN is replaced with **MyPartName** and the output written to your file is:

```
START MyPartName
```

51.2.4 Template Setup Screen

This screen allows you to create, edit, and save templates for later output. When the Template Setup screen first opens, no template is loaded and all boxes are disabled.

Select Template Path and Name

This contains the text with the Template's path and name. The default path is **C:\Prolink\QC-CALC 3.4\Export Template**. The default template shipped with QC-CALC is **Default.QCT**. You can use this one or create as many as you like.

New

To create a new Template, click the **New** button. A dialog box opens asking you to select a path and name for the new file. When you have finished this step the setup window becomes enabled and you see the path and name of the file you selected.

Browse

To open a Template that already exists you click the **Browse** button and choose a file from the dialog box that follows.

Set as Active Template

This check box activates this template for use in automatic exports which is set on the **Export – Edit Stats Output Schedule** window. When you want to choose a different Template to export, you must return to this screen, choose the Template through the **Browse** button and set the new template as the active Template.

Separate file for each record

This check box allows you to create a separate file for each exported part. If you do not choose this option all part data is stored in one large file.

Number to begin appending

If separate files are being created for each record, the file names must be unique. The number entered here is appended to the file name you chose and is incremented each time a new part is processed.

For example:

MyFile001.txt; MyFile002.txt; MyFile003.txt, etc.

Export Format

This is where the actual format of your Template is designed. A Template can be constructed manually (typed in), or it can be selected piece by piece from the list provided. As you add items to the template using the **Add Item** button, you will notice that they are not very readable. Each item has a code attached to it. For example: the code for the nominal value of a dimension is “@NM”. To see a sample of what your export will be, click the **Sample Output** button in the bottom left corner and a brief output is displayed.

Delimiter

This list allows you to select from a group of pre-selected delimiters, or type in one of your own.

Insert Delimiter

This button inserts a delimiter Tag into the currently highlighted Template section. A section becomes highlighted when it receives focus from the cursor (clicking on it), or by using the Tab key to move between items. When you click this button, the delimiter code (@DR) is inserted at the cursor position. If you need to move text around, you can cut and paste just like in any text editing.

Items available to export

All of the codes QC-CALC recognizes are stored in this list. The list has two main purposes. First it acts as a reference as you build the template manually. Its main purpose however, is to allow you to choose an item from the list, and then click the **Add Item** button to let QC-CALC build the Template for you.

Insert Item

After selecting an item to add and a Template to add it into, this button appends the code to the selected Template section you're typing.

Template Sections

The five Template sections are described here and are written to the export file in the order listed.

Part Header

This section of the Template is printed once for each part and is the first record(s) added to your output file.

Feature Data

All data that pertains to a specific part should go here. For example: nominal, tolerances, actual value, etc. This section will loop through all of your features in your part program, printing a line for each feature.

Non-Measurement Data

This section addresses the Non-Measurement Data, also called Factors, or Trace Fields and will loop through all of the Numeric and Text Factors in your file. This data is added to the end of your output file.

Assignable Cause / Corrective Action

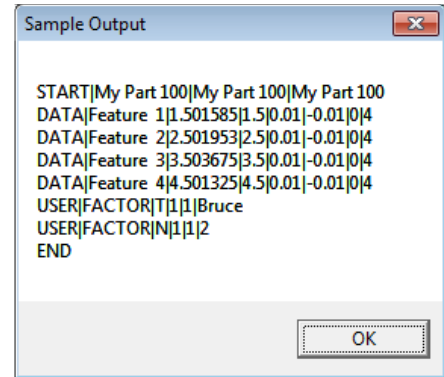
Here the index value and the description of each “assigned cause” and “corrective action” is written. This section will loop through the number of assignable causes and the corrective actions that you have in your file.

Part Footer

This is printed once per record and you might add some text to identify the end of the part such as END:.

Sample Output

Any time during construction of your Template you can look at what an export might look like by clicking this button. If your output is not what you expected, you may need to edit your Templates to obtain the right output. Even one character can make a large difference.



Apply

Clicking the **Apply** button will save your changes, without leaving the form.

Example File

The settings shown at the beginning of this section will produce the following output when SAMPLE.QCC is the active QCC file:

```
START,MyPart 10,9/2/2009 12:25:45 PM
Feature 1 = 1.504586
Feature 2 = 2.503695
Feature 3 = 3.499657
Feature 4 = 4.498199
Feature 5 = 5.498194
Feature 6 = 6.496982
Feature 7 = 7.495679
Feature 8 = 8.507266
Feature 9 = 9.500092
Feature 10 = 10.4988
My Manual Dim = 0.5
Dim 1 + Dim 2 = 4.008281
Operator = Not Used
Lot = 0
Machine = 0
Cavity = 0
END!
```

51.3 Becker Quality Solutions


51.3.1 Introduction

Becker Quality Solutions (BQS) offers a software package called “Process Toolbox” or “Reaction Plan Manager”. The software analyzes measurement data and reports specific instructions to adjust or fix a process. Used with QC-CALC Real time software, measurement data and statistical information are automatically exported to Process Toolbox for analysis. Process Toolbox creates custom reports containing needed step-by-step operator instructions to fix the process. The custom report is displayed in an easy to read slide show format. Together, the operator has the statistical information to evaluate the process and the step-by-step instructions needed to fix it.

51.3.2 How it Works

This software solution is divided into two software applications:

Process Toolbox  **Editor** and

Process Toolbox  **Viewer**.

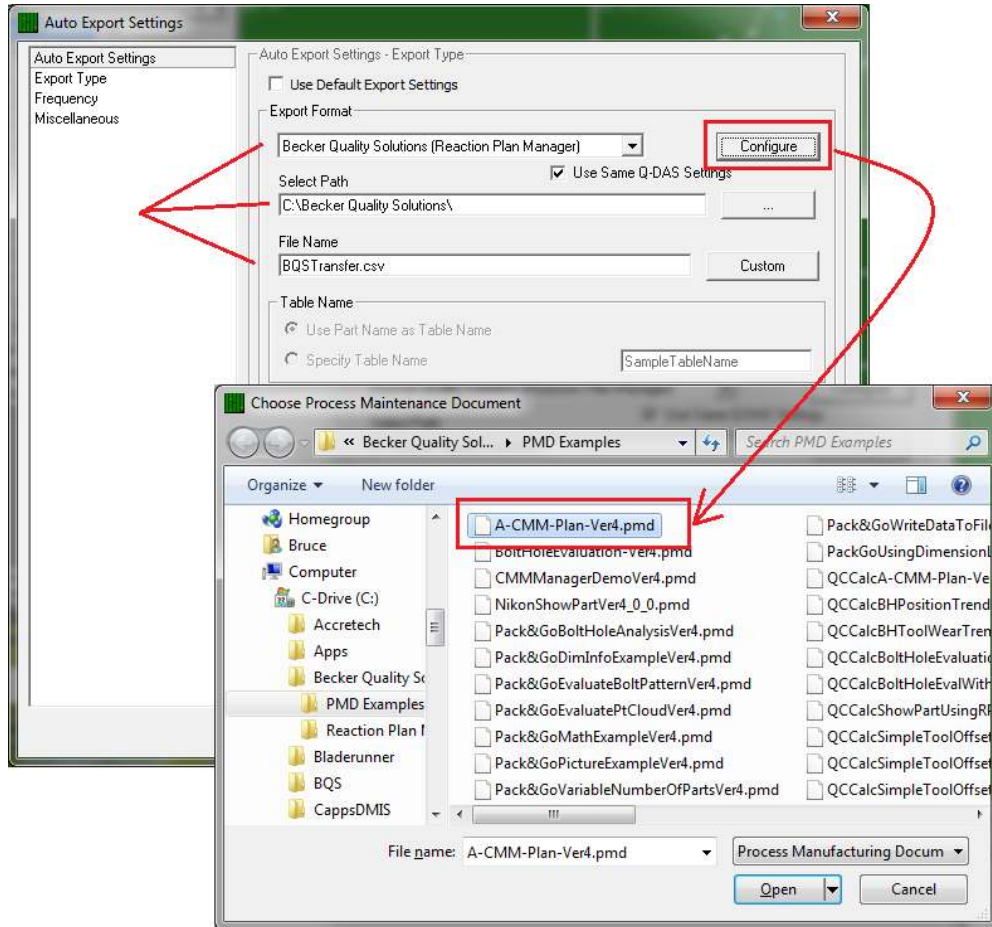
The editor is used to build Reaction Plans (PT documents) containing the instructions needed to convey how to make the machine adjustments and the intelligence to analyze the measurement data. Once the Reaction Plan is complete and released to the factory floor, the Viewer application displays the instructions in a slide show format. All the machine operator sees is the information telling him what to adjust and how much to adjust it. (Reference “QC-CALC Software” and “Process Toolbox Viewer” help topics found in the Process Toolbox Editor for more information).

51.3.3 Automatic Export

Using the QC-CALC Automatic Export feature you output inspection data to the Viewer which automatically triggers the specific reaction plan (PT document) to be processed. The chosen reaction plan is displayed until QC-CALC triggers the execution of the same plan with new data. This operation continues endless, updating the instructions as needed.

Select the Plan

You select **Export – Setup Automatic Export – Becker Quality Solutions** – and then click the **Configure** button. A file dialog box is displayed where you select the process document file (.PMD) you want QC-CALC to run. This is a one-time setup for each part program.



Select the File and Path

Be sure to enter and output file name and path as shown. These are the default and will work without any other setting.

Select the Data

As with all QC-CALC exports, be sure to adjust the amount of data you want to send to the plan. If the plan calls for averaging the last 5-parts inspected, enter a 5 into the **Range of Records** using **Newest Records in File**. If you want the document to display after each inspected part, set the **Frequency** to 1 **New Records Received**.

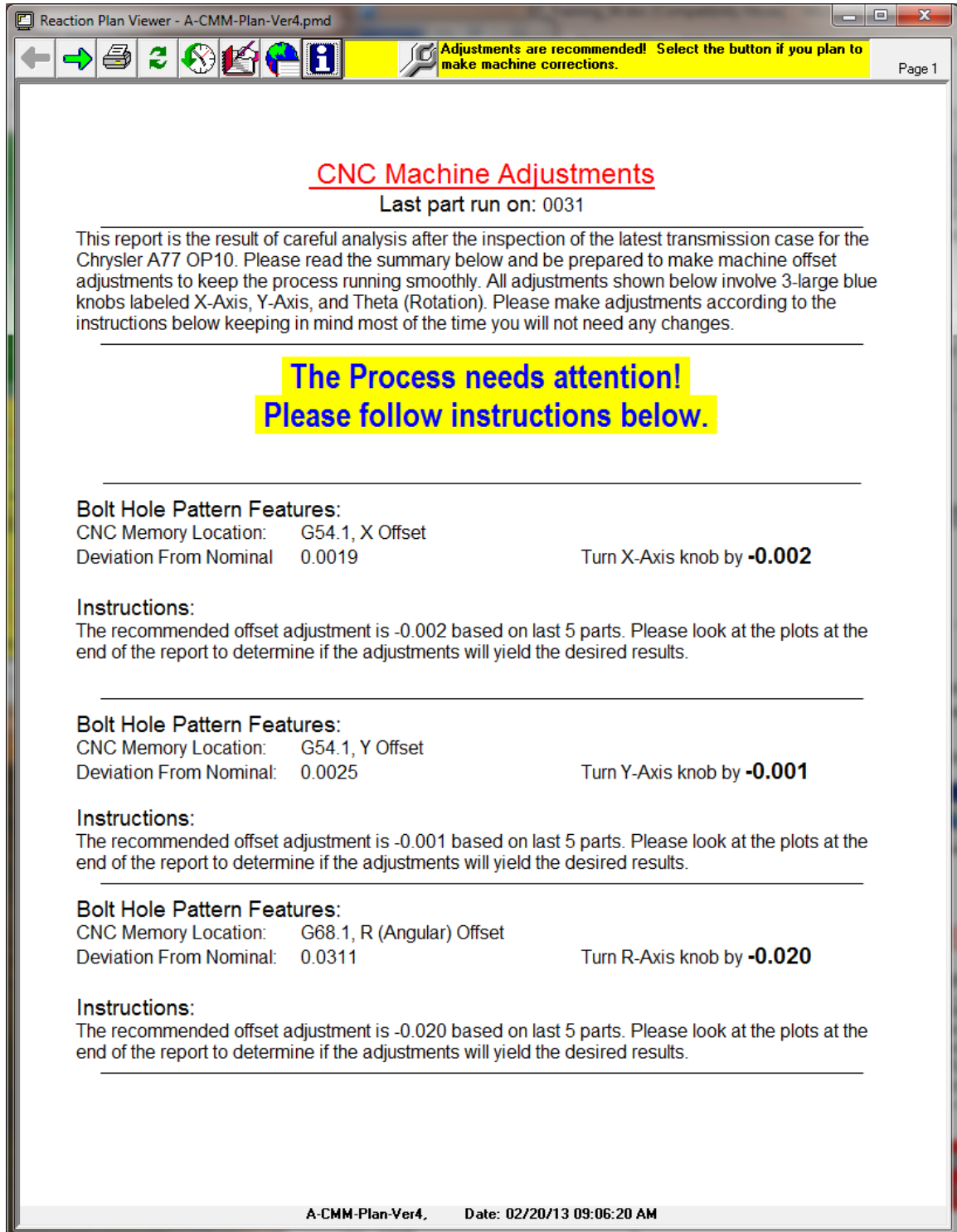
When your part inspection is complete, QC-CALC reads your CMM data, saves it in its database, updates the live graphs, and sends the data the Viewer. This triggers the Viewer to display the report automatically (See next page). For more detailed operation of this software, please see the BQS instruction manual.

Trends

QC-CALC can be set to monitor and display the 7-Western Electric trends (plus a few more) within each live plot. This trend information is passed to the Reaction Plan and can be used to trigger the report. More details are available on the BQS website.

Reaction Plan Example

This sample report is one example of many possible outcomes displayed on the machine operator’s screen. Notice it includes instructions to the operator for the necessary adjustments. The operator may or may not have the ability to make these adjustments depending on your corporate procedures.



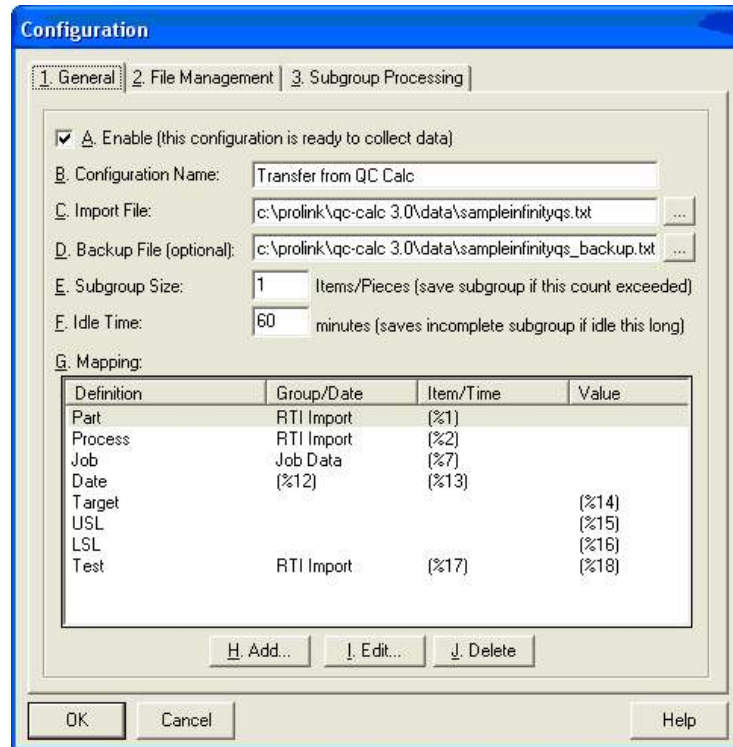
Please visit the BQS website at www.beckerqualitysolutions.com for more information on this product.

51.4 InfinityQS Proficient

This section describes the steps necessary to export your data from QC-CALC Real-Time to InfinityQS Proficient. We have several customers who use Proficient and need to get CMM data into it without typing. This article assumes you are using the Real Time Importer (RTI) from Infinity.

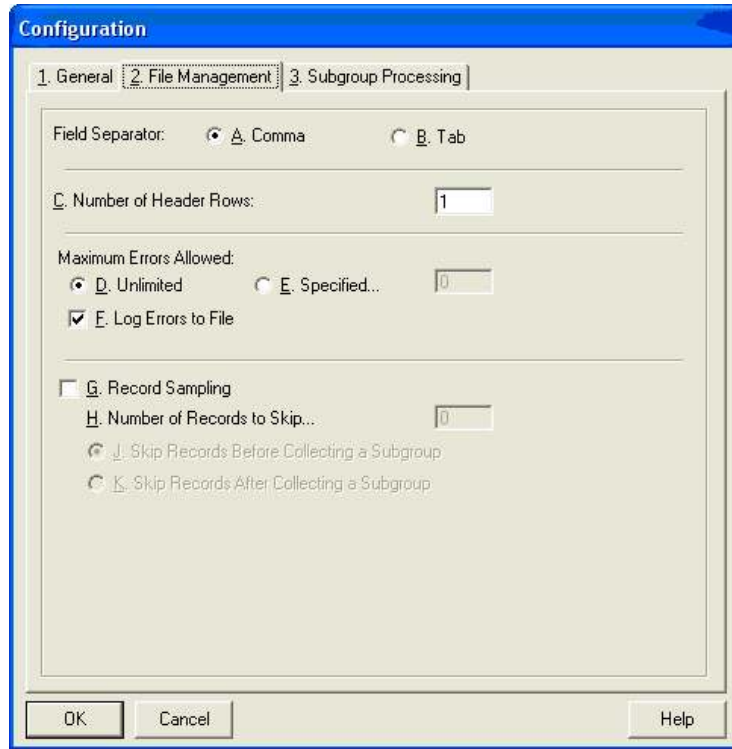
51.4.1 Steps within InfinityQS

1. First you'll need to set up a data access driver in Infinity that tells the RTI how to import the data from QC-CALC. To do this, go to the **Configuration** screen in the RTI.



2. On this **General** tab, make sure you fill out **C. Import File** which specifies the path to the output file from QC-CALC. RTI should continuously poll the output directory looking for this file and will import it when it's found.
3. In the **G Mapping** section, add the various definitions so they match the picture above. The important thing is to get the correct percentage numbers as they match the fields in the CSV file that will be imported. For example, the Part will be coming from the first field in the CSV file and the Lower Spec Limit will be coming from the 16th field.

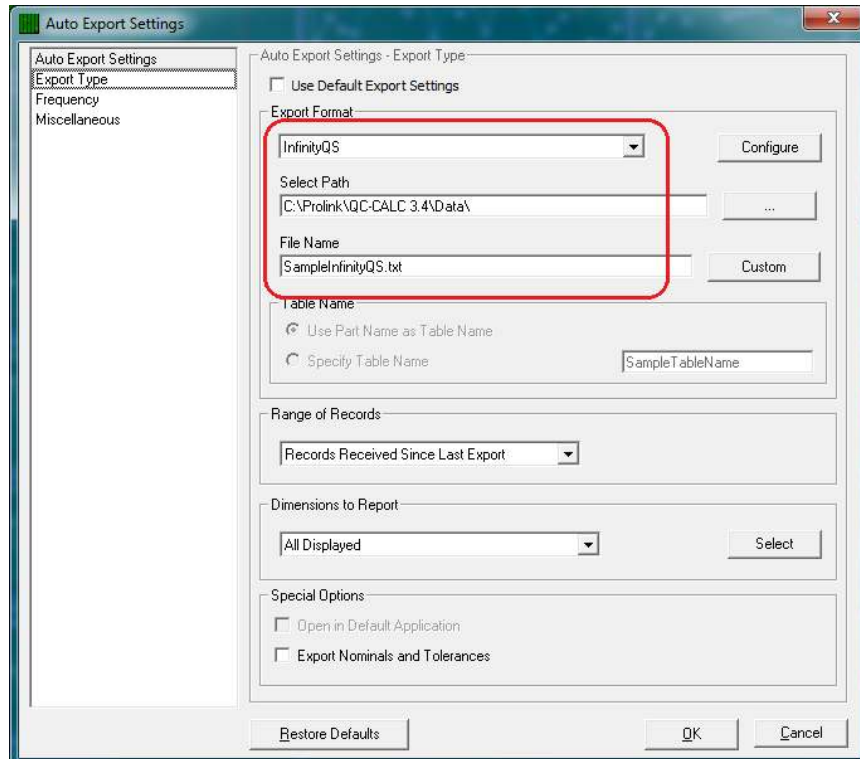
- On the File Management tab, make sure to specify the Field Separator as A. Comma and the C. Number of Header Rows as 1.



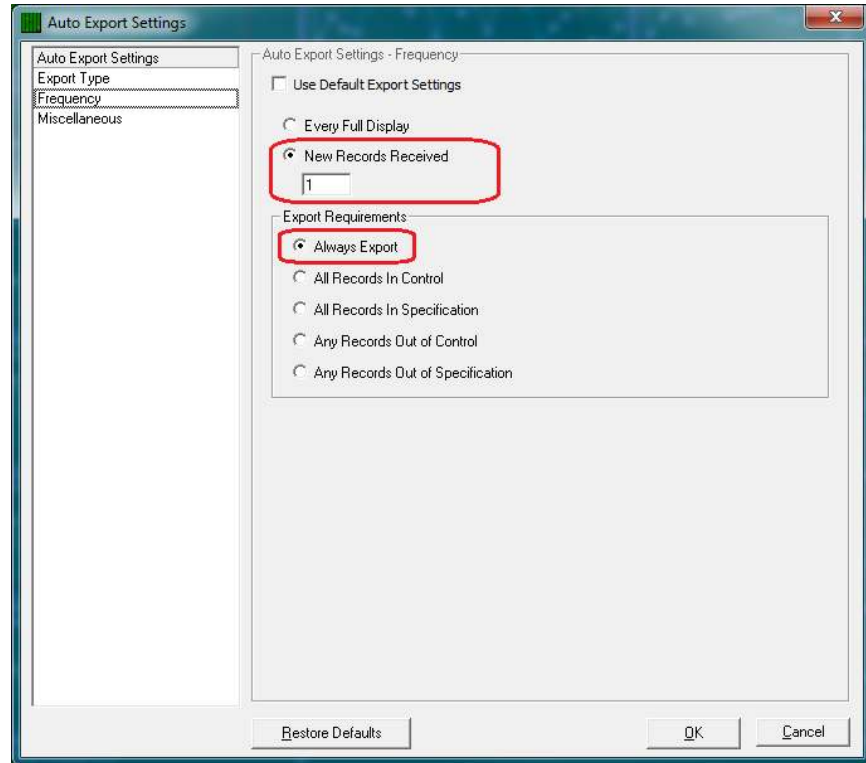
51.4.2 Steps within QC-CALC Real-Time

These settings should be all you need to set up an import in the RTI tool.

- In QC-CALC, go to **Export - Setup Automatic Exporting** and choose the settings shown below.



2. On the **Frequency** tab choose the following:



3. Make sure to enable Automatic Reporting in QC-CALC by choosing **Export - Automatic Exporting (Off)**. This menu should be checked so it is on.
4. Measure parts and the data should automatically flow from QC-CALC to Proficient.

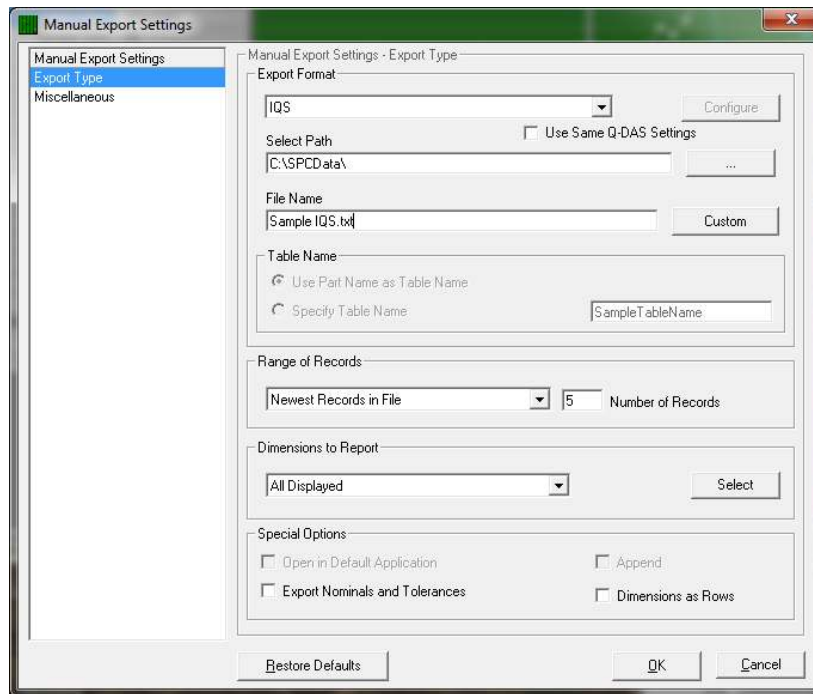
51.5 IQS Export

51.5.1 Introduction

QC-CALC can export inspection results from its database to IQS' Enterprise Quality Management Software. The raw inspection results are saved in files without nominal & tolerance information. However, the output does contain 3-extra fields of Factor data (non-measurement data). The output file is easily generated from QC-CALC and easily imported into the IQS system. Read this section to understand how to create your output file for the IQS system to read.

51.5.2 Output the File

You simply select the **Export** menu, pick **IQS** as the **Export Type**, select the **Range of Records** to Export, and press the **Export** button. Be sure to save the file in a location the IQS software can find.



51.5.3 Factor Information

Among the other content, the output file contains a **Rev** letter, an **OP** number, and the **Operator** name. QC-CALC obtains these 3-extra items (Factors) from the database's Text Factor 1, 2, and 3 respectively. These 3-extra values are important information to help identify the measurement so your results are organized and retrievable within the IQS system. A partial listing is shown below:

Part Name	Rev	Op	Label	Char	Operator	Date	Result
Test Part	A	20	My Dia	46_1	Big George	07/24/08 11:15:41	0.022298
Test Part	A	20	My 1X	46_2	Big George	07/24/08 11:15:41	4.001608
Test Part	A	20	My 1Y	46_3	Big George	07/24/08 11:15:41	0.003410

51.5.4 File Content Description

Part Name	The QC-CALC database name
Rev	From QC-CALC Text Factor 1 - you must ensure it is present
Op	From QC-CALC Text Factor 2 - you must ensure it is present
Label	Feature label from your gage
Char	Characteristic number preceded with the QC-CALC record number
Operator	From QC-CALC Text Factor 3 - you must ensure it is present
Date	The date and time of inspection
Result	Measured value

Please read the special section of your QC-CALC user manual (gage section usually printed on gray paper) that describes how to send Factor information from your gage to these specific locations.

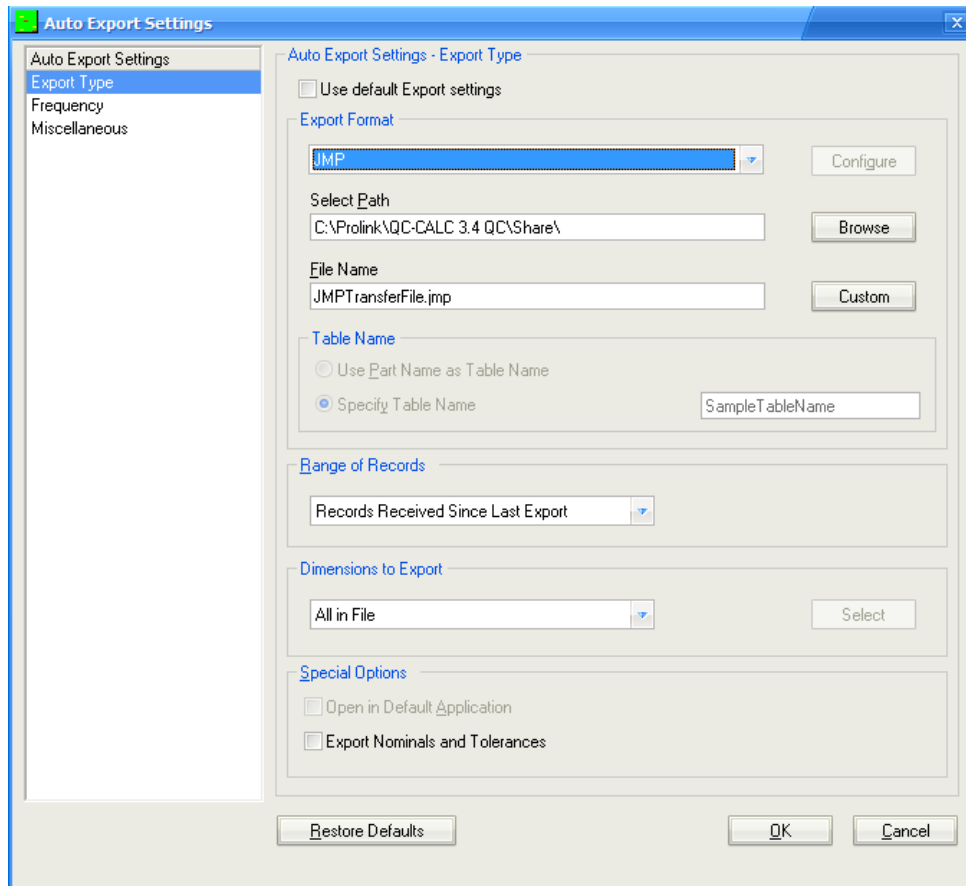
51.6 JMP

51.6.1 Introduction

For the export to JMP we don't just create a file that can be consumed by JMP, we literally launch JMP and add the data directly into a JMP Datatable. This includes the nominals and tolerances for all the features you've selected.

51.6.2 Export to JMP

1. Simply choose **Export – Export Data**.



2. In the **Export Type** list, choose **JMP**.
3. Choose the **Range of Records** you want to export.
4. Click **Export**.

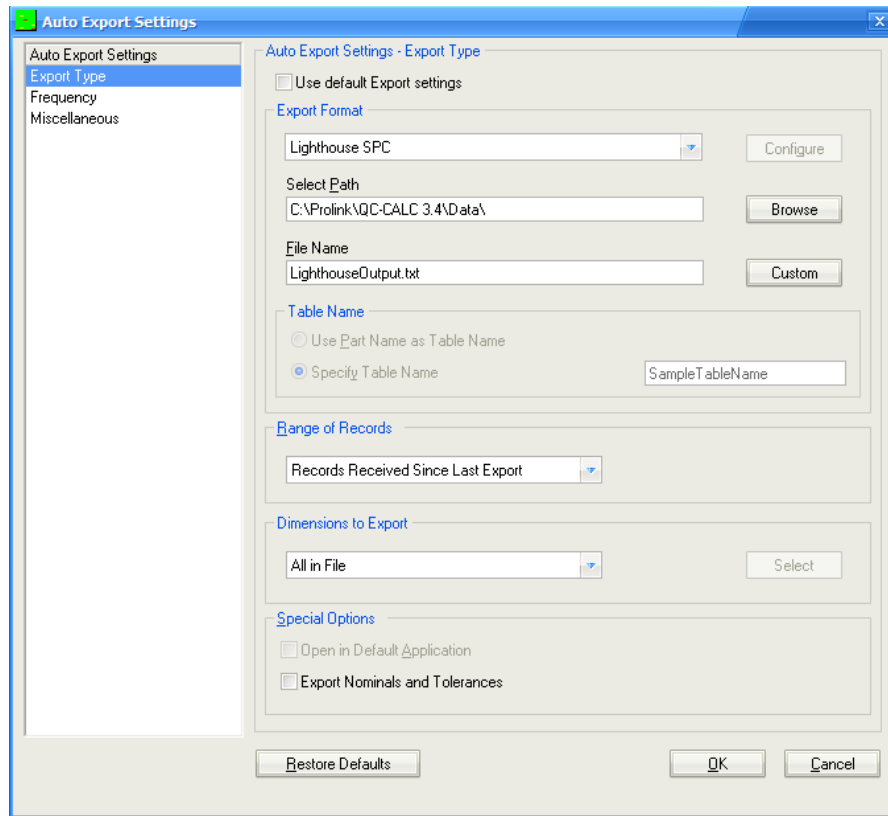
51.7 Lighthouse SPC

51.7.1 Introduction

QC-CALC allows the automatic exporting of data to many different formats including Lighthouse SPC. This creates an automatic seamless flow of data from the inspection machine, through QC-CALC, to the SPC statistics package. Setting up Automatic Data Collection and Exporting saves time and data entry errors with your statistics package. In addition, it provides visible real-time data and plots to the operator on the shop floor where parts can be corrected before problems get out of hand.

51.7.2 Export to Lighthouse SPC

1. Simply choose **Export – Export Data**.



2. In the **Export Type** list, choose **Lighthouse SPC**.
3. Choose the path and type the output file name where the output file will be placed by QC-CALC and click Open when finished. This should be the path Lighthouse SPC is currently checking for new import files. The file name should also be a file name Lighthouse SPC is expecting.

NOTE: Since locations and file names differ based on the implementation, please consult your Lighthouse SPC documentation for exact pickup location and file name.

NOTE: With QC-CALC, you will need to use a different export folder path than that of the data collection path. This will prevent the possibility of endless looping by QC-CALC as it continues to collect and export the same file.

4. Choose the **Range of Records** you want to export.
5. Click **Export**.

51.8 Minitab

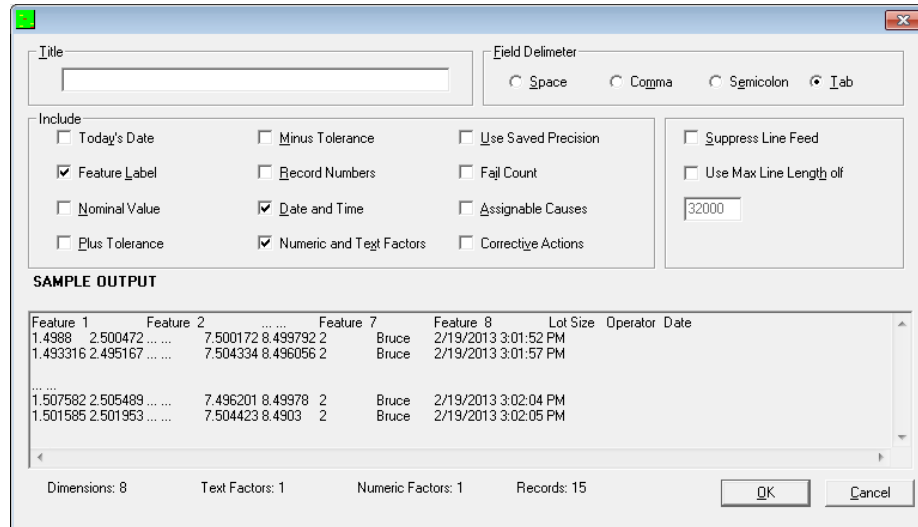
51.8.1 Introduction

The direct export to Minitab from QC-CALC is setup to be fully automatic. However, a **Configure** button is enabled in the export screen should you desire to send a different set of data directly into Minitab. Clicking this button brings you to the Export Setup screen.

51.8.2 Export Setup

By default, QC-CALC only sends the Feature labels, the data, the Factor values and the date & time. Should you want to send the Nominal & Tolerance information come to this screen and make your changes.

Triangle	Circle	Rectangle	Circle	Cavity	Date
132.1325	154.4522	121.0038	262.5875	1	10/12/2007 9:10:59 AM
132.1959	154.4422	121.0040	262.5861	2	10/12/2007 9:11:30 AM
132.1754	154.4424	121.0038	262.5871	3	10/12/2007 9:11:46 AM



51.8.3 Launching Minitab

If Minitab is installed in the same PC as QC-CALC Real-Time, Minitab is automatically launched and the exported data is inserted into Minitab automatically for you.

51.8.4 Using the SPC Office Buddy

The SPC Office Buddy is a Windows software program that provides a fast and easy method of moving CMM and gage inspection results directly into Minitab® Statistical Software. The Buddy displays your data as a grid of numbers that you filter by both rows (records) and columns (dimensions). After you reduce the raw data to the items you want to analyze, the Buddy can export the data to Minitab and/or directly run selected Minitab reports for you. This saves an enormous amount of typing since all nominal and tolerance data is automatically sent to the report. For more details on this useful, time saving tool, please visit our website at www.prolinksoftware.com. For more details see the [SPC Office Buddy](#) section on page [261](#).

51.9 Mitutoyo Measurlink

51.9.1 Introduction

This section will go through the steps necessary in QC-CALC and Measurlink to set up an automatic export of data in order to get your QC-CALC data into Measurlink.

NOTE: This section only concentrates on the normal measurement fields in QC-CALC and unfortunately does not include set up to import trace factor fields. This setup is complicated in Measurlink and it is recommended that you call Measurlink Tech Support in order to import the trace fields into your Measurlink database. Also, the formats were obtained from Measurlink technical support. Any and all questions with Measurlink should be directed to their support department.

51.9.2 Prerequisites

You must have Mitutoyo Measurlink Real-Time or Real-Time Plus installed and an accessible location on the Measurlink machine where files will be sent from QC-CALC.

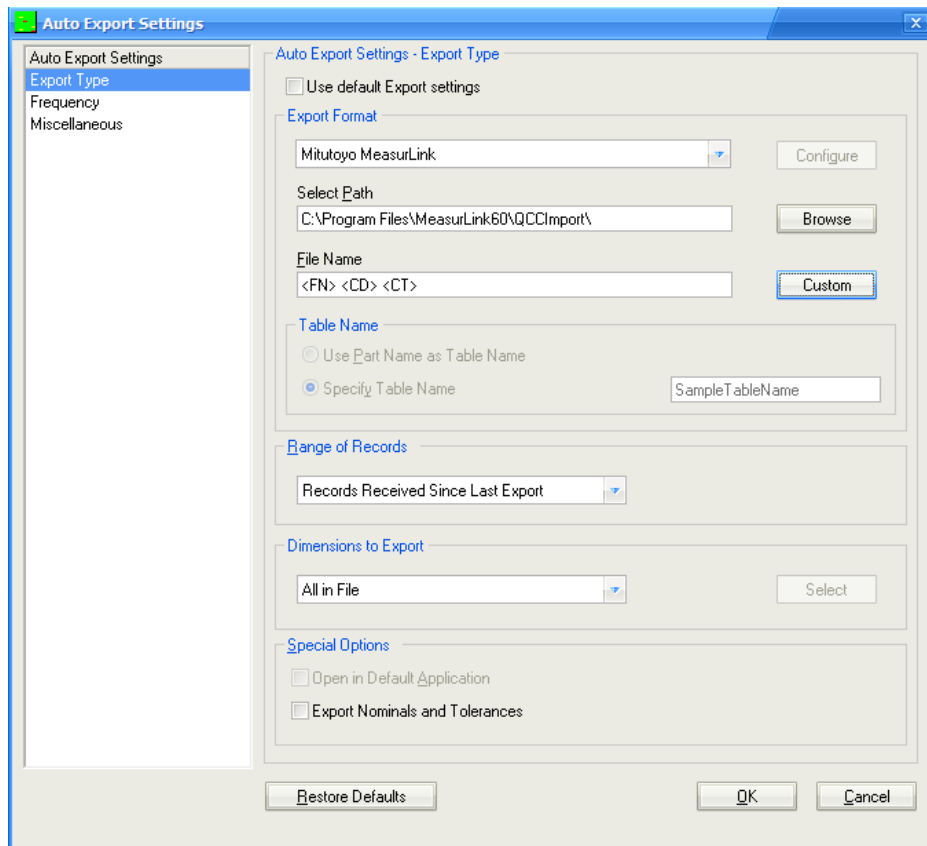
It is recommended that you create a path on the Measurlink machine under the installation directory for Measurlink Real Time. You can create any folder you want. For this example, we recommend creating the following folder:

c:\Program Files\Measurlink60\QCCImport

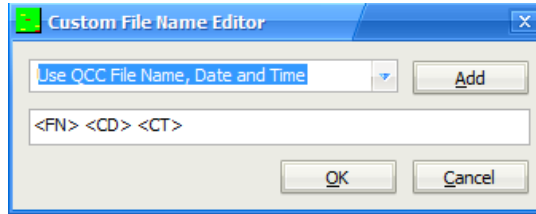
QC-CALC will drop off the exported data into this directory and Measurlink will pick up the data from this directory.

51.9.3 Steps in QC-CALC

1. Go to **Export – Setup Automatic Exporting**.



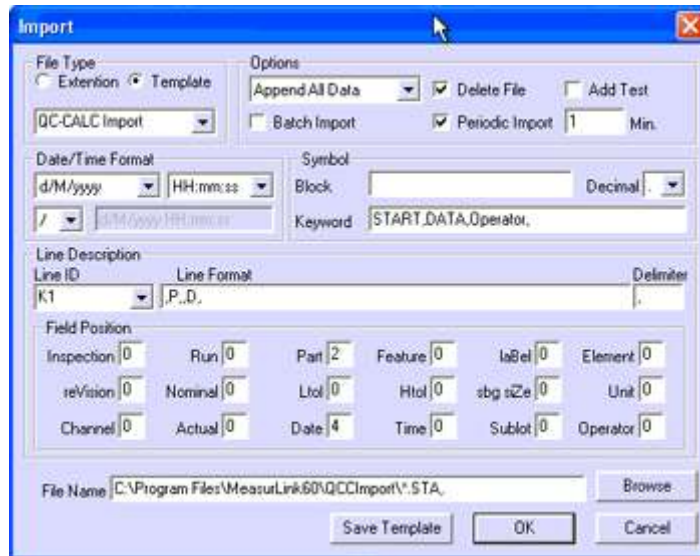
2. On this screen, choose **Mitutoyo Measurlink** from the **Export Type** list.
3. Choose the path to the Measurlink drop off directory. This should have been created above in the Prerequisites section.
4. Click the **Custom** button in the **File Name** area, delete any existing text in the box, choose **Use Part Name, Date, and Time**, and then click the **Add** button. Click **OK** and this will guarantee unique filenames so QC-CALC will not overwrite the file if it still exists in the drop off directory at the time of export.



5. Choose **Records Received Since Last Export** in the **Range of Records** section.
6. On the **Frequency** tab choose **Records Received** and enter 1 in the box below. You can choose any frequency you want. This is just an example.
7. Click **OK**.
8. Turn on Auto Exporting by choosing the **Export – Automatic Exporting** menu.

51.9.4 Steps In Mitutoyo Measurlink

1. In Measurlink, go to **Tools – Import**.



2. In the **File Type** area, choose **Template** and name the template “QC-CALC Import.”
3. For **Options** (just to the right), choose **Append All Data**. Make sure the **Delete File** and **Periodic Import** checkboxes are checked and enter 1 in the **Min.** box.
4. In the **Date/Time Format**, choose **dd/MM/yyyy** and make sure the “/” is chosen just below.
5. In the **Symbol – Keyword** field, enter “START, DATA, Operator,”.
6. In the **Line Description** area, follow these instructions very carefully or Measurlink will not do what you are intending:
 - a) In the **Delimiter** field, type a comma (,).
 - b) In the **Line ID** field, type “K1”.

- c) In the **Line Format** box, type “,P,,D,” and hit the **Enter** key. The **Enter** key is critical here as it tells Measurlink to save the line. If you do not hit it, it will NOT work.
 - d) In the **Line ID** field, type “K2”.
 - e) In the **Line Format** box, type “,F,A,N,H,L” and hit the **Enter** key.
 - f) In the **Line ID** field, type “K3”.
 - g) In the **Line Format** box, type “K,,,,,X(3)” and hit the **Enter** key.
7. In the **File Name** box at the bottom type: “c:\Program Files\Measurlink60\QCCImport*.sta,”. If you have created an alternate path, use that path instead.
 8. Click **Save Template**.
 9. Click **OK**.

Once you have completed the above steps, QC-CALC will begin dropping off the data every x parts. Measurlink should then automatically import the data into the Measurlink database once every minute.

MORE INFORMATION

If you have questions about the Measurlink software, please contact their technical support department at 630-723-3585. More information can be found at www.measurlink.com.

51.10 Net-Inspect Web Export

51.10.1 Introduction

QC-CALC has the ability to export directly to Net-Inspect's website without any need for you to upload files. It seamlessly connects to their website via a web service and uploads the data you specify using your user credentials. If the part file doesn't exist on the NI website at the time of export, it will be automatically created on their side.

The steps below are for the manual export, but the automatic export works identically (other than setting the frequency of the export). Many of our customers actually set it to upload each part as it is received from the CMM allowing you use QC-CALC as an intermediary between the CMM and Net-Inspect.

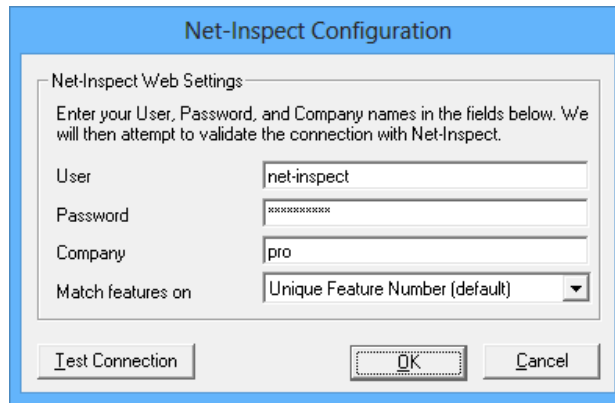
51.10.2 Steps

1. In QC-CALC Real-Time, select **Export – Export Data**.
2. From the **Manual Export Settings** screen, choose **Net-Inspect Web Export** as the export type.

IMPORTANT: Do not choose the regular Net-Inspect export type as this only creates a file. This is an older export type and is being left in there for backwards compatibility.

The screenshot shows the 'Manual Export Settings' dialog box. The 'Export Format' is set to 'Net-Inspect Web Export'. The 'Select Path' is 'C:\Prolink\QC-CALC 3.4\Data\' and the 'File Name' is 'NI.xml'. The 'Table Name' section has 'Use Part Name as Table Name' selected. The 'Range of Records' is 'Records Received Since Last Export'. The 'Dimensions to Export' is 'All Displayed'. The 'Special Options' section has 'Open in Default Application' and 'Export Nominals and Tolerances' unchecked. The 'Export' button is highlighted.

3. QC-CALC will ask for an export path. Choose any path where you have read/write access. The actual path is not important because the file is only created temporarily and is deleted once the upload to Net-Inspect is completed.
4. Click the **Configure** button.

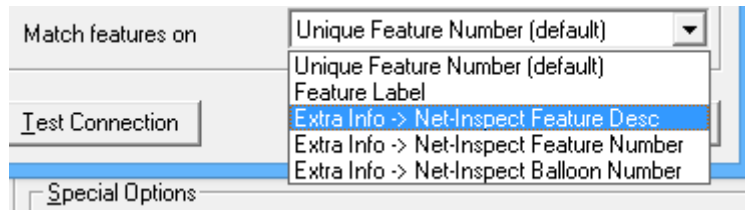


5. On the **Net-Inspect Configuration** screen, type the same user, password, and company credentials that you typically use to log in.
6. At the bottom of the screen, choose the field on which to match your dimensions. If you are unsure of this field, leave it set to **Unique Feature Number**. (see below for details)
7. Click **OK**. (You should receive a message indicating that the user credentials have been validated.)
8. Choose the number of records and dimensions to export and click **Export**.
9. Your export should occur and the file will be uploaded. Data should be viewable on Net-Inspect's website immediately.

51.10.3 More Information

On the configuration screen, the match features field allows you to match the features you're uploading to those of an existing file already in Net-Inspect. For instance, some customers balloon their print in a product such as Discus and upload this balloon information to Net-Inspect. They then want to make sure that the measured feature data actually matches up to the correct fields from Discus given that CMMs are typically not programmed to measure in the same order as the balloon numbers.

To do this, use the **Extra Info** (Dimension Info) field in QC-CALC to set unique identifiers that can be matched in Net-Inspect. You can match them to feature description, feature number or balloon number in Net-Inspect. The setting of the extra info field is done via **File – Edit Nominals and Tolerances** in QC-CALC Real-Time. The Dimension Info (synonymous with Extra Info) field is a free form text field that is saved at the dimension level (meaning you only have to set it once per dimension and not for each part like factors). In the Extra Info field, type the identifier for each feature where you want to match it to a corresponding feature in NI. For instance, let's say you want to match it to balloon numbers in Net-Inspect. In **File – Edit Nominals and Tolerances**, choose the dimension on the left side and type the balloon number into the Dimension Info field on the right side. Continue doing this for all your balloon numbers by selecting the appropriate dimension and typing each balloon number into the Dimension Info field. Click **OK** when finished to save your results.



When ready to export to Net-Inspect, choose **Match Features on – Extra Info -> Net-Inspect Balloon Number**. When the file is sent to Net-Inspect, it will contain all the information as well as a command to NI to match the dimensions by balloon. NI will automatically place the data in the right spot.

51.11 ODBC – Open Database Connectivity

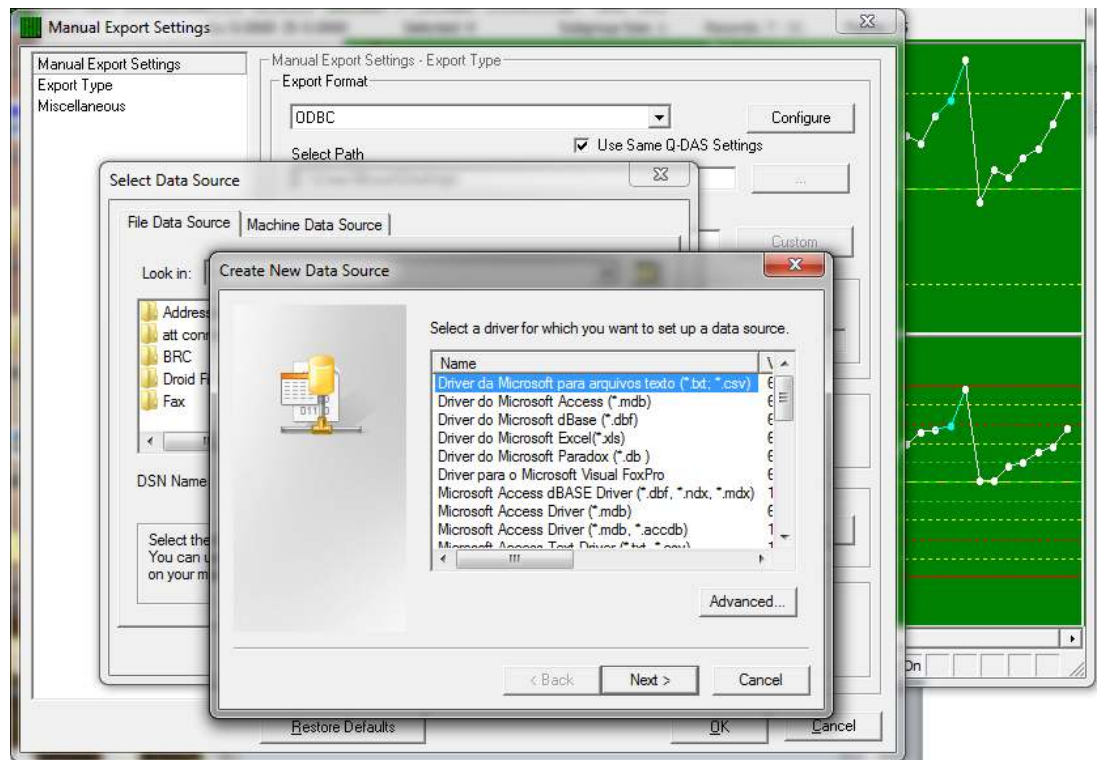
51.11.1 Introduction

When you export data and choose an **Export Type** of **ODBC** the **Configure** button is enabled. Clicking the **Configure** button brings you here.

The ODBC interface permits maximum flexibility in accessing Database systems. You can add modules called “database drivers” that link QC-CALC to your choice of database management systems.

51.11.2 Creating and Naming a Data Source

After selecting ODBC as your Export Type you will be prompted to create or select a Data Source. Also, clicking the **Configure** button later will allow you to edit or change your Data Source. Click the **New** button and you will be shown a list of the available database drivers that you can select.



After clicking **Next** you will name your new **Data Source**, click **Next**, and then click **Finish**. From this point on, the screen(s) that you see and the information that you are prompted for will depend on which database driver you have chosen. Once the Data Source is saved you will be able to use it to export all of your data.

51.11.3 Have your IT Professional Set These

1. Permissions
2. Users
3. Server-Side Requirements before Exporting

51.11.4 Server-Side Requirements

Before exporting using the ODBC interface, you must setup 2 tables following exact specifications. The Field Names and Data types must match EXACTLY.

51.11.5 Create Tables

The SQL Scripts necessary to generate these tables are listed here should you desire to cut and paste them into your system.

51.11.6 Data Table

To create a table in your database with a table of QC-CALC use:

```
if exists (select * from dbo.sysobjects where id =
object_id(N'[dbo].[QC_CALC]') and OBJECTPROPERTY(id, N'IsUserTable') = 1)
drop table [dbo].[QC_CALC]
GO
```

```
CREATE TABLE [dbo].[QC_CALC] (
    [ID] [int] IDENTITY (1, 1) NOT NULL ,
    [data] [real] NOT NULL ,
    [DimNumber] [smallint] NOT NULL ,
    [RecordNumber] [int] NOT NULL ,
    [PartName] [varchar] (256) NOT NULL ,
    [ExportDate] [datetime] NOT NULL ,
    [PartDate] [datetime] NOT NULL ,
    [NFactor1] [real] NULL ,
    [NFactor2] [real] NULL ,
    [NFactor3] [real] NULL ,
    [NFactor4] [real] NULL ,
    [NFactor5] [real] NULL ,
    [NFactor6] [real] NULL ,
    [NFactor7] [real] NULL ,
    [NFactor8] [real] NULL ,
    [NFactor9] [real] NULL ,
    [NFactor10] [real] NULL ,
    [NFactor11] [real] NULL ,
    [NFactor12] [real] NULL ,
    [NFactor13] [real] NULL ,
    [NFactor14] [real] NULL ,
    [NFactor15] [real] NULL ,
    [TFactor1] [varchar] (50) NULL ,
    [TFactor2] [varchar] (50) NULL ,
    [TFactor3] [varchar] (50) NULL ,
    [TFactor4] [varchar] (50) NULL ,
    [TFactor5] [varchar] (50) NULL ,
    [TFactor6] [varchar] (50) NULL ,
    [TFactor7] [varchar] (50) NULL ,
    [TFactor8] [varchar] (50) NULL ,
    [TFactor9] [varchar] (50) NULL ,
    [TFactor10] [varchar] (50) NULL ,
    [TFactor11] [varchar] (50) NULL ,
    [TFactor12] [varchar] (50) NULL ,
    [TFactor13] [varchar] (50) NULL ,
    [TFactor14] [varchar] (50) NULL ,
    [TFactor15] [varchar] (50) NULL ,
    [Cause1] [varchar] (16) NULL ,
    [Cause2] [varchar] (16) NULL ,
    [Cause3] [varchar] (16) NULL ,
    [Action1] [varchar] (16) NULL ,
    [Action2] [varchar] (16) NULL ,
    [Action3] [varchar] (16) NULL ,
    [Fails] [smallint] NOT NULL
) ON [PRIMARY]
GO

ALTER TABLE [dbo].[QC_CALC] WITH NOCHECK ADD
    CONSTRAINT [PK_QC_CALC] PRIMARY KEY CLUSTERED
    (
        [ID]
    ) ON [PRIMARY]
GO
CREATE INDEX [DimNumber] ON [dbo].[QC_CALC]([DimNumber]) ON [PRIMARY]
GO
CREATE INDEX [RecordNumber] ON [dbo].[QC_CALC]([RecordNumber]) ON
[PRIMARY]
GO
CREATE INDEX [PartName] ON [dbo].[QC_CALC]([PartName]) ON [PRIMARY]
GO
```

```
CREATE INDEX [Date] ON [dbo].[QC_CALC]([PartDate]) ON [PRIMARY]
GO
```

51.11.7 Nominal Table (Meta)

To create the nominal table in your database called **QC-CALC_META** use:

```
if exists (select * from dbo.sysobjects where id =
object_id(N'[dbo].[QC_CALC_META]') and OBJECTPROPERTY(id, N'IsUserTable')
= 1)
drop table [dbo].[QC_CALC_META]
GO

CREATE TABLE [dbo].[QC_CALC_META] (
    [PartName] [varchar] (256) NOT NULL ,
    [DimNumber] [smallint] NOT NULL ,
    [DimName] [varchar] (50) NOT NULL ,
    [Nominal] [real] NULL ,
    [TolerancePlus] [real] NULL ,
    [ToleranceMinus] [real] NULL ,
    [Type] [varchar] (10) NOT NULL
) ON [PRIMARY]
GO

ALTER TABLE [dbo].[QC_CALC_META] WITH NOCHECK ADD
    CONSTRAINT [PK_QC_CALC_META] PRIMARY KEY CLUSTERED
    (
        [PartName],
        [DimNumber],
        [Type]
    ) ON [PRIMARY]
GO
```

51.12 OleDB Export

51.12.1 Introduction

OleDB (Object Linking and Embedding, Database, sometimes written as OLEDB or OLE-DB) is an API designed by Microsoft for accessing different types of data stores in a uniform manner. It is a set of interfaces implemented using the Component Object Model (COM); it is otherwise unrelated to OLE. It was designed as a higher-level replacement for, and successor to, ODBC, extending its feature set to support a wider variety of non-relational databases, such as object databases and spreadsheets that do not necessarily implement SQL.

OleDB separates the data store from the application that needs access to it through a set of abstractions that include the datasource, session, command and rowsets. This was done because different applications need access to different types and sources of data and do not necessarily want to know how to access functionality with technology-specific methods. OleDB is conceptually divided into consumers and providers. The consumers are the applications that need access to the data and the provider is the software component that implements the interface and therefore provides the data to the consumer.

51.12.2 OleDB Export Configuration

When you export data and choose an **Export Type** of **OleDB** the **Configure** button is enabled. Clicking the **Configure** button may display a screen similar to:



You must click **Yes** before QC-CALC can safely and intelligently export its data in the correct format to the correct database tables. Clicking **Yes** brings you to the connection string screen. Here you enter the entire connection string need to establish conductivity to your database.



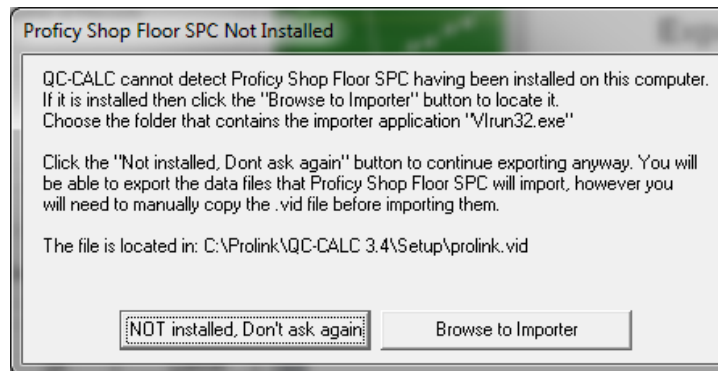
51.13 Proficy Shop Floor (Visual SPC)

51.13.1 Introduction

QC-CALC can export inspection results from its database to GE Fanuc Proficy Shop Floor (Visual SPC) in specially formatted files. The raw inspection results are saved in files with nominal & tolerance information and extra trace data (non-measurement data). The contents of QC-CALC's output file are defined by a special VID file shipped with QC-CALC. This VID file is used with Proficy's importer program. You must use the importer with the **Prolink.VID** file detailed in this section of the manual.

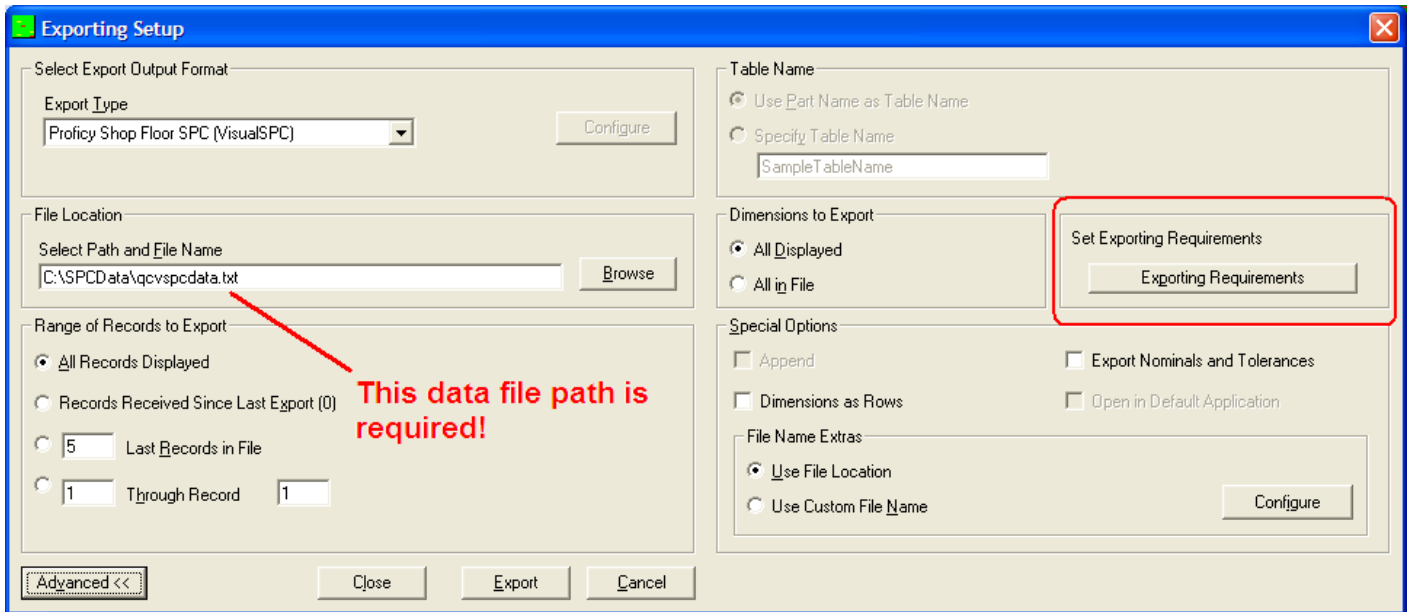
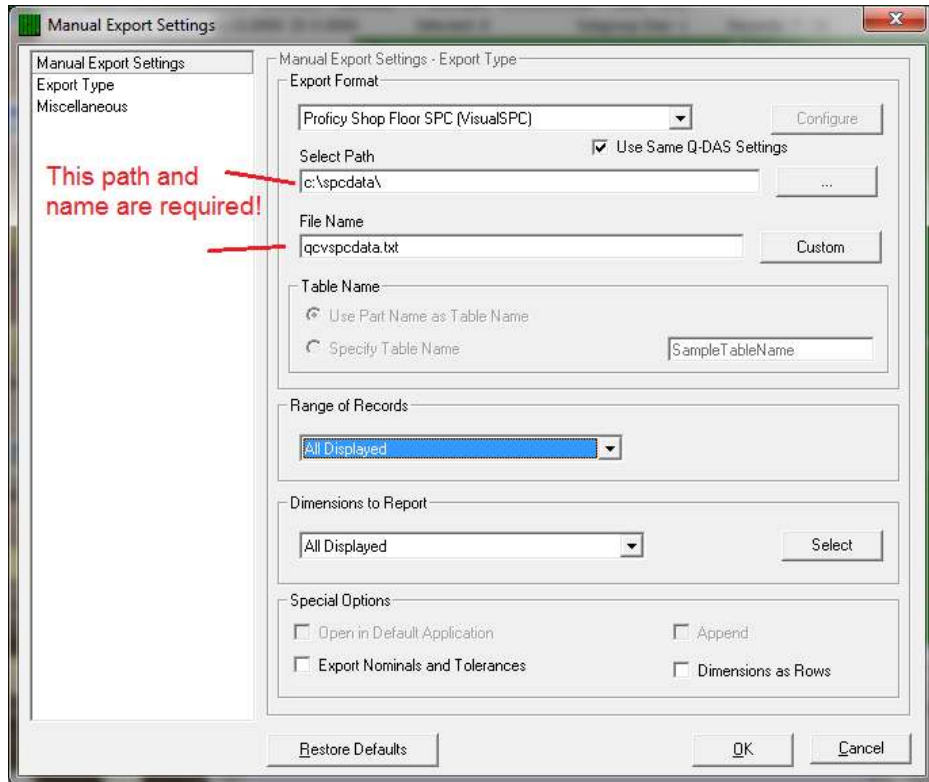
51.13.2 Export Option

When you choose an **Export Type** of **Proficy**, you may be asked to locate the installation of the Proficy software. If you see this screen it means QC-CALC did not find Proficy installed in this PC in the default location. The window below clearly says what to do so follow the directions. If you want QC-CALC to export the data to this drive or a public network drive so another PC can read the data, simply choose **NOT Installed, Don't Ask Again**. The only thing needed for another computer to read this data will be for you to manually move the VID file as the message states. If Proficy is installed in a different location then simply browse to the Importer to tell QC-CALC where.



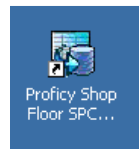
51.13.3 The QC-CALC Shortcut

The **Advanced** button found in QC-CALC's Export screen has a special button to help you setup Proficy. Click this button and a Windows Shortcut is written to your desktop. This shortcut will start the Proficy Importer and pass special information to the importer.



You should see a new icon on your desktop that looks like the one shown to the right. This shortcut has a target of:

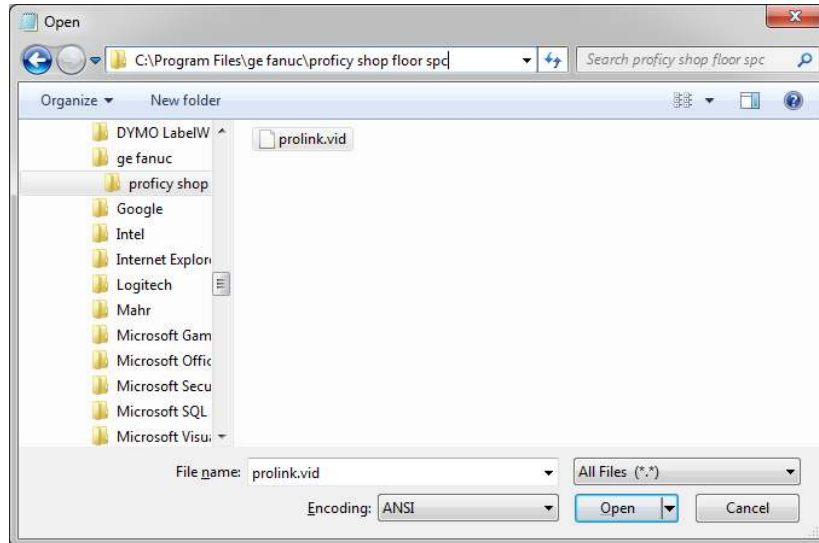
C:\Program Files\GE Fanuc\Proficy Shop Floor SPC\virun32.exe



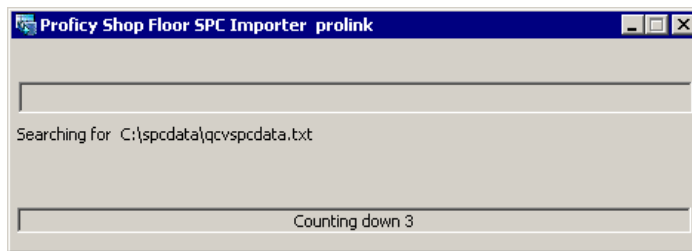
This is the default location of Proficy. If it is installed in another location, you should click the “Browse to Importer” button on the earlier message. This will point the shortcut to the correct location. Otherwise you will need to change the shortcut’s target path manually.

QC-CALC adds **C:\Program Files\ge fanuc\proficy shop floor spc\prolink.vid** to this target which is the location of the VID file used to import the data. When you double click the icon the importer is started and the **Prolink.VID** file is used to describe the QC-CALC file contents to the importer.

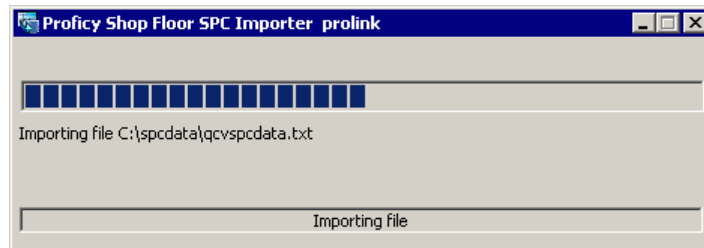
If no data file is found, the Importer waits for the data by presenting a Count Down number in seconds as shown in the picture below.



Proficy Shop Floor will wait for QC-CALC to export the file.

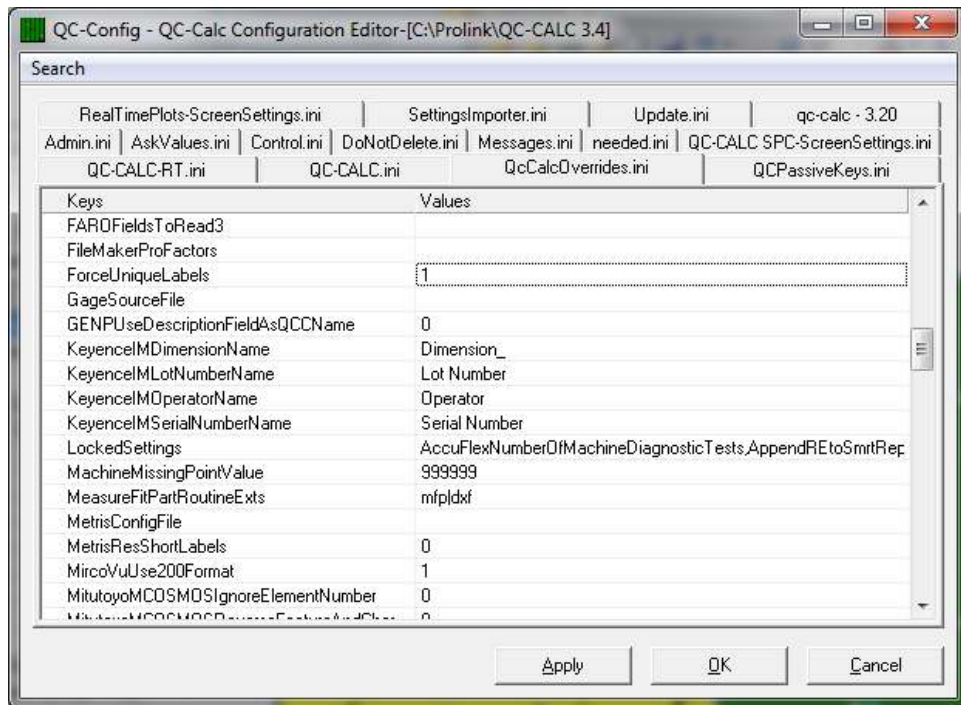


Once QC-CALC has exported the Proficy text file, the automatic import begins. A progress bar shows the activity of importing the QC-CALC data file. Once it finishes, all QC-CALC data can be found in the Proficy database.



51.13.4 Unique labels

Databases in the Proficy software require unique feature labels. This is not true of QC-CALC. To force QC-CALC to make its feature labels unique when collecting data, you can apply a setting called **Force Unique Dimension Labels**. This setting is accessed in the QC-CALC Configuration Editor, shown below.



Double-click on the setting and a box appears allowing you to input your new setting. Enter a 1 to force unique labels.

51.14 Q-DAS Format ASCII Output

51.14.1 Introduction

QC-CALC can export inspection results from its database to Q-DAS formatted files. The raw inspection results are saved in .DFX files while the nominals & tolerances and extra trace data (non-measurement data) are stored in .DFD files. These two files make up the Q-DAS inspection results file that is read into the qs-STAT program. This section of the manual discusses the method of exporting QC-CALC data in Q-DAS format.

51.14.2 Q-DAS K-Field Definitions

The K-Field numbers vary from K0000 to K9999. Many are not needed but QC-CALC allows you to enter whatever value you need. Per the Q-DAS definitions, the K-Field information is falls into the following groups:

K0000 K0999 description of value formats
 K1000 K1999 parts data
 K2000 K2999 characteristics data
 K3000 K3999 test plan data
 K4000 K4999 administrative data
 K6000 K7999 reserved
 K8000 K8999 QCC
 K9000 K9999 other data
 K10000 K32000 reserved

51.14.3 DFX File Contents

The **Value File (DFX)** contains the raw inspection results for each individual part. K-Field numbers from K0001 – K0999 are also written to the .DFX file (individual parts) and therefore they are written after every separate data record.

This file may contain one or more records (parts) and each record is an entire part. If QC-CALC exports 3 parts of 5 features, you will find 3 records in the file with 5 dimensions within each record. After the raw inspection results for each part the extra K-Fields follow. Remember, any low numbered K-Fields (K0001-K0999) are added to this file. This allows you to tag each part by operator, etc.

Example DFX File

```
1.000467001.07.2004/11:23:50#2.001697001.07.2004/11:23:50#2.9978057001.07.2004/11:
23:50#4.0000957001.07.2004/11:23:50#4.9974377001.07.2004/11:23:50#
K0008 12345
K0006 LargeBatch

1.0001327001.07.2004/11:23:50#1.9985787001.07.2004/11:23:50#2.9975037001.07.2004/1
1:23:50#3.9957467001.07.2004/11:23:50#4.9971357001.07.2004/11:23:50#
K0008 11112
K0006 Batch 22

1.0003227001.07.2004/11:23:50#1.9985657001.07.2004/11:23:50#2.9988767001.07.2004/1
1:23:50#4.0012977001.07.2004/11:23:50#5.0003967001.07.2004/11:23:50#
K0008 12345
K0006 Batch 23
```


51.14.4 DFD File Contents

The **Description File (DFD)** includes values that are in common with all parts and the features. These include nominals, tolerances, part number, sample size, etc. K-Field numbers greater than K0999 are all written to the .DFD file (across all parts in the file). e.g.

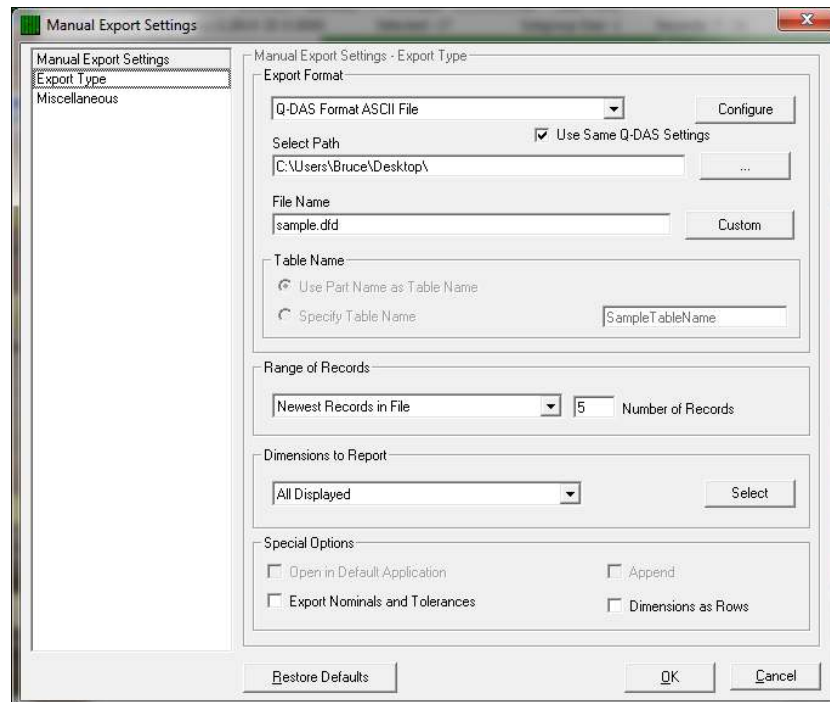
```
K0100 20
K1001 Sample
K1002 Sample
K2404/0 0.1
K2060/0 0
K2002/1 X Hole Position
K2022/1 4
K2101/1 1
K2110/1 0.999
K2111/1 1.001
K2112/1 -0.001
K2113/1 0.001
...
```

51.14.5 The Catalog File

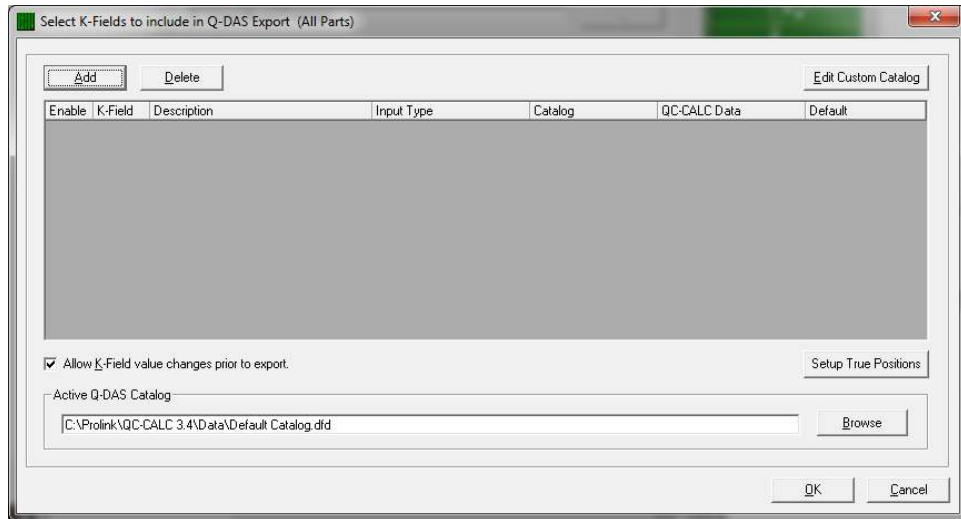
The Catalog File is generated by the Q-DAS software and is used to standardize certain K-Fields values. It has many of the properties of a relational database, and allows you to see and use text, while an index value is stored by the software behind the scenes. It allows you to pick a value out of a list which avoids errors and limits choices to only valid values.

51.14.6 The Export Screen for Q-DAS

From QC-CALC Real-Time, choose **Export – Export Data** and the following screen is displayed. Choosing an **Export Format** of **Q-DAS Format ASCII File** enables the **Configure** button, which is only enabled for certain export types.



Clicking the **Configure** button displays the following screen where you setup the details of the Q-DAS output.

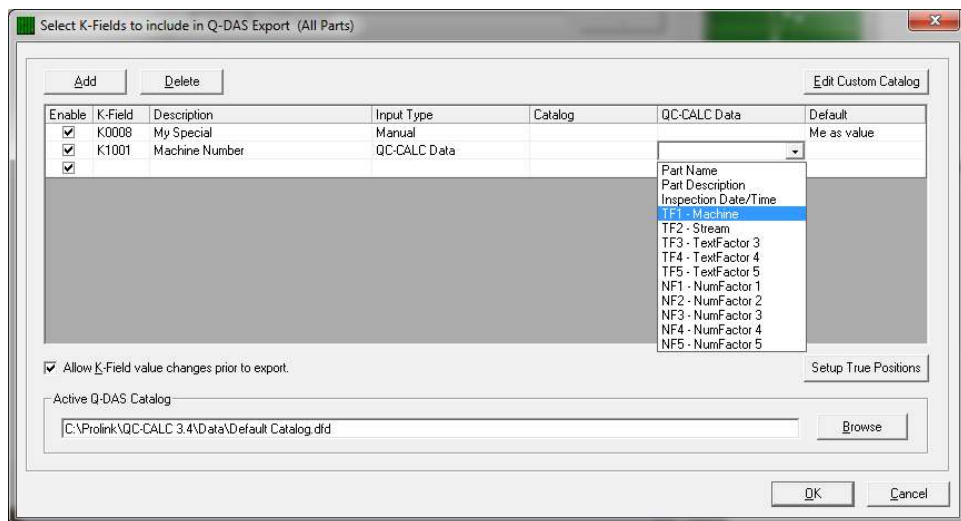


51.14.7 Q-DAS K-Field Setup Screen

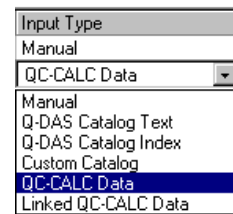
Once you press the **Configure** button on the Exporting screen, the setup screen is displayed where you add the data you want QC-CALC to send to your Q-DAS files. You can add as many additional K-Fields as needed. You can enter a default value for each K-Field which is used if no other value overwrites it. Using default values improves the speed and accuracy when the value does not change.

How to Add a New K-Field

Click the **Add** button to insert a new row and enter a valid Kxxxx number in the first column. Add a description in the second column to remind you of the item.



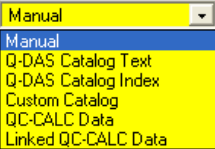
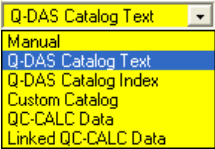
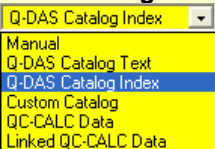
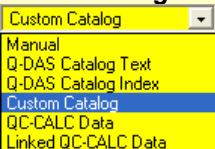
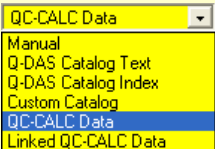
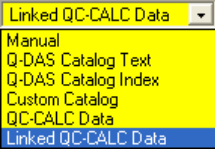
Next, select the source of the data by choosing the **Input Type** from the list as shown. There are 6 **Input Types** and each type requires additional information in the columns that follow. The next section describes what you must enter to complete each Input type. The **Delete** button is used to remove the row you are editing.



One thing to note is the location the values are exported to depends on which file the specified K-Field number is mapped to. If the K-Field number is to be written to the .DFX file, each record contains an individual value. If the K-Field number is

to be written to the .DFD file, the value from the final record exported is written to the Q-DAS file.

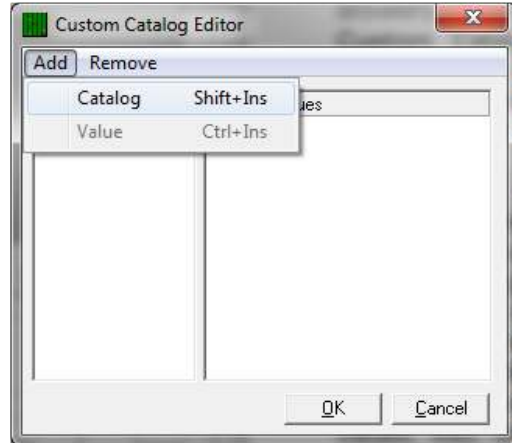
Completing the Row

Input Type	Description
<p>Manual</p> 	<p>This is the simplest Kxxxx to enter. You simply type the Kxxxx number, choose Manual in the Input Type column, and enter a value in the Default column. A Default value is optional for ALL Input Types but if you do not enter a default value in this Input Type, nothing will be exported for this K-Field.</p>
<p>Q-DAS Catalog Text</p> 	<p>Enter the Kxxxx number to assign a value and then select the value from your Q-DAS catalog. When you choose Q-DAS Catalog Text, a list becomes available in the Catalog column. Select the catalog and then choose the value from that catalog in the Default column. The text you see in the Default column is sent to your Q-DAS file for that K-Field.</p>
<p>Q-DAS Catalog Index</p> 	<p>When you choose Q-DAS Catalog Index, a list becomes available in the Catalog column showing all of the catalogs in your Default Catalog.dfd file. Choose one of your Catalogs and a list of all of the values of that catalog appears in the Default column. After you make your choice from the list in the Default column, QC-CALC looks up the index of that value from your Catalog File and this index number is sent to your Q-DAS file at export time.</p>
<p>Custom Catalog</p> 	<p>Enter a Kxxxx number and select Custom Catalog from the Input Type column. A list becomes available in the Catalog column showing the catalogs you created using the Edit Custom Catalogs button. Choose one of your Custom Catalogs and a list of values appears in the Default column. The text that you see in the Default column is sent to your Q-DAS file.</p>
<p>QC-CALC Data</p> 	<p>When you choose QC-CALC Data for your Input Type a list of available QC-CALC choices becomes available to select and assign to this K-Field. Currently, the QC-CALC choices are the Part Name, Part Description, Inspection Date/Time, and any Factors in the database.</p>
<p>Linked QC-CALC Data</p> 	<p>The Linked QC-CALC Data Input Type is very similar to QC-CALC Data but you must choose a Q-DAS Catalog. The text that is extracted from the QC-CALC database is used as a look-up in the Q-DAS Catalog. The index value associated with the text is sent to the Q-DAS file instead of the text. e.g. if the Employee catalog is selected and John is the name found in QC-CALC database, the index number in found the catalog for the entry "John" is sent to the Q-DAS, not the text "John."</p>

Custom Catalog Editor

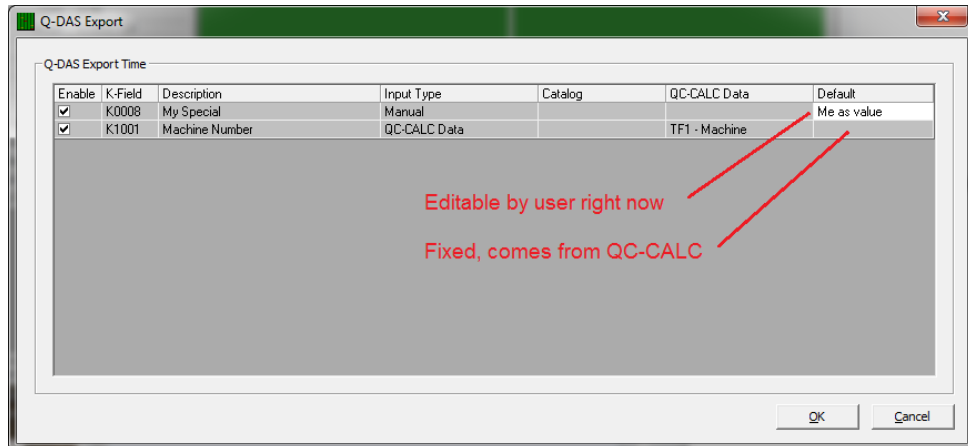
The purpose of the Custom Catalog is to provide your own list of standard answers to be sent to the Q-DAS file with its associated K-Field. Click the **Edit Custom Catalog** button to display the screen below and create your own catalogs. This way you can choose your own output value from a list rather than typing it manually. These catalogs act the same as the Q-DAS catalogs and are used the same way.

To add new catalogs with their associated values, click the **Add – Catalog** menu. Change the name of the Catalog by double clicking on the name in the left-hand box and edit the name of a value for this catalog. Next, click the **Add – Value** menu several times to add values into this catalog. Do the same for all values in the right-hand side of each catalog. Add as many Catalogs and Values as you like.



Allow K-Field Value Changes Prior To Export.

The **Allow K-Field Value Changes Prior To Export** checkbox on the Selection screen is used to display the K-Field values just before QC-CALC exports the data to your Q-DAS file. Some of the values are editable and some are not. The only Input Types that are not **editable** are **QC-CALC Data** and **Linked QC-CALC Data**. This is because the values are taken from the database and it is assumed these values are correct. However, it does make sense to allow a last minute edit in some cases. Editable values are shown with a white background instead of gray. Once you are satisfied with your values, click the **OK** button and the export occurs along with your changed default values.



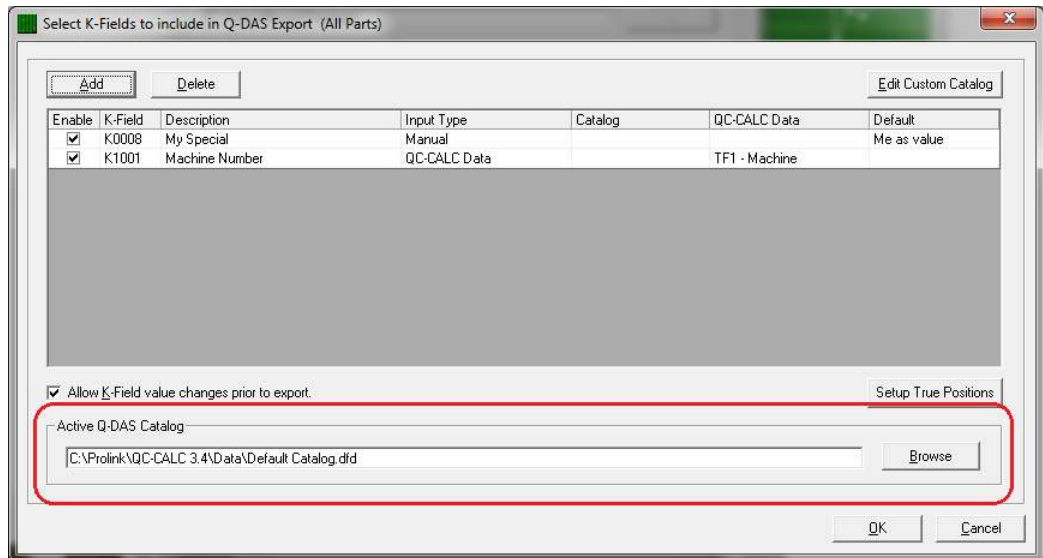
Set Automatic Export Defaults

This checkable menu checkbox is used to save all of your choices to one common place to be used across all QC-CALC databases. If you have consistent part programs that use the same factor values for the same items, this is the fastest method to use. You setup all of your K-Fields once and all new databases are setup the same.

If you want each QC-CALC database to have different Q-DAS export settings, uncheck this menu. Remember to Configure each database before exporting data in the Q-DAS format to ensure you have complete data sets.

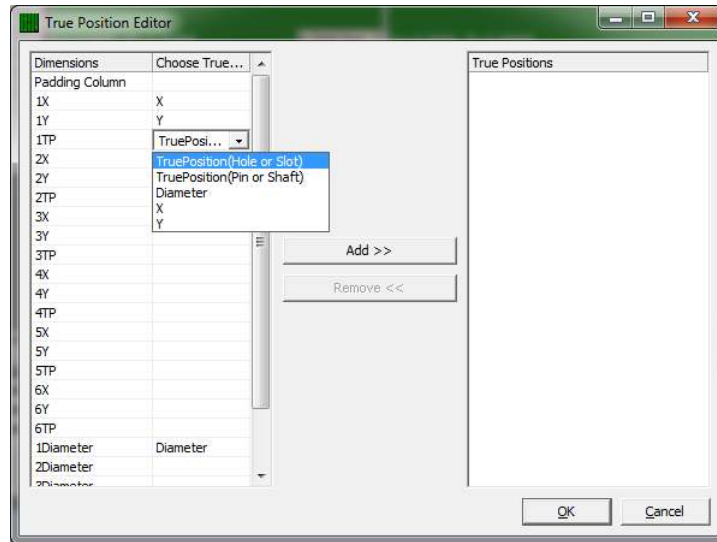
Active Q-DAS Catalog

QC-CALC is shipped with a sample catalog file called **Default Catalog.dfd**. This file has some sample entries but you should select and use your company's catalog to ensure each entry makes sense. Your Q-DAS coordinator will know where and how to obtain this file. When possible, you should use a shared network file so each copy of QC-CALC uses the exact same file. The **Browse** button allows you to select or change the location of the desired Catalog file. This includes using your network to share a common catalog across all QC-CALCs.

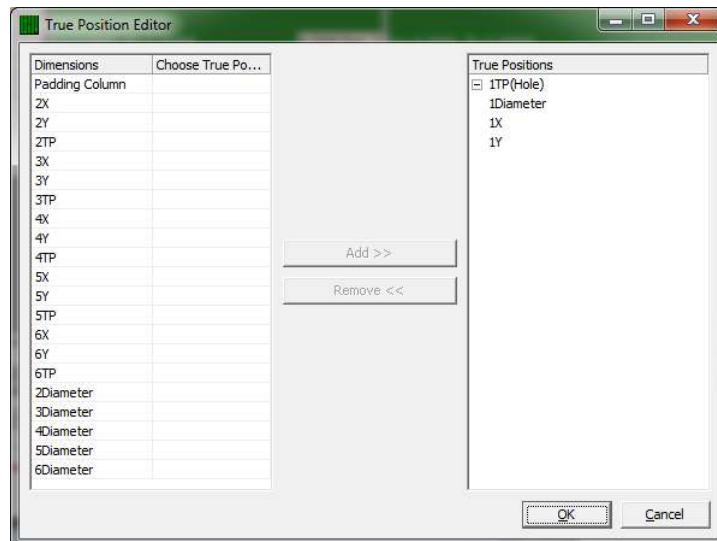


Tagging True Position Features

True position features exported to Q-DAS must be grouped and identified before the export occurs. Because many inspection machines do not indicate this relationship you must perform a one-time “join” by using QC-CALC’s built-in editor. You setup the true position relationships by pressing the **Setup True Position** button and the following screen appears.



On the left side of the screen click the dropdown list and select the X, Y, and True Position features that are related. When you finish associating TP, X, and Y as one group, click the **Add True Position** button and your selections are moved to the right column as a group. You can click on the right side list to remove a group which causes the three items to be moved back to the left list.



Your selections are remembered forever but can be changed by joining more features or removing existing ones.

51.15 SPC Office Buddy

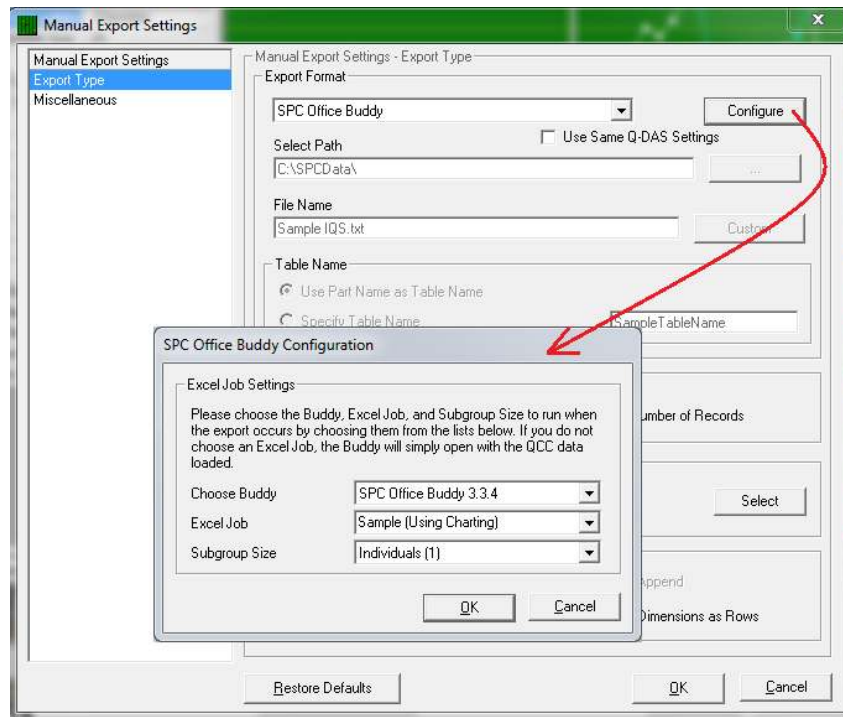
51.15.1 Introduction

SPC Office Buddy is an optional software package written and sold by Prolink and is available for download from our website. SPC Office Buddy (referred to as Buddy) is a Windows software program that provides a fast and easy method of moving CMM and gage inspection results directly into Minitab® and JMP® Statistical Software. In addition, data can be exported directly into Excel.

Normally, Buddy runs separately in your office PC using shared QC-CALC data found on your internal server. We added the ability to directly trigger an automatic export using Buddy. This section of the manual explains how to use QC-CALC Real-Time to generate Excel formatted reports when your inspection is complete.

51.15.2 Output the File

Select the **Export** menu, pick **SPC Office Buddy** as the Export Type and select the **Range of Records** to Export. See NOTE below.



51.15.3 Configure Button

Click the **Configure** button and a special window requests three items:

1. The version of Buddy to use.
2. The **Excel Job** to run.
3. The **Subgroup Size**.

Usually, you only have 1 Buddy installed so there is only 1 item listed.

The **Excel Job** must have been previously written using Buddy and then chosen here. The **Subgroup Size** may be used within the Excel Job.

NOTE: When you write the Excel Job you choose the records and dimensions to use. This limits the amount of data to send to the report. However, QC-CALC Real-Time has the same filters available during the export. So setup your filters in QC-CALC before performing the export and Buddy will use this limited data set just as if you selected it while running Buddy.

NOTE: SPC Office Buddy must be installed in the same computer running QC-CALC Real-Time.

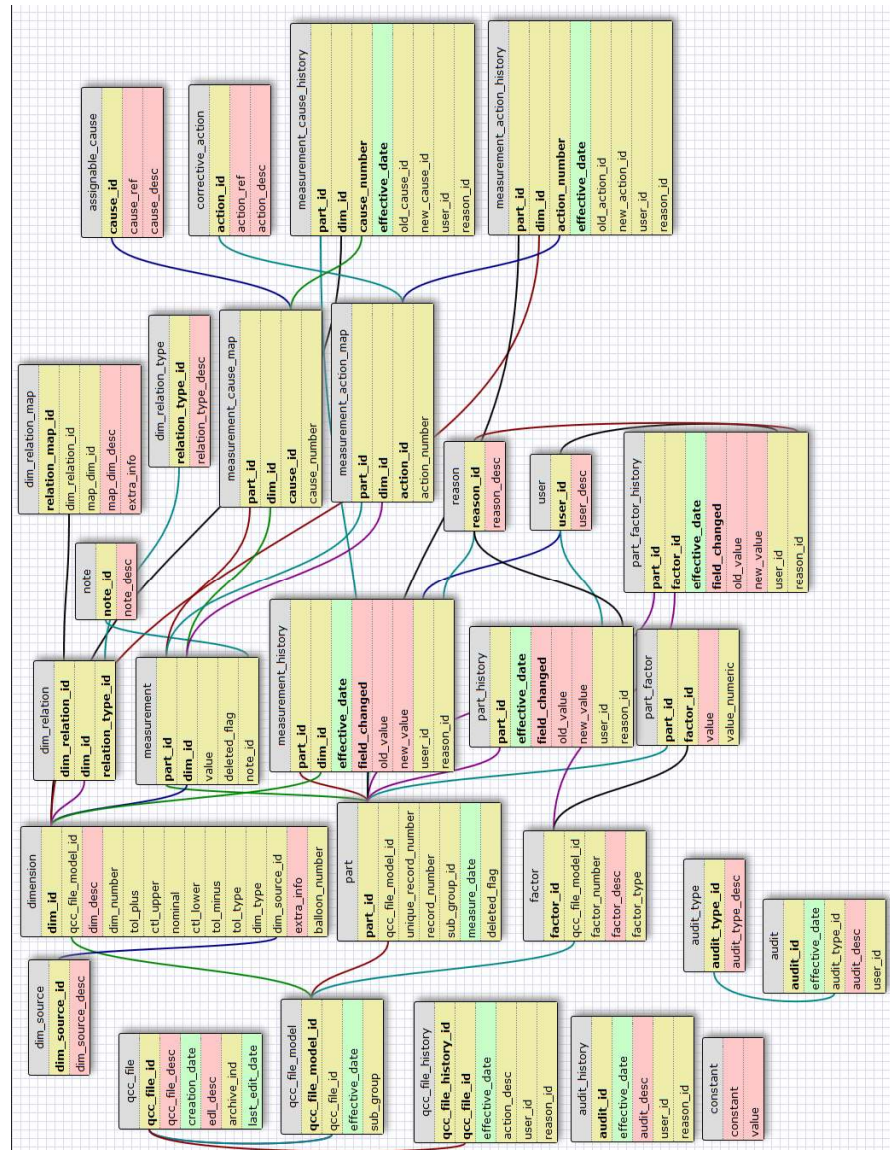
51.16 SQL Server Export

51.16.1 Introduction

The definition of QC-CALC's new advanced SQL output is found on our website. To read the definition click http://www.prolinksoftware.com/download.aspx?product_help_id=390 and look for a link labeled **SQL Server Advanced Export Setup Manual** that describes the design of the new normalized SQL Server database output format. Explore the pros and cons of this new format. The document includes information about the new structure, table definitions, sample SQL to query the data, and step-by-step instructions on setting up the SQL database for use. At the current time, this specification is only available on SQL Server and is not available for use on Oracle or other RDBMS's (Relational Database Management Systems). If you are interested in this output, please email us at support@prolinksoftware.com and formally request the new output.

51.16.2 New Database Design

The new database design is a normalized version of the current design and has many more tables. The diagram is as follows:



51.16.3 General Design Description

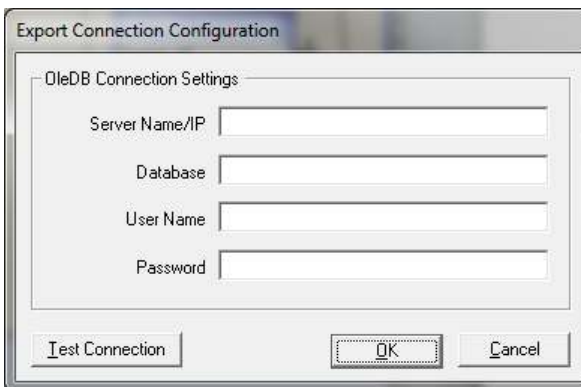
The new format involves several (currently 11 tables) and breaks both the actual and meta data into smaller chunks for easier storage and processing. Since QC-CALC is very flexible and allows the QCC database to seamlessly change over time, the database was designed to do the same.

Exact table definitions are on the website, but basically parts are stored in `part_type_groups` at their highest level. The `part_type_group` is synonymous with the QCC file and is meant to represent a particular type of part that is measured over time (i.e. a particular engine block). As things change with the part type (i.e. tolerances change or another feature is added), the definition of the part type is re-written to preserve the historical nature of the data.

This new definition is defined as a `part_type` and is stored by effective date. For instance, the engine block measured had 5 features as of 1/1/2007 and has 6 features as of 6/1/2007. These would be two different part types both grouped under the same engine block `part_type_group`. Each time anything about the part definition changes, a new part type is added within the part group, and the definitions for dimensions and factors are redefined. All measurements are then linked to the new dims and factors of the new part type.

51.16.4 Configure Export Connection

When you click the Configure button a window is displayed asking for server name, the database name, the User Name, and the Password. Have your IT professional answer these questions and test the connection.



These settings are stored in the local PC and used during export so this is a one-time setup.

51.16.5 IT Professional Notes

Setting up database and tables can be easily done by using the tools provide in the online documentation. Follow the instructions found in the section labeled **Setting Up The SQL Server Export**. The instructions tell you to download "**SQLServerAdvCreateDB.sql**" from our website which is found attached to the Knowledge Base article entitled "**SQL Server Advanced Setup Script**".

51.17 Stat Summary File

51.17.1 Introduction

When you export data and choose an **Export Type** of **Stat Summary** the **Configure** button is enabled. Clicking the **Configure** button brings you here.

QC-CALC can output a special Statistical Summary file that is written in a format easily read by other computer programs. This file is intended to be used in a process control environment. Since its inception QC-CALC has always been a program that monitors, display, and reports inspection results with no control outputs of any kind. If you have a process you wish to control using the results of statistical calculations, QC-CALC can output the calculations for you using this file format. You must write a program to read this file and use the calculations to adjust your machine's offsets, energize alarm lights, stop processes, etc. Note: exporting 1 record yields the actual value in the Mean, Min, Max columns.

51.17.2 Sample Output

Before describing the file details a quick glance shows the file output format. This format is fixed and is not adjustable. The partial listing below was modified for human readability and normally contains no <space> characters.

```

START: Stat Summary Report
NAME: C:\Prolink\QC-CALC 3.4\Data\Sample.qcc
DATE: 9/16/2005 11:53:28 AM , 38611.495462963
RECORD RANGE: 91 - 100
LABELS: Label, Mean, Min, Max, Range, Sigma,3 Sigma,Nominal,Up Ctr,
D0001: X Hole Position, 0.9999,0.9991,1.0005,0.0013,0.0005,0.0014,1.0000,...
D0002: Y Hole Position, 1.9999,1.9981,2.0017,0.0036,0.0012,0.0037,2.0000,...
D0003: Z Hole Position, 2.9993,2.9975,3.0011,0.0036,0.0014,0.0042,3.0000,...
D0004: Line Length, 3.9998,3.9957,4.0018,0.0061,0.0020,0.0059,4.0000,...
D0005: Snap Dia, 4.9990,4.9966,5.0029,0.0064,0.0021,0.0062,5.0000,...
D0006: Ring length, 6.0006,5.9945,6.0063,0.0118,0.0038,0.0113,6.0000,...
D0007: Shaft Dia, 7.0012,6.9954,7.0063,0.0108,0.0033,0.0099,7.0000,...
D0008: OD Fit, 8.0001,7.9943,8.0057,0.0114,0.0038,0.0114,8.0000,...
D0009: Chamfer Angle, 8.9991,8.9916,9.0053,0.0137,0.0043,0.0128,9.0000,...
END:

```

51.17.3 File Format

Introduction

Each record in the file starts with a keyword followed by a colon character. This was done to make it easy to parse and identify each record type. Since each export is appended to previous export files it is important that you delete this file after you read and use it. It may grow very large if left unchecked.

Start: & End:

These two records are added to frame one complete export from another and therefore identify the beginning and end of an event. For example, if you request QC-CALC to export a Stat File after every 10 parts inspected and use the most recent 10 parts in the calculations, you will write a block of records from START to END that represents the statistical calculations for just those parts. You might monitor the Average Shaft diameter (D0007 above) and use this calculation to adjust a cutter offset.

Name:

This record contains the full path and name of the active QC-CALC file generating this export summary (currently running part program). Remember, QC-CALC can be made to export the same details for all part programs and therefore this file might contain different part calculations if you are using your CMM or vision system for multiple parts. Use this name to identify the correct Stat Summary data.

Date:

The date record contains the date and time formatted in your PC's international settings. Because date formats can be difficult to parse and use, we include the Microsoft date and time format in a double precision number. This is a preferred date format because it is unambiguous, it always sorts correctly, and is independent of the international setting in Windows. Dates in the Microsoft format are displayed in the format specified in the Windows International setting. This allows users to see dates in the format they are accustomed to seeing. Simply stated, the Microsoft date format for any date & time is the number of days since Jan 1, 1900 + current time divided by the number of seconds in a day. The Microsoft date can be calculated for years after 1900 as follows:

$$\begin{aligned} \text{Integer} &= \text{Int}((\text{Year} - 1901) * 365.25) + 366 + \text{DayOfYear} \\ \text{Fraction} &= (\text{Seconds} + (60 * \text{Minutes}) + (3600 * \text{Hours})) / 86400 \\ \text{Date} &= \text{Integer} + \text{Fraction} \end{aligned}$$

Where DayOfYear for Jan 1 is 1 and Hours for 12:34 AM is 0

e.g. **01-25-1995 14:15:07**

$$\begin{aligned} \text{Integer} &= (1995-1901) * 365.25 + 366 + 25 \\ \text{Integer} &= 34724 \\ \text{Fraction} &= (7 + (60 * 15) + (3600 * 14)) / 86400 \\ \text{Fraction} &= 0.5938310185185 \\ \text{Date} &= 34724 + .59383 = 34724.59383 \end{aligned}$$

Record Range:

This is the actual QC-CALC record number range where the data was extracted to make these calculations.

Labels:

These labels help you identify the column of a particular calculation. The record is too long to see all labels in this document so you should parse on the labels seen here since the example above has been edited to make it man readable.

Label, Mean, Min, Max, Range, Sigma, 3 Sigma, Nominal, Upper Ctrl, Lower Ctrl, Tolerance+, Tolerance-, Cp, Cpk, Average, Cpk(Calc), Plus PE (Calc), Minus PE (Calc), Tolerance(Calc)+, Tolerance(Calc)-, Normal, Records

Most of these calculations are obvious but a few require some detail.

Upper & Lower Ctrl

This is the control limit value as displayed on the plots

Cpk (Calc)

The (CALC) means if you asked QC-CALC to calculate the Cpk based using the sigma multiplier set in the stats section this would be that value. This is the same for **Plus PE (Calc)**, **Minus PE (Calc)**, **Tolerance(Calc)+**, **Tolerance(Calc)-**. Note: Plus & Minus PE (Calc) are control limits.

Average and Mean

Are the same and were repeated by accident under a different name. Use either one.

Normal

Is set to a 1 or 0 indicating the data set is normal or not.

Records

Is the number of parts in the calculation

Data:

Each inspected dimension has a record beginning with the letter D followed by its dimension number as read from the inspection results file. The dimension label is next and the calculations that follow are indicated by the column heading.

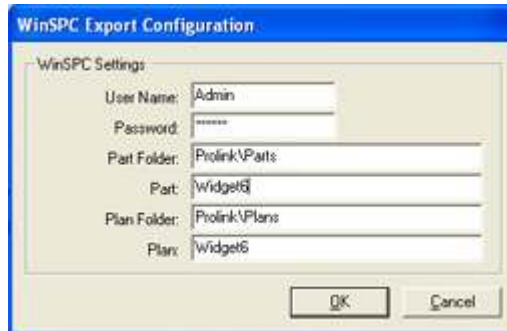
51.18 WinSPC

51.18.1 Introduction

The WinSPC export allows you to literally send your data directly into WinSPC without having to type anything or even set up the part. All you do is configure the export with the user account, password, and paths to the part and inspection plan. QC-CALC will export all the nominals, tolerances, actuals, tag information, etc.

51.18.2 Export to WinSPC

1. Simply choose **Export – Export Data**.
2. In the **Export Type** list, choose **WinSPC**.
3. Click the **Configure** button on the right side of the screen.



4. On the **WinSPC Export Configuration** screen, fill in the user account information and the paths to the part and inspection plan to which the data will be exported. See picture on below.
5. Click **OK** when completed.
6. Choose the **Range of Records** you want to export.
7. Click **Export**.

52. Administrative Tool & Part 11

52.1 Introduction

Historically, QC-CALC Real-Time has been used within an individual inspection machine as a single copy of software. Each person controlled and adjusted QC-CALC's operation individually. As networks became more prevalent, the inspection devices were connected to the network making data movement easier. This created the need to control the individual copies of QC-CALC running throughout the shop from a central location.

As of QC-CALC version 3.2, an **Administrative Tool** was added to help the Quality Department set up and control every copy of QC-CALC within the entire company. This tool can be activated and used from any of the QC-CALC copies on the network.

In addition, the medical supply companies must satisfy FDA title 21 Code of Federal Regulations (CFR21 Part 11) Electronic Records; Electronic Signatures, as it applies in a medical manufacturing environment. A special section has been added to this document which describes how QC-CALC can be configured to help you meet the requirements of Part 11.

- [Setup and Installation Instructions](#) pg. [270](#)
- [Silent Install](#) pg. [271](#)
- [Setup Batch File](#) pg. [271](#)
- [Running QC-CALC Real-Time](#) pg. [272](#)
- [Manage User Groups](#) pg. [272](#)
- [Establishing First Time Password](#) pg. [273](#)
- [Create User Groups](#) pg. [273](#)
- [Manage Options](#) pg. [274](#)
- [Edit Application Defaults](#) pg. [276](#)
- [Set Current User Group](#) pg. [277](#)
- [Logout](#) pg. [277](#)
- [Disconnecting from Admin Path](#) pg. [278](#)
- [Troubleshooting](#) pg. [278](#)
- [CFR21 Part 11 Considerations](#) pg. [278](#)
 - [Trackable Changes](#) pg. [278](#)
 - [The Setup](#) pg. [279](#)
 - [Adding Users to the Group](#) pg. [280](#)
 - [LDAP](#) pg. [280](#)
 - [Account Management](#) pg. [281](#)
 - [Enable Auditing](#) pg. [282](#)
 - [Set Current User Group](#) pg. [282](#)
 - [Editing the Data](#) pg. [282](#)
 - [Documenting the Change in Real-Time](#) pg. [283](#)
 - [Documenting the Change in SPC](#) pg. [285](#)
 - [CFR Part 11 Audit Report](#) pg. [285](#)
 - [Sample Audit Report](#) pg. [287](#)
 - [LDAP \(Lightweight Directory Access Protocol\)](#) pg. [288](#)

52.2 Setup and Installation Instructions

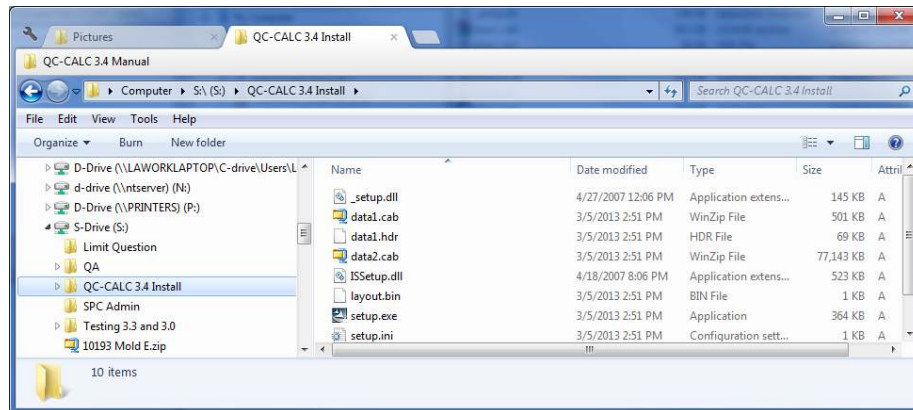
52.2.1 Introduction

There are several installation options for QC-CALC. You can install the standard QC-CALC Enterprise or a QC-CALC Administrative copy. Installing the Administrator copy involves copying all setup files to a server and running the **setup.exe** from this location. This saves you from carrying a CD or USB Flash Drive. Furthermore, you can write a batch file to perform a silent install as well.

You can use a System Management Server such as **Microsoft's SMS** or **Altiris' Service-Oriented Management** solution. Both of these programs can be used to install multiple copies of QC-CALC throughout your company at the same time. By using our batch file commands, you can run these installations in silent mode or allow the user to see the installation on their local screen.

52.2.2 Install

Create a folder on a shared drive such as **S:\QC-CALC 3.4 Install**. This folder must be available to all computers that will use QC-CALC.

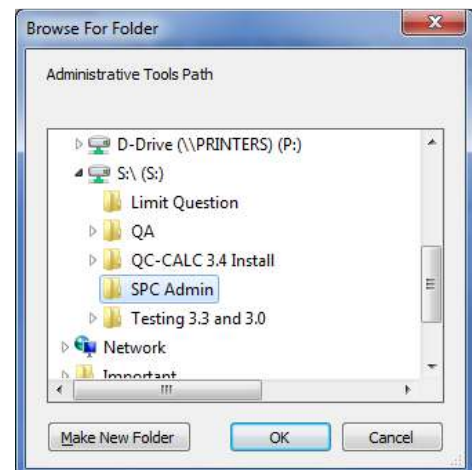


Note: If you use a mapped drive, the same drive letter must be used on all PCs.

1. Download the QC-CALC Administrator file from our website.
2. Unzip the contents of this file into the **QC-CALC 3.4 Install** folder just created on the shared drive.
3. From any computer use Windows Explorer to open the **QC-CALC 3.4 install** folder on the shared drive. (S: drive in our example)
4. Double-click the **Setup.exe** file.
5. During installation the Install Wizard shows 6 screens but take special note of the **Install Folder**. Installation screens are as follows:

- The Welcome Screen
- The License Screen
- The Customer Screen
- **The Install Folder** →
- The Destination Location
- The Program Folder

The **Install Folder** is an added screen to tell QC-CALC where to obtain the common settings for all QC-CALCs configured for common control. In this example we created **S:\SPC Admin**



6. Browse to the **SPC Admin** folder on the shared drive, click **OK**, and finish the rest of the install process.
7. Steps 3-6 are repeated for every PC on which you want QC-CALC installed

52.3 Silent Install

The installation of QC-CALC (Administrative Copy) can be automated to a point where no questions are asked. Optionally, you can run the install in a silent mode where no screens are displayed. This type of installation requires a batch file that contains instructions to tell QC-CALC what to do and how to do it.

Normally, this type of automated installation is used in companies where the IT department “rolls out” the installation from a central server. This type of install reduces time and increase control in physically large companies.

You can use a System Management Server such as **Microsoft’s SMS** or **Altiris’ Service-Oriented Management** solution. Both programs can be used to install multiple copies of QC-CALC throughout your company at the same time. By using our batch file commands, you can run these installations in silent mode or allow the user to see the installation on their local screen.

The silent install commands can be used with QC-CALC 3.4, QC-Gage 3.4, EDL 3.3, QC-Audit 3.0, and QC-Sort 3.0.



Note: In all cases, an installation screen will appear briefly during the installation process. Following this, a progress bar will be displayed. This is meant as a visual cue that the install is taking place.

52.4 Setup Batch File

52.4.1 The Batch File Location

The batch file needed to automate QC-CALC’s installation should be located on a shared server that is accessible to all shop floor PCs. In our continuing example, let’s assume you chose to store this batch file in the **S:\QC-CALC 3.4 Install** folder. Instead of running SETUP.EXE, you will run QC34.bat.

52.4.2 The Batch File Contents

The batch file consists of one line starting with the server path and **Setup.exe** followed by optional arguments. The following shows the contents of an example file called QC34.BAT. Keep in mind this is one long command even though it appears on 3 lines. All arguments are separated by (;) semi-colons.

If you omit any of the arguments below, the corresponding installation screen will appear asking the user to provide this information.

```
q:\QC-CALC\setup.exe /silent;destinationpath=c:\prolink\;
adminpath=S:\SPC Admin\;usergroup=CMM
User;username=Ben;companyname= My Co
```

Batch File Command Item	Comments
Q:\QC-CALC\SETUP.EXE	Command to install a Windows program. Must be first
/silent;	If this switch is present, the installation process is not visible on the target PC. If this switch is omitted, the InstallShield screen is displayed and someone will have to click the installation

destinationpath=c:\prolink\;	wizard's Next > button to continue the setup. The answers to the wizard's questions are filled in by the contents of the batch file but you should include the /silent switch.
adminpath=S:\SPC Admin\;	This is the installation path where QC-CALC will be installed in the CMM or gaging station. You can change it to whatever path you desire.
usergroup=CMM User;	This is the folder used to control all QC-CALC's in your facility. All common settings are stored here. You should standardize on the location by using a batch file like this one.
username=Ben;	This command sets the active user group when the installation is complete. This command will work if you set up one copy of QC-CALC on your desktop PC and created this user groups first.
companyname=My Co	Sets the user name into QC-CALC. This name appears on some reports.
	Sets the company name into QC-CALC. This name appears on some reports.

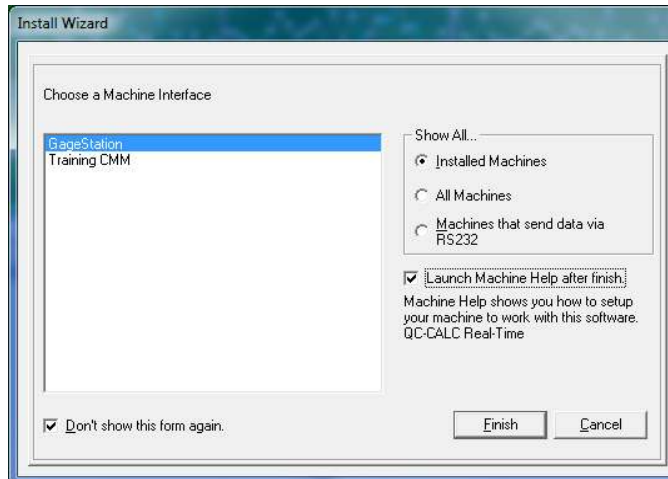


Note: `adminpath` and `usergroup` only apply to QC-CALC installations.

52.5 Running QC-CALC Real-Time

Now that you have QC-CALC installed in your office PC, you'll want to change some settings. First, you must run QC-CALC and answer a few questions:

1. Double click the **QC-CALC 3.4 Real-Time** icon on your Desktop.
2. When running for the first time you will be asked what type of inspection machine you are working with. Choose **QC-CALC Gage Central** from the list since you probably are not seated at an inspection machine.
3. Uncheck the **Launch Machine Help After Finish** option.
4. Click **Finish**.



5. The SAMPLE.QCC file is displayed in QC-CALC Real-Time.

52.6 Manage User Groups

For simplicity reasons, QC-CALC does not save administrative settings at the user level. Instead, groups are created with default settings and locked from being changed. Copies of QC-CALC are then assigned to these groups. It is not necessary to log in as a particular user in order to obtain your group settings

since groups are assigned at the PC level. It is assumed that all users using a particular PC are in the same group. This form of security was chosen because QC-CALC runs without human intervention. It is critical not to interrupt data collection due to login errors.

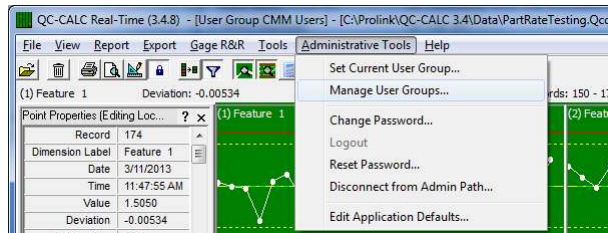


Note: Individual user id/password combinations are assigned to individual persons for Part 11 related activities such as auditing and the digital signing of reports. However, the user name and password are only requested when a change is being made to the data. Please see the [CFR21 Part 11 Considerations](#) section on page 278 for details.

52.7 Establishing First Time Password

You must establish a password as Administrator the first time you run the Administrative Tool in QC-CALC. You are requested to enter this password twice as discussed in the next section.

1. Select the **Administrative Tools – Manage User Groups** menu and the password screen is seen only the first time you select this option.

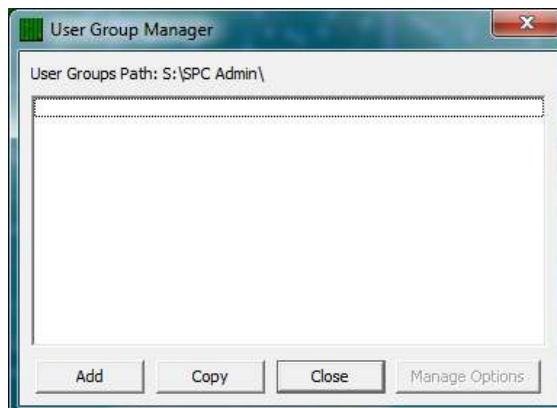


2. You are asked to set your password as the Administrator for the Administrative Tool. This Password is the key to logging in as the administrator from any copy of QC-CALC using this network install.



52.8 Create User Groups

After your password is established, the **Manage User Groups** screen is displayed. There are no User Groups shown since this is the first time you have run the software.



1. To create a new user group, click the **Add** button and enter a name for the first group. For our example we entered **CMM User**.



2. Choose the settings you wish the **CMM User** computers to follow by clicking the **Manage Options** button. You can set the available features your users have access to and the features you want locked.

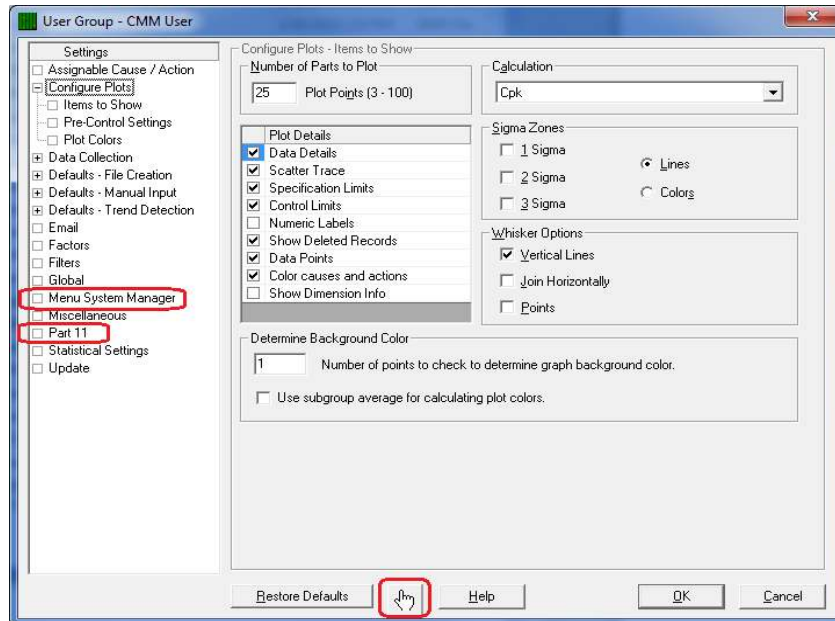
52.8.1 Manage Options

The **Manage Options** button is used to set the configurations applied to all computers within a group and therefore establish the look and feel of each QC-CALC in the group. The settings you choose can optionally be locked to ensure the operation of each QC-CALC is controlled. You can:

- Select Common Settings
- Lock the Settings

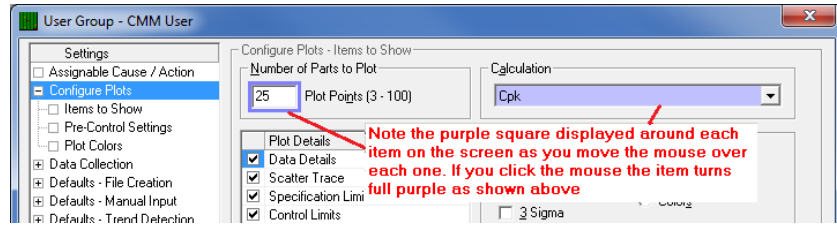
Select Common Settings

The **Settings** screen that appears is the same as the **Tools – Options** screen used in QC-CALC Real-Time. There is an additional **Finger** button at the bottom of the window and two items in the list on the left labeled **Menu System Manager** and **Part 11**. To lock a setting, change any option to the desired value, click the Finger button, and click the option. The option becomes purple which indicates it cannot be changed by the user.



Lock the Settings

When the **Finger** button is depressed and you float the mouse over any option, the item is temporarily outlined with a purple square. Clicking on the item while the purple square is shown causes the item to turn fully purple indicating it's locked.



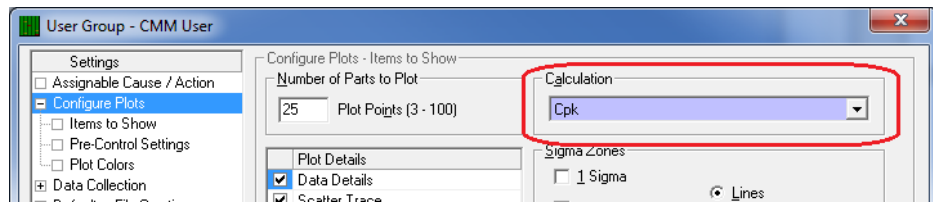
On some screens there are items that are grayed out. Any grayed item changes from part-to-part so they cannot be assigned globally in the Admin Tool.



Note: Any file settings needing global access such as Assignable Causes, Corrective Actions, Filters, and the Update location should be set so that all computers use the same files. This ensures the entire company uses the same settings. You set these items in this configure window.

The Finger Button

Change all settings to values that make sense for your company and use the **Finger** button to lock all values you want restricted from the Group.



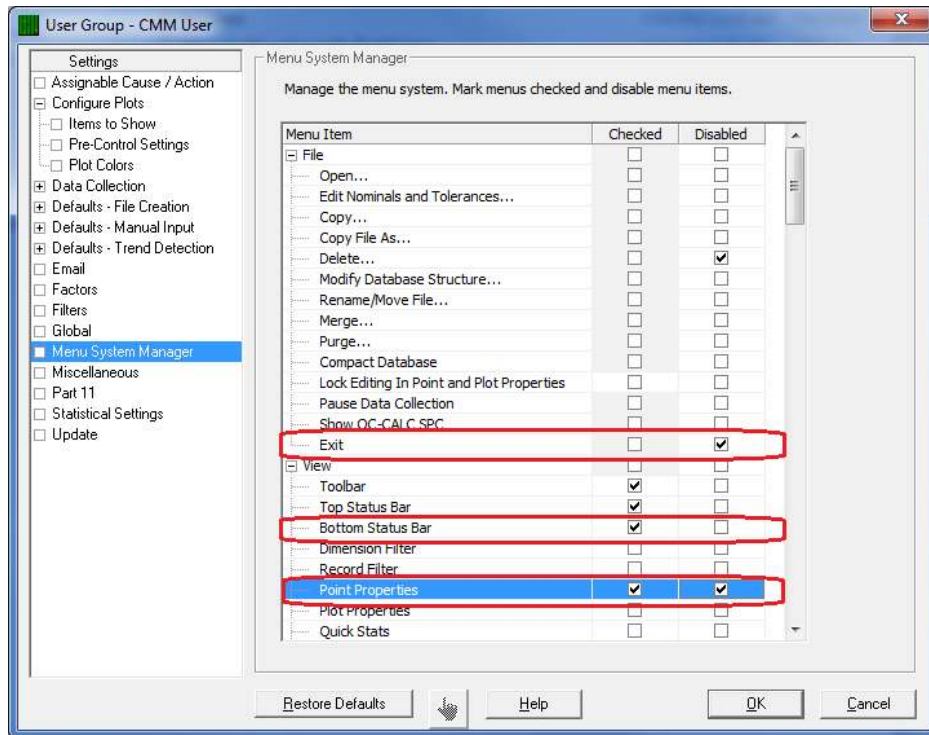
In this example the **Calculation** was set to **Cpk** and then locked so all computers in the group display the Cpk value in the lower left corner of each plot. The computers in the Group cannot change this setting since you locked it.



TIP: By default, the **Finger** button stays depressed allowing you to multi-select many items. Once depressed, the button stays down until you click it again or you click on an item that is not lockable.

Menu System Manager

All menus can be disabled and/or checked from the **Menu System Manager** in the **Manage Options** screen. There is no need to use the Finger button on this particular screen. Simply check the box in the **Disabled** column for the menus you want to disable for the particular group you're currently editing.



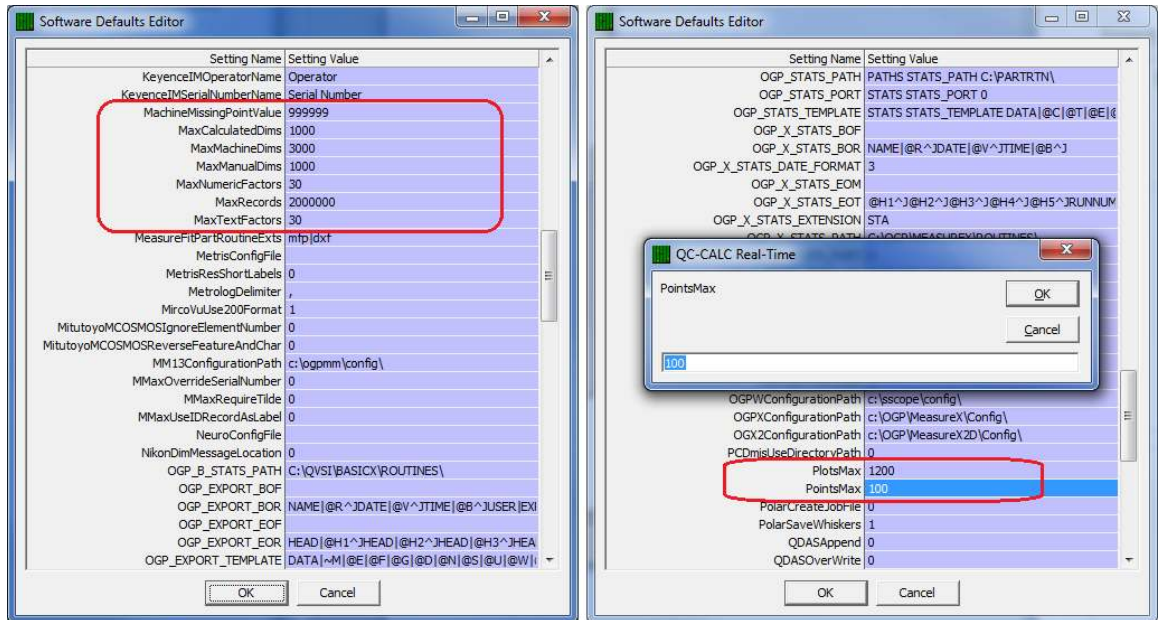
In addition, “checkable” menus throughout QC-CALC can be set and locked. The menus without a gray background in the Checked column are the “checkable” menus. These menu items include viewing the Dimension Filter, Point Properties, Plot Properties, etc.

In the picture above the **File – Exit** menu was disabled (a user hitting the X button will be prompted to enter a password to exit the program), the **View - Bottom Status Bar** was checked (so that status bar will be displayed), and the **View - Point Properties** panel was checked to be displayed and disabled so no one can shut it off.

52.9 Edit Application Defaults

The **Edit Application Defaults** selection gives the administrator the ability to modify the default values for QC-CALC Real-Time. Normally, these values do not need to be modified but they can be under certain conditions. The most commonly changed default values are surrounded with red.

Choose the **Administrative Tools – Edit Application Defaults** menu to display this window.



To modify the values in the boxes simply double click on the item on the right side in the grid you wish to change. This displays a dialog box with the current value in it as shown above on the right.

Be sure that you follow the current format in the box, for example if it is a number you can only change it to another number. If it is a folder path you can only change it to a new path and so on. If the format changes and you click **OK**, you will get an error message saying **An Invalid Input value was entered** and you will have to change it.



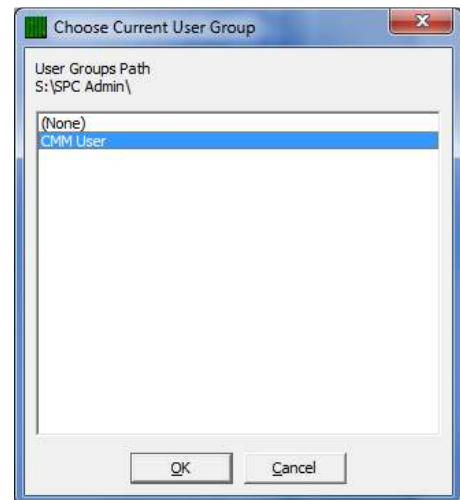
Note: Changing the default values that are numbers are much simpler than changing the paths (C:\QVSI\BasicX\Config) or any of the values that have pipes (|) in them. You have to be very careful because you can change those values and QC-CALC may not know your value is invalid.

52.10 Set Current User Group

Once the User Groups are created and the options are set for each group, you activate the group by choosing **Administrative Tools – Set Current User Group** menu. This should be a one-time change and QC-CALC will remain in this configuration until further notice.

52.11 Logout

When you enter your password to modify anything in the **Administrative Tools**, there is a checkbox saying **Keep me logged in**. Once you check this you can modify multiple settings without re-typing your password each time. The Logout feature is used to cancel the edit feature. Closing QC-CALC and re-starting it cancels the login as well.



52.12 Disconnecting from Admin Path

In the Administrative Tools menu, there is the **Disconnect from Admin Path** option which will allow you to leave the Administrative settings you're currently connected to.

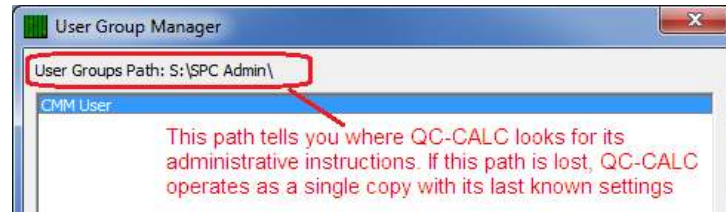
52.13 Troubleshooting

Administrative Tools Menu Not Visible

If you do not see the Administrative Tools menu when you start QC-CALC, it either means QC-CALC was not installed as an Admin copy (there are special installation instructions for this) or QC-CALC no longer has access to the central admin settings folder. If QC-CALC was installed correctly then check the following:

- Check to make sure the user currently logged on has access to the central administrative folder.
- If you are using mapped drive letters, make sure the drive letter originally specified is still pointing to the same shared directory on the network.

The User Group Path is shown at the top of the User Group Manager window.



52.14 CFR21 Part 11 Considerations

52.14.1 Introduction

This section describes QC-CALC's operation as it pertains to the FDA title 21 Code of Federal Regulations (21CFR Part 11) requirements. It discusses how QC-CALC is configured to meet the high level requirements of Part 11.

In order to run QC-CALC in Part 11 Mode, you must run the Administrator Version of QC-CALC due to the control nature of the Part 11 requirements. Part 11 settings are stored at the group level, so you will find the settings screen for Part 11 in the **Manage Options** window of each group.

52.14.2 Trackable Changes

QC-CALC's Part 11 Auditing feature tracks all changes made to the collected data. Each time a change is made, the user making the change is required to enter his user name, password, and a reason for the change. The following changes to the data trigger an audit dialog:

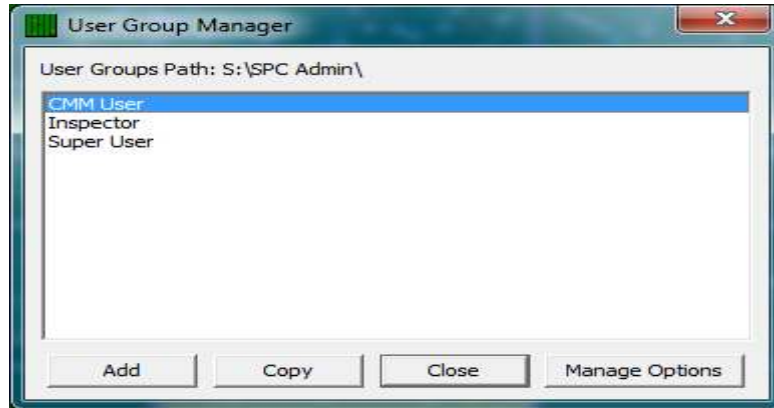
1. Changes to the actual value measured
2. Changes to the measure date or time of the measurement
3. Changes to the number of fails count
4. Changes to the name of any factor (non-measurement trace field)
5. Changes to the value of any factor (non-measurement trace field)
6. Deletions/un-deletions of individual points
7. Deletions/un-deletions of records (parts)
8. Re-measurements of a part
9. Additions, removals, or display order changes of assignable causes
10. Additions, removals, or display order changes of corrective actions

52.14.3 The Setup

The setup of Part 11 Auditing requires you to:

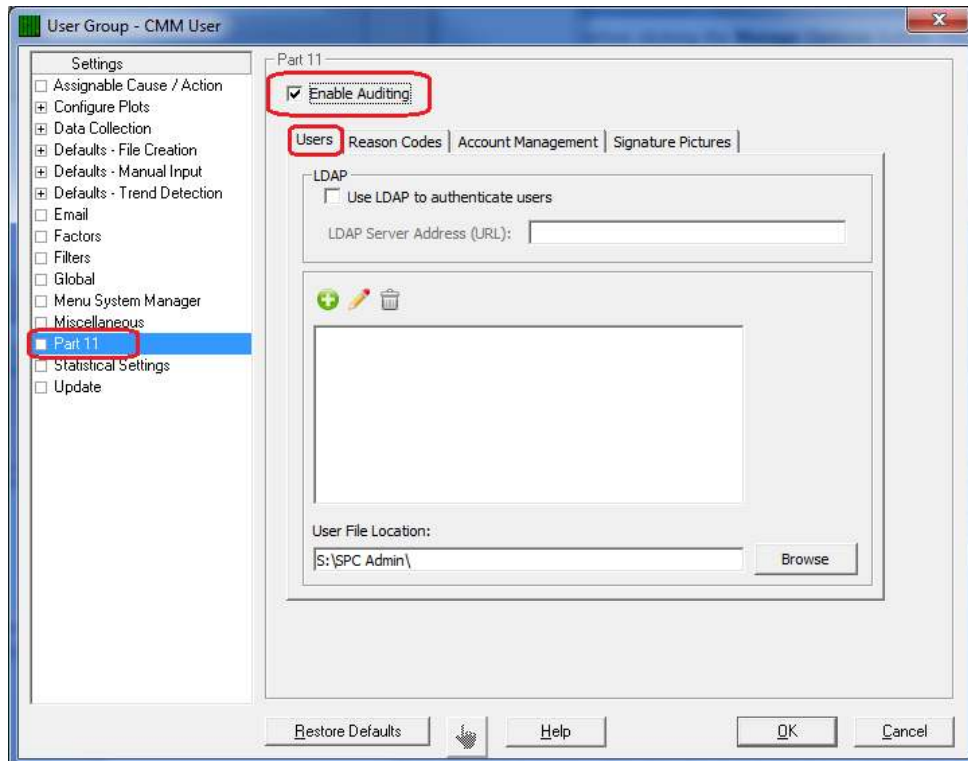
- Create User Groups Administrative Tool
- Set the Options for each Group Administrative Tool
- Add Users to the Groups Part 11 Setting
- Enter Reason Codes Part 11 Setting
- Enable Auditing Part 11 Setting

Begin the Part 11 setup by selecting the **Administrative Tools – Manage User Groups** menus. Add as many user groups as necessary. Here we added Inspector and Super User to our original CMM User.



Select the user group before clicking the **Manage Options** button. This sets the group you edit. Set and lock the options for each group as discussed in the previous section.

Select the **Part11** menu on the left side to see the following screen.



52.14.4 Adding Users to the Group

You use the **User** tab and the **Add** button to add individual people to your groups. Each person requires a name and password. You may also add a graphic signature file to the user record. This is optional and can be placed on digitally signed PDF reports.



Note: Graphic signature files are digitally stored within QC-CALC for security reasons. As such, there is a 100K byte size limit to each uploaded image. You can manage your uploaded signature pictures on the **Signature Pictures** tab.

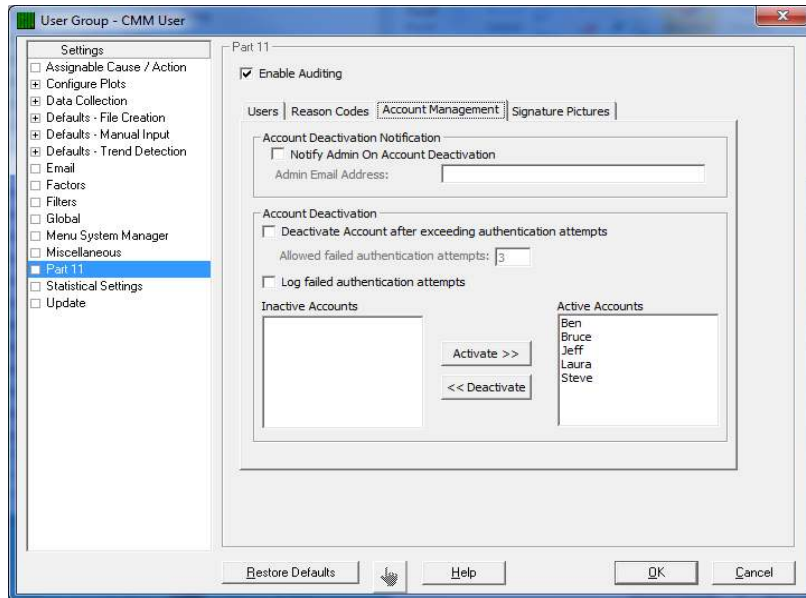
Add as many users as desired and remember that users are not group specific and are shared across all groups.

52.14.5 LDAP

You cannot add Users if you choose LDAP as discussed in the [LDAP \(Lightweight Directory Access Protocol\)](#) section on page [288](#).

52.14.6 Account Management

The **Account Management** tab houses several options for account configuration, specifically options for account deactivation, failed login attempts, along with managing active and inactive accounts.



Account Deactivation Notification

If this box is checked, an email will be sent to the address specified whenever an account is deactivated

Account Deactivation

Deactivate Account after exceeding authentication attempts

If this box is checked, an account will be activated after a certain number of failed attempts to access it. You can set the number of attempts in the box immediately below

Log failed authentication attempts

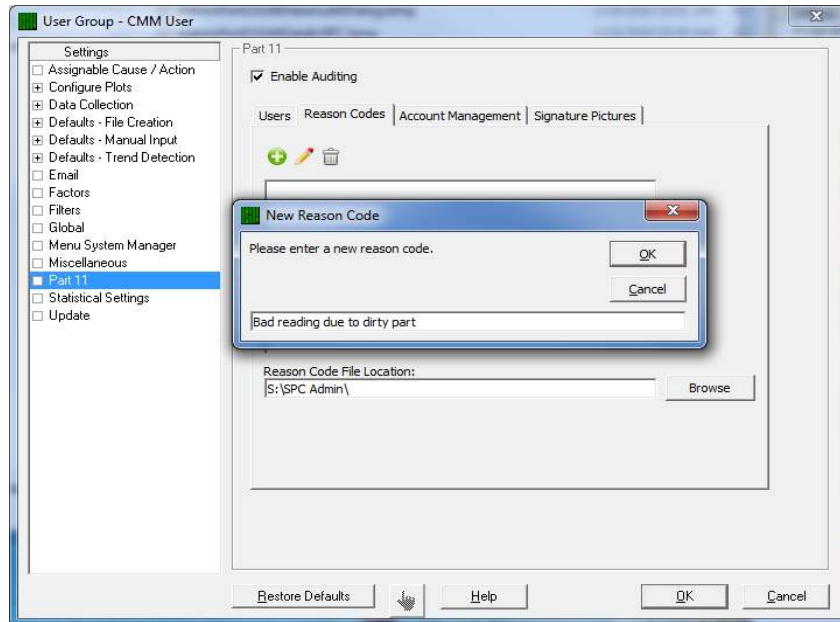
If this box is checked, all failed authentication attempts will be logged and saved to the administrative folder path

Active and Inactive Accounts

Here you can deactivate accounts or reactivate accounts that had been deactivated.

Adding Reason Codes to the Group

Reason Codes are added to a list so your users can pick from a list to assign a reason why a value was changed. You must add all reason codes since your Users will be picking the reason from this list and are not allowed to type free-hand notes.



It is recommended that you choose brief codes and keep the list short since users tend not to scroll through long lists. Reason codes are shared across all groups and are not group specific. The max length of a reason code is 64 characters.

52.14.7 Enable Auditing

The last thing you must do is enable the auditing system. This is done by checking the checkbox labeled **Enable Auditing**. You now have all of the requirements established to use the system.



Note: The **Enable Auditing** setting is not shared across all groups. Therefore, you should set this value manually for each group that requires auditing.

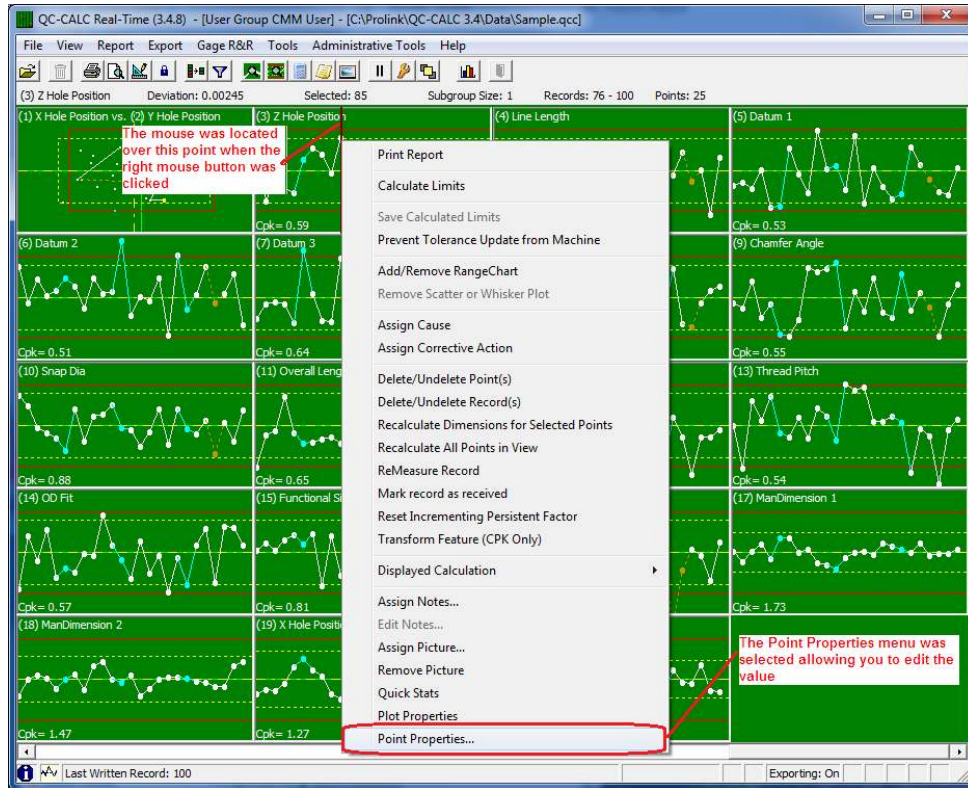
52.14.8 Set Current User Group

Once the User Groups are created and the options are set for each group, you activate the group by choosing the **Administrative Tools – Set Current User Group** menu. This should be a one-time change and QC-CALC will remain in this configuration until further notice.

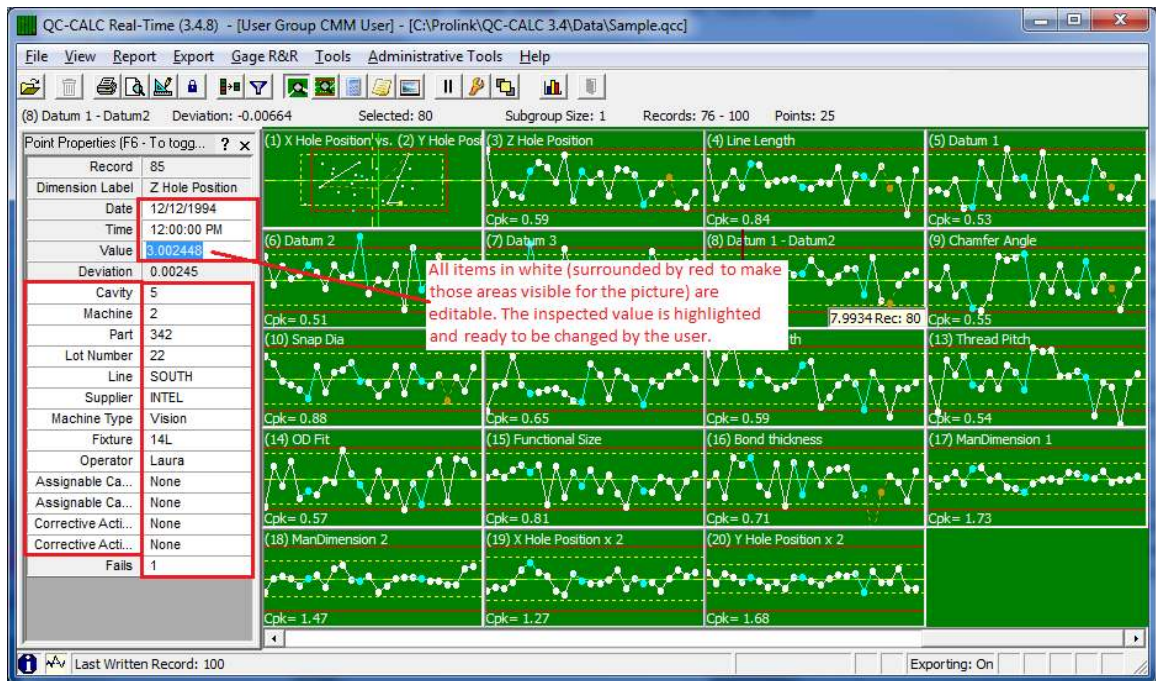
52.14.9 Editing the Data

Editing tools were added to QC-CALC to help you fix bad readings. Please recognize Prolink makes a distinction between bad readings vs. bad parts. When a gage saves a reading that must be changed due to gaging errors, the Part 11 tools described here help control the “who, what, and why” of the change that was made.

Right clicking on a point in QC-CALC Real-Time yields the familiar pop-up menu shown below.



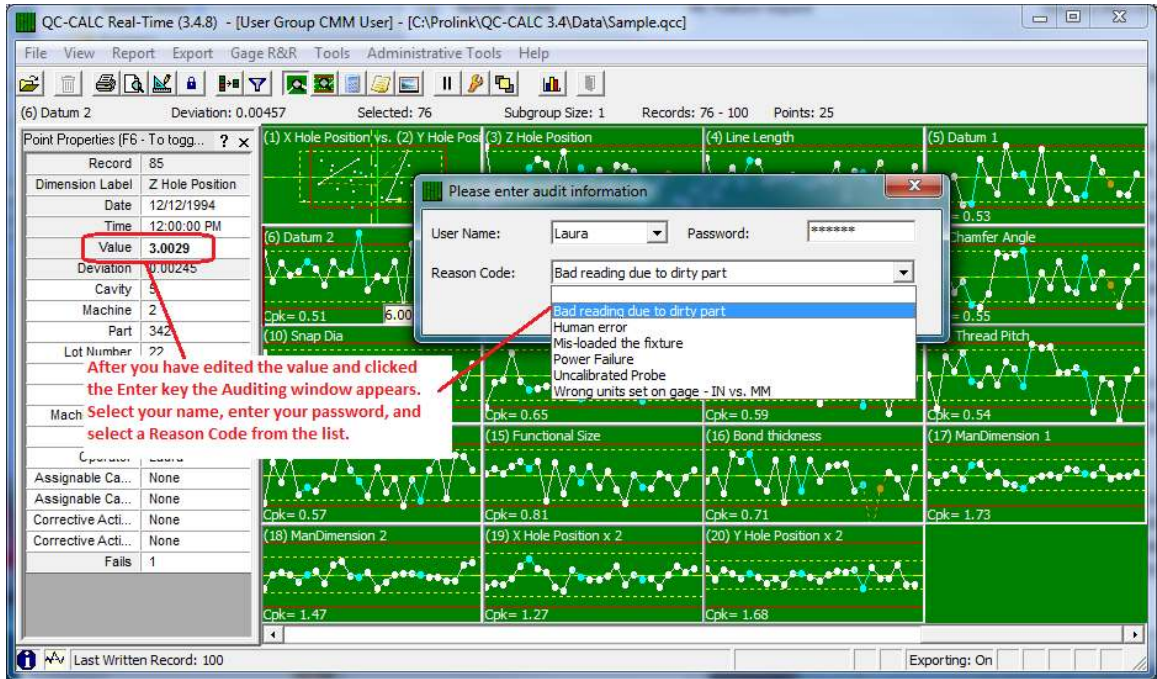
Selecting **Point Properties** allows you to edit the value as shown.



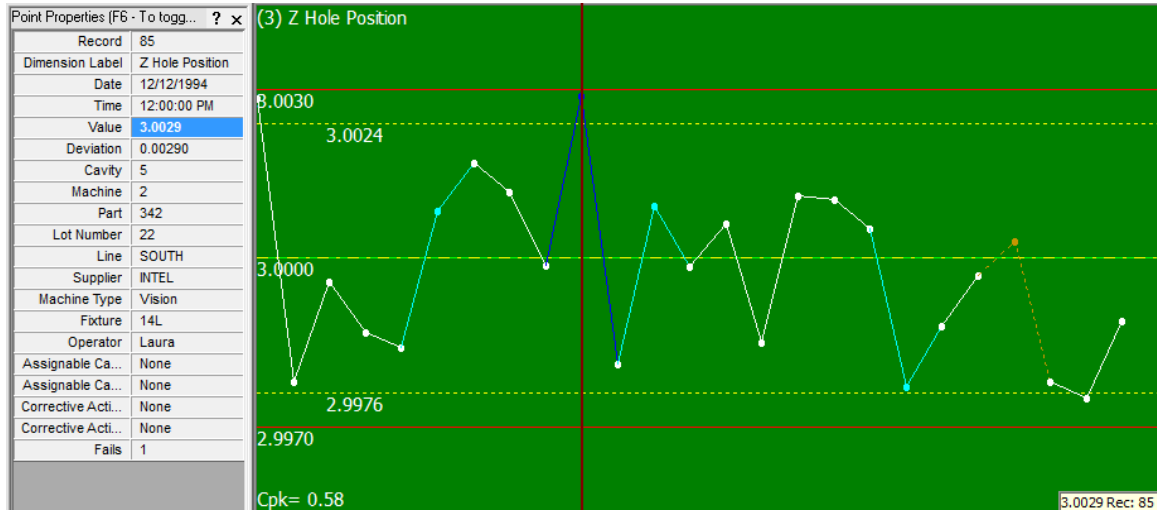
52.14.10 Documenting the Change in Real-Time

When you finish the edit and press ENTER or attempt close the **Point Properties** dialog box, the Part 11 Audit dialog box appears requesting information. You must complete this dialog or your changes are discarded!

Select your name from the **User Name** list, enter your **Password**, and select a **Reason Code** from the list. Now click **OK** and your changes are saved. If you do not complete this sequence or press Cancel, your changes are discarded.

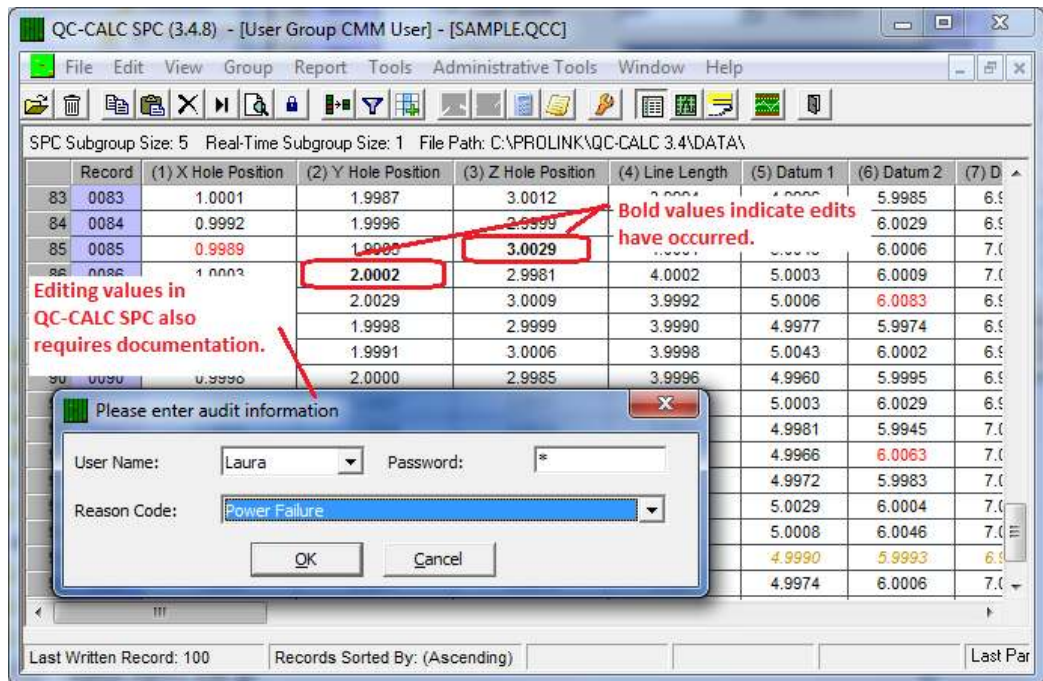


Once the Audit dialog box is removed from the screen, the edited point turns navy blue. The connecting lines also are blue. The value is displayed in the **Point Properties** dialog box as bold text. This is your visual clue the value has been edited. Press the F6 key if editing is still active.



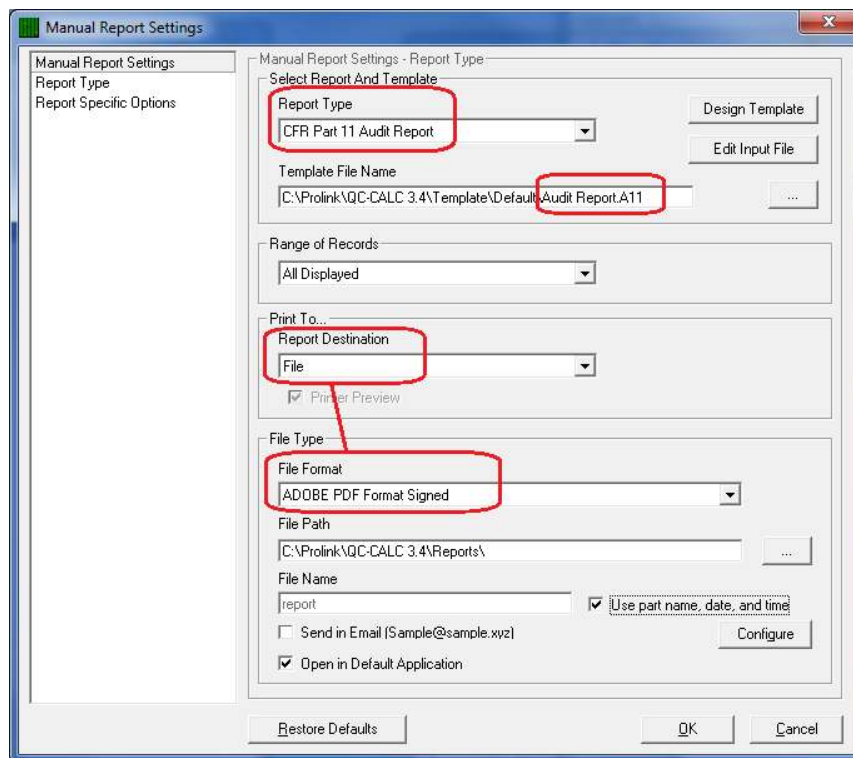
52.14.11 Documenting the Change in SPC

Should you decide to edit data in the QC-CALC SPC screen, you are prompted the same as in QC-CALC Real-Time. All edited values are displayed in bold text as in the Point Properties of QC-CALC Real-Time.



52.14.12 CFR Part 11 Audit Report

You can generate a report containing all changes made to a part file by printing a special report included in the Real-Time report list called the “CFR Part 11 Audit Report.” This report is generated the same as all other Real-Time reports but it contains the pertinent audit trail information as required by Part 11.

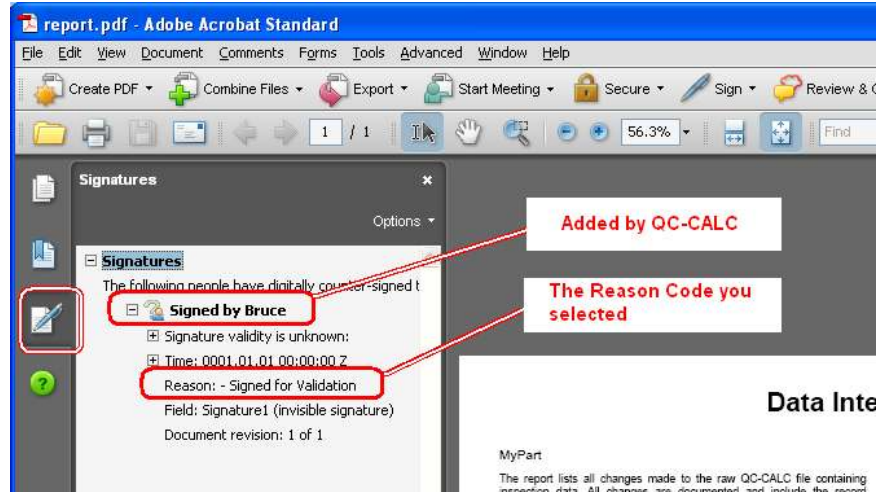


Signed Reports PDF Only

You must print signed reports to **File** and select a **File Type** of **Adobe PDF Format Signed** in order to see your signature. If the file has been tampered with, it will say so. Change the File Name and location to the appropriate name and click **OK**. The PDF file has properties that you can review.

PDF File Signature Properties

The tamper proof signature is found in the signature section of the final PDF file. Clicking the Signature button reveals the status of the file. QC-CALC adds the password protected user name to the document and includes the Reason Code they chose. If the file is modified in any way, the signature property indicates it is a tampered file.




52.14.13 Sample Audit Report

This sample audit report shows the detail necessary to trace any changes to any QC-CALC database. It includes the original value before the edit and the new value. All editable items in the database are added to this report. You can print this report for an individual point by **right clicking** on the point and selecting the **Print Report** menu. A history of that one point (part) is printed.

Data Integrity Report

Printed on May 12, 2008



Electronically Signed by: Bruce South

If you desire a report for a specific part, serial number, or other condition, please create a record filter to reduce this report. For example, you can create a date filter to see all changes made for a particular day or range of days. Likewise, you can search for a particular serial number and create a report for one part. See filtering data for more details.

The report lists all changes made to the raw QC-CALC file containing inspection data. All changes are documented and include the record number, user, and reason the change occurred.

Rec	Date of Change	Item Changed	Label	Old Value	New Value	User	Reason
8	5/12/2008 3:41:30 PM	Dimension 8	Feature 8	8.4992	8.5000	Tom	Uncalibrated Probe
12	5/9/2008 5:39:14 PM	Dimension 4	Hole 1 TP	4.5000	4.5020	Bruce	Bad reading due to dirty part
12	5/12/2008 3:42:27 PM	Dimension 8	Feature 8	8.5048	8.5010	Bruce	Typo during data entry

MyPart

You create a signature file and add it to your user name and password to ensure the document has a name associated with it.

You can add a picture or Avitar to your signature to ensure it was you that signed this PDF file.

This name will only be present if the user enters his or her password.

Page 1

52.14.14 LDAP (Lightweight Directory Access Protocol)

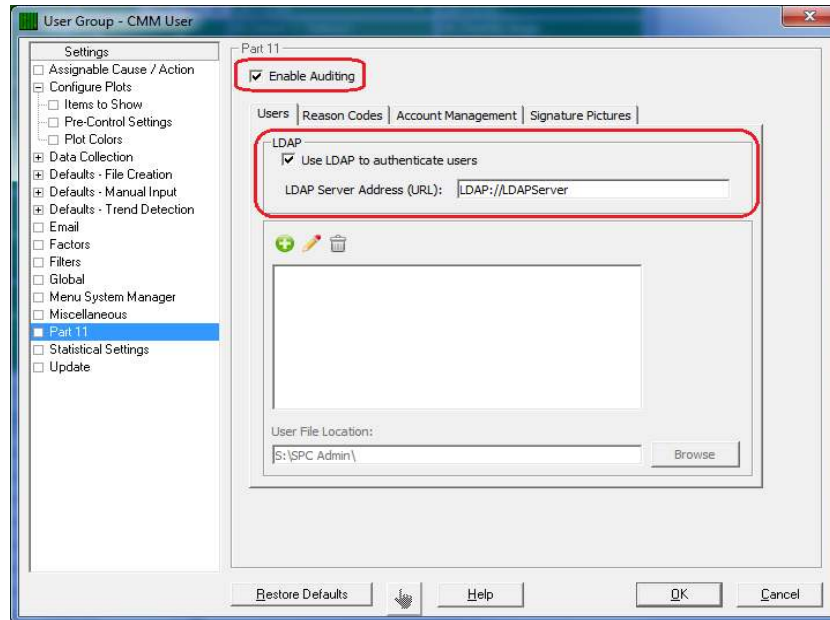
Introduction

The Lightweight Directory Access Protocol (LDAP) is a directory service protocol that provides a mechanism used to connect to, search, and modify Internet directories. LDAP servers exist at three levels: big public servers, large organizational servers at universities and corporations, and smaller LDAP servers for workgroups.

LDAP was designed at the University of Michigan to adapt a complex enterprise directory system (called X.500) to the modern Internet. X.500 is too complex to support on desktops and over the Internet, so LDAP was created to provide this service "for the rest of us."

QC-CALC has a built-in **User – Password** system but some organizations require these account names be stored and managed at the company level, not the PC level. The chosen standard is an LDAP server. For such organizations, QC-CALC provides a simple interface.

When the “**Use LDAP to authenticate users**” checkbox is unchecked, QC-CALC uses its built-in system for auditing Part 11 Users.



When you check the “**Use LDAP to authenticate users**” checkbox the **Add**, **Edit**, **Remove** buttons are grayed out indicating all user information is stored elsewhere within the company server. You will need to contact your IT department to setup the required “connection string”. When you record data changes you are asked for your **User Name** and **Password**. You must enter your company logon name and password instead of any identification you may have entered into the QC-CALC system.

53. Equations

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53.1 Control Charts

Terms used:

USL	=	Upper Specification Limit (+Tolerance + Nominal)
LSL	=	Lower Specification Limit (-Tolerance + Nominal)
UCL _{xxxx}	=	Upper Control Limit where xxxx is the type of chart
LCL _{xxxx}	=	Lower Control Limit where xxxx is the type of chart
CLine _{xxxx}	=	Center Line where xxxx is the type of chart
\tilde{X}_i	=	The Median of the i^{th} subgroup
X_i	=	The i^{th} reading in the database
$X_{i,k}$	=	The k^{th} reading in the i^{th} subgroup
$X^{i,k}$	=	The k^{th} reading in the i^{th} subgroup after the subgroup has been sorted.
$X_{i \max}$	=	The largest reading in the i^{th} subgroup
$X_{i \min}$	=	The smallest reading in the i^{th} subgroup
n	=	The number of parts (readings) in each subgroup
n^i	=	The number of parts in subgroup i (same as n except in some attribute charts)
m	=	number of subgroups
Defective _{i}	=	The number of defective parts in subgroup i
c_i	=	The number of defects observed on part i
exp(X)	=	An alternate notation for e^X , exp(X) is easier to read in large equations
σ	=	Standard deviation
k	=	The "Sigma Multiplier" - a constant the user can change in the Statistical Values section of the Tool – Options menu. This should almost always be left at 3.

53.1.1 Variable Control Charts

For Range control charts

$$R_i = X_{i \max} - X_{i \min}$$

$$\bar{R} = \left(\frac{1}{m}\right) \sum_{i=1}^m R_i$$

$$\sigma_{\bar{X}} = \frac{\bar{R}}{d_2 \sqrt{n}}$$

$$UCL_{Range} = D_4 \bar{R}$$

$$LCL_{Range} = D_3 \bar{R}$$

$$CLine_{Range} = \bar{R}$$

For σ control charts

$$\sigma_i = \sqrt{\left(\frac{1}{n}\right) \sum_{j=1}^n (X_{i,j} - \bar{X}_i)^2}$$

$$\bar{\sigma} = \left(\frac{1}{m}\right) \sum_{i=1}^m \sigma_i$$

$$\sigma_{\bar{X}} = \frac{\bar{\sigma}}{C_2 \sqrt{n}}$$

$$UCL_{\sigma} = B_4 \bar{\sigma}$$

$$LCL_{\sigma} = B_3 \bar{\sigma}$$

$$CLine_{\sigma} = \bar{\sigma}$$

For \bar{X} control charts

$$\bar{X}_i = \left(\frac{1}{n}\right) \sum_{j=1}^n X_{i,j}$$

$$\bar{\bar{X}} = \left(\frac{1}{m}\right) \sum_{i=1}^m \bar{X}_i$$

$$UCL_{\bar{X}} = \bar{\bar{X}} + k\sigma_{\bar{X}}$$

$$LCL_{\bar{X}} = \bar{\bar{X}} - k\sigma_{\bar{X}}$$

$$CLine_{\bar{X}} = \bar{\bar{X}}$$

For \tilde{X} (median) control charts

$$\tilde{X}_i = \begin{cases} X'_{i, \frac{n+1}{2}} & \text{n odd} \\ \frac{1}{2} (X'_{i, \frac{n}{2}} + X'_{i, \frac{n}{2}+1}) & \text{n even} \end{cases}$$

$$\tilde{\bar{X}} = \left(\frac{1}{m}\right) \sum_{i=1}^m \tilde{X}_i$$

$$UCL_{\tilde{X}} = \tilde{\bar{X}} + k\sigma_{\tilde{X}}$$

$$LCL_{\tilde{X}} = \tilde{\bar{X}} - k\sigma_{\tilde{X}}$$

$$CLine_{\tilde{X}} = \tilde{\bar{X}}$$

Note that for the moving range control chart $X_{i+1, j} = X_{i, j+1}$ because adjacent subgroups overlap by n-1 measurements.

Constants used:

n	d ²	D ³	D ⁴	C ²	B ³	B ⁴	E ²
2	1.128	0.00	3.27	0.5642	0.00	3.27	2.660
3	1.693	0.00	2.57	0.7236	0.00	2.57	1.772
4	2.059	0.00	2.28	0.7979	0.00	2.27	1.457
5	2.326	0.00	2.11	0.8407	0.00	2.09	1.290
6	2.534	0.00	2.00	0.8686	0.03	1.97	1.184
7	2.704	0.08	1.92	0.8882	0.12	1.88	1.109
8	2.847	0.14	1.86	0.9027	0.19	1.81	1.054
9	2.970	0.18	1.82	0.9139	0.24	1.76	1.010
10	3.078	0.22	1.78	0.9227	0.28	1.72	0.975
11	3.173	0.26	1.74	0.9300	0.32	1.68	0.946
12	3.258	0.28	1.72	0.9359	0.35	1.65	0.921
13	3.336	0.31	1.69	0.9410	0.38	1.62	0.899
14	3.407	0.33	1.67	0.9453	0.41	1.59	0.881
15	3.472	0.35	1.65	0.9490	0.43	1.57	0.864
16	3.532	0.36	1.64	0.9523	0.45	1.57	
17	3.588	0.38	1.62	0.9551	0.47	1.53	
18	3.600	0.39	1.61	0.9576	0.48	1.52	
19	3.689	0.40	1.60	0.9599	0.50	1.50	
20	3.735	0.41	1.59	0.9619	0.51	1.49	

53.2 Descriptive Statistics

These terms and equations are common to all of the following graphs. Additional terms and equations specific to a graph are given under the heading for that graph.

Terms used:

X_i	=	The i^{th} reading in the database
$X_{i \max}$	=	The largest reading in the i^{th} subgroup
$X_{i \min}$	=	The smallest reading in the i^{th} subgroup
n	=	The number of parts (readings) in the sample
$\exp(X)$	=	An alternate notation for e^X , $\exp(X)$ is easier to read in large equations
$F(X)$	=	The Cumulative Distribution Function for the selected dimension (assumed normal)
$F^{-1}(p)$	=	The inverse of the Cumulative Distribution Function, for $0 < p < 1$ this function returns the z such that $p = F(z)$
USL	=	Upper Specification Limit (+Tolerance + Nominal)
LSL	=	Lower Specification Limit (-Tolerance + Nominal)
σ	=	The standard deviation of the population estimated from sample standard deviation
$\sigma_{\text{by R}}$	=	The standard deviation of the population estimated from subgroup ranges
$\sigma_{\text{by S}}$	=	The standard deviation of the population estimated from subgroup standard deviations
m_k	=	The k^{th} moment of the sample
α	=	The significance level (expressed as a probability) of a test of hypothesis. For example, a significance level of .05 in a test of normality means there is a 5% chance of claiming a sample came from a non-normal process when it came from a normal process.

for $0 < p \leq 0.5$

$$B = \sqrt{\ln\left(\frac{1}{p}\right)}$$

$$F^{-1}(p) = -A$$

for $0 < p \leq 0.5$

$$B = \sqrt{\ln\left(\frac{1}{1-p}\right)}$$

$$F^{-1}(p) = A$$

$$\text{where } A = B - \frac{2.515517 + 0.802853B + 0.010328B^2}{1 + 1.432788B + 0.189269B^2 + 0.001308B^2}$$

$$\bar{X} = \left(\frac{1}{n}\right) \sum_{i=1}^n X_i$$

$$m_k = \left(\frac{1}{n}\right) \sum_{i=1}^n (X_i - \bar{X})^k$$

$$\sigma = \sqrt{\frac{n \sum_{i=1}^n X_i^2 - \left(\sum_{i=1}^n X_i\right)^2}{n(n-1)}} \quad \text{or} \quad \sigma = \sqrt{\left(\frac{1}{n-1}\right) \sum_{i=1}^n (X_i - \bar{X})^2}$$

53.3 Process Capability

$$F(X) = \int_{-\infty}^X \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{1}{2}\left(\frac{y-\mu}{\sigma}\right)^2\right) dy \quad \text{normalized by } z = \frac{y-\mu}{\sigma}$$

This cannot be evaluated directly so we make the substitutions below. The continued fraction expansion of R(z) may take one of 2 forms, depending on the value of z. In either case N recursions (20 in QC-CALC) are used to calculate W(1).

$$\begin{array}{lll} z \leq 2.5 & & z > 2.5 \\ z = \frac{X - \bar{X}}{\sigma} & R(z) = z + \sum_{i=1}^N \frac{i(-1)^i z^2}{2i+1} & R(z) = \frac{1}{z} + \sum_{i=1}^N \frac{i}{z} \\ \mathcal{O}(z) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{z^2}{2}\right) & W(N) = 2N - 1 + z^2(-1)^N N & W(N) = z + \frac{N}{z} \\ \Phi(z) = \int_{-\infty}^z \mathcal{O}(x) dx & W(J) = 2J - 1 + \frac{z^2(-1)^J J}{W(J+1)} & W(J) = z + \frac{J}{W(J+1)} \\ \therefore & & \\ F(X) = \Phi(z) & & \\ R(z) = \frac{1 - \Phi(z)}{\mathcal{O}(z)} & & \\ \therefore \Phi(z) = 1 - R(z)\mathcal{O}(z) & & \end{array}$$

in either case

$$R(z) = \frac{z}{W(1)} \quad F(X) = 1 - R(z)\mathcal{O}(z)$$

$$\begin{array}{ll} \% \text{ Over Upper Tolerance} & = [1 - F(\text{USL})] * 100 \\ \% \text{ Under Lower Tolerance} & = F(\text{LSL}) * 100 \\ \text{Maximum Process Extent} & = \bar{X} + 3\sigma \\ \text{Minimum Process Extent} & = \bar{X} - 3\sigma \\ C_p & = (\text{USL} - \text{LSL}) / 6\sigma \\ \text{Process Capability} & = 100 * 6\sigma / (\text{USL} - \text{LSL}) \\ C_{pk} \text{ based on upper tolerance} & = (\text{USL} - \bar{X}) / 3\sigma \\ C_{pk} \text{ based on lower tolerance} & = (\bar{X} - \text{LSL}) / 3\sigma \\ C_{pk} & = \text{Lesser of } C_{pk} \text{ upper or } C_{pk} \text{ lower} \\ C_{pk R} & = C_{pk} \text{ except } \sigma_{by R} \text{ is used instead of } \sigma \\ C_{pk S} & = C_{pk} \text{ except } \sigma_{by S} \text{ is used instead of } \sigma \\ C_{pm} & = \frac{(\text{USL} - \text{LSL})}{6\sqrt{(\sigma^2 + (\bar{X} - \text{Nom})^2)}} \\ \bar{R} & \text{ as defined in Variable Control Charts.} \\ X_{i,k} & \text{ The } k^{\text{th}} \text{ reading in the } i^{\text{th}} \text{ subgroup} \end{array}$$

- n The number of parts (readings) in each subgroup
m number of subgroups

$$\sigma_i = \sqrt{\left(\frac{1}{n-1}\right) \sum_{j=1}^n (X_{i,j} - \bar{X}_i)^2}$$
$$\bar{\sigma} = \sqrt{\left(\frac{1}{m}\right) \sum_{i=1}^m \sigma_i^2}$$

$$\sigma_{\bar{X}} = \sqrt{\frac{\sum_{i=1}^m (\bar{X}_i - \bar{\bar{X}})^2}{m-1}}$$
$$\sigma_{by S} = \sqrt{\sigma_{\bar{X}}^2 + \bar{\sigma}^2 \frac{n-1}{n}}$$
$$\sigma_{by R} = \frac{\bar{R}}{d_2}$$

53.4 Histogram Analysis

The Number of cells is either specified in **Tools – Options – Statistical Settings** or automatically calculated from the sample size. If calculated, the following table is used.

Sample Size	Cells
< 90	7
< 181	8
< 362	9
< 724	10
< 1448	11
< 2896	12
>= 2896	13

The size of each cell (bar width) in the pictorial histogram is determined by the range of data. The range is the difference between the largest and smallest values in the data set. The cell width is calculated by dividing the range by the number of cells required.

$$\text{Range} = X_{MAX} - X_{MIN} \qquad \text{Cell Width} = \frac{\text{Range}}{\text{Number Of Intervals}}$$

The cell frequency or number of data points falling within a particular interval is determined by comparing the value of each data point with the lower and upper cell limits. For the i^{th} cell:

$$\text{Lower Cell Limit}_i = X_{MIN} + (\text{Cell Width})(i - 1)$$

$$\text{Upper Cell Limit}_i = X_{MIN} + (\text{Cell Width})(i)$$

The test of normality used is a chi-square with 7 degrees of freedom. This procedure divides a normal distribution into 10 cells each containing 10% of a normal distribution. The cell boundaries are listed below:

Cell #	Lower Bound	Upper Bound
1	Minimum	$\bar{X} - 1.2817\sigma$
2	$\bar{X} - 1.2817\sigma$	$\bar{X} - 0.8418\sigma$
3	$\bar{X} - 0.8418\sigma$	$\bar{X} - 0.5244\sigma$
4	$\bar{X} - 0.5244\sigma$	$\bar{X} - 0.2533\sigma$
5	$\bar{X} - 0.2533\sigma$	\bar{X}
6	\bar{X}	$\bar{X} + 0.2533\sigma$
7	$\bar{X} + 0.2533\sigma$	$\bar{X} + 0.5244\sigma$
8	$\bar{X} + 0.5244\sigma$	$\bar{X} + 0.8418\sigma$
9	$\bar{X} + 0.8418\sigma$	$\bar{X} + 1.2817\sigma$
10	$\bar{X} + 1.2817\sigma$	Maximum

Each cell has 10% of a normal distribution. Therefore, the expected frequency in each cell is:

$$E = n/10$$

The actual or observed frequency (O) of each cell is determined by comparing each data point to the cell boundaries above. Chi-square is then calculated by the formula

$$\chi^2 = \frac{1}{E} \sum_{i=1}^{10} (O_i - E)^2$$

Note that large data sets are required for this test to work properly. 100 to 300 samples should be considered the minimum with 500 to 1000 recommended. If the χ^2 of the data is < 6.35 the data is assumed normal with a risk, α , obtained from the table below with linear interpolation. If the χ^2 of the data is > 6.35 the data is assumed non-normal with a risk $1-\alpha$.

Critical values of χ^2 with 7 degrees of freedom and the risk error if normality is assumed.

Risk	.005	.010	.025	.050	.100	.250	.500	.750	.900	.950	.975	.990	.995
Critical	.989	1.24	1.69	2.17	2.83	4.25	6.35	9.04	12.0	14.1	16.0	18.5	20.3

Skewness

$$Skewness = \frac{m_3}{\sqrt{m_2^3}}$$

$$A = (Skewness) \sqrt{\left(\frac{(n+1)(n+3)}{6(n-2)} \right)}$$

$$B = \frac{3(n^2 + 27n - 70)(n+1)(n+3)}{(n-2)(n+5)(n+7)(n+9)}$$

$$C = \frac{1}{\sqrt{\ln\left(\sqrt{-1 + \sqrt{2(B-1)}}\right)}}$$

$$D = \sqrt{\frac{2}{\sqrt{2(B-1)} - 2}}$$

$$Z_{Skew} = C \ln\left(\frac{A}{D} + \sqrt{\left(\frac{A}{D}\right)^2 + 1}\right)$$

$$Z_{Critical} = F^{-1}\left(\frac{\alpha}{2}\right)$$

$$K^2 = Z_{Skew}^2 + Z_{Kurt}^2$$

Kurtosis

$$Kurtosis = \frac{m_4}{m_2^2}$$

$$A = \frac{Kurtosis - \frac{3(n-1)}{n+1}}{\sqrt{\frac{24n(n-2)(n-3)}{(n+1)^2(n+3)(n+5)}}}$$

$$B = \frac{6(n^2 - 5n + 2)}{(n+7)(n+9)} \sqrt{\frac{6(n+3)(n+5)}{n(n-2)(n-3)}}$$

$$C = 6 + \frac{8}{B} \left(\frac{2}{B} + \sqrt{\left(1 + \frac{4}{B^2}\right)} \right)$$

$$Z_{Kurt} = \frac{1 - \frac{2}{9C} - \sqrt{\frac{1 - \frac{2}{C}}{1 + A\sqrt{\frac{2}{C-4}}}}}{\sqrt{\frac{2}{9C}}}$$

$$Z_{Critical} = F^{-1}\left(\frac{\alpha}{2}\right)$$

For both Skewness and Kurtosis α is 0.05 and the process is considered non-normal if:

$$|Z_{Skew}| > Z_{Critical} \quad \text{or} \quad |Z_{Kurt}| > Z_{Critical}$$

53.5 Probability Plot

The Probability Plot is constructed by sorting the most recent 100 records thereby limiting the sample size. Each element of the sorted sample, X_i , is plotted against and correlated with:

$$F^{-1}\left(\frac{i - 0.375}{n + 0.25}\right)$$

using the equations listed in Correlation and Regression. The hypothesis of normality is rejected if the correlation coefficient, R , is lower than a critical value determined from the table below. All values in the table are for $\alpha = 0.05$ (5%).

n	R	n	R	n	R	n	R	n	R	n	R
		11	.923	21	.952	31	.965	41	.973	55	.979
		12	.928	22	.954	32	.966	42	.973	60	.980
3	.879	13	.932	23	.956	33	.967	43	.974	65	.981
4	.868	14	.935	24	.957	34	.968	44	.974	70	.983
5	.880	15	.939	25	.959	35	.969	45	.974	75	.984
6	.888	16	.941	26	.960	36	.969	46	.975	80	.985
7	.898	17	.944	27	.961	37	.970	47	.976	85	.985
8	.906	18	.946	28	.962	38	.971	48	.976	90	.986
9	.912	19	.949	29	.963	39	.971	49	.976	95	.987
10	.918	20	.951	30	.964	40	.972	50	.977	100	.987

53.5.1 Outlier detect

Point X_i is considered an outlier if:

$$X_i > \bar{X} + 3\hat{\sigma} \quad \text{or} \quad X_i < \bar{X} - 3\hat{\sigma}$$

53.6 Regression and Correlation

- Y_i = The i^{th} reading of the Y dimension in the database
- X_i = The i^{th} reading of the X dimension in the database
- n = The number of parts (readings) in the sample
- USL = Upper Specification Limit (+Tolerance + Nominal)
- LSL = Lower Specification Limit (-Tolerance + Nominal)
- t = A test of the significance of the slope of the regression line
- F = Another test of significance of the slope of the regression line. Use the distribution you have tables for or pick either, the results will be identical.
- r = The correlation coefficient. r^2 represents the proportion of the variance of Y that can be attributed to its linear regression on X.
- σ^{b1} = The standard deviation of the regression coefficient
- $\exp(X)$ = An alternate notation for e^X , $\exp(X)$ is easier to read in large equations
- dF = The degrees of freedom
- SSE = The sum of squares of deviations
- MSE = The mean square deviation from regression

$$\bar{X} = \left(\frac{1}{n}\right) \sum_{i=1}^n X_i$$

$$\bar{Y} = \left(\frac{1}{n}\right) \sum_{i=1}^n Y_i$$

The equations in this section make use of the following notation.

$$\begin{aligned}\sum x^2 &= \sum_{i=1}^n (X_i - \bar{X})^2 &= \sum_{i=1}^n X_i^2 - \left(\frac{1}{n}\right) \left(\sum_{i=1}^n X_i\right)^2 \\ \sum y^2 &= \sum_{i=1}^n (Y_i - \bar{Y})^2 &= \sum_{i=1}^n Y_i^2 - \left(\frac{1}{n}\right) \left(\sum_{i=1}^n Y_i\right)^2 \\ \sum xy &= \sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y}) &= \sum_{i=1}^n (Y_i X_i) - \frac{1}{n} \sum_{i=1}^n Y_i \sum_{i=1}^n X_i \\ b_1 &= \frac{\sum xy}{\sum x^2} & b_0 &= \bar{Y} - b_1 \bar{X}\end{aligned}$$

The regression line has the following equation: ordinate = (abscissa) $b_1 + b_0$

$$\begin{aligned}SSE &= \sum y^2 - \frac{(\sum xy)^2}{\sum x^2} & MSE &= \frac{SSE}{N-2} \\ t &= \frac{b_1}{\sigma_{b_1}} & \sigma_{b_1} &= \sqrt{\frac{MSE}{\sum x^2}} \\ r &= \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}} & SST &= \sum y^2 \\ \sigma_{\hat{y}_m} &= \sqrt{MSE \left(\frac{1}{n} + \frac{x^2}{\sum x^2} \right)} & SSR &= \frac{(\sum xy)^2}{\sum x^2} \\ & & SSE &= SST - SSR \\ & \text{or} & & \\ \sigma_{\hat{y}_i} &= \sqrt{MSE \left(1 + \frac{1}{n} + \frac{x^2}{\sum x^2} \right)} & & \text{(for individual)}\end{aligned}$$

Writing the sample regression equation of Y on X as:

$$\hat{Y} = \bar{Y} + b_1(X - \bar{X})$$

We can obtain 95% confidence intervals for the population mean and for prediction of an individual Y using the equation:

$$\hat{Y} \pm t_{.05} \sigma_{\hat{y}} \quad \text{where } t_{.05} \text{ is the 5\% level of the } t \text{ distribution with } n-2 \text{ degrees of freedom.}$$

ANOVA (Analysis of Variance) Table for linear regression

Source	dF	SS	MS	F
Regression	1	SSR	MSR	MSR/MSE
Residual	n-2	SSE	MSE	
Total	n-1	SST		

Note that either t or F can be used to determine whether or not the correlation between the variables is significantly different from 0.

53.7 Bivariate Analysis

$$(1) \quad \hat{\sigma}_x^2 = \frac{N \sum x^2 - (\sum x)^2}{N(N-1)}$$

$$(2) \quad \hat{\sigma}_y^2 = \frac{N \sum y^2 - (\sum y)^2}{N(N-1)}$$

$$(3) \quad \hat{\sigma}_{xy} = \frac{N \sum xy - \sum x \sum y}{N(N-1)}$$

$$(4) \quad \hat{\rho} = \frac{\hat{\sigma}_{xy}}{\hat{\sigma}_x \hat{\sigma}_y}$$

$$(5) \quad T_{critical}^2 = \frac{2(N-1)}{N-2} F(\alpha, n_1, n_2)$$

where $\alpha=0.05$, $n_1=2$ and $n_2=N-2$.

The equation for Hotelling's T^2 is:

$$(6) \quad T^2 = \frac{\hat{\sigma}_x^2 \hat{\sigma}_y^2}{\hat{\sigma}_x^2 \hat{\sigma}_y^2 - \hat{\sigma}_{xy}^2} \left(\frac{(x-\bar{x})^2}{\hat{\sigma}_x^2} + \frac{(y-\bar{y})^2}{\hat{\sigma}_y^2} - \frac{2\hat{\sigma}_{xy}(x-\bar{x})(y-\bar{y})}{\hat{\sigma}_x^2 \hat{\sigma}_y^2} \right)$$

(7) To plot the control ellipse use $T^2 = T_{critical}^2$ and find all values of X and Y that satisfy the equation for Hotelling's T^2 .

The equation for the probability density of the bivariate random normal is

$$(8) \quad f(x,y) = \frac{e^{-\left(\frac{(x-\mu_x)^2}{\hat{\sigma}_x^2} + \frac{(y-\mu_y)^2}{\hat{\sigma}_y^2} - \frac{2\hat{\sigma}_{xy}(x-\mu_x)(y-\mu_y)}{\hat{\sigma}_x^2 \hat{\sigma}_y^2} \right)}}{2\pi \hat{\sigma}_x \hat{\sigma}_y \sqrt{1-\hat{\rho}^2}}$$

Equations 1, 2, 3, 4, 5, 6, and 7 are from Jackson, J. Edward, "Quality Control Methods for Two Related Variables", Industrial Quality Control, January, 1956.

Equation 8 and the F table are from Devore, Jay L., Probability and Statistics for Engineering and the Sciences, Brooks/Cole, Monterey CA, 1987

Also according to Jackson the α error (the probability of the control chart indicating an out of control process when the process is in control) is 0.05 (5%).

53.8 Attribute Control Charts

Percent Defective (P Chart)

$$P_i = \frac{\text{Defective}_i}{n_i}$$

$$\bar{P} = \frac{\sum_{i=1}^m \text{Defective}_i}{\sum_{i=1}^m n_i}$$

$$\sigma_{P_i} = \sqrt{\frac{(1 - \bar{P})\bar{P}}{n_i}}$$

$$UCL_{P_i} = \bar{P} + k\sigma_{P_i}$$

$$LCL_{P_i} = \bar{P} - k\sigma_{P_i}$$

$$CLine_p = \bar{P}$$

Number Defective (nP Chart)

$$P_i = \frac{\text{Defective}_i}{n}$$

$$\bar{P} = \frac{1}{m} \sum_{i=1}^m P_i$$

$$\sigma_{nP} = \sqrt{n(1 - \bar{P})\bar{P}}$$

$$UCL_{nP} = n\bar{P} + k\sigma_{nP}$$

$$LCL_{nP} = n\bar{P} - k\sigma_{nP}$$

$$CLine_{nP} = n\bar{P}$$

Number of Defects (C chart)

$$\bar{c} = \frac{1}{m} \sum_{i=1}^m c_i$$

$$\sigma_c = \sqrt{\bar{c}}$$

$$UCL_c = \bar{c} + k\sigma_c$$

$$LCL_c = \bar{c} - k\sigma_c$$

$$CLine_c = \bar{c}$$

Unit Defects (U chart)

$$u_i = \frac{c_i}{n_i}$$

$$\bar{u} = \frac{\sum_{i=1}^m c_i}{\sum_{i=1}^m n_i}$$

$$\sigma_{u_i} = \sqrt{\frac{\bar{u}}{n_i}}$$

$$UCL_{u_i} = \bar{u} + k\sigma_{u_i}$$

$$LCL_{u_i} = \bar{u} - k\sigma_{u_i}$$

$$CLine_{u_i} = \bar{u}$$

53.9 Gage Repeatability And Reproducibility

Variables used in equations

$\bar{\bar{R}}$	=	The average of the operator average ranges
\bar{R}_n	=	the average of the ranges measured by operator n
\bar{X}_n	=	The average of all reading for operator n
\bar{X}_{Diff}	=	The largest \bar{X}_n - the smallest \bar{X}_n
R_p	=	The range of part averages (largest part average - smallest part average)
\bar{XP}_p	=	The average of all readings taken by all operators for part p
$M_{part,operator,trial}$	=	The observed Measurement of a given part, taken by a specific operator on the specified trial.
$R_{part,operator}$	=	The range (largest - smallest) of observed measurements for a given part by a given operator.
LCL	=	Lower control limit.
UCL	=	Upper control limit
Repeatability	=	Equipment Variation (EV)
Reproducibility	=	Appraiser Variation (AV)
R&R	=	The combined effect of EV and AV (Repeatability & Reproducibility)
$d_2^*(m,g)$	=	A constant used to estimate the standard deviation from the range
nr	=	number of parts times the number of trials

$$K_1 = (6/d_2^*) * (\text{Number of Trials}, \text{Number of Parts} * \text{Number of Operators})$$

$$K_2 = (6/d_2^*) * (\text{Number of Operators}, 1)$$

$$K_3 = (6/d_2^*) * (\text{Number of Parts}, 1)$$

$$R_{part,operator} = MAX\left(M_{Part,Operator,1}, M_{Part,Operator,2}, \dots, M_{Part,Operator,NumberOfTrials}\right) - MIN\left(M_{Part,Operator,1}, M_{Part,Operator,2}, \dots, M_{Part,Operator,NumberOfTrials}\right)$$

$$\bar{R}_{Operator} = \frac{\sum_{Part=1}^{\text{Number Of Parts}} R_{Part,Operator}}{\text{Number Of parts}}$$

$$\bar{\bar{R}} = \frac{\sum_{Operator=1}^{\text{Number Of Operators}} \bar{R}_{Operator}}{\text{Number Of Operators}}$$

$$\bar{XP}_{Part} = \frac{\sum_{Operator=1}^{\text{Number Of Operators}} \sum_{Trial=1}^{\text{Number Of Trials}} M_{Part,Operator,Trial}}{\left(\text{Number Of Operators}\right) * \left(\text{Number Of Trials}\right)}$$

$$\bar{X}_{Diff} = MAX\left(\bar{X}_1, \bar{X}_2, \dots, \bar{X}_{\text{Number Of Operators}}\right) - MIN\left(\bar{X}_1, \bar{X}_2, \dots, \bar{X}_{\text{Number Of Operators}}\right)$$

$$R_p = MAX\left(\bar{XP}_1, \bar{XP}_2, \dots, \bar{XP}_{\text{Number Of Parts}}\right) - MIN\left(\bar{XP}_1, \bar{XP}_2, \dots, \bar{XP}_{\text{Number Of Parts}}\right)$$

$$UCL = \bar{\bar{R}} * D_4$$

$$LCL = \bar{\bar{R}} * D_3$$

$$Total\ Variation = \sqrt{(Part\ Variation)^2 + R\&\ R^2}$$

$$repeatability = \bar{\bar{R}} * K_1$$

$$reproducibility = \sqrt{(\bar{X}_{Diff} * K_2)^2 - (repeatability^2 / nr)}$$

$$R\&\ R = \sqrt{repeatability^2 + reproducibility^2}$$

$$Part\ Variation = R_p * K_3$$

% Of Process Variation

$$\%repeatability = 100 * \frac{repeatability}{Total\ Variation}$$

$$\%reproducibility = 100 * \frac{reproducibility}{Total\ Variation}$$

$$\%R\&\ R = 100 * \frac{R\&\ R}{Total\ Variation}$$

$$\%Part\ Variation = 100 * \frac{Part\ Variation}{Total\ Variation}$$

% Of Tolerance

$$\%repeatability = 100 * \frac{repeatability}{Tolerance}$$

$$\%reproducibility = 100 * \frac{reproducibility}{Tolerance}$$

$$\%R\&\ R = 100 * \frac{R\&\ R}{Tolerance}$$

$$\%Part\ Variation = 100 * \frac{Part\ Variation}{Tolerance}$$

d2* values for selected m and g

	g=1	g>15
m=2	1.41	1.128
3	1.91	1.693
4	2.24	2.059
5	2.48	2.326
6	2.67	2.534
7	2.83	2.704
8	2.96	2.847
9	3.08	2.970
10	3.18	3.078
11	3.27	3.173
12	3.35	3.258
13	3.42	3.336
14	3.49	3.407
15	3.55	3.472