ChartReporter Data Sheet

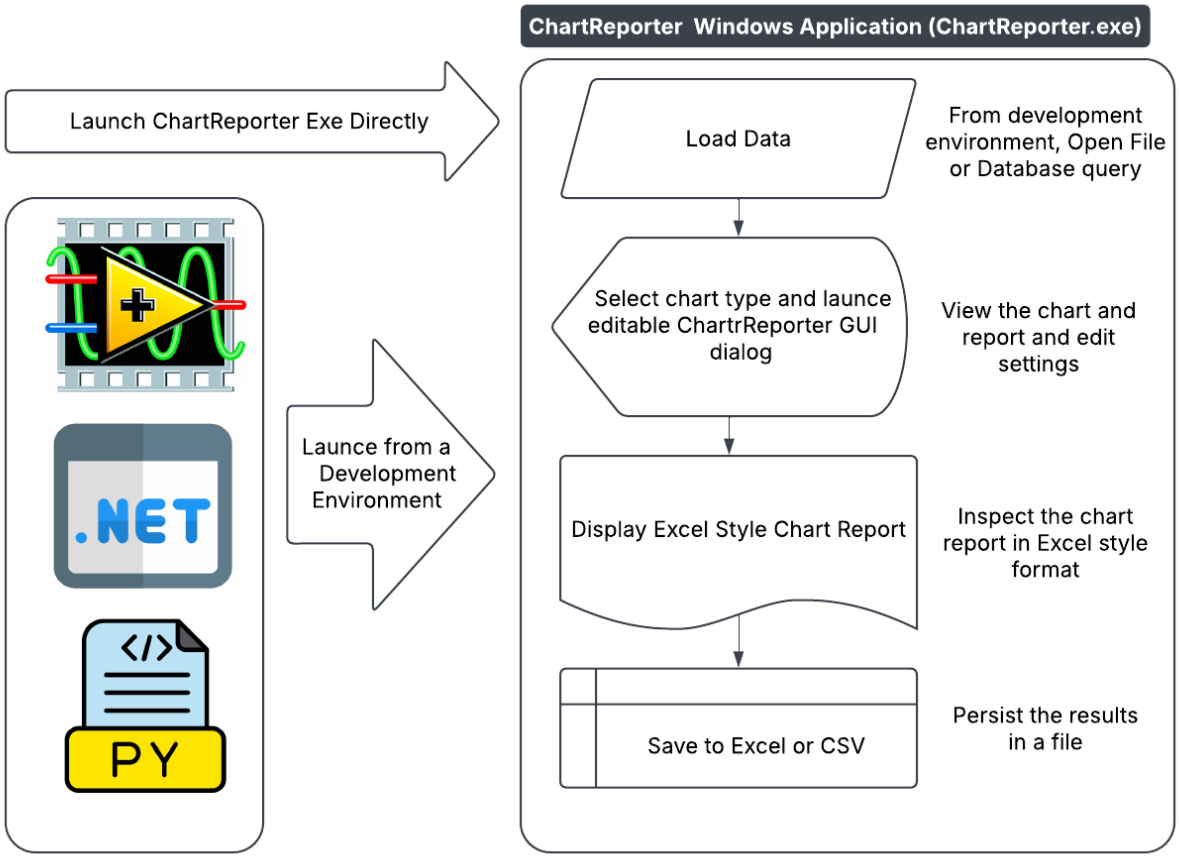
Contents

Overview

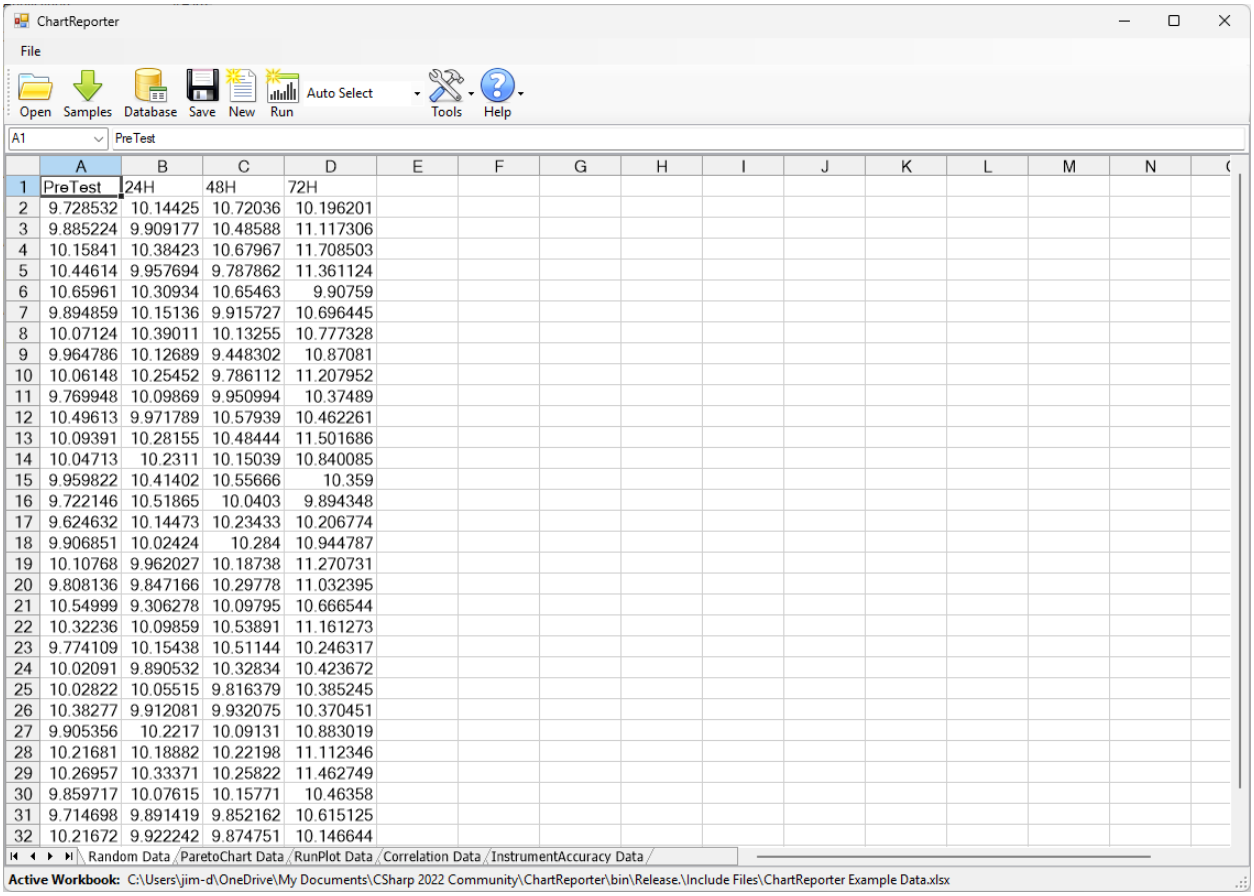
ChartReporter is a windows application that can produce full featured reports that include both charts and report analysis of the data. Key features are:

- The main user interface contains an Excel style workbook where data can either be imported from a file or sent directly into it from a separate development environment such as LabVIEW.
- Source code from a LabVIEW project can launch so developers can use the VIs to pass data and settings to the ChartReporter application via the Windows API.
- When a report is created inside ChartReporter, an application GUI is provided to edit settings to refine the report format before it is made final.
- Once a report is finalized on the application GUI, the both the chart and the analysis tables can be sent to a worksheet in the Main window.

The target audience are engineers, scientists, researchers, metrologists, or any others that are interested in analyzing data.



Main Application Window



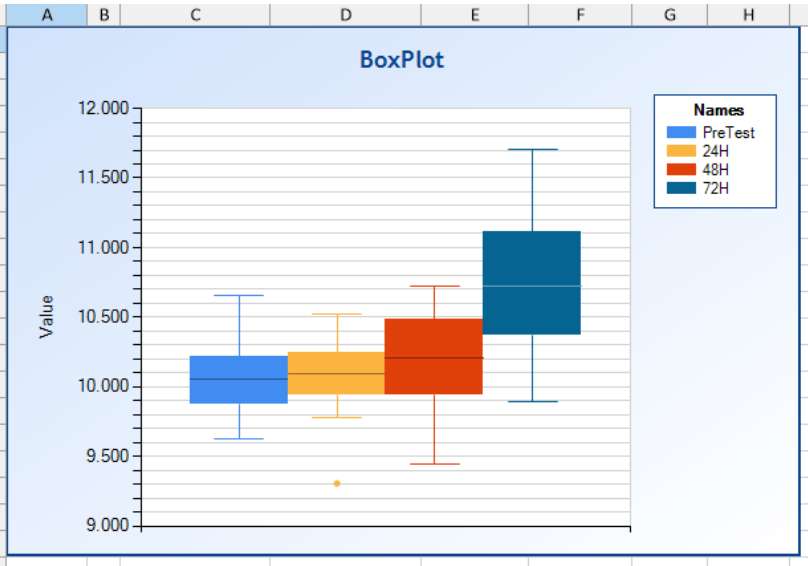
	A	B	C	D
1	PreTest	24H	48H	72H
2	9.728532	10.14425	10.72036	10.196201
3	9.885224	9.909177	10.48588	11.117306
4	10.15841	10.38423	10.67967	11.708503
5	10.44614	9.957694	9.787862	11.361124
6	10.65961	10.30934	10.65463	9.90759
7	9.894859	10.15136	9.915727	10.696445
8	10.07124	10.39011	10.13255	10.777328
9	9.964786	10.12689	9.448302	10.87081
10	10.06148	10.25452	9.786112	11.207952
11	9.769948	10.09869	9.950994	10.37489
12	10.49613	9.971789	10.57939	10.462261
13	10.09391	10.28155	10.48444	11.501686
14	10.04713	10.2311	10.15039	10.840085
15	9.959822	10.41402	10.55666	10.359
16	9.722146	10.51865	10.0403	9.894348
17	9.624632	10.14473	10.23433	10.206774
18	9.906851	10.02424	10.284	10.944787
19	10.10768	9.962027	10.18738	11.270731
20	9.808136	9.847166	10.29778	11.032395
21	10.54999	9.306278	10.09795	10.666544
22	10.32236	10.09859	10.53891	11.161273
23	9.774109	10.15438	10.51144	10.246317
24	10.02091	9.890532	10.32834	10.423672
25	10.02822	10.05515	9.816379	10.385245
26	10.38277	9.912081	9.932075	10.370451
27	9.905356	10.2217	10.09131	10.883019
28	10.21681	10.18882	10.22198	11.112346
29	10.26957	10.33371	10.25822	11.462749
30	9.859717	10.07615	10.15771	10.46358
31	9.714698	9.891419	9.852162	10.615125
32	10.21672	9.922242	9.874751	10.146644

The form contains an Excel like interface, a Menu Bar, a Toolbar and a Status at the bottom of the form.

- Data can be loaded using either clicking **Open** or loaded automatically via an external development environment such as LabVIEW.
- A **Samples** button can be used to open a Workbook containing sample data to practice the capabilities.
- A **Database** button lets you query data from a database and copy it to a worksheet on the main application window.
- A report can be started by first loading in data and then clicking the **Run** button to start the report creation process. If data comes from an external application, the report starts automatically. The **Dropdown** to the right of the **Run** button allows you to select a rectangular regio automatically or do a manual selection.
- A **Tools** button is provided to provide custom reports or analysis
- A **Help** button is provided to give application help.
- Once a report is created, the workbook can be saved using the **Save** tool.

Chart Report Types

BoxPlot



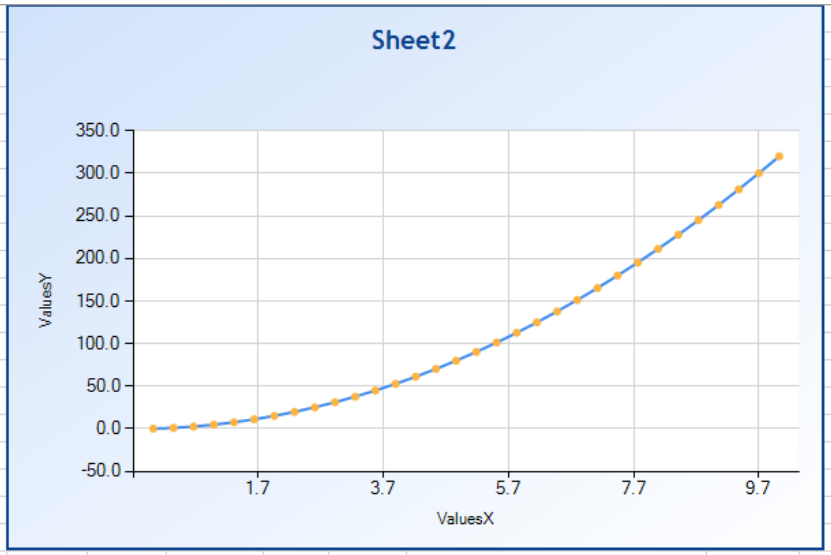
BoxPlot Parameters

Name	N	Lower Whisker	Upper Whisker	Lower Box	UpperBox	Meaan	Median	Outliers	Minimum	Maximum	Range
PreTest	32	9.625	10.66	9.872	10.217	10.056	10.056		9.625	10.66	1.035
24H	32	9.782	10.519	9.94	10.243	10.092	10.092	9.306	9.306	10.519	1.213
48H	32	9.448	10.72	9.942	10.485	10.203	10.203		9.448	10.72	1.272
72H	32	9.894	11.709	10.372	11.114	10.727	10.727		9.894	11.709	1.815

BoxPlots visualize a distribution of data by showing a solid box from the 25th percentile to the 75th percentile (Inner quartile Range) and end points of the distribution as typically min and max. Outliers are shown as dots. BoxPlots versus histograms are best used when there are small samples or when the distribution is not normal. BoxPlots are an excellent way to show multiple distributions side by side on the same chart.

Correlation

	Correlation Data		
2	XData	YData	YFit
3	0	0	0.001
4	0.323	0.957	0.96
5	0.645	2.539	2.539
6	0.968	4.745	4.748
7	1.29	7.575	7.573
8	1.613	11.03	11.031
9	1.935	15.109	15.103
10	2.258	19.813	19.811
11	2.581	25.14	25.146
12	2.903	31.093	31.088
13	3.226	37.669	37.673
14	3.548	44.87	44.86
15	3.871	52.695	52.695
16	4.194	61.145	61.156
17	4.516	70.219	70.214
18	4.839	79.917	79.925
19	5.161	90.239	90.229
20	5.484	101.186	101.19
21	5.806	112.758	112.74
22	6.129	124.953	124.951
23	6.452	137.773	137.788
24	6.774	151.217	151.209
25	7.097	165.286	165.296
26	7.419	179.979	179.963
27	7.742	195.297	195.3
28	8.065	211.238	211.263
29	8.387	227.804	227.8
30	8.71	244.995	245.013
31	9.032	262.81	262.796
32	9.355	281.249	281.26
33	9.677	300.312	300.289
34	10	320	320.002



Summary					
XName	YName	Fit Order	MSEE	RMSEE	Coefficients
X	Y	2	0	0.01	a0=0.001 a1=1.999 a2=3.000

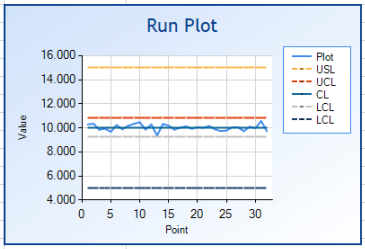
The Correlation report provides a curve fit between two variables by allowing the user to adjust the fit order until the desired fit accuracy is determined. Polynomial coefficients are provided that can then be used to accurately determine a Y value given the X value. A use application is in a wind tunnel wind speed setup where a voltage is used to adjust the air velocity from a fan. Once the relationship coefficients are determined, the voltage setting for any specified air velocity can be set. A report tabulation of the polynomial coefficients and the resulting fit accuracy is provided.

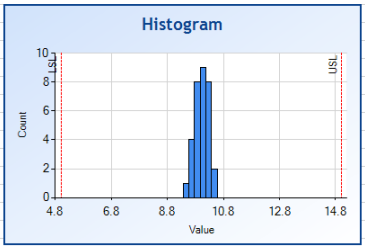
GageStudy

Run Data		
Point	Value	Event
1	10.293	
2	10.352	
3	9.847	
4	9.947	
5	9.681	
6	10.241	
7	9.887	
8	10.179	
9	10.343	
10	10.47	
11	9.866	
12	10.295	
13	9.354	
14	10.325	
15	10.194	
16	9.855	
17	10.028	
18	10.136	
19	9.934	
20	10.065	
21	10.021	
22	10.163	
23	9.889	
24	9.743	
25	9.783	
26	10.053	
27	10.054	
28	9.738	
29	10.098	
30	9.986	
31	10.574	
32	9.732	

Results

Item	Description	Value	Status
Column	The name of the data being studied	Gage1	
LSL	Lower specification limit	5	
USL	Upper specification limit	15	
Tolerance	USL - LSL	10	
N	The sample size of the data	32	
Mean	Average of the data	10.035	
SD	The sanple statndard deviation of the data	0.26	
Reference	The specified reference value or standard	10	
LCL	The Lower Control Limit of the Run Chart: Reference - 0.1*Tolerance	9.256	
CL	The Centrol LIne of the Run Chart: (LCL + UCL)/2	10.035	
UCL	The Uppwe Control Limit of the Run Chart: Reference + 0.1*Tolerance	10.815	
Bias	Mean - Reference	0.035	
Cg	Gage capability without bias - >= 1.33 is capabile	1.28	Not Capable
Cgk	Gage capability with bias - >= 1.33 is capabile)	1.24	Not Capable
%Var without bias	% Variability without bias. Value <= 10 acceptable, between 10 and 30 marginal, above 30 unacceptable	15.59	Marginal
%Var with bias	% Variability with bias. Value <= 10 acceptable, between 10 and 30 marginal, above 30 unacceptable	16.15	Marginal
t-statistic	The ratio of the departure of the estimated value of a parameter from its hypothesized value to its standard error	0.766	
p-value	A p value greater than 0.05 means that difference in the Mean and the Reference is not statisitically significant	0.449	Not Significant

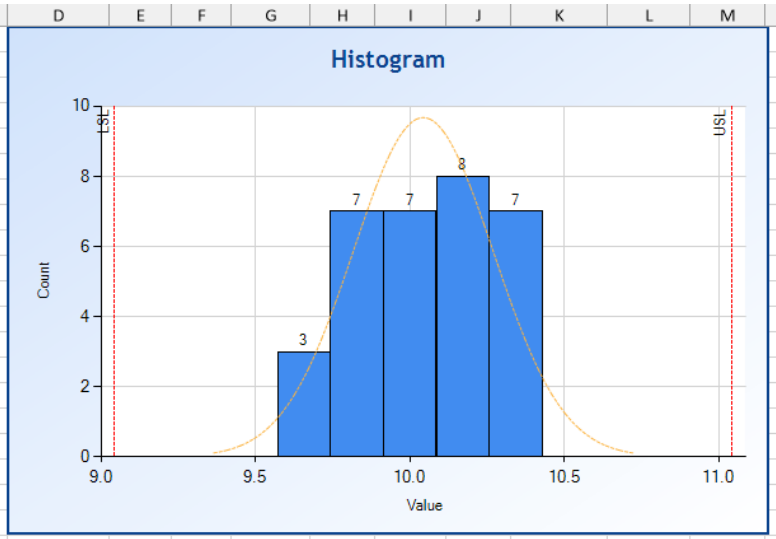




GageStudy performs a Type 1 Gage Study on a single sample of gage data to check its suitability to make capable measurements considering the gage spec limits and a reference standard. The above two charts show the variability of the gage being studied as a RunPlot and as a Histogram. The GageStudy report among other items, the Gage capabilities Cg (variability only) and Cgk (variability considering the mean relative to the standard reference).

Histogram

Bin Width: 0.172	
Value	Count
9.613	3
9.784	7
9.956	7
10.128	8
10.299	7



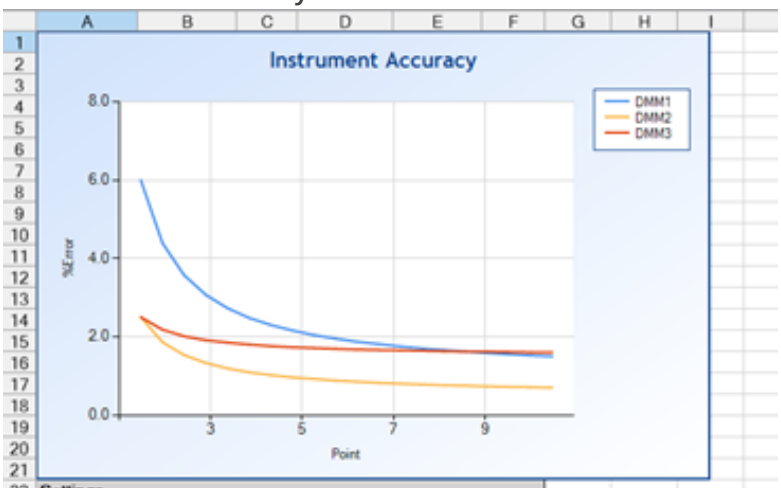
Statistics															
Name	LSL	USL	N	Mean	S	Median	Min	Max	Range	Skewness	Kurtosis	CP	CPL	CPU	CPK
Data	9	11	32	9.999	0.226	10.004	9.527	10.385	0.858	-0.14	-1.038	1.47	1.47	1.47	1.47

Attributes							
Fail Low	%Fail Low	Fail High	%Fail High	Fail	%Fail	Pass	%Pass
0	0	0	0	0	0	32	100

Outliers			
Rule	Low	High	Total
3Sigma	0	0	0

Histogram Chart Report provides a feature-rich results and editing capability to view data in a histogram format. The dialog view allows users to edit how the histogram is presented. For example, number of bins, showing or hiding the normal approximation on the chart, showing or hiding histogram point values, etc. A limit optimizer too lets the user automatically adjust the limits based on a target Cpk.

InstrumentAccuracy



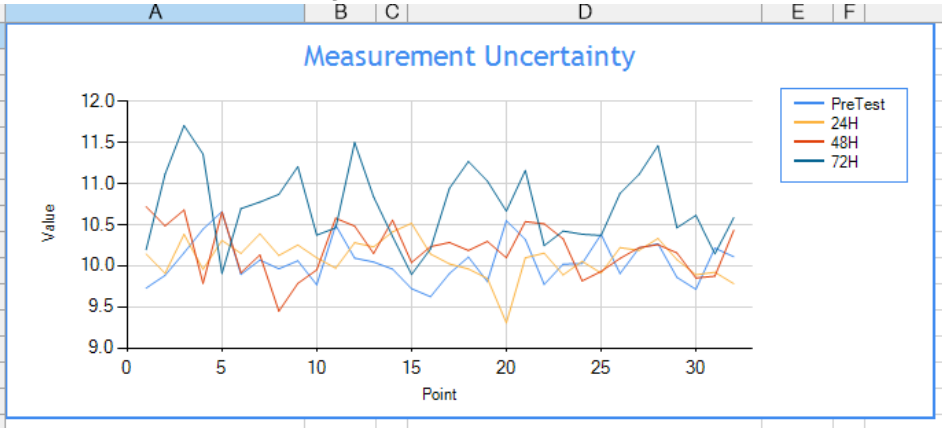
Settings					
Points	Range	Min%	Min Value	Precision	Units
20	10	10	1	2	None

Instrument Table			
Instrument	%Reading	Offset	Range
DMM1	1	0.05	10
DMM2	0.5	0.02	10
DMM3	1.5	0.01	10

Accuracy			
Points	DMM1	DMM2	DMM3
1	6	2.5	2.5
1.47	4.39	1.86	2.18
1.95	3.57	1.53	2.01
2.42	3.07	1.33	1.91
2.89	2.73	1.19	1.85
3.37	2.48	1.09	1.8
3.84	2.3	1.02	1.76
4.32	2.16	0.96	1.73
4.79	2.04	0.92	1.71
5.26	1.95	0.88	1.69
5.74	1.87	0.85	1.67
6.21	1.81	0.82	1.66
6.68	1.75	0.8	1.65
7.16	1.7	0.78	1.64
7.63	1.66	0.76	1.63
8.11	1.62	0.75	1.62
8.58	1.58	0.73	1.62
9.05	1.55	0.72	1.61
9.53	1.52	0.71	1.6
10	1.5	0.7	1.6

The InstrumentsAccuracy chart type is a tool to characterize the accuracy of measuring instruments over s specified range based on %Reading Error, Offset Error and Range. The tool can be used to characterize a single instrument, or multiple instruments performing the same task to compare capabilities. The latter is useful if multiples manufacturers/models are being considered, and it is desired to select the best one for the task and cost.

MeasurementUncertainty



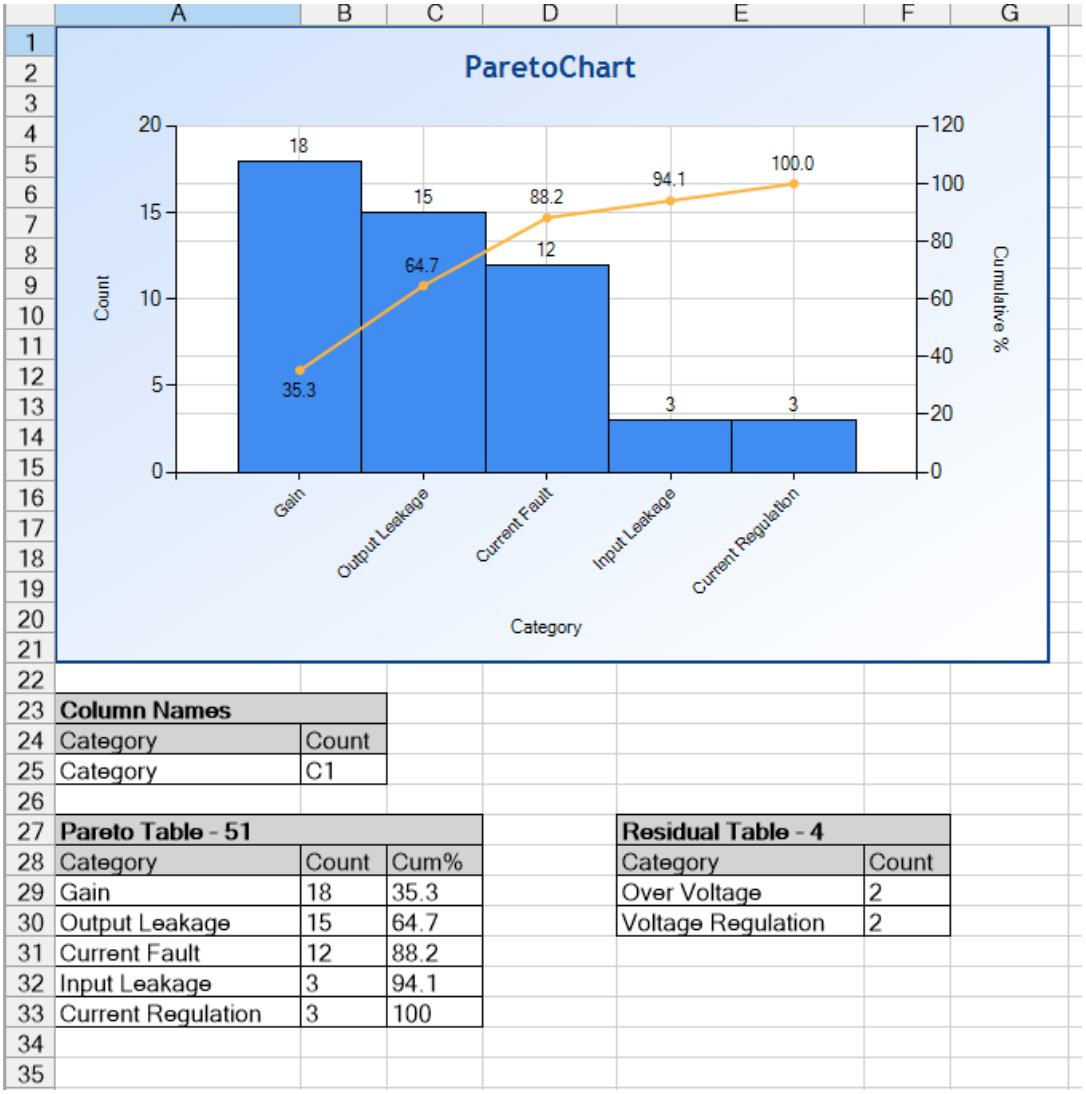
Settings	
Name	Value
Gage Resolution	0.01
STD Resolution	0.001
STD Expanded Uncertainty	0.2
STD Coverage	2
Gage Coverage	2

Type B Uncertainties	
Name	Value
Gage Resolution Uncertainty	0.003
Standard Resolution Uncertainty	0.032
Standard Combined Uncertainty	0.1

Study Results	
Name	Value
Instrument	DMM1
Units	Volts
Samples	32
Trials	4
Repeatability	0.749
Reproducibility	0.311
Type A Uncertainty	0.81
Type B Uncertainty	0.11
Combined Uncertainty	0.11
Gage Coverage	2
Expanded Uncertainty	0.21

The MeasurementUncertainty chart report provides a full measurement uncertainty analysis including running GR&R to obtain repeatability and reproducibility values to calculate the Type A statistical variation component. The user can also input custom Type B uncertainties not otherwise provided in the default settings. The automation means that it can provide a useful add-on for other development environments such as LabVIEW and .NET.

ParetoChart



Column Names	
Category	Count
Category	C1

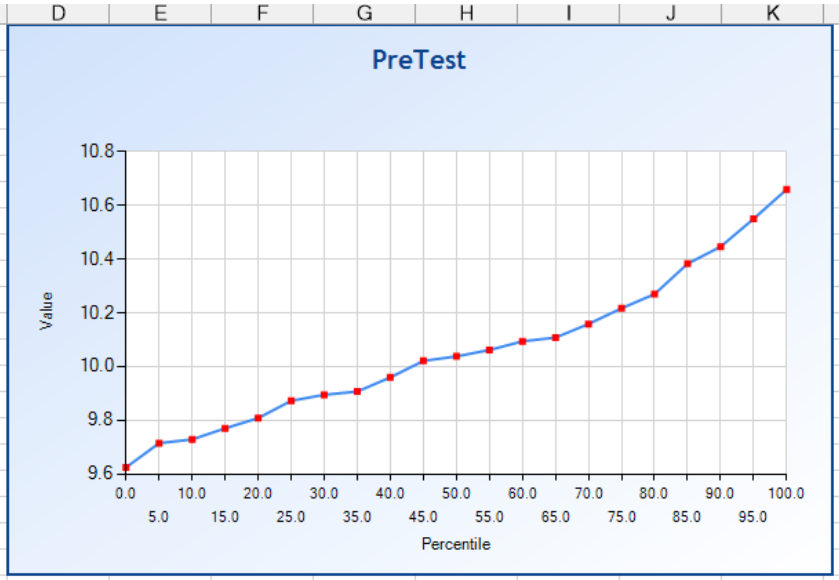
Pareto Table - 51		
Category	Count	Cum%
Gain	18	35.3
Output Leakage	15	64.7
Current Fault	12	88.2
Input Leakage	3	94.1
Current Regulation	3	100

Residual Table - 4	
Category	Count
Over Voltage	2
Voltage Regulation	2

Determines the vital few test names that exhibit the highest failure rate. The dialog view allows reducing the number to consider using the Maximum Categories entry in cases where there are many trivial ones. Residuals, if any, are shown on the right.

Percentile

Percentile Table	
Percentile	Value
0	9.624632
5	9.714698
10	9.728532
15	9.769948
20	9.808136
25	9.872471
30	9.894859
35	9.906851
40	9.959822
45	10.020906
50	10.037674
55	10.061479
60	10.093912
65	10.107675
70	10.158413
75	10.216765
80	10.269567
85	10.382769
90	10.446141
95	10.549986
100	10.659606

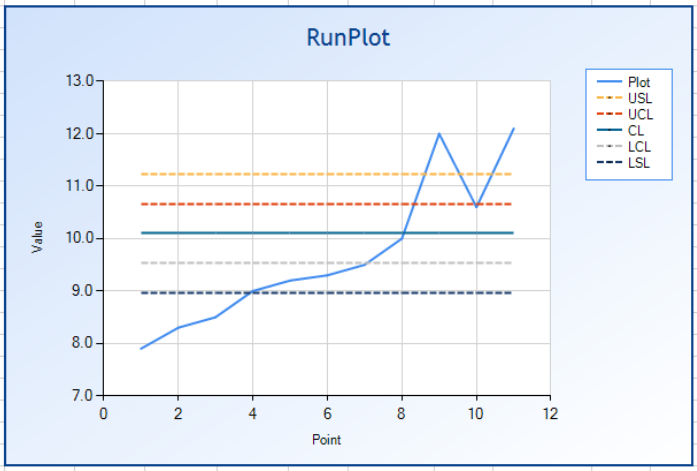


The Percentile ChartReport provides a view of the data percentiles. This is useful if it is important to granularly determine percentiles from data min to max.

RunPlot

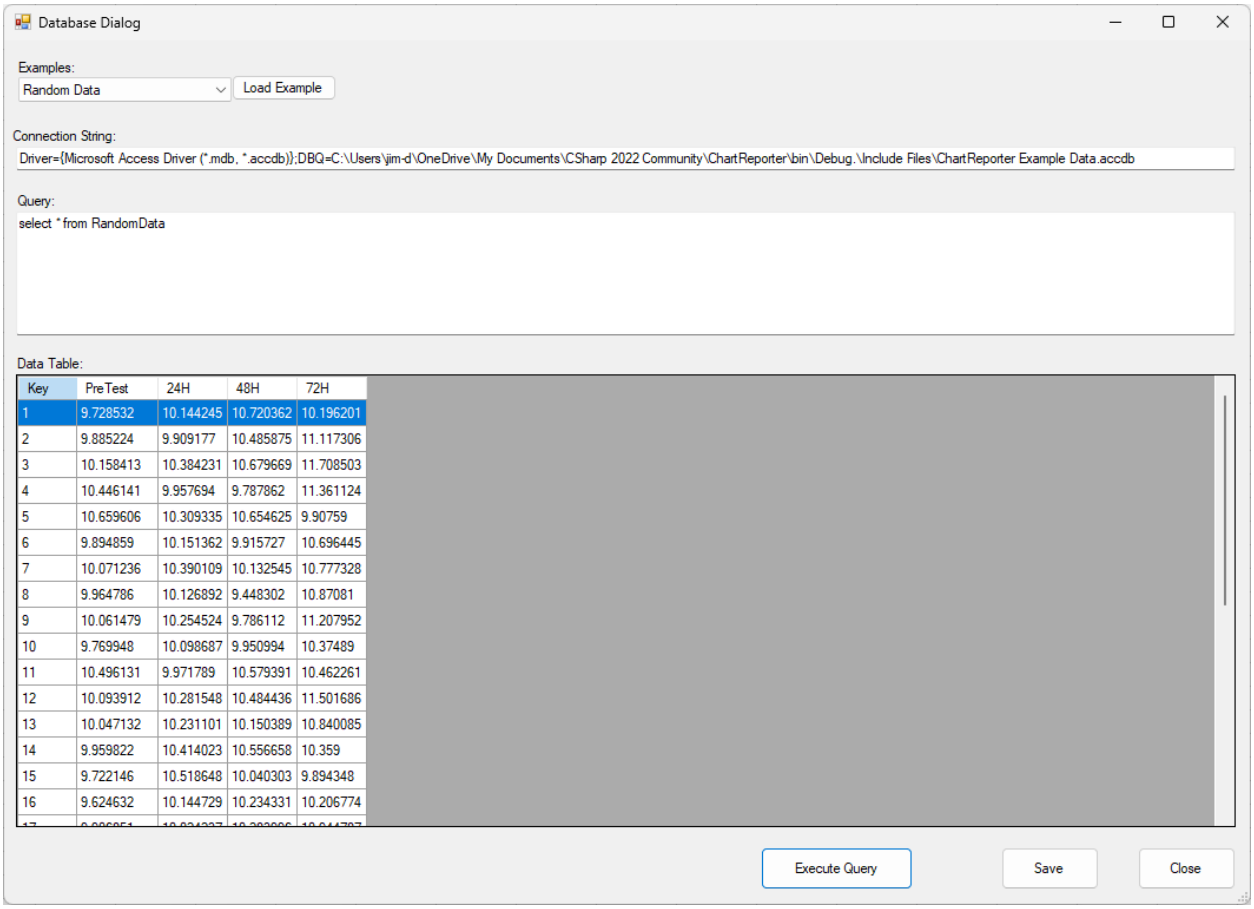
A RunPlot is used to track a test result through several process steps and detect any out-of-control points or trend characteristics. In the example below, a positive trend is detected. The Event column of the Run Data table shows any points that are not in control.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	**Summary**															
2	Name	N	LSL	LCL	CL	UCL	USL	CL Fail	SL Fail	Slope	Intercept	R	RSquared	T	PValue	Trend
3	Positive Trend	11	8.97	9.534	10.098	10.662	11.227	4	5	0.391	7.327	0.928	0.861	7.194	0	Positive
4																
5	**Run Data**															
6	Point	Name	Value	Event												
7	1	0H	7.9	LSL												
8	2	1000H	8.3	LSL												
9	3	2000H	8.5	LSL												
10	4	3000H	9	LCL												
11	5	4000H	9.2	LCL												
12	6	5000H	9.3	LCL												
13	7	6000H	9.5	LCL												
14	8	7000H	10													
15	9	8000H	12	USL												
16	10	9000H	10.6													
17	11	1000H	12.1	USL												
18																
19																
20																
21																
22																
23																
24																
25																
26																



Determines the vital few test Categories that exhibit the highest failure rate. The dialog view allows reducing the number to consider using the Maximum Categories entry in cases where there are many trivial ones. Residuals, if any, are shown on the right.

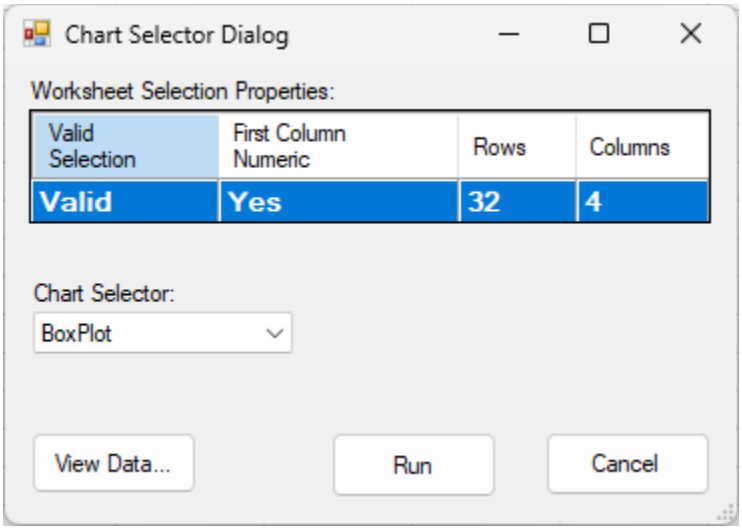
Getting Data from a Database



To obtain data from a database first click **Database** on the main window toolbar. Then you can enter the database **Connection String** and **Query**. Click **Execute Query** executes the query as shown above. Clicking **Save** saves the data table to a worksheet on the Main window. Then you can run one of the reports that supports this kind of data.

Operating ChartReporter as Stand-Alone

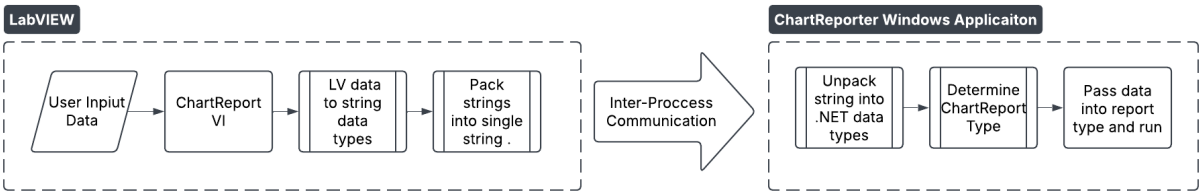
When operating ChartReporter as a stand-alone application, data is first loaded into the application using the Open tool. The user then selects a worksheet and data and clicks the Run tool and the ChartSelector dialog is shown:



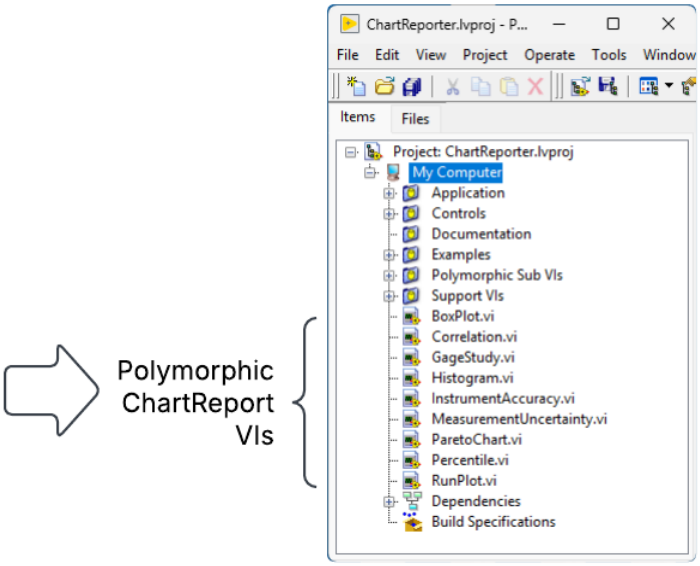
The Chart Selector drop-down shows the available Chart Reports based on the format of the data selected. Once a selection is main, the user clicks run to run the chart report.

Interfacing with the LabVIEW Development Environment

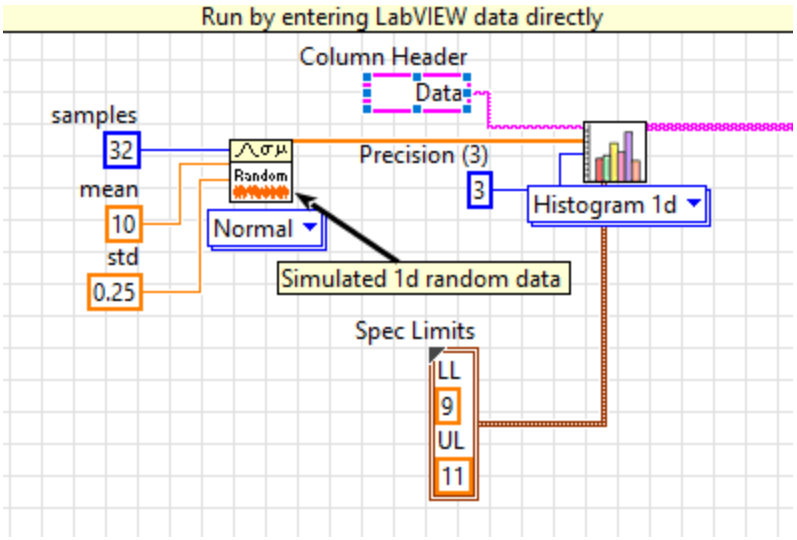
A LabVIEW project is provided to run chart reports from it such that data and required functionality is passed from the LabVIEW environment to the .NET ChartReporter application using inter-process communication as shown below.

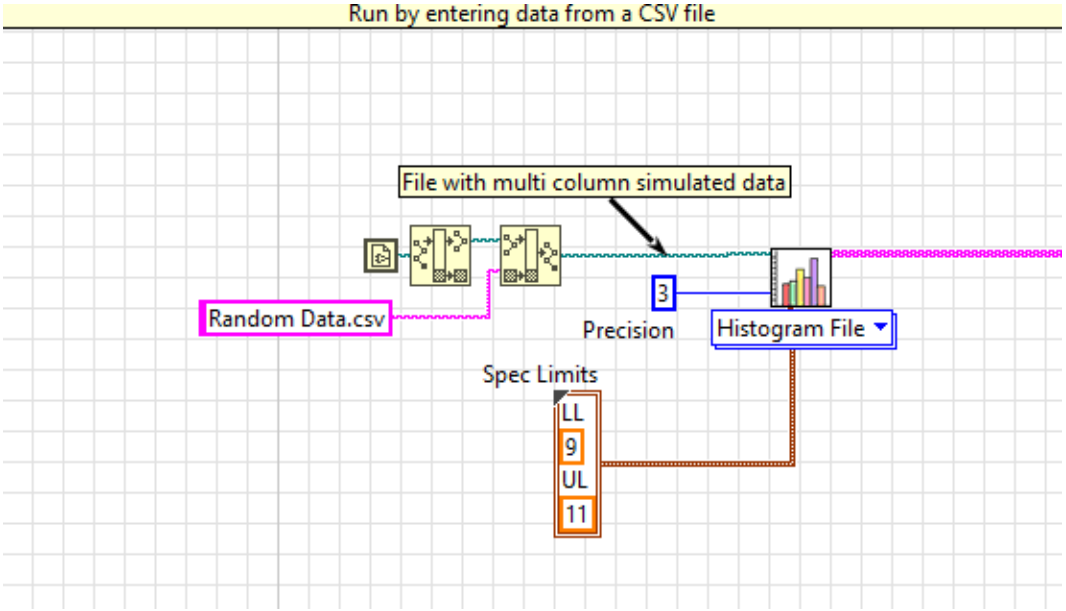


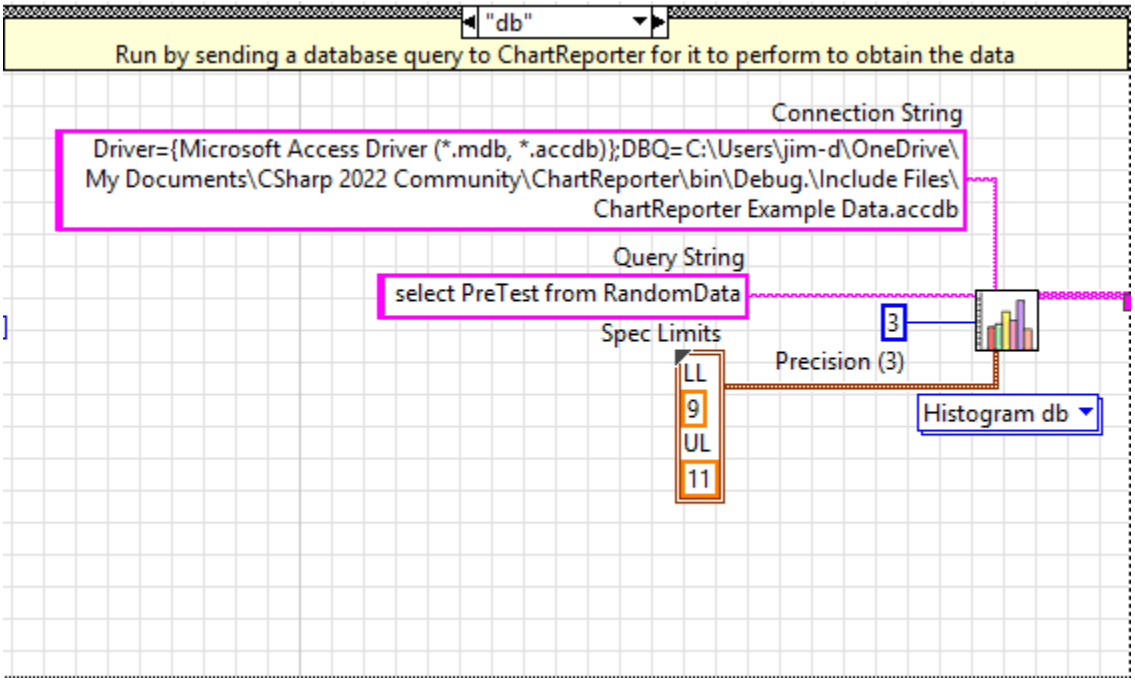
The LabVIEW project provides all the chart reports that are supported in the ChartReporter windows application. A screenshot of the LabVIEW project is shown below.



The polymorphic ChartReport VIs allows users to enter data from several methods, such as LabVIEW data input or a file containing the data.


Run by entering LabVIEW data directly
Column Header
Data
samples
32
mean
10
std
0.25
Random
Normal
Precision (3)
3
Histogram 1d
Simulated 1d random data
Spec Limits
LL
9
UL
11


Run by entering data from a CSV file
File with multi column simulated data
Random Data.csv
3
Precision
Histogram File
Spec Limits
LL
9
UL
11


"db"
Run by sending a database query to ChartReporter for it to perform to obtain the data
Connection String
Driver={Microsoft Access Driver (*.mdb, *.accdb)};DBQ=C:\Users\jim-d\OneDrive\
My Documents\CSharp 2022 Community\ChartReporter\bin\Debug.\Include Files\
ChartReporter Example Data.accdb
Query String
select PreTest from RandomData
Spec Limits
LL
9
UL
11
3
Precision (3)
Histogram db

Operating as a .NET Add-On

A .NET class library is provided to operate in the .NET environment. In this manner, the class library can be added as a reference to your own development .NET projects so you can call the functionality of ChartReporter to run any of the chart reports.

From Data:

The example C# code below shows how a Histogram is called by referencing the class library method Histograam1d.

```
private void Histogram1d_Example()
{
    int precision = 3;
    List<double> dataList = new List<double>();
    //Create random data
    for (int i=0; i < 32; i++)
    {
        dataList.Add(MathNet.Numerics.Distributions.Normal.Sample(10, .25));
    }
    string existingWorkbook = tbExistingWorkbook.Text;
    string columnName = "Data";
    double lsl = 9;
    double usl = 11;
    ChartReporterClassLibrary.Histogram(existingWorkbook, precision, columnName, dataList, lsl, usl);
}
```

Data is simulated for this example using an open source MathNet library. Observe the functionality allows specifying an existing Excel workbook to be opened in ChartReporter so that reports can be included there.

From a Database query:

```
private void Histogram_db_Example()
{
    int precision = 3;
    string existingWorkbook = "";
    string filePath = "C:\\Users\\jim-d\\OneDrive\\My Documents\\CSharp 2022 Community\\ChartReporter\\bin\\Debug.\\Include Files\\ChartReporter Example Data.accdb";
    string connectionString = "Driver={Microsoft Access Driver (*.mdb, *.accdb)};DBQ=" + filePath;
    string queryString = "select PreTest from RandomData";
    double lsl = 9;
    double usl = 11;
    string arguments = Main.Histogram_db(existingWorkbook, precision, connectionString, queryString, lsl, usl);
}
```