

ATE Toolbox User Guide



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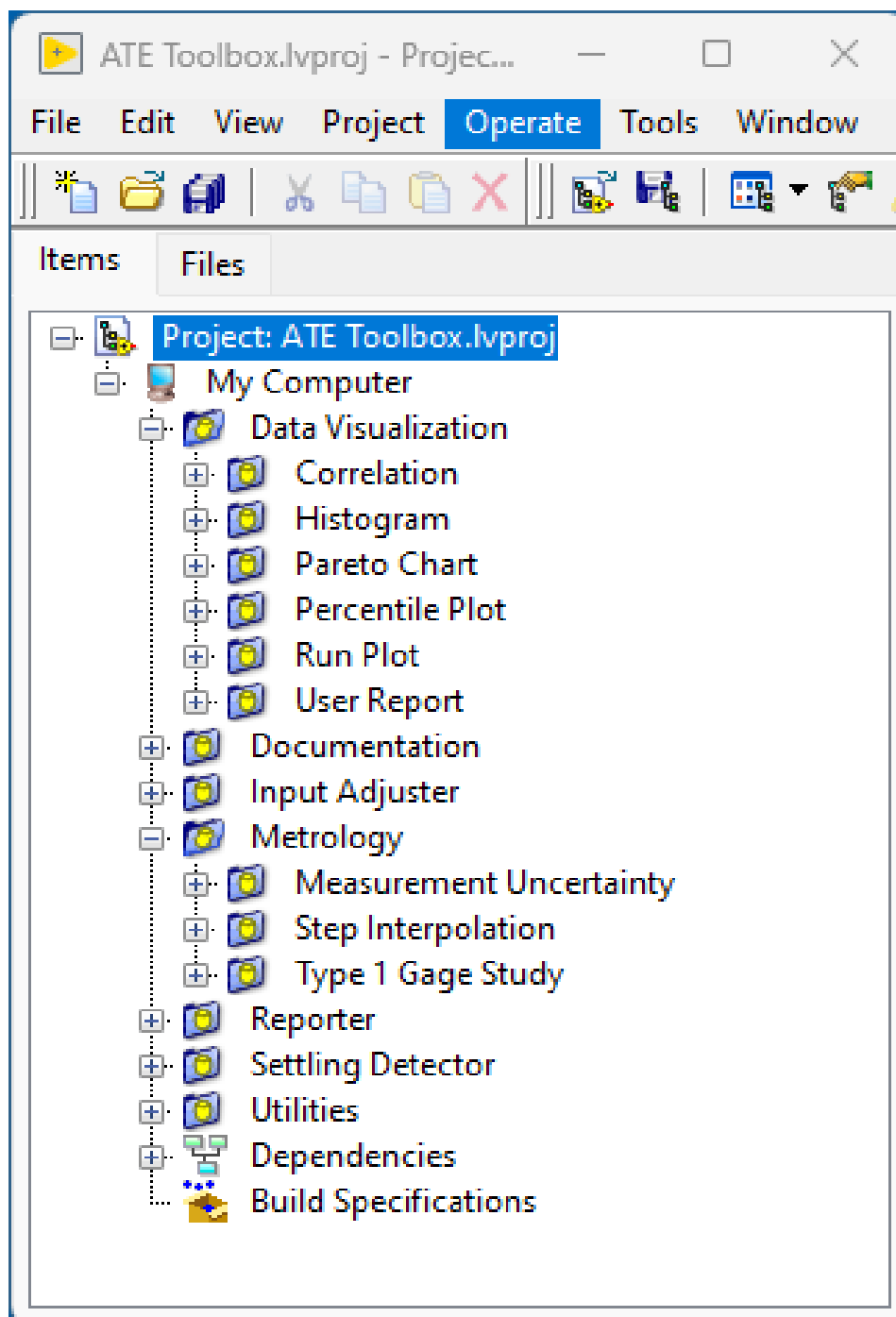
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Overview

The ATE Toolbox consists of two parts:

1. A **LabVIEW Project** containing VIs to create full featured statistical reports and to perform real time ATE control functions.
2. A **Reporter Application**:
 - LabVIEW data is passed to it to view and save reports in Microsoft Excel
 - Contains tools to manage reports and perform statistical functions

ATE Toolbox LabVIEW Project



LabVIEW Project Tools Summary:

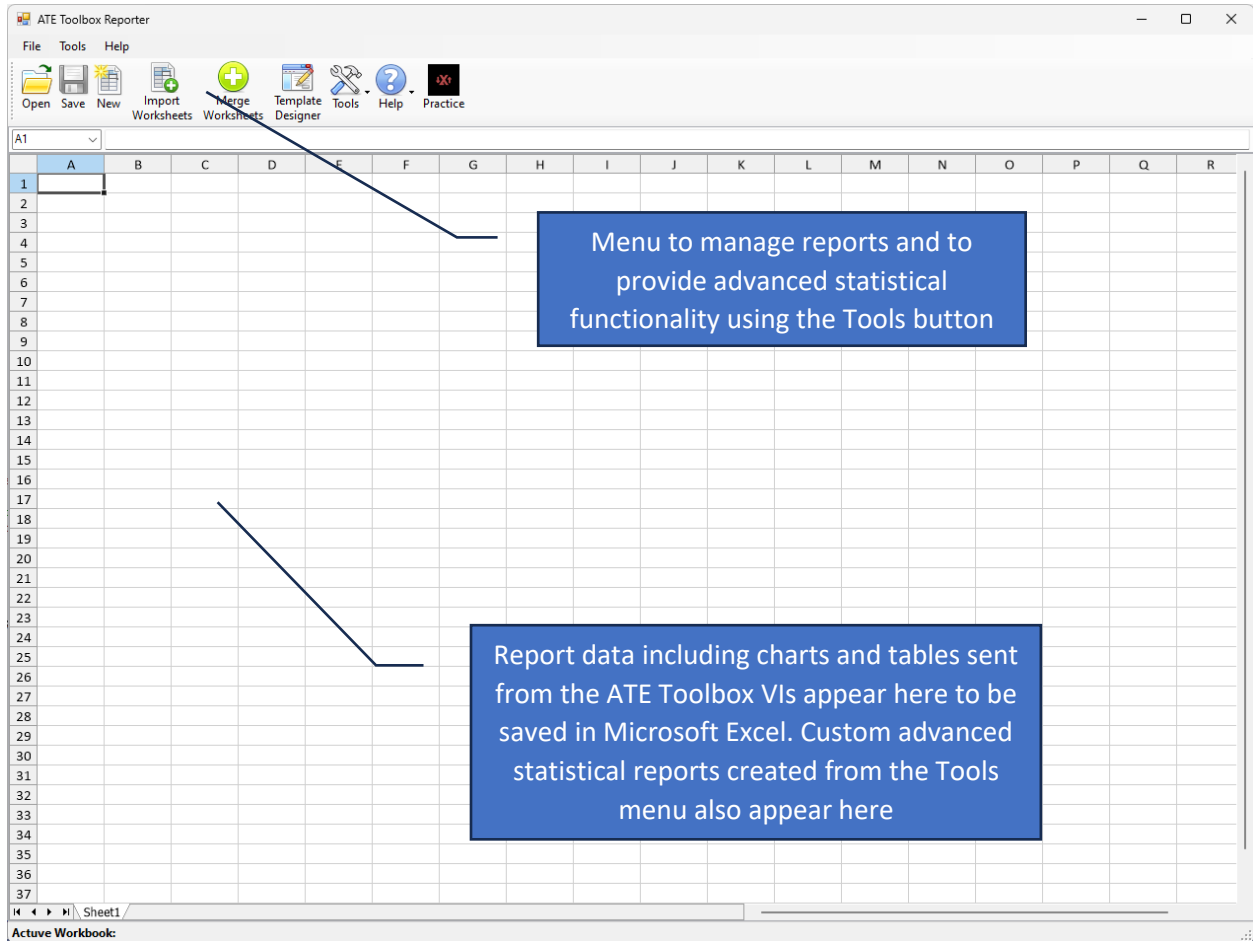
Tool	Type	Description	Excel Report*
Correlation*	Data Visualization	Curve fits two data series into a plot and provides polynomial coefficients to correlate one data series to the other for later use in a test program for accurate control of a process.	Template Report
Histogram*	Data Visualization	Provides full featured histogram style data visualization including statistics, test fail attributes, outliers and a Cpk test limit optimizer.	Template Report
Pareto Chart*	Data Visualization	A prioritization rank order visual tool of category data to determine high occurrences of importance such as test failure categories or test time.	Template Report
Percentile Plot*	Data Visualization	Plots percentile from 0 to 100% of a data series to visualize data in this format	Template Report
Run Plot*	Data Visualization	Plots a run plot of measurements in time and determine points out of control or failing and test for positive or negative trends. When a binary search can be used it greatly reduces the number of iterations, therefore overall test time.	Template Report
User Report	Data Visualization	Vis are provided to produce an Excel report from within LabVIEW. Excel elements provided are: Cell Text, Text Box, Comments, Data Table, Charts. Formatting options included.	User Report
Input Adjuster	Test Control	Provides control feedback for real time linear and binary searches of an input stimulus to achieve a desired output measurement result.	None
Measurement Uncertainty*	Metrology	Provides a measurement uncertainty based on user provided repeatability data, reproducibility data, type B factors and the test standard.	User Report
Step Interpolation	Metrology	A method to accurately provide calibrated measurement results based on a table of raw and standard (true) values.	None
Type 1 Gage Study*	Metrology	This study provides assessment metrics for a measurement instrument based on a calibrated reference. The results indicate how well the instrument is suited to perform accurately by providing gage study figures of merit, Cg and Cgk.	Template Report

Settling Detector	Test Control	Determines when a slower moving signal (msec and above) has settled so the test program can continue with a known condition result.	None
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ATE Toolbox Reporter Application

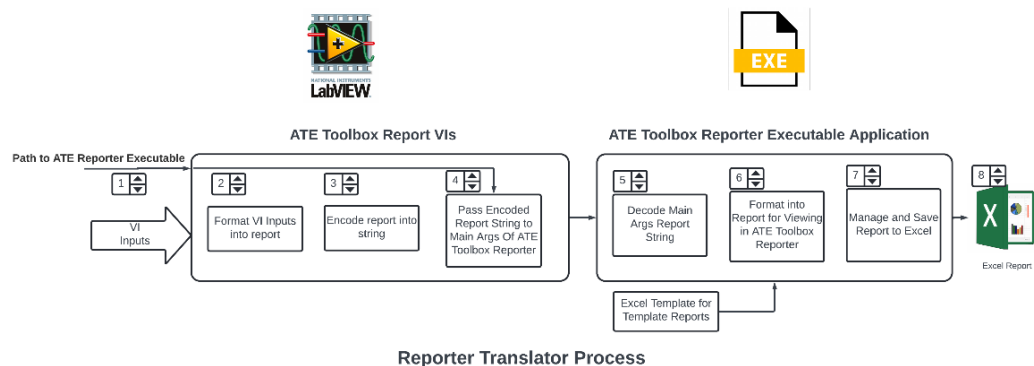
An executable application that is launched two ways:

1. From a ATT Toolbox project VI to present and save a report in Excel format
2. Separate tools to perform advanced statistical methods such as T-Test and others



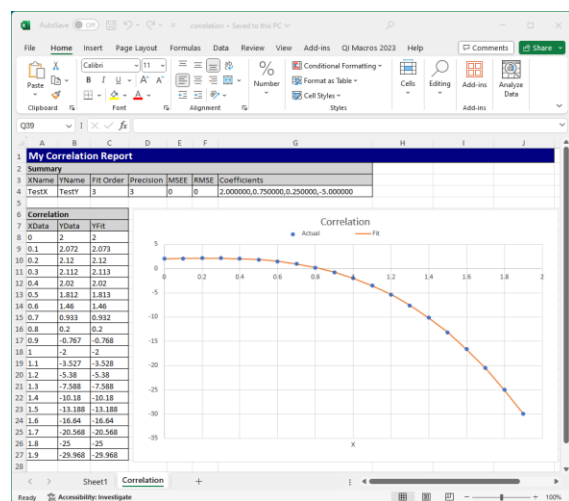
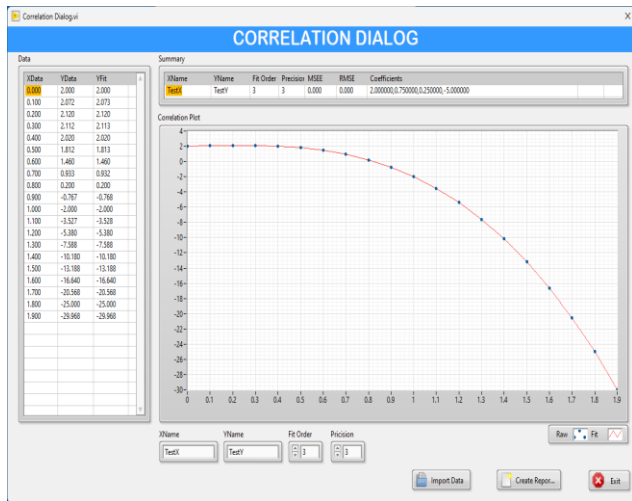
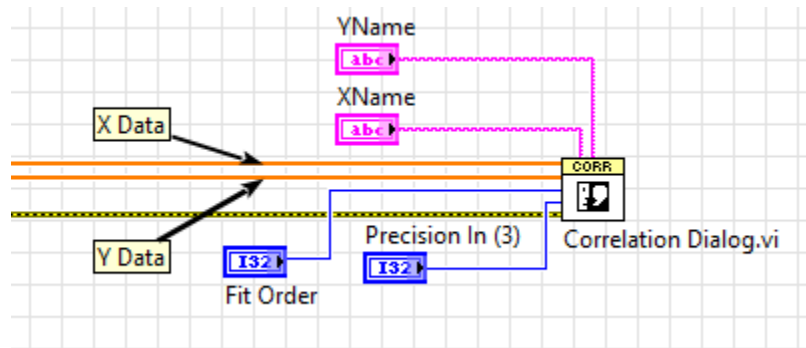
Reporter Translator Process

An Excel report is made from the LabVIEW report is goes though the Reporter Translator Process to convert from a LabVIEW report to an Excel equivalent as shown below:



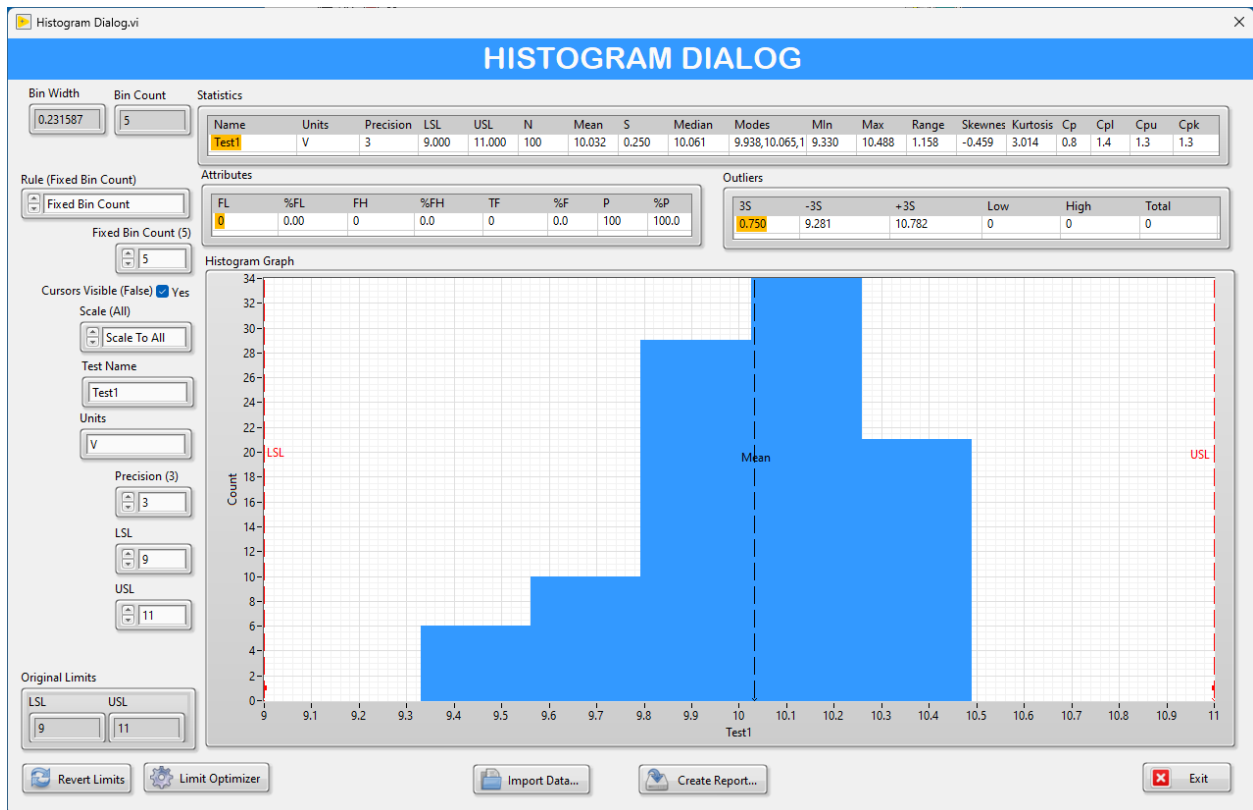
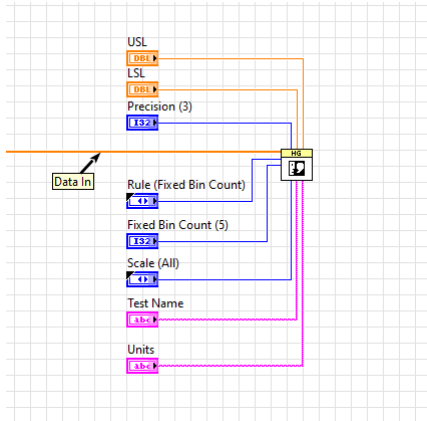
Data Visualization

Correlation



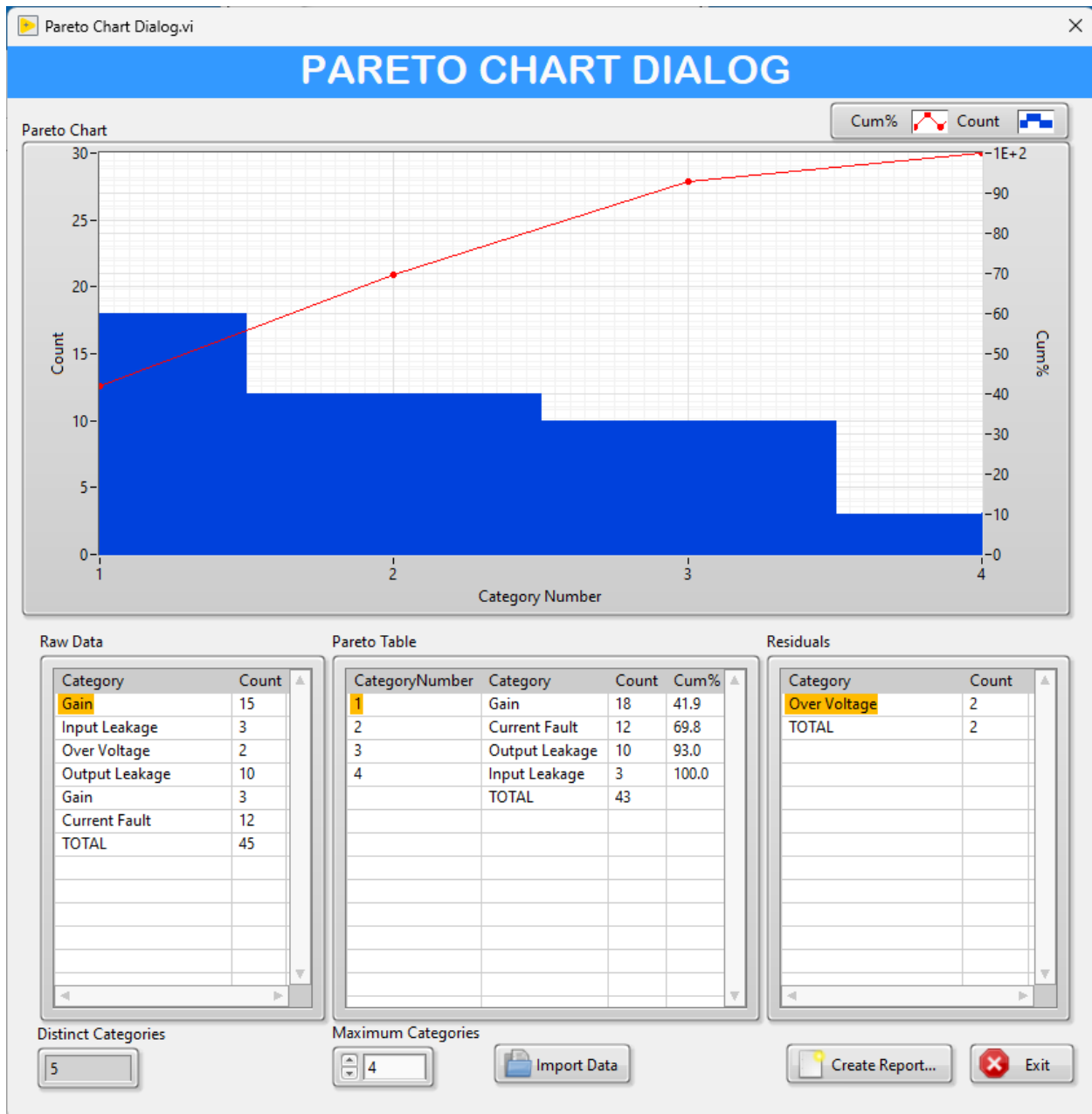
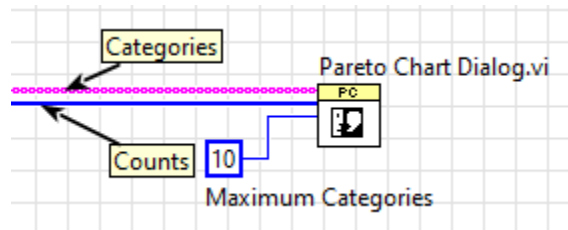
- The **Correlation Dialog** takes X Data and Y Data and computes polynomial coefficients to fit the data into YFit.
- An example use case is a DC voltage-controlled air velocity fan that has a nonlinear relationship with air velocity. Once the coefficients are determined, the relationship can be used to compute the DC voltage required to achieve a specified air velocity.
- The dialog can be run as a sub-vi or as stand-alone.
- An Excel report can be created and saved.

Histogram



- The Histogram Dialog provides a full featured Histogram to characterize the data.
- A **Statistics** summary, test failure **Attributes** and **Outliers** are provided.
- Settings can be edited once the dialog is shown.
- A **Limit Optimizer** tool is provided to automatically adjust limits based on a target Cpk and the data.
- The dialog can be run as a sub-vi or as stand-alone.
- An Excel report can be created and saved.

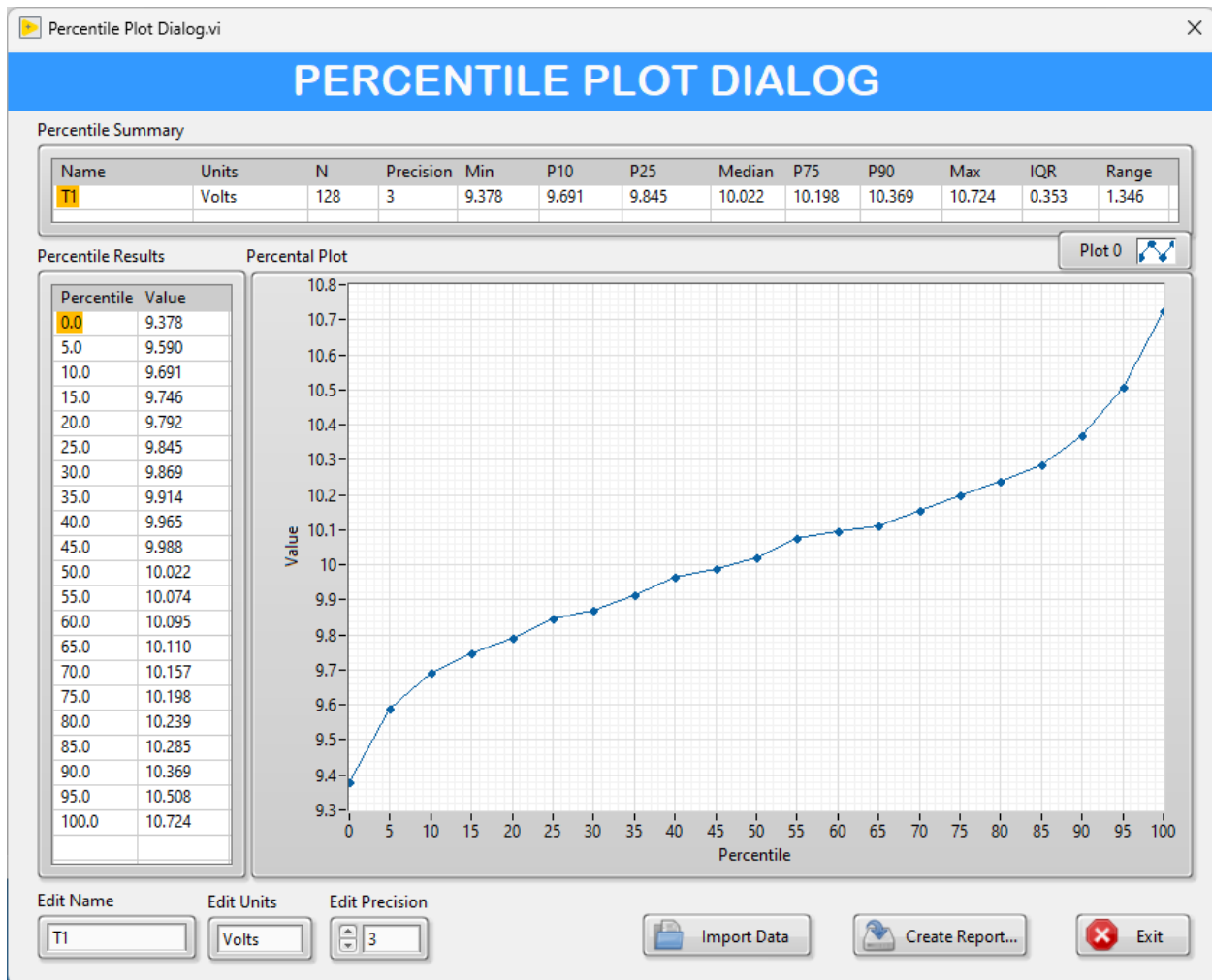
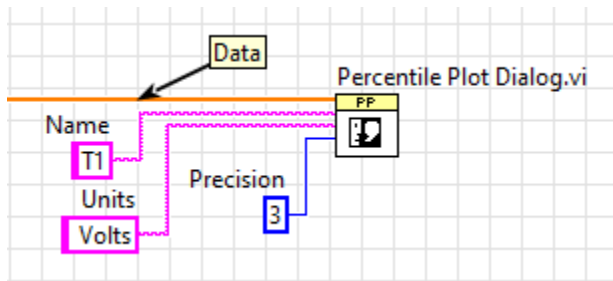
Pareto Chart



- The **Pareto Chart Dialog** rank orders category data counts from highest to lowest.
- The most impacting categories can be readily seen for subsequent addressing.
- Example use cases are test failures counts and test executing times.

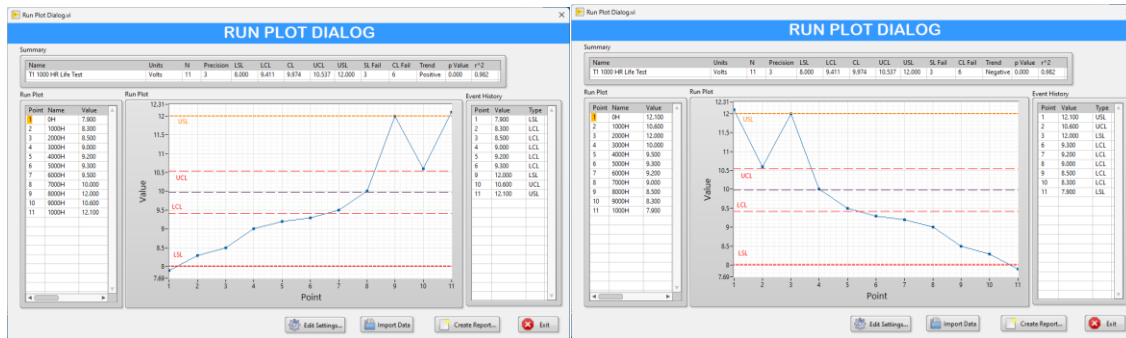
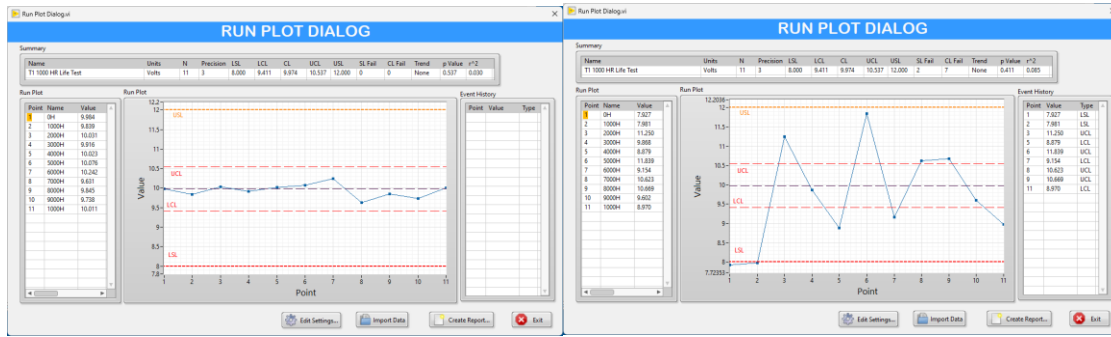
- A capability to limit the total number of distinct categories for the main Pareto is provided. This capability helps reduce the number of categories when there are too many to consider. The Residuals from the analysis are listed in a separate table.
- The dialog can be run as a sub-vi or as stand-alone.
- An Excel report can be created and saved.

Percentile Plot



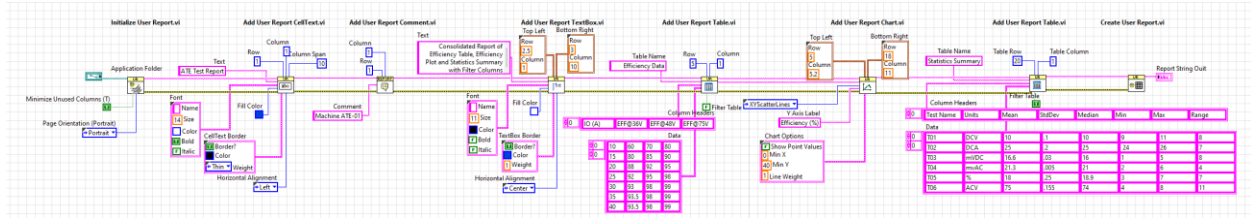
- The **Percentile Plot Dialog** plots percentiles of a data series from 0% to 100%.
- Useful in determining the value that has specified percentage below it.
- The dialog can be run as a sub-vi or as stand-alone.
- An Excel report can be created and saved.

Run Plot



- The **Run Plot Dialog** plots individual reading over time in a control chart style graph
- An example is a 1000-hour life test.
- Detects out of control, positive trends, and negative trends.
- In above figures left to right top to bottom examples: No Trend, In Control, No Trend Out Of Control, Positive Trend, Negative Trend.
- The dialog can be run as a sub-vi or as stand-alone.
- An Excel report can be created and saved.

User Report



AutoSave Off user report

File Home Insert Page Layout Formulas Data Review View Add-ins QI Macros 2023 Help

Calibri 14

ATE Test Report

ATE Test Report			
Consolidated Report of Efficiency Table, Efficiency Plot and Statistics Summary with Filter Columns			
Efficiency Data			
IO (A)	EFF@36V	EFF@48V	EFF@75V
10	60	70	80
15	80	85	90
20	88	92	95
25	92	95	98
30	93	98	99
35	93.5	98	99
40	93.5	98	99

Efficiency Data

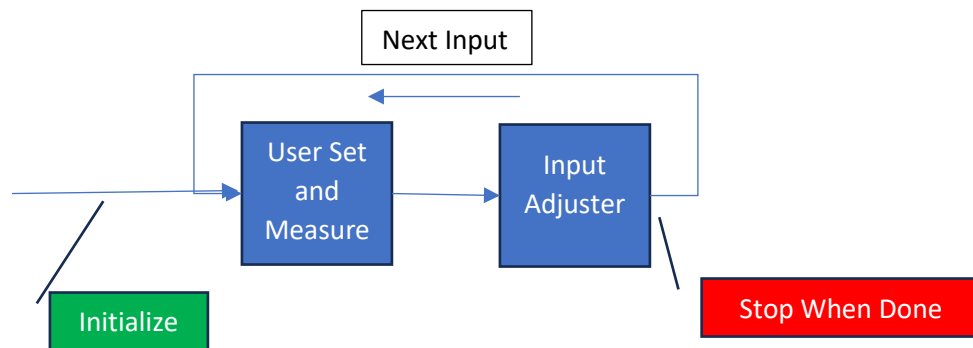
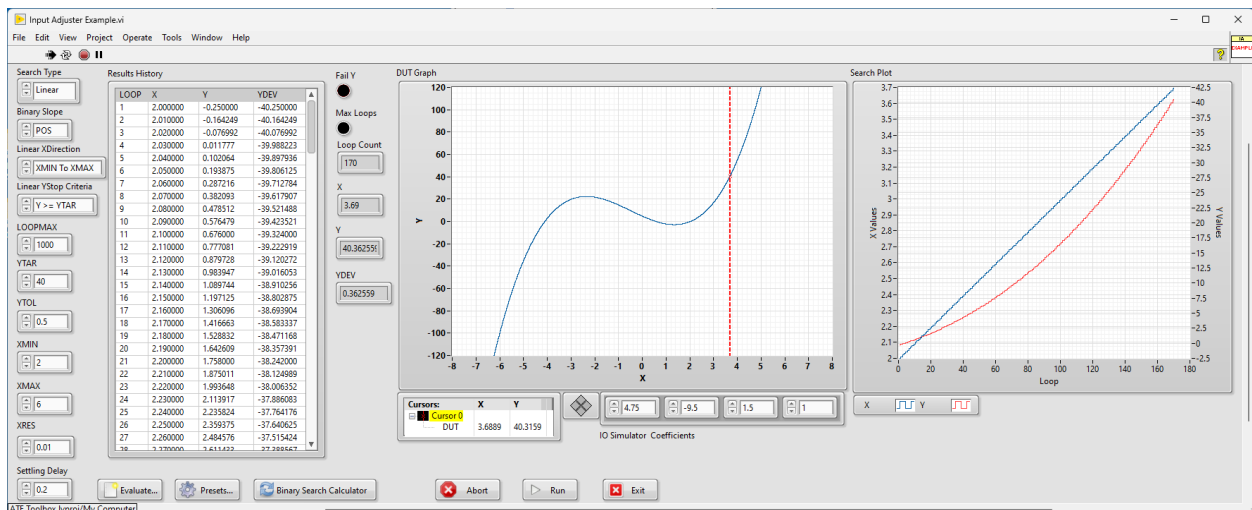
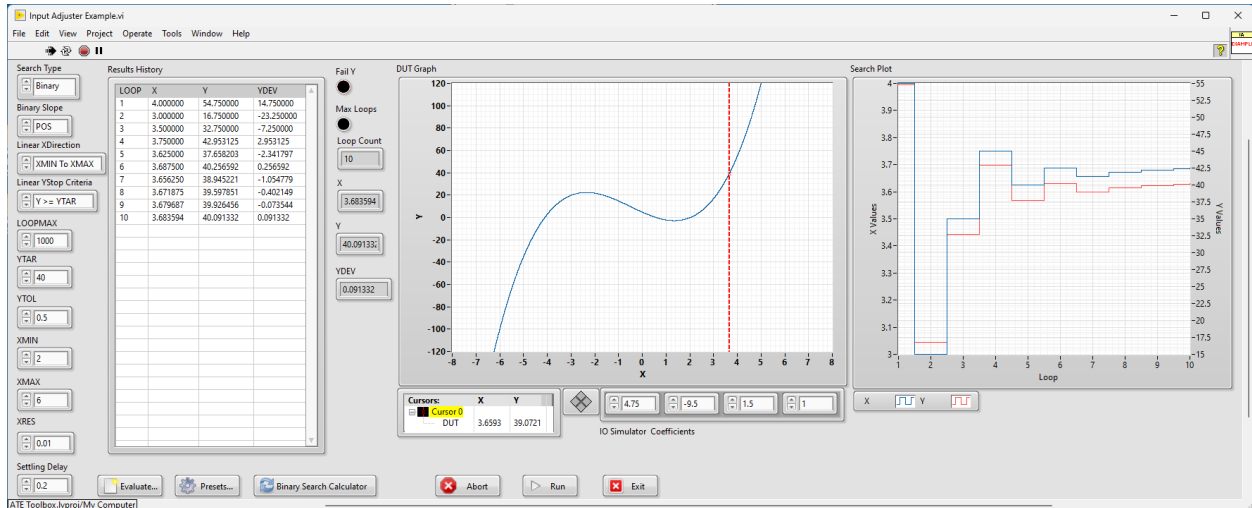
Test Name	Units	Mean	StdDev	Median	Min	Max	Range
T01	DCV	10	0.1	10	9	11	8
T02	DCA	25	0.2	25	24	26	7
T03	mVDC	16.6	0.03	16	1	5	8
T04	mvAC	21.3	0.005	21	2	6	4
T05	%	18	0.25	18.9	3	7	7
T06	ACV	75	0.155	74	4	8	11

Machine ATE-01

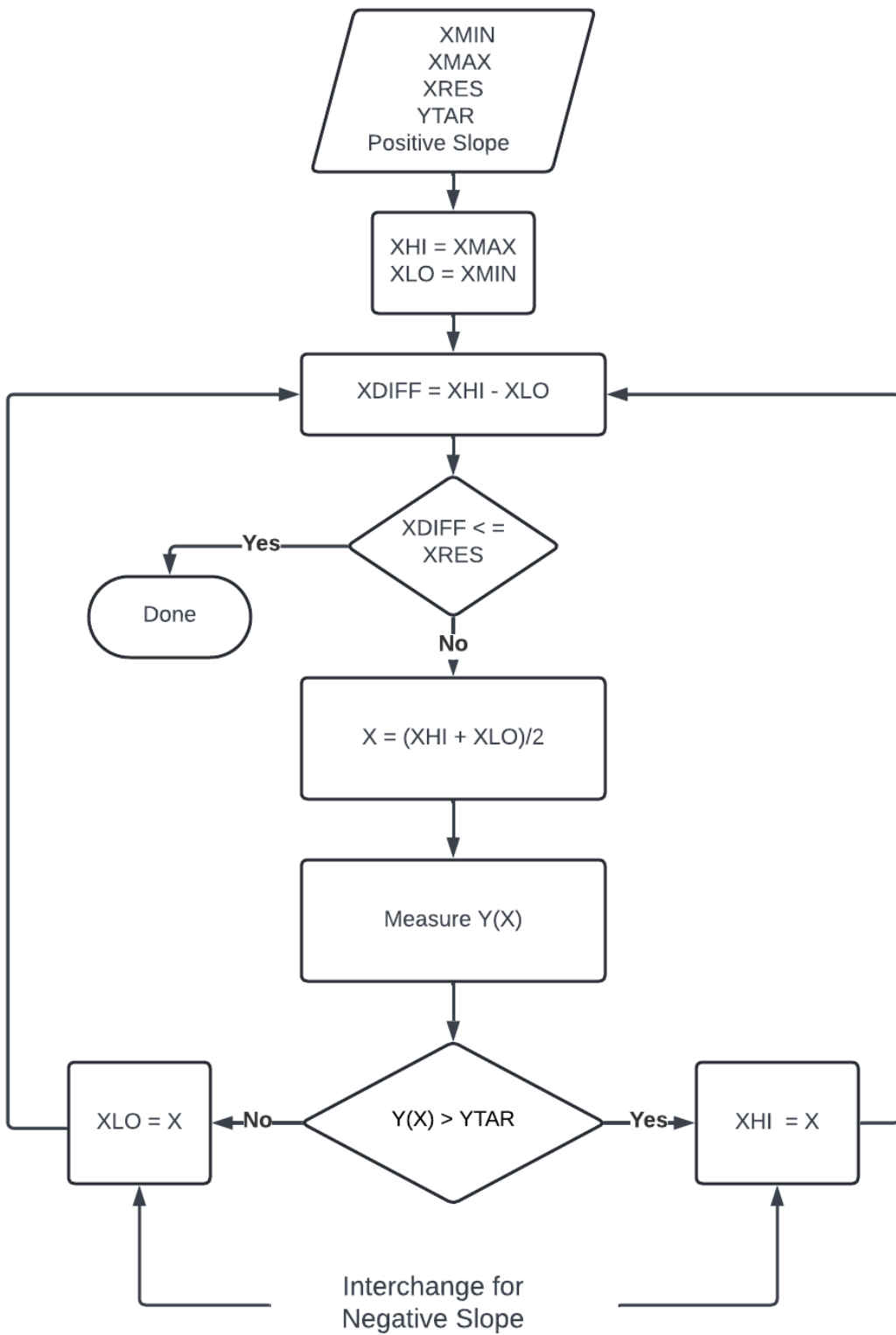
Sheet1

Ready Accessibility: Investigate Count: 10 100%

Input Adjuster

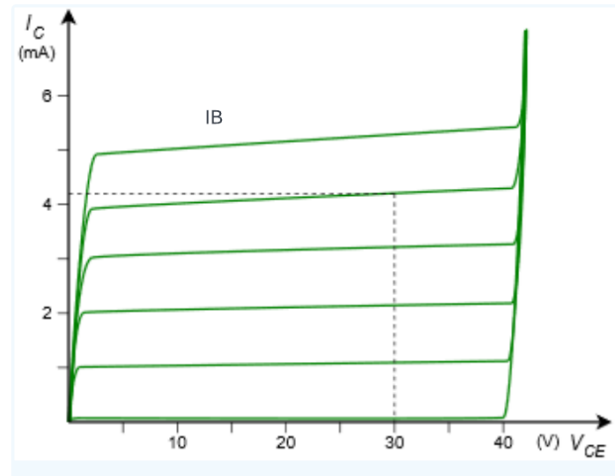
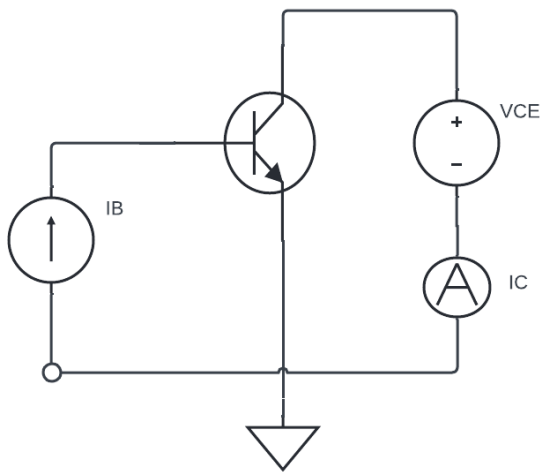


- An **Input Adjuster** VI is provided to adjust an input stimulus to achieve a specified output condition in real time.
- An Input Adjuster VI is provided to implement a controlled stimulus inside your own test application.
- Input adjusting is useful when there is an unknown relationship between the input stimulus and a measured output result.
- Two types of input adjusting are provided: Binary Search as shown in the top image and Linear Search shown in the bottom image.
- The I/O search pattern is shown on the far-right graph.
- In general, a Binary Search is much more efficient and quicker than a Linear Search when it can be used. In the examples above, the Binary Search took 10 steps while the Linear Search took 170 steps! This of course depends on where the Linear Search begins.
- A Binary Search is restricted to use cases where there is minimal hysteresis, and the I/O relationship is monotonic with no inflection points. The I/O relationship is allowed to be nonlinear.



Binary Search Flowchart

Bipolar Transistor IC Search Application:



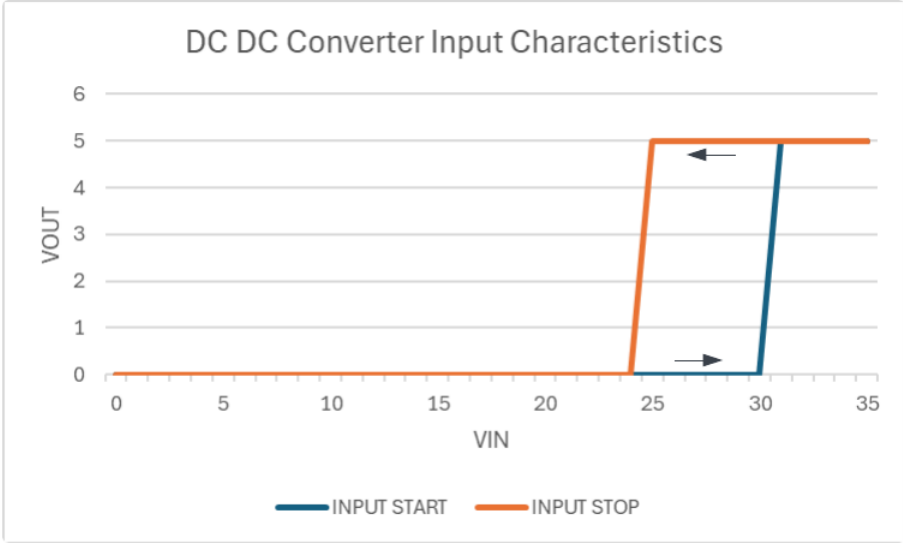
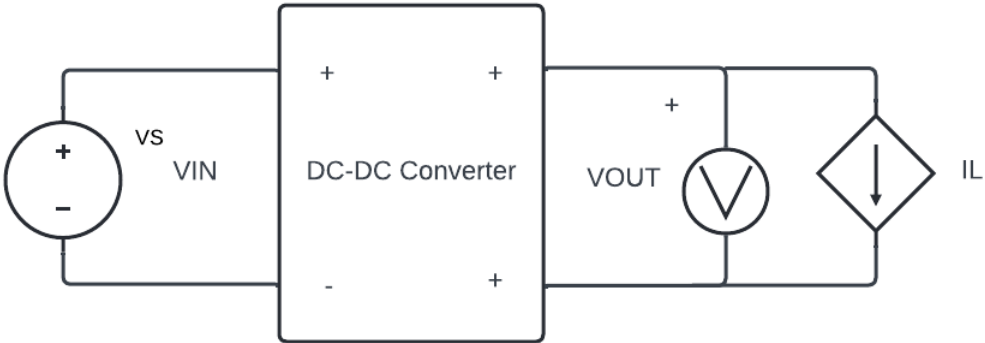
Objective: Determine Beta (HFE) at $I_C = I_{CX}$ and $V_{CC} = V_{CCX}$

Why Search: Cannot directly set I_C , must be set by adjusting I_B to achieve desired I_C value

Search Solution: Apply $V_{CC} = V_{CCX}$ and adjust I_B until $I_C = I_{CX}$. Then compute $\text{Beta} = I_{CCX} / I_{BX}$

Search Type: Binary Search best, linear search typically takes much longer

DC-DC Converter Input Start Voltage Search Application:



Metrology

This section addresses metrology applications such as performed in the calibration process or during the test process when a correction must be performed from previous calibration data.

Measurement Uncertainty

MEASUREMENT UNCERTAINTY DIALOG

GENERAL:

General Entry Table	Value
Operator	John Doe
Gage	Gage1
Gage Function	DCV
Gage Range	10V
Units	V
Standard	STD1
Laboratory	Lab1

Edit Values to Change

TYPE A:

Trial 1	Trial 2	Trial 3	Trial 4
9.783	10.236	9.701	9.904
9.950	10.209	10.627	10.502
10.407	9.394	10.035	9.906
10.106	9.876	10.152	10.033
10.089	9.893	9.997	9.322
9.851	10.274	9.967	10.106
10.389	9.842	10.287	10.257
9.870	9.494	10.291	10.145
10.145	9.886	9.947	9.859
10.196	10.156	9.974	9.980
10.286	9.820	10.211	9.873
10.068	10.225	10.108	10.282
9.969	9.739	9.983	10.168
9.802	9.902	9.814	9.756
10.134	10.066	10.047	10.139
10.021	9.993	9.701	9.839
9.750	9.930	10.090	9.904
10.207	9.814	9.524	10.207
9.989	9.677	10.024	10.031
9.989	9.714	9.704	10.120

TYPE B:

Gage Resolution: 0.01
 STD Resolution: 0.1
 STD Expanded Uncertainty: 0.05
 STD Coverage: 2

Type B Settings:

Name	Value
Gage Resolution	0.010000
STD Resolution	0.100000
STD Expanded Uncertainty	0.050000
STD Coverage	2.000000

Type B Uncertainties:

Name	Value
Gage Resolution Uncertainty	0.002887
STD Resolution Uncertainty	0.057735
STD Combined Uncertainty	0.025000

RESULTS:

Name	Value
Samples	20
Trials	4
Repeatability	0.232596
Reproducibility	0.061760
Type A Uncertainty	0.240656
Type B Uncertainty	0.062981
Combined Uncertainty	0.248761
Gage Coverage	2.000000
Expanded Uncertainty	0.497522

Gage Coverage: 2

Buttons: Load Data, Create Report..., Exit

- Provides a Measurement Uncertainty based on user provided repeatability data, reproducibility data, type B factors and the test standard.
- For ATE automatic test, reproducibility data is typically not necessary due to minimal impact of multiple test operators.
- The dialog runs as stand-alone.
- An Excel report can be created and saved.

Step Interpolation

Step Interpolation Example.vi

Interpolation Table

Raw	Standard
20.0000	20.0600
50.0000	50.2700
67.0000	67.4689
100.0000	101.0200
120.0000	121.4600
150.0000	152.2700

DUT Raw: 55

DUT Corrected: 55.3215

Standard: 55.3225

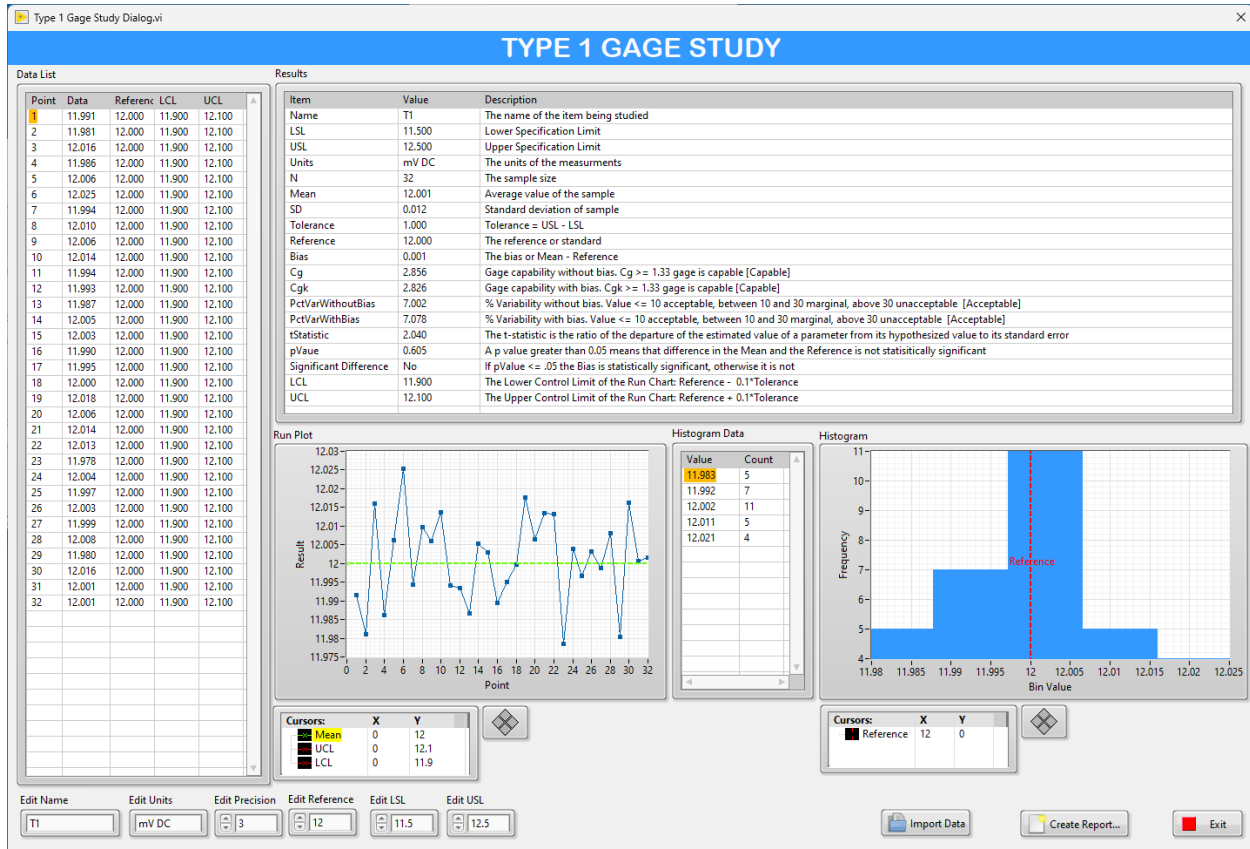
Deviation: -0.0010092

% Error: -0.002

Exit

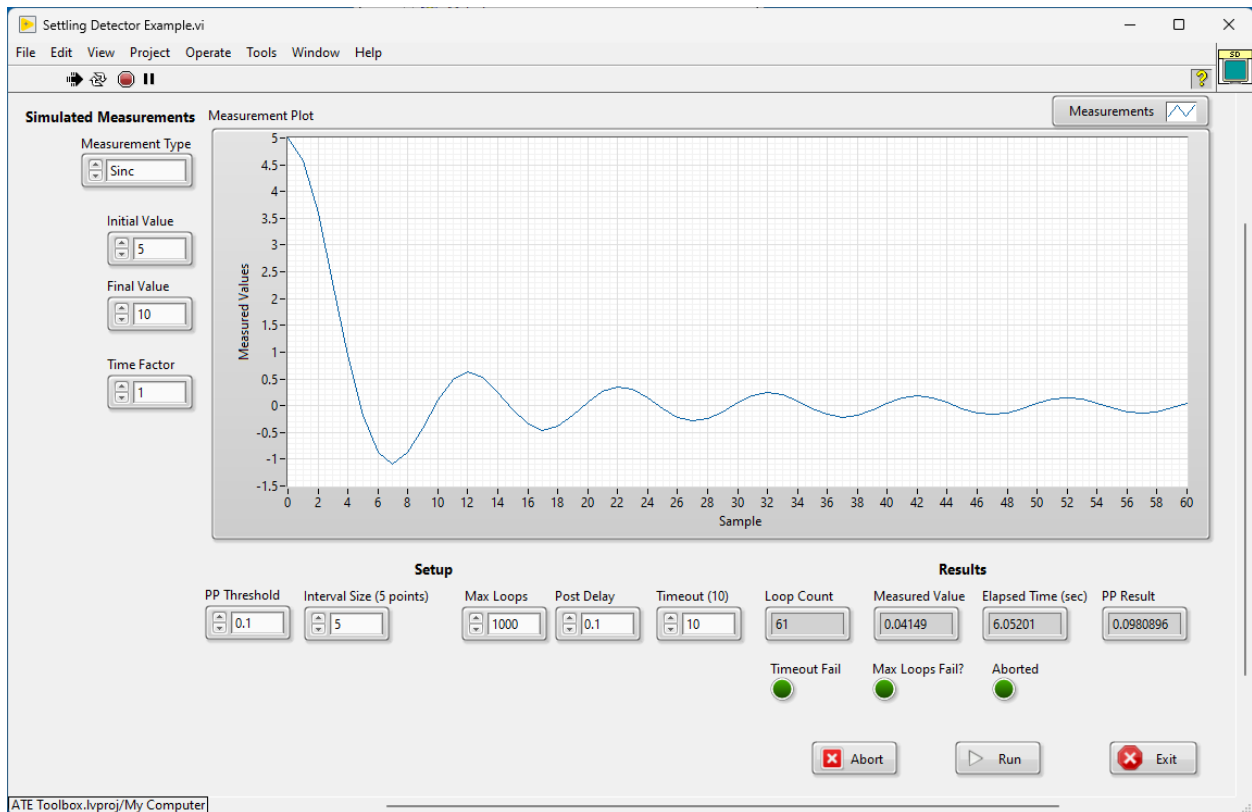
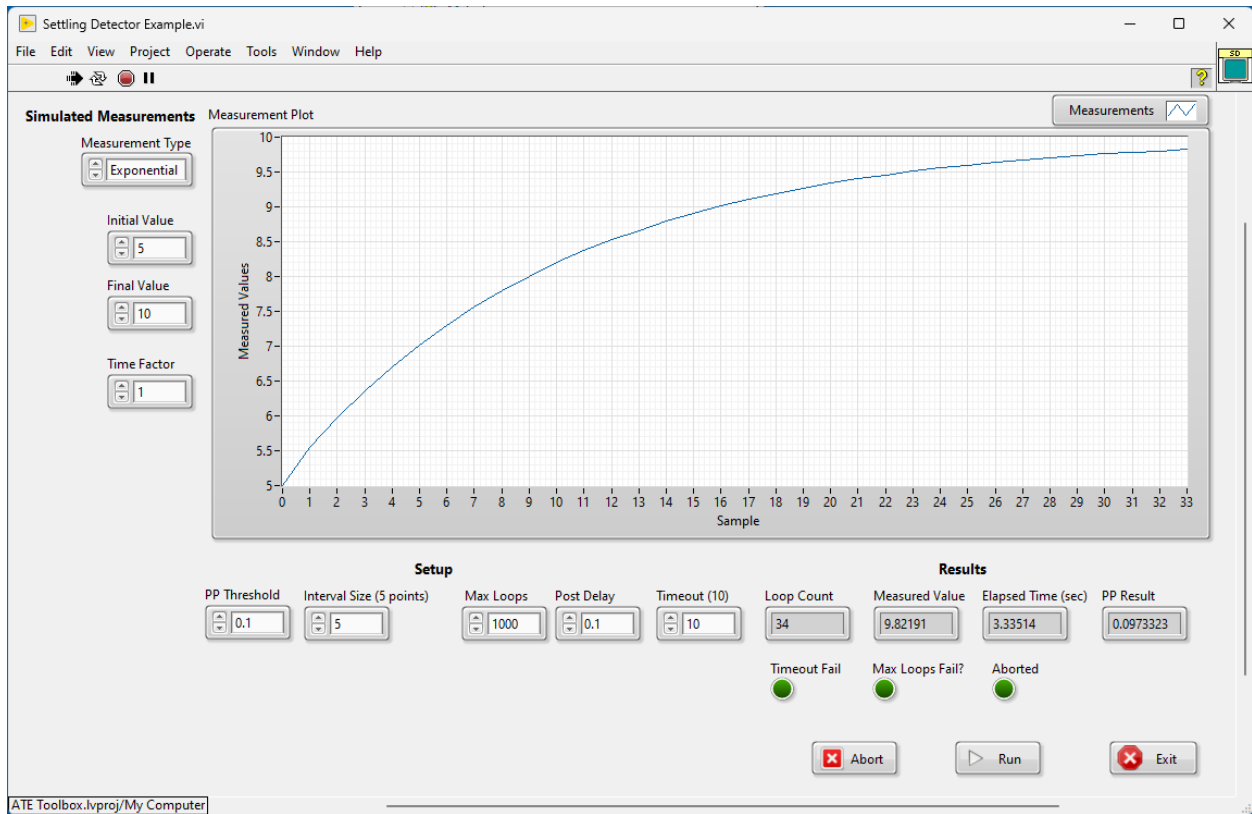
- Step Interpolation is a way to obtain precise measurements from inaccurate measurements by using a lookup table to correct the raw measurements.
- In the above example a table of Raw vs Standard measurements had been previously obtained and stored. Then, when a subsequent raw measurement is made anywhere in the range of the table, a provided Step Interpolation Calculator VI is used to correct the reading to give an accurate result.
- In the example above verification is performed to demonstrate the accuracy of the method.

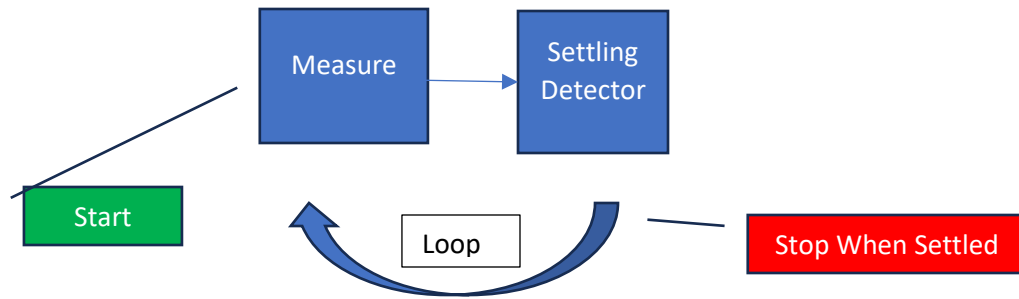
Type 1 Gage Study



- A Type 1 Gage Study is a way to characterize the ability of a measuring instrument to accurately perform measurements using a reference standard and upper and lower specifications placed on the accuracy of the instrument.
- This method is ideal for automatic test instruments where there is not a reproducibility concern, thus eliminating the need to consider the impact of multiple users.
- The primary metrics for this study are Cg and Cgk, which are similar to product Cp and Cpk, but applicable to the instrument or gage.
- Having Cg and Cgk > 1.33 ensures plenty of margin considering sampling variation and the stated specification.
- The dialog can be run as a sub-vi or as stand-alone.
- An Excel report can be created and saved.

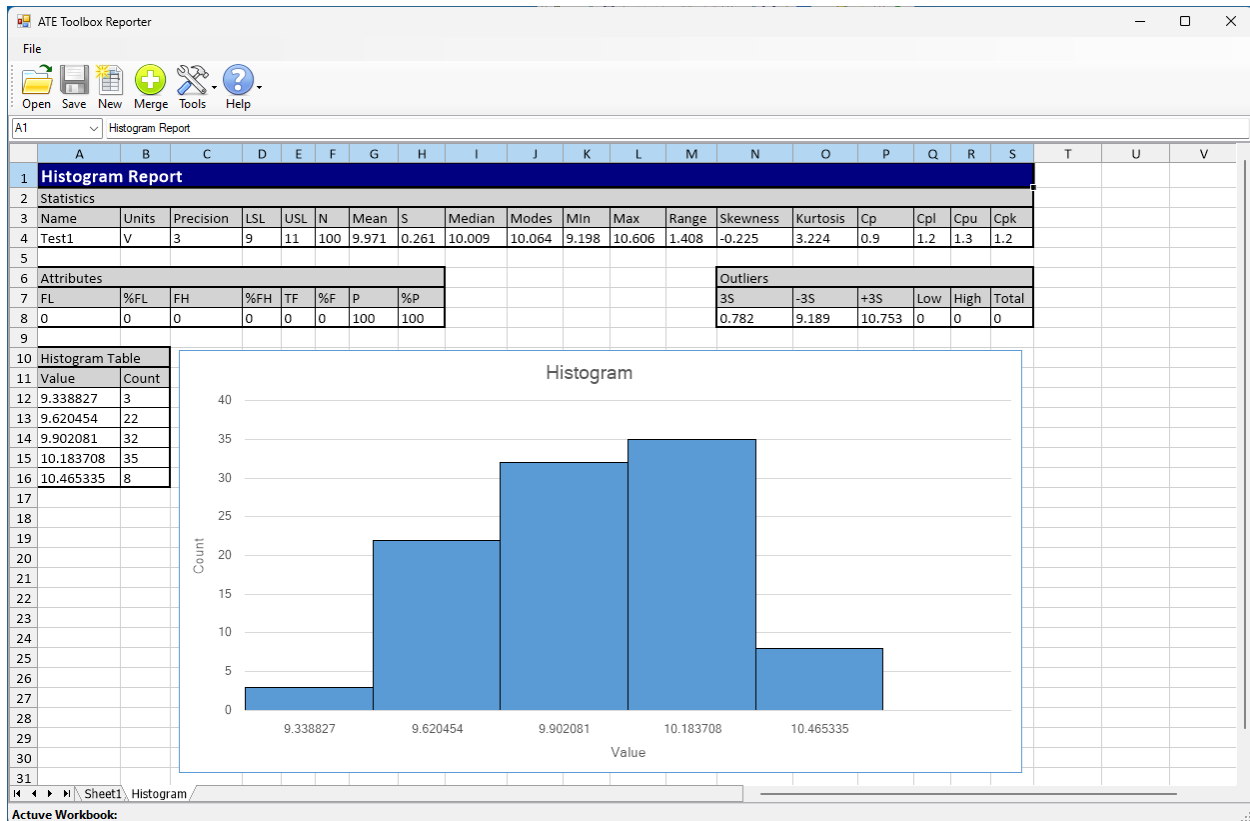
Setting Detector





- A Settling Detector VI is provided to detect when a time varying signal has settled within an interval size and pp value.
- The signal is required to be slower moving in the msec and above range.
- In the top image the signal is rising to a final value. Another example is a decaying sine ringing as shown in the bottom image.
- An example use-case the startup of a slow-moving power supply signal when it is desired to only continue testing after the voltage has settled within predefined parameters of pp voltage and interval size.

ATE Toolbox Reporter



- The ATE Toolbox reporter is a Windows application used to produce Excel reports from the LabVIEW ATE Toolbox.
- The above example shows how a Histogram report appears in the ATE Toolbox Reporter as an Excel report.
- This is done by passing a report data string from report style tool Vis to the Main Args of the Windows executable.
- The Windows Toolbox Reporter then unpacks the string and produces an Excel style report to be viewed and saved to Microsoft Excel
- In this manner, the users LabVIEW Development environment do not need the Excel Report Generation Toolkit installed.
- The report style emulates the LabVIEW report but with differences to account for LabVIEW vs Excel capabilities.
- A tool option is provided in the application to merge an individual report with other worksheets that are contained in a separate Excel workbook.
- A Tools menu provides special purpose test analysis functionality. They include:
 - Accuracy Plot to perform instrument comparisons.
 - Sample Size Calculator to determine the appropriate samples sizes to accurately assess distribution means from a sample.
- The ATE Toolbox Reporter can be used by calling it from an ATE Toolbox VI to create a report or by running it stand-alone to use its menu functionality.