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17 February 2022

From: Scott P. Chapman
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To:      Precision Tester and Vision Framework User

Subj:     Things that You Didn't Know Vision Would

Dear Sir or Madam:

This document is presented as a summary of Vision tools that are available but that you may not be aware of. Each of these tools is fully documented in the main Vision help topics found in the Vision menus under the Help->Help Topics. This document summarizes the available tools. See the main Vision help for complete details.
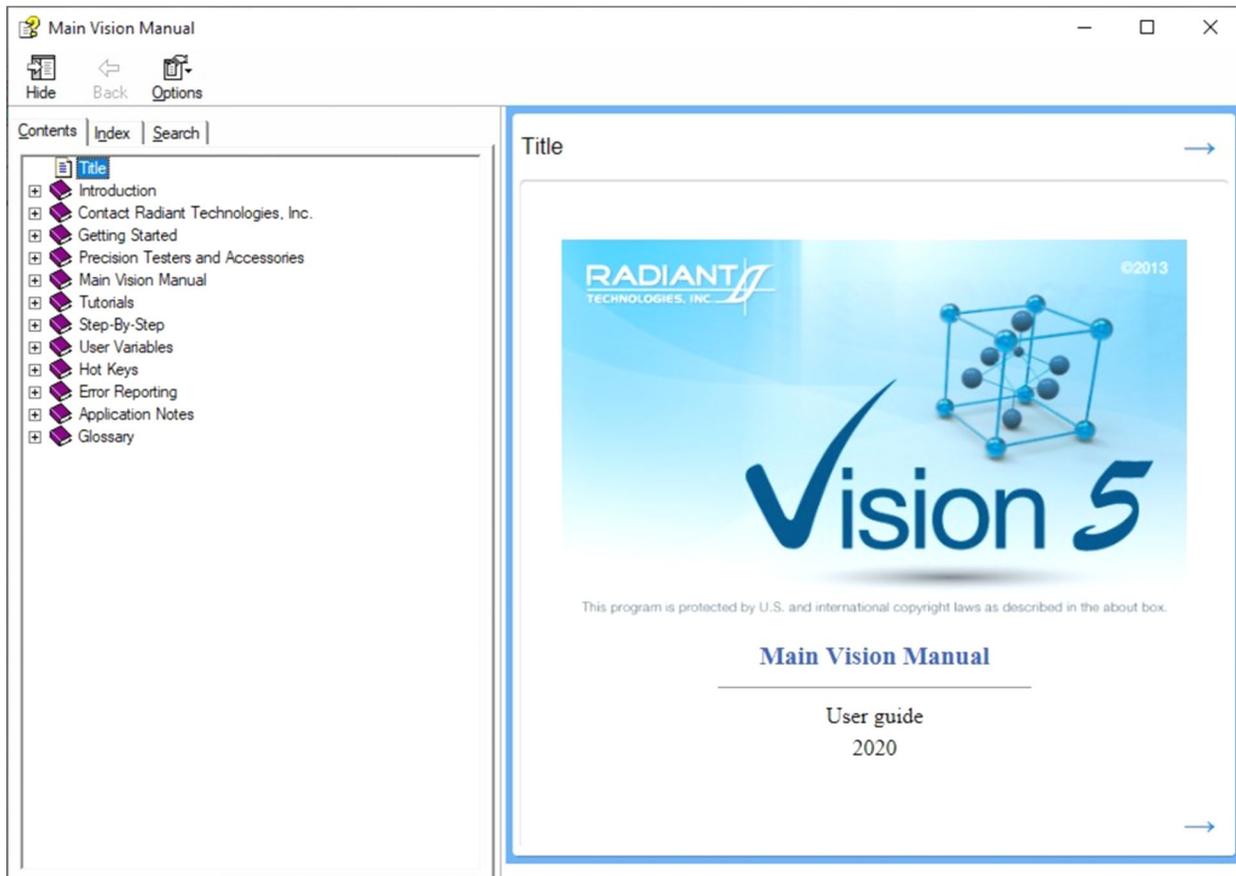


**Figure 1 - Main Vision Help Pages.**

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# I.      Introduction:

This discussion assumes that you have moved beyond the "all QuikLook all the time" stage and are working with Vision Test Definition, DataSets, Filter Tasks and Branch Looping. With these basic Vision objects in your toolbox, this document will provide a survey of more-advanced Vision features that will make your work simpler and more- productive.

With the exception of the Hyperlink, General Information, File Start/Abort and Branching Tasks, this document does not discuss particular Tasks. For a summary of available Tasks review the entries in the TASK LIBRARY. For details on a particular Task, click the *Click For Task Instructions* button.



The Hysteresis Task provides the user with the most general and common tool for characterizing a ferroelectric sample. In this Task a voltage waveform is applied to the sample in a series of voltage steps. At each voltage step, the current induced in the sample by the voltage step is integrated and the integral value is captured and converted into Polarization ($\mu C/cm^2$) by:

$$\frac{\mu C}{cm^2} = \frac{Q}{Area} = \frac{CV}{Area} = \frac{Integrator\,Volts \times Sense\,Capacitor}{Sample\,Area} \tag{1}$$

(1) is scaled by appropriate factors to properly adjust computed values to the standard polarization units of $\mu C/cm^2$.

The voltage waveform is normally a standard bipolar triangular waveform that can be simply defined by providing the maximum voltage and the entire duration of the waveform in milliseconds. The sign of the voltage indicates the direction of the first leg of the waveform. The number of points is controlled primarily by the duration of the waveform, though it may also be adjusted by the voltage. The software automatically computes the number of points and provides the maximum number possible for the conditions specified. (See additional discussion of point calculation, below.) The
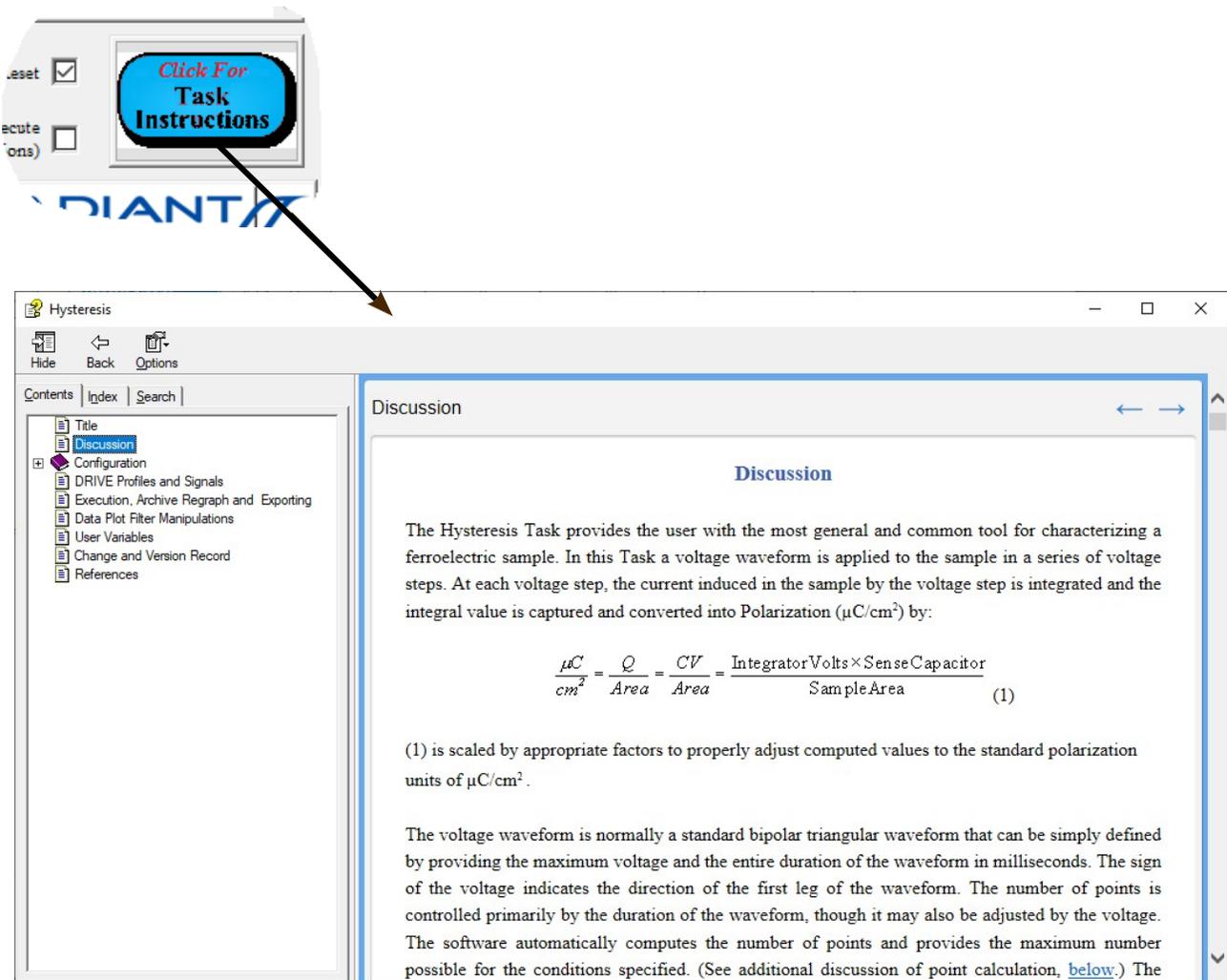
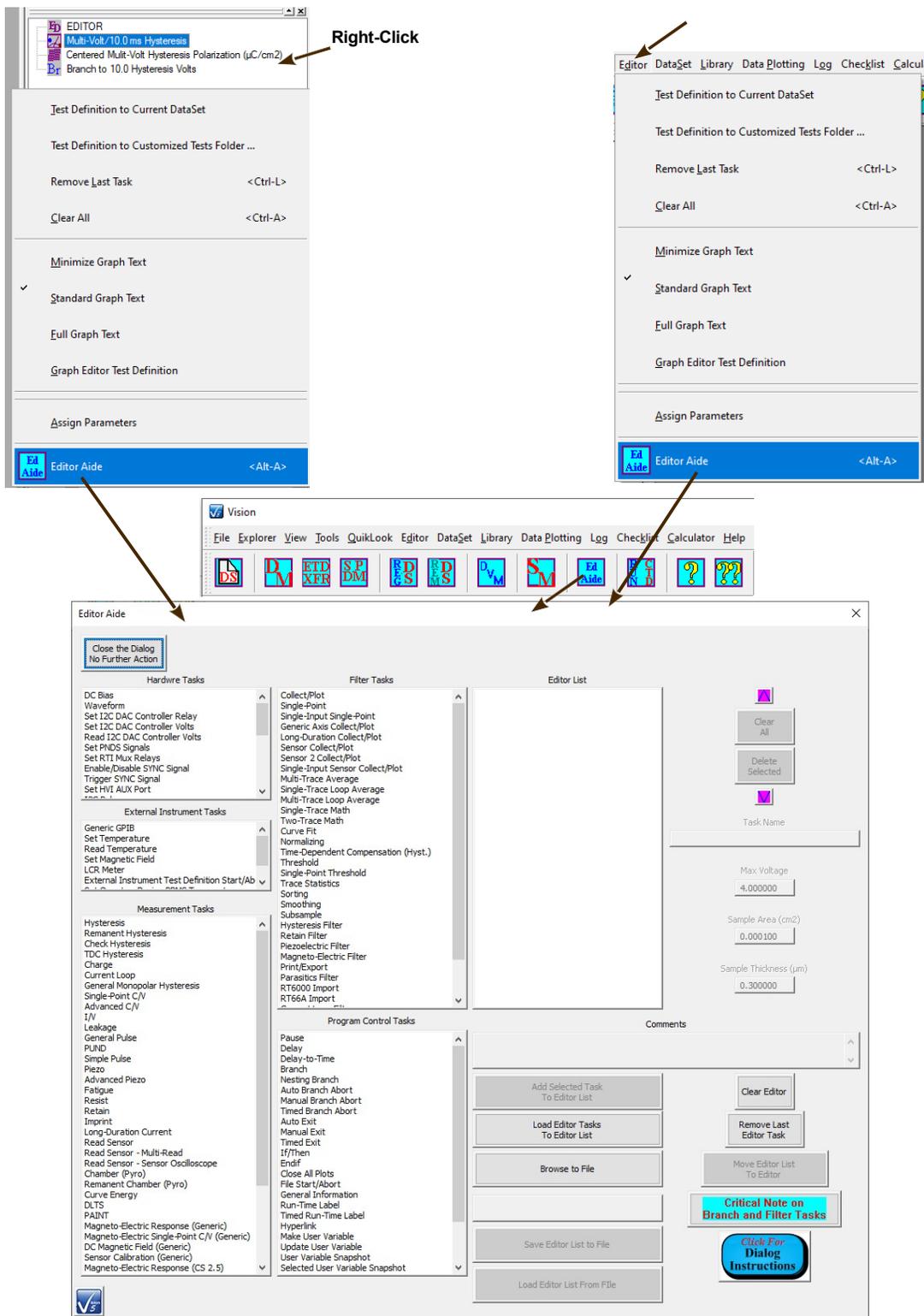**Figure I.1 – Task-Specific Task Instructions.**

## II.    Editor Aide:



**Figure II.1 - Initiate the Editor Aide.**
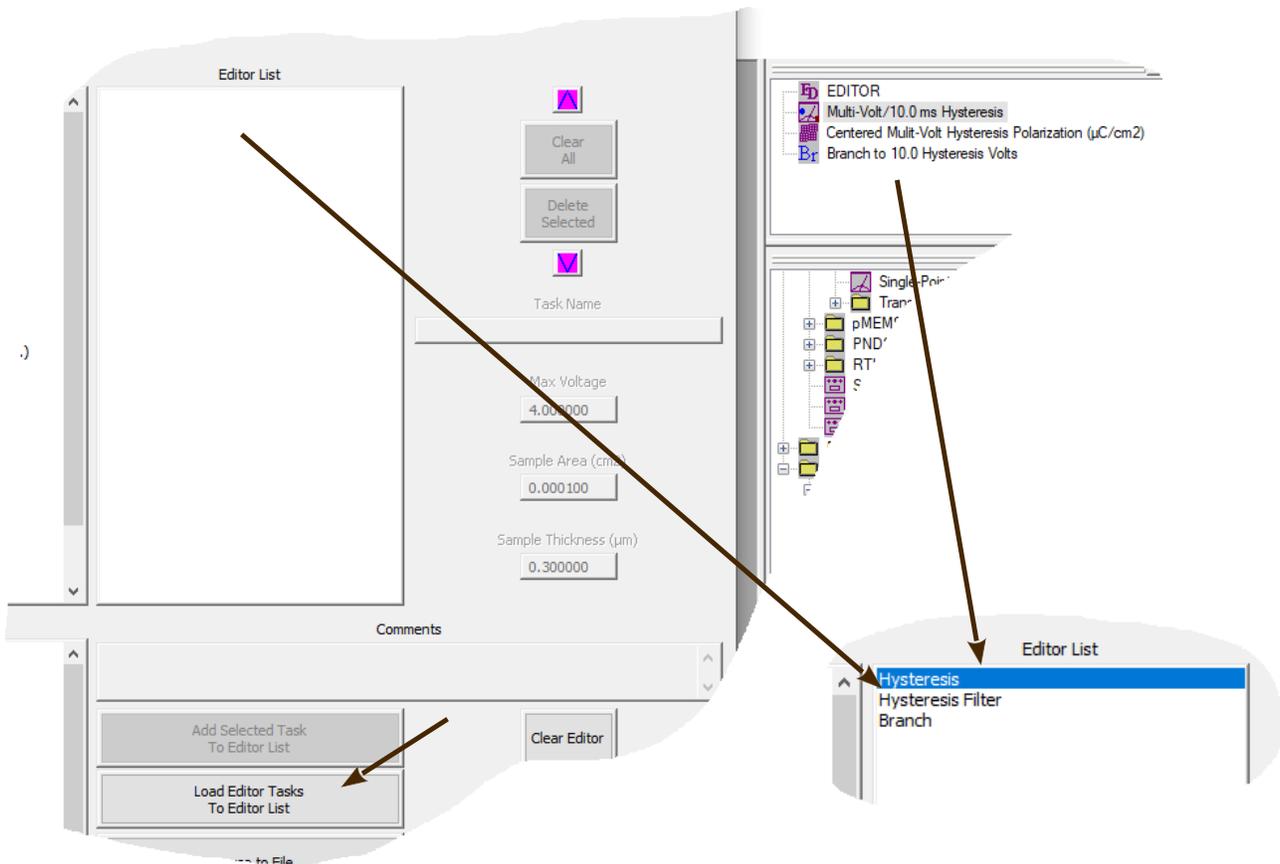
**Figure II.2 - Load the Editor List from the Editor.**

The single largest drawback in Vision is that the EDITOR is not a completely general tool for inserting and removing Tasks. This is because of the complex dependencies between Branch and Filter Tasks and their targets. Here are the things that can be done in the EDITOR:

- Clear the EDITOR of all Tasks.
- Append a Task or series of Tasks to existing Tasks in the EDITOR.
- Remove the last Task from the EDITOR.
- Prepend a Task or series of Tasks to the top of the Test Definition Task list in the EDITOR. This is done by copying the existing Test Definition to a temporary location (DataSet CTD orCustomized Test), writing the Task(s) to be prepended to the EDITOR and then restoring the original list of Tasks from the temporary location.

Here are examples of things that cannot be done in the Editor:

- Remove any Tasks from the interior of the Test Definition in the EDITOR. Only the last Task may be removed. This may be done repeatedly to remove a series of Tasks, but a Task cannot be removed that is not the last (bottom-most) Task. Tasks may be disabled by checking *No Execute*. This is functionally equivalent to removing them from the Test Definition.
- Insert any Task into the interior of the Test Definition. Tasks may only be appended or prepended. Tasks are prepended by copying the existing Test Definition to a temporary location (DataSet CTD or Customized Test), writing the Task(s) to be prepended to the Editor and then restoring the original list of Tasks from the temporary location.

- Move a Task's position in the Test Definition up or down.

The Editor Aide tool is provided as a method for making the process of modifying complex Test Definitions simpler and completely general. The tools can be used to build complete Test Definitions from scratch. It can also move the Test Definition from the EDITOR into the Test Definition under construction in the tool. Tasks can only be appended to the end of the Test Definition under development, but they may be easily moved up or down in the list. Any Task may be immediately removed from the list. The Test Definition in the EDITOR may be completely cleared of Tasks from without the Editor Aide tool. Whether or not the EDITOR is cleared of Tasks, all Tasks in the Editor Aide list can be moved to the Editor, appending them to any existing Tasks.

Certain common Task parameters can be set for any Task selected in the Editor Aide *Editor List* control. These include *Task Name* and *Comments* for all Tasks and *Max. Voltage*, *Sample Area (cm2)* and *Sample Thickness (µm)* for Hardware Tasks.

This solution is still not completely general. Tasks are not actually constructed in the Editor Aide and dependencies between Tasks are not established. As Tasks are moved from the Editor Aide to the Editor, they must be configured. A few general parameters including *Task Name*, *Max. Voltage*, *Sample Area (cm2)*, *Sample Thickness (µm)* and *Comments* can be assigned in the Editor Aide tool.

See the Main Vision Manual "Main Manual->XV – Editor Aide", "Tutorials–>XII - Editor Aide" and "Step-By-Step->Test Definition & Editor->Editor Aide" sections for complete details.

**See Also Vision Manual:**

- Main Vision Manual->XV – Editor Aide
- Tutorials->XII – Editor Aide
    - Step-By-Step->Test Definition & Editor->Editor Aide

## III.    Global EDITOR Parameter Assignment:

Any given Test Definition in the EDITOR has every control in every Task set to a particular state. After complete configuration the Test Definition is ready to perform a specific sequence, possibly tailored to a specific Device Under Test (DUT - often referred to as a "Sample"). The Bulk Editor Parameter Assignment Tools is intended to render any given Test Sequence more general. For example, using the tool, a Test Definition that includes a particular *Max. Voltage* and/or *Sample Area (cm2)* and/or *Sample Thickness (µm)* can have all Tasks updated quickly and automatically to a new *Max. Voltage* and/or *Sample Area (cm2)* and/or *Sample Thickness (µm)* in a single step.

Consider the Test Definition of **Figure III.1**. In this simple sequence a +5.0-Volt/10.0 ms Hysteresis, a - 5.0-Volt/10.0 ms Hysteresis and a +5.0-Volt/1000.0 ms Leakage are programmed for a 0.025 cm$^2$/100 µm sample.
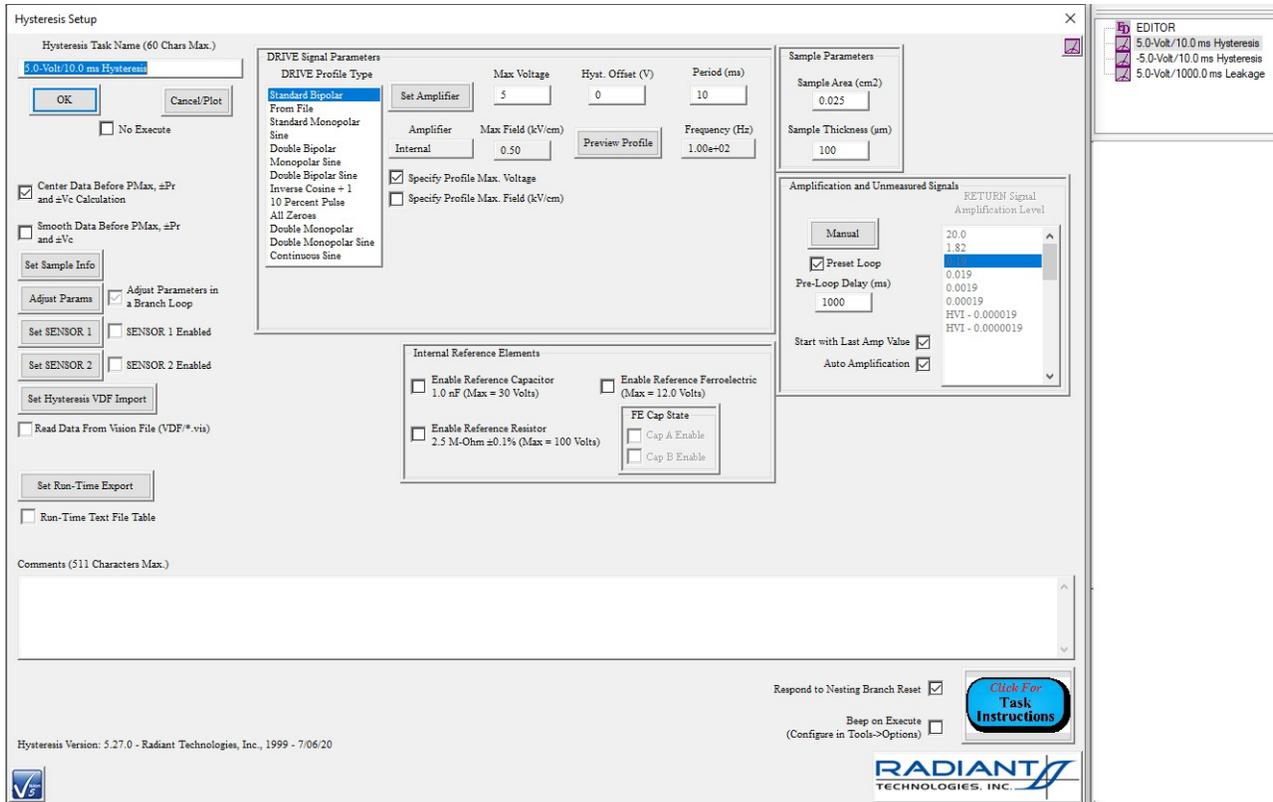
**Figure III.1 - Simple Test Definition.**

Suppose that the Test Definition would serve for the measurement of a DUT with a 0.125 cm$^2$ sample area and a sample thickness of 220 µm. Any voltage or period adjustments must be done on a Task-by-Task basis. In this case, voltage cannot be automatically adjusted because applying the global adjustment would eliminate the sign difference between the first and second Hysteresis. However, allTasks can have their sample areas and thickness updated in a single step.

Right-click in the EDITOR window and select "Assign Parameters". The global parameter adjustment dialog appears.
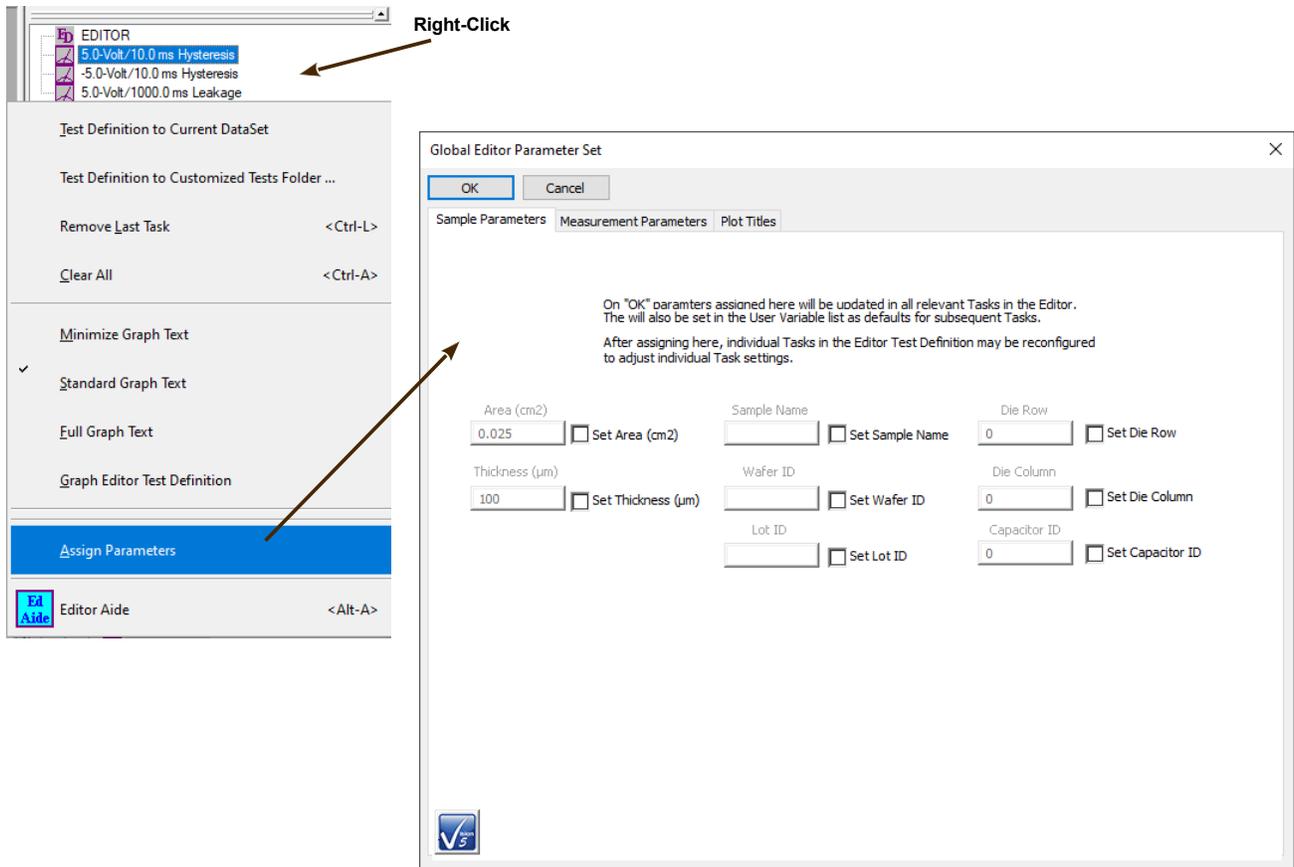
**Figure III.2 - Global Parameter Adjustment Dialog.**

Checking any parameter check box will enable its associated value control. Setting the value and then clicking *OK* will update all Tasks in the EDITOR to which the value pertains.
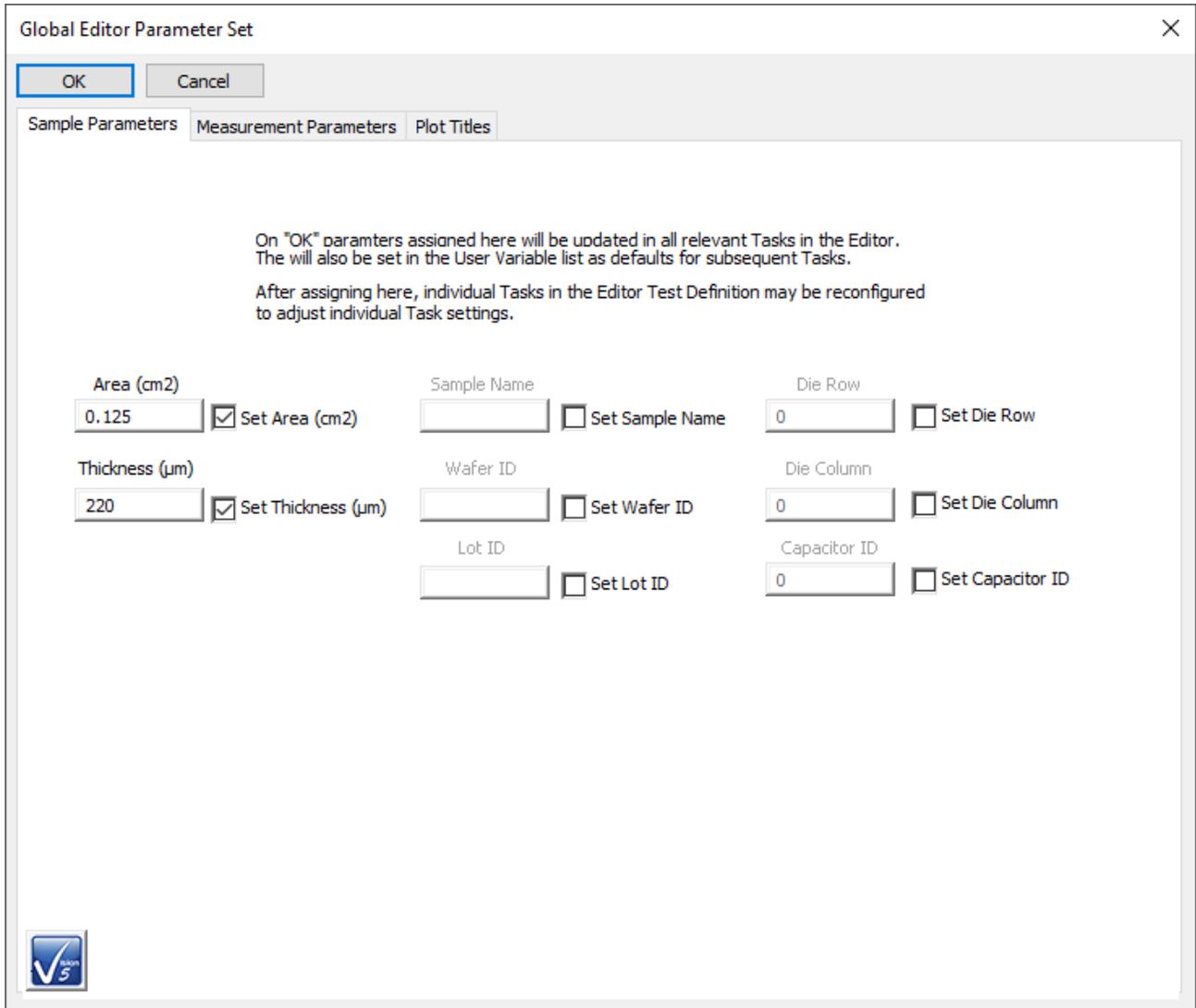
**Figure III.3 - Globally-Updated *Sample Area (cm2)* and *Sample Thickness(μm)*.**

Three categories of parameters can be updated globally using the "Assign Parameters" tool.

## III.a   Sample Parameters



**Figure III.a.1 - Sample Parameters Tab.**

The category includes all general sample parameters:

- *Sample Area (cm2)*: Smaller electrode surface area ($cm^2$).
- *Sample Thickness (μm)*: Depth of ferroelectric or dielectric material between the sample electrodes (μm).
- *Sample Name* (24 character maximum): Brief description of the Device Under Test.
- *Wafer ID* (12 character maximum): For wafer-mounted samples, wafer-identifying text.
- *Lot ID* (12 character maximum): For wafer-mounted samples, an identifier specifying the wafer lot.
- *Die Row*: For wafer-mounted samples, the vertical position of the sample on the

wafer.

- *Die Column*: For wafer-mounted samples, the horizontal position of the sample on the wafer.
- *Capacitor ID*: A numeric value to identify the capacitor.

## III.b   Measurement Parameters
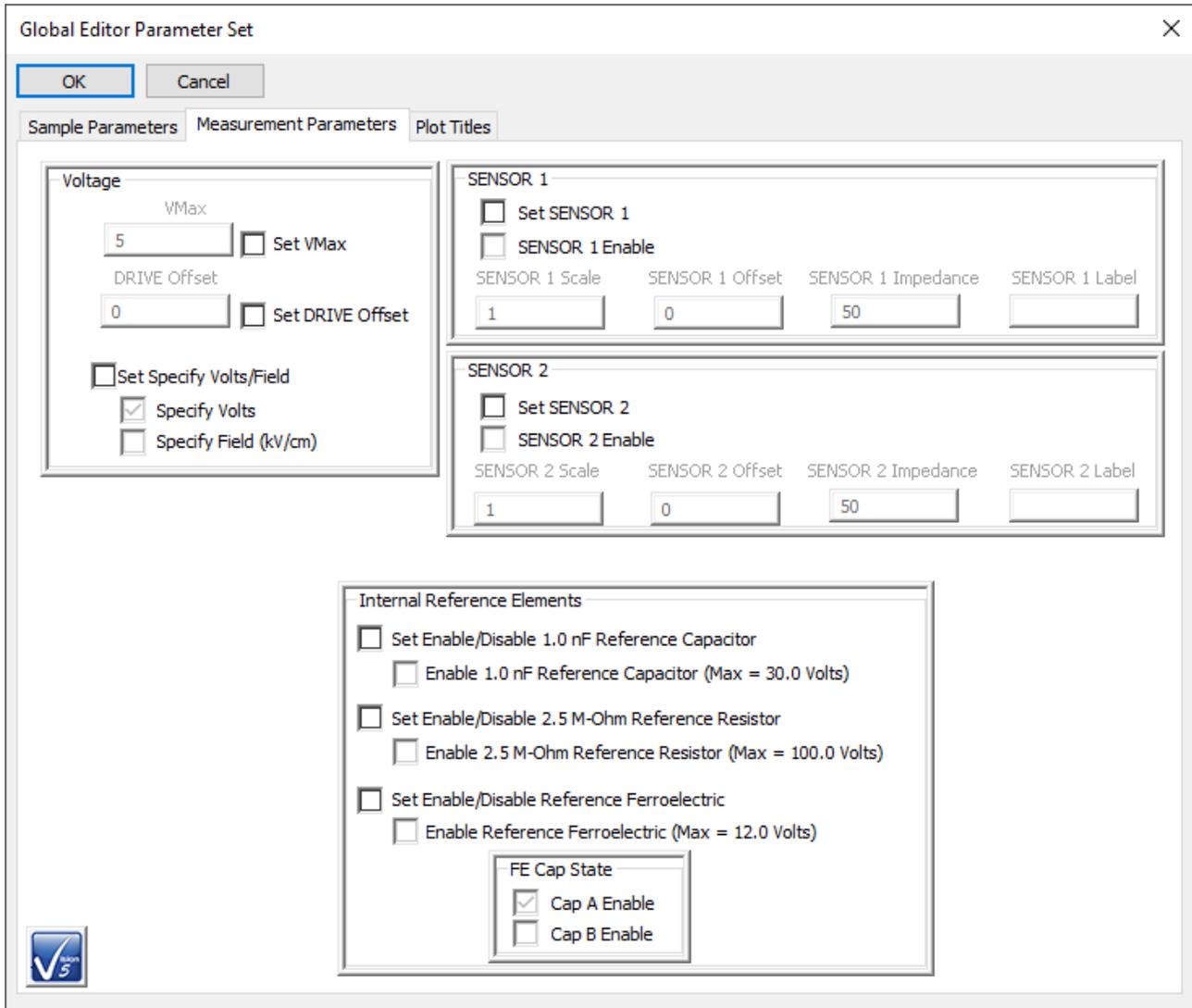


**Figure III.b.1 - Measurement Parameters Tab.**
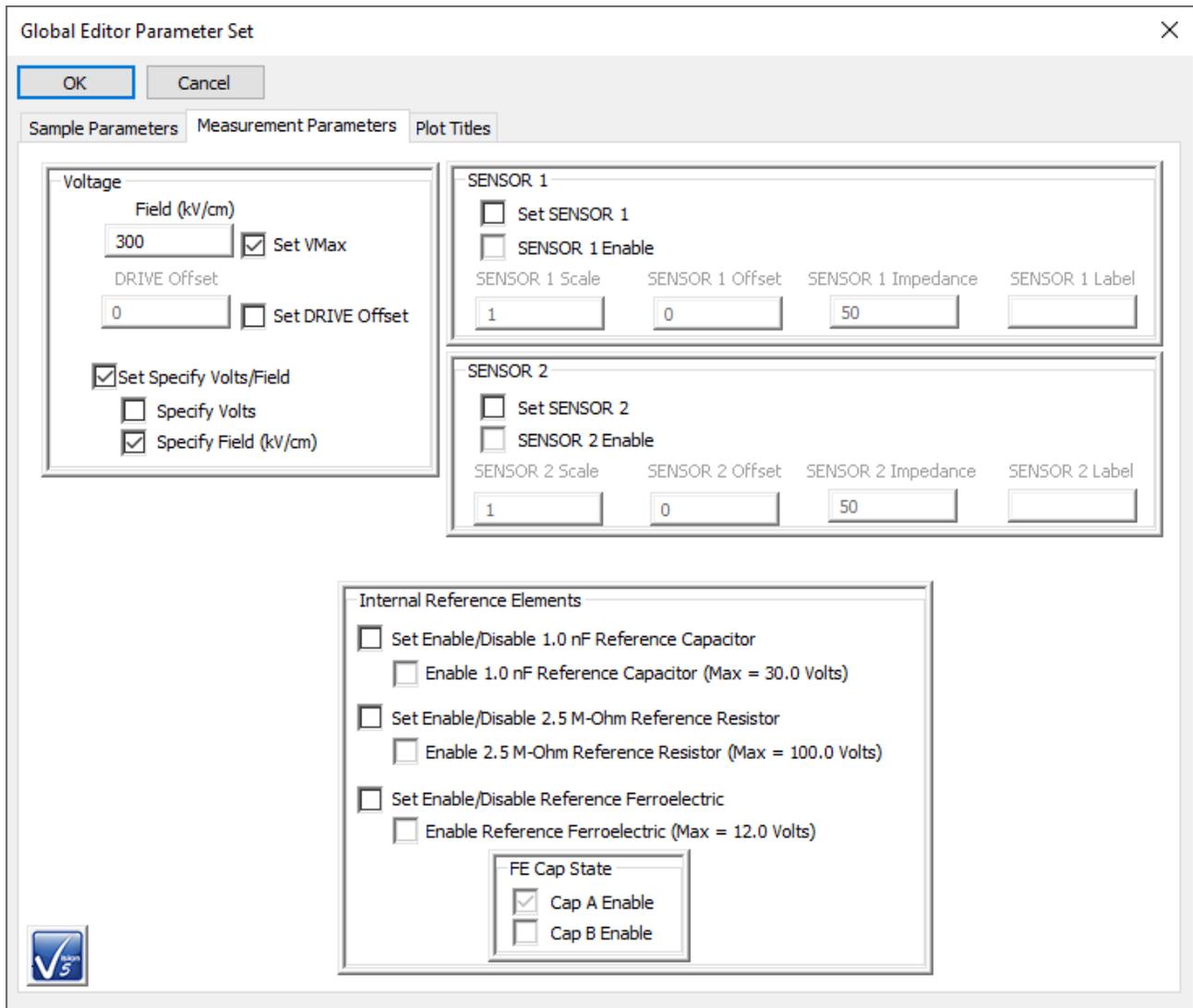
**Figure III.b.2 - DRIVE Signal in Units of Electric Field (kV/cm).**

This tab specifies DRIVE port output parameters and allows for the configuration of SENSORport 1 and/or 2 input.

- *VMax/Field (kV/cm)*: This is the maximum DRIVE port signal to apply to the sample. The units are either Volts or Electric Field (kV/cm) where Field (kV/cm) is given by:

$$Electric\ Field\ \left(kV/cm\right) = \frac{Volts}{1000\ \left(V/kV\right) \times Sample\ Thickness\ (\mu m) \times 10^{-4}\ \left(cm/\mu m\right)} \text{(III.1)}$$

- The units of the value are determined by checking Specify Volts or Specify Field (kV/cm).
- *Drive Offset* (V or kV/cm): This is a bias value added to every point in the DRIVE waveform to shift the entire waveform vertically without changing its shape. The value should be entered here scaled to the units assumed by checking *Specify Volts* or *Specify Field (kV/cm)*. If *Set Specify Volts/Field* is not checked the units will be as specified in each Task.
- *Specify Volts*: When checked, the Tasks will apply the value(s) in their respective DRIVE signal fields in units of Volts. Checking this control unchecks *Specify Field (kV/cm)* and sets the signal label to *VMax*. Unchecking this control checks *Specify Field (kV/cm)* and sets the DRIVE signal level label to *Field (kV/cm)*.
- *Specify Field (kV/cm)*: When checked, the Tasks will adjust the value(s) in their respective DRIVE signal fields to units of Volts, before applying the signal to the DRIVE port by:

$$Volts = Electric\ Field \left(\frac{kV}{cm}\right) \times 1000 \left(\frac{V}{kV}\right) \times Sample\ Thickness\ (\mu m)\ \times\ 10^{-4}\left(\frac{cm}{\mu m}\right) \quad \text{(III.2)}$$

Checking this control unchecks *Specify Volts* and sets the signal label to *Field (kV/cm)*. Unchecking this control checks *Specify Volts* and sets the DRIVE signal level label to *VMax*.
- *Sensor 1/2 Enable*: When checked, these controls enable the capture of voltage data at the tester's SENSOR 1 and/or SENSOR 2 ports. When checked, *Sensor 1/2 Scale*, *Sensor 1/2 Offs*et, *Sensor 1/2 Impedance* and *Sensor 1/2 Label* are enabled. The values in these controls will be applied to the SENSOR 1/2 port signal as it is captured.
- *Sensor 1/2 Scale*: These control(s) is/are enabled when *Sensor 1/2 Enable* is/are checked. This is a scale term applied to the SENSOR 1/2 port voltage(s) when captured. These convert the voltage(s) to the property being measured at the port by:

Property =
Sensed Voltage x *Sensor Scale* (Tester Input Impedance + Sensor Impedance) / Tester Input Impedance + *Offset* (III.3)

- *Sensor 1/2 Offset*: These control(s) is/are enabled when *Sensor 1/2 Enable* is/are checked. This is an offset term applied to the SENSOR 1/2 port voltage(s) when captured. These convert the voltage(s) to the property being measured at the port by (3).
- *Sensor 1/2 Impedance* ($\Omega$): These control(s) is/are enabled when *Sensor 1/2 Enable* is/are checked. This is the impedance term ap- plied to the SENSOR 1/2 port voltage(s) when captured. These convert the voltage(s) to the property being measured at the port by (3). Note that the tester impedance of all models except the original Precision LC is infinite and this term becomes irrelevant. It should be left at the default value of 50 $\Omega$.
- *Sensor Label* (12 characters maximum): These control(s) is/are enabled when *Sensor 1/2 Enable* is/are checked. This is text that identifies the property being captured at the SENSOR 1/2 port(s).
- *Enable 2.5 M-Ohm Reference Resistor*: When checked the Precision Tester will switch the 2.5 M-$\Omega$ Linear Internal Reference Resistor into the signal path for measurement. If the 1.0 nF Linear Internal Reference Capacitor and/or the 4/20/80 PNZT Internal Refer-

ence Ferroelectric A and/or B capacitor(s) is/are also switched in, the Internal Reference Resistor will be measured in parallel with these elements. If there is a sample connected externally to the tester DRIVE and RETURN ports, the Internal Reference Resistor will be measured in parallel with the external sample only for testers that were sold before 2014. For newer testers, the external sample will be switch out of the signal path. This control is enabled if *Set Enable/Disable 1.0 nF Reference Capacitor* is checked.

- *Enable 1.0 nF Reference Capacitor*: When checked the Precision Tester will switch the 1.0 nF Linear Internal Reference Capacitor into the signal path for measurement. If the 2.5 M-$\Omega$ Linear Internal Reference Resistor and/or the 4/20/80 PNZT Internal Reference Ferroelectric A and/or B capacitor(s) is/are also switched in, the Internal Reference Capacitor will be measured in parallel with these elements. If there is a sample connected externally to the tester DRIVE and RETURN ports, the Internal Reference Capacitor will be measured in parallel with the external sample only for testers that were sold before 2014. For newer testers, the external sample will be switch out of the signal path. This control is enabled if*Set Enable/Disable 1.0 nF Reference Capacitor* is checked.

- *Enable Reference Ferroelectric*: When checked the Precision Tester will switch the selected 4/20/80 PNZT Internal Reference Ferroelectric A and/or B capacitor into the signal path for measurement. If the 1.0 nF Internal Reference Capacitor and/or the 2.5 M-$\Omega$ Internal Reference Resistor is/are also switched in, the Internal Reference Ferroelectric will be measured in parallel with these elements. If there is a sample connected externally to the tester DRIVE and RETURN ports, the Internal Reference Ferroelectric will be measured in parallel with the external sample only for testers that were sold before 2014. For newer testers, the external sample will be switch out of the signal path. This control is enabled if *Set Enable/Disable Reference Ferroelectric* is checked. If checked, *Cap A Enable* and *Cap B Enable* are enabled.

- *Cap A Enable/Cap B Enable*: These controls are enabled if both *Set Enable/Disable Reference Ferroelectric* and *Enable Reference Ferroelectric* are checked. Either or both of these may be selected. When checked, the selected 4/20/80 PNZT ferroelectric capacitor will be switched into the tester's measurement capacitor in parallel with the other (if checked) and any other enabled internal reference element.

## III.c   Plot Titles
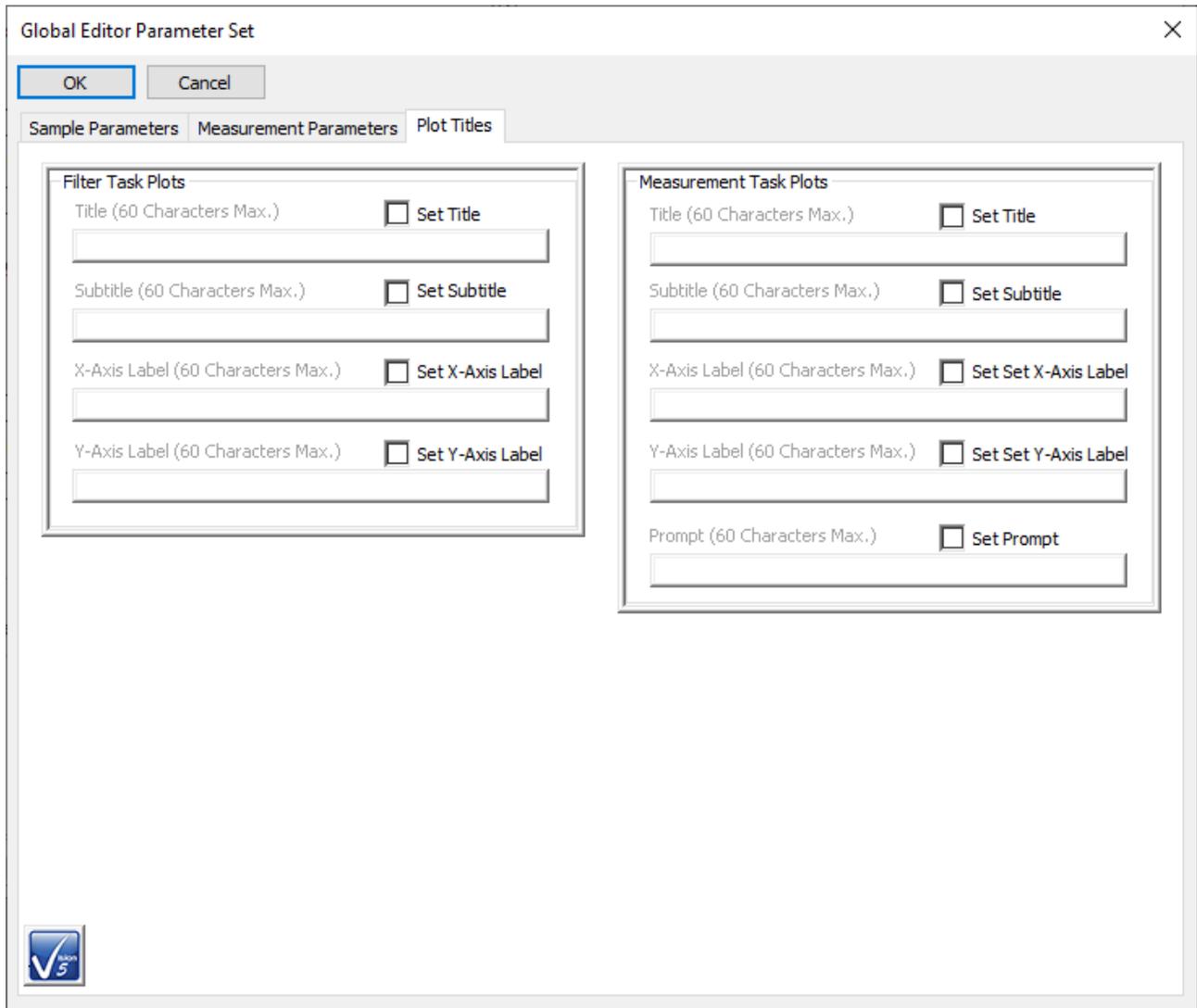


**Figure III.c.1 - Plot Titles Global Parameters Adjustment Tab.**

This tab allows distinct plot titles to be applied to all Filter Tasks and to all Measurement Tasks that generate plots. All plot-generating Tasks include *Title*, *Subtitle*, *X-Axis Label* and *Y-Axis Label* text. Measurement Tasks will also include a User Self-*Prompt* that can have the value of a single User Variable appended to it. The User Variable cannot be selected in this tab. All titles have a 60-character maximum length.

**See Also Vision Manual:**

- Main Vision Manual->V – Main Menu->F. Editor Menu->Assign Parameters

# IV. Polarization Parameters Calculator



## Figure IV.1 - Polarization Parameters Tool.

Given any three polarization ($\mu C/cm^2$) parameters, derive the fourth. If a parameter is to be derived from sample Charge ($\mu C$) instead of Polarization ($\mu C/cm^2$) then only two parameters are required since Polarization ($\mu C/cm^2$) is Charge ($\mu C$) normalized by Sample Area ($cm^2$). In the cases, Area (cm2) need not be known.

The calculations are:

- Capacitance (nF) (Calculate by Polarization ($\mu C/cm^2$)):

$$Capacitance\ (nF) = \frac{Q}{V} = \frac{Polarization\left(\mu C/cm^2\right) \times 1000\left(nC/\mu C\right) \times Sample\ Area\ (cm^2)}{Voltage} \text{(IV.1)}$$

- Capacitance (nF) (Calculate by Charge ($\mu C$)):

$$Capacitance\ (nF) = \frac{Q}{V} = \frac{Charge\ (\mu C) \times 1000\left(nC/\mu C\right)}{Voltage} \text{(IV.2)}$$

- Charge ($\mu C$) and Polarization ($\mu C/cm^2$):

$$Q = CV \rightarrow Charge\ (\mu C) \times 10^{-3}\left(\mu F/nF\right) \times V \text{(IV.3)}$$

$$Polarization\left(\mu C/cm^2\right) = \frac{Charge\ (\mu C)}{Sample\ Area\ (cm^2)} \text{(IV.4)}$$

- Area (cm$^2$):

$$Polarization \left(\frac{\mu C}{cm^2}\right) = \frac{Q\ (\mu C)}{Sample\ Area\ (cm^2)} \rightarrow Area\ (cm^2) = \frac{Q\ (\mu C)}{Polarization \left(\frac{\mu C}{cm^2}\right)} \rightarrow$$

$$Area\ (cm^2) = \frac{Capacitance\ (nF) \times 10^{-3} \left(\frac{\mu F}{nF}\right) \times Voltage}{Polarization \left(\frac{\mu C}{cm^2}\right)} \quad (IV/5)$$

- Voltage (Calculate by Polarization ($\mu$C/cm$^2$)):

$$V = \frac{Q}{C} \rightarrow Voltage = \frac{Polarization \left(\frac{\mu C}{cm^2}\right) \times 1000 \left(\frac{nC}{\mu C}\right) \times Sample\ Area\ (cm^2)}{Capacitance\ (nF)} \quad (IV.6)$$

- Voltage (Calculate by Charge ($\mu$C)):

$$V = \frac{Q}{C} \rightarrow Voltage = \frac{Charge\ (\mu C) \times 1000 \left(\frac{nC}{\mu C}\right) \times Sample\ Area\ (cm^2)}{Capacitance\ (nF)} \quad (IV.7)$$

**See Also Vision Manual:**

- Main Vision Manual->V – Main Menu->K. Calculator Menu
- Step-By-Step->Using the Ferroelectric Calculator

# V. Data Mining:



**Figure V.1 - Initiate Data Mining.**
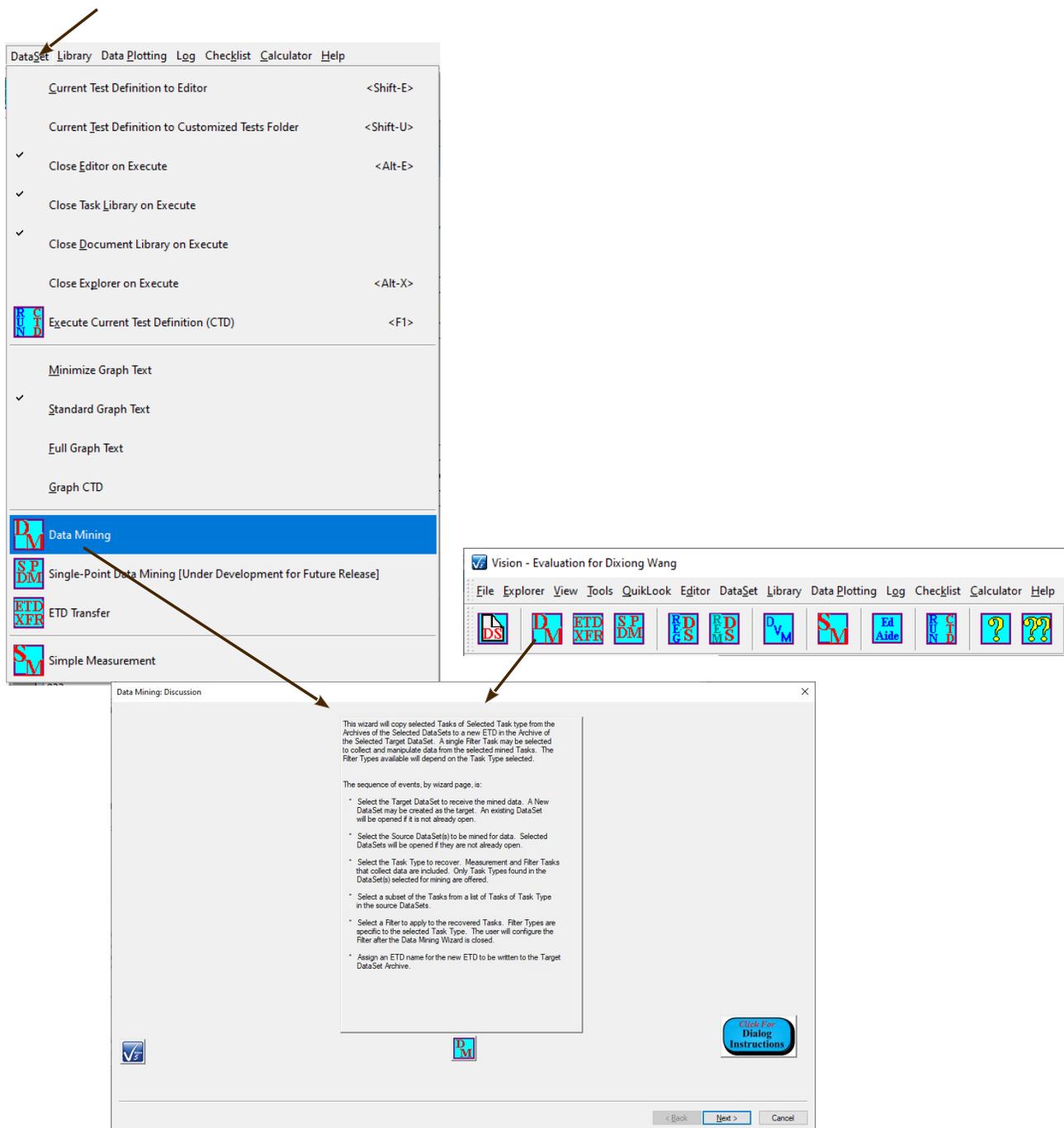
The Data Mining tool allows any number of data-collecting Tasks (Measurement or Filter Tasks), of one specific type, from any number of registered DataSets to be completely copied into a single Test Definition in a new or existing DataSet. A single Filter Task, appropriate to the Task type of the transferred data, may be selected to be applied to the collected data. The steps are:

- Identify or create the single target DataSet. If the DataSet is new it is created and opened. Otherwise, open the existing DataSets if they are not already open.
- Identify one or more registered DataSets as source DataSets from which to collect the data. When moving to the next tab, open any DataSets that are not already open and identify all data-collecting Task types in the DataSet.
- A list appears of all data-collecting Task types found in the selected source Data- Set(s). Select the single Task type that is to be collected. When moving to the next tab, assemble a complete list of all Tasks in the source DataSet(s) of the selected type.
- A tree list appears of all existing Tasks of the selected type in the selected source DataSets. The tree hierarchy is DataSets->ETDs->Tasks. In the list select all Tasks to be collected in the target DataSet. Tasks can be selected individually or complete ETDs or complete DataSets may be se-lected.
- In the next tab, all selected Tasks are listed. As a result of Branch Looping, repeated Test Definition execution, etc. source many of the Tasks may have duplicate Task Names. In this tab individual Tasks may be selected and renamed.
- In the next tab a list of all Filter Tasks that are appropriate to the selected Task type is presented. A single Filter may be selected to be applied to the selected Tasks. Otherwise "<<None>>" may be selected.
- In the final tab an ETD name is specified. A unique and meaningful name of up to 60 characters should be assigned.
- When the Data Mining wizard is closed, the selected Tasks are completely copied into a single Executed Test Definition (ETD) appended to the Archive in the tar- get DataSet.
- The configuration dialog for the selected Filter Task, if any, appears. The Filter must be completely and correctly configured at this time. Configuration includes selecting the input Tasks and clicking *Add Task* to register them as target Tasks. Filter Task Name, plot titles, Filter operations, etc. must all be specified. When the Filter configuration dialog is closed theFilter executes and is appended to the ETD. This completes the process.

Clearly this is a very useful tool. It is also a complex tool that requires preplanning. The exact locations of all Tasks to be collected must be identified before the tool is started.

A complete and detailed discussion of Data Mining, or examples, are beyond the scope of this document. Please see the main Vision help pages under the Help->Help Topics menu for complete de- tails and examples.

**See Also Vision Manual:**

- Main Vision Manual->V – Main Menu->K. Calculator Menu
- Tutorials->XI – Data Mining, ETD Transfer and Simple Measure->A – Data Mining
- Step-By-Step->Using the Ferroelectric Calculator

# VI.    ETD Transfer:
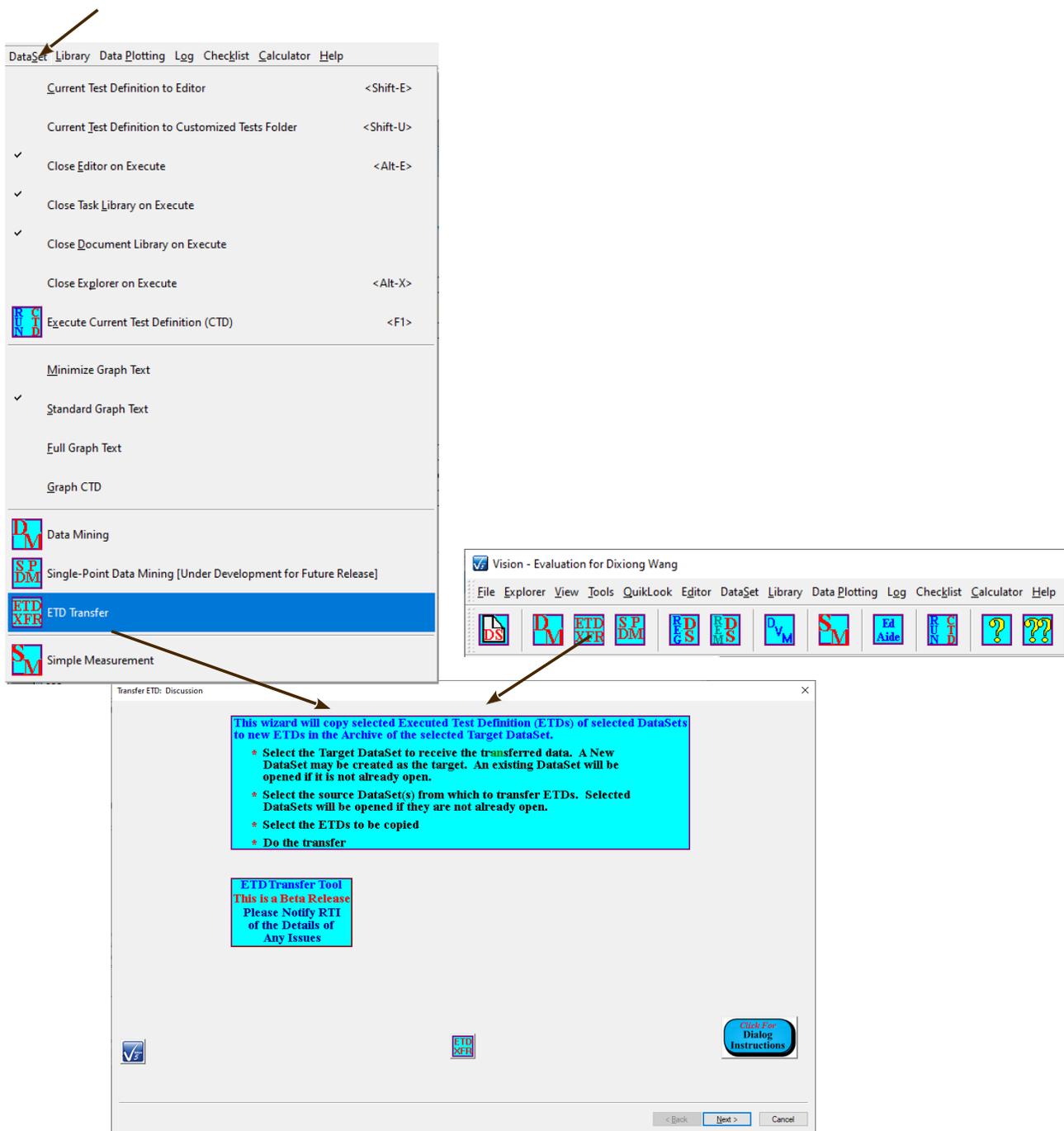


**Figure VI.1 - Initiate ETD Transfer.**

This tool is similar to the Data Mining tool, though simpler to operate and capable of larger data transfer. The tool allows any number of Executed Test Definitions (ETDs) to be transferred from any number of DataSets and appended to the Archive of a single tar- get DataSet. An ETD is the complete record of the execution of a single Test Definition (experiment) in a DataSet  Archive. The steps are:

- Identify or create the single target DataSet. If the DataSet is new it is created and opened. Otherwise, open the existing DataSets if they are not already open.
- Identify one or more registered DataSets as source DataSets from which to collect the ETD data. When moving to the next tab, open any DataSets that are not al- ready open and identify all ETDs in each DataSet.
- A tree list appears of all existing ETDs with all selected DataSets, sorted by DataSet and by execution order. Select all ETDs to be transferred. Click *Finish*.
- Each of the selected ETDS will be transferred to the target DataSet, in tree list or- der. Then, any previously-closed DataSets will be closed.

A complete and detailed discussion, including examples, is beyond the scope of this document. Please see the Main Vision help pages under Help->Help Topics for the detailed presentation of the ETD Transfer tool.

<u>**See Also Vision Manual:**</u>

- Main Vision Manual->XVII – ETD Transfer
- Tutorials->XI – Data Mining, ETD Transfer and Sample Measure->B – ETD Transfer

## VII.   Digital Voltmeter:
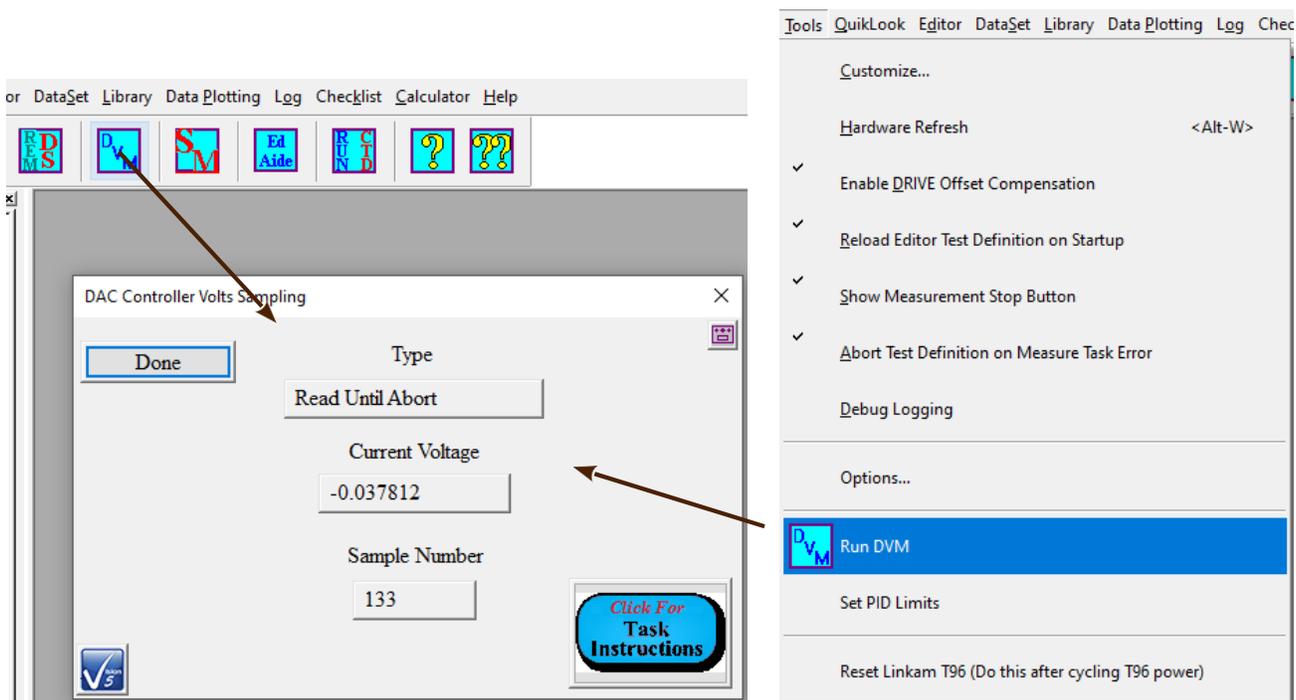


### Figure VII.1 - Digital Voltmeter.

With the addition of the I$^2$C Voltage Controller accessory, the Precision tester and Vision program can work together to form a simple low-speed, low-resolution Digital Voltage Meter (DVM). The DVM captures the voltage input at the I$^2$C Voltage controller, in the ±10.0-Volt range, at a sample rate of approximately 30 samples/second. Although the data are presented in units of Volts to the sixth decimal, the accuracy is limited to ±0.305 mV (305.0 µV). The tools can help serve in the calibration of the voltage output of an external instrument.



**Figure VII.2 - I$^2$C Voltage Controller.**

**See Also Vision Manual:**

- Main Vision Manual->V – Main Menu->D. Tools Menu

## VIII. Simple Measurement:

The Simple Measurement tool allows the user to quickly make a series of Hysteresis measurements, of various configurations, group those measurements together and store them to a new or existing DataSet.

On initialization, the user selects (perhaps creates) the target DataSet.
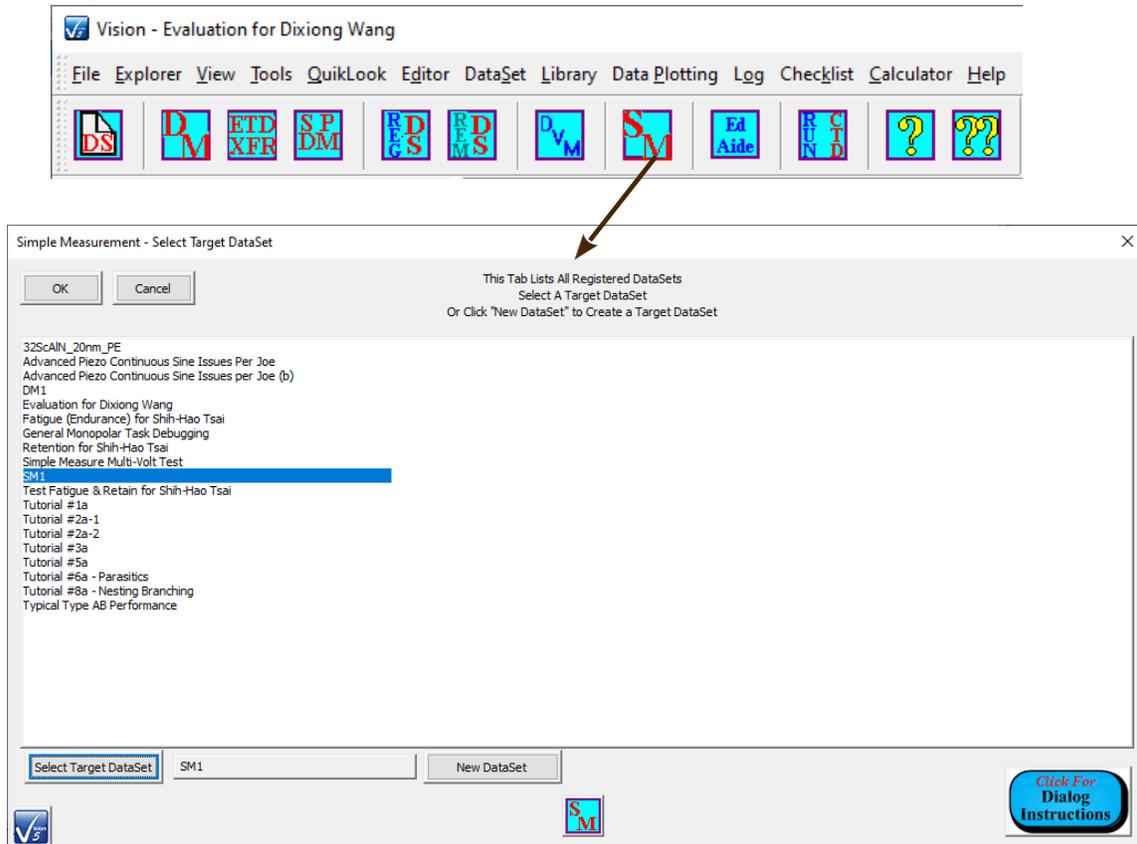


**Figure VIII.1 - Simple Measurement - Select Target DataSet.**

After that the main dialog appears. From this dialog a configuration and execution sub- dialogscan be executed. The measurement must be configured at least once. Any number of measurements may be made in any configuration. A limited number of parameters are available for con- figuration including *Volts*, *Period (ms)*, *Preset* enabling/disabling, *Present Delay* and *Sample Area (cm2)* and *Thickness (μm)*.
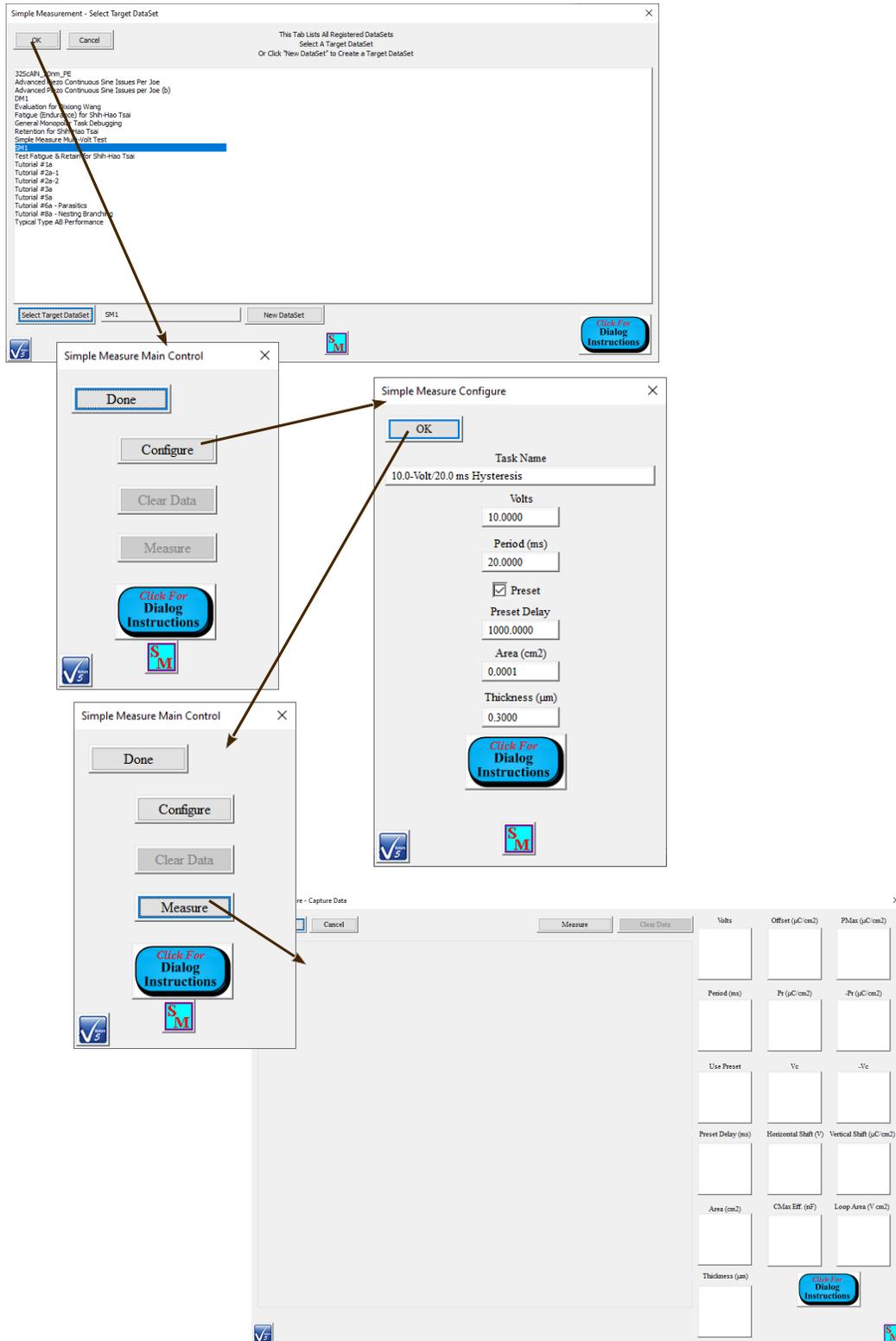
**Figure VIII.2(A) - Simple Measurement Sequence (a).**
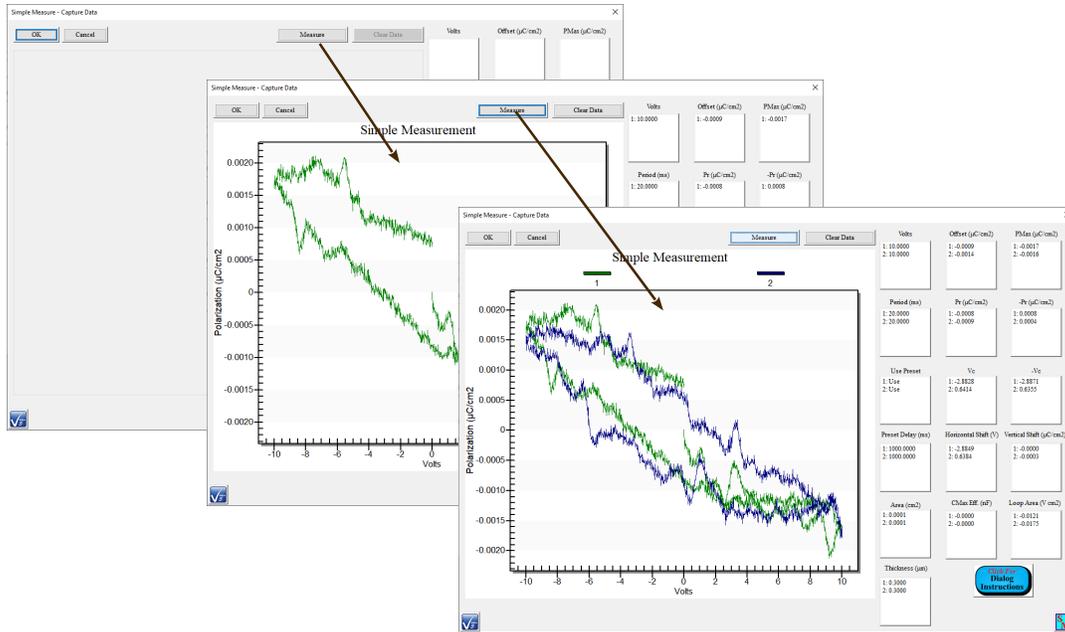
# Figure VIII.2(B) - Simple Measurement Sequence (b).

Note that the data of **Figure VIII.2(B)** are real data from a Precision tester with no sample connected between DRIVE and RETURN.

**See Also Vision Manual:**

- Main Vision Manual->XVIII – Simple Measurement
- Tutorials->XI – Data Mining, ETD Transfer and Simple Measure->C – Simple Measure

## IX.    The Vision Options Dialog.

Vision offers considerable freedom to customize the program to the user's needs. The Vision Options

dialog, accessed through the <u>T</u>ools->Options… menu or the  toolbar button, gathers these options into a single tabbed dialog. A selected set of the options that can be adjusted in this dialog is presented here.

**Figure IX.1 – Access the Options Dialog.**
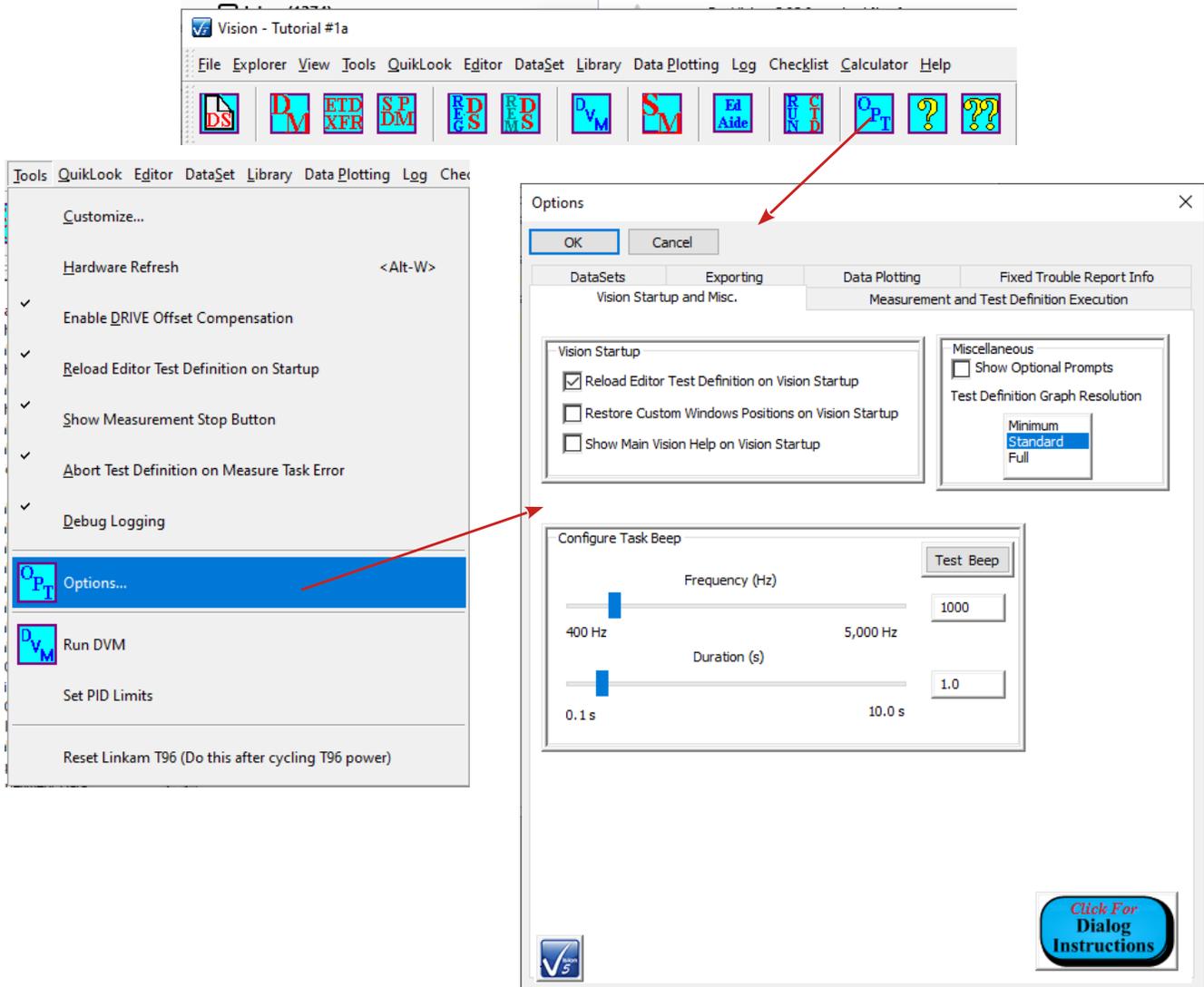
## IX.a  Vision Startup and Misc.
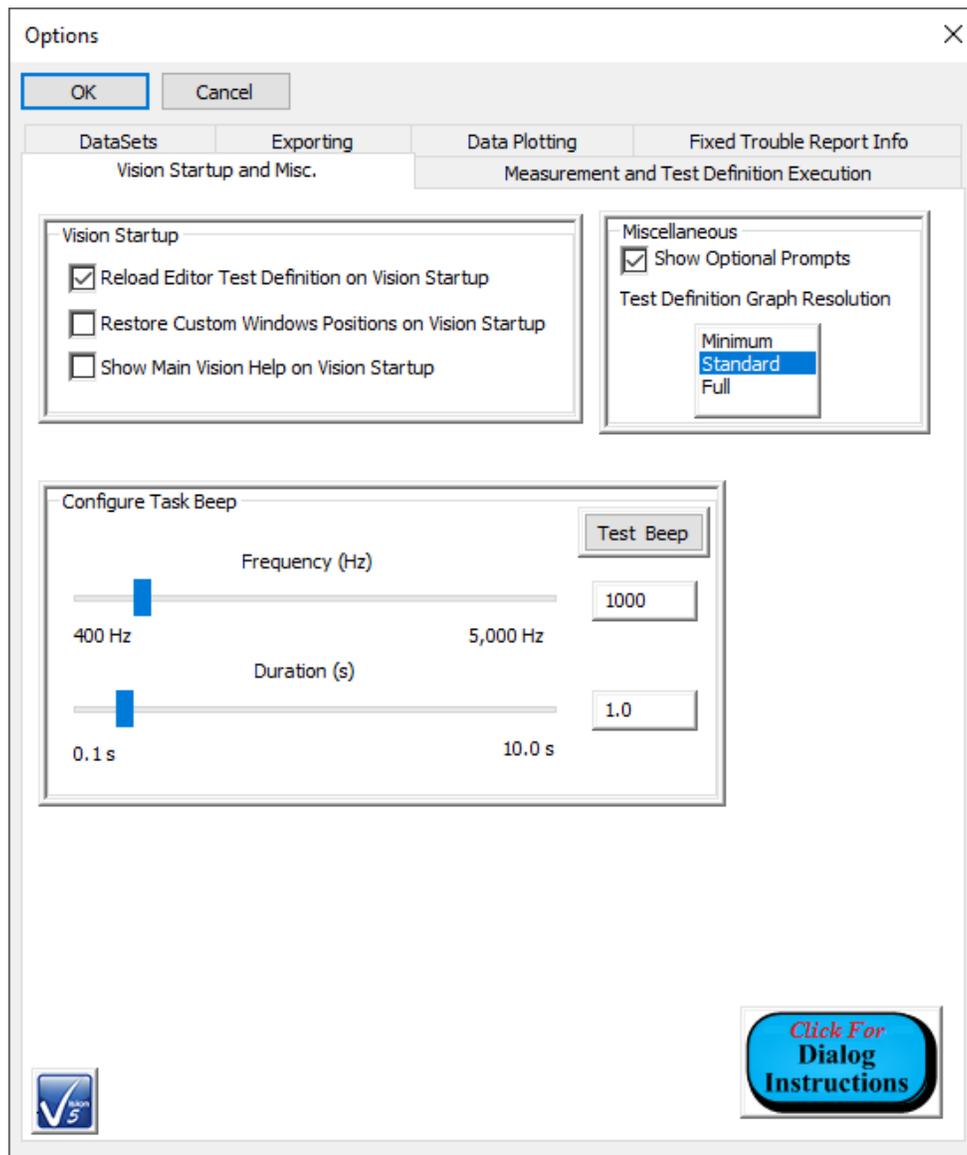


## Figure IX.a.1 – Vision Startup and Miscellaneous Options Tab.

- *Reload Editor Test Definition on Vision Startup* [Default: Checked]: When checked the Test Definition in the EDITOR window will be stored on Vision shutdown. When Vision is re-started the Test Definition will be restored to the EDITOR window. When unchecked, the EDITOR window will be empty on Vision startup.
- *Restore Custom Windows Positions on Vision Startup* [Default: Unchecked]: The windows in the Vision program a resizable and dockable. When this control is checked custom windows sizing and placement will be restored between program executions. When unchecked, Vision will take on the default appearance.
- *Show Main Vision Help on Vision Startup* [Default: Checked]: When checked the Main Vision Manual will open in a separate window on Vision startup.

## IX.b   Measurement and Test Definition Execution.
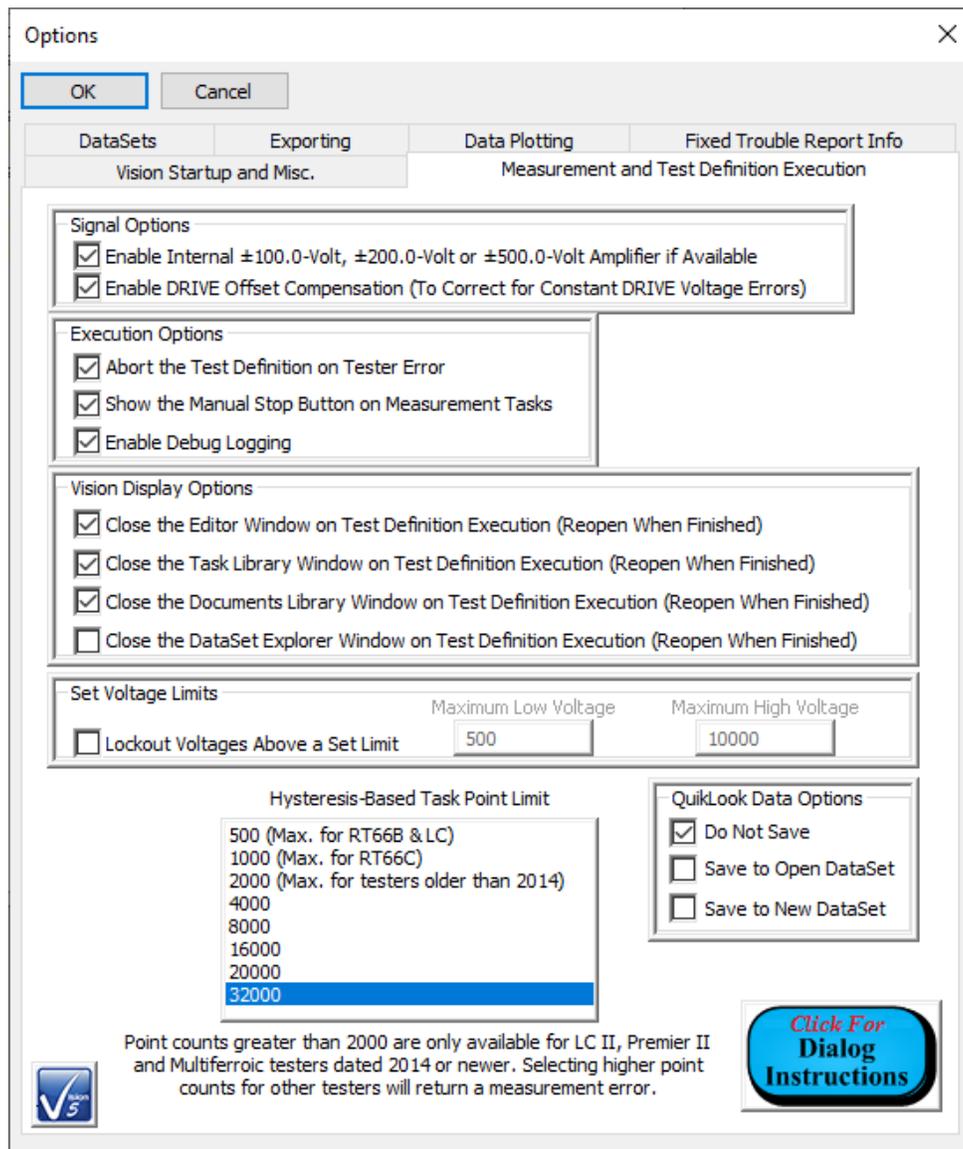


**Figure IX.b.1 – Measurement and Test Definition Execution Tab.**

- *Abort Test Definition on Tester Error* [Default: Checked]: When checked execution of all further Tasks in a Test Definition in a DataSet will stop if a Hardware or Measurement Task has an error returned to it by the Hardware Abstraction Layer [HAL]. When unchecked, execution will proceed unless the error is "Manual Abort by User".
- *Lockout Voltages Above a Set Limit* [Default: unchecked]: When checked, the user may specify a programmatic upper limit to the absolute voltage that Vision will apply for both tester voltages and High-Voltage Amplifier (HVA) voltages. Absolute voltage limits are specified in Maximum Low Voltage [500.0 Volts maximum] and Maximum High Voltage [10,000.0 Volts Maximum].

## IX.c  DataSets.
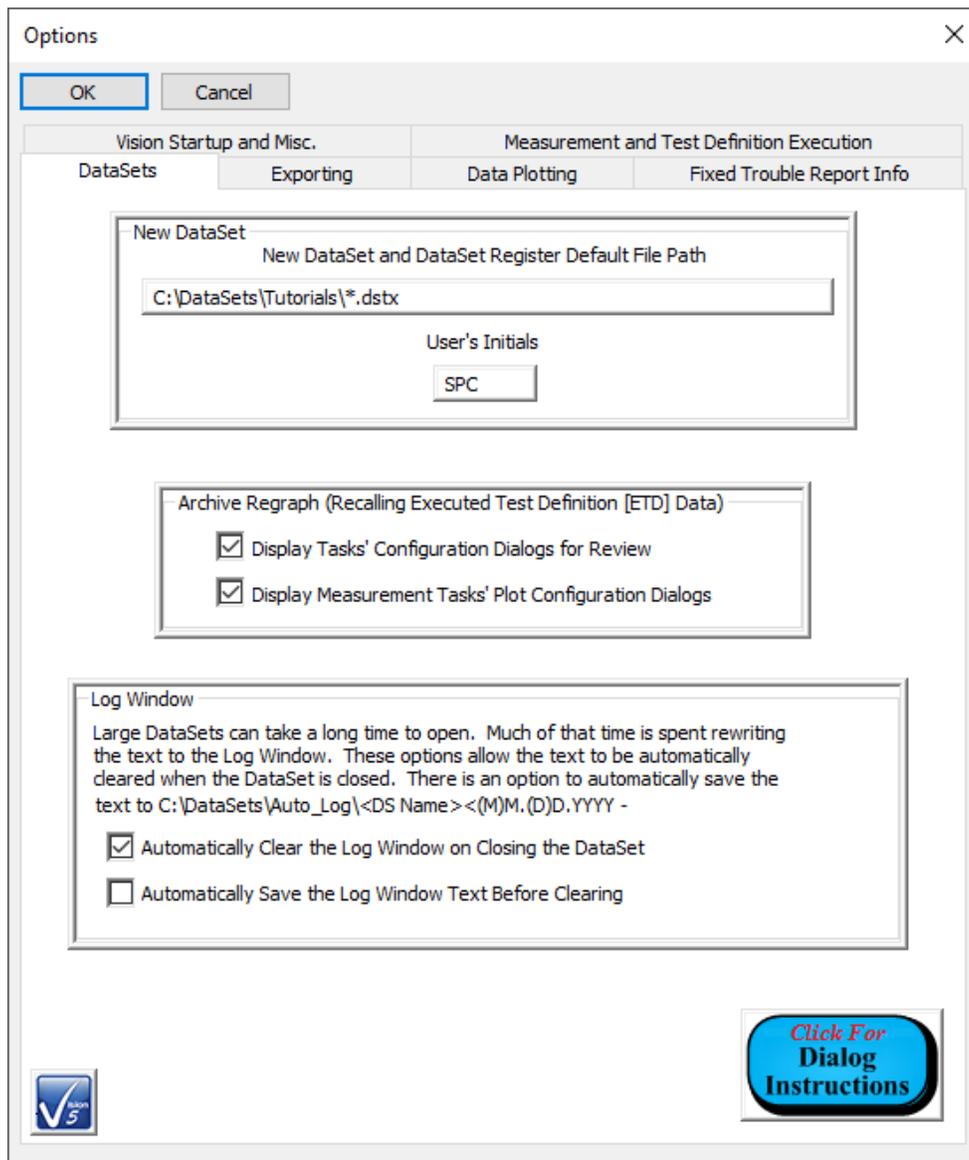


**Figure IX.c.1 – DataSets Tab.**

- *Display Tasks' Configuration Dialogs for Review* [Default: Checked]: When checked, all Tasks will display their configuration dialog immediately when recalled from a DataSet Archive. This is done to review Task configuration and serves as a form or permanent documentation. When unchecked data-collecting Tasks will bypass the configuration dialog display. This speeds access to the data to be reviewed. This option does not affect Program Control Tasks. These Tasks only offer their configuration dialog when recalled.
- *Display Measurement Tasks' Plot Configuration Dialogs* [Default: Checked]: When checked, Measurement Tasks will display the plot configuration dialog immediately after the configuration dialog is called on Archive Regraph. This allows the plot labels, and, possibly, data filter, to be configured before the data are plotted. When unchecked, the dialog is bypassed allowing the user quicker access to the data to be plotted.
- *Automatically Clear the Log Window Text Before Closing* [Default: Checked]: When

checked, all text written to a DataSet's log window will automatically be cleared when closing the DataSet. If *Automatically Save the Log Window Text Before Clearing* is checked, the text will be written to a text file. Removing the limited-value text from a Log Window can help a large DataSet open faster as writing text back to the log window is a slow operation for a large amount of text.

## IX.d   Exporting.
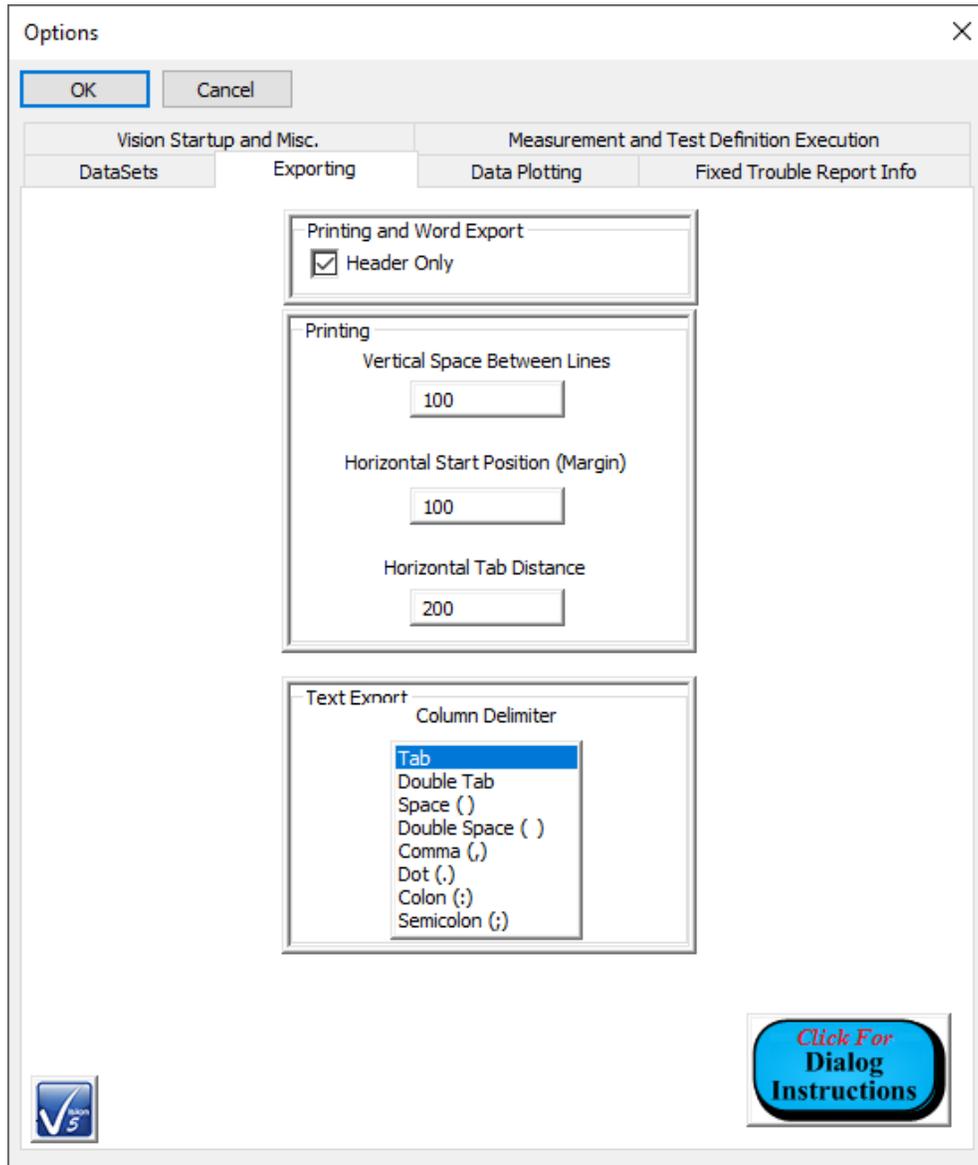


**Figure IX.d.1 – Exporting Options Tab.**

- *Header Only* [Default Checked]: When checked, Word file exporting and printer exporting will be limited to Task information and extracted data for Tasks that would normally output lengthy data vector lists. When unchecked the data vector values will be exported.
- *Printing*: Assign the vertical and horizontal spacing of text.
- *Text Export::Column Delimiter* [Default "Tab"]: Assign the character or characters to use in separating columns of text and parameter names from parameter values in text exporting.

## IX.e  Data Plotting.
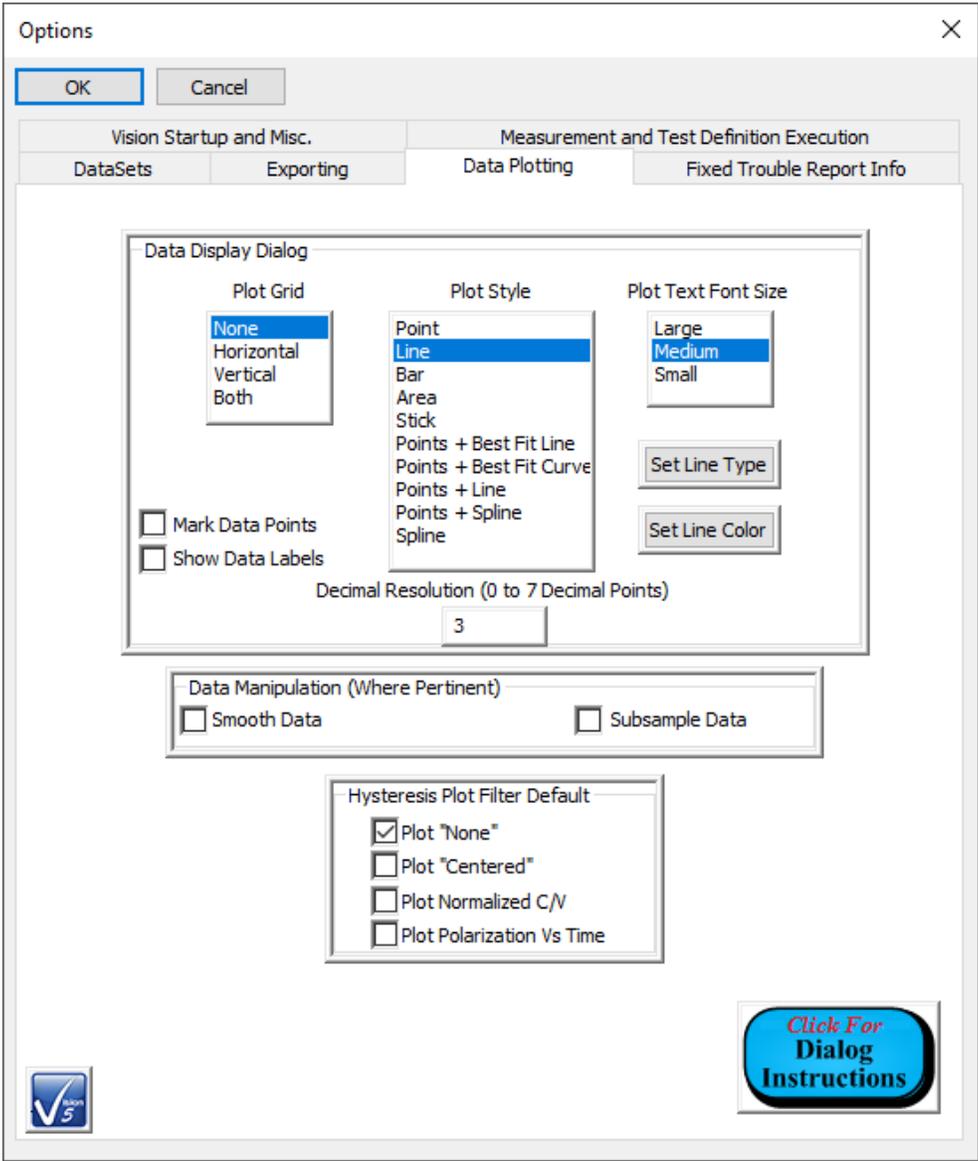


**Figure IX.e.1 – Data Plotting Options Tab.**

- *Data Display Dialog*: Define various aspects of the plotted data appearance including the styles of the data vector traces and the plot surface.
- *Data Manipulation*: Set the default data noise reduction manipulations when performing numerical differentiation on data before plotting.
- *Hysteresis Plot Filter Default*: Set the default data manipulation when plotting data from Hysteresis-based Tasks. Not all possible representations are configured here. Common representations are presented so that they do not need to be re-selected each time data are recovered and plotted.

## IX.f    Fixed Trouble Report Info



**Figure IX.f.1 – Trouble Report Basic Information Options Tab.**

This tab assigns and permanently records information that is used to fill out the first page of the Help->Trouble Report Vision menu option. This option provides a semi-automatic method for providing complete troubleshooting information to Radiant Technologies, Inc. when the Precision tester and/or Vision program is not behaving as expected.


**See Also Vision Manual:**

- Main Vision Manual->V – Main Menu->V.D – Tools Menu->Options.

**See Also Tools->Options…->Click For Dialog Instructions**

## X.    DataSet Rename:

A DataSet may be renamed for any reason that it is convenient and essential to do so. In particular, it

is confusing and bad practice to have two DataSets of the same name. Vision permits this provided the DataSet have different file names and/or file paths.

In the DataSet Explorer, select the DataSet to be renamed in the Explorer tree. Right- click or go to the "Explorer" menu and select "Rename Selected DataSet". Overwrite the existing name in the dialog and click *OK*. The DataSet is permanently renamed.
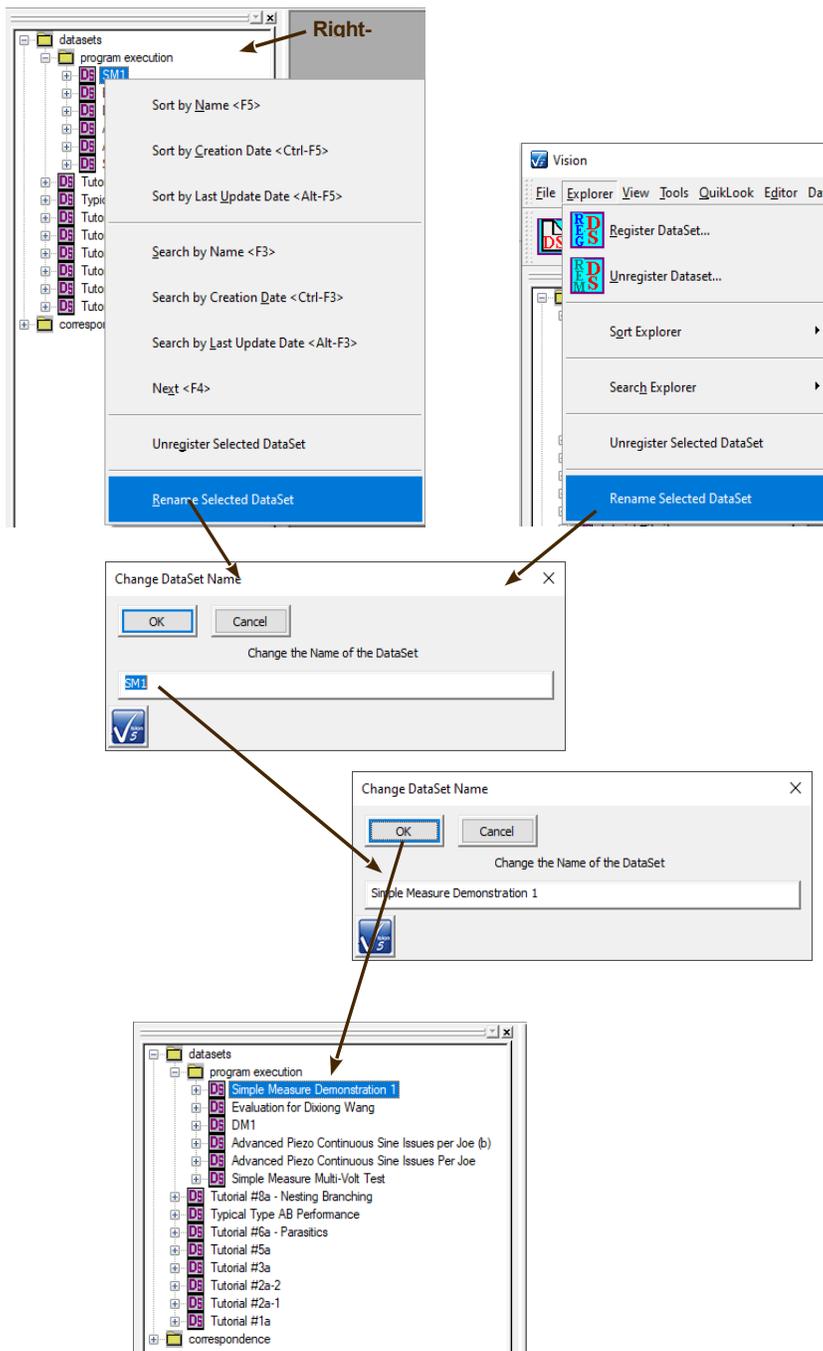


**Figure X.1 - Rename a DataSet.**

.

- Main Vision Manual->V – Main Menu->B. Explorer Menu->Rename Selected DataSet

## XI.    ETD Rename:

By policy, all data stored to a DataSet Archive are permanent. A "Bad" experiment can- not have its Executed Test Definition (ETD) removed. The next several Vision tools offer mechanisms for adjusting the documentation of an ETD. There may be any number of reasons to do so, but indicating an experiment run in error or with errors is a primary one.

The ETD Rename tool is very similar to the DataSet Rename tool. With the DataSet open select the appropriate ETD, right-click and select "Rename ETD". In the dialog that appears, overwrite the existing ETD name and click *OK*. The ETD will be permanently renamed.
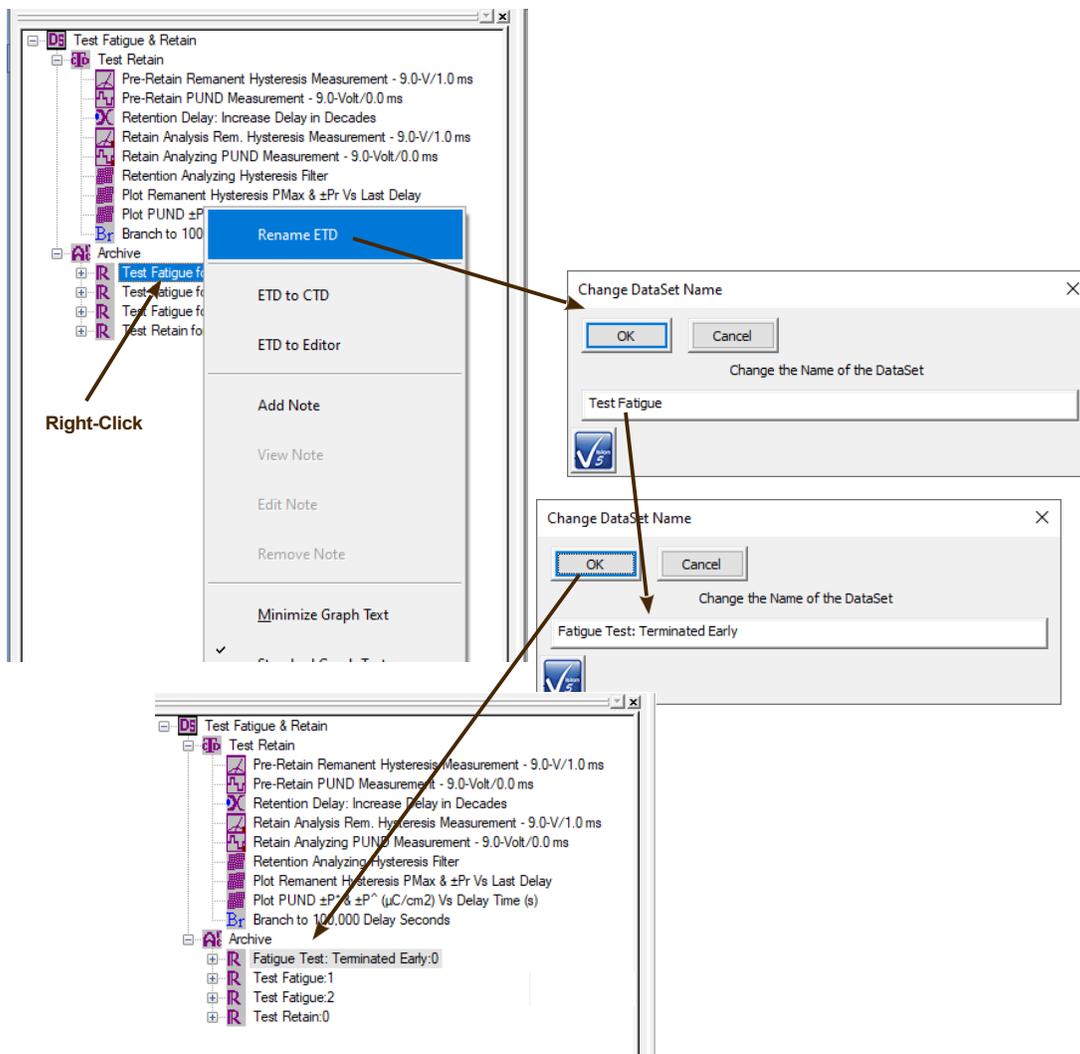


## Figure XI.1 - Rename an ETD.

## XII.    ETD Note:

After execution an Executed Test Definition (ETD) in a DataSet Archive is self-documenting in that it records the complete configuration and user documentation (Task Names, Comments, etc.) of each Task on execution. After the Tasks and their data are permanently stored in the ETD, additional documentation can be provided in the form of an ETD Note. A complete and detailed discussion of ETD notes is beyond the scope of this document. Please see the main Vision help project, under Help->Help Topics, for that detail.

In a brief discussion, an ETD Note consists of a date/time stamp, a single line of descriptive text (title) and up to 2000 characters of Rich Text-formatted discussion. Once the Note is added, the ETD is visibly flagged by replacing the standard ETD icon with the icon $R^n$.
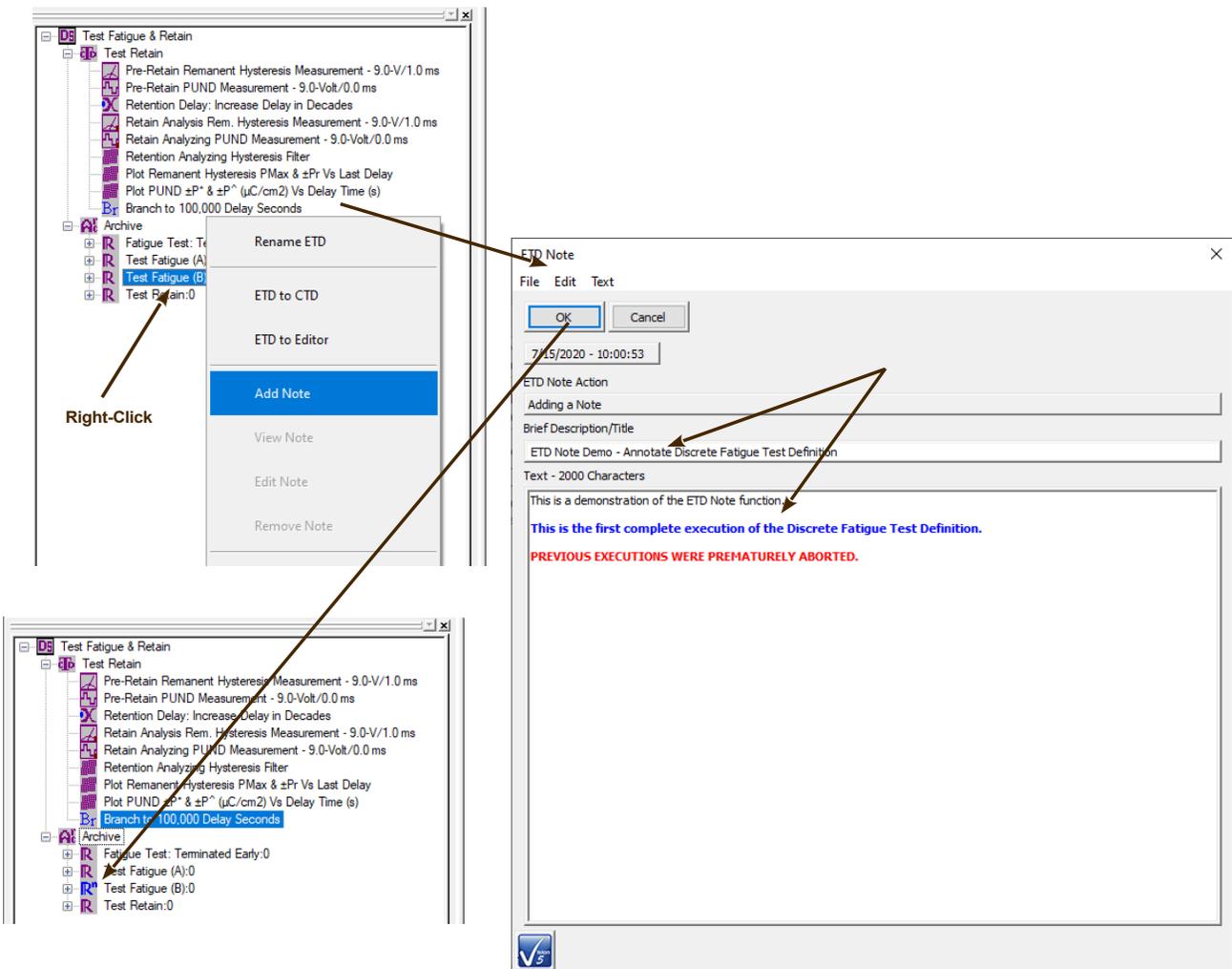


**Figure XII.1 - Add an ETD Note.**

- Main Vision Manual->X - DataSets and the DataSet Explorer->X.5 – ETD Notes
- Step-By-Step->Executed Test Definitions (ETDs)->ETD Notes

# XIII. ETD Markers:

Just as the ETD Note adjusts an ETD icon to flag its association with a Note, the user can easily flag the ETD, for any reason, by replacing the standard icon with one of three icons. For convenience, these are labeled as below, but can take on any meaning that the user chooses:

- : Error
- : Important
- : Special Attention

To add an icon, simply right-click on the target ETD and select "Add Marker-><Intended Marker>".
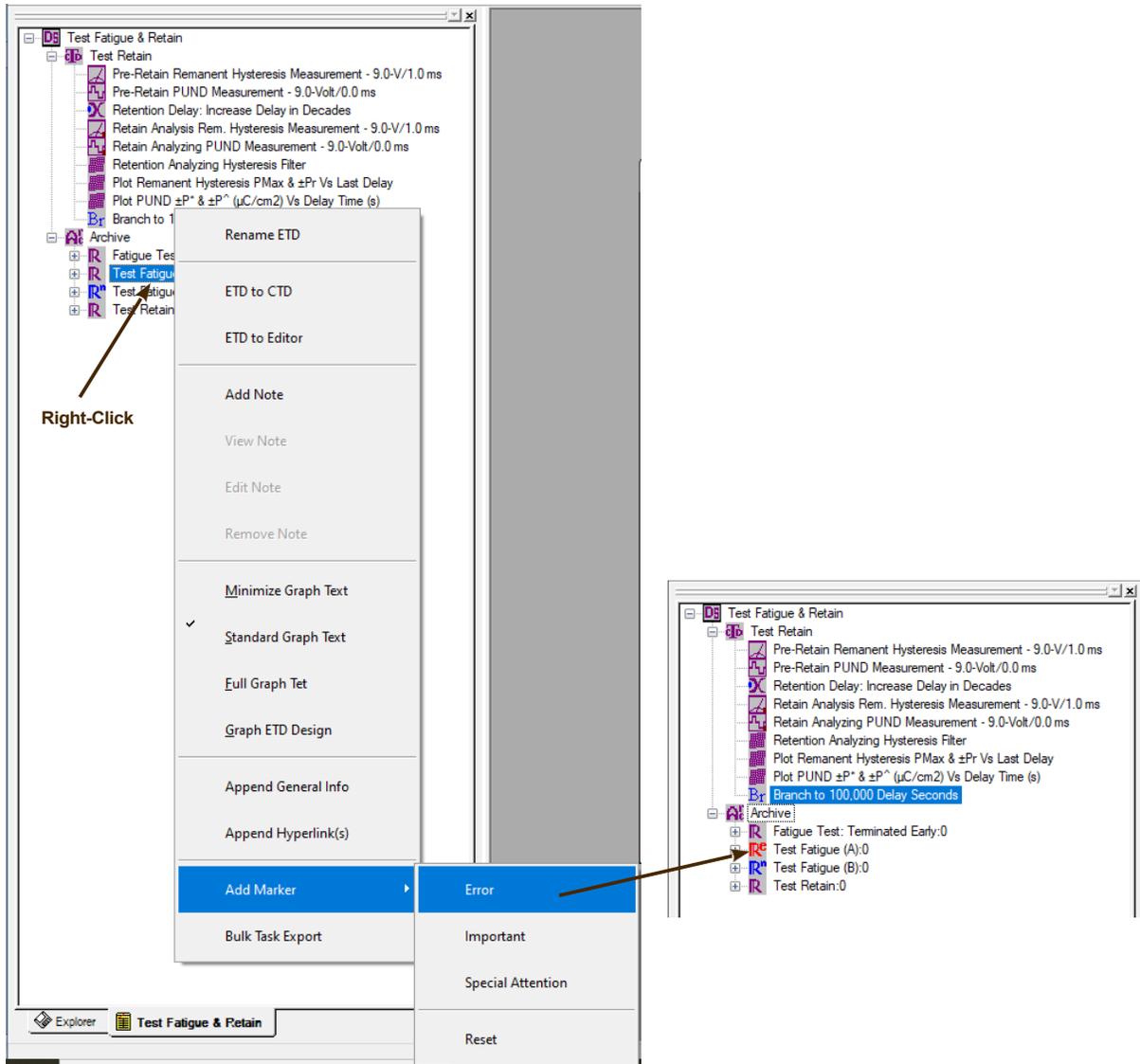
**Figure XIII.1 - Adjust ETD Marker Icon.**

**See Also Vision Manual:**

- Main Vision Manual->X – DataSets and the DataSet Explorer->X.4 – ETD Markers.
- Tutorials->I – Basic Vision Operations->L – Adjust ETD Markers

## XIV.   Immediate General Information:

The General Information Task is a documentation Task found in TASK LIBRARY-> Program Control->Documentation. It is a simple Task, specifying a few documenting parameters and including a Comments that is not limited in the number of characters. As with any Task, it could be configured into a Test Definition in the Editor, moved into a DataSet Current Test Definitions (CTD) and executed, appending its ETD to the list of ETDs in the DataSet Archive. However, Vision offers a toolto allow the Task to be immediately configured and appended to the Archive without the labor of standard Test Definition configuration, relocation and execution. This allows for very quick documentation of the DataSet Archive, perhaps discussing the ETD immediately above it for additional documentation purposes.

Right-click on any ETD in the DataSet Archive. Select "Append General Info". The Task configuration dialog opens. Record the comments and other fields. NOTE: DO NOT EXCEED SIXTY CHARACTERS IN THE TASK NAME. Close the configuration dialog the Tasks is appended as an ETD in the Archive with a specific identifying icon and named "Appended General Info:x".
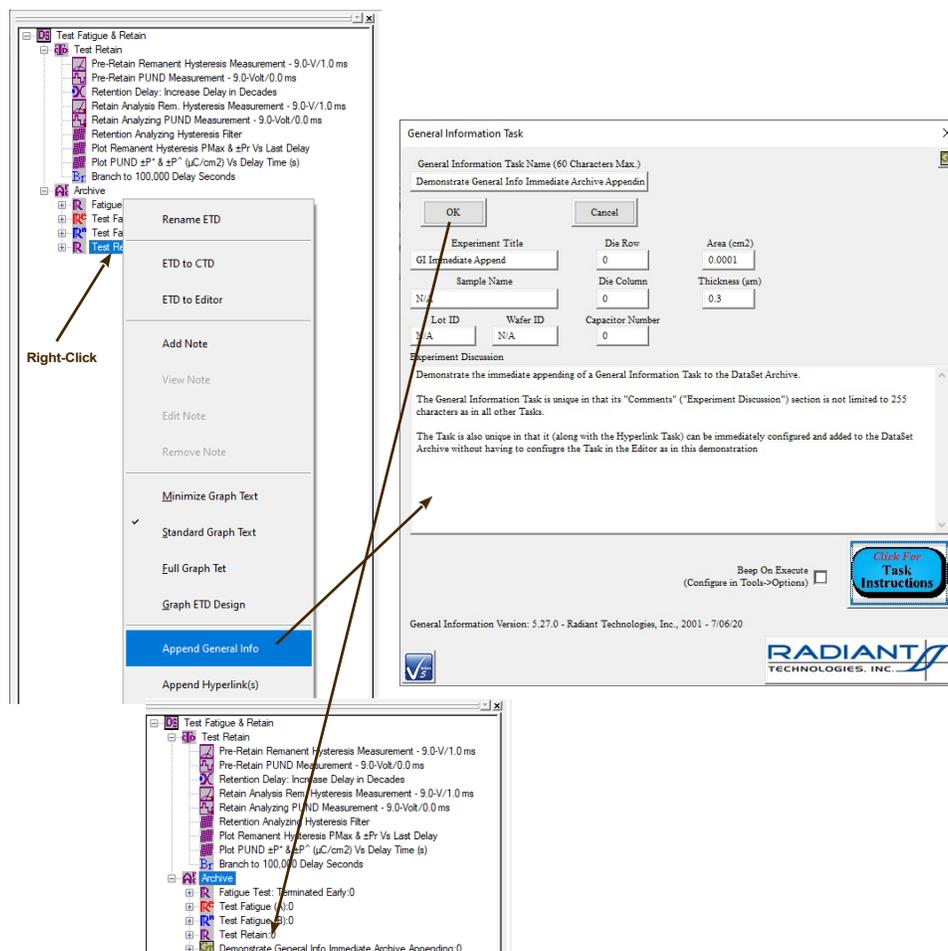


# Figure XIV.1 - Immediate Appending of the General Information Task.

- Tutorials->I – Basic Vision Operations->M – Append a General Information Task

## XV.    Immediate Hyperlink:

In a very similar process to Immediate General Information, the user can also append an ETD that contains a Hyperlink Task without needing to go through the Editor Test Definition configuration. The Hyperlink Task allows the user to add any number of hyperlinks to documents at run-time. HTML documents found on the web may be hyperlinked by copying and pasting the URL. For documents on the local computer, a browser may be used to locate the object. Once stored in the DataSet Archive, the Task dialog may be reopened to exercise the link(s).
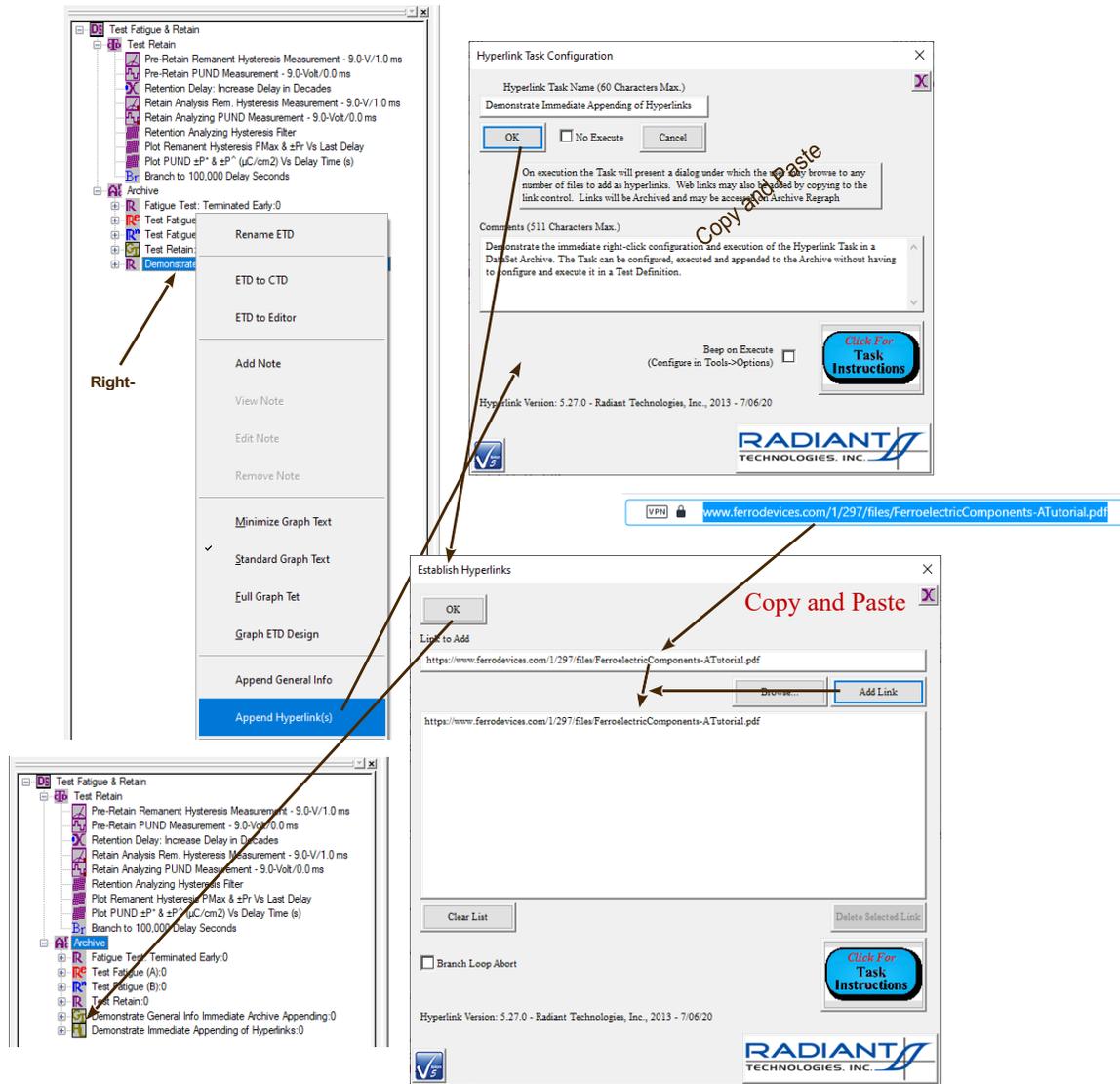


**Figure XV.1 - Immediate Access Hyperlink Task.**

- Tutorials->I – Basic Vision Operations->N – Append a Hyperlink Task

## XVI.    Bulk Task Export:

Using this tool, all Tasks of a particular type, stored in a single Executed Test Definition (ETD) in a DataSet Archive, can be exported as a group to a series of files in a specified location with a specified base file name. Any Task type in the ETD can be exported. Tasks can be exported to Excel or text files. Data-collecting Tasks (Measurement Tasks and Filter Tasks) can also be exported to Vision Data Files (VDF, *.vis).
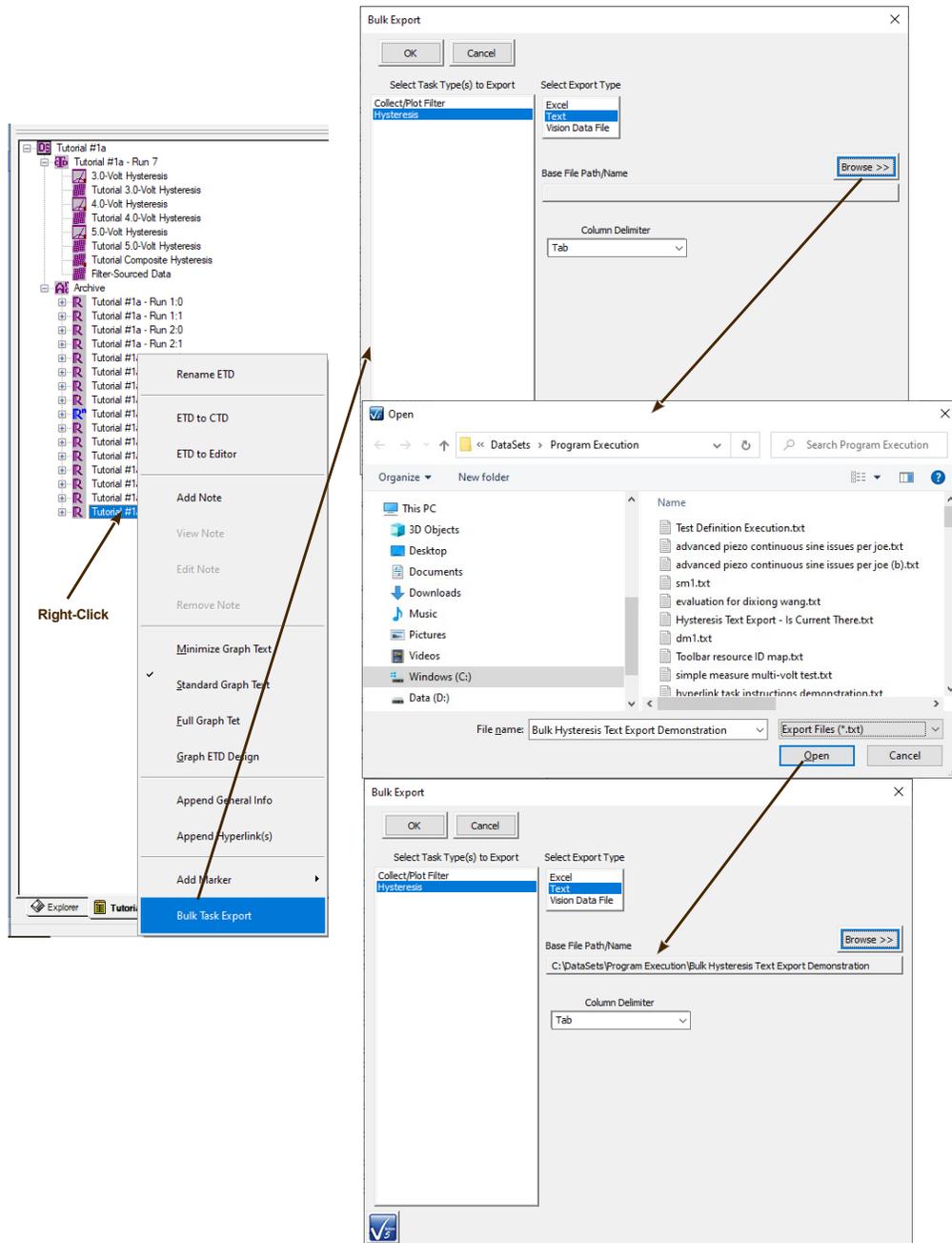


**Figure XVI.1 - Bulk Hysteresis Task Export (A).**

**Figure XVI.2 - Bulk Hysteresis Task Export (B).**

## XVII.  Test Definition Graphing:

There are many ways to transmit a Test Definition configuration to colleagues, students, the community, etc. A DataSet file can be emailed or posted for downloading. The interested party can then register the DataSet and executed it immediately. A Customized Test file (*.UDT) can be place in any C:\DataSets File. The Test Definition will appear in the TASK LIBRARY->Customized Tests folder. Vision also offers a tool that allows a Test Definition to be shown graphically and then copied to the clipboard for pasting into any appropriate document.

With the Test Definition in the Editor, right-click and select "Graph Editor Test Definition". A graphical representation of the Test Definition will appear in two panes. The right pane shows a simple organizational chart that shows the Task sequence by type and links between Branch and Filter Tasks and their targets. The left pane shows considerable detail for each Task including Task Name, Type, Type Icon, Type Color, text describing the Task configuration and links showing links between Branch and Filter Tasks and their target Tasks.

Selecting a Task highlights the Task with a dark pink outline. Right-clicking allow the entire graph to be printed and/or copied to the Clipboard for pasting elsewhere. The user can change the Task outline color to highlight it. The Tasks self-description can be appended to and Comments can be associated with the graph. (These will appear as text in the right pane.) Finally the graph can besaved and recalled into Vision at any time. Test Definition Graphing is also available from any DataSet Archive.
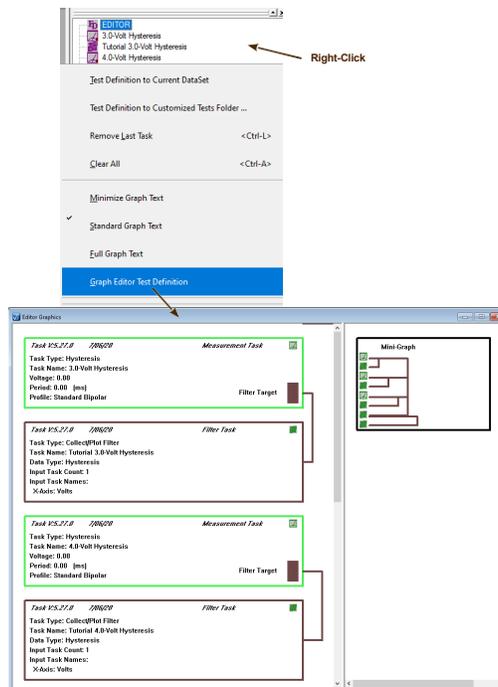


**Figure XVII.1 - Test Definition Graphing.**

- Main Vision Manual->XIV – Test Definition Graphing
- Tutorials->IX – Test Definition Graphing
- Step-By-Step->Test Definition Graphs

## XVIII. Branching Under Multiple Logic Conditions:

The Branch Task returns Test Definition sequencing to a previous Branch Target Task for as long as a Branch Logic Condition is true. A Branch Logic Condition is given as:

if <Selected User Variable><Selected Comparison><Assigned Limit> then Branch (a)

The type (Real, Integer, Text or Boolean Logic) of the <Assigned Limit> depends on the type of the<Selected User Variable>. It is incumbent on the user to ensure that the Branch Logic Condition is based on a <Selected User Variable> that changes as the sequencing continues so that the Branch Logic Condition will arrive at a point at which it is false and Branching terminates. For example:

if < "Hysteresis: Current Volts" >< "<=" >< 9.0 > then Branch (b)

will continue to iterate until the "Hysteresis: Current Volts" User Variable > 9.0. This is correct, provided the Hysteresis Task within the Branch Loop is configured to increase its voltage at each iteration. Note that the Branch Logic Condition is expressed, in plain English, in a text control on the Branch Task configuration dialog.
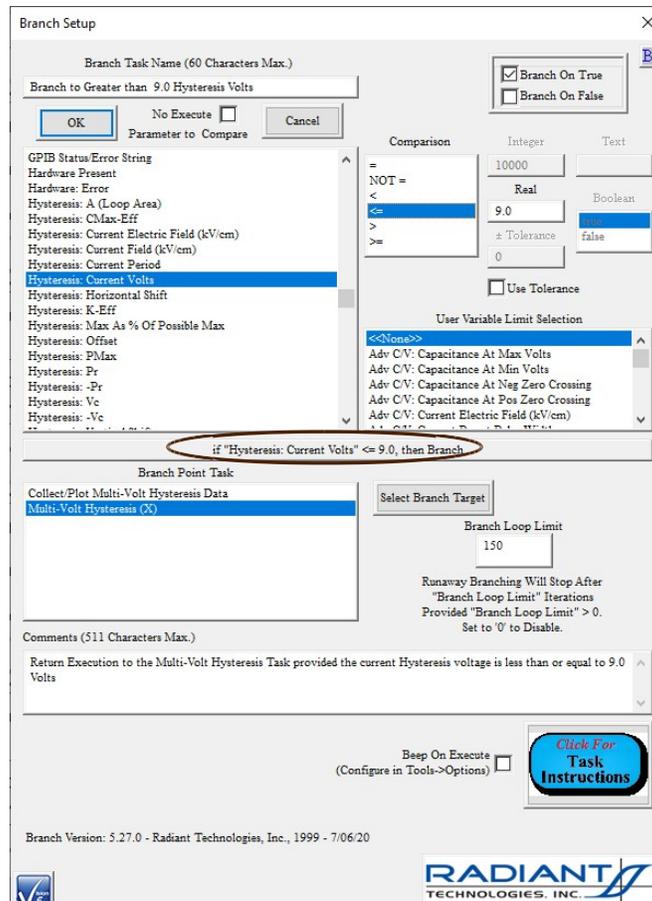
**Figure XVIII.1 - Branch Task Configuration. Branch Logic Condition Circled in Red.**

There are several ways to cause the Branch Task to stop Branch Loop iterations even if the Branch Logic condition remains true:

- On the Branch Task configuration dialog set *Branch Loop Limit* to a value other than '0'. The Branch Task will not return execution to the Branch Target more than this number of times. This can be used as a safeguard to prevent possible in- finite branching.

- Place a Manual Branch Abort Task before Branch Task. This Task presents a dialog on execution. The user must acknowledge the dialog and decided either to continue or stop branching. If branching is terminated, the Test Definition execution will continue with any Task that follows the Branch Task. The dialog may display a single selected User Variable that may help in the decision to continue or terminate branching.

- Place a Timed Branch Abort Task before the Branch Task. This Task is identical to the Manual Branch Abort Task except that the decision dialog appears only for a user-specified period of time. If the time expires, the Task removes the dialog and allows the Branch Task to continue Branching. The Test Definition continues sequencing. This allows the equivalent of a Manual Branch Abort Task to be included in the Test Definition, but also allows the Test

Definition to run without human supervision.

- Place one or more Automatic Branch Abort Tasks before the Branch Task.

It is the final option that is the true subject of this topic. By using one or more Automatic Branch Abort Tasks in the Test Definition, the Branch Task can be made to depend on two or more Branch Logic Conditions. The configuration of the Automatic Branch Abort Task is nearly identical to that of the Branch Task. However, in the Automatic Branch Abort Task, the Branch Logic Condition has inverse meaning. In the Branch Task, if the Branch Logic Condition is true, Branching continues. In the Automatic Branch Abort Task, if the Branch Logic Condition is true Branching is aborted. In fact, the condition should be called Abort Logic Condition:

if <Selected User Variable><Selected Comparison><Assigned Limit> then Abort Branching (c)

For example, measurements are to continue until "Hysteresis: Current Volts" > 9.0, as in (C), above. However, "Hysteresis: $P_{Max}$" must remain in the range 20.0 µC/cm$^2$ to 30.0 µC/cm$^2$. Two Automatic Branch Abort Tasks are included before the Branch with Abort Logic Conditions. The total logic condition is:

if < "Hysteresis: Current Volts" >< "<=" >< 9.0 > then Branch
if < "Hysteresis: PMax" >< "<" >< 20.0 > then Abort Branching
if < "Hysteresis: PMax" >< ">" >< 30.0 > then Abort Branching

**Figure XVIII.2 - Abort Branching if P<sub>Max</sub> < 20.0 μC/cm².**

The following is the reconstruction of the dialog content shown in the figure:

## Automatic Branch Abort Setup ✕

Auto Branch Abort Task Name (60 Characters Max.)

`Abort Branching for Hysteresis PMax < 20.0 µC/cm2`

☑ Abort On True
☐ Abort On False

[ OK ]  ☐ No Execute  [ Cancel ]

**Parameter to Compare**

- GPIB Start: Start Type
- GPIB Status Word
- GPIB Status/Error String
- Hardware Present
- Hardware: Error
- Hysteresis: A (Loop Area)
- Hysteresis: CMax-Eff
- Hysteresis: Current Electric Field (kV/cm)
- Hysteresis: Current Field (kV/cm)
- Hysteresis: Current Period
- Hysteresis: Current Volts
- Hysteresis: Horizontal Shift
- Hysteresis: K-Eff
- Hysteresis: Max As % Of Possible Max
- Hysteresis: Offset
- **Hysteresis: PMax**
- Hysteresis: Pr
- Hysteresis: -Pr
- Hysteresis: Vc
- Hysteresis: -Vc
- Hysteresis: Vertical Shift
- I/V: Current (Amps)
- I/V: Current At Max Volts
- I/V: Current At Min Volts

**Comparison**

- =
- NOT =
- **<**
- <=
- >
- >=

Integer: `0`

Real: `20.0`

± Tolerance: `0`

Text

Boolean:
- **true**
- false

**User Variable Limit Selection**

- **<<None>>**
- Adv C/V: Capacitance At Max Volts
- Adv C/V: Capacitance At Min Volts
- Adv C/V: Capacitance At Neg Zero Crossing
- Adv C/V: Capacitance At Pos Zero Crossing
- Adv C/V: Current Electric Field (kV/cm)
- Adv C/V: Current Preset Pulse Width
- Adv C/V: Current Preset Volts
- Adv C/V: Current Soak Delay
- Adv C/V: Current Tickle Pulse Width
- Adv C/V: Current Tickle Volts

**if "Hysteresis: PMax" < 20.0, then Abort**

Comments (511 Characters Max.)

This Automatic Branch Abort Task is used to assign a second Branch Logic Condition to the Branch Loop defined by the subsequent Branch Task. The Auto Branch Abort Task appears within the Branch Loop, and so is placed between the Branch Target Hysteresis Task and the Branch Task. Here Branching is aborted for Hysteresis PMax < 20.0 µC/cm2

Beep On Execute
(Configure in Tools->Options) ☐

**Click For Task Instructions**

Automatic Branch Abort Version: 5.27.0 - Radiant Technologies, Inc., 2001 - 7/06/20

**RADIANT** TECHNOLOGIES, INC.

- Tutorials->III – Branch Loop Operations->Step 4 – Add an Automatic Branch Abort Task

## XIX.    Nesting Branch Loops:

Vision allows a group of Tasks to operate within an inner Branch Loop, controlled by a Branch Task, and an outer Branch Loop, services by a Nesting Branch Task. This is a very complex subject outside the scope of this document. Please see the main Vision help, Main Manual XIII - Nested Branch Looping and Tutorials VIII - Nesting Branch Loop.

## XX.    External Trigger Vision (File Start/Abort Task):
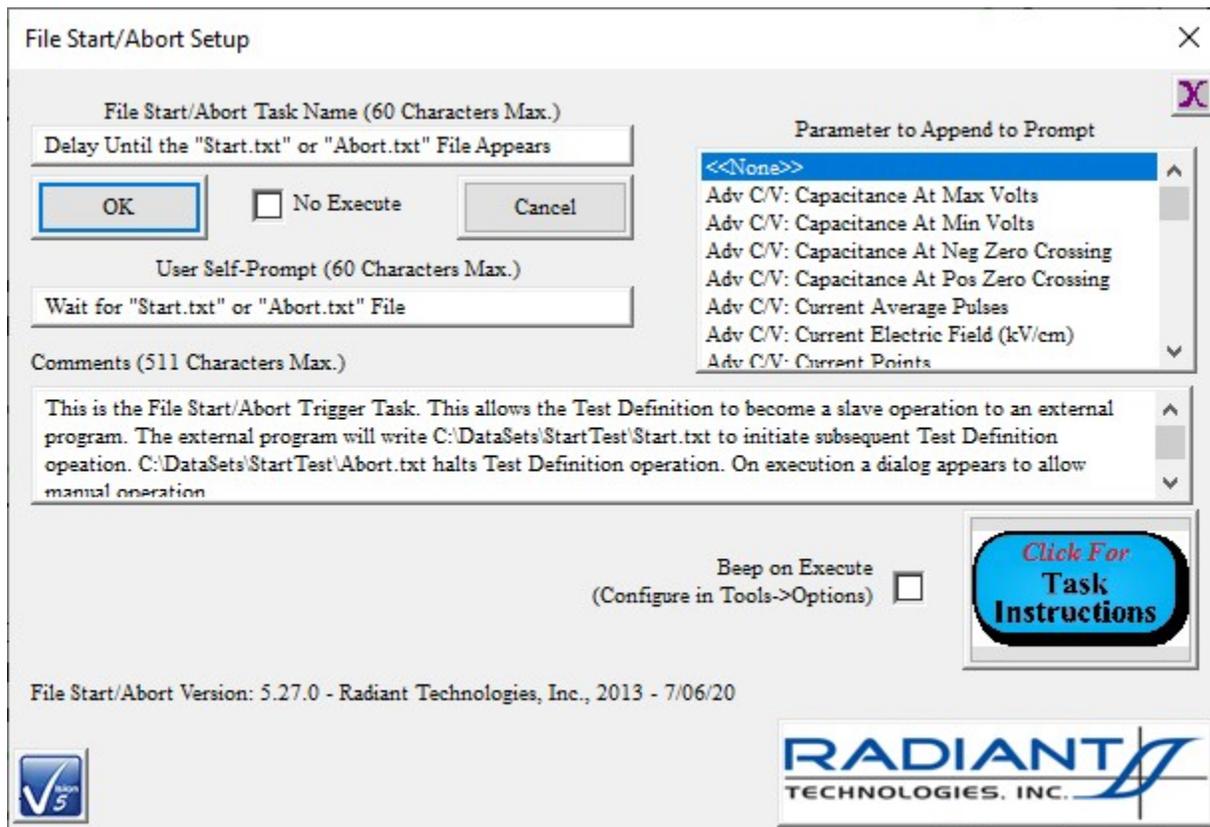


**Figure XX.1 - File Start/Abort Task.**

Vision Test Definition sequencing can be triggered (or aborted) by an external program, such as Lab-VIEW, by including the File Start/Abort Task, normally (but not necessarily) as the first Task in the Test Definition. On execution the Task waits until a file named C:\DataSets\StartTest\Start.txt appears. When the file appears, the Task deletes it and then passes execution to the next Task in the Test Definition. The file C:\DataSets\StartTest\Abort.txt causes the Task to delete the file and stop Test Definition execution. (In this case, the File Start/Abort Task is the last Task written to the Da- taSet Archive.)

On execution the Task also presents a dialog that allows the user to manually trigger or abort the
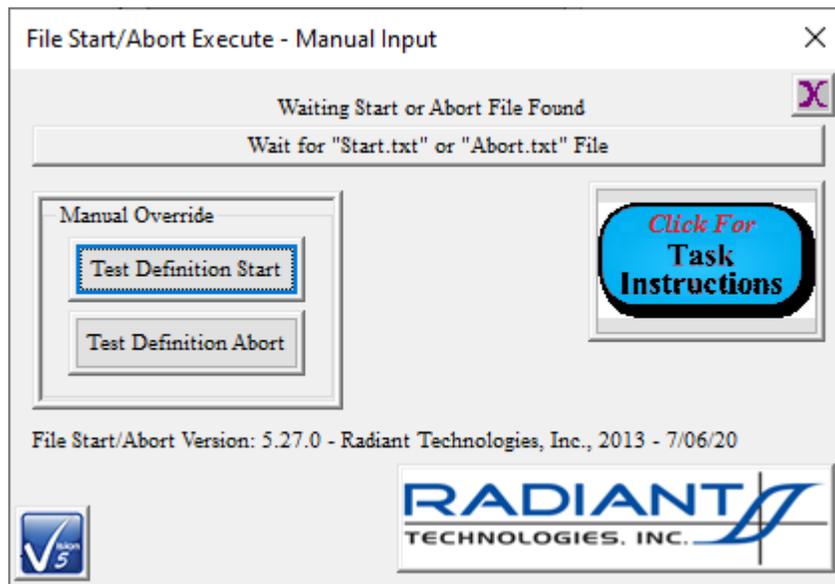
Test Definition sequence.



**Figure XX.2 - File Start/Abort Task Execution Dialog.**

## XXI. Checklists:

Vision can be a complex program to configure, operate and recover and analyze data in. It can also involve sophisticated interactions between the researcher, the experiment apparatus and the program. For example the program may need to pause while the researcher moves probe station probe tips from one sample to another on a wafer. In many cases a checklist may be useful to ensure that every step in a complex process is completed and in proper order.

Vision allows the user to create, edit and employ named checklists of up to twenty steps. Longer checklists can be created by breaking the operations down into smaller checklists and then running the checklists in sequence.

### XXI.a Create a Checklist

A checklist is created by selecting Checklist->Create/Update Checklist in the Vision menu. A dialog opens that allows existing checklists to be edited and new checklists to be created. Centered at the top of the dialog is the *Open Existing Checklist for Editing* list box containing all existing checklists. Vision includes a "CS 2.5 Magneto-Electric Hookup – Magnetic Measurement" checklist and a "High-Voltage Measurement Hookup" checklist. Selecting any checklist in the list box will populate the sequence of checklist item labels and set the number of items in *Checklist Length*. Only *Checklist Length* number of item labels will be shown. *Entry* x *Label* can have the text for the entry adjusted. The number of entries can also be adjusted in *Checklist Length*.

A new checklist is created by specifying the *Checklist Length* and editing the labels for each of the *Checklist Length* number of steps. A new name is assigned in *Checklist Name*.
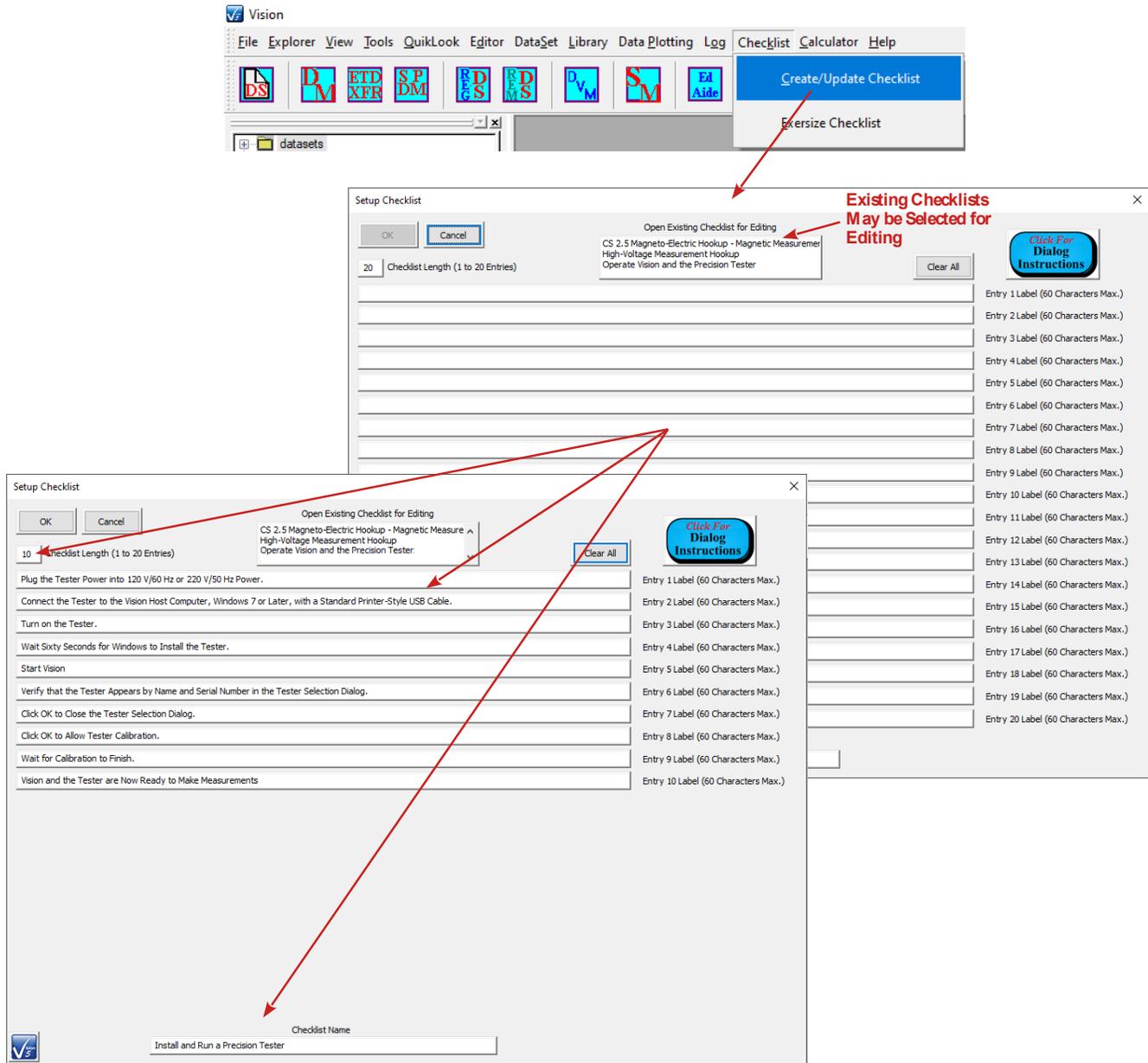
**Figure XXI.a.1 – Create a New Checklist.**

## XXI.b Exercise a Checklist

To use a checklist, go to the Checklist->Exercise Checklist Vision menu option. In the *Select Checklist to Use* list box select the checklist to be exercised. A list of checkbox and label pairs will appear, with the number of pairs matching the number of steps assigned when the checklist was created. If the checklist is being used for the first time, most pairs will be disabled. Only the first pair will be enabled. As actions are completed and the labeled entry for that action is checked, the next action to be completed will be enabled in the checklist.
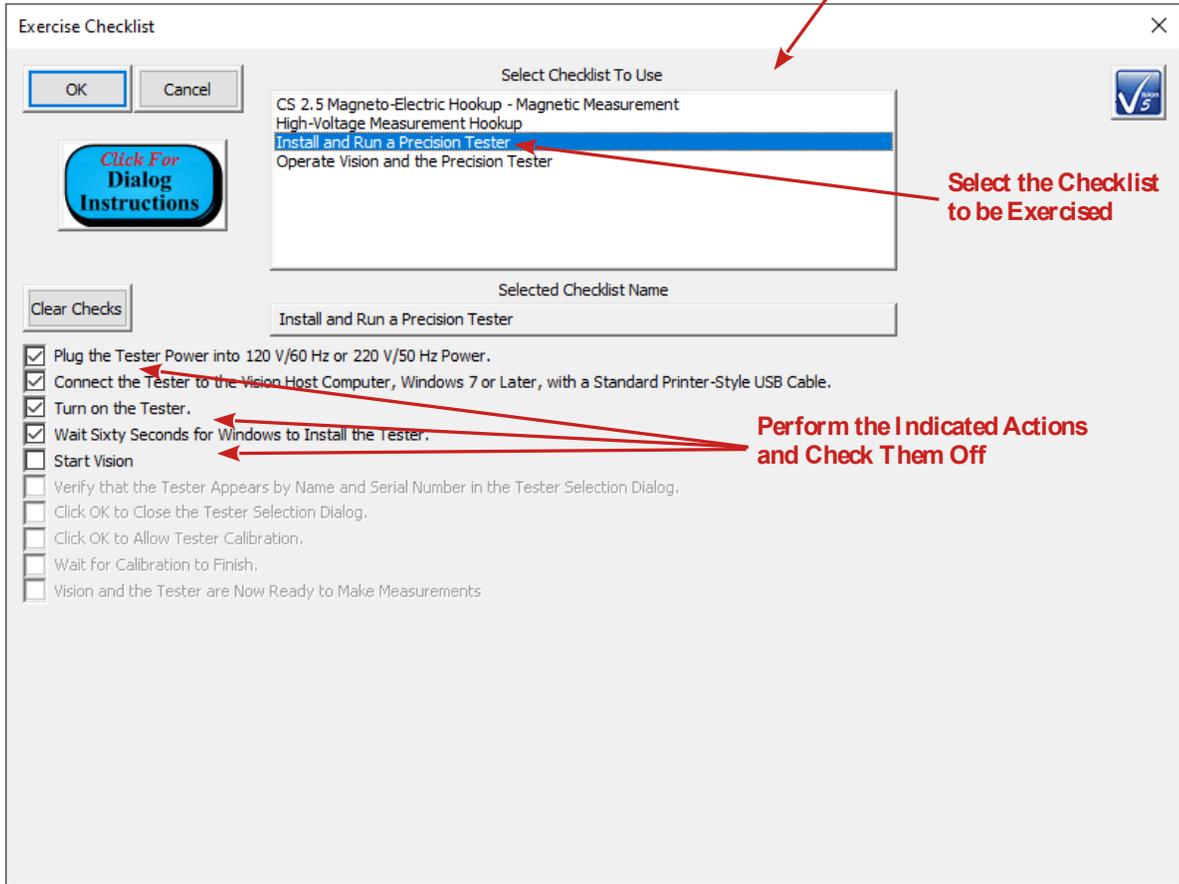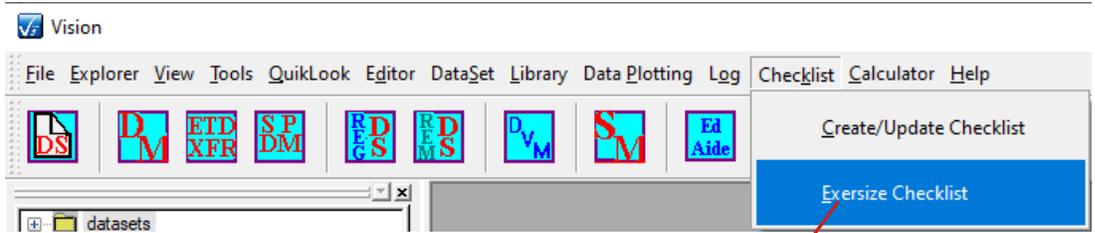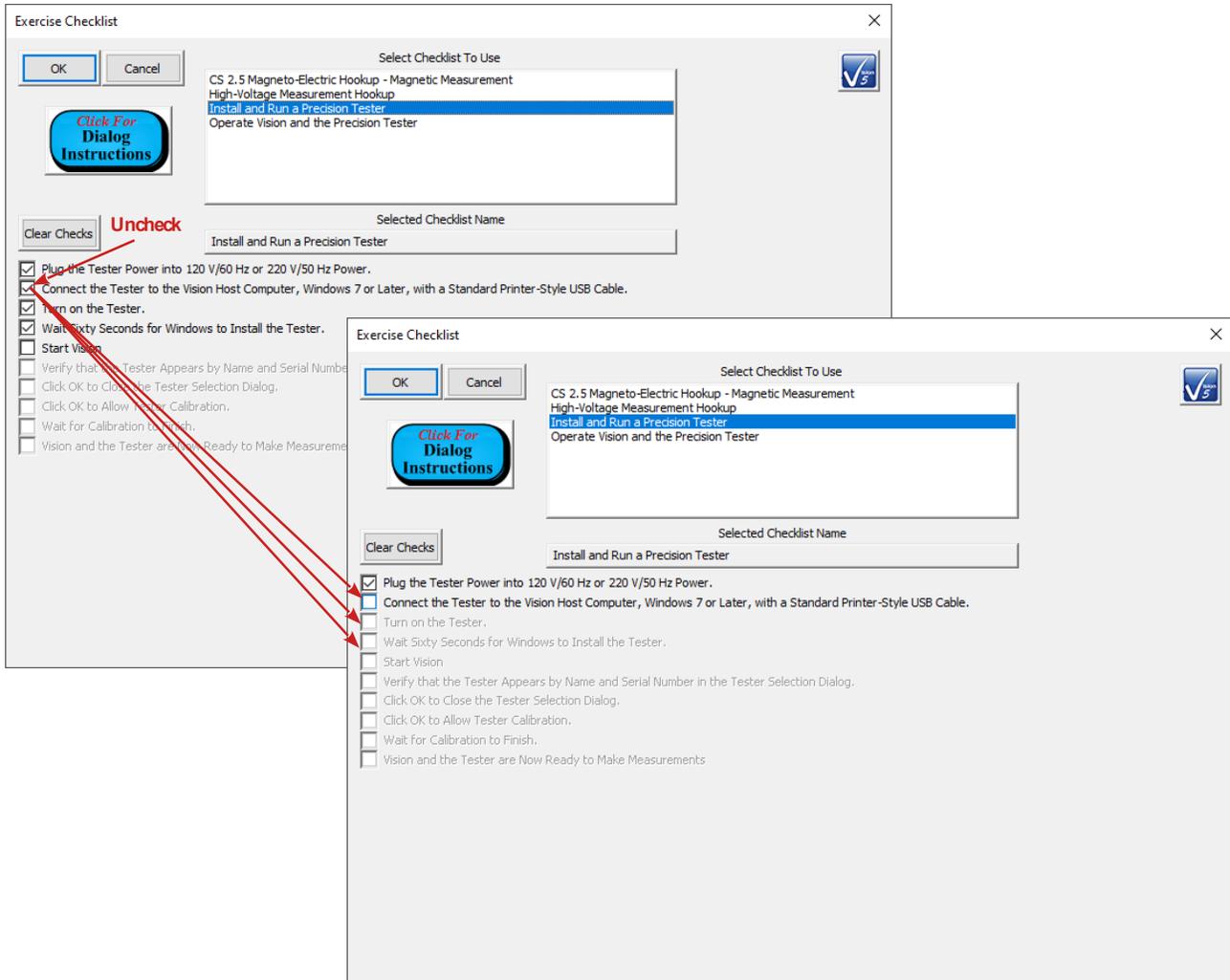
**Figure XXI.b.1 – Exercise a Checklist.**

All checked items can be cleared by clicking *Clear Checks*. This returns the checklist to its initial state. Any single checked item can be unchecked. In this case all subsequent checked items will also be unchecked.

Checklists items must be checked in sequence.

A checklist may be partially completed. If *OK* is click when the checklist is partially completed the current state of the list will be saved back to the list and recalled when the checklist is accessed again.

**See Also Main Manual:**

- Main Vision Manual->V – Main Menu->V.K - Checklists

## XXII. Shortcut Keys:

When running any program user interaction using a keyboard rather than a mouse is faster and more convenient, provided the shortcut keys on the keyboard are known. With shortcut keys, one or a simultaneous combination of two or possibly three keys produces the intended action. With a mouse, the user must move hands from the keyboard to the mouse and move the mouse cursor to the intended action. In the simplest case the user clicks a button. If a menu is accessed with the mouse, the menu must be clicked and then an item, and possibly sub-items, must then also be selected. All of this is slow compared to a few keystrokes. For example, to copy selected text in Notepad, use the mouse to select the text, and then:

Press <Ctrl-C>

Or:

Move the cursor to the Edit menu
Click the left mouse button
Move the cursor to "Copy Ctrl + C"
Click the left mouse button.

Vision offers a large number of shortcut keys (also known as "Hot Keys") to perform the actions described in this document and many more. The keys are listed in this table. (Note that some attempt has been made to sort the controls in order of importance):

| Key | Menu | Action |
|---|---|---|
| <Alt-H> | Help | Open the "About Vision" dialog. |
| <Ctrl-H> | Help | Open the main Vision help project - main Vision manual. |
| <F1> | DataSet | Execute the Current Test Definition in the open DataSet. |
| <F10> | File | Exit the Vision Program |
| <Alt-W> | Tools | Perform a Hardware Refresh. Do this any time the status of the hardware connected to the Vision host computer changes. Ex:<br><br>• Tester is turned off or on.<br>• High-Voltage Interface (HVI) is turned off or on.<br>• I2C accessory (I²C Voltage Controller, CS 2.5 Current Source, etc.) are connected or disconnected or turned off or on.<br><br>This informs Vision of the change in hardware status. |
| <Ctrl-R> | QuikLook | Reopen the configuration dialog for the last Task configured and execution under QuikLook. Most configuration parameters will be retained from the previous execution. |
| <Ctrl-N> | File | Initiate the creation of a new DataSet. |
| <Ctrl-O> | File | Open the DataSet that is selected in the DataSet Explorer. |
| <Ctrl-L> | Editor | Remove the last Task from the Test Definition in the Edi-tor. |
| <Ctrl-A> | Editor | Clear the Editor of all Tasks. |
| <Alt-A> | Editor | Open the Editor Aide tool. |
| <Shift-E> | DataSet | Move the open DataSet's Current Test Definition (CTD) to the EDITOR. The Tasks in the CTD will be appended to any Tasks already in the EDITOR. |
| <Shift-U> | DataSet | Initial moving the DataSet's Current Test Definition (CTD) to the "Customized Tests" folder in the TASK LIBRARY. |
| <Shift-T> | View | Toggle the Toolbar between shown and hidden. |
| <Shift-S> | View | Toggle the status bar between shown and hidden. |
| <Shift-X> | View | Toggle the DataSet Explorer between shown and hidden. |
| <Shift-O> | View | Toggle the EDITOR between shown and hidden. |
| <Shift-L> | View | Toggle the TASK LIBRARY between shown and hidden. |
| <Shift-M> | View | Toggle the Document Library between shown and hidden. |
| <Alt-E> | DataSet | Toggle closing the EDITOR window on Test Definition execution between enabled and disabled. |
| <Alt-L> | DataSet | Toggle closing the TASK LIBRARY window on Test Definition execution between enabled and disabled. |
| <Alt-X> | DataSet | Toggle closing the DataSet Explorer window on Test Definition execution between enabled and disabled. |

| | | |
|---|---|---|
| <Ctrl-F> | DataSet Log Window | Open the Log Window text search tool. |
| <Alt-F> | DataSet Log Window | Repeat the previous log window text search. |
| <Ctrl-W> | View | Close all open plot windows. |
| <Ctrl-G> | View | Close all open Test Definition Graph windows. Do not prompt to save the graph to file. |

Several tools also offer toolbar icons:

| Icon | Menu | Action |
|---|---|---|
| DS | File | Initiate the creation of a new DataSet. |
| DM | DataSet | Open the Data Mining Wizard. |
| ETD XFR | DataSet | Open the ETD Transfer wizard. |
| REG DS | Explorer | Open a browser to locate a DataSet file and register the DataSet to Vision |
| REM DS | Explorer | Open a dialog that allows one or more registered DataSet(s) to be selected. Selected DataSets will be unregistered from Vision on the next Vision startup |
| DVM | Tools | Run the Digital Voltmeter tool if an $I^2C$ Voltage Controller is connected to the tester. |
| SM | DataSet | Run the Simple Measurement tool. |
| Ed Aide | Editor | Open the Editor Aide dialog. |
| ? | Help | Open the "About Vision" dialog. |
| ?? | Help | Open the main Vision help project - main Vision manual. |

Exercise any and all of these tools as suits your needs. Some are quite involved, so refer to the various sources including the main Vision help project, and/or the Dialog Instructions or Task Instructions. Please let me know if you have questions, comments or difficulties.

Good luck in your research.

Sincerely,


Scott P. Chapman
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