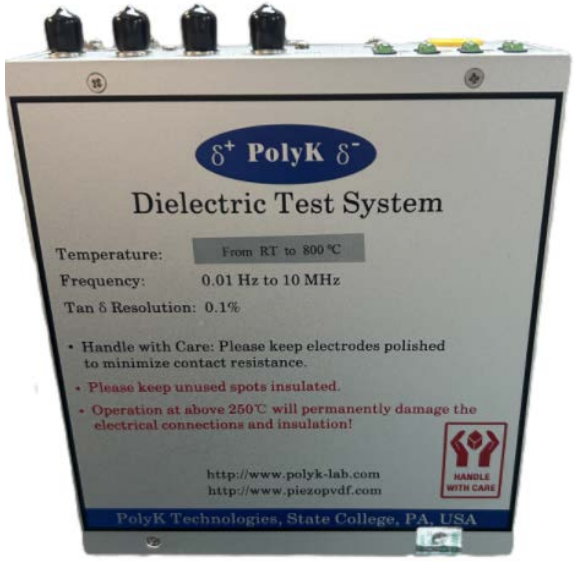
Turnkey Dielectric Test System

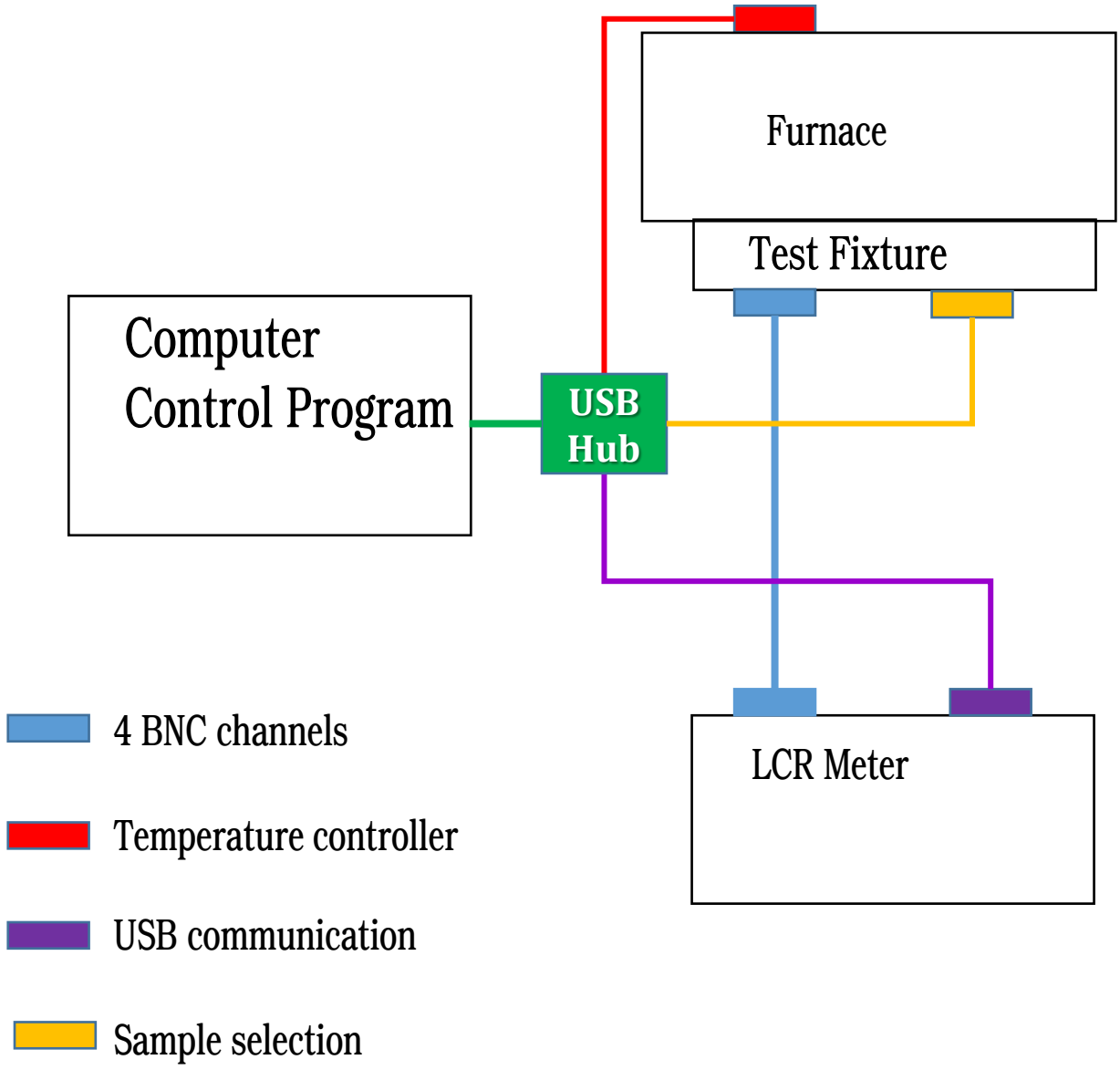


PolyK Technologies
State College, PA, USA
www.piezopvdf.com
Email: sale@polyk-lab.com

Configurations and Accessories

1. 1050 C Furnace, 220 V input voltage.
2. One USB Cable - Connect test fixture (right side of the oven) to the host computer USB port.
3. One USB cable- connect PolyK oven temperature controller to the host computer USB port.
4. One USB cable connect Keysight E4980AL LCR meter to computer.
5. 4-BNC- connect Furnace control box BNC to LCR Meter front panel – please make sure the colors of the cable match the colors on the test fixture.
6. Electrical insulators (alumina) to insulate un-used test channels
7. PZT ceramic samples for training.
8. Laptop with pre-installed control software
9. Software USB drive – all installed in the Dell laptop.
10. One pair of tweezer to load and unload samples

Setup and Connections



Connections: Oven-PC

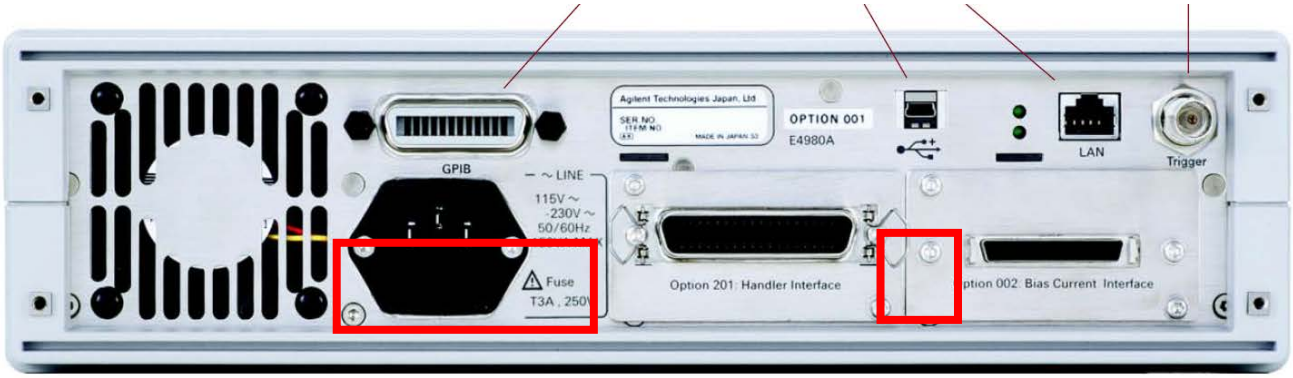
1. Use USB cable to connect the PolyK temperature furnace with the computer USB hub.

USB cable to Amazon USB Hub

2. To operate the furnace, first switch the black knob (main power) on the right bottom to turn on the power; then press the green button down (heating ready), which turns on the heating elements.
   After measurement, press down the red button (heating off) to disengage the heating elements.

Connections: LCR Meter-PC

2. Use the GPIB/USB cable to connect the LCR meter with computer USB port (USB end of the cable should be connected to the USB hub or computer USB port).



USB Mini B

Connections: Fixture-PC and Power

Multi-channel control USB Cable

Use the USB-DAQ cable to connect the DAQ port on top of the test fixture to the computer USB port.

Power connection

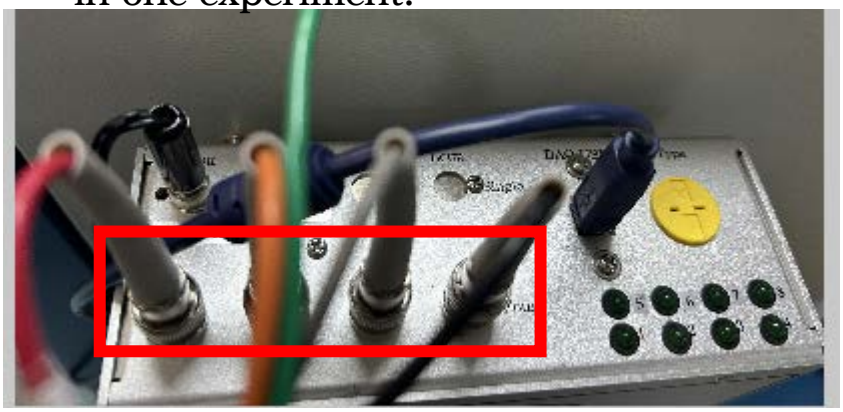
Connect +12v power adapter to the top panel. Before the dielectric test ,please put the switch on.

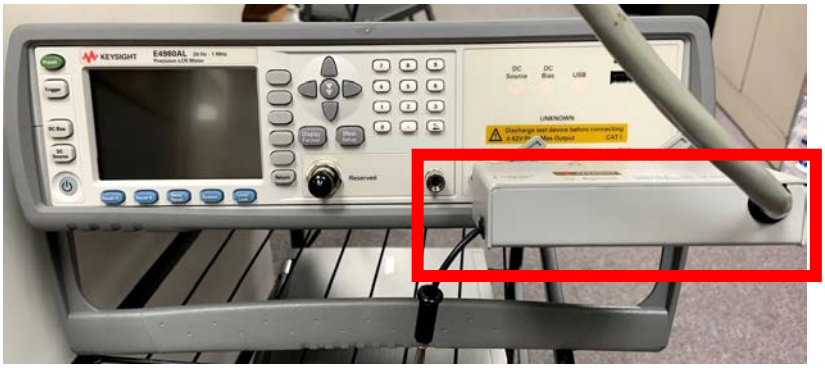
Connections: LCR meter-Fixture

Four BNC Cables are used to connect the front of the LCR meter with the PolyK Test Fixture.

The four BNC connectors to the test fixture: the connectors are **H_{CUR}, H_{POT}, L_{CUR}, L_{POT}** and they are different. Match the color and label of the cable to that on the test fixture.

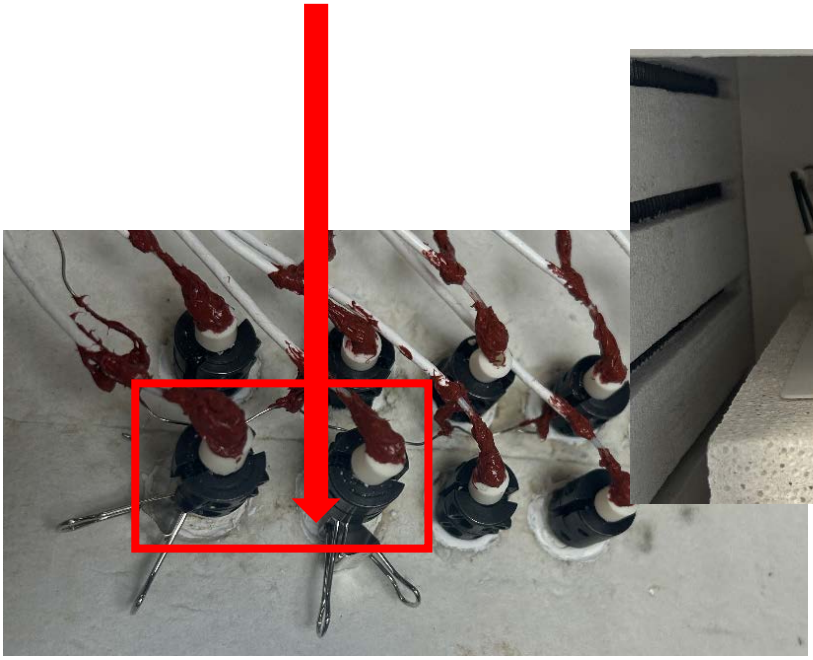
Use the 4 BNC connectors along “FOUR” label in the sample fixture, this allows the concurrent measurement up to 4 specimen in one experiment.

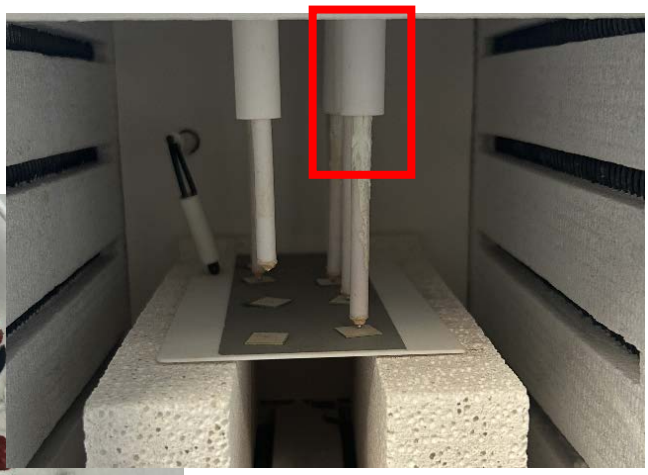




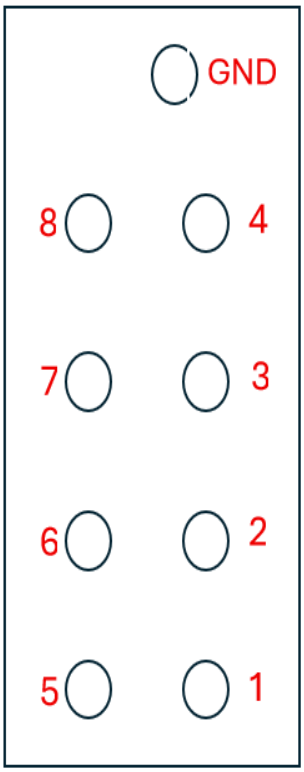
Test Fixture - Put samples

Use a paper clip to hold the top of the ceramic and lift the electrode. Use the tweezer to load the samples. There are sample marks on the bottom electrode.





Test Fixture



Warning

1. There are eight channels allowing the concurrent measurement in a single measurement.
2. "1" to "8" are arranged as shown in the graph. The 4980AL shall be connected to the BNC ports along the "FOUR" row.
3. If less than 8 samples are tested, all un-used probes (channels) shall be insulated with alumina discs.
   Note: you shall use the probes in the sequence of 1-8.
4. When measuring multiple specimens in the same run, please try to keep their capacitance as close as possible.
5. The thermocouple is put on the bottom electrode plate to ensure the measured temperature as close to the sample temperature as possible. When performing test using "ramp" mode, the temperature of the specimen may slightly lag behind the air temperature. Using lower cooling/heating rate can minimize the temperature lag. Isothermal test with >5 minutes temperature soaking can almost eliminate the temperature lag.

Test Fixture

Warning

1. The bottom grounding electrode is made with screen printed platinum in order to maintain electrical conductivity at a high temperature up to 1000 ^{0}C. At such temperatures, many metals will be melted or oxidized into a non-conductive oxides.
2. Top probes are also made with platinum wires, which are then enclosed by ceramic sheathes. The mass load on top of the probe (hidden/invisible, encapsulated inside the oven) will keep a reasonable pressure on samples to maintain suitable electrical contact, particularly when measured in a large temperature range.
3. The probes are electrically insulated from other parts of the test fixture. If you found weird test results, you can use multimeter to measure the resistance between the probe and other parts of the test fixture (Note, all probes shall be insulated from the bottom platinum electrode during this measurement). If you measure a very low resistance, it indicates the ceramic insulation inside the tube is broken and they shall be replaced).
4. The bottom platinum electrode is also electrically insulated from the fixture frame. You shall measure an infinite resistance between the bottom electrode and the frame.
5. To maintain good electrical contact between the platinum ball electrode to the top surface of the samples, it is better to use certain mass (heavy) to push down the top Pt/ceramic/SS tube assembly. If you found some samples have capacitance fluctuating or abnormal, it is likely that the top electrode is NOT sufficiently heavy to maintain good electrical contact.

Software Installation

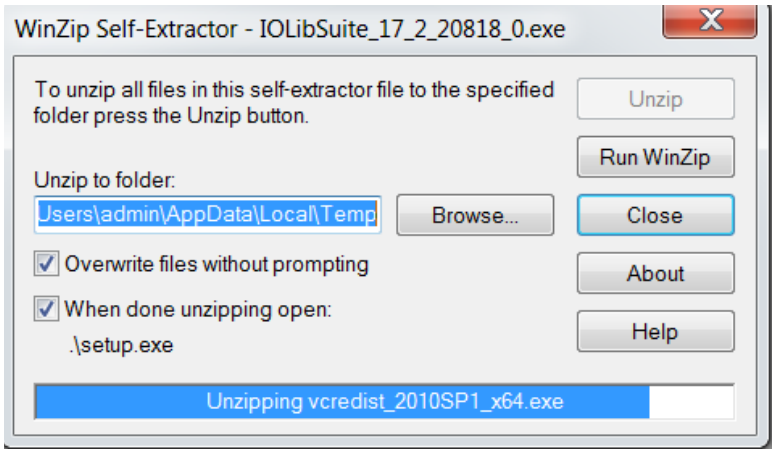
Operation System: Windows 7 or higher version

First Install Keysight IO Library Suite, then install PolyK DRS Software.

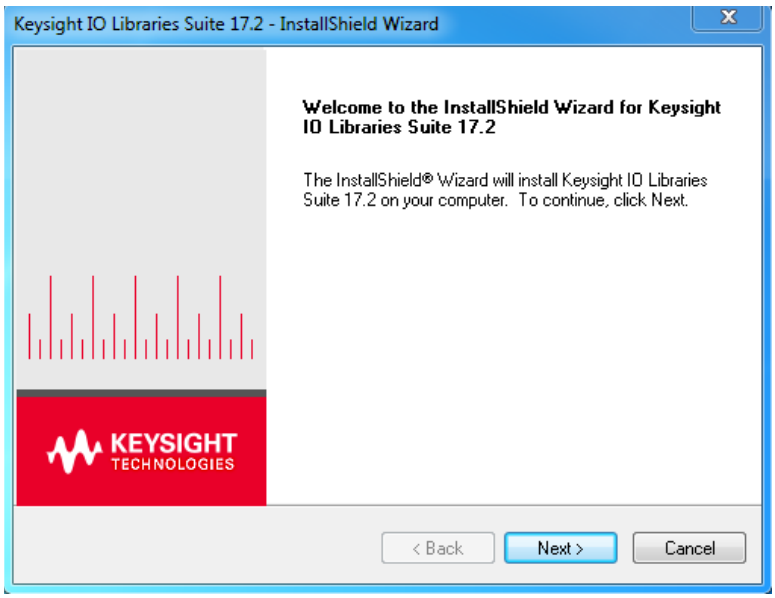
Computer shall be re-started after installing each software.

Install Keysight USB-GPIB driver

1. Double click “IOLibSuite_17_2_20818_0.exe”



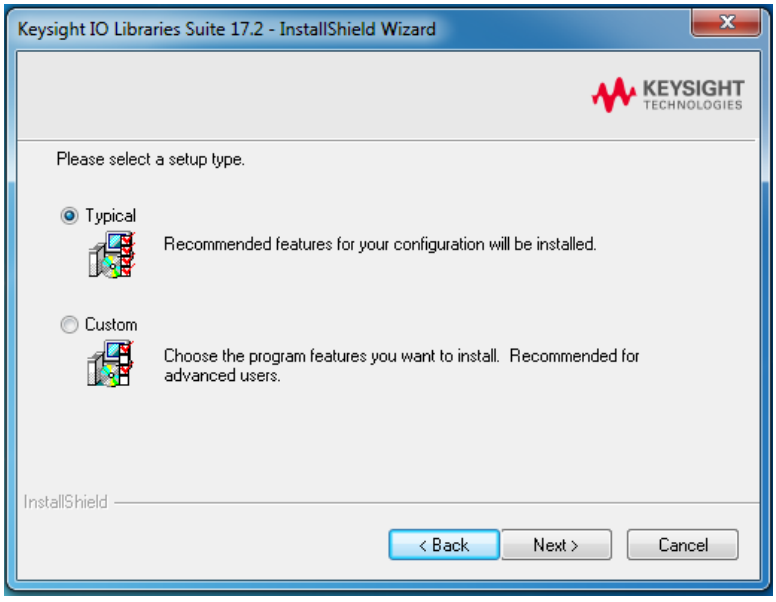
2. Install and click “NEXT”



Software Installation

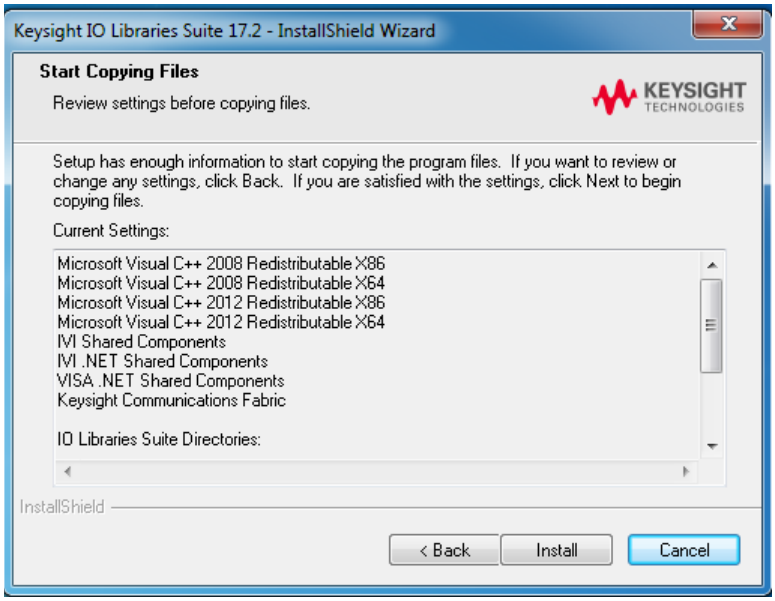
3. Select “Agree” and click “NEXT”

4. Select “Typical” → click “NEXT”

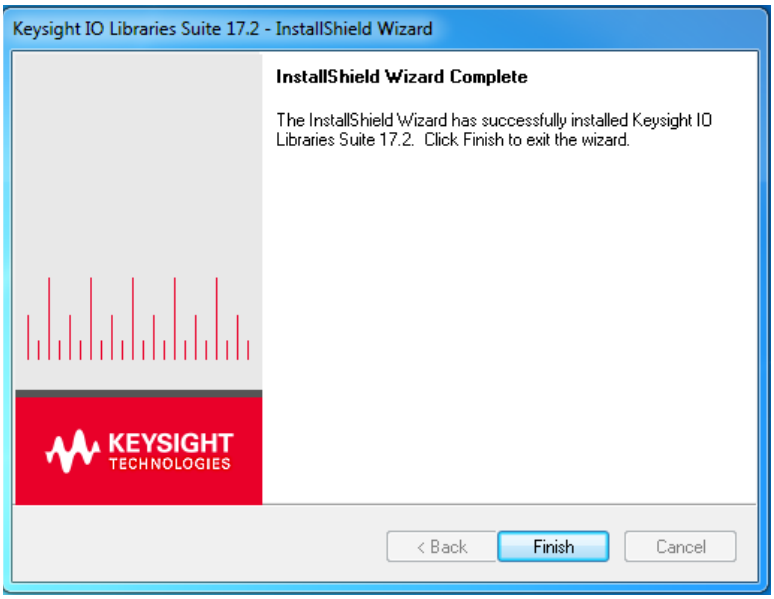


Software Installation

5. Click “Install”

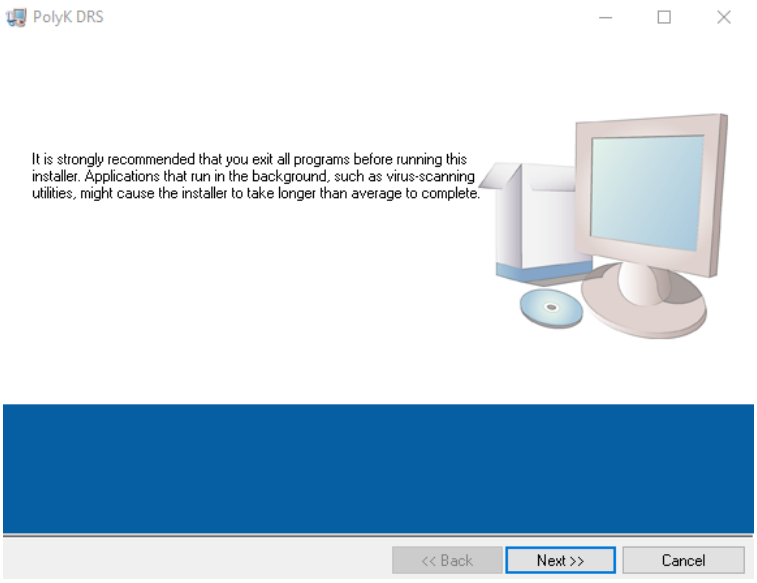


6. “Finish” install and re-start computer.

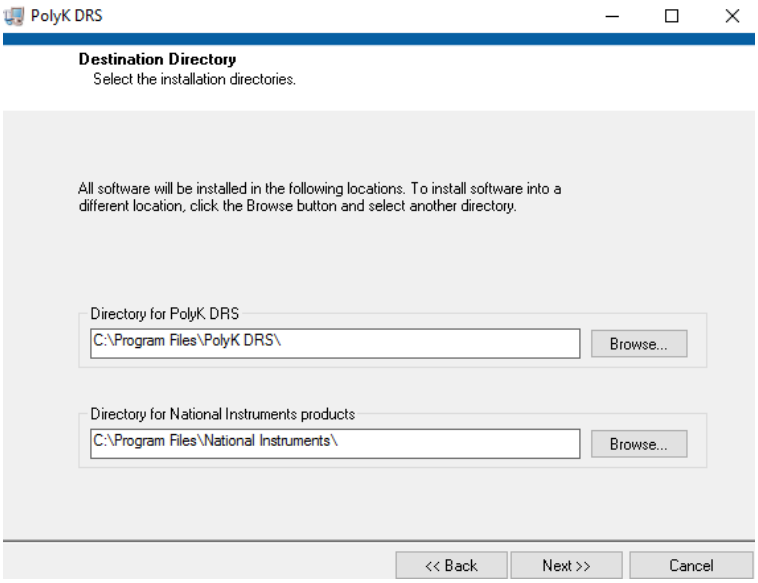


Install PolyK DRS Software

1. Run Setup.exe, the following window pop out, click “next”

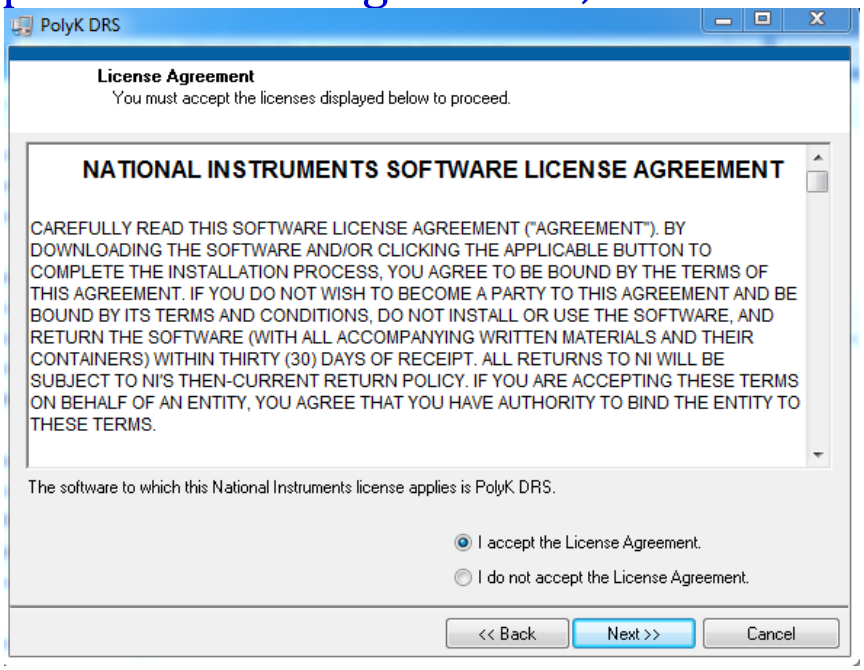


2. Select install folder, then “Next”

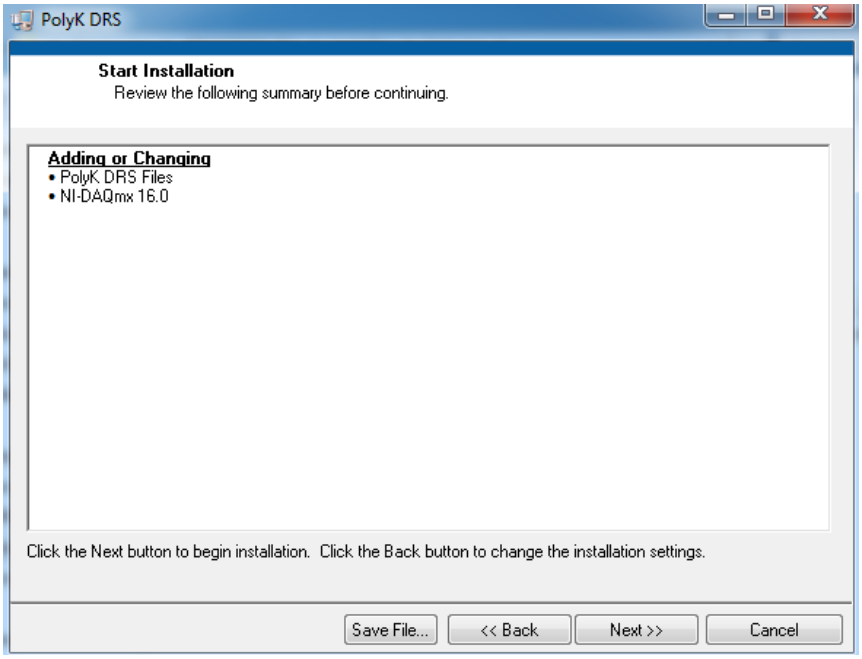


Software Install

3. “Accept” NI License Agreement, click “NEXT”

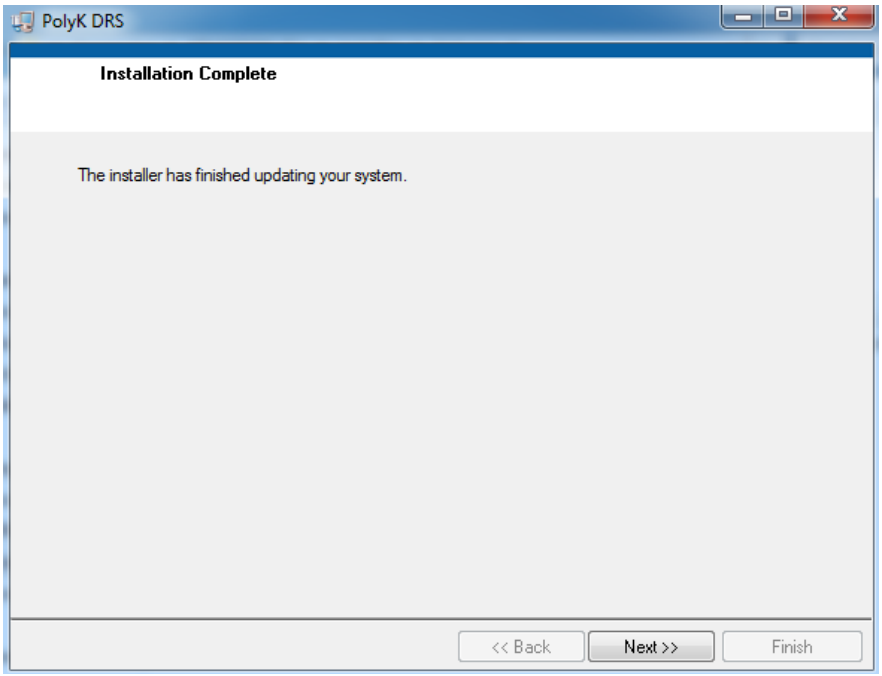


4. Start Install and click “NEXT”



Software Install

5. Click “Finish” and re-start computer

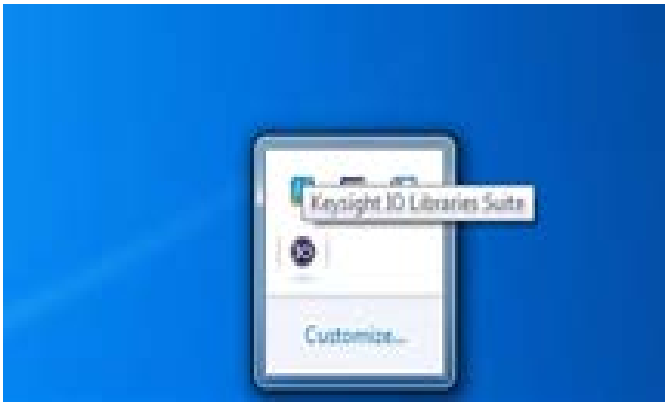


Software Install

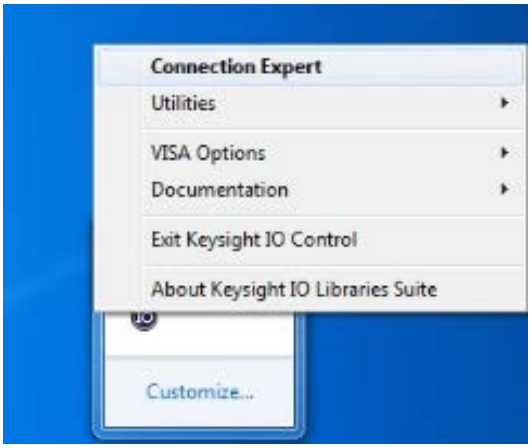
Before running PolyK DRS Software, we need to run Keysight IO software to find the Address of EC10/EC1A chamber and the LCR meter

Following the instructions:

Find the Keysight IO icon on the bottom right corner of your computer.



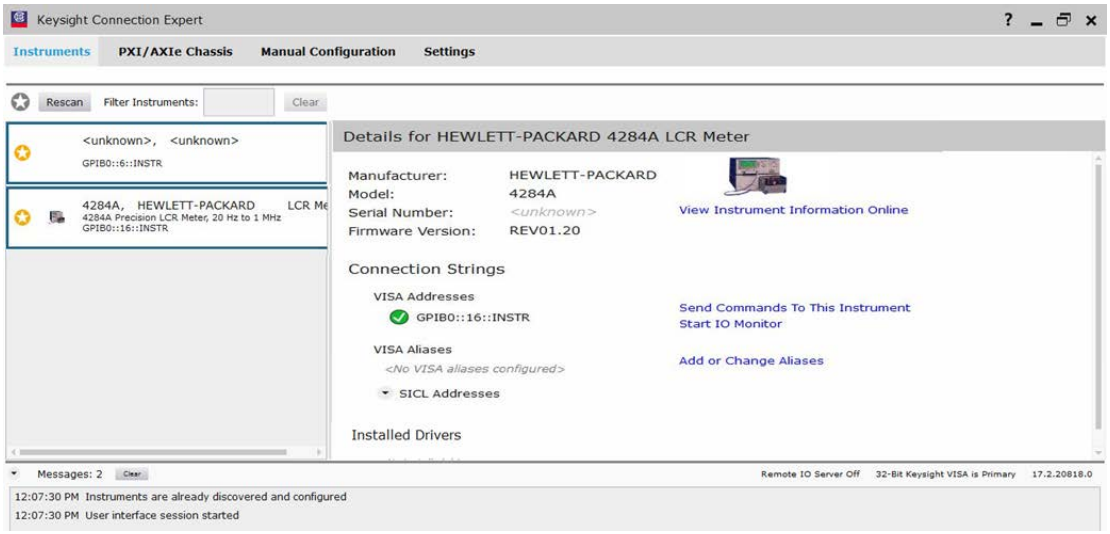
Left click and find the IO Icon, use the mice click the icon, and click the "CONNNECTION EXPERT"



Software Install

If the LCR meter have been connected to the computer with GPIB-USB, after running the IO software, the address will be shown as following picture.

If the chamber/meter not connected to the computer, connected and click “RESCAN”



1. Instruction

There are three measurement modes for the user to select.

After start the software, the following figure pop up:

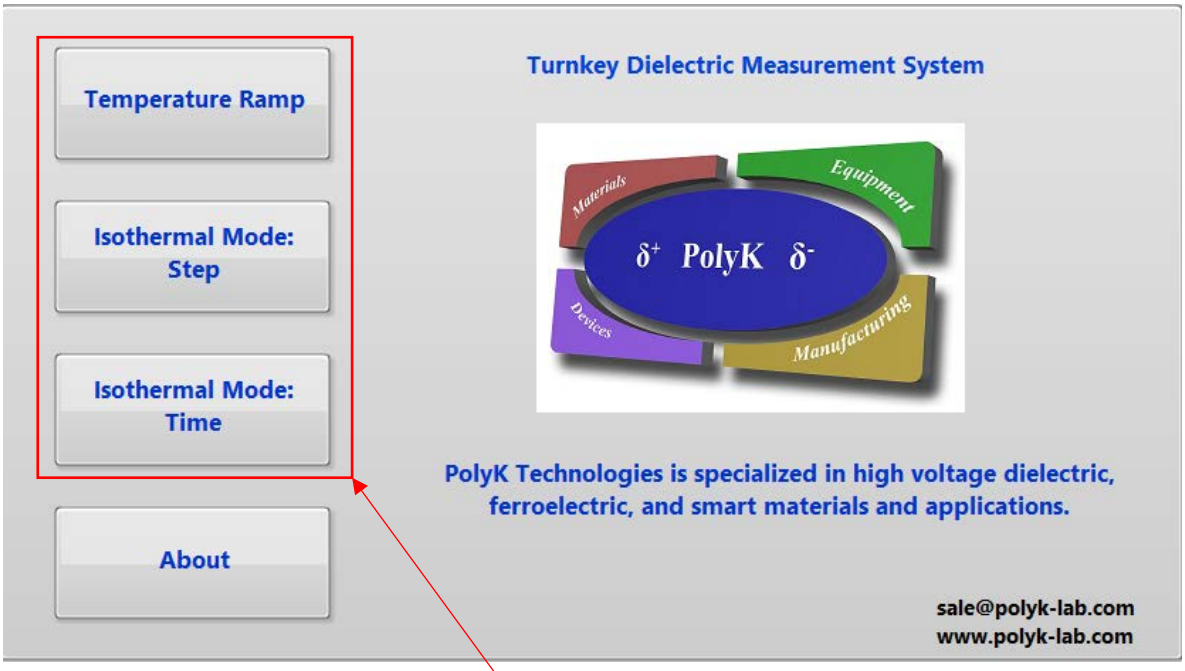


Figure 1. Software Main Interface

Temperature ramp mode

In this mode, the user shall set the temperature ramp process, the LCR meter will perform the test (frequency scan and specimen scan) during the temperature ramp.

The temperature control (chamber), the LCR meter, and the specimen scan are three independent parameters:

1. Chamber temperature following preset ramp/soak continuously change.
2. PolyK control system automatically scan each specimen (green LED light lit for the specimen being measured). For each specimen, it will be connected to the LCR meter with an internal relay: LCR meter continuously measure Cp/DF following the frequency list defined in the software for the selected specimen.
3. After completing the frequency sweep of the selected specimen (while temperature still changing), the software will disconnect the current specimen and connect the next specimen to the LCR meter.
4. The saved data consist of specimen No., temperature, frequency, capacitance, dissipation factor, and dielectric constant.
5. There are two temperatures saved: the “chamber temperature” and the “sample temperature” (the thermocouple on the test fixture).

This mode is mainly used to evaluate the dielectric properties of new dielectric materials as a function of temperature and frequency. It takes much short time than the isothermal mode. However, the recorded temperature is the air temperature measured by the fixture K-TC and the actual specimen temperature may lag behind the air temperature. The lag is larger than for thicker specimen.

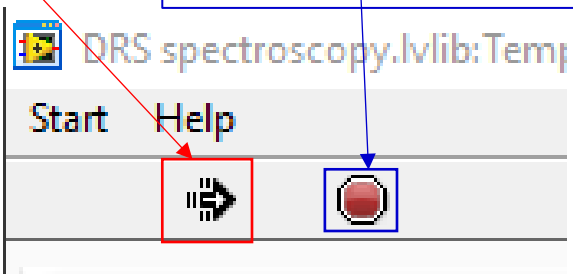
Test Process:

Instrument Initiation (Fig 4)→ Self-Test (Fig 5)→ set up temperature, frequency (Fig 6 and Fig 7) → enter specimen information (Fig 8) → set file save folder → start test (Fig 9).

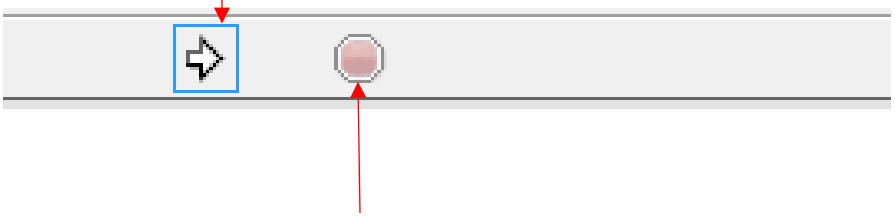
Test Software: LabView

Before performing the setting, make sure the Arrow icon in in dashed line, which means that it has been clicked (software already started).

The Stop Sign Icon is in solid line dark red, which means it can be clicked at anytime to stop the test.



If the Arrow is in Solid line, you have to click it to start the software before you can set up your test (temperature, frequency, specimen information, System initiation, etc).



The Stop Sign is in gray light red color, indicate that it is inactive and cannot be clicked at this status.

Temperature Ramp Mode

The Main Interface has three functions

- Initiation Setup: instrument port address, number of specimens, other setting of the LCR meter and chamber
- Test Parameter Setup: set temperature, frequency, data saving, and specimen information
- Test Results: display real-time test results.

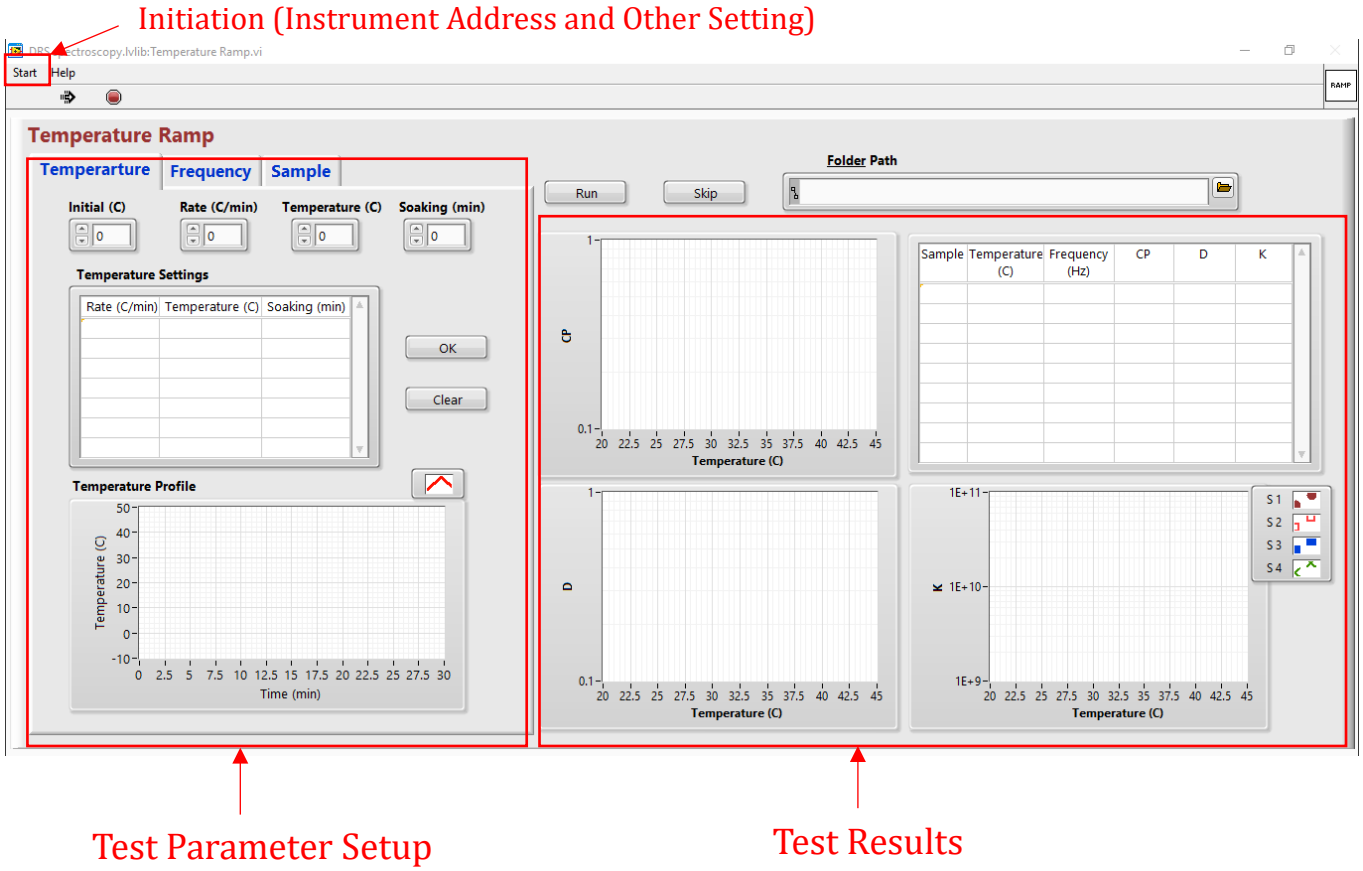


Figure 2: temperature ramp mode

Temperature Ramp Mode

Other functions are shown in Fig 3

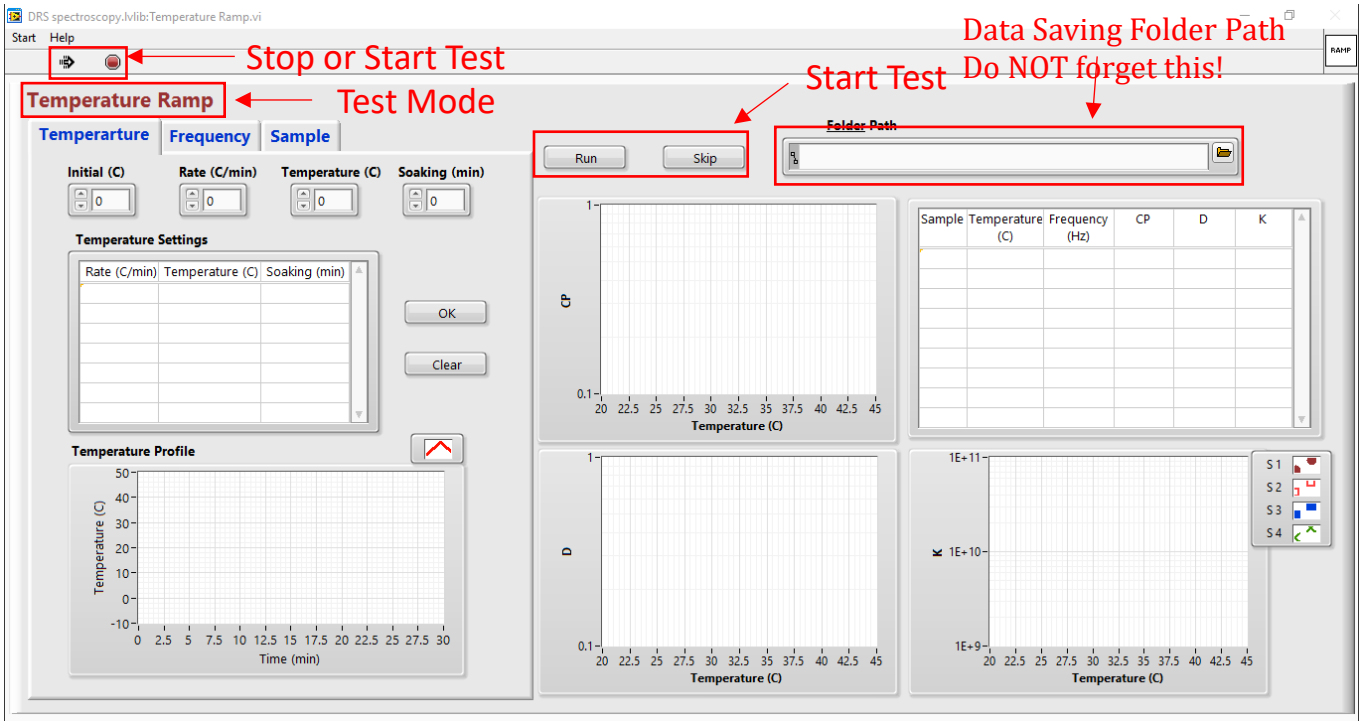


Figure 3: Setting Temperature Ramp Mode

Temperature Ramp Mode

Before test, you need to initiate the LCR meter and the chamber.

Click “Start” → “Initialization”, enter the Fig 4 setting window

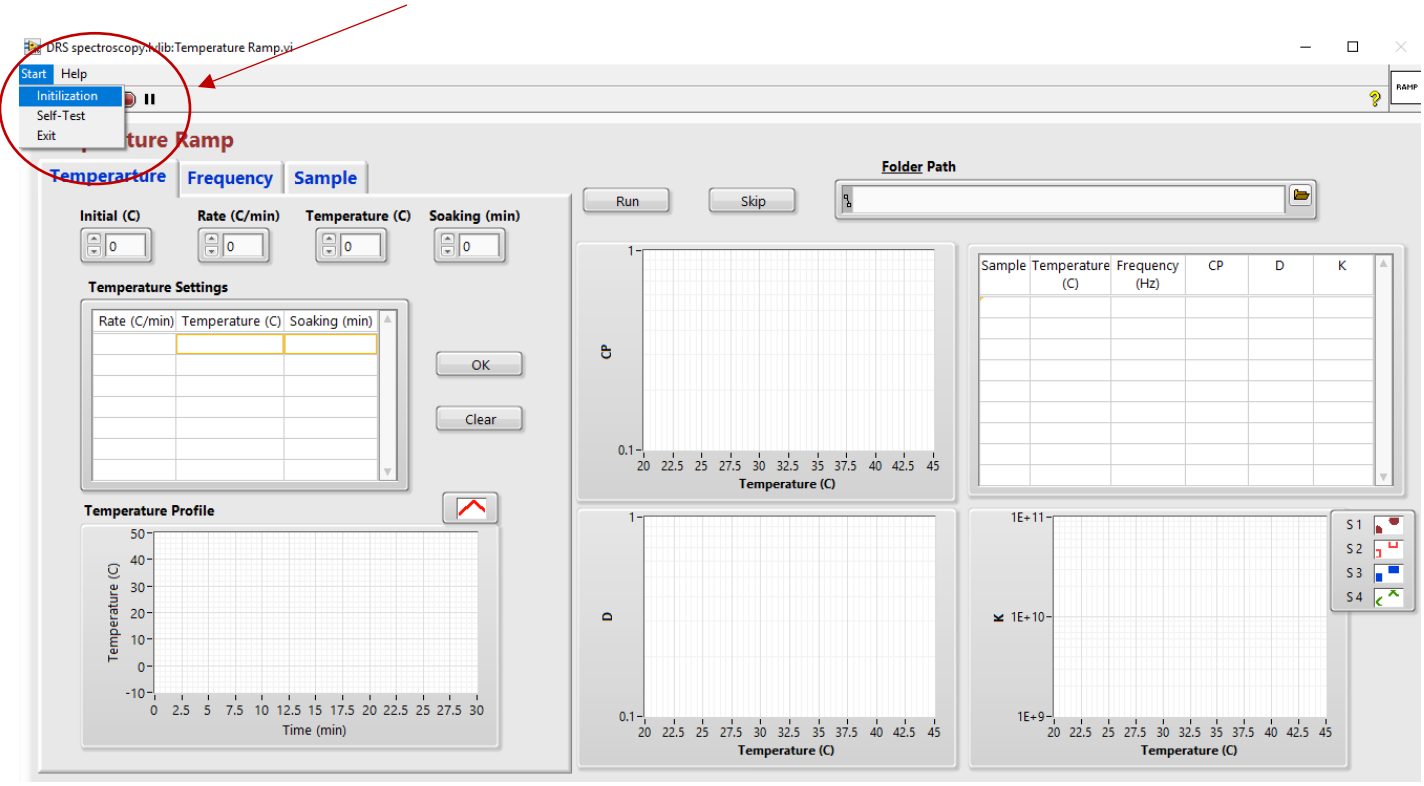


Fig 4: Enter Initiation Window

Temperature Ramp Mode

LCR Meter Setting (Left) and Chamber Setting (Right).

After finish setting, click "OK" and then the red "**X**" on top right corner to exit the window.

"Default" is to reset the default values of the LCR meter and the chamber

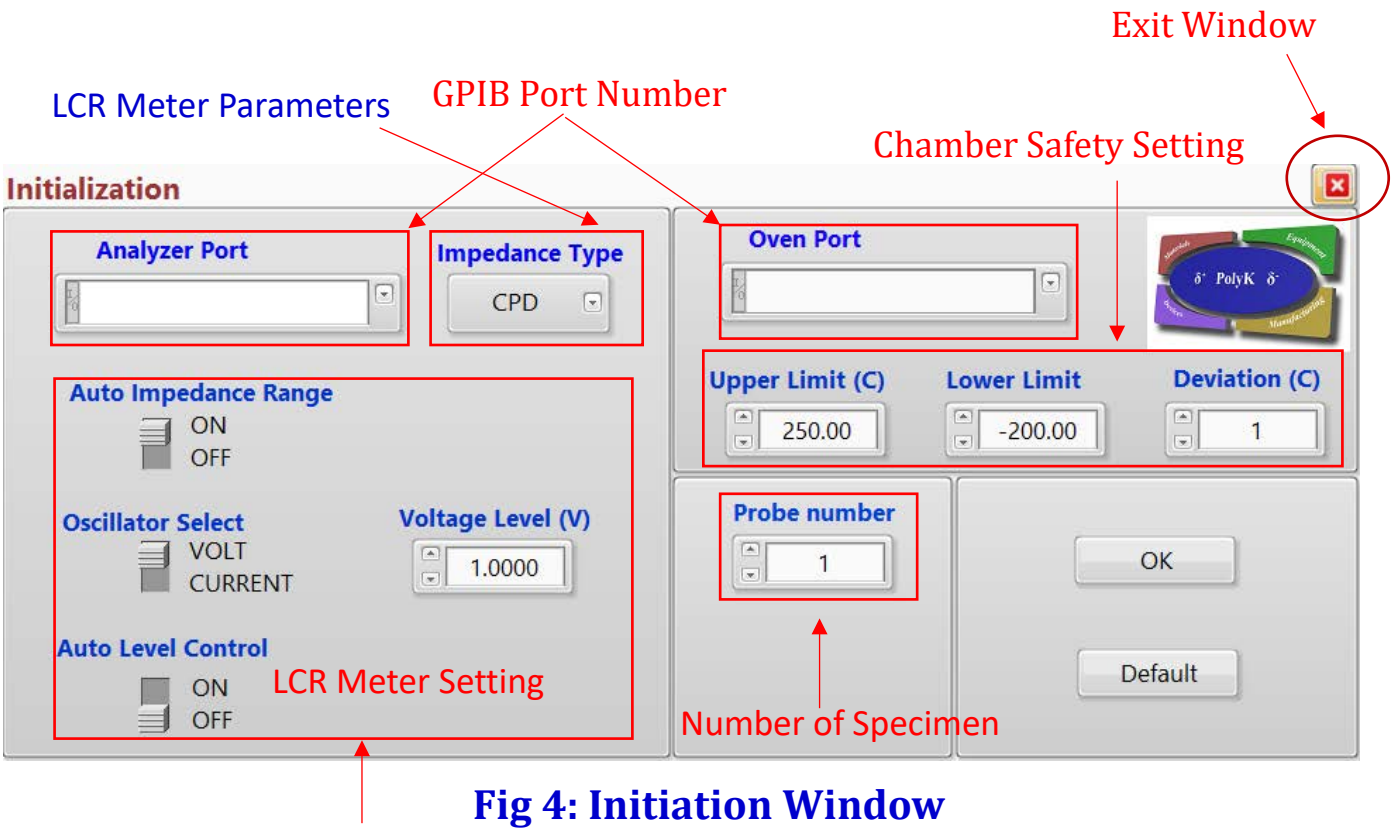


Fig 4: Initiation Window

Probe Number: set up how many specimens that you are going to measure in one run. You can run up to 4 specimens in one single test.
If you have only specimen, you will have to use the probe channel "0" on the most left side of the fixture. You need to connect the 16048A to the four BNC connectors along the "SINGLE" label.
If you have 2-4 specimens, use probe from 1 to 4 and follow the order. Keep the unused probes to the right side and keep them electrically insulated from the silver grounding electrode.

Temperature Ramp Mode

To ensure the secure electrical contact of the test specimens, the software provides a self-test function to measure the specimen capacitance before starting the temperature control program. Select “Start” → “Self-Test” and the window in Fig 5 pop up.

Select the test frequency and parameters, then click “Measure”, the test results will be displayed in the table.

If the measured values are consistent with your expectation, you can start the test.

If you observe negative capacitance, it measures the specimen is short-circuited due to the defects (pinhole) in the specimen or it was pressed too tight.

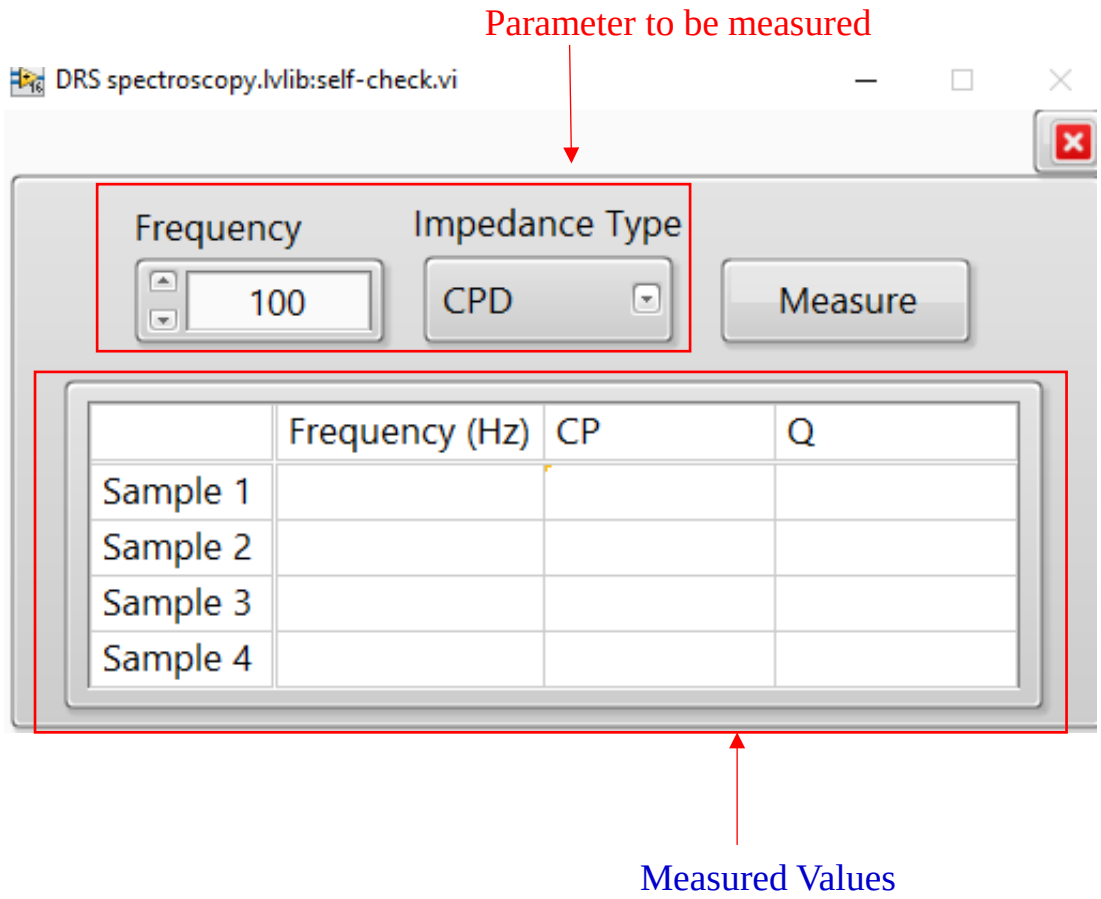


Fig 5: Self-test to ensure good specimen loading

Temperature Setting

As shown in Figure 6, the software allows multi-step temperature ramp test.

Each ramp step is defined by the ramp rate (C/min), end temperature (c), and soak time (min, at the end temperature). The initial temperature is only valid for the first ramp step. In any following ramp step, the software will use the last end temperature as the new start temperature.

After set each step, click “OK” to add it to the temperature setting table.

Click “Clear” to delete all the temperature setting.

The example in Figure 6:

Heat from 20 C at 2 C/min to 30 C, hold (soak) for 3 minutes.

Then heat from 30 C at 5 C/min to 100 C, hold 20 minutes.

Finally, cool down from 100 C at 10 C/min to -10 C, no hold.

Dielectric measurement will be performed even during temperature hold.

Note: This system has two thermocouples (TC). The “Chamber” TC is located close to the heater on the back of the chamber (you cannot see it). The “User” TC is the brown K-TC in the PolyK test fixture (on top of the specimen, suspended in the air). By default, the PolyK software controls the “User” temperature (labeled as “sample” temperature in the saved data file). Strictly speaking, the measured temperature is the air temperature on top of the test specimen. There is always lag in the air temperature and the sample temperature:

- The lag is more significant at higher heating/cooling rate (C/min).
- The lag is more significant for larger specimen (thicker).
- The lag is more significant if large size brass plates are used to sandwich the specimen.

More actual temperature measurement can be achieved using the isothermal test mode (which takes longer time than the ramp mode).

It is always challenging to accurately measure the specimen temperature in temperature ramp mode in other commercial test systems as well. In DSC test, you can use standard sample such as Indium or Zinc to calibrate the sample cell. Dielectric and DMA specimens are much larger (heavier and thicker) and it is more difficult to calibrate the temperature. Particularly, in practically use, different specimens with different size and thickness (polymer, ceramic, etc) may be used and each specimen may require different calibration.

You can also try to embed the K-TC under the silver plate to measure the silver plate temperature, though there will be still temperature lag between specimen and the silver plate.

In certain commercial measure systems, the specimen is under vacuum and the measured temperature is the bottom electrode. The heat transfer is by convection from the bottom plate to the specimen, and temperature still lag. In addition, the temperature across the bottom plate may be NOT uniform. Hot air and strong circulation will increase temperature uniform in the test chamber, while it is very hard for a vacuum chamber.

Temperature Ramp Mode

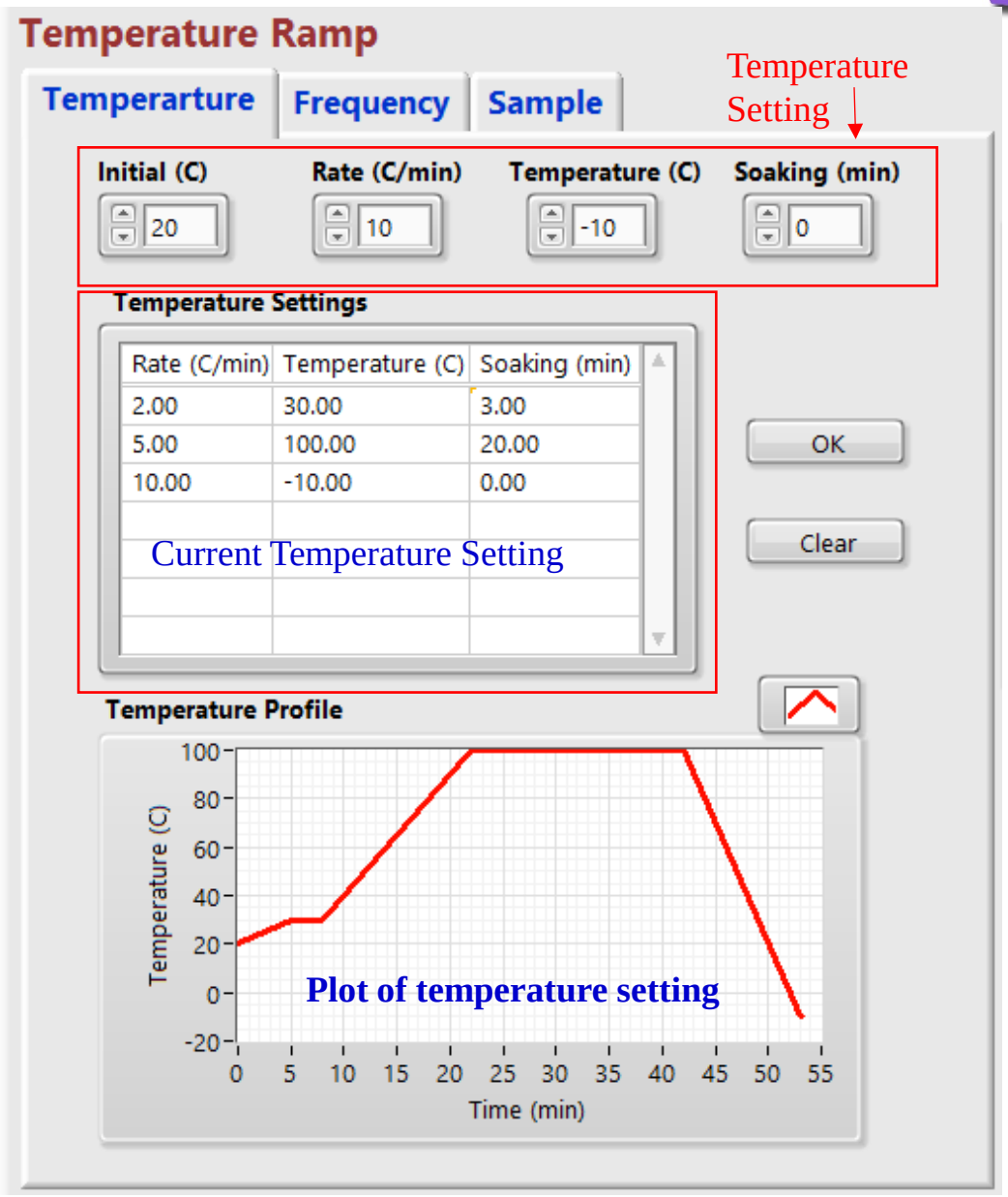


Figure 6. Temperature Setting

Temperature Ramp Mode

Temperature Ramp Mode

Frequency Setting [Figure 7]

Start Frequency and End Frequency are self-explaining.

Points/Decade: number of frequency point for every decade (e.g., from 100 Hz to 1 kHz, from 1 kHz to 10 kHz, etc). The frequencies are determined in equivalent log scale.

Click “OK” and software will automatically calculate the frequencies and display in the frequency table.

For special frequencies not in the log scale, you can enter the values in the “Discrete Frequencies” row.

Use computer mice to select one frequency that you want the software to display in real time during the test. You can change the selection during the test process.

In the Figure 7 example:

- From 100 Hz to 1 MHz, measure 1 Points/decade (this is very typical. The software will measure 100 Hz, 1 kHz, 10 kHz, 100 kHz, and 1 MHz)
- Real time display the test results at 1000 Hz

Temperature Ramp Mode

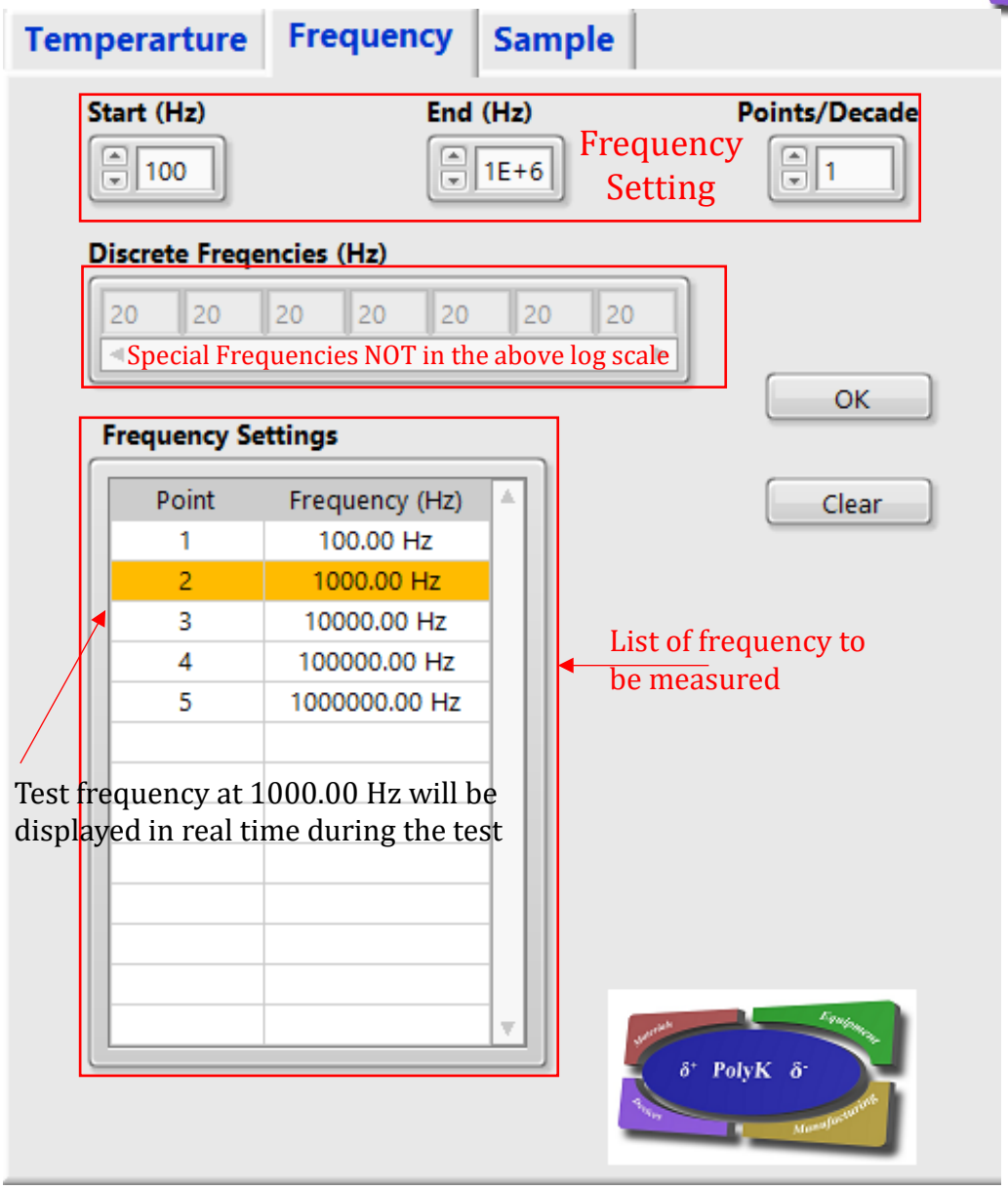


Figure 7. Frequency Setting

Note: during the temperature ramp test, if multiple specimens are measured simultaneously, if too many frequencies are measured, particularly low-frequency points(<1000 Hz), it may take a couple of minutes to scan all the four specimens and the temperature gap (between two measurement for the same specimen at the same frequency) will be large (>2 C) for the same specimen and you may not have sufficient temperature points.

It is recommended to measure at 1k, 10k, 100k, and 1MHz, or use slower heating or cooling rate.

In Isothermal Step Mode, you can measure hundreds of frequencies at one temperature.

- We added "Discrete Frequencies" function in case the user want to measure special frequencies such as 50/60 Hz (electrical grid frequencies)or 2 kHz, 20 kHz (switching frequencies for certain power systems)

Temperature Ramp Mode

Figure 8 shows example of how to enter the specimen information.

The “Name” will be the file name saved to the selected folder. Results of each specimen will be save to one individual file.

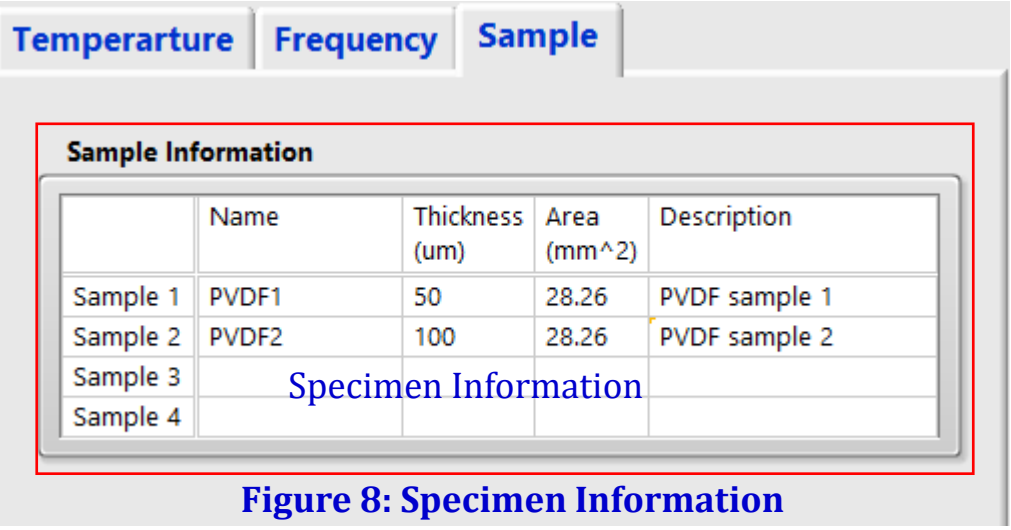
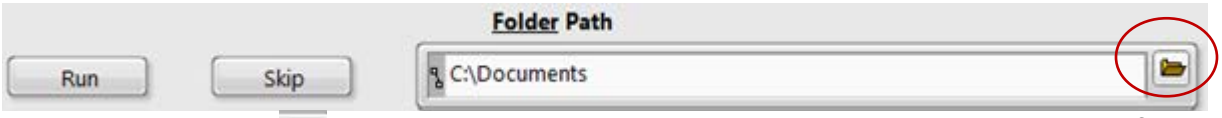


Figure 8: Specimen Information

Temperature Ramp Mode

As shown in Figure 9, before starting the test, you need to set up the computer folder where the test results will be saved. The name of the files will be the same as the specimen name as in Figure 8. Each specimen will have its own file.



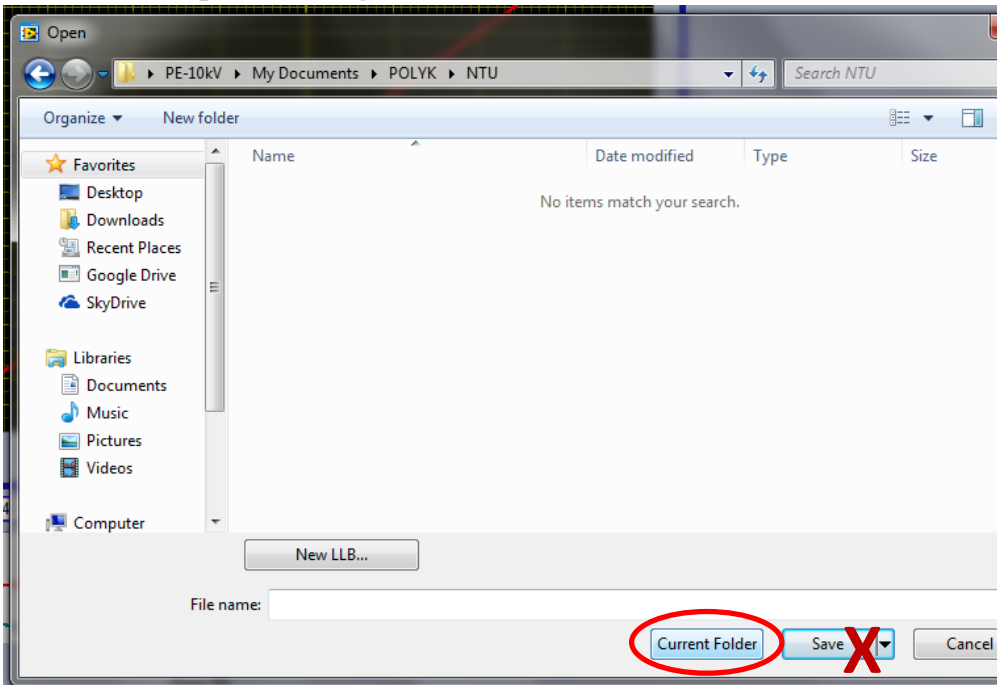
When you click the icon, a new window will pop up and you can select a folder in your computer (or create a new folder).

Do NOT enter a file name in the blank area, Do NOT click "Save" → after identify the folder, simply click "Current Folder". Otherwise your results will NOT be saved.

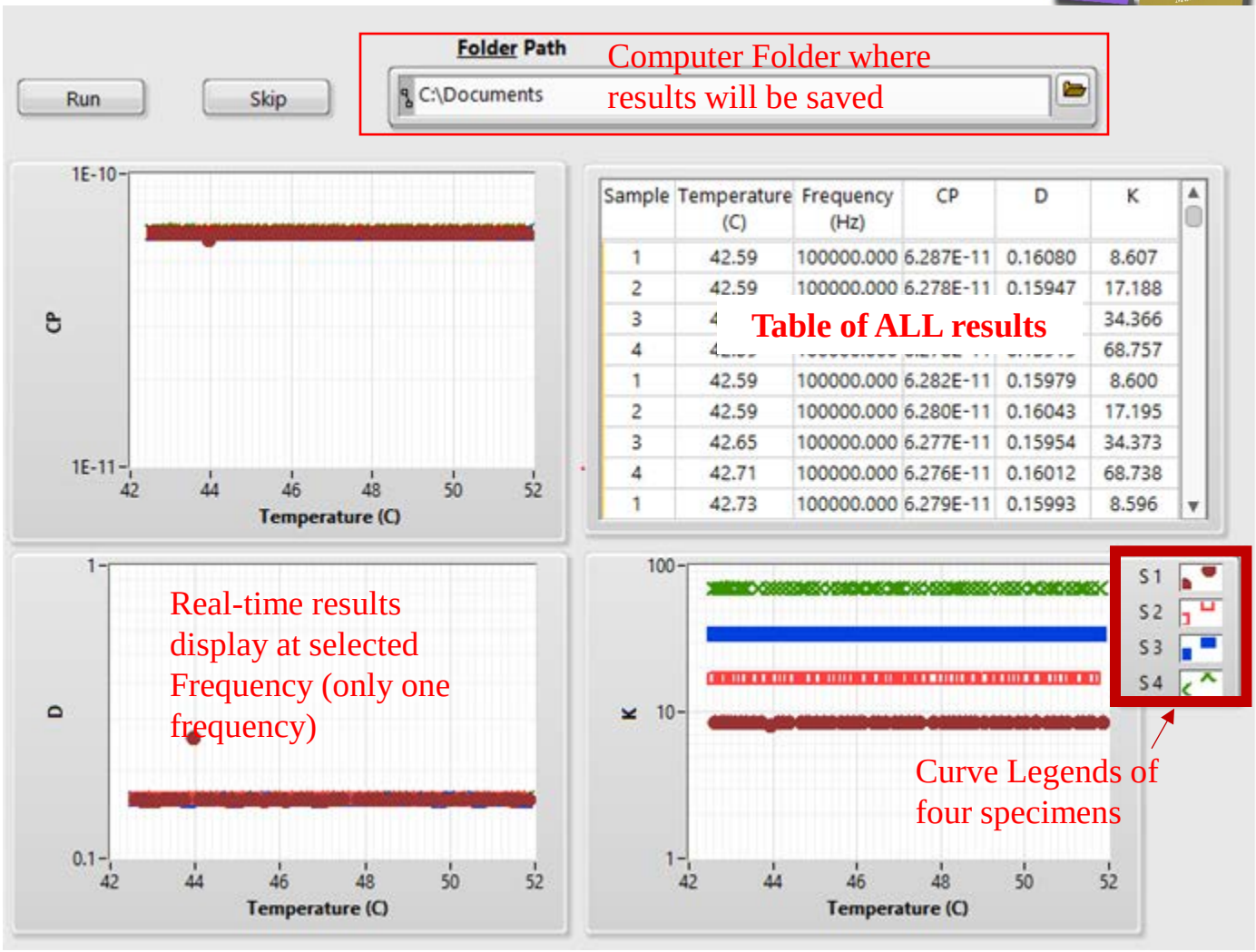
After completing the set up, click "run" to start the test. The software will wait until the first start temperature is reached (and soaking time completed) before measure with the LCR meter. If you do not wait for temperature stabilization, you can click "skip" to start the measurement immediately.

The test results will be displayed in the Table and the real-time plot. Only the results at the selected frequency will be displayed in the plot (only one frequency can be selected). Different specimen will be shown in different colors.

When the CpD, CpQ, CpG, or CpRP parameter are selected (Figure 5), the software will automatically calculate the dielectric constant K which will be shown in the K – temperature figure.



Temperature Ramp Mode



Sample	Temperature (C)	Frequency (Hz)	CP	D	K
1	42.59	100000.000	6.287E-11	0.16080	8.607
2	42.59	100000.000	6.278E-11	0.15947	17.188
3	4				34.366
4	4				68.757
1	42.59	100000.000	6.282E-11	0.15979	8.600
2	42.59	100000.000	6.280E-11	0.16043	17.195
3	42.65	100000.000	6.277E-11	0.15954	34.373
4	42.71	100000.000	6.276E-11	0.16012	68.738
1	42.73	100000.000	6.279E-11	0.15993	8.596

Figure 9: Test Results

After complete the test, you can find the test results under your computer folder where it was specified in Figure 9. If you cannot find the files, you may made mistakes when specify the folder in Figure 9.

The data files are created immediately once you click “Run”. You can open the folder to check where the files are created after start the run to verify where you have specified the correct folder. Test results are added to the corresponding files immediately after measuring each frequency so the size of the files becomes larger with the progress of test. Therefore, even in case of any mis-function of the test system or power outrage, you will still have the data for the test that have been completed.

Isothermal: Step Mode

This test mode is straightforward.

The user will set up a list if discrete temperatures and soaking time at each temperature.

The user also defines a frequency list.

The software will control the temperature first. Once the pre-set temperature reached and the soaking time completed, each specimen will be measured at this constant temperature using the defined frequency list.

Once all specimens are measured at this temperature, the chamber will be set to the next temperature in the temperature table.

With reasonable soaking time (>5 minutes) at each temperature, the specimen temperature is expected to reach equilibrium with the chamber air temperature to minimize any temperature lag.

This mode can be used to study the relaxation process of dielectric materials.

Typical Operation Procedure:

Initiation of LCR Meter/Chamber (Figure 12) → Self-Test (Figure 13) → Set Temperature List and Frequency List (Figures 14 & 15) → Enter Specimen Information (Figure 16) → Select Computer Folder to save results (Figure 17)

Isothermal: Step Mode

Figure 10 shows the main software interface:

- System Initiation: LCR Meter/Chamber Port Address, Measurement parameters of LCR Meter & Chamber
- Test Parameters Setting: Temperature List, Frequency List, and other information (specimen and data saving)
- Test Results Display Window

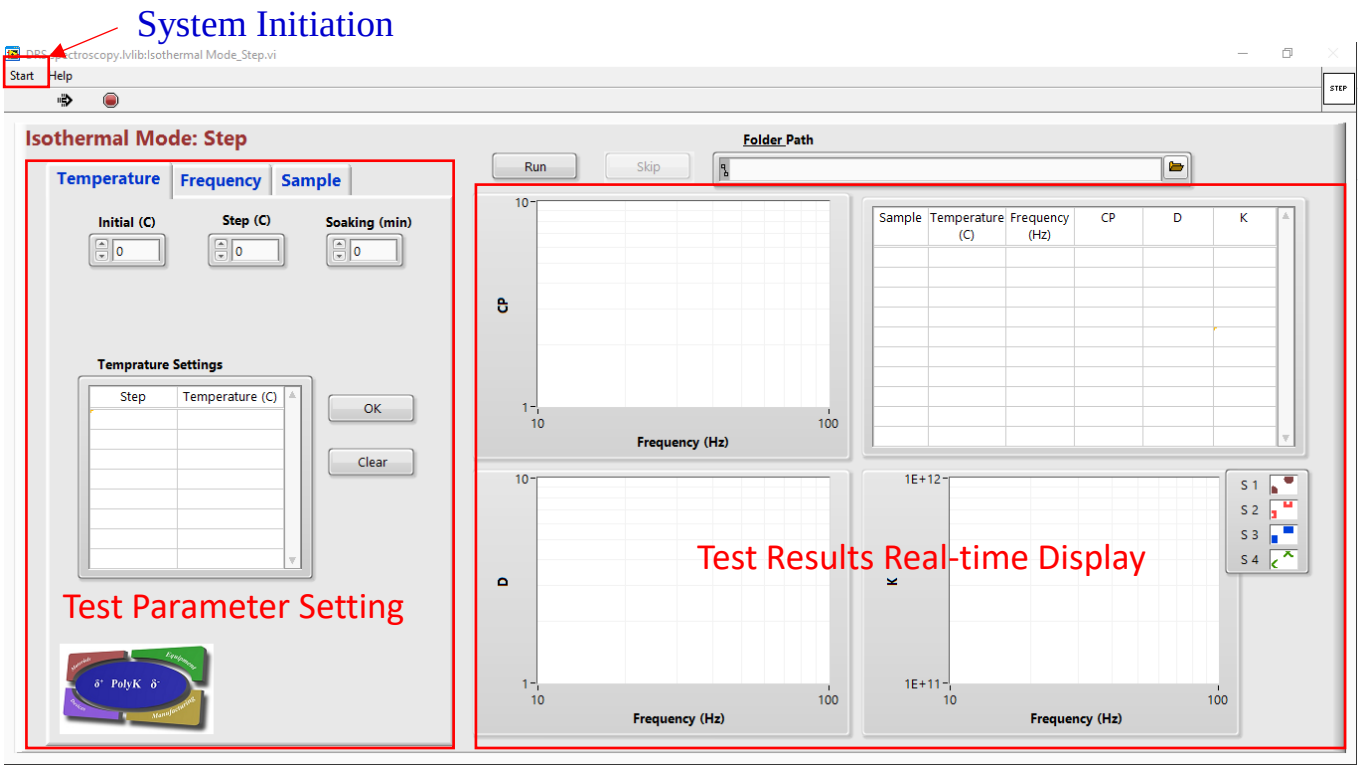


Figure 10: Isothermal – Step Mode

Isothermal: Step Mode

Figure 11 shows other setting in the software

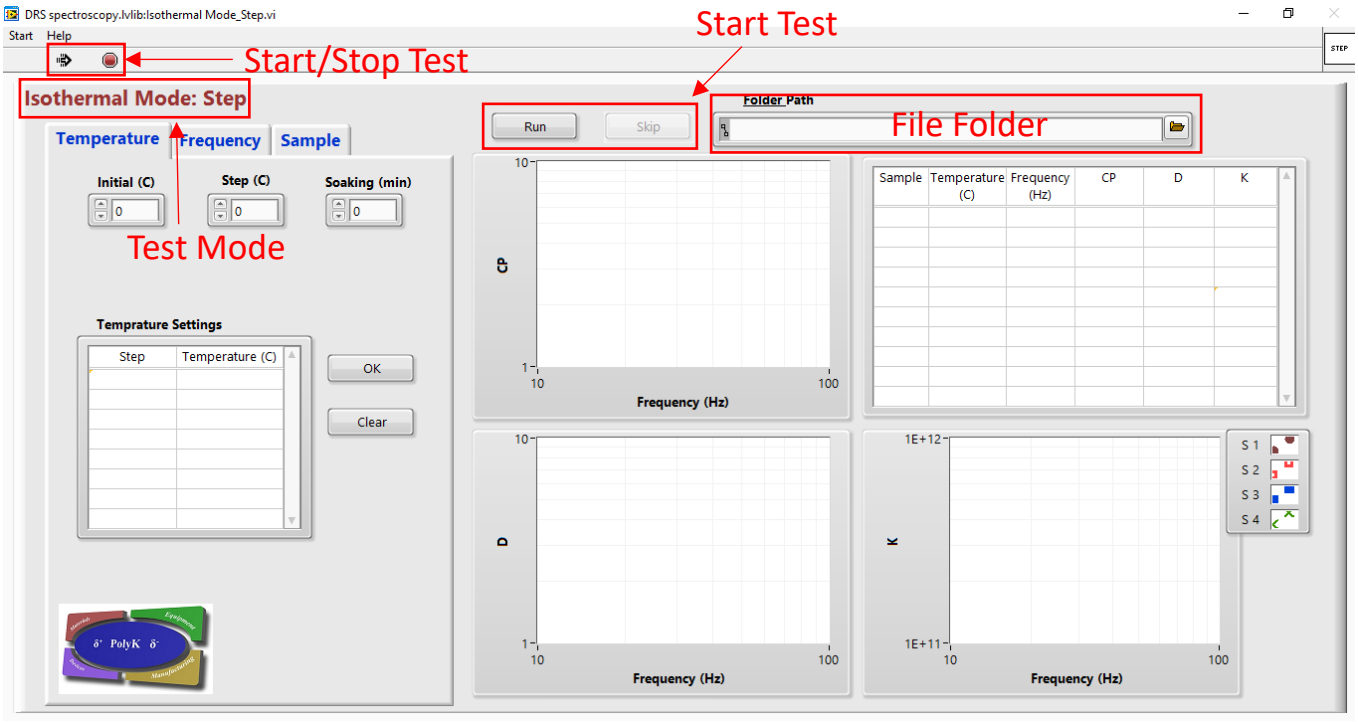


Figure 11: Isothermal – Step Mode Test

Isothermal: Step Mode

Before the test, initiation of the test system (Figure 12) as for the temperature ramp mode (figure 4 and figure 5).

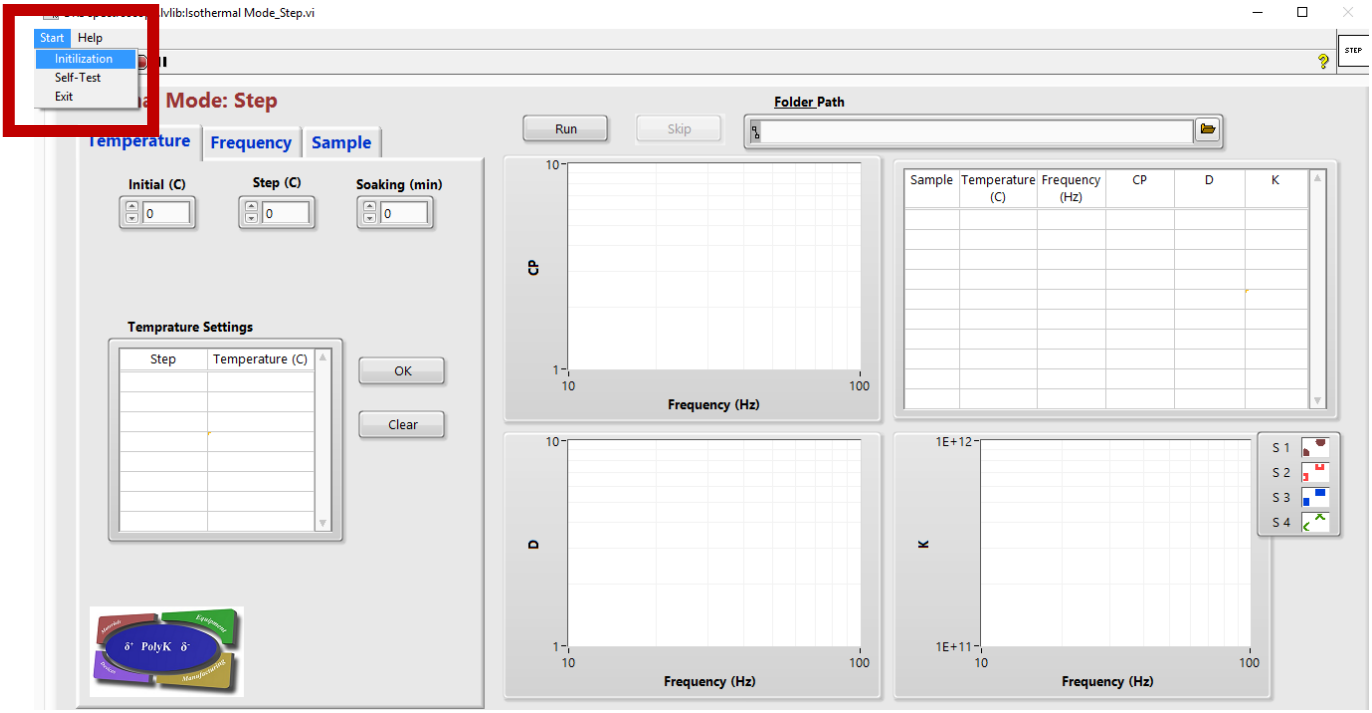


Figure 12. System Initiation (Follow Figure 4 and Figure 5 for detailed instructions)

Isothermal: Step Mode

Temperature Setting (Figure 13): Enter Initial temperature, temperature Step, and Soaking time.

Click “OK” → a new line will be added to the temperature table. Each click will add a new line (temperature) to the table. The “Initial” temperature is only used to define the first temperature row. In the following temperatures, the previous temperature will be used as the initial temperature, and the “Step” temperature will be added.

Click “Clear” will delete all the entries in the table.

Figure 13 Examples:

From 20 C with a Step of 10 C to 40 C (20, 30, 40 C)

Then increase temperature to 50 C with Step of 5 C (45 C and 50 C)

Then increase temperature to 52 C with Step of 1 C (51 C and 52 C)

When each temperature is reached, it will be stabilized for 10 min before starting the test.

Isothermal: Step Mode

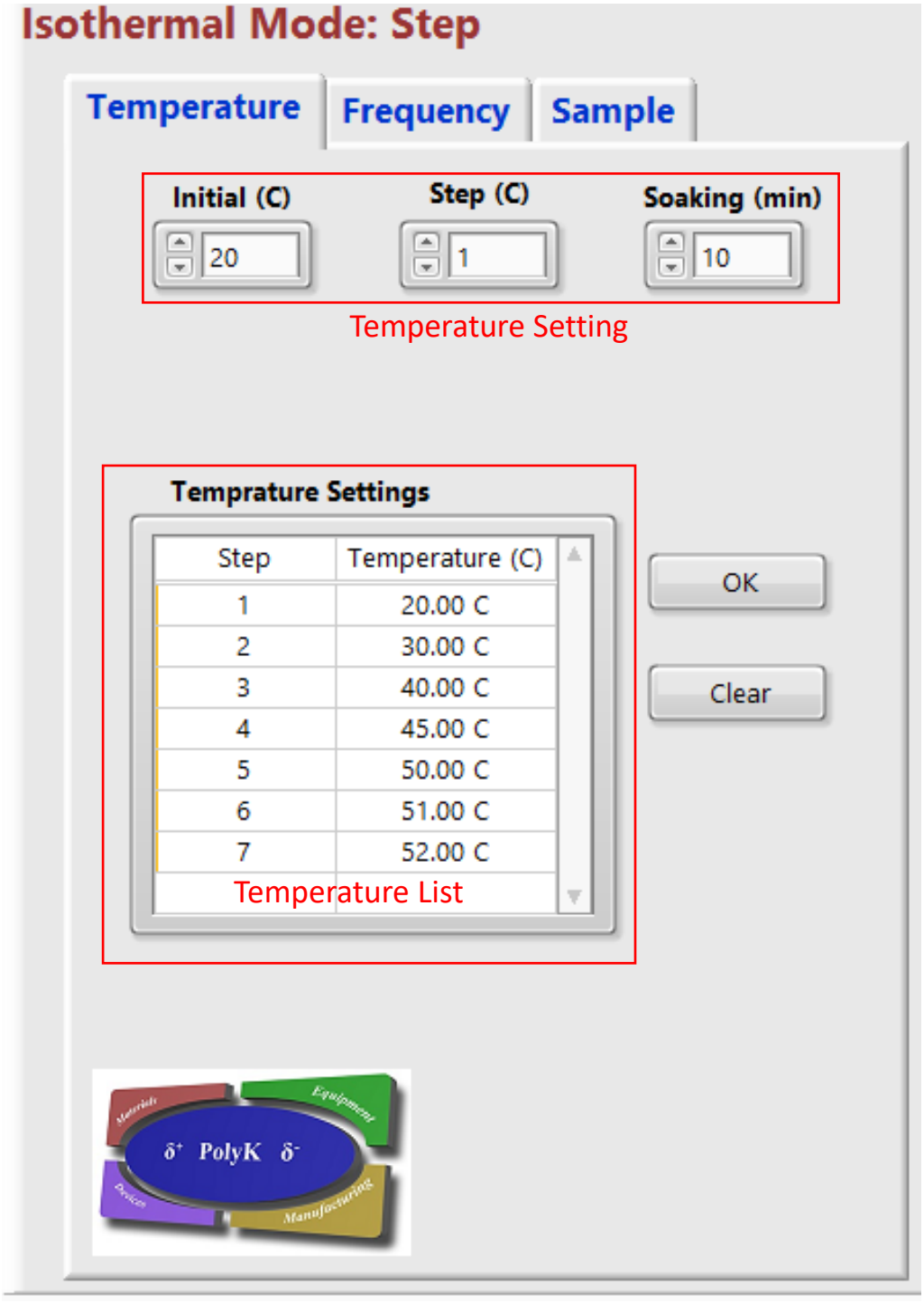


Figure 13. Temperature Setting

Isothermal: Step Mode

Frequency setting is similar to that in Temperature Ramp Mode.

In the Figure 14 Example:

- From 100Hz to 1MHz，every decade（e.g., from 100 to 1 kHz, etc）will have ten frequency points equally distributed in log scale.
- Also include 62, 63, 64, 65 Hz points.

Note: Although most LCR meters claim frequency range from 20 Hz to 1 MHz, however, the noises are much higher at <100 Hz and >100 kHz:

- **At low frequencies, the impedance of the specimen is very large (inversely proportion to the frequency), therefore, the current to be measured is very low, which may be lower than the current capability of the LCR meter, therefore, leads to larger noise. This low-frequency noise may be partially addressed by using specimens with thinner thickness and/or larger diameter (larger capacitance, lower impedance, larger current to be measured).**
- **High frequency noise is usually a result of the parasitic inductance from the test system (all connection cables and fixtures). You need to do careful compensation.**

When selecting an LCR meter or impedance analyzer, please check their Impedance capability (with unit of ohm) and Phase Angle capability (dielectric loss).

We work with our partners to offer low-cost LCR Meter/analyzers to measure low frequencies (0.1 Hz) at much lower cost than Novocontrol.

Specifications of 4284A LCR Meter

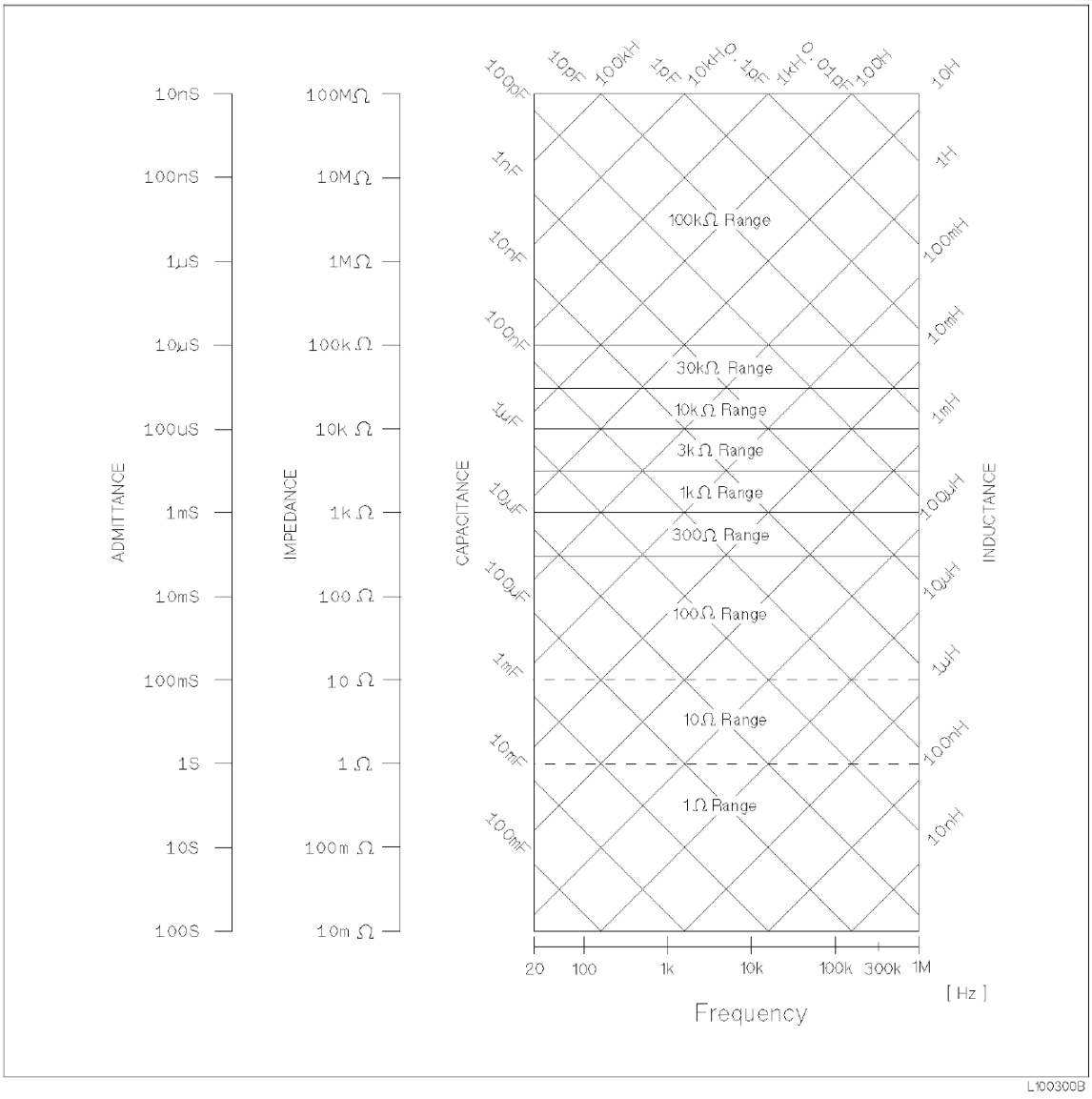


Figure 3-5.
Effective Measuring Range
(Oscillator Level > 2V or > 20 mA)

Isothermal: Step Mode

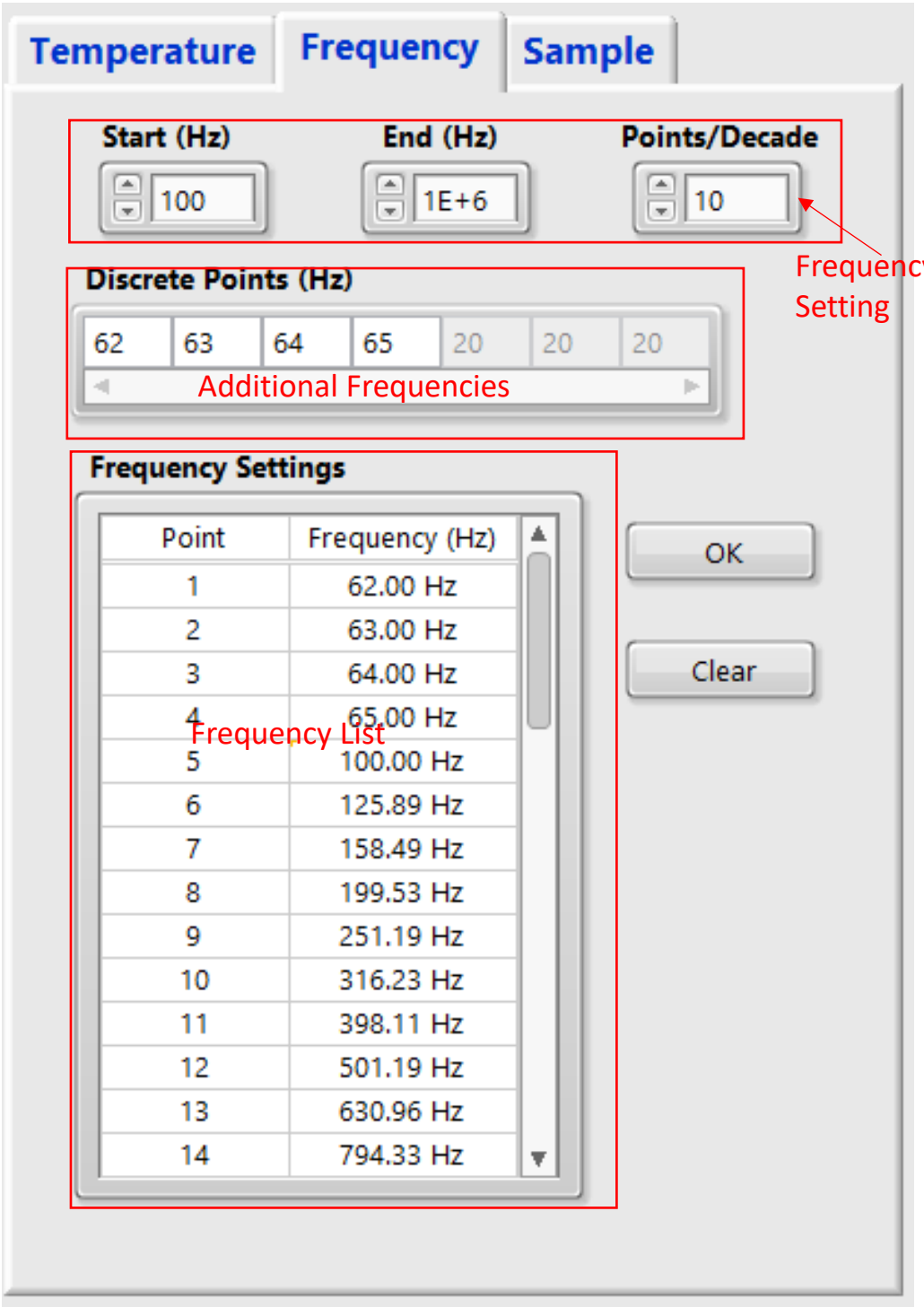
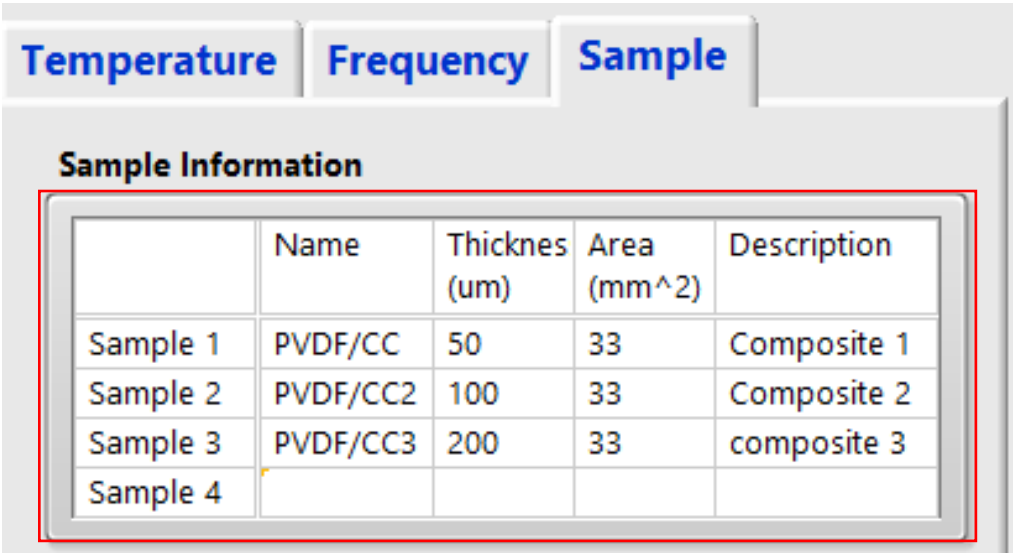


Figure 14. Frequency Setting

Isothermal: Step Mode

Specimen Setting is shown in Figure 15.



	Name	Thicknes (um)	Area (mm^2)	Description
Sample 1	PVDF/CC	50	33	Composite 1
Sample 2	PVDF/CC2	100	33	Composite 2
Sample 3	PVDF/CC3	200	33	composite 3
Sample 4				

Figure 15. Specimen Information

As shown in Figure 16, before starting the test, you need to set up the computer folder where the test results will be saved. (Same process as in the Temperature Ramp mode Figure 8)

After completing the set up, click “run” to start the test. The software will wait until the first start temperature is reached (and soaking time completed) before measure with the LCR meter. If you do not wait for temperature stabilization, you can click “skip” to start the measurement immediately.

The test results will be displayed in the Table and the real-time plot. Only the results at the current temperature will be displayed in the plot (as a function of frequency). Different specimen will be shown in different colors.

When the CpD, CpQ, CpG, or CpRP parameter are selected (Figure 5), the software will automatically calculate the dielectric constant K which will be shown in the K – temperature figure.

Isothermal: Step Mode

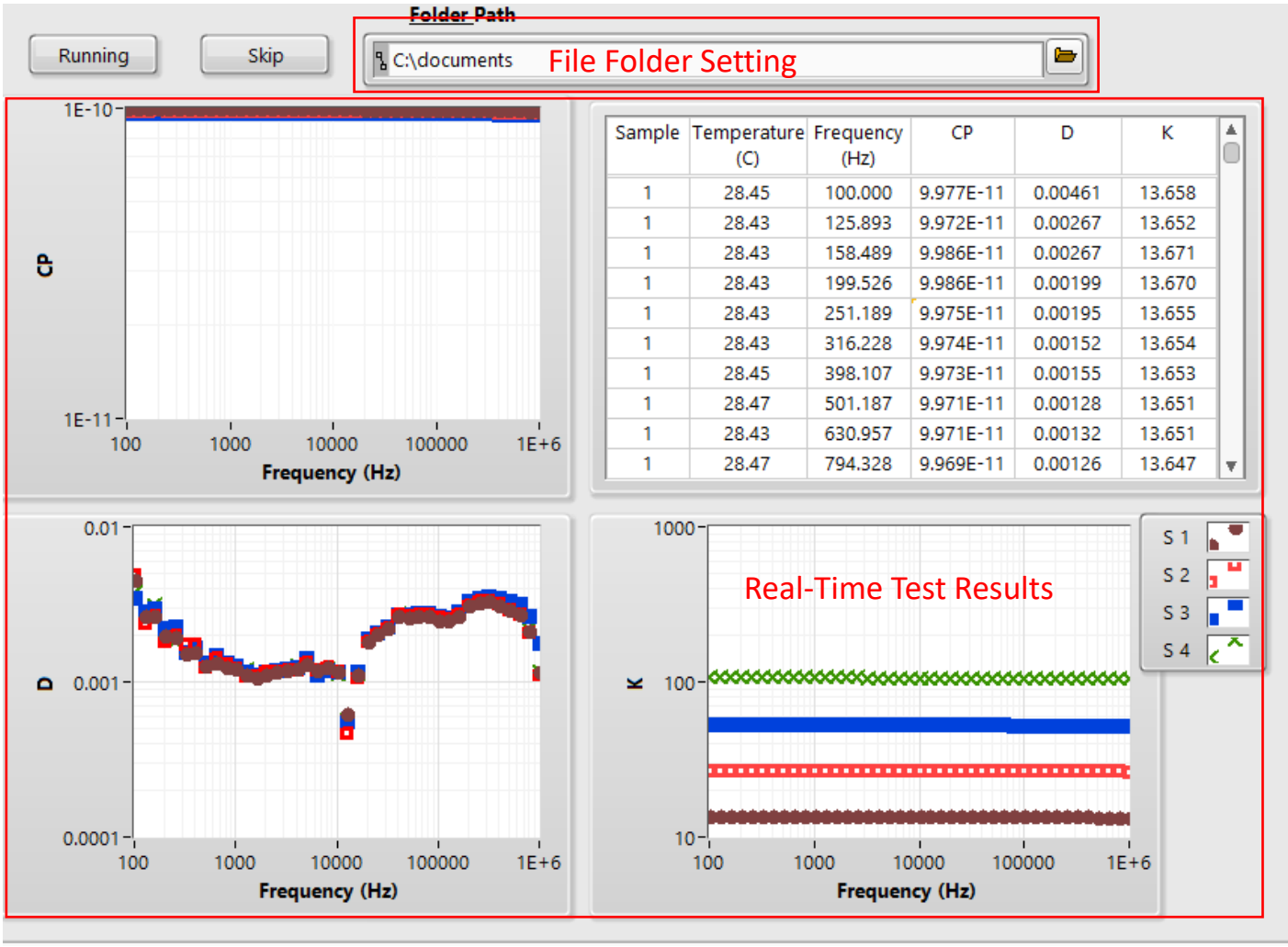


Figure 16. File Folder Setting and Real-Time Test Results Display

After complete the test, you can find the test results under your computer folder where it was specified in Figure 16. If you cannot find the files, you may made mistakes when specify the folder in Figure 16.

The data files are created immediately once you click “Run”. You can open the folder to check where the files are created after start the run to verify where you have specified the correct folder. Test results are added to the corresponding files immediately after measuring each frequency so the size of the files becomes larger with the progress of test. Therefore, even in case of any mis-function of the test system or power outrage, you will still have the data for the test that have been completed.

Isothermal – Time Mode

In this mode, you can set a constant temperature, a frequency list, and then the time step.

The frequency sweep of each specimen under the pre-set temperature will be performed following the time setting.

This mode can be used to study the chemical reaction, curing process, aging process of certain materials. For example, the curing of epoxy or silicone. It can be used to study the kinetics.

The test process is similar to the Isothermal – Step Mode.

Isothermal: Time Mode

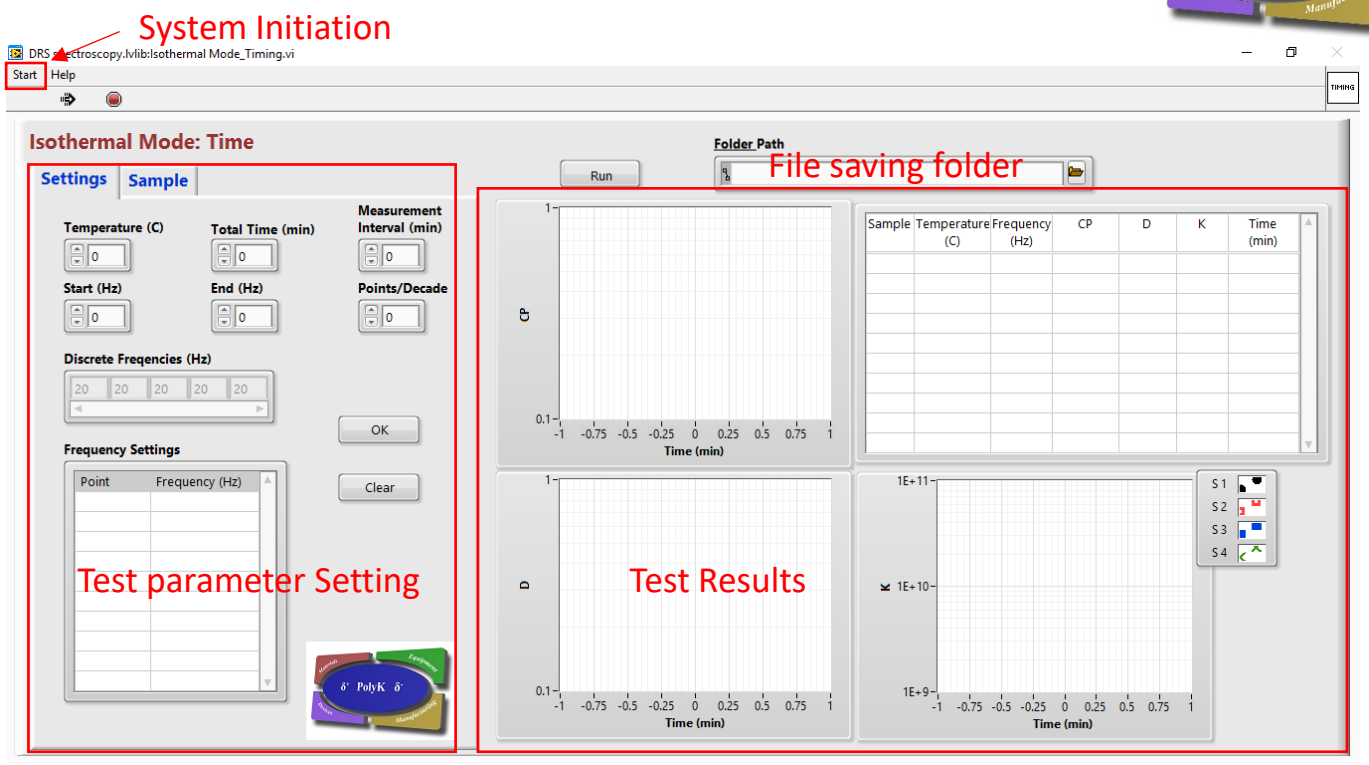


Figure 17: Main Software Interface of isothermal – time mode

Isothermal: Time Mode

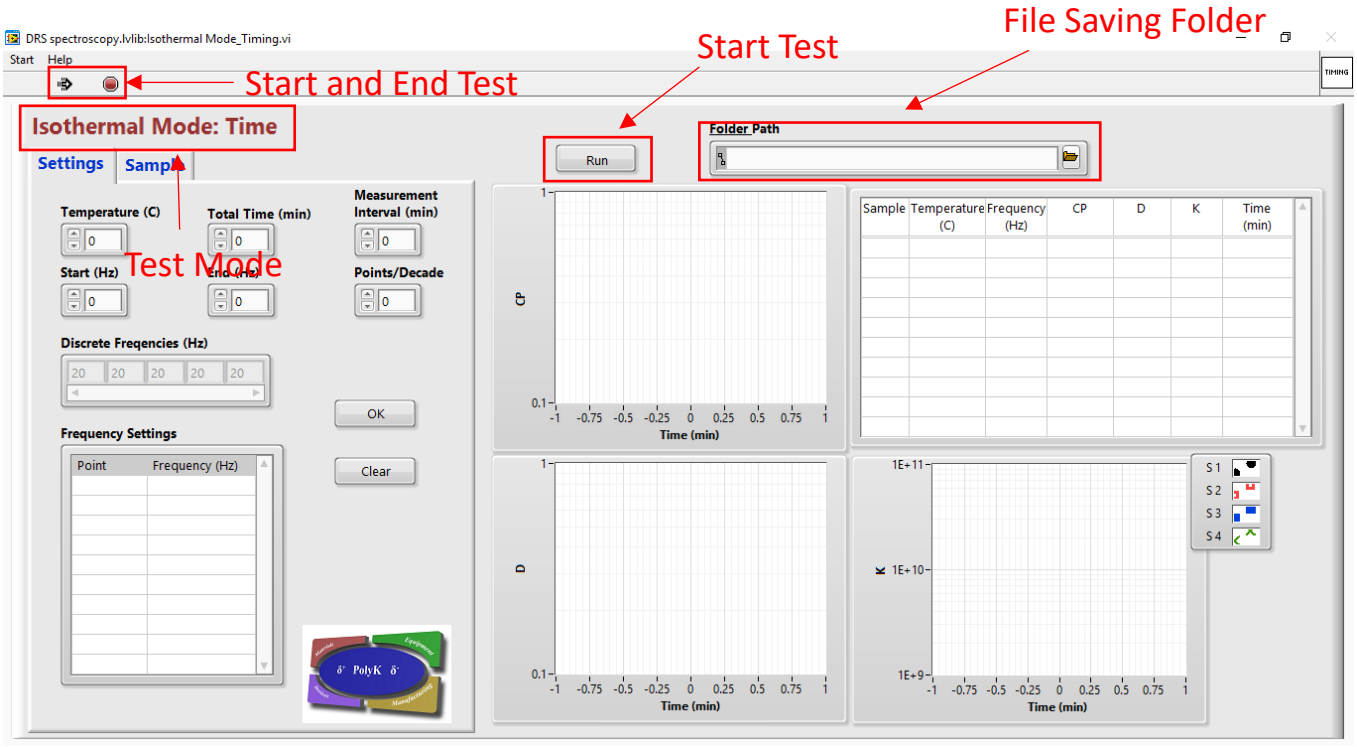


Figure 18: Isothermal – Time Mode Setting

Isothermal: Time Mode

Figure 19 shows the temperature – frequency – time setting.

- At 40 C, continuously measure 120 minutes, with time interval of 1 minutes
- Make sure the time interval is longer than the time required to perform one frequency sweep (or use fewer frequencies, do not use low frequencies, etc)

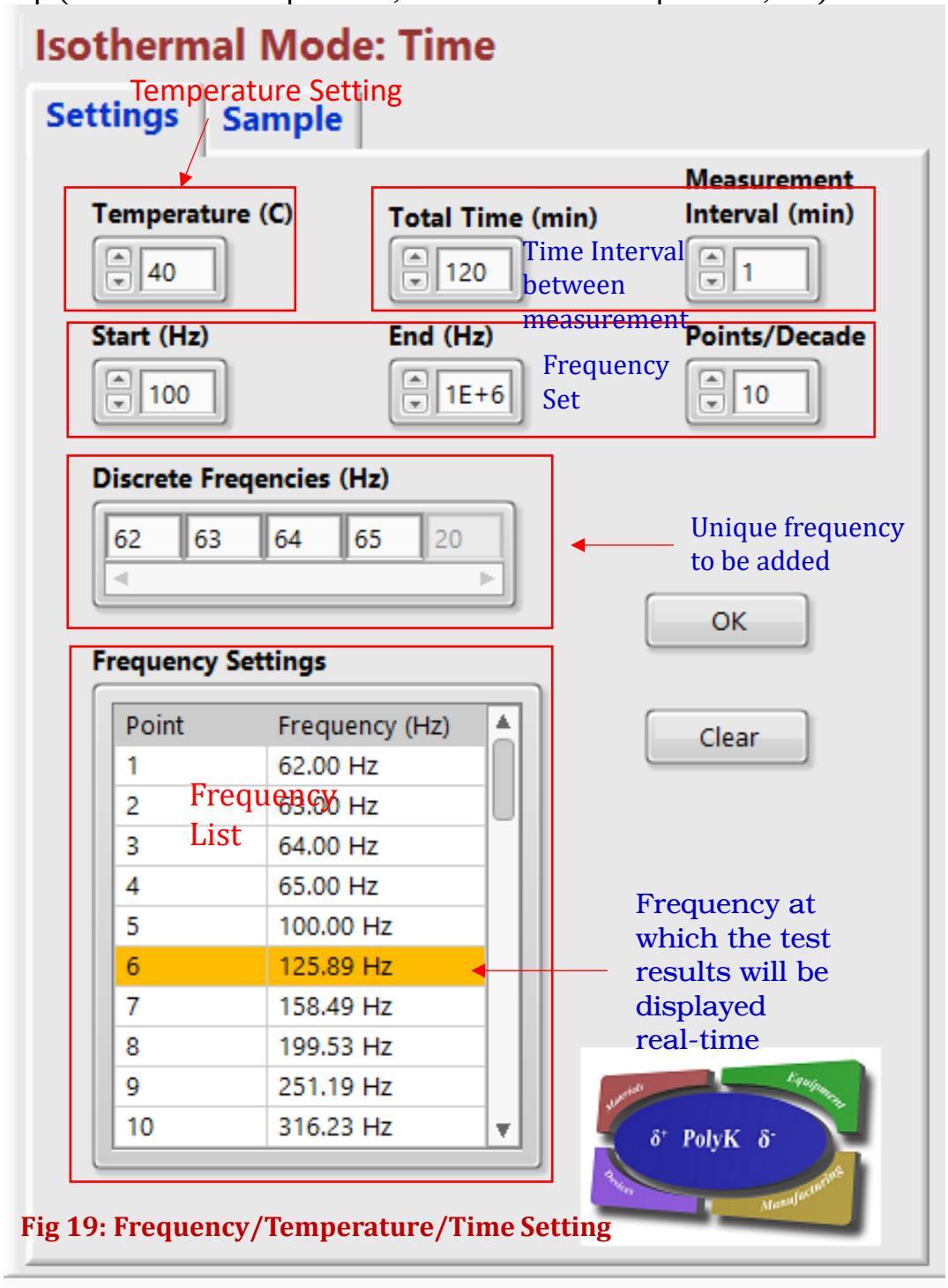


Fig 19: Frequency/Temperature/Time Setting

Isothermal: Time Mode

Specimen information shall be entered into this table. You can measure up to 4 specimens in one run. The name will be specimen name and the saved file name

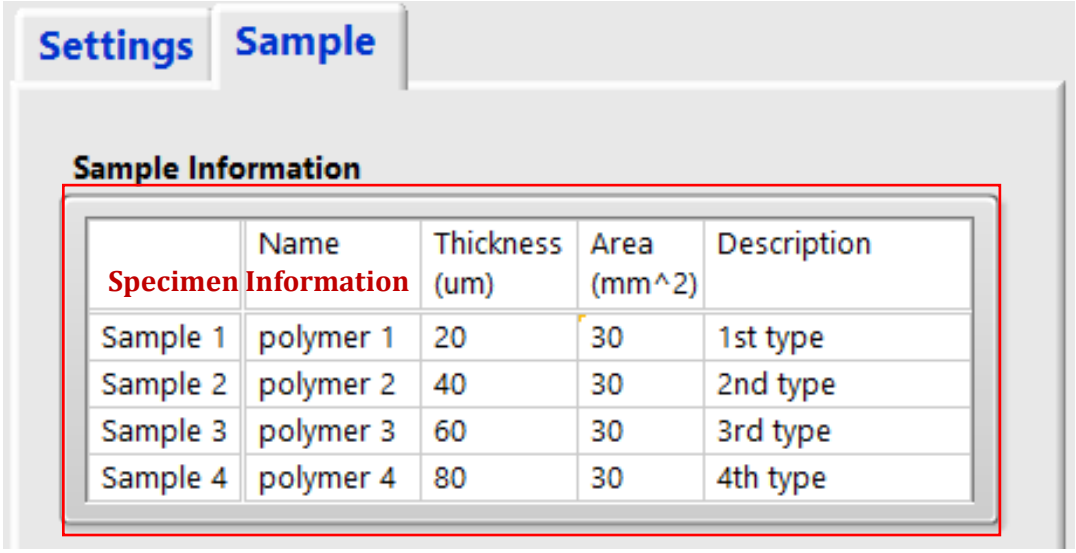


Fig 20: Specimen Information

Isothermal: Time Mode

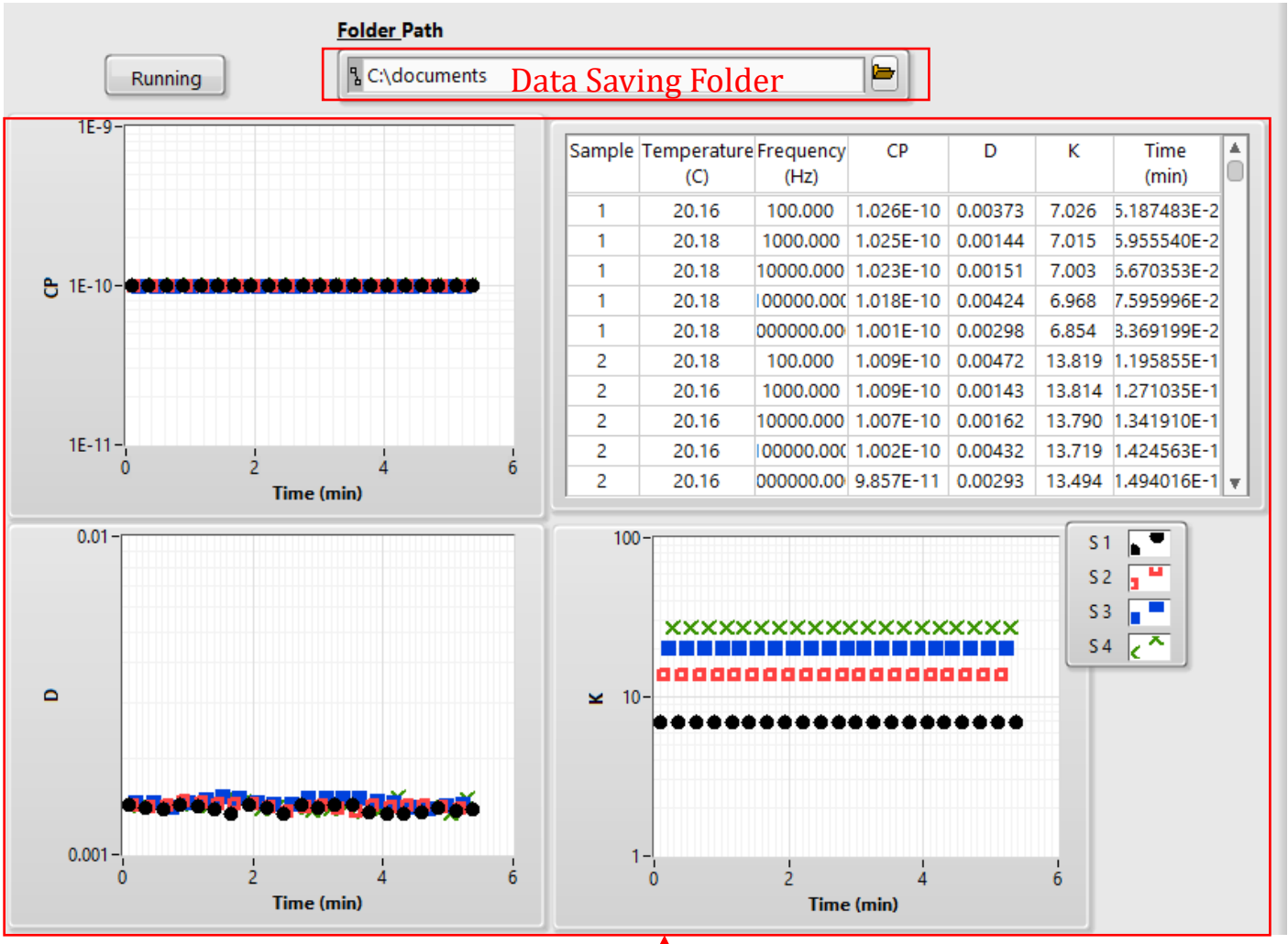
As shown in Fig 21, before starting test, enter the data saving folder path, the test results will be saved into different file name (same as the specimen name, can be set in the specimen information table in Fig 20)

After setting, click “Run” to start the test. The software will set the temperature to the first temperature. Then test will start and measured data will be displayed in the figure and the table.

All test results will be displayed in the table. To avoid confusion, only the results at the selected frequency will be displayed in the plot. Different specimen will be displayed with different colors (S1 for specimen 1， etc).

When the test parameters are CpD, CpQ, CpG or CpRP (Set in Fig 5), the dielectric constant will be automatically calculated using the specimen dimension and displayed in the K-T plot

Isothermal Test: Time



Real-Time Test Results Display

Fig 21: Test Results Display

Isothermal: Time - Mode

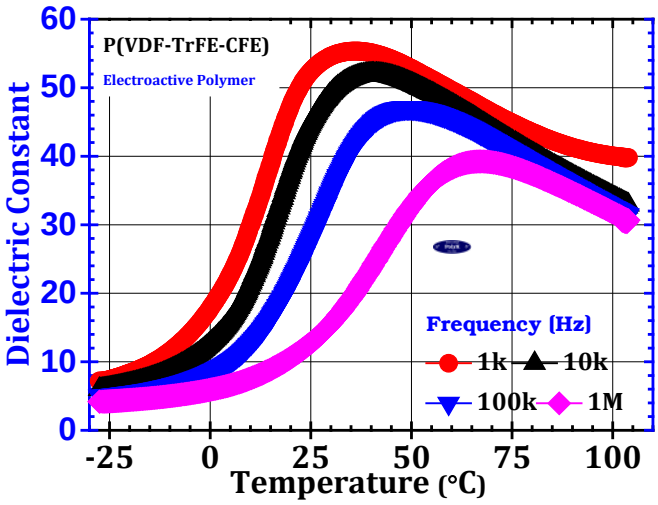
After test completed, the software automatically stops test and data saving (it can also turn off the chamber). The test results can be found in the chosen folder and the file can be open by excel or notepad for further edit.

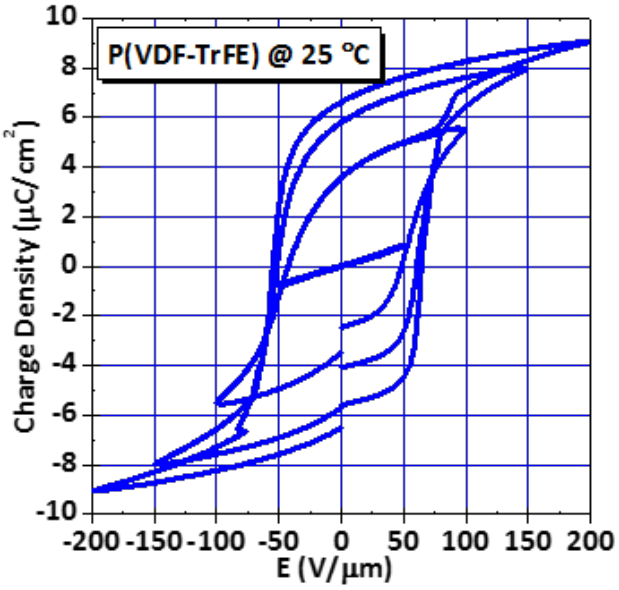
Accessories

1. Polishing compound to clean the silver ground electrode.
2. Metallized PET polymer film samples: for instrument training. 20 mm x 20 mm size.
3. Metallized PVDF-TrFE-CTFE film samples: for instrument training. This polymer has dielectric constant around 50 at 25 C and 1 kHz and it does NOT contain any fillers.

High Voltage Dielectric Test Systems

- Measure capacitance and dissipation factor under high DC bias voltage: prevent dielectric breakdown of sample from damaging expensive LCR meter
- Measure capacitance and dissipation factor under high AC voltage up to ±4000 V [4284A or E4980A measures at <3 V)





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