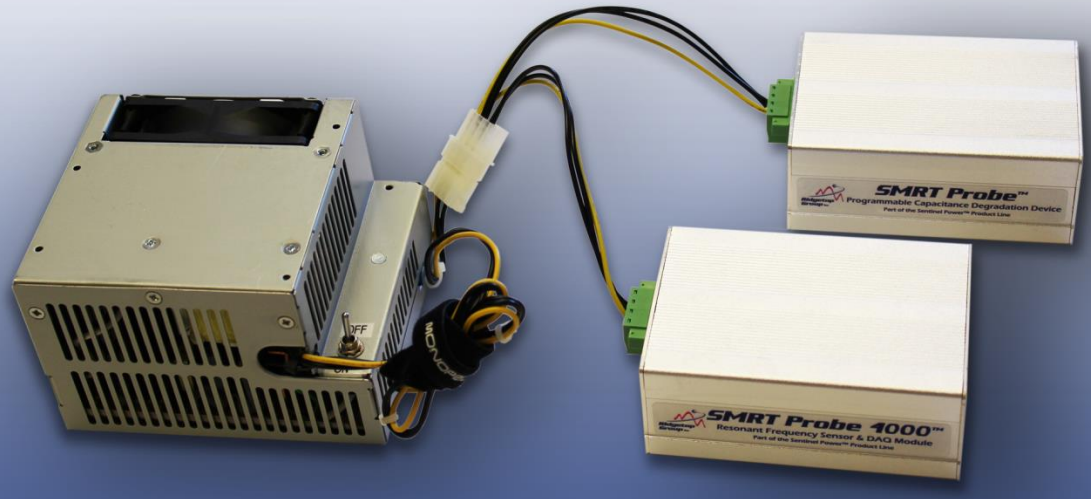
Sentinel Power™

DEMONSTRATION KIT

User Guide



Products included:
SMRT Probe 4000™
ARULE™
and Sentinel PowerView™

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The product described in this user guide is Sentinel Power™ Demonstration Kit, by Ridgetop Group.

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1 Introduction to the Sentinel Power Demonstration Kit

About the Sentinel Power Demonstration Kit

Ridgetop's Sentinel Power™ Demonstration Kit (Demo Kit) consists of a SMRT Probe 4000™ sensor (Sample Mode Response Technique™), software algorithms and reasoners, a Programmable Capacitance Degradation Device (PCDD), and a power supply. The Demo Kit comprises a complete end-to-end demonstration of prognostics and health management (PHM) for power supplies, to show how the Ridgetop Group's prognostics technology functions.

Using the Demo Kit, you can introduce power supply degradation by decreasing power supply capacitance with the PCDD, which enables you to observe the performance of the power supply as it degrades. The included ARULE™ prognostic reasoner software analyzes the output signature of the power supply to determine the current state of health (SoH) and remaining useful life (RUL). The system then provides a visual demonstration of PHM in an easily to use graphical user interface (GUI).

The SMRT Probe 4000 is a non-intrusive resonant voltage-sampling sensor that is attached to a power supply to extract prognostic degradation signatures, combined with a control/communication module and a data acquisition (DAQ) module.

The Sentinel Power Demo Kit is shown in Figure 1.

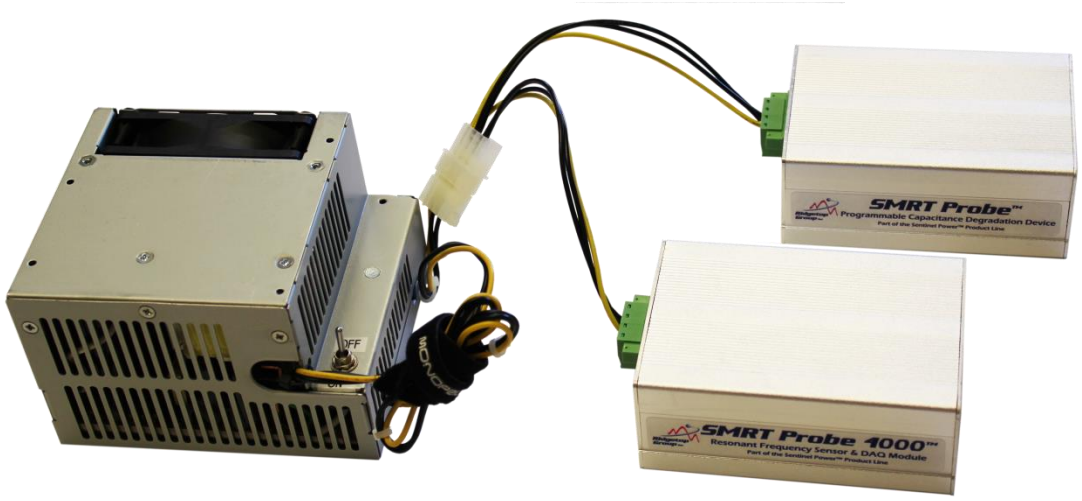

Figure 1: Sentinel Power Demonstration Kit

Sentinel Power monitors power systems by the SMRT Probe 4000 injecting a small, short-duration, controlled load change and observing the power system's response to the induced load change, enabling prognostic and degradation analysis. The system response will change due to loss of filter capacitance, changes in equivalent series resistance (ESR), MOSFET switch degradation, or other component degradation.

The sensor processing unit (SPU) embedded in the SMRT Probe 4000 unit controlled by the host Sentinel Power prognostic analysis platform controls the SMRT Probe sensor and processes the data sampled by the probing section of the device.

Objectives

The Demo Kit provides a working demonstration of its components – SMRT Probe 4000, PCDD, ARULE, the GUI, and a power supply – and also serves as a power prognostic evaluator providing real-time monitoring of power supply performance.

Box Contents

Your Sentinel Power Demonstration Kit box contains:

- SMRT Probe 4000 device
- SMRT Probe Programmable Capacitance Degradation Device (referred to as PCDD)
- AcBel 200W power supply
- Two USB cables: one for SMRT Probe, and one for PCDD
- Sentinel Power Demo Kit CD or an FTP folder location containing the software and User Guide
- Screwdriver specified for the green plugs

If your box contents differ, please contact us at +1 520-742-3300 or by email at info@ridgetopgroup.com.

System Requirements

1. Windows 8.1 or Windows 7 Professional operating system (either 32- or 64-bit) or Windows XP Service Pack 3. Do not use Windows 7 Home Edition.
2. The MATLAB software requires the following:
   a. Intel or AMD x86 processor supporting SSE2 instruction set
   b. 1 GB RAM
   c. 600 MB of disk space

3. PC with two USB ports available (PC is not provided)
4. The latest version of the free Java software run-time environment is required; the steps for Java installation and updating are included in Chapter 2, Installing the Sentinel Power Demonstration Kit.

Sentinel Power Demo Kit System Configuration

The block diagram in Figure 2 illustrates the Demo Kit configuration.

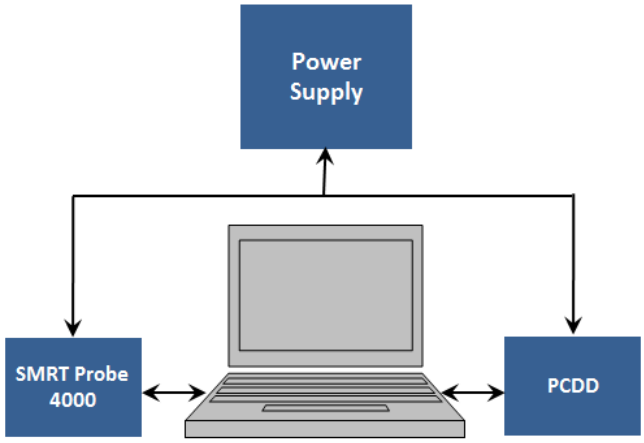

Figure 2: Demo Kit configuration diagram

Component Specifications

The SMRT Probe 4000 has the following specifications:

Capacitance range	132 to 13,200 µF	Output connector	Micro USB
Input voltage range	2.5 to 33 V	Temperature range	0 to 40 °C
Connectivity	USB	Frequency response range	850 Hz to 4.1 kHz
Dimensions	L = 4.38 in. (11.1 cm) W = 3 in. (7.6 cm) H = 1.75 in. (4.5 cm)		

The **SMRT Probe Programmable Capacitance Degradation Device (PCDD)** has the following specifications:

Capacitance range	0 to 6,820 µF	Output connector	Micro USB
Input voltage range	2.5 to 33 V	Temperature range	0 to 40 °C
Connectivity	USB	Size	L = 4.38 in. (11.1 cm) W = 3 in. (7.6 cm) H = 1.75 in. (4.5 cm)

The **power supply** provided in the Demo Kit has the following specifications:

Output capacitance	47 µF, 50 V	Input connector	TBD by customer, as it is voltage input-dependent
Input voltage range	115 VAC or 230 VAC	Output voltage	+12 VDC
Size	L = 5 in. (12.7 cm) W = 4.25 in. (10.8 cm) H = 3.13 in. (7.9 cm)	Output current	10 amps

2 Installing the Sentinel Power Demonstration Kit

It is advisable to read through all the setup instructions before beginning the setup process.

Installing the Software

1. The first step is to make sure the PC is running version 8.25 of Java or greater. If the PC is not running the latest version of Java, the Sentinel PowerView user interface may not work properly. To check your Java version, simply go to the following URL – http://www.java.com/en/download/installed.jsp – then follow the on-screen instructions to update to the most current Java version.
2. Create a folder named "SMRT Probe" on the computer that will control the SMRT Probe 4000 unit.
3. Copy the contents of the SMRT Probe CD (or copy content from the FTP folder) and save all of it into the new SMRT Probe folder you created.
4. Double-click the file in that folder called **setup.exe**, and follow the on-screen instructions.
5. When the installation is complete, click **Finish**.

Installing the Hardware

1. On the back of the power supply there is a red switch for selecting 115 V or 230 V input power, as shown in Figure 3.

WARNING: Be sure to set the power supply switch to match your locally available power source. If the wrong voltage is selected it will destroy the power supply!

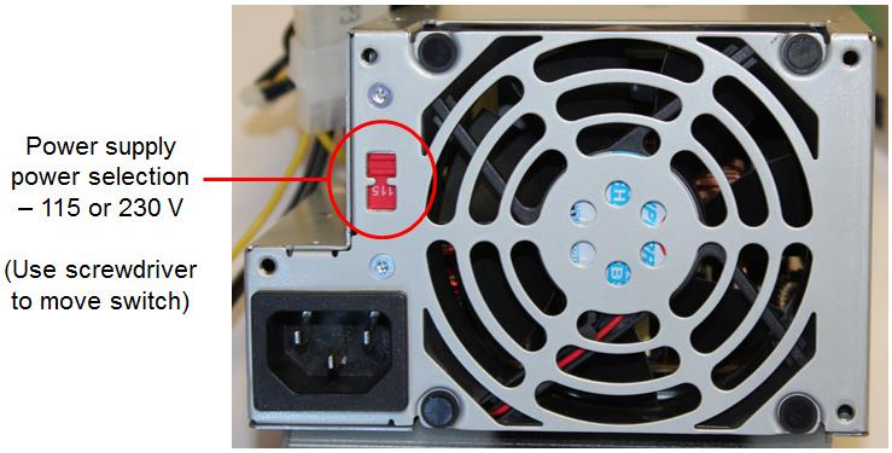

Figure 3: Power supply setting switch; use the small screwdriver supplied with the Demo Kit to change the switch setting

2. A "Y" connector is included in the package with two green plugs and one white plug. Tighten the wire connection screws on each green connector on both the SMRT Probe 4000 and PCDD (in case they loosened during shipping), using the small screwdriver supplied with the Demo Kit. See Figure 4.

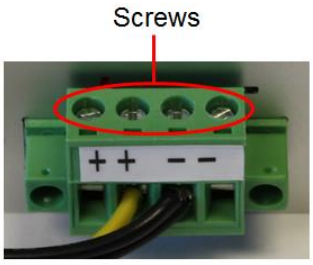

Figure 4: Wire connection screws on green connectors

3. Plug the green connectors into the SMRT Probe 4000 and the PCDD. It does not matter which green connector you connect to each device.
4. Connect the white plug coming from the AcBel 200W power supply to the white plastic "Y" connector that is wired to both the SMRT Probe device and the PCDD, as shown in Figure 5.

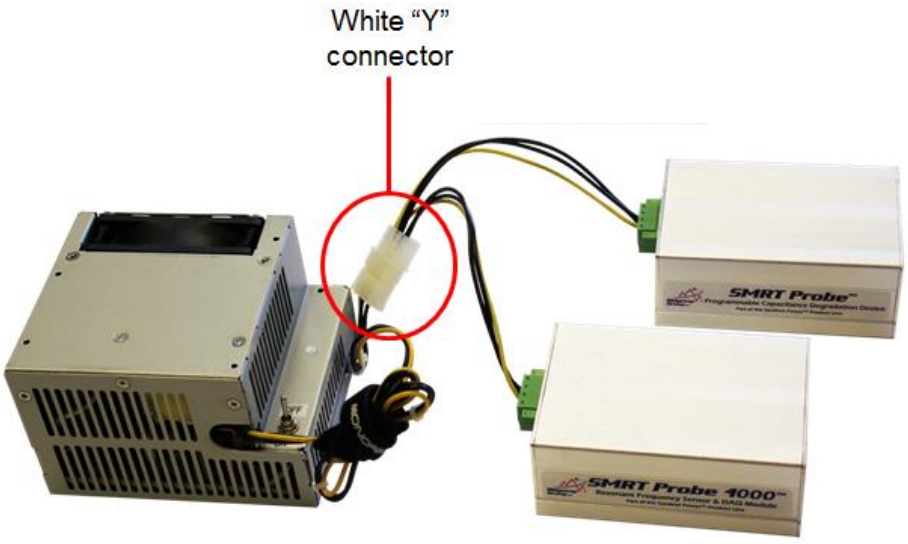

Figure 5: Connecting the white plugs

5. Connect the micro USB cable to the SMRT Probe 4000 socket shown in Figure 6.

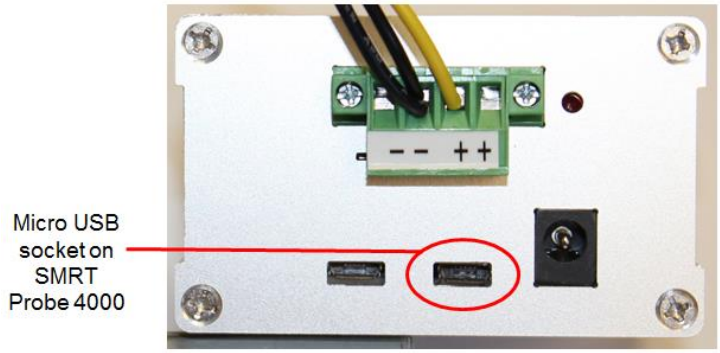

Figure 6: SMRT Probe 4000 micro USB cable socket

6. Connect the other end of the SMRT Probe 4000 USB cable to a USB port on the PC. The device driver automatically installs.
7. Connect the other USB cable to the PCDD socket shown in Figure 7.

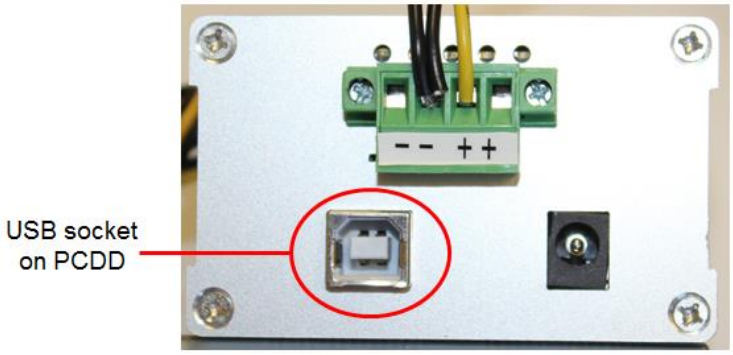

Figure 7: PCDD USB cable socket

8. Connect the PCDD USB cable to another USB socket on the PC. The device driver installs.
9. Make sure that the ON-OFF switch on the power supply is set to the OFF position.
10. Connect the included power cable to the socket on the power supply, and plug the other end into the locally available power. Note that when the power supply is connected to the AC power source, its internal circuit boards have power supplied to them. There is no output power until the switch is placed in the ON position, which is indicated by the green LED being lit.

Caution: Do not set the ON-OFF switch on the power supply to the ON position at this time. Instructions for when to turn it ON are included in the next chapter.

The next chapter explains how to use the Sentinel Power Demo Kit.

3 Using the Sentinel Power Demonstration Kit

Getting Started

1. Ensure that the following actions have been performed:
    - SMRT Probe 4000 is plugged into the PC (USB)
    - PCDD is plugged into the PC (USB)
    - Power supply ON-OFF switch is in the OFF position
    - Power supply red power selection button has the correct power setting (see Figure 3)
    - The green connectors are plugged into the SMRT Probe 4000 and the PCDD (see Figure 5)
    - The white plug coming from the AcBel 200W power supply is connected to the white plastic "Y" connector (see Figure 5)
    - Power supply AC plug is connected to local power (first ensure that the power supply ON-OFF switch is in the OFF position)
2. Navigate to the folder that contains the Sentinel Power Demo Kit installation files.
3. Double-click the file named **Start Demo**. The Sentinel PowerView GUI appears along with a Windows Command screen; allow the Command window to run in the background (Figure 10).

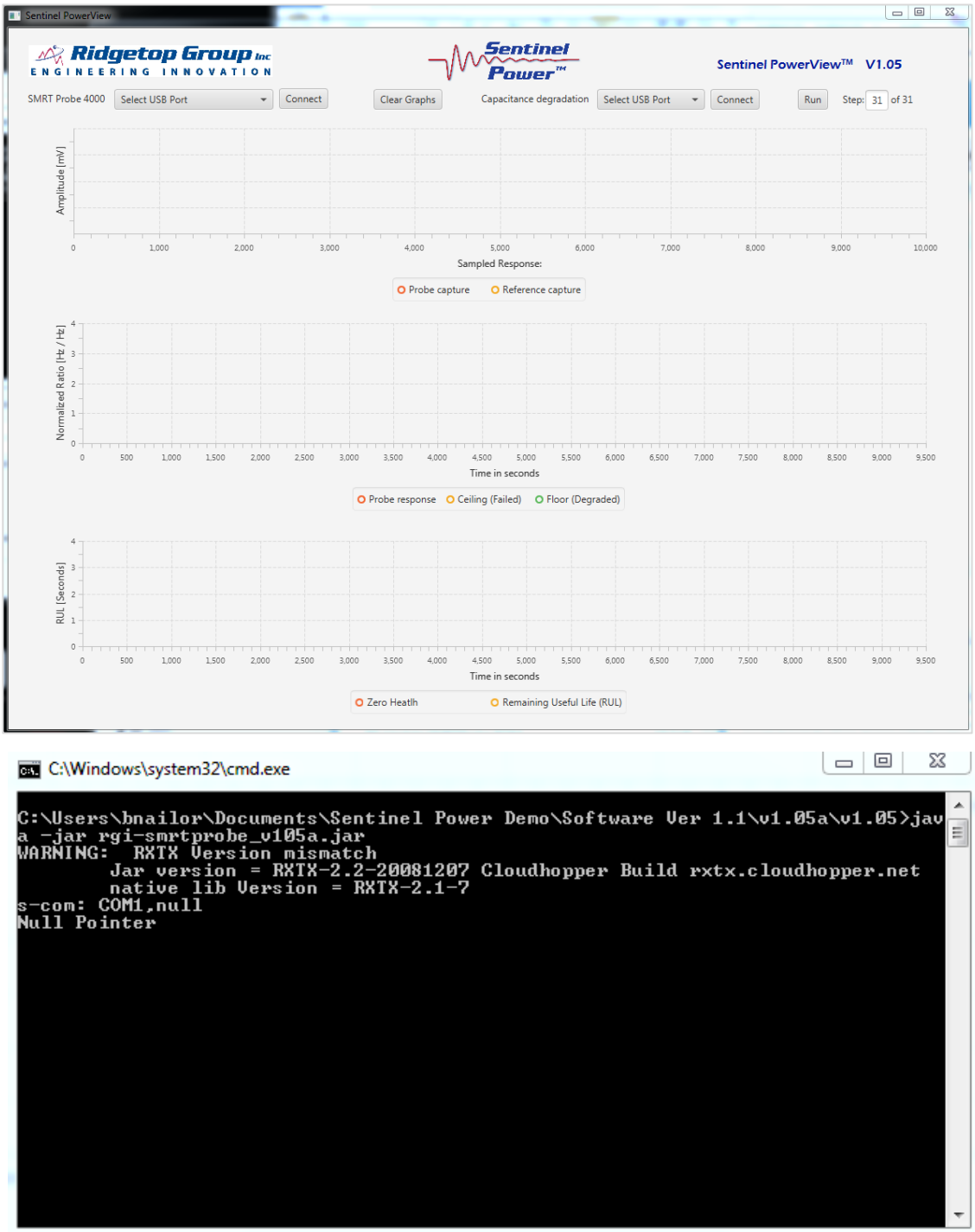

Figure 8: Sentinel PowerView GUI before running tests

4. In the Sentinel PowerView interface, click the drop-down list box next to **SMRT Probe 4000**.
5. Select the COM port associated with the SMRT Probe.
6. Click the SMRT Probe 4000 **Connect** button. (Once the device has connected, the button name changes to Disconnect.)

Note: The connection might not occur instantly.

7. Click the drop-down list box next to Capacitance degradation (the PCDD).
8. Select the COM port associated with the PCDD.
9. Click the Capacitance degradation **Connect** button.
10. Turn on the power supply by moving the toggle switch toward the LED to the ON position. The green LED lights up (Figure 9).

Figure 9: Power supply ON-OFF switch in the ON position, and lit LED

Running the Demo

1. Click the **Run** button in the user interface. The Demo automatically runs 31 tests to demonstrate different levels of power supply degradation. The lower the number in the Step field, the greater the degradation demonstrated. The Demo runs the tests, counting down from 31 to 01; this takes approximately seven minutes to complete. The button name changes to Stop while it is running. The test can be stopped at any time and restarted by clicking the **Stop/Run button**.
2. To reset the Demo at any time during the test, click the **Stop** button, then click **Run.** (See Figure 10.)

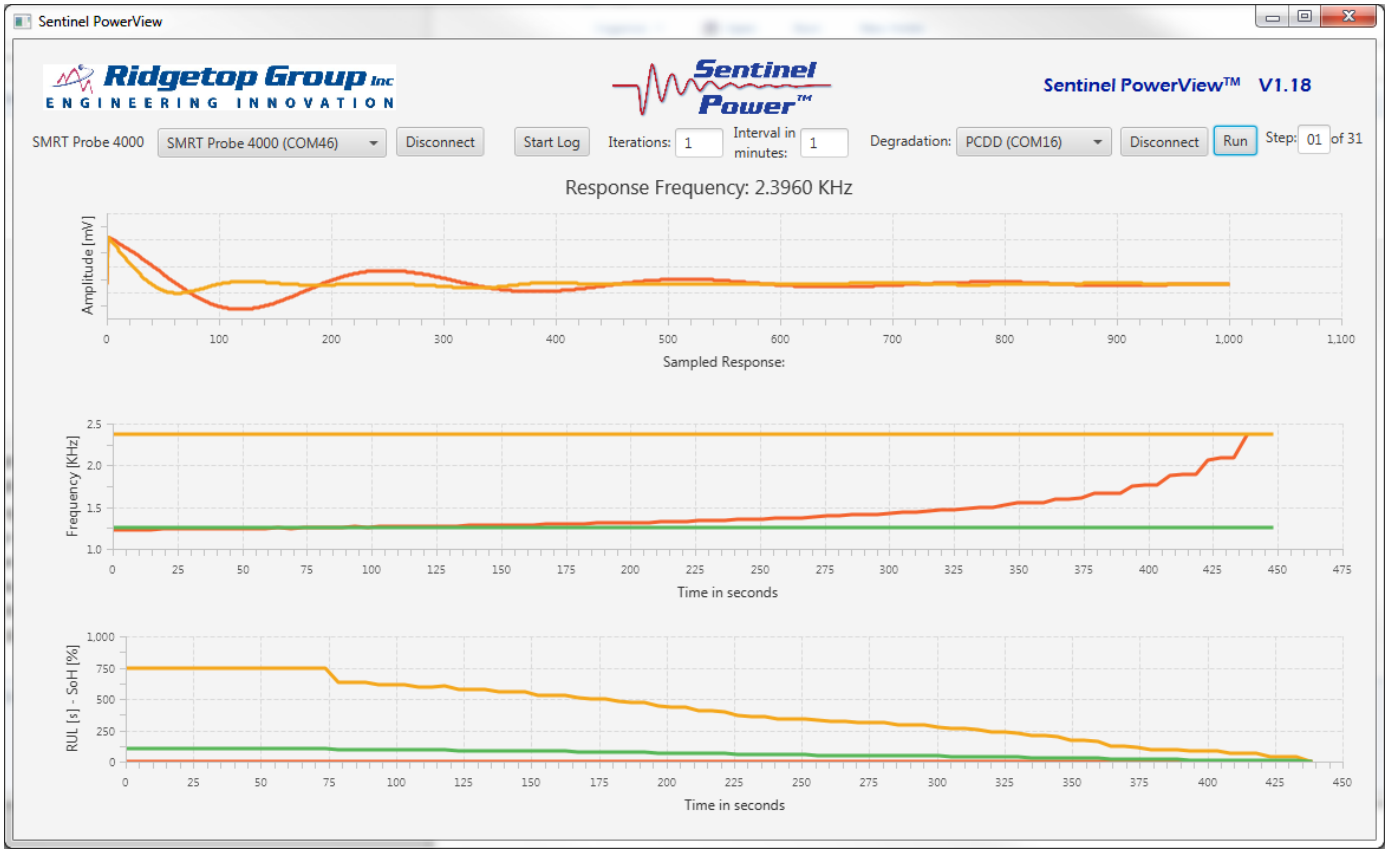

Figure 10: The top graph shows damped waveform and frequency reading; middle graph shows frequency over time; bottom graph shows RUL and SoH over time

- In the top power source probe response graph, the vertical axis titled **Amplitude** indicates mV. The horizontal axis indicates sampled response. The red line shows the nominal response (the healthy state), and the orange line shows probe response (actual response).
- In the second graph, the vertical axis indicates **frequency in kHz**. The horizontal axis indicates time in seconds. The red line represents the probe response at the power supply; when it is below the green line, the power supply is not degraded. The orange line represents the preset Ceiling threshold; if the probe response rises above that point, the power supply is considered failed. In a failed condition the state of the power supply is defined as 0% healthy; and even though the power supply might still be operating, complete failure is imminent. The green line shows the preset Floor threshold; if the probe response rises above that point it means the power supply is considered degraded. In a degraded condition, the health state of the power supply is less than 100% healthy.
- In the third graph, **Remaining Useful Life (RUL)** and **State of Health (SoH)**, the numbers along the vertical axis represent the predicted RUL and SoH in percent. In an actual application, remaining useful life is predicted in months,

weeks, and days. The horizontal axis indicates the time in seconds that the test has run. The red line is the RUL floor, the green line indicates the SoH, and the orange line represents the power supply's RUL.

Probe Response Verification

- The probe response to the power source can be verified by changing the number of capacitors applied to it and monitoring the upper graph titled Sampled Response.
- This mode shows how the PCDD changes the capacitance and the resulting captured response.
- With the demo idle, manually enter a number between 1 and 31 in the step window, then press **Enter** on the PC keyboard. Do not press the Run button. The upper graph shows both the nominal response and the response corresponding to the current step (as shown in the step window). The lower graphs will neither clear nor change.
- In the top power supply probe response graph, the vertical axis titled **Amplitude** indicates mV. The horizontal axis indicates sampled response. The red line shows the nominal response (the healthy state) and the orange line shows probe response (actual response).