
20 Peltier Cooling Curve

During each measurement Thermocouple-C is measured at a 10Hz frequency for 30 seconds resulting in 300 readings per Peltier cooling pulse. A two second running average filter is applied to the output to account for any electrical noise. This data is then stored in RAM of the PSY1. In the manual mode this data can be recalled after each reading and immediately graphed.

The 300 raw data points for each Peltier cooling pulse can also be logged to a separate data file *_rdf.csv. This is configured through **“SD Card Logging Options”** via the **“PSY”** menu.

20.1.1 Get Latest Data:

This icon reads the raw data points from internal RAM and makes them available for plotting on screen in the PSY1 software. The Peltier cooling curve for the last measurement taken can be recalled and plotted.

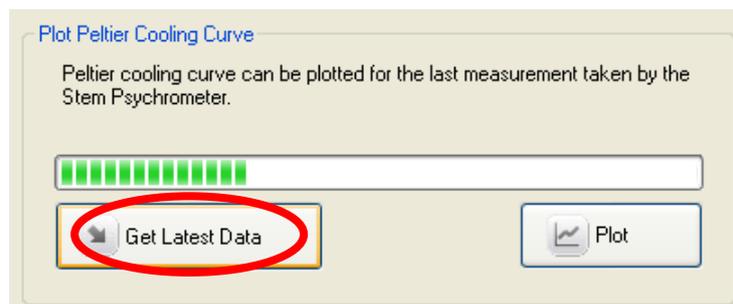


Figure 88: Peltier Cooling Curve - Get Latest Data button.

20.1.2 Plot:

Click this icon to automatically plot the Peltier cooling data.

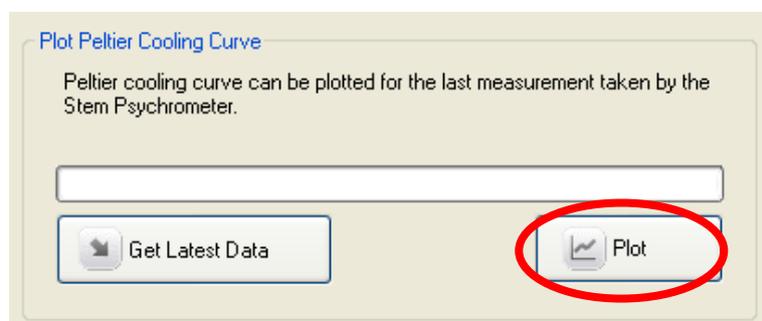


Figure 89: Automatically plot the latest Peltier Cooling Curve data by clicking the Plot icon.

20.2 Peltier Cooling Curve Plot

The graph generated displays time in seconds (s) along the X-axis and Thermocouple-C output (μV) on the Y-axis.

Time zero = the end of the Peltier cooling pulse. The plot begins at Time = 4.5 s after the end of the Peltier cooling pulse. This provides a 1.5 second section of plot prior to recording the Psychrometric Wet Bulb Depression at 6 seconds, the standard “wait time” protocol after the end of Peltier cooling. The plot of the Wet Bulb Depression plateau commences at 4.5 seconds after the end of cooling. The duration of the plateau will depend on two main factors:

- (1) Water status of the sample - a wetter sample (less negative water potential closer to zero MPa) will take longer to evaporate and,
- (2) the cooling time – a longer cooling time (say 10 seconds) will condense more water on the thermocouple than will a short cooling time (say 5 seconds).

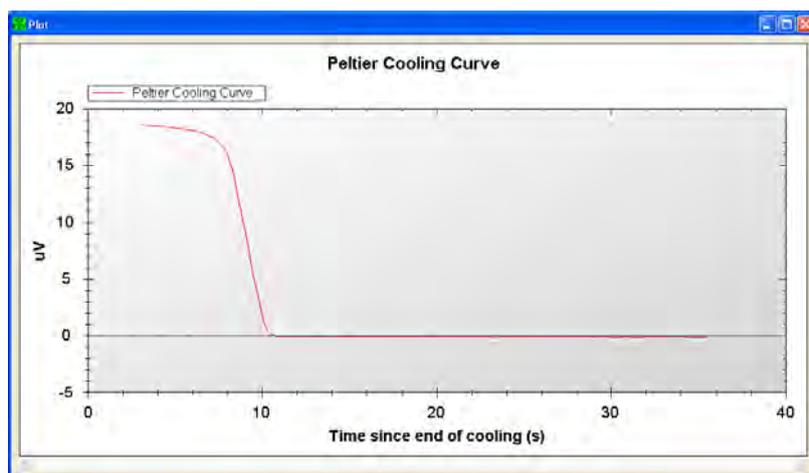


Figure 90 Shows the characteristic response of a clean Thermocouple-C; The output response of Thermocouple-C is in the range of 19 μV (for a 1.0 Molal solution); the plateau of the psychrometric Wet Bulb Depression lasts until approx 10 seconds after the end of cooling and, rapidly falls to zero (the pre-pulse zero reference) and remains steady at this temperature indicating there is no thermal or electronic drift.

20.3 Peltier Cooling Curve – Diagnostic Tool

The decay of the Wet Bulb Depression as the output returns to zero reference (i.e., the thermocouple warms back up to the initial starting temperature after having been cooled) is indicative of the “cleanliness” of the thermocouple. Dirt and dust, silicon grease used to seal the chamber, contact with living plant tissues that can accumulate through general field use and oxidation of the thermocouples, both through general field use and or poor maintenance during storage, all cause the thermocouple response to be less sensitive, and take longer to (and be less likely to), return to zero after a cooling pulse.

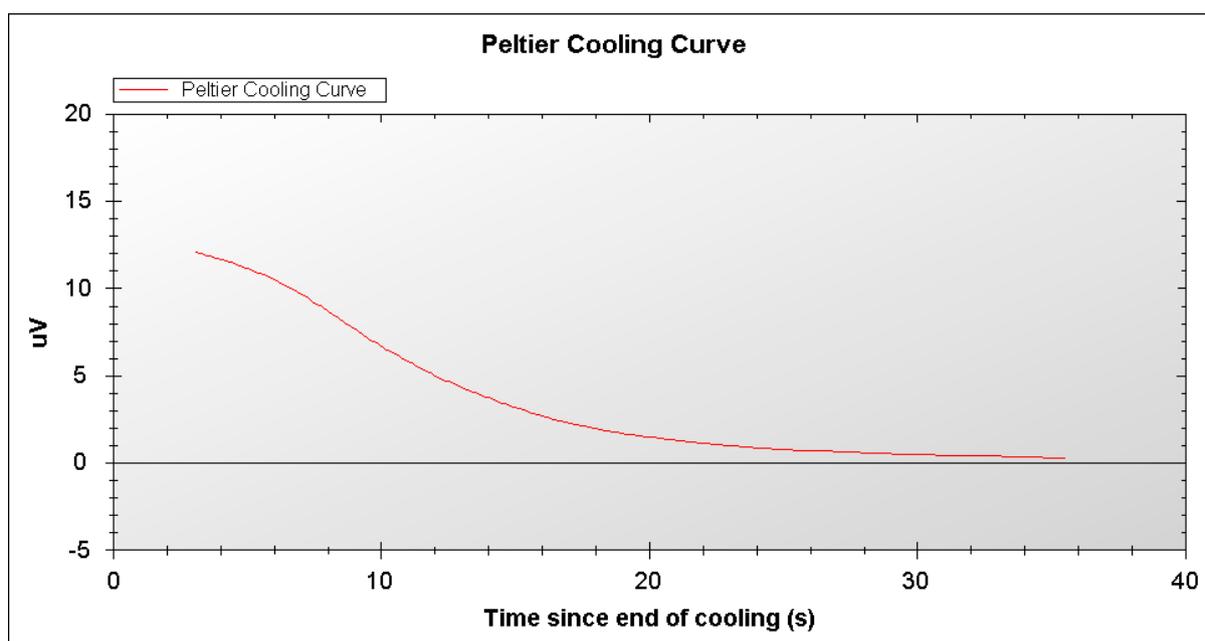


Figure 91 shows the characteristic response of Thermocouple-C that requires cleaning. Note the low output response of the Wet Bulb Depression (in the range of only 12 μV for a 1.0 Molal solution), the absence of a clear plateau representing the psychrometric Wet Bulb Depression and a long drawn out gentle gradient and failure to return to the pre-pulse zero reference.

A recommended performance and verification check of the psychrometers sensitivity and performance prior to deployment is as follows: place a 1.0 Molal calibration solution in the calibration lid and perform a measurement using a five (5) second cooling time and a 6 second wait time. For a clean, sensitive and well performing psychrometer the Wet Bulb Depression should generate an output of approx 19 μV , have a pronounced plateau between 4.5 seconds and 10 seconds with a rapid drop to zero (μV) at around 10 to 11 seconds returning completely to, and remaining stable at zero (μV). If this is not the case the thermocouples of the psychrometer should be cleaned, see: [Cleaning the Psychrometer](#).

NOTE 58: For a particularly dirty psychrometer this procedure of cleaning and verifying may be required to be repeated up to 3 times. If a satisfactory response cannot be achieved within three attempts please contact ICT International for support.

20.3.1 Plot Options:

The graph generated by the plot function can be formatted using standard Windows formatting commands. These options are available by right clicking on the graph.

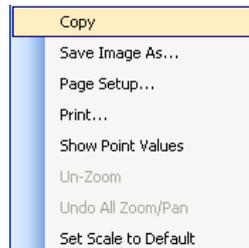


Figure 92: Windows Plot options.

20.3.2 Copy:

The graph can now be pasted into a word processing program such as Microsoft Word for inclusion in reports.



Figure 93: Image copied window.

20.3.3 Save Image As...

The graph can be saved as an independent image in a range of image formats (most typically JPG) for inclusion in reports or other media.

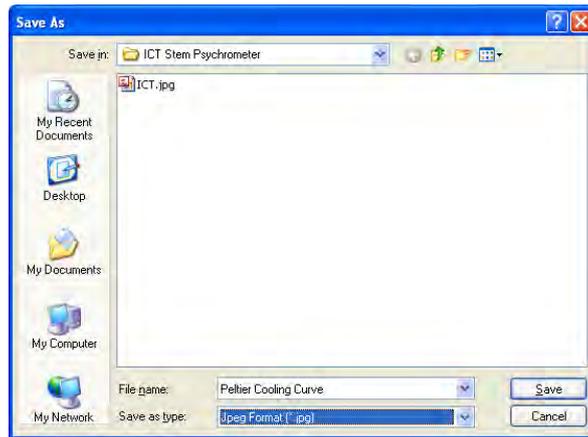


Figure 94: Save As window.

20.3.4 Page Setup

Provides access to the printer's "page setup" settings to configure the printer for printing directly to paper.

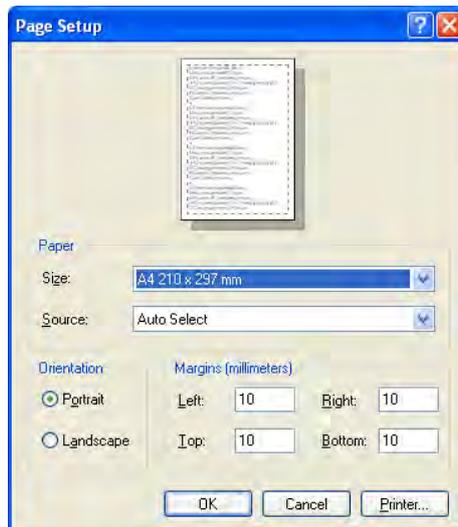


Figure 95: Page setup window.

20.3.5 Print

Provides access to the Printer for printing a copy of the graph to paper.

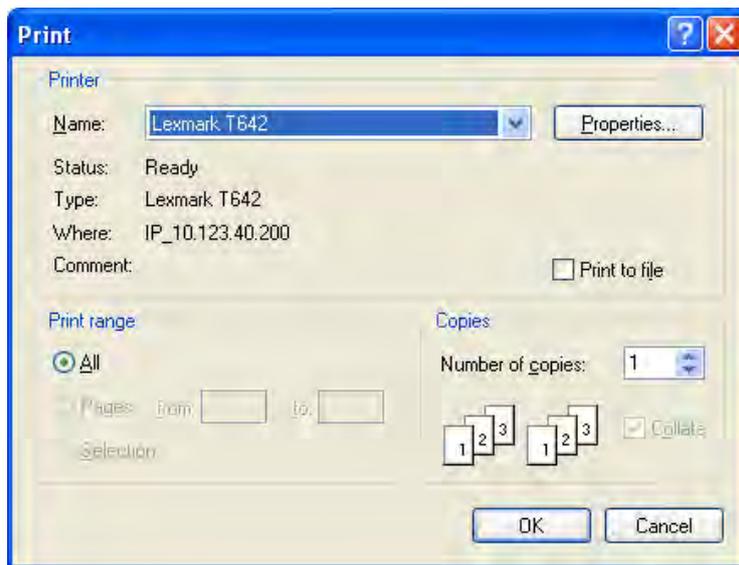


Figure 96: Print window.

20.3.6 Show Point Values

The microvolt value for each corresponding time is displayed on the graph for each data point wherever the cursor is held over the line.

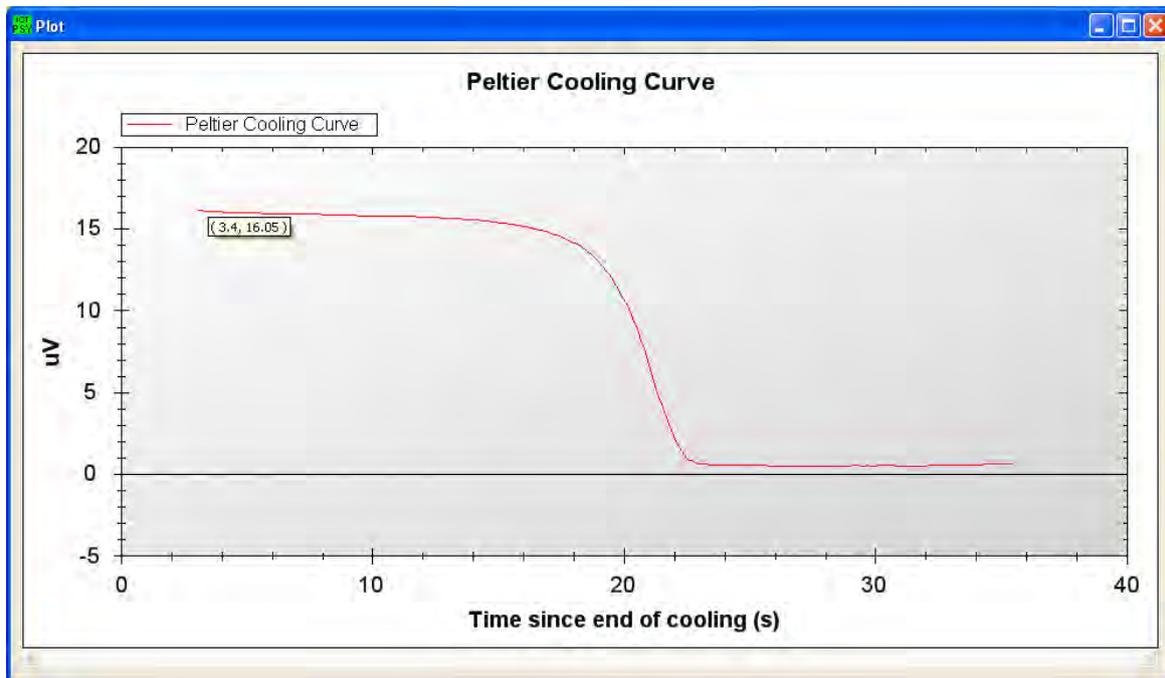


Figure 97: Point values displayed when moving mouse over the line. In this example at 3.4 seconds after the cooling pulse Thermocouple-C output is 16.05 (μV).

20.3.7 Zoom

Specific aspects of the plot can be zoomed in one of two ways:

- (a) Select a region of the plot, click & hold the left mouse button and drag to the chosen portion of the plot. The graph will now zoom in on this particular aspect
- (b) If you have a mouse with a wheel you can zoom and un-zoom automatically by rolling the wheel forwards and backwards.

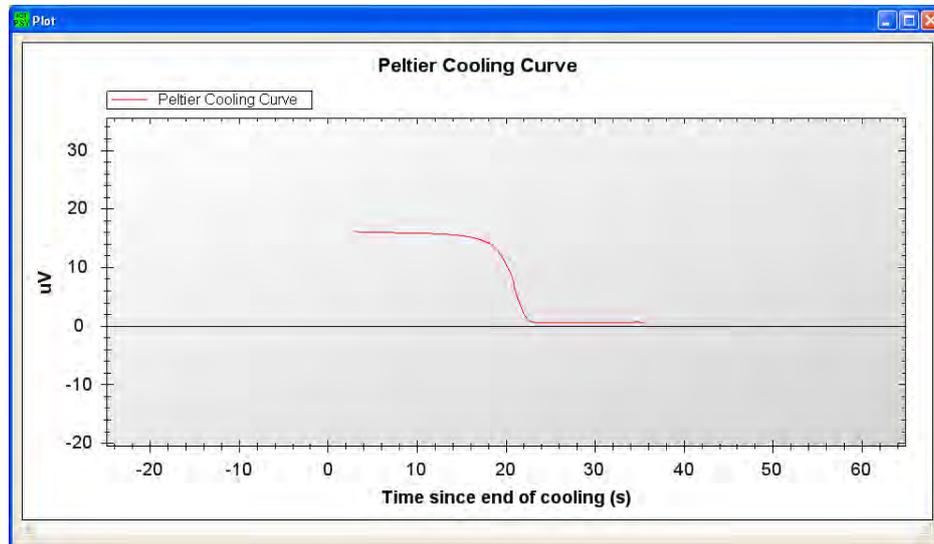


Figure 98: Zoom function on the Peltier Cooling curve plot.

20.3.8 Un-Zoom

Provides an incremental reversal of each incremental zoom performed on the graph.

20.3.9 Undo all Zoom/Pan

Provides reversal of all Zoom/Pan's performed on the graph in a single command.

20.3.10 Set to Default Scale

Right click on the graph and select set to default scale and all modifications to the graph scale are discarded and the graph is reset to the original scale.

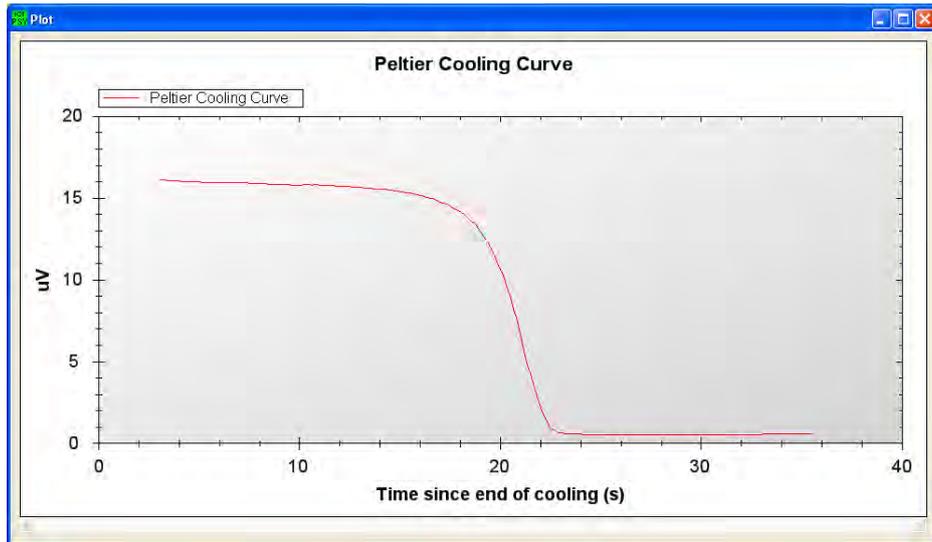


Figure 99: Set to default Auto rescale of Peltier Cooling Curve plot.

20.4 Peltier Cooling Curve Raw Data File

The Raw Data File (*_rdf.csv) is a true *.csv file and can be directly opened in Excel. It is a log of the Peltier cooling curve data for each measurement. It is sampled at 10Hz frequency and it is synchronised with the Main Data file (PSY0A201.csv). It contains an 8 row header line that corresponds to the same header line information of the main data file. This enables direct cross referencing between data files to check the performance or “cleanliness” of the thermocouple against each Corrected Water Potential value recorded. Providing a means of determining if readings are valid throughout the measurement period especially as an installation reaches the end of its productive life.

Serial Number:	PSY0A201	
APP Serial #:	3000008	
Head Serial #:	6	
APP Ver:	R1-4-2	
COM Ver:	R1-3-0G	
Instrument Name:	ICT Demo Stem Psychrometer	
Comment:	Armidale NSW Australia	
Date	Time	Chamber Temperature (°C)
5/11/2010	19:14:19:0000	20.01
5/11/2010	19:14:19:0100	19.99
5/11/2010	19:14:19:0200	19.97
5/11/2010	19:14:19:0300	19.95
5/11/2010	19:14:19:0400	19.93
5/11/2010	19:14:19:0500	19.91
5/11/2010	19:14:19:0600	19.89
5/11/2010	19:14:19:0700	19.88
5/11/2010	19:14:19:0800	19.85
5/11/2010	19:14:19:0900	19.83
5/11/2010	19:14:20:0000	19.81

Table 2: Raw Data logged data file of the Peltier cooling pulse curve. Used for manual plotting of the Peltier cooling curve.

This data can be manually graphed in spreadsheet software such as Excel to generate the same graph and Peltier cooling curve as the PSY1 software can generate after each manual measurement.

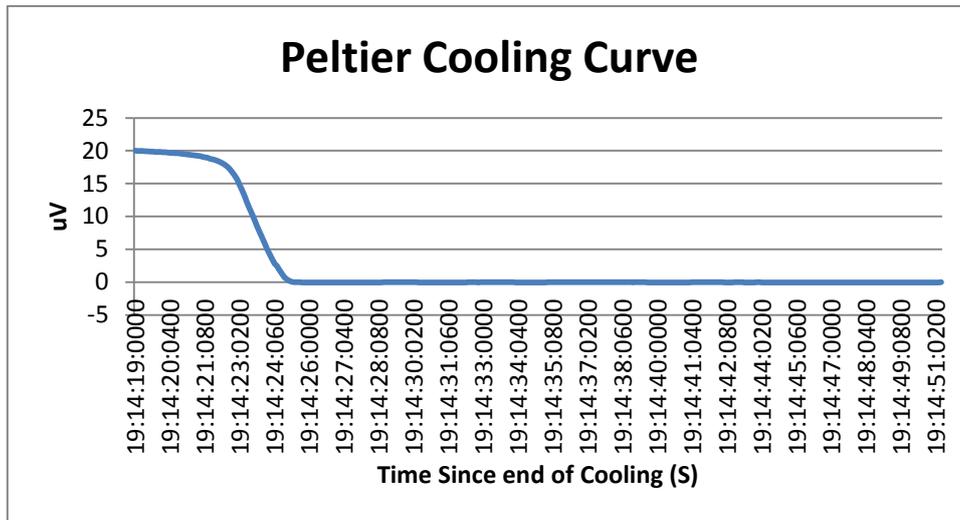


Figure 100: Peltier cooling curve manually graphed in Excel.

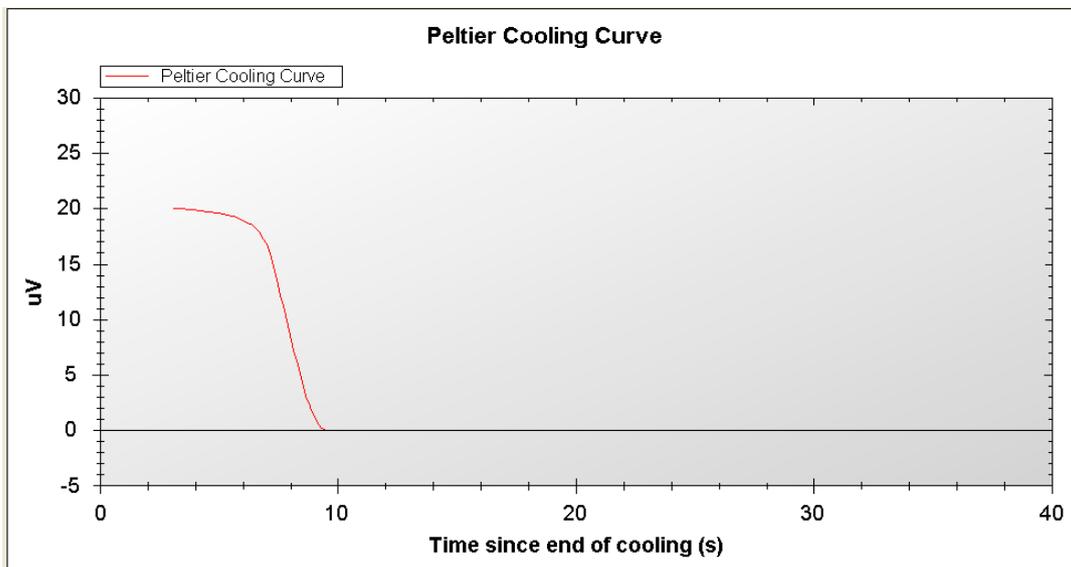


Figure 101: Peltier cooling curve automatically graphed in PSY1 software.