



# CAV<sup>®</sup> 4.2

## Dual-Bath Kinematic Viscometer



### *Operation Manual*

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## Overview

The CANNON CAV 4.2 is an automated, high throughput, dual-bath kinematic viscometer for ASTM D445. The CAV 4.2 combines CANNON<sup>®</sup> quality and reliability with modern design and unique features to enhance lab productivity, reduce costs, and improve data quality.

## Specifications/Compliances

**Table 1 — Specifications and Compliances**

Specifications	Details
Model	CAV 4.2
Methodology	ASTM D445/D446, ISO 3104/3105, IP 71
Applications	Formulated oil analysis, hydraulic oil analysis, additive analysis, marine fuel testing, base stock analysis, light and heavy fuel testing, waxes/paraffin, crude oil testing, glycols
Dimensions (W × D × H)	36 cm × 66 cm × 72 cm (14.25 in × 26 in × 28.5 in)
Weight	63 kg (140 lb)
Operational temperature range	20 °C to +100 °C (± 0.01 °C); without a TE bath cooler, the minimum temperature is +5 °C above ambient temperature Up to 150 °C (± 0.03 °C) with integrated high temperature bath Down to 15 °C (± 0.03 °C) with integrated TE bath cooler
Maximum throughput	24 tests per hour
Automated sample capacity	28 positions (2 × 14 positions)
Minimum sample/solvent volume required	8 mL sample/15 mL solvent per test
Viscosity range	0.5 mm <sup>2</sup> /s to 10,000 mm <sup>2</sup> /s in 100-fold increments (depending on viscometer tubes selected). Fast run tubes are also available.
Timing resolution	0.01 seconds (timing accuracy to ± 0.001 seconds)
Power requirements	100 VAC, 50/60 Hz, 1200 W 115 VAC, 50/60 Hz, 1200 W 230 VAC, 50/60 Hz, 1200 W
Operating conditions	15 °C to 30 °C, 10% to 75% relative humidity (non-condensing), Installation Category II, Pollution Degree 2
Compliance	CE Mark: EMC Directive (2004/108/EC); Low Voltage Directive (2006/95/EC); ROHS

## Notes/Cautions/Warnings

Notes, caution, and warnings are used in the manual to call an operator's attention to important details prior to performing a procedure or step. Read and follow these important instructions. Failure to observe these instructions may void warranties, compromise operator safety, and/or result in damage to the CAV 4.2.



**Note:** *Provides more information about the content that follows.*



**Caution:** *Alerts the operator to conditions that may damage equipment.*



**Warning:** *Alerts the operator to conditions that may cause injury.*

## Safety Precautions

- Please observe the following general safety precautions for proper and safe operation of the CAV 4.2.
- Only qualified personnel should operate the CAV 4.2.
- Make sure that you read and understand all operating instructions and safety precautions listed in this manual before installing or operating your unit. If you have questions regarding instrument operation or documentation, contact CANNON Instrument Company.
- Do not deviate from the installation, operation, or maintenance procedures described in this manual. Improper use of the CAV 4.2 may result in a hazardous situation and may void the manufacturer's warranty.
- Handle and transport the unit with care. Sudden jolts or impacts may cause damage to components.
- Observe all warning labels. Never remove warning labels.
- Never operate damaged or leaking equipment.
- Unless procedures specify otherwise, always turn off the unit and disconnect the mains cable from the power source before performing service or maintenance procedures, or before moving the unit.
- Refer all service and repairs to qualified personnel.

The **~MAINS** symbol indicates the connections for the AC power supply.  
The AC power input must match the electrical specifications of the instrument.

**~MAINS**

Never operate the equipment with a damaged MAINS AC power cable.

Use only the manufacturer-supplied MAINS AC power cable. This cable must be inserted into a receptacle with a protective earth ground.

**(O)**

The **(O)** symbol indicates the OFF position for the electrical switches for your unit.



## Getting Started

This chapter covers all steps necessary to set up, calibrate, and run a sample on the CAV 4.2. Procedures are intended to be performed in the order written. These are basic, simplified procedures that will familiarize an operator with the instrument. More detailed instructions are provided in other chapters.

### Unpack and Inspect

Unpack and inspect the complete CANNON CAV 4.2 and all accessories as soon as they are received.



**Caution:** Many components are fragile. Use caution when moving and handling the CAV 4.2 and accessories.

1. Carefully unpack the entire contents of the shipment.
2. Referring to the packaging list, verify that all materials were received. See Table 2—Table 7.
3. Inspect materials for defects and shipping damage. Contact your CANNON representative to resolve any issues.

**Table 2 — Packing List (Main Components)**

Description	Part Number
CAV 4.2	68.0229
Sample carousel (2)	68.0049 for use with glass vials 68.0564 for use with metal vials
MAINS AC power cable	Varies by locale
Dostmann digital thermometer	61.5600
Thermometer probes (2)	61.5601
CAV 4.2 Operator's Manual	68.0505

**Table 3 — Packing List (Installation)**

	Description	Part Number
Solvent	1/8" blue FEP tubing (25 ft)	81.2185
	Brass tee fittings (2)	81.0007
	Bottle caps for GL-38 bottles (4)	65.3201
	20 micron filters (4)	65.0047
Waste	1/2" white nylon tubing (15 ft)	62.1500.3
	Brass elbow	68.0309
	1/2" white nylon elbows (2)	62.1500.2
	1/2" white nylon tees (2)	62.1500.4
Exhaust	6 mm blue FEP tubing (15 ft)	81.2102

**Table 4 — Packing List (Tools)**

Description	Part Number
1/8" Allen wrench	27.1340
3/16" Allen wrench	68.0464
T-wrench	81.2222
Glass funnel	81.3112
Rubber stoppers (3)	11.3115
Tubing cutter	81.1074
Yellow Tygon tubing (2 ft)	71.4.16

**Table 5 — Packing List (Consumables)**

Description	Part Number
Sample test oils	varies
Glass vials (144 vials) (optional) Metal sleeves (14)	9717-V01: glass vials 68.0455: metal sleeves
Silicone bath fluid (2 L)	Varies by application

**Table 6 — Packing List (Networking)**

Description	Part Number
CAT cables, red (2)	61.3378
USB to Ethernet adapter	68.0496
8-port network switch	68.0495
USB cable	68.0508
USB flash drive	17.5121

**Table 7 — Packing List (Spares)**

Description	Part Number
6 A fuses (4)	28.0851
12 A fuses (4)	25.2455
Thermal fuse	68.0439
Hose fittings (2)	81.2101
Compression connectors (4)	81.2096
Brass $\frac{3}{8}$ " to $\frac{1}{4}$ " reducer fittings (2)	61.3566
O-rings (4)	61.3567

## Setup the CAV 4.2

Initial setup of the CAV 4.2 involves connecting the hoses and cables and filling the baths with silicone bath fluid. See Figure 1 and Table 8.



Figure 1 — Complete CAV 4.2 System

Table 8 — Tools and Materials Required for Setup

Description	Hose connections
Complete CAV 4.2	1/8" blue FEP tubing (25 ft)
MAINS AC power cable	1/2" white nylon tubing (15 ft)
Waste receiver	Bottle caps for GL-38 bottles (4)
Solvent	20 micron filters (4)
7/8" wrench	3/16" Allen wrench
Glass funnel	Rubber stopper
Silicone bath fluid (2 L)	Tubing cutter
Glass or metal vials	<b>Optional</b>
<b>Networking</b>	Brass tee fittings (2)
CAT cables, red (2)	Brass elbow
USB to Ethernet adapter	1/2" white elbows (2)
8-port network switch	1/2" white tees (2)
	6 mm blue FEP tubing (15 ft)

### **Connect Hoses**

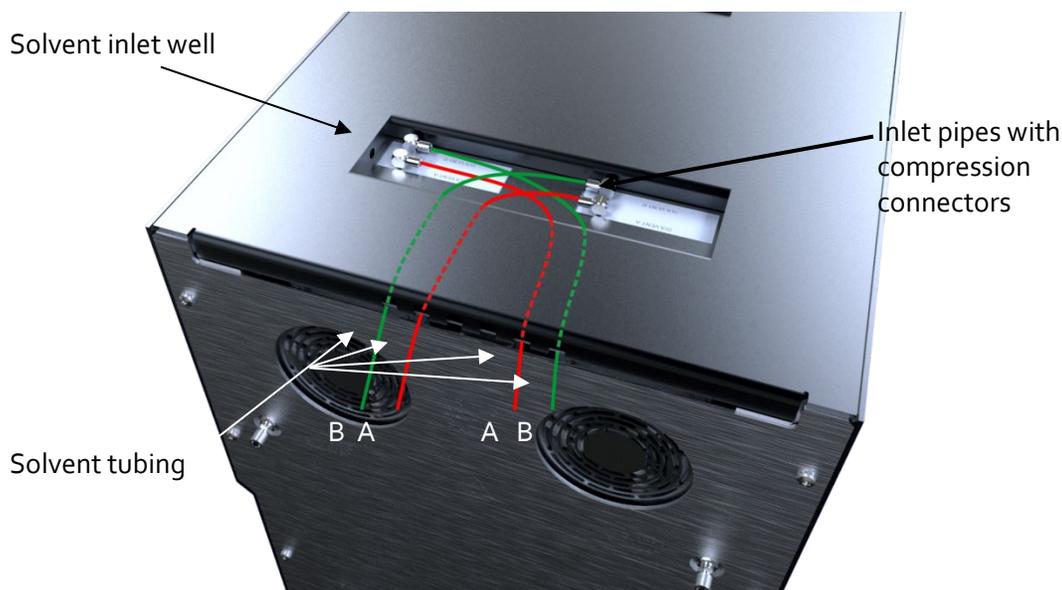
Assemble the CAV 4.2 on a secure, level surface with sufficient room behind the instrument to maintain a clear airflow and allow for unimpeded connection of the solvent inlet and waste outlet tubing. See Figure 2.



**Figure 2 — Tubing Connections**

1. Place the CAV 4.2 on a solid, level workbench. The workbench must be located near a MAINS AC power connection capable of providing sufficient current (10 A at 115 VAC) to the CAV 4.2. Depending on the materials tested, solvent used, and laboratory regulations, the work area may also need to be equipped with a ventilation system.
2. Place the waste receiver beneath the CAV 4.2. In order to promote proper drainage, the top of the waste receiver must be lower than the waste outlets on the back of the instrument.
3. Place the solvent bottles alongside or beneath the CAV 4.2.

4. Measure and cut the  $\frac{1}{8}$ " blue FEP tubing to use as the solvent tubing. Each piece of tubing must run from the solvent inlet well to the bottom of a solvent bottle.
5. Connect the solvent tubing to the CAV 4.2. See Figure 3.
  - a. Remove the cover plate from the solvent inlet well.
  - b. Thread the tubing through the solvent inlets on the back of the lid.
  - c. Unscrew the appropriate compression connector and slide it onto the tubing.
  - d. Slide the tubing onto the flared inlet pipe and hand tighten the compression connector.



**Figure 3 — Solvent Inlets**

6. Insert the solvent tubing into the solvent bottle:
  - a. Thread the tubing through the bottle cap.
  - b. Screw a 20 micron filter onto the end of the tubing.
  - c. Screw the bottle cap onto the solvent bottle.
7. Repeat steps 4 through 6 for each piece of solvent tubing.



**Note:** Each piece of tubing must run from the middle of the CAV 4.2 into the waste receiver.  $\frac{1}{2}$ " white nylon elbows and tees are provided to enable combining both waste tubes into one tube before entering the waste receiver. A brass elbow is also provided to connect the waste tubing to the waste receiver.

8. Measure and cut the  $\frac{1}{2}$ " white nylon tubing to use as the waste tubing.



**Caution:** *Do not overtighten the waste outlet compression nut.*

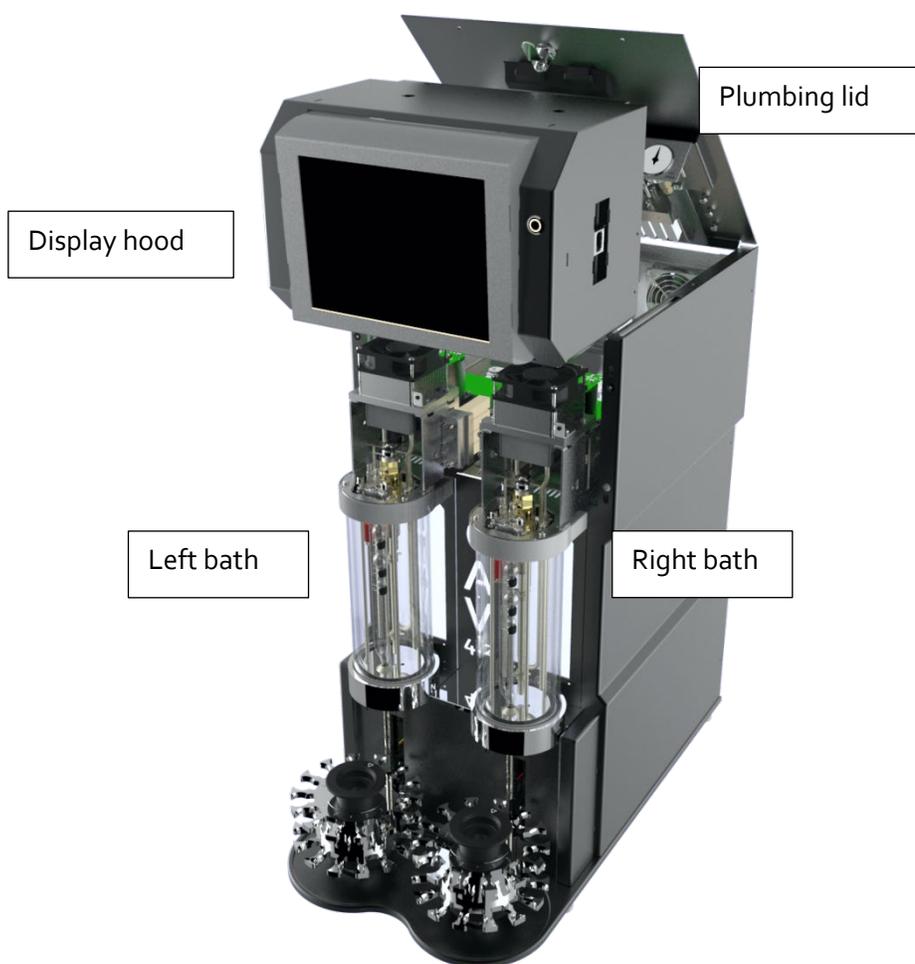
9. For each bath, connect the waste tubing to the CAV 4.2:
  - a. Unscrew the brass compression nut from the waste outlet fitting.
  - b. Thread the tubing through the compression nut.
  - c. Slide the ferrule onto the tubing. Position it  $\frac{1}{2}$ " from the end of the tubing.
  - d. Insert the tubing into the outlet fitting until the ferrule is seated.
  - e. Tighten the compression nut by hand.
  - f. Using a  $\frac{7}{8}$ " wrench, tighten the compression nut to create a good seal.
10. Connect the waste tubing to the waste receiver.
11. Measure, cut, and install the 6 mm blue FEP tubing as exhaust tubing.

### Fill Baths

Each temperature bath must be filled with Dow Corning 200 silicone fluid prior to operation. The viscosity of the fluid depends upon the temperature of the bath during most operations. See Table 9 for bath fluid selection. See Figure 4 for bath location overview.

**Table 9 — Silicone Bath Fluid Selection**

Bath Operating Range	Recommended Bath Fluid Viscosity
20 °C to 100 °C	10 cSt
101 °C to 150 °C	20 cSt



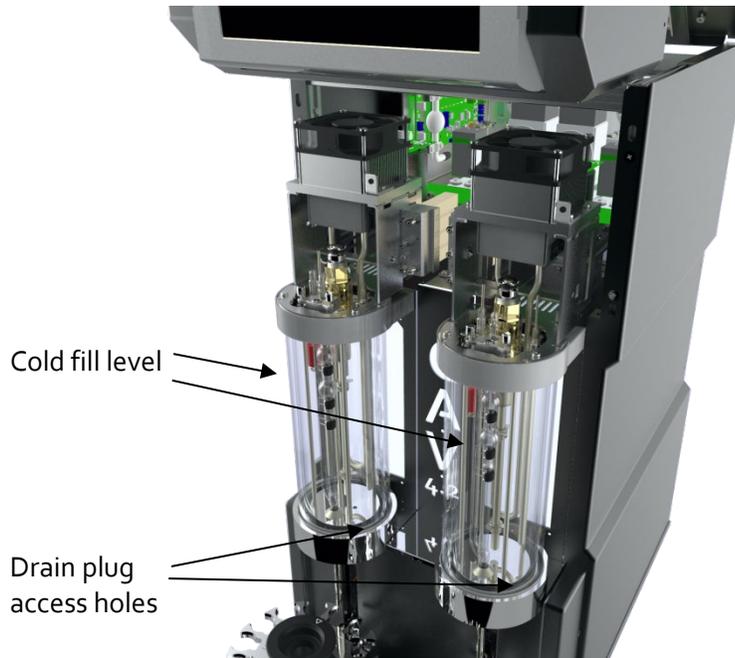
**Figure 4 — Temperature Baths**



**Warning:** Follow all lab policies regarding the safe handling and disposal of all hazardous materials.

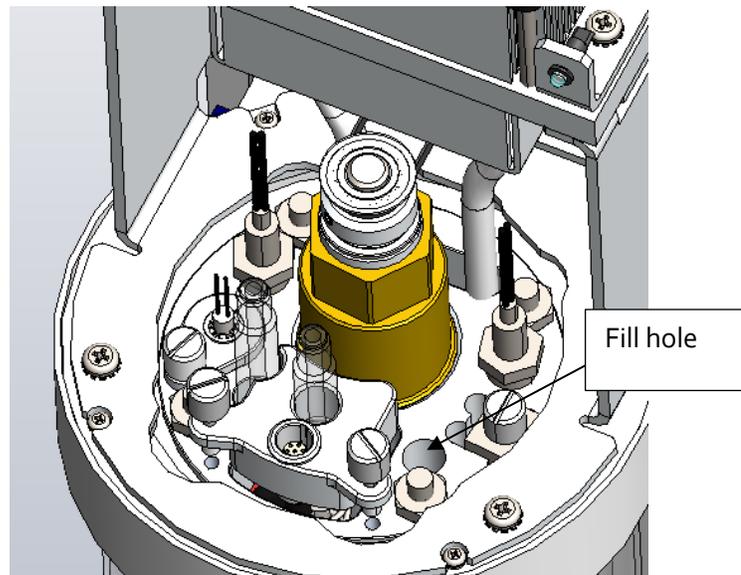
1. Open the plumbing lid.

2. Raise the display hood by pulling it forward, up, and then back in an arcing motion until the hood rests on top of the frame. Once raised, the latches will keep the hood in position.
3. Insert the  $\frac{3}{16}$ " Allen wrench into each drain plug access hole and verify that the drain plug is closed (clockwise to close). See Figure 5 for drain plug location.



**Figure 5 — Temperature Bath Details**

4. Insert the funnel into the thermometer hole in the top of the bath to be filled. See Figure 6.



**Figure 6 — Bath Top (Fill Hole)**

5. Slowly pour a small amount of silicone fluid into the bath. Check for leaks. Continue filling until the bath fluid reaches the cold fill level (marked with a thin black/red line on the glass), approximately 0.9 L.
6. Repeat steps 3 through 5 for the second bath.

### Connect Cables

1. Connect the MAINS AC power cord to the CAV 4.2.
2. Plug the power cord into the MAINS AC outlet at the work station.
3. (optional) Connect the CAV 4.2 to the network switch with one CAT cable.
4. (optional) Connect the network switch to the PC with a CAT cable and USB adapter.

### Set Bath Temperature (CAV 4.2 GUI)

Set the temperature of the baths before calibrating the instrument.

1. From the main screen, see Figure 7, click the target temperature button  for the appropriate bath. The temperature settings screen opens.

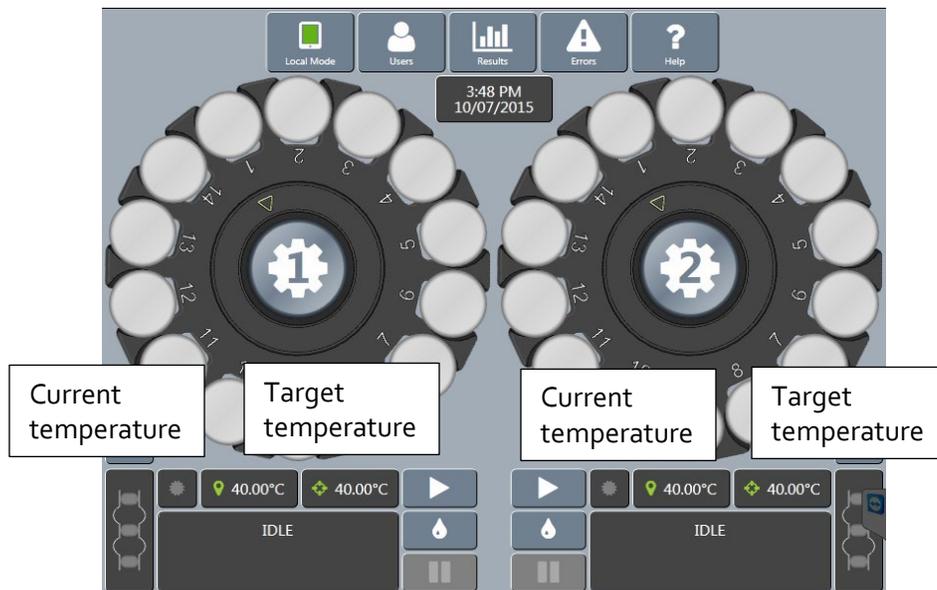
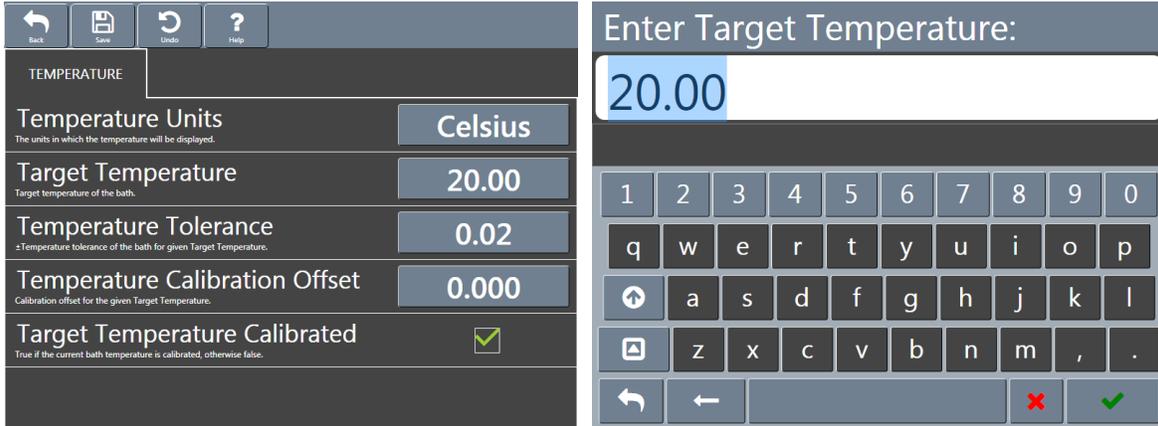


Figure 7 — Main Screen

- Click the **Target Temperature** field. A field entry screen opens. See Figure 8.



**Figure 8 — Temperature Settings Screen and Field Entry Screen**

- Enter the target temperature, then click the green checkmark to submit it and return to the temperature settings screen.
- Click **Save** and then **Back** to return to the main screen.
- Wait for the current temperature to match the target temperature.
- Repeat steps 1 through 5 for the second bath.

### Calibrate Temperature (CAV 4.2 GUI)

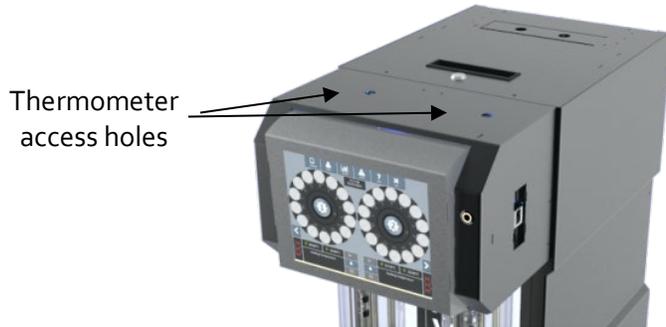
The temperature calibration of the CAV 4.2 should be verified whenever the instrument is moved, bath fluid is refilled, or a new temperature is to be used. The instrument is calibrated by inserting a thermometer through an access hole in the display hood, measuring the actual temperature of the bath fluid, and entering that temperature into the CAV 4.2 software. See Table 10 for tools and materials required.

**Table 10 — Tools and Materials Required to Calibrate Temperature**

Description
Assembled CAV 4.2
Dostmann digital thermometer
Thermometer probe

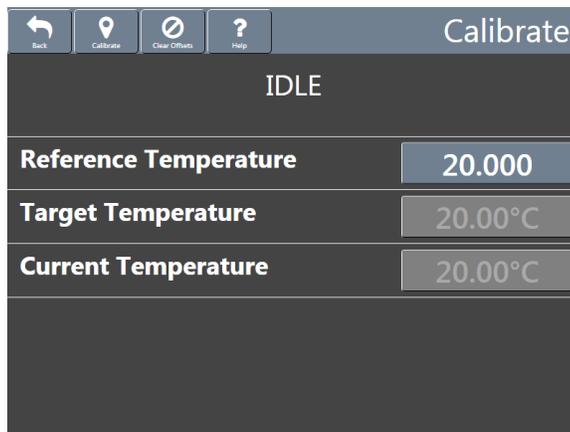
- If it is raised, lower the display hood and plumbing lid.

- Carefully insert a thermometer through the access hole in the display hood and into the bath until the tip of the thermometer is in the middle of the capillary portion of the viscometer tube. The thermometer passes through the same hole in the top of the bath unit that was used to fill the unit with fluid. See Figure 9.



**Figure 9 — Thermometer Access Holes**

- Wait for the thermometer to adjust to the temperature of the bath fluid. Read the reference temperature.
- From the main screen, click the current bath temperature button 20.00°C for the appropriate bath. The temperature calibration screen opens.
- Click the **Reference Temperature** field. See Figure 10.



**Figure 10 — Temperature Calibration Screen**

- A field entry screens opens; enter the reference temperature measured in step 3, then click the green checkmark to submit it and return to the temperature calibration screen.
- Click **Calibrate**, wait for the system to save the adjustment, and then click **Back** to return to the main screen.
- Remove and clean the thermometer.
- Repeat steps 2 through 8 for the second bath.

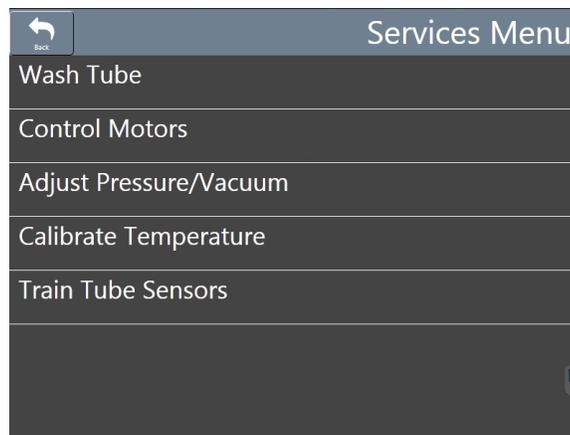
## Set Vacuum and Pressure (CAV 4.2 GUI)

Set the vacuum and pressure of the CAV 4.2 before running the instrument. Table 11 for tools and materials required.

**Table 11 — Tools and Materials Required to Set Vacuum and Pressure**

Description
Assembled CAV 4.2
Rubber stoppers

1. From the main screen, swipe the screen with left or right to move to the appropriate bath screen.
2. On the bath screen, click on the **Service** button. The services menu opens. See Figure 11.



**Figure 11 — Services Menu**

3. Click **Adjust Pressure/Vacuum**. Follow the instructions on the screen. See Figure 12.



**Figure 12 — Pressure/vacuum Adjustment Screen**

4. Click **Back** to return to the bath screen.
5. Repeat steps 1 through 4 for the second bath.

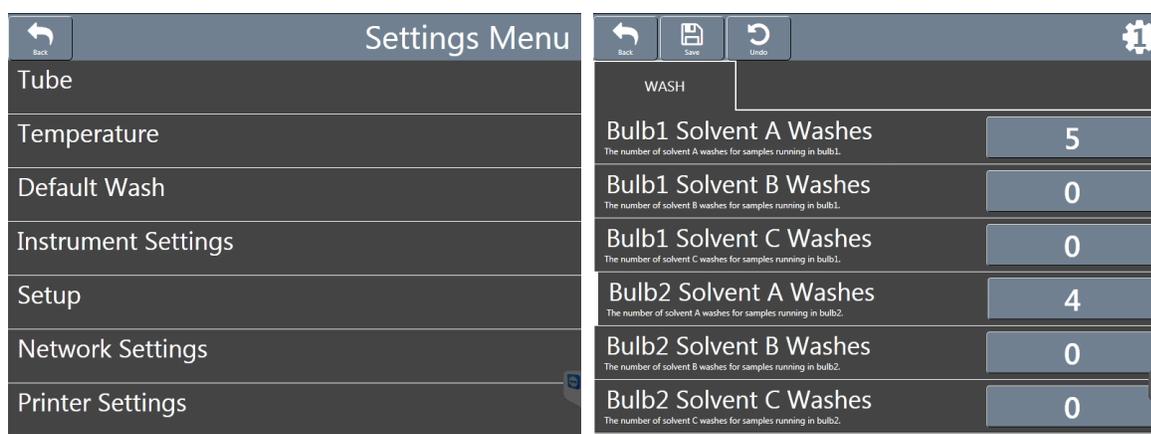
## Adjust the Default Wash Settings (CAV 4.2 GUI)

Verify and adjust the default wash settings before running a wash for the first time.



**Note:** The CAV 4.2 wash settings are defined in the method settings of the last run test. When you start the CAV 4.2 from a complete shutdown, it has no knowledge of the last run test and uses the default wash settings.

1. From the main screen, swipe the screen with left or right to move to the appropriate bath screen.
2. On the bath screen, click the **Settings** button. The settings menu opens.
3. Click **Default Wash**. The **Wash** screen opens. See Figure 13.



**Figure 13 — Settings Menu and Wash Screen**

4. Verify and adjust the wash values as necessary. To change the wash value, you must be logged onto the CAV 4.2 with appropriate privileges.
5. Click **Save** when you are done adjusting the settings.
6. Click **Back** to return to the bath screen.
7. Repeat steps 1 through 6 for the second bath.

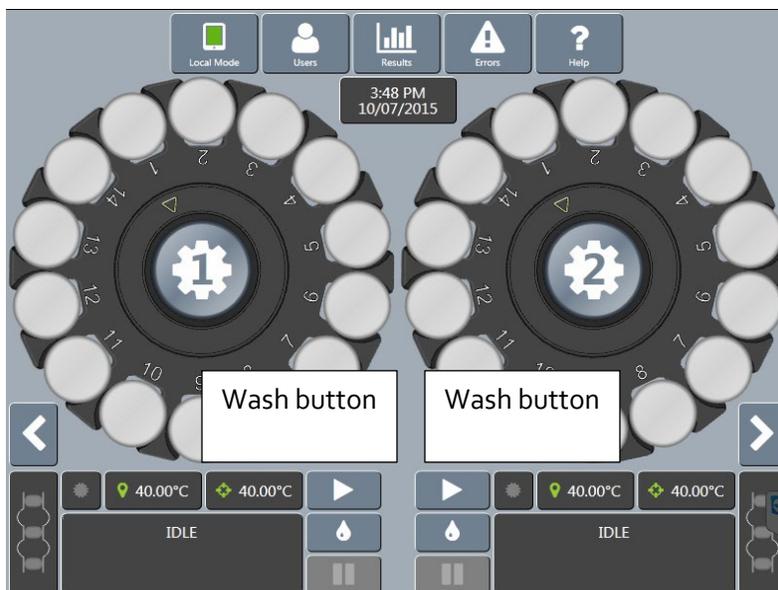
## Run a Wash (CAV 4.2 GUI)

Wash solvent through the CAV 4.2 prior to training sensors or running a test. See Table 12 for tools and materials needed.

**Table 12 — Tools and Materials Required to Run a Wash**

Description
Assembled CAV 4.2
Sample vials

1. Insert an empty vial into position 1 of the carousel for the bath to be washed.
2. From the main screen, click the wash button  for the appropriate bath. The instrument immediately starts the wash cycle. See Figure 14.



**Figure 14 — Main Screen (Wash Button)**

3. When the wash cycle is complete, repeat steps 1 and 2 for the second bath.

### Train Sensors (CAV 4.2 GUI)

Train the sensors whenever a CAV 4.2 bath is to operate at a new temperature. Once trained, the calibration values for a particular temperature are saved and will be recalled if the CAV 4.2 is set to run at that temperature again. Retraining for a particular temperature is only necessary when the viscometer tube is changed or if sensor performance changes over time. See Table 13 for tools and materials needed to train sensors.

**Table 13 — Tools and Materials Required to Train Sensors**

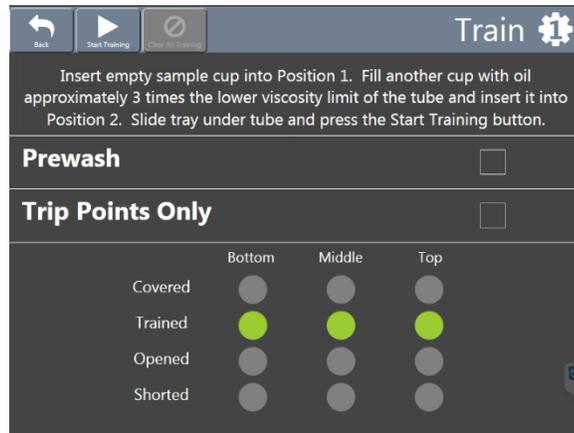
Description	Description
Assembled CAV 4.2	Sample test oil
Sample vials	Sample preparation materials



**Note:** *The viscometer tubes in each bath may have different viscosity limits. Temperature calibration must be performed first.*

1. Insert an empty vial into position 1 of the carousel for the bath to be trained.
2. Fill a vial with a test solution that has a viscosity approximately 3 times higher than the lower viscosity limit of the ubbelohde tube. Insert the vial into position 2.

- From the main screen, click the tube button  for the appropriate bath. The train screen opens. See Figure 15.



**Figure 15 — Train Screen**



**Note:** Do not check the *Prewash* or *Trip Points Only* boxes.

- Click **Start Training**.
- When training is complete, repeat steps 1 through 4 for the second bath.

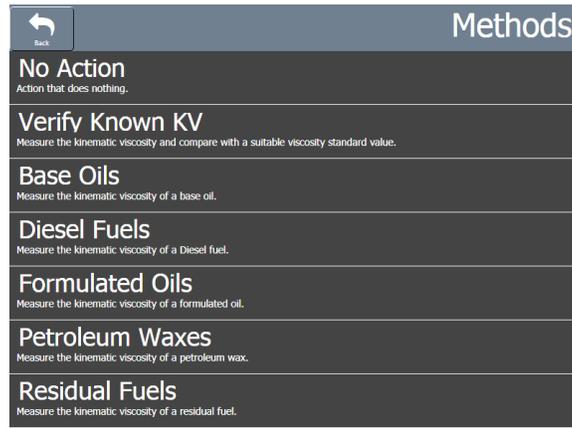
## Run a Sample Test (CAV 4.2 GUI)

This test verifies system calibration and provides a technician with basic training in operating the CANNON CAV 4.2. See Table 14 for tools and materials required.

**Table 14 — Tools and Materials Required to Run a Sample Test**

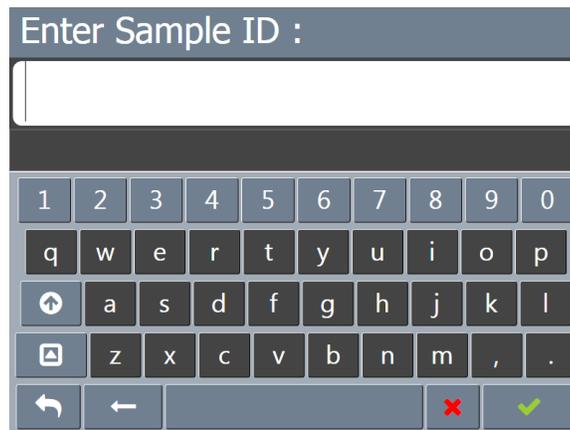
Description	Description
Assembled CAV 4.2	Sample test oil
Sample vials	Sample preparation materials

1. Following your laboratory practices, prepare a 10 mL sample of test oil in the provided sample vials, and then insert the sample vial into position 1 of the appropriate carousel.
2. From the main screen, click the circle representing position 1 on the appropriate bath. The methods screen opens. See Figure 16.



**Figure 16 — Methods Screen**

3. Click **Verify Known KV**. The field entry screen opens. See Figure 17.



**Figure 17 — Verify Known KV Field Entry Screen**

4. Enter the sample ID, then click the green checkmark to submit it. Another field entry screen opens.

5. Enter the viscosity value (in cSt) of the test oil, then click the green checkmark to submit it and return to the main screen.
6. Click the run button .
7. When the test is complete, click the **Results** button to review the test results.

### Review and Export Data (CAV 4.2 GUI)

Once a test completes, the results can be exported to a USB drive in CSV format.

1. From the main screen, click the **Results** button.
2. Review the results.
3. Click the **Export** button. A field entry screen opens.
4. Enter the sample filename, then click the green checkmark to submit it. A **Save As** window opens.
5. Select the location to which to save the data file, then click **Save**



## Connecting with VISCPRO II

The CAV 4.2 ships from CANNON ready for deployment on a dedicated, closed network.<sup>1</sup> Figure 18 displays the default settings for the closed network.

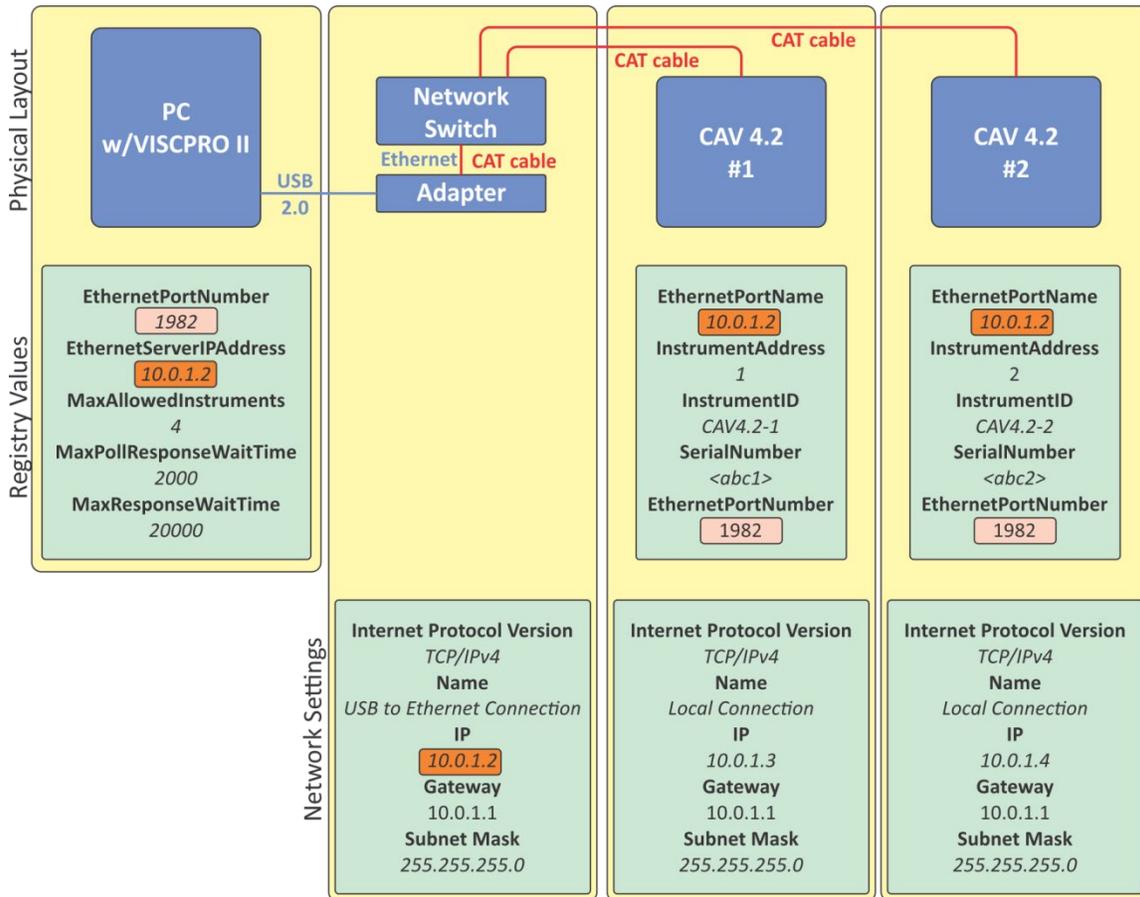


Figure 18 — Closed Network Settings

<sup>1</sup> For other network configurations, please contact the CANNON service department.

## Connect Equipment

All CAV systems and the PC (with USB 2.0 to Ethernet adapter) connect to the network switch using standard CAT 5e/6 cables. See Table 15.

**Table 15 — Tools and Materials Required to Connect Equipment**

Description	Description
Assembled CAV 4.2	CAT cables, red (1 + 1 per CAV 4.2)
USB flash drive with VISCPRO II installation software and drivers	USB to Ethernet adapter
PC with Windows® 10	8-port network switch

1. Start and log onto the PC.
2. Plug the USB to Ethernet adapter into a USB 2.0 port on the PC. Windows® will attempt to automatically install the required drivers. If necessary, a copy of the driver is provided on the USB flash drive.
3. Connect a CAT cable from the Ethernet adapter to the network switch.
4. Connect CAT cables from each CAV 4.2 to the network switch.

## Install VISC PRO II

There are no configurable options in the VISC PRO installation routine.

1. Uninstall any previous version of VISC PRO software.
2. Insert the USB drive into an open USB port on the PC.
3. Run **USB Flash Drive > VISC PRO > setup.exe**.

Table 16 provides the registry keys that are set to default values during installation of VISC PRO. You cannot edit them from within the VISC PRO software. The only way to change these values is by directly editing the registry.



**Caution:** *Editing registry entries may be hazardous to the health of your Windows® installation.*

**Table 16 — VISC PRO II Registry Entries**

Registry Key	Default value	Description
EthernetPortNumber	1982	TCP port on which VISC PRO listens
EthernetServerIPAddress	10.0.1.2	IP address of the Ethernet connection that VISC PRO uses
MaxAllowedInstruments	4	Maximum number of instrument to which VISC PRO will connect. VISC PRO polls for instruments in sequential order of the InstrumentAddress. Once the maximum number of allowed instrument has been reached, it stops polling.
MaxPollResponseWaitTime	2000 (2 seconds)	Maximum time in milliseconds that VISC PRO waits for an instrument response when polling.
MaxResponseWaitTime	20000 (20 seconds)	Maximum time in milliseconds that VISC PRO waits for an instrument response.

## Set Up Network Adapter

1. Open **Network and Sharing Center** on the PC.
2. Click **Change adapter settings**. The **Network Connections** window opens. Right-click the device associated with the USB adapter, and rename the connection **USB To Ethernet Connection**. See Figure 19.



Figure 19 — Network Connections

3. Right-click the connection and select **Properties**. The **Connection Properties** window opens. See Figure 20.

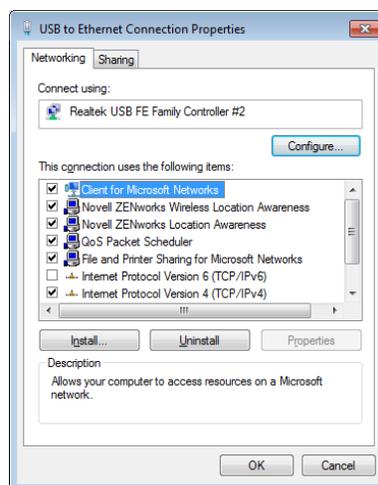
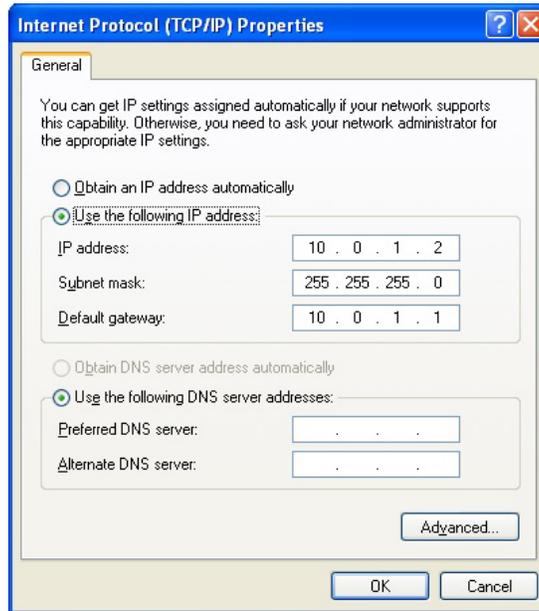


Figure 20 — Connection Properties

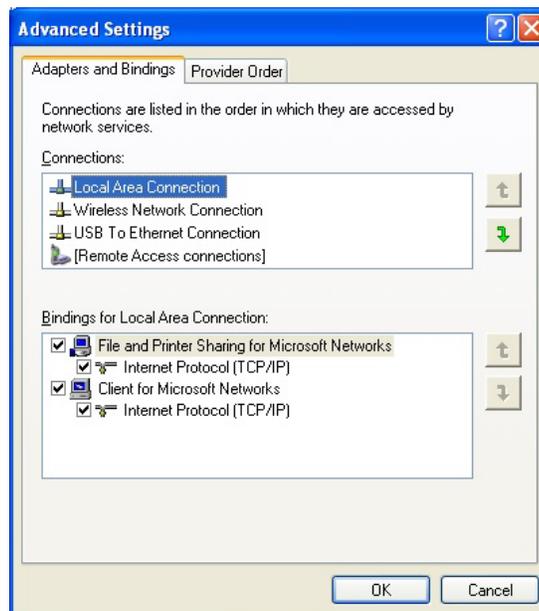
4. Click **Configure**. The **Controller Properties** window opens.
5. Select the **Power Management** tab. Uncheck **Allow the computer to turn off this device to save power**. Click **OK**.
6. Right-click the connection and select **Properties**. The **Connection Properties** window opens.
7. Uncheck **Internet Protocol Version 6 (TCP/IPv6)**.

8. Double-click **Internet Protocol Version 4 (TCP/IPv4)**. The **Internet Protocol (TCP/IP) Properties** window opens. See Figure 21.



**Figure 21 — TCP/IP Properties**

9. Set the IP address to **10.0.1.2**, the subnet mask to **255.255.255.0**, and the default gateway to **10.0.1.1**, then click **OK** to close the **Internet Protocol (TCP/IP) Properties** window.
10. Click **OK** to close the **Properties** window.
11. In the top **Network Connections** menu bar, click **Advanced > Advanced Settings**. See Figure 22.



**Figure 22 — Advanced settings**

12. Move the **USB to Ethernet Connection** to the last connection position. Click **OK**.

## Configure Firewall Rules

The Windows® Firewall on the PC on which VISCPRO is installed must be configured to permit inbound, outbound, and ping communications on port 1982 (default).

1. If necessary, close VISCPRO.
2. Open **Control Panel > Windows Firewall > Advanced Settings**. This opens the **Windows Firewall with Advanced Security** window.
3. Configure an inbound rule:
  - In the upper left corner, click **Inbound Rules**.
  - In the upper right corner under **Actions**, click **New Rule**.
  - Select **Port**. Click **Next**.
  - Select **TCP** and **Specific local ports**. Enter **1982** in the port field.
  - Select **Allow the connection**. Click **Next**.
  - Check all boxes: **Domain**, **Private**, and **Public**. Click **Next**.
  - In the **Name** field, enter **Viscprom\_IN**. Click **Finish**.
4. Configure an outbound rule:
  - In the upper left corner, click **Outbound Rules**.
  - In the upper right corner under **Actions**, click **New Rule**.
  - Select **Port** and click **Next**.
  - Select **TCP** and **Specific local ports**. Enter **1982** in the port field.
  - Select **Allow the connection**. Click **Next**.
  - Check all boxes: **Domain**, **Private**, and **Public**. Click **Next**.
  - In the **Name** field, enter **Viscprom\_Out**. Click **Finish**.
5. Configure on inbound rule to respond to ping requests:
  - In the upper left corner, click **Inbound Rules**.
  - In the upper right corner, under **Actions**, click **New Rule**.
  - Select **Custom**. Click **Next**.
  - Select **All programs** and click **Next**.
  - Change **Protocol Type** to **ICMPv4**.
  - Click **Customize**.
  - Select **Specific ICMP types**.

- Check **Echo Request** and click **OK**. Click **Next**.
  - Select both **Any IP address** boxes. Click **Next**.
  - Select **Allow the connection**. Click **Next**.
  - Check all boxes: **Domain**, **Private**, and **Public**. Click **Next**.
  - In the **Name** field, enter **Ping In**. Click **Finish**.
6. Configure on outbound rule to send ping requests:
- In the upper left corner, click **Outbound Rules**.
  - In the upper right corner, under **Actions**, click **New Rule**.
  - Select **Custom**. Click **Next**.
  - Select **All programs** and click **Next**.
  - Change **Protocol Type** to **ICMPv4**.
  - Click **Customize**.
  - Select **Specific ICMP types**.
  - Check **Echo Request** and click **OK**. Click **Next**.
  - Select both **Any IP address** boxes. Click **Next**.
  - Select **Allow the connection**. Click **Next**.
  - Check all boxes: **Domain**, **Private**, and **Public**. Click **Next**.
  - In the **Name** field, enter **Ping Out**. Click **Finish**.
7. Close the **Windows Firewall with Advanced Security** window.

## Configure USB Power Settings

The Windows® Firewall on the PC on which VISCPRO is installed must be configured to constantly provide power to the USB port for the **USB to Ethernet adapter**.

Hints:

- Under **Control Panel > Power Options**, select **Change plan settings** for your power plan. Select **Change advanced power settings**:
- Under the **Hard Disk > Turn off hard disk after**, change the setting to **Never**.
- Under the **USB settings > USB selective suspend setting**, change the setting to **Disabled**.
- Under **Device Manager > Universal Serial Bus controllers**, double-click on the appropriate USB hub, select the **Power Management** tab, and uncheck **Allow the computer to turn off this device to save power**.

## CAV Registry Settings

The registry keys in Table 17 are set up at CANNON prior to shipping and should not need to be adjusted for the initial installation. However, when reconfiguring a network or adding an additional CAV 4.2 to your setup, you may need to change the **Instrument Address** and **Instrument ID** to avoid device collision. These values and the **Remote Client Name** can be editing from within the CAV 4.2 GUI. Other values can only be changed by directly editing the registry.



**Caution:** *Editing registry entries may be hazardous to the health of your Windows® installation.*

**Table 17 — CAV 4.2 Registry Entries**

Registry Key	CAV 4.2 GUI	Default value	Description
EthernetPortName	Remote Client Name <sup>2</sup>	10.0.1.2	IP address of the Ethernet connection to which the instrument connects
InstrumentAddress	Instrument Address <sup>2</sup>	1-4	Numeric address for the instrument
Instrument ID	Instrument ID <sup>2</sup>	4	Instrument name
Serial Number	Serial Number <sup>3</sup>	Text string	Instrument serial number
EthernetPortNumber	Not available	1982	TCP port on which VISCPRO listens

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<sup>2</sup> On either bath screen, click **Settings > Instrument Settings** to access these entries.

<sup>3</sup> On either bath screen, click **Settings > Setup** to access this entry.



## Operation

The CAV 4.2 can be operated in either local or remote mode through a pair of software programs. In **Local Mode**, the CAV 4.2 GUI (graphical user interface) software program controls the instrument, while in **Remote Mode** a separate computer with the VISCPRO II software program installed controls it. Each of these programs is independent of the other and maintains its own data set, where a data set consists of a run of tests, test results and error logs. Common instrument settings, method templates, and equipment status are shared between the programs.

The operating status of the CAV 4.2 is shown on the left-most button of the main screen menu of the CAV 4.2 GUI. This button toggles between **Local Mode** and **Remote Mode**. A green icon indicates that the instrument is connected to VISCPRO II. In **Remote Mode**, the **Users**, **Results**, and **Errors** action buttons are grayed to indicate that instrument operation cannot be managed from the CAV 4.2 GUI. See Figure 23.

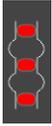


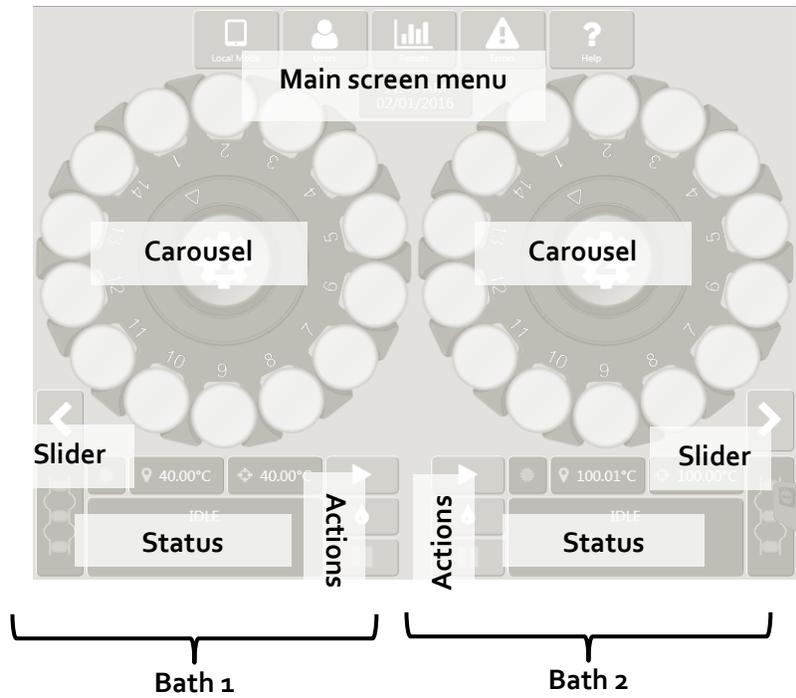
Figure 23 — Main Menu Screen

### CAV 4.2 GUI

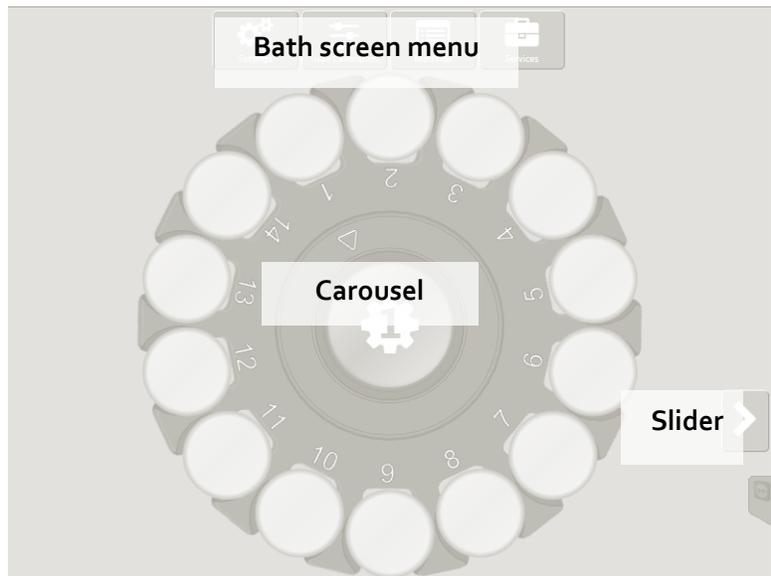
The CAV 4.2 GUI is the software program shown on the touch-screen embedded in the display hood of the CAV 4.2. The **Getting Started** chapter of this manual introduces the operator to the basic usage of the CAV 4.2 GUI. This chapter provides more in-depth instructions. Table 18, Figure 24, and Figure 25 provide an overview of the GUI screens.

**Table 18 — GUI Screen Details**

Area	Button	Action
Main screen menu	Local/Remote Mode	Toggles between control modes.
	Users	Opens login menu.
	Results	Opens local results log.
	Errors	Opens local errors log.
	Help	Opens help menu.
Bath screen menu	Settings	Opens settings menu.
	Tube Calibration	Opens tube calibration menu.
	Methods	Opens methods menu.
	Services	Opens services.
Carousel	Positions 1 – 14	Each position displays the title of the sample. Click to configure a sample. Click center of carousel for bath options.
Screen sliders	Left/right arrows	Slides between screens.
Status	Sensors 	Displays the status of the bath sensors. Red – unavailable Green – covered; Gray – uncovered Click to train sensors.
	TE Cooler 	Displays the status of the TE cooler. Click to turn on/off the TE cooler.
	Current temperature 	Displays the current bath temperature. Click to calibrate temperature.
	Target temperature 	Displays the target temperature. Click to set target temperature.
	Activity message	Displays current activity.
	Preheater temperature	Displays current preheater temperature.
Actions	Run/Stop 	Click to start or stop a run.
	Wash 	Click to run a wash.
	Pause 	Click to pause a run or wash.



**Figure 24 — Main Screen**



**Figure 25 — Bath Screen**

## VISCPRO® II Software Interface

VISCPRO II is a Windows® software program comprising the general interface application and instrument/analysis-specific modules. Figure 26 shows a typical VISCPRO II interface with an open instrument window, analysis log, application specific status window, and general information status windows. Table 19 provides description for window details.

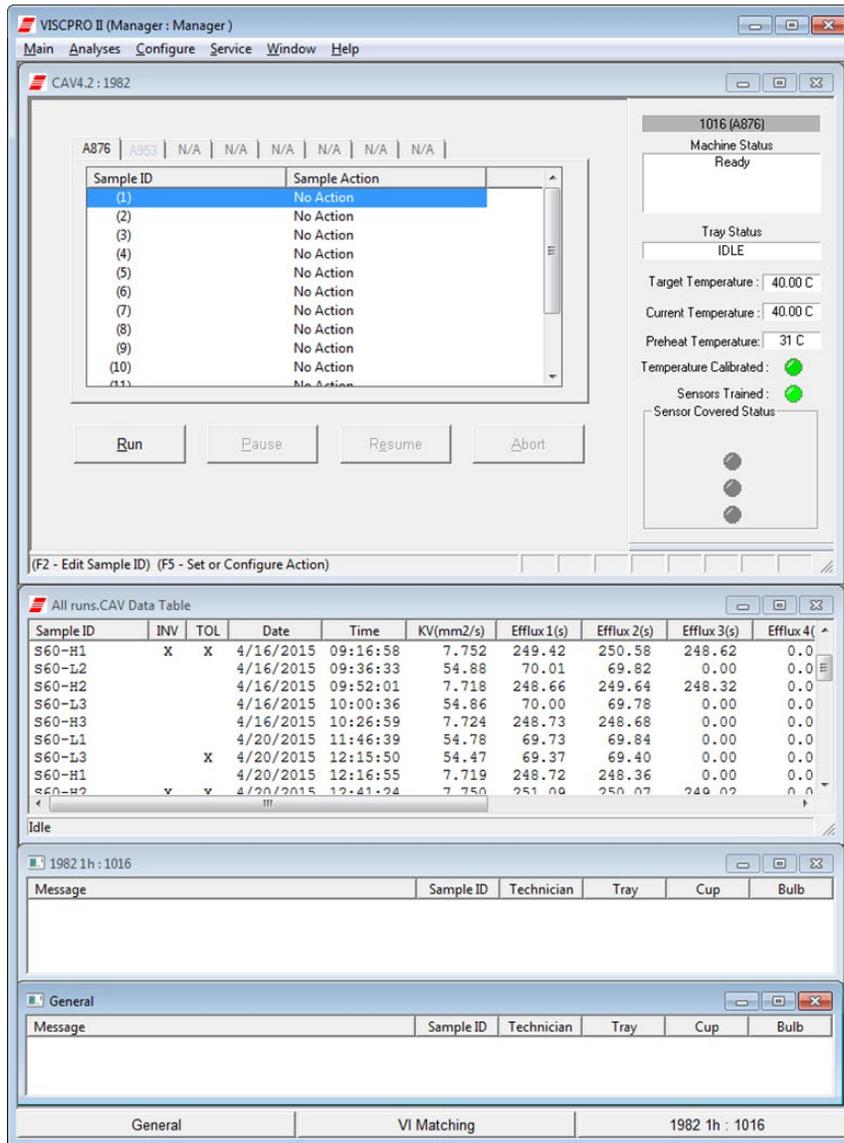


Figure 26 — VISCPRO Interface Window

**Table 19 — VISCPRO Window Details**

Area	Detail	Click to open a window for ...
VISCPRO II Menu	Main	... managing the VISCPRO application.
	Analyses	... displaying, configuring, and managing analysis logs.
	Configure	... configuring the settings of attached instruments.
	Service	... servicing an attached instrument.
	Window	... managing the open windows.
	Help	... managing VISCPRO help.
CAV 4.2 Instrument Window	Use this window to view the status of the instrument and manage sample test runs.	
Analysis Log	Displays a specific analysis report.	
Information Status Bar	General	Click to open the general information status window.
	VI Matching	Click to open the VI Matching information status window.
	< <i>instrument</i> >	Click to open a status window for a particular instrument.

## Manage User Accounts (VISCPRO II/CAV 4.2 GUI)

VISCPRO II and CAV 4.2 GUI user accounts are independent of each another. The VISCPRO II accounts are associated with the entire software installation and are not instrument specific.

Both VISCPRO II and the CAV 4.2 GUI start with three default accounts. See Table 20.

**Table 20 — Default User Accounts**

Username	Privilege level	Privileges
CANNON Instrument Company Inc	Service	Access to all instrument and security parameters. Call CANNON for the current login and password
Manager	Manager	Access to advanced configuration and reporting options
Unknown	Technician	Access to operational features required for testing samples and routine operations

VISCPRO II displays the username and privilege level of the active user in the title bar of the main window. If no user is logged in, VISCPRO II displays the default account (**Unknown: Technician**). The CAV 4.2 GUI does not display login status.

### Log In

Log in as soon as possible to avoid problems. You can log in as another user even if you are already logged in.



**Note:** *The initial password for the Manager account is blank.*

1. For **VISCPRO II**: click **Main > Log In...** The **Log In** window opens.  
For **CAV 4.2 GUI**: click **Users**. The **Login Menu** window opens.
2. Select the appropriate user. Type the corresponding password.
3. Click **OK**.

### Change Password

In order to change a password, you must be logged in as the user whose password you are changing. However, in VISCPRO II a user with a higher privilege level may assign a new password by editing a user account.

1. For **VISCPRO II**: click **Main > Change Password ...** The **Change Password** window opens.  
For **CAV 4.2 GUI**: click **Users > Change Manager Password**. Because new accounts cannot be created using the CAV 4.2 GUI, this is the only option.
2. Type your new password into the appropriate fields.
3. Click **OK** or the green checkmark.

### Setup and Edit User Accounts

(VISCPRO II only) Service level users can setup and edit manager and technician accounts. Manager level users can setup and edit only technicians. The default account may not be edited.

1. Click **Main > Update User Information ...**. The **Change User List** window opens.
2. Select the appropriate user. To create a new user, type a unique user name.
3. To assign a password to a user, type the password into the appropriate fields.
4. To assign a privilege level, select the appropriate level in the drop-down box.
5. To save changes click **Add or Update User**.
6. To close the **Change User List** window, click **Done**.
7. To delete the user record from the database, click **Remove User**.

### Logout

It is not necessary to logout in order to change user accounts. Logout does not close VISCPRO II. It changes the login to the default (**Unknown: Technician**) account.

- For **VISCPRO II**: click **Main > Logout**.
- For **CAV 4.2 GUI**: click **Users > Logout**.

### Connect VISCPRO II to the CAV 4.2

VISCPRO II and the CAV 4.2 must be set up and communicating prior to attempting to establish a connection. Refer to Connecting with VISCPRO II for instructions.

1. Start VISCPRO II on the PC.
2. On the **CAV 4.2 GUI**, touch the **Local Mode/Remote Mode** button to toggle the instrument state. The icon will turn green to indicate that the CAV 4.2 has found VISCPRO II.
3. In the VISCPRO II Menu, click **Main > Poll for Instruments**. If an instrument is located, an associated message box will be added to the status bar on the bottom of the VISCPRO II window.



**Note:** *CAV 4.2 are grouped according to the Ethernet port number on which they communicate. Since VISCPRO II can only communicate on one Ethernet port at a time, there will be only one group of CAV 4.2 instruments.*

4. Click **Main > View Instrument** and select the CAV 4.2 instrument group. The CAV 4.2 Instrument Window opens.



**Caution:** *When multiple instruments (CAV 2100/2200, miniAV, CAV 4.2) are connected to the same instance of VISCPRO II, verify that all instruments have completed their current operations before closing VISCPRO II.*

## Set Bath Temperature (VISCPRO II)

1. In the VISCPRO II Menu, select **Configure** > *[instrument group]* > *[instrument]* > **Tray Settings: Temperature**.
2. Adjust the **Temperature Units**, **Target Temperature**, and **Temperature Tolerance** as necessary.
3. Click **Save**; wait for the system to save the changes, and then click **Close**.
4. Wait for the bath to adjust to the new temperature.



**Note:** *Temperature calibration, vacuum and pressure adjustment, and sensor training can easily be performed directly from the CAV 4.2 GUI. Refer to **Getting Started** for more information.*

## Calibrate Temperature (VISCPRO II)

Calibrate the temperature of the CAV 4.2 whenever the instrument is moved, a new bath temperature is to be used, or the bath fluid is refilled. The instrument is calibrated by inserting a thermometer through an access hole in the display hood, measuring the actual temperature of the bath fluid, and entering that temperature into the CAV 4.2 software.

1. If it is raised, lower the display hood and plumbing lid.
2. Carefully insert a thermometer through the access hole in the display hood and into the bath until the top of the thermometer is in the middle of the capillary portion of the viscometer tube. The thermometer passes through the same hole in the top of the bath unit that was used to fill the unit with fluid.
3. Wait for the thermometer to adjust to the temperature of the bath fluid. Read the reference temperature.
4. In the VISCPRO II Menu, select **Service** > *[instrument group]* > *[instrument]* > **Temperature Calibration**. The Temperature Calibration window opens.
5. Enter the reference temperature measured in step 3 in the **Reference Temperature** field.
6. Click **Calibrate**; wait for the system to save the adjustment, and then click **Done** to close the window.
7. Remove and clean the thermometer.
8. Repeat steps 2 through 7 for the second bath if necessary.

## Set Vacuum and Pressure (VISCPRO II)

Set the vacuum and pressure of the CAV 4.2 before running the instrument.

1. In the VISCPRO II Menu, select **Service** > *[instrument group]* > *[instrument]* > **Adjust Vacuum/Pressure**.
2. Follow the instructions on the screen to set the vacuum, then the pressure for each bath.

## Train Sensors (VISCPRO II)

Train the sensors whenever the CAV 4.2 bath is to operate at a new temperature. Once trained, the calibration values for a particular temperature are saved and will be recalled if the CAV 4.2 is set to run at that temperature again. Retraining for a particular temperature is only necessary when the viscometer tube is changed or if sensor performance changes over time.



**Note:** *Sensor training uses **Test and Advanced** settings from the default method, but **Default Wash** settings.*

1. Insert an empty vial into position 1 of the carousel for the bath to be trained.
2. Fill a vial with a test solution that has a viscosity approximately 3 times higher than the lower viscosity limit of the ubbelohde tube. Insert the vial into position 2.
3. In the **VISCPRO II Menu**, select **Service > [instrument group] > [instrument] > Train viscometer tube sensors**. The **Train viscometer tube sensors** window opens.
4. (Optional) Check **Prewash** to run a wash cycle prior to training sensors.
5. (Optional) Check **Trip Points Only** to skip adjusting the power levels of the sensors.
6. Click **Start**.
7. When training is complete, repeat this procedure for the second bath if necessary.

## Run a Wash (VISCPRO II)

When necessary, washes may be run independent of a sample test.

1. In the **VISCPRO II Menu**, select **Service > [instrument group] > [instrument] > Wash viscometer tube**.
2. Select the tube to wash.
3. Select whether to use wash parameters from the last sample run or use default wash parameters.
4. The initial cup evacuation can be bypassed by checking the appropriate box.
5. Click **Begin Wash**.

## Run a Sample Test (VISCPRO II)

This procedure details how to run and configure various kinematic viscosity tests on the CAV 4.2 using VISCPRO II software.

1. Verify that the CAV 4.2 is running and has achieved steady-state temperature in each bath to be used.
  - The status window displays **IDLE**. During warmup, **SEEKING TEMPERATURE** will be displayed.

- The current temperature and target temperature icons are green, indicating that the bath has been temperature calibrated at that temperature. If any other condition is indicated, refer to **Calibrate temperature**.
  - The tube sensor icons are all grey, indicating that the sensors are trained and uncovered. If any other condition is indicated, refer to **Train sensors**.
2. Connect VISCPRO II to the CAV 4.2:
    - a. Start **VISCPRO II** on the PC.
    - b. On the **CAV 4.2 GUI**, touch the **Local Mode/Remote Mode** button to toggle the instrument state. The icon will turn green to indicate that the CAV 4.2 has found **VISCPRO II**.
    - c. In the **VISCPRO II Menu**, click **Main > Poll for Instruments**. If an instrument is located, an associated message box will be added to the status bar on the bottom of the **VISCPRO II** window.
    - d. Click **Main > View Instrument** and select the CAV 4.2 instrument group. The **CAV 4.2 Instrument** window opens.



**Note:** *Do not overfill the vials or your sample may overflow when the vial is raised into position and the viscometer tube displaces some sample.*

3. Follow your laboratory practices to prepare 10 mL samples and load the vials into the carousel. 10 mL is half a vial.
4. Populate the sample run in VISCPRO II:
  - a. In the **CAV 4.2 Instrument** window, click on the tab corresponding to the desired CAV 4.2 tray.
  - b. **Left-click** on the first tray position that is populated with a sample. The entire entry highlights blue.
  - c. **Left-click** the **Sample ID** field and enter a short description for the sample. Press **Enter**. The **Sample Action** field is populated with the default action ("Method") associated with the viscometer tube.  
  
If the default action is **Verify Known KV**, the **Sample Configuration** window opens automatically. Enter the kinematic viscosity value (cSt) of the sample as the **Parameter Value** of **Check Standard KV**. When finished, click **Save**, and then **Close**.
  - d. Continue entering data in the remaining positions. Press ESC to stop entering data.
5. To edit or customize the sample action for a particular tray position, right-click anywhere on the row to open the editing menu.
  - **Shift-left-click**—to select a contiguous range of entries.
  - **Ctrl-left-click**—to select multiple entries.

- **Configure**—enables editing of all values for the selected entry. These localized changes do not affect the default values of the sample action ("Method").
- **Sample Actions**—selecting a new action (method template) will replace the existing action. All localized changes will be lost.
- **Delete**—deletes the selected entry. All following positions are decreased one place.
- **Insert At**—inserts a new entry into the carousel at the active position. All following positions are advanced one place.
- **Copy All Selected Samples**—copies selected entries to the clipboard.
- **Paste Into Selected Samples**—pastes all entries that were copied to the clipboard into the carousel, only at the highlighted positions. This is not an "insert" action. Existing entries are overwritten, not moved.

**Note:** *Other actions—several additional actions are available from the right-click editing menu:*

- **Sequential Sample IDs**—use this action to populate sequential Sample ID fields.
- **Clear All Trays**—clears all entries from all trays
- **Save Tray to Archive**—saves the current tray (carousel) to an archive file. Each saved tray is associated with a specific bath. You cannot save a tray for bath 1 and load it into bath 2. However, you can copy the complete set of entries from one tray to another.
- **Restore Tray from Archive**—restores a previously saved tray.
- **Delete Tray from Archive**—opens the archive to allow deleting saved trays.



6. Click **Run**. The **Select Trays** window opens.
7. Select the trays to run. Click **OK**. The CAV 4.2 begins running the selected trays. Additional samples may be added to the trays until the run completes.
  - **Pause**—opens a selection window. Pausing a tray "Now" immediately halts all actions for that tray. If a test is halted prior to the start of the wash cycle, the data for that sample is discarded.
  - **Resume**—opens a selection window to resume operation for selected trays.
  - **Abort**—opens a selection window to abort all activity for selected trays.
8. When each test completes, the measured KV is shown in the **Sample Action** field. Once the entire test run finishes, the tray pauses. No additional samples may be added to the run. Click **Resume** to clear all data for the active tray.

## View Test Results (VISCPRO II)

Data obtained during sample testing is temporarily displayed in the **Sample Action** field and permanently stored in the data base, which may be viewed by opening an analysis package.

Tests must finish running before they can be viewed. The entire tray does not need to have finished, but individual results are only available in the database after they have completely finished running.

1. In the **VISCPRO II Menu**, select **Analyses > View Analysis**. The **Choose Analysis** window opens.
2. Open **Basic Package** and select **CAV Data Table**.
3. Select the **Open Select Analysis Configuration** radio button.
4. Select an analysis and click **OK**.

## Control Preheaters

The preheaters are associated with the sample test. Preheater settings can be modified by editing the configuration of a specific sample test or editing the test method template. See Table 21.

**Table 21 — Preheater Settings**

Parameter name	Description
Preheat Type	No preheat <b>Minimum preheat</b> starts the preheat cycle as soon as the previous sample begins running and runs for at least the set preheat time. <b>Serialized preheat</b> starts the preheat cycle after the previous sample finishes and runs for exactly the set preheat time.
Minimum Preheat Time	This is the time that the preheater is applied to the sample.
Preheat Temperature Units	Select either Fahrenheit or Celsius.
Preheat Temperature	Fahrenheit: 0 °F to 437 °F; Celsius: 0 °C to 225 °C The heater temperature is determined by the <b>Preheat Temperature</b> setting of the sample that is in the preheat position, even if that sample is set to <b>No preheat</b> . Set the temperature to 0 (zero) to turn off the heater.

## Control Sample Cup Heaters



**Note:** You must be logged onto the GUI or into VISCPRO as a manager in order to change tray/tube settings.

The sample cup heaters assist in maintaining sample temperature during a run and in improving the efficiency of the wash cycle. They are associated with the tray/tube settings.

1. For **VISCPRO II**: select **Configure > [instrument group] > [instrument] > Tray Settings: Tube**. The **Tray Settings** window opens.
2. Select the correct tube, and enter the appropriate number of duty cycle into the **Sample Cup Heater Duty Cycle, Parameter Value** field. Click **Save** and then **Close**.
3. For **CAV 4.2 GUI**: navigate to the appropriate **Bath Screen**, click **Settings > Tube**.
4. Enter the appropriate number of duty cycle into the **Sample Cup Heater Duty Cycle** field. See Table 22 for starting reference but note actual number may vary between instruments.

**Table 22 — Sample Cup Heater Settings  
(may vary between instruments)**

<i>Bath temperature</i>	<i>Sample cup heater duty cycle</i>
< 40 °C	0
40–50 °C	20%
50–60 °C	30%
60–70 °C	40%
70–80 °C	50%
80–90 °C	60%
90–100 °C	70%
100–110 °C	80%
110–120 °C	90%
> 120 °C	100%

5. Click **Save** and then **Close**.



## Advanced Setup



**Note:** You must be logged into the CAV4.2 GUI or VISCPRO as a manager in order to perform advanced procedures.

### Calibrate Viscometer Tube (VISCPRO II)

Viscometer tube calibration values are associated with specific temperatures, so calibration must be performed when operating a CAV 4.2 bath at a new temperature. Once a tube is calibrated at a particular temperature, the C and E constants are saved by the instrument and will be recalled if that tube is set to run at that temperature again.

1. Assemble a set of standard oils with known kinematic viscosities. Use at least different two standards for each bulb to be calibrated. The CAV 4.2 is designed to run "thin" standards (those with viscosities less than 10X the lower limit of the viscometer tube) in two bulbs, while "thick" standards (those with viscosities greater than 10x the lower limit of the viscometer tube) run in only the lower bulb.
2. Follow the procedures in **Run a sample test** to prepare, load, and run all of the calibration standards as method **Verify Known KV**.
3. When all tests have completed, from the **VISCPRO II Menu**, select **Configure > [instrument group] > [instrument] > Tube Calibration**. The **Tube Calibration** window opens.
4. Select the tube and the bulb to calibrate.
5. Select the date range from which to retrieve appropriate test data.
6. Select the sample entries to use for calibration. You must select at least two entries or the software will not recalculate the constants.
  - **Shift-left-click**—to select a contiguous range of entries.
  - **Ctrl-left-click**—to select multiple entries.
7. Click **Calculate** new constants. The new C and E constants display in their respective fields.
  - Evaluate the accuracy of the new calibration constants for each standard by comparing the **Known Viscosity** with the **Calculated Viscosity**. This difference is displayed as a percentage in the **% Difference** column. You can repeat the calibration by selecting other sample entries.
  - Check **Limit E Constant** before calculating constants to limit the E constant to no more than 10000.
8. When the new calibration constants are acceptable, click **Update bulb** to save the C and E constants and calibration data to the local database and update the C & E constants in the registry of the CAV 4.2.

## Method/Test Settings

Method templates are stored in the registry of the CAV 4.2. When an instance of VISCPRO II connects with a CAV 4.2, those method templates are pushed to VISCPRO II. Any changes made to the method templates in VISCPRO II are synchronized with the CAV 4.2. No method templates are permanently stored with VISCPRO II.

All method templates have the same set of fields. However, when the **Verify Known KV** method is applied to a sample test, the **Check Standard KV** value is added to the information set for that test. The Verify Known KV method must be used when running sample test for calibration.

### Print Method Settings

- For **VISCPRO II**: select **Configure > [instrument group] > [instrument] > Print Instrument Settings**. The **Select Methods to Print** window opens.
- Select the methods to print. **Shift-left-click**—to select a contiguous range of entries; **Ctrl-left-click**—to select multiple entries.
- Click **OK**. The print dialog box opens.
- For **CAV 4.2 GUI**: navigate to the appropriate **Bath Screen**, click **Methods**.
- Select the method. Click **Export**, and follow the on-screen instruction to export the method settings as a text file to a USB drive.

### Edit method settings

- For **VISCPRO II**: select **Configure > [instrument group] > [instrument] > Method Settings**. The **Select Methods** window opens.
- Select the tube and method to edit.
- Click **OK**. The **Method Settings** dialog box opens.
- For **CAV 4.2 GUI**: navigate to the appropriate **Bath Screen**, click **Methods**.
- Select the method to edit. See Table 23–Table 26.

**Table 23 — Method Settings: Test**

Parameter name	Description
Wet Tube	Runs an initial, unrecorded sample drop to coat the inside of the tube with the sample material.
Soak Time Units	Time unit in seconds, minutes, or hours
Bulb1 Soak Time	Time to thermal soak a sample that draws only into bulb 1.
Bulb2 Soak Time	Time to thermal soak a sample that draws only into bulb 2.
Bulb3 Soak Time	Time to thermal soak a sample that draws only into bulb 3.
Preheat Type	No preheat <b>Minimum preheat</b> starts the preheat cycle as soon as the previous sample begins running and runs for at least the set preheat time. <b>Serialized preheat</b> starts the preheat cycle after the previous sample finishes and runs for exactly the set preheat time.
Minimum Preheat Time	This is the time that the preheater is applied to the sample.
Preheat Temperature Units	Select either Fahrenheit or Celsius.
Preheat Temperature	Fahrenheit: 0 °F to 437 °F; Celsius: 0 °C to 225 °C The heater temperature is determined by the <b>Preheat Temperature</b> setting of the sample that is in the preheat position, even if that sample is set to <b>No preheat</b> . Set the temperature to 0 (zero) to turn off the heater.

**Table 24 — Method Settings: Wash**

Setting	Description
Bulb1 Solvent A Washes	Number of solvent A washes for samples run in only bulb 1
Bulb1 Solvent B Washes	Number of solvent B washes for samples run in only bulb 1
Bulb1 Solvent C Washes	Number of solvent C washes for samples run in only bulb 1
Bulb2 Solvent A Washes	Number of solvent A washes for samples run in bulbs 1/2
Bulb2 Solvent B Washes	Number of solvent B washes for samples run in bulbs 1/2
Bulb2 Solvent C Washes	Number of solvent C washes for samples run in bulbs 1/2
Bulb3 Solvent A Washes	Number of solvent A washes for samples run in bulbs 1/2/3
Bulb3 Solvent B Washes	Number of solvent B washes for samples run in bulbs 1/2/3
Bulb3 Solvent C Washes	Number of solvent C washes for samples run in bulbs 1/2/3
Maximum Solvent A Fill Time	Max time (sec) to fill the solvent bulb with solvent A
Maximum Solvent B Fill Time	Max time (sec) to fill the solvent bulb with solvent B
Maximum Solvent C Fill Time	Max time (sec) to fill the solvent bulb with solvent C
Solvent A Injection Time	Time (sec) that solvent A will be injected after bulb empties
Solvent B Injection Time	Time (sec) that solvent B will be injected after bulb empties
Solvent C Injection Time	Time (sec) that solvent C will be injected after bulb empties
Cup Empty Time	Time (sec) to empty cup of sample at start of wash cycle
Tube Tip Soak Time	Time (sec) for tip to soak after solvent injection
Solvent Evacuation Time	Time(sec) to empty cup of solvent after soaking
Final Air Dry Time	Time(sec) to force air dry A-Pipe at end of wash cycle
Wash B-Pipe	Specify if B-Pipe should be washed
B-Pipe Solvent A Washes	Number of solvent A washes for B-Pipe
B-Pipe Solvent B Washes	Number of solvent B washes for B-Pipe
B-Pipe Solvent C Washes	Number of solvent C washes for B-Pipe
B-Pipe Dry Time	Time(sec) to force air dry B-Pipe

**Table 25 — Method Settings: Advanced**

Setting	Description
Maximum Bulb 1 Fill Time	Maximum time (sec) to fill bulb 1
Minimum Bulb 1 Select Time	Time (1/10 sec) used to determine whether the sample will run in bulb 1 or 2. Bulb 1 will be selected if the efflux exceeds this time
Minimum Bulb 2 Fill Time	Maximum time (sec) to fill bulb 2
Maximum Bulb Empty Time	Maximum time (sec) for the sample to drop between the target sensor and the bottom sensor
Tube Empty Time	Percentage of the bulb 1 efflux time that is used to empty the tube after the bottom sensor becomes uncovered
Bulb 1 Overdraw Time	Time (sec) that the sample is pulled past the target sensor during a bulb 1 sample fill
Bulb 2 Overdraw Time	Time (sec) that the sample is pulled past the target sensor during a bulb 2 sample fill
Bulb 3 Overdraw Time	Time (sec) that the sample is pulled past the target sensor during a bulb 3 sample fill
Sample Draw Delay	Time (sec) after the sample cup is raised before sample is drawn into the tube
Bulb 1 Vent Drain Time	Time (sec) for a bulb 1 sample between when the tube vent is opened to atmosphere and the sample efflux starts
Bulb 2 Vent Drain Time	Time (sec) for a bulb 2 sample between when the tube vent is opened to atmosphere and the sample efflux starts
Bulb 3 Vent Drain Time	Time (sec) for a bulb 2 sample between when the tube vent is opened to atmosphere and the sample efflux starts

**Table 26 — Method Settings: Drop Criteria**

Setting	Description
Maximum Determinations	Maximum number of efflux determinations that will be run when trying to match a set
Required Determinations	Number of valid efflux determination needed to produce a matched set
Maximum % Difference	Maximum percent difference between efflux determinations in order to be considered for inclusion in a matched set
Maximum Efflux Difference	Maximum efflux difference between efflux determinations in order to be considered for inclusion in a matched set
Drop Criteria Mode	Determines how the efflux determination will be selected for inclusion in a matched set
Use Percent Difference	Stipulates that a positive match between two determination is dependent upon the percent difference between the two
Use Efflux Difference	Stipulates that a positive match between two determinations is dependent upon the efflux difference between the two
Use Either	If 'Use Percent Difference' and 'Use Efflux Difference' are both set, then, if true, a match between two determinations is made if either criteria is met; else if false, both criteria must be met to produce a matched set.

## Adjust Default Wash Settings

- For **VISCPRO II**: select **Configure > [instrument group] > [instrument] > Tray Settings: Default Wash**. The **Tray Settings: Default Wash** window opens.
- Select the tube to edit.
- For **CAV 4.2 GUI**: navigate to the appropriate **Bath Screen**, click **Settings > Default Wash**.

## Create a Standard CAV Data Table Analysis

An analysis is used to view detailed data stored in the VISCPRO II database.

1. Select **Analysis > View Analysis**. The **Choose Analysis** window opens.
2. Open **Basic Package**.
3. Click on **CAV DATA Table**.
4. Select **Define and Open New Configuration**. Click **OK**. The **CAV Analysis Configuration** window opens.
5. On the **Date Filter** tab, set the appropriate range for the data to be displayed.
6. On the **Sample Filter** tab, set the filters on the type of data to be displayed.
7. On the **Report** tab, select the data items to display. See Table 27.
8. Click **OK**. You will be prompted to save the analysis.
  - If you choose **YES**, the analysis will be displayed after it is saved.
  - If you choose **NO**, the analysis will still be displayed.

**Table 27 — CAV Data Table Fields**

Setting	Description
Sample ID	Descriptive name given to the sample
INV	Invalid test indication
TOL	(Tolerance) Acceptable difference in multiple test results for the test
Date	Date the test was run
Time	Time the test was run
Tube S/N	Tube serial number
Tray	Bath number
Smple Index	Sample position
Bulb	Bulb in which the sample ran
Technician	The technician logged into VISCPRO when the test was run
Instrument Type	Instrument type (CAV, CCS, etc.)
Instrument ID	Instrument identification, from Instrument Settings
Comment	Displays comments associated with the sample
Method Name	Name of the method used to run the sample
KV	Average kinematic viscosity of the sample
% KE	% contribution of the kinetic energy correction to the measured viscosity
Known KV	Value entered for the known KV of the sample
% Diff KV	% difference between the measured KV and the known KV
Temp	Average bath temperature
T1-T4	Times for the valid effluxes used in the calculations
% Diff	(Max efflux time – Min efflux time)/average efflux time
Abs. Diff	Max efflux time – Min efflux time
{1,10} Efflux %d	Adds the first 10 efflux times to the analysis
{1,20} Efflux %d	Adds the first 20 efflux times to the analysis
Avg Efflux	Average efflux time calculated using valid effluxes
C	C constant of calibration
E	E constant of calibration
SUS	Saybolt Furol Seconds calculation
Display Kinematic Viscosity Data	Check to display samples not run with Verify Known KV method
Display KV Check Data	Check to display sample run with Verify Known KV method
Max KV % Difference	When the % Diff KV exceeds this value, an "X" is displayed in the TOL column



## Maintenance and Service

### Update CAV 4.2 Software and Firmware

Software and firmware code updates may occasionally need to be manually installed on the CAV 4.2 user-interface, controller boards, and controlling PCs. There are four types of code that can be installed:

- UI updater: this software is actually the complete UI updater program (UpdateUI.exe) that runs on the CAV 4.2. It is used to install the UI software and firmware updates. It is updated by copying it over the existing UpdateUI.exe.
- CAV 4.2 GUI software: this software is the CAV 4.2 user-interface. To update the CAV 4.2 GUI software, you must be logged out of the user-interface and running the UI updater instead.
- Firmware updates: this code controls the baths, sample handlers, and valve controls. It is installed directly onto the respective controller boards using the UI updater.
- VISCPRO II: this software is installed on the controlling PC.

### Tools and Materials Required

See Table 28 for tools and materials required to update the software and firmware.

**Table 28 — Tools and Materials Required for Software and Firmware Update**

Setting	Description
#2 Philips screwdriver	USB flash drive
Software/firmware updates	USB keyboard
USB Type A-Male to Mini B cable (6ft)	

### Prepare the USB Flash Drive

A USB flash drive must be loaded with the software and firmware to be updated.

1. On a PC, download the update packages from the CANNON website Software & Downloads page.
2. Unpack and copy the update files to the USB flash drive. Only one set of files can be on the USB flash drive during an update.

### Replace the UI Updater

1. From the GUI, click [Help > Upgrade UpdateUI](#).
2. Plug the prepared USB flash drive into the USB connection.
3. Follow the instructions on the screen.

## Update the UI Software



**Note:** A video of this procedure is available at <https://vimeo.com/139739339>.

1. From the GUI, click **Help > Upgrade Instrument**. Click **OK**. The baths are placed into Bootloader mode (orange lights), and the Windows logon screen displays.
2. Plug the prepared USB flash drive into the USB connection
3. Click **Updates**. This runs the UpdateUI.exe program, which opens into the update shell.
4. Click **Update Software**. A **File Open** dialog opens.
5. Select and run the setup.exe program in the CAV UI update directory on the E: drive.
6. Follow the instructions provided by the setup program.
7. Click **Save And Exit**. The CAV unit will reboot several times, but the bath lights will remain orange, indicating that they are still in Bootloader mode.
8. After the CAV finishes its rebooting routine, power cycle the unit by completely turning it off with the power switch on the hood, waiting 10 seconds, then turning it on.

## Update the Controller Firmware



**Warning:** Be careful not to touch any moving parts or live wires in the CAV 4.2.



**Note:** A video of this procedure is available at <https://vimeo.com/139737507>.

1. Slide the trays out and remove the carousels.
2. With the Philips screwdriver, remove the screws securing the corner panels.
3. Remove the corner panels. Remove the center panel. Raise the lid. Push the trays in.
4. From the GUI, click **Help > Upgrade Instrument**. A dialog box asks you to confirm your action.
5. Click **OK**. The baths are placed into Bootloader mode (orange lights), and the Windows logon screen displays.
6. Click **Updates**. The update shell opens.
7. Plug the prepared USB flash drive into the USB connection
8. Click **Update Firmware**.
9. Select the type of controller to update. Windows Explorer opens.

10. Using the GUI touch-screen, select and open the firmware update in the firmware update directory on the E: drive.
11. Remove the USB flash drive.
12. To update a sample handler or valve controller, connect a USB cable between the USB connection and the appropriate controller board. Both bath controllers can be updated without connecting them with a USB cable.
13. Repeat steps 7 through 10 as necessary to update all applicable controller boards.
14. Click **Save And Exit**.
15. Power cycle the unit by completely turning it off with the power switch on the hood, waiting 10 seconds, then turning it on.

### **Update the VISCPRO II software**

Run the VISCPRO II installation program. Follow all instructions in the installation program.

### **Change Viscometer Tube**



**Warning:** *Do not drain the silicone bath fluid until it has cooled off to a safe temperature.*

1. Turn off the CAV 4.2 and allow the bath to cool down.
2. Drain the silicone bath fluid into a clean container and save for refilling the unit.
3. Raise the hood.
4. Note the solvent line connections. Gently unscrew the solvent lines from the top of the viscometer tube.
5. Disconnect the sensor cable by gently pulling straight up.
6. Unscrew the thumb screws until they spring free of the bath top.
7. Gently draw the viscometer tube straight up and out of the bath.
8. Inspect the new viscometer tube for defects, especially small chips on the top and bottom of the tube. These can cause vacuum leaks and problems with solvent contamination.
9. Clean the bottom of the new tube and apply a light coating of silicone bath fluid.
10. Gently lower the viscometer tube into the bath and press it into the cone of the tube tip in the bottom of the bath. The viscometer tube must pass through 2 O-rings in the cone and seat gently onto the top of the metal tube tip. Failure to seat the viscometer tube properly may result in poor performance.
11. Press the top bracket into position and evenly tighten the thumb screws.
12. Verify that the bath drain set screw is tight and refill the bath with silicone bath fluid.

13. Connect the solvent lines and sensor cable.
14. Turn the CAV 4.2 on.
15. In **Tube Settings**, enter the name of the new tube.
16. If necessary, adjust and calibrate the temperature of the bath. If the temperature has not changed, temperature calibration is not necessary.



**Note:** *Sensor training data is associated with the temperature setting of a bath. When a tube is changed and the bath temperature is either kept the same or changed to a temperature at which a tube was previously trained, the CAV will display that the sensors are trained. This is correct. The sensors must be trained whenever a tube is changed.*

17. Train the sensors.
18. Verify the **Default Wash** and **Method Settings**, especially **Verify Known KV**, for the bath in which the tube was changed.
19. Calibrate the new viscometer tube.

## Replace Power Supply

The CAV 4.2 power supply is a switching regulated power supply designed to handle 90 – 240 VAC. To accommodate different locales, only the MAINS AC power cable needs to be changed.



**Caution:** *The power supply is easy to replace. The side panels do not need to be removed to access the power supply attachment point. It is not connected via cable. Instead, a mating coupler is attached to a bulkhead in the chassis.*

1. Turn off the CAV 4.2 and unplug it from the MAINS AC power.
2. Remove the power cable.
3. Remove the four screws securing the power supply assembly to the chassis.
4. Firmly pull the power supply assembly from the chassis.

## Adjust Solvent Dosing Chamber Sensors

Each CAV 4.2 bath has its own solvent dosing chamber, mounted on the side panel. Optical sensors on the inlet and the outlet of the dosing chamber must be adjusted to "see" the solvents that are drawn past them.

When the chamber is full of solvent, adjust the sensors by turning the set screws counter-clockwise until the associated green light turns on. When running multiple solvents, verify each solvent, always adjusting by turning the screws counter-clockwise. See Figure 27.

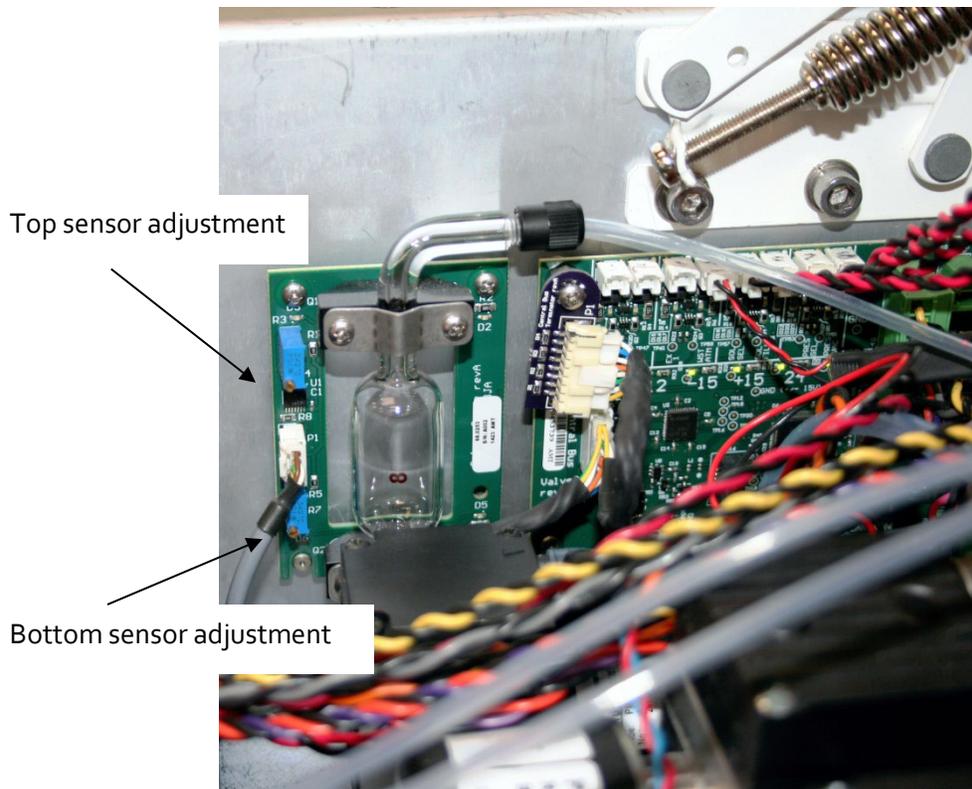


Figure 27 — Solvent Dosing Chamber



# Warranty

## Products Limited Warranty

In addition to other manufacturers' warranties, CANNON Instrument Company ("the Company") warrants all products (other than reagents and chemicals) delivered to and retained by their original purchasers to be free from defect in material and workmanship for one year from the date of the Company's invoice to the purchaser. For a period of one year from the date of such invoice, the Company will correct, either by repair or replacement at the Company's sole discretion, any defect in material or workmanship (not including defects due to misuse, abuse, abnormal conditions or operation, accident or acts of God, or to service or modification of the product without prior authorization of the Company) without charge for parts and labor. The determination of whether any product has been subject to misuse or abuse will be made solely by the Company.

The Company shall not be liable for any special, incidental, or consequential damages, or any damage to plant, personnel, equipment or products, directly or indirectly resulting from the use or misuse of any product. Representations and warranties made by any person, including dealers and representatives of the Company, which are inconsistent, in conflict with, or in excess of the terms of this warranty shall not be binding upon the Company unless placed in writing and approved by an officer of the Company.

## Reagent and Chemical Warranty

CANNON Instrument Company ("the Company") warrants all reagents and chemicals sold by the Company and delivered to and retained by their original purchasers to conform to the weight, specifications and standards stated on the package. The Company will, at its sole option, either replace or refund the price (net of freight, handling charges and taxes), of any reagent or chemical sold by the Company which does not conform to such weight, specifications and standards upon the prompt return of the unused portion. Except for replacement or refund of the net price, the Company shall not be liable for any damages occurring as a consequence of the failure of any reagent or chemical sold by the Company to conform to the weight, specifications and standards stated on the package.

## Returning a Product to CANNON

Before returning a CANNON product for repair or service, make every attempt to identify the problem. If, after careful checking, the problem remains unidentified or unsolved, telephone CANNON Instrument Company (or the local service agent) to consult with a product specialist. If the specialist cannot recommend a simple solution or repair, CANNON will authorize the return of the product through the issuance of a Return Authorization number (RA).

- CANNON Telephone Number: 814-353-8000
- CANNON Email: [info@cannoninstrument.com](mailto:info@cannoninstrument.com)

Products returned to CANNON must be carefully packed. Ship prepaid to the following address:

CANNON Instrument Company

ATTN: Return Authorization # \_\_\_\_\_

2139 High Tech Road

State College, PA 16803 USA

Please include the following:

***Required Information***

- The Return Authorization number (RA).
- The name and telephone number of the person at your company to contact regarding the product.
- Shipping and billing instructions for the return of the product to your location.
- A detailed explanation of the reason for the return. If the product is not covered by warranty, the customer will be provided with an estimate of the repair costs and asked for approval before any repairs are made. The customer will be required to issue a purchase order for the cost of the repairs.

***Hazardous Materials***

Please contact CANNON before returning a product that could possibly contain hazardous material.

***Shipping Notification***

Products returned without CANNON's prior authorization will not be accepted. The customer may be billed a testing fee if a product is returned to CANNON and found to be working properly.



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