

**MALCOM**  
**Laboratory Digital**  
**Viscometer**  
**Model PCU-200 Series**

**INSTRUCTION MANUAL**

**MALCOM TECH INTERNATIONAL**  
**26200 INDUSTRIAL BLVD.**  
**HAYWARD, CA 94545 USA**

**TEL. (510) 293-0580    FAX. (510) 293-0940**  
**WEB. [www.malcomtech.com](http://www.malcomtech.com)    EMAIL. [info@malcomtech.com](mailto:info@malcomtech.com)**

*Revised 4/01/01*



# ***LAB Online Exhibition***



## FORWARD

Thank you for purchasing this Malcom PCU-200 series laboratory viscometer. Like all Malcom viscometers, the PCU-200 series employs the patented spiral pump method for accurate and repeatable measurements. Please read this instruction manual thoroughly in order to take full advantage of this unit.

## NOTES

1. Specifications and features are subject to change without notice.
2. Please retain the packing material and shipping box used for when this unit will be transported. Since this unit is a precision instrument, it can be damaged if it is transported in an inadequate container. In such circumstances, repairs will be charged even if the nature of the damage is covered by the warranty.
3. Never disassemble the unit. If the unit is disassembled or if it appears to have been disassembled before, you will not be entitled to warranty repairs. All such repairs will be charged for.
4. PACKING INSTRUCTIONS FOR SHIPPING PCU-200 SERIES:
  - a) When placing the unit in the box, place the unit on its backside, with the unit door facing up.
  - b) Place packing material inside the unit (inside the door) around the cylinder so that it does not move during shipment. This area should be packed tightly with bubble wrap. The cylinder should not be able to shift and should be stabilized.
  - c) The door to the unit is very fragile, make sure that there are layers of bubble wrap around it, to protect it from being cracked.
  - d) The whole unit should be then tightly wrapped in bubble wrap.
  - e) Make sure to include INNER AND OUTER CYLINDERS, AND POWER CORD.

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**PACKING LIST**

Upon opening your PCU-200 series viscometer, you will find the following items. Should any of them be missing, please contact your Malcom dealer as soon as possible.

- 1. PCU-200 Main Unit ----- 1
- 2. Inner Spiral----- 1
- 3. Outer Cylinder----- 1
- 4. Thermal Paper ----- 1 roll
- 5. Power Cord ----- 1
- 6. RS-232C Cable (PCU-205)----- 1
- 7. VAM-1 Software (PCU-205)----- 1
- 8. Aluminum Adapters (300cc thermostat) ----- 1
- 9. Plastic Spatula ----- 1
- 10. Operation Manual ----- 1
- 11. Inspection Certificate ----- 1
- 12. Warranty Sheet ----- 1

## I. OVERVIEW

### A. Introduction

The concept of viscosity as a process variable in the use of pastes and inks has become a significant quality control criterion. Traditionally, measurements of simple, viscous liquids could be done with a T-bar spindle type viscometer. However unlike newtonian or ideal liquids, the viscosity of non-newtonian liquids change when subjected to changing or prolonged shearing. Pseudoplastic-thixotropic liquids, as are pastes and inks, have a viscosity drop when they are subjected to increasing shear or extended shear time. Often, this drop is irreversible. Bearing this in mind, the comparison and standardization of viscosity as a control variable cannot be done if the viscometer employed does not resolve these characteristics. Because of the spiral pump design of the Malcom PCU-200 series of laboratory viscometers, the shear time is a function of the shear rate and both are a constant for a given rotational speed. By recording the viscosity of a pseudoplastic-thixotropic fluid at several speeds for known durations, it is possible to calculate the rheological characteristics of that fluid.

### B. Features

- Continuous measurement of newtonian and non-newtonian fluids with constant shear rate and shear time.
- Automatic control of measurement according to JIS standards, (PCU-203, 205), so results are not user dependent.
- Built-in dot matrix printer for logging acquired measurements.
- Fully automatic temperature control of sample by use of built-in thermostat.
- External computer control for acquisition, computation and rheological analysis of sample. (PCU-205)
- Measured values are easily read on digital displays.
- Re-calibration is user possible.

C. Specifications and Options

<b>Model Number</b>	<b>PCU-201</b>	<b>PCU-203</b>	<b>PCU-205</b>
<b>Sample Size</b>	100cc, 300cc containers (500g, 1500g solder paste)		
<b>Sensor</b>	Malcom Spiral Pump Type		
<b>Measurement Range</b>	5 Pa·s – 1000 Pa·s		
<b>Speed Range</b>	1 – 50 RPM		
<b>Shear Rate</b>	0.6 – 30 seconds <sup>-1</sup> (0.6 x speed)		
<b>Measurement Accuracy</b>	±5% of indicated value		
<b>Speed Accuracy</b>	±2% of set point (encoder controlled)		
<b>Repeatability</b>	±1.0%		
<b>Temp. Control Range</b>	15 – 30°C (±5°C of room temperature)		
<b>Alarm Audio Output</b>	Beep when viscosity set point is reached		
<b>Alarm Output Terminals</b>	Switch rated 2.5A 120VAC		
<b>Recorder Output</b>	Viscosity: 1mV/Pa·s, Temperature: 10mV/°C		
<b>Printer Displays</b>	Temp, Visc, S. Rate, RPM, Date, Time	Same as PCU-201, plus JIS standard	
<b>Interface</b>	RS232C	Interface	

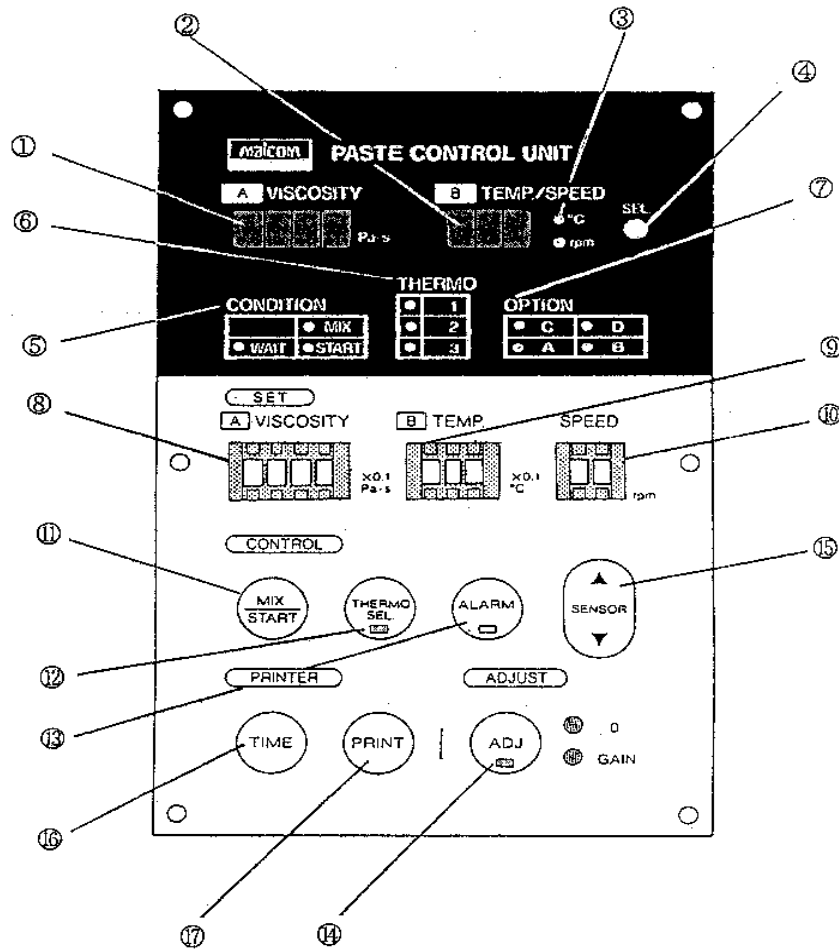
*NOTE: The PCU-205 requires a PC compatible computer and the optional on-line software for extended operation. All specifications are subject to change without notice.*

<b>Option</b>	<b>Feature</b>	<b>Part Number</b>
Ultrasonic Cleaner	Built-in-timer	AUC-201
Standard Calibration Fluid	Silicon Oil KF96A, 100cc, 300cc	SS-100, SS-300
Spare Cylinders	Inner and Outer	ROU-1A, RIU-1A
Strip Chart Recorder	Graph viscosity and temperature	SR65511-2
Recorder Pens and Paper	KX1103R (red), KX1103B (black), PZ280	
On-Line Software	Control, acquisition and computation of flow characteristics, thixotropic index recovery ratio, fluid constant and more.	VAM-1

D. Nomenclature

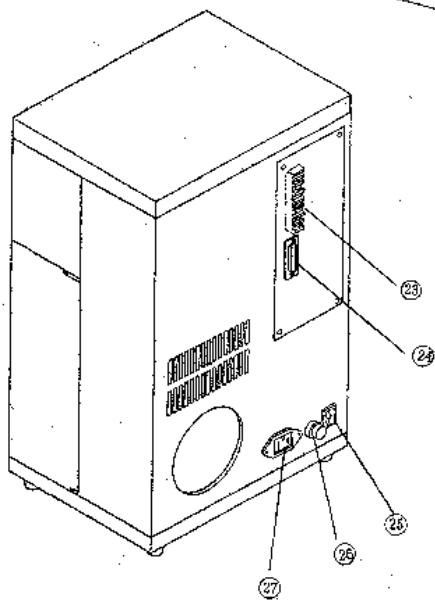
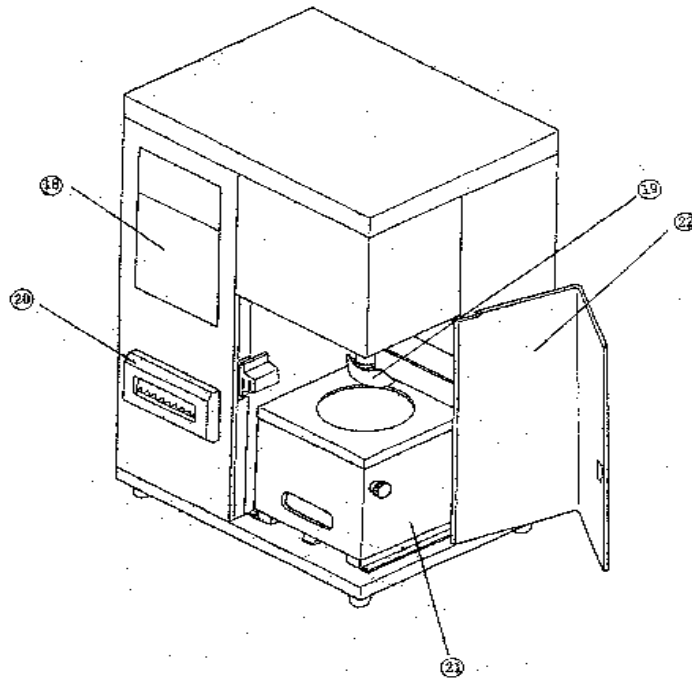
Control Panel

- |                               |                                      |
|-------------------------------|--------------------------------------|
| 1. Viscosity Digital Display  | 10. Speed Set Switch                 |
| 2. Temp/Speed Digital Display | 11. Mix/Start Switch                 |
| 3. Temp/Speed LEDs            | 12. Thermostat Select Switch and LED |
| 4. Temp/Speed Select Switch   | 13. Alarm Switch and LED             |
| 5. Condition LEDs             | 14. Adjust Switch and LED            |
| 6. Thermostat LEDs            | 15. Sensor Up/Down Switch            |
| 7. Option LEDs                | 16. Time Switch                      |
| 8. Viscosity Set Switch       | 17. Print Switch                     |
| 9. Temperature Set Switch     |                                      |



### Front View

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- 24. RS-232C Connector
- 25. Power Switch
- 26. Fuse Holder
- 27. Power Cord Receptacle
- 28. Thermostat Size Switch

## E. Functions

### 1. Viscosity Digital Display

This four-digit display normally shows the present viscosity in Pa·s. If you were to ignore the decimal point, then the display would be in poise. This display also shows the year, day of month and hour of day when the time switch is pressed.

### 2. Temp/Speed Digital Display

This three-digit display normally shows either the current sample temperature or outer cylinder speed. This display also shows the month of the year and the minute of the hour when the time switch is pressed.

### 3. Temp/Speed LEDs

These LEDs indicate if the temp/speed digital display is showing the temperature in °C or the speed in RPM.

### 4. Temp/Speed Select Switch

This button is used to toggle the temp/speed digital between the temperature or speed.

### 5. Condition LEDs

These LEDs indicate what state the sensor is in. It is either MIXing the sample STARTing to measure the sample, or WAITing for the sample to recover. The MIX and START conditions can be selected by using the mix/start switch.

### 6. Thermostat LEDs

These LEDs indicate which mode of temperature control is being used. “1” is the standard solder paste mode. “2” is the calibration liquid mode. “3” IS IDENTICAL TO “1”. These modes are selected by the thermostat select switch.

### 7. Option LEDs

These LEDs indicate which option is being utilized: JIS standard (A), or on-line operation (B).

### 8. Viscosity Set Switch

Set this digital switch to the minimal acceptable value of viscosity. When utilizing the JIS standard or on-line operation options, (PCU-203, PCU-205), set this switch to 0000.

### 9. Temperature Set Switch

Set this digital switch to the desired temperature of the sample. The set temperature cannot be lower than 15°C, nor higher than 35°C. The temp/speed digital display will flash in this situation.

### 10. Speed Set Switch

Set this digital switch to the speed/shear rate required. Do not set the speed for greater than 50 RPM. The temp/speed digital display will flash if this is done. The shear rate is the speed multiplied by 0.6.

Example, 10 RPM x 0.6 = 6 sec.

### 11. Mix/Start Switch

Press this button when you wish to change the mode of operation. Each model of PCU-200 series viscometer has a different sequence of modes to choose from. The modes are cyclic according to the following:

PCU-201: Mixing, Measuring, no mode, Mixing.
PCU-203: Mixing, Measuring, JIS standard (option A), no mode, Mixing.
PCU-205: Mixing, Measuring, JIS standard (option A), on-line (option B), no mode, Mixing.

The viscosity set switch must be set to 0000 when utilizing the JIS standard or on-line modes.

### 12. Thermostat Select Switch and LED

This button allows you to select the mode of temperature control to use. The first press of the button will turn on the thermostat and this is indicated by the LED for Mode 1 illuminating. Mode 1 is for when measuring solder paste. The next press of the thermostat select switch will select mode 2, for when calibrating the PCU-200 with silicon oil. A third press selects mode 3, which is identical to mode 1. The fourth press turns off the temperature control. This selecting is cyclic. The LED within the button flashes to indicate operation.

### 13. Alarm Switch and LED

Press this button on to activate the alarm [program]. The LED in the button will light. If the measured viscosity is over the viscosity set switch value, then the LED will slowly flash. However, if the viscosity drops below the viscosity set value, an alarm condition will occur. The wait LED will illuminate, the outer cylinder will stop rotating, and the two upper terminals of the rear panel terminal block will become closed. To reset the alarm, press this button a second time. If the viscosity set value is "0000", then the alarm program will not function.

### 14. Adjust Switch and LED

When calibrating the PCU-200, press this button to enable the zero adjustment. The LED will light when the button is pressed. Do not adjust the gain while this LED is illuminated. When setting the time, the adjust switch increments the flashing, selected, digit.

### 15. Sensor Up/Down Switch

Push on the arrows to raise or lower the sensor accordingly. There are limit switches to prevent overrun. The sensor should be in the fully up position when removing or installation the inner spiral and outer cylinder and when sliding the thermostat in or out.

### 16. Time Switch

Press this button to display date and time on the viscosity and temp/speed digital displays. The following is the format of the displays:

	Viscosity Display	Temp/Speed Display
First Press	year	month
Second Press	day of month, hour	minute
Third Press	viscosity	temp/speed

The sequence is cyclic and the hour is military, i.e., “13” means 1 o’clock in the afternoon. If the time switch is depressed while the power is turned on, it is then possible to set the time and date using the print and adjust switches.

### 17. Print Switch

Pressing this button will cause the built-in thermal printer to print out: the date and time, the speed and shear rate, the sample temperature and the viscosity. When setting the time, the print switch selects which digit is going to be changed.

### 18. Control Panel

This membrane organizes the many switches and LEDs used in the operation of the PCU-200.

### 19. Sensor

This is the heart of the viscometer. Here an outer cylinder rotates around an inner spiral. When fluid is subjected to this geometry, it undergoes constant shearing and is pumped through the sensor.

### 20. Printer

This thermal printer uses 2.25 inch wide rolls of thermal paper. Use the feed button to advance the paper out of the printer. Tear off the paper with an upward motion. The paper LED will illuminate when the paper supply is exhausted or torn.

### 21. Thermostat

This is the device that maintains the temperature of the sample. It is constructed of a peltier cooler/heater, a heat sink and a fan. If your thermostat is for 300cc jars, two aluminum adapters can be used for 100cc jar operation. The opening at the front of the thermostat has a catch that must be pressed to allow the thermostat to slide part way out of the PCU-200. Make sure the sensor is in full upright position before doing this.

### 22. Door

This tinted cover protects the sample from airborne contaminants. Additionally, it helps maintain a closed temperature controlled environment for the sample being measured. The door has a push-open, push-close locking mechanism.

### 23. Terminal Block

The terminal block on the rear panel has outputs for the alarm, viscosity and temperature. The viscosity output is 1mV/Pa·s and the temperature output is 10mV/°C.

#### 24. RS-232C Connector

The PCU-205 comes equipped with this interface. It enables an IBM compatible computer to communicate, acquire data and controls the PCU-205 through use of the VAM-1 software. Connect only a Malcom specific cable to this connector. Other cables may damage the viscometer and hence, void the warranty. Connect the other end of the cable only to a serial port, not a parallel port.

#### 25. Power Switch

This switch supplies power to the PCU-200. “Up” is ON and “Down” is OFF. If the time switch is held down while the power is turned ON, it then becomes possible to set the time and date.

#### 26. Fuse Holder

This holds the fuse. Replace only with a 2A 250V fuse.

#### 27. Power Cord Receptacle

One end of the power cord attaches here. The other plugs into an appropriate power outlet. Only supply the voltage indicated above the receptacle. Improper voltage will damage the PCU-200 and void the warranty.

#### 28. Thermostat Size Switch

This three position toggle switch should be set in respect to the type of thermostat you have. If you have a 100cc thermostat that will only accept 100cc jars, then set the switch to 100cc. If you have a 300cc thermostat and you are using a 300cc jar, set the switch to 300cc. If you have a 300cc thermostat, but you are using a 100cc jar in conjunction with the aluminum adapters, set the switch to adapter.

F. Exceptions

These are the exceptions to the operation of the PCU-200 series viscometer.

	<b>PCU-201</b>	<b>PCU-203</b>	<b>PCU-205</b>
<b>JIS Standard Sequence</b>	no	yes	yes
<b>On-Line Computer Control</b>	no	no	yes

	<b>Standard Operation</b>	<b>JIS Standard</b>	<b>On-Line Control</b>
<b>Viscosity Set Switch</b>	settable	set to 0000	set to 0000
<b>Temperature Set Switch</b>	settable	settable	ignored
<b>Speed Set Switch</b>	settable	ignored	ignored
<b>Mix/Start Switch</b>	useable	press 3 times to invoke	press 4 times to invoke
<b>Thermostat Select Switch</b>	useable	useable	ignored
<b>Alarm Switch</b>	useable	turned OFF	turned OFF
<b>Print Switch</b>	useable	useable and automatic	useable

## II. USE

### A. Normal Operation

1. Place the PCU-200 on a clean, level, sturdy working surface. There should be no blockage of the fan intake or exhaust.
2. Plug the power cord into the rear panel receptacle. Note the voltage labeled above the receptacle.
3. Plug the other end of the cord into an appropriate electrical outlet.
4. Well before measurement, the solder paste should be brought out of storage and allowed to come to room temperature.
5. The paste should then be mixed to an even consistency. A Malcom SPS-1 Solder paste Softener is recommended for this task.
6. Push on the latch and open the door.
7. Switch on the power. The displays should illuminate and the paper will feed.
8. Use the sensor up/down switch to raise the sensor all the way up.
9. Insert your forefinger and index finger into the hole at the front of the thermostat.
10. Depress the metal catch with your forefinger and pull the thermostat out with your index finger. Pull the thermostat out about 5 inches. This is so the inner spiral and outer cylinder can be installed behind the thermostat.
11. Slide the clean inner spiral up the clean sensor shaft and very gently turn it clockwise so that it threads onto the shaft. Stop when you feel resistance. ***DO NOT TORQUE THE SENSOR SHAFT OR INNER SPIRAL.***
12. Slide the clean outer cylinder over the inner spiral and turn it counter-clockwise to screw it onto the spindle. ***DO NOT TORQUE THE OUTER CYLINDER.***
13. Turn the clamp knob a few revolutions counter-clockwise.
14. If you are going to be using a 100cc jar in a 300cc thermostat, then put the two aluminum adapters into the thermostat.
15. Remove the cover and the solder paste jar. Slide the jar into the thermostat. If there is difficulty, loosen the clamp a few more turns.
16. Turn the clamp knob clockwise to tighten the thermoband around the jar. The clamp should be snug, but do not over tighten the knob.

17. Slide the thermostat back in until it stops.
18. Use the sensor up/down switch to lower the sensor into the solder paste. The sensor should penetrate just far enough so that the liquid level is at the lower lip of the outlet on the side of the outer cylinder.
19. Close the door and push to latch in.
20. Set the select switches to the alarm viscosity, the desired temperature and the required speed.
21. Push the thermostat select switch once, so that the mode 1 LED is illuminated. Temperature control will start.
22. Push the mix/start switch once, so that the mix LED is illuminated. The solder paste will be mixed at 10RPM, regardless of the setting of the speed select switch, for five minutes. Then, the start LED will light and viscosity measurement will begin. If you do not wish to wait the five minutes, press the mix/start switch a second time.
23. If desired, the speed may be changed at this time.
24. Push the print switch to receive a hardcopy printout of: the date & time, speed and shear rate, temperature and viscosity.
25. When finished, raise the sensor all the way out of the sample, using the sensor up/down switch.
26. Turn off the power and clean up.

B. JIS Standard Operation (PCU-203, PCU-205)

Besides normal operation, the PCU-203 and 205 have the ability to perform a sequence of measurements according to the JIS standard. Follow this procedure:

1. Conduct a normal operation up to and including step 21.
2. Set the temperature to 25.0°C and allow it to stabilize. This may take an hour to achieve.
3. Set the viscosity set switch to “0000”.
4. The start LED will most likely be illuminated. Press the mix/start switch so that the option A, LED lights.
5. The following sequence will begin:

	<b>Speed</b>	<b>Shear Rate</b>	<b>Time</b>
Step 1	10 RPM	6.0 sec <sup>-1</sup>	3 minutes
Step 2	3 RPM	1.8 sec <sup>-1</sup>	6 minutes
Step 3	4 RPM	2.4 sec <sup>-1</sup>	3 minutes
Step 4	5 RPM	3.0 sec <sup>-1</sup>	3 minutes
Step 5	10 RPM	6.0 sec <sup>-1</sup>	3 minutes
Step 6	20 RPM	12.0 sec <sup>-1</sup>	1 minute
Step 7	30 RPM	18.0 sec <sup>-1</sup>	1 minute
Step 8	10 RPM	6.0 sec <sup>-1</sup>	1 minute

The printer will print the date and time. After each speed change, the printer will automatically print: the speed, shear rate, duration, temperature and viscosity.

6. When finished, raise the sensor all the way out of the sample. Using the sensor up/down switch.
7. Turn off the power and clean up.

### C. On-Line Operation (PCU-205)

The PCU-205 has the ability to be controlled by a PC compatible computer. You will need the Malcom specific serial cable and the VAM-1 software to utilize this feature. Follow these steps:

1. Attach the Malcom specific serial cable from the computer serial port to the PCU-205.
2. Turn on the computer and prepare to run the VAM-1 software.
3. Conduct a normal operation up to and including Step 19.
4. Set the viscosity set switch to "0000".
5. Run the VAM-1 software.
6. When the Malcom logo appears and you are requested to put the PCU-205 on-line, press the mix/start switch four times so that the option B, LED lights. In a moment, the computer will have control of the PCU-205.
7. Should the option B, LED flash, then there is something wrong with the RS-232C connection. Refer to the VAM-1 manual for assistance.
8. When finished, raise the sensor all the way out of the sample, using the sensor up/down switch.
9. Turn off the power and clean up.

#### D. Printer Operation

The internal thermal printer provided with the PCU-200 is capable of two modes of printing, manual and automatic. Automatic printing is available only on the PCU-203 and PCU-205. Manual printing occurs when the print switch is pushed. The information printed is the: date, time, speed, shear rate, temperature, and viscosity. Automatic printing is part of the JIS standard sequence. When option A (JIS standard) is invoked, the printer will automatically print the: viscometer model number, date, time, "FORMAT JIS", and "START". At the end of the first step and for each following step of the sequence, the printer will print the: speed, shear rate, duration of step, temperature, and viscosity. At the end of the sequence, the printer will print "STOP" and the viscometer will return to the no-mode condition. Below is an example of both the manual and automatic printouts. The printouts should be read from bottom to top.

<pre> ▲ 000.0 Pa·S ▲ 24.3 °C ▲ 6.0 S-1 ▲ 10 RPM  03:14 ▼ 1995-03-28 </pre>	<pre> STOP  ▲ 000.0 Pa·S ▲ 24.3 °C ▲ 1 min ▲ 10 RPM ● ● ●  ▲ 000.0 Pa·S ▲ 24.0 °C ▲ 3 min ▲ 6.0 S-1 ▼ 10 RPM START  FORMAT: JIS 02:46 ▲ 1995-03-28 PCU-203 </pre>
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It is possible to check the operation of the printer by following this procedure.

1. Turn off the power.
2. Hold down the FEED button on the printer, while turning on the power.
3. The printer will now print out a collection of letters and symbols, and then continuously print a checkerboard pattern.
4. If these characters are unclear or incomplete, then the printer is malfunctioning.

## E. Guidelines

For correct, repeatable measurements, refer to these guidelines.

1. When a solder paste sample is brought from storage and readied for measurement, it is necessary to thoroughly mix the paste, to bring it to an even consistency. However, care must be given that no air entrapment happens. These bubbles or voids can cause inaccurate measurement. The Malcom SPS-1 recommend for proper preparation of solder paste.
2. Water and low viscosity oils are newtonian, all other liquids are non-newtonian. Of the non-newtonian fluids, solder paste is pseudoplastic and thixotropic. This means that with increasing shear, the viscosity will lower, and with continued constant shearing, the viscosity will also decrease. Fluids such as solder paste will recover their lost viscosity, but only after a long duration without shear. With this in mind, it is suggested that if a rheological analysis of solder paste is going to be conducted, the paste should be subjected to an increasing sequence of shear rates. If the trend were to be reversed, the solder paste might not fully restore before the next shear rate change, and hence would exhibit undesirable behavior.
3. It is important that the outer cylinder be inserted into the sample fluid to the proper depth. This is achieved when the liquid surface is at the lower lip of the outlet. If the sensor is inserted too far, an excessive load will be put upon both the inner spiral and the outer cylinder. If not deep enough, then the fluid will not be properly circulated through the sensor.
4. Viscosity is greatly influenced by temperature. Quite often, what is thought as instability of viscosity is actually an instability of temperature. With this in mind, the measurement environment should have a constant, stable temperature.

## F. Removing “Inner Spiral and Outer Cylinder

Great care must be taken when removing and installing the inner spiral, so that the sensor shaft is not over torqued. Doing so would cause the viscometer to lose accuracy and therefore require calibration. For these instructions, the sensor is in the fully up position and the thermostat is slid all the way back. Directions are referenced as looking down upon the PCU-200.

1. Hold the upper knurled end of the spindle with your left hand. Your fingers will be up, inside the housing.
2. Loosen the outer cylinder with your right hand, by turning it clockwise and sliding it down over the inner spiral.

3. ***HOLD BUT DO NOT TORQUE*** the lowered knurled collar of the sensor shaft with your left hand.
4. Grasp the knurling of the inner spiral with your right hand and gently turn it ***COUNTER-CLOCKWISE***.
5. Slide the inner spiral down off the sensor shaft.

Installation is the reverse of the above procedure. Remember ***DO NOT TORQUE THE SENSOR SHAFT, THE INNER SPIRAL OR THE OUTER CYLINDER***.

### G. Cleaning

Clean the inner spiral, outer cylinder and sensor shaft immediately after every use. Failure to do so may cause the respective components to adhere together and become inseparable. Damage such as this is not covered by, and will void, the warranty. The cabinet of the PCU-200 should be cleaned with a mild detergent or isopropyl alcohol and a soft rag.

1. Use the plastic spatula to remove the majority of the sample off of the outside of the outer cylinder.
2. Remove the outer cylinder by turning it CLOCKWISE. Take care not to get sample into the gap between the sensor shaft and the spindle. Use the spatula to clean out the inside of the outer cylinder.
3. TURN THE INNER SPIRAL COUNTER-CLOCKWISE to remove it from the sensor shaft. DO NOT TURN IT CLOCKWISE! Use the spatula again to clean the flutes of the inner spiral.
4. Remove more of the sample by wiping the inner spiral and outer cylinder with a soft tissue, such as toilet tissue.
5. Place the inner spiral and outer cylinder into a container with a mild solvent. Water, detergent, isopropyl alcohol or white gas are the recommended thinners. Harsher solvents can dissolve epoxies used in the construction of viscometer components, rendering them inoperable. Use of these solvents, such as acetone, touene or flux remover, will void the warranty.
6. Gloves and a toothbrush are suggested to facilitate cleaning. However, to simplify the cleaning process, an ultrasonic cleaner is recommended. For convenience, the AUC-201 Ultrasonic Cleaner is available from your Malcom dealer.
7. Be sure to clean the inside of the inner spiral and the threading of the outer cylinder with a small brush. Wipe off the sensor shaft, the sensor shaft gap, and the temperature probe, with a tissue moistened in solvent.

## HOW TO CLEAN CYLINDER

Clean the inner and outer cylinders immediately after every use. Failure to do so may cause the cylinders to adhere together and become inseparable.

Using a small spatula helps to remove the liquid from the cylinders.

### TYPE A Cylinder

Hold the upper knurled end of the shaft. Loosen the outer cylinder by twisting the knurled area counter-clockwise. (see Fig. G) Slide the outer cylinder down off of the inner cylinder.

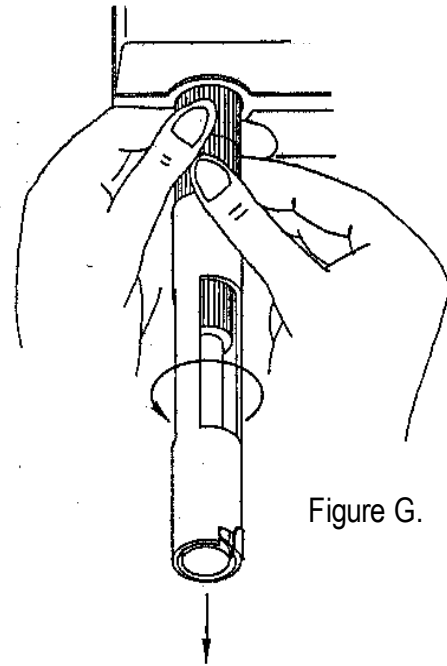


Figure G.

Hold but do not torque the small knurled collar. Grasp the knurling of the inner cylinder and rotate clockwise. Slide the inner cylinder down off the shaft. (see Fig. H) It should require minimal or no torque at all to remove the inner cylinder.

Clean the shaft of the VS-3 with tissue or toilet tissue.

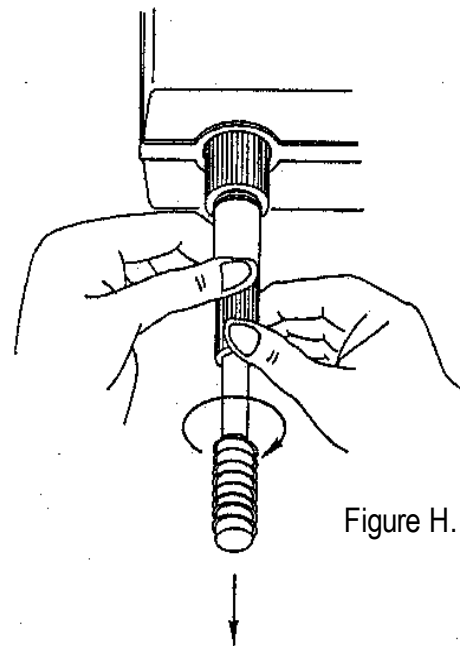


Figure H.

### TYPE "B" CYLINDER & TYPE "C" CYLINDER

Hold the upper knurled end of the shaft. Loosen the outer cylinder by twisting the knurled area counter-clockwise. (see Fig. I) The outer cylinder can drop down and rest on the inner cylinder.

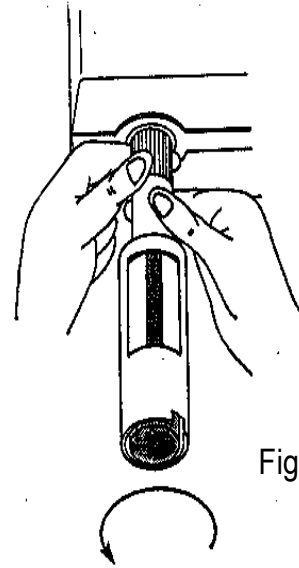


Figure I.

Hold but do not torque the small knurled collar. Grasp the knurling of the inner cylinder and rotate clockwise, slide both inner and outer cylinders down off the shaft together. (see Fig. J) It should require minimal or no torque at all to remove the inner cylinder.

Clean the shaft of the VS-3 with tissue or toiler tissue.

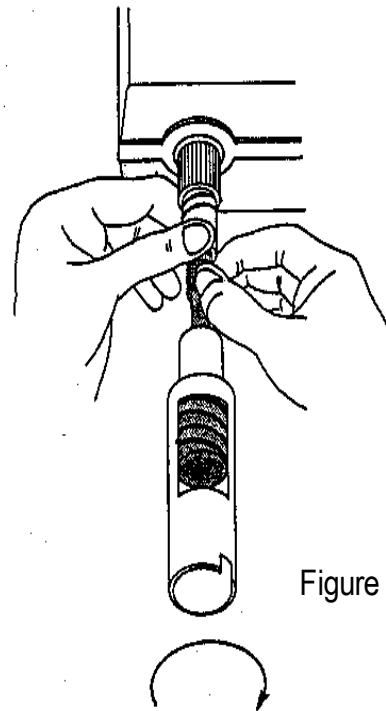


Figure J.

Wash the cylinders in a solvent to completely remove the liquid residue. An ultrasonic cleaner is recommended for thorough cleaning.

### III. MAINTENANCE & REPAIR

To maintain reliable and accurate operation of the PCU-200, proper care, handling and storage are necessary. Additionally, periodic calibrations and inspections are needed to guarantee continued accuracy of measurement. While user calibration is sufficient for normal use, with time the PCU-200 will become out-of-specification and require servicing. In this case, contact your dealer or Malcom directly for assistance. Past experience has indicated that factory calibration is required on an annual basis.

#### A. Storage

Before storing the PCU-200 for extended periods, make sure the inner spiral, outer cylinder, temperature sensor and sensor shaft are clean. Disconnect the power cord from the power outlet and the receptacle at the rear of the PCU-200. Store the cord with the PCU-200 in a clean, cool, dry and dark environment.

#### B. Changing the Paper

With time, the printer will eventually run out of paper. Follow this procedure for replacing the paper. Use only 2.25 inch wide thermal paper. Thermal paper that prints black is recommended.

1. Turn the power off.
2. Pinch the two buttons on either side of the printer faceplate together. Remove the faceplate.
3. Use your forefinger to pull on the little tab, to pull out the printer. It will stop.
4. If there is still a little paper left on the spool, cut the paper with scissors. Carefully pull the cut piece out of the printer, from the front, using a downward motion.
5. Remove the old spool by sliding it off to the right.
6. Prepare the new roll by removing the tape and cutting a clean angled edge in the paper.

7. Slide the roll onto the shaft so that the paper unrolls in a counter-clockwise direction.
8. Carefully feed the paper up into the slot at the bottom front of the printer. You will see some soldered wires off to the side of the slot.
9. Feed the paper until you feel resistance.
10. Turn on the power. Be careful not to touch the bare circuit board.
11. Hold down the feed button while pushing the paper into the slot. It will eventually grab the paper and pull it in.
12. Continue to press the feed button until about 2 inches of paper is exposed.
13. Push the metal tab, so to slide the printer back into the housing.
14. Grasp the faceplate by the two side buttons and feed the paper from the back of the faceplate to the front.
15. Carefully snap the faceplate back on, make sure the feed button and the paper LED align up with their respective holes.
16. Pull on the paper to take up any slack, and tear off the end with an upward motion.

### C. Setting The Time

1. Turn off the power.
2. Push and hold the time switch while turning the power back on.
3. The viscosity display will now show the year, with the first two digits flashing.
4. Press the adjust switch to select either 19 or 20, representing 1900 or 2000 respectively.
5. Push the print switch to select the third or decade digit.
6. Press the adjust switch to increment the flashing digit. The digit will rollover from 9 to 0.
7. Proceed in this fashion for the rest of the “year” and month setting in the temp/speed display.
8. Push print again and the displays will change to day of month and time. Set these parameters in the same manner as the year and month.
9. After setting the minute, press print and the time and date will be entered. Turn off the power.

#### D. User Calibration

User calibration should be performed whenever the viscometer's performance is questionable. Should you find that the calibration procedure is not giving satisfactory results, or that you do not wish to do the calibration yourself, please contact your dealer or Malcomtech International.

Equipment necessary for calibration:

1. Malcom calibration fluid (check the certificate for viscosity)
2. Jeweler's screwdriver
3. Calculator

Before calibration, the inner spiral and outer cylinder must be clean and installed on the PCU-200. The calibration fluid has a viscosity, in Pa·s, printed on its label. Make note of this viscosity. A temperature compensation table is included in the appendix. Familiarize yourself with this information, in case you are not able to attain the 25.0°C temperature necessary for calibration.

1. Follow the procedure for normal operation, up to step 14. Use calibration fluid instead of solder paste.
2. Set the temperature set switch to 25.0°C and the speed set switch to 10RPM.
3. Turn on the power, but **DO NOT** lower the sensor into the calibration fluid yet. Shut and latch the door.
4. Push the adjust switch. The LED will light and the viscosity digital display will show the zero value. Allow a few minutes for the zero to stabilize.
5. If the display is flashing, then the value is negative. Use the jeweler's screwdriver and adjust the "0" trim potentiometer so that the display shows a steady 000.0. The adjustment is very sensitive and there is a several minute delay in response to an adjustment.
6. Press the adjust switch a second time and the viscometer will enter the start mode.
7. Press the mix/start switch as necessary to enter the no mode condition. Use the sensor up/down switch to lower the sensor into the calibration fluid. Position the sensor so that the lower lip of the outlet is even with the surface of the liquid.
8. Push the thermostat select switch twice so that mode 2 is selected. This will begin temperature control.

9. Push the mix/start switch as twice so that the start LED is illuminated. The PCU-200 will begin measurement of the calibration fluid.
10. You may have to wait several hours for the temperature of the fluid to stabilize at 25.0°C.
11. The viscosity you previously noted is for when the calibration fluid is at 25.0°C. When the temperature is stable at this value, the viscosity seen on the display should be what you wrote down. The display shows the viscosity in Pa·s, or poise times ten. If you want to know the viscosity in poise, just ignore the decimal point.
12. If the displayed viscosity is not the same as the noted value, adjust the “GAIN” trim potentiometer with the jeweler’s screwdriver. It too, is very sensitive and requires a long time to respond to adjustment.
13. Test the viscosity at 5 rpm, 10 rpm, 20 rpm, 30 rpm. (viscosity are not same)
14. When the displayed viscosity is correct, calibration is finished. Raise the sensor from the fluid and clean up.

### E. Troubleshooting

When experiencing difficulty with the operation of the PCU-200, consult this troubleshooting chart before contacting your Malcom dealer or Malcom for assistance.

<b>Situation</b>	<b>Cause</b>	<b>Solution</b>	
Power switch is turned on, but no display is shown	Fuse has blown	Replace fuse with 2A 250V type	
	Internal circuit board damage	Contact your Malcom dealer for repairs	
A constant value of 000.0 or 1999 is displayed on LCD	Adjusting zero value	Press the adjust switch	
	Strain gage wire has broken	Contact your Malcom dealer for repairs	
Values displayed do not change	Sample has "glued" bearing inside of spindle	Internal circuit board damage	
	Contact your Malcom dealer for repairs	Contact your Malcom dealer for repairs	
	Strain gage wire has broken	Contact your Malcom dealer for repairs	
Values displayed fluctuate greatly	Some object is caught between outer cylinder and inner spiral	Remove outer cylinder and inner spiral, clean them and inspect for object	
	Sample has "glued" bearing inside of spindle	Contact your Malcom dealer for repairs	
	Sensor shaft is bent	Contact your Malcom dealer for repairs	
Values displayed fluctuate mildly	Air entrapment	Remove the bubbles with gentle stirring, or vacuum cleaner	
	Temperature instability	Sample size is too small	
	Changing speed	There is a big difference between room and sample temperatures	Alter either or both temperatures to decrease difference
		Shear rate is transient	Wait a few minutes for stability

Situation	Cause	Solution
<b>Large values are displayed, but no sample is being measured</b>	Sample has “glued” bearing inside of spindle	Contact your Malcom dealer for repairs
	Sensor shaft or outer cylinder is bent, causing rubbing	Contact your Malcom dealer for repairs
<b>Measured value is different from expected</b>	Zero adjustment is shifted	Re-adjust the zero value
	Mis-calibrated by user	Re-perform the calibration or contact your Malcom dealer for assistance
	Internal circuit board is damaged	Contact your Malcom dealer for repairs
<b>Paper LED illuminates</b>	Paper has torn or run out	Check the paper and replace if necessary
<b>Printing of paper is too light to be easily read</b>	Paper is old	Install new black printing thermal paper
	Printing on paper is blue, or pink	Install new BLACK printing thermal paper
<b>Viscometer is a PCU-203 or PCU-205, but neither option A nor option B can be utilized</b>	Viscosity set switch is not a 0000	Set the viscosity set switch to 0000. Select option A or option B again with mix/start switch
<b>Option B, LED flashes no computer control is possible</b>	VAM-1 software was initiated too late	Exit the VAM-1 software and ready it for re-running. Turn the PCU-205 power off then back on. Run the VAM-1 software. Press the mix/start switch repeatedly until the option B , LED is illuminated
	An improper RS-232C cable is being used	Use only the cable supplied with your PCU-205. Contact your dealer or Malcom for replacements

## F. Checking Sensor

The sensor is the most sensitive and crucial part of the PCU-200. If you are experiencing difficulties not covered by the above chart, the following procedure will identify if the sensor is at fault. **FOR THIS SEQUENCE, THE DIRECTIONS ARE REFERENCED WITH THE SENSOR POINTING AWAY FROM YOU.**

1. Remove the outer cylinder and inner spiral
2. Turn the power on and press the mix/start switch twice so that the start LED is illuminated.
3. The viscosity value should drop to zero within 1 minute.
4. Gently, turn the sensor shaft clockwise. It should rotate from 15° to 30° until major resistance is felt.
5. While turning, the viscosity displayed should increase. There is a time delay of 20 seconds for this to happen.
6. Release the sensor shaft.
7. The viscosity displayed will decrease. There is a time delay of 20 seconds for this to happen.
8. Within a few minutes, the viscosity should return to zero.
9. Gently, turn the sensor shaft counter-clockwise.
10. The viscosity displayed should stay at zero.
11. Release the sensor shaft.

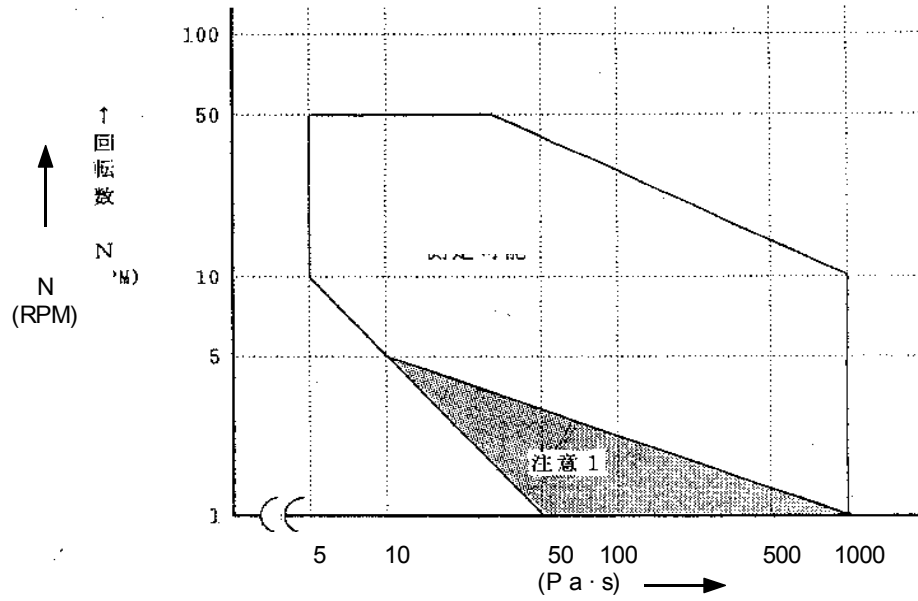
Should you observe results different from the procedure, then there is possibly something wrong with the sensor. In this case, check with the troubleshooting chart again and if you still are unable to resolve the problem, contact your dealer or Malcom.

Malcomtech International  
26200 Industrial Blvd.  
Hayward, CA 94545 USA  
(510) 293-0580 (510) 293-0940

IV. APPENDIX

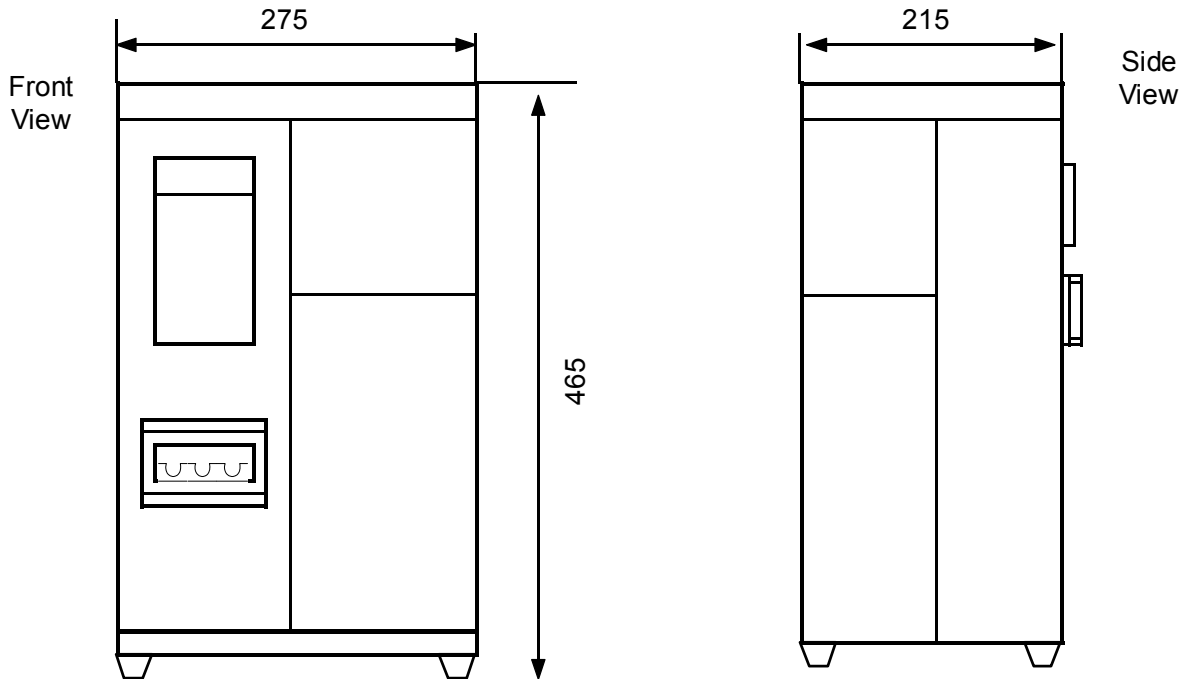
A. Measurement Window

This diagram is the measurement window for the PCU-200 series. It represents the relationship of the maximum and minimum speeds of operation and the maximum and minimum viscosities accurately measurable. For this diagram, the vertical axis is the speed in RPM, the horizontal axis is the viscosity in Pa·s. The shaded area represents a measurement accuracy of 20%.



B. Dimensions

For this diagram, the measurements are in millimeters and the weight of the PCU-200 is 14 kilograms.



### C. Calibration Fluid

Malcom Calibration Fluid is a silicone-based oil which is viscosity stable, chemically inert and relatively non-toxic. The fluid has an indefinite shelf life and service life is diminished only by chemical, particulate and moisture contamination. With this in mind, the fluid should be stored in a clean, cool, dry environment, with its lid securely tightened. Parts that have come in contact with the fluid can be cleaned by using gasoline, kerosene or mineral spirits. An alternate method is repeated cleanings with isopropyl alcohol and/or detergents.

On the label of the calibration fluid are several values of importance. The viscosity is expressed in poise, (P), or Pascal seconds (Pa·s), at 25.0°C when undergoing a shear rate of “D” reciprocal seconds, (sec<sup>-1</sup>). By Malcom’s patented design, “D” is constant, but it is dependent upon the type of inner spiral and outer cylinder attached to the viscosity sensor and the speed that the sensor rotates. For the PCU-200 series, an “A” Type, D is 6 at 10RPM. You should not attempt to calibrate the viscometer at different rotational speeds, as this will yield incorrect measurements.

### D. Temperature Compensation

When calibrating your viscometer, it is recommended that the silicone oil be at a constant temperature of 25.0°C. Since some Malcom viscometers do not have a “thermostat”, obtaining this temperature can be difficult. For that reason, a temperature compensation table was constructed.

As an example, consider that the calibration fluid has a standard viscosity of 931 poise at 25.0°C under a shear rate of 6 reciprocal seconds. This is “A” Type. After waiting an hour for stabilization, the best temperature control you can obtain is 24.6°C, as seen on the viscometer digital display. Go to the left-most column of the table and proceed down to the 24. Now move to the right so that you are in the .6 column. You should see 1.008. This is the multiplier. At 25.0°C and standard conditions, the viscosity of the calibration fluid is 931 poise. However at 24.6°C, the viscosity is 931 x 1.008 = 938.448 poise. This should be rounded to the nearest poise. So, at 24.6°C, you should calibrate the viscometer to 938 poise.

°C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
23	1.040	1.038	1.036	1.034	1.032	1.030	1.028	1.026	1.024	1.022
24	1.020	1.018	1.016	1.014	1.012	1.010	1.008	1.006	1.004	1.002
25	1.000	0.998	0.996	0.994	0.992	0.990	0.988	0.986	0.984	0.982
26	0.980	0.978	0.976	0.974	0.972	0.970	0.969	0.967	0.965	0.963
27	0.961	0.959	0.957	0.955	0.953	0.951	0.950	0.948	0.946	0.944

## VAM-2 Startup Instructions

### Preliminary Settings on PCU-205

1. Set the viscosity settings "**VISCOSITY [A]**" to "**0000**". If it is not set to zero, the unit will not communicate with the computer.
2. It is recommended that the temperature setting for "**TEMP[B]**" be set at "**25.0C**"

### Software Installation Steps(Windows 95/98):

1. Insert VAM-2 diskette into the 1.44 floppy drive.
2. Go to Windows Explorer by:
  - A) Placing the arrow cursor on the Start button and click the right side button on the mouse to bring up a shortcut menu.
  - B) Click on "Explore".
3. On the leftside of Explorer, locate the floppy drive icon and open it.
4. On the rightside, locate the "**Install.bat**" executable icon and double click on it to activate the installation process.
5. Wait a few minutes, the program will install in a MS-DOS Windows mode. After the installation process is completed, close the MS-DOS window.
6. Under Windows Explorer, locate the "vmw" folder and open it. On the rightside, locate the "Vam-2.exe" icon, click and drag it to the desktop. Windows will create a shortcut icon.
7. Remove Vam-2 diskette from the floppy drive and restart the computer.

### Installation Steps for Windows NT:

1. Go to MS-DOS prompt
2. Insert VAM-2 disk software. Go to "A" prompt by typing "**A:**" .
3. Type "**instnt\_a\_c**" to activate the software installation process.
4. After the software installation is complete, restart the computer.

5. Go to Explorer window for NT. Locate the "VAM-2.exe" in the "VMW" folder and make a shortcut for the desktop.

Activation Steps:

1. Turn the PCU-205 unit off completely.
2. Turn off the computer system that is to be connected to the PCU-205.
3. Connect the RS-232 cable to both the PCU-205 and the computer system.
4. Turn the computer on. Start the VAM-2 software.
5. Go to "Measure" on the top menu bar and click on it.
6. When "C:\vmw\data\untitled" window is displayed, click the "Online" tab.
7. Turn the PCU-205 unit on.
8. Wait a few seconds, then click on the communication button under the "Online" tab.
9. Press the Mix/Start button on the PCU-205 (four times, slowly) until the LED for Option B is activated. Wait fifteen seconds and the unit will activate communications with the computer.