

BROOKFIELD MODEL AST100
IN-LINE VISCOSITY CONTROL SYSTEM
Installation, Operation and Maintenance Instructions
Manual No. **M02-590-D0404**



SPECIALISTS IN THE
MEASUREMENT AND
CONTROL OF VISCOSITY

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Section 1 - In-Line Viscosity Control System Description

Introduction

The Brookfield Model AST100 In-Line Viscosity Control System is a highly sensitive, versatile instrument that measures process fluid viscosity in a fully flooded product stream under pressure or vacuum. Brookfield In-Line Viscometers are unaffected by changes in pressure or laminar flow.

The AST100 In-Line Viscosity Sensor is a vibratory style sensor that generates a digital signal that is proportional to viscosity. This digital signal remains unaffected by severe process conditions.

The System shown in Figure 1-1 can be used in a variety of industrial applications where the viscosity of chemicals, coatings, inks, and many other process fluids must be controlled or monitored.

Features and Benefits

The AST100 In-Line Viscosity Control System incorporates the following features:

- Easy startup, control and operation
- Instantaneous response
- Large viscosity range
- Multiple output signal options
- Versatile, easy-to-use Viscosity Controller

The AST100 In-Line Viscometer incorporates the following benefits:

- No rotating parts, therefore, the only seals are static o-ring seals.
- Sensor is cleaned-in-place as part of the system cleaning procedure, thereby, minimizing downtime.
- Repeatable and stable control — optimizes product consistency and quality.
- Provides a permanent record for quality control when used with a data recorder or computer system.
- Operates continuously and instantly responds to changes in viscosity.
- Minimal to no pressure drop across the sensor housing.
- Linear output signals are compatible with most industrial process control equipment.
- Installs directly in-line or in a by-pass line.

Theory of Operation

The product stream flows through the inlet into the AST100 viscosity sensor-measuring chamber, as shown in Figure 1-1, where it is exposed to the sensing probe which is vibrating in a torsional mode. The viscometer has been calibrated and correlates the viscous damping effect of the fluid on the probe to viscosity. The fluid temperature is measured using an RTD (Pt100) located in the probe. Viscosity and Temperature are displayed on the Controller. The

Controller may be used to control the viscosity of the fluid using a relay controlled solenoid valve that opens based on a setpoint that is entered by the operator. Aside from controlling, the system has available 4-20 mA outputs for viscosity and temperature, RS485 output, and RS232 output (see data string information described in Appendix E).

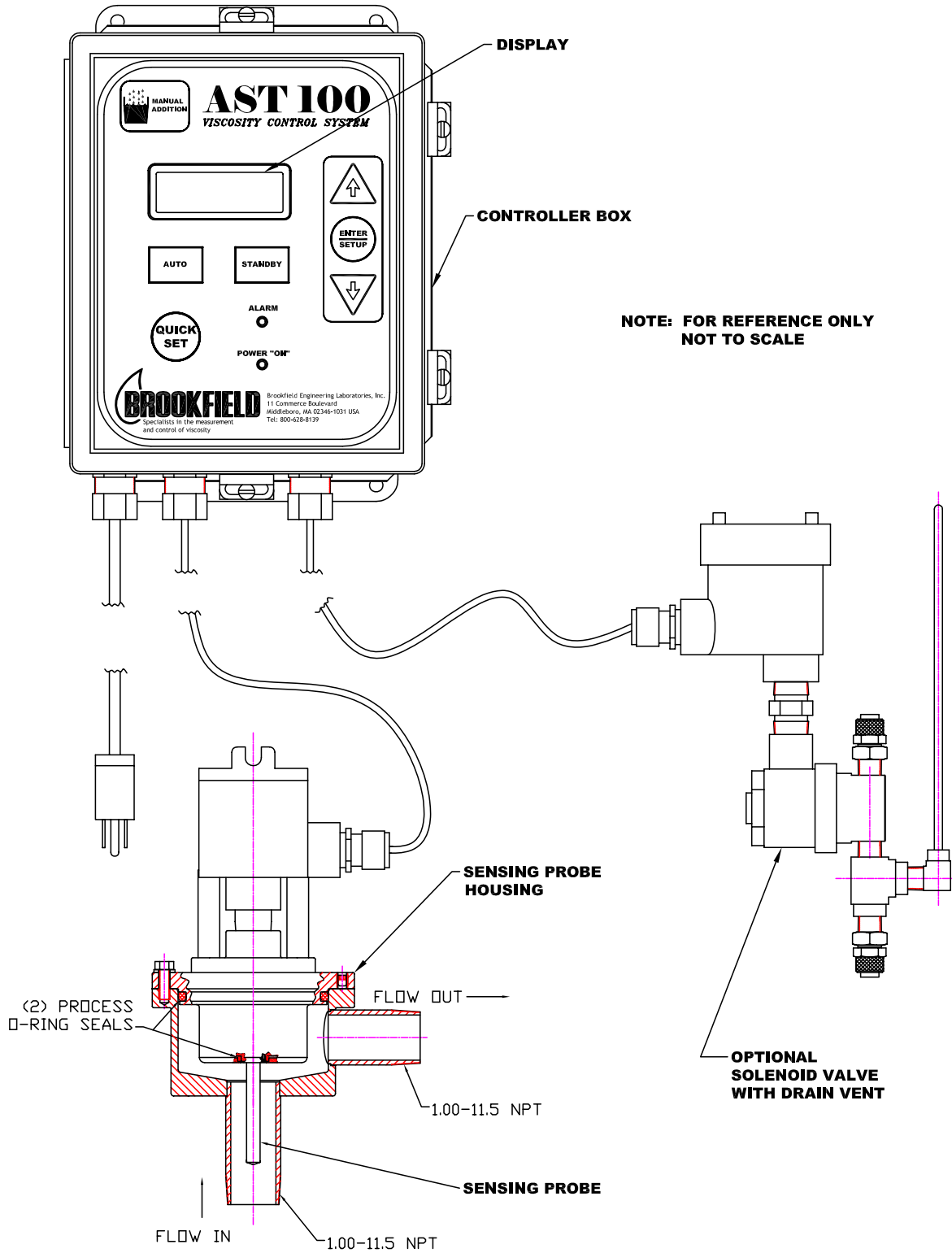


Figure 1-1: Typical AST100 System

Specifications

Table 1-1: Model AST100 In-Line Viscosity Control System Specifications

Parameter	Value
Viscosity Range	2 - 3,000 cP
Temperature Range	-20° - 120° C
Pressure Range	Vacuum to 200 psig
Reproducibility Unit to Unit	± 5% of reading
Repeatability and Stability	± 1% of reading
Signal Outputs	4-20 mA, RS232, RS485
Sensor Housing Connection	1 inch Male NPT inlet and outlet
Material of Construction	316L Series S/S
O-ring Material	EPDM –chamber & Isolast –probe
Weight of Sensor Housing and Sensor	<10 pounds

Component Identification

The following paragraphs provide a brief description of each component within the AST100 Viscosity Control System. Refer to Figure 1-1 for the component location within the system.

Viscosity Controller

The Controller contains all of the electronics and software that operates the sensor, controls the viscosity, and sends the data out. The Operator Interface is located on the front face of the Controller Box. The Display is located within the Operator Interface.

Sensing Probe

The Sensing Probe is the 5/16 diameter rod that is immersed in the fluid. This rod senses the viscous damping of the material and that information is taken back to the Controller for processing.

Sensing Probe Housing

This housing is the component that is plumbed into the process line. Its main function is to house and protect the sensor. The housing is provided with 1" NPT male connections.

Solenoid Valve

This is an optional component used in dilutant controlling applications or where required. This solenoid valve is controlled by the "Dosing" Relay located in the Controller (wiring connection is labeled "Out 1" and is located at G-3 on the Terminal Board as shown in Figure 2-7). The solution that is used to dilute the process fluid is dispensed through this valve into the fluid reservoir. The valve is supplied with a drain vent standard to avoid vacuum locking the dilutant solution in the line between the valve and the reservoir.

Section 2 - Installation

Unpacking and Inspection

NOTE: Upon receipt, inspect the shipping carton and viscometer components for shipping damage. Report any damage to the shipping company immediately.

The shipping carton should contain the following components:

- AST100 Viscosity Sensor in its Housing
- AST100 Controller Box
- Cabling
- Instruction Manual
- Optional Equipment

Installation Requirements

The AST100 must be installed in a manner that will optimize its performance. The installation requirements are:

- Provide a continuous product stream to the viscometer with a minimum time lag between the viscometer location and point of changes.
- The AST Sensor Cable should not be installed through the same conduit as line voltage. Use separate conduit. Do not run cable past line voltage terminals.

NOTE: Sensor must be rinsed clean after use. This is accomplished as part of the system cleaning. If material is allowed to dry out on the sensor, it may affect the proper operation of the unit.

- Install the viscometer so that it is always full of fluid. Mounting is recommended as shown in Figure 2-1. Avoid pipe configurations that allow air or solids to collect in the Sensor Housing. The viscometer only measures the viscosity of fluid located around the probe sensor.
- To avoid damage to the viscosity sensor, it should always be installed after some sort of filtering device or screen.

Installation

Cleaning

To ensure proper operation of the viscometer, it is important to flush clean the sensor once the operation has been shut down. Do not allow material to dry out on the sensor or it may not work properly. If the sensor is flushed clean as part of the system cleaning procedure, it will continue to operate accurately. Long term tests have shown that there are no effects of build-up on the probe sensor surface during operation.

NOTE: Do not exceed the Temperature or Pressure ratings of the system during cleaning. Care should be taken to ensure that all cleaning materials are compatible with the elastomeric o-rings in the probe housing.

Mechanical

Depending upon your mounting requirements, refer to the appropriate installation diagram as shown in Figures 2-1 through 2-6 to install your viscometer. Additional components (brackets, solenoid valves, etc.) may be desired depending on your specific process equipment.

Required Utilities

The AST100 requires the utility connections listed in Table 2-1 to operate.

Parameter	Value
Supply Voltage	115/230 VAC (auto set), 1 \emptyset
Line Frequency	50 or 60 Hz
Power	5 A Draw Maximum

Table 2-1: Utility Requirements

Electrical

Figures 2-1 through 2-10 shows the Controller Terminal Board that is located inside of the Controller enclosure. Refer to this figure for the following hook-ups.

NOTE: The AST Sensor Cable should not be installed through the same conduit as line voltage. Use separate conduit. Do not run cable past line voltage terminals.

Power In

The unit is supplied with a 3-prong plug with six feet of cord as standard. This cord may be removed and the power cabling may be hooked directly into the terminal board. Location G-2 on the terminal board is where this hook-up is located. The terminal board itself is printed with "AC IN". At this screw terminal, you will see three letters printed on the terminal board at three corresponding screw terminals. These letters stand for the following (this connotation is the same wherever used):

E = Earth

L = Line

N = Neutral

NOTE: The Earth terminal is not used. The ground wire from the input power cable must be connected to the panel ground stud shown in Figure 2-10.

The Live and Neutral wiring should be hooked up to the screw terminal accordingly. If the customer is bringing power to the screw terminals, the cord fittings must be used on the Controller enclosure. Failure to do so will allow materials to migrate into the Controller enclosure. The power-input rating is 115/230 VAC, 50/60 Hz, 5 amp maximum. The unit has a 1000 Watt maximum power specification. The typical power requirement is 50 Watts.

Dosing Relay Out

Located next to the Power In terminal is the Relay Out Terminal ("OUT 1" at location G-3). The Relay is closed when the system determines that a "Dose" should be issued. This terminal should be wired to the Solenoid Valve (or other mechanism) that controls the addition of dilutant to the fluid reservoir. The power rating of this relay is the same voltage and frequency as the power input and 1.5 Amp maximum. The screw terminals are marked "E", "L", & "N" for hook-up. See Figure 2-3 for Solenoid Valve recommended wiring.

NOTE: The "E" (Earth) terminal is not to be used. Bring the valve ground wire to the panel ground stud shown in Figure 2-10.

Feed Pump Sensing Hook-Up

This controller has a provision for sensing when the Feed Pump is on and when it is off. On the Terminal Board at location G-8 is a 3-wire terminal marked "ACSENSE". These terminals are once again marked "E", "L", and "N". This terminal should be wired from the Feed Pump as shown in Figure 2-8. The AC Sense input rating is 115/230 VAC 50/60 Hz single phase. Contact the factory for instructions on wiring a three-phase Feed Pump.

NOTE: The "E" (Earth) terminal is not to be used. Bring the valve ground wire to the panel ground stud shown in Figure 2-10.

NOTE: If the AC Sense feature is not used, caution should be taken to avoid over-dosing the process material if the feed pump is turned off. Due to the shearing action of the fluid flow, some materials are "thinner" while being pumped and may thicken up when the pump is turned off.

Viscosity Sensing Probe Hook-Up

There are eight wires and a Sensing Cable Ground/Shield coming from the Viscosity Sensor to the Controller. The screw terminals for connecting the sensor to the Terminal can be found at location A7 through A8. The terminals are labeled "RTD" and "PROBE". Figure 2-10 shows the connections. The Sensing Cable Ground/Shield must be terminated to the Panel Ground Stud shown in Figure 2-10.

NOTE: The system is supplied with (2) ferrites shipped loose (BEL Part No. VPV-115). These ferrites must be installed over the probe sensing cable inside the controller box as shown in Figure 2-10.

NOTE: The sensing cable should not be installed through the same conduit as line voltage. Use separate conduit. Do not run cable past line voltage terminals.

NOTE: At the probe end, connect the ground/shield cable from the sensing probe hook-up wire to the ground stud as shown in Figure 2-9.

4-20mA Output

The milliamp outputs are at location C-6 on the Terminal board. There is one labeled Vis for the Viscosity Output and one labeled Temp for the Temperature Output. The terminals are two-screw terminals and are marked with + and -. See Appendix C for settings.

NOTE: Negative terminal is earth grounded and max. load impedance is 1000 W..

RS-232 Output

At location B-4 on the Terminal board you will find the RS232 screw terminal. There are three screw terminals marked "R", "T", and "G". They mean as follows:

R = Receive

T = Transmit

G = Ground

Port Settings

Bits Per Second: 9600

Data Bits: 8

Parity: None

Stop Bits: 1

There is no hand-shaking with this output, See Appendix E for a description of the output string.

RS485

The RS485 screw terminal is located at B-2 on the Terminal board. There are three screw terminals that are labeled "+", "-", and "G". The G stands for Ground. See Appendix E for a description of the output string.

Alarm Relay

At location G-4/G-5 is a connection labeled "OUT 2". Whenever the Controller is in an "Alarm" condition, this relay closes. The power rating of this relay is the same voltage and frequency as the power input and 1.5 A maximum.

NOTE: If this relay is wired to a secondary device such as a light or valve, do not connect the device's ground wire directly to the "Out2" terminal block. Connect the ground wire to the panel ground stud shown in Figure 2-10.

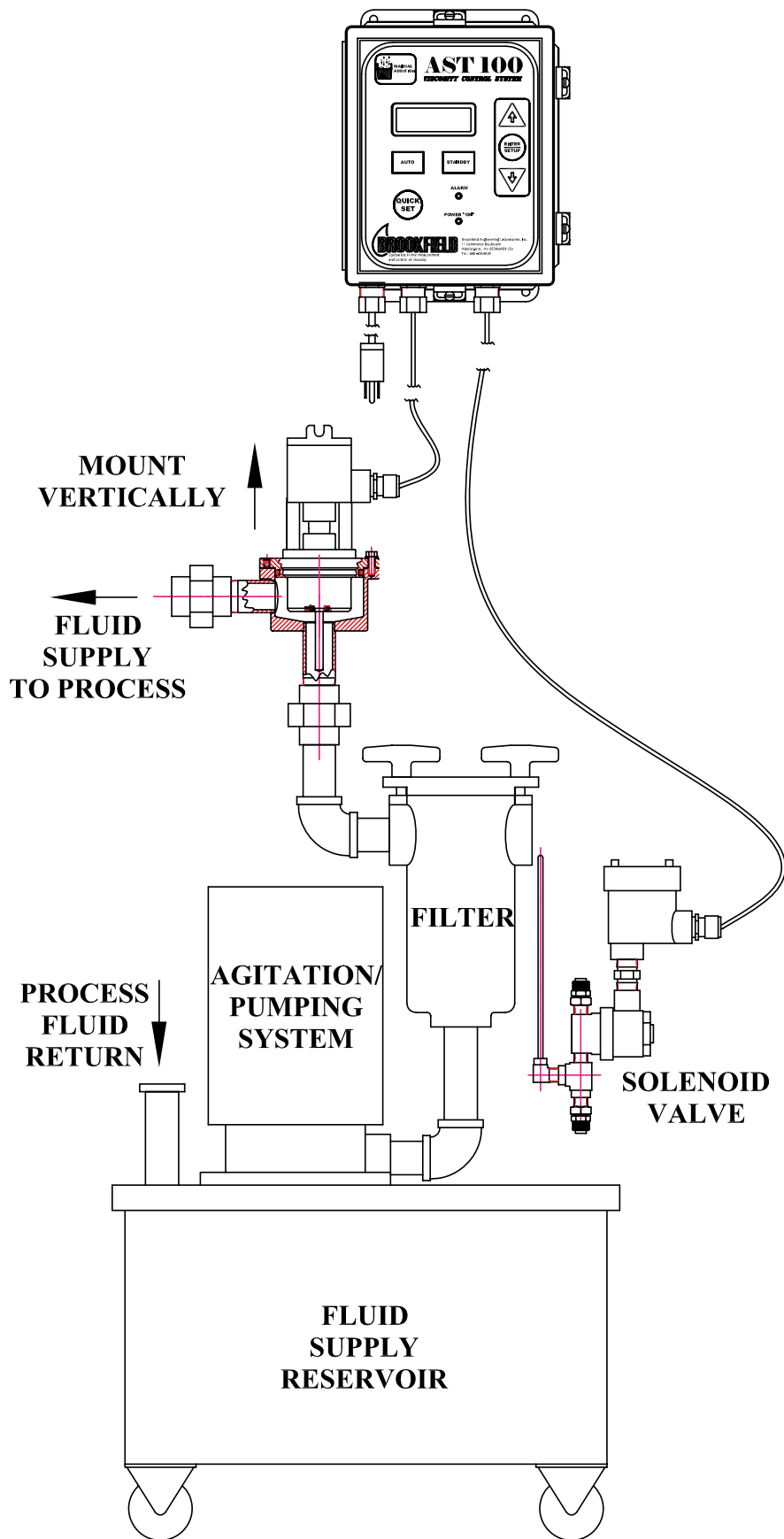
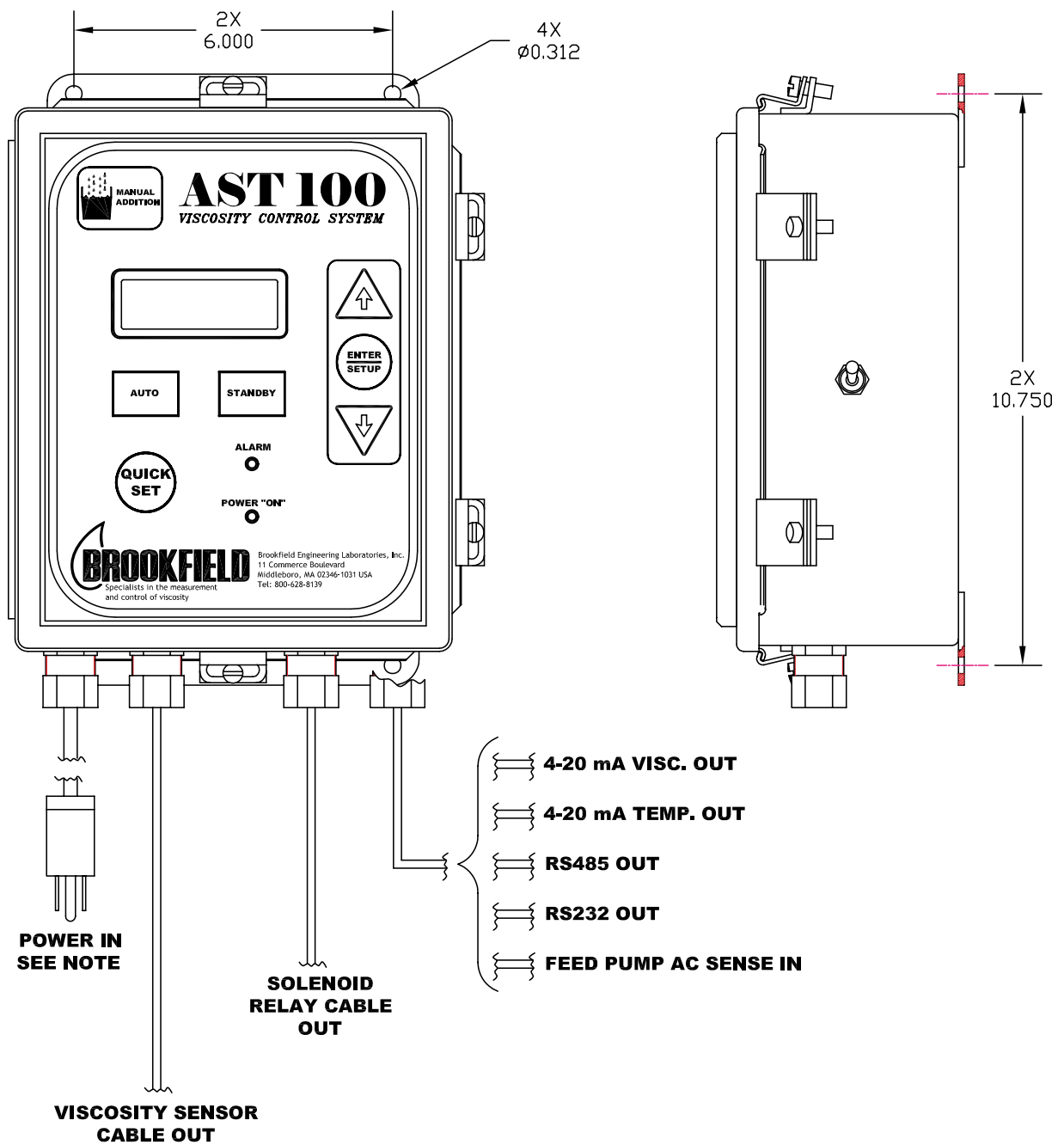


Figure 2-1: Typical AST100 Installation



NOTE: Power In cord may be removed and power may be brought directly into the terminal board located inside of the controller enclosure. The earth ground wire of the power cable must be terminated at the panel ground stud located inside the controller box as shown in Figure 2-10. All grounding wires that are brought into the controller must be terminated to the panel ground stud shown in Figure 2-10.

Figure 2-2: Viscosity Controller

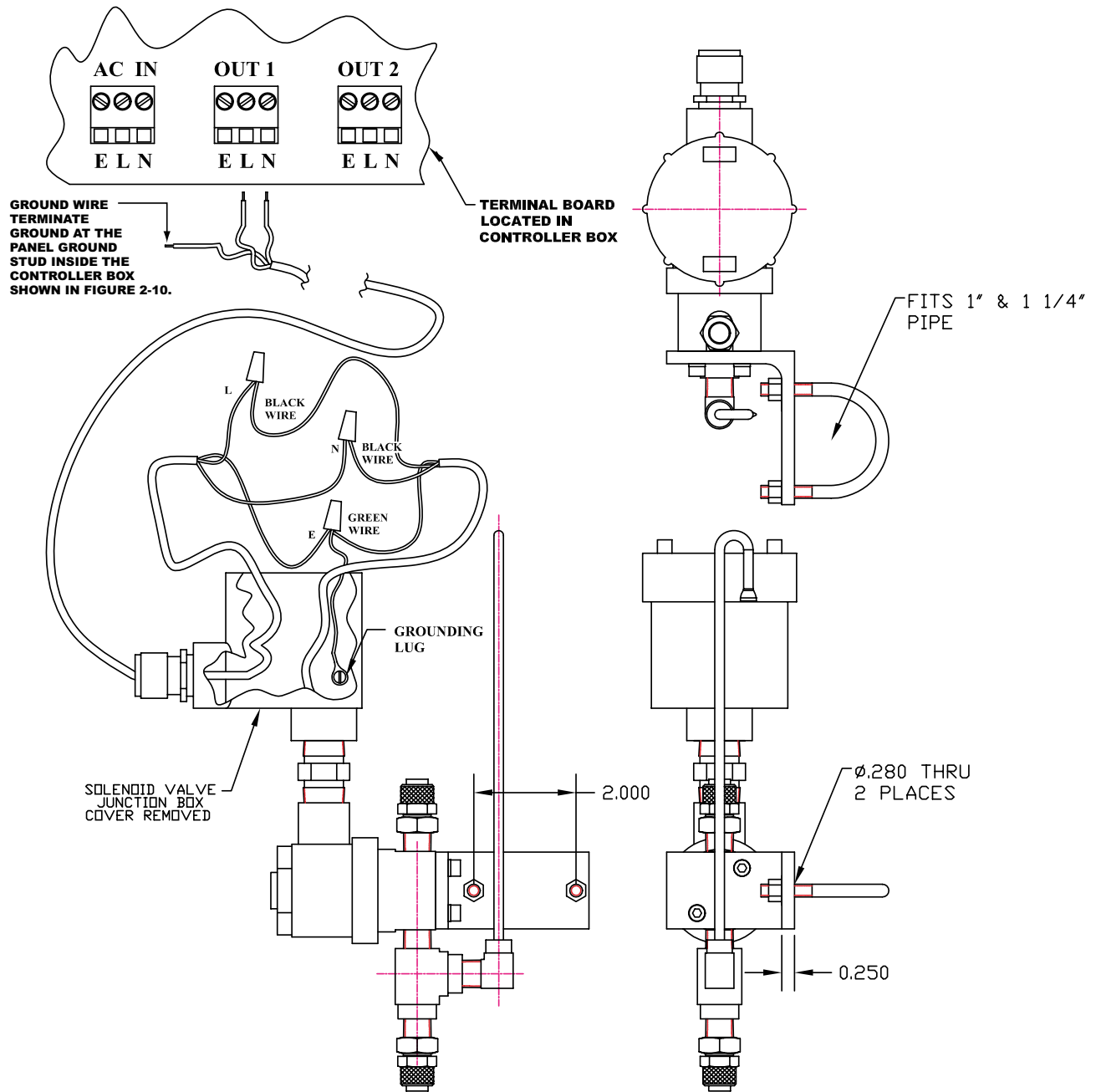


Figure 2-3: Solenoid Valve Wiring

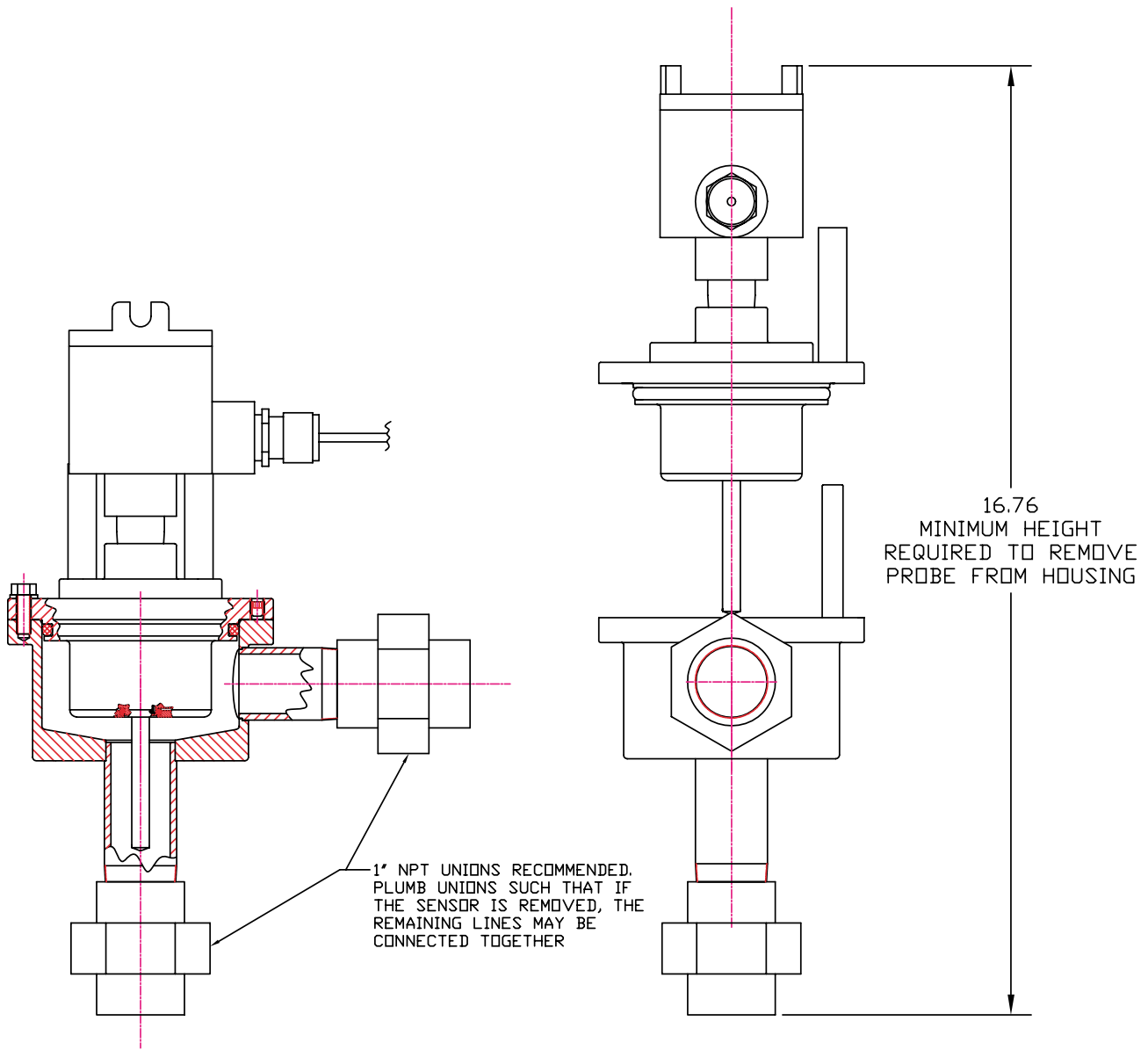


Figure 2-4: AST-100 Installation Clearance

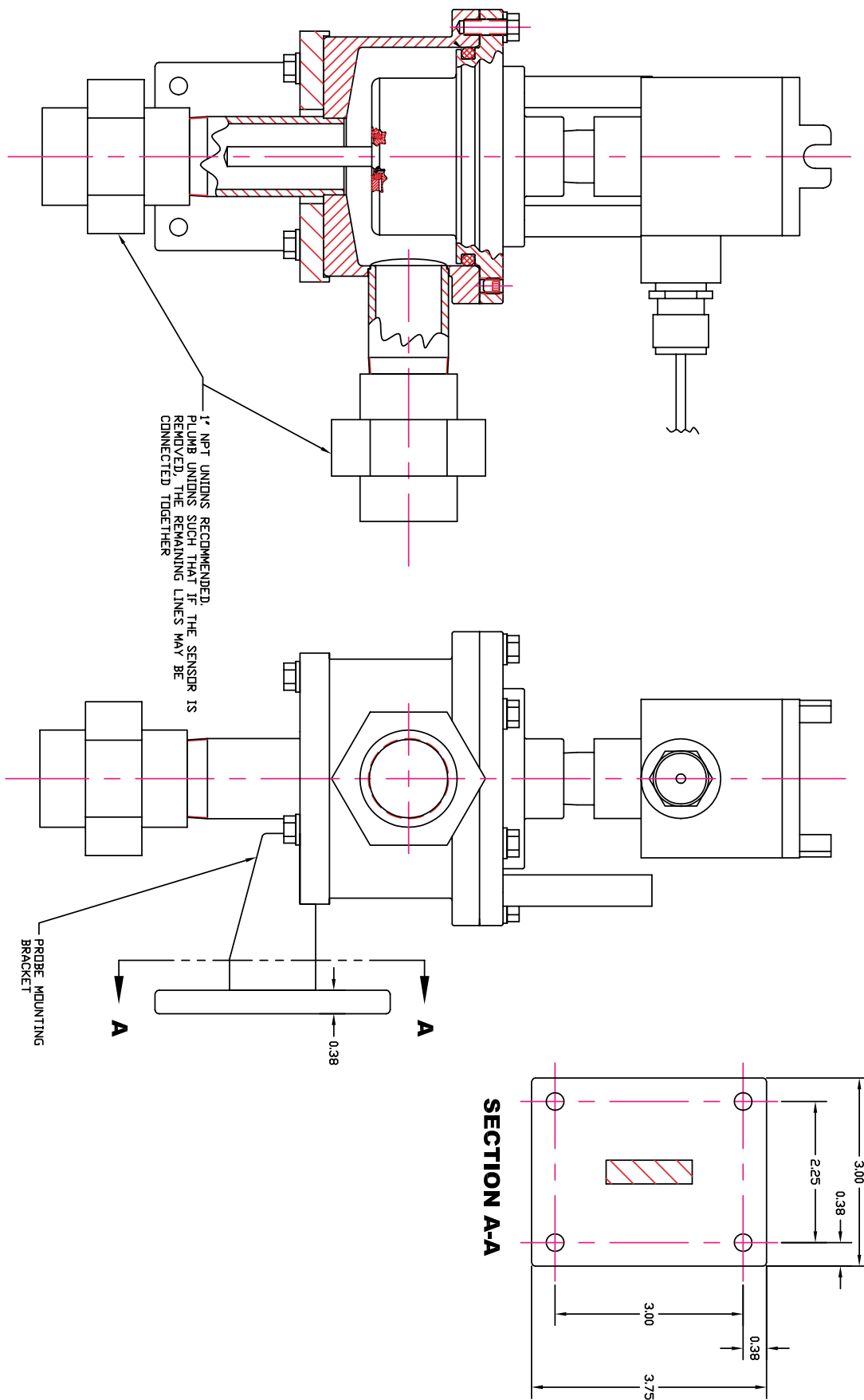


Figure 2-5: Optional Bracket Mounted Viscosity Sensor

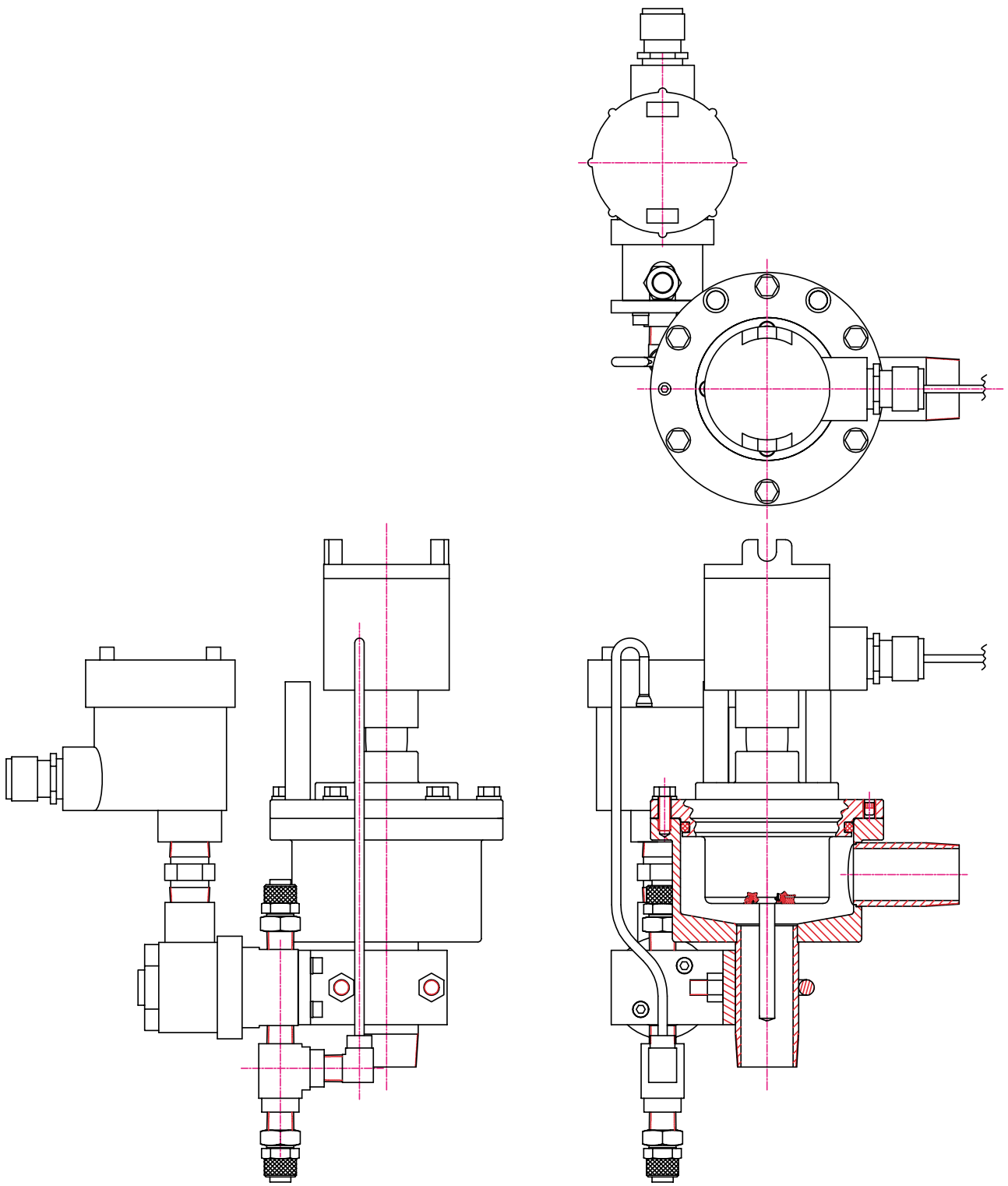


Figure 2-6: Stand-Alone Optional Solenoid Valve Mounted to Stand-Alone Viscosity Sensor

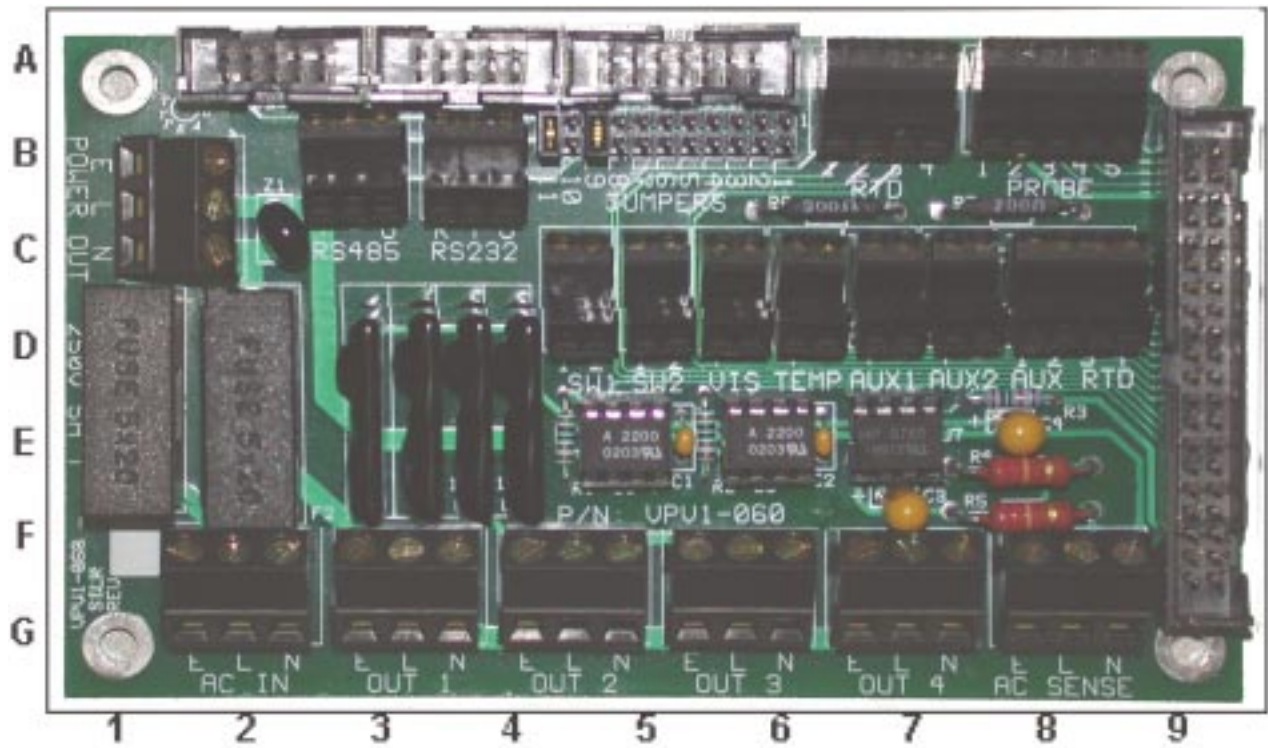


Figure 2-7: Terminal Connector Board Located Inside of the Controller

NOTE: Do not connect ground wires directly to the terminal connector board. Terminate the ground wires at the panel ground stud located in the controller box.

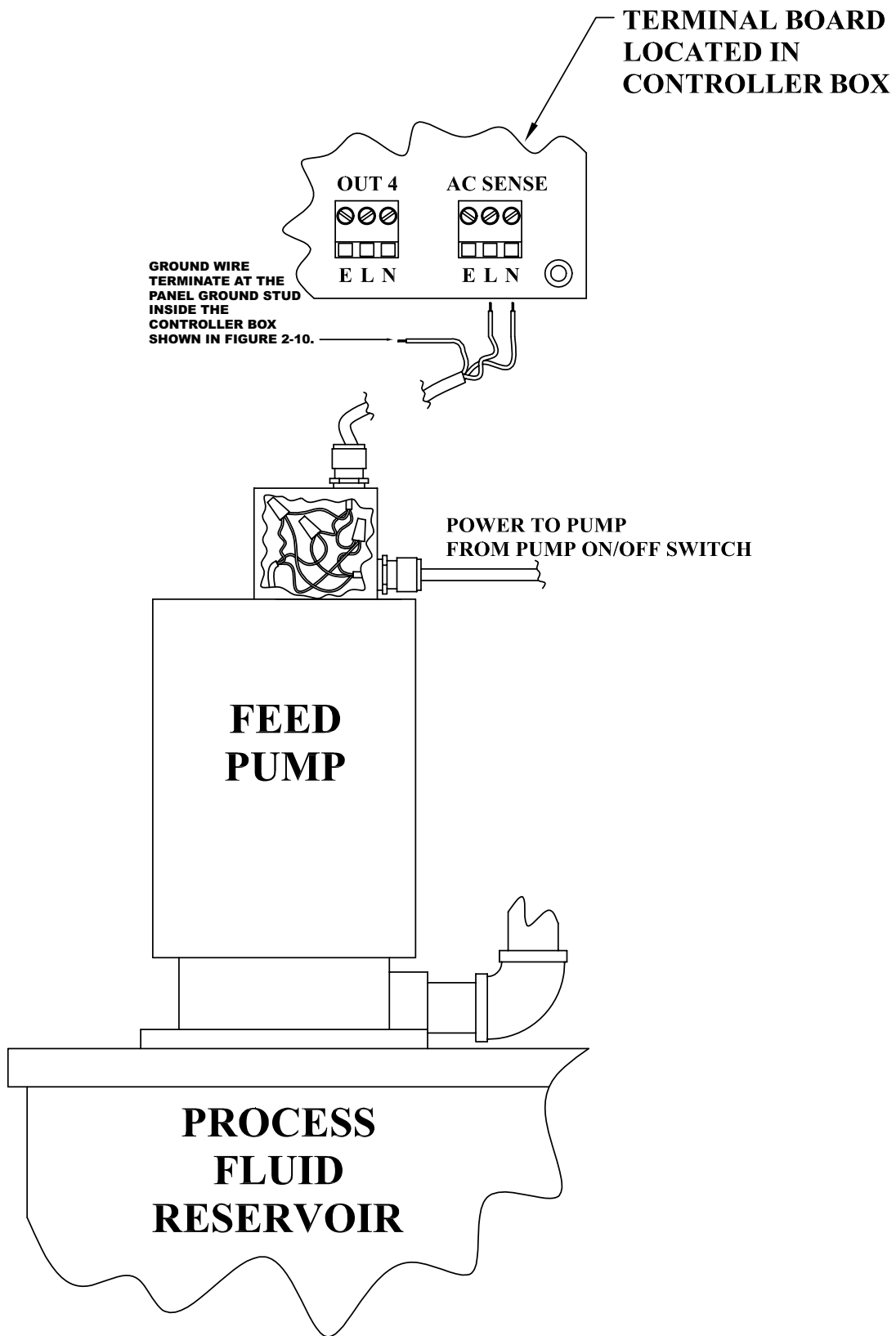


Figure 2-8: Terminal Connector Board Located Inside of the Controller

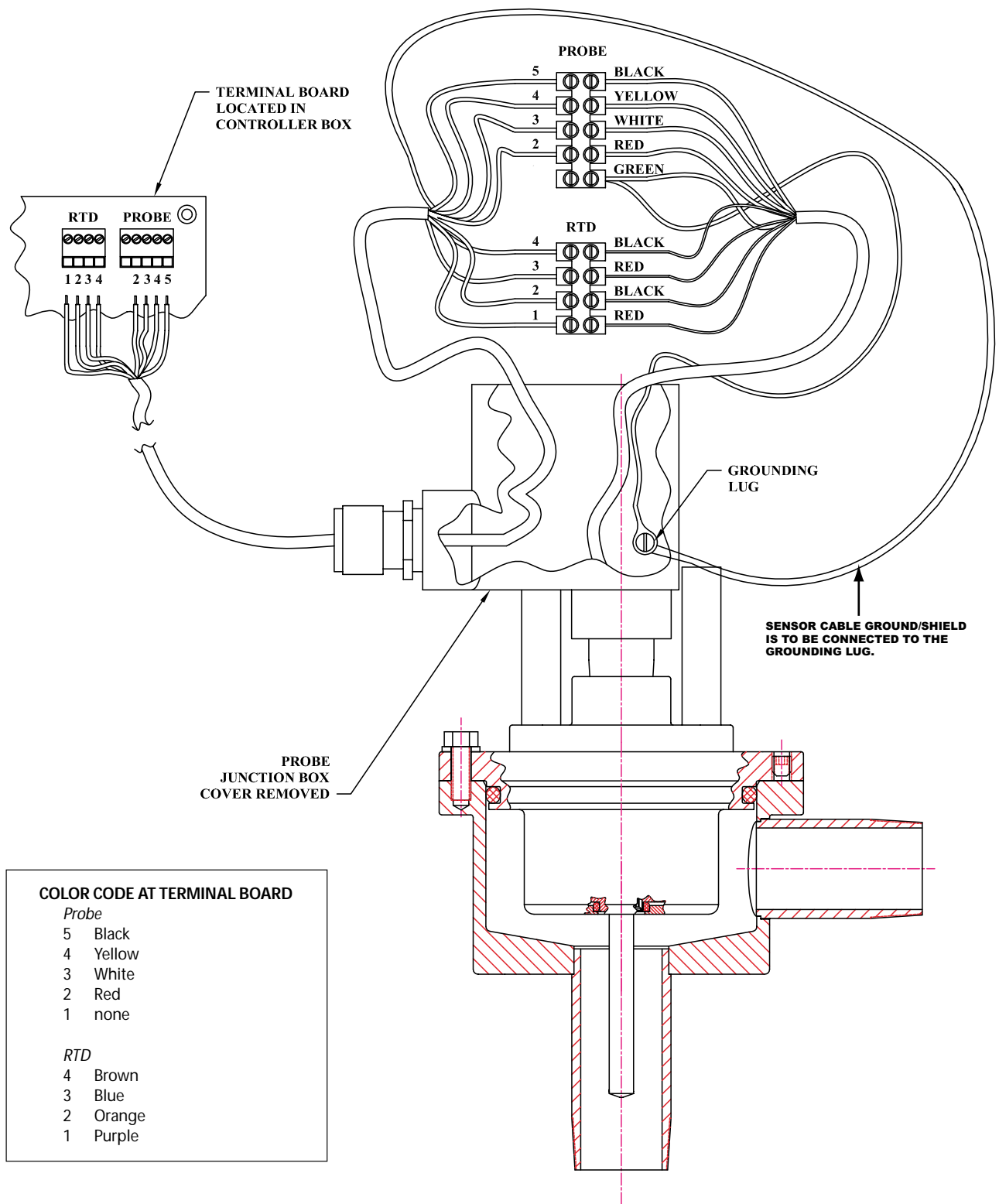


Figure 2-9: Terminal Connection

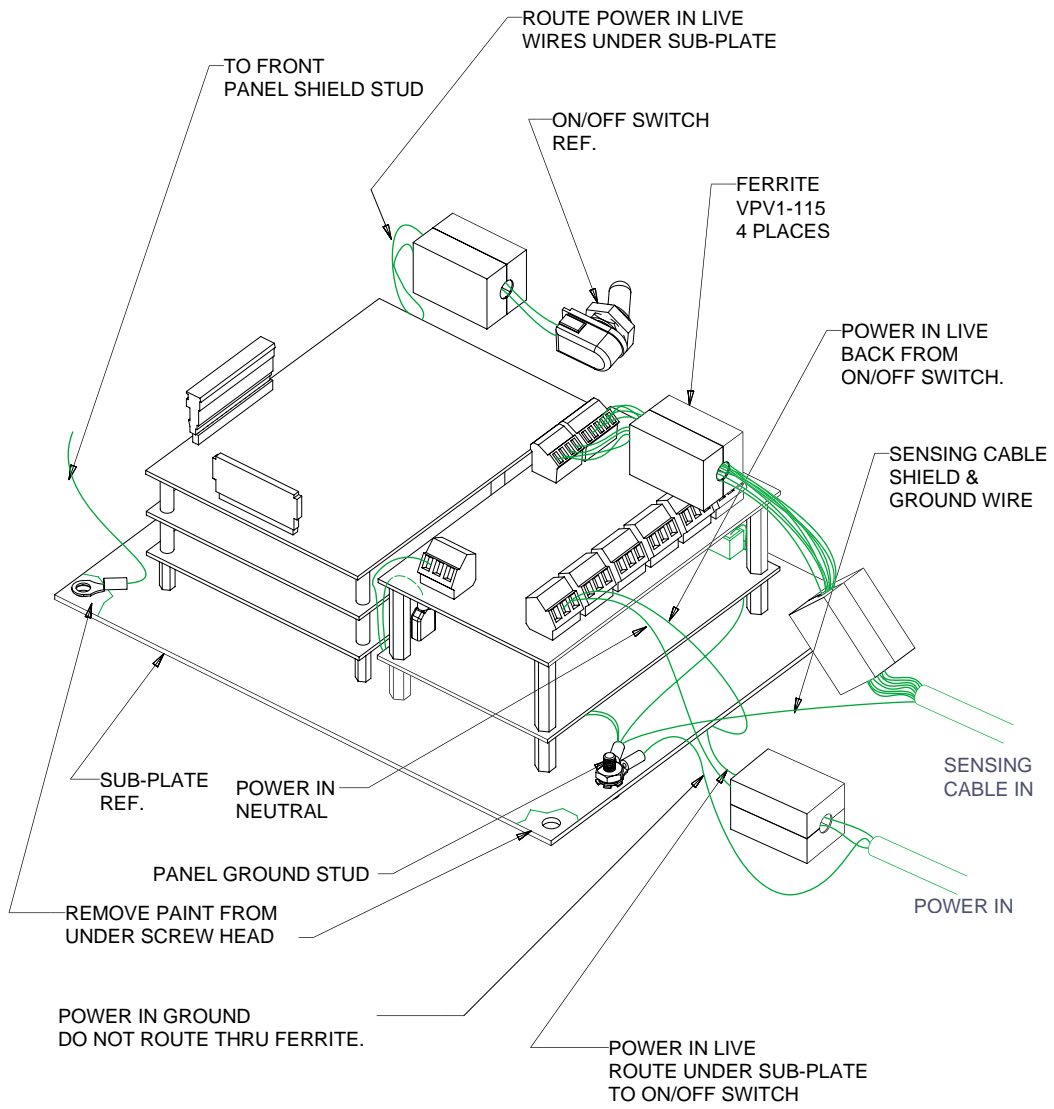


Figure 2-10: Ferrite installation and grounding detail. Components shown are located inside of the AST control box.

Section 3 - Operation

Theory of Operation

The AST100 Viscosity Control System is designed to maintain the viscosity of a material to a customer-selected setpoint. When in "AUTO" mode, the controller will wait a preset amount of time (Interval Timer) and then compare the present viscosity reading to the viscosity setpoint. If the present viscosity reading is higher than the viscosity setpoint, the controller closes a relay (which opens a solenoid valve) for a determined amount of time (Dose Time). The Controller then resets the Interval Timer and starts to count down to 0 again. When it once again reaches 0, another comparison will take place as described above. This loop continues until the operator intervenes. The customer can vary the Interval Time setting and the Dose Time setting to match their process characteristics. These variables are discussed later in this section.

Setup and Variable Description

The following Variables need to be set by the end user prior to operation. The variables are set by entering the Setup menu and by saving the changes upon exiting.

ViscUnits

This variable determines the units that the viscosity is calculated and displayed in. There are 29 different units to choose from. The majority of these (26) are Viscosity Dip Cup ranges. Refer to Appendix B for information on the settings as well as the minimum and maximum values of the range. These ranges are based on empirical data from actual Dip Cups but they may not correlate exactly to your cup readings. If you are in a particular ViscUnits but are outside the range, the Present Value will display *****. You will need to change ranges. An easy way to determine a Cup Seconds range that is applicable is to set the ViscUnits on "cstks" (the centistokes range). Exit and Save from the setup menu and the display will now give you a reading in centistokes. In Appendix B the Cup Seconds minimums and maximums have centistoke values in columns adjacent to them. Choose a range where the Present Value being displayed is in the middle of the range.

NOTE: When changing ViscUnits, the operator must exit and save. If further parameter changes are desired, the Set-Up Menu must then be re-entered after ViscUnits are saved.

ViscStpt

This variable is the viscosity setpoint that you are trying to control your process to. This can be set during the setup procedure or it may be set by hitting the "QuickSet" button on the user interface. This Quick Set value will auto set the same units as the selected ViscUnits. The QuickSet feature will set the setpoint value equal to the current displayed viscosity value of instrument.

IntTimeStpt

This timer can be set from 30 to 990 seconds. This is the amount of time that the controller waits between comparisons. The intention is that if the system determines that a "Dose" is necessary, we need to give that "Dose" enough time to thoroughly mix into the system and allow the viscosity to come to equilibrium

before we dose again. An easy way to determine a good setting is to be in standby mode and add a "Dose" manually by hitting the Manual Addition button on the user interface. Watch the Present Viscosity on the Display and record the amount of time it took from when you "Dosed" to when the Present Viscosity reading stabilizes (this should be done with the system feed pump on). Add 15 seconds more to the time value you get and that should be an adequate Interval Timer Setpoint.

Dose Time

This timer can be set from 1 to 20 seconds. This is the amount of time that the controller closes the Relay (therefore Solenoid Valve) when it determines that a "Dose" is necessary. This setting will depend on the flow constant of the Solenoid Valve (Cv) and the amount of fluid volume in the system. The more volume in the system the larger the required "Dose" will be.

Pump Delay

It has been Brookfield's experience that the viscosity of the material may change when it goes from being at rest to being pumped through a system (ex. the material is shear-thinning). Therefore, a mechanism to let the controller know when the pump is on and when it is off was provided. On the Controller Terminal Board there is a wiring terminal labeled AC Sense. The installer should wire the switched side of the feed pump to this terminal (as shown in Figure 2-8). The Controller then senses when there is AC current at the terminal and when there isn't (thus when the feed pump is on and when it isn't). The Pump Delay is a timer that can be set from 0 to 990 seconds. When the controller is put into Auto Mode, it will wait this amount of time before it starts controlling. This ensures that, on start-up, the fluid in the system has had time to equalize under the pumping action. If the Controller senses that the AC power has been removed from the AC Sense terminal (thus the pump has been shut off), the Controller goes into Standby Mode and the top line of the display reads Feed Pump Off. Once AC current is again sensed at the AC Sense terminal, the operator can put the Controller back into Auto Mode. Once again the timer will count down to 0 before the viscosity is controlled. To disable this setting, set the timer value to 0.

NOTE: If AC Sense is not used, caution should be taken to avoid over-dosing the process material if the feed pump is turned off.

High Alarm

This is a differential alarm setting. If the Present Viscosity reading exceeds the Setpoint + High Alarm, then the alarm light is lit and the Alarm Relay is closed. The Controller will still control in this situation.

Low Alarm

This is a differential alarm setting. If the Present Viscosity reading is below the Setpoint - Low Alarm, then the alarm light is lit and the Alarm Relay (Out 2) is closed. The Controller will still be controlling in this situation although it will never "Dose" since the value is below the Setpoint.

Temp Units

This value can be toggled between degrees Fahrenheit and Celsius.

Date

The operator may change the date setting.

Time

The operator may change the time setting. The Default is Eastern Standard Time.

NOTE: If the time or date are changed, it will be changed in the data that is sent to the RS232 and RS485 port. Be careful not to create data with overlapping dates. This will not create any errors in the controller but it may create problems when you try to use the data.

mAmpOut

The operator may choose from a number of settings for this variable. See Appendix C for available options. Since the viscosity range is large for this instrument, a way is provided to use the 4-20mA output and yet retain the resolution of measurement that is available. To do this, the operator may select ranges for the output. This narrows the range to where the process is running and thus allows the resolution of the measurement to be very good. Refer to Appendix C for the viscosity corresponding to 4 mA and for the value corresponding to 20 mA. The remainder of the range is linear between those two points. These values are set digitally in the controller and there is no adjustment necessary.

Restore Defaults

This variable is used to read the default information from a chip located on one of the Circuit Boards in the Controller. This feature is used when replacing the Sensing Probe. Upon installation of the new probe, the operator needs to remove the old chip from the Circuit Board and install the replacement chip received with the new probe. The operator then should choose the restore defaults feature to read the new calibration data from the chip. Additional information is provided with a new probe.

NOTE: If Restore Defaults is chosen, all of the settings will be changed to the stored settings on the chip they may be re-entered after the new probe is installed. Prior to installing a new probe, the user settings from the Setup Menu should be recorded so they may be re-entered after the new probe is installed.

Operation

Interface Description

Display

The display is a 4-line 20-character display. All pertinent information is shown here including reasons for alarm.

Manual Addition Button

When pushed this button closes the "Dosing" relay ("OUT 1" on the Terminal Board) and thus opens the Solenoid Valve that is wired to it. The top line of the display will say "Manual Addition" and will display a counter that counts up the amount of time that the relay is held closed.

CAUTION: Since the Solenoid Valve is plumbed into the Fluid Reservoir, the Viscosity Sensor does not see the "Dose" immediately. Holding the button down for too long may overdose the system.

Auto Button

When pushed, this button places the system into Automatic Control Mode. The system will then control the viscosity (PV) of the fluid to the setpoint (SV) by closing the "Dose" Relay when it determines it appropriate.

Standby Button

When pushed this button will suspend the Automatic Control Mode thus putting the system into StandBy Mode.

QuickSet Button

When pushed, this button will set the Setpoint (SV) equal to the Present Value (PV) and put the system into Automatic Control Mode. If the system is already in Automatic Control Mode and this button is pushed, the Setpoint (SV) will be set to equal the Present Value (PV) and the Interval Timer will be reset.

Enter/Setup and the Arrow Keys

These keys are used to set the Controller Variables that were described in the Setup and Variable Description section.

Operating Mode (See Appendix C for Operation Flow-Chart)

Once the Probe Sensor has been installed and power has been brought to the Controller Box, you can turn the power switch located on the side of the Controller Box to on.

NOTE: The system is Never to be Run with the Controller Box Door Open. Electrocutation may result.

NOTE: Once the system is powered on, all data ports (4-20mA, RS232, & RS485) become active.

1. Turn the Power Switch to On.
2. Ensure that there are no leaking connections in the Piping.
3. Set all Controller Variables as desired.

NOTE: Once variables have been changed and stored, the values are saved even if the unit is turned off.

4. Ensure that there is Diluting Material (vent supply tank if gravity feed) plumbed to the Solenoid Valve that is controlled by the Viscosity Controller and that the fluid can freely flow to it.

NOTE: Make sure that the Diluting material is all the way to the Solenoid Valve. You may need to hold the Manual Addition button open until the fluid has flowed up to the Valve inlet. If this is not done, the first number of Doses will be air only.

5. Put the system into Auto Mode by hitting the Auto key or the QuickSet buttons.

NOTE: The QuickSet feature was designed so that once the operator has the initial viscosity exactly where they want it, they can hit the QuickSet button which would then set the Setpoint (SV) equal to the Present Value (PV) from the Sensor and put the Controller into Automatic Control Mode.

6. If the "Pump Delay" feature is being used, then when the unit goes into "Auto" cycle for the first time after the Feed Pump has been turned on the Controller will count down to zero from the Pump Delay Timer setting before it actually starts controlling.
7. Once the run is complete, the sensor is cleaned as part of the system cleaning process.
8. The unit may be turned off or left in "StandBy" Mode once the run is completed and the Unit is flushed.

Once the system is in Automatic Control Mode it should maintain the viscosity within a $\pm 1\%$ of the Setpoint.

NOTE: There is a self-diagnostic routine that is continuously monitoring the operation of the sensor. In rare cases, the system may automatically go into an "Auto-Cal" routine. This should not affect the control of viscosity if in Auto mode. If the unit goes into "Auto-Cal" three times in under 10 minutes, the unit will halt operation and display an error message (see Troubleshooting Section).

PV to SV Readout Alignment Procedure

NOTE: This optional procedure is intended for use where numerical compliance with setpoint SV control value (entered from off line measurements) to the PV displayed value is desirable. Adjustment is limited to within the standard high and low limits of the range selection in use. When the viscosity drops below the allowable low limit for the range in use '----' will be displayed for the PV value and '*****' will be displayed for the PV value if the high range limit is exceeded.

1. Refer to Sections 2 and 3 of this manual for initial setup and general operating procedures.
2. Upon completion of all the AST-100 hook ups to the process feed line, power up the AST-100, place on standby and allow 20 minutes for initial warm-up.
3. Allow the process fluid supply to circulate through the AST-100 chamber. The chamber should be full with a representative flow of the process fluid at all times.
4. Enter the required process fluid viscosity set point (SV) value into the Operational Control Menu together with all other required parameters (Re. Section 3 — Operation).
5. Verify the current process viscosity is at entered set point value as determined by the off line grab sample measurement in Step #4.
6. Provided an adjustment of the displayed processed viscosity value (PV) is required, press the controller "Quick Set" button. The current PV reading will be displayed.
7. Use the Up or Down arrow buttons to adjust the PV value displayed to match the SV set point value verified in Step #5.

8. Once the adjustment has been completed, press the “Quick Set” button again to enter the value which at the same time will place the AST-100 into auto control and set the corrected PV reading.
9. Wait 15 seconds for the AST-100 PV data buffer to clear — reload and then display the corrected PV reading.
10. At the upper left hand corner of the screen display, a flashing asterisk (*) will appear to indicate that the PV adjustment was entered. Commence with standard automatic control mode.

Pitfalls to Avoid:

- Do not allow the fluid to dry out on the Probe Sensor once the process is completed. The system should be flushed in a timely manner to avoid this.
- Do not allow the system to run out of the dilutant fluid that is being used to maintain the viscosity (use vented supply for gravity feed vessels).

Viscosity Control System Calibration Check

When you receive your AST-100 Viscosity Control System, you may wish to run a calibration check. To check the calibration, do as follows:

1. Remove the Probe Assembly from the in-line housing, as shown in Figure 2-4.

NOTE: The Sensing Tube is delicate and can be damaged. Take caution not to damage the Sensing Tube as this will cause the unit to not work properly.

2. Submerge the Sensing Tube into the AST-100 calibration fluid which can be purchased from Brookfield Engineering Laboratories or an authorized representative.
3. Go into the Set-up mode on the AST-100 Controller and change the ViscUnits variable to "CSTKS". Exit and Save from the Set-Up Mode.
4. Included with your Viscosity Control System was a certificate that states the calibration value for your probe along with the probe's serial number. Ensure that the serial number of the probe on the certificate matches the serial number on the probe.
5. The PV (present viscosity) reading on the AST-100 display should match the value on the certificate within +/-1%.
6. After verifying this value, clean the probe and re-assemble the probe assembly to the in-line housing. Verify that all bolts are replaced and tightened.

Section 4 - Maintenance

Cleaning in Place

The solvent used for cleaning the viscometer is dependent upon the process fluid being measured. It may be preferable to isolate the section of pipe in which the viscometer is installed from the main process system.

1. Drain the process fluid from the system or isolated section of pipe in which the viscometer is installed.
2. Fill the system, or isolated section of pipe in which the viscometer is installed, with cleaning fluid.
3. The instrument should flush clean along with normal process piping.
4. The instrument should be flushed clean prior to any extended downtime to avoid product buildup.

NOTE: The time duration of step 5 varies by the amount of process fluid build-up and its cleaning characteristics.

5. Drain the cleaning fluid from the system or isolated section of pipe in which the viscometer is installed
6. Refer to *Section 3 - Operation* and perform the Start-up procedure.

Section 5 - Service

Introduction

The AST100 Viscosity Controller is a highly reliable and rugged unit that requires little maintenance. This section provides information on component replacement.

To order replacement parts, Refer to Appendix A and contact Brookfield Engineering Laboratories, Inc. When ordering replacement assemblies, make sure that all associated components (gaskets, O-rings, etc.) have been ordered to ensure the new assemblies can be properly installed.

CAUTION

The internal components of the viscometer must be empty of process fluid, clean, and free of obstructions before it can be serviced. Refer to Section 4 - Maintenance and perform the cleaning procedure for the process fluid application.

Instrument Repair Procedure and Guidelines

In the event that your Process Viscometer should require factory maintenance, Brookfield Engineering has provided the following guidelines and recommendations to follow to ensure a prompt turn around time for all repaired items.

Before returning any Brookfield Process Viscometer, please contact our Process Service/Sales Department to obtain a **Return Materials Authorization Number** (RMA #). This will ensure that your instrument is routed to the proper Repair Department when received. Unnecessary delays result when “unannounced” repairs arrive at our facility and have to be sorted and routed outside standard procedures. To contact the Process Service/Sales Department, please call **508-946-6200** or **800-628-8139**; or you may prefer to email us at **service@brookfieldengineering.com**.

Please be sure to follow these guidelines when returning your instrument:

1. The RMA form received from us is completely filled out with the correct information.
2. Ensure that the MSDS section of the RMA is completed and any applicable MSDS sheets are also included with your instrument to be repaired. Failure to comply with MSDS regulations may result in delays to your repair.
3. Including a Purchase Order Number with your RMA will allow us to complete repairs to a specified dollar amount determined by the product type, and thereby, bypassing the need to complete an “Estimate of Repair” to submit for your approval. If you wish to be informed of repair cost before proceeding, please specify on the RMA form.
4. Our method of return shipment is via UPS. Should you prefer a different method or wish to charge to your carrier account number, be sure to include this information.

Section 6 - Troubleshooting

Troubleshooting

The information in this section will help you troubleshoot problems when they occur. The problem presented below is followed by a possible cause and corrective action.

Should you need technical assistance, refer to Appendix A and call Brookfield Engineering Laboratories, Inc.

Unit Display:

*Reads System Error: 100
Vco Probe Failure*

This error surfaces when the operating parameters of the sensor are exceeded. Before calling Brookfield for service, check the following:

- The probe wiring is correct
- At the terminal blocks where the probe wiring is connected, check to make sure that the terminals are not screwed down on top of the wire's insulating covering.
- Check the sensor portion of the probe to ensure that it is not coated with dried material or damaged. If coated, carefully clean material off. If damaged, contact Brookfield Engineering Laboratories.

The unit must be powered down to reset this error. If the problem cannot be resolved by the means mentioned above, contact Brookfield Engineering Laboratories for further assistance.

File Restoration Procedure

1. Power up the controller:
 - Initial screen will indicate two black bar lines
 - First screen will then display for five seconds
 - Up — run controller
 - Down — restore files
2. Select restore file **within five seconds** by pressing the Down arrow key to enter.

NOTE: A rolling screen view of the restoring status will be displayed ending with a prompt to restart the controller.

3. Power off the controller at the screen prompt and then restart controller.
4. Allow the controller display to default to second screen indicating:
 - Up — std. mode
 - Down — setup mode
5. **Within five seconds**, select Setup mode by pressing the Down arrow key to enter menu.

6. Scroll the cursor with the Down arrow key to “restore defaults” selection and press Enter.
7. Scroll the cursor with the Up arrow key to “Exit and Save” and then press Enter. The Standby screen will appear.
8. When the Standby screen appears, power down and then restart the controller.
9. At the second screen display, within five seconds, select the Setup mode by pressing the Down arrow.

NOTE: At this point, the first line at the top of the menu titled “Setup Mode” will be followed by the serial number of the unit sensor in use. If not, repeat procedure from step one.

10. Scroll through the menu items and re-enter your custom process operational parameters.
11. Scroll the menu cursor with the Up arrow to “Exit and Save” position and press Enter.
12. Resume normal operation as required.

Appendix A - Customer Support

Introduction

Use the following information to Contact Brookfield Engineering Laboratories, Inc. for technical assistance or service:

Brookfield Engineering Laboratories, Inc.
11 Commerce Boulevard
Middleboro, Massachusetts 02346 U.S.A.
TEL: 508-946-6200 800-628-8139 (USA only)
FAX: 508-946-6262
EMAIL: sales@brookfieldengineering.com

Please have the following information available when calling so that we may assist you:

- Product Part Number
- Product Serial Number
- Product Application
- Specific Problem Area
- Hours of Operation
- Equipment Type

Appendix B - ViscUnits (Viscosity Display Units)

Table B-1: Display Units and Ranges

Controller Variable VISCUNIT	Display Extension	Range Minimum	Centistoke Equivalent	Range Maximum	Centistoke Equivalent
cstk	cstk	1.1	1.1	3300	3300
cPs	cPs	1	1	3000	3000
mPas	mPs	1	1	3000	3000
EZ Zahn1	sec	34.5	1	70	47
EZ Zahn2	sec	16.5	1	70	185
EZ Zahn3	sec	8	7	70	698
EZ Zahn4	sec	8	22	70	918
EZ Zahn5	sec	7	60	65	1520
S90 Zahn1	sec	26	1	72	100
S90 Zahn2	sec	13.5	1	74	300
S90 Zahn3	sec	9.8	41	70	512
S90 Zahn4	sec	9	75	70	855
S90 Zahn5	sec	9.4	200	55	1293
Ford #1	sec	41.5	1	130	67
Ford #2	sec	25	1	130	155
Ford #3	sec	15.5	1	130	295
Ford #4	sec	10.5	1	130	478
Ford #5	sec	8	66	130	1532
Shell #1	sec	17	1	120	24
Shell #2	sec	9	2	120	70
Shell #3	sec	9	10	120	177
Shell #4	sec	9	30	120	400
Shell #5	sec	9	55	120	750
Shell #6	sec	9	140	80	1250
ISO 3mm	sec	22	1	130	56
ISO 4mm	sec	12.5	1	130	175
ISO 6mm	sec	9	1	130	892
ISO 8mm	sec	8	135	70	1520
DIN 4mm	sec	10	1	130	590

Appendix C - 4-20 mA Outputs

Table C-1: Viscosity and Temperature milli-Amp Outputs

Viscosity milli-Amp Output

mAmpOut (Operator Selected)	4 mAmps Equivalent	20 mAmps Equivalent
VISCUNITS	Min of VISCUNITS Range	Max of VISCUNITS Range
CK0-50	0 Centistokes	50 Centistokes
CK0-250	0 Centistokes	250 Centistokes
CK0-500	0 Centistokes	500 Centistokes
CK0-1500	0 Centistokes	1500 Centistokes
CK500-3300	500 Centistokes	3300 Centistokes
CP0-50	0 Centipoise	50 Centipoise
CP0-250	0 Centipoise	250 Centipoise
CP0-500	0 Centipoise	500 Centipoise
CP0-1500	0 Centipoise	1500 Centipoise
CP500-3000	500 Centipoise	3000 Centipoise

Temperature milli-Amp Output

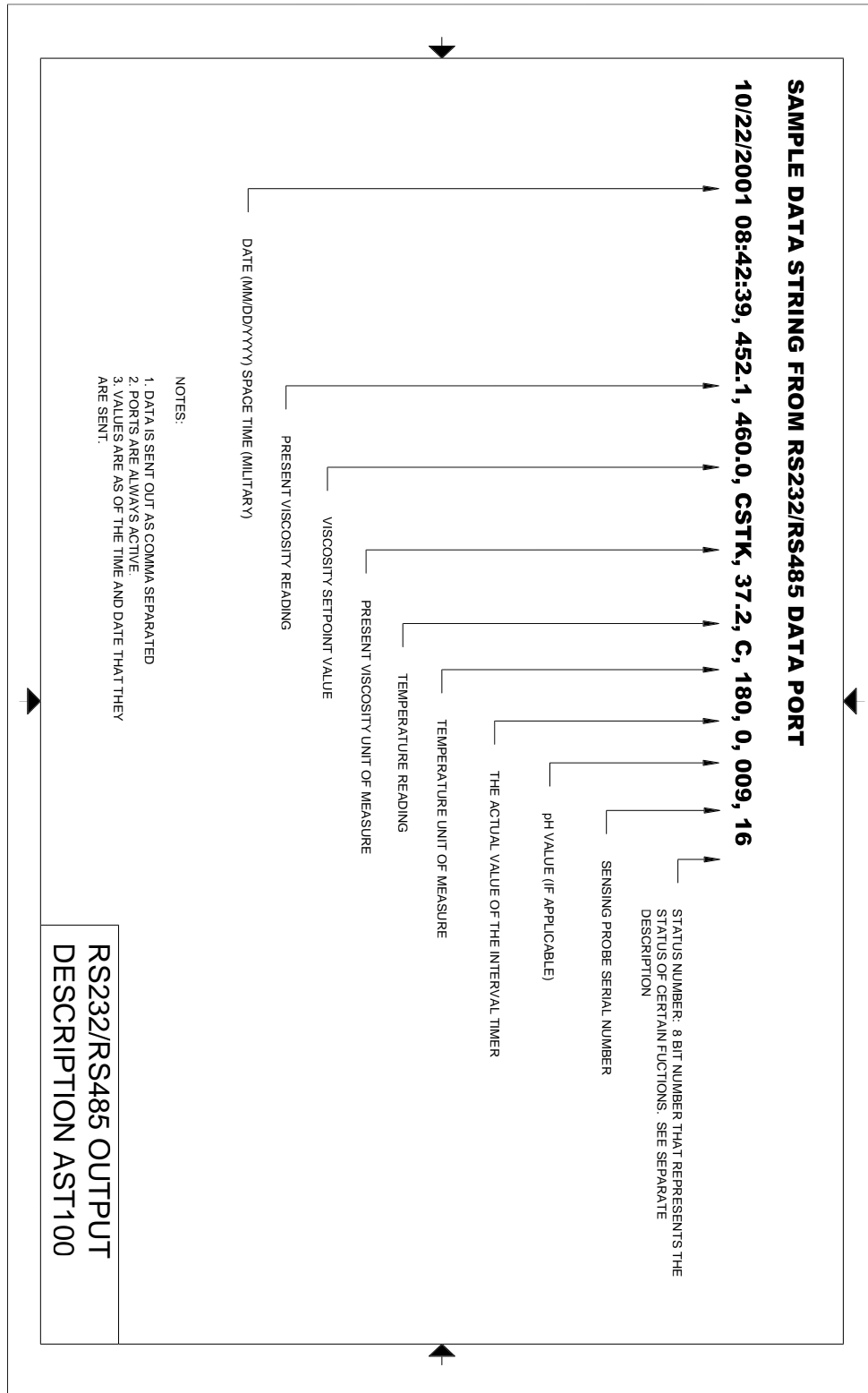
4 mAmps Equivalent	20 mAmps Equivalent
-20 Degrees Celsius	+150 Degrees Celsius

Notes:

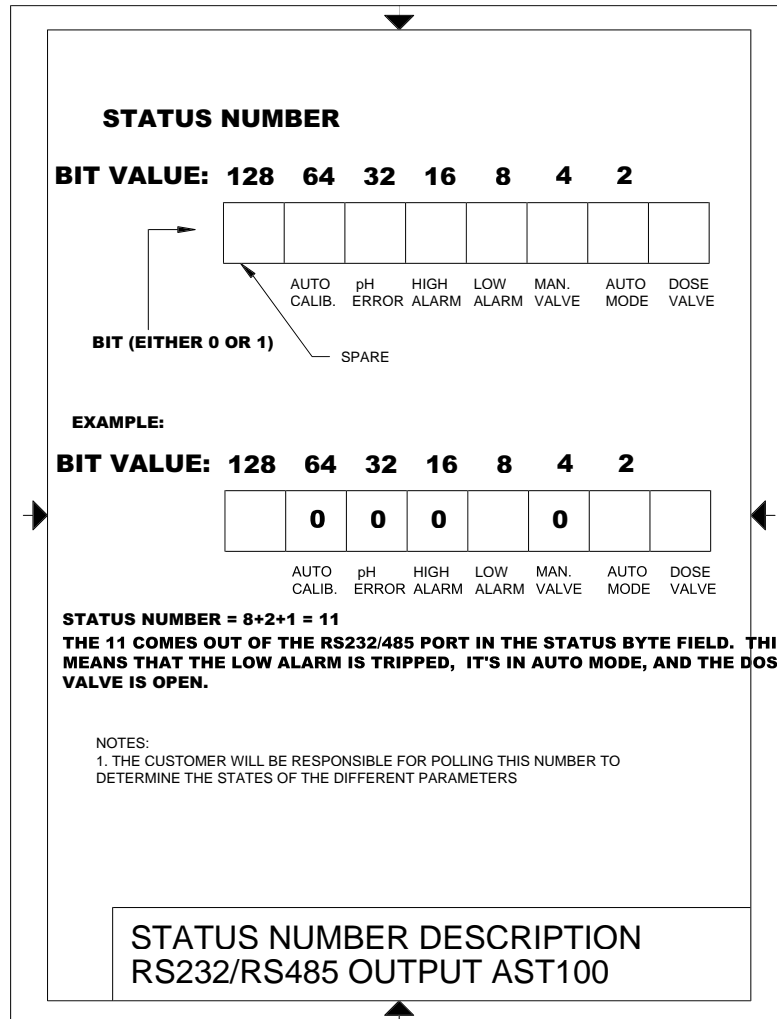
1. Scaling between the 4 and 20 mA limits is linear.
2. There is no calibration of the milli-Amp output required. All values are set digitally within the controller.
3. Resolution limit is approximately 1600 data points between the 4 and 20 mA.
4. The mAmp output for temperature is always in degrees Celsius.

Appendix E - Output Descriptions

Drawing E-1: RS232 / RS485 Output Descriptions



Drawing E-2: Status Number Description RS232 / RS485 Output



Appendix F - Warranty Information

We hereby warranty this Brookfield Viscometer to be free from defects in workmanship and materials. If found to be defective in workmanship or materials upon being returned, within one year from the date of purchase to our factory, it will be repaired or replaced at the factory without charges. Transportation charges shall be at the owner's expense.

However, if upon being so returned and after inspection, we determine that the instrument has been subjected to tampering, careless handling, improper or faulty application or installation, the above guarantee shall not be applicable and we shall have the right in any such case to make a charge to cover the cost of repairs or servicing. Brookfield Engineering Laboratories, Inc. assumes and shall have no liability for consequential damages resulting from the use or misuse of the instrument.

The foregoing warranty is in lieu of all other guarantees or warranties, expressed or implied, and of all other obligations or liabilities, contractual or otherwise, either to the original purchaser of said instrument or to any other person whomsoever.

Glossary

Control High and Low Limits

The measured values, expressed in engineering units, which cause control output to change.

Centipoise/milli-pascal-seconds

Units of absolute viscosity. The viscosity of water at room temperature is 1 centipoise or 1 milli-pascal-second.

Cup Seconds

The amount of time required for a given fluid to flow completely from an efflux cup through its chamber and accurately machined bottom orifice.

Engineering Units

Units of viscosity as displayed on the readout panel of a viscometer. These units may be in centipoise, or other units which relate to absolute viscosity, such as cup seconds.

Full Scale

The upper limit, in engineering units, of a viscometer.

Laboratory Measurements

Viscosity measurements made off-line by a different instrument, usually for purposes of quality control. Due to the unique nature of viscosity measurement, the numerical value of this measurement will not agree with that measured by the Brookfield AST-100 Viscosity Controller.

Laminar Flow

Flow which occurs when layers of fluid move uniformly with respect to one another, without mixing between elements.

Measuring Chamber

The container through which a fluid is caused to flow, in laminar flow conditions, and where its viscosity is measured.

Repeatability

The ability of an instrument to measure the same value whenever identical conditions of viscosity are presented to it.

Shear Rate

The speed at which layers of fluid move with respect to one another. Also known as velocity gradient.

Shear Stress

The force per unit area required to move layers of fluid with respect to one another.

Turbulent Flow

Flow which occurs when fluid moves randomly with respect to other elements of fluid, with mixing between elements.

Viscous Drag

The resistance to rotation produced by an object such as a spindle when it is rotated in a fluid.

Viscosity

A measure of the internal resistance within a fluid to resist flow. Mathematically defined as shear stress divided by shear rate. Sometimes called absolute viscosity.

4-20 mA Signal

The continuous electrical output produced by a viscometer which is proportional to the % torque being measured and also proportional to the scale. For Brookfield Process Viscometers, 4 mA = 0 cP, 12 mA = half of full scale, and 20 mA = full scale, linear between 0cP and full scale.

% Torque

Brookfield Process Viscometers function as a rotating torque meter, whose response is linear with respect to viscosity. A % torque measurement displays the proportion of full scale which a measured fluid produces. This factor is applied to full scale in order to give a measurement in engineering units.