Operation Instructions

DVNext™ Rheometer

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1. INTRODUCTION

AMETEK Brookfield has been the world leader in viscosity measurement instruments for over 85 years.The DVNext Rheometer is AMETEK Brookfield's latest model that incorporates new advanced features that our customers have been asking for with the repeatability and reliability you expect from us.

Standard Version	Compliant Version
• Digital Leveling • Ethernet Connectivity • Start-up Wizard • Gel-Timer Functionality • Optional Magnetic Coupling Attachment (replaces EZ-lock) • Optional Barcode Scanner	• Hand-held Scanner for Barcode Detection • Accessory Detection with Barcode Detection • Magnetic Coupling Attachment (replaces EZ-Lock) • Compliance to 21 CFR 11 in Stand-alone and GAMP Compliant • LIMS Connectivity • Printing to non-editable PDF

The AMETEK Brookfield DVNext Rheometer measures fluid viscosity at given shear rates. Viscosity is a measure of a fluid's resistance to flow. You will find a detailed description of the science of viscosity in the AMETEK Brookfield publication "More Solutions to Sticky Problems".

This manual covers the DVNext Rheometer. The DVNext offers exceptional versatility in modes of control, allowing choice of traditional standalone operation and automatic operation through programs downloaded from the PC or with complete control by PC using AMETEK Brookfield RheocalcT or DV360 Software.

- The DVNext can be used as a traditional AMETEK Brookfield rheometer for collection of single speed viscosity data through the easy-to-use touch screen; just select the spindle and speed and read the value from the display. [See Section 2: Getting Started]
- The DVNext can collect multiple data points through programs created directly on the touch-screen display.
- The DVNext can make a direct measurement of yield stress when using optional vane spindles.
- The AMETEK Brookfield RheocalcT or DV360 Software will perform all control and data collection functions of the DVNext from the PC while also providing a platform for advanced data collection and analysis.

In any of these modes of control, the DVNext will provide the best in viscosity measurement and control. The principal of operation of the DVNext is to drive a spindle (which is immersed in the test fluid) through a calibrated spring. The viscous drag of the fluid against the spindle is measured by the spring deflection. Spring deflection is measured with a rotary transducer. The measurement range of a DVNext (in centipoise or milliPascal•seconds) is determined by the rotational speed of the spindle, the size and shape of the spindle, the container the spindle is rotating in, and the full-scale torque of the calibrated spring.

There are four basic spring torque series offered by AMETEK Brookfield:

Spring Torque

Model	dyne•cm dyn•cm	milliNewton•m mN•m
DVNEXT LV	673.7	0.0673
DVNEXT RV	7,187.0	0.7187
DVNEXT HA	14,374.0	1.4374
DVNEXT HB	57,469.0	5.7469

The higher the torque calibration, the higher the measurement range. The measurement range for each torque calibration is found in Appendix B.

All units of measurement are displayed according to either the CGS system or the SI system.

- Viscosity appears in units of centipoise (cP), Poise (P), milliPascal-seconds (mPa•s) or Pascal-seconds (Pa•s) on the DVNext Rheometer display or centistokes (cSt) or millimeter squared per second (mm^2/sec).
- Shear Stress appears in units of dynes/square centimeter (D/cm^2) or Newtons/square meter (N/m^2)/or Pascals (Pa).
- Shear Rate appears in units of reciprocal seconds (1/sec).
- Torque appears in units of dyne-centimeters or Newton-meters (shown as percent "%" in both cases) on the DVNext Rheometer display.
- Density appears in units of grams/cubic centimeter (g/cm^3) or kilograms/cubic meter (kg/m^3).

Note: To change CGS to SI units on the display (see section 5.3: Global Settings)

The equivalent units of measurement in the SI system are calculated using the following conversions:

	SI	CGS
Viscosity:	1mpa.s	1cp
Shear Stress:	1n/m^2	10dyn/cm^2
Torque:	1N.m	10^7dyn.cm

References to viscosity throughout this manual are done in CGS units. The DVNext Rheometer provides equivalent information in SI units.

1.1 Components

Please check to be sure that you have received all components, and that there is no damage. If you are missing any parts, please notify AMETEK Brookfield or your local authorized dealer. Any shipping damage must be reported to the carrier.

Components	Part Number	Quantity	
		Standard Version	Compliant Version
DVNext Rheometer	varies	1	1
Laboratory Stand Model G Lab Stand Model QB Lab Stand (Optional)	MODEL G MODEL QB	1	1
Spindle Set with Case* DVNext LV set of four spindles DVNext RV set of six spindles (#2 - #7) DVNext HA/HB set of six spindles (#2 - #7)	varies SSL or SSLM† SSR or SSRM† SSH or SSHM†	1	1

For Cone/Plate versions: Threaded coupling: a spindle wrench (SP-23), one cone spindle (CPA-XXZ or CPA-XXCZ), a sample cup (CPA-44YZ) replace the spindle set. Magnetic coupling: one cone spindle (CPM-XXZ or CPM-XXCZ) and a sample cup (CPA-44YZ) replace the spindle set.			
Power Cord	varies	1	1
RTD Temperature Probe	DVP-94Y*	1	1
Guard Leg DVNext LV DVNext RV	varies B-20Y* B-21Y* GV-3531* GV-3532*	1	1
Carrying Case	GV-1302Y	1	1
RheocalcT Software (Optional) Standard Advanced	varies	0	0
DV360 Software (Optional) Standard Advanced	varies	0	0
Shipping Cap	varies	1	1
Screen Protector	GV-1020	1	1
Barcode Scanner (Optional for Standard Version)	GV-1412	0	1
4 GB Flash Drive (Includes Manual M19-2101)	MFD-DVNX	1	1

* Not supplied with Cone/Plate version.

† “M” in the part number identifies magnetic spindles.

Component Diagram

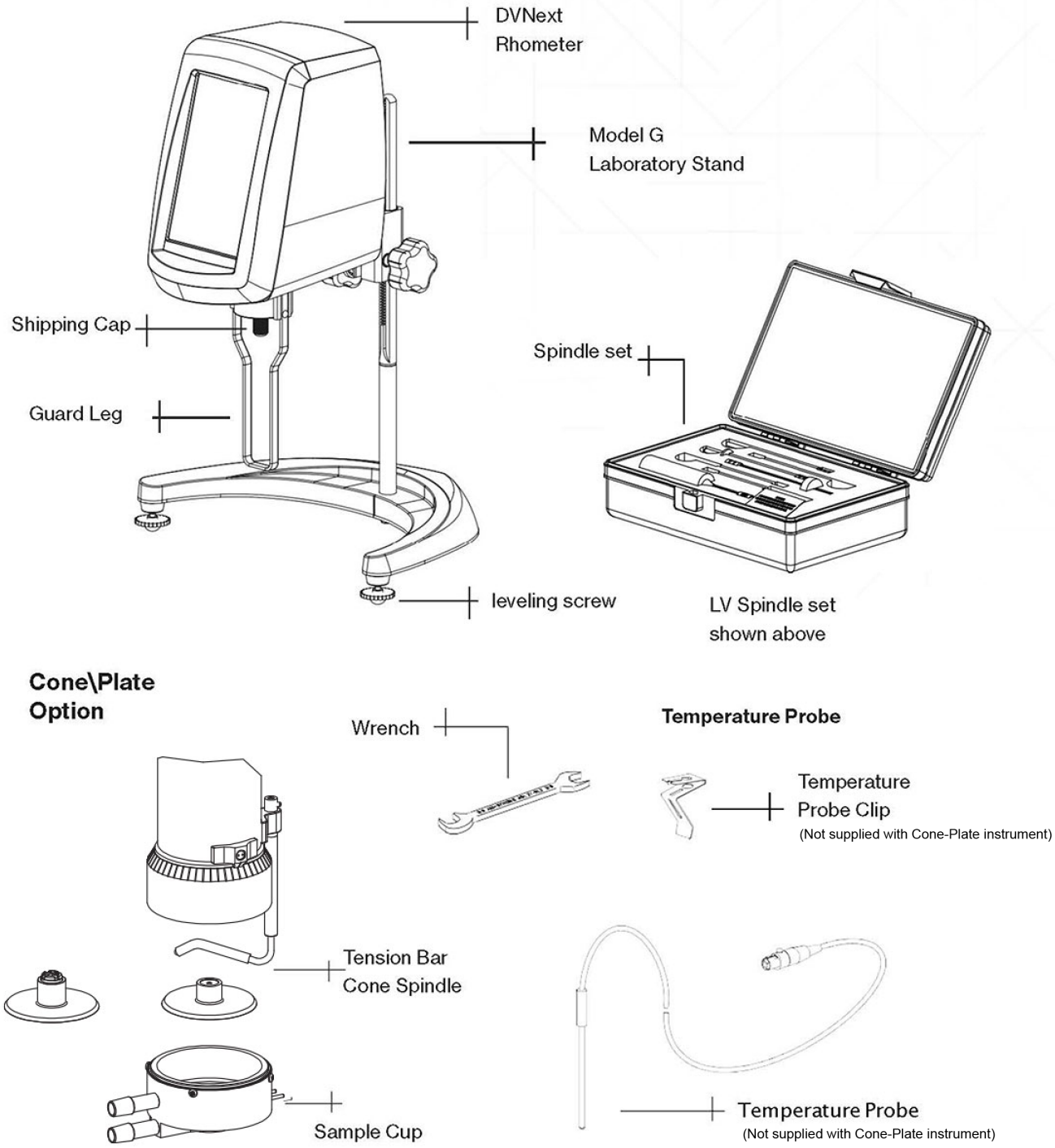


Figure 1-1

1.2 Utilities

Input Voltage:	Universal Power Supply (90 - 260 VAC)
Input Frequency:	50/60 Hz
Power Consumption:	150 VA
Fuse:	5 x 20mm 4A time delay
Power Cord Color Code:	

	United States	Outside United States
Hot (live)	Black	Brown
Neutral Ground	White	Blue
(Earth)	Green	Green/Yellow

Main supply voltage fluctuations are not to exceed ±10% of the nominal supply voltage.

1.3 Specifications

Speed:	0.01 - 250 RPM
Weight:	Gross Weight: 26 lbs.; 11.8 kg. Net Weight: 22 lbs.; 10.0 kg.
Carton Volume:	2.48 cu. ft.; 0.07 m3
Carton Dimensions:	21 in. (53 cm) W x 12 in. (30 cm) L x 17 in. (43 cm) H
Temperature Sensing Range:	-100˚C to 300˚C (-148˚F to 572˚F) ±1.0% of Full-Scale Range
USB B port for use with an attached PC **USB A port (x3) for use with a USB Flash Drive and Dymo Printer** **RJ45 Ethernet port for network connection**	
Viscosity Accuracy:	The use of accessory items will have an effect on the measurement accuracy. See Appendix B
Viscosity Repeatability:	±0.2% of Full-Scale Range
Temperature Accuracy:	±1˚C | -100˚C to +149˚C ±2˚C | +150˚C to +300˚C
Operating Environment:	0˚C to 40˚C temperature range (32˚F to 104˚F)20% - 80% R.H.: non-condensing atmosphere Conforms to CE Standards:
Electrical Certification:	BSEN 61326-1:2013: Electrical equipment for measurement, control and laboratory use - EMC requirements. BSEN 61010-1:2010: Safety requirements for electrical equipment, for measurement, control, and laboratory use. BSEN IEC 63000:2018: Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances (ROHS 3).

Ball Bearing Option

If you ordered the ball bearing suspension system with your new instrument, please note the following:

- The ball bearing suspension in your AMETEK Brookfield instrument is noted on the serial tag on the back of the head by the letter “B” in the part number (the ninth digit; for example: XDVNTHBTBG0U00.
- When attaching and detaching the spindle, it is not necessary to lift the coupling where the spindle

connects to the instrument.

- The Oscillation Check, explained in Section V.1: Device Setup, does not pertain to this instrument.

Notice to customer:

This symbol indicates that this product is to be recycled at an appropriate collection center.

Users within the European Union:
Please contact your dealer or the local authorities in charge of waste management on how to dispose of this product properly. All AMETEK Brookfield offices and our network of representatives and dealers can be found on our website: www.brookfieldengineering.com.

Users outside of the European Union:
Please dispose of this product according to your local laws.

1.4 Installation

- Assemble the Model G Laboratory Stand (refer to assembly instructions in Appendix I)
  - **Note**: IQ, OQ, PQ, an abbreviated guideline document for installation, operation and performance validation for your DVNext digital rheometer is available for purchase from AMETEK Brookfield or your local authorized dealer.
- Put the rheometer on the stand.
- Connect the RTD probe to the socket on the rear panel of the DVNext.
- The rheometer must be leveled. Follow the instructions on the screen.
- Remove the shipping cap which secures the coupling nut on the rheometer to the pivot cup. For Cone/Plate Models, hold the Sample Cup and swing the tension bar away from the bottom of the cup. Lower the cup and remove the foam insert (Save for future shipments).
- Install the screen protector per the instructions on the package (and also shown in Appendix M). Failure to properly install the screen protector may result in touch screen malfunction. Additional installation help can also be found on our YouTube channel: www.youtube.com/user/brookfieldEng.

The AC input voltage and frequency must be within the appropriate range as shown on the name plate of the viscometer (see Section I.2).

Make sure that the AC power switch at the rear of the DVNext is in the OFF position. Connect the power cord to the socket on the back panel of the instrument and plug it into the appropriate AC line.

The AC input voltage and frequency must be within the appropriate range as shown on the name plate of the rheometer.

- Turn the power switch to the ON position and allow the rheometer to warm up for 10 minutes before performing autozero.
- For Cone/Plate models, refer to Appendix A.
- If appropriate, connect USB type A to USB type B cable (DVP-202 or user supplied) to USB port for connection of DVNext to PC or printer.

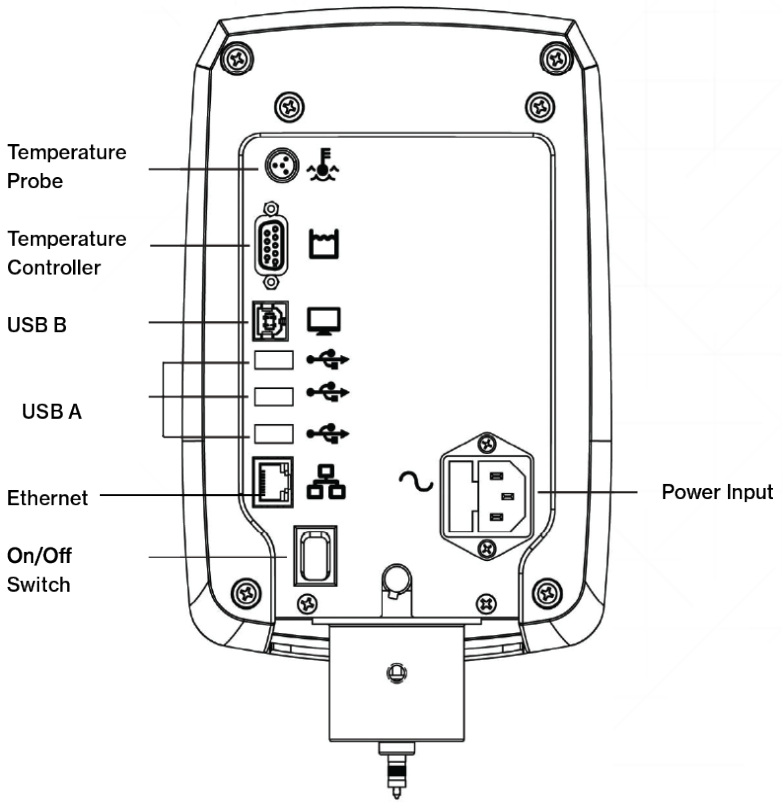


Figure 1-2

1.5 Safety symbols and precautions

Safety Symbols:
The following explains safety symbols which may be found in this operating manual.

	Indicates hazardous voltages may be present.
	Refer to the manual for specific warning or caution information to avoid personal injury or damage to the instrument.

Precautions:

	If this instrument is used in a manner not specified by the manufacturer, the protection provided by the instrument may be impaired.
	This instrument is not intended for use in a potentially hazardous environment.
	In case of emergency, turn off the instrument and then disconnect the electrical cord from the wall outlet.
	The user should ensure that the substances placed under test do not release poisonous, toxic or flammable gases at the temperatures which they are subjected to during the testing.
	The safety of any system incorporating this equipment is the responsibility of the assembler of the system.

1.6 Key functions

The DVNext Rheometer utilizes a touch screen display and interface. The user will provide all input to the rheometer through the touch screen. Figure I-3 details the different types of information and actions available.

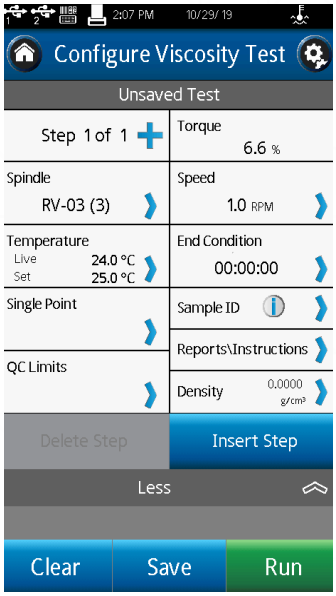


Figure 1-3

Status Bar The Status Bar provides information relating to the date and time (as configured by the user) and various connections to the DVNext Rheometer.

Title Bar The Title Bar identifies the activity to be conducted in the current view and includes any navigation icons that are relevant.

Test Name The Test Name identifies the name of the currently loaded test.

Data Fields The Data Fields include measurement results and test parameters.

More/Less Bar The More/Less Bar informs the user when more Data Fields are available and when the number of Data Fields can be reduced.

Command Keys The Command Keys indicate action that can be taken. These keys will vary from view to view depending on what actions are relevant.

1.7 Cleaning

⚠	Make sure that the instrument is in a clean, dry working environment (dust free, moderate temperature, low humidity, etc.).
⚠	Make sure the instrument is on a level surface.
⚠	Hands/fingers must be clean and free of sample residue. Not doing so may result in deposit build up on the upper part of the shaft and cause interference between the shaft and the pivot cup.
⚠	Be sure to remove the spindle from the instrument prior to cleaning. Note left-handed thread. Severe instrument damage may result if the spindle is cleaned in place.
⚠	When cleaning, do not apply excessive force, which may result in bending spindles. Instrument and Display: Clean with a dry, non-abrasive cloth. Do not use solvents or cleaners. The instrument housing is manufactured from polycarbonate ABS. Clean Instrument housing with mild soap and water. Do not apply solvent to the instrument! Immersed Components (spindles): Spindles are made of stainless steel. Clean with a non-abrasive cloth and solvent appropriate for sample material.

2. GETTING STARTED

2.1 Powering up

The DVNext will go through a Power Up sequence when the power is turned on. The Rheometer will issue a beep, present a blue screen, and finally show the DVNext About screen for 5 seconds. The About screen is shown below and includes several critical parameters about the rheometer including; rheometer torque (LV, RV, HA, HB, or other), firmware version number, model number (DVNext LV, for example) and the serial number.

The About screen can also be accessed through the Settings Menu (see Section V.1).

The DVNext Rheometer will automatically transition from the About screen to the AutoZero screen.

TIP: When contacting AMETEK Brookfield or your local authorized dealer for technical support or repair services, please record the information on the About screen and include this detail in your email.

Figure 2-1

2.2 Digital leveling

Upon powering up the DVNext, the user will be prompted to level the DVNext device, if not already level. To level the DVNext, adjust the leveling screws on the base. When the device is not level, the centering dot will be red. While adjusting to a level position, the dot will become yellow, signifying that the device is approaching a position where it will be level. Once the dot is within specified limits of the center circle, the dot will turn green to signify that the DVNext is now level and ready to operate (see Figure II-2). Following this process, the device will then move onto the autozero function (Section II.2). For compliant DVNext devices, the Administrator can prevent other users from skipping the leveling popup. When this occurs, the user will not be able to skip/ignore the popup warning as the option will be grayed out. This option is only available to Compliant Edition devices and is not available on Standard Edition devices.

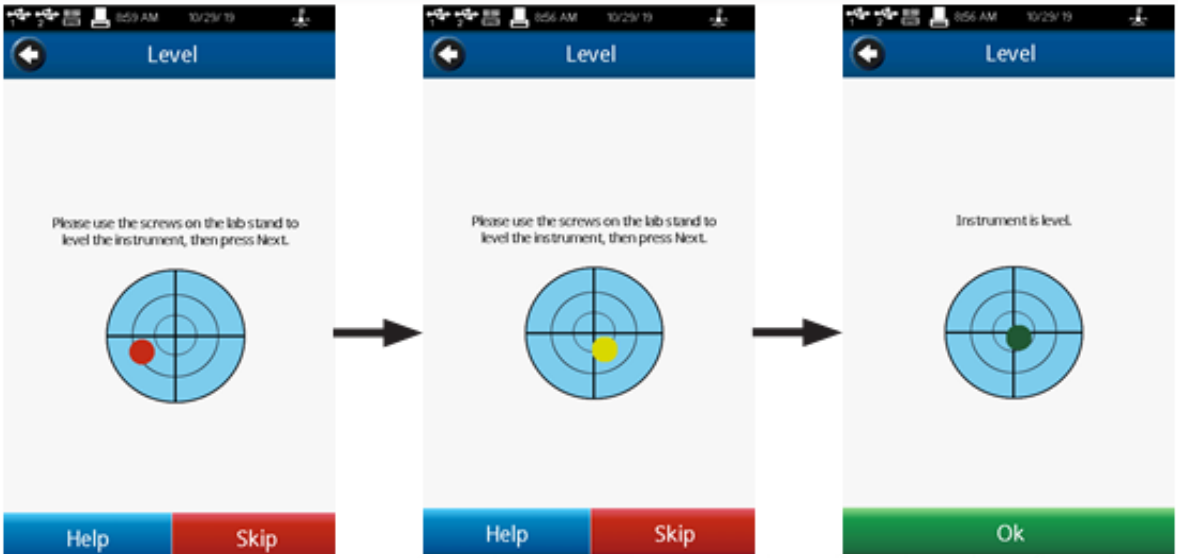


Figure 2-2

2.2.1 AutoZero

The DVNext Rheometer must perform an AutoZero prior to making viscosity measurements. This process sets the zero reading for the measurement system. The AutoZero will be performed every time the instrument is turned on. Additionally, you may perform an AutoZero at any time through the Settings Menu (see Section V.1).

The AutoZero screen will be presented automatically, after the About screen, during a power up.

The operator must ensure that the rheometer is level (see Section I.4) and remove any attached spindle or coupling. When the Next button is pressed, the rheometer will operate for approximately 13 seconds. After the AutoZero is complete and the operator presses the Next button, the rheometer will transition to the Configure Viscosity Test screen. If the AutoZero was performed from the Settings Menu, then the rheometer will return to the Settings Menu.

TIP: For instruments with Magnetic Coupling System, keep spindle end and other magnetic materials 1-inch away from the coupling during autozero.

TIP: Do not touch the rheometer during the AutoZero process to ensure the best zero value.

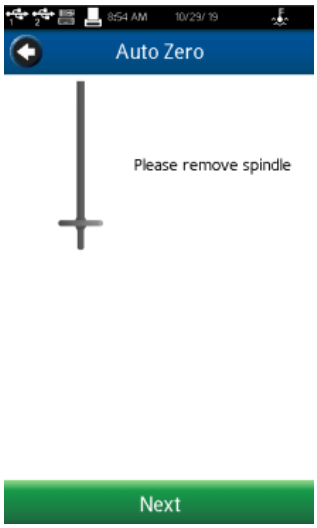


Figure 2-3

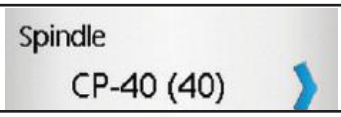
The DVNext Rheometer will display a status bar at the top of the screen at all times.

This status bar will indicate the following: time of day, date, and connection status for a variety of connection devices. The status icons are defined as:

	USB Icon 1, 2, 3:	The DVNext Rheometer can store data and tests to USB storage device (USB B) such as a USB Flash Drive. There are three USB ports. These ports are represented as 1, 2 and 3 based on the order of connection.
	Printer Icon:	The DVNext Rheometer can communicate to a label printer for printing test results.
	Computer Icon:	The DVNext Rheometer can communicate with a computer through the USB B port. Communication is supported with AMETEK Brookfield RheocalcT or DV360 software.
	Bath Icon:	The DVNext Rheometer can communicate with a AMETEK Brookfield Thermosel (HT-106 Controller) or Temperature Bath (SD or AP Controllers) to control sample temperature.
	Temperature Probe Icon:	The DVNext Rheometer can read the temperature probe sensor and shows the icon when the probe is plugged in.
	Ethernet	The DVNext Rheometer can connect to a Network.

2.3 Navigation

The DVNext Rheometer uses a touch screen display. Navigation of the instrument features is done using a variety of Data Fields, Arrows, Command Keys and Navigation Icons. The operating system has been designed for intuitive operation and employs color to assist the user in identifying options.

	Data Fields require that the user touch the screen to initiate the data entry/ selection process. These fields are normally outlined in black. They may also include a blue arrow.
	Blue Arrows indicate that options exist for a Data Field. The user may be required to press anywhere in the Data Field or they may have to press the Blue Arrow specifically.
	Command Keys are buttons which direct the DVNext to perform a specific action such as SAVE a data set or STOP a program. Command Keys are presented in a variety of colors. These keys are normally found at the bottom of the screen.

	Navigation Icons are normally found in the Title Bar to the left and right. These buttons will take you to specific areas of the operating system.

	Home Menu		Perform data entry from a scroll list
	Log In (will only be available if the administrator has activated user log in)		Sort files according to create date
	Settings Menu		Sort files according to alphabet
	Service Menu (only available for authorized AMETEK Brookfield service centers)		Choose from additional options
	Lock Out (during a test)		Back (return to previous screen)
	Remove Lock (during a test)		Up (return to previous level in the file structure)
	Perform data entry using a number pad		

2.4 Home Screen

The DVNext Home screen can be accessed by using the Home Icon. The Home screen shows the Main Menu functions and provides access to the following as shown in Figure 2-4.

Configure viscosity test : Create and run viscosity tests.

Configure yield test : Create and run yield tests.

Load test : Load a test that has previously been saved. Tests may be loaded from internal memory or a USB Flash Drive.

View results : Load Results (saved test data) that have previously been saved. Results may be loaded from internal memory or a USB Flash Drive.

Manage files : Manage the file system in the internal memory or on a USB Flash Drive for test programs and saved data. Create new folder structures, delete files, rename files and move files.

External mode : Direct the DVNext to communicate with AMETEK Brookfield RheocalcT or DV360 Software for complete rheometer control.

Viscosity wizard : The Viscosity Wizard will provide a step-by-step guide to setup and run a test.

Each of the Main Menu items are detailed in the following sections of the manual.

2.4.1 Viscosity Wizard

The DVNext can help determine the test parameters for a viscosity test via the Viscosity Wizard. The Viscosity Wizard provides a step-by-step guide to setup and run a test. Accessing the viscosity Wizard can be done from the Main Menu screen (see Figure 2-5).

Upon selecting the Viscosity Wizard, the DVNext will display two options to estimate the viscosity. The first option is to select an example fluid that is like the intended test sample. The example fluids can be selected from a preset menu that includes: Water, Olive Oil, Shampoo, Honey, Molasses, and Non-Flowing (see Figure 2-6). If Non-Flowing is selected, the DVNext will display a prompt for the user to contact AMETEK Brookfield to discuss options for measuring the viscosity of non-flowing materials (see Figure 2-7). The second option is to input the approximate viscosity for the intended test sample (see Figure 2-8).

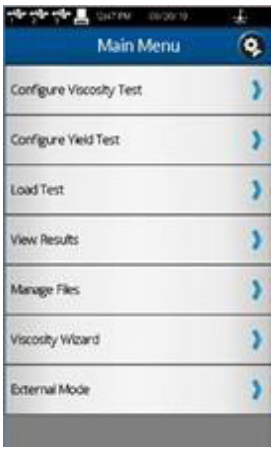


Figure 2-5

Figure 2-6

Figure 2-7

Figure 2-8

Regardless of whether the first or second option is selected, when the next key is pressed,the “Choose Spindle” screen will appear (see Figure 2-9).

Choose Spindle: There are two options for spindle selection. The first option is that the Wizard will recommend the spindle to use, which is shown by the blue arrow in the figure below (see Figure 2-9). The second option will allow a spindle to be selected by manually entering the spindle code as shown via the yellow arrow (see Figure 2-9).

The DVNext will alert the user that the device will run a test to determine the optimal measurement parameters (see Figure 2-10). If OK is selected, the DVNext will prompt the user to setup the sample and recommended spindle (see Figure 2-11).

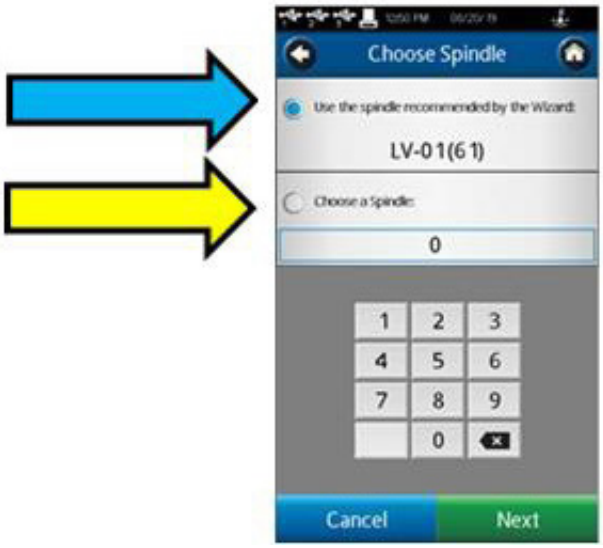


Figure 2-9

Figure 2-10

If OK is selected, the DVNext will then begin the first attempt at optimizing the speed & spindle combination. In order to evaluate the spindle/speed combination, the DVNext will run a viscosity test at a standard RPM with a torque stabilization end condition with a tolerance of +/- 0.5% and a one-minute time period for the stabilization. The goal of the Viscosity Wizard is to obtain the torque reading between 20% and 80%. Depending on the setup, the time to complete the Viscosity Wizard test could be up to five minutes.

If the Viscosity Wizard obtained a torque measurement between 20-80%, the DVNext will display the “Wizard Complete” screen (see Figure 2-12). The Wizard Complete screen will provide the user the optimal spindle and speed for the sample tested. This screen will also give the user the run time that the wizard took in order to arrive at that conclusion.

Figure 2-11

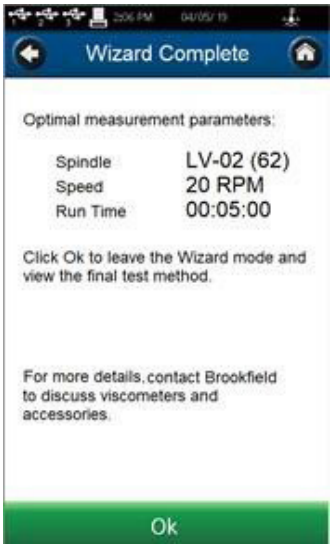


Figure 2-12

When OK is pressed, the configure viscosity screen will be populated with the recommended parameters from the Viscosity Wizard. If the Viscosity Wizard was unable to obtain a torque between 20% and 80%, the device will adjust the speed. In some cases, the device may recommend switching to a different spindle (see Figure 2-13).

If the Viscosity Wizard is not able to obtain torque measurements within 20-80%, the “Please Contact AMETEK Brookfield” screen will be displayed (see Figure 2-14).

Figure 2-13

Figure 2-14

2.4.2 Configure viscosity test

If the user does not wish to use the Viscosity Wizard, the Configure Viscosity Test function can be used. The Configure Viscosity Test is shown at the conclusion of the AutoZero function or by selection on the Home Menu All elements related to the measurement of viscosity are selected within Configure Viscosity Test. Tests that are created can be saved to the internal memory of the DVNext Rheometer or onto a connected USB Flash Drive. Tests can be loaded from memory by selecting Load Test from the Home Screen. Many aspects of Configure Viscosity Test can be limited when User ID and Log In functions are implemented (see Section V.4.2). The basic Configure Viscosity Test view is shown in Figure 2-15. This view includes the Status Bar, Title Bar (which includes the Home and Settings icons), test name, test parameters, the More/Less bar, and Command Keys.

The user can see the name of any test that has been loaded through the Load Test function. In Figure 2-15, the file name is listed as Unsaved Test, indicating that the current test has not been saved.

The More/Less bar is seen just below the test parameters. In Figure 2-15, this bar includes a down arrow, which indicates that more information is available. Figure 2-16 shows the additional information that can be accessed. The More/Less bar in this view has an up arrow indicating that the additional information can be hidden.

The Command Keys include Clear, Save and Run.

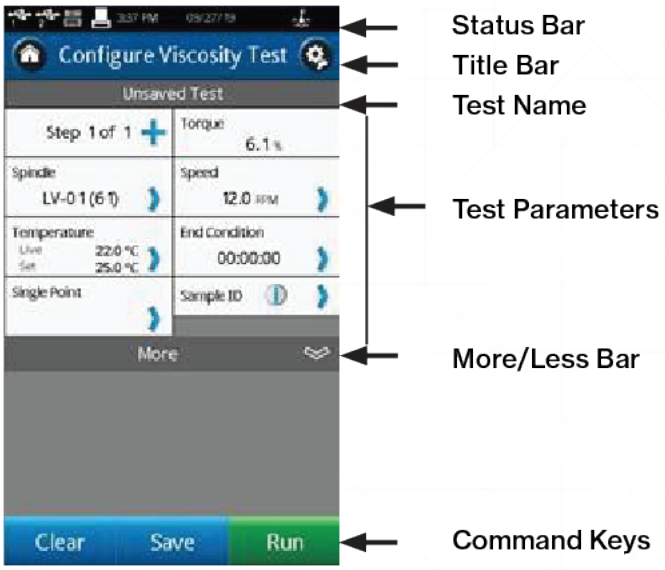


Figure 2-15

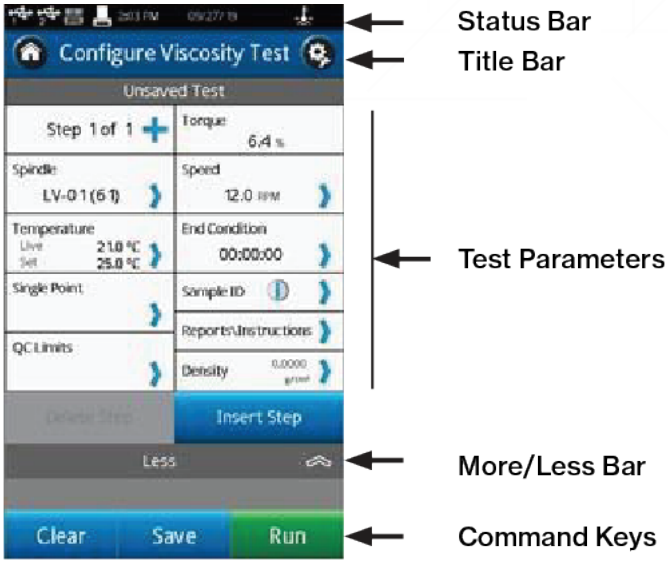


Figure 2-16

Clear	Clear:	Clear all data that has been entered into the test parameters and restore the values to the factorydefault.
Save	Save:	Save the current test.
Run	Run:	Run the current test.

Test Parameter area includes many elements of the viscosity test as well as live measurements of Torque % and Temperature. Temperature data will only be displayed if a AMETEK Brookfield temperature probe is connected to the DVNext Rheometer.

Torque 6.3 %	Torque:	A live signal from the rheometer.

Spindle LV-01 (61)	Spindle:	The currently selected spindle. All viscosity, shear rate, and shear stress calculations will be made based on this spindle. The spindle number may be changed by pressing the blue arrow.
Speed 6.0 RPM	Speed:	The currently selected speed of rotation. The rheometer will operate at this speed once the RUN command key is pressed. The speed may be changed by pressing the blue arrow.
Temperature Live 29.0 °C	Temperature:	A live signal from the rheometer when a temperature probe is attached (AMETEK Brookfield part number DVP-94Y orSC4-61Y).
End Condition Time 00:00:10	End Condition:	Specify the condition that will end the test.
Single Point	Data- Collection:	Specify the amount of data to be collected during a test.
Instructions	Instructions:	Create a message that the user will see when the test begins.
Reports	Reports:	Define how the data will be viewed when the test is complete.
QC Limits	QC Limits:	Define the limits for acceptable measurement data.
Density 0.0000 g/cm³	Density:	Define the density of the test sample. This information will be used when kinematic viscosity units are selected for display (see Section V.4.2)

2.4.3 Configure yield test

Yield measurements are made on the DVNext Rheometer through the Configure Yield Test function. The user can select Configure Yield Test from the Home Menu.

All elements related to the measurement of yield are selected within Configure Yield Test. Tests that are created can be saved to the internal memory of the DVNext Rheometer or onto a connected USB Flash Drive. Tests can be loaded from memory by selecting Load Test from the Home Screen.

TIP: Many aspects of configure Yield Test can be limited when User ID and Log In functions are implemented for compliant editions.

The basic Configure Yield Test view is shown in Figure 2-17. This view includes the Status Bar, Title Bar (which includes the Home and Settings icons), test name, test parameters, the More/Less bar, and Command Keys.

The user can see the name of any test that has been loaded thorough the Load Test function. In Figure 2-6, the file name is listed as Unsaved Test, indicating that the current test has not been saved. The More/Less bar is seen just below the test parameters.

In Figure 2-17, the bar includes a down arrow, which indicates that more information is available. Figure 2-18 shows the additional information that can be accessed. The More/Less bar in this view now has an up arrow indicating that the additional information can be hidden.

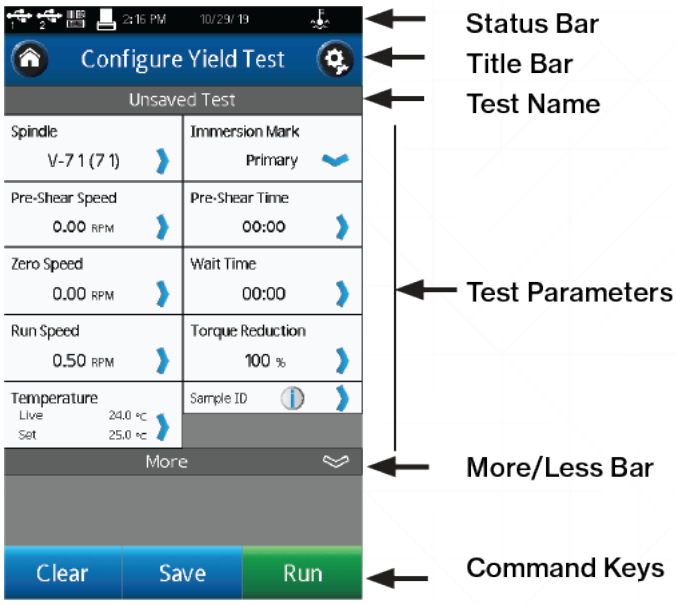


Figure 2-17

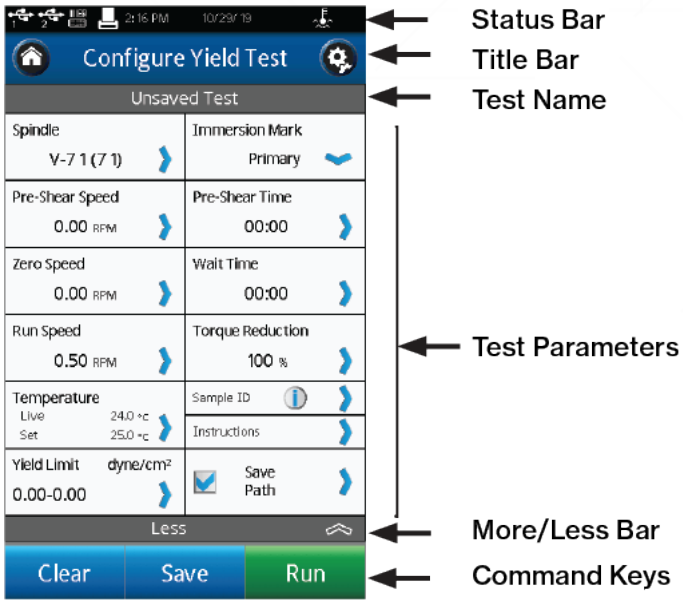


Figure 2-18

Clear	Clear:	Clear all data that has been entered into the test parameters and restore the values to the factory default.
Save	Save:	Save the current test.
Run	Run:	Run the current test.

The test parameter area includes many elements of the yield test as well as live measurement of temperature. Temperature data will only be displayed if a AMETEK Brookfield temperature probe is connected to the DVNext Rheometer.

Spindle V-7 1 (7 1)	Spindle:	The currently selected spindle. All Yield and Stress calculations will be made based on the Spindle selection and the Immersion Mark. Spindle choice is limited to vane spindles or user defined custom spindles.
Immersion Mark Primary	Immersion Mark:	Specify the immersion location of the AMETEK Brookfield vane spindle. Primary is at the immersion mark shown on the spindle shaft. Secondary is at the mid-point of the vane surface (see Section IV.5).
Pre-Shear Speed 0.00 RPM	Pre-Shear Speed:	Specify a speed of rotation for Pre-Shear of the sample. Pre-Shear
Pre-Shear Time	Time:	Specify the duration of the Pre-Shear step.
Zero Speed 0.00 RPM	Zero:	Specify the speed of rotation used to return the %Torque reading to zero before starting the yield measurement.
Wait Time	Wait Time:	Specify the duration of a rest period prior to starting the yield test.
Run Speed	Run Speed:	Specify the speed of the yield test.
Torque Reduction 100 %	Torque Reduction:	Specify the end point of the test. Normally set to 100%.
Temperature Live 29.0 °C Set 25.0 °C	Temperature:	A live signal from the rheometer when a temperature probe is attached (AMETEK Brookfield Part No. DVP-94Y). Also shown is the set point used to control the attached temperature controller (AMETEK Brookfield Thermosel or TC-XX0SD / TC-XX0AP Temperature Baths).
Yield Limit dyne/cm	Yield Limit:	Define the limits for acceptable measurement data.
Instructions	Instructions:	Create a message that the user will see when the test begins.
Save Path	Save Path:	Define the memory location where the data will be saved.

2.4.4 Load test

Test programs that are created (Configure Viscosity Test/Configure Yield Test) can be saved to the internal memory of the DVNext or to a USB Flash Drive. These files can bere loaded into the DVNext for immediate use through the Load Test function. A file that is placed onto a USB Flash Drive can be loaded onto any DVNext Rheometer.

Within the Load Test function, the user can access the internal memory of the rheometeror any USB Flash Drive that is connected to a USB port . The rheometer will point to the USB Flash Drive according to the order in which it is connected. The first USB Flash Drive that is connected will be referred to as #1 on both the Load Test screens and the Status Bar. As many as three USB Flash Drives can be connected to the DVNext at any time.

Test files that are displayed on the screen can be sorted by date of creation or by alpha/numeric. This sorting is selected by pressing the Navigation Icon or.

TIP: Manage Files function can be used to move Test files from internal memory to a USB Flash Drive.

2.4.5 View results

Test results (data files) can be saved to the internal memory of the DVNext or to a USB Flash Drive. These files can be reloaded into the DVNext for review, analysis, or printing through the View Results function. A file of Test Results that is saved onto a USB Flash Drive can be viewed on any DVNext Rheometer.

Within the View Results function, the user can access the internal memory of the DVNext Rheometer or any USB Flash Drive that is connected to a USB port . The rheometer will point to the USB Flash Drive according to the order in which it is connected. The first USB Flash Drive that is connected will be referred to as #1 on both the View Results screen and the Status Bar. As many as three USB Flash Drives can be connected to the DVNext at any time.

Results files that are displayed on the screen can be sorted by date of creation or by alpha/numeric name. This sorting is selected by pressing the Navigation Icon or .

TIP: Manage Files function can be used to move Results files from internal memory to a USB Flash Drive.

2.5 Out-of-range

The DVNext Rheometer will give on screen indications when the measurement is out of range of the instrument. When the %Torque reading exceeds 100% (over range), the display of %Torque, Viscosity, and Shear Stress will be EEEE (see Figure 2-20). If the %Torque value is between 0 - 9.9%, the data field label will flash. When the %Torque is below zero (negative values), the display of Viscosity and shear Stress will be ----.

TIP: AMETEK Brookfield recommends collecting data only when the %Torque reading is between 10 - 100%.

Figure 2-20

Measurement data should not be collected when the %Torque reading is out of range. The out of range condition can be resolved by either changing the speed (reduce speed when reading is out of range: high) or changing the spindle (increase the spindle size when the reading is out of range: low).

TIP: When comparing data, the test method is critical. Be sure that you know the proper spindle and speed required for the test method. If readings are out of range, this condition should be reported as the test result.

2.6 Printing

The DVNext Rheometer can communicate to a Dymo Label Writer 550 Turbo label printer.
This printer can be purchased from AMETEK Brookfield (Part No. GV-1098). The communication to the printer is by USB. When the printer is connected to the DVNext, the printer icon will be visible in the status bar.

There is no provision currently to have other drivers for other printers work with the DVNext.
The DVNext Rheometer can configure the printout for several formats of paper/labels.These various paper/label stocks are available from AMETEK Brookfield. (see Figure 2-21)

Label Type	Part Number - Standard
Data label, small (1.13 X 3.5 in.), pkg. of 5	GV-1096-5
Data label, large (2.31 X 4 in.), pkg. of 5	GV-1097-5
Continuous paper (2.25 in. wide), pkg. of 5	GV-1095-5

Figure 2-21

Printer formats are detailed below:

Data Label (small)

03/04/13 12:09 PM			Administrator
LV	LV-01	1.0 RPM	20.3 °C
900.0 ± 60.00 cP			15.0 %

Data Label (large)

FINAL DATA POINT			02/21/13 10:08 AM
S/N: 206	RV	ULA	Administrator
Test: Unsaved Test			
Visc(cP)	Acc(±cP)	Torq(%)	Speed(RPM)
4.63	0.07	69.4	90
Sh Stress(dyne/cm²)	Temp(°C)	Density(g/cm³)	
5.09	---	0.0000	

TIP: When printing to a label, if the data set includes more than one point, only the last point will be printed.

Data Continuous

VISCOSITY REPORT			Step Pt		Time	Viscosity	Torq	Speed	Sh Stress	Sh Rate	Temp	Density	Accurac
02/20/13 10:20 AM		Administrator	(#)	(#)	(hh:mm:ss)	(cP)	(%)	(RPM)	(dyne/cm²)	(1/s)	(°C)	(g/cm³)	(±cP)
S/N: 206	RV	LV-03	1	1	00:00:10	5,472	11.4	2.5	0.00	0.000	---	0.0000	480.00
Test: barbcomp16.dvt			2	2	00:00:20	5,472	45.6	10	0.00	0.000	---	0.0000	120.00
File: barbcompresults2.vdt			3	3	00:00:30	5,484	91.4	20	0.00	0.000	---	0.0000	60.00
Sample Notes:			4	4	00:00:40	5,532	46.1	10	0.00	0.000	---	0.0000	120.00
			5	5	00:00:50	5,616	11.7	2.5	0.00	0.000	---	0.0000	480.00

3. MAKING VISCOSITY MEASUREMENTS

3.1 Quick start

The DVNext Rheometer uses the same methodology for viscosity measurements as previous AMETEK Brookfield instruments. If you have experience with other AMETEK Brookfield equipment, this section will give you quick steps for taking a viscosity reading. If you have not used a AMETEK Brookfield Rheometer before, skip this section and go to Section 4.2 for a detailed description.

- Assemble DVNext Rheometer (Section 2-2).
- Turn power on.
- There will be a prompt to level the DVNext, if not already level. Follow instructions on screen. (Section 2.2)
- Autozero the rheometer (Section 2.2.1).
- The DVNext will display the Configure Viscosity Test Screen. In this screen, select spindle and speed. Confirm that Data Collection is set to Single Point and End Condition is set to Time 00:00:00.
- Attach the spindle to the coupling nut.
    - Note: Left-hand thread. If equipped with magnetic coupling, use the appropriate procedure to connect the spindle (see Section 3.5).
- Immerse the spindle gently into the test sample by lowering the DVNext on the Model G laboratory stand.
- Press the Run button. The screen will change to the Running Viscosity Test Screen.
- When ready to record the measurement results, press the Stop Test button. The screen will change to the Results Table. Record the % torque and viscosity.
- To run another test, press Configure Test. To return to the Home Menu, press the Home Icon.

3.2 Preparations for making measurements

- RHEOMETER: The DVNext should be turned on, leveled and autozeroed. The level is adjusted using the two feet on the bottom of the base and confirmed through aligning the digital bubble on the screen with the center of the leveling circle. Adjust the feet until the bubble is inside the center target. Set the level prior to autozero. The proper level is essential for correct operation of the DVNext.
- SAMPLE: The fluid to be measured (sample) must be in a container. The standard spindles supplied with the DVNext [LV (1-4), RV (2-7), or HA/HB (2-7)] are designed to be used with a 600 mL low form Griffin beaker (or equivalent container with a diameter of 8.25 cm). The same applies to the optional RV1, HA/HB1, and Vane spindles. Many other spindle systems are supplied from AMETEK Brookfield with specific sample chambers such as the Small Sample Adapter, UL Adapter and Thermosel.

AMETEK Brookfield recommends that you use the appropriate container for the selected spindle. You may choose an alternate container for convenience; however, this may influence the measured viscosity. The DVNext is calibrated considering the specified container.

Alternate containers will provide results that are repeatable but may not be “true”.
The LV (1-4) and RV (1-7) are designed to be used with the guard leg attached. Measurements made without the guard leg will provide repeatable results but may not provide “true” results.

When comparing data, be sure to specify the sample container and presence/absence of the guard leg.

Many samples must be controlled to a specific temperature for viscosity measurement. When conditioning a sample for temperature, be sure to temperature control the container and spindle as well as the sample.

Please see our publication, “More Solutions to Sticky Problems”, for more detail relating to sample preparation.

3.3 Programming

The DVNext Rheometer provides a powerful programming capability for data collection. The interface in Configure Viscosity Test allows for control of all instrument parameters including Spindle, Speed, Temperature (optional), End Condition, Data Collection, Instructions, Reports, Density, and QC Limits (described in the next sections of this chapter). Any collection of these parameters is considered a Test Step. The DVNext allows you to create multiple steps to better evaluate your sample material. Several parameters are only active in the first step including Spindle and Instructions.

Multiple steps in a Test can be useful to evaluate the rheology of a sample or to simply aid in data collection. A multi-step Test that has a change in speed in each step can show Newtonian or non-Newtonian flow behavior. A first step with No Data can be useful when pre shearing is required. A step with No Data can be useful when a temperature change is affected, and some time is required for thermal equilibrium.

The Configure Viscosity Test screen (see Figure 2I-1) includes several tools for creating Tests with multiple steps.

Figure 3-1

Step 2 of 2	Navigation / Add:	Use the + to add a new step at the end of the Test. Use ❮ the to navigate to previous steps.
Delete Step	Delete:	Delete the current step.
Insert Step	Insert:	Insert a new step after the current step.

Two multi-step Tests are shown below. The first Test shows a three-step Test where each step has a different speed with a single data point collection. The results will include three viscosity points, one for each speed. The second Test shows a two-step Test where the first step is a pre-shear step. The pre-shear is conducted at 200 RPM for one minute and no data is collected.

The second step generates a single data point.

Three-step Test:

Figure 3-2a:step 1

Figure 3-2a:step 2

Figure 3-2a:step 3

Two-step Test:

Figure 3-3a:step 1

Figure 3-3a:step 2

3.4 Selecting a spindle/speed

The DVNext has the capability of measuring viscosity over an extremely wide range. For example, the DVNext RV can measure fluids within the range of 100-40,000,000 cP. This range is achieved by using several spindles over many speeds. See Appendix B for details.

The process of selecting a spindle and speed for an unknown fluid is normally trial and error. An appropriate selection will result in measurements made between 10-100 on the instrument % torque scale. There are two general rules that will help in the trial and error process:

- Viscosity range is inversely proportional to the size of the spindle.
- Viscosity range is inversely proportional to the rotational speed.

In other words: to measure high viscosity, choose a small spindle and/or a slow speed. If the chosen spindle/speed results in a reading above 100%, then reduce the speed or choose a smaller spindle.

Experimentation may reveal that several spindle/speed combinations will produce satisfactory results between 10-100%. When this circumstance occurs, any of the spindles may be selected.

Non-Newtonian fluid behavior can result in the measured viscosity and yield stress changing if the spindle and/or speed is changed. See our publication, “More Solutions toSticky Problems”, for more details.

When viscosity data must be compared, be sure to use the same test methodology: namely the same instrument, spindle, speed, container, temperature and test time.

DVNext LV Rheometers are provided with a set of four spindles and a narrow guard leg; DVNext RV Rheometers come with a set of six spindles and a wider guard leg; DVNextHA and DVNext HB Rheometers come with a set of six spindles and no guard leg. (See Appendix G for more information on the guard leg.)

The spindles are attached to the rheometer by screwing them onto the coupling nut on the lower shaft (see Figure 2I-4). Note that the spindles have a left-hand thread. The lower shaft should be secured and slightly lifted with one hand while screwing the spindle to the left. The face of the spindle nut and the matching surface on the lower shaft should be smooth and clean to prevent eccentric rotation of the spindle. Spindles can be identified by the number on the side of the spindle coupling nut.

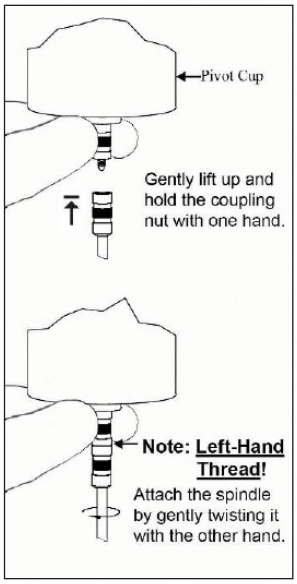


Figure 3-4

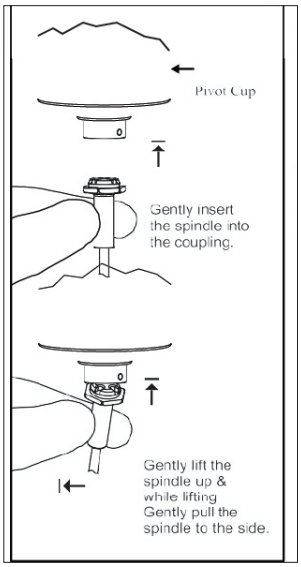


Figure 3-5

⚠	The motor should be OFF whenever spindles are being removed or attached.

3.5 Attaching a spindle to the magnetic coupling

Align two opposing spindle slots (see Figure 3-6) with the two pins inside the coupling (see Figure 3-7).

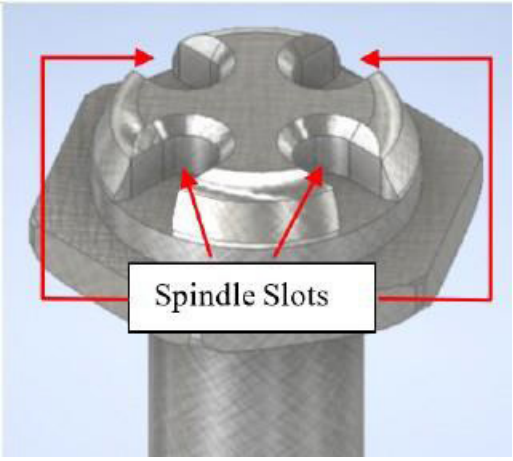


Figure 3-6

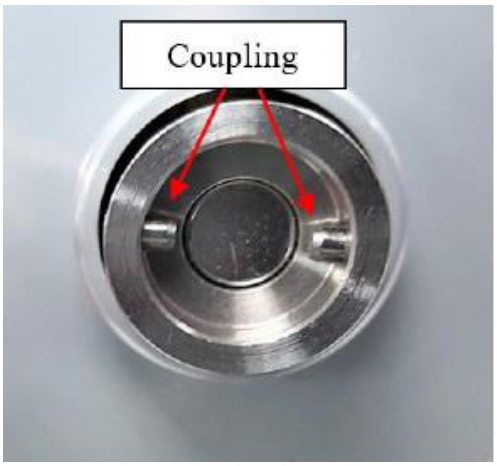


Figure 3-7

Carefully insert the spindle into the coupling so the slots are fully engaged with the pins. You should feel the pull of the magnet as the spindle seats in the coupling.

When properly aligned, there should be no gap between the spindle and the coupling (see Figures 3-8 and 3-9).

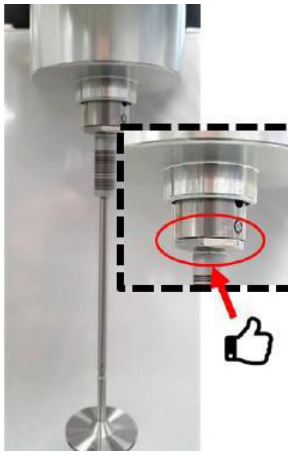


Figure 3-8: No Gap, Correct

Figure 3-9: Gap, Not Correct

3.6 Removing a spindle from the magnetic coupling

- With the motor turned OFF, carefully grasp the spindle shaft (see Figure 2I-10). and pivot it sideways to separate it from the magnetic coupling (see Figure 2I-11). DO NOT PULL DOWN ON THE SPINDLE!!
- Gently lift the Spindle just enough to minimize any pressure on the pivot point and jewel inside the DVNext.
- While still lifting, gently push the Spindle to the side like a pendulum to disengage it from the magnetic coupling. The spindle and coupling should separate easily. If they do not separate easily, DO NOT FORCE IT. Stop and try pushing it in a different direction.
- Continue pushing the spindle in an unrestrictive direction until it is completely detached from the magnetic coupling.

Figure 2I-10

Figure 2I-11

3.7 Barcode scanner

Set-Up the Zebra DS4308-HD (recommended) Digital Barcode Scanner for First Time Use:

Plug the barcode scanner into one of the USB-A Ports on the back panel of the DVNX. Wait for the barcode scanner to beep.

Scan the ADD AN ENTER KEY (Carriage Return/Line Feed) Barcode on the SET DEFAULTS/ENTER KEY BARCODES page of the Barcode Scanner Manual (see Figure 3-12).

Your Barcode Scanner is now ready for use with AMETEK Brookfield DVNext Viscometers and Accessories.

Figure 3-12

3.7.1 Scanning non-cone/plate spindles with the barcode scanner (C & G models)

Plug the barcode scanner into one of the USB-A Ports on the back panel of the DVNext (see Figure 3-13). Wait for the barcode scanner to beep.

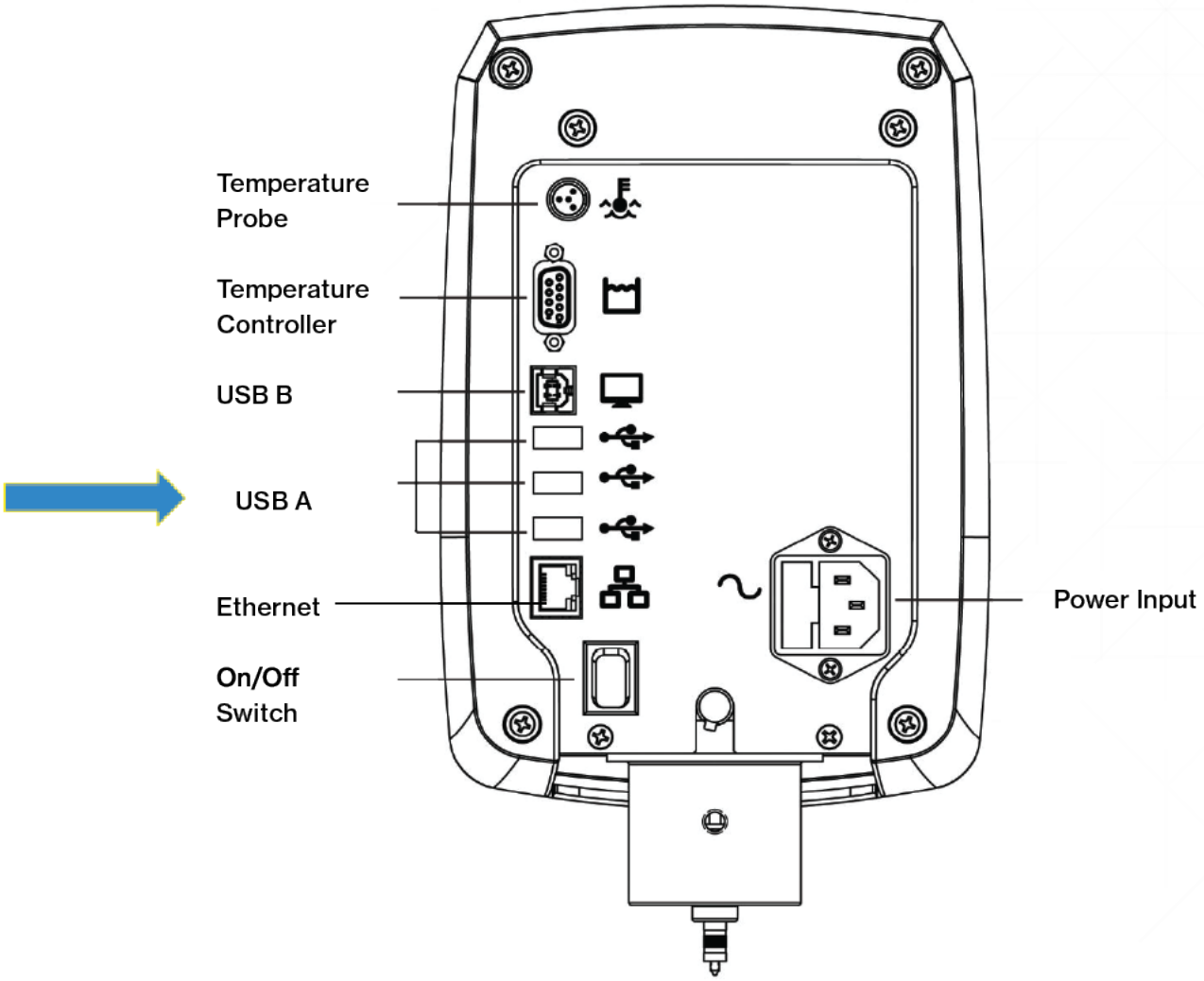


Figure 3-13

On the Configure Viscosity Test screen, touch the Blue Arrow in the Spindle field (see Figure 3-14) to open Set Spindle (see Figure 3-15).

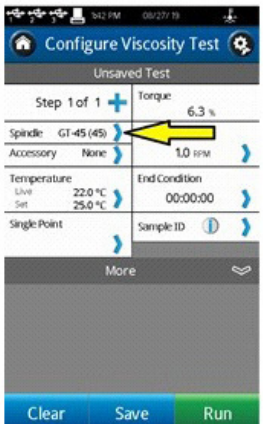


Figure 3-14

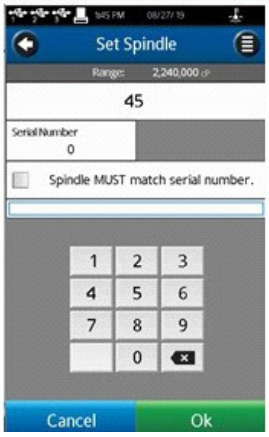


Figure 3-15

Attach the Spindle to the DVNX magnetic coupling (see Figures 3-16 and 17).

Figure 3-16

Figure 3-17

Hold the barcode scanner approximately 3-5 inches from the spindle at a slight upward angle of 10-20°. Aim the barcode scanners red dot at the spindle barcode (see Figure 3-18).

Squeeze the barcode scanner trigger until it beeps and the Spindle field on the DVNext screen populates (see Figure 3-19). Verify the correct spindle and serial number were scanned.

Figure 3-18

Figure 3-19

3.7.2 Scanning cone/plate spindles

Plug the barcode scanner into one of the USB ports on the back panel of the DVNext. Wait for the barcode scanner to beep. On the Configure Viscosity Test screen, touch the blue arrow in the Spindle field to open Set Spindle. Place the Cone/Plate Spindle on a clean, flat surface (see Figures 3-20 and 21).

Figure 3-20

Figure 3-21

Hold the barcode scanner at a 20-30° downward angle, approximately 3-6 inches from the spindle (see Figure 3-22). Aim the barcode scanner's red dot at the spindle barcode (see Figure 3-23). Squeeze the barcode scanner trigger until it beeps and the Spindle field on the DVNext screen populates. Verify the correct Spindle number was scanned.

Figure 3-22

Figure 3-23

3.7.3 Scanning cone/plate spindles, attached to the DVNext

Plug the barcode scanner into one of the USB Ports on the back panel of the DVNext. Wait for the barcode scanner to beep. On the Configure Viscosity Test screen, touch the Blue Arrow in the Spindle field to open Set Spindle. Locate the barcode on the Cone/Plate Spindle (see Figure 3-24).

Hold the barcode scanner at a 0-10° angle, approximately 3-5 inches from the spindle. Aim the barcode scanners red dot at the spindle barcode. Squeeze the barcode scanner trigger until it beeps and the Spindle field on the DVNext screen populates (see Figure 3-25). Verify the correct spindle number was scanned.

Figure 3-24

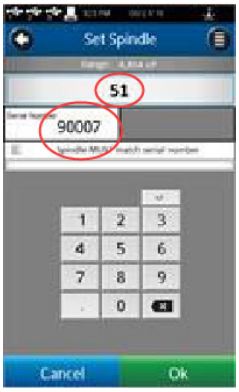


Figure 3-25

3.7.4 Scanning sample barcodes (standard & compliant instruments)

Plug the barcode scanner into one of the USB Ports on the back panel of the DVNext. Wait for the barcode scanner to beep. On the Configure Viscosity Test screen, touch the Blue Arrow (see Figure 3-26) in the Sample ID field to open the Enter Sample ID screen (see Figure 3-27).

Figure 3-26

Figure 3-27

Hold the barcode scanner approximately 4-6 inches from your sample barcode. Aim the barcode scanner red dot at the sample barcode (see Figure 3-28). Squeeze the barcode scanner trigger until it beeps and the Sample ID field on the DVNX screen populates (seeFigure 3-29). Verify the correct sample number was scanned.

Figure 3-28

Figure 3-29

3.7.5 Scanning accessory barcodes (compliant instruments only)

Plug the barcode scanner into one of the USB Ports on the back panel of the DVNext. Wait for the barcode scanner to beep. On the Configure Viscosity Test screen touch the blue arrow in the accessory field to open the Set Accessory screen (see Figure 3-30).

Hold the barcode scanner approximately 3-6 inches from the accessory barcode angled left or right at 0-20°. Aim the barcode scanner red dot at the accessory barcode. Squeeze the barcode scanner trigger until it beeps and the Accessory field on the DVNX screen populates (see Figure 3-31). Verify the correct sample number was scanned. Examples of some accessories is shown in Figure 3-32 and Figure 3-33.

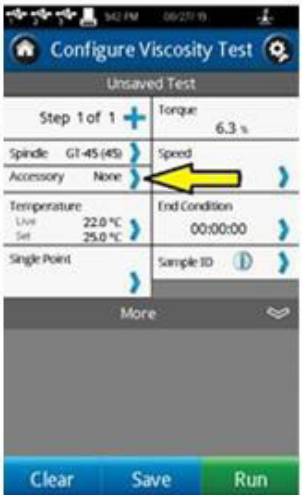


Figure 3-30

Figure 3-31

Figure 3-32: ULA

Figure 3-33: RV Guard Leg

3.8 Temperature control

The DVNext Rheometer provides the ability to control the temperature of a connected AMETEK Brookfield temperature control device such as the Thermosel (HT-106 controller) and water baths with SD or AP controllers (for example: TC-550SD). The Thermosel or waterbath can then be used to control the temperature of the sample under test.

The DVNext connects to the temperature control device through a dedicated communication cable. The Thermosel requires cable DVP-141. The water baths require cable DVP-207. These cables are available from AMETEK Brookfield.

When configured for control of a temperature control device, the DVNext may have two temperature inputs:

- The temperature probe supplied with the DVNext (DVP-94Y, CPA-44PYZ, or SC4-13RPY)
- The temperature probe supplied with the temperature control device (water bath or Thermosel)

Only one temperature probe can be used for display of live temperature, control, and data collection. Select the probe to be used in the Temperature menu (see Figure 3-34). Temperature control must be initiated each time the DVNext is powered on. Be sure that the temperature control device is powered on prior to initiating communication. Choose Device Setup in the Settings menu. Choose Temperature and the Temperature menu will appear (see Figure 3-35). Temperature Offset is described in Section 4.4.

Figure 3-34

Figure 3-35

Select Temperature Controller and you will be presented with the Default Temperature menu (see Figure 3-35). This menu allows the user to 1) initiate communication with the temperature controller and 2) set a default temperature.

Initiate temperature control by pressing the Test Connection. The connection status will be confirmed with a message box and the appearance of the bath icon in the status bar (see Section 2.3).

The Default Temperature is the temperature value that the control device will return to at the conclusion of a Test. This value is set only if the check box is checked. When the check box is unchecked, the temperature controller will hold at the last set point used in the Test.

TIP: When a test involves several temperature set points, set the Default Temperature to the first set point used in the Test. This will reduce the transition time from one Test run to the next Test run.

Note that temperature controllers can also be controlled through the RheocalcT or DV360 software when they are connected to the computer using the proper cable. The Thermosel requires the HT-106 cable (RS-232), available from AMETEK Brookfield. The water bath requires the 225-173 cable (RS-232), which comes with the bath.

3.9 Multiple data points

Most of the viscosity and yield stress measurements are made at the quality control level and often consist of a single data point. The test is conducted with one spindle at one speed. The data point is a useful benchmark for the go/no-go decision in a production setting. The DVNext can be used for single point measurement.

Many fluids exhibit a characteristic change in viscosity and yield stress with a change in applied force. This non-Newtonian flow behavior is commonly seen in paints, coatings, and food products as a decrease in viscosity as shear rate increases or an increase in yield stress as a rotational speed increases. This behavior cannot be detected or evaluated with the single point measurement.

Non-Newtonian flow is analyzed through the collection of viscosity data over a range of shear rates and the generation of a graph of viscosity versus shear rate (a rheogram). This information will allow for a more complete characterization of a fluid and may help in formulation and production of a product. The DVNext is capable of collecting multiple data points for comprehensive analysis of flow behavior.

More information on flow behavior, shear rate and rheograms is available in our publication, “More Solutions to Sticky Problems”.

3.10 Selecting data collection

The DVNext Rheometer offers several options for data collection. The Data Collection setting is shown in Configure

Viscosity Test directly under the Temperature display. The factory setting is Single Point (see Figure 3-36). Pressing the blue arrow, in this field, will present the Data Collection screen (see Figure 3-37).

Figure 3-36

Figure 3-37

Single point

Collect only a single data point when the End Condition is met.

Single point averaging

Specify an amount of time over which to average measured data. Collect a single datapoint when the End Condition is met. This data point is an averaged value. If the time for averaging is shorter than the total time for the step, then the average will be performed for the specified time at the end of the test.

Example 1: The End Condition is Time with a value of 1 minute and 30 seconds, the Single Point Averaging Duration is 30 seconds, the single data point collected from this step will be an average of the data measured from 1 minute to 1 minute 30 seconds.

Multi-point

Collect multiple data points based on time. The Data Interval is specified in Hours: Mins:-Secs. If the End Condition is set to Time, then the total number of points will be calculated and displayed in the Data Collection screen. If the End Condition is not based on time, then it is possible that the step will conclude prior to a data point being collected. If you want a data point at the conclusion of the step regardless of the time interval, you can check the check box in the Data Interval screen.

Example 2: End Condition is Time = 2 minutes, Multi Point Data Interval is 10 seconds. Total points collected will be 12 with the last data point taken in the last second of the step.

Example 3: End Condition is set to Viscosity = 200 cP, Multi Point Data Interval is 10 seconds. During the test the total time required to reach 200 cP is 65 seconds. Total points collected will be 6 with the last data point taken at 60 seconds, 5 seconds before the test is finished.

Example 4: End Condition is set to Viscosity = 200 cP, Multi Point Data Interval is 10 seconds. Check the check box to Also Collect Single Point at Step End. During the test, the total time required to reach 200 cP is 65 seconds. Total points collected will be 7 with the last data point.

Multi-point averaging

Specify an amount of time over which to average measured data. Collect multiple data points based on time until the End Condition is met. Each data point is an averaged value. If the Averaging Duration is shorter than the Data Interval for the step, then the average will be performed for the specified time at the end of the Data Interval. The

total number of points to be collected will be displayed if the End Condition is set to Time. If the End Condition is not based on time, then it is possible that the step will conclude prior to a data point being collected. If you want a data point at the conclusion of the step regardless of the time interval, you can check the check box in the Data Interval screen.

Example 5: End Condition is Time = 2 minutes, Multi Point Data Interval is 10 seconds. Averaging Duration is 5 seconds. Total points collected will be 12 with the last data point taken in the last second of the step. Each data point will be an average of the data measured in the last 5 seconds of each Data Interval.

Example 6: End Condition is set to Viscosity = 200 cP, Multi Point Data Interval is 10 seconds. Averaging Duration is 5 seconds. During the test, the total time required to reach 200 cP is 63 seconds. Total points collected will be 6 with the last data point taken at 60 seconds, 3 seconds before the test is finished. Each data point will be an average of the data measured in the last 5 seconds of each Data Interval.

Example 7: End Condition is set to Viscosity = 200 cP, Multi Point Data Interval is 10 seconds. Averaging Duration is 5 seconds. Check the check box to Also Collect Single Point at Step End. During the test, the total time required to reach 200 cP is 65 seconds. Total points collected will be 7 with the last data point taken at 65 seconds, an average of the 5 seconds after point #6.

Example 8: End Condition is set to Viscosity = 200 cP, Multi Point Data Interval is 1 minute. Averaging Duration is 20 seconds. Check the check box to Also Collect Single Point at Step End. During the test, the total time required to reach 200 cP is 10 minutes 40 seconds. Total points collected will be 11 with the last data point taken at 10 minutes 40 seconds, an average of the last 20 seconds of the step.

No data

End Condition is met and no data is collected.

3.11 End condition types

The DVNext comes available with a “type” parameter for some end conditions that allow the user to evaluate results a variety of different ways. These “type” parameters are applicable to the viscosity, torque, and temperature end conditions and are as follows: Equal to, Greater than, Less than, Stabilization, and Peak Exotherm (Temperature end condition ONLY). These parameters can be selected from the “type” dropdown menu in the end condition screen once the end condition selected is torque, viscosity, or temperature (see Figure 3-38).

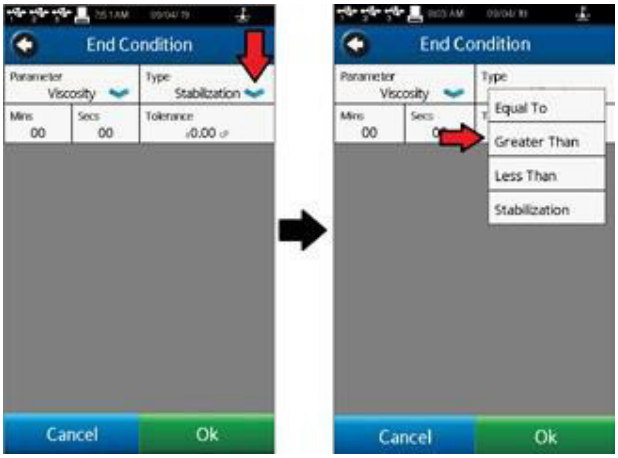


Figure 3-38

Equal to

The test will complete or move onto the next step once the specified end condition parameter (viscosity, torque, or temperature) measured by the device is equal to the value that is set by the user. The “Equal To” end condition can also be set up to have a tolerance. If the value measured reaches within the tolerance set for the value set,

the end condition will be met and the DVNext will end the test or move onto the next step, depending on the test parameters.

Greater than

The test will complete or move onto the next step once the specified end condition parameter (viscosity, torque, or temperature) measured by the device is greater than the value that is set by the user. The device will not end the test/ move onto the next step whilst the value measured is less than the value set by the user. The greater than type does not have a tolerance option.

Less than

The test will complete or move onto the next step once the specified end condition parameter (viscosity, torque, or temperature) measured by the device is lower than the value that is set by the user. The device will not end the test/ move onto the next step whilst the value measured is greater than the value set by the user. The less than type does not have a tolerance option.

Stabilization

The test will complete or move onto the next step once the specified end condition parameter (viscosity, torque, or temperature) measured by the device has stabilized. The DVNext provides the ability to set both the time period and a tolerance for the stabilization end condition. The time period is a set length of time that the user would like the value to stabilize over before the device deems the stabilization as successful. The time period can be set with the maximum time allowed at 30:59. The max and min values of the tolerance and the units is dependent on what value is being evaluated using the stabilization end condition. For temperature, the value is +/- 9.9 °C. For torque, the value is +/- 9.9 %. For viscosity the value is +/- 1.000E+10 cP.

Peak exotherm

This option is available only to the temperature end condition parameter. The only value that can be set for this end condition is the tolerance (+/- °C). When using this end condition, the DVNext will deem the test complete or move onto the next step once the temperature peaks and then drops by the tolerance set as the end condition.

3.12 Additional test parameters

The Configure Viscosity Test screen includes a More/Less Bar. When pressed, the More Bar will present several additional Test Parameters including: QC Limits, Instructions, Reports, and Density. These parameters are always available and active regardless of the position of the More/Less Bar.

QC limits

Select an acceptable range for measurement results. The range may be defined by Viscosity, Torque, Time, Temperature, or Shear Stress. The possible range for Viscosity and Shear Stress will be defined by the spindle and speed selected. QC Limits are a visual and audible signal to the operator during the test. The data set does not include an indication of QC Limits violation.

A violation of the QC Limits during the test will be indicated by a flashing yellow box around the display for the specified parameter. Note that Time does not have a dedicated display. A violation will result in an audible beep and a warning message (see Figure 3-39). Data will continue to be collected while the warning message is displayed. If Viscosity or Torque are the selected for QC Limits, QC Limits will be shown during the test on the Real Time Graph if that parameter is selected for display (see Figure 3-40). The QC Limits are represented by dashed lines.

TIP: Audible alarms may be turned off in the User Settings.

TIP: An indication of a QC Limit violation is not part of the data set. The user can record a violation by using the Notes available when viewing test Results (see Section 3.9).

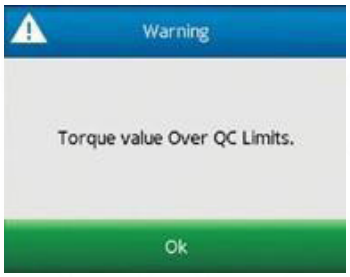
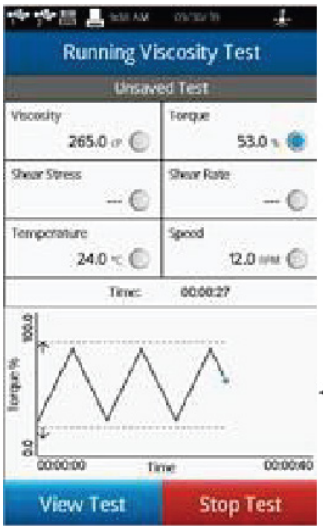


Figure 3-39



Trend Bar

Figure 3-40

Figure 3-41

Instructions

Record specific instructions to the operator. This information will be presented immediately when the program is Run (see Figure 3-41). The operator is required to acknowledge the message before the program will continue.

TIP: If the operator selects "Do not show this message again" within the Instructions message box, then Instructions will no longer be displayed for any test. This condition can be reset to allow Instructions to be displayed in the Display section of User Setting.

TIP: Instructions can be viewed during the test by selecting instructions (more/less bar) in the View Test screen.

Reports

Define how data will be presented at the conclusion of the test and specify the path for saving data files. Upon the conclusion of a test, the user can be presented with either: a Graph, Table, Math Model, or an Average of collected data points. Once in the Results section, the down arrow can be used to change the view.

Post Test Averaging can be specified as either Test Averaging or Step Averaging. Test Averaging allows you to select which step from the program (created with PG Flash) is to be averaged and displayed. Step Averaging is used when there is a single test step. See Section 3.11 for more detail relating to Data Averaging.

The data path for saving data can be preselected as part of the test report.

TIP: Selecting a data path can help to organize data storage in the internal memory of DVNext. By preselecting the data path, operators are directed to put data from specific tests into specific areas.

TIP: If you select a data path that includes a USB Flash Drive location and the USB Flash Drive has been removed, an error message will be displayed.

Density
Input a density value for the sample to be tested. This value will be used to calculate viscosity when kinematic viscosity units have been chosen for display (see Section V.3).

3.13 Running a test

A viscosity test is started by pressing the Run button on the Configure Viscosity Test screen. When Run is pressed, the display will change to the Running Viscosity Test screen (see Figure 3-42). The Running Viscosity Test screen provides information on the current measurement including: Torque, Viscosity, Shear Stress, Shear Rate, Temperature and Speed.

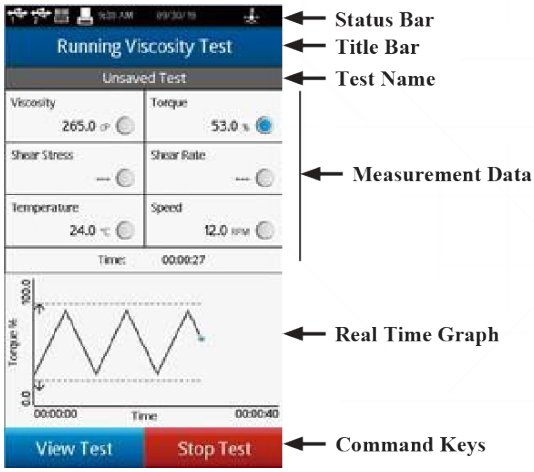


Figure 3-42

Torque
Torque is the deflection of the Rheometer torque sensor. It is described as a percent (%)and has a range of 0–100%. The DVNext will provide measurement results within the stated accuracy provided the Torque reading is between 10-100%. If the Torque reading falls below 10% the labels in the data fields will flash to indicate an error condition. AMETEK Brookfield does not recommend that data be collected below 10% Torque; however, data collection is not restricted.

TIP: Torque on the DVNext is equivalent to the dial reading from the AMETEK Brookfield Dial Reading Viscometer or the % reading from AMETEK Brookfield Digital Viscometers (DV-E, DV-I, DV-II, DV-III).

Viscosity
Viscosity is calculated from the measured Torque based on the selected spindle and speed of rotation. The units of viscosity are defined in the Global Settings section of the Settings Menu. If the Torque reading falls below 10%, the labels in the data fields will flash to indicate an error condition.

Shear Stress
Shear Stress is calculated from the measured Torque based on the selected spindle. The units of shear stress are defined in the Global Settings section of the Settings Menu. If the Torque reading falls below 10%, the labels in the data fields will flash to indicate an error condition.

TIP: Shear Stress will be displayed as zero for spindles that do not have SRC values.

Shear Rate
Shear Rate is calculated from the selected speed based on the selected spindle.

TIP: Shear Rate will be displayed as zero for spindles that do not have SRC values.

Temperature
Temperature is the input value from a connected AMETEK Brookfield temperature probe. The DVNext (Non Cone-Plate versions) is provided with a DVP-94Y probe that can be inserted into the test sample or a water bath. The Cone/Plate version of the DVNext can be utilized with a sample cup that includes an embedded temperature

probe. Some AMETEK Brookfield accessories include temperature probes (Thermosel) or optional chambers with embedded temperature probes (Small Sample Adapter). The units of temperature are defined in the Global Settings section of the Settings Menu. The temperature will not be displayed when no temperature probe is connected.

Speed

Speed is the selected speed from the Configure Viscosity Test screen

TIP: Speed can be changed by switching from the Running Viscosity Test screen to the View Test screen using the blue arrow in the Speed field.

TIP: When Speed is changed in the View Test screen, the Test Name will be changed to unsaved.

The status of the test configuration is indicated in the gray bar above the data fields. A configuration that has been saved will be indicated by a display of the test file name. A configuration that is not saved will be indicated by a display of Unsaved Test.

The Real Time Graph is displayed at the bottom of the Running Viscosity Test screen. This graph shows all measurements during the life of the test. The Y-axis can represent any data field. The data field represented on the graph is shown by the blue dot; for example, in Figure 3-42, Torque is shown on the graph. Any data field can be selected by touching the screen.

The Real Time Graph will indicate data points collected as part of the test with a blue dot on the data line. At the conclusion of the test, the Real Time Graph is displayed for review. Once the OK button is pressed, only the data points collected as part of the test will be available for review/save. The Real Time Graph cannot be seen again once the Results page is in view.

QC Limits will be indicated on the Real Time Graph when the selection for Y-Axis is the same as the selection for QC Limits (see Section III.9).

Two Command Keys are available on the Running Viscosity Test screen: Stop Test and View Test.

Stop test

Immediately stops the current test. The user will be presented with a confirmation box. The test will continue to run until Yes is selected in the Confirmation box. If any data had been collected during the test, the user will be presented with the Results screen. If data was not collected, the user will be returned to the Configure Viscosity Test screen.

TIP: If the operator selects “Do not show this message again” within the Confirmation box, then the Confirmation box will no longer be displayed when Stop Test is pressed. This condition can be reset in the Display section of User Settings.

View test

Change the view from measurement to test parameters including: Spindle, Speed, Temperature, End Condition, Data Collection, QC Limits, Instructions, and Density. The View Test screen includes a live display of Torque and a Time parameter that shows the total elapsed time for the test (see Figure 3-43).

Figure 3-43

The More/Less Bar can be used to reduce the number of parameters shown in the display.

The Speed parameter is active in this view. The operator can change the speed of test without returning to the Configure Viscosity Test screen.

TIP: If the speed is changed during the execution of a saved test, then the test status will be changed to "Unsaved Test". This will also be reflected if the collected data is saved.

View Test includes the Stop Test command key and a Back Arrow navigation key. The Back Arrow is used to return the display to the Running Viscosity Test view.

3.14 Results

Measurement data is viewed in the Results screen. This screen is presented at the conclusion of a test or when data is loaded through the View Results selection from the Home Menu.

The DVNext utilizes a comprehensive data format. Data files include the complete set of measurement results and calculated values along with the test protocol. All elements of the test can be viewed in the Results screen.

The DVNext Rheometer allows for 5000 total data points per file. When viewing large data files, additional time is required when moving from the various Results options listed below. There may be some delay on the screen while the DVNext prepares the data.

The Results screen includes several Navigation Icons and Command Keys.

	Home:	Return to the Home Menu.
	Down Arrow:	Select Results Options.
	Blue Arrow:	Select Page of Results Table.
Print	Print:	Print Data to USB printer.

Save	Save:	Save data.
Configure Test	Configure Test:	Return to Configure Viscosity Test screen.
	Scroll Bar:	Move up/down through a page of data.

The Results screen offers several options for viewing test data. These options are accessed via the Down Arrow in the Navigation Bar at the top of the screen (see Figure 3-44).

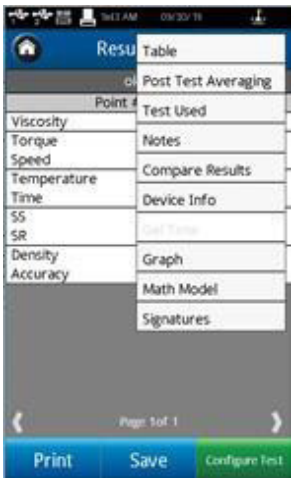


Figure 3-44

Table

Display all data points. Data will be shown in a scroll list where each page can hold a maximum of 50 points. If the data set has more than 50 points, then additional pages will be indicated at the bottom of the screen. Additional pages of data can be accessed using the Blue Arrows.

Each data point includes: Viscosity, Torque, Speed, Temperature, Time, Shear Stress (SS), Shear Rate (SR), Density, and Accuracy.

Post test averaging

Average and Standard Deviation are calculated for measured and calculated parameters including: Viscosity, Torque, Shear Stress, and Temperature.

Post Test Averaging is calculated regardless of the Data Collection setting. If Data Collection was set to Multi-point Averaging, then the Post Test Averaging will calculate an average of the averaged data.

When using multiple step programs, the test step utilized for Post Test Averaging is specified in the Report setting (see Section III.11).

Test used

Display the test elements used to generate the data set. In this view, the Configure Test button is available. Selecting Configure Test will program the DVNext to run the same test utilized to collect the data set being viewed and present

the Configure Viscosity Test screen.

Notes
Document any relevant information about the test or data. This information will be stored with the data set once saved.

Compare results
Load two data sets and view side by side, must be run from the same test to be able to compare results.

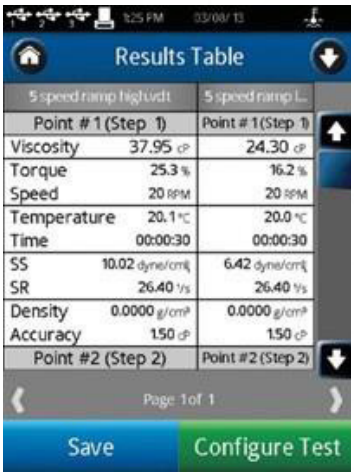


Figure 3-45

Device info
Display basic information about the data file and the specific DVNext Rheometer used to collect the data including: date and time the test started, completed and was saved; if user accounts are active, which user saved the data; rheometer serial number, firmware version, rheometer Torque range (LV, RV, HA, HB, other).

Graph
Display a graph of the collected data. The axis will default to the values selected in the Report section of the Test. The value displayed on each axis can be changed by selecting from the blue drop down arrow in each field. Individual data points can be selected, and the X / Y coordinate values will be displayed. The selected point is represented by a blue dot (other points are shown as gray dots).

TIP: Some spindle selections do not allow for the calculation of shear stress and shear rate. Shear Stress and Shear rate will be represented as " ---" for all data points for this type of spindle.

TIP: If the temperature probe is not connected to the DVNext, then the temperature field will not contain any data. The Graph will not display temperature under this condition.

The buttons at the bottom of the graph are for zooming in, zooming out, and resetting.

Math models
Analyze collected data through several defined equations. The selected math model will default to the selection from the Report section of the Test. You can change the selected model by pressing the blue drop down arrow.

Math Models available on the DVNext Rheometer include Bingham, Casson, NCA/CMACasson, Power Law, IPC Paste, and thix index. Each Math Model will be displayed in equation form with parameter values and confidence of fit calculations shown. Additionally, a graph of the model will be shown when available (no graph is available for this Index). The graph is a visual aid only and will not be included with a print.

Figure 3-47 shows the Power Law equation for a typical set of data. A brief definition ofthe equation will be shown if the "i" (information) button is pressed.

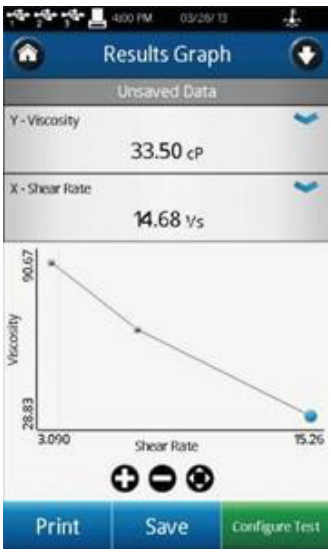


Figure 3-46

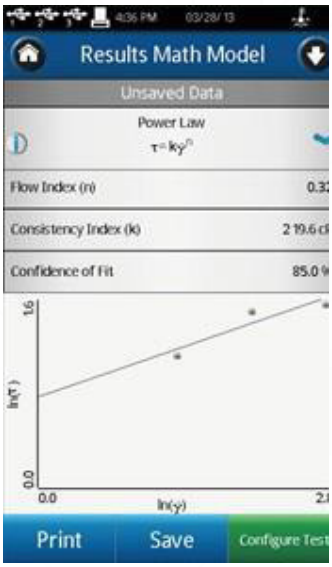


Figure 3-47

Data averaging

The DVNext Rheometer offers two techniques to average data, Live Averaging and Post Test Averaging. Data averaging can be useful when measuring samples with entrained air or suspended particles that cause some variation in measurement results. Data averaging may not be useful when changes in measurement results are caused by the rheological properties of the test sample such as thixotropy or pseudoplasticity (shear thinning). Materials that exhibit thixotropy will show a steadily decreasing measured viscosity over time. Materials that exhibit pseudoplasticity will show a changing viscosity as the spindle speed changes.

TIP: When averaging data for a thixotropic material, begin the Averaging Duration after the period of most significant change in measured viscosity. This will reduce the variability in the averaged value.

TIP: When averaging data for a pseudoplastic material, do not average together (Test Averaging) data collected at different speeds (or shear rates).

Live Averaging of data occurs during actual testing of a sample. Data can be collected as an average of readings over a specific time interval; each data point saved in the file is an averaged value. This averaging is defined in the Data Collection section of Configure Viscosity Test.

Single Point Averaging

Single Point Averaging requires a definition of Averaging Duration, the amount of time for which readings will be averaged. This time parameter will be applied at the end of the End Condition. In this case a single data point will be collected which represents the average of all data measured during the specified time period (Averaging Duration).

Multi-Point Averaging

Multi-point Averaging requires a definition of 1) Data Interval, the frequency of data collection and 2) Averaging Duration, the amount of time for which readings will be averaged. These two parameters will work in conjunction to generate multiple data points each of which represent the average of all data measured during the average duration within the specified Data Interval.

Post Test Averaging

Post Test Averaging of data occurs after the test is complete, through the Results screen. Averages and standard deviation values can be generated for data collected in a single step or across several steps. If the test used to collect data utilized Live Averaging (described above), then the Post Test Averaging will produce an average value of averaged data points. Post Test Averaging can be specified in the Report section of Configure Viscosity Test When configured as part of the test, the average values will be displayed immediately upon test conclusion. If not specified

in Report, Post Test Averaging can be selected from the Down Arrow in the Results screen.

Post Test Averaging offers two options: Step Averaging and Test Averaging (see Figure 3-48).

Step Averaging

Calculate Average and Standard Deviation for all data collected within a single step test. Step Averages will be displayed as shown below in Figure 3-49

Test Averaging

Calculate Average and Standard Deviation for all data collected within step specified. Test Averages will be displayed as shown below in Figure 3-50.

Figure 3-48

Figure 3-49

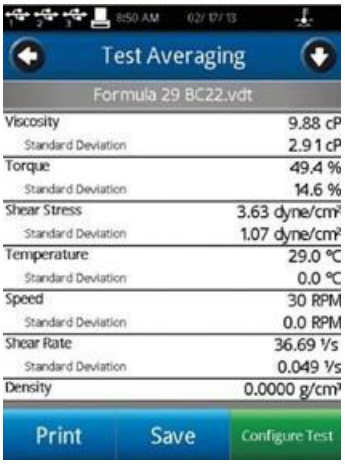


Figure 3-50

4. MAKING YIELD MEASUREMENTS

4.1 Quick start

The DVNext Rheometer uses the same methodology for yield measurements as the AMETEK Brookfield YR-1 and DV-III Ultra Rheometers. If you have experience with other AMETEK Brookfield equipment, this section will give you quick steps for making a yield measurement. If you have not used a AMETEK Brookfield Rheometer before, skip this section and go to (Section 4.2) for a detailed description.

- Assemble and level the DVNext Rheometer (Section 1.4).
- Turn power on.
- Autozero the rheometer (Section 2.2).
- The DVNext will display the Configure Viscosity Test Screen. Press the Home Icon in the Navigation Bar. From the Home Menu, select Configure Yield Test.
- Select: Spindle, Immersion Mark, and Run Speed.
- Attach the vane spindle to the DVNext.
    - **NOTE:** If equipped with magnetic coupling, use the appropriate procedure to connect the spindle (see Section III.3). Immerse the spindle gently into the test sample by lowering the DVNext on the Model G laboratory stand.
- Press the Run button. The screen will change to the Running Yield Test Screen.
- When the Yield Test is complete, the DVNext will present the Yield Test Complete screen. Record the Stress (yield stress), Torque, and Temperature.
- To run another test, press Configure Test. To return to the Home Menu, press the Home Icon.

4.2 Preparations for making measurements

A RHEOMETER: The DVNext should be turned on, leveled and autozeroed. The level is adjusted using the two feet on the bottom of the base and confirmed through aligning the digital bubble on the screen with the center of the leveling circle. Adjust the feet until the bubble is inside the center target. Set the level prior to autozero.

The proper level is essential for correct operation of the DVNext.

B Sample: The measured yield value is very dependent on how the sample is handled prior to the measurement. The sample should be disturbed as little as possible prior to inserting the vane spindle. AMETEK Brookfield recommends testing the sample in the container in which it is provided when possible. If it is necessary to transfer the sample to a new container, then it is recommended to include a pre-shear and/or wait time in the Yield Test. This pre-shear and wait time will provide a common history to each sample to aid in sample to sample comparison.

AMETEK Brookfield recommends the use of vane spindles for measuring yield value. The vane spindle provides a unique geometry that minimizes disturbance of the sample during spindle insertion.

Many samples must be controlled to a specific temperature for yield measurement.
When conditioning a sample for temperature, be sure to temperature control the contrainer and spindle as well as the sample.

4.3 Selecting a spindle/speed

The DVNext has the capability of measuring viscosity over an extremely wide range. For example, the DVNext RV can measure fluids within the range of 100-40,000,000 cP. This range is achieved by using several spindles over many speeds. See Appendix B for details.

The process of selecting a spindle and speed for an unknown fluid is normally trial and error. An appropriate selection will result in measurements made between 10-100 on the instrument % torque scale. There are two general rules that will help in the trial and error process:

- Viscosity range is inversely proportional to the size ofthe spindle.
- Viscosity range is inversely proportional to the rotational speed.

In other words: to measure high viscosity, choose a small spindle and/or a slow speed. If the chosen spindle/speed results in a reading above 100%, then reduce the speed or choose a smaller spindle.

Experimentation may reveal that several spindle/speed combinations will produce satisfactory results between 10-100%. When this circumstance occurs, any of the spindles may be selected.

Non-Newtonian fluid behavior can result in the measured viscosity and yield stress changing if the spindle and/or speed is changed. See our publication, “More Solutions to Sticky Problems”, for more details.

When viscosity data must be compared, be sure to use the same test methodology: namely the same instrument, spindle, speed, container, temperature, and test time. DVNext LV Rheometers are provided with a set of four spindles and a narrow guard leg; DVNext RV Rheometers come with a set of six spindles and a wider guard leg; DVNextHA and DVNext HB Rheometers come with a set of six spindles and no guard leg. (See Appendix G for more information on the guard leg.)

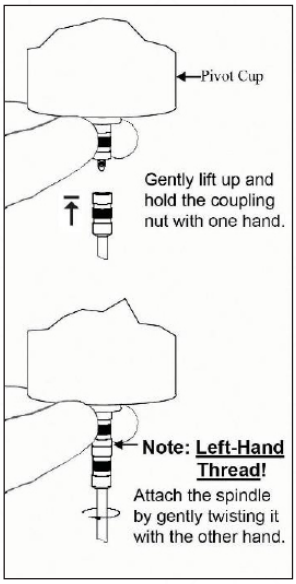


Figure 4-1

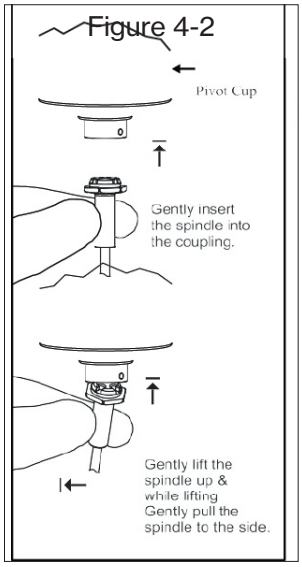


Figure 4-2

The spindles are attached to the rheometer by screwing them onto the coupling nut on the lower shaft (see Figure 3-4). Note that the spindles have a left-hand thread. The lower shaft should be secured and slightly lifted with one hand while screwing the spindle to the left. The face of the spindle nut and the matching surface on the lower shaft should be smooth and clean to prevent eccentric rotation of the spindle. Spindles can be identified by the number on the side of the spindle coupling nut.

⚠	The motor should be OFF whenever spindles are being removed or attached.

Note: Keep the Magnetic Coupling and inner sleeve as clean as possible and free from debris that could become lodged inside the adapter.

4.4 Temperature control

The DVNext Rheometer provides the ability to control the temperature of a connected AMETEK Brookfield temperature control device such as the Thermosel (HT-106 controller) and water baths with SD or AP controllers (for example: TC-550SD). The Thermosel or water bath can then be used to control the temperature of the sample under test.

The DVNext connects to the temperature control device through a dedicated communication cable. The Thermosel requires cable DVP-141. The water baths require cable DVP-207. These cables are available from AMETEK Brookfield.

When configured for control of a temperature control device, the DVNext may have two temperature inputs:

- The temperature probe supplied with the DVNext (DVP-94Y, CPA-44PYZ, or SC4-13RPY) and
- The temperature probe supplied with the temperature control device (water bath or Thermosel).

Only one temperature probe can be used for display of live temperature, control, and data collection. Select the probe to be used in the Temperature menu (see Figure 4-3).

Temperature control must be initiated each time the DVNext is powered on. Be sure that the temperature control device is powered on prior to initiating communication. Choose Device Setup in the Settings menu. Choose Temperature and the Temperature menu will appear (see Figure 4-4). Temperature Offset is described in Section 4.4.`

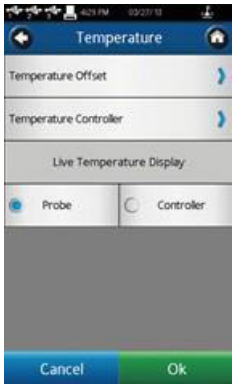


Figure 4-3

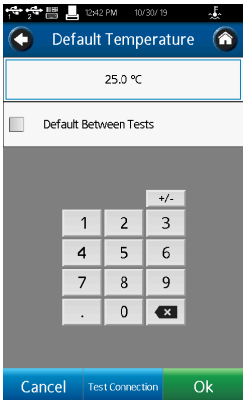


Figure 4-4

Select Temperature Controller and you will be presented with the Default Temperature menu (see Figure 4-4). This menu allows the user to 1) initiate communication with the temperature controller and 2) set a default temperature.

Initiate temperature control by pressing the Test Connection. The connection status will be confirmed with a message box and the appearance of the bath icon in the status bar (see Section 2.3).

The Default Temperature is the temperature value that the control device will return to at the conclusion of a Test. This value is set only if the check box is checked. When the check box is unchecked, the temperature controller will hold at the last set point used in the Test.

TIP: When a test involves several temperature set points, set the Default Temperature to the first set point used in the Test. This will reduce the transition time from one Test run to the next Test run.

Note that temperature controllers can also be controlled through the RheocalcT or DV360 software when they are connected to the computer using the proper cable. The Thermosel requires the HT-106 cable (RS-232), available from AMETEK Brookfield. The water bath requires the 225-173 cable (RS-232), which comes with the bath.

4.5 Test parameters

The Configure Yield Test screen includes several parameters to specify the test method; Spindle, Immersion Mark, Pre-Shear Speed, Pre-Shear Time, Zero Speed, Wait Time, Run Speed, Torque Reduction, and Temperature. The required parameters are Spindle, Immersion Mark, Run Speed and Torque Reduction. All other parameters are optional including those shown below the More/Less bar; Yield Limit, Instructions, Save Path.

Spindle

Spindle Number

A two (2) digit code representing the spindle number used for the test must be selected. See Appendix A for more information regarding spindles for use with the DVNext Rheometer. Selection of the appropriate spindle code is important to ensure correct stress calculations. AMETEK Brookfield recommends the use of vane spindles for yield measurements.

Immersion Mark

Each vane spindle has two (2) immersion marks. The primary immersion mark is located on the spindle shaft. Normally, the spindle should be inserted so that the sample reaches this mark. If the sample container is too small to allow the spindle to be inserted to this mark, the secondary immersion mark may be used. This mark appears half-way down the blades of the vane spindles. See Appendix D for more information regarding spindles and immersion marks.

Note: Selection of the appropriate immersion mark is important to ensure correct stress calculations.

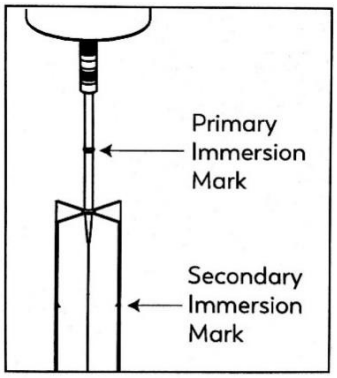


Figure 4-5

Pre-shear speed and time

An optional Pre-Shear step can be included in the test parameters. The user must supply the pre-shear speed (0.01-250 RPM) and pre-shear time (1 second-5 minutes 59 seconds).

Pre-shearing is the shearing of sample before measuring its yield properties. This process breaks down the sample's structure. It is particularly useful if the investigator wants to eliminate previous shear history (e.g., bumping, transferring) of the sample before testing and observe the structural rebuilding of the sample. This may simulate the following: ketchup pumped out of a bottle will rebuild after it comes to rest on the French Fries. There are materials whose measured yield stress will be lower after pre-shearing than if tested without pre-shearing. This may be used to compare the rate at which different materials rebuild. The yield stress measured in a pre-sheared sample is the "dynamic yield", while the yield stress measured for an originally undisturbed material is the "static yield". Zeroing after pre-shearing is performed on the sample is highly recommended for every test. The next section explains how to do this.

TIP: Set Pre-Shear Speed and Pre-Shear Time to zero if no Pre-Shear is required.

Zero

An optional, but highly recommended, torque Zero step can be included in the test parameters. A zero speed will cause the rheometer to rotate the motor in the appropriate direction until 0% torque is achieved.

This may be necessary because the spindle sometimes twists a small amount during insertion into the sample. This results in a small, although possibly significant, torque applied to the sample. Slow zeroing speeds are used to

eliminate this initial torque and minimize effects on the sample's structure before the test is started.
Zeroing is an essential step after pre-shearing. A zero step ensures a consistent starting point for each test. A speed for the step must be supplied in the appropriate box (0.01 - 0.50). Faster speeds achieve a "zero" quicker but may cause a more variable starting point. The DVNext will reset zero speed to 0.01 RPM when the %Torque value reaches 0.20% Torque.

Wait Time

An optional Wait Time step can be included in the test parameters. Wait Time creates a time delay after zeroing before the actual test run begins. During this delay, the motor shaft will be at zero (0) RPM.
Wait Time is the time the sample is allowed to rest between the completion of zeroing and the start of the yield measurement. Some samples rebuild structure more slowly than others after shearing, such as during handling, pouring sample into a beaker, etc. Certain low-viscosity paints may also have a low yield stress. Waiting 30 seconds, for example, after immersing the spindle may allow the sample to rebuild, producing a more consistent test method.

Run Speed

Run Speed is the motor speed for the DVNext at which the material is tested. It is common for materials to appear stiffer when tested at higher speeds. That is, the slope of the stress-vs.-strain curve increases with increasing speed. This is because the material structure has less time in which to react to dissipate the applied stress. Increasing the speed will, in most cases, increase the yield stress measured by the instrument. Most yield tests are conducted at relatively low speeds (<1 RPM) to minimize any inertial effects when using vane spindles. The range of acceptable run speeds is 0.01 - 5.0 RPM.

Torque Reduction

Torque Reduction is percentage change in torque value between successive data points. That is, the material yields or begins to break down and, as a result, the measured incremental torque begins to decrease. A value of 100% for this parameter causes the test to stop as soon as there are no torque increases during a base time increment. Some users may wish to see a drop in torque after the yield point. Setting this parameter to values greater than 100% allows data to be collected after the yield point by the RheocalcT or DV360 software so the decrease in torque may be more easily visualized. However, this will also affect the calculated yield stress value.

TIP: AMETEK Brookfield recommends a torque reduction value of 100%.

Yield Limits

These stress values can be used as a Quality Control tool. If the resulting yield stress from a test falls outside these limits, an appropriate message is displayed and printed with the results. Entering zero (0) for both these parameters disables this QC feature.

Instructions

Record specific instructions to the operator. This information will be presented immediately when the program is Run (see Figure IV-6). The operator is required to acknowledge the message before the program will continue.

Figure 4-6

TIP: If the operator selects "Do not show this message again" within the Instructions message box, then Instructions will no longer be displayed for any test. This condition can be reset to allow Instructions to be displayed in the Display section of User Settings .

TIP: Instructions can be viewed during the test by selecting instructions (more/less bar) in the View Test screen.

Save Path

Define the memory location (internal or USB Flash Drive) where the Test Results will be saved.

TIP: Selecting a data path can help to organize data storage in the internal memory of the DVNext. By preselecting the data path, operators are directed to put the data from specific tests into specific areas.

TIP: If you select a data path that includes a USB Flash Drive location and the Flash Drive has been removed, an error message will be displayed.

4.6 Running a Yield Test

A Yield Test is started by pressing the Run button on the Configure Yield Test screen. When Run is pressed, the display will change to the Running Yield Test screen (see Figure 4-7).

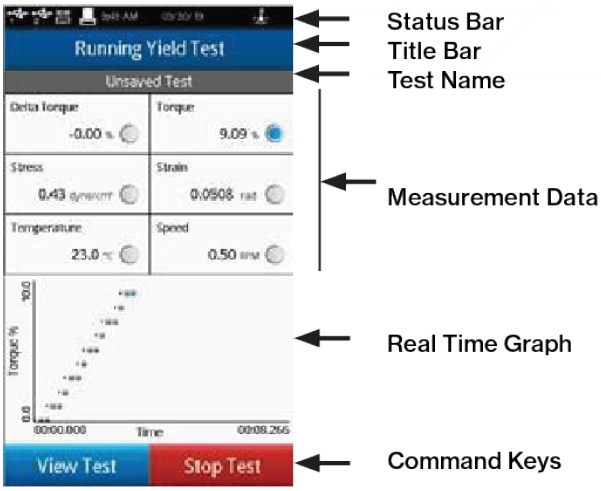


Figure 4-7

The Running Yield Test screen provides information on the current measurement including: Delta Torque, Torque, Stress, Strain, Temperature, and Speed.

Delta Torque

Delta Torque is the difference between the current %Torque value and the previous %Torque value. As the sample approaches its yield point, the Delta Torque percentage should decrease. If the Torque Reduction for the test is 100%, the yield point occurs when the % decrease in Torque = 100.

Torque

Torque is the deflection of the Rheometer torque sensor. It is described as percent (%) and has a range of 0 – 100%. The DVNext will provide measurement results within the stated accuracy provided the Torque reading is between 10 and 100%. If the torque reading falls below 10% the labels in the data fields will flash to indicate an error condition. AMETEK Brookfield does not recommend that data be collected below 10% Torque however data collection is not restricted.

TIP: Torque on the DVNext is equivalent to the % reading from the DV-III Ultra and the YR-1 Rheometer.

Stress

Stress is the calculated stress based on the Speed, Torque, and Spindle.

Strain
Strain is the Apparent Strain placed on the sample. The Apparent Strain is the angular distance that the spindle rotates in the sample.

Temperature
Temperature is the input value from a connected AMETEK Brookfield temperature probe. The DVNext is provided with a DVP-94Y probe that can be inserted into the test sample or a water bath. The Cone/Plate version of the DVNext can be utilized with a sample cup that includes an embedded temperature probe. Some AMETEK Brookfield accessories include temperature probes (Thermosel) or optional chambers with embedded temperature probes (Small Sample Adapter). The units of temperature are defined in the Global Settings section of the Settings Menu. The temperature display will be when no temperature probe is connected.

Speed
Speed is the selected speed from the Configure Yield Test screen.

The status of the test configuration is indicated in the gray bar above the data fields. A configuration that has been saved will be indicated by a display of the test file name. A configuration that is not saved will be indicated by a display of Unsaved Test.

The Real Time Graph is displayed at the bottom of the Running Yield Test. This graph shows all measurements during the test. The Y-Axis can represent any data field. The data field represented on the graph is shown by the blue dot; for example, in Figure 4-7, Torque is shown on the graph. Any data field can be selected by touching the screen.

The Real Time Graph will indicate data points collected as part of the Test with a blue dot indicating the final point. At the conclusion of the test, the Real Time Graph is displayed for review. Once the OK button is pressed, the screen will transition to Results.

QC Limits will be indicated on the Real Time Graph when the selection for Y-Axis is the same as the selection for QC Limits (see Section 3.9).

Two Command Keys are available on the Running Yield Test Screen: Stop Test and View Test.

Stop Test: Immediately stop the current test. The user will be presented with a confirmation box. The test will continue to run until Yes is selected in the Confirmation box. The user will be presented with the Results screen with any data that was collected.

View Test: Change the view from measurement to the test parameters. The View Test screen includes a live display of temperature. View Test includes the Stop Test command key and a Back Arrow in the Navigation Bar. The Back Arrow is used to return the display to the Running Yield Test view.

Measurement
Measurement data is viewed in the Results screen. This screen is presented at the conclusion of a test or when data is loaded through the View Results selection from the Home Menu .

The DVNext utilizes a comprehensive data format. Data files include the complete set of measurement results and calculated values along with the test protocol. All elements of the test can be viewed in the Results screen.

The DVNext Rheometer allows for 5000 total data points per file. When viewing large data files, additional time is required when moving from the various Results options listed below. There may be some delay on the screen while the DVNext prepares the data.

The results screen includes several Navigation Icons and Command Keys.

	Home:	Return to the Home Menu.

	Down Arrow:	Select Results Options.
	Blue Arrow:	Select Page of Results Table.
Print	Print:	Print Data to USB printer.
Save	Save:	Save data.
Configure Test	Configure Test:	Return to Configure Viscosity Test screen.
	Scroll Bar:	Move up/down through a page of data.

The Results screen offers several options for viewing test data. These options are accessed via the Down Arrow in the Navigation Bar at the top of the screen (see Figure 4-8).

Table
Display all data points. Data will be shown in a scroll list where each page can hold a maximum of 50 points. If the data set has more than 50 points, then additional pages will be indicated at the bottom of the screen. Additional pages of data can be accessed using the Blue Arrows.

Each Yield Results Table data point includes Delta Torque, Torque, Temperature, Time, Stress, and Strain.

Test used
Display the test elements used to generate the data set. In this view, the Configure Test button is available. Selecting Configure Test will program the DVNext to run the same test utilized to collect the data set being viewed and present the Configure Viscosity Test screen.

Notes
Document any relevant information about the test or data. This information will be stored with the data set once saved.

Compare results
Load two data sets and view side by side (see Figure IV-9), must be run from the same test to be able to compare results.

Device info
Display basic information about the data file and the specific DVNext Rheometer used to collect the data including: date and time the test started, completed and was saved; if user accounts are active, which user saved the data; rheometer serial number, firmware version, rheometer Torque range (LV, RV, HA, HB, other).

Graph
Display the final data point and graph (see Figure 4-10). The graph axis (X and Y) can be changed by selecting the blue drop down arrow in the appropriate data field. Zoom and reset controls are indicated under the X-Axis.

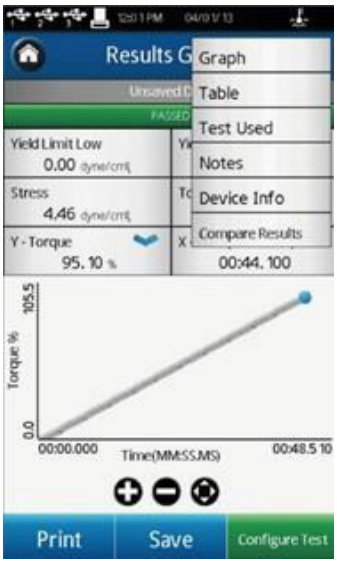


Figure 4-8

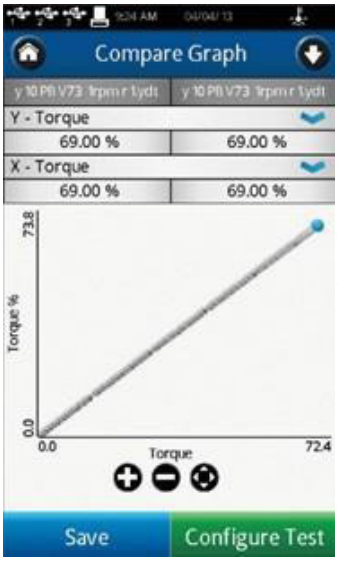


Figure 4-9

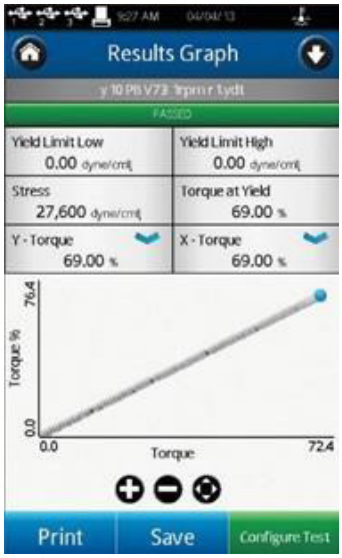


Figure 4-10

5. SETTINGS

The Settings menu provides access to the many controls and features of the DVNext Rheometer. This menu can be accessed through the Settings Navigation Icon which is often present in the Title Bar. Figure 5-1 shows the Settings Menu which is divided into: Device Setup, User Settings, Global Settings, and Admin Functions. Global Settings include items that affect the complete range of features within the DVNext. Admin Functions include items related to administrator level controls.

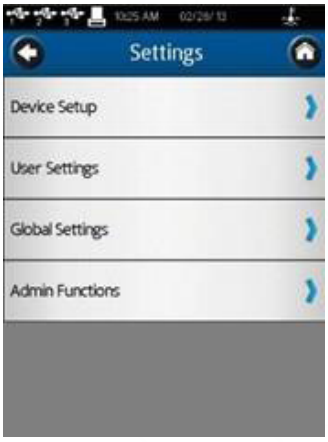


Figure 5-1

5.1 Device setup

The Device Setup menu includes settings related to the mechanical systems and connections of the DVNext. Eight settings are available including:

Temperature -	Create offsets to be used with specific temperature probes, initiate control of the AMETEK Brookfield Thermosel or Temperature Bath.
Printer Setup -	Define the print format to be used with the Dymo 450 Printer.
AutoZero -	Force the DVNext to perform an AutoZero as is done at start up.
Oscillation Check -	Evaluate the performance of the DVNext lower bearings. Technical Support Information that may be requested by AMETEK Brookfield Technical Info Support staff to assist with troubleshooting.
About -	Present basic information about the DVNext as is done at start up.

The temperature menu provides access to three functions: Temperature Offset,Temperature Controller Access, and Temperature Display/Settings.

Temperature

The Temperature Offset setting allows the user to create up to 10 temperature offset values for connected temperature probes. AMETEK Brookfield offers several types of temperature probes for use with the DVNext including: DVP-94Y immersion probe (supplied with Non Cone-Plate versions of the DVNext.), CPA-44PYZ embedded probe (optional with Cone/Plate DVNext Rheometers), and SC4-13RP embedded probe (optional with Small Sample Adapter). Any of these probes can be calibrated locally against a standard reference thermometer to determine an offset (how far from the actual temperature does the probe read). This offset can be entered the DVNext Rheometer and identified with a name defined by the user.

When Temperature is selected in the Device Setup menu, the Temperature Offset menu is presented (see Figure 5-3). From this menu you can create new offset values by pressing the Add Probe Offset command key at the bottom of the screen and you can select which offset to utilize with the DVNext by pressing the circle beside the name.

In Figure 5-3, the offset DVP-94Y 3 has been selected as indicated by the blue circle.

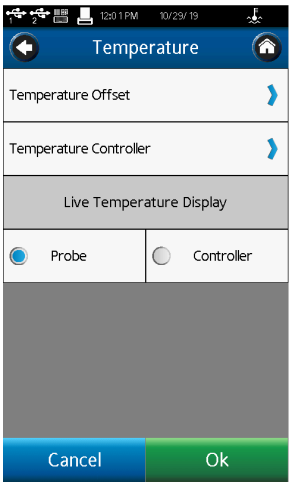


Figure 5-2

Figure 5-3

Figure 5-4

The creation of a Temperature Offset requires input of the offset value and a name. The offset value must be in the range of -9.9 to 9.9˚C. The Name can be up to 14 characters long. To delete an existing Temperature Offset, first select the offset from the list, then press the Delete command key at the bottom of the screen.

The use of a Temperature Offset will be indicated in the Temperature field displayed in the Configure Viscosity Test screen with a (o) beside the Live indication.

The Temperature menu also allows the user to initiate control over a connected temperature control device such as the AMETEK Brookfield Thermosel (HT-106 controller) or Water Bath (model TC-XX0SD or TC-XX0AP). Establish control over the external temperature controller by selecting Temperature Controller in the Temperature menu (see Figure 5-2). Press the Test Connection command button to verify that communication has been established between the DVNext and the temperature controller. Be sure that the temperature controller is turned on prior to pressing the Test Connection button. The Default Temperature screen also allows the user to set a Default Temperature. The Default Temperature is the set point value that will be used by the DVNext when a test (Viscosity Test or Yield Test) is not in use. To set the Default Temperature first, enter a temperature value and second check the Default Between Tests check box.

TIP: Use a Default Temperature when the test program includes a change in temperature and set the value equal to the first temperature control point in the test. At the conclusion of the test, the control device will be reset to the first temperature set point which will minimize the time required between tests.

The Temperature screen also allows you to choose which temperature probe will be used for data collection and temperature control. When the DVNext is controlling temperature through an external device, there may be two temperature probes available for data collection: 1) the temperature probe connected to the DVNext (Probe) and 2) the temperature probe associated with the temperature control device (Controller). Press either Probe or Controller in the Temperature menu.

Printer Setup

The DVNext is configured for use with the Dymo 450 printer. No other printers can be utilized with the rheometer. Printer Setup allows the user to choose from three different configurations for print out.

Label Small: A small label (1.13-inch x 3.5 inch) that allows for printing of limited data for a single data point. The label stock is available from AMETEK Brookfield; part number GV-1048 (standard) or GV-1082 (long life).

Label Large: A large label (2.31-inch x 4.0 inch) that allows for printing of a complete set of parameters for a single data point. The label stock is available from AMETEK Brookfield; part number GV-1049 (standard) or GV-1083 (long life).

Receipt: A continuous roll of paper that allows for printing of multiple data points. The paper stock is available from AMETEK Brookfield; part number GV-1047 (standard) or GV-1081 (long life).

The Printer Setup is selected by touching the desired configuration, which will result in a blue circle to appear to the left of the item. The OK command key must be selected to confirm the setting.

AutoZero

AutoZero is an operation performed by the DVNext Rheometer automatically during the power up sequence. This operation sets the instrument transducer to a correct zero value. The zero value should not shift over time, however, if the user determines that the zero is not correct, you can force an AutoZero to be performed without powering down the rheometer. When the AutoZero function is selected, the DVNext is immediately set to AutoZero mode and the user is presented with the AutoZero screen (see Figure 2-3). Upon completion, the user will be returned to the Device Setup menu.

Oscillation Check

The Oscillation Check is a check of the performance of the lower bearing of the DVNext.This lower bearing is either Point and Jewel or Ball Bearing. Correct performance of the lower bearing is essential for proper operation of the rheometer. A failed lower bearing will normally cause viscosity measurements to be lower than expected. Selecting Oscillation Check in the Device Setup menu will present the user first with a screen instructing to level the rheometer and remove the spindle. Confirmation of level and spindle removal will present the user with the Oscillation Check screen as shown below.

Figure 5-5

A successful Oscillation Check will show a very smooth decrease of %Torque with a final value within +/-0.3 of 0.0. Any value above 0.3 % or below -0.3% indicates that a calibration check should be performed (see Appendix F).

The Oscillation Check is not a guarantee of proper calibration. It is only an indication of the performance of the lower bearing of the rheometer. Calibration can only be verified using a calibration standard such as AMETEK Brookfield Silicone and Mineral Oil standards.

See Appendix H for additional information.

Technical Support Info

The information contained in the Technical Support Info menu is designed to support AMETEK Brookfield for problem resolution. When contacting AMETEK Brookfield for support, you may be asked to provide information contained in one of the menu choices within Technical Support Info. There are no settings within this section and the performance of the DVNext Rheometer cannot be affected by accessing this section.

About

The About screen is shown during the start-up sequence of the DVNext Rheometer. Selecting About in the Device Setup menu will show the same information (see Figure V-6). Information in the About screen includes: Torque Range (LV, RV, HA, HB), Model Number, Firmware Version, Rheometer Serial Number, TK version (torque table), Spindle version (spindle table).

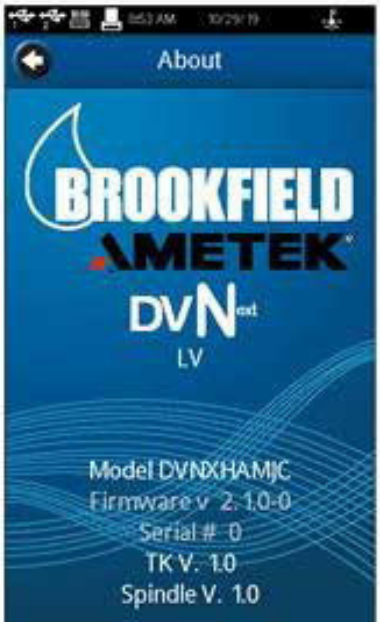


Figure 5-6

TIP: The information on the About screen will be needed when contacting AMETEK Brookfield for support.

To return from the About screen, press the Left Arrow navigation button in the Title Bar.

5.2 User settings

The User Settings menu includes settings related to specific users. The DVNext may be set up for a single user setting (used by one or more operators) or for multiple users who access through a Log in and Password.

Three User settings are available including:

Sound -	Adjust the volume of the DVNext sounds and select which sounds to silence.
Display -	Adjust the brightness, select language and restore Pop-Up messages.
Change Password -	Change the password for the Log In account used to access the DVNext Rheometer.

TIP: Each User can set their own preferences for Sound and Display.

Sound

The Sound menu provides adjustment of the volume for the sounds utilized by the DVNext. Additionally, specific sounds can be toggled on/off including: Button Click, TestEnd Alarm, QC Limits Alarm, Global Alarm, and Pop-Up.

TIP: Sound settings can be returned to Factory Setting through Settings Reset found in the Admin Function Settings menu.

Display

The Display menu provides adjustment of Screen Brightness, Language Selection, and Pop-Up Message management. The Screen Brightness adjustment applies to all screen views within the DVNext.

Note: The screen brightness is dimmed automatically after 5 minutes of no touch screen activity. The brightness will be dimmed to the lowest value. A single touch of the touch screen will return the display to the set brightness value.

The Language Setting is selected by pressing the Language field and choosing the appropriate language from the list. The selected language will be implemented immediately.

Pop-Up Messages can be toggled on/off through the check box (see Figure V-7). This check box applies to all Pop-Up Messages. Pop-Up Messages can be toggled off individually through the check box that appears within the

message box. Once the Pop-Up is turned off, it will not be shown again. Pop-Up Messages can be restored through the use of the Restore Hidden Pop-Ups command key at the bottom of the Display Settings screen. This command key will restore all Pop-Ups.

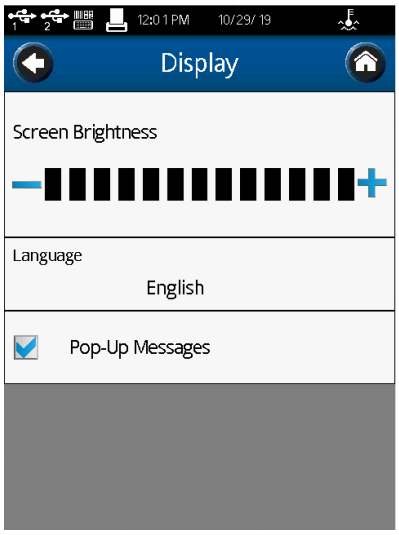


Figure 5-7

Change Password

A specific user can change their own password at any time. The user must first enter the current password. Then the user will be prompted to enter and confirm the new password.

TIP: If the administrator password is lost, it can be reset. Please contact AMETEK Brookfield or your local authorized dealer. Remember to have the information found in the About screen available.

Global Settings

The Global Settings menu includes settings that affect the operation of the DVNext across all users and menus. These settings are independent of user log in. The five Global Settings include:

Measurement Units -	Select the unit of measure for several parameters.
Regional Settings -	Specify language, number, time, and date formats.
Global Alarm -	Select single measurement parameter for alarm status.
Spindle List -	Configure the display of available spindles; create a special spindle.
Speed List -	Configure the display of available speeds; create a new speed.

Measurement Units

The Measurement Units menu displays the current selections for measurement units. Each unit can be changed by pressing the blue down arrow and selecting the desired value. Measurement Units are part of the data file for saved results. Available units include:

Viscosity	cP	centipoise
	P	Poise
	mPa•s	milliPascal seconds
	Pa•s	Pascal seconds
	cSt	centistokes
	mm^2/s	millimeters squared per second
		1000 cP = 10 P = 1000 mPa•s = 1 Pa•s
		1 cSt = 1 mm2/s
Speed	RPM	revolutions per minute
	1/s	reciprocal seconds

Temperature	C	Centigrade
	F	Fahrenheit
		100°C = 5/9 * (212°F – 32)
Stress (Shear)	Dyne/cm2	Dyne per square centimeter
	N/m2	Newton / square meter
	Pa	Pascal
		10 dyne/cm2 = 1 N/m2 = 1 Pa
Density	g/cm3	gram / cubic centimeter
	kg/m3	kilogram / cubic meter
		1 g/cm3 = 1000 kg/m3

TIP: When cSt units are chosen for viscosity, a density value must be entered in the Density field in Configure Viscosity Test.

The relationship between RPM and 1/s is defined by the SCR value of the selected spindle.

TIP: Density and viscosity are both sensitive to temperature. When using a density value in Configure Viscosity Test, be sure to enter a density value.

Regional Settings

The Regional Settings menu displays the current selections for the default language, number format, date format and day separator. Each setting can be changed by pressing the blue down arrow and selecting the desired value. Regional Settings are part of the data file for saved results.

The Language setting established the default language for the DVNext. Individual users can choose a different language for use with their specific log in.

The formats for Number, Time, Day Separator and Date offer several options.

Number Format	9,999,999.00 9.999.999,00 9 999 999,00	USA comma convention Europe decimal convention SI/ISO space convention
Time Format	13:59:59 1:59:59 PM	24 Hour Format 12 Hour Format
Day Separator	/ - .	Forward Slash Dash Period
Date Format	Year/Month/Day Month/Day/Year Day/Month/Year	ISO Standard USA Standard International Standard

Global Alarm

The Global Alarm establishes a single measurement parameter with a range of acceptance. Whenever the measured value exceeds this range of acceptance, an audible and visual alarm will be issued. The Global Alarm will apply to any test that is run. The QC Limit also establishes a measurement parameter with a range of acceptance; however, the QC Limit is applied only to the test in which it is defined.

Figure 5-8

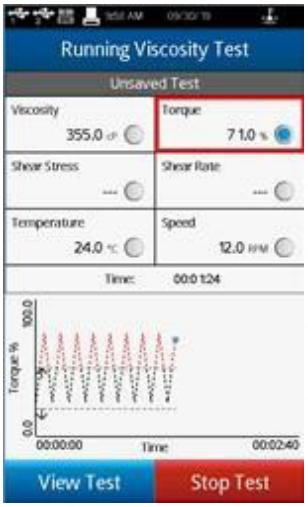


Figure 5-9

The error message will provide some detail about the alarm condition. The test and data collection will continue while the Warning message is displayed. The audible alarm will continue to sound until the operator touches the OK button within the Warning box. The Running Viscosity Test display will show a colored box around the data parameter associated with the Global Alarm. When the alarm condition is first met, the colored box will be yellow. If the measurement parameter returns to the acceptable range, then the colored box will be removed. When the alarm condition is met a second time, the colored box will be red (see Figure V-9). The audible alarm will only sound once.

TIP: The Global Alarm sound can be turned off in the Sounds menu of User Settings.The Global Alarm is deactivated by choosing None in the drop-down list of available measurement parameters. You must press OK to confirm your Global Alarm choice.

Spindle List

The selection of Spindle in Configure Viscosity Test can be done by using either a number pad or a scroll list. (This choice is selected through the navigation button in the Set Spindle screen.) The contents of the scroll list are defined in the Spindle List menu. Each spindle can be individually selected or deselected using a check box. Spindles, shown with both their name and their number, are listed numerically according to their spindle entry number.

The restricted spindle will not appear on the scroll list of available spindles when choosing Spindle in Configure Viscosity Test. If the user selects to enter the spindle by number, then the choice of a restricted spindle will present an Invalid Input message and prevent the selection of the spindle (see Figure 5-10).

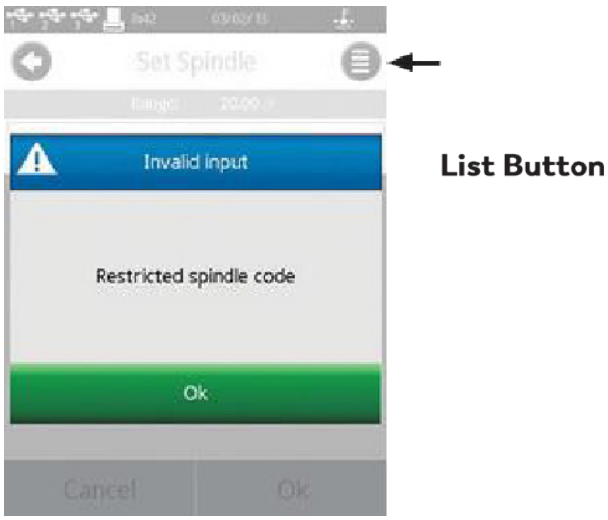


Figure 5-10

TIP: To ensure that the correct spindle code is always entered, create a test that is saved to the DVNext memory.

TIP: The selection of spindle can be restricted by User Log In. Use this restriction combined with a saved test configuration to ensure that the correct spindle is always used for critical tests.

A Special Spindle can be created when the user has developed a new spindle geometry or when using a standard AMETEK Brookfield spindle in a non-standard measurement container. The Special Spindle, once created, will be available to users through the Spindle selection in Configure Viscosity Test.

A Special Spindle is created by selecting the Special Spindle command button in the Edit Spindle List menu. A Special Spindle requires a code, a name, and an SMC value. Optional values include SRC and YMC.

Code	The code is the numerical value used to select the spindle. This value must be unique and cannot be the same as a standard AMETEK Brookfield spindle. The acceptable range for Code is 100-199.
Name	The Name is a unique value to describe the spindle. The Name will be displayed in the Spindle field. The Name can be comprised of alpha and numeric characters.
SMC	The SMC (Spindle Multiplier Constant) is used to convert the measured torque to viscosity. The acceptable range of SMC is 0.001 – 500. The SMC value can be determined through the use of the Range equation found in appendix D. Some experimentation with the spindle and a calibrated viscosity standard is required. Range (cP) = TK * SMC * 10,000/RPM
SRC	The Torque Constant (TK) can be found in Table D-2 in Appendix D. The SRC (Shear Rate Constant) is used to convert the set RPM to shear rate and calculate Shear Stress. The acceptable range of SRC is 0.001 – 500. The SRC value can be determined if the shear rate characteristics of the spindle geometry are known. Consult the AMETEK Brookfield publication, “More Solutions to Sticky Problems”, for a discussion about shear rate and some recomended equations. Shear Rate (1/s) = SRC * RPM
YMC	The YMC (Yield Multiplier Constant) is used to convert the measured torque to yield stress.

Speed List

The selection of Speed in Configure Viscosity Test can be done by using either a number pad or a scroll list. (This choice is selected through the navigation button in the Set Spindle screen). When scroll list is selected, the speed entry is restricted to the classic AMETEK Brookfield speed sets for the LV and RV/HA/HB rheometers. The contents of the scroll list are defined in the Speed List menu. Each speed can be individually selected or deselected through the use of a check box. Select or deselect all speeds by using the Select All checkbox. Select or deselect all LV (or RV/HA/HB) speeds by using the Select All LV check box.The classic AMETEK Brookfield speed sets are defined below.

LV:	0.3, 0.6, 1.5, 3, 6, 12, 30, 60
RV/HA/HB:	0.5, 1.0, 2.0, 2.5, 4, 5, 10, 20, 50, 100

Additionally, a new speed can be added to the list by selecting the New Speed command key at the bottom of the display. The New Speed must be selected within the range of available speeds on the DVNext: 0.0 – 250 RPM. Speed entry through the number pad is never restricted.

TIP: To ensure that the correct speed is always entered, create a test that is saved to the DVNext memory.

TIP: The selection of speed can be restricted by User Log In.

5.4 Administrator account and admin functions

The DVNext device comes with one default account, the Administrator. This account has access to the Admin Functions sub menu, which allows the Administrator to change the various settings and parameters of the device. The functionality of the Administrator account and the Admin Functions menu will depend on the edition of the DVNext device (Compliant Edition vs Standard Edition).

5.4.1 Scanning accessory barcodes (compliant instruments only)

The DVNext is available in two different versions: Compliant and Standard. As previously stated in Section 5, the administrator functions are different between these two versions, so it is very important to identify the version that is being used. The model number is located on the back of the device can be used for identification. The 9th digit of the model number signifies the edition of the device, and can be one of the following:

DVNX****C – Compliant Edition DVNext device
DVNX****G – Standard Edition DVNext device

This can also be found in the “Model” section on the device on the startup splash screen and the “about” page. The different models can be seen below in Figure 5-11, with the Compliant Edition shown on the left and the Standard Edition shown on the right.

Figure 5-11

Aside from the difference in model numbers on the device, there are several other differences that can help identify between the Compliant and Standard Edition DVNext devices. On the Compliant Edition DVNext, there will be a login button shown on the top left of the main menu screen. On the Standard Edition, no such button will appear. See Figure 5-12, with the Compliant Edition main menu shown on the left and the Standard Edition shown on the right.

Figure 5-12

On the **Compliant Edition DVNext**, the administrator account is automatically logged in when the device is powered up. The default is no login required (See section 5.4.2). When log in is set to required, the user can log into the administrator account with the default password. By default, the administrator password is “admin”. After logging into the administrator account for the first time when requiring login, the user will be required to set a new password for the administrator account.

On the **Standard Edition DVNext**, the administrator user account is automatically logged in any time the device is powered up. There is no method to set up another account on the Standard Edition DVNext nor is there a way to require a password like in the Compliant Edition. The administrator is the default account and the only account that will be on a Standard device.

In both the Compliant and Standard Editions, the Admin Functions menu includes settings related to access and basic instrument management of the DVNext. The Admin functions menu will be different depending on whether the instrument is a Compliant Edition DVNext or a Standard Edition.

For the Compliant Edition DVNext, the Admin Functions menu is only available to the Administrator. Users and Power Users do not have access rights to the Admin Functions. The Admin Functions menu on the Compliant Edition DVNext include:

Log in and Lock out	Require User ID and Password. Define Lock Out parameters.
Electronic Signatures	Enable/Disable electronic signing of files on device.
Users and Access	Define User ID, Password, User capabilities. Add User.
Manage Settings	These settings include Set Date and Time, Default Path, Calibration Reminder, Torque Filtering, Import Settings, Settings Reset and Device Reset.
Manage Data	The settings within this section include Backup, Export Results, Archive and FTP Settings.
Update Software	This function allows you to update the software on your instrument.

For the Standard Edition of the DVNext, several settings that appear on compliant edition instruments are not present in the menu. The Admin Functions menu on the Standard Edition DVNext include:

Manage Settings	These settings include Set Date and Time, Default Path, Calibration Reminder, Torque Filtering, Import Settings, Settings Reset and Device Reset.
Manage Data	The settings within in this section include Backup.
Update Software	This function allows you to update the software on your instrument.

The difference between the admin functions menu on the two different editions can be seen below in Figure 5-13. The Compliant Edition is shown on the left, and the Standard Edition is shown on the right.

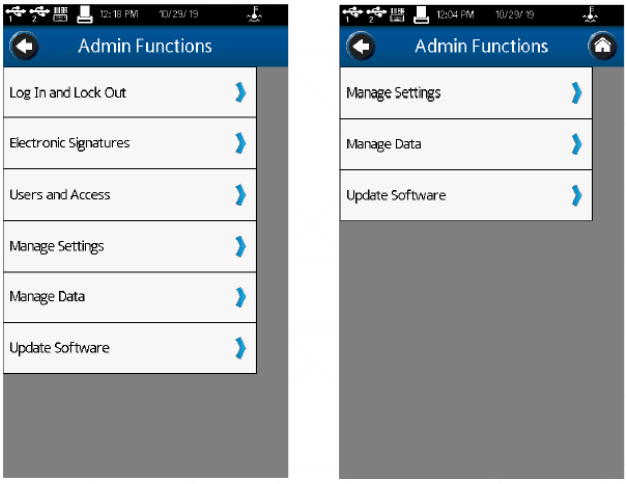


Figure 5-13

5.4.2 Log in and lock out (compliant instruments only)

The Log In and Lock Out menu allows the user to define the Log In requirement and toggle the Lock Out feature within Running Viscosity Test (see Figure 5-14).

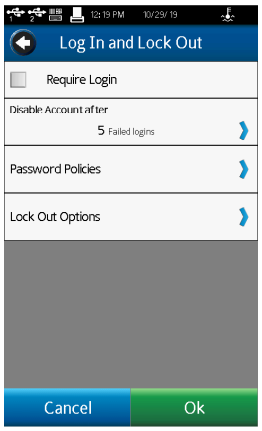


Figure 5-14

The Log In check box controls the Log In requirement. When Log In is checked, the DVNext will require a User ID and Password prior to allowing any activity. The Log In screen is presented on power up or when the User Icon is selected from the Home Menu.The user must select their user ID from the drop-down list and then enter their password.The Log In requirement is removed when the check box is unchecked.

Note: Administrator default password is admin.

The Allow Manual Lock Out check box found in the Lock Out Options sub menu controls the Running Viscosity Test Lock Out function. This function is only available when User Login is required. When Allow Lock Out is checked, the user may lock the DVNext during a test. The Lock Out is set by pressing the Lock Icon found in the Navigation Bar of Running Viscosity Test. Any touch of the screen during the Lock Out will show the user a Log In screen. No action can be taken on the DVNext until the proper password is entered. Only the User ID that was in effect when the Lock Out was initiated can unlock the DVNext. The test will continue to collect data during the Lock Out.

The Allow Timed Lock Out check box found in the Lock Out Options sub menu controls the automatic feature of Lock Out. Set the Timed Lock Out time value from 1 – 99 minutes. The DVNext will Lock automatically (without touching the Lock Icon) after the test is initiated (press Run) when the screen has not been touched for the time

specified. For example: Timed Lock Out is set to 1 minute; 30 seconds after the test has begun, the operator reviews the test parameters by touching Views Test; the DVNext will lock automatically 1 minute after that key press (90 seconds after the test began running).

TIP: The Lock Out feature can be useful if the operator must leave the DVNext unattended during a test.

The Disable Account After parameter defines how many failed Log In attempts are allowed before the User ID is locked. The range for Lock Out After is 1 – 20. Once a User ID is locked, the administrator must reset the password.

TIP: If the Require Login is checked, the default Administrator password is "admin", the administrator should change the default password prior to placing the instrument.

The Password Policies menu allows for the administrator to set the policies for passwords of users on the DVNext device. These options include setting the minimum length, require a capital letter, require a number, require a special character, and use password expiration. When password expiration is set to on, the password for every user (including the administrator) will expire the set amount of time.

5.4.3 Electronic signatures (compliant instruments only)

The Compliant Edition DVNext can be set up to require electronic signatures for files on the device. The Administrator can enable this through selecting the "Data Files Must Be Signed" option and ensuring the check box is checked (Note: The default option for electronic signatures is "On"). In this menu, the Administrator can select what workflow they would like to require on the documents: Submit/Approve or Submit/Review/Approve. **For more information about electronic signatures, see the section on 21 CFR Part 11 Compliance.**

5.4.4 Users and access (compliant instruments only)

The Compliant edition DVNext allows the administrator to create, edit, and delete additional user accounts.

Power User and User accounts can be created to restrict access and enhance data tracking. The two user levels can be customized by the Administrator. All user accounts require a password for access to the DVNext. In addition to setting the user level access,the administrator is able to set the username, password, and e-signature role with a full name if electronic signatures are turned on (see section V.4.3 for information on enabling electronic signatures).

The Power User and User level access settings are divided into four categories: General Settings, Data Access Functions, Viscosity Test Setup and Yield Test Setup. Table V-1 shows the factory default user settings for Power User and User. The administrator can customize both the Power User and User through the Power User Level Access and User Level Access in the Users and Access Menu. Place a check mark beside an attribute that is available to the user and remove the check mark from an attribute that will be unavailable to the user.

TIP: Users and User Access settings can be exported to a Flash USB drive. This file can be uploaded to another DVNext to quickly duplicate User settings.

The User ID utilized at Log In will be reflected in a saved data set. This parameter is viewable in the Results screen by selecting Device Info.

TIP: The User ID information is only visible once a data set is loaded from memory. An unsaved data set will not show the User ID.

User accounts can be managed within the Users and Access menu through Edit Users, Add User and Delete User.

Table 5-1: Factory Default User Settings (continued on following page)

			Administrator	Power User	User
General Settings	Enforce	Spindle MUST be scanned in External Mode Only			
		Use Accessory Rules	•	•	•
	Set	Default Temperature Set Point	N/A	N/A	N/A
		Temperature Probe Offset	•	•	
	Allow	Test Done Alarm	•	•	•
		QC Alarm	•	•	•
		Global Alarm	•	•	•
		Pop-Up Warnings	•	•	•
		Dismiss Pop-Up Warnings	•	•	
	Customize	Spindle List	•	•	
		Speed List	•	•	
		Regional Settings	•	•	•
		Measurement Units	•	•	•
		Language	•	•	•

Data Access Functions	Load a Test	Instrument	•	•	•
		USB	•	•	
		Ethernet	•	•	
	Save a Test	Instrument	•	•	•
		USB	•	•	
		Ethernet	•	•	
	Load Data	Instrument	•	•	•
		USB	•	•	
		Ethernet	•	•	
	Save Data	Instrument	•	•	•
		USB	•	•	
		Ethernet	•	•	
	Other Options	Delete Test & Data	•	•	
		Move Test & Data	•	•	
		Copy Test & Data	•	•	
		Rename Test & Data	•	•	
		Overwrite Test & Data	•	•	
		Print Data	•	•	•
Viscosity Test Setup	Set	Change Speed During a Test	•	•	
		Spindle	•	•	
		Speed	•	•	
		Temperature Setpoint	•	•	
		Step End Condition	•	•	
		Data Collection Mode	•	•	
		QC Limits	•	•	
		Density	•	•	
		Graph Axes	•	•	
		Math Model	•	•	
		Default Results Screen	•	•	

		Post Test Averaging	•	•	
		Instructions	•	•	
		Save Path	•	•	
Yield Test Setup	Set	Spindle	•	•	
		Immersion Mark	•	•	
		Pre-Shear Speed	•	•	
		Pre-Shear Time	•	•	
		Wait Time	•	•	
		Run Speed	•	•	
		Zero Speed	•	•	
		Torque Reduction	•	•	
		Yield Limits	•	•	
		Temperature Setpoint	•	•	
		Graph Axes	•	•	
		Instructions	•	•	
		Save Path	•	•	

Table 5-1: Factory Default User Settings (continued from previous page)

5.4.5 Set Time and Date

The Time and Date is displayed on the Status Bar at the top of every screen. These parameters are set within the Set Time and Date menu. The format for setting Time and Date will be based on the Regional Settings. To set Time and Date, touch the preferred field to display the Number Keypad. When both Date and Time are set correctly for your location, press OK to accept the change.

5.4.6 Manage data

The DVNext has all the data management options located conveniently under one menu. These options are:

- Backup
- Export Results
- Archive
- FTP Settings

Details of these options can be found below in their respective sections.

Backup

Create a backup file from the DVNext internal memory including: Settings, User Profiles, Results, and Tests. This backup file is saved to a USB Flash Drive and can be uploaded (Restore) to any DVNext Rheometer.

Automatic Backup: The backup sub-menu also contains the automatic backup option. Create Backup files according

to a schedule. The frequency is set to Daily, Weekly or Monthly increments. The Path must be specified and requires the use of a USB Flash Drive. Check the Allow Automatic Backup check box to initiate this feature. The current Backup file will overwrite the previous Backup file located in the path location.

TIP: You can preserve historical backup files by using multiple USB Flash Drives.

Export results

The DVNext has the ability to export results from the device as a specified format. Selecting the “Do automatic Export” will export each result file after its final approval. The file format can be chosen from the following: CSV, PDF, XML. The admin can set the export path for the files using the export path option.

Archiving

The administrator can archive files. Found in the “Admin Functions” menu under “Manage Data,” the admin can choose to archive the results files or the audit trail. Both can be set up to be automatically uploaded via external USB flash drive or via ethernet automatically. A frequency for the automatic archive can be chosen from the following list: daily, weekly, or monthly. The age of the files to archive can be set up using the “Archive files older than” option. In addition to this, the desired file type of the archive can be selected from the following file formats: .csv, .xml, or .pdf.

FTP settings

Allows the DVNext to be set up via the Ethernet. See Ethernet section for details.

Import settings

Upload Settings from a Backup file. Note: User profiles, Results and Tests are not included.

Locate the Backup file on the USB Flash Drive. Press the Import button to upload Settings from the Backup file.

Update software

The internal operating software of the AMETEK Brookfield DVNext can be updated from a USB Flash Drive as new versions become available from AMETEK Brookfield. Insert a USB Flash Drive into the DVNext that contains the operating software file. Select the appropriate path. Press the Update command button to bring the new software file into the DVNext. It is very important to follow instructions on the screen.

5.4.7 Default path

The Path is the location where data or tests are stored. The DVNext will allow for storage to the Internal Memory or to an attached USB Flash drive. The path will also include any file structure that has been created.

The Default Path identifies what location will be used as the initial location when Results are saved. The Default Path defined in Reports - Configure Viscosity Test (saved test or unsaved test) will take priority over the Default Path.

The DVNext can create file structure based on User ID and Test Name. The options provided for the Default Path specify what format the data path should utilize. For example: set the Default Path to Operator -> Test Name. The User is logged in as DAVID and the test to run is INK 5. The data path will be defaulted as shown in Figure 5-15.

Figure V-15

5.4.8 Settings reset

Settings Reset will return the DVNext settings (Device, User and Global) to the factory default. Internal memory will not be affected. User accounts will not be affected.

5.4.9 Device reset

⚠ DATA LOSS

Device Reset will return the DVNext to the factory default condition. All data, tests and Audit Trails will be deleted from internal memory. All User accounts will be deleted.

TIP: Move data files and test files to a USB Flash Drive prior to selecting Device Reset.

5.4.10 Calibration Reminder

The DVNext is programmed to provide the user with a reminder that calibration is due. Two parameters must be set: Frequency in Months and Start Date. When both parameters are entered, the Calibration Reminder screen (see Figure V-16) will calculate and display the day when the reminder will be presented.

Check the Calibration Reminder On check box to activate this feature.

The Calibration Reminder will be presented during the first power up on or after the specified day. The message box (see Figure V-17) requires that the user press OK before the leveling/AutoZero will be performed.

The calibration reminder might be reset by AMETEK Brookfield or your local authorized dealer when the unit is returned for calibration.

Figure 5-16

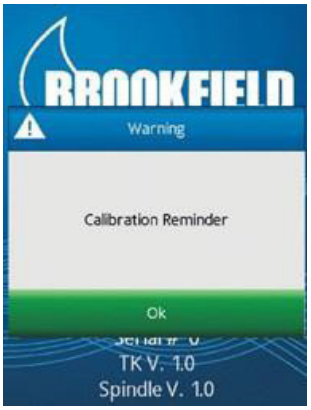


Figure 5-17

5.4.11 Torque filtering

Torque filtering is an option that is available on the DVNext. When torque filtering is turned on, quickly changing torque values are dampened. Through enabling torque filtering allows for the performance of the DVNext to meet the same performance of the Legacy DV-II and DV-III viscometers. The administrator is able to enable or disable this setting.

5.5 21 CFR Part 11 compliance (compliant instruments only)

The Compliant Edition DVNext provides features for 21 CFR Part 11 compliance. These features include:

- Password protection and Lockout
- Electronic Signatures
- Multiple User Access Levels
- Multiple User logins
- Archiving
- Audit Trail
- Uneditable PDF File Format

These ensure that the system performs record retention, protection, and allows for the systems administrator to track the actions of the individual users on the DVNext.

Password protection and lockout

The DVNext device features password protection and a lockout feature. The device can be set up to disable a user's account after a specified number of failed login attempts. Password policies for the device can also be set up. These include a minimum length requirement, options to require a capital letter, number, or special character. In addition to this, the device can be set up to have user passwords expire after a specified length of time, with a warning set up to alert the user a specified length of time before the expiration. In addition to password protection, the device can be set up to lock users outafter a specified period of inactivity. Alternatively, a manual lockout can also be used.

All of the settings for password protection and lockout settings are only available to the Administrator account on the device.

Electronic Signatures

The DVNext device features electronic signatures. The electronic signatures feature can be enabled by the admin under the Electronic Signatures menu in Admin Functions by selecting the "Data files must be signed" option. From this menu, the Admin can set the approval work-flow as well: Submit/Approve or Submit/Review/Approve. A user's individual signature role can be set during the creation of the user profile or can be changed through the Edit Users menu. From there, the user can be assigned to either the submitter (default), reviewer, or approver role. These electronic signatures can be added to any data file by selecting the drop-down menu and selecting signatures. This

process can be seen in the below figure (see Figure 5-18).

Figure 5-18

The DVNext also filters the results files according to their approval level. Once electronic signatures have been turned on, the device will create four new smart folders: Approved, Reviewed, Submitted, and Unsigned. Unsigned files will be filtered into the unsigned folder. Files signed as “submitted by” will appear in the submitted folder. Files signed as “reviewed by” will appear in the reviewed folder. Files signed “approved by” will appear in the approved folder. These folders can be accessed through the View Viscosity (or Yield) Results (see Figure 5-19).

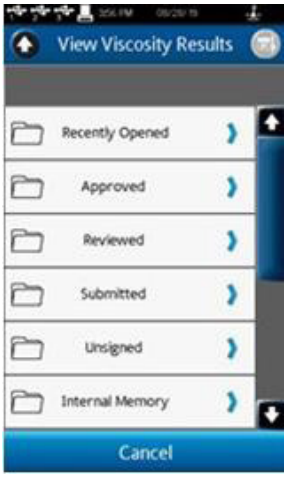


Figure 5-19

Multiple user access levels

The DVNext allows for users to be set with different access levels depending on how much access the administrator wants them to have. To do this, users can be sorted into the two levels: User or Power User. These user access levels are assigned during the creation of a user by an administrator and can also be changed through the “Edit Users” option through the admin functions menu. By default, the Power User level comes with more access allowances than the User level comes with. The allowances for both the User and Power User levels can be changed depending on what the Administrator desires. For both the User and Power User, the Admin can control each levels access in the following categories:

- General Settings
- Data Access Functions
- Viscosity Test Setup
- Yield Test Setup

Through this, the admin can sort how much access the individual user has on the device, depending on what user access level they have been assigned.

Multiple user logins

The device will by default have one user, the Administrator. The Administrator account has no restrictions placed on it and can set up other users on the device. When a new user is created, they are assigned a user-name, password, user access level, full name, and signature role. Once a user is created, they can log into the device into the device with their assigned level of access.

Archiving

The administrator can archive files. Found in the “Admin Functions” menu under “Manage Data,” the admin can choose to archive the results files or the audit trail. Both can be set up to be automatically offloaded via external USB flash drive or via Ethernet automatically. A frequency for the automatic archive can be chosen from the following list: daily, weekly, or monthly. The age of the files to archive can be set up using the “Archive files older than” option. In addition to this, the desired file type of the archive can be selected from the following file formats: .csv, .xml, or .pdf.

Audit trail

The DVNext is designed with a built-in audit trail. The audit trail will log actions performed on the instrument, as well as the user who was logged into the device while that action was performed. The DVNext allows for users to add comments to audit trail items by selecting the event and choosing the “entry details” and “add comment” option. When in putting a comment, the user is prompted to input their login credentials before the device will allow them to apply their comment. Comments that are added to an event can be viewed in the entry details with the individual who made the comment shown in the “Login” bar above it.

Uneditable PDF file format

All PDF files created by the Compliant Edition DVNext are unable to be edited in PDF editing software. This includes the audit trail, archive, viscosity/yield data reports, and the viscosity/yield test reports.

6.1 The Power Law (Ostwald) model

$\tau = K\dot{\gamma}\ n$ (τ= shear stress, K = consistency index, $\dot{\gamma}$= shear rate, and n = flow index)

What does it tell you?

The Power Law model provides a consistency index, k, which is a product's viscosity at one reciprocal second. (Reciprocal seconds are the units of measurement for shear rate). It also provides a flow index, n, which indicates the degree with which a material exhibits non-Newtonian flow behavior. Since Newtonian materials have linear shear stress vs. shear rate behavior and v describes the degree of non-Newtonian flow, the flow index essentially indicates how "non-linear" a material is.

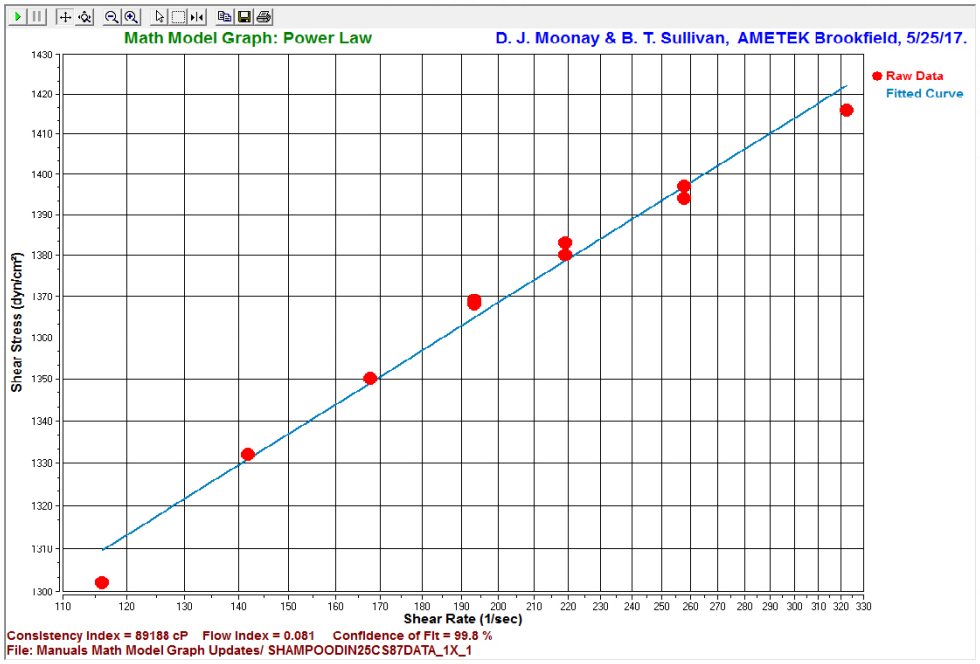


Figure 6-1

When n < 1 the product is shear-thinning or Pseudoplastic. This means the apparent viscosity decreases as shear rate increases. The closer n is to 0, the more shear thinning the material is.

When n > 1 the product is shear-thickening or Dilatant. Their apparent viscosity increases as shear rate increases.

When should you use it?

This model should be used with non-Newtonian, time-independent fluids that do not have a yield stress. These fluids will begin to flow under any amount of shear stress. Graphs of such material generally intersect the y-axis at 0.

An Example of the Power Law Model at Work

Formulators at a personal care company would like to use a substitute ingredient to decrease cost. They use the Power Law model to evaluate the effect the new ingredient will have on the behavior of their shampoo. They need to know how it will behave during processing and how it will behave when it is being used by the customer.

Shampoo
Flow Index (n) = 0.081
Consistency Index (k) = 89,188 cP

With the new ingredient the shampoo has a flow index (n) of 0.081. This indicates that the shampoo is shear-thinning enough to flow properly during processing and that it will flow properly for the end-user. The consistency index, k, indicates how the shampoo behaves when it experiences low shear rates. The power law values show that the shampoo becomes quite thin at process shear rates and therefore it can be easily pumped into filling equipment, hold tanks, etc. The consistency index of 89,188 cP shows that the shampoo is very viscous at low shear rates, and as a result, it will appear to customers to be “rich and creamy” while still being easy to apply.

6.2 The Herschel-Bulkley model

$\tau=\tau_0 + K\dot{\gamma}\, n$ (τ= shear stress, $\tau_0$0 = yield stress, K = consistency index, $\dot{\gamma}$= shear rate, and n = flow index)

The Herschel-Bulkley model is simply the Power Law model with the addition of τ_0 for yield stress. Yield stress, τ_0, denotes how much shear stress is required to initiate flow. This model also provides a consistency index, k, which is a product’s viscosity at 1 reciprocal second, and a flow index, n, which indicates the degree with which a material exhibits non-Newtonian flow behavior. Since Newtonian materials have linear shear stress vs. shear rate behavior and n describes the degree of non-Newtonian flow, the flow index essentially indicates how “non-linear” a material is. For Herschel-Bulkley fluids, n will always be greater than or less than 1.

When n < 1 the product is shear-thinning or Pseudoplastic. This means the apparent viscosity decreases as shear rate increases. The closer n is to 0, the more shear thinning the material is.

When n > 1 the product is shear-thickening or Dilatant. It’s apparent viscosity increases as shear rate increases.

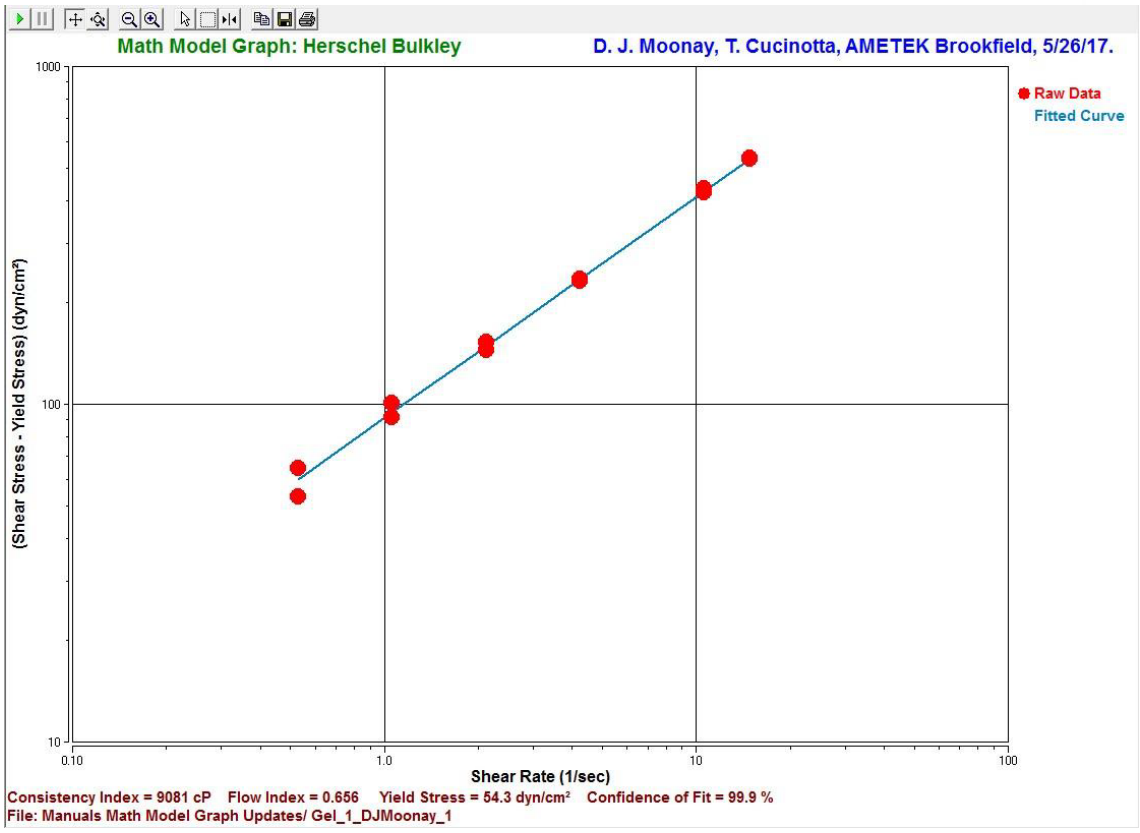


Figure 6-2

The Herschel-Bulkley model should be used with non-Newtonian, time-dependent materials that have a yield stress. Products with a yield stress only begin to flow after a certain amount of shear stress

is applied. As a result, the flow curve intersects the y-axis at a point greater than 0. After yielding, the product creates a flow curve and behaves as a Power Law fluid so that n indicates where there is a shear-thinning or shear-thickening tendency. (In this case, if n =1, the material is behaving as a Bingham fluid, which is discussed next.)

An Example of the Herschel-Bulkley Model at Work

A company uses a gel-like substance as part of their production process. Upon arrival they test the material and apply the Herschel-Bulkley model to ensure it will perform correctly during process. The results in Figure 6-2 show that the consistency index is 9,081 cP, the flow index is 0.656 and the yield stress is 54.3 dynes/cm². These results indicate that this batch of gel does not quite meet specification. While the consistency index is within spec, the yield value is higher than normal so the fluid will not begin to flow as easily. With a flow index of 0.66, this batch is also less shear thinning than normal. Pump and mixer speeds must be adjusted before using this material.

Gel-Like substance

n = 0.656

τ_0 = 54.3 dynes/cm²

K = 9081 cP

6.3 The Bingham model

$\tau=\tau_0 + K\dot{\gamma}\, n$ (τ= shear stress, $\tau_0$0 = yield stress, K = consistency index, $\dot{\gamma}$= shear rate, and n = flow index)

When Should you use it?

The Bingham model indicates a product's yield stress, which is the amount of shear stress required to initiate flow. It also provides the plastic viscosity, η, which is the viscosity after a product yields.

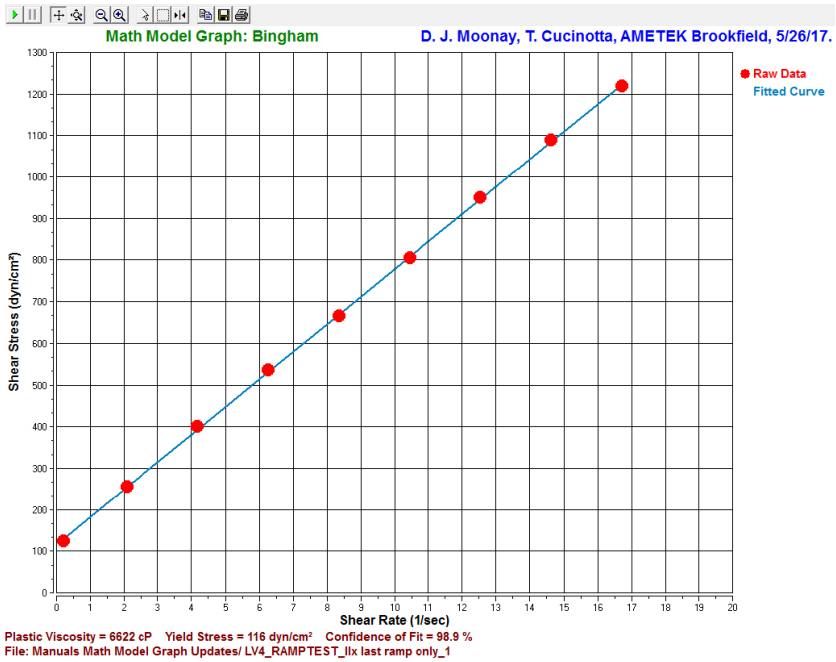


Figure 6-3

When should you use it?

This model should be used with non-Newtonian materials that have a yield stress and then behave in a Newtonian fashion once they begin to flow. As a result, the shear stress shear rate plot forms a straight line after yielding. (Products that have a yield stress only begin to flow after a certain amount of shear stress is applied. They are also called “viscoplastic”. Their shear stress vs. shear rate graphs intersect the y-axis at a point greater than 0.)

An Example of the Bingham Model at Work

A manufacturer of drilling fluid applies the Bingham Model to ensure the quality of their product. Results from a recent batch, shown in figure 6-3, showed that the yield stress and plastic viscosity were both below the pass/fail criteria, which would cause the fluid to insufficiently hold-up the cuttings. The shipment was canceled and the root cause of the problem was identified.

Drilling Fluid
Plastic Viscosity (η) = 6622 cP
Yield Stress (τ_0) = 116 dynes/cm^2

6.4. The Casson model

$\sqrt{\tau} = \sqrt{\tau_0} + \sqrt{\eta D}$ (τ = shear stress, τ_0 = yield stress, η = plastic viscosity and D = shear rate)

What does it tell you?

The Casson model provides parameters similar to that of the Bingham model. However, unlike the Bingham model, it was developed for materials that exhibit non-Newtonian flow after yielding. The Casson model indicates the product’s yield stress (τ_0) which is the amount of shear stress required to initiate flow, and the product’s plastic viscosity, h, which is the viscosity of the product after it yields.

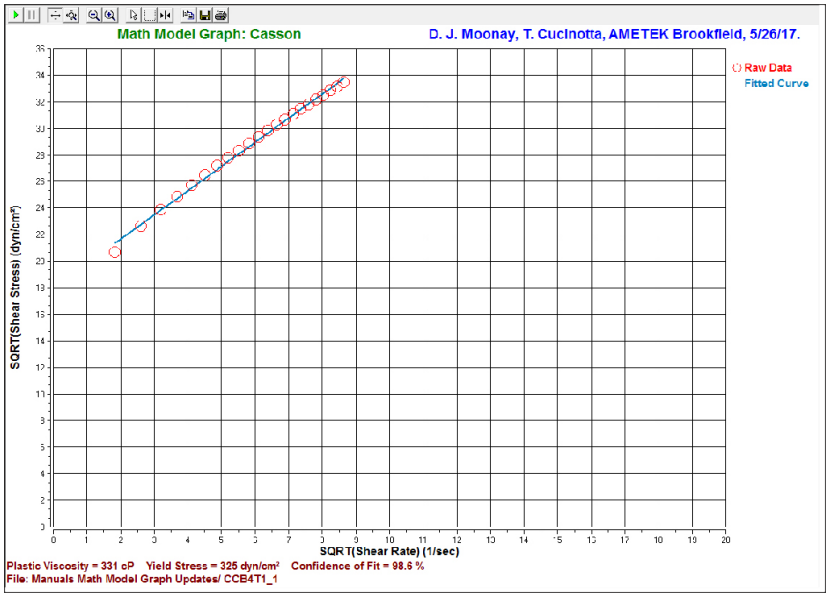


Figure 6-4

When should you use it?

The Casson model should be used with non-Newtonian materials that have a yield stress and that do not exhibit a “Newtonian-like” behavior once they begin to flow. This model is most suitable for fluids that exhibit Pseudoplastic or shear thinning, flow behavior after yielding.

These fluids have a non-linear flow curve. The point at which it crosses the y-axis is the product’s yield stress (τ_0). To project the point at which the curve will intersect with the y-axis, the Casson model linearizes or straightens the plot by taking the square root of the data. To ensure accurate extrapolation to yield stress it is best to take some data at

low shear rates.

An Example of the Casson Model at Work

Before releasing a new over the counter gel, a pharmaceutical company needs to learn how it will behave which it is being used by the end consumer. They perform a full viscosity profile and apply the Casson model. From the results, shown in Figure 6-4, they learn that their ointment has a higher yield stress τ_0 and lower plastic viscosity η than they originally intended. As a result it is difficult or dispense from its container (due to the high yield stress) and it does not hold it shape very well (due to the low plastic viscosity), making it difficult to apply a small amount to the affected area of the skin. Based on this data, formulators are able to modify the ingredients accordingly. Once a formulation is established, multi-point tests and the Casson Model are performed as a QC tool to check batches before and after processing.

Pharmaceutical Gel
Plastic viscosity (η) = 331 cP
Yield Stress (τ_0) = 325 dynes/cm^2

6.5 Other rheological models

THE NCA/CMA CASSON MODEL

$1 + a)\sqrt{\tau} = 2\sqrt{\tau_o} + (1 + a)\sqrt{\eta D}$ (τ = shear stress, τ_o = yield stress, η= plastic viscosity, and $\dot{\gamma}$= shear rate

The NCA/CMA Casson model is designed by the National Confectioners Association and the Chocolate Manufacturers Association as the standard rheological model for the industry. This model determines yield and flow properties under specified conditions and closely approximates the plastic behavior of chocolate before final processing.

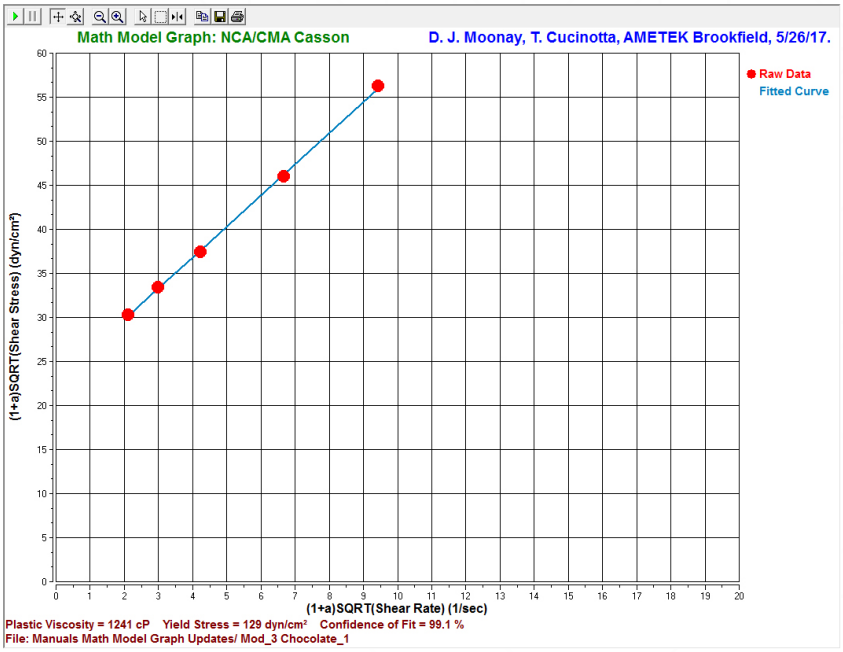


Figure 6-5

When chocolate is used for enrobing, it must have a yield stress high enough to stay in place once it enrobes the filling. In the case of decorating chocolate, the yield stress must be high enough so it can keep its shape once it has been squeezed into place through a nozzle. For molding chocolate, the plastic viscosity must be low enough to completely fill the mold.

(The NCA/CMA lists AMETEK Brookfield's HA-spring range viscometer with a Small Sample Adapter, SC4-27 spindle and SC4-13R sample chamber as the approved apparatus.)

6.6 The IPC Paste Model

$$\eta = kR^n$$

The IPC Paste Model was developed for solder pastes. It calculates the viscosity of solder pastes at 10 RPM. The IPC Paste Model requires that the product be tested with a AMETEK Brookfield Spiral Adapter at multiple speeds. More details can be found in the IPC- TM- 650 Test Methods Manual (methods 2.4.34.2 and 2.4.3).

This model is a variation of the Power Law Model. Unlike the Power Law Model, which relates apparent viscosity to shear rate, the IPC Paste Model relates apparent viscosity to the testing speed (RPM).

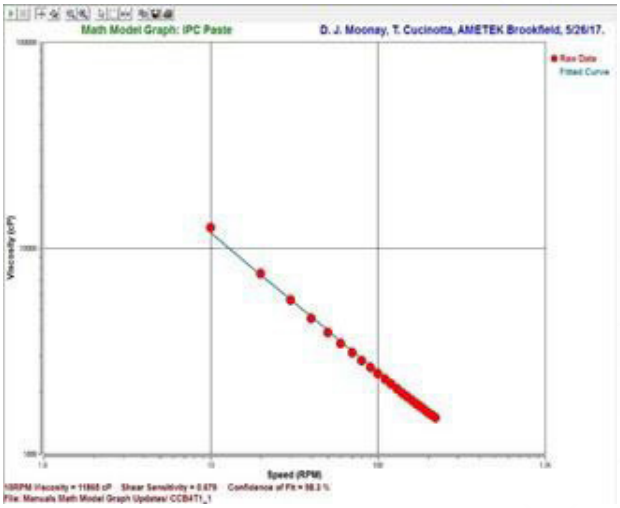


Figure 6-6

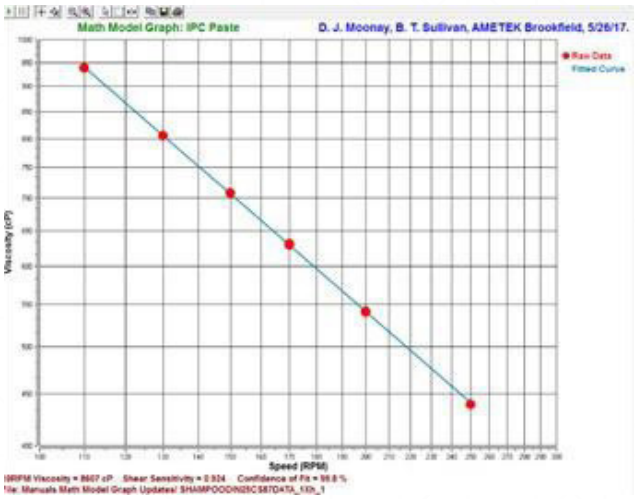


Figure 6-7

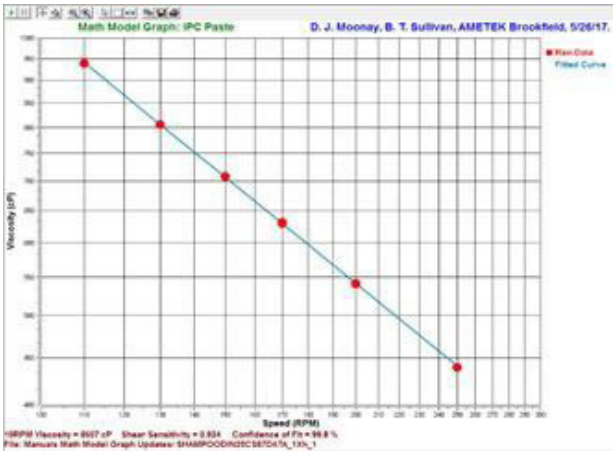


Figure 6-8

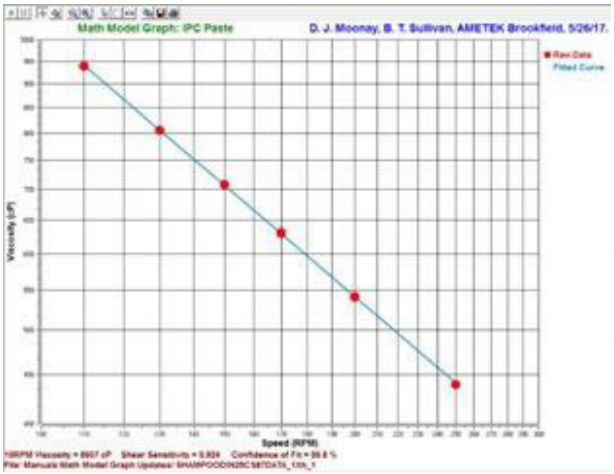


Figure 6-9

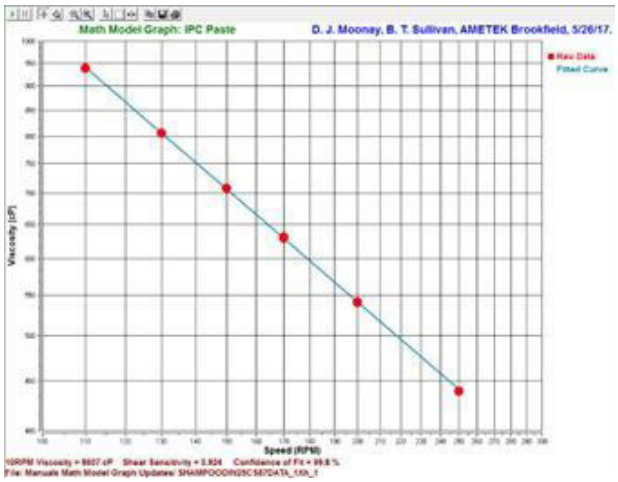


Figure 6-10

APPENDIX A - CONE/PLATE RHEOMETER SET UP

This Cone/Plate version of the DVNext uses the same operating instruction procedures as described in this manual. However, the “gap” between the cone and the plate must be verified/adjusted before measurements are made. This is done by moving the plate (built into the sample cup) up towards the cone until the pin in the center of the cone touches the surface of the plate, and then by separating (lowering) the plate 0.0005 inch (0.013 mm).

When operating the Cone/Plate at elevated temperature, the gap must be set with the cup and spindle equilibrated at the temperature recommended. Maximum temperature for Cone/Plate operation is 80ºC. Maximum operational temperature of sample cup is 100º C. Personal protection is recommended when controlling to temperatures above 80ºC.

⚠ Micrometer Adjustment Ring will become hot when controlling sample cup at temperatures above 50°C.

Programmable DVNext Cone/Plate Rheometers, S/N 50969 and higher, have an Electronic Gap Setting feature. This feature enables the user to easily find the 0.0005 inch gap setting that was established at AMETEK Brookfield prior to shipment.

AMETEK Brookfield recommends that the maximum particle size in the sample material for measurement with cone/plate geometry be less than 5 times the gap settings. A more conservative approach is to limit the maximum particle size to less than 10 times the gap setting.

The following information explains how to set the Electronic Gap and verify calibration of the DVNext Rheometer.

A.1 Electronic gap setting features

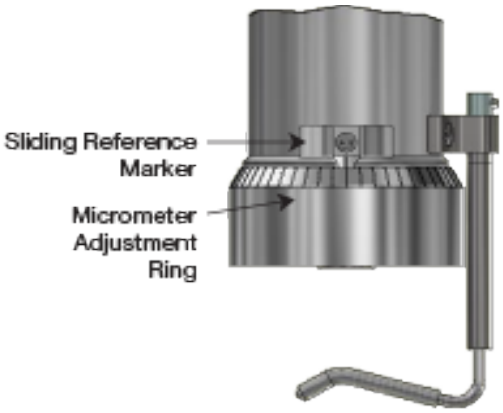


Figure A-1

Sliding Reference Marker is used after finding the “hit point;” it is the reference for establishing the 0.0005 inch gap.

Micrometer Adjustment Ring is used to move the cup up or down in relation to the cone spindle. Turning the ring left (clockwise) lowers the cup; turning it right (counterclockwise) raises the cup. Each line on the ring represents one scale division and is equivalent to 0.0005 inch movement of the plate relative to the cone.

A.2 Set-up

- Be sure that the Rheometer is securely mounted to the Laboratory Stand, leveled and zeroed with no cone or cup attached and 0% torque is displayed.
- Figure A-2 shows a typical water bath setup. Connect the sample cup inlet/outlet ports to the water bath inlet and outlet and set the bath to the desired test temperature. Allow sufficient time for the bath to reach the test temperature.

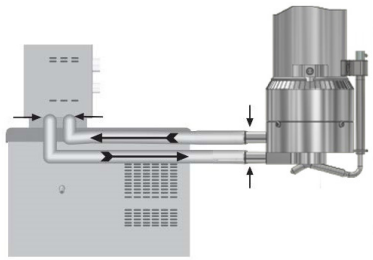


Figure A-2

Spindle Attachment Threaded CPA Spindles

- With the motor off, thread the cone spindle by using the spindle wrench to secure the rheometer coupling nut (see Figure A-3); gently push up on the coupling nut and hold this securely with the wrench. Thread the cone spindle by hand.
    - Note: Left hand Threads

Figure A-3

Magnetic CPM Spindles

- Carefully insert the spindle into the coupling so the slots are fully engaged with the pins. You should feel the pull of the magnet as the spindle seats in the coupling.
- When properly aligned, there should be no gap between the spindle and coupling (See Figure A-4).
- The CPM spindle can be removed by gently lifting the spindle up and pulling the spindle off to the side (See Section 3.6).
- If the CPM spindle gets stuck to the cup, it can be removed with GV-1712 (CP spindle remover). Slide GV-1712 over CPM spindle until magnet engages spindle. Pivot in direction of arrows to release spindle from fluid (See Figure A-4.1). Remove CPM spindle from GV-1712 by pulling out, using finger notches for access.
- Attach the cup, taking care not to hit the cone with the cup (Figure A-4), by positioning the cup against the mic ring and swinging the tension bar under the cup. The tension bar should have plastic tubing in place.

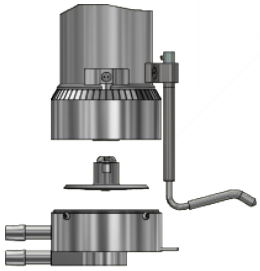


Figure A-3.1

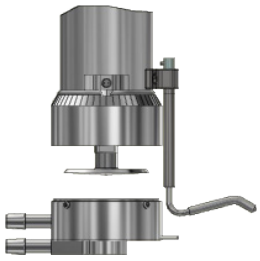


Figure A-4

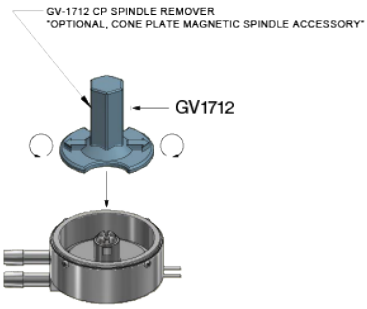


Figure A-4.1

A.3 Set-up

- Select configure viscosity test from the main menu.
- Press spindle and select or scan one of the cone plate spindles (40, 41, 42, 51, 52).
- Confirm you would like to set the gap by pressing Yes.
- If the contact light (yellow) is illuminated, turn the micrometer adjustment ring clockwise (as you look down on the instrument) until the light is no longer illuminated (see Figures A-1 and A-6).
- If the yellow contact light is not illuminated, slowly turn the micrometer adjustment ring in small increments (one or two scale divisions) counterclockwise.
- Continue moving the micrometer adjustment ring slowly counterclockwise until the contact light (yellow) first turns on. THIS IS THE “HIT POINT.”
- Adjust the sliding reference marker, right or left, to the closest full scale division mark (see Figure A-1).
- Turn the micrometer adjustment ring one scale division to the left to meet the line on the sliding reference marker. THE YELLOW CONTACT LIGHT SHOULD GO OFF.
- You have established the gap space needed for measurement. Press ok.
- Carefully remove the sample cup.

  Note:

  - The cup may be removed and replaced without resetting the gap if the micrometer adjustment ring has not been moved.
  - Remove the spindle from the rheometer when cleaning.
  - Re-establish the hit point every time the spindle is attached/detached.

Figure A-5

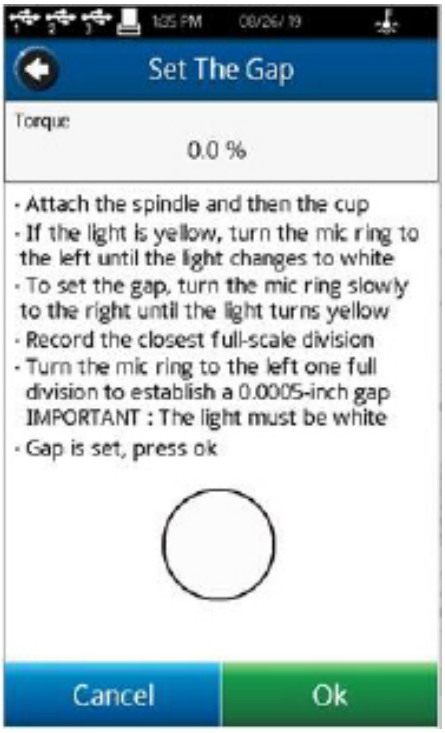


Figure A-6

A.4 Verifying calibration

- Determine the appropriate sample volume. Refer to Table A-1 to determine the correct sample volume required for the spindle to be utilized.
- Select a AMETEK Brookfield Viscosity Standard fluid that will give viscosity readings between 10% and 100% of full-scale range. Refer to Appendix B for viscosity ranges of cone spindles. AMETEK Brookfield uses mineral oil viscosity standard fluids to calibrate Wells Brookfield Cone/Plate Rheometers at the factory. AMETEK Brookfield recommends that customers use mineral oil viscosity standard fluids when you perform a calibration check.
    - If you decide to use a silicone viscosity standard fluid, do not use a fluid with a viscosity value greater than 5000 cP with a Cone/Plate. AMETEK Brookfield offers a complete range of mineral oil viscosity standards suitable for use with Cone/Plates for viscosities above 5,000 cP or shear rates above 500 sec-1; see Table E-2 in Appendix F for a list of available fluids.
    - It is best to use a viscosity standard fluid that will be close to the maximum viscosity for a given cone spindle/speed combination.
    - Example: DVNext LV Rheometer, Cone Spindle CPA-42Z, AMETEK Brookfield Viscosity Standard having a viscosity of 9.7 cP at 25°C.
    - At 60 RPM, the full-scale viscosity range is 10.0 cP. Thus, the Rheometer reading should be 97% torque and 9.7 cP viscosity ± 0.197 cP. The allowable error (±0.197 cP) is a combination of Rheometer accuracy and fluid tolerance (refer to Interpretation of Calibration Test Results in Appendix F).
- With the motor off, remove the sample cup and place the viscosity standard fluid into the cup.

Table A-1

CONE PART NO.	SAMPLE VOLUME
CPA-40Z or CPM-40Z	0.5 mL
CPA-41Z or CPM-41Z	2.0 mL
CPA-42Z or CPM-42Z	1.0 mL
CPA-51Z or CPM-51Z	0.5 mL
CPA-52Z or CPM-52Z	0.5 mL

- Attach the sample cup to the Rheometer and allow enough time for the sample, cup and cone to reach temperature equilibrium (25°C ±0.1°C).
- Go to Configure Viscosity. Set the desired parameter, e.g. Speed, Spindle, Sample ID, etc. Set the End Condition for Time 00:00:00. Press Run.
- Measure the viscosity and record the readings in both % torque and centipoise (cP).
- Verify that the viscosity reading is within the allowable 1% deviation, as explained earlier, for the specific viscosity standard fluid(s) that you are using.
- The CPE, CPM, or CPA designation on the cone spindle indicates use with Electronic Gap Setting Cone/Plate Rheometers/Rheometers only.

APPENDIX B - VISCOSITY RANGES

VISCOSITY RANGE TABLES
Viscosity ranges shown are for operational speeds 0.1 through 200 RPM.

LV Rheometer with LV spindles #1-4 and RV/HA/HB Rheometers with spindles #1-7

Viscosity Range cP		
Rheometer	**Minimum**	**Maximum**
DVNextLV	15	6,000,000
DVNextRV	100	40,000,000
DVNextHA	200	80,000,000
DVNextHB	800	320,000,000

Small Sample Adapter and Thermosel

SSA And Thermosel Spindle	**Viscosity (cP)**				**Shear Rate Sec-1**
	DVNextLV	DVNextRV	DVNextHA	DVNextHB	
S - S SC4-14	58.6 - 1,171.00	625 - 12,500,000	1,250 - 25,000,000	5,000 - 100,000,000	.40N
S - S SC4-15	23.4 - 468,650	250 - 5,000,000	500 - 10,000,000	2,000 - 40,000,000	.48N
S - S SC4-16	60 - 1,199,700	640 - 12,800,000	1,280 - 25,600,000	5,120 - 102,400,000	. 29N
SC4-18	1.5 - 30,000	16 - 320,000	32 - 640,000	128 - 2,560,000	1.32N
SC4-21	2.4 - 46,865	25 - 500,000	50 - 1,000,000	200 - 4,000,000	.93N
SC4-25	240 - 4,790,000	2,560 - 51,200,000	5,120 - 102,400,000	20,480 - 409,600,000	.22N
SC4-27	11.7 - 234,325	125 - 2,500,000	250 - 5,000,000	1,000 - 20,000.000	.34N
SC4-28	23.4 - 468,650	250 - 5,000,000	500 - 10,000,000	2,000 - 40,000,000	.28N
SC4-29	46.9 - 937,300	500 - 10,000,000	1,000 20,000,000	4,000 - 80,000,000	.25N
SC4-31	15 - 300,000	160 -3,200,000	320 6,400,000	1,280 - 25,600,000	.34N
SC4-34	30 - 600,000	320 -6,400,000	640 - 12,800,000	2,560 - 51,200,000	.28N
T - T HT-DIN-81	3.4 - 10,000	36.5 -10,000	73 - 10,000	292 - 10,000	1.29N
S -S SC4-DIN-82	3.4 - 10,000	36.5 -10,000	73 - 10,000	292 - 10,000	1.29N
S -S SC4-DIN-83	11.3 - 37,898	121.3 -50,000	242.6 -50,000	292 - 10,000	1.29N

T- This spindle used with Thermosel only
S- This spindle used with Small Sample Adapter only
N represents speed in RPM. For example, spindle SC4-14 operated at 5 RPM has a shear rate of 0.40 x 5 = 2.0 sec-1

UL Adapter

UL Spindle	Viscosity (cP)				Shear Rate Sec-1
	DVNextLV	DVNextRV	DVNextHA	DVNextHB	
YULA-15 or 15Z	1 - 2,000	3.2 - 2,000	6.4 - 2,000	25.6 - 2,000	1.22N

DIN Adapter Accessory

DDA Spindle	Viscosity (cP)				Shear Rate Sec-1
	DVNextLV	DVNextRV	DVNextHA	DVNextHB	
85	0.6 - 5,000	6.1 - 5,000	12.2 - 5,000	48.8 - 5,000	1.29N
86	1.8 - 10,000	18.2 - 10,000	36.5 - 10,000	146 - 10,000	1.29N
87	5.7 - 50,000	61 - 50,000	121 - 50,000	485 - 50,000	1.29N

Spiral Adapter

Spiral Spindle	Viscosity (cP)				Shear Rate Sec-1
	DVNextLV	DVNextRV	DVNextHA	DVNextHB	
SA-70	98 - 98,500	1,050 - 1,050,000	2,100 - 2,100,000	8,400 - 8,400,000	0.667N

Cone/Plate Rheometer

Cone Spindle	Viscosity (cP)				Shear Rate Sec-1
	DVNextLV	DVNextRV	DVNextHA	DVNextHB	
CPA-40Z or CPM-40Z	.15 - 3,065	1.7 - 32,700	3.3 - 65,400	13.1 - 261,000	7.5N
CPA-41Z or CPM-41Z	.58 - 11,510	6.2 - 122,800	12.3 - 245,600	49.1 - 982,400	2.0N
CPA-42Z or CPM-42Z	.3 - 6,000	3.2 - 64,000	6.4 - 128,000	25.6 - 512,000	3.84N
CPA-51Z or CPM-51Z	2.4 - 47,990	25.6 - 512,000	51.7 - 1,024,000	205 - 4,096,000	3.84N
CPA-52Z or CPM-52Z	4.6 - 92,130	49.2 - 983,000	99.2 - 1,966,000	393 - 7,864,000	2.0N

Helipath with T-Bar Spindle

T-Bar Spindle	Viscosity (cP)			
	DVNextLV	DVNextRV	DVNextHA	DVNextHB
T-A	156 - 187,460	2,000 - 2,000,000	4,000 - 4,000,000	16,000 - 16,000,000
T-B	312 - 374,920	4,000 - 4,000,000	8,000 - 8,000,000	32,000 - 32,000,000
T-C	780 - 937,300	10,000 - 10,000,000	20,000 - 20,000,000	80,000 - 80,000,000
T-D	1,560 - 1,874,600	20,000 - 20,000	40,000 - 40,000,000	60,000 - 160,000,000
T-E	3,900 - 4,686,500	50,000 - 50,000,000	100,000 - 100,000,000	400,000 - 400,000,000
T-F	7,800 - 9,373,000	100,000 - 100,000000	200,000 - 200,000,000	800,000 - 800,000,000

Vane Spindles

Spindle	Torque Range	Shear Stress Range (Pa)	Viscosity Range cP(mPa's)
V-71	NOT RECOMMENDED FOR USE ON LV TORQUE		
V-72	LV	.188-1.88	104.04-1.04K
V-73	LV	.938-9.38	502-5.02K
V-74	LV	9.38-93.8	5.09K-50.9K
V-75	LV	3.75-37.5	1.996K-19.96K
V-71	RV	.5-5	262-2.62K
V-72	RV	2-20	1.11K-11.1K
V-73	RV	10-100	5.35K-53.5K
V-74	RV	100-1K	54.3K-543K
V-75	RV	0-400	21.3K-213K
V-71	HA	1-10	524-5.24K
V-72	HA	4-40	2.22K-22.2K
V-73	HA	20-200	10.7K-107K
V-74	HA	200-2K	108.6K-1.086M
V-75	HA	80-800	42.6K-426K
V-71	HB	4-40	2.096K-20.96K
V-72	HB	16-160	8.88K-88.8K
V-73	HB	80-800	42.8K-428K
V-74	HB	800-8K	434.4K-4.344M
V-75	HB	320-3.2K	170.4K-1.704M
V-71	5xHB	20-200	10.48K-104.8K
V-72	5xHB	80-800	44.4K-444K
V-73	5xHB	400-4000	214K-2.14M
V-74	5xHB	4K-40K	2.172M-21.72M
V-75	5xHB	1.6K-16K	852K-8.52M

Note:

- 1 Pa = 10 dyne/cm2
- Viscosity Range is given at rotational speed of 10 RPM
- 5xHB is the highest torque range available
- Not for use with DV-E Viscometers

M = 1 million
K = 1 thousand
Pa = Pascal

cP = Centipoise
mPa•s = Millipascal•seconds

Special Considerations

In taking viscosity measurements with the DVNext Rheometer, there are two considerations which pertain to the low viscosity limit of effective measurement.

- Viscosity measurements should be accepted within the equivalent % Torque Range from 10% to 100% for any combination of spindle/speed rotation.
- Viscosity measurements should be taken under laminar flow conditions, not under turbulent flow conditions.

The first consideration has to do with the precision of the instrument. All DVNext Rheometers have an accuracy of +/- 1% of the range in use for any standard spindle or cone/plate spindle. (Note that accuracy values may be higher than 1% when using accessory devices with the DVNext). We discourage taking readings below 10% of range because the potential viscosity error of +/- 1% is a relatively high number compared to the instrument reading.

The second consideration involves the mechanics of fluid flow. All rheological measure me of fluid flow properties should be made under laminar flow conditions. Laminar flow is flow wherein all particle movement is in layers directed by the shearing force. For rotational systems, this means all fluid movement must be circumferential. When the inertial forces on the fluid become too great, the fluid can break into turbulent flow wherein the movement of fluid particles becomes random and the flow can not be analyzed with standard math models. This turbulence creates a falsely high rheometer reading with the degree of non-linear increase in reading being directly related to the degree of turbulence in the fluid.

For the following geometries, we have found that an approximate transition point to turbulent flow occurs:

- No. 1 LV Spindle: 15 cP at 60 RPM
- No. 2 LV Spindle: 100 cP at 200 RPM
- No. 1 RV Spindle: 100 cP at 50 RPM
- No. 2 RV Spindle: 500 cP at 60 RPM
- UL Adapter: 0.85 cP at 60 RPM
- SC4-18/13R: 1.25 cP at 240 RPM

The AMETEK Brookfield rheometer has a stated accuracy of +/- 1% of the range in use. This stated accuracy applies when the rheometer is used in accordance with the operating instructions detailed in the instrument instruction manual and the calibration test fluid is used in accordance with the instructions provided by the fluid supplier (including the critical parameters of temperature control and stated fluid accuracy). AMETEK Brookfield's accuracy statement of +/- 1% of the range in use applies to the AMETEK Brookfield rotational rheometer when used with the standard spindles supplied with the instrument, including LV spindles 1 through 4 (supplied with LV series rheometers), RV spindles 2 through 7 (supplied with RV series rheometers), and HV series spindles 2 through 7 (supplied with HA series rheometers and HB series rheometers) in a 600 mL low form Griffin beaker.

AMETEK Brookfield offers a range of accessories for use with the AMETEK Brookfield rheometer to accommodate special measurement circumstances. These accessories, while offering added capability to the user, also contribute to an expanded measurement tolerance beyond the instrument accuracy of +/- 1% of the range in use. This expanded measurement tolerance is a function of many parameters including spindle geometry, accessory alignment accuracy, sample volume requirement, and sample introduction techniques. The effect of these elements on measurement tolerance must be considered when verifying the calibration of your AMETEK Brookfield rheometer. Sample temperature in all test circumstances is very important and will also add an additional expanded tolerance depending on the temperature control system and the calibration verification tests begin with the standard rheometer spindles as detailed above.

Once the calibration of the rheometer itself is confirmed, the expanded tolerance of the measurement system may be determined using accessory devices. In many cases, this additional tolerance will be very minimal, but as a general statement, the addition of +/- 1% of the range in use is reasonable for accessories.

APPENDIX C - VARIABLES IN VISCOSITY MEASUREMENTS

As with any instrument measurement, there are variables that can affect a Rheometer measurement. These variables may be related to the instrument (Rheometer), or the test fluid. Variables related to the test fluid deal with the rheological properties of the fluid, while instrument variables would include the Rheometer design and the spindle geometry system utilized.

RHEOLOGICAL PROPERTIES

Fluids have different rheological characteristics that can be described by Rheometer measurements. We can then work with these fluids to suit our lab or process conditions.

There are two categories of fluids:

Newtonian	These fluids have the same viscosity at different Shear Rates (different RPMs) and are called Newtonian over the Shear Rate range they are measured.
Non-Newtonian	These fluids have different viscosities at different shear rates (different RPMs). They fall into two groups: Time Independent non-Newtonian Time Dependent non-Newtonian
Time Independent Pseudoplastic	A pseudoplastic material displays a decrease in viscosity with an increase in shear rate, and is also known as “shear thinning”. If you take Rheometer readings from a low to a high RPM and then back to the low RPM, and the readings fall upon themselves, the material is time independent pseudoplastic (shear thinning).
Time Dependent Thixotropic	A thixotropic material has decreasing viscosity under constant shear rate. If you set a Rheometer at a constant speed recording cP values over time and find that the cP values decrease with time, the material is thixotropic. If you take rheometer readings from a low RPM to a high RPM and then back to the low RPM, and the readings are lower for the descending step, the material is time dependent, thixotropic.

AMETEK Brookfield publication, “More Solutions to Sticky Problems”, includes a more detailed discussion of rheological properties and non-Newtonian behavior.

Rheometer related variables

Most fluid viscosities are found to be non-Newtonian. They are dependent on Shear Rate, time of test and the spindle geometry conditions. The specifications of the Rheometer spindle and chamber geometry will affect the viscosity readings. If one reading is taken at 2.5 RPM, and a second at 50 RPM, the two cP values produced will be different because the readings were made at different shear rates. The faster the spindle speed, the higher the shear rate.

The shear rate of a given measurement is determined by: the rotational speed of the spindle, the size and shape of the spindle, the size and shape of the container used and therefore the distance between the container wall and the spindle surface.

A repeatable viscosity test should control or specify the following:

- Test temperature
- Sample container size (or spindle/chamber geometry)
- Sample volume
- Rheometer model

- Spindle used
- Whether or not to attach the guard leg
- Test speed or speeds (or the shear rate)
- Length of time or number of spindle revolutions to record viscosity
- How the sample was prepared and/or loaded into the container

APPENDIX D - SPINDLE ENTRY CODES AND SMC/SRC VALUES

Each spindle has a two-digit entry code which is entered via the keypad on the DVNext. The entry code allows the DVNext to calculate Viscosity, Shear Rate and Shear Stress values. Each spindle has two constants which are used in these calculations. The Spindle Multiplier Constant (SMC) used for viscosity and shear stress calculations, and the Shear Rate Constant (SRC), used for shear rate and shear stress calculations. Note that where SRC = 0, no shear rate/shear stress calculations are done, and the data displayed is zero (0) for these functions.

Table D-1
(continued on following page)

SPINDLE	ENTRY CODE	SMC	SRC
RV1	01	1	0
RV2	02	4	0
RV3	03	10	0
RV4	04	20	0
RV5	05	40	0
RV6	06	100	0
RV7	07	400	0
HA1	01	1	0
HA2	02	4	0
HA3	03	10	0
HA4	04	20	0
HA5	05	40	0
HA6	06	100	0
HA7	07	400	0
HB1	01	1	0
HB2	02	4	0
HB3	03	10	0
HB4	04	20	0
HB5	05	40	0
HB6	06	100	0
HB7	07	400	0
LV1	61	6.4	0
LV2	62	32	0
LV3	63	128	0
LV4 or 4B2	64	640	0
LV5	65	1280	0
LV-2C	66	32	0.212
LV-3C	67	128	0.210
SA-70	70	105	0.677
T-A	91	20	0
T-B	92	40	0
T-C	93	100	0
T-D	94	200	0
T-E	95	500	0
T-F	96	1000	0

SPINDLE	ENTRY CODE	SMC	SRC
ULA	95	0.64	1.223
DIN81	81	3.7	1.29
DIN82	82	3.75	1.29
DIN83	83	12.09	1.29
DIN85	85	1.22	1.29
DIN86	86	3.65	1.29
DIN87	87	12.13	1.29
SC4-14	14	125	0.4
SC4-15	15	50	0.48
SC4-16	16	128	0.29
SC4-18	18	3.2	1.32
SC4-21	21	5	0.93
SC4-25	25	512	0.22
SC4-27	27	25	0.34
SC4-28	28	50	0.28
SC4-29	29	100	0.25
SC4-31	31	32	0.34
SC4-34	34	64	0.28
CPA-40Z or CPM-40Z	40	0.327	7.5
CPA-41Z or CPM-41Z	41	1.228	2
CPA-42Z or CPM-42Z	42	0.64	3.84
CPA-51Z or CPM-51Z	51	5.178	3.84
CPA-52Z or CPM-52Z	52	9.922	2

SPINDLE	ENTRY CODE	SMC	SRC	YMC
V-71	71	2.61	0	0.5
V-72	72	11.1	0	2
V-73	73	53.5	0	10
V-74	74	543	0	100
V-75	75	213	0	40

Table D-1
(continued from previous page)

Table D-2 lists the model codes and spring torque constants for each Rheometer model.

Table D-2

Model	TK	Model Code on DVNext Screen
DVNextLV	0.09375	LV
DVNextRV	1	RV
DVNextHA	2	HA
DVNextHB	8	HB

The full-scale viscosity range for any DVNext model and spindle may be calculated using the equation:

Full Scale Viscosity Range: $$[cP]=TK_{*}SMC^{*}\frac{10000}{RPM}$$

where:
TK = DVNext Torque Constant from Table D-2
SMC = Spindle Multiplier Constant from Table D-1

The Shear Rate calculation is:

(Shear Stress (D/cm2)) = Viscosity (P) * Shear Rate (1/sec)
= TK * SMC * SRC * TORQ

The immersion mark selected affects the stress calculations. Ensure the selected immersion mark reflects the mark in use.

Each spindle has a Yield Multiplier Constant (YMC) for stress calculations and a Spindle Multiplier Constant (SMC) for calibration checks (see Appendix E) as shown in Table D-3. Spindle dimensions are also listed.

Table D-3

Spindle	Spindle	YMC	SMC	Vane Length	Vane Diameter
V-71	71	0.5	2.62	2.708 6.878	1.354 3.439
V-72	72	2.0	11.1	1.706 4.333	.853 2.167
V-73	73	10.0	53.5	.998 2.535	.499 1.267
V-74	74	100.0	543	.463 1.176	.232 .589
V-75	75	40.0	213	.632 1.61	.316 .803

Note: If secondary immersion mark is selected, the YMC value is doubled.

The full scale Yield Stress range for any DVNext model and spindle may be calculated using the equation:

Full Scale Yield Stress Range (Pa) = TK x YMC x 10

Where: TK = DVNext Ultra Torque Constant from Table D-2
YMC = Yield Multiplier Constant from Table D-3

The following speeds are available for yield tests.

Table D-4

PRE-SHEAR SPEEDS (RPM)	
Range	Increment
0.01 to 0.09	0.01
0.1 to 5.0	0.1
6, 10, 12, 20, 30, 50, 60, 100, 200	N/A

ZERO STEP SPEEDS (RPM)	
RANGE	INCREMENT
0.01 to 0.09	0.01
0.1 to 0.5	0.1

RUN SPEEDS (RPM)	
RANGE	INCREMENT
0.01 to 0.09	0.01
0.1 to 5.0	0.1

The shear stress measurement range for the three standard (or supplied) vane spindles at each spring torque is as follows:

Table D-5

SPINDLE	MODEL CODE ON DVNext ULTRA SCREEN	TK	SHEAR STRESS RANGE (Pa)
V-71	LV	09373	0.047 - 0.47
V-72	LV	.09373	0.19 - 1.9
V-73	LV	.09373	0.94 - 9.4
V-71	RV	1	0.5 - 5
V-72	RV	1	2 - 20
V-73	RV	1	10 - 100
V-71	HB	8	4 - 40
V-72	HB	8	16 - 160
V-73	HB	8	80 - 800
V-71	5xHB	40	20 - 200
V-72	5xHB	40	80 - 800
V-73	5xHB	40	400 - 4000

Calculations for Shear Stress in Yield Test
The following equations can be used to calculate the shear stress values after each packet of data is obtained from the DVNext.

$$\tau = \frac{TK \times YMC \times T}{10}$$

Where:

τ = Yield Stress (Pascals)
TK = Model Torque Constant from Table D-2
YMC = Yield Multiplier Constant from Table D-3
T = % Torque reading

The following equations can be used to calculate the strain data after each packet of data is obtained from the DVNext:

$$\gamma = \theta_M — (S \times T)$$

Where:

γ	= Strain	(rad)
θ_M	= Angular rotation of motor shaft	(rad)
S	= Radial Spring Factor	(rad/%torque)
T	= % Torque reading	(%)

$$\theta_M = \omega \times t \times \frac{2\pi}{60}$$

Where:

θ_M	= Angular rotation of motor shaft	(rad)
ω	= Rotational speed	(rpm)
t	= Time of test	(seconds)

$$S = \theta_{cal} \times (2\pi) \times 0.01$$

Where:

S	= Radial spring factor	(rad/%torque)
θ_{cal}	= Spring windup angle	(revolutions)

$$\theta_{cal} = \frac{V_{cal} \times t_{cal}}{6000}$$

Where:

θ_{cal}	= Spring windup angle	(revolutions)
v_{cal}	= Calibration speed	(fixed at 0.1 rpm) (rpm)
t_{cal}	= Calibration time (time for 0% to 100% spring windup)	(milliseconds)

$$t_{cal} = \frac{bi}{b_{cal}} \times \frac{v}{v_{cal}} \times 100$$

Where:

v_{cal}	= Calibration time (time for 0% to 100% spring wind up during calibration)	(milliseconds)
bi	= Base increment	(milliseconds)
b_{cal}	= Base increment calibration torque	(%torque/base increment)
v	= Speed	(rpm)
v_{cal}	= Calibration speed (fixed at 0.1 rpm)	(rpm)

APPENDIX E - SPINDLE ENTRY CODES AND RANGE COEFFICIENTS

The range coefficient is a convenient tool for quickly determining the maximum viscosity that can be measured with a specific spindle/speed combination. Identify the spindle in use and the torque range (LV, RV, HA, HB) of the Viscometer/Rheometer. Look up the Range Coefficient in the following table. Divide the Range Coefficient by the spindle speed to determine the maximum viscosity in centipoise that can be measured.

E.g., RV Viscometer with RV3 spindle: Range Coefficient is 100,000. At 50 RPM, the maximum viscosity that can be measured is 100,000/50 or 2,000 cP.

The Entry Code is the two-digit number used to identify the spindle in use when operating a standard digital Viscometer/Rheometer.

Table E-1

Spindle	Entry Code	Range Coefficient			
		LV	RV	HA	HB
RV1	01	937	10,000	20,000	80,000
RV2	02	3,750	40,000	80,000	320,000
RV3	03	9,375	100,000	200,000	800,000
RV4	04	18,750	200,000	400,000	1,600,000
RV5	05	37,500	400,000	800,000	3,200,000
RV6	06	93,750	1,000,000	2,000,000	8,000,000
RV7	07	375,000	4,000,000	8,000,000	32,000,000
HA1	01	937	10,000	20,000	80,000
HA2	02	3,750	40,000	80,000	320,000
HA3	03	9,375	100,000	200,000	800,000
HA4	04	18,750	200,000	400,000	1,600,000
HA5	05	3,7500	400,000	800,000	3,200,000
HA6	06	93,750	1,000,000	2,000,000	8,000,000
HA7	07	375,000	4,000,000	8,000,000	32,000,000
HB1	01	937	10,000	20,000	80,000
HB2	02	3,750	40,000	80,000	320,000
HB3	03	9,375	100,000	200,000	800,000
HB4	04	18,750	200,000	400,000	1,600,000
HB5	05	37,500	400,000	800,000	3,200,000
HB6	06	93,750	1,000,000	2,000,000	8,000,000
HB7	07	375,000	4,000,000	8,000,000	32,000,000
LV1	61	6,000	64,000	128,000	512,000
LV2	62	30,000	320,000	640,000	2,560,000
LV3	63	120,000	1,280,000	2,560,000	10,240,000
LV4 or 4B2	64	600,000	6,400,000	12,800,000	51,200,000
LV5	65	1,200,000	12,800,000	25,600,000	102,400,000
LV-2C	66	30,000	320,000	640,000	2,560,000
LV-3C	67	120,000	1,280,000	2,560,000	10,240,000
T-A	91	18,750	200,000	400,000	1,600,000
T-B	92	37,440	400,000	800,000	3,200,000
T-C	93	9,3600	1,000,000	2,000,000	8,000,000

Spindle	Entry Code	Range Coefficient			
		LV	RV	HA	HB
T-D	94	187,200	2,000,000	4,000,000	16,000,000
T-E	95	468,000	5,000,000	10,000,000	40,000,000
T-F	96	936,000	10,000,000	20,000,000	80,000,000
Spiral	70	98,400	1,050,000	2,100,000	8,400,000
ULA	00	600	6,400	12,800	51,200
HT-DIN-81	81	3,420	36,500	73,000	292,000
SC4-DIN-82	82	3,420	36,500	73,000	292,000
SC4-DIN-83	83	11,340	121,300	242,600	970,400
ULA-DIN-85	85	1,144	12,200	24,400	97,600
ULA-DIN-86	86	3,420	36,500	73,000	292,000
ULA-DIN-87	87	11,340	121,300	242,600	970,400
SC4-14/6R	14	117,200	1,250,000	2,500,000	10,000,000
SC4-15/7R	15	46,880	500,000	1,000,000	4,000,000
SC4-16/8R	16	120,000	1,280,000	2,560,000	10,240,000
SC4-18/13R	18	3,000	32,000	64,000	256,000
SC4-21/13R	21	4,688	50,000	100,000	400,000
SC4-25/13R	25	480,000	5,120,000	10,240,000	40,960,000
SC4-27/13R	27	23,440	250,000	500,000	2,000,000
SC4-28/13R	28	46,880	500,000	1,000,000	4,000,000
SC4-29/13R	29	93,750	1,000,000	2,000,000	8,000,000
SC4-31/13R	31	30,000	320,000	640,000	2,560,000
SC4-34/13R	34	60,000	640,000	1,280,000	5,120,000
CPA-40Z or CPM-40Z	40	307	3,270	6,540	26,160
CPA-41Z or CPM-41Z	41	1,151	12,280	24,560	98,240
CPA-42Z or CPM-42Z	42	600	6,400	12,800	51,200
CPA-51Z or CPM-51Z	51	4,854	51,780	103,560	414,240
CPA-52Z or CPM-52Z	52	9,300	99,220	198,440	793,760
V-71	71	2,456	26,200	52,400	209,600
V-72	72	10,404	111,000	222,000	888,000
V-73	73	50,146	535,000	1,070,000	4,280,000
V-74	74	508,954	5,430,000	10,860,000	43,440,000
V-75	75	199,645	2,130,000	4,260,000	8,520,000

APPENDIX F - CALIBRATION PROCEDURES

The accuracy of the DVNext is verified using viscosity standard fluids which are available from AMETEK Brookfield or your local authorized dealer. Viscosity standards are Newtonian, and therefore, have the same viscosity regardless of spindle speed (or shear rate). Viscosity standards, calibrated at 25°C, are shown in Table F-1 (Silicone Oils) and Table F-2 (Mineral Oils).

Container Size: For Viscosity Standards < 30,000 cP, use a 600 mL Low Form Griffin Beaker having a working volume of 500 mL.

For Viscosity Standards > 30,000 cP, use the fluid container. Inside Diameter: 3.25” (8.25 cm) Height: 4.75” (12.1 cm)

Note: Container may be larger but may not be smaller.

Temperature Conditions: As stated on the fluid standard label: (+/-) 0.1°C
The DVNext should be set according to the operating instructions. The water bath must be stabilized at test temperature. Rheometers with the letters “LV” or “RV” in the model designation must have the guard leg attached (see Appendix G for more information on the guard leg).

Normal 25° C Viscosity (cP)	Standard Fluids Viscosity (cP)	High Temperature Standard Fluids Three Viscosity/Temperatures**
5	5,000	HT-30,000
10	12,500	HT-60,000
50	30,000	HT-100,000
100	60,000	
**25°C, 93.3°C, 149°C, Refer to AMETEK Brookfield catalog for more information		

Table - F1

Mineral Oil Viscosity Standard Fluids	
BEL Part No.	**Viscosity (cP) 25°C**
B29	29
B200	200
B600	600
B1060	1,060
B2000	2,000
B10200	10,200
B21000	21,000
B73000	73,000
B200000	200,000
B360000	360,000

Table - F2

AMETEK Brookfield Viscosity Standard Fluid general information

We recommend that AMETEK Brookfield Viscosity Standard Fluids be replaced on an annual basis, one year from date of initial use. These fluids are pure silicone and are not subject to change overtime. However, exposure to outside contaminants through normal use requires replacement on an annual basis. Contamination may occur by the introduction of solvent, standard of different viscosity or other foreign material.

Viscosity Standard Fluids may be stored under normal laboratory conditions. Disposal should be in accordance with state, local and federal regulations as specified on the material safety data sheet.

AMETEK Brookfield does not re-certify Viscosity Standard Fluids. We will issue duplicate copies of the Certificate of Calibration for any fluid within two years of the purchase date. AMETEK Brookfield Viscosity Standard Fluids are reusable provided they are not contaminated. Normal practice for usage in a 600 mL beaker is to return the material from the beaker back into the bottle. When using smaller volumes in accessories such as Small Sample Adapter, UL Adapter or Thermosel, the fluid is normally discarded.

CALIBRATION PROCEDURE FOR LV #1-3 (#61-63) AND RV, HA, HB #1-6 AMETEK Brookfield SPINDLES
Please Note That The LV#4(64) and RV, HV, HB#7 (07) Spindles have been omitted from this procedure. AMETEK Brookfield does not recommend the use of these spindles to perform a calibration check in your instrument. Reasons pertain to the small amount of spindle surface that conacts the viscosity standard, the difficulty of establishing the immersion mark precisely and the need for precise temperature control at 25^{0}C in the immediate vicinity of the spindle.

Follow these steps using one of the recommended spindles to verify calibration on your instrument:

- Place the viscosity standard fluid (in the proper container) into the water bath.
- Lower the DVNext into measurement position (with guard leg if LV or RV series Rheometer is used).
- Attach the spindle to the Rheometer. If you are using a disk-shaped spindle, avoid trapping air bubbles beneath the disk by first immersing the spindle at an angle, and then connecting it to the Rheometer.
- The viscosity standard fluid, together with the spindle, should be immersed in the bath for a minimum of 1 hour, stirring the fluid periodically, prior to taking measurements.
- After 1 hour, check the temperature of the viscosity standard fluid with an accurate thermometer.
- If the fluid is at test temperature (±0.1°C of the specified temperature, normally 25°C), measure the viscosity and record the Rheometer reading.
    - Note: The spindle must rotate at least five (5) times before readings are taken.
- The viscosity reading should equal the cP value on the fluid standard to within the combined accuracies of the Rheometer and the viscosity standard (as discussed in the section, at the end of this Appendix, entitled Interpretation of Calibration Test Results) which appears later in this section.

Calibration procedure for a Small Sample Adapter

AMETEK Brookfield recommends a two-step check. First, verify the calibration of the rheometer using the standard rheometer spindles (LV #1-3, RV #2-6, HA #2-6 and HB #2-6 or cone/plate spindles) as detailed in this appendix. Second, verify the calibration of the rheometer using the Small Sample Adapter.

When a Small Sample Adapter is used, the water jacket is connected to the water bath and the water is stabilized at the proper temperature:

- Put the proper amount of viscosity standard fluid into the sample chamber. The amount varies with each spindle/chamber combination (refer to the Small Sample Adapter instruction manual).
- Place the sample chamber into the water jacket.
- Put the spindle into the test fluid and attach the extension link, coupling nut and freehanging spindle (or directly attach the solid shaft spindle) to the DVNext.
- Allow 30 minutes for the viscosity standard, sample chamber and spindle to reach test temperature.

- Measure the viscosity and record the Rheometer reading.
    - Note: The spindle must rotate at least five (5) times before readings are taken.
- The viscosity reading should equal the cP value on the viscosity fluid standard to within the combined accuracies of the rheometer and the standard (as discussed in the section entitled, Interpretation of Calibration Test Results). However, instrument accuracy is ±2% of the maximum viscosity range and not the standard 1%.

Calibration procedure for a Thermosel System

AMETEK Brookfield recommends a two-step check. First verify the calibration of the rheometer using the standard rheometer spindles (LV #1-3, RV #2-6, HA #2-6 and HB #2-6 or cone/plate spindles) as detailed in this appendix. Second verify the calibration of the rheometer using the Thermosel. The use of an accessory device may decrease the accuracy of measurement associated with the DVNext.

When a Thermosel System is used, the controller stabilizes the Thermo Container at the test temperature.

- Put the proper amount of HT viscosity standard fluid into the HT-2 sample chamber. The amount varies with the spindle used (refer to the Thermosel instruction manual).
- Place the sample chamber into the Thermo Container.
- Put the spindle into the test fluid and attach the extension link, coupling nut and freehanging spindle (or directly attach the solid shaft spindle) to the DVNext.
- Allow 30 minutes for the viscosity standard, sample chamber and spindle to reach test temperature.
- Measure the viscosity and record the Rheometer reading. Note: The spindle must rotate at least five (5) times before readings are taken.
- The viscosity reading should equal the cP value on the viscosity fluid standard to within the combined accuracies of the rheometer and the standard (as discussed in the section entitled, Interpretation of Calibration Test Results). However, instrument accuracy is ±2% of the maximum viscosity range and not the standard 1%.

Calibration procedure using UL or DIN adapters

AMETEK Brookfield recommends a two-step check. First, verify the calibration of the rheometer using the standard rheometer spindles (LV #1-3, RV #2-6, HA #2-6 and HB #2-6 or cone/plate spindles) as detailed in this appendix. Second, verify the calibration of the rheometer using the UL or DIN Adapters. The use of an accessory device may increase the accuracy of measurement associated with the DVNext.

When a UL or DIN Adapter is used, the water bath is stabilized at the proper temperature:

- Put the proper amount of viscosity standard fluid into the UL Tube (refer to the UL Adapter instruction manual).
- Attach the spindle (with extension link and coupling nut) onto the DVNext.
- Attach the tube to the mounting channel.
- Lower the tube into the water bath reservoir, or if using the ULA-40Y water jacket, connect the inlet/outlets to the bath external circulating pump.
- Allow 30 minutes for the viscosity standard, sample chamber and spindle to reach test temperature.
- Measure the viscosity and record the Rheometer reading.
    - Note: The spindle must rotate at least five (5) times before readings are taken.
- The viscosity reading should equal the cP value on the viscosity fluid standard to within the combined accuracies of the rheometer and the standard (as discussed in the section entitled, Interpretation of Calibration Test Results). However, instrument accuracy is ±2% of the maximum viscosity range and not the standard 1%.

Calibration procedure using Helipath Stand and T-Bar spindles

When a Helipath Stand and T-Bar spindles are used:

- Remove the T-bar spindle and select a standard LV (#1-3) or RV, HA, HB (#1-6) spindle. Follow the procedures for LV (#1-3) and RV, HA, HB (#1-6) AMETEK Brookfield spindles outlined above.
- T-Bar spindles should not be used for verifying calibration of the DVNext Rheometer.

Calibration procedure for Spiral Adapter

AMETEK Brookfield recommends a two-step check. First, verify the calibration of the rheometer using the standard rheometer spindles (LV #1-3, RV #2-6, HA #2-6 and HB #2-6 or cone/plate spindles) as detailed in this appendix. Second, verify the calibration of the rheometer using the Spiral Adapter. The use of an accessory device may increase the accuracy of measurement associated with the DVNext.

- Place the viscosity standard fluid (in the proper container) into the water bath (refer to the Spiral Adapter instruction manual).
- Attach the spindle to the rheometer. Attach chamber (SA-1Y) and clamp to the rheometer.
- Lower the DVNext into measurement position. Operate the rheometer at 50 or 60 RPM until the chamber is fully flooded.
- The viscosity standard fluid, together with the spindle, should be immersed in the bath for a minimum of 1 hour, stirring the fluid periodically (operate at 50 or 60 RPM periodically), prior to taking measurements.
- After 1 hour, check the temperature of the viscosity standard fluid with an accurate thermometer.
- If the fluid is at test temperature (+/- 0.1°C of the specified temperature, normally 25°C), measure the viscosity and record the rheometer reading. Note: The spindle must rotate at least five (5) times or for one minute, whichever is greater before readings are taken.
- The viscosity reading should equal the cP value on the viscosity fluid standard to within the combined accuracies of the rheometer and the standard (as discussed in the section entitled, Interpretation of Calibration Test Results). However, instrument accuracy is ±2% of the maximum viscosity range and not the standard 1%.

Calibration procedure for Cone/Plate Rheometers

- Follow the above procedures for mechanically adjusting the setting of the cone spindle to the plate.
- Refer to Appendix A; Table A-1 and determine the correct sample volume required for the selected spindle.
- Select a viscosity standard fluid that will give viscosity readings between 10% and 100% of full-scale range. Refer to Appendix B for viscosity ranges of cone spindles. Consult with AMETEK Brookfield or an authorized dealer to determine which fluid is appropriate.
- It is best to use a viscosity standard fluid that will be close to the maximum viscosity for a given cone spindle/speed combination.
    - Example: DVNext LV Rheometer, Cone CP-42, Fluid10 Having a viscosity of 9.7 cP at 25°C
    - At 60 RPM, the full-scale viscosity range is 10.0 cP. Thus, the Rheometer reading should be 97% torque and 9.7 cP viscosity ± 0.197 cP (0.1 cP for the rheometer plus 0.097 cP for the fluid). The accuracy is a combination of Rheometer and fluid tolerance (refer to Interpretation of Calibration Test Results).
- With the rheometer stopped, remove the sample cup and place the viscosity standard fluid into the cup, waiting 10 minutes for temperature equilibrium.
- Connect the sample cup to the Rheometer. Allow enough time for temperature to reach equilibrium. Typically, 15 minutes is the maximum time that you must wait. Less time is required if spindle and cup are already at test temperature.
- Measure the viscosity and record the Rheometer reading in both % torque and centipoise (cP).

Notes:

- The spindle must rotate at least five (5) times before a viscosity reading is taken.
- The use of AMETEK Brookfield Viscosity Standard fluids in the range of 5 cP to 5000 cP is recommended for cone/plate instruments. Please contact AMETEK Brookfield or an authorized dealer if your calibration procedure requires more viscous standards.
- Select a viscosity standard fluid that will give viscosity readings between 10% and 100% of full-scale range. Refer to Appendix B for viscosity ranges of cone spindles. Do not use a silicone viscosity standard fluid with a viscosity value greater than 5000 cP with a Cone/Plate Rheometer. AMETEK Brookfield offers a complete range of mineral oil viscosity standards suitable for use with Cone/Plate.

Rheometers as shown in Table E-2. Consult with AMETEK Brookfield or an authorized dealer to determine which fluid is appropriate.

Interpretation of calibration test results

When verifying the calibration of the DVNext, the instrument and viscosity standard fluid error must be combined to calculate the total allowable error.

The DVNext is accurate to (+/-) 1% of the range in use when using spindles LV #1-3, RV #2- 6, HA #2-6 and HB #2-6. When using an accessory device with the DVNext such as Small Sample Adapter, UL Adapter, Thermosel, Spiral Adapter, and DIN Adapter the accuracy value may be increased. In general the decrease in accuracy will be minimal, however, it could be as much as 1% for a total accuracy of +/- 2% of the range in use.

AMETEK Brookfield Viscosity Standards Fluids are accurate to (+/-) 1% of their stated value.

Example: Calculate the acceptable range of viscosity using DVNext RV with RV-3 Spindle at 2 RPM; AMETEK Brookfield Standard Fluid 12,500 with a viscosity of 12,257 cP at 25°C:

1) Calculate full scale viscosity range using the equation:

Full scale Viscosity Range $$[cP] = TK * SMC * \frac{10{,}000}{RPM}$$

Where:

TK - 1.0 from **Table D-2**
SMC = 10 from **Table D-1**

Full Scale Viscosity Range $$\frac{1*10*10{,}000}{2} = 50{,}000 \text{ cP}$$

2) The viscosity standard fluid is 12,257 cP. Its accuracy is (+/-)1% of 12,257 or (+/-)122.57 cP.
Total allowable error is (122.57 + 500) cP = (+/-) 622.57 cP.

3) Therefore, any viscosity reading between 11,634.4 and 12,879.6 cP indicates that the Rheometer is operating correctly. Any reading outside these limits may indicate a Rheometer problem. Contact the AMETEK Brookfield technical sales department or your local AMETEK Brookfield dealer/distributor with test results to determine the nature of the problem.

Example: Calculate the acceptable accuracy for viscosity measurement using DVNext LV with SC4-21 spindle in Small Sample Adapter at 6, 12, and 30 RPM. AMETEK Brookfield viscosity standard fluid 100 cPs has an actual value of 101.5 cP at 25ºC.

1) Calculate the full scale viscosity range either by using the Spindle Range Coefficient in Appendix B of "More

Solutions to Sticky Problems" or by using the Auto Range button on your rheometer.

The Spindle Range Coefficient for the 21 spindle on an LV Torque instrument is 4,688.

At 6 RPM, the Full Scale Range (FSR) viscosity is 781 cP. Allow +/- 1% for the rheometer and +/- 1% for the Small Sample Adapter. Total allowable accuracy is:

+/- 2% x 781 cP = +/- 15.6 cP

A similar calculation at 12 RPM gives FSR = 391 cP: +/- 2% x 391 cP = +/- 7.8 cP

A similar calculation at 30 RPM gives FSR = 156 cP: +/- 2% x 156 cP = +/- 3.1 cP

2) The Viscosity Standard Fluid is 101.5 cP. Its accuracy is:

+/- 1% x 101.5 cP = +/- 1.015 cP or roughly +/- 1.0 cP for further calculations.

3) Total accuracy is the sum of the values n (1) and (2):

At 6 RPM, accuracy is: 15.6 cP + 1.0 cP = +/- 16.6 cP

At 12 RPM, accuracy is: 7.8 cP + 1.0 cP = +/- 9.8 cP

At 30 RPM, accuracy is: 3.1 cP = 1.0 cP = +/- 4.1 cP

4) Therefore, at each speed, the acceptable windows within which the measured viscosity value must lie is calculated relative to the viscosity value of the standard:

At 6 RPM: 84.9 cP to 118.1 cP

At 12 RPM: 91.7 cP to 111.3 cP

At 30 RPM: 97.4 cP to 105.6 cP

If your measured values fall outside of these windows, contact AMETEK Brookfield or your local authorized dealer to discuss your results and determine whether your instrument is out of calibration.

APPENDIX G - THE AMETEK BROOKFIELD GUARD LEG

The guard leg was originally designed to protect the spindle during use. The first applications of the AMETEK Brookfield Rheometer included hand-held operation while measuring fluids in a 55 gallon drum. It is clear that under those conditions the potential for damage to the spindle was great. Original construction included a sleeve that protected the spindle from side impact. Early RV guard legs attached to the dial housing and LV guard legs attached to the bottom of the pivot cup with a twist-and-lock mechanism.

The current guard leg is a band of metal in the shape of the letter U with a bracket at the top that attaches to the pivot cup of a AMETEK Brookfield Viscometer/Rheometer. Because it must attach to the pivot cup, the guard leg cannot be used with a Cone/Plate instrument. A guard leg is supplied with all LV and RV series instruments, but not with the HA or HB series. It's shape (shown in Figure G-1) is designed to accommodate the spindles of the appropriate spindle set; therefore, the RV guard leg is wider than the LV due to the large diameter of the RV #2 spindle. They are not interchangeable.

The calibration of the AMETEK Brookfield Viscometer/Rheometer is determined using a 600 mL Low Form Griffin Beaker. The calibration of LV and RV series instruments includes the guard leg. The beaker wall (for HA/HB instruments) or the guard leg (for LV/RV instruments) define what is called the "outer boundary" of the measurement. The spindle factors for the LV, RV, and HA/HB spindles were developed with the above boundary conditions. The spindle factors are used to convert the instrument torque (expressed as the dial reading or %Torque value) into centipoise. Theoretically, if measurements are made with different boundary conditions, e.g., without the guard leg or in a container other than 600 mL beaker, then the spindle factors found on the Factor Finder cannot be used to accurately calculate an absolute viscosity. Changing the boundary conditions does not change the viscosity of the fluid, but it does change how the instrument torque is converted to centipoise. Without changing the spindle factor to suit the new boundary conditions, the calculation from instrument torque to viscosity will be incorrect.

Practically speaking, the guard leg has the greatest effect when used with the #1 & #2 spindles of the LV and RV spindle sets (Note: RV/HA/HB #1 spindle is not included in standard spindle set). Any other LV (#3 & #4) or RV (#3 - #7) spindle can be used in a 600 mL beaker with or without the guard leg to produce correct results. The HA and HB series Viscometers/Rheometers are not supplied with guard legs in order to reduce the potential problems when measuring high viscosity materials. HA/HB spindles #3 through #7 are identical to those spindle numbers in the RV spindle set. The HA/HB #1 & #2 have slightly different dimensions than the corresponding RV spindles. This dimensional difference allows the factors between the RV and HA/HB #1 & #2 spindles to follow the same ratios as the instrument torque even though the boundary conditions are different. The recommended procedures of using a 600 mL beaker and the guard leg are difficult for some customers to follow. The guard leg is one more item to clean. In some applications the 500 mL of test fluid required to immerse the spindles in a 600 mL beaker is not available. In practice, a smaller vessel may be used, and the guard leg is removed. The AMETEK Brookfield Viscometer/ Rheometer will produce an accurate and repeatable torque reading under any measurement circumstance. However, the conversion of this torque reading to centipoise will only be correct if the factor used was developed for those specific conditions. AMETEK Brookfield has outlined a method for re-calibrating a AMETEK Brookfield Viscometer/ Rheometer to any measurement circumstance in "More Solutions to Sticky Problems". It is important to note that for many rheometer users, the true viscosity is not as important as a repeatable day-to-day value. This repeatable value can be obtained without any special effort for any measurement circumstance. But it should be known that this type of torque reading will not convert into a correct centipoise value when using a AMETEK Brookfield factor if the boundary conditions are not those specified by AMETEK Brookfield.

The guard leg is a part of the calibration check of the AMETEK Brookfield LV and RV series Viscometer/ Rheometer. Our customers should be aware of its existence, its purpose, and the effect that it may have on data. With this knowledge, the rheometer user may make modifications to the recommended method of operation to suit their needs.

B-21Y
Guard Leg For RV Torque

B-21Y
Guard Leg For RV Torque

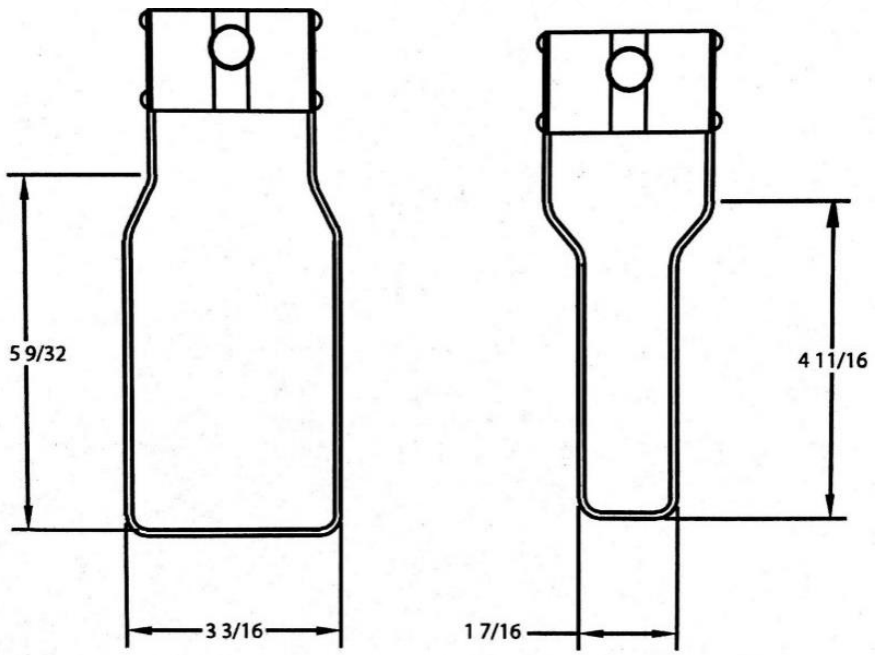


Figure G-1

APPENDIX H - AUTOMATIC OSCILLATION CHECK

The Oscillation Check is a test of the performance of the lower bearing of the DVNext Rheometer. This lower bearing is either Point and Jewel or Ball Bearing. Correct performance of the lower bearing is essential for proper operation of the rheometer. A failed lower bearing will normally cause viscosity measurements to be lower than expected.

Selecting Oscillation Check in the Device Setup menu will present the user with a screen instructing to remove the spindle (see Figure H-1).

Pressing the next key will perform an AutoZero (see Figure H-2).

When the autozero is complete pressing next will start the oscillation test.

The device will then perform a series of steps automatically. It is important that the DV Rheometer is not disturbed during the performance of the oscillation check. The oscillation check should take approximately 3 minutes.

A successful Oscillation Check (see Figure H-3) will show a very smooth decrease of %Torque with a final value within +/-0.3 of 0.0. Any value above 0.3 % or below -0.3% indicates that a calibration check should be performed (see Appendix F).

The Oscillation Check is not a guarantee of proper calibration. It is only an indication of the performance of the lower bearing of the rheometer. Calibration can only be verified through the use of a calibration standard such as AMETEK Brookfield Silicone and Mineral Oil standards.

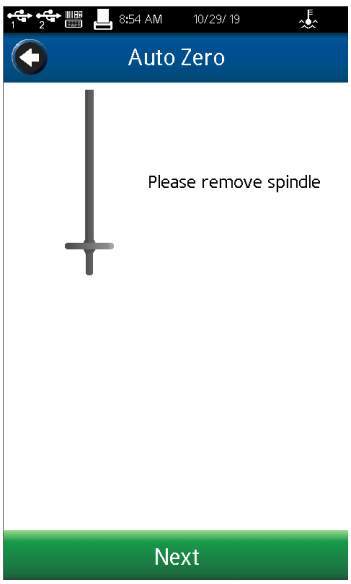


Figure H-1

Figure H-2

Figure H-3

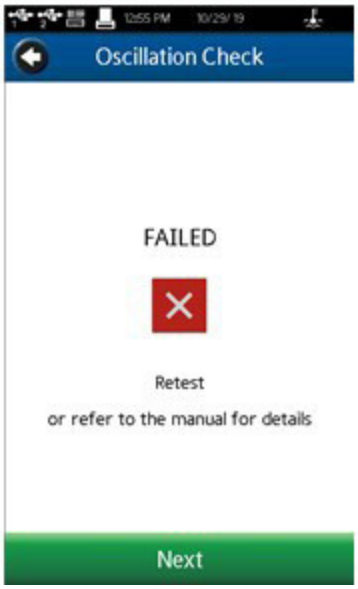


Figure H-4

APPENDIX I - FTP SERVER CONNECTION SPECIFICATION

Introduction

This guide will instruct you how to setup an Ethernet connection between your DVNext and personal Computer (PC) by using the File Transfer Protocol (FTP). The FTP connection feature on your DVNext device will enable you export files directly to an FTP Server program running on a PC.

FTP is a standard network protocol used for the transfer of computer files between a client (DVNext device) and a Server (PC/Laptop running a Windows Operating System) across an Ethernet computer network.

The following instructions will guide you through the steps on how to setup and use a free, opensource software FTP Server program called “FileZilla” which is licensed under the GNU General Public License.

For more information about FileZilla, you can visit their website at: https://filezilla-project.org/

It is important to note that your DVNext device is not strictly limited to working with FileZilla as the FTP server. Other FTP server implementations such as Microsoft’s “Internet Information Services” (IIS) may be used with your DVNext. Please refer to specific program installations and requirements when selecting another FTP program. For IIS setup and instructions, you can follow the guide at this link: https://docs.microsoft.com/en-us/iis/publish/using-the-ftp-service/configure-ftp-with-iis-manager-authentication-in-iis-7

Your DVNext device has a built-in FTP Server which will operate as a client to pass data to an FTP Server program running on a PC. The following instructions will assist you in creating a small Local Area Network (LAN) using a router. This will allow you to setup and easily test the DVNext FTP service using an ethernet connection to an adjacent PC.

The DVNext may be used on a Wide Area Network (WAN) or connection to the internet via your Internet Service Provider (ISP). Configuration of your router for use on a WAN/ISP connection is beyond the scope of this guide. For WAN/ISP configuration it is recommended that you consult the manufacturer’s instructions for your particular brand/model of router and contact your (ISP) for internet configurations setting.

To Establish a LAN connection to your DVNext you will need:

- A router with at least 2 available Ethernet ports.
- Windows PC/Laptop running Windows 10.
- 2 standard Ethernet cables (No crossover cables).
- DVNext Viscometer/Rheometer device(s).

Part a: Hardware configuration

Plug in one of the Straight Ethernet cables (Figure 1) into one of the open RJ-45 Ethernet ports on the router (Figure I- 2), but make sure you are not plugging it into the WAN port on the router. Connect the other end of the Ethernet cable to your Windows PC or Laptop’s RJ-45 jack for network interface connection (NIC)(Figure I- 3).

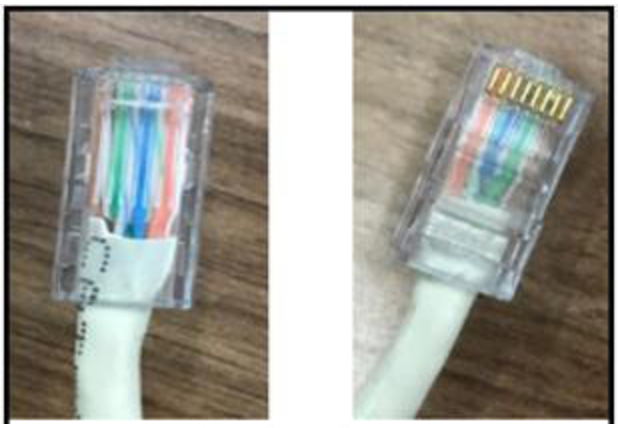


Figure I- 1: Cat 5 Ethernet RJ-45

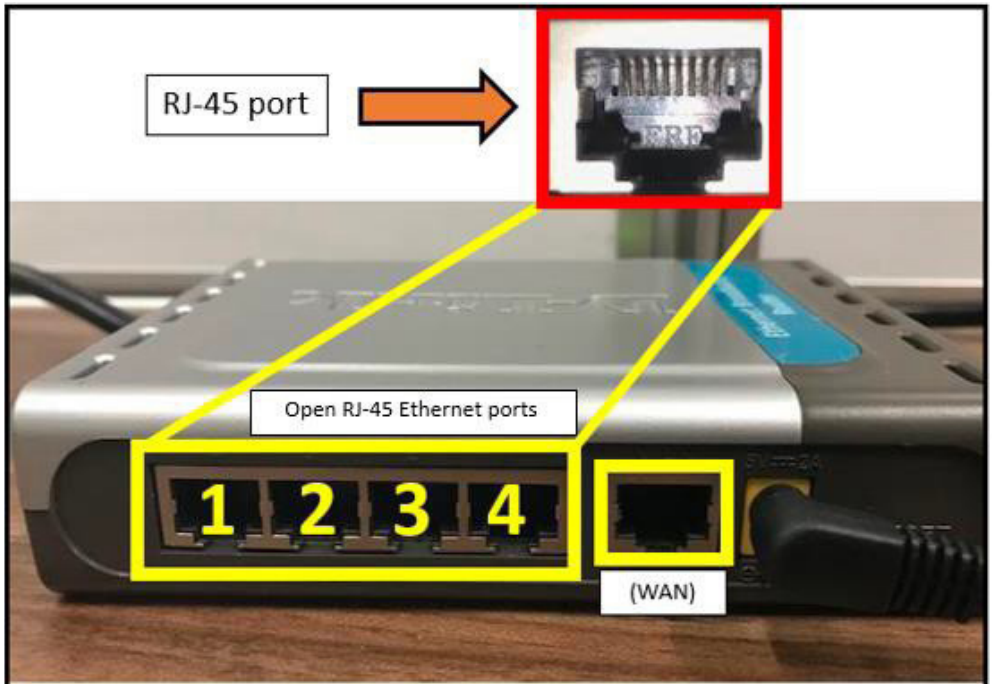


Figure I- 2: D-Link Ethernet Broadband Router – Model no DI 604

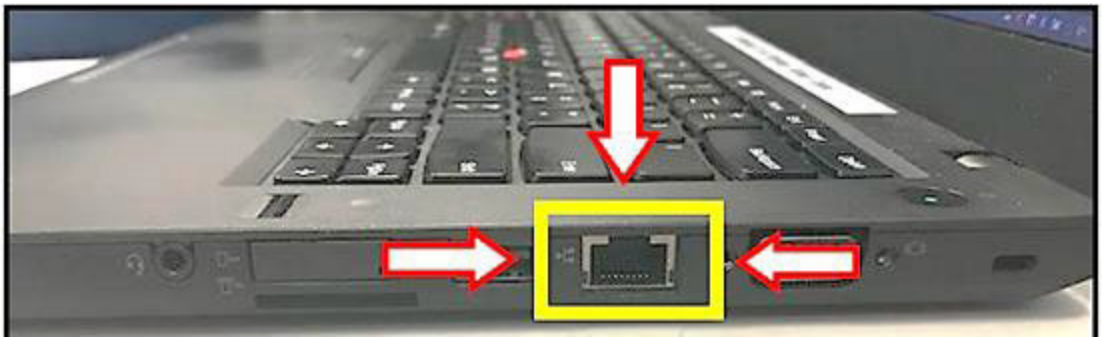


Figure I- 3: RJ-45 Ethernet port on Laptop

Plug in another Straight Ethernet cable (Figure I- 1) into another open RJ-45 Ethernet port on your router (Figure I- 2) and connect the other end to the RJ-45 Ethernet port on your DVNext Device (Figure I- 4).

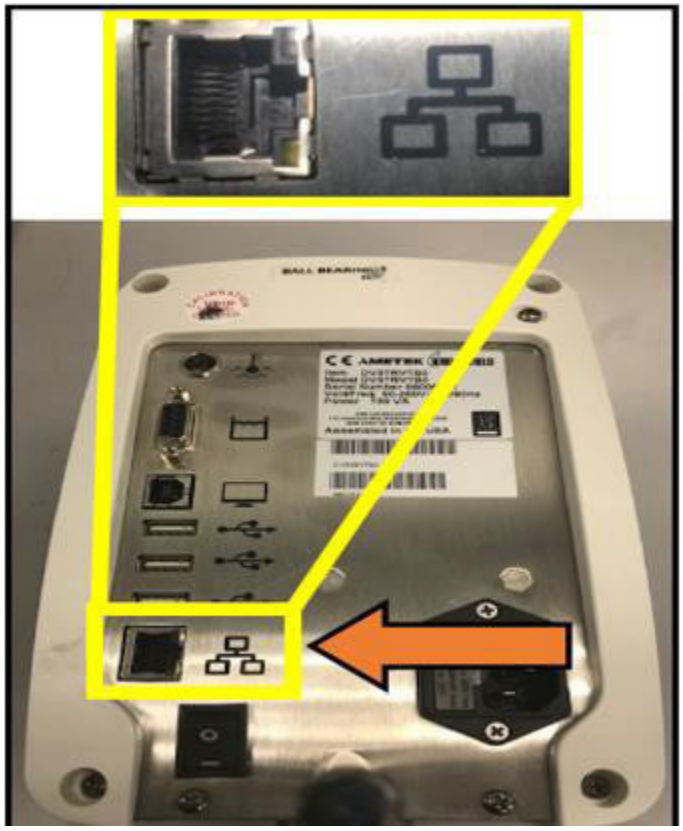


Figure I- 4: RJ-45 port located on back of DV device

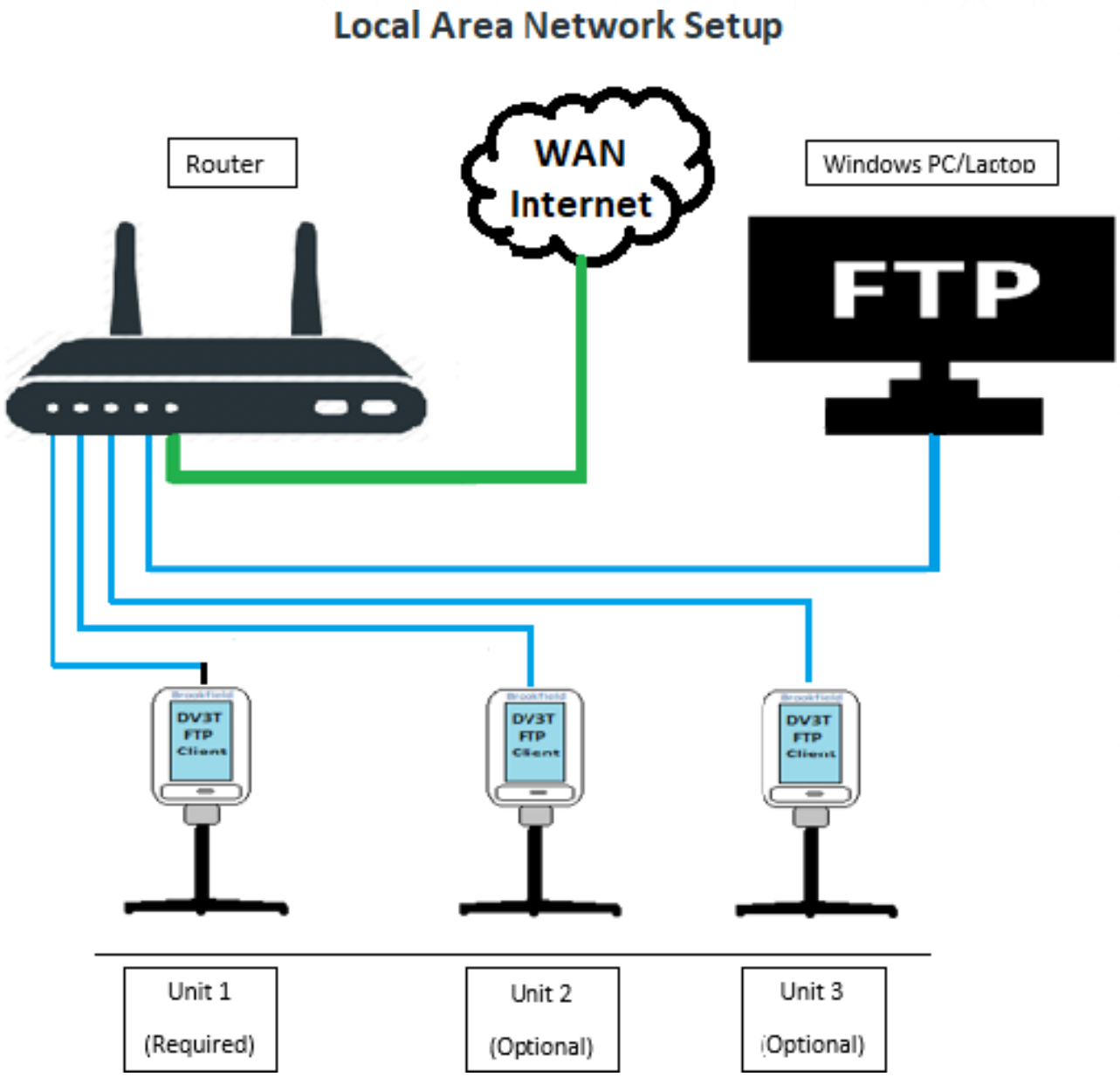


Figure I- 5: Simple Network

Part b: FileZilla FTP server

We recommend using FileZilla FTP Server (ver. 0.9.60.2 beta) on a Windows PC or Laptop to be able to set up and implement a personal FTP Server. Note: You may need administration access to be able to download and install necessary files.
Download and Installation link for Filezilla Server: https://filezilla-project.org

- Download " FileZilla Server " (Figure 6).
- The latest version will be downloaded. As of this writing, ver. 0.9.60.2 beta is the latest version available.

Figure I- 6

Clicking “Download FileZilla Server” will bring you to another window with a similar button to “Download FileZilla Server” for Windows Operating System (Figure I- 7). After clicking “Download FileZilla Server” from this window, the downloading file should pop up at the bottom left of your browser. Open the file to start the Installation (Figure I- 7).

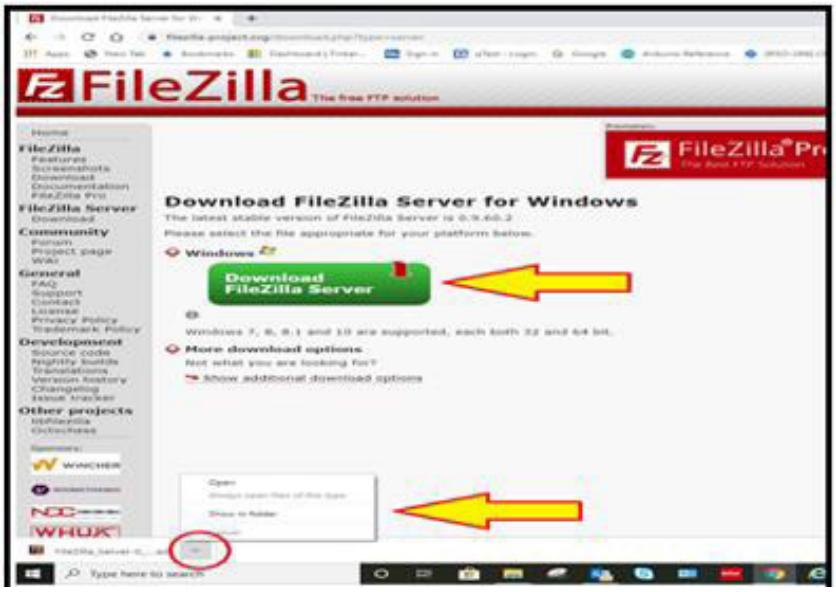


Figure I- 7: Opening downloaded

Allow the application to make changes to your device (Figure I- 8).

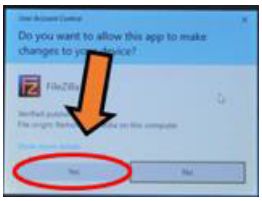


Figure I- 8

Agree to the EULA (Figure I- 9).

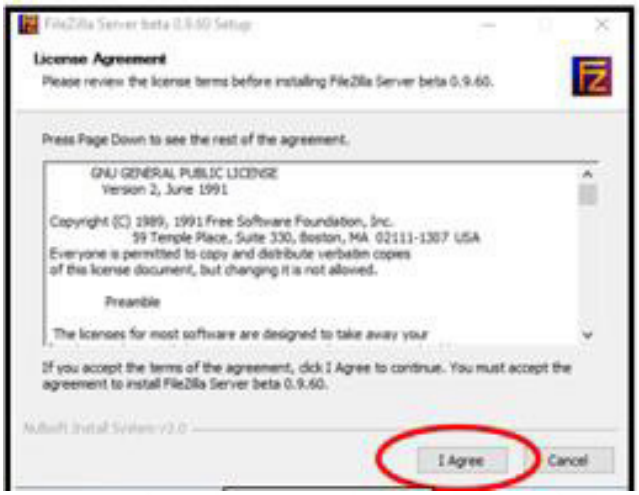


Figure I- 9: Agreeing to EULA

For the “Choose Components” screen, make sure the same defaults are chosen as seen in Figure I- 10 below.

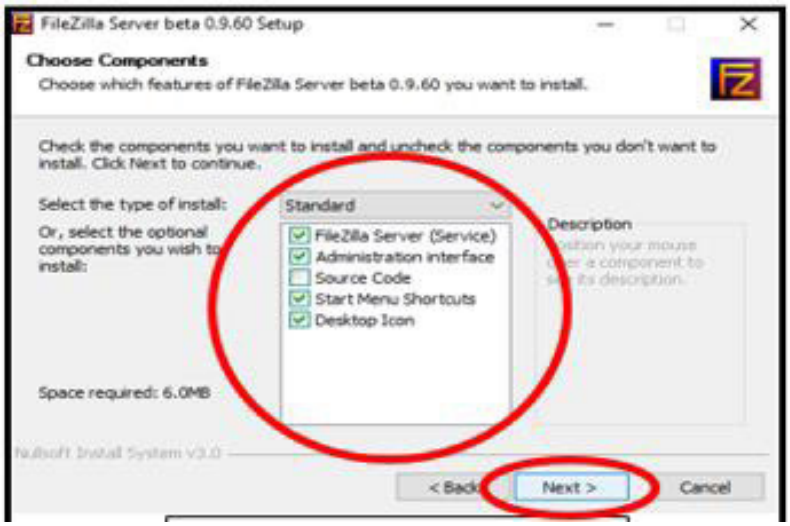


Figure I- 10: Choosing components

In the next window, you can choose the installation destination path for FileZilla. We kept the default destination path chosen which was "C:\Program Files (x86)\FileZilla Server\" (Figure I- 11).

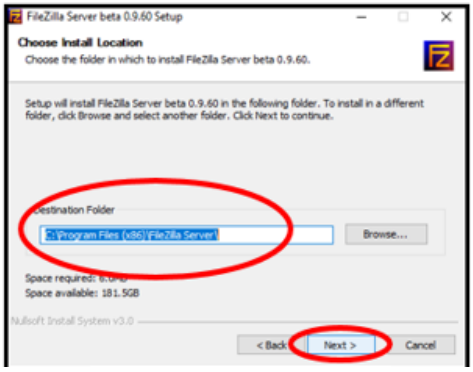


Figure I- 11: Installation

For the Startup settings window, just make sure the set defaults are the same as seen in Figure I-12 below. For choosing how FileZilla Server should be started, the selection that reads “Install as a service, started with windows

(default)" should be selected. The port for the admin interface should be "14147" (Figure I- 12).

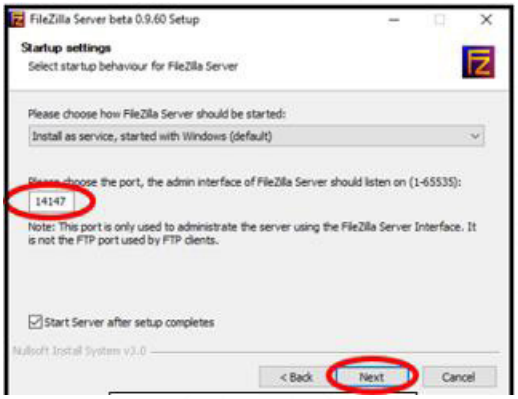


Figure I- 12: Startup settings and admin

Next, the Startup settings screen will pop up. Here you can choose whether or not you want FileZilla to automatically open when you log onto your computer and if you want FileZilla to open immediately when installation is complete. When you have chosen your settings, click the Install button at the bottom of the window. We kept the defaults for these settings as shown in Figure I- 13 below.

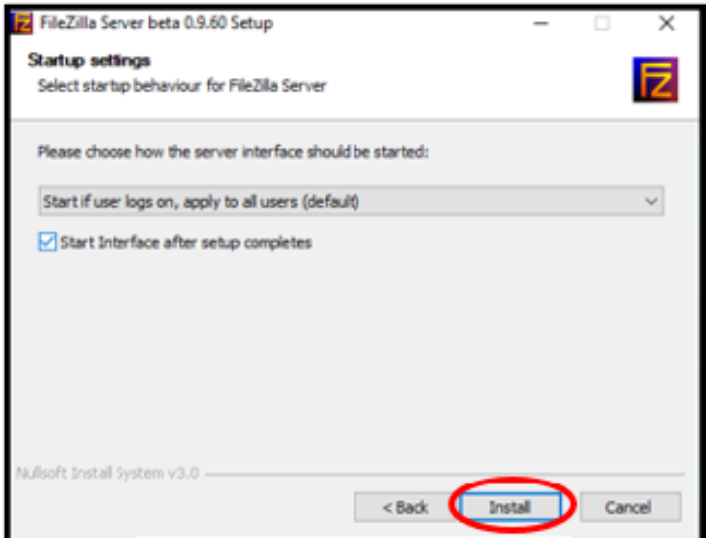


Figure I- 13: Startup settings and server

After clicking Install, there will be a window showing the progress of the installation (Figure I- 14). Once it says installation is completed, you may click the Close button at the bottom of the window.

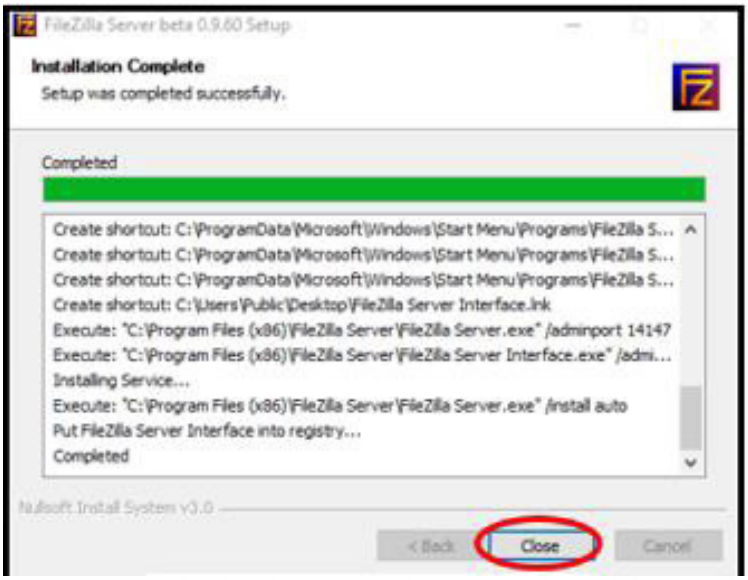


Figure 14: Installation progress window

When closing the “Installation complete” window, FileZilla Server should automatically open. There should be another prompt that pops up looking like Figure 15 shown below. For the “Host:” field, enter in “localhost” and keep the “Port:” field as "14147" (default). You do not need to set a Password or check the box for "Always connect to this server". When done, click Connect at the bottom of the window (Figure I- 15).

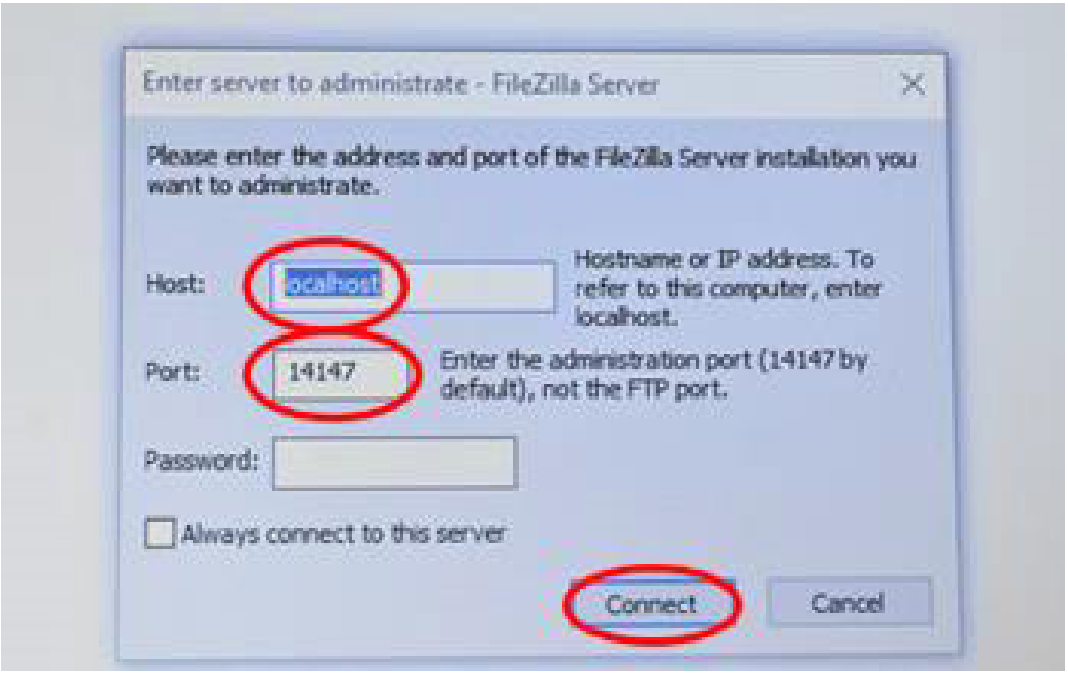


Figure I- 15: Server to administrate

When completed, your FileZilla Server window should now look something like Figure 16 shown below.

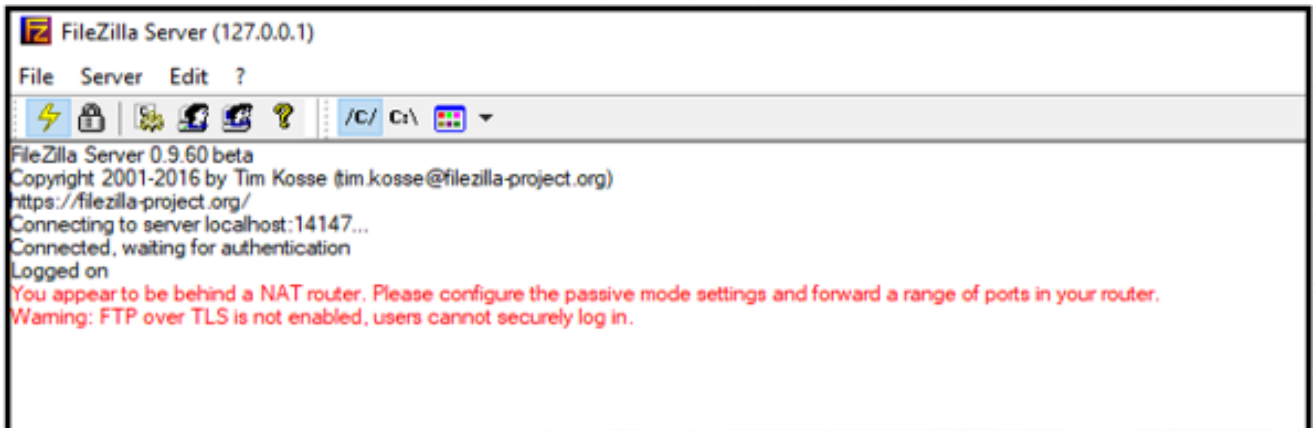


Figure I- 16: FileZilla Server start

Note, there is no means provided to change the port number of the DVNext, it is preset to be 21. This means that you must make sure that the FTP server is set up on port 21 ONLY (it is usually like this by default). To check this, go to the “Edit” dropdown menu in the top-left corner and click the “Settings” option as shown in Figure I- 17.

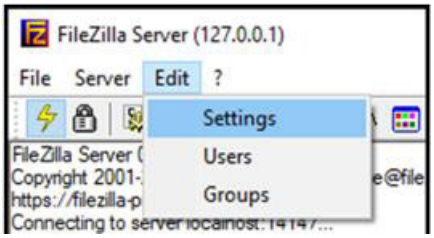


Figure I- 17: FileZilla Settings

After clicking "Settings" from the "Edit" dropdown menu, FileZilla Server Options window will pop up (Figure I- 18). Make sure you are in the “General settings” tab (default tab for FileZilla Server Options). Click the field next to "Listen to these ports:" and enter in "21" if it is not there already (Figure I- 18). Also in the same tab, change the "Connections timeout:" and the "No Transfer timeout:" fields under "Timeout settings" to 0 so FileZilla Server never times out (Figure 18). When done, press the OK button at the bottom left of the window (Figure I- 18).

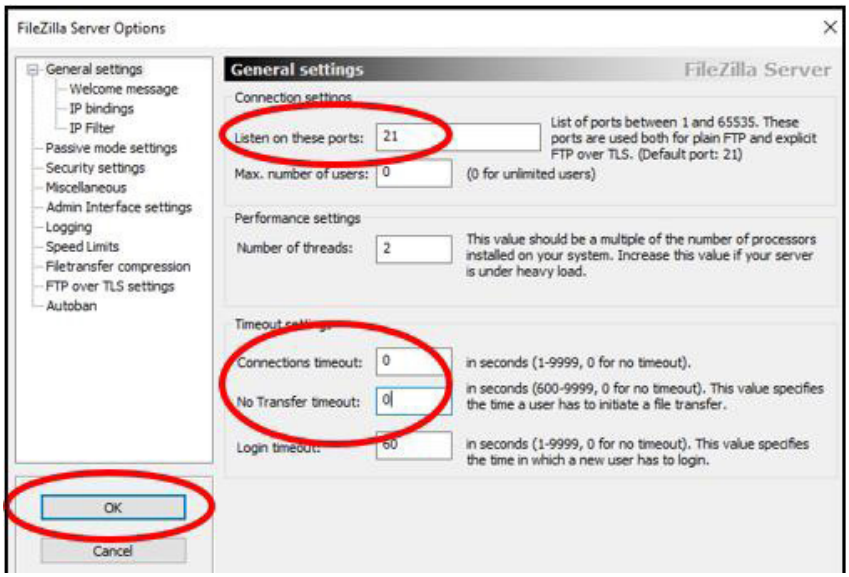


Figure 18: Changing General Settings

Part c: Create FTP home directory and any sub-directories

In this step we are going to create the Home Directory for the FTP Server. Optionally, you may add subfolders to help organize your files.

Open File Explorer on the Windows machine by clicking the “Type here to search” field near the bottom left corner, then begin typing in the word “File” to search for the File Explorer application. Once the File Explorer application icon appears, right click it to open it (Figure I- 19).

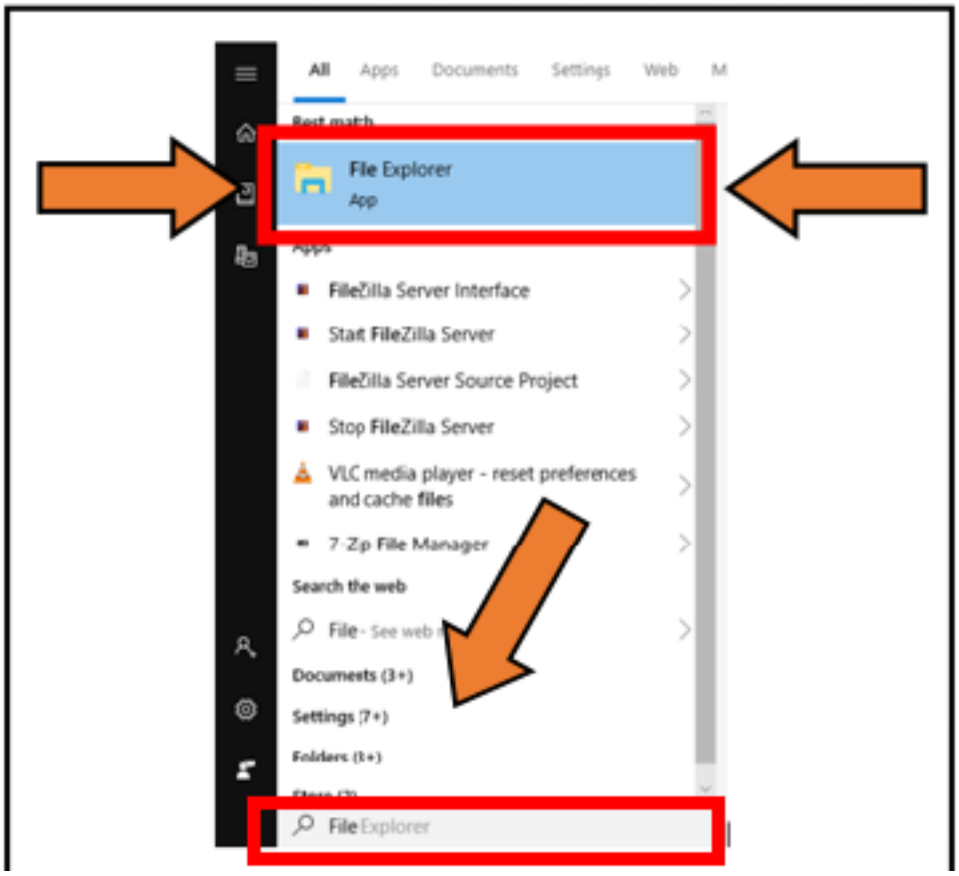


Figure I- 19: Searching for File Explorer

Next, navigate to a place in memory you will remember, then create and name a new Folder (this will be your Home directory for the FTP Server) (Figure I- 20). Here we named it “DVNext_FTP“ (Figure I- 21).

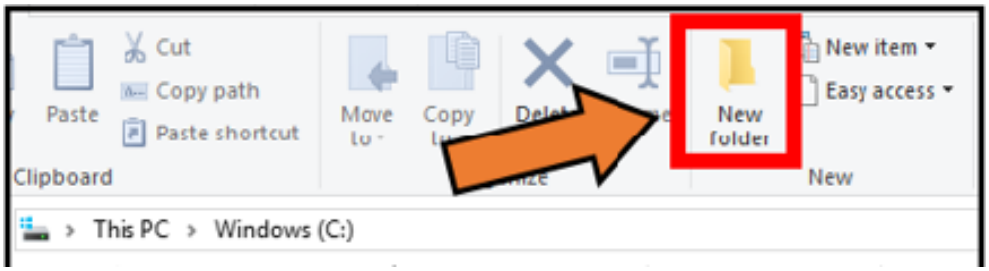


Figure I- 20

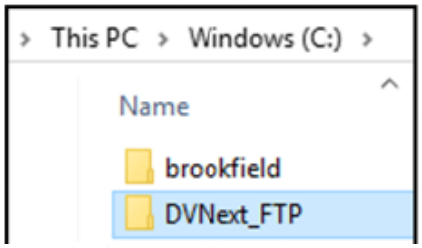


Figure I- 21

If you desire any sub-directories, open the new Home directory folder you just created and add as many new folders (sub-directories) you wish. We added one sub-directory called “Test Results” (Figure 22). The “Test Results" folder is going to be the directory we want to export our result files to in the future.

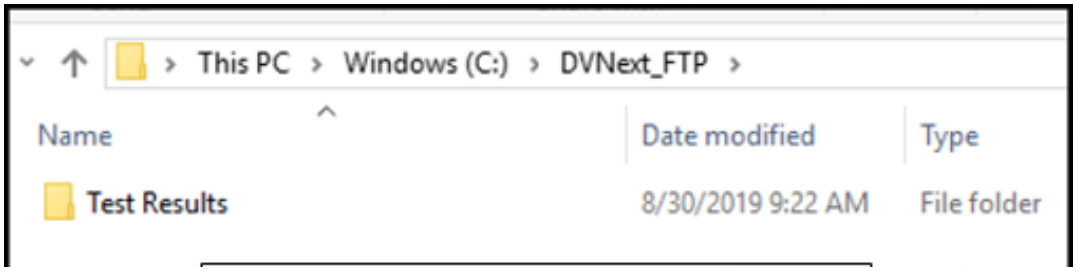


Figure I- 22: Subfolder path – C:/DVNext_FTP/

Part d: User(s) with access to the FTP home directory

In the FileZilla Server window, navigate to the "Edit" dropdown menu in the top-left corner and click the "Users" option as shown in Figure 23. This should bring up the Users configuration window (Figure 24).

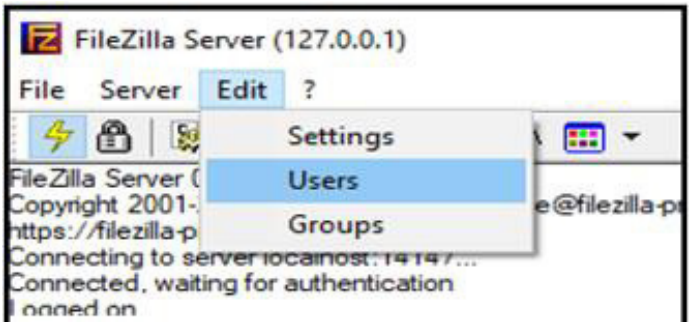


Figure I- 23: Selecting Users from Edit

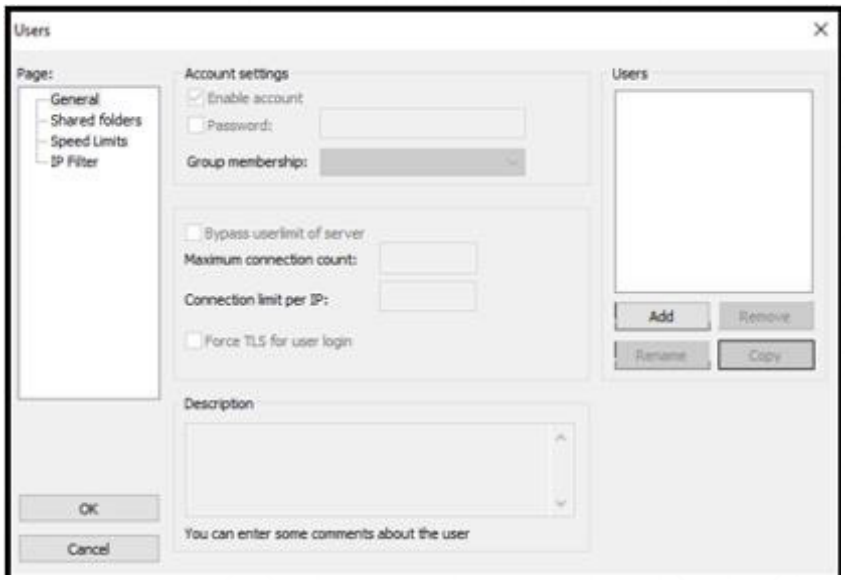


Figure I- 24: Users configuration

In the User configuration window, click the "General" page from the "Page:" Selection box (Figure I- 25).

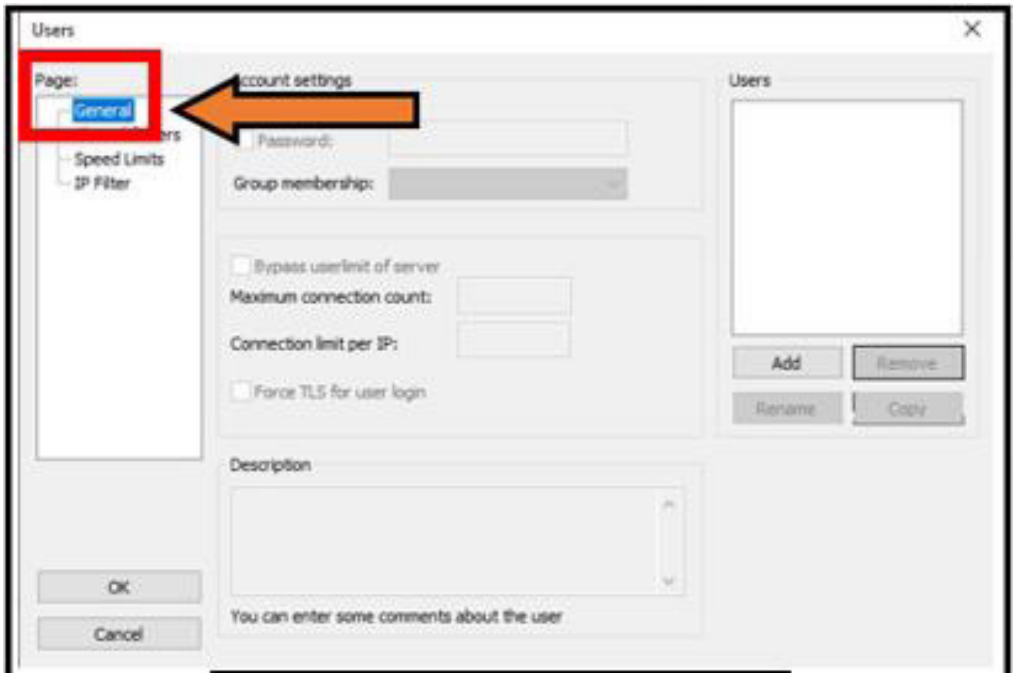


Figure I- 25: Selecting General

On the right side of the General page, locate the Users list. Click the Add button under the Users list (Figure I- 26).

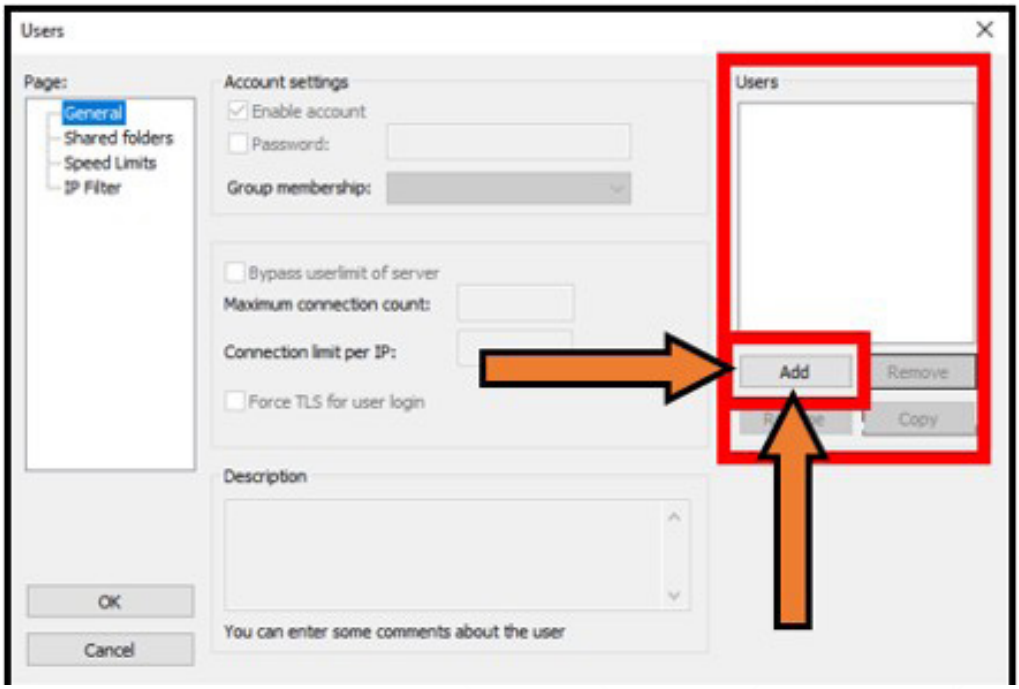


Figure I- 26: Adding a User

Go ahead and give a name for this user (we used “Lab Tech“), then click OK (Figure 27). Once the user is created, you should see the User’s name in the Users list (Figure 28).

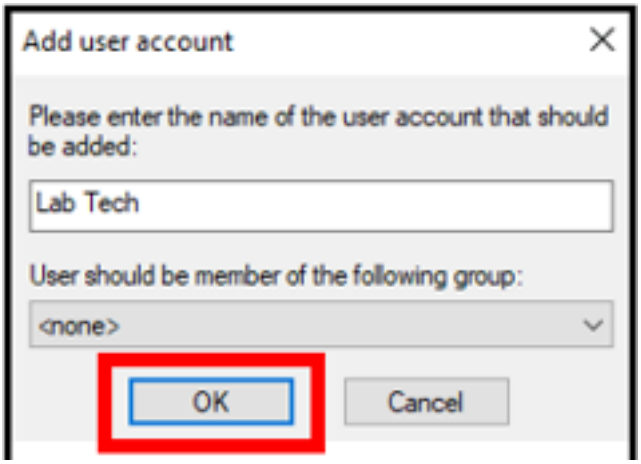


Figure I- 27: Naming created User

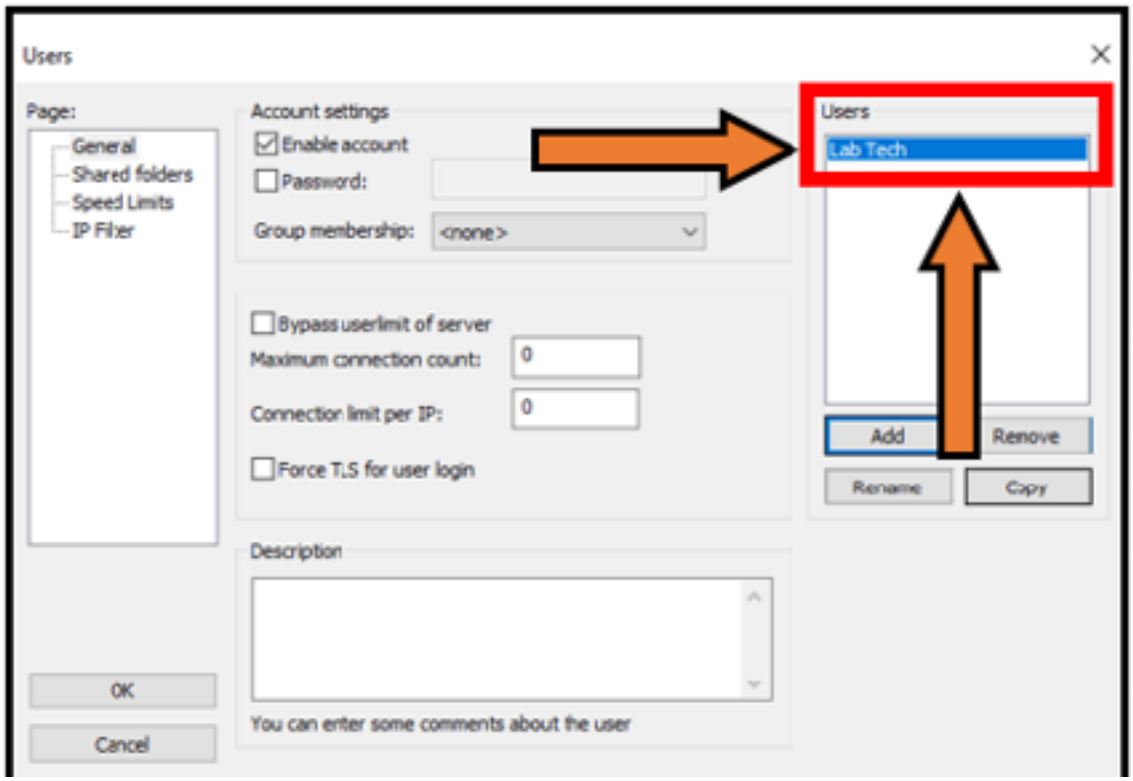


Figure I- 28: New User created

Next, under Account settings, click the box next to "Password": and enter a desired password for this user (you must remember this password). We chose “admin1” for our Password. (Figure I- 29).

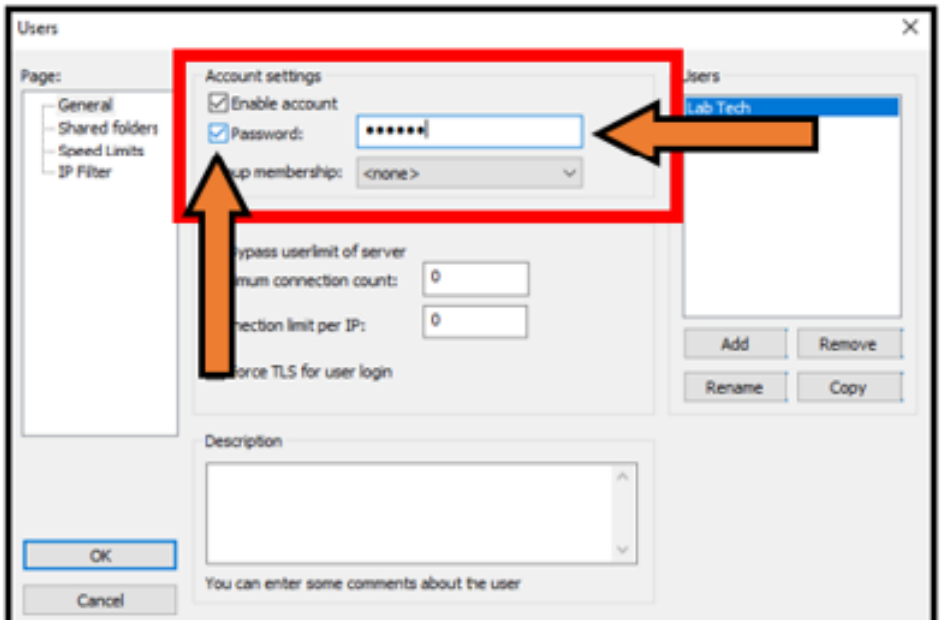


Figure I- 29: Creating Password for User

Go to the “Page:” listing box on the left and click the “Shared folders” menu (Figure 30).

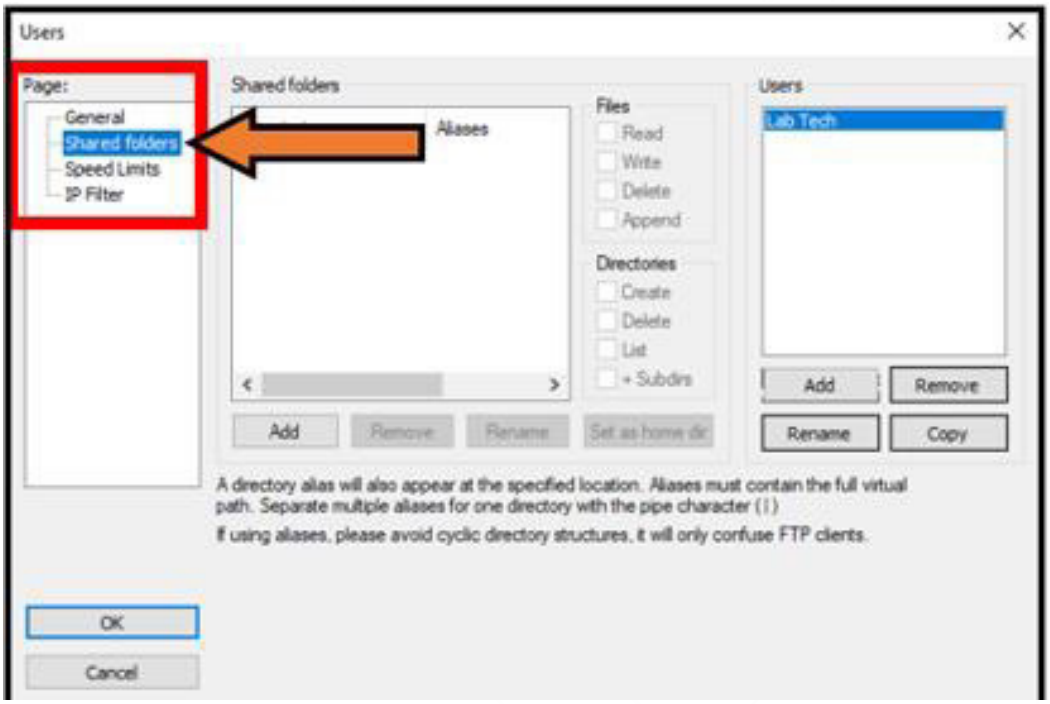


Figure I- 30: Selecting Shared folders

To the right, you should see the User you just created under the box labeled “Users”. Make sure the User is highlighted and click the "Add" button under the “Shared folders” selection menu (Figure 31).

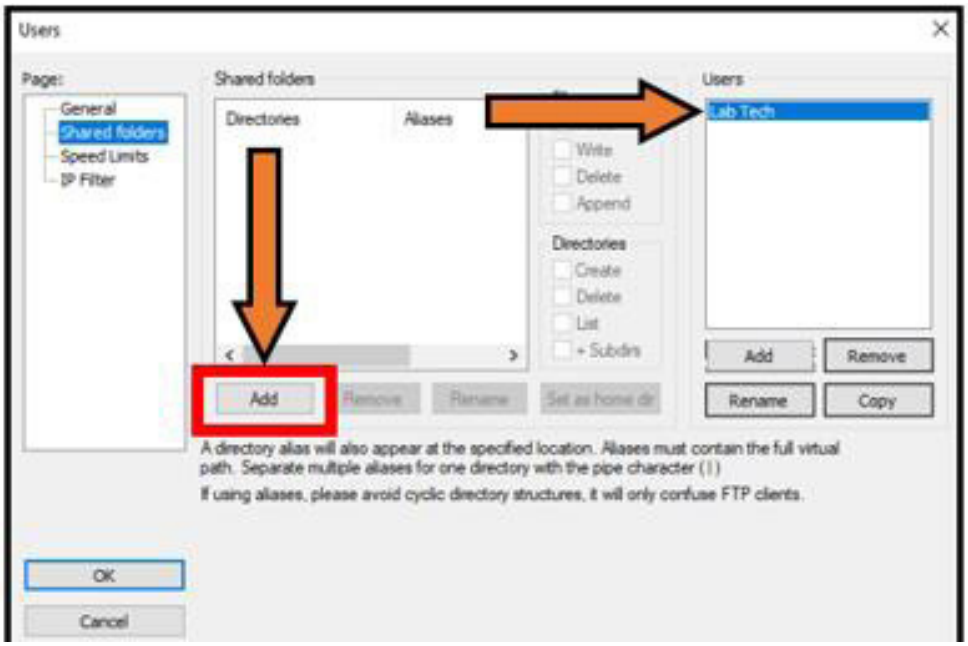


Figure I- 31: Adding directory for user Lab

A Folder Directory will pop up. Here you will be selecting the Home directory for your FTP Server. Select the folder you created previously, then press OK (Figure I- 32).

Figure I- 32: Selecting created FTP

Once selected, make sure there is a bold “H” appearing before the directory’s path indicating this is the Home directory (Figure 33). Also, make sure all the File privileges are checked as shown (Figure 33). When completed, press the OK button at the bottom left to save your settings (Figure I- 33).

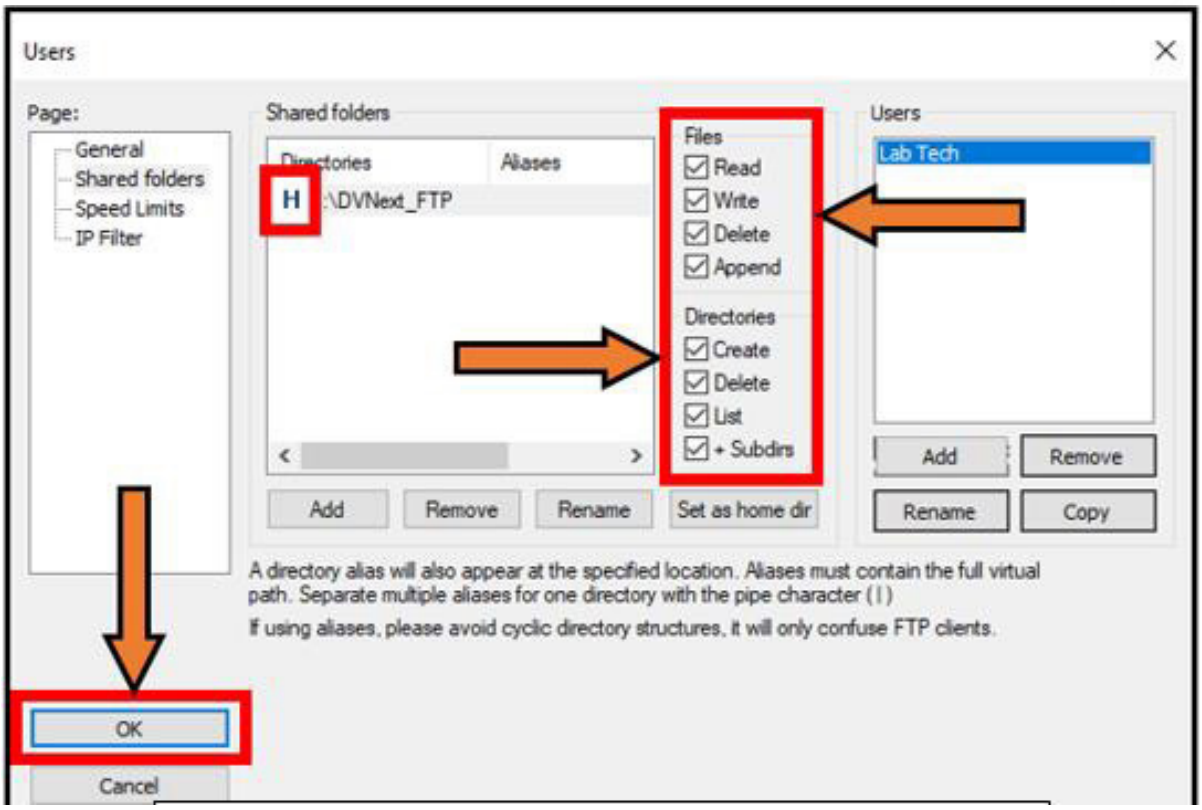


Figure I- 33: Selecting all File privileges for Home directory of Lab Tech and Testing

Part e: Temporarily turn off Firewall/security preferences

Remember that Windows Defender Firewall must always be disabled to communicate with the DVNext FTP Client unless you configure specific FTP settings.

Make sure the FTP server can communicate with your DVNext devices by turning off Windows Defender Firewall for both private and public networks on your Windows PC/Laptop. To disable Windows Defender Firewall, begin by clicking the Windows icon at the bottom left of your screen on your Windows computer.

Begin to type the word "Firewall". Once the “Windows Defender Firewall” from Control Panel pops up (Figure I- 34), click it. It should open a window that looks like Figure I- 35.

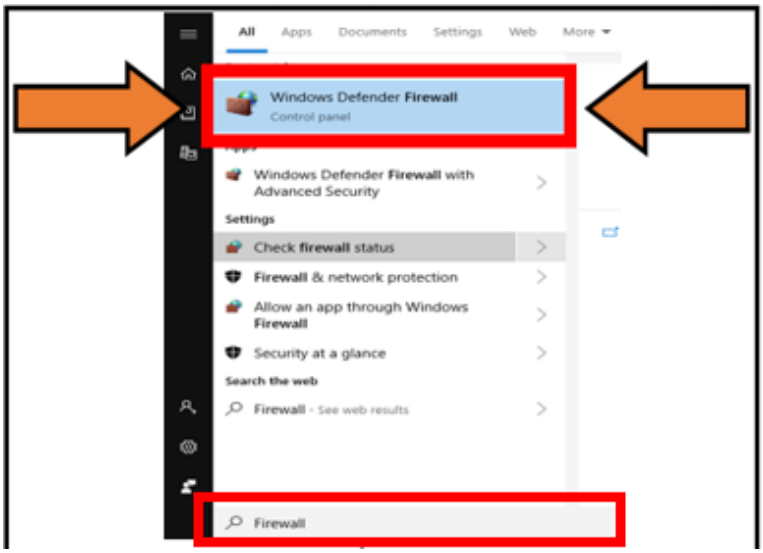


Figure I- 34: Search for Windows Defender

Figure I- 35: Windows Defender Firewall window from Control

Next, on the left side of the Windows Defender Firewall window, click the “Turn Windows Defender Firewall on or off” option (Figure I- 36). Your screen should now look like Figure I- 37.

Figure I- 36

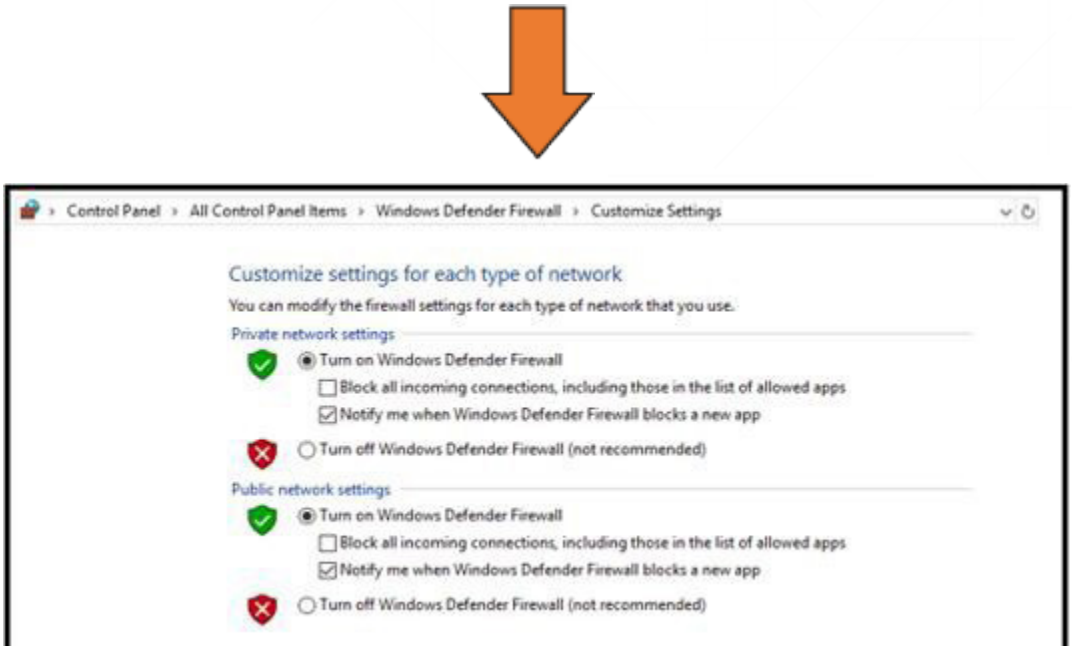


Figure I- 37

Now, click the bubbles to the left of “Turn off Windows Defender Firewall (not recommended)” under both Private Network settings and Public network settings, then click OK at the bottom of the window (Figure 38).

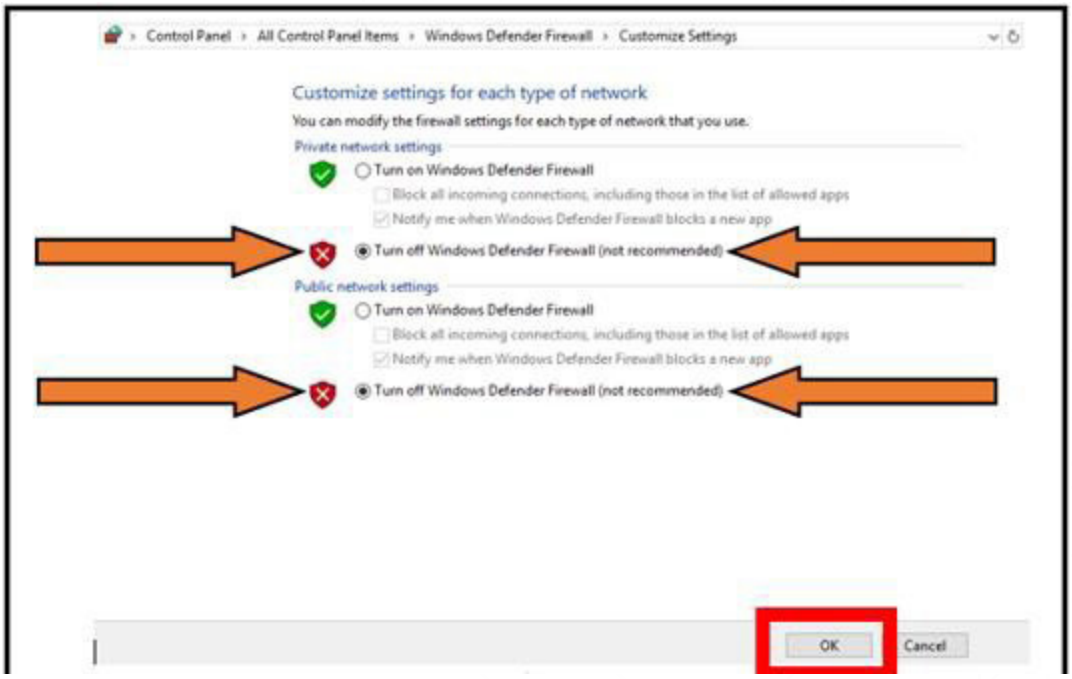


Figure I- 38: Turning off Windows Defender Firewall for both Private and Public

After clicking OK, the screen should look like Figure 39 below. If so, you may close the Windows Defender Firewall window.

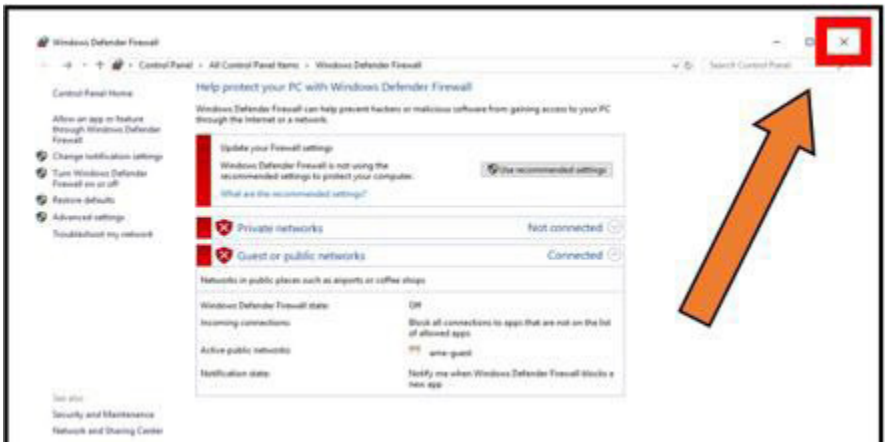


Figure 39: Closing Windows Defender Firewall

Note: We highly suggest and encourage you to turn your Windows Defender Firewall back on after testing the FTP Server is complete.

Part f: Determine IP address of the FTP server

To get IP address of your computer/FTP Server, click the Windows icon at the bottom left of your screen on your Windows computer. Begin to type the letters "cmd". Once the Command Prompt application appears, click it to open it (Figure I- 40). When opened, Command prompt window should look like Figure I- 41.

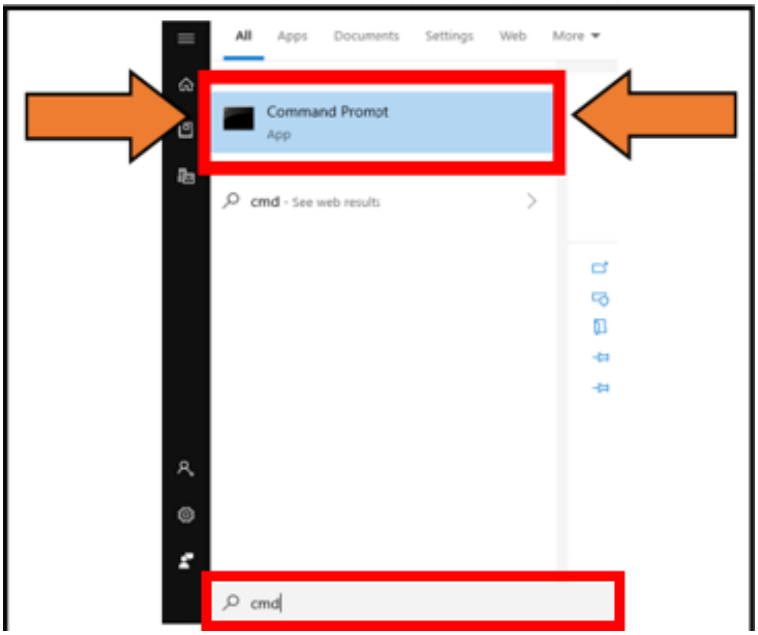


Figure 40: Searching for Command

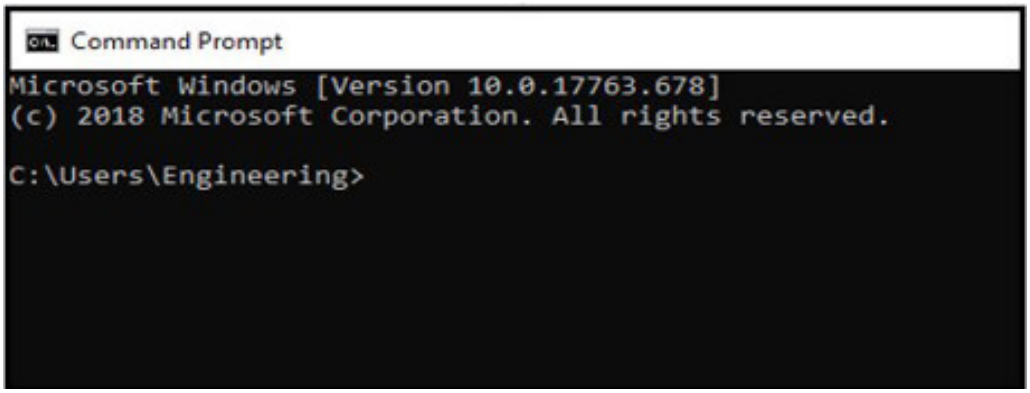


Figure I- 41: Command Prompt window

In the Command Prompt type "ipconfig" and press Enter (Figure I- 42).

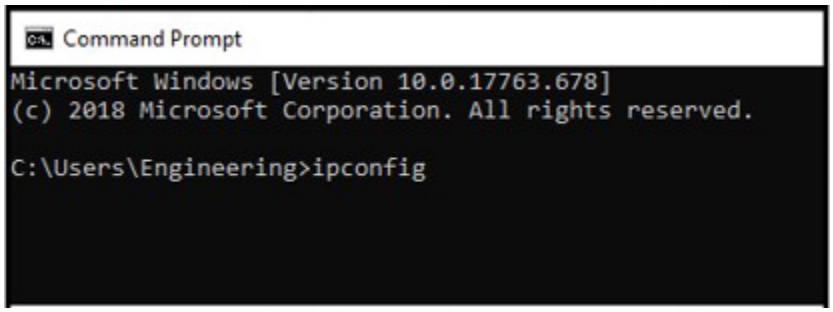


Figure I- 42: Typing ipconfig into Command Prompt and pressing <Enter>

Your IP address for the FTP Server will be the address associated with “IPv4 address” under the Ethernet connection. Looking at the example ipconfig results (Figure 43), the IP address for the server is 192.168.2.5. Remember this IP address. Note: your IP address maybe different than the one shown.

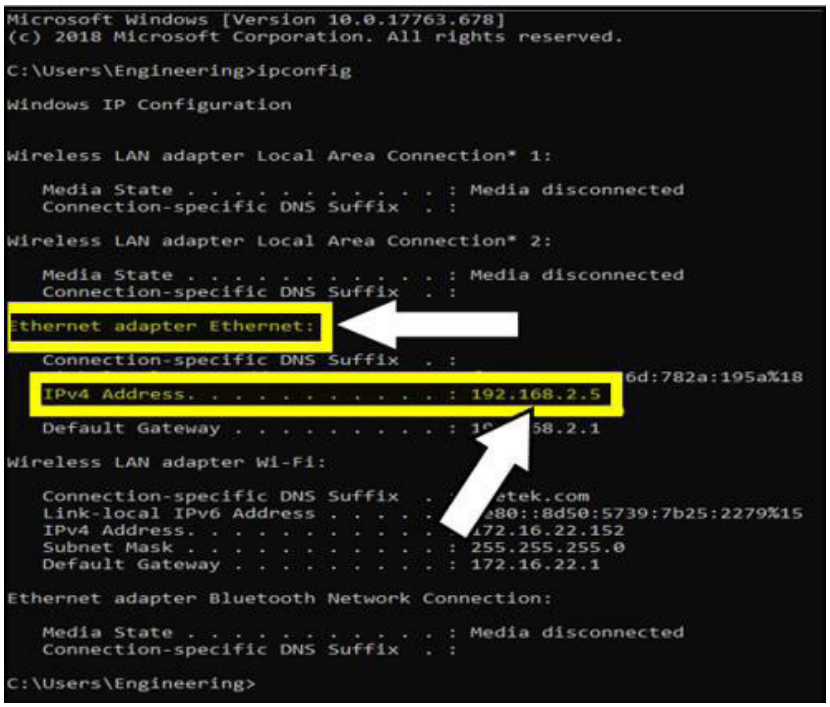


Figure I- 43: ipconfig

Part g: Setup FTP folder on the device with corresponding credentials

Note: The paths to certain menu screens may be slightly different than the figures shown in this section depending on which version of firmware is installed and/or if you have a Compliant or Non-compliant DVNext device. The firmware tested and shown here is version 2.1.3-9

Navigate to the FTP Settings screen on the device if you are not there already. To get there, make sure you are on the Main Menu Screen. You can get to the Main Menu screen by pressing the home icon located at the top left corner or by pressing the back icon at the top left corner until you are at the Main Menu. Then, tap the Settings icon (top right corner on Main Menu) (Figure I- 44).

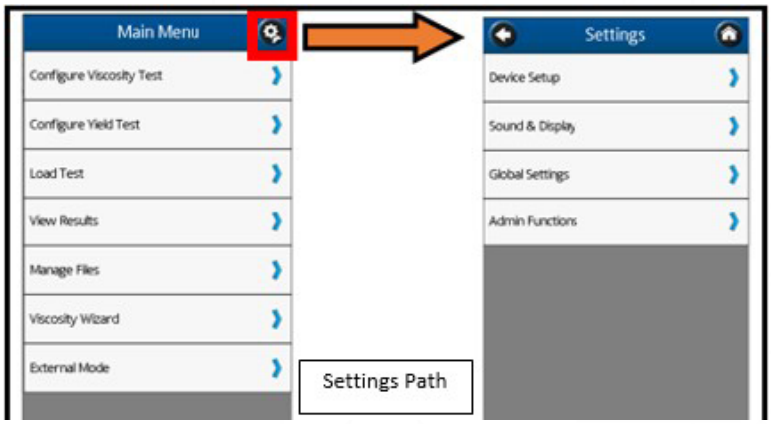


Figure I- 44: DVNext device path to settings

Go to Admin Functions>Manage Data >FTP Settings (Figure I- 45).

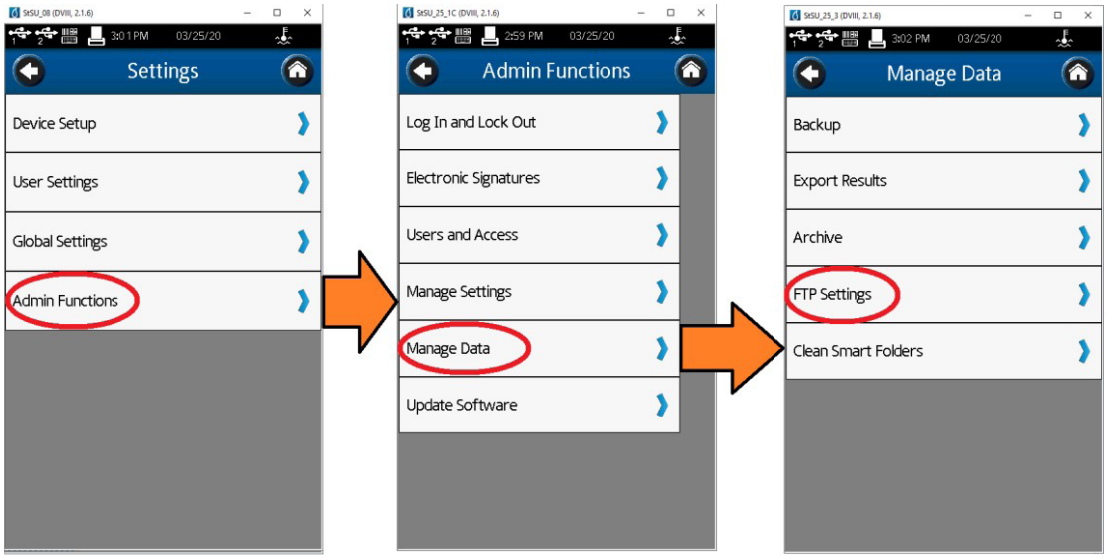


Figure I- 45: DV device path to get to FTP

Press the Add Folder button (bottom) from the FTP Settings screen (Figure I- 46).

Figure I- 46

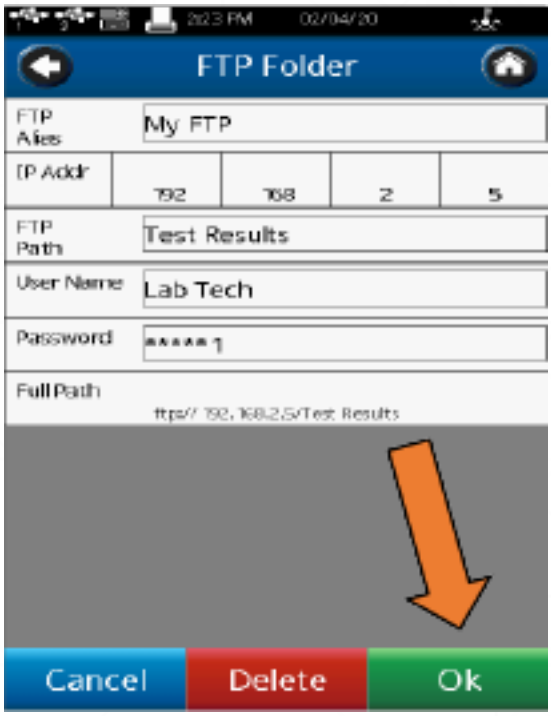
FTP Alias is a shortcut used by the DVNext to easily identify the folder. Enter in any name you would like (We chose “My FTP”).	 Figure I- 47: Inputting FTP Folder
The IP Address consists of 4 groups of numbers separated by a period. Tap on each group in the box and enter in the corresponding digits for that group. Enter IP address of the FTP server (the IPv4 IP address you got from “ipconfig” in the section before).	
Your FTP Path will be the folder/directory you want to send all your exported data to. If FTP Path field is blank, then the instrument will write files into FTP Root (Home) directory. The sub-directory you want to write files to should only be specified in the FTP Path field on the DVNext as shown.	
The User Name and Password will be the corresponding User and Password you created for the FTP server earlier in Part D. Press OK when done (Figure 47).	

Figure I- 47: Inputting FTP Folder

Part h: Log on to FTP server on the PC

Navigate to File Explorer like you did before and type the path "ftp://<ip_address>/" where the ip address is the ip address of the FTP server, then press Enter (Figure 48). For our case the IP address is 192.168.2.5.

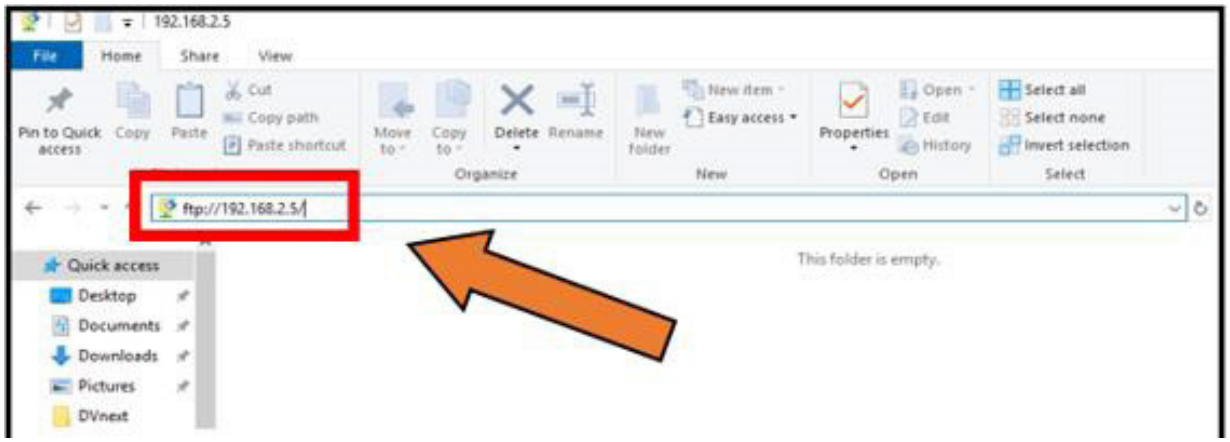


Figure I- 48: typing ftp server path and pressing <Enter>

A prompt should come up asking for the user and password. Enter in the User with the corresponding password you set previously in part D, then click Log On (Figure 49). For our case, User name is “Lab Tech” and the Password is “admin1”.

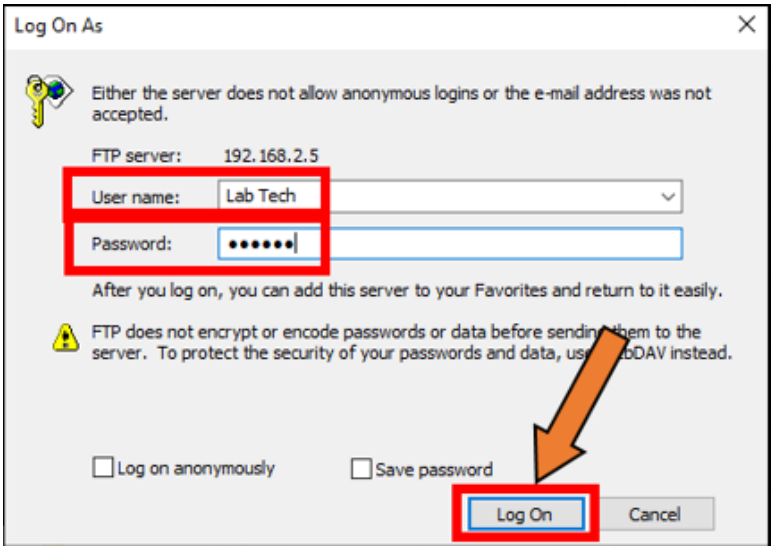


Figure I- 49: Logging onto FTP Server by Entering User name with corresponding Password

Once completed, another window should pop up showing any folders in your FTP server's Home directory (Figure I- 50).

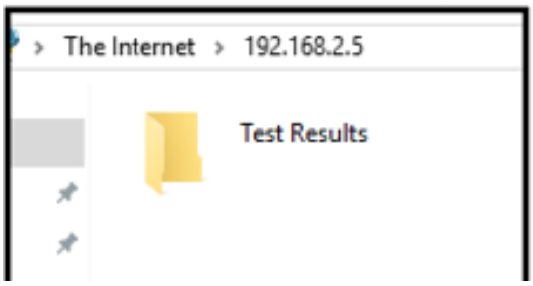


Figure I- 50

Look at your FileZilla Server window, it should now have some more information telling you that the user is connected (Figure I- 51).

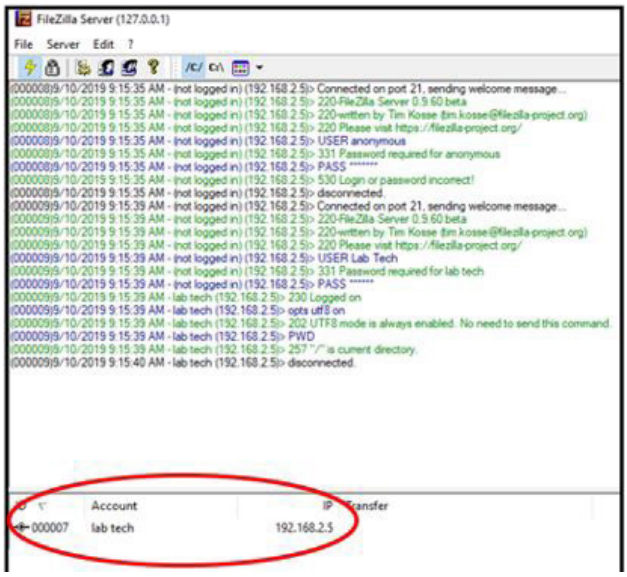


Figure I- 51: Connected instrument should be displayed in Status box

Part i: Exporting result files

Now your device should be all set to start exporting files to the FTP server. Let's test this by exporting result files to the FTP server. Navigate to the Export Results screen on the device: Settings icon (top right corner of Main Menu) (Figure I- 52).

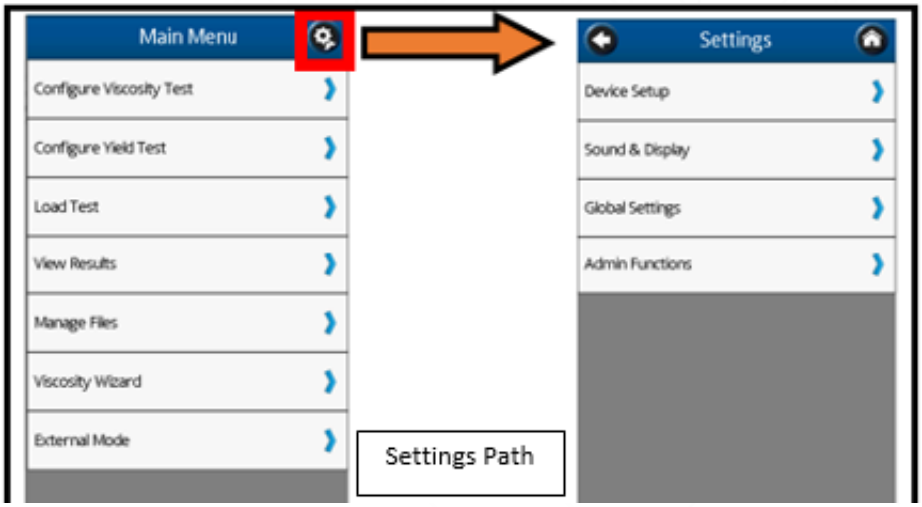


Figure I- 52: DVNext device path to settings

Now go to >Admin Functions>Manage Data>Export Results (Figure I -53).

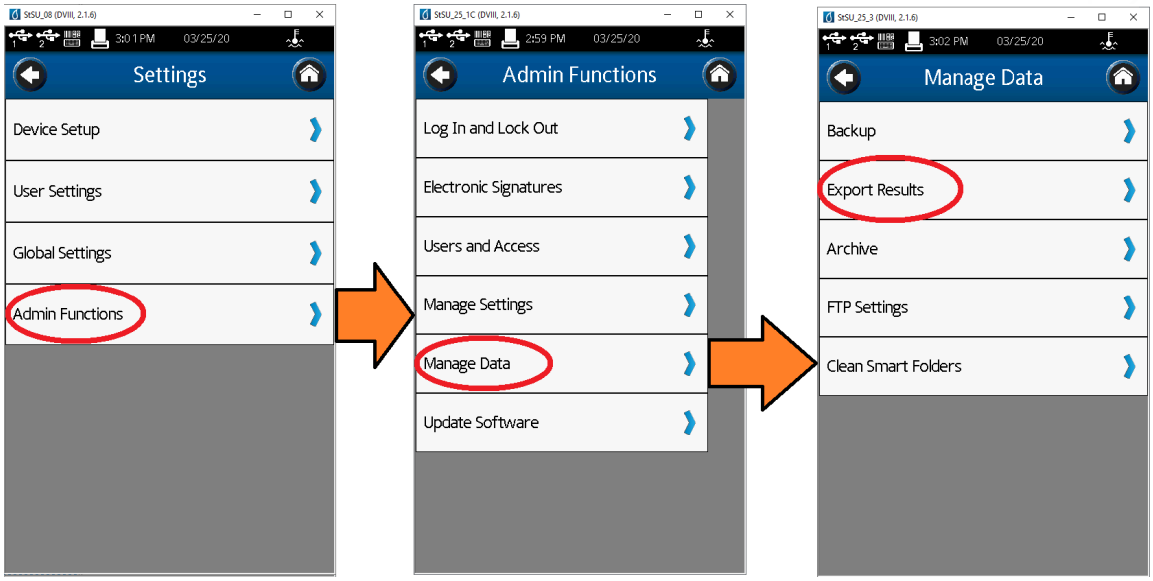


Figure I- 53: DVNext device path to Export

Here, you can choose the Export File Format which determines the file type of the result files you are exporting (.csv, .pdf, or .xml). Export Path should the exact same as your FTP Path. Once everything is filled out correctly, press Export Now (bottom right) (Figure I- 54).

The FTP Alias is also part of the Export Path →→→→→, not shown in picture

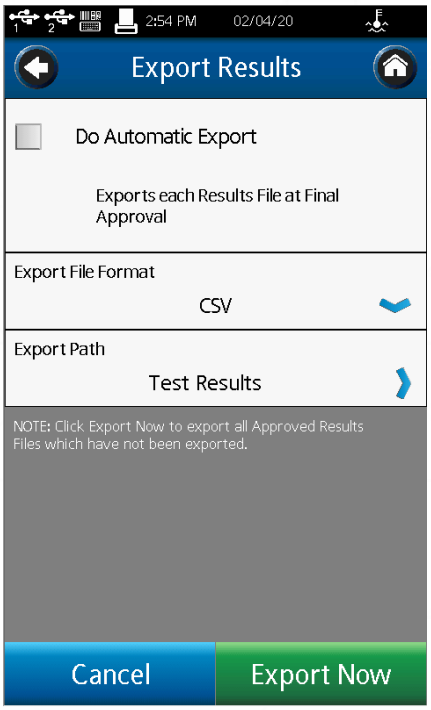
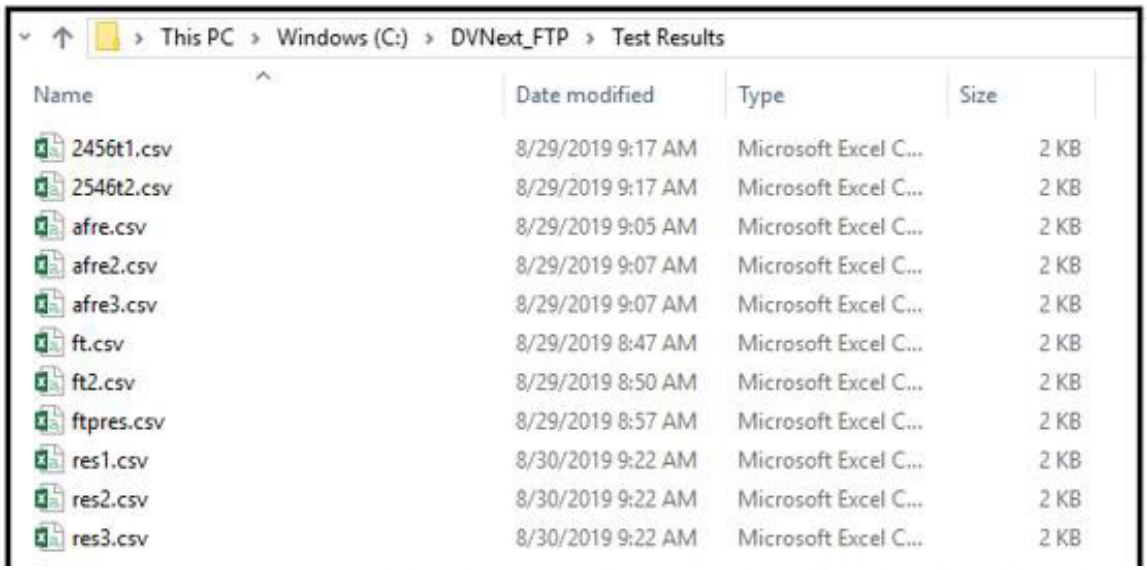


Figure I- 54: Specifying file format and export

You should see result files being exported to that folder in the format you chose (Figure I- 55).

Figure I- 55

Open another File Explorer tab as you have done previously and navigate to the folder you were exporting to. You can see here (Figure 56), files were properly exported to our specified folder location "Test Results" which is within our set FTP Home directory "DVNext_FTP". If the Server Path field on the DVNext device was not set and left blank, the files would have been directly exported to the "DVNext_FTP" folder.



This PC › Windows (C:) › DVNext_FTP › Test Results

Name	Date modified	Type	Size
2456t1.csv	8/29/2019 9:17 AM	Microsoft Excel C...	2 KB
2546t2.csv	8/29/2019 9:17 AM	Microsoft Excel C...	2 KB
afre.csv	8/29/2019 9:05 AM	Microsoft Excel C...	2 KB
afre2.csv	8/29/2019 9:07 AM	Microsoft Excel C...	2 KB
afre3.csv	8/29/2019 9:07 AM	Microsoft Excel C...	2 KB
ft.csv	8/29/2019 8:47 AM	Microsoft Excel C...	2 KB
ft2.csv	8/29/2019 8:50 AM	Microsoft Excel C...	2 KB
ftpres.csv	8/29/2019 8:57 AM	Microsoft Excel C...	2 KB
res1.csv	8/30/2019 9:22 AM	Microsoft Excel C...	2 KB
res2.csv	8/30/2019 9:22 AM	Microsoft Excel C...	2 KB
res3.csv	8/30/2019 9:22 AM	Microsoft Excel C...	2 KB

Figure 56: Path for folder – C:/DVNext_FTP/Test

Note: Testing is now complete so you may turn your Windows Defender Firewall back on if no further testing is to be done. Remember that Windows Defender Firewall must always be disabled to communicate with the DVNext FTP Client, unless you configure specific FTP settings.

Quick setup guide

If you have not already done so, we highly recommend you start from the beginning of this document in order to get a good idea of how to properly set up your FTP Server and DVNext device. This section is for users who have previously gone through the initial installation/setup for FileZilla and have successfully transferred files from their device onto their FTP Server via Ethernet. People reading this section should be familiar with both FileZilla and their DVNext device.This section will go over key settings and configurations to keep in mind when trying to export/archive files from your DVNext device to a FTP Server.

- Make sure everything is plugged in - The router that you are using should be powered and there should be two Ethernet cables plugged into the router (one plugged to the DVNext device, and the other plugged intoa PC). Make sure that neither of the Ethernet cables are plugged into a WAN port. Your DV device also needs to be plugged in to a power supply (wall socket) for it to have power.

- On your PC, make sure FileZilla is properly configured – When you open FileZilla there is a pop-up prompt telling you to enter the address and port of you the FileZilla Server want to administrate. Host should be “localhost”, Port should be “14147”, and Password should be left blank. Make sure the information provided matches the information in your prompt, if not, change the information to match (this information will probably match as these are FileZilla defaults). Next, make sure you have created at least one User account on the server. Make sure that user’s account is enabled and that they have a shared folder which is set as the home directory for the FTP Server. Also, make sure that the User account has all permissions to read, write, delete, and append files/directories to the set home directory.

- On your DVNext device, make sure FTP Settings correspond with correct FTP Server IP, FTP Path, and FTP Server User account name and password. When adding an FTP folder on your DV device, FTP alias can be any name, IP Address is the IP Address that corresponds with the Ethernet IPv4 address found by entering “ipconfig” into the command prompt on your PC when the router is hooked up to it. FTP Path is the name of the directory you wish to export/archive to within the FTP Server Home directory. User Name and Password must match the username and password of the user account you made on FileZilla.

- Make sure that no Malware/Virus protection is active. If there is Malware or Virus protection on your PC, it may block you from sending files to your FTP Server on the PC. To prevent this, make sure all Firewall and/or virus protection is turned off on your PC at least until you are done sending files to the FTP Server.

- Once you have successfully transferred files from your DVNext device to your FTP Server, no further options will need to be set or changed unless you update or change your DVNext instrument, change your router, or change your PC. Now, you should be able to export and archive files directly to the FTP Server via Ethernet by pressing “Archive Now”, “Backup Now”, or “Export Now”. Automatic archiving, backing up, and exporting over Ethernet should also function as expected.

APPENDIX J - SPEED SELECTION

AMETEK Brookfield Rheometers offer a variety of speeds to provide for a wide range of viscosity measurement capabilities. AMETEK Brookfield has traditionally supplied a defined set of speeds with specific Torque ranges:

LV	0.3, 0.6, 1.5, 3.0, 6.0, 12, 30, 60
RV	0.5, 1.0, 2.0, 2.5, 4.0, 5.0, 10, 20, 50, 100

The DVNext and earlier AMETEK Brookfield DV-III Series Rheometers offer additional speeds to enhance measurement capabilities. The DVNext offers speeds from 0.01 - 250 RPM with two options for speed selection: numeric key pad for direct entry; Scroll List. The user can choose from these two entry options by using the Navigation Bar (see Section IV.3: Global Settings). The Scroll List is the format used with previous versions of the DV-III rheometer. You may choose the Scroll List to provide the rheometer user with a familiar method for speed selection. The Scroll List can be customized to limit the available speeds and to add new speeds to the list of standard speeds.

APPENDIX K - LABORATORY STANDS

Model G is the standard laboratory stand which comes with the DVNext Rheometer.

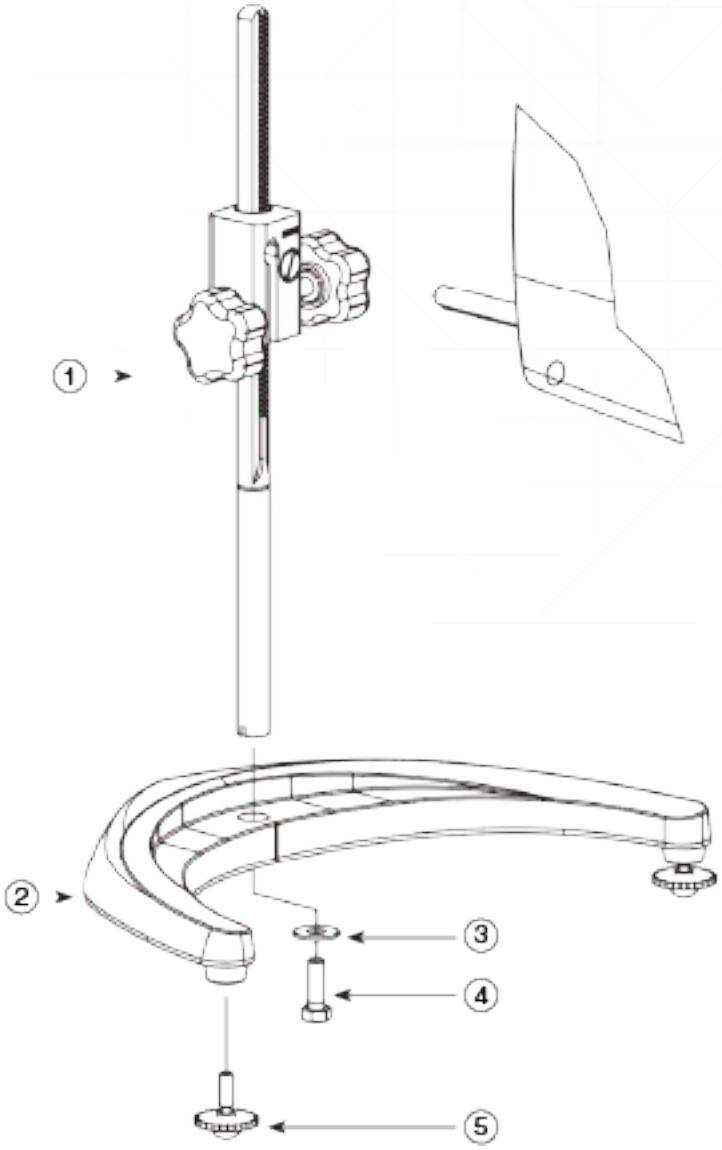


Figure K-1: Model G Laboratory Stand

Item	Part No.	Description	Qty
1	VS-CRA-14S	Upright Rod and Clamp Assembly	1
2	VS-CRA-18S	Upright Rod and Clamp Assembly	Optional
3	GV-1201	Base, includes 2 GV-1203 leveling screws	1
4	502028071S33B	Flat Washer 5/16 X 7/8 X .071	1
5	50S311832S01B	Screw, 5/16 - 18 X 1” Hex Head	1
6	GV-1203	Leveling Screws available separately or in assembly above	2

Model QB is an optional laboratory stand which can be ordered for use with the DVNext Rheometer. The advantage is the rapid speed of movement for lowering and raising the rheometer head.

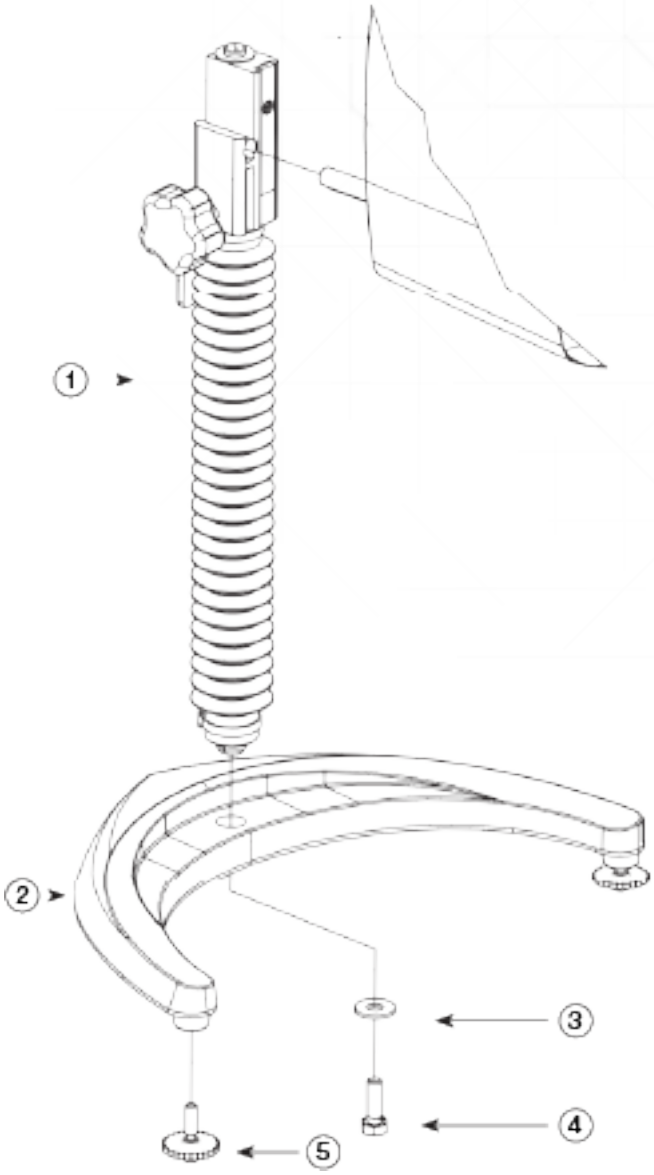


Figure K-2: Model QB Laboratory Stand

Item	Part No.	Description	Qty
1	VSQA-100Y	Upright Rod and Clamp Assembly	1
2	GV-1201	Base, includes 2 GV-1203 leveling screws	1
3	502028071S33B	Flat Washer 5/16 X 7/8 X .071	1
4	50S311832S01B	Screw, 5/16 - 18 X 1” Hex Head	1
5	GV-1203	Leveling Screws available separately or in assembly above	2

Unpacking

Check carefully to see that all the components are received with no concealed damage:

- 1 Base, GV-1201, with 2 Leveling Screws
- GV-1203, packed in a cardboard carton
- 1 Upright Rod with attached Clamp Assembly in the instrument case

Assembly (refer to figures k-1 or k-2)

- Remove the base assembly from the carton.
- Remove the screw and washer from the upright rod. Place the rod and clamp assembly into the hole in the top of the base.
    - Note: The “Front” designation on the clamp assembly should face toward you.
- Rotate the rod/clamp assembly slightly until the slot on the bottom of the rod intersects the pin located in the base.
- While holding the rod and base together, insert the slotted screw and washer as shown and tighten securely.
- Adjust the tension screw so that the clamp assembly is not loose on the upright rod.

Rheometer mounting

Insert the Rheometer mounting rod into the hole (with the cut-away slot) in the clamp assembly. Turn on the device and proceed to the leveling screen. Once this screen has been reached and the digital level can be seen, adjust the instrument level until the bubble is centered from right to left and tighten the clamp knob (clockwise). Use the leveling screws to “fine” adjust the rheometer level.

Note: If the Digital Rheometer cannot be leveled, check to ensure that the rod is installed with the gear rack facing forward.

Do not tighten the clamp knob unless the rheometer mounting rod is inserted in the clamp assembly.

Do not use the DVNext Rheometer with any laboratory stand that does not utilize the GV-1201 base. This large base is necessary for stability of the DVNext Rheometer during use. Earlier versions of the AMETEK Brookfield Laboratory Stand including the Model A and Model S should not be used with the DVNext.

Operation

Rotate the UP/DOWN knob to raise or lower the rheometer. Adjust the tension screw if the UP/ DOWN movement of the rheometer head is not acceptable, i.e. too easy or too difficult.

APPENDIX L - DVE 50-A PROBE CLIP

Probe Clip DVE-50A is supplied with all model DVNext Rheometers, DV-III Rheometers, and Digital Temperature Indicators. It is used to attach the RTD temperature probe to the LV Guard Leg (Part No. B-20Y) or 600 mL low form Griffin beaker. Figure L-1 is a view of the Probe Clip, showing the hole into which the RTD probe is inserted, and the slot which fits onto the LV guard leg. When inserting the RTD probe into the Probe Clip, the upper part of the Clip is compressed by squeezing the points shown in Figure L-1.

Note: All Viscometer/Rheometer models – except LV – use the Probe Clip as shown in Figure L-3.

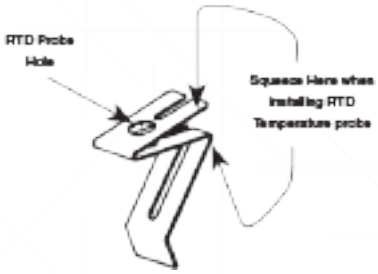


Figure L- 1

Figure L-2 shows the Probe Clip (with RTD temperature probe installed) mounted on the LV guard leg.

Figure L-3 shows the Probe Clip mounted in a 600 mL low form Griffin beaker. This mounting may be used with LV, RV, HA and HB series instruments.

Temperature probe must not contact the spindle during measurement.

Note: The RTD probe must be parallel to the beaker wall so as not to interfere with the viscosity measurement.

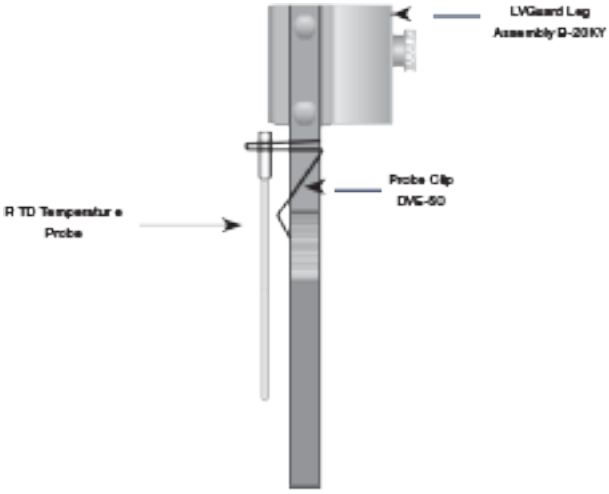


Figure L- 2

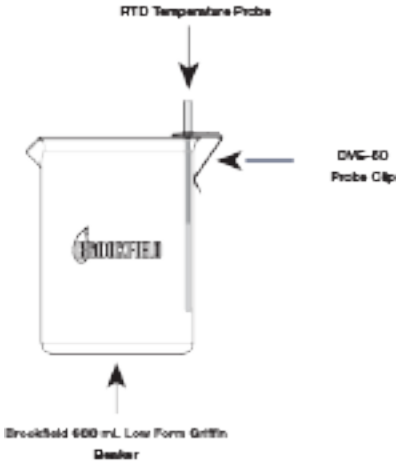


Figure L- 3

APPENDIX M - SCREEN PROTECTOR

The AMETEK Brookfield DVNext Rheometer is provided with a screen protector that can be applied to the touch screen surface. This screen protector is designed for prolonged use. AMETEK Brookfield recommends replacing the screen protector within 1 year of application. The screen protector is provided in a kit (part number GV-1019) that includes the following items:

- One screen protector (with mounted applicator and tabs)
- One screen cloth (part number GV-1045)
- One soft card
- Instructions printed on the package

Retain the soft card and screen cloth with any unused screen protector.

Install the screen protector

Installation instructions for the screen protector are available in three methods:

- Read printed instructions on the package
- View the instructional video on the AMETEK Brookfield YouTube Channel: www.youtube.com/user/brookfieldEng
- Read the expanded printed instructions in this appendix (see below)

Failure to properly install the screen protector may result in a disabled touchscreen.

Step 1:

- Turn off the DVNext rheometer (power down) prior to installation.
- Clean the DVNext touch screen with the screen cloth prior to installation. Any debris, dust, or oil on the touch screen may prevent proper adhesion of the screen protector.
- Identify Tab 1 and Tab 2 prior to removing any protective layer. Peel back adhesive Tab 1, from the bottom, to expose half of the protector (see Figure M-1).
- Do not touch the exposed surface of the adhesive side of the screen protector.

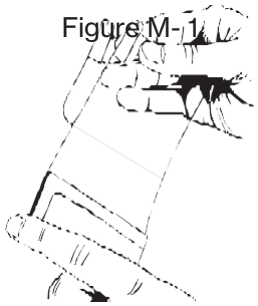


Figure M- 1

Step 2:

- Alignment of the screen protector to the bezel (frame) of the DVNext is critical. Be sure to avoid misalignment which may result in the screen protector contacting or locating under the bezel (frame). A foam alignment tool is attached to the screen protector's outer layer and should be used to locate the screen protector to the lower right-hand corner of the touch screen (see Figure M-2).

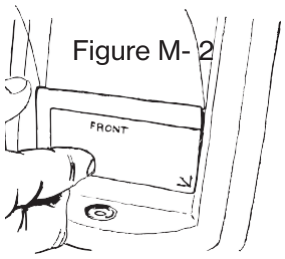


Figure M- 2

Failure to properly align (install) the screen protector could result in a failure of the touch screen.

Step 3:

- Completely remove Tab 1 (see Figure M-3).
- Lightly press the screen protector to the touch screen.
- Inspect the alignment of the screen protector. If the screen protector is touching the bezel (frame), then remove and reapply.

Figure M- 3

Step 4:

- Peel back Tab 2 all the way to remove the backing, which also removes the alignment tool (see Figure M-4). The screen protector is now in place.

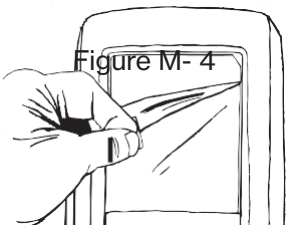


Figure M- 4

Step 5:

- Use the soft card provided to push trapped air bubbles from the center of the screen to the edge (see Figure M-5). Small bubbles should go away within 48 hours.
- DO NOT use the soft card to push the screen protector under the bezel (frame). If the screen protector is not properly aligned, remove and reapply. Two screen protectors are provided in this package in case the first attempt is unsuccessful.
- Test the viscometer (power on) to ensure that the screen protector is properly attached. The screen protector is properly aligned if the DVNext Rheometer responds normally to a touch on the touch screen. If the DVNext Rheometer is unresponsive to touch, then remove the screen protector and reapply.

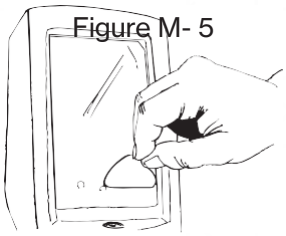


Figure M- 5

Removal of the screen protector

The screen protector should be replaced when it has become dirty. It can be easily removed from the DVNext Rheometer by hand. The upper right hand corner of the screen protector has a small angle cut. Use a finger nail or blunt object to pry the screen protector away from the touch screen and peel it off the touch screen.

Be careful not to scratch the touch screen when removing the screen protector.

APPENDIX N - FAULT DIAGNOSIS AND TROUBLESHOOTING

Listed are some of the more common problems that you may encounter while using your Rheometer.

Spindle does not rotate

- Make sure the rheometer is plugged in.
- Check the voltage rating on your rheometer (5, 220V); it must match the wall voltage.
- Make sure the motor is ON and the desired RPM is selected.
- Make sure the spindle is tightened securely to the rheometer coupling.
- Check the straightness of all other spindles; replace if bent.
- Inspect rheometer/spindle threaded coupling and mating areas for dirt; carefully clean threads in the spindle coupling with a 3/56 tap.
- Inspect rheometer/spindle magnetic couplings and mating areas for debris; e.g. metallic chips or shavings.
- Inspect threads for wear; if the threads are worn, the unit needs service (see Appendix O). Check to see if spindles rotate eccentrically or wobble. There is an allowable run-out of 1/32-inch in each direction (1/16-inch total) when measured from the bottom of the spindle rotating in air.
- Check to see if the rheometer coupling appears bent; if so, the unit is in need of service (see Appendix O: Warranty Repair and Service).
- Verify spindle, speed, and model selection.
- Verify spindle selection is correct on DVNext.
- If % readings are under-range (less than 10%), the display will flash; change spindle and/or speed.
- "EEEE" on the digital display means the unit is over-range (greater than 100%); reduce speed and/or change spindle.
- Verify test parameters: temperature, container, volume, method. Refer to: "More Solutions to Sticky Problems", Section III "DVNext Rheometer Operating Instructions", Appendix C: Variables in Viscosity Measurements.
- Perform a calibration check; follow the instructions in Appendix F.
- Verify tolerances are calculated correctly.
- Verify the calibration check procedures were followed exactly.
- If the unit is found to be out of tolerance, the unit may be in need of service. See Appendix O for details on Warranty Repair and Service.

Rheometer will not return to zero

- Rheometer is not level
  - Check with spindle out of the sample.
  - Adjust the laboratory stand.
- Pivot point or jewel bearing faulty
  - Perform an Oscillation Check*
  - Refer to Appendix H for Automatic Oscillation Check.

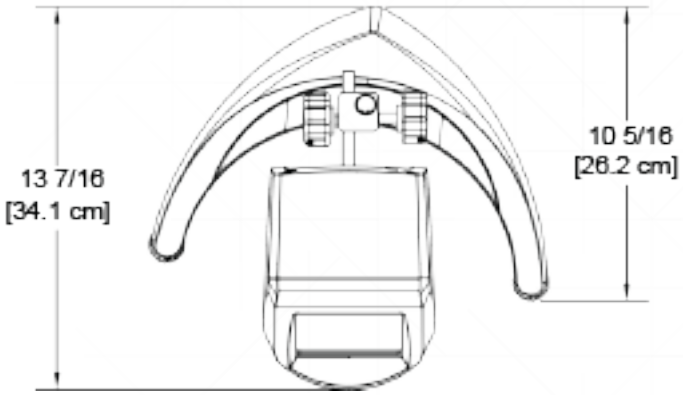
*This procedure does not apply to instruments with ball bearing suspension (see Section I.3).

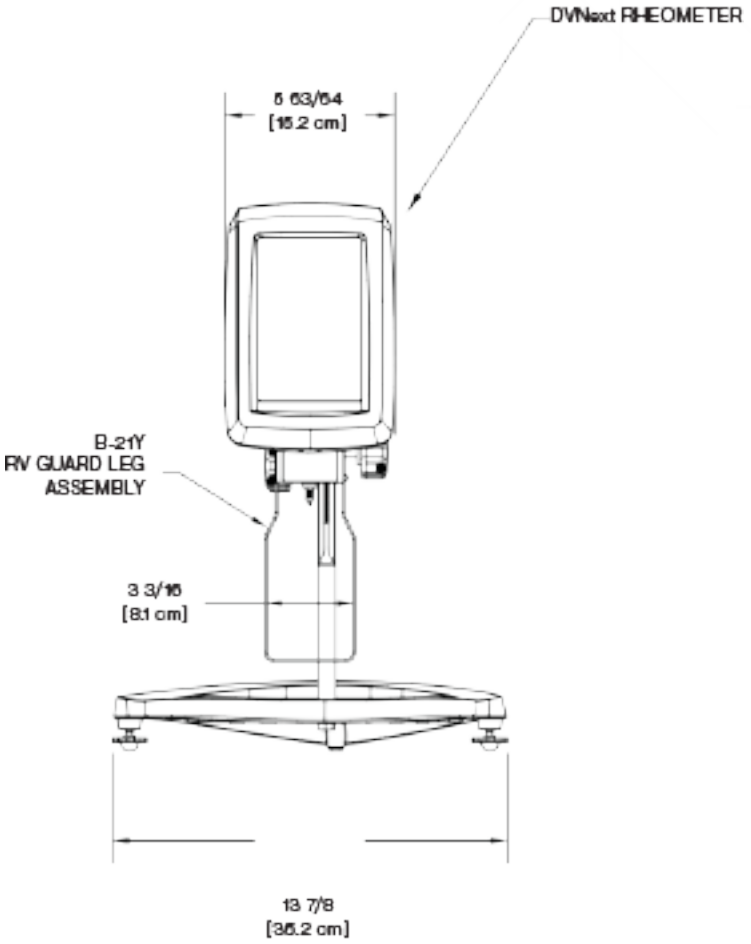
Display reading will not stabilize

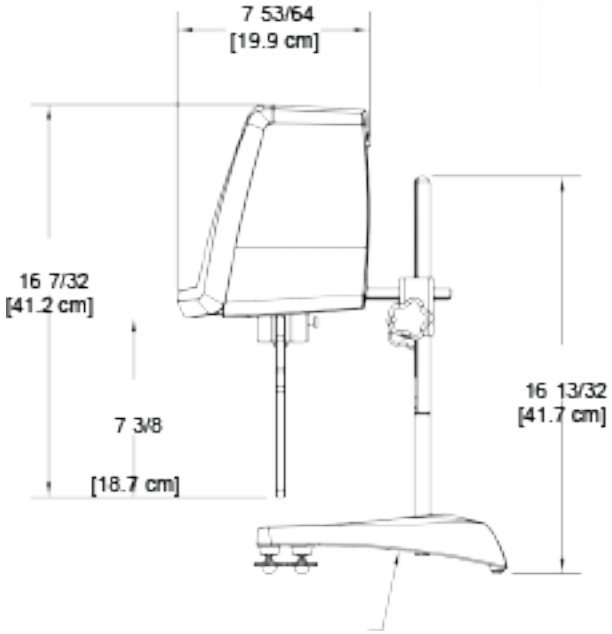
- Special characteristic of sample fluid. There is no problem with the rheometer.
- Refer to Appendix C.
- Check for erratic spindle rotation.

- Verify power supply.
- Contact AMETEK Brookfield or your local authorized dealer for repair (see Appendix Q).
- Bent spindle or spindle coupling.
- Temperature fluctuation in sample fluid.
- Use temperature bath for control.

APPENDIX O - INSTRUMENT DIMENSIONS







APPENDIX P - ONLINE HELP AND ADDITIONAL RESOURCES

www.brookfieldengineering.com

The AMETEK Brookfield website is a good resource for additional information and self-help whenever you need it. Our website offers a selection of “how-to” videos, application notes, conversion tables, instructional manuals, material safety data sheets, calibration templates, and other technical resources.

www.youtube.com/user/brookfieldEng

AMETEK Brookfield has its own YouTube channel. Videos posted to our website can be found here as well as other "homemade" videos made by our own technical sales group.

More Solutions to Sticky Problems

Learn more about viscosity and rheology with our most popular publication. This informative booklet will provide you with measurement techniques, advice, and much more. It’s a must-have for any AMETEK Brookfield Viscometer or Rheometer operator. "More Solutions to Sticky Problems" is available as a downloadable PDF on the AMETEK Brookfield website by following this path: www.brookfieldengineering.com/downloads/technical-documents.

AMETEK Brookfield University Training Courses

Whether it is instrument-specific courses, training to help you better prepare for auditing concerns, or just a better understanding of your methods, who better to learn from than the worldwide leaders of viscosity measuring equipment? Visit store.brookfieldengineering.com/us-training-schedule/ to learn more about training.

APPENDIX Q - WARRANTY REPAIR AND SERVICE

AMETEK Brookfield Viscometers/Rheometers are guaranteed for one year from date of purchase against defects in materials and workmanship. They are certified against primary viscosity standards traceable to the National Institute of Standards and Technology (N.I.S.T.). The Rheometer must be returned to AMETEK Brookfield or to the authorized dealer from whom it was purchased for a warranty evaluation.

Transportation is at the purchaser's expense. The Rheometer should be shipped in its carrying case together with all spindles originally provided with the instrument. If returning to AMETEK Brookfield, please contact us for a return authorization number prior to shipping.

All AMETEK Brookfield DVNext Rheometers are supplied from the factory with a Calibration Seal (located on the back of the viscometer). The warranty stated above will be voided if the Calibration Seal has been damaged. Only AMETEK Brookfield or our authorized servicing dealers may break the Calibration Seal for purposes of instrument repair or recalibration.

For a copy of the Repair Return Form, go to the AMETEK Brookfield website:

www.brookfieldengineering.com

For repair or service in the United States return to:

USA - Headquarters
AMETEK Brookfield
11 Commerce Blvd.
Middleboro, MA 02346 USA
Phone: 1-800-628-8139
Phone: 1-508-946-6200
Email (Sales): ma-mid.sales@ametek.com
Email (Service): ma-mid.ccs@ametek.com

www.brookfieldengineering.com

USA - Chandler, AZ
AMETEK Brookfield
3375 N. Delaware St.
Chandler, AZ 85225 USA
Phone: 1-800-528-7411
Phone: 1-602-470-1414
Fax: 1-602-281-1745
Email (Sales): SalesTeam.azic@ametek.com
Email (Service): CSS.azic@ametek.com

www.brookfieldengineering.com

For repair or service outside the United States, consult AMETEK Brookfield or the local authorized dealer from whom you purchased the instrument.

For repair or service in China return to:

AMETEK Commercial Enterprise (Shanghai) Co. Ltd.
Room 810 Dongbao Plaza, No.767 East
Dongfeng Road, Guangzhou, China (510600)
Tel: 86-20-8363 4768
Fax: 86-20-8363 3701
Email (Sales): brookfield-china.sales@ametek.com
Email (Service): brookfield-china.service@ametek.com

www.brookfieldengineering.cn

For repair or service in Germany return to:

AMETEK GmbH / B.U. Brookfield
Oberweyerer Str. 21
65589 Hadamar-Steinbach, Germany
Tel.: 06433-9145-4900
Service: 06433-9145-4901
Email (Sales): brookfield.de@ametek.com
Email (Service): brookfield-service.de@ametek.com

www.brookfieldengineering.de

For repair or service in India return to:

AMETEK Instruments India Pvt. Ltd.
Divyasree NR Enclave, 4th Floor, Block A, Plot No. 1, EPIP Industrial Area,
Whitefield, Bangalore
560066 Karnataka, India
Tel: (91) 11/6618-0800
Fax: (91) 11/6618-0836
Email (Sales): brookfield-india.sales@ametek.com
Email (Service): brookfield-india.service@ametek.com

www.brookfieldengineering.in

INDIA COE Office
AMETEK Instruments India Pvt. Ltd.
207-208, A Wing, 215 Atrium,
Andheri Kurla Road,
Behind Hotel Courtyard Marriot,
Andheri (East), Mumbai - 400059

www.brookfieldengineering.in

For repair or service in United Kingdom return to:

AMETEK GB LTD T/A Brookfield
Brookfield Technical Centre
1 Stadium Way
Harlow, Essex, CM19 5GX
Tel: +44 (0) 1279-451774
Email (Sales): uk-har.sales@ametek.com
Email (Service): uk-har.service@ametek.com

www.brookfieldengineering.uk

For repair or service in Thailand return to:

AMETEK (Thailand) Co., Ltd
Bhiraj Tower at Bitec, 23rd Floor,
Sukhumvit Road, Bangna, Bangna
Bangkok 10260 Thailand
Tel : +66(0)83 820 5872
Fax: +66 (0)2 012 7501
Email (Sales): brookfield-thailand.sales@ametek.com
Email (Service): brookfield-thailand.service@ametek.com

store.brookfieldengineering.asia

Onsite service at your facility is available from AMETEK Brookfield. Please contact our Service Department in the United States, United Kingdom, Germany, India, Thailand, or China for details.

VISCOSITY TEST REPORT

DATE:

FOR:

BY:

TEST INFORMATION:

SAMPLE	MODEL	SPINDLE	RPM	DIAL READING % TORQUE	FACTOR	VISCOSITY cP	SHEAR RATE	TEMP °C	TIME	NOTES

CONCLUSIONS:

AMETEK Brookfield • 11 Commerce Boulevard • Middleboro, MA 02346 • Tel: 508-946-6200 or 800-628-8139 Fax: 508-946-6262 • www.brookfieldengineering.com • TR1207