



COEFFICIENT OF FRICTION TESTER

MODEL COF-2000

OPERATING INSTRUCTIONS

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CONTENTS

PRODUCT DESCRIPTION	3
SPECIFICATIONS.....	3
UNPACKING.....	4
ASSEMBLY.....	5
CONNECTING THE POWER CORD	6
KEY COMPONENTS	7
OPERATION.....	9
POWER UP.....	9
TOUCH SCREEN FORMAT.....	10
MACHINE SETUP	14
RUNNING A TEST	19
COF TEST DESCRIPTION AND RESULTS	21
EZ DATA SOFTWARE SYSTEM	22
MAINTENANCE	24
TROUBLESHOOTING	24
MAINTENANCE PROCEDURES	24
CLEANING THE TOUCH SCREEN	25

PRODUCT DESCRIPTION

Congratulations on the purchase of your new ChemInstruments COF-2000, Coefficient of Friction Tester. This versatile, user-friendly, carefully designed instrument allows you to determine coefficient of friction values of many different materials according to many test methods including ASTM D-1894.



WARNING: This equipment can cause injury if not used properly. It is the operator's responsibility to observe all safety rules and warnings.

The unit has the following features:

- Internal load cell accurate to 0.1% of full scale.
- One step test sequence.
- Selectable units of measure: Kilograms, Grams, Newtons, Pounds, and Ounces.
- Compatible with EZ Data System software. See www.cheminstruments.com for details.

SPECIFICATIONS

Electrical	120/240 VAC, 50/60 Hz, 2 amps
Operating Temperature	32 – 122 degrees Fahrenheit (0 – 50 degrees Celsius)
Humidity	0 – 55% relative humidity
Speed	1 - 24 inches/minute, 1 IPM increments 3 - 60 centimeters/minute, 1 CPM increments
Sled Mass	1 – 2000 grams, 1 gram increments
Static Length	1 – 10 seconds, 1 second increments
Physical Dimensions	Width: 23 inches (58 centimeters) Depth: 12 inches (30 centimeters) Height: 8 inches (20 centimeters) Weight: 29 pounds (13 kilograms)

UNPACKING

ChemInstruments has made every effort to ensure that the COF-2000 arrives at your location without damage. Carefully unpack the instrument and check for any damage that may have occurred during shipment. If any damage did occur during transit, notify the **carrier** immediately.

The ChemInstruments COF-2000 consists of the following parts:

- Coefficient of Friction tester.
- An envelope with this manual.
- Test Sled with connecting cable.
- Calibration cable (attached).
- Power cord.

Make sure all of these components are present before discarding packaging material.

ASSEMBLY

Carefully remove the test frame/drive/data acquisition assembly from the packaging and set them on a sturdy bench top. Check the physical dimensions listed previously for the space required for the instrument. As with any precision piece of laboratory equipment, it is preferable to locate the COF-2000 in an area where temperature and humidity are controlled to standard conditions of 72 ± 2 degrees Fahrenheit and $50 \pm 5\%$ relative humidity.

Level the COF-2000 tester by adjusting the four leveling feet located at each corner of the unit.



CONNECTING THE POWER CORD

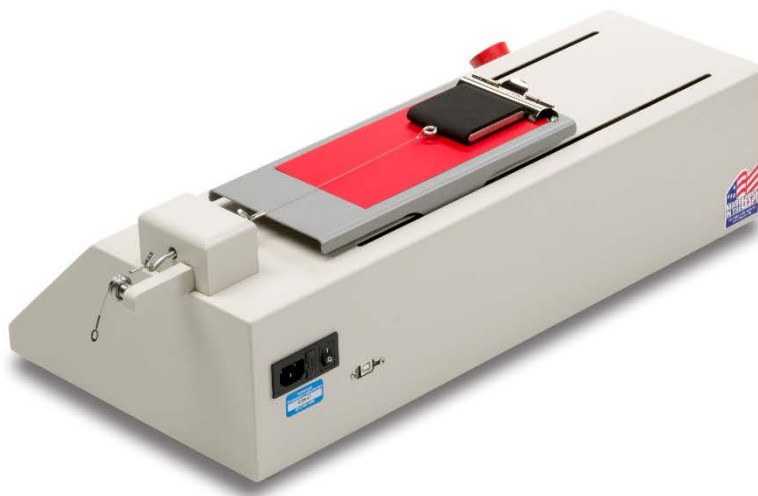


WARNING: Damage will occur if this unit is plugged into the incorrect power supply. This is a dual voltage machine. Connect either 120 or 240 VAC.

Connect the power cord to its receptacle on the backside of the control cabinet at the far left side when viewed from the rear. Complete the connection by inserting the male end of the power cord into a convenient AC outlet. Notice that the on/off power switch is located directly beside the power cord receptacle on the backside of the test frame.

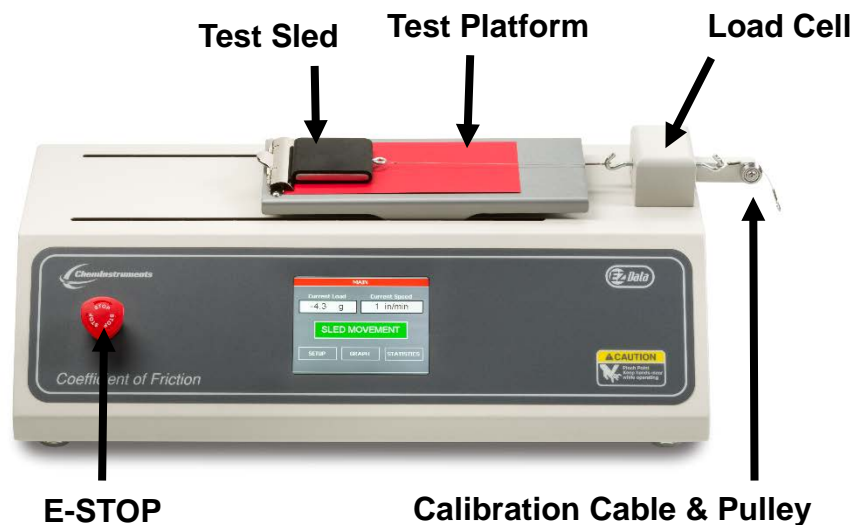


WARNING: Before proceeding with using the COF-2000, it is advisable to become familiar with the Key Components. These Key Components and a brief description of their function follow in the next section.



KEY COMPONENTS

- **POWER SWITCH** is located on the back panel of the COF tester at the left hand side.
- **TEST SLED** consists of a foam rubber wrapped 200 gram block that slides across the **Test Platform**.
- **LOAD CELL** measures the forces involved with a COF test.
- **CALIBRATION CABLE & PULLEY** consist of a cable connected to the load cell and threaded over the pulley to allow you to hang a weight during the calibration sequence
- **E-STOP** emergency stop button.



- **TOUCH SCREEN DISPLAY** is the control center for the COF-2000.



OPERATION

The Test Platform moves at a constant speed causing friction between itself and the stationary Test Sled.

An electronic load cell measures the force, then feeds the information to a data acquisition unit. The data acquisition unit collects the test data from the load cell and stores this information in memory for use in calculating the maximum, minimum and average values. The forces generated during the test are also used in calculating the Static COF and Kinetic COF of the test material.

The load cell samples at 400 times per second. Eight samples are collected, averaged, and stored as a data point. Therefore, a test will generate data points every 20 milliseconds.

A maximum of 10,000 data points can be saved with any given test.

POWER UP



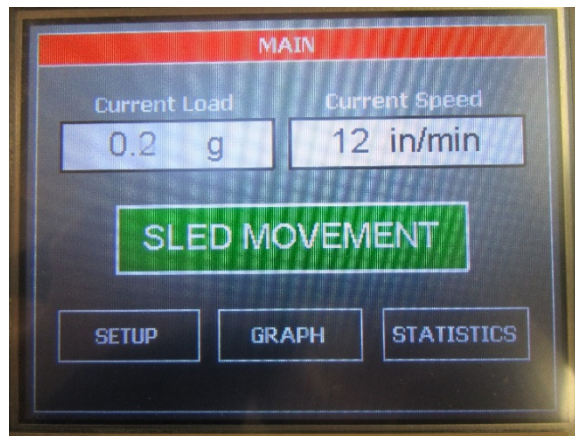
WARNING: Operating temperature for this equipment is 32 to 122 degrees Fahrenheit (0 to 50 degrees Celsius). The equipment needs to be completely free of condensation, inside and out, before applying power.

Turn on the master power switch located on the back panel of the control cabinet next to the power line receptacle.

TOUCH SCREEN FORMAT

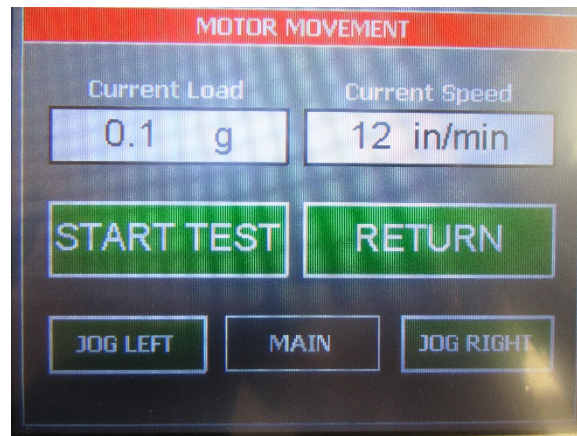
MAIN SCREEN

- **Current Load** – displays the force currently measured by the load cell.
- **Current Speed** – displays the set speed of the test platform.
- **Sled Movement** – will display a new screen which will allow the user to jog or start a test.
- **Setup** – will display all setup options.
- **Graph** – will display the graph, minimum, maximum, and average values of the last test.
- **Statistics** – will display the minimum, maximum, average, variance, standard deviation, and work of the last test.



SLED MOVEMENT SCREEN

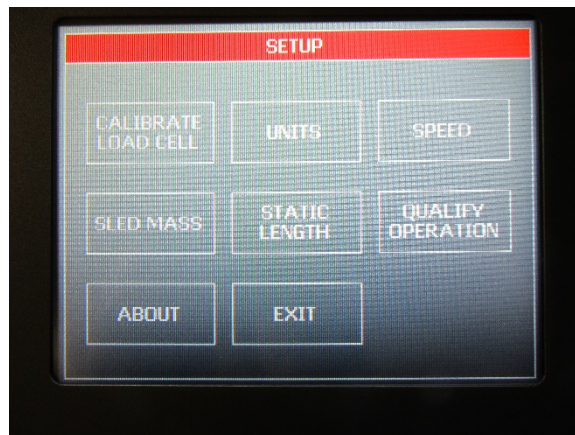
- **Start Test** – starts a test.
- **Return** – moves the test platform to the start position of the last test.
- **Jog Left** – jogs the test platform left until the STOP JOG button is pressed.
- **Main** – will go back to the main screen.
- **Jog Right** – jogs the test platform right until the STOP JOG button is pressed.



SETUP SCREEN

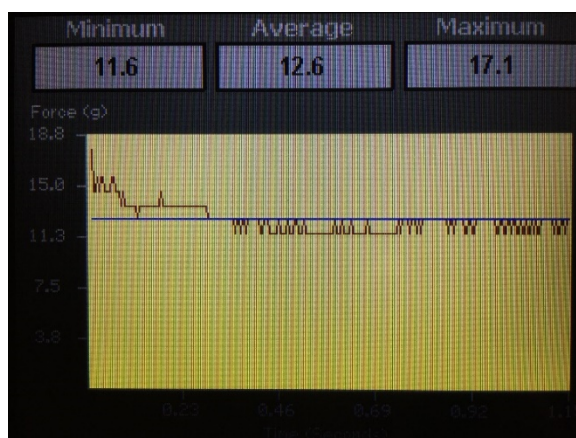
- **Calibrate Load Cell** – allows the user to calibrate the load cell.
- **Units** – change the force units and/or the speed units.
- **Speed** – set the test platform's test speed.
- **Sled Mass** – is used to define the test sled's mass. Valid values are between 1 and 2000 grams.
- **Static Length** – is used to select the amount of data collected during the static part of the test. Valid values are between 1 and 10 seconds.
- **Qualify Operation** – is used to troubleshoot hardware problems with the COF-2000.
- **About** – retrieve the machine's software version and control board's hardware revision.
- **Exit** – go back to the main screen.

If there are 30 seconds of no screen activity when in any of the setup screens except the qualify operation screen, then the machine will exit the setup screen and return to the main screen.



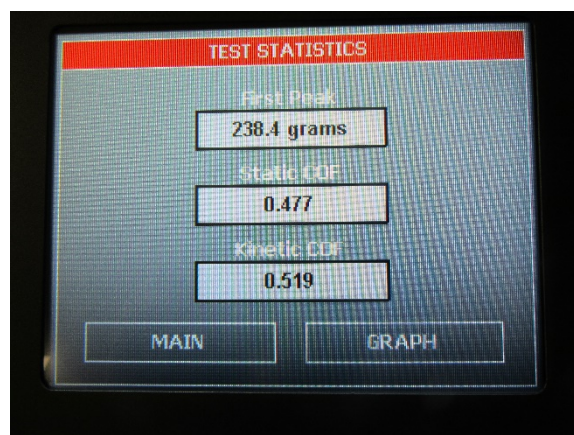
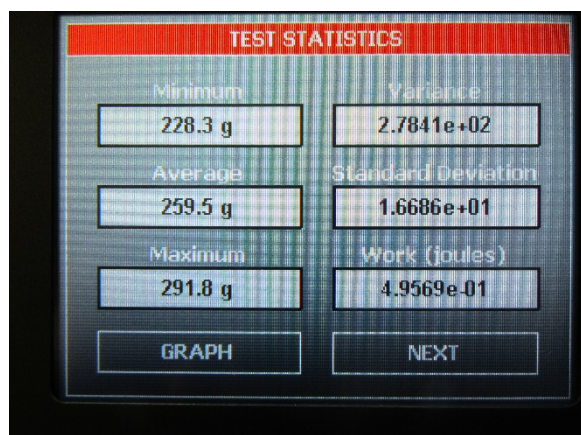
GRAPH SCREEN

The graph screen will display the graph, minimum, maximum, and average values of the last test. Touch anywhere on the screen to exit the graph screen and return to the main screen.



STATISTICS SCREEN

The statistics screen will display the minimum, maximum, average, variance, standard deviation, and work of the last test. Pressing NEXT on the “Test Statistics” screen will display static and kinetic coefficient of friction.



MACHINE SETUP

LOAD CELL CALIBRATION

It is important to calibrate the load cell to ensure that reliable data will be gathered. A calibration procedure is built into the software of the COF-2000. This procedure should be followed upon first use of the COF-2000 and whenever necessary thereafter. The following is the step-by-step procedure for calibrating the load cell.



MAKE SURE THE COF-2000 HAS BEEN ON FOR 30 MINUTES BEFORE PROCEEDING WITH CALIBRATION.



The calibration sequence defaults to grams as the unit of measure. Make sure that your calibration weights and entries are in grams.

LOAD CELL CALIBRATION PROCEDURE

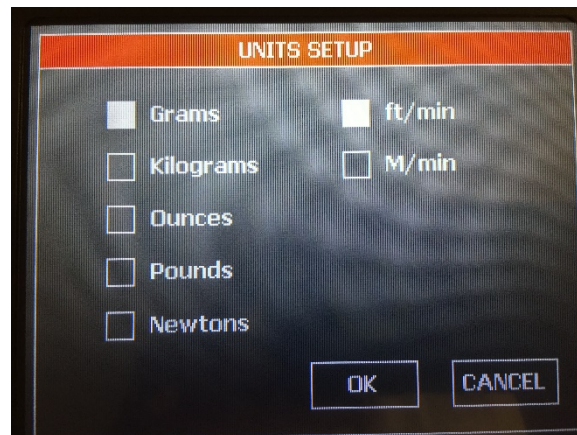
1. Run the wire over the pulley so that a calibration weight can be attached to the end of the wire.
2. Select SETUP from the main screen.
3. Select CALIBRATE LOAD CELL from the setup screen.
4. The first screen in the calibration process describes the 2 point calibration process. Select OK to continue.
5. The next screen measures the low calibration value (typically 0). Make sure that you do not have a weight hanging from the calibration wire and select OK.
6. The next screen measures the high calibration value. This weight should be close to the maximum rated load cell value. Hang the weight on the loop end of the calibration wire making sure that the wire is able to move freely.
7. Set the high calibration value by selecting CHANGE and entering the value of the weight in grams and select ENTER.

8. Make sure that the calibration weight is completely at rest and then select OK.
9. The display will show the main screen and the current reading of force will be displayed under CURRENT LOAD.
10. Verify the calibration by hanging a different calibration weight on the calibration wire.
11. Repeat the calibration procedure if necessary.

FORCE AND SPEED UNITS

Force and speed units can be changed with the following procedure.

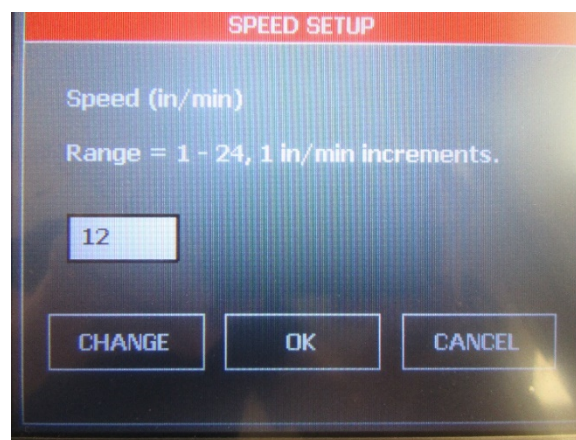
1. Select SETUP from the main screen.
2. Select UNITS from the setup screen.
3. Select the desired units. Select OK to confirm the entered units.



SPEED

To perform a test correctly, it is necessary to set the test speed in accordance with the selected test method. The following is a step-by-step procedure for setting the speed.

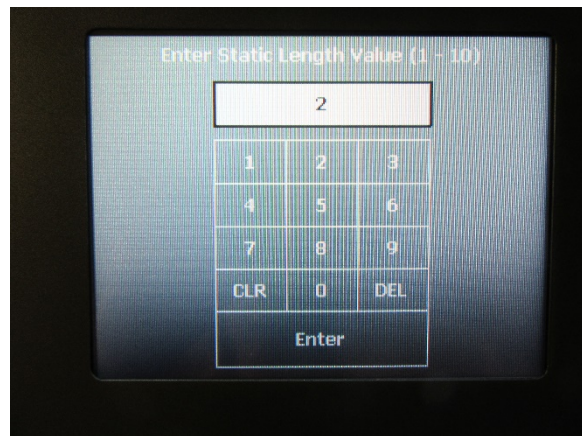
1. Select SETUP from the main screen.
2. Select SPEED from the setup screen.
3. Select CHANGE and enter the desired test speed in the selected units and press ENTER. Select OK to confirm the entered speed.



STATIC LENGTH

The static length is variable between 1 and 10 seconds. This defines the amount of data collected for the static portion of the test. The following is a step-by-step procedure for setting the static length.

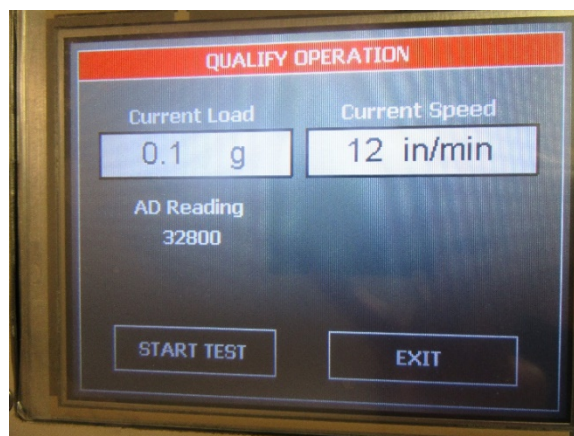
1. Select SETUP from the main screen.
2. Select STATIC LENGTH from the setup screen.
3. Select CHANGE and using the arrow buttons, select the desired static length and select OK. Select OK again to confirm the entered static length.



QUALIFY OPERATION

Some of the hardware functions of the COF-2000 can be verified with the qualify operation screen.

- **Current Load** – displays the force currently measured by the load cell. It will be displayed in the selected units.
- **Current Speed** – displays the set speed of the sled.
- **AD Reading** – displays the hardware counts measured on the control board from the load cell interface. Pulling on the load cell will display values greater than 32000. Pushing on the load cell will display values less than 32000.
- **Start Test** – will run a test at the set speed. A test can be simulated with a weight hanging to verify the load cell calibration if necessary.



RUNNING A TEST

Make sure the load cell has been calibrated and is reading correctly.

The load cell samples at 400 times per second. Eight samples are collected, averaged, and stored as a data point. Therefore, a test will generate data points every 20 milliseconds.

A maximum of 10,000 data points can be saved with any given test.

TEST PROCEDURE

The following procedure will describe a normal test sequence for the COF-2000 tester.

1. Attach the sample material to both the Test Sled and Test Platform according to the appropriate test method.
2. Place the Test Sled on the center of the Test Platform and as far left as the connecting cable will allow.
3. Position the Test Sled so that the edges of the Test Sled are parallel to the edge of the Test Platform.
4. Adjust the position so that the cable has enough slack for it to rest on the Test Platform. The Instant Force reading should be below 5 grams at this point.



WARNING: Before proceeding, make sure there is nothing in the path of the test platform.

5. Press the START TEST button.
6. Wait for the test platform to come to a complete stop.
7. The computed Static and Kinetic COF results will be available in the STATISTICS screen.



WARNING: Make sure the Test Sled is removed from the path of the Test Platform before pushing the Return button

8. Pushing the Return key will return the test platform to the start position for the next test.

COF TEST DESCRIPTION AND RESULTS

The COF moves at a constant speed causing friction between itself and the stationary test sled. The forces generated during the test are measured and used in calculating the Static COF and the Kinetic COF of the test material.

STATIC

The first part of the test is the static part. The static length is defined in setup and can range from 1 second to 10 seconds. The peak value during this part of the test is saved and displayed in the EZ Data graph as “First Peak”. The Static COF value is defined as follows:

$$\text{Static COF} = \frac{\text{First Peak (in grams)}}{\text{Sled Mass (in grams)}}$$

KINETIC

The total test length is 7 inches. The kinetic data will follow the static data.

The number of data points collected during the kinetic part of the test is dependent on speed.

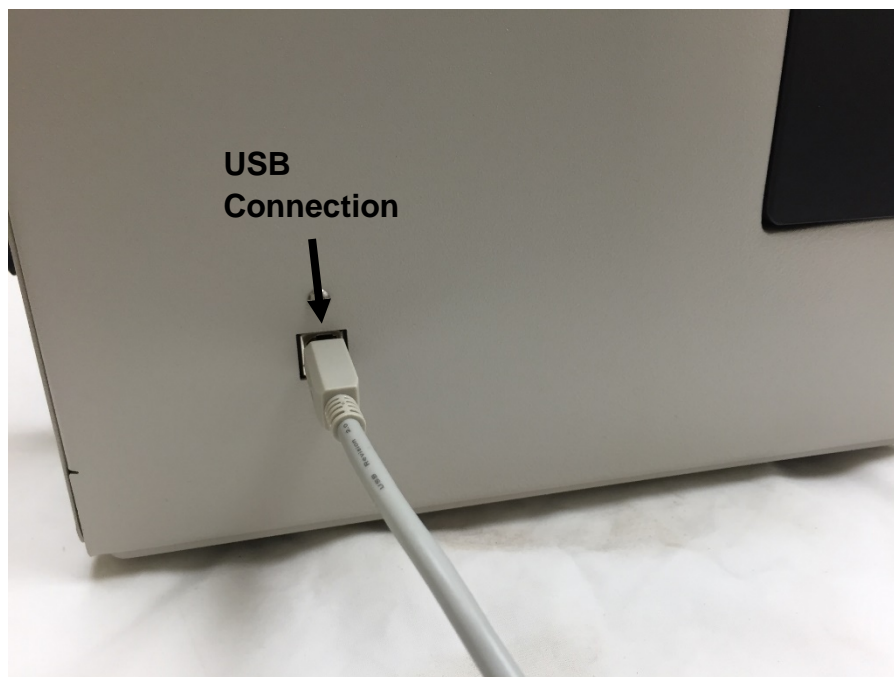
The average, high, and low values are calculated from this part of the test and displayed on the graph screen in EZ Lab. The Kinetic COF value is defined as follows:

$$\text{Kinetic COF} = \frac{\text{Average (in grams)}}{\text{Sled Mass (in grams)}}$$

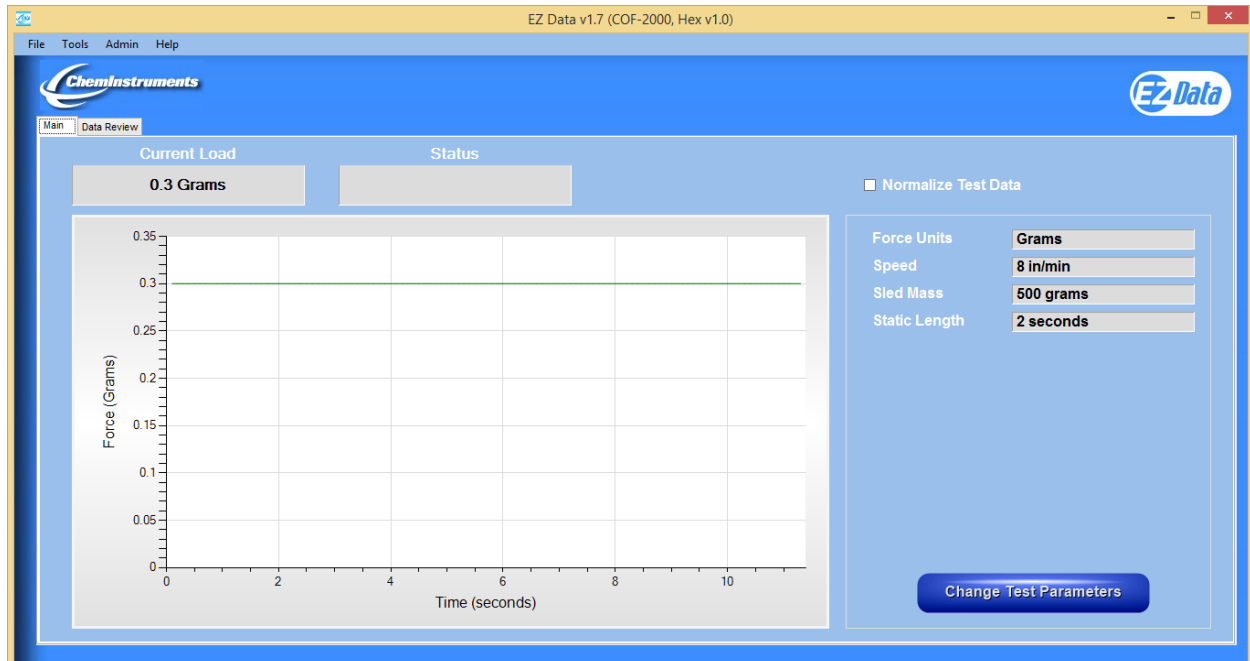
EZ DATA SOFTWARE SYSTEM

EZ Data is a ChemInstruments program that runs on your computer. It will allow you to interface to your ChemInstruments machine in order to save test data files, save raw test data to excel, graph and crop test data, tabulate test data files, and overlay test data files. Please refer to the EZ Data manual for specific information on how to use the EZ Data software system.

The COF-2000 can be connected to your computer with a Type A-B, Revision 2.0 Compliant, USB cable.



The following picture is the main screen of EZ Data with a COF-2000 connected. This screen will show the current load as a value and a real time graph as data is collected from the load cell. It shows the test setup parameters. It will also allow you to change the test parameters.



The following picture shows the COF-2000 parameter setup.

MAINTENANCE

TROUBLESHOOTING

The troubleshooting chart describes some problems that may occur over time. After determining the problem, follow one of the following maintenance procedures.

Troubleshooting Chart

Problem	Possible Cause	Procedure
No Data collected	Display is in SETUP screen	Go to MAIN screen to run a test
	Sample is not attached to the load cell	Attach sample to load cell per drawing
Data measurement consistently low/high	Improper calibration	Check calibration and/or calibration angle
	Bad calibration	Refer to load cell calibration
Calibration drifts	Bad or damaged load cell	Replace load cell
Display is black.	Display is bad.	Replace display.
	Power switch is not ON.	Turn ON power.
	Power supply is bad.	Replace power supply.
Display is stuck at ChemInstruments logo.	Control board is bad.	Replace control board.

MAINTENANCE PROCEDURES

As with any precision equipment it is important to provide care and maintenance to ensure proper performance and long life. General cleaning and care will ensure accurate test and trouble free performance.

CLEANING THE TOUCH SCREEN

It's important to realize the touch panel is sensitive to chemicals.

Specific Cleaning Information: Use a soft, lint-free cloth. The 3M Microfiber Lens Cleaning Cloth is especially recommended for cleaning touch panels without requiring liquid cleaner. The cloth may be used dry or lightly dampened with a mild cleaner or Ethanol. Be sure the cloth is only lightly dampened, not wet. Never apply cleaner directly to the touch panel surface; if cleaner is spilled onto touch panel, soak it up immediately with absorbent cloth. Cleaner must be neither acid nor alkali (neutral pH). When using cleaner, avoid contact with the edges of the film or glass, and with the flex tail. Wipe the surface gently; if there is a directional surface texture, wipe in the same direction as the texture. Never use acidic or alkaline cleaners, or organic chemicals such as: paint thinner, acetone, toluene, xylene, propyl or isopropyl alcohol, or kerosene. Suitable cleaning products are commercially available pre-packaged for use; one example of such a product is **Klear Screen™** or commercially available off-the shelf retail brands such as **Glass Plus® Glass and Surface Cleaner** made by Reckitt-Benckiser. Use of incorrect cleaners can result in optical impairment of touch panel and/or damage to functionality.

Note: Most products contain 1-3% Isopropyl Alcohol by volume, which is within acceptable limits for Resistive Touch Panel cleaning use.

Caution: Many products contain Ammonia, Phosphates, and/or Ethylene Glycol, which are NOT ACCEPTABLE; check product content label carefully.