PULLTEST Version 2.0

YieldPoint Inc.

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Warranty and Service Policy

Product Warranty

YieldPoint Inc warrants the instruments described in this manual to be free from defects in materials and factory workmanship to the original buyer. This warranty is contingent upon proper use of the equipment, and does not cover equipment that has been modified or has been subjected to abusive physical or electrical stresses. YieldPoint Inc., agrees to repair or replace, at its sole discretion, any instrument that fails to perform as specified within 6 months after date of the original shipment from the factory, or 3 months after the date of installation, whichever date comes first.

Yieldpoint Inc., reserves the right to make substitutions and modifications in the specifications of equipment that do not materially or adversely affect the performance of the equipment.

New equipment may be returned within 30 days of shipment with prior approval. New items which are less than thirty days old after shipment may be returned for credit, less a minimum restocking and testing charge of twenty percent of the list price upon factory approval only, provided the customer pays all shipping and handling charges. Specially ordered, or modified goods, or goods which have been used or have been unpacked, or goods which have been shipped more than thirty days prior are not returnable.

The information contained in this manual is subject to change without notice. YieldPoint Inc. makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Further, YieldPoint Inc., assumes no responsibility for any errors that may appear in this manual and makes no commitment to update, or keep current, the information contained in this manual.

Service Policy

Units within the warranty period returned for repair, test, and recalibration are serviced at no charge in accordance with the terms of the warranty policy. The Customer pays all transportation and other charges to the factory.

Units out of warranty returned for repair, test, and/or recalibration are handled on a time and material basis. If requested, or if costs exceed 50% of current list price, YieldPoint Inc., advises the customer prior to making the repairs. Such repairs are performed at the customer's expense. Typical test, recalibration, and repairs are 25% of the instrument's current list price. Transportation charges both ways are at the customer's expense.

Please be sure all returns are shipped with the following information included:

1. Your company Name with Billing and Shipping Addresses.

2. A complete description of your problem, or re-calibration data.

3. The contact person at your company, with their telephone and facsimile numbers.

4. Non-Warranty returns additionally need your Purchase Order Number.

Please pack your returned instruments in their original shipping cartons, or in equivalent strong protective shipping cartons.
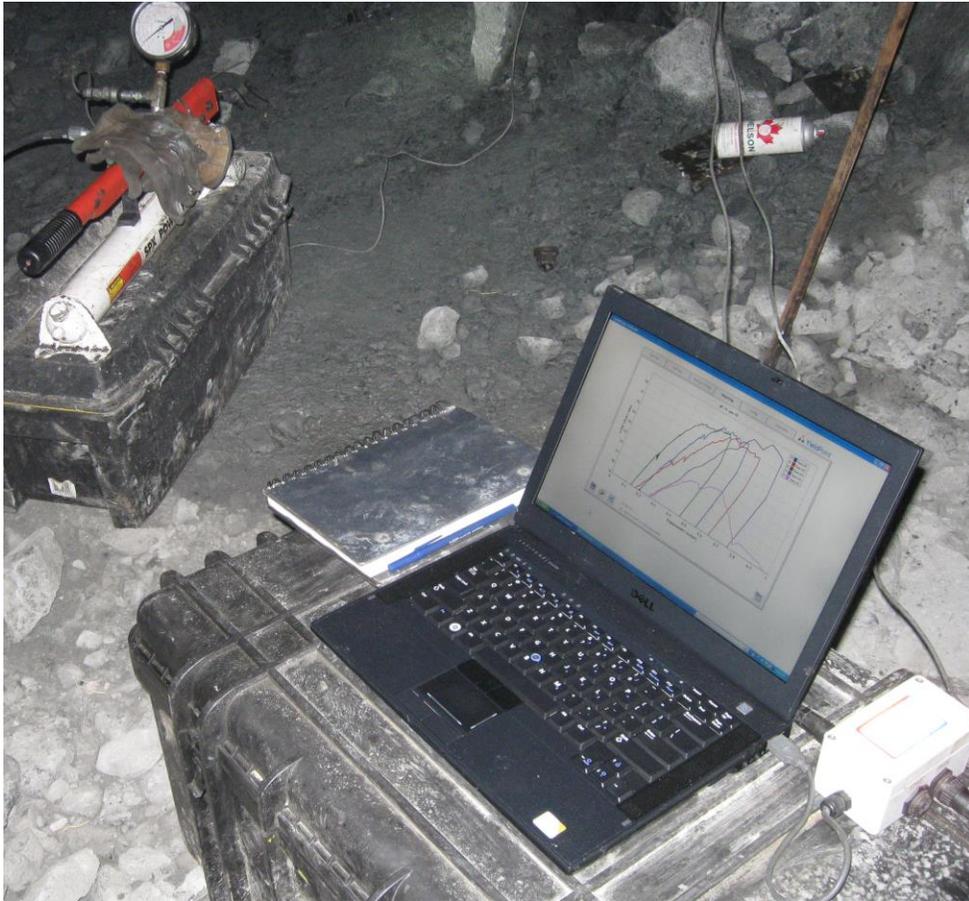
Figure 1. The pull test unit being used at Kidd Mine (courtesy of Jennmar Canada)

Table of Contents

1. INTRODUCTION

1.1. What is PullTest?

PullTest is a turnkey solution system for accurately and efficiently monitoring pull tests on bolts and anchors. A Data Acquisition (DAQ) unit converts analog signals from displacement, load and pressure transducers directly to the USB port of a PC or tablet. The preferred operating system is Windows 10. YieldPoint cannot ensure operation with computers running Windows 7. Real-time monitoring of pull test results enables on-the-fly interactive optimization of the number, type and location of tests.

PullTest has been designed to be low cost and low weight (2.5kg). The user can select to minimize weight and inconvenience further by using a Tablet computer to read and store the data, as opposed to the standard laptop interface

All aspects of PullTest design incorporate redundancy features which include:

- displacement measurement based on two independent sensors(Disp1 and Disp2)
- load can also be calculated based on a measurement of the in-line pressure (Pres).Two pressure cells are provided, and,
- an optional interchangeable backup load-cell is provided (Load).

This design strategy ensures that the system will continue to operate even under the most t scenarios.

Reporting tools enable plots to be prepared easily and efficiently, so that a presentation can be made to a customer or client within minutes of the test program being completed.

1.2 Units Conversions form Metric to Imperial

PullTest works with and stores data in metric units. However options exist to work in imperial units without inconvenience. Should conversion factors be required they are listed below.

Metric To Imperial	Imperial to Metric
1 inch =25.4mm	1mm = 0.03937"
1kN = 0.1004 tons (2240lbs)	1 ton(2240lbs) =9.964 kN
1kN = 0.1124 short tons	1 short Ton = 8.896kN
1 metric tonne =1.102 short tons	1 short ton = 0.9071 short tons
1 MPa = 145psi	1psi=0.006894MPa
1kPa = 0.145psi	1psi = 6.894kPa
1tonne= 2204.62lbf	1lbf= 0.000453tonnes

Table 1: Units conversions

2. COMPONENTS and CONNECTIONS

2.1. Data Acquisition Units.

PullTest electronic components combine analog sensors to monitor load and displacement and a 4 channel, 12-bit data Acquisition unit. The Data Acquisition unit (DAQ) streams data to a USB port of a PC.

2.2 Displacement Sensors

The two displacement sensors operate using a magnetostrictive principle that measures the relative position of a flexible waveguide and a ring-magnet. This transducer has the advantage that there is no physical connection across the loading jack, so that if the bolt ruptures the sensor will not be damaged. The specification sheet for the displacement sensors is provided in Appendix A1. *PullTest* enables either a single displacement sensor or a pair of displacement sensors(average result plotted) to be used to monitor the pull test.

The two displacement sensors are fully interchangeable and can be plugged into either port 1 or 2 on either DAQ unit. PullTest/PC must be modified depending on which port is used.

Figure 1. The magnetostrictive displacement sensor. The extended red probe is the waveguide.

2.3 In-Line Pressure Cell.

The load applied to the bolt can also be calculated based on the line pressure multiplied by the area of the ram (see section 3 below). The pressure cell is rated for a range 0-69MPa or 0-10000psi. The corresponding force applied to the bolt through a hydraulic cyclinder is:

$$F = \text{In-Line Pressure} * \text{Area}$$

Where the area is the specified area of the cylinder (see Appendix 2 for Enerpac specs).
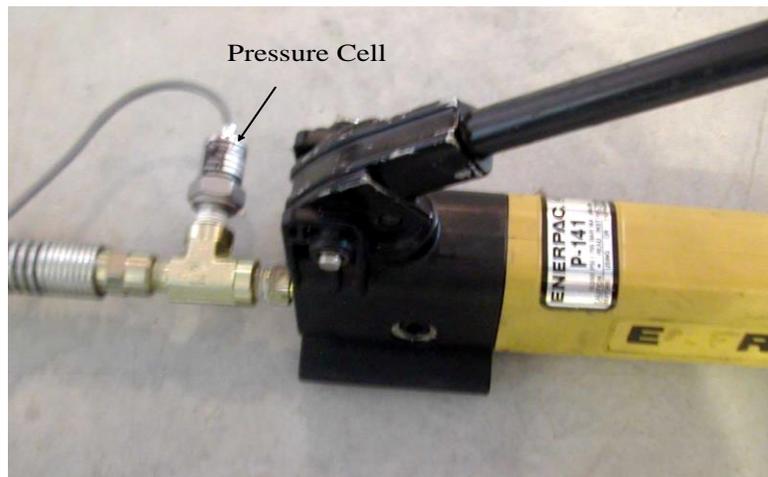

Figure 2. The In-Line Pressure Cell

2.4 Load Cells (Optional).

Two load cells are provided with the *PullTest* system.

Load cell 1

Load Cell 1 is a rated for 50000lbf with an output of 10mV FS. The sensing element incorporates bonded foil strain gages of the highest quality and is sealed for protection against most industrial environments. To obtain accurate results with the load cell it is imperative that the lower surface be evenly load. Therefore a stainless steel disc with a central hole is provided on which the load cell must sit. It is recommended that a sacrificial washer be used at the upper surface of the load cell to avoid damaging the finish.

The specification and calibration sheets for the load cell is provided in Appendix A2

Load cell 2

Load Cell 2 is a rated for 80000lbf with an output of 10mV FS. This load cell is generally less accurate (2% non-linearity compared with 0.25% for load cell 1) than load cell 1 and is provided as a lightweight backup load cell. For accurate load measurement it is imperative to ensure that load cell 2 is aligned concentrically to the bolt shaft, and that eccentric loading is avoided.

The specification and calibration sheets for the load cell is provided in Appendix A2


a. Load cell 1
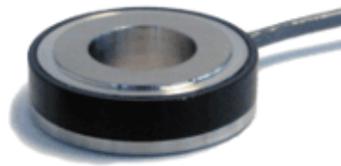
b. Load cell 2

Figure 3 The load cells. Load cell 2 is intended as a lightweight backup

2.5 Connections

The transducers must be attached to the DAQ system as indicated in Figure 4. The DAQs is turned on/off by the rocker switch - white dot depressed is on.

Each DAQ has a 9V battery power source. It is recommended that the battery be replaced at the beginning of each day's testing. Turning the system off between tests will conserve battery power.

IMPORTANT: The DAQ should be turned off before connecting or disconnecting sensors.
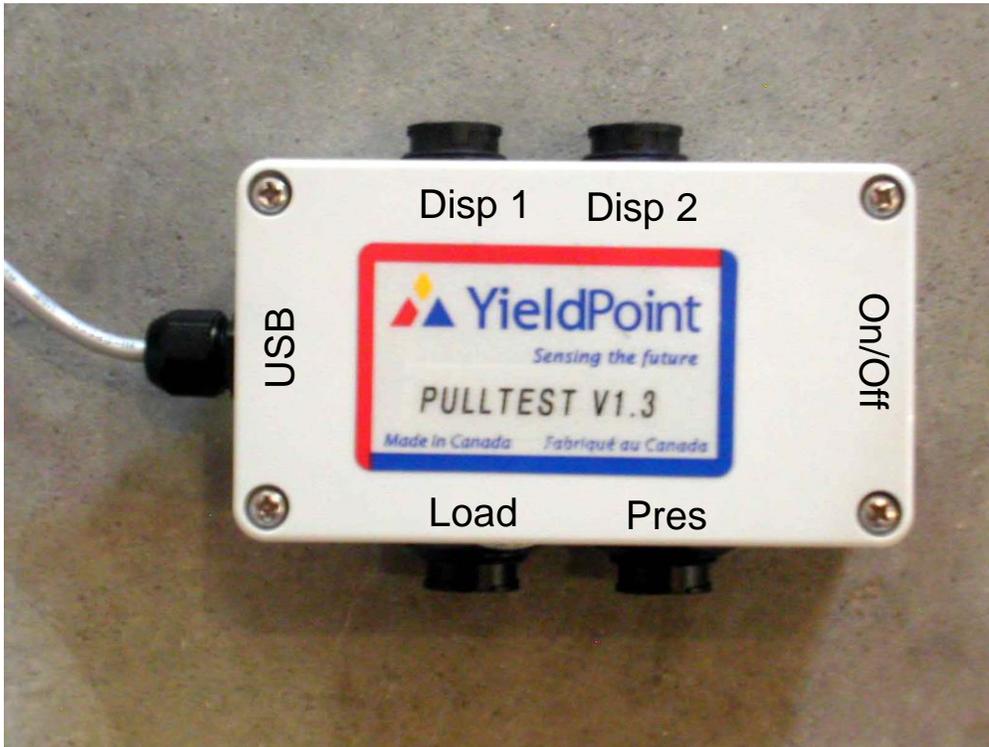
USB DAQ Unit

Figure 4. Connections to the DAQ Unit

3. PULLTESTWindows Software

PullTest is a PC Windows database application for automated real-time monitoring of pull tests. Data from an external DAQ unit is streamed through the USB port at a rate of approximately 1 readings/second. During a test the application allows the user to observe the detailed pull test response, either as load *versus* displacement, or displacement *versus* time,. All graphs can be saved or printed as JPEGs, and data can be exported to both MS Word and MS Excel. . Real-time reporting allows the user to optimize the number and type of pull tests within a test series, provide the client with immediate results. Time spent preparing a final report is minimized.

The application is laid out in a tabular format which allows rapid access to the information required. When the form loads it will always display the Test Info tab. To move from field to field you can use the Tab key on your keyboard, or click on the field using the mouse.

3 The Test Info Tab.

3.1 Selecting a Virtual Com Port(VCP)

Once the DAQ has been powered with a 9V battery (preferably Litium for longer life), and with the DAQ turned off (LED not flashing/zero depressed on rocker switch), the USB plug should be plugged intothe laptop or tablet. Drivers will load once the USB adapter is detected for the first time. If the drivers do not load and the USB is not recognized then:

(i)   The files (setup executable is best option) can be downloaded from the webpage: http://www.ftdichip.com/Drivers/VCP.htm

SH4	Comments
-	WHQL Certified. Includes VCP and D2XX. Available as a setup executable Please read the Release Notes and Installation Guides.
	All FTDI devices now supported in Ubuntu 11.10, kernel 3.0.0-19

(ii)   Follow the instructions in the PDF guide (FTDI_AN352_Driver_Installation _Guide) that can be downloaded from the YieldPoint website

Once the drivers are properly installed a VCP will be created for the DAQ each time it is plugged into the PC. The designation (COM3, COM$ etc) will vary from computer to computer. Use the following steps to deduce which COM is associated with the DAQ:

(i) with the DAQ's USB unplugged from the laptop click the green arrows next to the Select COM dropdown. Record the COM ports

(ii) Plug in the DAQ and repeat the process. The addition COM port is associated with the DAQ.
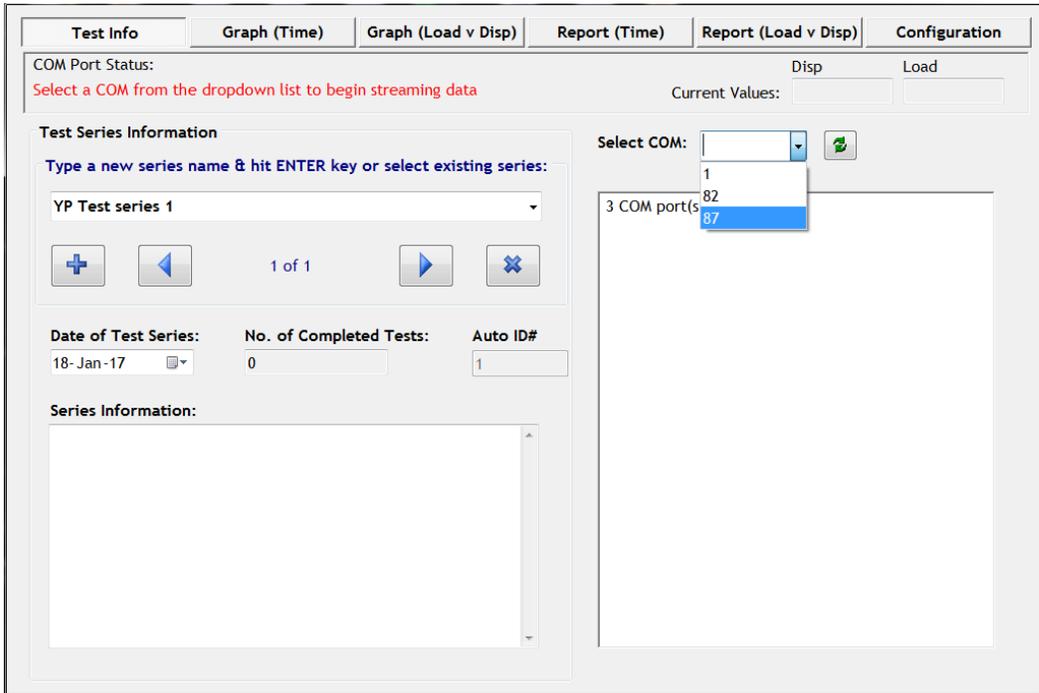
Next, select the appropriate COM port and the COM port will be connected. Turn on the DAQ
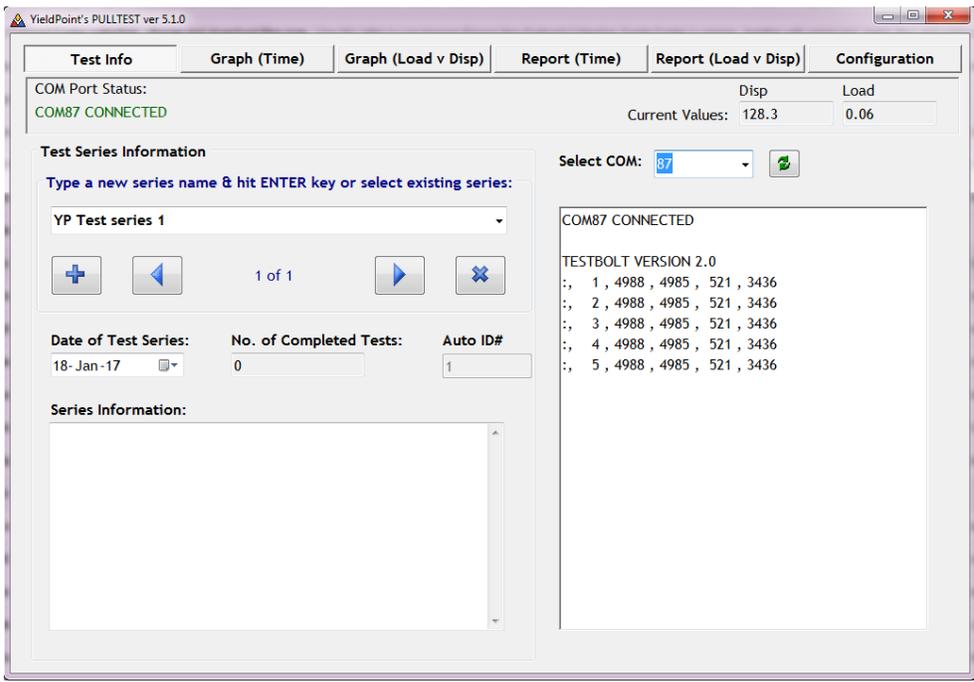
Data will begin to stream from the DAQ over the USB to the laptop with an approximately 1/sec interval.

The output string is

;, Reading #,Disp1,Disp2,Pressure,Load CRLF

The Disp1, Disp 2,Pressure are monitored directly in mV. In the figure above 4988 corresponds to 4.988V which is the voltage output of Disp 1 with the actuation magnet absent.

The displacement sensors range from slightly less than 5V (e.g. 4.970-4.990) to slightly greater than 0V (0.010-0.100) and the in-line pressure cell ranges from aprox 0.5V (500mV) to 4.5V (4500mV).

To test the displacement sensor, with the DAQ running run the actuator magnet (additional provided) over the yellow probe of the displacement sensor. As shown below the Disp1 values will cjhnage from aprox 5v with the magnet off to approx. 0V with the magnet fully on.
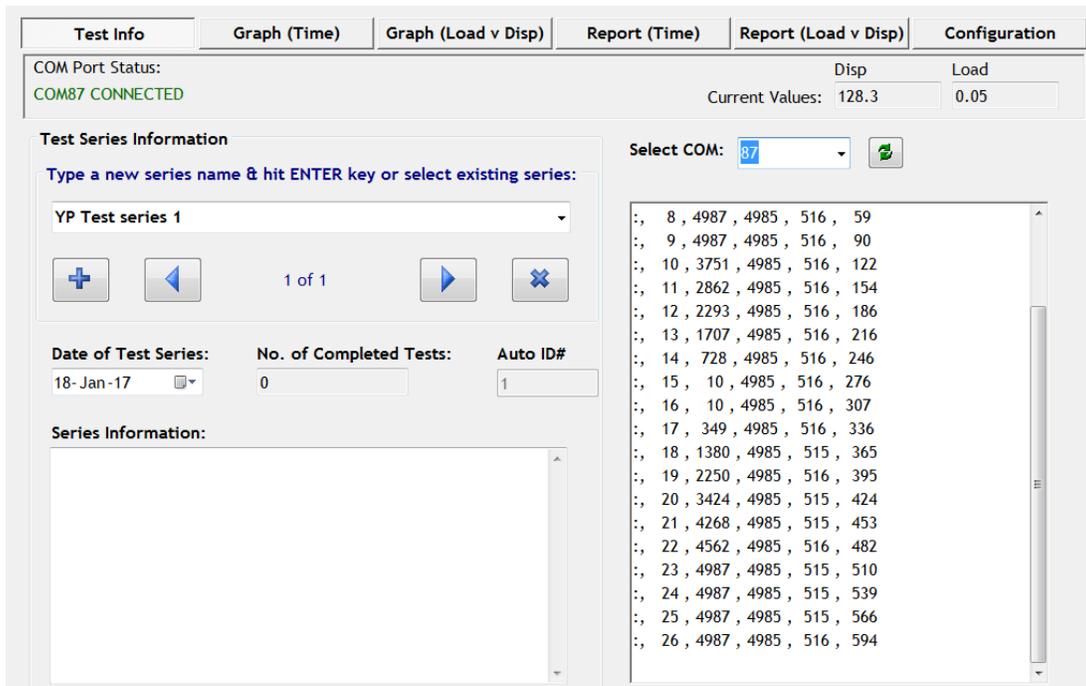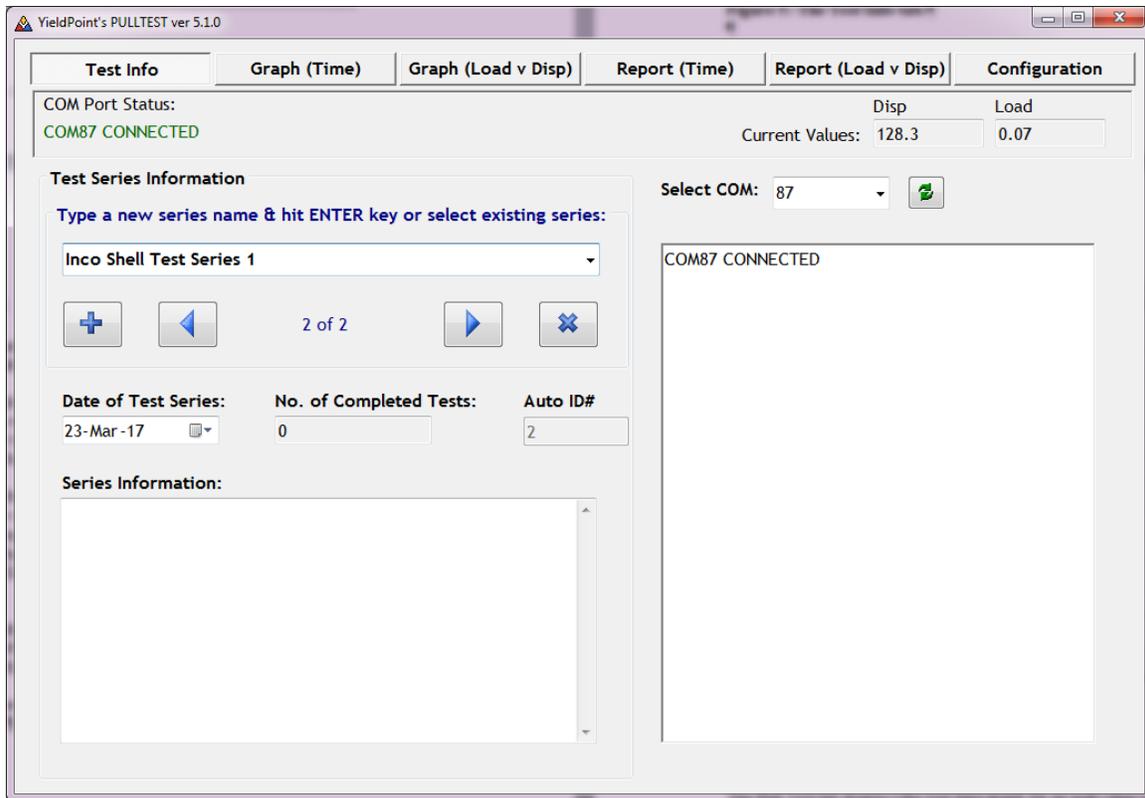

Figure 5: The Test Info tab.

3.2 Series Information:

A test series usually designates a number of identical tests in the same location used to assess variability. To add a new test series type the description in the Test Series drop down field and click "+". The new series will be created The date can be enetered and then other relevant Series information such as Location, rock type, bolt type etc can be entered in the **Series Information** field.

The series information applies to all tests done for that series. Click the "Add a new series button" to create a new test series. The only required information is a series name, which is entered at the prompt. The current date is automatically entered in the Date field but can be changed by typing the preferred date in the field.

Once a series exists in the database, it can be selected by clicking the Series dropdown list. If there are a large number of series in the list, typing the first few letters of the series will bring up the closest match in the list. Simply hit the Enter key on the keyboard to select that series. When the program opens, the series are sorted in descending order on the Date field, so that the most current test series is displayed first.

Each test series can contain a maximum of ten individual tests. The test information can be entered before or after a test is run. Use the Test Number dropdown list to select a particular test, or click on the Previous or Next buttons to navigate through tests.

4.0 The Configuration Tab
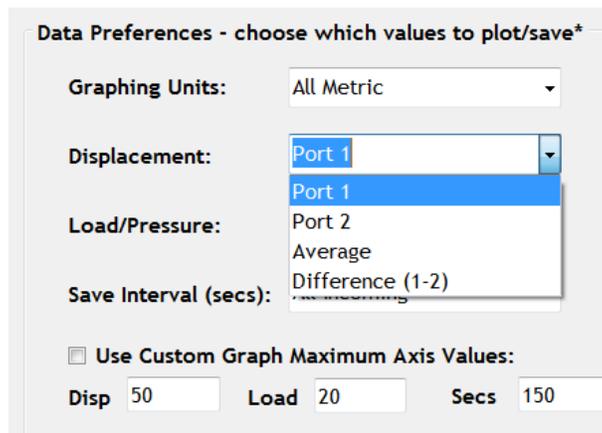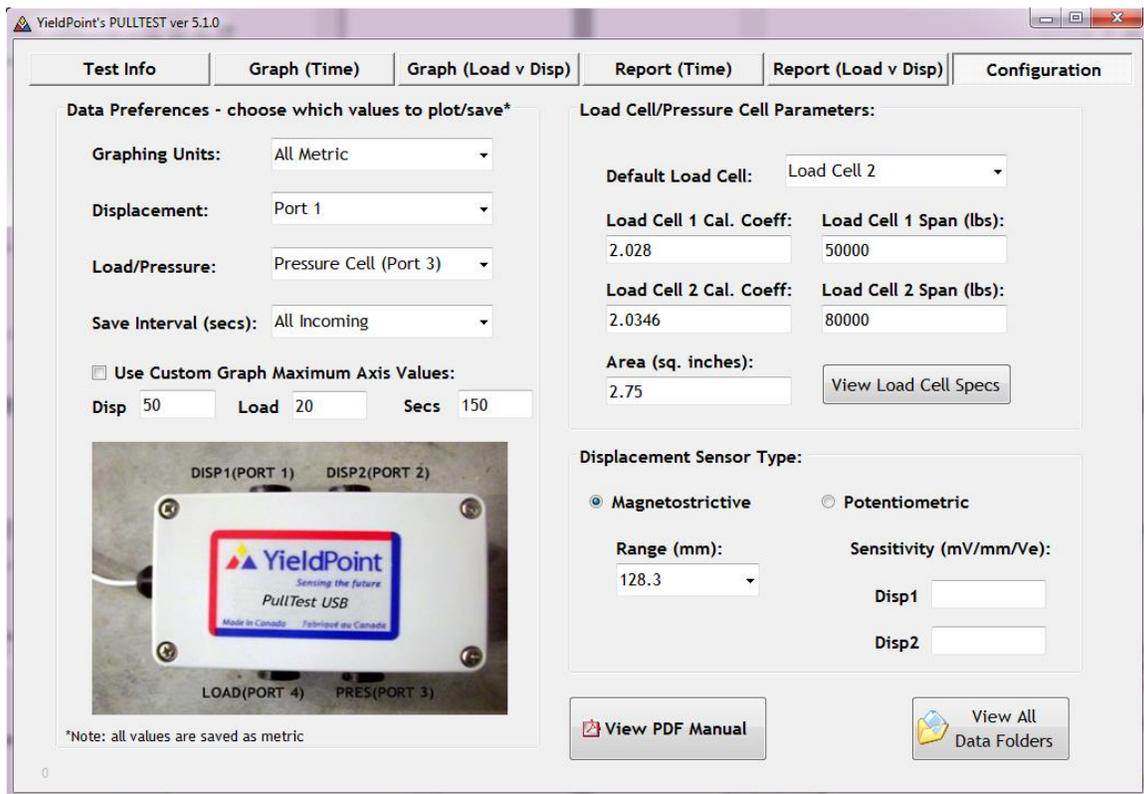
The Configuration Tab is used to set up the software for the specific types of instruments that are plugged into the DAQ. Options related to the data preferences (Metric versus Imperial), whether to graph using Disp1 or Disp2, or some kind of combination (see above), whether to plot load calculated from the in-line pressure or measured directly from the load cell.
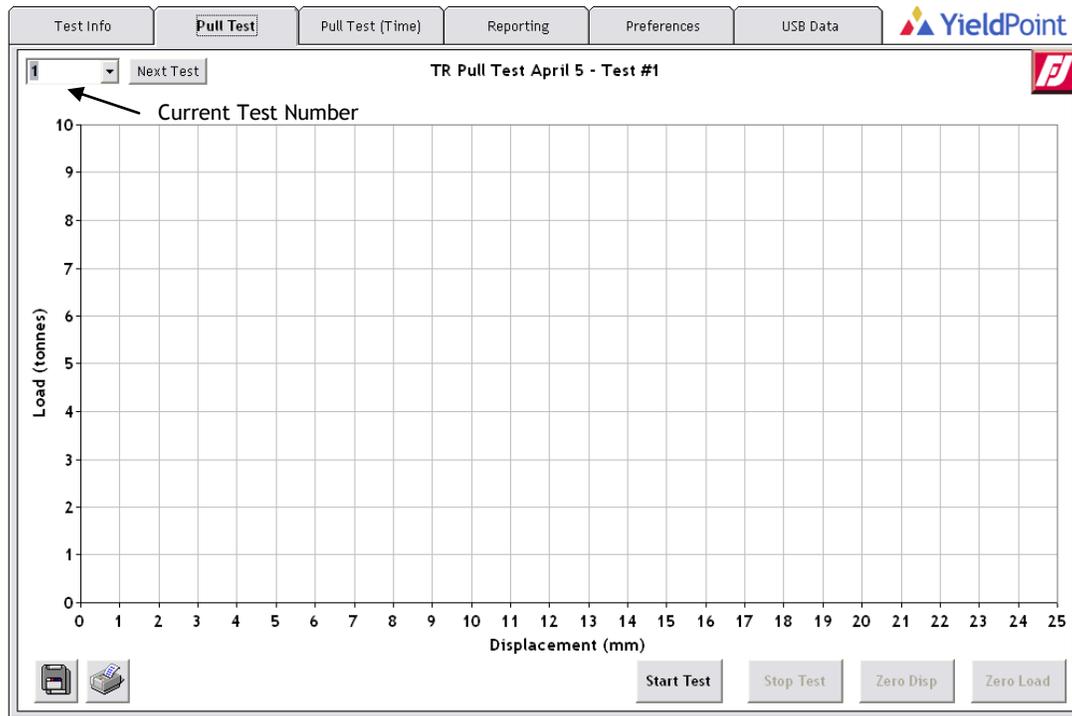
3.4 The Graph (Time) Tab.

Figure 6. The Pull Test tab

The Pull Test tab displays the real time graph for an individual test. On this graph, Load is plotted directly against Displacement. The name of the series is displayed at the top of the graph, and the dropdown list at the top indicates which test number is being run.

Once the correct test is selected and the serial or usb is connected to the PC, click the "Start Test" button to begin. The remaining buttons will now be enabled. Data can be plotted and saved at different intervals, and can be shown in Metric or Imperial units. Both of these settings are found on the Preferences tab.

To "zero out" the Load data or the Displacement data, click the corresponding Zero button in the lower right corner. At any time during or after a test, click the Pull Test(Time) tab to view the current test being simultaneously plotted as Load and Displacement against Time. Click the Pull Test tab to return to the original graph.

To end a test, click the Stop Test button. The data is saved and the incoming data is no longer plotted on the graph. The saved data is now viewable on the Reporting tab, but a copy of the individual pull test graph can be saved as a JPEG by clicking on the Save button in the lower left corner, or printed directly to a printer by clicking the Print button.

To continue with a new test in the same series, simply click the Next Test button and the graph is ready to start a new test. Click here for information on zooming in on graphs
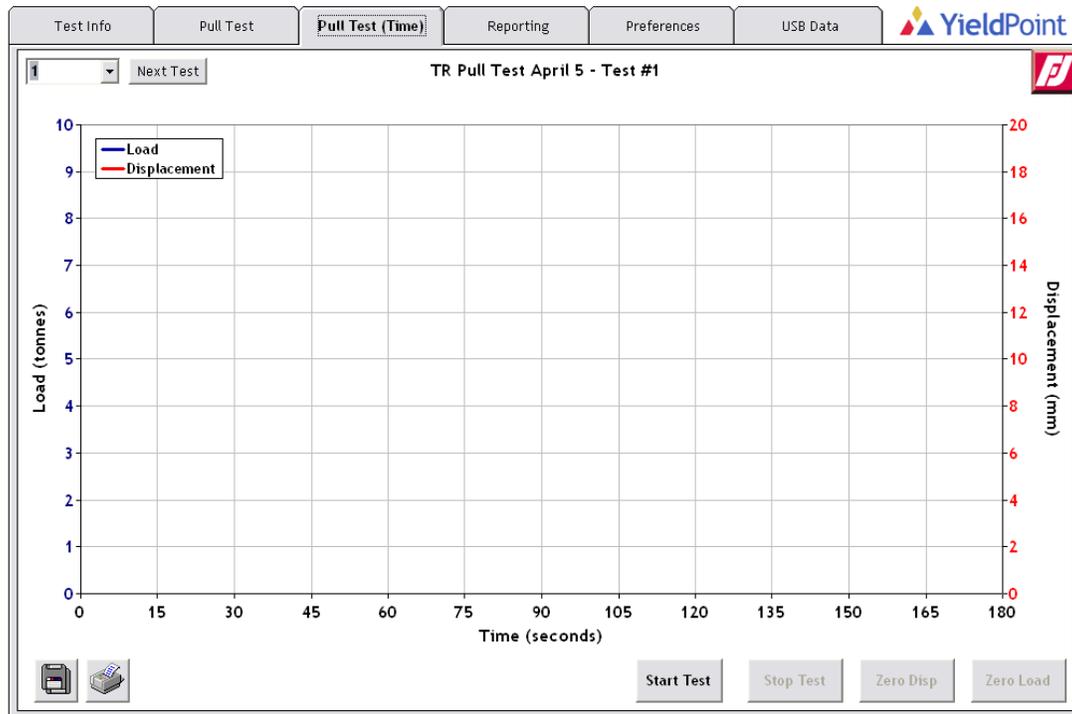
3.5 The Pull Test (Time) Tab

Figure 7. The Pull Test (Time) tab

The Pull Test (Time) tab displays the real time graph for an individual test. On this graph, Load and Displacement are plotted individually against time in Seconds. Load is shown on the left axis in blue, and Displacement is shown on the right axis in red. If a test exceeds 90 seconds, the graph will begin to scroll to the right to show the most current incoming data.

The name of the series is displayed at the top of the graph, and the dropdown list at the top indicates which test number is being run.

Once the correct test is selected and the serial or USB is connected to the PC, click the "Start Test" button to begin. The remaining buttons will now be enabled. Data can be plotted and saved at different intervals, and can be shown in Metric or Imperial units. Both of these settings are found in the Config tab.

To "zero out" either the Load data or the Displacement data, click the corresponding Zero button in the lower right corner. At any time during or after a test, click the Pull Test tab to view the current test being simultaneously plotted as Load *versus* Displacement. Click the Pull Test (Time) tab to return to the original graph.

To end a test, click the Stop Test button. The data is saved and the incoming data is no longer plotted on the graph. The saved data is now viewable on the Reporting tab, and a copy of the individual pull test graph can be saved as a JPEG by clicking on the Save button in the lower left corner, or printed directly to a printer by clicking the Print button.

To continue with a new test in the same series, simply click the Next Test button and the graph is ready to start a new test.
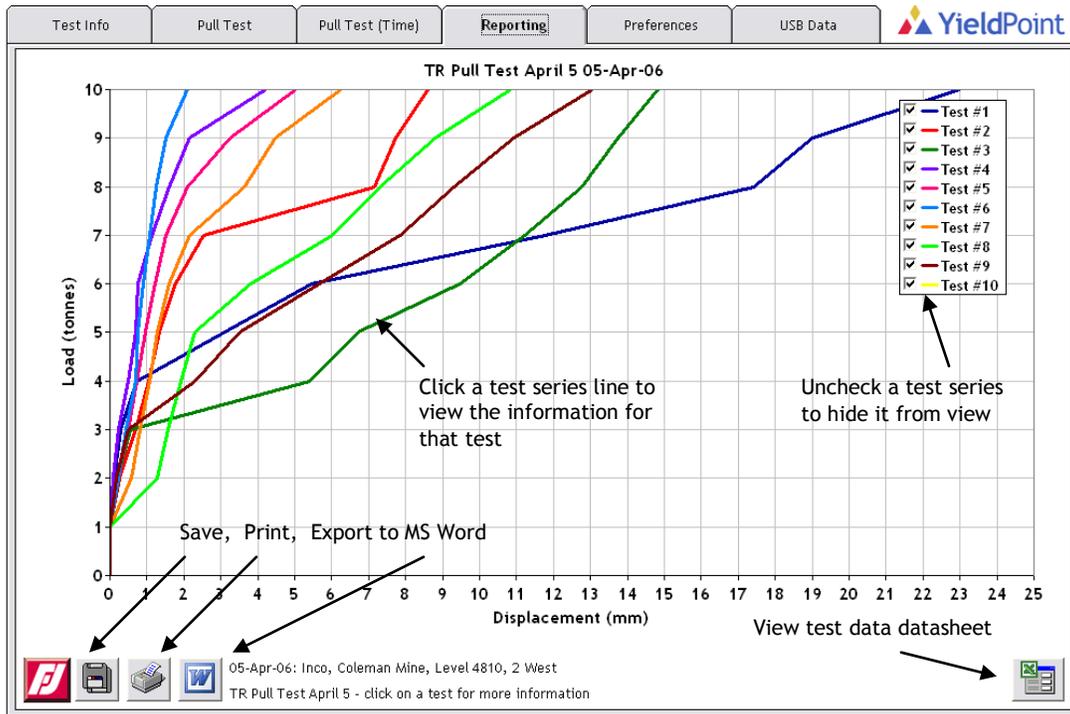
3.6 The Reporting Tab.

Figure 8 The Reporting tab shows the graph of all the completed tests for a series. Data can be plotted in Imperial or Metric units. Series information is shown below the graph. To view individual test information, click on the test data line in the graph.

To remove a test from the plot, uncheck the corresponding test number in the graph legend. To show a hidden test, re-check the corresponding test number.

Both graph axes can be moved by clicking on the axis with the left mouse button and dragging the axis in the desired direction while the mouse button is held down. The axis can also be scrolled using the wheel button if your mouse has one.

Zooming in on graphs: To zoom in on an area in the graph, use the mouse to 'draw' a rectangle around the area to be viewed.

Start with your mouse pointer positioned at the top left of where you would like your selection to begin. Click and drag using the left mouse button and move your mouse diagonally down and to the right. You will see a grey outline of a rectangle to use as your guide. Once you have the desired area selected, release the left mouse button and the graph will zoom in to that area.

To return the graph to its original view, draw the rectangle in reverse. To see a demonstration of this, double-click the short movie clip below. ↓
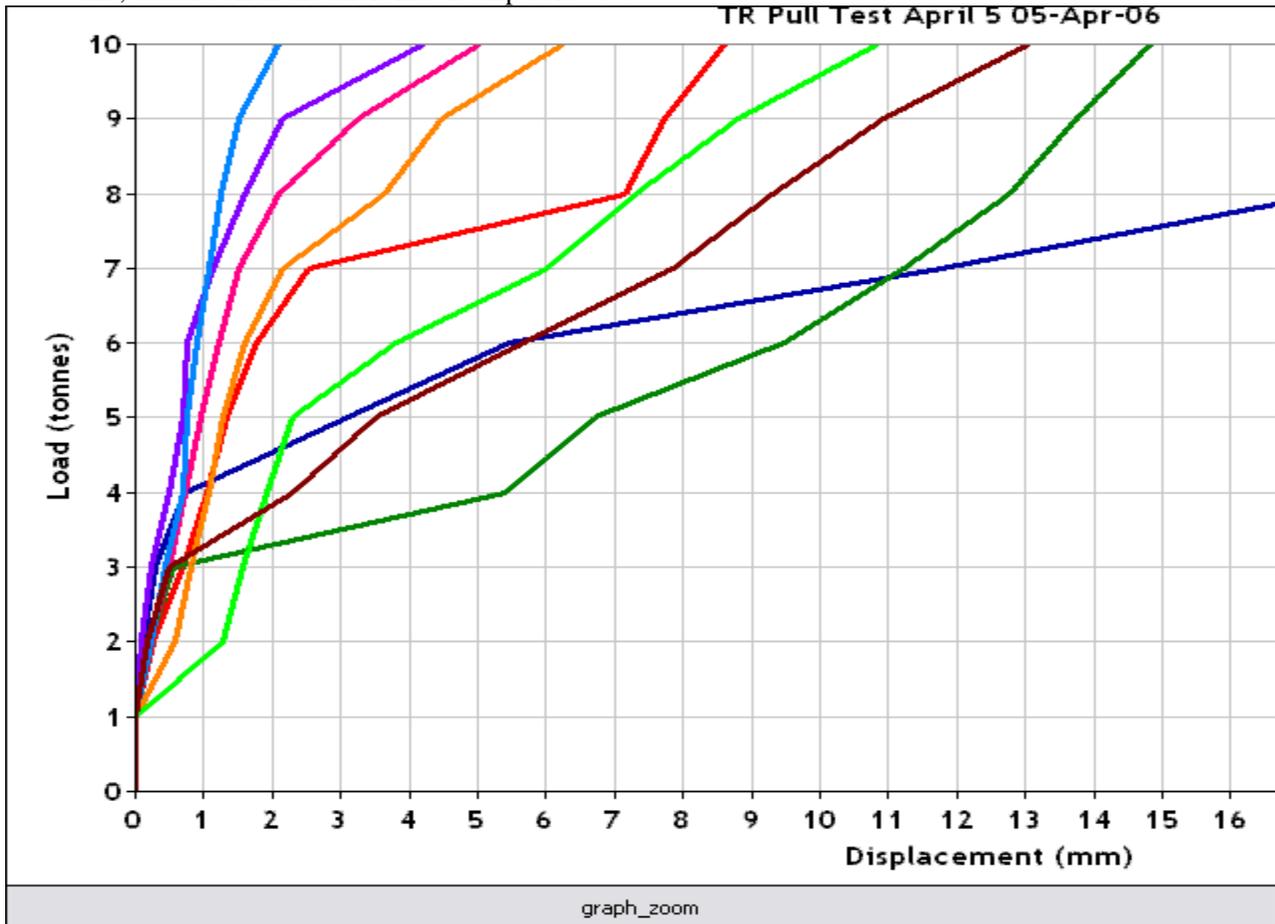

Figure 9. A video clip indicating how to use the Reporting Tab.

This graph can be saved as a JPEG by clicking the Save button, printed directly to a printer by hitting the Print button, or exported to MS Word by clicking the Export to Word button.

If there is no existing test data for a series, a message box will display when the Reporting tab is clicked.

Raw data:
The raw data can be viewed by clicking the Datasheet button on the lower right corner of then reporting Tab. All data is saved in the database with metric units.

Figure 10. The raw data

Delete one row of data at a time by clicking on the desired row at the 'ReadingNo1' column which will highlight the selected row in green. Click the "Delete Row" button to permanently delete that row.

To export all the data to MS Excel, click the Export to Excel button at the top right on the Datasheet form. The series information is exported along with the test data.
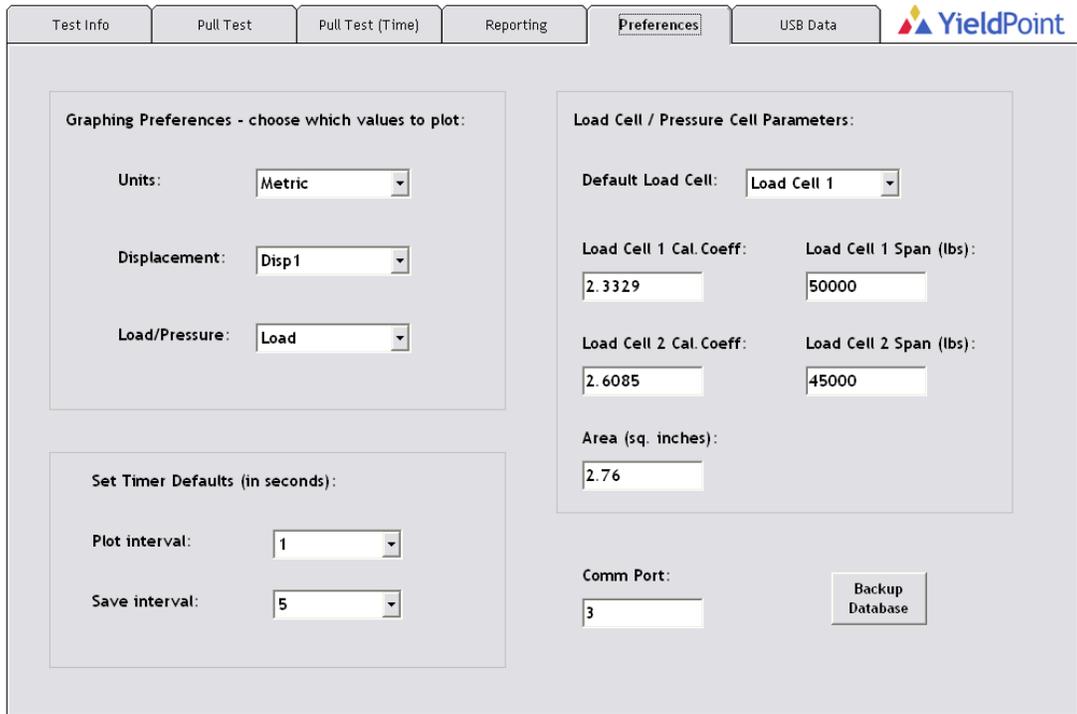
3.7 The Config Tab.

Figure 11 The Preferences Tab. The graphing preferences determine which port the displacement sensor is plugged into , and whether the load value is based on a pressure cell plugged into port 3 or a load cell plugged into port 4. Although data is streamed drom the DAQ unit at 0.1mm intervals the interval between saved values and plotted values can be varied. Finally the calibration coefficents for the load and pressure cell s are input on the RHS. The should only be changed if the transducers are replaced or the recalibrated.

Graphing Preferences:

The Figure shows a top view of the DAQ/PC with the location of the 4 ports indicated. It is imperative that each transducer be plugged into the appropriate port.

Units dropdown list – select either Metric or Imperial from the list. This preference applies only to the values plotted on the graph. Metric values are always written to the database.

Displacement dropdown list – select Port1, Port 2 depending on which port the displacement sensor is plugged into. Select average to use an arithmetic average from both displacement sensors.

Load/Pressure dropdown list – select either Load cell (Port 4) or Pressure cell(port 3) depending on which transducer the load value is based on.

Set Timer Defaults:

Plotting and saving intervals can be the same value, or set to different values.

Plot Interval – select the frequency in seconds in which the graph will plot a point of data when running a test.

Save Interval – select the frequency in seconds in which the program will save a point of data to the database.

Load Cell/Pressure Cell Parameters:

Default Load Cell – select Load Cell 1(port 4) or Load Cell 2(port 4) from the dropdown list.

The Area of the Ram depends on the capacity of the ram used for testing.

Load Cell Coefficients. and Span values are pre-entered for the Load and Pressure equipment, based on the specification and calibration data provided in Appendices A2 and A3
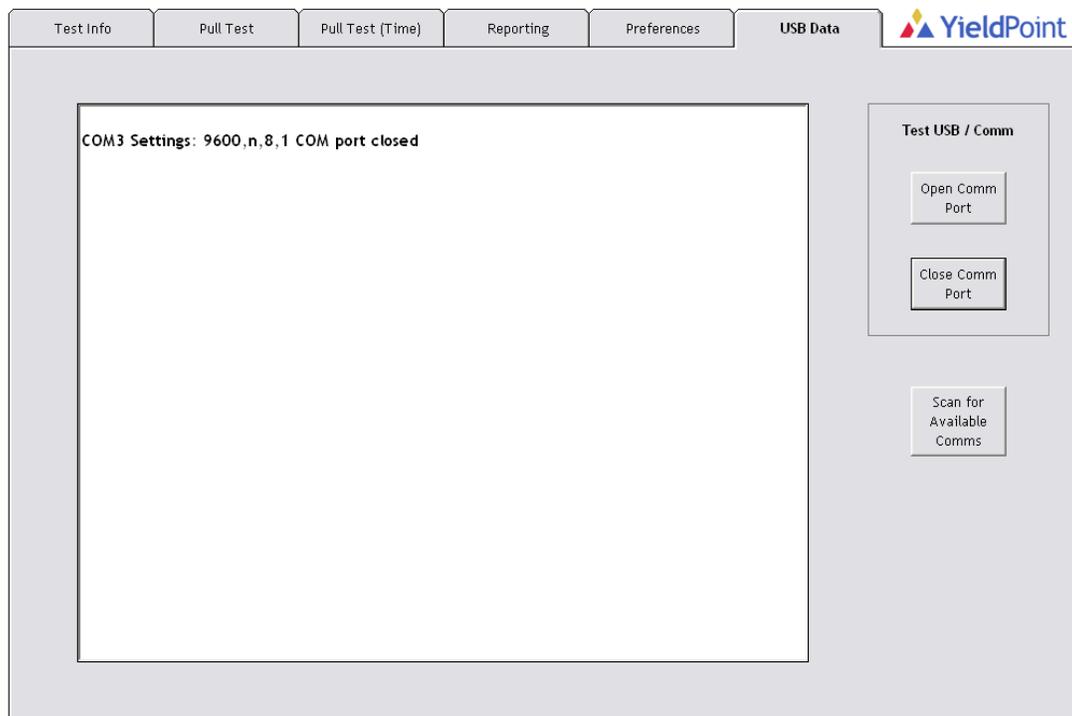
3.8 The Comms Tab

Figure 12. The comms Tab

The Comms tab is primarily used to select a COM port and then ensure that COM port is functional and correct. Click the "Open Comm Port" button to open the default COM. Any error messages are displayed in the main screen. If the COM is correct and the USB is plugged in to the PC, the incoming raw data should be shown in this window as well. Click the "Close Comm Port" to close the port and free up the COM for testing. If you have ensured that the USB is

properly connected, and there is no incoming data being shown, the most likely reason is that the COM port number selected as default is not correct.

Click the "Scan for Available Comms" button to scan the PC for any usable COM ports. Select the port to be used from the dropdown list.
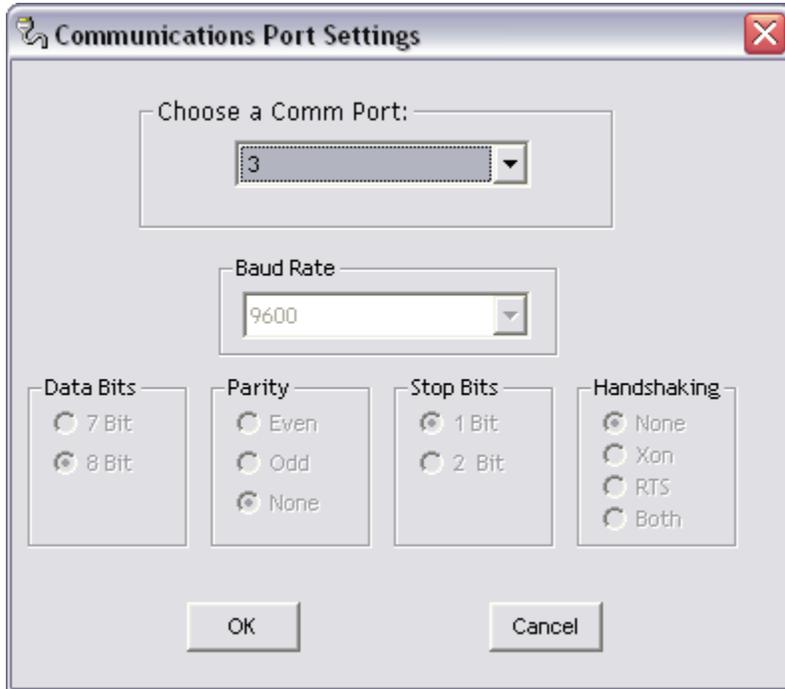

Figure 12 The Com Port settings

Click OK to close the form and use the selected port, or click Cancel to abort.

Step 1: The RCH cylinder and stand should be bolted together using the bolts which are supplied (middle).

Step 2: Assemble the Displacement Sensor Clamp
The displacement sensor clamp should be assembled as shown below.

Step 3: Clamp the displacement sensor to the cylinder.
Step 4: Add the Displacement actuator.
The actuator contains a ring magnet which interacts with the displacement sensor to measure
load. A spare ring magnet was supplied.

APPENDIX 2:

This information can be found at: http://www.enerpac.com/en-us/print/3502

RCH-Series, Hollow Plunger Cylinders

- Enerpac hollow plunger cylinders provide versatility in testing, maintenance and tensioning applications. The hollow plunger design allows for both pull and push forces
- Single-acting spring return
- Cylinders are nickel-plated, floating center tube on models over 20 tons increases product life
- Baked enamel finish for increased corrosion resistance
- Collar threads for easy fixturing
- RCH-120 cylinders include AR-630 coupler and has 1/4 NPTF port
- RCH-121 and RCH-1211 cylinders have FZ-1630 reducer and AR-630 coupler, all other models feature CR-400 coupler

Chart (Imperial) | **Chart (Metric)** | **Downloads** | **Applications**

Cylinder Capacity	Stroke	Model Number	Cylinder Effective rea	Oil Capacity	Collapsed Height	Extended Height	Outside Diameter	Center Hole Dia.	Weight
tons (max)	(in)		(in^2)	(in^3)	(in)	(in)	(in)	(in)	(lbs)
	0.31	RCH-120	2.76	0.86	2.19	2.5	2.75	0.77	3.2
	1.63	RCH-121*	2.76	4.49	4.75	6.38	2.75	0.77	6.2
12 (13.8)	1.63	RCH-1211	2.76	4.49	4.75	6.38	2.75	0.77	6.2
	3.00	RCH-123	2.76	8.29	7.25	10.25	2.75	0.77	9.8
20 (23.6)	2.00	RCH-202*	4.72	9.46	6.38	8.38	3.88	1.06	17
	6.10	RCH-206	4.72	28.67	12.05	18.11	3.88	1.06	31
30 (36.1)	2.50	RCH-302*	7.22	18.05	7.03	9.53	4.50	1.31	24
	6.13	RCH-306	7.22	44.23	13.00	19.13	4.50	1.31	48
60 (63.6)	3.00	RCH-603*	12.73	38.20	9.75	12.75	6.25	2.12	62
	6.00	RCH-606	12.73	76.41	12.75	18.75	6.25	2.12	78
100 (103.1)	3.00	RCH-1003*	20.63	61.88	10.00	13.00	8.38	3.11	132

Step 4: Add the donut load cell.
It is of paramount importance that the load cell be inserted between the two flat platens. Failure to compress the load cell between two flat surfaces may result in inaccurate readings. Eccentric loading may also result in inaccurate load cell reading. Always compare load cell reading with the pressure in the line multiplied by the area of the cylinder.