MACTECH
PEMS 2.1
PIPE END MEASUREMENT SYSTEM
SETUP AND OPERATION MANUAL

Model	PEMS 2.1
Description	Pipe End Measurement System 2.1
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REVISIONS

NOTE: *Information contained within this manual is not to be used without the written consent of Mactech.*

Revision Level	ECO No.	Description	Date
A	n/a	Initial Release	1/14/2016
B	n/a	Updated instructions for 2.0 Software, Added Leg Setup	11/11/2022
C	n/a	Updated instructions for 2.0 Software, Added Single Sensor Setup	12/2/2022
D	n/a	Updated Range for Bar and Legs	11/27/2023
E	n/a	Updated to PEMS 2.1, Add 0.5" Range instructions, Updated Exporting Data	1/5/2024
F	n/a	Updates to: 4"-16" Leg attachment, New Measurment Session, Calibration	4/22/2024
G	n/a	Updated Calibration Ring chart	9/23/2024

TABLE OF CONTENTS

SECTION 1 - DESCRIPTION

This procedure describes the step-by-step operation of the PEMS tool and software. The procedure guides the user through the entire process to configure and install the tool, set up a measurement session in the software, and analyze the data produced by the measurement session.

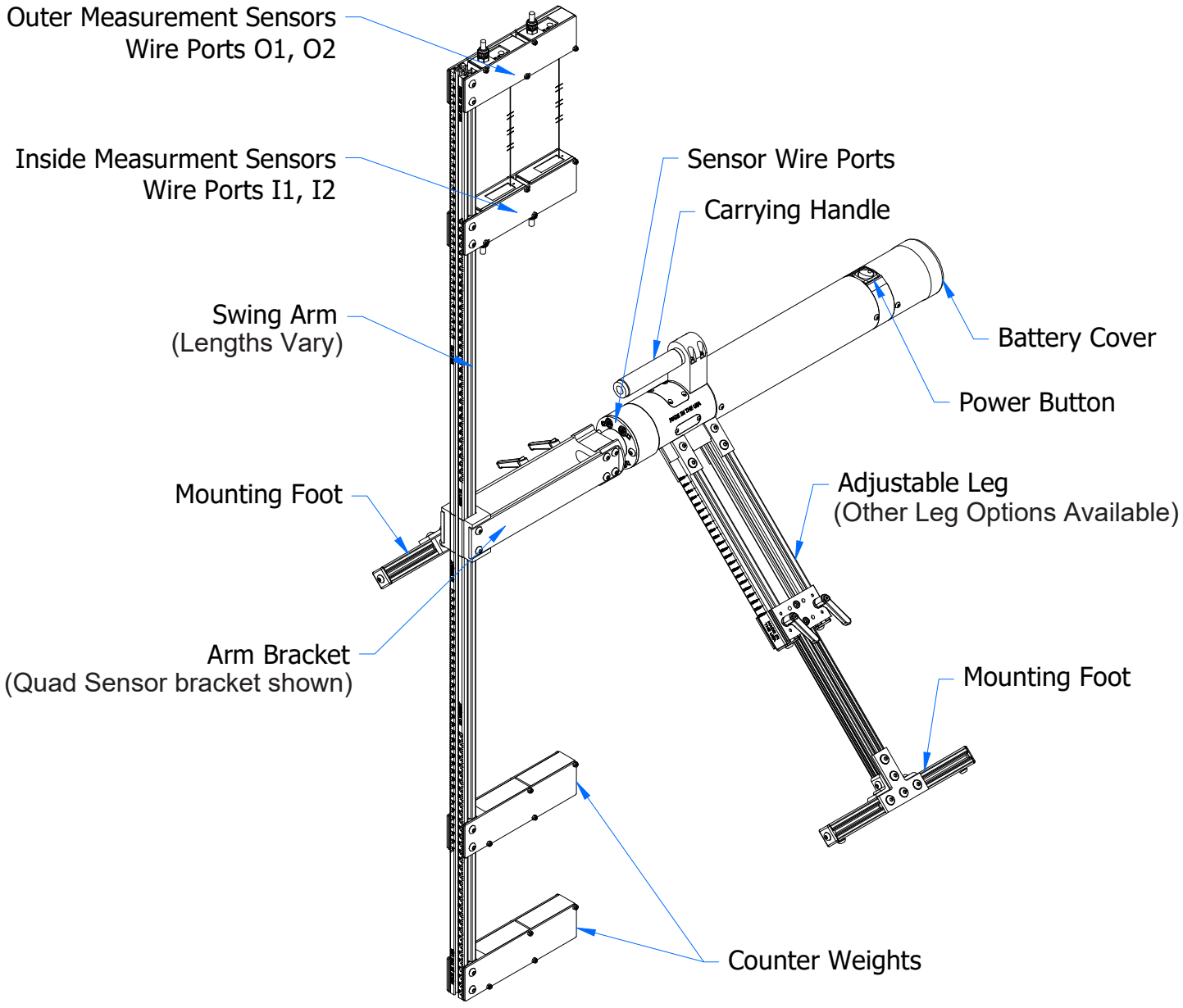


Figure 1-1 - PEMS Components

SECTION 1 - DESCRIPTION

Measurement Sensor Configurations

The measurement sensors for the PEMS unit can be configured in a variety of positions and pairings on the swing arm to achieve your measurement goals (see fig. 1-2 below). Each sensor used is paired with a counterweight on the opposite end of the swing arm in the equivalent position.
Pair or Single sensors also require shorter sensor plates and swing arm bracket, while Dual or Quad require the longer plates and bracket (see fig. 1-3 below).
Note: *The number of Measurement Sensors, brackets, and counterweights will vary depending on what you have ordered.*

Pair: Single measurement sensors for both Outer and Inside Diameter
Single O.D. or I.D.: Only one sensor installed in either the O.D. or I.D. position

Quad: Dual measurement sensors for both Outer and Inside Diameter
Dual O.D. or I.D.: Dual sensors installed in either the O.D. or I.D. position

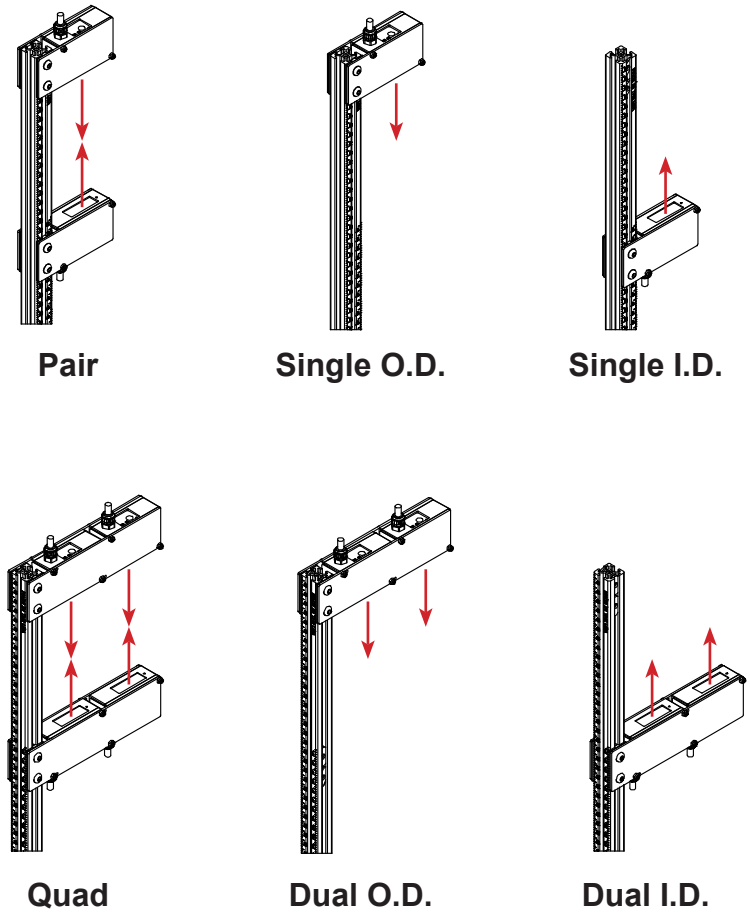


Figure 1-2 - Measurement Sensor Configurations

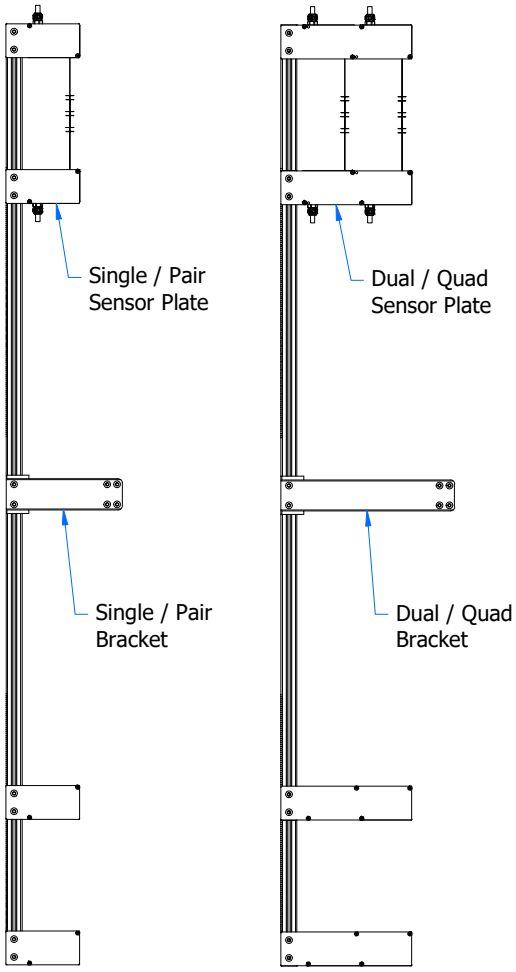


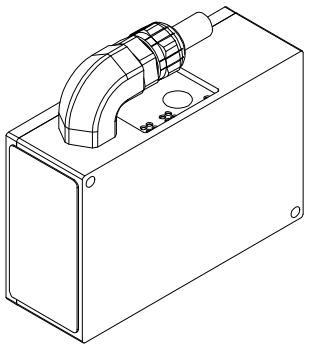
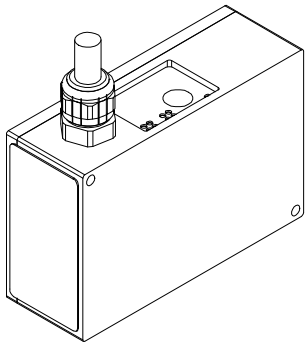
Figure 1-3 - Sensor Plates and Arm Brackets

SECTION 1 - DESCRIPTION

Measurement Sensor Model Types

Different Measurement Sensors are used for different ranges measurement and laser measurement range to accommodate the bore sizes. Below is a table of the different sensor models, their measurement range, and which swing arm they are compatible with.

NOTE: *The swing arms are created with specific sensor measurement ranges in mind, the sensors can only work with its listed swing arms and can not be swapped. Check your sales order for which sensors and arms you have ordered.*

Sensor Model	Range	Compatible Swing Arms	
AP7110205 Mactech #800-0155 0.5" Range (12mm)	0.5" (12mm) reading range within 1" to 1.5" (25-38mm) of the pipe wall. Small bore diameter readings from 4.2" to 16" (107-406mm)	#820-0259 - 16" O.D. *Note: Minimum on this bar is 4.2"*	
AP7010020 Mactech #800-0133 2.0" Range (51mm)	2" (51mm) reading range within 2.38" to 4.38" (60-111mm) of the pipe wall. Larger bore diameter readings from 15" to 58" (381-1473mm)	#820-0225 - 24" O.D. #820-0226 - 32" O.D. #820-0224 - 48" O.D. #820-0250 - 56" O.D. *Note: Minimum on these bars is 14"*	

SECTION 2 - SETUP

Charging the Battery

The battery pack is accessed by removing the black dust cap off the end of the PEMS unit and disconnecting the linkage.

To prevent damage to this charger or injury to yourself or to others, please read the following instructions before using this charger (for expanded details refer to the instructions included with the charger itself).

The charger is designed for fast charging Ni-Cd and Ni-MH battery packs from 9.6V to 18.0V.
Charging time is roughly 3 Hours for the 12V 4500mAh battery included with the PEMS unit.

1. Connect the battery pack to output connector and plug AC power source.
2. Make sure battery polarity is connected correctly (Red wire is positive).
3. When the unit is connected to an AC source the Red and Green LED lights will flash two times and then both will turn off.
4. When the battery pack is connected the Red LED will shine for as long as it is charging.
5. The Green LED light will shine when the battery is fully charged and the charger will switch to a trickle charge.

⚠	***CAUTION:*** *The charger is designed for indoor use only. The charger should be horizontally positioned and work in a well ventilated condition. Avoid wet surfaces and keep it away from flammable or explosive chemicals. When charging, the charger can reach an ambient temperature of 25C / 77F. Cut off the power supply before connecting or disconnecting the charger with batteries. Do not try to disassemble the charger -- high voltage inside.*

SECTION 2 - SETUP

This section describes the setup that is required of the Pipe End Measurement System. Refer to the assembly drawings in the provided Drawing Package for more specific details.

Attaching Calibration Ring to Pipe

Calibration Rings of varying sizes are available and attach to the end of a pipe. This allows a round ring for the PEMS to calibrate against. See fig. 2-1 below

1. Select the calibration ring that matches the outer diameter of the pipe that is being measured.
2. The calibration ring has a series of magnets to affix the ring to the face of the pipe.
3. The calibration ring has a series of centering brackets that should be positioned on the top half of the pipe. These allow extra support to the magnets by hanging the calibration ring on the pipe.
4. Use the Face Adjustment Screws to square the calibration ring if the pipe face is not square.
5. Adjust the centering bracket screws until the ring is centered within 1/16" (1.5mm)

Note: *Refer to the Calibration Rings drawing within the provided drawing package for more detailed setting parameters.*

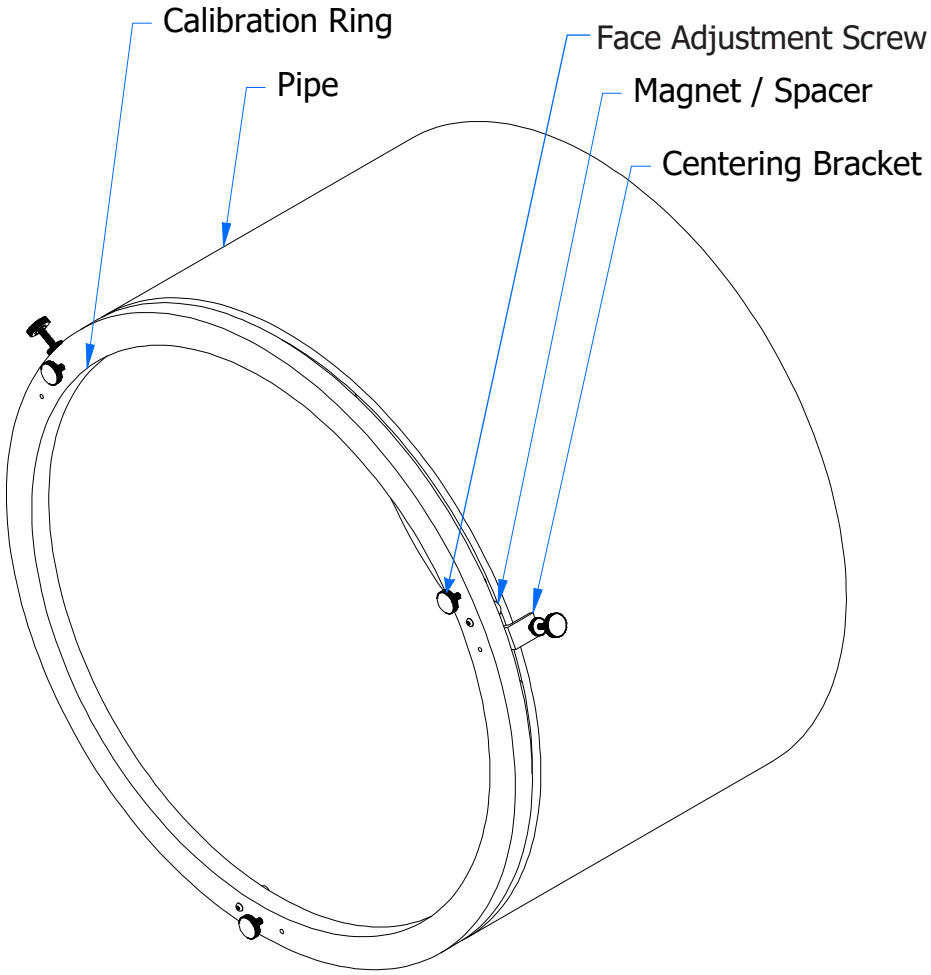


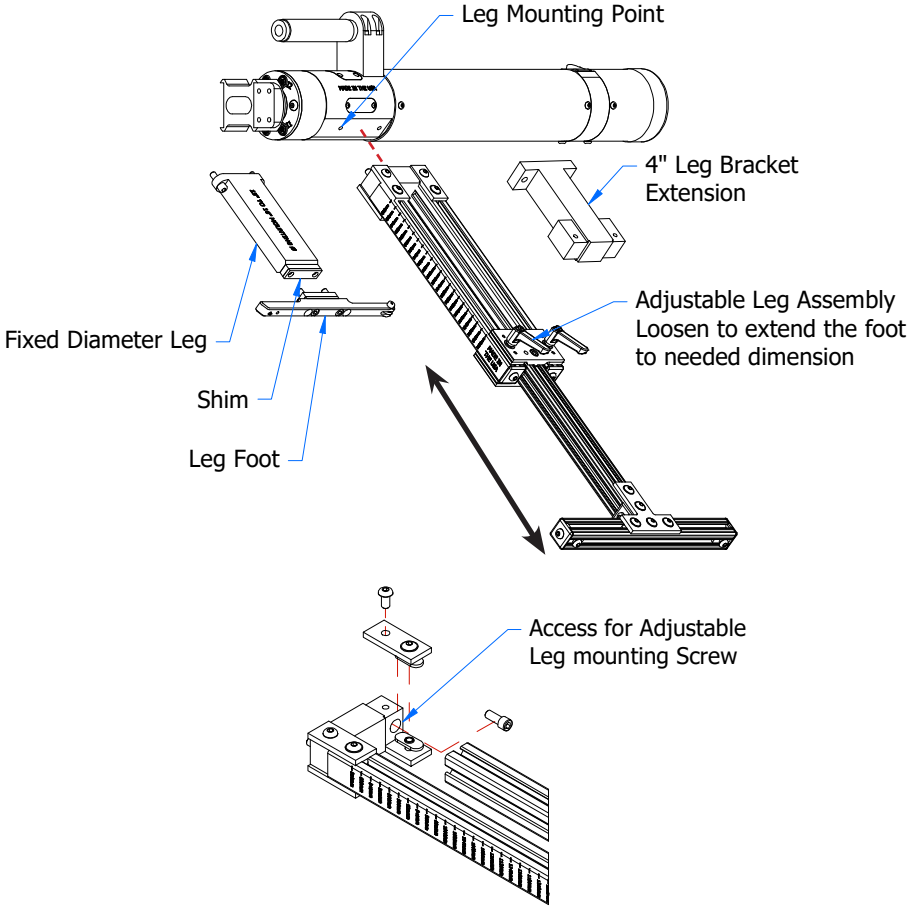
Figure 2-1 - Calibration Ring

SECTION 2 - SETUP

Attach Legs to PEMS Unit (15" to 56"Ø with 2" Range Sensor)

NOTE: The correct legs needs to be chosen in order to position the PEMS unit within the center of the pipe. These legs are designed to be used with the 2" range measurement sensor.

1. Measure the interior diameter of the pipe and establish the center point. Use this measurement to determine which leg assembly will be needed.
2. Attach a matching pair of legs on each side of the PEMS unit. The 15" to 20"Ø legs have a pair of accessible screws to attach the legs to the mounting points. The adjustable legs require you to remove four flat plates to access the mounting screws. The 4" extension bracket connects via these four flat plates as well. See fig. 2-2 below
3. Place the PEMS unit with the legs attached and confirm that it is within the center of the pipe. Adjust or change the legs if necessary.



Leg Assembly and Shim Combinations (2" Range Sensor)		
Mounting Ø	Leg Part #	Shim / Extension Part #
15" to 15.25"	820-0163	-
15.25" to 15.5"	820-0163	820-0175
15.5" to 15.75"	820-0163	820-0176
15.75" to 16"	820-0163	820-0175+820-0176
16" to 16.25"	820-0162	-
16.25" to 16.5"	820-0162	820-0175
16.5" to 16.75"	820-0162	820-0176
16.75" to 17"	820-0162	820-0175+820-0176
17" to 17.25"	820-0161	-
17.25" to 17.5"	820-0161	820-0175
17.5" to 17.75"	820-0161	820-0176
17.75" to 18"	820-0161	820-0175+820-0176
18" to 18.25"	820-0160	-
18.25" to 18.5"	820-0160	820-0175
18.5" to 18.75"	820-0160	820-0176
18.75" to 19"	820-0160	820-0175+820-0176
19" to 19.25"	820-0159	-
19.25" to 19.5"	820-0159	820-0175
19.5" to 19.75"	820-0159	820-0176
19.75" to 20"	820-0159	820-0175+820-0176
20" to 24"	800-0117	N/A - Adjustable
24" to 32"	800-0116	N/A - Adjustable
32" to 48"	800-0111	N/A - Adjustable
40" to 56"	800-0111	820-0242

Figure 2-2 - Attaching Legs

SECTION 2 - SETUP

Attach Legs to PEMS Unit (4" to 16"Ø with 0.5" Range Sensor)

NOTE: The correct legs needs to be chosen in order to position the PEMS unit within the center of the pipe. These legs are designed to be used with the 0.5" range measurement sensor.

1. Measure the inside diameter of the pipe and establish the center point. Use this measurement to determine which leg assembly will be needed.
2. Attach the matching pair of legs for the size range needed on each side of the PEMS unit. The sets of legs for this range require the PEMS unit be turned over so that the power button is facing down and for the handle to be detached. See fig. 2-3 below.
3. To adjust the leg length after the legs have been mounted: **800-0162** you will loosen the mounting screws and then turn the adjustment screw on both legs until the base of the mounting plate matches the measurement line, then re-tighten the mounting screws. **800-0163** flip the lock lever to allow the leg to be slid so the base of the mounting plate matches the measurement line. See fig. 2-3 below.

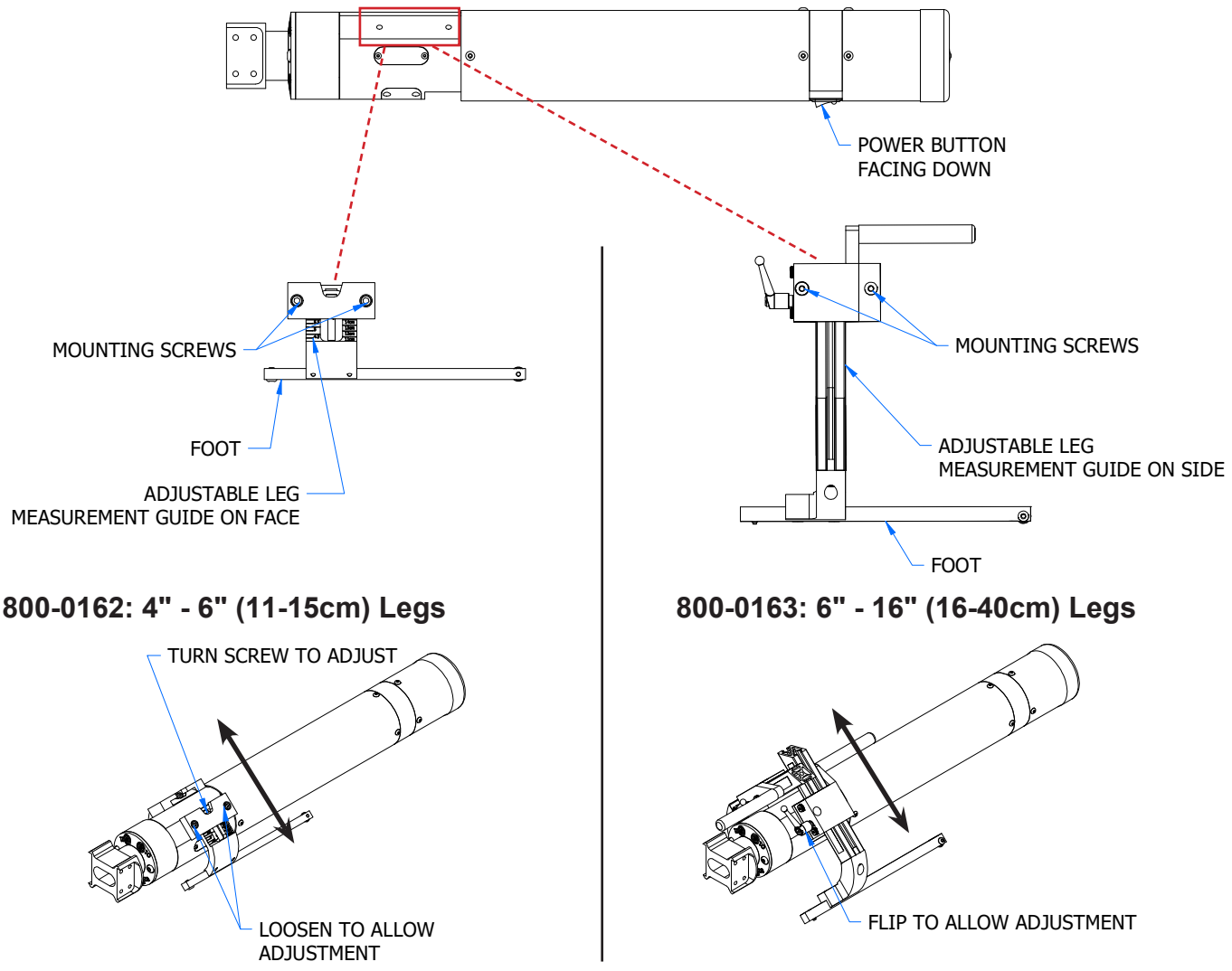


Figure 2-3 - Attaching and Adjusting 4"-16"Ø Legs

SECTION 2 - SETUP

Position Measurement Sensors and Counterweights

Attach the measurement sensors and counter weights to the swing arm based on the diameter(s) of the pipe. Follow the instructions below and reference the chart on the next page for where the sensors should be placed.

NOTE: *Ensure you are using the sensor with the needed range, see pg. 1-3 for sensor details.*

1. Attach the arm attachment bracket to the center of the swing arm. Remember that there is separate brackets if operating a Pair/Single or Dual/Quad sensor setup. See fig. 2-5
2. On the next page there is a chart for the nominal pipe sizes and its equivalent calibration ring that will be used for ensuring the sensors are positioned correctly. Each size listing also has the OD measuring range, as well as the ID sensor position options (due to varying wall thicknesses). See fig. 2-4 below on how to use the chart:

Nominal Pipe Size and Calibration Ring Size. The OD Sensor is placed at this same point on the swing arms measurment label.

The OD Sensor will cover this OD pipe size range when placed at the "OD Sensor Position"

Type of Sensor

Calibration Ring Measuring Range - 2" Sensor			
OD Sensor Position Matches Pipe Size and Cal. Ring	**OD Measuring Range**	**ID Sensor Position**	**ID Measuring Range**
22" / 559mm	20.625 - 23.375" 524 - 593mm	17.75" / 450mm	16.375 - 19.125" 416 - 485mm
		20.25" / 514mm	18.875 - 21.625" 479 - 549mm
Based on .25" max pipe out of roundness and .13" total setup accuracy ranges increase with rounder pipe and more accurate setups.			

Place the ID sensor at this point on the swing arms measurment label to meansure the ID range listed in the "ID Measuring Range" column

The ID range that can be measured when the senor is placed in the "ID Sensor Position" column

Figure 2-4 - How to use sensor position and measurement range chart

3. Attaching the I.D. sensor: Measure the diameter of the inside wall of the pipe. Find the measuring range listed on the chart and determine which sensor position it falls into. Slide the sensor onto the swing arm and match it on the established ID Sensor Position mark.
4. Attaching O.D. sensor: Measure the diameter of the outside wall of the pipe and match it with its Nominal Pipe size. Slide the sensor onto the swing arm and match it on the established OD Sensor Position mark.
5. Attach the counter weights on the other end of the swing arm in positions matching the two sensors.
6. The swing arm can now be attached to the PEMS unit.

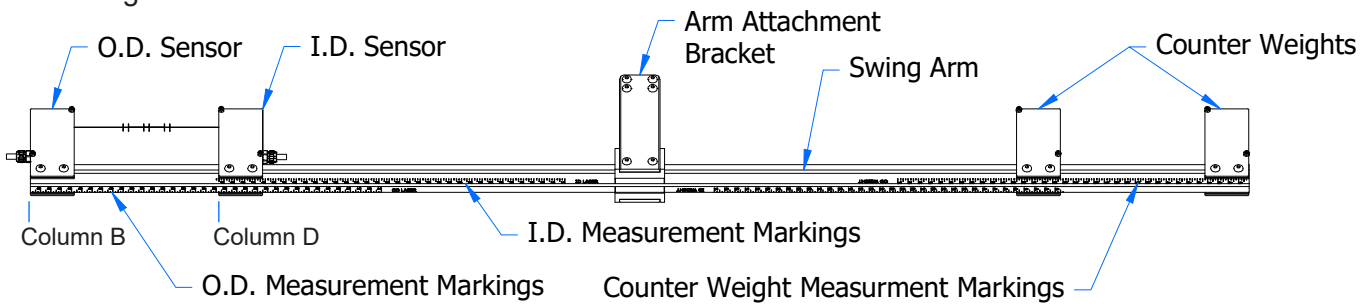


Figure 2-5 - Sensor Position Chart for Swing Arm

SECTION 2 - SETUP

Sensor Position and Measurment Range Chart

Calibration Ring Measuring Range - 1/2" Sensor			
OD Sensor Position Matches Pipe Size and Cal. Ring	**OD Measuring Range**	**ID Sensor Position**	**ID Measuring Range**
5" 127mm	5.25 - 6.0" 133 - 152mm	8.125" 206 mm	4.75" - 5.5" 120 - 139mm
		7.375" 187mm	4.0" - 4.75" 101 - 120mm
		6.625" 168mm	3.25" - 4.0" 82 - 101mm
		5.875" 149mm	2.5" - 3.25" 63 - 82mm
6" 152mm	6.25 - 7.0" 158 - 177mm	6.125" 155mm	5.75" - 6.5" 146 - 165mm
		7.375" 187mm	5.0" - 5.75" 127 - 146mm
		6.625" 168mm	4.25" - 5.0" 108 - 127mm
		5.875" 149mm	3.5" - 4.25" 89 - 108mm
Based on .125 max pipe out of roundness and .0625 total setup accuracy ranges increase with rounder pipe and more accurate setups.			

Calibration Ring Measuring Range - 2" Sensor			
OD Sensor Position Matches Pipe Size and Cal. Ring	**OD Measuring Range**	**ID Sensor Position**	**ID Measuring Range**
8" 203mm	7.25 - 10" 184 - 254mm	6.875" 174mm	5.5 - 8.25" 139 - 209mm
10" 254mm	9.375 - 12.125" 238 - 308mm	9" 228mm	7.625 - 10.375" 193 - 263mm
		6.5" 165mm	5.125 - 7.875" 130 - 200mm
12" 304mm	11.375 - 14.125" 289 - 358mm	11" 279mm	9.625 - 12/375" 244 - 314mm
		8.5" 215mm	7.125 - 9.875" 181 - 251mm
14" 355mm	12.625 - 15.375" 320 - 390mm	12.25" 311mm	10.875 - 13.625" 276 - 346mm
		9.75" 247mm	8.375 - 11.125" 212 - 282mm
16" 406mm	14.625 - 17.375 371 - 441mm	14.25" 361mm	12.875 - 15.625" 327 - 396mm
		11.75" 298mm	10.375 - 13.125" 263 - 333mm
18" 457mm	16.625 - 19.375" 422 - 492mm	16.25" 412mm	14.875- 17.625" 377 - 447mm
		13.75" 349mm	12.375 - 15.125" 314 - 384mm
20" 508mm	18.625 - 21.375" 473 - 542mm	18.25" 463mm	16.875 - 19.625" 428 - 498mm
		15.75" 400mm	14.375 - 17.125" 365 - 435mm
Based on .25 max pipe out of roundness and .13 total setup accuracy ranges increase with rounder pipe and more accurate setups.			

Calibration Ring Measuring Range - 2" Sensor			
OD Sensor Position Matches Pipe Size and Cal. Ring	**OD Measuring Range**	**ID Sensor Setting**	**ID Measuring Range**
22" 559mm	20.625 - 23.375" 524 - 593mm	20.25" 514mm	18.875 - 21.625" 479 - 549mm
		17.75" 450mm	16.375 - 19.125" 416 - 485mm
30" 762mm	28.625 - 31.375" 727 - 796mm	28.25" 717mm	26.875 - 29.625" 682 - 752mm
		25.75" 654mm	24.375 - 27.125" 619 - 688mm
32" 812mm	30.625 - 33.375" 777 - 847mm	30.25" 768mm	28.875 - 31.625" 733 - 803mm
		27.75" 704mm	26.375 - 29.125" 669 - 739mm
34" 863mm	32.625 - 35.375" 828 - 898mm	32.25" 819mm	30.875 - 33.625" 784 - 854mm
		29.75" 755mm	28.375 - 31.125" 720 - 790mm
36" 914mm	34.625 - 37.375" 879 - 949mm	34.25" 869mm	32.875 - 35.625" 835 - 904mm
		31.75" 806mm	30.375 - 23.125" 771 - 841mm
40" 1016mm	38.625 - 41.375" 981 - 1050mm	38.25" 971mm	36.875 - 39.625" 936 -1006mm
		35.75" 908mm	34.375" - 37.125" 873 - 942mm
42" 1066mm	40.625 - 43.375" 1031 - 1101mm	40.25" 1022mm	38.875 - 41.525" 987 - 1057mm
		37.75" 958mm	36.375 - 39.125" 923 - 993mm
48" 1219mm	46.625 - 49.375" 1184 - 1254mm	46.25" 1174mm	44.875 - 46.625" 1139- 1209mm
		43.75" 1111mm	42.375 - 45.125" 1076 - 1146mm
56" 1422mm	54.625 - 57.375" 1387 - 1457mm	54.25" 1377mm	52.875 - 55.625" 1343 - 1412mm
		51.75" 1314mm	50.375 - 53.125" 1279 - 1349mm
Based on .25 max pipe out of roundness and .13 total setup accuracy ranges increase with rounder pipe and more accurate setups.			

SECTION 2 - SETUP

Attaching Swing Arm and Wiring the Measurement Sensors

The two measurement sensors need to be connected to the PEMS unit after the Swing arm has been attached. See fig. 2-6 below

1. Attach the assembled swing arm by its bracket to the central hub on the PEMS unit.
2. The wire attaches to the O.D. sensor plugs into the port marked O1 on the PEMS Unit.
   Note: *Align the red dots on the wire and housing to make connection.*
3. The wire attached to the I.D. sensor plugs into the port marked I1 on the PEMS Unit.
4. If using a Dual or Quad setup for the sensors, connect the back sensors to O2 and I2 ports on the PEMS unit.
5. O1 and I1 are FRONT sensors, and O2 and I2 are BACK sensors.
6. Tie off any excess wire to the swing arm so it won't be entangled as the swing arm rotates during operation.

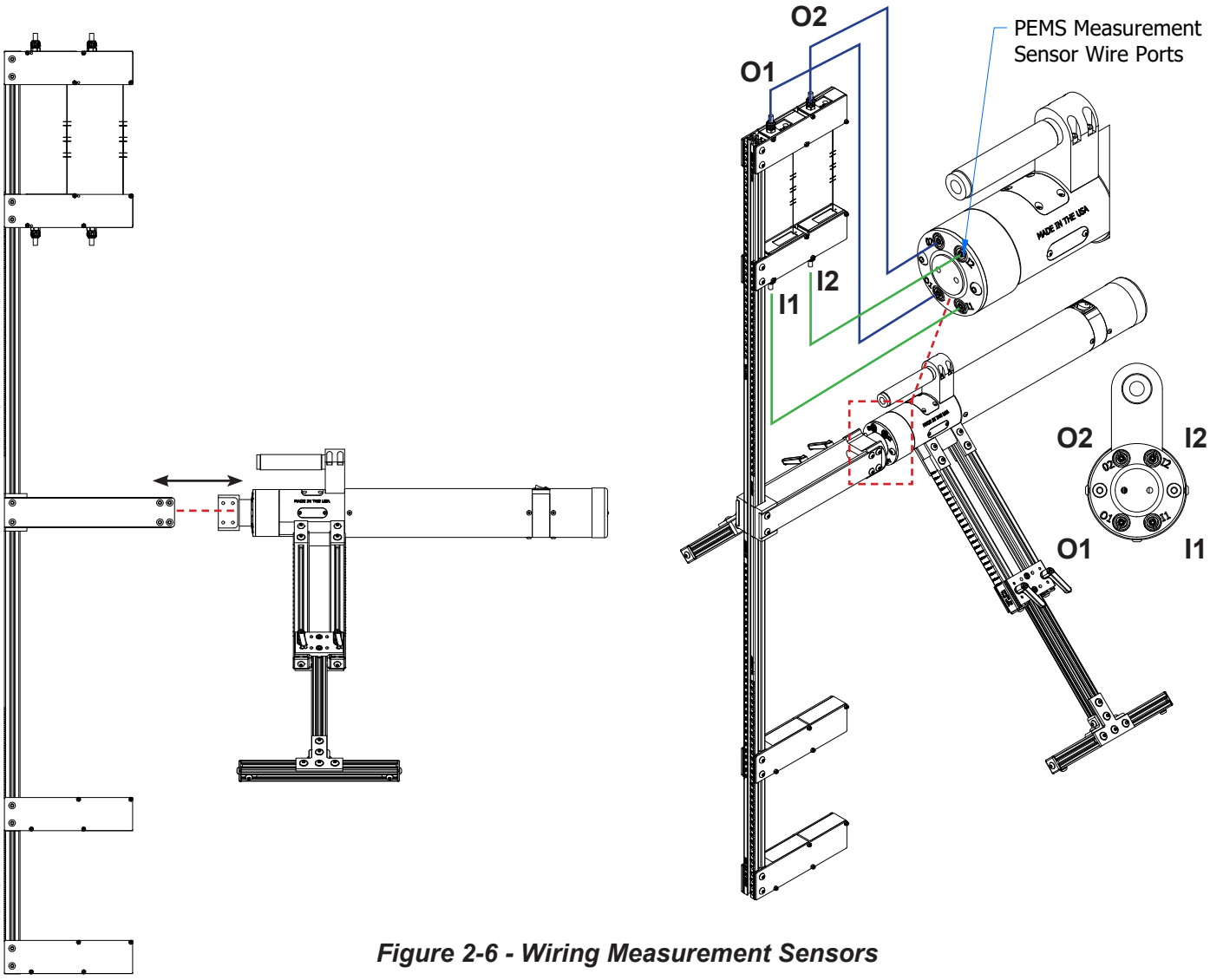


Figure 2-6 - Wiring Measurement Sensors

SECTION 2 - SETUP

Single / Pair Sensor Setup

If using a Single or Pair of sensor setup, ensure that the sensor is plugged into the proper ports on the PEMS Unit. See fig. 2-7 below

1. "I1" and "O1" ports on the PEMS Unit will report as "Front" readings in the software. Ensure the sensors closest to the swing arm are plugged into I1 or O1.
2. Do not connect a single sensor setup to a "Back" port, the software requires a "Front" port in order to properly calibrate.
3. Repeat with the other sensor if using a Pair setup.

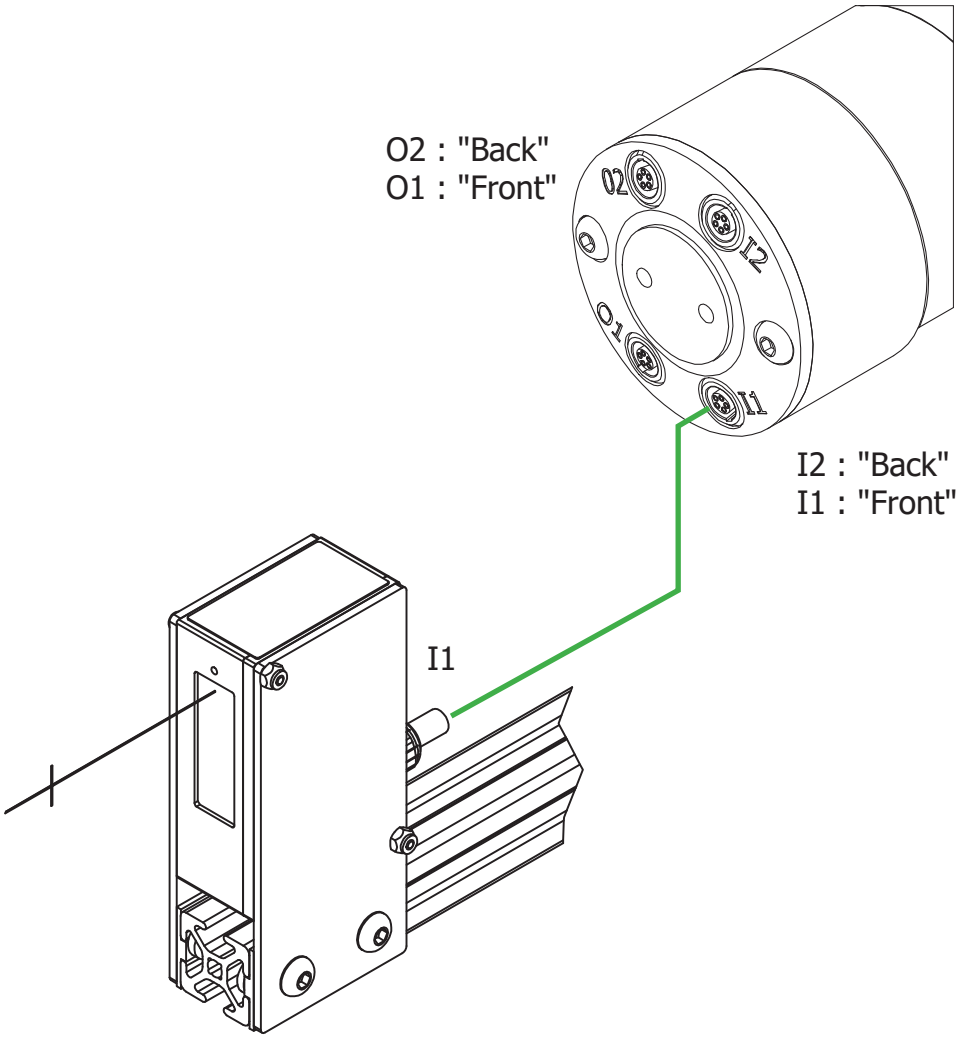


Figure 2-7 - Single Sensor Setup

SECTION 2 - SETUP

Dual / Quad Sensor Setup

If using a Dual or Quad Sensor setup ensure that the two sensors are plugged into the proper ports on the PEMS Unit. See fig. 2-8 below

1. "I1" and "O1" ports on the PEMS Unit will report as "Front" readings in the software. Ensure the sensors closest to the swing arm are plugged into I1 or O1.
2. "I2" and "O2" ports on the PEMS Unit will report as "Back" readings in the software. Ensure the sensors further into the pipe are plugged into I2 or O2.
3. Repeat with the other sensor if using a quad setup.

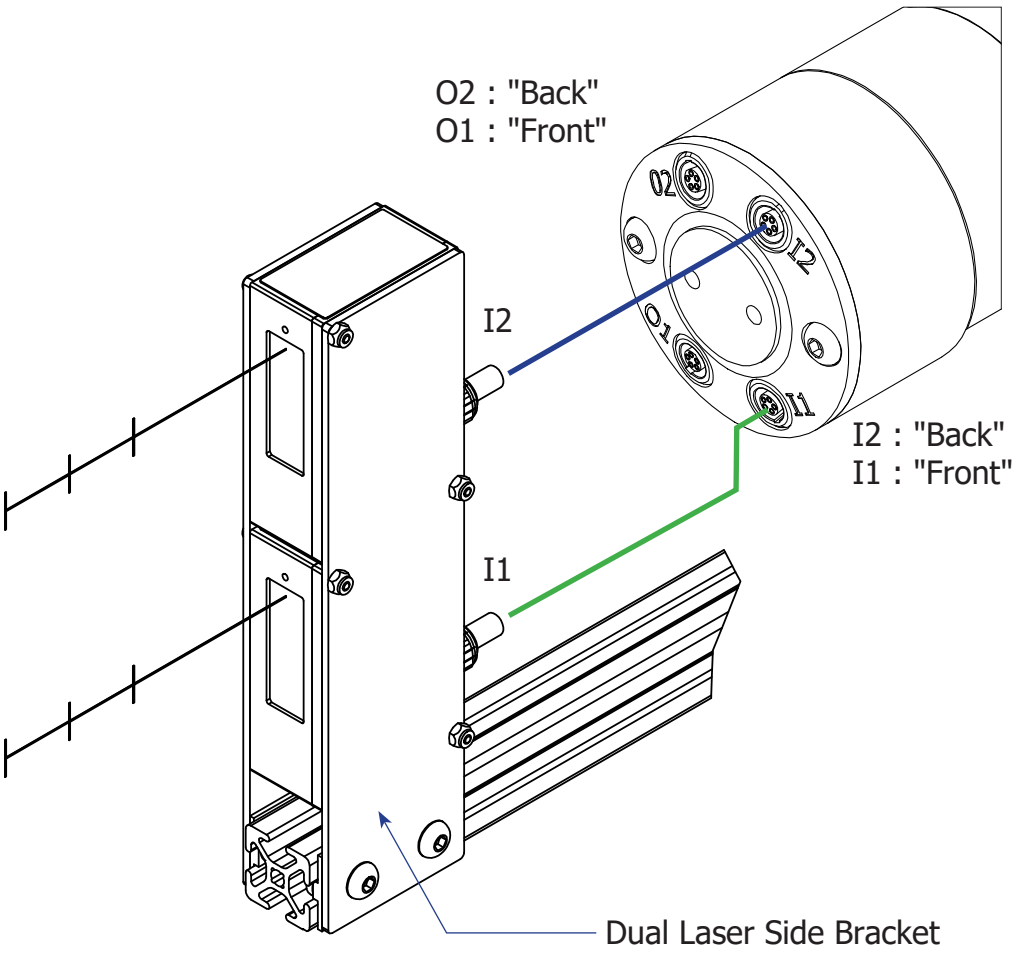


Figure 2-8 - Dual Sensor Setup

SECTION 2 - SETUP

Preparing the Software for Measurement

Power On the PEMS Unit

1. Press the power switch on top of the PEMS unit. See fig. 1-1
   NOTE: *Ensure PEMS Unit sensor wires have been connected prior to powering on. Connecting wires after powering on will result in measurement errors.*

2. It will illuminate red to indicate it has power from the battery. If the light does not turn on the battery needs to be charged. See page 2-1 for battery charging instructions.

Set the Computer Clock and Start the Applications

1. Turn on the computer. Enter your password to log on to the windows screen (NOTE: Default password is: PEMS).

2. Check the computer clock at the lower right corner of the windows screen. If the time is incorrect, double-click the clock and set to the current local time.

Ensure Computer is Connecting with PEMS Unit's wireless Network

1. Double click on the Network icon on the Windows task bar.

2. A Network with the same name as the PEMS unit should appear (after a few minutes) in the list of found networks. Click on the network and enter the Security Key password, by default the password will match the name of the PEMS network name (case sensitive).
   NOTE: *The name of the Unit is on a sticker above the wire ports on the PEMS unit.*

Start the PEMS Analyst application

1. Double-click the PEMS Analyst shortcut on the Windows desktop. See fig. 2-9

2. Set the PEMS Workspace (NOTE: will not ask if already established). Click on Browse and navigate to a folder where you want the PEMS data to be stored. Click on "Set as Default Workspace" to retain this setting for all future jobs. See fig. 2-10

Figure 2-9 - Desktop Shortcut

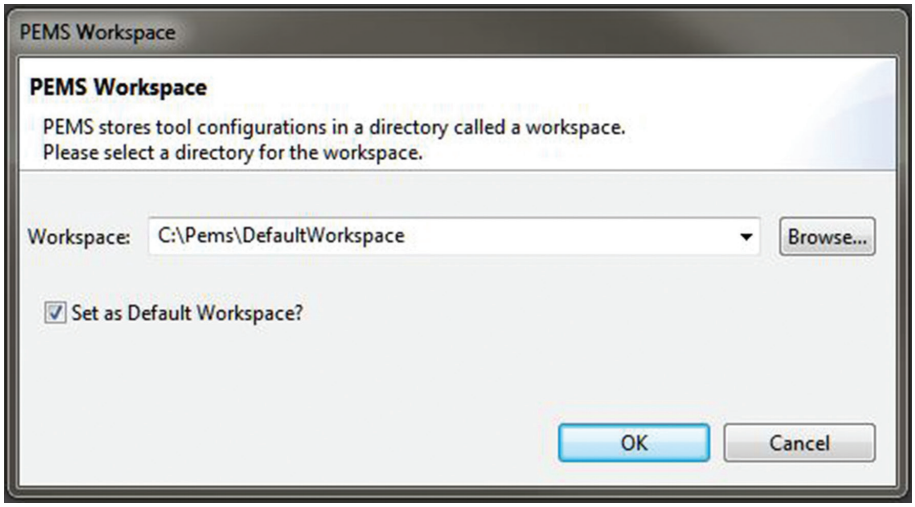
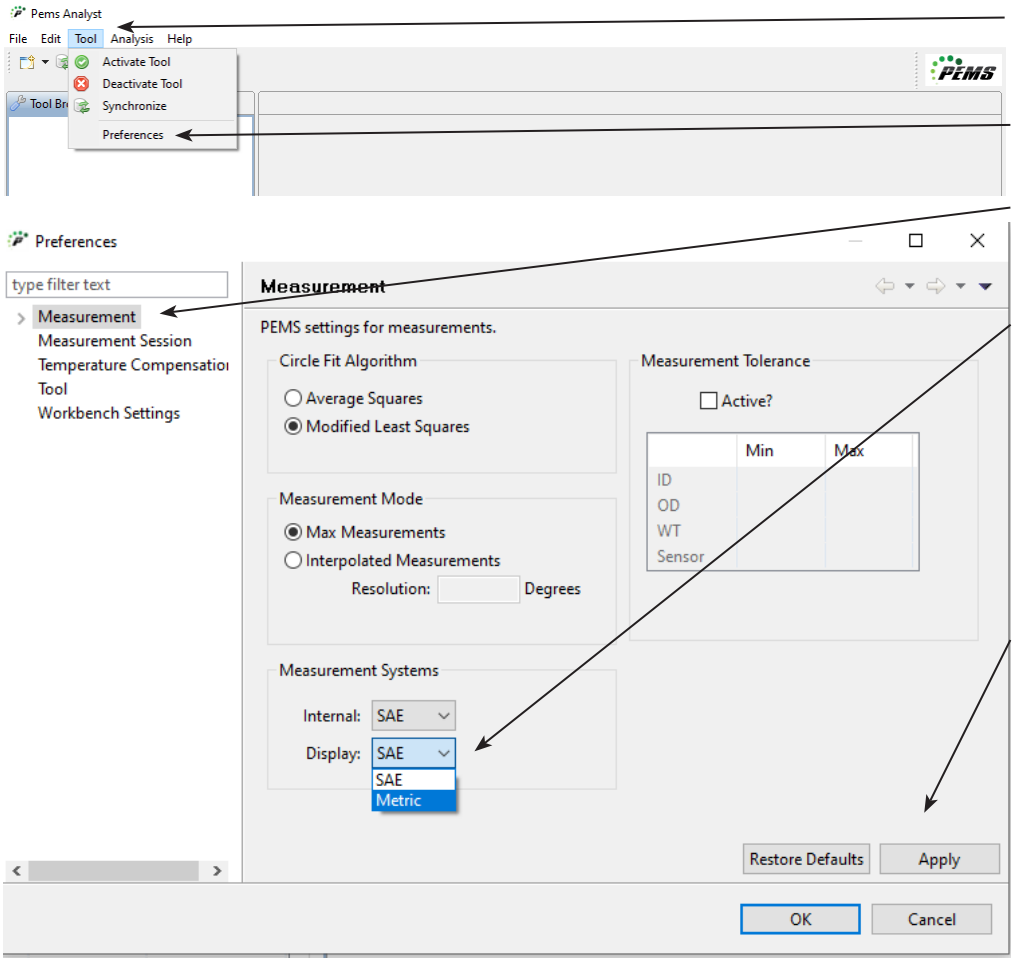


Figure 2-10 - Set the PEMS Workspace

SECTION 2 - SETUP

Choosing Unit of Measurement

In the Preferences the user can choose between SAE (Standard) or Metric measurements.



a. Choose "Tool" from the drop down menus.

b. Select "Preferences"

c. Click on "Measurement" in the left side column

d. In the "Measurement Systems" area choose SAE or Metric for the Display category.
Note: Leave the Internal setting as SAE regardless of Display preference.

e. Click on the "Apply" button and then the "OK" button.

f. Once these have been applied the PEMS Analyst software needs to be restarted. In the "File" drop down menu either choose "Restart" or close the software and reopen in. The measurement setting will remain set until the user changes them.

Figure 2-11 - Measurement Preferences

SECTION 2 - SETUP

Configure a New Tool

1. Creating a New Tool. Go to the PEMS Analyst window. Select File → New → Tool. See fig. 2-12.

   Any previous made Tools will be listed in the Tool Browser window.

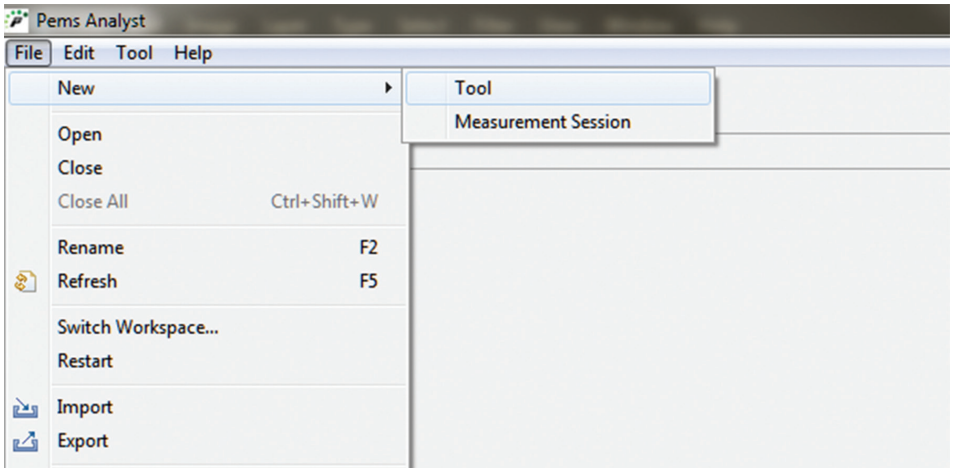
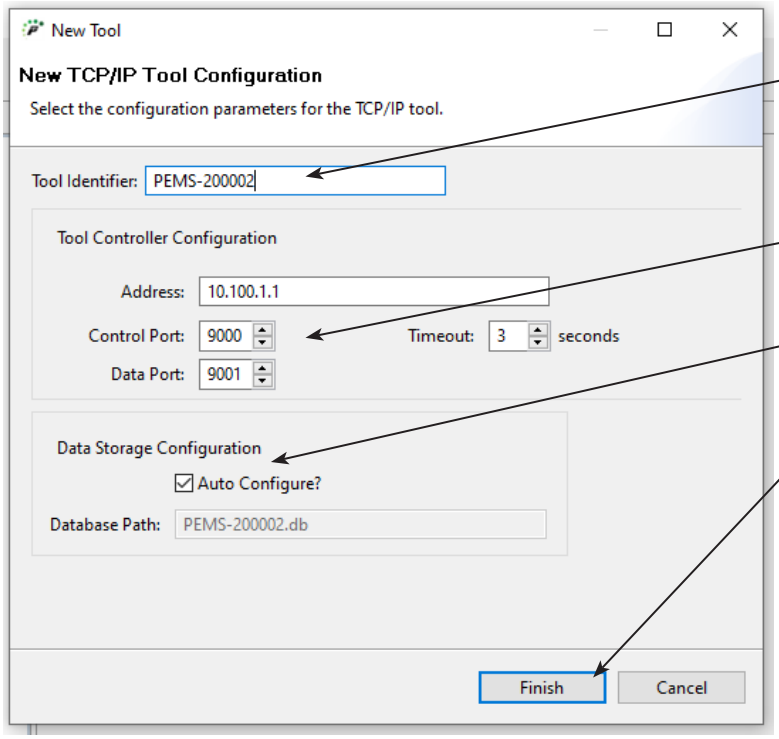


Figure 2-12 - Create a New Tool Configuration

2. Creating a New Tool opens the New Tool Configuration window. See fig. 2-13. Enter the values as shown in each of the fields.



a. Tool Identifier: Enter the tool name. The tool name is marked above the wire ports on the PEMS Unit. The tool name will be formatted such as "PEMS-200002", as an example.

b. The address and port information will be auto-populated in the address field.

c. Leave Auto Configure checked for Data Storage.

d. Once a tool has been selected, the finish button will become active. Click finish to add the configured PEMS tool.

Note: *Refer to "Advanced Configuration" on page 5-2 of the Troubleshooting section for additional options.*

Figure 2-13 - New Tool Configuration Example

SECTION 2 - SETUP

Create a New Measurement Session

1. Create a New Measurement Session. Go to the PEMS Analyst window. Select File → New → Measurement Session. See Figure 2-14.

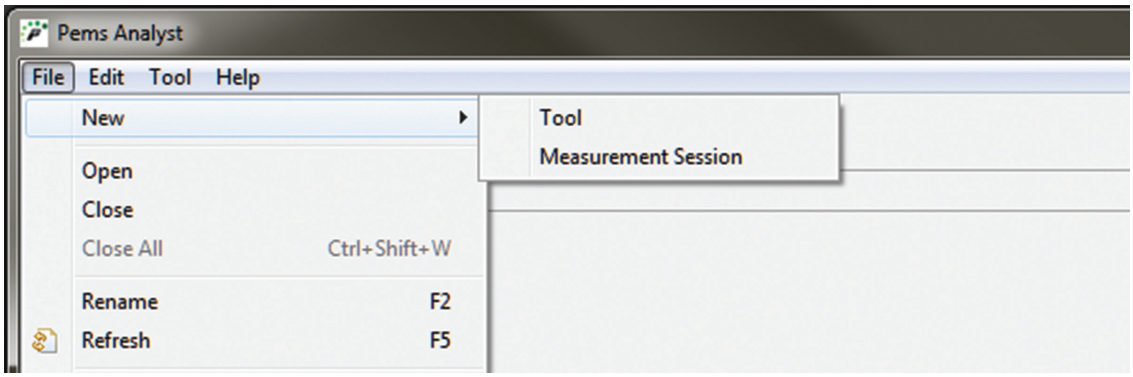


Figure 2-14 - Create New Measurement Session

2. Creating a New Measurement Session opens the New Measurement Session Configuration window. See Figure 2-15. Enter the values as shown in each of the fields.

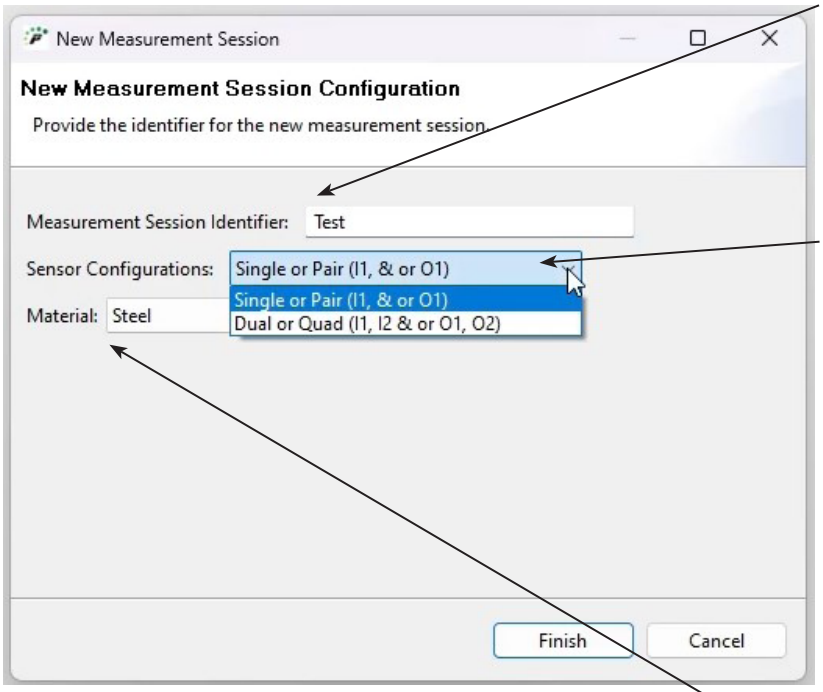


Figure 2-15 - New Measurement Session Configuration

a. Measurement Session Identifier: Enter a measurement session name. Use a name that identifies your unique measurement session. Establish the session naming convention at the beginning of the job.

b. Sensor Configurations: Use the drop-down menu to select the number of sensors used. Select:
Single of Pair (I1, & or O1): Select this if using one sensor for ID (I1) or OD (O1) alone, or a Pair plugged into I1 and O1 measuring ID and OD together.
Dual or Quad (I1, I2 & or O1, O2): Select this if using dual sensors for ID (I1 & I2) or OD (O1 & O2) alone, or a quad of sensors plugged into I1 & I2 and O1 & O2 measuring ID and OD together

c. Material: Use the drop-down menu to select the material, either Steel or Aluminum.

d. Click Finish to create a New Measurement Session.

SECTION 2 - SETUP

Calibration

1. In the Tool Browser, open (double-click) the Measurement Session you created. This opens the Measurement Session Summary. See fig. 2-16

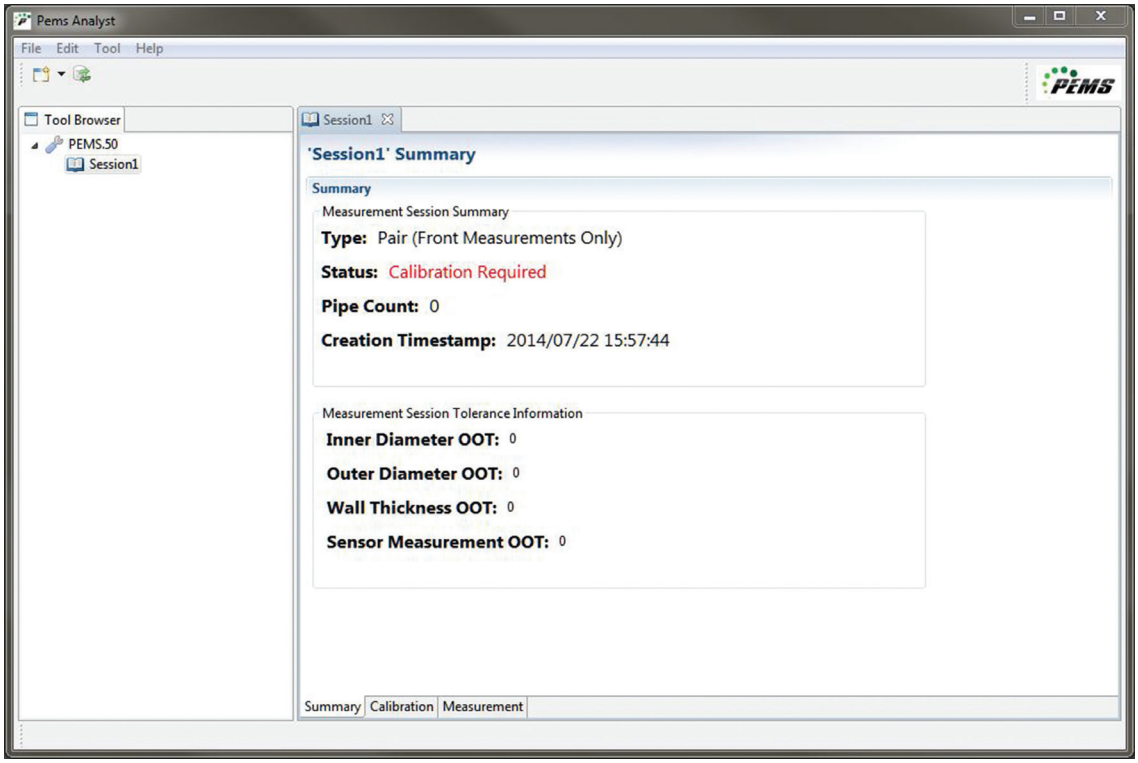


Figure 2-16 - Measurement Session Summary

2. Right click on the tool name in the Tool Browser and choose Activate to make connection with the PEMS unit.

3. If not already done so, install the calibration ring onto the pipe as outlined on page 2-2 of this manual and confirm measurement sensor positions on page 2-5 or 2-6.

4. Select the Calibration tab at the bottom of the Session window. Enter the information on the next page to define the pipe identification, dimensions, and other data required for calibration.
See fig. 2-17 on the next page. The step by step instructions continue on page 2-15.

SECTION 2 - SETUP

Calibration cont.

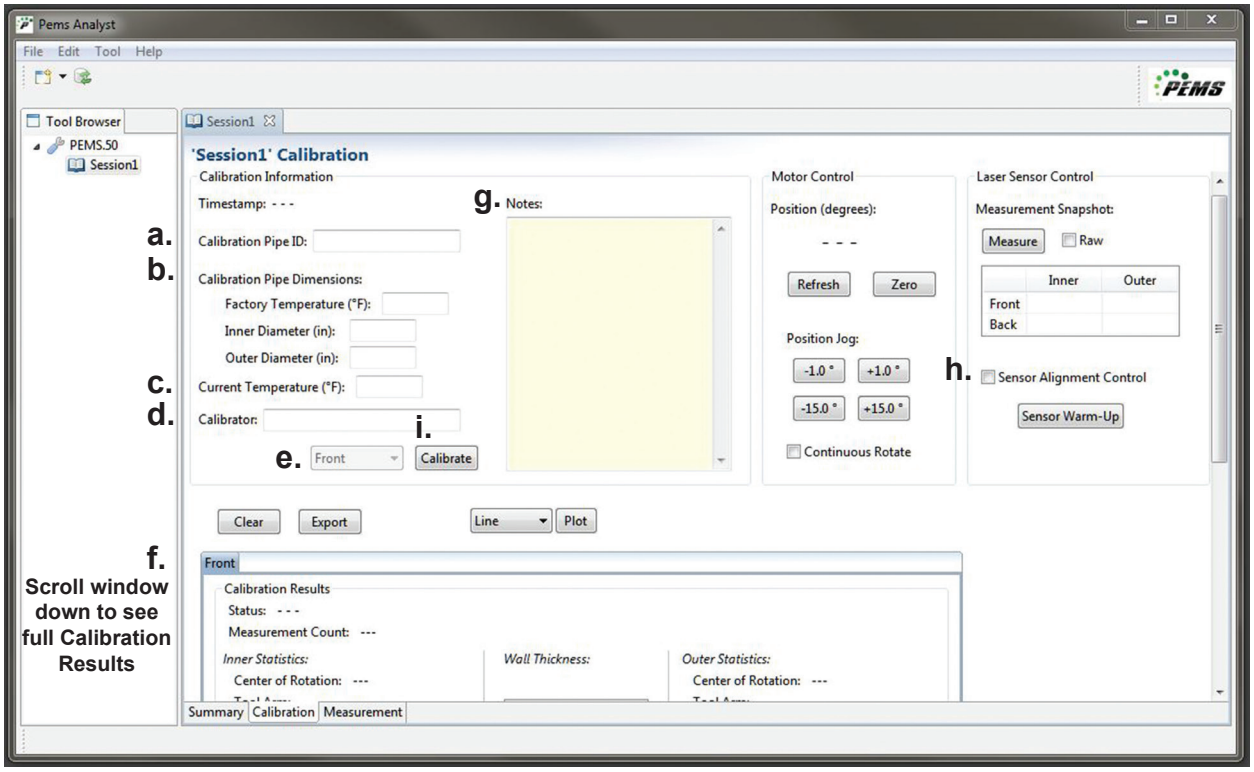


Figure 2-17 - Calibration Screen

a. Calibration Pipe ID: Enter the identification information for the Calibration Ring being used.

b. Calibration Pipe Dimensions:
- Factory Temperature (°F or °C): Enter the temperature (in degrees Fahrenheit) marked on the Calibration Ring.
- Inner Diameter (in/mm): Enter the inner diameter marked on the Calibration Ring.
- Outer Diameter (in/mm): Enter the outer diameter marked on the Calibration Ring.

***NOTE:** If the interior or exterior is not being measured enter that diameter as zero.*

c. Current Temperature: Allow the Calibration Ring to normalize to the ambient air temperature. Enter the current temperature of the Calibration Ring.

d. Calibrator: Enter the name of the technician performing the calibration.

e. If Quad was selected in Measurement Session Type, two calibrations must be performed, one each for the front and back of the dual sensors.

f. Calibration Results will be listed here. Front and Back sensors (depending on which chosen) will have the information separated. This information is needed to ensure the PEMS unit is centered properly in the pipe.

g. Notes: A typical note may include the distance from the face of the pipe to the front and back sensors.

Calibration continues on next page

SECTION 2 - SETUP

Calibration cont.

h. Sensor Alignment Control: Checking this box will turn on the measurement sensor laser so you can see where the laser is landing.

i. Calibrate Button: Pressing this will begin the arms rotation and measurements will be taken from the sensor lasers.

5. Ensure the measurement sensor you are calibrating is shining on the calibration ring and not the pipe. Check the "Sensor Alignment Control" box ("h" on the right side of fig. 2-17) to turn on the laser, and slide the PEMS unit to ensure the sensor is in the proper position.
NOTE: *Uncheck this box before running the calibration or measurement or it will report a "Failed Measurement"*

⚠	***CAUTION:*** *Do not make direct eye contact with the laser beam emanating from the sensor. Only view the laser from where it is making contact with a surface. Direct eye contact with the laser could cause harm to the users eyes.*

6. Position the laptop computer with a clear line of the sight to the front of the PEMS unit. If the signal has to path through the walls of the pipe it may not be as reliable.

7. Choose "Front" (see letter "e" on fig 2-17) to calibrate the front sensor first.
NOTE: *Always calibrate the "Front" sensor first, if you try to calibrate the "Back" sensor first it will error.*

8. Press the CALIBRATE button (see letter "i" on fig 2-17) located on the left-hand side of the calibration window to begin the calibration process.

Calibration continues on next page

SECTION 2 - SETUP

Calibration cont.

9. The swing arm will begin to rotate and the senors will make their readings. It will turn a full 360 degrees and stop at its starting point. When the process is complete the Calibration Results (see letter "f" on fig 2-17) will have filled in based on its readings.

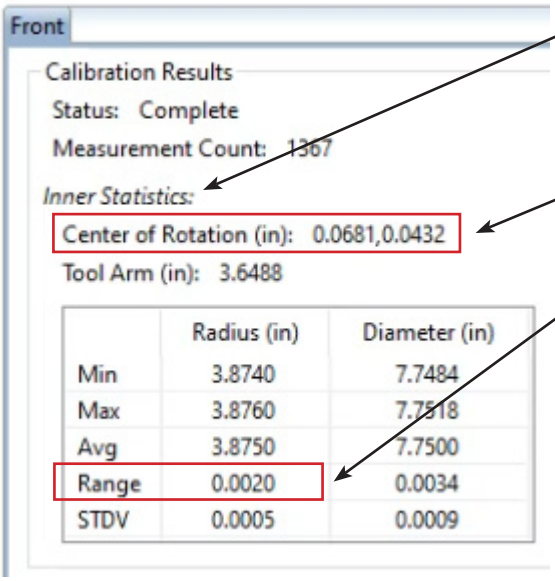


Figure 2-18 - Calibration Results within the Calibration Tab

Using the **Inner Statistics** column you will need to reference a few numbers to ensure the PEMS unit is centered within the Pipe and the arms are rotating evenly.

Center of Rotation: These two numbers should be within .05" / 1.25mm, this indicates the PEMS unit is in the center of the pipe.

Range: This indicates the variance of the measurement senor as it passes over the wall of the cal ring (or pipe). The "Radius" column should have number within .01" / .25mm.

If you are not getting such results, adjustments need to be made to the Legs and the PEMS position within the pipe. Calibration does need to be cleared out and re-started to get new results. Please refer to the Troubleshooting section in this manual for further information.

10. If using the Quad (front and back) set up, move the Back sensor into position with the calibration ring and repeat steps 5 through 9 but with "Back" chosen for calibration.

11. Click on the Summary tab at the bottom of the window and it should read that the status is now "Ready for Measurements".

Calibration is complete.

SECTION 3 - OPERATION

Measurement Operation

1. After calibration, the tool is ready to take measurements of the pipe. Select the Measurements tab at the bottom of the Session window. Enter the information to define the pipe identification, temperature, and other data required for measurement. See Figure 3-1.

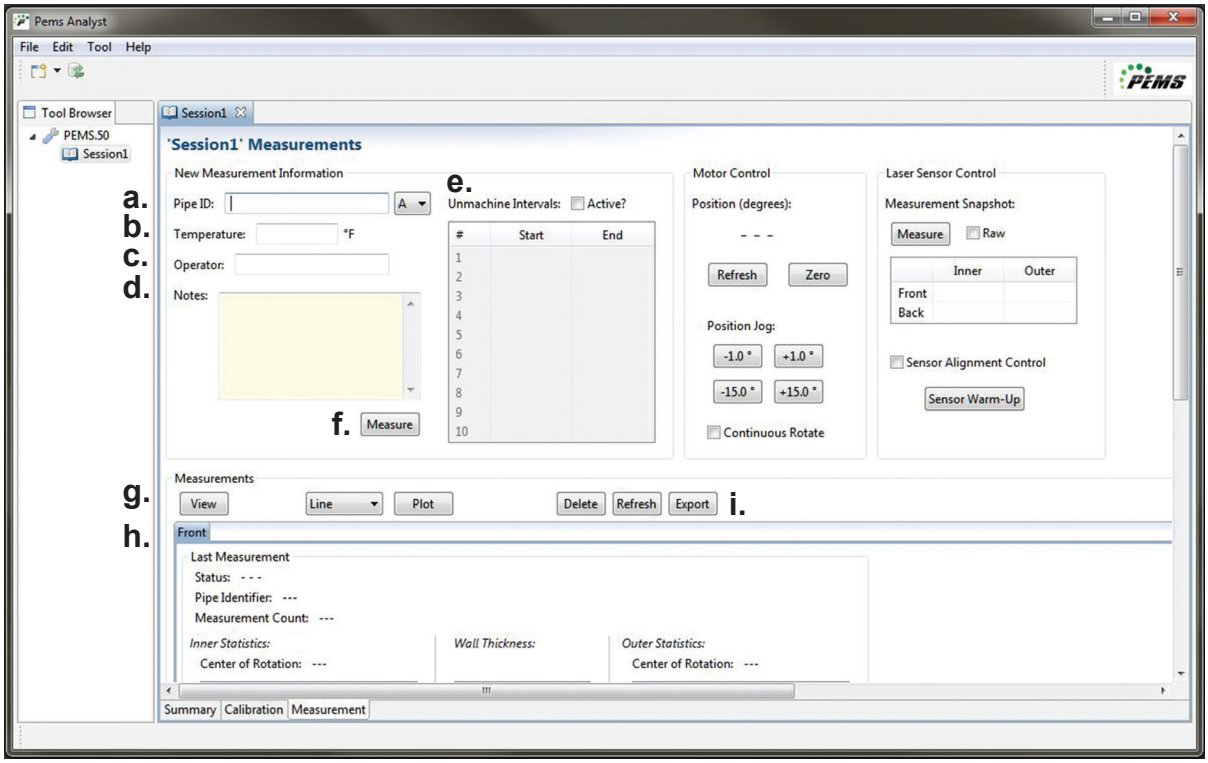


Figure 3-1 - Measurement Window

a. Pipe ID: Enter the identification information marked on the pipe. This will be customer-supplied identification information.

b. Temperature: Enter the current ambient temperature.

c. Operator: Enter the name of the technician performing the measurement.

d. Notes: Record any relevant information to help the understand the measurement data.

e. Unmachined Intervals: Excludes defined areas on the pipe from the measurement process.
- Select "Active?" to use this function.
- Define the start and end of arcs in degrees to be excluded from the measurement process.

f. Measure: Select this button to begin measurement.

g. View: Choose Line or Polar graphs and then press plot. These graphs plot the inner and outer radius of the pipe after the measurement is complete. They will open in a new tab for the operator to use as a reference.

Measurement operation continues on next page

SECTION 3 - OPERATION

h. Last Measurement: Results of the last measurement ran. Scroll the window down to see list of measurements performed in this session, double click on a listed measurement to see a readout of all the measurements performed by the laster during a pass (opens in new Tab).

i. Export: Press this button to export the measurement data. Follow the Exporting Data process outlined later in this section.

2. Ensure the measurement sensors on the PEMS unit are facing the walls of the pipe (Use Sensor Alignment Control button).

3. Press the MEASURE button located below the Notes on the left-hand side of the Measurements window to begin the measurement process. (see letter "f." on fig. 3-1)

4. The swing arm will begin to rotate and the senors will make their readings. It will turn a full 360 degrees and stop at its starting point.

5. When the process is complete the data is logged in the "Last Measurement" section (see letter "h." in fig. 3-1)
NOTE: *In scenarios where you may only be using a sensor(s) to measure just the ID or OD, and have no sensor(s) wired for the opposite side, the readings will register as a repeating identical numeral for the side with no sensor hooked up.*

Measurement is complete.

SECTION 4 - DATA

Data Saving

- Data is saved after each measurement to the established default workspace, refer to page 2-11.
- All the sessions data will be archived in that folder. It is recommended to back up the folder often.
- To review a measurement sessions data they can be exported in several manners and will be outlined in this section.
- Previous measurement session data may need to be re-synchronized to the stored data file in order for it be analyzed or exported. Press the Synchronize button above the tool browser to re-sync all sessions (see fig. 4-1) or right-click on a specific session and choose "Synchronize".

Measurement Data Excel Report (Basic):

1. When a measurement session is completed the data can be output to a Excel Report document.
2. In the Pems Analyst software window, choose the menu "Analysis"
3. In the Analysis menu, highlight "Report" and choose "Create Excel Report..."

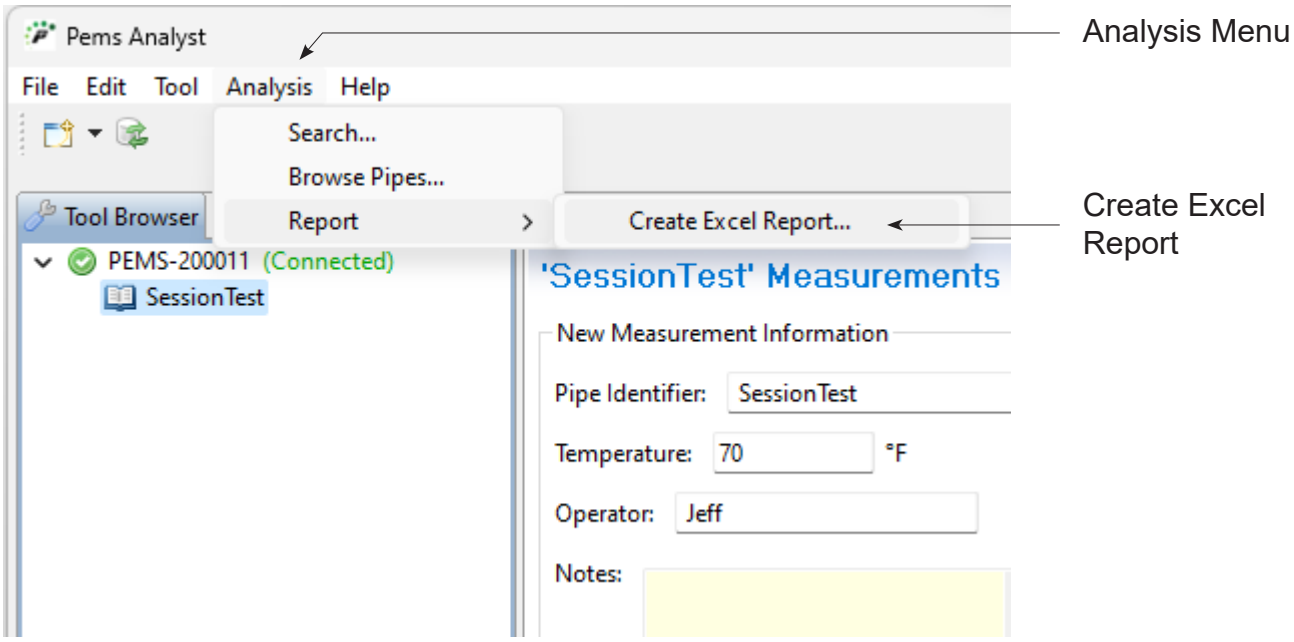


Figure 4-1 - Menu location for Create Excel Report

Measurement Data Excel Report (Basic) instructions continue:

SECTION 4 - DATA

4. The Excel Report Generator will open and ask you to configure a few choices.
5. A Report Title is required.
6. Add any Report Notes you wish but they are not required to generate report.
7. Click the "Browse" button to choose a location save and name the report.
8. Choose Excel File Type
9. In the Report Data Selection area check the box next to which Tools or saved Sessions you want the report to pull the data from.
10. When all choices are made and required blanks are filled, click "Finish" for the report to be generated.

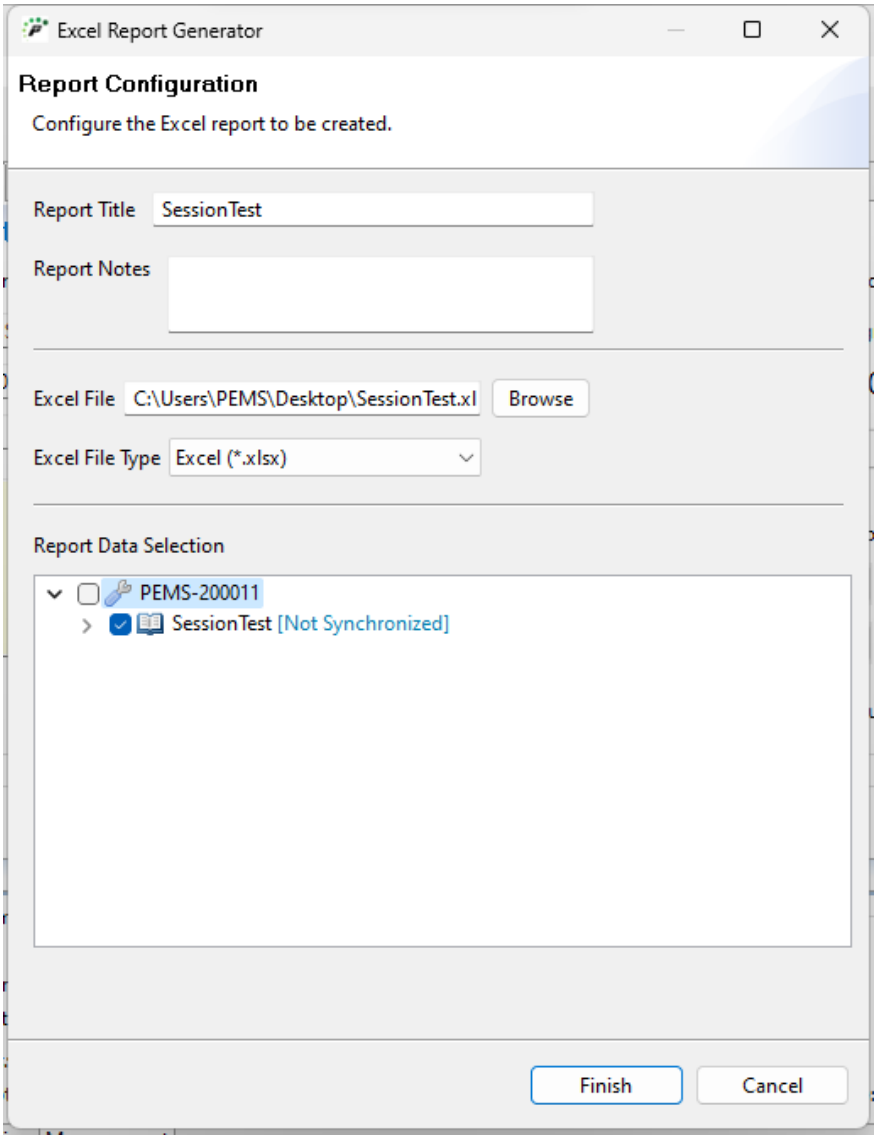
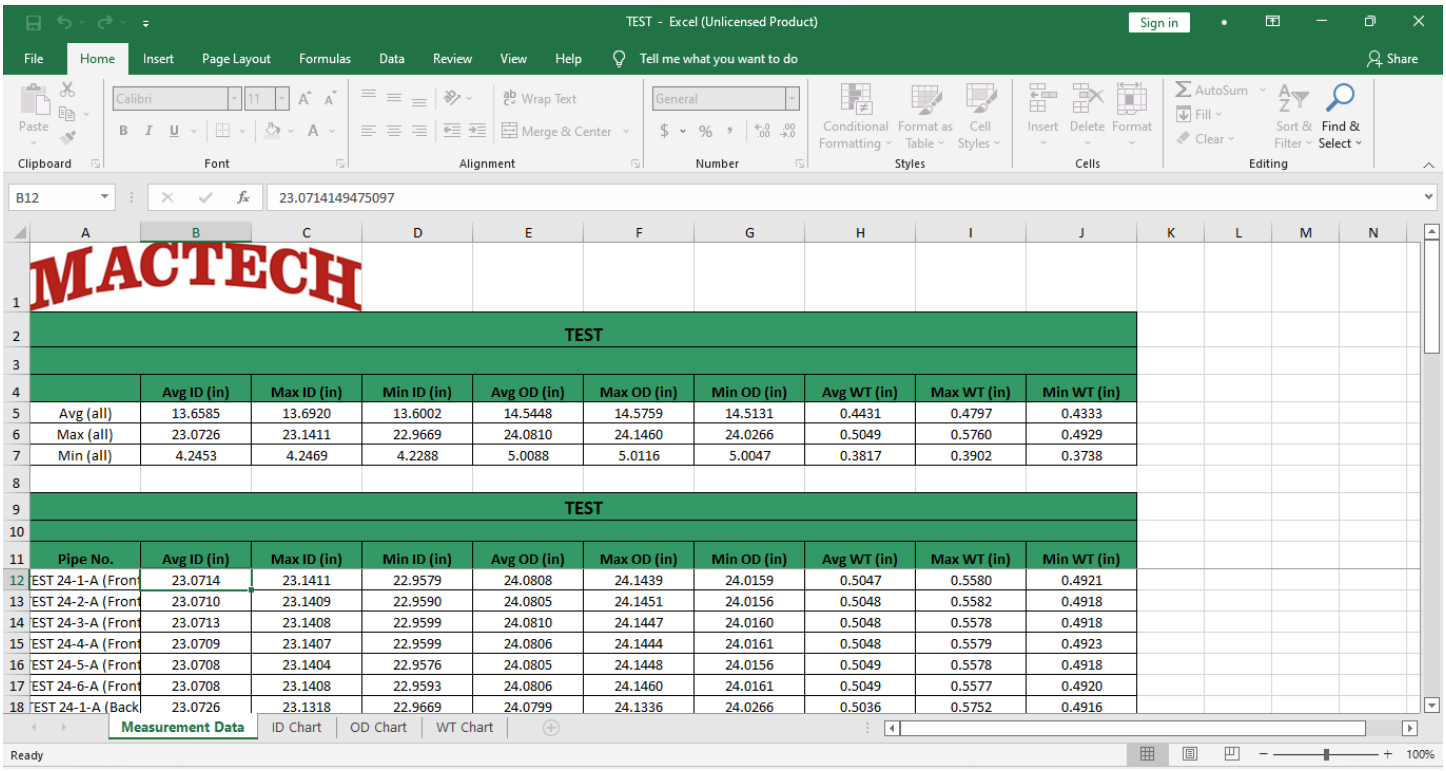


Figure 4-2 - Excel Report Generator

Measurement Data Excel Report (Basic) instructions continue:

SECTION 4 - DATA

11. The generated report will organize all the data pulled from the session into a pre-formatted excel doc. There is separate tabs for overall Measurement Data, ID Chart, OD Chart, and WT Chart (Wall Thickness) at the bottom of the excel document.



TEST - Excel (Unlicensed Product)

B12: 23.0714149475097

	Avg ID (in)	Max ID (in)	Min ID (in)	Avg OD (in)	Max OD (in)	Min OD (in)	Avg WT (in)	Max WT (in)	Min WT (in)
TEST									
Avg (all)	13.6585	13.6920	13.6002	14.5448	14.5759	14.5131	0.4431	0.4797	0.4333
Max (all)	23.0726	23.1411	22.9669	24.0810	24.1460	24.0266	0.5049	0.5760	0.4929
Min (all)	4.2453	4.2469	4.2288	5.0088	5.0116	5.0047	0.3817	0.3902	0.3738

Pipe No.	Avg ID (in)	Max ID (in)	Min ID (in)	Avg OD (in)	Max OD (in)	Min OD (in)	Avg WT (in)	Max WT (in)	Min WT (in)
TEST									
EST 24-1-A (Front	23.0714	23.1411	22.9579	24.0808	24.1439	24.0159	0.5047	0.5580	0.4921
EST 24-2-A (Front	23.0710	23.1409	22.9590	24.0805	24.1451	24.0156	0.5048	0.5582	0.4918
EST 24-3-A (Front	23.0713	23.1408	22.9599	24.0810	24.1447	24.0160	0.5048	0.5578	0.4918
EST 24-4-A (Front	23.0709	23.1407	22.9599	24.0806	24.1444	24.0161	0.5048	0.5579	0.4923
EST 24-5-A (Front	23.0708	23.1404	22.9576	24.0805	24.1448	24.0156	0.5049	0.5578	0.4918
EST 24-6-A (Front	23.0708	23.1408	22.9593	24.0806	24.1460	24.0161	0.5049	0.5577	0.4920
EST 24-1-A (Back	23.0726	23.1318	22.9669	24.0799	24.1336	24.0266	0.5036	0.5752	0.4916

Measurement Data | ID Chart | OD Chart | WT Chart

Ready

Figure 4-3 - Sample of a Generated Report

Measurement Data Excel Report (Basic) is complete.

SECTION 4 - DATA

Export Measurement Data (Advanced)

1. There are several other ways to export measurement data that allow some extra customization of the data being exported beyond what is offered in the basic Excel Report.

- Main file menu, choose "Export".
- Tool Browser: Right-click the session to export data from in the Tool Browser. See fig. 4-4
- Measurement Tab: If within the measurement tab during a session, choose the "Export" button (see letter "i." in fig. 3-1) and you can now skip to Step 3 in these instructions

2. Before choosing one of these options to export the data, press the Synchronize Button to ensure the sessions are in sync. See fig. 4-4

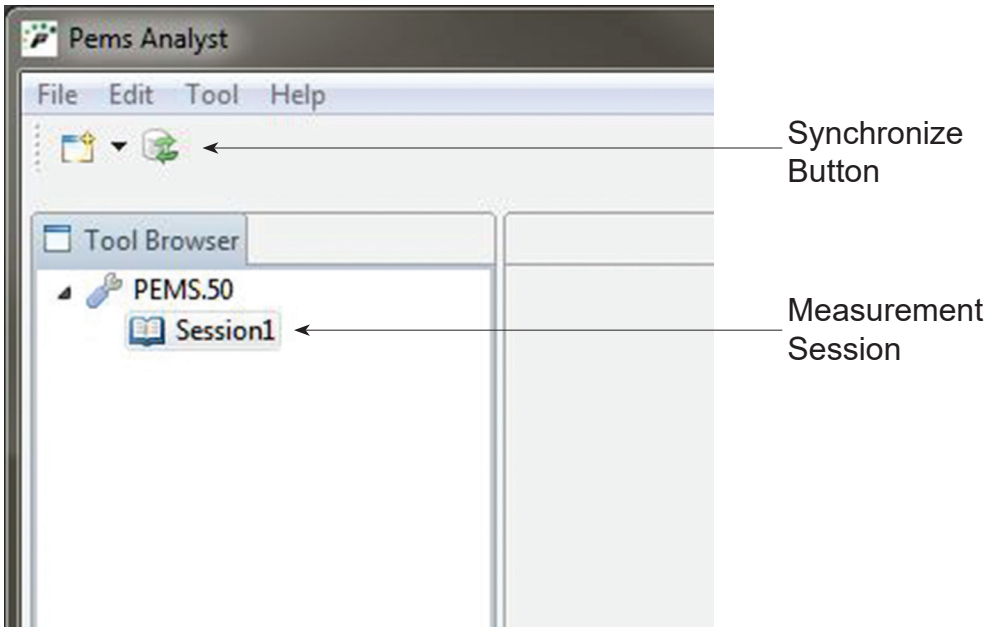


Figure 4-4 - Select Session to Export

Export Measurement Data (Advanced) instructions continue:

SECTION 4 - DATA

3. Select File → Export, or right-click the session and select Export. Select PEMS Data Export. Click Next to proceed to the next window. See Figure 4-5.

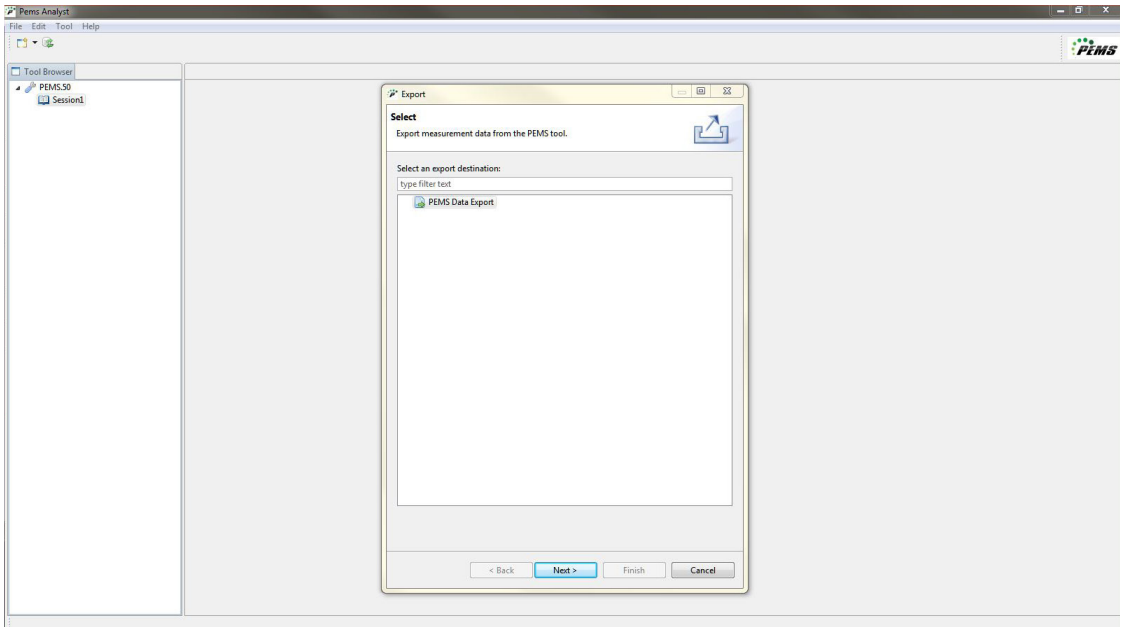


Figure 4-5 - Export Data

4. Select the data to be exported by checking the box next to the data name. Export all measurement sessions on a tool by clicking on the tool name, or select specific measurement sessions. See Figure 4-6.

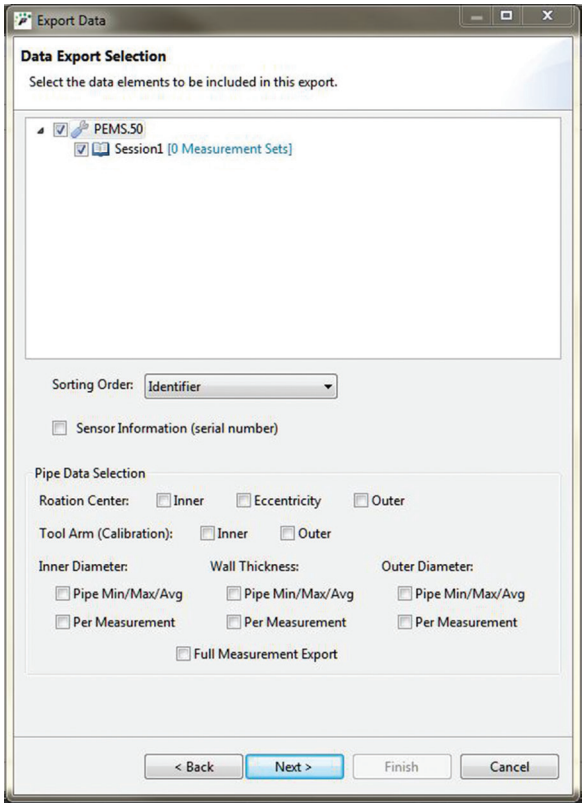


Figure 4-6 - Select Data to be Exported

SECTION 4 - DATA

5. Select the Sorting Order of the data. Identifier, Timestamp or Temperature.

6. Select the Sensor Information (serial number) box so that the box is checked on. This box should always have check mark on. See Figure 4-7.

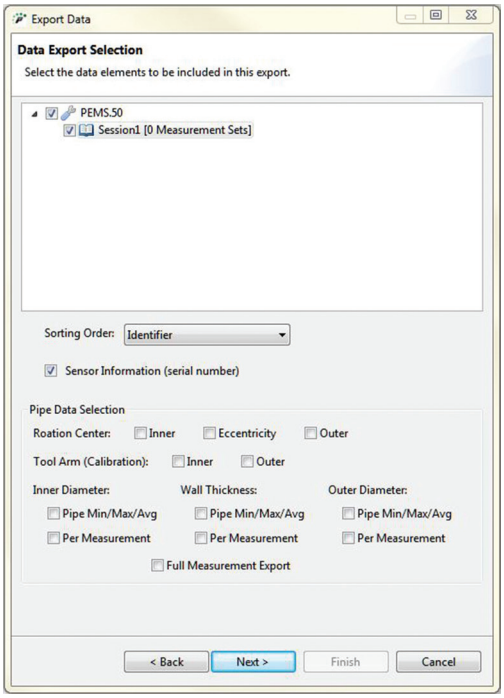


Figure 4-7 - Sensor Information Selection

7. Select the pipe data attributes to be exported. Select each parameter individually, or select Full Measurement Report to select all data for export. See Figure 4-8.

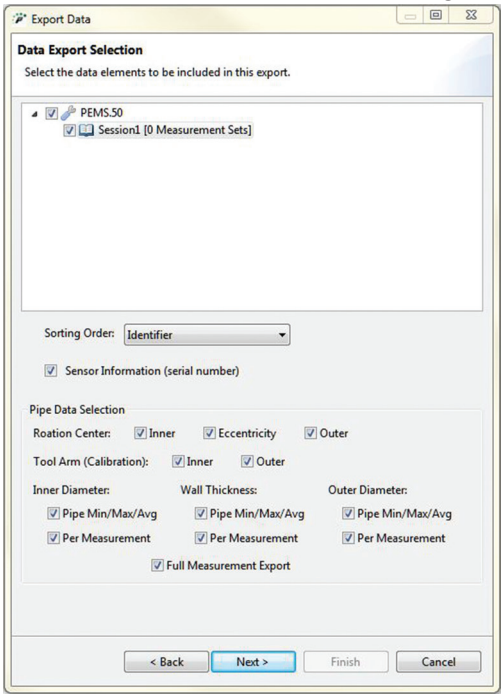


Figure 4-8 - Select Pipe Data Attributes

SECTION 4 - DATA

8. Select Next to proceed to the Export File Selection window.

a. Select Browse to choose where you would like the file to be exported to.

b. Enter the name of the file to export.

c. Choose .TXT File for the format

8. Select Finish to export the file.

Export to Excel / Spreadsheet

The exported file can be read as a .TXT file or it can be imported into a spreadsheet. Unlike the basic excel report process the advanced process requires the user to sort the data into their own report.

The simplest way for a spreadsheet to sort the data is to open the .TXT file with Microsoft Excel and follow its commands to sort the data as "Delimited" with the delimiter group set to "Comma" and "Tabs". This will break down everything in columns and rows which can be organized to your preference. The process to complete this can vary depending on which spreadsheet software you use or version of Excel.

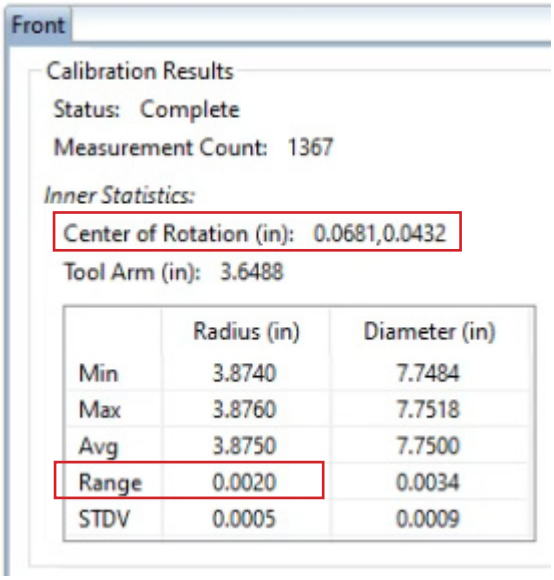
Export Measurement Data (Advanced) instructions is complete.

SECTION 5 - TROUBLESHOOTING

Troubleshooting

Calibration

- The machine may not be centered within the pipe and when the arm rotation makes its sweep, the laser sensors are moving outside of its reading range. If the calibration results are out of the range listed on page 2-17, the Legs need adjusting or the PEMS units position within the pipe needs to be adjusted.



The **Center of Rotation** shows two numbers: the first number indicates the X-axis position of the center of the measurement arm when it is in its starting position (the arm in a vertical position). Typically it should be within .05"/1.25mm of 0 when using a Calibration Ring.

The second number shows the Y-axis position of the arm in its starting position. Typically it should be within .05"/1.25mm of 0 when using a Calibration Ring.

To change the Center of Rotation adjust the legs to compensate for the distance it is out of range. Equal adjustments in both legs with raise it +/- along the Y-axis, adjusting one leg will tip it more +/- along the X-axis.

Clear the calibration and run it again and re-check the results of Center of Rotation.

- If the **Range** radius reading is exceeding .01"/.25mm adjust the Center of Rotation as mentioned above, but also ensure the measurement sensor lasers are positioned correctly as shown on pages 2-5 or 2-6, and within the specific distance from the cal ring or pipe wall.

- The measurement laser beam could be rotating off the of the calibration ring or the pipe wall. This means the PEMS unit is not in a parallel position with the length of the pipe or the calibration ring is positioned unevenly. Make adjustments to these and run the rotation again to ensure the beam stays within the width of the cal ring.

Mechanical Issues

- Misalignment of the sensor faces to the pipe. Make sure the sensor faces are 3-3/8 inches from the pipe. Check the axial position (lengthwise) of the PEMS in the pipe. Make sure the PEMS is centered in the pipe. Re-calibrate if the measure sensors are moved.
- Never manually rotate the sensor arm. Only use the software to position the sensor arm.
- Arm stops mid-measurement: check battery.

Power Issues

- Check the battery condition.

Electronics

- Check electrical connections. Make sure connections are not loose.
- Return the PEMS to Mactech for service.

SECTION 5 - TROUBLESHOOTING

Bad Data

- The calibration process must be performed correctly. If data is suspected of being wrong, re-calibrate the Pems and start the measurement process from the beginning.
- Check the pipe surface for anomalies, such as blisters, excessive scale, paint or any material or blemish that might cause the data to be unreliable.
- No valid measurement data found: check battery.
- Failed to retrieve tool position: check battery.

Failed Measurement

- Make sure the "Sensor Alignment Control" box is not checked in the Calibration or Measurement tabs when running the calibration or measurement process. If the box is checked it will report as a failed measurement.
- Sensor wires connected to their ports after the PEMS Unit had been powered on. Cycle the PEMS Unit power to ensure sensors are communicating properly.
- Attempted to calibrate the "Back" sensor before the "Front" sensor.

Advanced Configuration

These advanced configurations are for experienced users only. Do not make any of these modifications without additional support from Mactech.

Address Field:

- This can be manually entered or modified; useful if the tool discovery process does not find a tool

Control Port

- This must match the configured control port number on the PEMS tool. 1 is the factory default for all PEMS tools.

Data Port

- This must match the configured data port number on the PEMS tool. 2 is the factory default for all PEMS tools.

Timeout

- Number of seconds before a communications failure is triggered in the PEMS software. 5 is the factory default. Can be increased if communication error are experienced.

Database Path

- If the file system location provided by auto configuration is not desired, a file system path can be manually entered to specify the location of the PEMS database file.