Part I  Configuring the PT878 Transport Ultrasonic Flow Meter

Overview
The PT878 TransPort Ultrasonic Flow Meter:
- Measures liquid flow in a pipe.
- Is a non-intrusive, clamp-on ultrasonic liquid flow meter for chilled and hot water applications.
- Monitors flow of fluids that are homogenous, relatively clean, flowing steadily, and have no gas-phase substance present.
- Has data logging capabilities and a digital display for instantaneous flow measurements.

Applications
The PT878 Flow Meter is often used for:
- Water demand analysis, including leaks. The portable flow meter can serve as a sub-meter to measure cumulative amount of water used by a device or a sub-system of a larger metered system.
- Diagnosing system performance issues like variation in flow and flow direction.
- Assessing load variation in hydronic heating or cooling systems. Load is calculated using the flow rate and the associated supply and return fluid temperatures. This application is beyond the scope of this Application Note.

How it Works
This ultrasonic flow meter uses a pair of transducers, with each transducer sending and receiving coded ultrasonic signals through the fluid. When the fluid is flowing, signal transit time in the downstream direction (Figure 2a) is shorter than in the upstream direction (Figure 2b). The difference between these transit times is proportional to the flow velocity. The flow meter measures this time difference and uses programmed pipe parameters to determine flow rate and direction.
Flow Transducers

Figure 2: Theory of transit-time flow measurement
A) Top view of pipe. The ultrasonic signal takes time $t_1$ to travel downstream between transducers.
B) The ultrasonic signal takes time $t_2$ to travel upstream between transducers.
*The flow meter uses the difference between the transit times ($t_2 - t_1 = \Delta t$), along with the parameters input by the user, to calculate fluid speed and volume flow. If the transit time is negative, the flow is moving opposite the expected direction.

This Application Note
This Application Note consists of two parts. Part I describes how to configure the meter for flow measurements and data logging using the keypad interface. Part II describes how to install two different types of ultrasonic flow transducers: those designed for pipes of between two and twenty-four inches in diameter and those designed for pipes of less than two inches in diameter.

Components of the Ultrasonic Flow Meter Kit
1. TransPort portable flow meter
2. Measurement rails, including one indexed rail and one un-indexed rail.
3. Clamping fixtures and chains
4. Transducer cables
5. Ultrasonic transducers
6. Small pipe ultrasonic transducers (may be included instead of standard transducers)
7. AC power adapter (not shown)
8. Ultrasonic couplant (not shown)
9. Pipe diameter tape (not shown)
10. Thickness gauge (not shown)

Powering Up and Shutting Down the Meter
1. Press the red button to power up the meter. The meter takes a few seconds to respond.
2. To shut down the meter, press the red power button until the shutdown options screen appears. Choose Shutdown to shut to meter off, Sleep to put the meter in idle mode, or Cancel to resume operation.
Using Battery Power
A new fully charged battery can provide a maximum of 8 to 10 hours of continuous operation. Batteries must be charged 8 hours to receive the maximum charge. The batteries recharge when the unit is plugged in to AC power. When data logging, it is recommended that the PT878 be run on the AC power.
When the meter is running on battery power, the battery icon in the upper right-hand corner of the screen will show a battery level. When the meter is running on AC power, the battery icon will either indicate that the battery is charging or will contain a lightning-bolt symbol when the battery is fully charged.

Defining a Site
Before entering new meter configuration parameters the user must create a new site. Previously saved parameters can be reused by selecting an existing site and using it directly or using it as a template for a new site.

Creating a New Site
1. Press the Menu button until the menu bar appears at the top of the screen.
2. Use the arrow keys to select the Site menu and press Enter. Site Manager will be highlighted by default (Figure 4).

![Figure 4: Screen after pressing the Menu button and selecting the Site menu.](image)

3. Press Enter to open the Site Manager menu.
4. Press the Menu button to highlight the File menu (Figure 5) and press Enter. New will be highlighted by default.
5. Press **Enter** to open the New Site screen.
6. Press **F1** (Delete) to delete the default site name and use the arrow keys to navigate the alphanumeric table to enter a descriptive site name of up to 8 characters. Press **Enter** to select each character. Press **F3** (OK) when the complete site name has been entered.
7. Choose whether or not to use the selected site as a template. (All parameters are editable so this selection is not critical, but may save time if there is an existing site with similar characteristics already programmed into the meter.)
8. Press **F3** (Exit) to exit the **Site Manager**.

**Selecting an Existing Site**
1. Press the **Menu** button until the menu bar appears at the top of the screen.
2. Use the arrow keys to select the **Site** menu and press **Enter**. **Site Manager** will be highlighted by default (Figure 4).
3. Press **Enter** to open the **Site Manager** menu (Figure 6).
4. Use the up/down arrow keys to highlight the site the user wishes to select.
5. Press the **Menu** button to highlight the **File** menu and press **Enter** (Figure 5).
6. Use the up/down arrow keys to highlight **Open** and press **Enter**.
7. Press **F3** (Yes) or **Enter** to select the desired site.
8. Press **F3** (Exit) to exit the **Site Manager**.

**Configuring Flow Parameters**

The five main configuration tabs are **Transducer**, **Pipe**, **Lining**, **Fluid** and **Path**. The information entered is used by the meter to calculate the fluid flow rate.

<table>
<thead>
<tr>
<th>Tab</th>
<th>Field</th>
<th>Parameter</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transducer</td>
<td>Type</td>
<td>Transducer type</td>
<td>Always clamp-on.</td>
</tr>
<tr>
<td>Transducer</td>
<td>Transducer</td>
<td>Transducer model number</td>
<td>Most commonly used transducers: #24 - 1/2” to 2” pipe. #402 - 2” to 24” pipe. #407 - 1/2” to 4” pipe.</td>
</tr>
<tr>
<td>Transducer</td>
<td>Wedge Tmp</td>
<td>Approximate transducer temperature*</td>
<td>Use the average of room temperature and fluid operating temperature.</td>
</tr>
<tr>
<td>Pipe</td>
<td>OD, in</td>
<td>Pipe outside diameter*</td>
<td>Measure with pipe diameter tape.</td>
</tr>
<tr>
<td>Pipe</td>
<td>Wall, in</td>
<td>Pipe wall thickness*</td>
<td>Measure with PT878 thickness gauge.</td>
</tr>
<tr>
<td>Pipe</td>
<td>Material</td>
<td>Pipe material*</td>
<td></td>
</tr>
<tr>
<td>Fluid</td>
<td>Tracking Windows?</td>
<td>Activate Tracking Windows</td>
<td>Usually OFF. Used when the fluid is unknown.</td>
</tr>
<tr>
<td>Fluid</td>
<td>Fluid</td>
<td>Fluid type</td>
<td></td>
</tr>
<tr>
<td>Fluid</td>
<td>Sound Speed</td>
<td>Sound Speed</td>
<td>Editable only if Other is the selected fluid.</td>
</tr>
<tr>
<td>Fluid</td>
<td>Temp</td>
<td>Fluid temperature*</td>
<td>Editable unless Water/Glycol is the selected fluid.</td>
</tr>
<tr>
<td>Fluid</td>
<td>Glycol</td>
<td>Percent glycol*</td>
<td>Editable only if Water/Glycol is the selected fluid.</td>
</tr>
<tr>
<td>Path</td>
<td>Traverses</td>
<td>Number of signal traverses</td>
<td>Number of times the ultrasonic signal crosses the pipe.</td>
</tr>
</tbody>
</table>

**Table 1: PT878 configuration parameters.**

Table 1 lists the parameters that must be entered into the configuration tabs listed above. To the degree possible inputs should be determined before going into the field, based on personal knowledge, site documentation and/or inquiries to facility operators. Parameters marked with an asterisk [*] should be verified with field measurements or observations.
Transducer Tab

1. Press F1 (Transducer) to display the Transducer configuration tab (Figure 7).

![Figure 7: Transducer configuration tab](image)

2. Use the down arrow key to select the transducer Type. If Clamp-on is not selected, use horizontal arrow key to highlight Clamp-on. Press Enter to accept the entry.

3. Use the down arrow to highlight the Transducer field. Press Enter to view the list of transducers. See Table 1 for a list of transducer types.

4. Use up/down arrow keys to highlight correct transducer number. Use up/down arrows to move one row at a time and left/right arrows to page up or down. Press Enter to accept the entry. Transducers are chosen based on pipe diameter.

5. The next field is labeled Wedge Tmp. The wedge temperature is the approximate temperature of the ultrasonic transducer ("wedge"). The manufacturer recommends calculating this value by averaging the room temperature and the operating temperature of the fluid.

6. Use the down arrow to highlight the Wedge Tmp field. Press Enter to clear field and use the numeric keys to enter the wedge temperature. Press Enter to accept the value.

7. Press F3 [OK] to accept the changes to the Transducer tab configuration parameters and return to the main display screen.
Pipe Tab
8. Press **F1** (Transducer) to display the meter configuration tabs. Use the right arrow key to select *Pipe*. Press **Enter** to open the tab (Figure 8).

![Pipe Tab Configuration](image)

9. Press the down arrow key to highlight pipe **Material** field and press **Enter** to open the **Material** menu. Highlight the correct pipe material from the list with the arrow keys. Press **Enter** to select the pipe material.

Pipe Thickness Measurement
10. The GE Panametrics flow meter includes a gauge to measure pipe thickness (Figure 9).
11. Use the down arrow to highlight **Measure Wall with TGauge** box and press **Enter**. The **Thickness Gauge Measure** screen will appear (Figure 10).

![Pipe Thickness Measurement](image)

Figure 9:
(A) Pipe thickness gage
(B) Calibration case
(C) Couplant gel
(D) Pipe diameter tape
12. Check the calibration of the thickness gauge using the 0.2 inch and 1.5 inch dual calibration block.
   a. Connect the thickness gauge to the keyed connector jacks on top of the meter.
   b. On the Thickness Gauge Measure screen, use the right arrow key to select the Material tab and press Enter to open the tab.
   c. Use the down arrow key to highlight the Material field and press Enter to open the Material menu. Use the arrow keys to select material indicated on the calibration block and press Enter to accept the selection.
   d. Use the arrow keys to select the Display tab and press Enter to open the tab.
   e. Place a small bead of thickness gauge couplant (Couplant B) on the 0.2 inch side of the dual calibration block and press the calibration gauge against that side of the block. A clock icon will appear for several seconds until the thickness reading appears. Note the reading.
   f. Repeat step e with the 1.5 inch side of the calibration block.
   g. If the readings vary more than ±0.002 inch from 0.2 inches or ±0.02 inch from 1.5 inches, respectively, calibrate the thickness gauge per step 13 below. Otherwise skip calibration.

13. If necessary, calibrate the thickness gauge using the 0.2 inch and 1.5 inch dual calibration block.
   a. If it has not been done already, connect the thickness gauge to the meter and select the material indicated on the calibration block in the Material field on the Material tab, as described in step 12a, b and c above.
   b. Use the arrow keys to the select the Zero tab and press Enter to open.
   c. Use the arrow keys to highlight Dual Calibration and press Enter to select.
   d. Use the down arrow key to highlight the Block 1 Length field. Press Enter to edit the field, enter 0.2 and press Enter again.
   e. Use the right arrow key to highlight the box containing the word "Calibrate" located to the right of the Block 1 Length field. Press Enter. The box will now read "Ready".
   f. Place a small bead of thickness gauge couplant (Couplant B) on the 0.2 inch side of the dual calibration block and press the calibration gauge against that side of the block. Press Enter. A clock icon will appear for several seconds and then the box will again read "Calibrate".
   g. Repeat steps f, g and h for the 1.5 inch side of the dual calibration block using the fields associated with Block 2 Length. The Set button will appear once the user is done calibrating with the 1.5 side of the dual calibration block.
   h. Once the Set button appears, press Enter. Press F3 to go back to the Pipe tab.
   i. Check that calibration has been successful. With Measure Wall with TGauge highlighted, press Enter to return to the Thickness Gauge Measure screen. Evaluate the results as indicated in 12g above.
14. Before measuring pipe thickness, select the correct pipe material. From the Thickness Gauge Measure screen, use the right arrow key to select the Material tab and press Enter. Use the down arrow key to highlight the Material field and press Enter to open the Material menu. Use the arrow keys to select the appropriate pipe material and press Enter to accept the selection.

15. Prepare the pipe. The user will take thickness measurements on the section of pipe where the clamping fixture, rails and transducers will be installed. On this section of pipe, cut back the insulation, remove any loose paint, and clean the pipe and sand off any corrosion or rough spots. If the pipe is extremely rough the thickness measurements may not be accurate and, once the transducers are installed, the ultrasonic signal will be scattered by the rough surface and will not be received by the flow meter, preventing flow measurement.

16. Calculate average pipe thickness. The thickness value will be used to determine both the trajectory of the ultrasonic signal and the cross-sectional area of the pipe. For the latter, an average pipe thickness should be calculated. Take at least four thickness measurements at even intervals around the diameter of the pipe in between where the transducers will be installed.

17. Apply thickness gauge couplant (Couplant B) at an appropriate spot on the pipe where the user will be making the thickness measurement. The smoother the pipe surface the thinner the couplant should be applied. The line on the face of the transducer should be positioned so that it is perpendicular to the liquid flow in the pipe (Figure 11).

18. Hold the pipe thickness transducer flat against the pipe surface. Note the measured pipe wall thickness value displayed on the meter.

19. Repeat at three or more other locations evenly spaced around the pipe diameter. Calculate the average thickness.

20. Once done with thickness measurements, press F3 (OK) to return to the Pipe menu. Use the arrow keys to highlight the Wall, in field. Press Enter to clear the field and enter the average pipe thickness with the numeric keys. Press Enter to accept the value.

21. Measure the outside diameter of the pipe with the pipe diameter measuring tape included with the pipe thickness gauge kit, as shown in Figure 12. Use the arrow keys to toggle to the OD, in field and press Enter to clear the field. Enter the pipe outside diameter in inches with the numeric keys and press Enter to accept the value.

22. Press F3 (OK) to accept the changes to the Pipe tab configuration parameters and return to the main display screen.
Lining Tab
23. Press F1 (Transducer) to display the meter configuration tabs. Use the arrow keys to select the Lining tab and press Enter.
24. If the pipe has no anti-corrosion lining, check that the lining Material field is set to None, the default value.
25. If the pipe has an anti-corrosion lining, use the arrow keys to highlight the Material field and press Enter to open the lining Material menu. Use the up/down arrow keys to highlight the lining material. Press Enter to select.
26. Press F3 (OK) to accept the default setting or the changes to the Lining tab.

Fluid Tab
The options available on the Fluid tab will vary depending on whether the meter’s Energy Options are enabled or disabled.

Selecting Energy Options
This section will address Energy Options as they relate to configuration of the Fluid tab. Though it is beyond the scope of this Application Note, the Energy Options screen can also be used to configure temperature inputs required for the meter to calculate heating or cooling loads. See the PT878 Operation & Installation Guide for details.

If Energy Options are disabled, the Fluid field on the Fluid tab will display a pre-defined list of fluids, including Water, and an Other fluid option. If Energy Options are enabled, the Fluid field will display a list including Other, Water, and Water/Glycol, with no additional pre-defined fluids available.

As a result, if the working fluid is water or a custom fluid not defined in the PT878’s fluid list, Energy Options may be either enabled or disabled. If the working fluid is a water-and-glycol mix, enabling Energy Options will simplify the configuration of fluid parameters because the fluid will not have to be entered as a custom fluid. In order to select a fluid other than water from the PT878’s pre-defined fluid list, Energy Options must be disabled.

a. To configure Energy Options, first press the Menu button until the menu list appears at the top of the screen.
b. Use the arrow keys to select the Program menu and press Enter. Use the down arrow key to select Energy (Figure 13). Press Enter again to open the Energy Options screen (Figure 14).

Figure 13: Select Energy from the Program menu to open the Energy Options screen.
c. Use the arrow keys to select **Enable** or **Disable**. Press **Enter** and then **F3** (OK) to accept the selection and return to the main screen. Note that when **Energy Options** are enabled a flame icon appears in the System Tray near the bottom of the screen.

27. Once the appropriate **Energy Options** are selected, press **F1** (Transducer) to display the meter configuration tabs. Use the arrow keys to highlight the **Fluid** tab. Press **Enter** to open the tab (Figure 15).

28. Leave the **Tracking Windows** option set to “No”. The tracking window option is used when fluid is unknown and is beyond the scope of this Application Note.

29. Use the arrow keys to highlight the **Fluid** field and press **Enter** to open flow meter’s **Fluid** list. Select either a pre-defined fluid from the Fluid list, or, if the fluid is not on the list, select **Other**. Press **Enter** to accept the selection.
30. If Other was selected as the fluid type the user will need to define the fluid's behavior by entering a sound speed into the Sound Speed field. Fluid sound speeds can be found in the Installation Reference manual titled Sound Speed and Pipe Size Data (included with this flow meter) or in an alternative reference source. Use the arrow keys to toggle to the Sound Speed field. Press Enter to clear the field and enter the speed of sound for the appropriate fluid with the numeric keys. Press Enter to accept the selection.

31. If a pre-defined fluid or Other has been chosen from the Fluid list, use the arrow keys to highlight the fluid Temperature field.

32. If a water/glycol mix has been selected as the working fluid, the Glycol field will be editable rather than the fluid Temperature field. Use the arrow keys to highlight the Glycol percent field.

33. Once the editable field has been selected (either Temperature or Glycol), press Enter to clear the field and use the numeric keys to enter appropriate value. Press Enter to accept the new value.

34. Press F3 (OK) to accept the changes to the Fluid tab configuration parameters and return to the main display screen.

Path Tab

35. Press F1 (Transducer) to display the meter configuration tabs. Use the arrow keys to highlight the Path tab and press Enter (Figure 16). The Traverses field is the only editable field on the Path tab. The transducer spacing shown in the Spacing field is calculated based on all of the other user-input parameters and is required for correct installation of the flow transducers.

36. The value in the Traverses field indicates the number of times the ultrasonic signal crosses through the fluid from one side of the pipe to the other in transit between the two ultrasonic flow transducers. See Figure 17. To input this value, use the arrow keys to highlight the Traverses field. Press Enter. Use the arrow keys to choose 2 traverses, unless the user has a reason to use a different transducer configuration. Press Enter to select.
Flow Transducer

Ultrasonic Signal Path

Figure 17: Ultrasonic signal traverses

Top views of pipe. The number of traverses indicates the number of times the ultrasonic signal crosses the pipe. 
a) One (1) traverse. b) Two (2) traverses c) Three (3) traverses c) Four (4) traverses. It is most common to use two (2) traverses. Additional traverses weaken the signal but provide a more accurate flow measurement.

37. The value in the Spacing field is the Transducer Spacing calculated by the meter after all of the measurement parameters have been entered. Press F3 [OK]. If prompted, press F3 [OK] again to acknowledge the Warning message that indicates that the transducer spacing has changed. Make note of the Transducer Spacing value.

38. Press F3 [Save Now]. Press F3 [Yes] to choose the site name that is displayed in the Save Site screen.

Changing Display Values and Units
To change the display units between Metric and English units do the following:
1. Press the Menu button until the menu bar appears at the top of the screen.
2. Use the arrow keys to select the Meter menu. Press Enter.
3. Use the arrow keys to highlight Units. Press Enter.
4. Use the arrow keys to select Metric or English units. Press F3 [OK] to accept the selection.

To display different measured and calculated values and change display units in any of the PT878 output windows, do the following:
1. Press the Menu button until the date and time are shown at the top of the screen.
2. Press the down arrow key until a triangle appears on the left edge of the title bar in the appropriate output window. Press Enter.
3. Use the arrow keys to highlight Measurement and press Enter.
4. Use the up and down arrow keys to highlight the desired display parameter.
5. Press the SEL button to select the parameter and use the up and down arrow keys to highlight the desired units. Press F3 [OK] to accept the selection.
Configuring Flow Meter for Data Logging

1. When logging, it is recommended that the PT878 be run on AC power. Note that a new, fully-charged battery can provide a maximum of 8 to 10 hours of continuous operation.

2. Press the Menu button until the menu bar appears at the top of the screen.

3. Use the arrow keys to highlight Logging tab, New Log and press Enter.

4. Press F1 (Delete) to delete the default log name and use the arrow keys to enter a descriptive log name, pressing Enter after each letter or number is highlighted. Press F3 (OK) when the complete log name has been entered. Two logging configuration tabs will be displayed: General and Measurements.

General Tab

5. Use the arrow keys to toggle between the Format options and press Enter to select. Choose Linear to program the meter to stop logging when the memory is full. The Linear option is the more appropriate one for most logging applications. Choose Circular to program the meter to continue to log when the memory is full by overwriting the earliest data records with the newest data.

6. Use the arrow keys to select log Type. Choose Standard and press Enter.

7. Enter the Start and End dates and times. Toggle to the correct field to highlight. Press Enter and then edit the values in the field with the arrow keys. Press Enter after each field has been edited and use the arrow keys to toggle to the next field.

8. Use the arrow keys to toggle to the Logging Interval field. Press Enter to activate the text box and use the numeric keys to enter the number of seconds in the logging interval.

Measurements Tab

9. Use the arrow keys to select the Measurements tab and press Enter to open.

10. Use the arrow keys to highlight one of the variable boxes on the Measurements table. The box will initially read “NO UNITS”. Press Enter to open the Measurements variable list.

11. Use arrow keys to indicate the desired variable. Press the SEL button to confirm the selection. The prompt automatically moves to the list of units.

12. Use the arrow keys to highlight the desired units. Press the SEL button to select the units and then press F3 (OK) to confirm the selection. Once selected, the measurement variable and units will appear in the Measurements table.

13. Repeat for up to 12 different parameters.

14. Press F3 (Activate) to Activate the Log.

15. Press F3 (Exit) to exit the log menu and return to the main flow screen. Press F3 (Save Now) to save changes.

16. Note that log files cannot be edited once created. If a log file must be changed, create a new log file that includes the desired changes.
17. Note that if a log has been created and has started logging (Running), a pencil with horizontal lines on its left side will appear in the System Tray at the bottom of the screen. If a log has been created but has not started logging (Pending), a pencil without horizontal lines will appear in the System Tray. If all logging is complete or no logs have been created (no logs are Pending or Running), no pencil will appear in the System Tray.

**Downloading the Data Log from the meter to the PC**

1. Load the PanaLogViwer software from the CD included with the flow meter. This software is compatible with Windows operating systems only.
2. Load the IR adaptor drivers from the mini-CD provided with the adaptor. Then connect the IR Adaptor to an available USB port.
3. Once the IR adaptor is working, place the IR port on the adaptor directly in front of the IR port on the meter.
4. On the PT878 console, press the **Menu** button and use the arrow keys to highlight the **Logging** menu heading. Press **Enter**.
5. Highlight **Log Manager** and press **Enter**. Use the arrow keys to highlight the correct log to download.
6. Press the **Menu** button to highlight the **File** menu heading and press **Enter**. Use the arrow keys to highlight **Transfer** and press **Enter**.
7. A message will be displayed on the computer screen indicating that a file is being sent through a wireless link. Click **yes** to accept the file transfer. It may take several minutes for the file to transfer to the user’s computer. The transfer is proceeding correctly unless an error message is displayed.
8. Open the PanaLogViewer software. Choose **File; Open**. Select the .LOG file and click the **OPEN** button.
9. Click the **EXPORT** button to convert the .LOG file to a .CSV file that can be opened and viewed in EXCEL. (Note that exporting directly to an XLS spreadsheet data format is unreliable and may cause the Panalog application to terminate without warning. However, this does not damage the data file.)
10. When finished, turn the meter power off.