The below listed items are a number of technical points to observe when installing a Dynasonics PFP-600 partially filled pipe flow meter. It is absolutely necessary to follow these “guidelines” to insure proper operation of the unit!

1. In order to properly install the meter, access to the bottom-dead-center line of a horizontal (\(<4^\circ\) pipe is necessary. The transducer mounting area should be free of oxidation, scale, or other foreign accumulations. Clean the mounting surface down to bare metal when need be.

\textbf{NOTE:} Pipes with well adhered coating such as paint or epoxy will not influence operation and need not be removed.

2. The transducer cables provided with the unit may be cut to desired length, however the cables cannot be extended. The maximum cable length available is 50ft.

\textbf{NOTE:} Splicing of the coaxial cables may degrade sensor performance beyond usable levels. The shielded coaxial leads are designed to isolate the low level signals from undesirable ambient noise and must be continuous to the transmitter.

3. There must be at least ten (10) straight pipe diameters upstream and five (5) straight pipe diameters downstream from the transducer mounting location to maintain the highest level of meter accuracy. Less than these straight pipe requirements may degrade meter performance.

4. When locating the two transducers on the pipe, the non-connector ends should be butted up against each other in the track provided. The transducer clamps should be hand tightened only, over-tightening will squeeze out couplant. The level sensor should have sufficient couplant to fill the gap between the rubber spacers when mounted to the pipe. If the mounting location does not allow this
configuration, the transducers should be located as close as possible to each other to maintain system integrity.
SECTION 2

SPECIFICATIONS

MODEL PFP-600 TRANSMITTER/INDICATOR/TOTALIZER

Flow Accuracy............................ +\-2.0% (Application Dependent) at 70° F (25° C)
Level Accuracy.......................... Better than +\- 1.0% (Application Dependent) at 70° F (25° F)
Linearity..................................... Better than +\-0.5% under flow.
Repeatability................................ Better than +\-0.5% under flow.
Rangeability................................ 10:1 or greater.
Standard Scale........................... Gallons per Minute (as specified). Other engineering units, optional.
Display......................................... LCD-BACKLIT, dual line, 20 Characters, 0.23" high.
Resolution................................... 0.01 Engineering unit.
Standard Output.......................... 4-20 mA dc into 1000 ohms max. isolated.
Totalizer...................................... Resettable, first line of LCD display, With multiplier.
Service........................................ Partially filled pipe flow in engineering units.
                                       Wall or pipe stand mounting. General purpose areas only.
Enclosure..................................... Fiberglass, NEMA 4X, Water resistant.
Power.......................................... 115 VAC +/-10%, 50/60Hz.
Ambient Temperature Range...... 32° F. (0° C) to 122° F. (50° C) Optional enclosure heater available for extended low temperature operation.
Operation Liquids......................... Liquids containing 25 PPM 30 micron or larger suspended solids, up to 1.0% suspended solids.
Minimum Velocity Sensing.......... 0.2 FPS
Minimum Level Sensing............. 2.6"
MODEL T-600-PFP FLOW TRANSDUCER

SERVICE ....................... Non-invasive. General purpose areas only.
Housing material ............. Aluminum, Stainless Steel, epoxy.
Cable .......................... 20 ft. (6 meters) Standard. 50ft. (15.2 meters) optional.
Temperature ...................... -40°F. (-40°C.) to 180°F. (82.2°C.)
Mounting ......................... Aluminum track, Stainless Steel Pipe Clamp. (Supplied).
Coupling ......................... Silicone based adhesive (supplied), or epoxy.

MODEL L600-PFP LEVEL TRANSDUCER

SERVICE ....................... Non-invasive. General purpose areas only.
Housing material ............. Aluminum, Stainless Steel, epoxy.
Cable .......................... 20 ft. (6 meters) Standard. 50ft. (15.2 meters) optional.
Temperature ...................... -40°F. (-40°C.) to 180°F. (82.2°C.)
Mounting ......................... Aluminum track, Stainless Steel Pipe Clamp. (Supplied).
Coupling ......................... Silicone based adhesive (supplied), or epoxy.
SECTION 3

THEORY OF OPERATION

The Dynasonics PFP-600 partially filled pipe flow meter combines a traditional clap-on Doppler type velocity sensor with a unique non-invasive bottom-up level monitor to accurately determine volumetric flow in horizontal pipes that have dynamically changing velocity and level characteristics. Unlike traditional velocity sensing flow meters which assume a full pipe condition and make volumetric flow calculations based on a known fixed cross-sectional pipe area, the Dynasonics flow meter senses both velocity and level which allows the micro-processor based electronics to calculate the cross-sectional area of pipe that is displaced by the liquid and then factored by the sensed velocity to determine volumetric flow data, regardless of the liquid level in the pipe.

This distinctive technology allows the user to address partially filled pipes as never before. The major advantages to this type of technology are unparalleled by other partially filled pipe flow metering devices. First the Dynasonics PFP-600 is non-invasive. This is extremely important in applications where liquid contact is undesirable. Secondly, because the systems sensors are located external to the pipe, installation costs are considerably lower. Finally, because the sensors have no moving parts, are insensitive to coating materials, or have no pressure sensing ports to clog the system it is virtually maintenance free.

The PFP-600 is designed around three basic building blocks. The Doppler velocity sensing electronics, the non-invasive level monitor, and a micro-processor which controls the timing of velocity and level sensing sequences. The micro-processor evaluates the flow and level data and calculates the instantaneous volumetric flow, the total volumetric flow, and drives the 4-20 mA dc output for recording instantaneous volumetric flow information.

**The velocity sensor** is a Doppler type sensor. This sensing methodology requires that the liquid being sensed contain a minimum of 25 PPM of 30 micron suspended particles
or entrained gas. The system will also sense velocity from turbulence caused by flowing liquids. It should be noted that in un-pressurized partially filled pipes, most liquids will contain a sufficient amount of entrained gas for proper operation even though the liquid may be virtually clean. For sensing velocity, the transmitted signal from the velocity transducer is passed through the pipe wall material and comes in contact with a discontinuity in the liquid. The transmitted signal is reflected off of the particle or gas bubble: This reflected signal, according to Doppler theory, has change in frequency with respect to the transmitted frequency: This shift in frequency is proportional to the velocity of the liquid.

The level sensor is a pulsed ultrasonic transit time type. A carefully selected transmission frequency and beam spread have been incorporated into this non-invasive transducer. This design allows for bottom-up sensing of liquid level without coming in contact with the liquid. The transmission frequency has been selected for its unique ability to penetrate pipe wall material, pass freely through the contained liquid, yet effectively reflect off the liquid/air/vapor interface within the pipe.

The electronics is designed to emit a short duration ultrasonic pulse. during the transmitter “off” period the transducer then “listens” for a reflected signal. At the moment of transmission a timer determines the beginning of the transmit cycle to the end of the received cycle. The circuit then divides this time by two and then relates this time to distance or level in the case of the PFP-600.

The micro-processor acts as a controller for the timing of the periods (1 second) in which the Doppler circuit detects velocity and the level monitor senses level. This circuit is essential to eliminate the possibility of flow and level data from becoming entangled with each other thus producing erroneous information. The micro-processor essentially turns on the Doppler circuit while turning off the level circuits and visa versa on a continual basis to keep the micro-processor updated as to the latest occurrences in velocity and level changes. The micro-processor section of the PFP-600 is the heart of the system. This is the portion of the electronics that evaluates the flow and level data and then, converts the data to volumetric flow information based on the equation:
\[ Q = V \times A \]

Where:  
\( Q \) = Volumetric Flow.  
\( V \) = The velocity of the liquid.  
\( A \) = The cross-sectional area of the pipe displaced by liquid.

In addition, the micro-processor performs other evaluations to insure the integrity of the volumetric flow information.
SECTION 4

INSTALLATION

Installation is simple but should be done correctly to assure proper operation. The transmitter can be mounted in any position. The enclosure is weather-resistant; however, it should be protected from direct exposure to sun or rain (NEMA 4X). In order to achieve the best possible results with this flow meter sufficient straight metering runs of pipe are required. The recommended mounting location for both the velocity and level sensors is ten (10) straight pipe diameters down stream and five (5) straight diameters upstream from elbows or fittings. The sensors must be mounted to the bottom of the pipe. In the case of control valves or other disrupting hardware the straight diameters should be doubled.

The PFP-600 is designed to determine volumetric flow in partially filled closed horizontal (<4°) piping systems. Do not use this meter in open channel or open sewer applications whereby the transducers may be submerged, or on vertical closed pipes that may be partially full.

For proper operation in applications for partially filled horizontal pipes, the bottom of the pipe must be accessible. Select a convenient location for the transmitter, one that will accommodate the length of transducer cable supplied. Supply 115 VAC+/-10%, and connect the velocity and level sensors to the appropriate terminals, connect 4-20mA as needed. Refer to the marked terminals inside the transmitter enclosure terminal identification. The level detection sensor must be mounted to the bottom-dead-center of the horizontal pipe to insure proper operation. Diagnostic LED’s on the front of the enclosure will assist in sensor location. With some level of liquid in the pipe, place two beads of silicone adhesive on the face of the level transducer. Using the track level locate the bottom-dead-center of the pipe you are going to be mounting the level sensor to. With the transducer centerline parallel to the centerline of the pipe contact the transducer to the pipe, do not apply a lot of pressure to the transducer, it is essential that the silicone coupling be maintained to assure proper transmission of the ultrasonic
signal. At this time the diagnostic LED’s should be observed at the transmitter. A red “fault” LED indicated that the transducer must be repositioned on the pipe. By moving the sensor + or - the original position toward the top of the pipe a green “read” LED should be achieved.

**NOTE:** For applications that may be turbulent in nature, the green “read” LED, and red “fault” LED may blink intermittently. Under these conditions, position the level transducer such that the green LED is on more than the red LED. At this point the Transducer clamp can be used to hold the transducer in place, again, do not over tighten the clamp such that the couplant may be lost.

The Velocity sensor is mounted in much the same manner as the level sensor. the velocity sensor should also be mounted at the bottom-dead-center of the pipe. The non-connector ends of the two transducers should be butted up to each other. For those applications where this type of orientation is not possible, the two sensors should be mounted as close to one another as possible to avoid system degradation. Apply two beads of silicone adhesive to the face of the velocity sensor. Install the sensor in the mounting track. Using minimal pressure, contact the sensor to the pipe and secure with the Transducer clamp. It should be noted that the velocity sensor is less position sensitive than the level transducer and alignment by eye is typically sufficient. Set meter to read FPS (UNITS=0), meter should indicate flow, and indicate both sufficient particulate or bubble content in the liquid being measured as well as proper transducer placement.

Upon flowing liquid the display will indicate GPM (Standard) or other engineering units as specified and the totalizer will begin to accumulate flow data over time. The diagnostic LED’s should be observed after 24 hrs. of operation (the curing time for the transducer couplant to insure proper adhesion had occurred). If the diagnostic LED’s indicate a level or velocity sensing failure, determine if pipe has liquid in it and/or the liquid is flowing. If the level status indicates a red “fault” light the level sensor may need to be remounted. Likewise should the micro-processor display show OFPS, the velocity sensor may need to be remounted. Should these steps not solve the indicated difficulties contact the factory for further direction.
NOTES
1) LEVEL SENSOR MARKED "L+" AND "L-"
2) HORIZONTAL PIPE INCLINATION MUST BE LESS THAN 4 DEGREES
3) MOUNT BRACKET FIRST TRANSDUCER CLAMPS SHOULD BE "TIGHTENED HAND SNUG TIGHT PLUS 1/2 TURN"
4) LEVEL SENSOR MUST HAVE ENOUGH COUPLANT TO FILL VOID BETWEEN RUBBER SPACERS

Flow Transducer (XDCR) Hook UP

RIG G T
FLOW XDCR

ELEMENT LEVEL XDCR

LEVEL XDCR HOOK UP HERE

Velocity Sensor

Level Sensor

Bottom of Pipe

TRANSINUER MOUNTING BRACKET

TRANSINUER CLAMPS

1" minimum spacing

BUBBLE LEVEL
(USE TO LOCATE BOTTOM CENTER OF PIPE)

MODEL: ___________________________
QTY: __________________________
PO#: __________________________
WO#: __________________________
CONTRACT/PROJECT#: ________________
TAG#: __________________________
CUSTOMER: __________________________
ENGINEER: __________________________
END USER: __________________________
OPTIONS: __________________________

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REV: 8-17-94
DWG. BY: S.J.PARRISH
TITLE: PFP-600 FIELD WIRING DRAWING
DATE: 10-1-93
DWG #: 091-1051-000

SPECIAL INSTRUCTIONS: __________________________

______________________________
PFP KEYPAD LAYOUT

- Signal Str
- 4 mA
- Reset
- 20 mA
- High Alarm
- Total Alarm Level
- Power Fail
- Total Level
- Lock On
- Cal
- Input F.S.
- Cal
- Damp
- Test
- Contrast
PFP µP FUNCTIONS

To set engineering units press “UNITS” key. The µP display will show “UNITS”. Use the “SCROLL” keys to increase or decrease value. The default value is 1. When finished, press “ENTER” key to exit.

NOTE: after units has been changed, all other levels for FULL-SCALE, ID, ALARMS, must be re-entered.

0 = FPS  6 = CMH  
1 = GPM  7 = LPM  
2 = GPH  8 = MLD  
3 = MGD  9 = LEVEL INCHES  
4 = CFM  10 = LEVEL CENTIMETERS  
5 = MPS

To set 4-20 mA full-scale, press “FULL-SCALE” key. The µP display will show “FULL-SCALE”. Use the “SCROLL” keys to increase or decrease value. The default value is 10.00. When finished, press “ENTER” key to exit.

units = 1-4  
full-scale range is 1.00 - 20.00 FPS  

\[
\text{GPM} \quad \text{F.S (FPS)} = \text{ID} \times \text{ID} \times 2.45
\]

units = 5-8  
full-scale range is 0.304 - 6.08 MPS  

\[
\text{LPM} \quad \text{F.S (MPS)} = \text{ID} \times \text{ID} \times .047
\]

units = 9  
full-scale range is 4.00” - 60.00”

units = 10  
full-scale range is 10.2 cm. - 152.00 cm.

To set pipe ID, press “I.D.” key. The µP display will show “ID (IN)” or “ID (MM)”. Use the “SCROLL” keys to increase or decrease value. The default value is 10.00. When finished, press “ENTER” key to exit.

units = 1-4, and 9  
pipe ID range is 4.00” - 60.00”
To set high alarm (RELAY-2), press “HIGH ALARM” key. The µP display will show “ALARM HIGH”. Use the “SCROLL” keys to increase or decrease value. The default value is 20.00. When finished, press “ENTER” key to exit.

units = 1-4  
high alarm range is 0.00” - 60.00”

units = 5-8  
high alarm range is 0.00 - 6.08 MPS

units = 9  
high alarm range is 0.00” - 60.00”

units = 10  
high alarm range is 0.00 cm. - 152.00 cm.

To set low alarm (RELAY-1), press “LOW ALARM” key. The µP display will show “ALARM LOW”. Use the “SCROLL” keys to increase or decrease value. Default value is 00.00. When finished, press “ENTER” key to exit.

units = 1-4 (flow)  
low alarm range is 0.00 - 20.00 FPS

units = 5-8 (flow)  
low alarm range is 0.00 - 6.08 MPS

units = 9 (level)  
low alarm range is 0.00” - 60.00”

units = 10 (level)  
low alarm range is 0.00 cm. - 152.00 cm.

Totalizer operation display with or without multiplier

units = 2 - 4  
totalizer range is 0 - 99999999 GALS (GALLONS)

units = 6 - 8  
totalizer range is 0 - 99999999 LTRS (liters)
units = 1 & 9
  totalizer is off and no display

units = 5 & 10
  totalizer is off and no display

To set totalizer multiplier, press “TOT MULT” key. The µP display will show “TOTAL MULT.” Use the “SCROLL” keys to increase or decrease value. The default value is 0. When finished, press “ENTER” key to exit.

  0 = X1
  1 = X10
  2 = X100
  3 = X1000
  4 = X10,000

To set totalizer on, off or reset, press “TOT ON/OFF” key once to stop totalizing, twice to reset, and third to start. Note: when changing engineering units, totalizer will stop totalizing.

To enable key board lock out, press “LOCK ON” key, display will show “LOCK ON”, then press “ENTER” key to exit. To turn off lock, use arrows to set a value of 125, and press “ENTER” key, display will show “LOCK OFF”.

“F1” & “F2” keys are not used.

To set velocity calibration factor, press “CAL” key. The µP display will show “VEL. CAL”. Use the “SCROLL” keys to increase or decrease value, cal. range is 0-255%, default is 100%. When finished, press “ENTER” key to exit. NOTE: calibration factor will affect the display, alarms, and 4-20mA.

To set damping factor, press “DAMP” key. The µP display will show “DAMPING”. Use the “SCROLL” keys to increase or decrease value, damping range is 1-10 seconds, default is 2 seconds. When finished, press “ENTER” key to exit.
**NOTE:** damping factor will affect the display, alarms, and 4-20mA.

To turn on test mode, press “TEST” key, display will show “TEST MODE”. The 4-20mA output will be set to 20mA. Press “ENTER” key to exit function.

To access the 2nd function, press the “2nd FUNCT” key, display will show “SERVICE MODE”. Then select any function that is located in the yellow part of the key pad. Press “ENTER” key to exit function.

To view the Doppler’s signal strength level, press “2nd FUNCT” key, then “SIGNAL STR” key. The display will show “SERVICE MODE” and “SIGNAL STR.”. When flow is present, a good signal strength level is 150 or higher. Press 'ENTER' key to exit function.

To adjust the 4mA output press “2nd FUNCT” key then the “4mA” key. The µP display will show “SERVICE MODE” and “4mA”. Use the ‘SCROLL” keys to increase or decrease the 4-20mA output level. When finished with function, press “ENTER” key.

To view the Doppler’s raw velocity level, press “2nd FUNCT” key and then “VEL ADC” key. The µP display will show “SERVICE MODE” and “VEL ADC1”. When flow is at 10 FPS, a level of 1024 will be displayed. Press “ENTER” key to exit function.

To set the liquid Blanking time, press “2nd FUNCT” key and then the “BLANKING” key. The µP display will show “SERVICE MODE” and “BLANKING”. Use the “SCROLL” keys to increase or decrease the minimum liquid level the unit can read. This is done by rejecting receive signals that are less than the set value 17 (0" -2.0") or (1 blanking change is equal to 0.2" liquid level). Changing the Blanking setting may also alleviate unstable readings in some applications. Default level is 20 [0" - 2.6”]. Press “ENTER” key to exit function.

**NOTE:** never set the blanking range greater than 75% of the minimum level you desire to detect.
To set the liquid detection level, press “2nd FUNCT” key and then the “DETECT LEVEL” key. The µP display will show “SERVICE MODE” and “DET LEVEL”. Use the “SCROLL” keys to increase or decrease level in which the receive signal is filtered. Lowering the value will allow the unit to produce a reading when none existed before. Raising the value will allow the unit to stabilize unwanted “Fault Light” occurrences as well as helping to stabilize readings and outputs. Default level is 150. Press ‘ENTER” key to exit function.

To adjust the 20mA output press “2nd FUNCT” key then the “20mA” key. The µP display will show “SERVICE MODE” and “20mA”. Use the “SCROLL” keys to increase or decrease the 4-20mA output level. When finished with function, press “ENTER” KEY.

To set the liquid level gain, press 2nd FUNCT” key and then the “LL GAIN “ key. The µP display will show “SERVICE MODE” and “GAIN”. Use the “SCROLL” keys to increase or decrease level in which the receive signal is amplified. Lowering the value will help to stabilize unstable readings and outputs. Raising the value will allow the unit to produce a reading when none existed before. Default level is 55. Press “ENTER” key to exit function.

To set the Doppler’s velocity signal strength cutoff level, press “2nd FUNCT” key and then the ‘VEL SS CUTOFF” key. The µP display will show “SERVICE MODE” and “VEL SS CUTOFF”. Use the “SCROLL” keys to increase or decrease level in which the microprocessor stops reading the velocity because of low signal strength. Default level is 100. Press “ENTER” key to exit function. Note: if velocity signal strength cutoff level is set higher than velocity signal strength, the meter will not show flow.

To set the power fail level, press “2nd FUNCT” key and then the “POWER FAIL” key. The µP display will show “SERVICE MODE” and “PWR FAIL”. Use the “SCROLL” keys to increase or decrease voltage level in which triggers a power failure warning. The microprocessor will then store totalizer readings. The default level is 200. Press
“ENTER” key to exit function. Note: It is not recommended to alter this level from factory settings.

To set liquid level calibration factor, press “2nd FUNCT” key and then the “CAL LEVEL” key. The µP display will show “SERVICE MODE” and “VEL CAL.”. Use the “SCROLL” keys to increase or decrease value, cal. range is 0 - 255%. When finished, press “ENTER” key to exit.

**NOTE:** calibration factor will affect the display, alarms, and 4-20mA.

“INPUT F.S.” key is not used.

“DAC -- 3” key is not used.

To toggle backlight on or off, press “2nd FUNCT” key and then “BACKLIGHT” key. The µP display will show “SERVICE MODE” and backlight will toggle when “BACKLIGHT” key is depressed. Press “ENTER” key to exit function.

To adjusted the display contrast press “2nd FUNCT” key then the “CONTRAST” key. The µP display will show “SERVICE MODE” and “CONTRAST”. Use the “SCROLL” keys to increase or decrease the contrast level, defaults is 10. When finished with function, press “ENTER” key.