DYNASONICS

Series 902/903

Portable Doppler Ultrasonic Flow Meter

Operations & Maintenance
Manual

REV 10/99

BEFORE OPERATING THE D902/3

Important Notice!

The D902/3 flow meter is equipped with a Lead Acid Gel Cell battery. This battery will require charging before initial operation.

Apply AC power, utilizing the enclosed line power cord, to the D902/3 for a period of 16-24 hours prior to using the product for the first time. The line cord connects to the socket connection located on the side of the enclosure.

The D902/3 has an integral charging circuit that prevents overcharging. The instrument can be permanently connected to AC line power without damaging the flow meter or the battery.

TABLE OF CONTENTS

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This manual contains detailed operating instructions for all aspects of the D902/3 instrument. The following condensed instructions are provided to assist the operator in getting the instrument started up and running as quickly as possible. This pertains to basic operation only. If specific instrument features are to be used or if the installer is unfamiliar with this type of instrument, refer to the appropriate section in the manual for complete details.

Location

1. TRANSDUCER LOCATION

A. Determine the appropriate mounting location for the transducers by referring to **Figure 1**.

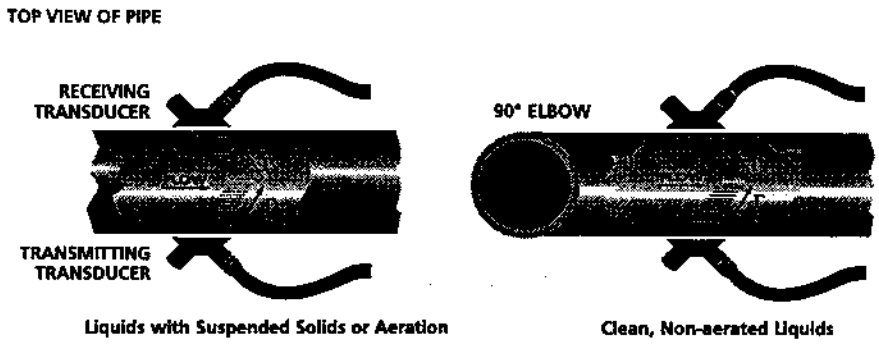


Figure 1 Transducer Locations

Pipe Preparation and Mounting

2. PIPE PREPARATION AND TRANSDUCER MOUNTING

A. The piping surface, where the transducers are to be mounted, needs to be clean and dry. Remove loose scale, rust and paint to ensure satisfactory acoustical bonds.

B. Connect the elastic mounting strap around the pipe. Leave the strap just loose enough to slip the transducers underneath.

C. Apply a liberal amount of silicone grease (enclosed) onto the transducer faces and the pre-

pared areas of the pipe.

D. Place each transducer under the mounting strap, 180° apart on the pipe. Ensure that the transducer cables are facing the same direction. See **Figure 2**.

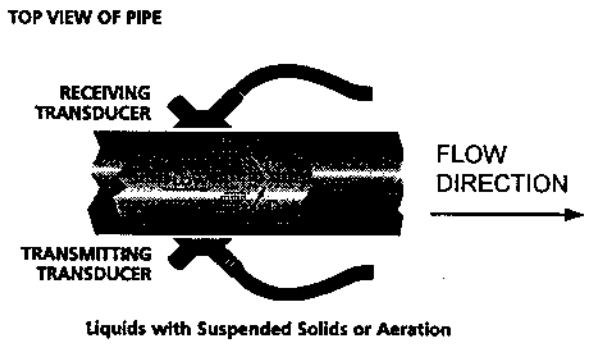


Figure 2 Transducer Cable Direction

E. Route the transducer cable back to the transmitter, avoiding locations near high voltage supply wires.

Connections

3. TRANSDUCER CONNECTION

A. Connect the transducer plug to the appropriate mating socket on the side the D902/3 enclosure.

Startup

4. INITIAL SETTINGS AND POWER UP

A. Set the SENSITIVITY control to - 2.

B. Press the POWER button. The POWER indicator will illuminate.

C. **If the pipe is full of a flowing liquid,** the SIGNAL STRENGTH meter will indicate and the READ indicator will illuminate.

D. Adjust the SENSITIVITY control so that the right-most green LED just comes ON.

E. The default display indicates fluid velocity as either FPS or MPS. Refer to the appropriate place in this manual for specific features and options.

PART 1 - INTRODUCTION

General

The D902/3 ultrasonic flow meter is designed to measure the fluid velocity of liquid within closed conduit. The transducers are a non-contacting, clamp-on type, which will provide benefits of non-fouling operation and ease of installation.

The flow meter operates by transmitting an ultrasonic sound from its transmitting transducer through the pipe wall into the flowing liquid. The sound will be reflected by suspended particles or bubbles within the liquid and recorded by the receiving transducer. A frequency shift (Doppler effect) will occur that is directly related to the speed of the moving particle or bubble. This shift in frequency is interpreted by the instrument and converted to various user defined measuring units.

A unique feature of this product is that it employs a proprietary digital filtering system and recognition circuit. This feature allows the instrument to measure fluid velocities of clean liquids if the transducers are mounted downstream from a 90° elbow. The non-symmetrical hydraulic turbulence which occurs downstream of an elbow is captured, linearized and can be displayed as liquid velocity and volume. This capability is not available in conventional Doppler technology.

Application Versatility

The D902/3 flow meter can be successfully applied on a wide range of metering applications. The simple to program transmitter allows the standard product to be used on pipe sizes ranging from 1 - 120 inch [25 - 3048 mm] pipe I.D. (With the small pipe transducer option, the pipe size range is 0.25 - 1 inch [6 - 25 mm]). A variety of liquid applications can be accommodated: raw sewage, reclaimed water, cooling water, river water, plant effluent, mining slurries, sludge, etc. Because the transducers are non-contacting and have no moving parts, the flow meter is not affected by system pressure, fouling or wear. Standard transducers are rated to 180°F [82°C]. Optional high temperature transducers are rated to operate to 400°F [204°C].

PART 1 - INTRODUCTION

User Safety

The D902/3 employs modular construction and provides electrical safety for the operator. The display face contains voltages no greater than 9 Vdc and the metal work is electrically connected to Earth Ground. All user connections are made through sealed bulk-head plugs located on the side of the D902/3 enclosure.

Battery Backup

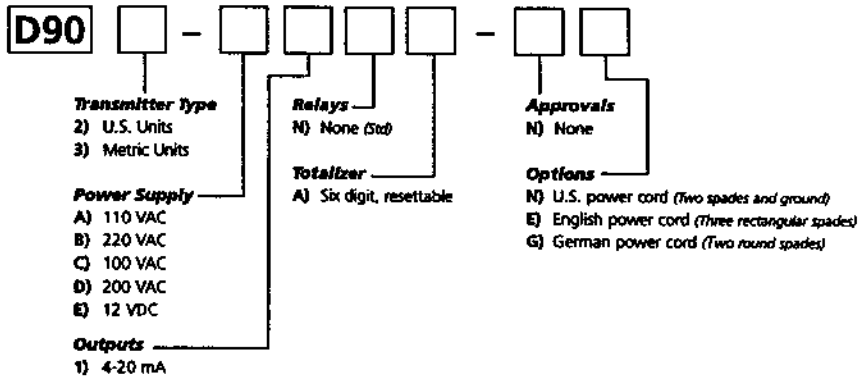
A rechargeable nickel-cadmium battery on the back of the display board retains all user-entered configuration values in memory for several years (at 25°C), even if power is lost or turned off. The ten year battery is continually trickle charged whenever line power is applied. A completely discharged battery recharges fully after 48 hours of instrument operation.

Product Identification

The serial number and complete model number of your D902/3 is located on the inside of the transmitter's cover. Should technical assistance be required, please provide the Dynasonics' Customer Service Department with this information.

Product Matrix

TRANSDUCER/TRANSMITTER
(Includes: Accessory pouch, standard transducer, mounting straps, acoustic couplant and power cord.)



D-902 ACCESSORIES

D070-1006-001 High Temp Transducer
D070-1004-003 Small Pipe Transducer
D010-0200-100 Transducer cable extension, 20 feet [6 m]

PART 1 - SPECIFICATIONS

TRANSMITTER

DESCRIPTION	SPECIFICATION
POWER REQUIREMENTS	Internal Lead acid Gel Cell battery provides 8 hrs of continuous operation. AC charging: (Std) 115/230 VAC 50/60 Hz ±10%. (Opt) 100/200 VAC 50/60 Hz ±10%. (Opt) 12 VDC
VELOCITY	0.5 - 20 FPS [0.15 - 6.08 MPS]
OUTPUTS	4-20 mA, 600 Ohms max., isolated.
INDICATORS	Power, Signal Strength, Flow Analyzer, Fault, Over-range, Read, Low Battery, Charge
DISPLAY	2 line x 20 character alphanumeric LCD (backlit). Digit height 0.2 inches [5 mm], 6 digit rate, 6 digit totalizer (resettable)
UNITS:	User configured
RATE U.S. [METRIC]	FPS, GPM, MGD [MPS, LPM, M^3/hr]
TOTALIZER U.S. [METRIC]	Gallons [liters, M^3]
AMBIENT CONDITIONS	-22 to 160°F [-30 to 70 °C], 0-95% relative humidity, non-condensing.
ENCLOSURE	NEMA 4X, [IP-65] ABS with SS hardware. 11W x 17L x 8D inches [279W x 432L x 203D mm]
NON-LINEARITY (ACCURACY)	±2% Full Scale
SENSITIVITY	0.4% of Full Scale
REPEATABILITY	±0.4% of Full Scale
RESPONSE TIME	5-50 seconds, user configured, to 90% of value, step change in flow.

TRANSDUCER

DESCRIPTION	SPECIFICATION
LIQUID REQUIREMENTS	25 ppm of 30 micron size* suspended solids or entrained gases (air). *Less than this minimum will require transducer mount downstream of a 90° elbow.
TRANSDUCER TO TRANSMITTER DISTANCE	(Std) 20 feet [6.08 meters], retractable cord.
PIPE SIZES	(Std) 1 - 120 inches [25 - 3050 mm] Pipe I.D. (Opt.) 0.25 - 1 inch [6 - 25 mm], Small Pipe Transducer
TEMPERATURE	(Std) -40° to 250°F [-40° to 121°C]. (Opt) -40° to 400°F [-40° to 204°C]
HOUSING MATERIAL	(Std) Aluminum, Ultem™ w/epoxy encapsulation (High Temp) Torlon™ w/SS

PART 2 - PRE-INSTALLATION CHECKOUT

Unpacking

After unpacking, it is recommended to save the shipping carton and packing materials in case the instrument is stored or re-shipped. Inspect the equipment and carton for damage. If there is evidence of shipping damage, notify the carrier immediately.

Functional Test

The D902/3 flow meter can be checked for basic functionality using the following **Bench Test** procedure. It is recommended that this operation be performed before each day of operation.

Procedure:

1. Open the D902/3 transmitter cover.
2. Connect the transducer cable connector plug to the corresponding connector socket location on the side of the D902/3 enclosure. See **Figure 3**.
3. Set the transmitter SENSITIVITY control [located on the front panel] to -2.
4. Apply power.
5. Hold the transducers, the flat sides facing each other, approximately 6-8 inches [150-200 mm] apart.
6. Move the transducers towards and away from each other 1 inch [25mm] for several cycles at approximately 1 second interval.
7. If unit is functioning properly, the READ LED will illuminate and the rate display will indicate flow readings.

Bench Test is Complete

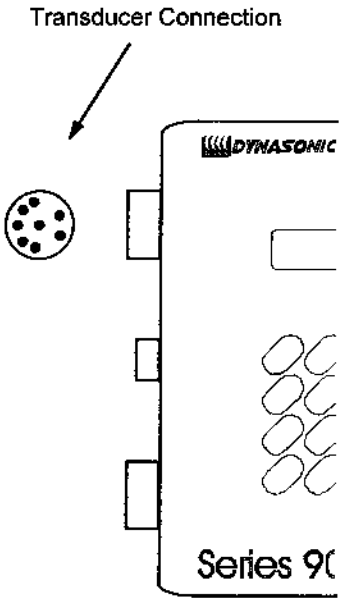


Figure 3

PART 2 - TRANSDUCER INSTALLATION

Transducer Mounting Considerations

The transducers that are utilized by the D902/3 contain piezo electric crystals for transmitting and receiving ultrasonic sound energy through the pipe wall.

The transducers can be mounted in three different configurations. The selection of the proper configuration is dependent on the liquid to be measured characteristics.

The three liquid characteristics, which will affect mounting location and orientation, are as follows:

Step A - Mounting Locations

CASE 1: Liquid that contains 25 to 10,000 PPM [1%] of 30 micron or larger suspended solids or aeration.

CASE 2: Liquid that contains greater than 10,000 PPM [1%] of 30 micron or larger suspended solids or aeration.

CASE 3: Liquid that contains fewer than 25 PPM of 30 micron or larger suspended solids or aeration and suspended solids and aeration content which is smaller than 30 microns.

CASE 1:

Liquid that contains 25 to 10,000 PPM [1%] of 30 micron or larger suspended solids or aeration.

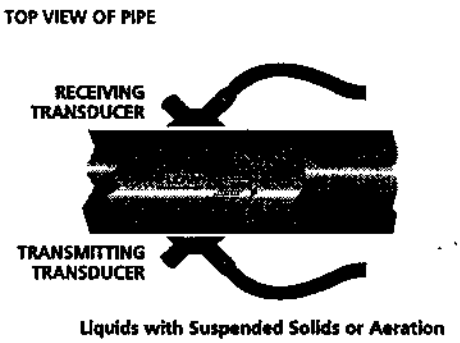
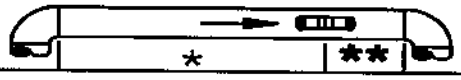
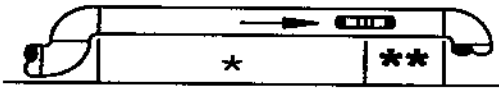
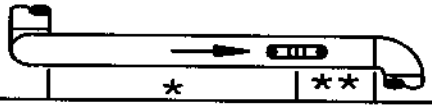
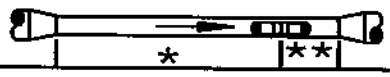


Figure 4

Select a transducer mounting location with adequate straight runs of pipe, both upstream and downstream, to achieve stable readings. Examples of minimum upstream and downstream requirements are included in **Table 1**.

Mount the transducers 180° apart and facing each other on the pipe. If the pipe is horizontal, the preferred mounting orientation is 3 and 9 o'clock, with 12 o'clock being the top of the pipe. Orientation on vertical pipes does not matter. See **Figure 4**.

Table 1[1]

Piping Configuration and Transducer Position	Upstream Dimension: Pipe Diameters *	Downstream Dimension: Pipe Diameters **
	9	3
	14	3
	24	4
	8	3
	8	3
	24	4

[1] The D902/3 system will provide repeatable measurements on piping systems that do not meet these requirements, but the accuracy of these readings may be influenced to various degrees.

CASE 2:

Liquid that contains greater than 10,000 PPM [1%] of 30 micron or greater suspended solids or aeration.

The mounting location and straight pipe requirements for CASE 2 liquid characteristics are the same as those describe in CASE 1. The difference will be in the location of the transducers on the pipe. As the discontinuities (suspended solids or aeration) reach a level of approxi-

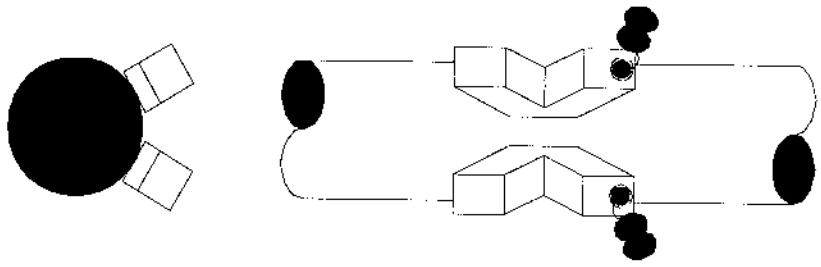


Figure 5

mately 1% or 10,000 PPM, sound can no longer be reliably transmitted through the liquid as it has a tendency to scatter and absorb into the high concentration of discontinuity. To compensate for this, the D902/3 transducers can be located on the same region of the pipe. In a horizontal pipe, mount the transducers at 2 o'clock and 4 o'clock positions. (Assuming 12 o'clock as the top of the pipe.) See **Figure 5.**

CASE 3:

Liquid that contains fewer than 25 PPM of 30 micron or larger suspended solids or aeration. Or, liquid that contains solids or aeration which is smaller than 30 microns.

The transducers will be mounted 1 to 3 pipe diameters downstream from a 90° elbow. The orientation of the transducers on the pipe will be 180° apart and facing each other and 90° out of the plane of the elbow. See **Figure 6.**

PART 2 - TRANSDUCER INSTALLATION

STEP B - PIPE SURFACE PREPARATION

Before the transducer heads are bonded to the pipe surface, an area slightly larger than the flat surface of the transducer must be cleaned to bare metal on the pipe. (Plastic pipes do not require preparation beyond removal of paint.) Remove all scale, rust and paint. Thoroughly dry and degrease the mounting surfaces.

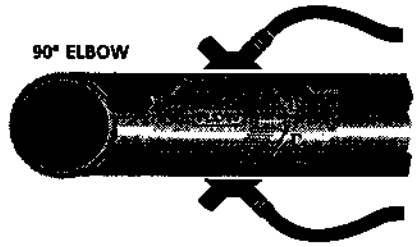


Figure 6

NOTE: Small pits in the piping surface typically do not significantly impact ultrasonic transmission or signal reception.

STEP C - TRANSDUCER MOUNTING

After selecting the applicable mounting location and preparing the piping surface as detailed in Steps A and B, the transducer can be mounted to the pipe.

Note: High Temperature transducer installations require specialized mounting hardware and instructions. Drawings detailing installation of this option is located in the Appendix of this manual.

Steps A and B, Mounting Locations and Pipe Preparation sections of this manual apply to the High Temperature option. Reference these sections as required.

PART 2 - TRANSDUCER INSTALLATION

To assure an acoustically conductive path between the transducer face and the prepared piping surface, a coupling compound is employed. Enclosed with the D902/3 system is tube of Dow Corning 111, silicone grease. This couplant is satisfactory for temporarily mounting the transducers to the pipe. If the installation is long-term (more than a few days), Dynasonics recommends utilizing a silicone-based RTV such as Dow Corning RTV-732. If alternate couplants are utilized, the grease chosen must be rated to not flow at the temperature of the pipe.

1. Wrap the elastic strap (enclosed) around the pipe in the area where the transducers are to be mounted. Mount the strap snuggly, but leave the strap just loose enough to allow the transducers to be placed underneath.
2. Spread an even layer of coupling compound, approximately 1/8 inch [3mm] thick, to the prepared transducer mounting areas of the pipe. Utilize Dow 111 for temporary mounting or Dow 732 for permanent mounting.
3. Spread an even layer of the coupling compound, approximately 1/8 inch [3mm] thick, to the flat face of the two transducers.
4. Place each transducer under the strap with the flat face positioned towards the pipe. The notch on the back of the transducer will provide a mounting surface for the strap. The transducer cables must be facing in the same direction for proper operation. See **Figure 7**. NOTE: Large pipes may require two people for this procedure.
5. Tighten the strap tight enough to hold the transducers in place, but not so tight that all of the couplant squeezes out of the gap between the transducer face and pipe. Ensure that the transducers are squarely aligned on the pipe.
6. Route the transducer cable back to the transmitter mounting area avoiding high voltage cable trays and conduits. Do not attempt to add additional cable to the

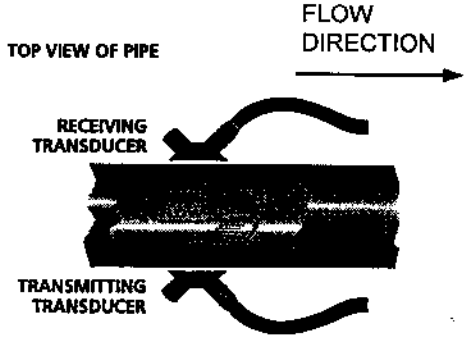


Figure 7

factory supplied transducer cable. The D902/3 processes very small signals, so the cable shield must be continuous.

7. If the transducers are to be permanently mounted using Dow 732, the RTV must be completely cured before proceeding to Instrument Start up. Ensure that no relative motion between the transducer and pipe occurs during the 24 hour curing process. If Dow 111 grease was used for temporary operation of the D902/3 system, proceed with the Instrument Start-up procedures.

Transducer Installation is complete.

PART 2 - ELECTRICAL CONNECTIONS

Transmitter Location

The D902/3 enclosure should be located in an area that is convenient for observation of the LCD readout and keypad operations. To prolong the life of the keypad and controls, the enclosure cover should be left closed when the unit is unattended.

Place the D902/3 transmitter in a location that is:

- Where little vibration exist.
- Protected from falling corrosive fluids.
- Within ambient temperature limits - 22 to 122°F [30 to 50°C]
- Out of direct sunlight. Direct sunlight may increase temperatures within the transmitter to above maximum limit.

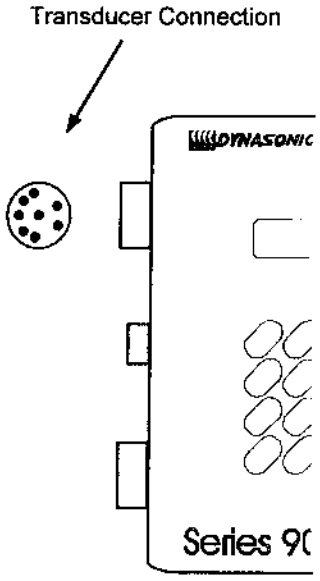


Figure 8

Connect the transducer plug to the socket connection located on the side of the D902/3 enclosure. Refer to **Figure 8.** Ensure that tension on the retractable cables has not pulled either of the transducers out of position on the pipe. The transducers must be squarely mounted to achieve greatest accuracy.

NOTE: The transducer cable carries low level signals. Do not attempt to add additional cable to the factory supplied transducer cable.

4-20mA Output

The 4-20mA output is proportional to the flow rate measuring scale and can drive a load of up to 600 ohms. The output is isolated from earth ground and circuit low. Connect the load to the **4-20 mA** connection socket located

on the side of the D902/3 enclosure, matching polarity as indicated. **See Figure 9.** A mating plug for the connection socket has been included.

Battery Charging and AC Power Operation

To recharge the internal battery of the D902/3 or to operate the meter for periods of time greater than 8 hours, connect the meter to AC line power. Line power is connected by plugging the enclosed line cord, to the appropriate connector socket located on the side of the D902/3 enclosure. See **Figure 10**. Use wiring practices that conform to local codes (National Electric Code Hand book in the USA). Use only the standard three wire connection. The ground terminal grounds the instrument, which is mandatory for safe operation.

CAUTION: Any other wiring method may be unsafe or cause improper operation of the instrument.

It is recommended not to run line power with other signal wires within the same wiring tray or conduit.

NOTE: This instrument requires clean electrical line power. Do not operate this unit on circuits with noisy components (i.e. Fluorescent lights, relays, compressors, variable frequency drives, etc.).

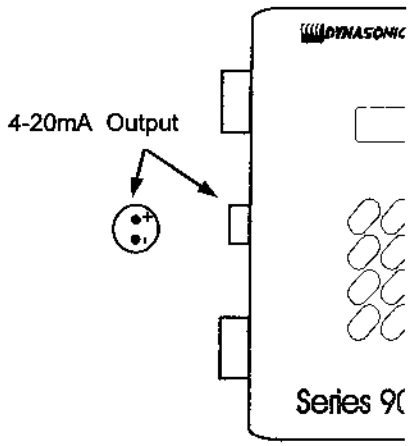


Figure 9

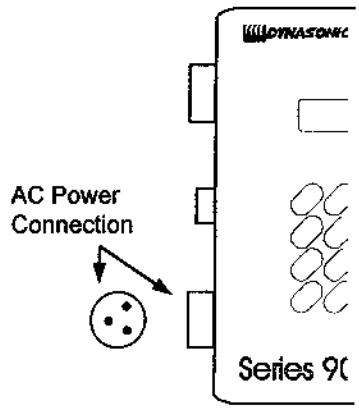


Figure 10

Battery Care and Maintenance

The D902/3 flow meter is equipped with a Lead Acid Gel Cell battery. This battery will require charging before initial operation. Apply AC power, utilizing the enclosed line power cord, to the D902/3 for a period of 16-24 hours prior to using the product for the first time. The line cord connects to the socket connection located on the side of the enclosure.

The D902/3's integral battery provides continuous operation for up to 8 hours on a full-charge. The battery is "maintenance free", but it still requires a certain amount of attention to prolong its useful life. To obtain the greatest capacity and longevity from the battery, the following practices are recommended:

- Do not allow the battery to completely discharge. (Discharging the battery to the point where the LOW BATTERY indicator illuminates will not damage the battery. Allowing the battery to stay discharged for long periods of time can degrade the storage capacity of the battery.) When not in use, continually charge the battery by keeping it plugged into line power. The D902/3 battery management circuitry will not allow the battery to become "over-charged".

NOTE: The D902/3 will automatically enter a low power consumption mode approximately 1-1/2 minutes after the LOW BATTERY indicator illuminates. This circuit prevents excessive discharge of the internal battery.

- If the D902/3 is stored for prolonged periods of time, monthly charging is recommended.
- If the D902/3 is stored for prolonged periods of time, store at a temperature below 70°F [21°C].

The CHARGING indicator will always be illuminated when the D902/3 is connected to line power and the flow meter is turned ON. If the D902/3 is turned OFF and line power is connected, the CHARGING indicator will illuminate only when the internal circuit is charging the battery. During

storage, the CHARGING indicator will cycle as necessary.

Desiccant Cartridge

The D902/3 is equipped with a DESICCANT CARTRIDGE, which is located in the face plate of the meter. The purpose of the cartridge is to absorb the humidity that was present inside of the enclosure when the product was manufactured and to absorb moisture that may seep into the enclosure during field operation. Observing the color indicator of the DESICCANT CARTRIDGE and replacing it when it turns PINK will decrease the chance of corrosion and resulting failure of the internal components of the D902/3.

Procedure

1. Obtain a new DESICCANT CARTRIDGE from Dynasonics (Dynasonics P.N. D005-9909-001).
2. Replace the cartridge in a temperature and humidity controlled environment. Allow the meter to reach the same ambient temperature as the area in which the cartridge will be replaced. (Do not attempt to change the cartridge if the meter is below the Dew Point Temperature.)
3. Remove the old cartridge with a 1-3/8" open-end wrench or appropriate adjustable wrench.
4. Insert the new cartridge and tighten with the wrench.
5. Discard the used cartridge.

PART 3 - STARTUP AND CONFIGURATION

Before Starting the Instrument

Note: The D902/3 flow meter system **requires a full pipe of flowing liquid** before a successful startup can be completed. Do not attempt to make adjustments or change configurations until both a full pipe and liquid flow are verified.

Note: If Dow 732 RTV was utilized to couple the transducers to the pipe, the adhesive must fully cure before power is applied to the instrument. Dow 732 requires 24 hours to cure satisfactorily. If Dow 111 silicone grease was utilized as a couplant, the curing time is not required.

Instrument Startup

Procedure:

1. Verify that all wiring is properly connected and routed.

2. Set the SENSITIVITY Control to -2. This control is located on the D902/3 front panel.

3. Apply power. The POWER indicator will illuminate.

4. Adjust the SENSITIVITY control so that the right-most LED on the SIGNAL STRENGTH bar meter just illuminates or SIGNAL STRENGTH is at least in the yellow/ green region.

Important!

Note: It is undesirable to adjust the SENSITIVITY control to a position higher than necessary, as ambient noise can also be amplified. This noise can cause false readings to occur.

5. If the pipe is full of a flowing liquid, the READ indicator will illuminate and the display will begin reading fluid velocity as FPS (Feet per Second) or MPS (Meters per Second). It is normal to have low SIGNAL STRENGTH and FAULT indication at ZERO flow.

6.If a SIGNAL STRENGTH reading in the green portion of the bar meter or a FLOW ANALYZER indication could not be obtained, refer to the troubleshooting section of this manual.

PART 3 - STARTUP AND CONFIGURATION

Keypad Configurations

After a successful flow meter installation and startup (covered in the previous sections of this manual) the D902/3 can be keypad configured to provide select engineering unit readings of flow and a scaled 4-20mA output. Configuration inputs are made via the keypad and are stored by the microprocessor. The entries are retained by the flow meter's backup battery in the event of power failure. If fluid velocity readings in FPS or MPS are the only required measurement, keypad configuration is not required.

Modes of Operation

The RUN/ENT key toggles the flow meter between the two modes of operation.

RUN Mode: This is the primary operating mode of the flow meter. The meter is in RUN mode when the readout is displaying flow as velocity (FPS, MPS) OR volume (GPM, LPM, LPS). In RUN mode the outputs are active and transmitting signals proportional to flow rate.

ENTRY Mode: This mode is used to view or change the configuration of the flow meter. When the D902/3 ships from the Dynasonics factory, it contains the following Default configuration:

Default Configuration

PARAMETER	US	METRIC
ID	1 Inch	25 mm
UNITS	1 [FPS]	1 [MPS]
DAMP	1 Sec	1 Sec
Volume/PLS	ϕ	ϕ
FULL SCALE	5 FPS	6.08 MPS
CAL	100%	100%

Each of these parameters may be viewed and/or modified in the ENTRY Mode. Changes are processed when the

RUN/ENT is pressed and the meter returns to RUN MODE. In ENTRY Mode flow totalization is suspended and process outputs are frozen at the last value recorded.

Pipe I.D. Input

The ID key allows the entry of a pipe's Internal Diameter. The D902/3 utilizes the I.D. constant to process volumetric flow rates such as GPM (Gallons per Minute) or LPM (Liters per Minute). The entry is made as either inches or mm, dependent on whether the unit is configured as U.S. units or Metric units.

Press the I.D. key from the ENTRY MODE. The display will show

INSIDE DIAMETER

This is the present I.D. constant. Enter a new I.D. based on information obtained from the pipe manufacturer, a physical measurement or a pipe chart. Some common pipe sizes and dimensions are located on a series of charts located in the Appendix of this manual. The acceptable input range for the I.D. constant is shown in Table 3.

Table 3

I.D.	US	METRIC
Max	120 Inches	3048 mm
Min *	0.25 Inches	6 mm

* Pipe sizes less than 1 inch [25 mm] require a Small Pipe Transducer. Dynasonics P.N. D070-1004-003.

Note: If a decimal value of less than 1 is to be entered, enter 0 . X X X. The zero must precede the decimal value.

Note: If an entered value is out of the acceptable range of the instrument, an UNDER! or OVER! indication will be displayed. The meter will not allow any other entries to be made until a legitimate value is entered.

Full Scale Input

The FULL SCALE key allows the entry of the highest anticipated fluid velocity. The entry is made as either FPS (Feet per Second) or MPS (Meters per Second) dependent on whether the unit is configured as US units or Metric units. The FULL SCALE input is used by the D902/3 microprocessor to scale the 4-20mA output and adjust the resolution of the flow rate display.

Acceptable input range for the FULL SCALE constant is shown in **Table 4**.

Table 4

I.D.	US	METRIC
Max	40 FPS	8 MPS
Min *	n/a	n/a

Important!

* Note: FULL SCALE values below 1.5 FPS [0.5 MPS] are not recommended.

Note: If an entered value is out of the acceptable range of the instrument, a RANGE! indication will be displayed. The meter will not allow any additional entries to be made until a legitimate value is entered.

Volume to Velocity Conversion

Two useful equations which relate volumetric flow in round pipes to flow velocity are as follows:

$$FPS = \frac{U.S.\ GPM \times 0.409}{ID^2\ (inches)}$$

$$MPS = \frac{LPM \times 21.23}{ID^2\ (mm)}$$

Totalizer Exponent Input

The VOL. PULSE key allows the entry of a totalizer exponent. This feature is useful for accommodating a very large accumulated flow. The exponent is a " X 10 " multiplier, which can be from 0 (no multiplier) to 6 (10^6). For example, to totalize in kilo-gallons, a VOL. PULSE value of 3 would be used (10^3 or 1000).

Acceptable input range for the VOL. PULSE constant is shown in **Table 5**.

Table 5

I.D.	US	METRIC
Max	6	6
Min *	0	0

* Note: If an entry greater than 6 is attempted, the meter will display OVER!. If a non- whole number value is attempted, the meter will display RANGE!. A legitimate value will need to be entered.

After a VOL. PULSE value is entered, the display will reflect the unit as 10En, where "n" is the exponent.

Table 6 illustrates various codes and their display results.

Table 6

VOL. PULSE CODE	ENG. NOTATION	DISPLAY MAXIMUM
0	10E0	999,999
1	10E1	999,999
2	10E2	999,999
3	10E3	999,999
4	10E4	429,299
5	10E5	42,929
6	10E6	4,295

Important Note for MGD Configurations

When utilizing the MGD engineering UNITS, the totalizer defaults to a VOL. PULSE multiplier of 10E3. This is not reflected on the display. Example: In MGD mode, a VOL. PULSE entry of 3 will result in an effective accumulation of E106 gallons (millions of gallons).

Engineering Units Input

The UNITS key allows the selection of measuring units. **Table 7** shows applicable codes for the engineering units available.

Table 7

UNITS CODE	U.S.	METRIC
1	FPS	MPS
2	GPM	LPM
3	MGD	LPS

Attempting to enter values other than 1, 2 or 3 will result in an UNDER! or OVER! to be displayed. Non-whole number values will result in a RANGE! display. A legiti-

mate value must be entered.

Altering the CALibration of the D902/3

A few factors can influence the readings of the M3-902 flow meter. The CAL entry allows the user to compensate for flow discrepancies without affecting the factory calibration. Examples of situations that can cause reading discrepancies are:

- Operation on liquids with sonic velocity carrying properties that are different than water. Please refer to the Fluid Sound Speed correction chart located in the Appendix of this manual.
- Transducers mounted in non-recommended locations.
- Operation on fluids with a large amount of suspended solids.

By applying a CAL value other than 100%, the factory calibrated readings will be altered by the percentage entered. This CAL value will not be reflected in the 4-20mA output.

For example, if a reading of 175 GPM is displayed and the known flow rate is 160 GPM, a CAL value of

$$\frac{160\ \text{GPM}}{175\ \text{GPM}} \times 100 = 91.4\%$$

The M3-902 will not allow decimal values to be entered as a CAL constant, so round to the nearest whole number. In this case 91%.

Table 8

I.D.	US	METRIC
Max	200%	200%
Min	3%	3%

Acceptable input ranges for the CAL constant are shown in **Table 8**. Values outside of this range will result in an OVER! or UNDER! Display. Non-whole number entries will result in a RANGE! Display. Enter an appropriate value.

Display Damping

The DAMP key allows the selection of time duration between display updates. The value selected and entered will result in display updates of

n x 2 = seconds between updates

Table 9

I.D.	US	METRIC
Max	20	20
Min	0.5	0.5

Acceptable input ranges for the DAMP constant are shown in **Table 9**. Values outside of this range will result in an OVER! or UNDER! display. Entry of an appropriate value is required.

The TEST Diagnostic Key

The TEST key is used for diagnostic purposes. It displays the operand presently available at the analog to digital converter. This value will always be in the range of 0 to 255.

System and Totalizer RESET

The RESET key is used for generating a system reset or to reset the accumulated (totalized) flow. Press the RESET button from the ENTER Mode. A choice is then made to :

RESET	Reset the system
VOL. MULT	Press VOL PULSE to re-set the totalizer to zero.

If the RESET key is pressed again, all configuration constants will return to default values.

If the VOL. PULSE key is pressed, the accumulated flow will be erased and the display will return to zero.

Reset the Flow Totalizer

In RUN Mode, pressing the decimal point once will suspend totalizer accumulation. Pressing the decimal point again will clear the total. Pressing it a third time will restart the accumulation from zero.

Note: In RUN mode, the key presses are processed and displayed at the interval defined by the DAMP constant setting. (i.e. If the DAMP constant is set to 10, the key presses will be acknowledged only every 20 seconds.)

FLOW ANALYZER

The FLOW ANALYZER bar meter indicates the relative condition of the Doppler signal that is being processed by the D902/3. When the instrument is utilized on liquids with suspended solids or aeration, the FLOW ANALYZER will indicate within the two right segments — an ideal Doppler condition. When the D902/3 is used to measure cleaner liquids, the FLOW ANALYZER bar meter will search through its discrete filter banks and adjust to match the particular liquid parameters that are present. The bar meter will indicate these changes when they occur. If no segments are illuminated on the FLOW ANALYZER, the level of liquid discontinuity or hydraulic turbulence is inadequate and the transducers will have to be

relocated. Typically, moving the transducers closer to a 90° elbow will provide adequate liquid conditions.

PART 4 - TROUBLE SHOOTING

CONDITION	POSSIBLE CAUSE
Unit does not turn "ON" when power is applied These procedures require the face plate to be removed from the enclosure.	• Verify that the battery is charged. Plug into an AC power source. • Test the fuse • Ensure the terminal block located in the upper left corner of the main PCB is secure • Verify that ribbon cables between PCBs are connected.
OVERRANGE light is ON	• Increase the value of the FULL SCALE constant. • Verify that fluid velocity is not greater than 20 FPS [6.08 MPS]
FAULT light is ON; low SIGNAL STRENGTH indication	• Ensure that the transducers are properly mounted to the pipe. • Verify that transducer connections are correct • Ensure that the pipe is full of moving liquid. • Increase SENSITIVITY so that right-most SIGNAL STRENGTH light just comes ON. • On cleaner liquids, move the transducers closer to a 90° pipe elbow. • On dirtier liquids, mount the transducers as described in CASE 3 of Part 2 of this manual. • If the pipe has a polyethylene liner, move the transducers to another area. The liner may contain an air void at this location. (continued)

FAULT light is ON; low SIGNAL STRENGTH indication (continued)	• If GND connection and pipe are at different potentials, ground D902/3 to pipe potential. • If Variable Frequency Drives are being utilized, verify that the D902/3 obtains a READ light when the pump turn OFF. If possible, increase the carrier frequency of the drive.
Stability of flow readings are unsatisfactory This procedure requires the face plate to be removed from the enclosure.	• Increase the DAMP constant from keypad. • Increase the system time constant by turning R17 (DAMP) clockwise till readings are satisfactory. • Move transducers to a location further from piping tees, elbows, valves, filters, etc.
Erroneous Reading	• Transducers mounted incorrectly. • Another local ultrasonic instrument is operating at about the same frequency [consult the Dynasonics factory]. • Presence of large amounts of suspended solids or aeration. Use CAL constant to compensate. • Sources of radiated interference are present. Apply appropriate shielding. • An electrically noisy power supply is powering the D902/3. Power the meter with a circuit that does not power motors, ballasts or switching supplies.
The D902/3 display indicates flow, when true fluid velocity is zero.	• Verify that residual leakage and flow is not present. [I.e. leaking check valves] • Verify that SENSITIVITY is not adjusted too high. With nominal flow running through the pipe, adjust SENSITIVITY control till the right-most bar meter light just comes ON.

PART 5 - APPENDICES

Appendices

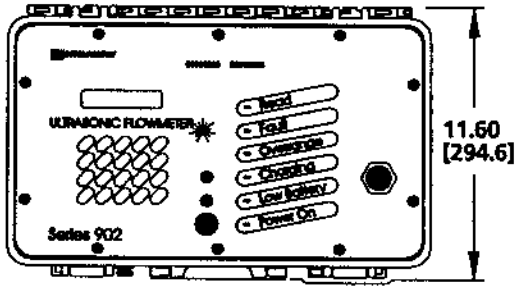
Spare Parts List
Fluid Sound Speed Conversion Chart
Mechanical Drawing
High-Temperature Transducers
Intrinsically Safe Transducer Installation
Clean Liquid Installation Guide
Pipe Dimension Chart: Cast Iron
Pipe Dimension Chart: Steel, SS, PVC
Velocity to Volumetric Conversion Chart
Statement of Warranty
Customer Service

SPARE PARTS - D902/3

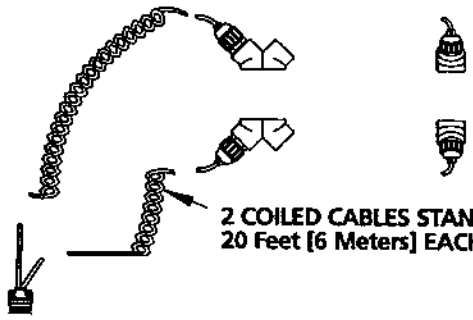
PART NUMBER	DESCRIPTION
D070-1004-001	Series D902 Std. Temp./Std. Pipe Transducer
D040-0402-001	Series D902 High Temp./Std. Pipe Transducer
D070-1004-003	Series D902 Std. Temp./Small Pipe Transducer
D902 O&M	Series D902 Installation and Operations Manual
D005-1003-100	Two conductor, 20 AWG, unshielded cable
D003-0825-001	Stainless Steel Identification Tag
D005-9909-001	Series 902 Desiccant Cartridge
D005-1201-001	Series 902 Gel Cell Battery
D002-2011-002	Couplant, RTV (for permanent mounting)
D002-2011-001	Couplant, Silicone (for temporary mounting)
D005-2109-002	Series 902 U.S. Line Cord (Two spades and ground)
D005-2109-011	Series 902 U.K. Line Cord (Three rectangular spades)
D005-2109-021	Series 902 German Line Cord (Two round spades)
D010-0200-100	Series 902 Transducer Extension Cable, 20 ft. [6 m]
D005-1301-002	Fuse, 0.125A Slow Blow, 250V
D005-1301-004	Fuse, 0.75A Slow Blow, 250V
D002-2009-046	Elastic Pipe Strap, 46" [1100 mm]
D002-2009-076	Elastic Pipe Strap, 76" [2000 mm]
D005-0904-001	4-20mA MIL Connector

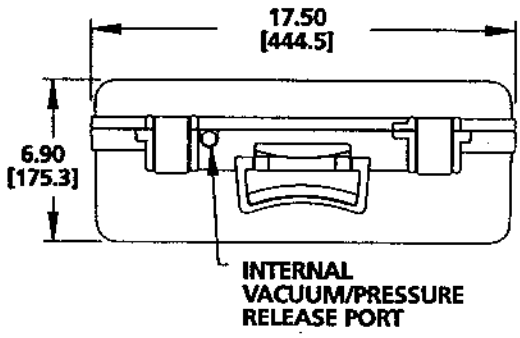
MECHANICAL DRAWING - D902/3

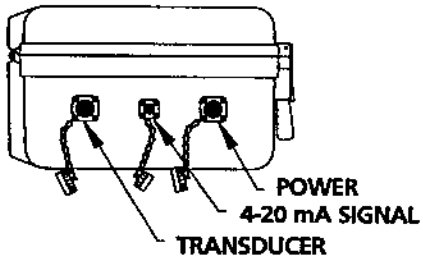
Inches
[mm]

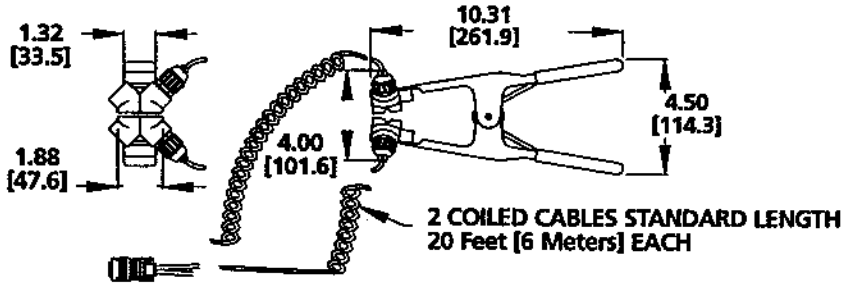


STANDARD CABLES & TRANSDUCERS CONFIGURATION









2 COILED CABLES STANDARD LENGTH
20 Feet [6 Meter] EACH

SMALL PIPE TRANSDUCER AND CABLE ASSEMBLY

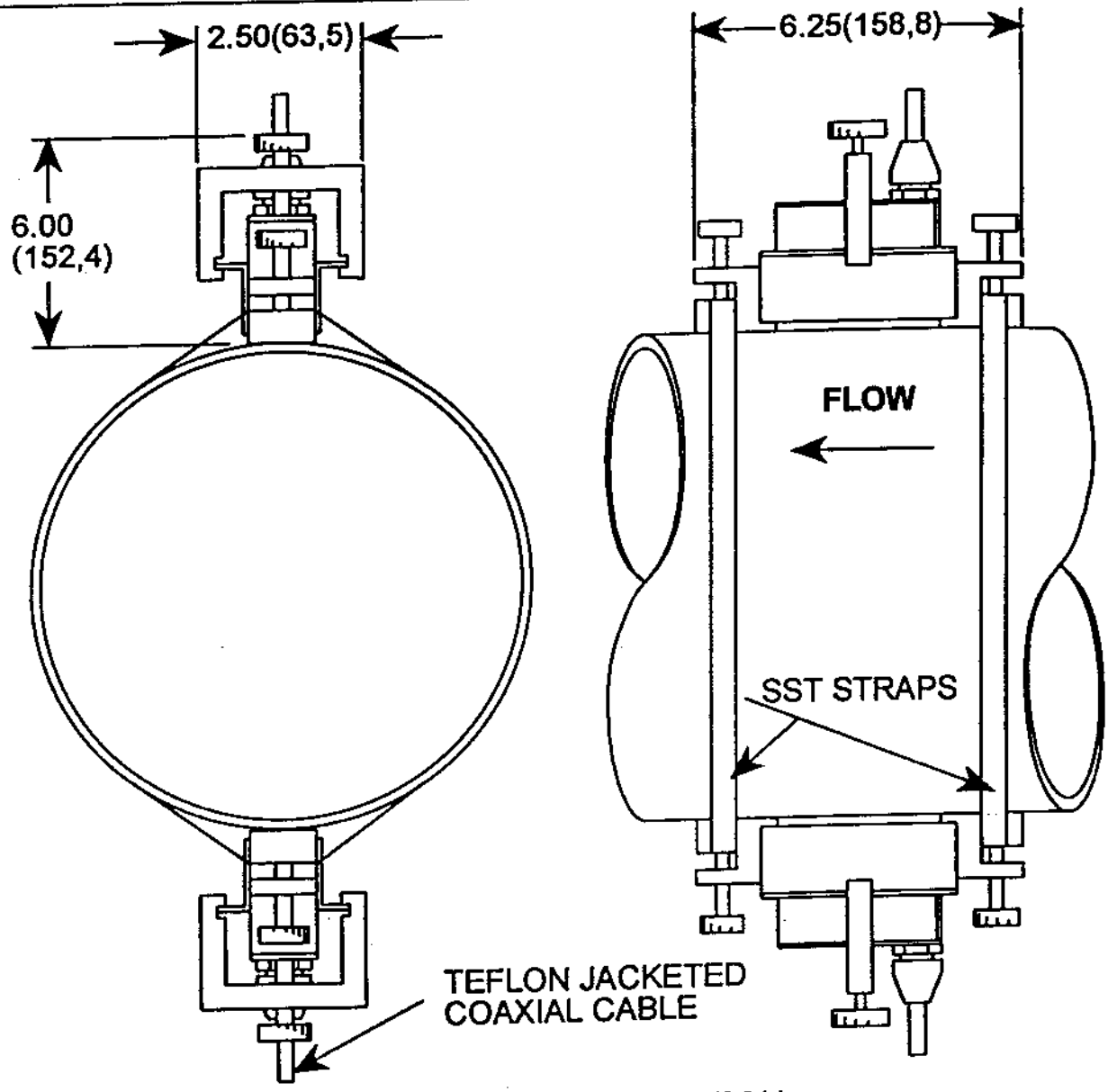
Fluid Sound Speeds

Original Date: 10/19/99
Revision: none
Revision Date: none
File: I:/dynasonics/dyna_code/tables/doppler ss conversions.xls

199.4423754

Fluid	Specific Gravity 20 degrees C	Sound Speed m/s	Sound Speed ft/s	Doppler Calibration Entry relative to 25C water
Acetate, Butyl (n)		1270	4163.9	85
Acetate, Ethyl	0.901	1085	3559.7	72
Acetate, Methyl	0.934	1211	3973.1	81
Acetate, Propyl		1280	4196.7	85
Acetone	0.79	1174	3851.7	78
Alcohol	0.79	1207	3960.0	81
Alcohol, Butyl (n)	0.83	1270	4163.9	85
Alcohol, Ethyl	0.83	1180	3868.9	79
Alcohol, Methyl	0.791	1120	3672.1	75
Alcohol, Propyl (I)		1170	3836.1	78
Alcohol, Propyl (n)	0.78	1222	4009.2	82
Ammonia (35)	0.77	1729	5672.6	115
Anlline (41)	1.02	1639	5377.3	109
Benzene (29,40,41)	0.88	1306	4284.8	87
Benzol, Ethyl	0.867	1338	4389.8	89
Bromine (21)	2.93	889	2916.7	59
n-Butane (2)	0.60	1085	3559.7	72
Butyrate, Ethyl		1170	3836.1	78
Carbon dioxide (26)	1.10	839	2752.6	56
Carbon tetrachloride	1.60	926	3038.1	62
Chloro-benezene	1.11	1273	4176.5	85
Chloroform (47)	1.49	979	3211.9	65
Diethyl ether	0.71	985	3231.6	66
Diethyl Ketone		1310	4295.1	87
Diethylene glycol	1.12	1586	5203.4	106
Ethanol	0.79	1207	3960.0	81
Ethyl alcohol	0.79	1207	3960.0	81
Ether	0.71	985	3231.6	66
Ethyl ether	0.71	985	3231.6	66
Ethylene glycol	1.11	1658	5439.6	111
Freon R12		774.2	2540	52
Gasoline	0.7	1250	4098.4	83
Glycerin	1.26	1904	6246.7	127
Glycol	1.11	1658	5439.6	111
Isobutanol	0.81	1212	3976.4	81
Iso-Butane		1219.8	4002	81
Isopentane (36)	0.62	980	3215.2	65
Isopropanol (46)	0.79	1170	3838.6	78

Isopropyl alcohol (46)	0.79	1170	3838.6	78
Kerosene	0.81	1324	4343.8	88
Linalool		1400	4590.2	93
Linseed Oil	.925-.939	1770	5803.3	118
Methanol (40,41)	0.79	1076	3530.2	72
Methyl alcohol (40,44)	0.79	1076	3530.2	72
Methylene chloride (3)	1.33	1070	3510.5	71
Methylethyl Ketone		1210	3967.2	81
Motor Oil (SAE 20/30)	.88-.935	1487	4875.4	99
Octane (23)	0.70	1172	3845.1	78
Oil, Castor	0.97	1477	4845.8	99
Oil, Diesel	0.80	1250	4101	83
Oil (Lubricating X200)		1530	5019.9	102
Oil (Olive)	0.91	1431	4694.9	96
Oil (Peanut)	0.94	1458	4783.5	97
Paraffin Oil		1420	4655.7	95
Pentane	0.626	1020	3346.5	68
Petroleum	0.876	1290	4229.5	86
1-Propanol (46)	0.78	1222	4009.2	82
Refrigerant 11 (3,4)	1.49	828.3	2717.5	55
Refrigerant 12 (3)	1.52	774.1	2539.7	52
Refrigerant 14 (14)	1.75	875.24	2871.5	58
Refrigerant 21 (3)	1.43	891	2923.2	59
Refrigerant 22 (3)	1.49	893.9	2932.7	60
Refrigerant 113 (3)	1.56	783.7	2571.2	52
Refrigerant 114 (3)	1.46	665.3	2182.7	44
Refrigerant 115 (3)		656.4	2153.5	44
Refrigerant C318 (3)	1.62	574	1883.2	38
Silicone (30 cp)	0.99	990	3248	66
Toluene (16,52)	0.87	1328	4357	89
Transformer Oil		1390	4557.4	93
Trichlorethylene		1050	3442.6	70
1,1,1-Trichloro-ethane	1.33	985	3231.6	66
Turpentine	0.88	1255	4117.5	84
Water, distilled (49,50	0.996	1498	4914.7	100
Water, heavy	1	1400	4593	93
Water, sea	1.025	1531	5023	102
Wood Alcohol (40,41)	0.791	1076	3530.2	72
m-Xylene (46)	0.868	1343	4406.2	90
o-Xylene (29,46)	0.897	1331.5	4368.4	89
p-Xylene (46)		1334	4376.8	89



TRANSDUCER MATL: TORLON

MTG. MATL.: ALUMINUM

TEMP. RATING: 400° F (max.)

MTG. NOTES:
MOUNT 3 TO 5 PIPE DIAMETERS DOWNSTREAM ELBOWS. (SEE AN# 900-2)

MOUNT TRANSDUCER USING HIGH TEMP. GREASE PER O&M.

ON HORIZONTAL PIPES MOUNT THE TRANSDUCERS AT 9 & 3 O'CLOCK.

MODEL: T-904,T-914 - _____

CUSTOMER: _____

PO#: _____

SPECIAL INSTRUCTIONS: _____

_____

DYNASONICS™
DIVISION OF RACINE FEDERATED INC.

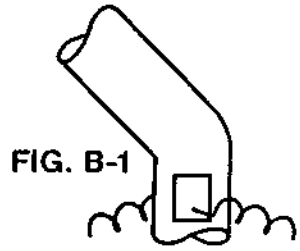
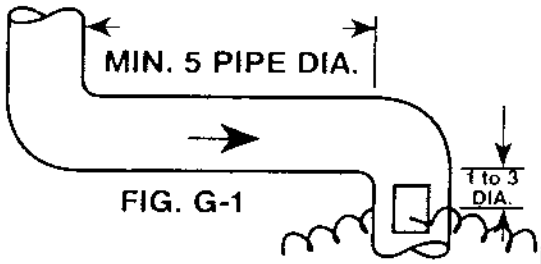
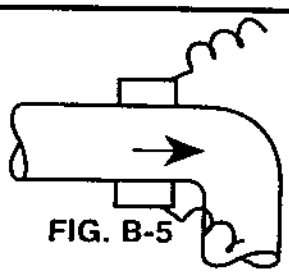
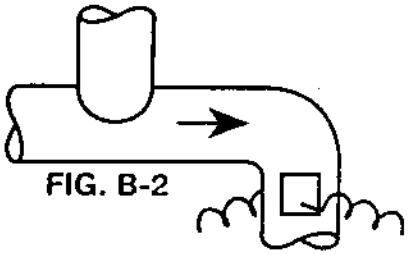
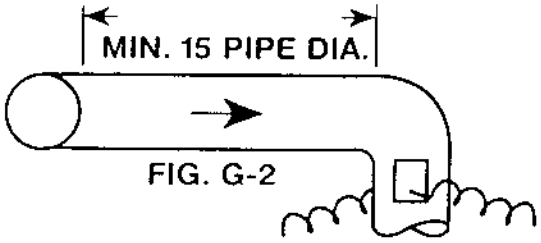
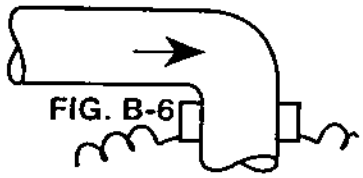
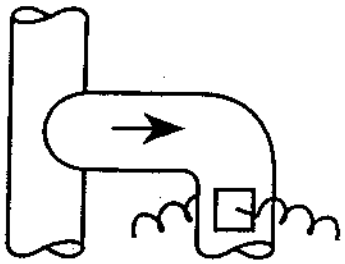
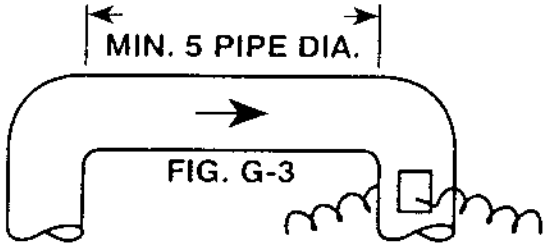
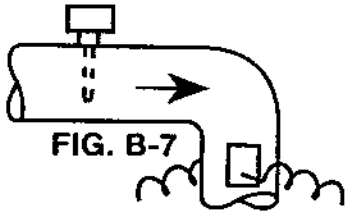
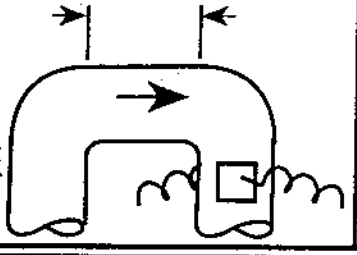
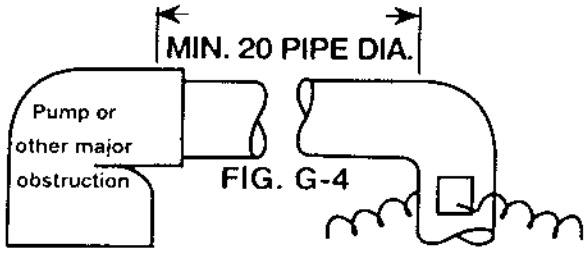
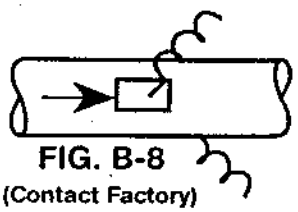
REV: 2-2-94	DWG. BY: S.J. PARRISH
TITLE: HIGH TEMP. DOPPLER XDCR MTG.	
DATE: 1-18-93	DWG # 091-1038-001

DYNASONICS™
REVISED 6/21/88
DATE 2/97

APPLICATION NOTE

SERIES 900
ULTRASONIC FLOWMETER

MOUNTING LOCATIONS FOR **CLEAN** LIQUID APPLICATIONS
(Mount 1 to 3 Pipe Diameters Downstream from a 90° Elbow)

NOT RECOMMENDED	RECOMMENDED INSTALLATIONS	NOT RECOMMENDED
 FIG. B-1	 FIG. G-1	 FIG. B-5
 FIG. B-2	 FIG. G-2	 FIG. B-6
 FIG. B-3	 FIG. G-3	 FIG. B-7
 FIG. B-4	 FIG. G-4	 FIG. B-8 (Contact Factory)

INFLUENCES THAT CAN CAUSE READING INSTABILITY

- Flow Rates less than 0.5 fps (0.15 MPS)
- Improper Piping Configurations will result in incorrect readings
- Extreme Pipe Vibration
- Extreme EMI, RFI, VFD
- Electrical Potential between Earth and Pipe
- Pipe Temperature exceeds Ratings (Std. 180° F (82°F) Otp. 400°F (240°C)