



Series 771/771C

Insertion Ultrasonic Flow Meter

Operations & Maintenance
Manual

REV 12/97

QUICK-START OPERATING INSTRUCTIONS

This manual contains detailed operating instructions for all aspects of the D77X 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 AND PIPE PREPARATION

- A. Select an appropriate mounting location for the DT7 transducer probe.
- B. The probe should be located on a straight piece of pipe with a minimum of 10 unobstructed pipe diameters upstream from the installation point and a minimum of 5 unobstructed diameters downstream of the installation point.
- C. A 1-1/2" NPT female threaded connection on the pipe is required for the probe assembly to be mounted. This connection is typically made by welding a threaded coupling to the pipe wall or installing a pipe saddle. The connection should be mounted perpendicular to the pipe at a radial location 20-160 degrees from the top of the pipe.

Pipe Preparation and Mounting

2. TRANSDUCER INSTALLATION

DO NOT remove the cotter pins located at the ends of the threaded rods. They prevent the probe from being completely extracted from the insertion fitting and causing a potentially dangerous condition.

- A. Insert the DT7 Transducer Probe tip to the 1/8 pipe I.D. location. The velocity measurement is made 0.67 inches [17 mm] from the very tip of the probe. Total insertion depth can be calculated at:

QUICK-START OPERATING INSTRUCTIONS

Insertion Depth =

(pipe I.D. inches) X 0.125 + 0.67 inches

or

(pipe I.D. mm) X 0.125 + 17 mm

- B. Secure the probe insertion distance using the upper and lower brass jam nuts located on the threaded rods.
- C. Loosen the set screw located in the probe retaining collar with the enclosed allen wrench.
- D. Rotate the probe body till the arrowhead, located on the top of the probe, is parallel with the pipe and points down stream in the direction of flow.
- E. Lock the probe rotation with the set screw in the retaining collar.
- F. Route the transducer cable back to the transmitter, avoiding locations near high voltage supply wires. Transducer connections are made through the left conduit hole in the bottom of the transmitter.

Connections

3. TRANSDUCER CONNECTION

- A. DO NOT attempt to connect additional cable to the factory supplied transducers.
- B. Connect the transducer spade terminals to the XDCR terminal block located on the lower left corner of the main PCB.

Startup

4. INITIAL SETTINGS AND POWER UP

- A. Route a stable, grounded power supply to the transmitter. Power wiring is made through the right conduit hole.
- B. Connect Power to the upper right terminal block as appropriate. Apply power.
- C. Press the RESET key on the keypad.
- D. If the pipe is full of a flowing liquid, the default readings will be FPS (Feet per Second).

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PART 1 - INTRODUCTION

General

The D77 ultrasonic flow meter is designed to measure the fluid velocity of liquid within closed conduit. The rugged insertion probe has no moving parts, is insensitive to coating buildup and can be accurately positioned at the precise depth in the pipe required to measure liquid velocity in a variety of liquid phases. (Conventional, through the pipe wall, Doppler flow meters are sensitive to large changes in liquid viscosity and solids content. The D77 is not sensitive to such changes.)

The flow meter operates by transmitting an ultrasonic sound from its transmitting piezoelectric crystal into the flowing liquid. The sound will be reflected by suspended particles or bubbles within the liquid and recorded by the receiving piezoelectric crystal. 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.

Application Versatility

The D77 flow meter can be successfully applied on a wide range of metering applications. The simple to program transmitter allows standard D77 to be used on pipe sizes ranging from 1.5 - 120 inch [38 - 3048 mm] pipe I.D. A variety of liquid applications can be accommodated: raw sewage, reclaimed water, cooling water, river water, plant effluent, mining slurries, sludge, etc. The D77 is ideal for measuring through thick walled pipes. The D77C is designed specifically for Crude Oil measurements. Because the transducers are encapsulated in a resilient PVDF plastic shell and have no moving parts (in the traditional sense), the flow meter is very resistant to fouling and wear. Standard transducers are rated to 180°F [82°C].

User Safety

The D77 employs modular construction and provides electrical safety for the operator. The display face contains voltages no greater than 15 Vdc and the enclosure is made from non-conductive fiberglass. All user connections are made through conduit hole located on the under side of the D77 enclosure.

PART 1 - INTRODUCTION

Battery Backup

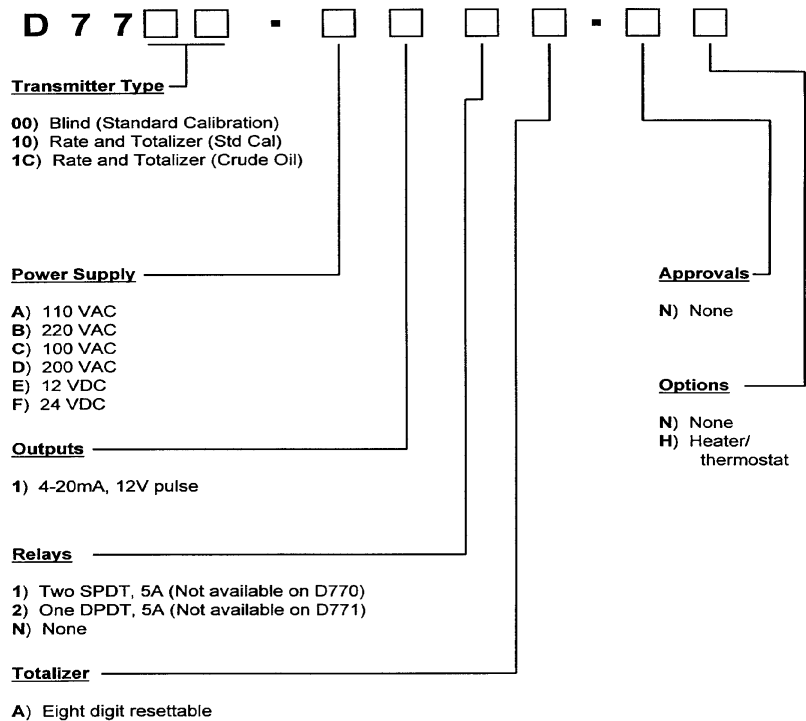
A rechargeable nickel-cadmium battery on the back of the display board retains all user-entered configuration values in memory for several years (at 25°C), even if power is lost or turned off. The ten year battery is continually trickle charged whenever line power is applied. A completely discharged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

Product Identification

The serial number and complete model number of your D77 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

SERIES D77 Phase-Shift Ultrasonic Flow Meter



PART 1 - SPECIFICATIONS

Description	Specification
Power Requirements	(Std) 110/220 VAC 50/60 Hz ? 5%. (Opt) 100/200 VAC 50/60 Hz ? 5% and 12/24 VDC. Power consumption less than 12 VA.
Velocity	0.12 - 30 FPS [0.03 – 9.1 MPS]
Outputs	4-20 mA, 1000 Ohms max., Isolated. 12 Vdc pulse, 100 ?S duration, 10 Hz max, pulses with totalizer increments Two Relays, 5A @ 250VAC resistive, SPDT
Display	2 line x 20 character alphanumeric LCD, back lit. Digit height 0.2 inches [5 mm] 6 digit rate, 8 digit totalizer (resettable)
Units:	User configured
Rate US [Metric]	FPS, GPM, GPH, ft. ³ /M, MGD, BPM, BPH, BPD [MPS, LPM, M ³ /hr, LPD]
Totalizer US [Metric]	Gallons, barrels (crude oil) [liters]
Ambient Conditions	-22 to 160°F [- 30 to 70 °C], 0-95% relative humidity, non-condensing.
Enclosure	NEMA 4X, [IP-65] Fiberglass w/SS hardware. 11H x 9.25W x 5.5D inches [280H x 235W x 140D mm]

PART 1 - SPECIFICATIONS

Non-linearity (Accuracy)	?2% Full Scale
Sensitivity	0.05% of Full Scale
Repeatability	?0.2% of Full Scale
Response Time	5-50 seconds, user configured, to 90% of value, step change in flow.
Security	Keypad lockout, access code enable

DT7 Insertion Probe

Description	Specification
Liquid Requirements	25 ppm of 30 micron suspended solids or bubbles minimum
Transducer to Transmitter Distance	(Std) 15 feet [4.6 meters], flexible armored conduit. (Opt) lengths to 300 feet [90 meters]
Pipe Sizes	(Std.) 1½ - 120 inches [38 – 3050 mm] Pipe I.D.
Temperature	(Std) - 40° to 180°F [-40° to 82°C].
Housing Material	(Std) 316 ss, PVDF, Viton™, Teflon™
Mounting	(Std) 1½ MNPT, pipe saddle or female threaded coupling required. (Opt) 1½ 150#
Approvals	(Opt) FM approval I.S., Class I, Div 1, Groups A-G.

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 D77 flow meter can be checked for basic functionality using the following **Bench Test** procedure. It is recommended that this operation be performed before permanently installing the system.

Procedure:

1. Open the D77 transmitter cover.
2. Connect the transducer cable connector to the terminal locations on the lower left corner of the D77 main circuit card. See **Figure 1**.
3. Connect supply power to the appropriate terminal locations on the upper right corner of the main circuit card. See **Figure 2**.
4. Apply power.
5. Verify that the display indicates 0.00 FPS (or 0.0 flow rate of any other unit). If the display does not register 0.0, then press the **2nd FUNCT** key, then press **SIGNAL STR.** Verify that SIGNAL STR. is lower than 000100. If SIGNAL STR. is greater than 000100, verify that the sensor/transmitter are not located near electrically noisy components. (VFDs, inverters, motors, power relays, etc) Verify that DT7 transmitter connections are proper and secure. If the SIGNAL STR. remains greater than 000100, consult the Dynasonics Factory for assistance.
6. Press the **2nd FUNCT** key to enter SERVICE MODE. Press the SIGNAL STR key to display SIGNAL STR. XXXXXX.
7. Tap the rounded black tip of the DT7 transducer on the side facing opposite the flow direction arrow (the arrow is located on the top cap of the DT7

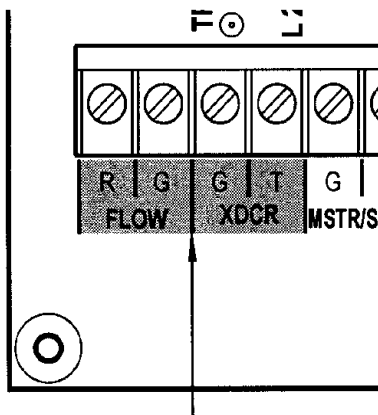


Figure 1

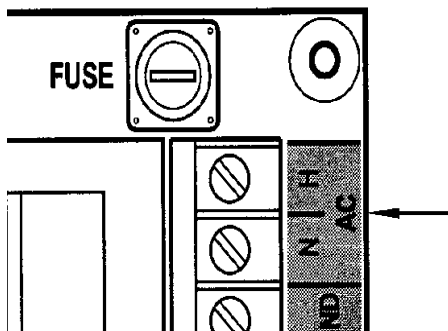


Figure 2

PART 2 - PRE-INSTALLATION CHECKOUT

transducer) with the handle of a screwdriver or similar blunt instrument.

8. Verify that signal strength increases with frequency of the tapping. Typical increases will range from 20-30 counts.
9. Verify that signal strength decreases when tapping ceases.

Bench Test is Complete

PART 2 - TRANSDUCER INSTALLATION

Transducer Mounting Considerations

The DT7 insertion transducer that is utilized by the D77 contains piezo electric crystals for transmitting and receiving ultrasonic sound energy. The black PVDF plastic tip of the DT7 contains these crystals, which are designed to be inserted to the average fluid velocity point within a pipe. Not all liquid within a pipe is flowing at a uniform fluid velocity. But, a straight run of pipe, full of flowing liquid, contains a predictable liquid velocity profile. By selecting proper upstream and downstream lengths of straight pipe from the transducer installation point and precise insertion depths into the pipe, very accurate and reliable volumetric flow rates and totals can be realized.

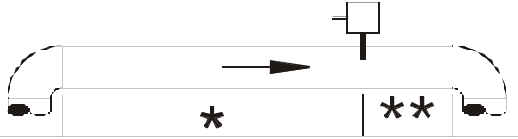
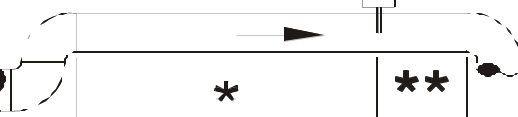
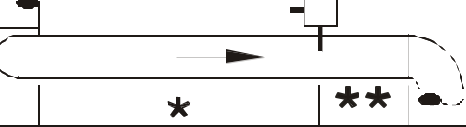


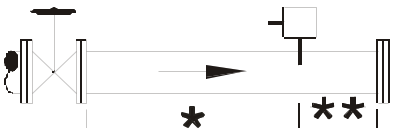
Step A - Mounting Locations

Select a transducer mounting location with adequate straight runs (without disturbances) of pipe, both upstream and downstream, to achieve stable and accurate readings. Examples of minimum upstream and downstream requirements are included in **Table 1**. Note that if adequate straight plumbing cannot be provided the D77 system will operate repeatably, but will probably not achieve ideal accuracy.

When installing the DT7 transducer in a horizontal pipe, the preferred orientation is at least 20 degrees from the top or bottom of the pipe. Ensure that the mounting location allows for adequate clearance to install and retract the probe fully from the pipe.

PART 2 - TRANSDUCER INSTALLATION

Table 1
Straight Pipe Recommendations¹

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

¹ The D77 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.

PART 2 - TRANSDUCER INSTALLATION

Step B - Hot Tapped Installation

The installation instructions cover Hot-Tapped installations (installations where it is required to install or remove the transducer probe without shutting down the process pressure). If the product is being installed without an isolation valve, ignore the steps that pertain to its installation. **Figure 3** illustrates an exploded view of an isolation valve assembly and names the various components.

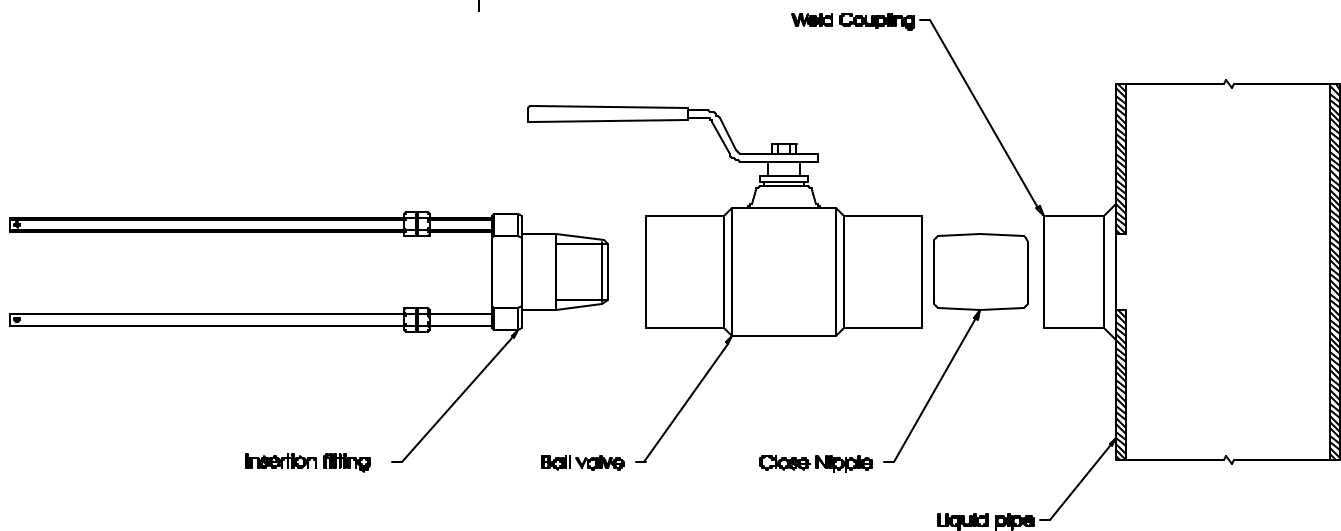


Figure 3 Isolation Valve Installation

If the DBV or DSSV accessory kits were ordered with the DT7 probe, a Hot-tapped installation can be conducted. The kits include an isolation valve assembly and is designed for installation in pipes under pressure, up to 700 psi at 70° F.

All items required for installation are provided with the kit, except for the 1.5" NPT weld coupling or service saddle and the drilling and welding equipment. These instructions call for the use of a drilling machine designed for operations under pressure (for example, Muller Co., Decatur, Illinois).

PART 2 - TRANSDUCER INSTALLATION

Step C - Component Assembly

Procedures are as follows:

1. Verify that the pipe's line pressure is rated limits of the pressure drilling machine to be used.
2. Grind off paint or other coatings from the pipe in the area where the DT7 Probe Assembly is to be installed. Recommended minimum straight pipe lengths for best accuracy are 10 diameters upstream and 5 downstream.
3. Tack weld a 1 ½"NPT weld coupling to the pipe or install service saddle according to the suppliers instructions. The coupling or saddle must be aligned perpendicular to the pipe axis and square to its plane.
4. Complete welding. A water tight, 0.25" weld bead is recommended.
5. Install the close nipple (supplied with into the weld coupling. Use appropriate pipe sealant.
6. Install the isolating ball valve on the close nipple. Verify that the valve is in fully open position.
7. Install drill bit and adapter into the pressure drilling machine. Then attach the machine to the isolation valve.
8. Drill through the pipe wall in accordance with the instructions supplied with the drilling machine.
9. Withdraw the drill bit through the isolating valve. Close the valve and remove the drilling machine. Check for leakage at valve and connections.
10. Place pipe sealant on the 1-½" NPT threads of the Insertion Fitting assembly. Screw the assembly into the isolation valve and tighten with a 2-½" Pump wrench.

PART 2 - TRANSDUCER INSTALLATION

Step D - Probe Insertion Distances

PROBE INSERTION

Before beginning the probe insertion procedure, it is necessary to calculate the probe insertion depth of the sensor. For normal pipe runs, the probe tip must be located at 1/8th of the pipe inside diameter. Figure 4 outlines the Necessary measurements and calculations that will be needed to insure that the probe tip is at the proper insertion point.

TO CALCULATE INSERTION DEPTH

P = PROBE LENGTH = _____

H = LOWER FLANGE TO PIPE WALL
= _____

T = PIPE WALL THICKNESS
= _____

IL = 0.125 x PIPE ID = _____

M = INSERTION DEPTH

$M = P - IL - T - H - 0.67"$

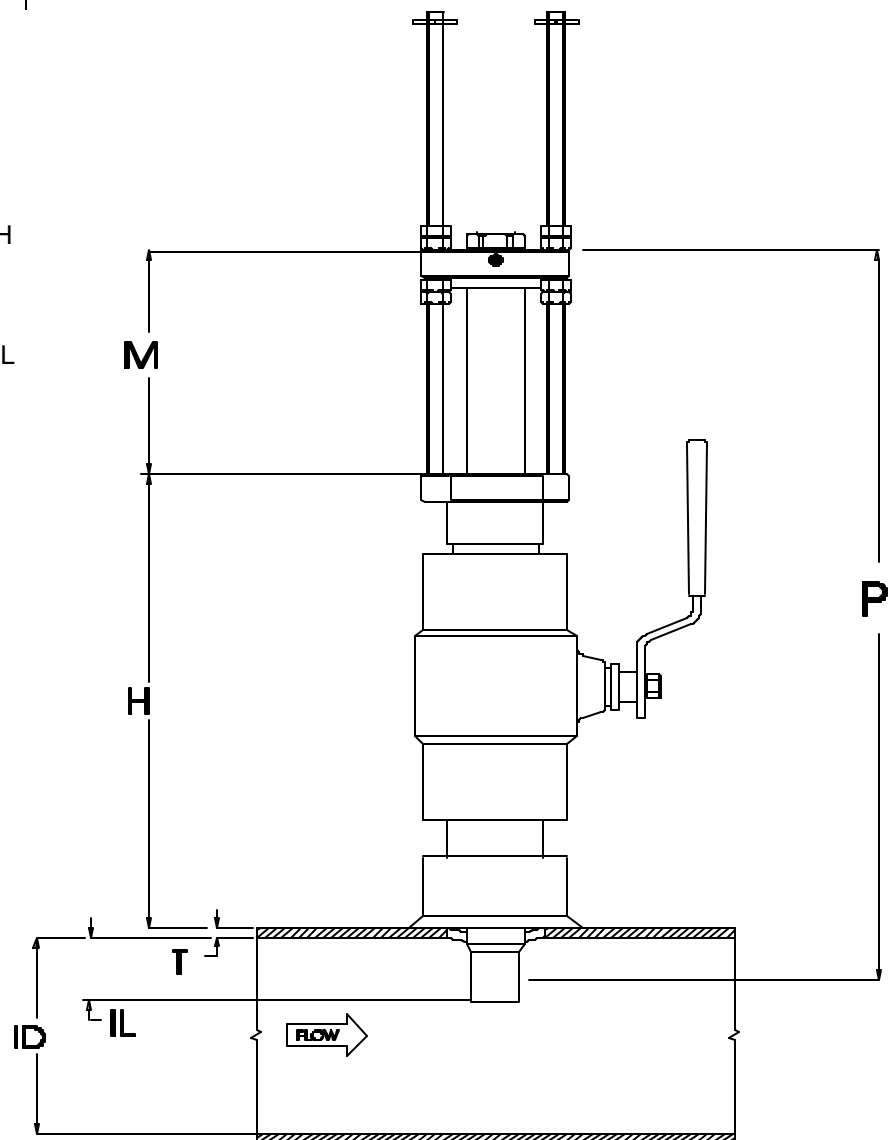


Figure 4

PART 2 - TRANSDUCER INSTALLATION

In order to calculate the proper insertion depth of the probe several pieces of data will have to be collected. The following five constants defines the variables found in the insertion depth calculation.

P = The overall length of the probe. This measurement is taken from the top of the probe flange to the very tip of the sensor. Subtract 0.67" from this measurement and record this figure.

H= The distance from the bottom of the insertion \retraction rod assembly flange to the outside wall of the pipe.

T= Is the wall thickness of the pipe. The Appendix provides wall thickness of a wide range of pipe sizes and schedules. If the pipe size and schedule are not found in the appendix, your pipe supplier should be able to provide you with this data.

I.L.= The insertion point in the pipe. This is calculated by multiplying the pipe inside diameter by 0.125.

M = The distance from the top of the probe flange to the bottom of the insertion\retraction rod assembly flange

$$M = P - I.L. - T - H$$

Important!

To insure that the probe tip is inserted to the proper insertion point, the distance M, which is described above should be measured and set very carefully.

PART 2 - TRANSDUCER INSTALLATION

Step E - Cable Routing

PROBE CABLES

Before inserting the probe into the pipe, the sensor cables should be routed to the transmitter location. Verify that the supplied cable length is sufficient to meet the installation requirements. If the supplied length is found to be insufficient, contact the factory to make probe exchange arrangements.

CAUTION: Do not proceed with probe insertion should the supplied cable length be insufficient for the installation. Probes that have been exposed to process liquids are not exchangeable.

CAUTION: The probe cables are designed to carry low level signals that are developed by the sensor. Care should be taken in routing the cables. Avoid running cables near sources of high voltage or EMI/RFI. Also avoid routing the cables in cable tray configurations, unless the trays are specifically used for other low voltage, low level, signal cables.

CAUTION: The internal DT7 Probe wiring is epoxy encapsulated to seal it from moisture. The Probe is provided with two coaxial cables to shield the low level signals and must be continuous to the DT7 Probe Transmitter. Do not splice the probe cable to extend it's length as the integrity of the shielding must be maintained to insure proper sensor operation. The cable may be cut to a shorter length. If you have extra cable do not coil the excess wire in the enclosure.

1. Run the lower Jam nuts down to a point that approximates the final insertion position or at least far enough to allow insertion into the Insertion Fitting. Using the threaded rods as a guide, position the probe in the Insertion Fitting. Continue to insert the probe as far into the isolation assembly as possible. The probe tip will come in contact with the closed "ball" in the isolation valve.

PART 2 - TRANSDUCER INSTALLATION

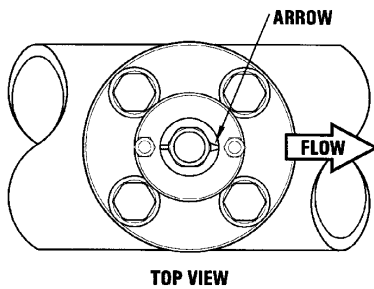


Figure 5

CAUTION: Do Not Force the Probe Tip Against the "Ball", damage to the probe tip may result.

2. Replace the upper Jam Nuts (2 on each rod) and the cotter pins. The nuts should be run down to the top side of the retaining collar and the cotter pins replaced. Orient the probe in the direction of flow as indicated on by the FLOW direction arrow located on the top of the probe flange. See **Figure 5**. Lock the probe in position with the enclosed allen wrench.

CAUTION: The nuts on both ends of the retaining rods must always be in place as a safety measure to prevent possible probe blow out. Inserting cotter pins is a further safety measure.

3. Slowly open the isolation valve. When the valve is fully open, use the proper size wrench on the insertion nuts, alternately tightening each nut about two complete turns to avoid uneven seal loading.

NOTE: For some low pressure\low temperature (less than 30 PSIG and less than 100° F (38°C) the probe may be pushed in by hand to decrease the insertion time.

PART 2 - TRANSDUCER INSTALLATION

Retracting the Probe

PROBE RETRACTION PROCEDURE

1. Retract the Probe by loosening the Upper Jam nuts counterclockwise as viewed from the top of the probe using the proper size wrench. If the pipe is under pressure, the nuts must be turned alternately about two turns at a time to prevent, binding as a result of non-equal seal loading. In many cases, the line pressure will cause the probe to retract. Should the probe bind, use the retraction nuts on the lower side of the probe flange to assist in the probe retraction. Continue this procedure until the Probe is fully retracted into the Isolation Valve.

CAUTION: Do not run the drive nuts off the rods until the isolation valve is fully closed.

2. After the Probe is retracted past the "ball" in the isolation valve, the Isolation Valve may be closed to isolate the Probe from the line and the probe can be removed entirely.

3. **CAUTION:** If the sensor is not above the "ball" of the isolation valve, the valve cannot be closed. If the valve will not close smoothly, the body or tip of the probe is most likely not above the "ball". Attempting to force the valve into the closed position may result in damage to the sensor.

PART 2 - TRANSMITTER INSTALLATION

Transmitter Installation

The D77 enclosure should be located in an area that is convenient for observation of the LCD readout and keypad operations.

1. Place the D77 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.
2. Mounting: Refer to **Figure 6** for enclosure and mounting dimension details. Ensure that enough room is available to allow for door swing, maintenance and conduit entrances. Secure the enclosure to a flat surface with four appropriate fasteners.
3. Conduit holes. Conduit hubs should be used where cables enter the enclosure. Holes not used for cable entry should be sealed with plugs.

NOTE: Use NEMA 4 [IP65] rated fittings plugs to maintain the water tight integrity of the enclosure. Generally, the left conduit hole (viewed from front) is used for line power; the right conduit hole for transducer connections.

4. If additional holes are required, (analog outputs, etc.) drill the appropriate size hole in the enclosure's bottom. Use extreme care not to run the drill bit into the wiring or circuits cards.

PART 2 - TRANSMITTER INSTALLATION

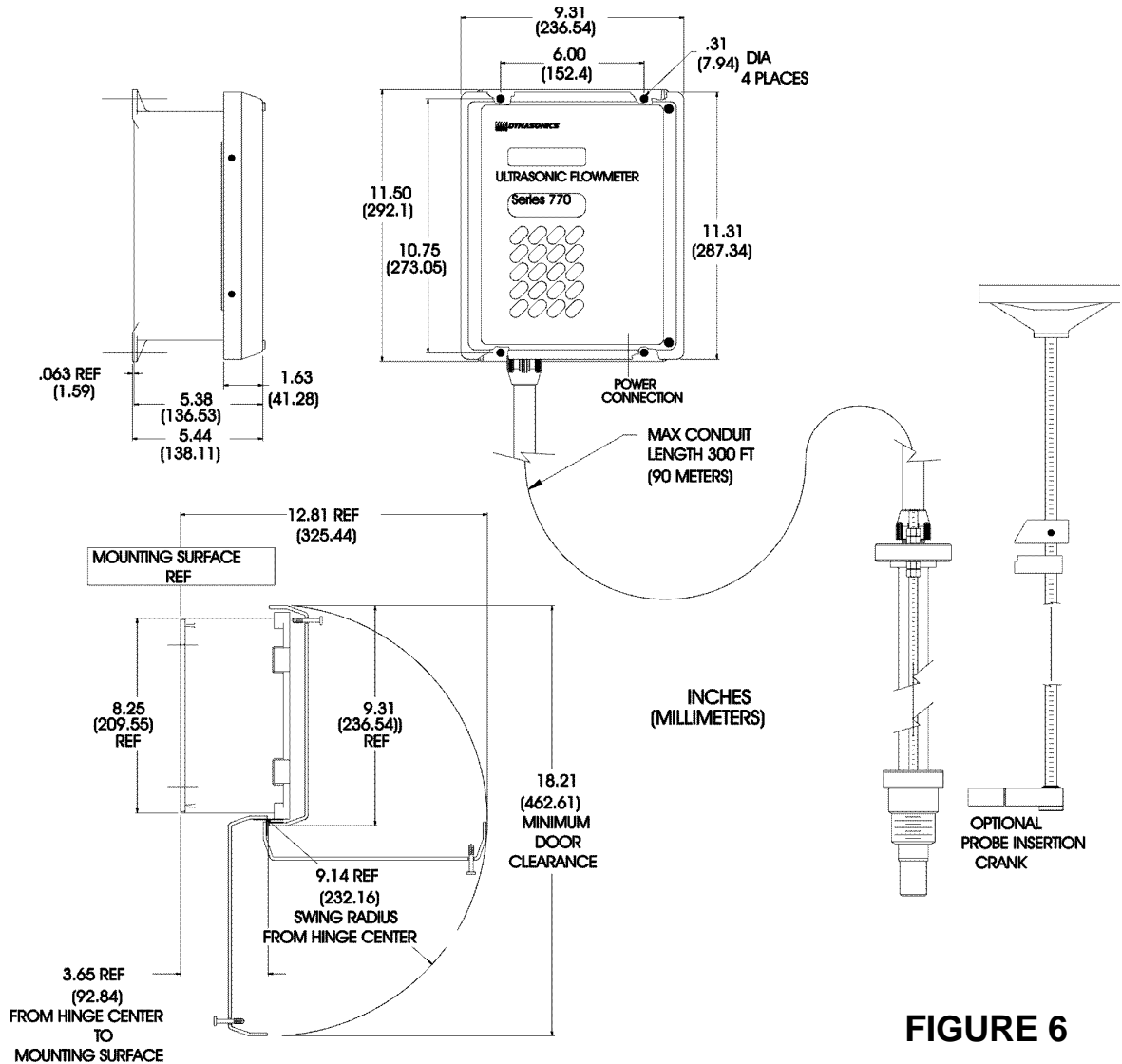


FIGURE 6

Important !

To access terminal strips for electronic connectors, loosen the two screws in the enclosure door and open the door.

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

PART 2 - TRANSMITTER INSTALLATION

4-20mA OUTPUT

The 4-20mA output is proportional to the flow rate measuring scale and can drive a load of up to 1000 ohms. The output is isolated from earth ground and circuit low. Connect the load to the **4-20 mA** connection terminals located on the inside of the D77 enclosure, matching polarity as indicated.

Power Connections

Line power is connected by supplying power to the appropriate terminals located inside of the D77 enclosure. 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

Transducer Connections

1. Guide the transducer terminations through the transmitter conduit hole located on the left side of the enclosure. Secure the transducer cable with the supplied conduit nut.
2. The terminals on the transducer cable are coded with wire markings. Connect the appropriate wires to the corresponding screw terminals in the transmitter.

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

PART 2 - TRANSMITTER INSTALLATION

If additional cable is required, contact the Dynasonics factory to arrange for an exchange transducer with the appropriate length of cable. Cables to 300 feet [90 meters] are available.

NOTE: An additional hole in the transmitter enclosure is required for outputs. Drill the hole in the the enclosure bottom taking care not to drive the drill bit into wiring or the circuit boards with the transmitter.

CTR Output

The CTR pulse output is proportional to the flow rate measuring scale. This output may be used one of two ways:

- ? To drive a 12V logic device.
- ? To drive a low impedance, 12V device. Minimum resistance 50 ohms.

The pulse output pulses with totalizer increments. The connections are located on the right side of the signal processing PCB in the back of the enclosure. The pulse width is fixed at 100 milli-seconds. CTR “ - ” represents circuit low. CTR “ + ” represents 12 Vdc pulse output.

PART 3 - STARTUP AND CONFIGURATION

Before Starting the Instrument

Note: The D77/DT7 flow meter system requires a full pipe of liquid before a successful startup can be completed. Do not attempt to make adjustments or change configurations until a full pipe is verified.

Instrument Startup

Procedure:

1. Verify that all wiring is properly connected and routed.
2. Apply power. The POWER indicator will illuminate.
3. Press the SIGNAL STR key and verify SIGNAL STR counts greater than 100. Adjust the GAIN (R13 on the Main PCB) control so that a reading greater than 100 counts is observed. It is rare that this setting will need adjustment from factory settings.

Important!

Note: It is undesirable to adjust the GAIN 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/zero SIGNAL STRENGTH and FAULT indication at ZERO flow.

PART 3 - KEYPAD CONFIGURATION

After a successful flow meter installation and startup (covered in the previous sections of this manual) the D77 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, FPS or MPS, are the only required measurement keypad configuration is not required.



UP/DOWN Arrows

Allow changing of the D77 configuration constants. Use the UP arrow to increase constant values and the DOWN arrow to decrease values. The arrows can be momentarily pressed to change values incrementally or held to advance continuously. Constants outside of the valid range of the D77 cannot be displayed. The scrolling rate at which the values will change is two tiered. Scrolling will be relatively slow during the first five seconds of a continuous keypad press; the scrolling rate will increase after that time to allow rapid changes of large values.



2nd FUNCT

Controls access to the commands located on the lower half of the keys. After pressing this key the word SERVICE MODE will appear on the LCD indicator.



ENTER

Records and activates the configuration constant value that is displayed on the LCD indicator. Can also be used to return the meter to its run mode.

PART 3 - KEYPAD CONFIGURATION



F1 and F2

Not utilized.

RESET

Caution: Conducts a system reset. All configuration constants will be lost and the D77 will load default values for all constants.

I.D.

Allows entry of a pipes internal diameter. Internal diameters must be entered if volumetric flow rates are to be displayed.

- ✍ If a UNITS code for U.S. measurements was made the I.D. value will be entered in inches. Valid ranges for this entry are 0.25 to 120.00 inches.
- ✍ If a UNITS code for metric measurement was made the I.D. value will be entered in millimeters. Valid ranges for this entry are 6 to 3050 millimeters.

The appendices in the back of this manual contain tables of common pipe sizes and schedules. If the pipe size does not appear in the table, consult the pipe manufacture or conduct a physical measurement of the pipe internal diameter. Errors in the entry of this value can result in large inaccuracies.

FULL SCALE

Allows entry of the maximum fluid velocity anticipated within the pipe. This value does not have any bearing on displayed flow rates or values, but is used to scale the span value of the 4-20mA analog output. If the analog output is not going to be utilized set this value to 30.00 if measuring in U.S. units or 10.00 if measuring in metric units.

PART 3 - KEYPAD CONFIGURATION

- ✍ If a UNITS code for U.S. measurements was made the FULL SCALE value will be entered in FPS (feet per second). Valid ranges for this entry are 0.00 to 30.00 FPS. Two useful equations that relate liquid velocity to volume:

$$\text{GPM} = 2.45 \times \text{I.D.}^2 \times \text{FPS}$$

$$\text{FPS} = (\text{GPM} \times 0.408) / \text{I.D.}^2$$

I.D. in inches

- ✍ If a UNITS code for metric measurement was made the I.D. value will be entered in MPS (meters per second). Valid ranges for this entry are 0 to 10.00 MPS. Two equations that relate liquid velocity to volume are

$$\text{LPM} = 0.047 \times \text{I.D.}^2 \times \text{MPS}$$

$$\text{MPS} = (\text{LPM} \times 21.28) / \text{I.D.}^2$$

I.D. in inches

Note: Attempting to set a FULL SCALE value of less than 0.5 FPS [0.15 MPS] may result in an unstable transmitted output. If flows are typically lower than this range, the LOW FLOW FILTERS and higher DAMPING values may be required.



UNITS

Utilized to set engineering units of measure. There are twelve different selections possible. The **Table 2** lists the entry code number, flow rate unit of measure and totalizer unit of measure.

Note: After changing the UNITS value, it may be necessary to change other configuration values accordingly. For example, FULL SCALE, I.D., HIGH/LOW ALARM are influenced by the UNITS entry.

Note: Flow already accumulated will not be correctly compensated for if the UNITS of measure changes.

PART 3 - KEYPAD CONFIGURATION

Table 2

UNITS Code	Flow Rate	Totalizer
0	FPS (feet per sec)	N/A
1	GPM (gallons per min)	GALLONS
2	GPH (gallons per hr)	GALLONS
3	MGD (millions of gal pre day)	GALLONS
4	CFM (ft. ³ per min)	CF
5	MPS (meters per sec)	N/A
6	CMH (m ³ per hr)	m ³
7	LPM (liters per min)	Liters
8	MLD (millions of liters per day)	Liters
9	BPM (barrels per min)	BARRELS
10	BPH (barrels per hr)	BARRELS
11	BPD (barrels per day)	BARRELS

PART 3 - KEYPAD CONFIGURATION

HIGH ALARM

HIGH ALARM (Labeled RELAY-1 on the Main PCB)

Controls the set-point of the SPDT relay labeled RELAY-1 on the Main PCB. Enter a liquid velocity at which a relay-contact action is desired. Relay contacts are utilized for signaling flow rate conditions that are higher or lower than a desired set point. If a relay setting is made very close to a nominal liquid velocity, relay “chatter” (rapid opening and closing of the relay) may result.

- ✍ If a UNITS code for U.S. measurements was made the HIGH ALARM value will be entered in FPS. Valid ranges for this entry are 0.00 to 30.00 FPS.
- ✍ If a UNITS code for metric measurements was made the HIGH ALARM value will be entered in MPS. Valid ranges for this entry are 0.00 to 10.00 MPS.

LOW ALARM

LOW ALARM (Labeled RELAY-2 on the Main PCB)

Controls the set-point of the SPDT relay labeled RELAY-2 on the Main PCB. Enter a liquid velocity at which a relay-contact action is desired. Relay contacts are utilized for signaling flow rate conditions that are higher or lower than a desired set point. If a relay setting is made very close to a nominal liquid velocity, relay “chatter” (rapid opening and closing of the relay) may result.

- ✍ If a UNITS code for U.S. measurements was made the HIGH ALARM value will be entered in FPS. Valid ranges for this entry are 0.00 to 30.00 FPS.
- ✍ If a UNITS code for metric measurements was made the HIGH ALARM value will be entered in MPS. Valid ranges for this entry are 0.00 to 10.00 MPS.

TOTAL MULT

TOTAL MULT

Utilized for setting the flow totalizer exponent and changing the External Counter output. This feature is

PART 3 - KEYPAD CONFIGURATION

useful for accommodating a very large accumulated flow. The exponent is a “X 10ⁿ” multiplier, where “n” can be from 0 (10⁰, X 1 multiplier) to 4 (10⁴, X 10,000 multiplier).

The External Counter output, available at the two terminals labeled CTR on the Main PCB, is influenced by the TOTAL MULT value. Since the output is designed to operate electromechanical accumulators, large flow rates will require that the TOTAL MULT be set to a value usable by these types of counters (typically speeds no faster than 3 cps). The following chart tabulates suggested settings

Exponent	Multiplier	Useable CTR Range: GPM or LPM
0	X1	30-600
1	X10	300-6,000
2	X100	3,000-60,000
3	X1,000	30,000-600,000
4	X10,000	300,000-6,000,000

vs. flow ranges:



Key press number	Operation
First press	Stops the internal totalizer/ external CTR and displays the last value
Second press	Resets the internal totalizer to zero

TOTAL ON/OFF

(continued)

PART 3 - KEYPAD CONFIGURATION

(continued)

Third press	Restarts the internal totalizer/external CTR (The internal totalizer starts from zero.)
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If inhibiting (pausing) the totalizer is necessary, there are two methods suggested:

1. Connect and external totalizer to the CTR terminals. See the section of this manual related to CTR electrical connections for connection parameters.
2. To inhibit the internal totalizer without resetting the accumulation, press the TEST key to pause the accumulation. Press the ENTER key to resume accumulation.



LOCK ON

To ensure security of the configuration and accumulated flow, the keypad can be locked. To enable the keyboard lock out, press LOCK ON key, the display will show LOCK ON. Press ENTER to return to Run mode. To turn the lock off, press the LOCK ON key. Use the arrow keys to set a value of **125**. Press the ENTER key. The display will show LOCK OFF to acknowledge that all keypad entries can now be made.



CAL

A few factors can influence the readings of a D77 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:

- ✍ Operations on liquids with sonic velocity carrying properties that are different from water.

PART 3 - KEYPAD CONFIGURATION

✍ Transducer mounted in non-recommended locations.

By applying a CAL value other than 100%, the factory-calibrated readings will be altered by the percentage entered. This CAL value will be reflected in the display, 4-20mA and CTR outputs and relay settings.

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 D77 will not allow decimal values to be entered as a CAL constant, so round to the nearest whole number; in this case 91%.

Acceptable input ranges for the CAL constant are 0-255%.

DAMP



In installations where very turbulent or erratic flow is encountered, increasing the Damping setting can increase display and output stability. The DAMP setting increases and decreases the response time of the flow meter display and outputs. To set the damping time constant, press the DAMP key. Set a value between 1 and 10, 1 having the fastest response and 10 having the slowest response. Press ENTER to complete the configuration.

TEST



The meter contains a test function for verification of the 4-20mA analog and CTR external counter outputs. To activate the test function, press the TEST key. Verify that 20mA is flowing in the 4-20mA output and verify that the CTR output is supplying 100mS pulses. Press ENTER to exit the test function.

2nd FUNCT - SERVICE MODE

PART 3 - KEYPAD CONFIGURATION



{2nd FUNCT} **SIGNAL STR**

Displays the raw Doppler signal strength value. This value will increase as the velocity of the liquid increases. Typically, a liquid flowing at a velocity greater than 0.2 FPS [0.06 MPS], with adequate suspended solids (25 ppm or 30 micron or larger solids) or aeration, will produce SIGNAL STR readings over 150 counts.

NOTE: If the liquid is not flowing a low SIGNAL STR reading is non-conclusive. If a high SIGNAL STR is indicated at zero flow rate, it indicates that a source of interference (another ultrasonic instrument, VFD, or poor electrical ground) may be present. Verify that SIGNAL STR increases when the flow starts. If it does, increase the SS CUTOFF setting (see SS CUTOFF).

If SIGNAL STR is lower than 100 counts in a flowing liquid, one or more of the following steps may need to be invoked:

1. If the liquid velocity is less than 1 FPS (0.3 MPS) turn SW-1 "LOW FLOW" switch ON. (This dual DIP switch is located near the center of the Main PCB.)
2. If SW-1 did not cause an increase in SIGNAL STR to a level above 100, turn ON SW-2.
3. There may not be adequate reflectors for the Doppler principle to operate. The DT7 probe can be relocated to a source of liquid degasification, such as would be found a 1-3 diameters down stream of a 90-degree elbow. A surrogate source of aeration can also be introduced by bleeding a small amount of compressed air into the line several diameters upstream of the DT7 probe.

{2nd FUNCT} **4 mA**

The 4-20mA output on standard D77 flow meters is scaled

PART 3 - KEYPAD CONFIGURATION



at zero flow equals 4mA and 20 FPS (6.08 MPS) equals 20mA. The 4mA key allows fine adjustments to be made to the “zero” of the 4-20mA output or allows offset to be placed on the 4-20mA output. To adjust the 4mA output, an ammeter or reliable reference connection to the 4-20mA output must be present.

Procedure:

1. Either break the present current loop and connect the ammeter in series (disconnect either wire at the terminal block labeled 4-20mA on the Main PCB of the D77) or, if this output is not being utilized, connect the ammeter + to the + terminal and – to the – terminal of the 4-20mA output.
2. Press the 4mA key.
3. With no flow moving through the pipe, adjust the setting count using the arrow keys until 4.00mA is indicated on the ammeter. The typical count value range for this setting is between 3350 and 3850.
4. Press ENTER to store the value.
5. Re connect the 4-20mA output circuitry as required.

{2nd FUNCT} **VEL ADC**

Press VEL ADC to display the raw analog to digital converter counts that are being processed by the microprocessor. This count value will vary linearly with flow rate from 0000 at zero flow rate to 1024 at maximum full-scale flow rate. No modifications of this count can be made, this display is for diagnostic purposes only.



{2nd FUNCT} **BLANKING**

This key is unused.



{2nd FUNCT} **20mA**

The 4-20mA output on standard D77 flow meters is scaled

PART 3 - KEYPAD CONFIGURATION



at zero flow equals 4mA and 20 FPS (6.08 MPS) equals 20mA. The 20mA key allows fine adjustments to be made to the “span” of the 4-20mA output. To adjust the 20mA output, an ammeter or reliable reference connection to the 4-20mA output must be present.

Procedure:

1. Either break the present current loop and connect the ammeter in series (disconnect either wire at the terminal block labeled 4-20mA on the Main PCB of the D77) or, if this output is not being utilized, connect the ammeter + to the + terminal and – to the – terminal of the 4-20mA output.
2. Press the 20mA key.
3. With maximum flow moving through the pipe, adjust the setting count using the arrow keys until 20.00mA is indicated on the ammeter. The typical count value range for this setting is between 1450 and 1950.
4. Press ENTER to store the value.
5. Re connect the 4-20mA output circuitry as required.

{2nd FUNCT} **SS CUTOFF**

This entry represents the signal strength cutoff level (low velocity cutoff). At flow rates below 0.2 FPS [0.06 MPS] the readings displayed by the D77 are unreliable. By utilizing the default SS CUTOFF of 100 counts, small unstable readings at low flow rates will be avoided.

Note: If SS CUTOFF is set to a level higher than the SIGNAL STR value the meter will not show flow or output any values.



{2nd FUNCT} **INPUT F.S.**

This key is used to select a maximum velocity that the

PART 3 - KEYPAD CONFIGURATION



instrument will operate. Choices are 10, 20 and 30 FPS. It is not recommended to deviate alter this value from factory settings, as certain spans have been set that correlate to the set maximum velocity. Consult the Dynasonics factory for adjustment procedures.

{2nd FUNCT} **DAC 3**

This key is not used.



{2nd FUNCT} **BACK LIGHT**

Toggles the electro-luminescent LCD back lighting ON and OFF. This type of back lighting has an illumination half-life of approximately one year. If the instrument is left unattended for long periods of time, turning the back lighting OFF can preserve the electro-luminescent panel and save a small amount of power.



{2nd FUNCT} **CONTRAST**

This setting allows the adjustment of the LCD contrast. An LCD's viewing quality is affected by temperature, ambient lighting, back lighting and viewing angle. Adjust the contrast level to provide the best contrast possible. Default count is 50.



PART 4 - TROUBLE SHOOTING

CONDITION	POSSIBLE CAUSE
Unit does not turn “ON” when power is applied	<ul style="list-style-type: none"> ? Verify that AC power source is live. ? Test the fuse
FAULT CONDITION is indicated on LCD indicator	<ul style="list-style-type: none"> ? Ensure that the transducer is properly mounted to the pipe. ? Verify that transducer connections are correct ? Ensure that the pipe is full of moving liquid. ? If SIGNAL STR is less than 100 counts and flow rate is greater than 1 FPS [0.3 MPS], adjust GAIN control (R13 on the Main PCB) till SIGNAL STR reaches at least 130 counts. ? On cleaner liquids, move the transducers closer to a 90° pipe elbow. ? If GND connection and pipe are at different potentials, ground D77 to pipe potential. ? If Variable Frequency Drives are being utilized, verify that the D77 obtains a flow indication when the pump turns OFF. If it does, contact the Dynasonics factory.

PART 4 - TROUBLE SHOOTING

Stability of flow readings are unsatisfactory	<ul style="list-style-type: none">? Increase the DAMP constant from keypad.? Move transducers to a location further from piping tees, elbows, valves, filters, etc.
Erroneous Reading	<ul style="list-style-type: none">? Transducer mounted incorrectly or not true to the pipe.? 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 D77. Power the meter with a circuit that does not power motors, ballasts or switching supplies.
The D77 display indicates flow, when true fluid velocity is zero.	<ul style="list-style-type: none">? Verify that residual leakage and flow is not present. [I.e. leaking check valves]? Verify that GAIN control (R13 on the Main PCB) is not adjusted too high. With nominal flow running through the pipe, adjust GAIN control till the display zeros with no flow.

PART 5 - APPENDICES

Appendices

Spare Parts List

Face Plate Drawing

Intrinsic Safety Connections

Pipe Dimension Chart: Cast Iron

Pipe Dimension Chart: Steel, SS, PVC

Velocity to Volumetric Conversion Chart

Statement of Warranty

Customer Service

SPARE PARTS - D77/DT77

Description	Dynasonics Part Number
Series D77 Main PCB	D020-1042-051
Series D77 Micro PCB	D020-1038-005
Series D77 Enclosure w/keypad	D040-0121-001
D77 Installation and Operations Manual	D77 O&M
Two conductor, 20 AWG wire	D005-1003-100
Stainless Steel I.D. Tag	DSS TAG
Probe Seal Kit	D003-0135-000
Bronze Ball Valve Kit, 1-1/2" NPT	DBV
SS Ball Valve Kit, 1-1/2" NPT	DSSV
Portable Probe Crank: 8" probe	DPC-1
Portable Probe Crank: 18" probe	DPC-2
Portable Probe Crank: 28" probe	DPC-3
Portable Probe Crank: 38" probe	DPC-4
Portable Probe Crank: 48" probe	DPC-5



Ductile Iron Pipe

Standard Classes

Pipe Size (inches)	Outside Diameter (inches)	Class 50		Class 51		Class 52		Class 53		Class 54		Class 55		Class 56		Cement Lining Std./Double Thickness
		ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	
3	3.96			3.46	0.25	3.40	0.28	3.34	0.31	3.28	0.34	3.22	0.37	3.14	0.41	.123/.250
4	4.80			4.28	0.26	4.22	0.29	4.16	0.32	4.10	0.35	4.04	0.38	3.93	0.44	
6	6.90	6.40	0.25	6.34	0.28	6.28	0.31	6.22	0.34	6.16	0.37	6.10	0.40	6.04	0.43	
8	9.05	8.51	0.27	8.45	0.30	8.39	0.33	8.33	0.36	8.27	0.39	8.21	0.42	8.15	0.45	
10	11.10	10.32	0.39	10.46	0.32	10.40	0.35	10.34	0.38	10.28	0.41	10.22	0.44	10.16	0.47	
12	13.20	12.58	0.31	12.52	0.34	12.46	0.37	12.40	0.40	12.34	0.43	12.28	0.46	12.22	0.49	
14	15.30	14.64	0.33	14.58	0.36	14.52	0.39	14.46	0.42	14.40	0.45	14.34	0.48	14.28	0.51	.1875/.375
16	17.40	16.72	0.34	16.66	0.37	16.60	0.40	16.54	0.43	16.48	0.46	16.42	0.49	16.36	0.52	
18	19.50	18.80	0.35	18.74	0.38	18.68	0.41	18.62	0.44	18.56	0.47	18.50	0.50	18.44	0.53	
20	21.60	20.88	0.36	20.82	0.39	20.76	0.42	20.70	0.45	20.64	0.48	20.58	0.51	20.52	0.54	
24	25.80	25.04	0.38	24.98	0.41	24.92	0.44	24.86	0.47	24.80	0.50	24.74	0.53	24.68	0.56	
30	32.00	31.22	0.39	31.14	0.43	31.06	0.47	30.98	0.51	30.90	0.55	30.82	0.59	30.74	0.63	.250/.500
36	38.30	37.44	0.43	37.34	0.48	37.06	0.62	37.14	0.58	37.40	0.45	36.94	0.68	36.84	0.73	
42	44.50	43.56	0.47	43.44	0.53	43.32	0.59	43.20	0.65	43.08	0.71	42.96	0.77	42.84	0.83	
48	50.80	49.78	0.51	49.64	0.58	49.50	0.65	49.36	0.72	49.22	0.79	49.08	0.86	48.94	0.93	
54	57.10	55.96	0.57	55.80	0.65	55.64	0.73	55.48	0.81	55.32	0.89	55.16	0.97	55.00	1.05	



Cast Iron Pipe Standard Classes

	CLASS A			CLASS B			CLASS C			CLASS D			CLASS E			CLASS F			CLASS G			CLASS H			
Size (Inches)	O.D. Inch	I.D. Inch	Wall	O.D. Inch	I.D. Inch	Wall	O.D. Inch	I.D. Inch	Wall	O.D. Inch	I.D. Inch	Wall	O.D. Inch	I.D. Inch	Wall	O.D. Inch	I.D. Inch	Wall	O.D. Inch	I.D. Inch	Wall	O.D. Inch	I.D. Inch	Wall	
3	3.80	3.02	0.39	3.96	3.12	0.42	3.96	3.06	0.45	3.96	3.00	0.48													
4	4.80	3.96	0.42	5.00	4.10	0.45	5.00	4.04	0.48	5.00	3.96	0.52													
6	6.90	6.02	0.44	7.10	6.14	0.48	7.10	6.08	0.51	7.10	6.00	0.55	7.22	6.06	0.58	7.22	6.00	0.61	7.38	6.08	0.65	7.38	6.00	0.69	
8	9.05	8.13	0.46	9.05	8.03	0.51	9.30	8.18	0.56	9.30	8.10	0.60	9.42	8.10	0.66	9.42	8.10	0.66	9.60	8.10	0.75	9.60	8.00	0.8	
10	11.10	10.10	0.50	11.10	9.96	0.57	11.40	10.16	0.62	11.40	10.04	0.68	11.60	10.12	0.74	11.60	10.00	0.80	11.84	10.12	0.86	11.84	10.00	0.92	
12	13.20	12.12	0.54	13.20	11.96	0.62	13.50	12.14	0.68	13.50	12.00	0.75	13.78	12.14	0.82	13.78	12.00	0.89	14.08	12.14	0.97	14.08	12.00	1.04	
14	15.30	14.16	0.57	15.30	13.98	0.66	15.65	14.17	0.74	15.65	14.01	0.82	15.98	14.18	0.90	15.98	14.00	0.99	16.32	14.18	1.07	16.32	14.00	1.16	
16	17.40	16.20	0.60	17.40	16.00	0.70	17.80	16.20	0.80	17.80	16.02	0.89	18.16	16.20	0.98	18.16	16.00	1.08	18.54	16.18	1.18	18.54	16.00	1.27	
18	19.50	18.22	0.64	19.50	18.00	0.75	19.92	18.18	0.87	19.92	18.00	0.96	20.34	18.20	1.07	20.34	18.00	1.17	20.78	18.22	1.28	20.78	18.00	1.39	
20	21.60	20.26	0.67	21.60	20.00	0.80	22.06	20.22	0.92	22.06	20.00	1.03	22.54	20.24	1.15	22.54	20.00	1.27	23.02	20.24	1.39	23.02	20.00	1.51	
24	25.80	24.28	0.76	25.80	24.02	0.89	26.32	24.22	1.05	26.32	24.00	1.16	26.90	24.28	1.31	26.90	24.00	1.45	27.76	24.26	1.75	27.76	24.00	1.88	
30	31.74	29.98	0.88	32.00	29.94	1.03	32.40	30.00	1.20	32.74	30.00	1.37	33.10	30.00	1.55	33.46	30.00	1.73							
36	37.96	35.98	0.99	38.30	36.00	1.15	38.70	35.98	1.36	39.16	36.00	1.58	39.60	36.00	1.80	40.04	36.00	2.02							
42	44.20	42.00	1.10	44.50	41.94	1.28	45.10	42.02	1.54	45.58	42.02	1.78													
48	50.50	47.98	1.26	50.80	47.96	1.42	51.40	47.98	1.71	51.98	48.00	1.99													
54	56.66	53.96	1.35	57.10	54.00	1.55	57.80	54.00	1.90	58.40	53.94	2.23													
60	62.80	60.02	1.39	63.40	60.06	1.67	64.20	60.20	2.00	64.82	60.06	2.38													
72	75.34	72.10	1.62	76.00	72.10	1.95	76.88	72.10	2.39																
84	87.54	84.10	1.72	88.54	84.10	2.22																			



Steel, Stainless Steel, P.V.C.

Standard Schedules

Nominal Pipe Size Inches	OUTSIDE DIAMETER	SCH. 5		SCH. 10 (LTWALL)		SCH. 20		SCH. 30		STD.		SCH. 40		SCH. 60		X STG.		SCH. 80		SCH. 100		SCH. 120		SCH. 140		SCH. 180			
		ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall	ID	Wall		
1	1.315	1.185	0.065	1.097	0.109					1.049		1.049	0.133			0.957	0.179	0.957	0.179									0.815	0.250
1.25	1.660	1.530	0.065	1.442	0.109					1.380		1.380	0.140			1.278	0.191	1.278	0.191									1.160	0.250
1.5	1.900	1.770	0.065	1.682	0.109					1.610		1.610	0.145			1.500	0.200	1.500	0.200									1.338	0.281
2	2.375	2.245	0.065	2.157	0.109					2.067		2.067	0.154			1.939	0.218	1.939	0.218									1.687	0.344
2.5	2.875	2.709	0.083	2.635	0.120					2.469		2.469	0.203			2.323	0.276	2.323	0.276									2.125	0.375
3	3.500	3.334	0.083	3.260	0.120					3.068		3.068	0.216			2.900	0.300	2.900	0.300									2.624	0.438
3.5	4.000	3.834	0.083	3.760	0.120					3.548		3.548	0.226			3.364	0.318	3.364	0.318										
4	4.500	4.334	0.083	4.260	0.120					4.026	0.237	4.026	0.237			3.826	0.337	3.826	0.337			3.624	0.438	3.624	0.438	3.438	0.531		
5	5.563	5.345	0.109	5.295	0.134					5.047	0.258	5.047	0.258			4.813	0.375	4.813	0.375			4.563	0.500	4.563	0.500	4.313	0.625		
6	6.625	6.407	0.109	6.357	0.134					6.065	0.280	6.065	0.280			5.761	0.432	5.761	0.432			5.501	0.562	5.501	0.562	5.187	0.719		
8	8.625	8.407	0.109	8.329	0.148	8.125	0.250	8.071	0.277	7.981	0.322	7.981	0.322	7.813	0.406	7.625	0.500	7.625	0.500	7.437	0.594	7.187	0.719	7.187	0.719	6.183	1.221		
10	10.750	10.482	0.134	10.42	0.165	10.25	0.250	10.13	0.310	10.02	0.365	10.020	0.365	9.750	0.500	9.750	0.500	9.562	0.594	9.312	0.719	9.062	0.844	9.062	0.844	8.500	1.125		
12	12.750	12.420	0.165	12.39	0.180	12.25	0.250	12.09	0.330	12.00	0.375	11.938	0.406	11.626	0.562	11.750	0.500	11.370	0.690	11.060	0.845	10.750	1.000	10.750	1.000	10.120	1.315		
14	14.000			13.50	0.250	13.37	0.315	13.25	0.375	13.25	0.375	13.124	0.438	12.814	0.593	13.000	0.500	12.500	0.750	12.310	0.845	11.810	1.095	11.810	1.095	11.180	1.410		
16	16.000			15.50	0.250	15.37	0.315	15.25	0.375	15.25	0.375	15.000	0.500	14.688	0.656	15.000	0.500	14.310	0.845	13.930	1.035	13.560	1.220	13.560	1.220	12.810	1.595		
18	18.000			17.50	0.250	17.37	0.315	17.12	0.440	17.25	0.375	16.876	0.562	16.564	0.718	17.000	0.500	16.120	0.940	15.680	1.160	15.250	1.375	15.250	1.375	14.430	1.785		
20	20.000			19.50	0.250	19.25	0.375	19.25	0.375	19.25	0.375	18.814	0.593	18.376	0.812	19.000	0.500	17.930	1.035	17.430	1.285	17.000	1.500	17.000	1.500	16.060	1.970		
24	24.000			23.50	0.250	23.25	0.375	23.25	0.375	23.25	0.375	22.626	0.687	22.126	0.937	23.000	0.500	21.560	1.220	20.930	1.535	20.930	1.535	20.930	1.535	19.310	2.345		
30	30.000			29.37	0.315	29.00	0.500	29.00	0.500	29.25	0.375	29.250	0.375			29.000	0.500												
36	36.000			35.37	0.315	35.00	0.500	35.00	0.500	35.25	0.375	35.250	0.375			35.000	0.500												
42	42.000									41.25	0.375	41.250	0.375			41.000	0.500												
48	48.000									47.25	0.375	47.250	0.375			47.000	0.500												



FPS TO GPM CROSS - REFERENCE (Schedule 40)

Nominal Pipe (Inches)	I.D. INCH	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
1	1.05	2.6989	4.0484	5.3978	6.7473	8.097	9.4462	10.796	12.145	13.490	14.844	16.190	17.540	18.890	20.240	21.590	22.941	24.290
1.25	1.38	4.6620	6.9929	9.3239	11.655	13.99	16.317	18.648	20.979	23.310	25.641	27.970	30.300	32.630	34.960	37.300	39.627	41.958
1.5	1.61	6.3454	9.5182	12.691	15.864	19.04	22.209	25.382	28.555	31.730	34.900	38.070	41.250	44.420	47.590	50.760	53.936	57.109
2	2.07	10.489	15.734	20.979	26.224	31.47	36.713	41.958	47.202	52.450	57.692	62.940	68.180	73.430	78.670	83.920	89.160	94.405
2.5	2.47	14.935	22.402	29.870	37.337	44.80	52.272	59.740	67.207	74.670	82.142	89.610	97.080	104.50	112.00	119.50	126.95	134.41
3	3.07	23.072	34.608	46.144	57.680	69.22	80.752	92.288	103.82	115.40	126.90	138.40	150.00	161.50	173.00	184.60	196.11	207.65
3.5	3.55	30.851	46.276	61.702	77.127	92.55	107.98	123.40	138.83	154.30	169.68	185.10	200.50	216.00	231.40	246.80	262.23	277.66
4	4.03	39.758	59.636	79.515	99.394	119.3	139.15	159.03	178.91	198.80	218.67	238.50	258.40	278.30	298.20	318.10	337.94	357.82
5	5.05	62.430	93.645	124.86	156.07	187.3	218.50	249.72	280.93	312.10	343.36	374.60	405.80	437.00	468.20	499.40	530.65	561.87
6	6.06	89.899	134.85	179.80	224.75	269.7	314.65	359.60	404.55	449.50	494.45	539.40	584.30	629.30	674.20	719.20	764.14	809.09
8	7.98	155.89	233.83	311.78	389.72	467.7	545.61	623.56	701.50	779.40	857.39	935.30	1013.0	1091.0	1169.0	1247.0	1325.1	1403.0
10	10.02	245.78	368.67	491.56	614.45	737.3	860.23	983.12	1106.0	1229.0	1351.8	1475.0	1598.0	1720.0	1843.0	1966.0	2089.1	2212.0
12	11.94	348.99	523.49	697.99	872.49	1047.0	1221.5	1396.0	1570.5	1745.0	1919.5	2094.0	2268.0	2443.0	2617.0	2792.0	2966.5	3141.0
14	13.13	422.03	633.04	844.05	1055.1	1266.0	1477.1	1688.1	1899.1	2110.0	2321.1	2532.0	2743.0	2954.0	3165.0	3376.0	3587.2	3798.2
16	15.00	550.80	826.20	1101.6	1377.0	1652.0	1927.8	2203.2	2478.6	2754.0	3029.4	3305.0	3580.0	3856.0	4131.0	4406.0	4681.8	4957.2

FPS TO GPM: $GPM = (PIPE\ ID)^2 \times VELOCITY\ IN\ FPS \times 2.45$

GPM TO FPS: $FPS = \frac{GPM}{(ID)^2 \times 2.45}$

FPS X .3048 = MPS

GPM X .0007 = GPD

GPM X 3.7878 = LPM



FPS TO GPM CROSS - REFERENCE (Schedule 40)

Nominal Pipe (Inches)	I.D. INCH	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
18	16.88	697.52	1046.3	1395.0	1743.8	2093.0	2441.3	2790.1	3138.8	3488.0	3836.3	4185.0	4534.0	4883.0	5231.0	5580.0	5928.9	6277.7
20	18.81	866.14	1299.0	1732.0	2165.3	2598.4	3031.5	3464.6	3897.6	4330.7	4763.8	5196.8	5629.9	6063.0	6496.0	6929.1	7362.2	7795.3
24	22.63	1253.7	1880.0	2507.0	3134.1	3761.0	4387.8	5014.6	5641.5	6268.3	6895.1	7522.0	8148.8	8775.6	9402.4	10029	10656	11283
26	25.25	1560.7	2341.0	3121.0	3901.9	4682.2	5462.6	6243.0	7023.4	7803.7	8584.1	9364.5	10145	10925	11706	12486	13266	14047
28	27.25	1817.8	2727.0	3636.0	4544.5	5453.4	6362.3	7271.2	8180.0	9088.9	9997.8	10907	11816	12725	13633	14542	15451	16360
30	29.25	2094.4	3142.0	4189.0	5236.0	6283.2	7330.4	8377.6	9424.9	10472	11519	12566	13614	14661	15708	16755	17803	18850
32	31.25	2390.6	3586.0	4781.0	5976.5	7171.9	8367.2	9562.5	10758	11953	13148	14344	15539	16734	17930	19125	20320	21516
34	33.25	2706.4	4060.0	5413.0	6766.0	8119.2	9472.4	10826	12179	13532	14885	16238	17592	18945	20298	21651	23004	24358
36	35.25	3041.8	4563.0	6084.0	7604.5	9125.4	10646	12167	13688	15209	16730	18251	19772	21292	22813	24334	25855	27376
42	41.25	4165.4	6248.0	8331.0	10414	12496	14579	16662	18744	20827	22910	24992	27075	29158	31241	33323	35406	37489
48	47.99	5637.8	8457.0	11276	14095	16913	19732	22551	25370	28189	31008	33827	36646	39465	42284	45103	47922	50740
54	53.98	7133.1	10700	14266	17833	21399	24966	28532	32099	35665	39232	42798	46365	49931	53498	57065	60631	64198
60	60.09	8839.2	13259	17678	22098	26518	30937	35357	39777	44196	48616	53035	57455	61875	66294	70714	75134	79553
72	72.10	12726	19089	25451	31814	38177	44540	50903	57266	63628	69991	76354	82717	89080	95443	101805	108168	114531
84	84.10	17314	25971	34628	43285	51943	60600	69257	77914	86571	95228	103885	112542	121199	129856	138514	147171	155828

FPS TO GPM: $GPM = (PIPE\ ID)^2 \times VELOCITY\ IN\ FPS \times 2.45$

GPM TO FPS: $FPS = \frac{GPM}{(ID)^2 \times 2.45}$

FPS X .3048 = MPS

GPM X .0007 = GPD

GPM X 3.7878 = LPM



Limited Warranty and Disclaimer

Dynasonics, div. of Racine Federated Inc. warrants to the end purchaser, for a period of one year from the date of shipment from our factory, that all new transmitters and transducers manufactured by it are free from defects in materials and workmanship. This warranty does not cover products that have been damaged due to normal use, misapplication, abuse, lack of maintenance, or improper installation. Dynasonics' obligation under this warranty is limited to the repair or replacement of a defective product, at no charge to the end purchaser, if the product is inspected by Dynasonics and found to be defective. Repair or replacement is at Dynasonics' discretion. An authorization number must be obtained from Dynasonics before any product may be returned for warranty repair or replacement. The product must be thoroughly cleaned and any process chemicals removed before it will be accepted for return.

The purchaser must determine the applicability of the product for its desired use and assumes all risks in connection therewith. Dynasonics assumes no responsibility or liability for any omissions or errors in connection with the use of its products. Dynasonics will under no circumstances be liable for any incidental, consequential, contingent or special damages or loss to any person or property arising out of the failure of any product, component or accessory.

All expressed or implied warranties, including **the implied warranty of merchantability and the implied warranty of fitness for a particular purpose or application are expressly disclaimed** and shall not apply to any products sold or services rendered by Dynasonics.

The above warranty supersedes and is in lieu of all other warranties, either expressed or implied and all other obligations or liabilities. No agent or representative has any authority to alter the terms of this warranty in any way.



GENERAL TERMS AND CONDITIONS OF SALES

1. **PAYMENT** – Terms of payment are effective from the actual date of invoice. If, in the Seller's opinion, the financial condition of the Buyer at any time – or any other circumstances – do not justify the incurrence of production costs of shipment on the terms of payment specified, the Seller may require partial or full payment in advance. Payment terms are net 30 days unless otherwise stated on invoice.
2. **F.O.B.** – All shipments are from Racine, Wisconsin, USA, unless otherwise other stated, and title transfers to the buyer upon leaving factory.
3. **QUOTATION AND PRICES** – Quoted prices are firm for 30 days unless stated in the quotation and are subject to change without notice after expiration of this period.
4. **TAXES** – Any applicable sales, use, revenue, excise or other taxes not specifically stated in the quotation are to be remitted by the Buyer directly to the appropriate regulatory agency.
5. **WARRANTY** – Seller's standard published warranty in effect at the time of shipment shall apply. This warranty is exclusive and is in lieu of all other warranties, express, implied, or statutory, including the warranty of merchantability.
6. **DELIVERY** – The Seller shall not be liable for loss or damage of any kind resulting from delay or inability to deliver on account of flood, fire, labor trouble, riots, civil disturbances, accidents, acts or orders or regulations of civil or military authorities, shortages of material, or any other causes beyond Seller's control.
7. **PRODUCT CHANGES** – In keeping with our continuing policy of product improvement, we reserve the right to make changes in our products at any time, without incurring an obligation to change, replace or upgrade equipment previously shipped.
8. **CANCELLATIONS** – An order placed by Buyer and accepted by Seller may be cancelled only with the Seller's consent and upon terms that will indemnify the Seller against loss.
9. **RESTOCKING CHARGE** – On standard equipment, the charge is 25%, provided the equipment is returned within 30 days in acceptable condition with a RGA number. Restocking charges for special equipment may vary from standard equipment, and will be handled on a case-by-case basis. No returns will be taken after one year.



DIVISION OF RACINE FEDERATED INC.
2200 SOUTH STREET, RACINE, WI 53404

RETURN OF EQUIPMENT/SALES INFORMATION

CONTACTS AND PROCEDURES

Customer Service/Application Engineer:

If you have a question regarding order status, placing an order, reviewing applications for future purchases, or wish to purchase a new flowmeter, please contact our new National Sales and Marketing Headquarters:

DYNASONICS
Division of Racine Federated, Inc.
2200 South Street
Racine, WI 53404-1526
PHONE: (262)639-6770
FAX: (262)639-2267

Service/Repair Department:

If you already purchased equipment and have an operation problem, require service, or need to schedule field service, please contact our Service Department:

DYNASONICS
Division of Racine Federated, Inc.
2200 South Street
Racine, WI 53404-1526
PHONE: (262)639-6770
FAX: (262)639-2267

Return Goods Authorization:

When returning equipment, it is necessary for you to contact our Service Department at (262)639-6770 to obtain an RGA number for the authority and proper tracking of your material and its prompt inspection and return. All returns of equipment go to the following address:

DYNASONICS
Division of Racine Federated, Inc.
2200 South Street
Racine, WI 53404-1526
RGA #0000



2200 SOUTH STREET RACINE, WI 53404
TOLL-FREE IN North America: TEL: (800) 535-3569
TEL: (262) 639-6770 FAX: (262) 639-2267
URL: www.dynasonics.com