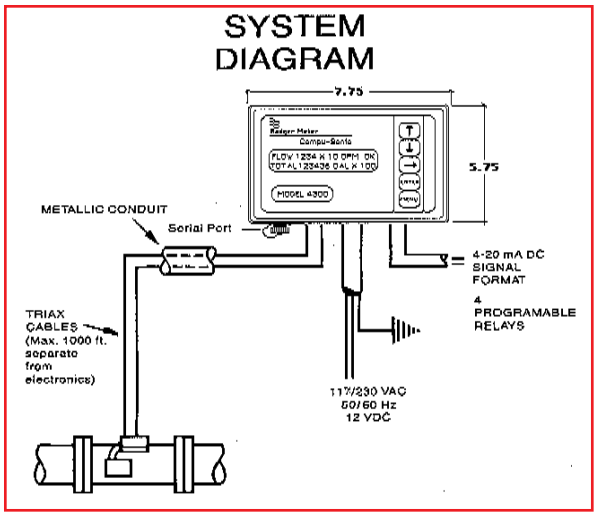
tech BRIEF

SERIES 4500 Transit-Time Ultrasonic Flowmeter



Features:

- No Head Loss - External or Internal Sensors are Obstruction Free
- Easily Installed - Simple Mounting Techniques
- High Accuracy - Transit Time Operation
- Bi-Directional - Forward and/or Reverse Flow

Description

The Series 4500 Compu-Sonic™ is a transit-time ultrasonic flowmeter designed for use in full pipe liquid flow applications. It uses the chordal velocity measurement principle which provides accurate and reliable flow information. The microprocessor based meter is supplied with a 24 character, 2 line alphanumeric LCD display for rate of flow and totalized flow information. A front panel key pad activates a scroll through menu for full meter programming plus functions such as the meter's operational status, rescaling and calibration of the 4-20 mA output signal.

The meter can be supplied for measuring flow rates in two inch and larger pipes. Various styles of sensors are available allowing the use on any type of pipe material.

Standard output signals are a 4-20 mA current linear to flow, four programmable relays and a serial communications port. The relays can be programmed for High and Low Alarms, Remote Totalizer, Meter Faults, Flow Direction and Contact Integrator.

The serial communications port allows for programming the flowmeter to a specific application or direct connection to a computer system. The flowmeter supports either RS232 or RS485. The communications utilizes the Modbus™ protocol.

Applications

The Series 4500 can be applied to water, wastewater and industrial process fluids.

Typical applications:

Water: Influent / effluent of WTP, distribution monitoring, billing, water wells.

Wastewater: Lift stations, WWTP Influent / effluent, clarifier effluents, clarifier underflows, RAS, WAS.

Industrial process: In plant monitoring, transportation lines, HVAC.

Irrigation: Turnouts, aqueduct flows.

Piping Requirements

The Series 4500 flowmeters may be mounted on horizontal or vertical piping runs. A well-developed velocity profile is needed. General practice requires the pipe to be full and the upstream piping run to be sufficient to assure predictable fluid velocity distribution.

Electronics Enclosure

The Series 4500 electronics are housed in a NEMA 4X foam molded polycarbonate enclosure suited for wall mounting. The inside of the enclosure has a Cobaloy coating for RFI protection. The enclosure dimensions are 7.75" wide, 5.75" high and 4.00" deep.

Velocity Sensors

The Series 4500 flowmeters utilize acoustic signals transmitted from pipe mounted sensors to accurately measure fluid velocities. Because of the diverse application in fluid monitoring, as well as different pipe materials available, several versions of the acoustic velocity sensor are available. All sensors are fully potted and sealed to ensure long-term durability even when submerged under water.

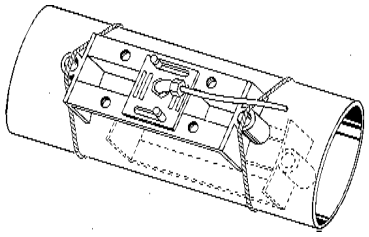
Badger Meter, Inc.
P.O. Box 581390
Tulsa, Oklahoma 74158
918.836.8411
FAX: 918.832.9962

941432
4/97-1.5M

Externally Mounted Strap-on Sensors
The externally mounted non-wetted sensor is designed to transmit ultrasonic energy pulses through the pipe wall. These sensors can be used on pipes with homogenous materials such as steels, ductile iron and plastic. They can be used on pipe sizes from 2 inches and larger. The mounting hardware is constructed of 304 stainless steel.

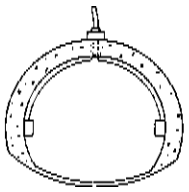
The strap-on sensors can be mounted in one of two different configurations. The "v-shot" arrangement places both sensors on the same side of the conduit sending acoustic transmission through the pipe, reflecting off the inside wall back to the second sensor. This configuration is normally recommended for smaller line sizes and carbon steel or PVC pipes.

The through the pipe configuration (as shown) mounts the sensors 180 degrees apart on the outside of the pipe.



STRAP-ON SENSORS

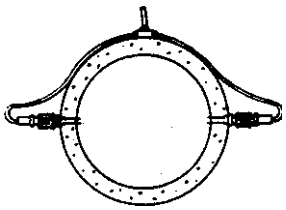
Instream Velocity Sensors
The instream velocity sensors are designed for use in applications where the outside of the pipe is not accessible, or the pipe size allows easy entrance. The sensors can be mounted directly to the inside wall. These sensors are for use on pipes 24 inches and larger. A second mounting technique pre-installs the sensor on a mounting band that can be inserted into the pipe. The hoop is manufactured out of stainless steel.



INSTREAM SENSORS

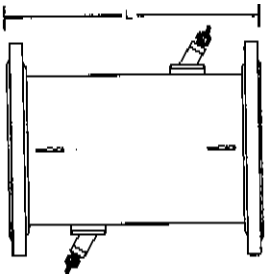
Thru-wall Wetted Velocity Sensors
The thru-wall wetted velocity sensors are designed for penetration through the pipe wall. These are used where the ultrasonic signal cannot penetrate the pipe wall because of the pipe material or internal condition of the pipe. These can be used on pipes 6 inches and larger.

The Hot-Shot style of sensor is normally used in these applications. A valve assembly is recommended with tapping saddles or a nipple welded to the pipe. This allows insertion and withdrawal of the sensor without dewetting the pipe. Other thru-wall sensor styles are available without valve assemblies.



"HOT-SHOT" SENSOR

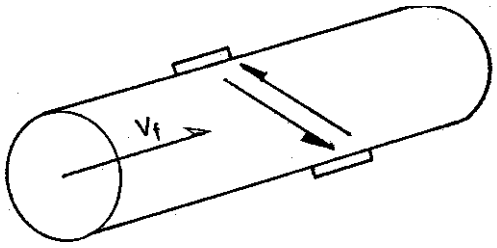
Fabricated Spool Sensors
Fabricated spool sections are available with a choice of end connections and material of construction. The sensors used with the spool are mounted in windows. These windows are constructed of Ultem® plastic and attached to the spool which allows the sensor to be installed or removed without dewatering or process shutdown. The windows have a maximum pressure rating of 250 psi.



SPOOL PIECE

All of the sensor styles, except for the windowed sensors, can be located up to 1000 feet from the electronics. The windowed sensors can be located up to 250 feet.

All of the sensor styles except for the windowed sensors have been Factory Mutual approved for use in Class I Division I Groups A, B, C and D except for acetic atmospheres. The electronics must be located in a safe area and the sensors installed in accordance to FM approved methods to assure the rating.



PRINCIPLES OF OPERATION

$$\bar{v} = \frac{l_p}{2\cos\theta} \times \frac{T_U - T_D}{T_U T_D}$$

$\bar{v}$ = Mean Chordal Velocity
θ = Crossing Angel
lp = Path Length
T_U = Time Up
T_D = Time Down

Specifications

Electronics

Microprocessor based: Advanced single chip microcomputer with 8K bytes of ROM, 512 bytes of EEPROM and 256 bytes of RAM.

Linearity:	+/- 0.5%
Repeatability:	0.25%
Accuracy:	+/- 1% of actual flow*
Output Signals:	
4-20 mADC isolated into a max of 1000 ohms	
4 programmable relays	
SPDT 0.5 amp @ 120 VAC or 1 amp @ 24 VDC	
Temperature Rating:	32 to 140 degrees F
Humidity Rating:	5 to 95% Relative
Power Requirements:	117/230 VAC 50/60 Hz maximum 5 watts
	12 VDC

* Accuracy statement is predicated on velocities above 1 FPS, meter location in piping run with proper straight runs for establishment of predictable velocity profile, proper installation of sensors and accurate pipe dimensions are supplied. For velocities below 1 FPS, the accuracy is +/-0.01 FPS.

Sensors:

Temperature Rating:	-30 to 150 degrees F
Optional to 300 degrees F Strap-on only	
Pressure Rating:	
Strap-on:	Not applicable
Instream:	150 PSI
Hot-shot valve:	150 PSI
Windowed:	250 PSI
Materials of Construction:	
Sensors:	PVC
Strap-on hardware:	304 SS
Hot-shot Valve hardware:	Brass
Sensor Cable:	Triax Beldon 9222
Sensor Cable Length:	
Standard:	100 feet
Maximum:	1000 feet (250 feet for windowed sensors)

sample

SERIES 4500

S P E C I F I C A T I O N S

General

A transit-time ultrasonic flowmeter shall be installed on the piping system as shown in the plans and shall be in accordance with the manufacturer's recommendations. The meter shall consist of a set of acoustic transducers, interconnecting cable, remote microprocessor-based electronic transmitter and accessories as required for the installation. The meter shall be a Badger Meter Model 4500 Compu-Sonic.

Acoustic Sensors and Mounting Requirements

Two flow sensors shall be permanently mounted to the pipe to ensure accurate and stable measurement of flow. The sensors shall be positioned in accordance with the manufacturer's specifications and factory approved methods. Mounting templates and/or fixtures for sensor attachments shall be provided by the manufacturer.

The mounting hardware and transducers shall have sufficient integrity to maintain accurate sensor placement withstanding normal pipe vibration and shall be capable of operating over a temperature range of (-30° to 70° C) or (-30° to 150° F). In addition, the sensors shall be so designed as to operate under submerged conditions indefinitely.

The acoustic sensors shall alternately transmit and receive acoustic energy pulses propagated along the centerline of the fluid. Only transit-time method of operation will be accepted.

(1.) *For External Sensors (2" Dia. Meters and Larger):* The integrity of the pipe shall be maintained during installation and operation. Cutting into the pipe to install the sensors or holders shall not be allowed. Stainless steel mounting bands shall be placed about the pipe circumference to secure the sensor brackets; the mounting bands shall have sufficient strength to maintain accurate sensor position.

Positioning of the sensor mounting brackets shall be in accordance with the manufacturer's specifications. The acoustic sensors shall be secure ly held in the sensor brackets and shall transmit acoustic energy through the (steel, cast iron, plastic) pipe wall for measurement of flow.

These sensors shall be so designed as to be operated directly buried (in accordance with the manufacturer's recommendations) or underwater.

(2.) *For "Hot Shot" Sensors (12" Dia. Meters and Larger):*
Two acoustic sensors of the "hot shot" style shall be mounted on the piping at the positions shown on plans. Valve assemblies shall be supplied to allow the insertion or withdrawal of the sensors without dewatering the conduit.

(3.) *For Instream Wetted Sensors (24" Dia. Meters and Larger):*
The sensor design and mounting hardware shall be such as to allow mounting against the inside of the pipewall. Installation shall be in accordance with the manufacturer's specifications.

(or)

The manufacturer shall supply an internal strap design that will be installed on the inside diameter of the conduit. This design will have the instream sensors accurately positioned and mounted on the field installed "hoop". The manufacturer shall supply all the necessary hardware to ensure proper installation.

(4.) *For Fabricated Spool Design:*
The meter body installed in the piping shall be _____" internal diameter with a laying length of _____. It shall be constructed from _____ material with (ANSI, 150, or 300#), (AWWA, Class D, 150#), carbon steel or plain end connections. The design shall incorporate externally mounted sensors that are field replaceable, factory mounted on the meter body. This design will be in accordance with ASME pressure vessel code

(or)

A windowed sensor design shall be supplied by the manufacturer that allows sensor removal without dewatering of the line. The sensors and windows shall be constructed of Ultem® thermoplastic and shall have a temperature rating of 150° F. The sensor shall be replaceable without dewatering the pipe.

Transmitter Requirements

The transmitter shall contain all the circuitry necessary to produce a 4-20 mA DC signal linear with the flow rate. The transmitter shall be capable of measuring and totalizing forward and reverse flow. It shall be microprocessor-controlled. The microprocessor shall be of a single chip design using at least 8K bytes of ROM, 512 bytes of EEROM, and 512 bytes of RAM. The transmitter shall be housed in a foam-molded polycarbonate enclosure suitable for wall/panel mounting, rated NEMA 4X. The display on the enclosure will be a 24-character, 2-line alphanumeric LCD clearly indicating instantaneous flow rate and totalized flow information with the engineering units and multiplier as specified. The transmitter shall utilize menu-driven sequencing of the internal functions from the front panel switches without the need or use of external equipment.

- RATE INDICATION
- TOTALIZATION
- ON-LINE METER STATUS
- SELF-TEST
- METER IDENTIFICATION AND TAG NUMBER
- SPAN ADJUSTMENT
- ZERO ADJUSTMENT
- FLOW DAMPING
- METER RESCALE
- METER RECALIBRATION

Meter output shall be an isolated 4-20mA DC signal linearly proportional to flow rate operating into a maximum of 1000 ohms. The power requirements for the meter shall be a maximum of 5 watts operating on 117 VAC 50/60 Hz. It shall be capable of operating off 12 VDC continuous or battery back up. The temperature range for the transmitter shall be from (32° to 140° F) or 0° to 60° C).

The transmitter shall be equipped with a serial communication port capable of interactive communication with hand-held microcomputers or mainframe machines operating in a modbus format.

Performance Specifications

The flowmeter shall measure, indicate and totalize the flow to within the following parameters:

Accuracy equal to or better than +/- 3% of actual flow above 1 fps velocity for field mounted sensors.
Accuracy +/- 1% of actual flow above 1 fps velocity for spool piece mounted sensors.
Linearity of the units shall be +/- 0.5%.
Repeatability to within +/- 0.25%.
Sensitivity of +/- 0.005 ft./sec.

Flowmeter Maintenance

The flowmeter manufacturer shall incorporate trouble-shooting guides with the instruction manuals. In addition, the meter shall be so designed as to provide a continuous on-line indication of meter status via the LCD display. Through the front panel menu, a user operated, self-test program can be activated that assesses the health of the meter by checking the EEROM, signal strength, transmission status, as well as the electronic circuitry to assure reliable operation of the meter.

Badger Meter, Inc.®