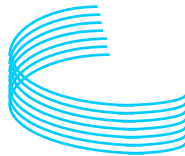


**CPS-460
ULTRASONIC
DOPPLER
FLOWMETER**

INSTRUCTION MANUAL



Ship To:



Via UPS

CONTROL ELECTRONICS, INC.

148 Brandamore Road
Brandamore, PA 19316

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... Please read first before installing flow meter.

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CPS-460 Specifications

Electronics

Power Requirements:	120/220 VAC, $\pm 15\%$, 50/60 Hz 12-24 VDC @ 15W max.
Temperature:	30°F to 120°F (-5°F with opt. heater)
Display:	2 line x 20 character, Alphanumeric, LCD with LED backlighting
Totalizer:	8 digit accumulative with programmable multiplier. x1, x10, x100, x1000 31 daily, 8 digit totalizers
Outputs:	0-10 VDC adjustable, 4-20 mA isolated into 1000 ohms, RS-232, RS-485 opt., 4 relay outputs - 2 Setpoints and 2 programmable pulse, SPDT 7A/250 VAC
Flow Range*:	0.5-30.0 feet per second
Sensitivity**:	Minimum 75ppm Suspended Solids or entrained gas/air bubbles
Resolution:	0.01FPS, 0.01 GAL/MIN
Accuracy***:	$\pm 0.5\%$ of received signal
Memory:	Non-volatile RAM, Flash
Data Log:	31 day summary recording Date, DailyAvg GPM, Total pump run time, Total pump cycles, Total gallons pumped. 14 day detailed recording Date, Cycle number, start/run time, Avg GPM pumped, Total pumped for each cycle.

Sensor

Material:	PVC Housing, Epoxy
Temperature:	-40°F to 160°F exposure
Cable:	20 feet in PVC coated, flexible conduit, 0.6" OD. 50 feet max.
Mounting:	1.0" to 72" pipe using stainless steel pipe strap and supplied couplant paste
Pipe Material:	Steel, PVC, Cast Iron, Most FRP and some lined pipes
Dimensions:	1.5"W x 2.0"Lx 1.0"H (sensor head only)

Enclosure

Material:	Fiberglass with clear hinged Polycarbonate cover.
Rating:	NEMA 4X, IP65, Water-Tight, Dust-Tight Corrosion-Resistant: CSA, UL listed
Dimensions:	7.2"x11.8"x6.8": mounting 4.92"x12.3" with stainless steel mounting feet

Options

Dual-Head or insertion Sensor, Recorders, 460R remote,
Heater/Thermostat, Sensor Cable

Warranty: The CPS-460 system is pre-tested and quality
control inspected before shipping. Warranty is against defects
in parts and workmanship for a period of 1(one) year.

*Flow velocities of less than approximately 1 FPS not recommended

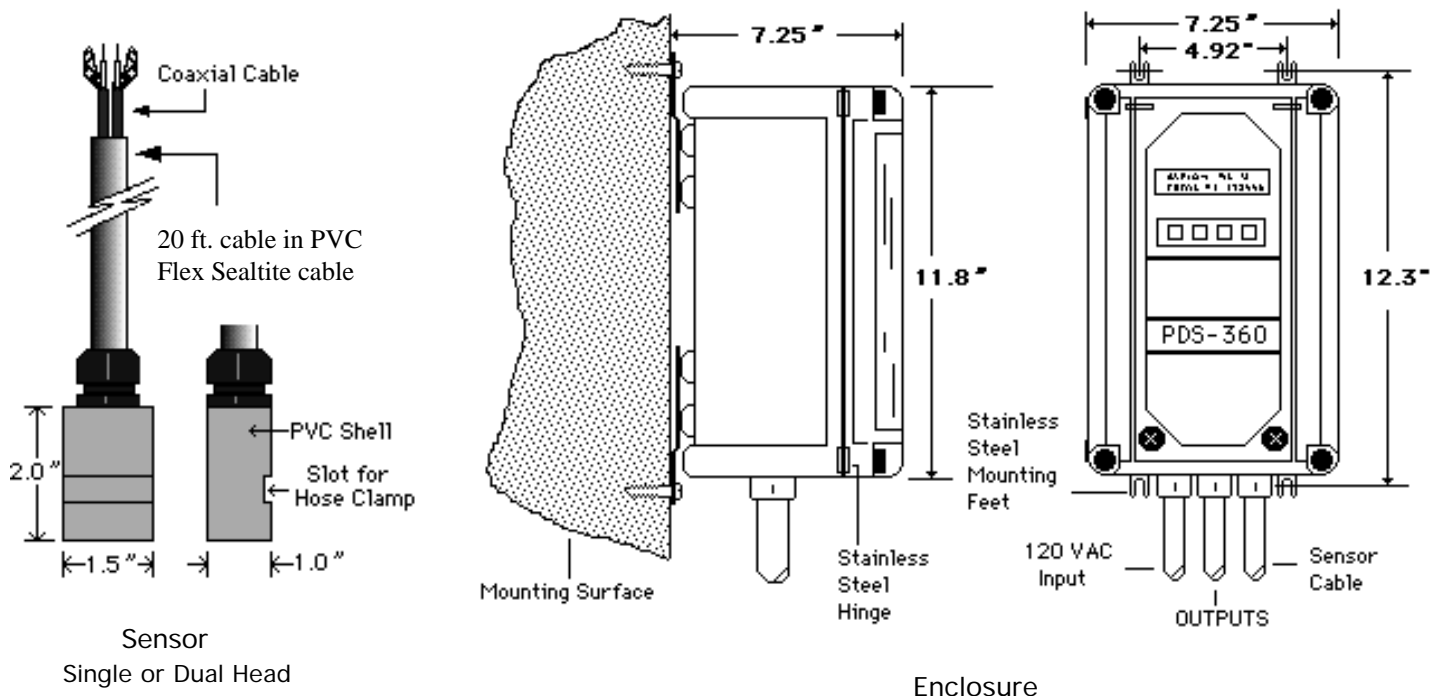
**Application Dependent - velocity/pipe may necessitate higher ppm

***Received signal is application dependent. Field/application
conditions can affect apparent accuracy.

Specifications and design subject to change without notice.

Made in USA

DIMENSIONS



Repair Policy: All repairs are performed on our premises. Repairs must be sent to Control Electronics by UPS prepaid. Customer must enclose a description of problem, who to contact, phone number, return ship-to address and **purchase order number** to cover repairs. Delay of repair may occur if information is not provided. No ARM number is required.

Repair Cost: Most repairs are processed within 48 hours unless major repair is required. Minimal repair charge is \$ 150.00 plus shipping. This covers most repairs. If repair exceeds \$ 150.00, we will notify the customer before we proceed. **Payment is COD or Credit Card only** unless other arrangements are made.



Warranty repairs are made at our discretion and returned UPS GROUND at our expense.

Return Policy: Control Electronics will accept 'return of product' for credit within 6 months of shipping date if it is determined that the product is not performing to specification as described in Product Performance statement in this manual (provided application is not the cause of problem). We do not accept returns for credit when the application is the source of the problem (i.e. poorly installed flumes, poor piping arrangements, interference from other equipment etc.) , product is misapplied or not used properly and/or if product is out of warranty (12 months from ship date).

(within 6 months)

(after 6 months) A **35% restocking charge** will be applied if product is returned for credit after 6 months from ship date. (7 to 12th month from shipping date).

Control Electronics does not accept returns of options such as circular recorders and other products not manufactured by Control electronics, Inc.

Control Electronics will not accept returns of used Sensors, cables, or spare parts unless shown to be defective under warranty or not performing as specified.

Any credit issued will be at the discretion of Control Electronics, Inc. Warranty of product is limited only to the repair or replacement (with same model) of defective product.

Any product or part of product returned damaged will not be considered for any credit.

Customer must call for authorization before returning product for credit. Products returned for credit will not be considered without prior authorization.

A description of how it was determined that the product was not performing to specification must accompany the return of the product for our evaluation before Control Electronics will consider any credit. The name of who to contact along with phone number should also be included with the return.

Ship To Adress: All repairs or returns must be shipped prepaid via UPS or equal to: Control Electronics, Inc., 148 Brandamore Rd., Brandamore, PA 19316

CONTROL ELECTRONICS, INC.

CPS-460 Product Performance

Control Electronics CPS-460 Series will perform as specified when tested under known, simulated conditions. All CPS-460's are tested on a closed pipe flow loop with an in-line turbine meter, NIST traceable, for full functionality and performance before shipping.

The *accuracy* of the product is determined by inputting a known frequency (± 1.0 Hz) into the system and monitoring its ability to process the information accurately. Specifications on for the product are determined by this method.

The *accuracy* of the product is not determined by wet-well draw-down test, pump curve charts etc. Such test indicate the accuracy of the over-all application/installation, not just that of the product. Such tests are not acceptable as an indication of product(s) accuracy. However, draw-down test etc. can be used to determine if the calibration of the product should be changed from factory calibration to compensate for application/installation conditions. This should only be done if no other application/installation corrections can be initiated to correct the problem.

Some equipment such as variable speed drives, nearby radio transmitters (i.e.: radio dispatch or hand held transmitters) etc. located next to the product or even at times in adjacent rooms may interfere with the products performance. The worst of these is the variable speed drive controllers. This type of equipment generates large amounts of electrical and RF (radio frequency) noise that can interfere with the products interpretation of the signal it is looking for and processing. Some adjustment to the product , relocation of the product or different electrical grounding arrangements may minimize or eliminate the interference. Ultimately, it is up to the user to make the corrections necessary and require that the product that is causing the interference be corrected.

If you have any questions in regards to product performance, please contact Control Electronics at (610) 942-3190 or fax us with application conditions and questions at (610) 942-3672. You may also e-mail us at: cei@controlelectronics.com

CONTROL ELECTRONICS, INC.

PRODUCT WARRANTY

WARRANTY:

Control Electronics, Inc. warrants to the buyer that its products are free from defects in materials and workmanship at the time of shipment and during the WARRANTY PERIOD. Control Electronics, Inc. obligation under this warranty is limited to the replacement of the product(s) by same product(s) manufactured by Control Electronics, Inc. or repair of the product(s) at the Control Electronics, Inc. facility. Control Electronics, Inc. products are sold with the understanding that the buyer has determined the applicability of the product(s) to its intended use. It is the responsibility of the buyer to verify acceptability of performance to the actual conditions of use. Performance may vary depending upon these actual conditions.

This Warranty is in lieu of any other warranty, expressed or implied. This includes, but is not limited to, any implied warranty of fitness for a particular purpose, or other obligations or liabilities on the part of Control Electronics, Inc. Under no circumstances will Control Electronics, Inc. be liable for any loss, damage, expense, or consequential damages of any kind arising in connection with the use, or inability for use, of Control Electronics, Inc. products.

WARRANTY PERIOD:

This warranty is in effect for twelve (12) months from the date of shipment from Control Electronics, Inc. place of business. Any extension of warranty period must be requested at time of purchase and made part of purchase order.

LIMITATIONS:

Control Electronics, Inc. products must be installed and maintained in accordance with Control Electronics, Inc. published instructions. Users are responsible for the suitability of the product(s) to their application. There is no warranty against damage resulting from corrosion, misapplication, improper specification, improper installation or any conditions beyond the control of Control Electronics, Inc. Claims against carriers for damage in transit must be filed by the buyer. Control Electronics, Inc. is not liable for labor costs incurred in removal, reinstallation, or unauthorized repair of its product(s). Control Electronics, Inc. warranty does not cover travel time or expenses for job site service. Requests for field service must be accompanied by a signed purchase order. Travel time and expenses will be charged to this purchase order, along with service time if the cause of the failure is not covered by the warranty. No service will be performed on any product(s) unless full payment has been made for product(s).

WARRANTY CLAIM:

If Control Electronics, Inc. products are found to be defective in materials or workmanship within twelve (12) months of the date of shipment, they will be repaired or replaced with same product at the discretion of Control Electronics, Inc. at its place of business at no charge to the buyer. The defective product(s) must be sent, freight prepaid, to the ship-to address on the front page of this manual for warranty claim. All claims must be made in writing. Enclose a brief description of problem, person to contact, phone number and return ship-to address. Product(s) received without this information may not be processed on a timely basis.

If warranty and/or product(s) is not acceptable to buyer, please contact Control Electronics, Inc. and/or return product(s) used for credit. This action must be made within 60 days from ship date from Control Electronics, Inc. Installation of product(s) or non-response within 60 day period indicates the buyers acceptance of product(s) and above warranty.

INTRODUCTION

Control Electronics model CPS-460 Ultrasonic Closed Pipe Doppler Flowmeter is a microprocessor controlled, non-contacting Flowmetering system engineered to accurately measure liquid flow through most full pipes, using high frequency Doppler techniques. The CPS-460 flowmeter has been designed with the user in mind, allowing for simple, intuitive programming through a menu driven interface. Control Electronics has been designing and manufacturing Ultrasonic Doppler flowmeters since 1980.

In theory, the CPS-460 Flowmetering system determines flow velocity in a pipe by calculating the difference between a transmitted, high-frequency sound wave through the pipe wall into the flow stream and the returned frequency that has been shifted as a result of reflecting off moving particles/ air bubbles suspended in the liquid. The system makes these measurements continuously and without contact to the flow. The increase or decrease of the returned frequency or Doppler shift, is directly proportional to flow velocity. This signal is mixed with the transmit signal and modulates much like an AM radio signal. The receiver demodulates the high frequency signal to recover the difference in the transmit and shifted frequency. This is accurately processed electronically to produce a flow velocity in feet-per-second. The Flow velocity signal is used for indicating, Recording, Totalizing and Process Control.

All CPS-460 circuits are protected in a NEMA 4 X, IP65 corrosion resistant fiberglass enclosure with a clear polycarbonate hinged cover for easy viewing of flow indications.

The Sensing element is a non-contacting probe of the single-head or dual-head type. Both Sensor arrangements are capable of transmitting and receiving high-frequency sound waves. Installation is easy, requiring no stoppage of flow or intrusion into the pipe. This eliminates costly down time and product contamination.

After installing the flowmeter and sensor, the operator will find the CPS-460 Flowchart in the back of this manual extremely helpful in navigating through the many options and features of the flowmeter.

With proper understanding of Doppler technology and successful installation of your flowmeter, the CPS-460 will provide the user with many years of continuous, reliable operation.

INSTALLATION

The CPS-460 Flowmetering system is easy to install. Adherence to all installation instructions will result in successful operation of your system. If any deviation must be made from the prescribed installation procedures, please call our service department for change approval. Failure to install your system properly could lead to operational problems and become costly if a service technician is required on-site to remedy. We suggest you read the entire manual to familiarize yourself with the equipment before installing.

1. Enclosure Location

The CPS-460 electronics controller is housed in a NEMA 4X, IP65 fiberglass enclosure. This enclosure is rated as being water-tight, dust-tight and corrosion resistant. However, care should be taken in selecting a location that will offer protection from rain, chemical spills, extreme temperatures etc.

The electronics enclosure is suitable for outdoor installation, but it is recommended that the enclosure be mounted indoors or in a fiberglass shed located next to the measuring site. If the instrument has to be located outdoors, provisions must be made to maintain a temperature range between 30°F and 120°F within the enclosure. For cold locations, our optional Heater and Thermostat should be purchased. This option can be installed at any time by the user. In warmer climates the enclosure should be mounted away from direct sunlight or a sun shade should be erected.

Important



On a hot day, direct sun light could damage the LCD display and raise the internal temperature of the enclosure well above ambient temperature causing malfunction and/or possible damage to the unit. A Sun Shade should be provided.

The CPS-460 Electronics requires a 120/220 VAC power source. Though the flowmeter is designed to minimize external noise interference you should avoid installation in locations near equipment that may be electrically noisy or instruments that generate R.F. (radio frequency) noise such as SCR controlled equipment (i.e. variable speed controllers). You should also maintain at least a 12" separation from additional Doppler meters to prevent any possible crosstalk between units. This will minimize any potential problems.

The enclosure must be located no more than 20 feet from the measuring point. Standard cable length is 20 feet. Longer cable runs up to 50 feet may be ordered or extended in the field up to 50 feet total length using an RG174U coaxial cable. Added cable must be ran in metal conduit with no other cables in the conduit. **DO NOT** run any other cables, including other Doppler meter sensor cables in the same conduit. Maintain at least a 12" spacing between other cables. Our model CPS-460R is recommended for cables greater than 50 feet.

2. Sensor Location

The Sensor location is the most important consideration for proper operation of your Flowmetering system. The Sensor should be located at least 10 pipe diameters downstream from elbows, tees etc., 15 pipe diameters from a fully opened valve and 25 pipe diameters from partially opened valves. 5 pipe diameters of straight pipe upstream should be available. If proper pipe diameters are not available, calibration inaccuracies may arise and in-field calibration correction factors will be necessary to program. Sensor location applies to all type sensors. Single-head, Dual-Head and Insertion type.

Potential noise sources such as excessive mechanical vibration and hard to reach areas should be avoided. Lined pipe (i.e.: concrete lined) or old cast iron pipe may be problems. Concrete and clay pipes are not acceptable, though most homogeneous pipe materials such as PVC and steel are good. Insertion of a spool piece or use of our optional US40IS insertion sensor may be required if your application cannot provide suitable pipe. Vertical risers from a pump are generally very good locations. On horizontal pipe you should avoid long runs from the pumping source. Gravity pulls downward on the flow in the pipe and long horizontal runs may distort the flow profile, affecting calibration and performance.

Refer to **APPLICATION GUIDE** page 26, or call our service department.

Variable Speed Drive problems

If your Variable Speed Drive interferes with the Doppler flowmeter, the following steps may be tried to eliminate the problem:

- 1] increase the FILTER FACTOR (%) in the program mode.
- 2] increase the THRESHOLD adjustment on the Doppler card.
- 3] increase the NOISE FILTER adjustment on the DOPPLER card.
- 4] install the flowmeter in a metal enclosure (aluminum preferred) with its own earth grounding and run the sensor cable through metal conduit grounded to the enclosure.

These steps may not be completely successful. The interference from the VFD's is both RF (through the air) and noise on the AC line or even on the 4-20mA. line if connected to the flowmeter. It is ultimately up to the user to make the corrections necessary and require that the source of the interference be corrected.

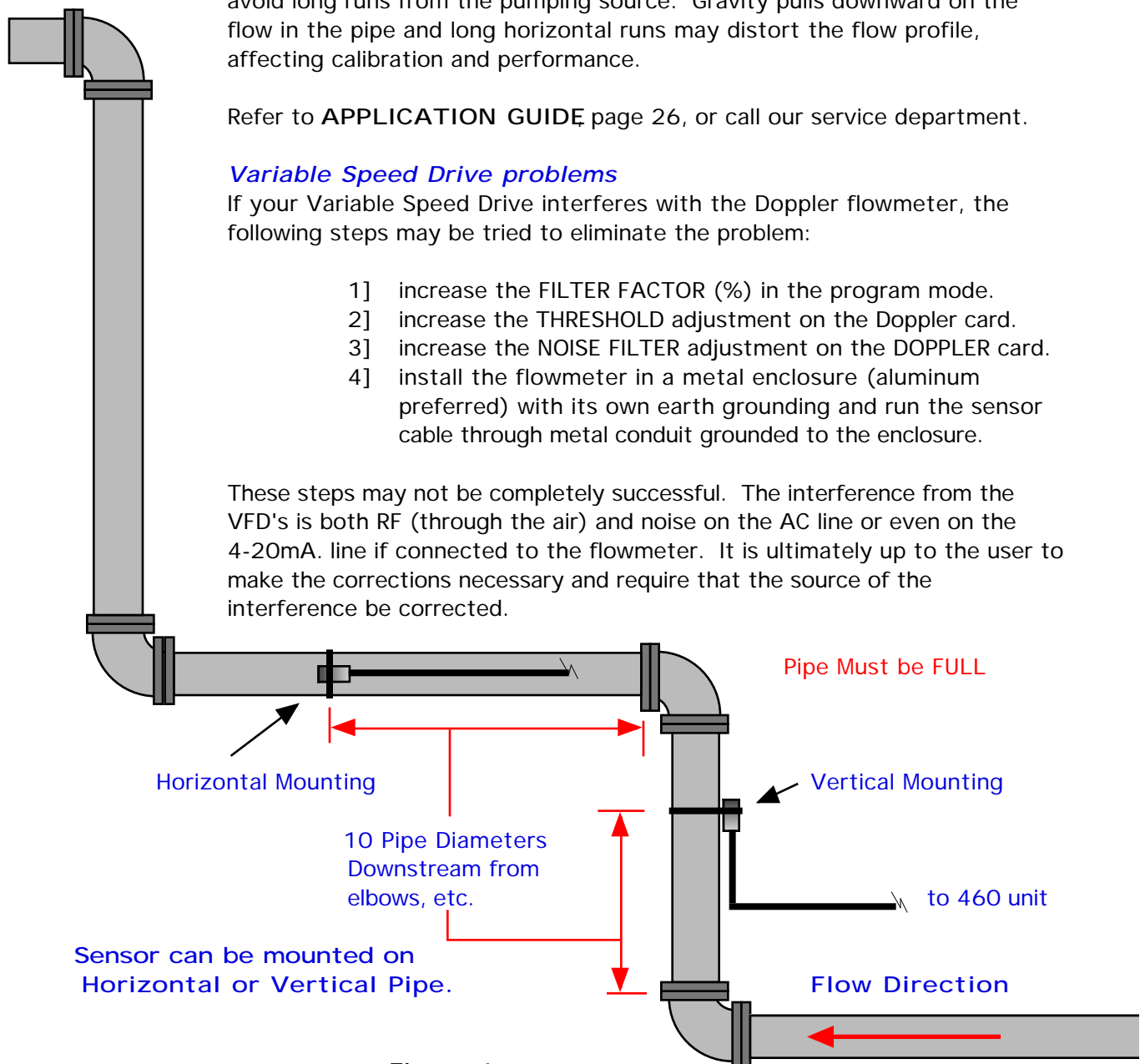


Figure 1.

3. Enclosure Mounting

Once a suitable location has been selected for the controller, carefully screw mount the enclosure as shown in figure 2. Be sure to leave room for conduit entrance to the enclosure. All conduits must enter through the bottom side.

IMPORTANT



AC power is required and should enter through its own conduit (not required if supplied with optional AC power cord). Output signal wires should exit the enclosure through a separate conduit. **All conduit entrances must be made water tight to maintain the NEMA 4X rating.** Failure to make water tight entrances may void your warranty if damage to electronics is caused by water or gases entering into the enclosure. Use electricians putty to plug the conduit entrance to prevent condensation and gas migration.

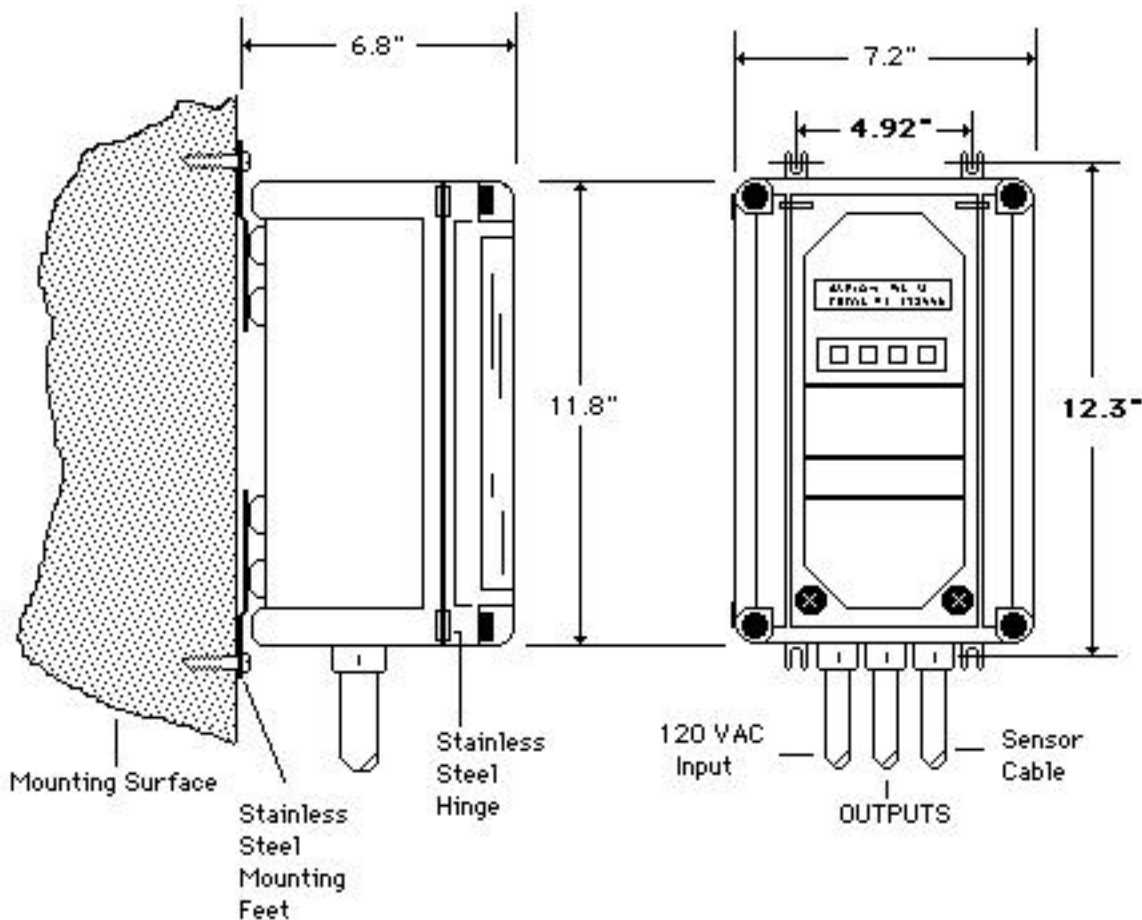


Figure 2.

When punching holes in the enclosure for conduit entrance, protect the electronics circuit card from damage. The circuit card may be removed from the enclosure by first removing the four (4) retaining screws on the Doppler Card, unplugging it from the main circuit board, then removing the four (4) retaining screws on the main electronics board and unplugging the ribbon cable. After the holes have been punched, replace the circuit boards in the enclosure.

GREENLEE punches are recommended for punching holes.

4. Sensor Mounting

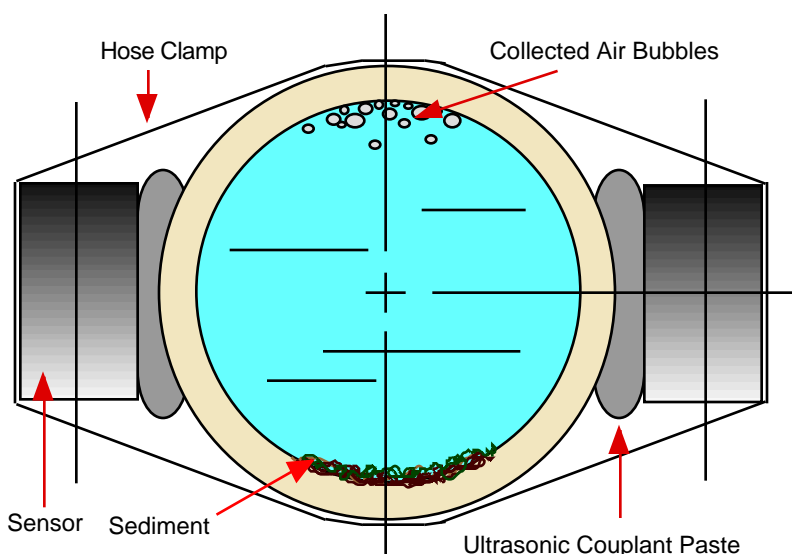
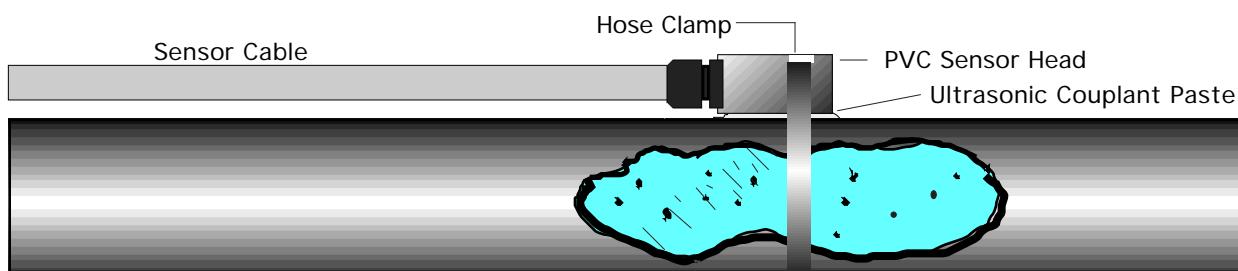
Proper Sensor mounting is important in achieving satisfactory performance from your flowmeter. It is necessary that the Sensor be mounted and oriented properly on the pipe as illustrated in figure 3.

Once a location has been selected, clean thoroughly an area slightly larger than the Sensor head on the pipe, removing all paint, rust, grease etc. On metal pipe, clean down to bare metal. The area selected should be approximately 2 to 4 o'clock or 8 to 10 o'clock on a horizontal pipe.

IMPORTANT

DO NOT mount the Sensor on top or bottom of the pipe. This will seriously degrade the performance of the flowmeter.

Mount the Sensor by first applying a generous amount of couplant paste (supplied) to the Sensor's epoxy surface. Be sure the entire surface is covered. Using a hose clamp or duct tape, fasten the Sensor snugly (do not over-tighten) to the pipe making sure the Sensor's cable is running parallel to the pipe axis. Liquid flow may be in either direction. Remember, most problems with the flowmeters performance can be traced to poor Sensor location and/or mounting.



Sensor Mounting:

1. Do not mount sensor on top or bottom of horizontal pipe.
2. Clean pipe thoroughly where Sensor is to be mounted.
3. Cover entire sensor surface with a thick layer (1/4") of ultrasonic couplant paste.
4. Secure sensor to pipe with hose clamp or other means. (do not over tighten).

DUAL HEAD MOUNTING

Mount Sensors as shown on pipes of 20" or less diameter. For larger pipes, mount sensors at 2 and 3 o'clock position on pipe.

Figure 3.

5. ELECTRICAL CONNECTIONS

SENSOR CABLE

When running the Sensor's interconnecting cable, you must avoid close proximity to AC power lines and other frequency carrying lines. Variable Speed Drives for pumps can create a lot of problems for Doppler flowmeters and should be avoided.

The Sensor cable must enter through the bottom side of the enclosure. Be certain to make a good water tight entrance with the cable to maintain the enclosure NEMA 4X rating. If the cable is ran in conduit, plug the conduit with electricians putty to prevent moisture/gas migration.

Connect the Sensors cables to the four (4) pin terminal barrier strip at the top right of the electronics card in the enclosure. The coax shield to **SHIELD** and the centers to **CENTER** as shown in figure 4. The two cables are identical and interchangeable. Either can be used as the XMITer or RECeiver.

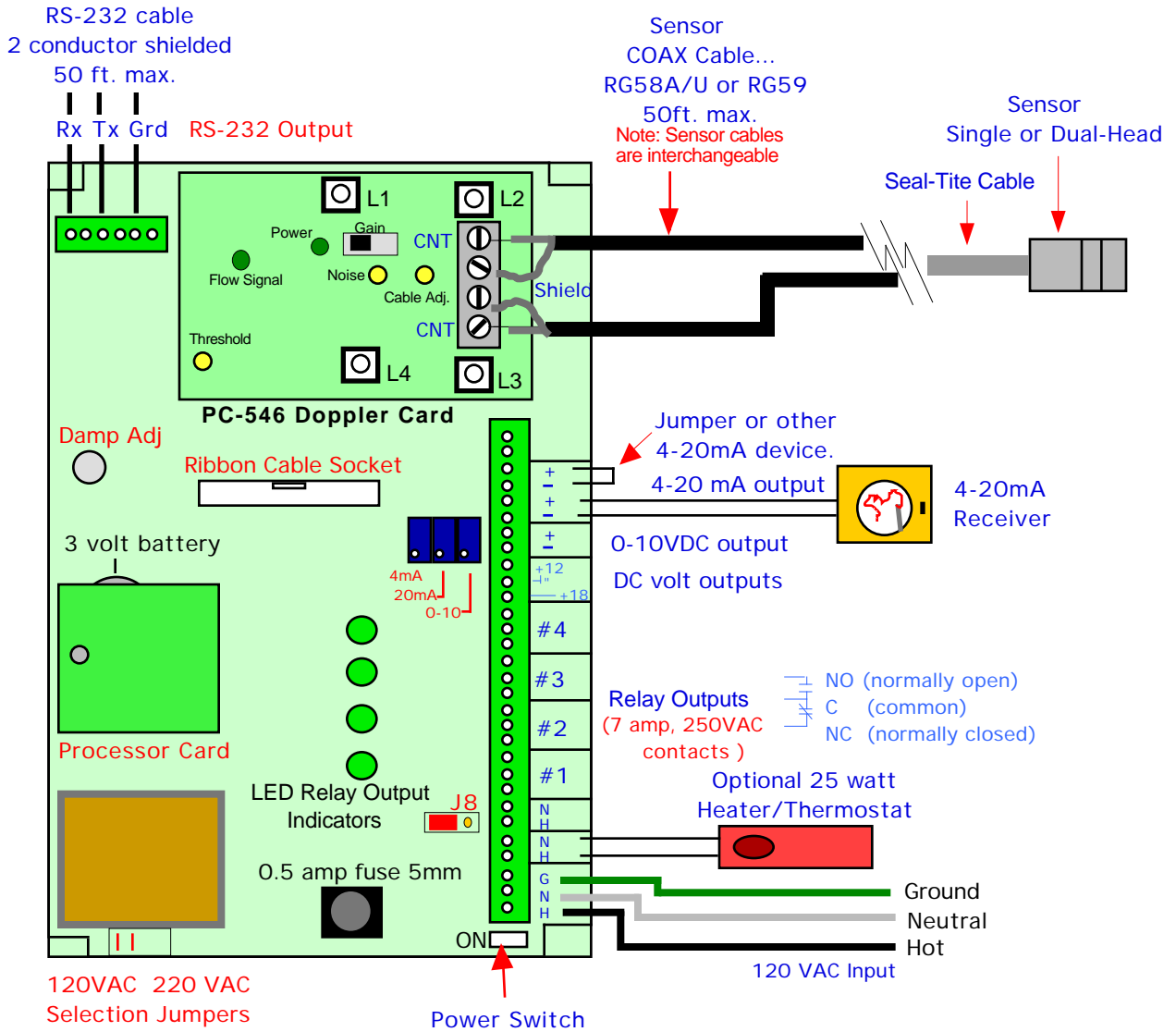
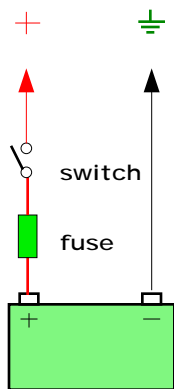


Figure 4.
CPS-460 Wiring Diagram

- 0-10VDC OUTPUT** The 0-10VDC output is used to control setpoint controls, telemetry equipment and other devices that require a voltage input. The voltage output may be scaled for 0-5VDC output or other scale by adjusting the 0-10 Potentiometer adjustment on the main circuit board. Remote connections should be made first before making this adjustment.
- 4-20mA output** The 4-20mA. output is used to control Samplers, setpoint controls, recorders, chlorinators etc. This analog output signal is a FLOATING output (both the '+' and '-' terminals have their potential above system ground) and is DC isolated from electrical ground. The signal output is connected as shown in figure 4. Polarity must be observed through the entire control loop for proper operation. Maximum loop resistance is 700 ohms. 1000 ohms with J8 jumper moved toward terminal barrier.
- RELAY #1, 2 (Setpoints)** Relay #1 and #2 are two independently programmed setpoint outputs used for alarming and control. They are 7 amp, 250 VAC contacts with associated LED status indicators on board.
- RELAY #3, 4 (Sampler/Counter)** #3 and #4 relays are used for pulsing a remote totalizer/counter or for Sampler control. The outputs are dry contacts rated at 7 amp, 250VAC. Closure duration is 250 ms. (milliseconds). #3 relay is considered the COUNTER output and #4 as the SAMPLER pulse output. Both circuits are identical and are interchangeable.
- Note: When selecting 'RELAY' in the VALVE CONTROL FUNCTION, the 'counter' relay is used to close the valve and the 'sampler' relay to open the valve.**
- 120/220 VAC INPUT** 120/220 VAC power should enter through the bottom side of the enclosure in its own committed conduit (not required if supplied with optional AC power cord). Connect AC power to the terminal barrier strip marked AC INPUT. DO NOT allow the AC wires to lay all about in the enclosure. Keep as short as possible. 16/18 gauge wire is preferred over a heavier wire that may put unnecessary stress on the terminal barrier strip.
- AC OUT** This provides a switched VAC power to control an external recorder or other device that operates in conjunction with the flowmeter.
- NOTE: The flowmeter uses a .5 amp 5mm fuse. It may be necessary to increase the fuse rating to accommodate external devices. Max rating should not exceed 3 amps.
- HEATER** This output provides a switched 120 VAC power to the optional 25 watt Heater/Thermostat for cold climates. (120 VAC only).
- SHUT OFF** Contact closure across SHUT OFF will force the Flowmeter to go to ZERO . This can be controlled by a dry relay closure to indicate that the pumps have stopped to eliminate any noise during no flow condition or to prevent monitoring back flow conditions.

+ 12VDC, UNREG DC These inputs/outputs provide DC power for optional accessories or Battery Operation allow for battery operation of the flowmeter.



12V Gel Cell
shown with optional
3 amp fuse and switch

BATTERY OPERATION ONLY

If system is going to operate from a battery only (no AC power), a standard 12 volt gel cell battery (maximum 24 volt) may be connected at this location: the plus '+' of battery to UNREG DC and the negative '-' to (⏏).

BATTERY BACK-UP and AC OPERATION

If battery back-up is desired in the event of a power failure, you may connect a standard 12 volt gel cell battery of approximately 6 amp hour at the +12VDC connection and (⏏) on the terminal barrier. The flowmeter will maintain a charge to the battery when AC power is applied.

NOTE: The power switch on the circuit board does not switch the battery supply. Power is applied as soon as the battery is connected. You may install a switch if desired. Also, the battery is not fused. An in-line 3 amp fuse should be installed.

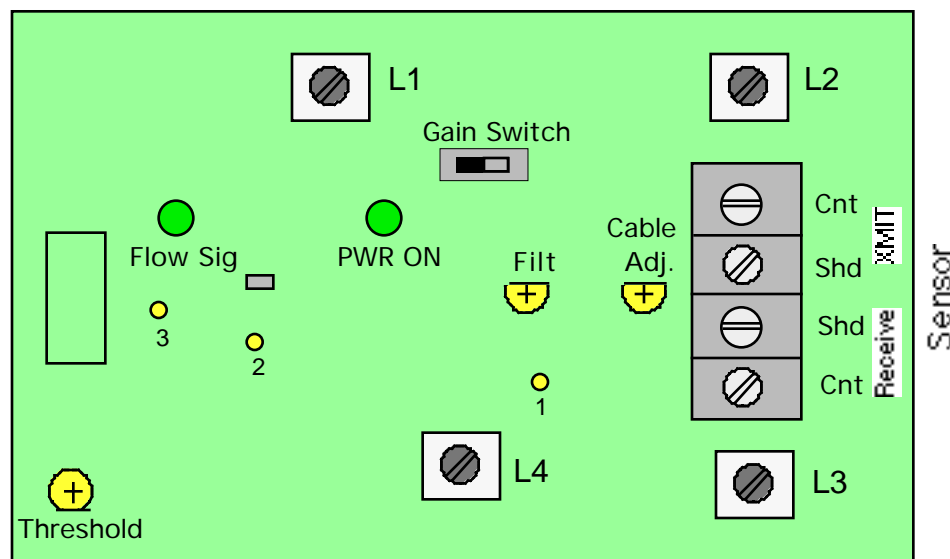
ADJUSTMENTS AND CONTROLS

There are very few adjustments that can be made on the CPS-460 system. Do not attempt to make any if you do not understand their purpose.

1. Doppler Circuit Card PC-546 (see figure 5)

- L1 Coil** Sets the transmit frequency. Approximately 640KHz.
L2 Coil Couples the Transmitter to the transmit Sensor.
L3 Coil Couples the receive Sensor to Receiver circuit.
L4 Coil Tunes the Receiver to the Transmit frequency.
- THRESHOLD** Sets the threshold level for the Doppler Signal. Increase CW slowly if FLOW SIG LED flickers when there is no flow.
- FLOW SIG LED** This LED lights when there is a flow signal. Intermittent flashing indicates poor signal return. The LED should be OFF when no flow.
- NOISE FILTER** This adjustment may be used in conjunction with the THRESHOLD adjustment to reduce problems in noisy applications. Turn CW to increase filtering. NOTE: too much filtering may cause loss of higher flow velocities.
- GAIN SWITCH** Slide switch to ON position. When the flow velocity drops below the LOW FLOW SHUT OFF setting programmed by the user, the system will reduce the GAIN of the receiver to reduce unwanted noise during no-flow conditions. Slide switch to 'right' to defeat this function.

PC-546 Ultrasonic Xmit / Receive Doppler Card



Adjustments shown in their NORMAL position

Figure 5.

2. Main Circuit Board

Refer to Figure 4 for the following adjustments.

- 4 mA.** The 4 mA. adjustment is used to set the 4-20 mA. current output loop to 4 mA. This should be set before the 20 mA. adjustment. This will prevent any apparent interaction of the 4 and 20 mA. adjustments. You can Simulate 0% output using the **TEST ANALOG OUTPUT** feature under **CAL/TEST/.....** mode in the programming to set the 4 mA. output.
- 20 mA.** Adjust the 20 mA. control for 20 mA. output on the 4-20 mA. current output loop. Simulate 100% output using the **TEST ANALOG OUTPUT** feature found under **CAL/TEST/.....** mode in the programming.
- 0-10 VDC** Adjust the 0-10 VDC potentiometer for a scaled voltage output. It is best to have the receiving device connected to the terminal barrier when making this adjustment.
- DAMP ADJ** Adjust clockwise to increase the Analog Output Dampening for steadier chart recordings.
- ON/OFF** Applies AC power to the circuit board and AC out to the HEATER and AC OUT on the terminal barrier. Note: this switch does not control battery if connected.
- 120/220 VAC** Install or remove appropriate jumper(s) to change operating voltage to 120 or 220 VAC.

FRONT PANEL

The keypad on the front panel is used for selecting the various RUN MODE indications and program modes of the flowmeter. When in the RUN MODE, press SELECT button for the display type you want. The 4-20 mA. output is not affected by the selection of any RUN MODE window. Refer to the PROGRAM FLOWCHART on page 16 for navigating through the programming.

The programming of the flowmeter is accomplished by pressing the SELECT button until you are asked if you want to **GO TO PROGRAM MODE?** If you select YES you will be asked to **ENTER YOUR PASS CODE** Enter the PASS CODE using the SHIFT, UP and DOWN buttons. If the wrong PASS CODE is entered, the display will return to the RUN MODES.

Note: The flowmeter leaves the factory with pass code 0000.

Once in the PROGRAM MODES, use the SELECT button to scroll through the various selections, selecting NO/YES where needed. To change any value, use the SHIFT, UP and DOWN buttons. Refer to the PROGRAM FLOWCHART.

LCD DISPLAY

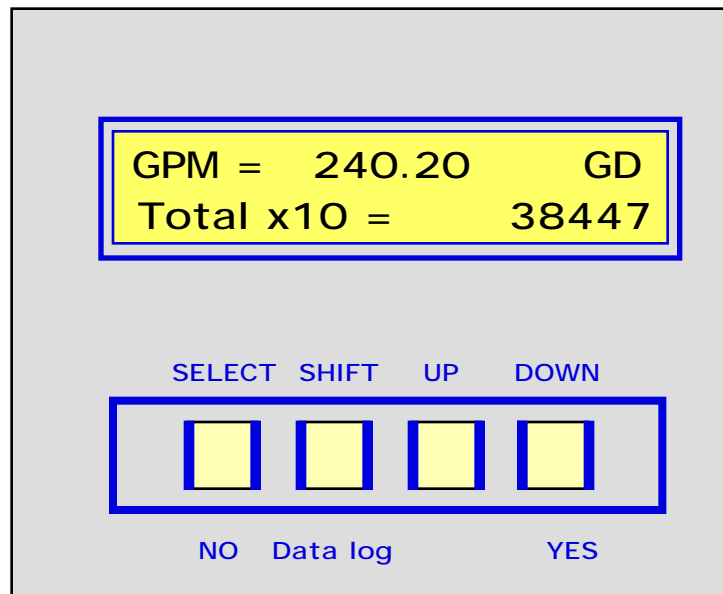
LCD DISPLAY The CPS-460 display is a 2 line, 20 character alpha-numeric display with LED back lighting. All flow information and programming data is indicated by this display.

GPM, MGD Flow rates may be displayed in GPM (gallons per minute) or in MGD (million gallons per day) units.

SIGNAL STATUS The CPS-460 software monitors the Doppler flow signal strength and displays the condition of the signal in the top right hand corner of the display. GD = Good; FR = Fair; NF = No Flow.

TOTALIZER An 8 digit totalizer indicates total accumulated flow to date. The total will be equal to the count showing times the multiplier (i.e. x10). The multiplier may be programmed under the PROGRAM MODE.

TYPICAL DISPLAY AND KEYPAD LAYOUT

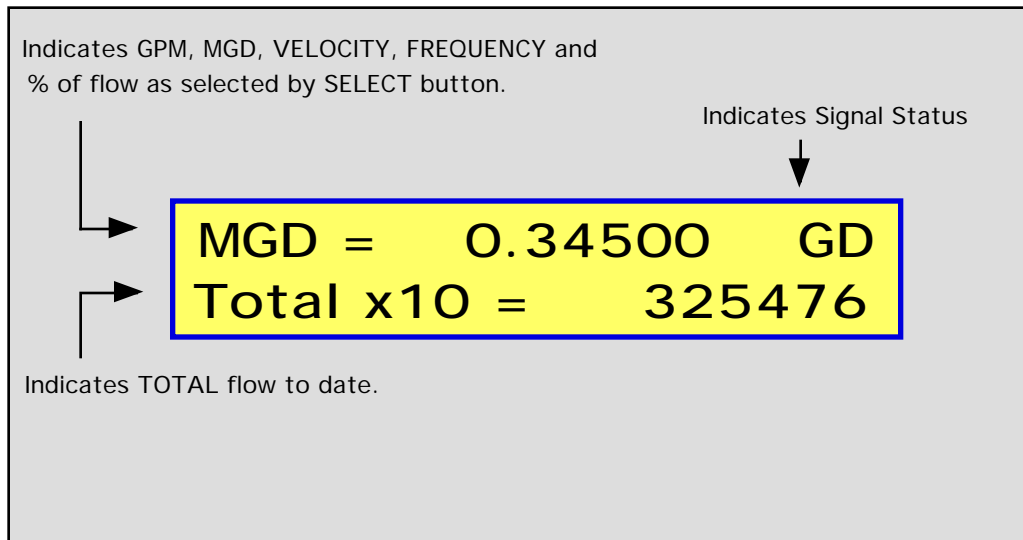


VELOCITY Flow velocity is indicated in Feet/Second in the third RUN MODE display. It is not recommended to monitor flows of less than 1.0 fps ± 0.50 . Flows in this range usually are not Newtonian in nature and cannot be monitored accurately if at all. Velocities of less than 1.0 fps also are inherently poor in signal strength and may be difficult to maintain signal.

FLOW % FLOW % indicates the percent of flow as found on the 4-20 mA. output. The output is scaled by the **SCALE ANALOG OUTPUT** under the PROGRAM MODE.

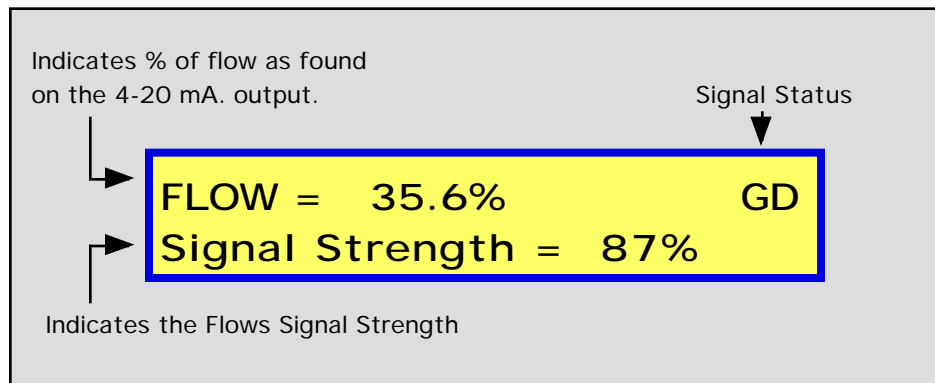
Signal Strength SIGNAL STRENGTH indicates the integrity of the flow signal. Signal Strength of 40% or greater is considered GOOD (GD). Signal Strength of 40% or less is considered FAIR (FR). Though the flowmeter can and will

retrieve and process signals down to 20% of signal strength with good accuracy, it is advisable to try and relocate the sensor for better signal. If the signal strength fluctuates significantly (i.e. more than 30%) try setting the **MEASURE FLOW TYPE** under MISC SETUP to ERRATIC to improve flow processing and display.



Avg FREQ Average Frequency indicates the recovered Doppler frequency shift created by the flow velocity in the pipe.

VALVE CONTROL The CPS-460 has a built-in valve control positioning function. If the user desires to maintain a fixed flow rate by opening or closing a valve, the valve control control function can be turned ON under **SET VALVE CONTROL** in program section. The valve can be controlled by the 4-20 mA. output or by Relay contact closure. The operator can set the valve position manually to the desired flow rate or enter a desired flow rate for automatic control. The valve control window in the RUN MODE will be activated when the Valve Control function is turned ON. The window indicates the GPM flow and whether the valve is 'closing', 'stopped' or 'opening' to maintain the desired flow rate. When the 4-20mA. output is used to control the valve, the percent (%) OPEN is indicated. When in the manual control, the UP and DOWN buttons on the front panel are used to CLOSE and OPEN the valve.



CALIBRATION

GENERAL

All CPS-460 systems are calibrated through the PROGRAM and MISC SETUP modes. The operator first installs the Sensor as described in the manual. Enter the PROGRAM MODE by pressing the SELECT button until asked "GO TO PROGRAM MODE?". Select YES and enter the PASS CODE . Press SELECT to move to the SET FLOW PARAMETERS. You will need to enter the PIPE ID and SCALE ANALOG OUTPUT to calibrate the flowmeter to your application. Enter the inside diameter of the pipe the Sensor is monitoring using the SHIFT, UP and DOWN buttons. SHIFT selects the digit you want to change. The digit selected will have the cursor under it. The UP/DOWN buttons change the selected digits value. Enter the 100% Analog output value (i.e.: if 100% output is to be 500 GPM, enter 00500.00. This scales the 4-20 mA. and 0-10VDC analog outputs. It is also important to verify the TIME and DATE for DATA LOG time stamping. Refer to the FLOWCHART starting on page 15 for detailed information.

SETTING THE ANALOG OUTPUTS

4-20mA.

The 4-20 mA. output can be set by using the TEST ANALOG OUTPUT? function under the CAL/TEST/...mode. Enter the TEST OUTPUT feature and press SHIFT to simulate 0% (4mA), UP for 50% (16mA) and the DOWN button for 100% (20mA). Simulate 0% and adjust the "4 mA." potentiometer adjustment (figure 3) for 4 mA. output. Simulate 100% and adjust the "20 mA." potentiometer for 20 mA. output.

Note: perform the 4 mA. adjustment first to eliminate any interaction between the 4 and 20 mA. adjustments.

0-10VDC

This may be adjusted at any time for any scaled voltage output desired up to 10VDC. Example: if full scale output required is 0-5 VDC adjust the 0-10 trim pot for correct voltage out.

SAMPLER AND COUNTER OUTPUTS

The SAMPLER and COUNT outputs are functionally the same but independently programmable under the SETPOINT/RELAY mode. Example: if you need to sample your flow every 1000 gallons you would program the SAMPLER PULSE RATE for 001000.

If a remote counter needs to be pulsed you would use EXTERNAL COUNT and program the multiplier i.e enter 000100 for x100.

The relay will close for a duration of 250 ms. (milliseconds = 1/4 sec) when the count is reached. The function will automatically reset itself for next count. The relay contacts are dry contact closures rated 7 amp, 250 VAC.

Note: When the VALVE CONTROL function is used with RELAY control, the SAMPLER and COUNTER relays closures control the opening and closing of the valve. The SAMPLER / COUNTER functions are disabled.

ALARM SETPOINTS

The CPS-460 has two independently programmed alarm setpoint outputs. The programming is performed under the **SETPOINT/RELAY** mode. Each alarm has a separate percent ON and OFF setting for differential control of pump ON and pump OFF or valve open/close control etc. The relay contacts are dry contact closures rated 7 amp, 250VAC.

3 VOLT BATTERY (type CR2325)

This battery is for retaining programmed information and keeping the clock running when power is turned OFF. The battery should last for approximately 8 to 10 years under normal operation. Replace the battery if it is over 5 years old and the system fails to start-up after attempting the start-up resets as described in the Program Flowchart page 15-16.

It will be necessary to remove the processor card above the battery. Refer to figure 3. Install a new battery and reinstall the processor card. Start-up the system as described and reset the meter to factory defaults. Proceed to program section and reprogram the flowmeter and setting the clock. The reset to factory defaults may need to be repeated 2 or 3 times to clear the memory properly.

Using The CPS-460 FLOWCHART

OPERATING INSTRUCTIONS

When power is first applied, the CPS-460 flowmeter will run through its POWER-UP windows. It should display a greeting informing the user that the settings have not been changed; a request that the user should read the instruction manual; the software revision number, copyright notice and manufacturers name. The process takes a few seconds and will then enter the RUN MODE. The flowmeter will display the window that was selected prior to turning power 'OFF'. To select or scroll through the RUN MODES, use the SELECT button. Each press of the SELECT button takes you to the next window. Selecting any of the RUN MODES will not affect the 4-20 mA. output or any of the programmed settings. The flowmeter begins monitoring flow automatically.

To enter the **PROGRAM MODE**, press the SELECT button until asked **GO TO PROGRAM MODE?** Press 'YES'. You will be asked for the **PASS CODE** before you can enter into the **PROGRAM MODES**. The pass code is 0000 when it leaves the factory and will remain this until you change it. Press SELECT. If you like to change the code at this time, use the SHIFT, UP and DOWN buttons to enter your new pass code then press SELECT. This stores your new code. You now have access to the program section. If the incorrect pass code is entered, you will be returned to the RUN MODE.

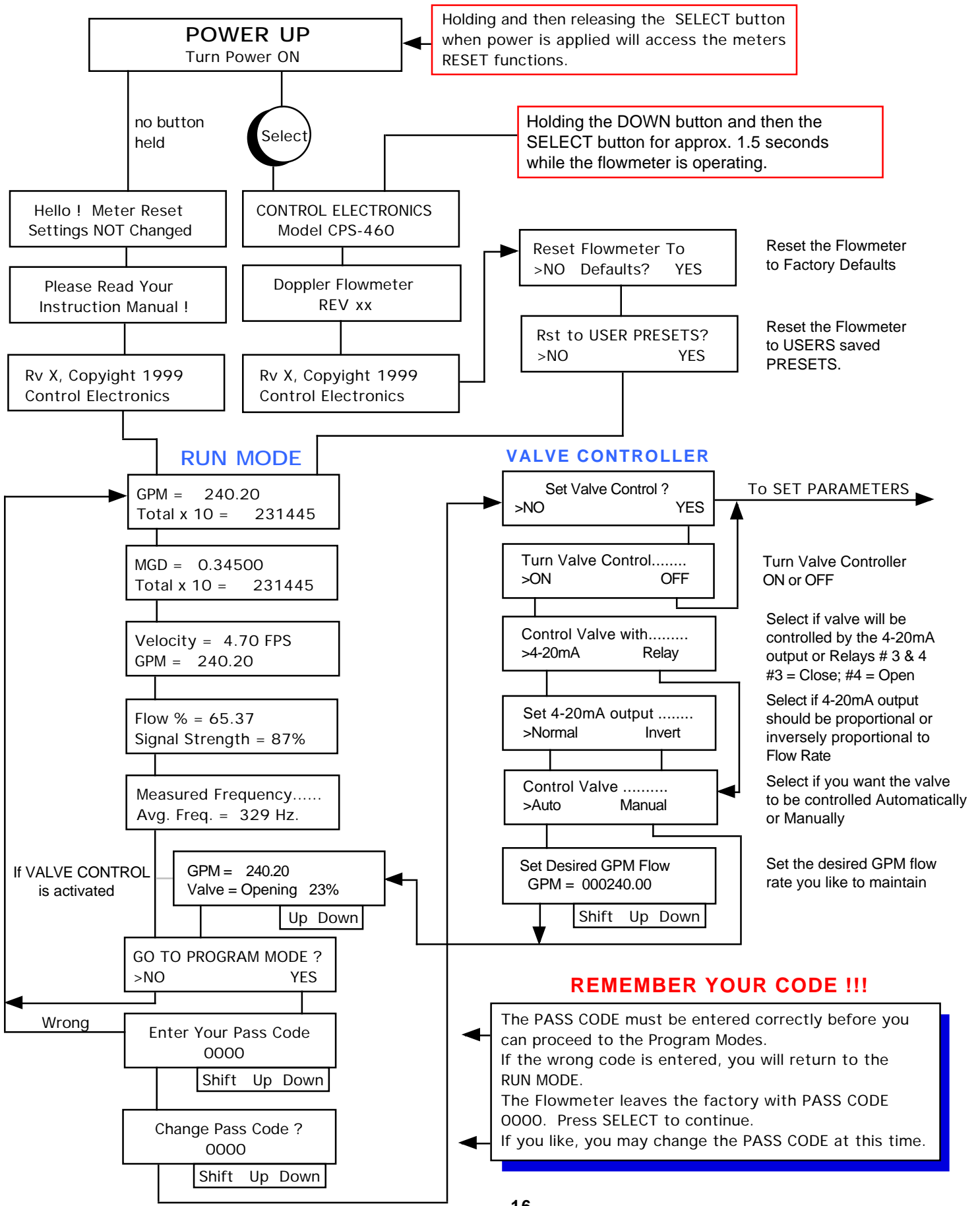
Once you entered the **PROGRAM MODE** you can scroll through it by pressing the SELECT button. The SELECT button performs three functions: 1] NO, 2] ENTER and 3] NEXT WINDOW. Use the SHIFT, UP and DOWN buttons to change the values in each window as needed. The DOWN button is used to select YES when data values are not displayed.

RESETTING THE FLOWMETER

If the SELECT button is held when power is applied, then released, the user will have access to the flowmeters reset functions. The user may reset the flowmeter to factory defaults. This reset will set the pass code to '0000'. The user may also reload the saved **USER PRESETS** for quick resetting/programming of the flowmeter (provided the user **SAVED** the settings when prompted to in the programming). This function can help recover from a processor crash or lock-up. Both of these resets do not affect the totalizer or data log. The user may proceed to resetting the totalizer and /or data log in the **PROGRAMMING** section.

IF THE FLOWMETER SHOULD LOCK-UP or CRASH

It is possible that the flow of the program may be interrupted by some external event such as lightning, testing back-up generators or some other anomaly on the AC or Sensor input that may cause the flowmeter to crash or lock-up. Turning power OFF and waiting approximately 10 seconds before turning the meter back ON may correct/unlock the meter. If not, it may be necessary to perform a **RESET** using the SELECT button mentioned above. Resetting to factory defaults is considered a hard reset and it will be necessary to reprogram the meter after this reset. Resetting to **USER PRESETS** is preferred. You can first do a **FACTORY DEFAULT** reset and then a **USER PRESETS** if you like. You should not need to reset the totalizer or data log.



Holding and then releasing the SELECT button when power is applied will access the meters RESET functions.

Holding the DOWN button and then the SELECT button for approx. 1.5 seconds while the flowmeter is operating.

Reset the Flowmeter to Factory Defaults

Reset the Flowmeter to USERS saved PRESETS.

Turn Valve Controller ON or OFF

Select if valve will be controlled by the 4-20mA output or Relays # 3 & 4 #3 = Close; #4 = Open

Select if 4-20mA output should be proportional or inversely proportional to Flow Rate

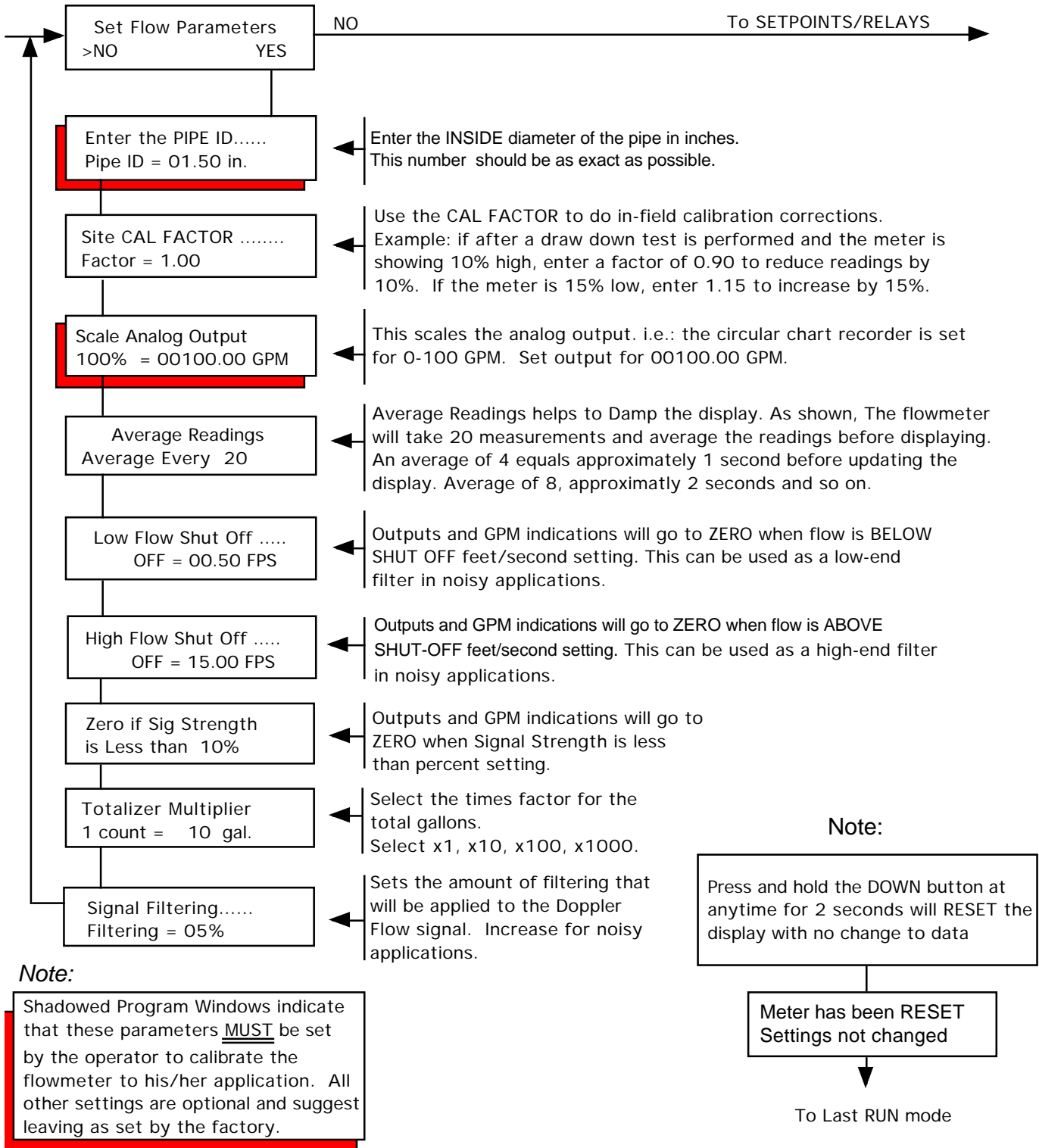
Select if you want the valve to be controlled Automatically or Manually

Set the desired GPM flow rate you like to maintain

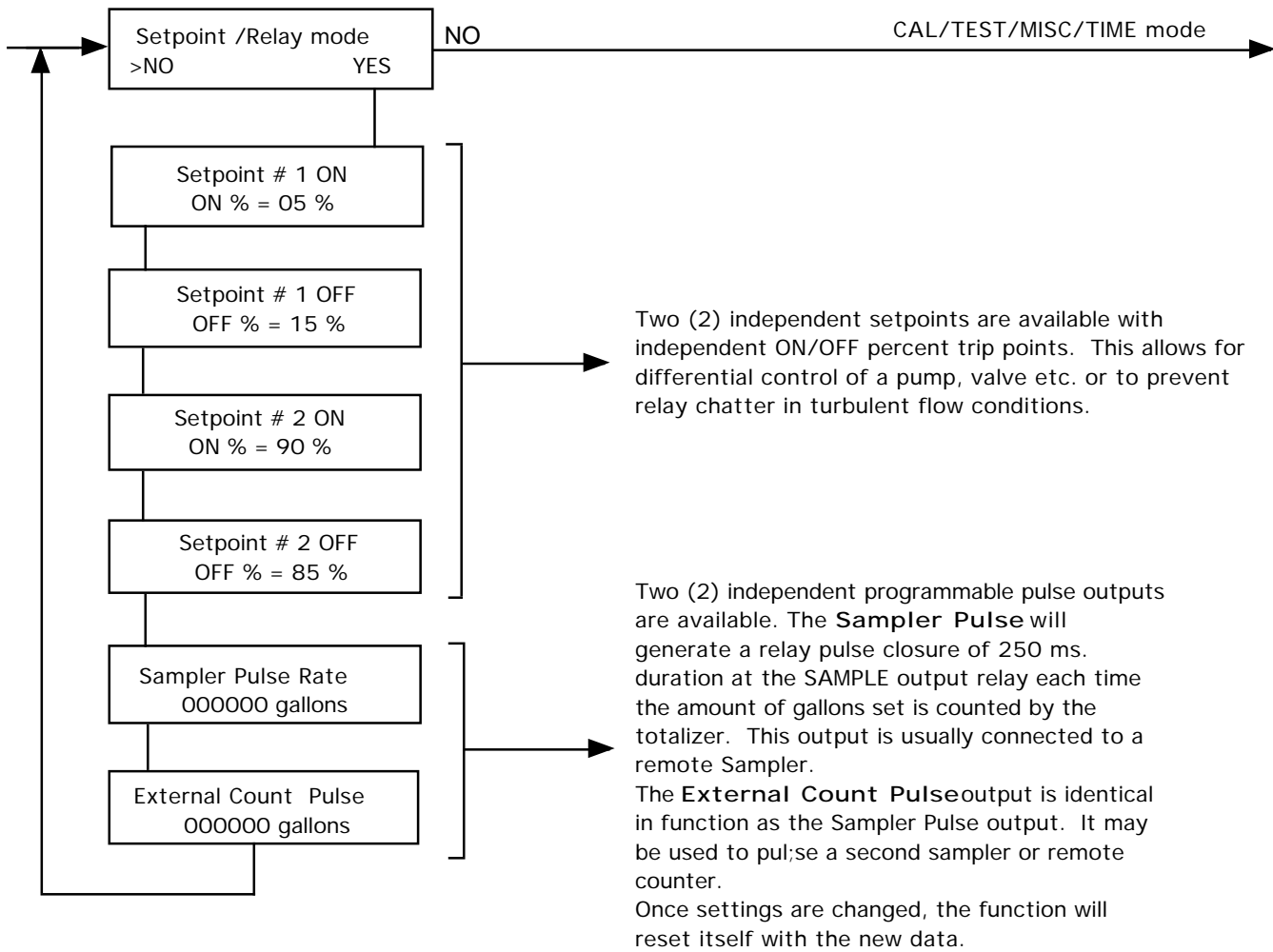
REMEMBER YOUR CODE !!!

The PASS CODE must be entered correctly before you can proceed to the Program Modes. If the wrong code is entered, you will return to the RUN MODE. The Flowmeter leaves the factory with PASS CODE 0000. Press SELECT to continue. If you like, you may change the PASS CODE at this time.

PROGRAM MODE



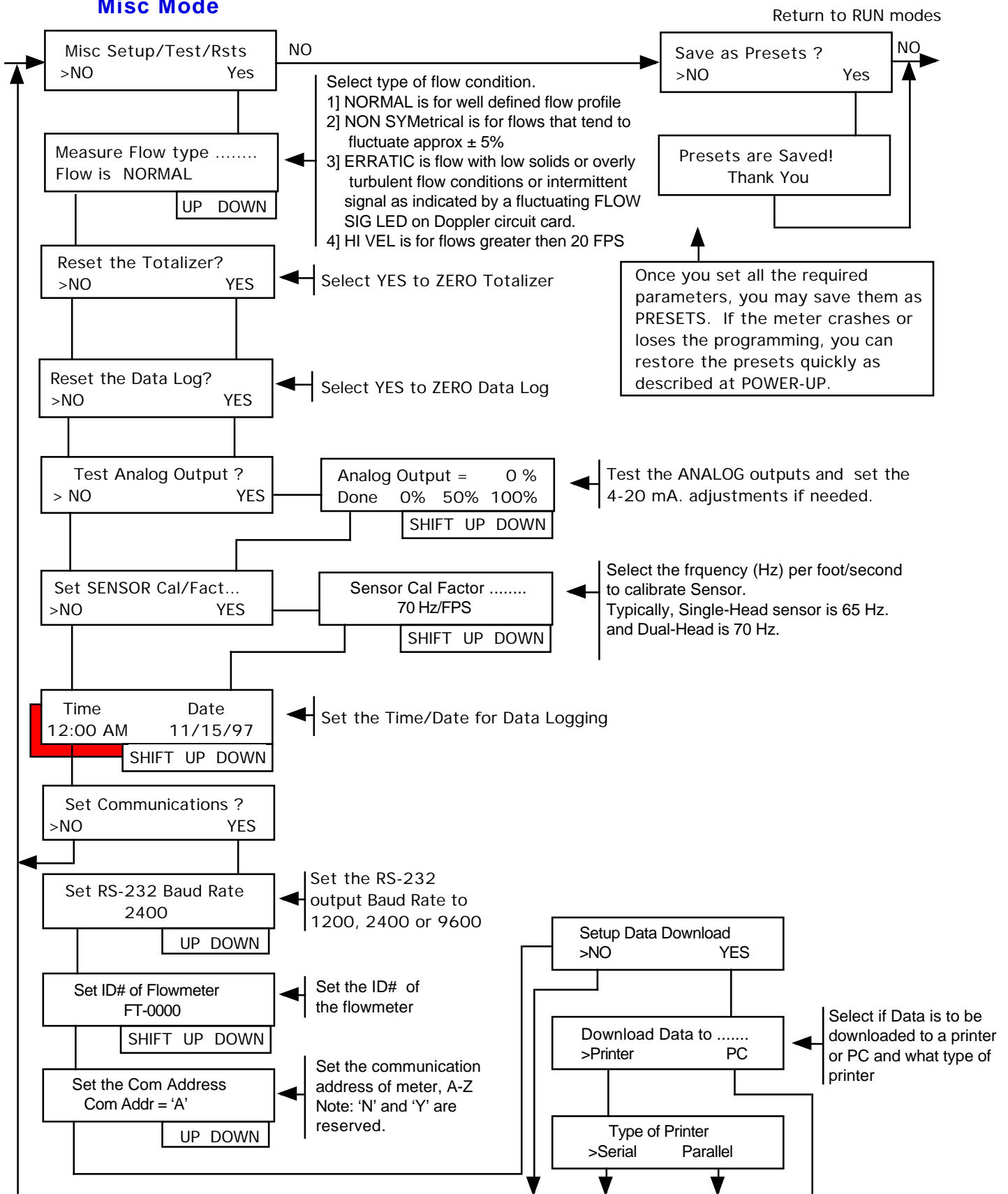
SET POINT MODE



NOTE:

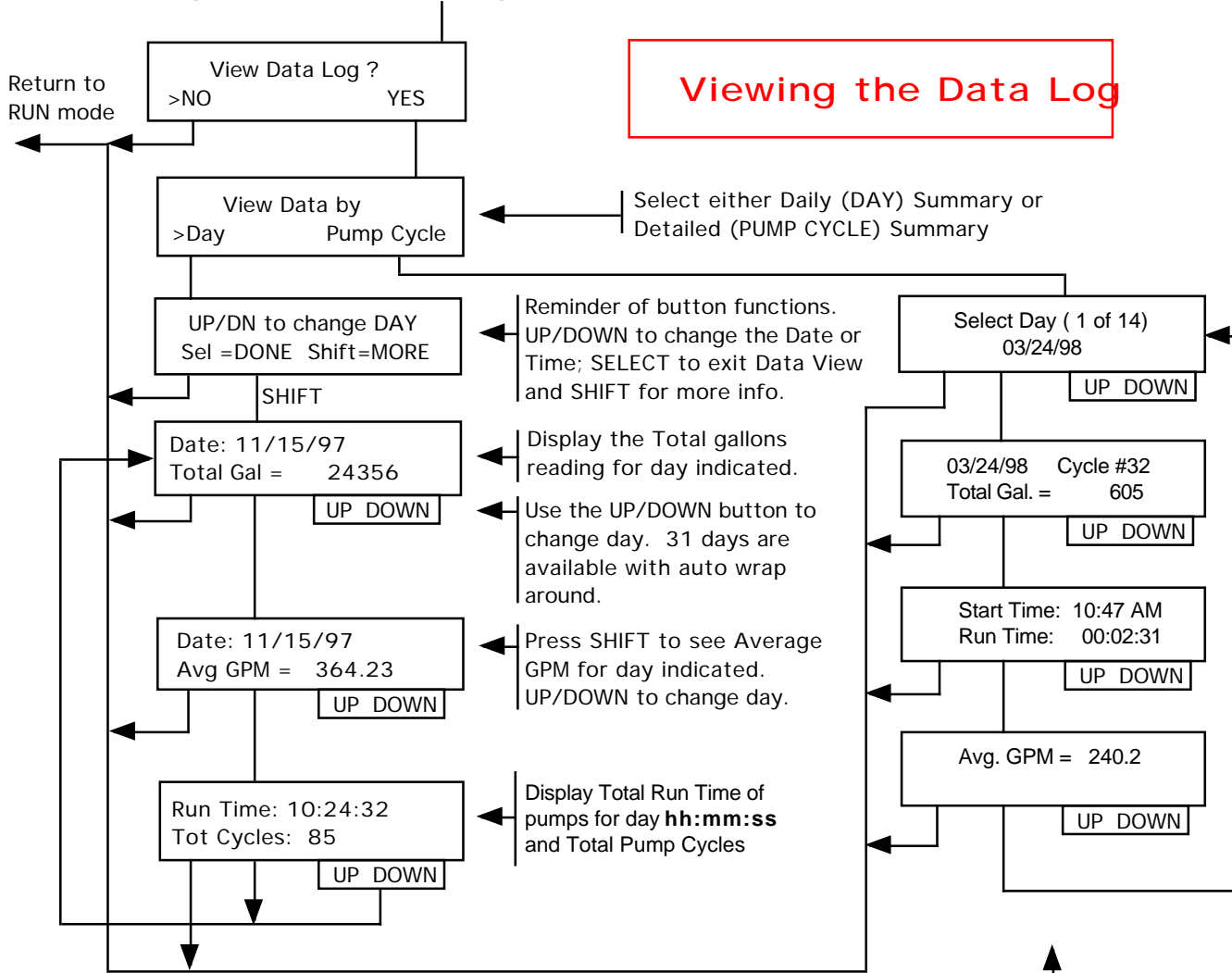
If the VALVE CONTROL function is activated, the COUNTER and SAMPLER outputs will be disabled. The COUNTER relay will be used for CLOSING the valve and the SAMPLER relay will be used to OPEN the valve. Once the VALVE CONTROL is disabled, the COUNTER and SAMPLER functions will be enabled again.

Misc Mode



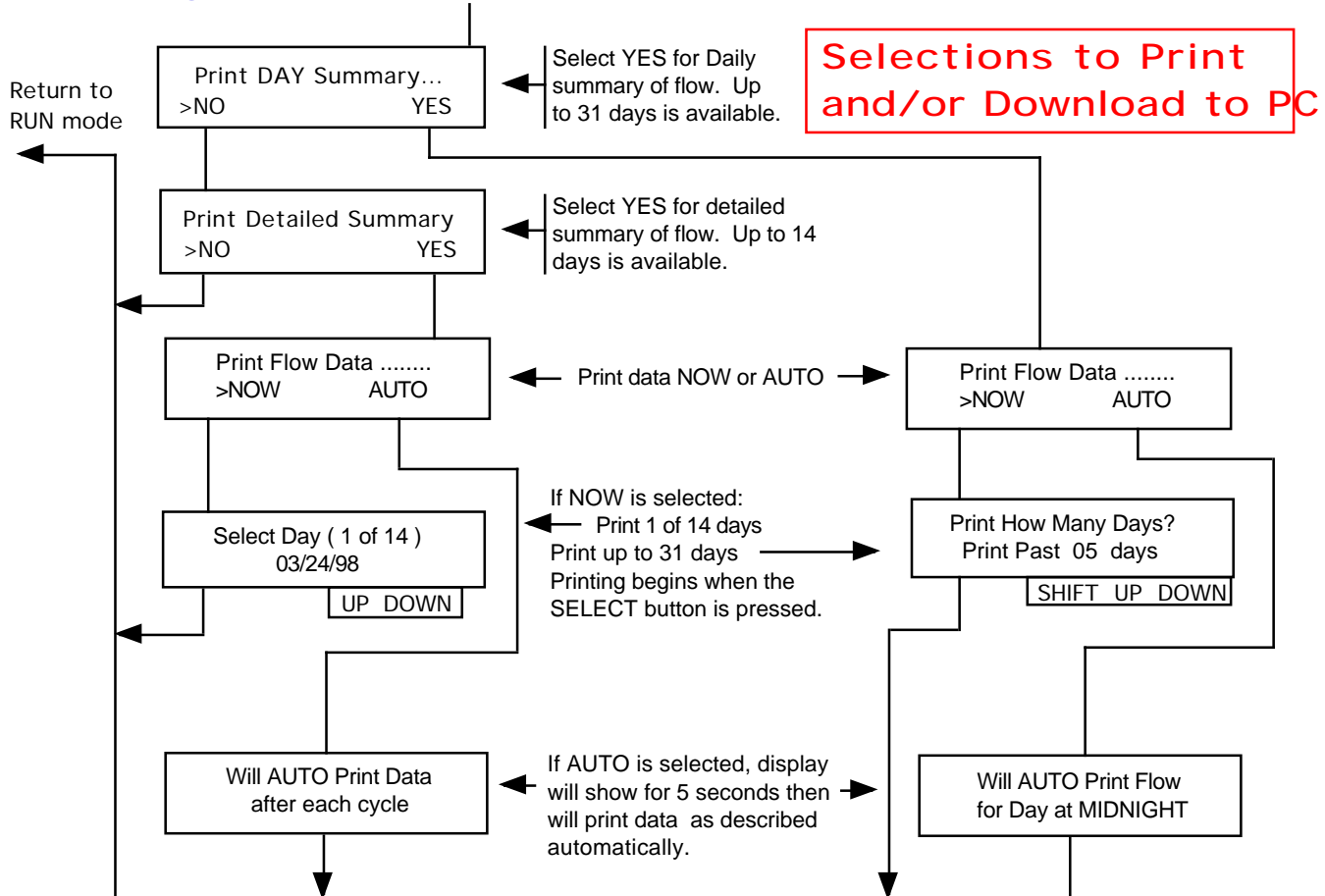
Pressing SHIFT (Data Log) while in RUN mode

Viewing the Data Log



Selecting PUMP CYCLE allows a more detailed viewing of the day selected. Use the UP/DOWN buttons to select the day and to select the pump cycle for that day. As shown, the day selected is March 24, Pump Cycle #32; Total gallons pumped was 605; Pumping began at 10:47 in the morning; Duration of pump cycle was 2 minutes and 31 seconds; Average GPM pump rate was 240.2 GPM.

Pressing UP button while in RUN mode

**NOTE**

- 1] You must first set-up communication parameters under MISC SETUP / TEST / RST section of program before printing data.
- 2] keypad is disabled when printing starts. Hold the DOWN button for 5 seconds to interrupt printing.

Making your selections then pressing the SELECT button will begin the printing or downloading to a PC. Connect your PC to COM 1 and the RS-232 output on the flowmeter for downloading. The CPS-460 will download data in the selected ASCII format to any standard communication package such as Microsofts HYPER-TERMINAL in WINDOWS 95/98. Data may be captured to file, printed out or imported into a spread sheet for graphing and analysis.

Using the RS-232 Communication Output Port

The Operator may choose to communicate with the flowmeter using their PC or Laptop computer in order to download the logged data for further viewing and analysis. This may be accomplished by using any standard communication software package such as WINDOWS HYPER-TERMINAL, PROCOM etc. All data downloaded is in ASCII format. Each line of data is terminated by a CR (carriage return) and line feed. Downloading of flow data may be initiated from the flowmeter using the PRINT functions (see FLOWCHART page 21) or by the PC / Laptop computer. Connect your communication cable to the RS-232 terminal barrier as indicated (see page 28).

In order to successfully download data by either method, you must first match the communication settings in both the flowmeter and the PC. The flowmeter sends data in one of three baud rates - 1200, 2400 (default) or 9600 baud. The baud rate is set in the flowmeter by the user under the CAL program section. You may set the flowmeter ID# at this time and whether data will be sent in SERIAL or PC format (required if you are going to initiate downloading from the flowmeter only).

If you like to save the data to a file, you must first set your communication software in the PC to 'begin capture'. (See your PC/software owners manual for assistance). It is not necessary to 'capture' the data if you only want to view it on the PC/Lap top. You may set the 'begin capture' after the initial 'MENU' has been downloaded.

PC's Communication Settings

You should set the PC parameters to match the flowmeters baud rate, no parity, 8 bit, 1 stop bit, XON/XOFF disabled. (i.e. 2400,N,8,1)

Serial Output (printer Only)

This mode is used to send data to a serial printer and is fairly slow, because a 3 second delay is performed by the flowmeter for each line sent to allow the printer time to print the line. Be sure to set the serial printers baud rate to match the flowmeters. Use the Tx connection on the RS-232 terminal barrier, not the 'serial' output connection.

NOTE: The 'serial out' on the terminal barrier is for factory use only. Do not use for communications.

PC Output

Use this selection to download to a PC/Laptop.

To Initiate Downloading from the Flowmeter: _____

Use this method if your PC software does not support 2 way communication.

Select the PRINT function on the flowmeter (press the UP button while in the RUN modes) and select data type to send. i.e. 31 day summary or individual detailed entries.

Once download begins, it will continue until completed or interrupted by holding the DOWN button for 2 seconds.

Once data has been downloaded and 'captured' to file, you may import it into a spread sheet for graphing and analysis or reformat the data in a word processor for printing etc.

To Initiate Download from a PC or Laptop:

Communication is kept simple. Connect the communication cable to the RS-232 connector on the PC board . Open your PC communication software (i.e. HYPER-TERMINAL), then:

- 1] type an upper case 'A' (= com addr as set by user)to get the flowmeters attention .
- 2] Flowmeter should respond with a greeting, model number and a short menu.

```
Hello!
CPS-460 Doppler Flowmeter
Enter Download Selection Type....

    1] 31 Day Daily Summary
    2] 14 Day Detailed Summary
    3] Auto Detailed Data Entry
    4] Terminate Auto Data Entry [#3 above]
    5] Terminate Communication
    6] Reset the Data Log
Hit ENTER to interrupt Download Selection number 2.

Your Choice .....
>
```

Once communication is established, you may select type of download by typing the number of the selection.

- Selection 1:** will download the past 31 day flow summary with DATE, TOTAL PUMP CYCLES, TOTAL RUN TIME, AVG GPM, and TOTAL GAL for each day.
- Selection 2:** Will download the past 14 days of detailed flow data with DATE,PUMP CYCLE#, START/RUN TIME, AVG GPM and TOTAL GAL for cycle.
- Selection 3:** allows the PC to capture the data as it is logged. This allows monitoring each pump cycle as it occurs. Once it begins, communication is suspended until a data stream is sent. The keypad is enabled at this time. Data will be sent at the end of each pump cycle.
- Selection 4:** will terminate selection number 3, but only after you obtain the flowmeters attention once again by typing an upper case 'A' and ENTER.
- Selection 5:** terminates communication.
- Selection 6:** Resets the Data Log and terminates communication.

Please note:

- 1] while the flowmeter is downloading data, the flowmeters keypad is disabled except for the DOWN button which will interrupt the downloading if held for 2 seconds. The flowmeter continues to monitor and total the flow during communication and downloading to a PC.
- 2] Press 'SPACE' bar at any time during selection 2 above to interrupt the download.
- 3] All downloads begin with the most recent data.
- 4] All downloads begin with a header indicating model number, ID number, date and type of download.
- 5] Once the flowmeters 'attention' has been acquired, the user has approximately 2 minute to respond or the flowmeter will automatically terminate communication. This is to prevent communication port lockup and flowmeter keypad lockup.
- 6] The optional RS-485 output allows communication with the flowmeter up to 4000 feet away and networking. It does require that the receiving end has an RS-485 receiver.

Application Guide Lines For The CPS-460 and 460P Doppler Flowmeter

Doppler Flowmeters are designed to monitor liquid flows containing suspended particles (solids) or entrained air/gas bubbles. Flow velocities, of which the suspended solids will represent, should be in the range of 0.50 to 30.0 fps (feet/second). The flow should be Newtonian in nature with a well defined flow profile for best results. Reynolds numbers greater than 4000 are preferred and is considered a turbulent flow. Flows with less than 4000 Reynolds numbers are considered to be in a transitional condition from turbulent flow to laminar flow (flows of less than 2000 Reynolds number). This usually occurs at low velocities (below 2.0 fps) and can have an affect on both accuracy and retrievability of the flow signal. In the absence of sufficient solids, an aerator device may be used to introduce gas/air bubbles into the flow for improved performance.

Liquid Characteristics

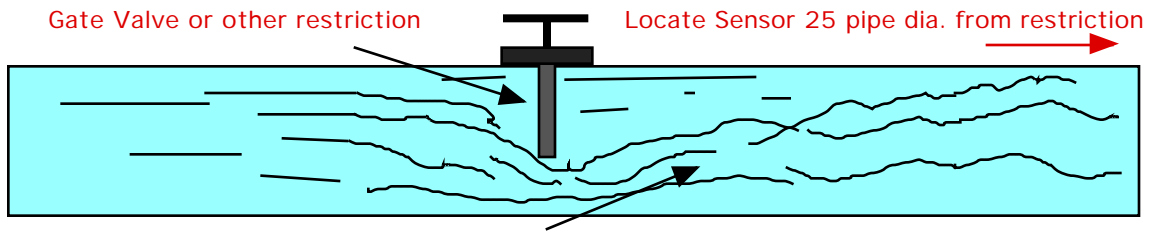
Requirements for best performance are:

- 1] Uniform distribution of suspended particles or gas/air bubbles. Particles/bubbles that tend to accumulate in pockets may cause significant flow errors. This type of flow may be considered non-symmetrical or ERRATIC and require that the user select NON-SYMetrical or ERRATIC flow type under MISC SETUP mode in the 460's program.
- 2] Flow should be Newtonian for best results. Non-Newtonian flows may not be measurable. Non-Newtonian flow is a flow in which a non-linear relationship exists between the applied shear stress and the rate of liquid deformation.
- 3] Suspended colloids (non-Newtonian) may not be measurable.
- 4] Suspended particles such as starches or powders may not be good sonic reflectors resulting in poor (erratic) operation. Select ERRATIC flow type under MISC SETUP for this condition, provided you are receiving a flow signal.
- 5] Dissolved solids are not acceptable.

Problem Areas

Some things to consider and avoid when selecting a site for sensor mounting.

- 1] Low suspended solids in the liquid reduces the amount of sonic reflectors. This is the case with potable water, well water etc. The sensor may have to be located such that the sonic wave is reflected by flow disturbances such as swirls, shear pressure points, vortices etc., created by flanged connections, fully opened valves, elbows, tees etc. Generally the flowmeter will require an in-field calibration 'correction factor' be programmed in the system, but only if you can establish a repeatable flow signal. This type of application is not considered good.
- 2] Avoid venturies, partially closed valves and reduced pipe sections. These cause restrictions to the flow and will increase the flow velocity in their vicinities, causing significant volumetric errors.



Increased Flow Velocity caused by gate valve or other restriction will cause volumetric errors if flow is monitored in the vicinity of the restriction.

Note: In liquids with low solids (less than 75-100ppm), it may be necessary to find a sections of pipe that creates disturbances/turbulence in the flow in order to retrieve a useful flow reading. Finding a good location on the pipe under these circumstances may require some trial and error. In general, it will be necessary that the sensor be located several pipe diameters from the source of the disturbance to allow some diffusion of the disturbance in the flow stream.

- 3] The greater the amount of noise in an application (mechanical and/or electrical) the more solids/bubbles required in the liquid to maintain a good flow reading i.e. good signal-to-noise ratio.

Pipe Considerations

- 1] Pipe must be acoustically compatible. It must allow the high frequency transmit and return signal to pass through the pipe wall and into the flow stream.
- 2] Liner materials tend to insulate and attenuate the ultrasonic signal. This may make it difficult to acquire a flow signal.
- 3] Deposits on the inside pipe wall (i.e. calcium, rust etc.) will both tend to block the flow signal and decrease the pipe ID causing volumetric readings to increase.
- 4] Some liners such as coal tar can result in erroneous readings due to sonic refraction. A calibration factor can be entered in the program to correct under this condition.
- 5] Pipe should be homogeneous. Any breaks in liners or change in pipe wall materials may prevent flow readings from being made.

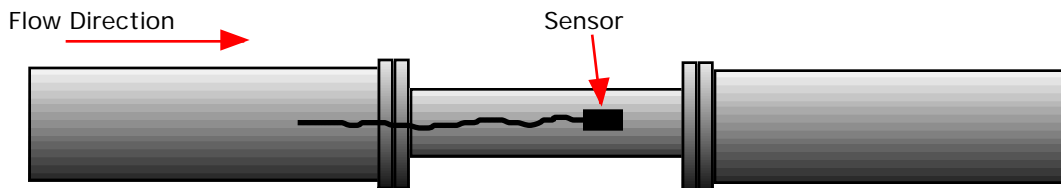
ACCEPTABLE PIPE MATERIAL

GOOD	OK	PROBLEM
Carbon Steel PVC Stainless Steel Aluminum Ductile Iron	Brass Fiberglass Rigid Plastic Cast Iron Concrete Lined*	Flex Tubing Sleeve Liners Copper Concrete Some Liners

*note: concrete lined pipes can be unpredictable

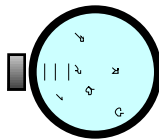
Measuring Site Considerations

- 1] Piping meets above criteria.
- 2] Measuring point and controller should be located to accommodate the cable length. No attempts should be made to lengthen the sensor cable.
- 3] Site location should avoid potential interference from AC motors, variable speed drives, transformers, radio transmitters (antennas), valves or other restrictions.
- 4] Sensor mounting point should be easily accessible.
- 5] Sensor location should provide at least 10 pipe diameters of straight run. Shorter pipe runs may work fine but may require an in-field calibration by programming a 'calibration factor'.
- 6] Low solids in the flow stream may require moving the sensor closer to elbows or other flow disturbances to acquire a flow reading.
- 7] Mount the sensor on the reduced pipe section when different pipe size sections are encountered.

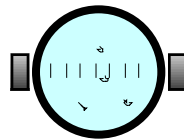


- 8] Mount the sensor at a 3/9 o'clock position on a horizontal pipe (does not apply to vertical pipes). Dual-Head sensors mount across from each other on same horizontal plane. When the pipe size is greater than 12 inches, the sensors may need to be mounted on the same side of the pipe at a 2 and 4 o'clock position.

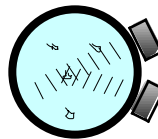
Sensors On Horizontal Pipe



Single-Head
Sensor

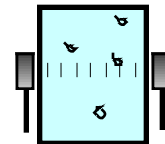


Dual-Head Sensor
under 12" pipe



over 12" pipe

Vertical Pipe

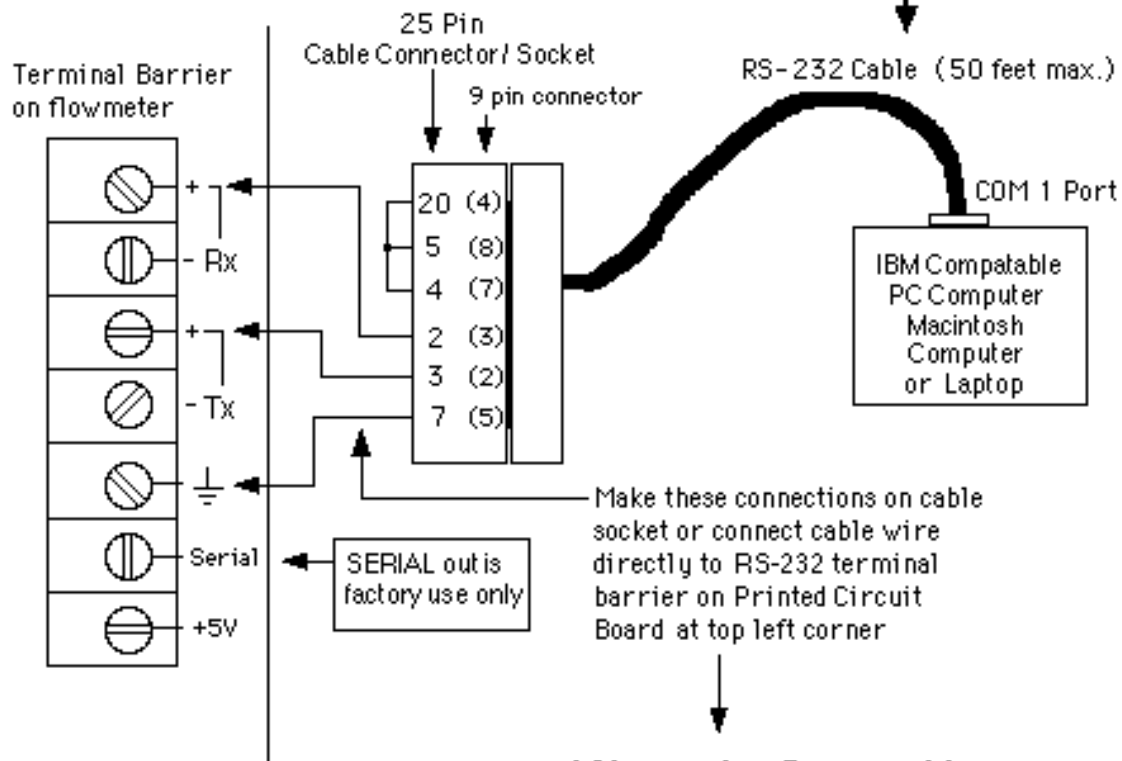


Dual-Head Sensor

- 9] Choose a section of pipe that is always full. Empty pipes can be noisy and partially full pipes with flow will yield erroneous volumetric readings.
- 10] Mount the sensor using the supplied couplant paste. A generous amount should be used to fill all the gaps between the sensor surface and the pipe wall. Use a metal hose clamp (permanent) or duct tape (temporary) to secure the sensor to the pipe. DO NOT over tighten. Silicone grease, lithium grease or zinc oxide may be used as an alternative couplant paste.

Read Your Instruction Manual!!

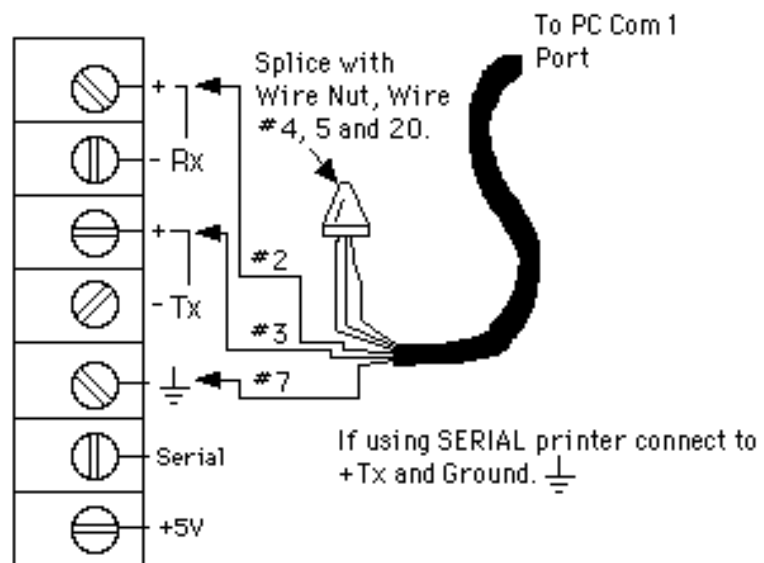
If your software supports 2 way communication, type an upper case 'A' then ENTER to get the flowmeters attention.



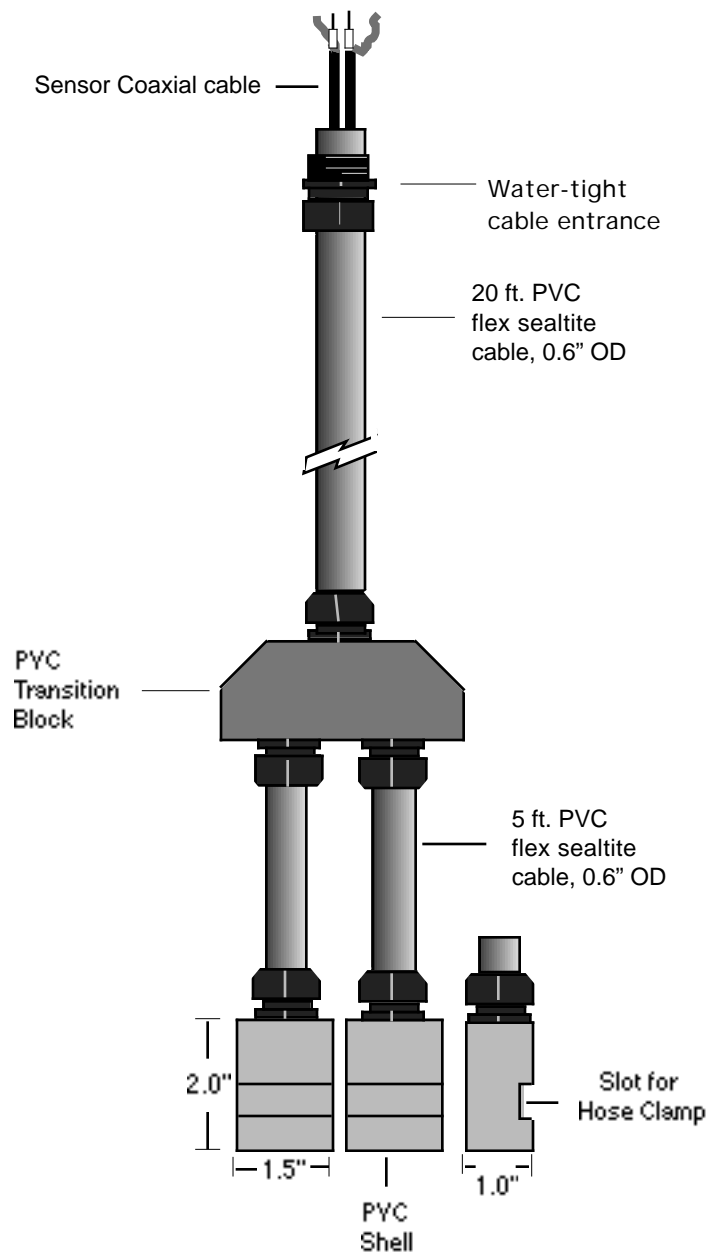
Important

Make sure the PC's COM port matches the flowmeters baud rate setting, typically 2400 baud, no parity, 8 bit, 1 stop bit, XON/XOFF disabled. Flowmeter will download data to any standard communication package as found in WINDOWS 98 HYPER-TERMINAL, PROCOM or Macintosh CLARISWORKS and APPLEWORKS etc. Download is in ASCII format and may be saved to file or imported into a spread sheet for analysis. Any PRINT function as selected will download data directly to a PC or Macintosh computer on demand or automatically.

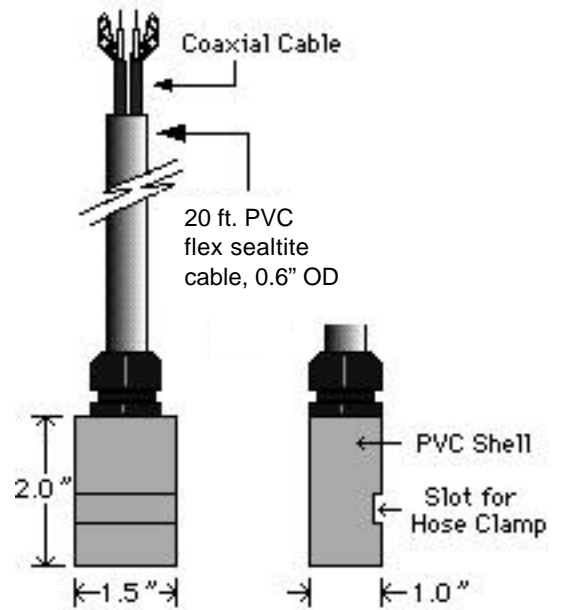
Alternate Connection



RS-232 Wiring Connection



DUAL-HEAD DOPPLER SENSOR



SINGLE-HEAD DOPPLER SENSOR

CPS-460 Ultrasonic Doppler Sensors