ACCUSONIC®
TECHNOLOGIES

7720 Series Flowmeter
Technical Reference Manual

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Accusonic Model 7720 Flowmeter

CUSTOMER SPECIFIC DRAWINGS - FP-

OPTIONAL INTERFACES SUPPLIED

- **Power Supply**
  Voltage   90 to 250 V a.c. 47 to 63 Hz,   or 100 to 300 V d.c.

-
- **Signal Filters**
  Transducer Frequency   1 MHz , 200 kHz and 500 kHz

- **Analog Inputs**
  Number   4
  Load resistance   100 Ω
  Power supply   +24 V d.c.

- **Analog Outputs**
  Number   4
  Type   Isolated
  Maximum load   1000Ω

- **Relays   Optional**
  Number   9 max
  Type   SPDT

- **Heater**
  Voltage   Optional

- **Internal Data Logging**
  Memory   2 Mb

Accusonic Model 7720 Flowmeter

Chapter 1
Flowmeter Description

The Accusonic Model 7720 Flowmeter is designed for use in pipes, channels and sewers, ranging from 8 inches to 300 feet (0.2m to 90m) in width, and of cross section which may be circular, rectangular, trapezoidal, "horseshoe" or other defined shape.

The depth of water above the invert or bottom of the conduit may vary from zero to surcharged. The flow may be in either direction, and generally there is no assumed relation between depth and flow. Under certain conditions of low water level, a Manning type of relation between level and flow may exist. To cope with all these three possible flow conditions, and the possible temporary loss of velocity measurements, "Compound" flowmeter logic is required.

The water may range in quality from clean to raw sewage, from natural or industrial sources, having a pH in the range 3.5 to 10, temperature between 32°F and 105°F (0°C and 40°C), and a solids loading from near zero to 2000 parts per million. It is assumed that the conduit does not contain vapors of ketones or esters which might eventually reduce the integrity of the plastic housing of the transducers. In addition, the water may contain floating weed, rag, paper and plastic debris, and may deposit grease on the walls and any devices attached to the walls, especially in the region around the dry weather flow level.

Sewers may be classified as "confined spaces" as regards access: they may also contain potentially explosive atmospheres. If this is the case, the Hazardous Area Classification in USA and Canada, is typically Class I, Division 1, Gas groups C & D; elsewhere it is usually classified according to IEC codes as Zone 0 or Zone 1, Gas groups IIA & IIB.
For these applications, all transducers, cabling and other electrical equipment in the sewer and associated with it, should be installed in accordance with the appropriate National codes.
In USA installation should follow NEC Articles 500 & 501 for Explosion proof protection; or NEC Article 504 for Intrinsically Safe protection.
Elsewhere IEC 79-14, or EN 50014 & EN 50018 should be consulted.

For those conduits which are always surcharged the flowmeter may be configured in the "Pipe" mode. In this mode the level inputs are ignored, and in some cases the flowmeter may be supplied from the factory without level input circuits. For the flow computation, either the "Gaussian" or "Chebyshev" multi-path integration methods can be implemented by setting the parameters describing path lengths, angles and weighting coefficients in accordance with ASME or IEC codes.

For all other conduits the "Compound" mode should be used. The flowmeter is based on the "velocity-area" method for flow determination, generally described in ISO 6416 1992, and more specifically in Appendix A of this manual.

The water velocity is determined using the multi-path ultrasonic time-of-flight method. The elevation of the water surface above the site datum is called the "Level," and the variable component of this value is input to the flow computer in analog form from one or two sensors, (typically downlooker ultrasonic units or pressure transmitters). A single arbitrated value for Level is obtained from the two inputs. The wetted cross section area is computed from the Level and parameters stored in the computer defining the shape of the conduit. The integration technique for computing the flow from the velocity data is determined automatically from the water level and from the quality of the velocity data.

When the Level is too low for any acoustic paths to operate (or if they are submerged and have failed), flow may be computed using the Manning equation. When the level is higher and ultrasonic paths are operating, a "Trapezoidal" integration method is used. When the conduit is surcharged, either the same integration algorithm may be used (modified to allow for the friction effect of the top of the conduit), or alternatively the "Pipe" mode may be used.

The flowmeter may be configured to provide determinations of flow in up to four separate and dissimilar conduits or "Sections", each with one or two analog Level inputs and a number of acoustic paths. The total number of Level inputs allocated among the Sections is limited to 4, and the total number of paths allocated among the Sections is limited to 10.

The electronic unit provides up to four independent outputs in a 4-20 mA analog form, which may be differently scaled to output separately forward and reverse flow, flow over any range from reverse to forward, mean velocity, level, water temperature or sum of section flows.

Up to a maximum of 9 relays may be fitted to the electronic unit to provide flow and level threshold alarms for each section or sum of sections, section status (fail) alarms, or totalizer pulses.

An alpha-numeric display of flow and diagnostic data is provided on a separate hand-held terminal, which is connected to the flowmeter via an RS232 serial data port. The site parameters may be inserted into the flowmeter's non-volatile memory from this terminal, by way of a "user-friendly" menu.
Alternatively, a PC with communications software, such as HyperTerminal, may be used in place of the hand-held terminal.

A second RS232 port is provided that can be used with a PC which has "Accuflow Flowmeter Interface" software installed. This provides a "Windows" based user friendly flowmeter configuration routine, as well as graphics showing trends from recent flow data, the received acoustic signal waveforms and other data to aid commissioning.

An integral data logger is standard, which stores any combination of the measured variables (Flows, Levels Velocities, Temperatures, Diagnostic data etc.) at a chosen interval, using non-volatile "Flash" memory technology. The logger can be configured from the "Logging to Flash" menu.

The flowmeter may be fitted with an optional liquid crystal display (LCD), which can offer a range of flow data displays, depending on the configuration of the flowmeter.

Special hardware versions are also available to suit low frequency transducers and path lengths up to 300 ft (90m).

Chapter 2
General Specifications

Transducers

Temperature range:	operating	32°F to 105°F	0°C to 40°C
	storage	0°F to 150°F	–18°C to 65°C
Pressure range:		Dependent on Model.	
Water quality:	pH	3.5 to 10	
	Solids loading	0 to 2000 parts/million	
	Vapors of Ketones & Esters must not be present		

Characteristic frequency: 1MHz , 500 kHz and 200 kHz using standard electronic filters.

Maximum Transmit Voltage:

Standard systems,	1100 V peak.
Flameproof protected transducers	1100 V peak

Electronic Unit

Standard Model

Power supply: Electronic Unit   90 to 250 V a.c.   47 to 63 Hz
or 100 to 300 V d.c. without adjustment.

Power consumption:

Standard unit	26 Watts, 50 VA. (with a.c. power supply)
With relays or power for level sensors	35 Watts, 70 VA. (with a.c. power supply)
Heater a.c. power only,	200 Watts, Voltage as specified on equipment

Contact Accusonic for details of Models suitable for 12 Vor 24 V d.c. power supply.

Temperature range:	operating	+15°F to 140°F	–10°C to 60°C
	operating with heater	–15°F to 140°F	–25°C to 60°C
	storage	0°F to 150°F	–18°C to 65°C

Maximum Altitude for normal operation	6500 ft	2000 m

For higher altitudes, contact Accusonic.

Dimensions:	20 x 20 x 9 inches	500 x 500 x 230 mm
Weight:	60 lb	27 kg
Enclosure protection:	NEMA 4	IP65

Acoustic Paths (Up to 10 in total, allocated between all the Sections).

Length (Standard range)	0.7 to 50 ft	0.2 to 15 m
(Extended ranges)	5 to 300 ft	1.5 to 90 m

Permanent Data Display (Optional)   LCD   2 lines x 20 alpha-numeric characters
Character height   9 mm

Level inputs (4)

useable input range with standard 100Ω load	4 -20 mA, (0.4 - 2.0 V)	
maximum load (optional)	250Ω (1.0 - 5.0 V range)	
maximum voltage relative to ground for operation	± 20 V dc.	
maximum withstand voltage relative to ground	240 V rms.	
Power supply for external transducers	+24 V dc. 0.5 A max	

Analog Outputs: (4)

Isolated	range	4-20 mA	
	maximum load	1000Ω	24 Volts
	resolution	0.005 mA	(15 bit)
	linearity and stability	±0.01 mA	0.06% full scale
	isolation	1500 V rms. common mode relative to ground	
	protection	± 50 VDC.	

Alarm relays (Optional up to 9)   For Flow or Level exceedance, Faults or Totalizer.
Normally open contacts. 10 A carrying capacity.
Switching capacity: 0.5 A, 110 V d.c, L/R = 40 ms
Isolation 2000 V a.c.

Integral Data Logger   104 different variables selectable.
Any interval selectable between 1 second and 24 hours
Capacity of main memory: 192 K data points.

Transducer Cable

Unbalanced mode: Coaxial RG59 A/U. A special double jacketed version for underwater use
Balanced mode: Twin-axial RG108 for lengths up to 300 ft (100 m).
   Twin-axial RG 22 for long lengths.

Maximum length between Transducers and Electronic unit: 1600 ft (500m)
Approval from Accusonic should be obtained if the cables are expected to exceed 300 ft (100m)

Hand-held Terminal

Type TT-8045 (Two Technologies Inc)

Temperature range:	operating	32°F to 120°F	0°C to 50°C
	storage	0°F to 150°F	−18°C to 65°C
Dimensions:		4.1 x 7 x 1 inches	105 x 180 x 25 mm
Weight:		0.5 lb.	0.23 kg
Enclosure Protection:		Not NEMA rated,	IP41
Power supply:		5 V d.c. from the 7510Plus unit, on pin 9 of D connector	
RS232 signals: Factory setting		19200 baud, 8 data bits, No parity, 1 Stop bit	
Display		4 Lines x 20 Characters	

Conformity with EMC and Safety Standards

The Model 7720 Flowmeter is designed and constructed in conformity with the following standards or normative documents, and with the essential requirements of the European Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC with amend. 92/31/EEC and 93/68/EEC

Low Voltage Directive

EN 61010-1	Safety Requirements for Electrical Equipment.
IEC 255-5	Insulation: 2 kV common mode, 1 kV Normal mode, >100 MΩ

EMC Directive, Immunity:

EN 50082-2 (1995)	Part 2 Industrial
IEC 77A.	Harmonics on power supply
EN 61000-4-11	Interruptions (100 ms), dips and voltage variations (+12 to -15%) on supply
EN 61000-4-4	Fast transient/bursts. 2 kV common, 1 kV normal mode
EN 61000-4-5	High energy pulse/transient 2 kV common, 1 kV normal mode
EN 61000-4-12	Damped oscillatory waves 1 kV common, 0.5 kV normal mode
IEC 1000-4-6	Conducted disturbances, induced by radio frequency fields. 150 kHz to 80 MHz. (10 V)
EN 61000-4-2	Electrostatic discharge 8 kV in air, 6 kV in contact
EN 61000-4-8	Power frequency magnetic fields. 1000 Aeff/m
EN 61000-4-10	Damped oscillatory magnetic fields. 0.1 MHz and 1.0 MHz 30 Ap/m
IEC 1000-4-3	Radiated electromagnetic field 80-1000 MHz, 10 V/m

EMC Directive, Emission:

IEC 1000-3-2	Harmonic current emitted into power source
EN 50081-2 (1994)	Part 2 Industrial Electro-magnetic field radiated in bands 0.15 to 30 MHz and 30 to 1000 MHz

Warning

This is a Class A (ITE) product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

FCC Compliance

To comply with the Federal Communications Commission (FCC), Accusonic Technologies provides the following information concerning the 7510Plus flow meter installation and operation.

Part 68

This equipment complies with Part 68 of the FCC Rules and the requirements adopted by the ACTA. It bears a label displaying, among other information, a product identifier in the format US: AAAEQ##TXXXX. The user must provide this information to the telephone company if requested.

The REN identifies the number of devices that may be connected to the telephone line. Excessive RENs on the telephone line may prevent devices from ringing in response to an incoming call. In most areas, the sum of the RENs should not exceed five (5.0). To determine the number of devices you may connect to a line, as determined by the total RENs, contact your telephone company. For this product the REN is part of the product identifier, the digits represented by ## are the REN without the decimal point (e.g., 03 is a REN of 0.3).

The plug and jack used to connect this equipment to the telephone network must comply with the applicable FCC Part 68 rules and the requirements adopted by the ACTA. A compliant telephone cord and modular plug is provided with this product. It is designed to be connected to a compatible modular jack that is also compliant. See installation instruction for details.

The telephone company may make changes in its facilities, equipment, operations, or procedures that could affect the operation of this equipment. If this occurs, the telephone company will provide advance notice so you can make necessary modifications to maintain uninterrupted service.

In the unlikely event that this equipment harms the telephone network, the telephone company will notify you that temporarily discontinuing telephone service may be required. Notification will occur in advance of discontinuation, or as soon as practically possible. They will also inform you of your right to file a complaint with the FCC if necessary.

This equipment may not be used on public coin phone service provided by the telephone company. Connection to party line service is subject to state tariffs.

This equipment is not field repairable. If you experience trouble with it, please refer to this manual for troubleshooting, replacement, or warranty information, or contact:

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Interface Specifications

Analog Level input

Level is input in 4-20 mA analog form, from an external current loop source.

Both terminals at the flowmeter must be within 20 volts of ground for operation.

The external device should be configured to give increasing current for increasing water depth. If it is configured to give increasing current for decreasing water depth, the Level Arbitration will not operate correctly.

For Level sensors requiring d.c. power,   24 Volts dc (at a total maximum current of 0.5 A) is available from the Level input terminal block.

Configuration of the Level input is defined by user-defined parameters. A parameter makes allowance for alternative load resistances to be placed across the input terminals.   Normally the input resistance is 100Ω.

For electrical characteristics see "Electronic Unit" Specifications, page 2-2.

- A Level input having an electric current (in mA) less than the value set by the parameter *Min mA Input,* or more than 21.0 mA is treated as being in a "fault" state.
- Level inputs between the value set by the parameter *Min mA Input* and 20.00 mA are interpreted as elevations in feet or meters, linearly interpolated in the range from 4.00 to 20.00 mA, between the values stored under the parameters *4mA Level Input & 20mA Level Input.*

Level Arbitration

- Applies when two Level inputs are allocated to a Section. Both inputs must be configured to give increasing current for increasing water depth.   Input #1 is the lower numbered input allocated to the section.
- If input #1 is between the value set by the parameter *Min mA Input* and 19.8 mA, the value scaled by the parameters *4mA Level* and *20mA Level* is used as the arbitrated value for Level.   Input #2 is ignored.
- If input #1 is below the value set by the parameter *Min mA Input*, it is rejected.   If at the same time, input #2 is between the value set by the parameter *Min mA Input* and 20.0 mA, the scaled value from input #2 is used as the arbitrated value for Level.
- If inputs #1 and #2 are both below their values set by the parameters *Min mA Input*, both are rejected, and no Level value is available. The flowmeter is declared failed.
- If input #1 is above 19.8 mA, and input #2 is not rejected, then the arbitrated level is the greater of that indicated by input #1 or input #2.
- If input #1 is above 19.8 mA, and input #2 is rejected, then Level is that indicated by input #1.
- Usually input #1 reading 20mA indicates pipe full. Input #2 is usually scaled for a larger range than #1.

Analog Outputs

These are configured for 4-20mA, and may be separately allocated to give a linear representation of the flow, level, average water velocity, water temperature or sum of section flows. If desired, the outputs may be scaled to cover any range of the variable from reverse, through zero, to forward: it is necessary only to define the output by the extremes of the range (i.e., at 4mA and 20mA).

Output allocation to flowmeter section, variable to be output, range and output under fault condition, are all defined under Analog Output parameters, (for definitions see Chapter 7)).

Under fault conditions, the outputs will go either to 4.00 mA or be held at the last good value, depending on the choice under the parameter *Hold on Error*. On some systems a zero output can be selected.
Under conditions of under-range, an output will go to   4.00 mA
Under conditions of over-range, an output will go to   20.00 mA
When the flowmeter is taken out of measurement mode the output holds the last value.
For electrical characteristics see "Electronic Unit" Specifications, page 2-2.

Relay Outputs

The relays which have been installed can be allocated to any section and to any of the functions by setting the Relay Output parameters described in Chapter 7. The logical operation for the different functions is:

Threshold Exceedance	The relay changes from its normal state when the value of the Flow or Level equals or exceeds the *Threshold* parameter for more than the number of consecutive measurement cycles defined by the *Delay* parameter.
	The relay returns to its normal state if the value of the Flow or Level falls below the *Threshold* for more than the number of consecutive measurement cycles defined by the *Delay*.
	If the section fails, the relay remains at, or immediately returns to its normal state.
	The Normal state (either energized or de-energized) can be selected by the parameter *Polarity*.
	The value of the *Threshold* can be positive or negative (–99999 to +999999).
	Note: In the logic, the value -6.00 is regarded as greater than -7.00.
Status Alarms	The relay changes from its normal state when the Fault state has been in existence for more than the number of consecutive measurement cycles defined by the *Delay* parameter.
	The relay returns to its normal state immediately if the Fault state ceases.
	The Normal state (either energized or de-energized) can be selected by the parameter *Polarity*.
	Note. A fault state due to a path failure is declared when the path has failed to provide data for more than a number of consecutive measurement cycles defined by the parameter *Max Bad Measures*. If the relay *Delay* is set to a value greater than zero, the relay will not operate until after that delay, even though the fault state will have already been in existence.
	The purpose of this routine is to hide short term faults which are known to occur, and only to give alarms for permanent faults.
Totalizer Relays	The relay changes from its normal state and returns 100 milli seconds later whenever the value for the Volume has increased by one complete unit.
	Only one operation of the relay can occur each measurement cycle.
	Only one relay can be allocated to each Section and only one to the Sum of Sections for totalizer pulses.
	In the event of power failure or the flowmeter being taken out of the Measure mode for less than one hour, the relay may operate at a rate of once per measurement cycle until the number of relay pulses has caught up with the Volume change which was computed to have occurred during the outage.

Data Display on Hand-held Terminal

In normal operation, 11 different display screens are available, one for each variable as follows:
Envelope Times, Travel Times,   Time Differences, Signal Gains,   Velocities,
Flow, Volume, Level, Temperature, Sum of the Section Flows & Volumes, Analog in.
The first five are for diagnostic purposes concerned with the water velocity determinations, the next five for observing flow data, and the last for diagnostic purposes concerned with the various Level inputs.
For details of the displays, see the section on Data displays at the end of Chapter 5.
For definitions of the variables, see the section on "Variables" at the end of Chapter 7.

Parameter Insertion and Reading, Hand-held Terminal

Parameters describing the flowmeter configuration are inserted using 7 different parameter menus. These are:
SYSTEM,   SECTIONS,   PATHS,   LEVEL INPUTS,   ANALOG OUTPUTS,   RELAYS,   LOGGING.
For instructions on how to insert the parameters, see Chapter 5.
For details on setting up the internal data logging, see Chapter 5.
For details of the parameters, see the section on "User Defined Parameters" in Chapter 7.

There are two command menus:
MEASURE: To put the flowmeter into the normal "Measure" mode.

SYSTEM ACTIONS   Under which any of the following three commands may be made.
   STORE ALL PARS: To store parameters once they have been entered correctly.
   RESTORE ALL PARS: To recall the stored parameters from non-volatile memory.
   XMIT PARAMETERS: To transmit the complete parameter list to a data terminal.

In addition there is a list called SYSTEM STATS, which contains the software revision number, a parameter to change the data baud rate to the Hand-held terminal, and the facility to change the real time clock.

Connection of a PC in place of Hand-held Terminal

A PC or other terminal with ANSI emulation may be connected to the 9 pin "Hand-held Communications" socket, as an alternative to the Hand-held terminal usually supplied. The same logic of operation and functions will be available. A "Null Modem" cable or standard serial cable with a "Null Modem adapter" is required to interconnect between this socket and a PC's serial port. Either the cable or adapter can be purchased at a PC supply or electronics store.
RS232 signals: 19200 baud, 8 data bits, No parity, 1 Stop bit,   No handshaking protocol
                          The baud rate may be changed using a parameter under SYSTEM STATS.

The connections on the 9 pin D socket are:
     Pin 2.   Data into the 7720 unit
     Pin 3   Data out from the 7720 unit
     Pin 5   Common, connected to ground in the 0Plus unit.
     Pin 9   +5 volts dc. (for power to the Hand-held terminal).

The following ASCII characters are recognized by the flowmeter.
Numbers **0** through **9**, **Enter**, **Esc**, **–** sign, Decimal point, **#**, Letters **U, D, L, R, P, S, T, M, Z**
The letters U, D, L, R, are used as cursor controls, ↑, ↓, ←, →
or **S** is used to cause a system Reset,
P to put the system in Pause,
T to prevent updating of the Terminal display
M to put the system in the Measure mode
Z as an alternative for Esc

A listing of parameters can be sent to the PC using the XMIT PARAMETERS command.
An example of a listing is included at the end of Chapter 5.

Connection of a PC for use with "Accuflow" Interface

A PC may be connected to the 9 pin "RS232" socket, for use with special Accusonic PC based programs. A "Null Modem" cable or standard serial cable with a "Null Modem adapter" is required to interconnect between this socket and a PC's serial port. Either the cable or adapter can be purchased at a PC supply or electronics store.

RS232 signals: 19200 baud, 8 data bits, No parity, 1 Stop bit, No hand-shaking protocol.
The connections on the 9 pin D socket are:
      Pin 2.   Data into the 7720 unit.
      Pin 3   Data out from the 7720 unit
      Pin 5   Common, connected to ground in the 7510Plus unit.

Optional High Speed Modem

A High Speed Modem can be supplied with the 7510Plus. A separate dedicated com-port is available for connection to the modem.

Data transfer (send or receive) at line speeds of 19200, 14400, 12000, 9600, 7200, 4800 and 2400 baud.

Auto-negotiating line speed connections at 19200, 14400, 12000, 9600, 7200, 4800 and 2400 baud using Fall Forward/Fallback handshaking (based on line signal quality) per EIA/TIA-P2330.

Lightning Surge Protection tested to IEEE C62.41-1991 and IEEE C62.45-1992.

Integral Data Logger

The integral data logger can be configured to log any combination of the measured variables (Flows, Levels Velocities, Temperatures, Diagnostic data etc.) at a chosen interval, using non-volatile "Flash" memory technology.

The memory part of the data logger resides on the DSP circuit card which is mounted next to the Analog card in the flowmeter console. The flowmeter processor (DSP) carries out all the house keeping functions necessary to format data and store them on the memory card. The DSP also formats the data when requested to upload them to a PC.

The user interfaces with the logger for setting up, either using the Hand-held terminal (see Chapter 5 & 7), or via the RS232 serial port using a PC running under the Accuflow Interface. (see Chapter 6)
Reading the logged data can only be achieved using the Accuflow Interface.

The logger is fully protected against data loss in the event of power failure.

Chapter 3
Flow Computation

The Accusonic Model 7720 Flowmeter may be configured with up to a maximum of ten acoustic paths and two inputs for Level (or water depth) in one conduit or "Section." Details of the configuration are defined by a set of parameters, the names of which appear in this document in *italics*.

Each path is characterized by parameters describing *Length* and *Angle* for "Pipe" mode integration, a *Weight* parameter is added: for "Compound" mode *Elevation* is added. Paths are numbered in order of elevation, with the lower path numbers having lower elevations. In Compound flowmeters, pairs of "Crossed Paths" in a section are indicated by having the same elevation. Other Path parameters include:
 Max. Bad Measures, Max Velocity Change, Max Path Velocity, Signal Delay and *Transducer Frequency*

In "Pipe" mode, path transducers are energized and measurements taken for all paths which are configured. In "Compound" mode, only those transducers submerged by an amount greater than the parameter *Min. submersion* are energized.
If a path fails to provide a good velocity value, because the signal is not found, or the velocity appears to exceed the *Max Path Velocity* parameter, then the last good velocity value is used for flow calculations until the number of consecutive failures exceeds the parameter *Max.Bad Measures*. If this value is exceeded, the path is declared to have failed, and its data are then not used for flow computation, unless and until new valid data are obtained. If the change in velocity appears to exceed the *Max Velocity Change* parameter, the computed velocity is incremented or decremented by an amount equal to the *Max Velocity Change.*

In "Pipe" mode, all *Manning, Level* and *Layer* parameters indicated by the letter "C" after their names are ignored. The conduit geometry and velocity integration are defined in terms only of *Pipe Area* and Path *weights.*

In "Compound" mode instantaneous values for velocity are averaged for paths having identical elevations, and the averaged velocity is used as the velocity at that elevation. If one of the paths has failed for more than the parameter *Max Bad Measures,* the good path will be used alone for providing the velocity at that elevation. Paths which do not have identical elevations will be treated as separate paths in the Trapezoidal Integration. The velocities displayed and the velocities sent to the "Com 1" port will be the individual velocities for each path.

The conduit cross-section is defined in terms of up to 8 "Layers," each layer being described by an elevation and a width. The width of the conduit at any elevation is computed by linear interpolation between the layer widths above and below.
The elevation and width of the channel bottom are defined by Layer #1. The layer elevations are independent of the path elevations. For a rectangular or trapezoidal conduit, only two layers need be defined, the first describing the channel bottom, and the second describing the top of the channel. For a closed conduit, the top-most layer elevation must be equal to or greater than the elevation of the soffit or top of the conduit (or the *Surcharge Level* parameter). For an open channel, the top-most layer elevation must be set above the highest possible level.
The other Section parameters required for Compound Integration are: *Bottom friction*, Top *weight* and the Surcharged Integration method to be used (*Surch Trap/Pipe*).
If "Trapezoidal" integration is chosen for the surcharged condition, certain "Pipe" mode parameters are ignored by the system, and these are indicated in Chapter 7.

Flow Computation Algorithms

In "Compound" Mode

The flowmeter automatically chooses one of 5 integration methods, depending on the value of the Level,   and on the status of any of the acoustic paths which are sufficiently submerged to operate,   (i.e. those whose elevations are defined to be less than   [Level - *Min. submersion*].   The 5 methods are:

1. Zero flow if the Level (or depth of water) is below a user defined value.
2. Manning Equation when the depth of water is too low for acoustic paths to operate, or, within-user defined limits, if none of the acoustic paths yields valid data.
3. Single Path Trapezoidal Integration, when the conduit is not surcharged and only one path (or one pair of crossed paths) is submerged, or when only one path (or one pair of crossed paths) is able to yield valid data.
4. Multi-path Trapezoidal Integration, when the conduit is not surcharged and at least two acoustic paths at different elevations (any of which may be pairs of crossed paths) yield valid data.
5. Surcharged Integration, when the pipe is surcharged. A user-selectable choice of two methods is available:
    "Pipe" as described for "Pipe" mode involving parameters of path weights and pipe area;
     "Surcharged Trapezoidal" where the pipe geometry and velocity integration are defined by methods
       similar to those used for non-surcharged trapezoidal integration.

Note.

If none of the above conditions is satisfied, the flowmeter is declared to be in a "fault" state.
On sites where the Manning equation is not appropriate, the facility can be inhibited by setting the parameter
Manning max lvl to a value equal to or below the parameter Layer elevation 1.

In Manning mode

The flow is computed from the variable Level and fixed parameters of channel roughness, channel slope, and dimensions of the conduit.

The flow = Flow scaling $* $ Area $*$ C $*$ n^{-1} $*$ $R^{0.667}$ $*$ $\sqrt{s}$

where: Area   = the cross-section area of fluid at the current Level, computed using layer data.
  C   = Manning Constant   = 1.49 if English units are used,   1.00 if metric units are used.
  n   = the Manning coefficient of roughness.
  R   = Hydraulic radius, which is the Area/Wetted Perimeter.
  s   = Slope of the energy line. For a long pipe, the pipe slope.

In Non-surcharged Single Path Trapezoidal Integration Mode

The flow is computed from the variables Level and Water Velocity, and fixed parameters describing the conduit.

The Flow =   Flow scaling $*$ Area $*$ Velocity $*$ Path position coefficient.
where: Area = the cross-section area of fluid at the current Level, computed using layer data.
Path position coefficient is obtained by interpolation from the following look-up table (from ISO 6416).

Ratio of path depth below surface to depth of water above bottom.	Ratio of point velocity to mean velocity in the vertical.
0.1	0.846
0.2	0.863
0.3	0.882
0.4	0.908
0.5	0.937
0.6	0.979
0.7	1.039
0.8	1.154
0.9	1.424
0.95	1.65 (extrapolation)

In some case using the ratio chart shown above in the single path mode can lead to flowrate errors due to the shape of the conduit. In these cases setting the section parameter **MIN GOOD PATHS** equal to 1 will cause the flowmeter to calculate single path flow without modifying the velocity according to the ratio chart.

In Non-surcharged Multi-Path Trapezoidal Integration Mode

The flow computation in this mode is performed in a series of steps, following the principles set out in ISO 6416 for the "mid-section" method.   Each step consists of determining the flow over a smaller cross-sectional area or panel. The total flowrate in the conduit then becomes the sum of the individual panel flows.
There are three basic types of panel:

1. Bottom panel which is bounded on the bottom by the bottom or bed of the conduit and on the top by the lowest operating path.
2. Intermediate panel bounded on the top and bottom by consecutive operating paths that are not at the same elevation.
3. Top panel bounded on the bottom by the highest operating path and on the top by the surface of the water.

Each of these panels is bounded on either side by the walls of the conduit, whose dimensions and shape are defined by the layer parameters. The actual area for each panel can therefore be a complicated computation involving the calculation of the conduit widths at the paths which bound the panel (from interpolation between the nearest layer widths), the calculation of the areas between these paths and the layer nearest them (or between the paths if there is no layer between them), and the calculation of the areas between any other layers which may lie between these paths.

The flow computation in the bottom panel is:

$$Q_{Bottom} = Area_{Bottom} * Vel_A * (1 + Bottom\ friction)/2$$

where: $Area_{Bottom}$ = conduit area between the bottom (Layer #1) and the lowest good path
(or pair of crossed paths)

Vel_A = Water velocity as computed from the lowest good path or pair of crossed paths

The flow in the intermediate panel above the bottom panel is:

$$Q_{Int} = Area_{Int} * (Vel_A + Vel_B)/2$$

where: $Area_{Int}$ = conduit area between good path A and the next good path B

Vel_B = water velocity as computed from the next good path or pair of crossed paths

The flows in all the intermediate panels is computed similarly

The flow in the uppermost panel bounded by the surface is:

$$Q_{Top} = Area_{Top} * (Vel_N + Top\ Weight * Vel_{Surface})/(1 + Top\ Weight)$$

where: $Area_{Top}$ = conduit area between the uppermost good path (or pair of crossed paths)
and the water surface.

Vel_N = water velocity computed from the uppermost good path or pair of crossed paths

$Vel_{Surface}$ = an estimated water velocity at the surface from a limited algebraic
extrapolation of the velocities from the uppermost good path (or pair of
crossed paths) and the next good path (or pair of crossed paths) below it.

If the difference in elevation between the water surface and the uppermost good path is less than the difference in elevations between the uppermost and next lower good paths, then:

$$Vel_{Surface} = Vel_N + (Vel_N - Vel_M) * (Level - Elevation_N)/(Elevation_N - Elevation_M)$$

where $Elevation_N$ and $Elevation_M$ are the elevations of the uppermost good path and of the next lower good path.
and Vel_N and Vel_M are the water velocities from the uppermost good path (or pair of crossed paths) and of the next lower good path (or pair of crossed paths)

If the difference in elevation between the water surface and the uppermost good path is greater than the difference in elevations between the uppermost and next lower good paths, then:

$$\text{Vel}_{\text{Surface}} = \text{Vel}_N + (\text{Vel}_N - \text{Vel}_M)$$

The total Flow in the conduit is the sum of the flows in all the panels.

$$\text{Flow} = \text{Flow scaling} * (Q_{\text{Bottom}} + \sum Q_{\text{Int}} + Q_{\text{Top}})$$

Alternative Crossed Path Configuration in Open Channels

When crossed paths are installed, the flowmeter may be configured as two separate sections having identical geometry and the same level inputs.   Section #1 is configured for the paths in one plane, and section #2 for those in the other plane. The *Flow Scaling* parameter is set to 0.5, and the channel flow is the sum of the section flows. Analog outputs should be allocated to section #1 to give Level, temperature and velocity, and to SF (Sum of Flows) for Flow.

In Surcharged Mode

A choice of two possible integration methods is available -- "Pipe" and "Surcharged Trapezoidal."

Surcharged Pipe Integration

See description on page 3-5 for "Pipe Mode."

Surcharged Trapezoidal Integration

The flow is computed from the path velocities and the cross-section area (which is computed from the layer parameters and the *Surcharge Level* parameter).

When paths at more than one elevation are good, the Flow is computed in the same manner as for non-surcharged trapezoidal integration, except that the flow in the panel between the uppermost good path (or pair of crossed paths) and the top of the conduit or soffit is set to:

$$Q_{\text{Top}} = \text{Area between uppermost good path and soffit} * \text{Vel}_N * (1 + \text{Bottom Friction})/2$$

When only one path (or pair of crossed paths) is good, the total section Flow calculation simplifies to:

The Flow = Flow scaling * Area * Vel_A * (1 + Bottom Friction)/2
where: Area = the surcharged cross section area of conduit computed from the Layer data and the *Surcharge Level* parameter.

For multi-path installations, the value of *Bottom Friction* is usually set between 0.5 and 0.8. The lower value is used when the lowest path is very close to the bottom of the channel.

For single path installations with the path located near to the bed, the value for *Bottom Friction* should be set according to:

Channel shape	Path elevation / Surcharge Level	Bottom Friction.
Rectangular	10%	1.6
Rectangular	20%	1.4
Round	10%	1.3
Round	20%	1.1

In "Pipe" Mode

In "Pipe" mode, the conduit is surcharged, and flow is computed by the product of average water velocity and the conduit cross-section area. The average water velocity is obtained from the sum of the path velocities, each weighted according to its position in the conduit.

The cross-section area is a fixed value defined by a single user-defined parameter, *Pipe area.*

The other user-defined parameters are: *Flow scaling* and Weight for each path W_n (n is the path number 1 to 8)

$$\text{The flow} = \text{Flow scaling} * \text{Pipe area} * \sum W_n * V_n$$
$$\text{where} \quad V_n = \text{velocity for path n.}$$

Details of the method, including path configurations and weights to be used in special formulae for different pipe shapes, are described in the ASME PTC 18 or IEC Pub 41 codes for hydraulic turbine efficiency testing. The formulae and the weighting factors used in the codes differ from the more general formula used in the flowmeter. Examples of weights to be inserted in the flowmeter are given in Chapter 7, under Path Parameters.

In the event of one or more paths failing, the flowmeter is capable of calculating Flow by invoking a "Path substitution" routine. The Flow continues to be computed from those paths which remain good; however the uncertainty increases with the number of paths failed. For this routine to operate, the following two conditions must be met:

1.   The number of good paths must be equal to or greater than the Section parameter *Min good Paths.*
2.   The flowmeter must have completed the "Learn" routine.

During the "Learn" routine, which must be implemented at the pipe's normal flow (non-zero!), a table of time-averaged historic flow components ($V_n * W_n$) is recorded and stored in the flowmeter's protected memory. The "learn" routine is implemented by setting the section parameter *Learn Path Ratios* to 1, and then setting the flowmeter to run. At the end of 1000 readings, the *Learn Path Ratios* parameter will automatically reset to zero. During the learning run, the letter "L" is displayed adjacent to the section Flow value. The learning run may be curtailed at any time by manually setting the *Learn Path Ratios* parameter to 0. Repeating the learning process will erase an old table and create a new one.

In the "Path Substitution" routine, the contributions towards the total pipe flow from the failed paths is replaced by a figure generated from the flow contribution from the remaining good paths, weighted as appropriate by the historic flow contribution ratios for all the paths. Mathematically, the routine can be represented as:

Flow = Current Flow from Good Paths * Historic Flow / Historic Flow from current good paths.

The Current Flow from Good Paths is = Pipe Area * $\sum V_n.W_n$
        in which the velocity from any failed paths is set to zero.

Historic Flow is the long time-averaged flow recorded during flowmeter commissioning.

Historic Flow from current good paths is = Pipe Area * $\sum$ Historic $V_n.W_n$ excluding those historic flow components which apply to the paths which are currently failed.

Volume Calculation

Volume is the totalized flow and is computed as:
        Volume = Flow in the displayed units * Time elapsed in seconds **/** *Volume Scaling*

If the flow is positive, the count will rise to a maximum of 99 999 999, and then reset to zero and start again. The Volume figure will be incremented or decremented depending on whether the flow is positive or negative. If the count is small, the Volume figure will be displayed as a number with up to 4 decimal places.

The volume counts transmitted by relay closures to an external counter are designed to maintain agreement between the displayed Volume (in the flowmeter) and the count as registered by the counter.

When the flow is positive, a count is usually transmitted by the relay whenever the Volume increases by one complete unit. However, if there is a period during which the flow is negative, the Volume figure displayed in the flowmeter will decrement, but there will be no counts transmitted by the relay.   If the flow should then return positive, no further counts will be transmitted until the Volume figure exceeds the value which it attained prior to the negative flow period.

In the event of the flowmeter being taken out of the Measure Mode or powered down for a period not exceeding one hour, the Volume count will be made up for the missing period. The count made up will be given by:

Make-up Count = Flow existing at time of Flowmeter recovery ∗ Down time in Seconds **/** *Volume Scaling*.

Water Temperature Calculation

Water temperature for a section is computed from the average speed of sound in water, as determined from the measurements made by all the good working paths in the section.

The result is in °F if the System Parameter *English / Metric* is set to "English", and in °C if it is set to "Metric".

The calculated temperature is:

Temperature °F $= 1.129 \ast 10^{-7} \ast c^3 - 1.46827 \ast 10^{-3} \ast c^2 + 6.450118 \ast c - 9559.7 + $ *Temp Correction*

Temperature °C $= 5.0822 \ast 10^{-6} \ast c^3 - 2.127056 \ast 10^{-2} \ast c^2 + 29.88592 \ast c - 14096 + $ *Temp Correction*

where c is the average speed of sound in water, and *Temp Correction* is a Section Parameter.

These formulae apply only to fresh water at low pressure.

At 10 bar pressure,   the flowmeter will indicate 0.6°F (0.3°C) high at near freezing,
and 1.4°F (0.8°C) high at 90°F (30°C)

At a salinity of sea water (35 parts / thousand), the flowmeter will indicate
19°F (10°C) high at near freezing,
and 30°F (17°C) high at 90°F (30°C)

Chapter 4
Unpacking and Installation

When the flowmeter arrives, inspect the packaging for signs of damage. If there is obvious external damage to the shipping container, request that the carrier's agent be present when the unit is unpacked. Be particularly careful not to destroy the shipping container during opening so that it may be used for future shipment of the unit.

Warning
Do not apply power to damaged components. Injury or further damage may occur.

Remove the flowmeter from the package and verify all parts against the packing list. Examine each of the components for physical damage. If a component is damaged, notify the carrier and follow the instructions for damage claims. Report any shipping problems immediately to Accusonic.

Physical Installation

The flowmeter should be mounted on a location so the cable run from the transducers to the unit does not exceed 300 feet or 100 meters without the approval of Accusonic. In addition, the unit requires a power connection, as well as connections to any pressure transmitters and to the site process control system.

The instrument should be mounted vertically and should be attached to a wall or mounting panel capable of safely supporting 100 pounds (50 kg).   Use 3/8 inch (10 mm) lag screws or carriage bolts.
If an external PC is used, provide a suitable table or shelf.

If the cabinet is to be mounted out-doors, it should be protected by a sun shield on the top and the south facing side.

Electrical Installation
Caution when drilling conduit holes, remove the circuit cards from the unit.

Note. In order to reduce the possibility of malfunction of the processor, due to electro-magnetic interference radiated from the various cables, all wiring brought into the unit should be routed to its terminals by the shortest reasonable route. **Spare cable should be looped in the conduit and trunking outside the flowmeter console**.

All wiring is brought into the unit through customer-supplied conduit connectors. This may include:

- ♦ a.c. or d.c. power supply mains to the electronic unit (and for the heater if fitted).
- ♦ Transducer cabling (may require more than one feedthrough)
- ♦ Level sensor inputs if required.
- ♦ 4-20mA Analog outputs
- ♦ Alarm and Totalizer relay outputs.

Check that the voltage ratings for the electronics and heater (if fitted) as specified on the label on the connector panel Fig 4-1, are appropriate for the supplies.

Power Wiring

Power consumption for the electronics is less than 70 VA.
Power consumption for the heater is 200 Watts, a.c. only.   Use #16 AWG or #14 AWG (1.5 mm^2 minimum).

The unit requires direct mains wiring and should be installed with a separate main power cutoff switch near the instrument, in compliance with the National Electrical Code (or IEC 60079-14 clauses).

Route power mains wiring into the unit through the appropriate feedthrough to the mains terminal block, and connect as shown in Figure 4-1. Be sure to follow appropriate local codes and practices, and to attach a proper earth ground to the instrument.

For low voltage d.c. power, observe the correct polarity.
For d.c. power 100 to 300 V d.c. the low potential side of the supply should be connected to the "-" terminal.
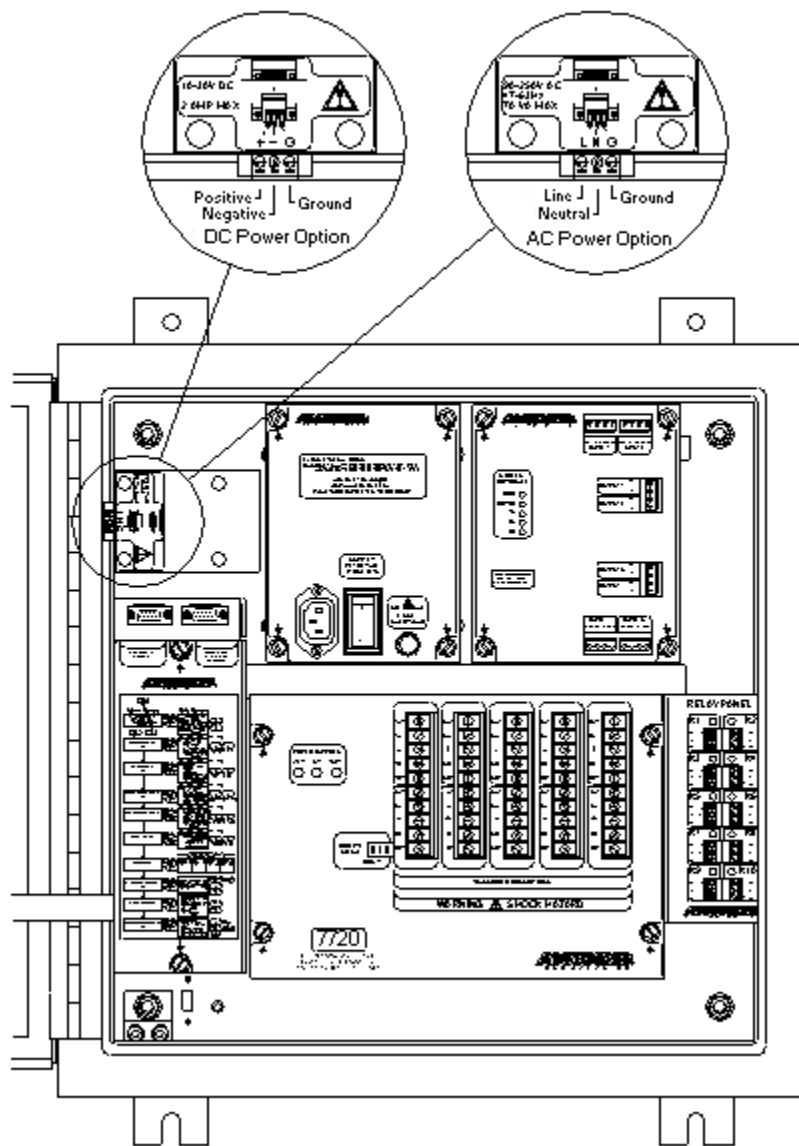
Figure 4-1 Location of Power Line Connections

Transducer Wiring

Pull transducer cabling through the appropriate feedthrough and trim each line, leaving enough cable to reach the transducer terminal blocks at the bottom of the flowmeter console. Tag each cable with a path number and transducer letter according to the Accusonic numbering convention as shown in Figure 4-2. Trim the cables, strip back 2 inches of outer sheathing from each, pull inner conductors back from inside the outer braid, solder spade lugs to the conductor and shield of each cable as shown in Figure 4-3.

Do not connect the cables to the flowmeter yet. Leave the ends of the cables so that the conductors are not in contact with one another or with any metal parts on the flowmeter console.

Caution
Double-check the cable numbering and verify sufficient reach before trimming.
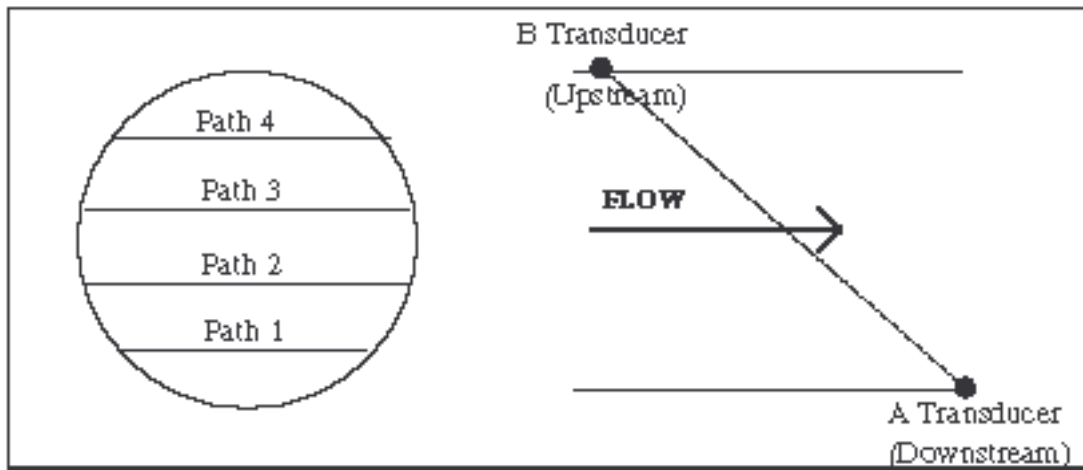
Figure 4-2 Transducer Numbering - Simple Pipe

1. Strip outer sheath back 2 inches (50mm), exposing braided shield.

2. Pierce the braid, snake inner conductors and insulation out.

3. Twist braid tightly, trim to 1.5 inches (35mm), attach forked lug, crimp and sol
4. Trim inner conductors to 1.5 inches (35mm), strip 3/8 inch(10 mm) of insula ic
5. Attach lugs, crimp and solder.
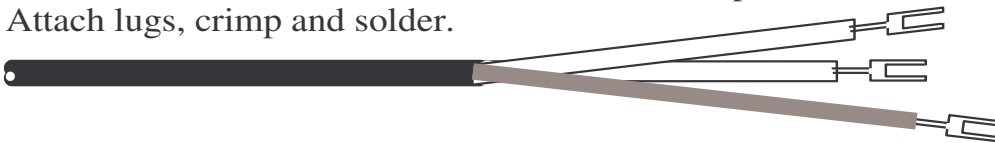
Figure 4-3 Stripping and Terminating the Transducer Cable

Transducer and Cabling Checkout

There are three steps to verify the transducer cabling and transducers:

1. Verify that there is infinite resistance across each transducer.
2. Verify that there are no internal shorts in any cable.
3. Verify continuity in the cabling.

Step 1 - Verify infinite resistance across each transducer

Measure the resistance across the transducer cable terminals using a Megohmmeter (high voltage ohmmeter) set to the highest resistance range. Each transducer should measure infinite resistance. Contact Accusonic if any transducer measures less than 20 MΩ resistance.

Test transducer resistance at the unit, with the cabling detached, if possible. This can usually be performed easily when the transducers are pipe-mounted, where the outside of the pipe is accessible, and when the transducers are fitted with E/O connectors. Use a short test cable attached to an E/O connector.

When the transducer is not accessible, or when the cable is permanently attached to the unit, do the best you can. Test the resistance at a wiring junction located as near as possible to the transducers. If it is not possible to detach the cabling back to the flowmeter console, be sure the console ends of the cables are detached from the unit and that they are not accidentally shorted together.

Step 2 - Verify that there are no internal shorts in any cable

With the free ends of all cables detached and isolated, test that the resistance across each cable is infinite. For coaxial cable, test conductor to shield, conductor to ground and shield to ground. For twin-axial cable, test conductor to conductor, each conductor to shield, each conductor to ground, and shield to ground.

Step 3 - Verify Continuity and Cable Identification.

Work from either end of the cable and use a partner to connect pairs together, one at a time, at the far end of the cable. For each coaxial cable, short the connector to shield and measure continuity. For each twin-axial cable, short each connector to shield and measure continuity.

Connecting Transducer Cabling

After verifying that all transducer cabling is sound, connect each line to the appropriate terminal on the flowmeter console.

On installations which utilize standard path selectors, coaxial cables are required. These should be connected thus.

A–	˩	No connection
A+	˩	Core (Downstream transducer)
GND	˩	Shields from both transducers.
B+	˩	Core (Upstream transducer)
B–	˩	No connection

For some installations, path selector circuit cards with isolation transformers will have been provided in the electronic unit. For these, balanced line configuration is required using either twin axial or coaxial cables. For twin-axial cable installations, connect as shown in Figure 4-4.

For coaxial cable installations, connect   Cores to the + terminals,

Shields to the – terminals, and link – terminals to GND terminal.

For installations which require intrinsically safe transducers and cabling in a potentially explosive environment, the transducers are connected via zener barriers. See the Customer specific drawings at the back of this manual for hook-up details.

Figure 4-4A Transducer Wiring Connections Balanced Cables

PATH-SELECTOR PANEL

PATH 7 CONNECTION SHOWN IN EXAMPLE. CONNECTIONS TYPICAL FOR EACH PATH, WITH CABLES LABELED APPROPRIATELY.

TERMINATION CAN BE DONE USING NUMBER SIX FORKED LUG

CABLE IS RG-59, RG-62 OR EQUIVALENT.
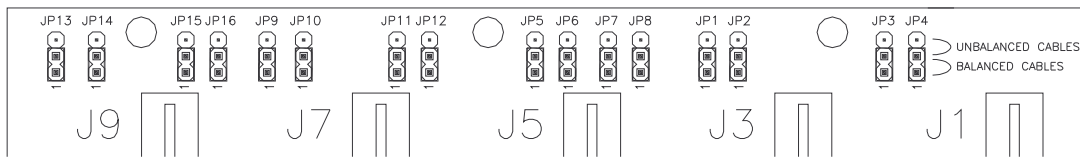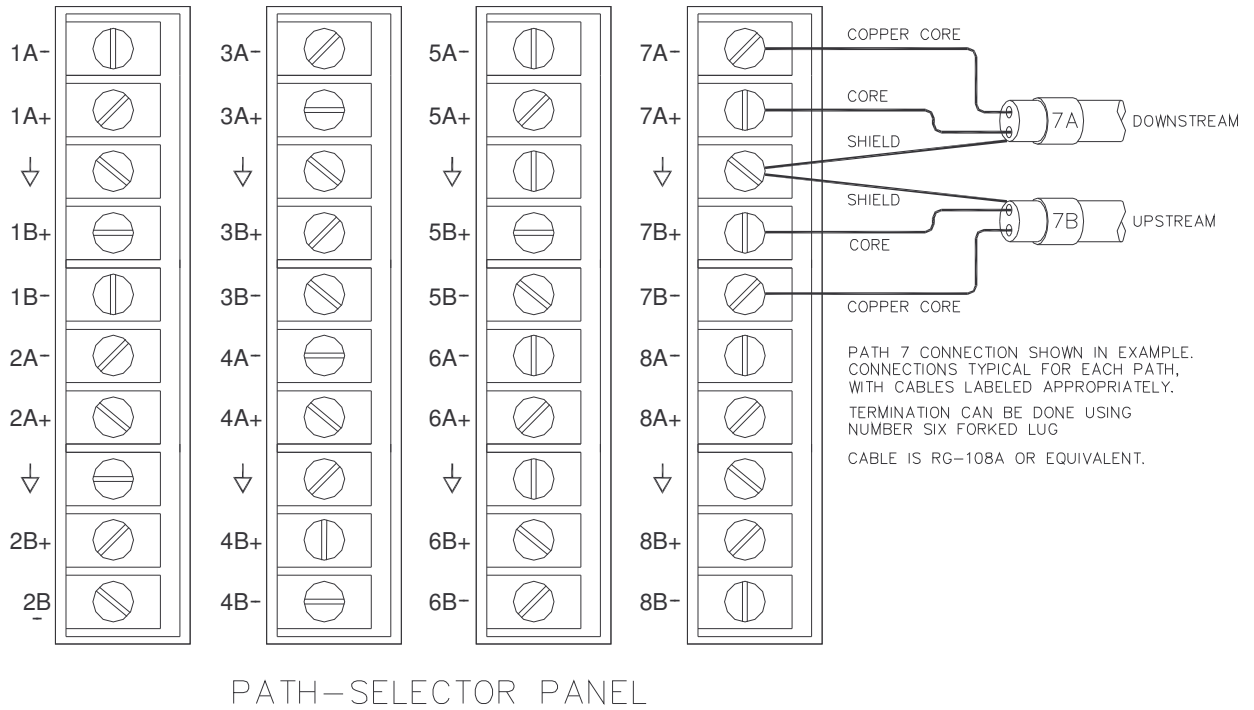
PATH-SELECTOR BACKPLANE JUMPER CONFIGURATION FOR UNBALANCED CABLES
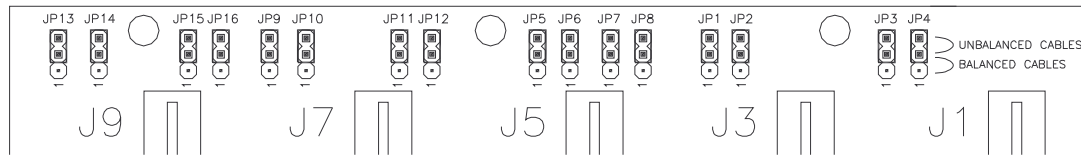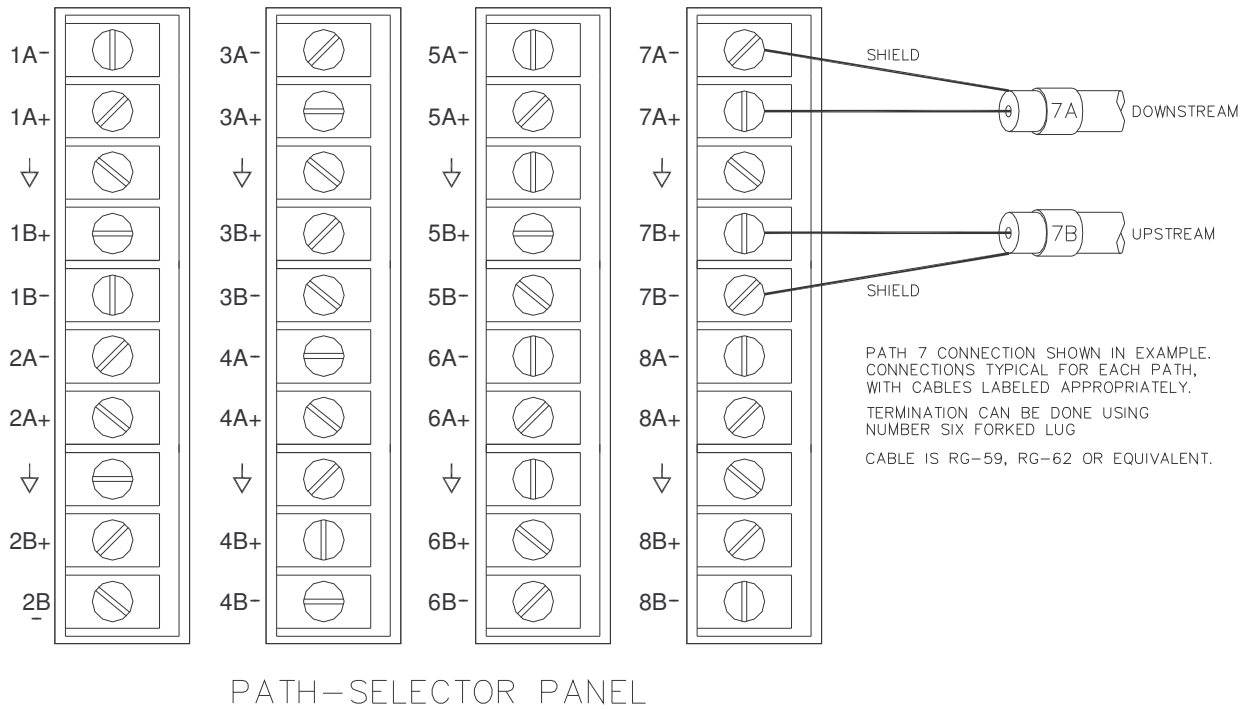
Figure 4-5B Transducer Wiring Connections Unbalanced Cables

Connecting the Analog Level Sensors

Any level sensor providing a 4-20 mA process loop signal can be used by the flowmeter.
After installing the external level sensor according to the manufacturer's instructions, use a twin-axial, shielded cable to connect the input to the terminal strip.

On most systems the terminal strip for the level inputs is located on the extreme right hand end of the connector panel shown in Figure 4-6.

Input impedance for each channel is 100 ohms.
For typical connection configurations see Figure 4-5 over leaf.
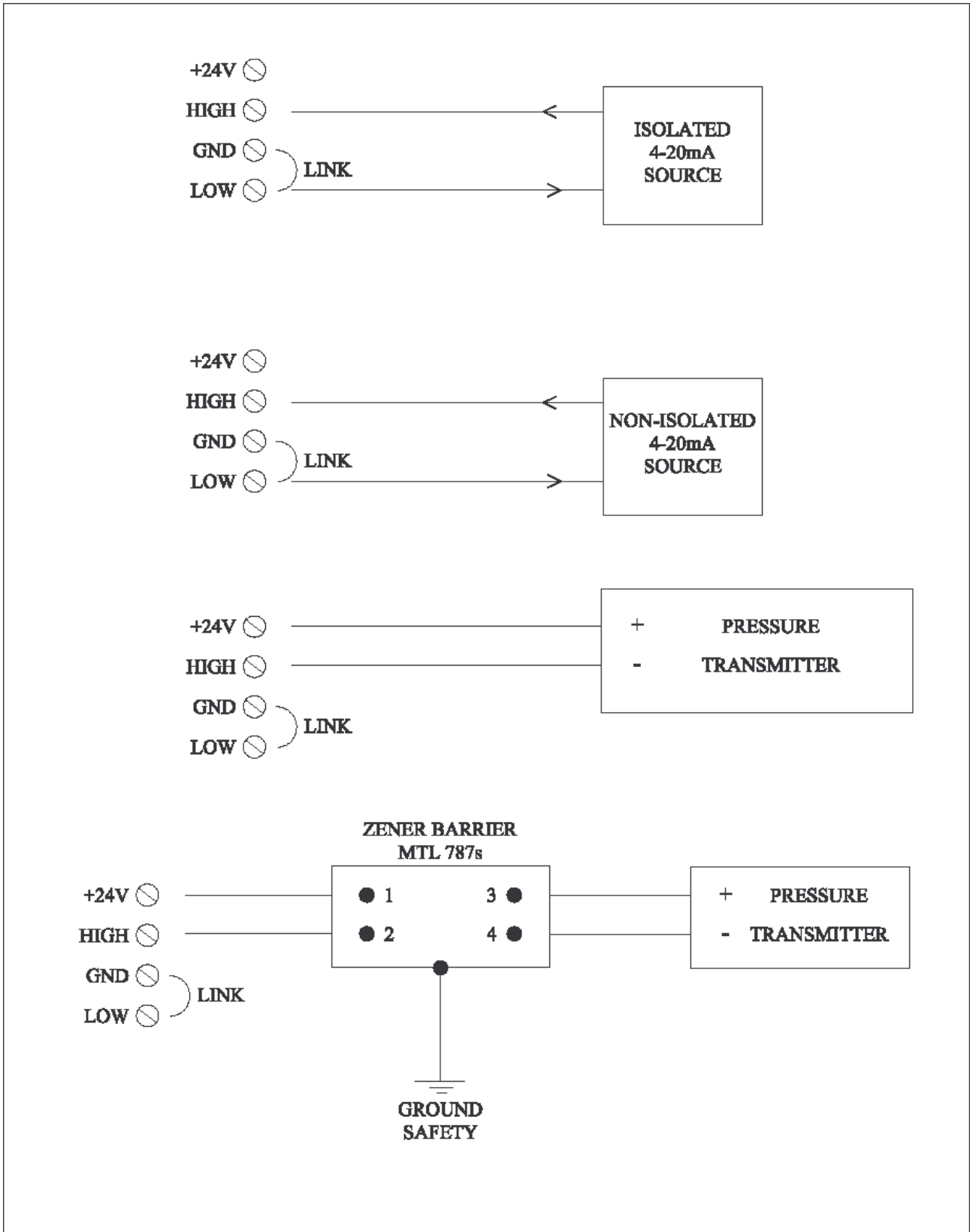
Figure 4-6 Typical Analog Level Connection

Connecting the Analog Outputs

Connect to the 4-20mA terminals as indicated in Figure 4-6
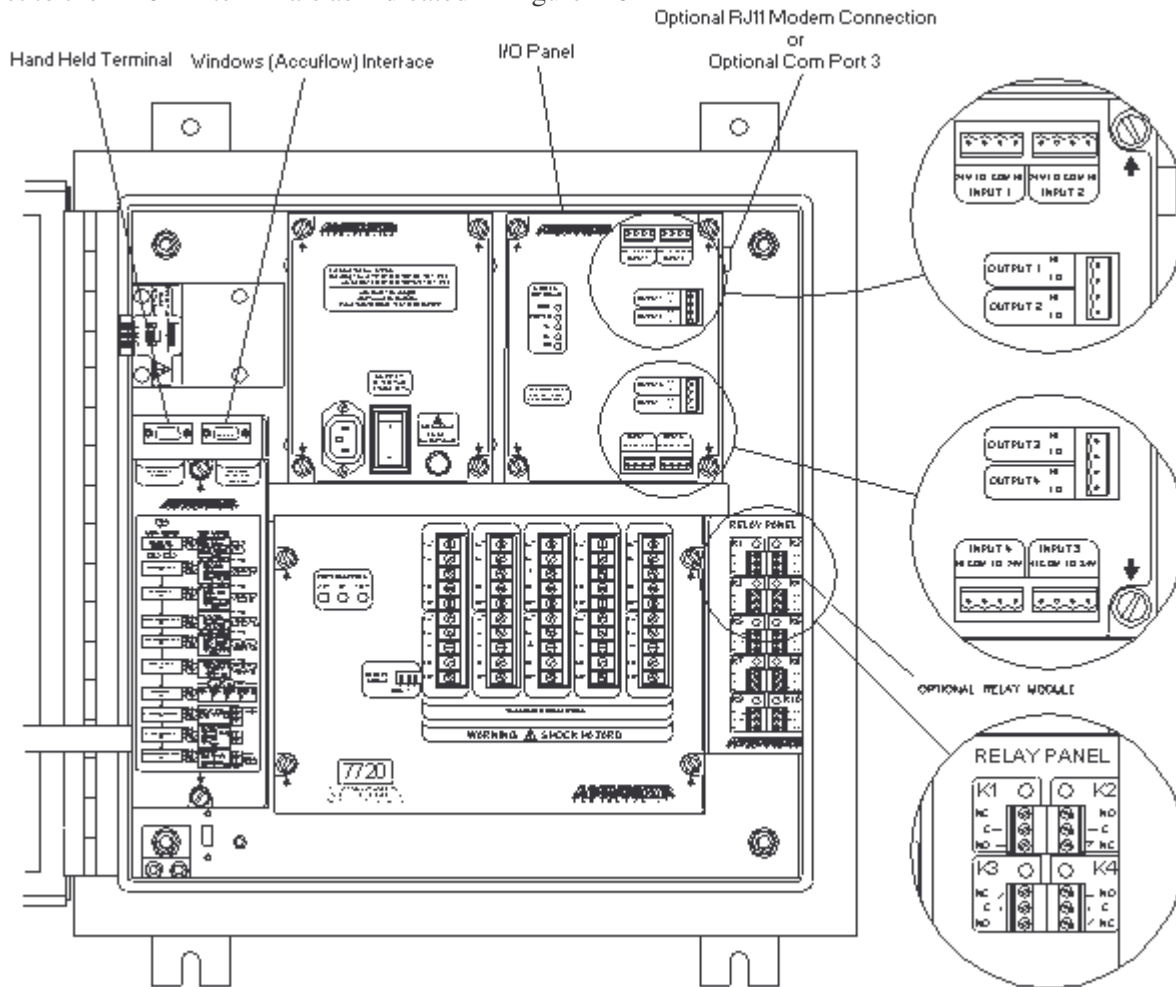
Figure 4-6 Location of the Analog Output, Level Input, Relays, RS232 Connections and Optional Modem Connection

Connecting to the Relay Outputs

On most systems the terminal strip for the relays is located on the extreme right hand end of the connector panel shown in Figure 4-6.   The labeling on the flowmeter and the Customer Specific drawings at the back of this manual will indicate the terminals to be used.

Connecting the Hand-held Terminal

On initial power up during the commissioning of the flowmeter, it may be necessary to ensure that the default baud rate of 19200 has been selected. To do this, switch off the power, connect together pins 2 & 3 of the 9-pin D socket marked *"Hand-held communication,"* and switch the power back on.

To connect the Hand-held terminal, plug the 9 pin D plug on the lead from the terminal into the socket marked *"Hand-held communication."*   Connecting and disconnecting the terminal can be done at any time with the flowmeter powered or unpowered.

Connecting a PC

A PC can be connected to the socket marked *"Hand-held communication"* and used instead of the hand-held terminal. The PC should be running under either a Terminal emulation or a Communications program.

Alternatively, a PC may be connected to the socket marked *"RS232"* for use with special Accusonic programs such as "Accuflow 7510Plus Flowmeter Interface".
A "Null Modem" cable or standard serial cable with a "Null Modem adapter" is required to interconnect between this socket and a PC's serial port. The cable or adapter can be purchased at a PC supply or electronics store.

Connecting a Modem

For remote access to the flowmeter from an office, via a telephone and modem link, connect RJ11 modular cable to RJ11 jack supplied on the I/O Panel. See figure 4.6

The equipment required at the office consists of a suitable telephone connection, V.32 modem and a PC running the Accusonic program "Accuflow 7510Plus Flowmeter Interface".

Chapter 5
Initial Setup, General Operations

This Chapter describes setup and operation of the flowmeter using the Hand-held Terminal. The alternative method using a PC with "Accuflow" is described in Chapter 6.
(Note: The instrument will not be damaged by entering incorrect parameters.)

Hand-held Terminal, Parameters and Variables
The hand-held terminal, which consists of a display and a keypad, is used to set up the flowmeter, start measurements, and observe the measured variables and status messages. Once the flowmeter starts taking measurements, it will continue to do so at a rate defined during setup. Flow measurements can be interrupted or halted from the terminal.

Set up the flowmeter by entering appropriate values for various parameters. Parameters define the geometry of each meter section and govern the operating modes of the flowmeter. All parameters are defined in Chapter 7.

Variables provide a view of measurements when the flowmeter is in normal "Measure" mode. At the end of this chapter typical display screens of the variables are shown. Chapter 7 contains definitions of the variables.

Menus
Refer to figures 5-1 and 5-2
After power-up, the flowmeter always returns to the "Measurement" mode, with the display showing Flow. Commands and control parameters are entered into the flowmeter using menus shown on the display. To cause the menus to appear, press the **Esc** key. Some menus display the available options, (e.g., "Pipe" or "Open Channel" mode), and you choose between them; in most cases, you need to enter data. The next section describes how to access these options.

Stepping through menus
Seven keys are used to navigate through the various menu options and to move through lists of parameters. The keys are the four cursor keys, plus **Enter, Esc** and **M** (or **Measure**). The shift key is not used. On the hand-held terminal, the cursor keys are:

↑,	or alternatively **U** on a PC	to move	Up.
↓,	or alternatively **D**	to move	Down.
←,	or alternatively **L**	to move	Left.
→,	or alternatively **R**	to move	Right.

The **Up**, **Down**, **Left, Right** keys enable you to select the required menu and to choose among the items within it.
- Pressing ↑, **U** displays the previous menu or item in the list
- Pressing ↓, **D** displays the next menu or item in the list
- Pressing ←, **L** displays the same parameter but for the previous path, level or analog output.
- Pressing →, **R** displays the same parameter but for the next path, level or analog output.

The cursor keys do not cause a wraparound from top to bottom, or from left to right.
If the **Up** key is held, the highest menu or the top parameter in the list is selected.
If the **Down** key is held, the lowest menu or the lowest parameter in the list is selected.
If the **Left** key is held, the display to the extreme left, (TENV), or the parameter for section 1 is selected.
If the **Right** key is held, the display to the extreme right (Level Input), or the parameter for section 4 is selected.

The **Enter** key invokes the currently active selection. For example,
• if you have stepped through to SECTION PARAMETERS and press Enter, you enter the Section parameter list, at the topmost parameter, Sn PATH ENABLE, where the characters "Sn" indicate the Section Number.
• If you type in a new value for a parameter and press enter, the new value is entered.
• If you have stepped through to MEASURE and press Enter, the system will enter "Measure" mode.

The **Esc** key (or **Z**) steps you out of Measure mode or out of a current list to the top of the menu. It may be pressed from anywhere in the list.

Pressing the **Measure** key (or **M**) when in any menu list, returns the flowmeter to the Measure mode.
Any changed parameters will be stored in non-volatile memory (provided that the parameter *Parameter Store* in the System menu is set to 1). A message "STORING PARAMETERS" appears briefly on the terminal screen to confirm that the storing has been done.

If the parameter *Parameter Store* in the System menu is set to 0, a separate "STORE" command is required to save the parameters to non-volatile memory if this is desired.

If the flowmeter is left in any menu, it will automatically return to the Measure mode and store any changed parameters, after a delay of about 60 seconds.

Other key operations
• **Reset** (or **#** or **S**) causes a system reset. Deletes all parameter changes unless they have been stored.
• In "Measure" mode, the **L**eft and **R**ight keys enable you to select alternative display screens.
• **Display** (or **T**) while viewing Variables stops the updating of the terminal display. Press again to restore updating. This is done to omit screen data from appearing on the hand-held RS232 output.
• **Pause** (or **P**) in "Measure" mode causes the flowmeter to "pause." This enables the user to compare data such as travel times, difference times and velocities, which have been computed from the same measurement cycle.
The flowmeter automatically returns to the Measure mode after 60 seconds or if **P** is pressed again.

The Menus and Commands are:

SYSTEM PAR's: One list of basic system parameters.
SECTION PAR's: Up to four parallel lists, one for each flowmeter section.
PATH PAR's: Up to ten parallel lists, one for each path.
LEVEL INPUT PAR's   Up to four parallel lists, one for each analog Level input.
ANALOG OUT PAR's   Up to eight parallel lists, two for each analog output.
RELAY PAR's   Up to 16 parallel lists, one for each Relay.

Then there are two command menus:
1. MEASURE: To put the flowmeter into the normal "Measure" mode.
2. SYSTEM ACTIONS:
    STORE ALL PARS: To store parameters once they have been entered correctly.
    RESTORE ALL PARS: To recall the stored parameters from non-volatile memory.
    XMIT PARAMETERS: To transmit the complete parameter list to a data terminal.

SYSTEM STATS: Data on the software revision for information only.
                                 Facility to set the real-time clock and baud rate for the Hand-held terminal port..

LOGGING TO FLASH   Facility to set the Variables to be logged and the interval between logs
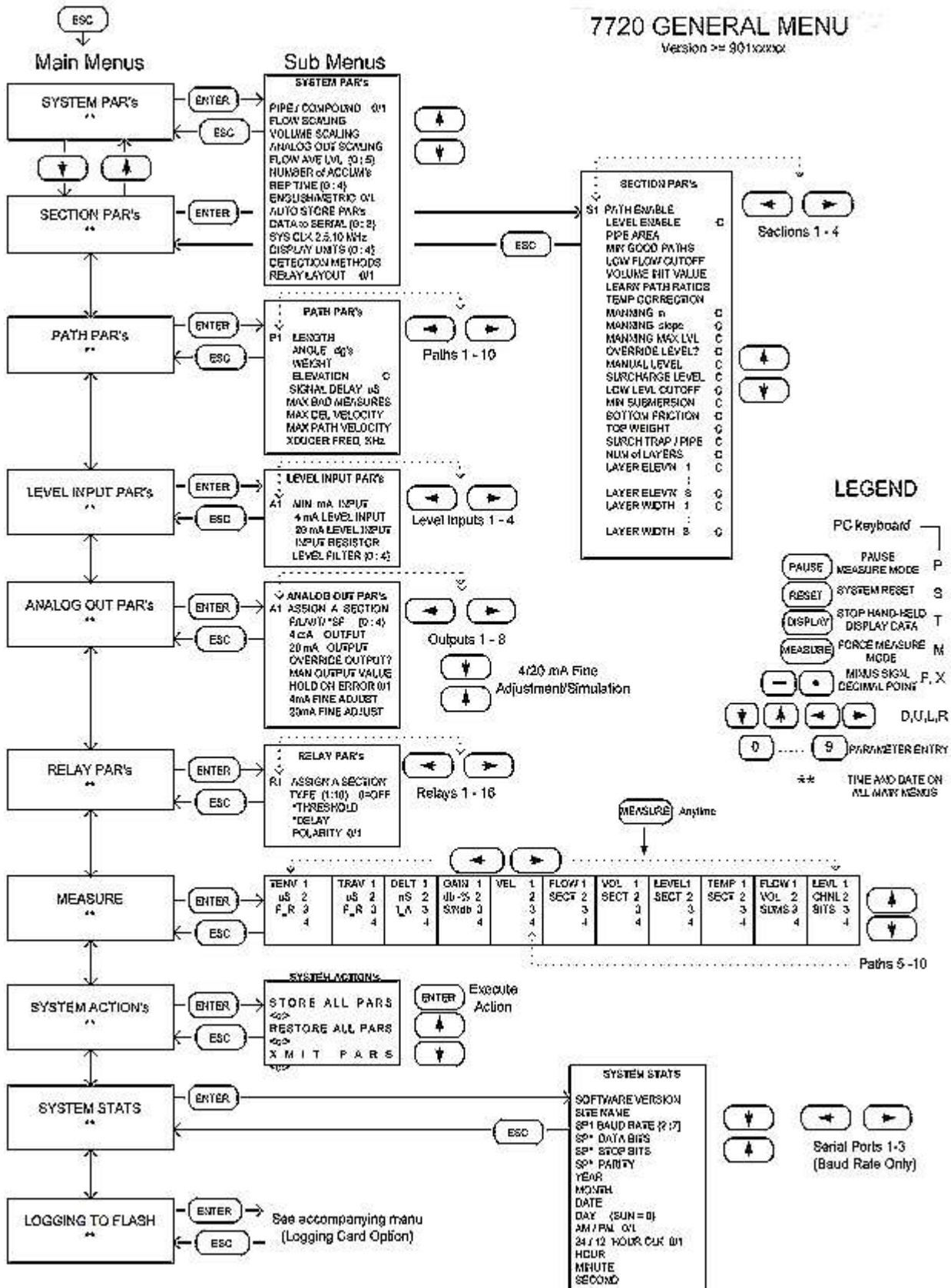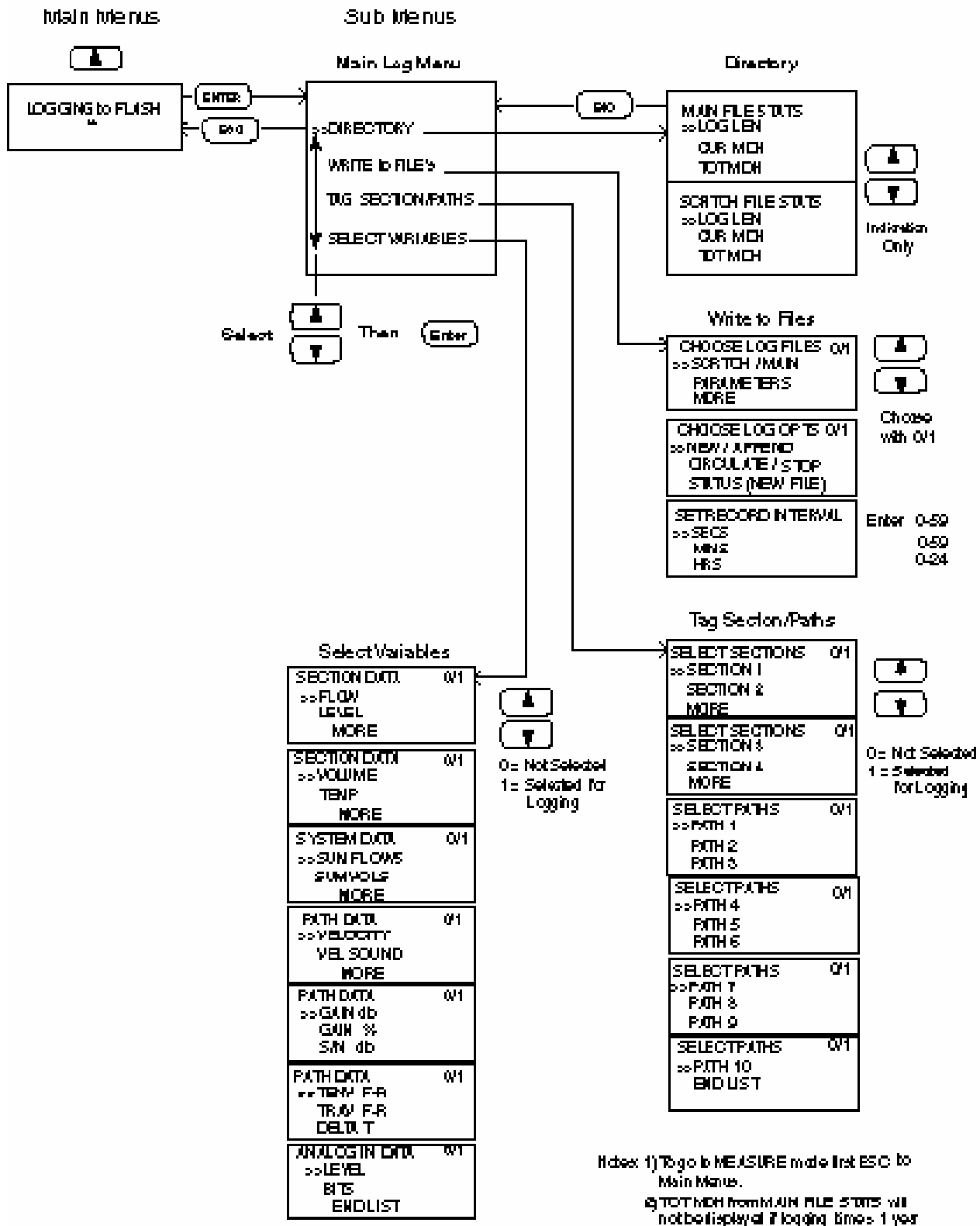
Figure 5-1

Figure 5-2

Parameter Data Entry

All parameters are entered using the same method. If the current value of the displayed parameter is correct, then step on to the next (either down or to the right, or as desired).

The keys on the terminal used for data are:

Numbers 0 through 9,   - sign (with F), decimal point (with x)

An example of the method of data entry follows, starting from the normal "Measure" mode:

Action	Terminal display shows	Comments
Press **Esc**	The Menu last used.	Measurements cease.
Press ↑, (**U**) until you get	SECTION PAR's	Step up past other lists
		This is the Section menu heading.
	09–16–96	Date: Month - Date - Year.
	14 : 28 : 56	Time: Hrs : Mins : Secs.
Press **Enter**	SECTION PAR's	
	S1 PATH ENABLE	First parameter in Section 1
	CUR = 0000000000	Current value, no path enabled
	ENT =	Place to enter a new value.
Press **11**	SECTION PAR's	
	S1 PATH ENABLE	First parameter in Section 1
	CUR = 0000000000	Current value, no path enabled
	ENT = 11	The new value. Paths 1 & 2 enable
Press **Enter**	SECTION PAR's	
	S1 PATH ENABLE	First parameter in Section 1
	CUR = 11	Current value, paths 1 & 2 enabled
	ENT = 11	The new value.
Press ↓, (**D**) twice	SECTION PAR's	
	S1 PIPE AREA	Third parameter in Section 1
	CUR = 25.732	Current value,
	ENT =	Place to enter a new value.

If you return to look at the Path Enable parameter of section 1, the display will be:

	SECTION PAR's	
	S1 PATH ENABLE	First parameter in Section 1.
	CUR = 1100000000	Current value, paths 1 & 2 enabled.
	ENT =	Place to enter a new value.

To return to the "Measure" mode:

Press **Esc** then **Measure** (**M**)	FLOW 1 47.54 MN 1	Flow in Section 1, in Manning mode
	SECT 2 LEVEL<CUTOFF	Flow in Section 2, Level too low.
	3	Section 3 not enabled.
	2 4	Section 4 not enabled

Typical Parameter List

(for a circular conduit, 10 ft. diameter)

Note: The parameters for configuring the Data Logger are not included in this listing.

** SYSTEM PARAMETERS **   One list for the whole flowmeter.

PIPE / COMPOUND 0/1	1	
FLOW SCALING	1.0000	
VOLUME SCALING	1000	
ANALOG OUT SCALING	1.0000	Factory setting depending on output module.
FLOW AVE LVL {0 : 5}	3	5 minute averaging for flow.
NUMBER of ACCUM's	1	
REP TIME {0 : 4}	1	1 second
ENGLISH / METRIC 0/1	0	English units (feet)
AUTO STORE PAR's	1	
DATA to SERIAL {0 : 3}	0	
SYSCLK 2, 5, 10 MHz	10.000	Paths less than 50ft (15m)
DISPLAY UNITS {0 : 5}	5	No units displayed.
DETECTION METHODS	0	Automatic

** SECTION PARAMETERS **   Separate list for each section.
** SECTION 1 **

S PATH ENABLE		1111000000	(Shows a four-path configuration.)
S LEVEL ENABLE	C	1100	Two level inputs are available for use.
S PIPE AREA		78.5	Used only under surcharged pipe mode conditions.
S MIN GOOD PATHS		1	Used only under surcharged pipe mode conditions.
S LOW FLOW CUTOFF		0.1000	
S VOLUME INIT VALUE		0	
S LEARN PATH RATIOS		0	
S TEMP CORRECTION		0	
S MANNING n	C	0.013	
S MANNING slope	C	0.010	
S MANNING MAX LVL	C	4.0000	Manning not used above this level.
S OVERRIDE LEVEL?	C	0	Level obtained from the analog inputs.
S MANUAL LEVEL	C	6.0000	
S SURCHARGE LEVEL	C	10.000	
S LOW LEVL CUTOFF	C	0.4000	
S MIN SUBMERSION	C	0.3000	
S BOTTOM FRICT'N	C	0.8000	
S TOP WEIGHT	C	0.1	
S SURCH TRAP / PIPE	C	1	Switches to Pipe mode when surcharged
S NUM of LAYERS	C	8	
S LAYER ELEV'N 1	C	0.0000	Note: This set of layer parameters gives a good
S LAYER ELEV'N 2	C	0.5000	representation of a circular conduit or pipe of 10 ft.
S LAYER ELEV'N 3	C	2.0000	diameter. For a different diameter, multiply each
S LAYER ELEV'N 4	C	4.0000	*LAYER ELEV'N.* and *LAYER WIDTH* by diameter/10.
S LAYER ELEV'N 5	C	6.0000	
S LAYER ELEV'N 6	C	8.0000	
S LAYER ELEV'N 7	C	9.5000	
S LAYER ELEV'N 8	C	10.000	
S LAYER WIDTH 1	C	1.1600	
S LAYER WIDTH 2	C	4.7200	
S LAYER WIDTH 3	C	8.2300	
S LAYER WIDTH 4	C	9.9300	
S LAYER WIDTH 5	C	9.9300	
S LAYER WIDTH 6	C	8.2300	
S LAYER WIDTH 7	C	4.7200	
S LAYER WIDTH 8	C	1.1600	

```
** PATH PARAMETERS **                                  Separate list for each Path.
** PATH 1 **
P  LENGTH                          12.000
P  ANGLE              dg's         45.000
P  WEIGHT                          0.1382              Used in surcharged pipe mode conditions
P  ELEVATION             C         0.95                Elevation used in non-surcharged conditions
P  SIGNAL  DELAY         us        12.000
P  MAX  BAD  MEASURES              10
P  MAX  VEL CHANGE                 1.0000
P  MAX PATH VELOCITY               10.000
P  XDUCER  FREQUkHz                500.00


** LEVEL  INPUT  PARAMETERS **                         Separate list for each input.  Not used in "Pipe" mode.
** LEVEL  1  **
A    MIN  mA  INPUT                4.100
A    4mA  LEVEL  INPUT             0.0000
A  20mA  LEVEL  INPUT              12.000
A  INPUT  RESISTOR                 100.00
A  LEVEL FILTER  {0:4}             2


** ANALOG  OUTPUT  PARAMETERS **                       Separate list for each output.
** ANALOG  OUT 1 **
A  ASSIGN  A  SECTION              1
A  F / L / V / T / *SF   {0 - 4}   0
A    4mA   OUTPUT                  0.0000
A  20mA  OUTPUT                    1000.0
A  OVERRIDE  OUTPUT                0
A  MAN  OUTPUT  VALUE              0
A  HOLD  ON  ERROR  0 / 1          0
A  4 /0  mA  ERROR  0 /1           0


** RELAY PARAMETERS **                                 Separate list for each output.
** RELAY  1  **
R  ASSIGN A SECTION                2
R  TYPE  (1 : 10)  0 = OFF         1                   Section Flow >  Max 1
R  *  THRESHOLD                    160
R  *  DELAY                        5
R  POLARITY  0 / 1                 0

** SYSTEM  STATS **
SOFTWARE  VERSION                  8371491
      SITE NAME                    Special             A name enterable only via Accuflow
      BAUD  RATE                   6                   19200 baud
      DATA  BITS                   8
      STOP  BITS                   1
      PARITY                       0
      YEAR                         98
      MONTH                        04
      DATE                         20
      DAY  (SUN=0)                 1
      AM / PM  0/1                 1
      24 /12  HOUR CLOCK  0/1      0
      HOUR                         14
      MINUTE                       28
      SECOND                       56
```
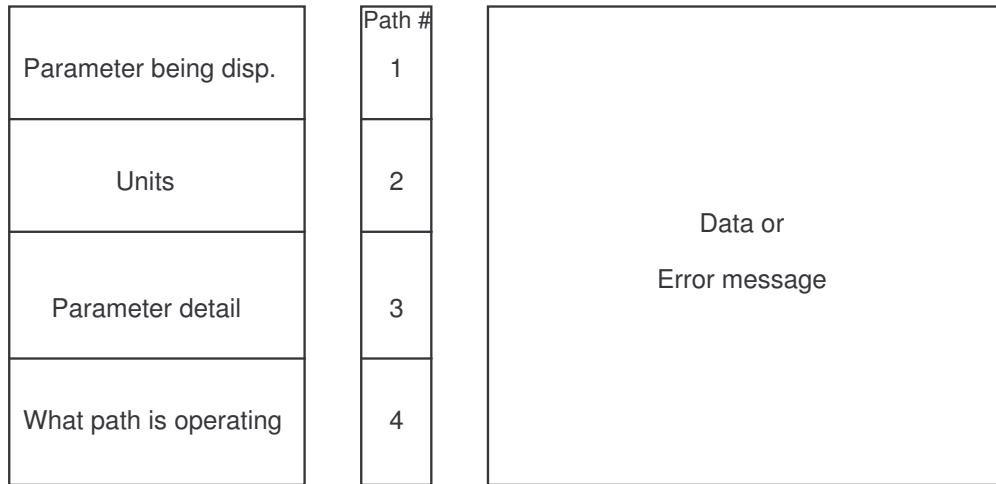
Display of Variables

All the display screens for the Variables have the following format.

	Path #	
Parameter being disp.	1	
Units	2	Data or Error message
Parameter detail	3	
What path is operating	4	

Variables are displayed only when the flowmeter is in "Measure" mode. Immediately after power up, the flowmeter will enter the "Measure" mode, and display whichever display had been selected when the flowmeter was last put into "Measure" mode..

When displaying variables concerning Path data (TENV, TRAV, DELT, GAIN, VEL), the Up and Down cursor keys enable the screens for the higher numbered paths (4 through 8) to be displayed.

Examples of typical screens from the most left (TENV) to most right (Level) are:

```
TENV 1 1087      1089        Forward and Reverse Envelope times for path 1 in µs
 us   2 1135      1138        Indication of units of display µs,   Envelope times for path 2
 F_R  3                       Indicates that first value is Forward time, second is Reverse time
  2   4                       blanks indicate path 3 and path 4 are not enabled


TRAV 1 1079      1081        Forward and Reverse Signal travel time through water for path 1 in µs
 us   2 1128      1031        Forward and Reverse Signal travel time through water for path 2 in µs
 F_R  3                       As for TENV
  2   4                       As for TENV


DELT 1 2107      2215        Instantaneous and averaged Travel time difference for path 1,  in ns.
 ns   2 3471      3385        Indication of units of display, nano secs.  Travel time difference path 2,
 I_A  3                       Indicates first value is instantaneous, second value is averaged.
  2   4                       As for TENV


GAIN 1  10   97   38         Path 1 Amplifier gain in dB,  signal in % of max.  signal / noise in dB
dB-%  2  27  103   22         Path 2 Amplifier gain in dB,  signal in % of max.  signal / noise in dB
S/NdB 3                       Indication of units of display.   Blanks indicate Paths 3 & 4 not enabled.
  2   4                       Changing number after P, indicates which paths are operating,
```

VEL	1 8.7543	4765	E	Water velocity path 1, Velocity of sound path 1. Detection method
	2 9.7564	4768	Z	Water velocity path 2, Velocity of sound path 2. Detection method
	3			Path 3 not enabled
2	4			Path 4 not enabled

FLOW	1 25.583	MN	1	Flow in section 1, Manning formula in use, Level #1 value used
SECT	2 157.48	SP F	4	Flow in section 2, Single Path Integration, Pipe Full, Level #4 used
	3			Section 3 not configured
2	4			Section 4 not configured

VOL	1 2367854.		Volume Section 1.
SECT	2 985.3731		Volume Section 2.
	3		Section 3 not configured
2	4		Section 4 not configured

LEVEL	1 3.8682	MN	1	Arbitrated Level value for section 1, using Level input # 1
SECT	2 16.793	SP F	4	Arbitrated Level value for section 2, using Level input # 4.
	3 0.0000	4094		Section 3 Level not configured
2	4 0.0000	4094		Section 4 Level not configured

TEMP	1 56.789	MN	1	Water temperature in Section 1
SECT	2 57.234	SP F	4	Water temperature in Section 2
	3			
2	4			

FLOW	183.06	The sum of the Flows in Section 1 & 2
VOL	2368839.	The sum of the Volumes in Section 1 & 2
SUMS		Indicates that this display is for the sum of the section data
2		

LEVEL	1 3.8682	750	Level input #1 value, Analog input = 750/4095∗50 = 9.157 mA
CHNL	2 0.0000	217	Level input #2 value, Analog input = 217/4095∗50 = 2.65 mA
BITS	3 10.005	4094	Level input #3 value, Analog input 50 mA
2	4 16.793	1437	Level input #4 value, Analog input = 1437/4095∗20 = 17.54 mA

Note
The figures for Analog Input assume an input load of 100Ω
In "Pipe" mode, the Level displays have no meaning

Serial Data Format on RS232 Hand-held Communication Port

When the System Parameter *Data to Serial* is set to 1, the data stream is output each measurement cycle.
Data are only output for sections, stages or paths which are configured.
A typical data string for a dual section flowmeter with Terminal Display Off (**Display** or **T** pressed).
Note: If the terminal display is left on, extra characters are inserted in between logs. The extra characters are those that are changed on the screen, therefore, the format is not fixed.

LDF125583#LDF2157480#LDO1183435#LD02746400#LDS14538#LDS20#LDS310005#LDS416793#LDT12#LDT24#LDE153#LDE248#LDV110006#LDV2263#LDG116#LDG227#LDC14798#LDC4796#LDB194#LDB298#

where

LDF125583#	Log Data Flow Section 1	= 25.583
LDF2157480#	Log Data Flow Section 2	= 157.480
LDO1183435#	Log Data Volume Section 1	= 183435
LDO02746400#	Log Data Volume Section 2	= 746400
LDS14538#	Log Data Level #1	= 4.538
LDS20#	Log Data Level #2	= 0
LDS310005#	Log Data Level #3	= 10.005
LDS416793#	Log Data Level #4	= 16.793
LDT12#	Log Data Integration Type Section 1	= 2 See below
LDT24#	Log Data Integration Type Section 2	= 4 See below
LDE153#	Log Data Temperature Section 1	= 53
LDE248#	Log Data Temperature Section 2	= 48
LDV110006#	Log Data Velocity Path 1	= 10.006
LDV2-263#	Log Data Velocity Path 2	= - 0.263 Reverse flow.
LDG116#	Log Data Gain Path 1	= 16dB
LDG227#	Log Data Gain Path 2	= 27dB
LDC14798#	Log Data Velocity SND Section 1	= 4798
LDC24796#	Log Data Velocity SND Section 2	= 4796
LDB194#	Log Data Gain Path 1	= 94%
LDB298#	Log Data Gain Path 2	= 98%

The types of Integration are: 0 = No integration, section failed
                                               1 = "Pipe"
                                               2 = Manning
                                               3 = Single path
                                               4 = Full
                                               5 = Multi-path.

RS232 signals   19200 baud, 8 data bits, no parity, 1 stop bit, no handshaking protocol.
                                The baud rate may be changed by changing a parameter under SYSTEM STATS.

Serial Data Formats on Optional RS232 Communication Port 3

When the System Parameter *Data to Serial* is set to 2, the following data stream (called "Argus") is output every 30 measurement cycles.

T ±FFFFF SSSS TTTT UUUU EEEE +00000 00

Where ±FFFFF is the flow x 100, SSSS arbitrated level x 1000, TTTT is Level one x 1000, UUUU is Level two x 1000.

When the System Parameter *Data to Serial* is set to 3, the following data stream (called "Drax") is output every measurement cycle.

±vvvv ±wwww ±xxxx ±yyyy aaaa bbbb cccc dddd

Where the first four fields are the water velocities x 1000, and the second four are the velocities of sound for paths 1 to 4. All the values are instantaneous, with no filtering.

Display of Variables on the Optional LCD

Depending on the number of sections which have been configured, different display formats are provided.

If only one section is configured in "Compound" mode, the display format can be chosen to be either:

```
| FLOW    25.583    1 /s  |
| VOL       2367854. Cm   |
```

or:

```
| FLOW    25.583    1 /s  |
| LEVEL   3.8682     m    |
```

The selection is made depending on the display screen chosen for the Hand-held terminal, when the measure mode is entered.
To select "Flow and Volume" to be displayed, from Measure mode, select any of the Hand-held terminal screens, then press **Esc** then **Measure**.
To select "Flow and Level" to be displayed, from Measure mode, select the "Level" screen on the Hand-held terminal, then press **Esc** then **Measure**.

If only one section is configured in "Pipe" mode, the display format is always of Flow and Volume.:
The units of Flow and Level are selected by the parameter *DISPLAY UNITS* in the System menu.

If two sections are configured in "Compound" mode, the display format is:

```
| FW 25.583  157.48 1 /s  |
| LV  3.8682   16.793 m   |
```

If two sections are configured in "Pipe" mode, the display format is:

```
| FW 56.987  157.48 1 /s  |
| VL  67854.  985.37  Ml  |
```

If three or four sections are configured in either "Compound" or "Pipe" mode, the display shows the variable selected for display on the Hand-held terminal. (Flow, Volume, Level or Temperature).
The variable and units are shown to the left of the screen.
The values of the variables for sections 1 & 2 are on the top row, for sections 3 & 4 on the bottom row.

```
┌──────────────────────┐
│FW1  25.583  2 157.48 │
│1/s 3  67.543  4  98.765 │
└──────────────────────┘
```

Operation of Integral Data Logging

The integral Data Logger may be configured to store any of the flowmeter variables. It can be setup through the hand-held terminal, or the AccuFlow Windows® interface. The data may be retrieved only through use of AccuFlow.

Operation through AccuFlow is described in Chapter 6, while the hand-held terminal parameters for the Data Logger are described in Chapter 7. Refer to data logging menu figure 5-2.

The method of setting the Data Logger parameters using the Hand-held terminal differs from that for setting most other flowmeter parameters, in that all the settings (except the time interval) are choices of whether to select or not to select a particular option. To select an option, simply press the **1** key; to omit the option, press the **0** key.

To configure the logger, escape from Measure mode and go down through the various menus using the ↓ key to the last menu "Logging to Flash". Press **Enter.**

Four menus will be presented:

DIRECTORY	Gives information on the length of the log and the time before the log file is full.
WRITE TO FILEs	Offers choices of which file to use (Scratch or main), other options and the "*RECORD INTERVAL*" or period between logs.
TAG SECTION / PATHS	Offers choices of which Sections and Paths are in use and for which data are required to be logged.
SELECT VARIABLES	Offers choices of the variables to be logged for the previously selected Sections and Paths.

To select a particular menu, use the ↑ or ↓ keys to move the cursor (**>>**) to the desired menu, and press **Enter**.

To select a particular item, use the ↑ or ↓ keys to move the cursor (**>>**) to the desired item, and press **1**.

To set the *RECORD INTERVAL*, set the time in seconds, minutes and hours by typing in the required figures for the units of time pointed to by the cursor.

Notes: The **Enter** key is not used for this routine.
The flowmeter will not automatically return to the Measure mode from the LOGGING TO FLASH menu. To return to Measure and (if set) to log data, first exit to the main menu by pressing **ESC**, and then press **Measure** or the **M** key

Chapter 6
"Accuflow" Windows Interface

This Chapter describes the alternative method of setting-up and operating the flowmeter using the Windows interface.
(Note: The instrument will not be damaged by entering incorrect parameters.)

Application Overview

The Accusonic Flowmeter Windows application, Accuflow, provides a user friendly interface to the flowmeter. From the application, the user can enter and examine flowmeter parameters, control the flowmeter measurement cycle, graph real time or historical data, and conduct diagnostic tests.

A wizard interface is provided to make common tasks easier by providing step-by-step instructions. From the wizard the user can load in the last used configuration, open an existing configuration, look at previously logged data graphically, connect to a flowmeter and begin measurements, or setup flowmeter parameters through use of the setup wizard.

The main application window provides the user with the ability to setup system and flowmeter parameters, control the flowmeter measurement mode, display graphical data, manage data logging operations, and use a variety of flowmeter diagnostics.

Wizard Interface

The wizard interface provides step-by-step instructions to the user to accomplish ordinary tasks. Each step will consist of a dialog window that will "ask" the user for information about what is required, or about setup parameter information. Every step has an available help button, and pressing F1 will bring up context sensitive help on the specific step. The main wizard interface provides buttons for the following tasks:

Receive Parameters from Flowmeter

When this button is selected, the application in the PC will connect with the flowmeter and request its parameters. After having successfully received the parameters, the user is given the option of saving them in a file.

Send Parameters to Flowmeter

When this button is selected, the application in the PC will send the parameters contained in the PC to the flowmeter. The parameters may have been from a file that was opened or a configuration that was created using the wizard. Any parameters the flowmeter had stored will be overwritten.

Setup Wizard

The setup wizard provides step-by-step instructions to setup all the parameters necessary to operate a flowmeter. The setup procedure is broken down into the following steps, each of which has its own dialog window:

Firmware Version Window
In this setup wizard window, the user inputs the firmware version of the flowmeter that is being interfaced. Inputting the correct firmware version will ensure proper parameter transfer.

Sections Window

In this setup wizard window the user enters the number of sections that the flowmeter will be measuring. A section is any single pipe, conduit, channel, river, etc. where flow is to be measured. So if there are two pipes, there are two sections. In addition, the user will enter the type of section, open channel, pipe, or compound. An open channel is a section that is never full, a river or canal, for example. A pipe is a section that is always full, like a water main. A compound section can be full at some times, but not full at others. Sewers are usually compound sections.

Units of Measure

In the measurement wizard window, the user selects the units in which flow and volume are to be measured and reported. Standard choices are provided for flow and volume, but the define buttons give the user the option of defining units that are not on the list. After selecting the define button, the user is asked for a unit name, and a scale factor. The unit name will be displayed on graphs and future menu choices, and is added to the list of standard units. The scale factor is a value by which the flow or volume measurements are to be multiplied in order to convert the measurements to the desired units. The flowmeter measures flow in cubic feet per second (CFS) and volume in cubic feet when English units are chosen, and measures flow in m^3/s and volume in m^3 when metric units are chosen. The scale factors must be chosen to convert from these units. For example, To convert the flow measurement units to $m^3/hour$, the scale factor is 3600. This factor essentially converts seconds to hours.

In addition, the flow averaging period is entered. The flow averaging period is the amount of time that the flow measurements will be averaged over.

Path Enable Window

In the path enable wizard window, the user will assign paths to a section by using the path checkboxes. At least on path must be enabled to move on. Then the low flow cutoff may be entered. If the absolute value of the computed flowrate is below the low flow cutoff, the flow is set to zero.

If the section always runs full (pipe mode), then the window will also ask for the section's shape and size, as well as the minimum number of good paths and whether learn path ratios should be on. The minimum number of good paths is the number of good path measurements which must be present to calculate flow. The contribution to the flow calculation from any failed paths will be provided by the replacement routine. The default is 4.

Learn path ratios enables a "learning" run that records information that is used in the case of path failures. In the event of one or more paths failing, a routine is implemented which enables flow to be computed from the remaining good paths. The contributions towards the flow measurement from the failed paths is replaced by a figure generated from the remaining good paths, weighted by the historic flow contribution ratios for all the paths. A table of time-averaged historic flow components is recorded during commissioning, involving about 1000 readings. The record is made automatically by the flowmeter in what is termed a "learning" run. The "learning" routine is implemented by checking the Learn Path Ratios checkbox. The learning run may be stopped by unchecking the checkbox, or allowing the flowmeter to complete the 1000 readings.

If the section does not always run full (open channel or compound), bottom friction and top weighting coefficients are to be entered. The bottom weighting and top weighting coefficients are used to extrapolate the velocities from the lowest and highest paths to the section bottom and/or top (or water surface).

Section Shape

For sections that do not always run full (open channel or compound), the section shape is requested. The section shape window gives two choices, round and other. Round is for circular pipes (they are assumed to be perfectly circular). Other is for sections that cannot be described so easily.

Round

After selecting round for the section shape, the wizard asks for the radius of the pipe. This should be the inner radius. When "Round" is selected, all layer data are automatically computed by the wizard.

Other

After selecting "other" for the section shape, the wizard asks for the number of layers, their elevations and widths. The layers describe the size and shape of the section. These should be available from the survey data taken at installation.

Flow Calculation When Level is Surcharged

For compound sections only, the flow calculation method when the level is surcharged is requested. In this wizard window, the user selects the integration method to be used when the section is surcharged (running full). For more information about integration methods, please see Chapter 3. The default for round pipes is pipe integration. For other shapes, the default is trapezoidal integration.

Level Input Enable Window

For sections that do not always run full (open channel or compound), the level input enable window is displayed. In this wizard window, the user enables the analog inputs for level (stage) measurements by selecting the appropriate checkbox for the section. For pipe and compound sections, the user is also asked for the level at which the section is surcharged (full). The user should also enter the level below which flow is defined as zero. There is also an option to enter a manual value for the level input, overriding the analog inputs. If override analog level input is checked, an entry box becomes visible for a manually entered value. The value entered will override all flowmeter calculated level values, and the flowrate will be calculated on the basis of the manually entered level. This option may be used for testing purposes.

Level Input Setup

For sections that do not always run full (open channel or compound), the level input setup is requested. In this window the user enters the level values for 4 and 20 mA. For these values the user should enter the elevation of the water surface at which the analog input is 4.0 or 20.0 mA. For example, if at 10.0 feet, the analog input is 20.0 mA, enter 10.0 for "Level at 20 mA". This value may be in the range of -50 to 50. Also the level filtering period should be entered. This is the period, in measurement cycles, that the level inputs will be averaged over. For example, if the measurement update rate (repetition rate) is 2 seconds, and the level filtering period is 15 cycles, then the averaging period is approximately 30 seconds. The tabs at the top of the "notebook" window can be clicked to switch from one input to another.

Manning Parameters

For sections that do not always run full (open channel or compound), the Manning equation parameters are requested. In this wizard window, the user is asked if they wish to use the Manning formula, and if so, for the parameters necessary. For more information on the Manning formula, see Chapter 3.

Path Setup

This window prompts the user for path parameters. The path length, angle, and elevation should be available from the survey data. The transducer model number should also be available in the as built data. If a new transducer model number needs to be added, select the "add to list" button. After that, a transducer model number, frequency, and signal delay must be entered. Elevations are not required for sections that always run full, and are not displayed.

Output Setup

In the output setup window, the user can define what section a given 4- 20 mA analog output is assigned to, what type of data is output, the output range and the output under error conditions. An output can be assigned to any active section, and can reflect flow, level, average velocity, temperature, or total flow data. In the 4 mA boxes the user should enter the value of the variable chosen for the analog output for which an output of 4.0 mA is desired.

For example, if flow has been chosen for output, and the units are m^3/s, enter -1.5 if it desired to have a 4.0 mA output at -1.5 m^3/s. 4.0 mA is the lowest valid output. A similar procedure should be used for the 20 mA entry. It is acceptable for the 4 mA output to represent a variable value that is either greater than or less than that of the 20 mA output

Under conditions where the chosen variable is below the selected range, 4 mA will be output. Under conditions where the chosen variable is over the selected range, 20 mA will be output. If a fault occurs, the output will either be held at the last known good value, or be set to 4 mA, depending on the choice made in the "On Error" box.

There is also an option to enter a manual value for the analog output, overriding the calculated outputs. If override analog output is checked, an entry box becomes visible for a manually entered value. The value entered will override all flowmeter calculated values, and the output current will be calculated on the basis of the manually entered value. This option may be used for testing purposes.

Relay Setup
In the relay setup window, the user can define what section a given relay is assigned to, what function the relay has, the threshold value, the polarity, and the delay before operation. Relays can be used as indicators that the section flow is over a threshold value, the section level is over a threshold, the sum of all the section flows is over a threshold, the section has failed, path substitution is active (pipe mode only), or as a section or sum of sections volume totalizer. For those functions that require it, the threshold value is entered in the appropriate units. The user can also define what polarity the relay is to be when operated. The delay before operation is in measurement cycles, so that if the measurement update rate (repetition rate) is 2 seconds, and the delay is 3 cycles, then the delay is approximately 6 seconds.

Open Setup
This choice allows the user to open a previously saved configuration file. A standard open file dialog box is shown, from which the user can select the desired file. Once the file is loaded, it can be used for flowmeter measurements, or can be modified.

Review Historical Data
The review historical data option allows the user to view graphs of previously logged data. When the button is selected, a flowmeter ID and data range window is displayed. In this window, the user selects the ID of the desired flowmeter. The start and stop date calendars will automatically update to show the full range of logged data for that flowmeter. The user can use the calendars to select a smaller range by clicking the arrows at the top of the calendars to change the month, and by clicking the desired date. The time is selected by using the list boxes below the calendars.

Once the ID and date/time range are selected, the user can choose which graph to be viewed. The *view data by variable* graph will display either flow or level for multiple sections. For example, in the view by variable graph, the user can graph flow for sections 1 through 4. Then they can select level for those sections. Flow and level cannot be graphed together on this view, however. The *view data by section* graph allows the user to look at flow, level and velocity for an individual section. Because there can be up to 10 velocity data curves in a section, the velocity graph is separate from the *flow/level* graph. If only one graph is selected, it will appear as a full page. If both flow/level and velocity are selected, they will share the screen. Please see "using graphs" for more information about their features.

Connect / Measure
If Connect / Measure is chosen, the application will connect to the flowmeter, and upload its parameters. The uploaded parameters will be used in building the graph. After parameter loading, measurements will begin, and the graph will start to display data. Initially, there is a delay in acquiring the data, and graph options are disabled. They are re-enabled when the initial acquire period is complete. Please see "using graphs" for more information about their features.

File Menu
The file menu provides access to basic file management operations.

File / New
File / New starts the setup wizard in order to allow the user to create a new configuration file. The configuration initially contains only the default values.

File / Open
Choosing File / Open opens an existing configuration file. When this menu choice is selected, the standard windows *open file* dialog box will appear with the current directory and *.cfg configuration files selected as defaults. Making a selection in this dialog and selecting OK will load in the selected configuration file. This will overwrite any previously loaded configuration. Once the file is loaded, it can be used for flowmeter measurements, or can be modified.

File / Save
This allows the user to save the currently loaded configuration file, while giving it a new name. An existing file name may be chosen, or a new name created. Choosing File / Save As opens the standard *save file* dialog box which is similar to the *open file* box described above.

File / Print
The File Print item allows the user to print the contents of the configuration file. This can be useful for record keeping. The print uses the Windows default printer, unless it is changed using the Setup button.

File / Exit
This item exits the flowmeter program.

Configure Menu
The configure menu allows the user to make modifications to the currently loaded configuration. The configure menu has the following choices:

Communications
The communications configure menu allows the user to make modifications to the communications setup. The flowmeter has particular communications formats, which are reflected in the defaults provided here. In most cases, the only two parameters that should require modification are the Comm. port number and the maximum consecutive communication errors.

Comm Port
The user chooses the communications port that is connected to the flowmeter.

Maximum Consecutive Communication Errors
This allows the user to enter the maximum consecutive number of communication errors that are to be tolerated without declaring a failure. The default is 3. A single communication error may take up to 10 seconds to confirm.

Dial Modem

The dial modem selection allows the user to choose a modem and a phone number, and establish a modem connection. After dial modem is selected, the user must choose a modem to use from the provided list. If "None" is chosen, that serial comm. port will be used directly with no modem, otherwise, the selected modem will be used. If a modem is selected, the next dialog requests a phone number to dial. The user can select a number from the list, or add one by clicking on "Add phone number". If the user wishes to configure the modem, click on "Set up modem". This will display the standard Windows95 modem properties dialog. Beware that these settings apply to all programs, not just AccuFlow. Once the phone number is entered, the modem will attempt a connection. It will retry 3 times, waiting one minute in between attempts. The connection attempt can be canceled at any time.

Hang Up Modem

The hang-up modem selection allows the user to break the existing modem connection and hang up the phone.

Get Flowmeter Version

When get flowmeter version is chosen, the application will attempt to connect with the flowmeter, and will ask for its version number. It will be reported to the user and stored in the current configuration.

System

The system configure menu allows the user to make modifications to the currently loaded configuration in the areas of section type, number of sections, measurement units, flowmeter RS-232 enabling, and other general parameters. For definitions of these parameters, please see the parameter definition section in Chapter 7.

Section

The Section configure menu allows the user to make modifications to the currently loaded configuration in the section parameter area. For definitions of section parameters, please see the parameter definition section in Chapter 7. From the section menu, the path, level, and relay setup windows can be accessed.

Path

The path setup window allows the user to make modifications to the currently loaded configuration in the path parameter area. For definitions of path parameters, please see the parameter definition section of this manual in Chapter 7.

Level Inputs

The level inputs setup window allows the user to make modifications to the currently loaded configuration in the level analog input area. For definitions of level parameters, please see the parameter definition section of this manual in Chapter 7.

Analog Outputs

The analog outputs configure menu allows the user to make modifications to the currently loaded configuration in the analog output area. For definitions of analog output parameters, please see the parameter definition section of this manual in Chapter 7.

Relay Setup

The relay setup configure menu allows the user to make modifications to the currently loaded configuration in the relay area. For definitions of relay parameters, please see the parameter definition section of this manual in Chapter 7.

Operate Menu

The operate menu provides the ability to connect to the flowmeter and send or receive parameters, to begin measurements, or to review historical data.

When *receive parameters* is selected, the application in the PC will connect with the flowmeter and request its parameters. After having successfully received the parameters, the user is given the option of saving them in a file.

When *send parameters* is selected, the application in the PC will send the parameters contained in the PC to the flowmeter. The parameters may have been from a file that was opened or a configuration that was created using the wizard. Any parameters the flowmeter had stored will be overwritten.

When *Connect / Measure* is chosen, the application will connect to the flowmeter, and upload its parameters. The uploaded parameters will be used in building the graph. After parameter loading, measurements will begin, and the graph will start to display data. Initially, there is a delay in acquiring the data, and graph options are disabled. They are re-enabled when the initial acquire period is complete. Please see using graphs for more information about their features.

When *Set Flowmeter Clock* is selected, a dialog will appear for the user to enter in the desired date and time to be sent to the flowmeter. It will default to the current time according to the PC clock. After making the desired entries, click on Set Meter Clock to send it to the flowmeter. If you wish to see the date and time according to the flowmeter, click on Get Flowmeter Clock.

Show Differences can be used to verify that the configuration sent to the flowmeter has been received and stored properly. When show differences is chosen, the application connects with the flowmeter and requests its parameters. When they are received, they are compared to the configuration currently loaded in the PC. The parameters in the PC are shown on the left as "Local Configuration", while the parameters on the right are the "Flowmeter Configuration". Only those parameters that are different are shown, so that if the configurations are identical, both lists will be blank. It is common for the section volume parameters to be different, as they are updated with every measurement. Clicking on the Re-Transmit Parameters button sends the PC configuration to the flowmeter. After it has been sent, it is read back and any differences are shown again.

The *Review Historical Data* option allows the user to view graphs of previously logged data. This function is the same as described in the wizard interface section.

Diagnostics Menu

The diagnostics menu allows the user to test the flowmeter system, and to view detailed path variables that are not ordinarily used. The diagnostics menu has the following choices:

Comm Port Test

If the Comm. port item is chosen, a window to test the Comm. port is opened. The comm. port test tests the function of the port on the PC. It does not test the flowmeter communications. Before testing the port, the user must put a wrap-around connector that connects the transmit and receive lines on the desired port. When the test port button is selected, the port will output patterns and read them back. It will compare the patterns to make sure that they are the same. If they are, it will display a good status in the memo box. If they do not match, it will display the expected pattern, and the actual pattern received.   If there is no response in one second, it will display a "no response" message.

The port menu item in the Comm. port test window can be used to configure and open the port. The Configure menu choice allows the user to set the desired port, the baud rate, number of data bits, parity, stop bits and flow control. These are set up initially to work with the flowmeter, and usually should not require modification. The

Open menu choice opens the desired port for communications. This must be done or a "no response" error will occur.

Path Variables

The path variables window allows the user to look at all the data coming from the flowmeter in tabular form. It is displayed as a multiple tab notebook. Each tab contains the variables for a given section. In addition, there is a settings tab that allows the user to choose only those variables and paths required. The user may choose to have the table continuously updated, or to pause the updates.

Before beginning measurements, the user is asked if the data are required to be logged. If so, the data logging menu is displayed. The data logging menu allows the user to enable and setup data logging to the PC. Checking enabled will allow data to be saved to the PC. The name of the data to be saved can have a maximum of 8 characters. This name is actually the sub-directory name where the data files will be stored. The data can be scheduled for every reading (about one every three seconds), or a set interval. The data recorded at the set interval, i.e. 15 minutes, will be the current value of the data, not an average. Once the setup is complete, clicking OK, will cause the measurements to begin.

This window is also used to display data log data. All of the variables below remain the same, but the PC is not connected to the flowmeter. The pause and resume buttons are replaced by record number and choose a new log controls.

The variables displayed are section, path and level variables, and are as follow:

Section
Section variables are flow, average level, section volume, average velocity, temperature, integration method, and section status. The status indicates if the section is full, has failed, has invoked path substitution because a path has failed, or is on a "learning" run.

Path
Path variables are velocity, gain (dB or %), signal-to-noise ratio, travel time, time difference, envelope time, path status (out of the water, failed, velocity error), and path detection method.

Level
Level variables are level and level status (good, greater than maximum layer height, below minimum level).

Scope Mode

Scope mode allows the user to look at the received transducer waveforms in a window that looks much like an oscilloscope. Scope mode will put the flowmeter into pipe mode, so that any selected paths will be active without regard to the water level, and will freeze the 4-20 mA analog outputs at their current values. The window displays the forward waveform in the top graph, and the reverse in the bottom graph. One path at a time may be displayed. The path to be traced may be set by using the Path Number spin control. There are a number of controls available. They are described below.

Single Sweep
When this button is clicked, the "oscilloscope" contacts the flowmeter and obtains the waveform to be displayed. Because of the volume of data, this process usually takes 3 to 4 seconds. Only one trace is taken in single sweep mode.

Continuous
When this button is clicked, the "oscilloscope" continuously contacts the flowmeter and obtains waveforms.

Pause
Clicking on the pause button stops the "oscilloscope from acquiring data after the latest waveform is taken. It is most commonly used to stop the continuous mode.

Mouse Control
When the mouse is moved into a graph that has a waveform displayed, a slidebar appears. It will follow the mouse until the mouse is clicked or the mouse exits the graph area. When the slidebar is visible, it's coordinates are displayed on the panel above the graph in engineering units (time and volts). Each graph can have its slidebar moved and set independently.

Zoom Level
Zoom level allows the user to control the length of the time period to be displayed. A value of 1 displays the smallest time period (usually 50 µS), or the maximum "zoom". A value of 8 displays the longest period (usually 400 µS). After the zoom level is selected, a new waveform must be obtained by clicking either single sweep or continuous.

Display Variables
If display variables is checked, velocity, gain, time difference, and travel time will be obtained in addition to the waveform.

Waveform/Envelope
This control is used to select what kind of waveform is displayed. Waveform displays the actual received signal. Envelope displays the envelope of the received waveform as computed by the flowmeter.

Build History
Normally, an old waveform is erased every time a new waveform is obtained and displayed. Build history allows the waveforms to display on top of each other. This can show any differences from measurement to measurement.

Restore Paths
Clicking restore paths will set the path enables and the pipe/open channel mode back to the state they were in prior to entering scope mode. The analog outputs will also become active.

Open File
A previously saved file can be opened and displayed. The variables are not active.

Save File
The currently displayed waveform is saved as a *.dat file.

Erase
Clicking the erase button clears both graphs.

Print
Print prints a copy of the scope mode window.

Flowmeter Reset

If flowmeter reset is selected, the application will attempt to connect to the flowmeter and send its reset command. A reset is the software equivalent of flipping the on/off switch.

DataLogging Menu

The DataLogging menu allows the user to set up and retrieve data logs stored in the flowmeter. The DataLogging menu has the following choices:

Data Log Setup

Choosing DataLogging/Data Log Setup from the main menu allows the user to set up the parameters for data logging at the flowmeter. This capability is optional, and requires the flowmeter to have the data logging memory card.

First choose the kind of log file you desire, main or temporary. The main file provides 192k of capacity, while the temporary provides only 16k. Typically, the temporary memory is used only for short term debugging. In addition, a measurement status can be logged with every measurement by checking "Log Status". The parameters in use may also be recorded by checking "Log Parameters". Normally, the log will overwrite memory when the logging memory is completely full, always keeping the most recent data. To prevent any overwriting, check "Stop logging when memory is full". Next, choose a logging interval in hours, minutes and seconds. The maximum interval is 24 hours.

Finally, choose the sections, paths and variables you wish to log. When complete, click on "Send Setup to Meter", and the parameters will be sent to the meter, and logging will begin. This action will start a new logging file, so any previous data will be overwritten. You can also view the flowmeter setup by clicking "Get Meter Setup", the meter must be in measure mode for successful setup transfer.

As changes are made to the setup, the amount of memory capacity in terms of logging hours is displayed. For example, if you log section 1 flow at 1 hour intervals, the memory capacity is 98,280 hours (about 11 years). The message will say you have chosen 2 parameters because time is always logged.
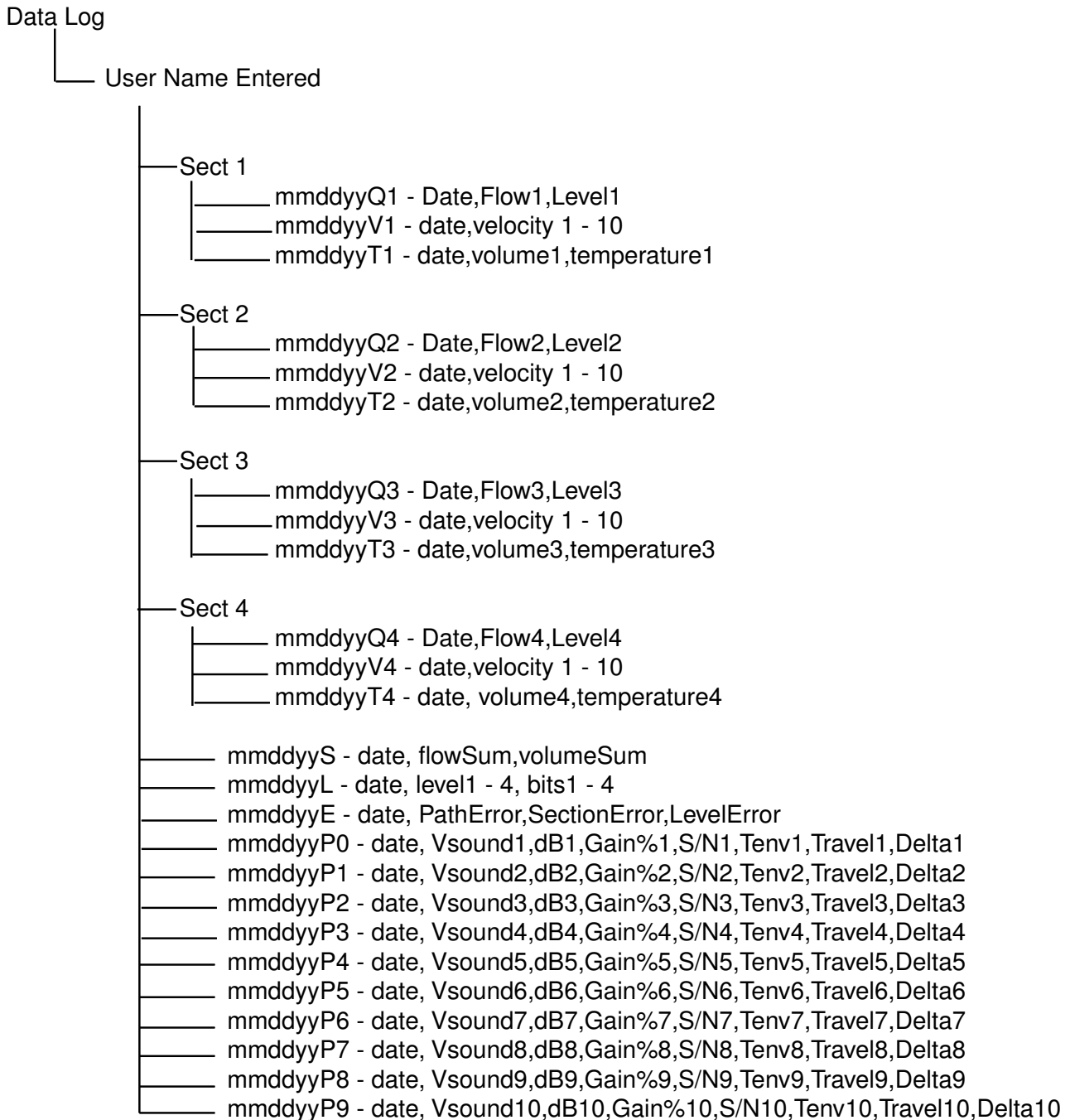
Retrieve Logged Data

Choosing DataLogging/Retrieve Logged Data from the main menu allows the user to retrieve data that has been logged at the flowmeter. This capability is optional, and requires the flowmeter to have the data logging memory card.

First, choose how much data to retrieve, the "most recent", or "all data". If you choose most recent, you must click on the "Retrieve Directory" button. This will provide you with the number of "blocks" available, and the number of hours of data stored in a block. Choose the number of blocks you wish to retrieve. For example, if 8 blocks are available, each with 1 week of data, and you wish to retrieve 2 weeks of data, select 2 blocks.

Next, choose a data name. This name has a maximum of 8 characters, and cannot have spaces or special characters. Now click on "Retrieve Data". Each data block takes about 45 seconds to retrieve. If the data is corrupted, this time can be longer. If you check for confirmations, you will be given the option of not retrieving a particular block.

Once the data is retrieved, it is stored in the data_log directory in a sub-directory with the name you provided. Flow, level and velocity are stored in section sub-directories, and can be viewed in "Review Historical Data." Section volume and temperature are also stored in the section sub-directories. The sum of flows and sum of volumes are stored in the "S" file, path data is stored in "P" files, and level data is stored in the "L" file. The file names will contain the date and the above code. For example, if the data log began on May 25, 1997, the data for path 1 (VSound, gains, times) will be stored in a file named "05297PO". All files are comma delimited text that can be imported into spreadsheets.

Logged Data Directory Structure

Data Log
└── User Name Entered
    ├── Sect 1
    │   ├────── mmddyyQ1 - Date,Flow1,Level1
    │   ├────── mmddyyV1 - date,velocity 1 - 10
    │   └────── mmddyyT1 - date,volume1,temperature1
    │
    ├── Sect 2
    │   ├────── mmddyyQ2 - Date,Flow2,Level2
    │   ├────── mmddyyV2 - date,velocity 1 - 10
    │   └────── mmddyyT2 - date,volume2,temperature2
    │
    ├── Sect 3
    │   ├────── mmddyyQ3 - Date,Flow3,Level3
    │   ├────── mmddyyV3 - date,velocity 1 - 10
    │   └────── mmddyyT3 - date,volume3,temperature3
    │
    ├── Sect 4
    │   ├────── mmddyyQ4 - Date,Flow4,Level4
    │   ├────── mmddyyV4 - date,velocity 1 - 10
    │   └────── mmddyyT4 - date, volume4,temperature4
    │
    ├────── mmddyyS - date, flowSum,volumeSum
    ├────── mmddyyL - date, level1 - 4, bits1 - 4
    ├────── mmddyyE - date, PathError,SectionError,LevelError
    ├────── mmddyyP0 - date, Vsound1,dB1,Gain%1,S/N1,Tenv1,Travel1,Delta1
    ├────── mmddyyP1 - date, Vsound2,dB2,Gain%2,S/N2,Tenv2,Travel2,Delta2
    ├────── mmddyyP2 - date, Vsound3,dB3,Gain%3,S/N3,Tenv3,Travel3,Delta3
    ├────── mmddyyP3 - date, Vsound4,dB4,Gain%4,S/N4,Tenv4,Travel4,Delta4
    ├────── mmddyyP4 - date, Vsound5,dB5,Gain%5,S/N5,Tenv5,Travel5,Delta5
    ├────── mmddyyP5 - date, Vsound6,dB6,Gain%6,S/N6,Tenv6,Travel6,Delta6
    ├────── mmddyyP6 - date, Vsound7,dB7,Gain%7,S/N7,Tenv7,Travel7,Delta7
    ├────── mmddyyP7 - date, Vsound8,dB8,Gain%8,S/N8,Tenv8,Travel8,Delta8
    ├────── mmddyyP8 - date, Vsound9,dB9,Gain%9,S/N9,Tenv9,Travel9,Delta9
    └────── mmddyyP9 - date, Vsound10,dB10,Gain%10,S/N10,Tenv10,Travel10,Delta10

Shown above is the sub-directory tree structure that is created to store the data downloaded from the datalog board. The number and types of files may differ slightly from site to site depending on the current system configuration. The top of the tree (Data_Log) is found in the sub-directory where the Accuflow software has been installed. The first branch below Data_Log (labeled ID above) will be the name entered as part of the download process. The file naming convention used is based on the start date of the specific data that is downloaded. For example if the datalog operation began on April 1, 1999 the mmddyy portion of the names shown above will be replaced with "040199". Note that the name is based on when the data collection started and not when it is downloaded. The last one or two characters in each filename (shown above in bold) indicate the type of data stored in each file.

The data type designators indicate the following:

- **Qn** indicates flowrate and level data for section n where n indicates the section number 1 through 4.
- **Vn** indicates the velocity data for section n. the velocity data file will store the velocity data for all paths in the system and not just the section. For example a 4- section system with 2 paths in each section (total of 8 paths) will store the velocity data for all 8 paths in each section meter sub-directory.
- **Tn** indicates the volume and temperature data for section n
- **S** indicates the system flowrate and volume that is simply the sum of the section flowrate and volume data.
- **L** indicates the level measurement data for each of the active level measurement inputs. This data consists of two parts, the first part contains the level data for each of the active level inputs scaled in engineering units (feet, meters, …). The second part contains the raw binary value as read from the A/D for each of the active level inputs.
- **E** contains the path error, section error and level error values. These values are the decimal equivalents of system

Pn contains the path data for path n. This data consists of:
the velocity of sound determined by the velocity measurement travel times
the gain required to obtain a useable signal level
the percentage of the full scale A/D resolution that the received signal achieved
the signal to noise ratio measured
average of the forward and reverse travel times measured when the path is operating in the envelope detect mode
average of the forward and reverse travel times measured when the path is operating in the zero crossing detect mode
difference between the forward and reverse travel time measurements, calculated as Trev – Tfwd

Display Retrieved Log

Choosing DataLogging/Display Retrieved Log from the main menu allows the user to display data log data that has been retrieved from the flowmeter. The data will be displayed in a tabular format, one measurement, or record, at a time.

Initially, a dialog to choose the data log ID and desired date/time appears. Once you have chosen an ID, the data log is scanned to determine its range. You can then choose a record to begin with, by entering a date and time. The default is the first record.

After choosing OK, the data is displayed in a table. To change to different records, use the record number spinner at the bottom of the screen.

Using Graphs

On the *view by variable* graph, the user can select which variable by selecting either the flow or the level button, and then select the section number(s) by using the buttons numbered 1 through 4. Multiple sections may be selected. The numbers below the section number buttons reflect the value of flow or level at the slidebar. The slidebar is the yellow vertical line that can be used as a marker for data points. It can be moved left or right by clicking and dragging the circular "knob" at the top of the slidebar. Notice that the numeric data changes as the slidebar is moved.

On the *view by section* graph, the user can select the section by clicking the radio buttons in the bottom right corner. Flow, level and velocity 1 through 10 are selected with the buttons on the bottom of the window. Slidebar operation is the same as in the *view by variable* graph, except that both graph panes are updated. If just velocities are selected, that graph will be expanded to the full window. Likewise, if only flow and/or level are selected their graph will be expanded. Otherwise, the window is split into two graph panes.

On the *settings* notebook tab, the user can select scaling options. They are normally automatically scaled based on the input value for historical data, or the maximum expected input for real-time data.
Set up the flowmeter by entering appropriate values for various parameters. Parameters define the geometry of each meter section and govern the operating modes of the flowmeter. All parameters are defined in Chapter 7.

Variables provide a view of measurements when the flowmeter is in normal "Measure" mode.
Chapter 7 contains definitions of the variables.

Chapter 7
User Defined Parameters

System Parameters

These parameters define the overall configuration of the flowmeter.

PIPE / COMPOUND 0 / 1   Set to 0 (zero). to select "Pipe" mode. for all sections.
set to 1. to select "Open Channel/Compound" mode

FLOW SCALING   The flowmeter calculates flow in either English or Metric units defined by the parameter below. If English is chosen, flow will be in ft^3/s: if Metric in m^3/s.
To express flow in alternative units, the value for the Flow may be multiplied by the *FLOW SCALING* parameter.
This scaled flow is output to the display, the analog outputs and RS232 ports,

For English units,	Flow in ft^3/s:		set to 1.0
	Flow in Millions of gallons/day:	(MGD)	set to 0.646
For Metric units,	Flow in m^3/s		set to 1.0
	Flow in Mega litres/day	(MLD)	set to 86.4
	Flow in l/s		set to 1000
	Flow in $m^3/$ hour		set to 3600

VOLUME SCALING   Sets the scaling of the totalized flow.

For English units,	Flow in ft^3/s:	Volume in 1000 ft^3	set to 1000
	Flow in ft^3/s:	Acre feet	set to 43560
	Flow in MGD:	Million gals	set to 86400
For Metric units,	Flow in m^3/s	1000m^3	set to 1000
	Flow in MLD	Mega litres	set to 86400
	Flow in l/s	m^3	set to 1000
	Flow in $m^3/$ hour	1000m^3	set to 3600000

ANALOG OUT SCALING   A factory set parameter. Set to 1.0 for non-isolated, or 0.5 for isolated outputs and 0.25 for the 7510+.

FLOW AVE LVL {0 : 5}   The time over which the Flow data are averaged.
Applies to the data displayed, logged and output on the analog output.
Set to 0, No time-averaging of the flow data
set to 1, the flow data are averaged over a period of 1 minute.
set to 2, the flow data are averaged over a period of 2 minutes.
set to 3, the flow data are averaged over a period of 5 minutes.
set to 4, the flow data are averaged over a period of 10 minutes.
set to 5, the flow data are averaged over a period of 15 minutes.

NUMBER OF ACCUM's	Number of accumulations of signal waveform for each velocity measurement. Range 1 to 16. This facility can be useful for increasing the signal: noise ratio. In high velocity applications, (>10 ft/s, 3m/s)) this parameter should be set to 1, otherwise signal cancellation can occur. If the acoustic signal quality is very good, a low value may be used, (1 to 4). Under adverse noise conditions, set to 8 or more. The advantage of using a low value is that the measurement cycle is shorter, and a better "snap-shot" of the flow in the conduit is taken.
REP TIME {0 : 4}	Sets the time interval between measurements. set to 0, the flowmeter meter will run at its maximum rate. set to 1, the flowmeter will take readings at 1 second intervals. set to 2, the flowmeter will take readings at 2 second intervals. set to 3, the flowmeter will take readings at 5 second intervals. set to 4, the flowmeter will take readings at 10 second intervals. **Note.** If the flowmeter is unable to complete the reading in the time selected, (because the path lengths are long or too many paths are selected) then the flowmeter will take the readings as quickly as possible without attempting to synchronize to any real time.
ENGLISH / METRIC 0/1	Selects the units of the Parameters and Variables of the flowmeter. For English units, (feet) set to 0. For metric units, (metres) set to 1.
AUTO STORE PAR's	Set to 1 normally, so that changed parameters are stored in non-volatile memory whenever the system is returned to the Measure mode. If set to 0, changed parameters are used by the system but not stored. The changed parameters will be lost and the old ones asserted if the **Esc** then the **Reset** (or **#**) key is pressed, or if there is a temporary loss of power.
DATA to SERIAL {0 : 3}	To select the outputting of data to RS232 serial ports. set to 0, for no serial data outputs. set to 1, for data output to the "Hand-held terminal" port, see page 5-10. set to 2, for data output to the optional Com 3 RS232 port in "Argus" format set to 3, for data output to the optional Com 3 RS232 port in "Drax" format
SYSCLK 2, 5, 10 MHz	Sets the sampling rate of the digitizer. For 1MHz transducers or path lengths less than 50 ft (15m): set to 10.0 For path lengths up to 100ft, (30m) and 500 kHz transducers set to 5.00. For path lengths up to 300ft, (90m) and 200 kHz transducers set to 2.00. **Note.** For the 10MHz setting, link JP50 on the DSP card must be towards the center of the card. For other settings, the link must be away from center.
DISPLAY UNITS 0 : 4	Selects the characters to indicate the units of the variables displayed on the optional Liquid Crystal Display. Set to 0 to display flow in "l/s", level in "m", Volume in Cm, Temp in °C. set to 1 to display flow in "MLD", level in "m", Volume in ML, Temp in °C. set to 2 to display flow in "CMS", level in "m", Volume in Cm, Temp in °C. set to 3 to display flow in "CFS", level in "ft", Volume in CF, Temp in °F. set to 4 to display flow in "MGD", level in "ft", Volume in MG, Temp in °F. set to 5 to omit the units in the display.

DETECTION METHODS	Set to 0, "AUTOMATIC" to enable the flowmeter to use the optimum signal detection method for the conditions. The normal setting. Set to 1, "FIRST NEG" to force the flowmeter to use only detection of the "first negative" edge of the received signal. (Use only if the water known to be clean and without aeration) Set to 2, "ENVELOPE" to force the flowmeter to use only detection of the "envelope" of the received signal. (For use if water is always aerated)

Section Parameters

These parameters describe each conduit and the method of flow computation. Separate lists are required for each section. For all unused sections, the parameters *Path Enable* and *Volume Init Value* must be set to zero. All other parameters for unused sections can be ignored; their values are not used by the system.

All lengths and elevations are limited to five figures.

Parameters with the letters C after their names are used only in Open Channel or Compound mode.

PATH ENABLE	For each section, a 10 bit binary number has to be set in order to define which paths are to be allocated to the section. e.g. For path 3 to be used, the number is set to 0010000000. For paths 1,2,3,4 to be used, set to 1111000000. When entering a value, the zeros after the last selected path need not be entered. If no paths are enabled, the section is not enabled.
LEVEL ENABLE C	This parameter is ignored if the system is in "Pipe" mode. For each section, a 4 bit binary number has to be set in order to define which of the analog level inputs apply to the section. A maximum of two inputs can be allocated to any section. e.g. For analog level input #1 only to be used, the number is set to 1000. For analog level inputs #1 & #2 to be used, the number is set to 1100. For analog level inputs #3 & #4 to be used, the number is set to 0011. A particular level input can be allocated to one or more sections.
PIPE AREA	"Pipe" mode only. The cross-section area of the conduit in ft^2 or m^2. This parameter is ignored in "Open Channel" or "Compound" mode.
MIN GOOD PATHS	In full pipe mode, the minimum number of good paths which must be present to calculate flow. The contribution to the Flow from any failed paths can be provided by the Path Substitution routine, providing that the "Learn path Ratios" routine has been correctly implemented. See page 3-5. If the "Learn" routine can not be implemented, because at the time of commissioning there is insufficient flow, this parameter must be set equal to the number of paths installed. Range 1 to number of paths installed. If set to number of paths installed, the flow will cease to be computed and the section fail, if any path fails. In compound single path mode, setting this parameter to 1 will cause the flowmeter to calculate flow based on the cross-sectional area and the unmodified velocity. Any other value will turn this feature off. See Non-surcharged Single path Trapezoidal Integration mode on pages 3-2 and 3-3 for more details.

LOW FLOW CUTOFF	Defines the range of flows which the flowmeter will declare to be zero. If set to 0.00, the flowmeter will be bi-directional, with no minimum flow. If set to a +ve value, all negative flows and positive flows up to the set value will be declared to be zero. If set to a −ve value,.all positive flows and negative flows down to the set value will be declared to be zero. Any flow which is declared to be zero will be output on the displays and analog outputs as zero, and treated as zero flow for the computation of Volume and the computation of Sum of Section Flows.
VOLUME INIT VALUE	The current value of the Totalized Flow or Volume. The volume may be reset to any value as required, Range 0 to 999 999 For unused sections, this parameter should be set to zero, otherwise it will contribute to the *Sum of Volumes*.
LEARN PATH RATIOS	"Pipe" mode only. If set to 1, the "Learning" routine will be invoked, and a new path ratio table will be created automatically. (See page 3-5 Pipe Mode). The parameter will reset to 0, and the table frozen after 1000 readings. **Warning: all paths must be good & flow non zero if this routine is invoked.**
TEMP CORRECTION	A constant in °F or °C which is added to the computed temperature to correct for minor variations in the water quality. Range -30 to +30. Normally set to 0.
MANNING n C	The Manning coefficient of roughness. Usually between 0.01 & 0.03.
MANNING slope C	The slope of the energy line in the conduit: a dimensionless number: Usually between 0.0 to 0.010
MANNING MAX LVL C	The maximum value of Level for which the Manning Formula is valid. Range: -5000 to +5000
OVERRIDE LEVEL? C	Selects whether the level is to be derived from the 4-20 mA analog level input or from a manually entered fixed value. To select the analog input: set to 0 To select the manually entered Level value: *LEVEL MANUAL*: set to 1.
MANUAL LEVEL C	A fixed Level value, representing the elevation of the water surface above the site datum. Range: -5000 to +5000
SURCHARGE LEVEL C	The value of Level at and above which the section is surcharged. For an open channel site, this must be set above the highest possible Level. For a closed conduit, it is set equal to the elevation of the top of the conduit or soffit. Range: -5000 to +5000
LOW LEVL CUTOFF C	Elevation of the water surface, above the site datum, below which the flowmeter will regard the flow as zero. Range -5000 to +5000

MIN SUBMERSION	C	The minimum submersion is the minimum distance which the water surface must be above a path for the path to be energized and used by the system to compute flow. Range: 0.0 to 5.0.
		Usually set to a value at least equal to the surface wave amplitude, or if the surface is smooth, set in accordance with the following:
		for 1 MHz transducers, 0.05√Path Length in ft, or 0.03√Path Length in m.
		for 500 kHz transducers, 0.07√Path Length in ft, or 0.04√Path Length in m.
		for 200 kHz transducers, 0.11√Path Length in ft, or 0.06√Path Length in m.
BOTTOM FRICT'N	C	The ratio between the assumed velocity at the conduit bottom and that at the elevation of the first good path above the bottom. Also used to compute the assumed velocity at the top of the conduit under surcharged conditions.
		Range: 0.0 to 2.0 Usually set to: 0.8 for multi-path open channels.
		A lower value, (0.5 min.), if the bottom path is very near the bed.
		A value of 1.2 to 1.8 may be appropriate for single path installations. See p 3-4
TOP WEIGHT	C	The weighting coefficient used to correct the extrapolated surface velocity
		Usually set to 0.1. In narrow conduits set to 0.
SURCH TRAP / PIPE	C	Selects the integration method to be used when the conduit is surcharged.
		Set to 0 if surcharged trapezoidal mode is to be used.
		Set to 1 if "Pipe" mode is to be used.
NUM of LAYERS	C	Number of layers used for defining the conduit cross-section area
		Any number between 2 and 8 layers may be defined.
LAYER ELEV'N 1	C	The elevation of the conduit bottom or invert relative to the site datum.
		Range –5000 to +5000
LAYER ELEV'N 2	C	The elevation of the next layer above the bottom relative to the site datum.
LAYER ELEV'N 3	C	The elevation of the next layer, if required.
		Note that if the conduit is closed, the elevation of the highest layer must be equal to or greater than that of the soffit or top of the conduit.
		If the conduit is an open channel, the elevation of the highest layer must be greater than that of the highest possible Level.
LAYER WIDTH 1	C	The effective width of the conduit at the bottom or invert of the conduit.
		Range 0.0 to 300
LAYER WIDTH 2	C	The width of the next layer above the bottom.
LAYER WIDTH 3	C	The width of the next layer, if required.

Notes
1. *The layer elevations must be in strict height order.*
2. *Two layers cannot be given the same elevation.*
3. *Data entered in layers having numbers higher than the parameter NUM of LAYERS will be ignored*
4. *For a Round Pipe, the layer configuration given on pages 5-4 or 7-14 is recommended*
5. *If, during operation of the flowmeter, the water level should exceed the elevation of the highest layer, without the conduit being surcharged, a warning LVL > MX LY HT will be displayed.*

Path Parameters

The paths are numbered in sequence, 1 through 8, any of which can be allocated to any section.
The individual paths are each described by:

LENGTH

The length between the transducer faces which are in contact with the water.
Standard range: 1.0 to 50ft. or 0.3 to 15m   Extended range 300ft or 90m.

ANGLE   dg's

The angle in degrees between the acoustic path and the center line of the
conduit.   Range of values: 10.00° to 80.00°.

WEIGHT

The weighting constant for the path.   Range: 0.000 to 1.000
This parameter is used only in "Pipe" mode; it is ignored in "Compound" mode.
For a multi-path pipe, the sum of all the weights should be approximately 1.0.
For 2-path round pipe, Chebyshev integration, set both path weights to: 0.500
For 4-path round pipe, Chebyshev integration,   Paths 1 & 4 set to: 0.1382
                                                Paths 2 & 3 set to: 0.3618
For 8-path round pipe, Chebyshev integration,   Outer Paths, set to: 0.0691
                                                Inner Paths set to: 0.1809
For 4-path rectangular pipe, Gaussian integ'n, Outer Paths, set to: 0.1739
                                                Inner Paths set to: 0.3261

ELEVATION   C

"Compound" mode only.   This parameter is ignored in "Pipe" mode.
The elevation of the center line of the path above the site datum.
In a given Section, the paths must be in the same numerical order as the
elevations. Crossed paths must have identical elevations. See page 3-1.

SIG DELAY μs

The part of the signal travel time in μs, which is due to the electronic circuits,
the total cable delay, and the signal travel time through the two transducer
windows at either end of the path.   Range: 0 to 20 μs
For Model 7600, 7601, 7630, 7634, 7616, 7618, 7657, 7658, set to 8μs.
For Model 7612 transducer, set to 10μs.
For Model 7617 or 7656 transducers, set to 12μs.
For model 7605 and 7625 transducers, set to 18μs.
These figures assume a cable run between the electronic unit and the section
of about 150 ft (50 m).   For longer cable runs, add 1μs for every additional
300ft (100m) of distance between electronic unit and transducers.

MAX BAD MEASURES

The maximum number of consecutive measurement cycles in which no valid
value of velocity on a particular path is obtained. If this value is not reached, the
last good velocity value from that path is used for the Flow computation.
If this value is reached, the path is declared to have failed, and its data are then
not used for Flow computation, unless and until new valid data are obtained.
Range: 1 to 500.   Usually set to: 10.

MAX VEL CHANGE

The maximum change of water velocity between successive measurement cycles
which is considered to be reasonable. If this value is exceeded, the computed
velocity will change towards the new value at a rate limited by this parameter &
the averaging filter. For changes which are large compared with this parameter,
the displayed velocity will change in steps of about 0.3 * *Max Vel Change*.

MAX PATH VELOCITY

The maximum water velocity which is regarded as physically realistic. Values in
excess of this value are regarded as erroneous.

XDUCER FREQU   kHz   The characteristic frequency of the transducers.
                              For Model 7600, 7601, 7605, 7625, 7630, 7657 , set to   1000kHz.
                              For Model 7616, 7617, 7618, 7634, 7656, 7658, set to   500kHz.
                              For Model 7612, set to   200kHz

Level Input Parameters

Either one or two can be allocated to a section. The allocation is defined in the Section menu.
Level parameters are ignored by the system when in "Pipe" mode.
Scaling for each individual analog level input is defined by the following parameters.

MIN mA INPUT   The value of the input in mA below which it is declared to be in a fault state.
                              The value may be in the range 0.0 to 19.0 mA.

4mA LEVEL INPUT   Elevation of the water surface above the site datum, at which the Level input
                              is 4.0 mA. The value may be in the range –5000 to +5000

20mA LEVEL INPUT   Elevation of the water surface, above the site datum, at which the Level input is
                              20.0 mA. The value may be in the range –5000 to +5000

LEVEL RESISTOR   The value of the input resistance of the 4-20 mA Level input.
                              The value may be in the range 250Ω to 50Ω.   Standard value is 100Ω.
                              This parameter is set at the factory to calibrate the input. The value should not
                              require changing.

LEVEL FILTER 0-4   The approximate time in units of 15 measurement cycles, over which the Level
                              data are averaged. e.g.: if set to 0   no averaging
                                                          if set to 4 (max)   averaged over 60 measurement cycles.
                              Applies to the data displayed, used in the computation of flow, logged and
                              output on the analog output.

Analog Output Parameters

Any number up to four analog outputs can be allocated to a section. The allocation to the section, the variable to
be output and the scaling for each individual analog output are defined by the following parameters.

ASSIGN A SECTION   Defines which section the output responds to.
                              For "sum of section" flow, set to 0.   For Section 1, set to 1, etc.

F / L / V / T / ∗SF {0-4}   Selects the variable to be represented by the analog output.
                              Set to 0 to output flow for the section.
                              Set to 1 to output the arbitrated value of the level for the section.
                              Set to 2 to output the average velocity for the section.
                              Set to 3 to output Temperature, in °F for *English* or °C for *metric* units.
                              Set to 4 to output the Sum of the Section Flows.
                              Note. The units of velocity are either ft/s or m/s depending on the parameter
                              English/metric. Velocity output is not affected by the *Flow Scaling*.
                              The velocity is equal to the flow divided by the wetted cross section area.

4mA OUTPUT	The value of the variable, in the units specified, for which an output of 4.00 mA is required.
20mA OUTPUT	The value of the variable, in the units specified, for which an output of 20.00 mA is required.
OVERRIDE OUTPUT?	Selects whether the output is to be derived from the variable or from a manually entered fixed value. Normally only used during system commissioning. To select the chosen Variable, (Flow, Level, Temperature etc.) set to 0 To select the manually entered *MAN OUTPUT VALUE*: set to 1.
MAN OUTPUT VALUE	The manual figure, in the scaled units used by the flowmeter.
HOLD ON ERROR 0 / 1	Set to 0 to cause the output to go to 4mA in the event of failure. Set to 1 to cause the output to hold the last good value in the event of failure.
4 mA FINE ADJUST	The binary value sent to the analog-to-digital converter that represents 4.00 mA. This typically is used to adjust the "zero" or 4 mA output. Nominal value 10,922.
20 mA FINE ADJUST	The binary value sent to the analog-to-digital converter that represents 20.00 mA. This typically is used to adjust the "span" or 20 mA output. Nominal value 54,672.

Relay Parameters

There are 16 separate lists, one for each relay. These describe the function, section allocation and behavior of each individual relay, if supplied.

ASSIGN A SECTION	Defines which section the relay responds to. For "sum of section" functions, set to 0.
TYPE (1 : 10) 0 = OFF	Defines the function of the relay. When a selection has been made, a code giving an indication of the function appears on the screen.

Value	Display Code	Function
Set to 0	**OFF**	if the relay is not used.
Set to 1	*SEC Q MX 1*	for the relay to operate when the section flow exceeds the threshold value in this relay's list.
Set to 2	*SEC L MX 1*	for the relay to operate when the section level exceeds the threshold value in this relay's list.
Set to 3	*PATH SUB*	for the relay to operate when Path Substitution is in operation in the section. (Pipe mode only).
Set to 4	*SECT FAIL*	for the relay to operate when the section fails.
Set to 5	*SECT VOL*	for the relay to transmit section totalizer pulses.

Note   Only one relay may be allocated to each section for this function.

Value	Display Code	Function
Set to 6	*SUM Q MX 1*	for the relay to operate when the sum of section flows exceeds the threshold value in this list.
Set to 7	*SUM VOL*	For the relay to transmit totalizer pulses for the sum of the sections.

THRESHOLD	The value of the variable (flow or level), above which the relay will eventually operate. Range –99999 to +999999
DELAY	The number of consecutive measurement cycles for which the variable exceeds or falls below the threshold, before the relay operates. When used for Section Fail or Path Substitution alarms, the relay operation is delayed by a number of measurement cycles, after the onset of the alarm state. If an alarm state ceases, the relay returns to its normal state immediately. Range 1 to 999 measurement cycles.
POLARITY 0 / 1	Defines whether the relay is energized or de-energized when it operates as a result of the event Set to 0 for the relay to be normally de-energized. Set to 1 for the relay to be normally energized. **Note**. All relays are de-energized when the electronic unit is without power.

Examples:

To configure a relay to close when the flow in section #1 is negative, set:
 TYPE = 1,   *ASSIGN A SECTION* = 1,   *THRESHOLD* = 0,   *DELAY* = 5,   *POLARITY* = 0
To configure a relay to indicate if section #3 fails, or if the power is off, set:
 TYPE = 6,   *ASSIGN A SECTION* = 3,   *THRESHOLD* = 0,   *DELAY* = 0,   *POLARITY* = 1

System Stats

This list contains general information on the system, as well as facilities for altering the baud rate for the *Hand-held Communication* port and for setting the clock date and time.
The method of changing the values of those which are not fixed is the same as for the other parameters.

SOFTWARE VERSION	A serial number defining the version of the software (for information only)
SITE NAME	An alpha / numeric name which can be entered only by using Accuflow Maximum number of characters: 9. Spaces are permitted.

SP1 BAUD RATE (2-6)   User selectable baud rate of channels 1 through 3 (SP1-3).
See notes below for special instructions.

Set to	2 for	1200 baud
	3 "	2400
	4 "	4800
	5 "	9600
	6 "	19200 Normal value

SP∗ DATA BITS	∗	Character length. Fixed value of 8.
SP∗ STOP BITS	∗	Fixed value of 1.
SP∗ PARITY	∗	Fixed value. No parity.

YEAR	Calendar year For the year 2000 set to 00.
MONTH	Calendar month.
DATE	Calendar date.
DAY (SUN = 0)	Day of the week.
AM / PM 0 / 1	Defines period of day if 12 hour clock is used.
24 / 12 HOUR CLK 0 /1	Defines whether 24 or 12 hour clock is used.
HOUR	Time.
MINUTE	Time.
SECOND	Time.

Baud Rate change

The baud rate of the communication to the hand-held terminal port can be selected.
To reduce the risk of changing the baud rate and then finding that re-entry to the flowmeter menu is impossible, the newly selected baud rate will not be implemented until the system has been reset.
To select a new baud rate, enter the code number of the desired rate in the menu, then press **Esc** and **Measure** (**M**) to return the system to the Measure mode.   Then, to reset the system and implement the new baud rate:
        either,   turn the power off and back on,
        or,   exit the measure mode by pressing **Esc,** then press the **Reset** (**#**) key.

To return the system to the default baud rate of 19200, switch off the power, connect together pins 2 & 3 of the 9-pin D socket marked "Hand-held communication," and switch the power back on.

Logging to Flash

The various menus for setting up the logging of data to flash memory are:

DIRECTORY   Provides a directory of the current log files. There are two,
                           the "Main, (capacity 192k values) and the "Scratch", (capacity 16k values)

          LOG LEN   Indicates the number of storage locations used so far in the current log.
          CUR MDH   Indicates the time in months, days, hours, for which the current log has been recording.

          TOT MDH   Indicates the total log time in months, days, hours, remaining before the memory is full. The value for this is automatically calculated by the computer, and can be used as a guide to the maximum duration of a log, for a particular chosen set of variables and logging frequency.

          **NOTE: CUR MDH and TOT MDH will not be displayed if programmed logging time exceeds 1 year.

WRITE TO FILE   Selects a log file, its characteristics, and its frequency.
          SCRATCH / MAIN   Choose which file to log into. Enter 0, to select "Scratch", 1 to select "Main"
          PARAMETERS   Enable logging of parameters (not currently implemented)
          NEW / APPEND   Enter 0, to Open new file,   Enter 1, to append new data to existing file.
          CIRCULATE / STOP   Enter 0, to circulate to beginning on file full.   Enter 1, to stop when file full.
          STATUS   Enter 1, to log the status of flowmeter with each log.   Enter 0, to omit status.
          SET LOG INTERVAL Enter logging frequency in seconds, hours, and minutes. (24 hours maximum)

          **NOTE: Appending will not occur if any other logging parameter is changed.

TAG SECTION / PATHS   Select sections and paths for which the selected variables will be logged.
          SECTION 1- 4   Enter a 0 to select "No logging for that section",   a 1 to select "Logging"
          PATHS 1-10   Enter a 0 to select "No logging for that path",   a 1 to select "Logging"

TAG VARIABLES   Select the variables to be logged. Entering a 0 selects "off", a 1 selects "on"
          FLOW   Section flow
          LEVEL   Section level (averaged)
          VOL   Section volume
          TEMP   Section temperature
          SUM of FLOWS   Sum of section flows
          SUM of VOLS   Sum of section volumes
          VELOCITY   Path velocity
          VSND   Path calculated velocity of sound
          GAIN dB   Path gain in dB
          GAINS %   Path gain in percent
          S / N dB   Path signal to noise ratio
          TENV F-R   Path forward and reverse envelope times
          TRAV F-R   Path forward and reverse travel times
          DELTA T   Path delta time
          LEVEL   Input level
          BITS   Input level in bits

Variables

All variables except average velocity are available to be displayed on the screen of the hand-held terminal, as live data with the flowmeter operating in the "Measure" mode. A separate screen has to be selected for each type of variable. The variables are:

TENV   The travel times of the overall signal envelopes (used for diagnostic purposes).

TRAV   The signal travel times in micro seconds (µs), Forward and Reverse. The values are the total times less the Signal Delays and represent the travel times of the signals through the water.

DELT   The time difference, in nano seconds (ns), between the forward and reverse signal travel times. A negative figure indicates reverse flow.
              The first figure is the latest instantaneous value; the second is an average taken over 8 readings.

GAIN   The value of the Receiver gain, nominally in dB units. Maximum value 40
              Equal to: $20 \times \log_{10}$ [Ratio of signal voltage at A/D converter**:** Transducer output]
              0dB indicates a signal level of 1Volt peak to peak at the transducer terminals.
              The second figure is the amplitude of the latest instantaneous signal, after amplification, expressed as a % of full signal at the detector. Normally this value will be between 95 and 105.
              The third figure is the Signal to Noise ratio expressed in dB. Less than 12dB indicates a serious noise problem, and that the data for that path will be rejected.

VEL   If the path is not enabled or is out of the water, the display for that velocity is blank.
              The first figure is the value of the individual water velocity in feet/second or metres/second, averaged over 8 readings. A negative figure indicates reverse flow.
              The second figure is the computed velocity of sound for that path, (used for diagnostic purposes).
              The letter E or Z indicates the signal detection method, either "Envelope" or "First Negative".
              The letter H indicates that the velocity reading has been "Held" The latest acoustic signal is unacceptable, and the previous value for water velocity is being used for the computation of flow.
              PATH FAILED indicates that consecutive acoustic signals for that path have been rejected for a period greater than the parameter *Max Bad Measures.* The path has failed.
              VEL > MAX   indicates path failure due to computed velocity greater than *Max Path Velocity*

FLOW   The time-averaged value of the water flow, scaled in the required units.
SECT   If the parameter *Flow Scaling* is set to 1, the units will be cubic ft/s or cubic metres/s.
              The averaging is carried out using an Infinite Impulse Response (IIR) digital filter, whose time is set by the System parameter *FLOW AVE 0 - 4 MINS.*

              The letters and number following the value indicate the method of flow determination selected by the flowmeter, whether the conduit is Full (surcharged), and which of the possible level inputs (Manual, #1 or #2) has been selected. Typical examples of these codes are:

              In Pipe Mode:
              PI   indicates that the system is configured for "Pipe" mode.
              PI   L   indicates that the Learn Path Ratio routine is in progress.
              PI   S   indicates that the Path Substitution routine is in use.
                                         (i.e. one or more paths have failed).

In Compound Mode:

MN	1	indicates Manning mode, non surcharged, level #1 used.
SP	1	indicates Single Path Trapezoidal Integration, non surcharged, level #1.
MP	1	indicates Multi Path Trapezoidal Integration, non-surcharged, level #1.
MP	F 2	indicates Multi Path Trapezoidal Integration, surcharged (Full), level #2.
PI	S 4	indicates Pipe Integration, surcharged. Path Substitution, level #4.
PI	F 0	indicates Pipe Integration, surcharged. Manual Level selected.

Under low flow or fault conditions, a message is substituted for the section flow value.

LVL > MX LY HT	indicates that the Level exceeds the elevation of the uppermost layer.
LEVEL<>Limits	indicates failure due to the Level input being below *Min mA Input* or above 21 mA.
LEVEL < CUTOFF	indicates that the flow is zero, due to valid but low Level.
NO GOOD PATHS	indicates failure of all paths, and Level too high for Manning to be valid.
SECTION FAIL	indicates that there are too few good paths to compute flow in "Pipe" mode. i.e. Number of good paths is less than *Min Good Paths*.

VOL
SECT

The totalized flow for each section, scaled according to the *Volume Scaling* parameter.
These values can be individually set or reset from the Section menus.
The maximum displayed value is 999,999 after which the display goes to zero and restarts.

LEVEL
SECT

The arbitrated time-averaged value of the Level in each section, which is used for the calculation of flow.   The averaging is carried out using an Infinite Impulse Response (IIR) digital filter, whose time is set by the parameter *LEVEL FILTER*.
The messages following are the same as are displayed on the "Flow" screen.

TEMP
SECT

The water temperature in each section, computed from the average velocity of sound for each good working path in that section. It is computed using the relationship for distilled water, corrected if necessary by a user defined offset; the section parameter *TEMP CORRECTION*

FLOW
VOL
SUMS

The sum of all the section flows.   If a section has failed, its contribution is deemed to be zero.
The sum of all the section volumes. If a section has failed, the value for its Volume accumulated up to the time of failure will be used for calculating the sum of all section volumes.

LEVEL
CHNL
BITS

The time-averaged value of each individual Level input, in terms of the elevation of the water surface above the site datum.
The second 4-digit number after the Level value is the instantaneous value of analog input. It is scaled so that an input of 0.00 volts is displayed as 0, and 5.00 volts as 4094.

If the input resistor fitted is the nominal 100Ω, the 4 digit number will be scaled so that:
0 mA is displayed as 0,   4 mA as 328,   20 mA as 1638 and 50 mA as 4095.

Special Configurations

Occasionally, it may be necessary to configure the meter in a "non-standard" mode to meet a particular requirement. This section contains special configurations.

Using Layer Boundary Parameters to Simulate a Round Pipe

When a "compound flowmeter" is set up in a pipe, the shape of the pipe has to be described using the Layer Boundary parameters. If the pipe is round, a large number of possible ways of describing its shape in terms of trapezoidal layers can be devised.

The table below gives one possibility, which has the merits of giving very close approximations to the wetted area, with only 11 numbers to be calculated. The maximum errors occur when the stage is below 0.1 x Pipe Diameter. This is below the lowest layer and likely to be below the lowest path, and so of no relevance. At a stage of 0.05 x Pipe Diameter, the error is 4.5% of actual area. For stages between 0.1 and 0.2 x Pipe Diameter, the errors are less than 0.2%. Above 0.2 x Pipe Diameter, the errors are small.

Layer Boundary Elevation	Layer Boundary Width
Zero x Diameter	0.116 x Diameter
0.05 x Diameter	0.472 x Diameter
0.20 x Diameter	0.823 x Diameter
0.40 x Diameter	0.993 x Diameter
0.60 x Diameter	0.993 x Diameter
0.80 x Diameter	0.823 x Diameter
0.95 x Diameter	0.472 x Diameter
1.00 x Diameter	0.116 x Diameter

All Path Elevations in terms of measured distance above the channel bottom.

Separating Forward and Reverse Flows, (for pump / generating plant)

For some full pipe systems, it may be desired to compute separate totalizer counts (from relay closures) and volumes for forward and reverse flows.
To achieve this, two sections should be configured, using the same paths, but with slightly different section parameters. In this example, Section #1 is for forward flow, and section #2 for reverse.

Parameter	Section #1	Section #2	Comment
Path Enable	1111000000	1111000000	both the same
Pipe Area	Actual value	− Actual value	Section #2 will read negative.
Low Flow Cutoff	0.0001 or more	− 0.0001 or less	See description on page 7-4

With this configuration,   Section #1 will give a positive value for all forward flows, and zero for reverse flows.
Section #2 will give a positive value for all reverse flows, and zero for forward flows.

For Compound or open channel situations, contact Accusonic.

Relay to indicate that a Section is Good

For flowmeters which are used for automatic plant control, it is often desirable to have a relay to indicate "Section Good", rather than "Section Failed". The difference being that "Section Good" should be energized only when the section is "good", be de-energized immediately it is "bad", and allow for a delay between the section recovering and the relay becoming energized. The "Section Failed" concept does not provide this logic.

To provide this: Enable a dummy path in the section, (e.g. Path #10), to which nothing is connected.
Set Section parameter *Min Good Paths* to the minimum number required for flow calculation.
Set "dummy" path *Length* to 1.0, *Weight* to 0, Other parameters to 1 or ignore.
Set Relay parameter for desired Section, *Type* to 3 (Path Sub), *Delay* as required, *Polarity* to 0.

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