Data Acquisition with Transonic Flowmeters

Transonic flowmeters employ line-to-meter, meter-to-probe and probe-to-patient isolation to yield a high degree of patient electrical protection. Connections between the meter and any external devices may degrade or bypass this isolation, and must be reviewed for compliance with local regulations. For line-operated accessory equipment, the Potential Equalization pin on the back panel of the flowmeter must be connected to the accessory instrument's ground.

Direct Digital Flow Readout

In “MEA” mode, the average volume of flow (in ml/min or L/min) can be read directly from the flowmeter’s front panel DIGITAL DISPLAY.

Flow Recording Using a Strip-Chart Recorder

Connect one of the rear panel FLOW MONITOR signals to a chart recorder.

If instantaneous flow is to be recorded, set the flow output low-pass filter to a frequency at least ten times the rate of the flow pulsation, and record the signal from the “pulsatile” connector (push in the “10 Hz” button for heart rates below 60 beats per minute; “30 Hz” for heart rates to 180 beats per minute, etc.). If average flow is to be recorded from the “PULSATILE” connector, depress the “0.1 Hz” filter button. In addition, the 0.1 Hz low-pass filtered flow is always available through the “AVERAGE” BNC connector on rear panel regardless of the filter push-button settings.

The following protocol calibrates the strip chart recorder to volume flow units.

1 . **Engage “CALIBRATE ZERO”** push button and align recorder pen with a convenient zero flow baseline setting on the chart paper near one extreme of the recorder range. Allow some room below this setting if flow is expected to pulsate through zero.

2. **Engage “CALIBRATE SCALE”** button. Use the recorder’s range switch and continuous sensitivity dial to adjust the recorder pen for deflections on the strip chart paper which allow easy direct readout of flow in ml/min or L/min and accommodate anticipated peak flow recordings in “MEA” mode. The meter can track flows five times the scale factor flow identified on the DIGITAL DISPLAY. If the recorder is equipped with a range switch with discrete markings, the switch may be used to alter the chart scale during a recording run provided that the scale expansion or contraction factor is also recorded. (Put flowmeter in the “CALIBRATE ZERO” mode and switch through the recorder ranges of interest to confirm that the recorder pen maintains the same baseline position over these ranges.) The recorder’s variable sensitivity dial should not be moved during a run without recalibrating the chart pen deflection.

3. **Engage “MEA” mode.** Select position of the “INVERT” button so that forward direction of recorded flow matches the polarity of the “CALIBRATE SCALE” recording. Push in “LO FLO” button if flow recorded on the strip chart occupies less than 25% of the full scale deflection available for positive flows. This will decrease the scale factor four-fold from the setting in step 2 above, and expand the flow trace vertically by a factor of four.

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Flow Recording Using a Computer with an A-to-D Interface

The following describes protocols for interfacing a flowmeter without the Personal Computer (-P) option installed.

A general purpose microcomputer with an Analog-to-Digital converter interface is easily adapted to read the flowmeter's output signals. The analog flow signal is available from either of two BNC connectors on the back panel. Mean flow only is available from the BNC connector labeled "AVERAGE" while pulsatile and mean flow are available from the connector labeled "PULSATILE". The frequency response of the "PULSATILE" flow signal is selected by depressing one of the four filter buttons on the front panel of the meter.

In order to capture the full information content of a digitized signal, sampling theory states that the sampling rate must be at least twice the highest frequency of interest. We recommend sampling three times as fast as the selected filter. As a rule of thumb, the harmonic content of a pulsatile signal such as the heart flow is well described by the first 10 harmonics of the signal. For instance, for a 1 Hz heart beat (60 beats/min) one would want to examine a 10 Hz band width which involves sampling at a 30 Hz rate. This leads to the following sampling rates:

Connector	Application	Suggested Sampling Rate
Back ("Average") @ 0.1Hz Back ("Pulsatile")	Mean Flow	.3 Hz
Back ("Pulsatile") @ 10Hz	Heart rate to 60 BPM	30 Hz
Back ("Pulsatile") @ 30Hz	Heart rate to 180 BPM	90 Hz
Back ("Pulsatile") @ 100Hz	Heart rate to 600 BPM	300 Hz

The analog flow output may range from - 5 V to + 5 V: Zero Volt corresponds to zero flow; 1 V corresponds to the scale factor. The scale factor or the amount of flow per Volt (in ml/min/Volt) varies with probe size and the position of the gain button. To determine the scale factor for a particular probe size, press the calibrate-scale button and record the value displaced on the digital display. For example, if a 4 mm R-Series flowprobe is installed with the "LO FLO" button pushed in, the scale factor is 100 ml/min.

A - TO - D CALIBRATION

Calibration of the A-to-D system prior to use is recommended to compensate for any analog drift in the Voltage reference of the computer's data acquisition board and to validate that the A-to-D converter references are properly selected.

The following is a suggested procedure to calibrate the A-to-D converter in volume flow units.

1. **Depress the CALIBRATE ZERO BUTTON.** When the signal is present and has stabilized (the average-reading output requires approximately 10 seconds to settle from previous value to a new level), the computer is instructed to sample the flow signal for several seconds and to calculate an average reading. This reading (in Volts or in A-to-D output bits) equals the zero-flow signal amplitude "CZ".
2. **Depress the CALIBRATE SCALE BUTTON.** When the signal is present and has stabilized, the computer is instructed to sample this signal for several seconds and to calculate the average scale factor reading, "CS" (in Volts or A-to-D output bits).
3. The computer then requests the operator to enter the ml/min equivalent scale factor (SF) displayed on the meter LEDS. The conversion factor, "CF", which converts an A-to-D output reading into flow in ml/min, can then be calculated: CF = SF/(CS-CZ).
4. Measured flow samples "SN" may then be taken in the flowmeter's measure mode, and converted to true flow with the equation:

$$\text{True Flow} = CF\ (\text{measured flow} - CZ)$$

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