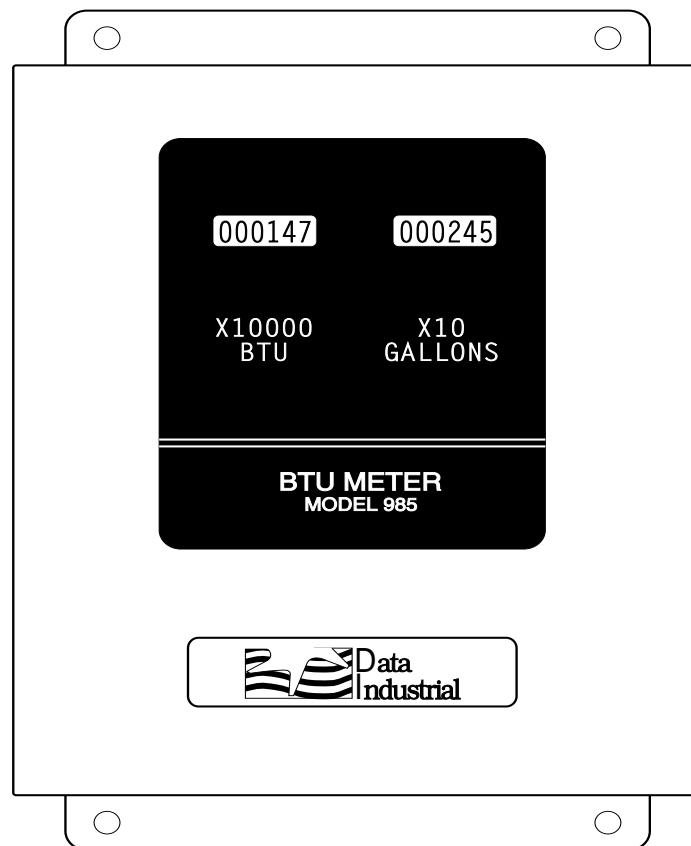


Series 985

Microprocessor-Based BTU
Meter

by Data Industrial



Owner's Manual

1/94
PN 72804



Table of Contents

Introduction	1
Meter Location	1
Installation	2
Mechanical	2
Electrical	3
Calibration	5
BTU Meter	5
Flow Sensor Board	6
BTU Processor Board	9
Analog Output Board.....	10
Specifications	18
Warranty	19

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Introduction

The Model 985 is a microprocessor-based BTU meter designed to provide an accurate measurement of total thermal energy and total liquid flow in a closed pipe system. The flow measurement is based on an input frequency signal from any Data Industrial flow sensor. The temperature measurement is based on two analog input signals from thermistor elements located across a load.

The Model 985 calculates the differential temperature of the system by subtracting the low temperature reading from the high temperature reading. It then calculates the BTUs consumed or produced by multiplying three factors: the volume of liquid, the temperature differential, and a heat constant. Total BTUs and total gallons are displayed on two six-digit mechanical totalizers. Integral SPDT relays are rated at 2 Amps at 120 VAC. One relay represents total gallons and the other represents BTUs.

Models Available

985-12 Standard unit

985-13 Standard unit with 250ms pulse width

985-22 Standard unit with 4-20mA option installed

985-22 Standard unit with 4-20mA option installed and 250ms pulse width

Options

Model 985-22 also includes two pair of 0-1mA and 4-20 mA DC analog output signals. One pair represents flow rate in GPM or LPM, and the other pair represents either energy consumption or production in BTUs/hr or KWH.

Flow Sensor

Flow sensors used with the Model 985 BTU Meter can be a tee-mounted or a direct insertion type, nonmagnetic impeller style sensor as manufactured by Data Industrial.

Temperature Sensors

The two temperature sensors used with the Model 985 are 10k ohm at 25°C curve matched thermistors with a thermal accuracy of $\pm 0.2^{\circ}\text{C}$ in the range of 0°C to 100°C. They do not require user calibration. Each thermistor may be replaced independently.

Meter Location

Mount the Model 985 in a location that allows easy viewing of the counters and convenient access to the wiring terminals. Be sure to allow enough room for the meter door to swing completely open. Ventilation is of minor concern, since the unit generates very little heat. Due to mechanical counters, room acoustics may be a consideration.

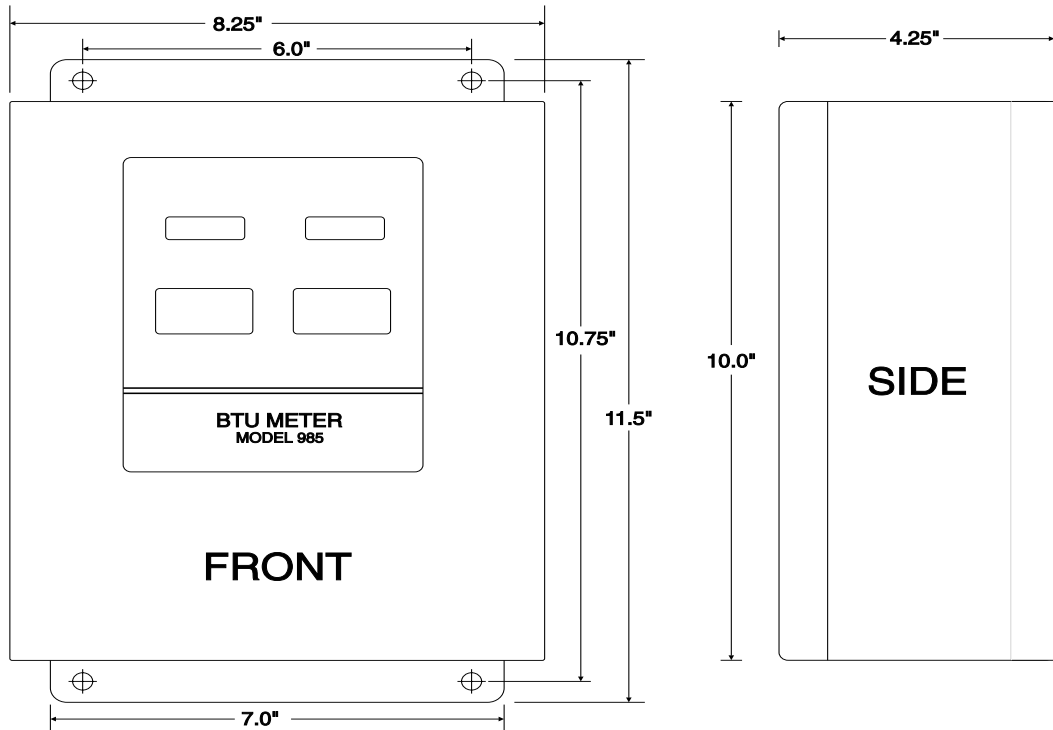
The Data Industrial flow sensor may be located up to 2000 feet from the monitor, using a Belden 9320 or similar shielded, twisted pair cable. The temperature sensors may be located up to 500 feet from the monitor using similar wiring. All sensor wiring is 12 VDC or less and conforms to Class II wiring.

Installation

Mechanical

The Model 985 is housed in a NEMA 4 enclosure for indoor or outdoor use or in areas that may be hosed down. It is intended for surface mounting on any wall or panel. Note the location considerations listed under *Meter Location* on Page 1. The mounting hole pattern and overall dimensions are shown in Figure 1.

Figure 1
Enclosure Mounting Dimensions



Flow Sensor Installation

All Data Industrial flow sensors should be installed in full pipelines, not gravity drained lines. The sensors should be installed with a minimum straight-run of 10 pipe diameters before and 5 pipe diameters after the sensor. Both horizontal and vertical pipelines are appropriate. The sensor should be located where it is accessible for service, and special care taken to allow enough clearance for removal of hot tap units. Tee mounted units with NPT connections or sockets can be installed in-line while insert-styles are mounted in 2" NPT saddles, weld-o-lets, etc. Care should be taken to align the sensor correctly and to maintain a 1 1/2" sensor insertion depth.

Note: For detailed installation instructions, see Data Industrial's "Sensor Installation Guide."

Temperature Sensors Installation

Correct, careful installation of the two temperature sensors is critical to maintaining accurate BTU calculations. Choose two locations, on either side of the energy load (or energy source) where flow is consistent and representative of the system.

DO NOT select locations that are stagnant or in a low flow branch.

The temperature sensing elements, at the tips of the temperature assemblies, must be fully immersed in the fluid stream. Make sure that the temperature assemblies are completely insulated so that no part is exposed to the outer environment. For high pressure, high velocity or large diameter pipelines, use thermowells rather than direct insertion units.

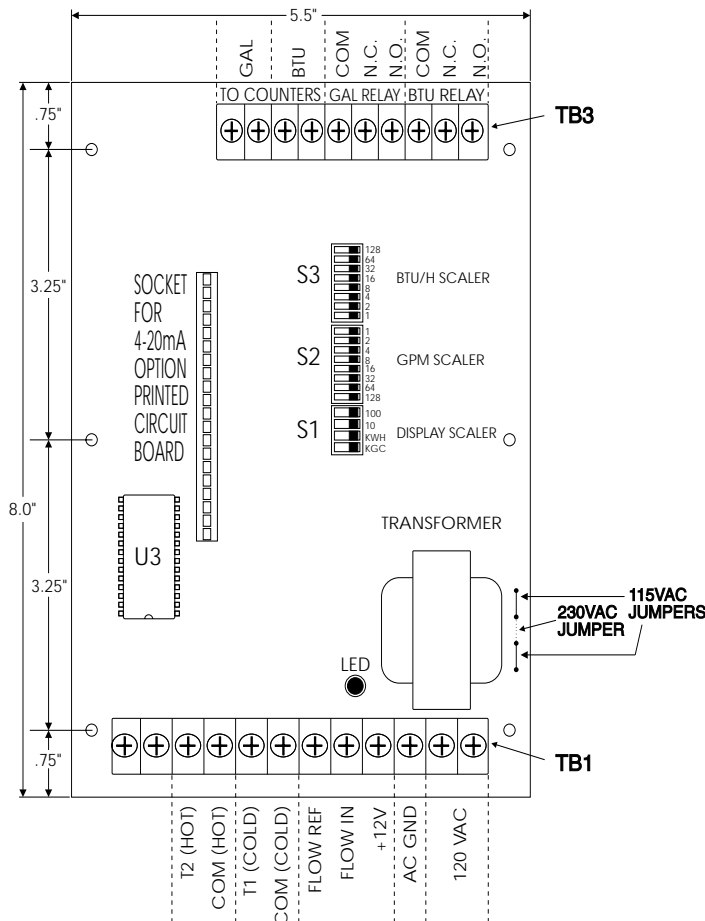
Electrical Installation

BTU Processor Board Wiring

Temperature Sensors

The low temperature sensor connects to Terminal Strip **TB1** at terminals **T₁(COLD)** and **COM(COLD)**. The high temperature sensor connects to Terminal Strip **TB1** at Terminals **T₂(HOT)** and **COM(HOT)**. Polarity of sensors is NOT important, but high and low temperature sensors are not reversible.

Figure 2
BTU Processor Board



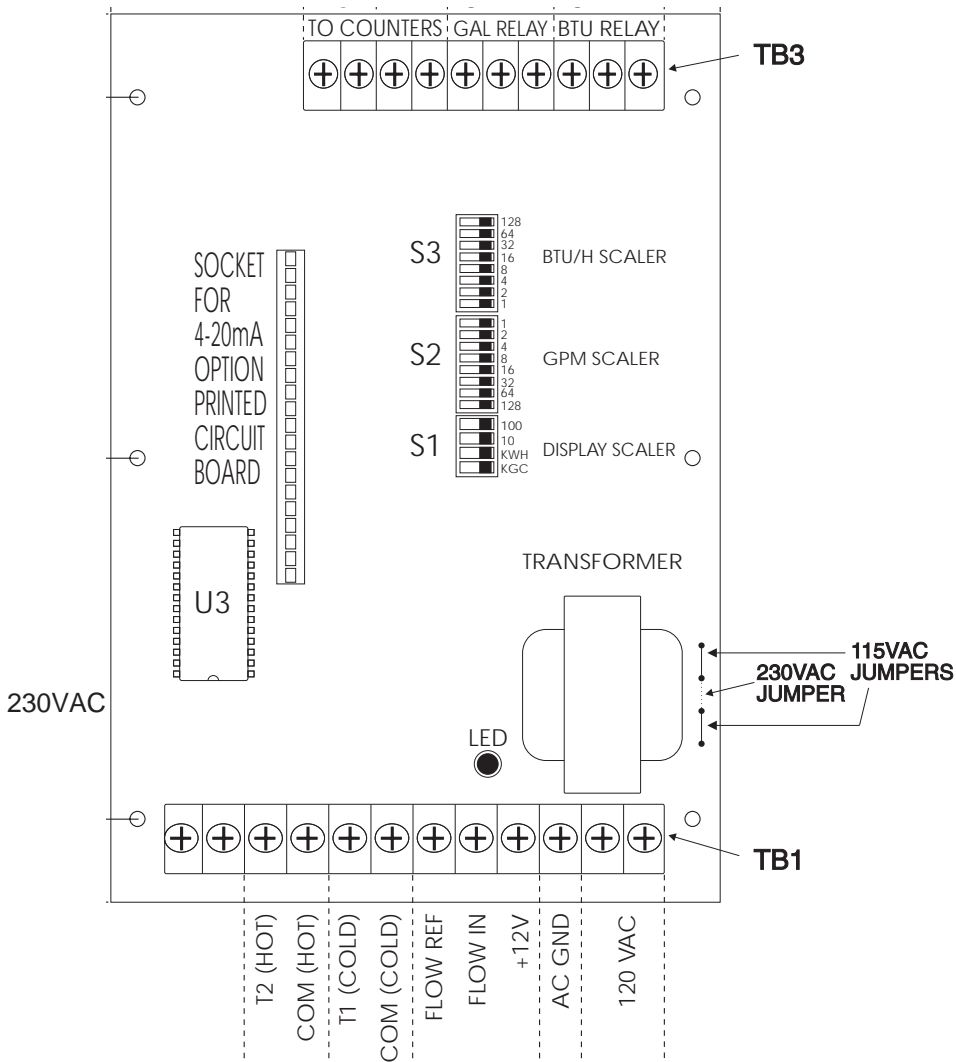
Power Supply

Connect 120 VAC, 60 HZ power supply (neutral and power) to Terminal Strip TB1 at the bottom two terminals labeled 120/240VAC.

WARNING: 230 VAC OPTION IS AVAILABLE ONLY AS A SPECIAL ORDER. DO NOT APPLY 230 VAC TO THE 120 VAC UNIT!!!

To Convert from 120VAC to 230VAC

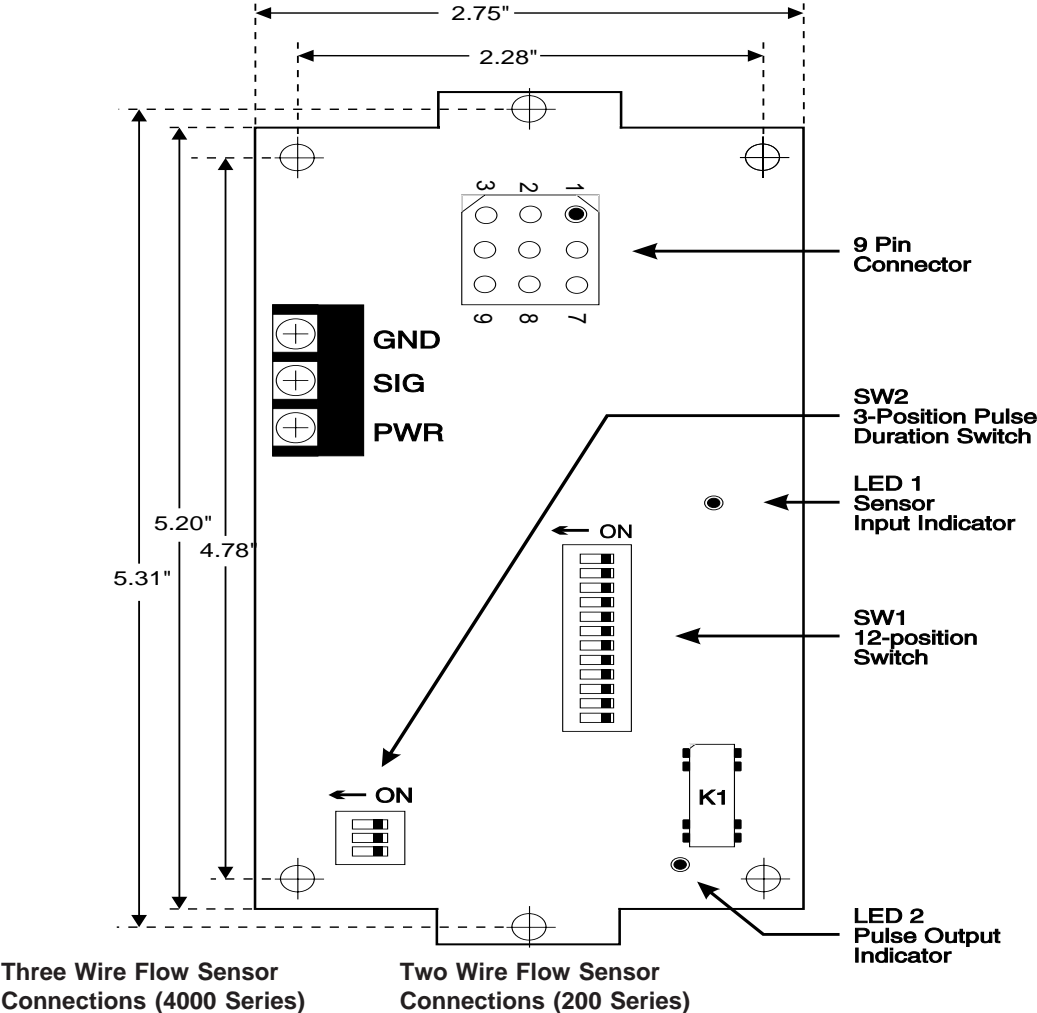
1. Remove the two (2) jumpers marked 115VAC, located to the left of the power transformer on the Main Processor P.C. Board.
2. Solder a wire into the jumper location marked 230VAC Jumper.



Wiring Flow Sensor Board

Wiring connections on the flow sensor board, Part Number 711576B, are as shown in Figure 3. Sensor connections are made at the 3 position terminal strip located on the flow sensor circuit board. All other connections to this board are made at the factory.

Figure 3
Flow Sensor Board



Three Wire Flow Sensor Connections (4000 Series)

- 1 - Red from Sensor to (PWR)
- 1 - Black from Sensor to (GND)
- 1 - White from Sensor to (SIG)

Two Wire Flow Sensor Connections (200 Series)

- 1. Red wire (+) from sensor to (SIG) (center terminal).
- 2. Black wire (-) and Shield wire (bare) together to (GND)

Calibration

The Model 985 BTU Meter may be calibrated in the field to any flow rate. All field calibration is accomplished through binary dip switch settings on the two circuit boards:

1. Flow sensor input/pulse output circuit board (Part Number 711576B) Figure 3
2. BTU processor circuit board (Part Number 711583) Figure 2

Flow Sensor Circuit Board

The “Gallons Per Pulse” range, based on flow sensor and/or pipe size, is the only function that must be set during field calibration of the flow sensor circuit board. This field adjustment is accomplished through setting ON/OFF dip switches located on the flow sensor circuit board.

SW1 (a 12 position switch) sets Gallons per Pulse output signals based on pipe size. **SW2** (a 3 position switch) is preset at the factory for 0.1 second pulse output length. All three dip switches of SW2 should be in the ON position. There are two LEDs located on the circuit board. LED1 flashes in conjunction with the actual pulses received from the flow sensor, while LED2 flashes with output pulse signals to the Main Processor Board.

Field Calibration of Output Pulse Signal

To program the Output Pulse Signal, locate the 12 position dip switch (SW1) on the Flow Sensor Circuit Board. Toggling the dip switches ON or OFF in the correct manner determines the resolution of the output signal.

The 12 position dip switch, SW1, is set following standard binary number format, beginning with switch location 1. This first switch is programmed to equal 1 when turned ON. Each adjacent switch is programmed to be a value two times the previous switch.

Switch 1	=	1
Switch 2	=	2
Switch 3	=	4
Switch 4	=	8
Switch 5	=	16
Switch 6	=	32
Switch 7	=	64
Switch 8	=	128
Switch 9	=	256
Switch 10	=	512
Switch 11	=	1024
Switch 12	=	2048

Setting the switches is an additive process. For example, if you select a pipe size/flow combination that requires programming the number “416” into the processor, you would turn ON switches 6, 8, and 9. Switch 6 = 32; Switch 8 = 128 and Switch 9 = 256. Adding these three numbers gives a total value of “416” to the divider circuitry. If you select a value of 51, you would turn ON Switches 1, 2, 5 and 6 for a total of 51 (1+2 +5+16+32 = 51).

Note: The largest binary number that can be programmed with the 12 position switch is 4,095, the total of all switches (1-12).

Table 1 on Page 7 provides the data to set the Flow Sensor Board dip switches for Data Industrial sensors in popular pipe sizes. The dip switch setting columns list the switch positions to be turned ON to program the divider circuitry for various pipe sizes. The divider circuitry “divides” the input sensor frequency by an appropriate number to provide either 1 gallon/pulse, 10 gallons/pulse, 100 gallons/pulse or 1,000 gallons/pulse. For special pulse output settings such as different gallons/pulse figures, cubic meters/pulse, liters/pulse or other pipe sizes or units not listed, please consult the factory or your local representative.

Note: In selecting a value of “gallons/pulse” for calibration purposes, 5 ft./sec. was chosen as being representative of typical flows. The velocity range for Data Industrial equipment is 1 to 30 ft/sec.

The dip switch positions have been calculated for current Data Industrial flow sensors. After locating the correct model number and/or pipe size, follow across to the appropriate “DIP SWITCH SETTING” column. The values listed here define which dip switches are to be turned ON. Make sure the balance of dip switches are turned OFF. This process will enter the correct “Divide-by” number to transmit the correct Gallons/Pulse.

When the analog option has been installed, the output of the Flow Sensor Circuit Board should be selected so that at the minimum flow of interest its output should occur at least once per minute; but not exceed 90 pulses per minute.

Table 1

FLOW SENSOR OR PIPE SIZE	PIPE ID	MIN FLOW IN GPM	DIP SWITCH SETTING FOR 1 GAL/PULSE	DIP SWITCH SETTING FOR 10 GAL/PULSE	DIP SWITCH SETTING FOR 100 GAL/PULSE	DIP SWITCH SETTING FOR 1000 GAL/PULSE
41020 - 1/2 w/jet	0.290	0.25	4.5,8,9	3,5,6,7,8,9,10,11,12	-	-
41120 - 3/4 w/jet	0.480	0.5	3,4,6,8	3,4,5,6,8,10,11	-	-
40020 - 1/2	0.530	1	1,2,4,5,7	5,8,9,10	-	-
40120 - 3/4	0.720	1	1,3,4,5,7	1,2,6,8,9,10	-	-
40220 - 1	0.930	1	2,3,4,5,7	1,3,4,6,8,9,10	-	-
220P-1	1.000	2	1,4,9	1,2,3,5,7,10,12	-	-
220P-1.5	1.500	8	6	7,9	1,3,4,5,6,7,11,12	-
220P-2	1.940	13	2,3,5	1,2,3,5,7,8	1,2,3,6,7,12	-
220P-3	4.020	35	1,2,3	4,7	1,2,4,7,8,10	-
220P-4	5.150	65	3	1,2,3,6	2,8,9	1,2,3,5,9,10,11,12
228B-2	1.990	10	2,3,5	2,4,5,7,8	4,8,12	-
228B-2.5	2.520	16	5	1,3,4,5,8	2,3,6,10,11	-
228C-2-150	2.070	12	1,3,5	2,5,7,8	4,5,6,12	-
228C-2.5	2.510	16	5	2,3,4,5,8	1,2,3,4,6,10,11	-
228SS-2	2.070	12	1,3,5	2,5,7,8	4,5,6,12	-
228SS-2.5	2.510	16	5	2,3,4,5,8	1,2,3,4,6,10,11	-
228C-2-400	2.100	12	1,2,3,5	3,6,7,8	3,6,7,8,12	-
250B-1	1.050	1.5	1,2,3,4,8	3,5,8,9,11	-	-
250B-1.25	1.380	2	2,3,4,7	1,3,4,9,10	-	-
250B-1.5	1.610	3	4,5,6	2,5,6,10	-	-
INSERTION SENSORS						
2.5" SCH40	2.470	15	2,4,5	1,2,3,9	1,2,4,7,10,12	-
3" SCH40	3.068	23	2,3,4	1,4,8	3,4,5,7,9,11	-
3" SCH80	2.900	21	5	1,2,4,5,8	1,5,10,11	-
4" SCH40	4.026	40	1,2,3	1,2,3,7	1,4,7,8,10	-
4" SCH80	3.826	36	4	1,5,7	2,4,6,9,10	-
6" SCH40	6.065	90	1,2	1,2,4,5	1,2,5,9	1,2,4,5,6,8,10,12
6" SCH80	5.761	81	1,2	2,3,4,5	1,5,6,9	2,3,6,7,8,9,10,12
8" SCH40	7.981	156	-	1,2,3,4	3,5,8	1,2,7,8,9,11
8" SCH80	7.625	142	-	5	1,2,6,8	1,3,4,5,7,10,11
10" SCH40	10.020	246	-	1,4	1,2,4,5,7	2,5,8,9,10
10" SCH80	9.564	224	-	2,4	1,3,6,7	1,2,3,4,6,7,8,9,10
12" SCH40	11.938	349	-	2,3	1,3,4,5,6	2,6,7,10
12" SCH80	11.376	317	-	1,2,3	1,3,7	1,3,4,6,8,10
14" SCH40	13.124	422	-	1,3	1,2,5,6	2,4,5,6,7,8,9
14" SCH80	12.500	383	-	2,3	1,2,3,5,6	1,4,6,10
16" SCH40	15.000	551	-	3	1,2,3,6	4,8,9
16" SCH80	14.314	502	-	3	1,2,4,6	2,3,4,6,8,9
18" SCH40	16.876	697	-	1,2	1,2,3,4,5	2,3,5,6,9
18" SCH80	16.126	637	-	1,2	2,6	3,5,7,9
20" SCH40	18.814	867	-	-	1,4,5	4,5,6,7,8
24" SCH40	22.626	1253	-	-	1,5	4,6,8
30" SCH10	29.376	2113	-	-	2,4	6,7

BTU Processor Board

After the flow board is calibrated, the S1 switches on the BTU processor board must be set. The S1 setting is used to select the computing scale and preset the volume multipliers for the totalizers. The larger the pipe size, the larger the total in both BTUs and gallons. Select the appropriate switch on S1 according to Table 2.

Table 2

Flow Meter Line Size	Recommended		Gal X	BTU X
	Pulse Output Of Flow Board	S1 Setting		
1", 1 1/4", 1 1/2", 2"	1 pulse/gal	ALL OFF	1	1000
3"	1 pulse/10gal	ALL OFF	10	10,000
6", 8"	1 pulse/100 gal	ALL OFF	100	100,000
12" +	1 pulse/1000 gal	ALL OFF	1000	1,000,000

“ALL OFF” refers to all of the dip S1 switches of , being placed in the “OFF” position. This causes the processor to increment the Gallons counter once for each pulse received from the Flow Sensor Circuit Board. The BTU processor board’s output capability is 90 pulses per minute to the Gallons counter. If this will result in a objectionably fast Gallons counter update , then turn on S1 #3(X10) or S1 #4(X100). This will result in a division of 10 or 100 respectively of the Flow Sensor Circuit Board pulse. As a result the Gallons and BTU counters resolutions will increase by a factor of 10, or 100 with a corresponding reduction in count rate. There will be no effect on the analog outputs.

Energy Readout

The energy readout may be some decade multiple of kBTU or kWh, depending on the volume signal from the flow meter and the factory programming of the delta T register. If the flow meter output is in gallons (or other decade factor, i.e. gallons x 10), the counter will read kBTU (or other decade factor, i.e. BTU x 10,000). If the flow meter puts out cubic meters and the board is properly programmed by switching the “MET” labelled dip switch to the ON position, the display will read kWh (kilowatt Hours). In either case, the decade multiplier depends upon the unit volume signal from the flow meter divider. S1 causes the flow meter signal to be divided by 1, 10, or 100. If the flow meter puts out 1 pulse per gallon, the display will read kBTU x 1, x 10, or x 100 depending on S1. The same applies for cubic meters and kWh.

Calibration Procedure

Model 985-22 Analog Output Section

The Analog Output Section of this unit is a separate P.C. Board, which plugs into TB2, a long terminal strip on the Main Processor Board. The Analog Output Section has four (4) outputs. The first pair of outputs (0-1mA and 4-20mA) represent flow rate. The second pair represent Energy Production/Usage (BTU/hour or KHW/Hour). Each pair tracks together. The 0-1mA outputs are useful to drive panel meters or other readout devices, while the 4-20mA outputs communicate with computer, data logging, or chart recording equipment.

Please note!!

The Analog output section is calibrated by DIP switch settings only. The POTENTIOMETERS on the P.C. Board are factory set, and sealed. **DO NOT ATTEMPT TO ADJUST THEM. BREAKING THE SEALS WILL VOID WARRANTY!** Before attempting to calibrate the analog output section, the calibration sections for the “Flow Sensor Circuit Board”, “Field Calibration of Output Pulse Signal” and “BTU Processor Board” sections of this Manual should be reviewed, as the switch settings discussed in those sections will effect the analog outputs.

General Information

1. Output Signals are not isolated from signal ground, internal power supplies (+12VDC and -12VDC), or each other. Signal errors can result if unintentional ground loops occur.
2. The S1 switch settings #3 (X10) and #4 (X100) located on the main processor board affect the relationship between the Flow Sensor Circuit Board and the Main Processor Board. When one of these switches are placed in the **ON** position, either Ten (10) or One Hundred (100) pulses will be accumulated from the Flow Sensor Circuit Board before the Flow Volume totalizer Updates. If all S1 #3(x10) and #4(x100) switches are **OFF** the totalizer will update once/pulse ; and analog outputs will step at a rate simultaneous with the Flow Volume Totalizer. If one of the S1 switch settings #3(X10) or #4 (X100) located on the Main Processor Board are **ON** the analog output will function independently from the totalizers, updating each time a pulse is received from the Flow Sensor Circuit Board.
3. Analog outputs will default to 4mA and 1mA if the Main Processor Board does not receive a pulse from the Flow Sensor Circuit Board within one minute. If this effect is not considered, tracking and linearity of the analog outputs may be affected.
4. DIP switches S2 & S3 are used to calibrate the Analog Output section of the BTU monitor. Like SW1 on the Flow Sensor Board, S2 and S3 located on the Main Processor Board, select binary values 1 thru 128. The switch settings are additive, as explained in the “Field Calibration of Output Pulse Signal” section of this Manual and in the steps that follow:
5. MINIMUM OUTPUT (4mA and 0mA)
 - a. Factory set - **CAN NOT** be adjusted.
 - b. Occurs at times of no flow, or any time the Main Processor Board does not receive a pulse from the Flow Sensor Circuit Board within a 1 minute period.

Switch S2
GPM SCALER

Switch S3
DELTA T in °F
BTU/HOUR SCALER

Switch 8 = 1
Switch 7 = 2
Switch 6 = 4
Switch 5 = 8
Switch 4 = 16
Switch 3 = 32
Switch 2 = 64
Switch 1 = 128

Switch 8 = 128
Switch 7 = 64
Switch 6 = 32
Switch 5 = 16
Switch 4 = 8
Switch 3 = 4
Switch 2 = 2
Switch 1 = 1

GPM/LPM ANALOG OUTPUT SIGNALS (4-20mA and 0-1mA)

1. Gallons and totalizer resolutions should be already be selected by SW1 switch settings on "Flow Sensor Circuit Board" so that the LED on the Main Processor Board is flashing more then once a minute at minimum flow and less then 90 pulses/minute at maximum flow.

Note: Greatest system accuracy is achieved with highest Gallons/Pulse resolutions as noted in general section, 4mA is factory set at zero flow and can not be adjusted

2. GPM/LPM FULL SCALE (20mA and 1mA)
 - a. Set by DIP Switch S2 (GPM SCALER) on main processor board.
 - b. Flow Rate chosen should be greater than system is ever expected to achieve. This prevents over ranging at times of high flow.
 - c. FULL SCALE = Flow Sensor Circuit Board Resolution in GPM X S2 setting

Full Scale output (20mA and 1mA) will occur when system flow rate is sufficient to cause the LED on the Main Processor Board to pulse the number of times in one minute represented by the S2 switch setting. For example if S2 = 4 (switch **#6 ON**) then the LED must pulse 4 times/min or once every 15 seconds for Full Scale (20mA and 1mA) outputs to result. A pulse once every 30 seconds will result in 12mA and 0.5mA respectively.

Data Industrial Model 985 Manual

DIAGNOSTIC

Example #1

Assume 2000 GPM is desired for Full Scale output (20mA and 1mA) with a Flow Sensor Circuit Board resolution of 1000 GALLONS/PULSE. When 2000 GPM is Flowing LED 2 on the Sensor Board, and LED 1 on the Processor Board will flash two (2) times per minute or once every 30 seconds. If S2 switch #7 representing a binary value of 2 is "ON" then output will be at Full Scale. If then the flow rate drops to 1000 GPM, the LEDs will flash only once per minute, and the GPM outputs will drop to 12.5mA and 0.5mA respectively. If on the other hand the flow drops to 500 GPM, the LEDs will flash only once every 2 minutes. This is less than once per minute and the Analog outputs will drop to 4mA and 0 mA respectively. If 500 GPM is a flow of interest then the Flow Sensor Circuit Board Resolution could be reduced to 100 GALLONS/PULSE, S1 switch #3 turned "ON" (Divide by 10), and then S2 switch #4 and #6 turned "ON" (16+4=20). Now at a flow rate of 2000 GPM the LEDs will flash 20 times per minute, the Analog outputs will be a 20mA and 1mA respectively, and yet the GALLONS totalizer will still have a resolution of 1000 GALLONS/UPDATE.

Example #2

Assume 7500 LPM is desired as Full Scale Output (20mA and 1mA), and totalizer resolution of 100 LITERS/UPDATE, at full scale flow the totalizer will update Seventy Five (75) times per minute, or once every 0.8 seconds when 7500 LPM is flowing. S2 switches #2,5,7,8 (64+8+2+1=75) representing a binary value of (75) should be **on**.

BTU/HOUR ANALOG OUTPUT SIGNALS (4-20mA and 0-1mA)

1. BTU/HOUR is computed by the microprocessor using the following formula.

$$\text{BTU/HOUR} = \text{GPM} \times \text{Delta T in } ^\circ\text{F} \times \text{Constant (500.4)}$$

$$\text{Constant} = \frac{1 \text{ BTU}}{\text{LBS (} ^\circ\text{F)}} \times \frac{8.34 \text{ LBS}}{\text{GALLON}} \times \frac{60 \text{ MINUTE}}{1 \text{ HOUR}} = 500.4$$

2. MINIMUM OUTPUT (4mA and 1mA)
 - a. Factory set - CAN NOT be adjusted.
 - b. Occurs anytime either Flow Rate, or Delta T are Zero (0).
3. FULL SCALE (20mA and 1mA)
 - a. GPM set by S2 DIP switch settings on main processor board, as explained in previous section.
 - b. Delta T (Differential Temperature in °F), is the variable controlling the BTU/Hour scaling.
 - c. S3 switch setting represents Maximum Delta T value.
 - d. Maximum Delta T should be chosen based on the following criteria.
 1. To prevent over ranging, value should be greater than maximum Delta T ever expected to be encountered in system.

2. To make Analog BTU/Hour scaling convenient values use following equation:

$$\text{Delta T} = \frac{\text{Desired BTU/HOUR FULL SCALE}}{\text{GPM FULL SCALE} \times 500.4}$$

3. Compare the Delta T in °F computed above to with the maximum system Delta T, to insure that system Delta T is not greater, as discussed in criteria # 1.

Example #1

Assume 2000 GPM has been chosen as Full Scale Flow Rate Output, with a totalizer resolution of 1000 GAL/UPDATE, and a maximum Delta T of 45°F then any S3 switch combination representing a value of 45 or greater can be selected.

The microprocessor will scale the BTU/HOUR analog output in the following manner.

$$\text{BTU/HOUR} = \text{GPM} \times \text{Delta T} \times \text{Constant (500.4)}$$

$$2000 \text{ GPM} \times 45 \text{ F} \times 500.4 = 45.036 \text{ Million BTU/HOUR}$$

If the 4-20mA output was being used to drive a chart recorder, this would not be a convenient value since paper of graduated 0-50, 0-100 etc. is standard. To select a convenient value such as 0 - 50.0 Million BTU/HOUR, compute as follows:

$$\text{Delta T} = \frac{\text{Desired BTU/HOUR FULL SCALE}}{\text{GPM FULL SCALE} \times 500.4}$$

$$\text{Delta T} = \frac{5.0 \text{ Million BTU/HOUR}}{2000 \text{ GPM} \times 500.4}$$

$$\text{Delta T} = 49.96$$

Since S3 binary switches can be set only to whole integer values round 49.96 off to 50. Flip S3 switches #6, #16, and #2 (32+16+2=50) **ON**, and all others **OFF**.

KILOWATT HOURS/HOUR (KWH/H) ANALOG OUTPUT (4-20mA and 0-1mA)

1. KWH/HR's are computed by the microprocessor using the following formula.

$$\text{KWH/HOUR} = \text{LITERS/MINUTE} \times \text{Delta T in } ^\circ\text{F} \times \text{Constant} (.0387122)$$

$$\text{Constant} = \frac{1 \text{ BTU}}{\text{LBS (} ^\circ\text{F)}} \times \frac{2.203 \text{ LBS}}{\text{LITER}} \times \frac{60 \text{ MINUTES}}{1 \text{ HOUR}} \times \frac{1 \text{ KWH}}{3414.43 \text{ BTU}} = .0387122$$

2. MINIMUM OUTPUT (4mA and 0mA)

- a. Occurs any time either Flow Rate or Delta T are zero (0).
- b. Factory set - CAN NOT be adjusted.

3. FULL SCALE (20mA and 1mA)

- a. Set by S2 DIP switch settings, on main processor board.
- b. Delta T (Differential Temperature in °F), is the variable controlling the KWH scaling.
- c. S3 switch positions represent Maximum delta T value in °F.
- d. Maximum Delta T should be chosen based on the following criteria.
 - 1. Greater than maximum Delta T ever expected to be encountered in system.
 - 2. Compute convenient Analog KWH/HR scaling with following equation.

$$\text{Delta T in } ^\circ\text{F} = \frac{\text{Desired KWH/HR. FULL SCALE}}{\text{LITERS/MINUTE FULL SCALE} \times .0387122}$$

- 3. Check that Delta T value computed above is greater than maximum system delta T as discussed in criteria #1.

Example #1

When metric operation is selected by switching **ON** S1 #2, totalizers register in LITERS and KILOWATT HOURS. ANALOG Output signals are therefore LITERS/MIN, AND KILOWATT HOURS/HOUR

Assume 7500 LPM is desired as Full Scale Output, with a totalizer resolution is 100 LITERS/UPDATE and maximum Delta T of 45°F. At full scale flow of 7500 LPM the totalizer will update Seventy Five (75) times per minute or once every 0.8 seconds, S2 switches #2,5,7,8 (64+8+2+1=75) representing a binary value of (75) should be turned **ON** resulting in a 20mA flow rate under this condition. With a maximum Delta T of 45°F any S3 switch combination representing a value of 45 or greater can be selected.

$$\text{KWH/HOUR} = \text{LPM} \times \text{Delta T in } ^\circ\text{F} \times \text{Constant (.0387122)}$$

$$7500 \text{ LPM} \times 45^\circ\text{F} \times 0.0387122 = 13,065.36 \text{ KWH/HOUR}$$

If the 4-20mA output is being used to drive a chart recorder, this may not be a convenient value to use since paper of 0-20, 0-50, 0-100 etc. is standard. To select a convenient value such as 0-20,000 KWH/HOUR compute as follows.

$$\text{Delta T} = \frac{\text{Desired KWH/HOUR FULL SCALE}}{\text{GPM FULL SCALE} \times .0387122}$$

$$\text{Delta T} = \frac{20,000 \text{ KWH/HOUR}}{7500 \text{ LPM} \times .0387122}$$

$$\text{Delta T} = 68.88$$

Since S3 binary switches can be set only to whole integer values round 68.88 off to 69. Switch **ON** S3 switches #7, #3 and #1 (64+4+1=69) all others **OFF**.

Troubleshooting

Troubleshooting the 985 series BTU meter can be broken into three parts.

I. Flow Sensor

1. If there is flow, and LED #1 on the sensor pulse scaling board is flashing, the sensor is working.
2. If a Model 1200 is being used for troubleshooting enter the proper pipe I.D. and connect to the sensor input terminals, the proper flow rate should be displayed.
3. If the sensor is not causing LED #1 to flash, measure the voltage across the sensor.
4. With no flow, voltage should be 7.2 to 8.0 VDC. If reading on voltmeter is 0.6 VDC sensor may be wired backwards, If the voltage is between 1 and 7 VDC sensor is defective and must be replaced. If the voltage is 0 VDC check for shorted wires.

II. Thermistors

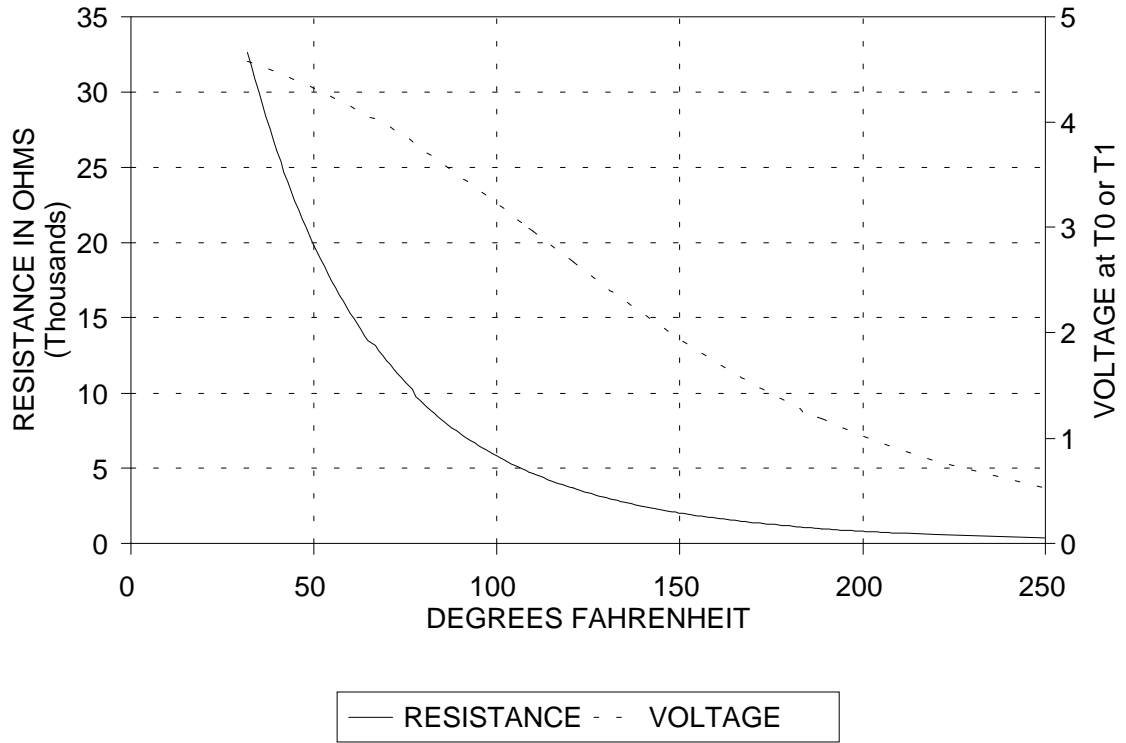
1. Measure the voltage across the thermistor input T0 and T1, and compare temperature to voltage/ resistance curves. If temperature Vs resistance reading are not correct replace thermistor element.

III. BTU Meter

1. If LED #1 is flashing, LED #2 on the sensor scaler board and LED #1 on the Main Processor Board should flash and the flow total counter should increment once per number of SW1 switch setting of LED #1. If LED #1 is flashing and LED#2 is not flashing check the reed relay on sensor scaler board.

BTU METER - TEMPERATURE INPUTS

FULL TEMPERATURE RANGE



This Graph shows thermistor resistance and voltages that appear across one of the thermistors inputs plotted against system temperature. This graph is intended as a troubleshooting/diagnostic tool.

Specifications

Display

Two non-resettable electromechanical counters

Enclosure

NEMA 4 steel

Dimensions: 8 1/2" X 10 1/2" X 4 1/2"

Operating Temperature Monitor

32°F to 130°F (0°C to 54.4°C)

Storage Temperature Monitor

-20°F to 150°F (-30°C to 65°C)

Weight

11 lbs. (4.99 kg.)

Power Supply

120 VAC, 60 Hz (230 VAC, 50 Hz option available)

110 mA maximum current draw

WARNING: Do not wire 230 VAC into 120 VAC unit

Flow Velocity Range

1 FPS to 30 FPS for all sensors except as noted.

1/2 FPS to 15 FPS (1", 1 1/2", 1 1/2" DIC bronze tee sensors)

1/4 FPS to 20 FPS (4000 Series depending on model)

Fluid Temperature Operating Range

32°F to 221°F (0°C to 105°C)

Temperature vs. Resistance Specifications

This chart is a reference to determine the temperature reading of the thermistor when disconnected from the circuit board and installed in the piping system.

°F	°C	Resistance
32	0	32654
50	10	19903
68	20	12493
86	30	8056
104	40	5326
122	50	3602
140	60	2488
158	70	1753
176	80	1257
194	90	917
212	100	679

Sensor Accuracy

Temperature: $\pm 0.2^\circ\text{C}$ from 0°C to 100°C , maximum temperature 350°F (176.7°C)

Flow: $\pm 1\%$ Full Scale

Linearity $\pm 1\%$

Repeatability $\pm 0.3\%$

Warranty

Data Industrial Corporation ("Seller") of 11 Industrial Drive, Mattapoisett, Massachusetts 02739, U.S.A., warrants to the original purchaser of its product that such product manufactured by Data Industrial Corporation shall be free from defects in materials or workmanship when installed, serviced and operated according to Data Industrial corporation instructions or in other such normal use. This warranty is effective for a period of 12 months from the date of installation by the Purchaser or 18 months from the date of shipment by the "Seller" whichever occurs or terminates first. This limited warranty does not cover damage or loss resulting from corrosion or erosion caused by acids or other chemicals or negligent installation improper operation, misuse, accident, unauthorized repair or substitution of components other than those provided by the "Seller", and does not cover limited life components such as bearings, shafts, impellers where wear rate is a function of application. Any component not manufactured by the "Seller" but included in its products shall not be covered by this warranty and is sold only sunder such warranty as the manufacturer may provide.

If Buyer or Purchaser wishes to make a claim hereunder, he shall send written notice of any defect within the warranty period, to "Seller" at the above address. "Seller" may at its sole option instruct Buyer to ship subject part, postage prepaid, to the "Seller" at above address or authorize a representative to inspect the part on site. "Seller" will at its sole option repair or replace any effective product covered by this warranty. If Buyer makes repairs or alterations to any product or part covered by this warranty without "Sellers" prior written approval, this warranty shall be null and void.

The foregoing shall constitute Buyers or Purchasers sole and exclusive remedy against "Seller", and no other remedy, including but not limited to, incidental or consequential damages for personal injury, loss of fluids, gases or other substances or for loss of profits or injury to property or person shall be available to the Buyer or Purchaser. The warranty extended herein shall be in lieu of any other implied warranty of merchantability or fitness for a particular purpose, and seller shall bear no liability for representatives or retail sellers. In no event shall Data Industrial Corporation be liable for any contingent, incidental, or consequential damage or expenses due to partial or complete inoperability of its product.