840205/206 Mass Flow Transducers (RoHS) Product Description
DMS# 10000025284

PREPARED BY:	**Todd Campbell 2278**	**DATE: 1/28/13**
APPROVED BY:	**Keith M. Kieffer 2395**	**DATE: 1/30/13**

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. DOCUMENT USAGE AND CONTROL

The following rules and guidelines should be followed whenever using or revising this document:

» *Before using* check the *ECO history.* This will inform you of any changes that have been made to the document since your last use.

» The BOM is considered the controlling document governing the construction of the instrument. Where there is a disparity between the assembly procedures and the BOM, the Bill of Materials is to be considered correct. Check the BOM to insure that the correct revision drawings and documents are being used. The master for this document is archived on the LAN.

» *USE THE STANDARD* ***ECO*** *SYSTEM (9020186: Engineering Change) TO PROCESS ANY CHANGES TO THIS DOCUMENT. For example; a discrepancy between the BOM and this assembly procedure. ALL CHANGES TO THIS DOCUMENT MUST COMPLY WITH TSI POLICIES OUTLINED IN 9020174 (Document and Data Control).*

» Record all changes made to this documentation in the table below:

2. ECO HISTORY

DATE	REV	ECO NO.	DESCRIPTION OF CHANGE
1/28/13	A	105416	Release of RoHS version of series 8402xx

3. PURPOSE AND SCOPE

This document contains the application notes and performance specifications for the TSI 840205/206 flowmeters. This is a controlled document that is listed on the Bill of Material (BOM) for both flowmeters. Changes to this document or to the flowmeter should be updated in this document if applicable.

4. APPLICABLE DOCUMENTS

The following documents are related to and applicable to the product contained in this document:

1. BOM 840205/840206 Bill of Materials
2. ASSY 9010429 Assembly Procedure
3. TCP 9030112 Test and Checkout Procedure.

5. PRODUCT SPECIFICATIONS

5.1. Description

The TSI flow transducer described here contains two sensors, one for sensing flow and the other for measuring temperature. Each sensor has a separate non-linear voltage output. To determine the mass-flowrate of the gas passing through the flow transducer, the voltage output of each sensor must be measured and then used in the algorithm described in this document. A microprocessor (not provided by TSI) is required to process the flow transducer outputs using the supplied algorithm. Calibration constants unique to each flow transducer are stored on an Electrically Erasable PROM chip (EEPROM) on the unit. These are read by the microprocessor at power up and used in the flow calculation.

The primary contents of the EEPROM are the calibration coefficients which are used in computing gas flowrate as documented in section 6.5. The A and B coefficients are unique to each flow sensor produced and calibrated, whereas the C coefficients change less frequently. Since the EEPROM contents are read from the flow sensor during initial power up, the fact that the coefficients are different and can change is not an issue. Periodically, TSI finds it necessary to optimize the C coefficient for improved performance. TSI reserves the right to change C coefficient values without prior customer notification. At the time of the C coefficient change, an updated copy of this product description will be sent out indicating a change was made, however TSI is not obligated to gain approval from the customer for such a change. In the event of a C coefficient change, both the revision of the flowmeter and the revision of this document will change accordingly.

The circuit that senses flow is commonly known as a thermal sensor or hot-film anemometer. This particular flow transducer utilizes a thin-film sensor maintained at a temperature of 150°C. The velocity of the gas moving past the sensor determines the heat transfer rate between the sensor and the gas. This heat transfer rate is translated into a voltage required to maintain the sensor temperature at 150°C. Therefore, this voltage is a function of the mass flow of gas past the sensor. The heat transfer rate is also influenced by the gas temperature. A thermistor circuit is used to measure gas temperature and a correction is made using the algorithm provided.

The Models 840205 and 840206 flow transducers both have a flow range of 0-300 slpm and are calibrated at room pressure. The Model 840205 is calibrated with air. The Model 840206 is calibrated with 100% oxygen.

Models 840205 and 840206 are manufactured to meet RoHS Directive 2011/65/EU.

5.2. Serial Number

All flowmeters will contain a 10 digit serial number. The format of the serial number is as follows:

Serial Number: **MMMYYWWXXX**

MMM - Alphanumeric representing model number
MMM = 205 for the 840205
MMM = 206 for the 840206
YY - Year of manufacture (last two digits of year, e.g. 01=2001)
WW - Week of manufacture (00 - 52, week 00 is the first partial week of the year)
XXX - Sequential number that restarts at 001, at the beginning of each new week of manufacture

5.3. Labeling

Each flowmeter will have a label attached that will specify the TSI part number, revision, gas calibration, and TSI's ten digit serial number. The serial number will be bar-coded with the Code 39 bar-code format.

5.4. Performance Specifications

Specification	Model 840205 (air)	Model 840206 (oxygen)
Calibration gas	Air	Oxygen (100%)
Flow range	0 to 300 Standard liters/min. (slpm)	0 to 300 Standard liters/min. (slpm)
Flow accuracy	±2.5% of reading ±0.1 slpm at 21°C	±2.5% of reading ±0.1 slpm at 21°C
Flow accuracy de-rating at extended temperatures	Add 0.05% +0.001 slpm per 1°C away from 21°C	Add 0.05% +0.001 slpm per 1°C away from 21°C
Temperature accuracy (thermistor)	±0.5 °C (see Figure 3) (at 100 slpm only)	±0.5 °C (see Figure 3) (at 100 slpm only)
Operating temperature range	0 to 65°C	0 to 65°C
Flow voltage output (Vf)	Zero flow[1]: 0.35 ± 0.2 volts Full scale[1]: 3.75 ± 0.3 volts (see Figure 2)	Zero flow[1]: 0.35 ± 0.2 volts Full scale[1]: 3.85 ± 0.3 volts (see Figure 2)
Response time to flow (Vf) (Low-pass filter on output 3db at 2.7khz)	Less than 5 milliseconds (63% to full scale flow)	Less than 5 milliseconds (63% to full scale flow)
Response time to temp. (Vt)	5 seconds: (flow = 2 slpm) 1 second: (flow = 100 slpm) (63% of final value)	5 seconds: (flow = 2 slpm) 1 second: (flow = 100 slpm) (63% of final value)
Burst pressure	100 psig without bursting	100 psig without bursting
Pressure drop	See Figure 4	See Figure 4
Operating pressure effects	See Figure 5	See Figure 5
Operating humidity effects	See Figure 6	See Figure 6
Supply voltage	5 VDC ± 5%, regulated	5 VDC ± 5%, regulated
Power consumption (at 21°C and 14.7 psia) (at 21°C and 25 psia) Models (840211,212)	Zero flow: 40 mA max (0.22 Watts) Full scale: 122 mA max (0.65 Watts) Zero flow: 55 mA max (0.30 Watts) Full scale: 124 mA max (0.66 Watts)	Zero flow: 40 mA max (0.22 Watts) Full scale: 122 mA max (0.65 Watts) Zero flow: 55 mA max (0.30 Watts) Full scale: 124 mA max (0.66 Watts)
Storage temperature Storage humidity Storage pressure	-40°C to +70°C 0 to 95% RH, non-condensing 6 to 18 psia (0.4 to 1.2 bar)	-40°C to +70°C 0 to 95% RH, non-condensing 6 to 18 psia (0.4 to 1.2 bar)
RoHS Compliance	Meets RoHS Directive 2011/65/EU	Meets RoHS Directive 2011/65/EU

Notes: [1] @ 21.11°C (70 °F) air with pressure = 14.2 psia

Table 1: Performance Specifications

5.5. Materials and Dimensions

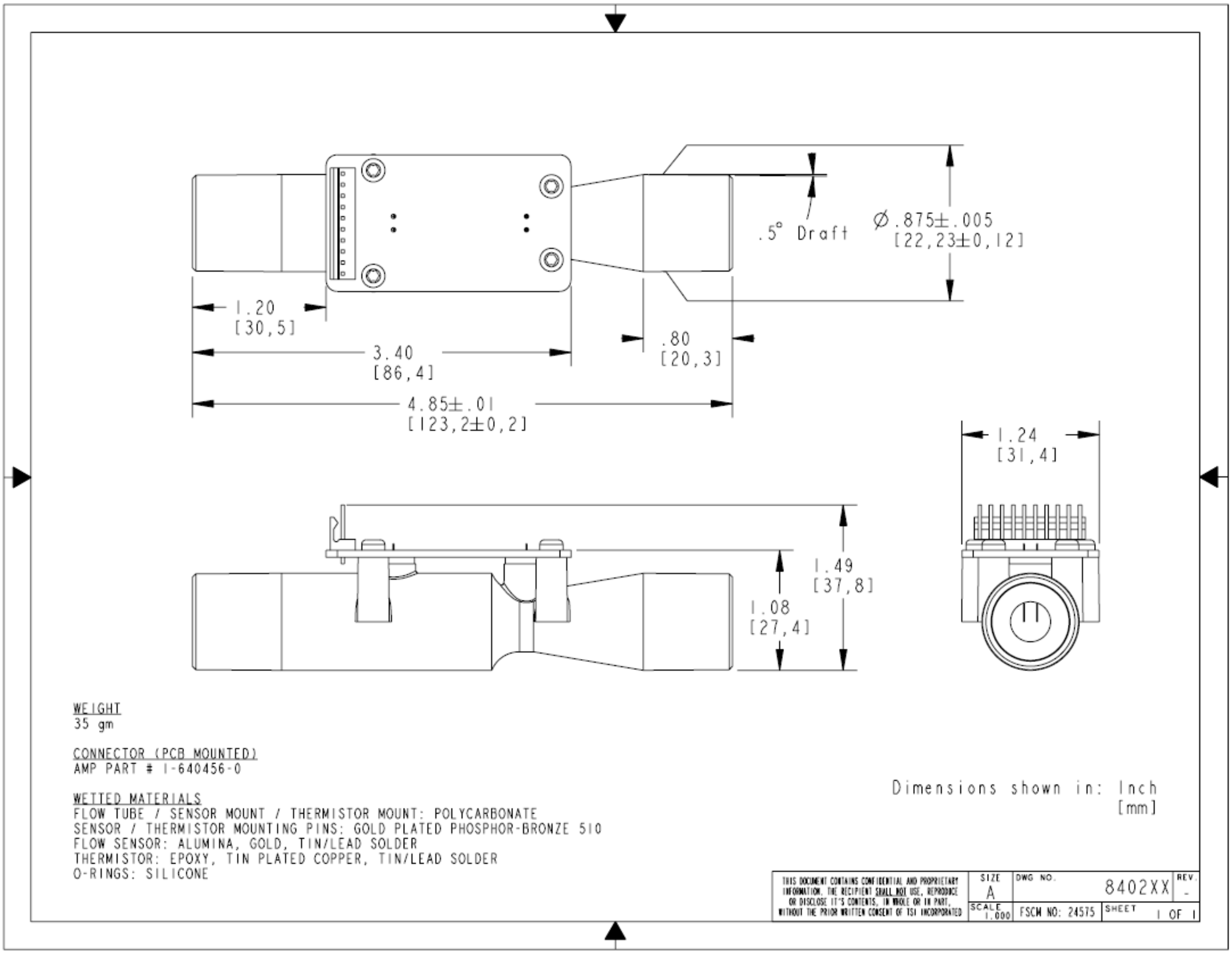


Figure 1. Materials and Dimensions

5.6. Flow Response

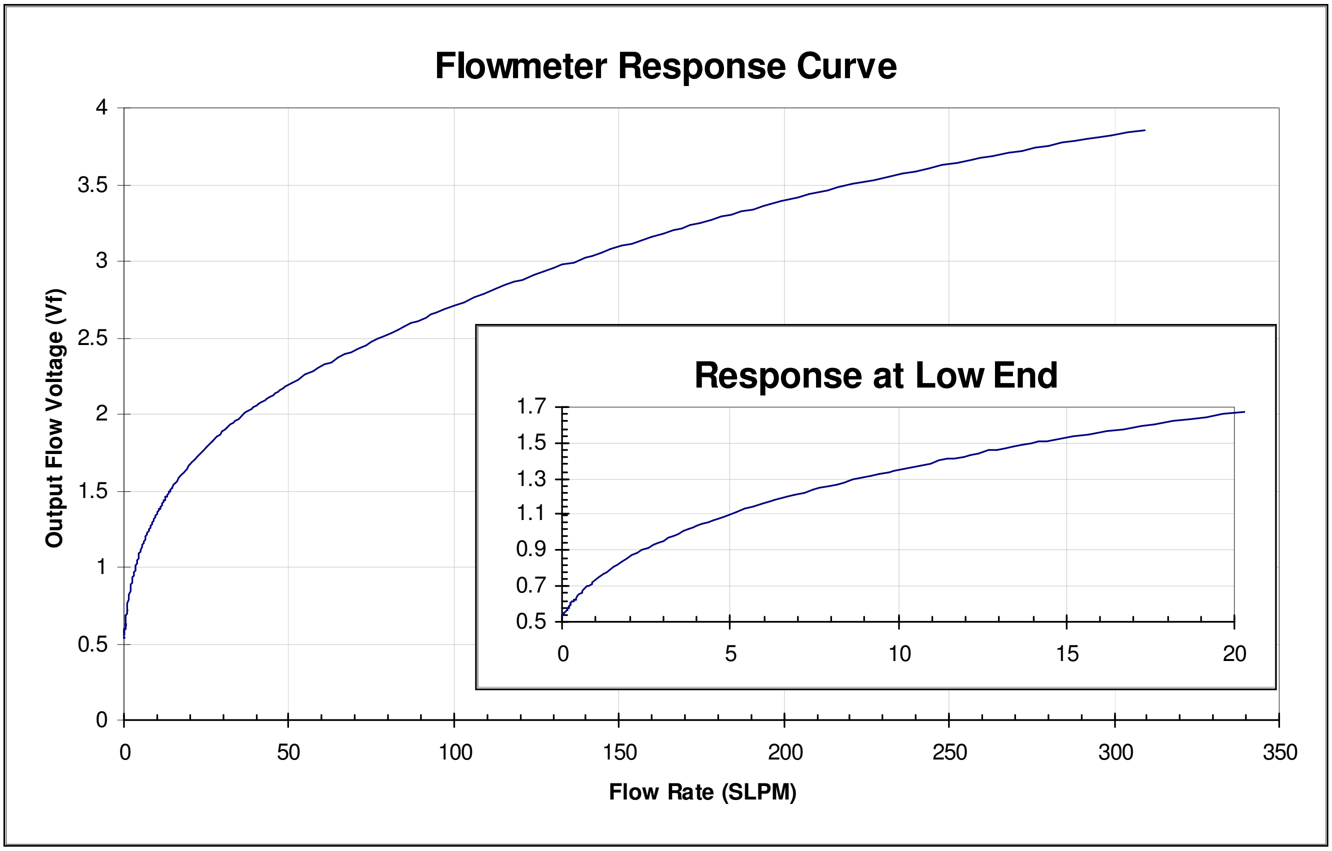


Figure 2. Typical Flow Response Curve

5.7. Temperature Skewing

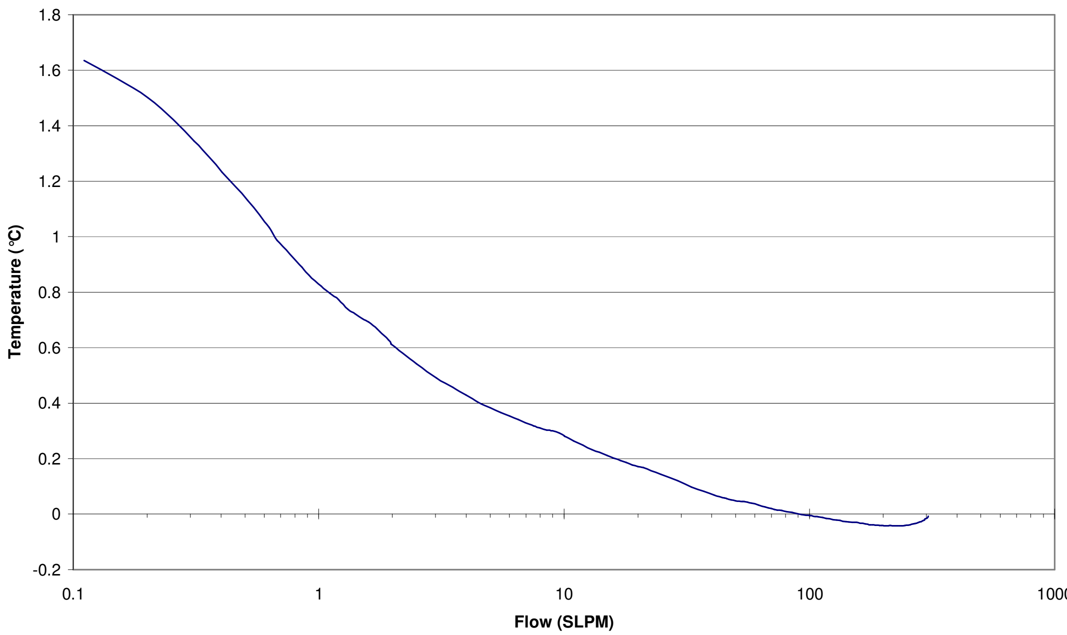


Figure 3: Temperature Skewing vs. Flow

Note: The above graph shows how the temperature measured by the flowmeter thermistor differs from the temperature reference used during calibration. The temperature difference is zero at the flowrate where the temperature correction offset was measured, which was 100 l/min.

5.8. Pressure Drop

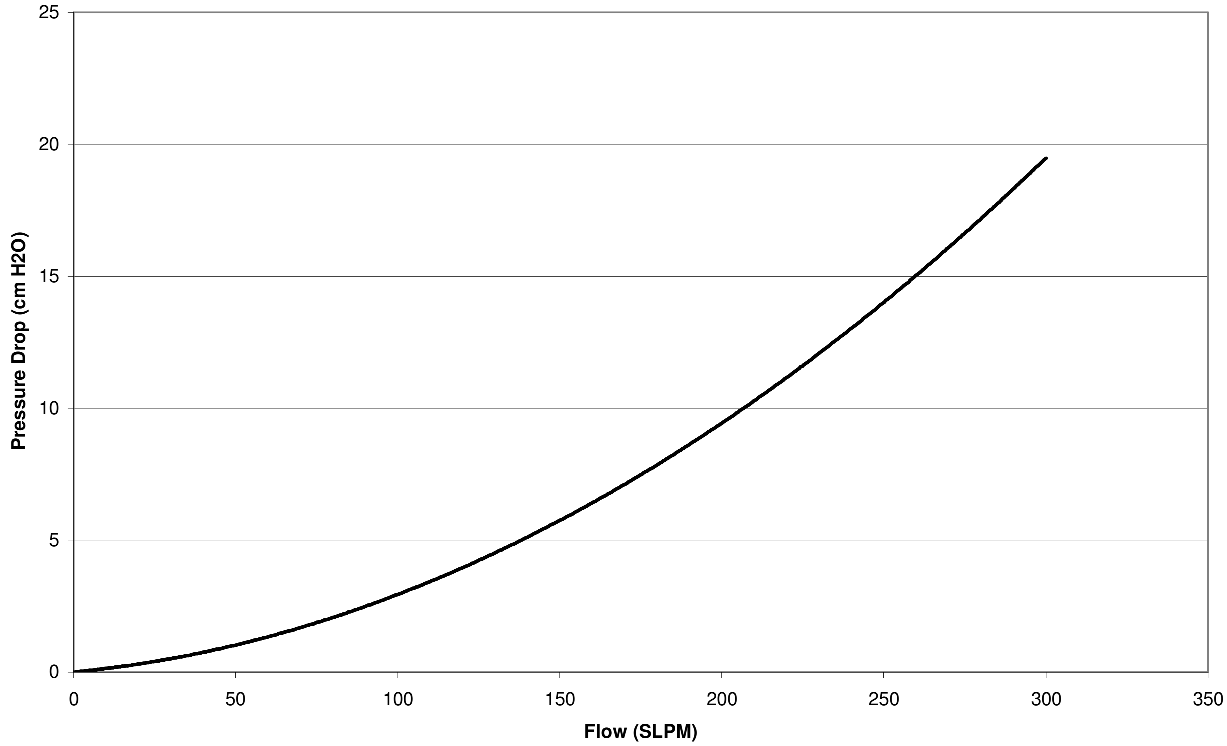


Figure 4. Pressure Drop as Related to Flow (Model 840205)

5.9. Pressure Effects

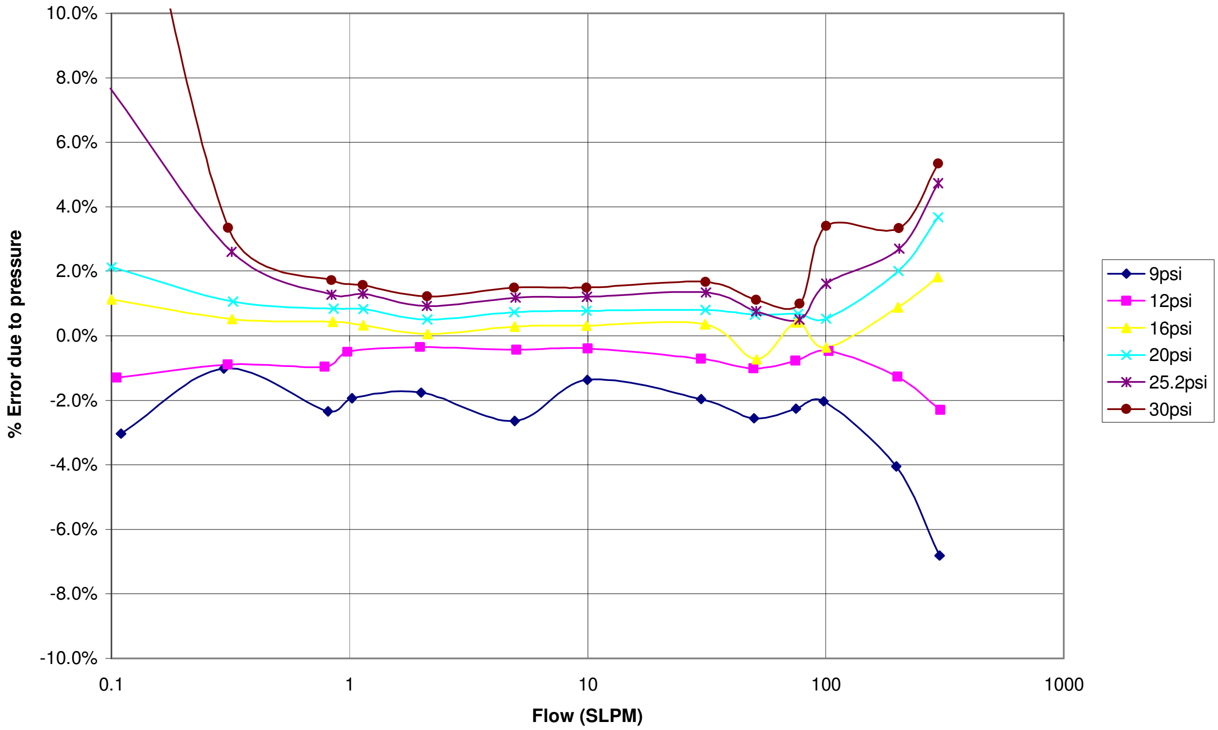
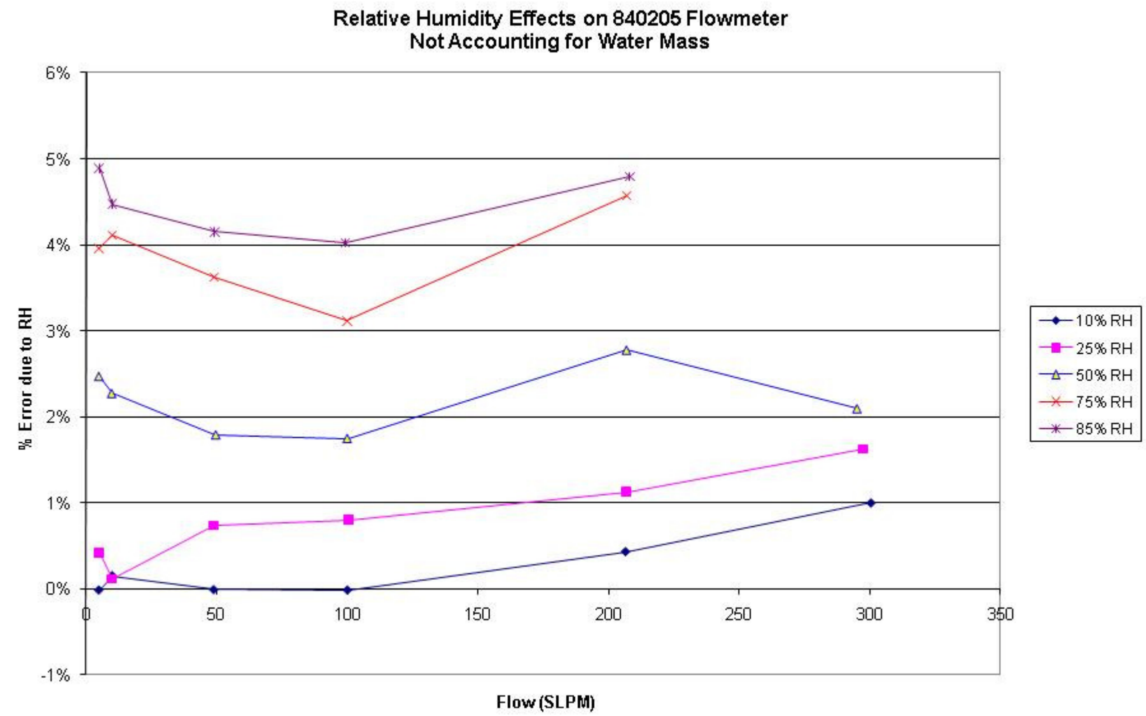


Figure 5. Effect of pressure on flow rate for models calibrated at 14.2 psia

The graph above shows that when gas pressure in the 840205/206 flow transducer is different from its calibration pressure of 14.2 psia, the flow transducer's accuracy is affected. This pressure dependency is caused by a mach number dependency and a free convection effect (Grashof number) which is not accounted for in the standard flowrate calculation.

5.10. Humidity Effects



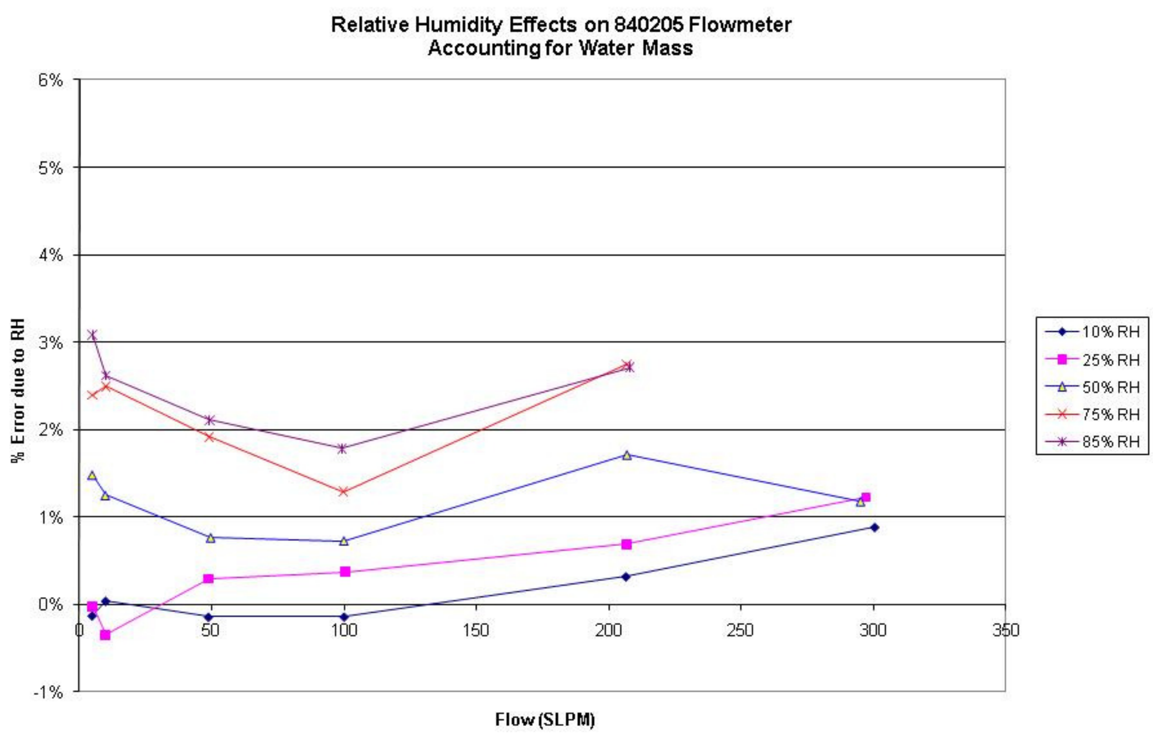
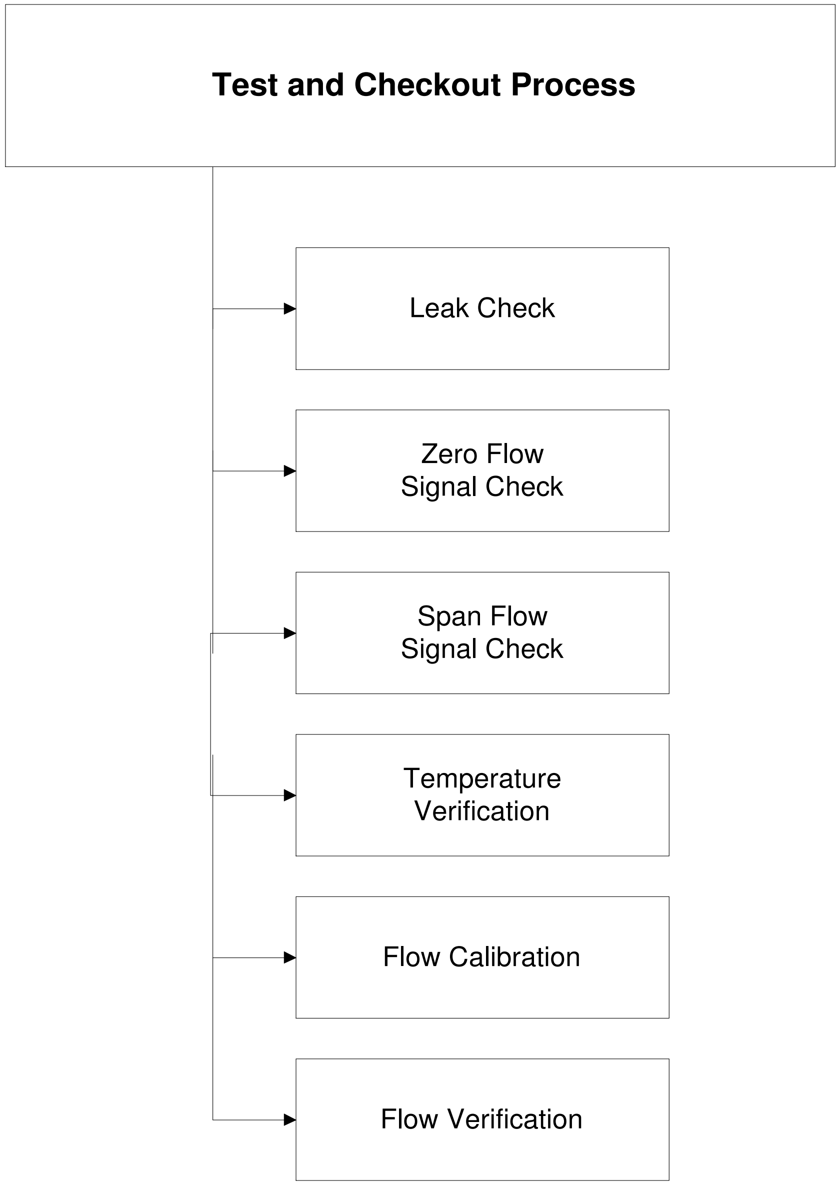


Figure 6. Effect of humidity on flow rate when operating at 25°C and 1 atmosphere

5.11. Test and Checkout Process

The following process is followed on all flowmeters upon completion of the assembly process. Refer to TSI document 9030112 for a description of these processes.



5.12. Certificate of Calibration

A *Certificate of Calibration* will be printed for every flowmeter. The certificate states the model, revision, calibration date, serial number, ambient pressure and temperature used to calibrate the flowmeter, and the flow verification data. Flow verification data is taken at the mid-points of each calibration flowrate. Data shown will include the standard flowrate, the flowmeter's flowrate, percent difference between these flows and percent tolerance. Tolerance is calculated as follows:

$$Tolerance = \frac{\left(Q_{flowmeter} - Q_{standard}\right)}{\left(Q_{standard} * \left[Flowmeter\ Accuracy\right] + \left[Flowmeter\ Offset\right]\right)} \cdot 100\%$$

Note: Q represents standard flowrate in liters per minute

Only flowmeters that have tolerances between ±100%, as listed on the Calibration Certificate, will be acceptable for final shipment.

Included on the *Certificate of Calibration* is the temperature correction value, which is measured and recorded during the test and check-out process of every flowmeter. The temperature correction is measured by comparing the output of the flowmeter's thermistor to a reference temperature sensor (measured at a flowrate between 75 and 125 liters per minute). The temperature difference between the flowmeter's thermistor and the reference temperature sensor is recorded and stored in the flowmeter EEPROM and printed on the calibration certificate. The calibration system verifies that the temperature correction is ±1°C or less. Temperature corrections greater than ±1°C are not accepted.

5.13. Packaging

Each flowmeter will be packaged in an ESD protective clamshell tray capable of storing multiple flowmeters. Each flowmeter will contain end caps to protect against contamination. All of the Calibration Certificates for the flowmeters contained within the tray will be attached to the outside of each tray. The tray and end caps are to be returned to TSI for re-use based on what is stated in the purchasing contract.

At the option of TSI, TSI may ship flowmeters in individual boxes and will use special ESD protective foam. When packaged individually, the Calibration Certificate would be included in each box. This packaging is not reusable.

6. APPLICATION NOTES

6.1. General Information

The following precautions must be taken in order to successfully apply the flow transducer:

The flow sensing element is susceptible to contamination. Material deposited on the sensor surface has the effect of insulating the sensor from the gas, thereby altering the relationship between the heat transfer rate and gas flow. It is critical that any form of contamination be eliminated from the gas flow before the gas is passed through the flow transducer. This is the responsibility of the customer, not TSI.

It is extremely important to prevent liquid of any kind from condensing on or contacting the flow sensing element. Liquids normally evaporate quickly due to the elevated sensor temperature. During the time the liquid is evaporating, large heat transfer rates will occur resulting in erroneous readings. Insoluble deposits on the flow sensing element may result once the liquid evaporates resulting in irreversible contamination. Preventing this problem is the responsibility of the customer, not TSI.

If possible, avoid locating the flow transducer such that the environmental temperature differs greatly from the gas temperature. Temperature differentials above 5°C will begin to affect the flow transducer's accuracy.

6.2. Pin Connections

PIN	FUNCTION
1	Flow voltage (Vf)
2	Temperature voltage (Vt)
3	+5 VDC supply
4	Ground
5	EEPROM - Data in
6	EEPROM - Serial Clock
7	EEPROM - Chip Select
8	EEPROM - Data out
9	EEPROM - Write Protect
10	Signal Ground

The EEPROM write protect pin (pin 9) will be pulled high to +5 volts by TSI when calibrating a unit. This will allow the calibration constants to be written to the EEPROM. However, during a unit's normal use this pin should be left unconnected. When unconnected, a pull down resistor on the PC board brings the write protect pin low and prevents the EEPROM from being accidentally written to.

6.3. Retrieving Data from the EEPROM

The calibration data unique to each flow transducer is stored on a 2048-bit (or 4096-bit) EEPROM on the unit's printed circuit board. Data is read out serially 8 bits at a time from the one of 256 (or 512) addresses. A microprocessor must use four, digital, 5-volt logic level lines to read the data from the EEPROM (microprocessor needs 3 outputs and 1 input). Consult TSI regarding the list of EEPROM manufacturers, which may be specified in the 840205/206 (example: ATMEL part number AT25020B-SSHL or equivalent). The EEPROM manufacturers data book will include further details on how to read data out of the ROM. Table 1 lists the data contained in each EEPROM with the information needed to retrieve and convert it.

The temperature correction will be a number between -1.00 and +1.00 °C. Each time the temperature is read from the flowmeter, this correction must be added to it.

The CRC is calculated on bytes 2 through 255. The CRC should be calculated and compared to the stored value each time data is read from the EEPROM. This will indicate if data has been corrupted.

6.4. EEPROM Data Map

DESCRIPTION	RANGE[1]	ADDRESS	BYTES[2]	FORMAT	CONVERSIONS/NOTES
CRC[6]		0	2	unsigned int 16	Calculation of CRC shown below
Serial Number[4]		2	4	unsigned int 32	
Model Number		6	4	unsigned int 32	840205 or 840206
Revision[5]	65-90 (A-Z), (-)	10	1	char	Convert to ASCII letter
Year	2000-2100	12	2	unsigned int 16	Year of calibration
Month	01-12	14	1	unsigned int 8	Month of calibration
Day	01-31	15	1	unsigned int 8	Day of calibration
K_0 [8]	± 2	16	4	IEEE float	Note: K values will be different
K_1	± 0.2	20	4	IEEE float	between Models 840205 & 840206
K_2	± 0.02	24	4	IEEE float	
K_3	± 0.002	28	4	IEEE float	
K_4	± 0.0002	32	4	IEEE float	
T_{Cal}	5-40	36	4	IEEE float	Calibration temperature, ºC (*Currently not used*)
S	0-9	40	4	IEEE float	Span
Z	0-9	44	4	IEEE float	Zero
T_{Corr}	1.00 to -1.00	48	4	IEEE float	Temperature Correction, ºC
# of sets of coeffs	1-12	62	1	unsigned int 8	
V_f70I[7]	0-8	64+16i[3]	4	IEEE float	
Ai	± 300	68+16i	4	IEEE float	
Bi	± 100	72+16i	4	IEEE float	
Ci	± 4	76+16i	4	IEEE float	

Table 2: EEPROM Data Map

Notes:

1 Range after conversion. These are nominal values only and should not be used as guaranteed design limits.

2 Most significant byte is always at lower address.

3 i = 0 to # of calibration coefficients - 1.

4 Serial number is ten digits and is interpreted as follows: MMMYYWW###

MMM= Model reference where 205 is air flowmeter, 206 is oxygen flowmeter

YY=Year of manufacture, WW=Week of manufacture

###=Sequential unit number built during week of manufacture.

5 Revision can change for multiple reasons. One possible cause for the revision level to change is a modification to the “C” coefficients (See section 5.1 for details regarding C coefficient changes).

6 CRC is calculated as shown below:

```
unsigned int CalcCRC(unsigned char *ubuff, unsigned int num)
{
      unsigned int crc;
      unsigned int bit_count;
      unsigned int i;

      crc = 0x0000;
      for(i = 0; i < num; i++)
      {
            crc ^= ubuff[i];
            for(bit_count = 8; bit_count; bit_count--)
            {
                  if(crc & 0x0001)
                  {
                        crc >>= 1;
                        crc ^= 0xa001;
                  }
                  else
                        crc >>= 1;
            }
      }
      return crc;
}
```

7 The first Vf coefficient and the last Vf coefficient represent zero and full-scale flow rates respectively.

8 Temperature compensation coefficients are different between air and oxygen calibrations as shown below.

Coefficient	Values for Air
K_0	0.939642740
K_1	0.002103325
K_2	0.002433017
K_3	0.000009284
K_4	0.000000137

Coefficient	Values for Oxygen
K_0	0.940033360
K_1	0.002305344
K_2	0.002381965
K_3	0.000010252
K_4	0.000000126

6.5. Mass Flowrate Calculation

1. At power up, read in the flow transducer's calibration data from the EEPROM.

EEPROM Contents	Description		
24174	CRC		
2050233001	Serial number		
840205	Model number		
-	Revision		
2002-07-18	Calibration date, Year-Month-Day		
0.939642740	K_0, Temperature compensation coefficient		
0.002103325	K_1, Temperature compensation coefficient		
0.002433017	K_2, Temperature compensation coefficient		
0.000009284	K_3, Temperature compensation coefficient		
0.000000137	K_4, Temperature compensation coefficient		
21.11	T_{cal} , Calibration temperature		
1.702430471	S, Span value for gain circuit		
1.243781095	Z, Zero value for gain circuit		
-0.21	T_{corr} , Temperature correction		
10	Number of air calibration coefficients		
V_f	A	B	C
0.331458	-0.291012	2.522600	3.464250
0.625030	-0.582271	3.790740	1.324040
0.960310	-1.209300	4.920690	0.815889
1.296682	-3.636020	7.049210	0.501591
1.749697	-11.579100	10.613100	0.320630
2.122120	-28.479400	16.583700	0.088561
2.742360	-21.293100	14.563300	0.140192
3.232111	-46.525500	16.356200	0.158628
3.744826	-46.525500	16.356200	0.158628

Table 3: Sample Data from Model 840205 EEPROM (air calibration)

2. Measure the flow voltage (V_f) and the temperature voltage (V_t).
3. Determine the gas temperature (T) using V_t and referring to Table 5.
4. Add the temperature correction to the temperature derived from step 3.

$$T = T + T_{corr}$$

5. Calculate bridge voltage (V_b).

$$V_b = \frac{(V_f + Z)}{S}$$

6. Calculate the temperature compensation correction factor (*TempCompFactor*).

$$TempCompFactor = K_0 + K_1 \cdot V_b + K_2 \cdot T + K_3 \cdot T^2 + K_4 \cdot T^3$$

where K_0, K_1, K_2, K_3, K_4 are the temperature compensation coefficients read in from the EEPROM.

Note: K coefficients are different between the air and oxygen calibrations.

6. Calculate $V_{f\,Std}$ *using* the following equation. $V_{f\,Std}$ is what V_f would be if the gas temperature were 21.11 °C (70 °F).

$$V_{f\,Std} = (V_f + Z) \cdot TempCompFactor - Z$$

7. Use the calculated value of $V_{f\,Std}$ to look up the appropriate set of A, B and C coefficients from the EEPROM data. Calibration coefficients are found by finding the closest voltage in the calibration table that is less than $V_{f\,Std}$. For example, using the sample data in table 3, if $V_{f\,Std}$ =0.8 volts, then use calibration data which corresponds to 0.625 volts. This gives the calibration coefficients of A=-0.58227, B=3.7907, C=1.324. The first and last coefficients are special cases. Using table 3 as an example, use A=-46.5255, B=16.3562, C=0.158628 for all $V_{f\,Std} > 3.7448$, and use A=-0.291, B=2.5226, C=3.46425 for all $V_{f\,Std} < 0.3314$.

8. Calculate mass flow (Q) using the following equation.

$$Q = A + BV_{f\,Std}^2 + CV_{f\,Std}^5$$

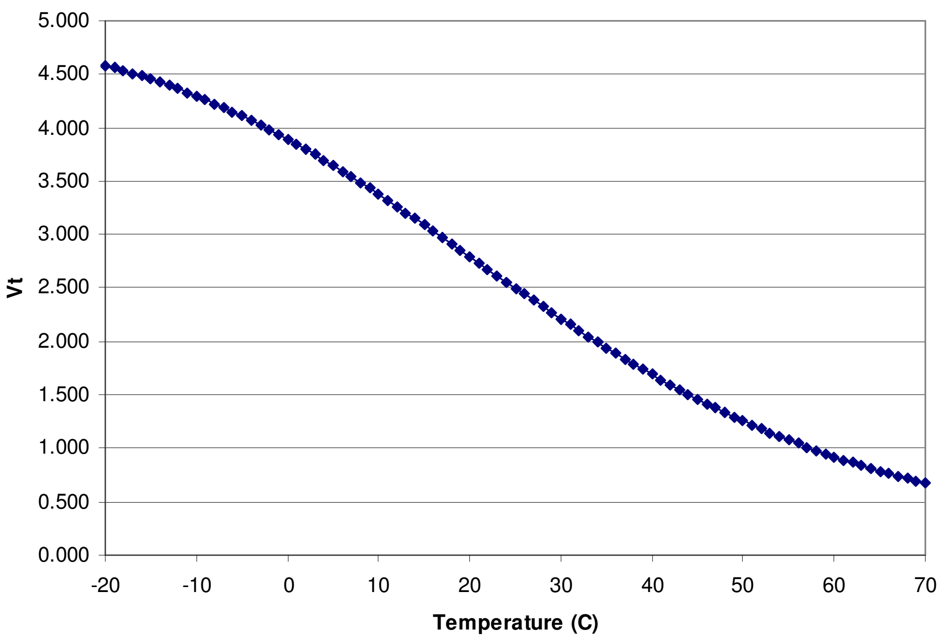
Q = flow rate in Standard Liters Per Minute (SLPM).

TSI's standard conditions are 70°F (21.11°C) and 14.7 psi (760 mmHg).

6.6. Temperature Conversion Table

Temperature (C)	Resistance (ohms)	Voltage (Vt)	Temperature (C)	Resistance (ohms)	Voltage (Vt)	Temperature (C)	Resistance (ohms)	Voltage (Vt)
-20	1103400	4.585	11	197560	3.320	42	46863	1.595
-19	1038600	4.561	12	187840	3.263	43	44917	1.550
-18	977910	4.536	13	178650	3.206	44	43062	1.505
-17	921100	4.510	14	169950	3.148	45	41292	1.461
-16	867910	4.483	15	161730	3.090	46	39605	1.418
-15	818070	4.455	16	153950	3.031	47	37995	1.377
-14	771370	4.426	17	146580	2.972	48	36458	1.336
-13	727590	4.396	18	139610	2.913	49	34991	1.296
-12	686530	4.364	19	133000	2.854	50	33591	1.257
-11	648020	4.332	20	126740	2.795	51	32253	1.219
-10	611870	4.298	21	120810	2.736	52	30976	1.183
-9	577940	4.262	22	115190	2.676	53	29756	1.147
-8	546070	4.226	23	109850	2.617	54	28590	1.112
-7	516130	4.188	24	104800	2.559	55	27475	1.078
-6	488000	4.150	25	100000	2.500	56	26409	1.045
-5	461550	4.110	26	95447	2.442	57	25390	1.012
-4	436680	4.068	27	91126	2.384	58	24415	0.981
-3	413280	4.026	28	87022	2.327	59	23483	0.951
-2	391270	3.982	29	83124	2.270	60	22590	0.921
-1	370540	3.937	30	79422	2.213	61	21736	0.893
0	351020	3.891	31	75903	2.158	62	20919	0.865
1	332640	3.844	32	72560	2.102	63	20136	0.838
2	315320	3.796	33	69380	2.048	64	19386	0.812
3	298990	3.747	34	66356	1.994	65	18668	0.787
4	283600	3.697	35	63480	1.942	66	17980	0.762
5	269080	3.645	36	60743	1.889	67	17321	0.738
6	255380	3.593	37	58138	1.838	68	16689	0.715
7	242460	3.540	38	55658	1.788	69	16083	0.693
8	230260	3.486	39	53297	1.738	70	15502	0.671
9	218730	3.431	40	51048	1.690			
10	207850	3.376	41	48905	1.642			

Table 4: Gas Temperature vs. Voltage (Vt)



7. WARRANTY INFORMATION

7.1. Warranty Statement

LIMITATION OF WARRANTY AND LIABILITY. Seller warrants the goods sold hereunder, under normal use and service as described in the operator's manual, shall be free from defects in workmanship and material for **12 months**, or if less, the length of time specified in the operator's manual, from the date of shipment to the customer. This warranty period is inclusive of any statutory warranty. This limited warranty is subject to the following exclusions and exceptions:

a. Hot-wire or hot-film sensors used with research anemometers, and certain other components when indicated in specifications, are warranted for 90 days from the date of shipment;

b. Pumps are warranted for hours of operation as set forth in product or operator's manuals;

c. Parts repaired or replaced as a result of repair services are warranted to be free from defects in workmanship and material, under normal use, for 90 days from the date of shipment;

d. Seller does not provide any warranty on finished goods manufactured by others or on any fuses, batteries or other consumable materials. Only the original manufacturer's warranty applies;

e. Unless specifically authorized in a separate writing by Seller, Seller makes no warranty with respect to, and shall have no liability in connection with, goods which are incorporated into other products or equipment, or which are modified by any person other than Seller.

The foregoing is **IN LIEU OF** all other warranties and is subject to the **LIMITATIONS** stated herein. **NO OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY IS MADE**. **WITH RESPECT TO SELLER'S BREACH OF THE IMPLIED WARRANTY AGAINST INFRINGEMENT, SAID WARRANTY IS LIMITED TO CLAIMS OF DIRECT INFRINGEMENT AND EXCLUDES CLAIMS OF CONTRIBUTORY OR INDUCED INFRINGEMENTS. BUYER'S EXCLUSIVE REMEDY SHALL BE THE RETURN OF THE PURCHASE PRICE DISCOUNTED FOR REASONABLE WEAR AND TEAR OR AT SELLER'S OPTION REPLACEMENT OF THE GOODS WITH NON-INFRINGING GOODS.**

TO THE EXTENT PERMITTED BY LAW, THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF SELLER'S LIABILITY FOR ANY AND ALL LOSSES, INJURIES, OR DAMAGES CONCERNING THE GOODS (INCLUDING CLAIMS BASED ON CONTRACT, NEGLIGENCE, TORT, STRICT LIABILITY OR OTHERWISE) SHALL BE THE RETURN OF GOODS TO SELLER AND THE REFUND OF THE PURCHASE PRICE, OR, AT THE OPTION OF SELLER, THE REPAIR OR REPLACEMENT OF THE GOODS. IN THE CASE OF SOFTWARE, SELLER WILL REPAIR OR REPLACE DEFECTIVE SOFTWARE OR IF UNABLE TO DO SO, WILL REFUND THE PURCHASE PRICE OF THE SOFTWARE. IN NO EVENT SHALL SELLER BE LIABLE FOR LOST PROFITS OR ANY SPECIAL, CONSEQUENTIAL OR INCIDENTAL DAMAGES. SELLER SHALL NOT BE RESPONSIBLE FOR INSTALLATION, DISMANTLING OR REINSTALLATION COSTS OR CHARGES. No Action, regardless of form, may be brought against Seller more than 12 months after a cause of action has accrued. The goods returned under warranty to Seller's factory shall be at Buyer's risk of loss, and will be returned, if at all, at Seller's risk of loss.

Buyer and all users are deemed to have accepted this LIMITATION OF WARRANTY AND LIABILITY, which contains the complete and exclusive limited warranty of Seller. This LIMITATION OF WARRANTY AND LIABILITY may not be amended, modified or its terms waived, except by writing signed by an Officer of Seller.