Honeywell

Honeywell Process Solutions

Turbo Monitor (TOM)

User Manual

October 2010

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1.00	Initial Release			April 2002
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	Modified:	Turbine Interface Board Operation	p11	May 2002
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Introduction

The Turbo Monitor (TOM) is an electronic device designed to receive inputs from the main and sense rotors of the Invensys Auto-Adjust Turbo-Meter (AAT). The TOM uses these inputs to calculate the adjusted volume, unadjusted volume, and percent deviation from factory calibration (ΔA). The TOM will display the totalized adjusted volume on the LCD, and output adjusted volume pulses. There is a pushbutton on the Turbo Monitor used to display Live Main and Sense Rotor Frequencies, Live Delta A and Live Adjusted Flow Rate as well as other configurable items. The TOM can also output the main and sense rotor pulse signals, as well as, a 4-to-20 milliamp output that can be configured to either Adjusted Volume Flow Rate or Instantaneous ΔA.

The TOM requires power from a DC power supply. The standard Mini-AT battery pack is used as a battery backup for the DC supply. Power supplies and barriers for hazardous locations (Class 1, Divisions 1 & 2) are also available

MasterLink32 software is the primary interface to the Turbo Monitor. MasterLink32 provides the means to configure and download data. Live graphing of both rotor frequencies, Delta A and Adjusted Flow Rate are also provided.

Specifications

Power
8.5 ± 0.5 VDC 100mA max

Inputs
2-wire inductive proximity slot sensor for main and sense rotors

Outputs for data collection systems
Adjusted Volume Pulse Output (Low Frequency)
Normal Alarm Output
AbNormal Alarm Output
Auxillary Alarm Output
4-20 mA output for Adjusted Flow or Delta A
Buffered Main Rotor Signal Output (High Frequency)
Buffered Sense Rotor Signal Output (High Frequency)
Adjusted Volume Frequency Output (with optional Turbo Frequency Board)

Enclosure
Cast aluminum alloy, surface treated, baked powder coat paint
Viewing window for adjusted volume with pushbutton for display list
Stainless steel door latch with padlock hasp
Wall mounting hangars (for wall-mounted units)
2” pipestand bracket (for pipe-mounted units)
Universal Mounting Bracket (for meter-mounted units)

Certifications
UL certified for Class I, Divisions 1 & 2, Group D
CSA certified for Class I, Divisions 1 & 2, Groups C & D
Measurement Canada (conditional) #AG-0493C

Any non-compliance with regulations and specifications will be corrected by Mercury Instruments.

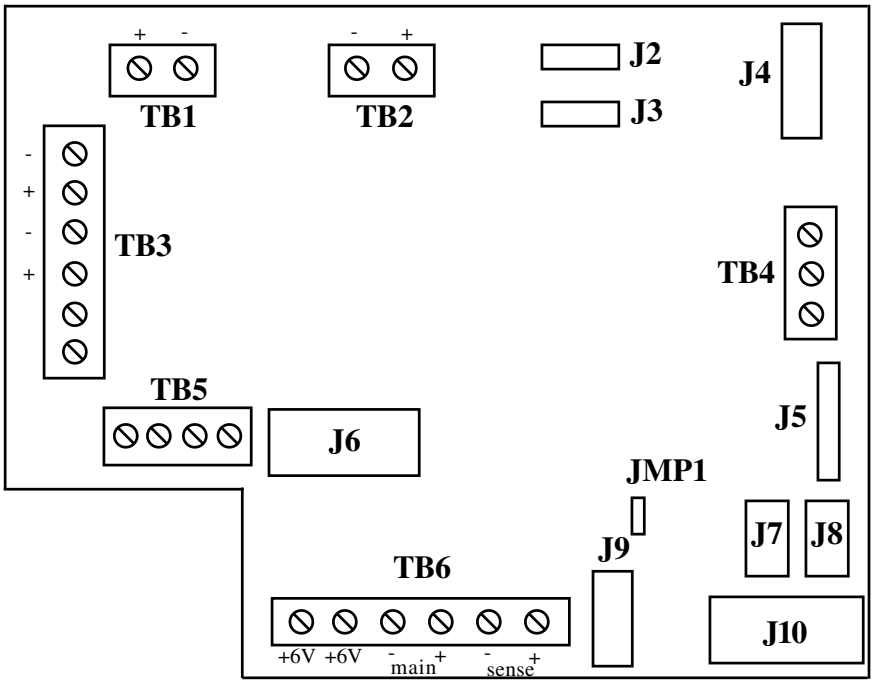


Figure 1
Diagram of the Turbine Input Board
(actual size)

Connector/Jumper	Purpose
J2, J3	Connection for TIB power
J4	Connection for LCD display
J5	RS-232 connection for external case connector
J6	Firmware upgrade connection #2 and connection for optional Turbo Frequency Board
J7	RS-232 connection to instrument (not used in TOM)
J8	CMOS connection to instrument (not used in TOM)
J9	Connection for AdjVol & UnadjVol pulse output to Mini-AT J9 (not used in TOM)
J10	Firmware upgrade connection #1
JMP1	Jumper to select RS-232 (J7) or CMOS (J8) port, set on pins 1 & 2 (RS-232)
TB1	Form-A Adjusted Volume Pulse Output (LF)
TB2	4-to-20 mA output connection
TB3	Form-A Pulse output connections for Normal, Abnormal and Auxillary Alarms
TB4	RS-232 connection for modem
TB5	Buffered Main and Sense rotor pulse output
TB6	Main and Sense rotor pulse input from turbine meter

Quick Start Guide

The following steps will guide you to getting the TOM instrument installed and operational.

1. Carefully unpack the instrument and verify that there is no shipping damage, also verify that nothing is missing from the shipment.

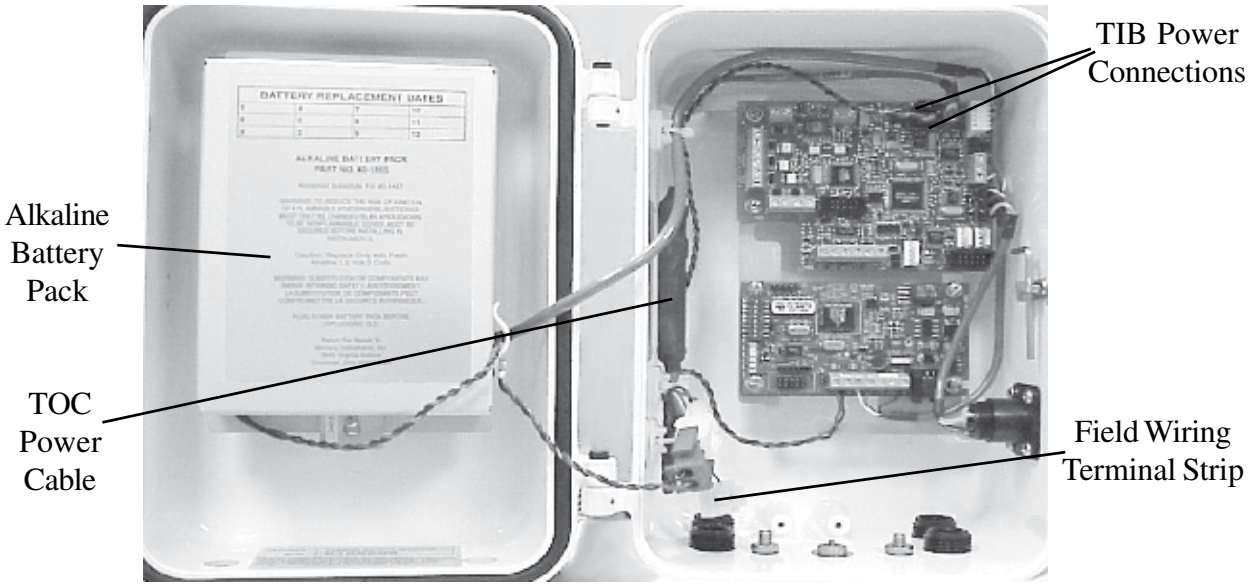
2. Open the case door and make sure there are no loose connections or loose hardware.

3. Mount the TOM using the wall hangars, pipestand mount or UMB and mounting kit provided.

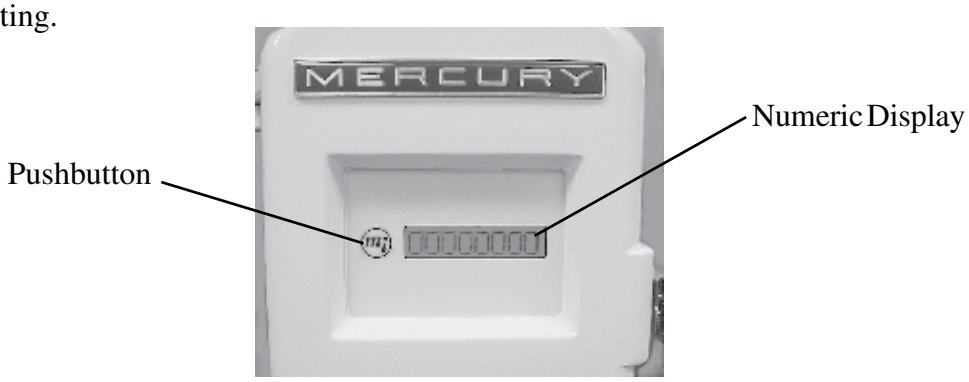
4. Install six new D-cell alkaline batteries if using the Alkaline Receptacle Pack. Plug the main battery connector into the receptacle of the power cable to the TIB. Hang the battery pack on the screws of the battery hanger plate located inside the door. Install the battery cover if using a disposable pack.

6. Connect the DC power from the transformer to the field wiring terminal strip of the TOM power cable.

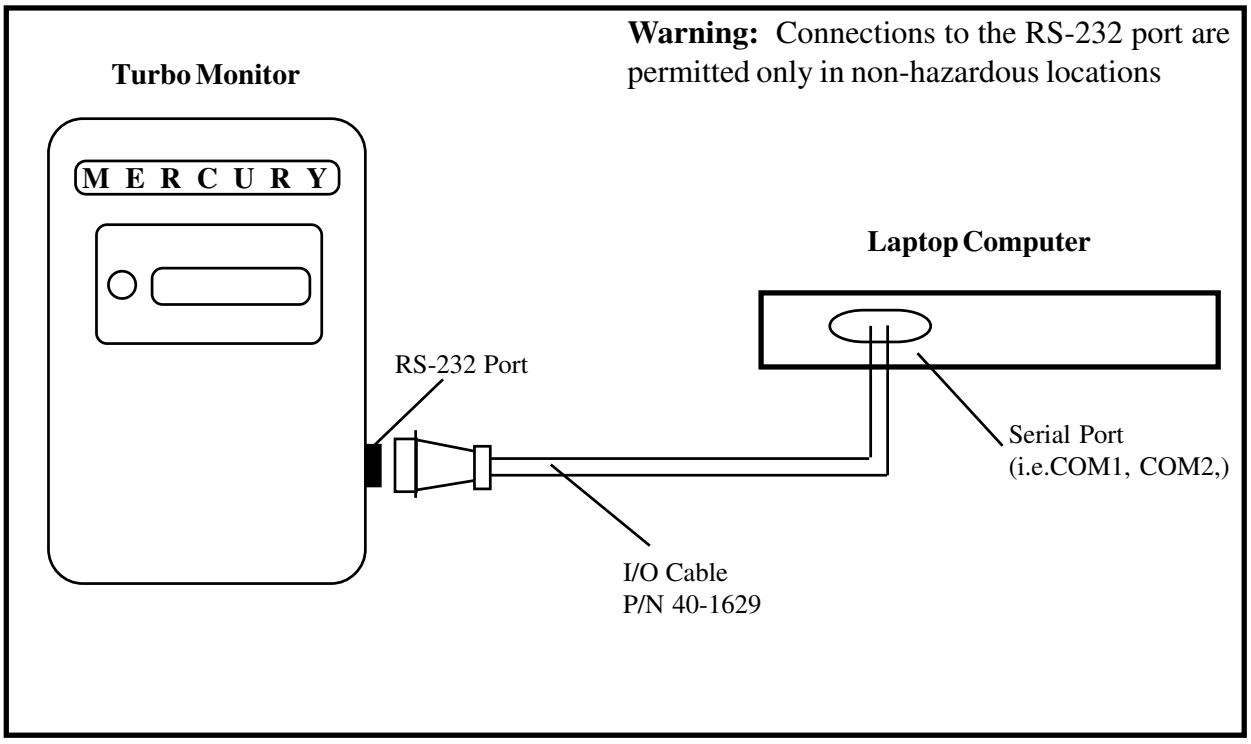
7. Connect the sensor cable to the Turbo-Meter.



8. Verify that digits appear in the LCD display (usually all zeroes). Scroll through the meter reader list by depressing the mi-logo pushbutton on the left side of the display window to verify the instrument is operating.



9. Connect a standard serial cable from the TOM serial connector to a computer serial port.



11. Run MasterLink32 to verify that company and site specific items are set properly, especially item 98 (Meter Index Code), and items 863-868. (Com Port and baud rate may need to be set for the Computer Serial Port. Default baud rate is 9600.)

12. Use the "Disconnect Link" function in the Instrument menu to return the TOM back to adjuster mode. Remove the I/O cable from the side of the instrument.

13. At this point the instrument should be ready for operation.

Power Connection

The Turbo Monitor requires 8.5VDC from an external source to operate. The standard external source is an AC to DC power supply (Div 1 w/barrier or Div 2) with an alkaline battery as backup power.

When using the standard power supply, the output is connected to the Turbo Monitor power cable (p/n: 40-2812) mounted to the left side of the case using the terminal strip provided. The Turbo Monitor power cable should already have one connection plugged into J2 of the TIB. The alkaline battery pack plugs into the power cable which plugs into the TIB at J3.

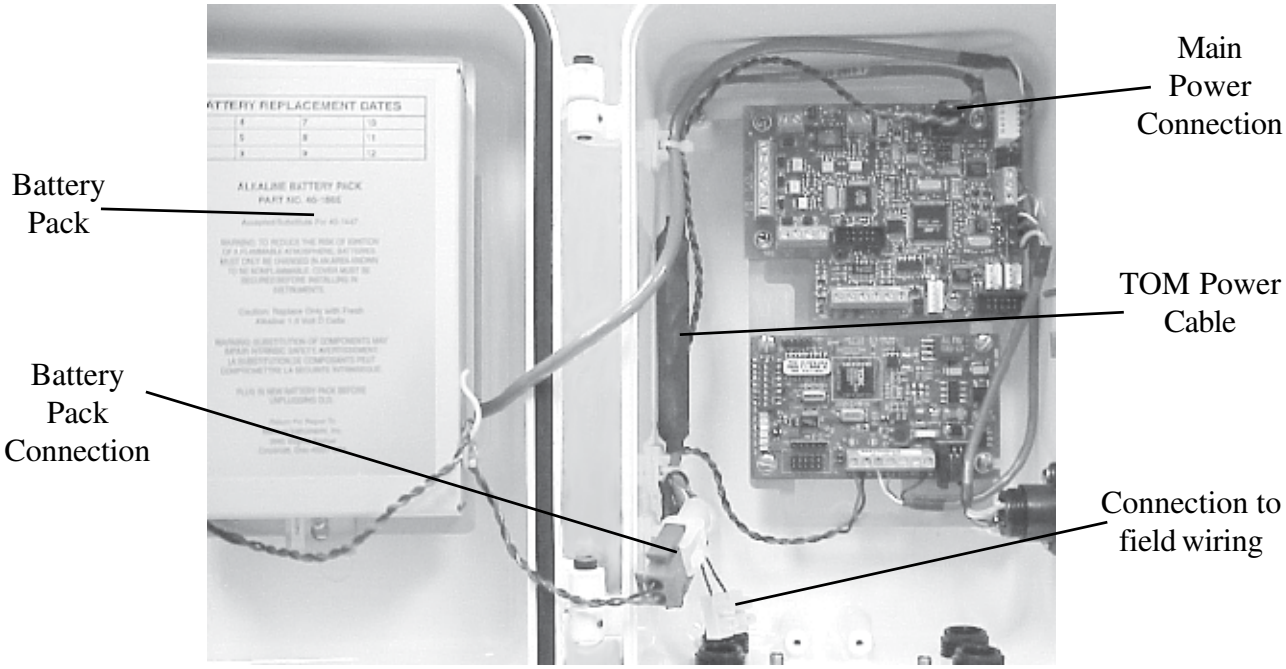


Figure 2
Standard Power Connection

Battery Backup

The Alkaline Receptacle Power Pack (p/n: 40-1865) is the battery backup for the TOM. With no external power applied, the battery pack will supply power to the TIB and sensors for approximately 48 hours.

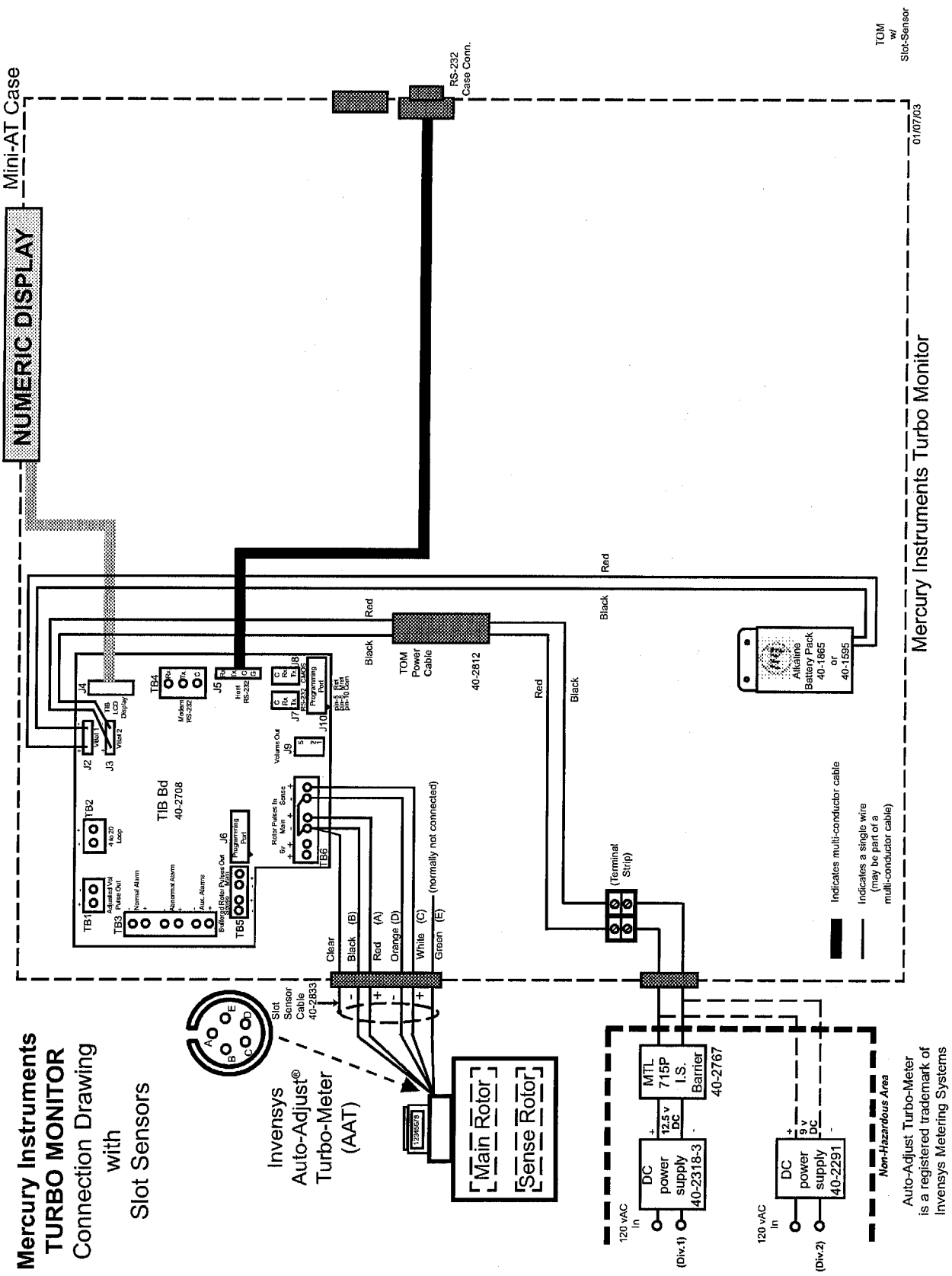


Figure 3
Turbo Monitor Connections with Slot Sensors

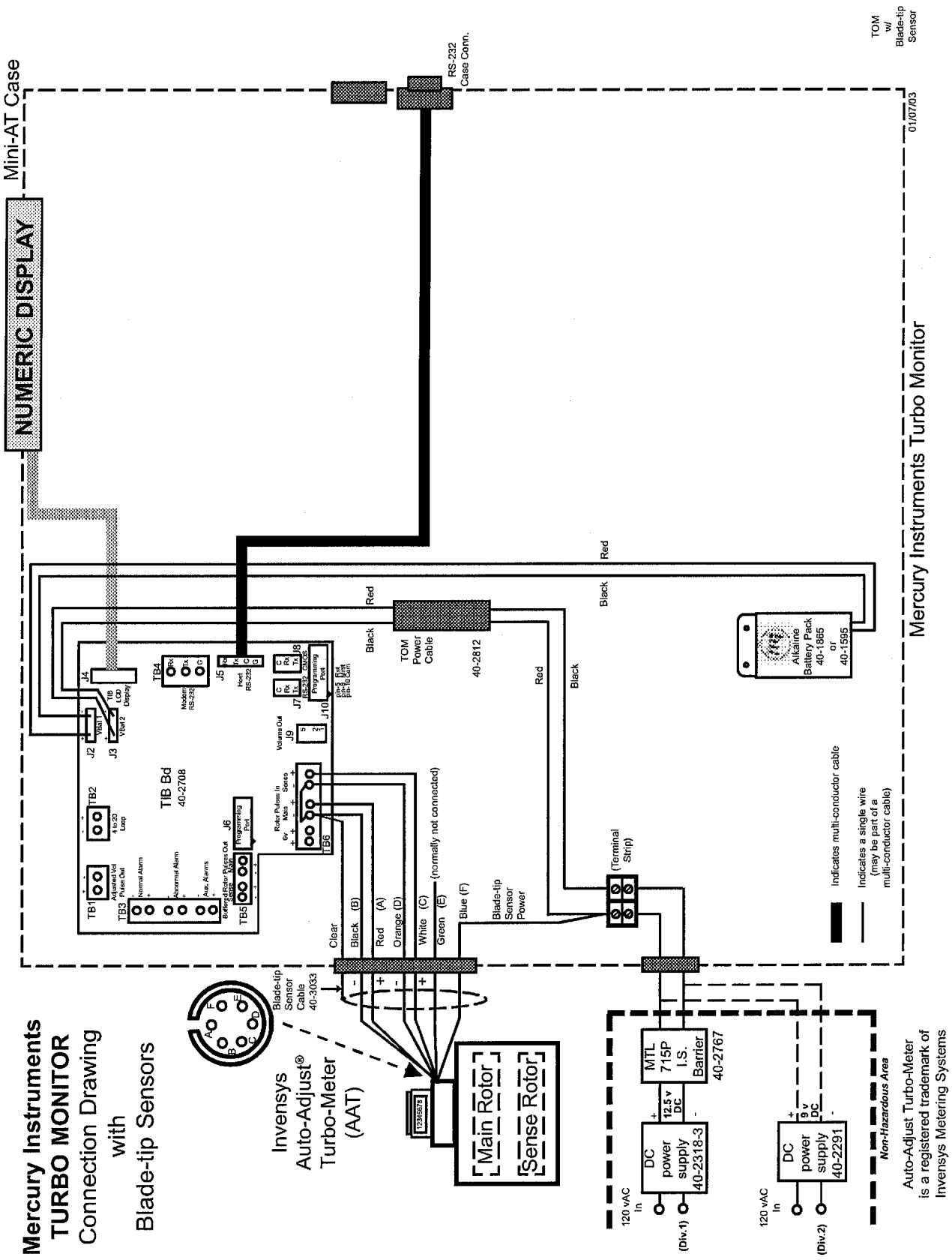


Figure 4
Turbo Monitor Connections with Blade Tip Sensors

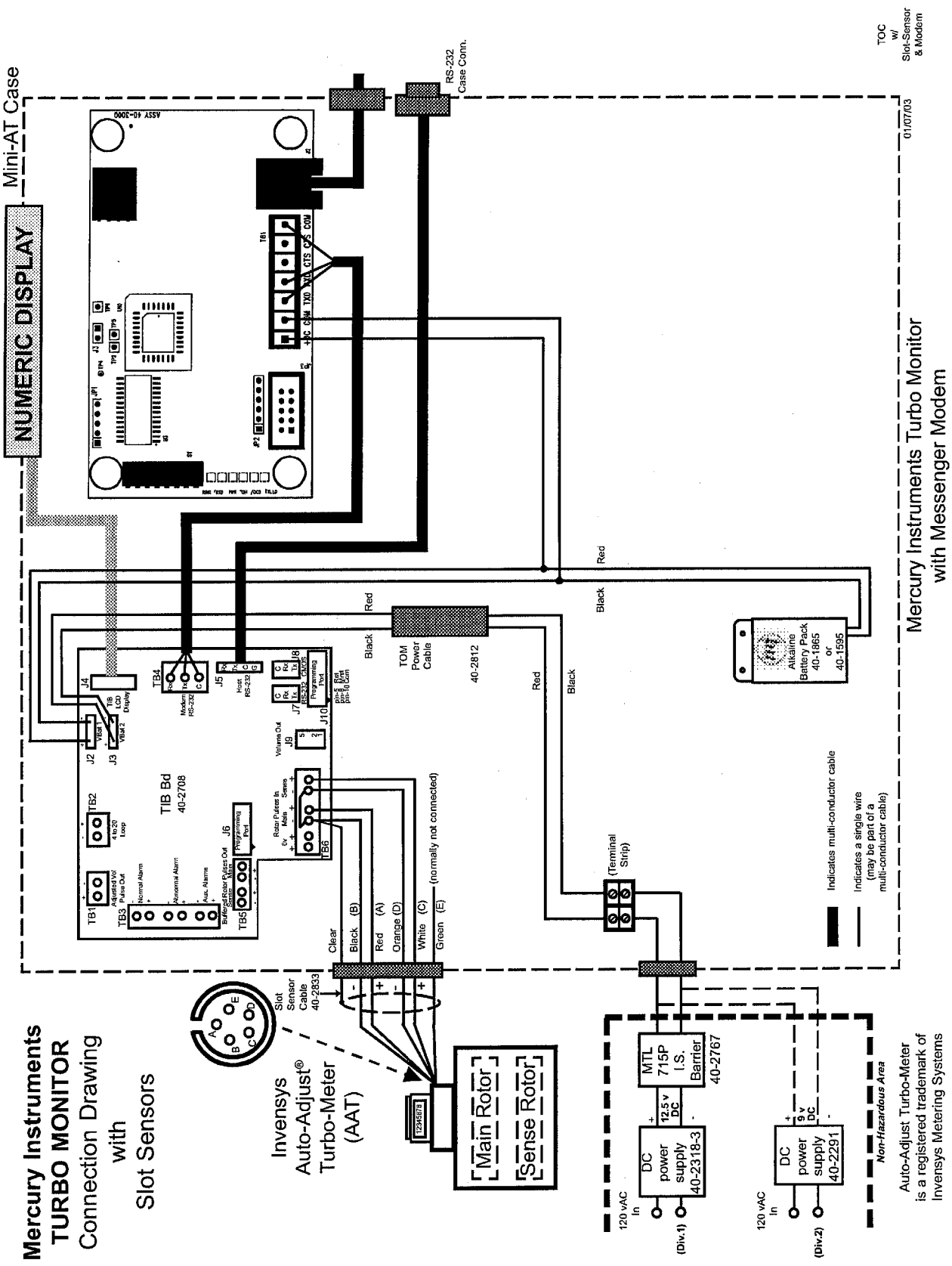


Figure 5
Turbo Monitor Connections with Slot Sensors and Modem

Turbine Interface Board Operation

The basic purpose of the Turbine Interface Board (TIB) is to accept high-frequency pulses from the main and sense rotor sensors of the Auto-Adjust Turbo-Meter (AAT), compute the Invensys algorithms, and output low-frequency adjusted volume pulses. The value of each of the low-frequency pulses is determined by the setting at item 098 (Meter Index Code). The TIB will check the main and sense rotor frequency every 1 second and send Adjusted and Unadjusted volume pulses when the volume accumulated has reached the value at item 098.

The Adjusted Volume (V_A) and Unadjusted Volume (V_U) are calculated as follows:

$$V_A = \frac{P_M}{K_M} - \frac{P_S}{K_S} \qquad V_U = \frac{P_M}{K_{MO}}$$

Where: V_A = Adjusted Volume V_U = Unadjusted Volume
P_M = Main Rotor Pulses P_S = Sense Rotor Pulses
K_M = Main Rotor Factor K_S = Sense Rotor Factor K_{MO} = Mechanical Output Factor

The calculated values of Adjusted and Unadjusted volume should be very close to each other. However, flow conditions, mechanical problems and electrical problems can cause a deviation between the two. This deviation is calculated by the TIB as a percentage. This percent deviation from factory calibration is known as Delta A (ΔA). The value of Delta A is updated every Auto-Adjust cycle. The Auto-Adjust cycle is defined as every 25,000 main rotor pulses or every 8.5 minutes, whichever occurs first.

Delta A is calcultated as follows:

$$\Delta A = \frac{100}{\left(\frac{\frac{P_M}{K_M}}{\frac{P_S}{K_S}} - 1\right)} - A_{bar}$$

Where: ΔA = % Deviation from Factory Calibration A_{bar} = Average Relative Adjustment at factory calibraton
P_M = Main Rotor Pulses P_S = Sense Rotor Pulses
K_M = Main Rotor Factor K_S = Sense Rotor Factor

Turbo Monitor Operating Modes

While in service, the Turbo-Monitor is always in one of three operating modes. The operation of the instrument in each state is well defined and suited to a particular purpose. The three states are referred to an "Operating Modes" and are:

1. Adjuster Mode
2. Meter Reader Mode
3. Serial Access Mode

In all three Modes, the Turbo Monitor may be receiving and processing sensor inputs.

Adjuster Mode

The Turbo Monitor normally operates in the Adjuster Mode. The other two modes always return to the Adjuster Mode when completed. While in adjuster mode, the totalized adjusted volume continuously appears on the LCD display.

Main and sense rotor pulses are detected by proximity slot sensors installed in the meter. The pulses are detected and always counted by the TIB electronics. The adjusted volume algorithm is calculated and the adjusted volume is displayed in the volume units selected (item 092).

Meter Reader Mode

This mode provides the meter reader the ability to view instrument item values in additional to the adjusted volume without opening the door. By pushing the "MI" button on the left edge of the display window, the meter reader can scroll through a sequence of readings.

At the time the meter reader activates the unit with the first display button input, the display will step through each item with every display button input and return to the Adjuster Mode after the last item is displayed. After a one minute time-out for non-live displays or a 10 minute time-out on live displays, the unit will automatically return to the adjuster mode. Input pulses that were processed while in Meter Reader Mode will be applied to the Adjusted Volume total and displayed on the LCD when returning to Adjuster Mode.

Serial Mode

Serial Mode allows the factory or the user to configure the Turbo Monitor. Serial access is gained through the use of a laptop computer running the instrument's companion software, MasterLink32, but requires the instrument to be connected to the computer's RS-232 serial port. The user must enter MasterLink's five-digit access code (default: "22222") at the computer's keyboard.

There are two levels of serial access. Level 1 Access permits a limited number of parameters to be displayed and changed if authorized. Also, if authorized, Alarm viewing and Alarm clearing are possible. The user must enter a valid five-digit access code (default: "11111") at the computer's keyboard to gain software access. Level 2 Access permits full instrument configuration. Any instrument parameter may be displayed and changed. The user must enter a valid five-digit access code (default: "22222") at the computer's keyboard to gain software access.

When attempting to establish a serial link to the Instrument, the software may request the user to input a five-digit Instrument Access Code. This access code is necessary to maintain instrument security. The default Instrument Access Code is: “33333”. This access code may be changed, if desired, when the user is at Level 2 Access.

The Turbo Monitor’s Serial Mode permits data transfer to and from the on-board memory of the instrument. The Turbo Monitor serial port operates at RS-232 levels. The serial device must be able to communicate using Mercury’s serial data protocol. While in serial mode, input sensor pulses will continue to be counted and processed, the Adjusted Volume display will continue to be updated and Adjusted volume pulses will continue to be output.

A low power modem (such as the Mercury Messenger Modem) may be installed in the Turbo Monitor enclosure and share power from the main battery. Modems are generally used to transfer data from a remote location to a host computer. All serial devices require Mercury’s Serial Protocol in the communication driver.

Display

The TOM has a built in alphanumeric display that displays the totalized Adjusted Volume. Pressing the ‘mi’ button allows the user to scroll through a configurable Display List.

Figure 6
TOM display window

Figure 7
TOM display test

Default Meter Reader Display

While in the Meter Reader Mode, the Turbo Monitor continues to recognize and accumulate meter input pulses. Also, 1 and 10-minute time-outs are used to automatically return the instrument to the Adjuster Mode. By design, the Adjuster Mode requires much less electrical energy than all other operating modes. The time-out periods are a safeguard to insure that the batteries are not needlessly wasted.

Refer to Figure 8 on Page 19. This is a flowchart of the default meter reader list. After the initial press of the pushbutton, the Turbo Monitor's operating program determines if there are any active alarms. Active alarms, while in the Adjuster Mode, are indicated by displaying all decimal points in the adjusted volume displayed on the LCD. If there are active alarms, all active alarm codes are displayed before the normal meter reader list items are displayed.

NOTE: While in the alarm display routine, all alarms may be cleared by allowing the instrument to time-out during the display of "E.E.E.E.E.E.E.E". If the instrument receives a pushbutton input during the "E.E.E.E.E.E.E.E" display, the alarms are not cleared and the sequence moves to the "Display Test" display. Refer to the section "Clearing Alarms" for more information.

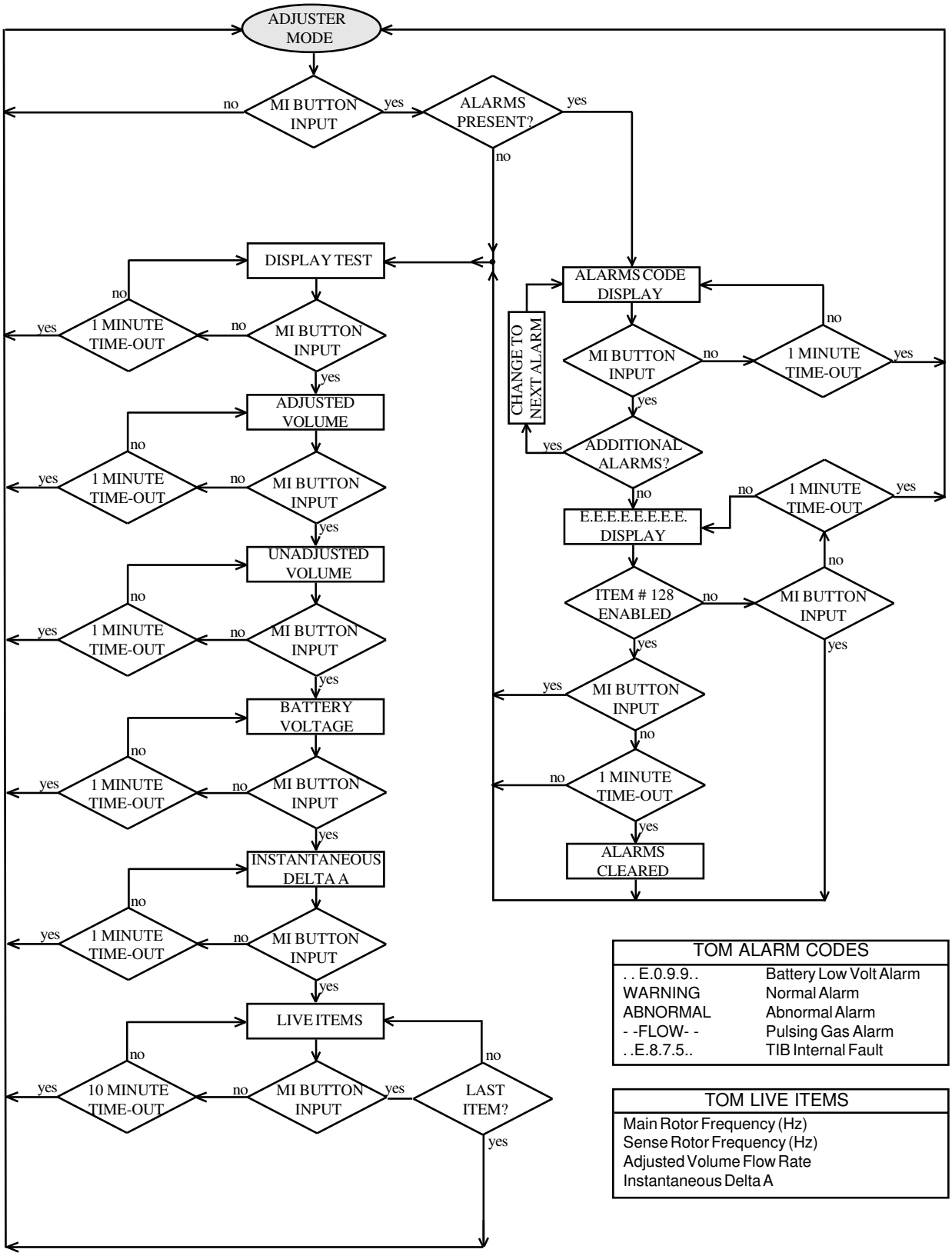
If there are no active alarms, the "Display Test" is the first meter reader list item. It provides a visual means of verifying that all LCD segments and decimal points are fully functional. If the "Display Test" does not appear as in Figure 7 on Page 17, the item code values and legends may not be accurately displayed.

When the Turbo Monitor receives a pushbutton input during the "Display Test", the current value for Adjusted Volume is displayed. Each additional pushbutton input will cause the next item code value to scroll onto the LCD. As each item is displayed, the name of the item will be displayed first. If the pushbutton is pressed while the name is displayed, the LCD will scroll to the next item name without showing the item code value. This allows the operator to quickly scroll down to the desired item. When the last Meter Reader item is being displayed, a pushbutton input will cause the LCD to go blank for 1-second while the instrument processes any stored uncorrected input pulses, prior to returning to the Adjuster Mode.

The default list consists of the following:

LCD Names:	Item:
	Display Test
AV ***	Adjusted Volume
U-AV ***	Unadjusted Volume
BAT-VOLT	Battery Voltage
I DELT-A	Instantaneous Delta A
MAIN HZ	Main Rotor Frequency (Live)
SENSE HZ	Sense Rotor Frequency (Live)
A-V RATE	Adjusted Volume Flow Rate (Live)
I DELT-A	Instantaneous Delta A (Live)

Note: *** will be displayed as the volume units (set at Item 092, default is MCF).



TOM ALARM CODES	
. . E.0.9.9..	Battery Low Volt Alarm
WARNING	Normal Alarm
ABNORMAL	Abnormal Alarm
- -FLOW- -	Pulsing Gas Alarm
. .E.8.7.5..	TIB Internal Fault

TOM LIVE ITEMS
Main Rotor Frequency (Hz)
Sense Rotor Frequency (Hz)
Adjusted Volume Flow Rate
Instantaneous Delta A

Figure 8
Default Meter Reader Display

The meter reader list is divided into four sections:

Section 1:	Alarms (Displayed only if alarms are active)
Section 2:	Display List 1 (configured by Items 130-135)
Section 3:	Live Items (non-configurable)
Section 4:	Display List 2 (configured by Items 075-086)

Display List 1

Display List 1 consists of six item codes (130-135) which define what items will appear in section 2 of the meter reader list. Normally, Display Test, Adjusted Volume, Unadjusted Volume, Battery Voltage and Instantaneous Delta A are the items assigned to Display List 1. However, any instrument item code can be placed into Display List 1. If less than six items are required, place the value "255" into the item code location after the last desired Display List 1 item. When the Display List 1 item values are displayed, all eight digits on the LCD are used, unless the volume items are configured for fewer digits using Item Code 097.

Live Parameters Display

The Live Parameter Display (section 3) will allow Live Main Rotor Frequency, Live Sense Rotor Frequency, Live Adjusted Volume Flow Rate, and Live Instantaneous Delta A to be displayed. These should not be confused with Item Codes 881 (Main Rotor Frequency), 882 (Sense Rotor Frequency), 853 (Adjusted Volume Flow Rate) and 869 (Instantaneous Delta A). The purpose of providing Live parameters is to allow the meter technician to monitor real-time meter parameters without the use of a laptop computer.

Note: Remember, all Mag List 1 & 2 items have a 1-minute time-out and all four live parameters have a 10-minute time-out.

Display List 2

Display List 2 consists of twelve item codes (075-086) which define what items will appear in section 4 of the meter reader list. The factory default has no items in this list, however any Turbo Monitor item code can be placed into Display List 2. If less than twelve items are required, place the value "255" into the item code location after the last desired Mag List 2 item.

Input Parameters from the Auto-Adjust Turbo-Meter

It is critical that the following Turbo Monitor items are properly configured with parameters from the Turbo-Meter. Without properly configuring these items, the Turbo Monitor will give incorrect volume readings.

The items are:

863	Meter Serial Number
864	Turbine Meter Size
865	Km Meter Factor - pulses per cubic foot of the main rotor
866	Ks Meter Factor - pulses per cubic foot of the sense rotor
867	ABar Meter Factor - average amount of adjustment from factory calibration
868	Kmo Meter Factor - pulses per cubic foot of the mechanical output (unadjusted)

The values for these items are found on the Turbo-Meter's serial plate with the exception of Kmo Meter Factor which can be found on the turbine's data sheet. Note: It is very important that Item 868 (Kmo Meter Factor) is properly configured. If not, the TIB will be unable to compute the Unadjusted Volume.

Sensor Input Connection

The main and sense rotor signals are to be connected from the Turbo Meter's slot sensors to TB6 of the TIB board using the supplied 4-foot Sensor Cable (p/n: 40-2833-1). An optional 25-foot sensor cable is available for remote mount locations (p/n: 40-2833-25).

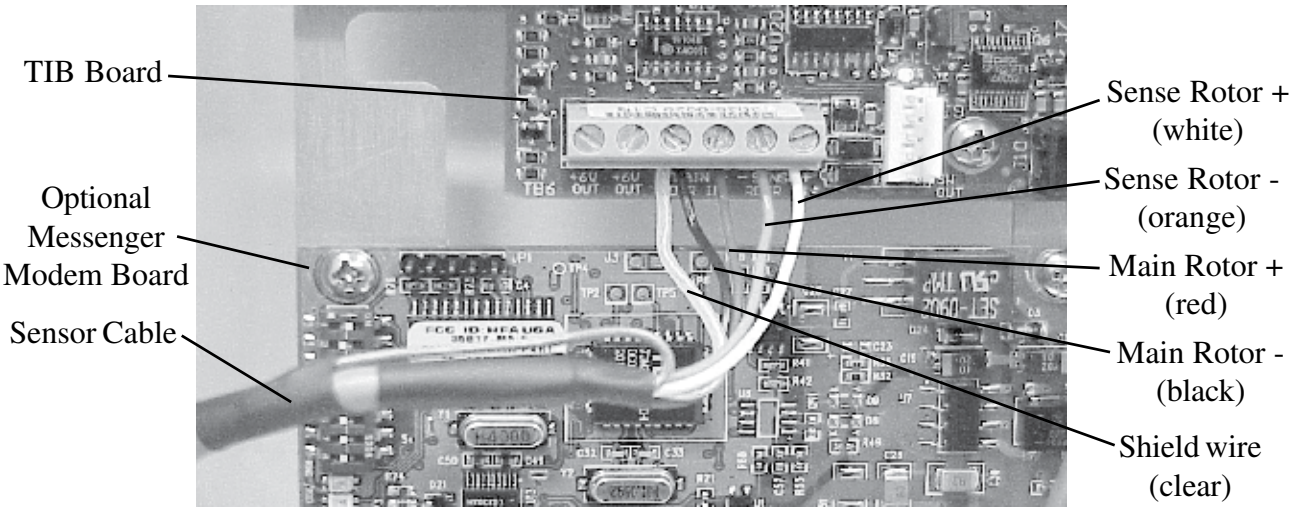


Figure 9
Sensor Cable Connections

Alarms

While in the adjuster mode, the LCD will display decimal points between each numerical digit when the instrument has recognized an alarm.

Examples:

0.0.0.4.5.6.7.8	0 0 0 4 5 6 7 8
LCD with Alarms	LCD without Alarms

Press the mi logo to activate the display list, which will display the first alarm code on the LCD. Continue scrolling using the push button to display additional alarms, if they exist. After displaying the last alarm code, continual use of the button will cause the normal Meter Reader List to be displayed on the LCD. Table 1 on Page 23 is a listing of all alarms currently available from the Turbo Monitor.

Clearing Alarms

The Turbo Monitor is configured to allow manual clearing of alarms using the display button. To clear all instrument alarms, scroll through the alarm codes until the LCD displays "E.E.E.E.E.E.E.E", then simply allow the display to time-out, which takes about 1-minute. After the "E.E.E.E.E.E.E.E" display has timed-out, the LCD will display the first item of the Meter Reader List, usually the Display Test, "8.8.8.8.8.8.8.8". This will happen only if Item 128 (Mag Alarm Acknowledge) is enabled. If it is disabled "E.E.E.E.E.E.E.E" will not be displayed, and the alarms cannot be cleared using the display button. Additionally, alarms may be cleared using the "Display and Clear Alarms" function in the MasterLink32 software.

HELP mode

When the Battery Voltage (Item 048) drops below the Shutdown Voltage (Item 050, usually 4.8 volts), the instrument enters HELP mode. In this mode, the LCD will display ". .H.E.L.P. ." to signify that the battery has reached a critical level. The batteries should be replaced immediately when the instrument is in HELP mode. After replacing the batteries, if the voltage is above 5.5 volts, a push button input or serial access will wake up the instrument. This will allow the Turbo Monitor to function normally again.

Report By Exception

RBX (Report By Exception, Item Code 165) is another alarm function that must be enabled using MasterLink32 software. When enabled, the RBX function automatically clears an instrument alarm **after** an alarm parameter has returned to its normal operating range, buffered by a user specified dead band. RBX will also clear the dots on the LCD when an alarm is cleared.

Alarm Outputs

The Turbo Monitor will generate a Form-A output on every new alarm. The alarm outputs are available on TB3 of the Turbine Interface Board. There are three outputs available: the Normal alarm, Abnormal alarm and Aux out. The Aux out channel is used for the low battery, internal fault and pulsing gas alarms. At the occurrence of any alarm, the appropriate output will latch into the ON or closed state and remain in that state until cleared by RBX, software or firmware. See figure 11 on page 26 for the wiring locations of the alarm outputs.

Alarm Description	Item #	Alarm Display	RBX Item #	Limit Item #
Battery Low	099	.E.0.9.9.	Fixed in Firmware	049
Pulsing Gas Alarm	874	--FLOW--	Fixed in Firmware	Fixed in Firmware
TIB Internal Fault	875	.E.8.7.5.	None	None
Normal Alarm	877	WARNING	879	872
Abnormal Alarm	878	ABNORMAL	880	873
Replace Main Battery (Shutdown)	.H.E.L.P.	. .H.E.L.P. .	None	050

Initial Recomended Alarm Configuration

Operating Conditions	Alarm Band		Dead Band	
	Normal (Item 872)	Abnormal (Item 873)	Normal (Item 879)	Abnormal (Item 880)
Meter flow rate 50% to 100% of rated capacity. Pressures over 275 psi.	+/- 0.5%	+/- 2.0%	0.05%	0.2%
Meter flow rate 20% to 100% of rated capacity. Pressures over 275 psi.	+/- 0.75% +/- 1.0%	+/- 3.0% +/- 3.0%	0.075% 0.1%	0.3% 0.3%
Meter flow rate 20% to 100% of rated capacity. Pressure range 50 to 275 psi.	+/- 1.25% +/- 1.5% +/- 1.75%	+/- 4.0% +/- 4.0% +/- 4.0%	0.125% 0.15% 0.175%	0.4% 0.4% 0.4%
Meter flow rate 5% to 100% of rated capacity. Pressures less than 50 psi.	+/- 2.0% +/- 2.5%	+/- 5.0% +/- 5.0%	0.2% 0.25%	0.5% 0.5%

Table 1
TOM Alarms

Pulse Outputs

As a standard feature, the Turbo Monitor provides 3 Form-A pulse outputs. The outputs are electronic switches that operate much like an 'open collector' transistor. All Turbo Monitor pulse outputs incorporate opto-isolators to isolate the TIB circuitry from the devices receiving pulses.

The Pulse Outputs are as follows:

TB1:

Adjusted Volume Output (Form A, scaled to units set at item 097)

TB5:

Buffered Main Rotor signal (Pm, high frequency)
Buffered Sense Rotor signal (Ps, high frequency)

Output Pulse Specifications

1. All outputs are isolated from ground and each other.
2. Outputs are rated for DC only, from 3.0 volts to 30.0 volts. (15.0 volts for CSA) Observe polarity.
3. The pulser circuits will sink up to 5 milliamperes (DC).

The Adjusted Volume pulse width and period can be varied by the selection of Item Code 115. The period is set to twice the pulse width. For example, a 0.0625 second pulse will have a total cycle time of .125 seconds.

Select: 0 – 0.0625 Sec. (Default)
1 – 0.5000 Sec.
2 – 1.0000 Sec.
3 – 0.1250 Sec.
4 – 0.2500 Sec.

Value At Item Code 115		Form-A		
Code	(Sec.)	Pulse Off Sec.	Pulse Cycle Sec.	Max Pulse Repetition Rate, CPS
0	.0625	.0625	.125	8
1	.500	.500	1.000	1
2	1.000	1.000	2.000	.5
3	.125	.125	.250	4
4	.250	.250	.500	2

Table 2
Output Pulse Codes

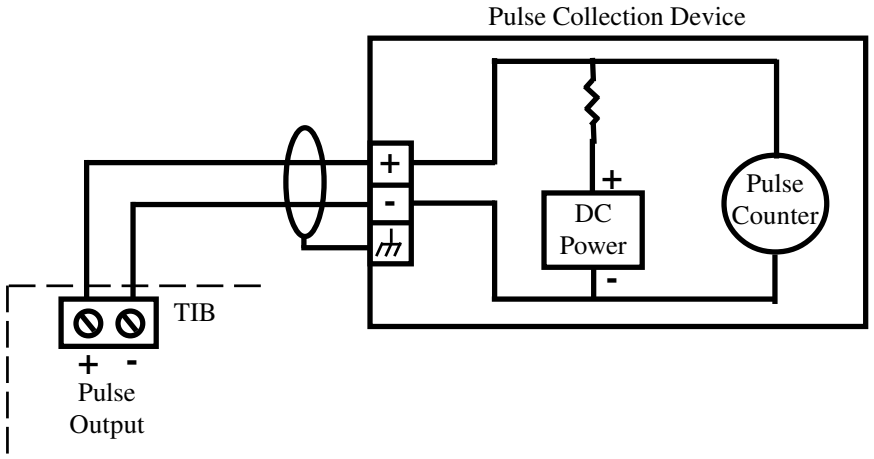
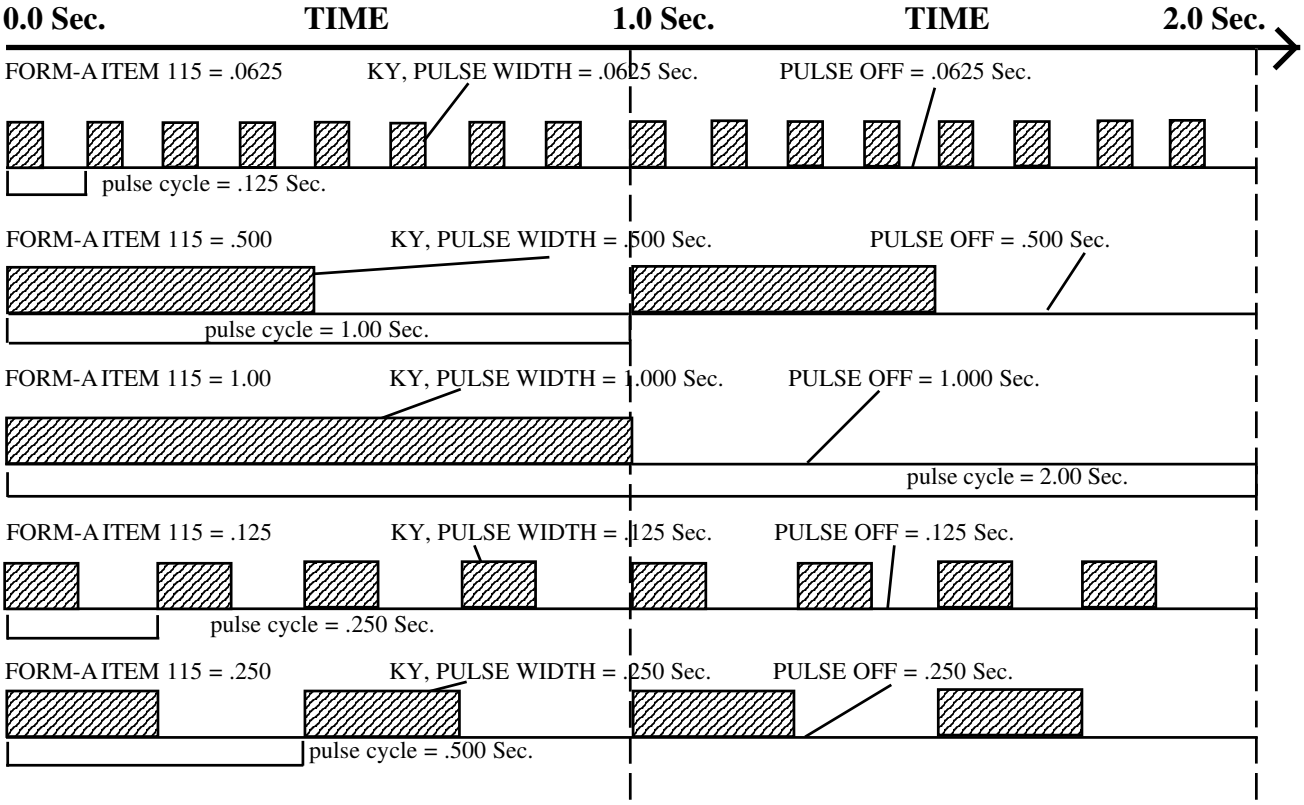


Figure 10
Pulse Connection Circuit

The pulse timing chart on this page compares the relationship of Pulse Width, Pulse Cycle, Pulse Off Time and Pulse Repetition Rate.Table 4



4-20 milliamp output

In addition to the pulse outputs, the Turbo Monitor has a single 4-to-20 milliamp output channel available at TB2. The TIB updates the 4-20mA output every 5 seconds. The channel is configurable to output either Delta A or Adj Vol Flowrate, and the selection is made at item 871. The limits for Delta A output are fixed at -5% (4ma) and +5% (20ma). The Adj Vol flow rate limits are user selected at items 884 (20ma) and 885 (4ma). The output is loop powered, and must have a minimum of 9VDC across the + and - terminals under any load condition.

The 4-20 milliamp output function can be verified by changing the selection at item 871. Depending on the setting, the 4-20 mA output can provide a constant 4, 12 or 20mA signal for verification purposes. After verification, Item 871 should be set back to either Delta A or Adj Vol Flowrate for the output to function normally.

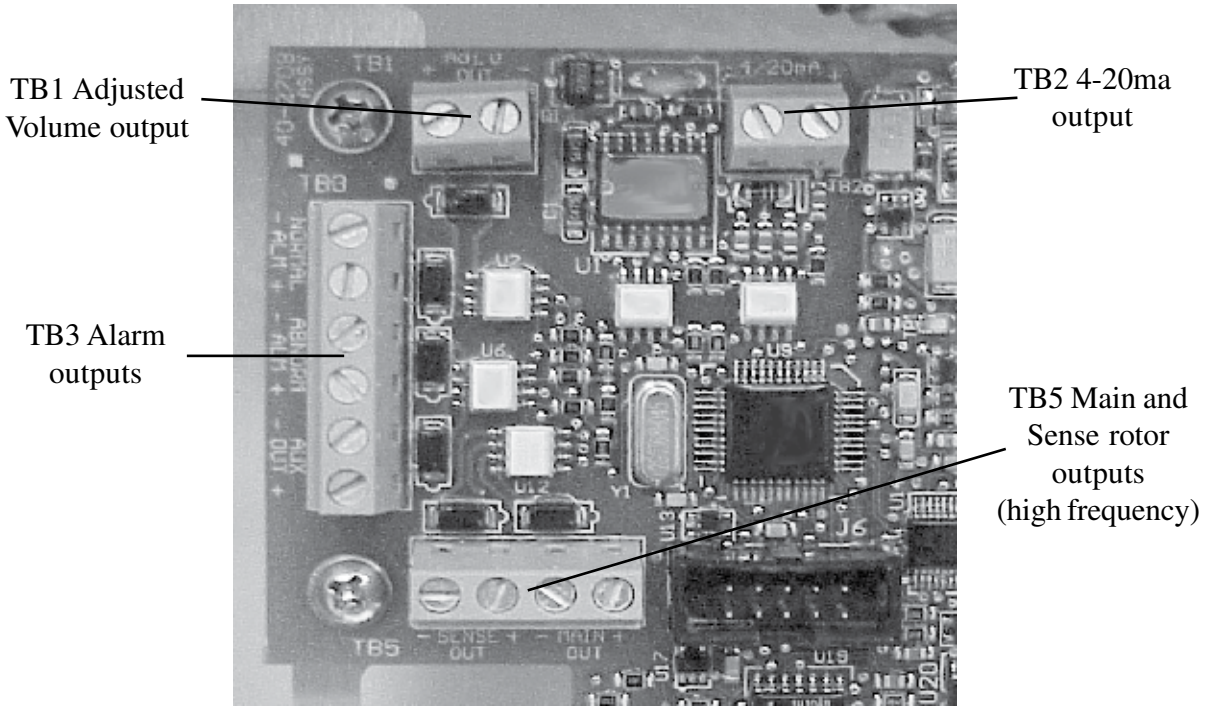


Figure 11
Pulse and 4-20mA Output Connection Locations

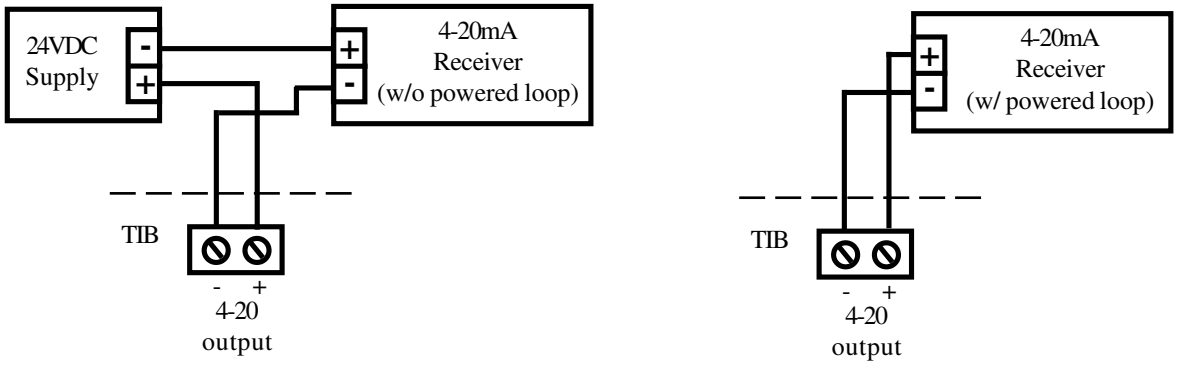


Figure 12
4-20mA Output Connections

Turbo Frequency Board (TFB)

The Turbo Frequency Board (TFB) is an optional accessory that outputs a proportional signal for Adjusted Volume flow, providing up to 1,000 pulses per second at the specified 100% flow rate of any Auto-Adjust Turbo-Meter. The high frequency output is accurately scaled so that each pulse can be accumulated for remote volume readings (either Ft^3 or m^3) or may be used as a flow rate signal. A maximum frequency parameter (Item 889) permits the user to select the desired number of pulses that will correspond to the maximum rated flow of the meter. Choices for maximum frequency are 50, 100, 200, 500 or 1,000 hertz. The size of the turbine meter (Item 864) and the meter index units (Item 098) will also have to be set.

The Turbo Frequency Board (TFB) plugs into the TIB at connector J6 and is secured by two mounting screws. The TFB receives its power and input signal through J6 while providing the output frequency at TB1. The frequency output, which must be wetted by a 3-15 volts DC receiver, is controlled by the setting at Item Code 889.

The TFB includes a red LED (D1) that blinks at the slow rate (once per second) when power is first applied while it is waiting for a valid packet of data. The faster rate (7 times per second) indicates that a valid packet has been received and an output frequency has been transmitted to the opto-coupler. During normal operation the LED will always blink at the faster rate.

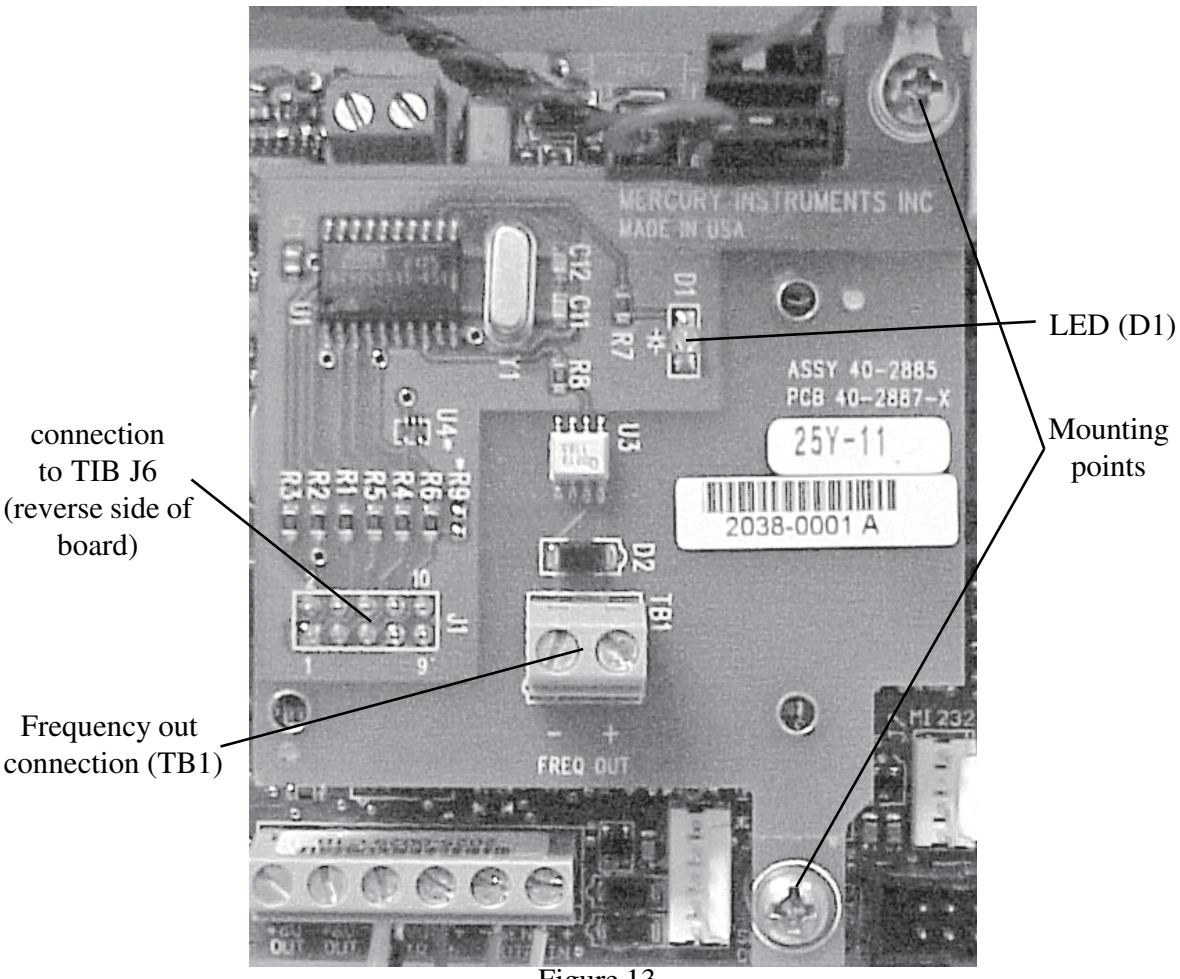


Figure 13
Turbo Frequency Board Installed

Turbo Frequency Board Pulse Factors

Meter *(English)*			Output Frequency @ Max. Flow Rate									
			50 Hz.		100 Hz.		200 Hz.		500 Hz.		1000 Hz.	
Model	Size (in.)	Blade Angle	Pulses per Ft^3	Ft^3 per pulse	Pulses per Ft^3	Ft^3 per pulse	Pulses per Ft^3	Ft^3 per pulse	Pulses per Ft^3	Ft^3 per pulse	Pulses per Ft^3	Ft^3 per pulse
AAT-18	4	45°	10	0.100000	20	0.050000	40	0.025000	100	0.010000	200	0.005000
AAT-35	6	45°	5	0.200000	10	0.100000	20	0.050000	50	0.020000	100	0.010000
AAT-60	8	45°	3	0.333333	6	0.166667	12	0.083333	30	0.033333	60	0.016667
AAT-140	12	45°	1.2	0.833333	2.4	0.416667	4.8	0.208333	12	0.083333	24	0.041667
AAT-27	4	30°	6	0.166667	12	0.083333	24	0.041667	60	0.016667	120	0.008333
AAT-57	6	30°	3	0.333333	6	0.166667	12	0.083333	30	0.033333	60	0.016667
AAT-90	8	30°	2	0.500000	4	0.250000	8	0.125000	20	0.050000	40	0.025000
AAT-230	12	30°	0.8	1.250000	1.6	0.625000	3.2	0.312500	8	0.125000	16	0.062500
Meter *(Metric)*			**Output Frequency @ Max. Flow Rate**									
			50 Hz.		**100 Hz.**		**200 Hz.**		**500 Hz.**		**1000 Hz.**	
Model	Size (mm)	Blade Angle	Pulses per m^3	m^3 per pulse	Pulses per m^3	m^3 per pulse	Pulses per m^3	m^3 per pulse	Pulses per m^3	m^3 per pulse	Pulses per m^3	m^3 per pulse
AAT-18	100	45°	350	0.002857	700	0.001429	1400	0.000714	3500	0.000286	7000	0.000143
AAT-35	150	45°	175	0.005714	350	0.002857	700	0.001429	1750	0.000571	3500	0.000286
AAT-60	200	45°	105	0.009524	210	0.004762	420	0.002381	1050	0.000952	2100	0.000476
AAT-140	300	45°	45	0.022222	90	0.0111111	180	0.005556	450	0.002222	900	0.001111
AAT-27	100	30°	210	0.004762	420	0.002381	840	0.001190	2100	0.000476	4200	0.000238
AAT-57	150	30°	105	0.009524	210	0.004762	420	0.002381	1050	0.000952	2100	0.000476
AAT-90	200	30°	70	0.014286	140	0.007143	280	0.003571	700	0.001429	1400	0.000714
AAT-230	300	30°	28	0.035714	56	0.017857	112	0.008929	280	0.003571	560	0.001786

Table 3
Volume Per Pulse for various meter sizes and Frequencies

Live Graphing (Turbine Related Items)

The Turbo Monitor, via MasterLink has the capability to graph turbine related items. The graphable items are Main Rotor Frequency, Sense Rotor Frequency, Instantaneous Delta A and Adjusted Volume Flow Rate. These items can be graphed one at a time, or all at once if desired. Each item has a configurable scale, line color and line style. The graph is 'live' with a configurable update interval and viewing interval. Figure 14 below shows a sample graph with all four items on the graph. Notice that the last updated value of each item is shown in a display box at the bottom of the graph. The graph also has a tool bar at the top that is used to customize the graph. The toolbar can be used to change background colors, show gridlines, zoom in or out and show the graph in 3D. There are three buttons at the bottom of the graph. The Graph Setup button will pull up the Graph Configuration screen discussed on page 30, while clicking the Reset Style button will reset the configuration to default. The Close button will exit the Live Graph.

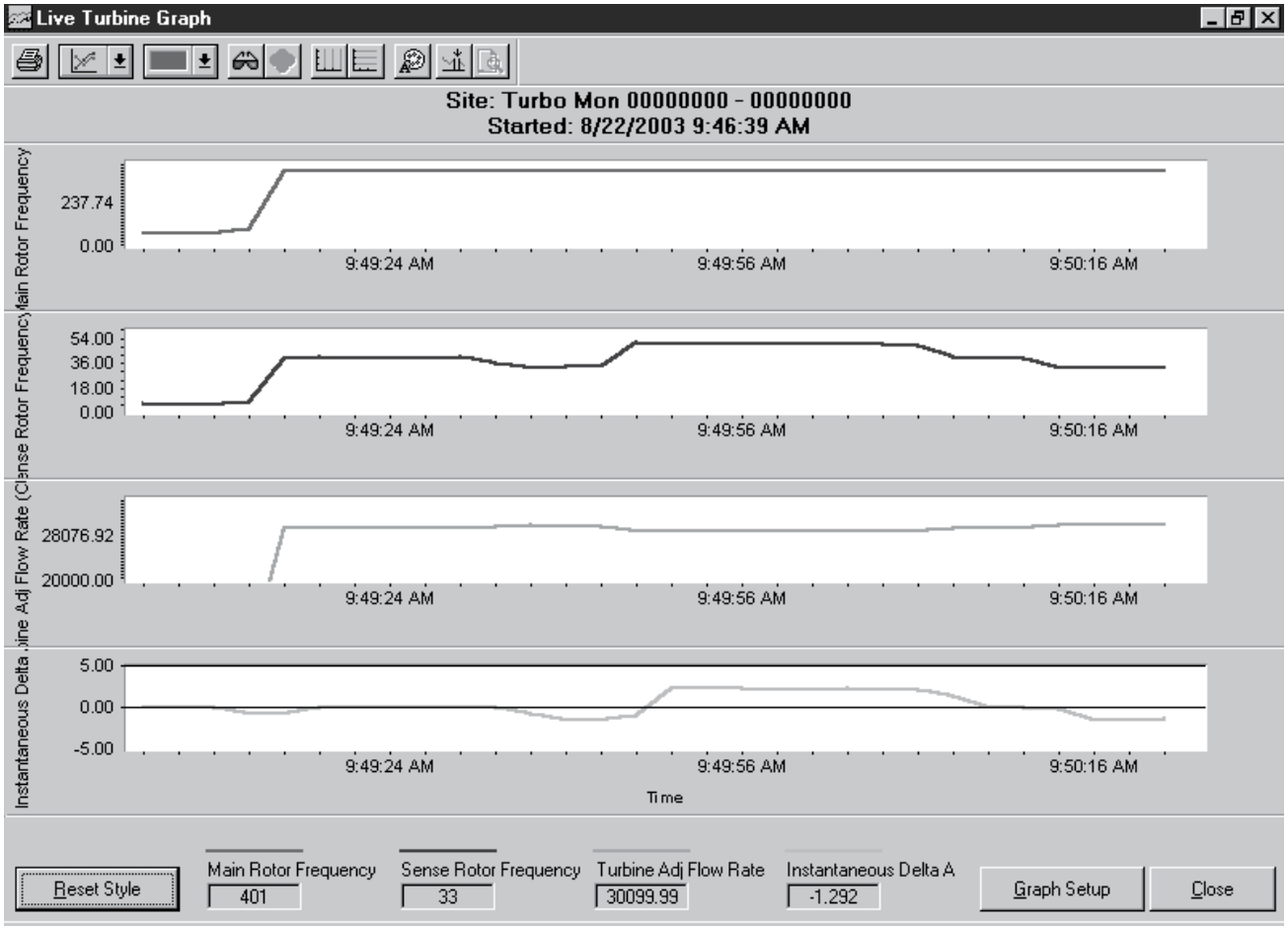


Figure 14
Live Graph Display

Live Graph Configuration

The live graph can be set-up using the Graph Configuration shown below in Figure 15. The Y Axis Item column is used to choose which items are to be graphed. Clicking on the drop down arrow will cause a list of items to appear. Simply select the desired item from the list. If only one or two items are to be graphed, select those items for the first one or two and change the remaining items to none. The Y Minimum and Y Maximum colums are use to select a range of values to scale on the graph. The Color and Line Style colums are used to configure the type of line to be displayed on the graph.

Other graphing options are set in the lower 'Options' portion of the Setup screen. The reading interval is used to set up how often the software interrogates the Turbo Monitor for the information that is being graphed. This can be set from 1 to 30 seconds. The X-axis with configures how much of a time interval to show on the graph. The default is 30 seconds. There are also two check boxes. The first is for displaying the toolbar, which appears at the top of the graph. The second is for displaying data point on the graphing lines.

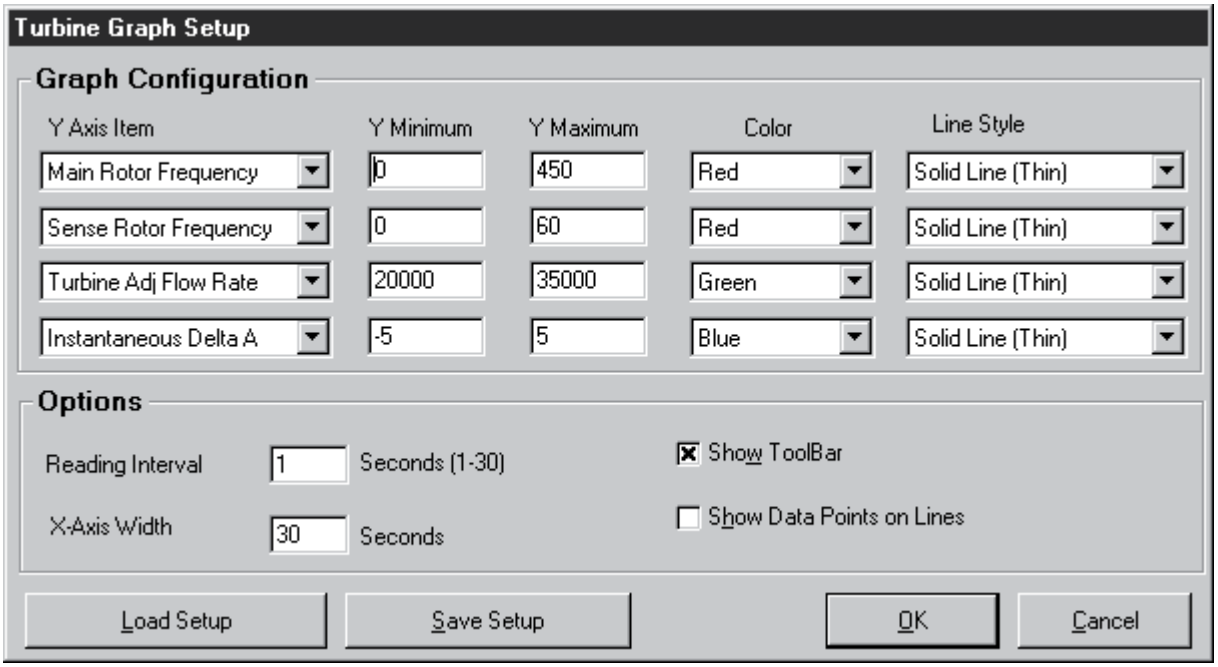
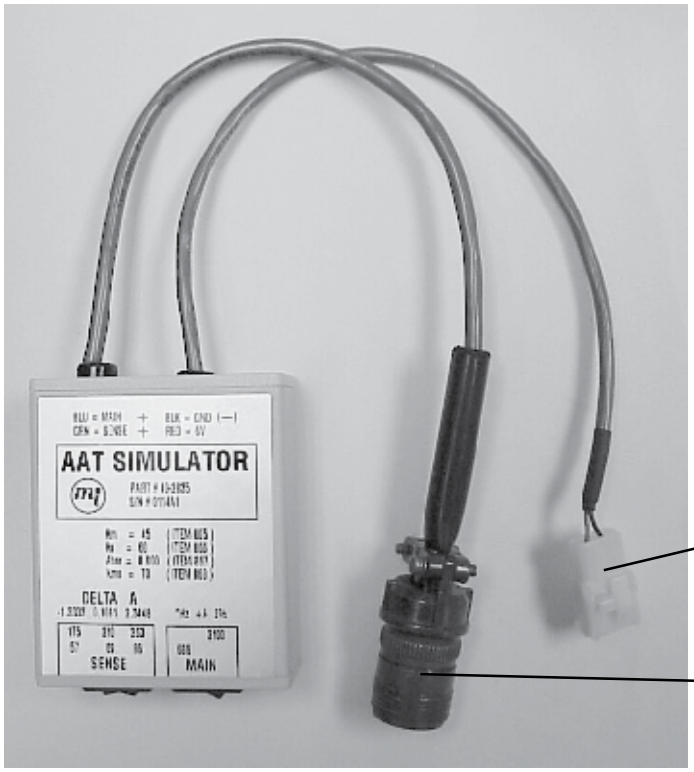
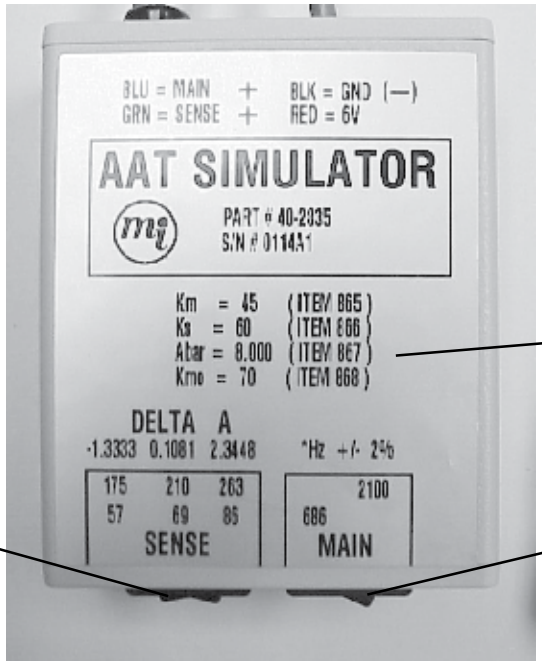


Figure 15
Live Graph Configuration

AAT Simulator

A compact device is available for testing the electronic functions of a Turbo Monitor. The AAT Simulator (p/n 40-2835) will simulate main and sense rotor inputs from the AAT. Two rocker switches are provided, a two position switch to change the main rotor frequency, and a three postion switch for changing the sense rotor frequency which will in turn affect the Delta A value. The device is connected to the Instrument through the sensor cable, and can be powered by a standard battery pack.





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