

Operator's Guide for
Mercury Instruments, Inc.
Turbo Monitor (TOM)

Version 2.00
October 2003

COPYRIGHT NOTICE

Operators Guide for Mercury Instruments, Inc. Turbo Monitor

COPYRIGHT © 2001-2003 by Mercury Instruments, Inc.

All Rights Reserved.

Table of Contents

Introduction	5
Specifications	6
TIB Connectors/Jumpers(location)	7
Quick Start Guide	8
Power Connection	10
Battery Backup	10
Drawing, Connections for TOM with Slot Sensors (w/o Modem)	11
Drawing, Connections for TOM with Blade Tip Sensors (w/o Modem)	12
Drawing, Connections for TOM with Slot Sensors (w/ Modem)	13
Turbine Interface Board (TIB)	14
Turbo Monitor Operating Modes	15
Display	17
Sensor Input Connection	21
Alarms	22
Pulse Outputs	24
4-20 milliamp output	26
Turbo Frequency Board	27
Live Graphing (Turbine Related Items)	29
AAT Simulator	31
Upgrading TIB Firmware	27
Item Codes	30
Drawing, Door Parts List	49
Drawing, Case Parts List (Wall Mount)	50
Drawing, Case Parts List (Meter Mount)	52
Drawing, Installation for Div. 1 Hazardous Locations	54
Drawing, Installation for Div. 2 Hazardous Locations	55
Drawing, Wiring AAT with Barrier	56

Revision List

1.00	Initial Release			April 2002
1.01	Modified:	Item Code Descriptions	p30-34, 37	May 2002
1.10	Moved:	Turbo Frequency Board	p22	
		Connection Drawing (w/Modem)	p10	
	Modified:	Turbine Interface Board Operation	p11	May 2002
2.00	Modified:	Firmware Upgrade Procedure	p27	
		Connection Drawings	p11-13	
		4 to 20 milliamp output	p26	
	Moved:	Alarms	p22	
		TIB Diagram	p7	
	Added:	Live Graphing	p28	
		TOM Door Parts List	p51	
		TOM Wall Mount Parts List	p52	
		TOM Meter Mount Parts List	p54	

Turbo Monitor

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.

Turbo Monitor

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.

Turbo Monitor

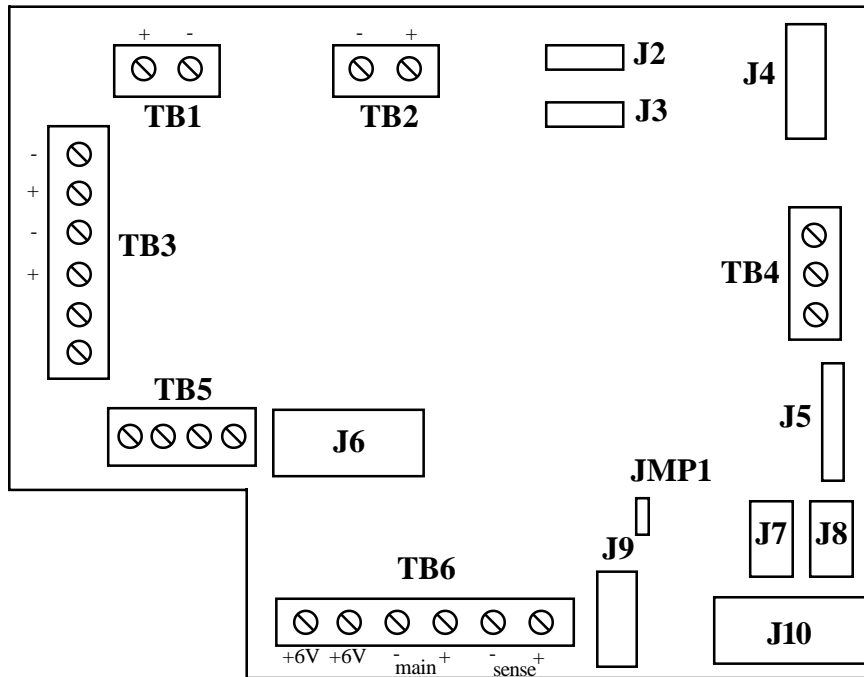


Figure 1
Diagram of the Turbine Input Board
(actual size)

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

Turbo Monitor

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.

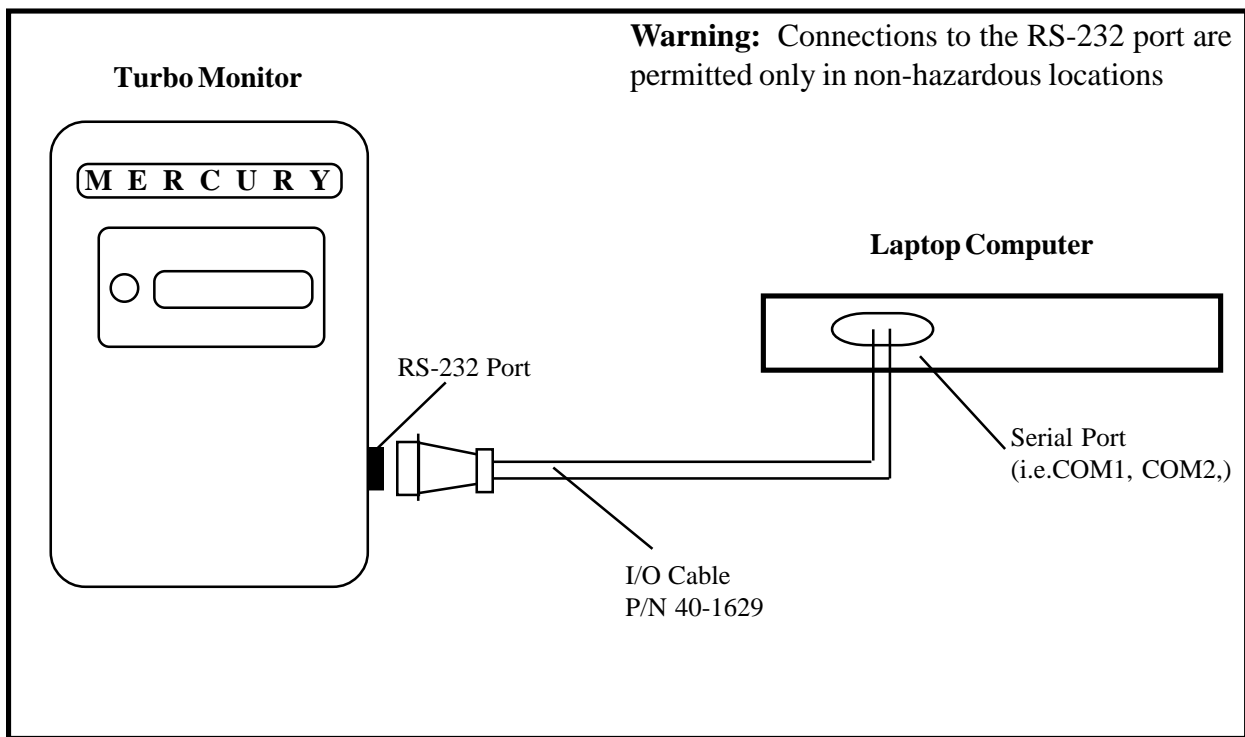


Turbo Monitor

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.

Turbo Monitor

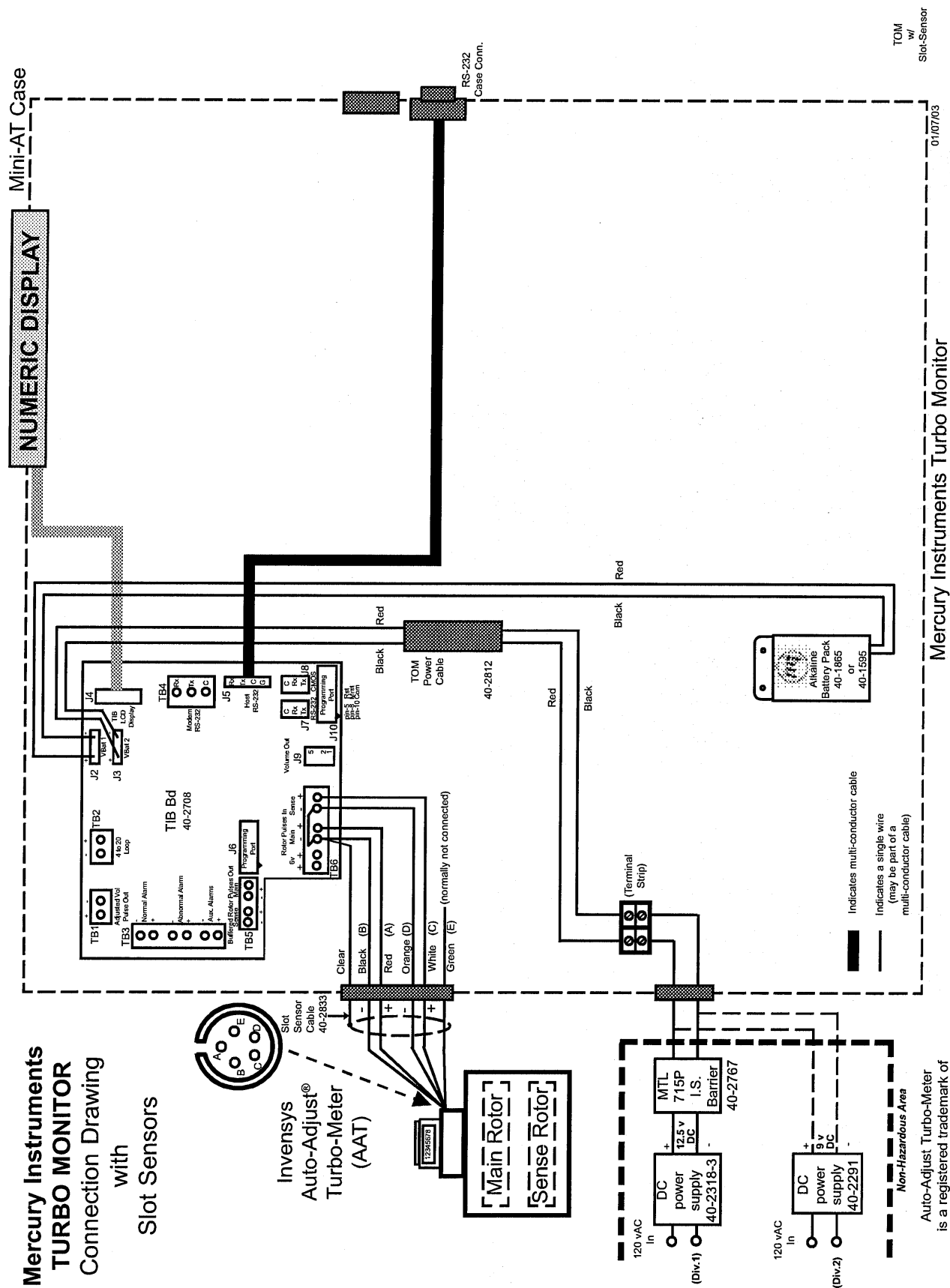


Figure 3
Turbo Monitor Connections with Slot Sensors

Turbo Monitor

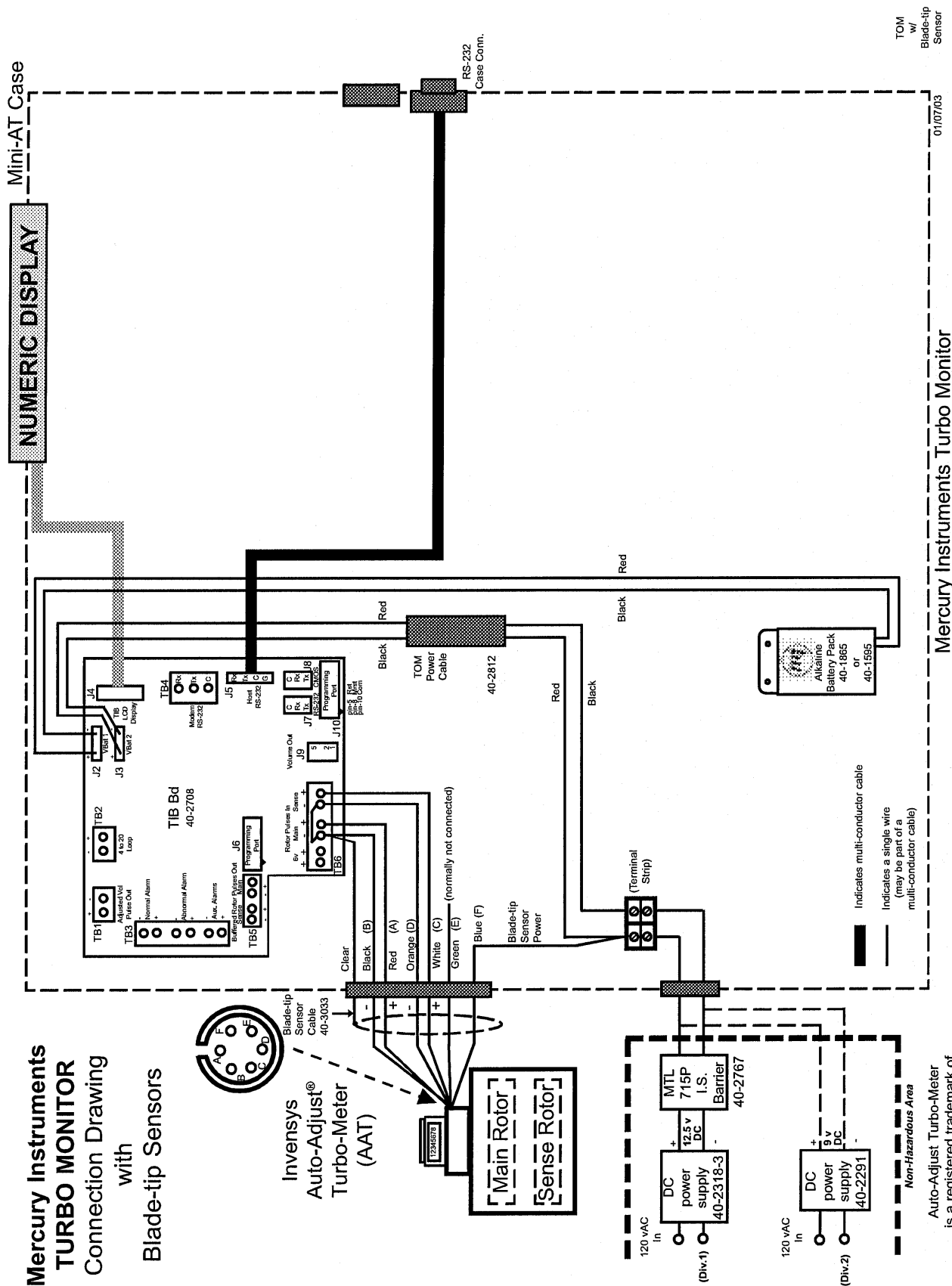


Figure 4
Turbo Monitor Connections with Blade Tip Sensors

Turbo Monitor

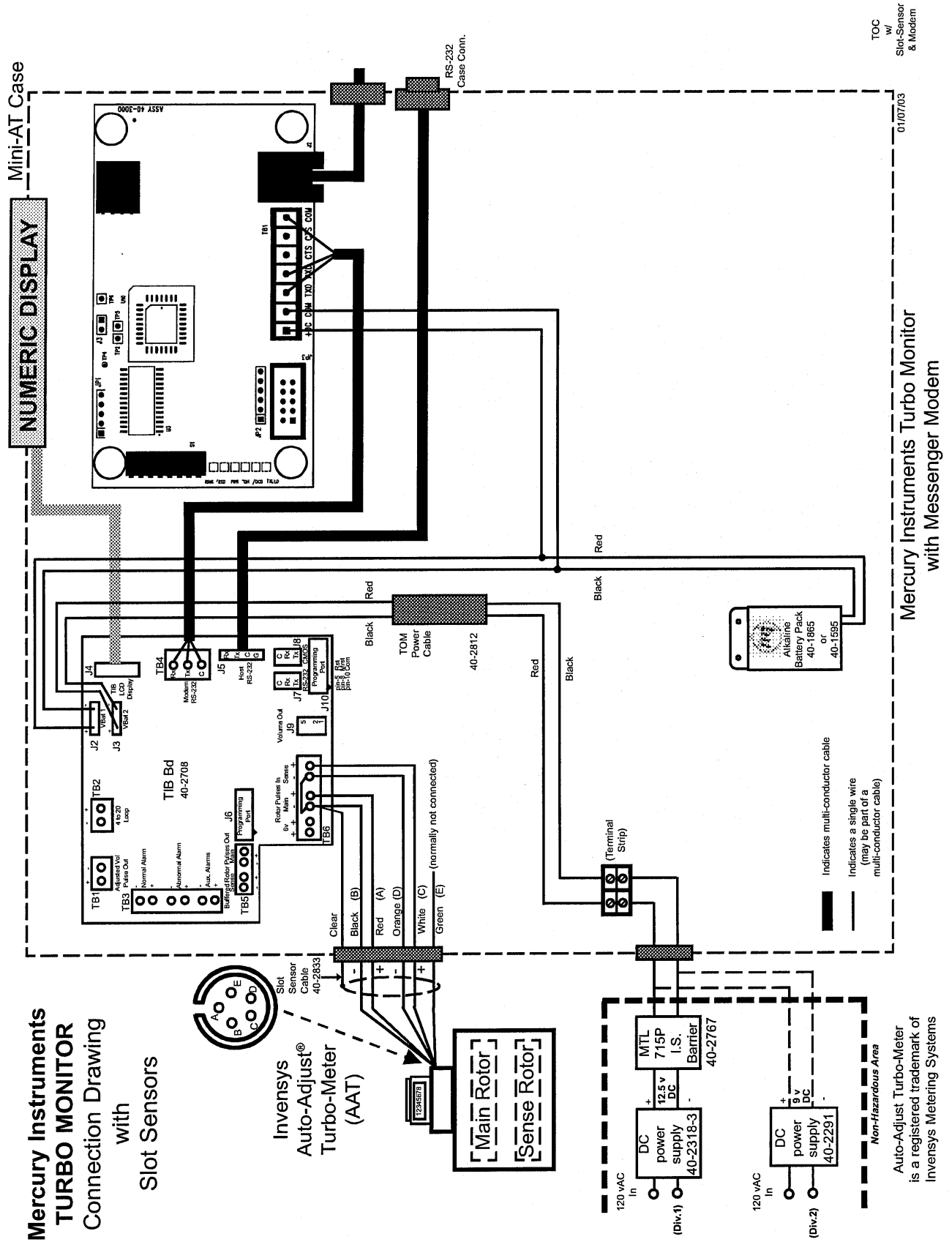


Figure 5
 Turbo Monitor Connections with Slot Sensors and Modem

Turbo Monitor

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 calculated as follows:

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

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

Turbo Monitor

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 as “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 addition 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.

Turbo Monitor

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.

Turbo Monitor

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

Turbo Monitor

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". If the instrument receives a pushbutton input during the "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:
AV ***	Display Test
U-AV ***	Adjusted Volume
BAT-VOLT	Unadjusted Volume
I DELT-A	Battery Voltage
MAIN HZ	Instantaneous Delta A
SENSE HZ	Main Rotor Frequency (Live)
A-V RATE	Sense Rotor Frequency (Live)
I DELT-A	Adjusted Volume Flow Rate (Live)
	Instantaneous Delta A (Live)

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

Turbo Monitor

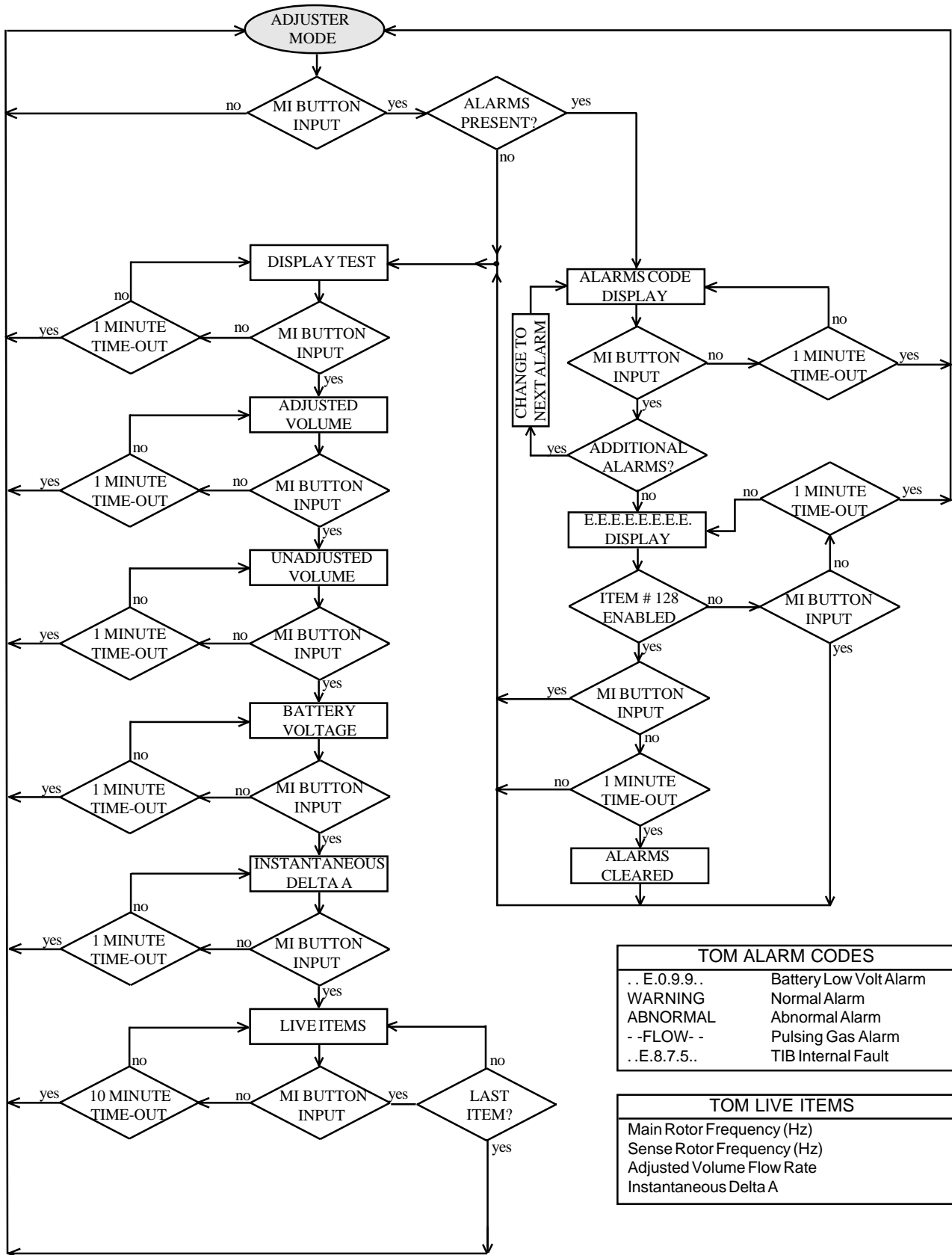


Figure 8
Default Meter Reader Display

Turbo Monitor

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.

Turbo Monitor

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).

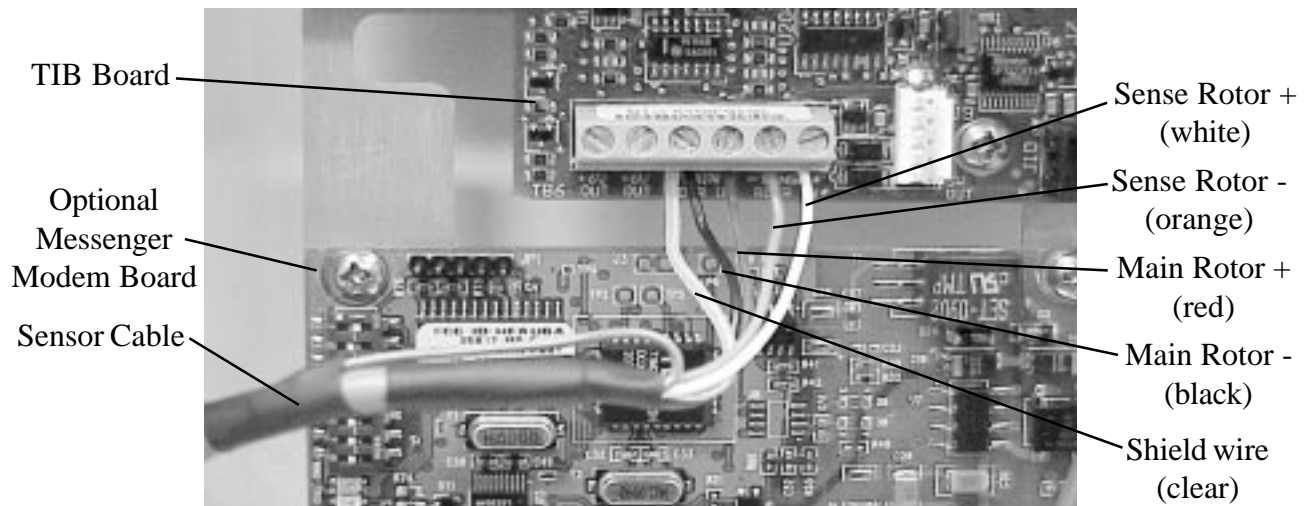


Figure 9
Sensor Cable Connections

Turbo Monitor

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

LCD with Alarms

0 0 0 4 5 6 7 8

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”, then simply allow the display to time-out, which takes about 1-minute. After the “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”. This will happen only if Item 128 (Mag Alarm Acknowledge) is enabled. If it is disabled “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.

Turbo Monitor

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 Recommended 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

Turbo Monitor

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 Code (Sec.)	Form-A		
	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

Turbo Monitor

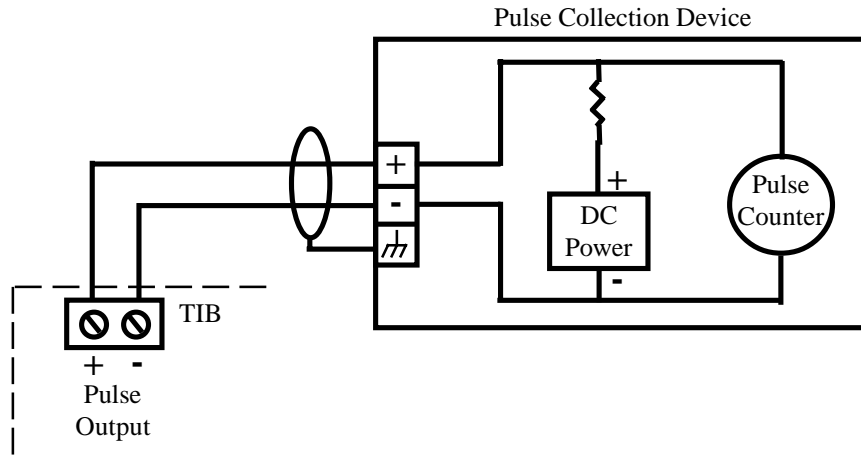
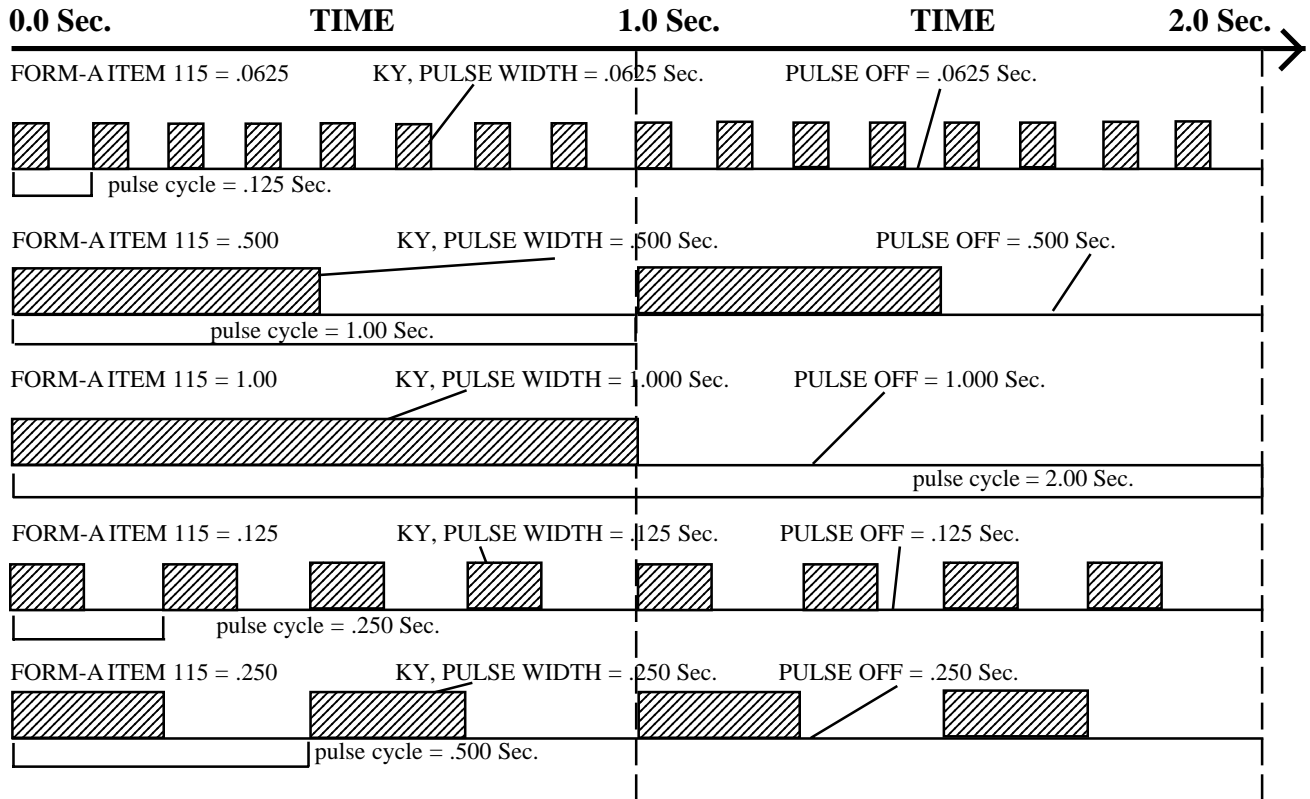


Figure 10
Pulse Connection Circuit

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



Turbo Monitor

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.

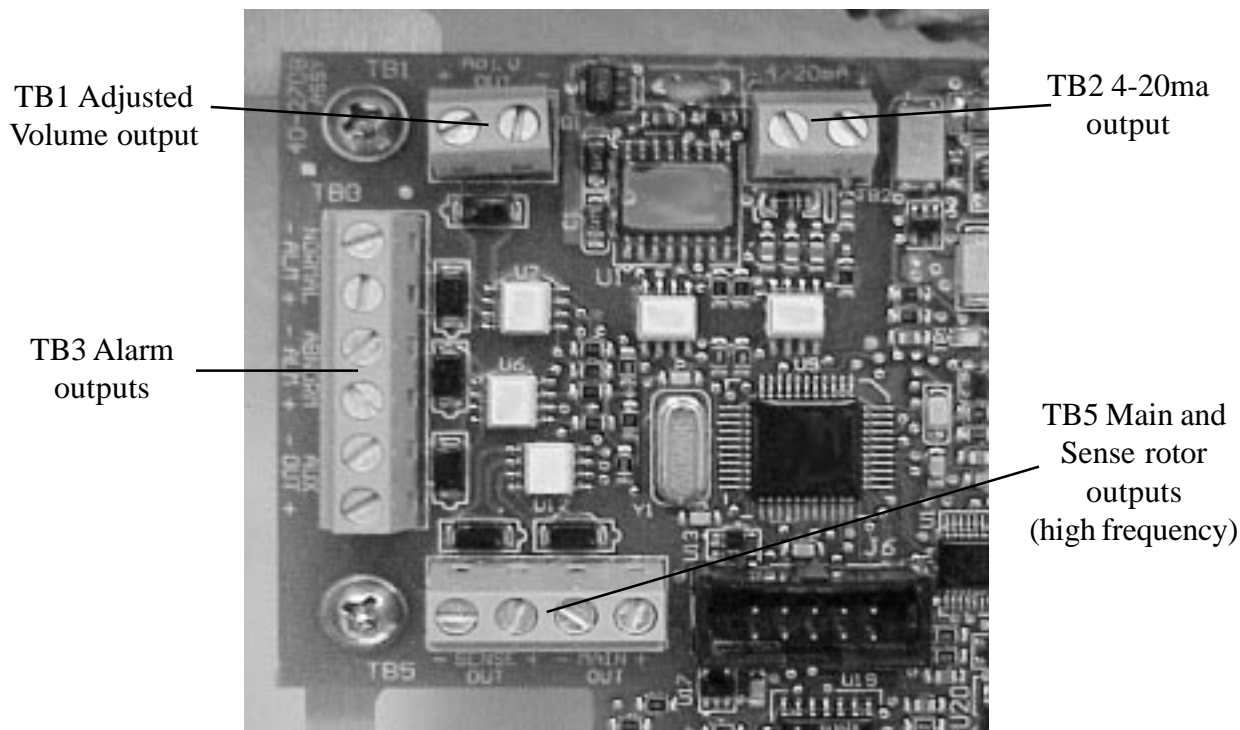


Figure 11
Pulse and 4-20mA Output Connection Locations

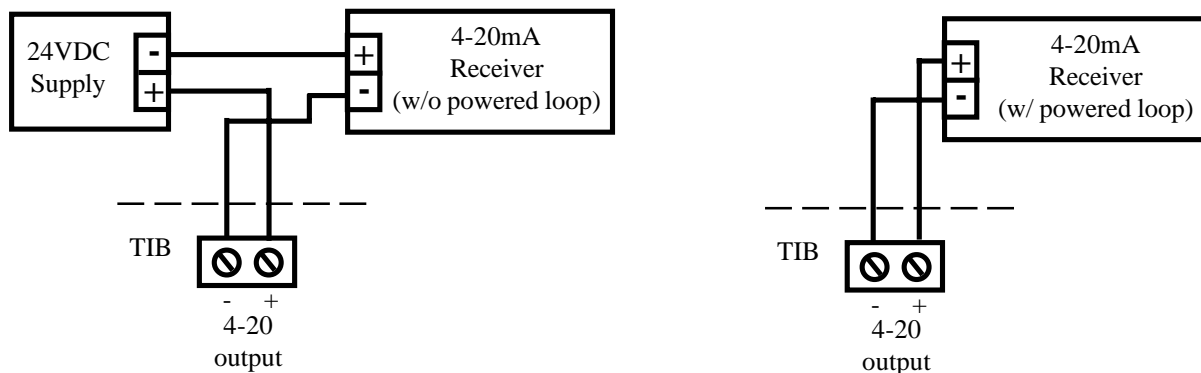


Figure 12
4-20mA Output Connections

Turbo Monitor

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 Ft³ or m³) 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.

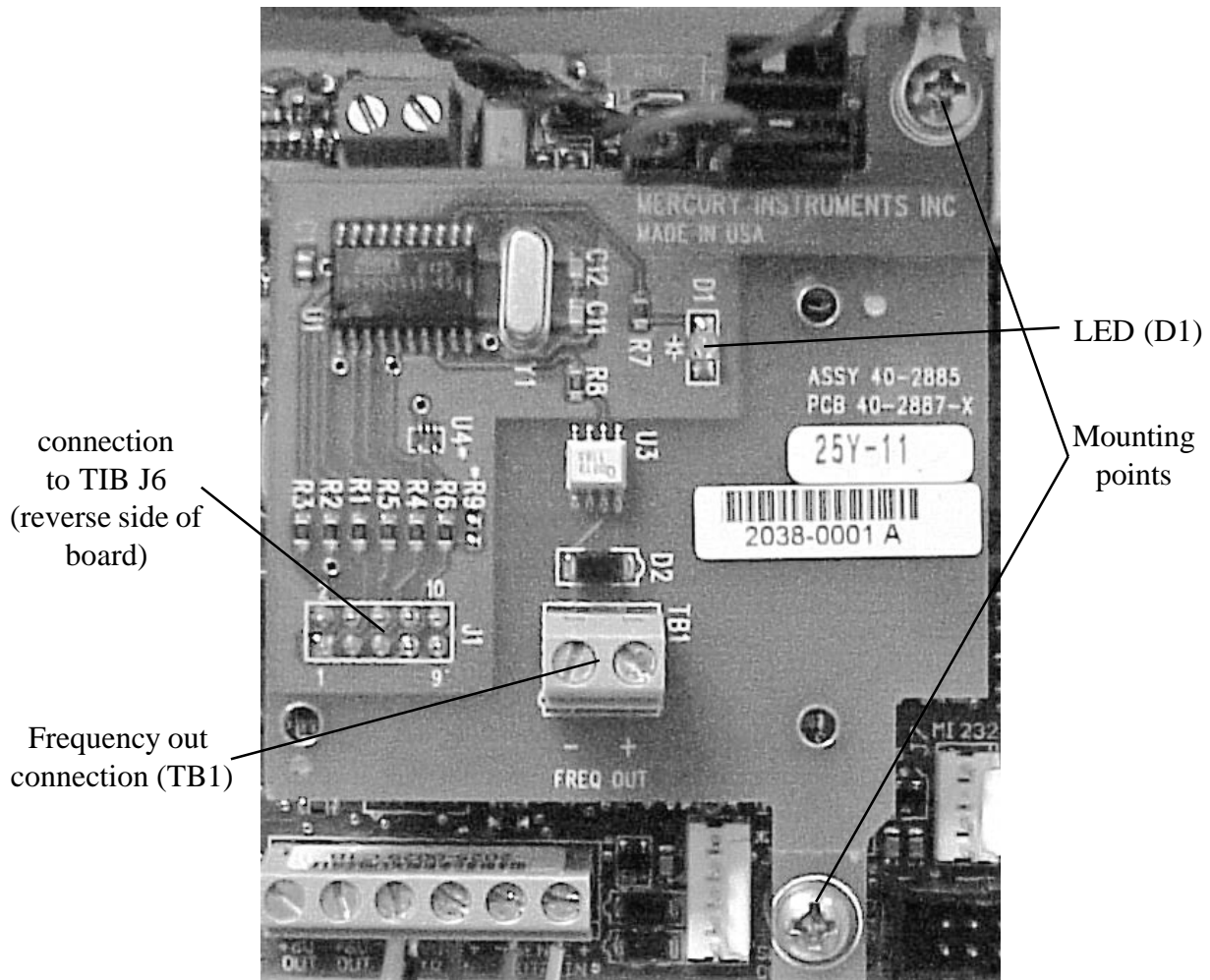


Figure 13
Turbo Frequency Board Installed

Turbo Monitor

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	0.011111	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

Turbo Monitor

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.

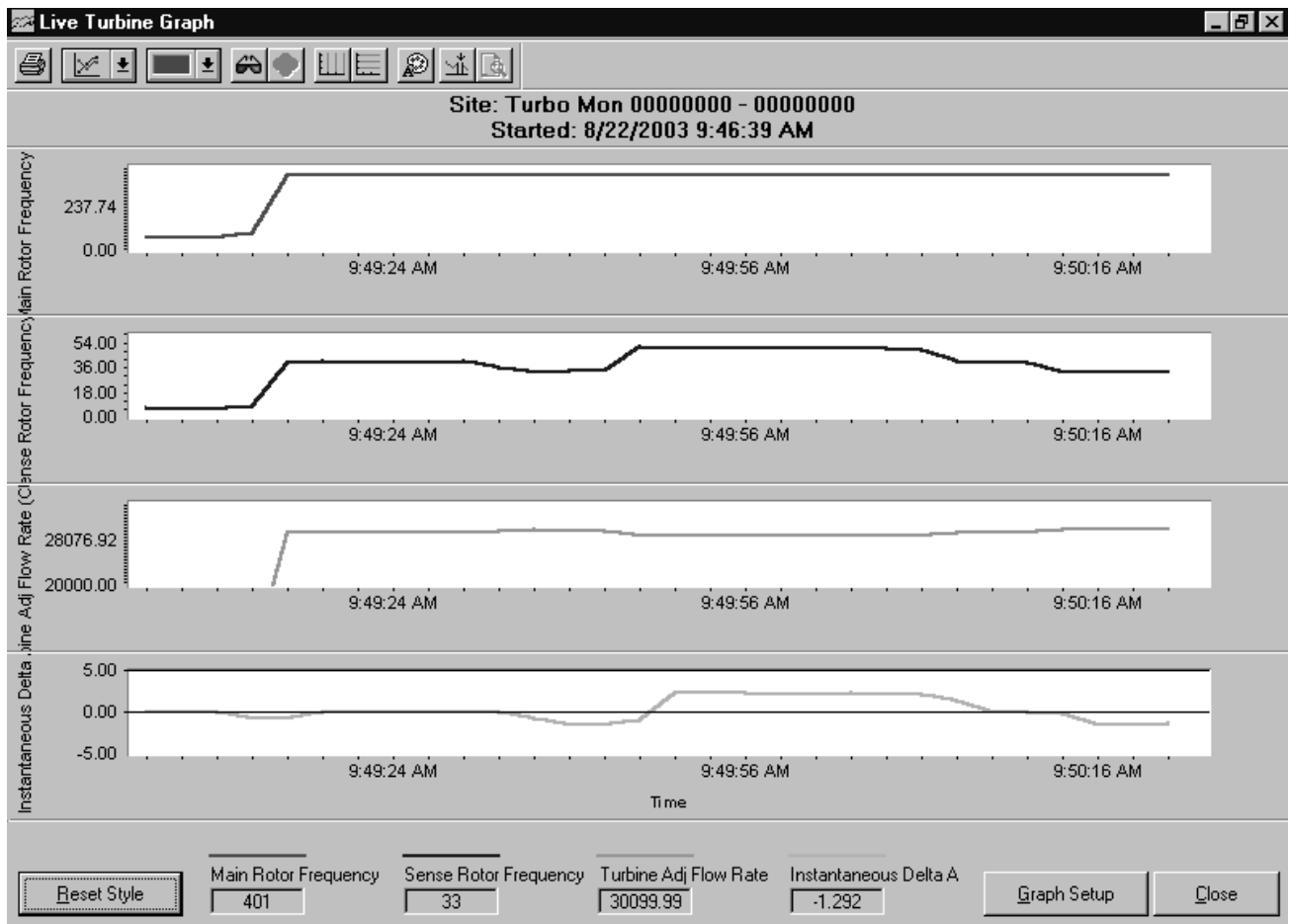


Figure 14
Live Graph Display

Turbo Monitor

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 columns are used to select a range of values to scale on the graph. The Color and Line Style columns 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 width 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.

The screenshot shows the 'Turbine Graph Setup' dialog box. It is divided into two main sections: 'Graph Configuration' and 'Options'. The 'Graph Configuration' section contains a table with five columns: 'Y Axis Item', 'Y Minimum', 'Y Maximum', 'Color', and 'Line Style'. There are four rows of data. The 'Options' section includes 'Reading Interval' (set to 1), 'X-Axis Width' (set to 30), and two checkboxes: 'Show ToolBar' (checked) and 'Show Data Points on Lines' (unchecked). At the bottom, there are four buttons: 'Load Setup', 'Save Setup', 'OK', and 'Cancel'.

Y Axis Item	Y Minimum	Y Maximum	Color	Line Style
Main Rotor Frequency	0	450	Red	Solid Line (Thin)
Sense Rotor Frequency	0	60	Red	Solid Line (Thin)
Turbine Adj Flow Rate	20000	35000	Green	Solid Line (Thin)
Instantaneous Delta A	-5	5	Blue	Solid Line (Thin)

Options

Reading Interval: 1 Seconds (1-30) Show ToolBar

X-Axis Width: 30 Seconds Show Data Points on Lines

Buttons: Load Setup, Save Setup, OK, Cancel

Figure 15
Live Graph Configuration

Turbo Monitor

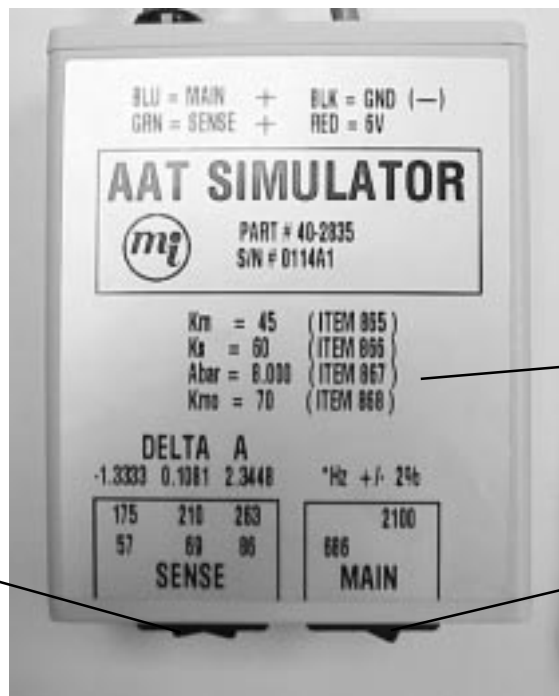
AAT Simulator

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 position 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.



Connection to
Battery Pack

Connection to
Sensor Cable



Turbine Data
to be entered

Sense Rotor
Switch

Main Rotor
Switch

Turbo Monitor

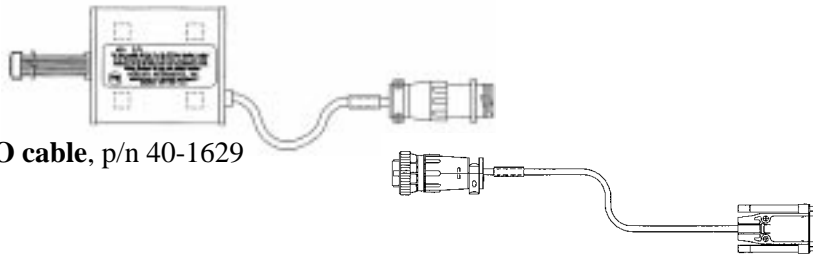
Upgrading TIB firmware

1. Items Required

- PC with Windows 95/98 OS (or higher)
- **Firmware Upgrade Manager** software (FWUM) version 2.1101 or later

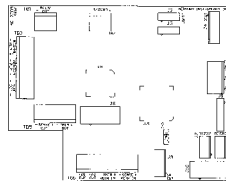
Install Firmware Upgrade Manager software using the following steps:

- Insert the 3-1/2" floppy disk containing the Firmware Upgrade Manager Software (disk #1) into drive-A.
 - Click the Windows **Start** button and select **Run** from the Start Menu
 - In the run box, type in **A:\setup.exe**
 - The Screen will display: "Firmware Upgrade Manager Setup". At the bottom of the screen will be a dialogue box to choose the installation drive (default is C:\). Select the drive letter you wish to install to and press continue
 - Setup will begin to install the files for Firmware Upgrade Manager from disk #1. After disk #1 is complete, setup will prompt for disk #2. Insert disk #2 and continue the installation.
 - At the end of the installation, there will be a message stating that the installation is complete. At this point, setup will give you the option of restarting the computer to update the system. Select "Yes" to update the system and restart the computer.
- **Mercury Programming Adapter** (MPA) p/n 40-2620, with version 1.1002 firmware (or higher).



- **RS-232 serial I/O cable**, p/n 40-1629

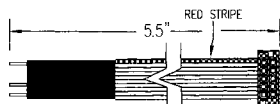
- **TIB Firmware file** for Controller 103 (U15) (TIBxxxxx.tbx) and **TIB Firmware file** for Controller 8515 (U9) (T8Bxxxxx.t8x)
- **TIB board** (may be part of a TOC or TOM assembly)



- **TOC Power cable** p/n 40-2809-1 (with battery or DC power connected) or **TOM Power cable** p/n 40-2812 (with battery or DC power connected)



- **TIB Programming/Voltage Adapter Cable**, p/n 40-3058 for supplying DC voltage to TIB programming port. This cable is sometimes required when programming certain TIB boards that needs a higher DC voltage (3.9 V DC) applied directly to the programming port to program the fuse bits in the main Controller (U15)

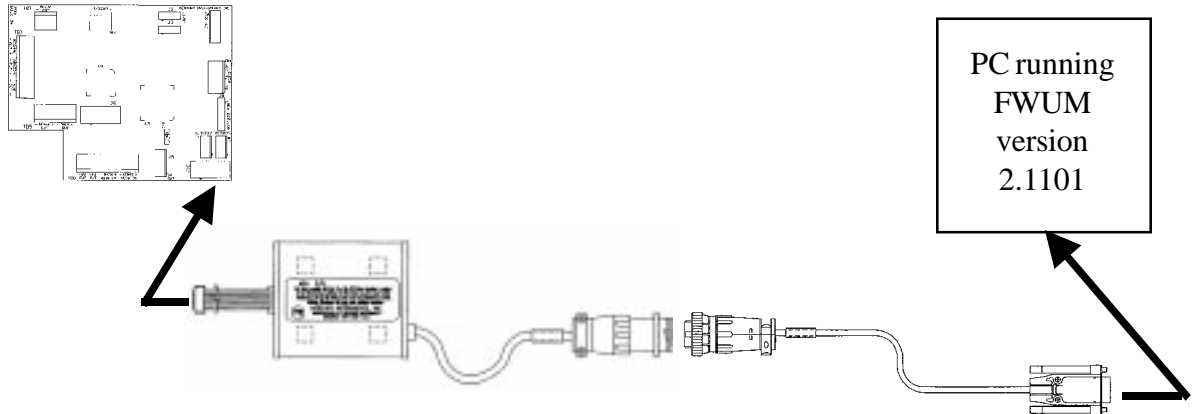


Turbo Monitor

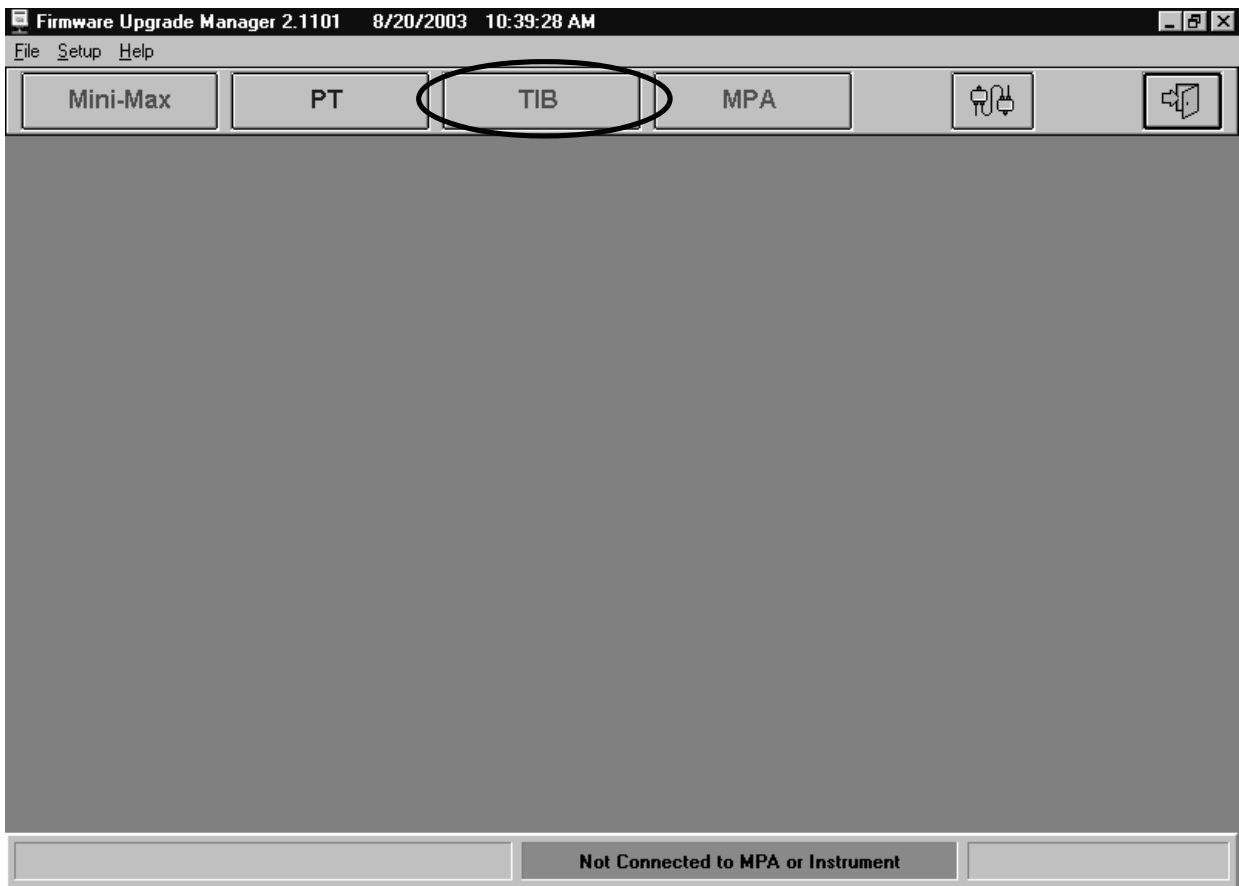
2. Programming the TIB:

2.1 Programming the 103 Microcontroller (U15) with Mercury MPA (only)

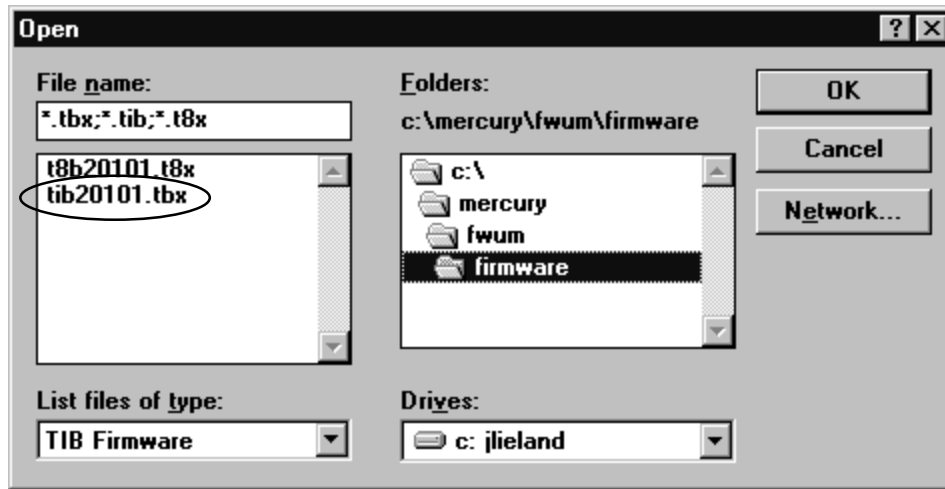
1. Connect MPA to PC serial port via the 40-1629 cable.
2. Connect MPA ribbon cable (10-pin header conn) to TIB (J10) port (red wire to pin #1).



3. Start Mercury Firmware Upgrade Manger and select “TIB “ from icon toolbar. A Dialog box appears to explain the sequence of connecting the MPA ribbon cable during programming.



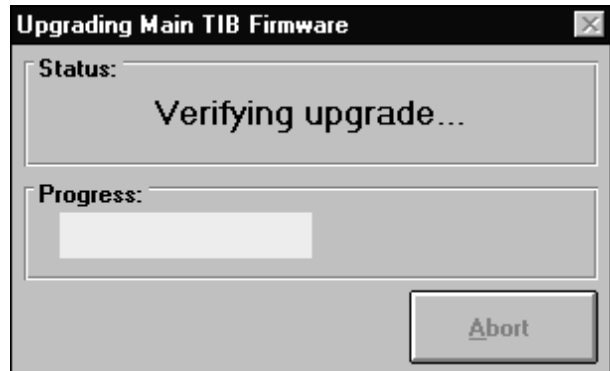
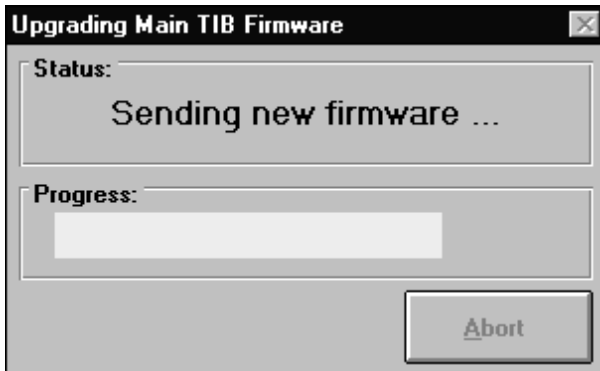
Turbo Monitor



4. Send ... \ tibXXXXX.tbX” file (use file browser if required).



5. FWUM erases, programs and then verifies the upgrade. The Firmware Upgrade Manager indicates upgrade successful when complete.

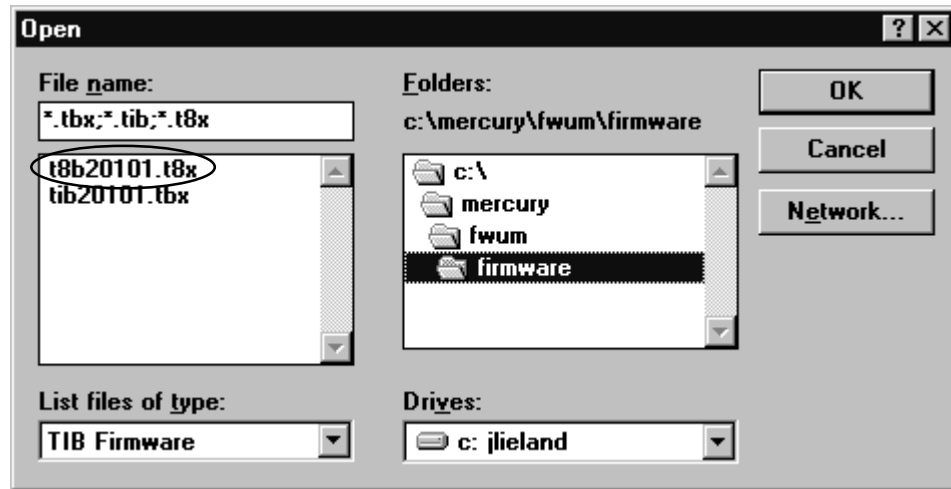


Turbo Monitor

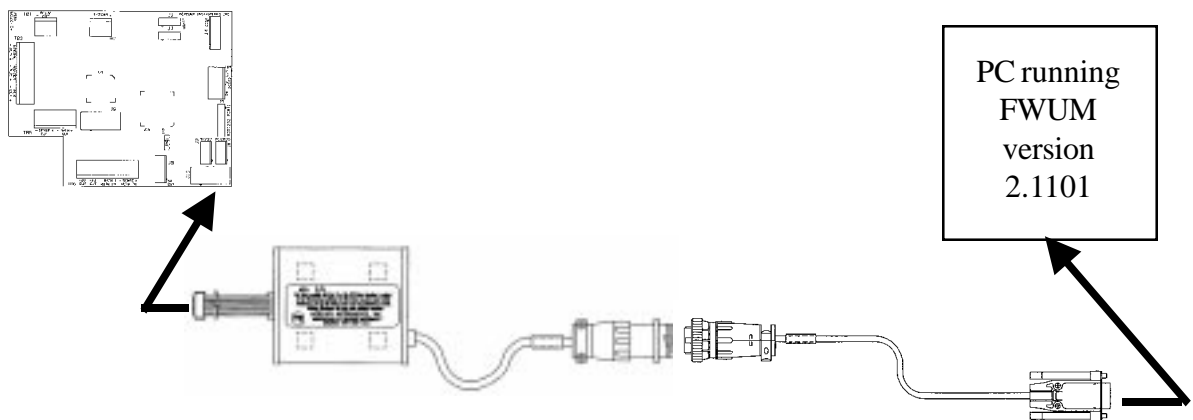
2.2 Programming the 8515 Microcontroller (U9) firmware with Mercury MPA

Note: The TIB requires the firmware in the 103 Microcontroller (U15) to be erased before the firmware in the 8515 Microcontroller (U9) can be programmed. This is the reason for the MPA to be plugged into J10 first to erase the 103 Microcontroller (U15) firmware before changing to J6 for programming the 8515 Microcontroller (U9) firmware.

1. Connect MPA to PC serial port via the 40-1629 cable.
2. Start Mercury Firmware Upgrade Manger and select “TIB “ from icon toolbar. A Dialog box appears to explain the sequence of connecting the MPA ribbon cable during programming

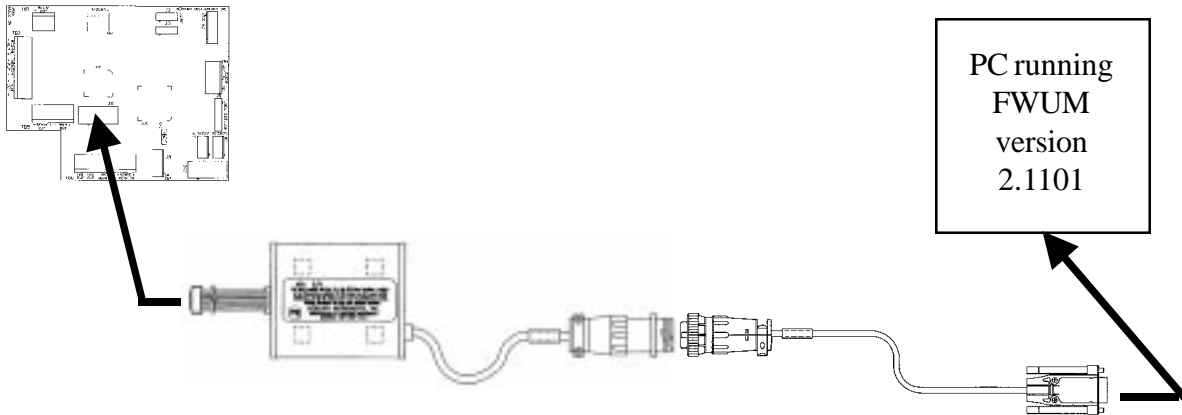


3. Send "... \ t8BXXXXX.t8x" file (use file browser if required). FWUM prompts you to connect the MPA ribbon cable (10-pin header conn) to TIB (J10) port (red wire to pin #1).



Turbo Monitor

4. FWUM erases the firmware in the 103 Microcontroller (U15) and then prompts you to connect the MPA (10-pin header conn) to TIB (J6) port (red wire to pin #1).

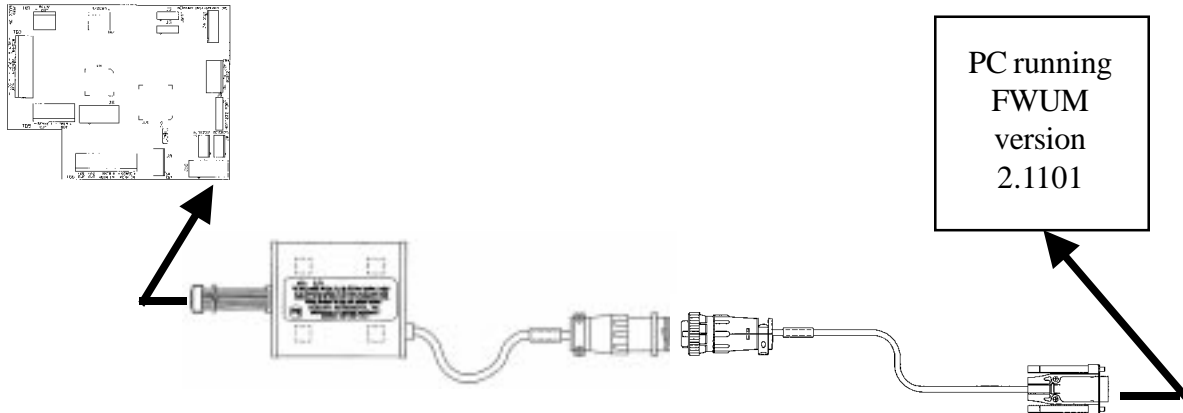


5. The FWUM then erases, programs and verifies the 8515 Microcontroller (U9) firmware. The Firmware Upgrade Manager indicates upgrade successful when complete.

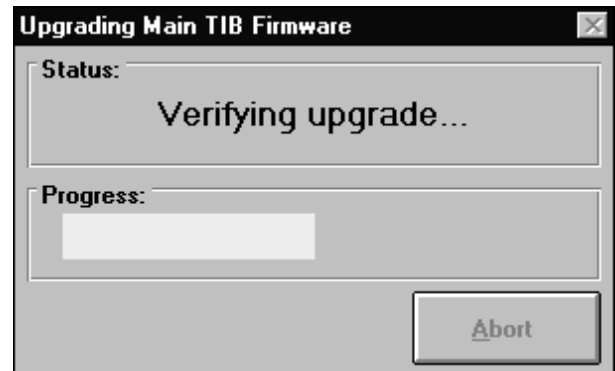
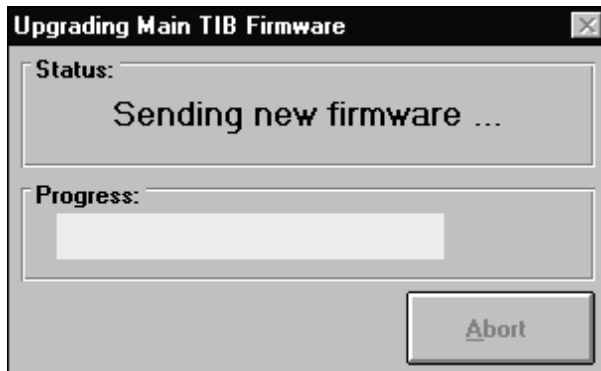


Turbo Monitor

6. FWUM prompts to Connect MPA (10-pin header conn) to TIB (J10) port (red wire to pin #1).



7. Load "... \tiBXXXXX.tbX" file (use file browser if required).
8. FWUM erases, programs and verifies the firmware in the ATmega 103 AVR Microcontroller (U15). The Firmware Upgrade Manager indicates upgrade successful when complete.



Turbo Monitor

2.3 Programming the 103 Microcontroller (U15) at a higher voltage to prevent “Verification Errors”

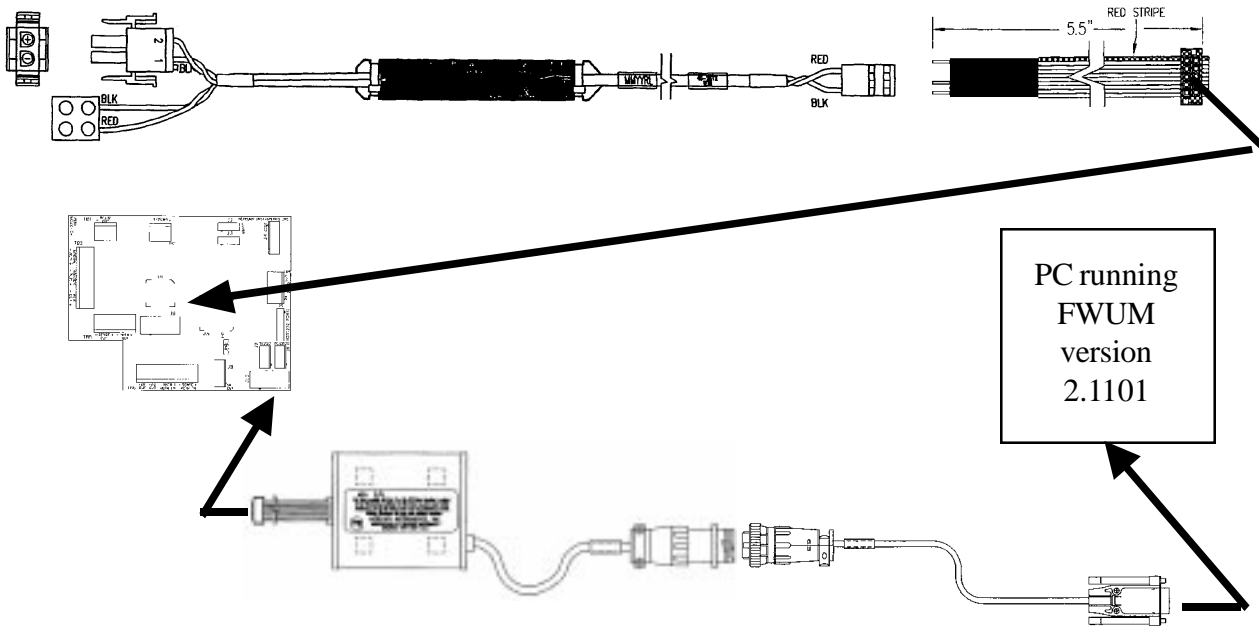
Note : Some of the main controllers 103 Microcontroller (U15) on the TIB may need a special operation to program the TIB if FWUM indicates a verification error and notifies the user the programming operation failed. This is due to a group of TIB boards that were manufactured to require a marginally higher voltage during firmware programming. The TIB Programming/Voltage Adapter Cable was created to provide the higher voltage required. This is a one-time operation (per board) and then any future programming will not require the use of the higher voltage.

1. Perform steps 2.1 or 2.2 above as required to attempt TIB firmware the programming. If FWUM indicates a *verification error* at the end of programming the 103 Microcontroller (U15), continue with the following steps.

2. To supply a higher voltage to the TIB programming ports:

Remove the incoming power connector from the V Bat connector (J2 or J3) of the TIB. Assure there are no other accessory connectors on J2 and J3 connectors TIB.

3. Install the keyed, three pin header of the TIB Programming/Voltage Adapter Cable into the power cable originally connected to TIB J2 or J3 **AND** connect the 10 pin ribbon cable (opposite end of the TIB Programming/Voltage Adapter Cable) into J6 on the TIB.



4. Program the main controller, i.e., the 103 Microcontroller (U15) per step 2.1 above.
5. Remove the TIB Programming/Voltage Adapter Cable from J6. Reconnect the incoming power cable to the TIB Vbat Connector (J2 or J3). Reconnect any accessory connectors to the TIB Vbat connectors if removed in step 2 above. Repeat all the steps in section 2.2, if required.

Turbo Monitor

Item Codes

Item

No.	Item Name	Description
048	Battery Voltage	Main battery voltage measured at last wake-up. Default = 0.00
049	Battery Voltage Low Limit	Low limit for main battery voltage, initiates alarm (item 099) if voltage drops below this value. Default = 5.50
050	Shutdown Voltage	The voltage level at which most of the electronic circuits terminate operation. “..H.E.L.P..” is displayed on the LCD as an indication that the battery is dead and needs replaced. Default = 4.80
075	Mag List 2 Item 1	Item number of the first item displayed in MAG LIST #2. The display of this selection follows the display of LIVE Parameters (if enabled at item 129) or the last MAG LIST 1 ITEM (if enabled, items 130-135). If neither LIVE Parameters nor MAG LIST 1 items are enabled, the item programmed into item 075 will be the first Mag Read Item to be displayed in the Meter Reader List. Any TOM item number may be entered as a Mag Read Item. Default = 255 (End-of-List)
076	Mag List 2 Item 2	Item number of the next Mag List #2 item. Any item code may be selected, or enter the value “255” at this item to indicate the End-of-List. Default = 255 (End-of-List)
077	Mag List 2 Item 3	Same as Item 76 above. Default = 255 (End-of-List)
078	Mag List 2 Item 4	Same as Item 76 above. Default = 255 (End-of-List)
079	Mag List 2 Item 5	Same as Item 76 above. Default = 255 (End-of-List)
080	Mag List 2 Item 6	Same as Item 76 above. Default = 255 (End-of-List)
081	Mag List 2 Item 7	Same as Item 76 above. Default = 255 (End-of-List)
082	Mag List 2 Item 8	Same as Item 76 above. Default = 255 (End-of-List)

Turbo Monitor

Item

No.	Item Name	Description																
083	Mag List 2 Item 9	Same as Item 76 above. Default = 255 (End-of-List)																
084	Mag List 2 Item 10	Same as Item 76 above. Default = 255 (End-of-List)																
085	Mag List 2 Item 11	Same as Item 76 above. Default = 255 (End-of-List)																
086	Mag List 2 Item 12	Same as Item 76 above. Default = 255 (End-of-List)																
092	Vol Unit Code	Code (0-14) that selects the display units, Adjusted Volume pulse output units and units of measure for Volume Related Items (850-854). Default =8 (MCF) Possible selections for Item 092 are: <table border="0" style="margin-left: 40px;"> <tr> <td>0 - CU FT</td> <td>8 - MCF</td> </tr> <tr> <td>1 - CU FTx10</td> <td>9 - m3x0.1</td> </tr> <tr> <td>2 - CUFTx100</td> <td>10 - m3</td> </tr> <tr> <td>3 - CF</td> <td>11 - m3x10</td> </tr> <tr> <td>4 - CFx10</td> <td>12 - m3x100</td> </tr> <tr> <td>5 - CFx100</td> <td>13 - m3x1000</td> </tr> <tr> <td>6 - CFx1000</td> <td>14 - CFx10000</td> </tr> <tr> <td>7 - CCF</td> <td></td> </tr> </table>	0 - CU FT	8 - MCF	1 - CU FTx10	9 - m3x0.1	2 - CUFTx100	10 - m3	3 - CF	11 - m3x10	4 - CFx10	12 - m3x100	5 - CFx100	13 - m3x1000	6 - CFx1000	14 - CFx10000	7 - CCF	
0 - CU FT	8 - MCF																	
1 - CU FTx10	9 - m3x0.1																	
2 - CUFTx100	10 - m3																	
3 - CF	11 - m3x10																	
4 - CFx10	12 - m3x100																	
5 - CFx100	13 - m3x1000																	
6 - CFx1000	14 - CFx10000																	
7 - CCF																		
097	Vol Display Resolution	Code (0-4) that selects the number of digits (out of eight) to be blanked on the left-side of the volume displays (items 850 and 852). <table border="0" style="margin-left: 40px;"> <tr> <td></td> <td style="text-align: right;">Example:</td> </tr> <tr> <td>Select: 0 - NO BLANKS--Default</td> <td style="text-align: right;">12345678</td> </tr> <tr> <td>1 - 1 BLANK</td> <td style="text-align: right;">2345678</td> </tr> <tr> <td>2 - 2 BLANK</td> <td style="text-align: right;">345678</td> </tr> <tr> <td>3 - 3 BLANK</td> <td style="text-align: right;">45678</td> </tr> <tr> <td>4 - 4 BLANK</td> <td style="text-align: right;">5678</td> </tr> </table>		Example:	Select: 0 - NO BLANKS-- Default	12345678	1 - 1 BLANK	2345678	2 - 2 BLANK	345678	3 - 3 BLANK	45678	4 - 4 BLANK	5678				
	Example:																	
Select: 0 - NO BLANKS-- Default	12345678																	
1 - 1 BLANK	2345678																	
2 - 2 BLANK	345678																	
3 - 3 BLANK	45678																	
4 - 4 BLANK	5678																	
098	Meter Index Code	Code (0-10) that selects the totalizer unit of measure for Volume related items (Items 850 through 854) <table border="0" style="margin-left: 40px;"> <tr> <td>Select: 0 - 1 CF</td> <td>6 - 1 m3</td> </tr> <tr> <td>1 - 5 CF</td> <td>7 - 10 m3</td> </tr> <tr> <td>2 - 10 CF</td> <td>8 - 100 m3</td> </tr> <tr> <td>3 - 100 CF</td> <td>9 - 1000 m3</td> </tr> <tr> <td>4 - 1000 CF-----Default</td> <td>10 - 10000 CF</td> </tr> <tr> <td>5 - .1m3</td> <td></td> </tr> </table>	Select: 0 - 1 CF	6 - 1 m3	1 - 5 CF	7 - 10 m3	2 - 10 CF	8 - 100 m3	3 - 100 CF	9 - 1000 m3	4 - 1000 CF----- Default	10 - 10000 CF	5 - .1m3					
Select: 0 - 1 CF	6 - 1 m3																	
1 - 5 CF	7 - 10 m3																	
2 - 10 CF	8 - 100 m3																	
3 - 100 CF	9 - 1000 m3																	
4 - 1000 CF----- Default	10 - 10000 CF																	
5 - .1m3																		

Turbo Monitor

Item

No. Item Name
099 Battery Low

Description

This item (099) indicates if a low voltage alarm for the main battery was generated. During a wake-cycle, if the measurement for item 048 (BATTERY VOLTAGE) is a value less than the value at item 049 (BATTERY LOLIM V), an alarm is initiated and is indicated by placing dots on the LCD and “11111111” at item 099. “00000000” at item 099 indicates there is no Low Battery Alarm. The alarm indicators will remain active until manually cleared (by software) or automatically when RBX (item 165) is enabled.

Default = 00000000

115 Pulser Scaling Factor

Code (**0 - 4**) to provide slower pulse rates for remote counter/readout devices that require more time to process volume pulses. The coded value represents the pulse width in seconds. The pulse-on time is half of the pulse cycle. The standard pulse-on time for a Form-A output is 62.5 milliseconds.

Select: **0** - 0.0625 **Default**
 1 - 0.500
 2 - 1.000
 3 - 0.125
 4 - 0.250

128 Mag Alarm Acknowledge

Code (**0 or 1**) to enable or disable the clearing of all active alarms using the mag wand. During the Meter Reader List, an “E.E.E.E.E.E.E” display will appear after scrolling through all active alarms. Allowing the instrument to time-out (1-minute) at this display will clear all alarms. If instead, the mag wand is used to scroll to the next mag list item before the “E.E.E.E.E.E.E” display times-out, the alarms are not cleared. This feature is most useful if alarms need to be cleared and a laptop computer is not available. If item 128 is configured for “Disabled”, the “E.E.E.E.E.E.E” pattern will never be displayed.

Select: **0** - Disabled----- **Default**
 1 - Enabled

130 Mag List 1 Item 1

Item number of the first item displayed in the Meter Reader List, unless there are active alarms. Active alarms are always displayed prior to the selected mag list items. Any Turbo Monitor item may be entered as a mag list item. Enter a 255 for this item if the Mag List 1 function is to be disabled. See the section on using the Meter Reader List for more information.

Default = 061 (Display Test)

Turbo Monitor

Item No.	Item Name	Description
131	Mag List 1 Item 2	Item number of the second Mag List 1 item. Any Turbo Monitor item may be entered. Entered a 255 at this item to indicate the End-of-List for Mag List 1. Default = 850 (Adjusted Volume)
132	Mag List 1 Item 3	Item number of the third Mag List 1 item. Any Turbo Monitor item may be entered. Entered a 255 at this item to indicate the End-of-List for Mag List 1. Default = 852 (Unadjusted Volume)
133	Mag List 1 Item 4	Item number of the fourth Mag List 1 item. Any Turbo Monitor item may be entered. Entered a 255 at this item to indicate the End-of-List for Mag List 1. Default = 048 (Battery Voltage)
134	Mag List 1 Item 5	Item number of the fifth Mag List 1 item. Any Turbo Monitor item may be entered. Entered a 255 at this item to indicate the End-of-List for Mag List 1. Default = 869 (Instantaneous Delta A)
135	Mag List 1 Item 6	Item number of the sixth Mag List 1 item. Any Turbo Monitor item may be entered. Entered a 255 at this item to indicate the End-of-List for Mag List 1. Default = 255 (End-of-List)
165	RBX Alarm Enable	Code (0-1) to determine the type of instrument alarm operation. When the RBX function (Report By Exception) is disabled, all instrument alarms stay active until manually cleared. When RBX is enabled, instrument alarms are automatically cleared after the alarm parameter returns to its normal operating range, buffered by a user-specified dead band. Exceptions; Battery Low, TIB Internal Fault and Pulsing Gas Alarm. Select: 0 - Standard Alarms----- Default 1 - RBX Alarms
170	Protocol Code A	Selection (0-1) to determine if a specific Mercury Protocol error code is transmitted while attempting a serial link sign-on. When this function is set to "0", (which is the recommended setting for most applications) all instrument error codes are transmitted as in previous versions of firmware. When this item is set to "1", the TIB will not send time-out errors during serial communications. The selection of "1" is provided as a convenience for some 3rd party communication interfaces. Select: 0 - Standard----- Default 1 - No Time-out Error

Turbo Monitor

Item No.	Item Name	Description
171	Timeout Delay 1	<p>The time (in seconds) the TIB waits for the host computer to send the protocol control character “ENQ” during instrument sign-on before issuing an error “21” (timeout error). This function is provided as a convenience for some 3rd party communication interfaces and under most situations, should not be changed from the default setting.</p> <p>Range: 7 to 60 Default = 7</p>
172	Timeout Delay 2	<p>The time (in seconds) the TIB waits for a valid “sign-on” from the host computer after receiving the protocol control character “ENQ” before issuing an error “21” (timeout error). This function is provided as a convenience for some 3rd party communication interfaces and under most situations, should not be changed from the default setting.</p> <p>Range: 7 to 60 Default = 7</p>
200	Site ID	<p>User assigned, eight digit numeric site number. Limited to characters: 0-9. The “.” and “-” are not valid characters. Note: All instruments downloaded using Mercury Instruments Windows-based software must be configured for unique Site ID Numbers at items 200 and 201.</p> <p>Default = 00000000</p>
201	Site ID Part 2	<p>Eight additional digits for the site number, if needed. Note: All instruments downloaded using Mercury Instruments Windows-based software must be configured for unique Site ID Numbers at items 200 and 201.</p> <p>Default = 00000000</p>
850	Adjusted Volume	<p>Totalized Adjusted Uncorrected Volume. Value is scaled to volume units selected at Item 092, with the number of digits defined by Item 097.</p> <p>Default = 00000000</p>
851	Hi Res Adjusted Volume	<p>Fractional portion of Item Code 850 (Adjusted Volume) displayed in units of ft³ or m³. This item is continuously updated until it reached the value of adjusted volume units at Item 092. At this point item 850 is updated and item 851 is reset to zero.</p> <p>Default = 0.000000</p>
852	UnAdjusted Volume	<p>Totalized Unadjusted Uncorrected Volume. Value is scaled to volume units selected at Item 092, with the number of digits defined by Item 097.</p> <p>Default = 00000000</p>

Turbo Monitor

Item

No.	Item Name	Description												
853	Turbine Adj Flow Rate	<p>The current instantaneous rate of flow for Adjusted Volume (850), expressed in the selected Adjusted Volume units (ft³ or m³) per hour. The value is updated every second in the TIB. When accessed, the unit will display the most recently computed value.</p> <p style="text-align: center;">Default = 0.00</p>												
854	Turbine UnAdj Dial Rate	<p>The current instantaneous rate of flow for Unadjusted Volume (852), expressed in the selected Unadjusted Volume units (ft³ or m³) per hour. The value is updated every second in the TIB. When accessed, the unit will display the most recently computed value.</p> <p style="text-align: center;">Default = 0.00</p>												
855	Turbine Configuration	<p>Item used to determine the configuration of the unit. A selection of '0' at item 855 is used for stand-alone Mini-AT and Turbo Monitor units. A selection of '1' at item 855 is used for Turbo Corrector units and enables serial communication between the TIB and Mini-AT mainboards.</p> <p style="text-align: center;">Select: 0 – TOC Disabled 1 – TOC Enabled</p>												
856	Corrector Baud Rate	<p>Code (0-7) to select the TIB's baud rate at port J7. This port is normally used to make a serial link to the Mini-AT in the Turbo Corrector Configuration and is generally not used in the Turbo Monitor configuration. A communication's error will occur if the baud rate does not match the baud rate of the connected corrector.</p> <table style="margin-left: auto; margin-right: auto;"> <tr> <td>Select: 0 – 9600</td> <td>Default</td> <td>4 – 600</td> </tr> <tr> <td>1 – 4800</td> <td></td> <td>5 – 300</td> </tr> <tr> <td>2 – 2400</td> <td></td> <td>6 – 19200</td> </tr> <tr> <td>3 – 1200</td> <td></td> <td>7 – 38400</td> </tr> </table>	Select: 0 – 9600	Default	4 – 600	1 – 4800		5 – 300	2 – 2400		6 – 19200	3 – 1200		7 – 38400
Select: 0 – 9600	Default	4 – 600												
1 – 4800		5 – 300												
2 – 2400		6 – 19200												
3 – 1200		7 – 38400												
857	Ext Case Conn Baud Rate	<p>Code (0-7) to select the TIB's baud rate when it makes a serial link to a local serial connection. A communication's error will occur if the baud rate does not match the baud rate of the connected device.</p> <table style="margin-left: auto; margin-right: auto;"> <tr> <td>Select: 0 – 9600</td> <td>Default</td> <td>4 – 600</td> </tr> <tr> <td>1 – 4800</td> <td></td> <td>5 – 300</td> </tr> <tr> <td>2 – 2400</td> <td></td> <td>6 – 19200</td> </tr> <tr> <td>3 – 1200</td> <td></td> <td>7 – 38400</td> </tr> </table>	Select: 0 – 9600	Default	4 – 600	1 – 4800		5 – 300	2 – 2400		6 – 19200	3 – 1200		7 – 38400
Select: 0 – 9600	Default	4 – 600												
1 – 4800		5 – 300												
2 – 2400		6 – 19200												
3 – 1200		7 – 38400												

Turbo Monitor

Item No.	Item Name	Description								
858	Modem Port Baud Rate	Code (0-7) to select the TIB's baud rate when it makes a serial link to a remote serial connection. A communication's error will occur if the baud rate does not match the baud rate of the connected device. <div style="margin-left: 40px;"> <table border="0"> <tr> <td>Select: 0 – 9600</td> <td>4 – 600</td> </tr> <tr> <td>1 – 4800</td> <td>5 – 300</td> </tr> <tr> <td>2 – 2400 Default</td> <td>6 – 19200</td> </tr> <tr> <td>3 – 1200</td> <td>7 – 38400</td> </tr> </table> </div>	Select: 0 – 9600	4 – 600	1 – 4800	5 – 300	2 – 2400 Default	6 – 19200	3 – 1200	7 – 38400
Select: 0 – 9600	4 – 600									
1 – 4800	5 – 300									
2 – 2400 Default	6 – 19200									
3 – 1200	7 – 38400									
859	Adj Vol Pulses Waiting	Number of Adjusted Volume output pulses waiting to be output at J9 of the TIB.								
860	UnAdj Vol Pulses Waiting	Number of Unadjusted Volume output pulses waiting to be output at J9 of the TIB.								
861	TIB Serial Number	Factory assigned TIB Serial Number. Example: 09901234. x9901234- disregard the leading zero x99xxxxx – 2 digit year of manufacture xxx01234 - 5 digit sequence number during the year of manufacture Default = 00000000.								
862	TIB Firmware Version	This item is used to display the TIB's operating firmware version number. The number reported is automatically inserted when a firmware file is uploaded into FLASH memory.								
863	Meter Serial Number	Serial number of the turbine meter connected to the TIB. Default = 00000000								
864	Turbine Meter Size	Size of AAT meter. Note: it is critical that this item be correct when using the TFB. Select 0 – AAT-18 Default 4 – AAT-60 1 – AAT-27 5 – AAT-90 2 – AAT-35 6 – AAT-140 3 – AAT-57 7 – AAT-230								
865	Km Meter Factor	Km Main rotor meter factor, i.e. the number of pulses per cubic foot or cubic meter for the main rotor as indicated by the connected turbine meter's serial plate. Default = 1.0000								
866	Ks Meter Factor	Ks Sense rotor meter factor, i.e. the number of pulses per cubic foot or cubic meter for the sense rotor as indicated by the connected turbine meter's serial plate. Default = 1.0000								

Turbo Monitor

Item No.	Item Name	Description
867	ABar Meter Factor	Amount of adjustment the sensor rotor supplied to the adjusted volume calculation during factory calibration. Default = 10.0000
868	Kmo Meter Factor	Kmo Mechanical output meter factor, i.e. the number of pulses per cubic foot or cubic meter for the main rotor mechanical output as indicated on the connected turbine's data sheet. Default = 1.0000
869	Instantaneous ΔA	The most recent calculated ΔA Factor used to indicate the amount of adjustment relative to factory calibration (Abar). Default = 0.0000
870	Turbine Sensor Type	Selection to indicate the type of sensor used in the connected turbine meter. Select 0 – Slot Sensor Default 1 – Blade Tip Sensor
871	TIB 4-20 Out Config	Selection that determines the type of analog signal provided at the 4-20 output port. Select 0 – ΔA Default 3 – Test 12mA 1 – Flow 4 – Test 20mA 2 – Test 4mA
872	Normal Alarm Limit	User selectable limit for ΔA , when exceeded produces a "Normal Alarm". The range is $\pm 10\%$. Default = $\pm 2.0\%$
873	Abnormal Alarm Limit	User selectable limit for ΔA , when exceeded produces an "Abnormal Alarm". The range is $\pm 10\%$. Default = $\pm 5.0\%$
874	Pulsing Gas Alarm	Indicates if pulsing gas is detected by the ΔA algorithm. If it is, an alarm is initiated and is indicated by placing dots on the LCD and "11111111" at Item 874. "00000000" in Item 874 indicates there is no Pulsing Gas Alarm. The alarm indicators will remain active until manually cleared (by software). Default = 00000000
875	TIB Internal Fault	This item indicates if an alarm for the TIB F/W was generated. If the microprocessor detects a TIB F/W Fault, an alarm is initiated and is indicated by placing dots on the LCD and "11111111" at Item 875. "00000000" at Item 875 indicates there is no TIB F/W Alarm. The alarm indicators will remain active until manually cleared (by software). Default = 00000000

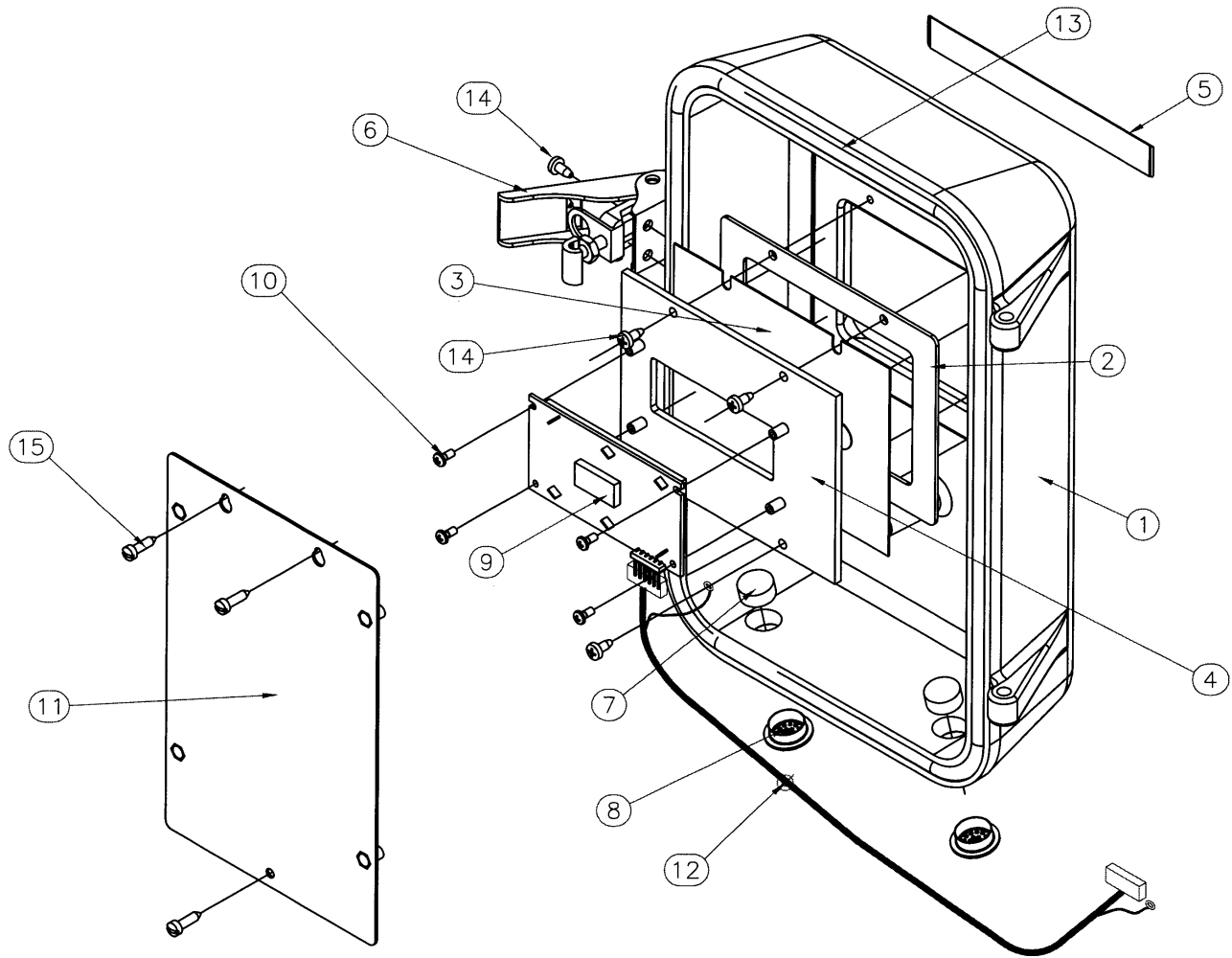
Turbo Monitor

Item No.	Item Name	Description
876	TIB Alarms Output	<p>This item displays “1111111” to indicate that a TIB alarm (874-875, or 877-878) has become active, and that an alarm pulse was transmitted out the Alarm Channel. “00000000” at Item 876 indicates there are no active alarms.</p> <p>Default = 00000000</p>
877	TIB Normal Alarm	<p>This item indicates if ΔA is outside the normal alarm band. If the measurement for Item 869 (Instantaneous ΔA) is a value greater than the value entered at Item 872 (Normal Alarm Limit), an alarm is initiated and is indicated by placing dots on the LCD and “1111111” at Item 877. “00000000” at Item 877 indicates there is no Normal Alarm. The alarm indicators will remain active until manually cleared (by software) or automatically when RBX (item 165) is enabled.</p> <p>Default = 00000000</p>
878	TIB Abnormal Alarm	<p>This item indicates if ΔA is outside the abnormal alarm band. If the measurement for Item 869 (Instantaneous ΔA) is a value greater than the value entered at Item 873 (Abnormal Alarm Limit), an alarm is initiated and is indicated by placing dots on the LCD and “1111111” at Item 878. “00000000” at Item 878 indicates there is no Abnormal Alarm. The alarm indicators will remain active until manually cleared (by software) or automatically when RBX (item 165) is enabled.</p> <p>Default = 00000000</p>
879	Normal Alarm Deadband	<p>A hysteresis band that provides a buffer below the Normal Alarm Limit (Item 872) when Normal Alarms are automatically cleared by RBX operation. The user specified value determines the magnitude of the band. The ΔA value must pass completely through the band before the alarm is reset. The band applies to both the plus and minus side of the Normal Alarm Limit.</p> <p>Default = 1.0000</p>
880	Abnormal Alarm Deadband	<p>A hysteresis band that provides a buffer below the Abnormal Alarm Limit (Item 873) when Abnormal Alarms are automatically cleared by RBX operation. The user specified value determines the magnitude of the band. The ΔA value must pass completely through the band before the alarm is reset. The band applies to both the plus and minus side of the Abnormal Alarm Limit.</p> <p>Default = 1.0000</p>

Turbo Monitor

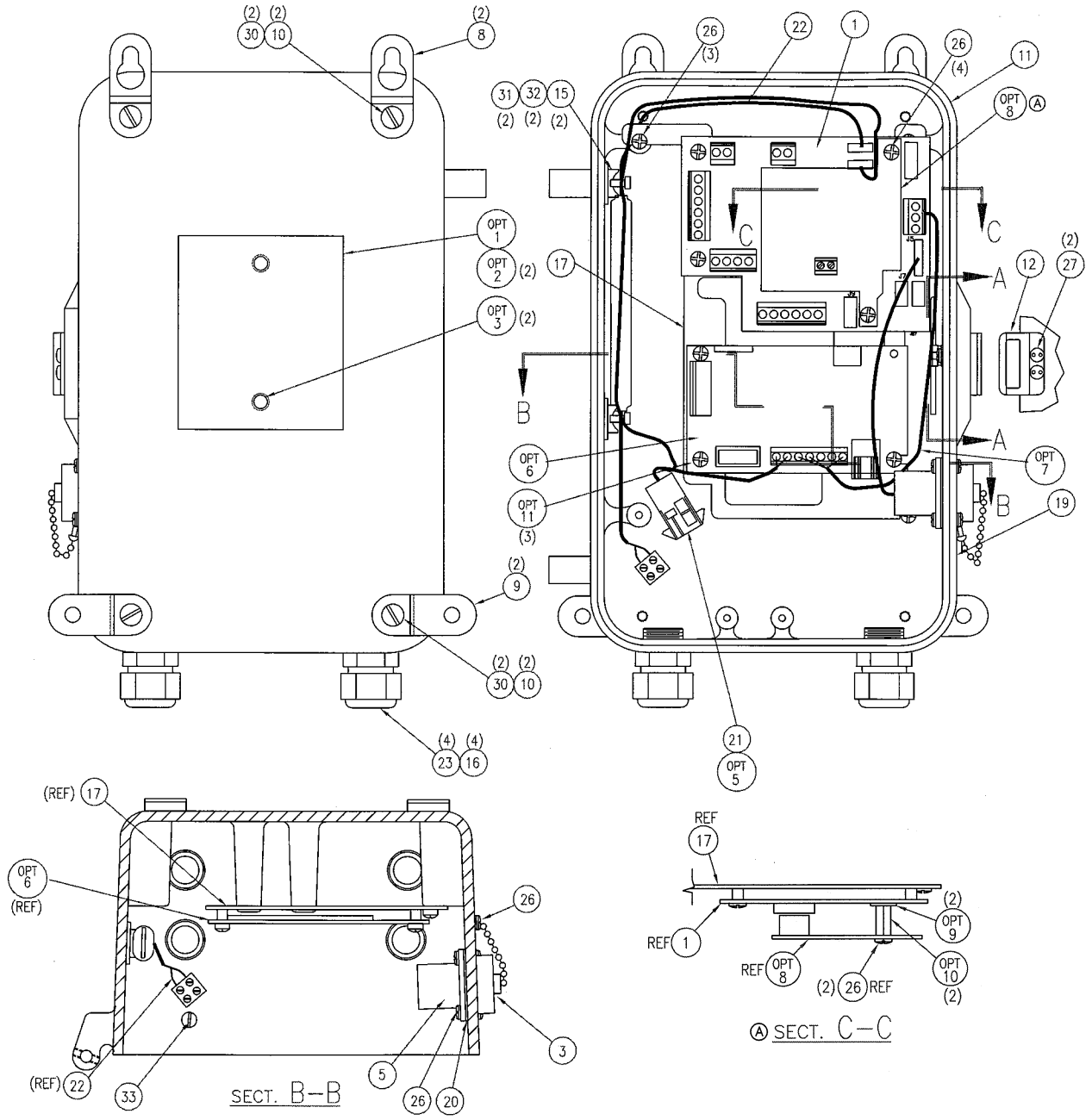
Item No.	Item Name	Description
881	Main Rotor Frequency	Display of the most recent measurement of frequency of the main rotor input in Hertz (pulses per second). Default = 0.0000
882	Sense Rotor Frequency	Display of the most recent measurement of frequency of the sense rotor input in Hertz (pulses per second). Default = 0.0000
883	Adjusted Volume Pulses	Number of Adj Vol output volume pulses waiting to be sent out the TIB pulse channel at TB1. Default = 0
884	Adj Flow 20mA Value	User selectable integer value to at what point the Adj Vol flow rate (Item 853) is equal to 20 mA. Default = 0.0000
885	Adj Flow 4mA Value	User selectable integer value to at what point the Adj Vol flow rate (Item 853) is equal to 4 mA. Default = 0.0000
887	8515 Firmware Version	The TIB's second operating firmware version. The number reported is automatically inserted when a firmware file is uploaded into flash memory.
889	High Freq Out Max Freq	Maximum Output Frequency in Hertz of the Turbo-Frequency Board (TFB). Select: 0 - 50Hz 1 - 100Hz 2 - 200Hz 3 - 500Hz 4 - 1000Hz Default

Turbo Monitor



Turbo Monitor Door Assembly Parts List			
Item	Qty	Part #	Description
1	1	20-9167	Door, Drilling
2	1	20-8286	Gasket, Window
3	1	40-2821	Switch Assembly, Membrane
4	1	20-9203	Backplate, Switch Assembly
5	1	20-8283	Nameplate, Mercury
6	1	20-9245	Assembly, Latch w/hasp
7	2	20-3737	Filter, Vent
8	2	20-2191	Grommet, Vent
9	1	40-2625	Assembly, Display, (8) Character
10	4	60-4161	Screw, #4-40 x 1/4", Phillips pan head
11	1	20-8744	Assembly, Shield
12	1	40-2600-2	Cable, Display
13	1	20-2196	Gasket, Door
14	6	60-1249	Screw, #6-32 x 5/16", Fil hd self tap
15	3	60-1241	Screw, #6-32 x 7/16", Fil hd self tap

Turbo Monitor

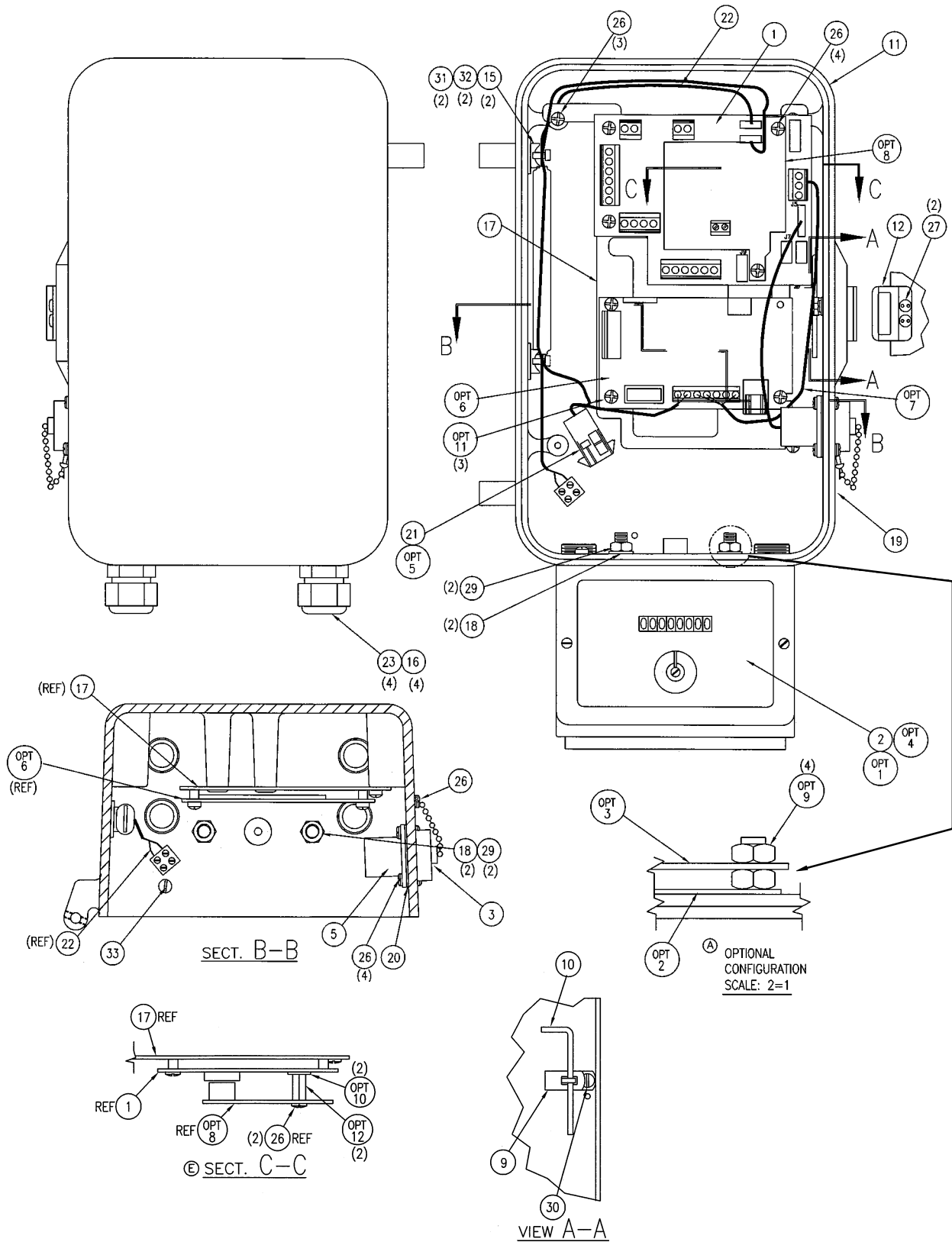


Turbo Monitor

TOM Wall Mount Case Assembly Parts List			
Item	Qty	Part #	Description
1	1	40-2708	Assembly, Turbine Interface Board
2			
3	1	40-1576	Cap & Chain Assembly
4			
5	1	40-1728	RS-232 Internal Cable Assembly
6			
7			
8	2	20-1586	Hangar, Case Top
9	2	20-1587	Hangar, Case Bottom
10	4	20-5300	Washer, #10 Ext Lock
11	1	20-9332	Case, Drilled - TOM
12	1	20-8969	Plate, Bent Strike
13			
14			
15	2	20-3827	Cable Tie
16	4	20-7289	Plug, Strain Relief 5/16 dia
17	1	20-9152	Assembly, Mounting Plate
18			
19	1	20-8087	Label, Warning DCU Jack
20	1	20-8196	Gasket, RS-232 Case Connector
21	1	40-2769	Assembly, Power Cable-Batt to 4-pin
22	1	40-2812	Assembly, Power Cable - TOM
23	4	20-8911	Fitting, Strain Relieief .20-.35
24			
25			
26	12	60-4219	Screw, PN #6-32 x 1/4
27	2	60-1247	Screw, Spanner #6-32 x 5/16
28			
29			
30	4	60-1353	Screw, BD #10-32 x 5/16"
31	2	40-1329	Holder, Cable Tie
32	2	60-1220	Screw, Flt HD #6-32 x 1/4
33	1	60-1353	Screw, BD #10-32 x 5/16" Green

TOM Wall Mount Case Options			
Item	Qty	Part #	Description
1	1	20-6892	Pipe Mounting Bracket, 2" Pipe
2	2	60-1451	Screw, Hex hd cap, 5/16-18 x 5/8
3	2	60-2501	Screw, Set 5/16-18 x 5/16
4			
5	1	40-2723	Assembly, Y-Power Cable
6	1	40-3000	Assembly, Messenger Modem PCB
7	1	40-2133-8	Cable 8" Tx,Rx
8	1	40-2885	Assembly, Turbo Frequency Board
9	2	20-1783	Washer, Flat, #6
10	2	20-8554	Standoff, #6-32 x 1/2, M-F
11	3	60-4219	Screw, PN #6-32 x 1/4
12			

Turbo Monitor



Turbo Monitor

TOM Meter Mount Case Assembly Parts List			
Item	Qty	Part #	Description
1	1	40-2708	Assembly, Turbine Interface Board
2	1	20-9289	U.M.B. Assembly
3	1	40-1576	Cap & Chain Assembly
4			
5	1	40-1728	RS-232 Internal Cable Assembly
6			
7			
8			
9	1	20-1009	Clip
10	1	20-1428	Wrench, Bristol
11	1	20-9157	Case, Drilled
12	1	20-8969	Plate, Bent Strike
13			
14			
15	2	20-3827	Cable Tie
16	4	20-7289	Plug, Strain Relief 5/16 dia
17	1	20-9152	Assembly, Mounting Plate
18	2	20-7469	Washer, 1/4" int lock
19	1	20-8087	Label, Warning DCU Jack
20	1	20-8196	Gasket, RS-232 Case Connector
21	1	40-2769	Assembly, Power Cable-Batt to 4-pin
22	1	40-2812	Assembly, Power Cable - TOM
23	4	20-8911	Fitting, Strain Relief .20-.35
24			
25			
26	12	60-4219	Screw, PN #6-32 x 1/4
27	2	60-1247	Screw, Spanner #6-32 x 5/16
28			
29	2	60-1607	Nut, Hex 1/4-20
30	1	60-1202	Screw, BD #6-32 x 1/4"
31	2	40-1329	Holder, Cable Tie
32	2	60-1220	Screw, Flt HD #6-32 x 1/4
33	1	60-1353	Screw, BD #10-32 x 5/16" Green

TOM Meter Mount Case Options			
Item	Qty	Part #	Description
1	1	20-7558	Optional Indexes
2	1	20-9279	Plate, Magnetic Shield
3	1	40-2768-2	Assembly, Switch Output Board
4	1	20-9290	U.M.B. Assembly w/sight glass
5	1	40-2723	Assembly, Y-Power Cable
6	1	40-3000	Assembly, Messenger Modem PCB
7	1	40-2133-8	Cable 8" Tx,Rx
8	1	40-2885	Assembly, Turbo Frequency Board
9	4	40-1607	Nut, Hex 1/4-20
10	2	20-1783	Washer, Flat, #6
11	3	60-4219	Screw, PN #6-32 x 1/4
12	2	20-8554	Standoff, #6-32 x 1/2, M-F

Turbo Monitor

40-2807-A

*NOTES
 1. APPROVED I. S. BARRIERS ONE BLOCK EQUALS ONE CHANNEL

TYPE 1:
 MTL #761ac <9V/90 OHM> (DUAL)
 MTL #7261ac <9V/90 OHM> (DUAL)

TYPE 2:
 MTL #758+ <7.5V/10 OHM> (DUAL)
 MTL #715+ <15V/100 OHM> (SINGLE)
 MTL #710+ <10V/50 OHM> (SINGLE)
 MTL #7162+ <10V/50 OHM> (DUAL)
 MTL #7167+ <15V/100 OHM> (DUAL)
 STAHL#9001/01-086-150-10<8.6V/62 OHM>

TYPE 3 (I. S. RELAY):
 PEPPERL & FUCHS #WE77/Ex1 (SINGLE) OR WE77/Ex2 (DUAL)<8V/8mA>
 P+F KFD2-SOT-Ex2 (12.6V/650 OHM)

TYPE 4:
 MTL #715P (15V, 50 OHM, 291 mA)

TYPE 6:
 MTL #796+ <26V/300 OHM>

2. USE ONLY BATTERY PART # 40-1595 OR 40-1865.

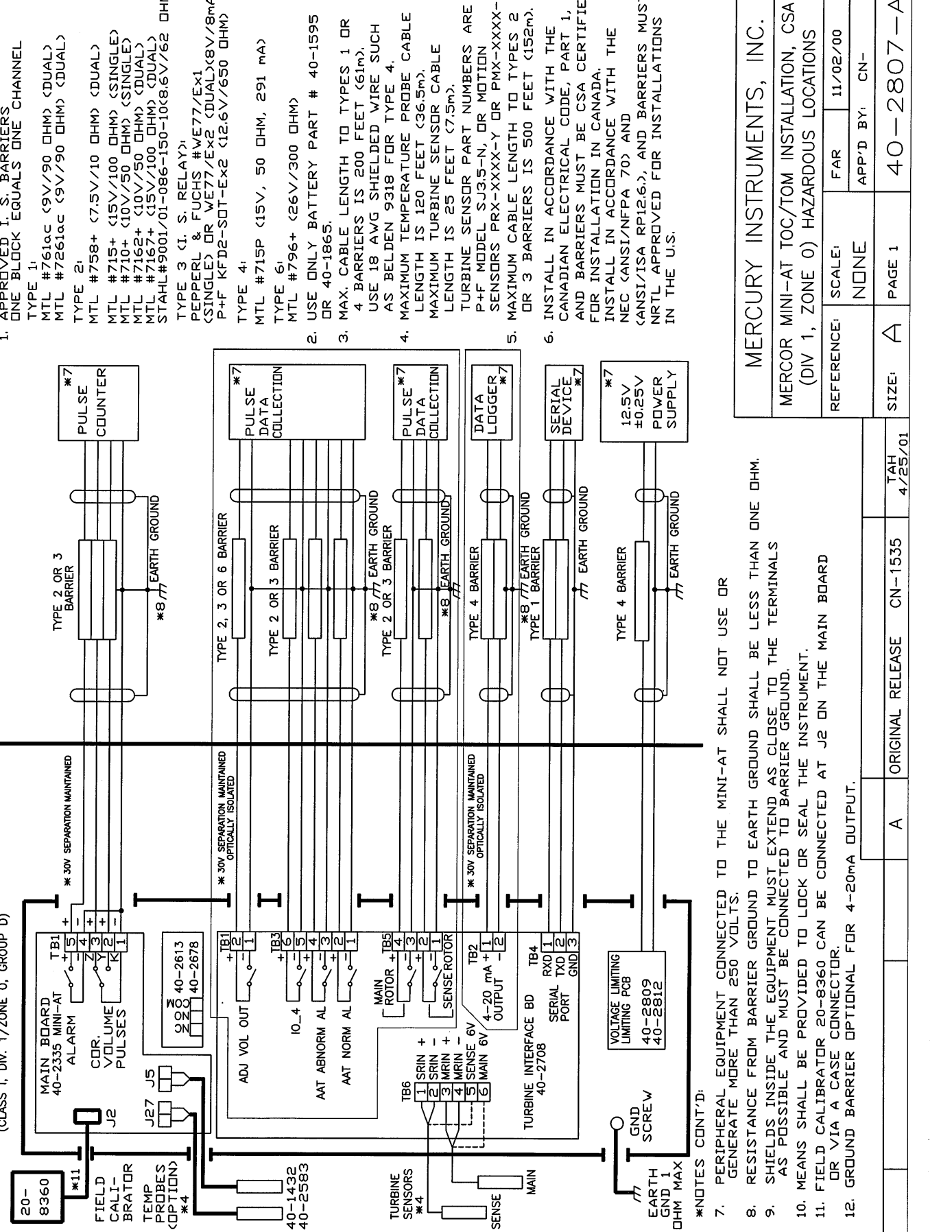
3. MAX. CABLE LENGTH TO TYPES 1 OR 4 BARRIERS IS 200 FEET (61m). USE 18 AWG SHIELDED WIRE SUCH AS BELDEN 9318 FOR TYPE 4.

4. MAXIMUM TEMPERATURE PROBE CABLE LENGTH IS 120 FEET (36.5m). MAXIMUM TURBINE SENSOR CABLE LENGTH IS 25 FEET (7.5m). TURBINE SENSOR PART NUMBERS ARE P+F MODEL SJ35-N, OR MOTION SENSORS PRX-XXX-Y OR PMX-XXX-Y.

5. MAXIMUM CABLE LENGTH TO TYPES 2 OR 3 BARRIERS IS 500 FEET (152m). INSTALL IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE, PART 1, AND BARRIERS MUST BE CSA CERTIFIED, FOR INSTALLATION IN CANADA. INSTALL IN ACCORDANCE WITH THE NEC (ANSI/NFPA 70) AND (ANSI/ISA RP12.6), AND BARRIERS MUST NRTL APPROVED FOR INSTALLATIONS IN THE U.S.

HAZARDOUS LOCATION
 (CLASS 1, DIV. 1, ZONE 0, GROUP D)

NON-HAZARDOUS LOCATION



- *NOTES CONT'D:
- PERIPHERAL EQUIPMENT CONNECTED TO THE MINI-AT SHALL NOT USE OR GENERATE MORE THAN 250 VOLTS.
 - RESISTANCE FROM BARRIER GROUND TO EARTH GROUND SHALL BE LESS THAN ONE OHM.
 - SHIELDS INSIDE THE EQUIPMENT MUST EXTEND AS CLOSE TO THE TERMINALS AS POSSIBLE AND MUST BE CONNECTED TO BARRIER GROUND.
 - MEANS SHALL BE PROVIDED TO LOCK OR SEAL THE INSTRUMENT.
 - FIELD CALIBRATOR 20-8360 CAN BE CONNECTED AT J2 ON THE MAIN BOARD OR VIA A CASE CONNECTOR.
 - GROUND BARRIER OPTIONAL FOR 4-20mA OUTPUT.

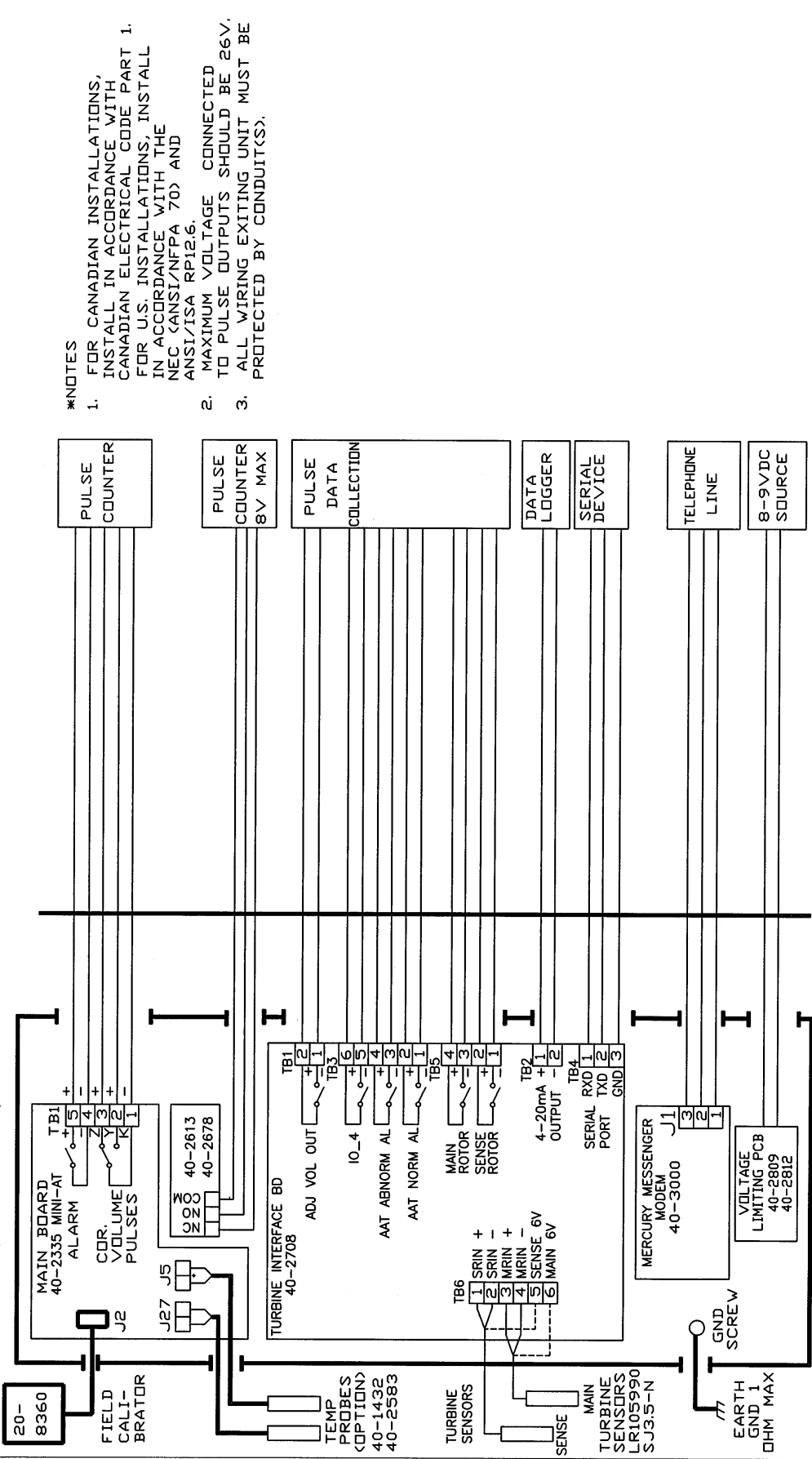
MERCURY INSTRUMENTS, INC.	
MERCOR MINI-AT TOC/TOM INSTALLATION, CSA (DIV 1, ZONE 0) HAZARDOUS LOCATIONS	
REFERENCE:	SCALE: NONE
	FAR 11/02/00
	APP'D BY: CN-
SIZE: A	PAGE 1
40-2807-A	

Turbo Monitor

40-2808-A

NON-HAZARDOUS LOCATION

HAZARDOUS LOCATION
(CLASS 1, DIV. 2/ZONE 2, GROUP D)



- *NOTES**
- FOR CANADIAN INSTALLATIONS, INSTALL IN ACCORDANCE WITH CANADIAN ELECTRICAL CODE PART 1. FOR U.S. INSTALLATIONS, INSTALL IN ACCORDANCE WITH THE NEC (ANSI/NFPA 70) AND ANSI/ISA RP12.6.
 - MAXIMUM VOLTAGE CONNECTED TO PULSE OUTPUTS SHOULD BE 26V.
 - ALL WIRING EXITING UNIT MUST BE PROTECTED BY CONDUITS.

MERCURY INSTRUMENTS, INC.	
MERCOR MINI-AT TOC/TOM INSTALLATION, CSA (DIV 2, ZONE 2) HAZARDOUS LOCATIONS	
REFERENCE:	SCALE:
FAR	11/02/00
APP'D BY:	CN-
SIZE:	A
PAGE 1 OF 1	40-2808-A

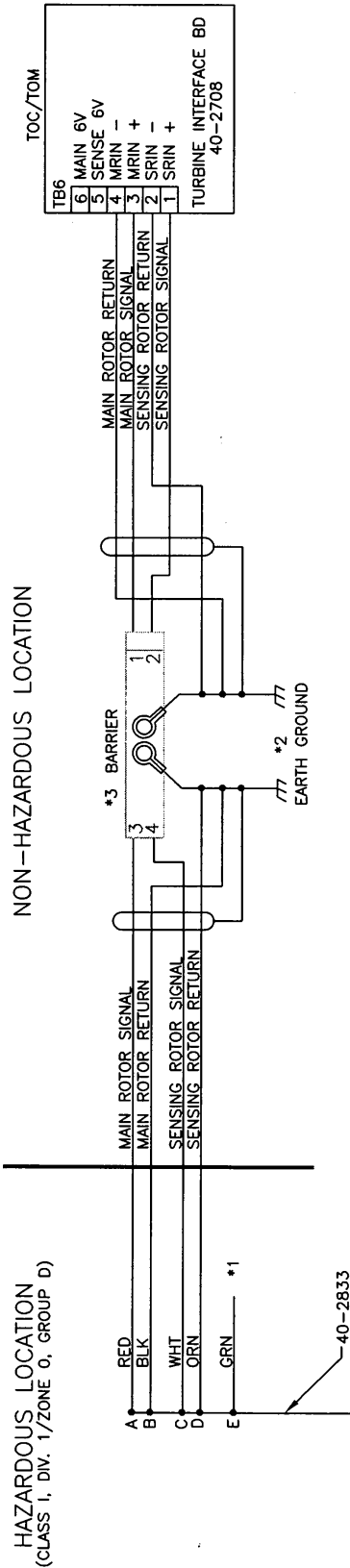
TAH
4/25/01

ORIGINAL RELEASE CN-1535

A

Turbo Monitor

40-2917



NOTES

1. IF METER IS ISOLATED, CONNECT GREEN WIRE TO EARTH GROUND AT SAFETY BARRIER. IF METER IS NOT ISOLATED, DO NOT CONNECT GREEN WIRE TO GROUND.
2. RESISTANCE FROM BARRIER GROUND TO EARTH GROUND SHALL BE LESS THAN ONE OHM.
3. BARRIER TYPE: MTL 796+ (26 V, 300 OHM).
4. MAXIMUM CABLE LENGTH FROM METER TO BARRIER 1000 FT.
5. FOR INSTALLATION IN CANADA, INSTALL IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE, PART 1, AND BARRIERS MUST BE CSA CERTIFIED.
FOR INSTALLATION IN THE U.S., INSTALL IN ACCORDANCE WITH THE NEC (ANSI/NFPA 70) AND (ANSI/ISA R012.6.), AND BARRIERS MUST BE NRTL APPROVED.
6. AUTO ADJUST® IS A REGISTERED TRADEMARK OF INVENSYS ENERGY METERING.

MTL 796+ - SMS P/N
950579

MT2 Enclosure -
SMS P/N 950580

MERCURY INSTRUMENTS, INC.	
MINI-AT TOC/TOM WIRING, AUTO ADJUST® METER WITH BARRIER	
REFERENCE:	SCALE: NONE
FAR	1-4-02
APP'D BY:	CN-1608
SIZE: A	PAGE 1
40-2917	