

Honeywell Process Solutions

Turbo Corrector (TOC) Supplement to : **Mini-AT User Manual**

October 2010



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Revision List

1.00	Initial	Release		May 2002
1.01	Modified:	Various minor changes		June 2002
2.00	Added:	Live Graphing	p24	
		Parts Lists	p41-51	
	Modified:	Firmware Upgrade Procedure	p27	
		Connection Drawings	p11-14	
		4-20mA Output	p21	
	Moved:	Alarms	p19	
		TIB Diagram	p6	October 2003
3.00	Modified:	Various major changes that include:		February 2008
		- New layout for the TOC-800		
		- Assembly drawings for the TOC-800		
		- Redesign of input switch assembly		
		- New assembly drawings for TOC (Mini-AT Case)		
		- Info on new AAT Linearization feature		
		- Info on new Low Frequency Cut-off feature		
		- Updates to the Connection Drawings on Pg 12 & 13		
3.01	Modified	-Revised cover page		July 2008
3.02		Honeywell update		October 2010

Introduction

The Turbo Corrector is a full featured Mini-AT Electronic Volume Corrector with an internal interface board called the Turbine Interface Board (TIB). The TIB accepts high-frequency main and sense rotor signals from the Sensus Auto-Adjust Turbo-Meter™ (AAT), and calculates the adjusted volume based on the Sensus AAT algorithms. The TIB transmits low-frequency adjusted and unadjusted volume pulses to the Mini-AT board. Depending on the setting of item 182, pressure, temperature, and supercompressibility correction is applied to either the Adjusted Uncorrected Volume, the Unadjusted Uncorrected Volume, or the Mechanical Uncorrected Volume (from the input reed switches) After each AAT calculation cycle (usually 25,000 main rotor pulses), the TIB initiates a serial communications session with the Mini-AT board to synchronize the values of mirrored item codes that coexist in both circuit boards.

With newer firmware (2.20 and higher) and newer MasterLink (3.60 and higher),

The TIB is also capable of producing separate outputs for the following parameters:

- Low-frequency Adjusted Volume pulses (either 100 or 1,000 CF per pulse)
- Normal Alarm (Form-A, State-change)
- Abnormal Alarm (Form-A, State-change)
- Auxiliary Alarm, normally Pulsing Gas (Form-A, State-change)
- Buffered main rotor pulses
- Buffered sense rotor pulses
- 4-20 milliamp (analog) output for either Instantaneous Delta-A or Adjusted Vol Flow Rate.

When the optional Turbo Frequency Board (TFB) is installed:

- High-frequency Adjusted Volume pulses, which can be used for volume totalization or instantaneous adjusted volume flow rate (Uncorrected)

Since the TOC's main and sense rotors require constant power, which would deplete the provided alkaline battery pack in a few days, an external power supply of +8.5 volts DC (+/- 0.5 volts) is always required. The external power is usually provided by an AC power supply, solar power supply or thermoelectric charger. The standard alkaline battery pack serves as short-term battery backup in case of external power failure. Power supplies and barriers for hazardous locations (Class 1, Divisions 1 & 2) are available.

MasterLink32 software is the primary user-interface to the Turbo Corrector. MasterLink32 provides the means to configure, calibrate, upload and download data. Live graphing and storage of both rotor frequencies, Delta-A and Adjusted Flow Rate are provided.

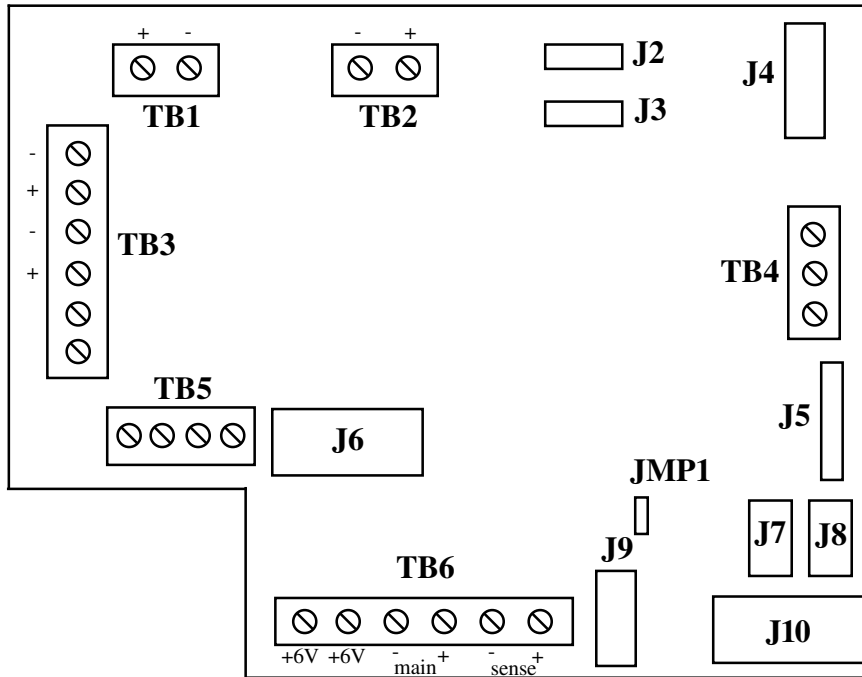


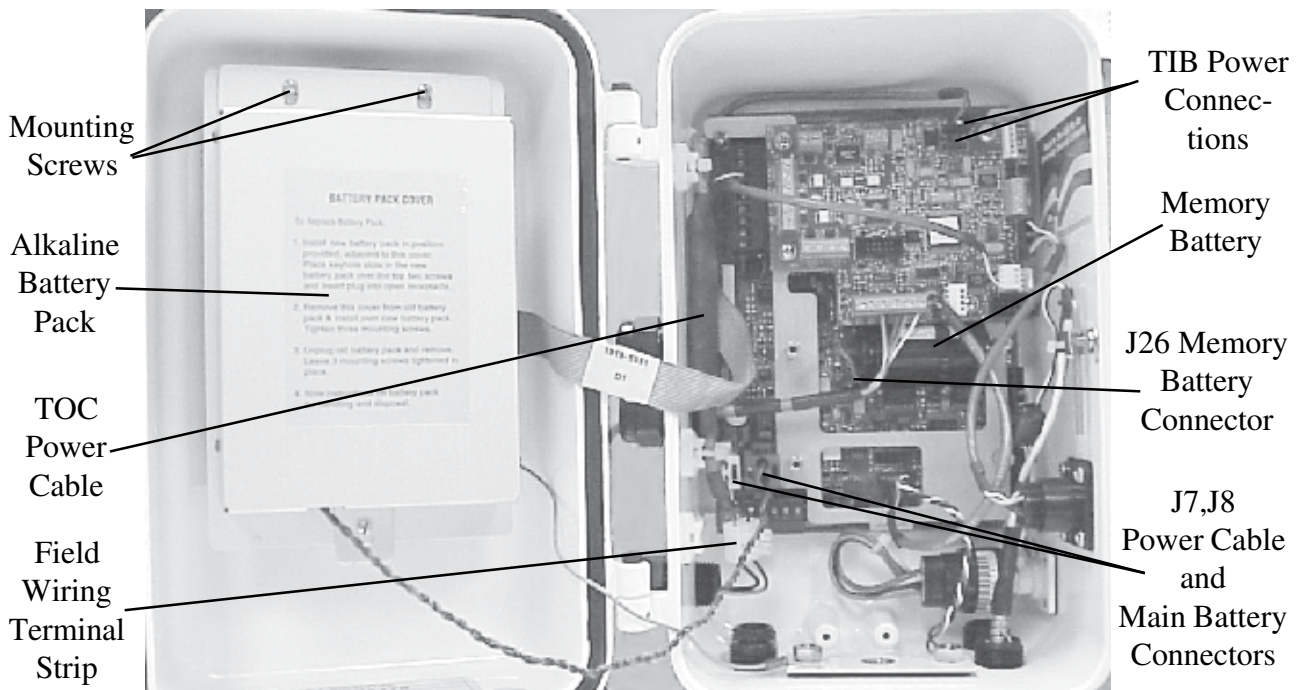
Diagram of the Turbine Input Board
(actual size)

Connector/Jumper	Purpose
J2, J3	Connection for TIB power
J4	Connection for LCD display (not used in TOC)
J5	RS-232 connection for external case connector
J6	Firmware upgrade connection #2 and connection for Turbo Frequency Board
J7	RS-232 connection to instrument
J8	CMOS connection to instrument (not used)
J9	Connection for AdjVol & UnadjVol pulse output to Mini-AT J9
J10	Firmware upgrade connection #1
JMP1	Jumper to select RS-232 (J7) or CMOS (J8) port, usually set on pins 1 & 2 (RS-232)
TB1	Form-A Adjusted Volume Pulse Output (LF)
TB2	4-to-20 mA output connection (external loop power required)
TB3	Form-A output connections for Normal, Abnormal and Auxiliary 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 TOC installed and operational.

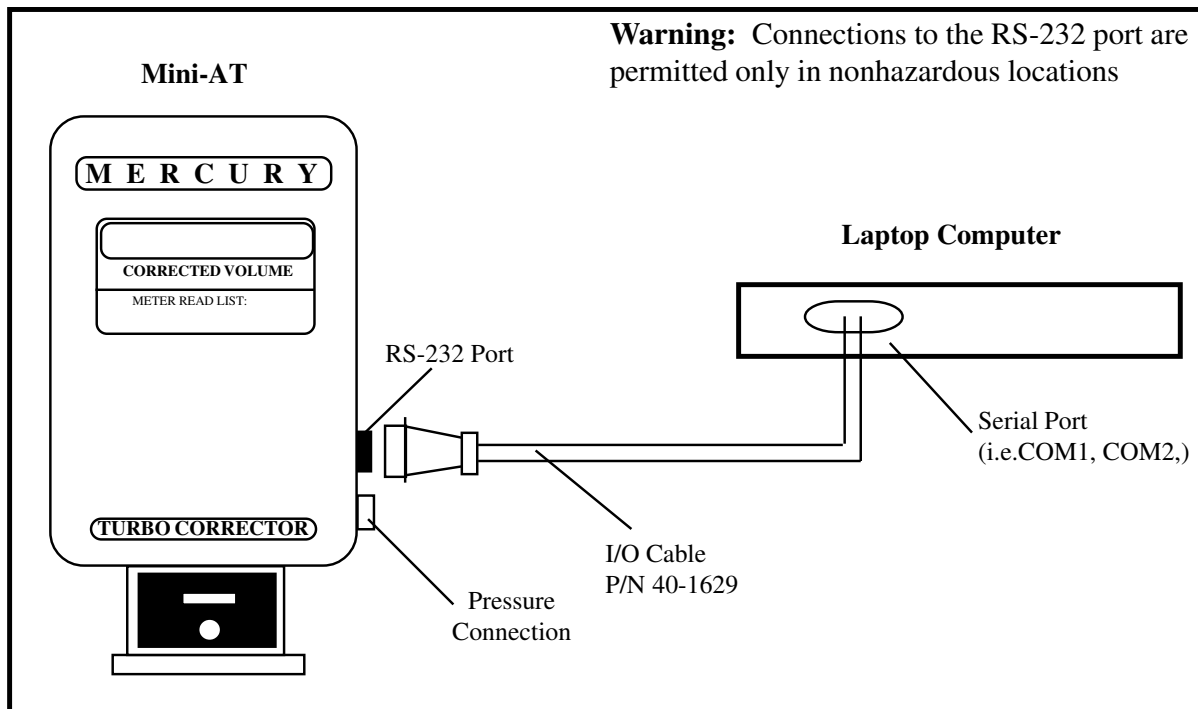
1. Unpack the instrument and verify that there is no shipping damage. Also verify that nothing is missing from the shipment.
2. Open the case door and make sure there are no loose connections or loose hardware.
3. Position the Turbo Corrector on the meter, making sure that the wriggler is aligned properly. Bolt the Turbo Corrector to the meter using the mounting bolts and gasket provided.
4. Plug the memory battery connector into J26. You may initially see eight 6's across the LCD while the unit is initializing.
5. Install six new D-cell alkaline batteries if using the Alkaline Receptacle Pack. 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. Plug the main battery connector into J8 (J7 will already be occupied by the TOC power cable).
6. Connect the external DC power wires to the field wiring terminal strip of the TOC power cable.
7. Connect the sensor cable to the Turbo-Meter.



- Verify that digits appear in the LCD display (usually all zeroes). Scroll through the meter reader list by swiping a mag wand down the right side of the display window to verify the instrument is operating.

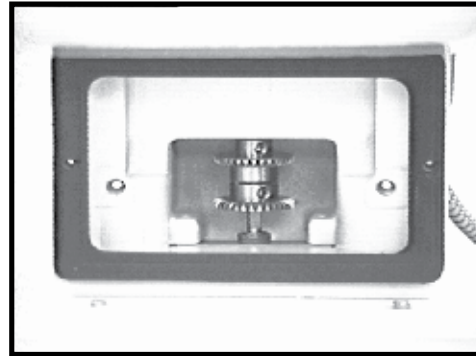


- Connect a standard serial cable from the TOC serial connector to a computer serial port.



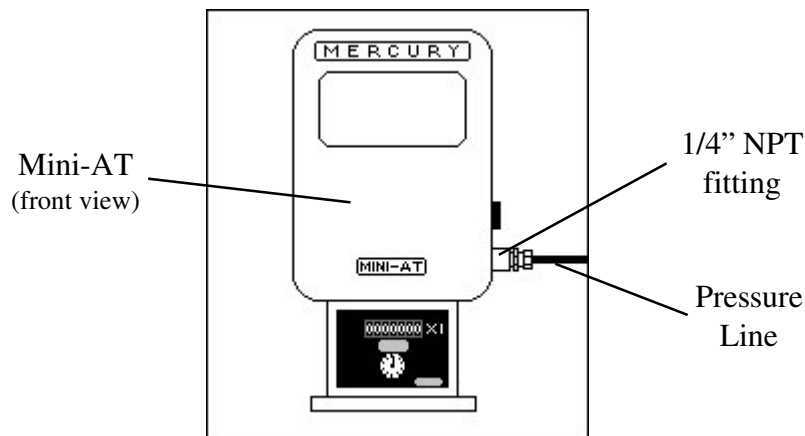
- Run MasterLink32 software and use the “Set Instr. Date/Time via Computer” selection in the Instrument Menu to set the date and time in the instrument. (Com Port and baud rate may need to be set for the Computer Serial Port. Default baud rate is 9600.)
- Use MasterLink32 to verify that company and site specific items are set properly, especially item 98 (Meter Index Code), and items 863-868.
- Using MasterLink32, run the Live Turbine Graph from the Graphs menu to determine if the meter is operating correctly, i.e. rotor frequencies, Delta-A and flow rate.
- Use the “Disconnect Link” function in the Instrument menu to return the Turbo Corrector back to corrector mode. Remove the I/O cable from the side of the instrument.

14. Verify the Test Hand rotates in the counter-clockwise direction. If not, remove the black mechanical index assembly and shift the lower bevel gear to the upper position for CCW meter rotation.

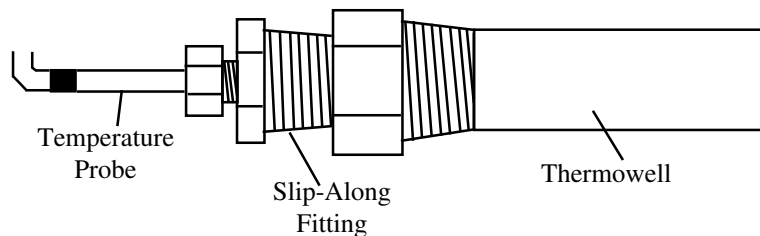


Bevel Gear UP for CCW

15. Connect the Pressure line to the 1/4" NPT fitting at the side of the instrument.



16. Insert the slip-along fitting into the thermowell, and place the temperature probe into the slip-along fitting, sliding the probe down until it nearly bottoms out in the thermowell before tightening the slip-along nut



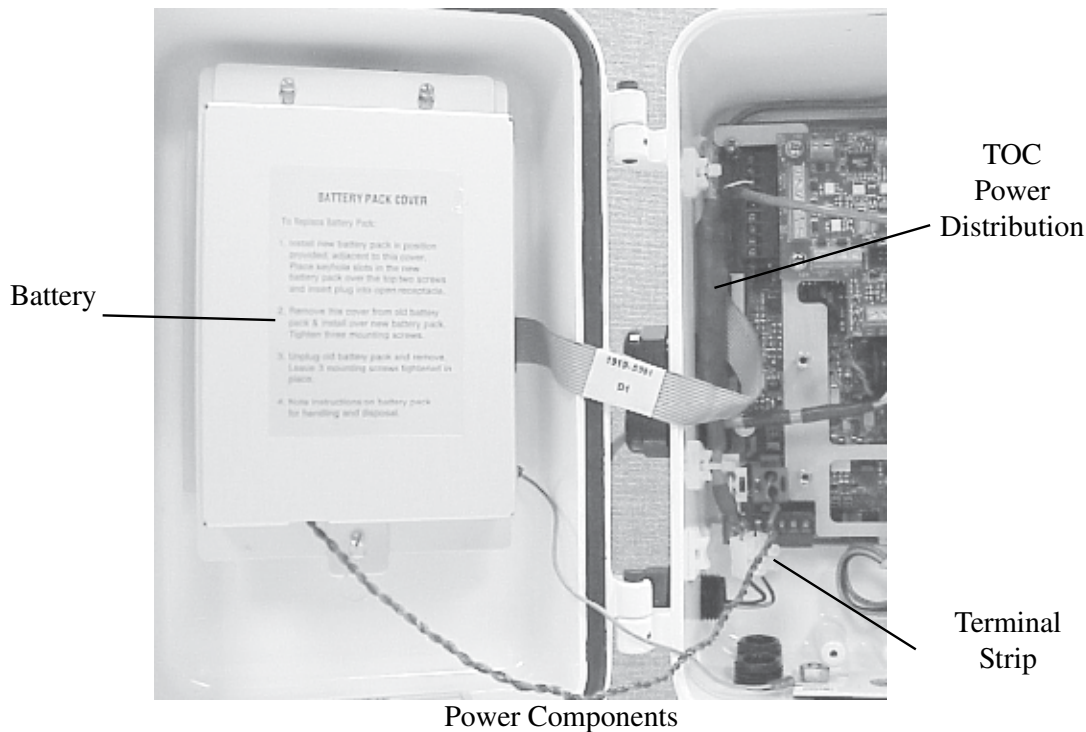
17. At this point the instrument should be ready for operation.

Power Connection

The Turbo Corrector requires 8.5 VDC (+/- 0.5 VDC) from an external source to operate. The standard external source is an AC-to-DC power supply (Div. 1 locations require barriers) with an alkaline battery as backup power. Alternatively, solar power is available, (location dependent).

Note: Damage to the internal Power Distribution Cable will result if external power exceeds 9.0VDC.

When using the standard power supply, the output is connected to the Turbo Corrector power cable mounted to the left side of the case using the provided terminal strip. The Turbo Corrector power cable should already have one connection plugged into J7 of the Mini-AT main board and the other connection plugged into J2 of the TIB. The alkaline battery pack plugs into J8 of the Mini-AT board.



Battery Backup

The Turbo Corrector with DC power supply has the option of two battery backup strategies; a short term backup strategy and a long term backup strategy. The short-term strategy (using power cable 40-2809-1) will allow the Mini-AT, TIB, and sensors to remain powered for approximately 48 hours. The long-term strategy (using power cable 40-2809-2) will power the Mini-AT for approximately 3 years. In the long term strategy, the TIB and sensors will not be powered by the backup battery.

The standard configuration for the Turbo Corrector is the short-term strategy. The long term configuration is available as an option.

Note: It is highly recommended that an Uninterruptible Power Supply (UPS) be used in conjunction with the DC power supply in the short-term configuration to compensate for possible power failures.

Serial Connection

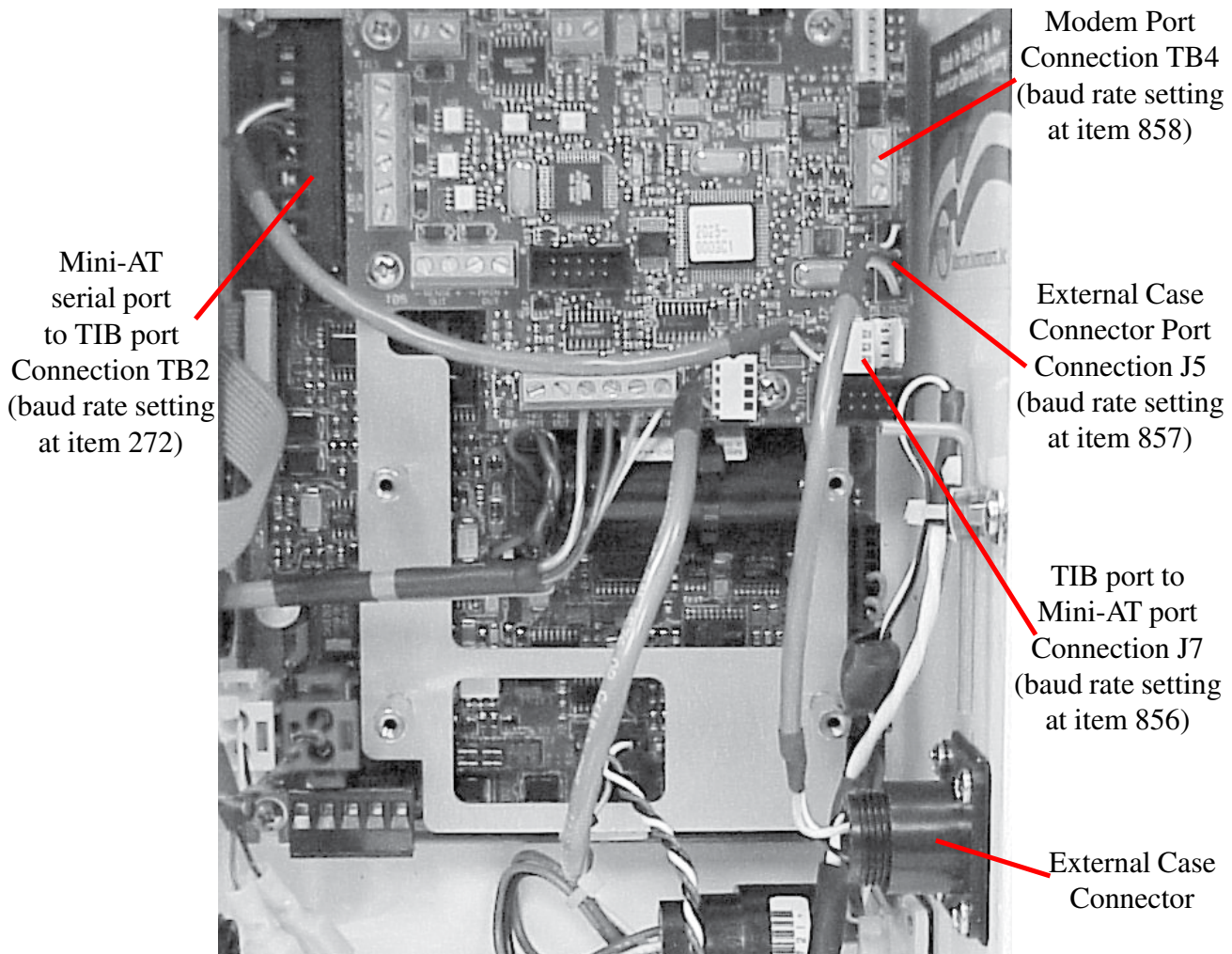
The TIB has three serial port connections:

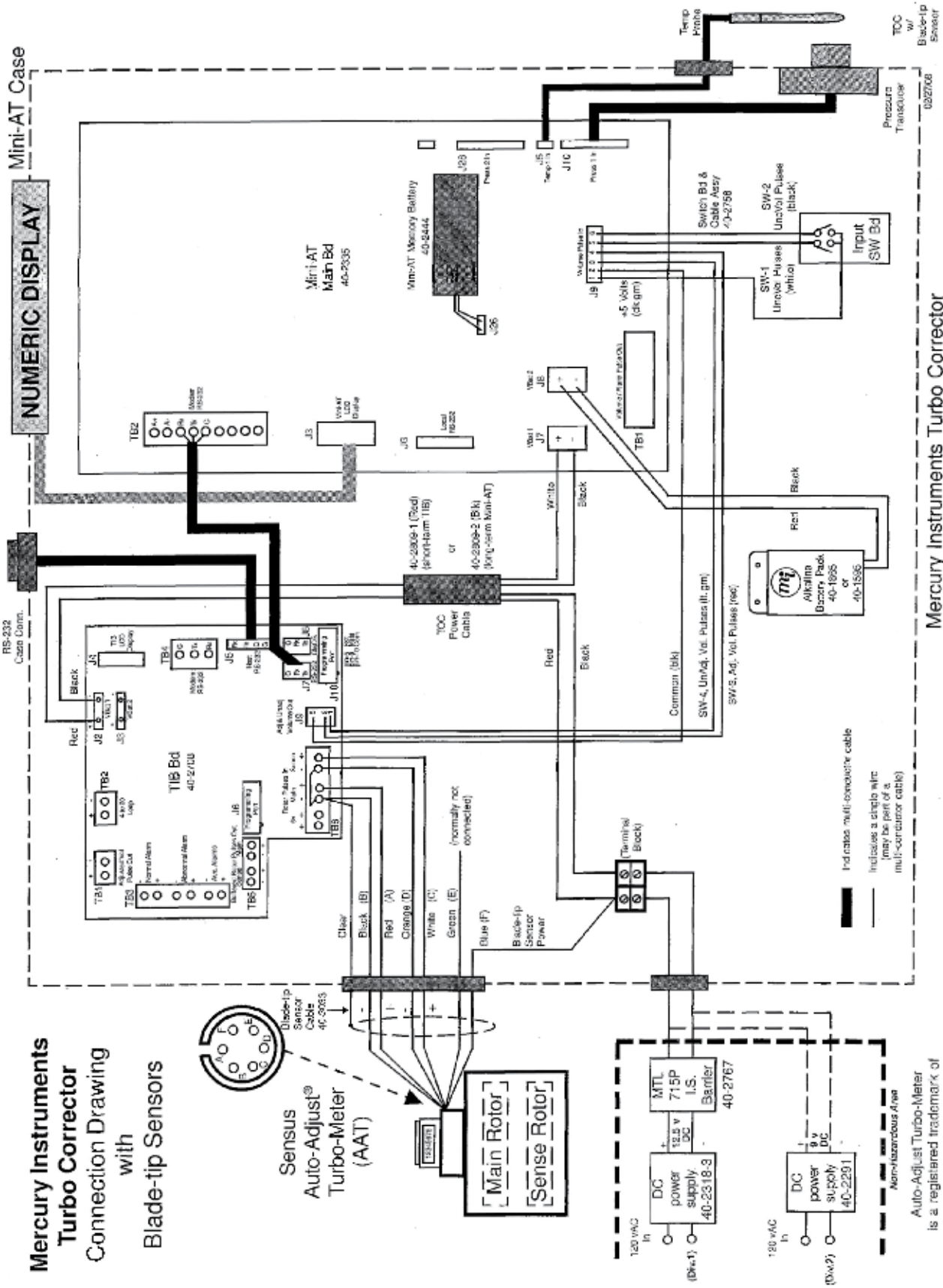
- one to connect the TIB to the Mini-AT board to allow internal communications to the Mini-AT board (at J7)
- one to connect the TIB to the case connector for a local serial connection (at J5)
- one to connect the TIB to remote communications device, modem, radio, etc. (at TB4).

Normal serial communications to the Mini-AT are routed through the TIB at J5.

MasterLink32 can communicate with either the Mini-AT or TIB depending upon which is selected in the MasterLink32 establish link dialogue box. Item 272 in the Mini-AT board (TB2) and item 856 in the TIB (J7) must be set to the same baud rate, which defaults to 9600 for both. Also, the settings at items 857 (External Port Baud Rate (J5), default 9600) and 858 (Modem Port Baud Rate (TB4), default 2400) must match the host baud rate for the device being used.

See the drawings on the next two pages more details on various cable connections.



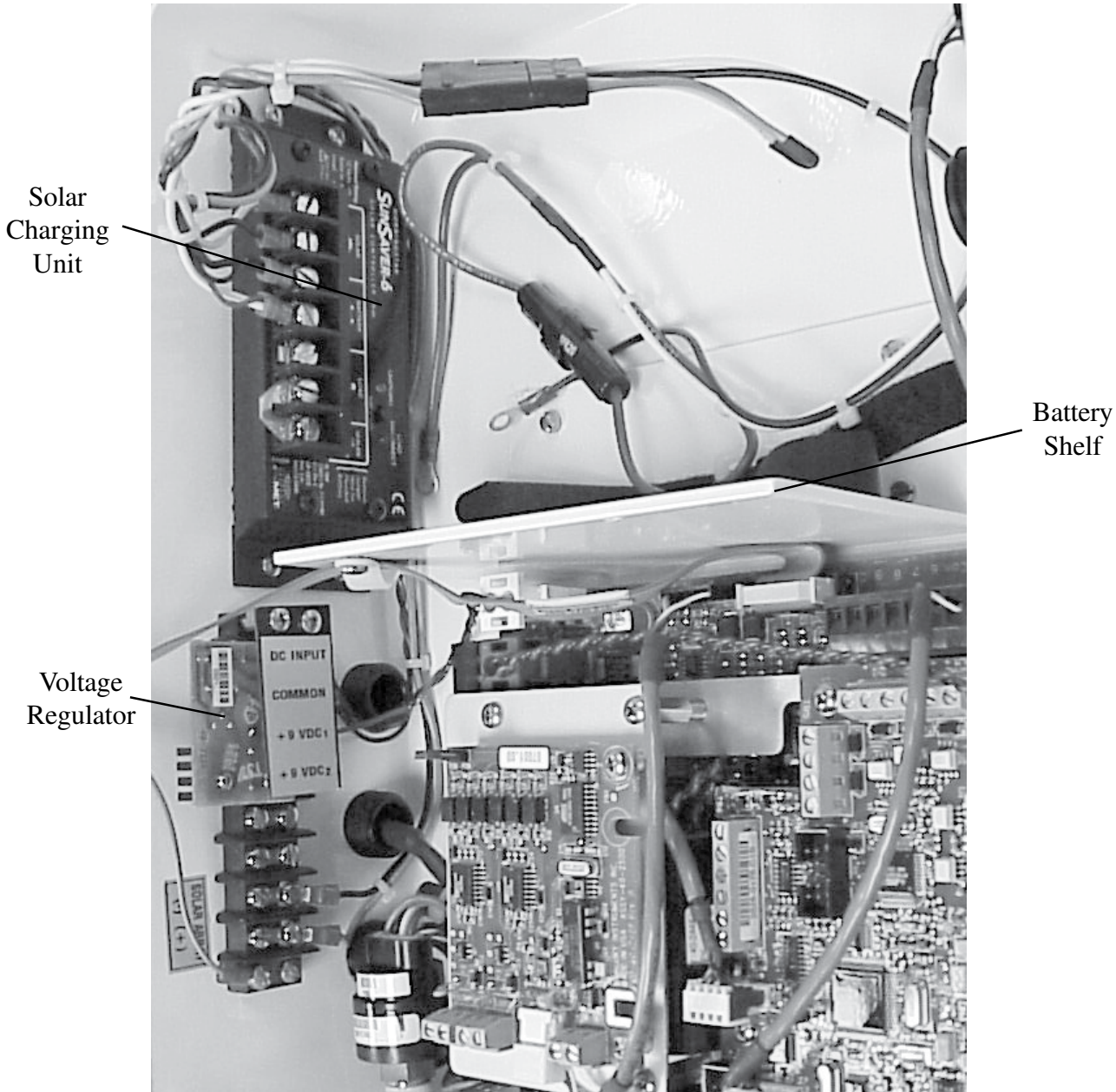


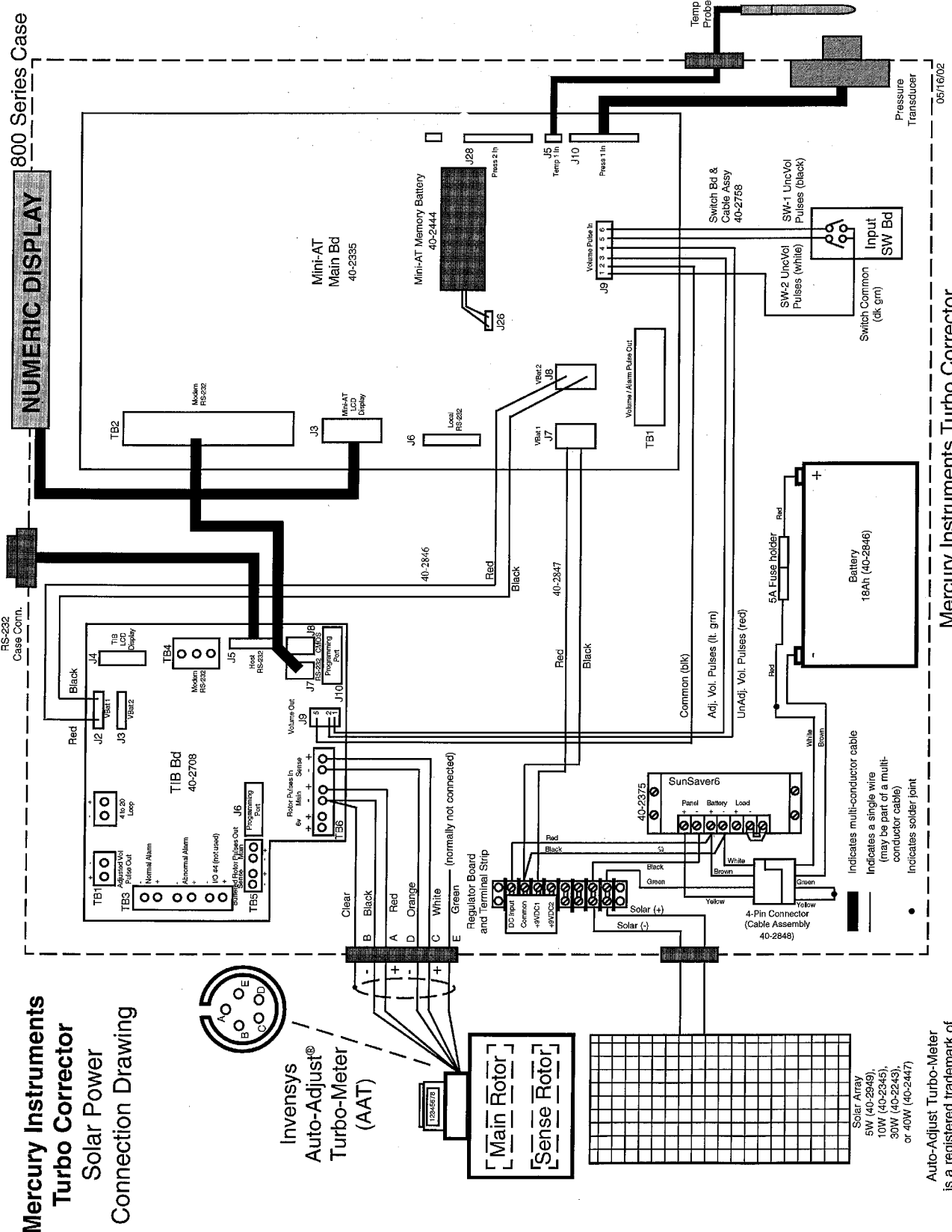
TOC w/ Slot Sensors Connection Drawing

Solar Power Option

Solar power consists of the solar panel, re-chargeable battery, solar charger, and voltage regulator. Power from the solar panel is cabled into the case to the solar charger. The solar charger prevents over-charging of the battery while providing power to the battery and the Turbo Corrector. Installation location and panel size must be taken into consideration to determine if the solar panel will generate enough power for the Turbo Corrector. Several panel and battery configurations are available.

Short-term is the only power back-up strategy available for the solar power option. If power from the solar panel is interrupted, a fully-charged battery can generally last 3.5 and 15 days, depending upon the size of the battery in the solar power system.





**Mercury Instruments
Turbo Corrector
Solar Power
Connection Drawing**

**Invensys
Auto-Adjust®
Turbo-Meter
(AAT)**

**TOC Solar Power Connection Drawing
with Slot Sensors**

Auto-Adjust Turbo-Meter
is a registered trademark of
Invensys Metering Systems

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 Sensus algorithms, and output low-frequency adjusted and unadjusted volume pulses to J9 of the Mini-AT main board. 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 (DA). 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: $\Delta A = \frac{100}{\left(\left(\frac{P_M}{K_M} \right) - \frac{P_S}{K_S} \right) - A_{bar}}$

Where:

DA = % Deviation from Factory Calibration	
A_{bar} = Average Relative Adjustment at factory calibration	
P_M = Main Rotor Pulses	P_S = Sense Rotor Pulses
K_M = Main Rotor Factor	K_S = Sense Rotor Fac

The TIB has certain functional characteristics that result from certain input conditions of the Auto-Adjust Turbo Meter. These characteristics are listed below.

Condition	Result
Main rotor pulses received from meter are less than the value programmed into item 406 (AAT Low Flow Cut-Off Hz.) Default = 3 Hz.	Item 881 (Main Rotor Frequency) is forced to zero
Sense rotor pulses received are less than 2 per second (2 Hz.)	Item 882 (Sense Rotor Frequency) is forced to zero
Main rotor input receives pulses but sense rotor frequency is zero	TIB calculates Un-adj volume and sends to the Mini-AT board as Adj volume. Delta-A is fixed at -Abar
Sense rotor input receives pulses but main rotor frequency is zero	No volume pulses are sent to the Mini-AT board. Delta-A is fixed at -100 -Abar (a value of about -110)

TIB Functional Characteristics

The TIB has the ability to establish a serial link with the Mini-AT board for exchange of item data. There are two triggers in which this data exchange occurs. The first is directly after a local or remote serial connection to the Mini-AT board has ended. This is done mainly for the TIB to read any configuration changes that may have been made to the Mini-AT. The second serial trigger occurs on every Auto-Adjust cycle, i.e. 25,000 main rotor pulses or 8 1/2 minutes, whichever occurs first.

The TIB reads and updates the following mirrored items (having the same item number) from the Mini-AT during a serial link, triggered by a local or remote serial connection.

049	Battery Low Volt Limit	864	Turbine Meter Size
050	Shutdown Voltage Limit	865	KM Meter Factor
092	UnCor Volume Units	866	KS Meter Factor
097	UnCor Vol Display Res	867	Abar Meter Factor
098	Meter Index Rate	868	KMO Meter Factor
115	Pulser Output Time	870	Turbine Sensor Type
165	RBX Alarm Enable	871	TIB 4-20 Out Config
170	Protocol Code A	872	Normal Alarm Limit
171	Timeout Delay 1	873	Abnormal Alarm Limit
172	Timeout Delay 2	879	Normal Alarm Dead Band
200	Site ID Number	880	Abnormal Alrm Dead Band
201	Site ID Number Part 2	884	Adj Flow 20mA Value
861	TIB Serial Number	885	Adj Flow 4mA Value
863	Meter Serial Number	889	High Freq Out Max Freq

The TIB writes the following items to the Mini-AT during a serial link, triggered by an Auto-Adjust cycle.

853	Turbine Adj Flow Rate	874	Pulsing Gas Alarm
854	Turbine UnAdj Dial Rate	875	TIB Internal Fault
859	AdjVol Pulses Waiting	881	Main Rotor Frequency
860	UnAdjVol Pulses Waiting	882	Sense Rotor Frequency
862	TIB Firmware Version	883	Adjusted Volume Pulses
869	Instantaneous Delta A	887	8515 Firmware Version

Original Configuration

In order to allow the instrument to function in Turbo Corrector mode (i.e. TIB periodically updating Mini-AT items), item 855 must be set to Turbo Corrector Mode. By enabling this mode, and with the default selection of item 182 (Input Volume to Corrector) set to TIB Adj Vol (SW3), volume correction is made from the adjusted volume pulses sent from the TIB to Mini-AT board at J9. Also, the numerous Serial Log Triggers generated by the TIB's serial connection are automatically disabled to keep Audit Trail memory from filling up with serial access logs from the TIB.

Input Parameters from the Auto-Adjust Turbo-Meter

It is critical that the following Turbo Corrector items are properly configured with parameters from the Auto-Adjust Turbo-Meter. Without properly configuring these items, the Turbo Corrector will produce incorrect volume information.

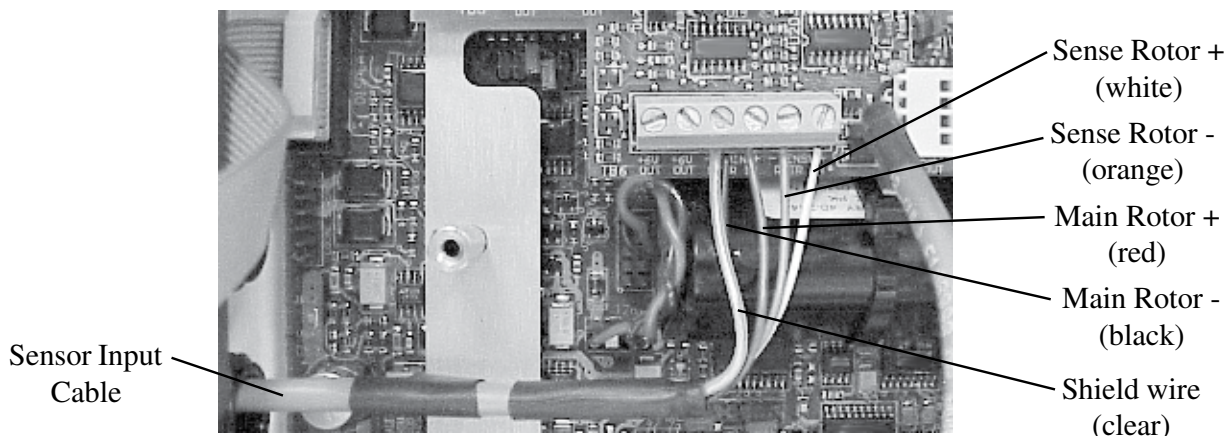
The items are:

- 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 factory calibration data sheet. **Note: It is very important that item 868 (Kmo Meter Factor) is configured with the KMO value. If not, the TIB will compute inaccurate values for 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 cable is also available for remote mounting locations (p/n: 40-2833-25). If the Turbo-Meter incorporates blade-tip sensors, a different input cable is required since the connector requires six pins instead of the normal five pins. For blade-tip meters, use input cable p/n 40-3033.



Pulse Outputs

In addition to the Mini-AT's standard pulse outputs, the TIB has 3 pulse outputs of it's own.

The Pulse Outputs are as follows:

TB1:

Low-frequency Adjusted Volume Output (Form A, scaled to units set at item 098)

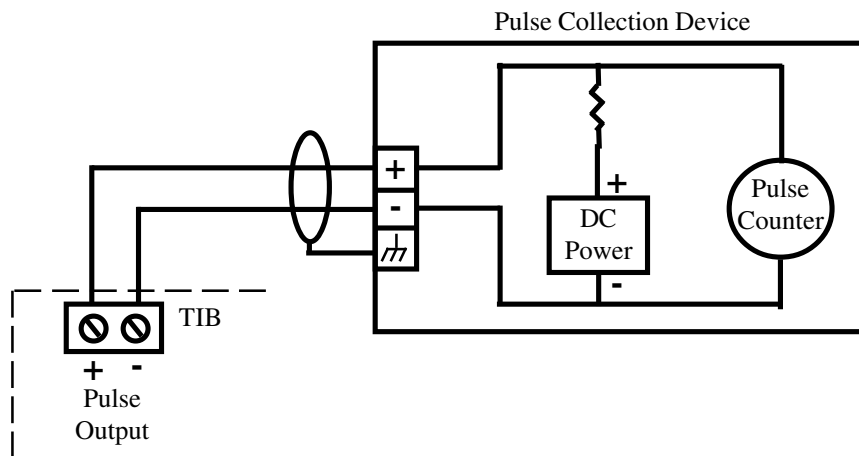
TB5:

High-frequency Buffered Main Rotor meter pulses (Form-A)

High-frequency Buffered Sense Rotor meter pulses (Form-A)

Output Pulse Specifications

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



Pulse Connection Circuit

Alarms

In addition to the standard Mini-AT Alarms (listed in the Mini-AT Operator's Guide) there are four alarms for the TOC. These alarms exist in the Turbine Interface Board (TIB) and are transferred to the Mini-AT on the AAT calculation cycle, where they are date & time-stamped into the Alarm Logger.

Alarm Description	Item#	Alarm Code	Dead Band Item#	Alarm Limit Item#
Pulsing Gas Alarm	874	.E.8.7.4.	Fixed in Firmware	Fixed in Firmware
TIB Internal Fault	875	.E.8.7.5.	None	None
Normal Alarm	877	.E.8.7.7.	879	872
Abnormal Alarm	878	.E.8.7.8.	880	873

Alarm Outputs

The Turbo Corrector 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.

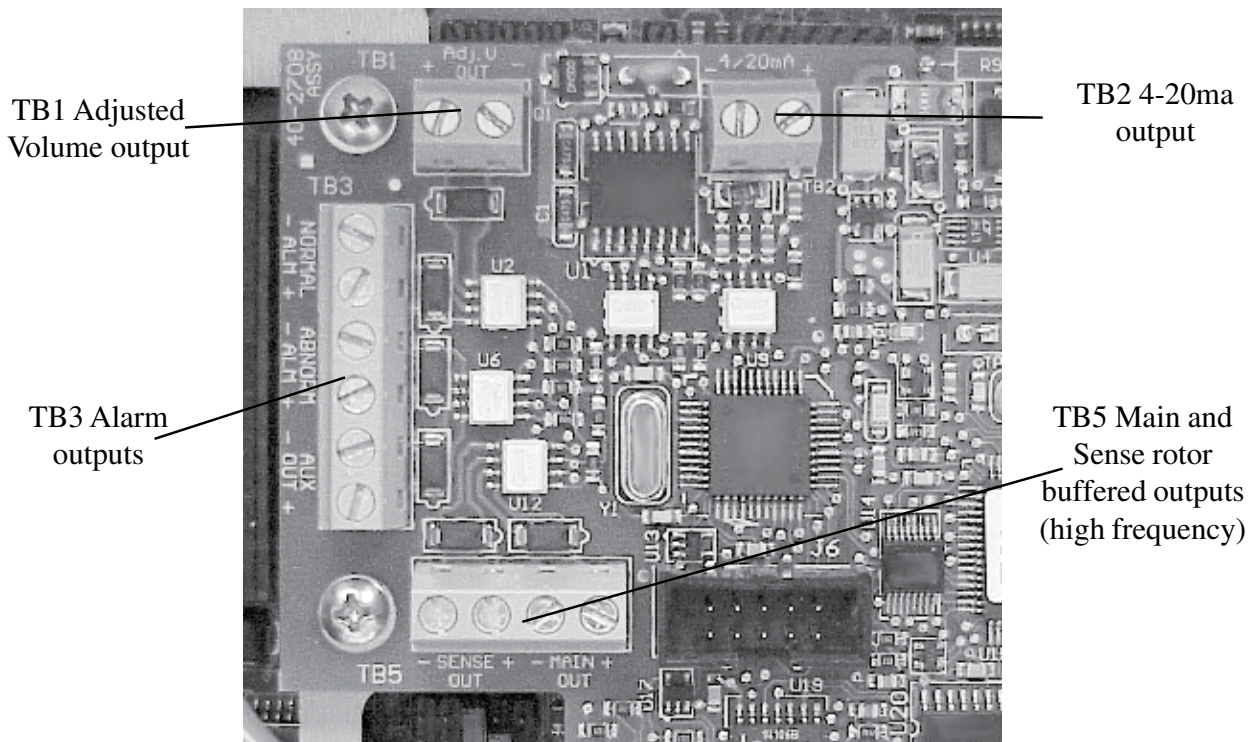
Initial Recommended Alarm Configuration				
Operating Conditions	Alarm Limits		Dead Band	
	Normal (Item 872)	Abnormal (Item 873)	Normal (Item 879)	Abnormal (Item 880)
Meter flow rate 50% to 100% of rated capacity. Pressures over 275 psi.	+/- 0.5%	+/- 2.0%	0.05%	0.2%
Meter flow rate 20% to 100% of rated 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%
Use these values if you can't decide on any of the above	+/- 2.0%	+/- 5.0%	0.2%	0.5%

TOC Alarms

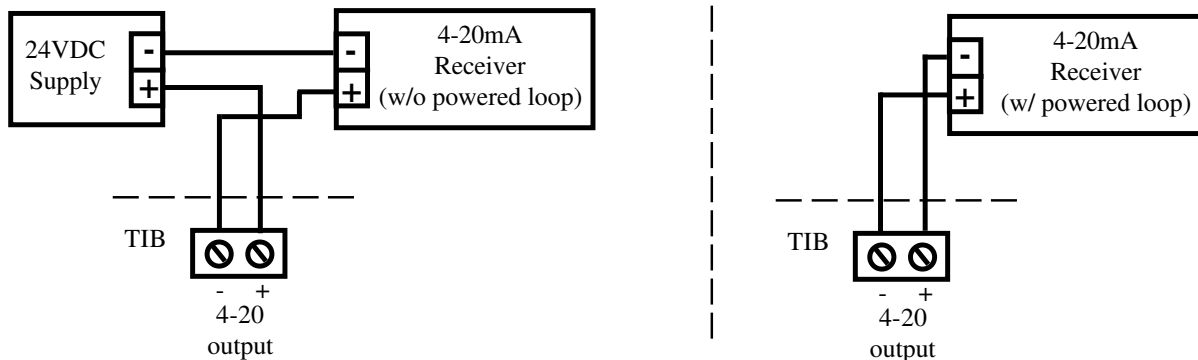
4-20 milliamp output

In addition to the pulse outputs, the Turbo Corrector has a single 4-20 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. The selection is made at item 871 (TIB 4-20 Out Config). 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 requires loop power, and must have a minimum of 9VDC across the + and - terminals under any load condition. 24 volts DC loop power is typical.

The 4-20 milliamp output function can be verified by changing the selection at item 871 and then disconnect the serial link. Depending on the setting, the 4-20 mA output can provide a constant 4, 12 or 20mA signal for verification or calibration purposes. Note, disconnect link after each change at allow the configuration to take affect. After verification, Item 871 should be set back to either Delta-A or Adj Vol Flowrate for the output to function normally.



Pulse and 4-20mA Output Connection Locations



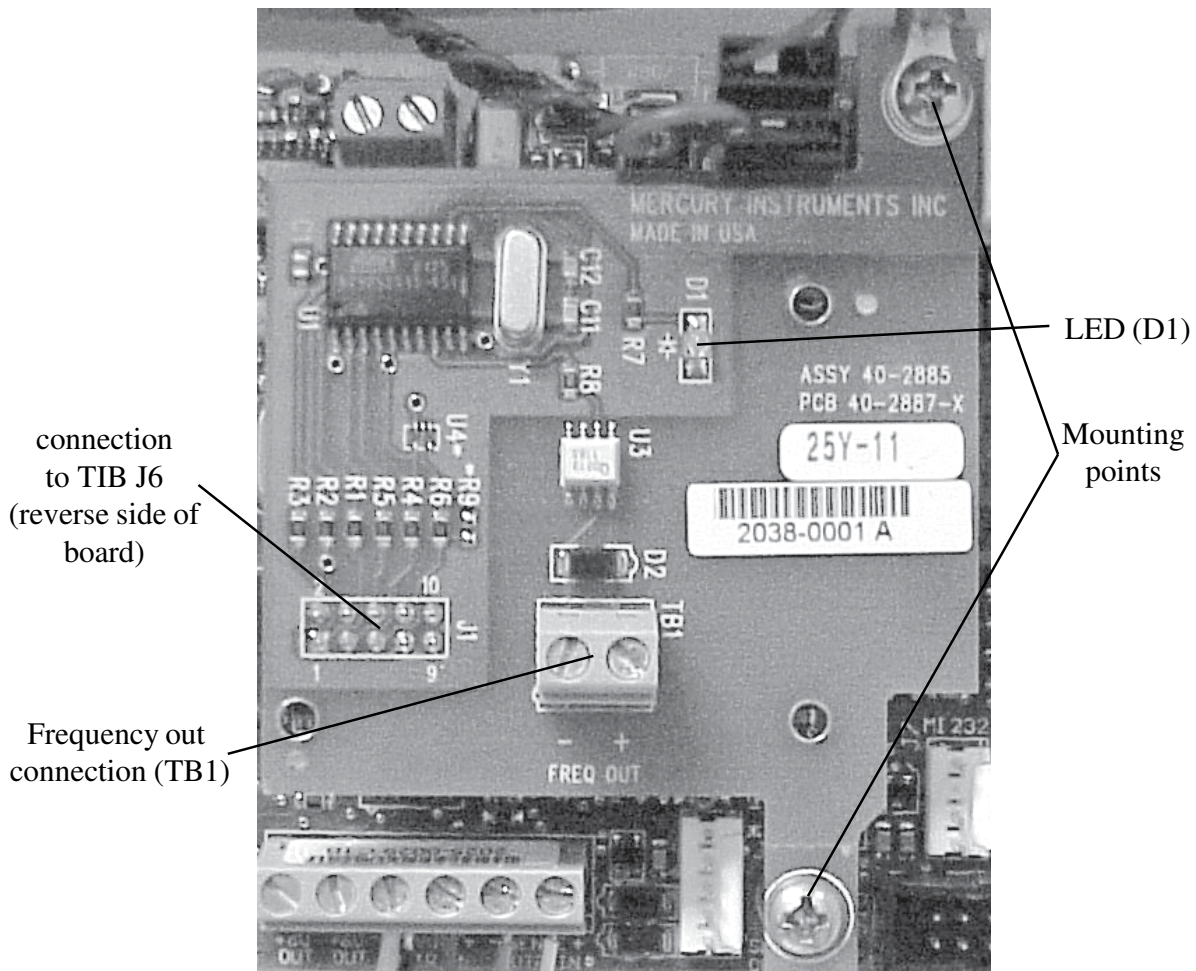
4-20mA Output Connections

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 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 turbine meter size (Item 864) and the meter index units (Item 098) must be properly configured to obtain the proper frequency from the TFB.

The Turbo Frequency Board 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 on the Turbo Frequency Board. The frequency output must be wetted by a 3-15 volts DC receiver for proper operation.

The TFB includes a red LED (D1) that blinks at a slow rate (once per second) when power is first applied and while waiting for a valid packet of data. The faster rate (7 times per second) indicates that a valid packets have 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.



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-30/35	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

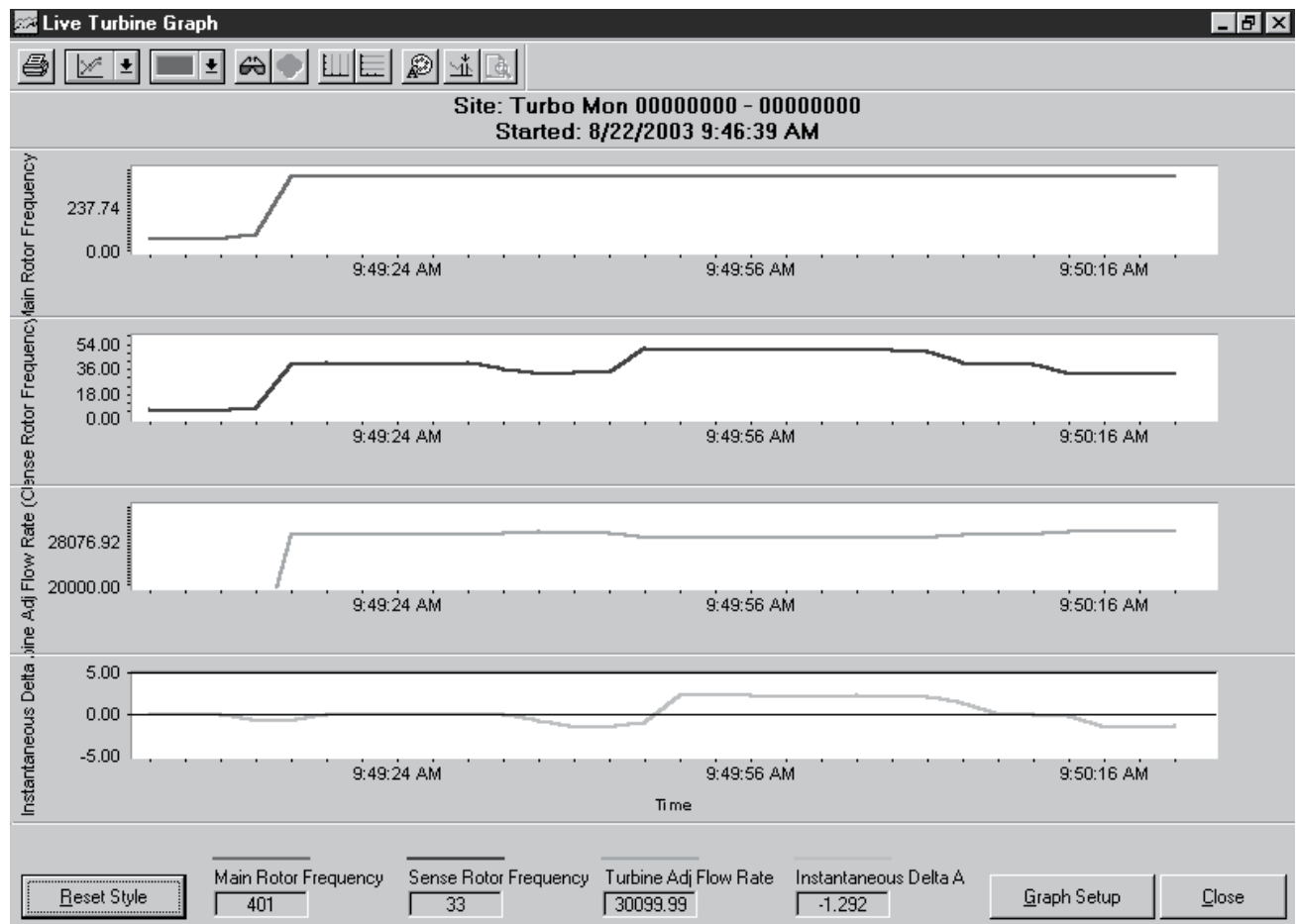
Meter (Metric)			Output Frequency @ Max. Flow Rate									
			50 Hz.		100 Hz.		200 Hz.		500 Hz.		1000 Hz.	
Model	Size (mm)	Blade Angle	Pulses per m ³	m ³ per pulse	Pulses per m ³	m ³ per pulse	Pulses per m ³	m ³ per pulse	Pulses per m ³	m ³ per pulse	Pulses per m ³	m ³ per pulse
AAT-18	100	45°	350	0.002857	700	0.001429	1400	0.000714	3500	0.000286	7000	0.000143
AAT-30/35	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

Live Graphing (Turbine Related Items)

The Turbo Corrector, via MasterLink has the capability to graph turbine related items. The graphable items are Main Rotor Frequency, Sense Rotor Frequency, Instantaneous Delta A, Adjusted Volume Flow Rate and High Frequency Adjusted Volume. These items can be graphed one at a time, or up to a maximum of four. Each item has a configurable scale, line color and line style. The graph is 'live' with a configurable update interval and viewing interval. The figure below shows a sample graph with four items on the graph. Notice that the last updated value of each item is shown as a numeric value in a display box at the bottom of the graph.

The graph window 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. The Graph Setup button at the bottom of the graph will pull up the Graph Configuration screen, as outlined on the next page. Clicking the Reset Style button will reset the configuration to default. Clicking the Close button will exit the Live Graph mode.



Live Graph Display

Live Graph Configuration

The live graph can be setup using the Graph Configuration. 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 use 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 instrument 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. When checked, the Show ToolBar displays the toolbar at the top of the graph window. The second, Show Data Points on Lines displays a dot on the graphing lines for each retrieved data value.

Turbine Graph Setup

Graph Configuration

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: Seconds (1-30) Show ToolBar

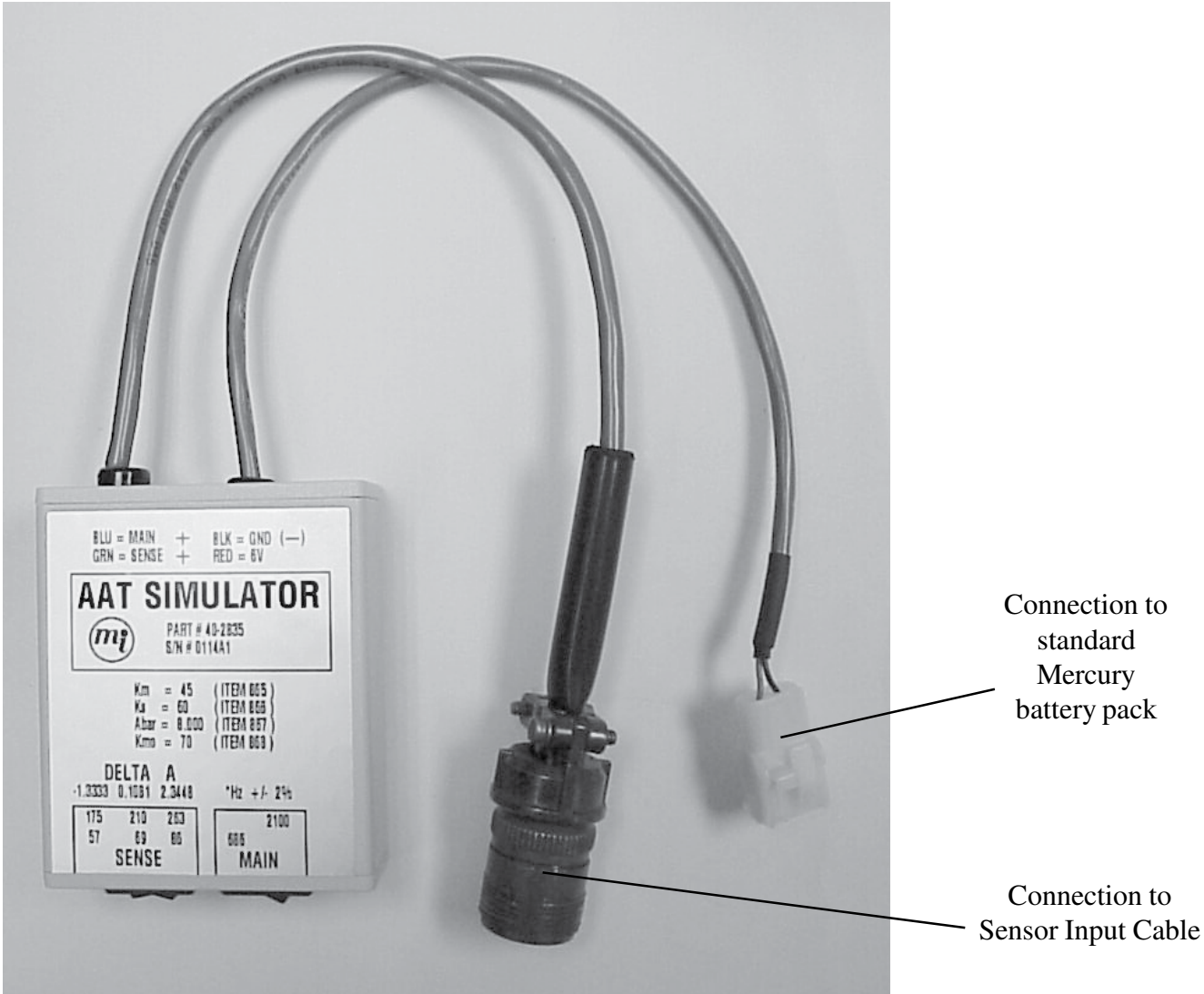
X-Axis Width: Seconds Show Data Points on Lines

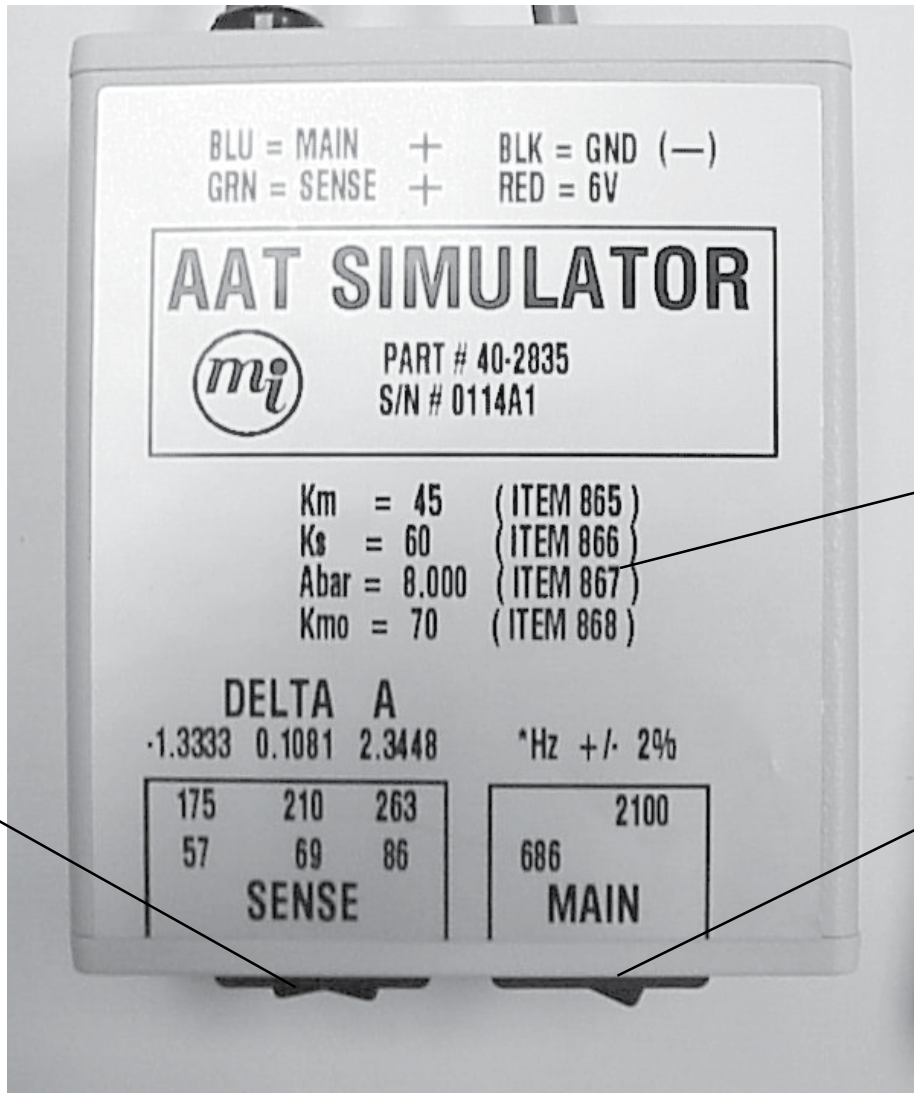
Buttons: Load Setup, Save Setup, OK, Cancel

Live Graph Configuration

AAT Simulator

A compact, portable device is available for testing the electronic functions of a Turbo Corrector. The AAT Simulator (p/n 40-2835) will simulate main and sense rotor signals 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 calculations. The simulator is connected to the Instrument through the sensor input cable and is powered by a standard, external Mercury battery pack.





AAT Linearization

Starting with firmware version 2.20, a more accurate flow rate calculation (especially at low flows) can be obtained when additional meter calibration data are used. The additional calibration data may contain up to six flow rates and up to four pressures. Based on live flow rates and live pressure readings measured by the TOC, a linear interpolation method is used to correct the error at live flow rates that fall between calibration flow rate data points. Live pressure readings are used to select the closest pressure calibration table stored within the instrument. In addition to linearization corrections to Adjusted and Unadjusted volumes, Delta-A calculations are also adjusted using the calibration data.

Linearization adjustments are applied at each volume calculation, i.e., every 1-second. The 'working linearization table' is updated based on live pressure at each Delta-A correction cycle, which is usually every 25,000 main rotor pulses or 8-1/2 minutes, whichever occurs first. The 1-second volume adjustment computations use the most recently computed linearized meter factors. However, Delta-A is linearized using the average flow rate of the most current AAT cycle.

Six new 'diagnostics' items were created and may be optionally placed in the audit trail for logging:

- Item 393 **Minimum Delta-A** (linearized) for log interval
- Item 394 **Maximum Delta-A** (linearized) for log interval
- Item 395 **Minimum Unadjusted meter factor** (linearized) for log interval
- Item 396 **Maximum Unadjusted meter factor** (linearized) for log interval
- Item 397 **Minimum Adjusted meter factor** (linearized) for log interval
- Item 398 **Maximum Adjusted meter factor** (linearized) for log interval

See the Item Code Listing section in this manual for more information of these items.

A text file (with a file extension of ".LIN") is used to send calibration data for a particular meter, to the TOC. The linearization data in the file is expressed as a "percent error". The Turbine Meter Size (item 864), displayed as "AAT-27", "AAT-35/30", "AAT-57", etc., is automatically set when the .LIN file is loaded. MasterLink software will also automatically handle the conversion if the file contains metric volume units.

Sending calibration data in either direction (between a .LIN file and the instrument) is handled in MasterLink's Transfer menu. An interactive read/write of AAT Linearization parameters is handled in MasterLink's Setup menu. An example of this setup form is shown on the next page.

NOTE: To take advantage of the AAT Linearization feature, calibration data beyond what's supplied on the AAT meter serial plate is required. Data similar to what's shown in the sample form on the next page is needed. Contact Sensus Metering Systems for information on how to obtain and use this calibration data.

Setup AAT Linearization Data

All Pressure Tables

Validate Form

Reset Form

Serial Number: 1234567890

Transfer Table Group

Send To: Files Instrument

Read From: Files Instrument

Table Units: PSIA

Meter Capacity(CF/h): 60000 (AAT-60)

Km (Pul/CF): 29.0

Ks (Pul/CF): 41.0

Kmo (Pul/CF): 32.0

A-bar: 10.0

Expected Operating Pressure (PSIA): 0.0

Read

Selected Table: 50.0 PSIA

Change

Add Table

Delete Table

Transfer Single Table

Send To: File Instrument

Read From: File Instrument

Close

% Errors Meter Factors

	Line Flow Rate	% Err. AdVol	% Err. UnAdVol	%Delta A(Offset)
Min	3080.0	0.55	-0.4	-0.6
1	6166.0	0.4	-0.3	-0.25
2	15300.0	0.25	0.0	-0.1
3	30373.5	-0.1	0.1	-0.05
4	45674.4	-0.07	0.08	-0.05
5	60975.3	0.0	0.07	-0.02
6	99999.9	0.0	0.0	0.0

Override minimum calculations

AAT Linearization Setup Form

Low Frequency Cut-Off (Main Rotor)

Starting with firmware version 2.20, item 406 (AAT Low Flow Cut-Off Hz) was added to allow the user to specify a low flow cut-off for the main rotor only. The cut-off is expressed in Hertz as an integer value from 1 to 40, and defaults to the previously hard-coded value of 3 Hz. Main rotor volume that comes into the TIB at a frequency at or above the 406 value is accepted, but volume that comes in at a frequency below 406 is not registered. This feature is to help reduce or eliminate the processing of no-net resonant flows, such as main rotor oscillation during no flow conditions.

Upgrading TIB firmware

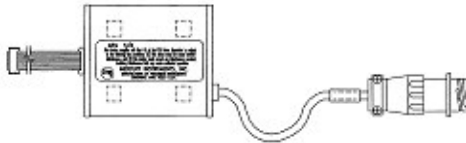
1. Items Required

PC with Windows 95/98 OS (or higher)

Firmware Upgrade Manager software (FWUM) version 2.1101 or later Install Firmware Upgrade Manager software, which is usually provided on the MasterLink32 CD under the “Bonus Software” folder. NOTE: Always install the program “Mercury Calculator” prior to Firmware Upgrade Manager when working on a Windows XP machine.

TIB Firmware file for Controller 103 (U15) (TIBxxxxx.tbx) and TIB Firmware file for Controller 8515 (U9) (T8Bxxxxx.t8x)

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 board, p/n 40-2708 (may be part of a TOC or TOM assembly)



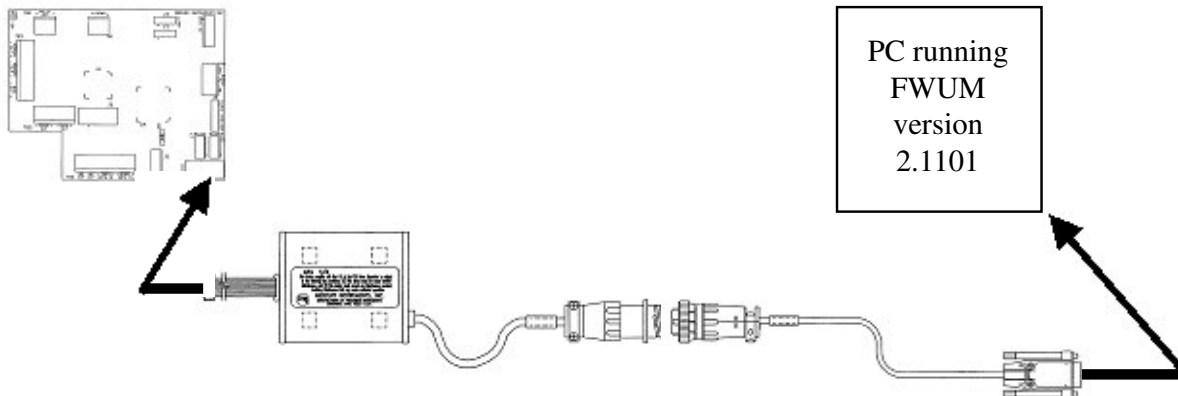
TOC Power cable p/n 40-2809-1 (with battery or DC power connected) or TOM Power cable p/n 40-2812 (with battery or DC power connected)



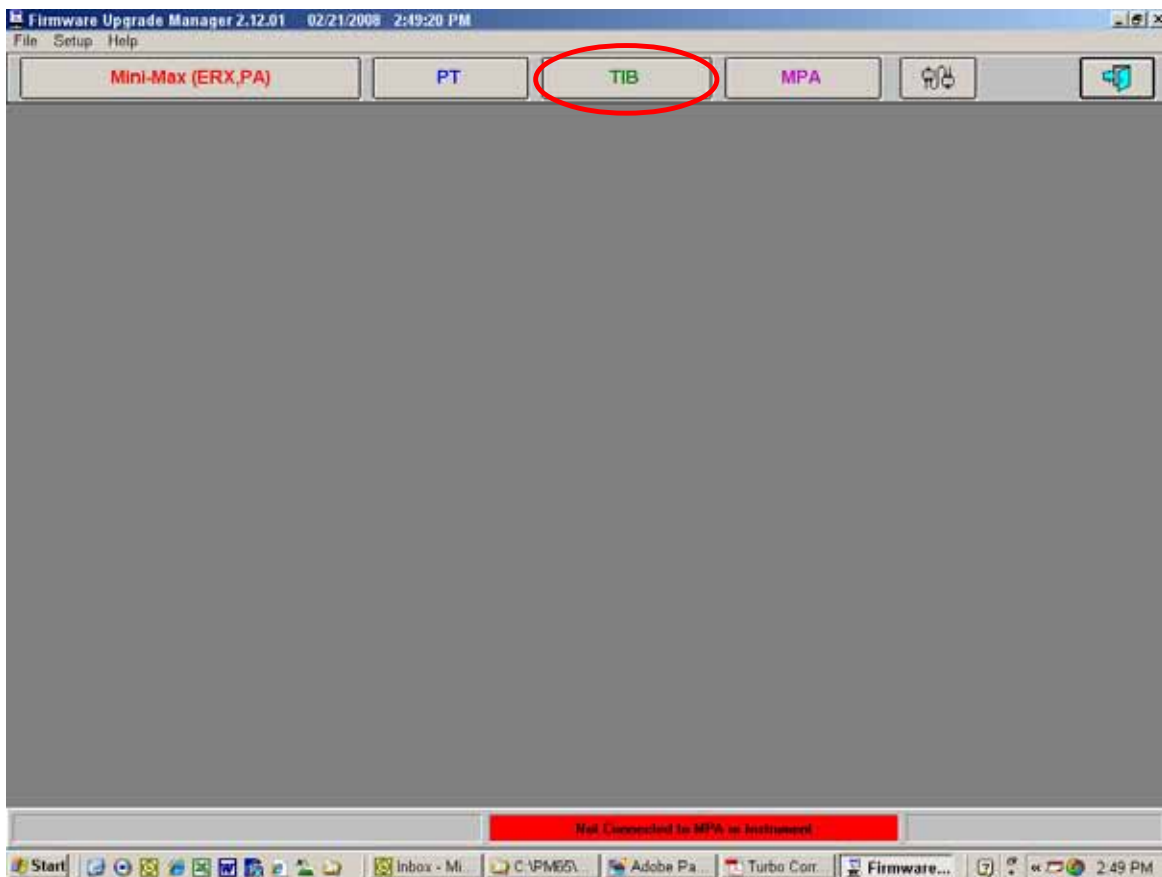
2. Programming the TIB:

2.1 Programming both Microcontrollers (103 & 8515) with Mercury MPA

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).

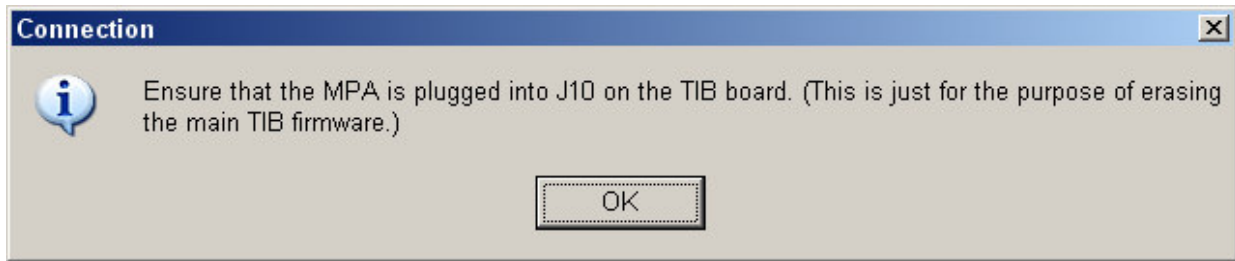
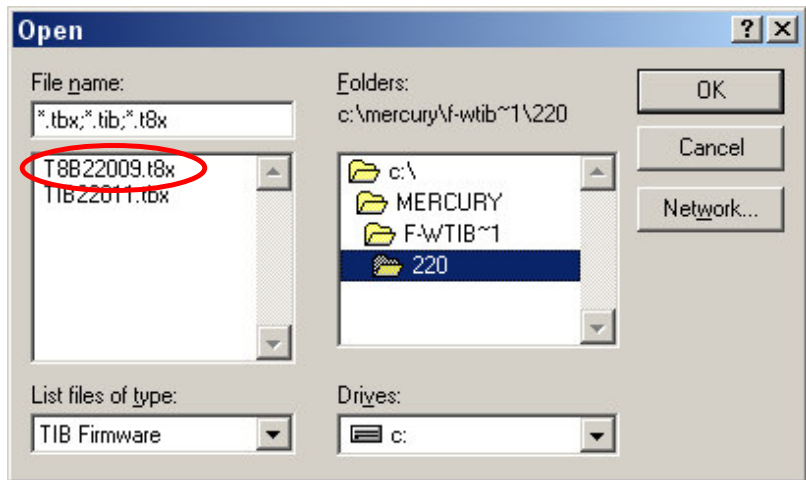


3. Start Mercury Firmware Upgrade Manager and select "TIB" from icon toolbar. A Dialog box appears to explain the sequence of connecting the MPA ribbon cable during programming.

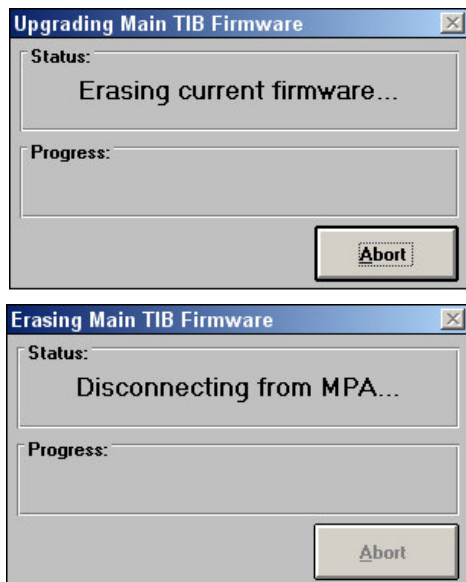


Note: The TIB requires the firmware in the 103 Microcontroller (U15) to be erased before the firmware in the 8515 Microcontroller (U9) can be programmed. For this reason, the MPA is to be plugged into **J10** first to erase the 103 Microcontroller (U15) firmware before changing to **J6** for programming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

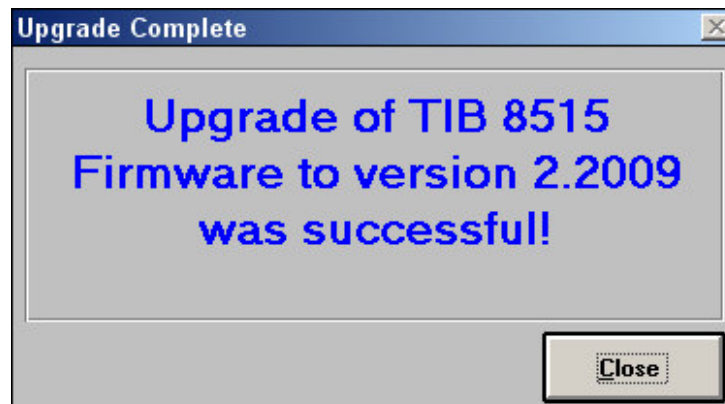
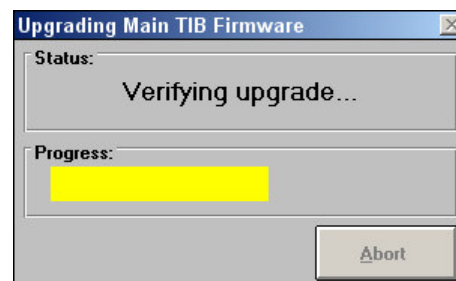
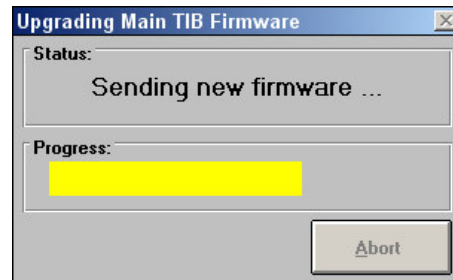
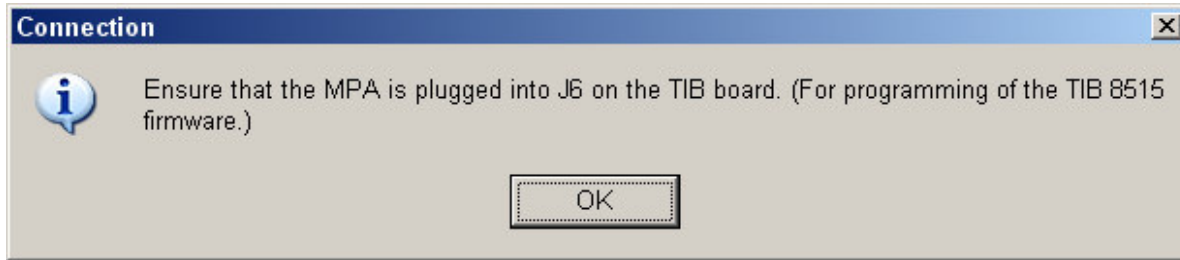
4. Send ... \tibXXXXX.t8x" file (use file browser if required).



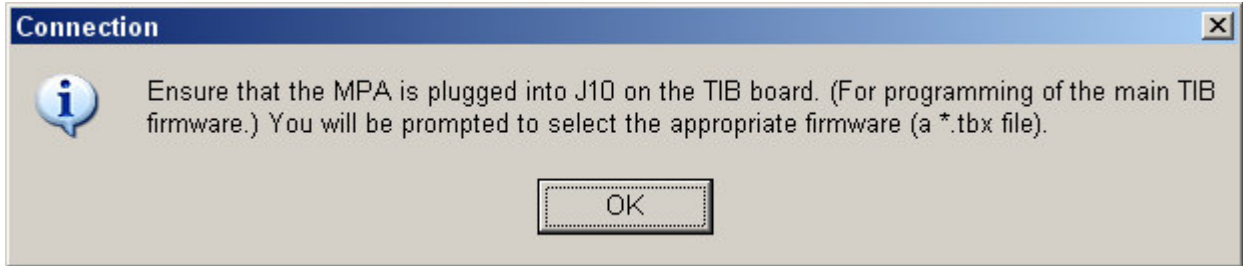
5. FWUM erases, the main program, then disconnects from the MPA.



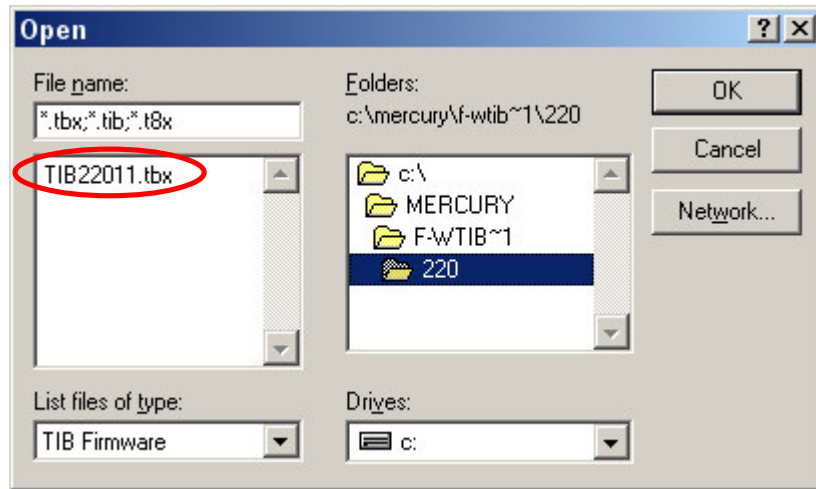
6. Unplug the MPA from J10 and plug it into J6 so FWUM can upgrade the 8515 firmware.

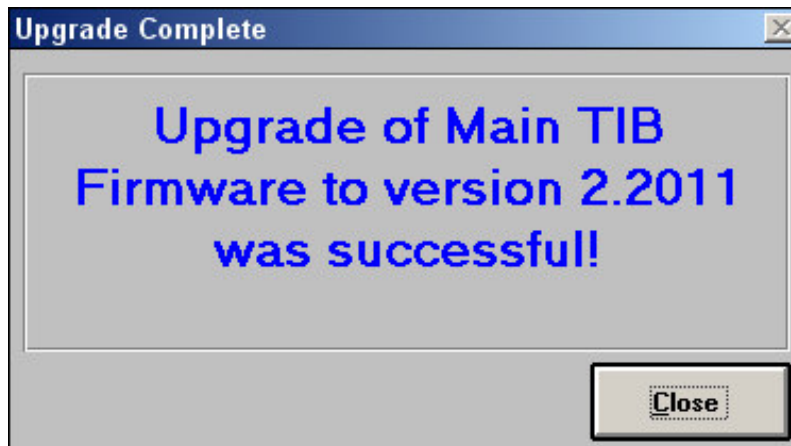
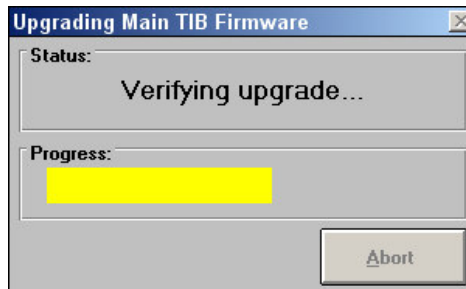
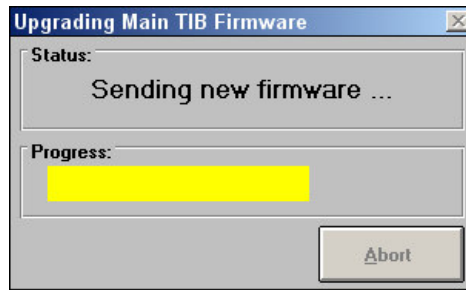


7. After the 8515 firmware upgrade is complete, unplug the MPA cable for J6 and plug it back into J10. Chose the .



8. Select the "tbx" file from list box and click OK to begin upgrading the main TIB firmware.





9. After both TIB processors are upgraded, exit FWUM.



TOC Item Code List (* indicates TIB only items)

Item No.	Item Name	Description
182	Input Vol to Corrector	Code (0-2) selects which type of uncorrected volume pulses used as the input to J9 of the Mini-AT main board, to produce corrected volume. Select: 0 – Unc mech. Switch (Sw 1 & 2) 1 – TIB Adj Vol Pulse (Sw3) Default 2 – TIB Unadj Vol Pulse (Sw4)
393	Cal Delta-A Min	The minimum , linearized value of Delta-A that has occurred during the current log interval (defined at item 202). This parameter, along with all linearizations diagnostic items (items 393-398) are helpful in verifying the performance of the AAT Linearization feature, especially when all six items are logged in the expanded audit trail. Default = 0.0000
394	Cal Delta-A Max	The maximum , linearized value of Delta-A that has occurred during the current log interval (defined at item 202). This parameter, along with all linearization diagnostic items (items 393-398) are helpful in verifying the performance of the AAT Linearization feature, especially when all six items are logged in the expanded audit trail. Default = 0.0000
395	Meter Factor Unadj Min	The minimum , linearized value of unadjusted meter factor that has occurred during the current log interval (defined at item 202). This parameter, along with all linearization diagnostic items (items 393-398) are helpful in verifying the performance of the AAT Linearization feature, especially when all six items are logged in the expanded audit trail. Default = 0.0000
396	Meter Factor Unadj Max	The maximum , linearized value of unadjusted meter factor that has occurred during the current log interval (defined at item 202). This parameter, along with all linearization diagnostic items (items 393-398) are helpful in verifying the performance of the AAT Linearization feature, especially when all six items are logged in the expanded audit trail. Default = 0.0000

Item No.	Item Name	Description
397	Meter Factor Adj Min	<p>The minimum, linearized value of <i>adjusted meter factor</i> that has occurred during the current log interval (defined at item 202). This parameter, along with all linearization diagnostic items (items 393-398) are helpful in verifying the performance of the AAT Linearization feature, especially when all six items are logged in the expanded audit trail.</p> <p>Default = 0.0000</p>
398	Meter Factor Adj Max	<p>The maximum, linearized value of <i>adjusted meter factor</i> that has occurred during the current log interval (defined at item 202). This parameter, along with all linearization diagnostic items (items 393-398) are helpful in verifying the performance of the AAT Linearization feature, especially when all six items are logged in the expanded audit trail.</p> <p>Default = 0.0000</p>
406	AAT Low Flow Cut-Off Hz.	<p>The low-end frequency of the main rotor signal at which the TIB assumes a value of zero, until exceeded. This user specified parameter is to help reduce or eliminate processing of no-net resonant flows, such as main rotor oscillation during no flow conditions.</p> <p>Range: 1 - 40 Hz. Default = 3 Hz.</p>
850	Adjusted Volume	<p>Totalized Adjusted Uncorrected Volume. This value is scaled to volume units selected at Item 092 and to 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 that 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. This value is scaled to volume units selected at Item 092 and to the number of digits defined by Item 097.</p> <p>Default = 00000000</p>

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 1-second in the TIB and transferred to the Mini-AT board on every AAT Cycle serial link. When accessed, the unit will display the most recently computed value.</p> <p>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 1-second in the TIB and transferred to the Mini-AT board on every AAT Cycle serial link. When accessed, the unit will display the most recently computed value.</p> <p>Default = 0</p>												
855	Turbine Configuration	<p>Item used to determine the configuration of the instrument, 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 Correctors and enables serial communication between the TIB and Mini-AT mainboards. FYI - Normally, serial communications with the Mini-AT board passes through the TIB.</p> <p>Select:</p> <ul style="list-style-type: none"> 0 – Turbine Support Off 1 – Turbo Monitor Mode 												
856*	Corrector Baud Rate Code	<p>Code (0-7) to select the baud rate at TIB port J7. This port is normally used to make a serial link to the Mini-AT in the Turbo Corrector mode and is generally not used in the Turbo Monitor mode. A communication's error will occur if this baud rate does not match the baud rate of TB2 of the connected Mini-AT board.</p> <p>Select:</p> <table border="0"> <tr> <td>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>	0 – 9600	Default	4 – 600	1 – 4800		5 – 300	2 – 2400		6 – 19200	3 – 1200		7 – 38400
0 – 9600	Default	4 – 600												
1 – 4800		5 – 300												
2 – 2400		6 – 19200												
3 – 1200		7 – 38400												

Item No.	Item Name	Description												
864	Turbine Meter Size	<p>Size of AAT meter, configured by the user. Note: it is critical that this item be correct when using the TFB (see item 889).</p> <p>Select:</p> <table border="0"> <tr> <td>0 – AAT-18</td> <td>Default</td> <td>4 – AAT-60</td> </tr> <tr> <td>1 – AAT-27</td> <td></td> <td>5 – AAT-90</td> </tr> <tr> <td>2 – AAT-30/35</td> <td></td> <td>6 – AAT-140</td> </tr> <tr> <td>3 – AAT-57</td> <td></td> <td>7 – AAT-230</td> </tr> </table>	0 – AAT-18	Default	4 – AAT-60	1 – AAT-27		5 – AAT-90	2 – AAT-30/35		6 – AAT-140	3 – AAT-57		7 – AAT-230
0 – AAT-18	Default	4 – AAT-60												
1 – AAT-27		5 – AAT-90												
2 – AAT-30/35		6 – AAT-140												
3 – AAT-57		7 – AAT-230												
865	KM Meter Factor	<p>K-factor for the main rotor for computing Adjusted Volume. This user configured value indicates the number of pulses per cubic foot (or cubic meter) for the main rotor, as indicated on the AAT meter’s serial plate as “M.R. FACTOR”.</p> <p>Default = 100.0000</p>												
866	KS Meter Factor	<p>K-factor for the sense rotor for computing Adjusted Volume. This user configured value indicates the number of pulses per cubic foot (or cubic meter) for the sense rotor, as indicated on the AAT meter’s serial plate as “S.R. FACTOR”.</p> <p>Default = 100.0000</p>												
867	ABar Meter Factor	<p>Amount of average relative adjustment the sensor rotor supplied to the adjusted volume calculation during factory calibration. This user configured value is indicated on the AAT meter’s serial plate as “AVG. REL. ADJ A”.</p> <p>Default = 10.0000</p>												
868	KMO Meter Factor	<p>K-factor for the main rotor for computing Unadjusted Volume. This user configured value indicates the number of pulses per cubic foot (or cubic meter) for the main rotor’s mechanical output, as indicated on the meter’s data sheet (not on the AAT meter’s serial plate).</p> <p>Default = 100.0000</p>												
869	Instantaneous Delta-A	<p>The most recent calculated value of Delta-A. This read-only value indicates the amount of adjustment required (relative to factory-derived Abar) to compute the most recent Adjusted Volume. Typically, Adjusted Volume accuracy is maintained as long as Delta-A is within +Abar to -Abar range.</p> <p>Default = 0.0000</p>												

Item No.	Item Name	Description
870	Turbine Sensor Type	<p>Selection to indicate the type of sensor used in the connected AAT meter. Typically, Slot Sensors output approximately 500 Hz. at max. capacity, while Blade Tip Sensors output approximately 1100 to 2100 Hz. at max. capacity.</p> <p>Select:</p> <p>0 – Slot Sensor Default 1 – Blade Tip Sensor</p>
871	TIB 4-20 Out Config	<p>Selection that determines the type of analog signal provided at the 4-20 output port (TB2).</p> <p>Select:</p> <p>0 – Delta-A Default 3 – 12mA (Test) 1 – AdjVol Flow Rate 4 – 20mA (Test) 2 – 4mA (Test)</p>
872	Normal Alarm Limit	<p>User selectable limit for Delta-A, entered as a percentage of Abar. When exceeded, produces a “Normal Alarm” at item 877. The range is $\pm 10\%$.</p> <p>Default = $\pm 2.0\%$</p>
873	Abnormal Alarm Limit	<p>User selectable limit for Delta-A, entered as a percentage of Abar. When exceeded, produces an “Abnormal Alarm” at item 878. The range is $\pm 10\%$.</p> <p>Default = $\pm 5.0\%$</p>
874	Pulsing Gas Alarm	<p>Indicates if pulsing gas is detected by the Delta-A algorithm. If detected, an alarm is indicated at TB3, 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) or automatically cleared (by RBX in the firmware).</p> <p>Default = 00000000</p>
875	TIB Internal Fault	<p>This item indicates if an alarm for the TIB F/W was generated. When the microprocessor detects a TIB F/W Fault, an alarm is indicated at TB3, 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).</p> <p>Default = 00000000</p>

Item No.	Item Name	Description
876*	TIB Alarms Output	<p>This item displays “11111111” 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 Delta-A is outside the normal alarm band, i.e., if the calculation for Item 869 (Instantaneous Delta-A) is a value (+ or -) that exceeds the Normal Alarm Limit (item 872), an alarm is indicated at TB3, placing dots on the LCD and “11111111” 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 Delta-A is outside the abnormal alarm band, i.e., If the calculation for Item 869 (Instantaneous Delta-A) is a value (+ or -) that exceeds the Abnormal Alarm Limit (item 873), an alarm is indicated at TB3, placing dots on the LCD and “11111111” 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 Dead Band	<p>A hysteresis band that provides a buffer above or 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 Delta-A 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>

Item No.	Item Name	Description
880	Abnormal Alarm Dead Band	<p>A hysteresis band that provides a buffer above or 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 Delta-A 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>
881	Main Rotor Frequency	<p>Value of the most recent measurement of main rotor input frequency, in Hertz (pulses per second).</p> <p>Default = 0.0000</p>
882	Sense Rotor Frequency	<p>Value of the most recent measurement of sense rotor input frequency, in Hertz (pulses per second).</p> <p>Default = 0.0000</p>
883	Adjusted Volume Pulses	<p>Number of Adj Vol output volume pulses waiting to be sent out the TIB pulse channel at TB1.</p> <p>Default = 0</p>
884	Adj Flow 20mA Value	<p>An integer number used to scale the high end of the TIB's 4-20 mA output signal at TB2. This user selectable value determines at what point the Adj Vol flow rate (Item 853) is equal to 20 mA.</p> <p>Default = 0.0000</p>
885	Adj Flow 4mA Value	<p>An integer number used to scale the low end of the TIB's 4-20 mA output signal at TB2. This user selectable value determines at what point the Adj Vol flow rate (Item 853) is equal to 4 mA.</p> <p>Default = 0.0000</p>
886	Average Delta A	<p>The average of all Delta-A calculations obtained during the Audit Trail log interval (item 202).</p> <p>Default = 0.0000</p>
887	8515 Firmware Version	<p>The version number of the TIB's second operating firmware. This read-only number is automatically inserted when a firmware file is uploaded into flash memory.</p>

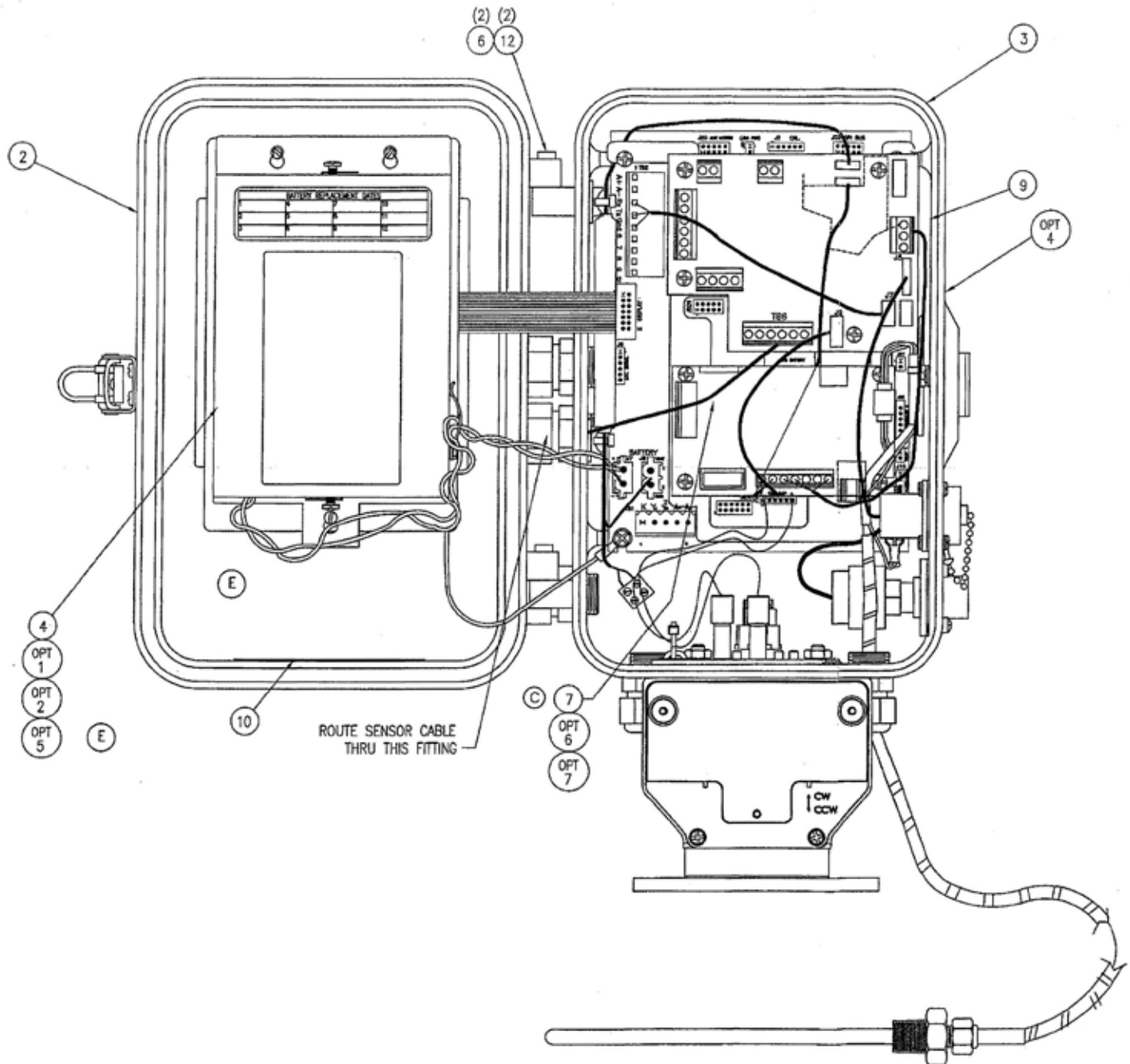
Item No.	Item Name	Description
888	Incremental Adjusted Volume	Same as ADJVOL (item 850), but is initialized (re-zeroed) at the beginning of every TIME-triggered wake up (item 202). If the instrument is accessed, this item will display the current value for that point in time.
889	High Freq Out Max Freq	The frequency out of the Turbo Frequency Board (at TB1) when the AAT meter is at its designed 100% flow rate. The frequency for this condition is user specified to allow compatibility with most data acquisition systems or RTU devices. Select: 0 - 50 Hz. Default 1 - 100 Hz. 2 - 200 Hz. 3 - 500 Hz. 4 - 1000 Hz. (Most common choice)
890	Counts per Delta-A	The number of main rotor pulses that triggers the next Delta-A calculation. If the specified number of pulses are not received within 8-1/2 minutes (due to low flow rates), Delta-A is automatically re-calculated based on the 8-1/2 minute timeout. Default = 25,000 Min. Allowed = 5,000

Mini-AT Items mirrored in the TIB

The following Mini-AT items are read by the TIB and the values duplicated in TIB items having the same item code number. Please refer to the Mini-AT Operator's guide for descriptions of these items.

049	Battery Voltage Low Limit
050	Shutdown Voltage
092	Uncorrected Volume Units
097	Uncorrected Volume Display Resolution
098	Meter Index Code
165	RBX Alarm Enable
170	Protocol Code A
171	Timeout Delay 1
172	Timeout Delay 2
200	Site ID 1
201	Site ID 2

TOC (Mini-AT Case) Assembly Drawing



ITEM	REQ	PART NO	DESCRIPTION
* 1	1	20-2365	MOUNTING KIT
2	1	20-9240	DOOR ASSEMBLY
3	1	20-9241	CASE CONFIGURATION
4	1	40-1865-2	ASS'Y-ALKALINE BATTERY PACK
(D) * 5	1	FD-471	FIELD INSTALLATION INSTRUCTIONS
6	2	20-4228	STUD, TAMPERPROOF HINGE
(C) 7	1	40-2833-1	TURBINE SENSOR CABLE ASSY, 4 FT
8			
9	1	20-8402	LABEL, MADE IN USA
10	1	20-8453	LABEL, SERIAL NUMBER
11			
12	2	60-2303	SCREW, SET #6-32 x 3/16

OPTIONS

ITEM	REQ	PART NO	DESCRIPTION
1	1	40-1595	ASSEMBLY ALKALINE 6 CELL DISPOSABLE
2	1	20-7418	COVER, BATTERY
* 3	1	20-7286	MAGNETIC WAND ASSEMBLY
(D) 4	1	20-9204	LABEL, CSA/CUS LISTING
(D) 5	1	20-8358	LABEL, DISPOSABLE BATTERY PACK
(C) 6	1	40-2833-25	TURBINE SENSOR CABLE ASSY, 25 FT
(C) 7	1	40-2833-XX	TURBINE SENSOR CABLE ASSY, XX FT
(C) * 8	1	40-2855	SIGNAL CABLE ASSY, AAT SIMULATOR
(C) * 9	1	40-2962	CABLE ASSY, SIGNAL CABLE TO AAT METER (UNTERMINATED)

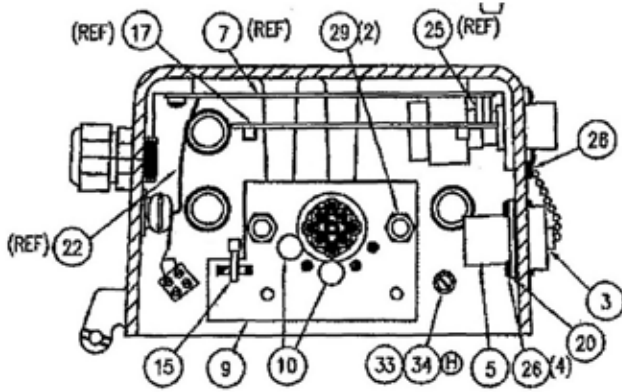
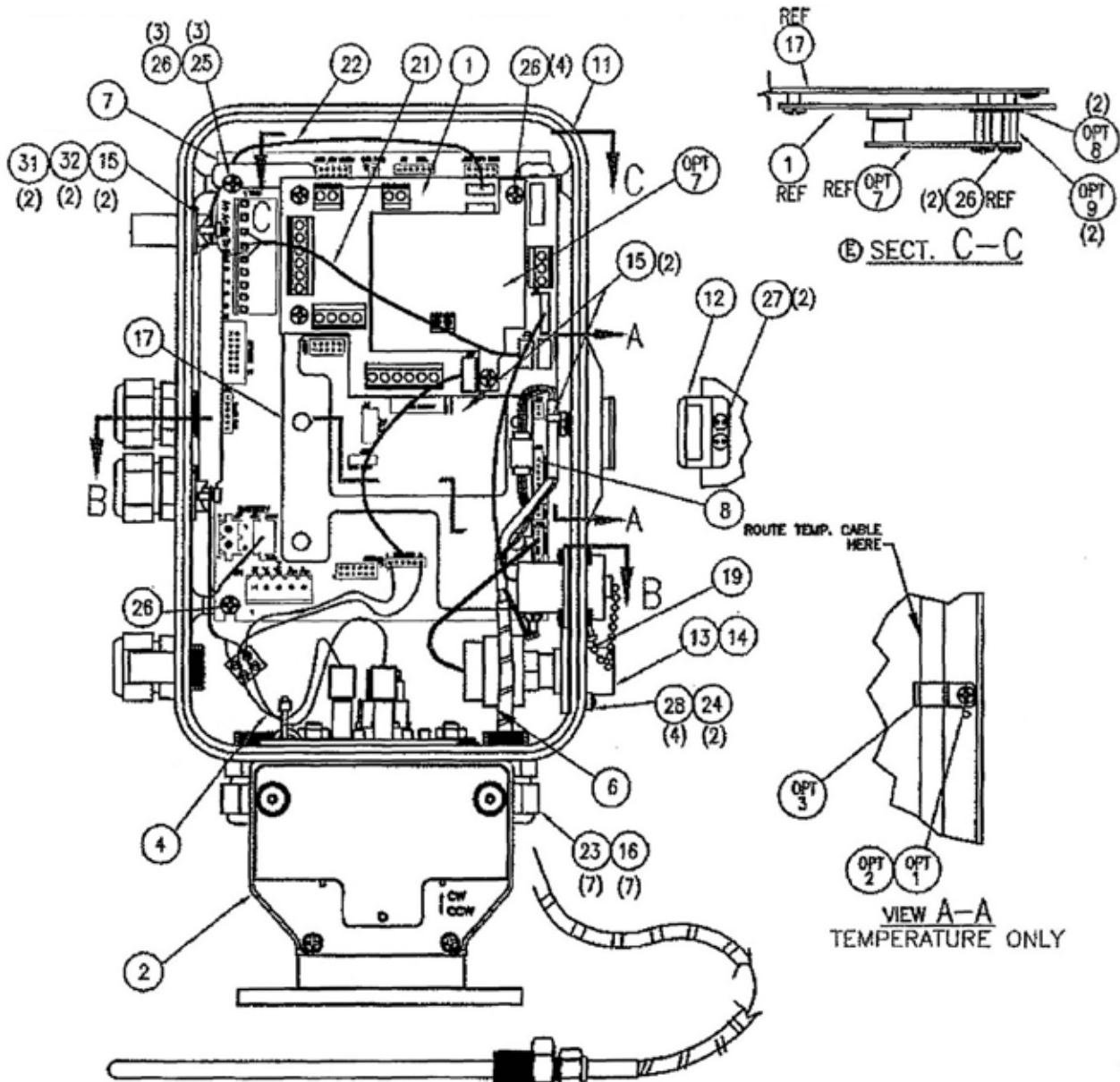
NOTES

1. CUSTOMER REQUIREMENTS MAY REQUIRE DEVIATION FROM THIS PARTS LIST.
- (B) 2. SOME OPTIONAL ITEMS SHOWN. REFER TO CASE CONFIGURATION DRAWING 20-9241.
3. ASTERISK * INDICATES ITEM NOT SHOWN.

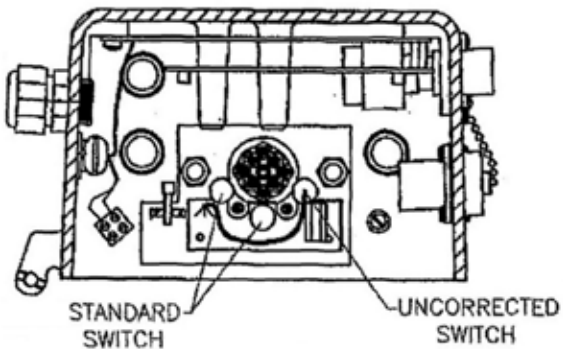
(C)

SLOT SENSOR CABLE WIRING DETAILS

WHITE - SENSE +
 ORANGE - SENSE -
 RED - MAIN +
 BLACK - MAIN -
 SHIELD - MAIN -

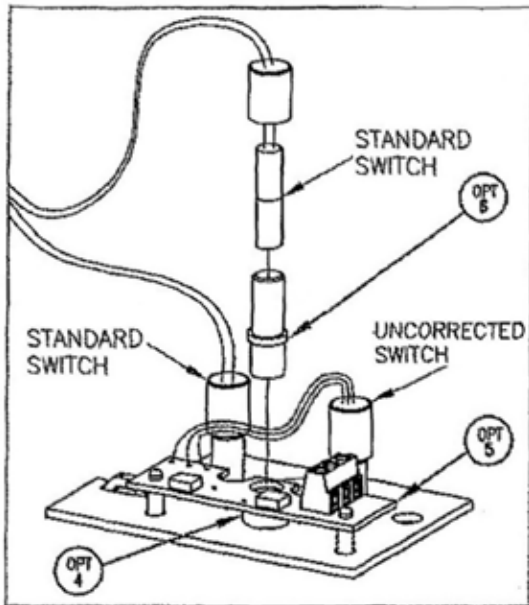


SECT. B-B
 STANDARD



SECT. B-B
 UNCORRECTED

TOC (Mini-AT Case) No Options

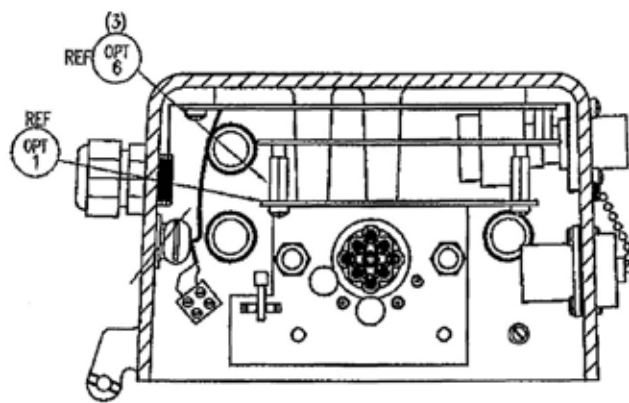
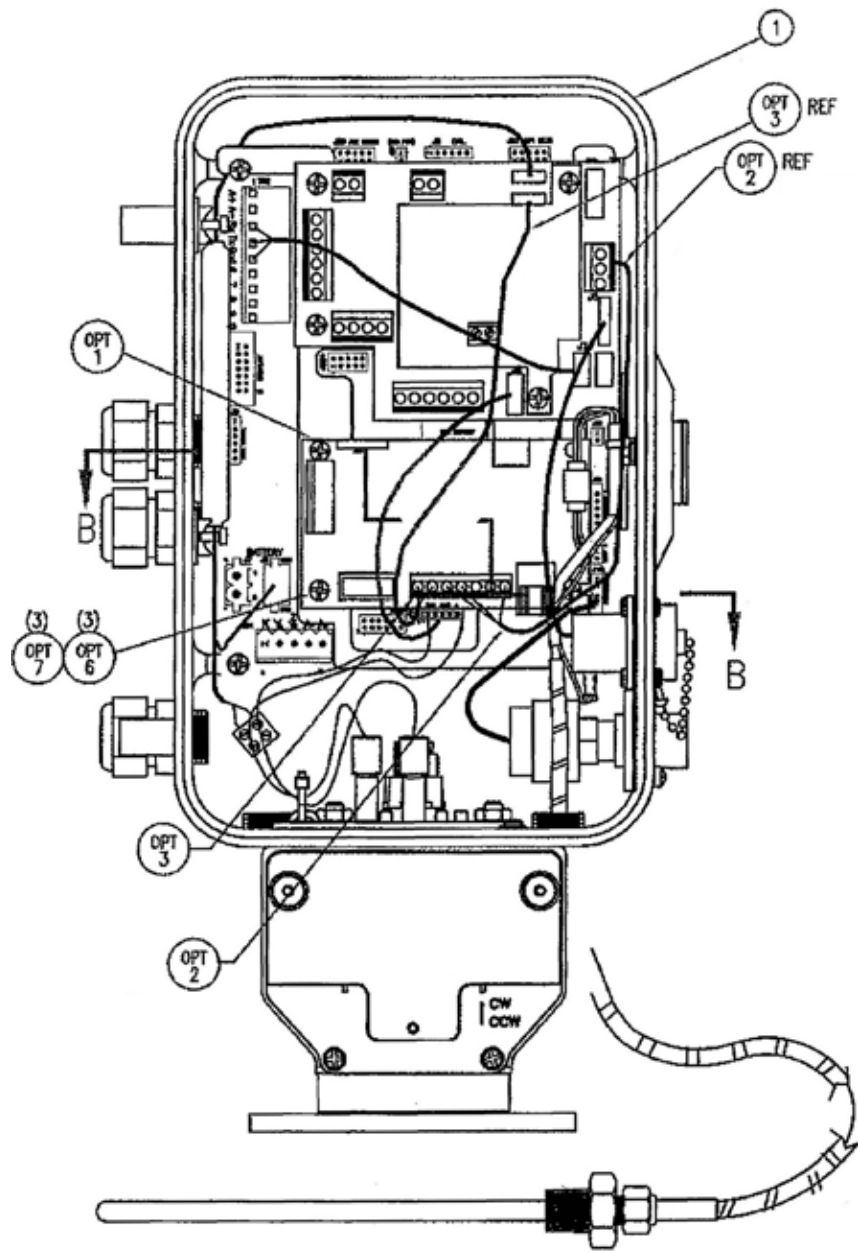


UNCORRECTED SWITCH BOARD
INSTALLATION DETAIL

ITEM	REQ	PART NO	DESCRIPTION
1	1	40-2708	ASSEMBLY, TURBINE INTERFACE PCB
2	1	20-9524 THRU 20-9531	UMB ASSEMBLY
		20-9543 THRU 20-9569	
		20-9852 THRU 20-9863	
3	1	40-1576	CAP & CHAIN ASSEMBLY
4	1	40-4413	ASSEMBLY, SWITCH, CAPSULE, W/ TIE TO MINI-AT CABLE
5	1	40-1728	RS-232 INTERNAL CABLE ASSEMBLY
6	1	40-1428	PRESSURE TRANSDUCERS
7	1	40-2335	MAIN BOARD ASSEMBLY
8	1	40-2112	PRESSURE TERMINATOR ASSY
9	1	22-1494	ASSEMBLY, PLATE, SWITCH MOUNTING
10	2	22-1161	HOLDER, SWITCH
11	1	20-9158	CASE, DRILLED
12	1	20-8689	PLATE, BENT STRIKE
13	1	20-9054	ASSEMBLY, PRESSURE CASE CONNECTION
14	1	20-8981	GASKET, CASE CONNECTOR
15	5	20-3827	CABLE TIE
16	7	20-7552	PLUG, STRAIN RELIEF
17	1	20-9152	ASSEMBLY, MOUNTING PLATE
18			
19	1	20-8087	LABEL, WARNING DCU JACK
20	1	20-8196	GASKET, AUDIT TRAIL
21	1	40-2724	ASSEMBLY, CABLE SERIAL 4 PIN
22	1	40-2809	ASSEMBLY, POWER CABLE
23	7	20-8911	FITTING, STRAIN RELIEF .20-.35
24	2	20-8159	WASHER, #8 INTERNAL LOCK
25	3	20-7284	STANDOFF, #8-32 X 7/16 M/F
26	13	60-4219	SCREW, PN #6-32 X 1/4
27	2	60-1247	SCREW, SPANNER #6-32 X 5/16
28	4	80-4320	SCREW, FIL #8-32 X 3/8
29	2	80-1607	NUT, HEX #1/4-20
30			
31	2	40-1329	HOLDER, CABLE TIE
32	2	60-1220	SCREW, FLT HD #6-32 X 1/4
33	1	60-1378	SCREW, BD #10-32 X 3/16" GREEN
34	1	20-5300	WASHER, LOCK, #10 EXTERNAL STAR
35			

OPTIONS

ITEM	REQ	PART NO	DESCRIPTION
1	1	20-8204	WASHER, #8 EXT LOCK
2	1	60-4219	SCREW, PN #6-32 X 1/4
3	1	40-1649	CABLE CLAMP, 3/16 DIA.
4	1	22-1490	SPACER, UNCORRECTED SWITCH BOARD
5	1	40-3564	UNCORRECTED SWITCH OUTPUT BOARD
6	1	22-1491	SLEEVE, SWITCH, UNCORRECTED
7	1	40-2885	ASSY, TURBO FREQUENCY BOARD
8	2	20-1783	WASHER, FLAT #6
9	2	20-8554	STANDOFF, #6-32 X 1/2, M/F



SECT. B-B

TOC (Mini-AT Case) w/ TFB and Messenger Modem

ITEM	REQ	PART NO	DESCRIPTION
1	1	20-9241SHT1	CASE CONFIGURATION, TOC BASE UNIT
2			

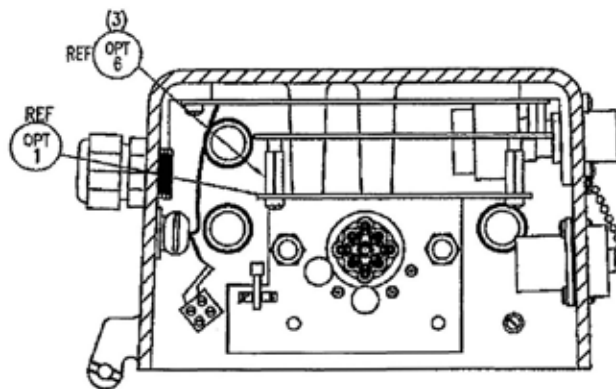
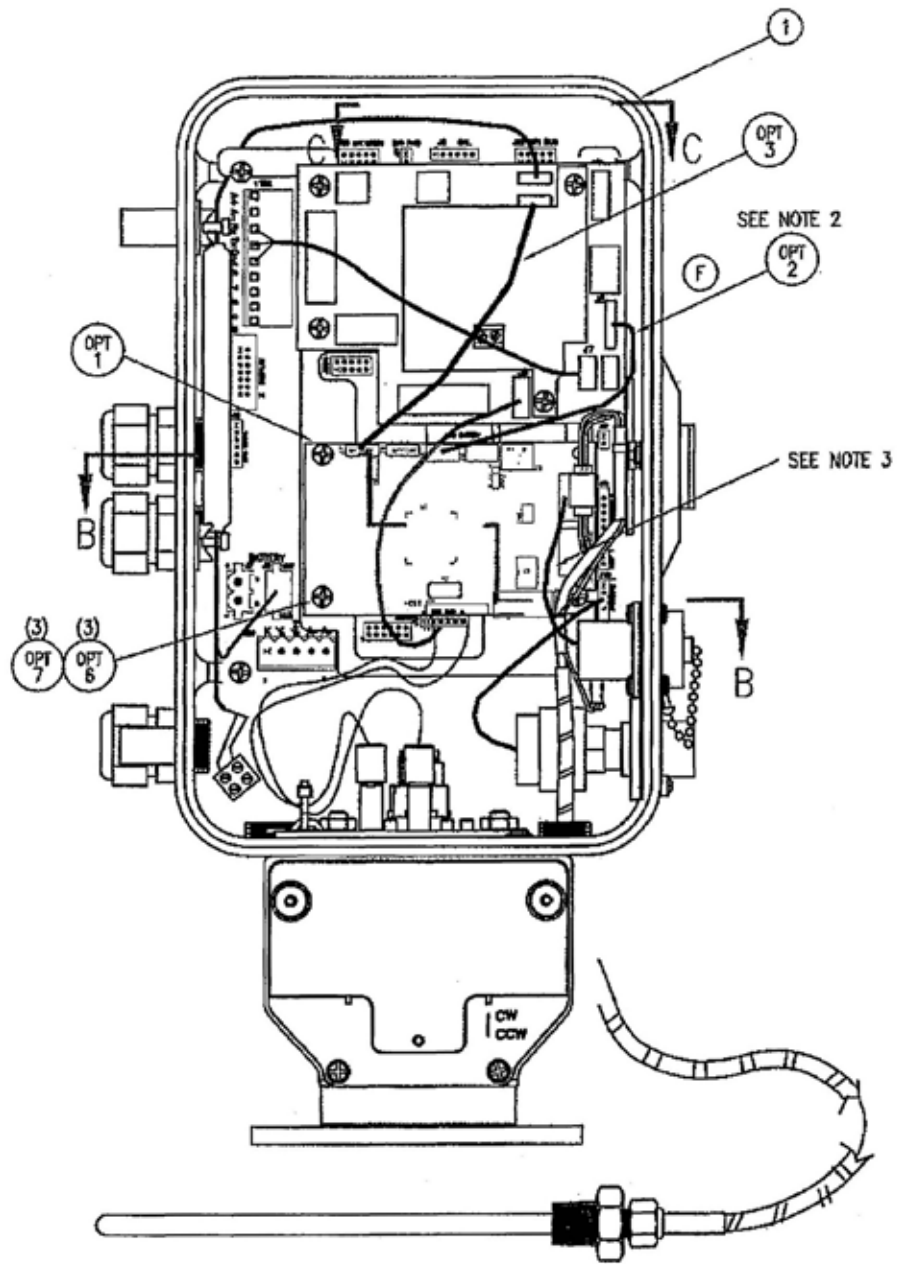
OPTIONS

ITEM	REQ	PART NO	DESCRIPTION
1	1	40-3000	ASSEMBLY, MESSENGER MODEM PCB
2	1	40-2133-8	CABLE 8' Tx,Rx
3	1	40-2820	ASSEMBLY, CABLE, INTERNAL POWER
4			
5			
6	3	20-7285	STANDOFF, #6-32 X 5/8 M/F
7	3	60-4219	SCREW, PN #6-32 x 1/4
8			
9			
10			

NOTES

1. CUSTOMER REQUIREMENTS MAY REQUIRE DEVIATION FROM THIS PARTS LIST.
2. CABLE WHI WIRE TO Tx, RED WIRE TO Rx, AND BLK WIRE TO COMMON.
3. CABLE WHI WIRE TO Rx, RED WIRE TO Tx, AND BLK WIRE TO COMMON.
4. CABLE WHI WIRE TO TOP POSITION OF J5.
5. CABLE RED WIRE TO +DC, BLK WIRE TO COMMON.
6. REFER TO SHEET 1 FOR CASE CONFIGURATION INFORMATION SUMMARY AND ILLUSTRATION OF TFB INSTALLATION.

(F)



SECT. B-B

TOC (Mini-AT Case) w/ TFB and PT Board

ITEM	REQ	PART NO	DESCRIPTION
1	1	20-92415HT1	CASE CONFIGURATION, TOC BASE UNIT
2			

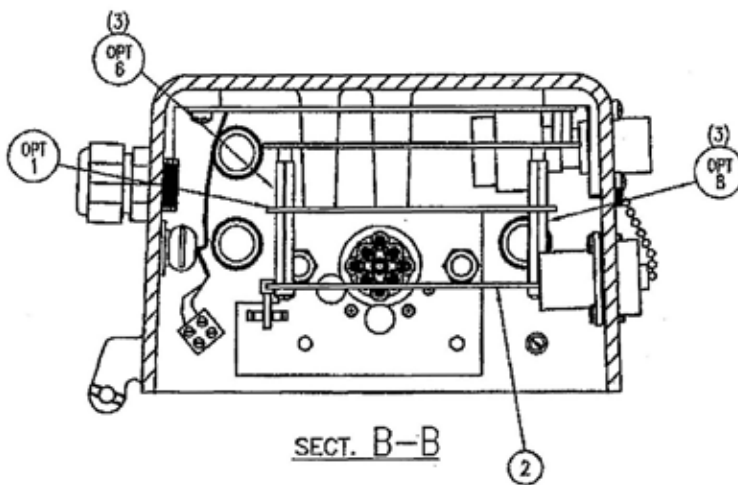
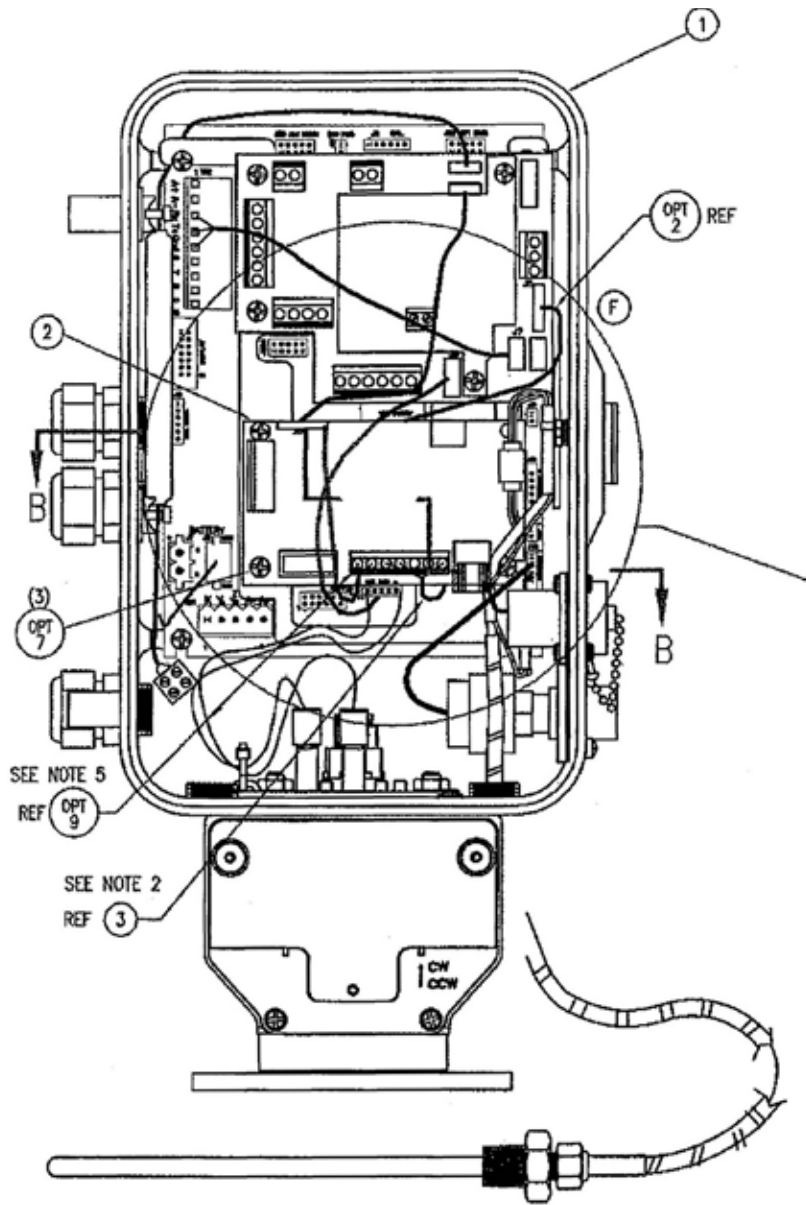
OPTIONS

ITEM	REQ	PART NO	DESCRIPTION
1	1	40-2855	ASSEMBLY, PROTOCOL TRANSLATOR PCB
2	1	40-2090	ASSEMBLY, CABLE, SCIB & 4-20 mA
3	1	40-2787	ASSEMBLY, CABLE, POWER, 4 PIN TO 4 PIN
4			
5			
6	3	20-7285	STANDOFF, #6-32 X 5/8 M/F
7	3	60-4219	SCREW, PN #6-32 x 1/4
8			
9			
10			

NOTES

1. CUSTOMER REQUIREMENTS MAY REQUIRE DEVIATION FROM THIS PARTS LIST.
2. CABLE WHI WIRE TO TOP POSITION OF J5.
3. UNPLUG CASE CONNECTOR CABLE FROM TIB J5 AND PLUG INTO PT BOARD J3, WHITE WIRE UP.
4. REFER TO SHEET 1 FOR CASE CONFIGURATION INFORMATION SUMMARY AND ILLUSTRATION OF TFB INSTALLATION.

(F)



TOC (Mini-AT Case) w/ TFB, Messenger Modem & PT Board

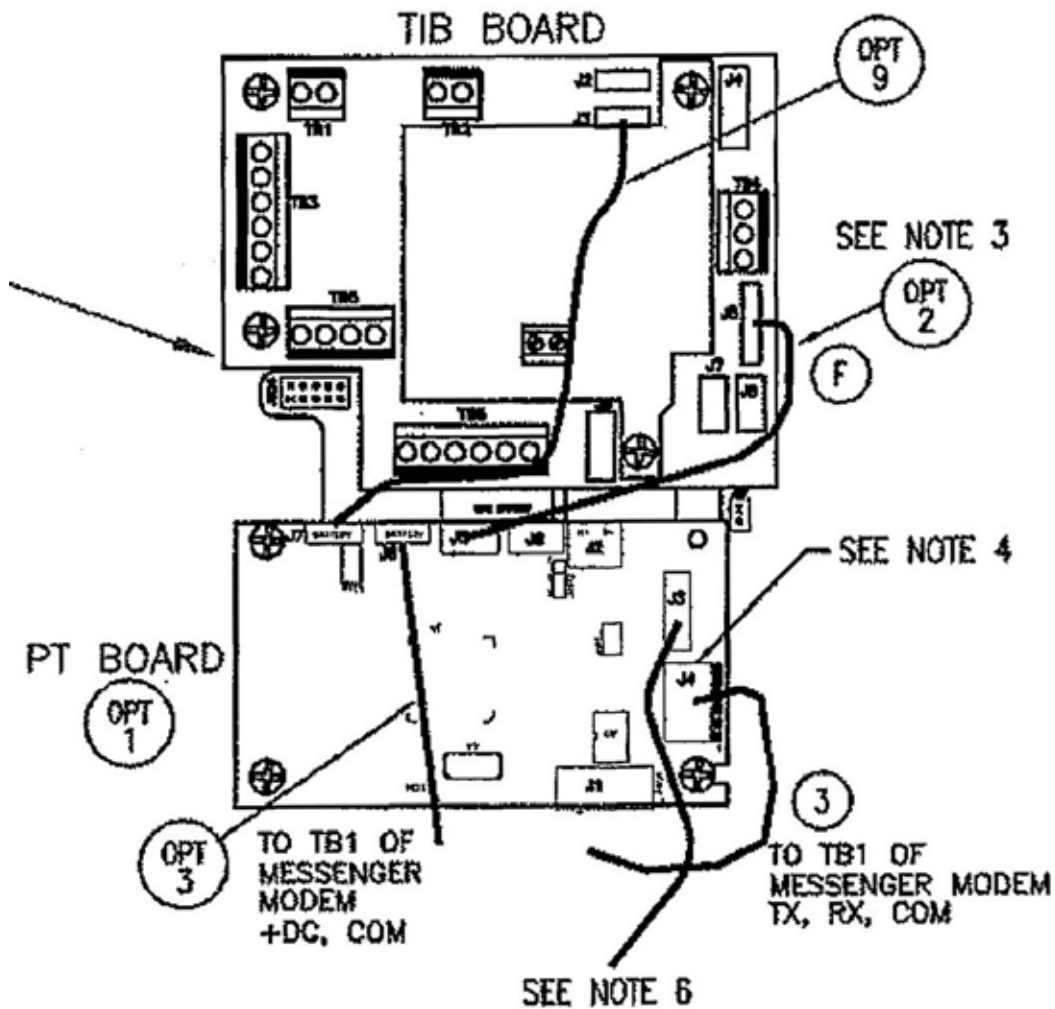
ITEM	REQ	PART NO	DESCRIPTION
1	1	20-8241SH12	CASE CONFIGURATION, TOC W/ TFB, MESSENGER
2	1	40-3000	ASSEMBLY, MESSENGER MODEM PCB
3	1	40-2133-3	CABLE, INTERNAL MODEM, 3 COND.

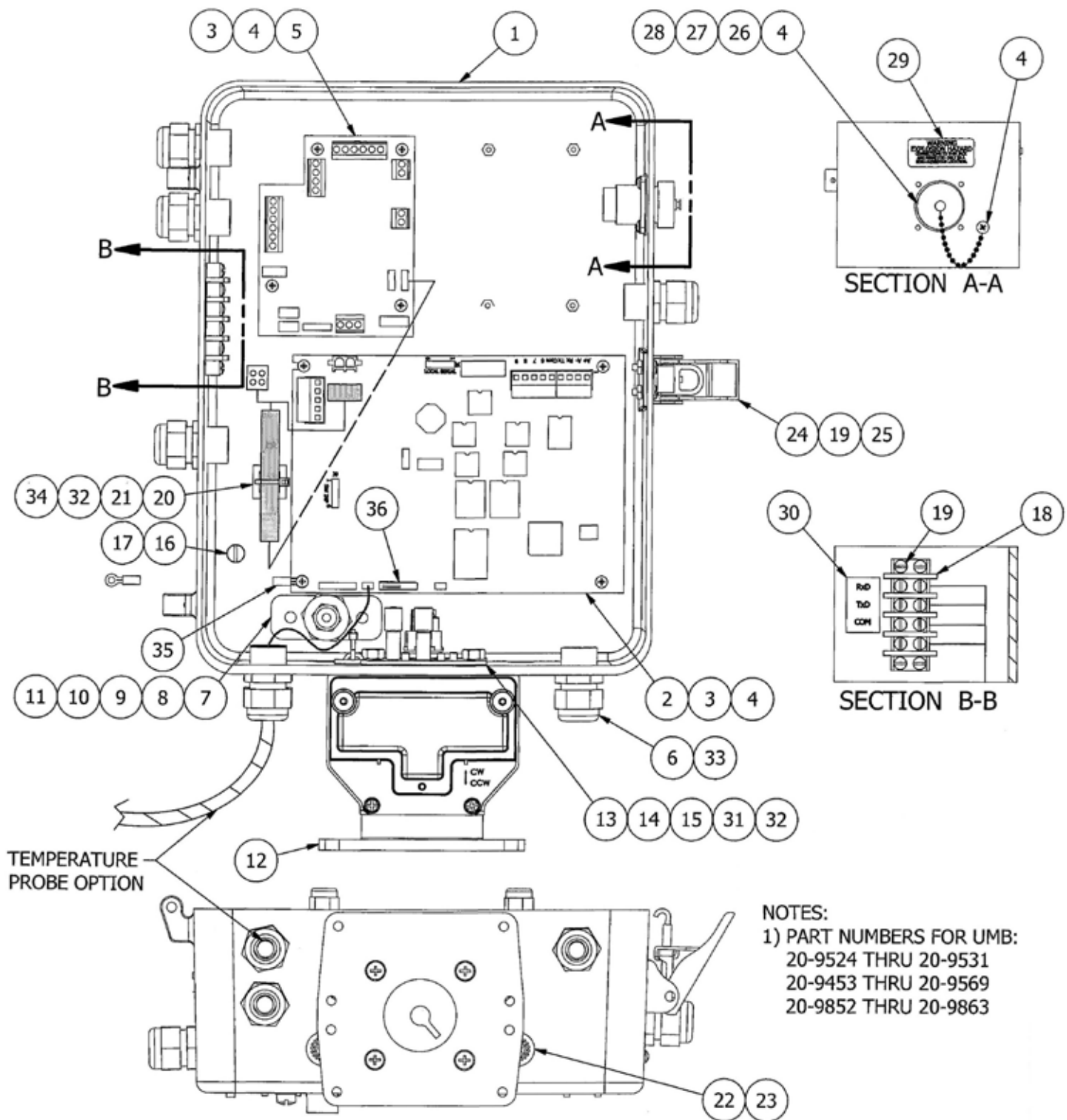
OPTIONS

ITEM	REQ	PART NO	DESCRIPTION
1	1	40-2655	ASSEMBLY, PROTOCOL TRANSLATOR PCB
2	1	40-2090	ASSEMBLY, CABLE, SCIB & 4-20mA
3	1	40-2820-8	CABLE, 4 PIN TO 2 LEAD
4			
5			
6	3	20-7285	STANDOFF, #6-32 X 5/8 M/F
7	3	80-4219	SCREW, PN #6-32 x 1/4
8	3	20-8460	STANDOFF, #6-32 x 1 M/F
9	1	40-2787	POWER CABLE ASSY, 4 PIN TO 4 PIN
10			

NOTES

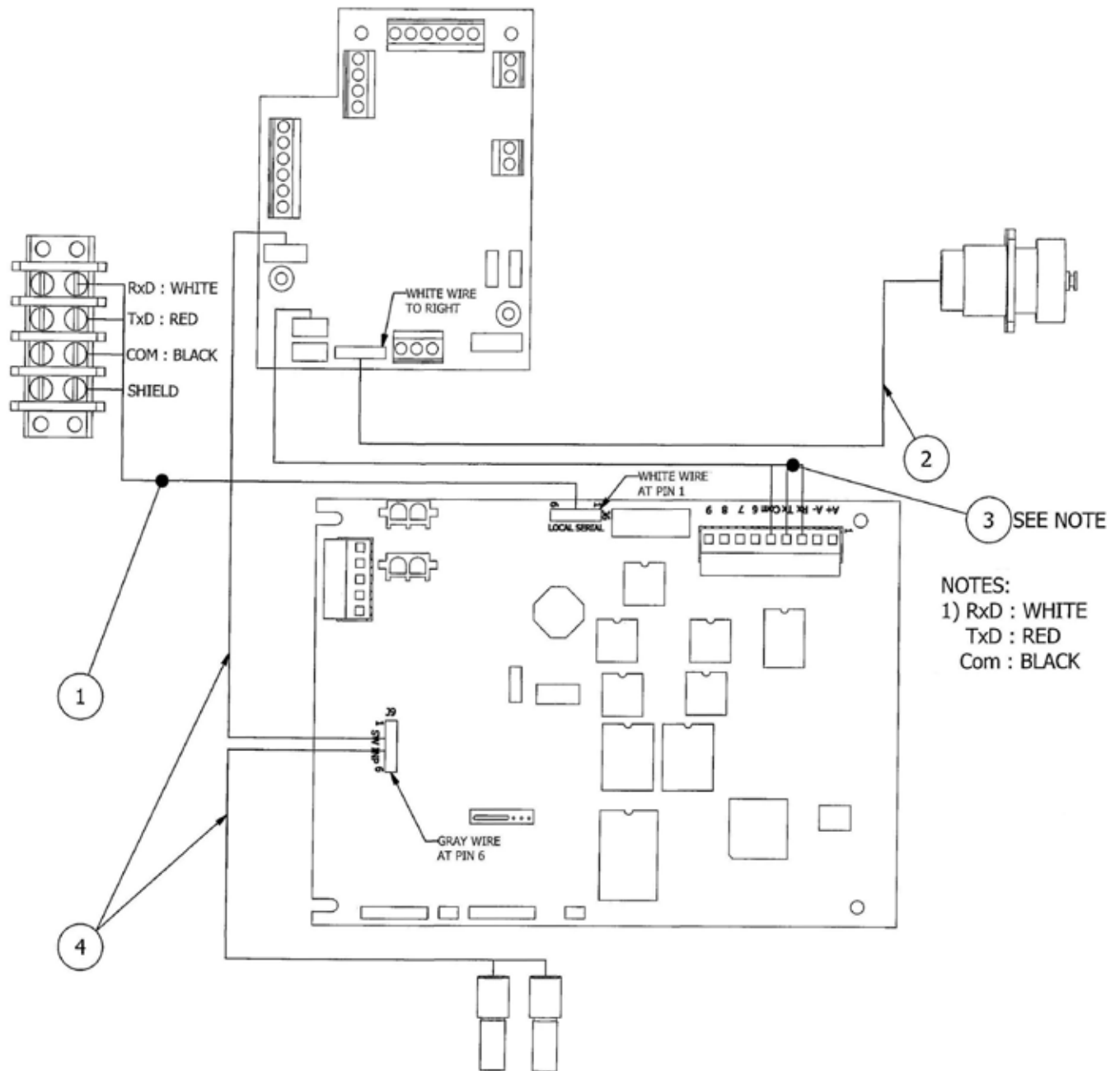
- CUSTOMER REQUIREMENTS MAY REQUIRE DEVIATION FROM THIS PARTS LIST.
- CABLE WHI WIRE TO Tx, RED WIRE TO Rx, AND BLK WIRE TO COMMON.
- CABLE WHI WIRE TO PIN 1 OF J5.
- CABLE WHI WIRE TO Rx, RED WIRE TO Tx, AND BLK WIRE TO COMMON.
- CABLE RED WIRE TO +DC, BLK WIRE TO COMMON.
- UNPLUG CASE CONNECTOR CABLE FROM TIB J5 AND PLUG INTO PT BOARD J3, WHITE WIRE UP.
- REFER TO SHEET 1 FOR CASE CONFIGURATION INFORMATION SUMMARY AND ILLUSTRATION OF TFB INSTALLATION.





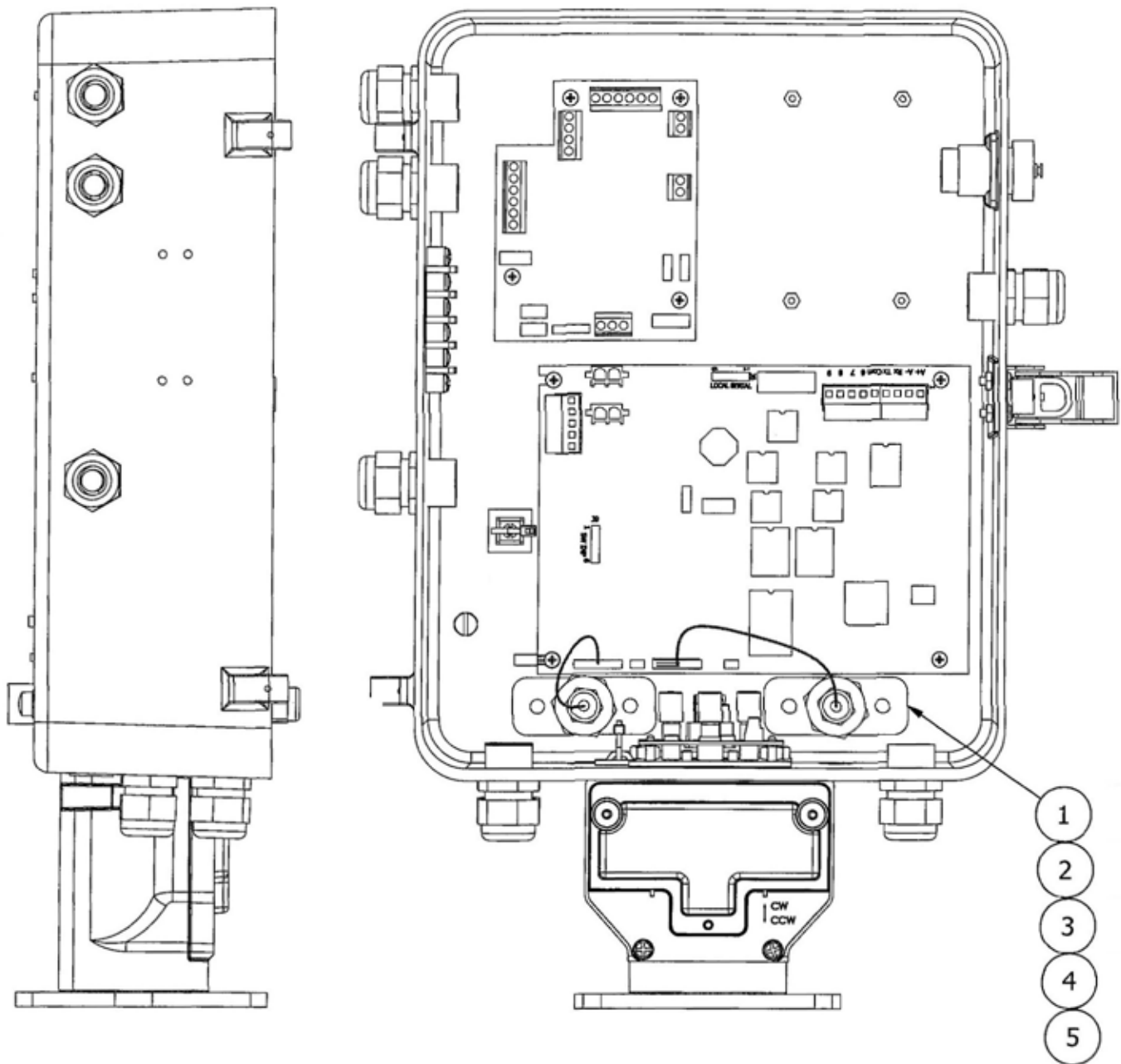
TOC - 800 Parts List

ITEM	QTY	PART #	DESCRIPTION
1	1	20-9310	DRILLING, CASE, TOC 800, ACCUTEST 800
2	1	40-2335	MAIN BOARD, MINI-AT
3	12	20-7284	STANDOFF, 6-32, 7/16 M-F
4	13	60-4219	SCREW, PN 6-32 x 1/4 PHILLIPS
5	1	40-2708	ASSEMBLY, PCB, TURBINE INTERFACE (TIB)
6	7	20-8911	FITTING, STRAIN RELIEF, 1/2 NPT
7	1	20-2284	GASKET, PRESSURE CASE CONNECTION
8	1	20-8386	ASSEMBLY, CASE PRESSURE CONNECTION
9	1	40-1428	TRANSDUCER DRAWING
10	2	60-1402	SCREW, 1/4-20 X 1/2", FLSTR HD
11	2	20-7649	WASHER, STAR, 1/4
12	1	SEE NOTE 1	UMB, COMPOSITE
13	2	60-1607	1/4-20 7/32" SS HEX NUT
14	1	22-1494	ASSEMBLY, PLATE, SWITCH MOUNTING
15	2	22-1161	SLEEVE, SWITCH
16	1	60-1375	SCREW, 10-32 X 5/15, BINDING HD, GREEN
17	1	20-5300	WASHER, #10 EXTERNAL LOCK
18	1	40-2289	TERMINAL BLOCK, 4 POSITION
19	6	60-1228	SCREW, BD HD 6-32 x 1/2"
20	1	40-1329	HOLDER, CABLE TIE
21	1	60-1220	SCREW, #6-32 x 1/4, FLAT HEAD
22	2	20-2191	VENT
23	2	20-3737	FILTER
24	1	20-4295	LATCH, w/ HASP
25	2	60-1604	NUT, HEX 6-32
26	1	40-1580	ASSEMBLY, RS-232 INTERNAL CABLE
27	1	20-8196	GASKET, AUDIT TRAIL
28	1	40-1576	CAP, W/ CHAIN
29	1	20-8087	LABEL, WARNING DCU
30	1	20-9656	LABEL, RxD/TxD/COM
31	1	40-4413	ASSEMBLY, SWITCH, CAPSULE, W/ TIB TO MINI-AT CABLE
32	2	20-3827	CABLE, TIE, WHITE
33	7	20-7552	PLUG, STRAIN RELIEF 3/8" DIA.
34	1	40-2809	ASSEMBLY, POWER CABLE, TOC
35	1	40-2013-12	GROUND WIRE, ELECTRONIC RECORDER
36	1	40-2112	ASM, TERMINATOR, PRESSURE



TOC Cabling Diagram

ITEM	QTY	PART #	DESCRIPTION
1	1	40-3144	CABLE, J6 TO REMOTE 4-20mA
2	1	40-1580	ASSEMBLY, RS-232 INTERNAL CABLE
3	1	40-2724-10	ASSEMBLY, SERIAL CABLE, 10"
4	1	40-4413	ASSEMBLY, SWITCH, CAPSULE, W/ TIB TO MINI-AT CABLE



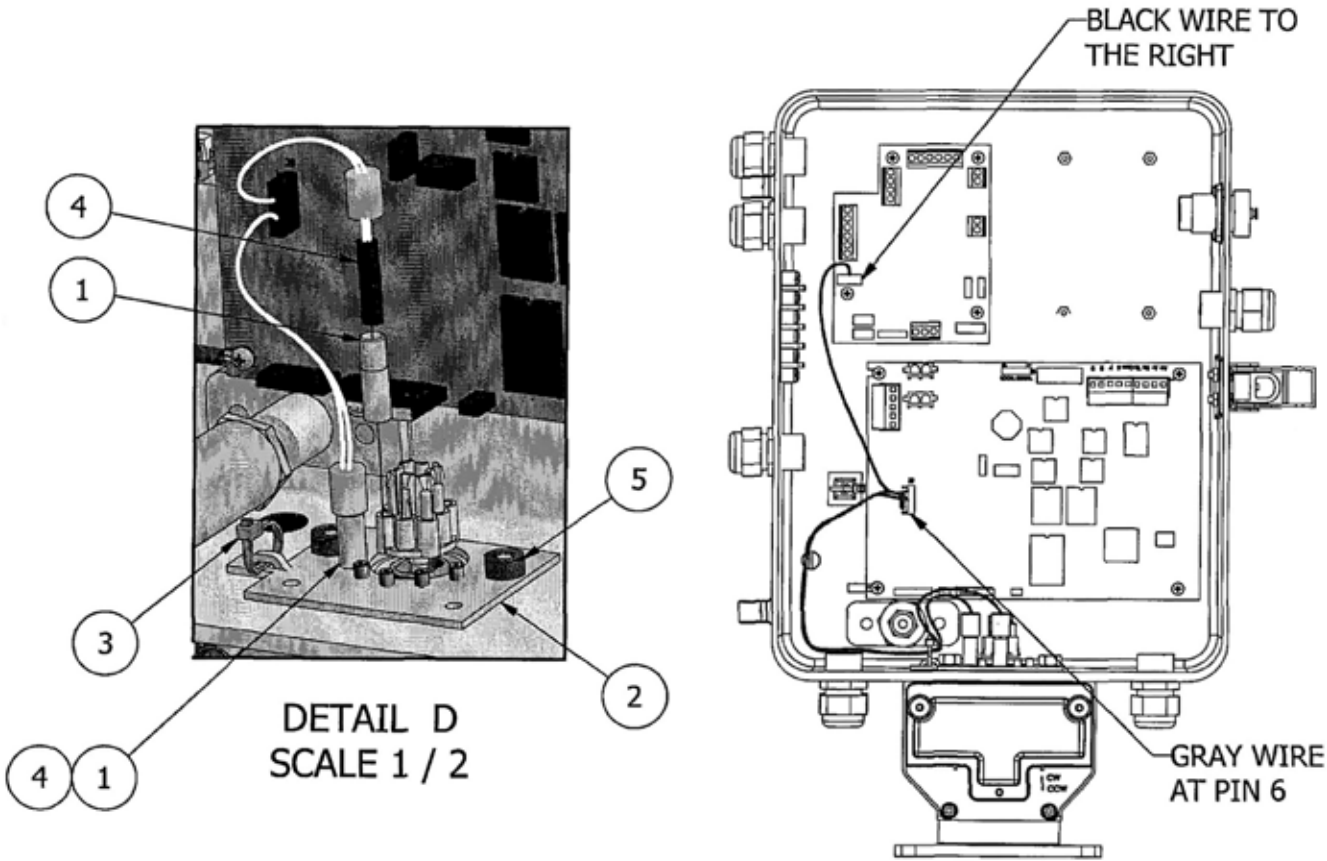
TOC - 800 2nd Pressure Option

1	1	20-2284	GASKET, PRESSURE CASE CONNECTION
2	1	20-8386	ASSEMBLY, CASE PRESSURE CONNECTION
3	1	40-1428	TRANSDUCER DRAWING
4	2	60-1402	SCREW, 1/4-20 X 1/2", FLSTR HD
5	2	20-7469	WASHER, STAR, 1/4

TOC - 800

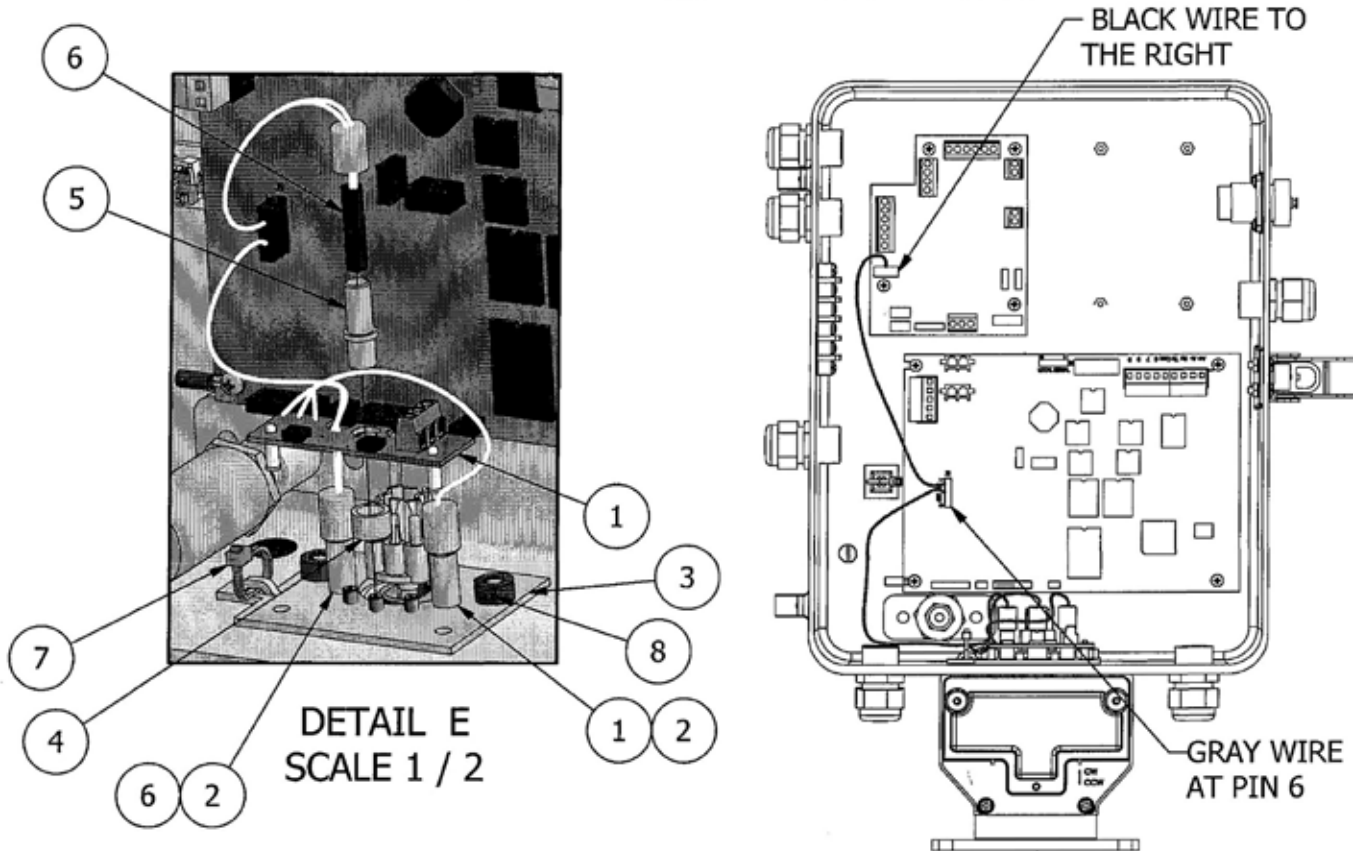
Standard Switches

ITEM	QTY	PART #	DESCRIPTION
1	2	22-1161	SLEEVE, SWITCH
2	1	22-1494	ASSEMBLY, PLATE, SWITCH, MOUNTING
3	1	20-3827	CABLE, TIE, WHITE
4	1	40-4413	ASSEMBLY, SWITCH, CAPSULE, W/ TIB TO MINI-AT CABLE
5	2	60-1607	1/4-20, SS HEX NUT



TOC - 800 Uncorrected Switch

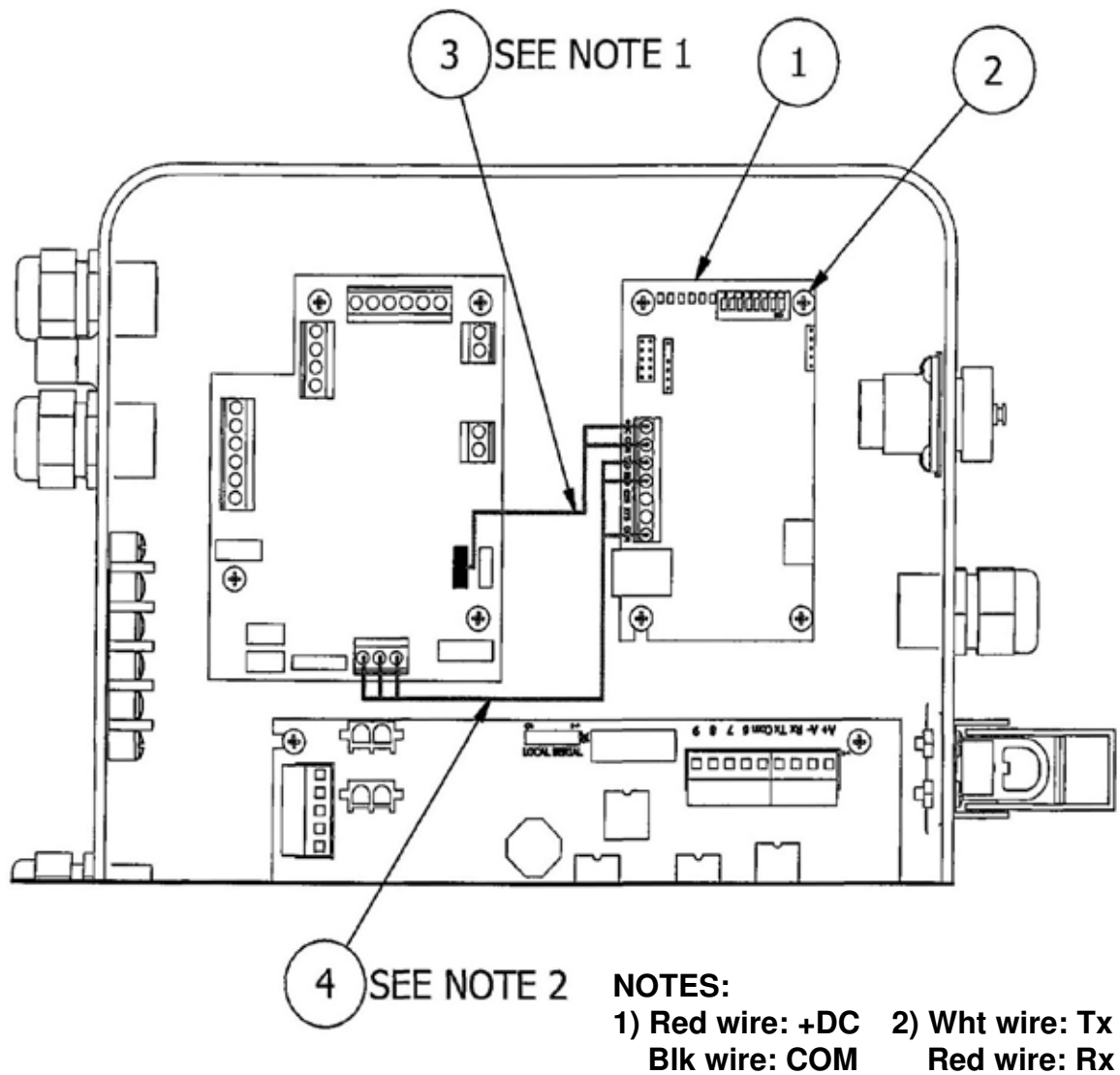
ITEM	QTY	PART #	DESCRIPTION
1	1	40-3564	ASM, MECHANICAL UNCORRECTED SWITCH INPUT BOARD
2	2	22-1161	SLEEVE, SWITCH
3	1	22-1494	ASSEMBLY, PLATE, SWITCH MOUNTING
4	1	22-1490	SPACER, UNCORRECTED SWITCH BOARD
5	1	22-1491	SLEEVE, SWITCH, UNCORRECTED
6	1	40-4413	ASSEMBLY, SWITCH, CAPSULE, W/ TIB TI MINI-AT CABLE
7	1	20-3827	CABLE, TIE, WHITE
8	2	60-1607	1/4-20, SS HEX NUT



TOC - 800

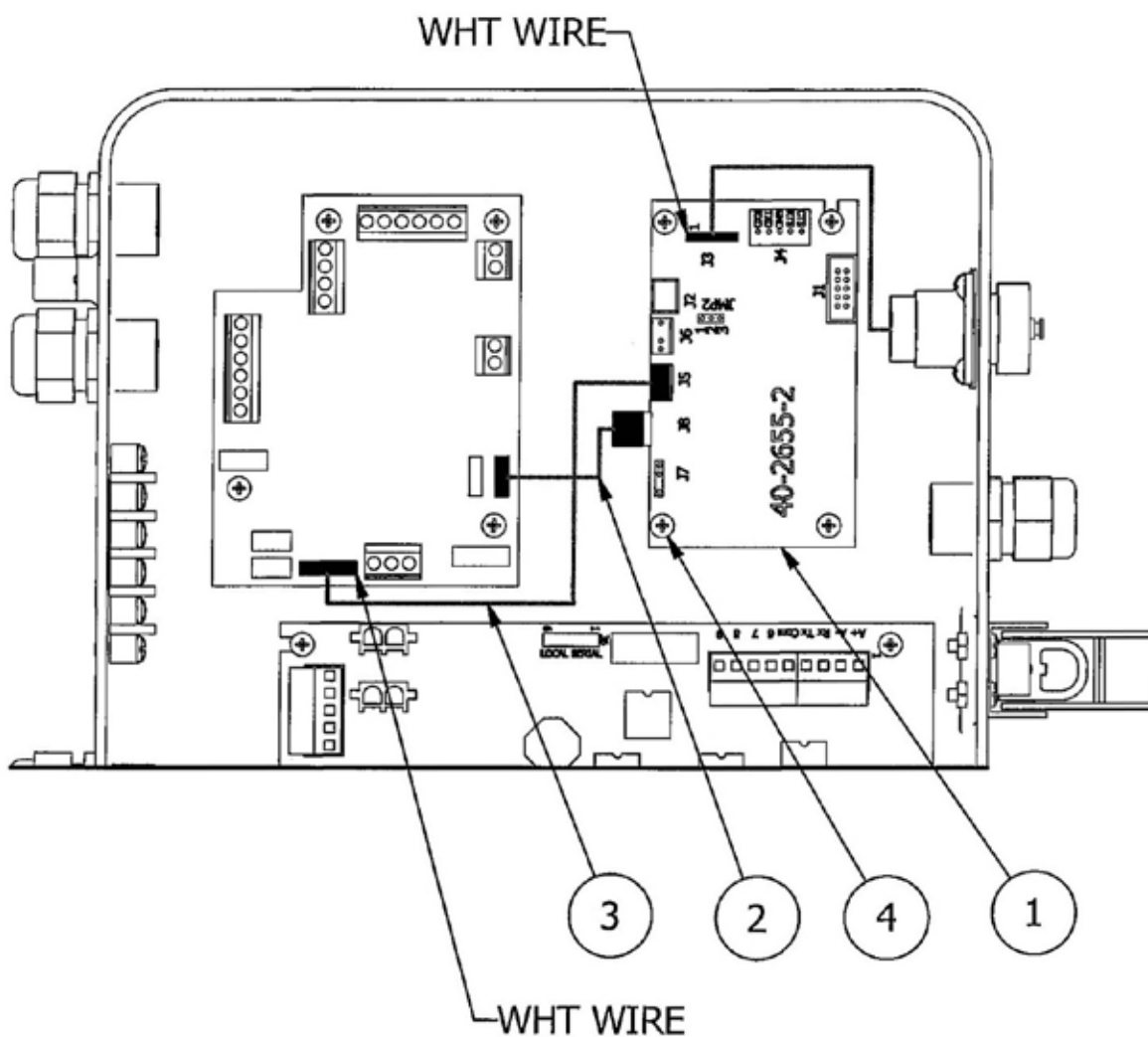
Messenger Modem Option

ITEM	QTY	PART #	DESCRIPTION
1	1	40-3000-3	MESSENGER MODEM
2	4	60-4219	SCREW, PN 6-32 X 1/4, PHILLIPS
3	1	40-2820-5	ASSEMBLY, INTERNAL POWER CABLE, 5"
4	1	40-2133-8	CABLE, INTERNAL MODEM, 8"



TOC - 800 PT Board Option

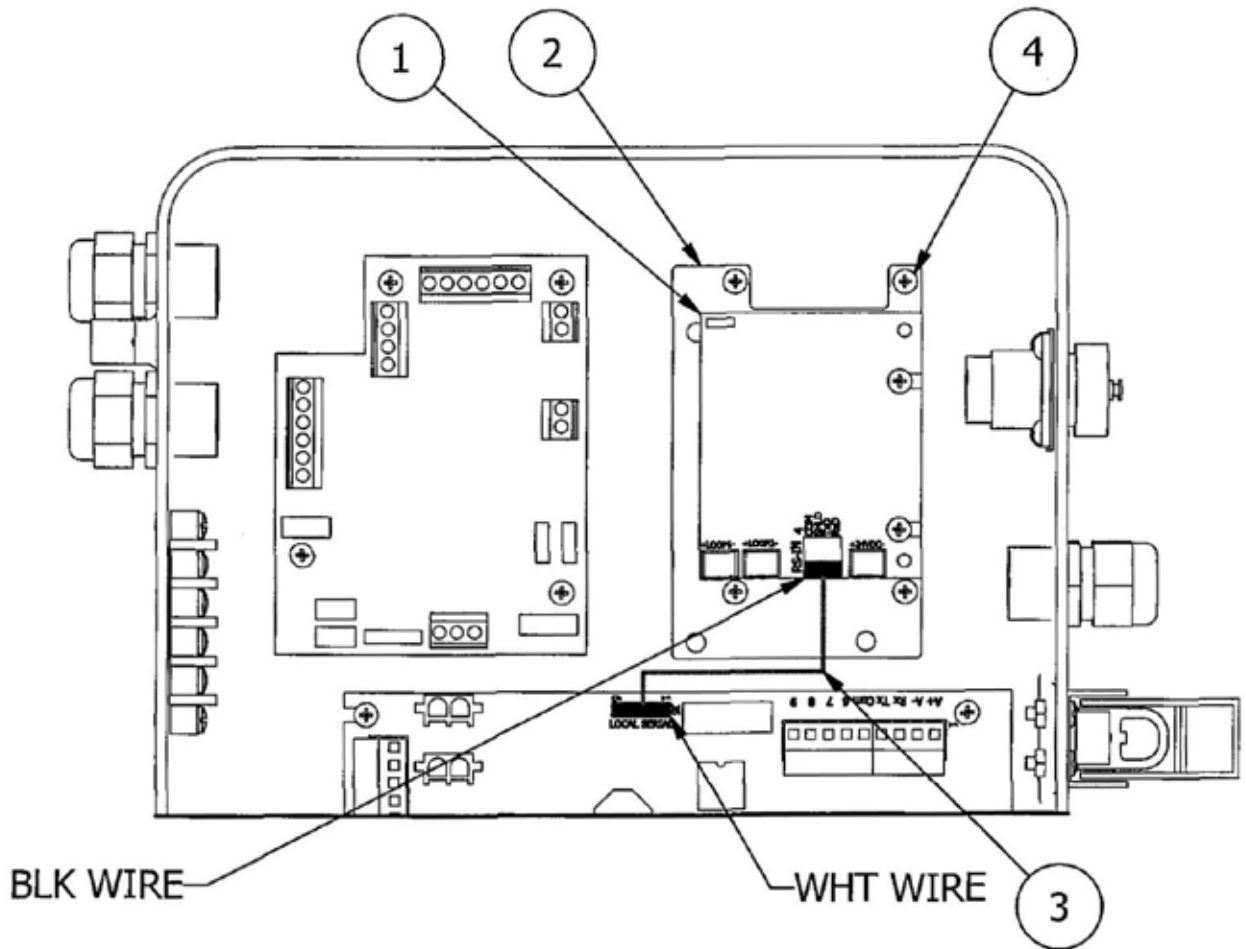
ITEM	QTY	PART #	DESCRIPTION
1	1	40-2655-2	ASSEMBLY, PROTOCOL TRANSLATOR PCB
2	1	40-2090	ASSEMBLY, CABLE, SCIB & 4-20 BOARD
3	1	40-2787	ASSEMBLY, CABLE, POWER, 4 PIN TO 4 PIN
4	4	60-4219	SCREW, 6-32 X 1/4"



TOC - 800

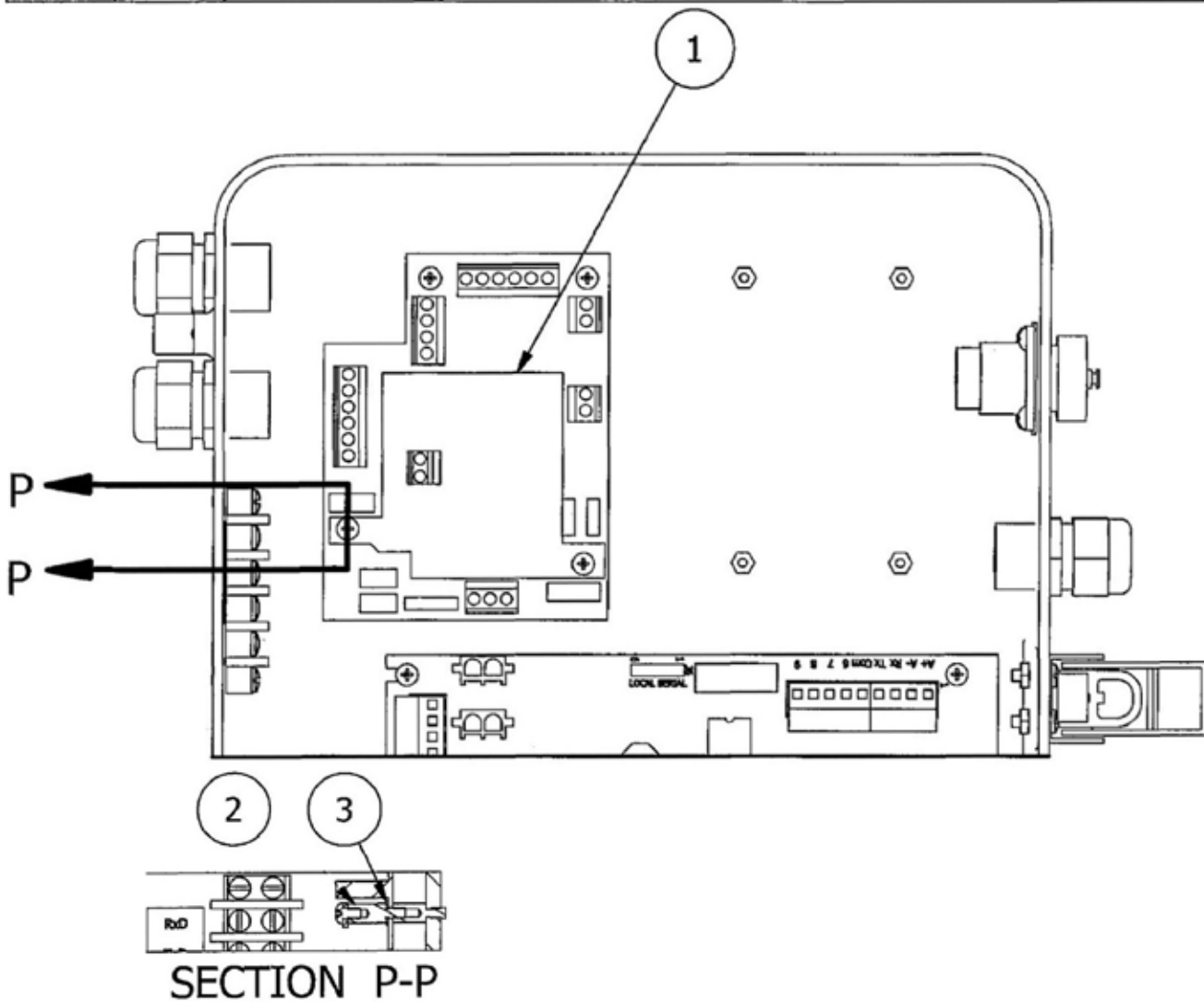
4-20 mA Board Option

ITEM	QTY	PART #	DESCRIPTION
1	1	40-2500	ASSEMBLY, 4-20 mA BOARD
2	1	20-9359	ASSEMBLY, MOUNTING PLATE, 4-20 BOARD
3	1	40-2090	CABLE, 4-20 mA BOARD
4	6	60-4219	SCREW, 6-32 X 1/4"



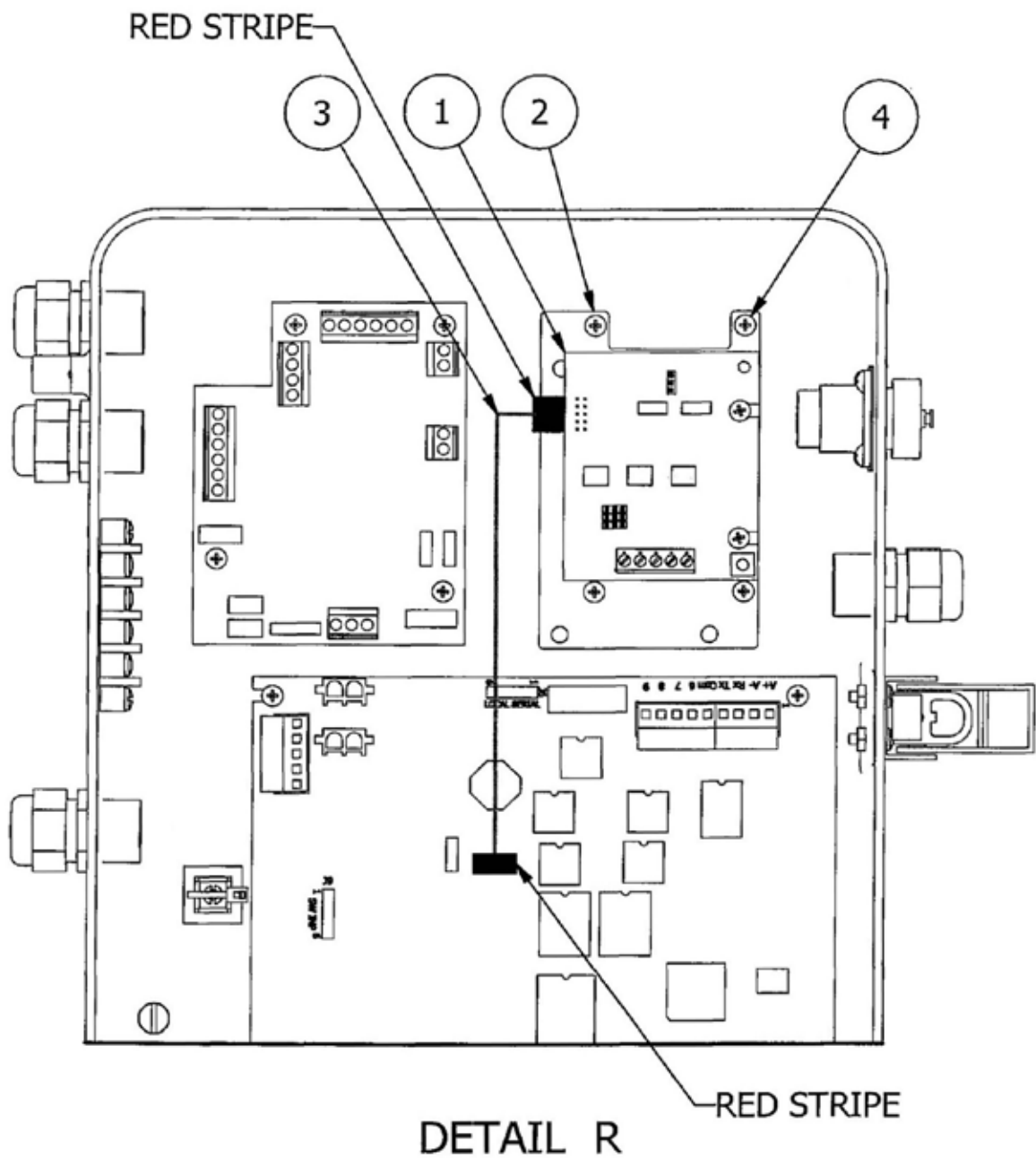
TOC - 800 PT Board Option

ITEM	QTY	PART #	DESCRIPTION
1	1	40-2885	ASSEMBLY, TURBO FREQUENCY BOARD
2	2	20-8554	STANDOFF, M/F, 6-32 X 1/2" LONG
3	2	20-1783	WASHER, #6 FLAT



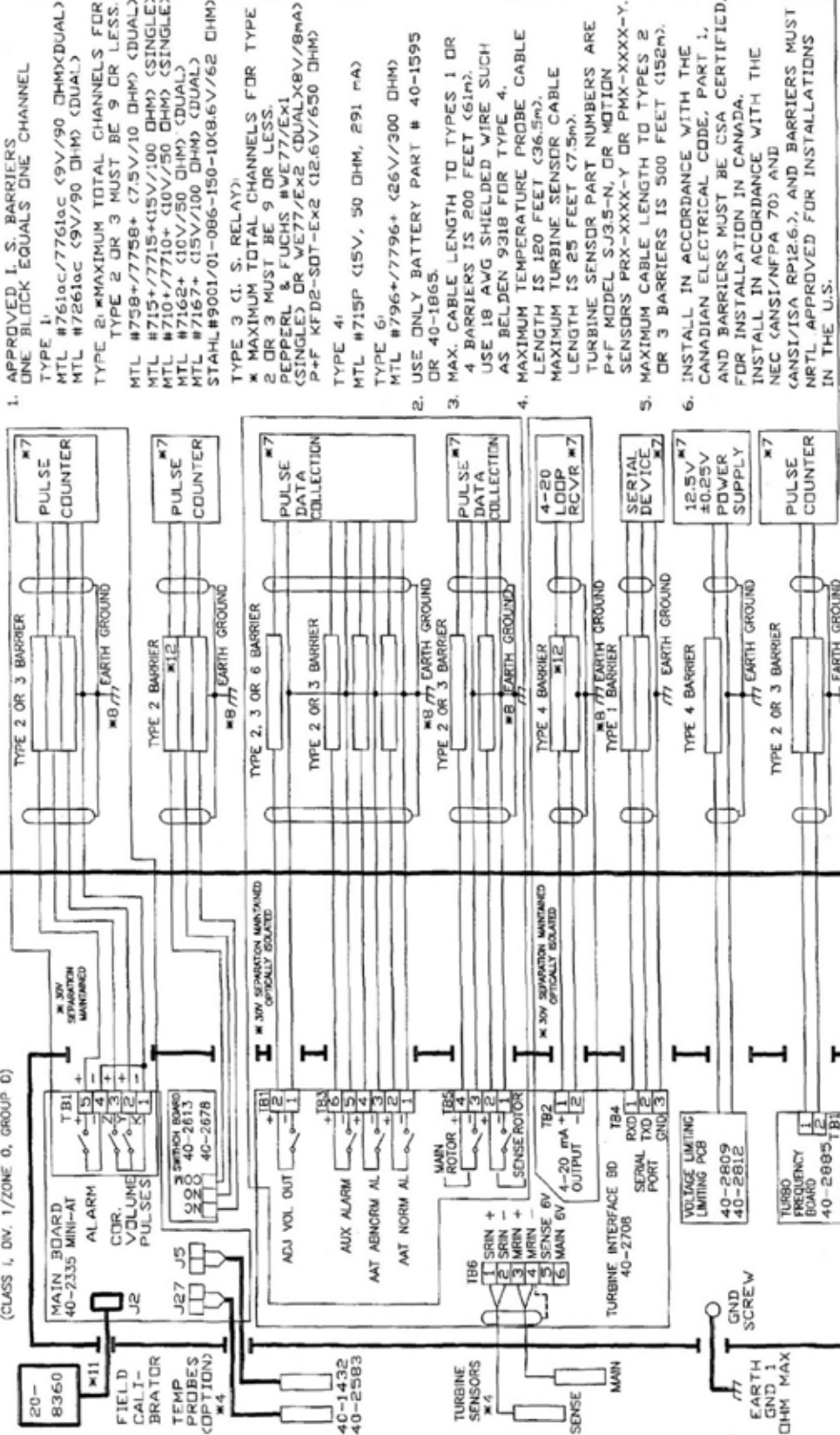
TOC - 800 SPA Board Option

ITEM	QTY	PART #	DESCRIPTION
1	1	40-1823	ASSY, SPA BOARD
2	1	20-9359	ASSY, MOUNTING PLATE, 4-20 mA BOARD
3	1	40-2551-1	ASSY, SPA CABLE, 10"
4	6	60-4219	SCREW, 6-32 X 1/4"



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

NON-HAZARDOUS LOCATION



NOTES

- APPROVED I. S. BARRIERS ONE BLOCK EQUALS ONE CHANNEL
- TYPE 1: MTL #7610c (9V/90 OHM) DUAL; MTL #72610c (9V/90 OHM) DUAL; TYPE 2: MAXIMUM TOTAL CHANNELS FOR TYPE 2 OR 3 MUST BE 9 OR LESS; MTL #758+/7758+ (7.5V/10 OHM) DUAL; MTL #715+/7715+ (15V/100 OHM) SINGLE; MTL #710+/7710+ (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)
- MAXIMUM TOTAL CHANNELS FOR TYPE 2 OR 3 MUST BE 9 OR LESS. PEPPERL & FUCHS #WE77/EX1 (SINGLE) OR WE77/EX2 (DUAL) X8V/8mA; P+F KFD2-SOT-Ex2 (12.6V/650 OHM)
- TYPE 4: MTL #715P (15V, 50 OHM, 291 mA)
- TYPE 6: MTL #796+/7796+ (26V/300 OHM)
- USE ONLY BATTERY PART # 40-1595
- 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.
- 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-XXXX-Y OR PMX-XXXX-Y.
- 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 RPI2.6), AND BARRIERS MUST BE NRTL APPROVED FOR INSTALLATIONS IN THE U.S.

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

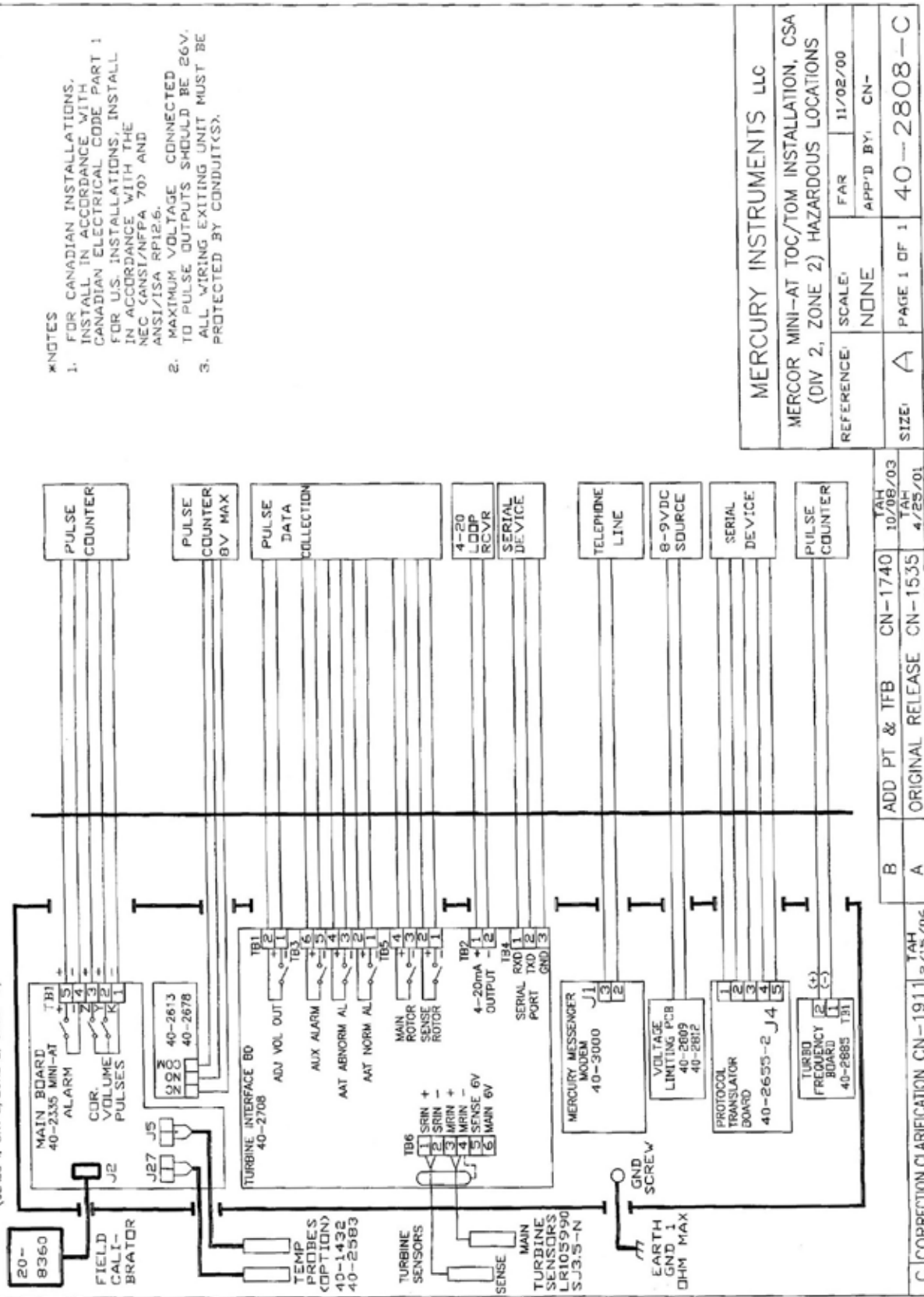
- PERIPHERAL EQUIPMENT CONNECTED TO THE MINI-AT SHALL NOT USE OR GENERATE MORE THAN 250 VOLTS.
- RESISTANCE FROM BARRIER GROUND TO EARTH GROUND SHALL BE LESS THAN ONE OHM.
- SHIELDS INSIDE THE EQUIPMENT MUST EXTEND AS CLOSE TO THE TERMINALS AS POSSIBLE AND MUST BE CONNECTED TO BARRIER GROUND.
- MEANS 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, AND SWITCH OUTPUT.

B	ADD 77XX BARRIERS, SWITCH OUTPUTS & TB	TAH 10/08/03	C	CLARIFICATION AND FIXES CN-1911	TAH 2/15/06
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40-2808-C

NON-HAZARDOUS LOCATION

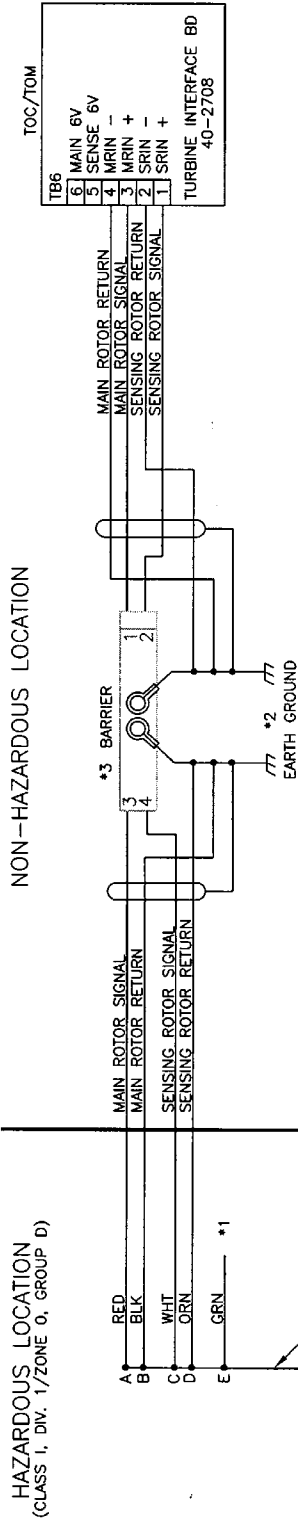
HAZARDOUS LOCATION
(CLASS 1, DIV. 2/ZONE 2, GROUP D)



- *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 CONDUIT(S).
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MERCURY INSTRUMENTS LLC		
MERCOR MINI-AT TOC/TOM INSTALLATION, CSA (DIV 2, ZONE 2) HAZARDOUS LOCATIONS		
REFERENCE:	SCALE:	FAR
NONE	NONE	11/02/00
APPR'D BY:	CN-	
SIZE:	A	PAGE 1 OF 1
40-2808-C		

C	CORRECTION, CLARIFICATION	CN-1911	TAH	2/15/05	A	ORIGINAL RELEASE	CN-1535	TAH	4/25/01
B	ADD PT & TFB	CN-1740	TAH	10/08/03					



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.

AUTO ADJUST® TURBO METER

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

Find Out More:

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