Honeywell

Honeywell Process Solutions

Mercury Protocol Translator Board

Mercury to Modbus Protocol Interface

User Manual

October 2010

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Reference Documents

Modicon Modbus Protocol Reference Guide

Document Number: PI-MBUS-300, Rev. J

Specifications and Requirements for an Electronic Flow Measurement Remote Terminal Unit.

Document Number: N/A, 07-18-1990, Revised 12-05-1994, Enron Corp.

Functional Specifications for an Electronic Flow Measurement Communications System.

Document Number: N/A, 09-11-1995, Enron Corp.

Serial Communications Interface & Protocol

Document Number: (per Instrument), Mercury Instruments, Inc.

Modbus is a trademark of MODICON, Inc.

Prerequisites

This guide assumes you have:

- Familiiarity with your Mercury Instrument.
- An understanding of the Modbus Host system being employed.
- An understanding of basic data communications concepts.
- All necessary hardware and software including PT Config.exe.
- This guide assumes you are using one of the following Mercury Instruments:

Electronic Correctors:

EC-AT
Mercor Mini
Mini-Max
Mini-AT
Turbo Corrector (TOC)
Turbo Monitor (TOM)

Electronic Recorders:

ER
ERX

Contents

Section A - General Desription and Connections

Section B - Configuration and Operation

Section C - Modbus Protocol Details

Section D - Diagnostic Help, Specifications, FW Upgrading

Section A

General Description and Connections

1 Overview

1.1 General Desription

The **Mercury Protocol Translator (PT Board**) is an adapter board that is connected between the Mercury Instrument and a Host SCADA system.

This manual is intended to support only Modbus protocols.

This device is designed for operations with a dedicated Mercury Instruments measuring device to allow communications with Modbus SCADA systems.

The PT Board will translate the Host's protocol to and from Mercury Protocol so the Host can communicate with a Mercury Instrument in its own native protocol (e.g. Modbus). The PT Board handles communications between the Host interface and the Mercury Instrument in a Master-Slave type fashion.

1.2 Host Protocols

- **MERCURY** Serial Protocol
- **MODBUS ASCII** (32-bits per register)
- **MODBUS RTU** (16-bits or 32-bits per register)

- All data is in **IEEE-745 32-bit floating point** format.
- Data is sent in either 16 or 32 bits per Register depending on configuration.

1.3 Archive Data Support

MODBUS Archive Data Support:

Implements **Enron Corp's** method for EFM Archive Data Collection using **Modbus ASCII** Protocol.

- **Enron variant**

  5-Items logged in every Daily and Hourly archive record.

  35 days for each Archive type + 100 Alarm-Events.

- **Mercury variant**

  10-Items logged in every Daily and Hourly archive record.

  35 days for each Archive type + 100 Alarm-Events.

1.4 Protocol Determination

1.4.1 Automatic Host Protocol Detection

The PT Board can automatically determine if the Host system is using Mercury or Modbus protocol. Once the PT Device has determined the protocol type (Mercury or Modbus), it will continue to adhere to this same protocol until the link session with the Host is terminated.

Mercury and or Modbus Protocols (ASCII/RTU) can be used on any one of the three Host Interface Serial Ports (J2, J3, or J4).

1.4.2 Only One Host Interface Port Active At A Time

Only one of the **three** Host Interface Serial Ports (J2, J3, or J4) may be used at a time. The Host must terminate the current communications session before a different Host Interface Port or Protocol can be utilized (no concurrent serial port activity allowed).

Protocol switching is allowed on all three Host ports. For example, the Host can talk Modbus protocol on serial port J4 and then switch to Mercury protocol after the Modbus session ends.

The communications session is normally terminated by a Sign-Off message from Mercury protocol, or from the configurable inactivity time-out when using Modbus protocols.

2 Interface Connections

2.1 Connection Description

The **Mercury Protocol Translator (PT Board**) has three serial ports for connections with a Host SCADA system. There are two ports for interfacing with a Mercury Instrument .

Host Serial Interface Ports

J2 - 2-wire RS-485 for multidrop connection (2-pin screw terminal)

J3 - 3-wire RS-232 for local connection (6-pin header)

J4 - 5-wire RS-232 for modem connection (5-pin screw terminal)

Instrument Serial Interface Ports

J5 - 3-wire RS-232 (4-pin header) [ECAT, ER, Mini, Mini-AT]

J6 - 3-wire CMOS (3-pin header) [Mini-Max, Sentry, ERX, PA]

☞ Only 1 port (J5 or J6) may be used in an application.

Power Supply

J7 VBatt / DC supply (3-pin header)

J8 VBatt / DC supply (3-pin header)

☞ Either J7 or J8 can be used - second connection is a spare.

Flash Programming Port (Firmware Upgrading)

J1 (10-pin header) for use with MPA (Mercury Programming Adapter).

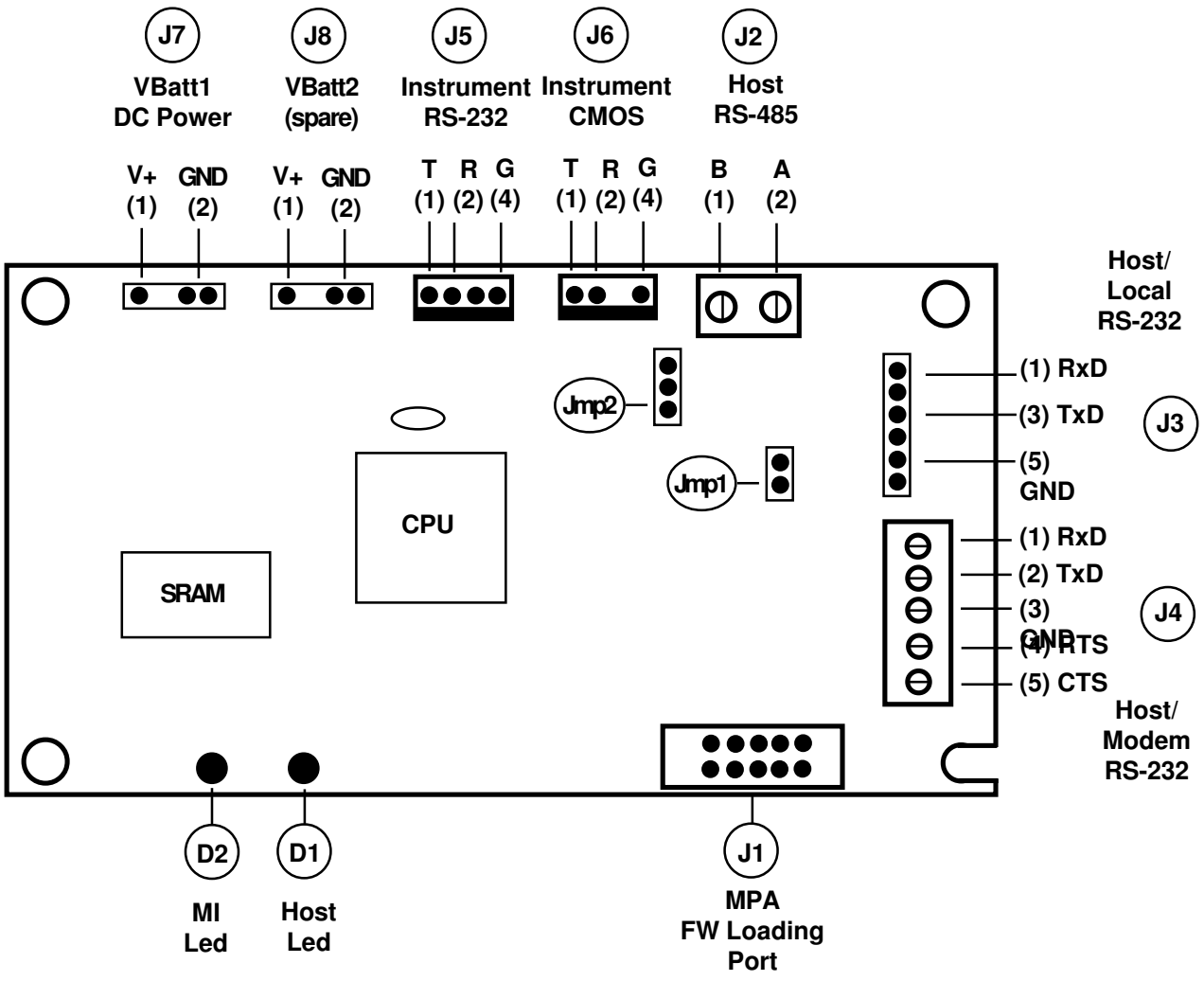
Jumper #2

Install shunt across JMP2 Pins 1 - 2 if Instrument is connected to **J5**

Install shunt across JMP2 Pins 2 - 3 if Instrument is connected to **J6**

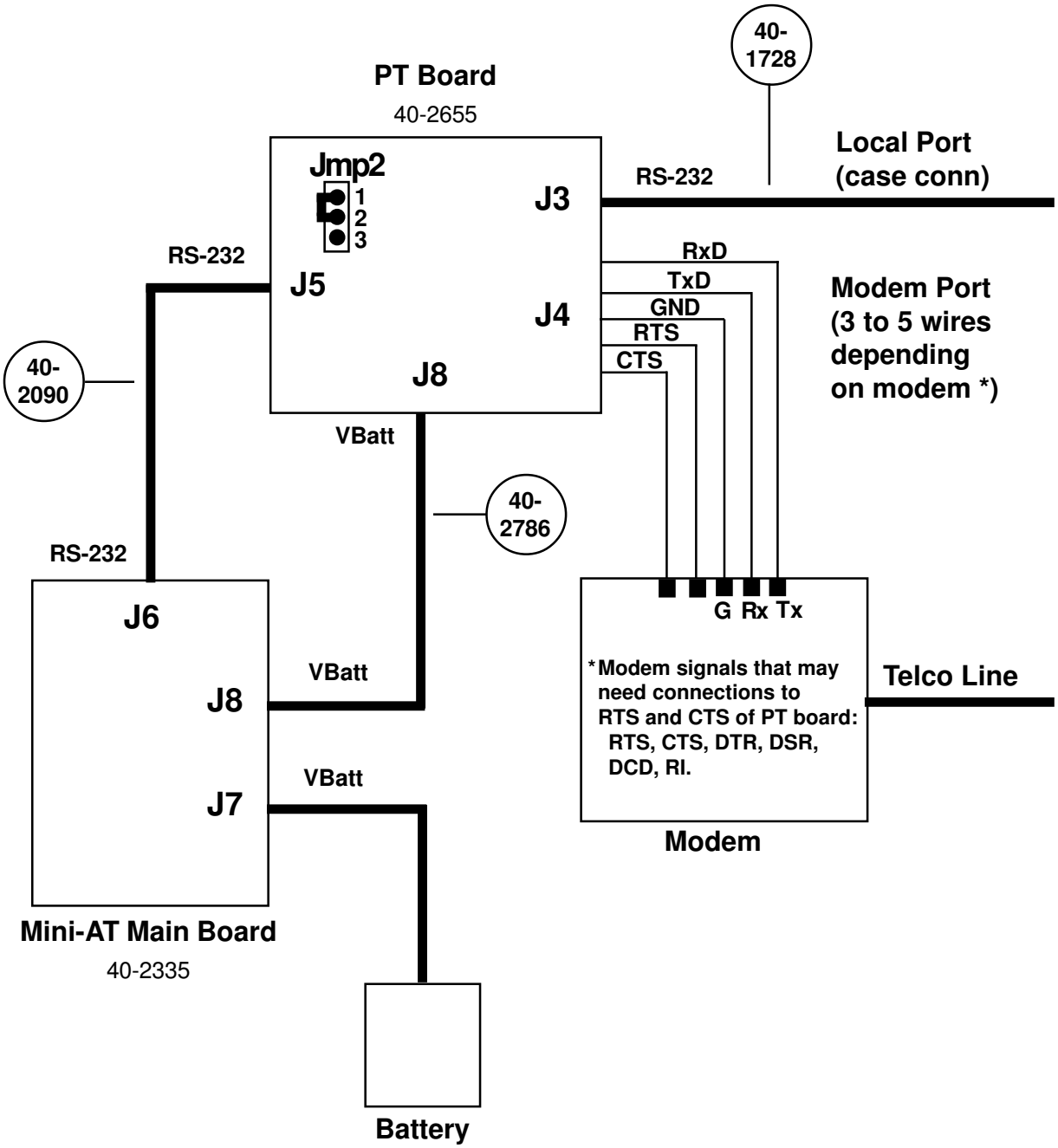
2.2 Connection Layout

Shown below is the PT Board with indentifiers for connections, LEDs, and Jumpers.



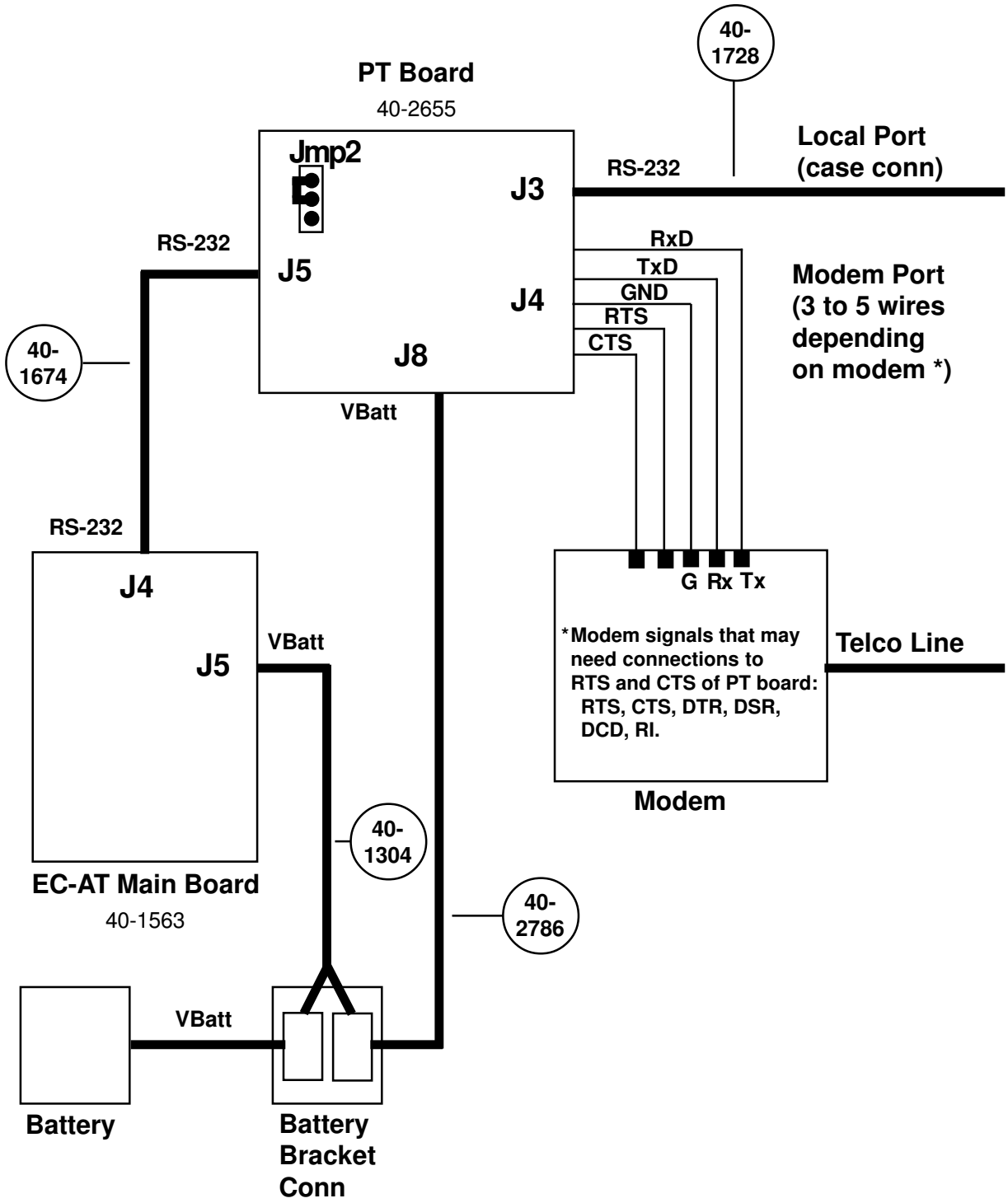
2.3 Connections to a Mini-AT and Modem

Basic Wiring Diagram Including Modem



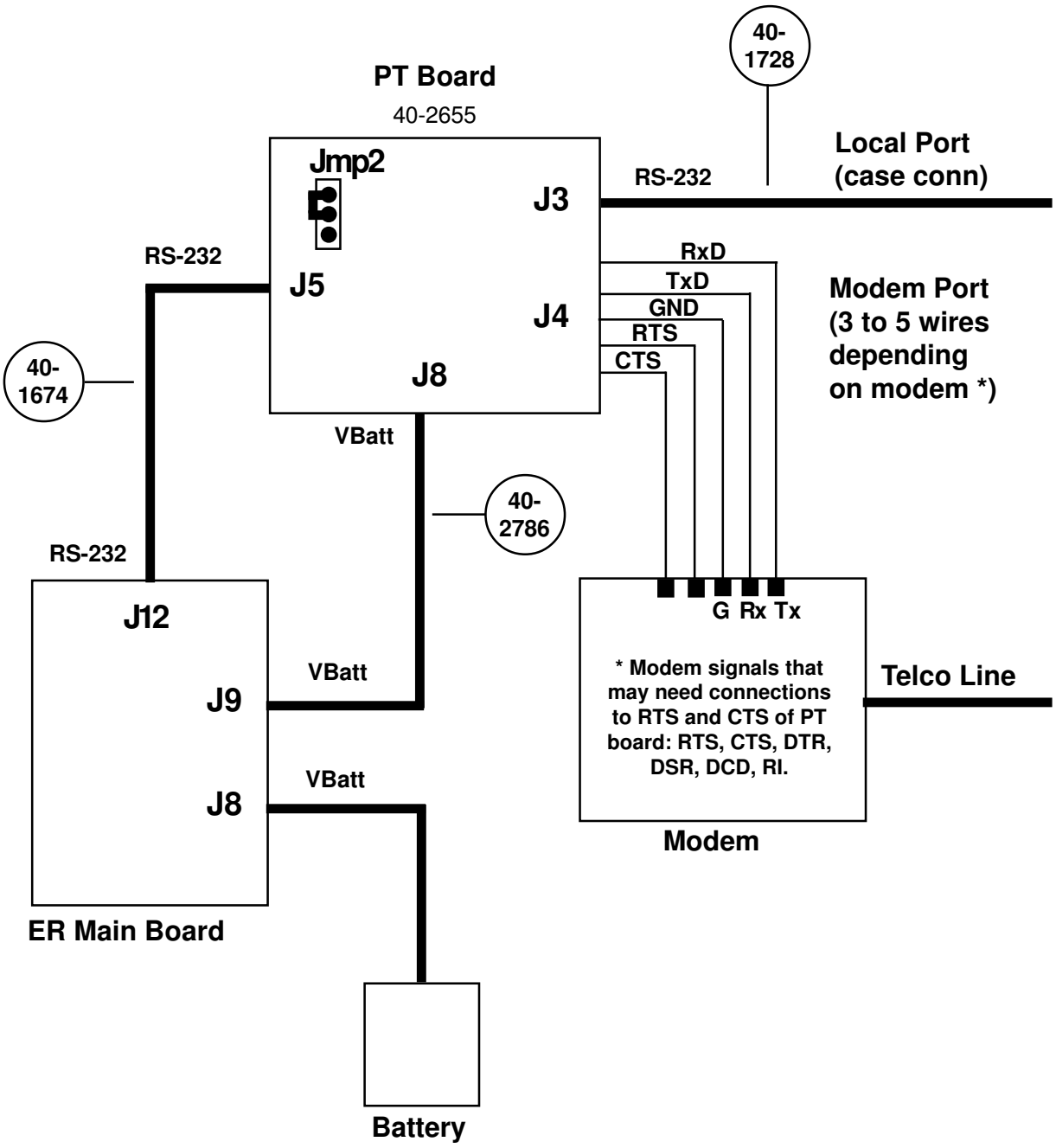
2.4 Connections to an EC-AT and Modem

Basic Wiring Diagram Including Modem



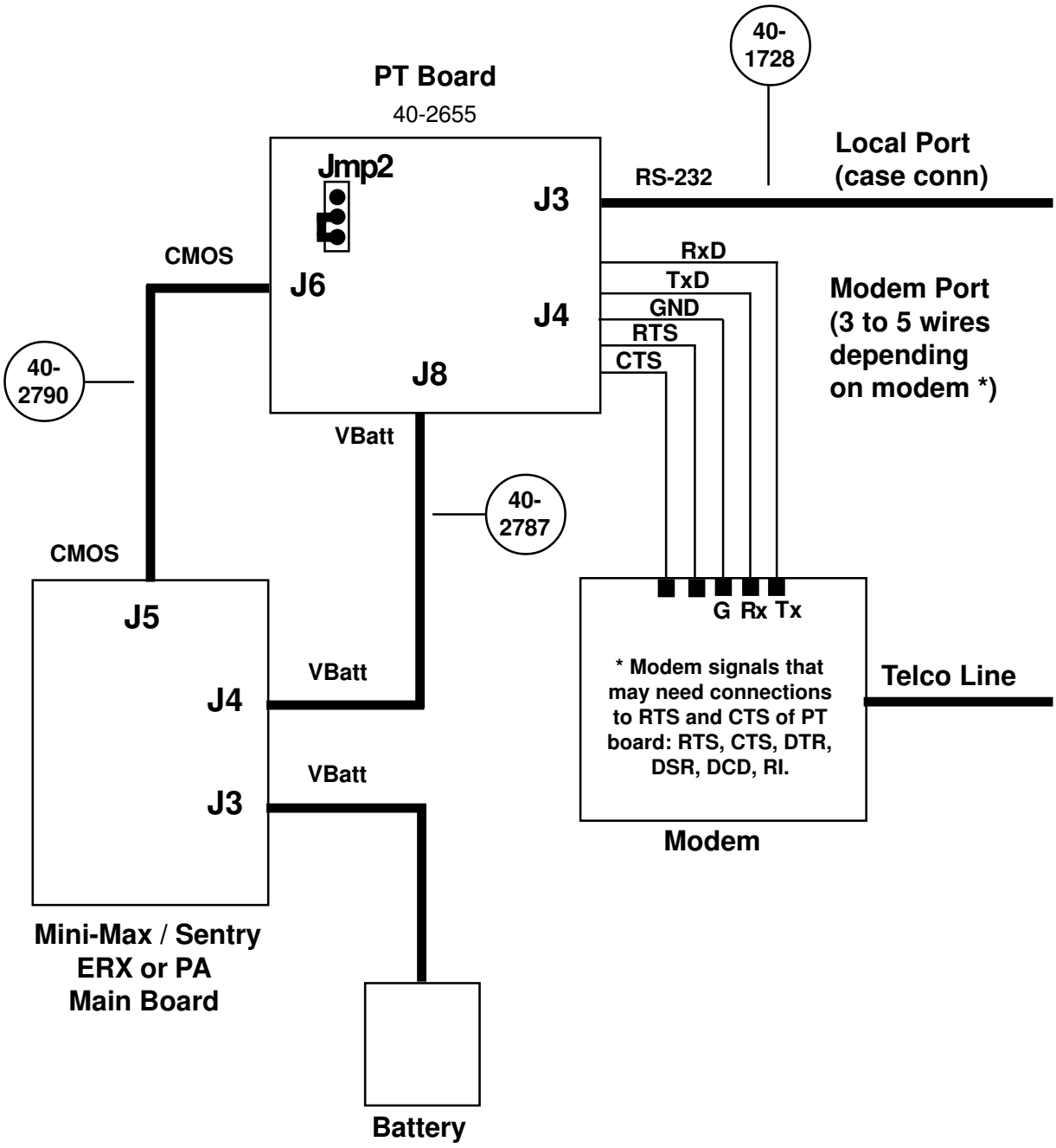
2.5 Connections to an ER and Modem

Basic Wiring Diagram Including Modem



2.6 Connections to Mini-MAX, ERX, or PA and Modem

Basic Wiring Diagram Including Modem - Valid for the following Instrument types: ERX, Mini-Max, Sentry, and Pulse Accumulator.



Section B

PT Board Configuration

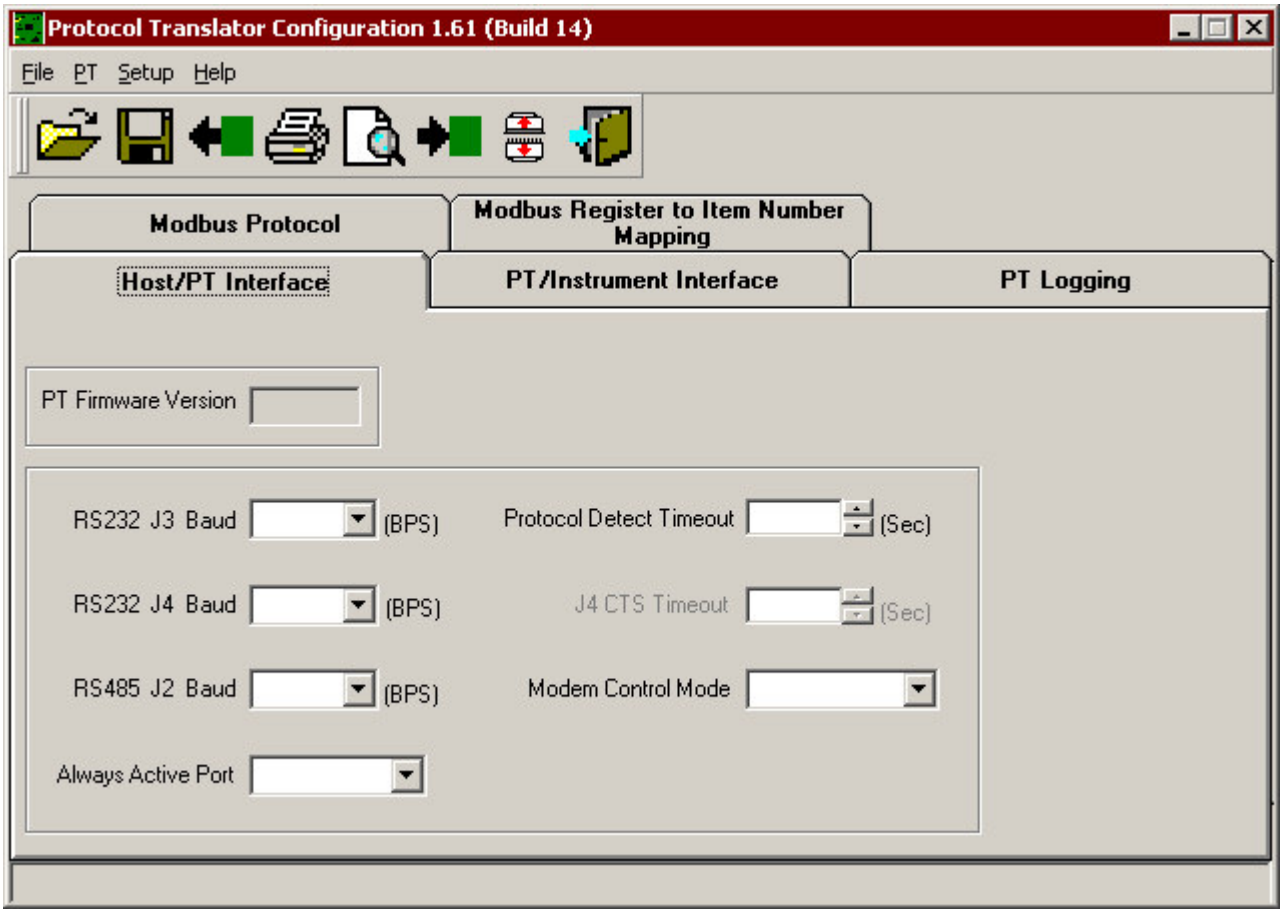
3 Configuring the PT Board

3.1 PT Config Software Overview

PT Config Software is a 32-bit Windows application used to configure the various configuration parameters of the PT board. This application runs under Windows98 or higher.

PT Config software can be used on any of the PT Board's Host interface ports (J2, J3 or J4). Make sure the PT Config's Comm port setting matches the PT board's Host ports baud rate.

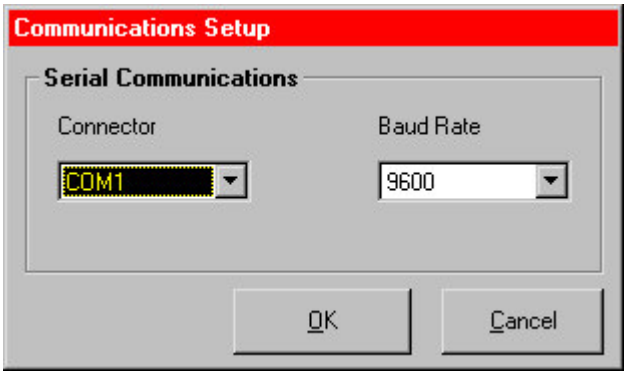
The most important aspect of this manual is to properly configure the PT Board per the application requirements as closely as possible.



3.1.1 PT Config Setup

From the Setup menu - select the Comm port and baud rate that is needed for communications with the PT Board.

- Normally, the J3 port of the PT Board is used for configurations and is typically set to 9600 bps.
- PT Board configurations can be done on any of the three Host interface serial ports (J2, J3, and J4).

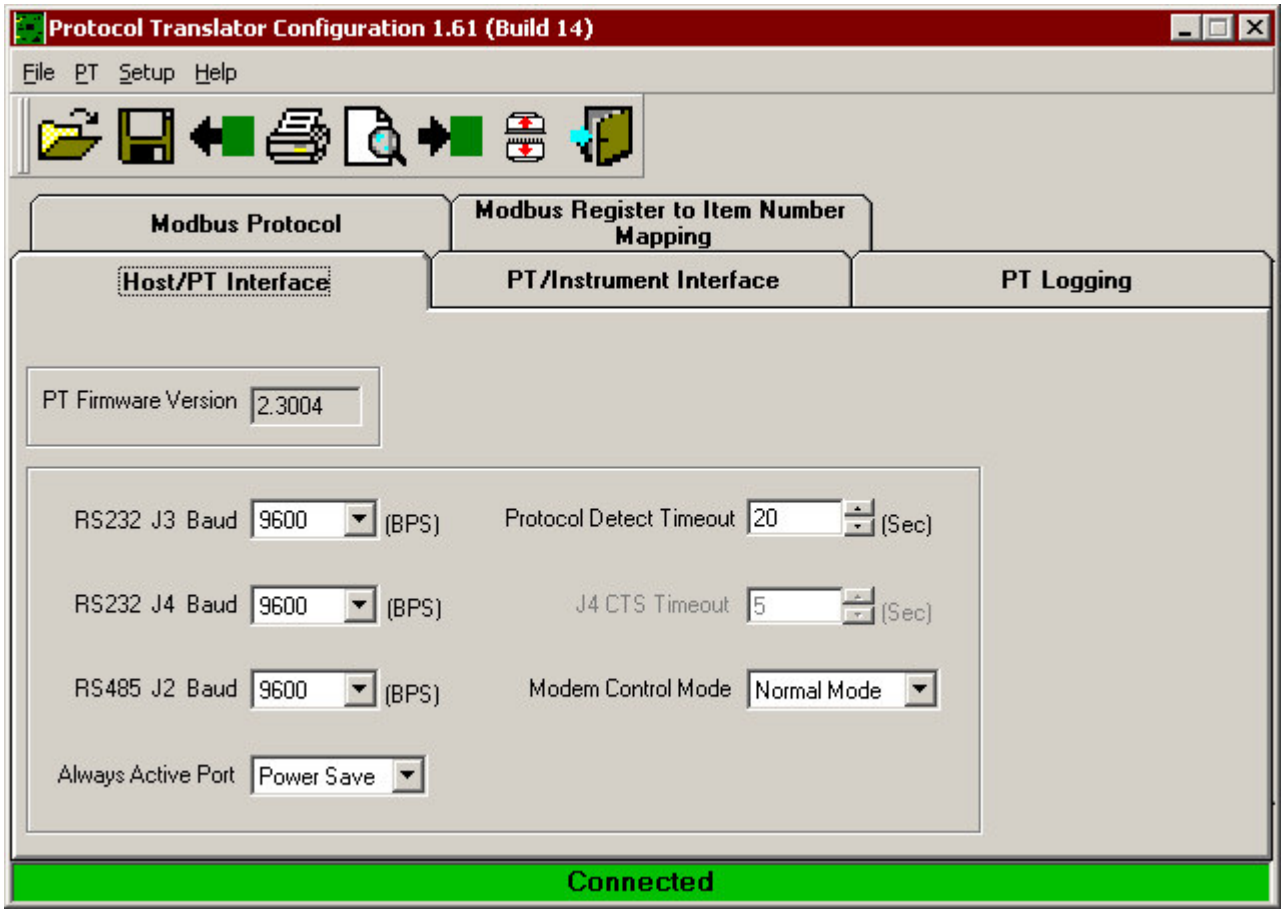


3.2 Host / PT Interface

The PT Board has several configuration options for interfacing to Host serial ports.

Each port of the PT Board can have its own baud rate and is able to communicate in any of the stated protocols (Mercury / Modbus).

Shown below is a screen shot of the PT Config software screen: “**Host** / **PT Interface**”.



3.2.1 Host Baud Rates

Listed below are the serial communications baud rate(s) options for each of the Host interface port (J2, J3, J4). Each port is independently configuarble. If the port is not used, the baud rate setting may be left as is.

Select the proper baud rate to match the device connecting directly with the PT Board's Host Interface Port (i.e. modem or PC).

RS-232 J3 Baud Rates:	**RS-232 J4 Baud Rates:**	**RS-485 J2 Baud Rates:**
• **1200 bps**	• **1200 bps**	• **1200 bps**
• **2400 bps**	• **2400 bps**	• **2400 bps**
• **4800 bps**	• **4800 bps**	• **4800 bps**
• **9600 bps**	• **9600 bps**	• **9600 bps** - default settings
• **19200 bps**	• **19200 bps**	• **19200 bps**
• **38400 bps**	• **38400 bps**	• **38400 bps**
• **57600 bps**	• **57600 bps**	• **57600 bps**

☞ It is recommended to leave the **J3 Port baud set to 9600** for local access, and use the J4 & J2 Ports for SCADA connections (modems, RTU controllers, etc.).

☞ If two SCADA connections are required (w/ RS-232 interface), then use J3 and J4 ports and set baud rates as required.

3.2.2 Always Active Port

Options:

- **Power Save** - default setting

This mode allows the PT Board to be powered by an Instrument's battery pack by returning back to ultra low power state after serial communications end. In this mode, the PT Board may not respond to the 1st poll from the Host since it requires a wake-up signal. The wake-up signal can either be a serial transmission (Host poll) or asserting the CTS signal on the J4 port (if used). Normally, the Host would issue a wake-up poll, wait for a time-out period, and then retry (issue a second poll) to obtain the response. Applies to all of the Ports J2, J3, and J4.

☞ Pro: allows for running off Instrument's battery (low power consumption)

☞ Con: requires two Modbus polls from Host system to obtain the response.

- **J2 Port** (J2 port always active - J3, J4 still require comm wake-up).
- **J3 Port** (J3 port always active - J2, J4 still require comm wake-up).
- **J4 Port** (J4 port always active - J2, J3 still require comm wake-up).

These options allow the user to configure one port (J2/J3/J4) to remain awake or active to respond to a Host system's poll on the 1st try. Only one port can be designated for this option - the others still require a wake-up signal. This option helps to eliminate wake-up retry polls from the Host to improve communications throughput.

☞ Pro: responds to 1st poll from Host on the configured port.

☞ Con: higher power consumption - may need AC or Solar power source.

3.2.3 Protocol Detect Timeout

Options:

- **10 to 60 (seconds**)

Configurable time-out (in seconds) to determine how long the PT Board will remain awake trying to detect the protocol on one the Host Interface ports.

On slow communicating system, it may be necessary to increase the Protocol Detect Time-out value to 15-20 seconds to prevent the PT Board from timing out early.

☞ Typical value should be **15-20** s

3.2.4 Modem Control Mode (J4 Port)

Options: (only for J4 Serial Port)

- **Normal Mode:** Data sent without wait delays - *default setting.*

  Use this option for standard modems types that do not require RTS signal control.

  Only a 3-wire interface is used in this mode (TxD, RxD, and Gnd).

- **Delay For CTS:** The response is not sent until a CTS signal is detected or until the CTS Time-out expires. The PT Board will assert the RTS signal and wait for a responding CTS. (See J4 CTS Time-out).

  Use this option for modems that require Transmitter enabling and that use CTS feedback. If CTS is not available, set CTS Time-out to lowest value acceptable by modem (data will always be sent to modem after the time-out expires).

! RTS and CTS signals must be connected properly between the PT Board and the modem.

- **Radio Keying:** Before data is sent to host, RTS signal is asserted. The response is not sent until a **150** ms time-out has expired *regardless* of CTS.

  Use this option for MDS radios that require “Transmitter Keying”.

! RTS signal wire must be connected properly between the PT Board and the modem.

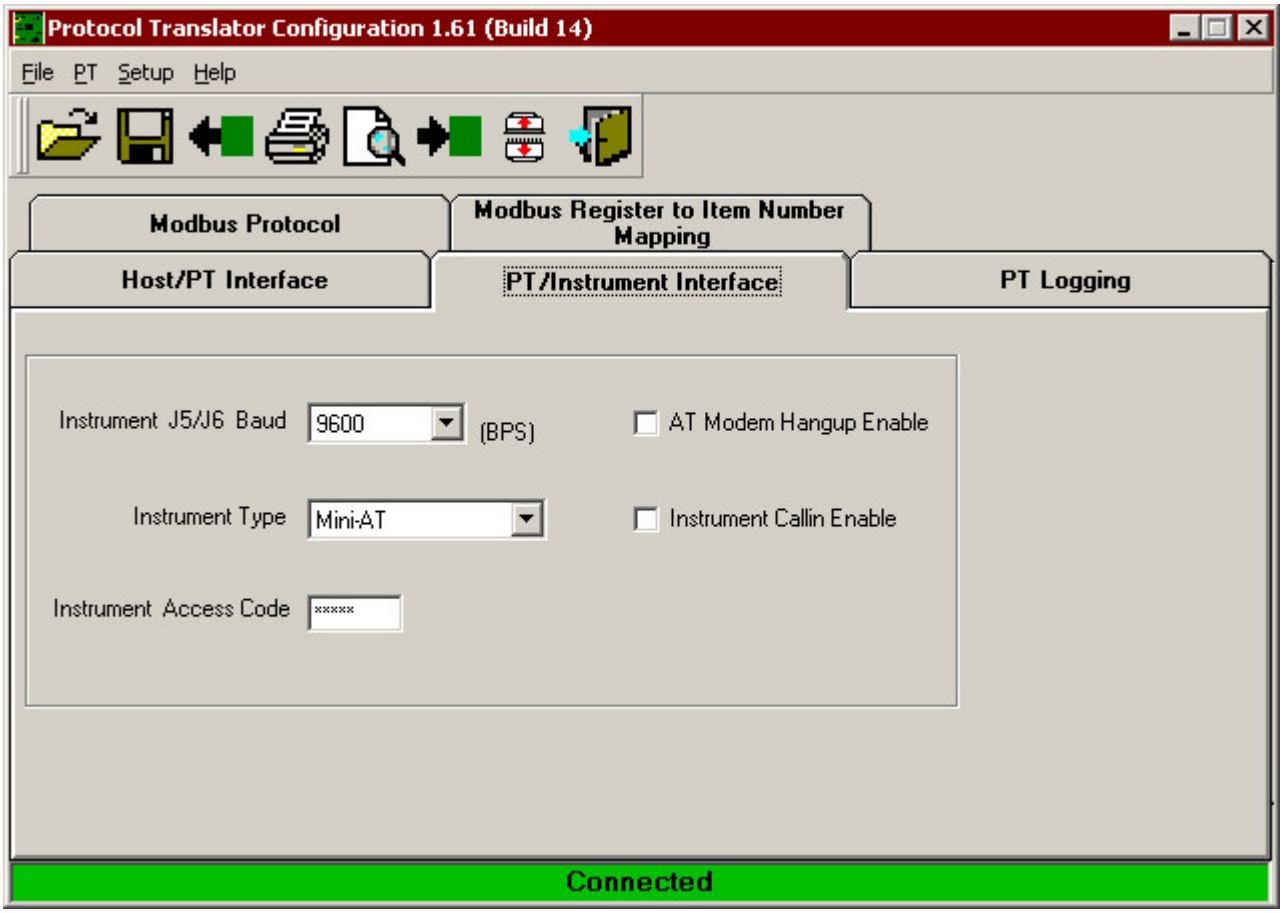
J4 CTS Timeout: configurable in seconds depending on modem (1 - 60).

3.3 PT / Instrument Interface

The PT Board has several configuration options for interfacing with various Mercury Instruments.

Two port of the PT Board are provided to accomodate both RS-232, as well as CMOS interfacing requirements. Each port can have its own baud rate, but only one port may be connected to a Mercury Instrument (no dual Instrument connections allowed!)

Shown below is a screen shot of the PT Config software screen: "**PT / Instrument Interface**".



3.3.1 Instrument Baud Rates

Listed below are the serial communications baud rate(s) options for either of the Instrument interface port (J5 or J6). The baud rate applies to both connection ports J5 and J6.

Options:

- **9600 bps** - default setting
- **4800 bps**
- **2400 bps**
- **19200 bps**
- **38400 bps**
- **57600 bps**

Select the proper baud rate to match the Instrument connecting with the PT Board.

☞ Normally this would be set to 9600 to simplify configurations.

3.3.2 Instrument Type

Options:

- **EC-AT**
- **ER / ERX**
- **Mini**
- **Mini-AT** (including AccuTest & Turbo Correctors) - *default setting*
- **Mini-Max / Pulse Accumulator** (and Sentry)
- **Reserved**
- **Turbo Monitor (TOM)**
- **Generic** (choose this if no other option available).

Select the proper type to match the Instrument connecting with the PT Board.

3.3.3 Instrument Access Code

Enter the five digit security access code that is used by the Instrument.

The PT Config software screen always displays the Access Code as : * * * * *

The default access code is: '33333'.

☞ If the Instrument's Access code has been changed from the default code, you will need to configure the PT Board with this same code.

! Failure to enter the proper access code will prevent the PT Board from connecting to the Instrument by means of MODBUS protocol!

3.3.4 AT Modem Hangup Enable (J4 Port)

Options:

☑ **indicates enabled**

☐ **indicates disabled**

Selecting this option causes the PT Board to issue an "ATH0" hang-up command after the serial communications session is terminated. This ensures the Slave modem (if installed) is back On-Hook again after completing a call.

☞ This options is normally not required.

3.3.5 Instrument Call-in Enable (J4 Port)

Options:

☑ **indicates enabled**

☐ **indicates disabled**

Enables the PT Board to allow an Instrument configured for AT style Call-in to pass on through to the Modem connected on the **J4 port**.

This options is normally not used.

☞ Call-in to a MODUS host system is NOT supported.

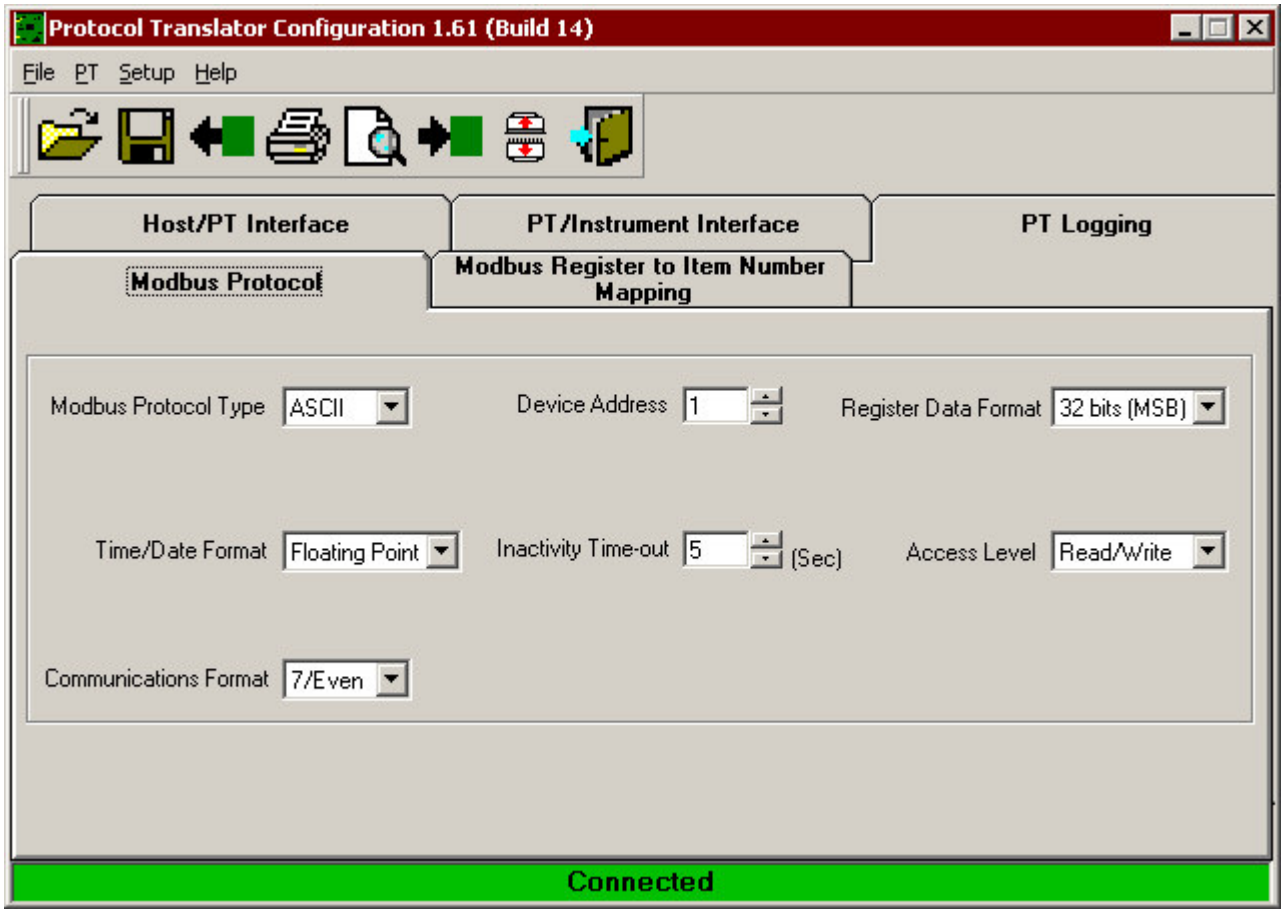
! **Call-in to Mercury Protocol compliant systems only!**

3.4 Modbus Protocol

The PT Board has several configuration options for interfacing to MODBUS protocol systems.

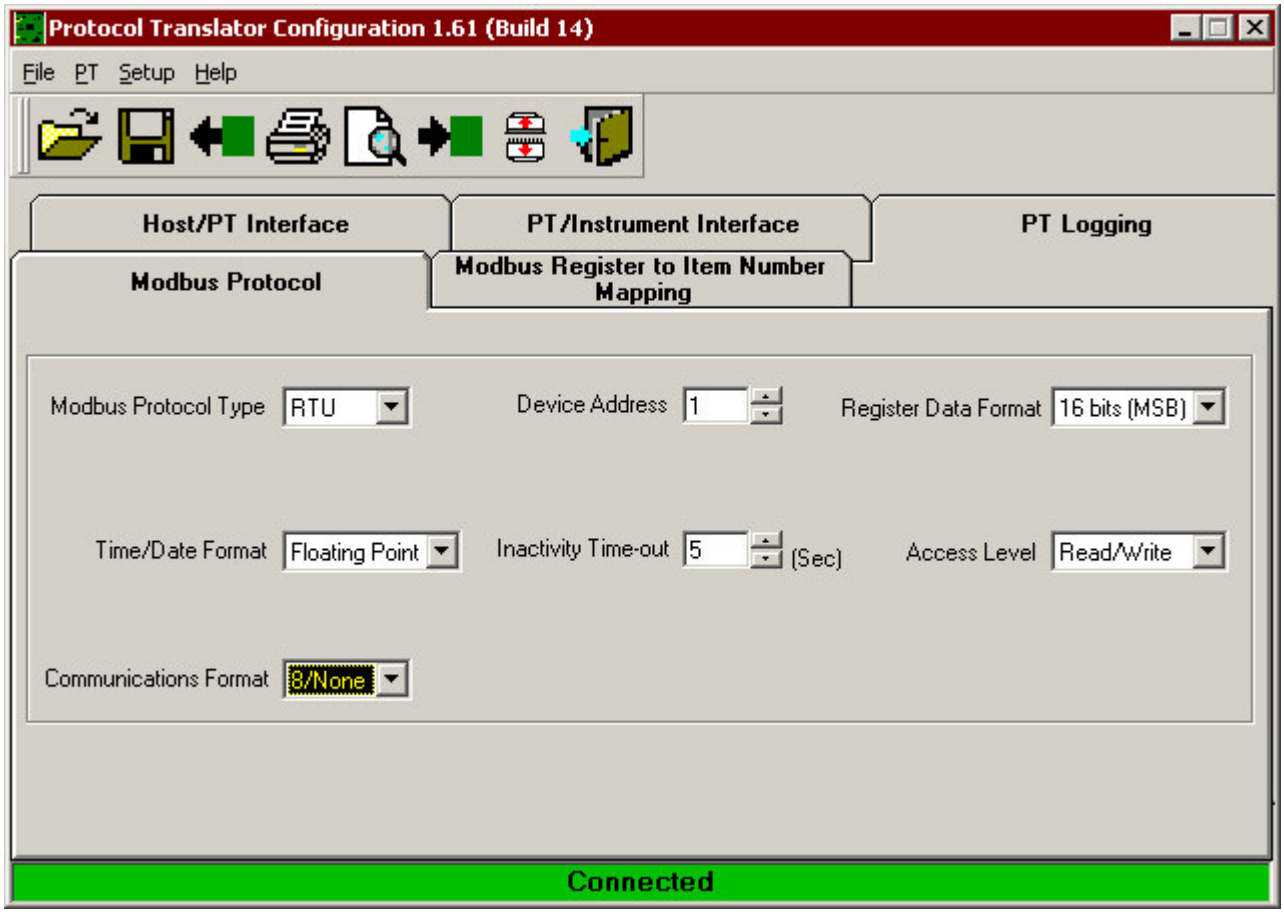
Shown below is a screen shot of the PT Config software screen: “**Modbus Protocol**”.

Example configuration for MODBUS ASCII (32-bit Register format).



Shown below is a screen shot of the PT Config software screen: “**Modbus Protocol**”.

Example configuration for MODBUS RTU using 16-bit MSB Register format.



3.4.1 Modbus Protocol Type

Options:

- **ASCII**
- **RTU**

Select the proper MODBUS Protocol format required for interfacing with the Host system.

☞ Modbus ASCII uses a register size of 32-bit data for Analog/float data.

☞ Modbus RTU uses a register size of either 16 or 32-bit data for Analog/float data.

3.4.2 Device Address

Options:

- **1 to 247**

Select a unique Slave Device address for each PT Board within the range of: 1 to 247.
Note: 0 is used for broadcast.

3.4.3 Register Data Format

Options:

- **32 bits (MSB)** - Single Register used to for the 32-bit data.
- **16 bits (MSB) -** Two Registers used for the 32-bit data.

  1st Register contains upper 16-bits (MSB 1st)

  2nd Register contains lower 16-bits.
- **16 bits (LSB)** - Two Registers used for the 32-bit data.

  1st Register contains lower 16-bits (LSB 1st)

  2nd Register contains upper 16-bits.

Select the Register size used by the Host system for storing floating point data.

See Section 4.3.3

3.4.4 Inactivity Timeout

Options:

- **1 to 255 (seconds)**

This option selects the length of time the PT Board will remain awake (locked in to Modbus protocol mode) waiting to receive another valid Modbus query from the Host. The Inactivity time-out period starts after the PT Board responds to a valid Modbus query. This timer resets when a valid Modbus query is received during the time-out period.

If no Modbus queries are received within the inactivity time-out period, the PT terminates that particular protocol session and is free to then begin a protocol session (Mercury or Modbus) on any available port. Select a low value (1-3 secs) if you plan to issue only one Modbus query poll in a session - or if there are no long delays between multi-poll queries.

☞ Recommended setting for most applications is 2-5 seconds.

3.4.5 Access Level

Options:

- **Read-Write** - default setting
- **Read-Only** - No Modbus writes

This option selects the access level of the Instrument's Item for Modbus protocol.

Read-Write allows the Host to use Modbus protocol to update Instrument Item values by using Function codes: 05, 06, 15, and 16.

Read-Only rejects Function codes: 05, 06, 15, 16 preventing a Modbus system from tampering with Instrument Item values.

3.4.6 Time-Date Format

Options: - for writing (changing) Time & Date.

- **Floating Point** - default setting
- **BCD** - certain VECTOR SCADA systems.

☞ Reading (output) of Time & Date is always Floating Point format.

3.4.7 Communications Format

Options:

- **8/ None** - 8 data + No parity
- **7 / Even** - 7 data + parity
- **7 / Odd** - 7 data + parity
- **8 / Even** - 8 data + parity
- **8 / Odd** - 8 data + parity

This option selects parity format of the Modbus protocol.

☞ Configuration does not apply to Mercury protocol which is always 8 / None.

☞ Modbus RTU protocol must use one of the 8 data bit options.

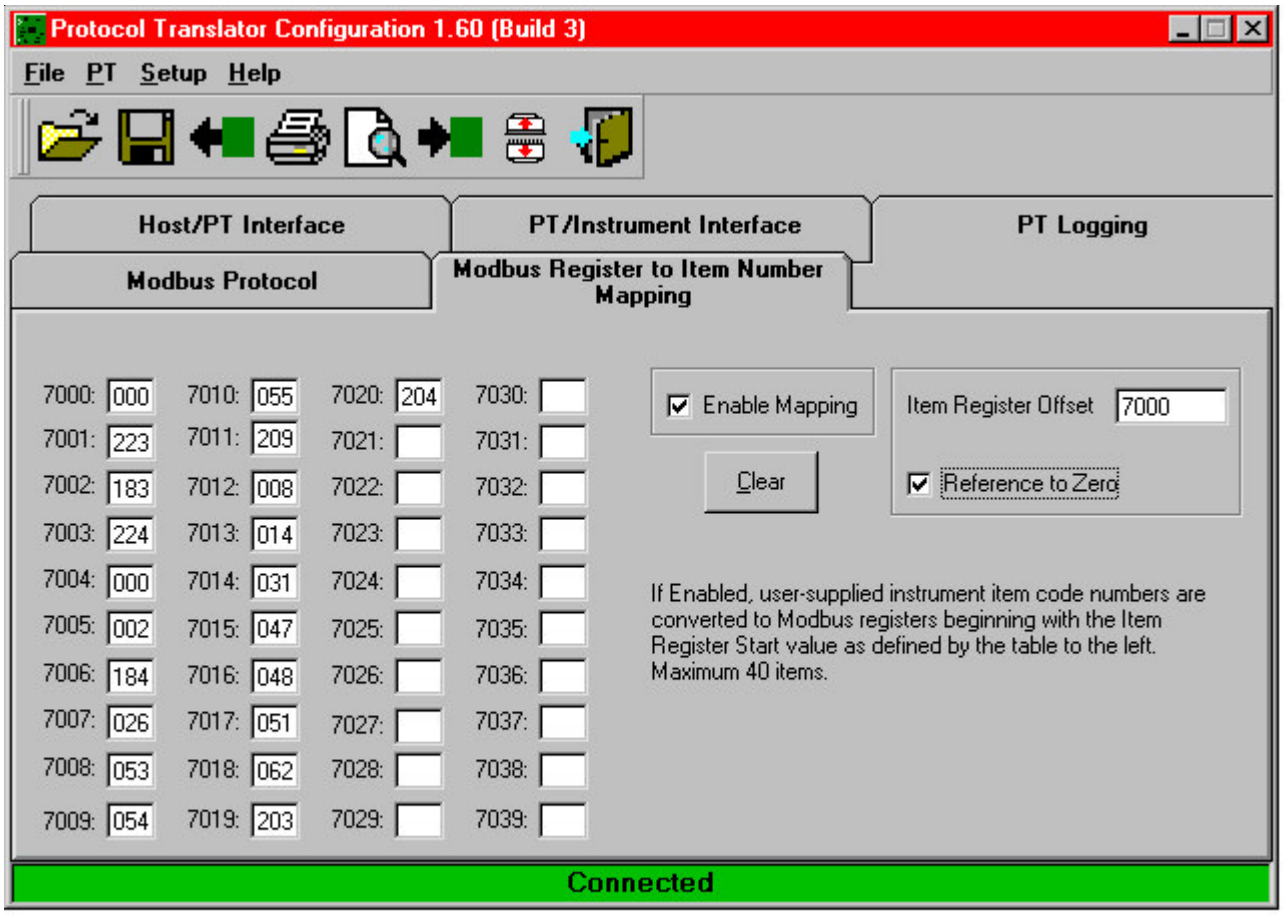
3.5 Modbus Register Mapping

The PT Board has several additional configuration options for interfacing to MODBUS protocol systems. Register mapping allows the user to obtain Instrument data points and store these values in Modbus registers per their application.

☞ It is highly recommended to use the “Register Mapping” feature of the PT Board

! The Register sequence (order) differs slightly between 32-bit Register and 16-bit register data formats

Shown below is a screen shot of the PT Config software screen: “**Modbus Register to Item Number Mapping**”. *Shown is just one example of Register mapping using 32-bit registers.*



3.5.1 Enable Mapping

Options:

☑ **indicates enabled**

☐ **indicates disabled**

Enables “mapping” of Mercury Item Numbers to specific Modbus Registers as required by the Host SCADA system.

3.5.2 Item - Register Assignments

Options:

- **000 to 999** (Mercury Item Numbers)

Enter the desired Mercury Item numbers in the corresponding Register cells of the map.

Only one Item number per Register cell.

☞ Refer to the corresponding Mercury reference manual for the proper Instrument Item numbers. Correctors and Recorders have very different Item numbering.

☞ When using **16-bit** Register Formats (MSB & LSB), enter Item numbers in every other cell - skipping one cell between each Item.

Example Mapping - Corrector using 32-bit Register format.

Register	Item #	(Description)
7000	002	(Meter Volume)
7001	000	(Corrected Volume)
7002	008	(Pcor Pressure
7003	026	(Tcor Temperature)

Example Mapping - Corrector using 16-bit Register format.

Register	Item #	(Description)
7000	002	(Meter Volume)
7001		
7002	000	(Corrected Volume)
7003		
7004	008	(Pcor Pressure
7005		
7006	026	(Tcor Temperature)
7007		

☞ Refer to heading **4.4.3** regarding 16-bit and 32-bit Register sizes.

3.5.3 Item Register Offset

Options:

- **0000 to 9000 7000 - default (floats)**

Allows changing the “base” address of Modbus Registers from 7000 to another value.

☞ Normally, this is not required and should would not be changed from since most SCADA systems use 7000 range for floating point data.

3.5.4 Reference to Zero

Options:

☐ **indicates disabled** - Enron / J-Bus format

☑ **indicates enabled** - Modicon format

Reference to Zero (Modicon Modbus)

Enable the Reference to Zero option if your Host system transmits the Start Register Address with a **value of 1 less** than the configured value (sends 6999 when configured Start Address is set to 7000).

Reference to One (Enron / J-Bus Modbus)

Disable the Reference to Zero option if your Host system transmits the Start Register Address with the **same value** as the configured value (sends 7000 when configured Start Address is set to 7000).

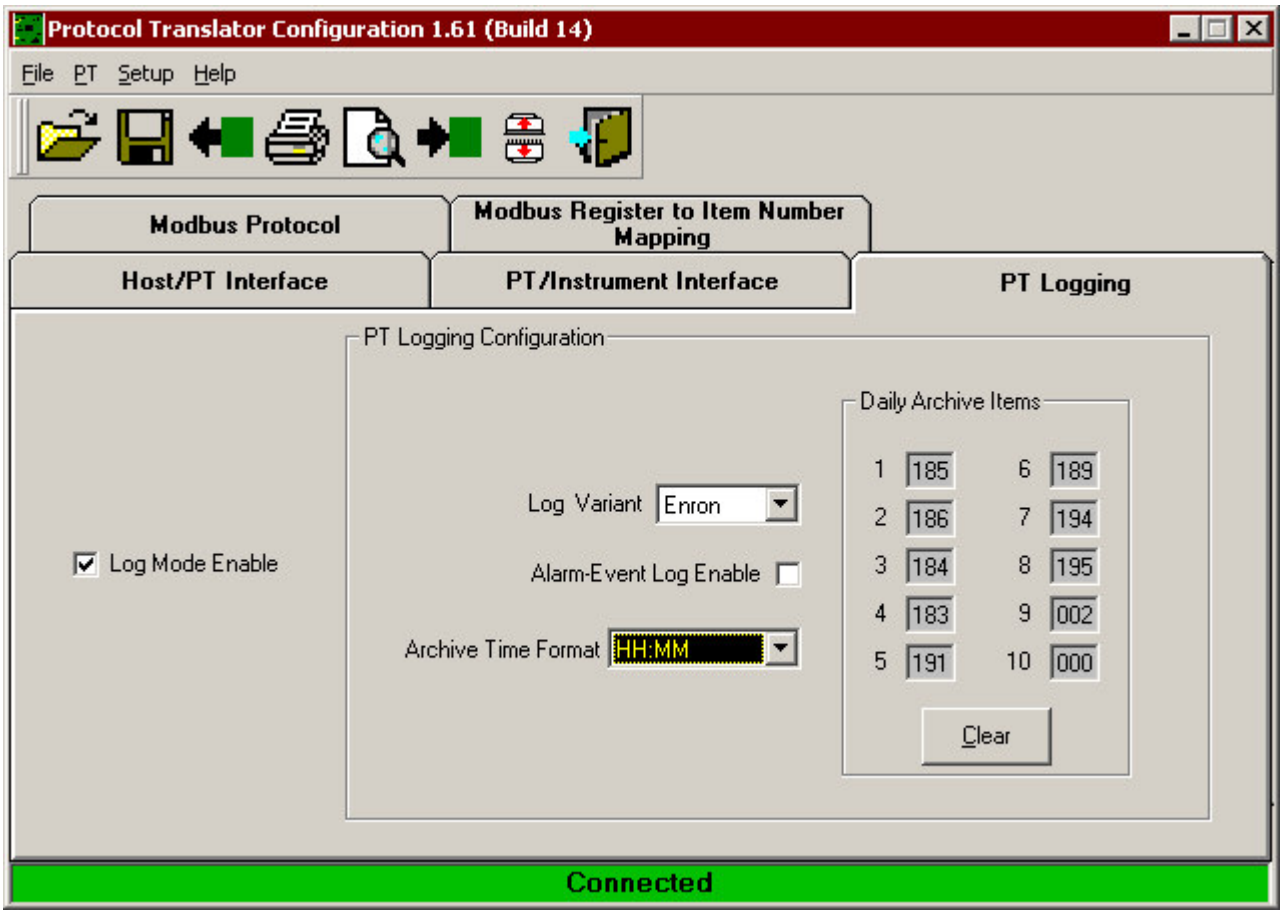
3.6 PT Logging

The PT Board supports the industry standard data collection process used to obtain Hourly and Daily Archive (historical) data required by EFM applications. Two options are available with regard to archive record size which are Enron and Mercury variant.

Shown below is a screen shot of the PT Config software screen: "**PT Logging**" with the Enron logging format enabled.

Enron format should be selected if the number of logged data points needs to be limited to 5 for both Hourly and Daily Archive records. The capacity is 35 days for each Archive.

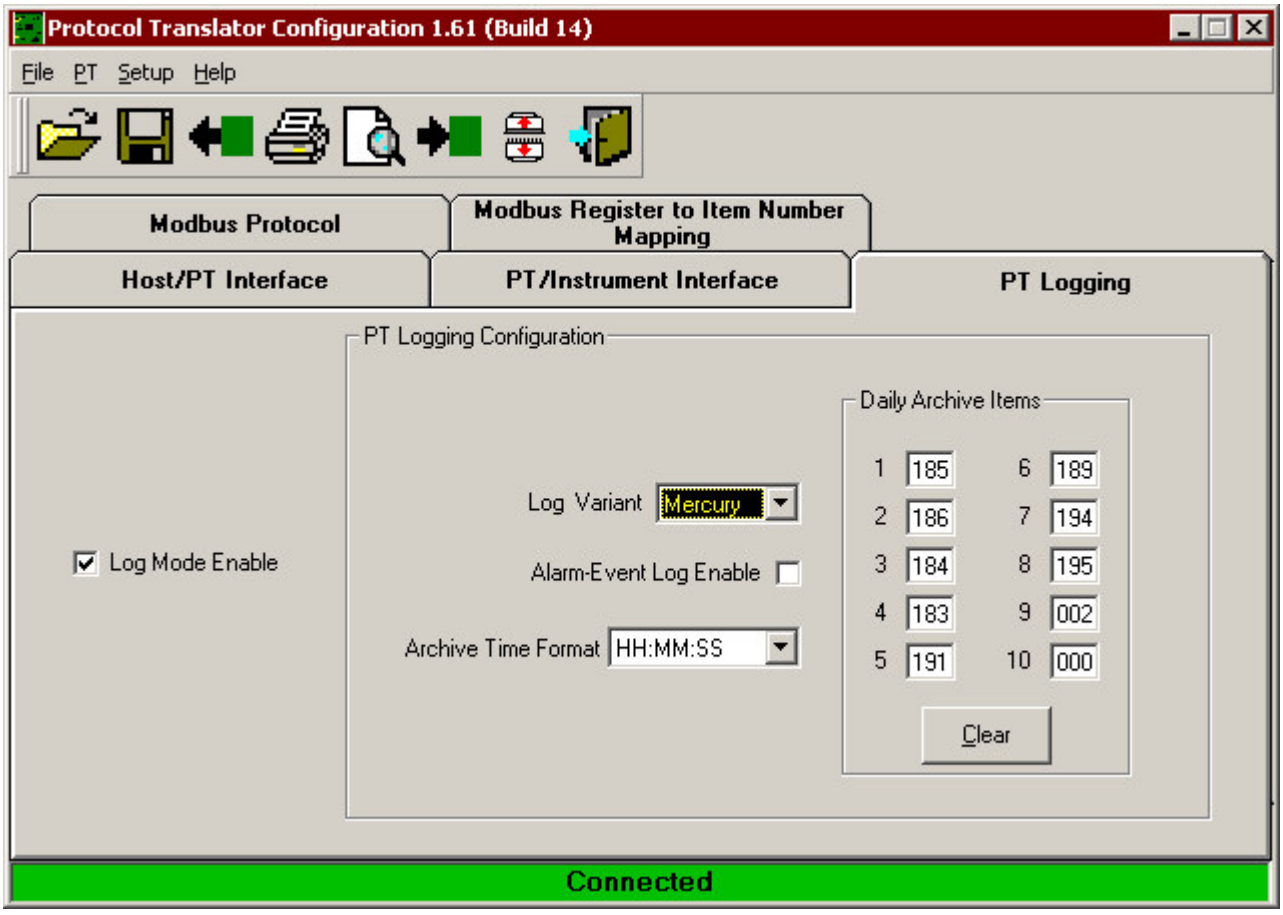
Note: Both the Daily and Hourly Archive data points (Items) are configured via the Instrument's Audit-Trail selectable Items using MasterLink software.



Shown below is a screen shot of the PT Config software screen: “**PT Logging**” with the Mercury (a.k.a extended) logging format enabled.

Mercury format can be selected if the number of logged data points needs can be up to 10 for both Hourly and Daily Archive records. The capacity is 35 days for each Archive.

Note: The Daily Archived data points (Items) are configured directly from within PT Config (shown below). The Hourly Archive is configured via the Instrument’s Audit-Trail Items using MasterLink software.



3.6.1 Log Mode Enable

Options:

☐ **indicates disabled**

☑ **indicates enabled**

Select if Historical / Archive data is required from the PT Board (Modbus format).

☞ Log Mode Enable must be enabled to obtain Archive data using Modbus protocol.

! Modbus ASCII protocol is required to retrieve the Archive data.

3.6.2 Log Variant

Options:

- **Enron**
- **Mercury**

Selects the record size / format for Archive data using Modbus ASCII protocol.

! Instrument must be configured for **10** Item Audit Trail logging.

Enron variant

Archive data is obtained solely from the Instrument's Audit Trail log memory.

The Archive data is updated once an hour - 1 min after the top of the hour.

The Hourly and Daily Archive share the Instrument's Audit Trail memory **t.** Hourly and Daily Archive records each contain a Time and Date stamp plus 5 Audit Trail Items. The Hourly Archive record contains the 1st 5 Items in the Audit Trail, while the Daily Archive record contains the last 5 Audit Trail Items.

⇒ Example Hourly Archive record:

Date, Time, AT Item-1, AT Item-2, AT Item-3, AT Item-4, AT Item- 5

⇒ Example Daily Archive record:

Date, Time, AT Item-6, AT Item-7, AT Item-8, AT Item-9, AT Item- 10

Mercury variant

Archive data is obtained from both the Instrument's Audit Trail memory, and by direct reading of configured Instrument Items when the Instrument's time matches the configured Start of Gas Day time. The main benifit of the Mercury log option is the increased record size from 5 to 10 data points for both Daily and Hourly archives.

The Hourly Archive record contains all 10 Items read from the Audit Trail memory (records). The Daily Archive record contains the 10 Item values read from the configured "Daily Archive Items" list.

⇒ Example Hourly Archive record:
Date, Time, AT Item-1, AT Item-2, AT Item-3, AT Item-4, AT Item- 5,
AT Item-6, AT Item-7, AT Item-8, AT Item-9, AT Item-10

⇒ Example Daily Archive record:
Date, Time, Daily Item-1, Daily Item-2, Daily Item-3, Daily Item-4, Daily Item-5,
Daily Item-6, Daily Item-7, Daily Item-8, Daily Item-9, Daily Item-10

The **Daily Archive** data is obtained by **direct reading** of the configured Items per the Daily Archive list (10 Items). These Items are read just after Start Time (Item 205 for Correctors). The Daily Archive list needs to be configured with "Previous Day" type Items to create a daily archive record useful for measurement / billing purposes.

! *Using the Mercury log variant, the Daily Archive data cannot be restored if the PT Board looses power. This is due to the fact that the Daily Archive records are obtained by directly reading Instrument Items once a day at Start Time.*

3.6.3 Alarm-Event Log Enable

Options:

☐ **indicates disabled**

☑ **indicates enabled**

Select if Alarm and/or Event data is required from the PT Board (Modbus format).

! Log Mode Enable must be selected to obtain Alarm-Event data.

☞ Alarm-Event data conforms to **Enron**'s specifications - use Modbus ASCII protocol.

3.6.4 Archive Time Format

Options:

- **HH : MM** - traditional Enron
- **HH : MM : SS** - include seconds in timestamp.

Select if the additional SS (seconds) information is required for the Archive timestamp.

☞ HH indicates hours, MM indicates minutes, SS indicates seconds.

Section C

Modbus Protocol Details and Archive Data Support

4 Modbus Protocol Details

4.1 Modbus Function Codes

Listed below are the Modbus Functions Codes supported by the PT Board.

- **Function 01 Read Output Status (Alarms)**
- **Function 02 Read Input Status (Alarms)**

Reads data from Mercury Instrument Boolean type Items (Alarm status Items).
Boolean values 0 /1 packed as 8-bits per byte - standard Modicon format.

- **Function 03 Read Output Registers (Analog / Floats)**
- **Function 04 Read Input Registers (Analog / Floats)**

Returns data (floating point) from Instrument. Also used to read Archive Historical data.

- **Function 05 Write Single Output (Alarm)**

Writes data to a Mercury Instrument Boolean Item (normally to clear a single active Alarm).
Writes single Boolean value 0 /1 to Instrument's Alarm Item.

- **Function 06 Write Single Register (Analog / Float)**

Writes a single value (floating point) to Instrument's Item.

☞ This Function codes requires the 32-bit Register Data format:

- **Function 15 (0Fh) Write Multiple Outputs (Alarms)**

Writes data to Mercury Instrument Boolean Items (normally to clear active Alarms).
Writes Boolean values 0 /1 packed as 8-bits per byte.

- **Function 16 (10h) Write Multiple Registers (Analog / Floats)**

Writes multiple values (floating point) to Instrument's Items.

4.2 Modbus Exception Codes

Listed below are the Modbus Exception Codes supported by the PT Board.

- **Exception 01 Illegal Function**

Function code is not an allowable action by slave device (PT board / Instrument).

- **Exception 02 Illegal Data Address**

Register address is out of range for the slave device (PT board / Instrument).

Attempting to access an register that is beyond the legal limit of the PT /Instrument.

☞ This error is usually a result of the Starting Address being off by 1. Try enabling the Reference To Zero option (see Modbus Register Mapping) to compensate.

- **Exception 03 Illegal Data Value**

Data value is invalid or out of range for the slave device (PT board / Instrument).

Value(s) received in query have invalid format for requested item of Mercury Instrument.

- **Exception 04 Slave Device Error**

Query cannot be processed. PT unable to get a valid reply from Mercury Instrument.

☞ Check cabling between PT and Instrument as well as configuration items involving PT to Instrument Interfacing.

- **Exception 06 Slave Device Busy**

Query cannot be processed. PT unable to establish a ‘link’ with the Mercury Instrument.

☞ Check cabling between PT and Instrument as well as configuration items involving PT to Instrument Interfacing.

4.3 Modbus Register Types

Listed below are the Modbus register types supported by the PT Board.

4.3.1 Boolean Registers [Alarms]

Data Description: **Instrument's Alarm Status**

Register Range: **1001 - 1999**

Mappable Registers : **NO - Fixed Assignments**

Modbus Function Codes: **01, 02, 05, and 15**

See Section "Boolean Item Cross Reference Table" for the listing of Mercury Alarms.

4.3.2 Floating Point Registers [Real Numbers]

Data Description: **Instrument's Measurement Data**

Register Range: **7000 - 7999**

Mappable Registers : **YES - Configurable Assignments**

Modbus Function Codes: **03, 04, 06, and 16**

Start Register value is configurable with: "Item Register Offset".

Reference to 1 is selected by disabling "Register Offset By 1".

Reference to 0 is selected by enabling "Register Offset By 1".

4.3.3 Register Sizes [Floats]

32 Bits per single Register

Float data stored in one Register. Example: Register 7002 used for Pressure readings. Register 7003 used for Temperature readings.

16 Bits in two consecutive Registers (both MSB and LSB 1st options supported)

Float data stored in two consecutive Register. Example: Register 7002 & 7003 used for Pressure readings. Register 7004 & 7005 used for Temperature readings.

ENRON compliant host systems should choose the 32-bit Register size option.

MODICON compliant host systems should choose the 16-bit (MSB or LSB) Register option.

See Section 3.4.3

4.4 Register Cross Reference for Boolean Items

Listed below is a listing of the Mercury Boolean Items (Alarms) with their corresponding Modbus Register number.

Modbus Register #	Mercury Item Description	Mercury Corrector Item	Mercury Recorder Item
1001	Reserved	n/a	n/a
1002	P1 Pressure High Alarm	145	559
1003	P1 Pressure Low Alarm	143	560
1004	Reserved	[0]	[0]
1005	T1 Temperature High Alarm	146	563
1006	T1 Temperature Low Alarm	144	564
1007	Reserved	[0]	[0]
1008	PLog / P2 Pressure High Alarm	451	561
1009	PLog / P2 Pressure Low Alarm	452	562
1010	P3 Pressure High Alarm	[0]	451 *(ERX only)*
1011	P3 Pressure Low Alarm	[0]	452 *(ERX only)*
1012	P3 Pressure High-High Alarm	[0]	809 *(ERX only)*
1013	P3 Pressure Low-Low Alarm	[0]	810 *(ERX only)*
1014	Main Battery Low Alarm	099	565
1015	Mem Batt Low Alarm	101	567
1016	Battery Wake Cycles Alarm	100	566
1017	Main Alarm Output	108	568
1018	P1 Pressure High-High Alarm	[0]	815 *(ERX only)*
1019	P1 Pressure Low-Low Alarm	[0]	816 *(ERX only)*
1020	P2 Pressure High-High Alarm	[0]	819 *(ERX only)*
1021	P2 Pressure Low-Low Alarm	[0]	820 *(ERX only)*
1022	Solenoid State	[0]	761
1023	Digital Input #1 Alarm	[0]	766
1024	Digital Input #2 Alarm	[0]	767
1025	Digital Input #3 Alarm	[0]	768
1026	RBX Alarm Event	176	777
1027	Station Assmy Batt Low Alarm	[0]	796 *(ER only)*
1028	Electronic Rundant Index Alarm	435	[0]
1029	Pulser A High Alarm	069	[0]
1030	Pulser B High Alarm	070	[0]
1031	Pulser C High Alarm	071	[0]
1032	Switch #1 Fault Alarm	102	[0]
1033	Switch #2 Fault Alarm	103	[0]
1034	Internal-Misc Alarm	104	[0]

Modbus Register #	Mercury Item Description	Mercury Corrector Item	Mercury Recorder Item
1035	Pressure Out of Range Alarm	105	[0]
1036	Temp Out of Range Alarm	106	[0]
1037	Tamper Detected Alarm	107	[0]
1038	Flow Rate High Alarm	163	[0]
1039	Daily CorVol High Alarm	222	[0]
1040	Reserved	[0]	[0]
1041	Scheduled Callin Active	338	[0]
1042	TOC -Pulsing Gas	874	[0]
1043	TIB - Fault	875	[0]
1044	TIB - AlarmOutput	876	[0]
1045	TOC - Normal Alarm	877	[0]
1046	TOC - Abnormal Alarm	878	[0]
1047	AccuTest Accuracy Alarm	826	[0]

☞ Alarms shown above may not be implemented in all versions of Mercury Instruments.

☞ Reserved = Future use.

☞ [0] = returns a value of ‘0’ for the specified Register.

5 Archive Data Desription

The PT Board's handling of Archive (Log) data is designed to meet the specifications determined by ENRON Corp. per the document: *Specifications and Requirements for an Electronic Flow Measurement Remote Terminal Unit (1995).*

5.1 Modbus Archive Registers

Description	Register	Value/range
☒ **Alarm & Event Data**	**32**	see Alarm-Event Structure
☒ **Daily Archive Data**	**703**	see Daily Structure
☒ **Hourly Archive Data**	**704**	see Hourly Structure
☒ **Daily Archive Index**	**7160**	1 - 35
☒ **Hourly Archive Index**	**7161**	1 - 840
☒ **Alarm-Event Counter**	**7162**	1- 100 (resets after Acks)

5.2. Archive Data Updating

The PT Board can retrieve Audit Trail data records from the Mercury Instrument on an **hourly** (60 min.) cycle. The PT will attempt to retrieve the Log Data at 1-minute after the top of the hour according to the Instrument's time. Upon connection, the PT will retrieve any *new* Archive (historical) data from the Instrument.

5.2.1 Enron Log Variant (5 item records)

Once an hour, **5** Audit Trail Items: 258, 259, 260, 261, and 229 are retrieved from the Instrument's Audit Trail log and stored in Modbus ASCII format in the **Hourly Archive Array**.

At the Start Time hour, **5** Audit Trail Items: 230, 231, 232, 233, and 234 are retrieved from the Instrument's Audit Trail log and stored in Modbus ASCII format in the **Daily Archive Array**.

5.2.2 Mercury Log Variant (10 item records)

Once an hour, **all 10** items of the Audit Trail are retrieved from the Instrument's Audit Trail log and stored in Modbus ASCII format in the **Hourly Archive Array**.

At the Start Time hour, **10** Mercury specific Items are read directly from the Instrument and stored in Modbus ASCII format in the **Daily Archive Array**.

5.3 Daily and Hourly Archive Collection

Basic desription on how to collect the Archive data from the PT Board. This method is generally employed by Enron EFM based systems.

1 **Read** Register **7160 - 7161** to obtain current **Daily & Hourly** Archive Index values.

2 **Read** Register **703** to obtain each Daily Archive record.

3 **Read** Register **704** to obtain each Hourly Archive record.

☞ Use Modbus **Function Code 03** to read Index and Data records.

☞ Use the “Total Registers” field to specify the particular record index desired.

5.4 Alarm-Event Collection

1 **Read** Register **7162** to obtain current **Alarm-Event** counter value.

2 **Read** Register **32** to obtain each Alarm-Event record.

All Alarm data is sent first - followed then by all Event data.

Alarm-Event Counter specifies only the total number of Alarms and or Events.

3 **Write** Register **32** (use Func 05) with the value **FF00** to acknowledge and clear the Alarm- Event output buffer.

☞ Use Modbus **Function Code 03** to read Index and Data records.

☞ The “Total Registers” field is ignored (N/A) - suggested value: 0001.

Special Notes:

☞ The Mercury Instrument must be configured for a **10 Item Audit Trail.**

☞ The Mercury Instrument should be configured for ‘**Disable Serial Log Triggers**’.

☞ Archived Data records use only 32-bit Register format (Modbus ASCII Protocol)

5.5 Enron Archive Items

5.5.1 Hourly Archive Record Structure

Position	Name	Desription	Item Logged
1	Date	Log Date	
2	Time	Log Time	
3	Item 258	Audit-Trail item 1	-> Item 206 (Avg. P)
4	Item 259	Audit-Trail item 2	-> Item 207 (Avg. T)
5	Item 260	Audit-Trail item 3	-> Item 225 (Interval Unc V)
6	Item 261	Audit-Trail item 4	-> Item 226 (Interval Cor V)
7	Item 229	Audit-Trail item 5	-> Item 148 (Interval Energy)

Properly configured the Mercury Instrument's Audit Trail items using MasterLink32.

☞ Data is formatted as 32-bit floating point values for all positions in record.

5.5.2 Daily Archive Record Structure

Position	Name	Desription	Item Logged
1	Date	Log Date	
2	Time	Log Time	
3	Item 230	Audit-Trail item 6	-> Item 256 (Daily P)
4	Item 231	Audit-Trail item 7	-> Item 257 (Daily T)
5	Item 232	Audit-Trail item 8	-> Item 224 (Daily Unc V)
6	Item 233	Audit-Trail item 9	-> Item 223 (Daily Cor V)
7	Item 234	Audit-Trail item 10	-> Item 190 (Daily Energy)

Properly configured the Mercury Instrument's Audit Trail items using MasterLink32.

☞ Data is formatted as 32-bit floating point values for all positions in record.

5.6 Mercury Archive Items

5.6.1 Hourly Archive Record Structure

Position	Name	Desription
1	Date	Log Date
2	Time	Log Time
3	Item 258	Audit-Trail item 1
4	Item 259	Audit-Trail item 2
5	Item 260	Audit-Trail item 3
6	Item 261	Audit-Trail item 4
7	Item 229	Audit-Trail item 5
8	Item 230	Audit-Trail item 6
9	Item 231	Audit-Trail item 7
10	Item 232	Audit-Trail item 8
11	Item 233	Audit-Trail item 9
12	Item 234	Audit-Trail item 10

Properly configured the Mercury Instrument's Audit Trail items using MasterLink32. Configure the Instrument's Audit-Trail Items listed above with desired Item numbers for the Hourly Archive.

- Use the value '255' for any unused Audit Trail Item.
- Data is formatted as 32-bit floating point values for all positions in record.

5.6.2 Daily Archive Record Structure

Position	Name	Desription	Suggested Item
1	Date	Date	
2	Time	Time	
3	Dail Archive Item 1	User selectable Item 1	185
4	Dail Archive Item 2	User selectable Item 2	186
5	Dail Archive Item 3	User selectable Item 3	184
6	Dail Archive Item 4	User selectable Item 4	183
7	Dail Archive Item 5	User selectable Item 5	191
8	Dail Archive Item 6	User selectable Item 6	189
9	Dail Archive Item 7	User selectable Item 7	194
10	Dail Archive Item 8	User selectable Item 8	195
11	Dail Archive Item 9	User selectable Item 9	002
12	Dail Archive Item 10	User selectable Item 10	000

Properly configured the Daily Archive items using PT Config software. The 10 Daily Archive text boxes are for Item numbers that are to logged in the Daily Archive.

At the Start Time hour, **the above 10** Mercury specific Items are read directly from the Instrument and stored in Modbus ASCII format in the **Daily Archive Array**. It is recommended tp select Items that are 'Daily' by nature (such as Daily Avg. Pressure).

☞ Use the value '255' for any unused Daily Archive Item.

☞ Data is formatted as 32-bit floating point values for all positions in record.

Section D

Diagnostic Help, Board Specifications, and Firmware Upgrading

6 LED Functions

6.1 Start-up Status

7.1.1 Initial power-up indication

Whenever the DC power supply is applied to the PT Device, a CPU self-check is performed.

Power & CPU OK:

☐ **Host (D1) and MI (D2) LEDs turn On solid for 2 seconds at power-up / reset.**

6.1.2 System memory checks

Whenever the DC power supply is applied to the PT Device, a self-check is performed to determine the status of both the SRAM (volatile) and EEPROM (nonvolatile) memories of the PT board.

Memory OK

☐ **Host (D1) and MI (D2) LEDs turn Off after inital 2 second startup.**

EEPROM Changed

☐ **Host (D1) and MI (D2) LEDs blink 5 times simultaneously after startup.**

This conditions indicates the PT Items (configurations) have returned back to factory default settings - unit must be re-configured per user's options.

☞ After FW upgrades, EEPROM may have changed - resulting in Blinking LEDs.

SRAM Changed

☐ **Host (D1) and MI (D2) LEDs blink 5 times in alternating pattern after startup.**

☞ This conditions indicates the Archive data has been cleared from the PT Board.

If Log Mode is enabled, the PT Board will restore lost Archive data by reading ALL of the Audit Trail data (and Alarm-Events if also ennabled) from the Instrument.

6.2 Communications Status

The 2 PT Board LEDs are used to indicate the status of communications with the Host system and the Mercury Instrument.

6.2.1 Host system comm status

Initial Serial Activity Detected

Host LED (D1) turns On at 1st sign of serial activity on one of the 3 Host interface ports (J2, J3, or J4).

Host LED (D1) will turn back Off if no valid protocol is detected within the configured "Protocol Detect Time-out" period.

Host LED (D1) being On does not indicate the Host is communicating properly .

Valid Protocol Detected

MI LED (D2) turns On when a valid protocol message is detected.

Host LED (D1) will already be On and remain so at this point.

Receipt of the ENQ character qualifies for Mercury protocol.

Receipt of the ':' (3Ah) character qualifies for Modbus ASCII protocol.

Modbus RTU protocol requires a framed packet with a valid CRC-16 to qualify.

Communications Ended

Host and MI LEDs (D1 + D2) turn Off when the protocol session is ended.

6.2.2 PT board to instrument comm status

Comm Errors Detected

MI LED (D2) blinks rapidly 5 times due to serial comm problems with the Instrument.

Host LED (D1) will already be On and remain so at this point.

If Log Mode is enabled, LED 2 (MI) is On when the PT Board is linked to the Instrument to retrieve Achieve data on an hourly interval (top of hour).

7 Setup Basics

7.1 Connections

Checked the following before performing a configuration of the PT Board.

Power cable is connected to either J7 or J8 (Supply = 5 --16 VDC).

PC serial cable is connected to J3 (for configuration setup).

PT Board is connected to Instrument via J5 or J6 and JMP-2 is properly installed.

Nothing connected to J1 PRGM port!

7.2 Initial Configurations

7.2.1 Setup for Mercury Link to Instrument

1. Connect to PT Board using **PT Config** software using the J3 connector. The J3 default baud is 9600 (ensure PT Config set to 9600)
2. Select baud rate for main Host system connection (see Section 3.2.1).
3. Select Instrument type (see Section 3.3.2)
4. Disconnect Link from PT Config (PT Board LEDs should both turn off).
5. Open **MasterLink** software and setup comm port to 9600 (same as PT Config).

☞ Test serial connection to Instrument by using *Display* / *Items by Function* from MasterLink's menu. PT Board LEDs should both turn On (solid) during serial link.

After a connection is confirmed, disconnect Link from MasterLink (PT Board LEDs should both turn off).

7.2.2 Setup Modbus Protocol

1. Reconnect to PT Board using **PT Config** software using the J3 connector.
2. Select Modbus Protocol parameters (see Section 3.4). Note: normally test using Device Address 1. Configure: Modbus type, Register size, etc.
3. Setup Modbus Register Mapping (see Section 3.5).
4. Disconnect Link from PT Config (PT Board LEDs should both turn off).

☞ Test the host Modbus system. PT Board Host LED should turn On as serial activity starts, while the MI LED should then turn On with an acceptable Modbus query. If the MI LED does not turn ON, the PT Board Modbus settings do not match the Host. See section 6.2 for details.

8 Problem Checks

8.1 Instrument Interface

The following points should be checked if communications problems occur when using the PT Board. Consult Mercury Instrument for any additional assistance.

- Confirm the **PT Instrument Access Code** matches that of the corresponding Instrument (typically 33333). ***See Section 3.3.3.***

  The PT Board "Instrument's Access Code" is displayed as: * * * * *.

  The PT Board does not require a matching Access Code to connect using Mercury Protocol - only required for Modbus Protocol.

- Confirm the **J5/J6 Baud rate** matches the Instrument's baud (typically 9600 bps).

- Confirm the **Instrument Type** selection is proper for the corresponding Instrument.

- Confirm the **JMP-2** jumper is installed in the correct position for the corresponding Instrument port used (J5 or J6). ***See Section 2.***

8.2 Host Interface

- Confirm the Host system's baud rate matches the PT Boards J2/J3/J4 baud rate(s) - depending on port used.

- Confirm a valid Modbus Starting Address.

  True Modicon systems transmit a Modbus Starting Address value of 1 less than the user's selection (e.g. Host sends 6999 when user has indicated 7000 for the Start Address).

  Possible resolve to this problem - enable PT Item: "Reference To Zero".

  Alternatively, the Host controller can handle this offset by setting the Starting Address 1 higher than the desired value (e.g. use 7001 for 7000).

  See Section 3.5

9 Specifications

9.1 Power Supply

- 5 to 16.0 V DC operations
- Designed for battery operations or with supplemental power supply.
- Active mode current: 15 - 20 mA (7.5 VDC)
- Power down mode current : 40 - 60 uA (7.5 VDC)

9.2 Host Interface serial ports

- RS-485 port (J2) for half duplex multidrop connections (2-wire).
- RS-232 port (J3) for local serial connections (3-wire interface for field serial communications, etc.).
- RS-232 port (J4) for modem serial connections (5-wire interface to modems, radios, etc.).

9.3 Instrument interface serial ports

- One (1) RS-232 port via J5
- One (1) CMOS port via J6

9.4 Operating temperature

- –40°F to 165°F (-40°C to 75°C)

9.5 Indicator LEDs

- Two (red)

9.6 Memory

- SRAM - for maintaining Archive data -separate storage from Instrument.
- E^{E}PROM - for PT Board configuration settings.
- FLASH - for operating system firmware (Programmable via J1 Program Port)

9.7 Mechanical

- Open PCB with four (4) mounting holes - *mount inside a protective enclosure.*
- Board dimensions: 2.40 x 4.00 inches

9.8 Mounting kits

- Available for field installation of PT boards for all Mercury Instruments

9.9 Certifications

- Designed for Class 1, Division 1 & 2, Group D

  Consult Mercury Instruments, Inc. for latest approval ratings.

10 Firmware Upgrading

PT Board firmware (device operating program) is stored in flash memory. Adding new features and capabilities to the device is simply a matter of uploading a file containing a newer version of firmware through the serial port connection. There are no EPROM chips to be removed or plugged into sockets.

! To upgrade flash program memory, use **Firmware Upgrade Manager** software in-conjunction with the **MPA** programming device (p/n: 40-2620).

☞ Consult Mercury Instruments customer service to obtain these parts if needed.

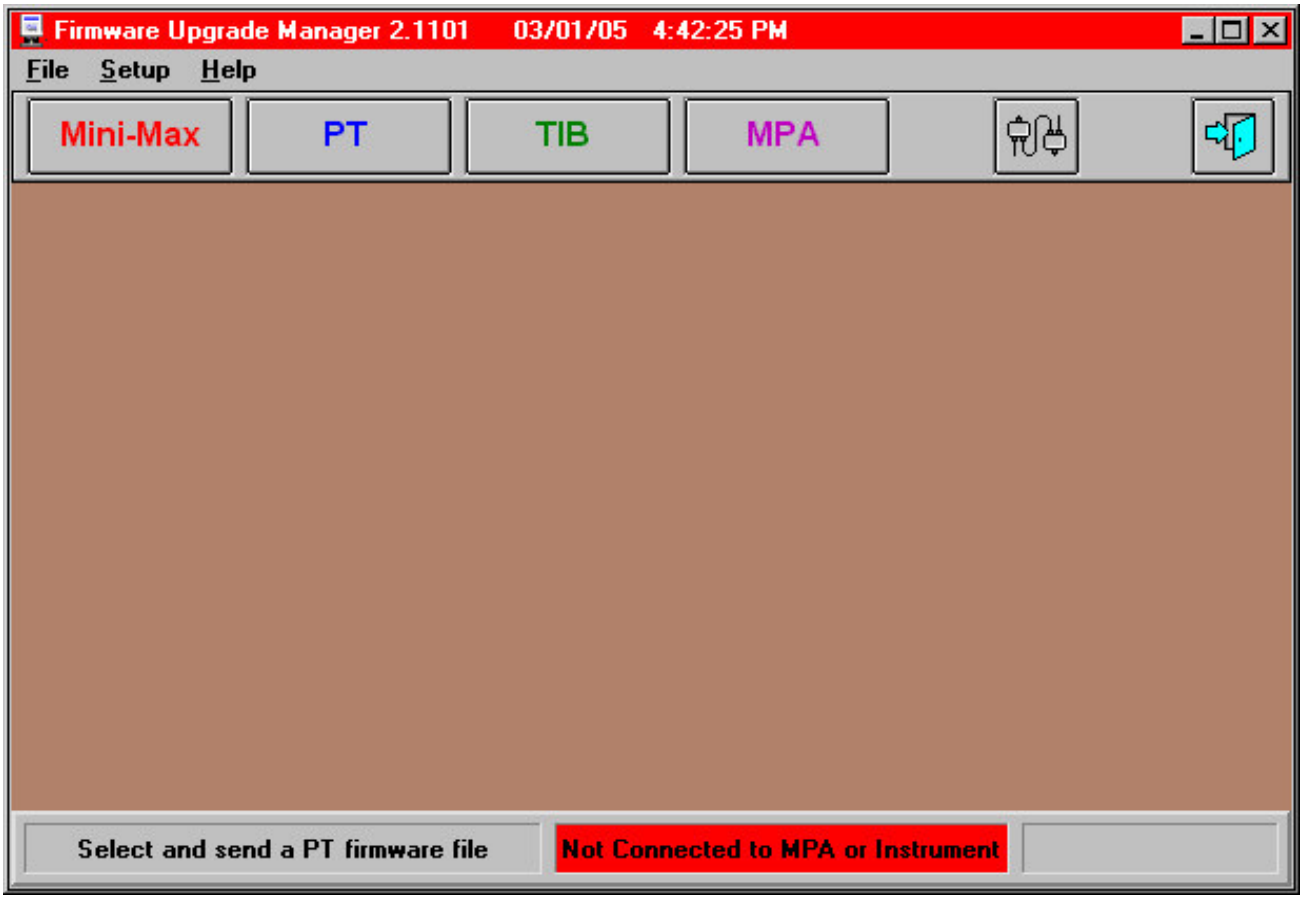
10.1 Programming steps

1 Connect the MPA to **J1** "**PRGM**" (10-pin connector) on the PT board

2 Connect the Serial Cable (40-1629) from the MPA to the computer Comm port.

3 Start "Firmware Upgrade Manager" program on your computer (install if required).

4 Choose "**PT**" icon from top of menu.

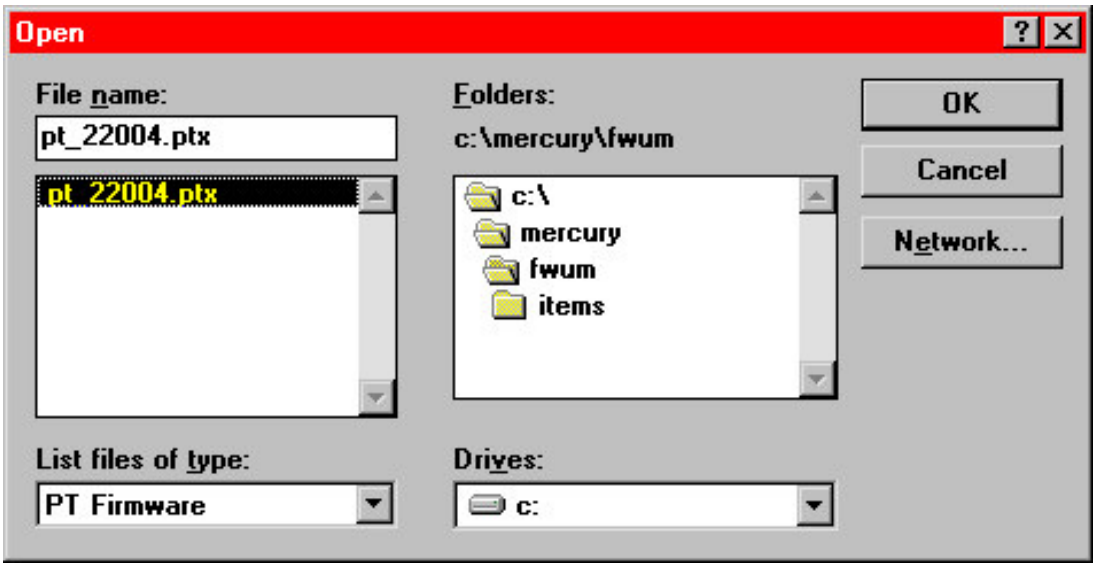


5 Browse to the desired PT Firmware file (*. ptf) - then press OK to send.

6 Firmware will then be programmed in to Flash memory and verified.

7 After successful programming - press OK to exit.

! Disconnect the MPA from the PT Board (J1 conn) after completing the Firmware up grade process.



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3940 Virginia Ave.
Cincinnati, OH 45227
513-272-1111
www.honeywell.com

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