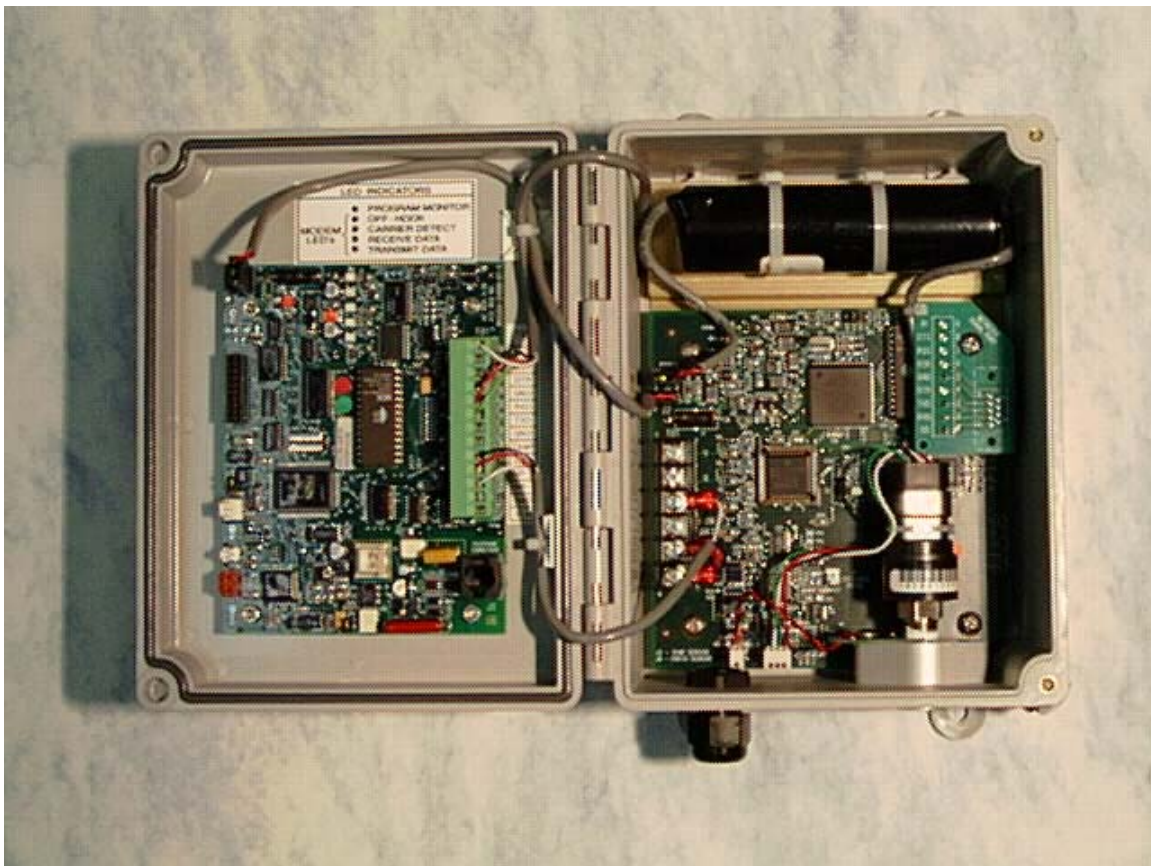


Pressure Tracker – II Installation Manual



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July 21, 2000
Revision: B

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Chapter One

Introduction & Hardware Summary

Introduction

To better meet customer needs for a pressure-sensing product, Metretek has developed the Pressure Tracker-II (PT-II). Highlights of the product specifications are detailed below:

- Accuracy of $\pm 1\%$ of full scale over the entire temperature range of -30° to $+70^{\circ}$ C.
- High and low pressure limit alarms provide instant notification of equipment failure or dangerous pressure drops.
- Integral modem delivers time-tagged data and also permits viewing of pressure readings in real-time. Data rates of 300, 1200 and 2400bps are supported.
- All components and wiring connections are internal with only the telephone line running outside the box.
- Lithium battery power is immune to AC power outages and eliminates external cable runs.
- UL listed for installation in a Class I, Division 2 hazardous environment.

Primary targets for the PT-II are applications where gas line pressure must be monitored continuously, data profiles collected, and alarms signaled when a pressure violation occurs. Thus, the PT-II can serve applications where an electronic corrector would be overkill in terms of both performance and cost.

Figure 1-1 provides an illustration of a typical installation from end to end.

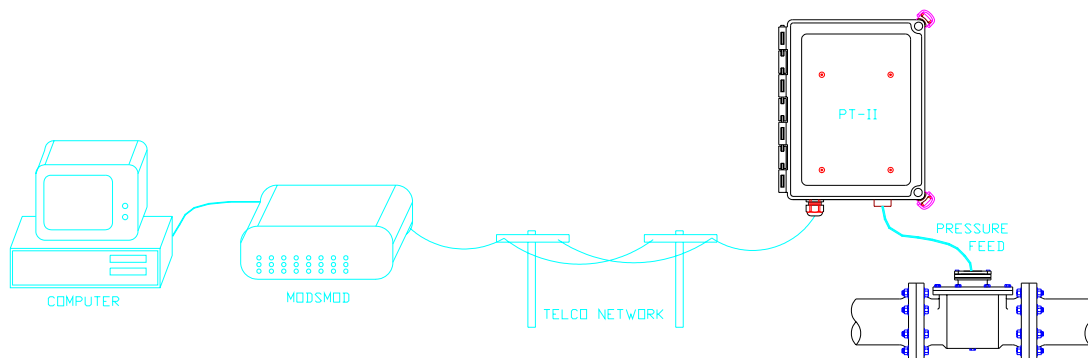


Figure 1-1.
Elements of a PT-II installation.

PRESSURE TRACKER HARDWARE

Figure 1-2 illustrates the major components of the PT-II that the user should become familiar with:

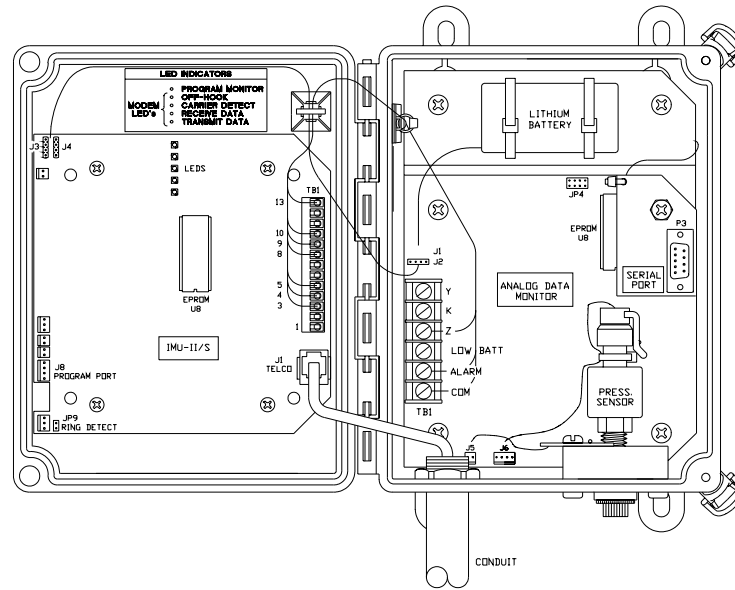


Figure 1-2.
Pressure Tracker-II

Analog Data Monitor Board Components

- J1, J2 Lithium battery power connector, accepts voltage range of 3.0 to 4.5Vdc. One connector is used to route power to the IMU-II/s board, and the other is available for the lithium battery. Recommended replacement battery pack is 1011-0022B-001.
- P3 RS-232 port connector with adaptor board, provides the serial communications path with the IMU-II/s board. When performing on-site calibration and configuration operations, the adaptor board is removed and a direct cable attachment to a PC is made.
- J5, J6 Temperature and pressure sensor connectors, these are pre-wired at the factory.

- JP4 Four position jumper for selecting the serial communications bit rate of the RS-232 port. This jumper must match the serial communications rate of the IMU-II/s for proper operation. Position A = 300bps, B=1200bps, C=2400bps, D=9600bps.
- TB1 Terminal block, provides access to the KYZ (Form-C) pulse signal, low battery alarm, and high/low pressure alarm output. These have already been pre-wired at the factory to the IMU-II/s board.
- U4 EPROM memory chip, contains the operating program for the Analog Data Monitor board. Due to periodic program updates containing bug corrections and feature enhancements, it might be desirable to replace this chip as new versions become available. when replacing the chip, always ensure that the 'U' shaped detent faces towards the bottom of the board (south).

IMU-II/s Board Components

- J3, J4 Power connector terminals, power is provided to the IMU-II/s board via a cable that runs to the Analog Data Monitor power connector.
- TB1 Thirteen position terminal block, provides attachment point for serial port communications wires as well as data and alarm inputs. All necessary wiring connections to the Analog Data Monitor board have been made at the factory.
- J8 Programmer access port, this is used in conjunction with the Metretek Programmer software and cable to provide EEPROM memory configuration of the IMU-II/s.
- J1 Telephone RJ-11C type 6-position connector, this provides the MODEM communications path to the telco network. Only two wires are required (Tip & Ring) to secure a landline telephone or cellular phone connection.
- JP9 Ring detect jumper; incoming calls will be answered when this jumper is installed. An appropriate ring count must also be configured into the EEPROM memory of the IMU-II/s board. Refer to Chapter Six for additional information regarding IMU-II/s configuration.
- U8 EPROM memory chip, contains the operating program for the IMU-II/s board. Due to periodic program updates containing bug corrections and feature enhancements, it might be desirable to replace this chip as new versions become available. when replacing the chip, always ensure that the 'U' shaped detent faces towards the bottom of the board (south).

LED's Light Emitting Diodes, these serve to indicate communications status. These lights will illuminate for a period of 4 minutes after initial application of power, as well as during active communications.

LED	Function
PROGRAM MONITOR	Blinks to indicate that the microprocessor is operating correctly. A rapid blink rate indicates that the device is in transparent mode.
OFF-HOOK	Illuminates when the MODEM circuit is either dialing or in active communications mode.
CARRIER DETECT	Indicates that a MODEM carrier signal has been detected from the central computer.
RECEIVE DATA	Blinks when data has been received from the central computer.
TRANSMIT DATA	Blinks as data is being transmitted out to the central computer.

LED Function Table.

Analog Data Monitor Duties:

- Samples pressure (at a user specified interval) and performs compensation calculations to correct for linearity and temperature effect errors.
- Provides pulse outputs on the terminal block that reflect the pressure sample. A pressure from zero to full-scale will generate a corresponding pulse frequency from 0 to 8 Hertz.
- Programmable limit alarms for high and low pressure will produce a contact closure on the terminal block when a violation occurs.
- Serial port permits a remote modem connection to view live pressure or to modify operating parameters such as alarm set points. Communications format on the serial port is simple ASCII text.

IMU-II/s Duties:

- Collects time-tagged interval (TTI) data.
- Internal modem can transfer TTI data to Metretek Modsmode modem at central computer site.
- A fully transparent modem mode is engaged when a Hayes type modem is on-line to substitute the Metretek Modsmode modem.
- Alarm inputs trigger the IMU-II/s to call the central computer, thereby notifying the user of a potential anomaly.

Telecom and safety notifications

Canadian Telecom

"NOTICE: The Industry Canada label identifies certified equipment. This certification means that the equipment meets certain telecommunications network protective, operational and safety requirements as prescribed in the appropriate Terminal Equipment Technical Requirements documents. The Department does not guarantee the equipment will operate to the user's satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. The customer should be aware that compliance with the above conditions might not prevent degradation of service in some situations.

Repairs to certified equipment should be coordinated by a representative designated by the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connections of the power utility, telephone lines and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

CAUTION

Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.

Use only Canadian telecom jack type CA11A when connecting to the telephone network.

The Ringer Equivalence Number (REN) of this device is 0.3B.

NOTICE: The **Ringer Equivalence Number (REN)** assigned to each terminal device provides an indication of the maximum number of terminals allowed to be connected to a telephone interface. The termination of an interface may consist of any combination of devices subject only to the requirement that the sum of the Ringer Equivalence Numbers of all the devices does not exceed 5.

US Telecom

This equipment complies with Part 68 of the FCC rules. On the front of this equipment is a label that includes the FCC registration number and ringer equivalence number (REN) for this equipment. If requested, this information must be provided to the telephone company.

The REN is used to determine the quantity of devices, which may be connected to the telephone line. Excessive RENs on the telephone line may result in the devices not ringing in response to an incoming call. In most areas, the number of RENs should not exceed five (5.0). To determine the number of RENs that may be connected to the line in a calling area - (maximum REN) - contact the telephone company.

This equipment uses the following USOC jacks: RJ11C

This equipment is designed to connect to the telephone network or premises wiring using a compatible modular jack that is Part 68 compliant.

If this equipment causes harm to the telephone network, the telephone company will notify you in advance that temporary discontinuance of service may be required. If advance notice isn't practical, the telephone company will notify you as soon as possible. Also, you will be advised of your right to file a complaint with the FCC.

The telephone company may make changes in its facilities, equipment, operations, or procedures that could affect the operation of the equipment. If this happens, the telephone company will provide advance notice in order for you to make the necessary modifications in order to maintain uninterrupted service.

If trouble is experienced with this equipment, please contact Metretek Technical Support at (800) 327-8559 for repair and warranty information. If the trouble is causing harm to the telephone network, the telephone company may ask you to remove the equipment from the network until the problem is resolved.

*See Appendix E for Warranty Information.

Chapter Two

Hardware Installation

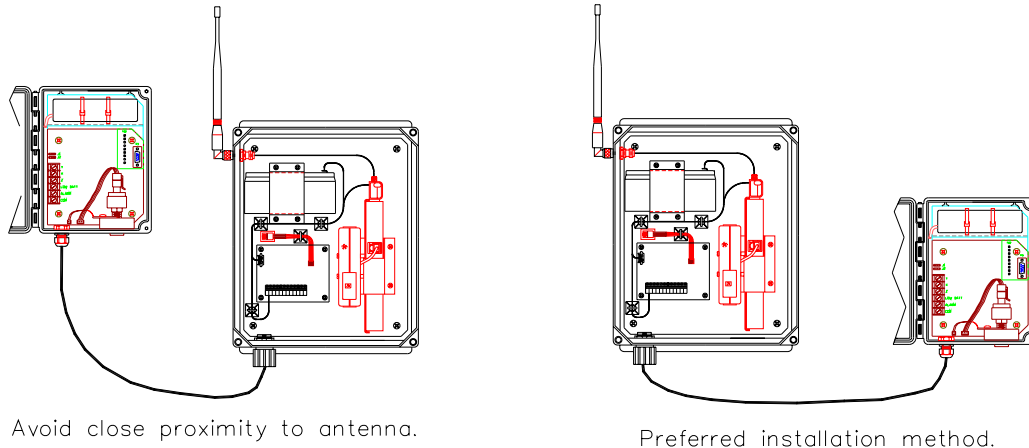


Figure 2-2.
Installation near cellular radio.

WARNING

The Cellular Radio Module is not UL listed and cannot be installed in a Class I, Division 2 hazardous environment.

Telephone Cable Installation

Efficient installation can be achieved if the proper tools and equipment are on-hand such as the items listed below:

- Telephone line cable, 4-conductor stranded wire, 26 or 28AWG.
- RJ-11C type plastic telephone connectors.
- Crimp tool, AMP 1-231652-0 or equivalent.
- TII telephone line station protector (included with PT-II).
- Slug-buster hole knockout tool for conduit installations (optional).

CAUTION

When routing the telephone cable into the enclosure (reference Figure 1-2), be certain to leave an extra length of cable loose inside the enclosure. This will permit the door to be opened wide without the possibility of the telephone connector being torn away from the IMU-II/s board.

Telephone Line Station Protector Installation

Follow the steps below to install the telephone line station protector and to make final connection to the phone line:

- 1) Install the telephone receptacle (telephone network interface) if it has not already been installed.
- 2) Mount the TII Station Protector in a suitable location. Wiring of the station protector is shown in Figure 2-4.

NOTE

TII Station Protector should not be installed in a Class I, Division 2 area.

- 3) Connect one end of the 12 AWG earth ground wire to the center terminal on the TII protector.
- 4) Connect the other end of the earth ground wire to a solid earth ground in conformance with local electrical code regulations.
- 5) Route the telephone cables from the telephone company connector and the IMU-II/s through the bottom of the TII station protector.
- 6) Connect the red wires from both of the telephone cables to the left screw inside the TII station protector.
- 7) Connect the green wires from both of the telephone cables to the right screw inside the TII station protector.
- 8) Assemble the cover to complete the TII installation.

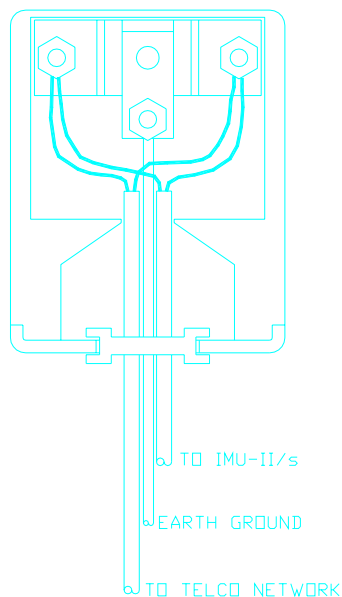


Figure 2-4.
TII Station Protector Wiring

Warning

- Do not disconnect live circuits unless area is known to be non-hazardous.
- Never install telephone wiring during a lightning storm.
- Never install telephone jacks in wet locations unless the jack is specifically designed for wet locations.
- Never touch un-insulated telephone wires unless the telephone line has been disconnected at the network interface.
- Use caution when installing or modifying telephone lines.

Verify Ring Detect Jumper

Ring detect allows the IMU-II/s to answer incoming calls from the central computer system. If this capability is desired, install a shorting jumper across JP9 on the IMU-II/s board. Factory new units sometimes have the shorting jumper taped to the inside wall of the enclosure.

Install Battery Pack

Warning

Do **not** disconnect or connect batteries unless area is known to be non-hazardous.

Install the battery pack at the location illustrated in Figure 1-2. Secure the battery pack with the tie wraps provided. Attach the electrical connector from the battery to either J1 or J2 on the Analog Data Monitor.

A good battery pack will result in the green LED of the IMU-II/s to begin flashing. A dim or completely dark LED may be due to a weak or dead battery.

Verify Power-up

Immediately after the IMU-II/s is powered, the Program Monitor LED will turn on solid green while a RAM memory test is being performed. In the unlikely event that the RAM test should fail, the bottom LEDs will turn solid red. Normally the RAM test will pass and the IMU-II/s will attempt to dial into the central computer if it has been so enabled.

Initiating a Call to the Central Computer

It is assumed at this point that the configuration memory of the IMU-II/s has already been programmed; if this is not the case then refer to Chapter Six for further instructions. An example of a good call sequence is detailed below.

- a) Activate the customer alarm input on the IMU-II/s. The bottom two positions of the terminal block should be momentarily shorted with a wire, tool, paperclip, etc., to force a call.
- b) The green program monitor LED will start flashing, followed by the illumination of the off-hook LED.
- c) After 10 or 15 seconds, the red Carrier Detect LED will light to indicate that it has made a connection with a modem at the central computer site.
- d) Receive Data and Transmit Data lights will flash alternately as data is being exchanged. Time duration is dependent on the amount of information being transferred.
- e) When the call is finished, the bottom two red LEDs will illuminate solid to indicate that the communications were successful.

It is normal for the LED indicators to remain lit for five minutes after the initial application of power to the IMU-II/s. Afterwards, the LEDs will only light while a call is in progress so that battery power will be conserved.

Securing the Enclosure Door

A lock can be installed on the latches (after removal of the circular punch-outs) to secure the enclosure. Alternatively, security screws can be used (must have 10-32 thread) in the top and bottom right-hand corners of the door after removal of the nylon plugs. Security screws are available from Metrotek that serve this function, and include a hole to accept a seal wire. These can be specified at time of order, or else obtained separately with part number 5305-0089B-001.

NOTES

Chapter Three

Central Computer Configuration

Central Computer Input Configuration

When setting-up the initial account, it will be necessary to select the 'IMU' device type from the menu. A PT-II device type is not listed or available as a selection.

Hardware wiring of the PT-II dictates that Input-1 is a pulse counting input, and that Input-2 is an alarm input. Account information in the central computer must correlate with the hardware configuration. In addition, the interval size of the remote will also need to match the value held in the central computer account. Chapter Six provides information on how to change the interval size value contained within the IMU-II/s.

Meter Multiplier Calculations

Maximum pulse frequency from the Analog Data Monitor board is 8 Hertz when full-scale pressure is applied. A formula for calculating the multiplier factor for the central computer is:

$$\text{Multiplier} = \text{Full Scale Pressure} / (8 \times 60 \times 2 \times \text{Interval Size})$$

Where: 8 = Maximum pulsing rate from Analog Data Monitor.
60 = Number of seconds per minute.
2 = Multiplier for Form-C switch. (Omit if Form-A input)

A simplified form of the same equation is shown below:

$$\text{Multiplier} = \text{Full Scale Pressure} / (480 \times \text{Interval Size}) \quad \{\text{Form-A input}\}$$
$$\text{Multiplier} = \text{Full Scale Pressure} / (960 \times \text{Interval Size}) \quad \{\text{Form-C input}\}$$

NOTE

The IMU-II/s product has a Form-A pulse counting input, therefore, the formula above with the value of 480 should be applied.

Alarm Messages

Various alarm messages are generated by the IMU-II/s board to describe both internal and external events that occur. Delivery method for these messages will vary depending on whether the IMU-II/s board is communicating in Metretek mode or transparent mode. Table 3-1 provides a brief description of these alarms.

Alarm Message	Description
LOW BATTERY	The IMU-II/s has detected that the battery pack is nearing a discharged condition.
CALL RETRY	A previous call attempt by the IMU-II/s was not successful. Busy phone lines or noise on the line are common reasons for this message to appear.
UNIT RESET	This indicates that the IMU-II/s has undergone a total system reset. A reset alarm will be reported if the battery power is lost and then restored.
CUSTOMER ALARM-1	If the Input-1 is assigned to be an alarm input, then this alarm is generated when the input is closed.
CUSTOMER ALARM-2	If the Input-2 is assigned to be an alarm input, then this alarm is generated when the input is closed.
TAMPER ALARM	Indicates that the tamper circuit has been activated by opening the normally closed circuit.
CUSTOMER ALARM	This alarm is generated when the input is closed.

Table 3-1.

Metretek Mode vs. Transparent Mode

Modem communications are handled by the IMU-II/s board with Metretek mode communications used to transfer time tagged interval data and transparent mode used for direct ASCII communications with the Analog Data Monitor.

Metretek mode communications require a Modsmode MODEM and data collection system (i.e.—DC2000) to transfer time-tagged interval data and alarm information. Special protocols are used to ensure the integrity of the data and to provide for data retransmission if data errors do occur.

Transparent mode communications require either a Hayes type MODEM (or Modsmode operating in Hayes compatible mode) to access the Analog Data Monitor directly. Time-tagged interval information cannot be accessed while in the transparent mode. When the transparent mode is utilized, it is possible to view live pressure readings or to change configuration settings within the Analog Data Monitor board. Switching between transparent and Metretek modes is automatic with the IMU-II/s board being able to detect the type of MODEM that it is connected to.

Two special commands are available that can be issued by the user at the central computer site:

Command	Result
+-+CA	Clears all IMU-II/s internal alarms, 'OK' is sent as response.
+-+SA	Displays the IMU-II/s unit ID and status of active alarms.

Table 3-2.

The sequence "+++" has been avoided and replaced with "+-+" to prevent the central computer site MODEM from switching into the command mode. These commands are of greatest utility for installations that do not have a data collection system installed, but instead perform manual polling and maintenance operations using only a MODEM and terminal emulation software.

NOTES

Chapter Four

Configuration of Analog Data Monitor

Configuration of the Analog Data Monitor

Most users will want to change the factory default settings of the Analog Data Monitor in order to provide a better fit for their application. Settings that fall into this category include Sample Rate, Pressure Alarm Setpoints, Entry Password, etc. Two methods for performing this task are presented here, and the most appropriate will ultimately depend on circumstances such as site proximity and available equipment.

Method One: Serial Cable link between PC & Analog Data Monitor

A direct serial cable link between the PC and the Analog Data Monitor will be necessary when a telephone network (or simulator) is not available. This will most often be the case when performing a pressure calibration in the field. Equipment requirements are itemized below:

- Analog Data Monitor board, lithium battery pack.
- DTE to DTE serial cable. (reference Figure 4-1)
- Personal Computer with terminal emulation software such as Procomm™, Hyperterminal™, or equivalent.
- Phillips screwdriver.

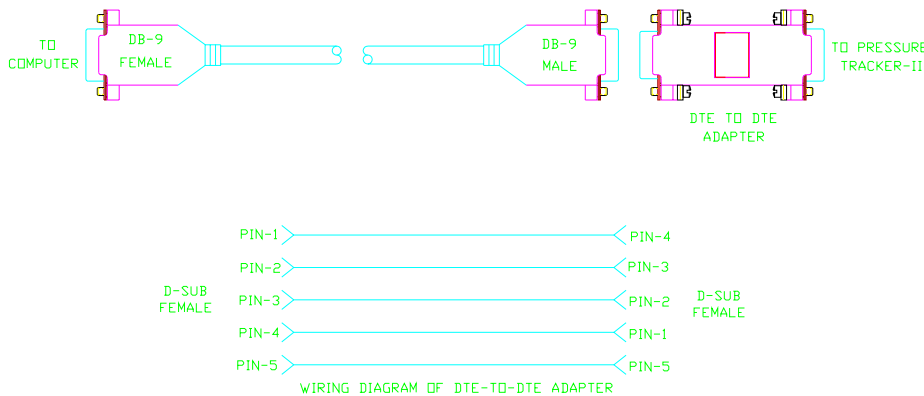


Figure 4-1.
DTE to DTE adaptor cable.

Warning

Do **not** disconnect or connect live circuits unless area is known to be non-hazardous.

The following process steps will establish the communications link:

- a) Note the setting of JP4 on the Analog Data Monitor board. Most landline telephone based systems should have the jumper on 'C' for 2400bps, while cellular systems should be set for 1200bps.
- b) Using a phillips screwdriver, remove the single screw and associated small circuit board from the top right-hand side of the Analog Data Monitor.
- c) Power the Analog Data Monitor board with a lithium battery.
- d) Power the computer and run the terminal emulation software. Ensure that the serial bit rate setting in the software matches that of the Analog Data Monitor. Attach one end of the DTE to DTE adaptor cable to the appropriate communications port on the PC.
- e) Attach the free end of the DTE to DTE cable to the Analog Data Monitor connector.

At this point, a menu should appear on the display of the PC as shown in Figure 4-2. If no menu appears, or if the characters are scrambled, then it is likely that the bit rate parameters are not coordinated properly. The PC should match the bit rate of the Analog Data Monitor board, and should be set for 8 data bits, 1 stop bit, no parity.

PRESSURE TRACKER-II	VERSION 1.xx
1) DISPLAY SYSTEM STATUS	
2) MONITOR LIVE PRESSURE (1-SECOND UPDATES)	
3) MONITOR LIVE PRESSURE (SAMPLE RATE UPDATES)	
4) ENTER CONFIGURATION/FIELD CALIBRATION MODE	
5) ENTER FACTORY TEST/CALIBRATION MODE	

Figure 4-2.
Main Menu Text

Proceed to Chapter Five for further discussion of the menu structure and configuration options.

Method Two: Telephone link between central computer & PT-II

A telephone link between the PT-II and a PC is normally made with units that are installed in the field at remote locations.

Equipment requirements are itemized below:

- Pressure Tracker-II with either landline or cellular phone connection. The IMU-II/s is assumed to have already been properly configured.
- Personal Computer with terminal emulation software such as Procomm™, Hyperterminal™, or equivalent.
- Hayes compatible modem (attached to the above PC) capable of supporting 1200 and 2400bps (V.22 and V.22bis respectively) speeds. Higher speed modems may need to have error correction turned off with the AT &Q0 command.

Dial out to the remote to establish a connection. Initially a few trash characters will appear as the IMU-II/s attempts to communicate with a Modsmod. After a few seconds the IMU-II/s will determine that a Modsmod is not available, and will then switch to a transparent data mode. A menu screen such as Figure 4-2 should appear. If not, try pressing the 'Enter' key to make the menu redraw.

Proceed to Chapter Five for further discussion of the menu structure and configuration options.

NOTES

Chapter Five
Analog Data Monitor Menu Structure

Analog Data Monitor Menu Structure

Figure 5-1 illustrates the five options that the user is presented with in the main menu. These options are discussed in detail below.

PRESSURE TRACKER-II	VERSION 1.xx
1) DISPLAY SYSTEM STATUS	
2) MONITOR LIVE PRESSURE (1-SECOND UPDATES)	
3) MONITOR LIVE PRESSURE (SAMPLE RATE UPDATES)	
4) ENTER CONFIGURATION/FIELD CALIBRATION MODE	
5) ENTER FACTORY TEST/CALIBRATION MODE	

Figure 5-1.
Main Menu Text

Selection of option '1' generates a display that provides a summary of the operating status. Figure 5-2 illustrates a typical status screen report. It is a good idea to review the status screen after making configuration changes. This provides verification that the desired configuration change has indeed been applied as expected.

PRESSURE TRACKER-II SYSTEM STATUS
PRESSURE: 0.0 PSIG
TEMPERATURE: 22.8 DEG. C
KYZ FREQUENCY: 0.00 HERTZ
BATTERY: 3.610 VOLTS
SAMPLE RATE: 15 SECONDS
LOW PRESSURE ALARM SETPOINT: 45 PSIG
HIGH PRESSURE ALARM SETPOINT: DISABLED
SETPOINT VIOLATION TIMER: 45 SECONDS
PRESSURE RANGE: 0-100 PSIG

Figure 5-2.
System Status Screen

Selection of option '2' generates a continuous pressure sample display that is updated every second (reference Figure 5-3). Pressure readings are taken and updated every second when in this mode, regardless of the stored setting for the sample rate. Applications for this menu include the monitoring of live pressure while equipment adjustments are made to the distribution network.

PRESSURE TRACKER-II LIVE SAMPLE DISPLAY (UPDATED EACH SECOND).
TYPE 'Q' TO RETURN TO MENU.

PRESS = 0.0 PSIG
PRESS = 0.0 PSIG
PRESS = 0.0 PSIG
PRESS = 0.0 PSIG

Figure 5-3.
Monitoring of live pressure.

Selection of option '3' generates a pressure sample display that is updated at the programmed sample rate (reference Figure 5-4). This sample rate can be set for a value in the range of 1 to 60 seconds under the configuration menu described in a later section. A less frequent sample rate is of utility when the data is being downloaded to a file for analysis by a spreadsheet program. Spreadsheet programs are capable of filtering out the non-numeric text and analyzing the numbers to produce a pressure profile chart.

PRESSURE TRACKER-II LIVE SAMPLE DISPLAY (UPDATED AT SAMPLE RATE).
CURRENT SAMPLE RATE = 15 SECONDS.
TYPE 'Q' TO RETURN TO MENU.

PRESS = 0.0 PSIG
PRESS = 0.0 PSIG
PRESS = 0.0 PSIG
PRESS = 0.0 PSIG

Figure 5-4.
Live pressure display, 15sec. update rate.

Selection of option '4' requires password entry to gain access to the configuration / calibration menu as shown in Figure 5-5. Factory default password is "PASSWORD" until changed by the user.

PASSWORD ENTRY IS REQUIRED BEFORE PROCEEDING TO NEXT LEVEL

NOTES: a) PASSWORD ENTRY IS NOT CASE SENSITIVE
b) DEFAULT PASSWORD IS "PASSWORD" UNLESS CHANGED BY USER
c) TYPE 'QUIT' TO RETURN TO MAIN MENU

<.....>

Figure 5-5.
Password entry screen.

CAUTION

Failure to change the default password will leave
the system vulnerable to intrusion by hackers.

After entry of the appropriate password, the configuration / calibration menu will appear as in Figure 5-6.

CONFIGURATION / FIELD CALIBRATION MENU	
1) CHANGE LOW PRESSURE ALARM LIMIT	
2) CHANGE HIGH PRESSURE ALARM LIMIT	
3) CHANGE ALARM VIOLATION TIMER VALUE	
4) CHANGE PRESSURE SAMPLE RATE	
5) DISPLAY EEPROM MEMORY CONTENTS	
6) MODIFY EEPROM MEMORY CONTENTS	-USE CAUTION-
7) CHANGE ENTRY PASSWORD	-USE CAUTION-
8) CALIBRATE PRESSURE SENSOR	-USE CAUTION-
Q) RETURN TO MAIN MENU	

Figure 5-6.
Configuration / calibration menu.

Itemized description of the configuration / calibration menu elements

Change low pressure alarm limit:

Permits the user to assign a low-pressure alarm setpoint with values in the range of zero to the full-scale rated pressure. Entries are made as a numeric value in psi units. This alarm can be defeated by typing 'X' at the prompt.

Change high pressure alarm limit:

Permits the user to assign a high-pressure alarm setpoint with values in the range of zero to the full-scale rated pressure. Entries are made as a numeric value in psi units. This alarm can be defeated by typing 'X' at the prompt.

Change alarm violation timer value:

Allows changing of the value contained in the countdown timer that is used to trigger the alarm signal on the terminal block. A pressure violation (either high or low) must exist continuously for the specified time interval before the alarm is triggered. This can be used to prevent frivolous alarms from being triggered based on only a few samples. Supported range of legal entry values is from 1 to 255 seconds, with the constraint that the number must be equal to or greater than the value used for the sample rate.

To illustrate the point, a system with a sample rate of once every 30 seconds may be configured to use an alarm violation timer value of 120 seconds. It will then be necessary for the pressure to be out of range for 4 continuous samples before the alarm will be triggered (which in turn will cause the IMU-II/s to call the central computer site).

Change pressure sample rate:

Permits changing of the frequency with which the Analog Data Monitor board takes a pressure sample with the transducer. Permitted entry values are limited to once every 1, 2, 3, 4, 5, 6, 10, 15, 30, or 60 seconds. A sample rate of once every second would consume the battery in short order, therefore it is not recommended unless the product is

AC powered. Factory default value is once every 15 seconds, and a value of once every 30 or 60 seconds will likely satisfy the requirements of most applications.

Display EEPROM memory contents:

This diagnostic tool displays the contents of EEPROM memory in hexadecimal number format. Normally this would not be invoked except at the request of a Metrotek service technician. Numerous operating parameters are stored in this memory, some of which include the pressure scale, unit of measure, user selectable parameters, and calibration coefficients for the transducer.

Modify EEPROM memory contents:

Permits the user to directly change the contents of EEPROM memory. This can be of utility in special cases where the user is receiving guidance from a Metrotek service technician. In situations where it is desired to change the unit of measure (from 'psi' to 'inches H2O' for example), one of the EEPROM registers would require modification. Normally it is advised to avoid manipulating the contents of EEPROM memory so that the possibility of causing an accuracy degradation or total failure can be minimized.

Change entry password:

Allows the user to assign a new password to the configuration / calibration entry menu, and is highly recommended for preventing hacker access to telephone based PT-II's. Special care should be taken however to ensure that the new password is not lost or forgotten. Passwords are not case sensitive (caps lock state can be ignored), and are permitted to be any combination of characters/symbols available on the keyboard.

Calibrate pressure sensor:

Permits field calibration of the pressure transducer used in the PT-II. When this option is selected, a new menu will appear as shown in Figure 5-7.

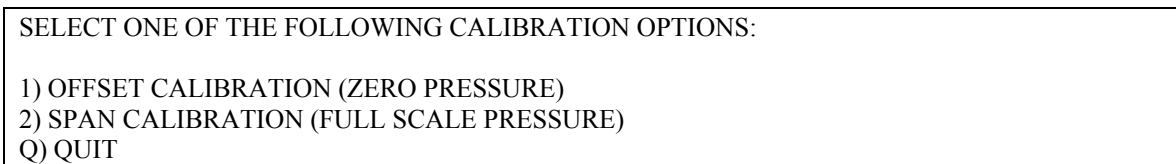


Figure 5-7.
Pressure calibration menu.

Select option '1' to calibrate the zero pressure point or option '2' to calibrate the full-scale pressure point. Calibration of the pressure sensor requires that the technician be able to apply zero psi pressure for the offset calibration and full-scale pressure to calibrate the span. A typical menu for calibrating the zero point is shown in Figure 5-8.

APPLY ZERO PRESSURE AND ADJUST THE OUTPUT TO REPORT ZERO

PRESS 'T' TO INCREMENT THE VALUE

PRESS 'D' TO DECREMENT THE VALUE

PRESS 'ENTER' TO SAVE THE CALIBRATION PARAMETERS

PRESSURE = 0.0 PSIG

Figure 5-8.
Zero point (offset) calibration menu.

Pressure readings are updated at a rapid rate at the bottom of the menu to provide feedback during the adjustment process. Pressing the 'T' or 'D' key will cause a small increment or decrement to the reported pressure reading. Each time a key is pressed, a beep sound will be made on the computer to signal an acknowledgement.

Since a precisely controlled temperature is not possible in the field, it should be expected that a field calibration would not be as accurate as a factory calibration. The original factory calibration was performed in an environmental chamber at six temperature points and with a high precision pressure source.

NOTE:

When possible, full-scale pressures should be used to execute the span calibration. In cases where this is not possible, line pressure can be utilized instead with the understanding that this method is less precise.

NOTES

Chapter Six

Configuration of IMU-II/s

Configuration of IMU-II/s EEPROM memory

Programming and configuration of the IMU-II/s are accomplished using the MP programmer software and serial interface cable. This process is detailed below:

Equipment requirements:

- a) IBM type personal computer with MP programmer software loaded.
- b) PC to Remote Interface cable, p/n: 2005-0019C-001.
- c) PT-II with battery power applied.

Warning

Do **not** disconnect or connect live circuits unless area is known to be nonhazardous.

Process Sequence:

- a) Attach the 9 pin D-sub end of the PC to Remote Interface cable to an available communications (COM) port on the computer.
- b) Start the MP programmer software with the command "MP COMx IMU/S" where COMx is either COM1 or COM2.
- c) Attach the opposite end of the PC to Remote Interface cable to the 4-position connector at the bottom left-hand corner of the IMU-II/s board.
- d) Select the appropriate action by pressing F2, F3 or F4. A typical configuration screen is shown in Figure 6-1.

12/31/99	METRETEK Programmer, Version 2.02	12:00
Dual Port IMU/S . . . <No >	Default . . . <xxxxxxxx>	Timeout . . . [xx] SECS
	Port 1	Port 2
Remote Unit ID	[000000]	[xxxxxx]
Enable Auto Dial	<Yes>	<Yes>
Phone Number 1	[3212599700]
Phone Number 2	[xx]	
Dialer Type	<Tone>	<xxxxx>
Alarm String Download . . .	<No >	
INPUT CONFIGURATION		
Input Type	<Data >	<Alarm >
Alarm Description . . .	[xxxxxxxxxxxxxxxxxxxx]	[xxxxxxxxxxxxxxxxxxxx]
COMMUNICATION PARAMETERS		
Data Bits	<8>	<x>
Stop Bits	<1 >	<xxx>
Parity Type	<None>	<xxxx>
Max Line Speed	<2400 > BPS	<xxxxxxx> BPS
Answer Ring Count (1-15)	[1]	
Primary Call Retry Count (1-15)	[15]	
Primary Call Retry Rate (1-15)	[4]	1 Minute Increments
Secondary Call Retry Rate (1-15)	[1]	1 Hour Increments
Time-Tagged Interval Size	<10> Minute (s)	
F1 = HELP F2 = READ F3 = MODIFY F4 = PROGRAM		Esc = QUIT

Figure 6-1.
Example MP Programmer Screen.

A brief description of each field is provided below:

Dual Port IMU/S

Select 'NO' to disable the dual port feature. PT-II hardware does not support dual serial ports.

Remote Unit ID

A six-digit identifier that is used by the data collection software to distinguish the individual field devices. Legal entry values are 000000-FFFFFF (hexadecimal notation). Sequential numbering is not required, nor is it a requirement to use any of the hexadecimal digits 'A, B, C, D, E, or F'.

Enable Auto Dial

Enables or disables the IMU-II/s from calling the central computer. Most installations have this parameter set to "YES" except for systems with a manually polled arrangement.

Phone Number 1

If 'Enable Auto Dial = YES', then this field will accept a telephone number with a maximum digit count of 31. If it is desired to wait for dial tone before dialing, then a 'B' character should be added in the first position. A 'Dx' character set inserts a delay where the duration of the delay is determined by the value of 'x' in units of ½ seconds. Examples of typical delay values are D1 = 0.5sec, D4 = 2sec, D9 = 4.5sec. An example phone number is "B 9 D4 259 9700".

				_____	Phone number
				_____	Delays 2 seconds
				_____	9 permits access to external line
				_____	Wait for dial tone before dialing

Dialer Type

Selects whether touch-tone or rotary pulse dialing methods are used when calling out to the central. Normally this is set for "TONE" so that the number will be dialed faster to achieve shorter call durations overall.

Alarm String Download

When making a connection in transparent mode (does not apply if in Metretek mode), the IMU-II/s can be enabled to provide a brief ASCII format summary of the unit ID and alarm status. Information is not lost if this option is not enabled since the '+--+SA' command will produce the same summary text.

Input Type

Permits selection of data or alarm functions for Input-1 (left-hand column position of Figure 6-1) and Input-2 (right-hand column). Factory wiring of the PT-II has assigned Input-1 to be a pulse counting data input and Input-2 to be a pressure violation alarm.

Alarm Description

If alarm string download is enabled, then this field will become active and permit the user to type in a description text such as "Low Pressure", "High Pressure", "Regulator Failure", etc.

Data Bits

Serial port setting for data bits should always be set for '8' to ensure proper operation with the Analog Data Monitor.

Stop Bits

Serial port setting for stop bits should always be set for '1' to ensure proper operation with the Analog Data Monitor.

Parity Type

Serial port setting for the parity type should always be set for 'None' to ensure proper operation with the Analog Data Monitor.

MAX Line Speed

This determines the MODEM connection speed, with user selectable values of 300, 1200, or 2400 bits per second (bps). Land line telephone based units are normally set for 2400, while cellular systems should be set for 1200. It is always necessary to ensure that the bit rate of the IMU-II/s matches that of the Analog Data Monitor board. Jumper JP-4 of the Analog Data Monitor is selectable for A=300, B=1200 or C=2400bps.

Answer Ring Count

Dedicated phone lines normally set this to a value of '1' for the fastest response to incoming calls. Shared phone lines may require a value greater than '1' depending on the specific application.

Primary Call Retry Count

Defines the number of times that the IMU-II/s will make call retry attempts at the primary call rate before switching to the secondary call retry rate. A value of '5' will serve most applications well.

Primary Call Retry Rate

Determines the time interval between attempting call retries. A value of 10 or 15 is suitable for most systems. Solar or battery powered cellular systems should use the less aggressive rate of 15 to permit the battery time to recover from the previous call attempt.

Secondary Call Retry Rate

After the primary call retry count has expired, the secondary call retry rate determines the interval between successive attempts in 1-hour increments.

Time Tagged Interval Size

Determines the resolution of the interval data collected on the pulse data input from the Analog Data Monitor. Possible selections available are 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, and 60 minutes, with 10, 15, 30, 60 being the most commonly used. A finer resolution permits short-term fluctuations to be more easily observed, but has the negative side effects of longer communications duration, associated shorter battery life, and more expensive telephone charges.

NOTE:

After programming the IMU-II/s with the MP software and cable, remember to disconnect the cable before attempting to make a call. MODEM communications will be blocked if the programming cable remains attached.

Chapter Seven

Trouble-shooting

MODEM / Telephone Problems

Problem:

IMU-II/s does not answer calls from the central computer site.

Solutions:

- a) Verify that the ring detect jumper is installed at JP9 on the IMU-II/s board.
- b) Check the ring count value in the IMU-II/s using the MP programmer software and cable. Legal values can range from 1 to 15 rings.

Warning

Do **not** disconnect or connect live circuits unless area is known to be nonhazardous.

Battery Problems

Problem:

Lithium battery pack dies prematurely.

Solutions:

- a) Frequent long duration connections to a computer via modem or direct connect will diminish battery life. The PT-II consumes more power when on-line due to the processor running at full speed and all power supplies being active. If frequent long-term sessions are required, an AC power supply should be considered.
- b) Sample rate should be checked and set to a reasonable value for the application. A sample rate of once per second should not be used if a rate of once every 15 seconds will suffice.

Accuracy Problems

Problem:

Pressure readings were accurate when product was first installed, but now registers significant pressure even when the pressure feed is disconnected.

Solution:

A pressure surge may have been encountered which has caused a shift in the zero point of the sensor. Field recalibration may be able to correct the error if the surge was not too destructive. A pressure snubber should also be installed to limit future surges.

Problem:

Pressure sensors between two units were swapped, and now the measurements are no longer accurate. Field calibration attempts did not resolve the problem.

Solution:

Each pressure sensor is characterized in conjunction with the circuit board electronics at the factory using precision pressure and temperature controls. Pressure sensors cannot be replaced or traded without repeating the factory calibration process. Units requiring a factory calibration can be shipped to Metretek to have this process performed.

Problem:

Communications with the PT-II are not possible with either the direct connection or modem connection. KYZ outputs still operate properly as expected.

Solution:

The serial port may have been programmed to a bit rate that is different from what the computer is set for. Trying an alternate bit rate (recheck JP4) may resolve the problem.

Problem:

The KYZ outputs of the PT-II do not respond immediately to pressure changes.

Solution:

This is normal due to the averaging process that takes place. Measurements are taken at the sample rate and averaged together over a period of 60 seconds. The KYZ generator is then updated with the average value. This method provides a greater accuracy level over what could be achieved if KYZ updates were done in real-time.

Configuration Memory Problems

Problem:

Previous settings in the Analog Data Monitor for the alarm limits, sample rate, etc., have suddenly changed to strange values. Unit was operating correctly the last time it was accessed.

Solution:

A hacker has likely gained entry and trashed the system. Change the settings back and remember to assign a new password to prevent further disruption.

Problem:

It is not possible to access the configuration memory of the IMU-II/s board using the MP programmer software and cable. A message appears that states: "Error reading the remote unit."

Solutions:

- a) Make certain that the correct communications serial port on the PC is being accessed.
The serial port is specified when the application is started with the command "MP COMx IMU/S". Normally COMx will be specified as either COM1 or COM2.
- b) Reading of the IMU-II/s configuration memory is not possible when the device is off-hook with the MODEM (as indicated by the on-board LED). Wait for the IMU-II/s to go back on-hook before attempting another access.

NOTES

Appendix – A
Menu Structure Summary

Summary of menu structure:

```

          PRESSURE TRACKER-II  VERSION 1.xx
-----1) VIEW SYSTEM STATUS
|  -----2) VIEW LIVE PRESSURE (1-SEC UPDATES)
|  |  -----3) VIEW LIVE PRESSURE (SAMPLE RATE UPDATES)
|  |  |  -----4) ENTER CONFIGURATION/FIELD CALIBRATION MODE
|  |  |  |  ---5) ENTER FACTORY TEST/CALIBRATION MODE
|  |  |  |  |
|  |  |  |  |  --- Factory test menu, not accessible.
|  |  |  |  |
|  |  |  |  |  --1) CHANGE LOW PRESSURE ALARM LIMIT SETPOINT
|  |  |  |  |  2) CHANGE HIGH PRESSURE ALARM LIMIT SETPOINT
|  |  |  |  |  3) CHANGE ALARM VIOLATION TIMER SETTING
|  |  |  |  |  4) CHANGE SAMPLE RATE
|  |  |  |  |  5) DISPLAY EEPROM MEMORY CONTENTS
|  |  |  |  |  6) MODIFY EEPROM MEMORY CONTENTS  -CAUTION-
|  |  |  |  |  7) CHANGE ENTRY PASSWORD          -CAUTION-
|  |  |  |  |  8) CALIBRATE PRESSURE SENSOR      -CAUTION-
|  |  |  |  |  Q) RETURN TO MAIN MENU
|  |  |  |  |
|  |  |  |  |  --- PRESSURE TRACKER LIVE SAMPLE DISPLAY (UPDATED AT SAMPLE RATE).
|  |  |  |  |  CURRENT SAMPLE RATE = 15 SECONDS.
|  |  |  |  |  TYPE 'Q' TO RETURN TO MENU.
|  |  |  |  |  PRESS = 0.0 PSIG
|  |  |  |  |  PRESS = 0.0 PSIG
|  |  |  |  |  PRESS = 0.0 PSIG
|  |  |  |  |
|  |  |  |  |  --- PRESSURE TRACKER-II LIVE SAMPLE DISPLAY (UPDATED EACH SECOND).
|  |  |  |  |  TYPE 'Q' TO RETURN TO MENU.
|  |  |  |  |  PRESS = 0.0 PSIG
|  |  |  |  |  PRESS = 0.0 PSIG
|  |  |  |  |  PRESS = 0.0 PSIG
|  |  |  |  |
|  |  |  |  |  ---PRESSURE TRACKER-II SYSTEM STATUS
|  |  |  |  |  PRESSURE: 0.0 PSIG
|  |  |  |  |  TEMPERATURE: 22.8 DEG. C
|  |  |  |  |  KYZ FREQUENCY: 0.00 HERTZ
|  |  |  |  |  BATTERY: 3.610 VOLTS
|  |  |  |  |  SAMPLE RATE: 15 SECONDS
|  |  |  |  |  LOW PRESSURE ALARM SETPOINT: DISABLED
|  |  |  |  |  HIGH PRESSURE ALARM SETPOINT: DISABLED
|  |  |  |  |  SETPOINT VIOLATION TIMER: 45 SECONDS
|  |  |  |  |  PRESSURE RANGE: 0-100 PSIG

```

NOTES

Appendix – B
Glossary of Terms

Analog Data Monitor	Designation assigned to the electronic circuit board contained within the PT-II that samples pressure and presents the result to the terminal block in the form of KYZ pulses. ASCII form data can also be retrieved from the serial port.
ASCII	Abbreviation for the term American Standard Code for Information Interchange. ASCII characters include all the upper and lowercase characters found on a keyboard as well as numbers, symbols, and special control characters. The Analog Data Monitor uses ASCII text to communicate through its serial port.
Baud	Serial data transmission speed, normally associated with RS-232 type communications. Common usage of this term is to equate it with 'bits per second'. In the case of the Analog Data Monitor, each ASCII character contains 8 data bits, 1 start bit and 1 stop bit, no parity. For a 2400bps data rate, this yields an effective transfer speed of $2400\text{bps}/10\text{bits} = 240$ characters per second.
Carrier	A signal that is transmitted by a MODEM and is often (but not always) used to carry information. Information is inserted into the carrier signal with modulation schemes that include frequency and phase elements.
CCITT	An advisory committee to the International Telecommunications Union that makes recommendations on telecommunications issues.
DCE	Data Communications Equipment. A device that provides for the establishment of a communications link, signal conversion of data, and the termination of the communications link. An example of a DCE device is the common MODEM, with the IMU-II/s being classified as such.
DTE	Data Terminal Equipment. A device that generates information for transmission over a communications network. The Analog Data Monitor is classified as a DTE.
EPROM	Erasable Programmable Read Only Memory, these hold the operating program for the microprocessor and retain the information even if power is lost. Devices with transparent windows can be erased with ultraviolet light and then reprogrammed
EEPROM	Electrically Erasable Programmable Read Only Memory, these devices hold information in a permanent manner even if power is lost. Erasure and programming of new information is entirely electronic and does not require a window and ultraviolet light. Metretek products use EEPROMs to hold information such as telephone numbers, sample rates, etc.

Hexadecimal	A number system based on 16 possible values per digit position. These include 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E, and F. A byte has two digit positions permitting a range of 00 to FF, which yields a decimal equivalent value range of 0 to 255. When displaying the contents of the PT-II EEPROM memory, the values are represented using two digit hexadecimal (bytes).
IMU-II/s	Industrial Metering Unit - II / serial. This product has two data inputs (can be reassigned as alarm inputs), one dedicated alarm input, and an RS-232 serial port for data communications. In addition, the integral modem provides the communications path to a central computer site.
LED	Light Emitting Diode, these are in common usage as indicator lights due to their high efficiency and long life.
MODEM	Acronym for Modulator / Demodulator. This device converts information presented on its port (normally RS-232 port) into a signal that can be transmitted/received over the telecommunications network.
On-Hook / Off-Hook	A term that originated when the first telephones were introduced due to the earpiece being placed 'On-Hook' when the call was finished and being taken 'Off-Hook' to initiate a call. On the IMU-II/s, the Off-Hook LED indicates that the MODEM circuit is either placing a call or is in the process of communicating data.
PCB	Printed Circuit Board, in this context refers to a board populated with components.
Pressure Monitor-II	Similar to the Pressure Tracker-II except that the IMU-II/s data collector board is not provided.
RS-232	A serial data communications interface that was published in 1969 by the Electronic Industries Association. Transmission of data is accomplished by level switching with +3V to +9V representing zero and -3V to -9V as one. A DTE type interface with a 9-pin D-sub connector exists on the Analog Data Monitor, while a DCE interface is available on the terminal block of the IMU-II/s.
Transducer	A device used to convert energy or physical stimulus from one form into another. In the PT-II, a transducer is used to convert applied gas pressure into a resistance value from a resistive bridge network. This transducer type is commonly referred to as a strain-gage transducer.

Appendix – C

Specifications

Pressure Tracker – II Specifications

Operating Temperature Range:

-30° to +70° C (-22° to 158° F)

Measurement Error:

Maximum error when combining all sources (linearity, repeatability, temperature drift, etc.) is 1% of full scale. This translates to ± 1 psi for a 100psi rated transducer and ± 3 psi for a 300psi transducer.

Enclosure Dimensions:

Height: 8.5 inches

Width: 6.9 inches

Depth: 4.3 inches

Weight:

3.0 pounds without a battery.

3.3 pounds including a 'D' battery.

Input Pressure Connection:

1/4" NPT (National Pipe Thread) female connection.

Maximum Overpressure:

2 times full scale or 750psi, whichever is less.

Burst Pressure:

3 times full scale or 750psi, whichever is less.

Electrical Isolation of Transducer:

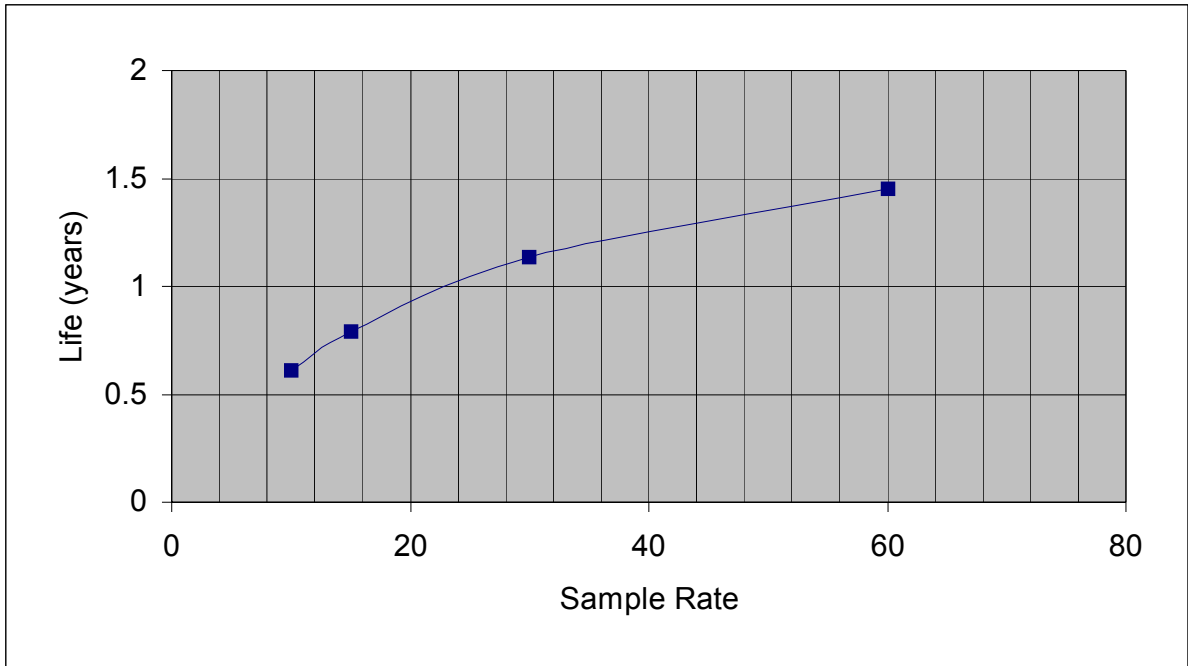
Up to 5000Vdc between electrical circuit and threaded metal fitting with no appreciable leakage. Systems with cathodic protection do not require additional isolation measures.

Power Source:

3.6V Lithium Battery, 10Ahr capacity, Metretek P/N: 1011-0022B-001

Lithium Battery Life:

Depends to a large extent on the sample rate with less frequent samples conserving battery power. A sample rate of once every thirty seconds will yield a life of approximately 1.2 years. Reference the battery life chart on the following page that demonstrates the impact of sampling frequency.



Battery Life vs. Sample Rate

Note: Sample rates shown are once every 10, 15, 30, or 60 seconds.

Analog Data Monitor Specifications

Alarm Outputs:

Low Battery Alarm: Active low output for period of 1 second indicates that the battery voltage has fallen below the 2.85V threshold and requires replacement. The battery voltage is sampled only once every 18 hours.

High/Low Pressure Alarm:

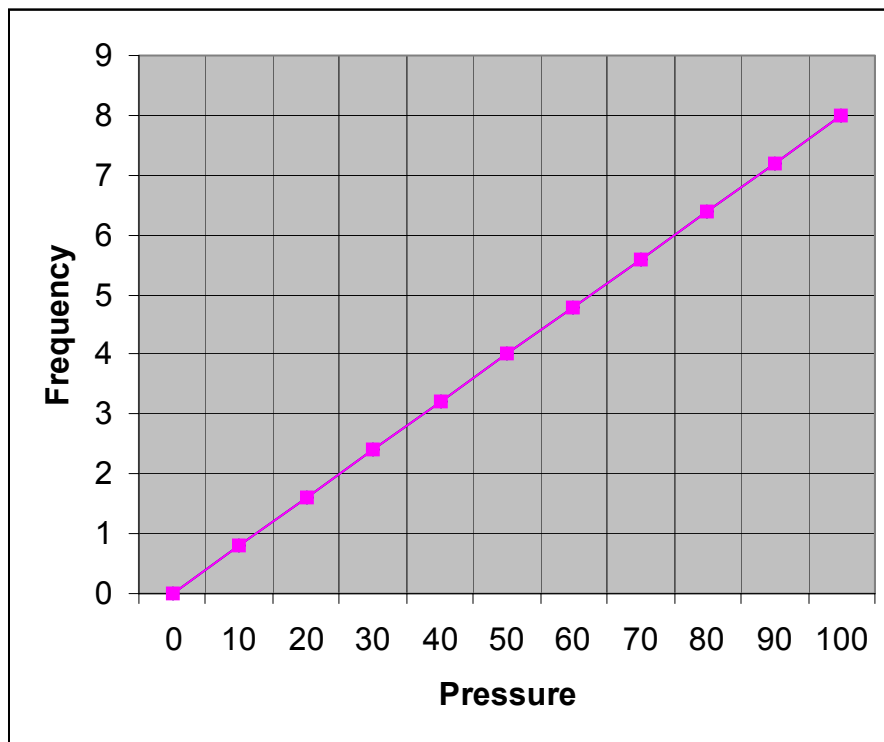
Active low output for 1-second duration indicates that either the high or the low-pressure limit threshold has been violated.

Sample Rate:

Number of seconds between each pressure sample with legal values in the range of 1, 2, 3, 4, 5, 6, 10, 15, 30, 60 seconds. This parameter is programmable by the user. Less frequent sampling (i.e.-- 60 seconds) extends the life of the battery.

KYZ Output Signals:

Form-C transistor outputs, open collector, capable of sinking 2mA minimum. Maximum wetting supply permitted is 5.6VDC. Frequency of switching is 0-8Hz linearly related to the applied input pressure. An example of the relationship between frequency and the applied pressure (chart shows a 100psi device) is shown below:



Pressure Input vs. Frequency Output
(100psi Transducer)

DB-9 (RS-232C) Connector Pinout: (Analog Data Monitor)

- 1 - Carrier Detect Signal (input)
- 2 - RXD (input)
- 3 - TXD (output)
- 4 - DTR (wired to DSR)
- 5 - Signal Common
- 6 - DSR (wired to DTR)
- 7 - No connection
- 8 - No connection
- 9 - No connection

NOTE:

Four wires are required to establish a serial data link with the Analog Data Monitor:
Carrier Detect, RXD, TXD, Signal Common.

IMU-II/s Specifications

Ringer Equivalence:

0.3 B

DTMF Dialing Tone Output Level:

-6dBm (nominal)

DTMF Dialing Rate:

3.3 digits per second.

MODEM Signaling Standards:

CCITT V.22bis (2400bps)

CCITT V.22 (1200bps)

Bell 212A (1200bps)

Bell 103 (300bps)

Modem Output Level:

-9dBm

Modem Sensitivity:

-40dBm

Telephone Connector:

RJ-11C

FCC Registration Number:

BK5USA-24666-DT-E

Data Storage Capacity:

28K RAM available for Time Tagged Interval data.

Serial Interface Bit Rate:

Programmable for 300, 1200, or 2400bps

Serial Interface Data Bits:

Programmable for 7 or 8. Recommended setting = 8.

Serial Interface Stop Bits:

Programmable for 1, 1.5 or 2. Recommended setting = 1.

Serial Interface Parity:

Programmable for Even, Odd, or None. Recommended setting = None.

Data Input – 1:

Form-A type switch input, a transition to closed causes a pulse to be recorded or an alarm to be triggered. Input is programmable for either the data or alarm functions. Minimum contact time is 40ms; maximum pulse frequency is 10 hertz.

Data Input – 2:

Form-A type switch input, a transition to closed causes a pulse to be recorded or an alarm to be triggered. Input is programmable for either the data or alarm functions. Minimum contact time is 40ms; maximum pulse frequency is 10 hertz.

Alarm Input:

Dedicated Form-A alarm input with a minimum contact time of 63ms. A switch transition from open to close will recorded as an alarm.

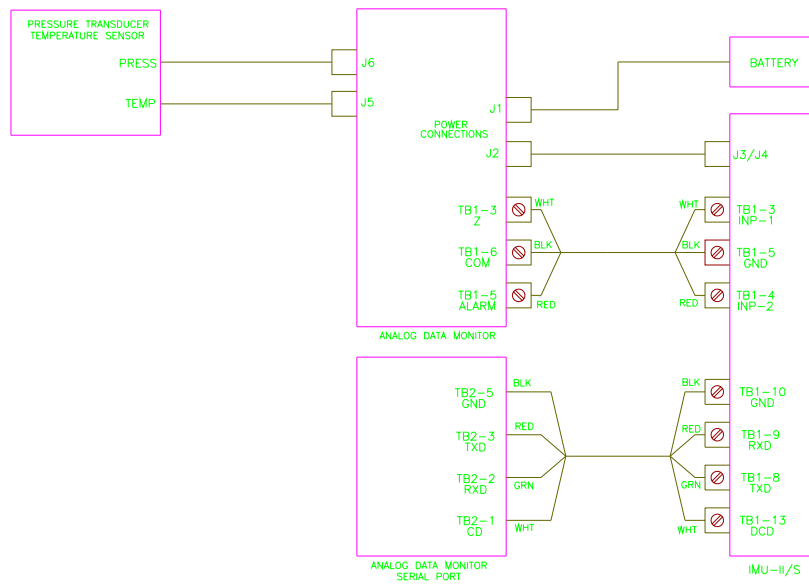
Tamper Alarm Input:

Dedicated Form-B alarm input with a minimum contact time of 63ms. A switch transition from closed to open will recorded as an alarm.

NOTES

Appendix – D

Wiring Diagram



WIRING DIAGRAM

Pressure Tracker-II products are factory wired in accordance with the above diagram.

NOTES

Appendix – E
Warranty Information

WARRANTY INFORMATION

The seller warrants its hardware to be free from defects in material and workmanship under normal and proper use for a period of 12 months from the date the hardware is shipped from Metrotek, Incorporated. The seller's sole liability and the buyer's sole remedy for any breach of the foregoing provision is, at the seller's option, the timely no-charge repair or replacement of any defective hardware or part that Metrotek inspects and finds reasonable evidence that a defect in material or workmanship exists. The buyer shall provide the labor required to remove the defective hardware and install its replacement at no charge to the seller. The equipment will be shipped to the seller at the buyer's expense. The replacement or repaired equipment will be shipped to the buyer at the seller's expense.

Warranty claims to be honored under this warranty must be made promptly. Such claims shall specify the nature and details of the claim, the date that the cause of the claim was first observed, and the affected equipment's unit serial number. Defective equipment shall not be returned to the seller's factory without prior authorization from the seller. A copy of the claim's documentation must be attached to the defective equipment and sent to the seller's manufacturing facility. Defective components replaced under this warranty shall become the property of the seller.

The seller makes no representation or warranty other than those set forth in this agreement. THE WARRANTY STATED HEREIN IS EXPRESSLY IN LIEU OF ALL WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY EXPRESSED OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SUCH WARRANTY CONSTITUTES THE ONLY WARRANTY MADE BY THE SELLER WITH RESPECT TO THIS AGREEMENT, THE EQUIPMENT UNITS, OR THE SERVICES TO BE SUPPLIED HEREBY. THE SELLER SHALL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND.

This warranty will not extend to equipment subjected to accident, to misuse, or to alterations/repair not made and documented in writing by Metrotek.

NOTES