Oil & Gas Wireless Enabled Monitoring System

Installer's Guide

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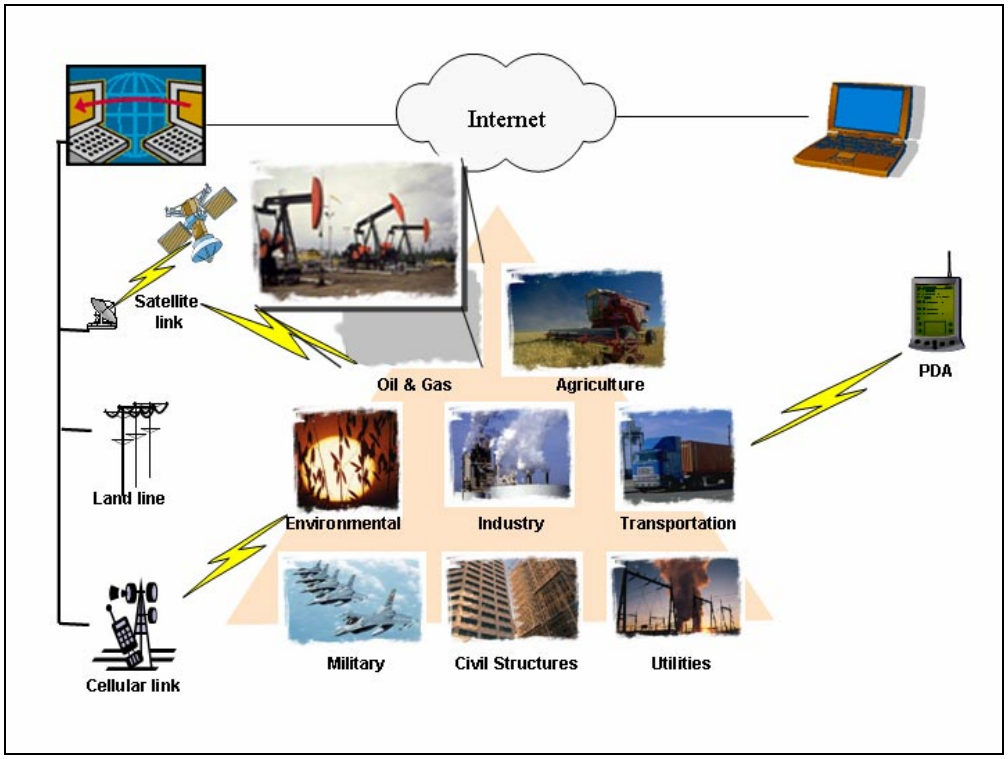


Figure 1. Applications for Luna iMonitoring's Intelligent Wireless Sensor Suite.

The Luna *i*Monitoring Oil and Gas Wireless Enabled Monitoring System (WEMS) is a network of monitors and computers used to collect production data within an oil field environment. Sensor and communication modules collect and transmit data via wireless RF and satellite links. These modules are part of Luna *i*Monitoring's Intelligent Wireless Sensor Suite.

The wireless oil field provides innovative, low-cost, remote asset management. Some of the advantages of wireless sensing include

- reduce cost for field labor and transportation;

- reduce administration cost for recording, generating, and distributing reports;
- provide better information to the Production Engineer for decision making;
- provide more efficient tasking of the Pumper;
- enhance revenue through optimized well performance and reduced downtime.

The Intelligent Wireless Sensor Suite

Luna *i*Monitoring's Intelligent Wireless Sensor Suite includes sensors, computers, software, and communication devices to collect and transmit data in a variety of industries and applications. The *i*Monitoring "smart" sensors use local processing to minimize power consumption and communication bandwidth. Intelligent software collects, processes, and stores the data in an information database. The *i*Monitoring system uses RF, cellular, Internet, and satellite links to transmit data between sensors, data collection sites, and central computers. For more information on the Intelligent Wireless Sensor Suite and its components, please visit the Luna *i*Monitoring web site at www.lunaimonitoring.com

WEMS Components

The current configuration of the WEMS includes one or more of each of the following components:

- Concentration and Communications Unit (*i*CCU),
- Compact Flash Radio (*i*CFR),
- Electronic Flow Monitor (*i*EFM)
- Tank Level Monitor (*i*TLM-1),
- Wellhead Pressure Monitor (*i*WPM-T),
- Secure Digital (SD) Card containing the WEMS Software.

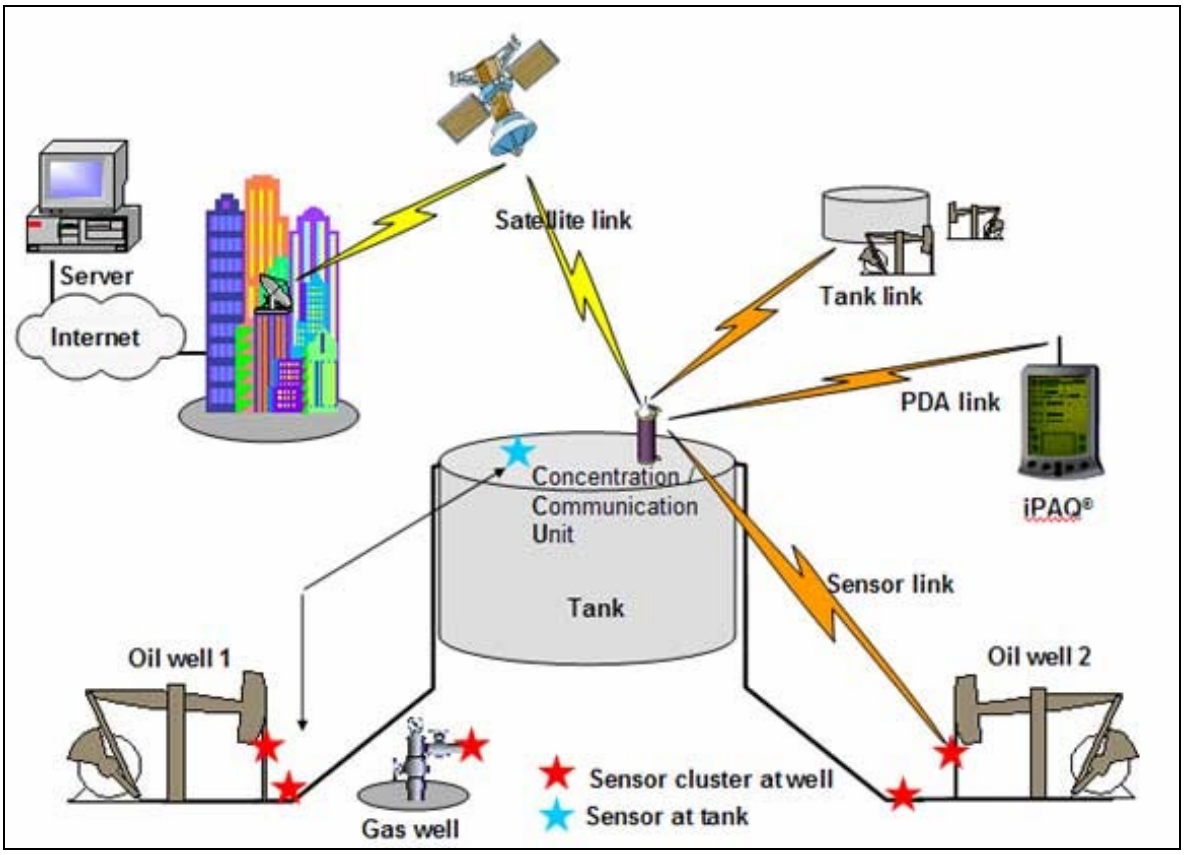


Figure 2. Luna iMonitoring's Wireless Oil Field.

The following sections discuss features of each component. For detailed specifications see Appendix A, "Specifications".

Concentration and Communications Unit (*i*CCU)

The Luna *i*Monitoring *i*CCU is an autonomous, wireless-LAN-to-wireless-WAN bridge, and data storage and collection unit. Data flows via a secure, bidirectional, local radio link. The *i*CCU can perform on-board data storage and processing, and can serve as a LAN repeater. It contains external WAN and LAN antenna ports. A single, solar-assisted battery powers the unit which optimizes power based on the current energy storage. The *i*CCU supports up to 128 wireless sensors, and is installer configurable and upgradeable.

Compact Flash Radio (*i*CFR)

The Luna *i*Monitoring *i*CFR is a self-contained Type I Compact Flash Radio for wireless sensing applications. The *i*CFR uses a

standard interface found on PocketPC®s. The unit communicates with *i*CCUs, and *i*Monitoring's sensors over a wireless interface. The *i*CFR does not require a battery since the host unit provides power. Other features include programmable output power to an upper limit as defined in Appendix A, low cost, and the ability to configure and upgrade the unit by the installer.

Electronic Flow Monitor (*i*EFM)

The Luna *i*Monitoring *i*EFM is an autonomous, wireless electronic flow monitor which monitors natural gas flow and provides total volumetric flow rate. Typically, the sensor acquires five flow readings per day in monitor mode. Each reading consists of an instantaneous measurement, an average over the previous hour, and an average over the previous 24 hours. An *i*CCU may interrogate an *i*EFM at any time within a range of 2500 feet, and a portable device, such as a PocketPC®, can poll the unit within a range of 500 feet. The *i*EFM performs on-board data storage and processing, and transmits over a secure, bidirectional radio link. The unit optimizes power based on the current energy storage, and requires only a single, solar-assisted battery. The *i*EFM is easy to install, and is installler configurable and upgradeable. The unit incorporates an IP65 ruggedized enclosure and meets UL-913 certification requirements for an intrinsically safe device in Class I, Division 1, Groups C and D hazardous areas.

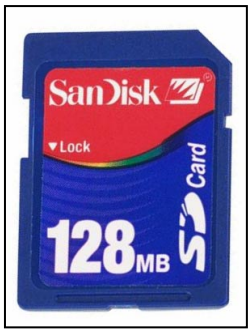
Tank Level Monitor (*i*TLM-1)

The Luna *i*Monitoring *i*TLM-1 is a self-contained, wireless tank level monitor using Ultrasonic Sensing Technology to provide temperature-compensated fluid level measurements in tanks and silos. Typically, the sensor acquires five pressure readings per day in monitor mode. An *i*CCU can communicate with a *i*TLM-1 within a range of 2500 feet, and a portable device, such as a PocketPC®, can poll the unit within a range of 500 feet. The *i*TLM-1 performs on-board data storage and processing, and transmits over a secure, bidirectional radio link. The unit optimizes power based on the current energy storage, and requires only a single, solar-assisted battery. The *i*TLM-1 is easy to install, and is installer configurable and upgradeable. The unit incorporates an IP65 ruggedized enclosure and meets UL-913 certification requirements for an intrinsically safe device in Class I, Division 1, Groups C and D hazardous areas.

Wellhead Pressure Monitor (*i*WPM-T)

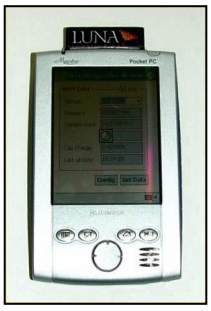
The Luna *i*Monitoring *i*WPM-T is an autonomous, wireless pressure monitor for sensing pressure at the wellhead in oil and gas applications. Typically, the sensor acquires five pressure and temperature readings per day in monitor mode. An *i*CCU may interrogate an *i*WPM-T at any time within a range of 2500 feet, and a portable device, such as a PocketPC®, can poll the unit within a range of 500 feet. The *i*WPM-T performs on-board data storage and processing, and transmits over a secure, bidirectional radio link. The unit optimizes power based on the current energy storage, and requires only a single, solar-assisted battery. The *i*WPM-T is easy to install, and is installer configurable and upgradeable. The unit incorporates an IP65 ruggedized enclosure and meets UL-913 certification requirements for an intrinsically safe device in Class I, Division 1, Groups C and D hazardous areas.

Secure Digital (SD) Card



The SD Card supplied with the system contains the WEMS Software for a PocketPC® running version 3.0 of the PocketPC® operating system. The SD Card plugs into the standard SD slot found on all PocketPC®s. The WEMS Software requires a one-time installation per PocketPC®, and includes programs for defining, accessing, and interrogating multiple *i*Monitoring devices. Chapter 3, "WEMS Software", includes a detailed discussion on the installation and use of the WEMS Software.

User-supplied Components



For on-demand sensor measurements and data acquisition in the field, the user must supply a PocketPC®, such as the one shown at the left, to interrogate the *i*CCU, *i*WPM-T, and *i*TLM-1. The PocketPC® must have a CF Card slot to accommodate the *i*CFR, and an SD slot for the WEMS Software SD Card

Chapter 2

Installation

The components in Luna *i*Monitoring's Intelligent Wireless Sensor Suite are easy to install using simple tools. The installation guidelines in this manual outline the steps for selecting the proper site for the device, and for handling, mounting and activating the device.

Site Selection for WEMS Components

The *i*TLM-1 and *i*WPM-T sensor modules mount directly onto oil and gas tanks, pipelines, and wellheads in the field. The *i*CCU mounts on a variety of structures in and around the oil field. Issues affecting the site selected for installation include obstructions in the line-of-sight between the sensor module and the *i*CCU; distance from the sensor module to an *i*CCU; height of the *i*CCU; proximity of the component to other electronic equipment or large metal objects that may affect the transmission of radio signals; orientation of the solar panels on the component; hazardous environmental conditions; and the surface mounting angle of the tank for the *i*TLM-1 installation.

Guidelines Concerning RF Signal Transmission

Luna *i*Monitoring's sensor modules use RF signals to communicate with *i*CCUs and PocketPC®s. Following the guidelines below maximizes the range over which the WEMS components will be able to transmit signals.

- Place the sensor module in the direct line-of-sight with the *i*CCU, whenever possible. A direct line-of-sight between the sensor module and the *i*CCU provides optimal signal transmission and reception. With a direct line-of-sight, the WEMS components communicate up to 2500 feet. However, without a direct line-of-sight, this distance decreases.
- Place the *i*CCU as high as possible to improve signal transmission and reception.
- Avoid placing sensor modules and *i*CCUs near electrical equipment or large metal objects. Electrical devices, such as large electric

motors, power lines, antennas, and electric fences cause electro-magnetic interference that adversely affect signal quality. Large metal objects, which are electrically conductive, reflect and scatter radio signals when placed between two RF-linked modules.

The Luna *i*Monitoring sensor modules, *i*CFR and *i*CCU meet FCC requirements for CFR 47 Part 15, which dictate that operation of the device is subject to the following two conditions:

1) The device will not cause harmful interference, and
2) The device must accept any interference received, including interference that may cause undesired operation.

Because the device meets FCC requirements for CFR 47 Part 15, the customer requires no operating license to transmit radio signals using the device.

To comply with current FCC RF Exposure limits, the antenna used for the Luna *i*Monitoring *i*CCU, *i*EFM, *i*TLM-1, and *i*WPM-T transmitter must be installed to provide a separation distance of at least 20 cm from all persons.

The Luna *i*Monitoring *i*CFR, *i*EFM, *i*TLM-1, and *i*WPM-T must not be co-located or operating in conjunction with any other antenna or transmitter.

The Luna *i*Monitoring *i*TLM-1 sensor module utilizes ultrasonic technology and is subject to the following additional authorization: Verification as a non-consumer ISM device as specified by Part 18.

The Luna *i*Monitoring *i*CCU is subject to the following additional authorization: Verification as a transmitter as specified by Part 25.

Any changes or modifications not expressly approved by the manufacturer will void the user's authority to operate the equipment.

Every radio-linked device in the Luna *i*Monitoring Intelligent Wireless Sensor Suite carries a label. Figure 3 below shows a typical label for a sensor device which includes the Model Number of the device, the FCC ID Number, the UL certification, the FCC certification(s), and the Serial Number.

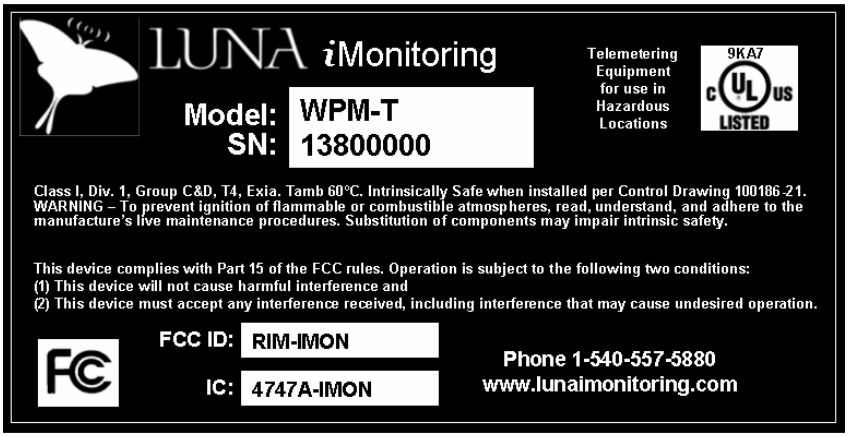


Figure 3. Typical Label Found on all Luna iMonitoring Radio-linked Devices.

Guidelines Concerning Solar Panels

All of Luna iMonitoring's sensor modules and iCCUs employ a single, solar-assisted battery for power. Properly orienting the solar panels on the WEMS component achieves a maximum battery life of more than two years. Place the component in a non-shaded area with the solar panels facing toward the sun. Also, ensure that the site chosen will not become shaded due to tree growth or installation of other structures.

Guidelines Concerning Hazardous Environments

Luna iMonitoring sensor modules mount directly onto structures such as a tanks, pipelines, or wellheads located in hazardous areas. These sensor modules (iEFM, iTLM-1, and iWPM-T) are, by design, intrinsically safe and meet the standard for UL-913 certification for Class I, Division 1, Groups C and D hazardous areas. By definition, an intrinsically safe apparatus is one in which all the circuits are intrinsically safe; and an intrinsically safe circuit is one in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions, according to the National Electrical Code.

The iCCU mounts onto structures outside the hazardous zones in the oil field; for example, an area greater than 3 meters from an oil tank.

Guidelines Concerning iTLM-1 Mounting

The iTLM-1 uses Ultrasonic Sensing Technology to provide tank fluid level measurements. The sensor projects an ultrasonic beam at the surface of the liquid in a tank. The beam reflects off the liquid's surface back to the sensor. The iTLM-1 acquires the raw measurement and then compensates for the effects of temperature on the raw data. To properly measure the fluid level in the tank,

the sensor must be mounted such that the path of the ultrasonic beam is perpendicular to the fluid surface. A mounting angle greater than 5 degrees may cause erroneous data. Figure 4 below provides a rendering of a properly installed *i*TLM-1 sensor module.

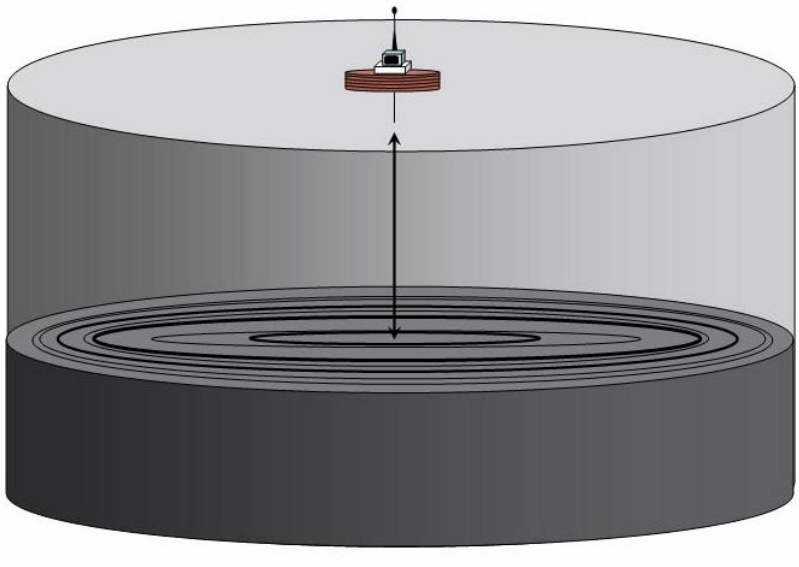


Figure 4. Proper Mounting Angle for the iTLM-1 Sensor.

Pre-installation *i*TLM-1 Depth Calibration

Before installing the *i*TLM-1 sensor device on a tank, perform the *i*TLM-1 depth calibration procedure. See the section on the *i*TLM-1 Depth Calibration in Chapter 3, "WEMS Software", for details.

Installation Instructions

When installing any of the *i*Monitoring wireless devices care must be taken to guarantee that the wireless devices are installed and provisioned in its intended configuration and the installation guarantees compliance to regulatory and safety requirements.

Monitor Installation Instructions

The following instructions are to be performed for each monitor (*i*EFM, *i*TLM-1, and *i*WPM-T) at installation.

1) Remove the monitor packing carton.

2) Remove the reset button access screw (Phillips head) on the bottom of the unit, and using a non-metallic probe, press and hold the reset button momentarily to bring the unit out of the sleep mode. Replace the screw.
3) Install the antenna onto the SMA connector on the monitor.
4) On the *i*EFM and *i*WPM-T, install the temperature sensor on the monitor.
5) Using the WEMS Software module **PocketConfig**, enter the monitor's unique serial number and press the **Configure** button to enter the unit-level configuration. Refer to Chapter 3, "WEMS Software", for more information on using **PocketConfig**.
6) In the resulting Config tab screen, enter the following information:
   a) Enter a value of -3 for the parameter Xmit Power if the antenna supplied with the unit is the Nearson S467AH-915S Omni whip antenna. Enter a value of -6 for Xmit Power if the antenna is the Bluewaby EDY-9432 Yagi antenna. FCC compliance requires these power settings.
   b) Enable the function Sync to PC by 'checking' (✔) this parameter.

   Once the proper value for Xmit Power is entered and Sync to PC is enabled, select the **Set Parameters** button and wait for the progress screen to complete.
7) Verify that the settings were accepted by checking the Current Device Settings window.

*i*CCU Installation Instructions

The following instructions are to be performed for the *i*CCU at installation.

1) Remove the *i*CCU packing carton.
2) Remove the enclosure cover. Locate the unattached red wire and attach it to the positive terminal on the battery. Replace the cover.
3) Using the WEMS Software module **PocketConfig**, enter the *i*CCU's unique serial number and press the **Configure** button to enter the unit-level configuration. Refer to Chapter 3, "WEMS Software", for more information on using **PocketConfig**.

4) In the resulting Config tab screen, enable the function Sync to PC by 'checking' (✔) this parameter. Once Sync to PC is enabled, select the **Set Parameters** button and wait for the progress screen to complete.

5) Verify that the setting was accepted by checking the Current Device Settings window.

*i*CFR Installation Instructions

The following instructions are to be performed for the *i*CFR at installation.

1) Install the WEMS Software on the PocketPC® to be used with the *i*CFR as described in Chapter3, "WEMS Software".

2) Remove the *i*CFR packing carton.

3) Insert the *i*CFR into the Compact Flash Card slot of the PocketPC®.

4) The *i*CFR is now ready for use as described in Chapter3, "WEMS Software".

Chapter 3

WEMS Software

The WEMS Software is a multi-purpose, menu-driven program for configuring and accessing all modules in Luna *i*Monitoring's Intelligent Wireless Sensor Suite. Once properly configured using the WEMS Software, the devices run autonomously based on the scheduling parameters set in the software. The WEMS Software also provides in-the-field access to any device. The following sections include procedures for initializing all WEMS modules, and instructions for interrogating these devices in the field.

Installing the WEMS Software

(a) *(b)*

Figure 5. (a) SD Card; (b) iCFR

The WEMS Software runs on a PocketPC® using the SD Card provided by Luna *i*Monitoring. The PocketPC® communicates with the sensors and *i*CCUs using the *i*CFR also provided by Luna *i*Monitoring. The user supplies the PocketPC®, which must contain a CF slot and SD slot, and must run PocketPC® Version 3.0 or higher. Follow the steps below to install and initialize the WEMS Software.

1) Insert the *i*CFR into the CF slot on the PocketPC®.

2) Insert the SD Card containing the WEMS software into the SD slot on the PocketPC®.

3) Access the files on the SD Card. The SD Card will contain two programs as shown in Figure 6 below.

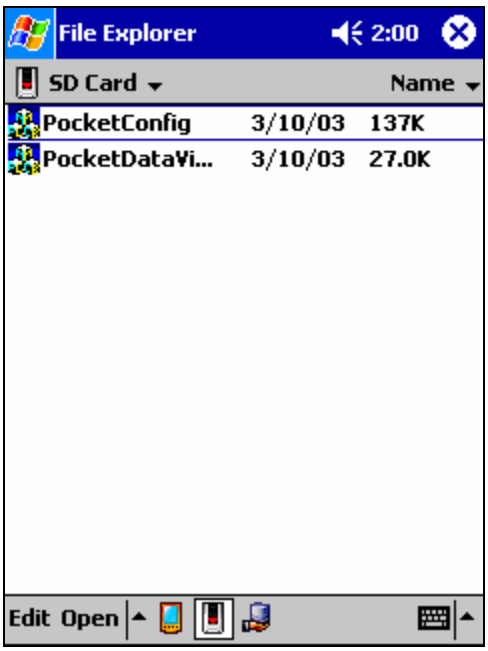


Figure 6. WEMS Software Programs on the SD Card.

4) Execute either one of the programs.

5) The first time the program runs, it will ask for the location of the ***i***CFR as in Figure 7 below.

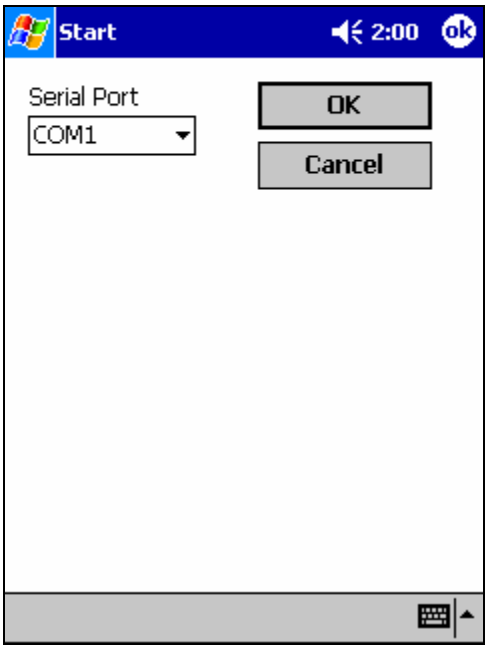


Figure 7. iCFR Serial Port Selection Menu.

Typically, the CF slot is located on COM2 or higher. Select COM2 from the Serial Port pull-down list and click **OK**. If the *i*CFR is on COM2, the program's main menu will open. If the *i*CFR in not on COM2, the program will return to the Start menu and wait for another port selection. Try other available ports until the program finds the *i*CFR port and opens the main menu.

PocketConfig

The program **PocketConfig** includes menus for configuring and interrogating devices. Before the PocketPC® can communicate with sensor and communication devices, it must have certain information about the device. Therefore, the software will not list any sensors at initial start-up of the program as in Figure 8.

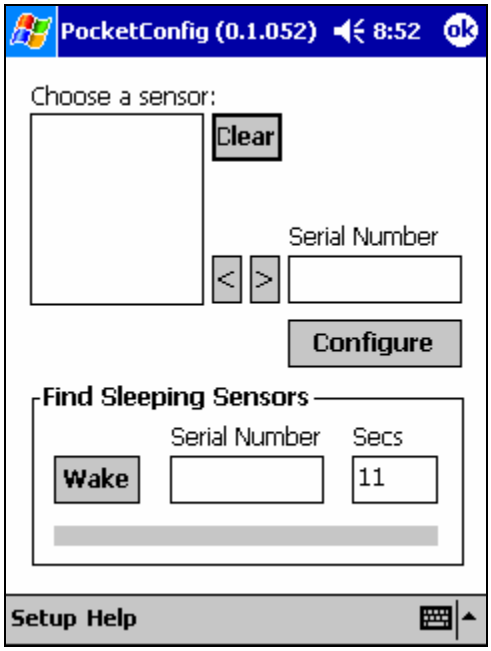


Figure 8. **PocketConfig** *Main Menu with No Defined Devices.*

Adding New Devices

Every Luna *i*Monitoring device has a unique serial number found on the Luna *i*Monitoring Serial Number label attached to the device. The software identifies each device by its unique serial number. The sensor list contains the serial numbers of the last ten devices accessed by the software. To add a device to the sensor list, enter the unique serial number of the device in the space provided and hit the "<" button. If the sensor list already contains ten serial numbers as in Figure 9 below, then the least recently accessed device drops from the sensor list. To interrogate a sensor already in the list, simply select the proper serial number from the list and hit the ">" button to copy the serial number into the Serial Number field. To access a sensor not in the list, type its serial number in the space provided. The software automatically adds the serial number to the list when the **Configure** button is selected. To clear the selected sensor from the sensor list, hit the **Clear** button.

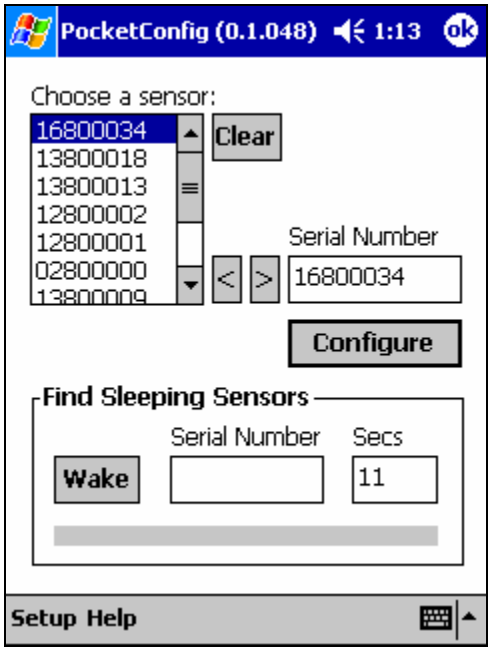


Figure 9. **PocketConfig** *Main Menu.*

Sensor Charge Modes

Sensor devices have four charge modes based on the current charge capacity of the device's battery. The four modes are

- Always On mode, when the battery is at 100%;
- Fast mode, when the battery is above 76.7% but below 100%;
- Slow mode, when the battery is at or below 76.7% but above 0%;
- Always Off mode, when the battery is fully discharged.

The device stays on continually in Always On mode which usually occurs on sunny days when the solar panels can power the device and keep the battery fully charged. In Fast mode the device "wakes up" every 10 seconds to see if it is being interrogated. In Slow mode the device only wakes up every 2 minutes. If the battery becomes fully discharged, then the device shuts off completely.

Setting the Default ReSync Time

The ReSync Time selected in the setup menu determines how long the software waits for a response from a device. To access this menu, select the **Setup** tab on the main menu, and hit the **Options** button shown in Figure 10 below.

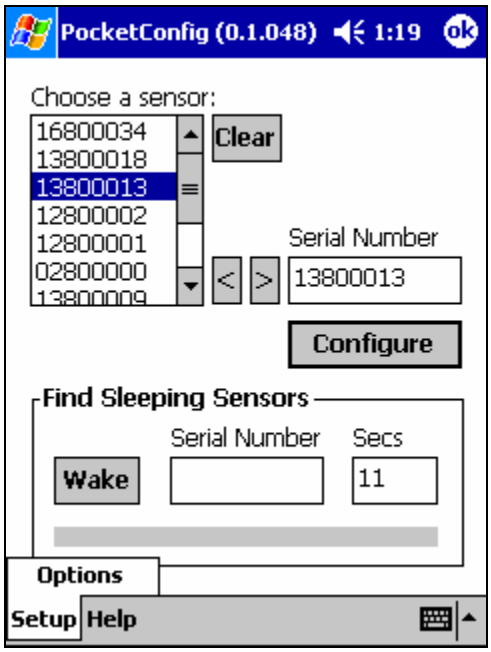


Figure 10. Accessing the Setup Menu.

Figure 11 shows the setup menu and the ReSync Time options. If Wait for devices in fast mode is selected, the software waits for 11 seconds to access a

device. Devices usually "wake up" every 10 seconds in Fast mode; therefore, searching for 11 seconds should find the device. If Wait for devices in slow mode is selected, the software waits for 121 seconds. The device may be in Slow mode and will only "wake up" every 2 minutes. If Custom wait time is selected, enter a wait time in milliseconds in the space provided. Once the proper mode is chosen, hit the **OK** button to set the ReSync Time option.

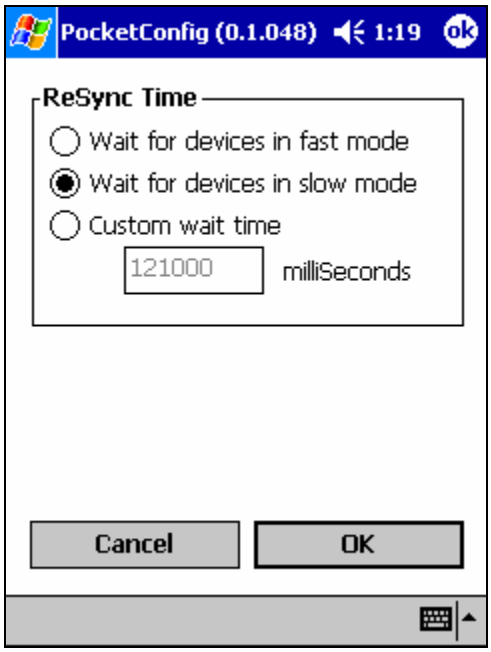


Figure 11. ReSync Wait Time Selection Menu.

Finding Sleeping Devices

If a known device does not respond when interrogated, the device may be "sleeping", and the Resync Time may be set to only wait for devices in fast mode. By default, the software searches for the device for the time interval specified in the setup menu. To wake a sleeping device, enter its serial number in the appropriate space under Find Sleeping Sensors in the main menu, and hit the **Wake** button. If the software still does not find the sleeping device, increase the search time to 121 seconds. If the software fails to find the device after 121 seconds, check the device for possible battery failure. Using Find Sleeping Sensors overrides the time interval selected in the setup menu. Note: Find Sleeping Sensors wakes the device and places it temporarily in Always On mode which significantly increases power consumption.

About PocketConfig

Luna *i*Monitoring includes information on each of its software programs that is accessed by selecting the **Help** tab at the bottom of the screen and hitting the **About** button as shown in Figure 12 below.

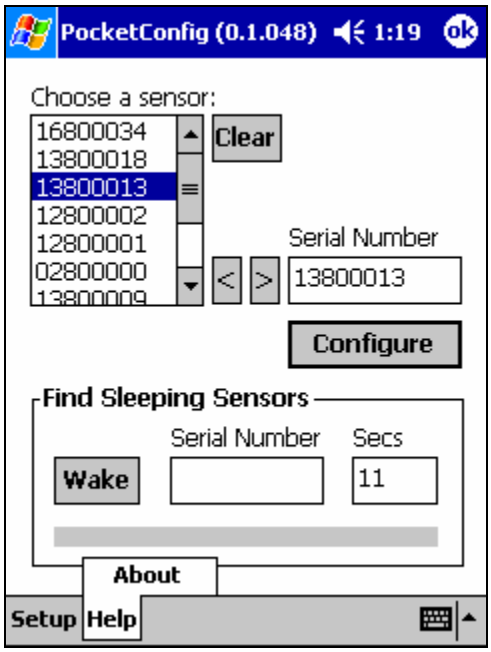


Figure 12. Accessing the About **PocketConfig** *Menu.*

The window shown in Figure 13 provides copyright and version information on the program and library software.

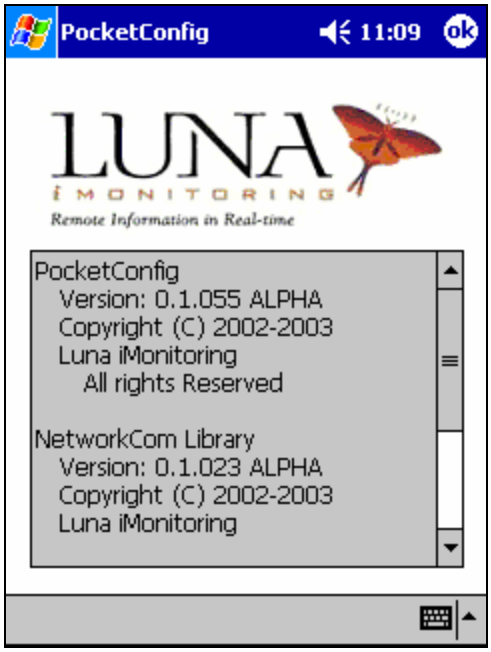
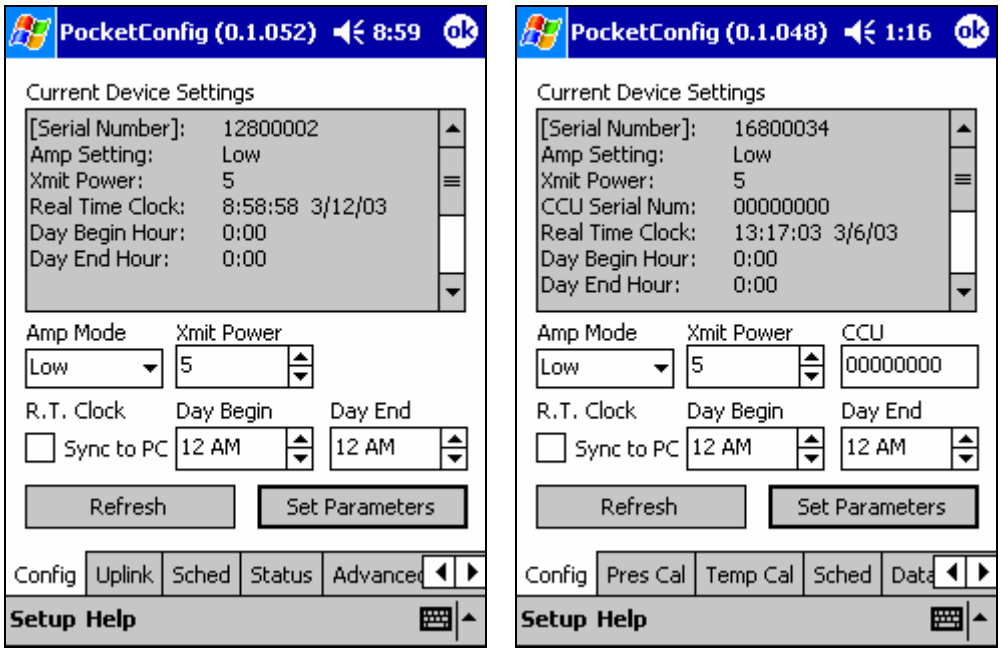


Figure 13. Detailed Information on **PocketConfig**.

Configuration Menus

Luna *i*Monitoring preconfigures the settings for all its devices. To view the current settings or to reconfigure the device, select the device in the main menu and hit the **Configure** button to bring up one of the menus shown in Figure 14. Menu (a) shows the sensor configuration menu for an *i*WPM-T, but other sensor configuration menus contain the same information and options. The sensor menu includes the serial number for the *i*CCU to which the sensor uplinks. If the CCU field contains all zeros, as in Figure 14, then the sensor broadcasts to all listening *i*CCUs. Menu (b) shows an *i*CCU configuration menu which does not include the CCU field.



(a) *(b)*

Figure 14. Configuration Menus for an (a) iCCU, and an (b) iWPM-T.

To change a parameter value, first highlight the value with a single tap, then enable the value for editing with another tap. Now select the keyboard entry screen by tapping the keyboard icon at the bottom right of the screen. Use the keyboard to enter the new value. When finished entering the data, exit the keyboard by tapping the icon again. DO NOT USE THE "ENTER" KEY, as this will cause the application to exit. Once all the new parameter values are entered, hit the **Set Parameters** button to accept the changes. Parameters shown in

brackets, [ ], in the Current Device Settings window may not be changed. The new values will appear in the Current Device Settings window.

To change Amp Mode, select an option, Low/Medium/High, from the pull-down list. To change XmitPower, use the up/down arrows to the right of the field. The Amp Setting and XmitPower controls are available only to reduce the power below the authorized limits stated Appendix A of this document when desired, the control will not allow power greater than the authorized limits. To uplink a sensor to a specific *i*CCU, enter the serial number of the *i*CCU in the CCU field, or enter all zeros to broadcast to all *i*CCUs in listening range. The Sync to PC option synchronizes the Real Time Clock on the device to the clock on the PocketPC®. Use this option to synchronize all devices in the field to the same clock. Normally, Day Begin and Day End are set to 12:00 AM. To change these parameters, use the up/down arrows to the right of the field. These parameters only increment in 1-hour intervals.

The Current Device Settings window provides other valuable information that is accessible using the scroll bar. Figure 15 below shows the Current Device Settings window for an *i*TLM-1 when scrolled down to reveal additional parameters. This other information includes:

- the device serial number;
- a 4-byte encryption key, called the cypher, which must be the same for all devices in a network;
- the home channel that the device waits on when there is no activity, (when active the device scans all channels, 0-52);
- the modulus through the scanning sequence, called the DSS skip, that can create additional sequences and must be the same for all devices in a network, (usually set to 1);
- the version number of the device's firmware.

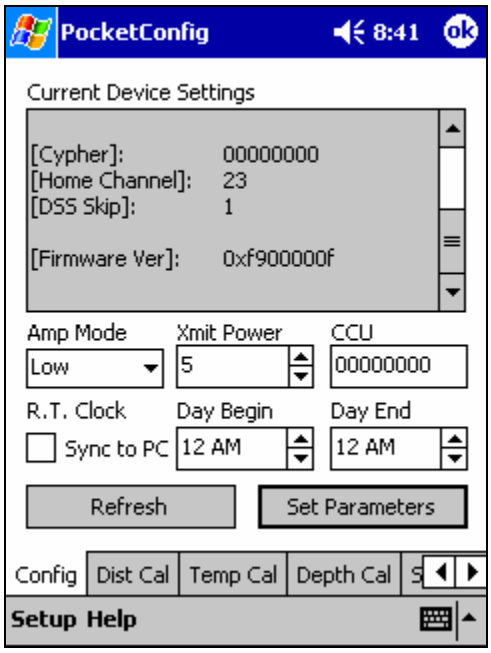


Figure 15. Current Device Settings Continuation Window for an iTLM-1.

Each device uses a different set of menus for configuring additional parameters. To access these menus, select one of the tabs along the bottom of the screen. Some menus are similar for all devices, and some menus are device-specific. All devices have menus for configuration, uplink scheduling, updating firmware, setting advanced parameters, and testing the device's radio. The *i*CCU has a status menu and an uplink menu, and sensor devices have calibration menus and a data menu.

Uplink Scheduling Menu

The WEMS devices run autonomously according to the uplink schedule set in the uplink scheduling menu. Sensors uplink to an *i*CCU, and an *i*CCU uplinks to a computer via satellite. To access this menu, select the Sched tab as shown in Figure 16 below. The software allows for four time schedules. For each time schedule, the software allows three pull-down options - Enabled, Disabled, or Hourly. In the Enabled mode, the device uplinks once daily at the time specified. In the Hourly mode, the device uplinks every hour at the minute/second specified. Normally, Hourly mode is only used for testing purposes. To change the time, click on the desired field, (hour, minute, second, AM/PM), and use the up/down arrows to change the field. Once the desired schedules and times are entered, hit **Set Uplink Times** to accept the changes.

Sensor devices must uplink to an *i*CCU at specific time intervals when the *i*CCU accepts data uplinks. The *i*CCU is active for one minute every ten minutes "on the tens" of every hour. In other words, the *i*CCU is active from 00 min. 00 sec. after the hour to 01 min. 00 sec. after the hour; from 10 min. 00 sec. after the hour to 11 min. 00 sec. after the hour; from 20 min. 00 sec. after the hour to 21 min. 00 sec. after the hour; etc. Therefore, synchronizing the real-time clocks on all devices and properly scheduling the uplink times on sensor devices are very important.

When setting the uplink time on a sensor device, keep in mind that, over time, the real-time clock may drift out of synchronization by a few seconds. Therefore, do not select an uplink time that is too close to the beginning or end of the uplink time window. Choose a value for the seconds field that falls between 15 and 45 seconds as in the example in Figure 16. Also, if the *i*CCU is linked to several sensor devices, space the uplink times for each device about five seconds apart to keep two devices from uplinking at the same time.

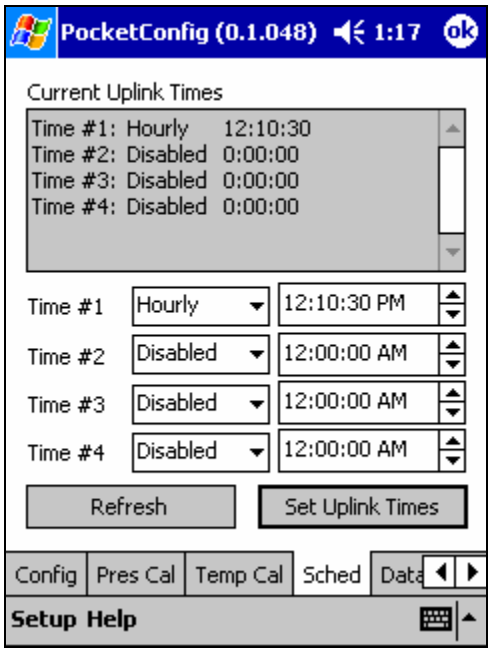


Figure 16. Uplink Scheduling Menu for an iWPM-T.

Update Flash Menu

The update flash menu <u>permanently</u> updates the firmware in a device and should only be performed with the approval of Luna *i*Monitoring.

When firmware updates are needed, Luna *i*Monitoring will provide firmware updates along with instructions on the type of devices to be updated. To open the update flash menu, select the Update tab as shown in Figure 17 below. **Always verify that the proper device is selected for updates.** Hit the **Update Flash** button to begin the update process. The progress bar shows the update progress. Always test the operation of the device thoroughly after performing firmware updates.

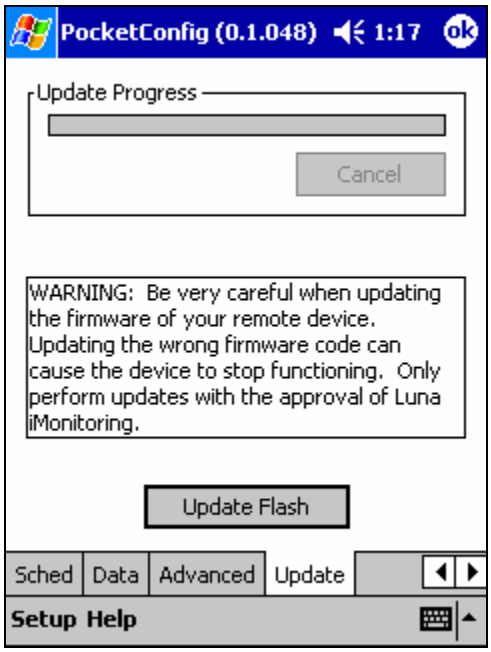


Figure 17. Firmware Update Menu.

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Sensor Data Menu

Figure 18 below shows the data menu for a sensor device, specifically an ***i***WPM-T, that is accessed by selecting the Data tab. To acquire new data points, hit the **Get Data** button. The Sensor Data window indicates the type of sensor, the serial number of the ***i***CCU, the sensor data points taken, the battery charge capacity, and the time that the **Get Data** was executed. To send the most recent data points to the ***i***CCU indicated by the serial number, hit the **Uplink NOW!** button.

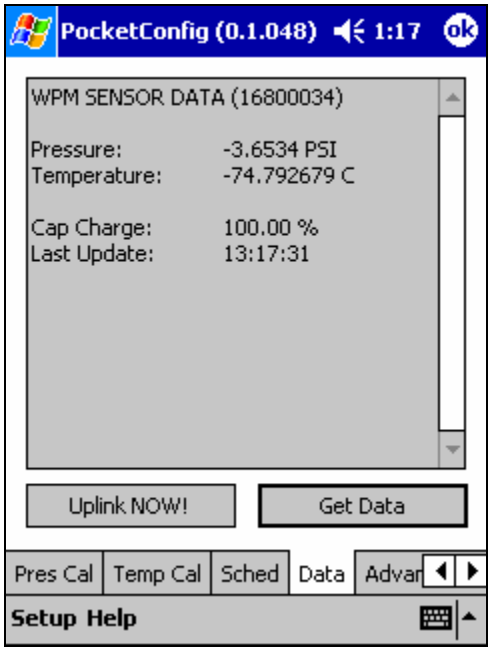


*Figure 18. **i**WPM-T Data Menu.*

*i*CCU-Specific Menus

The *i*CCU tabs include menus for uplinking the *i*CCU to a computer and displaying status information for the *i*CCU. Figure 19 shows the *i*CCU uplink menu that is accessed by selecting the Uplink tab, and Figure 20 shows the *i*CCU status menu that is accessed by selecting the Status tab.

*i*CCU Uplink Menu

The *i*CCU uplink menu, shown in Figure 19 below, uplinks the *i*CCU to a computer which downloads a data set. The Uplink Mode has two options - Modem, which is the default, and Direct. In Modem mode, the *i*CCU uplinks to a satellite which uses the Phone # to dial up the computer. To use the Direct mode, the *i*CCU must be hardware-configured to connect directly to the serial port of a computer using a special cable.

Before beginning an uplink, verify that the current battery charge is above the preset Uplink Threshold. To begin an uplink, choose the Uplink Mode, enter the Phone # for the computer, and hit the **Set Parameters** button. Once the software accepts the parameters, hit the **Uplink NOW!** button to send the most recent data points for each device uplinked to the *i*CCU.

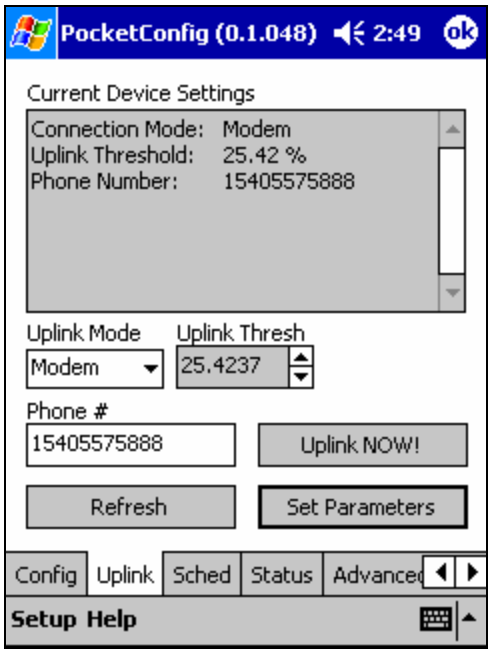


Figure 19. iCCU Uplink Menu.

*i*CCU Status Menu

The *i*CCU status menu, shown in Figure 20 below, provides additional information about the current status of the *i*CCU indicated by the serial number in the CCU Status window. To get the current status, select the Status tab and hit the **Get Status** button. The Charge field indicates the current charge of the battery. Fast Mode Level is the battery charge level below which the device switches from Fast Mode to Slow Mode, and the Always Off Level is the level where the device shuts itself off.

Under Uplink Status, Last Uplink indicates the time of the most recent uplink to the satellite, and Next Uplink indicates the scheduled time for the next uplink. A Status code of 0x00 indicates that the last uplink was successful.

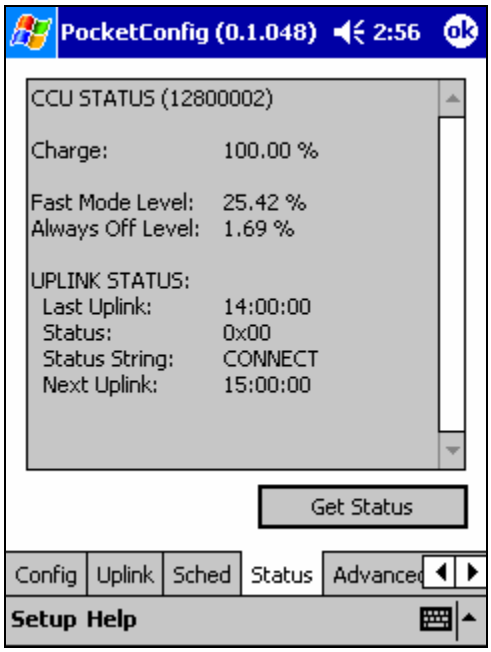


Figure 20. iCCU Status Menu.

*i*EFM-Specific Menus

The *i*EFM tabs include menus for calibrating the sensor and the gas element on the *i*EFM device. Figure 21 below shows the menu for calibrating the sensor, and Figure 22 on the following page shows the gas element calibration menu. This section also discusses the *i*EFM sensor data window.

*i*EFM Sensor Calibration

The *i*EFM operation requires a number of parameters for valid measurements that are entered using the sensor calibration menu shown in Figure 21 below, which is accessed by selecting the Sensor Cal tab. The values for Temp cal intercept and Temp cal slope are entered at the factory and are matched to the external sensor that is supplied with the *i*EFM. The other parameters are dependant on the process equipment to which the *i*EFM is attached.

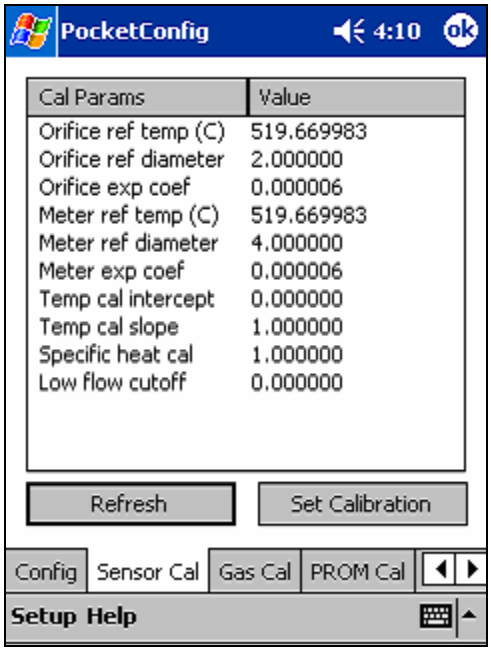


Figure 21. iEFM Sensor Calibration Menu.

*i*EFM Gas Calibration

The process gas consists of multiple gas concentrations. The *i*EFM operation requires that each gas element percentage of concentration be entered for valid measurements. Enter the percentage values in decimal form using the gas calibration menu shown in Figure 22 below, which is accessed by selecting the Gas Cal tab. When all values are entered, hit the **Set Calibration** button to accept the values.

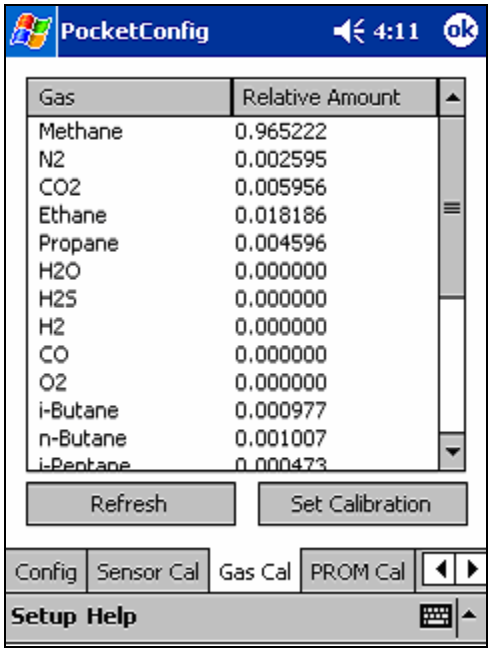


Figure 22. iEFM Gas Calibration Menu.

*i*EFM Sensor Data

The *i*EFM data may be viewed by selecting the Data tab at the bottom of the screen which opens the sensor data window shown in Figure 23 below. The first section of data reported is instantaneous data. The HOURLY DATA section shows data averaged over the last 1-hour period, and the DAILY DATA gives the data averaged over the last 24-hour period.

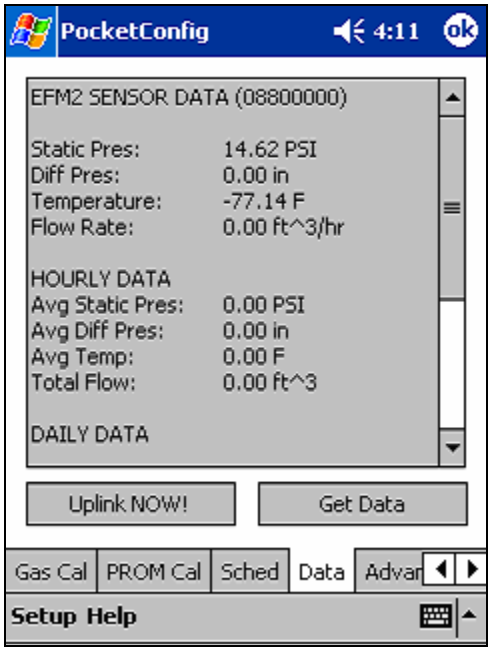


Figure 23. iEFM Sensor Data Window.

*i*TLM-1-Specific Menus

The *i*TLM-1 tabs include menus for calibrating the temperature and tank level sensors on the *i*TLM-1 device. Figure 24 below shows the menu for calibrating the temperature sensor. Figure 25 and Figure 26 on the following pages show the distance and depth calibration menus, respectively, for the tank level sensor. Luna *i*Monitoring performs the temperature and distance calibrations for the temperature and tank level sensors, respectively, before shipping. The installer performs the depth calibration for the tank level sensor.

*i*TLM-1 Temperature Calibration

To set the temperature calibration parameters, select the Temp Cal tab at the bottom of the screen to access the temperature calibration menu shown in Figure 24 below. Enter the correct Slope and Intercept, and hit the **Set Calibration** button. The *i*TLM-1 uses the temperature data to compensate for the effects of temperature on the tank level measurement.

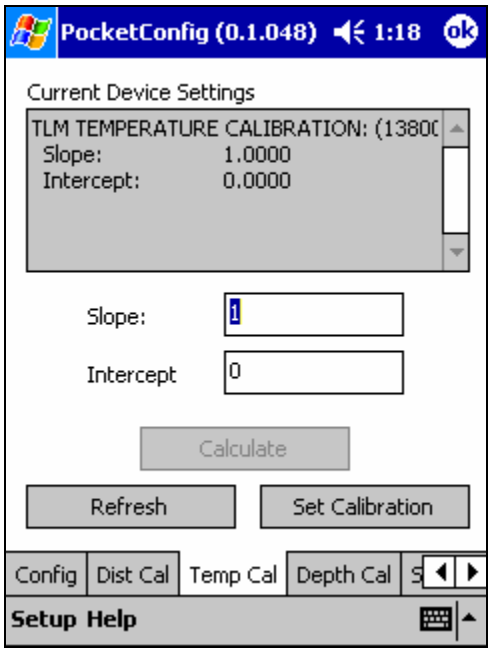


Figure 24. iTLM-1 Temperature Calibration Menu.

*i*TLM-1 Distance Calibration

Luna *i*Monitoring calibrates the *i*TLM-1 tank level sensor using a known distance from the sensor to a surface in the lab. To set the distance calibration parameters, select the Dist Cal tab at the bottom of the screen to access the distance calibration menu shown in Figure 25 below. Enter the correct Slope and Intercept, and hit the **Set Calibration** button.

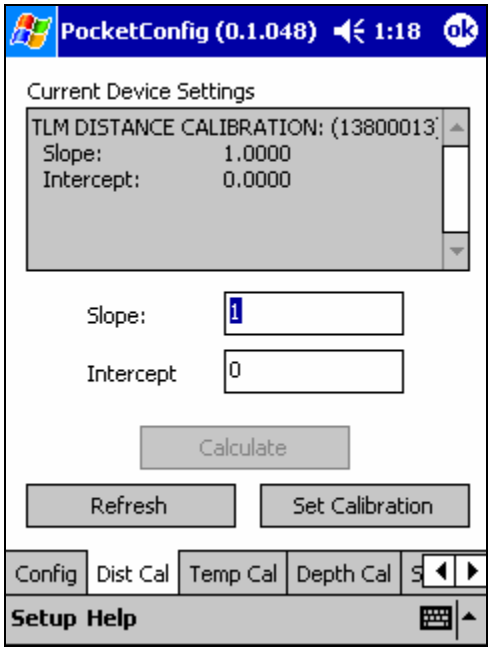


Figure 25. iTLM-1 Distance Calibration Menu.

*i*TLM-1 Depth Calibration

The *i*TLM-1 depth calibration must be performed during the process of installing the *i*TLM-1 sensor device on the tank.

At the time of the device installation, the *i*TLM-1 needs to know the exact depth of the fluid in the tank to perform the depth calibration for the tank level sensor. To set the depth calibration parameter, select the Depth Cal tab at the bottom of the screen to access the depth calibration menu shown in Figure 26 below. Enter the current depth of the fluid in the tank in inches in the Measured Depth field, install the *i*TLM-1 sensor, and hit the **Set Depth Cal** button. Once the depth calibration is complete, the value "-2" appears in the Measured Depth field to block any inadvertent changes to the calibration parameters. Luna *i*Monitoring personnel use the "-1" value, which removes the depth calibration and reports distance. This is useful when performing the distance calibration.

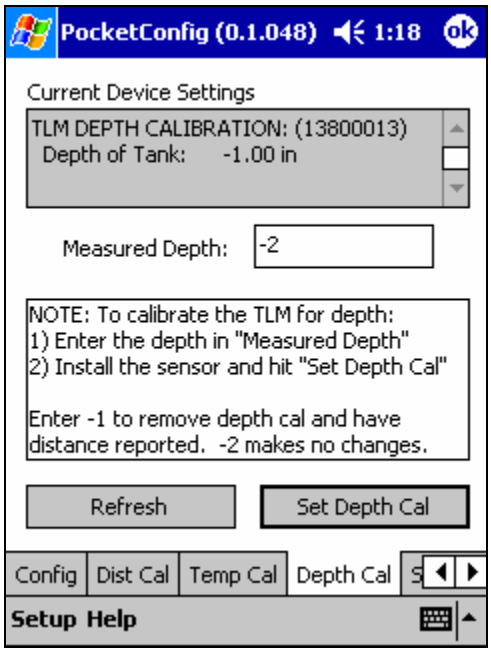


Figure 26. iTLM-1 Depth Calibration Menu.

*i*WPM-T-Specific Menus

The *i*WPM-T tabs include menus for calibrating the pressure and temperature sensors on the *i*WPM-T device. Figure 27 below shows the menu for calibrating the pressure sensor, and Figure 28 on the following page shows the temperature sensor calibration menu. Luna *i*Monitoring calibrates all of the *i*WPM-T's sensors before shipping.

*i*WPM-T Pressure Sensor Calibration

To set the pressure calibration parameters, select the Pres Cal tab at the bottom of the screen to access the pressure calibration menu shown in Figure 27 below. Select the proper Units from the pull-down list. The choices for Units are millivolts, PSI, mm Hg, kPa, and mBar. Enter the correct Slope and Intercept for the specified units, and hit the **Set Pressure Cal** button.

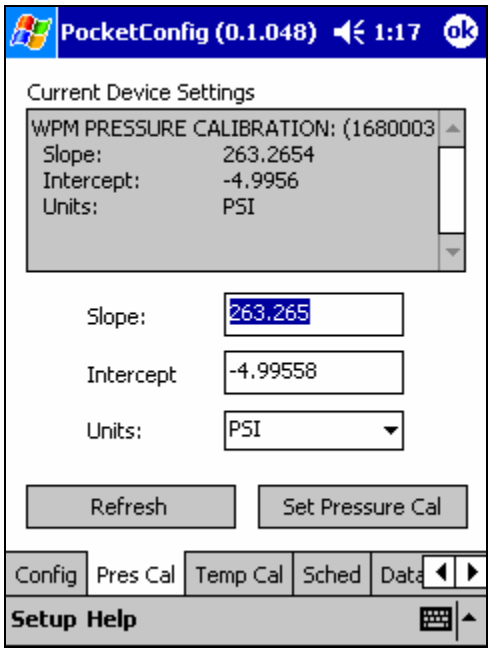


Figure 27. iWPM-T Pressure Sensor Calibration Menu.

*i*WPM-T Temperature Calibration

To set the temperature calibration parameters, select the Temp Cal tab at the bottom of the screen to access the temperature calibration menu shown in Figure 28 below. Select the proper Source from the pull-down list. The choices for Source are Internal for the *i*WPM-T, and External for the *i*WPM-T which has an external temperature sensor. Enter the correct Slope and Intercept, and hit the **Set Temperature Cal** button. The *i*WPM-T uses the temperature data to compensate for the effects of temperature on the pressure measurement.

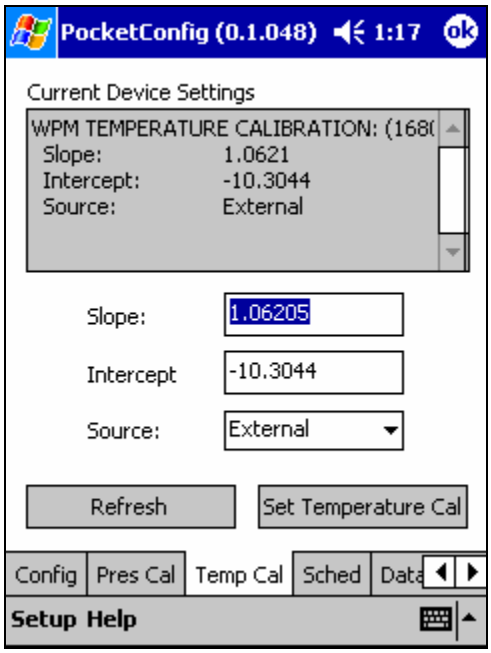


Figure 28. iWPM-T Temperature Sensor Calibration Menu.

PocketDataViewer

The other software program on the SD Card is **PocketDataViewer** which downloads a set of data points from a sensor device to the PocketPC®. Figure 33 on page 44 shows the main menu for the program. This program also includes the same Setup Options and Help About windows as in **PocketConfig** which are discussed in the following sections.

Setting the Default ReSync Time

The ReSync Time selected in the setup menu determines how long the software waits for a response from a device. To access this menu, select the **Setup** tab on the main menu, and hit the **Options** button shown in Figure 29 below.

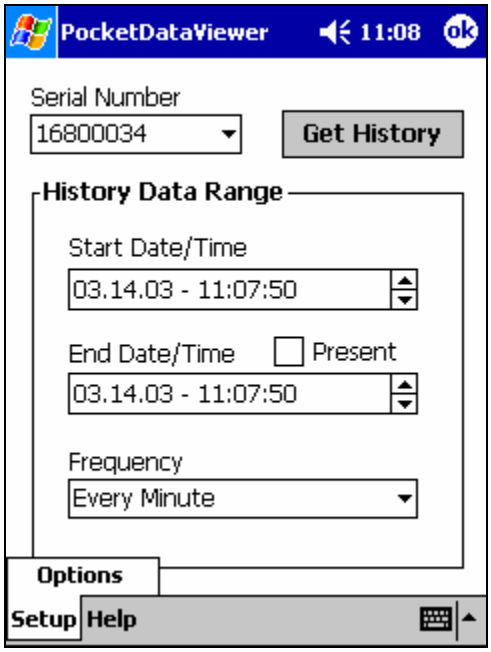


Figure 29. Accessing the **PocketDataViewer** *Setup Menu.*

Figure 30 shows the setup menu and the ReSync Time options. If Wait for devices in fast mode is selected, the software waits for 11 seconds to access a device. Devices usually "wake up" every 10 seconds in Fast mode; therefore, searching for 11 seconds should find the device. If Wait for devices in slow mode is selected, the software waits for 121 seconds. The device may be in Slow mode and will only "wake up" every 2 minutes. If Custom wait time is selected, enter a wait time in milliseconds in the space provided. Once the proper mode is chosen, hit the **OK** button to set the ReSync Time option.

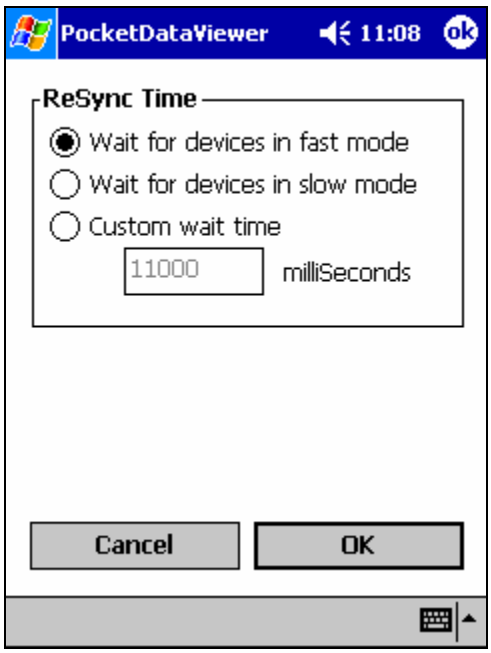


Figure 30. ReSync Wait Time Selection Menu.

About PocketDataViewer

Luna *i*Monitoring includes information on each of its software programs that is accessed by selecting the **Help** tab at the bottom of the screen and hitting the **About** button as shown in Figure 31 below.

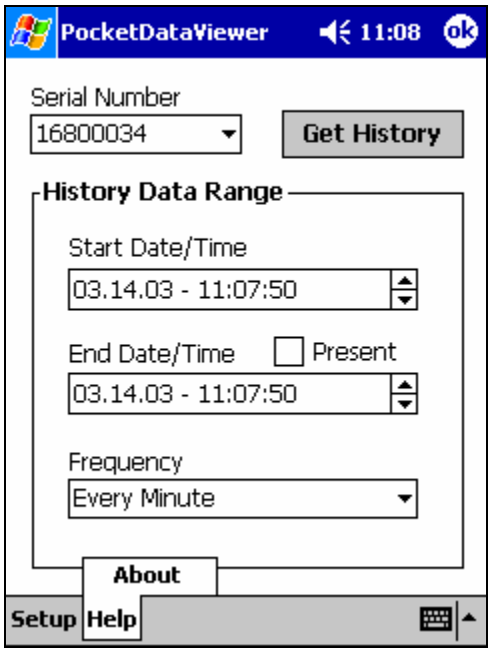


Figure 31. Accessing the About **PocketDataViewer** *Menu.*

This window shown in Figure 32 provides copyright and version information on the program and library software.

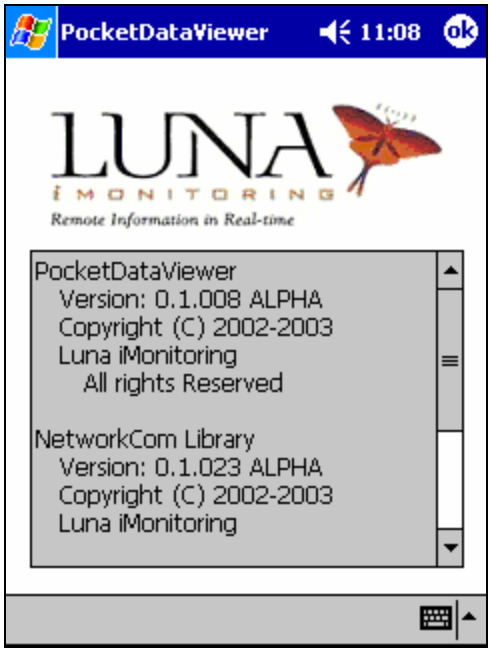


Figure 32. Detailed Information on **PocketDataViewer**.

Selecting a Sensor Device

To select the sensor device from which to download data, enter its unique serial number in the Serial Number field or select it from the pull-down list. Note: this program only recognizes sensor devices, not *i*CCU devices. The Serial Number field in this program functions the same as the Serial Number field in **PocketConfig**. The program stores the ten most recently accessed serial numbers in the pull-down list.

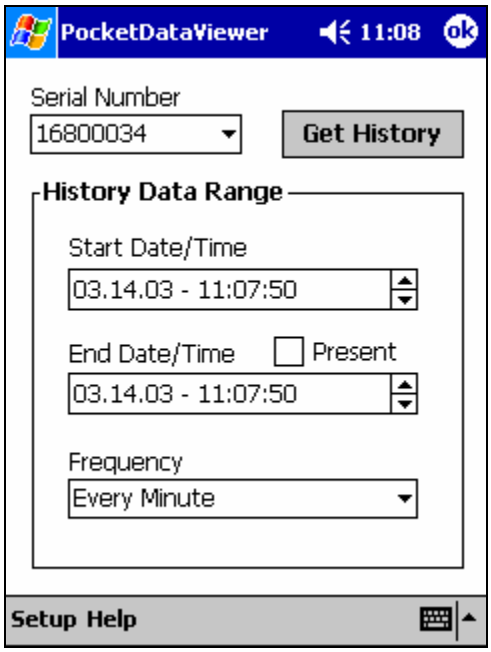


Figure 33. **PocketDataViewer** *Main Menu.*

Selecting the History Data Range

By default, the Start Date/Time and End Date/Time are initially set to the current time. To change a date or time field, select the appropriate field and change it using the up/down arrow buttons to the right of the field. To "hard code" the software to use the current date and time as the End Date/Time, select the Present option as shown in Figure 34 below.

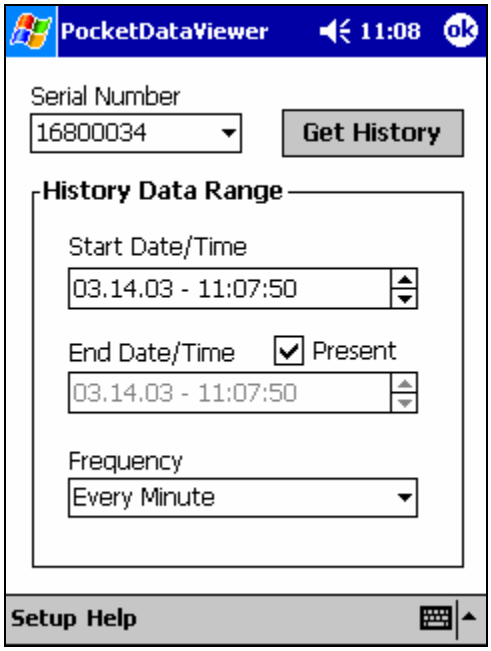


Figure 34. Selecting the End Date and Time.

Selecting the Data Point Frequency

By default, sensor devices acquire and internally store data points every minute, even though they may only uplink and transmit one set of data points per day. **PocketDataViewer** provides access to all or part of these data points based on the Frequency interval selected from the pull-down list shown below in Figure 35.

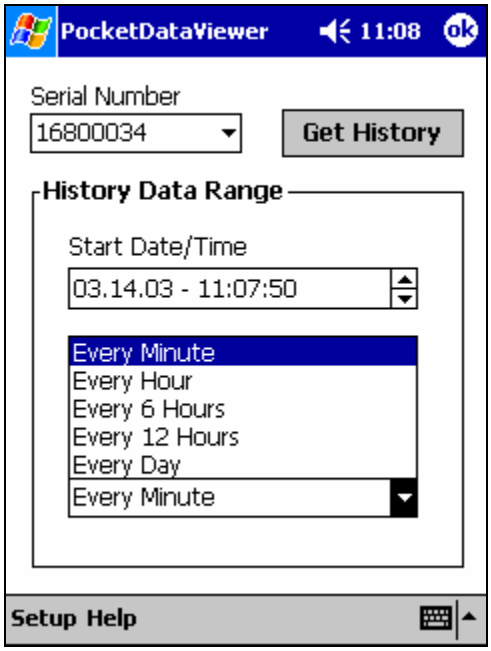
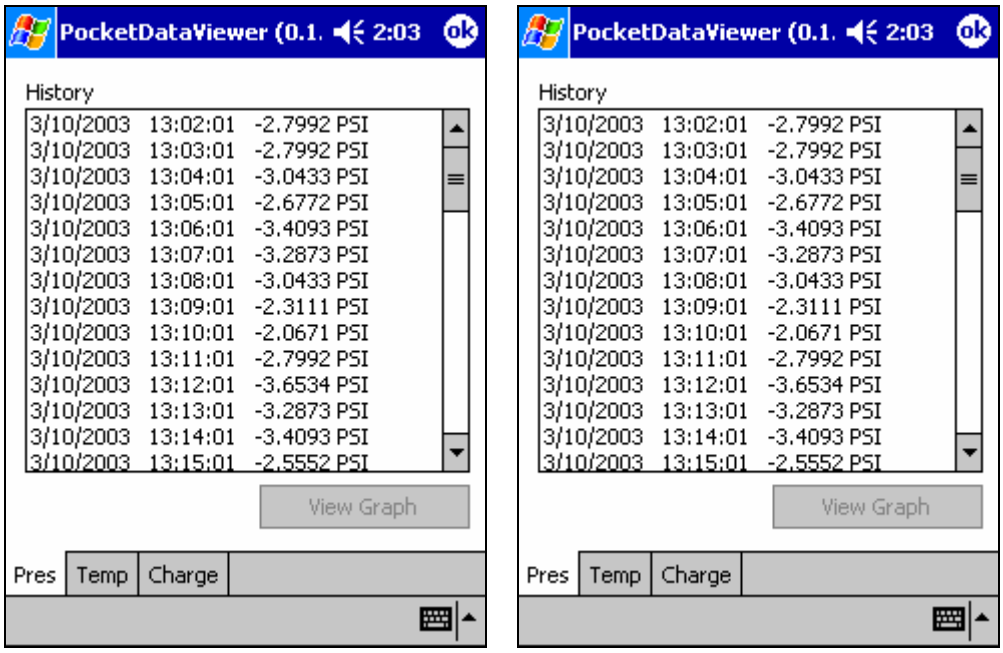


Figure 35. Data Point Frequency Interval Options.

Once the Serial Number and History Data Range are selected, hit the **Get History** button to download the data points and bring up the windows shown in the following two Sections. Note: the software issues a warning if the number of data sets requested is greater than 100.

Sensor Data History

The next two sections use history data from an *i*WPM-T sensor device; however, other sensor devices have similar displays. The History window has tabs for each of the sensor data measurements and the battery charge capacity. Figure 36 below shows the sensor data measurements for an *i*WPM-T which has pressure and temperature sensors. The *i*TLM-1 has depth and temperature sensors.



(a) *(b)*

Figure 36. (a) Pressure and (b) Temperature Sensor Data History for an iWPM-T.

In every data history window, column 1 contains the date, column 2 contains the time, and column 3 contains the data point and units. Use the scroll bar at the right of the window to scroll through the entire data range.

In a later release of the software, the **View Graph** option will display a graph of the entire data range.

Battery Charge History

Figure 37 below shows the battery charge capacity history for an *i*WPM-T sensor device, but this window is the same for all sensor devices.

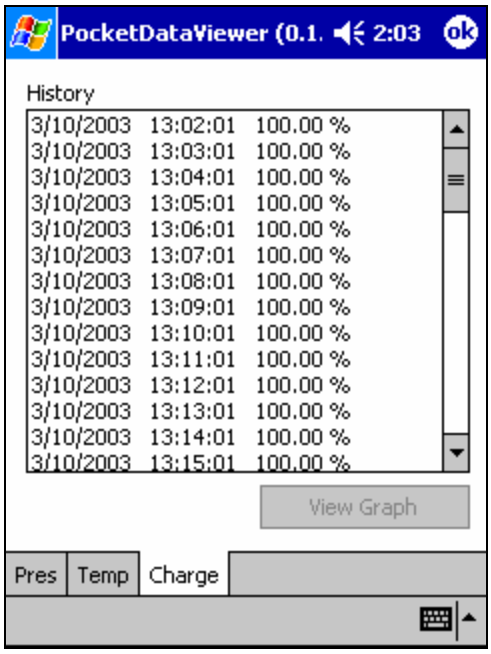


Figure 37. Battery Charge Capacity History for an iWPM-T.

Exiting the Software

To safely exit either software program, **PocketConfig** or **PocketDataViewer**, simply hit the button in the top right corner of the screen.

Appendix A

Specifications

Description	Specification
iCCU – Concentration & Communications Unit	
Dimensions: Enclosure Solar Panel	 11.5" x 8.0" x 5.0" 10.0" x 9.0" x 5.0"
LAN Transmit/ Receive Frequency	902 to 928 MHz (customizable)
LAN Output Power	17.0 dBm nominal, conducted
LAN Communications Protocol	Proprietary FHSS, per FCC Part 15.247
LAN Data Rate	4800 bps
WAN Options	Simplex or duplex sat com (released), Cellular and land line (near future)
WAN Data Rate	< 9.6 Kbps
Operational Temperature Range	-40 to +55 °C
Radio Link Range: *i*CCU to Sensor *i*CCU to PocketPC®	 2500 feet; typical, line of sight 500 feet; typical, line of sight
FCC LAN WAN	 CFR 47 Part 15 CFR 47 Part 25

Description	Specification
iCFR – Compact Flash Radio	
Transmit/Receive Frequency	902 to 928 MHz (customizable)
Form Factor	Type I compact flash
Power Supply	3 to 5V (from host unit)
Power Consumption: Transmit Receive	 25mA max 11.8 mA
Protocol	Propriety FHSS, per FCC Part 15.247
Receive Sensitivity	-97 to -110 dBm (depending on data rate)
Output Power	6.8 dBm nominal, conducted
Modulation	FSK
Data Rate	Up to 76 Kbps
Antenna	Internal
FCC	CFR 47 Part 15

Description	Specification
iEFM – Electronic Flow Monitor*	
Operational Temperature Range	-40 to +60°C
Output Power: Omni Antenna Yagi Antenna	 17.7 dBm max, conducted 13.4 dBm max, conducted
Radio Link Range: iCCU to Sensor iCCU to PocketPC®	 2500 feet; typical, line of sight 500 feet; typical, line of sight
UL	Intrinsically Safe for Class I, Division 1, Groups C and D per UL-913
FCC	CFR 47 Part 15 CFR 47 Part 18 (ultrasonic transducer)

*For additional specifications, see Honeywell specifications for MXA145 Flow Transmitter.

Description	Specification
iTLM-1 – Tank Level Monitor	
Fluid Level Range	12 to 144 inches
Resolution	0.1 inches
Accuracy	± 0.5 inches
Repeatability	± 0.2 inches
Mounting	1½ inch NPT, up to ¼ inch thickness
Mounting Angle	5° maximum
Temperature Compensated	Yes
Operational Temperature Range	-40 to +60°C
Output Power: Omni Antenna Yagi Antenna	 17.7 dBm max, conducted 13.4 dBm max, conducted
Radio Link Range: *i*CCU to Sensor *i*CCU to PocketPC®	 2500 feet; typical, line of sight 500 feet; typical, line of sight
UL	Intrinsically Safe for Class I, Division 1, Groups C and D per UL-913
FCC	CFR 47 Part 15 CFR 47 Part 18 (ultrasonic transducer)

Description	Specification
iWPM-T – Wireless Pressure Monitor	
Pressure Range	0 to 1400 psig
Resolution	10 psig
Accuracy	± 30 psig
Overpressure	2000 psig
Temperature Compensated	Yes
Mounting	¼ inch NPT
Operational Temperature Range	-40 to +60°C
Output Power: Omni Antenna Yagi Antenna	 17.7 dBm max, conducted 13.4 dBm max, conducted
Radio Link Range: *i*CCU to Sensor *i*CCU to PocketPC®	 2500 feet; typical, line of sight 500 feet; typical, line of sight
UL	Intrinsically Safe for Class I, Division 1, Groups C and D per UL-913
FCC	CFR 47 Part 15

Appendix B

Technical Support

If you experience any problems using the Oil and Gas Wireless Enabled Monitoring System, please contact Luna *i*Monitoring Technical Support at

2903 Commerce Street, Suite A
Blacksburg, VA 24060 USA
Voice: 540-557-5880
FAX: 540-951-0760
Email: solutions@lunaimonitoring.com
Web: www.lunaimonitoring.com

Appendix C

Using the Charge Cable

Figure 38. WEMS Charge Cable.

Luna *i*Monitoring provides a device Charge Cable, shown in Figure 38 above, with most Beta Test versions of the Wireless Enabled Monitoring System. **The Charge Cable is for use in a lab setting and is not tested or approved for use in hazardous environments.** The Charge Cable has an SMA connector at one end and a USB connector at the other end. The SMA connector plugs into the SMA antenna connector on the WEMS device being tested. The antenna on each WEMS device simply screws off of the SMA connector. The USB connector plugs into the USB port of any computer. The SMA connector serves as an antenna connection as well as a power connection. Therefore, the device receives power from the USB port on the computer when the computer is on. Even though the antenna is disconnected, the device can still receive and transmit radio signals in a lab setting.

The Charge Cable serves two purposes:

1) It quickly charges the battery to full capacity.
2) It maintains a full charge on the battery in a lab setting where the solar panels can not charge the battery.