



Intelligent Wireless SCADA Distributed RTU Systems

Precision Level Reader Portable Depth Management System

User Guide V1.16

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1.0 About this Document

This document provides the information you need to own and operate the Plexus Controls Precision Level Reader (PLR) System.

2.0 Plexus Controls System Overview

Plexus Controls PLR is a member of the next generation of distributed wireless mesh supervisory, control and data acquisition (SCADA) systems. The system features many benefits over existing SCADA products:

- Standard SCADA voltage and current loop sensors
- Reliable & scalable auto mesh wireless
- No wiring needed
- Ultra low power
- Full monitoring, control and back office support
- Low cost & fast install
- Rugged construction (NEMA6) for all weather conditions

3.0 PLR System Components

The PLR system consists of 2 components, the Remote Measurement System (RMS) and handheld portable rugged mini PC platform (Trimble®). The components of each system are listed below:

	Remote Measurement System (RMS)	Handheld Management Tool
Hardware	IP65 ABS enclosure housing the air pump, battery, pressure sensor and interface circuits	Rugged handheld unit running Windows Mobile 5 or 6 based operating system with 64MB RAM and 256MB Flash Bluetooth enabled
Software	Plexus Controls application firmware	Windows Mobile 5 or 6 operating system PDMS runtime application software

4.0 PLR System Quick Start

Charge the Handheld Unit and the Remote Management System (RMS) box for at least 8 hours before use. If your system Handset and RMS unit was provided together then the Bluetooth connection may already be paired and you can skip the Configuring the Bluetooth Connection section below:

Configuring the Bluetooth Connection (Windows Mobile V5.0-V6.1):

1. Select Start/Settings/Connection in the Windows Menu
2. Press the ON button on the Remote Measurement unit – this puts Bluetooth into discovery mode
3. Select Bluetooth on the Handheld Device
4. Select 'Add New Device' on the Handheld Device
5. After a few seconds the Handheld should display the Bluetooth device in the Remote Measurement Unit. This will show as RN42-XXXX where XXXX is a unique number
6. Select the device by clicking on the RN42-xxx
7. Click Next – this will show a screen asking for passcode
8. Enter 1234 as passcode and click next
9. Click on the COM ports tab
 - a. Select the Bluetooth Device you enabled above
 - b. Select New Outgoing Port
10. Select COM 8 and click finish
11. The Bluetooth connection is now enabled.

Configuring the Bluetooth Connection (Windows Mobile V6.5):

1. Select Start/Settings/Bluetooth in the Windows Menu
2. Press the ON button on the Remote Measurement unit – this puts Bluetooth into discovery mode
3. Select 'Add New Device' on the Handheld Device
4. After a few seconds the Handheld should display the Bluetooth device in the Remote Measurement Unit. This will show as RN42-XXXX where XXXX is a unique number
5. Select the device by clicking on the RN42-xxx
6. Click Next – this will show a screen asking for passcode
7. Enter 1234 as passcode and click next. If the screen asks if you want to add the system to your device list, click 'yes'
8. Click on the 'Advanced' tab at the bottom, select "Serial Port" and click save
9. At the top of the screen click on the "COM ports" tab and select "New Outgoing Port"
10. Select your RN42-XXXX device and click "Next"
11. Select COM 8 in the drop down menu, uncheck "Secure Connection", and click "Finish" and then "OK"
12. The Bluetooth connection is now enabled.

Running the Program and Taking a Measurement:

1. Connect the yellow hose to the upper port (nearest the on/off switch) on the back RMS. Use the spring retaining clip provided to ensure a good connection. See Section 13.
2. Connect the blue hose to the lower port on the back RMS. Use the spring retaining clip provided to ensure a good connection. See Section 13.
3. Switch the RMS unit on using the green button on the top.
4. Switch the Handheld unit on by pressing the button in the lower left corner once. Click on the top left menu icon and select **Plexus_Mobile_XX**
5. After the program loads select "New" at the top of the screen and enter the well site information. If you just want to take a quick measurement enter 'test' in the well name,, enter 0 in BGS and enter 0 in ASL. Press Save.
6. Press 'Read' to measure and display the depth. If this is the very first time the system has been used you will need to press 'Read' twice. The Status box will show any errors the system may encounter.

5.0 Measurement References

Getting Started

The PLR is a powerful but simple tool to use. Refer to Figure 1 below when setting up and entering information on the system. The system can measure and display water levels from the casing height (CH) down to the water level (WL) = reading L2, or from the bottom of the PLR weight (BW) to the water level (WL) = reading L1. Both readings, along with the water height above sea level (if the well configuration information is completed) are stored in the database when the Save button is pressed.

Because the PLR RMS can measure liquid levels to a maximum of 10m above the bottom of the weight, it is usually best to cut the tube length such that the bottom of the weight is about **5m below the average** (or static) water level. This enables the system to measure changes in water level of -5m to +5m, ensuring performance whether the level drops or rises.

In shallow measurement applications such as side slope risers, users may prefer to place to bottom of the weight at the bottom of the casing in order to measure from 0 to +10m.

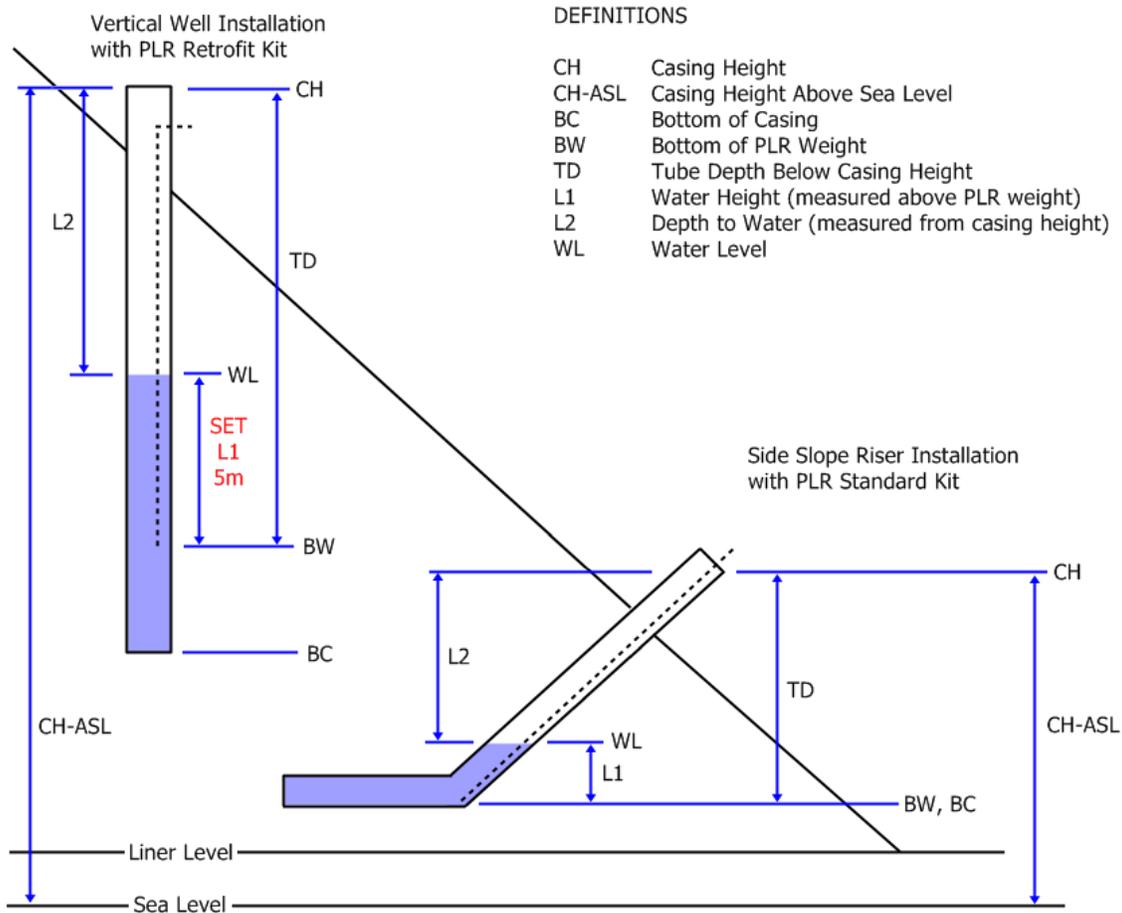


Figure 1 - Measurement References

In the event that the PLR measurement device is installed in an angled casing, one setup calculation is required to measure water levels from the casing height down to the water level accurately (L2). This is because the installed tube length, TD, is on an angle in reality while the computer assumes that it is a vertical dimension. This does not affect L1 measurements above the bottom of the weight, because the difference in pressure with depth is constant regardless of the angle.

To calculate the vertical value of 'Tube Depth Below Casing Height' (TD) to enter, refer to Figure 2 below and apply one of the two following formulas:

Formula 1; Use this formula if you know the angular distance and the slope

$$\text{Tube Depth} = \frac{\text{Angular Distance}}{\sqrt{1 + \frac{1}{\left(\frac{\text{Rise}}{\text{Run}}\right)^2}}}$$

Formula 2; Use this formula if you know the angular distance and the angle

$$\text{Tube Depth} = \sin(\text{Angle}) \times \text{Angular Distance}$$

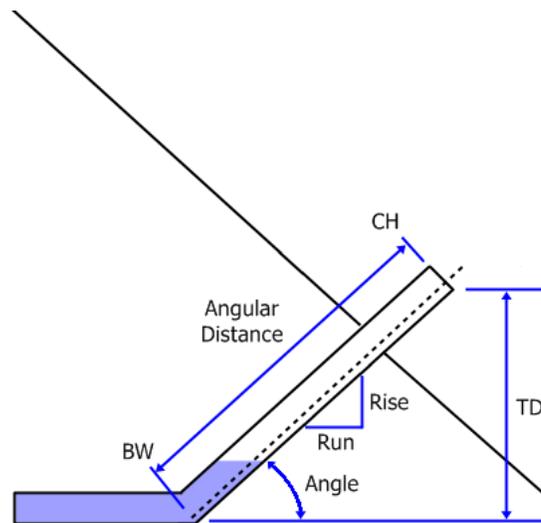


Figure 2 - Angled Casing Dimensions

An Excel spreadsheet to perform these calculations easily is available from Plexus Controls or ATZ Applied Technologies.

Once the vertical tube depth (TD) is entered in the handheld, it will correctly report the vertical distance from the casing height (CH) to the water level (WL).

6.0 PLR System Operation

Power on/off

Press button once to power the TRIMBLE system on and press once to power off. In addition this button can be held down for 5 seconds to display the reset menu.

1. Make sure the batteries are fully charged by connecting the charged to the TRIMBLE system for a minimum of 8 hours.
2. With the yellow hose open to the atmosphere, press the Remote Measurement System (RMS) remote green pushbutton to switch the system on. The green pushbutton on top will light. Having the hose disconnected ensures proper measurement calibration.
3. While located within 20m of a Remote Management System (Portable unit), switch the TRIMBLE400 system on, by pressing the power button once. Select **Start** and **File Explorer** from the dropdown menu at the top left side of the screen and then select **Plexus Mobile**. The runtime software application will run and display a screen similar to Main Screen shown in Figure 3 below.

Select **Start, File Explorer** from the dropdown menu at the top left side of the screen.

Power On/Off



Figure 3 - Set Up (Trimble Recon shown)

Continued next page...

4. Move to the well to be measured, and connect the yellow pressure hose of the RMS to the bubbler tube. If the well is under vacuum, connect the blue hose to the applied vacuum port. These connections are shown in figure 4 below.



Figure 4 – RMS hose connections to bubbler, gas well head

5. Select Well Name to be measured. If no well name exists then select 'New' and enter the well information as described in Section 6 below.
6. If the well has been measured by the PLR system before and the data saved then the last reading will show on the screen.
7. Press the 'READ HEIGHT' button or the return button to take a measurement. The RMS unit pump will start and the green pushbutton switch light will flash. After a period of 5-45 seconds the remote unit will shut off and the calculated reading (depth to water surface below casing top) will be displayed on the TRIMBLE unit. The reading can be saved along with the time (and GPS coordinated if fitted) by pressing the 'SAVE DATA' button

Note – if the connection between the handheld and the RMS box is lost because they become separated further than 20m, bring the pair back within range and re-start the Plexus Controls application to reconnect.

Navigating the System

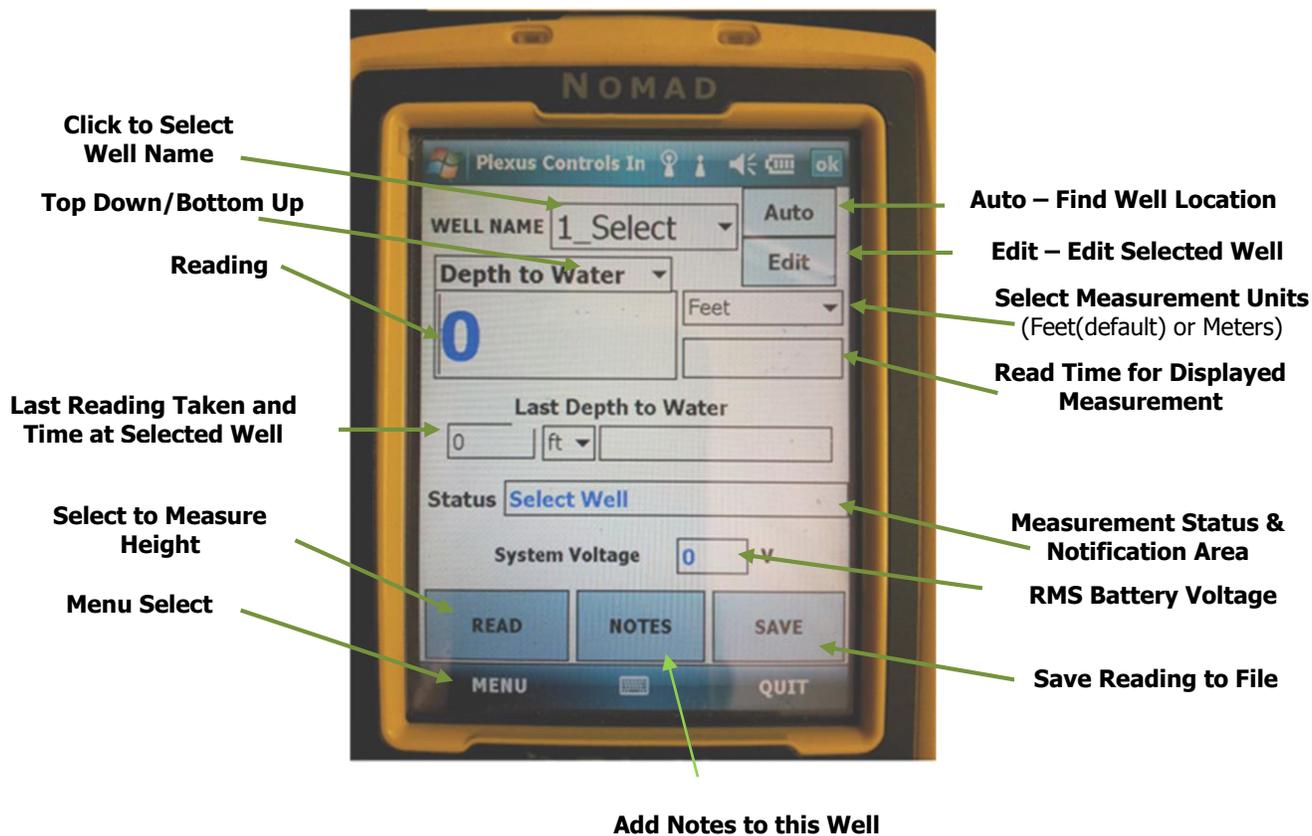


Figure 5 - MEASUREMENT VIEW (Trimble Nomad Shown)

Select Well

Click this field to select one of the following options:

1. Select a well for testing or for editing or for deleting
2. Select 2_New to generate an entry for a new well and enter its configuration
3. Select 3_Top_Det to run the top detect feature on the PLR

Auto

If the GPS option is installed (the GPS unit resides in the RMS unit) pressing Auto will identify if the well location and information resides in the handset database. The well location and information can be added to the database by selecting 'New' from the Select Well box

Edit

If the well location and information needs to be changed, select the well name from the Select Well box and click 'Edit'.

Reading (Depth to Water/Water Height)

Depth to Water: When Depth to Water is selected the displayed distance is the distance from the top of the casing to the water surface (measurement L2 shown on the diagram above).

Water Height: When Water Height is selected the displayed distance is the distance from the bottom of the PLR weight to the water surface (measurement L1 shown on the diagram above).

The measurement will be displayed in decimal feet a short time after one of the Measure depth buttons has been pressed. The measurement can take between 5 and 60 seconds to complete, during this time the value in the field will slowly change. The measurement is complete and the final measurement displayed when the Measurement Status and Notification field displays "Done!". In addition a short tone will be heard from the TRIMBLE. Note that the number displayed when the depth measurement is underway may be higher or lower than the final displayed reading. The maximum Water Height (L1) above the bottom of the PLR weight is 30 feet and the minimum is 0.1 feet.

Last Reading Height ASL

When the Well Name is selected the system will look in the database for the last reading that was taken from the well and enter in this field, along with the time and date in the Time and Date field. If no previous readings are found for the selected well then a "No reading available" message will show.

Last Reading Time and Date

This is the time and date that the last reading value was taken and saved.

Measurement Units

All readings displayed are in decimal feet by default. Readings logged in the database and recorded in the well configuration file may be decimal feet (US version) or meters (Canadian version)

Measurement Status and Notification

Various messages may be displayed in this field to assist the user understand the system and reading status. These include:

"Running..."	TRIMBLE has initiated depth measurement process with RMS unit
"Hose Connected?"	RMS unit has not detected any pressure on the high pressure hose. The hose may not be connected, or leaking or there is no water (ie water level is below the bottom of the tube)
"Hose Blocked?"	RMS unit has detected over range pressure on the high pressure hose
"Done!"	TRIMBLE has received the final depth reading from the RMS unit
"Time-out"	TRIMBLE unit has not received any notification from the RMS unit within the maximum time window (60 seconds) to take a depth reading
"GPS Time-out"	TRIMBLE unit has not received any notification from the GPS unit within the RMS unit within the maximum time window (10 seconds) to return data

RMS Battery Voltage

Displays the present battery voltage of the RMS unit. The RMS unit should be charged for 8hrs if the voltage drops below 10.5V

MEASURE DEPTH

Either of these buttons can be pressed once to initiate a depth measurement.

SAVE

Press to save the current reading to the flash memory. The reading will be added to the end of the history.csv file. The reading will also be added to the lastupdate.csv file, overwriting any existing entry for the selected well.

MENU

Select to view options below

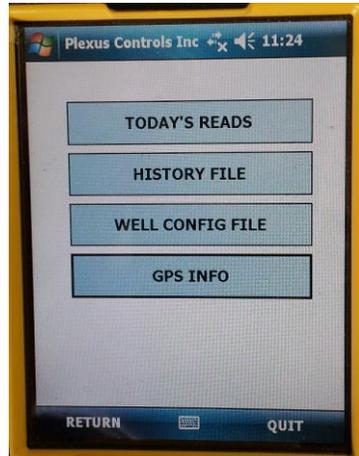


Figure 6 - MENU VIEW

Today's Reads

'Today's Reads' is a short version of the History file. Today's Reads provides at a glance all of all the well readings and notes saved on a particular day. Note that this file is automatically deleted and restarted by the system every calendar day, and if the information needs to be reviewed the History file permanently retains this data.

History File

A display of the CSV file history.csv file will be shown on the screen. All records will be displayed unless the history.csv file was transferred or deleted. The latest (most recent) record is at the bottom.

Well Config File

A display of the CSV file wellconfig.csv will be shown on the screen. The latest (most recent) record is at the bottom.

GPS Info

If the GPS option is installed in the system then this will display the current latitude and longitude geodetic coordinates (in decimal degrees format) along with other GPS status information

7.0 Entering New Well Information

Adding new well information to the handset can be done in either 2 ways:

1. Selecting 'New' under the Well Name menu and typing the information into the screen, then press 'SAVE', or
2. Loading a pre configuration file into the system flash memory

In this screen a well's information can also be edited and saved, or a well entry can be completely deleted from the file by clicking 'Delete'

1. Entering new well information directly on the Handheld system:

- a. After selecting 'New' under the Well Name menu a screen will be shown as below:



Figure 7 - ADD/EDIT VIEW

- b. Press the keyboard icon at the bottom centre of the screen and tap the cursor in the Well Name box to enter the new well name. The name can be either numbers or letters but must be limited to maximum 8 characters and cannot start with a number.
- c. Click on the 'Tube Depth BCH' box and enter the distance from the top of the well casing to the bottom of the tube in meters (or feet and inches for US version). Only a decimal number or 0 will be accepted. If 'Save' is clicked without entering any information in these fields then 0 will be auto entered.
- d. Press the 'Enter Casing Height' box and enter the height of the well casing from sea level in meters (or feet and inches for US version). Only a decimal number or 0 will be accepted. If 'Save' is clicked without entering any information in these fields then 0 will be auto entered.
- e. Enter the GPS coordinates (decimal degrees format) or press 'Get GPS Position' or leave blank (the GPS coordinated can be learned and/or entered later)
- f. Minimize the keyboard display by pressing the lower centre icon.
- g. Press the 'SAVE' button. Note if any information has been entered using an incorrect format then the status box at the bottom will display a message and the Well Configuration data will not be saved. Note that the system will not save GPS information if the system reports GPS Fix 0 or Fix 1 in the status box. The system must report GPS Fix 2 before the GPS data can be saved.

2. Entering new well information using an external file:

Well configuration data can be entered on a regular PC then downloaded into the TRIMBLE system. An example of the file data format is shown below:

```
PW1,45.28364,75.960913,0.2,2.1  
PW2,45.284088,75.961417,1.6,4.1  
PW_3,45.284645,75.962182,1.8,10.7  
Well4,45.285155,75.962485,0.5,0,3  
W_5,45.28514,75.963008,1.1,1.2  
W123,,,3.2,4.6
```

Note it is important that the file format (including the number of digits in the gps coordinates) is exactly as shown and that the file name must be wellconfig.txt. The file must be placed in the top folder in the TRIMBLE system or the system will not recognize the file.

3. Connecting to Trimble through a PC and Managing Files:

Uploading the history.csv File:

The saved data file can be retrieved easily from the TRIMBLE memory by using a USB cable. Navigate to the top view on the TRIMBLE system and look for history.csv file as follows: From the startup menu select 'File Explorer' then underneath the File Explorer title click to select 'My Device'. This is where the history.csv file may be uploaded from, or wellconfig.csv file may be uploaded to. After downloading this file it should be deleted from the TRIMBLE system or duplicate records will result. The TRIMBLE system automatically starts a new history.csv file if none exist.

Downloading a wellconfig.csv File:

A file that has been generated to hold all the well configuration data can easily be downloaded into the TRIMBLE memory by using a USB cable. Navigate to the top view on the TRIMBLE system as follows: From the startup menu select 'File Explorer' then underneath the File Explorer title click to select 'My Device'. This is where the wellconfig.csv file may be uploaded to. Note that any existing wellconfig.csv file must be deleted or the system will not run. Also note that the file format must be exactly as shown in 2. Above or the system will not run.

8.0 Top Detect Feature

This feature allows the user to measure the water level in the well and is useful to establish the tube length during the initial PLR hose kit installation. In Top Detect mode the user connects the high pressure outlet on the PLR RMS to a long tube. The tube is run down the well and the PLR system will indicate when it comes into contact with the water surface.

Top Detect can be used using the RMS unit on its own, or using the RMS and handheld together.

Using RMS Only:

The RMS automatically enters Top detect mode when the power button is pressed. The user connects a hose to the high pressure port on the RMS and runs the hose down into the well. When the tube contacts the water surface the RMS front panel light will blink rapidly. When the hose is drawn above the water surface the light will stop blinking. The RMS box exits Top Detect mode when a well is selected and a depth reading run in the normal way.

Note that the RMS unit takes a differential pressure reading on power up and then looks for an increase in differential pressure. Therefore if the water level to be detected is in a well that has a positive or negative pressure relative to atmospheric (due to vacuum or exhausting gases for example) then the Top detect feature may trigger early. To avoid this it is recommended that the negative (blue) hose is connected to the nipple fitting at the top of the well casing and the positive (yellow) hose is placed inside the top of the well casing before the RMS unit is switched on.

Using RMS and Handheld:

When 3_Top_Det is selected in the Well Name window the RMS and handheld will enter Top Detect Mode. "Top Detect Mode" is displayed in the Status bar on the handheld and in the Top Down/Bottom up window "Depth to Water" will be auto selected. Also, the user will note that the handheld emits a short beep sound once per second. Note the RMS compressor pump does not run in this mode. The user connects a hose to the high pressure port on the RMS and runs the hose down into the well. When the tube contacts the water surface the beep sound will increase rapidly and the RMS front light will blink rapidly. If the user continues to push the hose into the well the Reading field will start to increase, indicating the water height from the bottom of the hose to the water surface. When the hose is removed or drawn out of the water the beep will stop, the RMS light will stop blinking and the Reading field will indicate 0. The RMS and handheld exits Top Detect mode when a well is selected and a depth reading run in the normal way.

9.0 Entering Notes

This feature allows the user to add notes for any well location in a free text format. The notes are included as an additional column against a particular well in the downloaded .csv file. This capability allows any additional information to be captured directly in the field without having to keep paper notes. Enter all notes in the Well Notes text box. The Status box is a notification area used by the system.

The screenshot shows a dialog box titled "Plexus Controls Inc." with a close button (X) in the top right corner. The dialog contains the following elements:

- Well Name**: A label followed by a small rectangular text input field.
- WELL NOTES**: A label followed by a larger rectangular text area for entering notes.
- Status**: A label followed by a small rectangular text input field.
- SAVE** and **RETURN**: Two buttons located at the bottom of the dialog, separated by a vertical line.

Figure 8 - ADD NOTES

10.0 Loading the PLR Handset Software

This section only applies if your handset is not preloaded with the Plexus application software.

1. Connect the handset to your laptop or PC using the USB cable supplied. After a few minutes the driver software should find the handset and it will show up under the Start Menu/Computer on your machine.
Note: If the handset does not connect you can transfer the "Plexus_BTMobile_vX.X_Install.cab" and "NETCFv35.wm.armv4i.cab" files to the handset using a USB memory drive.
2. Transfer (drag and drop) both files provided to the root directory on the handset.:
 - a. "Plexus_BTMobile_vX.X_Install.cab" and
 - b. "NETCFv35.wm.armv4i.cab"
 - c. You may also need to load the Windows font type 'Tahoma' on the device. To do this, open the Windows/Font folder on you Windows PC and copy the files 'tahoma', then paste into the Trimble folder \Windows\Font. Reboot the Trimble by holding down the power button until the screen changes to show the 'Reset' button, then click 'Reset'
3. If you are using a handset with Windows Mobile 6.5 software (or later) you can miss this step and proceed to step 4.
Click on "NETCFv35.wm.armv4i.cab" and wait for the file to install. You may be asked to accept any security questions that arise. If the file is already installed cancel the installation process and move to the next step.
4. Click on "Plexus_BTMobile_vX.X_Install.cab" and wait for the file to install. You may be asked to accept any security questions that arise. If the file is already installed cancel the installation process and move to the next step.
5. The application installation is complete. Now you need to set up the Bluetooth link as described in the PLR System Quick Start section.

11.0 PLR Handset Software Upgrade

Plexus Controls provides an upgrade program that provides customers with qualified hardware to upgrade to the latest PLR operating software. The procedure for installing the software in the Windows Mobile handheld unit is as follows:

1. Open the folder My Device/Windows/Start Menu, right click the "Plexus_Mobile XX" file entry and select Delete.
2. Open the folder My Device/Programs/Plexus Controls, right click the "Plexus_Mobile XX" file entry and select Delete.
3. Plug the handheld unit into a PC or laptop (connected to the internet and running Win XP or Win7) through a USB cable. Allow a few minutes for the laptop to download and auto install the drivers if necessary. Alternatively transfer the new file(s) using a USB memory drive.
4. Transfer the new Plexus Controls .CAB file to the root ("") directory
5. Disconnect the USB cable and click on the .CAB file to install

12.0 Selecting Metric or Imperial File Entries

Before the PLR handset program is run for the first time it is possible to select data file entries in either imperial (decimal feet) or metric (meters). If your PLR system has been provided with the software pre-loaded in the handset, or you have upgraded the software then the file units will automatically default to decimal feet. Note that the Well Configuration file entries will also be in decimal feet. If you want decimal feet then there are no changes necessary, if you want the file entries to be in meters, including the Well Configuration entries then can be done by following the steps below:

1. Open the folder My Device/Windows/Start Menu, right click the "Plexus_Mobile XX" file entry and select "Delete".
2. Open the folder My Device/Programs/Plexus Controls, right click the "Plexus_Mobile XX" file entry and select "Rename".
3. Replace the "_f_" in the file name with "_m_".
4. Right click the new file name and select "Copy".
5. Open the folder My Device/Windows/Start Menu, right click below the file entries and select "Paste"

If you want to change the database units after the PLR file has been opened and run at least once, then you must first delete all user files under the folder My Device/My Documents/Plexus Controls/Mobile/.

Note that when using the PLR the displayed units always default to decimal feet, however meters can be selected on the screen, and will remain selected for the duration of the session.

13.0 Remote Measurement System Connections

Connection to the down tube for testing is made to the high pressure port. The Low pressure is used only if the top of the well is sealed and under a vacuum, otherwise leave open to air pressure.

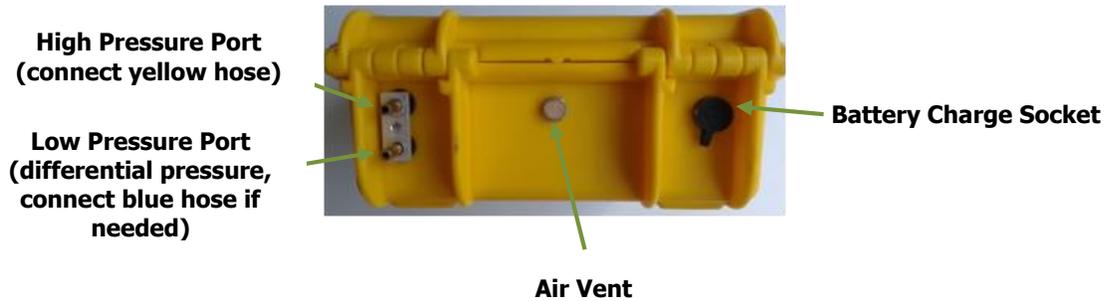


Figure 9 - CONNECTING TUBES

14.0 Troubleshooting

The Status window on the screen provides a guide to any operational errors that may be encountered. Should the system encounter an error that you are unable to recover from the following steps are recommended:

System	Inaccurate readings	<ul style="list-style-type: none"> • Check hose connections to make sure there are no leaks • Check that tube is not blocked • Check that water level measurement does not exceed 30ft (approx. 10m) above bottom of tube (measurement L2) • If well casing is sealed differential pressure may be required (connect the differential pressure hose)
Trimble Handheld	System does not power up	<ul style="list-style-type: none"> • Make sure the unit has been charged for a minimum of 8 hours. • Press and hold the power button for 3 seconds. The system will display a menu that has a 'RESET' button at the bottom of the screen. Press the reset button once and wait for the system to reboot.
	System keeps disconnecting from the PLR BT connection	Close Plexus program on the Trimble and reopen. To avoid this happening make sure the Trimble is not allowed to go to sleep when on battery power (Settings/Power/Advanced menu)
	System reports 'RMS Measurement System not Found'	Check to make sure the Remote Measurement System' is charged, switched on and in range of the handheld unit.
	System reports 'An unexpected error has occurred in Plexus_Mobile_Depth_VX.X.exe.'	<p>To recover from this error: Press and hold down the power key for a few seconds (do not hold the key down for longer than 5 seconds) then release. Select 'reset' from the menu displayed.</p> <p>To avoid this system error: Do not power down the system when the Plexus Mobile application is running. Close the application before powering down by selecting 'QUIT' before powering down (do not use 'OK')</p>
Remote Measurement	Does not power up (no green light)	Make sure the unit has been charged for a minimum of 8 hours. The charge plug must

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System		be fully inserted into the charge socket to ensure a good connection is made



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