



# Intelligent Wireless SCADA Distributed RTU Systems

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## Precision Level Reader Portable Depth Management System

### **User Guide** V3.5

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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 v3.0 (Windows 10 handset operating 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 3 components, the Remote Measurement System (RMS) and handheld portable PC platform, and the handset software as listed below:

Remote Measurement System	IP65 ABS enclosure housing the air pump, battery, pressure sensor and interface circuits
Handset	Rugged handheld unit with integrated Bluetooth radio system running Windows 10 based operating system with minimum 64MB RAM and 256MB Flash
Handset Software	Windows 10 OS PLR runtime application software for Smartphone or Tablet

## 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 10):**

1. Click the Windows icon in the bottom left corner and select the Settings icon (second from the bottom)
2. Select "Devices" and then "Bluetooth & other devices"
3. Press the ON button on the Remote Measurement unit – this puts Bluetooth into discovery mode
4. If there are any other Bluetooth devices with an RN42-xx name it is best to delete them before proceeding.
5. Select "Add Bluetooth or other device" then select "Bluetooth" at the top
6. After a few seconds the Handheld the RMS will show as RN42-XXXX where XXXX is a unique number
7. Select the device by clicking on the RN42-xxx
8. Enter 1234 as PIN and click "Connect"
9. Click "Done" then scroll down the "Bluetooth and other devices" page and select "More Bluetooth options"
10. Click on the "COM ports" tab at the top,
11. Windows automatically assigns a COM port to a Bluetooth connection. Note the COM port assigned to the Outgoing connection, you will need this at the next step.
12. Run the Plexus PLR program from the Windows menu in the lower left corner. When the main screen comes up select the COM port you noted down from step 10 above. The program will remember your selection the next time you run the program. The Bluetooth connection is now paired.

### **Loading New or Updating old PLR Software in the Handset (Windows 10):**

1. Unzip the files and folder and transfer them to the Windows 10 handset using a USB flash drive.
2. Make sure the PLR box is charged, switched on and close by.
3. Click on setup.exe. The old software will be removed and the new software installed
4. When the new software is installed it will run automatically. If you receive a message No connection to PLR or check serial port you will need to select the correct COM port (identified in Step 11 above). After selecting at the top of the software page allow a few seconds for the system to check the port allocation. This step only needs to be done once as the system will remember the correct port next time the software is run
5. If you receive any other error messages this may be due to corrupted or incompatible user files. Navigate to C:/Users/Public/Public Documents/Plexus Controls/Mobile and take a backup copy of all files. Then delete all the files in /Mobile folder and re run the PLR program from the Windows menu in the lower left corner.

### 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. Click on the Windows menu icon in the lower right corner, scroll down and click on "Plexus Controls" then select PLR\_Windows.
5. After the program loads select "New" at the top of the screen and enter the well site information. The well name "test" may already be entered and you can use this if you just want to take a quick measurement.
6. Press 'Read' to measure and display the depth. If this is the very first time the system has been used, you may need to press 'Read' twice. The Status box will provide any notifications and 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 (15ft) 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.

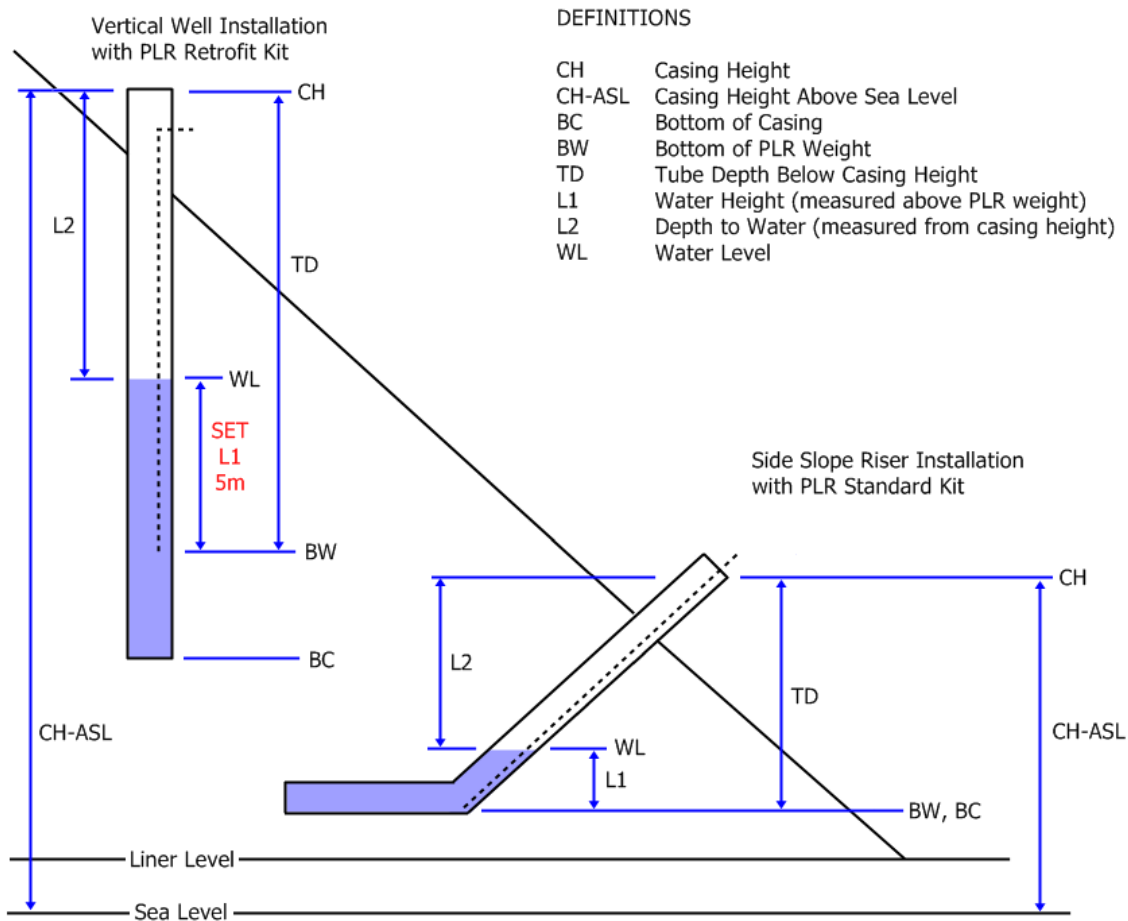


Figure 1 - Measurement References

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

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

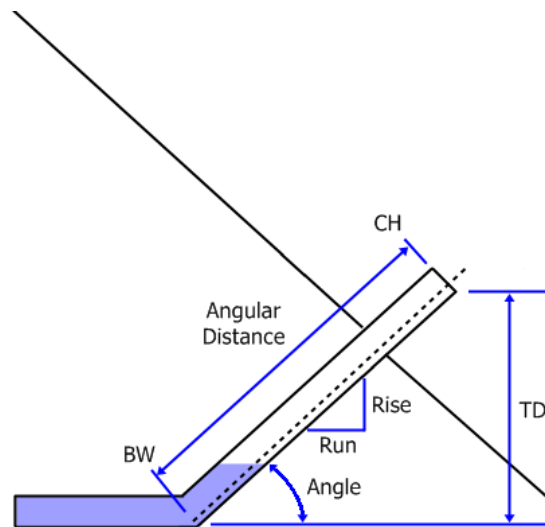


Figure 2 - Angled Casing Dimensions

An Excel spreadsheet to perform these calculations easily is available from Plexus Controls.

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

1. Make sure the batteries are fully charged by connecting the charger to the handset for a minimum of 8 hours.
2. Power up the handset
3. With the both pressures hoses open to the atmosphere, press the Remote Measurement System (RMS) pushbutton to switch at the top to switch the system on. The green pushbutton will light. (Having the both hoses disconnected on power up ensures proper measurement calibration)
4. While located within 5m of a Remote Management System select the Windows icon at the bottom left of the screen and scroll down through the programs to select "Plexus Controls" and the PLR application. The application software will run and display a screen similar to Main Screen shown in Figure 3 below.

PLEXUS CONTROLS INC

EXIT Com Port: COM8 MENU

**- PRECISION LEVEL READER -**

WELL NAME:  Auto  
Edit

Last Depth to Water

Status: Trying to connect to PLR

System Voltage:  V

READ NOTES SAVE

Figure 3 - Main Screen



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

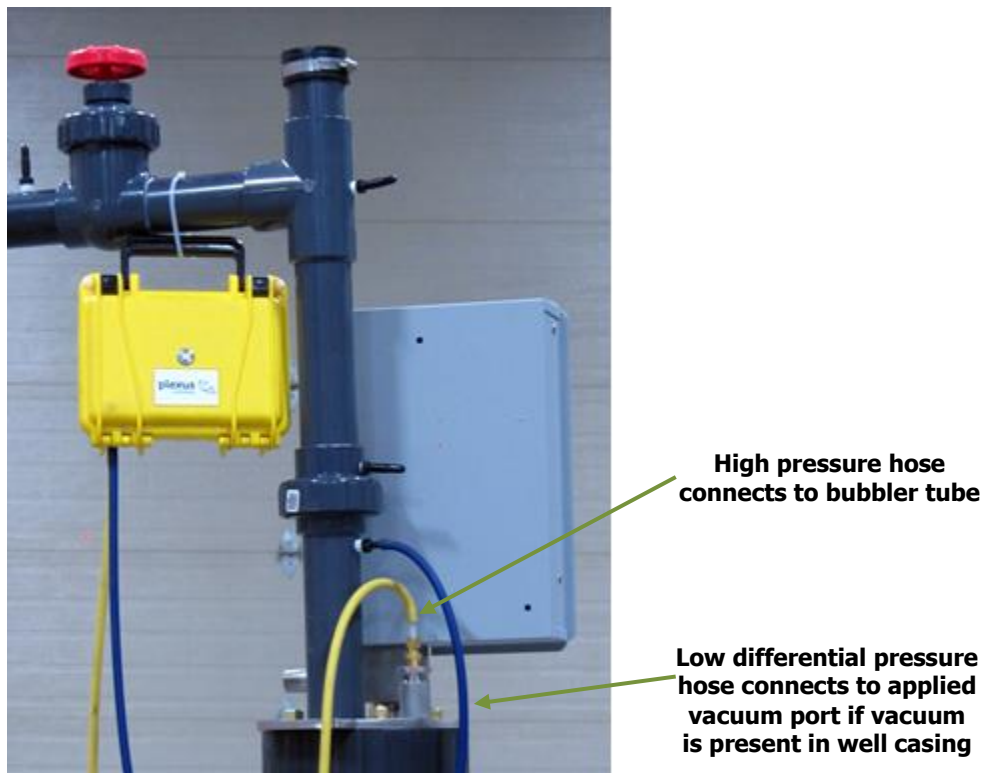


Figure 4 – RMS hose connections to bubbler, gas well head

6. 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.
7. If the well has been measured by the PLR system before and the data saved then the last reading will show on the screen.
8. 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 handset 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 handset and the RMS box is lost because they become separated further than 5m, bring the pair back within range, close and re-start the Plexus Controls application on the handset to reconnect.

## Navigating the System

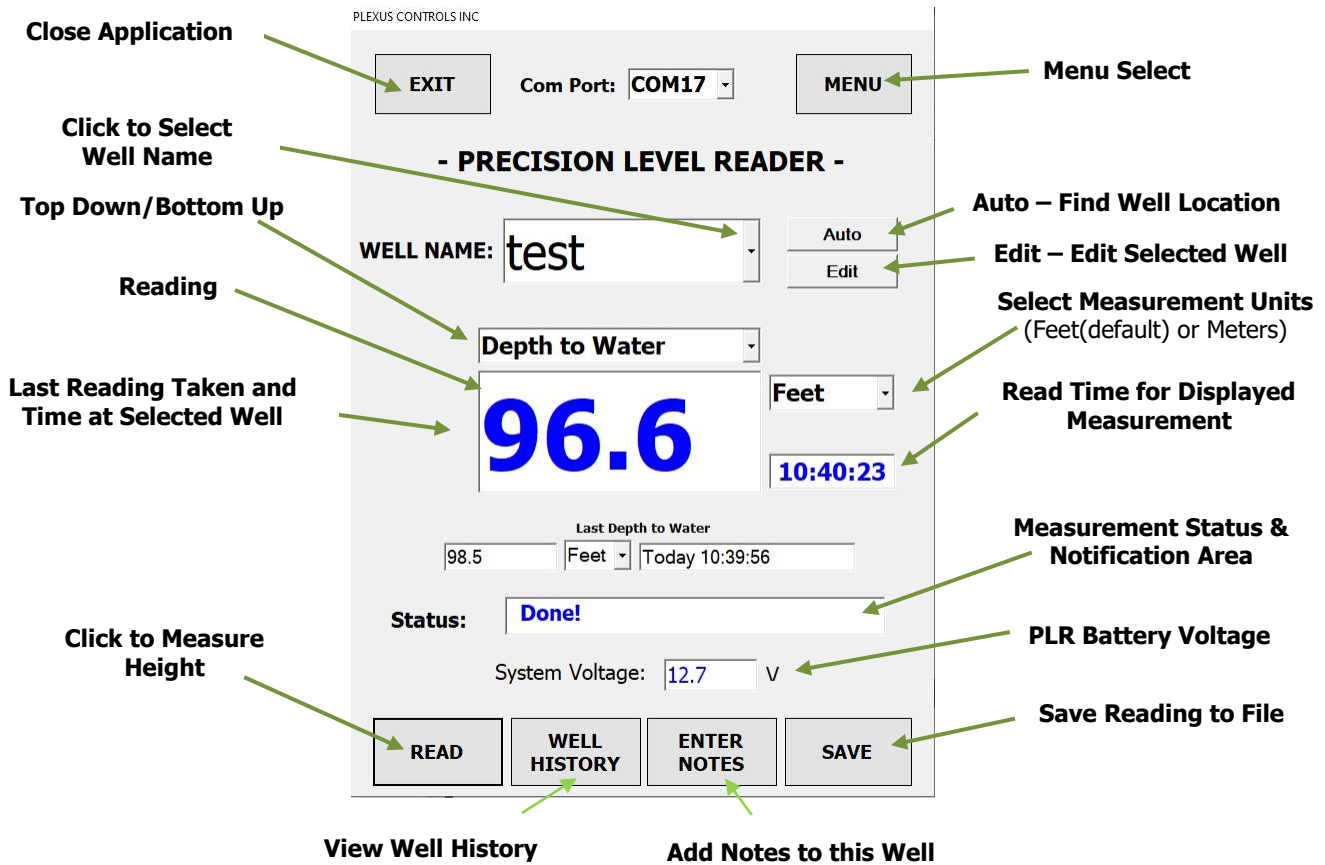


Figure 5 - MEASUREMENT VIEW

### 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 handset. 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..."	Handset 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!"	Handset has received the final depth reading from the RMS unit
"Time-out"	Handset 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"	Handset 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

## READ

Press 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

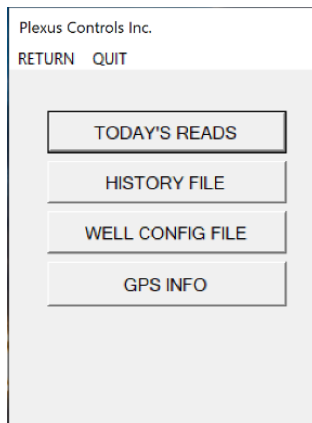


Figure 6 - MENU VIEW

### 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:

PLEXUS CONTROLS INC.

**ADD/EDIT/DELETE WELL**

Well Name:

Tube Depth BCH:

Case Height ASL:

GPS Latitude:

GPS Longitude:

Status:

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. 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 will accurately auto assign positioning to a well site.

### 2. Entering new well information using an external file:

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

```
Wellname,GPS_Lat,N/S,GPS_Long,E/W,TubeDepthBCH(ft),CaseHeightASL(ft)
Well1,45.345896,N,75.912975,W,100,200
Well2,45.340767,N,75.902982,W,120,250
Well3,45.363321,N,75.902111,W,132,220
```

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 handset or the system will not recognize the file. See the next section for information how to access internal files.

## 8.0 Transferring Files to a PC

Windows 10 application files can be managed or retrieved easily from the handset memory by uploading through the network or using a USB flash memory drive. Navigate to the correct folder as follows;

- Click on the folder icon at the bottom of the screen
- Expand the Desktop and select My PC
- At the bottom select Windows C:/Users/Public/Public Documents/Plexus Controls/Mobile

### Uploading the history.csv File:

The history.csv file or wellconfig.csv file may be copied onto a flash drive. After copying this file it the user can delete the history.csv file and the system will automatically start a new blank file, or the file can be left and new records will be added to it. Note that there must only be one history.csv file in this folder or the system will not run correctly.

### Format of history.csv File:

The data in the history file is saved in a comma separated text format. The fields are as follows:

Default Units Feet:

## Portable Level Management System - User Guide

Field	Heading Title	Description	Data Units
1	Wellname	User assigned name of well	Text
2	GPS_Lat	GPS Latitude of the well	Decimal degrees ending in "N" or "S"
3	GPS_Long	GPS Longitude of the well	Decimal degrees ending in "E" or "W"
4	TubeDepthBCH(ft)	The user entered distance between the bottom of the bubbler tube and the top of the well casing as entered by the user	Decimal feet
5	CaseHeightASL(ft)	The user entered height of the top of the well casing above sea level	Decimal feet
6	LeachateHeightASL(ft)	The system calculated height of the leachate above sea level	Decimal feet
7	Date_Time	Date and time reading was saved	month/day/year hour:min:sec AM or PM
8	Notes	Any notes typed in by the user relating to this well	Text
9	TD(ft),	The system calculated Top Down distance between the leachate level and the top of the well casing	Decimal feet
10	BU(ft)	The system calculated Bottom Up distance between the bottom of the tube to the leachate level	Decimal feet

### Downloading a wellconfig.csv File:

A file that has been generated to hold all the well configuration data can easily be copied into the flash drive and saved for backup or transfer to another handset. Note that there must only be one wellconfig.csv file in this folder or the system will not run correctly.

## 9.0 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.



## 10.0 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 software window titled "Plexus Controls Inc." with "SAVE" and "RETURN" buttons in the top-left corner. The main content area contains a "Well Name" label followed by a text input field. Below this is a large, empty text area labeled "WELL NOTES". At the bottom of the window, there is a "Status" label followed by another text input field.

Figure 8 - ADD NOTES

### 11.0 Loading the PLR Handset Software

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

Make sure you have completed the "Configuring the Bluetooth Connection (Windows 10)" in Section 4 above before proceeding.

1. Connect the handset to your laptop or PC either through a network connection such as WiFi/Ethernet or using an On The Go (OTG) USB cable.
2. Transfer all files provided to the Desktop directory on the handset.:
  - a. Application Files (application folder)
  - b. Plexus\_BTMobile\_f\_VX.X. (application file). Note that VX.X must be V6.0 or above to run on a Windows 10 platform)
  - c. setup (installation file)
3. Make sure the switch on the RMS system is ON by pressing the button on the top of the unit.
4. Click on "setup" and wait for the file to install. You may be asked to accept any security questions that arise.
5. After install the application will auto start

### 12.0 PLR Handset Software Upgrade

Plexus Controls provides an upgrade program that provides customers with qualified hardware to upgrade to the latest PLR operating software. Before installation of the new software open the handset Control Panel and select Programs. Un-install the old Plexus PLR software before proceeding with the new installation as in 10 above. Note that any user files (Well Configuration etc) will remain and are not deleted during this process.

### 13.0 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. Click the Windows icon in the lower left corner and scroll down to Plexus Controls, click to expand and then right click the "Plexus\_BTMobile f\_VX.X" file entry and select "Rename".
2. Replace the "\_f\_" in the file name with "\_m\_".

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 C:/Users/Public/Public Documents/Plexus Controls/Mobile/My Device/My Documents/Plexus Controls/Mobile/

## 14.0 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.

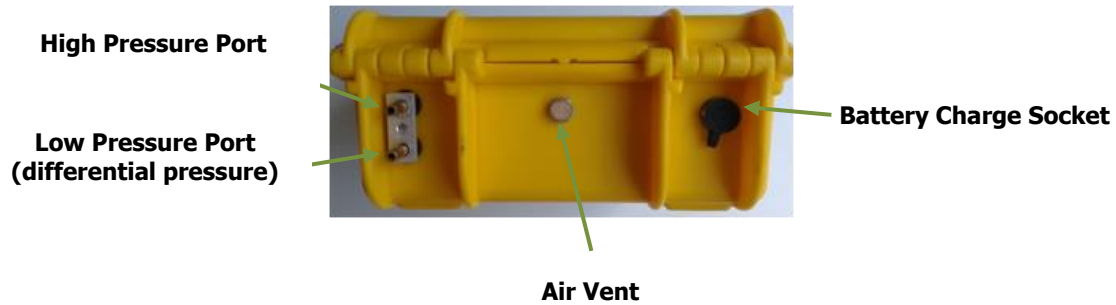


Figure 9 - CONNECTING TUBES

## 15.0 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:

<b>System</b>	Inaccurate readings	<ul style="list-style-type: none"> <li>• Check hose connections to make sure there are no leaks</li> <li>• Check that tube is not blocked</li> <li>• Check that water level measurement does not exceed 30ft (approx. 10m) above bottom of tube (measurement L2)</li> <li>• If well casing is sealed differential pressure may be required (connect the differential pressure hose)</li> </ul>
<b>Handset</b>	System does not power up	<ul style="list-style-type: none"> <li>• Make sure the unit has been charged for a minimum of 8 hours.</li> </ul>
	System keeps disconnecting from the PLR BT connection	<p>Close Plexus program on the handset and reopen.</p> <p>To avoid this happening make sure the handset is not allowed to go to sleep when on battery power (Settings/Power/Advanced menu)</p>
	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><b>To recover</b> 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><b>To avoid</b> 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>
<b>Remote Measurement System</b>	Does not power up (no green light)	Make sure the unit has been charged for a minimum of 8 hours. The charge plug must be fully inserted into the charge socket to ensure a good connection is made. The light on the charger will turn green when the charge is complete.



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