University of Idaho Boise
CENTER FOR ECOHYDRAULICS RESEARCH

Rob Green
208.364.4991
robg@uidaho.edu

River Drag Manual

The symbols used in this manual are intended to highlight risks associated with use of and maintenance of the River Drag instrumentation.

Danger describes a situation that likely could result in death or serious injury.

Warning describes a situation that could result in serious injury if proper care is not exercised.

Caution describes a situation that could result in minor or moderate injury, and could result in damage to equipment or property.

TABLE OF CONTENTS ... pg 1

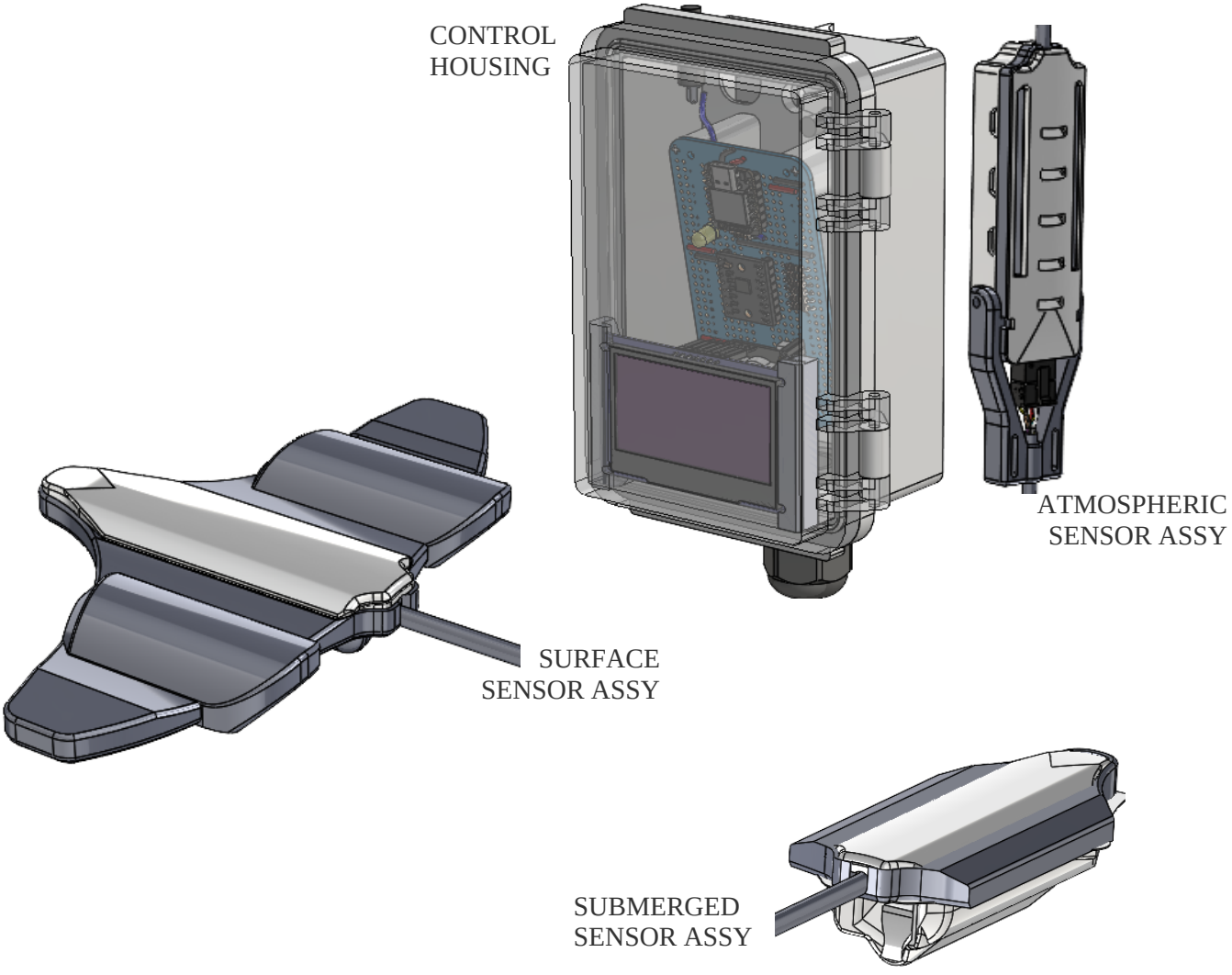
River Drag Manual

Rob Green
208.364.4991
robg@uidaho.edu

SECTION A ... ABSTRACT

The Center for Ecohydraulics at the University of Idaho has an ongoing program to provide cost effective methods for collecting field data on streambed behavior. The River Drag system is a microcontroller based device that can be used to collect streambed data at atmospheric, surface, and submerged points in an automatically timed mode, or manually on demand. A controls housing with OLED screen, provides user feedback, and stores data for later retrieval via Wifi.

Temperature and depth profiles can be developed from the stored data. While there are many data collection and retrieval ideas currently available in the literature, The River Drag system is a field ready device that can be supplied or built from open-source documentation. The River Drag system design utilizes common IOT electronics, inexpensive mechanical components, and open-source control software.



River Drag Manual

Rob Green
208.364.4991
robg@uidaho.edu

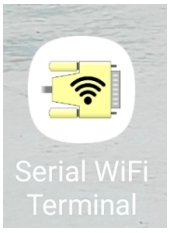
SECTION B ... INTRODUCTION

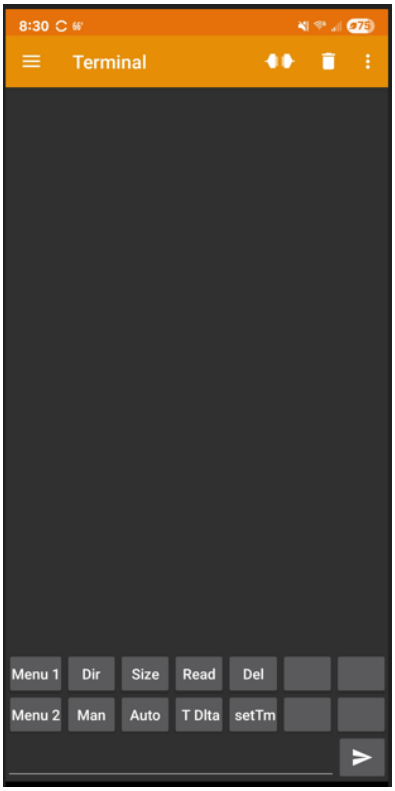
The River Drag data collection system is used to collect temperature and pressure data along a streambed. Each data point contains time, date, three pressures and temperatures. The pressure and temperature data is taken from a sensor in the atmosphere, at the streambed surface and submerged at the bottom of the streambed. Data points can be gathered based on an automatic data collection duty cycle, or based on a manual mode by actuating a record button. Data is stored internally in memory and can be retrieved via Wifi utilizing an Android app.

The controls housing contains an OLED screen that provides live feedback to the end user, as well as displaying system features and information. The OLED display show the current temperature of the submerged sensor. It also provides information about auto mode timing, recording confirmations, auto or manual mode status, Wifi mode status, as well as current date and time. It also serves to display error conditions to the end user.

The time and date are powered via a back up battery that should last years, so the recording of date and time should stay correct. The main system is powered by a LiFeP battery. The main cpu manages the battery drain and charge. However, care needs to be taken as with any Li Ion battery. More information is provided in the operating section.

The data is stored in a CSV text file format. It is retrieved by using an Android app, "Serial Wifi Terminal", written by Kai Morrich and is available on the Google Play Store for free. The River Drag specific customization file is available on Github. Figures below show the app logo, and a screen shot of the app with the River Drag customizations. A sample of retrieved data is also shown.






```
R... The file will be printed to screen now ...

2024/4/8, 14:9:50, 937.65, 23.86, 925.11, 24.37, 925.06, 24.35^M
2024/4/8, 14:10:0, 937.64, 23.86, 925.27, 24.35, 925.03, 24.33^M
2024/4/8, 14:10:10, 937.64, 23.85, 925.10, 24.37, 925.04, 24.32^M
2024/4/8, 14:10:20, 937.60, 23.84, 925.18, 24.37, 925.06, 24.31^M
2024/4/8, 14:10:30, 937.56, 23.84, 925.06, 24.35, 925.05, 24.33^M
2024/4/8, 14:10:40, 937.56, 23.83, 924.91, 24.36, 925.06, 24.34^M
2024/4/8, 14:10:50, 937.52, 23.82, 925.19, 24.34, 925.07, 24.36^M
```

Rob Green
208.364.4991
robg@uidaho.edu

SECTION C ... THEORY OF OPERATION

The River Drag system utilizes a standard microcontroller with custom software to interact with sensors and an Android phone app to collect, store, retrieve data, and control operating features of the system. There are multiple distinct functional phases to understand; system initialization, automatic data collection, manual data collection, phone app manipulation, and battery charging.

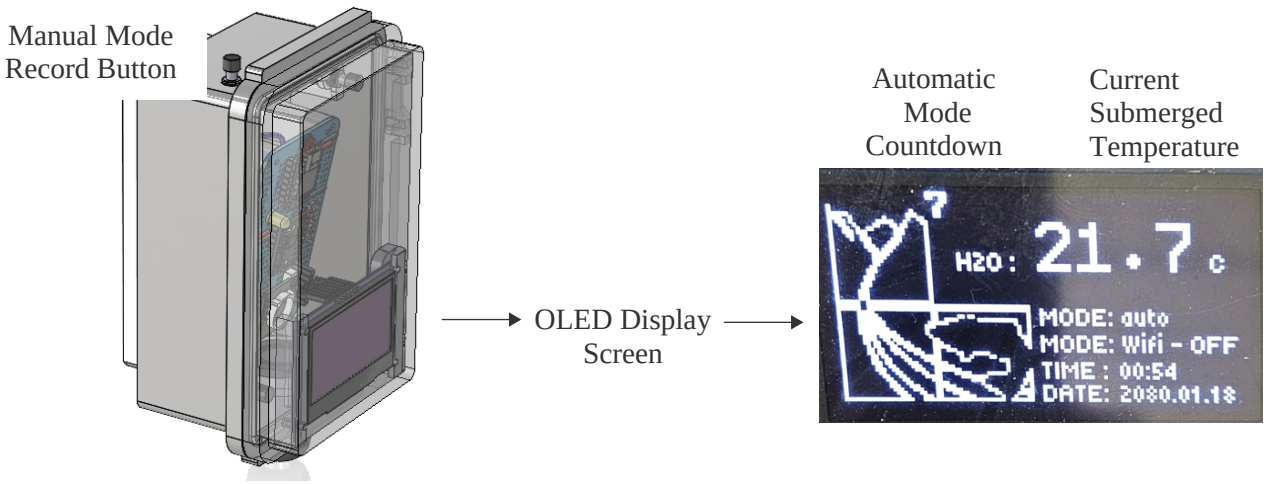
The system initialization phase follows the flowchart in fig. C.1 on the next page. The preprogrammed settings are to select the manual data collection mode for data recording. The software does look for certain failures during the initialization phase. If those occur, the display will show them, letting the user decide whether to continue, or restart the system. In addition, the software will equilabrate all sensors during the boot up phase.

There are two data collection modes. The first data collection mode is a manual mode. Figure C.2 is a flowchart showing the system steps. This mode can also be selected through the Android Wifi app. In this mode a user tells the system when to record a data point by pressing a button on top of the control cabinet. The image below shows the location of the manual record button.

The second is the automatic data collection mode. Figure C.2 is flowchart showing the system steps. This mode is programmable through the Android Wifi app. Instructions to change these settings are described in the Android app section. In the auto mode the display will show the current temperature of the submerged sensor, and the countdown to the next recording. The image below shows a sample screen operating in auto mode.

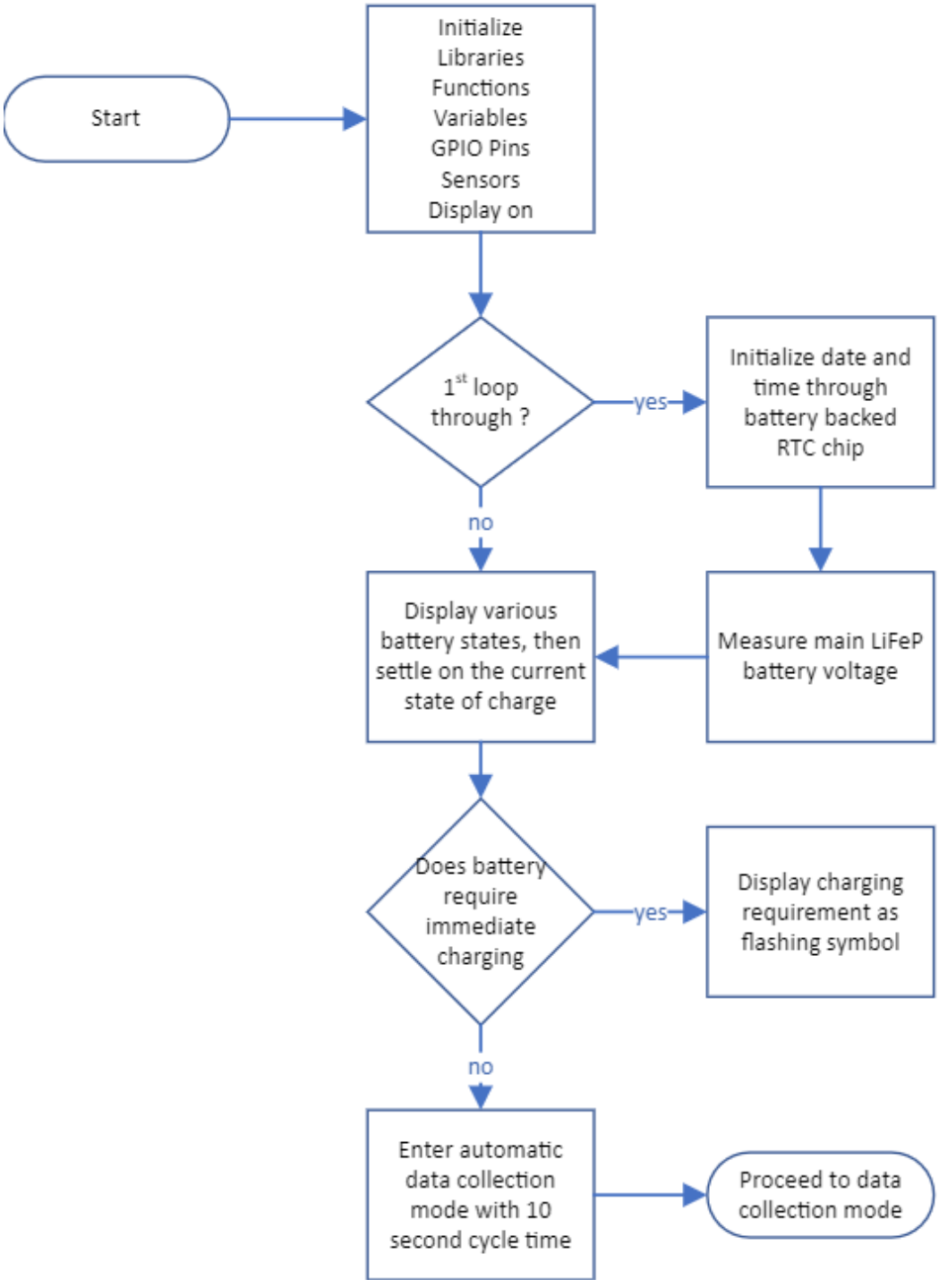
Data retrieval is executed through an Android Wifi app. Figure C.3 is a flowchart showing the system steps. A mechanical button press is used to tell the control to initiate a Wifi network named "Idahostreams". The Wifi app can be connected to this network, and the datafile read into the app, stored on the device and can then be imported into Excel or other programs.
NOTE: Data is collected in mbar and degC units.

The Android Wifi phone app is discussed in detail in scction E, later in the manual.



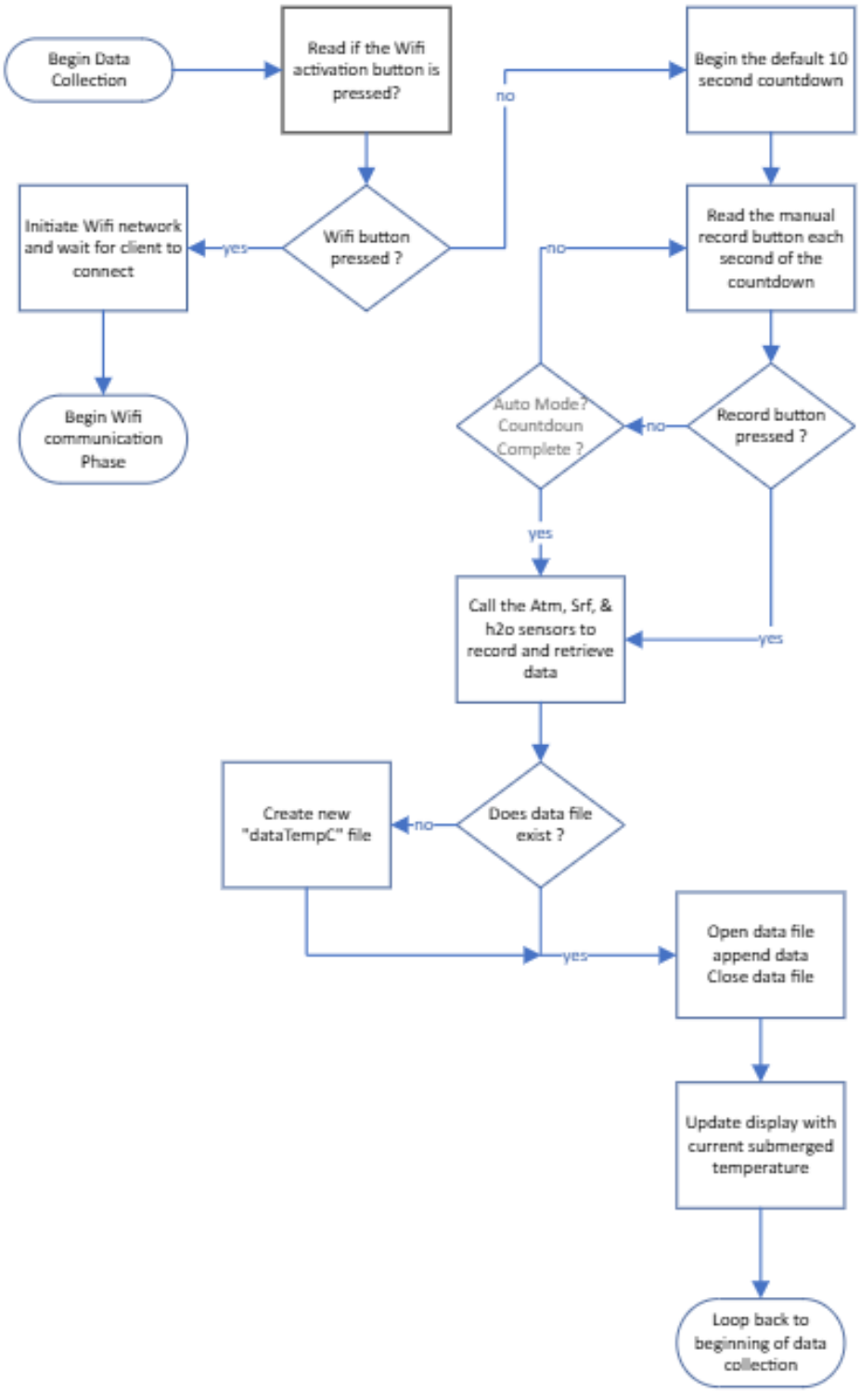
Rob Green
208.364.4991
robg@uidaho.edu

SECTION C ... THEORY OF OPERATION, Initialization Phase FIG C.1



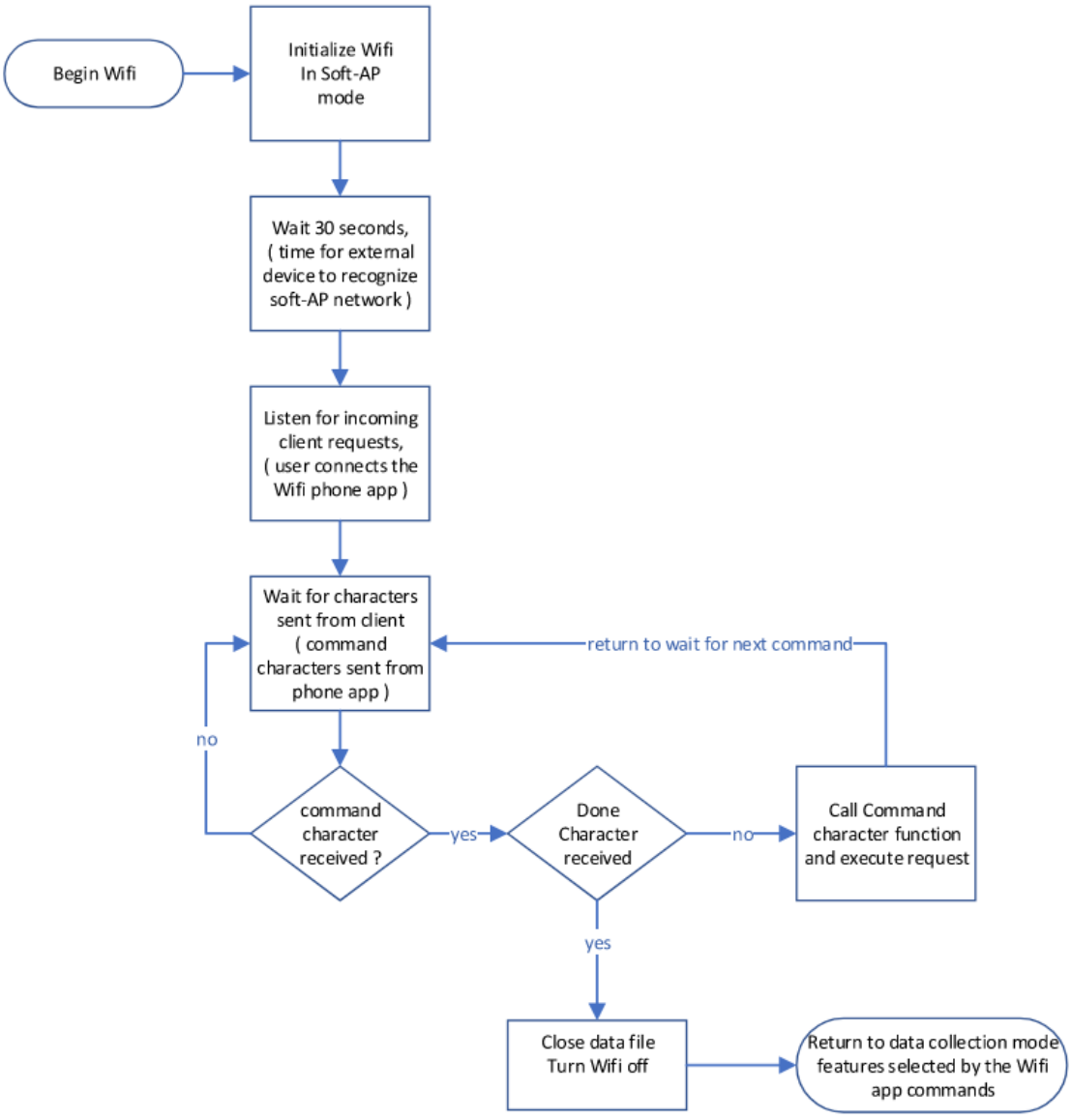
Rob Green
208.364.4991
robg@uidaho.edu

SECTION C ... THEORY OF OPERATION, Auto Data Collection Phase FIG C.2



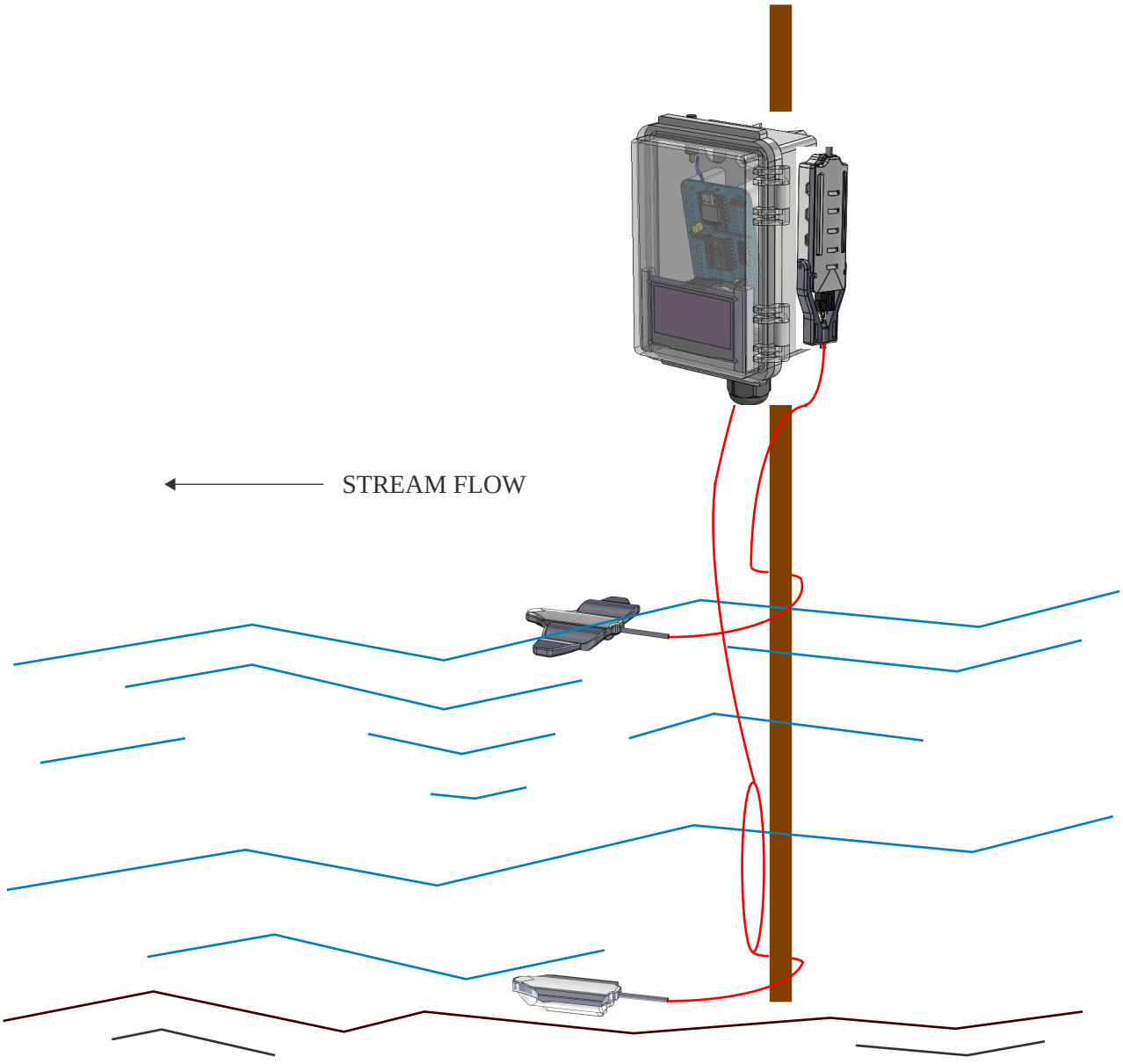
Rob Green
208.364.4991
robg@uidaho.edu

SECTION C ... THEORY OF OPERATION, Data Retrieval Phase FIG C.3



Rob Green
208.364.4991
robg@uidaho.edu

SECTION D ... OPERATING PROCEDURE: Physical Set Up



River Drag Manual

Rob Green
208.364.4991
robg@uidaho.edu

SECTION D ... OPERATING PROCEDURE: Physical Set Up

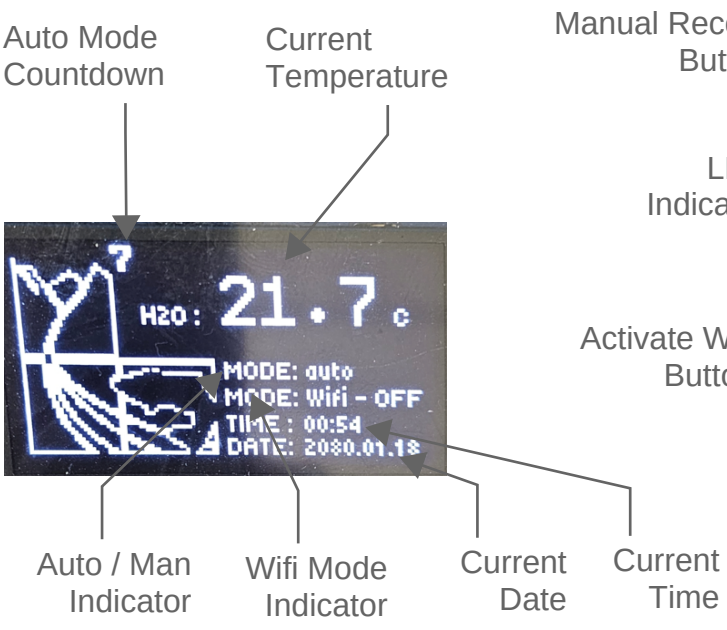
The system has three sensors. The atmospheric and surface sensors are cabled in series. There is a connector between the two sensors so the surface connector can be removed. The atmospheric sensor is permanently mounted to the control cabinet. There is significant venting in the sensor housing to provide for airflow. The submerged sensor also has a connector, though it is inside the control housing. Connectors inside the housing are present only for service.

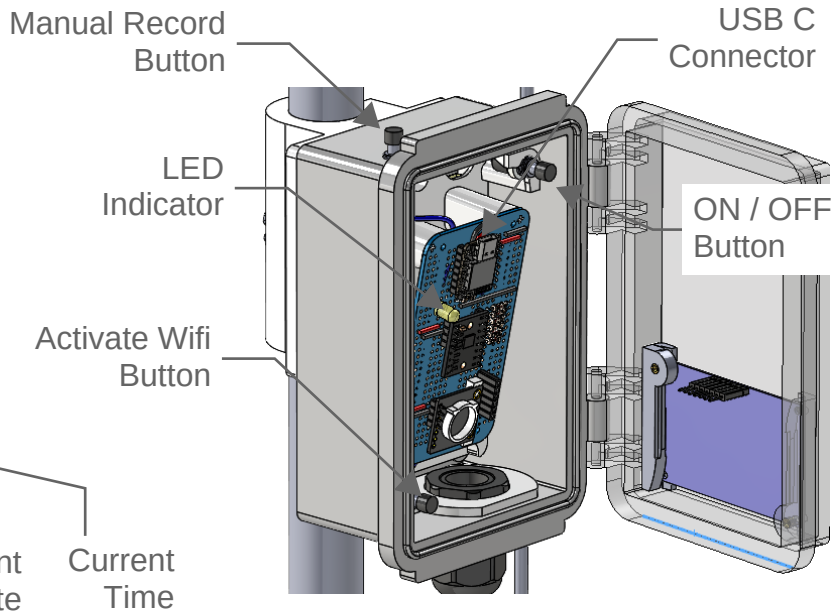
The control housing has a clamp mechanism that is used to mount the housing onto a 1" diameter pole. Once the housing is mounted, the atmospheric sensor is mounted by default, being attached to the controls housing. The surface sensor housing is hollow, so air filled, and floats. The sensor should have a tether length from the pole of around a couple feet. Any extra cabling should be coiled loosely and velcroed to the pole.

CAUTION: The cabling is carrying digital signaling, kinking or pinching the cabling can interrupt, or destroy the communications with the CPU in the controls housing.

The submerged sensor is also hollow, however, it is weighted inside, so sinks. Tether the submerged sensor out from the bottom of the pole. The sensor should be tethered out a couple feet from the pole. There will be significant extra cabling during use. The extra cabling should be loosely coiled and either velcroed to the pole, or carried. To measure deep pools, un-tether the sensor and drop the sensor into the pool.

SECTION C ... OPERATING PROCEDURE: Power Up and System Verification





Rob Green
208.364.4991
robg@uidaho.edu

SECTION D ... OPERATING PROCEDURE: Power Up and System Verification

Once the system is physically set up. The case can be opened to turn on the CPU.

CAUTION: The inside of the case is not water resistant. Take care to not open the case when there is a chance for water splashing into the housing.

Press the on/off button, then close and latch the case. The system will boot up, and display the current state of charge of the battery for a few seconds. A fully charged battery will last past any longest work day. However, it is recommended to charge the battery if the state of charge is 1 or 2 bars. There are a couple boot up errors that will display if they occur.

A) Low battery: If the battery voltage is low enough a low battery message will appear and the system will not enter data collection mode until the battery is charged.

B) No RTC: If the real time clock, (RTC), does not respond to set the correct time and date a message will appear. The system should be turned off for a few minutes, then back on.

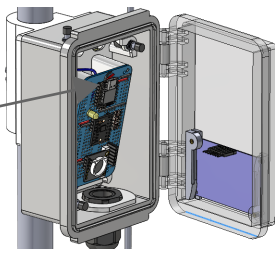
If there are no errors present the system enters data collection mode. Again, the default operating condition is to record data manually with the manual record button. If this needs to be changed, that process can be started now. It is started by pressing the Wifi button.

The system should now be running and collecting data. Status is displayed on the OLED screen and the indicator LED should blink once per second in auto mode. Each time the system records a data point the screen displays "**RECORD**".

WIFI ACTIVATION: To activate a Wifi session, the Wifi activation button needs to be pressed and held until a scheduled data record point. The software reads whether the button is pressed right after recording a data point. So, plan to press the button when the countdown timer is around 1 or 2 seconds, and hold until the Wifi indicator line shows **-on**. This should take just a second. The system features can now be revised, or data retrieved. See the Android App section for details.

CHARGING: To charge the main LiFeP battery. Turn the unit off. Then plug a usbC charger in the usbC port on the control board. The disply will initiate, then blink the battery charge symbol. When this symbol is seen, turn the unit on. While the unit is charging the screen will go blank. A small red led will blink. The led will stop blinking when fully charged. A full charge will take overnight.

USB C Charge Port



Rob Green
208.364.4991
robg@uidaho.edu

SECTION D ... OPERATING PROCEDURE: Stream Walking

During stream walking the surface sensor should be floating, tunnel side down. The sensor is in the tunnel. Note, the cable sinks, so having a short tether distance is helpful. However, can be long enough so the sensor adjusts elevation as the stream depth changes.

During stream walking, the submerged sensor is weighted and sinks. The cable is also dense and sinks. Care should be taken to avoid snagging the cable or sensor. A short tether distance helps here.

Extra cable should be attached securely yet loosely to the pole high enough to avoid snags.

The controls case should not be opened while stream walking to avoid any water damage to the electronics or battery.

The CPU has 1.5Mb of memory available for data point storage. This should be more than enough for any longest day of data collection. It is recommended though to retrieve data at the end of each day. Note, that when first beginning to use the system and developing confidence in it, data can be retrieved on an intermediate basis without deleting existing data on the system.

The battery charges at .1 amp. It is recommended to charge the system between each day of data collection. Note, the battery is LiFeP, a common lithium ion battery. There is always risk associated with charging these batteries. Use a quality USB C charger and charge in a location that does not provide a fire risk.

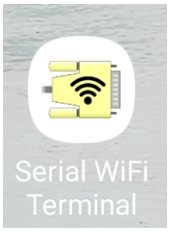
Charging the system is described in detail in Section E of the manual.

CAUTION: The manual does not contain any information regarding service. Contact should be made with the CER group at University of Idaho prior to any servicing.

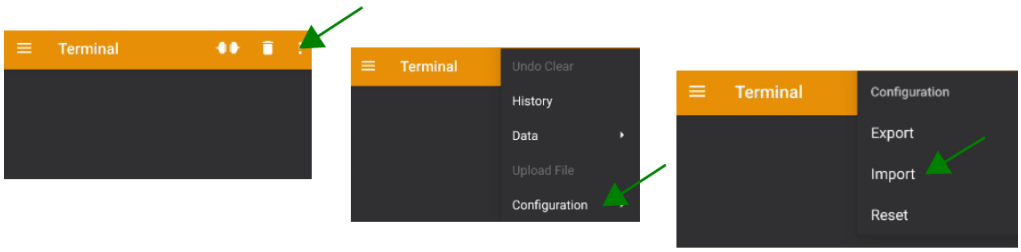
Rob Green
208.364.4991
robg@uidaho.edu

SECTION E ... ANDROID WIFI APP MANUAL: App Installation & Set Up

The Android app is available for Android devices that have Wifi. The app is customized for this Idaho River Drag project. The first step is to download the Android app. It is named "Serial Wifi Terminal", by Kai Morrich, and is available for free on the Google Play Store. The app icon is shown here. Download and install the app on an Android device that has Wifi.



Once the app is installed, it needs to be customized for this project. The customization is a file that needs to be imported into the app. The customization file is referred to as a configuration file. This file is available from Github @ Rob_Green6. Once at my Github, navigate to repositories, then Idaho-River-Drag-TP-Sensors. The direct link to this project repository on Github is in section F of the manual. The configuration file to download is "serial_wifi_terminal_cfg.txt". Once downloaded, open the app and import the configuration file following the image instructions below. When finished the app screen should contain two rows of menu buttons.

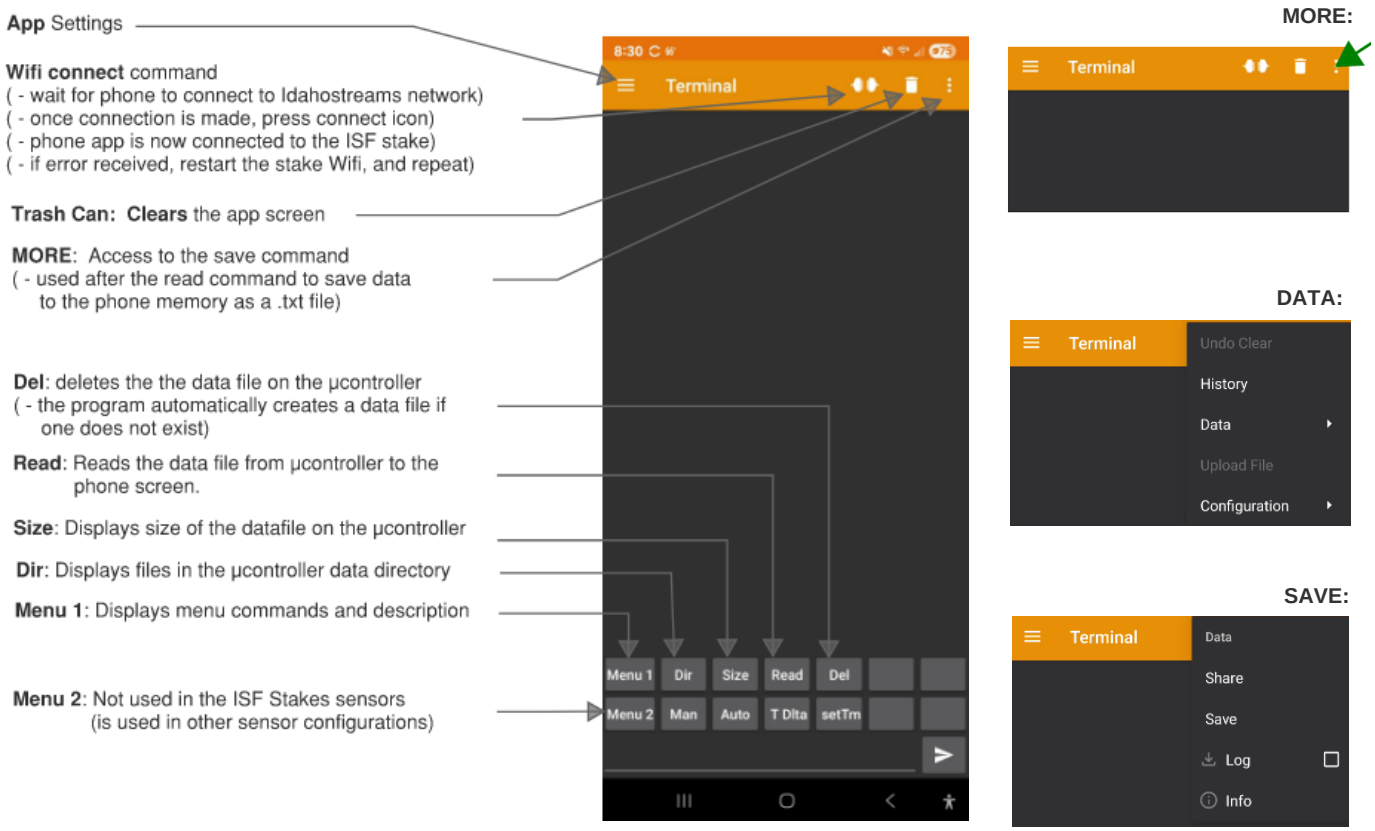


Rob Green
208.364.4991
robg@uidaho.edu

SECTION E ... ANDROID WIFI APP MANUAL: App Commands

The functions built into the app approximate simple operating system commands. The app commands are acutated by pressing one of the menu keys. This sends a letter to the CPU controller. The CPU interprets the letter received and executes a branch of code. Hence there are enough functions available on the app to perform basic file management, and control operational modes. The phone app's 1st line of menu commands are shown and described below.

a. Wifi connect icon - to initiate connection
b. Dir command- to see existing file
c. Size command- to see file size
d. Trash can - to clear the screen
e. Read- to read the data from the ISF stake to the phone
f. More- access save command
g. Save- saves .txt file to the data retrieval device
h. Trash can- to clear the screen
i. Del- to delete the file on the u-controller



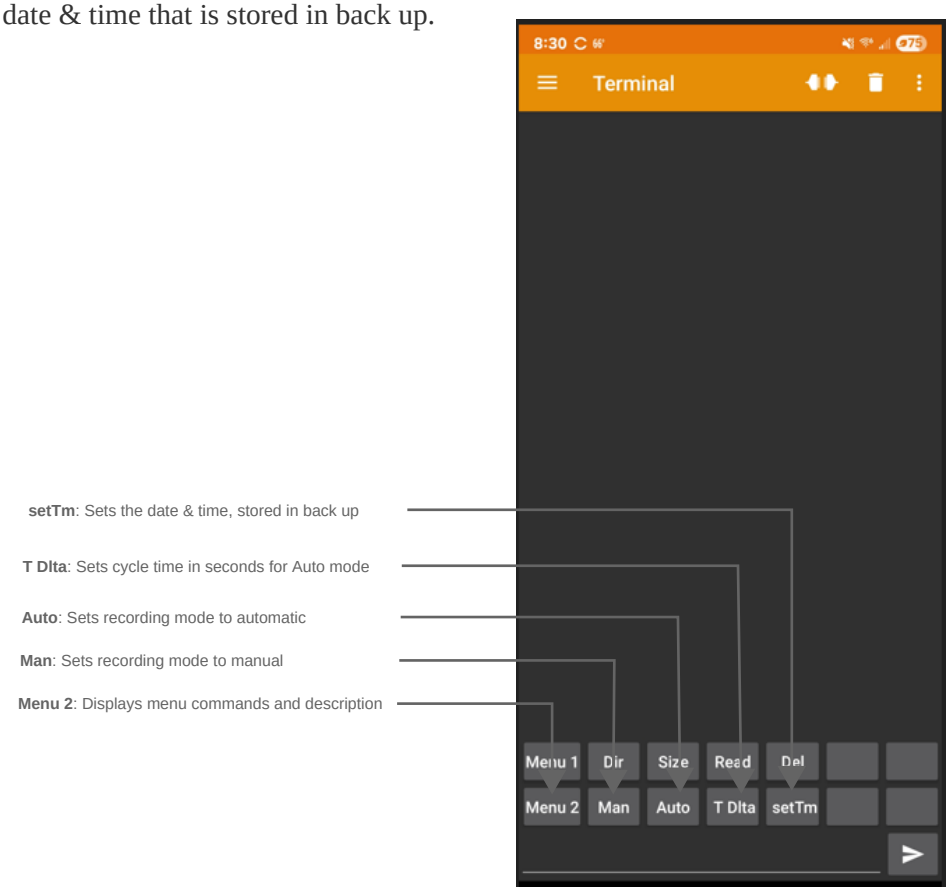
MENU 1 & TERMINAL COMMMANDS

Rob Green
208.364.4991
robg@uidaho.edu

SECTION E ... ANDROID WIFI APP MANUAL: App Commands

The phone app's 2nd line of menu commands are shown and described below.

a. Man command - Sets the data collection mode to manual
b. Auto command - Sets the data collection mode to automatic
c. T Dlta command - Sets the cycle time to collect data points in automatic mode
d. setTm command - Sets the date & time that is stored in back up.



MENU 2 & COMMMANDS

Rob Green
208.364.4991
robg@uidaho.edu

SECTION E ... ANDROID WIFI APP MANUAL: App Usage

The Android phone app is used for these main functions: Let's go over examples on how to accomplish each task.

1) Retrieve data from the CPU.
2) Use, Set and controls.

1) **DATA RETRIEVAL**:

Begin: The data retrieval process is started while the system is powered up and running. The software checks to see if the Wifi mode button is pressed at the beginning of each main loop. The user can initiate the process by pressing the Wifi start button just prior to a data recording, and holding it down for about 1 second.

Connect: The system turns Wifi on, establishes it's own network, assuming the role of server, and waits for a client to connect. It is recommended to have the Android device on with two apps running, the Serial Wifi Terminal, and the devices Wifi network settings. Have the network settings app present and look for the network "Idahostreams" show up.
NOTE: Make sure that the Android device is not currently connected to any network.
Once the Idahostreams network appears, switch to the Serial Wifi Terminal and press the **connect** command. Confirmation of a connection will be displayed on the screen. Press the **menu2** command to see a short description of the commands available.

This next steps are not neccessary, but are present for basic file management tasks. The **dir** command can be pressed to see if there is a datafile present. The **size** command can be pressed to see the size of any file present.

Retrieval: Just prior to reading the datafile from the CPU press the **Trashcan** command. This clears the screen. Next press the **read** command. The datafile in the CPU will read out to the Serial Wifi Terminal screen. Next use the **more** command in the top command bar, then select **file**, then **save**. The file will be saved to the Android device. **NOTE**: The existing datafile on the CPU is not automatically deleted. If it is desired to then delete the existing datafile on the CPU press the **Del** command.

Disconnecting Wifi: To disconnect from the TAD unit, press the connect icon, and verify that a disconnection takes place. This step is needed to return the unit to data collection mode.

CSV File Prep: The CSV datafile can be imported directly into Excel. There will be some clean up. There is an end of line character at each line. Excel find and replace function can eliminate these. There are times when a sensor may not respond properly during data collection. The software looks for these call errors and replaces them with the temperature of 1000degC, and 0mbar. If these exist, they indicate no data collected at that data point.

Rob Green
208.364.4991
robg@uidaho.edu

SECTION E ... ANDROID WIFI APP MANUAL: App Usage

2) Use, Set and Controls:

Use Manual Mode: This mode is the default mode when powered on, and constantly loops through software waiting for the manual record button to be pressed. To record a data point, press and hold the manual record button for about a second. The "RECORD" feedback is flashed on the screen, then the software again waits for another button press.

Use Auto Mode: This mode has two methods of collecting data. First, rely on the controls. To select the auto mode, Wifi needs to be activated, and select the auto mode icon in the app. A 10 second cycle time is set up as default. To change this select the T Dlta icon in the app. During operation there is "RECORD" feedback that is flashed on the screen, along with a timer countdown. In addition, even in auto mode, if the manual record button is pressed and held for about a second, the system will manually record a data point and then return to normal automatic mode starting an automatic countdown again.

Auto: This command will set the system to auto collection mode. The cycle time is not changed by this command, so the last used cycle time will still be in effect.

Man: This command will set the system to manual collection mode.

T Dlta: This command requires two steps. When the T Dlta command is pressed the screen will ask to enter a 2 digit value between 01 - 99 seconds. The value is entered in the data entry line at the bottom of the app screen. Then press send, which is the arrow at the right side of the data entry line.
NOTE: Always enter the time value using 2 digits.
NOTE: It is helpful to have the value entered into the data entry line, then press T Dlta, then be able to simply press send when the app asks for input.

Time Setting: The date & time can be set by pressing the setTm icon in the app. The date and time needs to be set utilizing a preset format.
The format is AAAA:BB:CC:XX:YY:ZZ!
YEAR:MO:DT:HR:MN:SC!
Do not forget the exclamation point.

Enter the expected date and time in the app command line prior to selecting the setTm icon. Once the setTm icon is pressed the unit will wait 60 seconds, then take the input and set the date and time to the backup chip.

Rob Green
208.364.4991
robg@uidaho.edu

SECTION F ... Links to Project Manual & Code

The following is a direct link to the Github project folder containing the project operating manual. This same folder also contains the Serial Wifi app configuration file.

https://github.com/Rob-Green6/Idaho-River-Drag-TP-Sensors/tree/main/Operating%20Instructions

The following is a direct link to the Github project folder containing the source code.

https://github.com/Rob-Green6/Idaho-River-Drag-TP-Sensors/tree/main/SRC