Battery Assure

Sensible Battery Management for Electric Cars

User Guide

MTHSystems

Copyright 2018

This document describes the installation, initial set-up and operation of the BatteryAssure System

Introduction

Congratulations on your purchase of the *BatteryAssure*™ system for motive battery monitoring. Once properly installed, your *BatteryAssure*™ will provide insight into the ongoing state of your expensive investment in your Golf Car batteries.

Features:

- Wireless monitoring of electric vehicle battery packs that can be used to track battery performance.
- Assists in achieving full useful battery pack life and identifying packs which may require early replacement
- Fleet Management Application capable of supporting a small 2 or 3 car fleet up to a full golf course sized fleet (50 to 80 cars).
- Bluetooth between Sensor and Android smartphone/tablet expedites car checkout and return.
- Easy one-time fleet configuration using RFID tags: Just tap the Sensor RFID tag, enter a few battery pack values and you'll ready to go.
- Easy Sensor installation. No electrical connection to high current wiring, Simple pass-through installation of drive controller and charging circuit wiring.
- Flexible installation on either Positive of Negative power leads for car controller and charging circuits; Solutions using current shunts MUST be installed on Negative leads.
- Powered by car battery pack connected by small gauge (18 AWG) wiring.
- Non-permanent installation allowing transfer to another car as fleet is upgraded: Maintains customer investment in *BatteryAssure*™.
- Can be installed on a variety of cars from different manufactures
- Supports 24 Volt, 36 Volt, 48 Volt and 72 Volt Lead Acid battery packs. Additional battery pack voltages supported upon request.
- Supports Flooded Cell, Sealed (low maintenance), Gel, and Absorbed Glass Matte (AGM) battery types.
- Extends the useful life of pre-electronic-control golf cars.

Disclaimers

The *BatteryAssure*™ Sensor device is intended to be installed only on golf cars/Neighborhood Electric Vehicles (NEV)/Low Speed electric Vehicles (LSVs) that are stored inside or under a shed and not subject to harsh environmental conditions. For battery powered maintenance vehicles left outside on a regular basis or routinely driven across very rough terrain, a special-order version is available.

Table of Contents

Product Overview

The *BatteryAssure*™ System is comprised of two components:

1) a Sensor installed on the primary current carrying conductors that supply the controller/drive motor and the charging circuit, see Figure 1, and

2) a fleet management application called *GC Fleet Assistant* installed on an Android smartphone or tablet; Apple iPhones will be supported in the future.

The Sensor measures primary current, voltage, and aggregate power consumed over time (WattHours). It relays this information wirelessly to the *GC Fleet Assistant* application. Each Sensor device has flexible installation capabilities. It also features a built in LCD display useful for direct observation by fleet management staff and to assist troubleshooting if needed.

GC Fleet Assistant can be used in ***Personal*** mode where it accompanies the car throughout its workday shift and provides minute by minute logging of car speed, distance travelled and performance. This mode of operation is useful tracking the performance of a single car or small number of cars. The other mode is called ***Fleet*** mode which is used to track and manage a large number of cars. In this mode of operation, key metrics are recorded when the car leaves in the morning for its shift (*check-out*) and collected again at the end of the shift (*check-in*). When coupled with the record from the previous days *check-in*, the morning *check-out* process can identify over-night charging issues. *GC Fleet Assistant* is designed to expedite both the *check-out* as well as the *check-in* process.

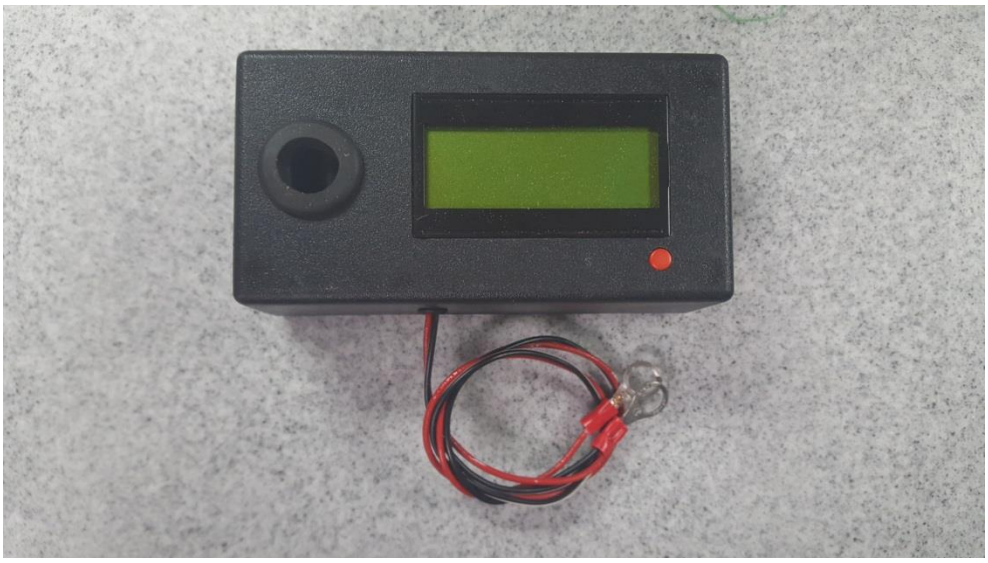


Figure 1 – *BatteryAssure* Sensor

Installation

Installation consists of installing a Sensor on each car in the fleet and then installing the application on a smartphone or tablet. After the application is installed, it must be configured. Depending on the fleet size, there are several methods that may be used.

Sensor Installation

Sensor installation has several steps:

1. Select an appropriate location where the Sensor will fit next to the battery pack without obstructing other important car systems or wiring. It can be installed on the Negative or Positive lead, or anywhere in the string of batteries that comprises the battery pack; wherever is most convenient. It is important to note the direction of the arrow labelled on the Sensor. In general the arrow should point in the direction of the largest current flow. For example, when the car is driven, current flows from the Positive battery terminal to the Negative battery pack terminal. In this case you want the arrow on the Sensor to point away **FROM** the Positive pack terminal **TO** the Negative pack terminal.

> **Tip:** If it is not possible to achieve this orientation, the current flow directionality can be reversed in a *GC Fleet Manager* Setting. See the section below on **Operations**

2. Disconnect all wire leads from the Negative (or Positive if chosen) battery terminal and thread the lead with the thickest wire (typically 4, 6, or 8 AWG) first and the thinner wire (e.g. 10 AWG for charging circuit) next. It this proves difficult, reverse the order, but experience has shown routing the thickest lead first and the thinner lead next works best.

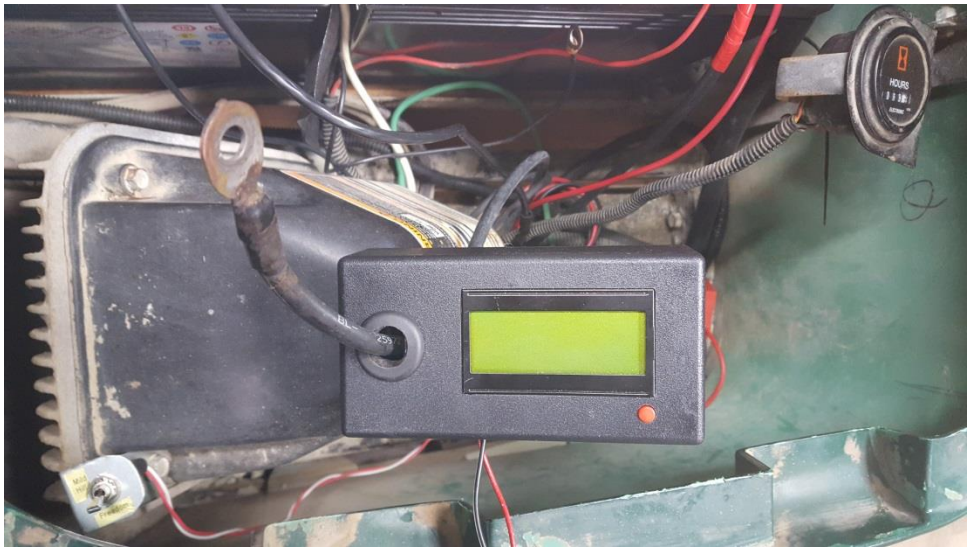


Figure 2 – *BatteryAssure* with the Primary drive/controller conductor threaded through

Tip: if you find it difficult to push a particularly wide ring lug through the rubber grommets, you can fashion a "hook" from a scrap piece of wire or use string to pull the conductor through

Tip: It is also possible to remove one or both rubber grommets from the Sensor housing and thread a grommet on the leads first, thread the leads through the Sensor housing, and then thread through the second rubber grommet afterwards. The rubber grommets can then be re-installed on the Sensor housing. The fitting is supposed to be snug.

Tip: It may be necessary to flatten the battery ring lug; this can be achieved by compressing the lug in a pair of pliers or ViseGrips.

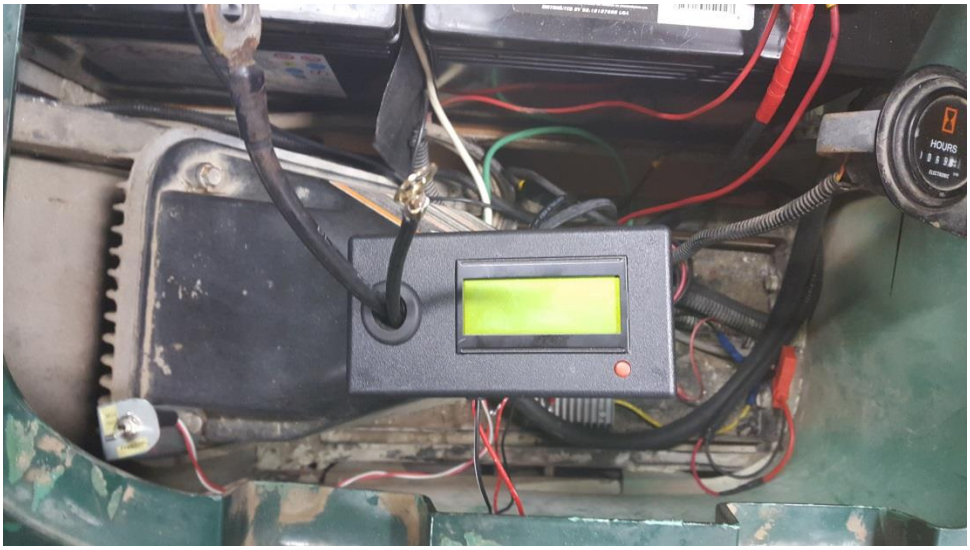


Figure 3 – *BatteryAssure* Sensor with the charging circuit conductor threaded through

3. At this point, all the leads attached to the Negative pack terminal can be reconnected. The black thin gauge wire from the Sensor housing should be also connected to the Negative pack terminal at this time as well (or red wire to the Positive pack terminal if the Sensor is installed on the Positive lead). Note that auxiliary leads are NOT routed through the Sensor. These should be low current or intermittent loads such as lights or hour meter.
4. Connect the thin red wire from the Sensor housing to the Positive pack terminal (or black wire to the Negative pack terminal if the Sensor is installed on the Positive lead).

Figure 4 – *BatteryAssure* Sensor installation complete

Sensor installation is now complete. The LCD display on the Senor should be showing the battery voltage as well as some other information by default. If the battery pack voltage is not showing, repeatedly press the red button until the battery pack voltage is shown. The Sensor LCD display has a number of "pages" that can be scrolled through using the red button. More detail about LCD display pages can be found in the ***Operation*** section of this user guide.

Tip: The Sensor can be secured to the primary power conductor and charging circuit conductor by using a 10" cable tie, and wrapping it around conductors where they enter the Sensor underneath, up along the narrow Sensor side, around the conductors exiting the Sensor, back down the narrow side, crisscrossing the cable tie and back to where you started (forming a figure 8); snug it firmly. See Figure 5

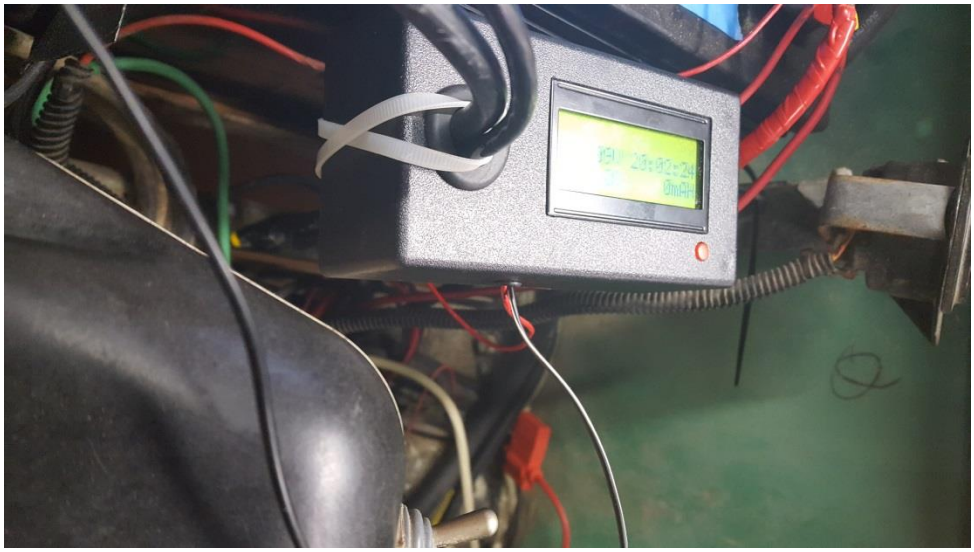


Figure 5 – Using a cable tie to secure the Sensor

RFID Tags

Each Sensor is shipped with two RFID tags; one is mounted on/inside the Sensor, the second can be mounted on the car in a convenient location, but out of the weather. The RFID tags are used only during initial set-up. It is required that the smartphone have N**ear Field Communication (NFC)** capability to use the RFID tags; some less expensive smartphones do not support this feature, so check your settings for this.

The smartphone will only recognize RFID tags when the smartphone or tablet is brought within an inch or so of the tag. Since the sensor is mounted somewhere in the car battery compartment, it may be inconvenient to access this location; the second RFID tag is provided so it can be mount in a more accessible location should it be necessary to reinitialize Sensor information in the smartphone.

> **Tip:** The second RFID tag should be mounted where it is not directly exposed to sun or rain, such as under the canopy, underneath the seat or inside the wall of the battery compartment. It is best to secure the tag with waterproof tape so moisture does affect the tag adhesive.

Application Installation

Currently the *CG Fleet Assistant* application is downloadable for our website at:

http://mthsystems.com/download.html

User opt-in for installing unknown apps

Android protects users from inadvertent download and install of *unknown apps*, or apps from sources other than Google Play, which is trusted. Android blocks such installs until the user opts

into allowing the installation of apps from other sources. The opt-in process depends on the version of Android running on the user's device:

- On devices running Android 8.0 (API level 26) and higher, users must navigate to the *Install unknown apps* system settings screen to enable app installations from a particular location, as shown in Figure 6.
- On devices running Android 7.1.1 (API level 25) and lower, users should enable the **Unknown sources** system setting, found in **Settings > Security** on their devices.

  Note: When users attempt to install an unknown app on a device running Android 7.1.1 (API level 25) or lower, the system sometimes shows a dialog that asks the user whether they want to allow only one particular unknown app to be installed. In almost all cases, users should allow only one unknown app installation at a time if the option is available to them.

In both cases, users need to complete the opt-in process *before* they can download and install unknown apps onto their devices.

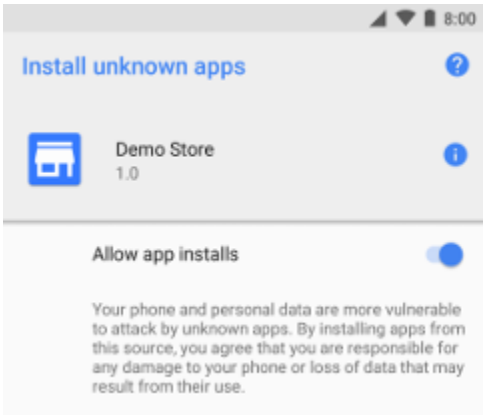


Figure 6 The *Install unknown apps* system settings screen, where users grant permission for a particular source to install unknown apps.

Application Configuration

Application Configuration can be performed in one of several ways depending on use and fleet size. In general, Application configuration is a one-time procedure; after initial set-up, all important Sensor information is store in the smartphone/tablet.

1. Use RFID Tags – this is the recommended way for small to medium sized fleets where only a single smartphone or tablet is used to manage the car fleet. This method is also useful to get started quickly. It can be used in conjunction with a manifest file
2. Use a manifest file – this method is recommended for large fleets or where multiple Android devices will be used by different personnel. There is one centrally managed manifest file used on all devices.
3. Ad-hoc method – this method is useful when your smartphone does not have a **Near Field Communications (NFC)** capability. With this method, you simply walk up to a cart with a Sensor already installed and scan for its address, matching the address label on the Sensor to the device found in the *GC Fleet Assistant* application. Then enter the battery back information and you are done.

Use RFID Tags

The two RFID Tags shipped with each Sensor contain operating parameters such a hardware version, device address, operating voltage, and current measuring capacity. Of these, the device address is most important.

To set-up the *GC Fleet Assistant* without a manifest file (described in the next section), the fleet operation personnel taps the Sensor of alternate RFID tag with his/her smartphone until an audible alert is heard; The application then switches to the **Battery Pack Profile** Settings screen as shown below.

Battery Pack Profile Settings

Battery Pack Profile for xx:yy:zz:aa:bb:cc (where xx:yy:zz:aa:bb:cc is the hardware address)

Current Sensor Name is 'XXXXX' – Presents a dialog bog to enter a new user-friendly name if one does not already exist or change the existing name.

System Voltage - Presents submenu to select the battery pack voltage, i.e. the sum of all batteries in the battery string, Selections are*: Auto-detect , 12 Volts, 24 Volts, 36 volts,* and *72 Volts. 48 Volts* is the default setting.

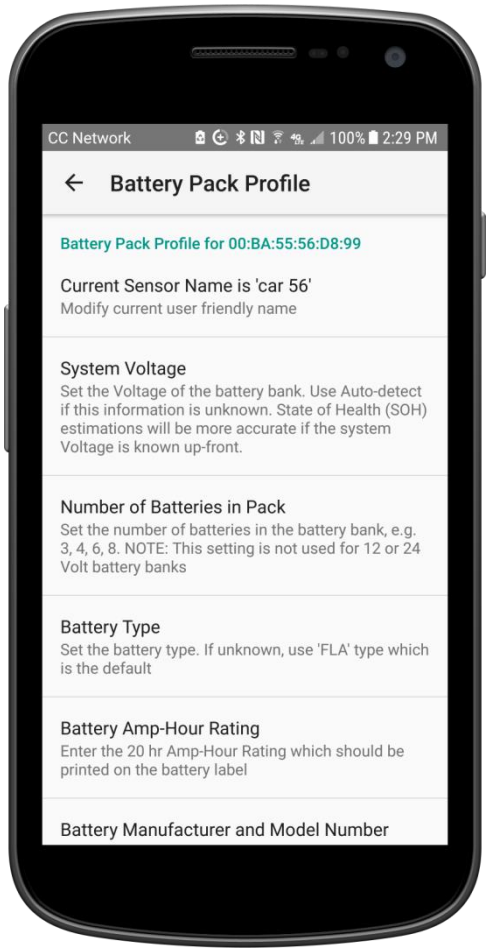
Number of Batteries in Pack – presents a submenu to select the number of batteries in the pack string (i.e. wired in series). Selections are: *3 Batteries, 4 Batteries, 6 Batteries,* and *8 Batteries.* The default is *6 Batteries.*

Battery Type – Submenu to set the battery type of *FLA* (Flooded Lead Acid), *AGM* (Absorbent Glass Mat), and *GEL* (Gel Cell). *FLA* is the most common type and is the default.

Battery Amp-Hour Rating - Selecting this setting opens a dialog into which a numeric value must be entered. This is an estimated value derived from the **System Voltage** and **Number of Batteries in Pack.** It is an average value based on manufacturer-stated battery specifications. Since this value

varies considerably between manufacturers, it is best to enter exact information specific for your batteries.

Battery Manufacturer and Model Number – Presents a dialog box where the battery manufacturer and model number of your installed batteries can be entered.



Battery Pack Profile

Once the settings for a Sensor have been established, it should be tested by following the instructions in the section for Ad-hoc Use. After testing your first sensor you can proceed to add additional sensors in the san=me way.

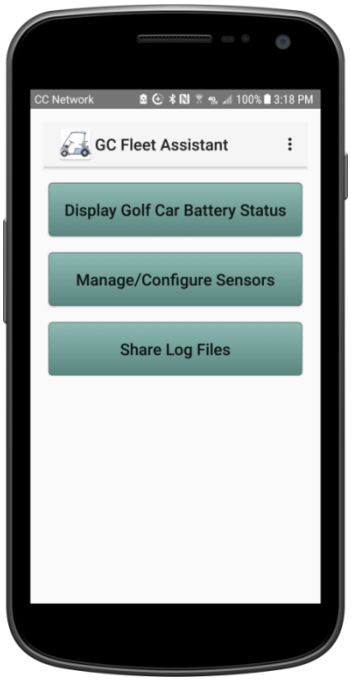
Use a Manifest File

The use of a manifest file is recommended for large fleets (50-70 cars). Further, it is recommended that the manifest file be created and maintained on a central office PC system so there is a backup copy in the event the smartphone(s) is/are lost or rendered inoperative. In this case, the manifest can be used to restore fleet information. See Appendix A for configuration through the use of a manifest file.

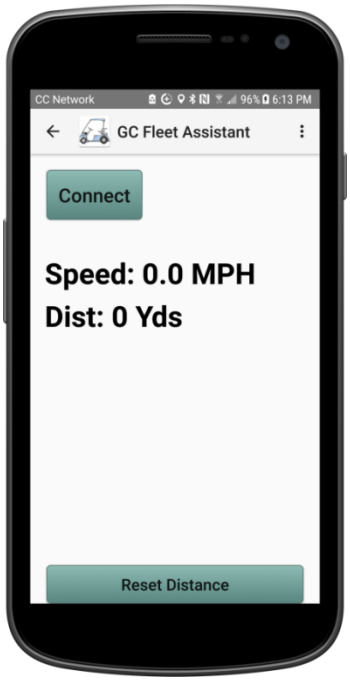
Ad-hoc Use

Ad-hoc usage is a simple and fast way to get started if your smartphone doesn't support **Near Field Communications (NFC)**. It works best when you have only a single Sensor installed. The basic process:

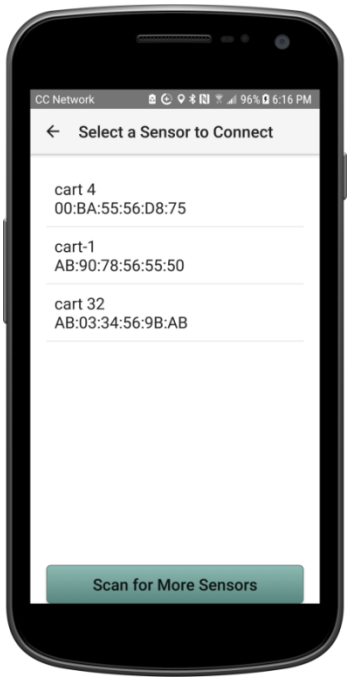
1. Select **Display Golf Car Battery Status** from **Main Menu,** then the **Connect** Button
2. .Select **Scan for More Sensors.**
3. Several new devices are discovered. The one we want is **SPP-CA** which is a standard name for new Sensors. Select **SPP-CA** to connect to it.



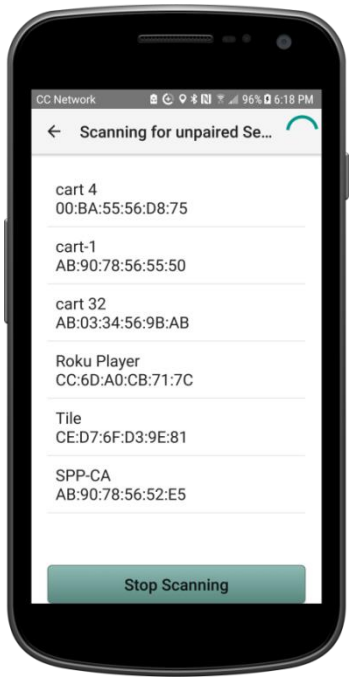
Main Menu



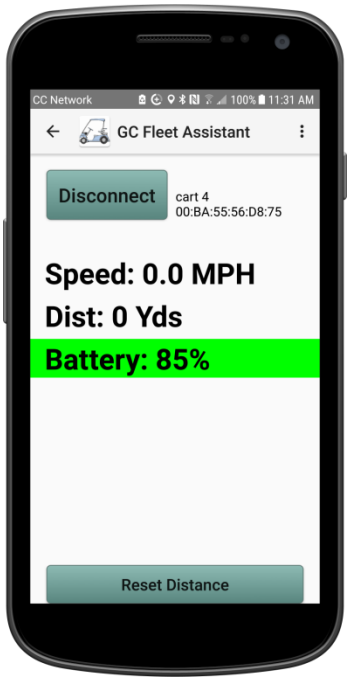
Connect to Sensor



Select a Sensor



Scan for More Sensors



Connected

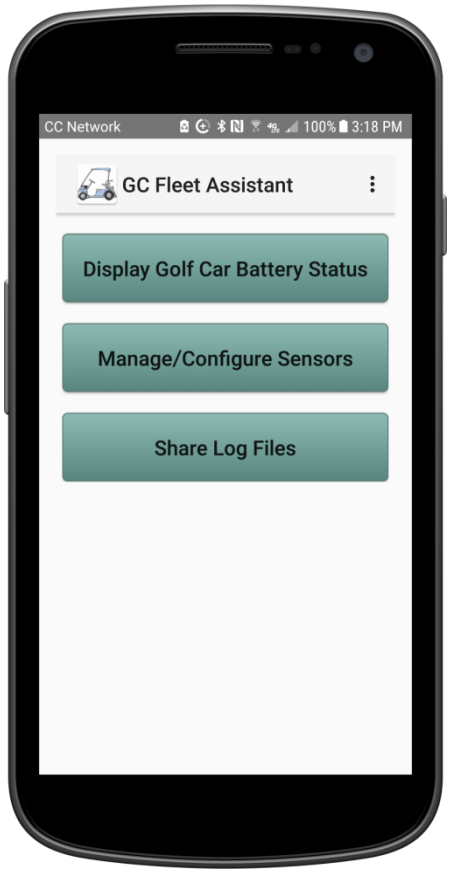
Operation

BatteryAssure™ operation consists primarily of using *CG Fleet Assistant* to discover, pair and connect to Sensors installed in the golf car fleet. *BatteryAssure*™ uses Bluetooth technology to wirelessly connect to each Sensor. *CG Fleet Assistant* can connect to a single Sensor at a time.

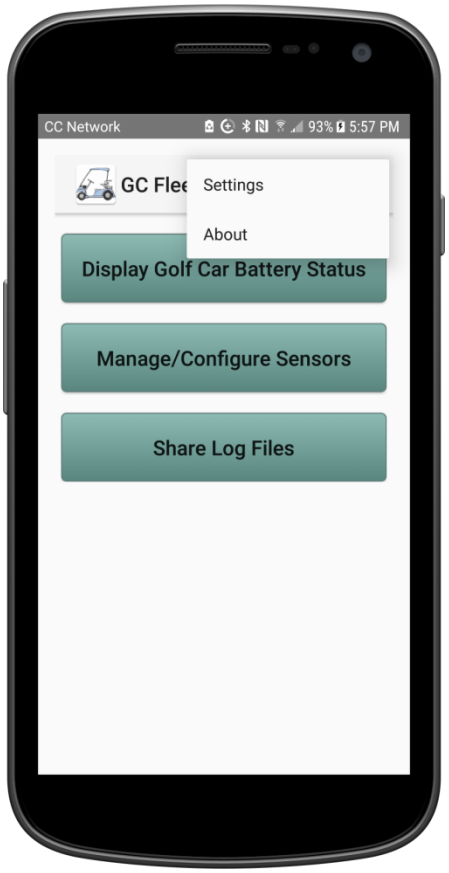
Top Level Menu

The Top level menu is the starting point for all further action in *CG Fleet Assistant.* From here you can access the **Display Golf Car Battery Status** menu, **Manage/Configure Sensors** menu, and **Share Log Files** with other fleet operations personnel and systems. In addition, there is an extensive set of Preferences or Settings that can be changed.

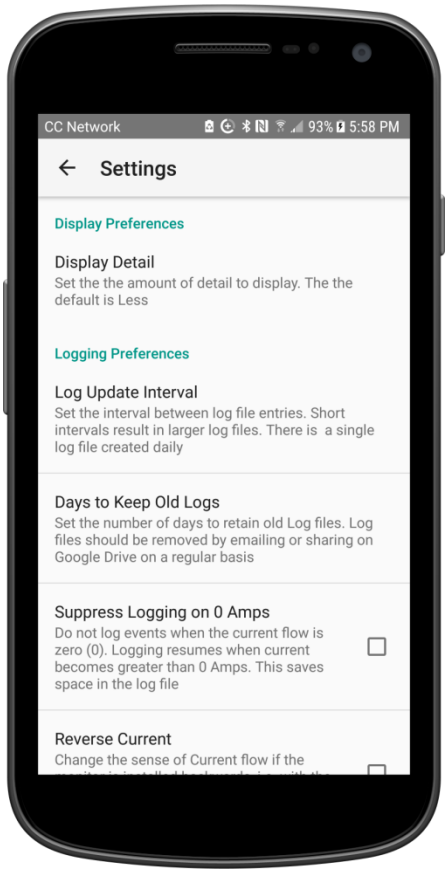
The **Settings** menu can also be accessed by selecting the three vertical dots in the upper right corner, then select **Settings.** Let's set the application's settings first. **Settings** are broken into three categories, those that influence the golf car monitoring display, those settings that change logging behavior, and those preferences that influence Configuration Management tasks.



Main Menu



Main Menu - Settings



Configuration Management Preferences Menu

Settings

Display Preferences

Display Detail – Presents submenu to select how much detail to display on the sensor status screen. The choices are: *Less, Medium,* and *More.* The default is *Less* which is the recommended level of detail to display.

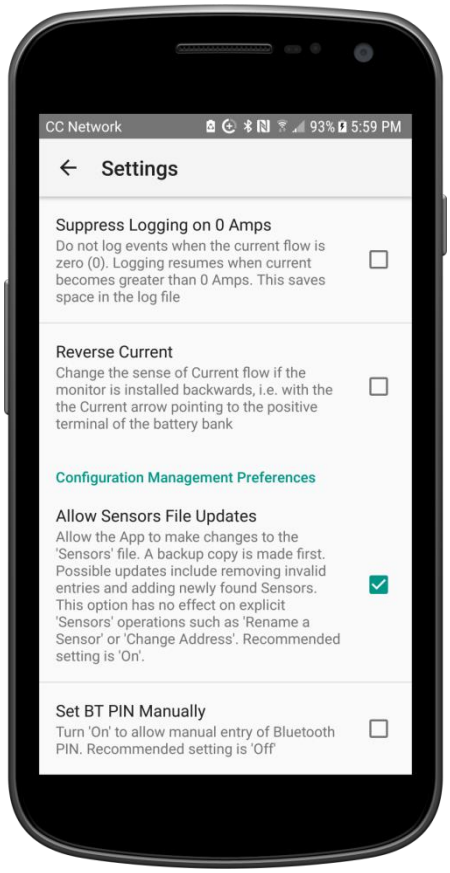
Logging Preferences

Log Update Interval – Submenu to select how often to record data to the log file. Every 5 minutes is recommended for normal operation, but for closer monitoring, data can be captured every 2 seconds maximum; setting this interval to less than every 15 seconds is not recommended for normal usage.

Suppress Logging at 0 Amps - This stops the recording of entries where this is no current flow. When the current flow is zero the battery is not being discharged or charged, so entries into the log only wastes storage space. Normally with a **Log Update Interval** of 1 minute or greater, suppressing logging updates is not important, but when the log is being updated every 15 seconds or less, a lot of non-useful data can get logged, so this option should be enabled in those case. These are only guidelines, it is recommended to leave this **unchecked.**

Days to Keep Old Logs – Determines how long to preserve log file in the applications private directory. The options are: 1 to 7 days, and *Do Not Remove*. *7 days* is the default. Tis permits a week worth of logs to be preserved.

Reverse Current – This changes the sense of current flow in case the Sensor had to be installed with the current flow arrow backwards due to mounting consideration. When moving, current flows from the Positive terminal to the Negative terminal; this results in a positive current reading on the Sensor LCD screen. When charging the battery pack, current flow in reversed, resulting in a negative current reading on the Sensor or the app. Therefore if current flow is positive while charging the battery pack, this setting should be **checked**.



More Configuration Management Preferences Menu

Manage/Configure Sensors

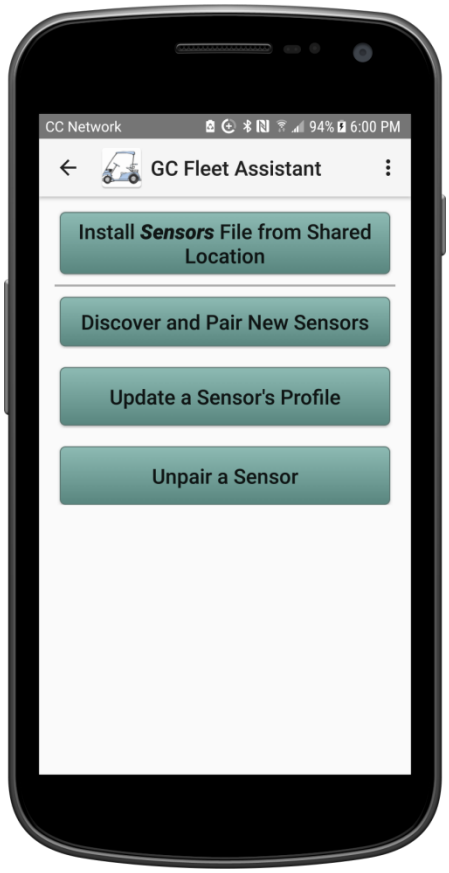
The next step is to make *CG Fleet Assistant* aware of all the installed Sensors. This is where the *sensors.csv* file is used. If the *sensors.csv* file is not present, the following dialog will be displayed:

Allow Sensor File Updates - This grants permission to the app to modify the *sensors.csv* manifest file when erroneous or invalid entries are found. These invalid entries are discarded and the file overwritten without the entries. The user is notified by temporary pop-up messages as invalid entries are detected and removed. This setting has no impact on explicit changes made by the **Rename a Sensor** and **Change Sensor Address** capabilities covered later. The recommended setting is **checked**.

Set BT PIN Manually – Normally the application will set the Bluetooth pairing code, call the PIN automatically for the use. In rare occasions it may be required to set the PIN manually. This option should be left **unchecked** unless instructed by Customer Service

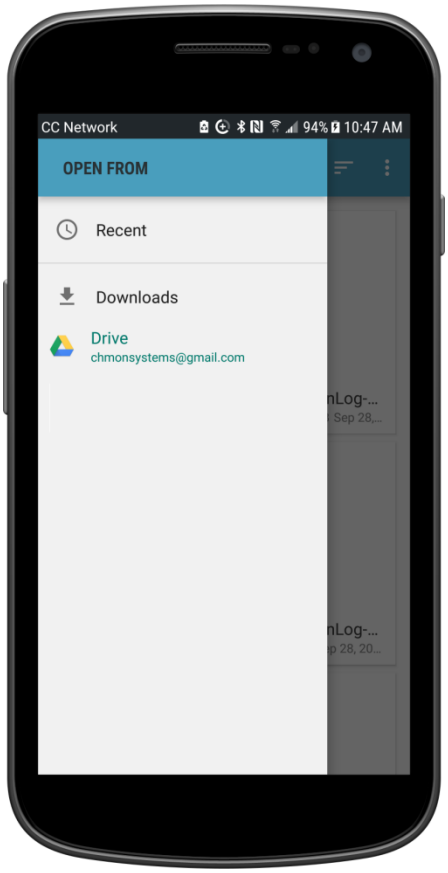
Once all the **Settings** have been made , we can return to the main menu by pressing the back arrow in the upper left corner. As a new user, the next task would be to manage and/or configure the Sensors. This is normally a one-time task.

All Sensor Configuration and Management tasks depend on the presence of the Sensors file, *sensors.csv*. It is still possible to **Display Golf Car Battery Status** without a Sensors file, but all Sensor discovery and pairing must be performed manually.

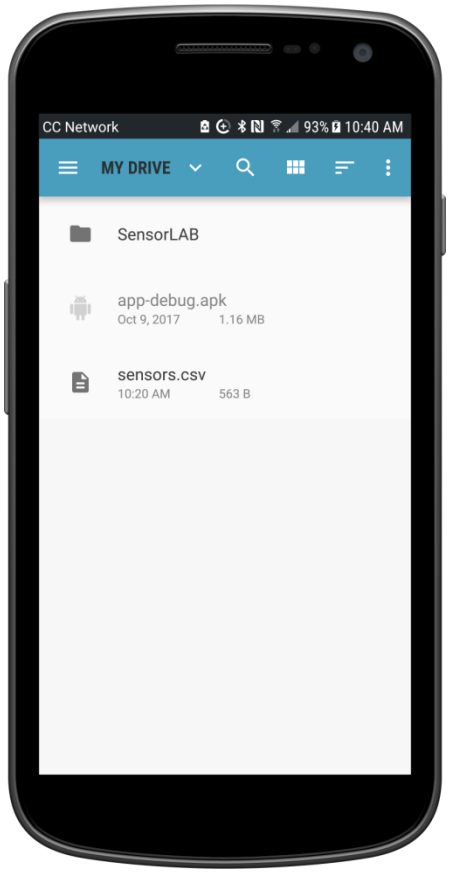


Sensor Management menu

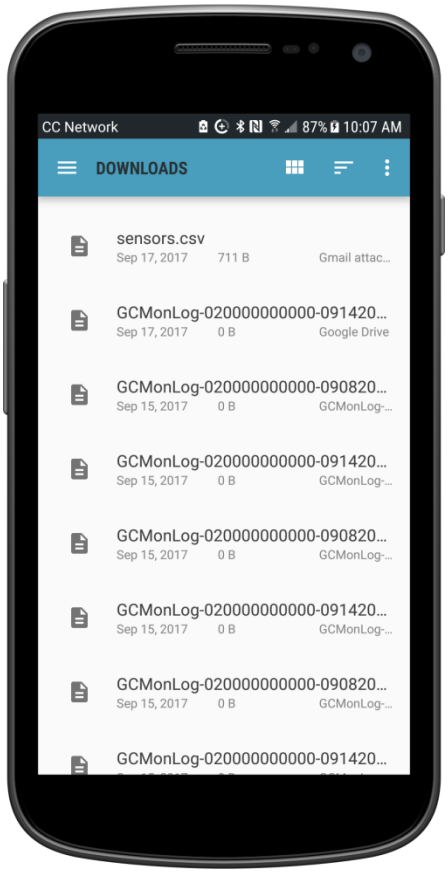
Install *Sensors* File From Shared Location - *GC Fleet Assistant* supports installing the Sensors file from several locations. After performing a download from email or Google Drive, this button will copy the *sensors.csv* file so it can be used by *CG Fleet Assistant.*



Select Google Drive or Downloads Directory



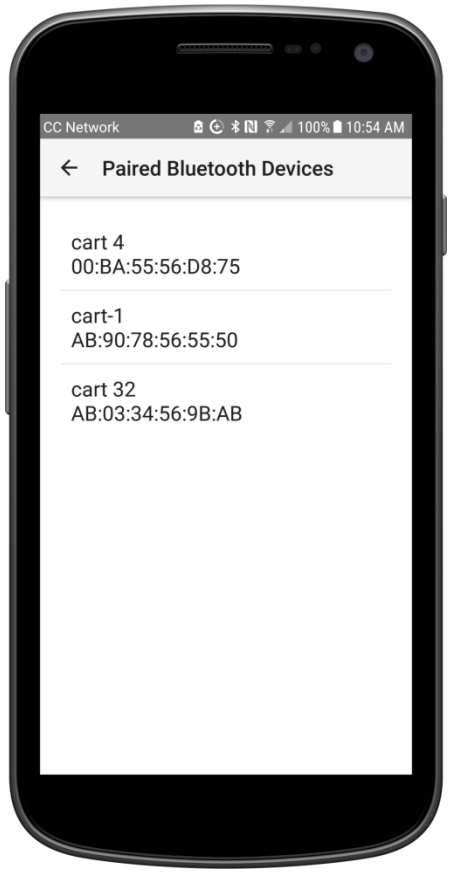
Install from Google Drive



Install from the Downloads

Discover and Pair New Sensors - this looks for all Sensors within range that are listed in the Sensors file and perform a pairing operation with them.

Unpair a Sensor – This brings up a list of paired Sensors from which the user can select one to unpair.



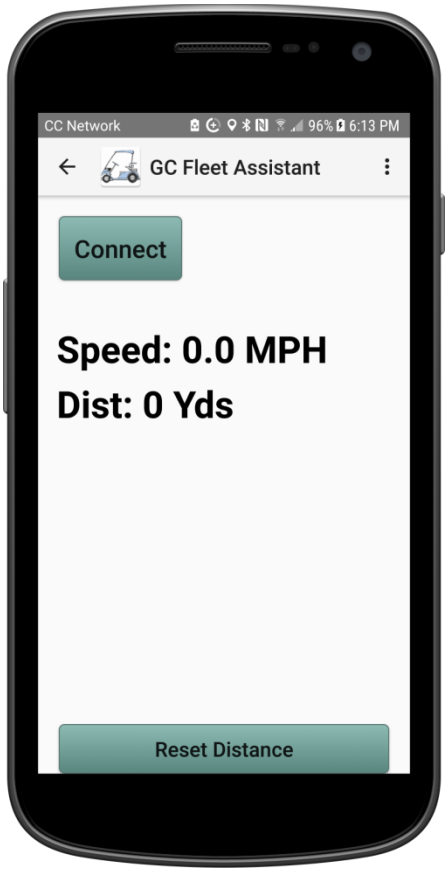
Sensor Unpair List

Rename a Sensor – Select a Sensor name from a list and change its friendly name. Note: friendly names must be unique. Once a new non-conflicting name is entered, the *sensors.csv* file is overwritten.

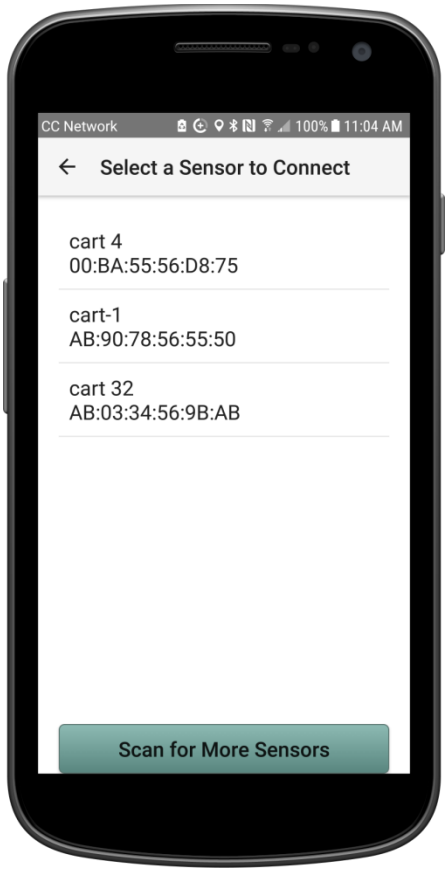
Once the Sensors have been configured, we can navigate back to the main menu by pressing the back arrow in the upper left corner. It is now time to actually monitor the battery pack in a car.

Display Golf Car Battery Status

Pressing this button gets us to the basic **Connect** menu. By pressing the **Connect** button, we can navigate to a list of currently recognized and paired Sensors. It is also possible to discover new unpaired Sensors by pressing the **Scan for More Sensors** button at the bottom of the page. This step might be required if it was decided to operate *CG Fleet Assistant* without a Sensors file installed. New Sensor discovery could take up to a minute or longer. New Sensor discovery can be halted at any time by pressing the **Stop Scanning** button at the bottom of the page.

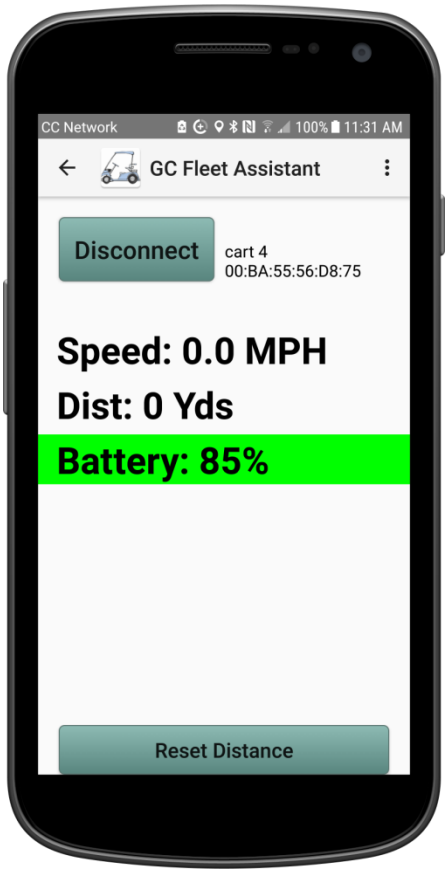


Connect menu



Sensors List

Select one entry from the list to start connecting. Once connection succeeds, the basic set of information is displayed as shown.



State of Charge (SOC) Display

This page contains a lot of information. Immediately to the right of the **Disconnect** button is the Sensor "friendly" name and hardware address; this confirms which Sensor/car you are connected to.

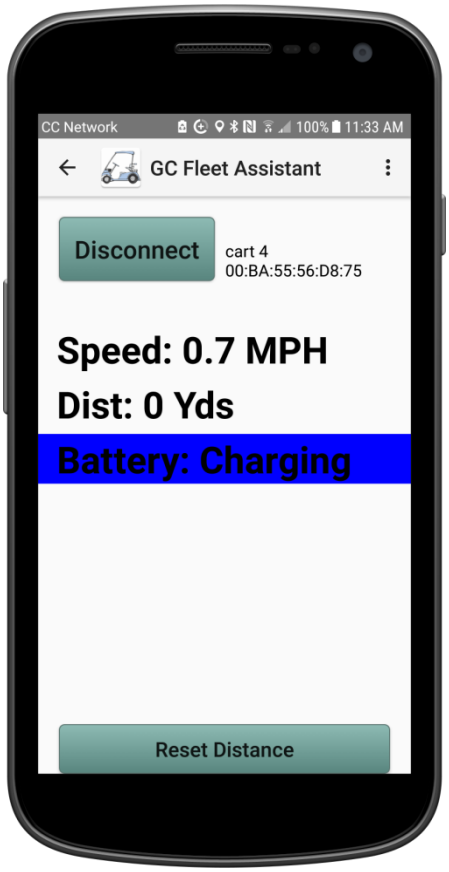
Underneath this is the car System Voltage. If the System Voltage had been set from the **Settings** menu, this would have read "36 Volt System determined from Settings Menu".

Below this is the current speed and distance travelled; GPS must ne enabled foe this feature to work.

Next is the State of Charge (SOC) information color coded to display SOC at a glance. The breakdowns are:

100% to 60%	GREEN
< 60% to 40%	YELLOW
< 40% to 20%	ORANGE
< 20% to 0%	RED
Charging	BLUE

Depending on the level of **Display Detail** chosen in the **Settings** menu, battery pack detailed technical data is displayed below the SOC information.



Charging Status Display

This information is recorded to a log file as soon as the *CG Fleet Assistant* connects and periodically based on the setting in the **Log Update Interval** preference. For fleet management where the car is being checked-out for the day, only a single reading is necessary.

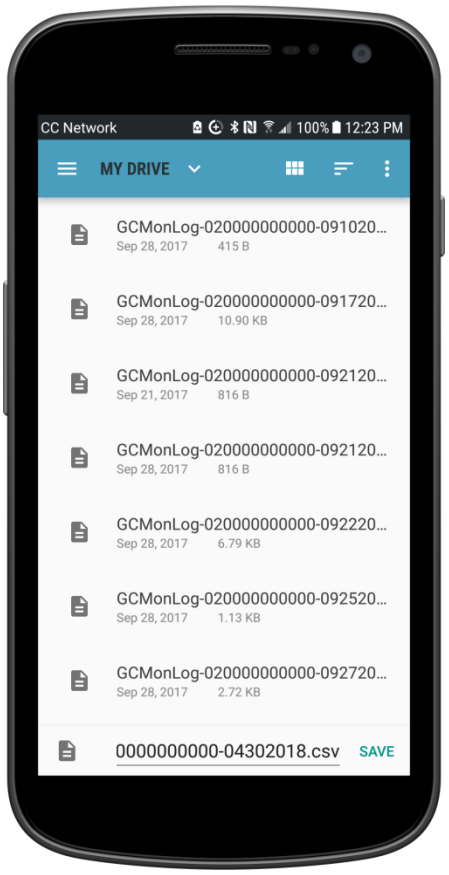
When it is time to collect information from the next car, the **Disconnect** button is pressed to disconnect from the current Sensor. This returns to the basic **Connect** menu except now the button says **Reconnect** and the battery SOC field says "Disconnected**".**

The cycle is repeated for the next car by selecting **Reconnect** which brings you back to the "Sensors List" page from which you can select the next car to process.

The process is the same for car return.

Share Log Files

By selecting this button, we are able to save one or more log files so it can be archived for safe keeping and reviewed later to identify battery performance issues. Files are saved to Google Drive. By using **Google Drive,** the daily log files from multiple users can be collected in one place.



Save to Google Drive

The user will be prompted to save all log files present in the applications private directory. The number of files archived in this private directory is set by the **Days to Keep Old Logs** option in the **Settings** menu. If you skip saving prior logs because you already did so previously, repeated hit the "hard" back button on the bottom of the screen.

At the bottom of the screenshot shown, there is a proposed file name to be saved to **Google Drive**; all the user needs to do is press SAVE.

It is highly recommended to use the proposed filename as these are uniquely named across multiple smartphones and/or tablets.

Appendix A – Use of a Manifest File

Introduction

The use of a manifest file is optional for very small fleets (1-4 cars), but is recommended. For a large fleet (5+ cars), it is strongly recommended. It would be possible to operate a large fleet without a manifest file, but efficient fleet management would be extremely difficult. Further, in the event of the loss of the Android device which contained the ad-hoc list of fleet information, the fleet staff would need to recreate the Sensor list, which can be time-consuming.

The manifest file is named *sensors.csv* and can be constructed on a Windows PC using Microsoft Excel or on a tablet using an appropriate spread sheet program. Creation on a smartphone is also possible. A sample manifest file is available for download from our website under DOWNLOADS.

The manifest file MUST be named *sensors.csv* and it must be saved as a "comma separated value" (CSV) file with an extension of *".csv*. Below is a sample file, which consists of a number of rows, one for each Sensor/car. Each row can have up to three fields: a) the friendly Sensor name, b) the hardware address of the Sensor (each Sensor is labelled with this unique address), and c) an optional comments field for notes and such. Each field is separated from the next by a comma (","). See below.

When saved as a CSV file, each field is separated from the next via a comma. Note the first field, which is a friendly name is freeform text. It identifies "cart-1" with a dash between "cart" and "1", whereas the next row uses a space to separate "cart" from "2". The second field is the Sensor address field must follow a specific format, consisting of six sets of 2 digits; each from 0-9 and a-f (known as hexadecimal characters). Each set of 2 digits is separated from the next by a colon (":") punctuation mark. This field should be copied directly from the label on each Sensor. The case (upper or lower) of the letters does not matter. If the entry does not follow the format correctly, it will be discarded when the file is read by the application. The third field is a freeform text comment; if you don't have a comment, the trailing comma is not necessary; "cart 4", "cart-5", cart 5", and "cart 6" are valid entries just like "cart 7", "cart 8", and "cart 9". Example *sensors.csv* file shown below:

```
cart-1,AB:90:78:56:55:50,the first one
cart 2,ab:90:78:56:52:e5,
cart 3,ab:90:78:56:55:41,Maintenace scheduled
cart 4,00:BA:55:56:d8:75
cart-5,AB:90:78:56:55:54
cart 5,ab:90:78:56:55:54
cart 6,ab:90:78:56:55:55
cart 7,AB:90:78:56:55:56,
cart 8,AB:90:78:56:55:57,
cart 9,AB:90:78:56:55:58,
```

There are several ways to create the *sensors.csv* file. You can skip the following section if you already know how to create a CSV file in the format described above

Creating a Manifest File in Microsoft Excel

When created in Microsoft Excel, the file must be named *sensors.csv* and it must be saved as a "comma separated value" type of file with an extension of *".csv",* not in Excel's native format, e.g. Excel Workbook (*.xlsx). Below is a sample file, which consists of a number of rows, one for each Sensor/car. Each row has three fields: a) the friendly Sensor name, b) the hardware address of the Sensor (each Sensor is labelled with this unique address), and c) an optional comments field for notes and such. See below.

This is what it looks like in Excel.

Cart-1	AB:90:78:56:55:50	the first one
cart 2	ab:90:78:56:52:e5	
cart 3	ab:90:78:56:55:41	Maintenance scheduled
cart 4	00:BA:55:56:d8:75	
cart-5	AB:90:78:56:55:54	
cart 5	ab:90:78:56:55:54	
cart 6	ab:90:78:56:55:55	
cart 7	AB:90:78:56:55:56	

Table 1 – Excel-like spreadsheet representation of *sensors.csv*

Once the *sensors.csv* file is created with one line for each Sensor, it can be emailed, sent via Google Drive, or copied directly to the **Download** directory when the phone/tablet is attached by a USB cable to a Windows PC.

Creating a Manifest File directly on the tablet or smartphone

To create a *sensors.csv* file directly on the tablet or smartphone, you will need a file manager utility and a text editor. There are a number of utilities in the Google Play Store. One popular utility which has both needed components, but by no means the only one is *ES File Explore File manager,*

http://es-file-explorer.en.uptodown.com/android/download

This file manager utility contains a file manager so the created *sensors.csv* file can be save to the requisite directory, namely **sdcard/Download** and a simple text editor to create the CSV file. There are also a number of Excel-like utilities in the Play Store.

Creating a Manifest File in a text Editor on a PC or Mac

It is also possible to create a manifest file in a text file editor, by entering each field, separated by a comma, and hitting ENTER at the end of each line.

Drive, or copied directly to the **Download** directory when the phone/tablet is attached by a USB cable to a Windows PC.

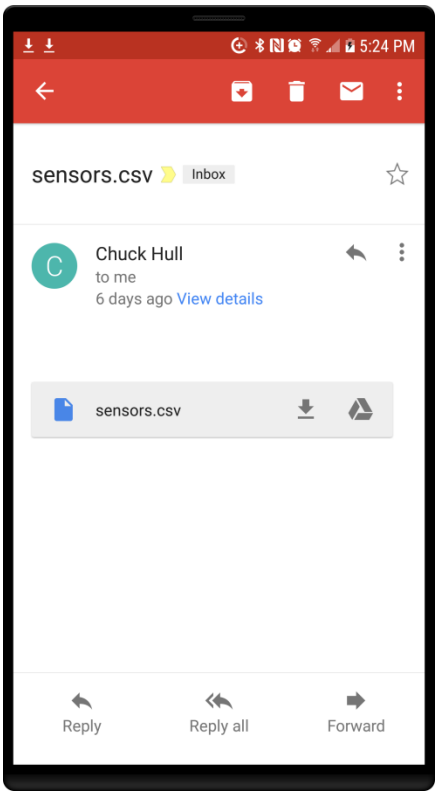
Installing the Manifest File

Once created, the *sensors.csv* file must be transferred to the smartphone or tablet where the *CG Fleet Assistant* application is installed. There are a couple of ways to do this:

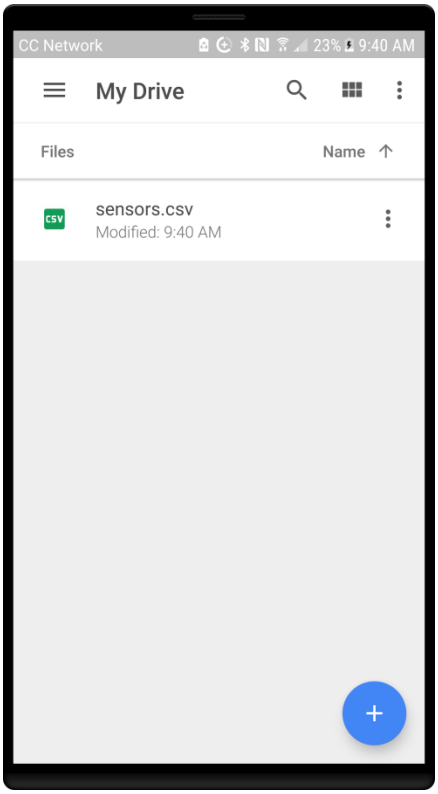
- Email it to a user account on the phone or tablet, and then save it in ether the **Downloads** directory or Google Drive
- Use Google Drive to store it in the cloud from your PC, and then retrieve it on the phone or tablet as described below in the Manage/Configure Sensors section.

In either case, the file must be downloaded from either email or Google Drive.

Email would look like:



And for Google Drive, it would look like:



Appendix B – Log File Details

Introduction

This section covers some of the details of the log files and is optional reading. Important points to note about log files.

- There is a single daily log file that collects the information from all fleet vehicles in a single file.
- Individual vehicles are identified by their friendly device name and wireless address, both of which are guaranteed to be unique.
- Each log file has a unique filename which consists of:
  - ✓ "GCMonlog-"
  - ✓ The unique wireless address of the smartphone or tablet collecting the vehicle information
  - ✓ A dash, "-"
  - ✓ Today's date in the form "MMDDYYYY"
  - ✓ The file extension of ".csv" which stands for Comma Separated Values (CSV).
- The log file is naturally ordered by time because this is how entries are collected.

Log File Format

The log file is saved as a CSV file which may read directly by spread sheet programs such as Microsoft Excel that support CSV files (most do). When opened in a supporting spread sheet program, each field in the log file creates an individual column which can be sorted or otherwise manipulated. Daily log files from different smartphones/tablets can be merged and then resorted based on time stamp and device address.

The log file consists of 14 columns as shown below. Because the table is so wide, it was broken into two tables with the *Date, Time, Speed,* and *Voltage* column overlapping.

Log File Column Description

DeviceName - the "friendly" device name as set by the user. This may be changed by the user based on fleet or course preferences. The Device Name must be unique within a fleet at a single location.

DeviceAddr – the unique 12 character wireless address. Consist of 6 two character pairs separated by colons. Set at the factory and cannot be changed.

Date, Time – contains the current date and time of each log entry as two separate columns.

Speed – The car speed in Miles Per hour (MPH). During car check-out and return, i.e. *check-out/check-in* mode, the speed should always be zero. Only when operated in *Personal* mode will the speed be recorded in the log, provided the smartphone/tablet accompanies the car. Accuracy is dependent on the smartphone/tablet in use.

Distance – the cumulative distance traveled since being reset. Accuracy is dependent on the smartphone/tablet in use.

Voltage – the Voltage when the data is sampled and recorded in the log.

SOC – State of Charge is a value in percent which represents the estimate charge left in the battery pack before requiring a recharge. SOC should not be allowed to go below 50% normally and never below 20% ever.

Avg Current – the averaged electrical current used by the car's controller and motor. This value is current averaged over 4 seconds to smooth rapid changes in the current flow which might occur in a fast stop/start mode of operation.

InstantCurrent – the instantaneous current flow. Depending on the value of the *Log Update Interval,* The instantaneous current may be reported as different as the **AvgCurrent.**

WattHours – measures the energy used since it was last rest. This is accumulative value.

AmpHours – this is a measure of the amount of current used over time independent of the voltage when it was consumed.

AmpHours2 - this is a measure of the amount of current used over time like **AmpHours**, except it decreases during batter charging.

DeviceName	DeviceAddr	SystemVoltage	How Determined	BatteryType	Date	Time	Speed	Voltage
cart 4	00:BA:55:56:D8:75	36	Auto-detected	Generic FLA	9/20/2017	12:21:22	0	37.64
cart 4	00:BA:55:56:D8:75	36	Auto-detected	Generic FLA	9/20/2017	12:27:01	0	37.64
cart 4	00:BA:55:56:D8:75	36	Auto-detected	Generic FLA	9/20/2017	12:27:01	0	37.64

Date	Time	Speed	Voltage	Avg Current	Instant Current	Watt Hours	Amp Hours	Amp Hours2
9/20/2017	12:21:22	0	37.64	0	0	175.65	5.024	5.024
9/20/2017	12:27:01	0	37.64	0	0	175.65	5.024	5.024
9/20/2017	12:27:01	0	37.64	0	0	175.65	5.024	5.024