REAL FLIGHT SYSTEMS

GPS-1

The GPS-1 telemetry module is a high performance, secure, tracking, monitoring, and data logging system which enables tranmission of GPS position and telemetry data up to 100 miles LOS (Line of sight) to the Base-station-1 or Base-station-2 receiver. It also features local logging of all sensor and GPS data onboard Micro-SD storage..

- 16MIPS RISC CPU for high-performance GPS system processing
    - Filtering for GPGGA/GPGSA to preserve RF Link bandwidth and real-time background processing
- SDIO Micro-SD Memory Card support (J6) for data logging
    - FAT16/FAT32 media (up to T10 V2.0 32GB Cards)
- High-performance uBlox LEA-6 GPS Receiver Module with uBlox u-Center USB support
- 30dbM (1Watt) 900Mhz Frequency Hopping Spread Spectrum Transceiver supporting up to 500Kbps data rate
    - Up to 16 independent channels operate concurrently
    - AES Encryption for link security
    - Requires no field configuration/provisioning or HAM Radio License
    - FCC and Canadian IC Certified for Unlicensed Operation
- External SMA connector for active input GPS Receiver antenna
    - Sarantel SL1206R GeoHelix®-P2 high-performance, high-gain, low-noise amplified active input GPS receiver antenna (recommended)
- Up to 12V, 10A input power support
- Temperature Sensing from -55°C to +125°C with 0.5°C Accuracy
- Voltage Metering of Primary battery, Current, and GPS Almanac Battery

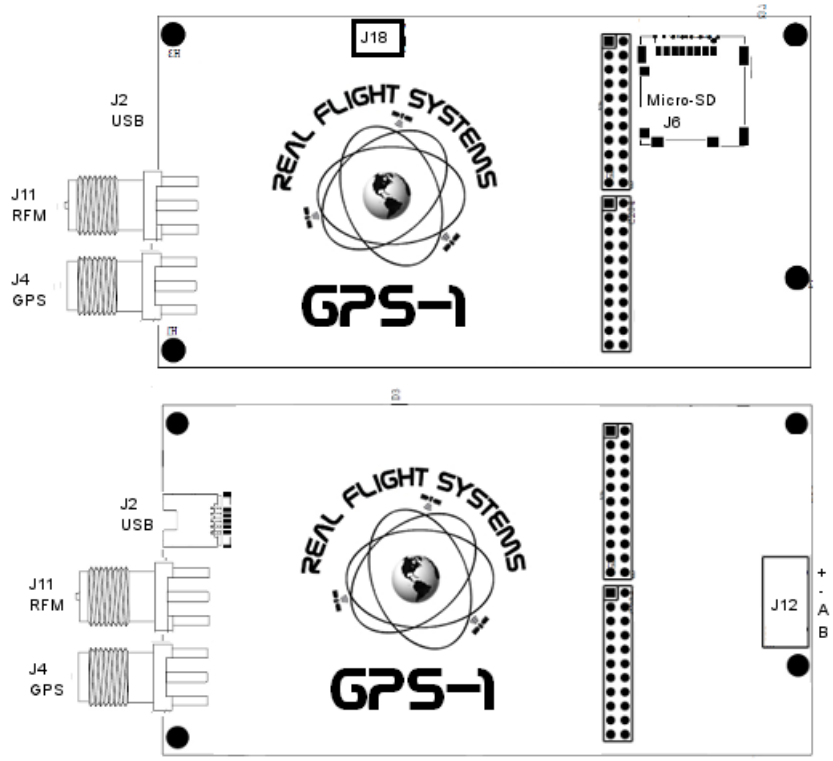
- Supported software: any NMEA GPS Program (ExpertGPS, VisualGPS, Google Earth, etc)
- 3V External battery for GPS Almanac back up and uBlox-6 Hot-Start™
- Over 9hrs operational time (running all features) using 9.6V 2200mah NiMh 8xAA battery pack

ACCESSORIES

- Sarantel SL1206R GeoHelix®-P2 high-performance, high-gain, low-noise amplified active input GPS antenna
- 0dBi RF Antenna + low-loss RG174 RPSMA extension cable
- Deans Male plug+wire
- Deans Micro Male plug+wire
- Micro-SD Card
- External 3V GPS Battery with JTEK connector

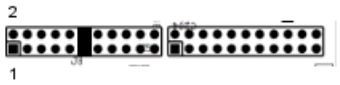
MECHANICAL

Dimensions: 49.35mm W x 91.35mm L (1.94" W x3.59" L)
PCB Mounting hole dimensions: 86.65mm x 43.65mm



- J6: Micro-SD Slot: Any Micro-SD card formatted as either FAT16 or FAT32 media is supported.
- J18: GPS Battery, attach GPS 3V Almanac battery to this connector. The connector is keyed for connection.
- J2: uBlox uCenter USB Port
- J11: RF Modem connection, RPSMA plug
- J4: GPS Modem connection, SMA plug
- J12: Power + Switch: Connective positive to +, negative to -, A/B to switch
    - To use without switch, either shunt A/B or connect positive(red) to B lead, and negative(black) to – lead.

CONFIGURATION JUMPER (CFG1/CFG2)



- J8 – leftmost 2MM header if board is facing (modem side up) away from you with SMA connectors forward
- J9 – to the right of J8,
- Default, Normally pins 11-12 are shorted (which runs GPS processing at boot). Note that this is the 6th Jumper position from the edge of the board.

NOTE: When this jumper is removed, the system allows for remote login and control (default password=rfs1)
NOTE: If this jumper is removed, your Base-station will NOT show any data on the display until the "gps" command is issued via the USB connection on the Basestation to the host computer.

Default J8 installed (pins 11-12 shorted - run GPS processing at boot)

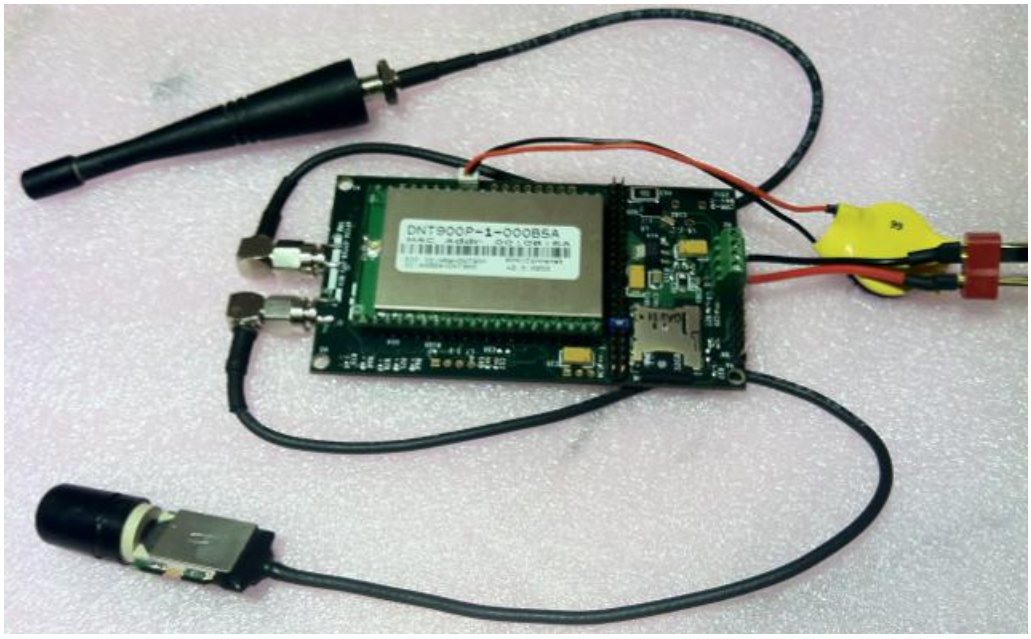
IO EXPANSION INTERFACE (J8/J9)

LEDS

- D22: BPWR – glows red with Battery Power
- D14: Activity – blinks green with RF Modem activity
- D4: Fix – Glows Blue with GPS position
- D3: Sys – Toggles with system activity
- D29: SDIO – Toggles when writing data to SD-Card

CONFIGURATION AND PRE-FLIGHT

1. Attach RPSMA Modem Antenna
2. Attach SMA GPS Antenna
3. Attach J18 GPS Battery
4. Download GPS Almanac to the device, connect J2 Mini-USB to host Computer and use uCenter 7.02 or later
5. Verify CFG_1 Jumper pins 11-12 are shorted (this is the 6th position from the far left of the pin header)
6. Connect Power, and optionally, power switch
7. Verify a fresh FAT32 or FAT16 formatted SD-Card is installed in J6, Micro-SD Slot
8. Wait for GPS Lock LED and airplane symbol on receiver



MOUNTING GPS-1

GPS1 requires a firm mounting in order to operate properly, mechanical vibrations may reduce performance and can damage your system if it is not mounted securely. It is best to mount the unit using stand-offs and 4-40 mounting bolts.

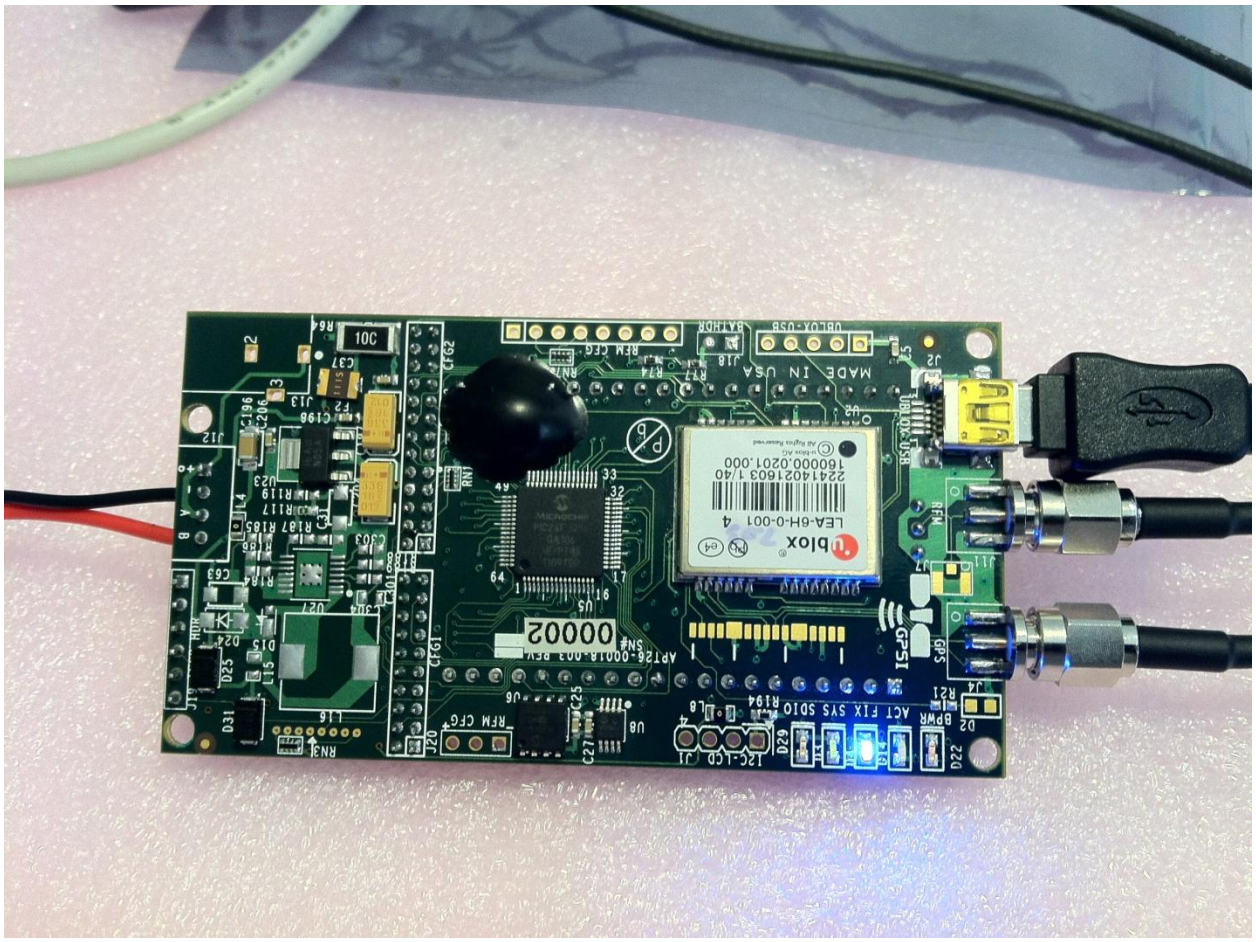
GPS PRE-FLIGHT CONFIGURATION

Your GPS1 module comes pre-configured for Aircraft mode GPS telemetry. The uBlox GPS chipset also features a 2 week GPS Almanac (cache) which works in conjunction with the GPS almanac cache battery. The GPS Almanac aids navigation by providing for Ephemeris data at start-up and allows for a so-called “hot-start”. When the GPS module is powered down, the GPS Back-up battery keeps the Almanac up to date until the unit is powered back on again. If the GPS almanac is pre-programmed, initial lock times can take as long as 5 minutes while the uBlox chip-

set downloads the GPS Almanac over the air (OTA). To accelerate start-up and provide a 2-week cache of data (with battery back-up), the following procedure is recommended for pre-flight configuration.

1. Install uCenter (7.02) or later
2. Connect the GPS battery to J18

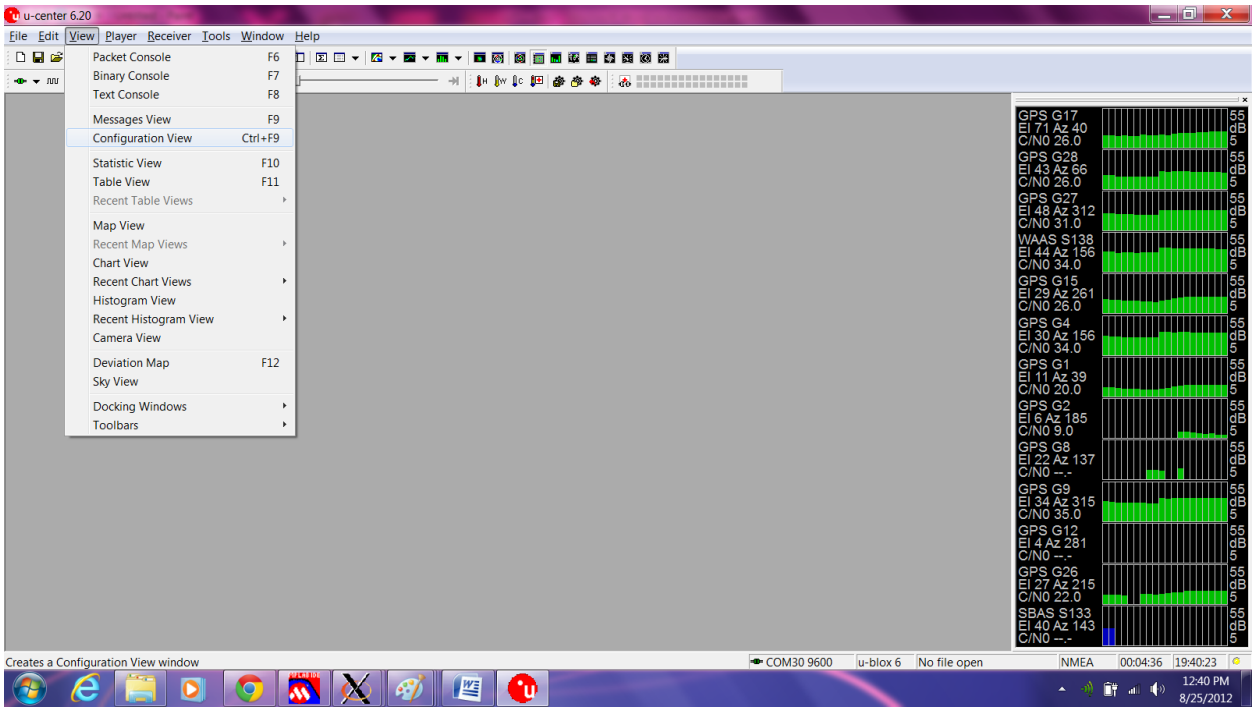
3. Connect the main 9.6v battery or turn on the power switch connected to J12
4. Connect a mini-USB cable to the GPS1 USB port and the other side to the computer



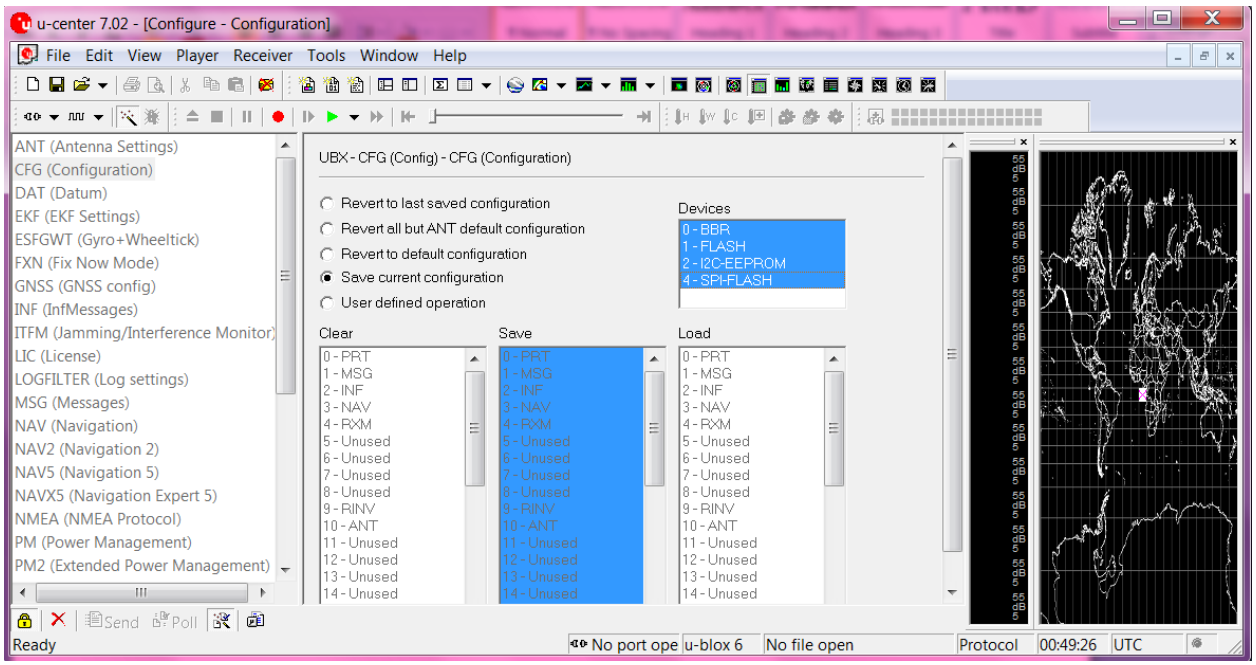
5. Start uCenter, select the “Receiver->Port->XXX” where XXX is the USB port found by your computer attached to GPS1. NOTE: you can use DeviceManager under Windows and find the uBlox USB Device port.

6. NOTE: once uCenter is installed, the uBlox should be detected under Device Manager. To download the latest version of uCenter, visit http://www.u-blox.com/

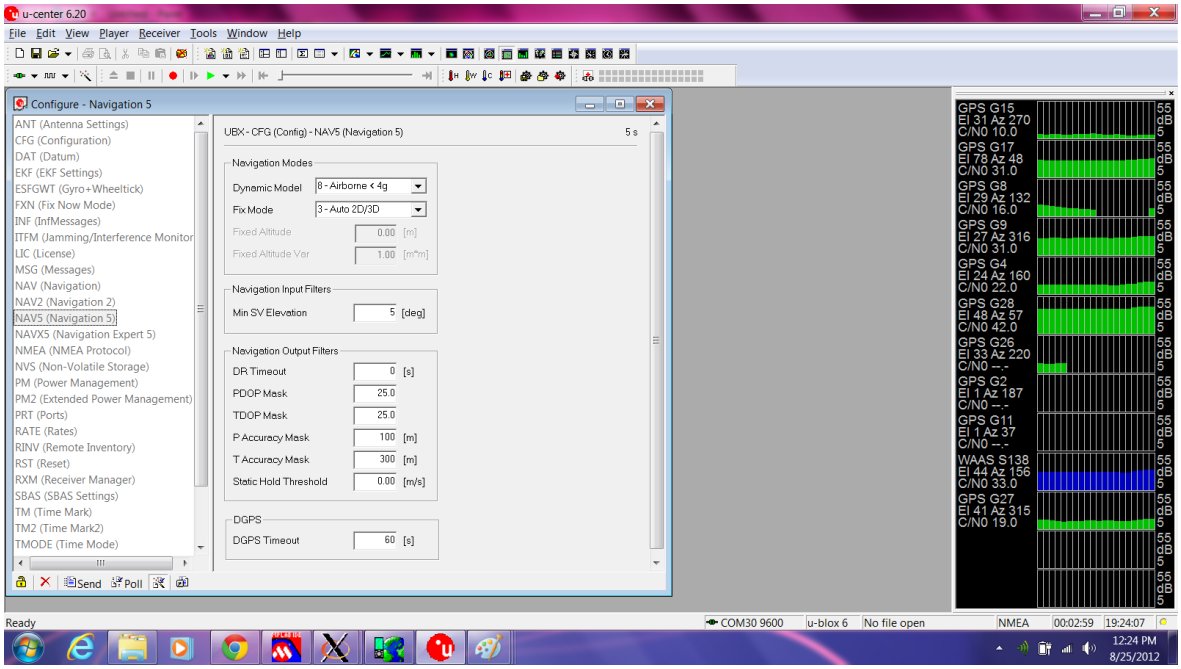
7. Select Configuration View as below



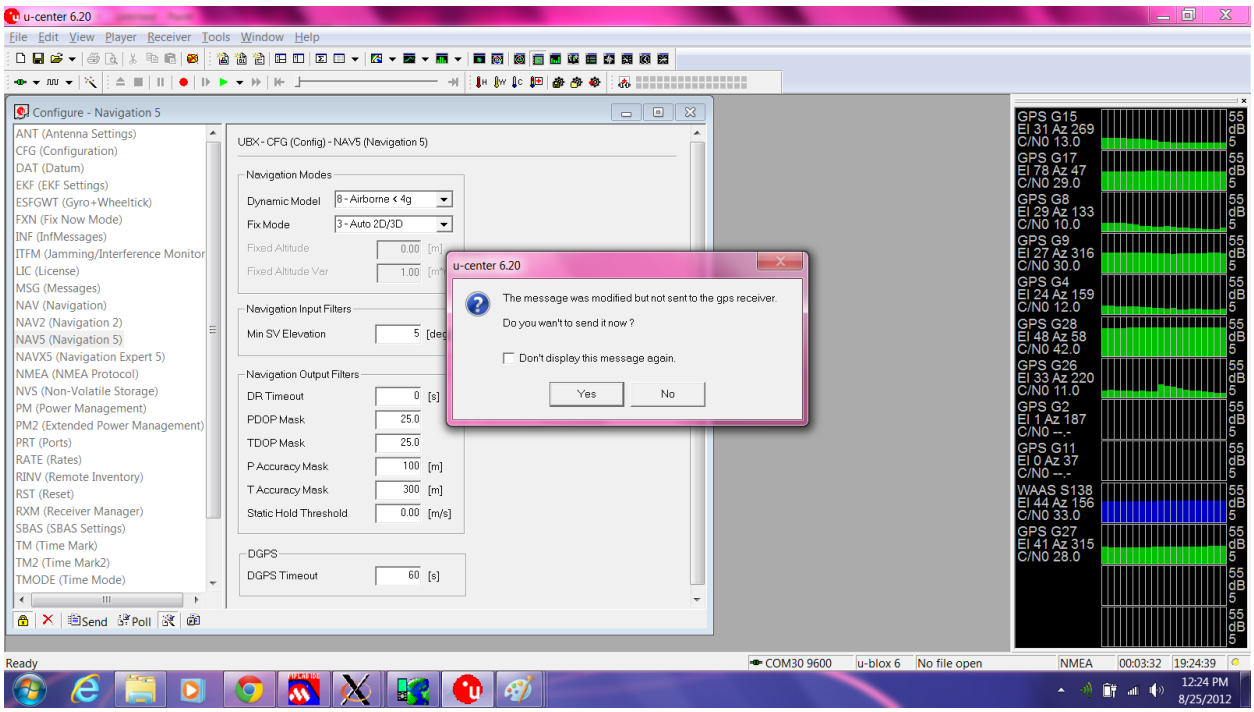
8. Verify that the configuration data will be saved to the device (BBR, FLASH, I2C EEPROM selected)



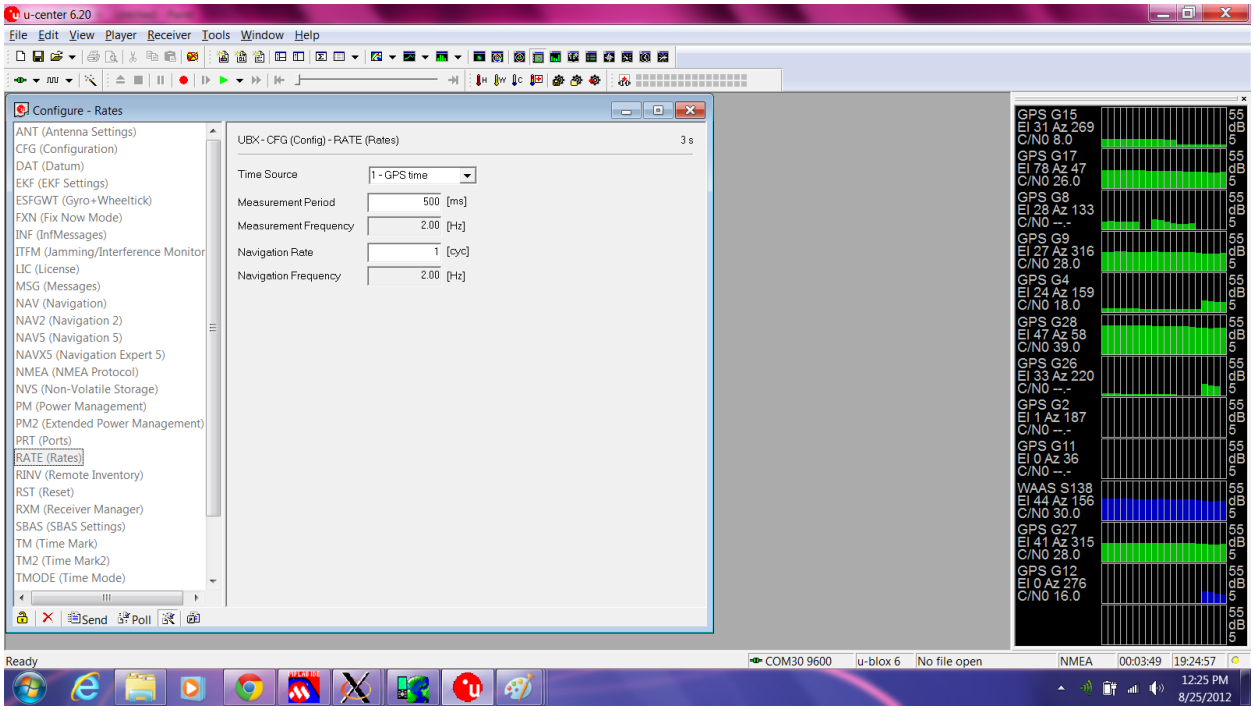
9. Verify that NAV5 is set to Airborne Mode



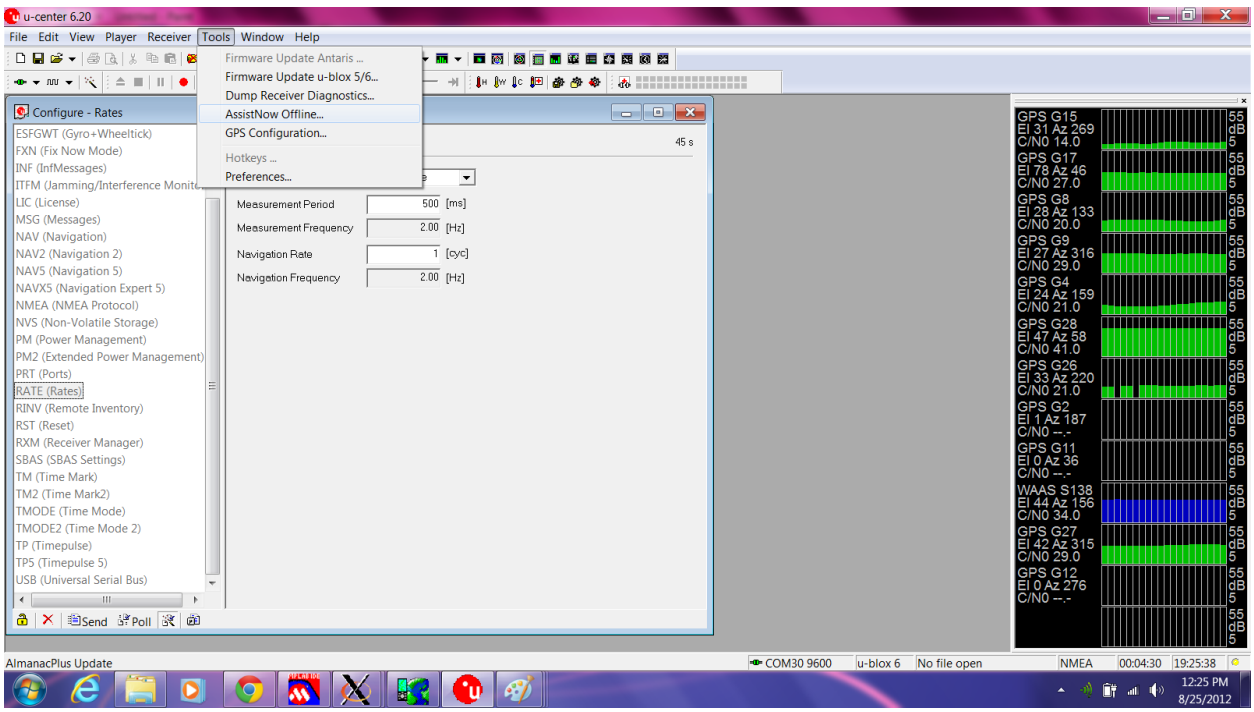
Note that if the configuration is not set, uCenter will prompt to write back the data to the receiver. Always answer Yes if you are sure of your configuration, if not, press "No"

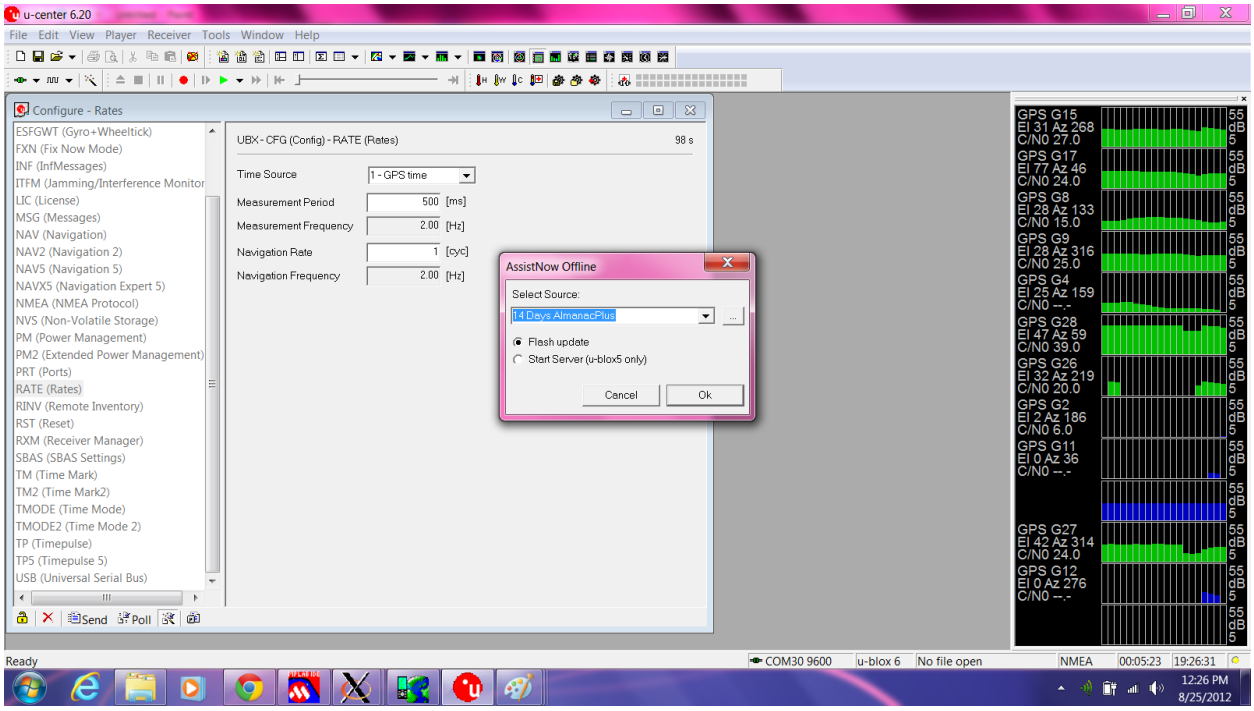


10. Verify the Rate is set to 2HZ (500msec) for 1-second real-time response with the Base station receiver

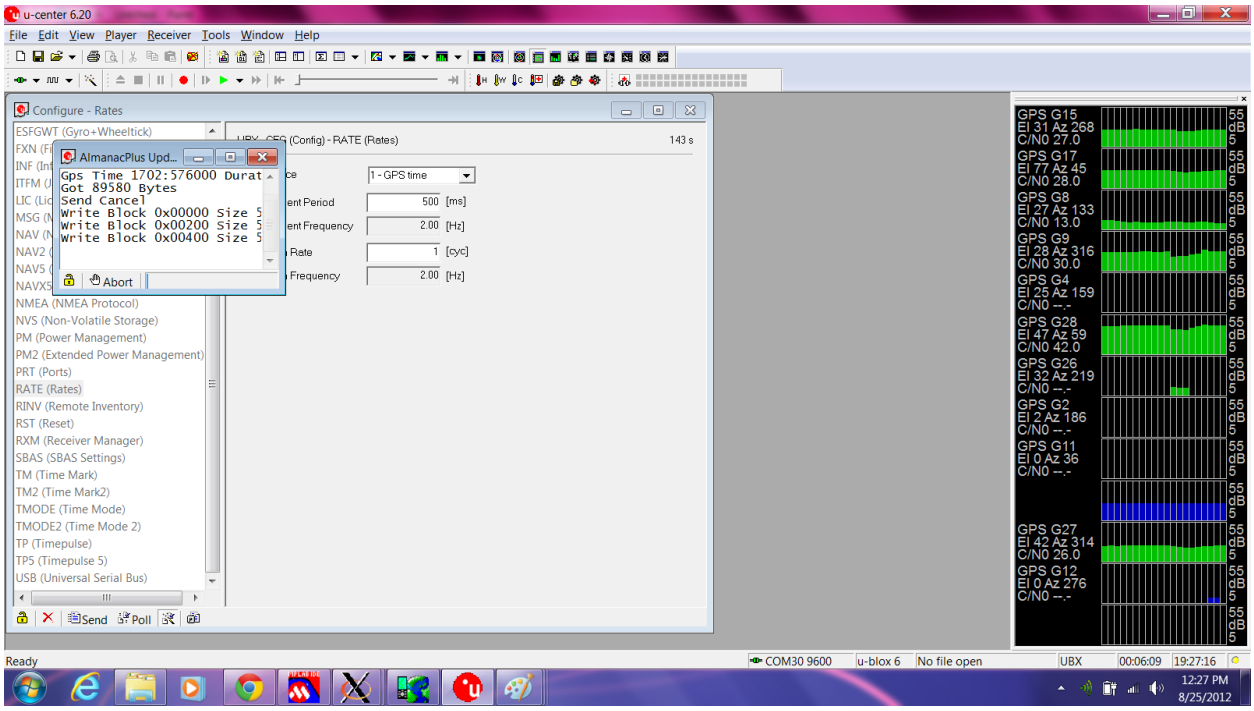


11. Select “Tools->AssistNow Offline”





12. Select 14 Days AlmanacPlus, and FLASH update



The unit is now configured. Be sure to leave the GPS Battery connected to the module so that the GPS Almanac data is preserved up to and during flight. Should the GPS lose telemetry lock during flight, the GPS battery will ensure hot-start and re-acquisition of fix in < 1 second with hot-start enabled.

When completed, use the uCenter menu options: GPS Configuration -> (GPS->File) to save your GPS configuration.

For fast recovery, use the GPS Configuration (File->GPS) option to program your receiver. Verify the firmware and uCenter version first before following this procedure (and note that newer versions of firmware require newer versions of uCenter for correct programming).

Sample configuration files may also be found at http://www.realflightsystems.com/techpubs/ublox/

PRE-FLIGHT

- Charge all batteries, they should be about 11V or more when fully charged.
    - The systems will shut down when the battery voltage reaches 5.36v, this is nominally 3-4hrs later on the base-station and 8hrs on the remote (2500ma battery on remote).
    - At 6 volts, a warning will appear on the base-station.
- Install GPS Battery
- Load the GPS Almanac – use uCenter 7.02 or later and select "14 Day Almanac Plus"
- Verify Lock sequence where you have multiple (> 4 total) satellites, a flashing airplane, and altitude.
- Freshly format SD Card, install into SD-Card
- Check Connections to battery and optional switch.

POST-FLIGHT

- Power off
- NOTE: on older firmware versions (green board)
    - Immediately remove SD-Card, do not re-insert, it will overwrite your files!
- On newer firmware versions (blue board and version 1.01 and later)
    - A new data-file is created (up to 100 datafiles). After 100 data-files the first file is perpetually overwritten.
    - All files are written with their appropriate time-stamp (GMT + TZ-Offset)
    - See also the "tz" timezone command.

TROUBLESHOOTING

When powering up the board without using a switch, make sure you plug in the connector quickly to avoid transients. When powering up the boaord using a twist-wire switch, make sure you firmly press the two leads together first and then twist the wire (also to avoid transients).

Note that when properly functioning, D29, SDIO will blink RED when writing data to SD-Card, if you do not see this behavior, power down the board, remove the SD-Card and re-insert it to make sure it is properly seated.

Verify the jumper on CFG_1 is set - normally pins 11-12 are shorted (which runs GPS processing at boot). Note that this is the 6th Jumper position from the edge of the board.

NOTE: removing CFG_1 jumper pins 11-12 for Basestation-2 users will render their system inoperable until the jumper is re-inserted (in this mode, GPS-1 waits for remote login from the Basetation-1 forever).

BATTERIES

GPS-1 is optimized for 9.6v NIMH batteries; as such it comes with an 8xAA-cell, 9.6v 2500ma NiMh battery measuring 57mm X 50mm x28mm (LxWxH). Average current draw is ~200 ma so expect approximately 7-10 hours of operation on a 2500mah NIMH battery pack. Using the supplied battery and charger, always select the 0.9A battery power charging option to preserve battery life.

- DC voltage 6.0 - 14V DC (LD117STR, LM317)
- Average current: 200-245ma

Note that any battery 6V, 7V, 9V, 12V may be used, select one with a current rating of 250mAh for one hour of use, higher mAh ratings for proportionally longer runtime (depending on battery type and chemistry).

Note also that a fully charged 12V battery may have an output voltage close to 14V so if using Lithium-Ion/Polymer batteries one should select a battery which does not exceed that voltage rating so as not to damage the onboard power regulators.

GPS OPERATIONAL LIMITS

uBlox-6 Operational Limits under good GPS signal conditions and assuming Airborne platform configuration as documented.

- Dynamics: ≤ 4 g
- Altitude: 50,000 m (164,042 ft MSL)
- Velocity: 500 m/s (1,118.47 MPH or 1640.42 feet/second, Mach 1.49)

RF OPERATIONAL LIMITS

DNT900 operational specifications are as below:

- Operating Frequency Range 902.75-927.25 MHz (Hop Dwell Time 5 ms min, 200 max)
- Number of RF Channels: 50, FSK Modulation
- RF Data Transmission Rate: 38.4 Kbps, 200 Kbps
- Receiver Sensitivity: 10E-05 BER @ 38.4 kb/s -108 dBm, 10E-05 BER @ 200 kb/s -98 dBm
- Transmitter RF Output Power Levels:1,10,100,250,500,1000 mW
- Optimum Antenna Impedance: 50 Ω

FIRMWARE HISTORY

The log below describes changes in each GPS-1 firmware release.

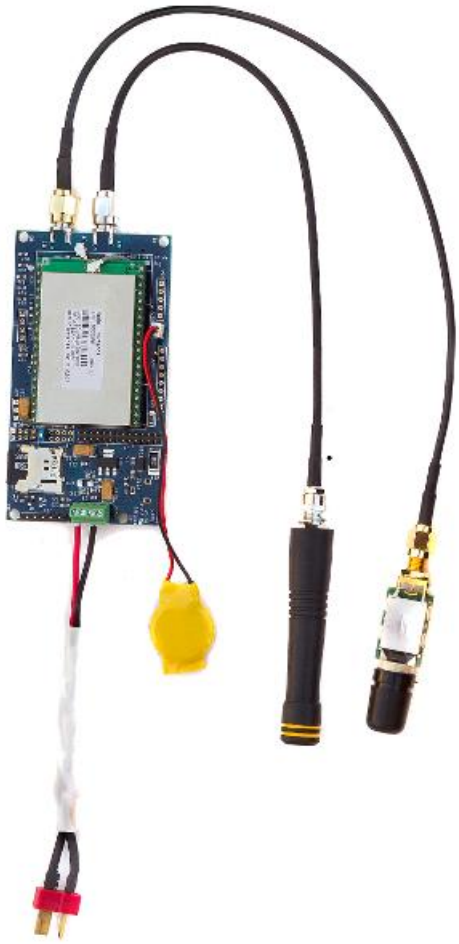
1.00 –07/12/12 Initial firmware for revision A/B PCB's

1.01 –12/29/12 Flight testing on over 14 flights, update time of day and system clock from GPRMC when data is known, add support for timezone offset (for localtime). Update time of day on files using localtime (GMT by default). Update logger subsystem to create a new file every time the system is booted. Up to 100 unique sequentially numbered files are

supported, afterwards the last file (gpslog99.log) is perpetually overwritten. The new datafiles are “gpslogXX.log” and “syslogXX.csv” where XX increment on every power-up of the GPS-1 module.

PREFLIGHT VIEW

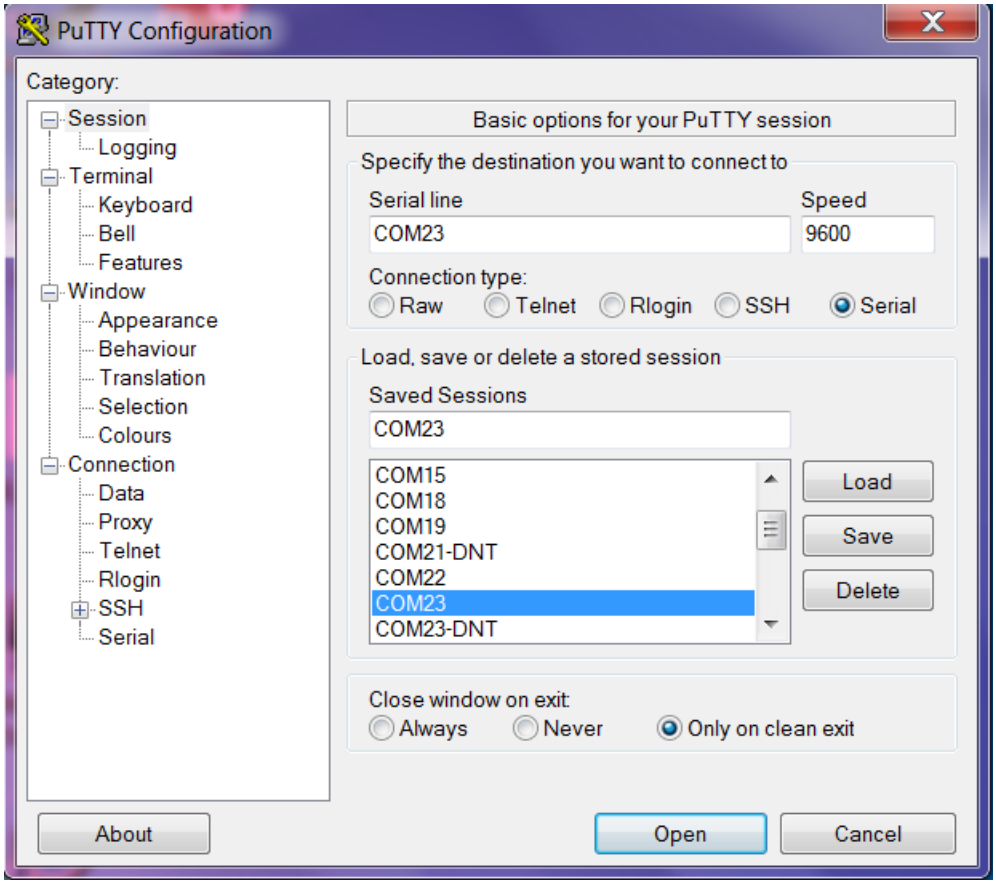
Deans connector with direct connection to J12 (DC power), all Antennas attached, GPS almanac battery attached.



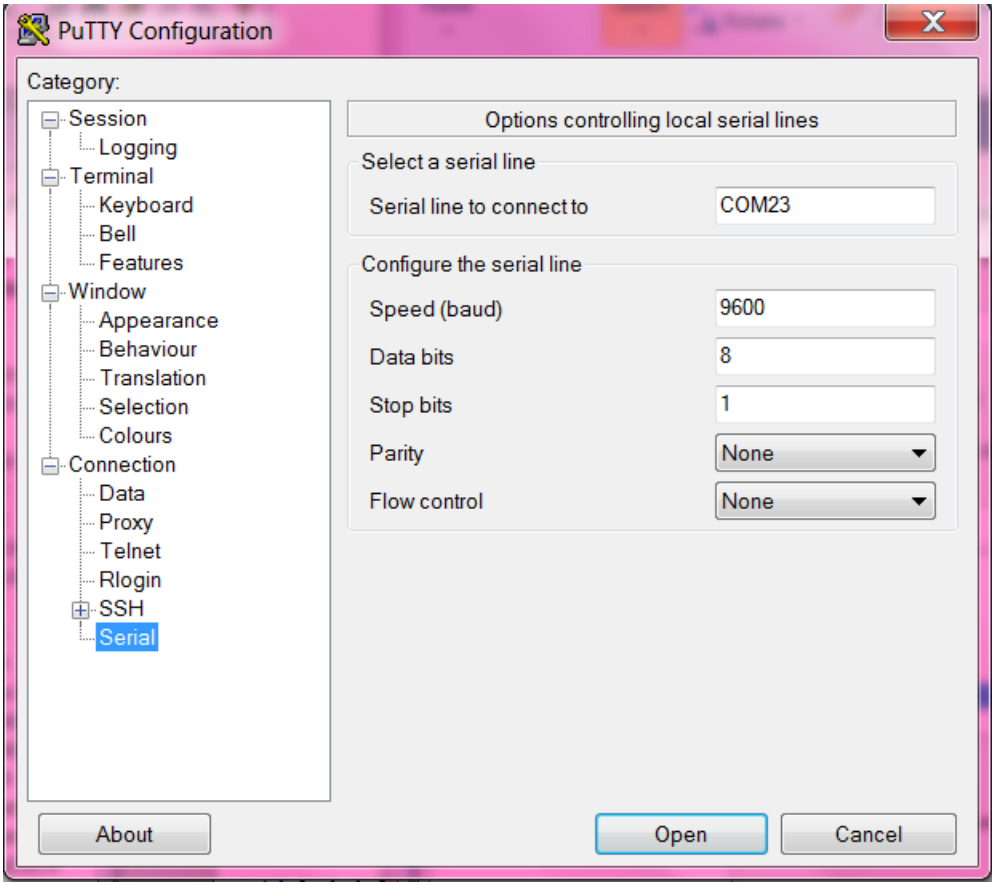
APPENDIX-1 GPS-1 REMOTE SHELL (BASESTATION-1 ONLY)

When the configuration jumper on pins 11-12 is removed (the 6th Jumper position from the edge of the board), and the Basestation-1 is connected to the host computer USB port, the system will boot up and provide a remote control serial console (like the remote control console on the GPS-2). Following is the remote control console procedure.

1. Connect the USB port of the Base station to the host PC. Windows will install drivers for the FTD232 serial device.
2. For Windows, use any terminal emulation program you have installed (e.g. Hyperterminal), or use Putty (located on the CD). Go to Device Manager and look under Com ports to find the name of the COM port to connect to. Launch Putty, you will want to type the NAME of the Com-Port (e.g. COM23) into "serial line", "9600" into speed, and type the name of the COM-Port (e.g. COM23) into the "Saved Sessions Field". Press "Save".

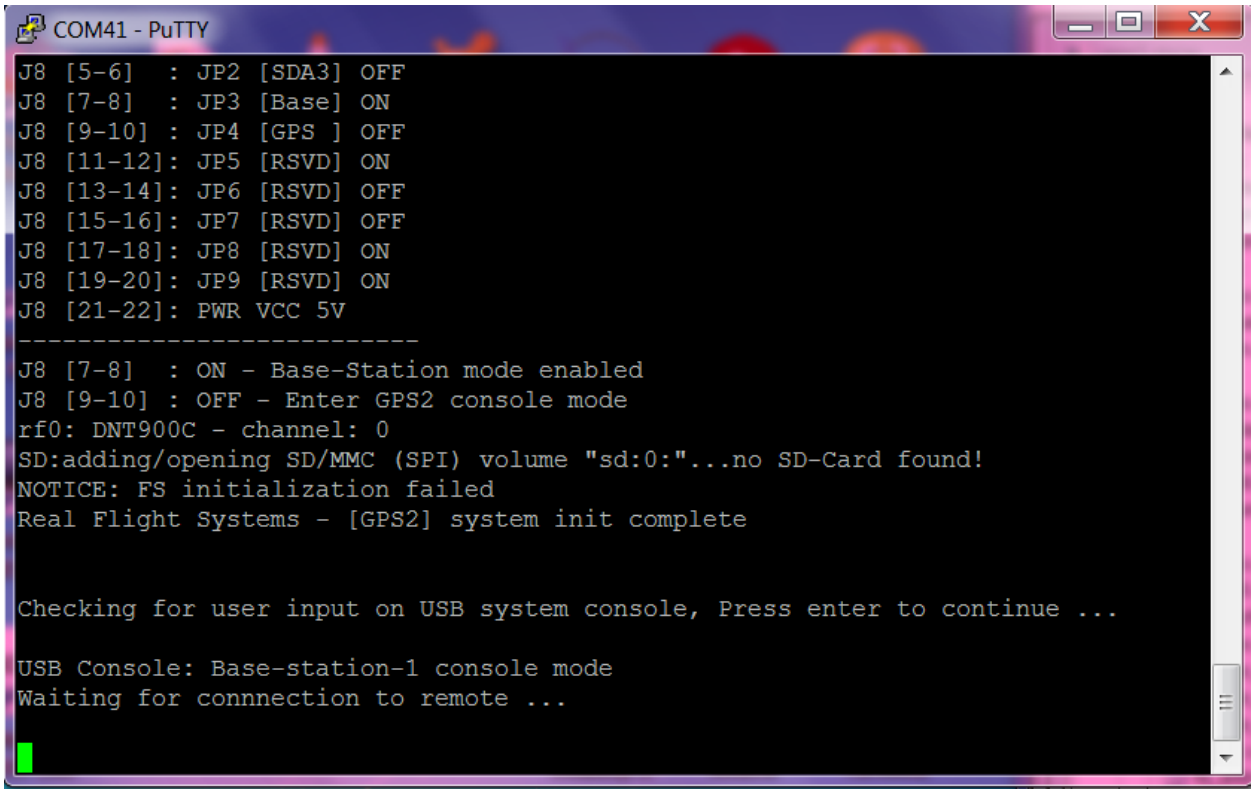


3. Next, click on the Serial item on the list to the left titled "Category"

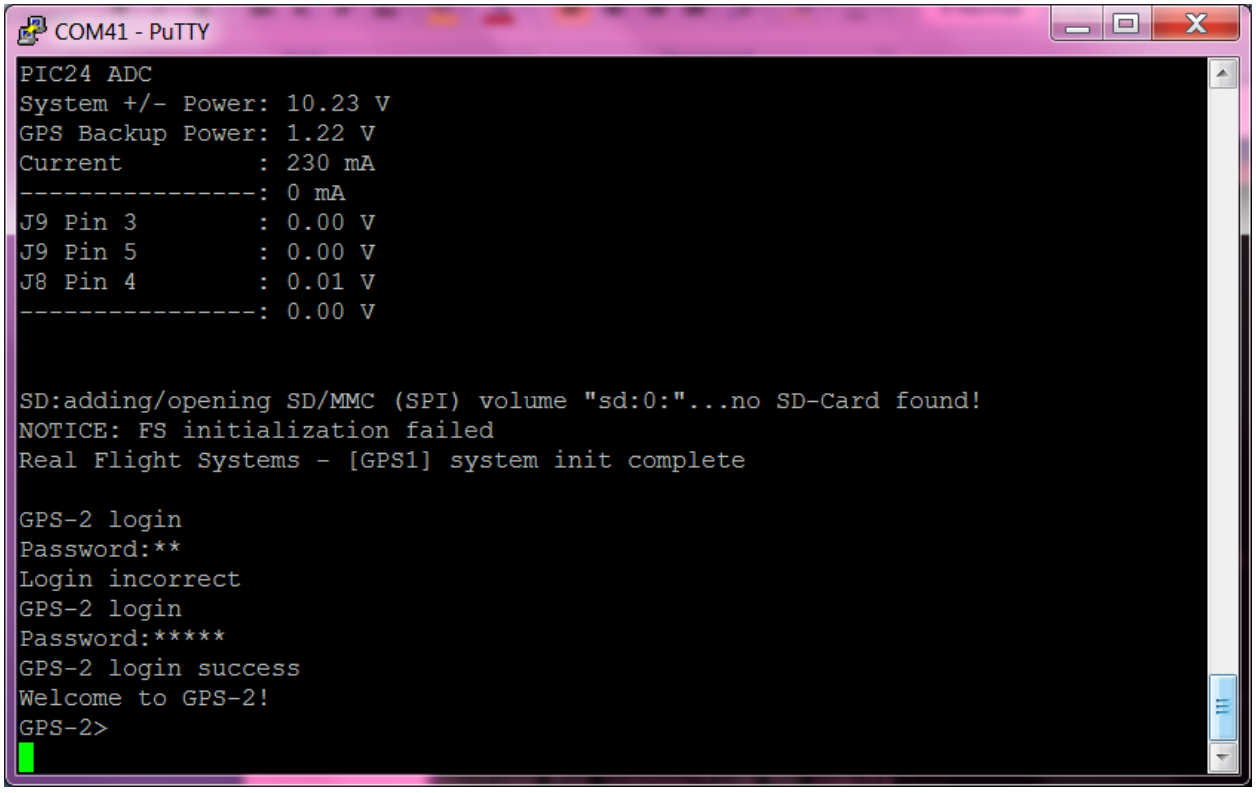


4. Confirm flow control off and 8,1,N serial settings. *Note that the default settings for the Putty terminal emulation program have XON/XOFF selected!* Keep in mind that if you use a new USB port on Windows, you may have to go through this process again (a well endowed desktop system may support dozens of USB ports). When satisfied with the new connection profile click on “Session” (under Category) to return to the previous menu. Press “Save”, then press “Open”.
5. Now, the next time you run Putty you may load the configuration and just press “Open”.

6. Now start putty and reboot the Base station (power cycle)
7. Press enter when the prompt below is seen. NOTE: if the enter key is not pressed (e.g. you type nothing when the Base station boots), the USB connection acts as an NMEA output console allowing other programs (e.g. ExpertGPS) to perform real-time mapping of the data.



8. Boot the GPS-1 transmitter with the jumper removed. Note, one should be careful removing the 2MM jumper, it is not designed to be pried off. Use a small-tipped flat-head screw-driver and gently lift up on the bottom of the jumper.



9. Login using the default password **rfs1** - commands may now be issue to the Telemetry transmitter.

APPENDIX-2 GPS-1 COMMAND REFERENCE (BASESTATION-1 ONLY)

gps – go into GPS mode, press "x" to exit

adc – show adc

stat – show statistics

restore – restore defaults

save – save configuration

pass <password> - set the password

reboot – reboot the system

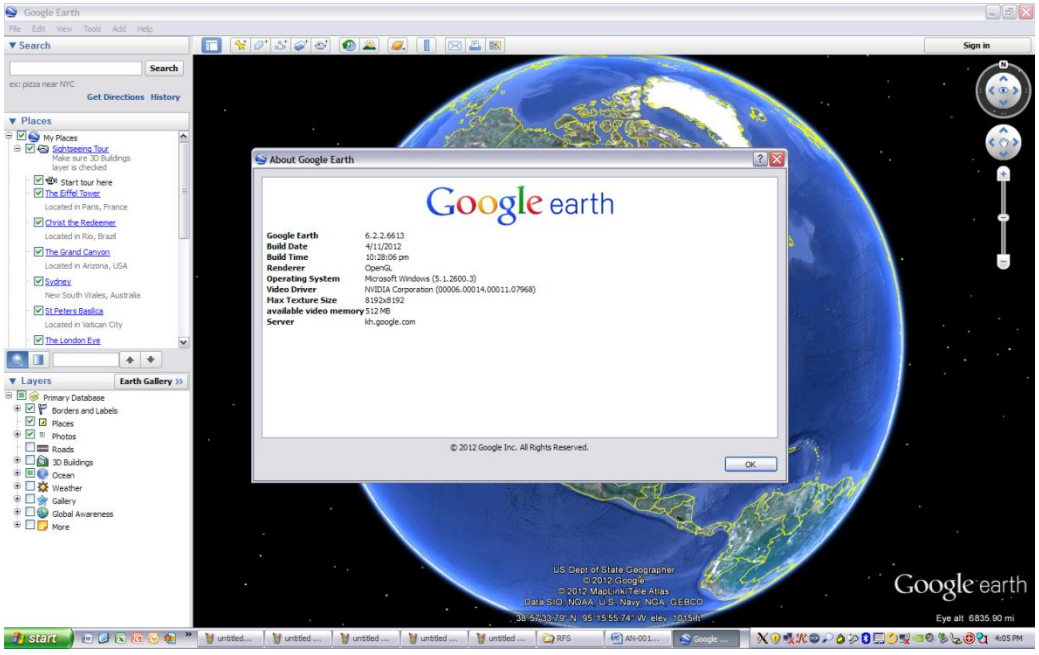
tz <offset> – set timezone offset (firmware versions 1.01 and later)

e.g. "tz +8" will set to PST time. (NOTE: use "save" command to make persist across reboots)

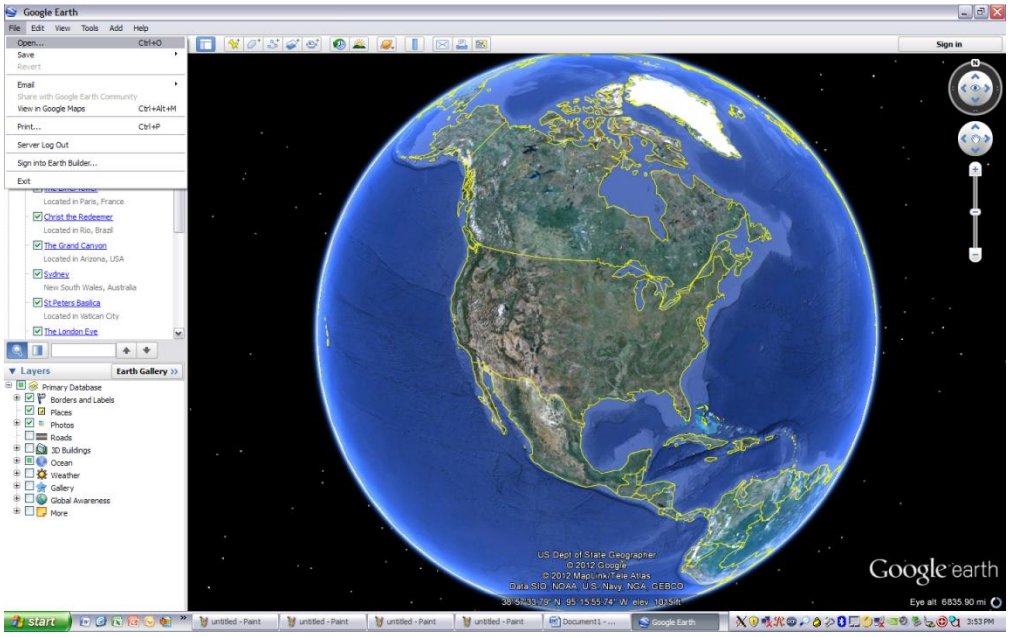
OPENING NMEA DATA FILES WITH GOOGLE EARTH

1) GPS Log files are stored as gpslogXX.log resulting in up to 100 files being named gpslog00.log to gpslog99.log. The date and time stamp of the file is updated every time the file is updated with GPS data. Note that the timestamps are stored in GMT time (which is GPS native time) by default. Basestation-1 users may change the timezone for localtime
2) Launch Google Earth, the version used is as shown (6.2.2.6613)

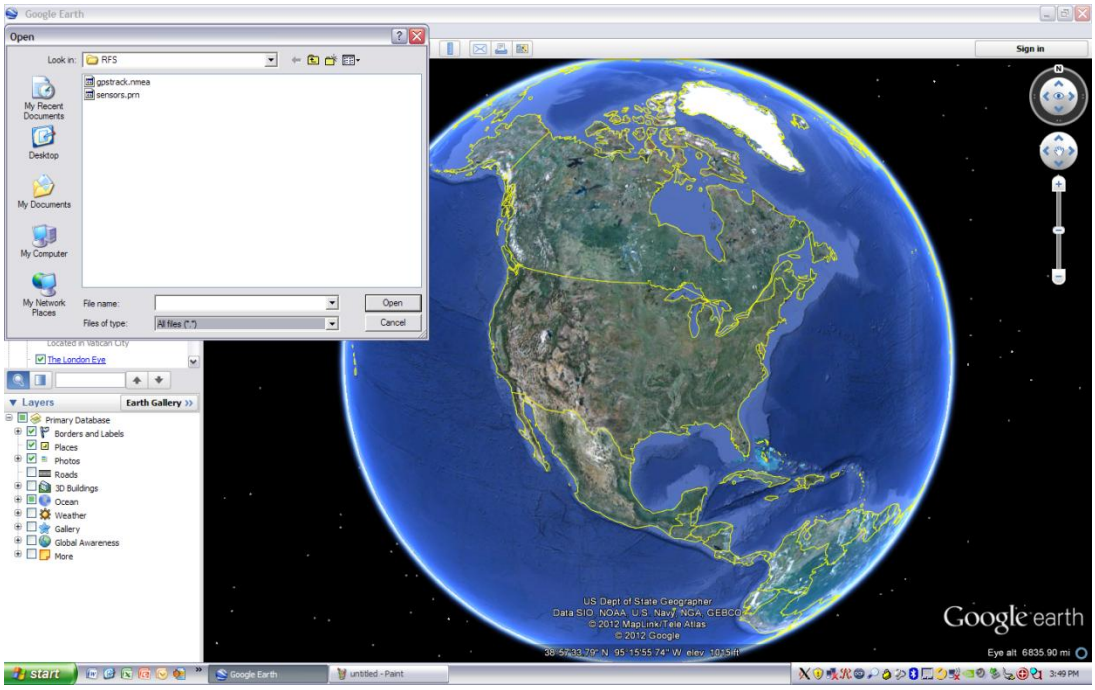
CHECK VERSION



FILE->OPEN

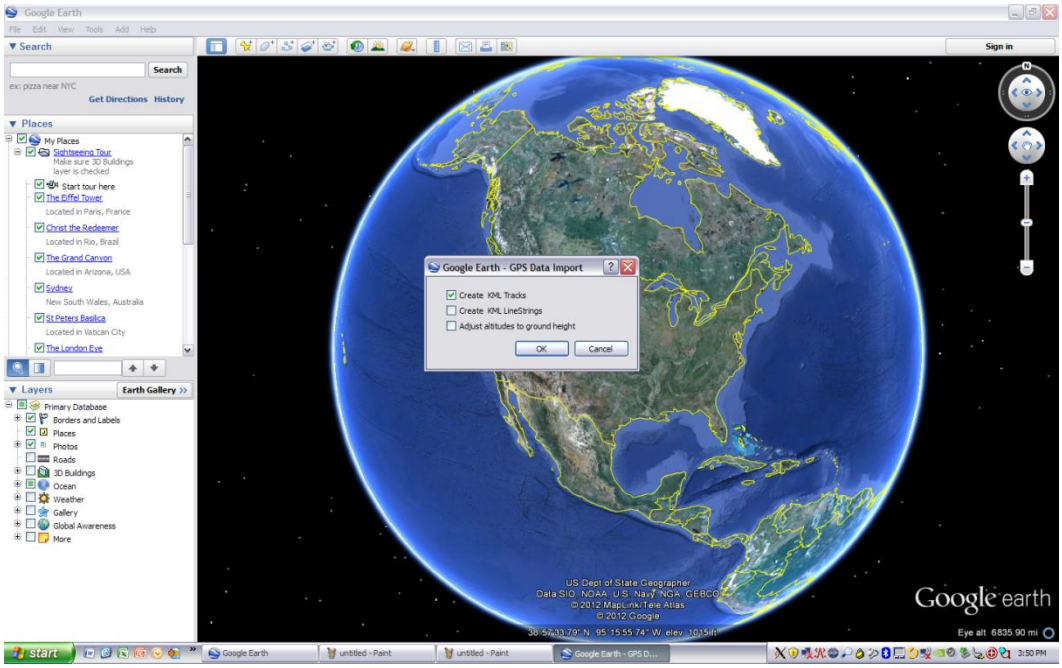


SELECT "ALL FILES"



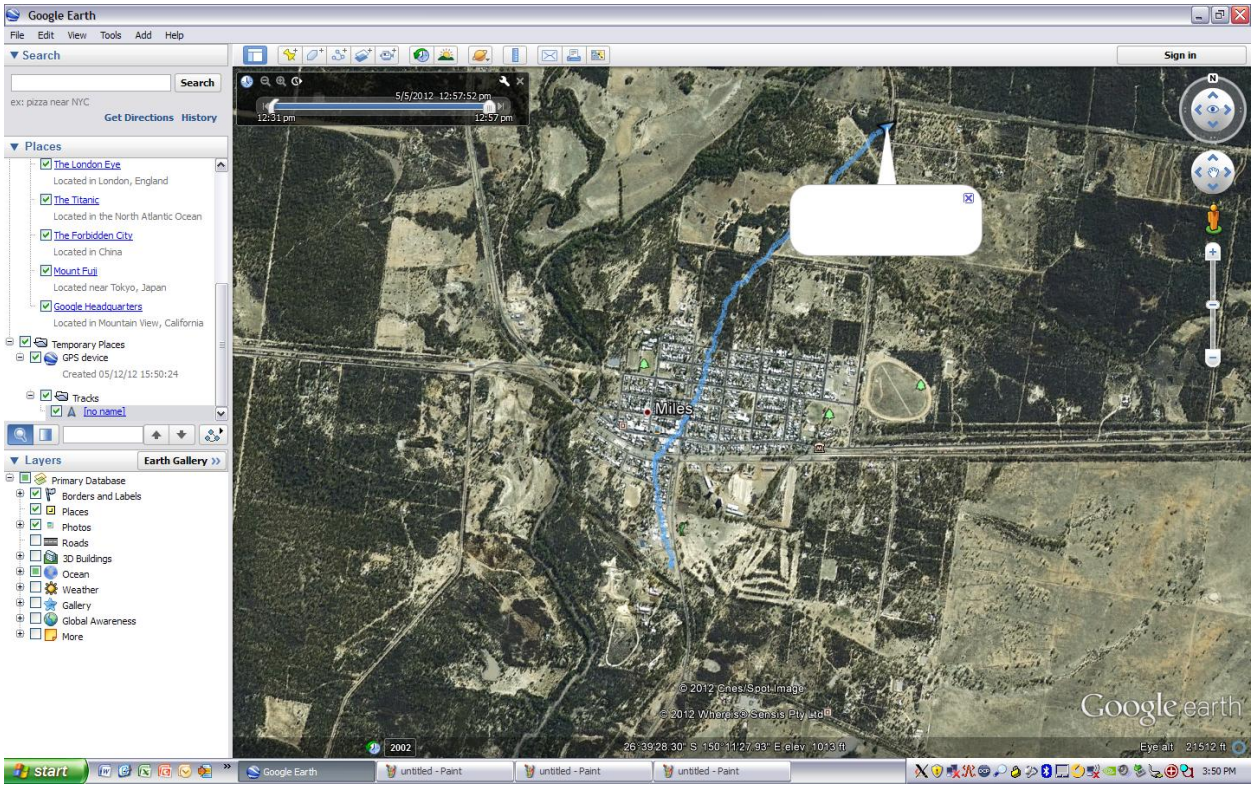
Double click on the NMEA data file (gpslogXX.log (where XX=0-99). A Dialog is presented to show options for the NMEA data-file import.

SELECT IMPORT OPTIONS



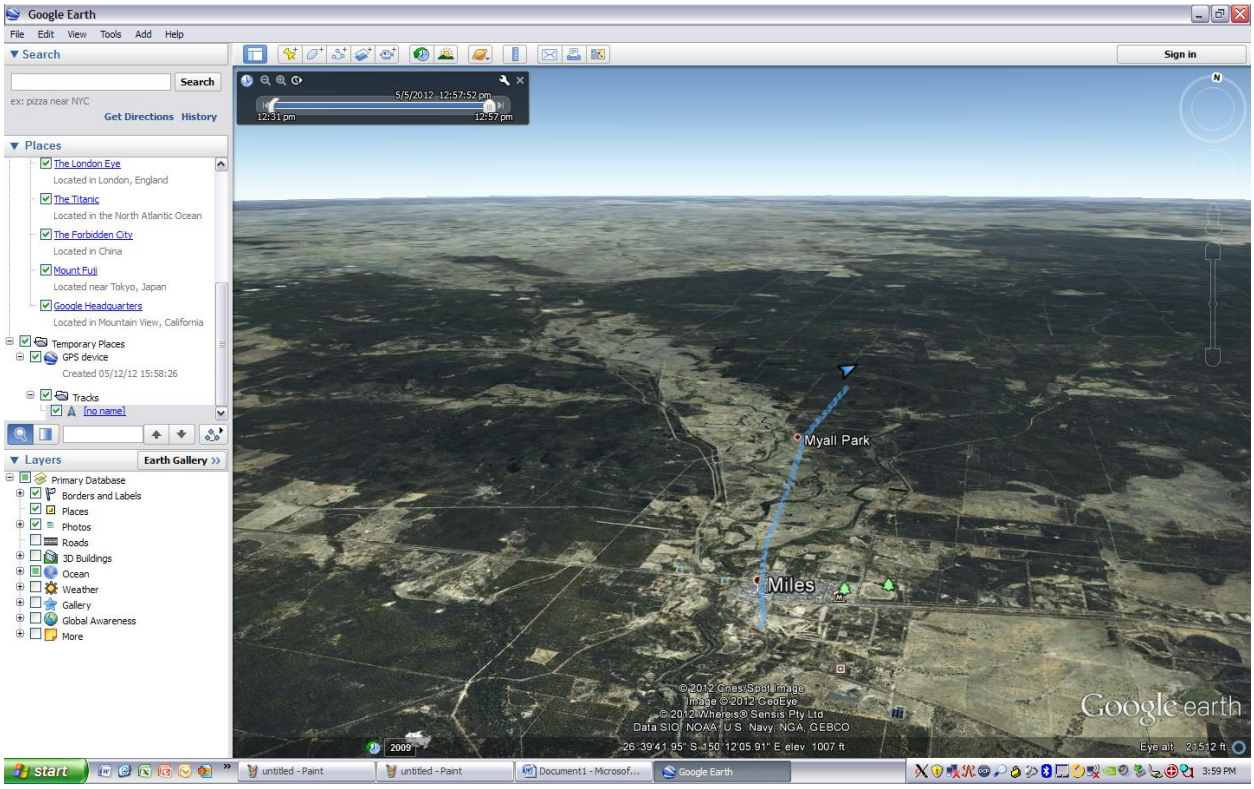
The above dialog is display, Select “Create KML Tracks”, deselect other options.The file is opened and the Globe will move to the tracks just imported.

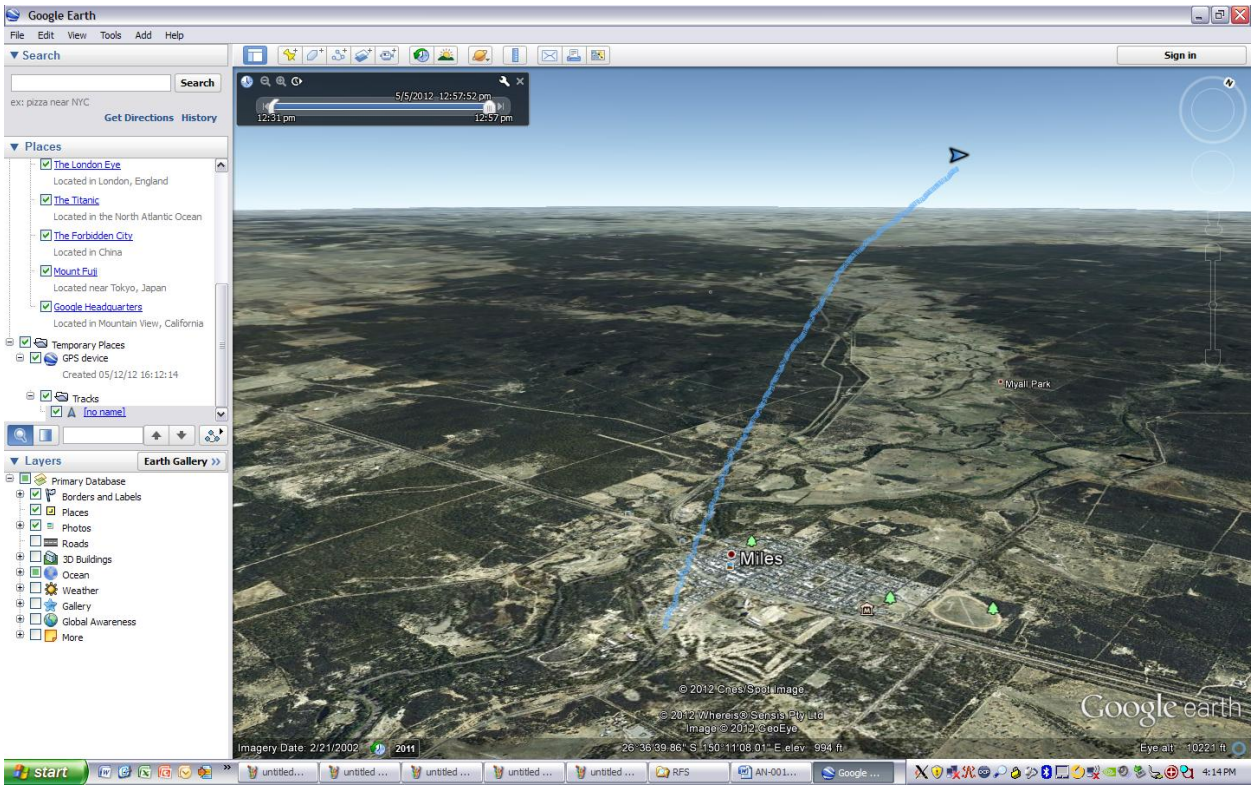
MOVE TO LOCATION



Double clock on the GPS Device, then click on the Tracks, and then the Arrow symbol entitled “No Name”. Google Earth will Zoom in on the area of interest, you can move the Google earth knobs to get a better view of the data.

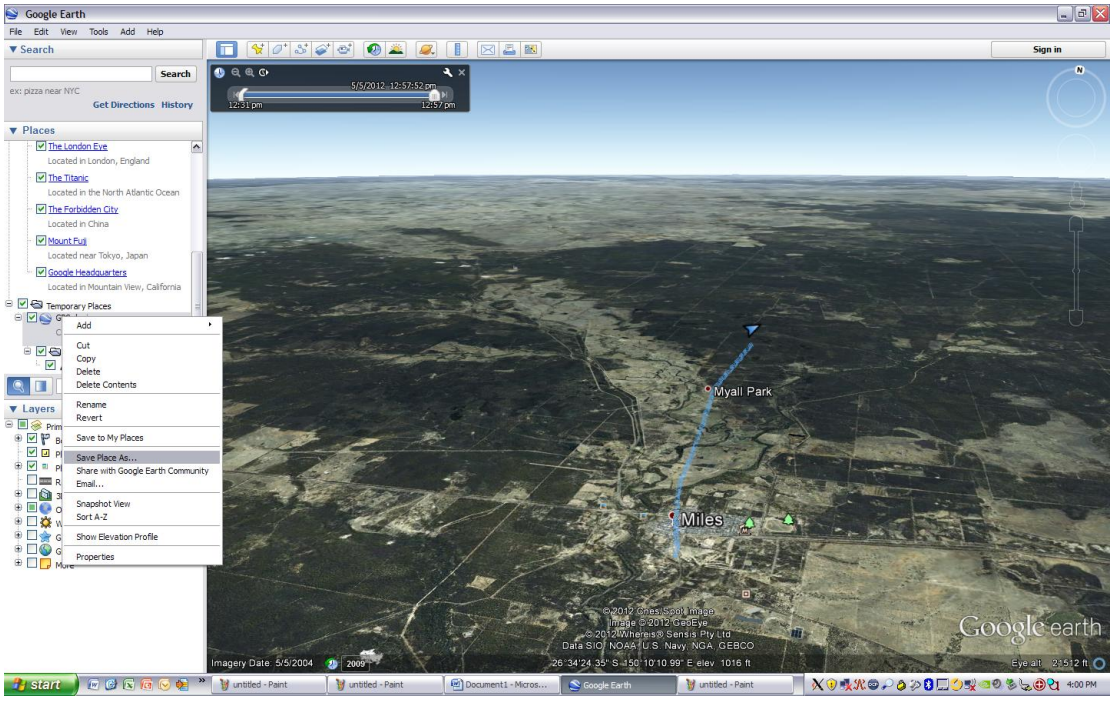
REPOSITION VIEW

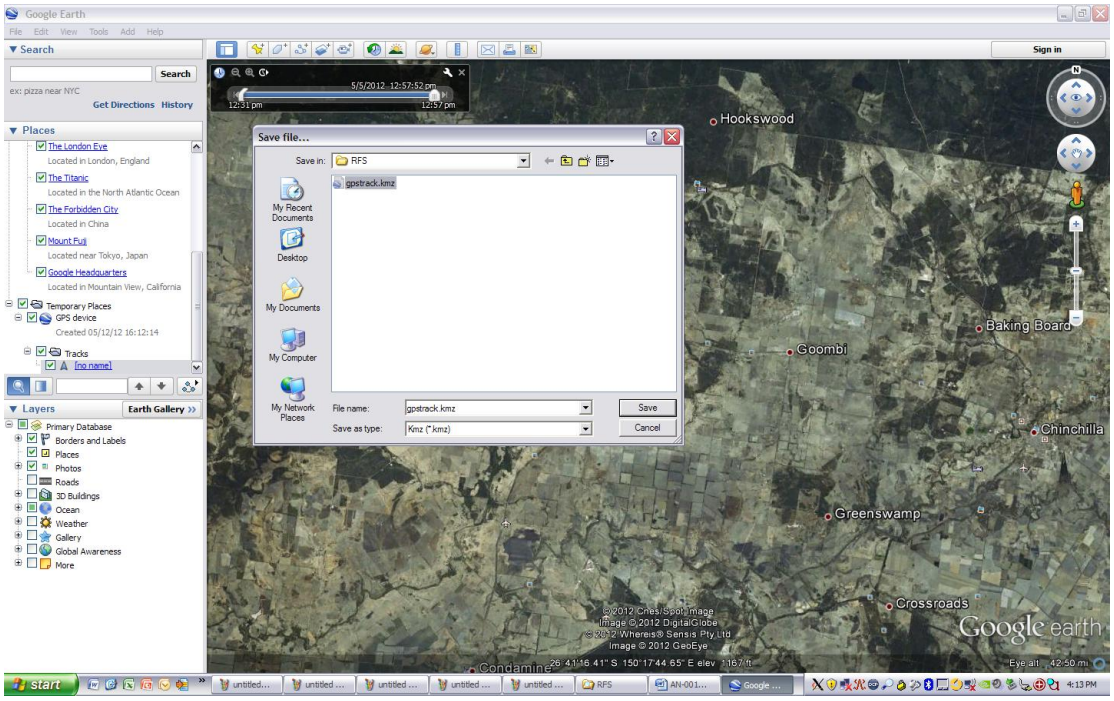




SAVE GPS TRACK AS KMZ FILE

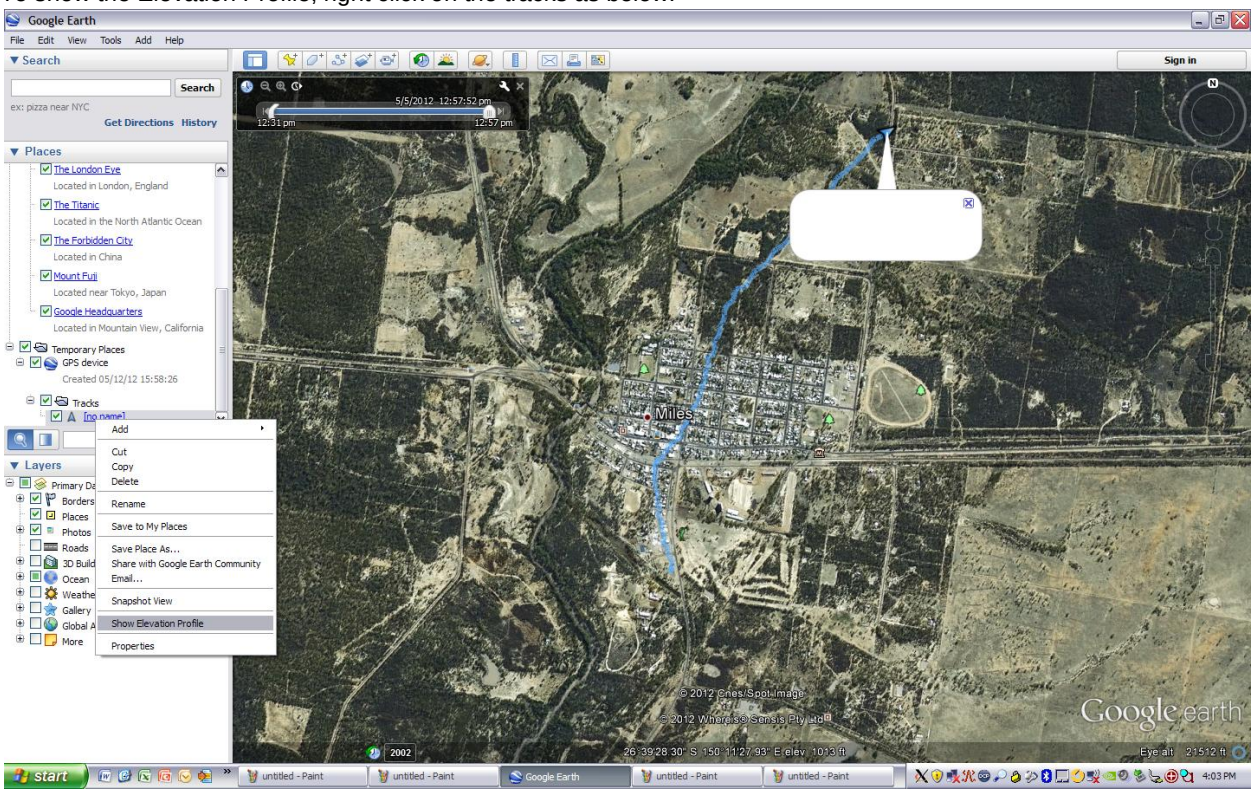
Right click on the GPS Device and select “Save Place as”

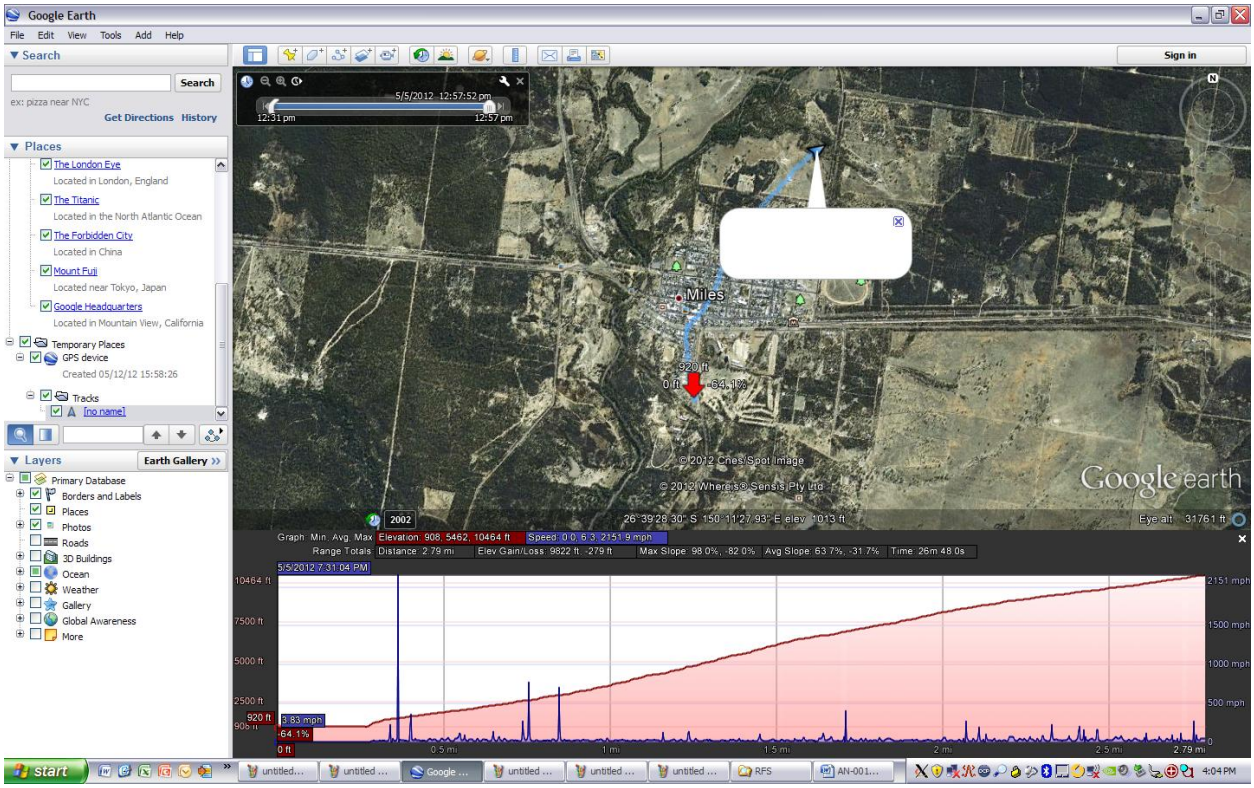




ELEVATION PROFILE.

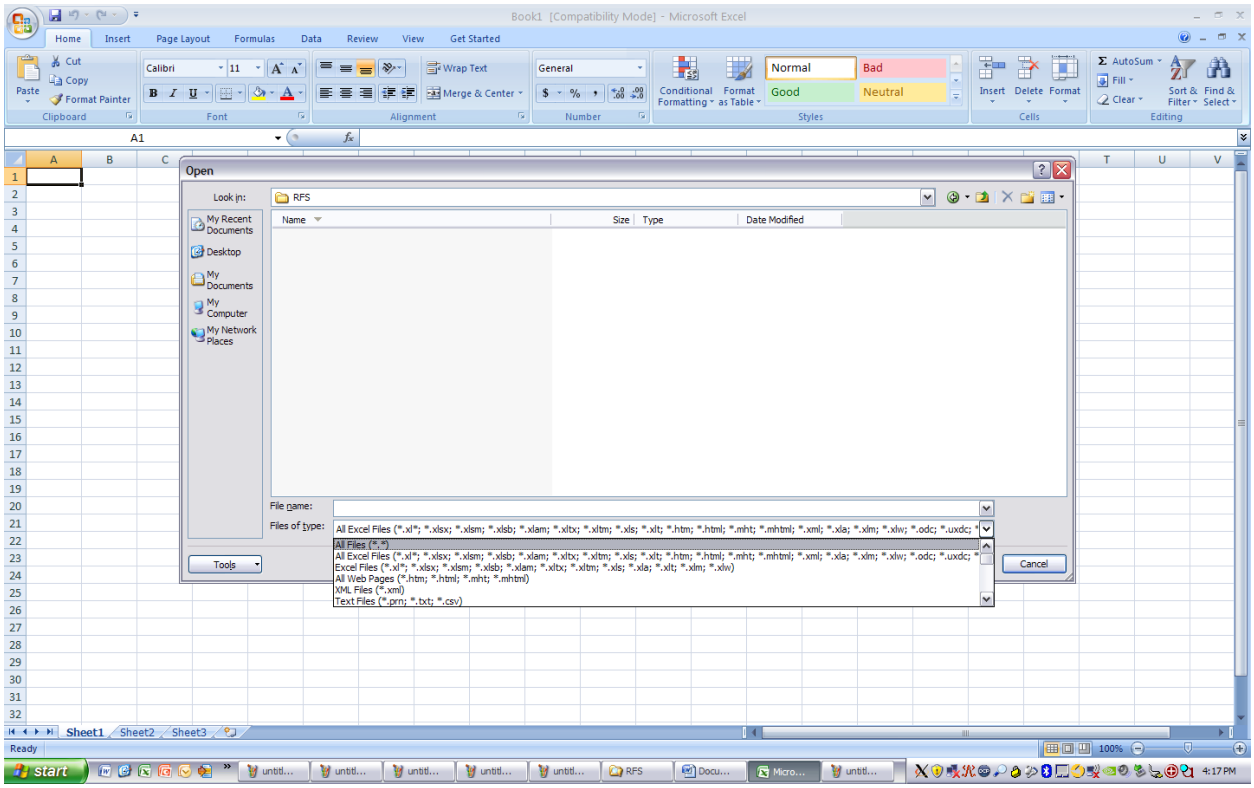
To show the Elevation Profile, right click on the tracks as below:



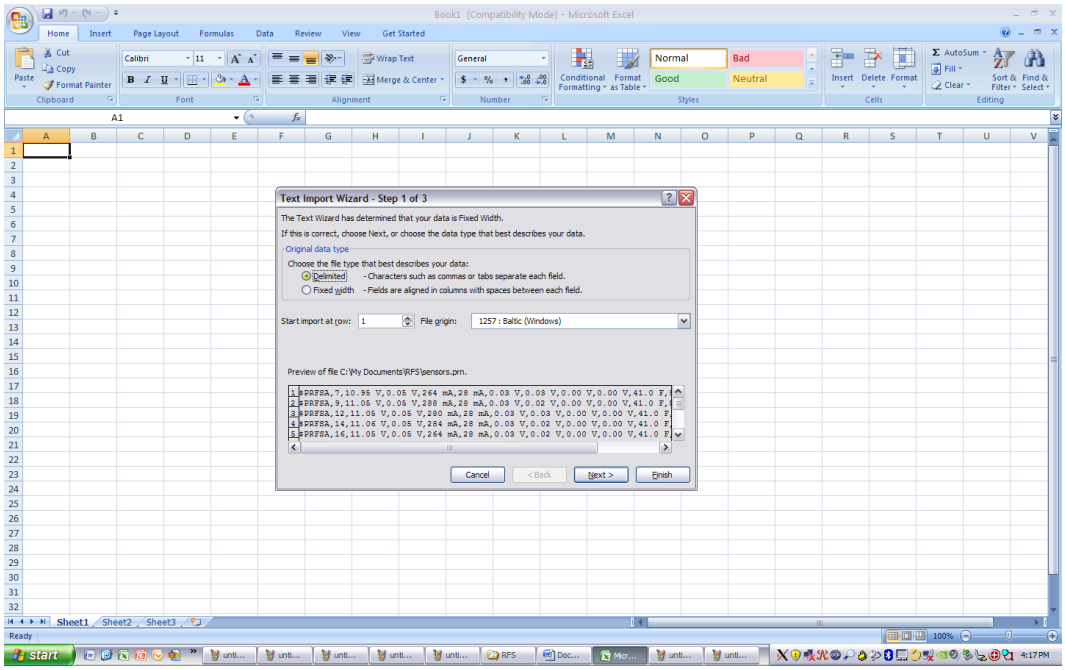


IMPORTİNG SENSOR DATA İNTO MİCROSOFT EXCEL

1) Launch Microsoft Excel, File->Open, All Files Selected

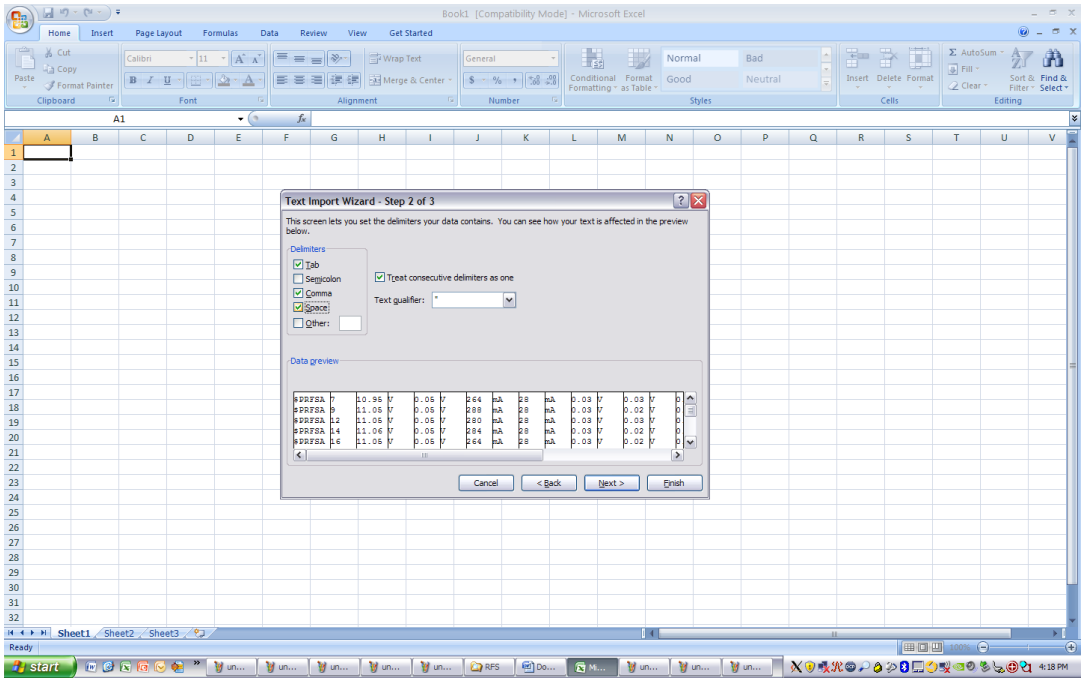


IMPORT WİZARD PAGE ONE



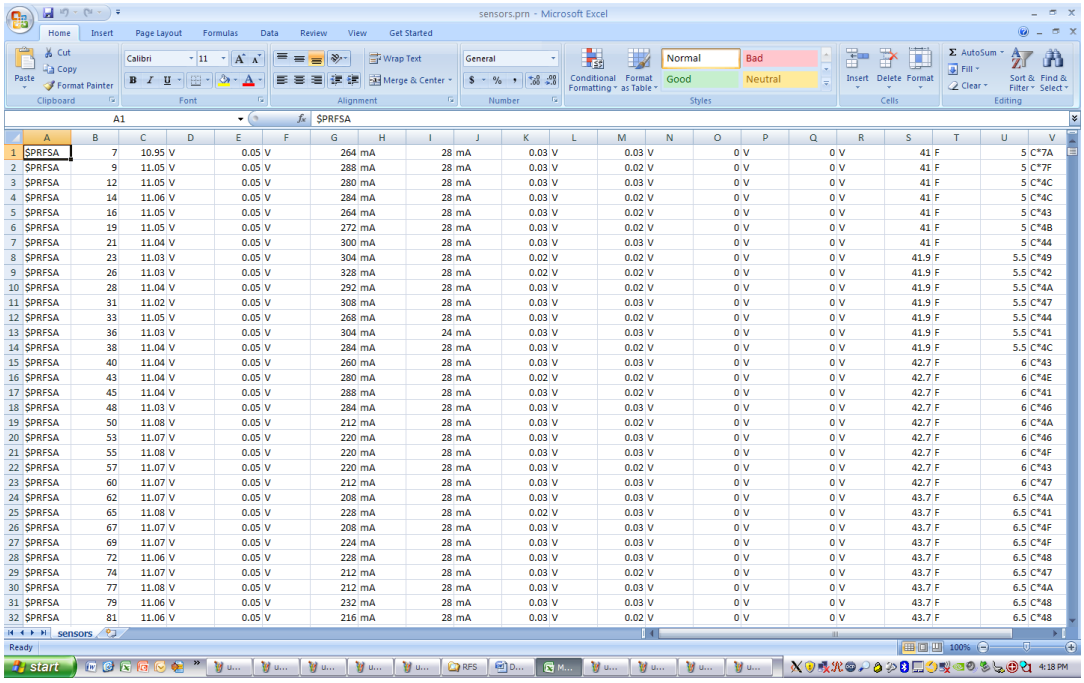
Select Delimited File, Press Next

WIZARD PAGE TWO: SELECT DELIMITERS



Select Tab, Comma, Space, and option “Treat consecutive delimiters as one”, “Text pattern” is “*”, press Finish”

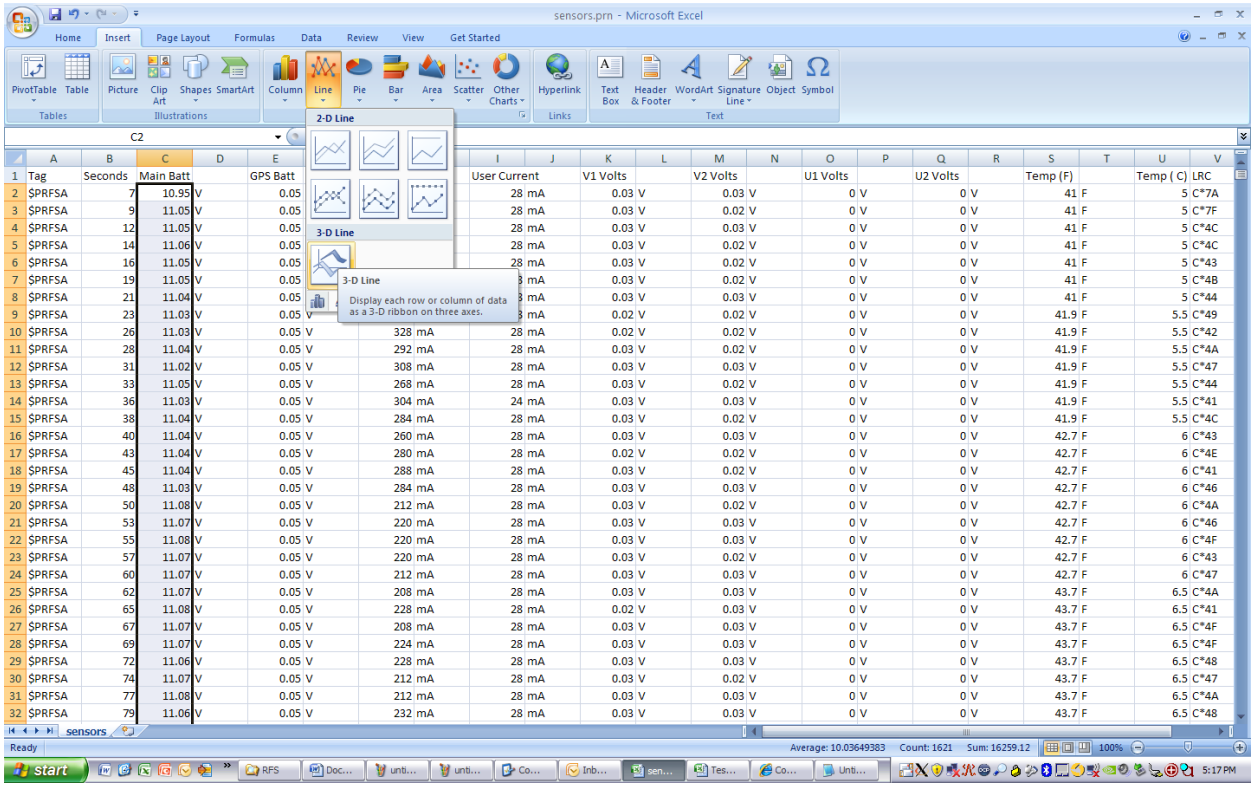
DATA IMPORTED

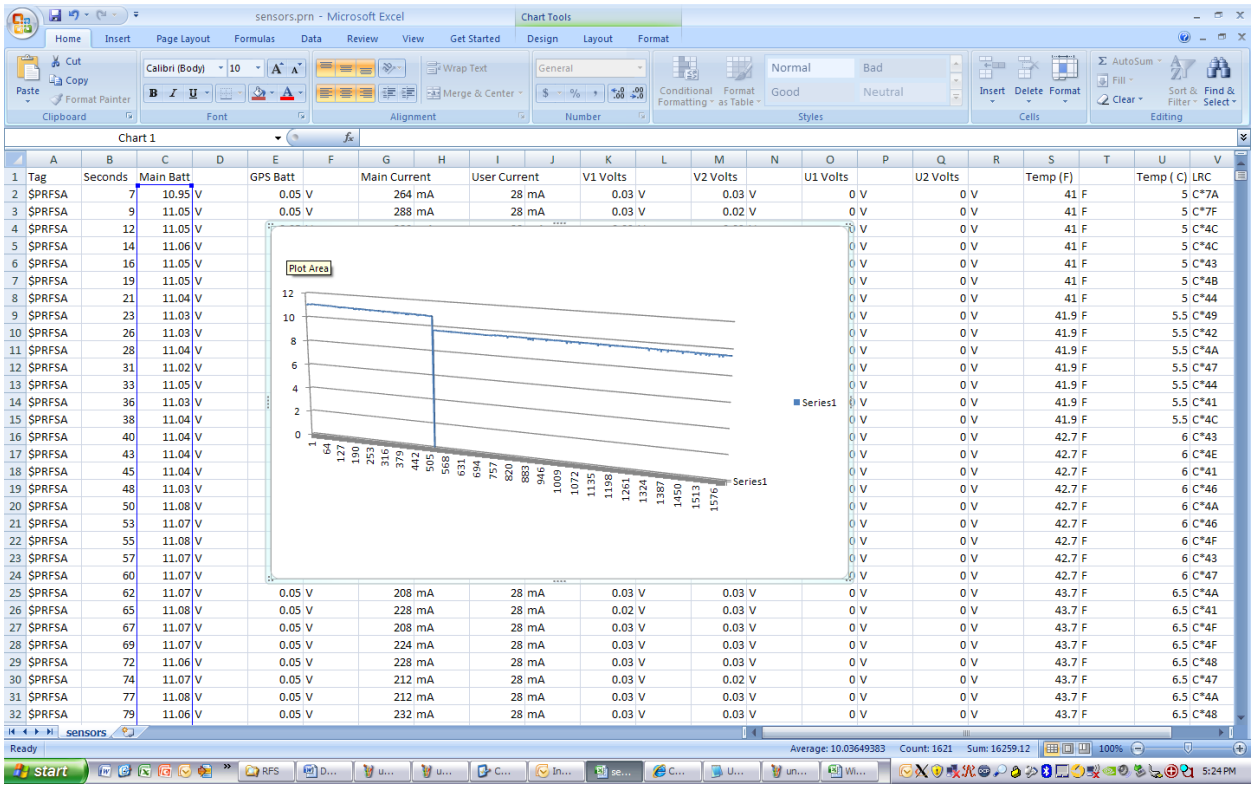


Insert Row for Labels, press “ALT+i+r” to insert a row with the cell cursor centered at 1A, the labels are as below:

Tag,Seconds,Main Batt,GPS Batt,Main Current,User Current,V1 Volts,V2 Volts,U1 Volts,U2 Volts,Temp (F),Temp (C),LRC

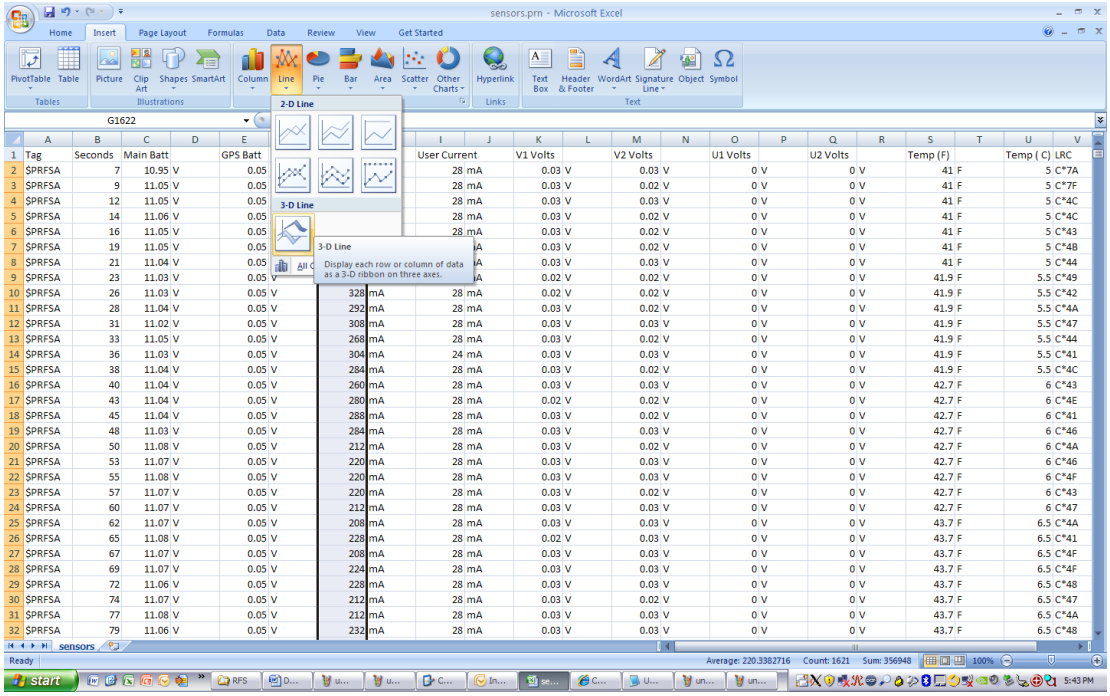
PLOT MAIN BATTERY VOLTAGE

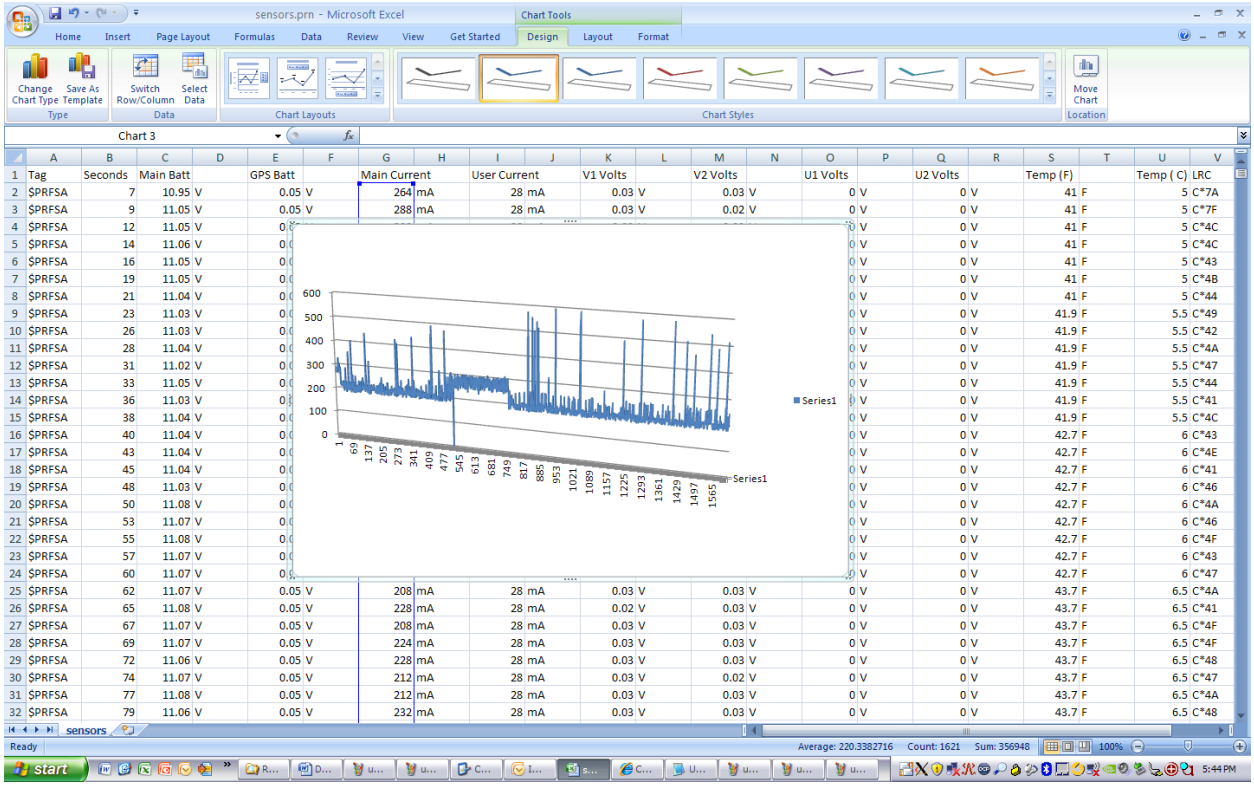




Select all Main Batt cells, press Insert->Chart,etc.

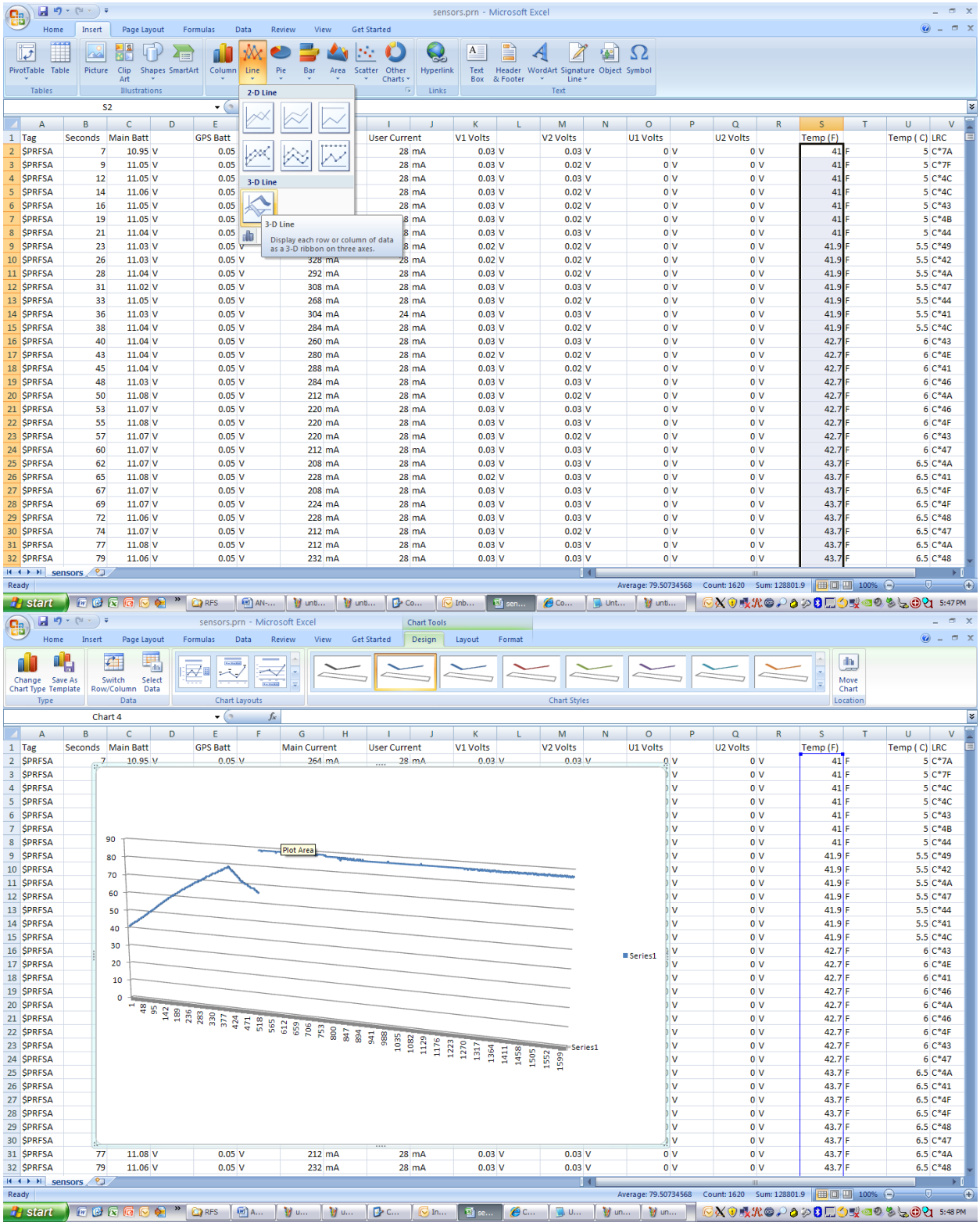
PLOT MAIN BATTERY CURRENT





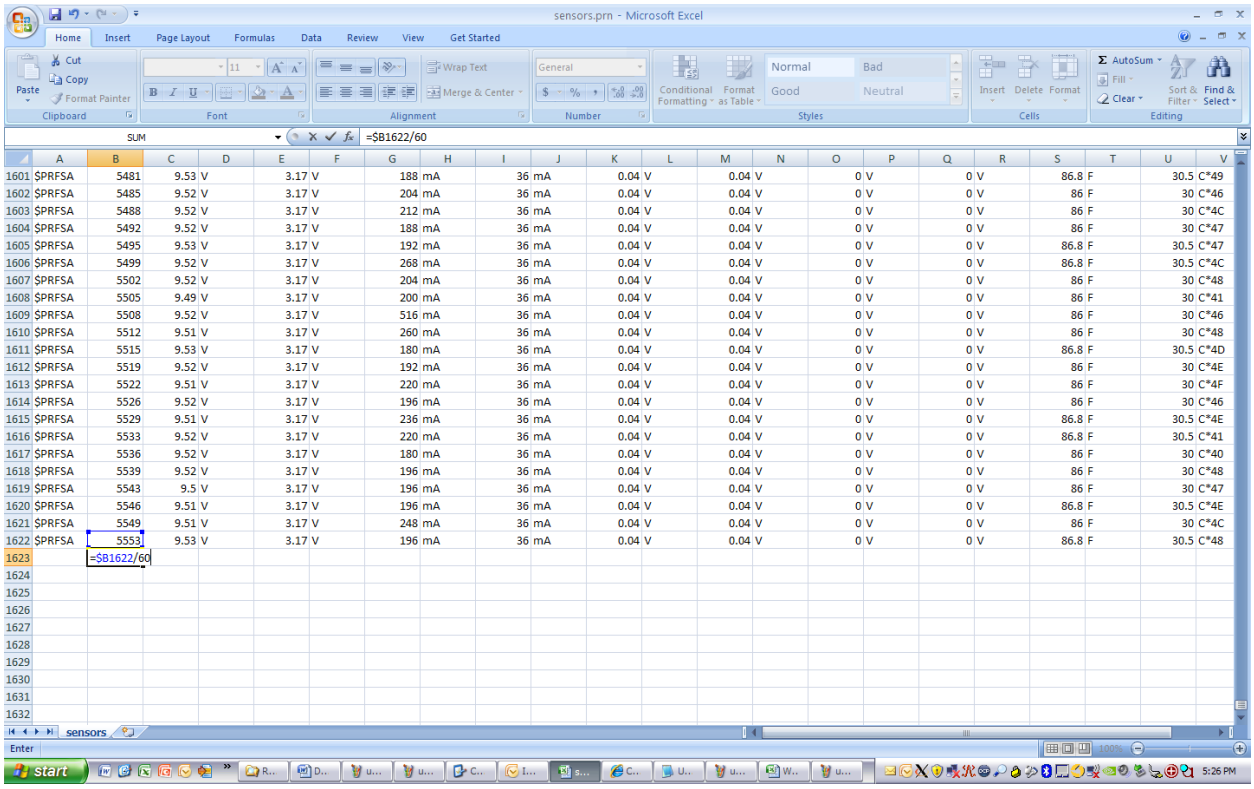
Select the Main current column, select Insert, Chart->3DLine and notice the plot.

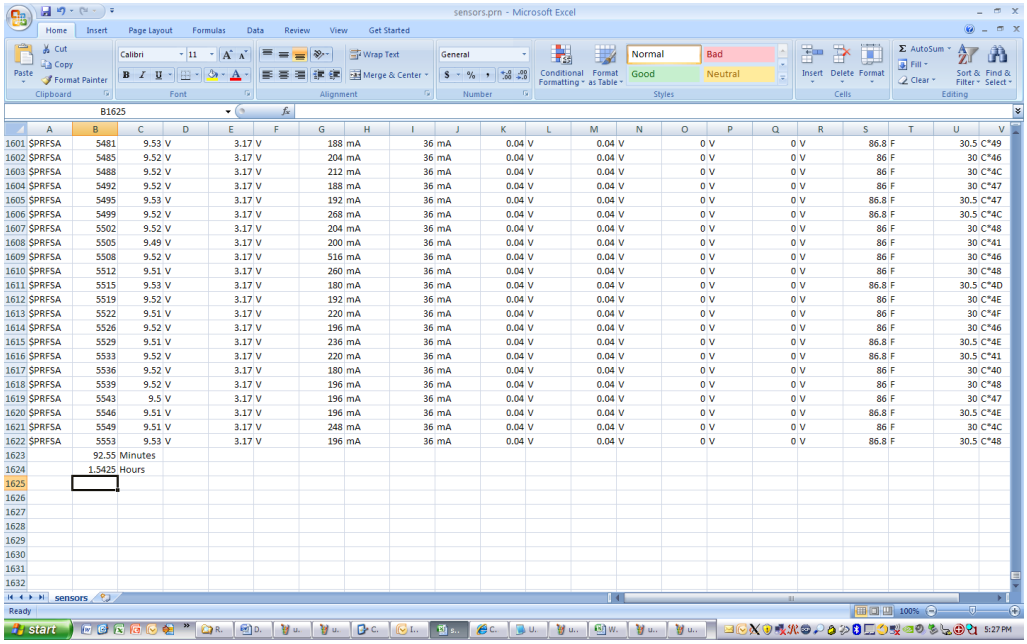
PLOT TEMPERATURE



Select the Temperature (F) row (all cells). Select the Insert 3D Line chart option.

TOTAL TIME RUNNING





Select the last row of seconds data, divide by 60 for minutes, divide that result by 60 for hours.

Important Regulatory Information
RFM Product FCC ID: HSW-DNT900P
IC 4492A-DNT900P

Note: This unit has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their expense.

DISCLAIMER

WARNING: All liability waived. Rocketry is an inherently dangerous undertaking. Make your choices and take personal responsibility for the outcome of your endeavors, protect your privilege to fly rockets by not making the headlines or becoming a statistic.