

# u-blox GPS Receiver Overview

## ***GPS upgrade for High Power Rocketry > 164K MSL***

This document outlines expected behavior and configuration of u-blox Global Navigation Satellite Systems (GNSS) receiver chipsets for high power rocket users in the high dynamic platform model. It forms the basis of data capture and reporting for all u-blox based receivers used by manufacturers for Tripoli altitude records.

The well defined operational limits and expected behaviour of the Airborne platform model for u-blox chipsets allows for high fidelity flight recording telemetry. Furthermore, the new series 9 u-blox GNSS Receiver chipsets are highly recommended for altitude and record submissions on flights up to 262,467 ft MSL (80km MSL). These new chipsets not only provide the new improved 262,467ft MSL ceiling, but the ability to log velocity data as well as integrated data/crash-logger capability using internal FLASH.

## u-blox 4-8 (164K' GNSS Receivers) Operational Limits

u-blox series 4-8 support the following operational limits (in Airborne < 4g platform mode):

- **Dynamics: < 4g**
- **Altitude: 164,042' MSL (50km)**
- **Velocity: 1118.47 MPH (500 m/s, or 1,640 ft/sec, Mach 1.5)**

See the [NEO-6 Datasheet](#), Table 2: NEO-6 GPS performance which is representative of all Series 4 through 8 receivers in Airborne <4g platform mode (CFG-NAV5).

## u-blox 9 (262K' GNSS Receiver) Operational Limits

u-blox series 9 support the following operational limits (in Airborne < 4g platform mode):

- **Dynamics: < 4g**
- **Max Altitude: 262,467' MSL (80km)**
- **Max Vertical Velocity: 44,739 MPH (20 km/s, or 65,616 ft/sec, Mach 60)**
- **Max Horizontal Velocity: 1118.47 MPH (500 m/s, or 1,640 ft/sec, Mach 1.5)**

See the [NEO-9M Integration Manual](#) Table 4, P. 12 (Dynamic Platform Details) Airborne < 4 g where the most distinguishing difference is the new 80km ceiling altitude and the vertical velocity supporting beyond anything Amateur rockets would need.

# Featureset Summary and Manufacturer Recommendations

- Dynamic mode (e.g. Airborne < 4g)
- Datum: WGS84 NMEA GPGGA,GPRMC, UBX UBX-NAV-PVT, custom per agreement.

## u-blox 4, 5, 6, 7, 8

- Altitude to 164K MSL (50Km)
- Velocity to Mach 1.5
- Series 7, 8 models support Integrated Data logger

13	GND	GND	12
14	LNA_EN / Reserved	RF_IN	11
15	Reserved	GND	10
16	Reserved	VCC_RF	9
17	Reserved	RESET_N	8
18	SDA / SPI CS_N	VDD_USB	7
19	SCL / SPI SCLK	USB_DP	6
20	TXD / SPI MISO	USB_DM	5
21	RXD / SPI MOSI	EXTINT	4
22	V_BCKP	TIMEPULSE	3
23	VCC	D_SEL	2
24	GND	SAFEBOOT_N	1

## u-blox 9

- Altitude to 262K MSL (80km)
- Velocity to Mach 60
- Horizontal Velocity to Mach 1.5
- Integrated FLASH Data logger

13	GND	GND	12
14	LNA_EN	RF_IN	11
15	Reserved	GND	10
16	Reserved	VCC_RF	9
17	Reserved	RESET_N	8
18	SDA / SPI CS_N	V_USB	7
19	SCL / SPI SCLK	USB_DP	6
20	TXD / SPI MISO	USB_DM	5
21	RXD / SPI MOSI	EXTINT	4
22	V_BCKP	TIMEPULSE	3
23	VCC	D_SEL	2
24	GND	SAFEBOOT_N	1

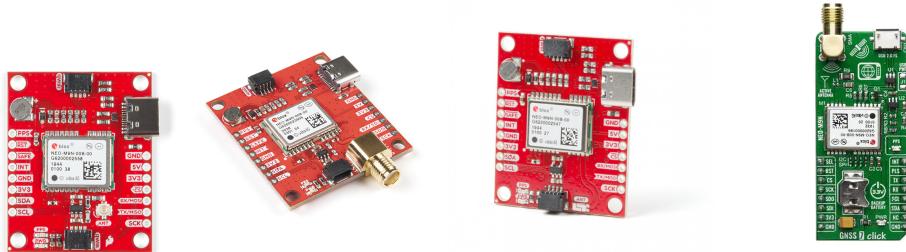
## Recommendations

- u-blox builds their modules based around form factors. The name of the module (NEO, ZED, LEA) represents the footprint, so any module that has a NEO prefix is pin to pin footprint compatible. That would include the NEO-M8, NEO-M7, or even the new NEO-M9
- The M9 Series was announced October 2019, uBlox recommendation was to start with the NEO-M8 and then transition to the NEO-M9 when it went to MP, which you could drop in on the same board.
- The data logger in M9N does 10Hz! With USB, after flight one could use uCenter to download the log from the on-chip/module FLASH. Even 1hz data would be sufficient for records reporting.  
Use NEO Footprint for small form-factor LCC package which is pin-compatible across models (at least it has been for NEO-M8 to NEO-M9)
- Use Series 9 Receiver (NEO-M9N-00B)
- Use GPS Almanac Battery back-up for fast hot-starts
- Support USB interface to host computer for uCenter support

## Minimum Datum WGS84

- UBX-NAV-PVT, GPGGA

# 262K' GPS Logging for under \$100 !



New Approved 262, 467' MSL (80km) GPS Receivers (with Logging)

- [SparkFun GPS Breakout - NEO-M9N, Chip Antenna](#) (integrated antenna)
    - [Digikey Link](#)
  - [SparkFun GPS Breakout - NEO-M9N, U.FL](#) \*
- [Digikey Link](#)
- [SparkFun GPS Breakout - NEO-M9N, SMA](#) \*
  - [Digikey Link](#)
- [MikroElektronika MIKROE-3922 GNSS 7 CLICK](#) \*

\* External antenna required.

How to make your Own 80km logger

Using a USB cable on your device and the instructions below, you can configure your receiver for Airborne mode (up to 262K' MSL with velocity) and capture telemetry with the integrated FLASH data-logger on the NEO-M9N module.

- I. u-blox Airborne Mode Receiver Configuration (All Models)
- II. Output Formats
- III. Data Logger Configuration (Series 7/8/9 only)
- IV. Data Logger Retrieval (Series 7/8/9 only)
- V. View Data Logger Capture and Export KML for Google Earth

# I. u-blox Airborne Mode Configuration (All Models)

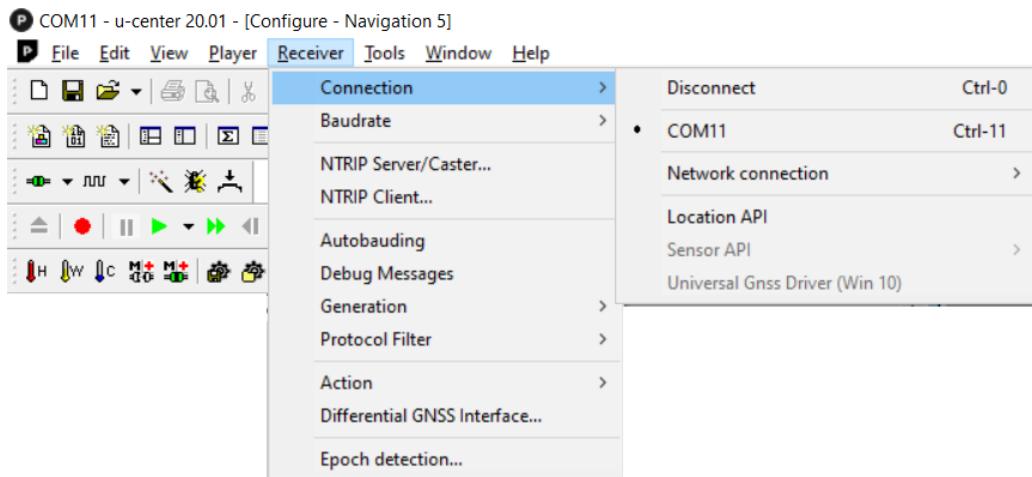
This configuration is required for all approved altitude reporting devices and is expected to operate on all u-blox chipsets (Series 4 through 9). This configuration procedure only applies to USB based systems and those pre-configured TRA approved devices need not perform this step (as it has already been done at the factory or by firmware).

## Prerequisites

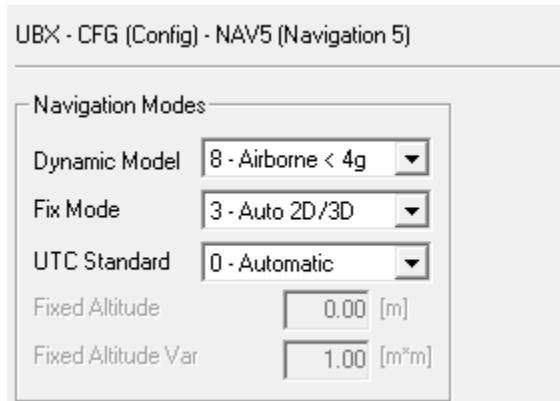
1. u-blox uCenter v20.00 or later (v21.05 recommended for Series 9 Receiver chipsets)
2. Host PC USB Connection to GNSS Receiver

## Configure NAV5 Dynamic Model - Airborne < 4g Platform Mode

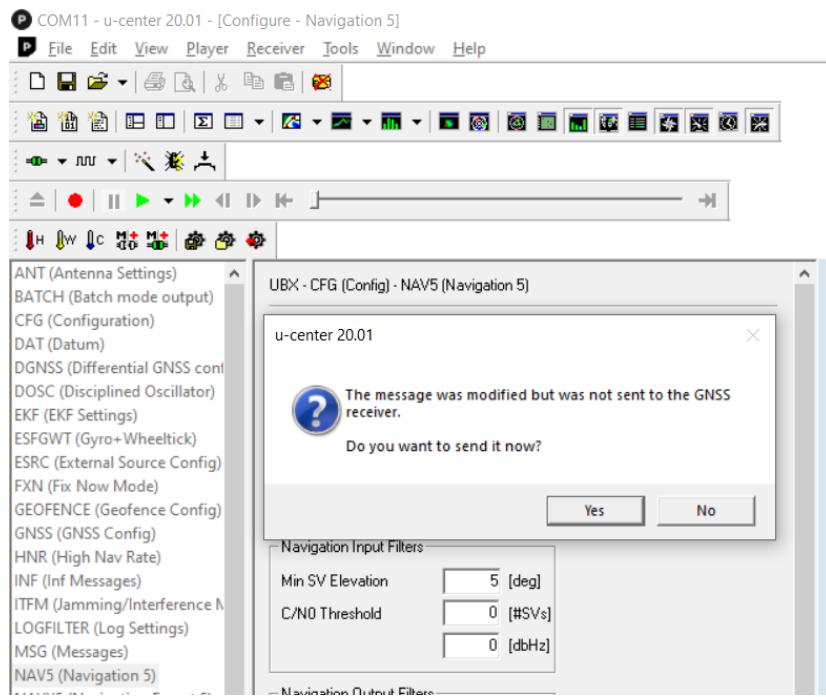
3. Connect the receiver to the PC via USB
4. Connect - Open uCenter and connect to the device (e.g. via USB connection). You can select “Connection” from the Receiver menu as below.



5. NAV5 - Select “View” and “Configuration View” to select GNSS receiver configuration, select the “NAV5 (Navigation 5)” List Item, select “8 - Airborne < 4g” for Dynamic Model under Navigation modes.

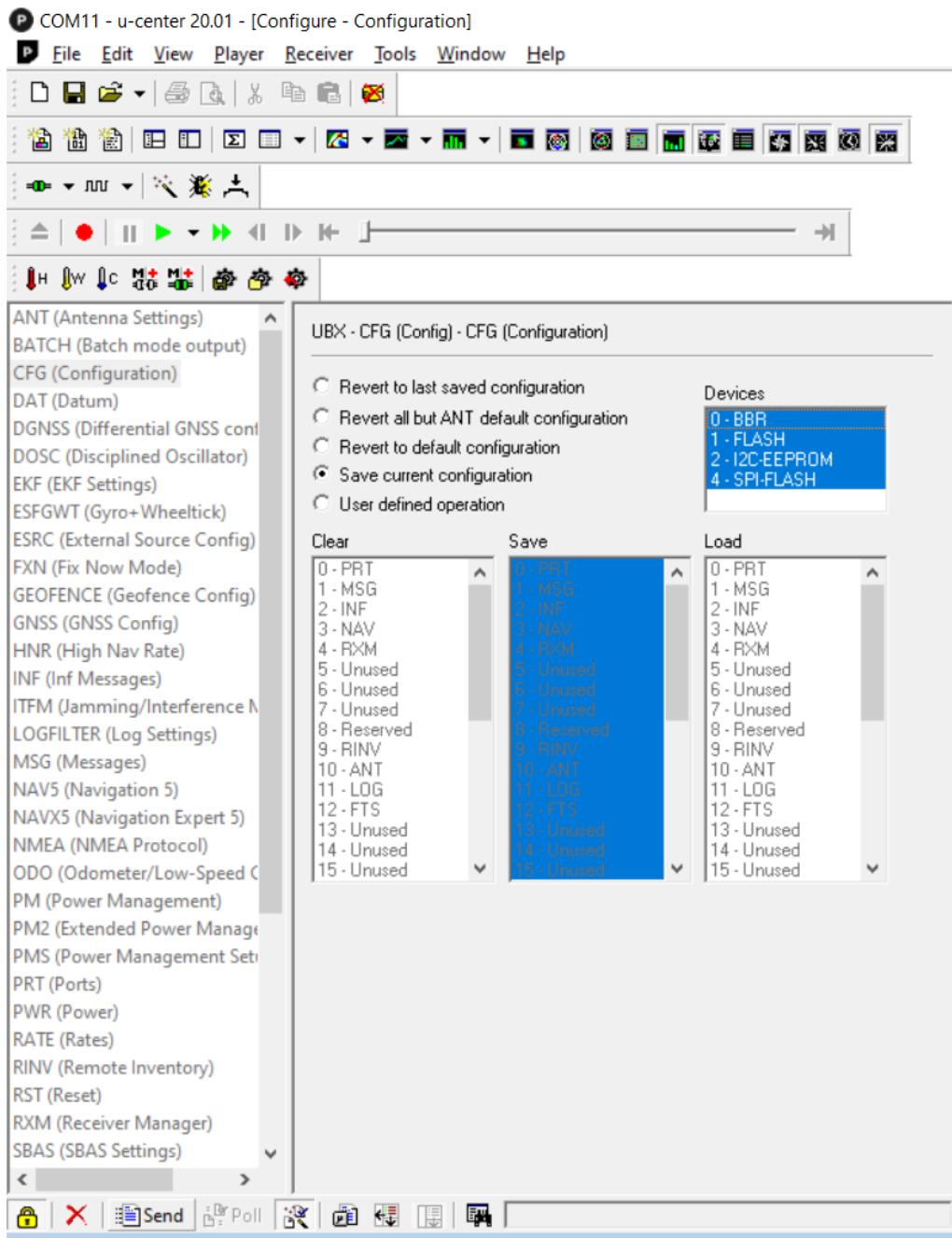


6. SAVE/Send - Selection “CFG (Configuration)” from the list on the left side, uCenter will detect the mode has changed. You should select “Yes” when prompted.



7. Note, you can also press the “Send” button at the bottom of the configuration view, after you have applied the change.
8. Also note that uCenter should always detect the change you made (if any) and will prompt you before committing (setting the chipset configuration) before allowing access to a new configuration page.

9. SAVE - CFG - select CFG (Configuration View), select all devices on the menu (e.g. BBR, FLASH, I2C EEPROM, SPI FLASH) and click “Send” at the bottom of the panel to save the configuration.

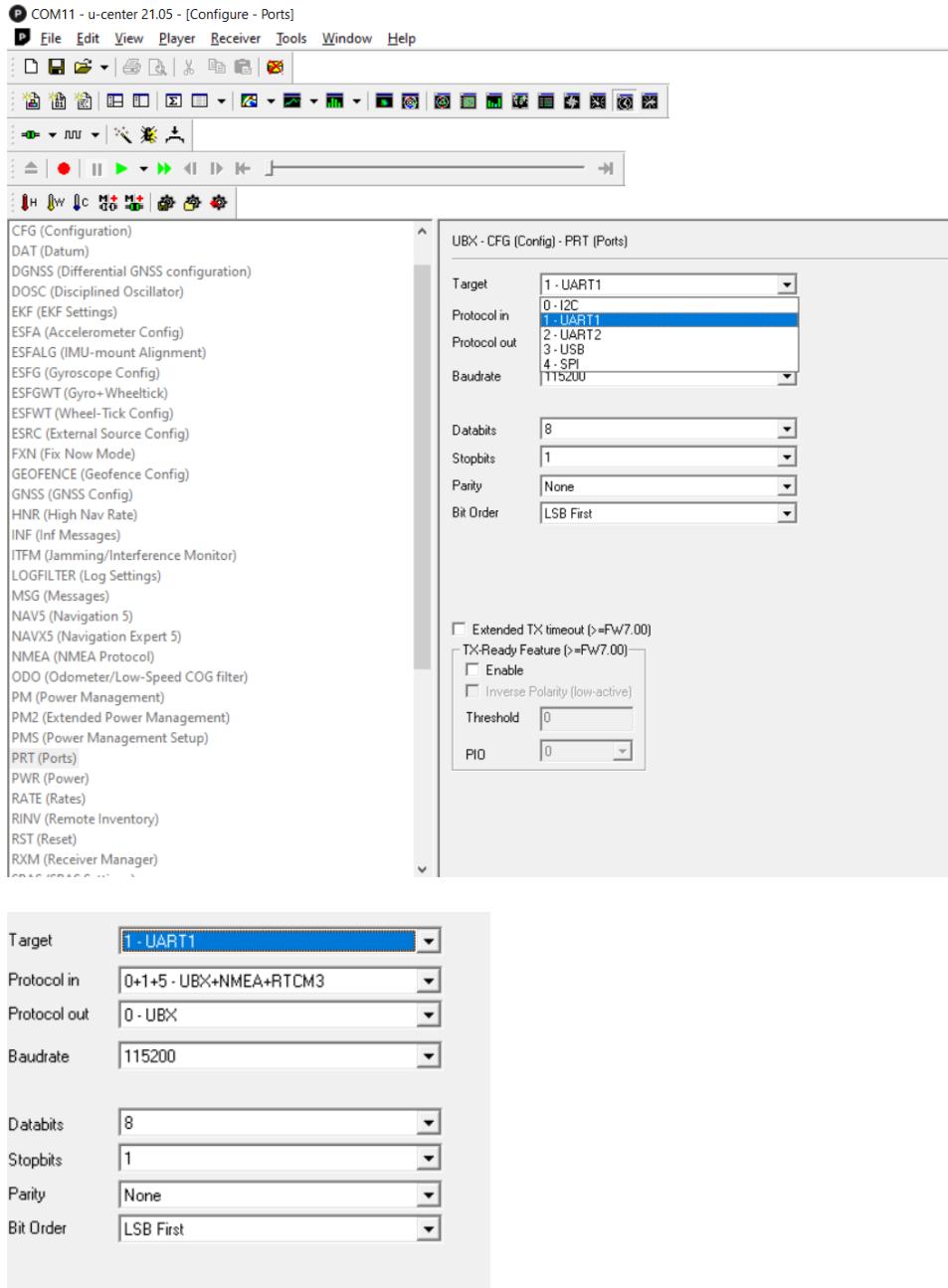


10. Disconnect the USB connection to the receiver. Restart the GPS receiver or system. Repeat the above steps and confirm the NAV5 configuration took effect. Repeat a longer cold boot to double check.

## II. Output Formats

Typically, we would like a “GPS Log” which is either raw NMEA or UBX (Binary) output. To configure the chipset correctly, you need to make sure the output port is setup. Most chipsets have one UART, which is connected to the host system (e.g. flight controller, logger, etc).

1. Select PRT (Ports) from the drop-down list in Configuration View Window.



2. Select one or more of UBX + NMEA. Note that RTCM is only for DGPS/RTK correction info and may be enabled although it will be inactive in Airborne < 4g mode.
3. NOTE: The default messages for UBX & NMEA are sufficient and come preconfigured.

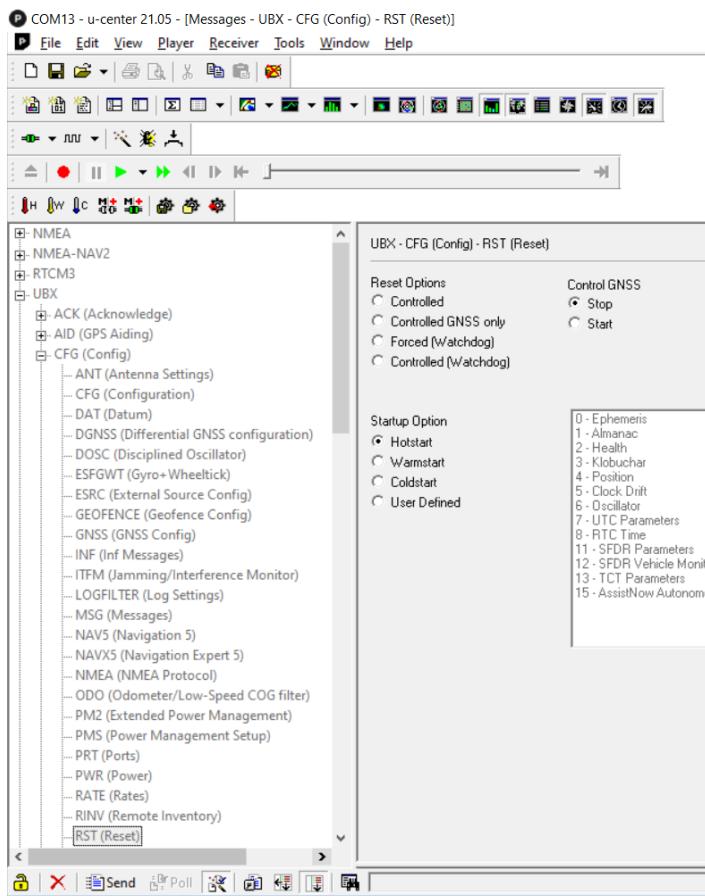
### III. Data Logger Configuration (Series 7/8/9 only)

For Series 9 configuration, you can also create a data-log which will store all of the messages within on-chip FLASH for retrieval and ultimately submission of record data. The UBX log file may be read by uCenter in Table view and any or all fields may be extracted from the log. The most important datum is the NAV-PVT Message which is enabled by default.

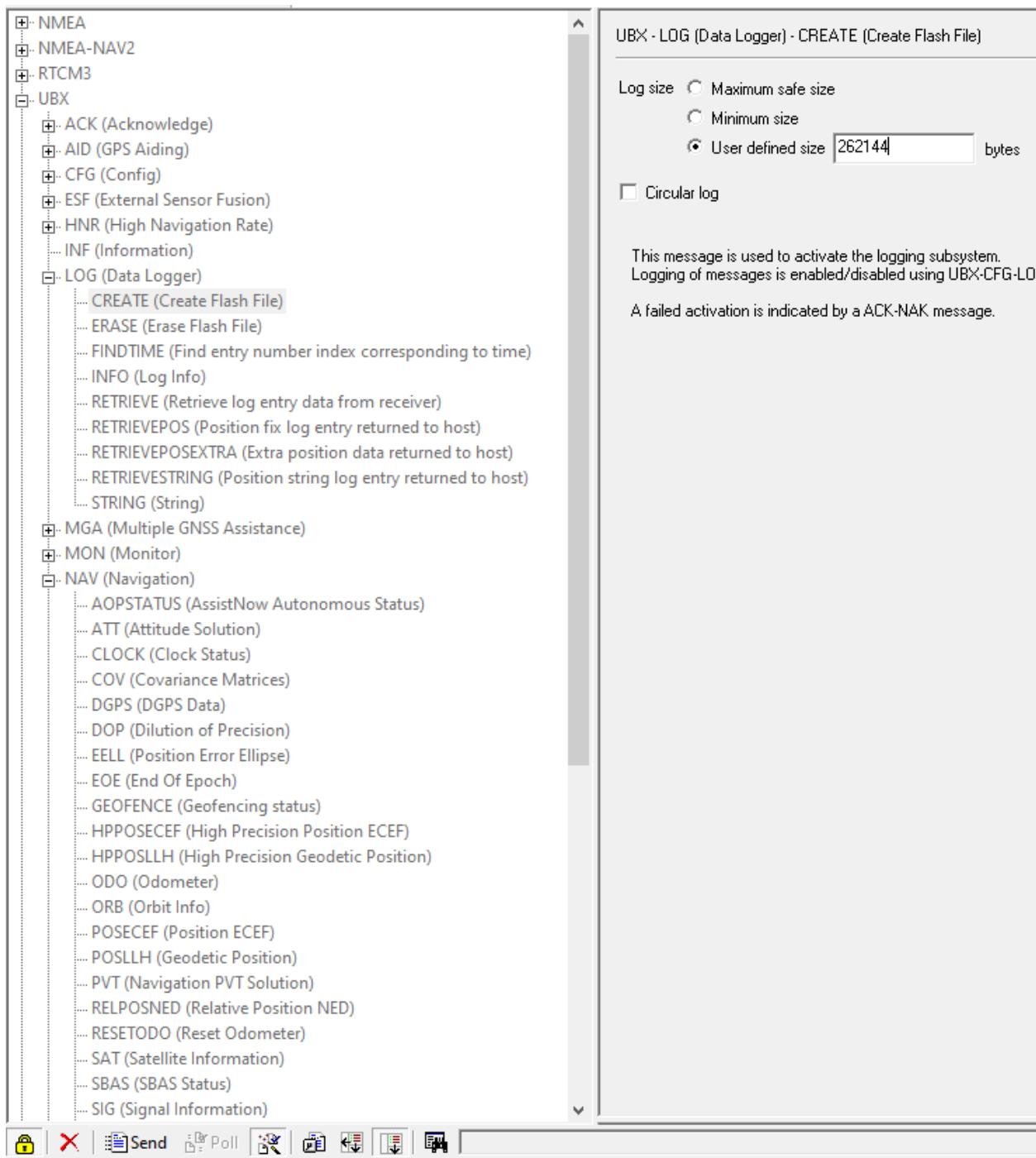
The logging feature of the NEO-M9N allows using the chip's internal FLASH to record flight data, typically we use this when we run the NEO-M9N with a power supply and no external host computer. Our process will be to connect a PC to the receiver over USB, load uCenter to configure and go through the steps of stopping the receiver, creating a FLASH log, enabling the logger, save settings, and validate again over USB. And then fly the rocket. When complete, we will stop the receiver, stop the logger and download.

The detailed steps are as below:

1. STOP - Stop the receiver. First select View, then "Messages View" and then select UBX and the RST (Reset) tab. Select "Stop" and then press Send as below. You will notice the receiver stops sending messages as the output windows will no longer update (e.g. in the Satellite Level View)



2. UBX-LOG-CREATE - use the Messages View, select the “LOG” menu item and then CREATE (Create FLASH File) with the size parameters of 256K (262,144 bytes). Don’t forget to press Send.



3. UBX-LOG-INFO - Select View, Messages View, then using Messages View, select LOG, and then INFO. The status will show the log was created, but recording is still not enabled.

Param	Value	Units
Filestore capacity	345600 (338 kB)	bytes
Maximum log size	261120 (255 kB)	bytes
Current log size	61 (0 kB)	bytes
Entry count	0	
Oldest time	00:00:00 00/00/00	hh:mm:ss dd/mm/yyyy (UTC)
Newest time	00:00:00 00/00/00	hh:mm:ss dd/mm/yyyy (UTC)
Log status	0	hex
Status: log created	yes	
Status: log recording	no	
Status: log is circular	no	

4. Next, enable the logging, to do this, go back to uCenter Configuration View (not Messages View), and select LOGFILTER (Log Settings), Select “Recording Enabled” and Time Threshold of 1 second and minimum interval of 1Hz; to save space and only capture the vehicle flying (and allow retrieval at a fixed position) make sure to select 1 meter of change as below. VERY IMPORTANT - Press “Send” to make changes.

UBX - CFG (Config) - LOGFILTER (Log Settings)

Recording enabled       Apply all filter settings

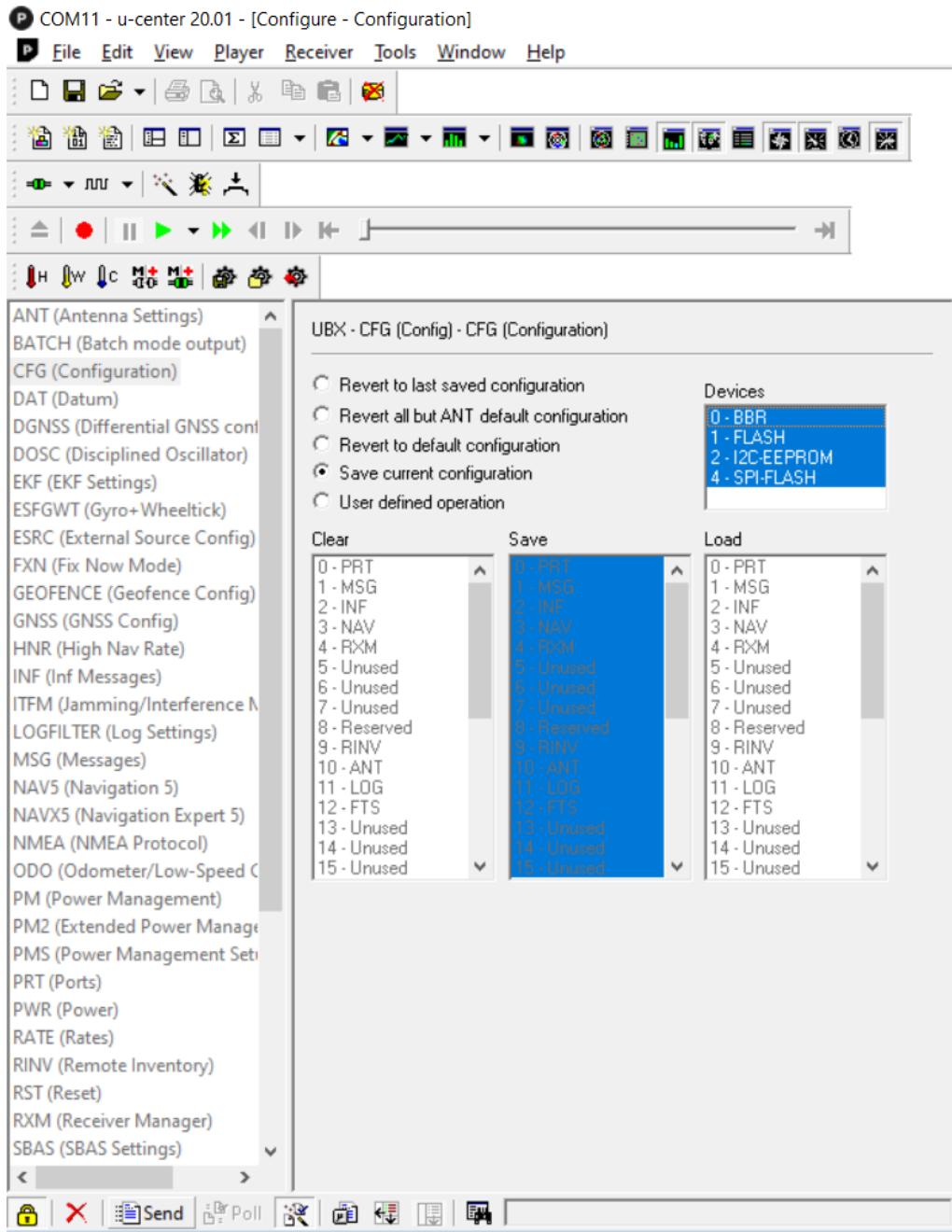
Log once per wake up (PSM on/off only)

Position threshold	<input type="text" value="1"/>	m	Min interval for position and speed logging
Speed threshold	<input type="text" value="0"/>	m/s	<input type="text" value="1"/> Secs
Time threshold	<input type="text" value="1"/>	Secs	

Log position if:

```
position changes by >= 1m AND >= 1s since the last position entry
OR
>= 1s since the last position entry
```

- Save the configuration. Select the CFG menu option, select all devices on the menu (e.g. BBR, FLASH, I2C EEPROM, SPI FLASH) and click “Send” at the bottom of the panel to save the configuration back to GNSS.



- Disconnect the USB connection to the receiver. Restart the GPS receiver or system.
- Now, we will go back and confirm in Messages View, the LOG section and INFO (Log Info) that the log has been created, and the system is recording. You will see the status

of recording and log creation as below. Once fix occurs you will see this info change to check the status we should visit this configuration item when connected over USB.

UBX - LOG (Data Logger) - INFO (Log Info)		
Param	Value	Units
Filestore capacity	345600 (338 kB)	bytes
Maximum log size	261120 (255 kB)	bytes
Current log size	61 (0 kB)	bytes
Entry count	0	
Oldest time	00:00:00 00/00/0	hh:mm:ss dd/mm
Newest time	00:00:00 00/00/0	hh:mm:ss dd/mm
Log status	8	hex
Status: log created	yes	
Status: log recording	yes	
Status: log is circular	no	

UBX - LOG (Data Logger) - INFO (Log Info)		
Param	Value	Units
Filestore capacity	345600 (338 kB)	bytes
Maximum log size	261120 (255 kB)	bytes
Current log size	14915 (15 kB)	bytes
Entry count	1469	
Oldest time	04:09:05 31/08/2021	hh:mm:ss dd/mm/yyyy (UTC)
Newest time	04:33:33 31/08/2021	hh:mm:ss dd/mm/yyyy (UTC)
Log status	8	hex
Status: log created	yes	
Status: log recording	yes	
Status: log is circular	no	

- If all checks out, you're now ready to fly your rocket. Make sure you power up near the launch site as the logger will log every second if there is a position change of more than 1 meter. Power up the system and do the usual flight checks. When you see the Blue LED on the uBlox module blink, 3D fix is established and you will be ready to fly.

## IV. Data Logger Retrieval (Series 7/8/9 only)

1. Connect to uBlox GNSS Receiver via USB, open uCenter and connect to the module as before.
2. Select “View”, and “Messages View”, UBX -> LOG -> Info to view the log info. You will find that the u-blox receiver can record a large amount of data very efficiently using a small amount of onboard FLASH.

Param	Value	Units
Filestore capacity	345600 (338 kB)	bytes
Maximum log size	261120 (255 kB)	bytes
Current log size	29569 (29 kB)	bytes
Entry count	2913	
Oldest time	04:09:05 31/08/2021	hh:mm:ss dd/mm/yyyy (UTC)
Newest time	04:57:37 31/08/2021	hh:mm:ss dd/mm/yyyy (UTC)
Log status	8	hex
Status: log created	yes	
Status: log recording	yes	
Status: log is circular	no	

3. Next, Stop Recording - enter Configuration View and select LOGFILTER, deselect “Recording enabled” and “Apply all Filter settings”, press Send at the bottom of the page:

Recording enabled     Apply all filter settings

Log once per wake up (PSM on/off only)

Position threshold	<input type="text" value="1"/>	m	Min interval for position and speed logging	
Speed threshold	<input type="text" value="0"/>	m/s	<input type="text" value="1"/>	Secs
Time threshold	<input type="text" value="1"/>	Secs		

Log position if:

position changes by >= 1m AND >= 1s since the last position entry  
OR  
>= 1s since the last position entry

4. Next, confirm that Recording has stopped by going back into Messages View as above to look at the LOG-INFO and confirm recording has stopped.

#### UBX - LOG (Data Logger) - INFO (Log Info)

Param	Value	Units
Filestore capacity	345600 (338 kB)	bytes
Maximum log size	261120 (255 kB)	bytes
Current log size	31994 (31 kB)	bytes
Entry count	3150	
Oldest time	04:09:05 31/08/2021	hh:mm:ss dd/mm/yyyy (UTC)
Newest time	05:01:34 31/08/2021	hh:mm:ss dd/mm/yyyy (UTC)
Log status	0	hex
Status: log created	yes	
Status: log recording	no	
Status: log is circular	no	

5. Now Stop the chip, Configuration View -> RST (Reset). Select "Stop" and press "Send"

#### UBX - CFG (Config) - RST (Reset)

Reset Options

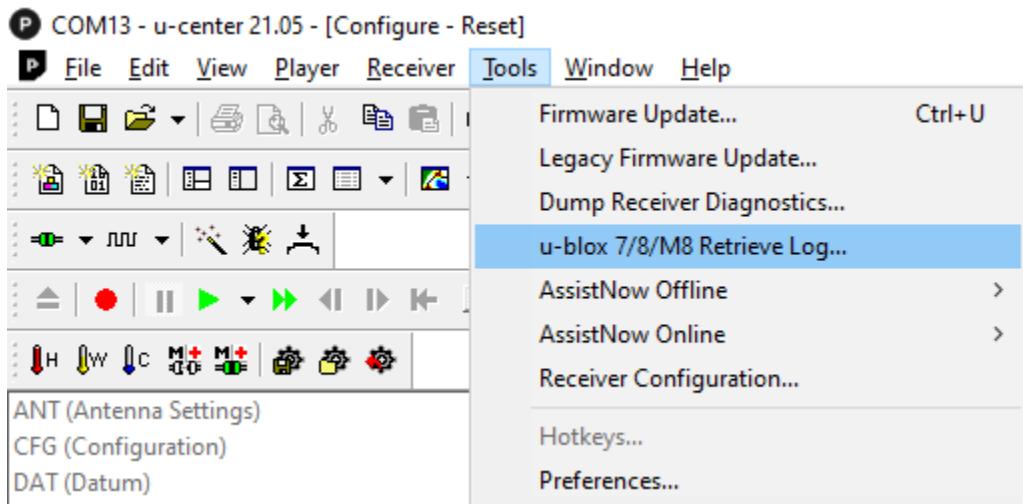
Controlled       Control GNSS  
 Controlled GNSS only       Stop  
 Forced (Watchdog)       Start  
 Controlled (Watchdog)

Startup Option

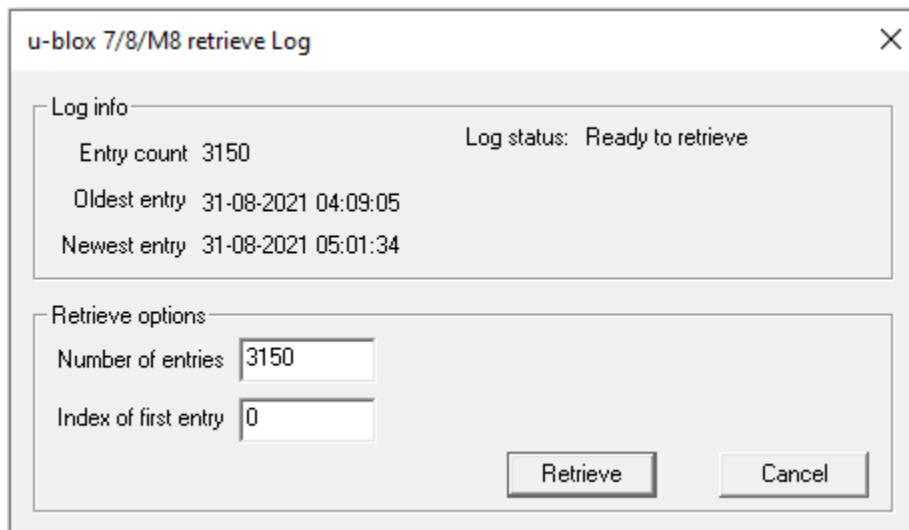
Hotstart  
 Warmstart  
 Coldstart  
 User Defined

- 0 - Ephemeris
- 1 - Almanac
- 2 - Health
- 3 - Klobuchar
- 4 - Position
- 5 - Clock Drift
- 6 - Oscillator
- 7 - UTC Parameters
- 8 - RTC Time
- 11 - SFDR Parameters
- 12 - SFDR Vehicle Monitor
- 13 - TCT Parameters
- 15 - AssistNow Autonomic

6. Now Select “Tools” and then uBlox 7/8/M8 retrieve log.



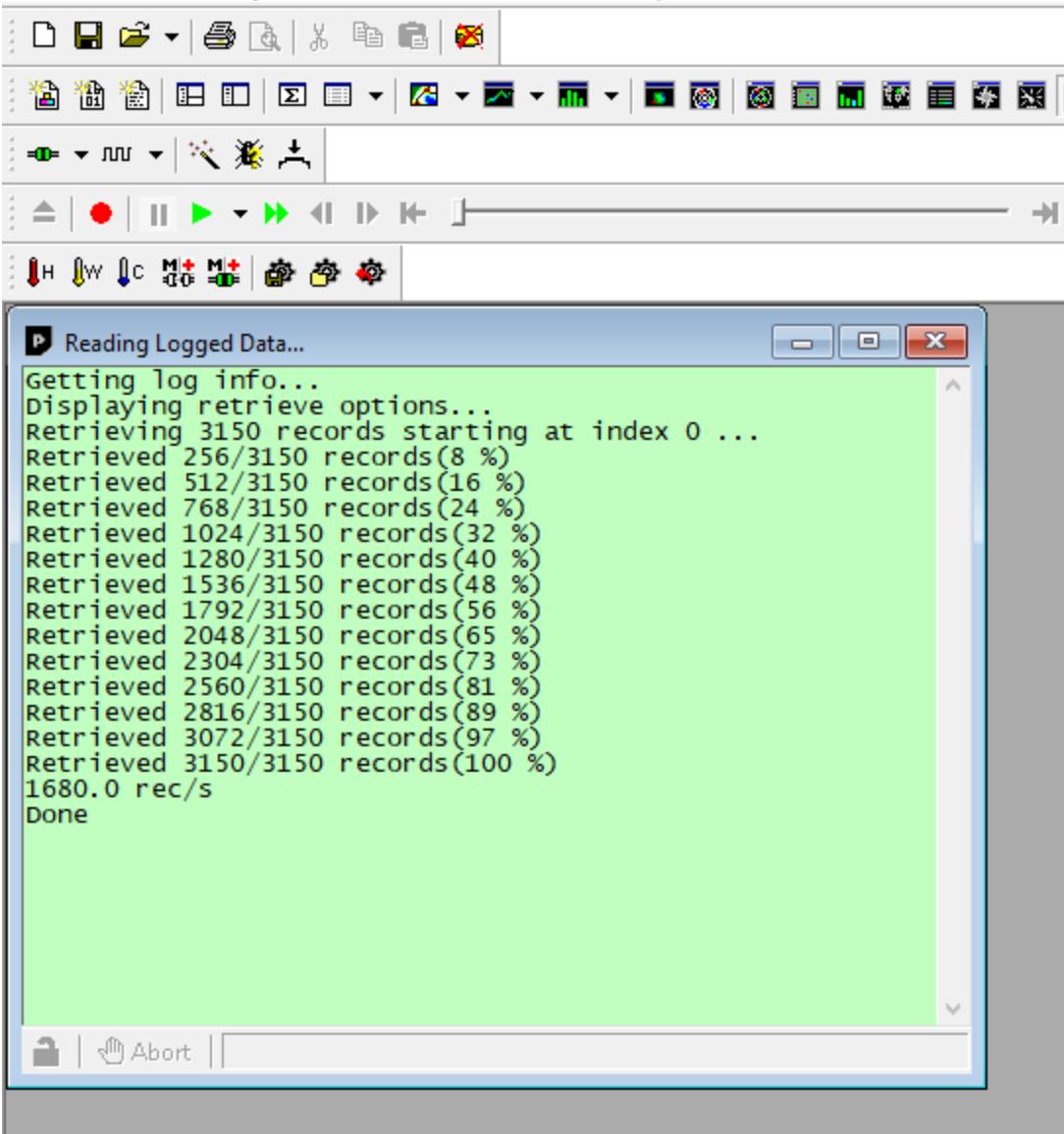
7. Press “Retrieve” when the Dialog below is shown:



You will be prompted for a filename to save. It will save in UBX File format and you will also see the log being retrieved from the device as shown below:

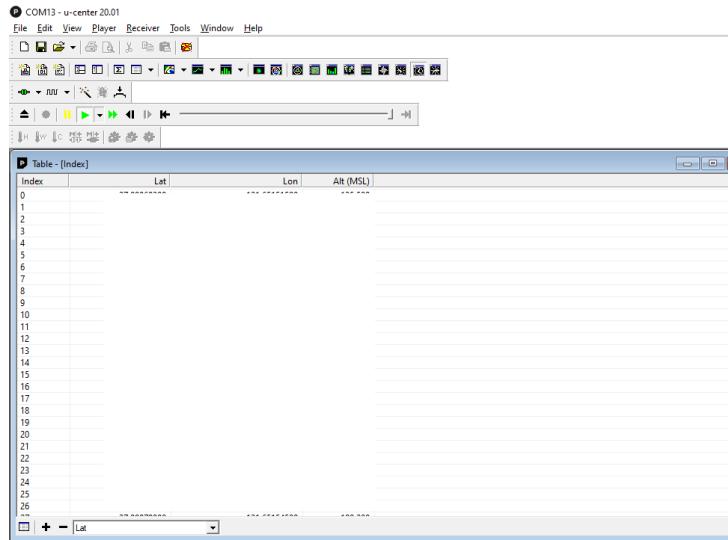
COM13 - u-center 20.01

File Edit View Player Receiver Tools Window Help

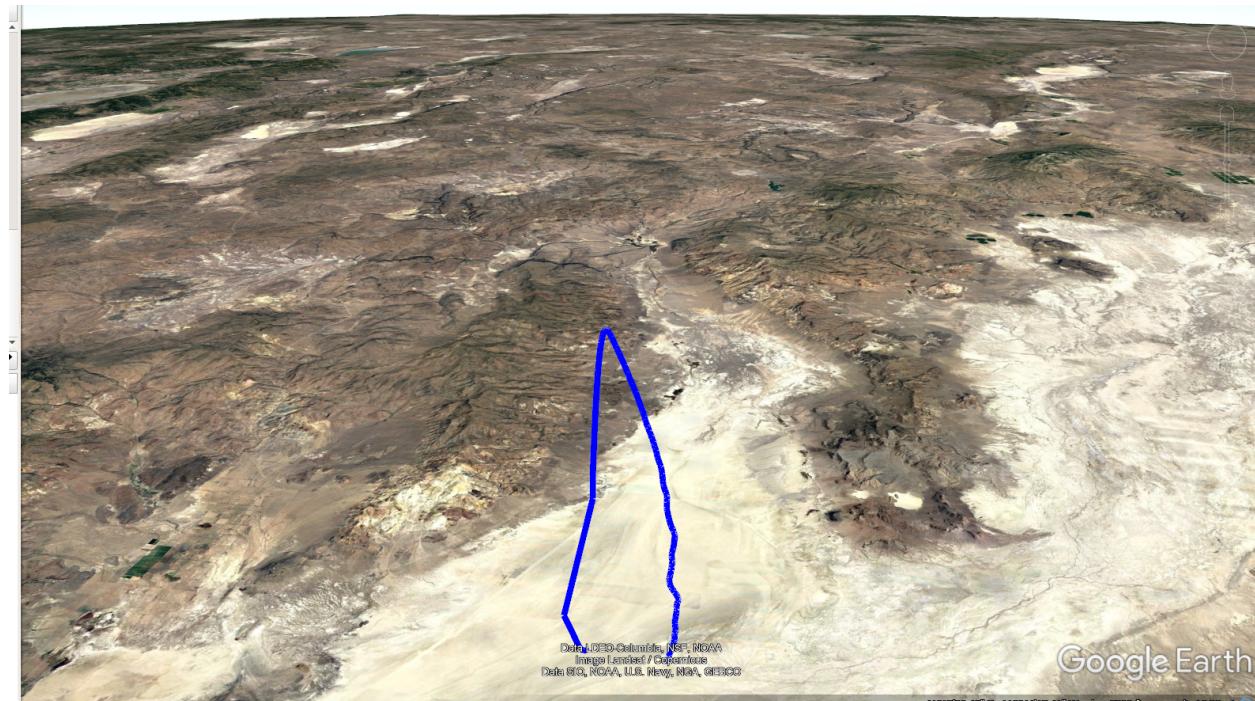


## V. View Data Logger Capture and Export KML for Google Earth

uCenter will also allow you to open the UBX File and extract the relevant GPS information as simple as “File->Open” and open the file. Next select Table View, select the “+” at the bottom of the view. Add “Lat, Lon, Alt (MSL)”, then press the green Play button.



Finally, select “File”->“Database Export” -> “Google Earth Kml ...” and when prompted, open the file and if you have Google Earth installed, you can see the flight as below:



E-mail the UBX and KML file to the records committee along with your completed submission form and pictures of you with your rocket.

## References

- [Sparkfun NEO-M9N Hookup Guide](#)
- [u-blox Series 6 Integration Manual](#) (for LEA/NEO 4 and later)
- [u-blox Series 6 Datasheet](#) (for LEA/NEO 4 and later)
- [u-blox NEO-M9N Standard precision GNSS module Integration manual](#) (UBX-19014286)
- [u-blox ZED F9P High precision Manual](#)
- [u-blox uCenter User Manual](#)