



2019 GPS Week Rollover – Assurance Made Easy

1.1 INTRODUCTION

On April 6th, 2019 the GPS week number will experience its second rollover to date. The GPS week number as detailed in ICD-200 is a 10-bit data field that keeps track of the current week in GPS time. Because this is represented in 10 bits, it has a limit of 1024 (0-1023 weeks), which is 19.7 years. Once this number reaches 1023, the next increment must rollover to 0 and enter the next epoch in GPS time. The last time this occurred was August 21st, 1999.

1.2 WHAT DOES THIS MEAN?

The GPS week number is significant because it is a key parameter that receivers use to convert between GPS and UTC time. Any receiver that is unable to handle this rollover properly could begin outputting navigation data with a UTC timestamp that is 19.7 years in the future or past. This means that any systems reliant on accurate UTC time to operate are at risk of failure when this event occurs. Furthermore, some receivers use a firmware timestamp to base the week number parameter from. This means that the rollover event isn't confined specifically to April 6th, 2019 and could instead occur at a different date in the future.

1.3 WHAT SHOULD I DO?

Check with your receiver manufacturer to see if they have tested this event on your specific receiver model. If they have not or you would like to confirm this event will not cause issues, you can simulate the GPS Week Rollover using a GPS simulator. When simulating the GPS rollover event, you will also need a method to collect and analyze the data that your GPS receiver is outputting to confirm that it handles the roll over properly and that no lasting effects are seen.

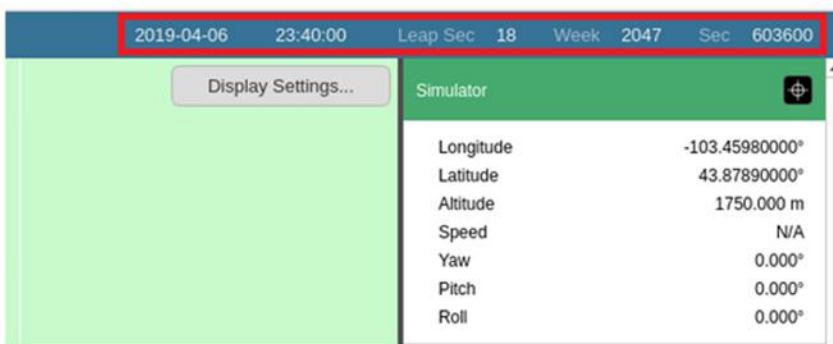
1.4 HOW TALEN-X CAN HELP

The first thing you will need is a GPS Simulator. If you do not have one, Talen-X sells BroadSim, a software defined GNSS Simulator which can be used to provide reliable GNSS signals for testing. The next thing you will need is a platform to collect and analyze the receiver data generated during the test. RxStudio is a versatile receiver data collection tool that accepts a plethora of receiver message protocols and outputs it into an organized, easy to understand format. RxStudio supports over 100 specific GPS receiver models as well as the ability to handle many generic protocols such as NMEA, ICD-153, ICD-177, UBX, MSID and more. Tests such as the GPS week rollover need to run for an extended period to ensure your receiver is working correctly. Typically, this comes with scanning through large csv files to look for specific data points at specific timestamps. Panorama eliminates the need to do this by taking those csv files and automatically generating over 60 plots to quickly visualize critical receiver data metrics. With Panorama, you will be able to quickly analyze a receiver's C/No, 3D LLA, UTC/GPS Time comparison, pulse error and much more. *The section below will show you how combining these tools provides for a quick an easy route to assuring that your receiver can survive the GPS Week Rollover.*



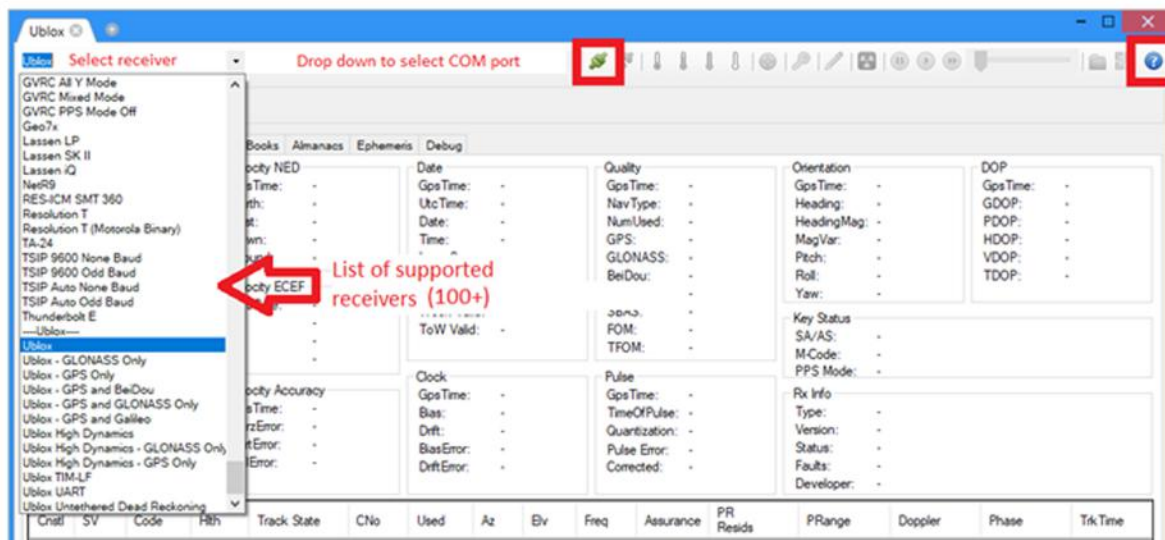
1.5 TESTING YOUR RECEIVER

1. If you are using a BroadSim, go to step 2. If you are using a different GPS Simulator, create a scenario that has a custom start Date/Time of April 6th, 2019 at 23:40:00, has a runtime of 40 minutes and is simulating at least 4 space vehicles (SVs). Start the simulation and proceed to step 5.
2. Download Talen-X_GPS_Week_Rollover.sdx and open the configuration in SDX.
3. Make sure your receiver's RF input is connected to Radio 1 RFA on BroadSim (with 60dB of physical attenuation).
4. Start the simulation, noting the date and time shown in the upper right-hand corner of the window, as this should match the date and time you see in RxStudio for your receiver.



5. Connect your receiver to a computer and open RxStudio. RxStudio contains recipe cards for most receivers and can be accessed by clicking the blue question mark in the upper right hand corner of the window. These recipe cards detail the recommended test configuration and scenario procedures as well as a section on how to interface with that receiver. Most receivers connect via USB, Ethernet or Serial. These connection types can be interfaced with using a COM port or IP address.

6. Click the drop down box in the upper left hand corner of the window and select your receiver from the list, if it is not on the list but you know the message protocol of your receiver you can select a corresponding generic controller. Contact sales@talen-x.com for a complete list of supported receivers.
7. Click on the drop down box next to that and select the COM port for your receiver or enter its IP address.
8. Click on the green connect button to open port and begin collecting data. You should see a port opened status and the NavDataFrame should start populating with values.





- Once your receiver starts tracking the simulator, verify that the date and time match what is shown in the simulator. It can take up to 12.5 minutes for all data fields to be populated correctly. Make sure to cold start or power cycle your receiver before you begin this test as the time will be jumping significantly into the future. (Note: system must be power cycled before being installed back into normal operation as the time will be jumping back to the current date/time from the simulated leap second date/time)

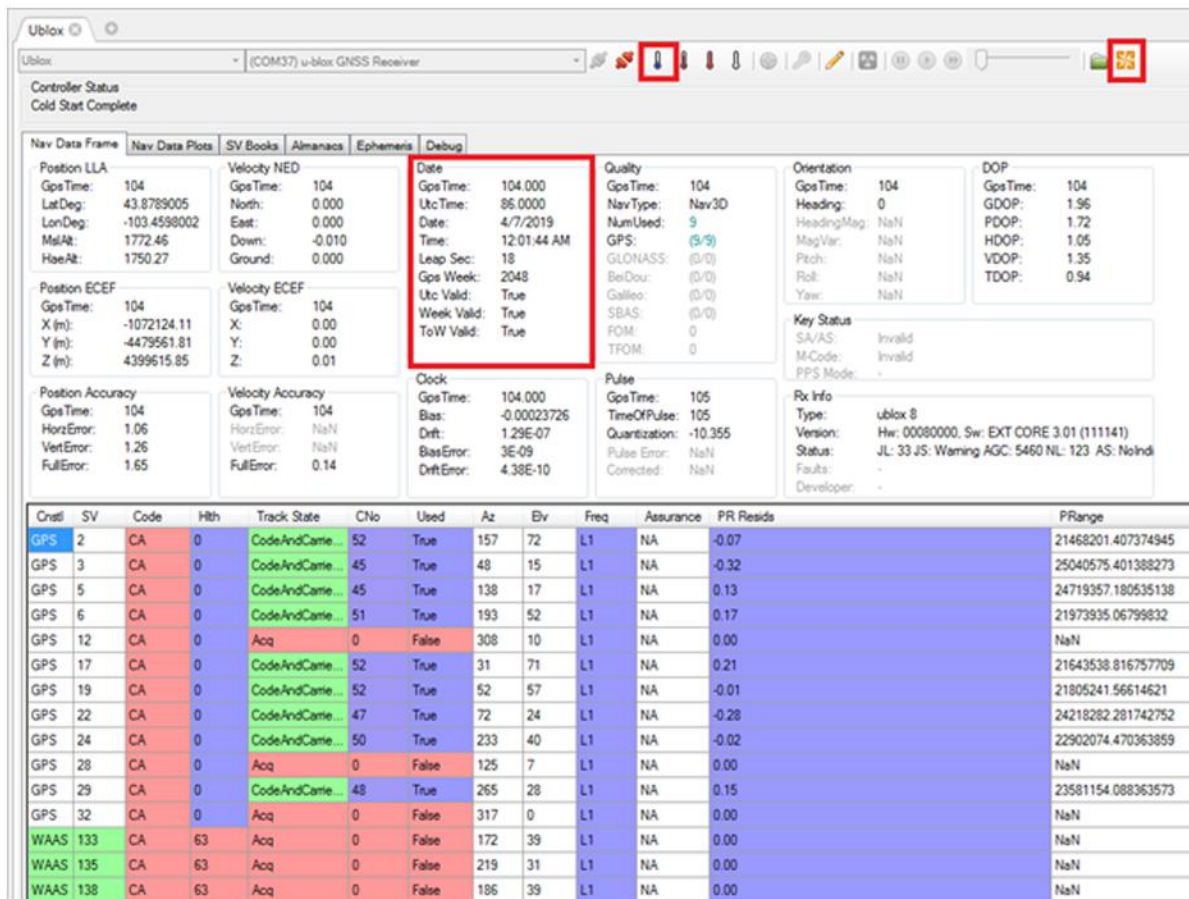
The screenshot shows the Ublox software interface for a (COM37) u-blox GNSS Receiver. The 'Controller Status' indicates 'Cold Start Complete'. The 'Debug' tab is selected, and a red box highlights the 'Date' section, which shows the following information:

- GpsTime: 604326.000
- UtcTime: 85908.0000
- Date: 4/6/2019
- Time: 11:52:06 PM
- Leap Sec: 18
- Gps Week: 2047
- Utc Valid: True
- Week Valid: True
- ToW Valid: True

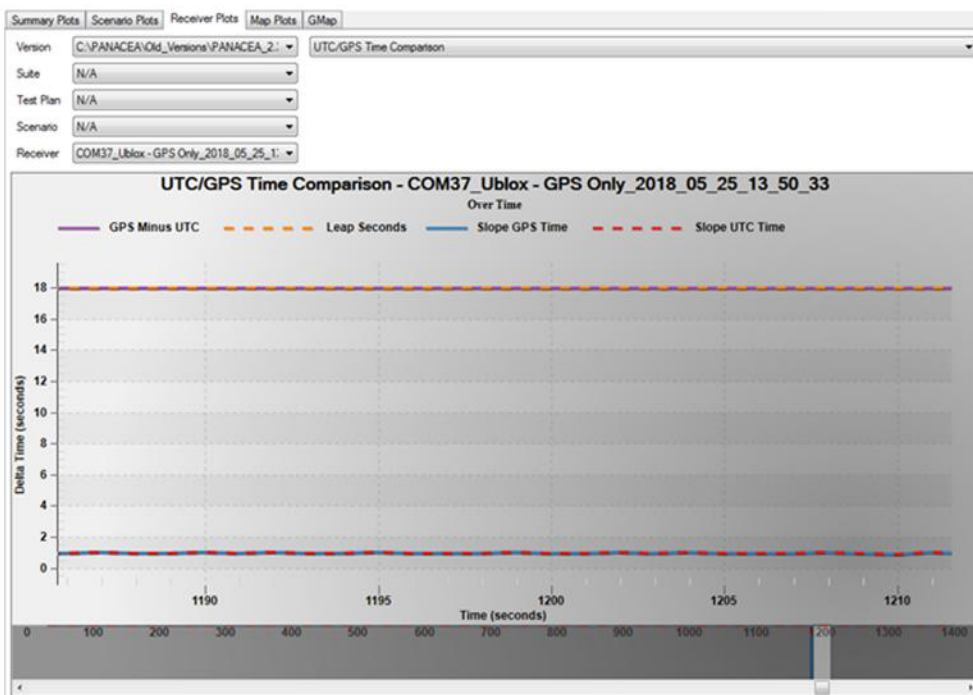
Other visible data includes Position LLA, Velocity NED, Position ECEF, Velocity ECEF, Position Accuracy, Velocity Accuracy, Clock, Quality, Orientation, DOP, Key Status, Rx Info, and a table of satellite data.

Cnsl	SV	Code	Hlth	Track State	CNo	Used	Az	Elv	Freq	Assurance	PR Resids
GPS	2	CA	0	CodeAndCarrie...	52	True	165	68	L1	NA	0.01
GPS	3	CA	0	CodeAndCarrie...	45	True	52	16	L1	NA	-0.44
GPS	5	CA	0	CodeAndCarrie...	44	True	141	13	L1	NA	0.04
GPS	6	CA	0	CodeAndCarrie...	51	True	193	47	L1	NA	-0.09
GPS	12	CA	0	Acq	0	False	306	6	L1	NA	0.00
GPS	17	CA	0	CodeAndCarrie...	52	True	20	74	L1	NA	-0.27
GPS	19	CA	0	CodeAndCarrie...	53	True	48	61	L1	NA	-0.09
GPS	22	CA	0	CodeAndCarrie...	47	True	77	24	L1	NA	0.07
GPS	24	CA	0	CodeAndCarrie...	50	True	238	44	L1	NA	-0.27
GPS	28	CA	0	CodeAndCarrie...	43	True	123	11	L1	NA	-0.11
GPS	29	CA	0	CodeAndCarrie...	47	True	261	24	L1	NA	-0.05
GPS	32	CA	0	Idle	0	False	320	0	L1	NA	0.00
WAAS	133	CA	63	Acq	0	False	172	39	L1	NA	0.00
WAAS	135	CA	63	Acq	0	False	219	31	L1	NA	0.00
WAAS	138	CA	63	Acq	0	False	186	39	L1	NA	0.00

- Once the simulation reaches 24:00:00 verify that your receiver incremented the week number and the date and time are still correct. The week number should go from 2047 to 2048 (or 1023 to 0 with epoch of 2)
- Click on the cold start button, once your receiver begins tracking again make sure that the date and time and week number are still correct. If your receiver does not support the cold start feature, power cycle it without stopping the simulation and confirm that the date and time populate correctly.
- With the Panorama application already open, click on the Panorama button in the top right of the window to open Panorama and view data plots of the simulation

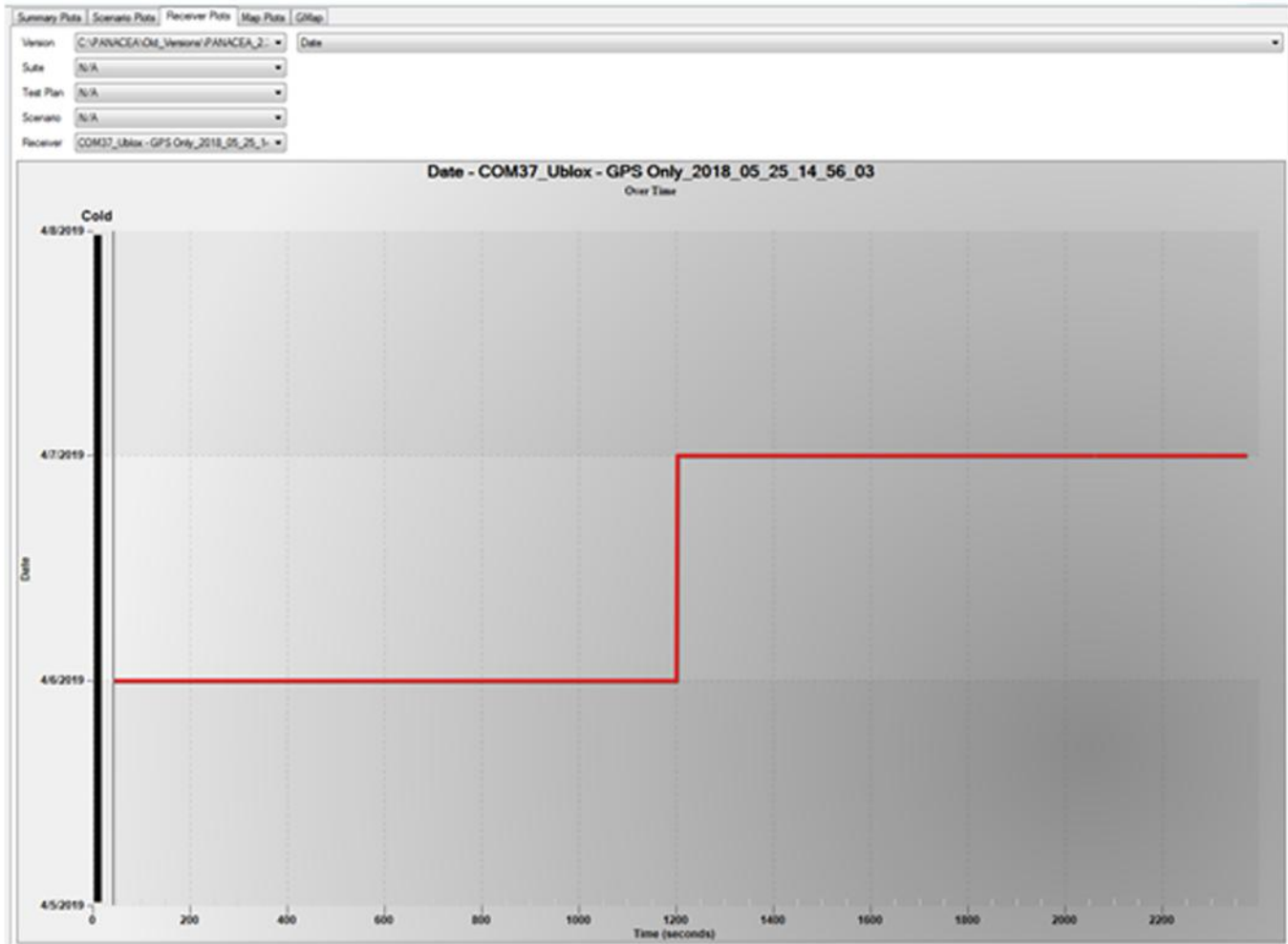


13. The UTC/GPS Time Comparison plot is a good metric to look at to see if your receiver was able to handle the rollover correctly. Your receiver should show an 18 second delta time before and after the rollover event. It may take up to 12.5 minutes for your receiver to show an 18 second delta time. In the image below, the week rollover occurs at t=1200s and it can be seen that no change in GPS/UTC time or leap seconds occur.





- Another important plot to look at is the Date plot. You want to make sure that your receiver shows April 6th, 2019 until the rollover which is at 1200 seconds and then jumps to April 7th, 2019. The picture below shows what your receiver Date plot should look like.



1.6 CONCLUSION

Testing your GPS receiver for this event is strongly suggested, especially if your receiver is dependent on using UTC time to run systems correctly or if your GPS system is 10+ years old. As demonstrated here, our products are designed to help engineers test these types of scenarios. BroadSim can provide the signal simulation for rollover events as well as countless other GNSS scenarios. RxStudio enables virtually anyone to connect their receiver to our software to collect and display data in an understandable format. Panorama gives users the ability to quickly visualize receiver data in color coded plots instead of sifting through csv files for hours.

If you are interested in having Talen-X help you test, email us at sales@talen-x.com or visit us on our website at www.talen-x.com.