

LabSat GNSS Simulators LabSat 2 User Guide

- [01 - LabSat 2 Introduction](#)
- [02 - LabSat 2 Operation](#)
- [03 - LabSat 2 Hardware overview](#)
- [04 - LabSat 2 PC Requirements](#)
- [05 - LabSat 2 Installing Software](#)
- [06 - LabSat 2 Connecting USB](#)
- [07 - LabSat 2 Software Overview](#)
- [08 - LabSat 2 Software Settings](#)
- [09 - LabSat 2 Recording GNSS Data](#)
- [10 - LabSat 2 Recording Event Inputs](#)
- [11 - LabSat 2 Replaying GNSS Data](#)
- [12 - LabSat 2 SatGen v2 Software](#)
- [13 - Converting LabSat scenarios](#)
- [14 - LabSat 2 Interface Modules](#)
- [15 - LabSat 2 Video Synchronisation](#)
- [16 - LabSat 2 Advanced functions](#)
- [17 - LabSat 2 Software Development Kit \(SDK\)](#)
- [18 - LabSat 2 Inventory and optional extras](#)
- [19 - LabSat 2 PIN OUTS](#)
- [20 - LabSat 2 Technical specifications](#)
- [21 - LabSat 2 Cable Identification](#)

01 - LabSat 2 Introduction

The LabSat 2 is a dedicated Global Navigation Satellite System (GNSS) signal generator with RF record and playback facilities, enabling real world GNSS RF testing to take place in the laboratory. The LabSat is small and rugged, allowing it to be used in the field to continuously record the Global Positioning System (GPS), Galileo, BeiDou Navigation Satellite System (BDS) and GLONASS RF signals in a digital form which can then be replayed at a later date.

LabSat 2 is ideal for almost any kind of GNSS development, e.g. GPS/Galileo/BDS/GLONASS engines, GNSS enabled Smartphones, Portable Navigation Devices (PND), tracking systems and much more. It is also very well suited to production line testing as it can represent a real world test as well as a carefully simulated scenario.

LabSat 2 works with the GPS/Galileo L1 (1575.42MHz) signal, BDS B1 (1561.098 MHz) signal and GLONASS L1 (Channels 06 to -7 or approximately 1606 MHz down to 1598 MHz) signal and has no limit to the number of satellites that can be logged.

In addition to recorded data, the Labsat 2 can replay simulated, GPS L1 and or GLONASS L1 scenarios generated using the optional Racelogic SatGen v2 software.

Real world GNSS effects can be seen in test scenarios

- Multipath
- Drop-outs
- Tree coverage
- Adverse terrain effects
- Atmospheric effects

Ability to replay data allows repeatable testing of GNSS receiver capabilities such as:

- Sensitivity – Tracking and Acquisition
- Time To First Fix (TTFF) – Cold, Warm and Hot Start
- Position Accuracy and Repeatability
- Tracking Accuracy and Repeatability



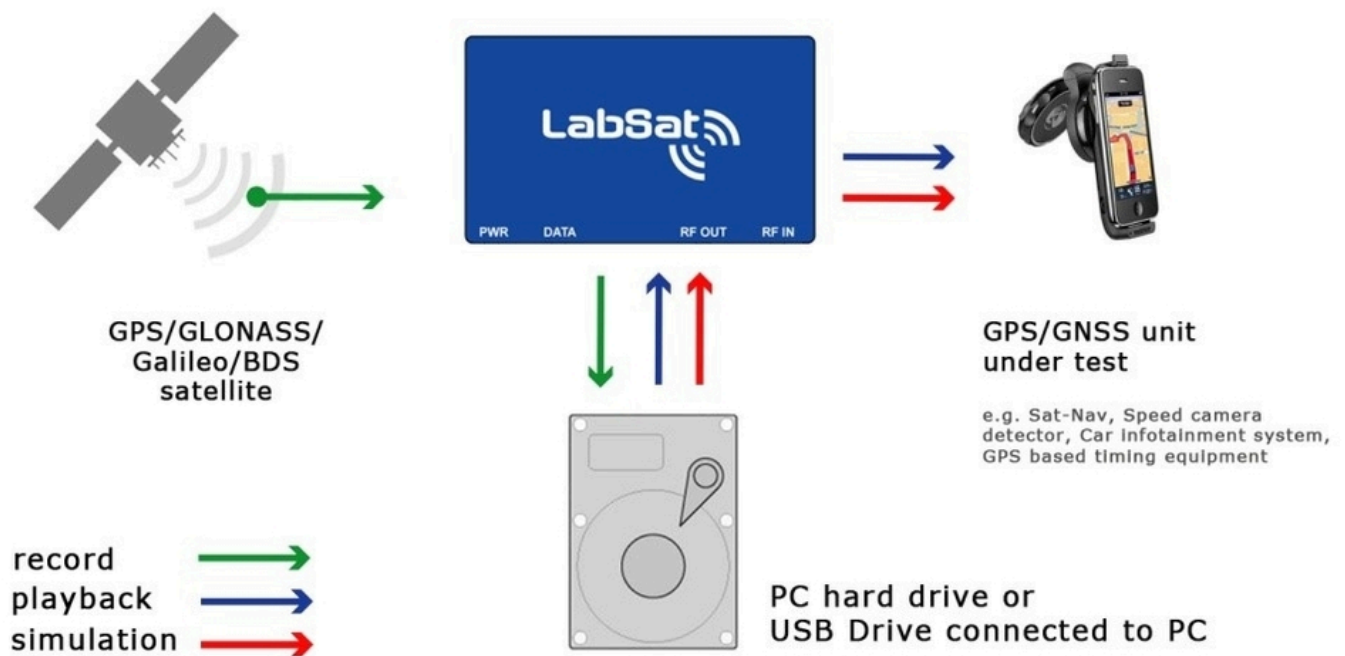
- Reacquisition Time



02 - LabSat 2 Operation

Depending on model type, the LabSat 2 is able to record RF data directly from an active antenna and store the data on a hard drive or generate GNSS RF signals from data stored on a hard drive.

There are three RF ports on the LabSat 2 these are marked CLOCK IN, RF IN, RF OUT.



The RF IN socket is used to connect an active GNSS antenna when recording data. During recording, the RF OUT port is switched off to ensure that it does not interfere with the recorded data.



The RF OUT port is used to connect the LabSat 2 to the GNSS system under test. The output signal of the LabSat 2 is at a nominal level of -83 dB when replaying previously recorded data. Using the PC software, it is possible to attenuate the LabSat 2 output by approximately 24 dB giving a signal power range of -83 dBm down to -107 dBm. Adjustment to the output attenuation is made using the slider controls which is accessed from the RF Attenuation tab in the LabSat software. With the slider positioned to the left on the screen, attenuation is 0 dB meaning 0 dB of attenuation on the nominal -83 dBm output. As the slider is moved to the right, in 0.5 dB steps, the attenuation increases, and the RF output level is reduced accordingly. The tick boxes allow for each channel to be muted simulating GNSS dropout.

When replaying RF data into a GNSS engine, it may be necessary to increase attenuation in order for the GNSS engine to acquire satellite data.

It is also important to note when replaying previously recorded GNSS data, that it may be required to cold start the GNSS engine under test. This is because GNSS engines often rely on downloaded almanac data to determine which satellites to look for at a given date and time. A cold start of the GNSS engine should clear any stored almanac data, forcing the GNSS engine to look for all satellites.



03 - LabSat 2 Hardware overview



Connector	Description	Comment
DATA	High speed USB 2.0 link	Transfers data to and from PC
GPS MONITOR	GPS Monitor - NMEA	Outputs NMEA from internal GPS engine during Replay and Record
PWR	12 Volt DC	Power Supply Input to LabSat 2
AUX	5 Pin LEMO	Digital In / Out – For connection of Interface Modules such as RLLSIM01
RF OUT	GNSS Simulation RF Output	GNSS signal output during replay mode
RF IN	GNSS Active Antenna Input	Used when recording GNSS signals
CLOCK IN	10 MHz Reference	External reference clock input
DIGITAL I/O	26 Way D-Type Connector	1 – PPS Output (refer to Connector Pin Data section for further pin out details)

LEDs	Description	Comment
PWR	Power status	Green LED indicates power good
PLAY	Replay Indication	Indicates that LabSat 2 is in Replay Mode
REC	Record Indication	Indicates that LabSat 2 is in Record Mode
BUFFER	Memory Buffer status	Indicates buffer status. If status reaches F (Full Buffer) during record or replay, this indicates that the PC cannot maintain the required transfer rate. Recorded data may be corrupt if full buffer occurs during record



04 - LabSat 2 PC Requirements

The LabSat 2 uses a USB 2.0 HI-SPEED interface for data transfer. When recording RF signals, the sustained USB transfer rate is in excess of 8Mbytes/s. It is therefore important to ensure that all intensive background tasks such as anti-virus scans are switched off to avoid interruption of data transfer to and from the hard drive. It may also be required to configure the laptop power settings to ensure maximum processor speed when using battery power as it is common for laptop PCs to reduce their processing speed when running without an external power supply.

Minimum recommended specification for the desktop or laptop PC to be used with the LabSat 2.

- Intel® Core2™ Duo 1.8 GHz
- 2 GB RAM
- 250 GB Hard Drive
- Microsoft Windows® XP Pro or Windows Vista® Business or Windows® 7 Professional, Windows® 8 Pro

Minimum recommended specification for the desktop or laptop PC to be used with SatGen v2 software.

- Intel® Core™ i5 2.27 GHz
- 4 GB RAM
- 250 GB Hard Drive
- Microsoft Windows Vista® Business or Windows® 7 Professional, Windows® 8 Pro



05 - LabSat 2 Installing Software

Configuration and control of the LabSat 2 is performed using the supplied LabSat Software. Before using your LabSat 2 it is necessary to install the software which also contains the USB drivers required for communication. Once this has been done the USB cables should be connected to the LabSat 2 prior to it being powered, this allows the configuration of the USB connection from LabSat 2 to the computer.

When you connect to the LabSat 2 via USB for the first time you will be required to install USB drivers, please see the section 'Connecting LabSat 2 USB' below.

Insert the supplied CD-ROM into the CD drive of your computer. An installation dialog will automatically appear; follow the onscreen instructions to complete the installation of the setup software.

After installation the CD-ROM can be removed and an icon should have appeared on your desktop that will allow you to start the LabSat software.

The LabSat 2 software can also be downloaded from [here](#).



06 - LabSat 2 Connecting USB

- Connect the USB A to B cable between the LabSat 2 and the computer. If you intend to use the GNSS monitor connect the Mini USB as well.
- The computer should now recognise the presence of a new USB device; after a short period of time a 'Found New Hardware Wizard' window will appear.

Click Next to continue the installation.

- Click 'next', with the option 'Install the software automatically (Recommended)' Selected. (See image right)
- At the last window click 'Finish' to complete the installation.
- This process will then repeat a second time beginning with step 2.

Now connect the LabSat 2 to its power supply. Your computer should now recognise the unit, and the USB connections will be recognised by the LabSat Setup software when started. Double-click the LabSat software icon to start the software

See the [Troubleshooting](#) section if the installation process fails at any stage.



Found New Hardware Wizard



This wizard helps you install software for:

Racelogic Upgrader



If your hardware came with an installation CD or floppy disk, insert it now.

What do you want the wizard to do?

- Install the software automatically (Recommended)
- Install from a list or specific location (Advanced)

Click Next to continue.

< Back

Next >

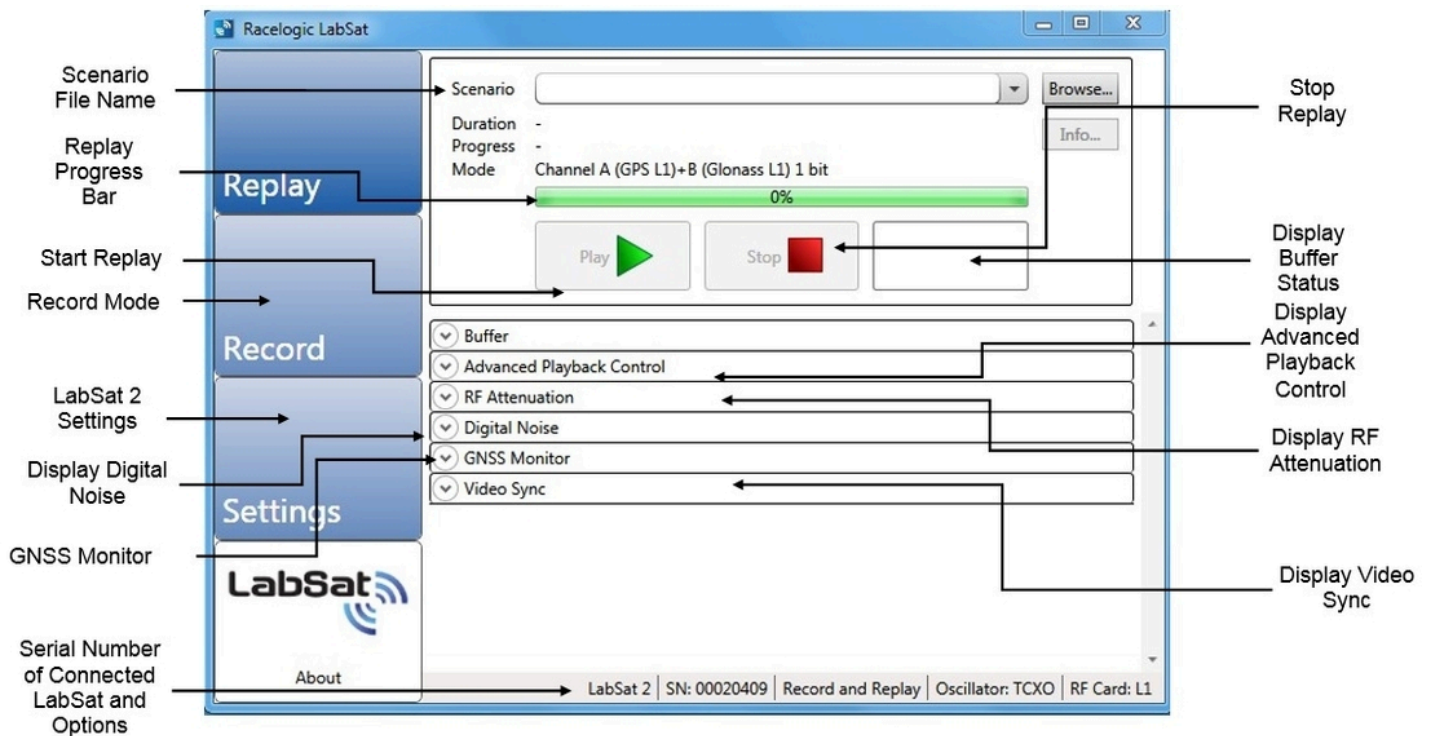
Cancel



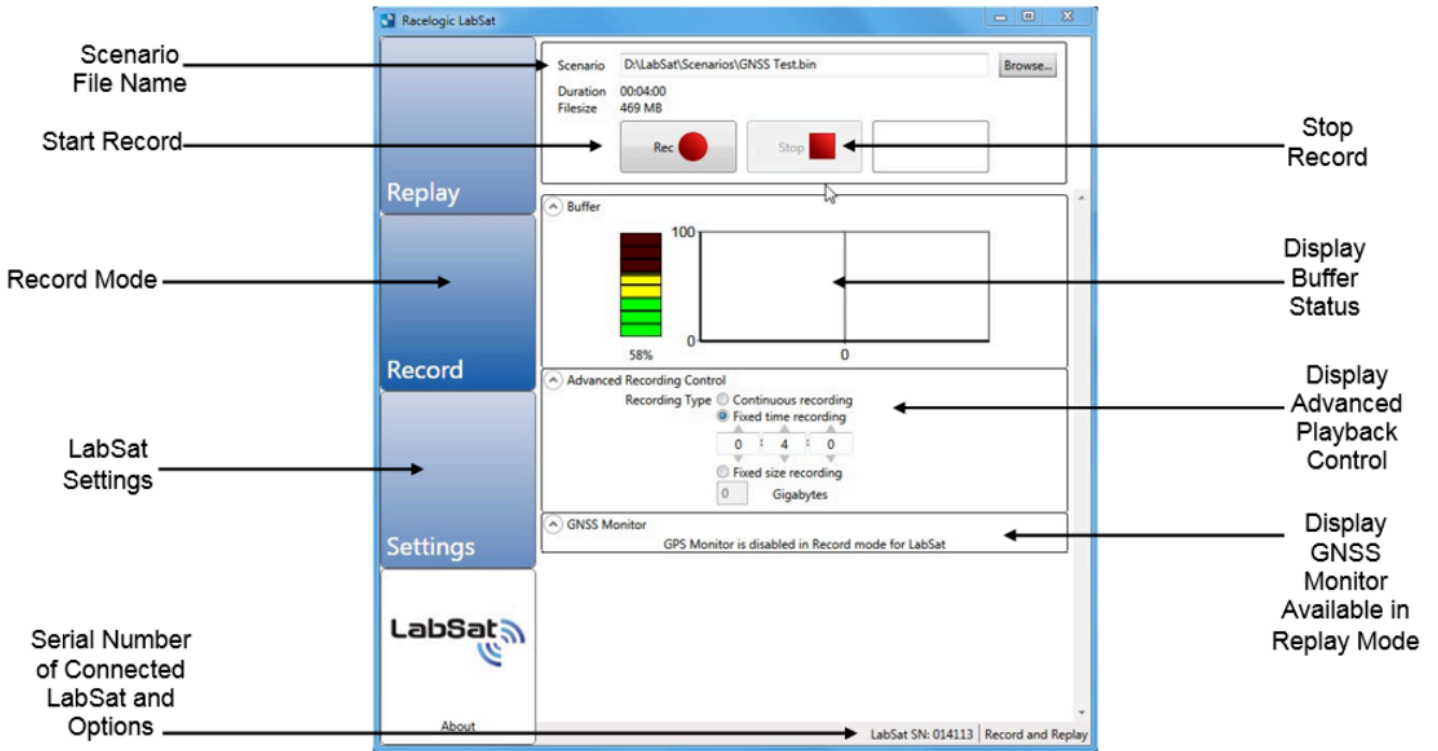
07 - LabSat 2 Software Overview

The LabSat software is used to control record or replay functions of the LabSat.

The picture below shows the LabSat Replay screen.



The picture below shows the LabSat Record screen.

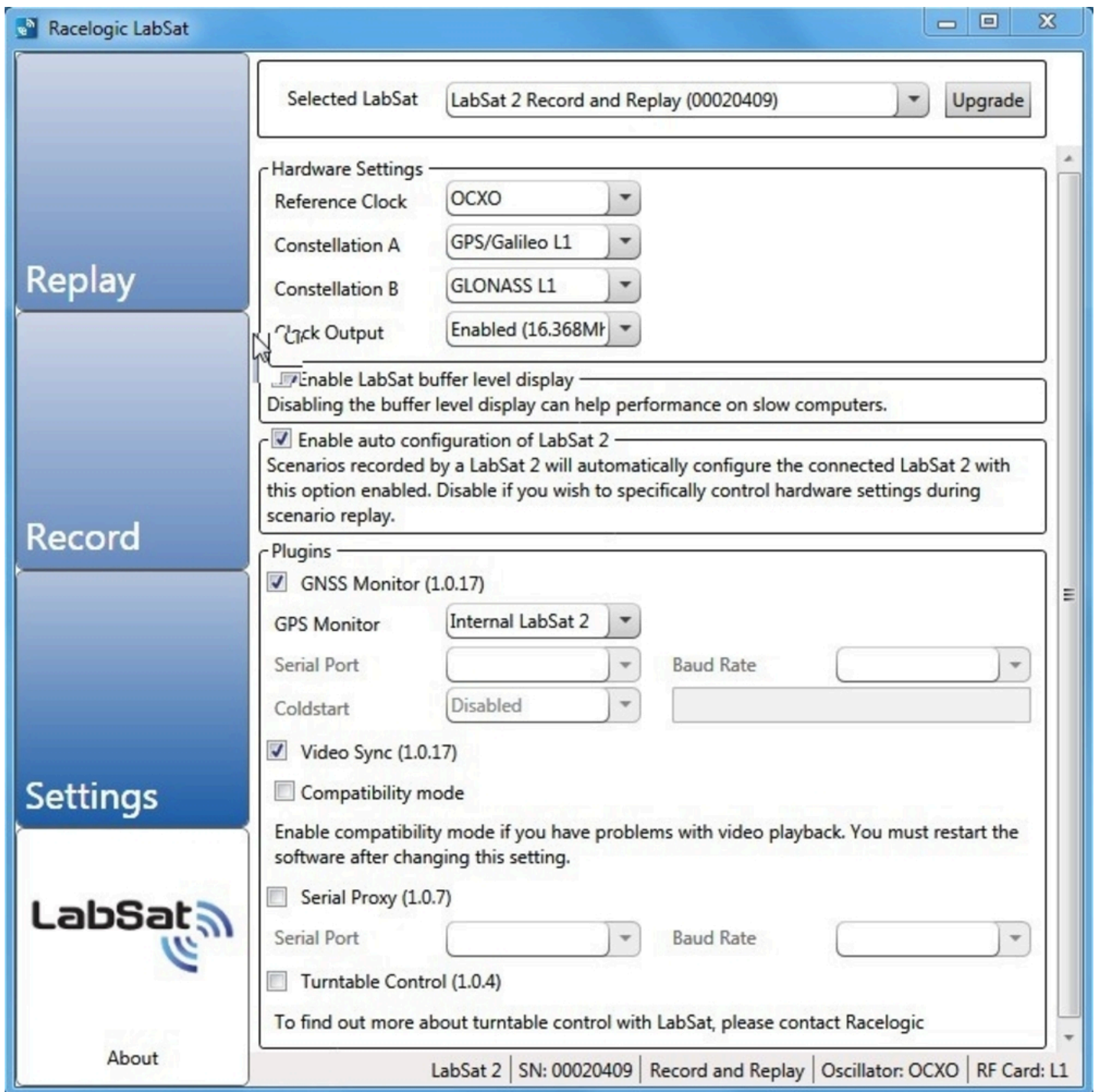


08 - LabSat 2 Software Settings

The LabSat software can be used to control the multi-GNSS LabSat 2, as well as LabSat hardware. When a LabSat is connected to the PC the LabSat software will auto-detect the type of hardware connected and configure LabSat accordingly.

In the example shown, below a LabSat 2 Replay and Record unit has been connected to the PC. The LabSat software has been started and the Settings menus accessed.





Hardware Settings:

LabSat 2 is a Multi GNSS Replay and Record Simulator. Each Channel is selectable to record and replay from the GPS L1, Galileo E1, BDS B1 or GLONASS L1 RF signals. The system can be set to record a single constellation at 2 bit or in pairs at 1 bit and one constellation with the second channel set to record DIO.



https://en.racelogic.support/Product_Info/LabSat_2/LabSat_2_User_Guide/08_-_LabSat_2_Software_Settings

Setting channel A will determine which constellation can be used with the DIO. See [channel mode](#) in advanced recording control for more information.

The Reference Clock can be set to use the optional OCXO (if installed) or the TCXO. If required external timing can be selected, either a 10 MHz or 16.368 MHz source. The Clock Output can be enabled or disabled for 16.368MHz output to the 26 way connector.

The GNSS Monitor is set to Internal LabSat 2. This uses the internal GPS engine to monitor GPS signals during Replay or Record, on the LabSat software GUI. The monitor can be set to Internal LabSat 2 (10 Hz) which will use up to to eight satellites only in this mode. The NVS NVO8C setting refers to an external monitor for GPS & GLONASS signals.

An external Serial Monitor may also be selected, to display NMEA data (if available) from the GNSS receiver under test (DUT) on the LabSat software. The GPS Monitor may also be disabled.

Note the Video Sync and Serial Proxy tick boxes. Video Sync allows for the synchronisation of the LabSat scenario with a video VBOX recording of the route. Serial Proxy allows for the serial NMEA data from the internal receiver to be redirected to another port. The Turntable Control is part of the LabSat Turntable application. Please contact your LabSat distributor or [Racelogic](#) for details.

The Upgrade Button is used for specific software upgrades such as input of data to allow for a Replay Only LabSat to be set up for a rental record period.

Please contact Racelogic or your LabSat distributor for details. Note: The Upgrade Button is not to be used for firmware upgrades, please refer to the [LabSat 2 Firmware section](#).



Selected LabSat: LabSat 2 Record and Replay (00022473) Upgrade

Hardware Settings

- Reference Clock: **TXCO** (Selected)
- Channel A Band: **GPS L1** (Selected)
- Channel B Band: **Glonass L1** (Selected)
- Clock Output: Disabled

Enable LabSat buffer level display
LabSat buffer level display is only available when connected to a LabSat 2

Enable auto configuration of LabSat 2
Scenarios recorded by a LabSat 2 will automatically configure the connected LabSat 2 with this option enabled. Disable if you wish to specifically control hardware settings during scenario replay.

Plugins

- GPS Monitor**
 - GPS Monitor: **Internal LabSat 2**
 - Serial Port: **COM1**
 - Coldstart: **Disabled**
- Video Sync
- Serial Proxy
 - Serial Port: **COM1**
 - Baud Rate: []
- Turntable Control

To find out more about turntable control with LabSat, please contact Racelogic

LabSat 2 | SN: 00022473 | Record and Replay | Oscillator: TCXO | RF Card: L1

Annotations:

- Upgrade button
- TXCO Reference Clock Selected
- Constellation selection
- Clock Output Selected
- Enable auto configuration of LabSat 2 Selected
- GNSS Monitor selected, Video Sync & Serial Proxy deselected
- Turntable control

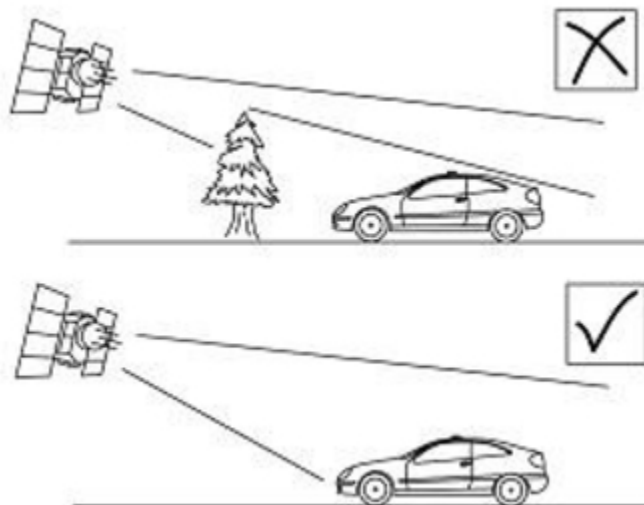


09 - LabSat 2 Recording GNSS Data

NB: Applicable to RLLSC02-GNL1 and RLLSR02-GNL1 LabSat 2 Models Only

The GNSS antenna supplied with the LabSat 2 is a 3 V active antenna with 28 dB gain. For the best possible signal quality, it is important to maintain a good RF connection between the antenna and the LabSat. Before fixing the antenna to the LabSat, ensure that there are no dust particles in either connector. Replacement antennas are available by contacting your LabSat distributor.

The antenna is a magnetic mounting type for quick and simple mounting to the vehicle roof. For optimum GNSS signal reception, make sure that the antenna is fitted to the highest point of the vehicle away from any obstructions that may block satellite reception. The GNSS antenna works best with a metal ground plane underneath (a metallic vehicle roof is perfect for this).



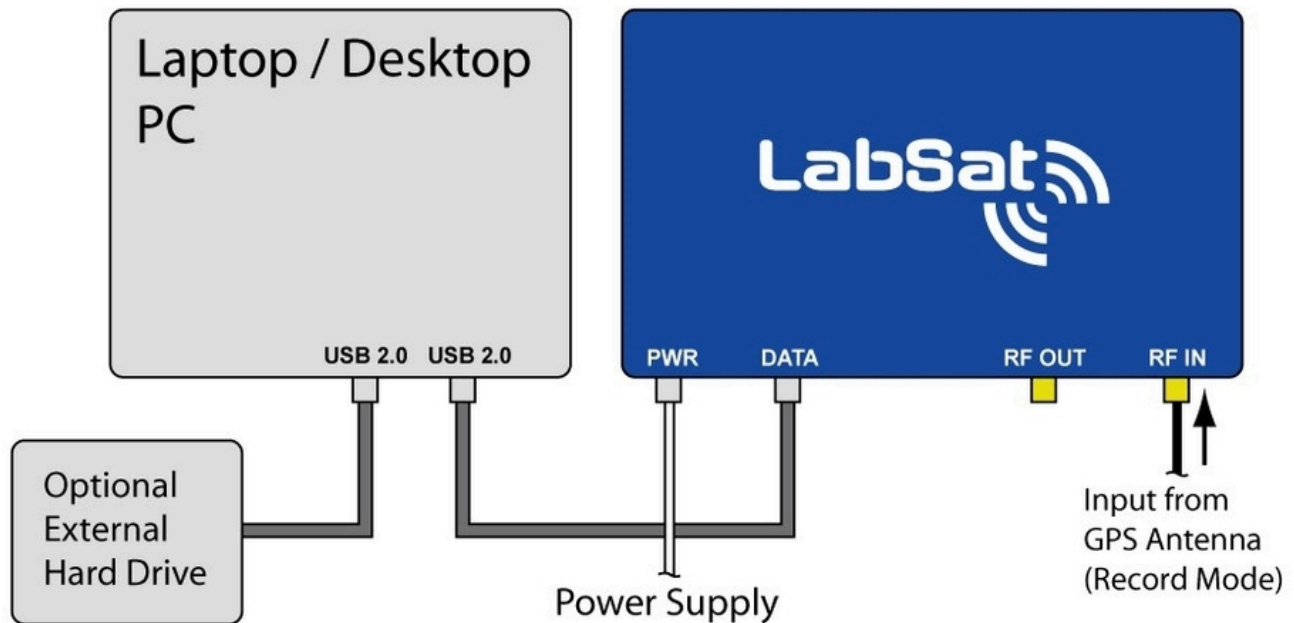
Please also note that when using any GNSS equipment, a clear view of the sky, without physical obscuration, is important. Objects in the surrounding area such as tall buildings or trees can block the GNSS signal causing a reduction in the number of satellites being tracked, or introducing reflected signals that can decrease the accuracy of the system. Note that clouds and other atmospheric conditions do not affect the LabSat's performance.



GNSS antennae require a ground plane to operate correctly. This helps to reduce unwanted reflections of the GNSS signals caused by nearby objects, and usually the metal roof of a vehicle performs this function. However, if a test requires an antenna to be placed either off the vehicle, or on a vehicle that does not have a metallic roof, a special *ground plane* antenna must be used. This has an internal ground plane and can operate perfectly without the need for mounting on a metal surface. Ground plane antennas are available from your LabSat distributor.

The LabSat 2 is set up according to the diagram below.

1. Connect the Active GNSS antenna to the RF IN port of the LabSat 2.
2. Connect the high speed USB cable to the computer on which the Scenario data file is to be recorded. It is possible to connect an external USB drive to the computer and stream the recorded file directly onto this drive.
3. Connect power to the LabSat 2.
4. Start the LabSat software.



Before recording Scenario data it is important to observe certain criteria, failure to follow these precautions may result in satellite data dropouts or corrupt data contained within the recorded file.



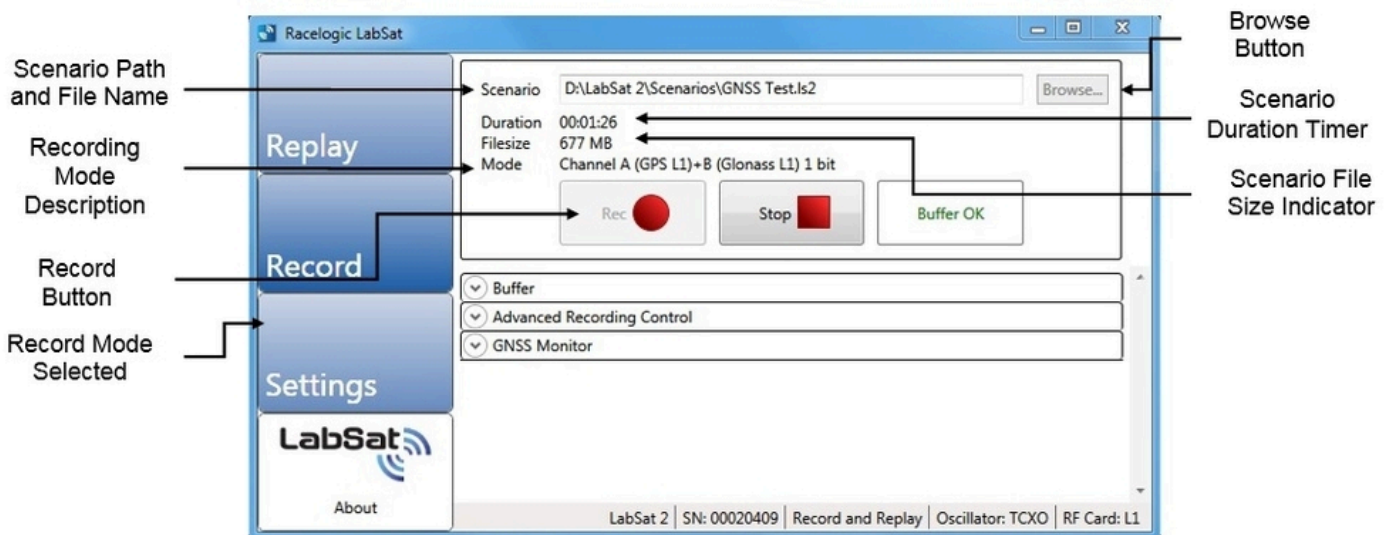
Very Important: Running Background Applications if Logging to Computer

The LabSat 2 has a two second USB buffer, but due to the exceptionally high data rates and processing power utilised by the LabSat 2 USB bus when recording GNSS data, it is important to have **no other applications running** on the computer and **not to start any other applications** whilst the LabSat 2 is recording data. Also make sure you do not start to move windows around, or do anything which takes processing power away from the LabSat 2 application, as Windows can occasionally stall for more than 2 seconds when launching/running other applications. Even though you may have multiple USB ports on your computer, in most cases they all share the same bus. Therefore try to limit any activity using additional USB devices.

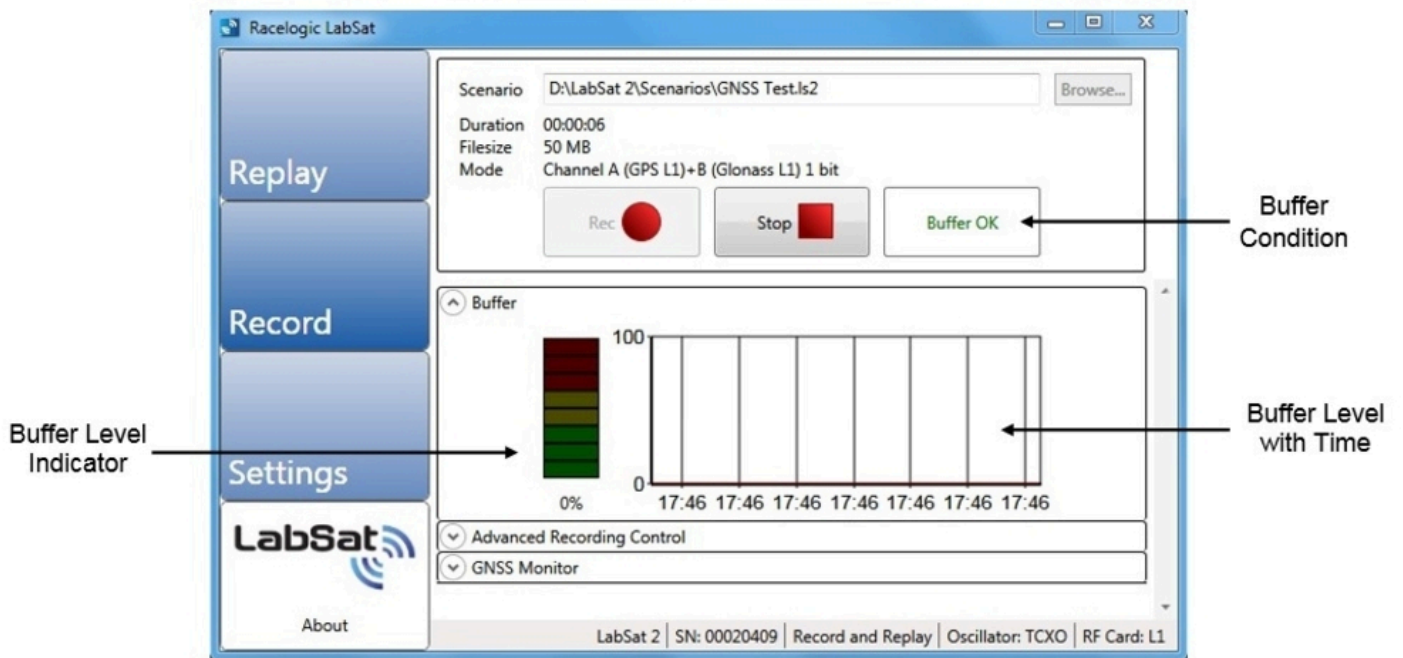
Recording Data to an External Drive:

It is recommended that any external drive used to record scenarios is formatted in the NTFS format. The FAT32 format has a file size limit of 4 GB, which is equivalent to about 34 minutes of recording. The USB drives supplied with the LabSat 2 are pre-formatted using the NTFS file format.

5. Once the LabSat software is running, LabSat 2 is now ready to record data.
6. Click the Browse Button. The user will be prompted to enter the filename and choose the location of the recorded file.
7. Click the Record Button. The REC Light on the front panel of LabSat 2 will start to flash, indicating that LabSat 2 is recording GNSS RF data.
8. As the LabSat 2 begins to record data the Duration timer will indicate the length of scenario recorded and file size will begin to increase.

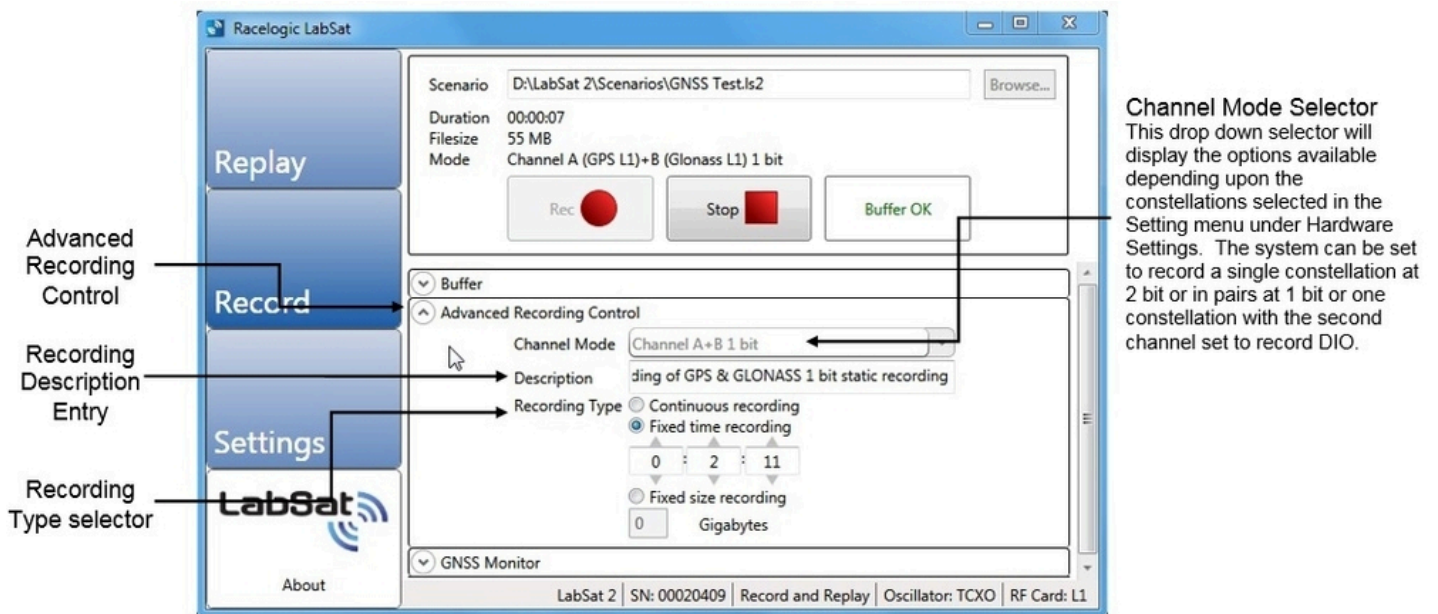


9. During Record, the Buffer display may be selected, to show that the buffer is not becoming overloaded. The illuminated bar graph indicates buffer level and there is also a moving line graph showing buffer level over time. The LED display on the LabSat 2 front panel also indicates the status of the buffer.

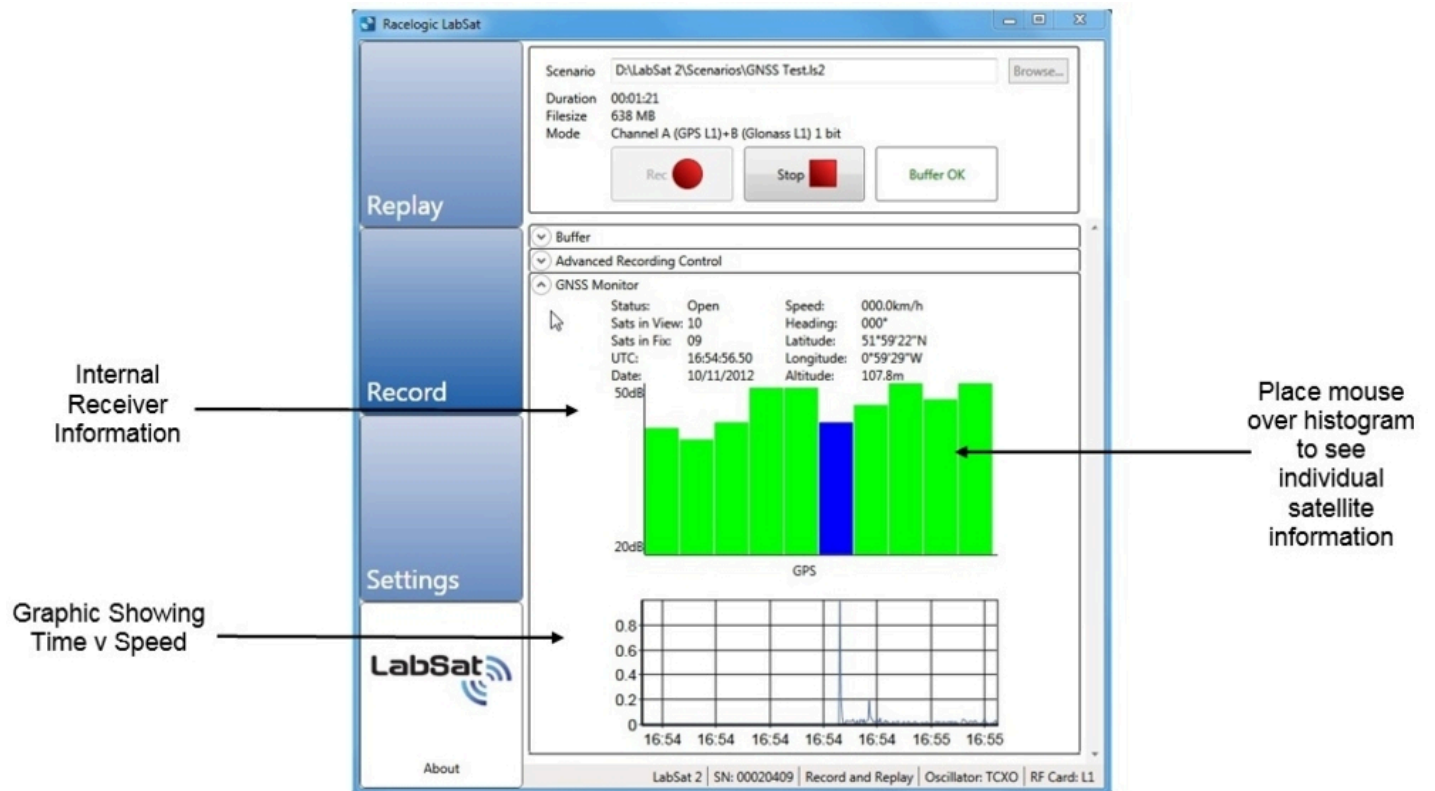


10. The Advanced Recording Control allows users to pre-select either a fixed recording time or a fixed recording file size. The default option is continuous recording. In the example, below, a fixed scenario time of 2 minutes 10 seconds has been selected. The scenario record time may also be limited by selecting a maximum file size, for the recorded scenario. The Description box allows for a detailed description of the recording to be entered.
11. The channel mode selector determines which channels are used and the quantisation level.





- GNSS Monitor displays the NMEA Output from the internal GPS Receiver within LabSat 2. Connect the GNSS Monitor Port (USB Mini 'B') to a spare USB Port on your PC. The GPS data being recorded is simultaneously displayed by LabSat 2's internal GPS receiver engine, on the GNSS Monitor display, as shown below.



13. Click Stop, to halt recording GNSS RF data.

Note: Satellite Lock

There is no 'acquisition time' as such when recording data with the LabSat 2 as it is recording the complete RF signal rather than tracking individual satellites. However, when recording data, we recommend that you allow around 5 - 10 minutes of stationary recording in an open location with good unrestricted visibility of the entire sky before moving off. In this way any GNSS engine receiving the LabSat scenario data will have plenty of time to lock onto satellites and begin storing almanac data.

Note: LabSat 2 Data Rate

LabSat 2 records RF data over high speed USB at a data rate in excess of 8 MB/sec, this means the data files created by LabSat 2 become large very quickly. It is important to ensure that there is sufficient space on the computer or USB hard drive where the recorded data file is to be stored.



10 - LabSat 2 Recording Event Inputs

The AUX connection on the front panel of the LabSat 2 carries a digital input which can be used to mark an event such as a brake trigger event. Contact Racelogic for details of hand-held or pedal mounted switches that can be used with LabSat 2 to record events.

When a change occurs on the digital input during a record session, a marker is placed in the recorded GPS data. Two marker types are used; one to signal a negative transition on the digital input and the other to signal a positive transition.

The digital input and digital output signals on the AUX connector allow connection of the optional interface modules to enable sampling of CAN Bus or RS232 data in synchronisation with the RF recording. See section on [Interface Modules](#) for more details.

Note: It is not possible to use a separate digital input when using one of the interface modules.



11 - LabSat 2 Replaying GNSS Data

Note: Applicable to RLLSP02-GNL1 and RLLSR02-GNL1 LabSat 2 Models.

Any LabSat 2 unit can replay a recorded scenario file to any connected GNSS device capable of receiving the L1 GPS signal, E1 Galileo, B1 BDS, L1 GLONASS signals. So that the receiver under test can accept the LabSat scenario it is strongly recommended that the receiver is cold started prior to each replay. This will remove and almanac and ephemeris data from the receiver to allow for the data contained in the scenario to be used.

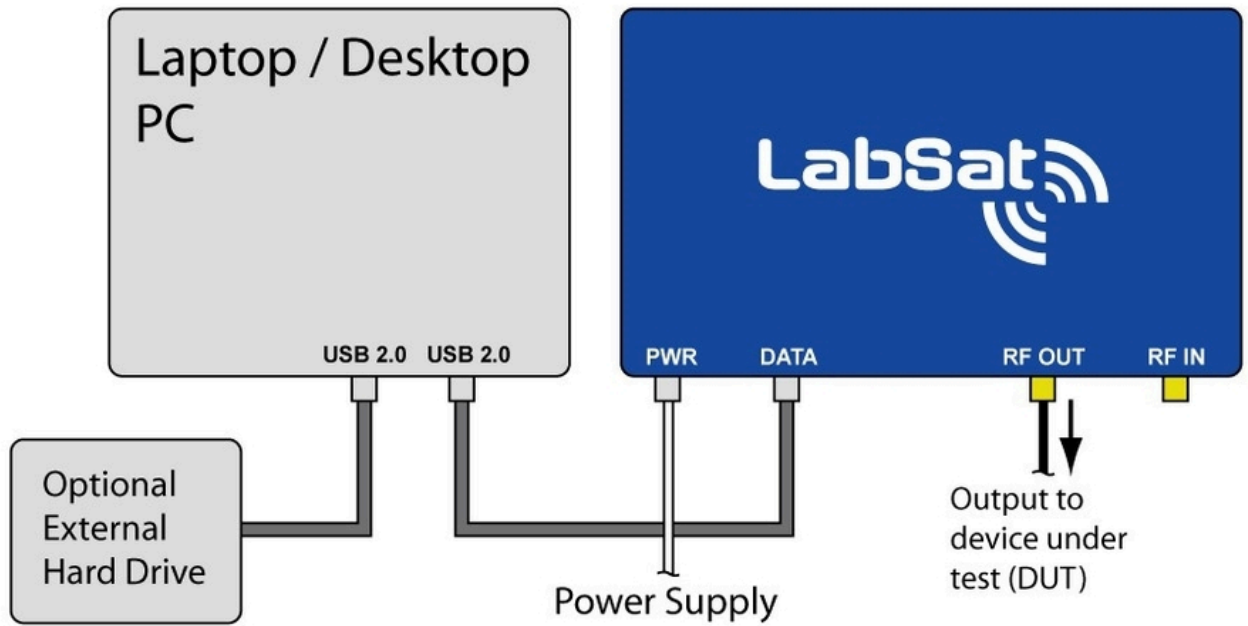
Note: LabSat 2 is designed for direct connection to a GNSS receiver via a suitably screened cable. If testing is to be performed on GNSS equipment without an external GNSS antenna connection, it is the responsibility of the user to ensure that this is done in a fully RF screened environment, such as an anechoic chamber to avoid interference with other GPS/GLONASS receivers.

[Contact Racelogic for more information.](#)

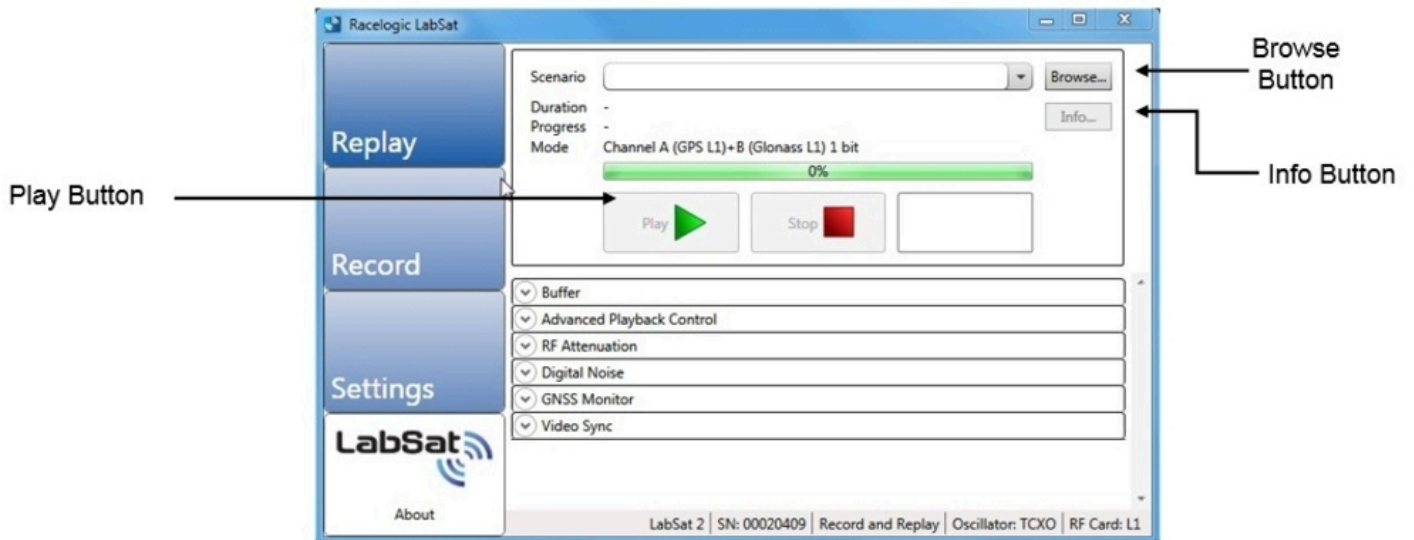
The LabSat 2 is connected as illustrated in the diagram below:

1. Connect the high speed USB cable from the LabSat 2 to the computer the Scenario data file will be replayed from.
2. Connect power to the LabSat 2, and the recipient GNSS device.
3. The LabSat 2 comes supplied with a number of adaptor cables which allow connection to a number of GNSS devices. Select the appropriate antenna cable for the device to be connected.
4. Connect the RF-OUT connector of the LabSat 2 (illustrated below) to the GNSS antenna input of the device.
5. Start the LabSat software.
6. The LabSat 2 is now ready to replay GNSS data to the DUT (Device under Test). Select the Replay Mode tab on the LabSat 2. The LabSat 2 is now ready to replay GNSS RF data.

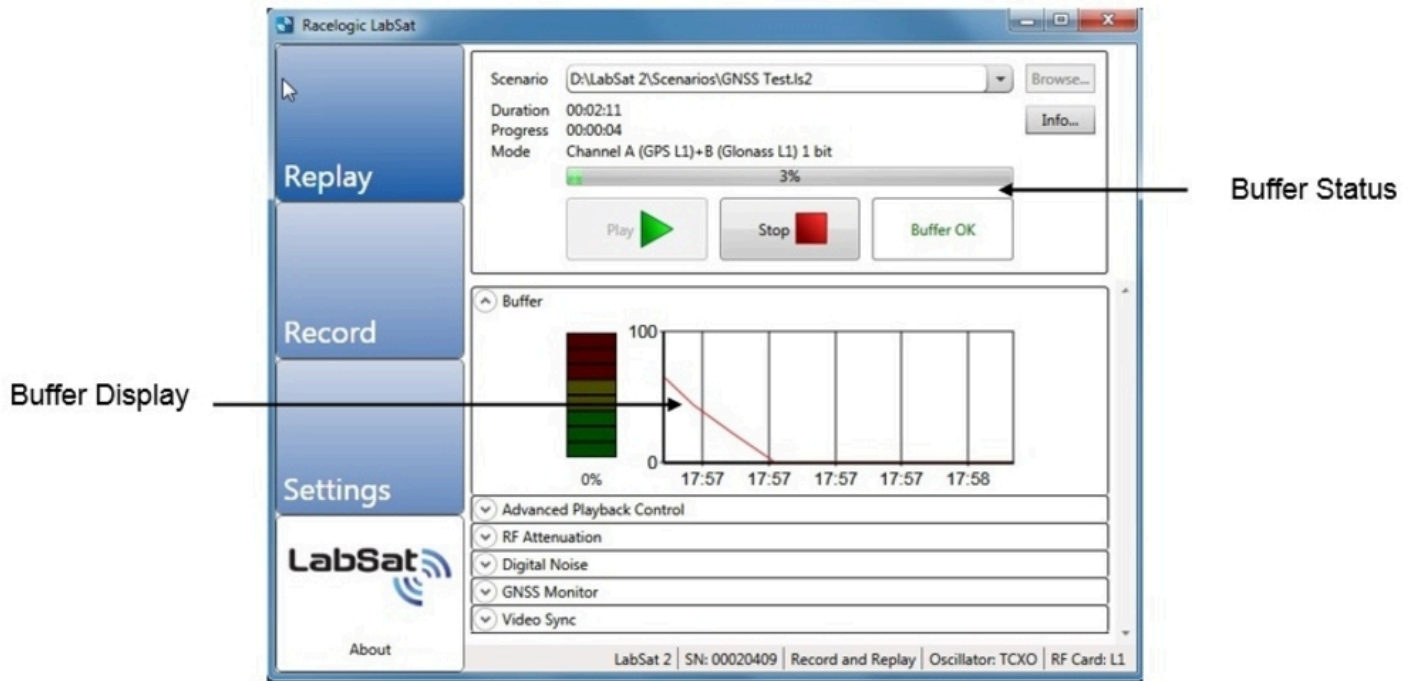




- Once the GNSS device is powered and ready to receive data and has been cold started, press the Browse button to locate the scenario required for the test. The Info button will display a full description of the scenario as entered in the description box display on the record screen. Information is also displayed about the LabSat recorder used and its configuration settings.



8. Click the Play button to start scenario replay on LabSat 2.
9. The progress bar gives a visual indication of the current progress through the scenario file being replayed.
10. The total duration of the scenario selected, and the progress of the scenario replay are also shown on the LabSat software, above.
11. The replay of the file can be stopped and restarted by pressing the 'Stop' button then the 'Play' button at any point during Playback.
12. During Replay the Buffer display may be selected, to display memory buffer loading. The LED display on the LabSat 2 front panel also indicates the status of the buffer.

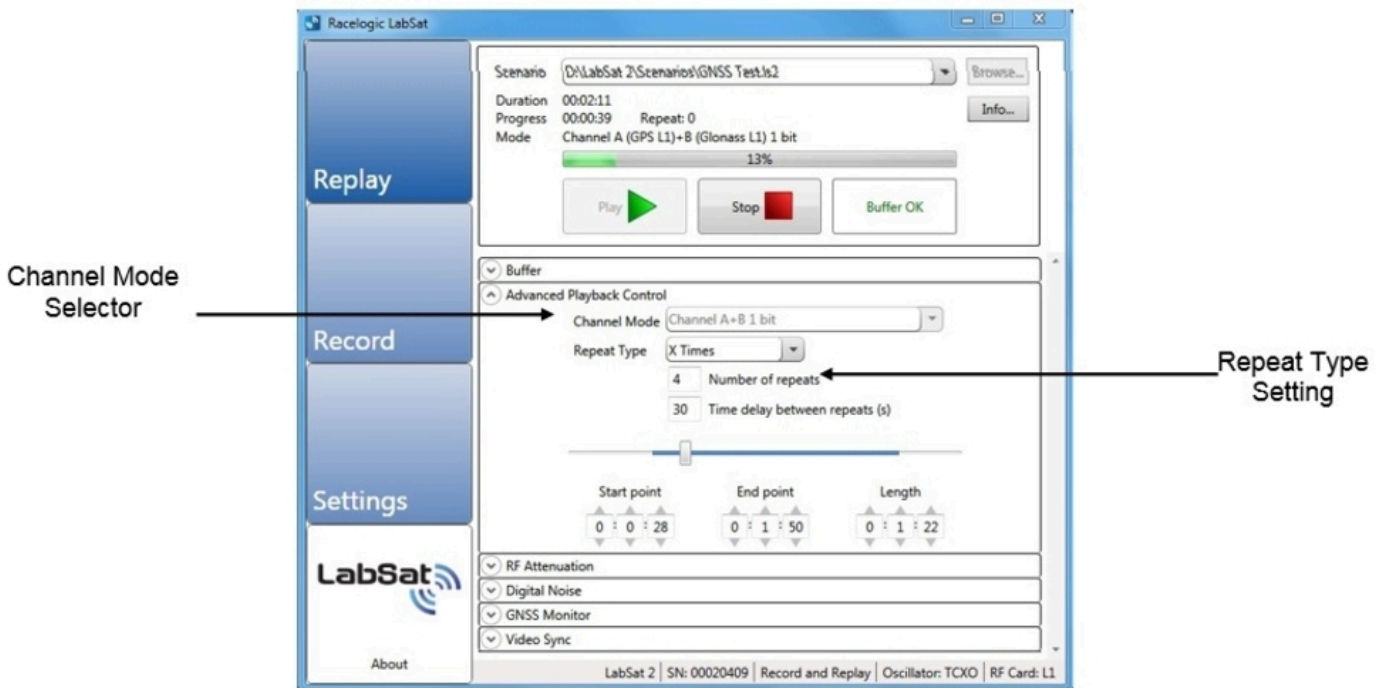


13. The Advanced Playback Control feature on LabSat 2 contains a feature that allows you to repeat the same scenario over again, so that at the end of the scenario replay the LabSat 2 will loop back to the start of the scenario, and start replaying the scenario over again.

The user can specify the number of repeats, or set the scenario to repeat indefinitely. You can also specify a time delay between repeats, for example to allow time for a cold-start of the DUT before the scenario re-starts. In the example shown below, four repeats have been selected, with a delay of 30 seconds between each repeat of the scenario replay.

Note: At least 30 seconds of constant satellite data is required for the receiver to collect the necessary data to use that satellite so choose sections of the recording with good view of the sky reflect the real world situation when commencing replaying a section of the scenario.





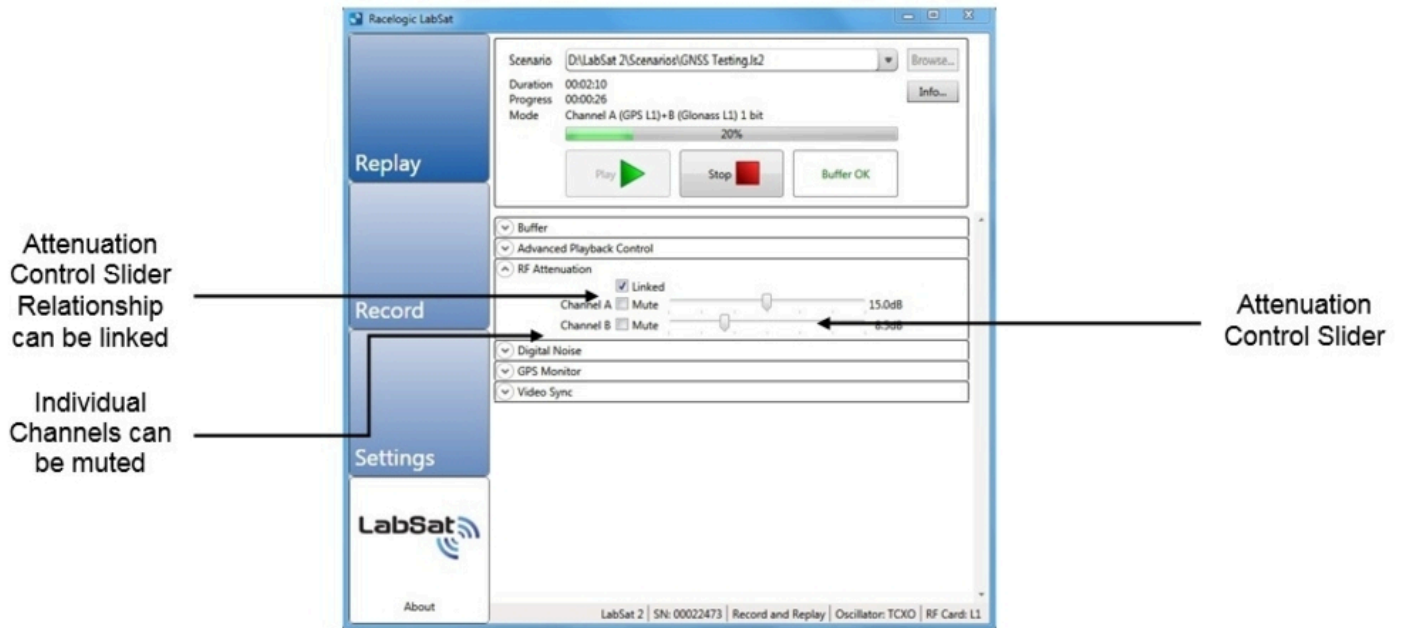
14. The Advanced Playback Control also allows users to define a specific start point, end point, or duration of a scenario. In the example shown previously the scenario is set to start 28 seconds from the beginning, and the end point has been set to 1 minute 50 seconds into the scenario, giving a total scenario replay time of 1 minute 22 seconds. The slider position, on Advanced Playback Control indicates progress along the specified scenario length. The scenario may also be fast forwarded, and rewound, by clicking on the progress pointer, and dragging it along the blue progress bar. If you wish to start replaying a scenario at some point other than the start of the file.

The Start Point setting may be used to specify the time to advance the replay start point. By combining the 'Start Point' and 'End Point' or 'Length' functions, it is possible to select a particular time segment out of any given scenario. The LabSat 2 will stop replaying the scenario when the replay duration has reached the time specified on the scenario length setting.

15. The Channel Mode selector will allow for the replay to separate out the data recorded. For example a Channel A+B 1 bit recorded scenario can be replayed as a GPS and GLONASS file, GPS only or GLONASS only. A Channel A 2 bit GPS only - 2 bit I & 2 bit Q recorded file will play the 2 bit file as recorded or can be set to replay GPS 1 bit only.
16. Depending on the sensitivity of the GNSS engine under test, it may be necessary to adjust the output attenuation control slider. This can be used to vary the output power of the LabSat 2 from a nominal -83 dBm down to -107 dB. In the example below, the digital output attenuator has been set to provide 15.5 dB of attenuation on channel A and 8.5 dB on Channel B.

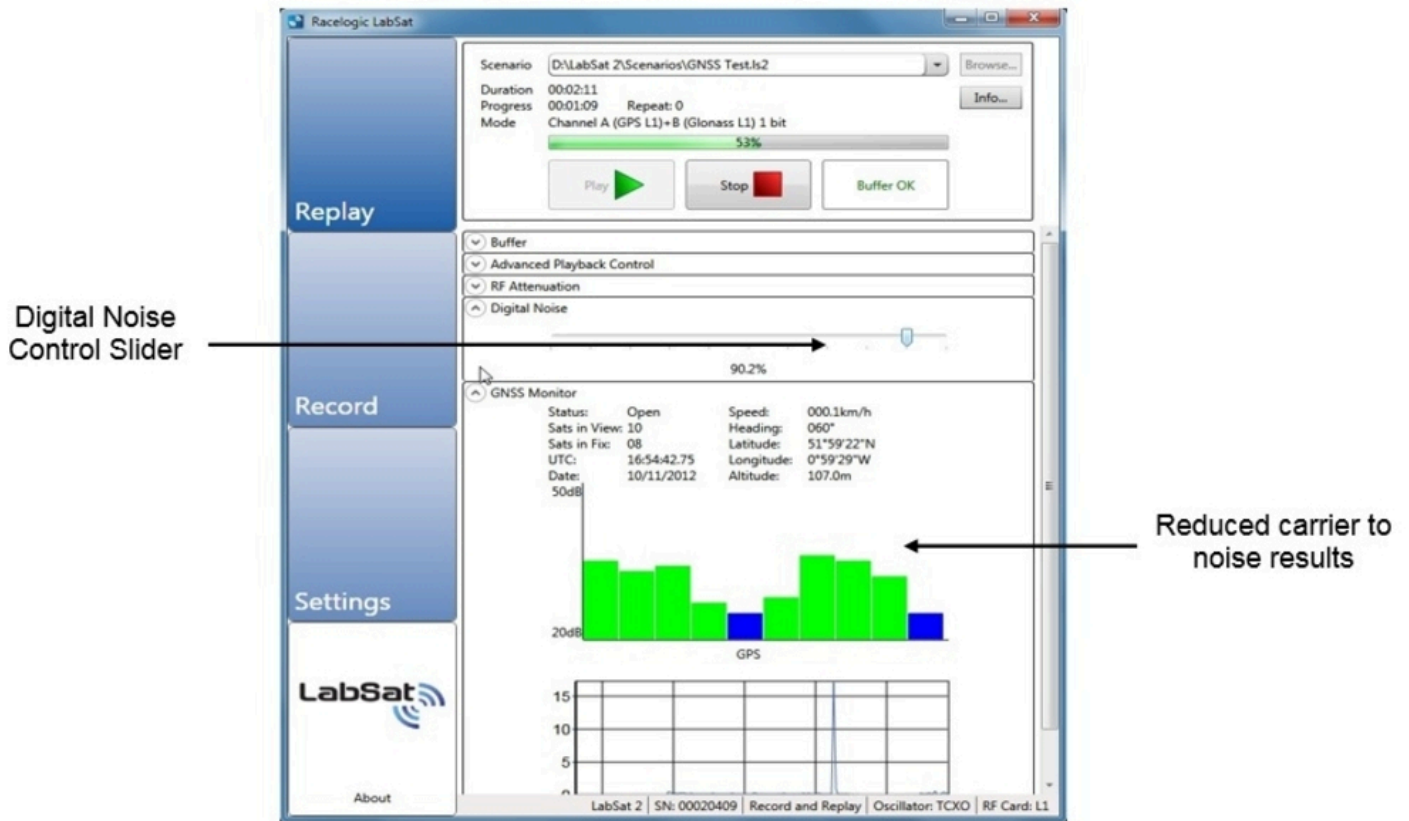
It is recommended to try the 0 dB slider setting (-83 dBm output) first. If the GNSS engine under test does not lock onto the LabSat 2 signal at 0 dB then increase the attenuation slider by 0.5 dB at a time and replay the file. It is also advisable to cold start the GPS / GLONASS device under test after starting each replay to clear any almanac data that the GNSS engine may have stored. By ticking the Linked Box the relationship between the attenuation on each channel is linked and fixed to each other.





- The digital noise function allows degradation of the replayed GNSS signals by mixing a noise source with the original recorded/simulated file. The Digital Noise slider in the LabSat software is used to adjust the output signal from 0% noise to 100% noise. At the 0% noise setting, the signal output is 100% of the original signal.





Digital Noise Control Slider

Reduced carrier to noise results

18. For GNSS Monitor details please refer to page 17 in the previous section.
19. The Video Sync is a powerful way of using a video recording of your live route to replay in synchronisation with the LabSat scenario file. For a full descriptions please go the the Video Synchronisation section. To play a LabSat scenario with the recorded video VBOX recording please tick the video sync tick box in the plug-in section of settings. The video sync drop down section will appear in the relay section of the software.

Locate the LabSat file as normal using the browse button and then locate the browse button in the video sync drop down menu. Click on the vbo file located in the same folder as the Video recording file. Wait for the file to load in the software and then click on the play button as normal. The LabSat scenario file will then play in synchronisation with the Video VBOX video. Please ensure that the GPS monitor is enabled and is showing the live data from the LabSat scenario.





The video VBOX video shown in the software can be expanded by clicking on it to the full screen size of the computer screen.

20. Click Stop, to halt replay of GNSS RF data and the video replay.



12 - LabSat 2 SatGen v2 Software

SatGen v2 software is a powerful tool for defining and creating RF playback scenario files for use with the LabSat Simulator. For many applications LabSat can record and playback real world, live sky data, but there may be times when you need a more controlled, user definable signal. When this is the case, SatGen v2 provides all of the tools necessary to create a predictable, stable and accurate output from LabSat. SatGen v2 has the distinct advantage of allowing for the creation of scenarios with any dynamics, location, date or time.

The screenshot displays the SatGen V2.3.7 software interface. The main window is titled "SatGen V2.3.7- looking for Dongle". The interface is divided into several sections:

- Left Panel:** A vertical menu with options: "Static scenario", "Draw route", "Import file", "User defined", and "Close".
- Define dynamic scenario:** A central area with a text editor containing the following commands:


```

      1 lat=0
      2 long=0
      3 StartHeight=0
      4 StartHeading=0
      5 speed=100@100m
      6 wait 10s
      7 heading=180@500m
      8 wait 10s
      9 heading=360@1000m
      10 speed=0@100m
      
```

 Below the text editor are buttons for "Position", "Speed", "Height", "Turn", "Preview", and "Examples". At the bottom of this section are "Load file" and "Save file" buttons, a checkbox for "Display line numbers on graph", and a "Help" icon.
- Scenario Details:** A graph titled "Position (x,y) m" showing a circular path with a radius of approximately 500m. Below it is a "Speed profile" graph showing speed in m/s over time (0 to 300s). To the right of the graphs, it displays "Total time 317.14s" and "Total distance 8609.51m". A "Create scenario" button is located to the right of the graphs.
- Scenario Settings:** A section at the bottom right with various configuration options:
 - Date of Simulation: 23/01/2012
 - UTC Time of Simulation: 0:09:00
 - Dynamics: Medium
 - Update rate: 10Hz
 - Elevation mask: 5
 - Almanac: Manual
 - Almanac file: 2012-023.aln
 - Initial acquisition delay: 0:04:00
 - End delay: 0:00:30
 - Buttons: "Update" and "more" (checked).



Why use SatGen v2 software?

You might be based in Europe, but your GPS devices will be deployed throughout the world. With SatGen v2 you can create a test scenario based on a user-generated trajectory file for virtually any location, including hostile areas for which live-sky field testing might be impossible. This allows you to verify that your GPS equipment design performs as required, in a variety of locations that may be geographically remote from your facility. It also means the same scenario can be replayed repeatedly to see how the device under test (DUT) performs.

Of course, LabSat can record and replay live data, but creating an artificial scenario allows you to precisely control the data content, and create a 'gold standard' file for carrying out true comparisons between receivers. From your bench you can try different acceleration levels, crossing different time zones, the equator, leap second roll-overs and many hard to replicate tests.

Artificial scenario files can easily be created from a static position, draw a route, import a file (NMEA, Google.kml, Video VBOX.vbo) and user defined instructions with inclusive pre defined examples.

Choice of two software programmes:

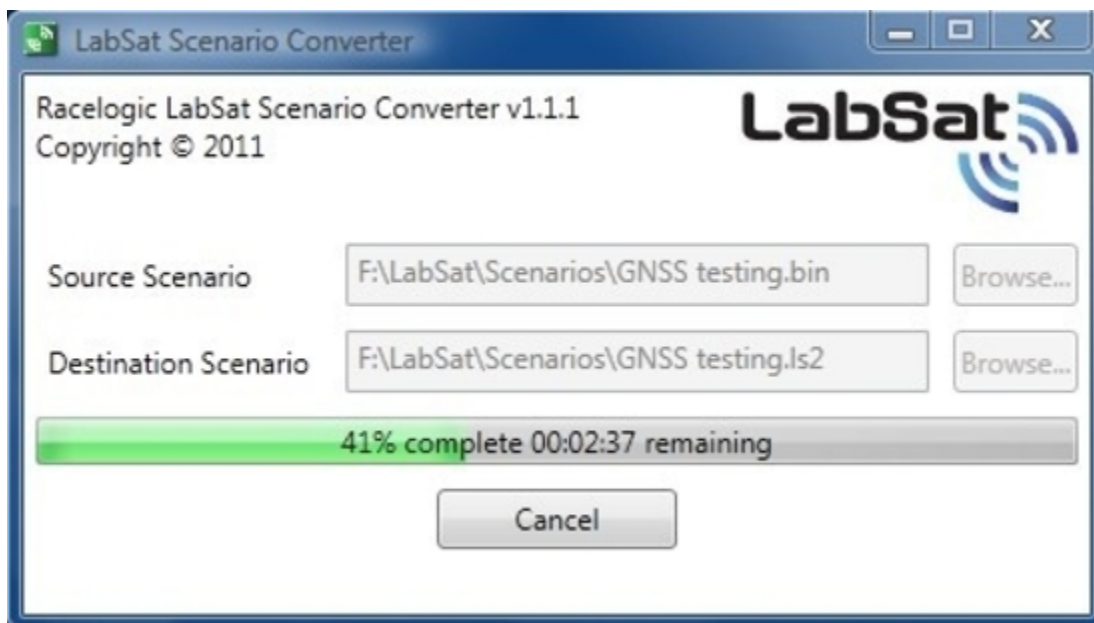
- **SatGen v2 GPS Only Simulation Software** with 'LabSat' 1 bit and 'LabSat 2' 2 bit GPS RF data output in static or dynamic modes: User configurable time, date and duration for static scenario creation. SatGen v2 dynamic scenario creation with draw a route, file upload and user defined command options.
- **SatGen v2 GPS & GLONASS Simulation Software** with 'LabSat' 1 bit and 'LabSat 2' 2 bit GPS and GLONASS RF data output in static or dynamic modes: User configurable time, date and duration input for static scenario creation. SatGen v2 dynamic scenario creation with draw a route, file upload and user defined command options.



13 - Converting LabSat scenarios

LabSat uses a binary Intermediate Frequency, to down convert GPS RF data into a binary file, whereas LabSat 2 stores GNSS RF data as an IQ binary file. This means that existing LabSat scenarios cannot be run natively on a LabSat 2 or vice versa.

Racelogic has therefore developed a conversion utility which allows LabSat 2 users to perform a one-time conversion of existing LabSat scenarios into the LabSat 2 *.ls2 format or LabSat 2 scenarios into the LabSat *.bin format. The conversion utility is provided with the LabSat software and provides for automatic conversion of LabSat scenario files. The operation of the conversion utility is shown below.



Clicking the browse button beside Source Scenario allows you to specify the existing LabSat scenario for conversion. LabSat scenarios have the file format: Filename.bin

The LabSat Scenario Converter tool will automatically convert the existing LabSat scenario, Filename.bin into a LabSat



2 scenario, Filename.ls2

The new LabSat 2 scenario will be automatically saved in the same location on the PC as the existing LabSat scenario. It is possible to specify a different location and filename by clicking the browse button beside Destination Scenario, on the LabSat Scenario Converter.

The new LabSat 2 scenario created can now be run on a LabSat 2 GNSS simulator. This new scenario contains only GPS L1 RF and or Galileo E1 data. The RF data for other Constellations is not created by the LabSat Scenario Conversion tool as LabSat does not record those constellations data. Conversely the utility will only convert the GPS/ Galileo data for LabSat files.



14 - LabSat 2 Interface Modules

During recording, the LabSat monitors the digital input pin, precisely recording the event time of LOW to HIGH or HIGH to LOW transitions. The event times are synchronised to the recorded GPS data with a resolution of around 60nS.

As data is replayed with the LabSat, any digital event markers in the data are used to drive the digital output to re-create the original event signal.

The Interface modules available for LabSat allow recording and playback of GPS synchronous CAN Bus, RS-232, RS-422 or RS-485 data. All of the interface modules connect directly to the **AUX** socket on the LabSat.

Order Code	Description
RLLSIM01	CAN Bus Interface module
RLLSIM02	RS-232 Interface module
RLLSIM03	RS-422 / RS-485 Interface module
RLLSIM04	Dual CAN Bus Interface Module

Because the LabSat is recording the transitions in the signal data and not intelligently interpreting the data, it is not necessary to configure baud rates for any of the modules.

During replay of data that has been recorded with one of the interface modules, the interface module will output the data as it was recorded.

Example Application 1

Development of GPS+IMU integration. Using the RLLSIM02 to record RS-232 data from an IMU during GPS recording. When replaying the GPS data, the LabSat Interface module will transmit the RS-232 IMU data exactly as it was recorded, in sync with the GPS data.



Example Application 2

Development of Navigation software using GPS+CAN Bus. Using the RLLSIM01 to record CAN Bus data from a vehicle while recording GPS on a test drive with the LabSat. When the GPS data is replayed, the RLLSIM01 outputs the CAN Data as it was recorded.

One important point to remember in replaying CAN bus data is that the LabSat is playing the CAN Data in the exact sequence and with the exact timing that it was recorded. This means that if replaying CAN Data onto a CAN bus with other transmitting nodes, the LabSat will try to transmit data even if another node is already sending a message causing corruption of data on the CAN bus.

For this reason, we do not recommend that the LabSat is used to replay CAN data onto a vehicle or any other CAN Bus in a safety critical application.

Note: It is not possible to use a separate digital input when using one of the interface modules.



15 - LabSat 2 Video Synchronisation

A unique feature of LabSat is the ability to synchronise RF data recording with video from the optional Racelogic Video VBOX GPS data logger. To record video, the Racelogic Video VBOX is simply placed in the test vehicle at the same time as LabSat. The Video VBOX contains its own high performance GPS engine for time stamping the video so that the RF data can be synchronised with the video when replayed on the bench. Not only is the video perfectly synchronised, but GPS data can be graphically superimposed on the image during recording.

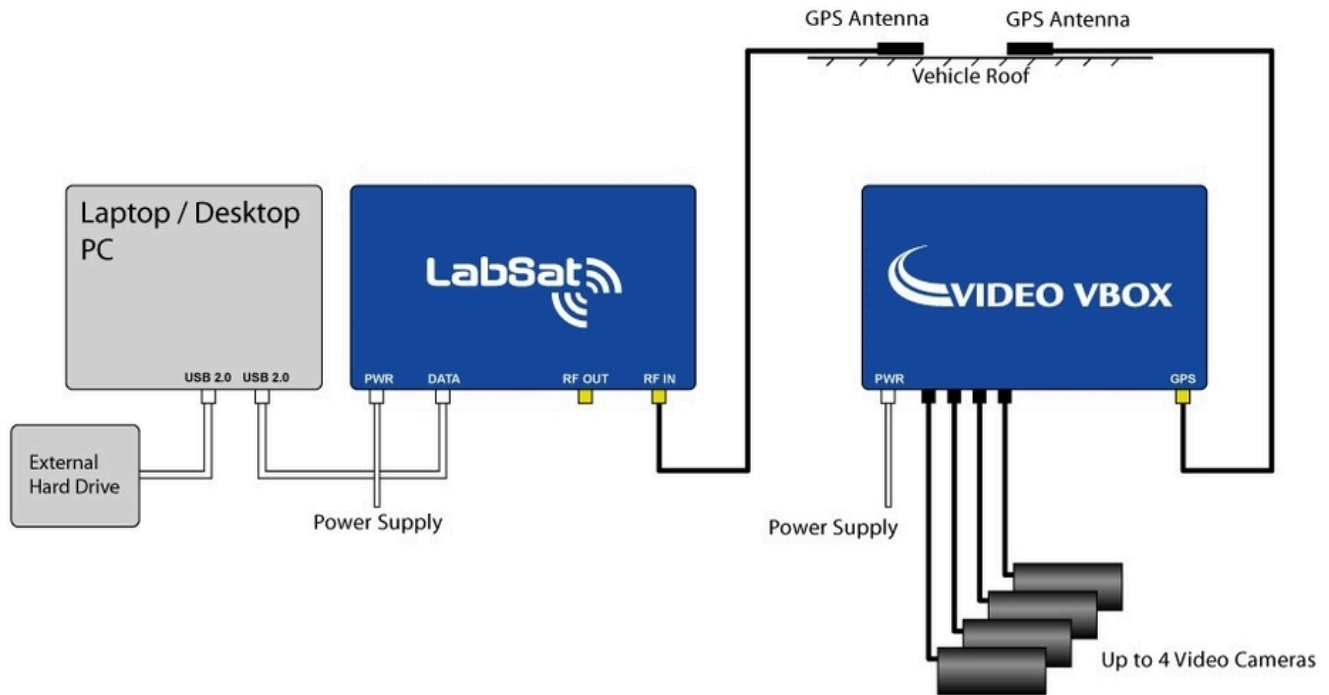
Synchronous replay is made possible because LabSat contains an internal GPS engine which is connected to its RF output channel. Therefore, during a replay, this GPS engine tracks satellites contained in the original recording, with the time-stamp from this GPS engine sent over the mini usb connection to a PC. The PC automatically synchronises the video with the UTC time embedded in the Video data. A range of Video VBOX products is available from Racelogic, all of which will enable the recording of GPS time stamped video.

Order Code	Description
RLVD10P2P	Video VBOX Pro 10Hz with 2 cameras
RLVD10P4P	Video VBOX Pro 10Hz with 4 cameras
RLVBVD10LT1	Video VBOX Lite – 1 camera option
RLVBVD10LT2	Video VBOX Lite – 2 camera option



Recording video using a Racelogic Video VBOX

To use the video synchronization feature, put the Video VBOX and the LabSat into the test vehicle at the same time. The Video VBOX should be set to 'Log all of the time' by pressing the front panel button after it has booted. Please refer to the Video VBOX manual, for full details on how to set up your Racelogic Video VBOX. To record GPS data on the LabSat, please refer to the earlier section: Recording GPS Data with LabSat. The Video VBOX is now recording the video, and the LabSat is recording the GPS data.



A new video (AVI) and data (VBO) file are created in a 'media' folder on the SD card or USB device every time the vehicle begins to move or the 'REC' button is pressed.

The current files are closed when the vehicle comes to a stop or the 'REC' button is pressed again. The filename format is as follows: VBOX####.VBO, and VBOX####.AVI, where #### represents an incrementing number. Both files are required to play back the recorded video, synchronised to the Labsat GPS data.



Replaying synchronised video using a Racelogic Video VBOX

In order to replay the Video synchronised to the LabSat playback, Racelogic provides free video synchronisation files to demonstrate this feature. The Video Sync application is included in the software supplied with the LabSat. No installation is required and it can easily be demonstrated using the files included in the LabSat Hard Disk Drive (HDD). The files are included in the Video Synchronisation folder.

To start playing back video, synchronised with the LabSat 2 GPS RF playback, connect the PC's USB port to the LabSat using the mini USB cable to the GPS monitor on the LabSat 2.

To replay a LabSat scenario, synchronised with video playback, you must first make sure that the VBOX####.VBO, and VBOX####.AVI are in the same folder. The LabSat scenario file #####.Is2 can be located in any location

To run the Video VBOX synchronisation demonstration:

1. First start the LabSat software and ensure that the GPS monitor function is enabled and the Video Sync is ticked in the Settings menu. Click the Replay button and select the LabSat 2 scenario that was recorded at the same time as the Video VBOX file. This file is located on the LabSat HDD in the Video Synchronisation folder called vidSync3.Is2.
2. Click the dropdown menu Video Sync, and locate the Video VBOX file called VBOX0003.vbo (This ###.vbo file file must be located in the same folder as the ###.avi file). Wait for the file to load.
3. Click the Play button and both the LabSat 2 scenario file and the Video VBOX file will play together in synchronisation.
4. Cold start the device under test (DUT).
5. The files have a four minute stationary period to allow for DUT to acquire the RF signals and start navigating.
6. The Video will show the vehicle driving off and the speed display in the GPS Monitor will show the speed increasing.
7. You can click the video screen in the software to maximise to the computer screen size. Click escape to return to normal size display.
8. Both files can be stopped by clicking the Stop button.

See [this article](#) on for more information on replaying Video and GPS data.

Because the Video VBOX is also a GPS data-logger with CAN Bus connectivity, it is possible to record many other signals at the same time, and overlay these on the video, producing a very powerful test environment. All overlaid graphics are user-customisable. The LabSat video synchronisation example playing into a DUT is shown below.





Personal Navigation Device under Test (DUT) replaying the GNSS scenario

VBOX Video replaying in sync with the LabSat scenario. Video maximised on the PC screen



16 - LabSat 2 Advanced functions

Pause Control

To allow for synchronised record or replay by LabSat 2 the pause input pin is normally pulled high to 3.3 V. When this pin is driven to 0 V the LabSat 2 will pause the record or replay until 3.3 V is restored. The pause function can be used to start record or relay in synchronisation with other devices. This feature can also be used to enable multiple LabSat 2's to synchronise record and replay. The Advanced Recording Control and the Advanced Playback Control features can be set to further control GNSS device testing.

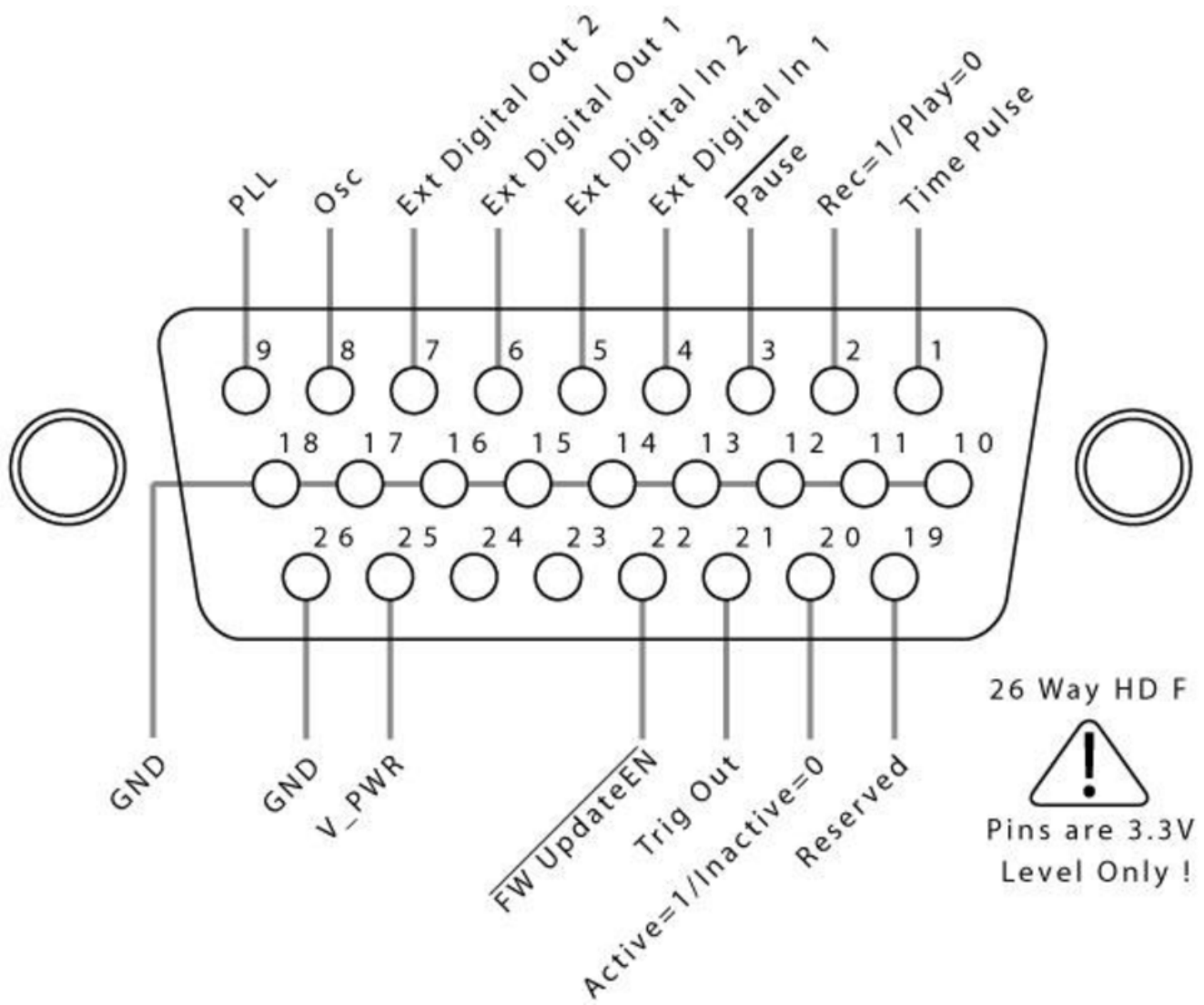
Digital Input /Output

The selection of the Channel A 1 bit + 2 Channel DIO in the Advanced Recording Control will allow recording of 3.3 V logic signals in synchronisation with the GPS-L1 signal. Since the extended digital inputs replace the GLONASS channel in the recorded data, it is not possible to record GLONASS signals at the same time as the extended digital inputs. Digital inputs are sampled at 16.368 MHz. Inputs are internally pulled up to 3.3 V and can be used to sample logic level serial data, synchronisation signals or for marking events. (see page 39. 26 Way D – Type Connector information)

Caution!

The Digital I/O connector uses 3.3 Volt logic levels. Connection of any of the IO signals to levels above 3.3 Volts will cause permanent damage to the internal logic.





17 - LabSat 2 Software Development Kit (SDK)

All LabSat functionality available through the graphical user interface is also made available by way of an API for customers to integrate into their own production testing or laboratory environment.

The LabSat API is provided as a managed C# assembly requiring the Microsoft .Net 4.0 Client Profile runtime. As well as being accessible from managed .Net code, the API is made COM visible allowing a wide range of programming environments to access the full LabSat API functionality. Samples are provided in C#, Windows Powershell, VBScript and C++. A full description, code samples and manual are included with your LabSat software in the folder located at C:\Program Files\Racelogic\LabSat 2\SDK\.



18 - LabSat 2 Inventory and optional extras

Standard equipment (RLLSx02-GNL1)

Description	Part Number
LabSat 2 Main Unit	LS02
LabSat Scenario Hard Disk Drive 500GB USB Drive	LS02HDD
Mains Power Supply	RLVBACS020
USB 'A' to USB 'B' Lead - 2M	RLCAB042
USB 'A' to USB Mini 'B' Lead - 2M	RLCAB066-2
Power Cable - 2 Way LEMO to vehicle 12V socket	RLCAB010L
GNSS Magnetic Mount Active Antenna (not applicable to replay-only LabSat 2)	RLACS156
LabSat 2 Carry Case	RLACS154
RG174 - 1M (SMA Plug to SMA Plug) Cable	RLCAB071-1
RG174 - 1M (SMA Plug to MCX Plug) Cable	RLCAB082-1
RG174 - 1M (SMA Plug to MMCX Plug) Cable	RLCAB083-1
RG174 - 1M (SMA Plug to TNC Plug) Cable	RLCAB084-1
LabSat Software CD	CDRLLS2
Calibration Certificate	RLLSCAL
LabSat Upgrade Connector	RLACS161



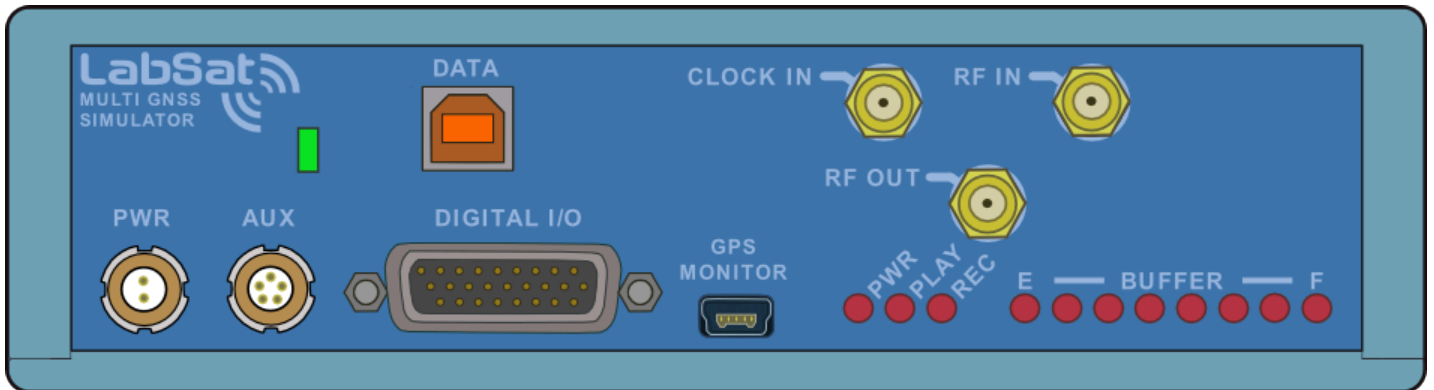
Description	Part Number
LabSat 02 Cable Identification Drawing	LS02-CABIDEN

Optional equipment

Description	Part Number
Interface Module for CAN Bus Input / Output	RLLSIM01
Interface Module for RS-232 Input / Output	RLLSIM02
Interface Module for RS-422 or RS-485 Input / Output	RLLSIM03
Dual CAN Bus Interface Module	RLLSIM04
SatGen v2 Software - GPS only scenario creation software. (Please contact your LabSat distributor or Racelogic for details)	RLLSSGSW02
SatGen Software – GPS / GLONASS scenario creation software. (Please contact your LabSat distributor or Racelogic for details)	RLLSSGSWG



19 - LabSat 2 PIN OUTS



Front View of LabSat 2



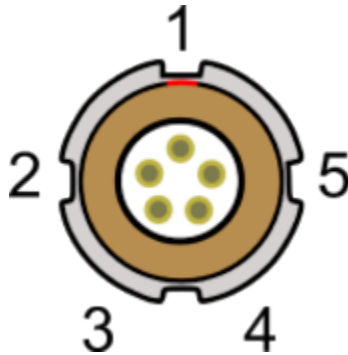
Connector 1 - POWER (Lemo 2 PIN)



PIN	I/O	Function	Range
1	I	Power+	5.4 V to 30 V
2	I	Ground	0V



Connector 2 - AUX (Lemo 5 PIN)



PIN	I/O	Function	Range
1	O	Module Direction Control	± 12 V
2	I	Reserved	± 12 V
3	I	Digital Input 1 (DIG IN)	0 V to 5 V
4	O	Digital Output 1	0 V to 5 V
5	O	+V Power	Same as Power+



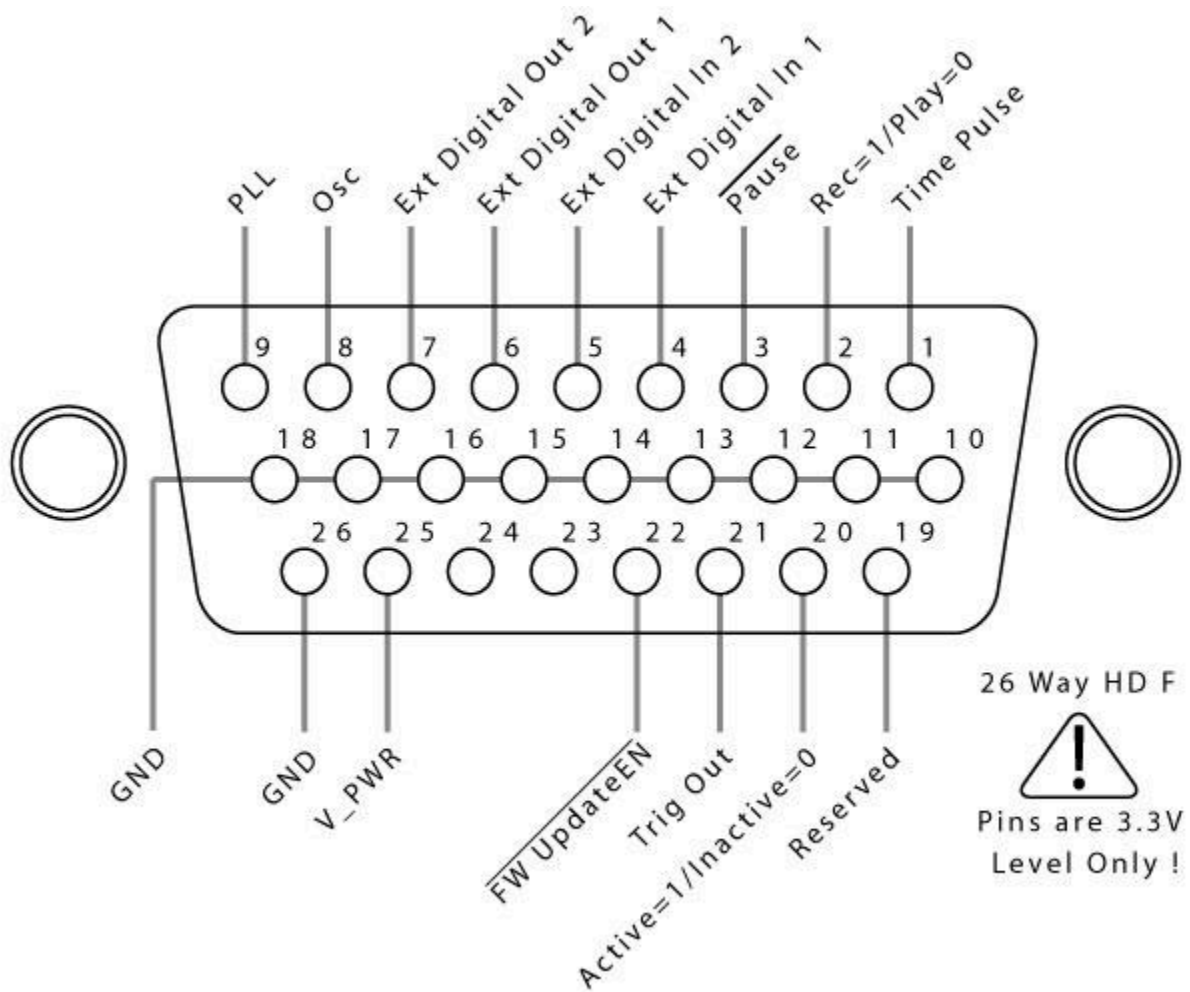
SMA Connectors - RF OUT, RF IN and CLOCK IN



PIN	Name	Function	Range
Center	RF IN	RF Signal including 3 V DC bias for active antenna	
	RF OUT	RF Signal Output DC Blocked	
	CLOCK IN	10 MHz Reference clock. Must be enabled in LabSat software	10.000 MHz +6 dB
Chassis	-	Ground	



26 way D type connector



The functionality available from the 26 Way D-Type connector on the front panel of LabSat 2, is described in the table below.

Number	Name	I/O	Function
1	DIO 0	O	1-PPS (From Internal GPS when locked to rec/play signal)
2	DIO 1	O	Rec/Play (Rec=1,Play=0)



https://en.racelogic.support/Product_Info/LabSat_2/LabSat_2_User_Guide/19_-_LabSat_2_PIN_OUTS

Number	Name	I/O	Function
3	DIO 2	I	Pause. Ground to Pause Rec/Rep
4	DIO 3	I	Extended Digital Input 1 (Replaces Second RF Channel)
5	DIO 4	I	Extended Digital Input 2 (Replaces Second RF Channel)
6	DIO 5	O	Extended Digital Output 1 (Replaces Second RF Channel)
7	DIO 6	O	Extended Digital Output 2 (Replaces Second RF Channel)
8	DIO 7	O	16.368 MHz Clock Signal (Direct from Osc)
9	DIO 8	O	16.368 MHz Reference signal output (must be enabled in software)
10 ~ 18	GND		Signal Ground
19	DIO 9	O	Reserved for factory test
20	DIO 10	O	Record/Replay activity output. 0=Inactive / 1=Recording Active
21	DIO 11	O	Trigger Output (Recorded Trigger Output during replay or pass-through of Trig In during record)
22	Update	I	Connect to pin 14(GND) to Enable firmware update mode on power-on
23	-	-	Not used
24	-	-	Not used



Number	Name	I/O	Function
25	V_PWR	O	Connected to PWR input (max 200 mA)
26	GND	O	

Caution!

The Digital I/O connector uses 3.3 Volt logic levels. Connection of any of the IO signals to levels above 3.3 Volts will cause permanent damage to the internal logic.



20 - LabSat 2 Technical specifications

PC	
Interface to PC	USB 2.0 Hi-speed 480 Mbit/s
PC Requirements	Minimum Core i5 with XP/Vista/Win7/Win 8
STD Reference Oscillator	16.368 MHz Temperature controlled +/-2.5 ppm options

RF Record	
Input Connector	Single SMA
RF Channels	2
RF Channel 1 Centre Frequency	Approx 1561.098 MHz or 1575.42 MHz or 1602.00 MHz
RF Channel 2 Centre Frequency	Approx 1561.098 MHz or 1575.42 MHz or 1602.00 MHz
Sample Frequency	16.368MHz
Data format	IQ
Quantisation	1-bit / 2-bit
Channel bandwidth	16 MHz
Input LNA Gain	13 dB
Input LNA Noise	1.14 dB



RF Replay	
Output Connector	Single SMA
Channels	2
Channel 1 Centre Frequency	Approx 1561.098 MHz or 1575.42 MHz or 1602.00 MHz
Channel 2 Centre Frequency	Approx 1561.098 MHz or 1575.42 MHz or 1602.00 MHz
RF Power Range	Approx -83 dBm to -107 dBm

Digital Input Capture	
Resolution	Approx 62 ns
1 PPS Output	Yes – When Internal GPS Locked to Input / Output
External Reference Clock Input	10 MHz

Options	
OCXO	Frequency Stability $\pm 1 \times 10^{-9}$
Record Only	Record GPS, Galileo, GLONASS, BDS
Replay Only	Record GPS, Galileo, GLONASS, BDS



Power	
Operating Voltage	8 V to 30 V DC
Power	7 W

Weight and Dimensions	
Weight	Approx 750 g
Size	Approx 170 mm x 128 mm x 46 mm

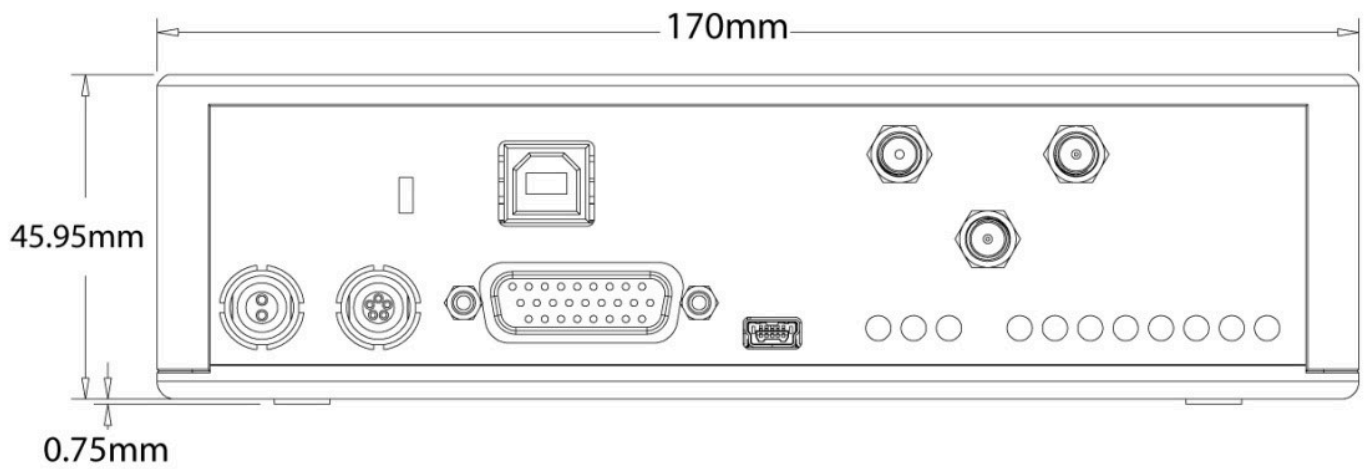
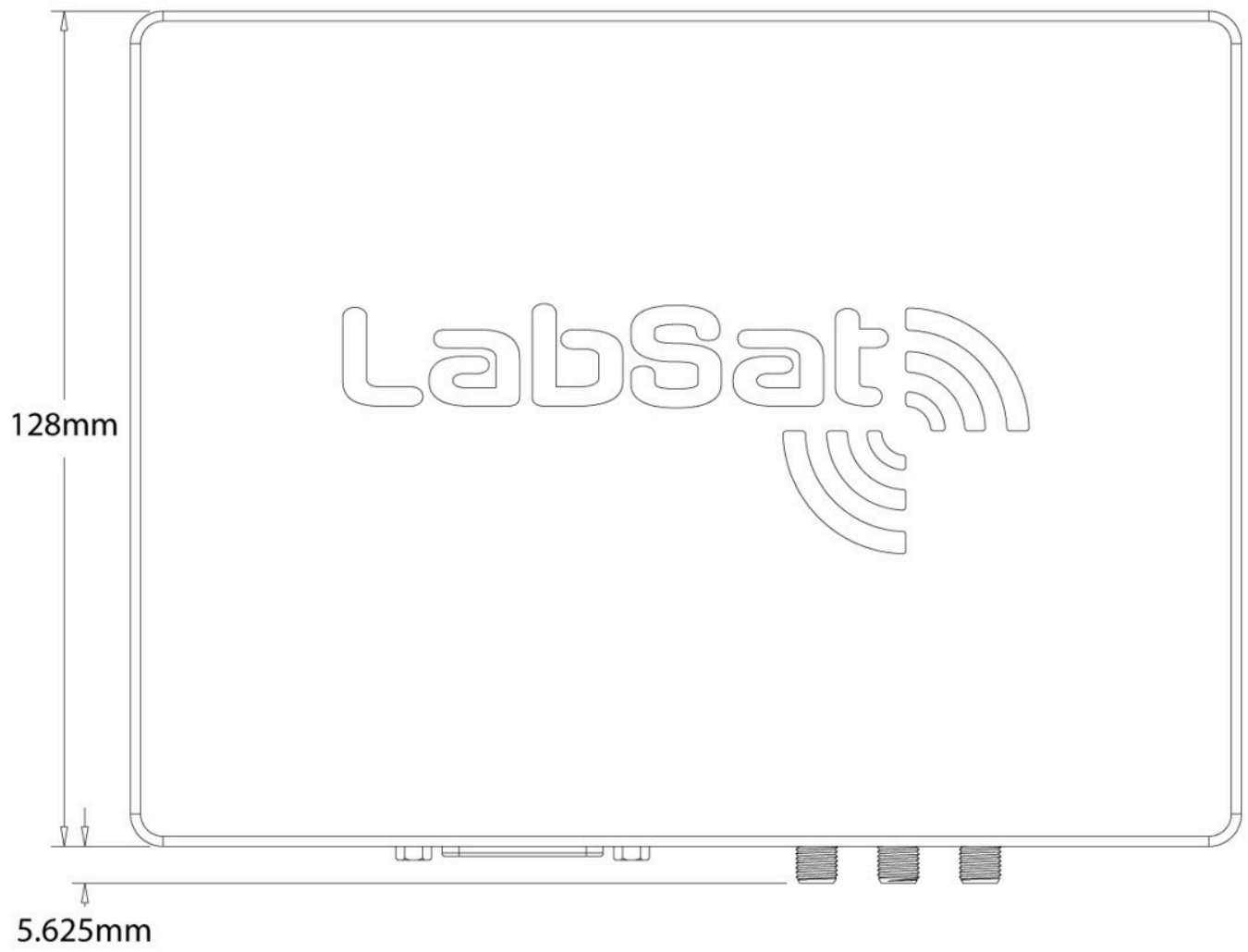
Future Options	
Dual Input / Output RF ports	<i>For dual antenna operation</i>
GPS L1 P / L2 P	<i>GPS Dual frequency operation</i>
Stand alone	<i>Integrated hard drive and screen</i>
Ethernet connectivity	<i>Device management over a network</i>



Module Dimensions



https://en.racelogic.support/Product_Info/LabSat_2/LabSat_2_User_Guide/20_-_LabSat_2_Technical_specifications



21 - LabSat 2 Cable Identification

[Click here](#) for a printable PDF.

