XT32 LIDAR UNIT LIDAR UNIT

PROCEDURES

Revision	1.0

XT32 LIDAR UNIT LIDAR UNIT PAYLOAD STANDARD OPERATING

Revision History

Revision	Date	Author	Description
1.0	Jan. 1, 2021	TK	Released version.
1.1	Aug. 9, 2022	AD, OR	Updated sections 2.1, 2.2, 2.5, and 3
1.11	Nov. 10, 2022	AD	Updated section 2.1

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1. Introduction

This document's aim is to provide the standard operating procedures for the XT32 LIDAR UNIT LIDAR UNIT payload, including the best-practices and guides to increasing the quality, repeatability, and accuracy of your raw lidar/camera data and your finished point-cloud data.

Contained within are procedures for your pre-flight set-up, your mission flight, a quick field-check, a more intense field-check, as well as your final post-processing.

Additionally, there is a pre-flight checklist, a mission flight checklist, and a postprocessing checklist.

Before flying and processing using your XT32 LIDAR UNIT LIDAR UNIT payload please make sure you are on the most recent firmware and are using the most recent software. If you are unsure of where to acquire the most recent firmware and software, please contact customer support and request to be added to the FIRMWARE/SW distribution lists.

NOTE: If Atlantic Laser Scanning Services is processing your data for you, ignore processing checklist and make sure to follow all setup and workflow
checklists to the letter. If your setup or workflow is out of order or incorrect, we cannot post process your flight data. Thank you!

2. Standard Operating Procedures

Below are the Standard Operating Procedures (or SOP) and best practices for preflight, mission flight, post-flight checks, and post-processing using your XT32 LIDAR UNIT payload.

2.1. Pre-flight
1. Offload all data/flights from USB drive, erase all data (on USB), and format USB drive (using the GUI, FAT32 format).
2. Make sure XT32 LIDAR UNIT LIDAR UNIT is on the most updated FIRMWARE (FIRMWARE version can be found in the top right corner of the GUI).

FIRMWARE version

3. Set up base station in an area with good satellite reception, recording ALL constellations (GPS, GLONASS, Galileo, BeiDou, QZSS), and make sure it is recording in a format that PCMaster accepts (recommended RTCM3, RINEX, uBlox, or Novatel Binary)

4. Plan mission flight and configure camera trigger period to a reasonable value based on your desired flight speed (recommended 5 m/s speed with 5 s camera trigger period).
5. Find a good take-off and landing location with good satellite reception (maximize distance from tree cover and buildings; use image above for example).
6. Ensure LiDAR and camera are connected correctly by verifying their location in the XT32 LIDAR UNIT's GUI:

LiDAR	PPS	GPRMC
Livox Avia	Present	Present

LiDAR

Camera Model	Serial Number
ILCE-5100	00000000000000003282767005437618

Camera

7. Determine Antenna Lever Arm offsets and input them into the IMU to Antenna Offset fields in the XT32 LIDAR UNIT GUI (GUI-Settings-Geometry-IMU to Antenna Offset)
8. Double check that the Vehicle to IMU Rotation offsets match the orientation of the XT32 LIDAR UNIT payload when mounted on the drone (GUI-Settings Geometry-Vehicle to IMU Rotation)
9. If planning on flying at high altitudes (>50 m), turn on high sensitivity mode in the XT32 LIDAR UNIT's GUI (GUI-Settings-Lidar-Service)

2.2. Mission Flight

1. Mount XT32 LIDAR UNIT payload to drone
2. Ensure antenna is securely mounted to drone
3. Connect GNSS cable to primary antenna port (designated PRI or PRM)
4. Connect power cable between the drone and XT32 LIDAR UNIT LIDAR UNIT payload
5. Turn on drone
6. Turn on XT32 LIDAR UNIT payload using the power button
7. Connect to XT32 LIDAR UNIT payload via WIFI connection
8. Verify GNSS connection in XT32 LIDAR UNIT GUI is Computed Single (for ppk processing)
9. Verify number of satellites in the XT32 LIDAR UNIT's GUI (recommended > 10 satellites)
10. Enter the project name in the "Project Name" area
11. Start recording (press start on GUI or press power button once)
12. Disconnect from XT32 LIDAR UNIT's WIFI
13. Wait 30 seconds for initial static alignment
14. Takeoff (completely vertically upward at 90 degrees)
15. Fly straight forward, laterally, for at least 5 seconds at a speed >= 5 m/s
16. Do at least one figure eight (at constant altitude)
17. DO NOT LAND immediately after figure eight (you may land later in the flight to swap batteries)
18. Proceed with mission flight

19. After mission flight, fly straight forward for at least 5 seconds at a speed >= 5 m/s to landing location
20. Land (completely vertically, small and slow horizontal deviations are acceptable but should be kept to the absolute minimum)
21. Wait 30 seconds for final static alignment (continue logging data during this time)
22. Connect to XT32 LIDAR UNIT payload via WIFI connection
23. Stop recording (press stop on GUI or press power button once)
24. Shut-down device (press Shutdown on GUI or press and hold power button for 4 seconds)
25. Turn off drone (ONLY after ALL LEDs on XT32 LIDAR UNIT are off)

2.3. Rapid Field Check

Please note that the rapid field check is only reliable in determining whether the GNSS measurements recorded by the XT32 LIDAR UNIT payload are accurate. For a higher level of confidence in the data acquired, the extensive field check is recommended.

1. Remove USB from the XT32 LIDAR UNIT Payload
2. Copy the flight folder from the USB to another computer's local hard drive
3. Open rtk.pcmp file (double click to open)[rtk.pcmp stands for RTK PC Master Software]
4. Examine the trajectory that to see:
    a. If the rtk trajectory looks similar to the trajectory you flew, the GNSS measurements that were taken during your flight are good. An example of a rtk.pcmp with good GNSS measurements is shown below (do not land after convergence maneuvers though). Notice that there are no erroneous data points.

b. If the rtk trajectory looks nothing like or deviates from the trajectory you flew, the GNSS measurements that were taken during your flight were poor and most likely requires another flight to get good data. An example of a rtk.pcmp with bad GNSS measurements is shown below. Notice that the horizontal straight line is NOT the path that the drone took during the flight.
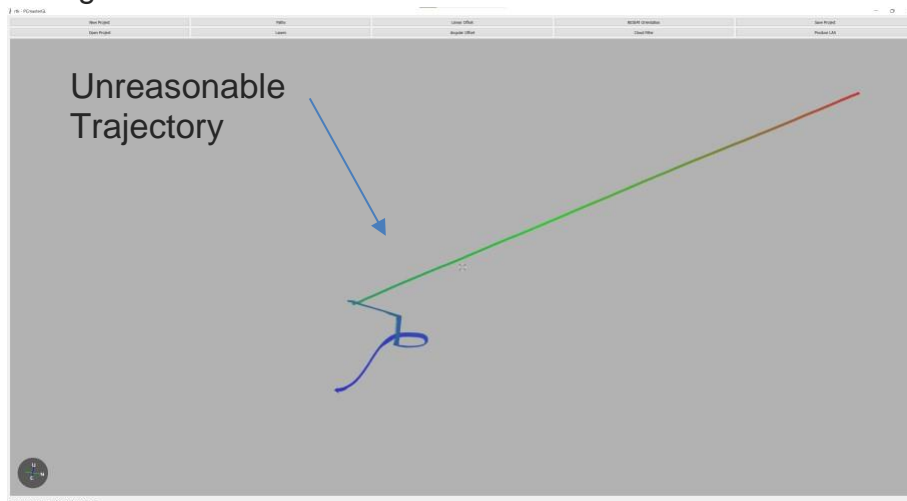

2.4. Extensive Field Check

0. **For extensive field check, make sure you have the Novatel IE license activated before going into the field (area of bad internet connection)**
1. Remove USB from the XT32 LIDAR UNIT LIDAR UNIT Payload
2. Download the flight folder from the USB to another computer's local hard drive
3. Open ppk.pcmp file (double click to open)
4. Select base-file that contains all constellations and covers the duration of the flight
5. Wait for trajectory processor to run
6. Navigate to the PPK Report in the INS folder
7. Examine the GNSS and IMU data from the rover (XT32 LIDAR UNIT LIDAR UNIT payload + drone) and the base station (graph titled "GNSS and IMU data"):
   a. Ensure that there are no gaps in either the rover's GNSS or IMU data, or the base station
   b. Ensure that the base station file covers the entire duration of the flight
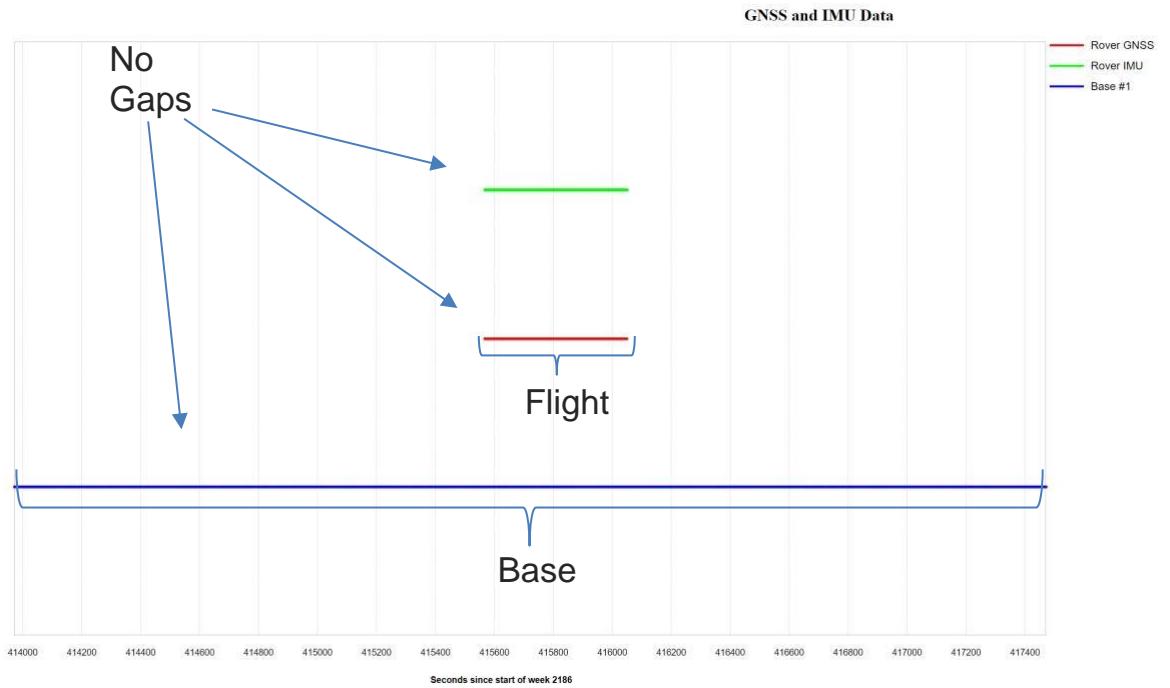
8. Examine the GNSS connection during your flight (graph titled "GNSS Position quality":
    a. Ensure that good GNSS solution was maintained throughout the duration of the flight (converged line, see below)
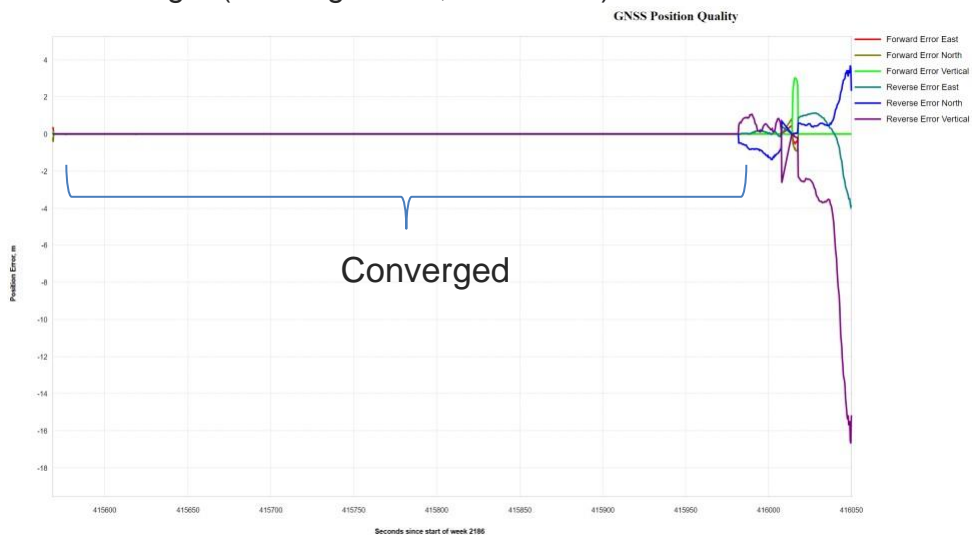
9. Examine the attitude separation of the tightly coupled solutions (graph titled "Attitude Separation of Tightly Coupled Solutions"):

    a. Ensure that the graph is in between -4 and 4 arcmins of separation (see below)
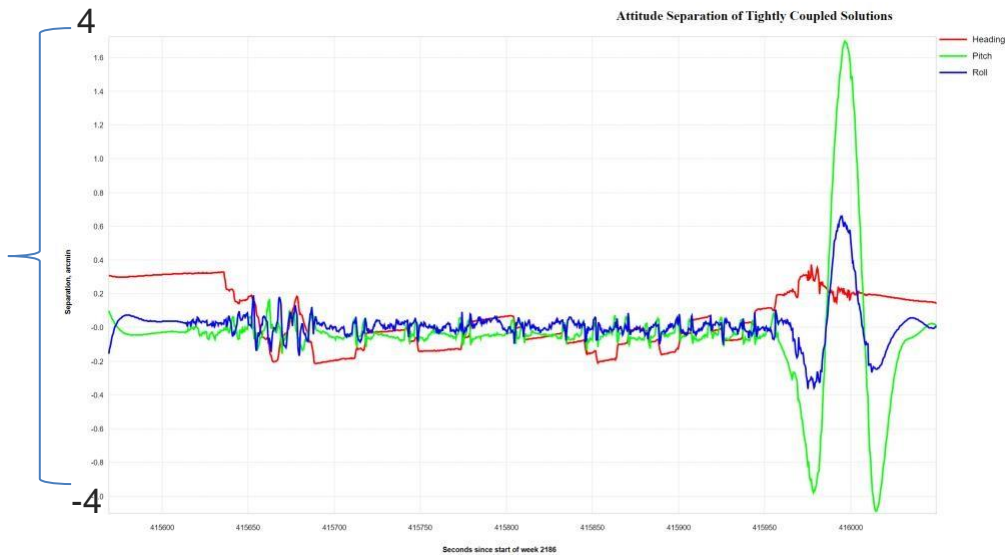

2.5. 2.5 Post-Processing

0. Ensure Novatel IE license is activated in the LLM (Local License Manager)
1. Download the flight folder from the USB to the computer's local hard drive
2. Copy the base-station files locally (I copy them to the data folder)
   a. For best data, find exact location of the base-station:
      i. Send your base .21o (RINEX) file to a service like we have in America called OPUS (https://geodesy.noaa.gov/OPUS/), they will return to you the exact location of your base-station
3. Open ppk.pcmp file (double click to open)
4. Select base-file that contains all constellations and covers the duration of the flight
5. Input exact coordinates of your base station if you have them
6. Wait for trajectory processor to run
7. Navigate to the PPK Report in the INS folder
8. Examine the GNSS and IMU data from the rover (XT32 LIDAR UNIT LIDAR UNIT payload + drone) and the base station (graph titled "GNSS and IMU data"):
   a. Ensure that there are no gaps in either the rover's GNSS or IMU data, or the base station

      b. Ensure that the base station file covers the entire duration of the flight

9. Examine the GNSS connection during your flight (graph titled "GNSS Position quality":

      a. Ensure that good GNSS solution was maintained throughout the duration of the flight (converged line, see below)
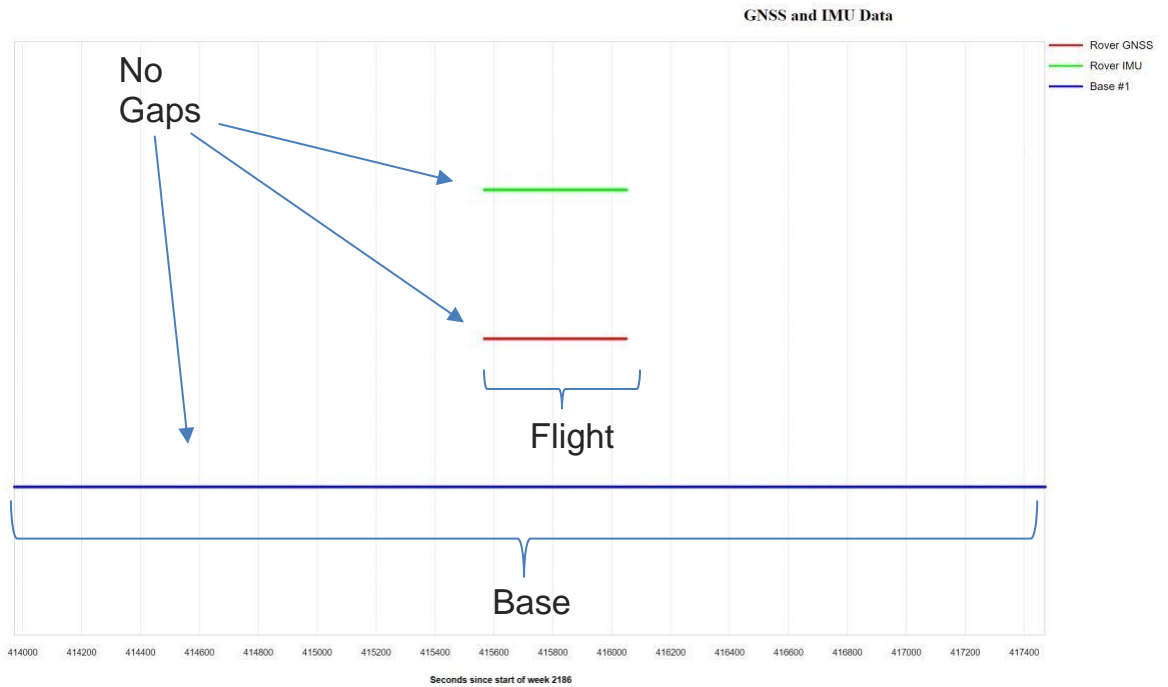
      c.
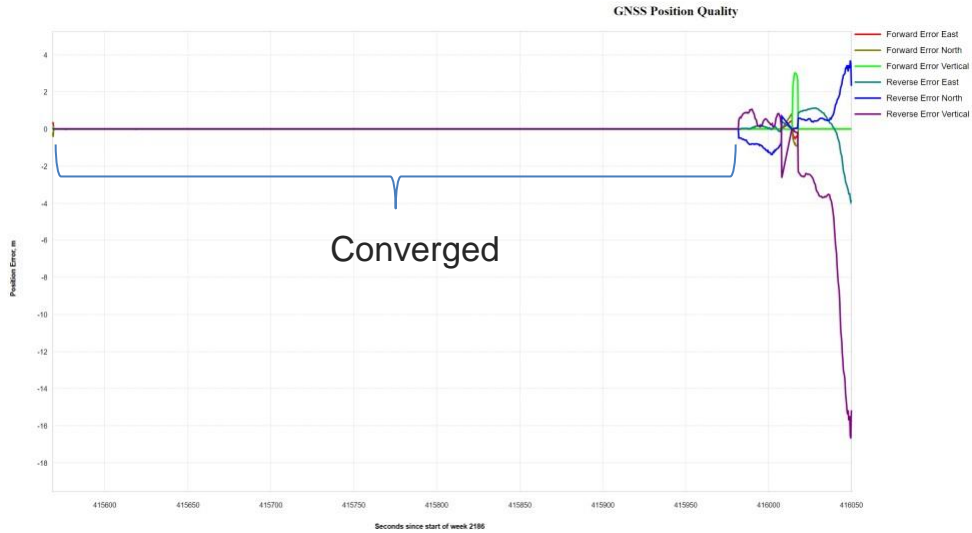
10. Examine the attitude separation of the tightly coupled solutions (graph titled "Attitude Separation of Tightly Coupled Solutions"):
    a. Ensure that the graph is in between -4 and 4 arcmins of separation (see below)
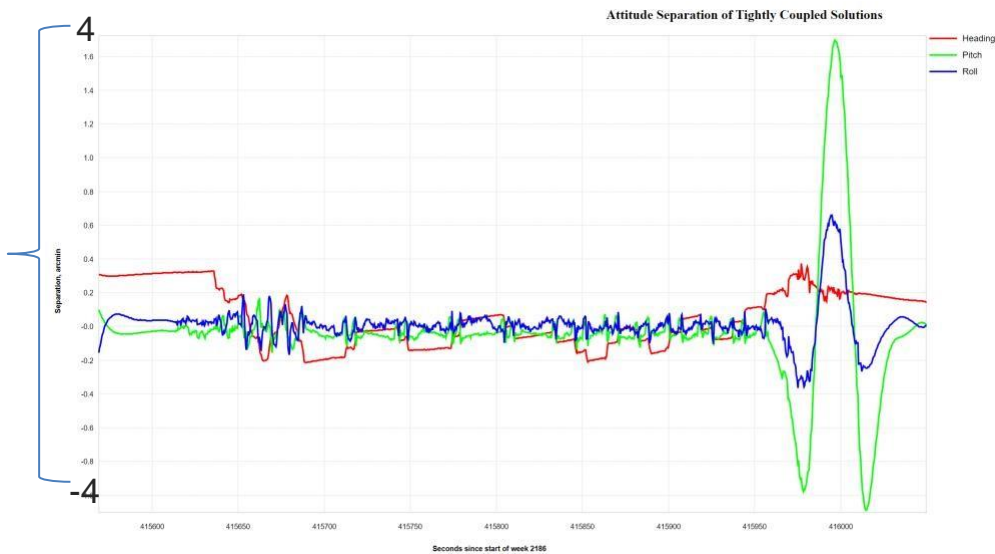
11. Return to PCMaster
12. If using a 360 degree lidar (such as Hesai), limit the cloud filter to 90 degrees:
    a. Navigate to "Cloud Filter" tab
    b. Check "Rotation Angle"
    c. Input values of 45 and 135 or 225 and 315 (this depends on the orientation of your payload, the incorrect one will show no points)

13. Select areas of the flight which you would like to produce:
    a. Select "Paths" tab
    b. Select "Remove" for the only path
    c. Right click and select "Start Selection here" where you would like to start
    d. Right click and select "Finish Selection here" where you would like to finish
    e. Wait for PCMaster to populate the selection
    f. Repeat instructions c-e until satisfied with the selections
14. Select "Produce LAS"
15. Return to flight folder
16. Right Click on ppk.pcpp (PCPainter Project)
17. Select "Process"
18. Wait for the processor to finish
19. Your uncolorized and colorized las files are located in the "Clouds" folder (inside the flight folder)

3. Pre-flight Checklist

- ☐ Offload all data from USB Drive
- ☐ Format USB Drive using XT32 LIDAR UNIT LIDAR UNIT WEB GUI (FAT32 format)
- ☐ Ensure XT32 LIDAR UNIT LIDAR UNIT is on updated FIRMWARE
- ☐ Ensure a project name is entered (if you want a specific name for the file or if applicable)
- ☐ Ensure correct antenna lever arm offsets are saved in XT32 LIDAR UNIT LIDAR UNIT Web GUI
- ☐ Ensure correct Vehicle to IMU rotation is saved in XT32 LIDAR UNIT LIDAR UNIT Web GUI
- ☐ Ensure high sensitivity mode is turned on in XT32 LIDAR UNIT LIDAR UNIT Web GUI (if applicable)
- ☐ Ensure LiDAR is connected correctly
- ☐ Ensure Camera is connected correctly (if applicable)
- ☐ (RTK) Ensure RTK USB modem is configured correctly in XT32 LIDAR UNIT LIDAR UNIT Web GUI
- ☐ Ensure appropriate camera trigger period is set in XT32 LIDAR UNIT LIDAR UNIT Web GUI
- ☐ Ensure base station is located in an area of good satellite coverage
- ☐ Ensure base station is recording all GNSS constellations
- ☐ Plan mission flight path, altitude, and speed
- ☐ Ensure takeoff location has good satellite reception
- ☐ Ensure landing location has good satellite reception

4. Mission flight Checklist

- ☐ Ensure XT32 LIDAR UNIT LIDAR UNIT is securely mounted to drone
- ☐ Ensure antenna is securely mounted to drone
- ☐ Ensure GNSS cable is securely connected to XT32 LIDAR UNIT LIDAR UNIT payload
- ☐ Ensure power cable is securely connected to XT32 LIDAR UNIT LIDAR UNIT payload (if applicable)
- ☐ Turn on drone
- ☐ Turn on XT32 LIDAR UNIT LIDAR UNIT payload
- ☐ Connect to XT32 LIDAR UNIT LIDAR UNIT payload via WIFI connection
- ☐ (PPK) Verify GNSS connection in XT32 LIDAR UNIT LIDAR UNIT Web GUI is Computed Single
- ☐ (RTK) Verify GNSS connection in XT32 LIDAR UNIT LIDAR UNIT Web GUI is Computed, Narrow Integer

☐ Verify sufficient number of satellites in XT32 LIDAR UNIT LIDAR UNIT Web GUI
☐ Start recording
☐ Disconnect from XT32 LIDAR UNIT LIDAR UNIT's WIFI
☐ Wait 30 seconds for initial static alignment
☐ Takeoff
☐ Fly straight forward, laterally, for at least 5 seconds at a speed >= 5 m/s
☐ Do at least one figure eight at constant altitude
☐ DO NOT LAND immediately after figure eight
☐ Proceed with mission flight
☐ After mission flight, fly straight forward for at least 5 seconds at a speed >= 5 m/s to landing location
☐ Land completely vertically
☐ Wait 30 seconds for final static alignment (continue logging data during this time)
☐ Connect to XT32 LIDAR UNIT LIDAR UNIT payload via WIFI connection
☐ Stop recording
☐ Shut-down device
☐ Turn off drone (ONLY after ALL LEDs on XT32 LIDAR UNIT LIDAR UNIT are off)

5. Post-Processing Checklist

☐ Ensure Novatel IE license is activated in the LLM
☐ COPY the flight folder from the USB to the computer's local hard drive
☐ Copy the base-station files locally
☐ Find exact location of base station
☐ Open ppk.pcmp file (PPK PC Master software)
☐ Select appropriate base-file
☐ Input exact coordinates of your base station
☐ Wait for trajectory processor to run
☐ Verify good flight using the PPK Report in the INS folder
☐ Return to PCMaster
☐ Limit cloud filter (if applicable)
☐ Select areas of the flight which you would like to produce
☐ Select "Produce LAS"
☐ Return to flight folder
☐ Right Click on ppk.pcpp (PCPainter Project)
☐ Select "Process"
☐ Wait for the processor to finish
☐ Locate .las files in Clouds folder