



Field manual for plot re-location using DGPS & RFID technology for the Bangladesh Forest Inventory





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1 INTRODUCTION

Bangladesh forest inventory (BFI) started in 2016 with an aim to collect robust and quality data of tree and forest resources of Bangladesh. Failure of relocating the previous inventoried (NFI 2005) plot made it mandatory to introduce technology for establishing permanent plot in current BFI. This inventory will provide information of existing forest resource as well as create scope for effective monitoring and sustainable management through establishing permanent sample plots.

The BFI design follows a stratified random sampling approach (Iqbal, et al., 2016) for selecting 1858 plots located in five different zones based on their climatic and geographic properties (Akter, et al., 2016). This inventory is designed to make it a permanent and continual process where plots will be periodically re-measured to observe changes over time. It is highly important to ensure that subsequent plot measurement is done in the same plot with exact plot center. A difference of 1 m can have significant implications for biomass/carbon estimation when results are extrapolated to per hectare level and subsequently at national scale.

Each plot has a corresponding GPS coordinates which are used to locate plot center in the field. However, standard handheld GPS units used by the BFI teams has the accuracy level of 3-5m and sometimes more in areas of difficult terrain or closed canopy vegetation. Sometimes GPS give confusing reading and mislead to the location of the plot. For this reason Differential Geographic Positioning Systems (DGPS) is more appropriate to establish and document the locations of the plot to make it permanent.

Differential Geographic Positioning Systems (DGPS) provide highly accurate GPS coordinates upto 10cm accuracy. The DGPS team will evaluate the accuracy of plot identification and make the plot location fixed. Besides DGPS team will assist the QA/QC procedure by remeasuring the attributes of reference point and witness objects of each and every BFI plots.

Moreover, this BFI will also use Radio Frequency Identification (RFID) chips for ensuring plot location more accurate. This chips will be inserted in trees available at the plot. Plot relevant data as well as tree information can be inserted in the chips. Relocation of the chips and information stored can be retrieved by using a special type of reader with a range of around 3 meter. This technology will help in management of existing stand. DGPS team will visit all plots both accessible and inaccessible, so the accessibility of the plots will also be verified by this team.

This protocol compliments the Field Instructions for the Bangladesh Forest Inventory (BFI, 2016) document and other protocols such as the manual for GPS (Costello, et. al, 2015), Soil measurements (SRDI, et.al, 2016) etc.

2 TEAM COMPOSITION AND RESPONSIBILITIES:

DGPS team will be composed of 4 members. Among them 2 are trained FD personnel and 1 local FD official and 1 labor. The team leader will distribute the responsibilities in discussion with other members. The team composition and major responsibilities of the members are defined in Table 2-

Table 1: DGPS team composition and responsibilities

Designation	Number	Major Responsibilities
Team Leader (TL)	1	<ul style="list-style-type: none"> ➤ Distribute work responsibilities among the team members ➤ Co-ordinate the field measurement process ➤ Contact with BFI control room and check for the necessary materials of field work ➤ Deliver the data and report ➤ Assist team members in field measurements
Technical Assistant (TA)	1	<ul style="list-style-type: none"> ➤ Prepare fieldwork plan by discussing with other team members ➤ Checking the equipment list and necessary documents before and after fieldwork ➤ Assist TL in field work coordination and decision-making process ➤ Conduct field measurement with help of all team members
Field Assistant	1	<ul style="list-style-type: none"> ➤ Conduct field measurements according to the instruction ➤ Communicate with the other team members ➤ Any other task assigned by the team leader.
Local Helper	1	<ul style="list-style-type: none"> ➤ Help to find out the access root ➤ Help to carry equipment ➤ Perform any other duties assigned by TL

3 DGPS EQUIPMENT

DGPS is a set of equipment assembled together for measurement. Each part of these set has individual function and by performing a set of activities together DGPS provide the desired location of a certain point. For data processing and identifying the desired locations, some background information is also required. The equipment needed for functionalizing and data generation by the DGPS are given below (Table: 2)

Table 2: List of equipment to be used by DGPS team

DGPS instruments	Number	Measurement tools	Number	Other Equipment	Number
Receiver	2	Carpenter tape	2	Tab	1
Tripod	1	Handheld GPS	1	Laptop (with charger and others)	1
Pole	2	Compass	1	Pendrive	2
Cronroller	2	30 m Tape	2	Plot Report	For each plot
Bipod	1	Metal detector	1	Marker	
Bracket	2	Range finder	1	Metal pin	
SoB survey point		Sunto Clinometer	1	Backpack (Water proof carrying system)	For each person
		Reflector for Range finder	1	Tent/Matt/polythine	1
				Bush Cutter (for cleaning under growth)	2
				Oil (WD- 40)	2

3.1 Maintenance of equipment

Most of the equipment of the DGPS set are made of metal and steel. These Equipment are susceptible to the harsh environmental condition and wrong handling by the user. Metal and steel equipment can be damaged due to corrosion and rust development as these are mostly exposed to salt, water and air. So, it is mandatory to ensure proper maintenance of these equipment. After every day work, base of the tripod, bipod, pole must be washed with fresh water and dried properly. Oil (WD-40) should be used on metal equipment to avoid corrosion and other instruments should be cleaned using carpenter brush.

4 FIELD MEASUREMENTS WITH DGPS

The DGPS model used by the BFI is Trimble R8s. Only static type survey can be performed with this device. The DGPS consists of two main systems: a Base and a Rover. Each system is supported by a number of accessories and each system have some special functionalities. The base is used to locate a known point called base point on the other part rover is used to record data to identify the desired point's coordinate named as rover point. In BFI the known points or base points are provided by the Survey of Bangladesh (SOB). SOB have fixed points all over the country in every two km distance and for one base point we can survey rover point within a maximum of 30 km distance. But without base point data a highly accurate DGPS have no difference to the handheld GPS.

The workflow requires one team member to set and stay near the base. After setting the base the other members will locate the plot center using the handheld GPS and for accuracy they will use reference points and witness object through triangulation and record data with the Rover. It is assumed that multiple plot can be assessed through one base location per day.



Figure 1: DGPS Base unit

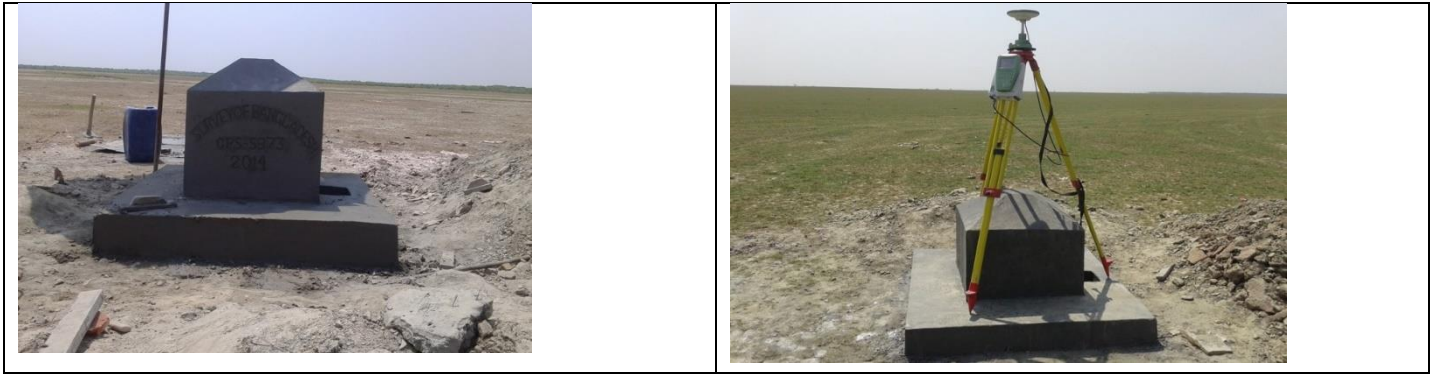


Figure 2: Positioning a DGPS base unit in a known point

Base unit is established in a known or previously fixed-point location. It verifies the reading of the Rover unit. In BFI, the known or previously fixed-point data will be collected from SoB. Following are the process of establishing base point in BFI-

1. Identify SoB point in proximity to the BFI plot. The SoB survey point list is provided by the BFI Unit.
2. Set up DGPS base unit properly, receiver unit will positioned on the top of a tripod with the help of a holding device
3. Establish base unit above of the known surver point
4. Align the cross hairs with the centre or the survey point marker by using the view finder
5. The base unit should be leveled completely before data recording. For leveling there is a bubble leveling system on the top of the tripod.
6. Make the device completely alligned and leveled before start to record data
7. Instruct the controller to start data recording
8. Attach the controller device with a bracker to the tripod. Don't carry the controller tab in hand.

4.1 Locating a Plot center (Rover point)

DGPS rover unit is used to identify GPS location of the desired points. Normally, rover is placed on the unknown point which location we want to know. In BFI, the rover unit will be set on the BFI plots center, so that the plot centers will be fixed by recording precise latitude and longitude of that point.



Figure 3: Rover installation and positioning

4.1.1 BFI Plot Design

In BFI a pre-stratified systematic sampling with different intensities for each stratum or ecological zone is used to select the sample plots. Total number of plots is 2245; however only 1858 plots will be visited because the remainders are in water.

Each plot is a cluster of several sub plots; for the Sundarbans and coastal plots the number of subplots is 3 (figure 4(A)) and for the rest zones the number is 5 (figure 4(B)). But the coordinates of the center subplot's (Subplot 1) center will be measured only.

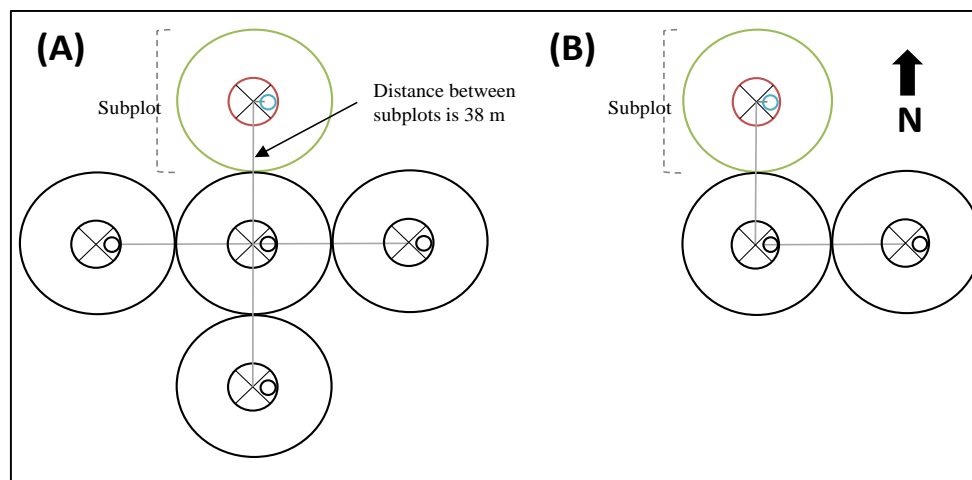


Figure 4: BFI plot design

4.1.2 Recording Plot center location (Rover Point)

The DGPS team will use the plot reports to identify assist in locating the plot center. Main identifying features for plot centers are Reference Points (RP), Witness Objects (WO) and a metal pin buried under ground at the exact plot center

1. First use handheld **GPS** to navigate the plot center
2. Find out the reference point according to the provided data. **Reference points (RP)** are generally identical object of the plot or near the plot. Identify plot center by measuring the bearing and distance from RP.
3. Calculating **Witness Objects** to find out the exact location of plot center. For each sub plots three WOs are taken in response with plot center. Witness objects are normally trees but it can be house or other structures too. In case of trees a engraved metal tag with a respective number is there. Measure the distance and reverse bearing from WOs to locate plot center precisely.
4. Using RP and WOs first narrow down the search area of plot center location To be sure about where the metal pin is inserted use **Metal detector**.
5. If any metal pin is missing, reestablish the plot center by using RP and WOs information and insert a metal pin into the ground.
6. After identifying plot center position the Rover unit on the point.
7. Set the receiver on the top of the pole with support of a bipod to stand stright (fig:2).
8. Turn the receiver on and ensure the necessary settings in controller for data recording (discussed in 5. DGPS preparation for data recording)
9. Enable data recording in the controller

10. When the controller will start data recording it will show automatically the required time period for recording data.
11. Attach the controller with the bipod with bracket.
12. Record data longer than minimum required time to avoid the risk of unprocessed data

5 DGPS PREPARATION FOR DATA RECORDING

Before start data recording DGPS device need to prepare properly for data recording. The controller need to connect with the receiver in the proper way. Some settings are common for controller with Base and controller with Rover for data recording but some options are different also.



Figure 5: Trimble access interface

- Ensure both receiver and controller is on
- Open Trimble access from the controller
- Click settings option from the interface

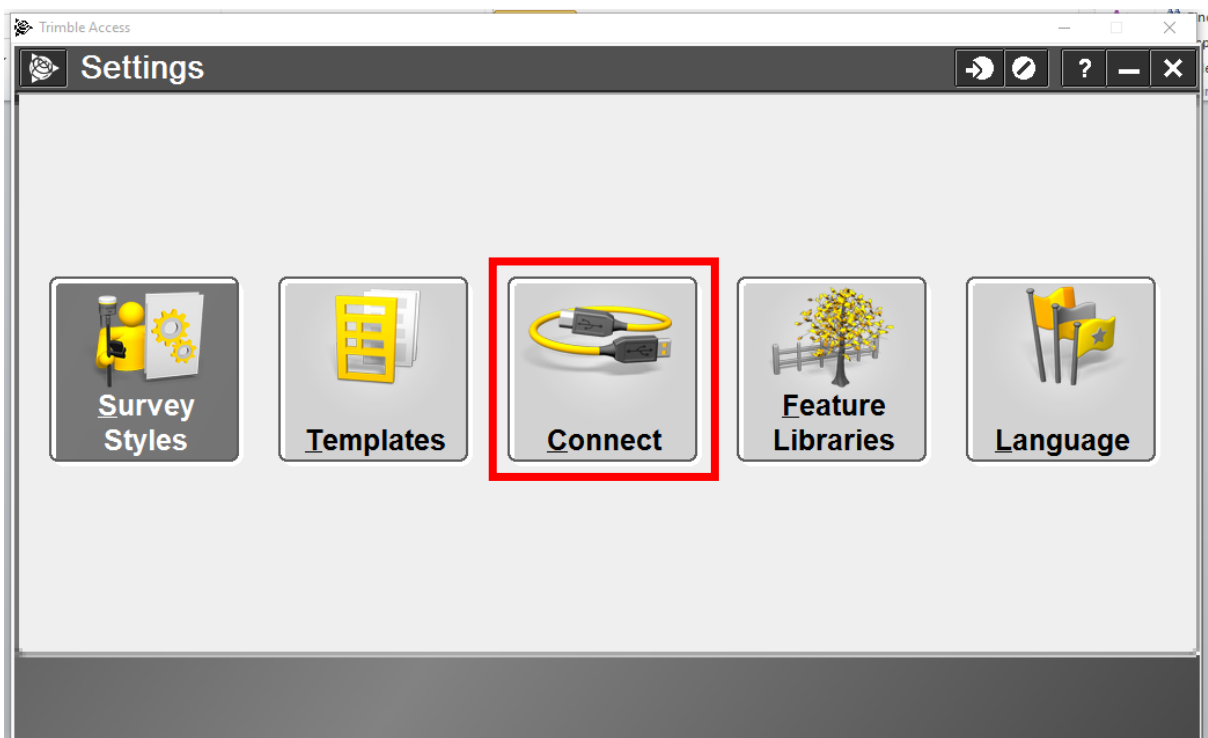


Figure 6: Settings interface

- Click connect to connect the controller with receiver



Figure 7: Connect Interface

- Select “Bluetooth” from the interface

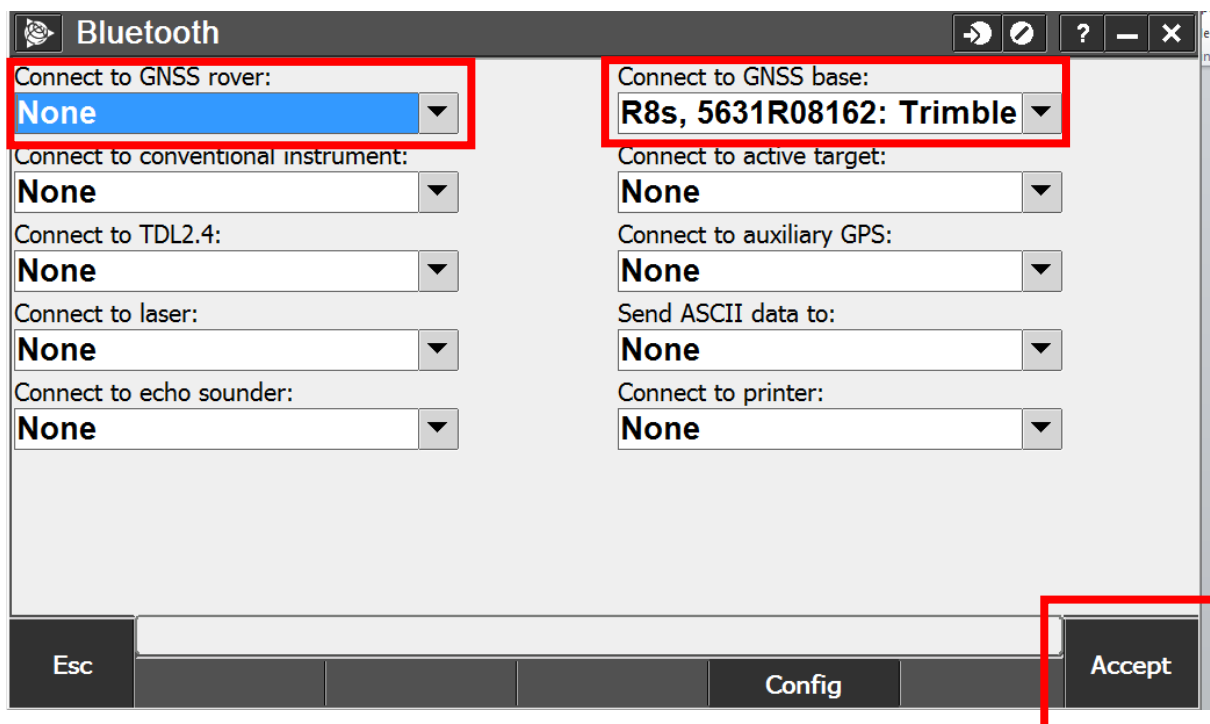


Figure 8: Bluetooth options

- Select “Connect to GNS rover” scroll to “None”
- Select “Connect to GNS base” to the receiver number used for base
- All other options should be “None”
- Click “Accept”

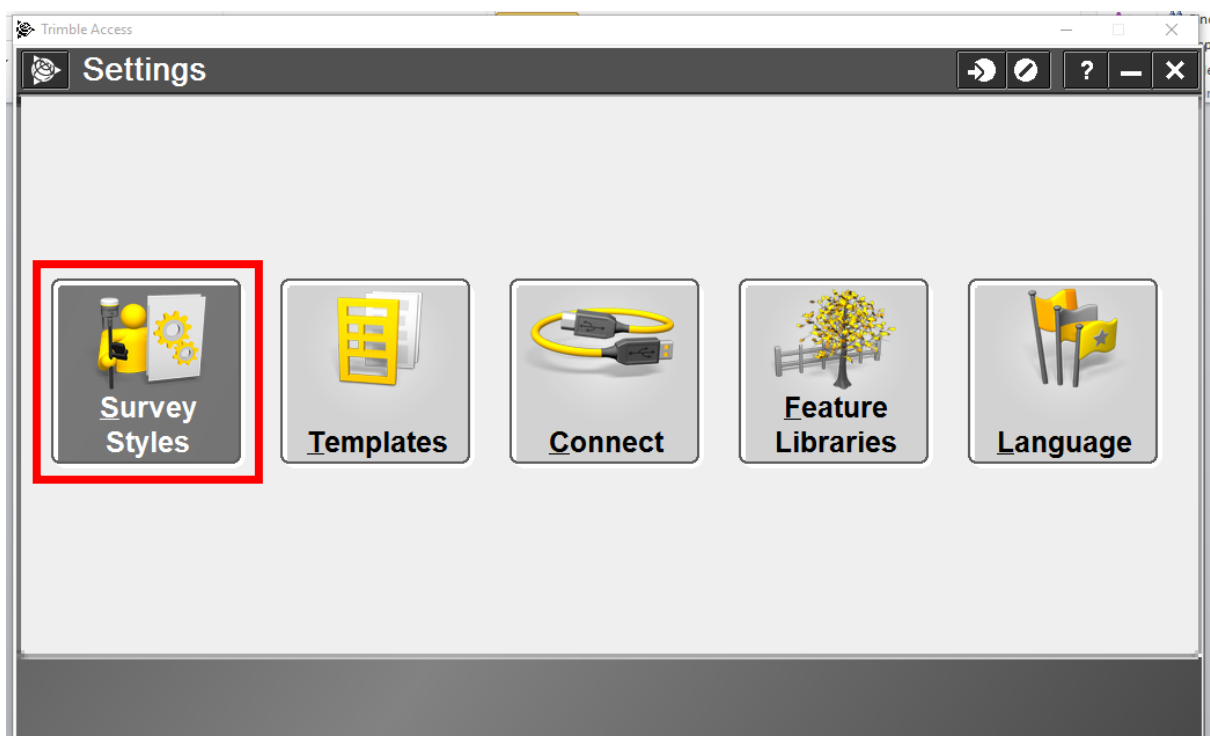


Figure 9: Settings

- Click “Survey Style” to select the survey type from the settings

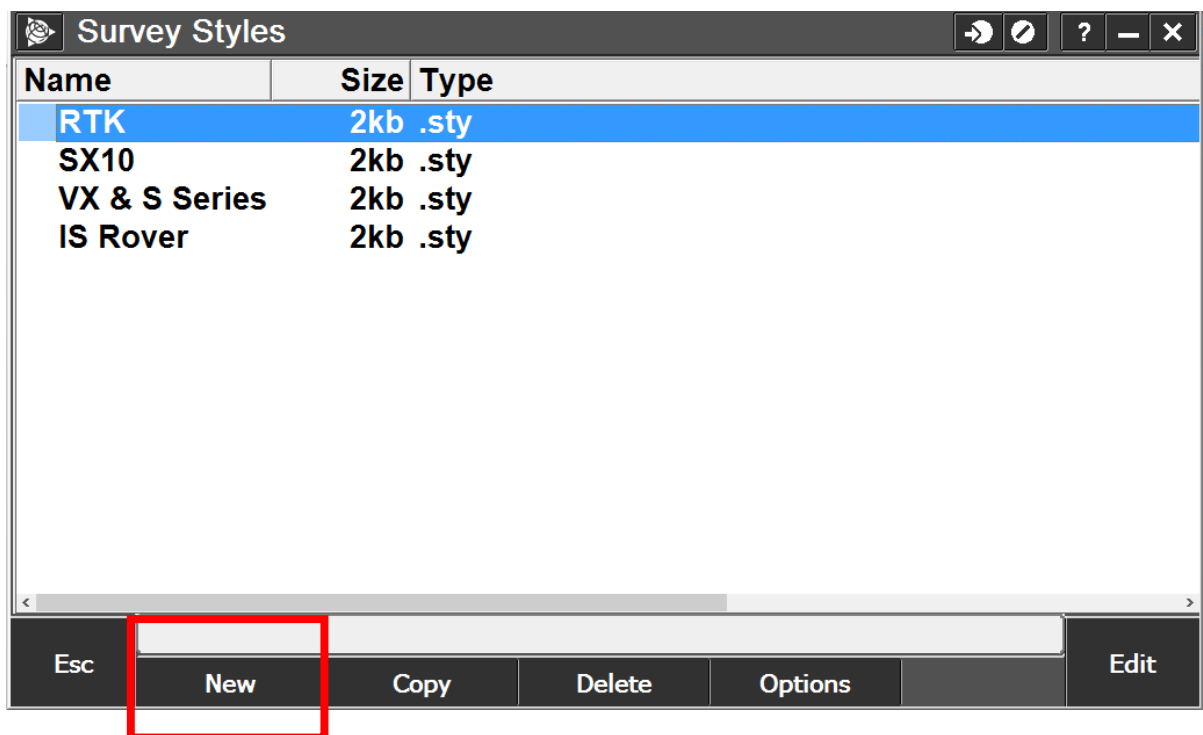


Figure 10: Survey style

- Please select “New” from the bottom of survey style interface
- This will make your desired survey mood

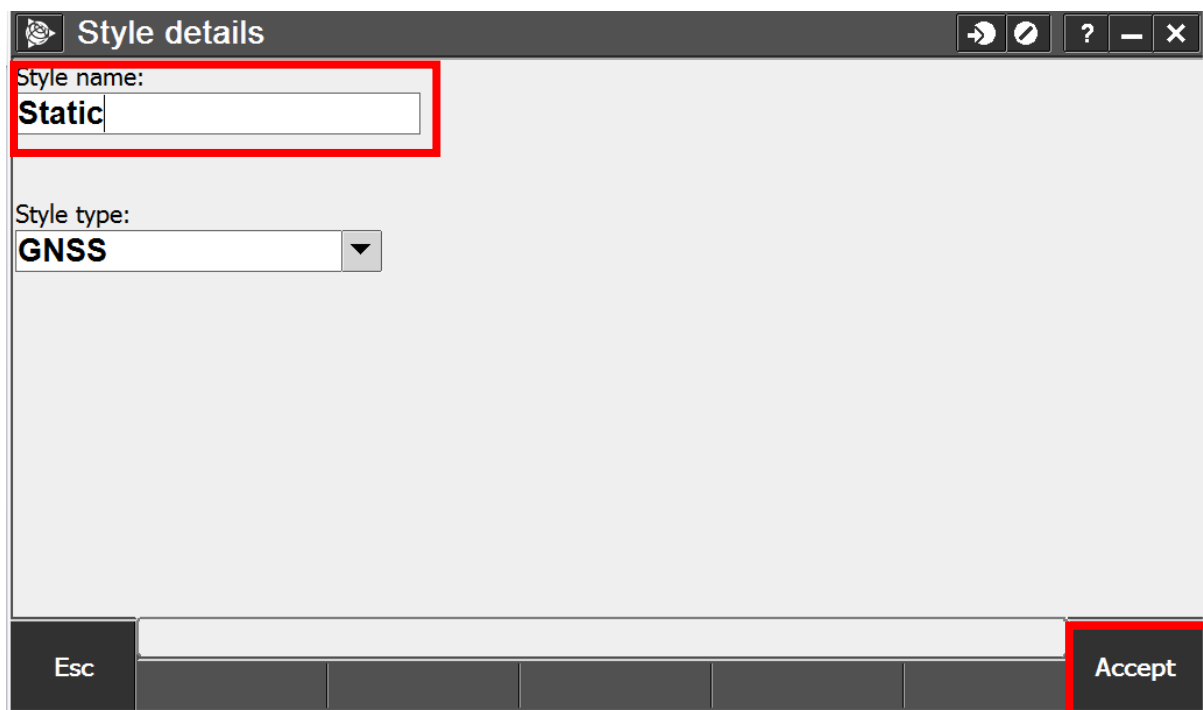


Figure 11: Survey Design

- In “Style details” please click on “Style name” box and write down the name “Static”
- “Style type” will be drop down to “GNSS”
- Press “Accept” after confirming

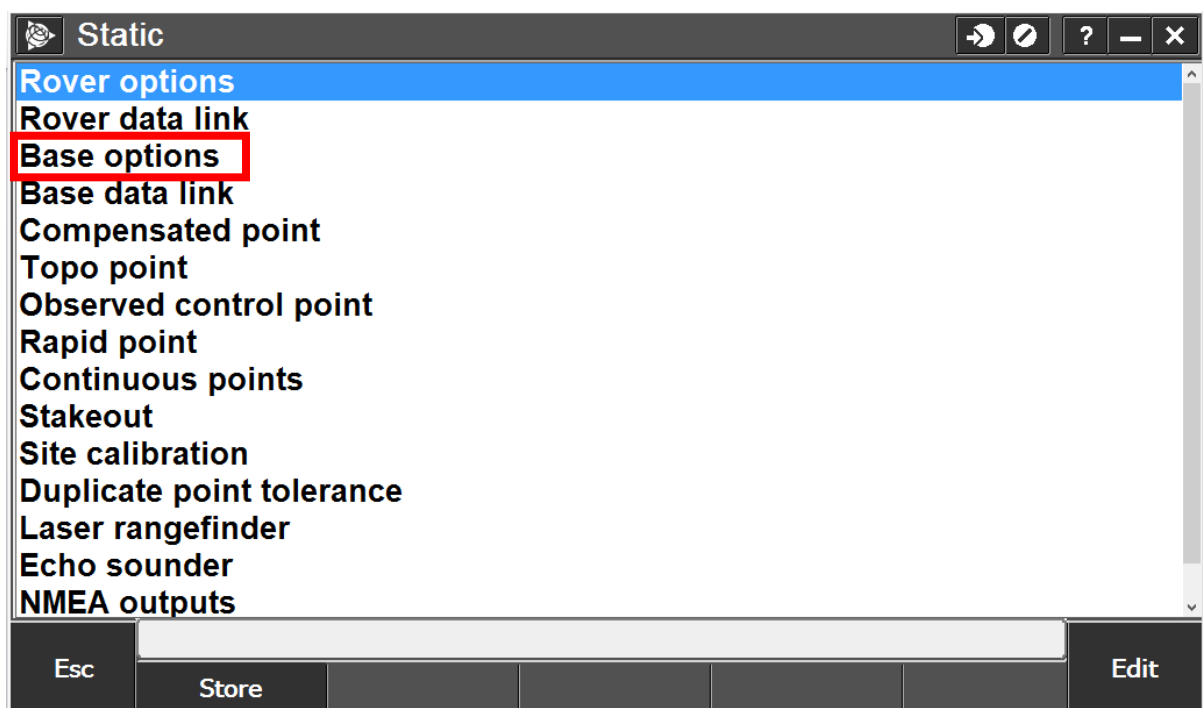


Figure 12: Static survey design (Base)

- Options for static survey design will open
- Select “Base options”

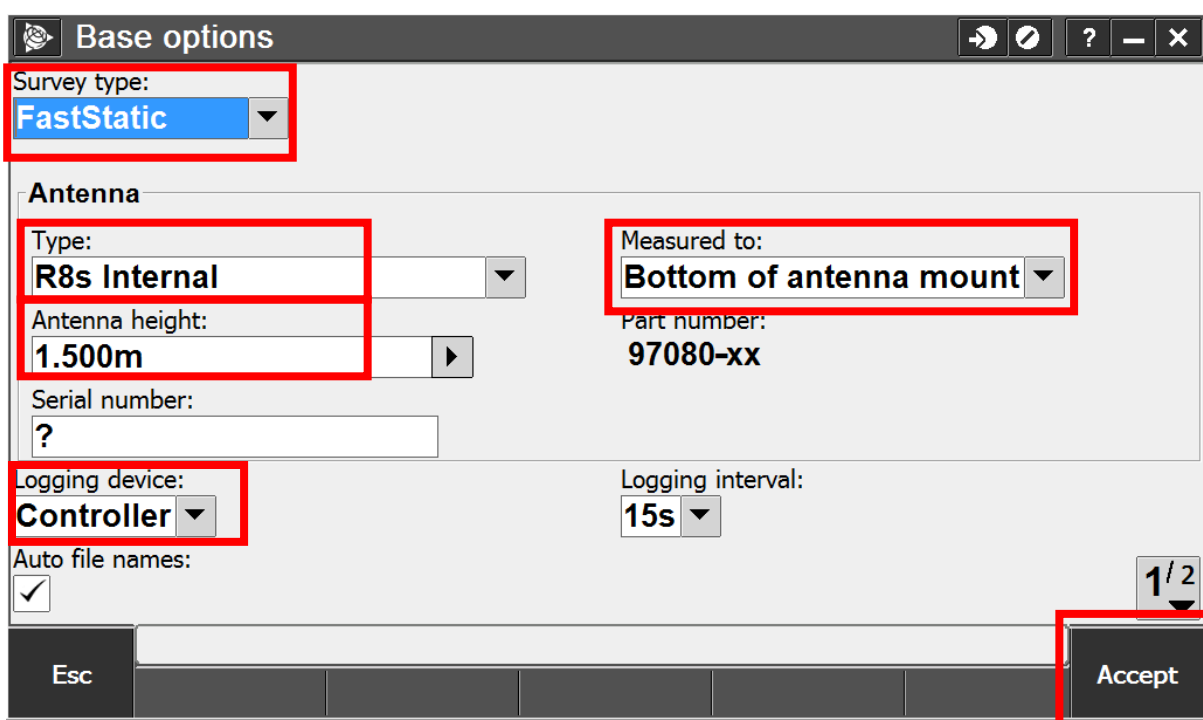


Figure 13: Base options interface

- From “Base options” first select ‘Survey type’ to “FastStatic”
- Antenna type will be “R8s Internal”
- Measure Antenna height by Carpenter tape and input the height into “Antenna height” box
- It should be mentioned that from bottom up to which level the height is measured
- No need to give any serial number
- “Logging device” will be selected to “Controller” and interval will be 15s as pre-set.
- Click “Accept” after confirming all settings

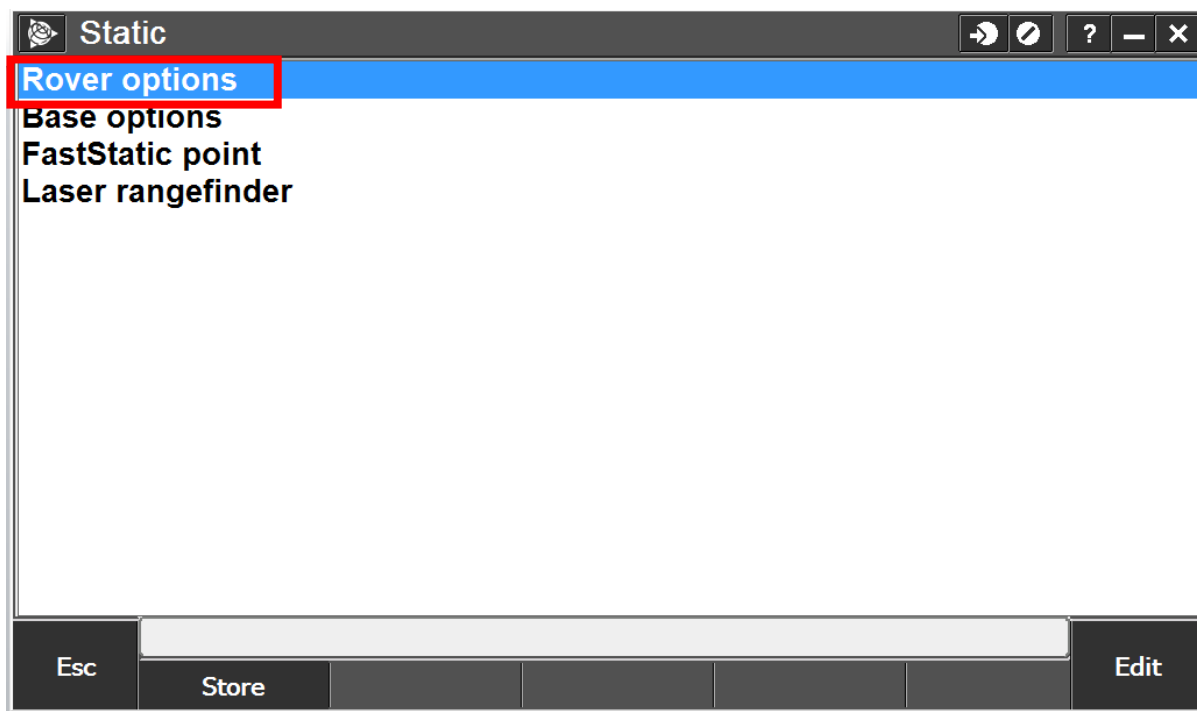


Figure 14: Static Survey Design (Rover)

- Now go for “Rover options” from the ‘Static’ page

Figure 15: Rover options interface

- From “Rover options” first select ‘Survey type’ to “FastStatic”
- Antenna type will be “R8s Internal”
- Measure Antenna height by Carpenter tape and input the height into “Antenna height” box
- It should be mentioned that from bottom up to which level the height is measured
- No need to give any serial number
- “Logging device” will be selected to “Controller” and interval will be 15s as pre-set.
- Click “Accept” after confirming all settings

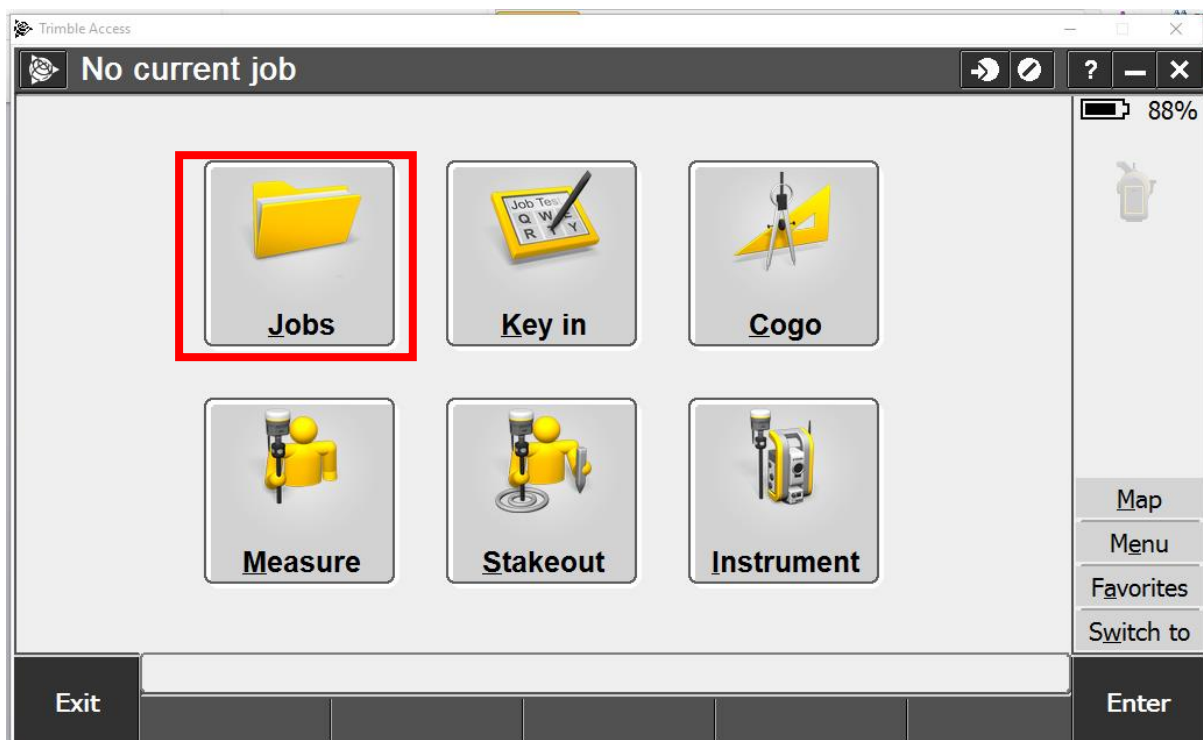


Figure 16: Select job

- Click “Jobs” to make a new job

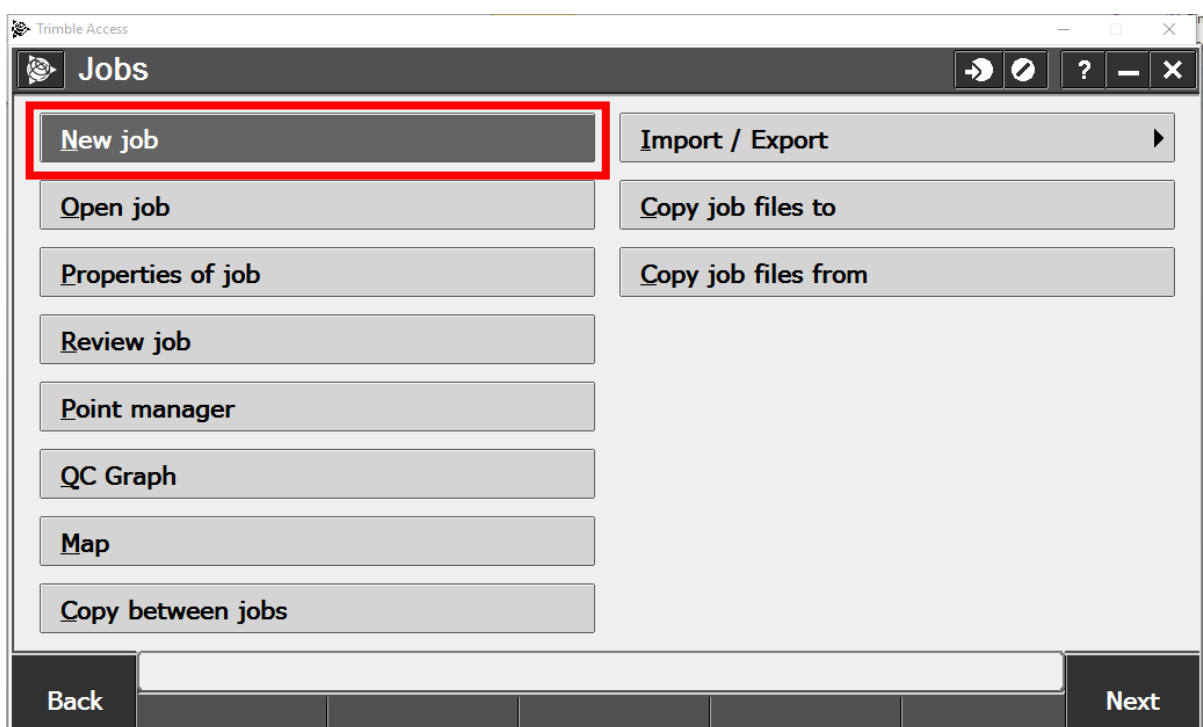


Figure 17: Job interface

- Select “New job” from the job interface

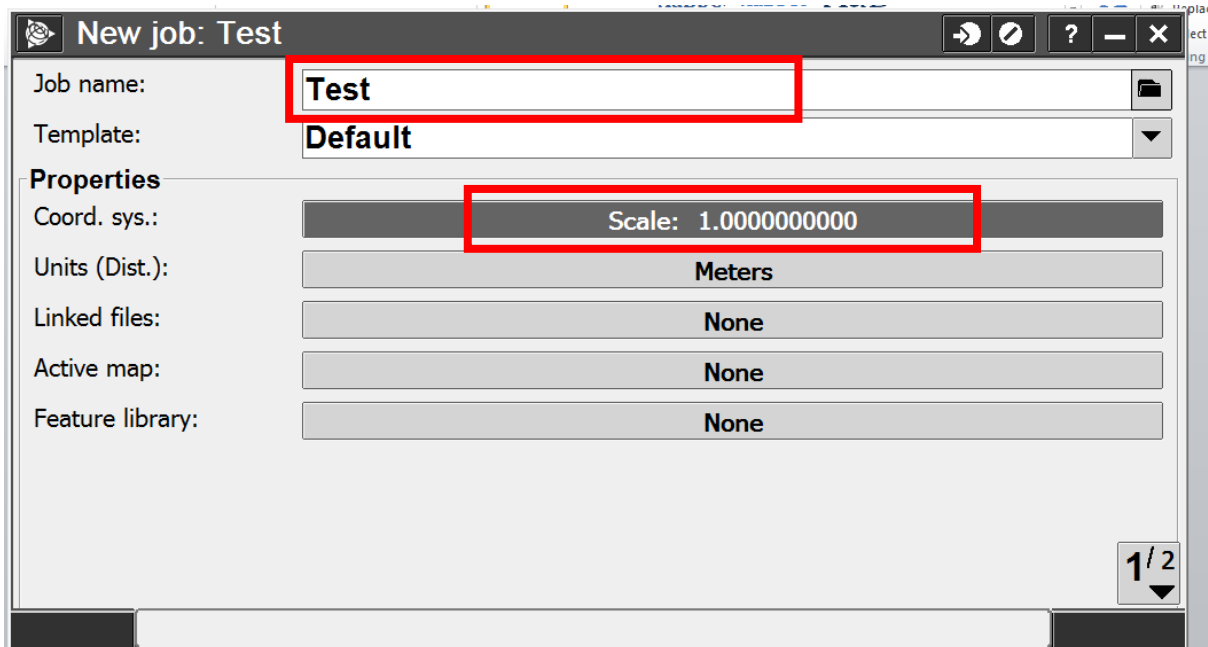


Figure 18: Creating new job

- Name your Job in the “Job name” box
- “Coordinate system” will be “Scale: 1.0000000000”
- Click “Next”

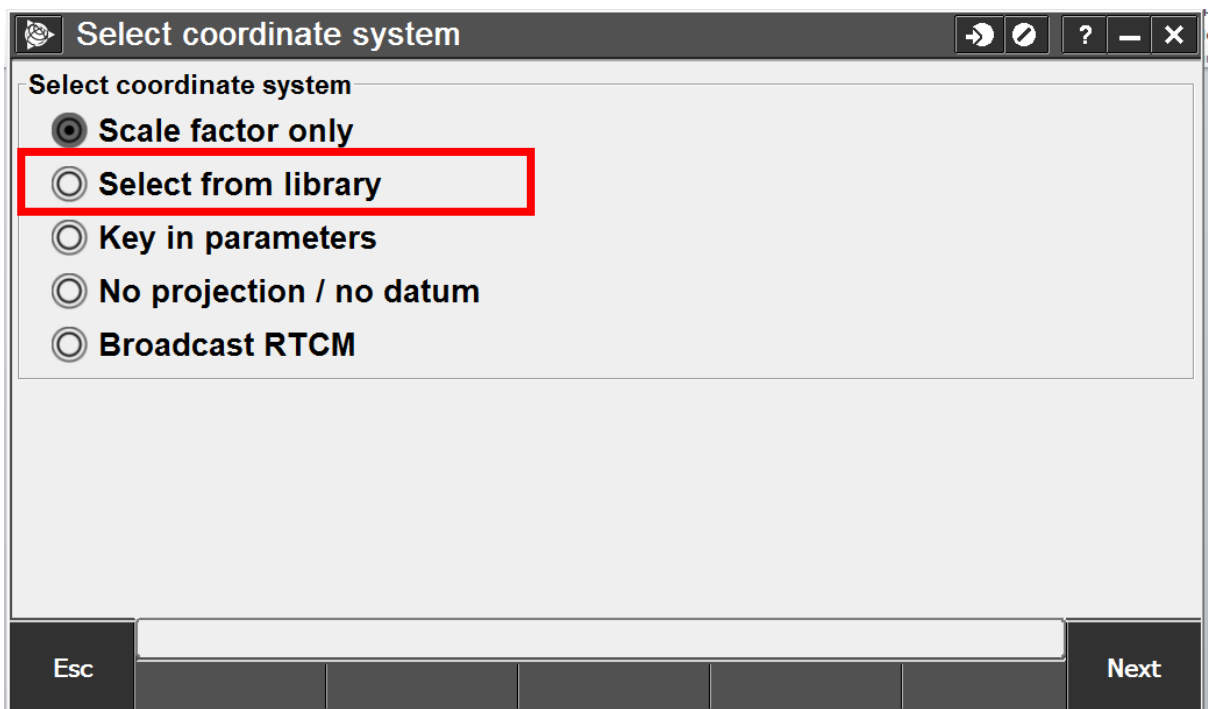


Figure 19: Selection of coordinate system

- To select coordinate system, click “Select from library” and “Next”

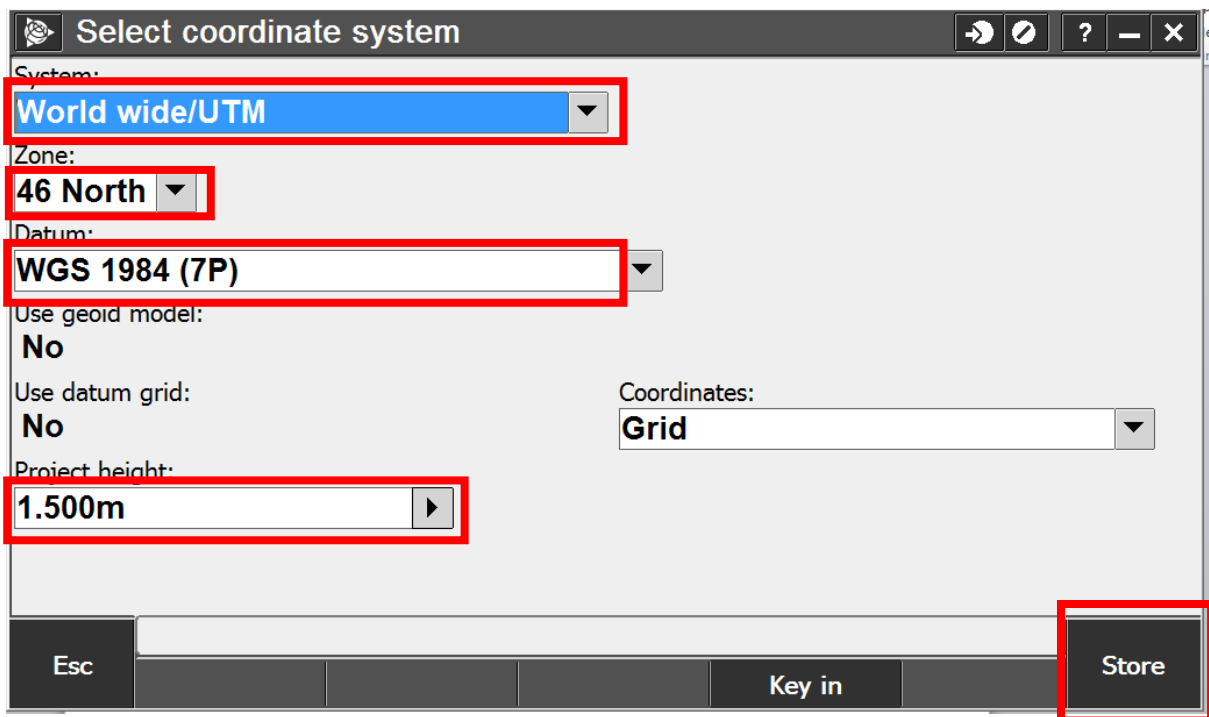


Figure 20: Selection of coordination system

- From “Select coordinate system” interface first go to “System” scroll down and select “World wide/UTM”
- Then select appropriate zone from the Zone box. The zone information will be collected from the Survey of Bangladesh (SoB). This should be changed from one area to another.
- Go to “Datum” and select “WGS 1984 (7P)”
- Enter the project height and then store.

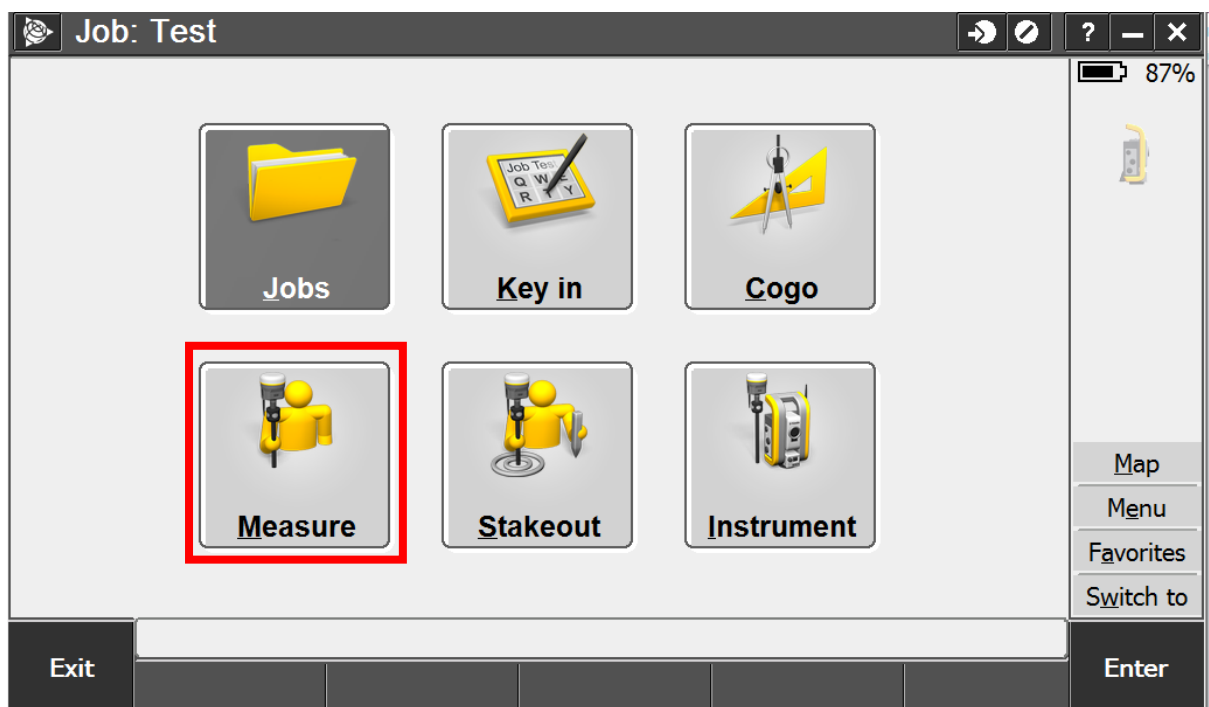


Figure 21: Measure point

- When new job is stored then go to “Measure” to record data

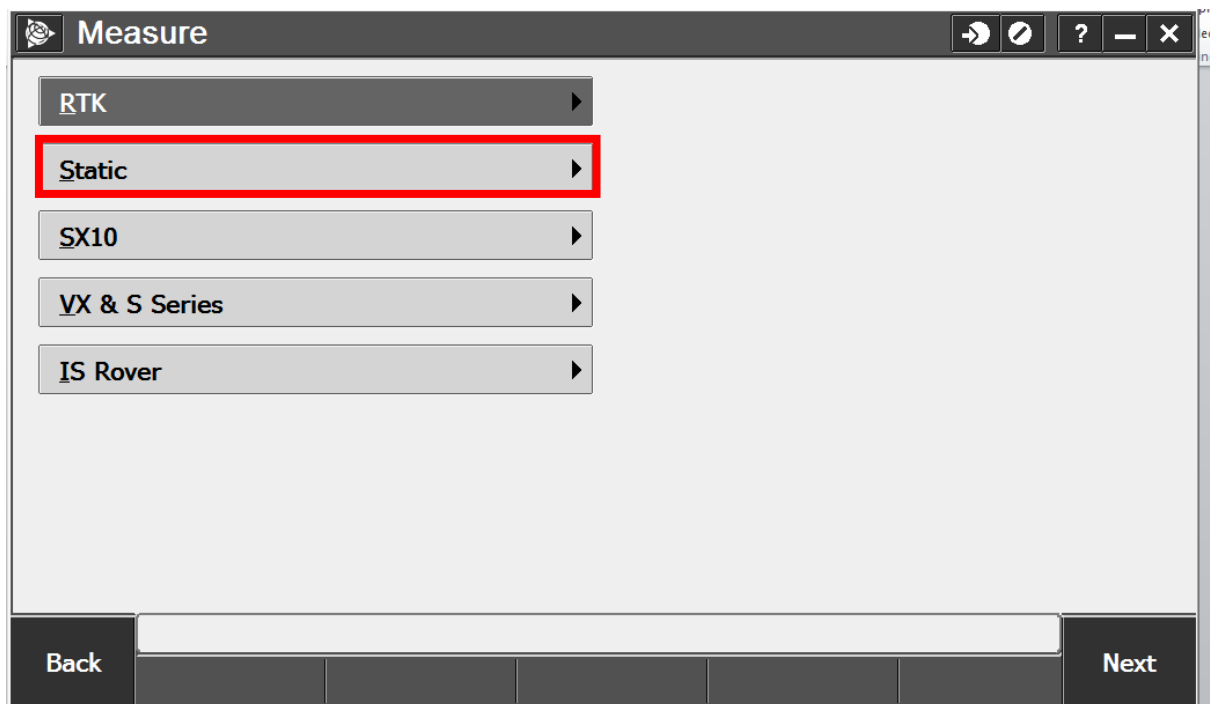


Figure 22: Static measure

- From "Measure" interface select "Static"

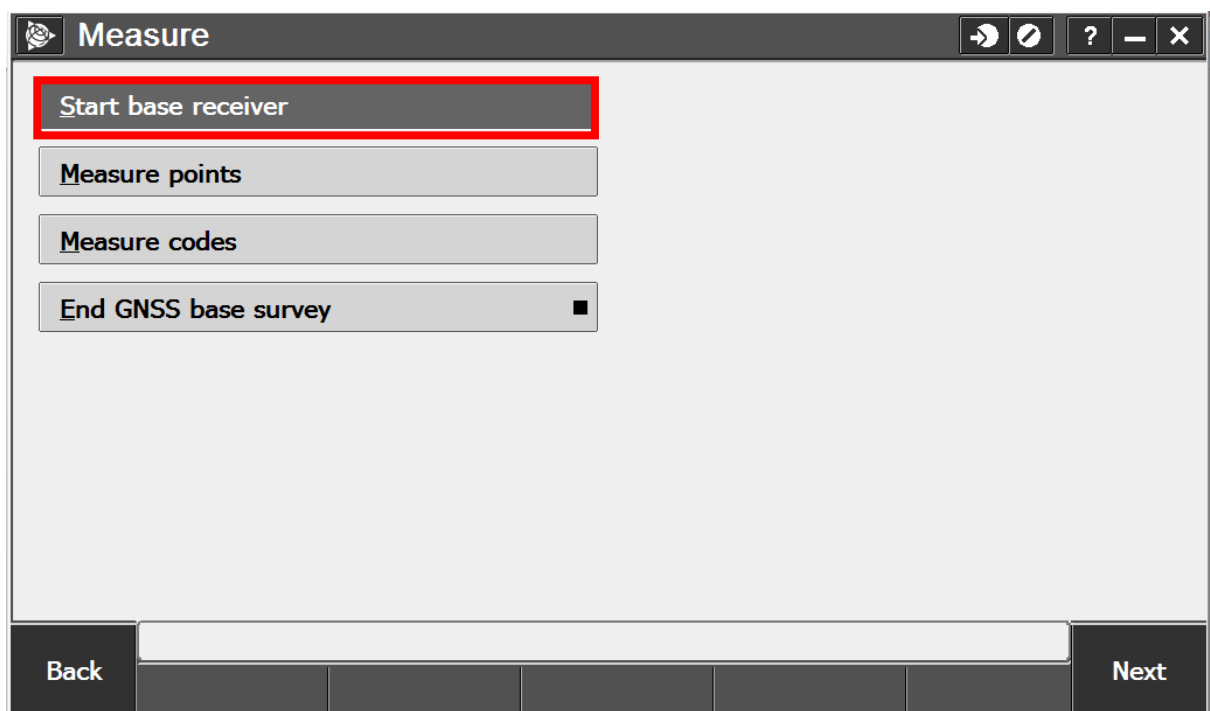


Figure 23: Base measurement

- New interface will open and select "Start base receiver"

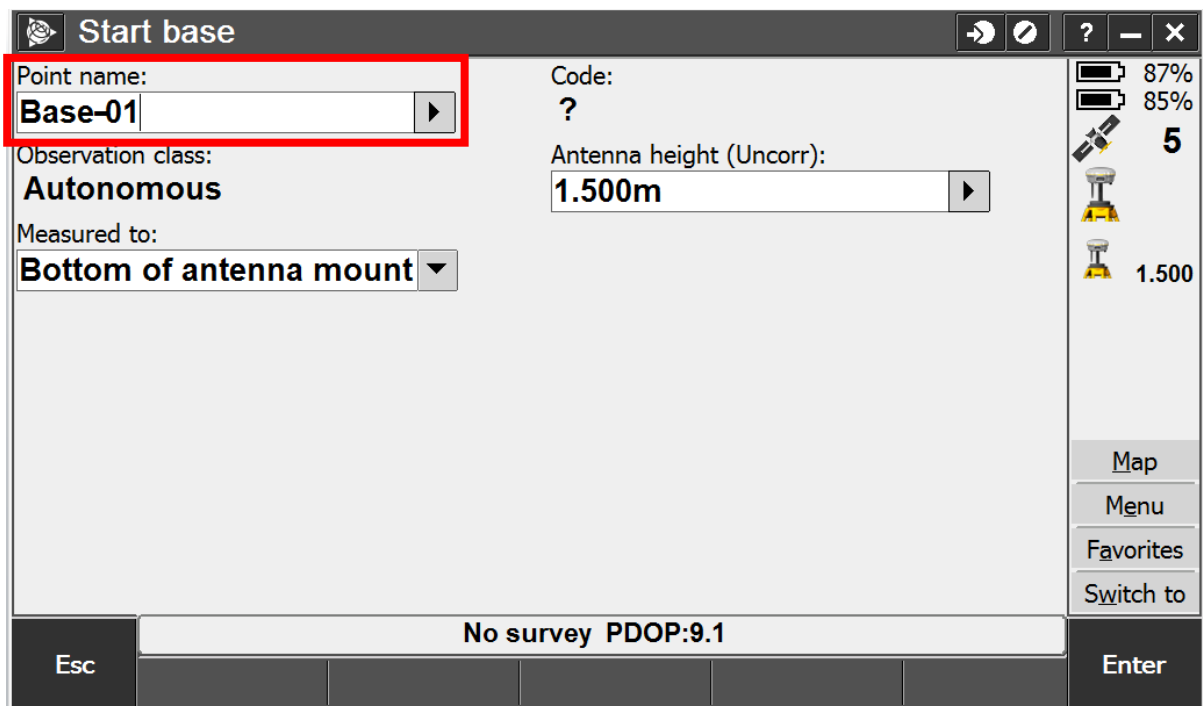


Figure 24: Base measurement

- The base will be ready to record base data. Give a name to the base point.
- The Antenna height and Measure up to point of antenna height will be entered.
- After finalizing other thing press enter.

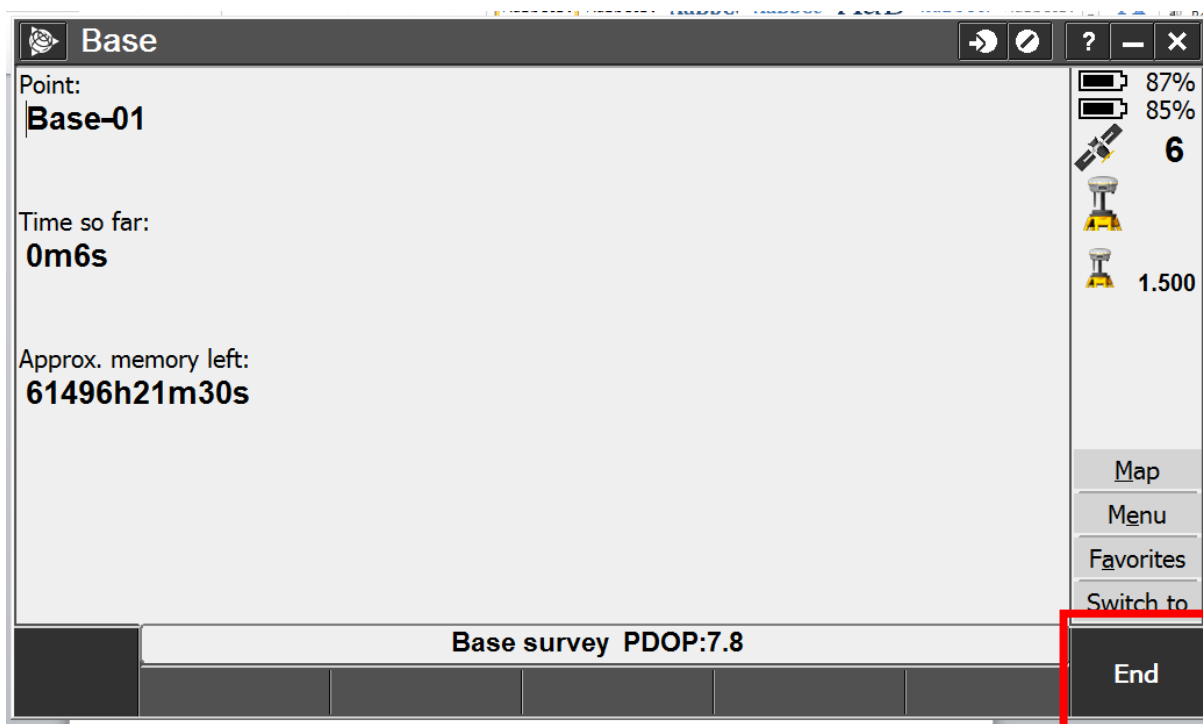


Figure 25: Base data recording

- Data recording will be started and the controller screen will show the time of data recording.
- After recording data for a desired time press end to stop data recording.
- When data recording is on, the controller tab can be placed with the receiver tripod with a bracket.

For Rover specially:

For controllers either rover or base the basic settings are the same, but for the rover it is different when to measure. Both base and rover should be indicated and introduced to the controller. The measure of rover point (plot no) is as follows-

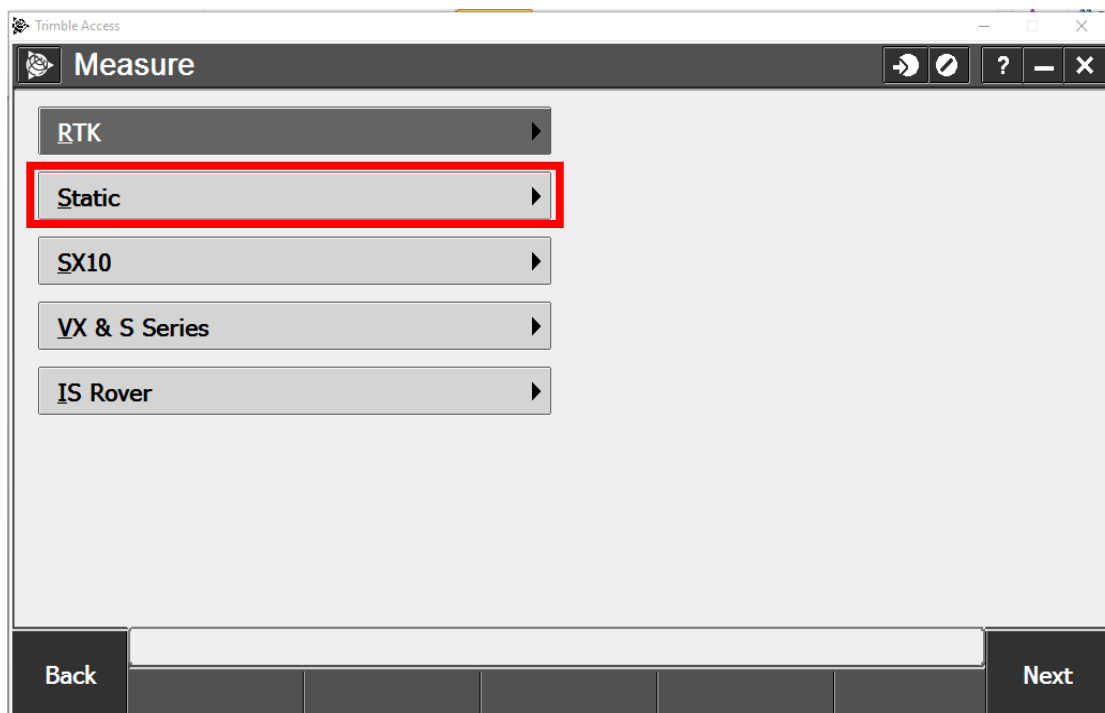


Figure 26: Measure for rover

- In the “Measure” interface click “Static”

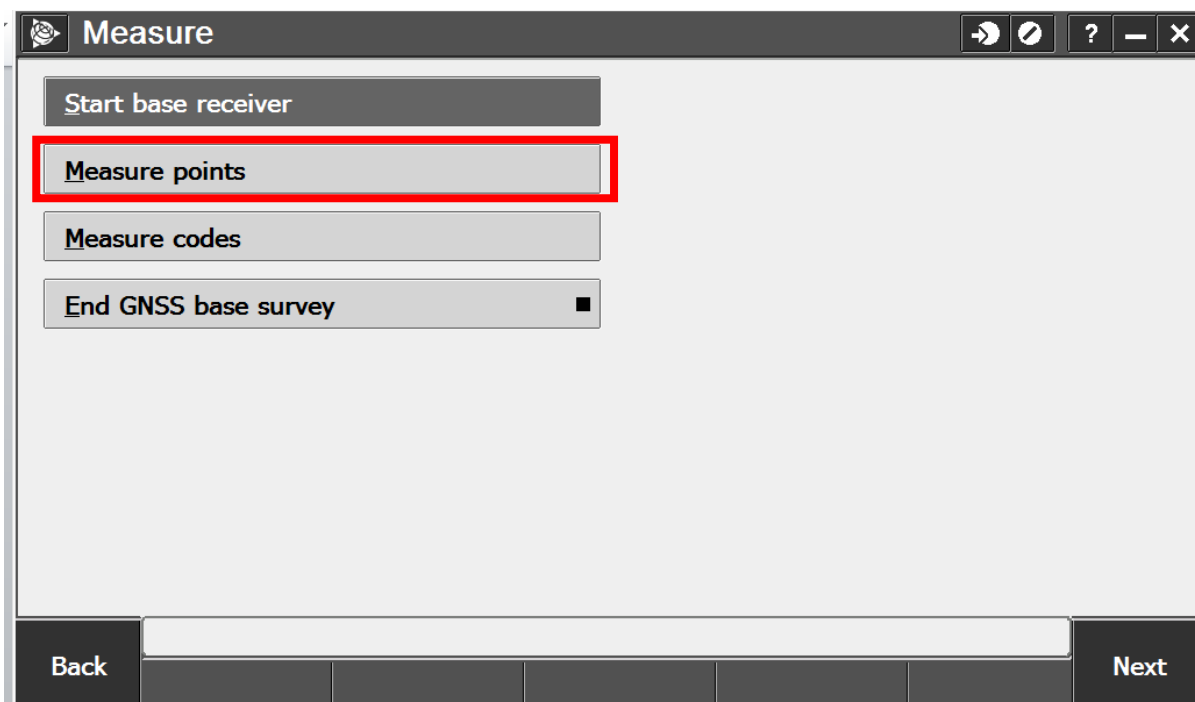


Figure 27: Measuring points with rover

- Select “Measure points” to record GPS data for the plot center.

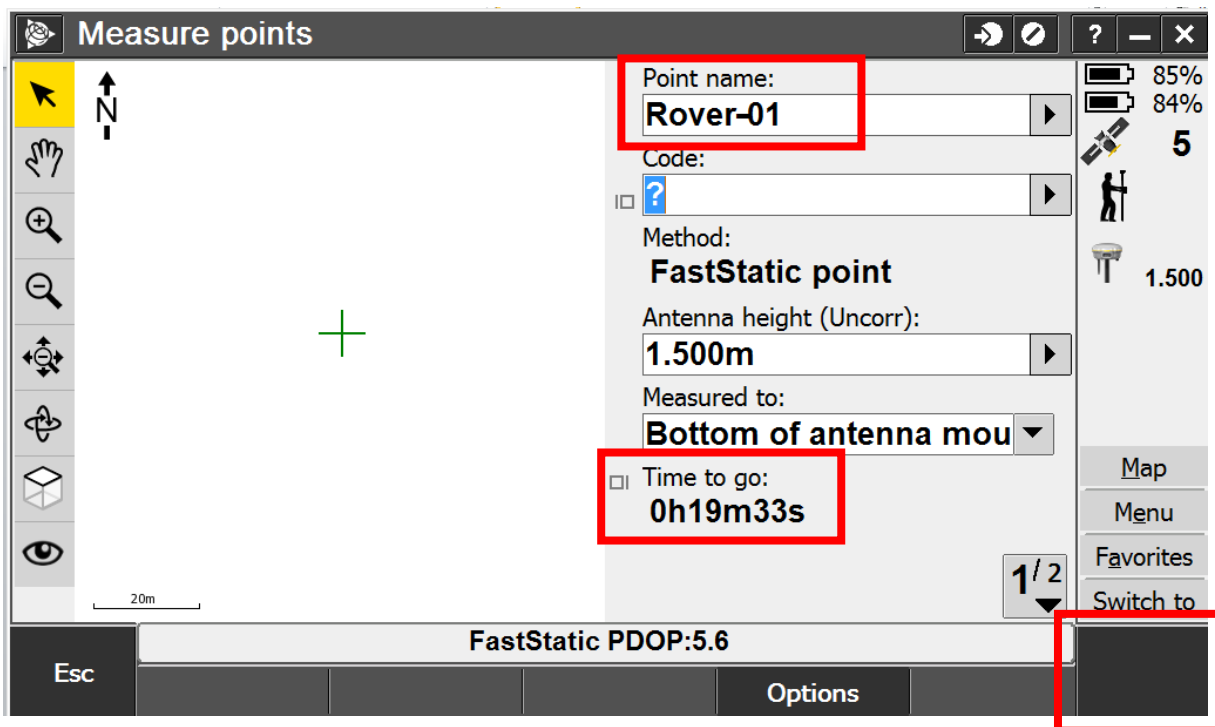


Figure 28: Plot center measurements

- Give a name to the point to be measure, this point name should be the plot number
- No need to give the code
- The Antenna height and Measure up to point of antenna height will be entered.
- The required time to record the data will appear automatically. Record data more than the required time to ensure accuracy and quality data.
- Press end when to stop data recording.

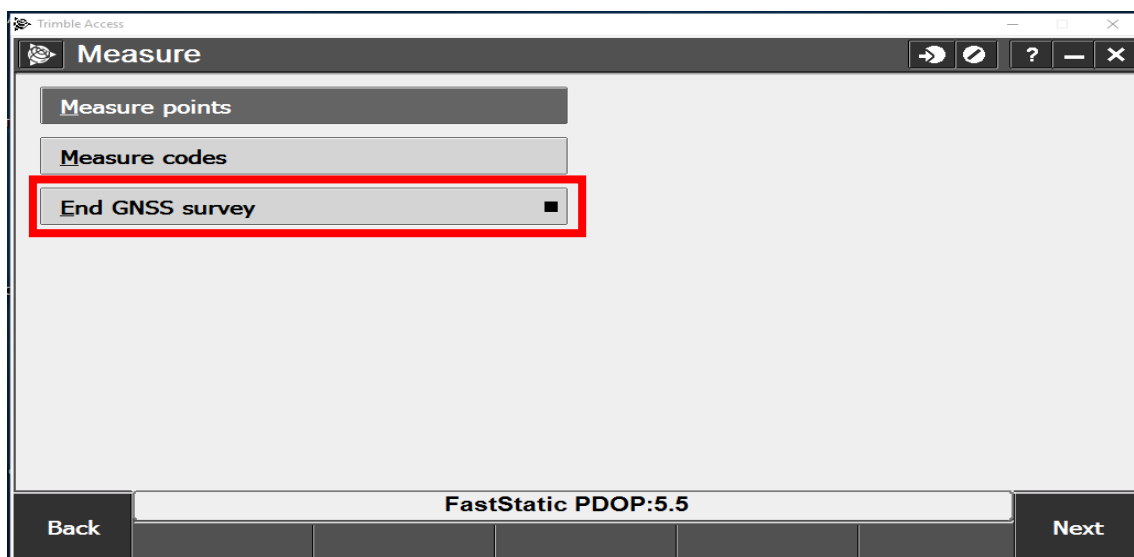


Figure 29: Completion of rover measurements

- When data recording will be complete click “End GNSS survey”

6 DATA PROCESSING

The data need to be processed in a computer after collecting from the field. In Static survey style data post processing in computer is must to identify the required location's coordinate. But before processing the data, Trimble Business Center software should installed in the computer and the dongle have to be insertd in the USB port.

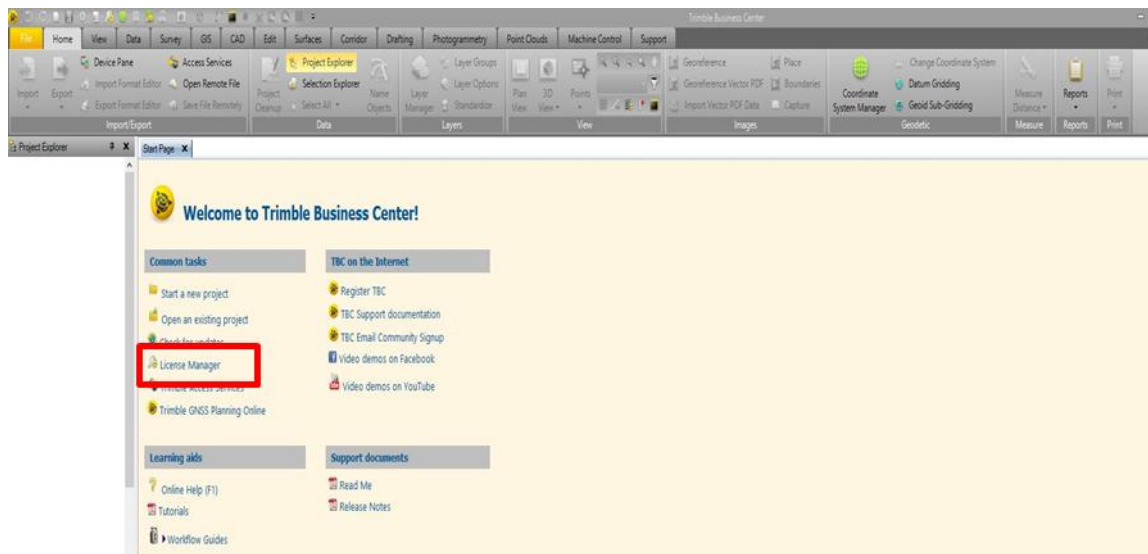


Figure 30: Trimble Business Center

- Open Trimble Business Center
- Click “License manager”

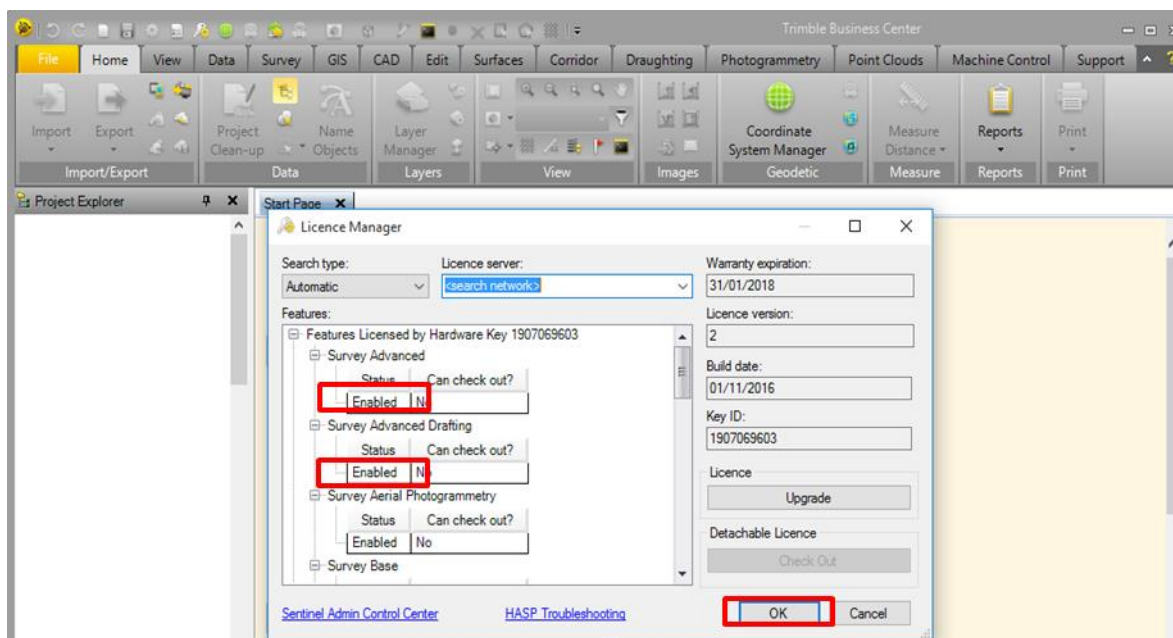


Figure 31: Checking of license manager

- Check the license status
- If all marked options are enabled in the window then it is ready to proceed for next process.

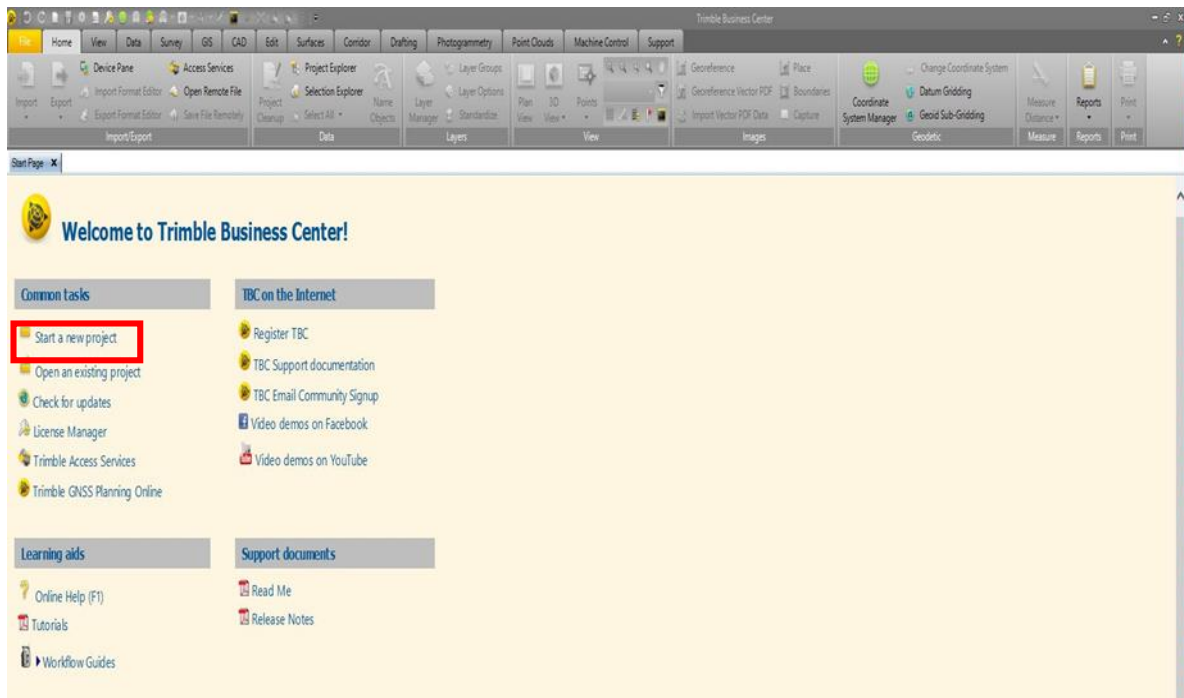


Figure 32: Trimble interface

- After checking the license click on Start a new project in the same window
- Connect the controller device with the computer using the USB cable
- Selecting “Start a new project”

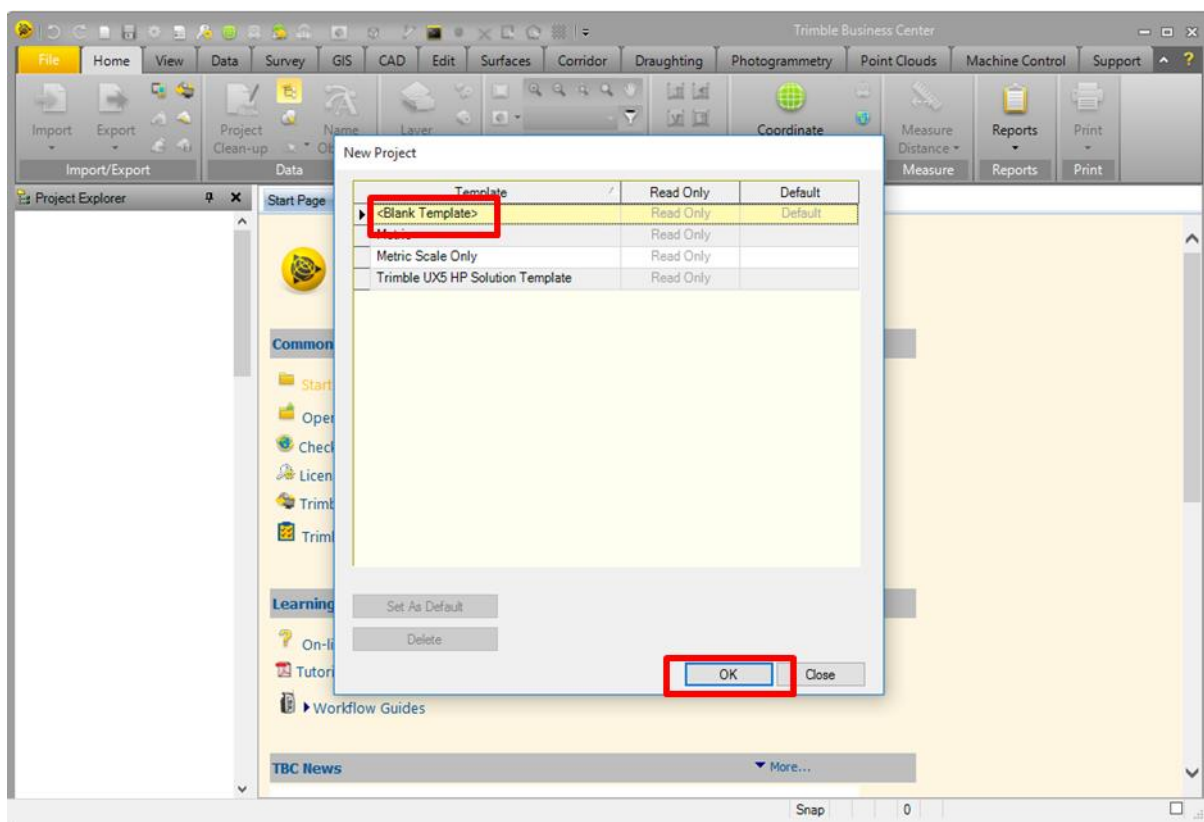


Figure 33: Start a new project

- In newly opened window select “Blank Template” and then press “Ok”

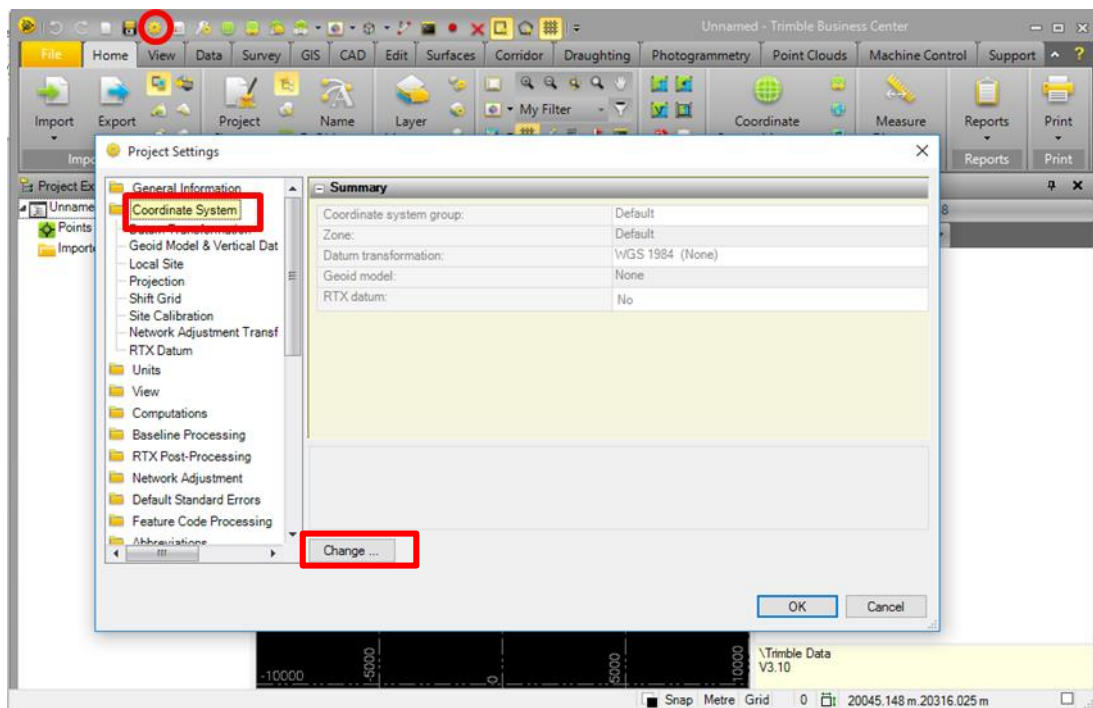


Figure 34: Coordinates of new project

- On the top title bar you will get icon of setting besides save icon
- Open the setting
- Click on “Coordinate system” in the new window then click “Change”

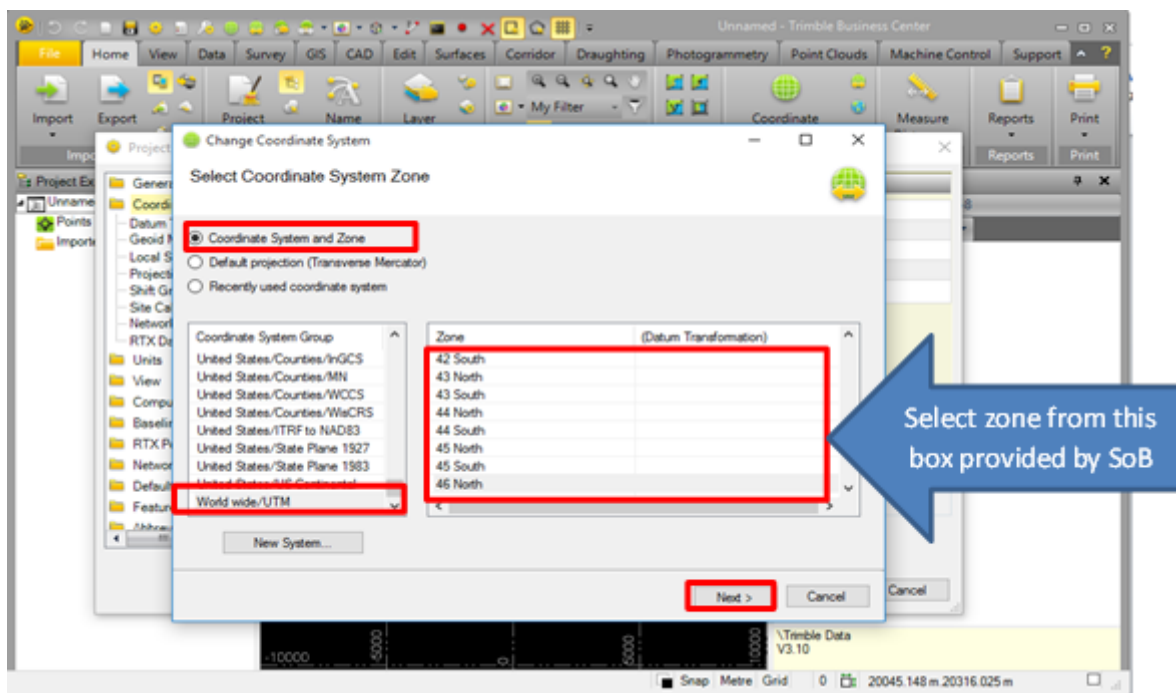


Figure 35: Select coordinate system

- Select “Coordinate system and zone”
- Select “World/UTM” from the drop down list
- Select “zones” collected from SoB then Select “datum” as “WGS 84”
- Select “Geoid Model” as EGM96 (Global) click Next

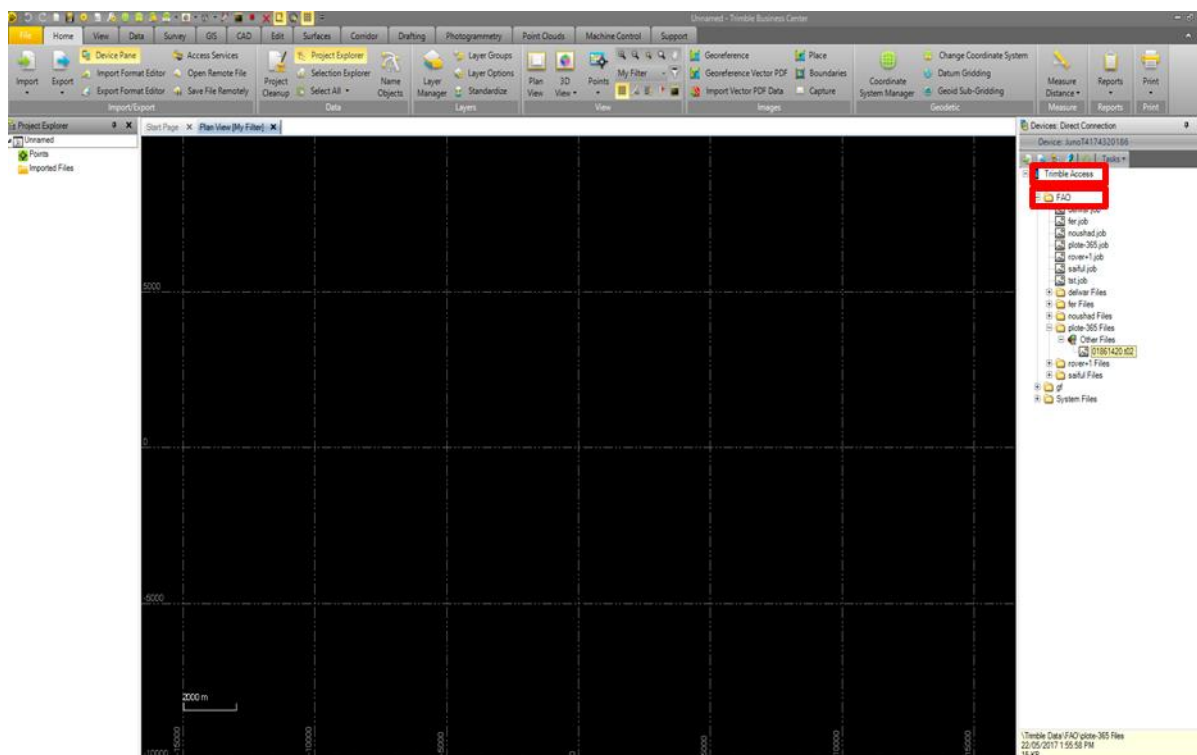


Figure 36: Data location selection

- On the right side of the window a new box will appear (Make sure that the device is connected correctly) and there you will get Trimble Access folder
- Click the folder to expand it and you will get another folder named “FAO”
- Unfold it and you will get the survey you have saved in the field

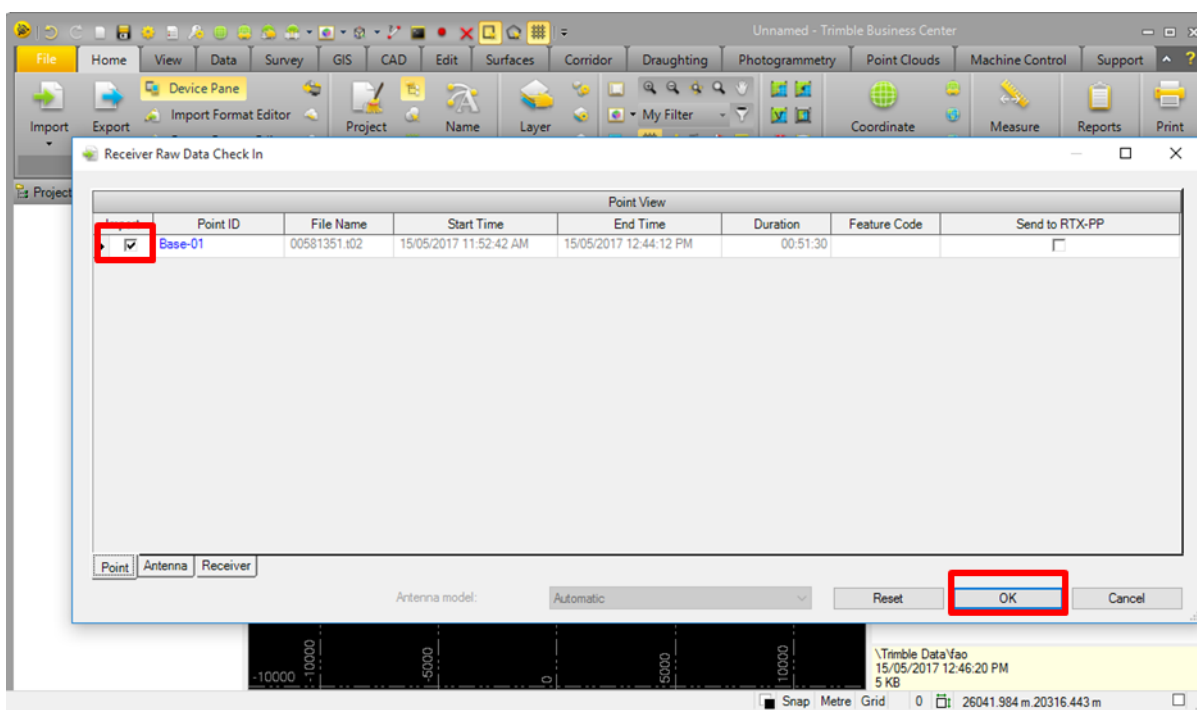


Figure 37: Selecting data recorded file

- Drag down the point into the black field
- Check the box and select OK to import. Then Base point will be in the window

For Rover

Connect rover controller with the Computer via USB cable and continue the same process discussed above (same as the base). After completing the process it will show the base and all measured the rover points.

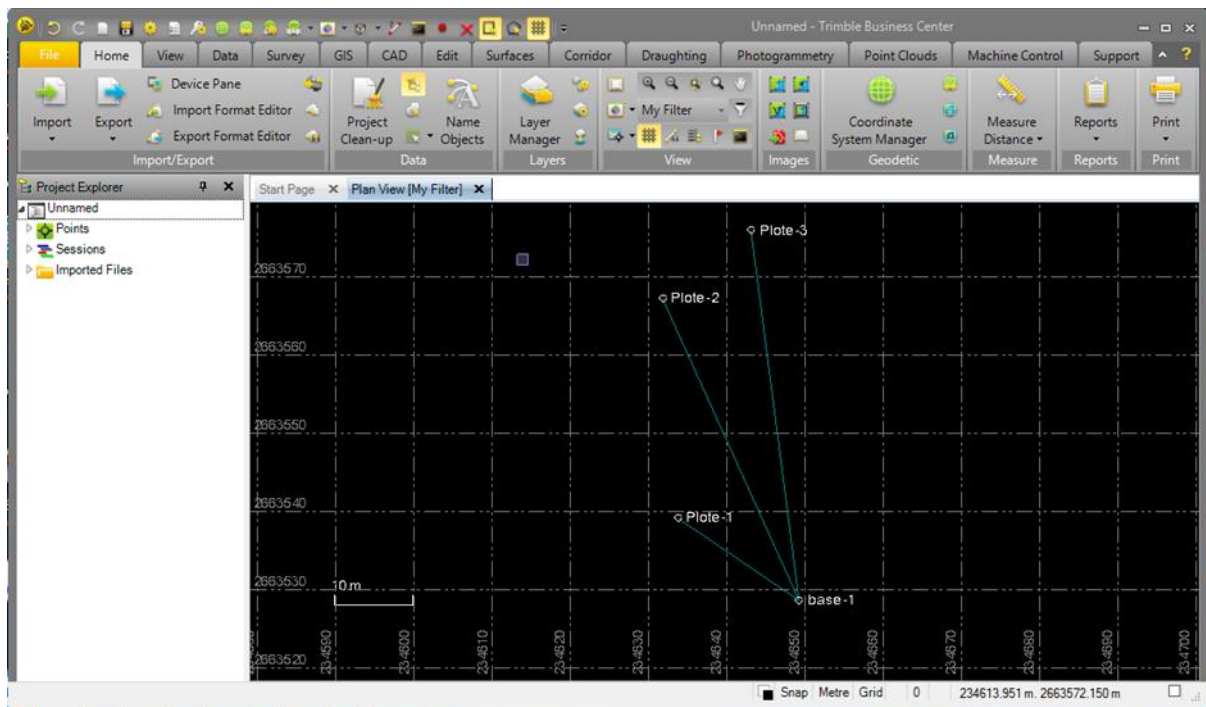


Figure 38: Base and rover points' distribution

- The base point and all the rover points will look like the figure no 36. Rover points will be scattered

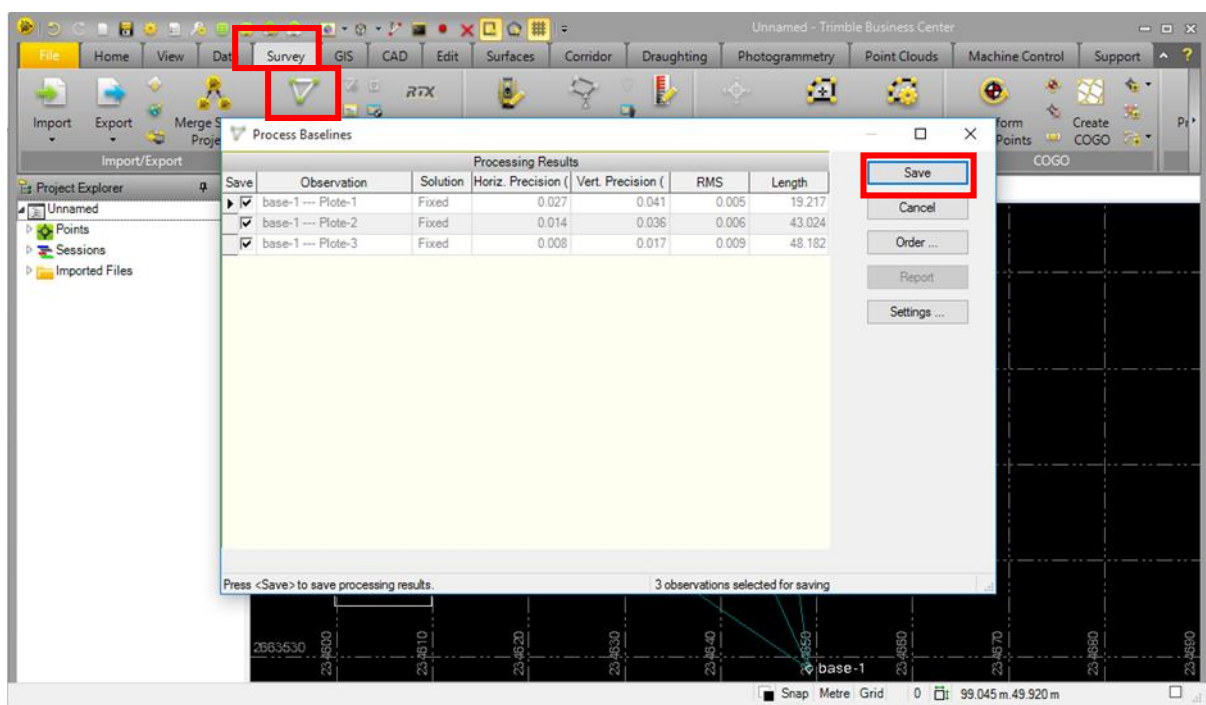


Figure 39: Baseline processing

- From the menu bar please select “survey” then “Process Baseline”
- Select “Save”

Producing Report

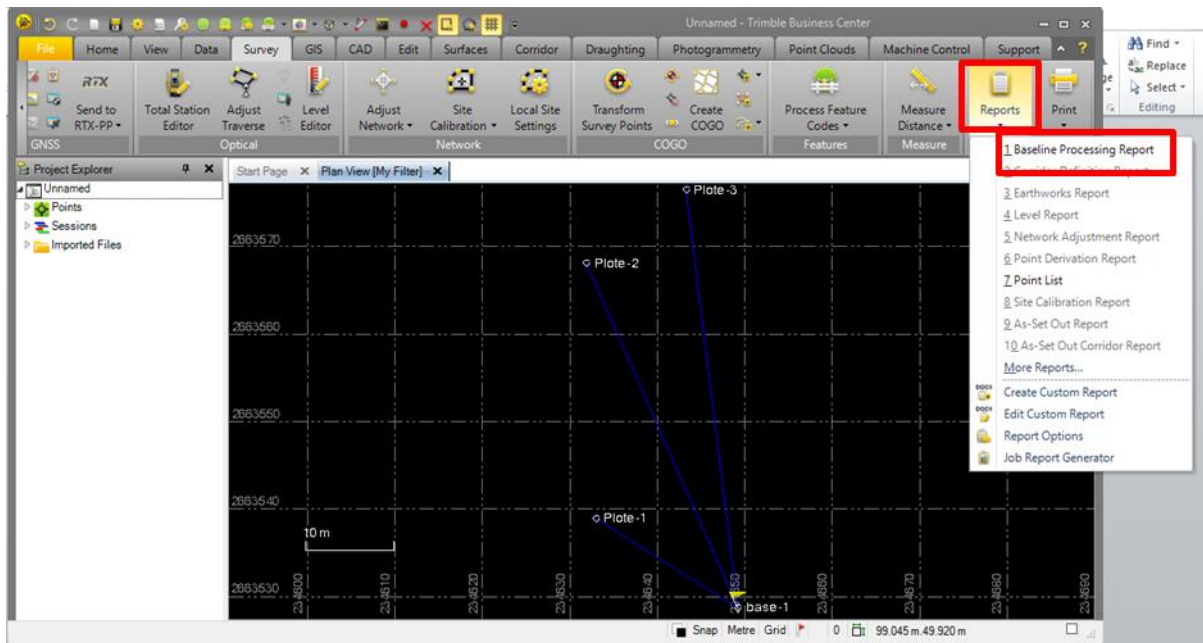


Figure 40: Report preparation

- Click the report button then “Baseline processing report”
- Report will be prepared and then the report could be saved in three different format (Word/PDF/Excel)
- Save the report as an Excel file. If for some reason it doesn't work, save as a PDF

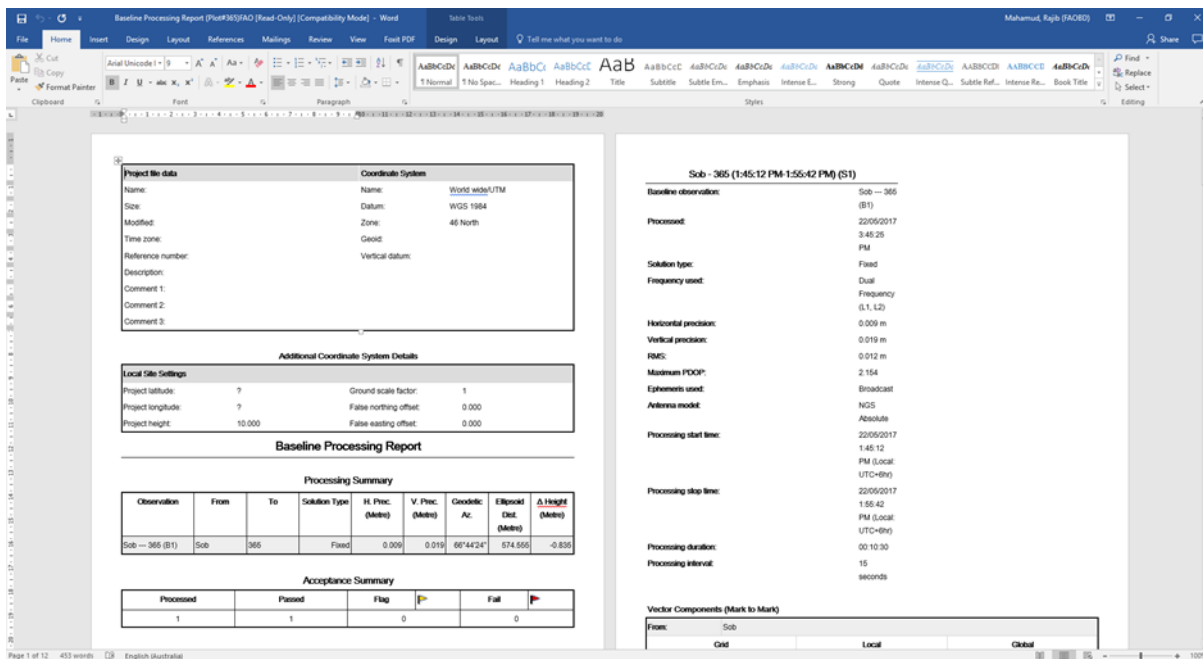


Figure 41: Report

- A sample of report is shown in figure-39.
- The rover points means plot center coordinates are listed in the report

7 DGPS DATA TRANSFER

- Record the data
- Connect the controller with computer
- Import data
- Process the data using Trimble Business Center software
- Generate the report (in Excel) containing the plot centers coordinates.
- Save the report
- Send the report to the BFI unit through dropbox,email or pendrive
- DGPS team has to send both processed report and raw data to the BFI unit

8 DGPS DATA BACKUP

- Take a back up after everyday's work
- Rename every individual backup file by it's collection date
- Store those backup files into the controller device
- Save the data as backup file in the computer while processing the data
- Keep a copy of those files into the provided pendrive
- After receiving data BFI unit will store the data into Mass storage another backup can be taken in any seperate hard drive of the responsible person

9 FIELD MEASUREMENTS BY DGPS TEAM

While the DGPS rover located in the plot center is recording data to identify the coordinates the team members will take few mwasurements to rank the accuracy of plot location idendification by the field teams.

- Measure the distance between metal bar inserted into the ground and the point hand held GPS navigates as plot center.
- Measure the bearing and distance of WOs from the plot center to cross check the recorded data in the plot report, besides the tree tag number inserted into the witness trees will be chacked. If there is any mismatch they will record the data into open foris form.
- The bearing and distance of plot center from the RP have to measured. If there is any mismatch they will record the data into open foris form
- Capture 4 photos around from the plot center and attach into open foris, it will be help full for the field teams to identify plot center when they will re measure the plot in future
- Record the information (distance, bearing, object type, species, height of the chip insertation) in open foris form regarding where RFID chip is inserted
- If variation found please indicate in the provided open foris form but don't change anything in the field
- For measurements please remember carefully that, RP bearing is measured from the RP to plot center but WO bearing is measured from plot center to WO

10 RFID CHIPS

RFID stands for **R**adio **F**requency **I**dentification, denoting technologies that use radio waves to identify people or objects carrying encoded microchips. RFID chip is a tag, label or card that can exchange data with a reader using radio frequency (RF) signals. It usually has a built-in antenna and an integrated circuit IC.

11 RFID CHIPS IN BFI

In the Bangladesh Forest Inventory (BFI), the witness objects and reference points are needed to be tagged. The witness objects and reference points are defined in the Field Instructions for the Bangladesh Forest Inventory manual (BFD, 2016). Witness objects (WO) and reference points (RP) are needed to be established in each plot to ensure that the plot centers remain identifiable and for plots to become permanent plots. Permanent plots are defined in the Field Instructions for the Bangladesh Forest Inventory manual (BFD, 2016). Those objects are normally tree but if there is no tree in the area then other objects are eligible to select as RP and WO. The target is to make the BFI plots permanent to ensure the possibility to revisit them periodically in next BFI cycles. BFI unit have the data, images and maps for the plots, but with time data can be lost in particular the identification of witness objects and reference points.

The use of RFID chip to tag witness objects and reference points was identified as a cost-effective solution to ensure the identification of the plot location in the future. If these chips are inserted to a nearby identifiable object like witness objects and reference points then the plot centers can be identified easily by using distance and bearing. This technology is the most advance technology which are in experimental level in the field of forestry. Bangladesh is going to be the first country of using this technology for national forest inventory. The RFID chips to be used in BFI are 15mm long and are produced by “Simtrona”. Those RFID chips are made from cellulose, so that it doesn’t cause any harm to the plant and stay 12 years safely within the tree. For every chip there is an identification number which is readable by the scanner. Information can be stored in excel sheets within the chips.

12 RFID CHIP INSTALLATION

Where and how many chips will be inserted in a plot that is an important matter. These special instructions for RFID chip insertion are regarding those issues. The process of insertion will be discussed in the next part.

- ✓ Install 4 RFID chips in each plot in 4 trees. The 4 trees will be composed of i) 1 Reference Point (if tree) and ii) 3 Witness Object (if tree). The number of trees may be less if RP or any WO are not trees.
- ✓ Insert the chip at 0.3m height of the trees
- ✓ Insert the RFID chip facing the subplot center.
- ✓ Record the following information to trace the chip and tree information in which the chip is inserted.






Table 3: Information table to be filled during RFID chip installation

SL	Plot ID	Object	WO tag no.	Chip No.	Tree height (m) at which RFID chip installed	Special Notes	Reason for not inserting Chips	Team of insertion
1		RP						
2		WO1						
3		WO2						
4		WO3						

13 EQUIPMENT LIST

A few equipment will be used in RFID chip insertion process. The list of the equipment with suitable description and figure is given in below table-

Table 4: RFID equipment list

SL.	Name	Description	Image
1	RFID chip	<ul style="list-style-type: none"> - About 15 mm long - Made of cellulose - Inserted into the tree - Sharp edge in one side 	
2	Axe	<ul style="list-style-type: none"> - Steel body - Wooden handle - Cover attached in sharp side - Lock pin on the back side 	
3	Liquide content	<ul style="list-style-type: none"> - Vaseline content - Plastic bottle - Help chip not to stuck with the axe - Use once in a day 	
4	RFID reader	<ul style="list-style-type: none"> - Electronic device - Attached radar - Touch display - Keyboard - Field team will not carry this during insertion phase 	
5	Bag pack	<ul style="list-style-type: none"> - To carry the equipment - Ensure the safety 	
5	Paper form	<ul style="list-style-type: none"> - To input the necessary data <p>paper form will be carried out</p>	

14 PROCESS OF RFID CHIP INSERTION

There are several simple steps of RFID chip insertion-

Step 1: Take out the axe and **unlock it by removing the lock pin** from its back side. After removing, the pin will be kept in the pin keeping hole located at the end of the wooden handle.



Figure 42: Step 1- unlocking the axe

Step 2: Put the Vaseline in the blank space of the axe. This blank space holds the RFID chips. Sometimes chip may have stuck there, that's why Vaseline is used so that the chances of stuck are reduced. Keep in mind that use the liquid gel **once in a day**.



Figure 43: step 2- Putting Vaseline in the axe

Step 3: Open a chip box and take a chip from the box. In field chip box may not be provided, **chips will be kept in small zip bags.**



Figure 44: Step 3- Taking out chip from storage

Step 4: Insert the chip into the narrow opening of the back side of the axe. First put the chip into the upper portion of the opening and then push it down to accommodate completely. But it need to be sure the **sharp edge of the chip must be faced outside.**

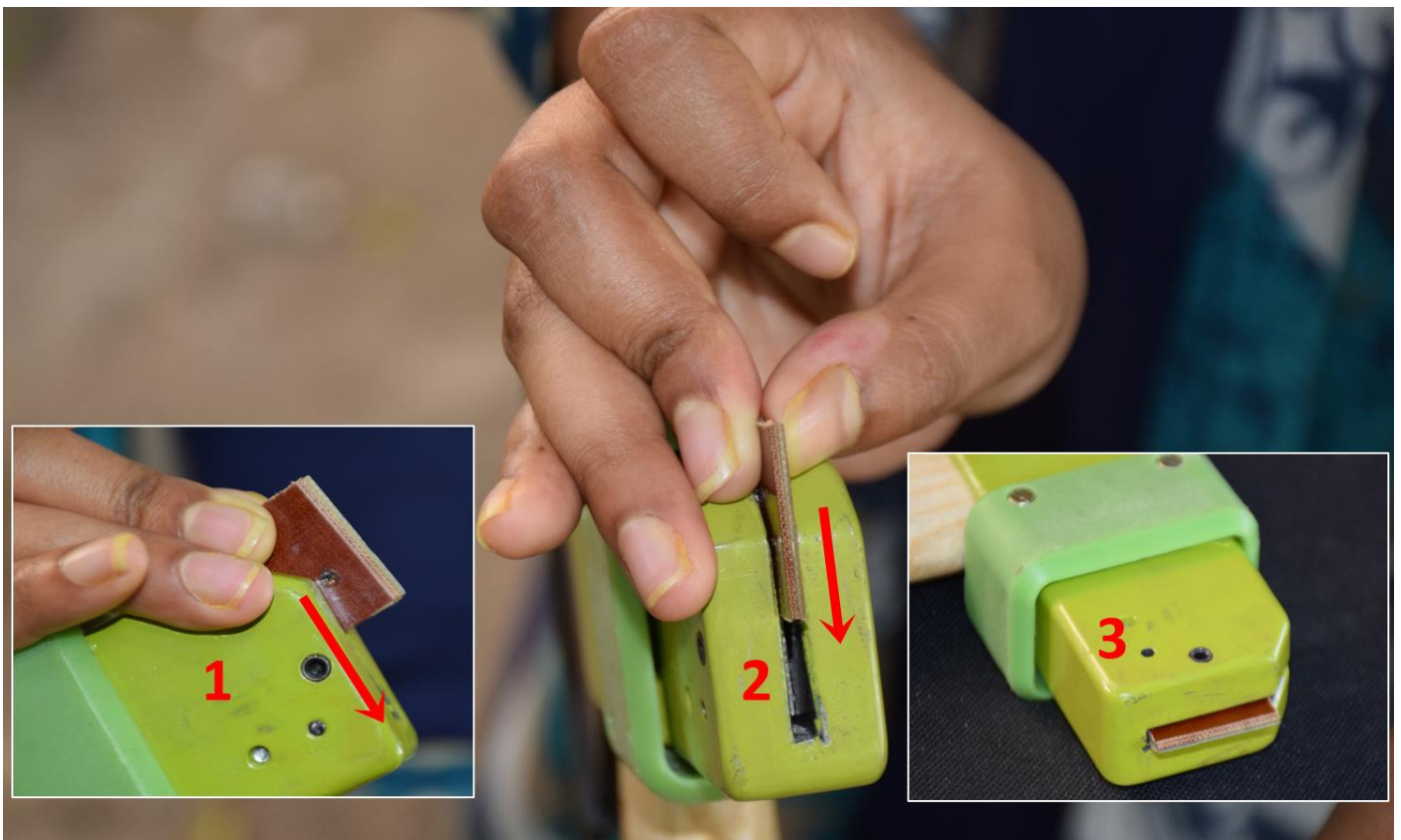


Figure 45: Step 4- Inserting chip into axe

Step 5: Hit the base point of the targeted tree with axe's back side having inserted chip with sharp edge faced outside. Hit should be made **with enough force**, so that the chip can be inserted properly into tree trunk. If there are thick bark in the outer surface then first **remove some bark**.



Figure 46: Inserting chip into tree trunk

Step 6: If chip is inserted wrongly then use the sharp edge of the axe (front side) to **remove the chip** and **insert again correctly**.



Figure 47: Step 6- Removing chip if necessary

15 RFID CHIPS DETECTION

DGPS team will insert the RFID chip into the targeted tree, but they will not perform the duty of RFID chip detection. RFID chip detection will take place when the BFI plots will be re-measured during next inventory. RFID chip detection included some very simple steps-

Step 1: Start RFID reader with power button and **open up the chip id locator file.**



Figure 48: Starting RFID reader

Step 2: Put the antenna of the reader **in line with the insertion point** as much as possible.



Figure 49: Putting Reader in line with chip insertion point

Step 3: Press the trigger attached with the reader handle and move the reader up and down in line with assumed insertion point of RFID chip according to the noted description of insertion until it locates the chip.



Figure 50: Pressing the trigger of the reader

Step 4: When the Reader will be in the nearby location of the chip it will detect the chip, and will **show chip ID** to the surveyor.



Figure 51: Locating a chip

16 USING PROCEDURE OF RFID CHIPS IN FIELD

This portion not included into RFID chip insertion process, it is a part of relocating and data collection from RFID chip which will be done later during next inventory. **This section is written for later use.**

A freeware software will be used to collect data from smart nail inserted inside tree. Data collection process has been depicted step-by-step as follows:

Step 1:

Save the file spremaen.zip to your computer or other device.

Unzip this file to new Folder named SPREMAEN in your preferable location.

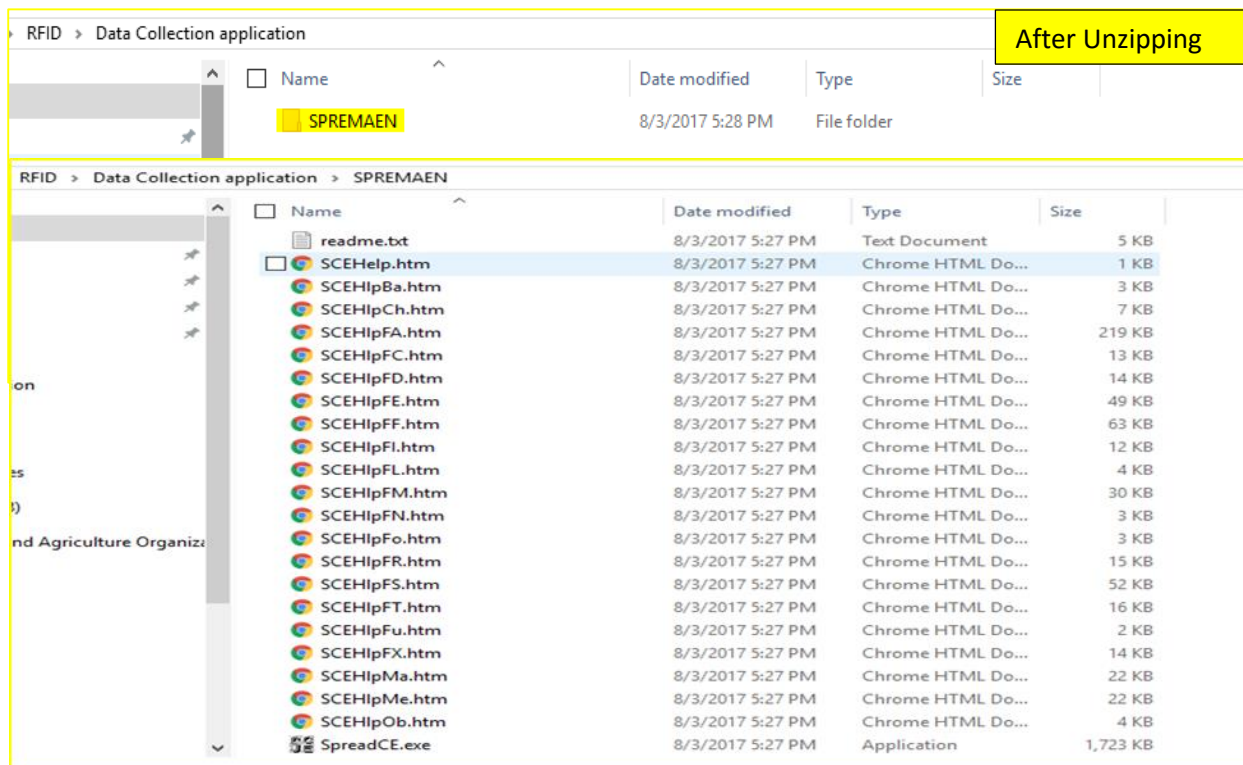


Figure 53: Unzipping and saving file

Step 2:

Put Your MERLIN (powered ON) in the cradle and connect cradle with Your computer by blue USB cable. (You can connect MERLIN with Your computer or other device over Bluetooth too)



A installed windows application “Windows Mobile Device Center” will show the connected Marlin. Make sure that USB is connected properly with computer.

The “Windows Mobile Device Center” will come up window in computer screen just as shown below; from where it can be made sure that the marlin is connected properly. If doesn't open the WMDC(“Windows Mobile Device Center”) application by clicking the icon from Desktop.



Figure 54: Windows mobile device counter interface

Step 3:

Now if you see the  sign then go to  browse the contents inside marlin.

Now, Copy SPREMAEN Folder from Your computer to MERLIN in folder Program files.

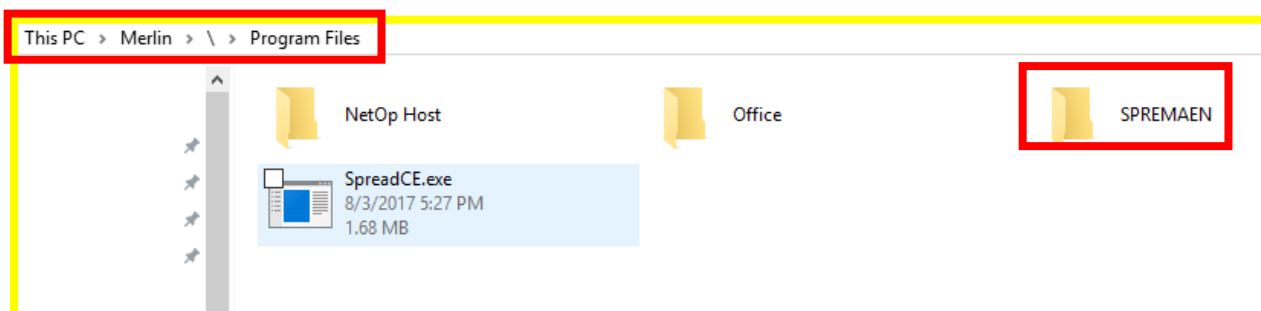


Figure 55: Copy Spremaen from pc to Merlin

Step 4:

On MERLIN screen double click on My devices icon and then go to Program file>SPREMAEN folder. Find in SPREMAEN folder file named SpreadCE.

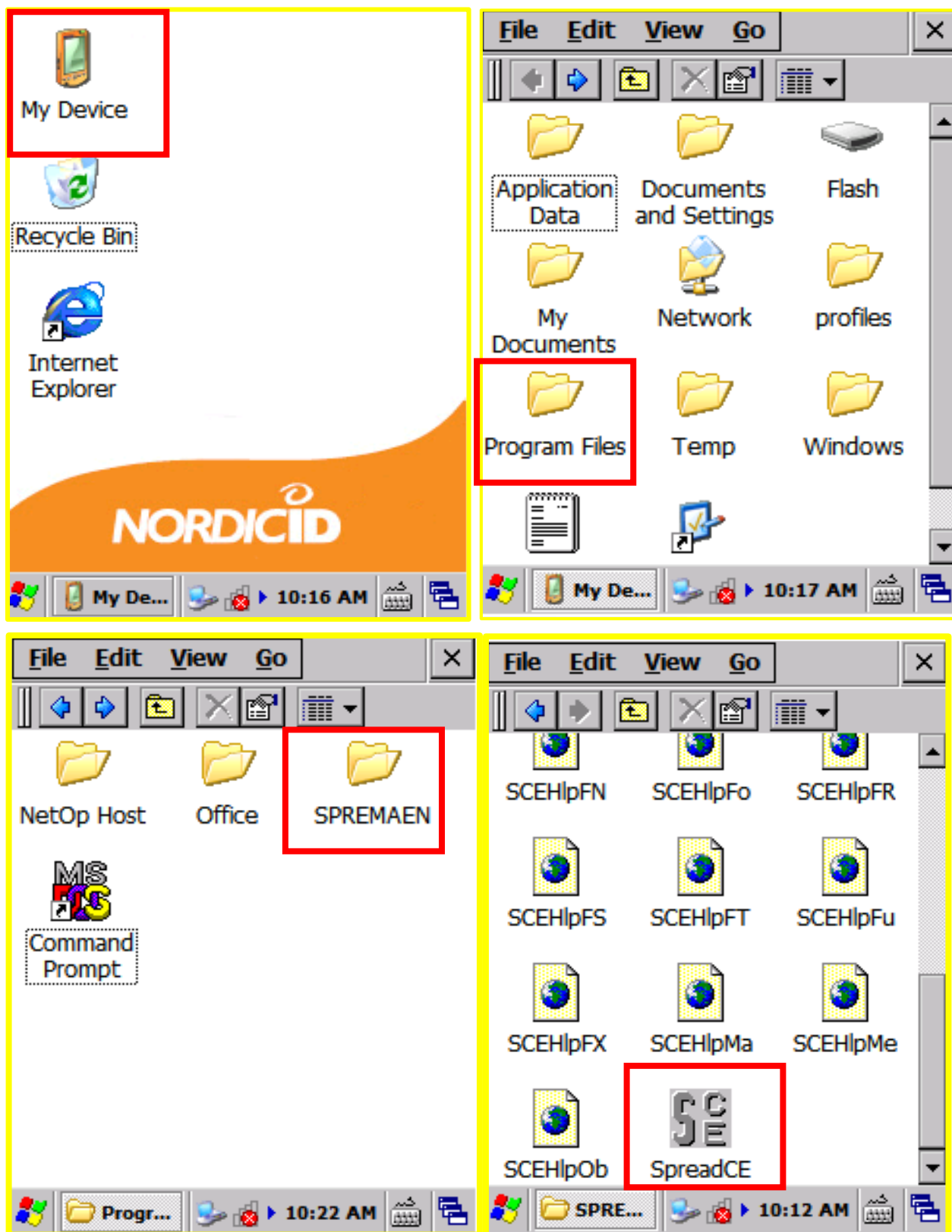


Figure 56: Finding SpreadCE folder

Step 5:

Put PDA pen (plastic stick) on SpreadCE and hold. Edit menu will appear. From there choose option copy. Close My Device menu by pressing X on upper right corner. Now put PDA pen on desktop and hold pen

there. An edit menu will appear again. This time choose Paste option. Now SpreadCE application can be started directly from desktop by double click on SpreadCE icon.

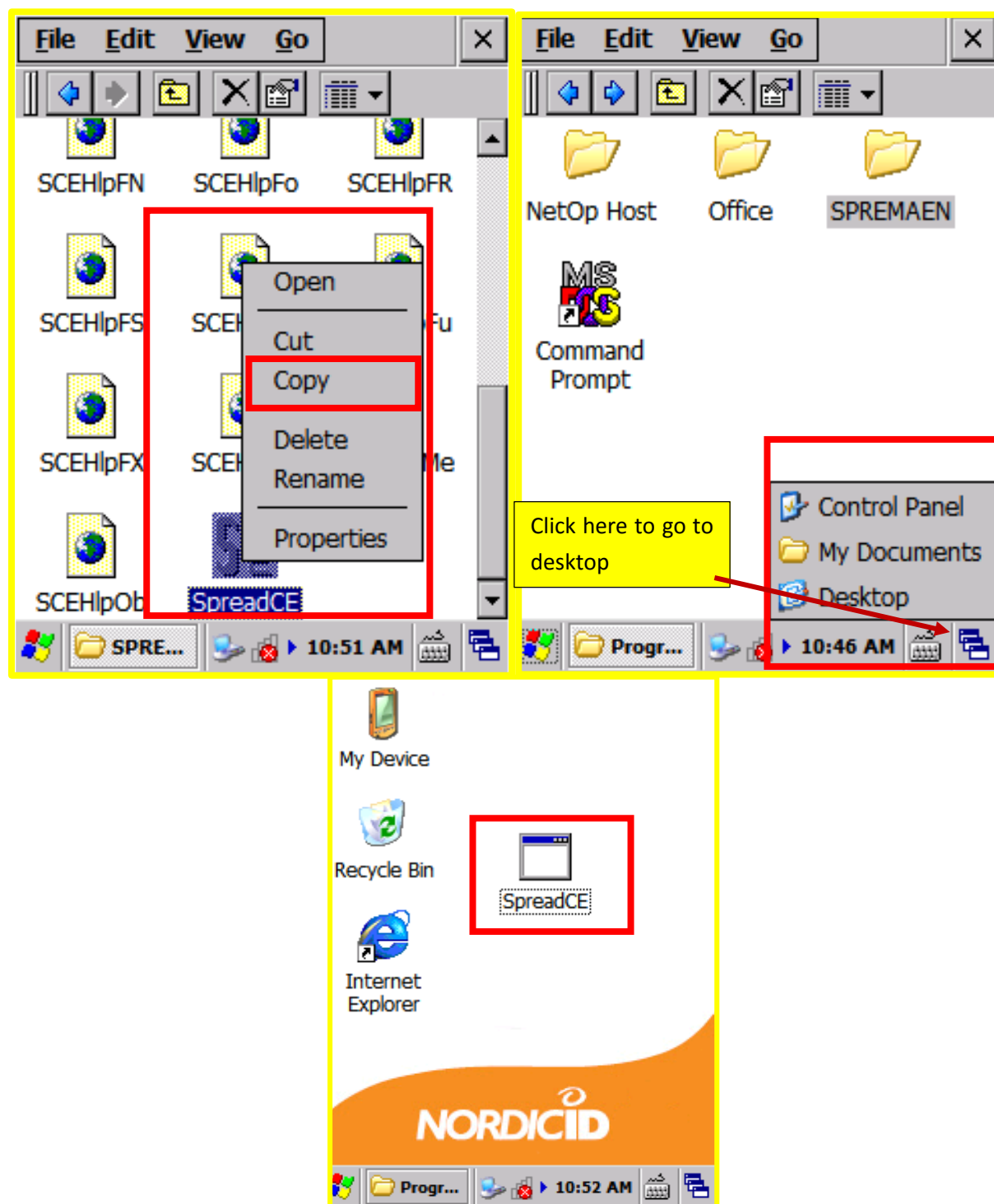


Figure 57: Starting SpreadCE application

Step 6:

Save a customized excel file created for data collection from computer named “Template.xls” from computer to Marlin.

Copy **Template.xls** file from computer to MERLIN in **My Documents** folder.

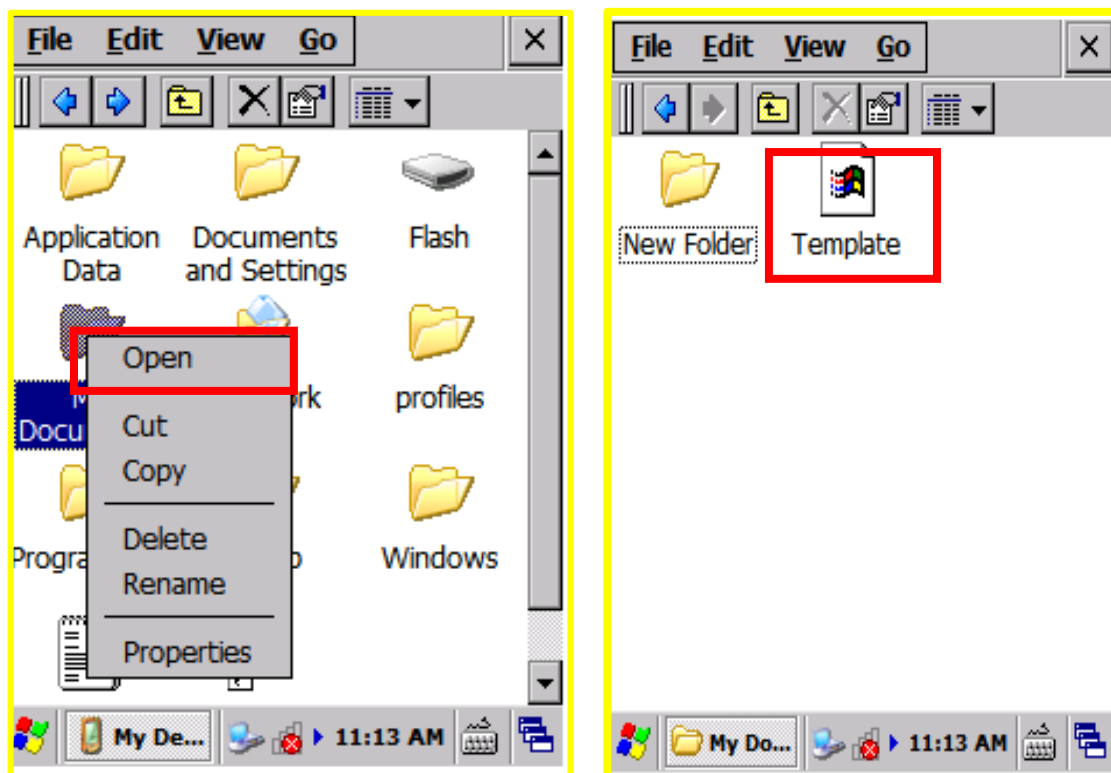


Figure 58: Creating data collection template

Now Start SpreadCE from desktop of Marlin and from there open file Template.xls. In the excel file there are some fields are created for collecting data corresponding to that Smart Nail/nails including the Nail ID, GPS locations, Tree Species, Height, Diameter etc. This excel file can be customized depending on plot circumstances. Steps are shown as below:

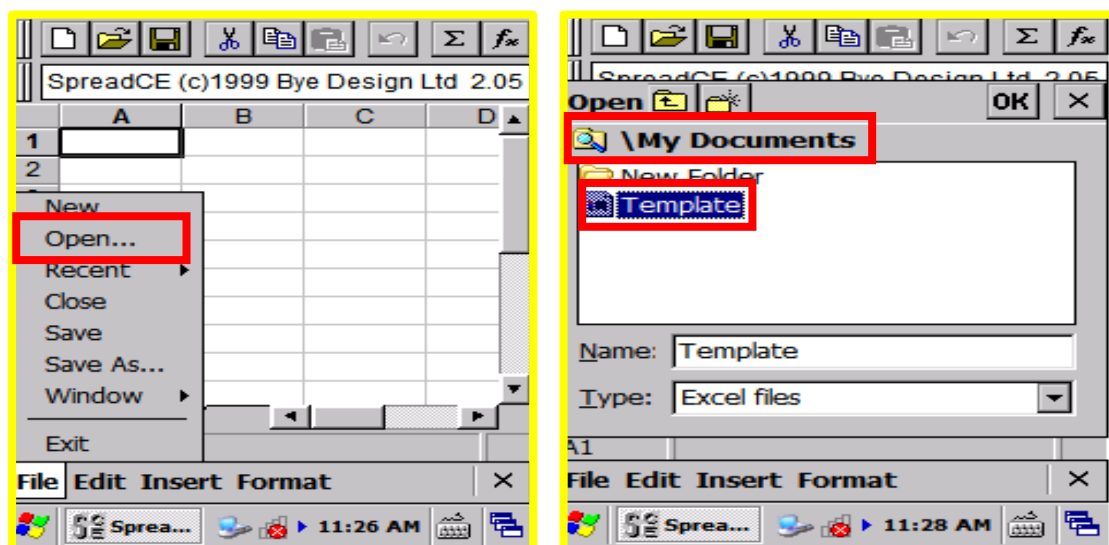


Figure 59: Data recording into excel file

After opening the customized excel file from *My Document*, a file will be shown as below:

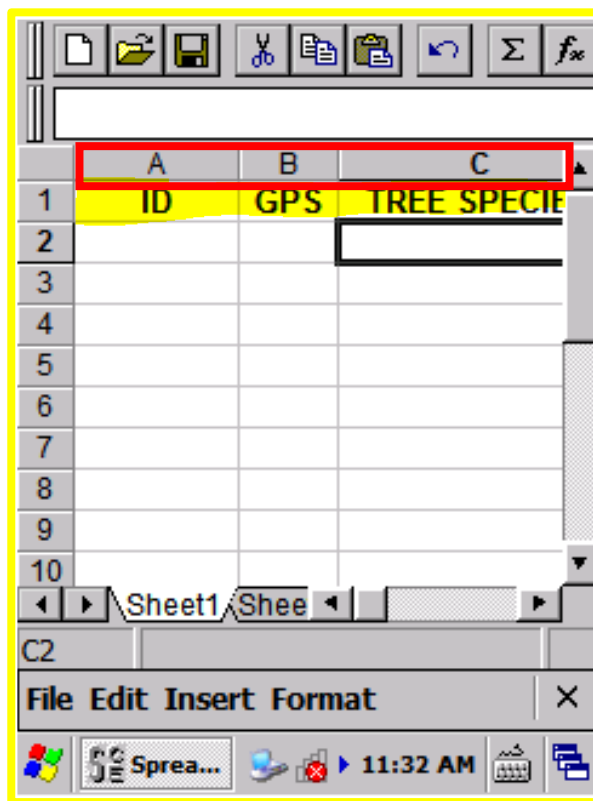


Figure 60: Opening customizes excel file

By moving the left-right arrow in the excel file, all column will be found. If required new column can be added. Save file by different name, for example SMARTNAIL_12_05_2017. Now you can insert data in columns. In first column there is ID, it means the HEX ID code of SMART nail.

Step 7:

At this stage of data collection, the Marlin needed to be prepared in order to read the ID from Smart nail. To activated RFID reader, follow next instructions: go to START -> settings ->Control panel from Marlin. There find a **Nid rfid Wedge** application and double click on it. From Wedge menu find option **Scan Button Mode**. Select there RFID (changing from SCANNER to RFID) and click OK on upper right corner of the screen. Close also the Control panel settings menu by clicking X. Now You can trigger RFID scan by pressing button on MERLIN holder by fore finger.

Follow the steps as depicted below:

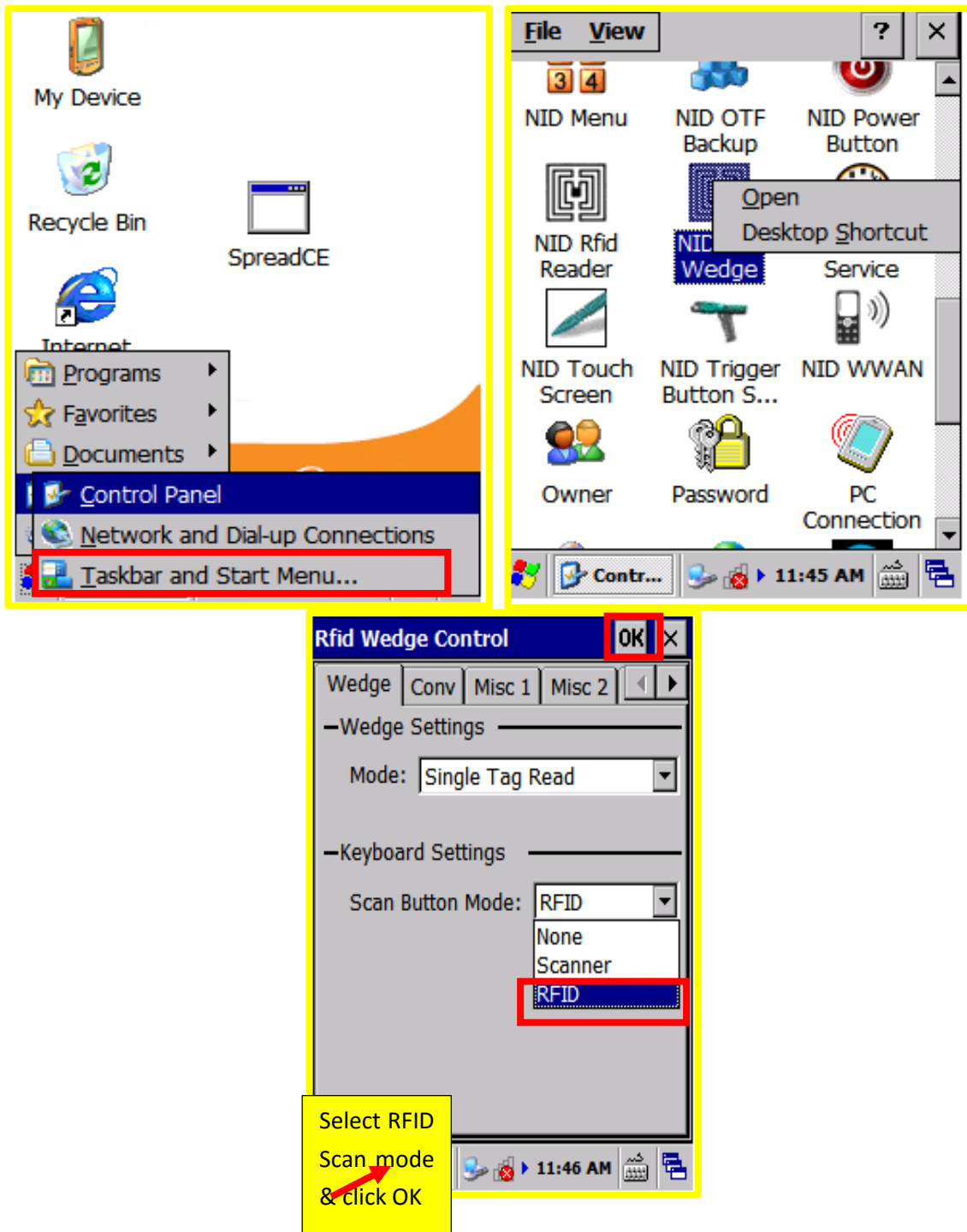


Figure 61: Activation of RFID reader

Now open the SpreadCE application from task bar. The excel file is ready to read the ID from smart nail and write information in excel file. User can use onscreen keyboard for typing. A sample is given below:

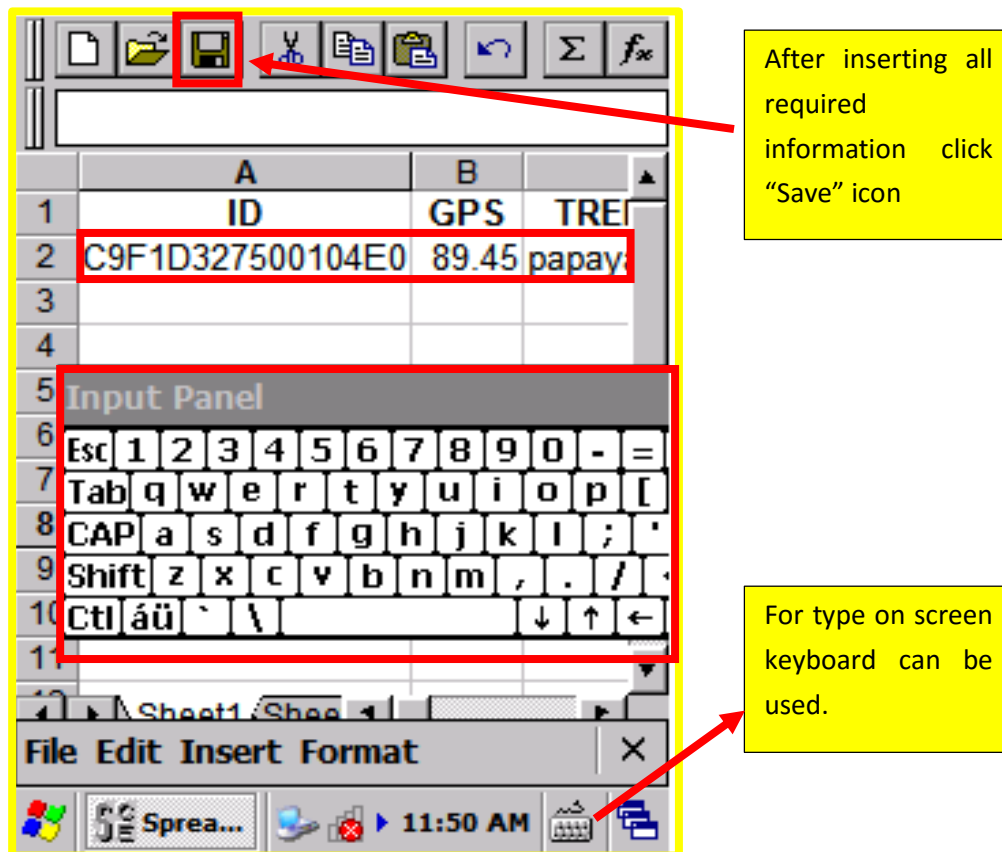


Figure 62: Saving information into the chip

To find the excel file go to “**Windows Mobile Device Center**” after connecting Marlin with PC as described before in step 2 and go to **File Management** and copy the excel file to PC.

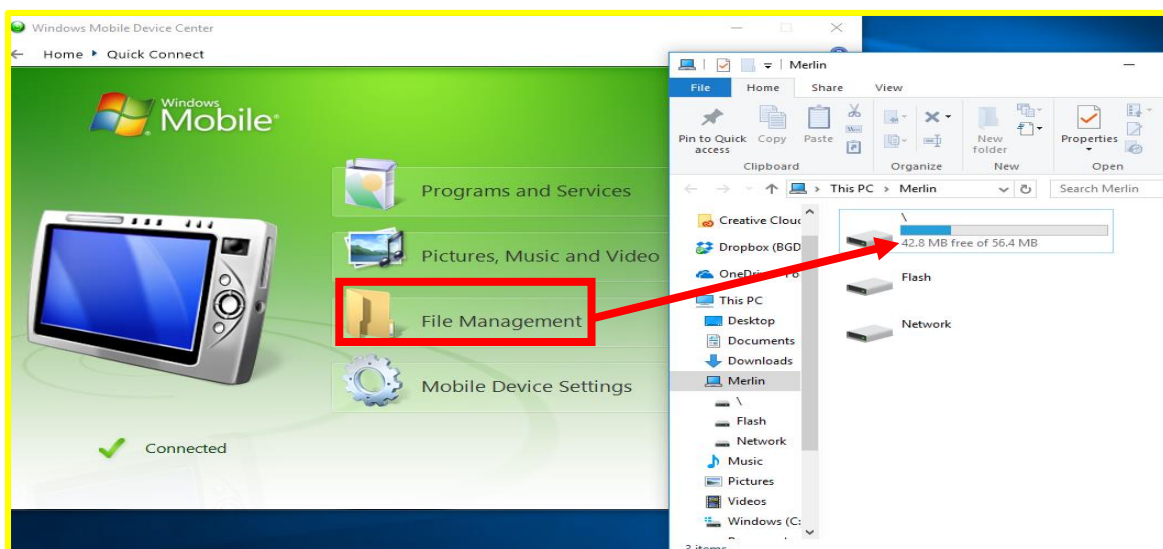


Figure 63: Save the file into pc

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