Data Logging Feature

INTRO and GUIDE for BETA Testing

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Introduction

The Data Logging Feature is a new App development for the Tiny Surveyor robots which enables the user to automatically log a variety of position and accuracy data whilst executing a job.

In this version there are 3 different types of Logging that can be activated, each with a specific purpose in mind. These could be considered as when and how often the robot logs data. (See **'LOGGING TYPES'**)

How is logging handled

The Robot will make a log in real-time whilst executing a job and store all loggable data points locally within a file on the robots internal memory with date, time and user defined file name.

These data files can then be exported to the tablet via bluetooth or directly to a USB connected to the robot in .CSV format containing the data points selected by the user.

These data points can then be used within Excel and your favourite CAD software to QC the job, check up on robot behaviour and make reporting easy.
(See **'DATA FILES'**)

What will be logged?

POSITION DATA

Calibrated Tool Coordinates, Antenna Coordinates (RAW + Proj.), Planned Coordinates

ACCURACY DATA

Standard Deviation from external GNSS via GPGST (1Hz) - latitude, longitude, altitude, RMS value

SURVEYED POINTS

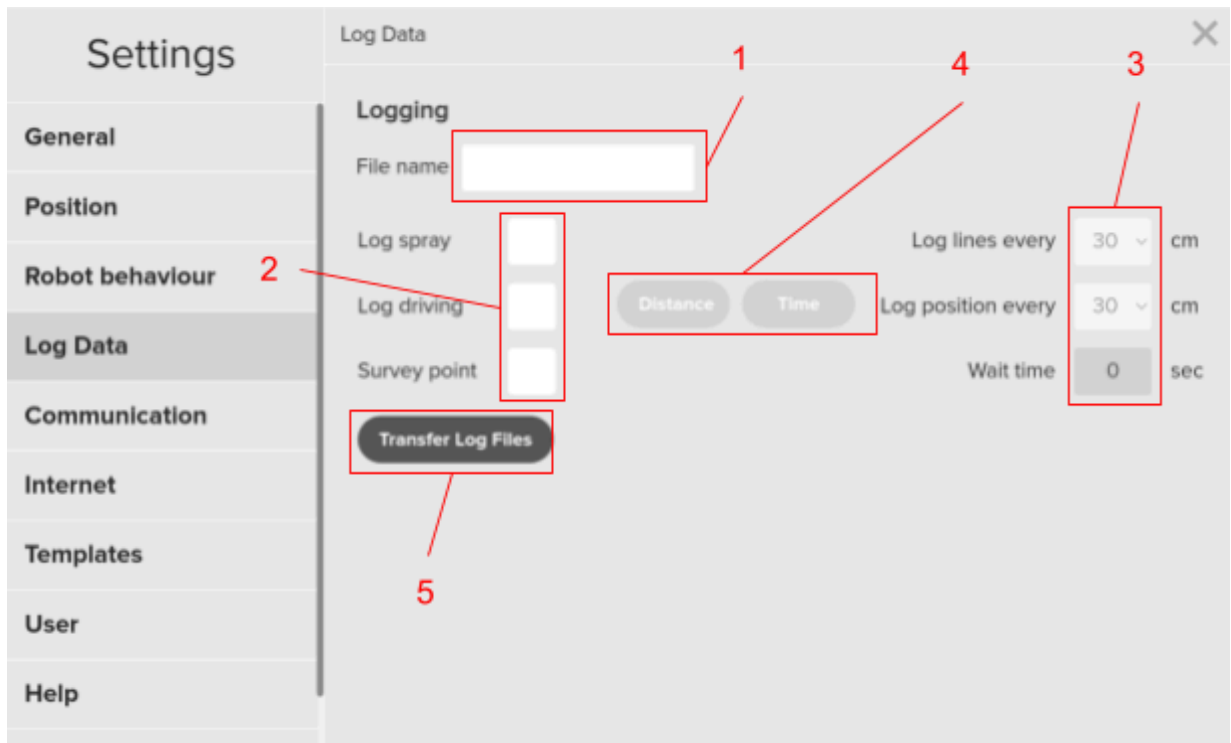Calculated average coordinates of time-series position data collected at stationary waypoint

ROBOT SETTINGS

Input Source, Tool Position, Tool Sideshift, Tool Height, Line Length, etc...

Log Data UI Layout

Navigate to '**Settings** > **Log Data**'

1. **File name -** Enter a desired name for the logged data file. This should always be your first step (note: date and time of creation will be added to the log file name automatically). If no file name is entered, a log file will be created with date and time stamp only for file name.

2. **Log Buttons -** Activate/Deactivate different kinds of logging. Select one or more logging types to enable logging. Once enabled, logging is armed and the robot will log data automatically when executing a job. Deselect all logging types to disable logging.

3. **Unit-** Specify units for logging options. How often do you want to log… Lower distances/times will result in more frequent data logs and a higher resolution of the robot's activity.

4. **Log Driving Type-** Choose to log the robot's driving position based on distance or time to achieve your desired data resolution.

5. **Transfer Log Files -** Press to access the '**Transfer**' page where you can format and export logged data files from the robot's internal memory to your tablet. You can also delete log files from the robot's internal memory on this page to clear up space.

Logging Types

There are three different types of logging available within this version of the logging feature. You can activate any combination of these to log simultaneously when executing a job.

Log Spray

Log Spray is tied directly to the operation of the spray tool, activate this to make a log of everywhere the robot has applied paint to the surface during a job. This will log data when painting points and also when painting lines.

- When painting **points**, Logs Data every time the spray tool is activated at a point. In the CSV file, this line of data will be identified as '**pt**'.
  *(Note: when Survey Point is active, these points will be replaced with '**survey_pt**')*

- When painting **lines**, a log is created whenever the spray tool Starts or Stops. In the CSV file, these lines of data will be identified as '**line_start**' and '**line_end**' respectively. This ensures we get a clear picture of where paint is applied to the surface regardless of using solid or dashed lines.

  Whilst the spray tool is still activated between start and stop, a log is created at a resolution of the user specified distance in units of cm. In the CSV file, these lines of data will be identified as '**line_dist**'
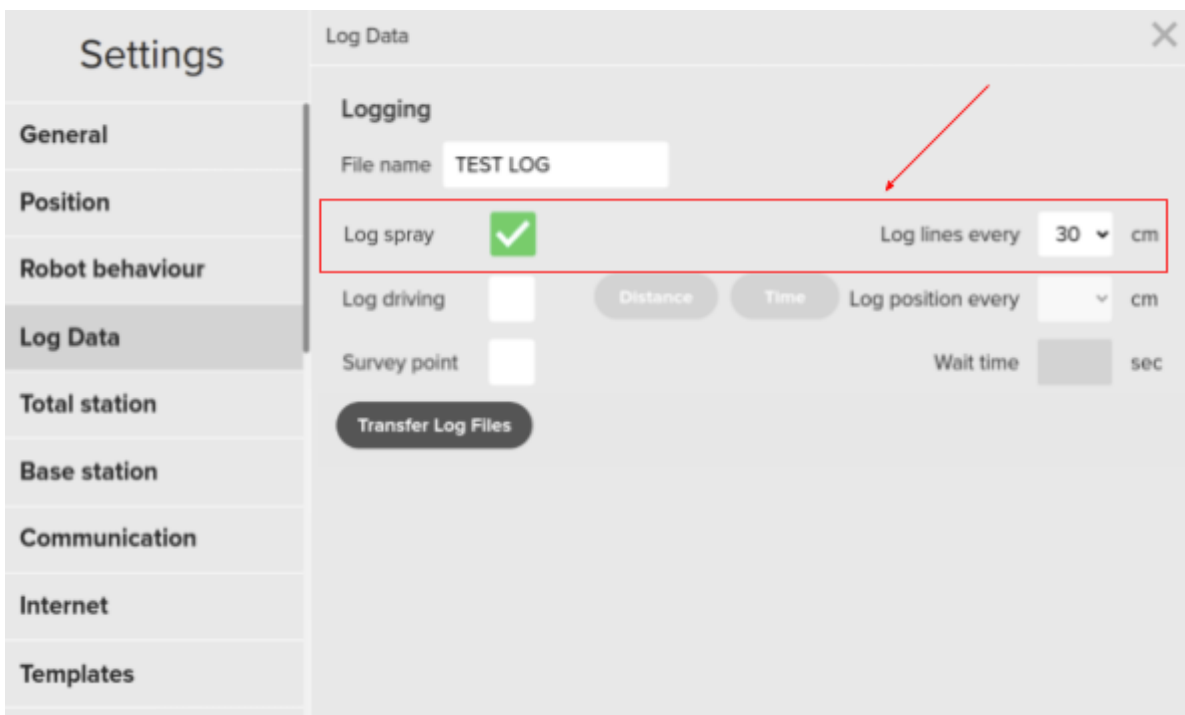
Example

We ran a job painting 10 points and 7 dashed lines with **Log Spray** enabled. An export was made from the logged data, containing tool coordinates to let us track where the robot applied paint to the surface. These logged coordinates were used to visualise in AutoCad software...

fig.1

fig. 2
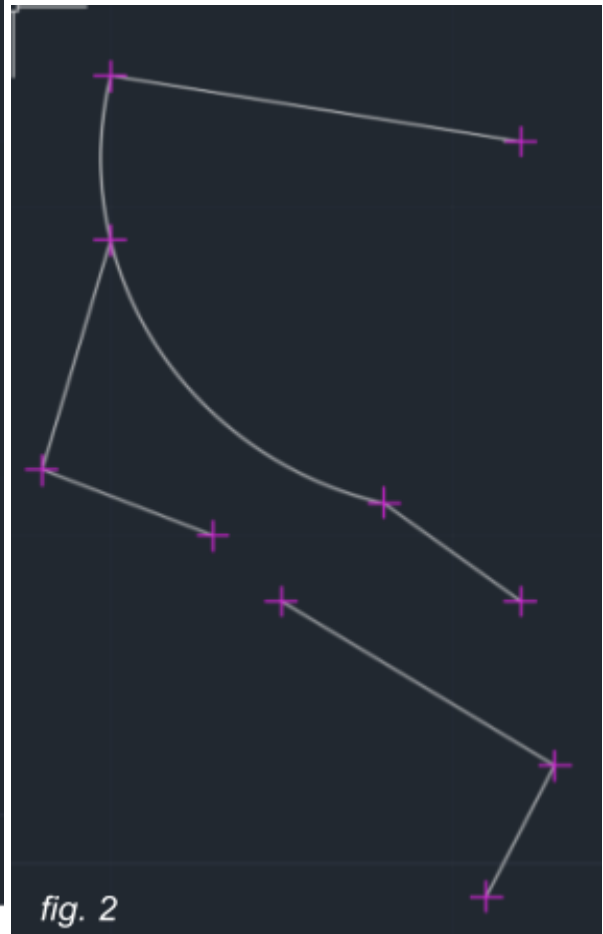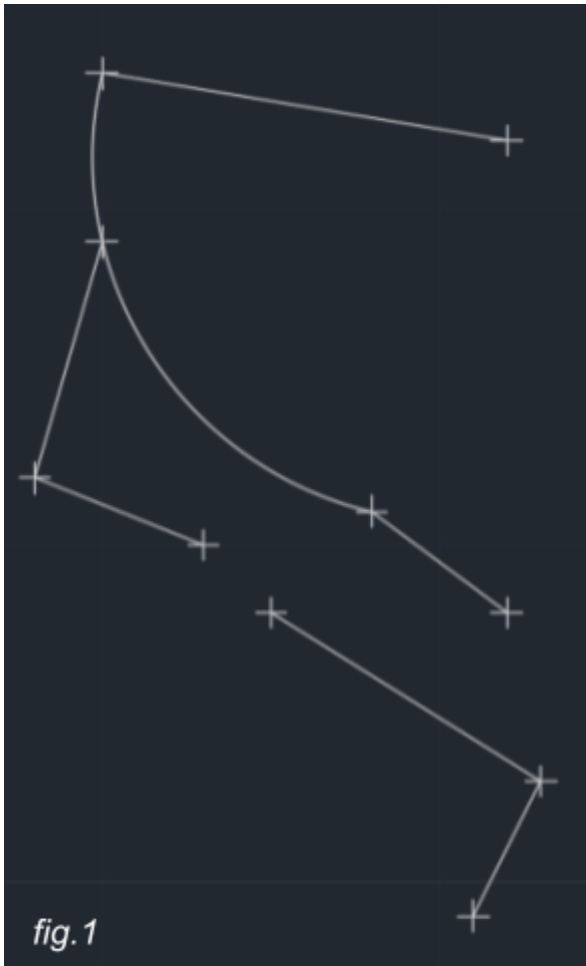
1. Planned lines + points from .DXF file are shown in White.

2. Logged '**pt**' in pink, shows when and where the spray tool was activated to spray a point.
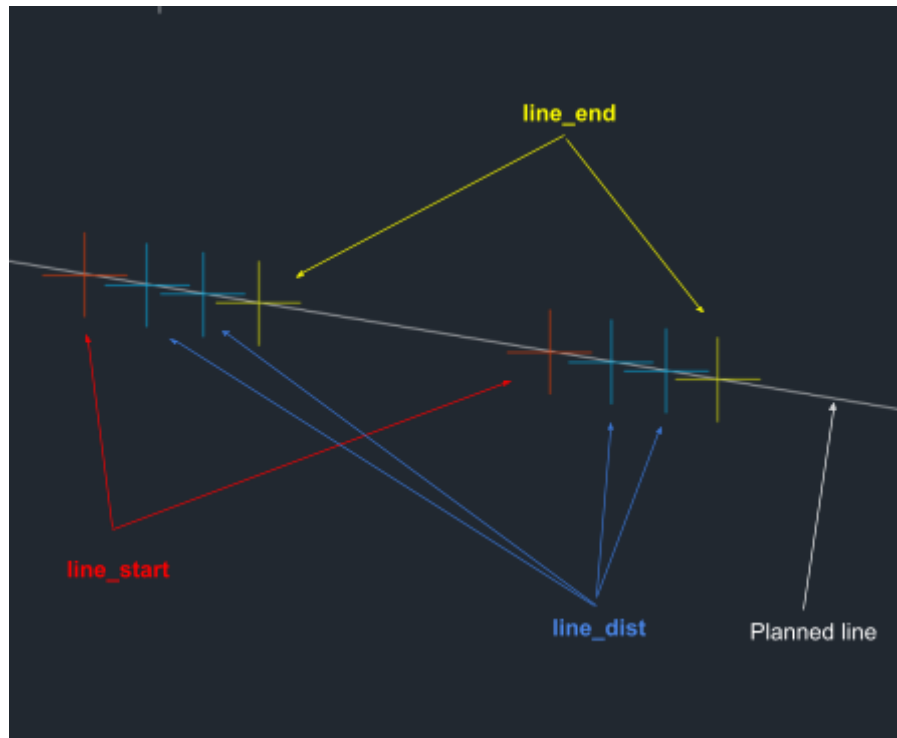
'**line_start**' shown in red and '**line_end**' shown in yellow give a clear picture of when and where the spray tool turned on and off respectively.

'**line_dist**' in blue shows when and where the spray tool was still active and painting between start and stop. In this case, logged at distance intervals of 30cm

T	I	P	Et	Nt	Zt
2024-02-19T14:24:51Z	line_start	line_start_0	574217.998294	6211410.991623	49.687600
2024-02-19T14:24:51Z	line_dist	line_dist_0_0	574218.083296	6211410.928823	49.684600
2024-02-19T14:24:51Z	line_dist	line_dist_0_1	574218.171476	6211410.863323	49.681000
2024-02-19T14:24:51Z	line_end	line_end_0	574218.234249	6211410.817023	49.681600
2024-02-19T14:24:52Z	line_start	line_start_1	574218.638005	6211410.514523	49.676100
2024-02-19T14:24:52Z	line_dist	line_dist_1_0	574218.722349	6211410.451423	49.679600
2024-02-19T14:24:52Z	line_dist	line_dist_1_1	574218.803133	6211410.390923	49.678100
2024-02-19T14:24:52Z	line_end	line_end_1	574218.880735	6211410.332923	49.673800
2024-02-19T14:24:53Z	line_start	line_start_2	574219.285636	6211410.031823	49.667300
2024-02-19T14:24:53Z	line_dist	line_dist_2_0	574219.371036	6211409.968423	49.671100
2024-02-19T14:24:53Z	line_dist	line_dist_2_1	574219.447786	6211409.910923	49.661900
2024-02-19T14:24:53Z	line_end	line_end_2	574219.525256	6211409.853123	49.661700

Notice in the data column '**P**' the unique identifiers include numbers which tie '**line_start**', '**line_dist**' and '**line_end**' logs together. This aids in giving clear visualisation and QC of painted lines, even when dashed lines were applied.

Using a simple CONCATENATE function in excel we can generate commands to draw the dashed lines painted during the job using just '**line_start**' and '**line_end**' logged tool coordinates in AutoCad. Here painted dashed lines are shown in **green** and painted **points** are shown in pink.

=CONCATENATE("LINE ",line_start Et,",",line_start Nt,",",line_start Zt," ",line_end Et,",",line_end Nt,",",line_end Zt," ")

For a higher degree of accuracy, polylines could be drawn using corresponding '**line_start**', '**line_dist**' and '**line_end**' logged tool coordinates

Log Driving

Log Driving tracks the position of the robot at all times during autonomous driving. This is useful if you need a record of where the robot has been and what route it took during a job.

- This option will log data whenever the robot is operating autonomously. (drive to,
- start job, etc...)
- This will not log data when the robot is being driven manually using the joystick

For LOG DRIVING you can choose to log data at intervals of distance driven or frequency of time to achieve the data resolution you require.

DISTANCE: Log data each time user specified distance is driven by the robot. Specified in units of cm. In the CSV file, these lines of data will be identified as '**driving_dist**'

TIME: Log data at intervals of seconds specified by the user. In the CSV file, these lines of data will be identified as '**driving_time**'
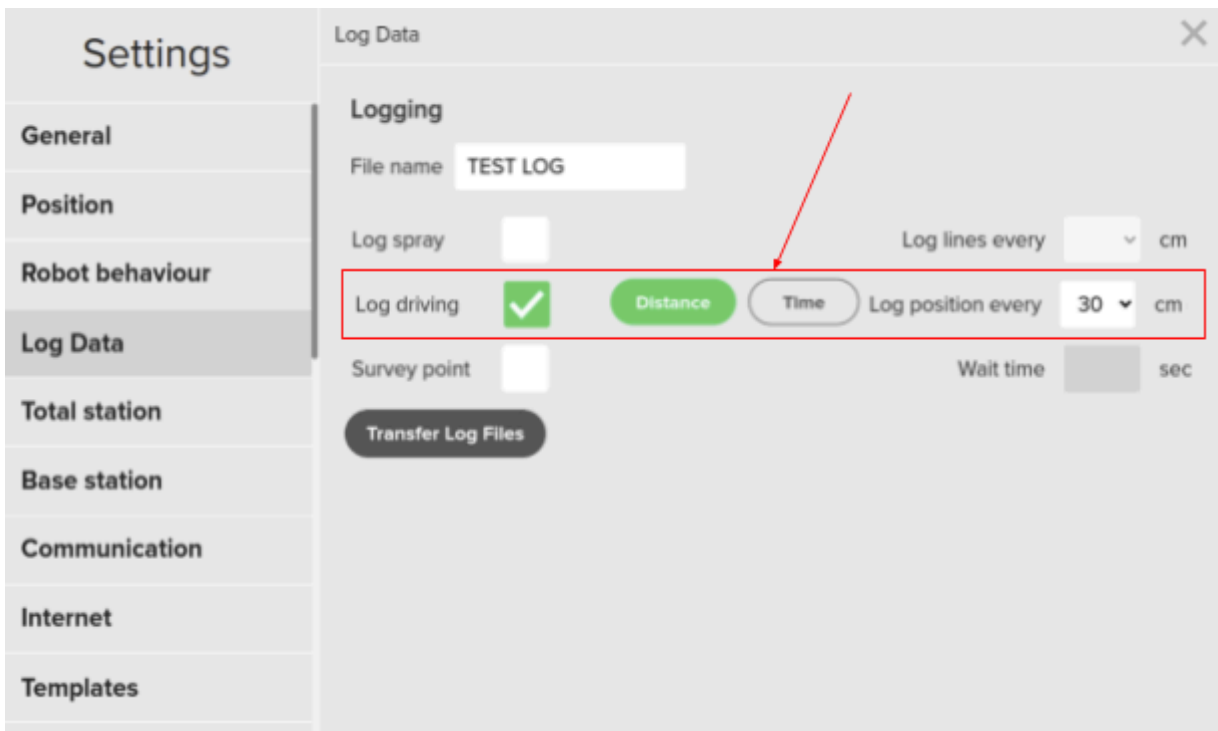
Example

'**driving_dist**' tool coordinates were used to draw red points in AutoCad to show where and when the robot was driving whilst executing the marking of 10 points shown in green.

This allows you to see everywhere the robot was driving whilst operating autonomously.
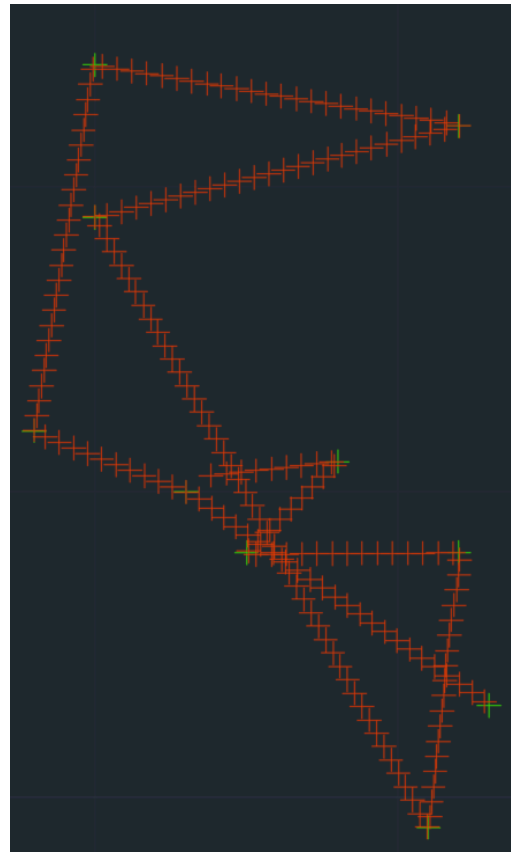
A simple CONCATENATE formula can be used to generate commands for quickly drawing points in AutoCAD.

=CONCATENATE("POINT ",Et,",",Nt,",",Zt)

TIP: The '**I**' column in your log data is a common identifier and is very useful for quickly filtering between different Log types to isolate the data you're interested in working with.

Survey Point

The purpose of this option is to collect position data at a stationary point, over a specified period of time. Similar to static survey methods. During the '**Wait Time**' the robot accumulates satellite signal data from the GNSS. The average of this position data is then calculated and logged to provide a more accurate positioning survey. Only one set of position data is logged per surveyed point and this is the result of the calculated average. The result is a highly accurate coordinate for the surveyed point.

- **Wait time** - This specifies how long the robot will wait at a point to accumulate position data. The longer it waits at the point, the more accurate the resulting logged survey will be.
  (note: After disabling Survey point, you may need to navigate to Settings > Robot behaviour and adjust the 'Default wait time' to your desired value for operating without using the 'Survey point' function)

- In the CSV file, these lines of data will be identified as '**survey_pt**'
  (note: when activated simultaneously with 'LOG SPRAY', survey points will replace spray points within the data file)
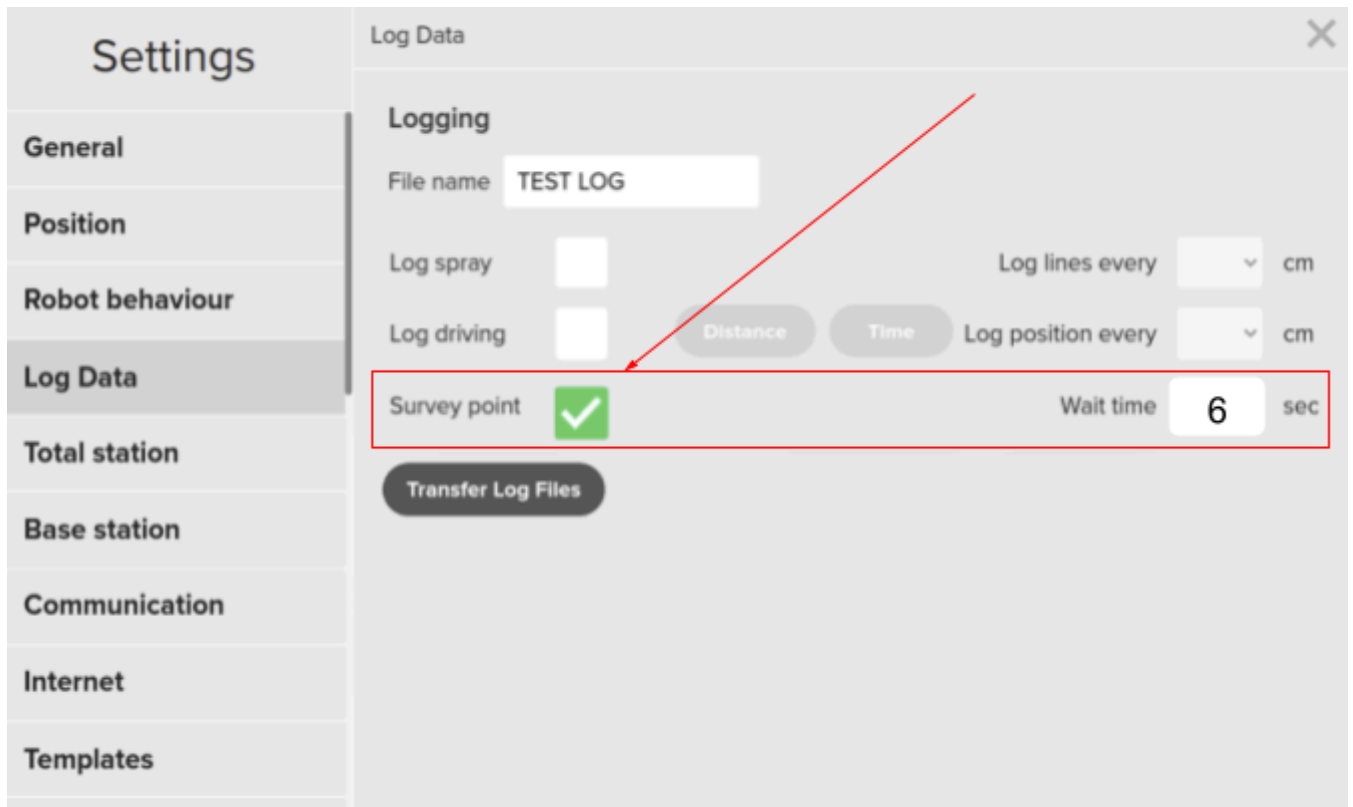
Logging Status Bar

A highly visible status bar has been added to the top of the main map screen. This ensures you don't forget to activate logging when on the job. It's accompanied by a data storage % to let you know when storage for data log files is getting limited on the robot.
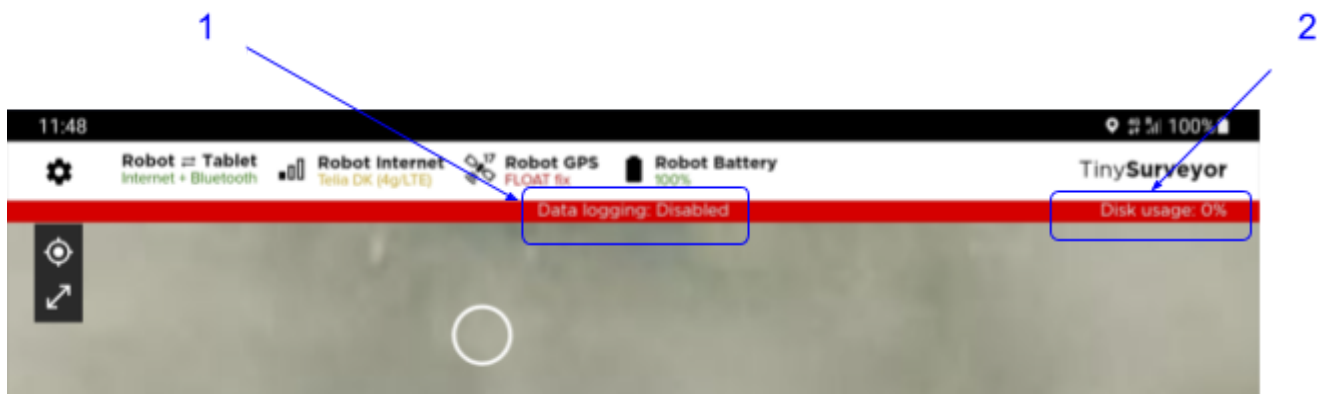
1. **Data logging -** Tells you the current status of the data logging tool

2. **Disk Storage -** Tells you how much data logging storage is currently used up on the robot. Indicated in %. When storage is full you must manually delete logs from the robot (See **'DATA LOG STORAGE'**)

Status

There are 3 different states the data logging tool can be in…
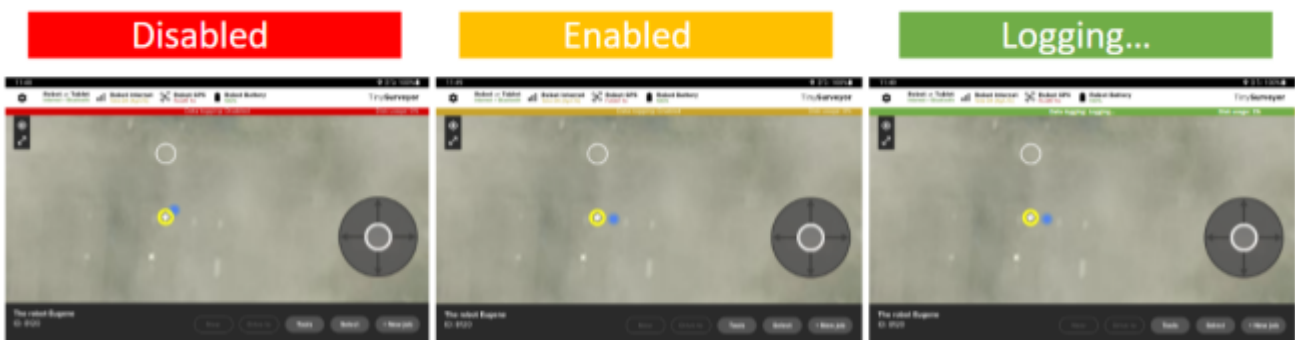
When no logging options are enabled. No data will be logged. Don't forget to activate logging options if you want to record data.

When one or more logging options are enabled. This means Logging is armed and ready to go. The robot will automatically log data when it executes a task/job.
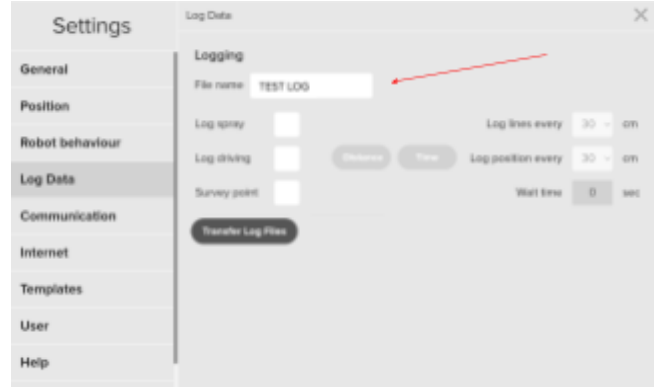
When the robot is executing a task/job and data is being logged.

Start Logging

Navigate to '**Settings** > **Log Data**'

1. Name log file

Enter a name in the File name field. This will be included in the logged data filename on the robot, along with date and time of creation. Here we called our file '**TEST LOG**'

2. Enable logging

Select the type of logging you want to activate (when you want to log) and set a desired unit for each (how often you want to log).

Here we want to log everywhere the robot sprays paint, with lines logged at a rate of every 30cm. We also want to log everywhere the robot drives at a distance interval of 30cm
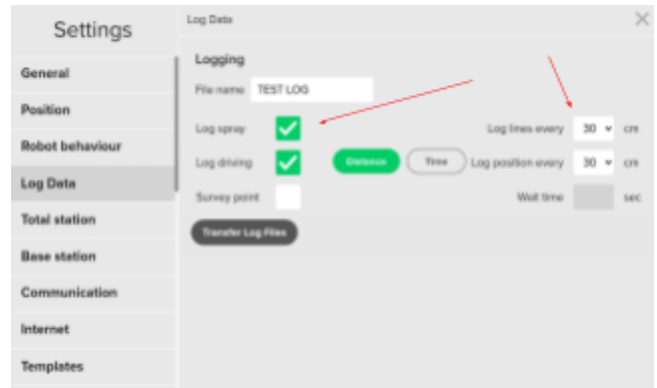
3. Ready to go...

Navigating back to the main Map screen, you will see that settings are sent to the robot and Logging is now 'Enabled' by the Logging status bar.

You can now operate the robot as normal and execute your job. The Logging Status bar will turn green whilst the robot is executing a job to illustrate that the robot is logging data.
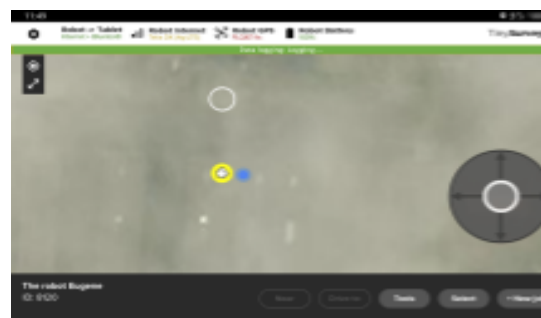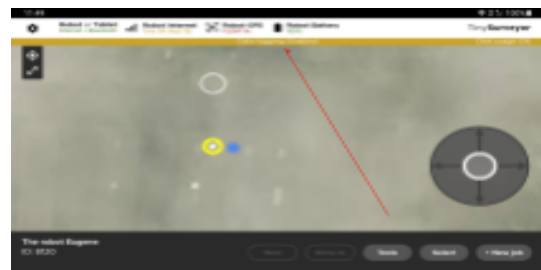
Format & Transfer

Navigate to '**Settings** > **Log Data**'

Access File Transfer Menu

Press the '**Transfer Log Files**' button to access the file transfer menu
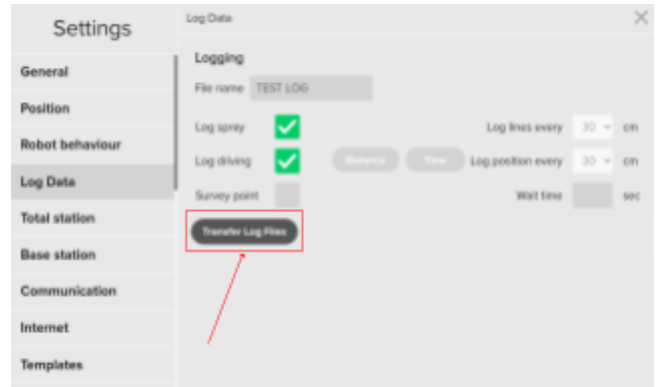
1. Select file from robot

Open the top drop down menu. This will let you see all of the log files which are currently stored on the robot's internal memory.

Select the file you wish to transfer from the robot to your tablet. We have selected our TEST LOG file
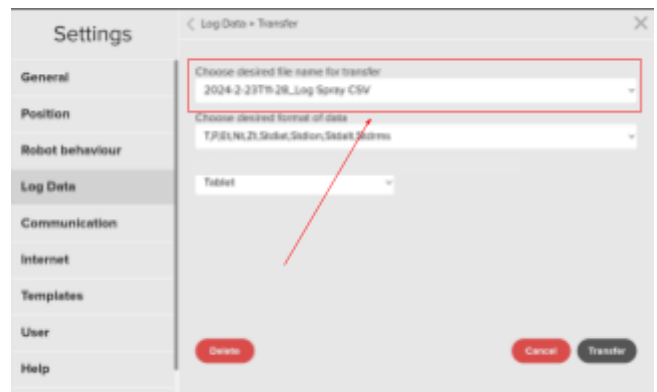
2. Configure file format

Open the format drop down box to select a preset format or choose custom to configure your own format. Here we have chosen 'Custom' to configure our own format and chose which data items will be included within the exported .CSV file.

If you choose a preset format from the drop down list then skip to step #7
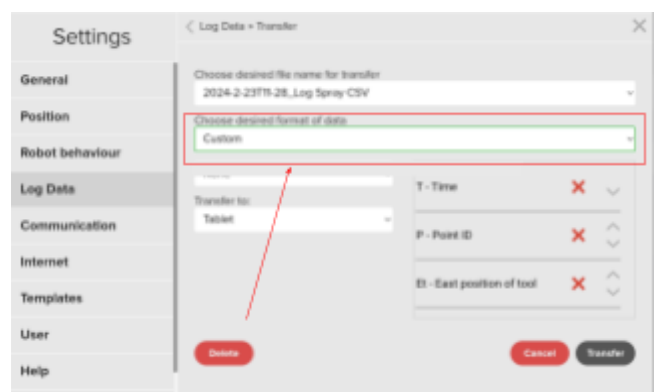
3. Select target device

Press the '**Transfer to**' drop down list to select tablet or USB. You can only select USB if a usb storage device is connected to the external USB port of your robot.
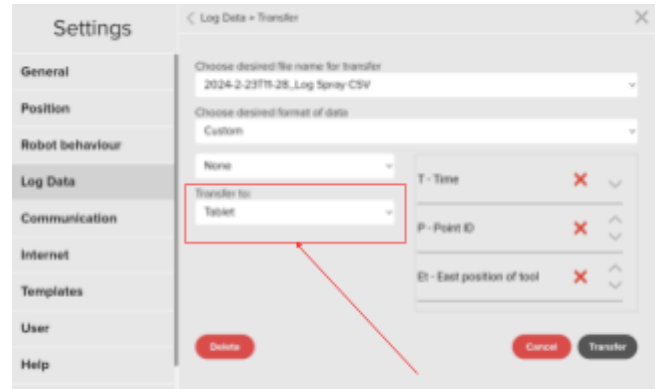
4. Transfer file

Press the '**Transfer**' button to export the log file in your selected format from the robot to the tablet or USB. Log files transferred to the tablet will be saved to the '**Downloads**' folder on your tablet's internal memory.

Note: *You must have bluetooth connection between tablet and robot to transfer files to tablet or USB.*

The bigger the data file, the longer the transfer will take to tablet over bluetooth. If the robot and tablet have both bluetooth and internet connection then the system will first try sending to the tablet via internet which may be faster.
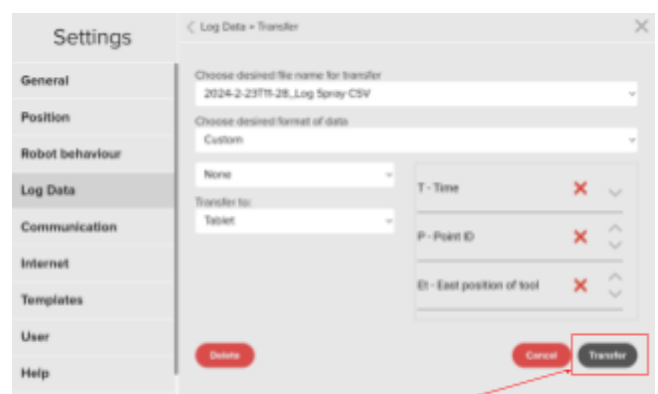
Data Log Storage

The robot has dedicated storage space on its internal hard drive for creating and storing Data Log files. This storage space is 100mb which would be equivalent to 150 hours of continuous logging with every option selected and set at its highest resolution.

You can see how much data log storage space is already used on the right hand side of the Data logging status bar, found within the main map screen
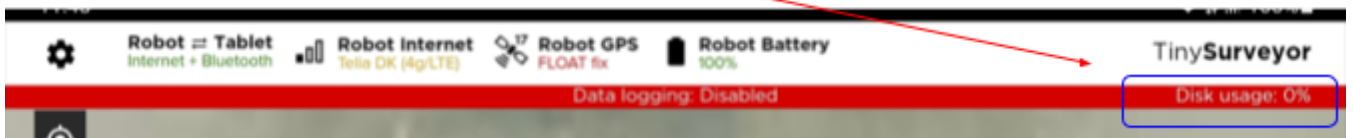
Data log files created on the robot will remain in it's internal memory, even after exporting a formatted .CSV file to your tablet or USB. This is a security measure to ensure you don't lose precious data created at the job site

When your robot's data log storage is getting full, you need to delete old data logs to clear up space for creating new data logs. You will be prompted to clean up the robot's data log memory when you get over 90% full.

You will be unable to activate logging functions when the robot's data log memory is 100% or above. Whilst executing a job and logging, the robot will continue logging above 100% until that job is finished to ensure you don't lose any data.
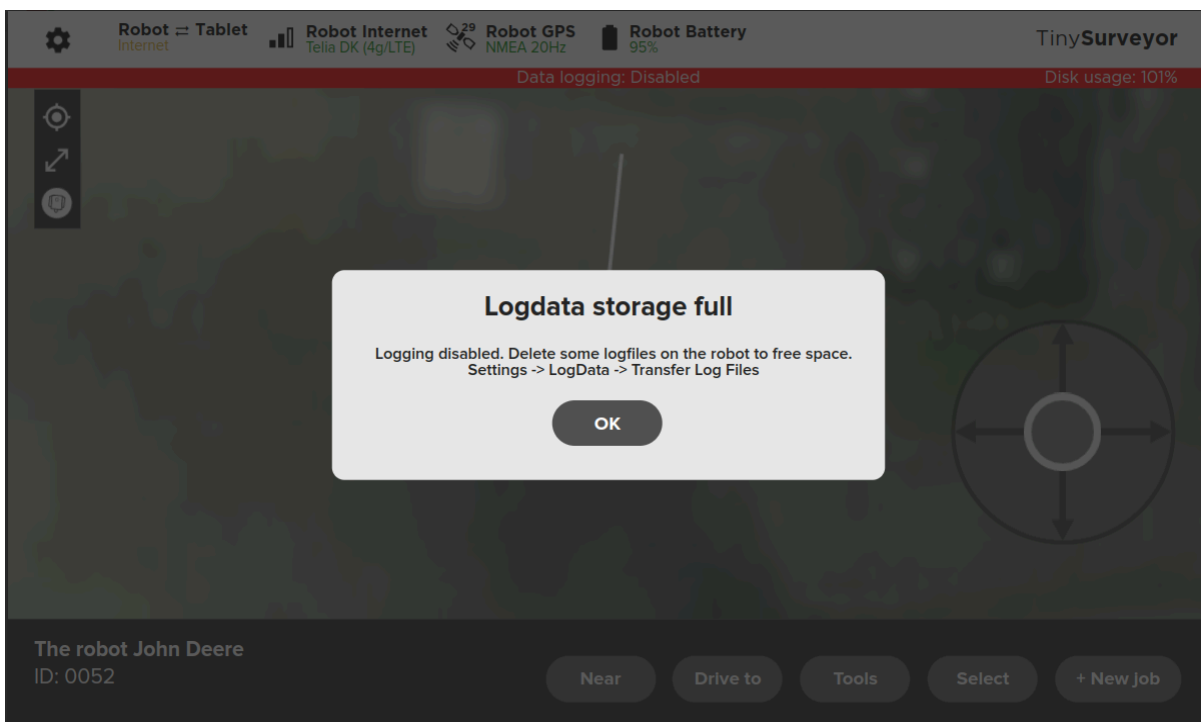
Deleting Data Logs

Navigate to '**Settings** > **Log Data** > **Transfer Log Files**'

1. Select File

Select which file on the robot you wish to delete from the drop down list
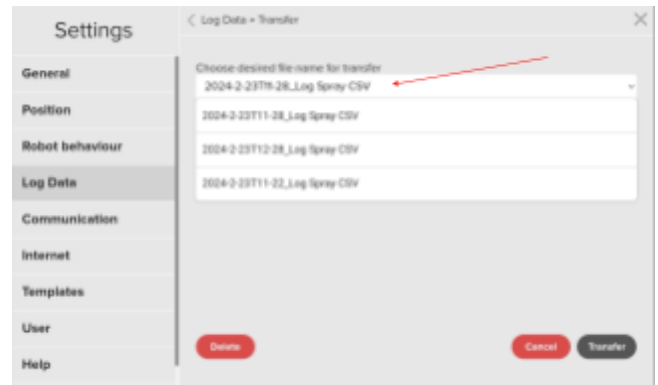
2. Initiate Delete Process

Press the '**Delete**' button to delete the file you have selected. Don't worry if you press it by mistake as this just initiates the delete process.
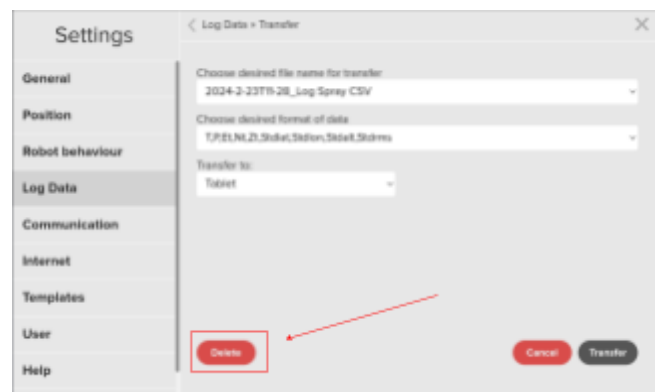
3. Confirm File Delete

Press the '**Delete**' button to confirm and permanently delete the log file from your robot.

Press the '**Cancel**' button to cancel the file delete process and keep your log file on the robot
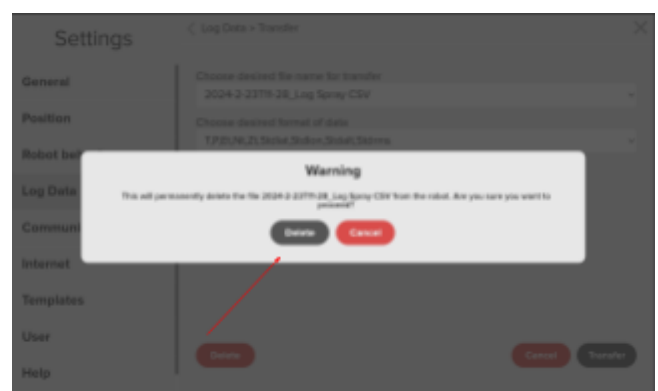
Data Files

Import into Excel

Open a blank workbook in Excel. Select '**Data**' from the top bar followed by '**From Text/CSV**' and select the exported log.CSV file

It's important to choose '**Do not detect data types**' before hitting the '**Load**' button

Data Keys

Key for definition of data identifiers. You will find these on the top row of the exported .CSV file when opened in Excel
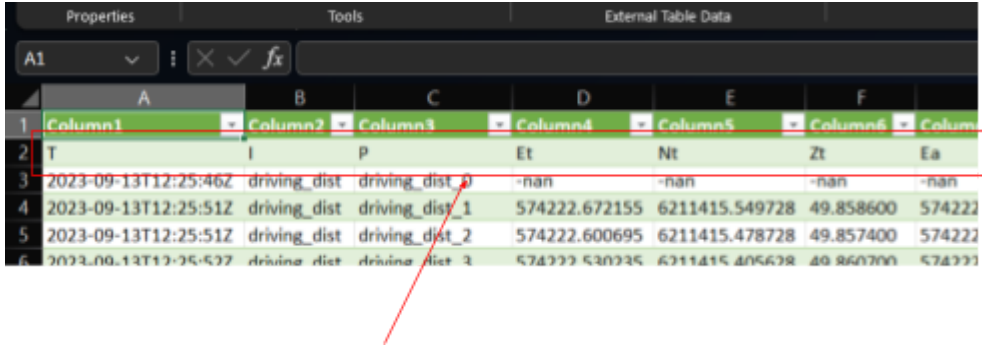
Position Data

The following key is for all position related data

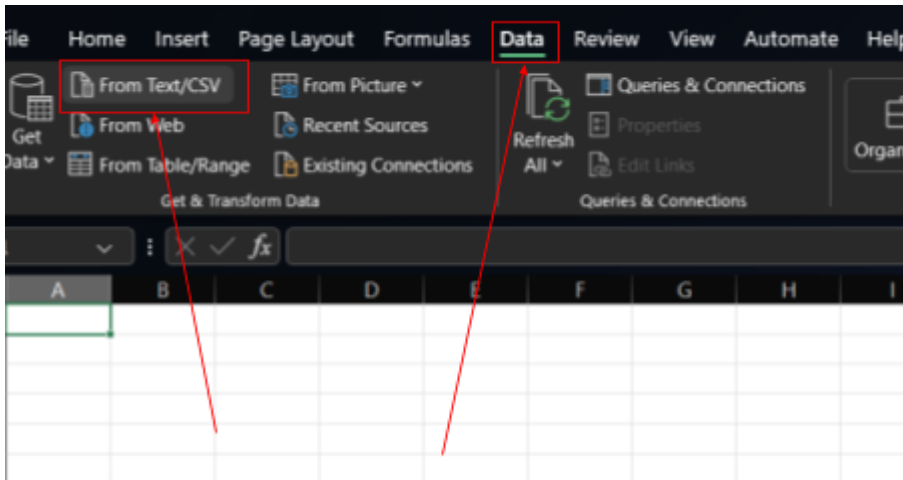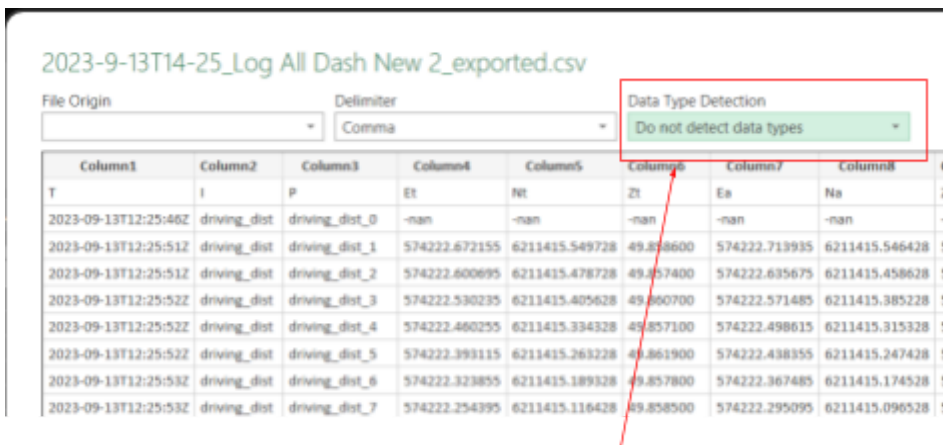| Top Row	Meaning	Text shown in TinySurveyor app
T	Timestamp - When was the data row logged. UTC Time in ISO-8601 format	T - Time
I	Common ID for log type. Included to make filtering within data file fast and easy	Not shown in App and always included in exported Log file
P	Point ID - Unique identifier created for every data row logged. Tells the kind of log it is, followed by number. Corresponding 'Line Start' and 'Line End' have corresponding numbers	P - Point ID
Et	Position of tool - Coordinate data with internal sensor fusion applied - point on the surface that the spray tool applied paint	Et - East position of tool
Nt	Position of tool - Coordinate data with internal sensor fusion applied - point on the surface that the spray tool applied paint	Nt - North position of tool
Zt	Position of tool - Coordinate data with internal sensor fusion applied - point on the surface that the spray tool applied paint	Zt - Height/Z position of tool
Ea	Position of antenna East - **RAW** GPS coordinate data with selected projection applied	Ea - East position of antenna
Na	Position of antenna North - **RAW** GPS coordinate data with selected projection applied	Na - North position of antenna
Za	Position of antenna Altitude - **RAW** GPS coordinate data with selected projection applied	Za - Height/Z position of antenna
Etp	Planned position of tool - Coordinates from input file	Etp - Planned East position of tool
Ntp	Planned position of tool - Coordinates from input file	Ntp - Planned North position of tool
Ztp	Planned position of tool - Coordinates from input file	Ztp - Planned Height/Z position of tool

Robot Data

The following key is for data related to robot settings

Top Row	Meaning	Text shown in TinySurveyor app
S	Postion source - Position data input source on the robot -Internal GNSS / External Device / Bluetooth	S - Input source
Tp	Tool position - Setting in Robot Behavior - Where is the spray tool mounted on the robot: Center / Left / Right	Tp - Tool Position
Ts	Tool sideshift setting in Robot Behavior in m - (adjusted when using spray tool side mount)	Ts - Tool side sideshift
Th	Tool height setting in Robot Behavior in m	Th - Tool Height
Ll	Line length (Dash length) setting in Robot Behavior in cm	Ll - Line Length (user parameter)
Ls	Line space (Space between dashes) setting in Robot Behavior in cm	Ls - Line Space (user parameter)
W	Default wait time setting in Robot Behavior (replaced by Survey Point wait time when active) in seconds	W - Waypoint wait time
spray_off set_start	Spray_offset_start setting in robot behaviour - delay for spray activation in seconds	Sos - Spray Offset Start
spray_off set_stop	spray_offset_stop setting in robot behaviour - delay for spray deactivation in seconds	Soe - Spray offset Stop

Accuracy Data

The following key is for accuracy data provided by your connected positioning equipment. Please note that this data is received over **GPGST**. Ensure you have **NMEA GPGST** output active on your external positioning equipment. Output frequency of NMEA GPGST should be set to **1Hz**, higher output frequency values could negatively affect the control and navigation of your robot.

Top Row	Meaning	Text shown in TinySurveyor app
Stdlat	Standard deviation value of latitudinal coordinate	Stdlat - Estimated std. Of GNSS latitude
Stdlon	Standard deviation value of longitudinal coordinate	Stdlon - Estimated std. Of GNSS longitude
Stdalt	Standard deviation value of altitudinal coordinate	Stdalt - Estimated std. Of GNSS altitude
Stdrms	Standard deviation of pseudoranges and DGNSS corrections (RMS value)	Stdrms - RMS value of GNSS pseudoranges

Common identifiers

The following key describes common identifiers used for data types in the '**I**' column of the data file. These can be used to quickly filter data

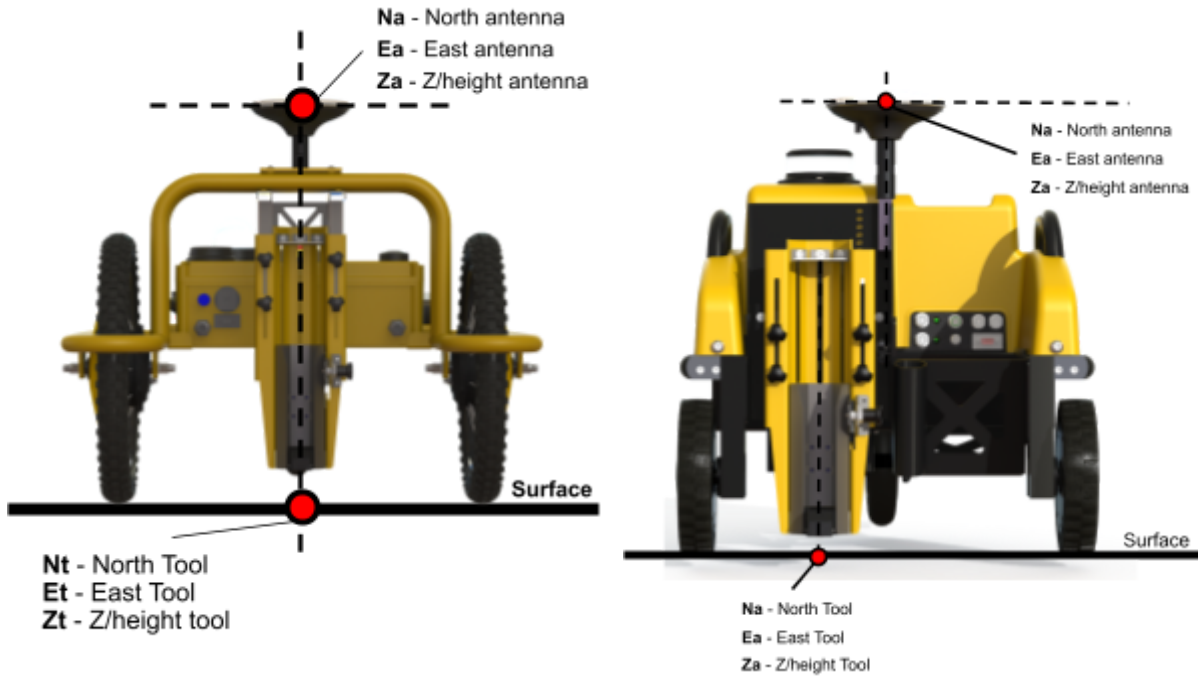| Identifier	Description	Log Type
pt	Logs data every time the spray tool is activated at a point	LOG SPRAY
line_start	Logs data when the spray tool is activated whilst painting a line	LOG SPRAY
line_end	Logs data when the spray tool is deactivated whilst painting a line	LOG SPRAY
line_dist	Logs data when the spray tool is active whilst painting a line. Distance interval of log can be adjusted by user	LOG SPRAY
driving_dist	Logs data whilst robot is driving autonomously and interval is set to Distance	LOG DRIVING
driving_time	Logs data whilst robot is driving autonomously and interval is set to Time	LOG DRIVING
survey_pt	Logs calculated average of accumulated position data during wait time at waypoint. Replaces pt for LOG SPRAY when SURVEY POINT is active	SURVEY POINT

Tool vs Antenna

Definition

Definition of tool and antenna position

Name	Description
Nt - North Tool Et - East Tool Zt - Z/height Tool	Projected coordinate at the surface beneath the spray tool (absolute, tilt compensated, tool calibrated). Input from antenna/prism is translated to marked position on the ground using sensor fusion with inputs from selected projection, IMU sensor and wheel encoders. Zt is the height of the surface beneath the spray tool. Assuming evenness of the surface
Na - North Antenna Ea - East Antenna Za - Z/height Antenna	Projected coordinate of input (absolute). Uses projection Raw input from GNSS receiver/total station + selected projection (settings > position > projection) If projection 'None' is selected, this data will be the raw input without coordinate system projection applied **Note:** *These coordinates are not tilt compensated*

Flat horizontal surface

Difference between tool and antenna position when robot is on flat surface

Na - North antenna
Ea - East antenna
Za - Z/height antenna

Nt - North Tool
Et - East Tool
Zt - Z/height tool

Surface

Na - North antenna
Ea - East antenna
Za - Z/height antenna

Na - North Tool
Ea - East Tool
Za - Z/height Tool

Surface

Tilted horizontal surface

Difference between tool and antenna position when robot is tilted

Vertical axis

Na - North antenna
Ea - East antenna
Za - Z/height antenna

Horizontal axis

α$_x$ -Tilt compensated angle
(about robot x)

Surface

Nt - North Tool
Et - East Tool
Zt - Z/height tool

Vertical axis

Na - North antenna
Ea - East antenna
Za - Z/height antenna

Horizontal axis

Nt - North tool
Et - East tool
Zt - Z/height tool

Surface