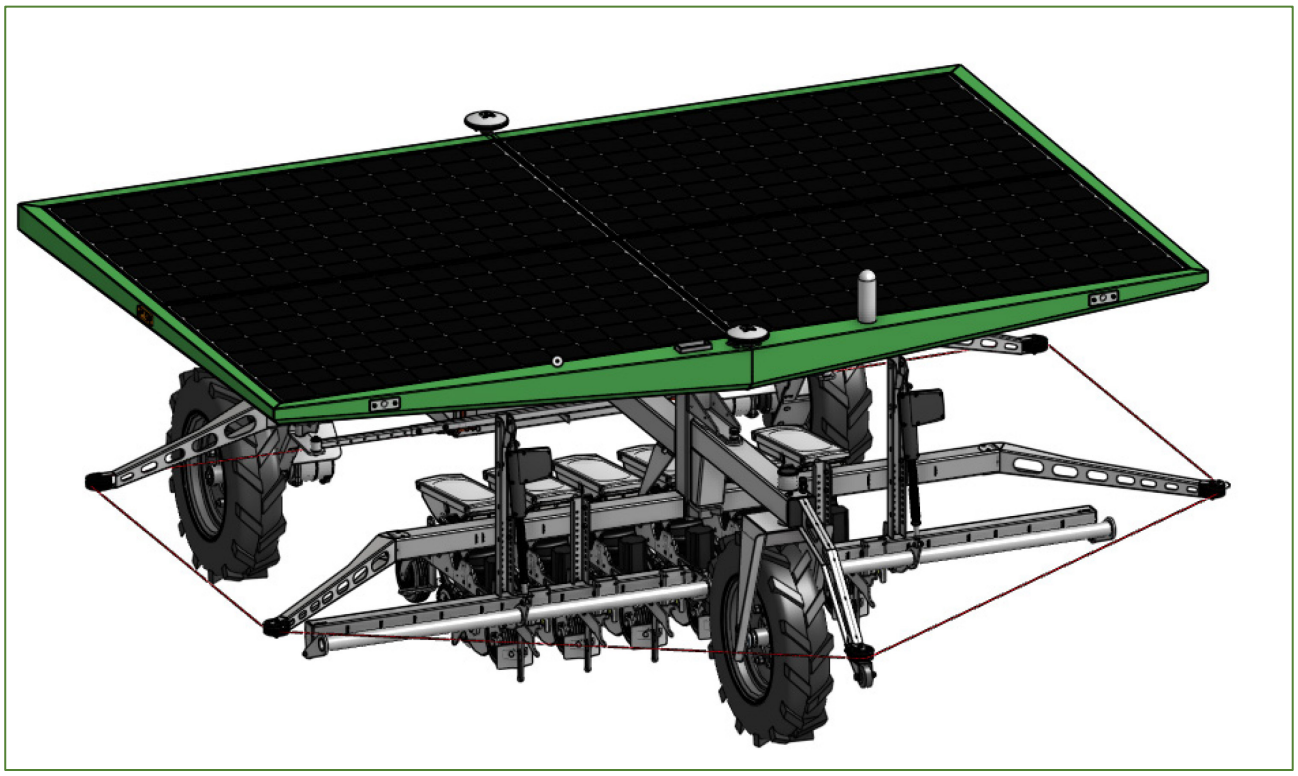
FARMDROID



FARMDROID FD20 v2.6

ORIGINAL USER MANUAL

Version 2.6.0 – Effective from January 2026

Table of Content

Table of Appendix content

1 General Information

This user manual is exclusively for the FarmDroid FD20 v2.6. in its basic configuration.

The FD20's functions and performance can be expanded by adding dedicated FarmDroid add-ons to the FD20. In that case this manual will be integrated with the manual for each of the attached add-ons.

The manual covers the following serial numbers.

10026xxxxxx

For more detailed guidance and support, please refer to the FarmDroid Guidelines which can be found in the knowledge base or contact your local distributor.

FarmDroid Knowledge Base:

https://knowledge.farmdroid.io/

Manufacturer contact information:

FarmDroid ApS
Industrisvinget 5
DK - 6600 Vejen

Web: www.farmdroid.dk
Mail: info@farmdroid.com

1.1 Reading and understanding this manual

The intention of this manual is to give operators and service technicians the necessary information to safely and efficiently operate and service the machine throughout its expected lifetime.

The manual must be carefully read and understood before commencing any work. In case of doubt, please consult your local distributor before carrying on. Please pay special attention to all safety-related information.

For FD20 with add-on equipment, ensure that all manuals covering the entire product are read and understood.

User group definition		
User Group	**Definition**	**Tasks**
Operators	Are familiar with the basic functions of the machine, including required mechanical and electrical adjustments for optimizing the performance of the machine. Have received a thorough introduction from the local FarmDroid Distributor and have read and understood the user manual. This user group includes Farmers and their workers which are responsible for operating the robot.	Commissioning and entry into service Daily operation Transportation Preventive maintenance Storage Troubleshooting Disposal
Service technicians	Are familiar with basic and advanced functions of the machine including fault finding and communication setup between base station and robot. Have received thorough training by FarmDroid and have read and understood the user manual together with all relevant guidelines, etc. This user group includes local FarmDroid distributors and service partners.	Prior to commissioning Commissioning and entry into service Maintenance Troubleshooting Storage
Support technicians	Are familiar with all functions of the machine, including factory setup and configuration, calibration procedures and advanced fault finding. Have been thoroughly trained at FarmDroid and are experience with working on the robot. This user group includes internal workers at FarmDroid with experience with designing and working on the robot.	Maintenance Troubleshooting

In this manual, two different symbols are used to indicate sections and paragraphs of special attention to the reader.

Used to draw special attention to important **operational** related information.

Used to draw special attention to important **safety** related information.

1.2 Common abbreviations

Listed below are the commonly used abbreviations together with their definition.

Abbreviations	
Abbreviation	**Definition**
GNSS	Global Navigation Satellite System – the abbreviation covers, in this case, common satellite positioning system.
GSM	Global System for Mobile Communications (Mobile phone / data network)
HMI	Human-Machine Interface
PCB	Printed Circuit Board – referring to the Electronic Control board on the sowing arm mounted on the active trailer
RTK	Real-Time Kinematic – Correction signals to improve GNSS accuracy. Also used to identify that the GNSS system is running using the RTK signals.
PV	Photo Voltaic
PLC	Programmable Logical Controller

1.3 EU Declaration of Conformity

EU Declaration of Conformity

CE

According to EU Machinery Directive 2006/42/EC, Annex II A

Manufacturer	**Authorized person in the Community to compile technical file**
FarmDroid ApS Industrisvinget 5 DK – 6600 Vejen	Thomas Vilsmark Olesen FarmDroid ApS Industrisvinget 5 DK – 6600 Vejen

Machine description and identification

Product	FarmDroid FD20
Version	2.6
Commercial name	FarmDroid FD20
Functional description	Self-propelled sowing and weeding robot for agricultural use, powered by PV-Panels and batteries. The robot is intended for 100% autonomous and un-supervised operation in field areas/non-public areas. It is controlled via the HMI panel on the robot or via App on mobile devices or PC.

The manufacturer hereby expressly declares that the mentioned product fulfills all relevant provisions on the following EU Directives/Regulations:

2006/42/EU	*DIRECTIVE 2006/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)*
RED 2014/53/EU	*DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC*
2011/65/EU	*DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast)*

The safety features of the product follow all essential requirements of Directive 2006/42/EC and complies with the following harmonized safety standards:

ISO 13849-1:2015	*Safety of machinery – Safety-related parts of control systems Part 1: General principles for design* The safety control system is designed as Performance Level d (PLr Level d) in accordance with the requirements of this standard
ISO 13850:2015	*Safety of machinery – Emergency stop functions – Principles for design* The emergency stop function is designed as a stop category 0 in accordance with the requirements of this standard. Power is switched off to hazardous moving parts resulting in instantaneous stop of the machine.
ISO/FDIS 3691-4:2020	*Industrial trucks – Safety requirements and verification – Part 4: Driverless industrial trucks and their systems* Movement signaling, speed limitations, safety organs and speed limitations are designed in accordance with the requirements of this standard.

A complete list of all applied harmonized standards is provided in the belonging product manual.

All relevant technical documentation is compiled according to Directive 2006/42/EC annex VII part A.

Thomas Vilsmark Olesen	**Head of R&D**	**Vejen - 06th of November 2025**
	Position	Place / Date

1.4 Technical Data

Below, basic technical information for the robot is specified.

Manufacturer:	FarmDroid ApS
Model Name:	FD 20 V2.6
Working Width:	Upon request
Maximum Recommended Covered Area:	20 ha
Maximum Speed Highly Automated Mode:	950 m/h
Maximum Speed Manual Mode:	1100 m/h
Maximum Brake holding slope (Static):	15% (Depending on soil type, wetness, and general properties)
Maximum recommended pitch for operation:	8% (Depending on soil type, wetness, and general properties)
Maximum recommended roll for operation:	5% (Depending on soil type, wetness, and general properties)
Seed Box Capacity:	5 liters per seed box (+SEED 6 mm system) 7 liters per seed box (+SEED 14 mm system)
Tool:	Configurable with 0 to 12 active rows
Propulsion Motor Power:	Nominal 2x400W (With a peak of 1000W per motor but restricted to a total of 1100W from both motors.)
Solar Cell Power:	1560W (Converter to 24V have a max capacity of 50A ≈ 1300W)
Battery Type:	2x 24V 120Ah Lithium Battery Pack (LiFePo4)
Battery Weight:	52 kg (2 x 26kg)
Robot Base Weight:	900 kg incl. batteries
Max Allowed Extra Robot Weight:	Max 4 x 35 kg mounted on back wheel frame
Max Allowed Extra Trailer Weight:	Total max 12 kg per row; 2 kg per seed pressure wheel + 10 kg per trailer
Max Total Robot Weight	1600 kg
Operating Temperature:	0 to 40°C
Storage Temperature:	-10 to 50°C
Noise Level:	Below 70 dB (A)
General Expected Lifetime:	More than 10 years for main components following professional maintenance.
Expected Battery lifetime:	3 to 8 years (Depending on use)

1.5 Data on Identification Plate

The identification plate is located on the rear end of the robot on the main frame and contains the following information.

1.6 Purpose, Structure and Function of the Robot

The FD20 is a Highly Automated field robot which in the standard configuration has the purpose of sowing and mechanically weeding row crops. It is designed to work automatically without supervision on private field areas in the respective crop seasons.

The robot's functions and performance can be expanded by upgrading the robot with dedicated FarmDroid add-ons.

The robot is battery powered and charged via solar panels. The machine can be operated by using the operator panel on the rear end of the robot. Furthermore, the progress of the robot can be tracked via the FarmDroid App. The robot is slow moving and operates when there is sufficient power on the batteries. The robot stops when the batteries are depleted, but it starts up again automatically when the solar panels has charged the batteries above then minimum threshold, if left in Highly Automated mode. Before automatically starting again, the robot will provide a warning signal to inform the surroundings.

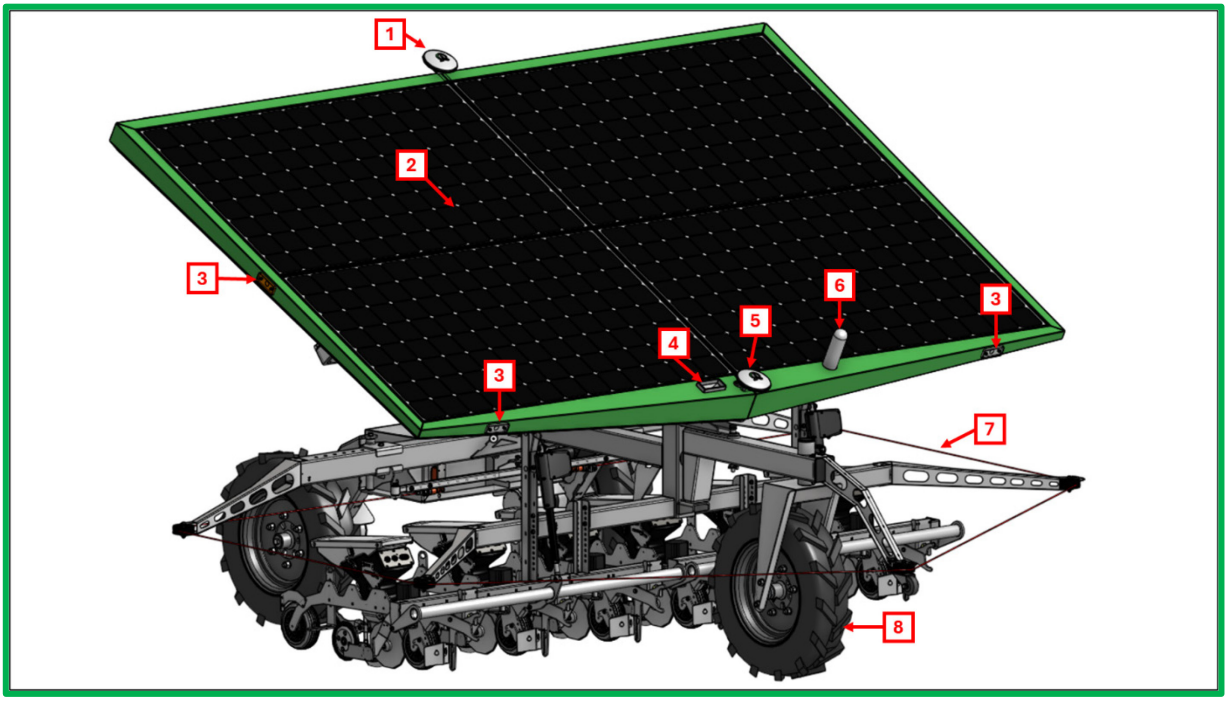
The robot in standard configuration has two driving wheels in the rear and a swivel caster wheel in the front. The robot navigates by changing speed and/or direction of rotation on the rear wheels, thereby turning the robot. In addition, the rear wheels can steer to compensate for skidding when running on slopes.

There are two different types of tools the robot has as standard equipment. The first type are active trailers, which are controlled by embedded electronics, and are responsible for seeding and weeding in-rows. There can be a maximum of 12 active trailers per robot. The second type are passive trailers which are equipped for mechanical weeding between rows. The number of passive trailers depends on the mechanical configuration of the robot and there is not a minimum requirement for what regards their number. The trailers can be raised with the aid of two actuators that also can apply force on the trailers when they are working on the soil by tensioning the springs in the front.

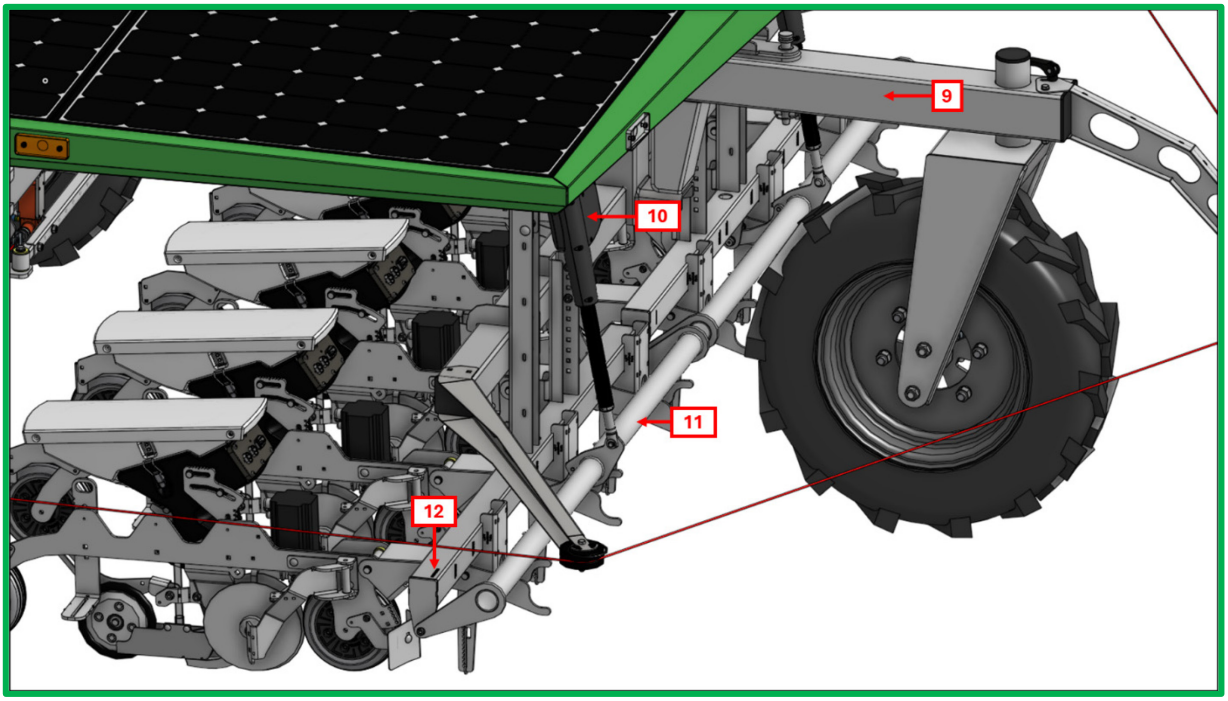
The solar panel tops can be tilted and are kept up by two gas springs. This eases the process of loading the machine with seeds as well as service and maintenance work.

The Solar panel top must always be closed during operation.

The pictures below show indications of relevant parts with references to their name or function.

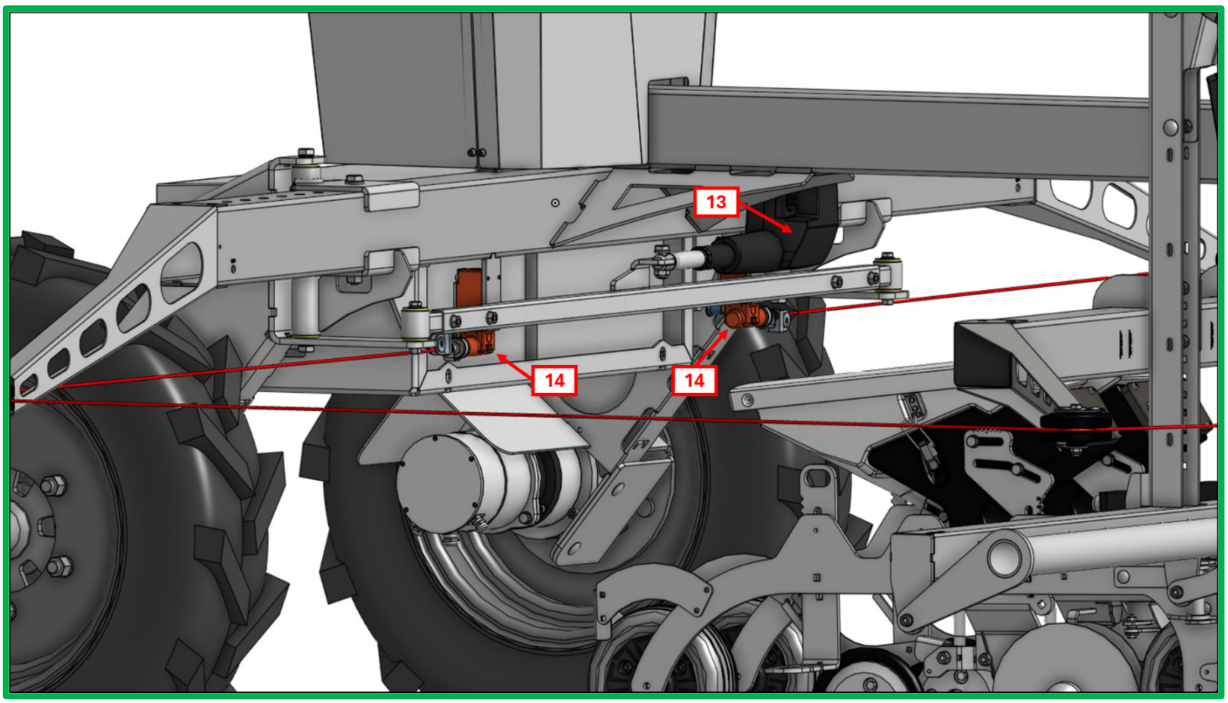


1	Rear GNSS antenna	2	Solar Panels	3	Light indicator
4	Rain gauge	5	Front GNSS antenna	6	GSM antenna
7	Safety wire	8	Front wheel		

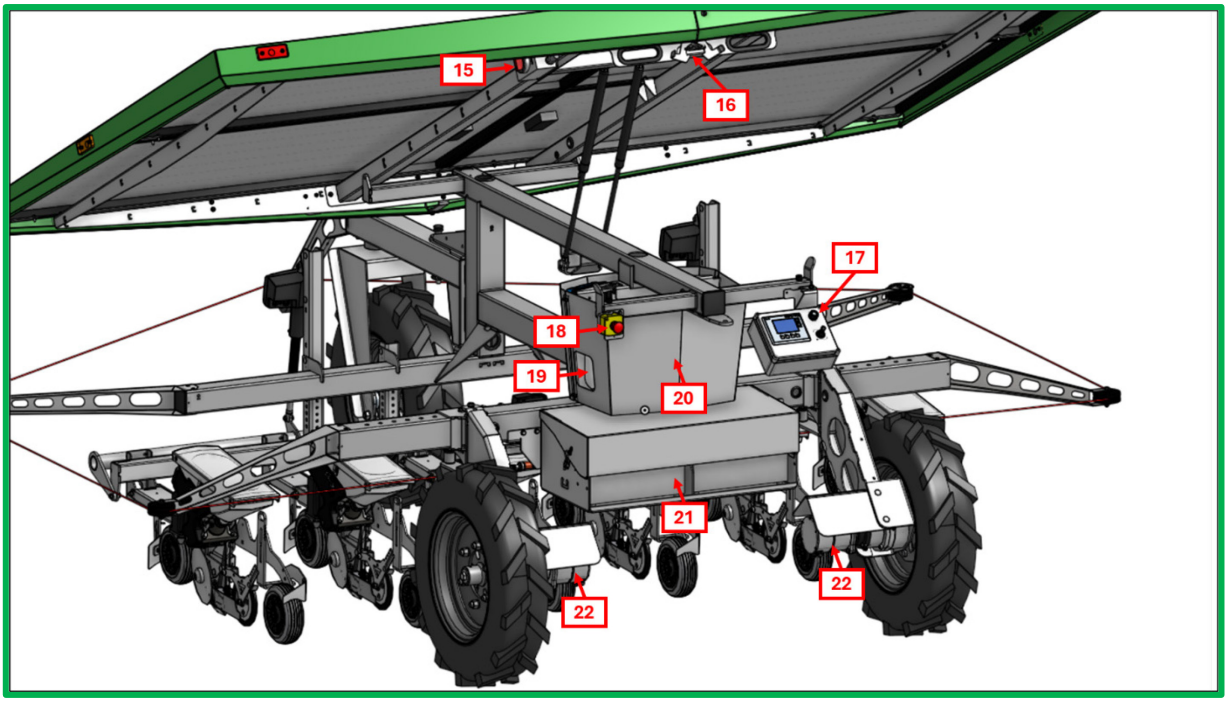


9	Front wheel assembly	10	Hitch actuator	11	Hitch beam

12	Tool beam

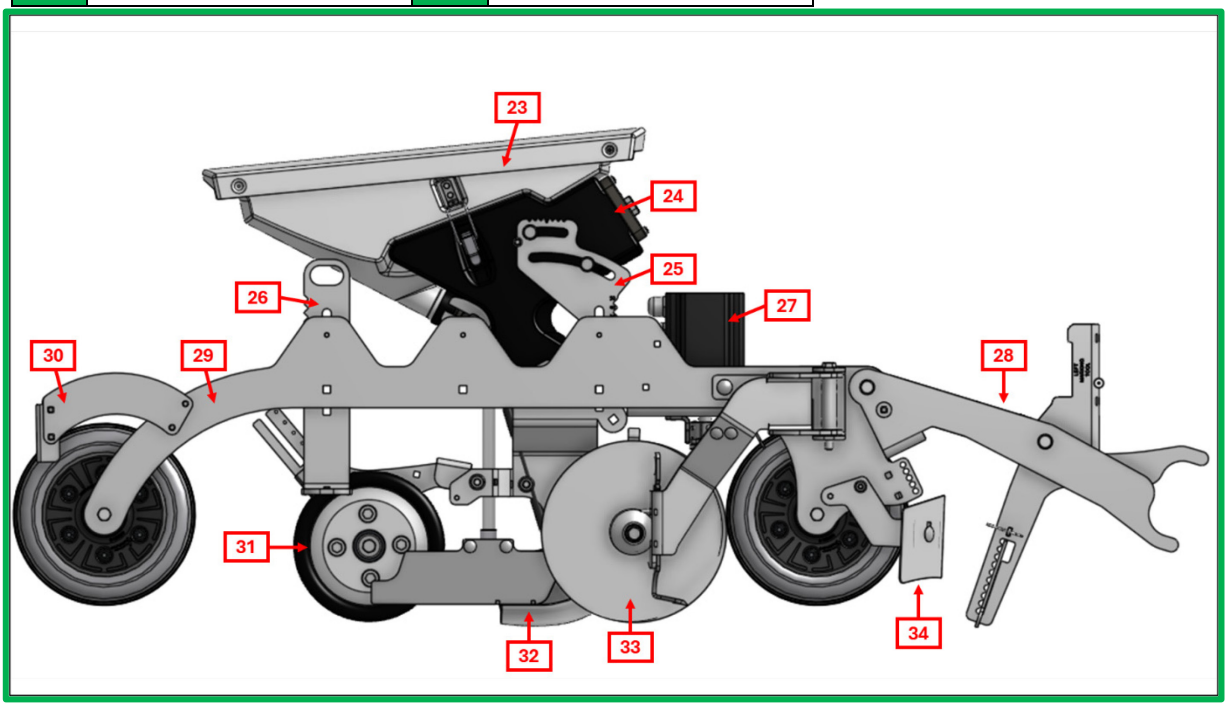


13	Rear end actuator	14	Safety wire emergency pull switch

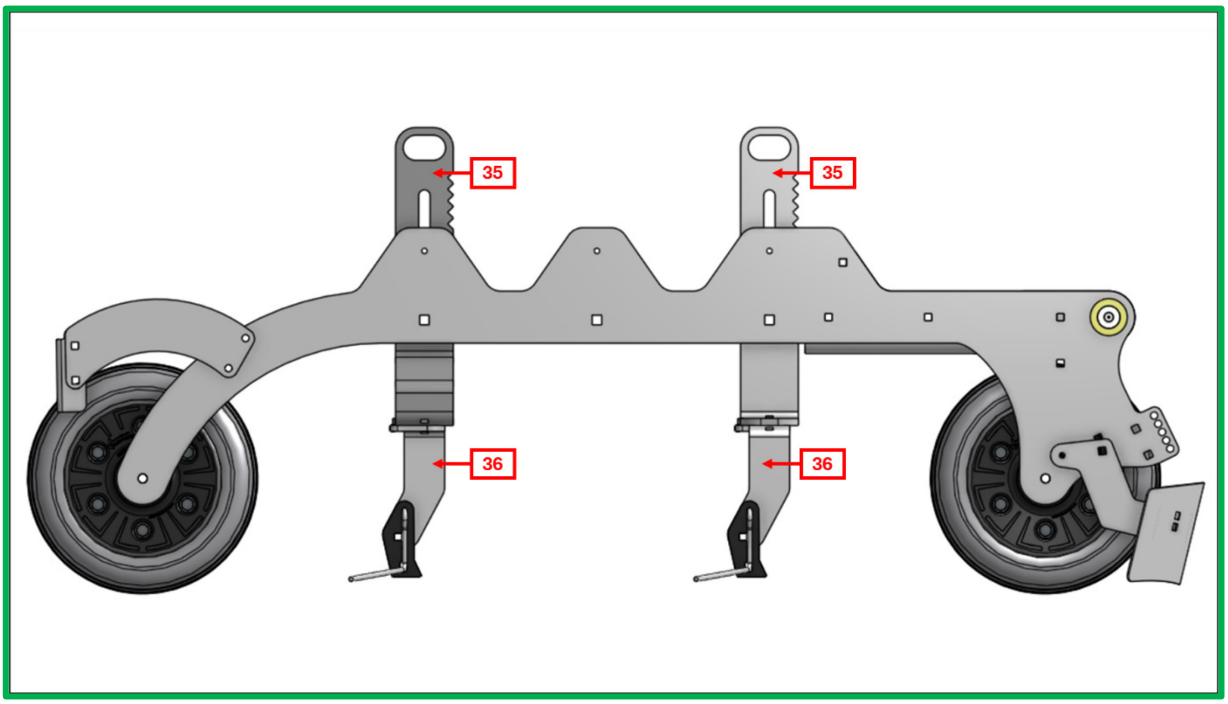


15	Solar panel switch	16	Solar panel locking device	17	Operator panel - HMI
18	Emergency stop button	19	Main power switch	20	Back cover plate for electrical box

21	Main batteries	22	Drive motors		



23	Seed container	24	Electronics enclosure	25	Sowing arm
26	Back support arm for active trailer	27	Weeding motor	28	Connection bracket assembly
29	Trailer arm	30	Back wheel scraper	31	Seed pressure wheel
32	Coulter share	33	Roller discs	34	Stone plow



35	Back support arm for passive trailer	36	Weeding wire assembly

1.7 Operator panel and Menu Structure

The operator panel can be accessed at the rear of the machine and is mounted on a hinged mount so that it can be folded away after use

Always leave the operator panel folded away (underneath the solar panels) to protect it best possible against the weather.

The operator panel consists of a control screen, a joystick for manually controlling the robot, and 2 stop buttons.

The screen is touch sensitive and can be operated by a light touch – also when wearing gloves. Under the screen there are 4 physical buttons that each have a unique function.

House icon [F1]: Always takes the user back to the main screen.

Left arrow [F2]: Scrolls to the left in the tabs at the bottom of the screen.

Right arrow [F3]: Scrolls to the right in the tabs at the bottom of the screen.

Triangle [F4]: Scrolls to the alarm list.

The menu structure is simple and logically structured.

For more guidance, please refer to FarmDroid guidelines in the FarmDroid Knowledge Base:

https://knowledge.farmdroid.io/hmi_manual

2 Safety Instructions

Special attention must be given to this section as it concerns the safety instructions regarding commissioning and using the machine.

It is important that the user has read and understood all the safety related information before use. Including all safety related information described in add-on manuals for attached add-on equipment.

The robot is only to be used for the purpose described including purposes described in manuals for add-on equipment attached to the robot. The robot must not be modified or changed in construction in any other way than described in the add-on manuals without a preceding agreement with FarmDroid ApS.

⚠ Always make sure that the robot is used in a secure private area where unauthorized people seldom are present. The location must also allow for safe operations for the robot.
See more in section: **Commissioning and Entry into Service**

⚠ The robot cannot “see” obstacles and therefore only stops at physical contact with the safety wire. Therefore, material damage may occur if objects (e.g., a car, a tractor, or the like) are left in the field, and which have not been registered as an obstacle during the set-up of the field.

⚠ When working on or in the machine one must always make sure that the power supply is disconnected. Make sure to use the designated switches.

⚠ The emergency stop must not be used for disconnecting the power in relation to work performed on the machine.

⚠ There are two power sources on the robot, batteries and solar panels respectively. Both power sources must be disconnected in relation to work performed on or inside the machine in the following order:

1. Turn off the solar panels on the switch located on the underside of the solar panels to the left.

2. Turn off the main switch on the left side of the main switchboard.

Attention: When turning on the power the main switch must be turned on first, followed by the solar panels switch. If this procedure is not followed, the solar panels will not charge the batteries. To turn on the power after reconnecting the main switch you must press and hold the stop button on the operator panel for approx. 15 seconds until the HMI turns on. The stop button lights up when pushed.

During electrical troubleshooting, the nationally applicable regulations with regards to work on or nearby live low voltage equipment must always be followed.

During function tests, one must always be located behind the operator panel. If the work requires a person to be on the inside of the safety wire, two people must be present for the job where one of them must always be located behind the operator panel, having a clear view of the other person and easy access to the emergency stop switch.

Always make sure to go through the tasks on the robot before work commences in order to make sure that the tasks will be executed effectively and safely.

When charging the batteries, take extra care with regards to polarity and charging currents.

⚠ The batteries can be charged with maximum 50A and 28,8VDC. Make sure not to over-charge the batteries as this might result in permanent damage to the batteries. Make sure to use a suitable battery charger for the specific battery type ($LiFePO_4$). Please consult with your local distributor or FarmDroid if in doubt.

Always charge the complete battery pack together to avoid different charge levels across the battery pack. If the batteries are charged independently and uneven, it will result in high cross-battery currents when connecting them together which potentially causes damage of the batteries.

The robot must only be used for the purposes described in **1.6 Purpose, Structure and Function of the Robot.** Neither goods nor persons are to be transported on the robot. Along the same lines, the robot must not be used as a propulsion system for other equipment/tools than those that are designated equipment mounted at delivery and equipment approved by FarmDroid ApS. Autonomous driving on public roads is prohibited.

2.1 Safety Devices and their Function

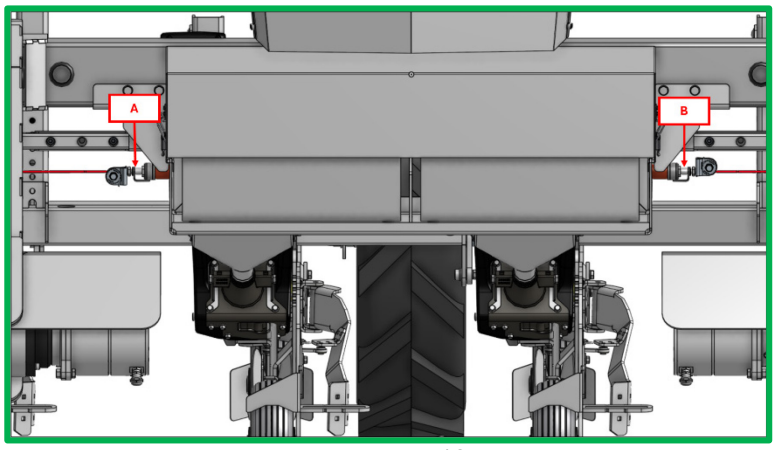
The Robot is equipped with five different safety devices. Together, their purpose is to protect the user and other people from dangerous situations when using the machine, especially during Highly Automated operation. The safety devices are described below.

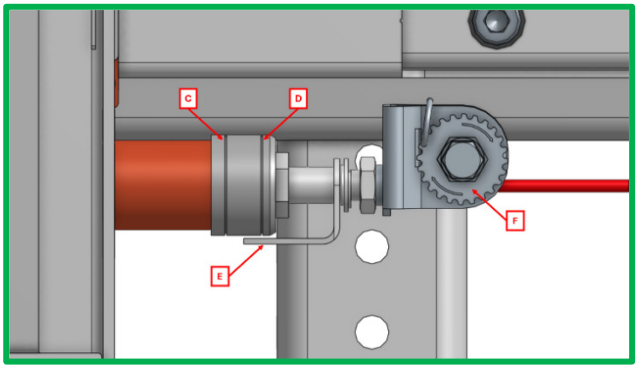
1. **The emergency stop safety-wire, with the following purpose:**
   - If an obstacle or object is pulling or pressing the wire, the emergency stop function will stop the machine and thereby avert a dangerous situation from escalating.
   - Marking off the machine's working area. This forms a natural limit for where the user is allowed and not allowed to be located during operation.

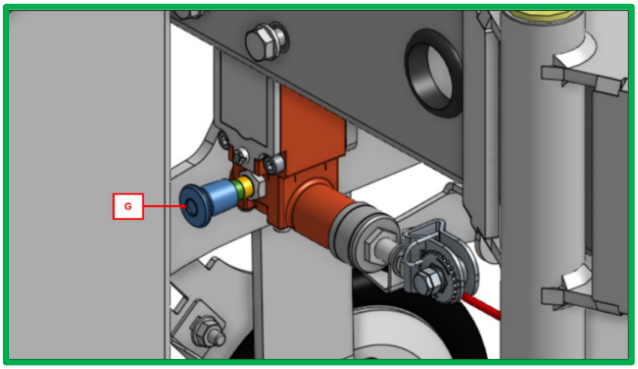
   By activating the emergency stop, the machine will stop, and the brakes are engaged thus stopping the robot's movement.

   To reset the safety-wire emergency stop:

   - Look at the safety-wire emergency switches, located to the sides of the battery box [A, B].
   - Make sure the tension indicator [E] on both switches is standing between the low-tension [C, innermost] and high tension [D, outermost] trigger lines.
   - If necessary, either slide the wire to distribute the tension evenly on the two switches or wind/unwind the tension mechanism [F] with a 10mm wrench to make the wire shorter or longer.
   - Pull the blue knob [G] to mechanically reset the emergency switch.
   - On the Home page 1.0 of the HMI, press the reset button to reset the emergency switch in the Software.



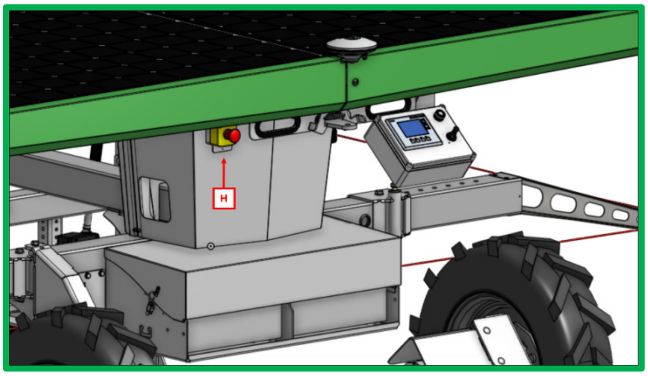




⚠ The emergency stop safety wire is placed in a height of approx. 580mm which ensures that crops do not unintendedly activate the emergency stop. This also means that the emergency stop safety wire will not be activated by objects lower than this height, thus lower obstacles or objects will not trigger the safety system.
The Robot can always be stopped at any time by manually activating the emergency stop safety wire or by engaging the emergency stop on the rear of the machine.

2. **Emergency stop push button located at the rear of the Robot by the Operator Panel, with the following purpose:**
   - Protecting the user during manual operation, when the user is located behind the Robot and operates the Robot by using the Operating Panel If a dangerous situation should occur, the user has easy access to the emergency stop push button [H]. The emergency stop push button will halt the movement of the robot both during automated or manual operations.

   By activating the emergency stop, the machine will stop, and the brakes are engaged thus stopping the robot's movement.



3. **Light and audible indicator, with the following purposes:**
   - Indicate that the robot will start after a standstill period longer than 10 seconds. The indications consist of a continuous 2 second audible indication along with light signals by flashing all the lights around the solar panel top.
   - To indicate changing direction of travel. Light signals in the turning side are engaged, consisting of flashing the lights on that side of the solar panel top.

4. **Geographic fencing around the field, with the following purpose:**
   - To ensure that the Robot stays inside the field in case of e.g., wrongful navigation. In case the robot, during automatic operation, reaches the geo-fence, consisting of virtual straight lines between field corner points, the machine will stop, and the brakes will engage thus stopping the robot's movement. An "Out of Field" error message will be displayed on the HMI.

5. **Interruption of run or operation if the target driving speed cannot be maintained or is too high, with the following purposes:**
   - Stop the run or operation and send message to the user if the Robot has stopped on a propulsion error.
   - Stop the run or operation and send message to the user if the Robot has reached a too high average propulsion speed (above 1000 m/h).

⚠ The machine's movement speed is an essential factor with regards to the choice of safety devices, and for this exact reason it is not necessary to use distance scanners or similar equipment.

The safety switches on the Robot are shown in the pictures below in accordance with the list above.

2.2 IT & Communication Safety

The robot is equipped with an internet gateway to support messaging to and from the operator, RTK positioning signals, and online support functions.

All communications to and from the robot to a cloud-based server are done through a TLS communication protocol (AES256 bit) and therefore protected against man-in-the-middle attacks (hacking).

The operator panels require a user-defined password input to switch between operating modes, which gives a low-level security against unwanted control of the Robot on-site.

⚠ Never share your password and do not leave it physically at the robot.

⚠ In case any indications of misuse or hacking are observed, please change your password, and consult your local FarmDroid Distributor immediately.

ℹ Data communication is required for the Robot to exchange information with the Base Station and Server, thereby a prerequisite for operation. This data, required for operation, is owned by FarmDroid, however data acquisition is limited to Robot and Base station specific data, i.e. the data acquisition does not cover personal information governed by GPDR.
Read our full GDPR policy here:

https://farmdroid.com/gdpr/

2.3 Commissioning and Operation of the Robot

⚠ At commissioning, all security measures must be checked for damages and repaired if there are any signs of damage. Make sure to check the devices regularly according to the maintenance instructions in section **8.5 Preventive maintenance checks of the Safety System** and similar sections in manuals for optional add-on equipment.

Always perform a thorough examination of the machine before commissioning to make sure that no components, cables, or the like are damaged.

The machine must only be operated by one person at the time unless two people are stated as required for doing tasks described in this manual. It is important that the operator always pays attention to the surroundings and always is located at the operator panel.

Always step back from the robot after starting Highly Automated operation and await the Robot's pattern of movement, as the Robot may run in any direction after starting.

Before commissioning, and again before operating the robot, make sure that the desired operating area of the robot is safe. The robot must only be commissioned on private areas and is solely intended for seeding and weeding of crops in field areas in its standard configuration. Approved add-on equipment can explicitly expand the robots' intended purpose.

For safe robot commissioning do a thorough safety check of the intended covered area of the robot, including the following points:

- Make sure that no public roads, trails, or paths cross the intended covered area of the robot.
- Make sure hills, low areas and inclines the robot need to operate or traverse are within the robots specified capabilities.
- Ensure optional add-on equipment does not have additional points to observe.

2.4 Handling of the Robot

The Robot can be transported using a tractor with the use of either the Field Bracket or the Road Transport Platform.

⚠ It is only permitted to use the Field Bracket for transportation use on private areas and not on public roads.

⚠ For transportation on public roads, the Robot must be transported on the Road Transport Platform or a suitable and approved trailer or wagon and securely lashed according to local legislation.

⚠ When choosing the tractor used for transportation, the operators must take due consideration of the Robot weight. The total dry weight of the Robot with 6 active wagons is approximately 950 kg, i.e. without any additional weight kits or add-ons mounted.

ⓘ It is recommended to remove the additional weight plates from the trailers, if installed, before transporting the robot with the Field Bracket.

Please follow below recommendations for selecting the appropriate tractor size:

Selection of tractor size for transportation		
Transport device	**Max Total Robot Weight Incl. transport device**	**Recommended minimum hitch category and tractor size**
Field Bracket	1260 kg	Cat 2 / 100Hp
Road Transport platform	1750 kg	Cat 3 / 150Hp

Transporting the Robot with a tractor must be done at a very slow and steady speed and the local conditions must be considered. The Robot is neither built for nor intended to function as a conventional tool for the tractor, and therefore it cannot withstand strong impacts from transportation.

⚠ The user should make sure the tractor has sufficient weight in the front to attain good steering properties when lifting the Road Transport Platform.

2.5 Robot maintenance

Before performing maintenance work on the robot always make sure to switch off both power sources.

If supporting parts of the robot have to be removed or disassembled, the operator must ensure that a safe temporary support is implemented, to prevent the robot from tipping over.

If springs or gas dampers needs to be removed or disassembled, ensure these are not under load before working on them.

⚠ It is not permitted to be inside the safety zone, marked by the safety wire, when performing function tests of the Robot.

2.6 Machine safety markings

Below all safety related markings on the Robot are listed together with their meaning and placement.

Machine Safety Markings		
Symbol	**Placement**	**Meaning**
	Lifting backets	The operator should inform him/herself about the instructions in the user manual regarding lifting and transportation of the robot, before commencing such activities.
	Tool Mounting	The operator should inform him/herself about the instructions in the user manual regarding sowing and weeding configuration of the tool, before commencing such activities.
	Top hitch bracket	The operator must read and understand the section covering lifting and transportation of the robot before the robot is transported.
	Solar Panel Charger, Solar panel switch	Danger, potential high voltage!
	Outer limit on tool section, Outside trailer on both sides	Danger, potential risk of pinching!
	Drive motor shields, Front wheel support arm	Danger, automatic start!
	Rear side of solar panel top near locking device	Danger, do not open the solar panel top in strong winds
	Batteries, electrical box, Solar Panel Charger	Avoid high pressure cleaning!

2.7 Residual risks

 When in manual mode it is solely up to the operator to safely move and control the Robot.

The Safety functions are still active, but it is of utmost importance that the operator pays special attention to the surroundings to avoid unintended situations from occurring.

Risk of pinching, crushing and minor bodily injuries.

 Never place yourself, others, or equipment in the running path of the robot as the robot does not have a visual detection system, due to low velocity while moving. Only the emergency stop system, including the safety wire, will stop the robot, which requires physical interaction.

Risk of pinching, crushing and minor bodily injuries.

 Never try to perform mechanical adjustments, etc. on the Robot while in operation. The Robot does not have sensors for detecting unwanted objects/persons within the area covered by the safety wire. Always stay outside the safety wire during operation!

Risk of pinching, crushing and minor bodily injuries.

 If add-ons are fitted to the robot, ensure those add-ons are fitted according to the accompanying manual for the add-on.

3 Upon Reception

Upon reception, a thorough visual inspection for damages and deficiencies on the machine must be performed.

Pay extra attention to the inspection of safety functions on the machine, including the safety wire and the emergency stop switch. The machine will not start unless all safety functions can be activated properly. See chapter **2.1 Safety Devices and their Function**.

Upon reception, make sure that the following components are properly and correctly mounted:

- GNSS-Antennas
- The front safety wire arm must not be in transport position and the wire holder at the end must be pushed to upper position holding the wire.
- Safety wire installed and correctly tensioned
- Emergency push button intact and functionable

At the detection of possible errors and shortcomings, contact your local distributor before commissioning of the robot.

For more guidance, please refer to FarmDroid unpacking guideline in the FarmDroid Knowledge Base:

Remove the robot from the pallet upon delivery

https://knowledge.farmdroid.io/removing-fd20-from-pallet-upon-delivery

Remove the robot from a container

https://knowledge.farmdroid.io/overseas_reassembly

4 Prior to Commissioning

Prior to commissioning, it is important that all users of the machine have read and understood this entire user manual as well as received training/instructions from your local distributor.

In addition, there are some practical measures that must be taken. These are described in the following.

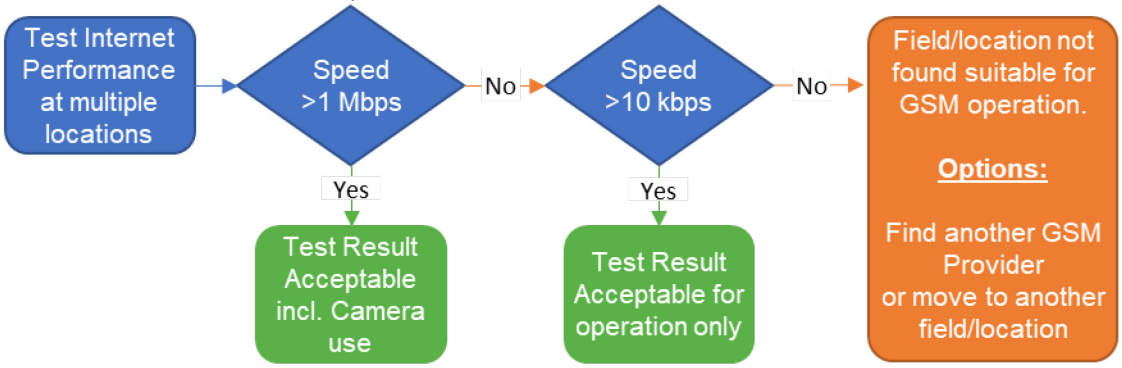
4.1 Test of Internet Performance

To ensure that the communication strength between the robot and the RTK Base Station is sufficient, the operator should perform initial tests of the internet connection. The tests must be performed both at the field where the robot is expected to operate and at the desired Base Station location.

It is recommended to use a smart phone to perform the internet performance test and follow the procedure below:

1. Download a “Speed test” app to a smart phone or use the following link: https://www.speedtest.net/
2. Test the internet connection and performance at the field where the robot is expected to operate and at the desired Base Station location.
3. Evaluate the test result of download speed to determine whether the connection is acceptable or additional testing is required:
    a. If the initial test result is above 1 Mbps, the internet connection is perceived as acceptable.
    b. If result is below 1 Mbps, additional tests are needed.

The illustration below shows how to perform the tests at the field:



4.2 SIM-card from FarmDroid

The Robot and Base Station are delivered with a factory mounted Multi-SIM solution which will provide the best and safest connection to both appliances. Subscription to this service and the data usage is free-of-charge for the first year. The service will continue if the customer purchases a FarmDroid Uptime Subscription the following years. For more information, please contact your distributor.

4.3 SIM-card from Third-party Provider

The customer can also decide to purchase a SIM-card from a third-party provider. When purchasing a SIM-card, it is highly important to choose a provider with stable and good coverage in all the areas where the Base Station and Robot are going to operate.

To provide the best possible conditions, it is recommended to use a Multi-SIM solution. A Multi-SIM is a single SIM-card that connects to various operators and thereby chooses the network with the best connection in the specific area.

In terms of data consumption, the Base Station will under normal operation of the robot upload approximately 1.5kB/s. This amounts to an upload of approximately 5GB per month when the robot is operating 24/7. Similarly, the robot uses the same amount of data monthly during operation.

Use of the Camera, and software updates temporarily increase the data upload from the robot significantly to around 125-175kB/s. This amounts to approx. 10GB of data upload at 15.5 – 22 hours daily operation of the functions.

Below is a summary of the expected data consumption related to normal operation and an example of additional data consumption related to the use of the camera.

Activity	Robot*	Base Station*
Normal Operation Download	~5GB per month*	~0.5GB per month*
Normal Operation Upload	~0.5GB per month*	~5GB per month*
Use of Camera Upload	~10GB for 15.5 – 22 Hours of use*	N/A

*FarmDroid cannot be held accountable for any additional or unexpected data use.

It is highly recommended to include some leeway in the data subscription until the owner has established some experience with the actual data consumption. Furthermore, it is recommended to have an alarm function included in the subscription to inform the owner prior to data being used up.

4.4 Replacing the SIM-Card in the Robot

It is not recommended to replace the factory mounted SIM-Card, unless it has been fully verified, that the SIM-card cannot obtain sufficient connectivity in the area.

Prior to commencing the replacement, it is important to consult your distributor, as settings in the modem must be changed.

If you wish to change your SIM-Card you need to contact your local FarmDroid distributor.

5 Commissioning and Entry into Service

Upon commissioning of a new robot, a field or more fields must be set up before operation with the robot can commence. The area where the FD20 should operate autonomously must be surveyed before the commissioning by following the Field Setup instructions described in this chapter.

Field set-up is only required once per field as the field data is saved in the robot for future use. You can save a maximum of 20 fields.

Make sure that the batteries are fully charged before surveying a field and the first operation.

Optionally, place the robot outdoors 24 hours before commissioning if the weather allows it, for the robot to charge the batteries via the solar panels during the day.

5.1 Field Setup and Obstacles

Field set-up is performed from the HMI panel of the Robot while the Robot is being moved physically around the field to each corner point.

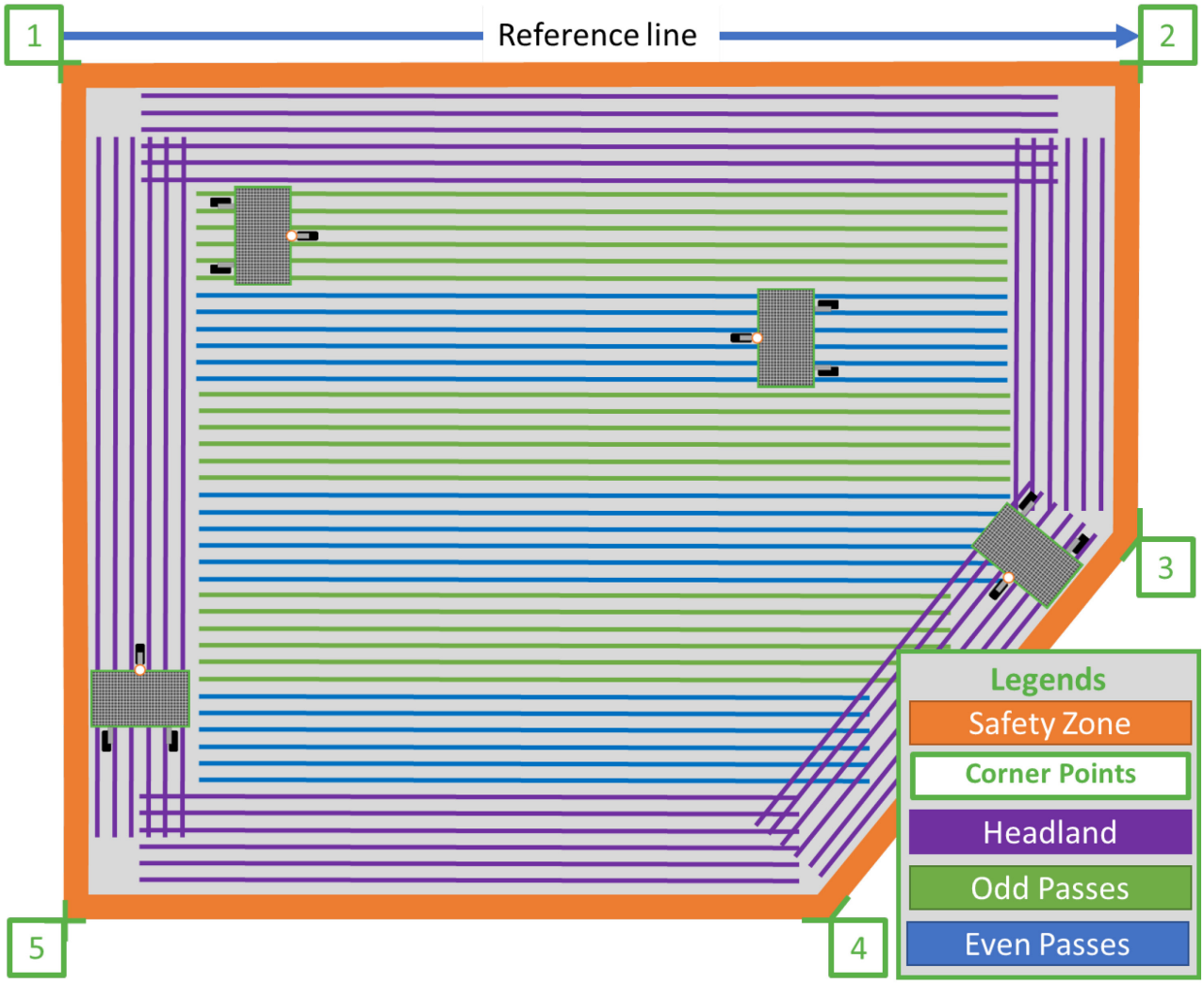
Special attention must be given to the following instructions when setting up the Field:

1. Ensure that the Batteries on the Robot are sufficiently charged before commencing (minimum 25,5V).
2. Before marking the corner points, a Field slot must be selected in the HMI and given a Field name. Use a name that makes the field easy to identify, remember, and distinguish from other fields. All corner points must be set in one continuous chronological string around the outer edge of the entire field.
3. The physical position of the front GNSS on the Robot is used when defining a corner point. Therefore, it is important to position the robot such that the front GNSS is located at the desired physical corner point, as close to the outer edge of the field as possible while still keeping any plow furrow, trees, or other obstacles outside of the field.
   The Robot will create a safety zone inside the outer lines of the fields physical corner points. This zone is used for turning as the front wheel during turning, in most cases, will run outside the areas covered by the robot.
   The safety zone width depends on the working width of the robot, as the robot always needs the same space to turn due to the zero-turn technology.

For safe robot commissioning please do a thorough safety check of the intended covered area of the robot, including the following points:

- The operator is allowed to link the robot to the tractor via the field transport bracket only if nobody is standing in between the vehicle and the FD20.
- Before creating a new field with the robot, the operator must take safety precautions. Specifically, any interaction with the HMI screen must be done with the robot standing firm on the ground and the tractor being immovable. This means that, whenever it is required to interact with the HMI, the operator must lower the robot on the ground, engage the parking brake of the tractor and shut off the engine to avoid any movement while the operator is not in the driver's seat. Only at this point is the operator allowed to leave the cabin of the tractor to interact with the HMI
- Make sure that no public roads, trails, or paths cross the intended covered area of the robot.
- Pay special attention when commissioning next to public roads. Keep good distance between the road and corner points during field setup.
- Make sure to keep a good distance to steep hills, ditches, etc., when setting up the fields.

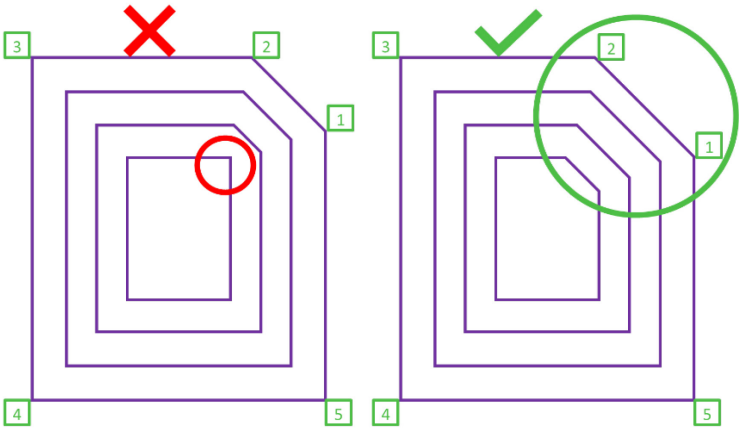
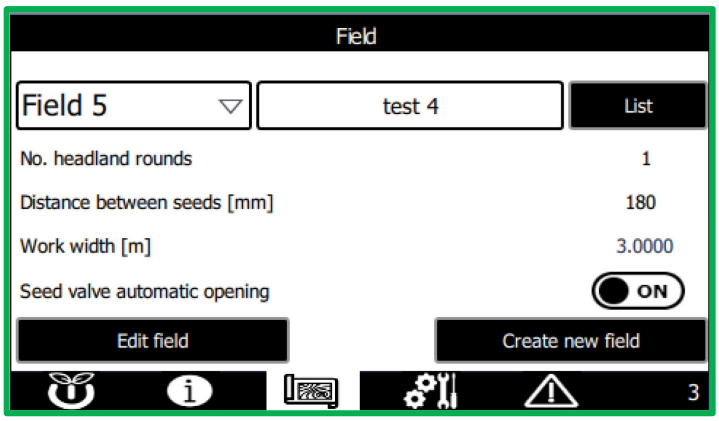
Below, illustration displays an example of a field setup. The orange border symbolizes the safety zone. The corner points, that have been marked using the front GNSS of the Robot, are the outside corners of the orange boarder.

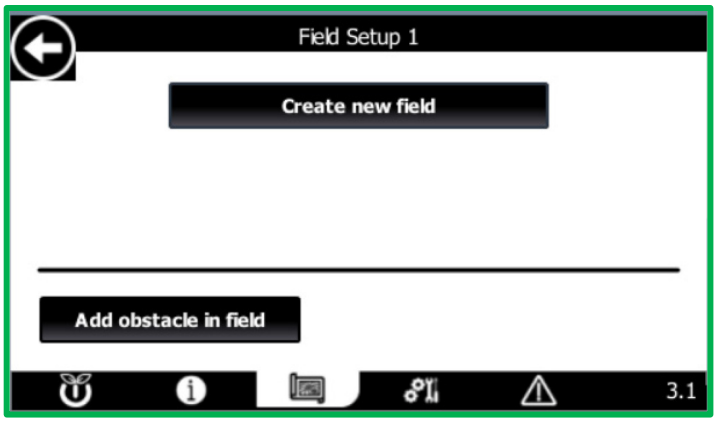
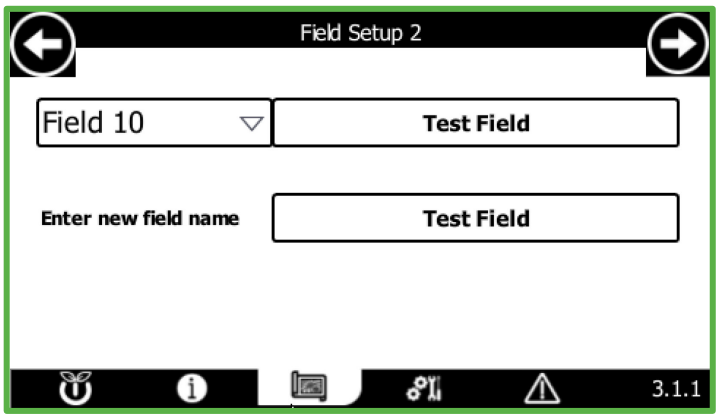


The table below summarizes the steps required to set up a new field, including the reference to the associated HMI page.

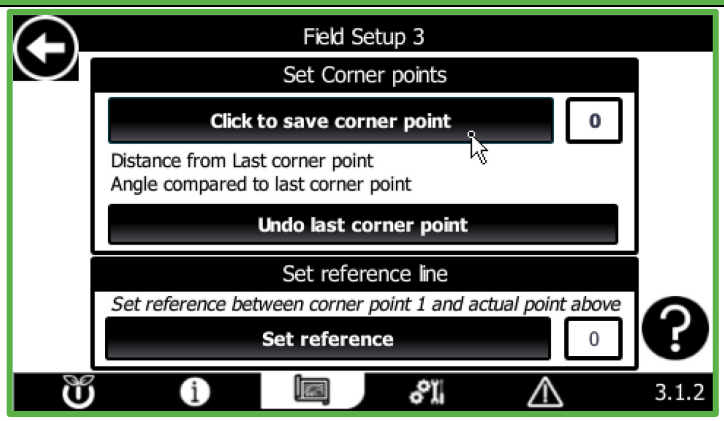
Please note that the screenshots attached below might slightly vary depending on the software version installed on your specific robot.

Step	Description	HMI Page
1	Complete the preparatory exercises, incl. reading this manual, and transporting the Robot to the desired field. It is recommended to transport the Robot around the field using a tractor and the field bracket or alternatively the Road transport platform Whenever the robot is carried by another vehicle, such as in the case of setting up a field, the operator must take safety precautions. Specifically, any interaction with the HMI screen must be done with the robot standing firm on the ground and the tractor being immovable. This means that, whenever it is required to interact with the HMI, the operator must lower the robot on the ground, engage the parking brake of the tractor and shut off the engine to avoid any movement while the operator is not in the	

Step	Description	HMI Page
	driver's seat. Only at this point, is the operator allowed to leave the cabin of the tractor to interact with the HMI.	
2	When setting up the field there are two rules that the user must follow: 1. No obstacle at corner point 1, as this works as a reference for the rest of the field. 2. The distance from corner point 1 and to the second and last corner point, corner respectively, must be sufficient for the corner points not to cancel each other.  On the illustration above, to the left, the distance between corner 1 and 2 combined with the angle, results in the two corners canceling each other, and becoming one point in the inner headland. This is not allowed around corner point 1, thus the distance must be increased, or corner point 1 located in another position.	n/a
2	In the HMI root structure, navigate to **Page 3 Field** and click the button "Create new field"  	**3** **Field**

Step	Description	HMI Page
3	In the HMI, select “Create New Field”.  If the option “Continue Field Setup” appears, it means that the field setup has been exited or aborted prior to the field was saved. This is an option to continue that field setup, however this option will disappear if it is selected to create a new field.	**3.1** **Field Setup 1**
4	Select a field number of your own choice and enter a suitable name for the field. When this is done, proceed to the next page by using the arrow in the top right corner.  If the selected field is already occupied, an attention message will appear and it will be possible to either overwrite the existing field or cancel, whereafter it is possible to select another field entry slot. When a field name has been entered, navigate to the next page using the arrow in the top right corner.	**3.1.1** **Field Setup 2**
5	Move the Robot to the first Corner Point of the field such that the front GNSS is located at the border of the field. When in place, press “Save Corner Point”. If the desired corner point is not in the place where you like, you can also undo the last corner point by pressing “Undo last corner point”.	**3.1.2** **Field Setup 3**

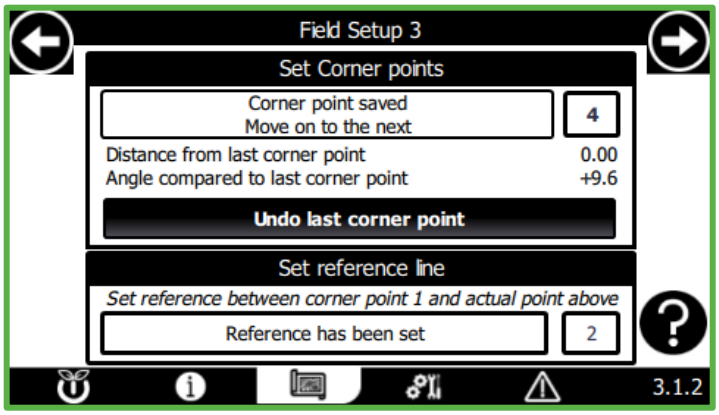
Step	Description	HMI Page

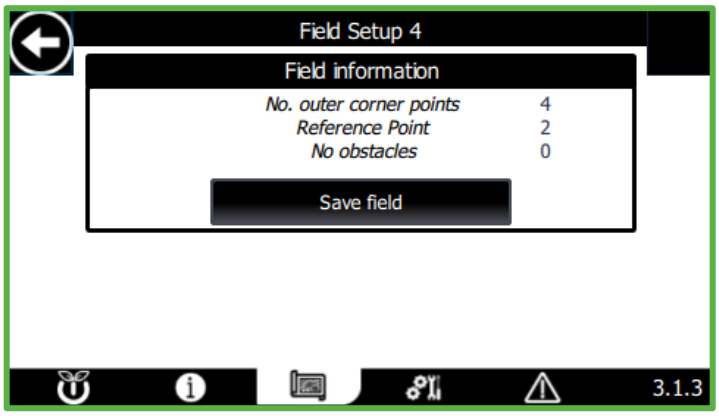
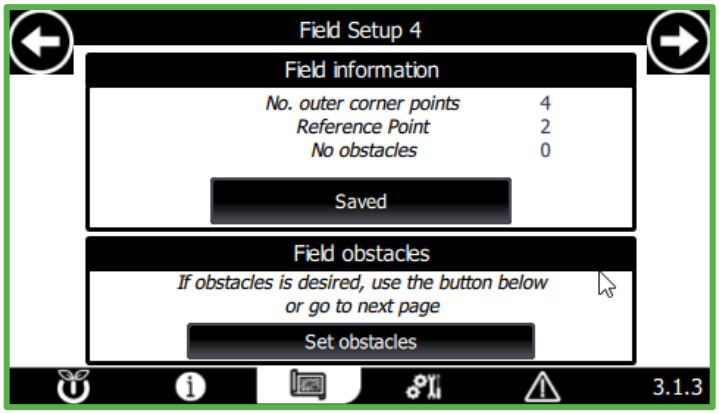


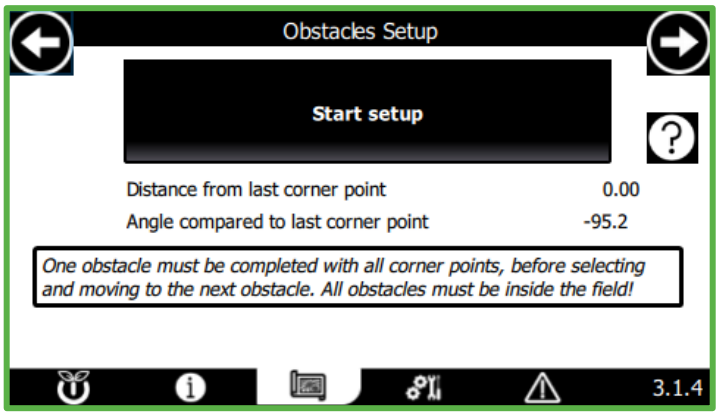
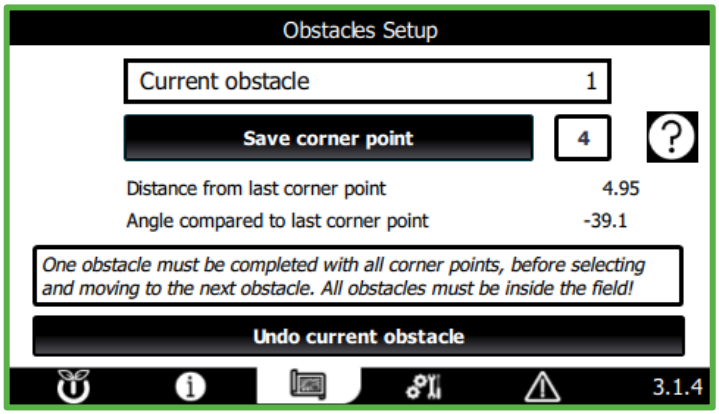
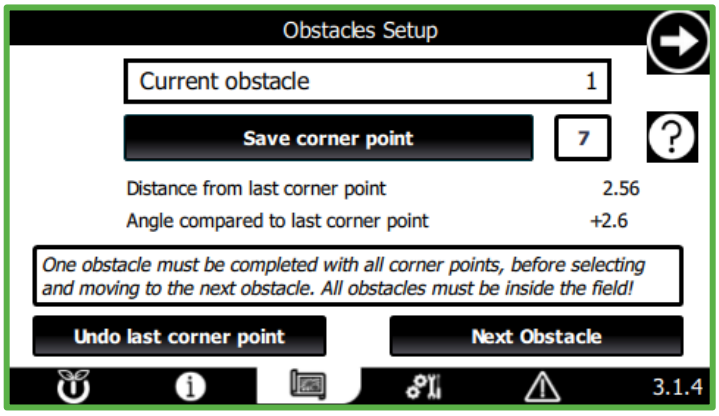
Then move the Robot to the next corner point as instructed on the HMI - Corner Point 1 will act as the A point of an A-B line. Continue to set up the corners one by one, by physically moving the robot to the next corner point and saving this by pressing the “Save Corner Point” button. For each corner, the number to the right of the button will count one up.

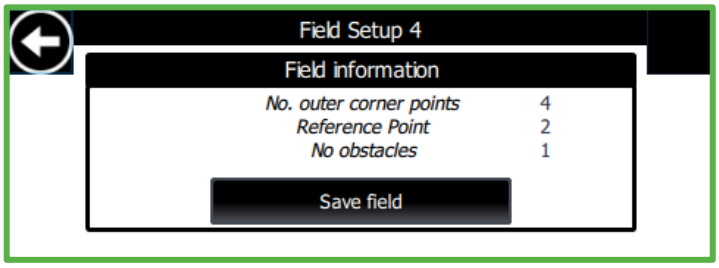
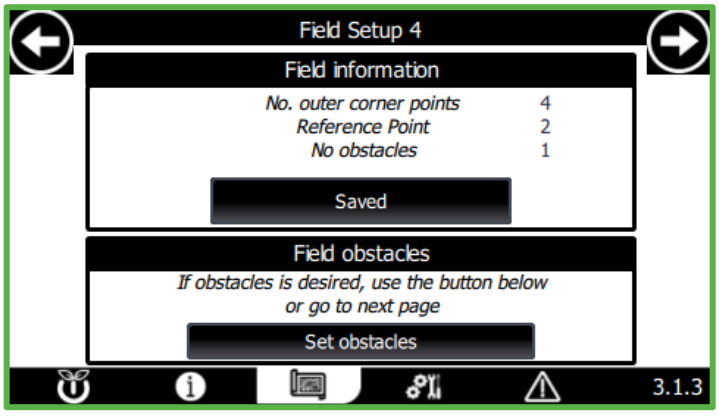
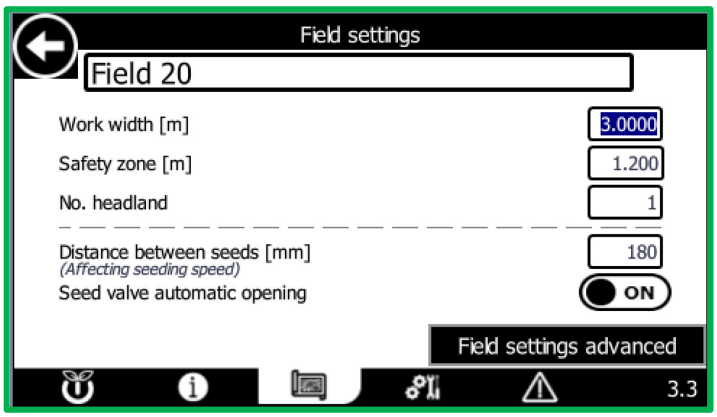
When the Robot is located at the desired reference corner point, remember to press “Set Reference”. The reference corner point will act as the B point of an A-B line . The passes will always be parallel to the reference line.

When all desired corner points have been saved, proceed to the next page by using the arrow in the top right corner. (This ONLY appears when the reference has been set)



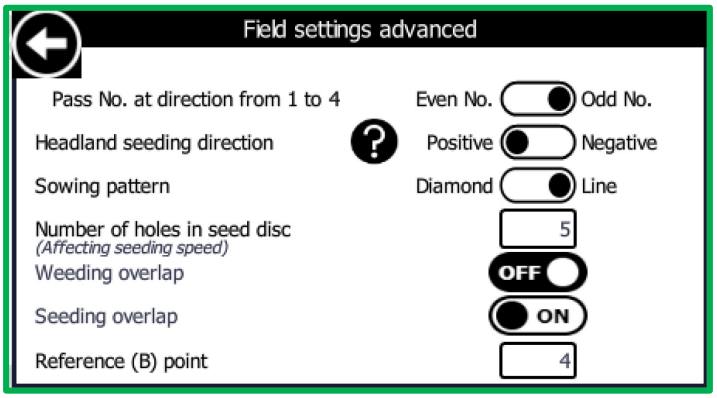
Step	Description	HMI Page
6	A Summary of the field settings is presented. If these reflect the expectations on the field, press “Save field” button. Otherwise go back using the arrow in the top left corner of the HMI.  The option to “Set obstacles” will now appear, allowing the user to setup restricted areas in which the robot will not operate e.g., around a tree or waterhole. For guidance on setting up obstacles, see step 7.  The right forward arrow will direct the user to the Field settings page.	**3.1.3 Field Setup 4**

7	If any obstacles exist within the field, the process described below should be followed. First move the Robot to the first corner point of the first obstacle and press “Start setup”.  When the front GNSS of the Robot is located on top of the first Obstacle Corner Point, press “Save Corner Point”. An obstacle requires a minimum of 3 corner points.  If a corner point was entered by mistake, the “Undo last corner point” function can be used. Pressing this will delete the coordinates of the last saved corner point, and the number indicating the corner point will count one down. This function can be used to delete all obstacle corner points if necessary.  When all corner points surrounding the obstacle have been saved, either press “Next obstacle” if another obstacle exists, otherwise press the upper right arrow. If next obstacle was pressed by mistake, then press “Undo current obstacle” and the “next” arrow will appear again.	**3.1.4 Obstacles**

	Pressing the “Next” arrow will take the user to the Save field page. Now the number of obstacles will appear in the summary. If correct press “Save field”.  If at this point the field has been fully setup, by pressing the arrow in the top right corner of the HMI page, the user will enter the page “**3.1.3 Field Setup 4**”. For guidance, see the next section. 	
8	Now that the field has been set up, the user must adjust the Field settings. This is done on Page: **3.3 Field Settings** as illustrated below.  a. Working width [m]: this value is set in the factory, based on the robot’s mechanical configuration. If the mechanical configuration is changed, this value should be adjusted. b. Safety zone (m): This is a calculated value depending upon the working width of the robot. FarmDroid recommends never to change it. c. No. headland: Choose how many full rounds of headlands there shout be in the current field. Each headland is as wide as the robot’s working width(i.e., with a working width of 3 meters and 3 headlands, the total headland width will be 9 meters).	**3.3 Field Settings**

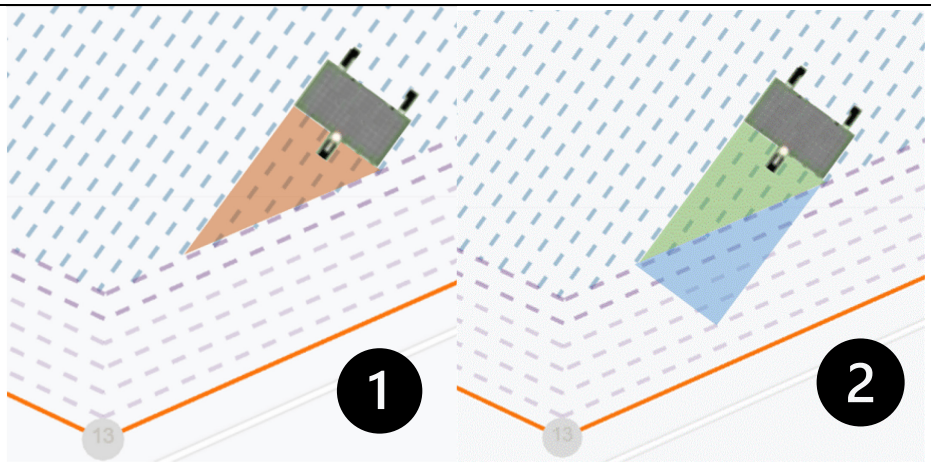
d. Distance between seeds (mm): Enter the desired seeding distance from one seed to the next, measured in millimeters.
e. Seed valve automatic opening: Turning this ON means the robot will seed the field in portions (ranging from 1 to multiple). Turning this OFF allows the robot to carry out line seeding. Seed valve automatic opening should be turned OFF for seeding distance below 10 cm.

When the settings have been verified or entered as desired, either press the check mark in the right corner to continue, or press “Field settings advanced” to adjust further settings.



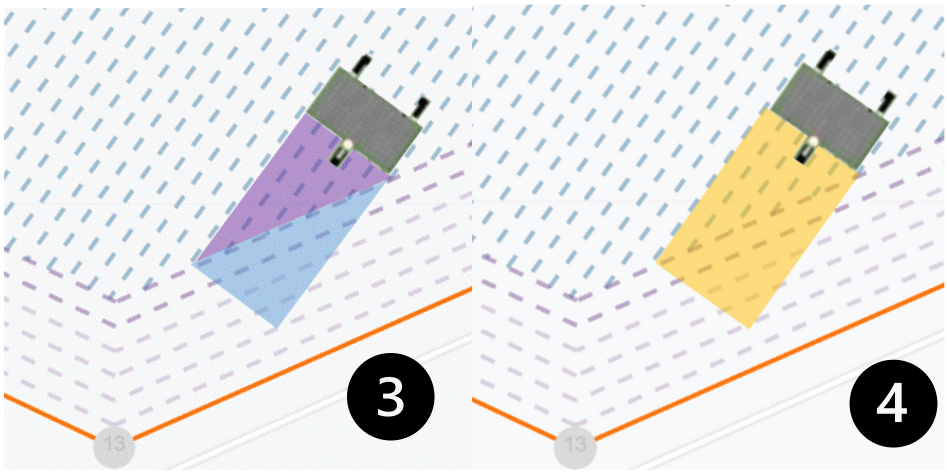
f. Pass no. at direction from 1 to “Reference”: This is used to select whether the robot should run in even or odd passes compared to the direction of the reference line. When a reference point has been selected, this reference point will appear (in this case “4”).
If **Odd No.** is selected, the robot will seed row 1, 3, 5, 7….. when running in the direction from corner point 1 towards the reference point.
If **Even No.** is selected, the robot will seed row 2, 4, 6, 8… when running in the direction from corner point 1 towards the reference point.
g. Headland seeding direction: When selected “Positive”, in the headlands, the robot will move from Corner Point 1 to 2, 3, 4… while when selected “Negative”, the robot will move from Corner Point 1 towards the last Corner Point, followed by the second last and so on.
h. Sowing pattern: Choose which seeding layout you prefer. You can either choose Line or Diamond.
i. Number of holes in seed disc: Enter the number of seed holes in the mounted seed disc. FarmDroid recommends to send a seed sample for testing, for you to receive an ad-hoc seed disc recommendation.

Seeding overlap: When the robot enters a pass from a headland, or enters a headland from a pass, unless the pass is perpendicular to the headland, an area is left untreated, or another is treated twice (depending on the settings of the overlap). When “Seeding overlap” is “ON” the entire pass will be seeded. When “OFF” an area will not be seeded. Weeding overlap: In the like manner, the same applies for the “Weeding overlap”. When the “Weeding overlap” is “ON” the entire pass will be weeded. When “OFF” an area is left untreated. An easy understanding to it is illustrated in the pictures below.



The first picture refers to when both functions i.e. seeding and weeding overlap are turned OFF. As the robot reaches to the point where the working width of the robot comes close to overlapping the headland, it will raise the hitch. As illustrated, the red zone will not be seeded and weeded. This part will be without crops, but with weeds.

The second picture shows when both functions are turned ON. In this case, the robot will continue to seed and weed until it reaches the end of the line. Therefore, a small area of headland (blue zone) will be seeded and weeded twice. The crops in the overlapping area would mostly be removed, but the weeds would be under control.



The third picture shows when the seeding overlap is turned ON, while the weeding overlap is turned OFF. Here, the small area in the pass would be seeded, however, the seeding in the headland would be wasted as the crops get removed during weeding in headland.

The fourth picture refers to when seeding overlap is turned OFF, and weeding overlap is turned ON. In this case, there will be no seeding in the overlap area. Other weeding supplements would be kept to a minimum, as the weeding overlap function will help in removing most of the weeds.

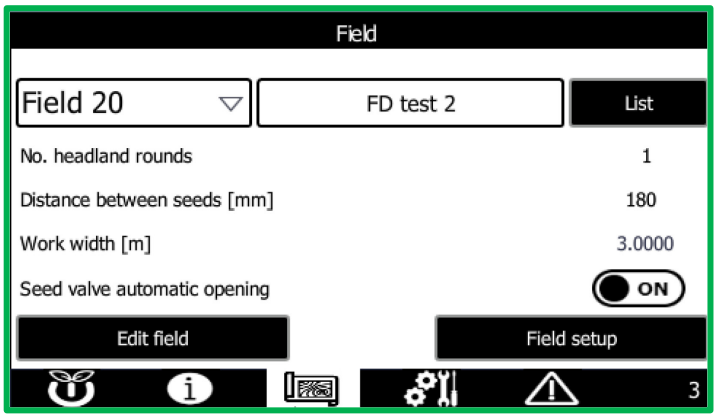
9

j. Reference (B) point: to change the reference point of the AB line from the value which has been decided during the field set-up

When the correct settings have been entered, press the checkmark button in the upper right corner, to apply the settings.

Now the field has been completely set up.

If the user wants to review or check the field settings at a later stage, it can be done so by going to **Page 3** and pressing “Edit field”.

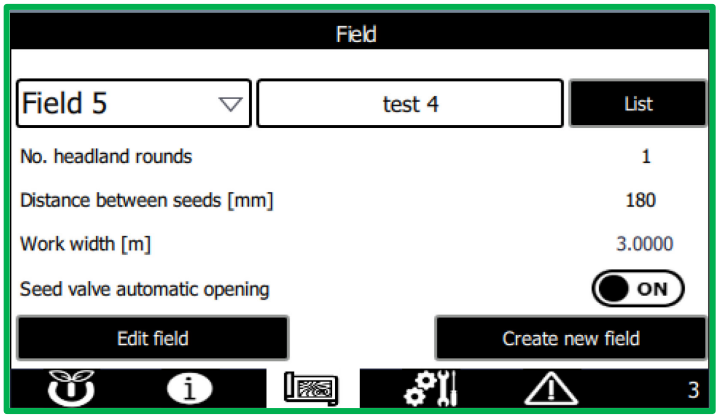


It is of utmost importance that the seeding settings are not changed after or during seeding operations in the specific field. If the seed distance is changed, this change will also apply for all previous planted seeds, thus resulting in the plants being weeded away when performing in-row weeding.

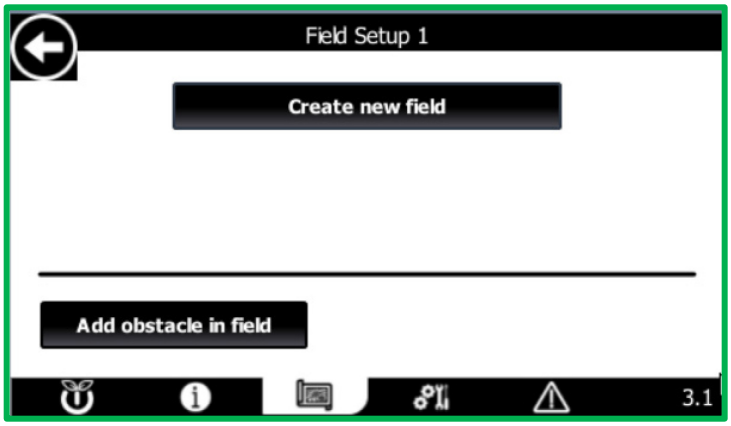
10

If the user wants to add an obstacle within a field in the future, it can be done so by choosing the right field on Page 3 and pressing “Create new field”.

To see how to change between different fields, refer to **Section 5.2 Changing Between Existing Fields.**

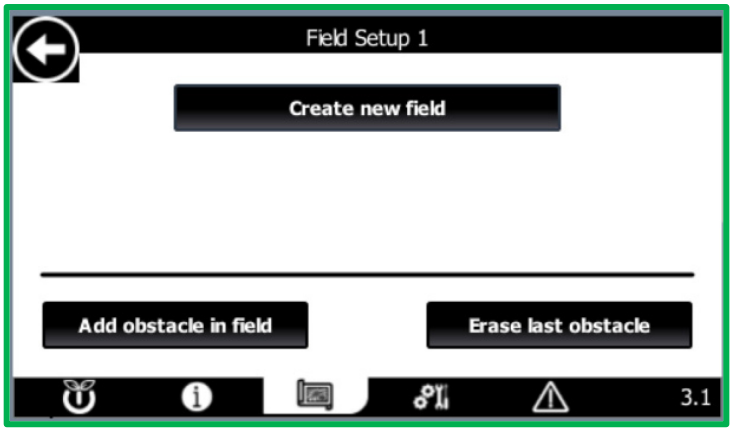


Press “Add obstacle in field”:



From here, it will repeat the process as mentioned in Step 7.

Once the obstacle has been set up, the user can also delete the last obstacle created. To do so, go to Page 3, press “Field setup”, and press “Erase last obstacle”.



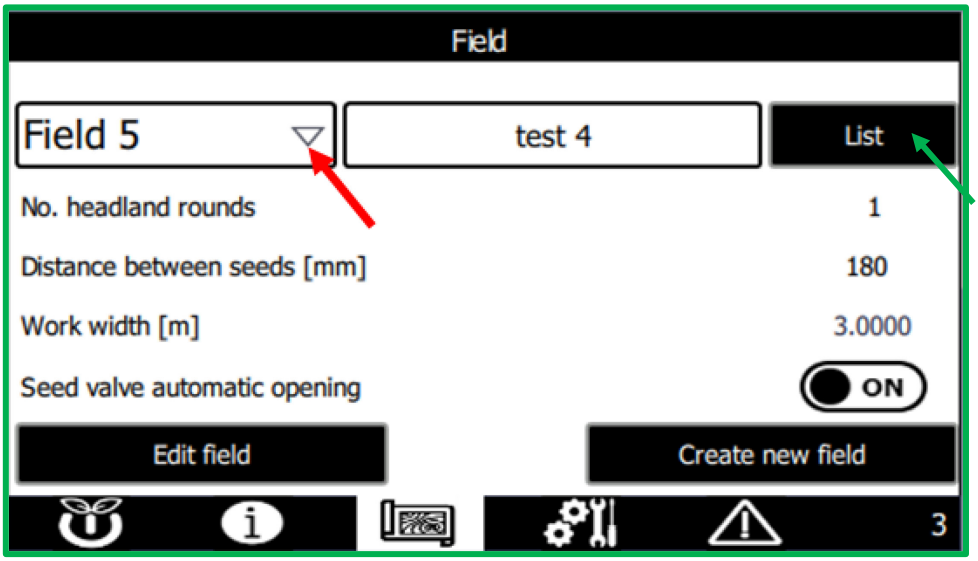
Confirm by pressing “Erase last obstacle”.

Now the last obstacle created is deleted.

5.2 Changing Between Existing Fields

If the Robot is used on more than one field, the current field must be selected in the HMI when the Robot has been physically moved to the field and prior to commencing Highly Automated operation.

The current field is selected in the HMI at page: **3. Field Selection and Information** by using the dropdown menu at the top-left of the screen. An overview of all fields saved on the robot can be shown pressing the "List" button in the top-right corner of the screen.



When the desired field has been selected, the name associated with the field will appear in the text box to the right of the dropdown menu. Furthermore, a selection of field settings will be displayed.

When a field has been set up in a robot using a specific Base Station, this specific Base Station must be used for that specific field for the entire season from seeding until the end of weeding. If the robot is connected to another Base Station, the virtual reference point moves significantly, and the crops might be weeded away. **For more information see: FarmDroid Base Station User Manual.**

Moving the communication tunnel from the Robot to another Base Station requires admin access, therefore this must be performed by a distributor.

6 Daily Operation

The daily operation is performed from the operator panel on the robot. There are two modes of operation, Manual and Highly Automated. It is only possible to switch between these two modes of operation using the HMI on the Robot, and for safety reasons it requires an operator password to switch between the modes. The password is active for 20 minute after entry i.e. if more time has passed the password will have to be entered again. These modes are further explained below.

6.1 Manual Operation

The manual operation function is primarily used for moving around the Robot at the farm, within the field or to place to Robot at a specific start location.

The manual operation does not require GNSS or data connection.

When operating manually, the Robot is moved by using the joystick at the operator panel. The speed can be switched between low and high by choosing Turtle and Hare respectively, on the HMI home page. Other tools on the robot can be operated from the HMI on the operator panel.

The manual operation function is also used during service or when troubleshooting the machine, as the manual operation function provides the option of testing the machine's components individually.

Always make sure to shut off both power sources before commencing any work inside the area enclosed by the safety wire.

6.2 Highly Automated Operation

When this function is chosen, the Robot can only be started and stopped by using the operator panel or from the FarmDroid User application. No other parts of the machine can be manually controlled during Highly Automated operation. However, it is possible to read out information, e.g. on HMI page **"2. General Information"** where the most relevant operating data is available.

It is not allowed to make mechanical adjustments or any other interventions on the machine during Highly Automated operation. The machine must always be stopped, manual operation selected, and the Robot made safe, before commencing mechanical work.

The Automated mode consists of four sub-statuses, which are clearly indicated by color on the HMI:

Running – Highly Automated Mode [Green]	The Robot is operating in Highly Automated mode i.e. moving around the field performing work.
Suspended – Highly Automated Mode [Green]	The Robot is in Highly Automated mode, however the operation has been suspended temporarily. This could either be due to low battery or missing GNSS-RTK signal. When the batteries are sufficiently charged by the solar panels, and/or the GNSS-RTK signal becomes available, the Robot will provide an acoustic signal and resume the operation.
Selected – Highly Automated Mode [Amber]	Highly Automated mode has been selected from the HMI, but the user has not given the Robot a start signal from the HMI or the FarmDroid User Application.
Error – Highly Automated Mode [Red]	An error occurred during Highly Automated mode, which stopped the robot. An error could be an activation of the safety system, a process value reaching a predefined threshold, a system or component malfunction. An active action from the user is required to resume the Highly Automated operation.

Before changing to Highly Automated mode, the user should inspect the Robot mechanically to ensure the safety system is fully functional.

6.3 Remote monitoring and operation

When the Robot is set to Highly Automated mode, it is possible to operate the Robot via the FarmDroid App. From the Application it is possible to see a status of the current operation as well as performing basic operation such as “Start” or “Stop”. The prerequisite for the simple remote operation is, that the user actively and physically has set the Robot in Highly Automated mode.

It is not possible to switch between Manual and Highly Automated mode from the FarmDroid App. For safety reasons this can only be done locally on the Robot.

6.4 Robot propulsion overload protection

The propulsion system is protected against overload. In case of abnormally high load, the robot will gradually reduce the speed down to 350m/h, if necessary, hence limiting the load to an acceptable level. The robot will automatically increase the speed when the load drops. When the function is active it will be displayed at the home screen in the HMI.

The conditions on the field such as wet or loose soil, stones and slopes will affect the load on the propulsion system. Slopes and especially sideways slopes will increase the load compared to flat areas. Sideways slopes will cause an uneven load distribution between the left and right side. To reduce this load, the speed reduces automatically and temporarily, until the load again is acceptable.

To avoid excess load on the propulsion system, the users must ensure to operate within the technical specifications of the robot in terms of weight, slopes number of tools and working depth.

When working on slopes FarmDroid has the Active Front Wheel add-on as an optional extra. This significantly reduces the motor load when working on sloping fields, thereby decreasing the chances of motor overload.

6.5 Auto Load control with hitch

If high load continues despite the propulsion overload protection has reduced the speed, and the Auto Load Controller is on, the Auto Load Controller will temporarily reduce force on the trailers and soil tools, by raising the hitch gradually, until the load is at an acceptable level. If the load continues to increase, the robot will stop and send an alarm.

The Auto Load Controller function is only activated if the robot speed has been reduced to 350 m/h by the overload protection function, and the load continues to be too high. When the load drops, the hitch will reapply the force to the trailers, to the predefined level and the propulsion speed will increase toward the predefined level.

If the Auto Load Controller is deactivated, the robot will stop and send an alarm message if the load remains too high after the propulsion speed has been reduced to 350 m/h.

The Auto Load Controller can be activated/deactivated in the HMI at page: **4.1.3 Run Settings**

6.6 Battery Replacement and Charging

The Robot is equipped with two 24 Volt (max 28,8v), 120Ah, Lithium batteries. The batteries are connected to the Robot with plug connectors.

Under normal conditions the excess production from the solar panels, during the day hours, will be used to charge the batteries. Dependent on the weather conditions and time of year the charging level can vary.

It is also possible to use an external charger to recharge the Robot's batteries when, for example, the charge level is low following a cloudy period. When the batteries are charged with an external device, the following instructions must be followed:

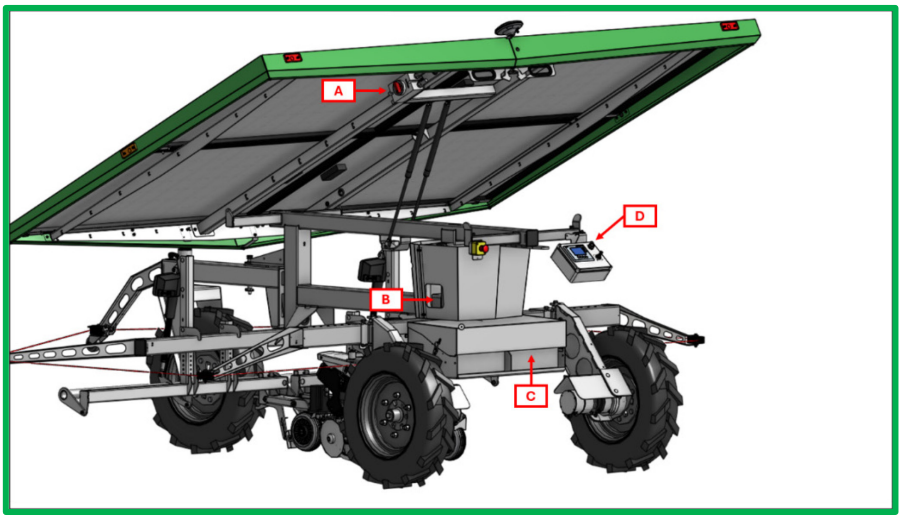
1. Disconnect the power supply on the robot following the four-step instruction below.
2. The batteries must be charged with maximum 50A and 28.8V and only by a suitable charger for Lithium battery technology
3. Both batteries must be charged to the same level, within 100mV, to avoid high and damaging circulation currents after re-connecting the batteries.
   For this reason, it is highly recommended to charge the batteries in parallel.
   Alternatively charge both batteries to 100% charge level before reconnecting them to the robot. This will ensure they are at the same voltage.

It is very important to disconnect the Robot's power supply BEFORE the batteries are dismounted. Otherwise, dangerous contact voltages may occur in the system induced by the solar panels. The power supply must be disconnected in the following order.

Follow the procedure below when changing the batteries (1 to 4):

1. Disconnect the power supply for the solar panels [A]
2. Disconnect the power supply for the main board on the main switch [B] on the left side of the board.
3. Remove the battery cover to make the batteries accessible.
4. Remove the batteries [C] one at the time by disconnecting the plug connectors.
5. When mounting the batteries and reconnecting the power supply, follow the procedure in opposite order (4 to 1). To power on the robot after disconnection, press and hold the stop button on the operator panel for approx. 15 seconds until the HMI turns on [D]. The stop button lights up when pushed.

See the picture with an explanation below.



A	Switch for the solar panel section	B	Main switch on the main board
C	Batteries with battery plug connector	D	Stop button on Operator Panel

The batteries weigh 26 kg each. Therefore, make sure to use suitable lifting equipment when dismounting and/or transporting the batteries to avoid personal injury.

If a lithium battery's voltage drops below 21.6V it will be irreversibly damaged. This state is typically called deep discharge and will cause the shutoff of the Battery Management System (BMS) as under-voltage protection and will not allow the battery pack to charge again, until it is restarted.

If the batteries are left in the under-voltage state, it will at some point deplete itself to a point where it cannot be re charged again. Such a battery must be discarded.

To restart the BMS use the FarmDroid Battery Charger (FarmDroid part number: C024PF025201):

1. Follow all the above-mentioned guidelines on how to safely remove the batteries from the FD20.
2. Connect the battery to the charger
3. Connect the charger to the 230v power supply

If the charger is plugged-in to the wall socket, when connecting to the battery, the pulse is not sent.

If multiple batteries are connected to the charger at the same time, the pulse will not be sent.

For further information on the batteries, please refer to the Batteries User Manual attached to the end of this document.

Seeding Settings

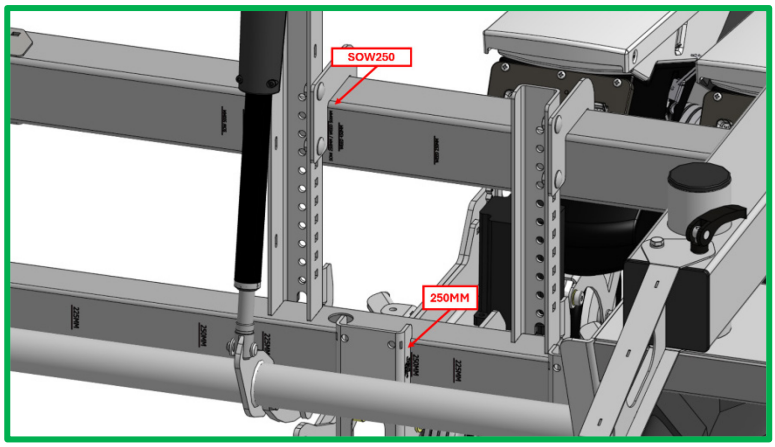
In this section, the basic necessary adjustments regarding seeding are described. For more elaborate guidance, please refer to FarmDroid Knowledge base:

https://knowledge.farmdroid.io/seeding.

Pay extra attention to adjustments during both seeding and weeding and do not leave the Robot during automatic operation before making sure that the Robot runs as desired.

The table below shows an overview of the seeding setup possibilities.

Possible Adjustments	Mech.	Elec.	Note
Height of tool section			The tool beam can mechanically be adjusted to different heights. It may be necessary to adjust the height if the Robot operates in a seedbed or for specific crops. Be aware that if the mechanical height is changed, setup changes in the HMI will also be required. If you want the mechanical height to be adjusted, you need to contact your local FarmDroid Distributor to make sure the settings in the Software are properly adjusted Changing the mechanical height of the tool section without the help of your local FarmDroid Distributor can result in significant deviation in seed location between the passes, potentially making it impossible to weed in both directions. The mechanical height of the tool beam should not be adjusted during the season from commencement of seeding until weeding has been completed.
Row distance			The row distance can be adjusted by moving the individual trailers as required. For row distances of: • 250 mm: the trailers must be mounted on the 250 mm marking on the tool beam. The tool beam should be fixed in the position “SOW250” or “WEED250”, depending on the operation. • 450 mm: the trailers must be mounted on the 225 mm marking on the tool beam. The tool beam should be fixed in the position “SOW450” or “WEED450”, depending on the operation.

Possible Adjustments	Mech.	Elec.	Note
			• 500 mm: the trailers must be mounted on the 250 mm marking on the tool beam. The tool beam should be fixed in the position “SOW500” or “WEED500”, depending on the operation. Always make sure that both the active and passive trailers are in the desired position and secured tightly. The image below shows the correct mechanical configuration for a 250MM row spacing: the tool beam is placed over the SOW250 line of the frame, while the trailers are placed over the “250MM” line on the tool beam. Please note that it is the vertical bracket standing behind the actuator which serves as indicator, when aligning the tool beam over the frame.  FarmDroid recommends contacting your local Distributor prior to moving the trailers on the tool beam, to ensure the overall configuration of the robot is correct. Be aware that it requires setting changes through the HMI if the mechanical changes affect the working width of the Robot. The working width is set on page **4.1.3 Propulsion & Run Settings.**
Seeding depth			The seeding depth is adjusted directly on the trailer by loosening the 13mm bolt and adjusting the seeding arm up and down. A scale is cut in the steel on the side of the seeding arm, which indicates the seeding depth in millimeters (10mm steps).
Roller disc height			The roller disc height in relation to the Coulter share can be adjusted by loosening the two 13mm bolts between the roller discs. A scale is cut in the roller disc adjustment bracket to ease similar adjustment across the rows.

Possible Adjustments	Mech.	Elec.	Note
			The bottom of the roller discs should never be set lower than the bottom of the coulter share, otherwise that might negatively influence the seeding accuracy by making an unnecessary large furrow in the ground.
Soil cover plow offset and depth			The soil cover plow offset is adjusted by loosening the two 10mm nuts on the arm. The depth is adjusted by loosening the 13mm bolt and adjusting the arm up and down.
Seed disc angle			The angle of the seed disc can be adjusted by loosening the electronics box and tilt the entire unit to the desired position. Depending on the seed type and whether it is desired to single-out or seed in clusters, the angle might have to be adjusted.
Trailer pressure on the soil			The hitch height, which determines the ground pressure of the trailers, can be adjusted via the HMI Page **4.1.9 Hitch Settings.** With a hitch height of 100% the actuators are fully extended, lifting the trailers to the maximum height. With a hitch height of 0%, the actuators are fully retracted, lowering the trailers in the ground and, potentially providing the highest ground pressure. Weight distribution between front and back wheel is depending on the trailer spring configuration.
Weight distribution on the trailer front/rear			The trailers' weight distribution can be adjusted by adjusting the spring between the different holes at the front of the trailer and on the arm holding the spring. If a hole towards the bottom of the trailer is used, weight will be put on the rear end of the trailer. As the spring is moved further up towards the top, more weight will be moved to the front wheel of the trailer. The spring can also be adjusted on the tensioning arm, the further down the spring is placed, the higher the tension will be applied to the front wheel while keeping the back-wheel pressure more or less the same, depending solely on the spring placement in the trailer holes.
Allowable seed-sensor errors			The allowed seed error threshold can be set in the HMI. The setting is available in page: **2.1.0 Tool Information** – when in seeding mode The set value represents the error percentage for the last 100 seed registrations.
Seed distance			On page **3.3 Field settings**, the seed distance can be set. The page can be accessed from **3. Field Selection and Information.**

6.7 Changeover Between Seeding and Weeding

After seeding has been completed, adjustments must be made to the robot to change from seeding to weeding functions. This is done according to the table below and it is recommended to follow the order presented in the table. For more elaborate guidance please refer to FarmDroid Knowledge Base:

https://knowledge.farmdroid.io/weeding

Activity	Mech.	Elec	Note
Empty seed containers.	■		Loosen the two clamps on the seed container, and block the seed outlet with a hand, while the seed container is lifted off. Empty the seed funnel by removing it.
Mount Funnel sealing ring	■		Remount the funnel including the sealing ring, so that the sealing foam is pushed against the back plate. This prevents dust, moisture, and water from entering the seeding motor and the seed valve internals.
Deactivate seed and activation of weeding.		■	Turn off the seeding function and turn on the weeding function via **4.1.2 Tool activation**. The weeding settings are performed at page **4.1.2.1 Weeding Tool Settings – Basic.** Remember to activate or deactivate in-row weeding.
Move sowing arms to idle position	■		The bolt holding the seeding equipment at the desired depth is loosened and the entire arm is moved up to the rest position.
Replace the soil cover plows with weeding wire kit	■		On all the active rows, remove the soil cover plows by loosening the two nuts on the horizontal bracket. Flip the support bracket around so that the horizontal part is in the wheels path. Install the weeding wire assembly in the desired position.
Move tool-section to weeding position	■		Loosen the four 13mm nuts for the two U-bolts, on each tool beams. Slide the tool beams to the correct marking on the frame. **Attention** use the correct “WEED” marking based on the current row distance: 250, 450 or 500mm ⚠ Please be aware of the heavy weight of the tool beams when shifting them sideways.
Mount an extra weeding wire kit on the outer left trailer	■		Mount an extra weeding wire kit on the outer left trailer. This is required for the wires to be able to cover the whole soil surface between the passes. Install the extra weeding wire kit on the left side of the trailer.
Adjust weeding wires	■		Adjust the weeding wires to the desired depth and offset to get the desired soil coverage.

			Attention: Remember to adjust the weeding wires between blind weeding, where the full surface is covered, and row weeding, where the wires only should cover the soil surface between the rows.

6.8 Weeding Settings

In this section, the necessary and relevant adjustments in relation to weeding are described.

Pay extra attention to adjustments during both seeding and weeding and do not leave the Robot during automatic operation before making sure that the Robot runs as desired.

The table below shows an overview of the weeding setup possibilities.

Possible Adjustments	Mech.	Elec	Note
Height of the tool section			The tool beam can mechanically be adjusted to different heights. It may be necessary to adjust the height if the Robot operates in a seedbed or for specific crops. Be aware that if the mechanical height is changed, setup changes in the HMI will also be required. If you want the mechanical height to be adjusted, you need to contact your local FarmDroid Distributor to make sure the settings in the Software are properly adjusted **Changing the mechanical height of the tool section without the help of your local FarmDroid Distributor can result in significant deviation in seed location between the passes, potentially making it impossible to weed in both directions.** The mechanical height of the tool beam should not be adjusted during the season from commencement of seeding until weeding has been completed.
Weeding arms' out-of-row position			Adjustment of the weeding arms' position when not in-row. The scale ranges from 0-100% where 0% represents the weeding arms mechanical being fully out of the row. Adjustments are made in the menu **4.1.2.1 Weeding Tool Settings – Basic**. Please refer to FarmDroid Knowledge Base for additional information: https://knowledge.farmdroid.io/weeding-settings-in-hmi
Weeding arms' in-row position			Adjustment of the weeding arms' position when in-row. The scale ranges from 0-100% where 100% represents the weeding arms mechanical being fully in the row. Adjustments are made in the menu **4.1.2.1 Weeding Tool Settings – Basic**.

Possible Adjustments	Mech.	Elec	Note
Non-weeding distance in front of the crop			Adjustment of the non-weeding distance in front of, i.e. before the crop in mm. Adjustments are made in the menu **4.1.2.1 Weeding Tool Settings – Basic**
Non-weeding distance behind crop			Adjustment of the non-weeding distance behind the crop in mm. Adjustments are made in the menu **4.1.2.1 Weeding Tool Settings – Basic**.
Weeding arm speed			Adjustment of the weeding arms' movement speed can be adjusted in 5 steps from minimum to maximum. Slower speeds can help reduce soil movement around the plant, while faster speed will fit better with faster driving speed of the robot.
Weeding knife depth			The weeding knife depth can be adjusted by loosening the two 10mm bolts that fasten the knife to the arm. Hereafter, the knife can be placed at the desired depth. The chosen weeding depth can be verified on the scale on the backside of the weeding knife.
Weeding wires depth			The weeding wire depth can be adjusted by loosening the 13mm bolt that fastens the bracket to the weeding wire. Hereafter, the wire can be placed at the desired depth. The chosen depth can be verified on the scale on the side of the arm above the trailer.
Weeding wires offset			The weeding wire distance to the crops (sideways) can be adjusted by loosening the two 10mm nuts that fasten the weeding wire bracket. Hereafter, the bracket including the weeding wire can be moved sideways to the desired position.
Trailer pressure on the soil			The hitch height, which determines the ground pressure of the trailers, can be adjusted via the HMI Page **4.1.9 Hitch Settings.** With a hitch height of 100% the actuators are fully extended, lifting the trailers to the maximum height. With a hitch height of 0%, the actuators are fully retracted, lowering the trailers in the ground and, potentially providing the highest ground pressure.
Weight distribution on the trailer front/rear			The trailers' weight distribution can be adjusted by adjusting the spring between the different holes at the front of the trailer and on the arm holding the spring. If a hole towards the bottom of the trailer is used, weight will be put on the rear end of the trailer. As the spring is moved further up towards the top, more weight will be moved to the front wheel of the trailer.

Possible Adjustments	Mech.	Elec	Note
			The spring can also be adjusted on the tensioning arm, the further down the spring is placed, the higher tension will be applied to the front wheel while keeping the back-wheel pressure more or less the same, depending solely on the spring placement in the trailer holes.
Weeding overlap adjustment			This adjustment determines what the robot will do when reaching an headland at an angle. With the overlap function ON, the robot will partially weed the headland with a different angle than that of seeding. With the weeding overlap function OFF, the robot will stop the weeding operation by raising the hitch, as soon as any of the trailers enters the headland's area.

6.9 Restart Following Unintended Stop

If, for any reason, an alarm threshold is reached or if an error occurs, the Robot will stop and notify the user. For safety reasons, it is not possible to reset the safety system remotely, thus if the safety wire or an emergency stop has been activated, the user must manually reset the safety system at the robot, whereafter the robot can be restarted.

If the stop is caused by a tool related alarm, e.g. each time an alarm threshold is reached, then this alarm can be reset remotely, and the robot can be restarted. If an error occurs twice or multiple times, the user has to perform physical remediation.

On the HMI, the user can find information about the alarms on the pages **1. Home**, **5. Event List** and **5.1 Event History**.

The User must actively evaluate the alarms before resetting these and resuming operation.

If there is a physical or electrical error on the Robot, the error must be corrected before restarting the Robot in Highly Automated mode. For troubleshooting support, see section **11 Troubleshooting.**

6.10 Factory settings and Back-up

It is possible to restore to factory settings for essential parameters in the HMI. The following pages contain a restore function relating to the specific settings on the page:

- **4.1.2.1 Weeding tool settings – basic**

Field setup and essential data are pushed to a FarmDroid Server each time these are saved. If essential data is lost or deleted in the robot this can in most cases be recreated by the FarmDroid Care team.

Please consult with your FD20 configuration paper or your local distributor in case of non-standard settings.

7 Transportation

The Robot can be moved between fields or to and from the farm with one of two different transport solutions from FarmDroid, the Field Bracket or the Road Transport Platform.

If the user has to transport the robot on public roads the Road Transport Platform must be used as it will comply to width, fixation, and light requirements. Alternatively, the user must use an appropriate and street legal wagon or trailer.

7.1 Field Bracket

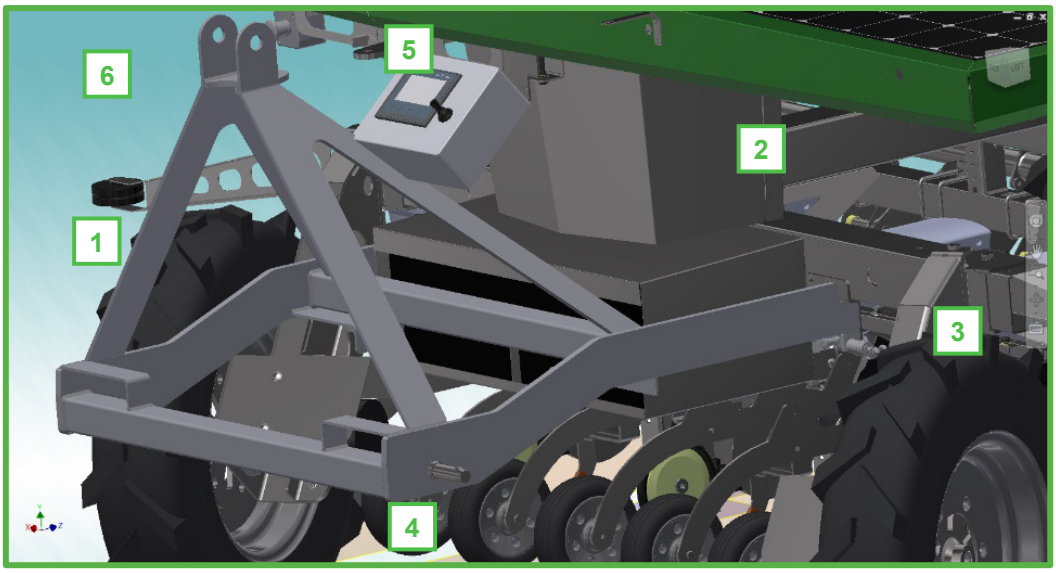
The Robot can be transported using a tractor with the help of the included Field Bracket which can be mounted on a tractor 3-point-hitch Cat. 2 or 3.

⚠ Be aware that the Field Bracket is solely allowed for moving the Robot on private areas and not on public roads.

Driving with the Robot must be done at a very slow and steady speed and the general conditions must be taken into considerations. The Robot is neither built for nor intended to function as a conventional tool for the tractor, and therefore it cannot withstand strong impacts from the tractor during transportation.

The Field Bracket is mounted in the 3-point hitch, just like normal tractor equipment. The Field bracket must be level with the ground when attaching to the Robot. Therefore, make sure to adjust the top point accordingly before lifting the Robot.

Pay special attention when reversing the tractor to grab the Robot. The two arms on the Field Bracket must be aligned with the lifting points on the Robot. Gently reverse until the Field bracket reaches contact with the Robot (gently make contact with the Robot attachment points). Please see illustrations below.



1	Field bracket	4	Field bracket bottom hitch points
2	Robot	5	Robot top hitch point
3	Robot bottom hitch points	6	Field Bracket top hitch point

When the Field bracket touches the lifting reinforcements on the robot, gently lift the Field bracket until positive contact between the Field bracket and the Robot's hitch points has been made (again, gently make contact with the Robot), and then stop.

Secure the tractor in parking mode and hook up the chain between the top hitch point of the Field Bracket and the Robot.

⚠Make sure to properly tighten the bolts in the shackles both when lifting the Robot and when the Robot is not hitched in the bracket. In this way, you will always transport the Robot safely and prevent dropping the shackles when not in use.

8 Maintenance

Maintenance is important for all types of machines and especially when dealing with high-precision equipment like the FarmDroid Robot. Please pay special attention to the recommendations in the following chapters to make sure that your Robot performs as expected.

By following the matrixes below including supplementary guidelines, you will ensure to keep the Robot in the best possible shape leading to the best possible seeding and weeding performance. Furthermore, this reduces the number of unintended stops that might occur.

Please consult your local distributor or FarmDroid for maintenance guidelines.

8.1 Preventive Maintenance Checks on the Robot

The table below contains the Robot's recommended service and maintenance intervals.

Before performing maintenance work, and especially if it requires to be inside the safety wire perimeter, the power must be turned off by: 1. Turn off the solar panels on the switch located on the underside of the solar panels on the left side of the robot. 2. Turn off the main switch on the left side of the main switchboard. If in doubt, please contact your local distributor for advice before commencing the service/maintenance task.

Always remember to follow the safety instructions when performing inspections or maintenance and service work on the Robot. Always turn off both power sources before entering the Robot safety zone.

Task	Type	Daily	Weekly	Monthly	Yearly	Comments
Check for general damage on the Robot and especially its safety system.	Visual Check	■				Replace parts if necessary. Contact your local distributor in case of damage on the safety system.
Check for unusual noise from the Robot, (i.e. from the drive motors, gears and brakes)	Auditory check		■			Replace parts if necessary.
Check for loose bolts and nuts			■			Tighten loose bolts and nuts to target torque.
Check the batteries for damages.	Visual check		■			Pay special attention when working with damaged batteries. Always refer to local legislation.
Check tire pressure.	Visual Check		■			Measure the tire pressure if needed. The tire pressure must be between 0.5-0.8bar.
Check for dirt in the rain sensor.	Visual check		■			Check if any leaves or other objects are clogging the funnel of the rain sensor. The rain sensor is easily accessible from the front of the Robot.
Check for unusual play in the rear wheel steering.	Auditory/ visual check		■			Push the frame sideways, back, and forth. The play should be audible if present. Check the steering rods for unusual play. If the play is more than 1mm at any of the connecting points, replace the bushings in the connection rod.

Task	Type	Daily	Weekly	Monthly	Yearly	Comments
Thorough check of the entire Robot						Perform a thorough inspection of the entire robot once a year. Check for loose bolts/nuts, cable conditions, bushings etc. This should be performed by an authorized distributor

8.2 Preventive Maintenance Checks on the Tools

The table below contains the service and maintenance intervals recommended for the tools.

Always make sure to follow the guidelines when performing maintenance work. If in doubt, please contact your local distributor for advice before commencing the service/maintenance task.

Always remember to follow the safety instructions when performing inspections or maintenance and service work on the Robot. Always turn off both power sources before entering the Robot safety zone.

Task	Type	Daily	Weekly	Monthly	Yearly	Comments
Check for general damage on the tools.	Visual check					Replace parts if necessary.
Check for unusual noise from the seeding system or weeding motors	Auditory check					In case of errors contact your local distributor.
Check light sensor contamination.	Visual check					Check all light sensors via the HMI screen in page 2.1.4.1 “Tool Information”**.** This is a good way to check if a sensor is unusually dirty and thereby prevent unintended stops during the sowing period by proactively cleaning the sensors. Only use compressed air or soft cloth to clean the sensors as they are very sensitive to mechanical damage.
Check for play in the trailer supports.	Visual check					When the tools are lifted, push sideways, back, and forth on each of the trailer arms. The play should be visible if present. Check both ends of the connecting rods for abnormal play. If the play is more than 1mm at any of the connecting points, replace the bushings in the shaft for trailer mount and the trailer mounting bracket.
Check roller disc bearings	Visual check					Check the roller disc bearings for unusual wear and verify that all discs are spinning freely and they don’t have lateral play.

Task	Type	Daily	Weekly	Monthly	Yearly	Comments
						(As default the discs are mechanically forced together in the front)
Check wear on the trailer flex wheels.	Visual check					When the tools are lifted, check each flex wheel for visible damages and replace them if needed.
Thorough check of the entire tool						Perform a thorough inspection of the entire tool once a year. Check for loose bolts/nuts, cables, plastic surfaces etc. This should be performed by an authorized distributor

8.3 Wear part Maintenance Checks

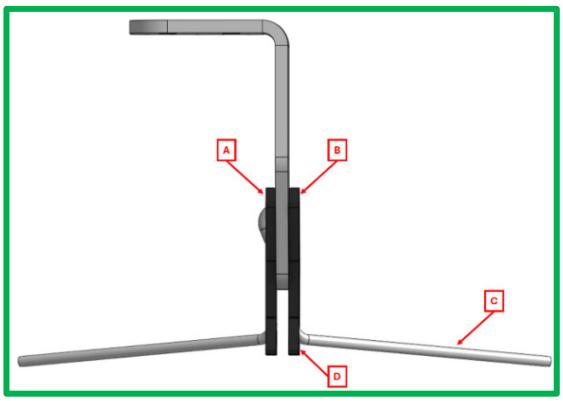
The table below contains the recommended maintenance checks of the wear parts.

The wear can vary significantly depending on the soil type and running conditions. Please pay special attention to how the wear develops under your specific conditions and take this into account to determine the most suitable replacement intervals for you.

Always make sure to follow the guidelines when performing maintenance work. If in doubt, please contact your local distributor for advice before commencing the service/maintenance task.

⚠ Always remember to follow the safety instructions when performing inspections or maintenance and service work on the Robot. Always turn off both power sources before entering the Robot safety zone.

Task	Type	Daily	Weekly	Monthly	Yearly	Comments
Wear on the in-row weeding knife.	Visual check					Check for wear along edge of the weeding knife, especially around the hook. The weeding knife should be replaced when the blade is worn away.
Wear on the connection rod between the weeding motor and the weeding arm.	Visual check					When the tools are lifted, gently rock the weeding arm back and forth to check the connection rod on the weeding motor for abnormal play. If the play is more than 1.5mm at any of the two connecting points, replace the bushings in the connection arm, and/or the bushings if damaged.
Wear on the hinges for the in-row weeding arm.	Visual check					When the tools are lifted, gently rock the in-row weeding arm up and down to check for abnormal play.

Task	Type	Daily	Weekly	Monthly	Yearly	Comments
						If the play is above 1,5mm at any of the two hinge points, replace the two bushings and/or the shaft if damaged.
Wear on the weeding wires	Visual check					Wear will be most visible close to the bends of the weeding wires. The weeding wires should be replaced if they are worn about halfway through or if they are broken.
Wear on locking plates holding the weeding wires	Visual check					Look at the weeding wire assemblies in the image below. If the two locking plates [A,B] holding the weeding wire [C] in position are wearing out at the bottom [D], then replace the plates. 
Check wear on seed coulter	Visual check					Wear will be on the bottom edge of the seed coulter Replace if the bottom is worn flat or too wide for the seeds.

8.4 Purchase and Replacement of Wear Parts and Spare Parts

Please contact your local distributor for purchase of wear parts and spare parts.

Wear parts can in general be changed by the user.

Spare parts must be replaced by a FarmDroid Service Technician through your local distributor to ensure proper functionality and to preserve the Robot's warranty.

Pay special attention to the instructions following the spare parts and make sure to read and understand them fully before commencing any work.

8.5 Preventive maintenance checks of the Safety System

The Safety System of the Robot is designed to have a lifetime of at least 30 years when correctly maintained. Maintenance of the Robot's safety system should only be performed by trained professionals.

The safety system fulfills the requirements for reaching Performance Level D, Category 2.
The PLC functions as the OTE in the Category 2 test circuit.

Please refer to Appendix A for electrical wiring diagrams.

Before performing maintenance work, and especially if it requires to be inside the safety wire perimeter, the power must be turned off by: 1. Turn off the solar panels on the switch located on the underside of the solar panels on the left side of the robot. 2. Turn off the main switch on the left side of the main switchboard. If in doubt, please contact your local distributor for advice before commencing the service/maintenance task.

⚠ Always remember to follow the safety instructions when performing inspections or maintenance and service work on the Robot. Always turn off both power sources before entering the Robot safety zone.

Task	Type	Daily	Weekly	Monthly	Yearly	Comments
Check for general damage on the Robot and especially its safety system.	Visual check	■				Consult your local distributor if damages on the safety system are detected.
Check for damage to the light indicators.	Visual check		■			Must be replaced immediately if damaged.
Check for damage to the audible indicator.	Audible check		■			Must be replaced immediately if damaged. The robot will automatically ask for a routine check of the audible indicator with 2 weeks intervals. Make sure to follow the instructions in the HMI.
Check safety wire tensioning.	Visual check		■			Check if the safety wire tension is acceptable and not close to the trigger lines on both wire switches. Adjust the wire tension, if necessary, by using a 10mm spanner at each wire switch.
Safety system	Visual check			■		Individually activate both emergency wire switches and the emergency push button to test the safety system. Perform a separate test for each switch to check for proper functionality. The robot will automatically ask for a routine check of the safety wire switches and emergency stop button with half-year intervals. Make sure to follow the instructions in the HMI.

⚠ It is of utmost importance that all the safety related parts listed below are only replaced with the exact same part with the same item number or by a similar component with exact same specifications. If in doubt, always contact your local distributor.

Safety Related Parts List			
Part Description	**Manufacturer**	**Part Number**	**Quantity**
Main Relay	Siemens	3RT2026-2KB40	1
Safety Relay	Schneider Electric	XPSUAF13AC	1
Emergency Push Button	Schneider Electric	XALK178F	1
Emergency Stop Trip Wire Switch, left	Schneider Electric	XY2CJL17H29	1
Emergency Stop Trip Wire Switch, right	Schneider Electric	XY2CJR17H29	1
Wire Tightener for Emergency Stop Trip Wire Switch	Schneider Electric	XY2CZ210	2
Red Wire, 10m	Schneider Electric	XY2CZ301	1

9 Storage

When the season is over, it is recommended to store the Robot in a barn, garage, or the equivalent where the Robot can stand in shelter from rain, snow, wind, or other negative impacts from the environment.

Before storing the Robot during winter months and off-season, some checks should be performed. These checks can be found in the checklist below:

⚠ Before working inside the safety wire perimeter, the power must be turned off by: **1.** Turn off the solar panels on the switch located on the underside of the solar panels on the left side of the robot. **2.** Turn off the main switch on the left side of the main switchboard.

#	Item	Description	Completed
1	Clean the robot	1. Make a visual inspection of the solar panels and cables. If no damages are found, wash the panels using water and a soft wash brush. 2. It is highly recommended to wash the robot with low pressure cold water and a medium soft brush avoiding direct splash at electrical components e.g. charge controller, motors, connectors, batteries, etc. Instead, a wrung wet cloth must be used to clean these components..  Never use high pressure for cleaning batteries, electrical box, solar panel charger.	
2	Safety Systems	1. Check that all emergency stops, and safety wires are working. These should be tested and reset one by one.	
3	Seeding System	1. Place the seeding units in the seeding position to straighten out the transparent seeding tubes. 2. Empty the seeding system and the seed boxes. Remove the seed boxes and funnels to verify that the system is empty and clean the boxes using compressed air. When clean and dry, the boxes can be remounted. 3. Clean the seed sensors using compressed air. Only use compressed air to clean the sensors as they are very sensitive to mechanical damage.	
4	Weeding System	1. Make a visual inspection of the weeding motors, bolts, the linkage, and weeding arms. If any wear is found on either one of the parts, these should be replaced. 2. If any bolts are found to be loose, these should be tightened. 3. Check the connection plugs and cables for any damages.	
5	Batteries	1. Fully charge the batteries by either placing the robot outside until the batteries reach 28V or by using an appropriate 24V LiNMC charger. With the charger approved and offered by FarmDroid this level is safely reached by an overnight charge. 2. Disconnect the main switch to isolate the batteries. 3. It is recommended to store the batteries to at least 10°C, 4. It is recommended to perform maintenance charging of the batteries whenever the voltage of the single battery reaches 23V or, at least every third month.	

#	Item	Description	Completed
		For any additional information, please refer to the Battery User Manual attached at the end of this document.	
6	Wheels and Gears	1. Perform a visual inspection of the propulsion motors and gears. Furthermore, check the gear shaft for any play by firmly grabbing the tires with your hands and rock the wheels back and forth. 2. If there are any damages to the coating of the motors or gears, these should be touched up by use of appropriate paint.	

When taking the Robot out of storage before beginning a new season, familiarize with the content of this manual again. Furthermore, it is required to check the safety system once again prior to starting operation.

For additional information on pre-season maintenance please visit FarmDroid Knowledge Base:

https://knowledge.farmdroid.io/service-checklist

10 Disposal

After end of use, the Robot must be disposed of or recycled according to local legislation and practices. It is the responsibility of the owner to ensure that items are not left in locations or in conditions that can negatively impact the environment and be a hazard to people and animals. Especially batteries and solar panels should be handled with care after decommissioning:

- The batteries should never be opened or disassembled by untrained personnel. If opened and handled incorrect, a risk of explosion could occur. The batteries contain chemical substances and materials which can be harmful to the environment. Furthermore, if recycled correctly, most of these materials can be reused for manufacturing of new batteries. Thus, the batteries could even represent a value, if recycled.

- Decommissioned and even damaged solar panels will be able to produce current at high voltage, when exposed to the sun. If solar panels or connectors are damaged, only trained electricians should handle them. To avoid hazards to unsuspecting people and animals the solar panels must be disconnected and disposed responsibly. During all handling of the solar panels, they should be kept away from sun light exposure.

The primary parts of the body and tooling of the Robot is made of stainless steel and could be recycled. These parts might represent a value after decommissioning of the robot.

Please refer to the attached battery user manual for further information regarding disposal.

11 Troubleshooting

During normal use, the Robot will inform the user of any errors related to operation via the “Activity” overview at page: **1. Home Auto** or **5. Event overview** and **5.1 Event history** in the HMI.

Depending on the event or alarm, the user might be required to reset or correct the cause of the error.

Error	Guide
Seeding-related errors	If the Robot has stopped because of a seeding error, check the following, in prioritized order. ⚠ Before working inside the safety wire perimeter, the power must be turned off in the following order. **1.** Turn off the solar panels on the switch located on the underside of the solar panels. **2.** Turn off the main switch on the left side of the main switchboard. Open the solar panels for easy access to the seeding tool and seed boxes. 1. Check if there are seeds in all the seed containers. 2. Identify from the HMI which seeding tool the alarm relates to. If the alarm relates to a dusted seed sensor, clean the sensor from the seed outlet of the seeding valve, using compressed air, a light brush or soft fabric that cannot scratch the surface of the light sensor. 3. Check if any seed is stuck in any of the seed discs. 4. Check that the outlet of each seed box is properly inserted into the seed funnels. 5. Check if the seeding valve is blocked or if any dirt or debris are preventing the valve from operating. If so, the seed valve should be removed, cleaned or serviced. When the issue has been identified and corrected, close the solar panels top, and when standing outside the safety wire, turn on the main switch on the left side of the main switchboard and then turn on the solar panels. Reset the safety wire and emergency stops if required. To turn on the power after reconnecting the main switch you must press and hold the stop button on the operator panel for approx. 15 seconds until the HMI turns on. The stop button lights up when pushed. It is recommended to perform a manual function test to verify the problem has been solved. Go to page **4.3 Manual Function Test** in the HMI. Select the relevant tool and activate function test. Then perform the following test: 1. Activate the seed valve, by pressing on the button 3-5 times. The seed valve should make a click sound each time it is activated and deactivated, otherwise this might indicate that the valve is stuck open or closed. 2. Activate the seed valve and leave it on, then start the seeding motor and verify the seed motor is turning and counting up the Position [°] and Seeds loaded. Then verify that Seed detected also count similar to seeds loaded. If the seed motor is turning but seeds are not detected through the open seed valve, then: a. the unit could be out of seeds or the system blocked between the seed disc and seed valve. b. The light sensor might have to be cleaned to detect the falling seeds.

Error	Guide
Weeding-related errors	If the robot has stopped on weeding related errors then perform the following: 1. Perform a visual inspection from outside the safety wire. If any objects are detected, turn off the power and proceed to step 2. If no objects are detected, then proceed to step 3. ⚠ Before working inside the safety wire perimeter, the power must be turned off in the following order. **1.** Turn off the solar panels on the switch located on the underside of the solar panels. **2.** Turn off the main switch on the left side of the main switchboard. **Attention:** When turning on the power, the main switch board must be turned on first, and then the solar panels, otherwise, the solar panels will not charge the batteries. 2. Remove any foreign objects or obstacles. 3. Identify from the HMI which tool the alarm relates to. If the alarm relates to a single tool, this might indicates a local problem, while if the error is on multiple tools this might indicate incorrect mechanical or software settings. • Check the workign depth of weeding knives and set them at a slightly shallower depth. Verify if the error appears again. • Edit the software settings for weeding by either reducing the driving speed of the robot, increasing the speed of the weeding arm, decreasing the outermost position value for the weeding arm. 4. Move the weeding arm of the trailer which triggered the weeding error. If there's additional resistance to its movement compared to the other tools, then it might be a mechanical problem. • Check for worn or broken bushing and shafts • Contact your local distributor for additional guidance 5. When the issue has been identified and corrected, the Robot can be restarted. When standing outside the safety wire, turn on the main switch on the left side of the main switchboard and then turn on the solar panels. Reset the safety wire and emergency stops if required. 6. Perform a manual function test to verify the function of the weeding arm. Go to page **4.3 Manual Function Test** in the HMI. Select the relevant tool and Activate function test. Set the Output strength to 50 and activate the weeding motor. If the motor does not perform a full movement, then deactivate the Manual function test and continue to step 5. 7. Go to page **4.1.2.2 Weeding Tool Settings – Advanced**, and perform a Clutch Check. All motors should not move all the way out and in again. If a clutch check fails, a visual inspection of the specific motor has to be performed. The power should be turned off according to step 2, whereafter it manually has to be checked that the weeding arm can move all the way out and in. If there is full movement, repower the robot. When the robot starts up, it will perform a clutch check. If this fails, please contact your distributor.
Robot Stuck	If the robot stops on a "stuck"-alarm, the following should be checked. 1. Visually inspect the Robot in the field with special attention to mud holes, big stones, or other obstacles preventing the Robot from moving forward.

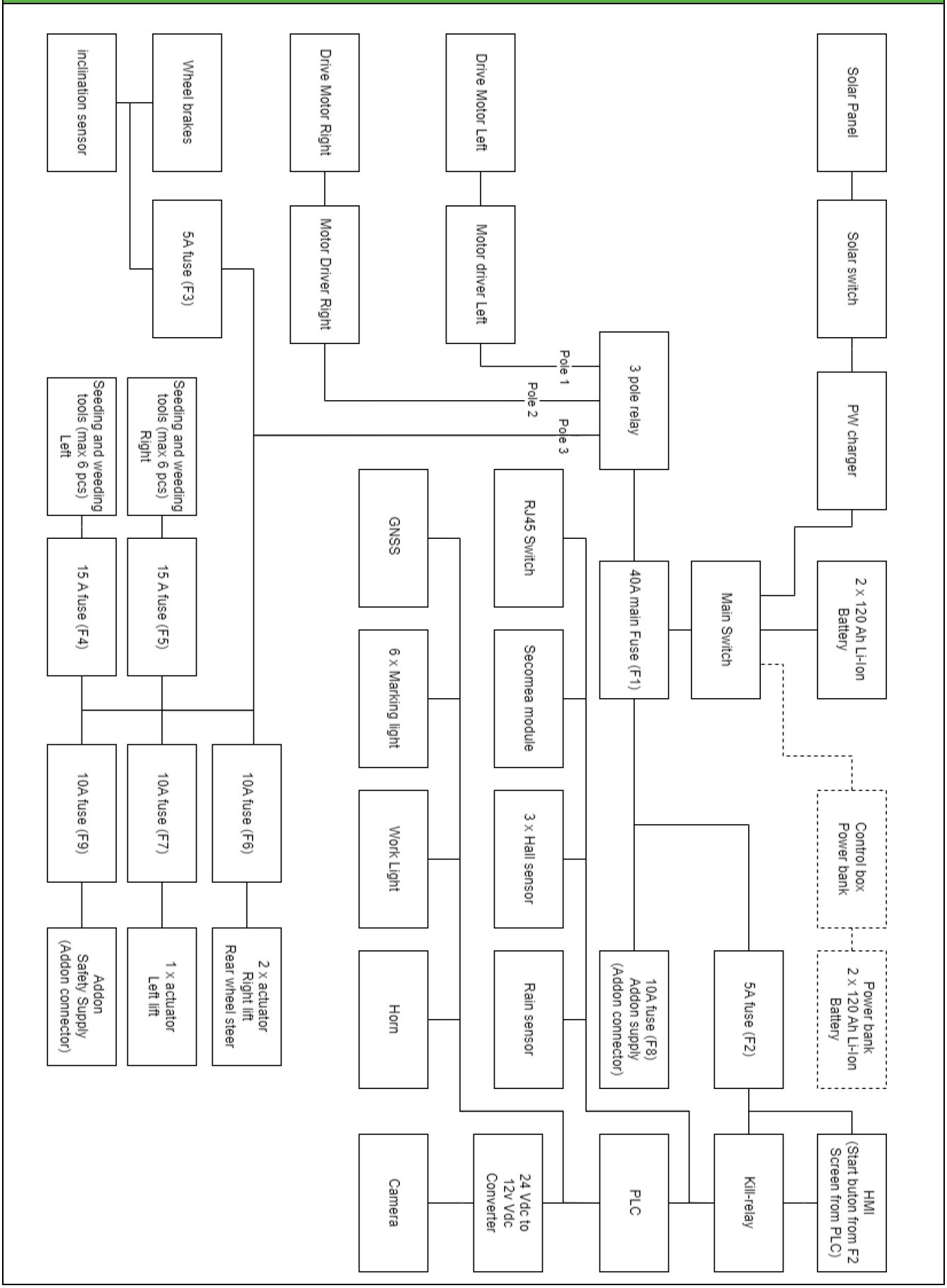
Error	Guide
	⚠ Before performing any physical work on the robot or close proximity inspection, set the operation mode to Manual in the HMI. 2. Inspect the propulsion motors and gears for any foreign or entangled objects. If any objects are identified, continue to step 5. 3. Test by means of the joystick if the robot can move forward and backwards, and drive in a straight line. Also check if the robot can turn in all directions. If no errors are identified, then reposition the robot and restart automatic operation. If an error is identified, please proceed to step 5. 4. Turn off the power in the following order. **1.** Turn off the solar panels on the switch located on the underside of the solar panels. **2.** Turn off the main switch on the left side of the main switchboard. **Attention:** When turning on the power, the main switch board must be turned on first, and then the solar panels, otherwise, the solar panels will not charge the batteries. 5. If present, remove any foreign objects or obstacles. Otherwise check the supply plugs for the faulty motor(s) are properly connected. When the issue has been identified and corrected, the Robot can be restarted. When standing outside the safety wire perimeter, turn on the main switch on the left side of the main switchboard and then turn on the solar panels. Reset the safety wire and emergency stops if required. To turn on the power after reconnecting the main switch, you must press and hold the stop button on the operator panel for approx. 15 seconds until the HMI turns on. The stop button lights up when pushed. If the problem is not resolved, the contact your distributor.
No RTK Signal	If the Robot does not have any RTK signal, then go to page **4.1.6 GNSS** in the HMI. If the GNSS data updates and the robot is connected to more than 10 satellites, without having RTK signal, then perform the following procedure: 1. Restart the GNSS-system by turning off and the 24v supply in the HMI on page **4.1**. After restart wait app. 2 minutes and see if the GNSS coordinates update on HMI page **4.1.6 GNSS**, and if the system receives RTK corrections. If this is not the case, then go to step two. 2. Check if the Base Station is powered on. 3. Restart the Base Station in accordance with the troubleshooting guide provided in the User manual Base Station v2.0. If the above does not solve the problem, this could indicate that data communication is missing between the Robot and Base Station. In this case contact the FarmDroid Care or your distributor.
Batteries and Solar Panels.	If the batteries are not being charged by the Solar Panels, this could indicate that the solar panel switch is turned off or that the Robot has been powered up in the wrong sequence, or the charge controller being in error mode. To verify if the solar panels are charging, complete the following steps: 1. Place the robot outside in daylight. 2. Turn off the solar panels on the switch located on the underside of the solar panels.

<table>
<tr><th>Error</th><th>Guide</th></tr>
<tr><td></td><td>
3. Turn off the main switch on the left side of the main switchboard and wait for 10 seconds.
4. Turn on the main switch on the left side of the main switchboard.
5. Press and hold the stop button on the operator panel for approx. 15 seconds until the HMI turns on and wait for it to start up. The stop button lights up when pushed.
6. In the HMI, go to Page 2.1.2. Run information and monitor the Battery Voltage.
7. Turn on the switch for the solar panels and see if there is energy flow to the batteries in Page 2.4. If the energy is not flowing, continue to step 8.
8. On the charge controller verify the status of the LEDs.
LED indication:
● permanent on
◎ blinking
○ off
Regular operation
<table>
<tr><th>LEDs</th><th>Bulk</th><th>Absorption</th><th>Float</th></tr>
<tr><td>Bulk (*1)</td><td>●</td><td>○</td><td>○</td></tr>
<tr><td>Absorption</td><td>○</td><td>●</td><td>○</td></tr>
<tr><td>Automatic equalisation (*2)</td><td>○</td><td>●</td><td>●</td></tr>
<tr><td>Float</td><td>○</td><td>○</td><td>●</td></tr>
</table>
Note (*1): The bulk LED will blink briefly every 3 seconds when the system is powered but there is insufficient power to start charging.
Note (*2): Automatic equalisation is introduced in firmware v1.16
Fault situations
<table>
<tr><th>LEDs</th><th>Bulk</th><th>Absorption</th><th>Float</th></tr>
<tr><td>Charger temperature too high</td><td>○</td><td>○</td><td>◎</td></tr>
<tr><td>Charger over-current</td><td>◎</td><td>○</td><td>◎</td></tr>
<tr><td>Charger over-voltage</td><td>○</td><td>◎</td><td>◎</td></tr>
<tr><td>Internal error (*3)</td><td>◎</td><td>◎</td><td>○</td></tr>
</table>
Note (*3): E.g. calibration and/or settings data lost, current sensor issue.
If the above does not solve the problem, the distributor must be contacted for professional support.
</td></tr>
</table>

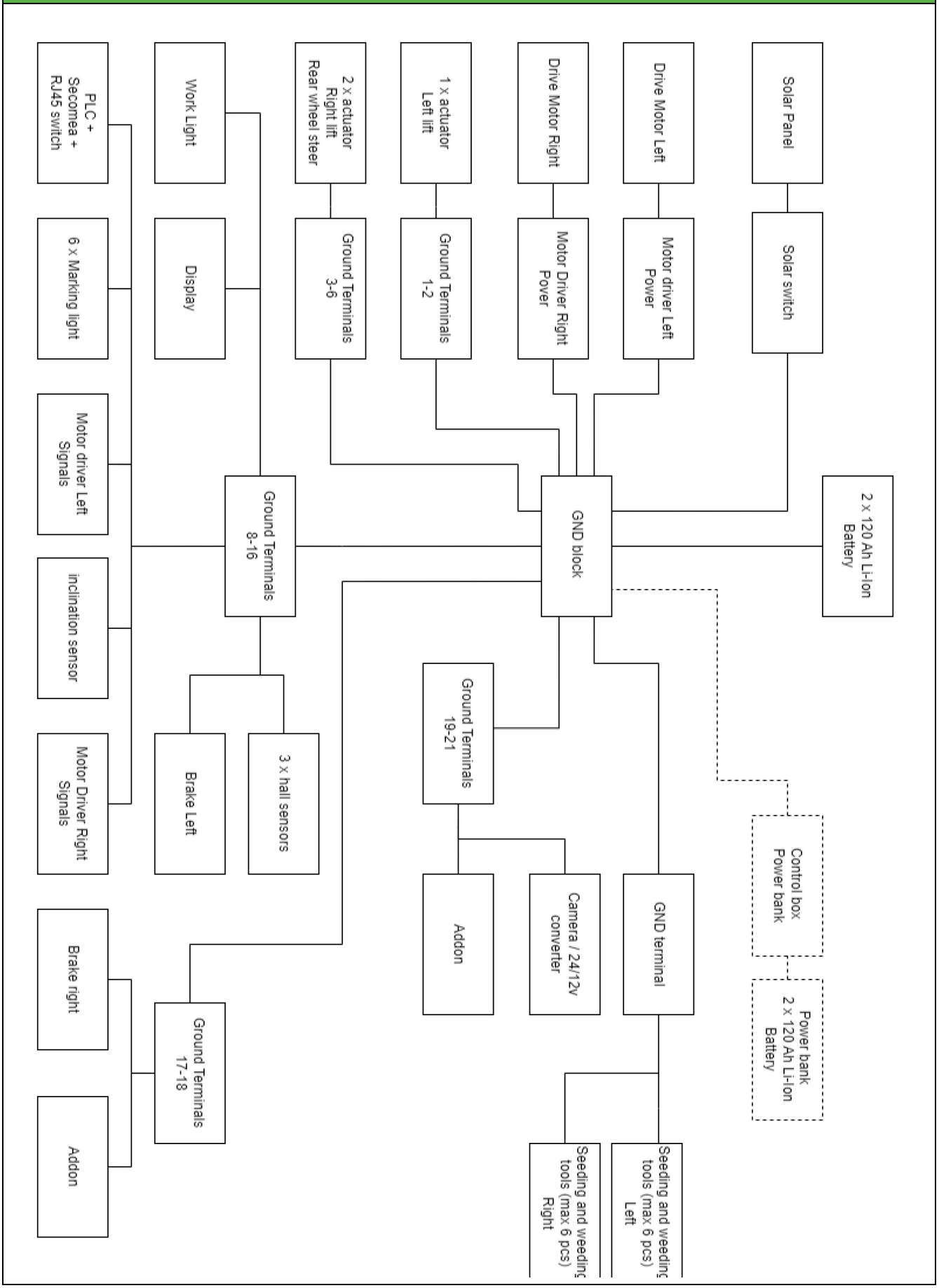
It is important that the user does not engage in any unauthorized modifications in order to bypass or by other means set aside a safety device in order to resume operation. Furthermore, the user should not make any operational modifications, as in both cases FarmDroid ApS cannot be held accountable for any negative consequences, nor will the warranty apply.

FarmDroid Care can be contacted directly by e-mail writing at support@farmdroid.com.

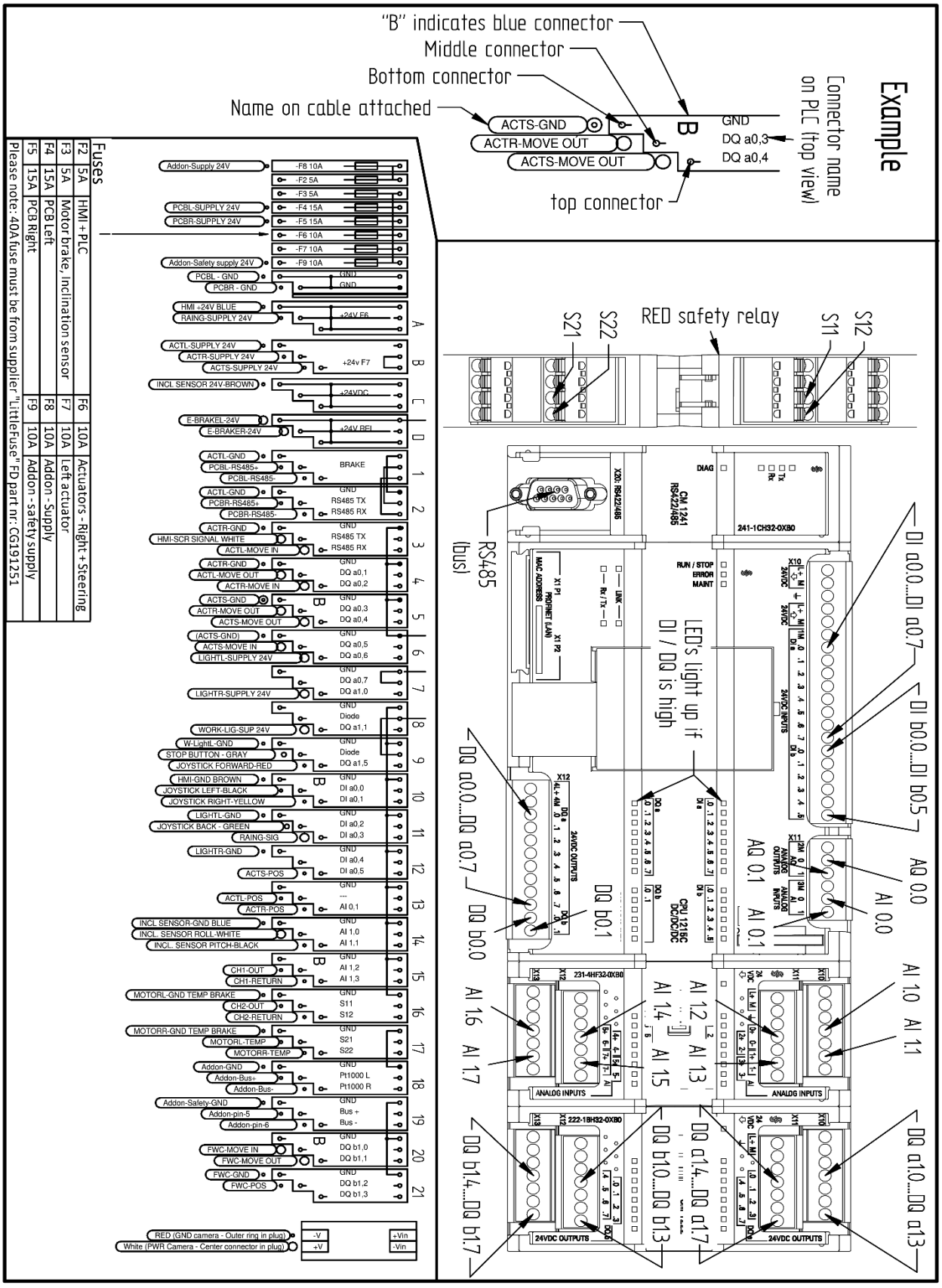
Electrical Connections – Power Diagram FD20 v2.6



Electrical Connections – Ground Diagram FD20 v2.6



Electrical Connections – Electrical Box termination overview



Battery manual – Battery manufacturers manual for the batteries

User Manual
FOR BATTERIES FROM WS TECHNICALS

WS TECHNICALS

WS Technicals A/S
Gjellerupvej 89A
8230 Åbyhøj
Denmark

+45 88 61 83 88
wstech@wstech.dk
wstech.dk

CVR: 37290785

Contents

Preface

Dear customer,

This manual contains relevant information necessary to install, use and maintain batteries from WS Technicals. Read this manual carefully before installing and using the batteries.

General Use

Environmental conditions

⚠ **Caution!**
Our batteries may only be used in conditions specified in this manual. Exposing the battery to conditions beyond the specified boundaries may lead to serious damage to the product and/or the user. Use the battery in a dry, clean, dust free, well-ventilated space. Do not expose the battery to fire or solvents.

When the batteries are placed in an enclosed environment without air circulation, it is advised to provide 2 ventilation holes of 100 mm x 100 mm each, to prevent heat built-up.

Recommended charge temperature range	0°C to +45°C*
Discharging operating temperature range	-10°C to +55°C*
Short term (<1 month) storage temperature range	-10°C to +35°C
Long term (>1 month) storage temperature range	15 ± 5°C (Constant Temperature)
Relative humidity	10-90%

Operation modes

Discharge

Discharge is when power is being drawn from the battery. The power drawn must never exceed the specified values for your model. Please refer to the specification sheet for your product.

Exceeding specifications for discharging will void all warranties given

Charge

Charge happens when the battery terminals are exposed to a voltage which is higher than the battery's voltage.

The voltage must never exceed the maximum charging voltage found in the specifications for your battery.

Charging must happen like specified in the later chapter "Battery use".

Exceeding specifications for discharging will void all warranties given

Sleep

If the battery does not sense any charge, discharge or active communication, it will sleep. This happens to preserve power and there is a built-in delay before it sleeps. This delay varies with the models.

When in sleep mode, the battery will only consume 1-2% of the current it is consuming when operational, so a battery which has been charged to 40% SoC before storage, will easily be able to maintain a healthy level of SoC during storage.

Recharge the batteries to 40% SoC every 3 months.

Deep discharge

If a lithium battery's voltage drops below a certain value, it will be irreversibly damaged. This state is typically called deep discharge.

To protect the batteries from deep discharge, the battery is monitored by a Battery management system (BMS), which among other features have an under voltage-protection (UV).

The under-voltage protection means that the BMS will monitor the cell voltages and shut off discharge if the voltages drop below the UV threshold for the specific pack.

Please note that the under-voltage protection is not to be viewed as a feature but instead as a safety measure and it is always the user's responsibility to ensure that the voltage never drops below the under-voltage protection threshold.

If the pack is left in the under-voltage state, it will at some point deplete itself to a point where it cannot be recharged again. Such a battery must be discarded.

⚠ **Warning!**
Never store a depleted battery! The battery should be charged to a voltage equivalent of 40% SoC when stored.

- Reaching the under-voltage threshold will void all warranties given.

⚠ **Warning!**
Please note that many chargers will NOT start charging unless they can measure a voltage from the battery, which is not possible if the BMS already has shut off discharging. Therefore, to "wake" the BMS, a charger with a wake-up function is needed. If a BMS has shut down, the wake-up pulse can also be used to power on the BMS again.

Please contact your supplier to learn if your charger supports this.

The wake-up voltage "pulse" should only be applied once (<5 seconds for most chargers employing this function). After this the battery cell voltages should be checked for:

1. Imbalance
- No cell voltages should differ more than 300mV between each other.
2. Low voltage
- No cells voltage should be lower than 2.8V (for Li-NMC), or 2.7V (for LFP – Lithium Iron Phosphate)

If either of these two conditions are not met, the battery should be discarded immediately.

Safety guidelines

DO NOT USE THE BATTERY IF IT HAS BEEN DROPPED, EXCESSIVELY HANDLED OR DAMAGED IN ANY WAY!

General

- Failure to treat the battery as described in this manual, will void all warranties given.
- Always maintain the battery voltage so that the BMS does not enter a protective or erroneous mode.
- Do not serial-connect or parallel-connect the batteries unless told otherwise by WS Technicals or an authorized dealer.
- Do not short-circuit the battery.
- Do not dismantle, repair, modify, crush, puncture, open or shred the battery.
- Do not expose battery to heat or fire. Avoid exposure to direct sunlight.
- Do not remove the battery from its original packaging until required for use.
- Use a battery charger approved by WS Technicals.
- Observe the plus (+) and minus (–) marks on the battery and equipment and ensure correct polarity.
- Do not mix batteries of different manufacture, capacity, size or type within a device.
- Keep the battery clean and dry.
- When storing the battery, it must be recharged to at least a voltage equivalent to 40% SoC every 6 months.
- Retain the original product documentation for future reference.

Disposal

Dispose of the battery in accordance with all applicable laws and regulations. Batteries may be returned to reseller or WS Technicals at the expense of the user.

In case you drop the battery

If a battery is dropped, it should not be used. Place it at a location that prevents propagation in case of fire and put it under human surveillance for 30 min. In this time check for signs of internal damage like heat buildup or smoke, before putting the battery aside.

The warranty is void after a battery has been dropped. If the user wishes, the battery can be shipped to WS Technicals for an inspection to verify the functionality of the battery and to reapply the warranty, in case no damage is found inside.

In case of smoke

⚠ **Warning!**
In case of fire, call your country's fire emergency.

⚠ **Warning!**
In case of a fire, do not inhale the fumes

If the battery starts to give off smoke, disconnect the load or charger and if possible, without touching the battery directly or inhaling the fumes, move the battery outside to a place where a possible fire cannot propagate.

If a battery cannot be moved to another location, a fire blanket, water or other appropriate extinguishing methods can be utilized to prevent the fire from propagating.

WS Technicals A/S
Gjellerupvej 89A
8230 Åbyhøj
Denmark

+45 88 61 83 88
wstech@wstech.dk
wstech.dk

CVR: 37290785

Installation

General Information

⚠ **Warning!**
Wear protective gear such as gloves and protective glasses while installing batteries.

⚠ **Warning!**
Do not directly touch the battery terminals as these present a hazard in terms of electric shock.

⚠ **Warning!**
Only install the batteries in series if you have a written confirmation from WS Technicals, that this is possible, or if the specifications for your model states that it is.

⚠ **Warning!**
Never install or use a damaged battery.

⚠ **Caution!**
Do not reverse connect the power cables (polarity).

⚠ **Warning!**
Never connect two batteries in parallel if the voltages are not the same. A voltage difference will mean that one battery will charge the other at an extreme current, which can damage the batteries.

When connecting multiple batteries in parallel always use batteries of the same model, age, capacity and with equal pack voltages (+/- 0.2V).

Unpacking

Check the battery for damage after unpacking. If the battery is damaged, please contact WS Technicals or your reseller. Do not install or use the battery if it is damaged!

Preparing the battery for use

⚠ **Warning!**
Always keep within the limits specified in the datasheet for the battery model you are using.

Connecting the battery

⚠ **Warning!**
Some applications will draw power even when left unused. It is the user's responsibility to ensure that deep discharge is prevented by disconnecting or switching off the load, when not used.

Make sure all cables are rated for the current that you are going to draw. This is especially important when paralleling the batteries.

Always use a fuse matching the wires and load.

⚠ **Warning!**
Please notice that each battery must be fused individually, when coupling them in parallel.

⚠ **Caution!**
Some applications may subject the battery to high voltage transients. These may damage the BMS and compromise safety.

Connecting the batteries in parallel

Before connecting the batteries in parallel, it is extremely important that they have the same pack voltage (+/- 0.2V).

When connecting batteries in parallel it is important that there is an equal cable length from each battery to the load. Failure to do this will lead to imbalances between the connected batteries.

Connecting the batteries in series

⚠ **Warning!**
Never attach loads to the individual batteries in a series configuration. This will create imbalances and could damage the batteries. If two 24V batteries are connected in series to reach 48V, then 48V is the only voltage you can draw.

Only connect the batteries in series if told by WS Technicals or if the specification sheet explicitly states this is possible and only connect as many as the specifications sheet states.

When the batteries are connected in a series configuration, it is important to minimize the cable lengths.

WS Technicals A/S
Gjellerupvej 89A
8230 Åbyhøj
Denmark

+45 88 61 83 88
wstech@wstech.dk
wstech.dk

CVR: 37290785

Battery use

Charging

⚠ **Warning!**
Always ensure that the charger is compatible with the battery and that all charging happens within the specifications for the battery. When in doubt, ask your reseller or WS Technicals.

⚠ **Warning!**
Never plug in more chargers to the same phase, than the phase can supply.

The negative (-) on the charger must be connected to negative (-) on the battery. The positive (+) on the charger must be connected to the positive (+) on the battery.

The charger can be connected while the application is connected.

⚠ **Caution!**
Disconnect the charger from the battery if it is not to be used for a long time.

Connect the charger to the battery as described in “Connecting and using a charger”

Charging rate

The standard charging rate (also called C-rating) for the batteries is 0.5C. This means that if the capacity is 40Ah, we can charge with 20A and if the capacity is 100Ah, we can charge with 50A.

Some of the batteries support charging at higher C-ratings. Please consult the specifications for your battery, to learn the possible charging rates for your battery.

At higher charging rates, the battery will increase in temperature. This is expected. If the ambient temperature is high, it is possible for the temperature to exceed the operating temperatures for the battery.

If the temperatures exceed the operating temperatures specified in the data sheet, the battery will prevent charging until it has cooled off.

Charging method

All lithium batteries from WS Technicals needs to be charged with a Constant current/Constant Voltage method.

In the first phase of charging an empty battery, the charger will use a constant current until the desired end voltage is reached, then it switches to a constant voltage charging, until the current that the battery accepts drops below 5% of the nominal capacity in Amperes.

⚠ **Warning!**
When the tail-current of 5% of the nominal capacity in amperes is reached, the charger must terminate the charging process.

⚠ **Warning!**
Mini-cycles and high voltage holds must be prevented by not recharging the battery before the voltage has dropped below the equivalent of 80% SoC.

Discharging

When discharging it is important that the current does not exceed the specifications for the battery.

⚠ **Warning!**
It is the user's responsibility to monitor the battery to avoid a deep discharge.

⚠ **Warning!**
After discharging, always charge the battery to at least a voltage equivalent to 20% SoC if it is to be used soon or a voltage equivalent to 40% SoC, if it is to be stored for a prolonged time.

Inspection, cleaning and maintenance

General information

⚠ **Warning!**
Never attempt to dismantle the battery. The batteries do not contain serviceable parts.

Disconnect the battery from loads or charger before inspection.

Inspection

Regularly check the battery's state of charge. The battery will consume a small amount of power, even when it is not in use or being stored.

If the run time drops below 80% of the initial run time or the charging time suddenly increases, please consider replacing the unit.

Cleaning

Never use any liquids, solvents or other abrasives to clean the battery.

If necessary, clean the battery with a soft and dry cloth.

Storage

The optimal storage temperature for the battery is 15 degrees Celsius.

The guidelines below must be followed when the battery is not in active usage. Failure to do so will void the warranty.

1. The battery should be charged to a voltage equivalent to 40% SoC
2. Kept at 15 degrees Celsius +/- 5 degrees.
3. Every 6 months the battery should be recharged to a voltage equivalent to 40% SoC

Disposal

Always discharge the battery and cover the connectors with electrical tape, before disposal.

Always dispose of the battery in accordance with any applicable laws and regulations.

The battery can be returned to WS Technicals at the expense of the user.

Contact information

In case of doubt, WS Technicals can be reach via phone or email at:

Email: wstech@wstech.dk

Telephone: +45 88 61 83 88