

# FARMDROID



## FARMDROID FD20 v2.4 ORIGINAL USER MANUAL

Version 2.4.0 – Effective from December 2022

## Table of Content

1	General Information .....	1
1.1	Reading and understanding this manual .....	2
1.2	Common abbreviations .....	3
1.3	EU Declaration of Conformity .....	4
1.4	UK Declaration of Conformity .....	5
1.5	Reference list to applied harmonized standards .....	6
1.6	Technical Data .....	7
1.7	Data on Identification Plate .....	7
1.8	Purpose, Structure and Function of the Robot .....	9
1.9	Operator panel and Menu Structure .....	12
2	Safety Instructions .....	13
2.1	Safety Devices and their Function .....	14
2.2	IT & Communication Safety .....	16
2.3	Commissioning and Operation of the Robot.....	16
2.4	Handling of the Robot .....	17
2.5	Robot maintenance.....	17
2.6	Machine safety markings .....	18
2.7	Residual risks .....	19
3	Upon Reception .....	20
4	Prior to Commissioning.....	21
4.1	Test of Internet Performance .....	21
4.2	SIM-card from FarmDroid .....	21
4.3	SIM-card from Third-party Provider .....	22
4.4	Replacing the SIM-Card in the Robot.....	23
5	Commissioning and Entry into Service .....	24
5.1	Field Setup and Obstacles.....	24
5.2	Changing Between Existing Fields .....	36
6	Daily Operation .....	37
6.1	Manual Operation .....	37
6.2	Highly Automated Operation.....	37
6.3	Remote monitoring and operation .....	38
6.4	Robot propulsion overload protection .....	38
6.5	Auto Load controller.....	38
6.6	Battery Replacement and Charging .....	38
6.7	Seeding Settings.....	40
6.8	Changeover Between Seeding and Weeding.....	42
6.9	Weeding Settings.....	43
6.10	Restart Following Unintended Stop .....	45
6.11	Factory settings and Back-up .....	45
7	Transportation.....	46

7.1	Field Bracket .....	46
8	Maintenance .....	48
8.1	Preventive Maintenance Checks on the Robot .....	48
8.2	Preventive Maintenance Checks on the Tools .....	49
8.3	Wear part Maintenance Checks .....	50
8.4	Purchase and Replacement of Wear Parts and Spare Parts .....	51
8.5	Preventive maintenance checks of the Safety System .....	52
9	Storage .....	54
10	Disposal .....	56
11	Troubleshooting .....	57

### Table of Appendix content

Electrical Connections – Power Diagram FD20 v2.4 .....	A
Electrical Connections – Ground Diagram FD20 v2.4.....	B
Electrical Connections – Electrical Box termination overview .....	C

## 1 General Information

This user manual is exclusively for the FarmDroid FD20 v2.4.

The manual covers the following serial numbers.

20230310XXX and 20230810XXX

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](http://www.farmdroid.dk)

Mail: [info@farmdroid.dk](mailto:info@farmdroid.dk)

**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.

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

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
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
PV	Photo Voltaic
PLC	Programmable Logical Controller
GPS	Global Positioning System – the abbreviation covers, in this case, common satellite positioning system.

### 1.3 EU Declaration of Conformity

# EU Declaration of Conformity



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

#### Manufacturer

FarmDroid ApS  
Industrisvinget 5  
DK – 6600 Vejen

#### Authorized person in the Community to compile technical file

Peter Farby-Madsen  
FarmDroid ApS  
Industrisvinget 5  
DK – 6600 Vejen

#### Machine description and identification

Product	FarmDroid FD20 – Version 2.4
Serial number/s	20230310XXX + 20230810XXX
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	<i>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)</i>
RED 2014/53/EU	<i>DIRECTIVE 2014/53/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</i>
2011/65/EU	<i>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)</i>

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	<i>Safety of machinery – Safety-related parts of control systems Part 1: General principles for design</i> The safety control system is designed as Performance Level d (PLr Level d) in accordance with the requirements of this standard
ISO 13850:2015	<i>Safety of machinery – Emergency stop functions – Principles for design</i> 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	<i>Industrial trucks – Safety requirements and verification – Part 4: Driverless industrial trucks and their systems</i> 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.

Peter Farby-Madsen

Head of Innovation

Position

03-11-2022 Vejen, DK

Date / Place

1.4 UK Declaration of Conformity

UK Declaration of Conformity

According to Supply of Machinery (Safety) Regulations 2008, Annex II A



Manufacturer: FarmDroid ApS, Industrisvinget 5, DK - 6600 Vejen. Authorized person in the Community to compile technical file: Peter Farby-Madsen, FarmDroid ApS, Industrisvinget 5, DK - 6600 Vejen.

Machine description and Identification

Product: FarmDroid FD20 - Version 2.4. Serial number-s: 20230310XXX + 20230810XXX. 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 Regulations:

- S.I. 2008:1597 Supply of Machinery (Safety) Regulations 2008
S.I. 2017:1206 Radio Equipment Regulations 2017
S.I. 2012:3032 The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

The safety features of the product follow all essential requirements of Supply of Machinery (Safety) Regulations 2008 and complies with the following harmonized safety standards:

- EN/ISO 12100:2011 Safety of machinery - General principles for design - Risk assessment and risk reduction
ISO 13849-1:2015 Safety of machinery - Safety-related parts of control systems Part 1: General principles for design
ISO 13850:2015 Safety of machinery - Emergency stop functions - Principles for design
ISO 3691-4:2020 Industrial trucks - Safety requirements and verification - Part 4: Driverless industrial trucks and their systems

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

All relevant technical documentation is compiled according to Supply of Machinery (Safety) Regulations 2008 annex VII part A.

[Signature]
Peter Farby-Madsen

Head of Innovation
Position

03-11-2022 Vejen, DK
Date / Place



## 1.5 Reference list to applied harmonized standards

Below are references to applied harmonized standards in relation to which the machine fully or partly meets in relation to the CE Certification.

Applied Harmonized Standards	
DS/EN 349 + A1:2010	Minimumafstande til forebyggelse af legemsbeskadigelse
DS/EN 894-1+A1:2008	Maskinsikkerhed – Ergonomiske krav til udformning af display og betjeningsudstyr – Del 1: Generelle principper for personbetjening af display og betjeningsudstyr
DS/EN 894-2 + A1:2008	Maskinsikkerhed - Ergonomiske krav til udformning af display og betjeningsudstyr - Del 2: Display
DS/EN 894-3+A1:2008	Maskinsikkerhed – Ergonomiske krav til udformning af display og betjeningsudstyr – Del 3: Betjeningsudstyr
DS/EN 894-4:2010	Maskinsikkerhed – Ergonomiske krav til udformning af display og betjeningsudstyr – Del 4: Placering og indretning af display og betjeningsudstyr
DS/EN 1005-1 + A1:2010	Maskinsikkerhed - Menneskets fysiske ydeevne - Del 1: Termer og definitioner
DS/EN 1005-2 + A1:2010	Maskinsikkerhed - Menneskets fysiske ydeevne - Del 2: Manuel håndtering af maskiner og maskindele
DS/EN ISO 12100:2011	Maskinsikkerhed - Generelle principper for konstruktion - Risikovurdering og risikonedsættelse
DS/EN ISO 13732-1:2008	Ergonomi – Termisk miljø – Metoder til vurdering af den menneskelige respons ved kontakt med overflader – Del 1: Varme overflader
DS/EN ISO 13732-3:2008	Ergonomi – Termisk miljø – Metoder til vurdering af den menneskelige respons ved kontakt med overflader – Del 3: Kolde overflader
DS/EN ISO 13849-1:2015	Maskinsikkerhed - Sikkerhedsrelaterede dele af styresystemer - Del 1: Generelle principper for konstruktion
DS/EN ISO 13849-2:2014	Maskinsikkerhed - Sikkerhedsrelaterede dele af styresystemer - Del 2: Validering
DS/EN ISO 13850:2015	Maskinsikkerhed - Nødstop - Principper for udformning
DS/EN ISO 13855:2010	Maskinsikkerhed - Placering af beskyttelsesanordninger under hensyntagen til legemsdeles bevægelsehastigheder
DS/EN ISO 13857:2008	Maskinsikkerhed - Sikkerhedsafstande til forhindring af, at hænder, arme, ben og fødder kan nå ind i fareområder
DS/EN ISO 14118:2018	Maskinsikkerhed - Forebyggelse af uventet opstart
DS/EN ISO 14119:2013	Maskinsikkerhed - Tvangskoblingsanordninger i forbindelse med afskærmninger - Konstruktionsprincipper og udvælgelse
DS/EN ISO 14120:2015	Maskinsikkerhed – Beskyttelseskærme – Generelle krav til konstruktion, fremstilling og valg af faste og bevægelige afskærmninger
DS/EN ISO 18497:2018	Landbrugsmaskiner og traktorer – Sikkerhed af højt automatiserede landbrugsmaskiner - Konstruktionsprincipper
DS/EN 60204-1:2006 +A1:2009	Maskinsikkerhed - Elektrisk udstyr på maskiner - Del 1: Generelle krav
DS/EN 60445:2010	Grundlæggende principper og sikkerhedsprincipper for mand-maskine-interface, mærkning og identifikation - Identifikation af terminaler på udstyr og tilslutninger
DS/EN 60447:2005	Grundlæggende principper og sikkerhedsprincipper for mand-maskine-grænseflade, mærkning og identifikation - Betjenings-principper
DS/EN 61000-6-1:2007	Elektromagnetisk kompatibilitet (EMC) - Del 6-1: Generiske standarder - Immunitet for bolig-, erhvervs- og letindustrimiljøer
DS/EN 61000-6-2:2005	Elektromagnetisk kompatibilitet (EMC) - Del 6-2: Generiske standarder - Immunitetsstandard for industrielle miljøer
DS/EN 61000-6-3:2007	Elektromagnetisk kompatibilitet (EMC) - Del 6-3: Generiske standarder - Emissionsstandard for bolig-, erhvervs- og letindustrimiljøer
DS/EN 61000-6-4:2007	Elektromagnetisk kompatibilitet (EMC) - Del 6-4: Generiske standarder - Emissionsstandard for industrielle miljøer
DS/EN 61310-1:2008	Maskinsikkerhed - Visning, mærkning og betjening - Del 1: Krav til synlige, hørbare og følbare signaler
DS/EN 61310-2:2008	Maskinsikkerhed - Visning, mærkning og betjening - Del 2: Krav til mærkning
DS/EN 61439-1:2011	Lavspændingstavler - Del 1: Generelle krav
DS/EN 61439-2:2011	Lavspændingstavler - Del 2: Effektfordelingstavler
DS/EN 61439-3:2012	Lavspændingstavler - Del 3: Fordelingstavler beregnet til at blive betjent af lægmand
DS/EN 61800-5-1:2007	Elektriske motordrev med variabel hastighed – Del 5-1: Sikkerhedskrav- Elektriske, termiske og energimæssige.

## 1.6 Technical Data

Below, basic technical information for the robot is specified.

<b>Manufacturer:</b>	FarmDroid ApS
<b>Model Name:</b>	FD 20 V2.4
<b>Working Width:</b>	Upon request
<b>Maximum Recommended Covered Area:</b>	20 ha
<b>Maximum Speed Highly Automated Mode:</b>	950 m/h
<b>Maximum Speed Manual Mode:</b>	1100 m/h
<b>Maximum Brake holding slope (Static):</b>	15% (Depending on soil type, wetness, and general properties)
<b>Maximum recommended pitch for operation:</b>	8% (Depending on soil type, wetness, and general properties)
<b>Maximum recommended roll for operation:</b>	5% (Depending on soil type, wetness, and general properties)
<b>Seed Box Capacity:</b>	6 liters per seed box
<b>Trailer Distance Min/Max:</b>	225/250mm
<b>Tool:</b>	Configurable with 0 to 12 active rows
<b>Propulsion Motor Power:</b>	2x400W
<b>Solar Cell Power:</b>	1560W
<b>Battery Type:</b>	2x 24V 120Ah Lithium Battery Pack (LiFePo4)
<b>Battery Weight:</b>	52 kg (2 x 26kg)
<b>Robot Base Weight:</b>	900 kg incl. batteries
<b>Max Allowed Extra Robot Weight:</b>	Max 4 x 35 kg mounted on back wheel frame
<b>Max Allowed Extra Trailer Weight:</b>	Total max 12 kg per row; 2 kg per seed pressure wheel + 10 kg per trailer
<b>Max Total Robot Weight</b>	1184 kg
<b>Operating Temperature:</b>	0 to 40°C
<b>Storage Temperature:</b>	-10 to 50°C
<b>Noise Level:</b>	Below 70 dB (A)
<b>General Expected Lifetime:</b>	More than 10 years for main components following professional maintenance.
<b>Expected Battery lifetime:</b>	3 to 8 years (Depending on use)


## 1.7 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.

**FARMDROID**

Unit name:	FarmDroid FD 20
Type & Model:	FD20 V2.4
Serial number:	20230310001
Production year:	2023
Motor power [kW]:	0,8
Dry weight [kg]:	900

**Manufacturer:**  
FarmDroid ApS  
Industrisvinget 5  
6600 Vejen  
DK-Denmark  
VAT: DK39408589



CE  
UK  
CA

**1.8 Purpose, Structure and Function of the Robot**

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

The robot is battery powered and charges via solar panels. The machine can be operated by using the operator panel on the rear end of the robot or via the FarmDroid App. The robot is slow moving and operates when there is sufficient power on the batteries. Depending on the weather, the robot can operate around the clock during sunny periods. At other times, the robot stops when the batteries are depleted, but it starts up again automatically when the solar panels deliver power again, if left in Highly Automated mode. Before automatically starting again, the robot will provide a warning signal to inform the surroundings.

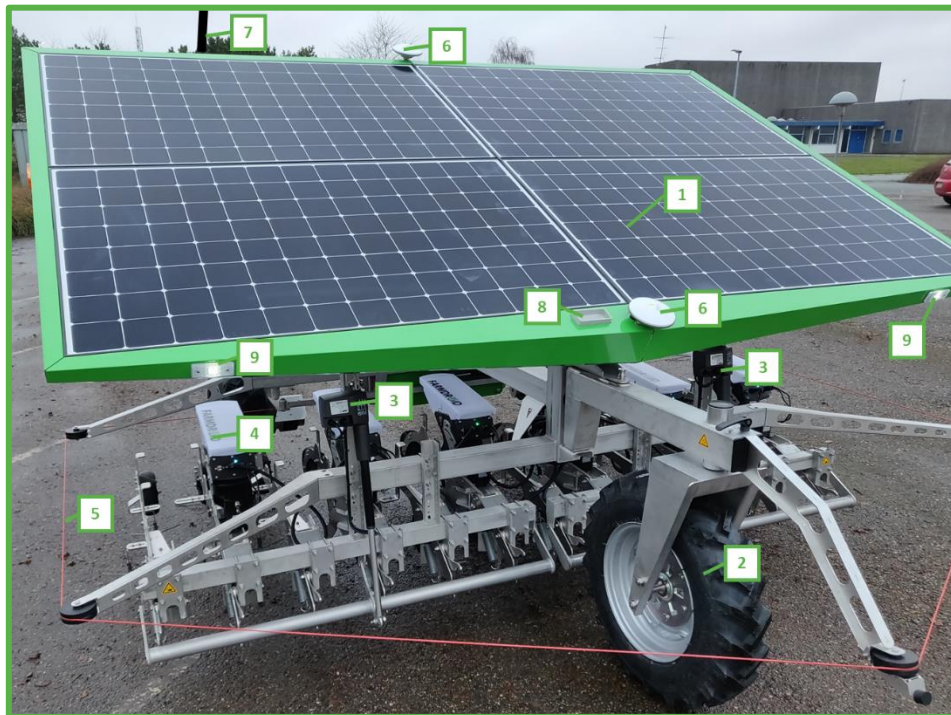
The robot has two driving wheels and in front a swivel caster wheel. The robot navigates by changing speed and/or direction of rotation on the rear wheels, thereby turning the robot. In addition, the rear wheels can steer to compensate for skidding when running on slopes.

The tool consists of 12 trailers that are individually suspended to operate independently on the soil. A configurable range of trailers is solely equipped with passive weeding equipment while the rest is equipped with both seeding and weeding equipment and associated electronics. 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.

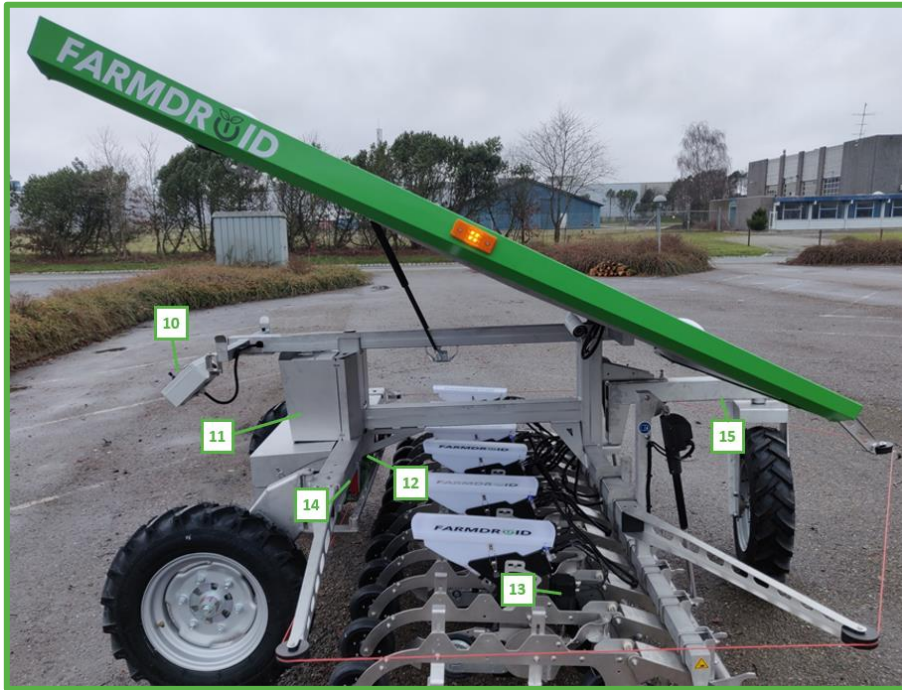
The solar panel tops can be tilted and are kept up by two gas springs. This eases the process of loading the machine with seeds as well as service and maintenance work.

**i** The Solar panel top must always be closed during operation.

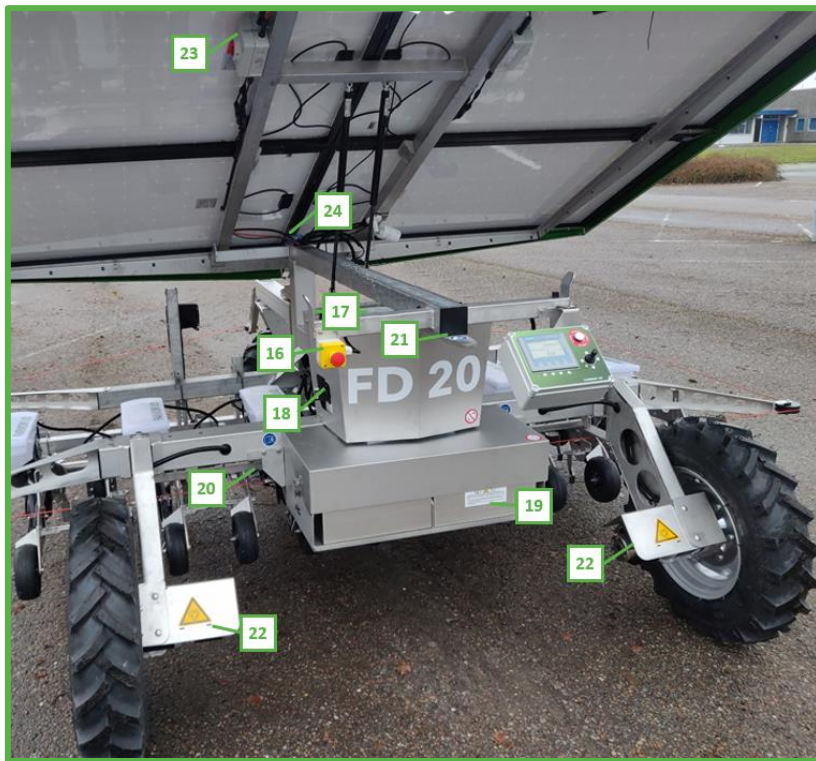
The pictures below show indications of relevant parts with references to their name or function.



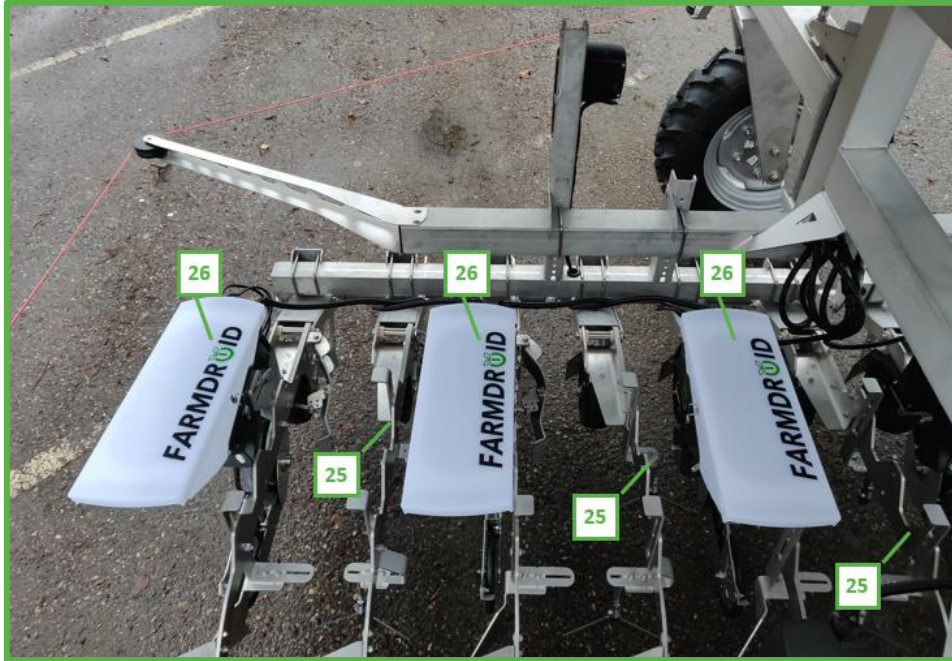
1	Solar panels	2	Front wheel	3	Hitch actuator
4	Seed containers	5	Safety wire	6	GPS-antennas
7	GSM-antenna	8	Rain sensor	9	Indicator lights



10	Operator Panel	11	Main board	12	Rear-end actuator
13	Weeding Motor	14	Safety wire switches	15	Front wheel suspension



16	Emergency stop switch	17	Solar panel charger	18	Main Switch
19	Batteries	20	Lifting points	21	Top hitch point
22	Propulsion Motor, Gear & Brake	23	Solar panel switch	24	Inclination sensor



25	Passive trailer (weeding tool)	26	Active trailer (Seeding and weeding)
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## 1.9 Operator panel and Menu Structure

The operator panel can be accessed at the rear of the machine and is mounted on a hinged mount. The operator panel can be easily accessed and folded away afterwards.



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:** Always takes the user back to the main screen.

**Left arrow:** Scrolls to the left in the tabs at the bottom of the screen.

**Right arrow:** Scrolls to the right in the tabs at the bottom of the screen.

**Triangle:** 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/>

## 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.

The robot is only to be used for the described purpose and must not be modified or changed in construction without a preceding agreement with FarmDroid ApS.



Always make sure that the robot is used in a secure private area where unauthorized persons 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 has 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 switchboard must be turned on first, and then the solar panels, otherwise the solar panels might not start charging 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 persons 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. 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 **1.8 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 the designated equipment mounted at delivery and equipment approved by FarmDroid ApS.

## 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.



The emergency stop safety wire is placed in a height of approx. 580mm which ensures that crops do not unintentionally 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 Operation Board, 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 Operation Board. If a dangerous situation should occur, the user has easy access to the emergency stop push button. Movement will also stop if the user stops activating the joystick during manual operation.

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:

- Indicates 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 are engaged thus stopping the robot's movement. An "Out of Field" error message will be displayed on the HMI.

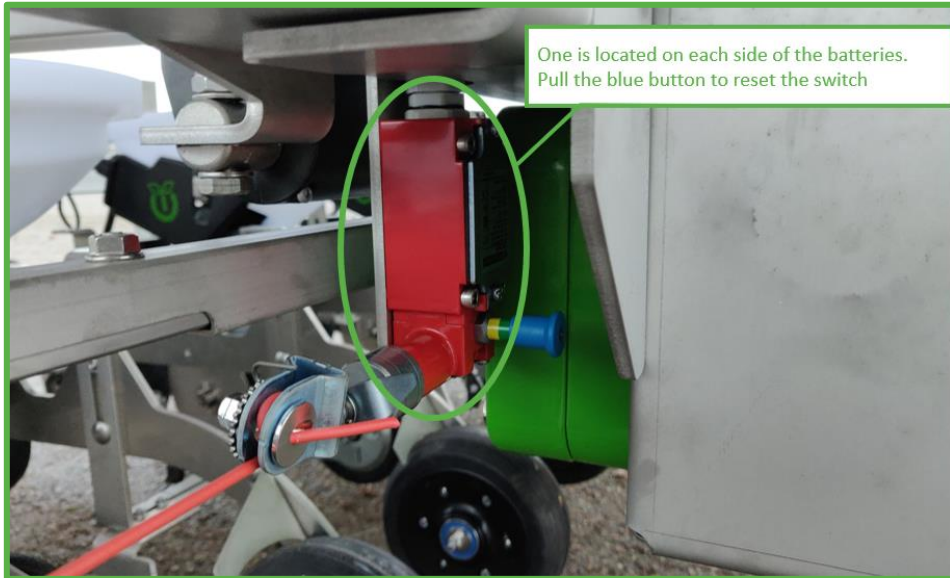
### 5. Interruption of run or operation if the target driving speed cannot be maintained or is too high, with the following purposes:

- 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 picture 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.



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 is not covering personal information governed by 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 damages. Make sure to check the devices regularly according to the maintenance instructions in section **8.5 Preventive maintenance checks of the Safety System**

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. 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 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.

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.
- 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 good distance to steep hills, ditches etc., when setting up the fields.

## 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 is approximately 900 kg, i.e. without any additional weight kits mounted.

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.



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 buckets	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.

### 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:

- GPS-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 functional

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: <https://knowledge.farmdroid.io/>

## 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 supplier.

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

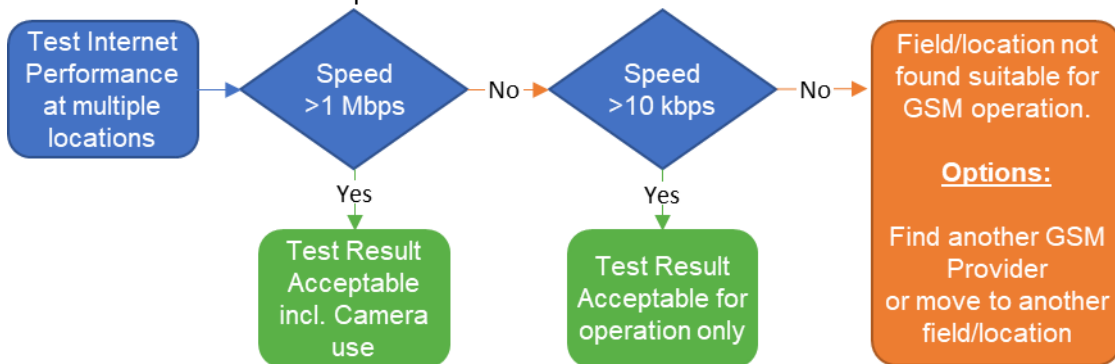
### 4.1 Test of Internet Performance

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 is delivered with a factory mounted Multi-SIM solution which will provide the best and safest connection to the Robot. 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 Care Subscription. 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 a 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, remote login to the HMI, and software updates temporarily increases 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 remote HMI and 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 Remote HMI and 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 the SIM-Card provider is changed, the APN settings must be updated by connecting a laptop via a LAN-cable. A guide for this can be found on the FarmDroid knowledge base, [knowledge.farmdroid.io](https://knowledge.farmdroid.io).

Follow these instructions to replace the SIM-card:

1. Arrange for a Distributor to update the APN settings prior to commencing SIM-Card replacement.
2. Disconnect the robots power supplies in correct order (both solar panels and main switch. Please refer to chapter 2. Safety Instructions for further information)
3. Remove the cover surrounding the control board
4. Remove the cover of the control board
5. Remove the existing SIM-Card by pressing down gently with a small screwdriver until you hear a small “click”. Now remove the screwdriver and the SIM-card will be released.
6. Insert the replacement SIM-card in the slot as illustrated in the picture below and press it gently down with a screwdriver until you hear a small “click”. Remount the cover for the control board and the cover surrounding the control board
7. Reconnect the power supply, first the main switch then the solar panels.
8. 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.
9. Connection establishment can take up to several hours, so please be patient.



The SIM-card is inserted into the slot as illustrated above. It is important to press the SIM-card fully into the slot until a mechanical click is heard. After re-powering the Robot, it can take up to several hours for the modem to reconnect to the server, after replacement of the SIM-card. In this period the RTK-signal will be unavailable.

## 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. For the robot to be able to navigate a specific area, the corner points must be fixed, and other field data must be saved in the robot's memory.



Field set up is only required one time 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 initiating field set up and the first operation.

Optionally, place the robot outdoors 24 hours before commissioning if the weather allows it. Hereby, the robot will 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.
3. All corner points must be set in one continuous chronological string around the outer edge of the entire field.
4. The physical position of the front GPS on the Robot is used when defining a corner point. Therefore, it is important to position the robot such, that the front GPS is located at the desired physical corner point, as close to the outer edge of the field as possible while still remaining inside any plow furrow, trees, or other obstacles.

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.

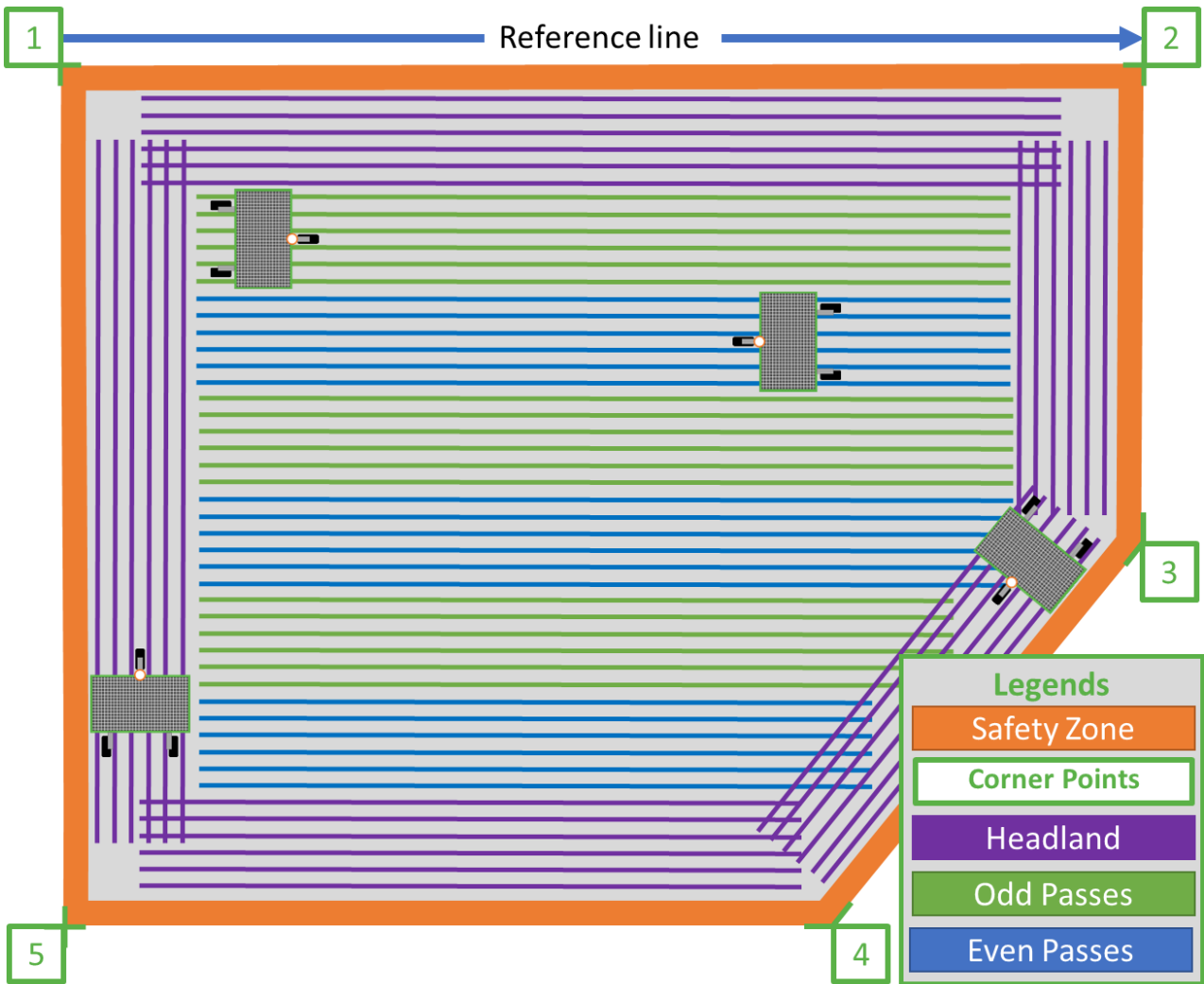
The safety zone width depends on the working width of the robot, as the robot always needs the same space to turn due to the zero-turn technology.



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

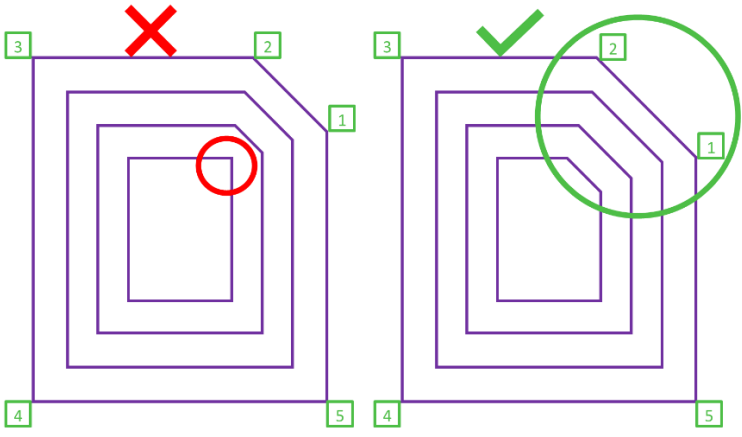
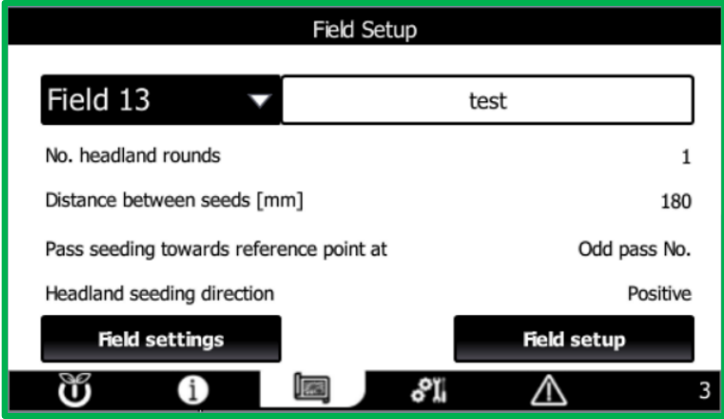
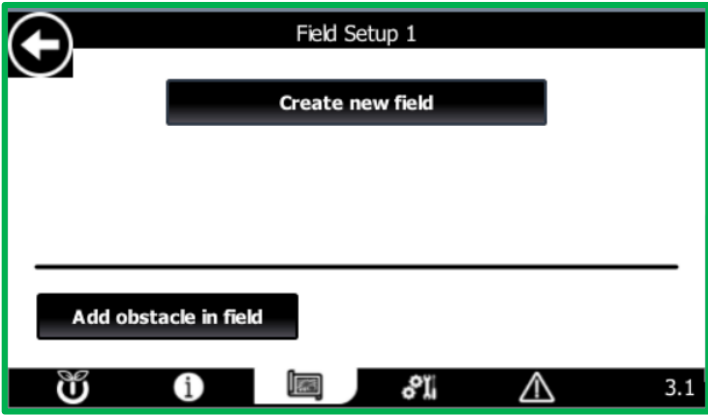
- Make sure that no public roads, trails, or paths cross the intended covered area of the robot.
- Pay special attention when commissioning next to public roads. Keep good distance between the road and corner points during field setup.
- Make sure to keep good distance to steep hills, ditches, etc., when setting up the fields.

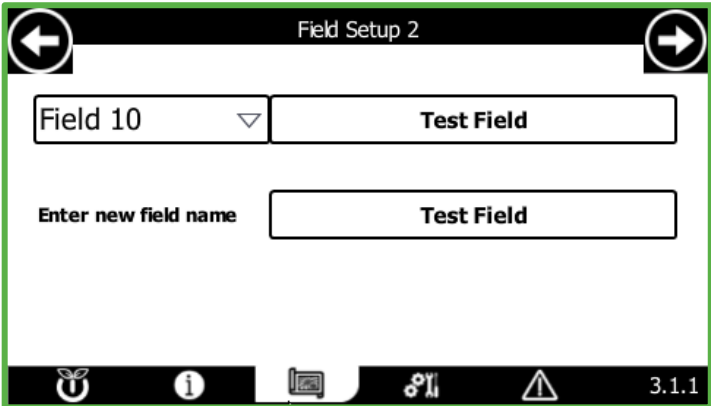
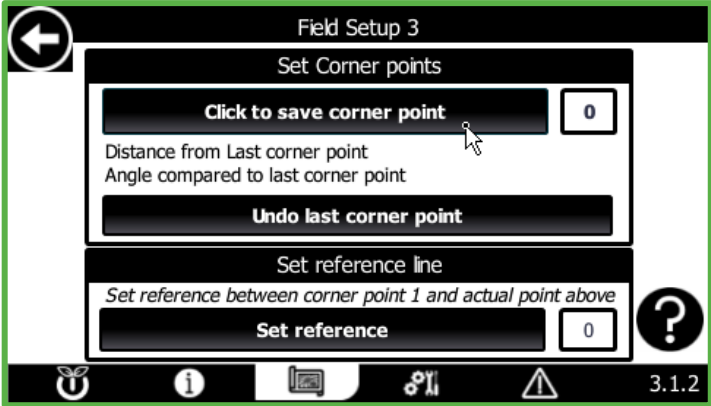
Below, illustration displays an example of a field setup. The orange boarder symbolizes the safety zone. The corner points, that have been marked using the front GPS of the Robot, are the outside corners of the orange boarder.

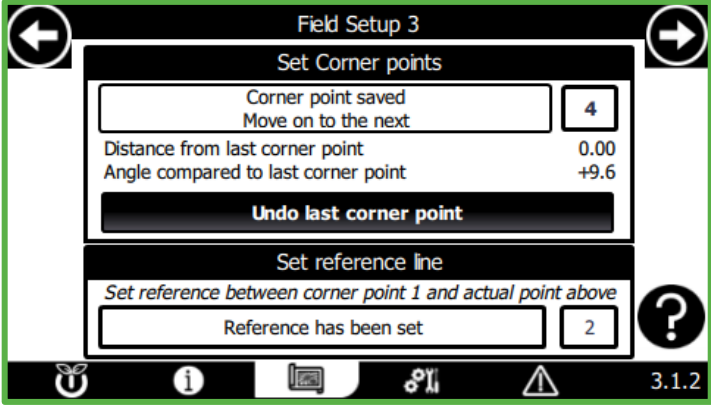

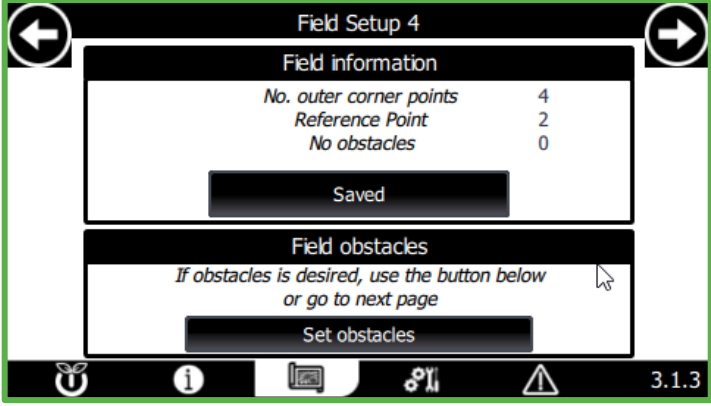


The table below summarizes the steps required to set up a new field, including the reference to the associated HMI page.

Step	Description	HMI Page
1	<p>Complete the preparatory exercises, incl. reading this manual, and transporting the Robot to the desired field.</p> <p>It is recommended to transport the Robot around the field using a tractor and the field bracket or alternatively the Road transport platform</p> <p>When setting up the field there are two rules that the user must follow:</p> <ol style="list-style-type: none"> <li>1. No obstacle at corner point 1, as this works as a reference for the rest of the field.</li> <li>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 cancelling each other.</li> </ol>	n/a

Step	Description	HMI Page
	 <p>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.</p>	
2	<p>In the HMI root structure, navigate to <b>Page 3 Field setup</b> and click the button “Field Setup”</p> 	3 <b>Field Setup</b>
3	<p>In the HMI, select “Create New Field”.</p>  <p>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.</p>	3.1 <b>Field Setup 1</b>

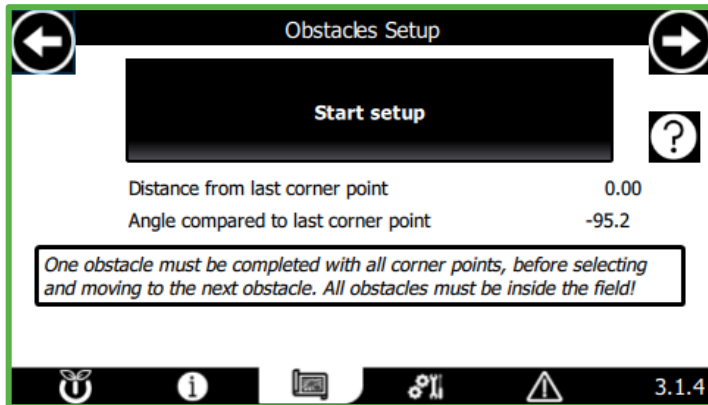
Step	Description	HMI Page
<p>4</p>	<p>Select a field number of your own choice and enter a suitable name for the field. When this is done, proceed to the next page by using the arrow in the top right corner.</p>  <p>If the selected field is already occupied, an attention message will appear and it will be possible to either overwrite the existing field or cancel, whereafter it is possible to select another field entry slot.</p> <p>When a field name has been entered, navigate to the next page using the arrow in the top right corner.</p>	<p>3.1.1 <b>Field Setup 2</b></p>
<p>5</p>	<p>Move the Robot to the first Corner Point of the field such that the front GPS 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”.</p>  <p>Then move the Robot to the next corner point as instructed on the HMI - Corner Point 1 will act as a reference point. 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.</p> <p><b>i</b> When the Robot is located at the desired reference corner point, remember to press “Set Reference”. This point together with corner point 1 will create the reference line. The passes will always be parallel to the reference line.</p> <p>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)</p>	<p>3.1.2 <b>Field Setup 3</b></p>

Step	Description	HMI Page
		
<p><b>6</b></p>	<p>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.</p>  <p>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.</p>  <p>The right forward arrow will direct the user to the Field settings page.</p>	<p><b>3.1.3</b> <b>Field Setup 4</b></p>

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”.

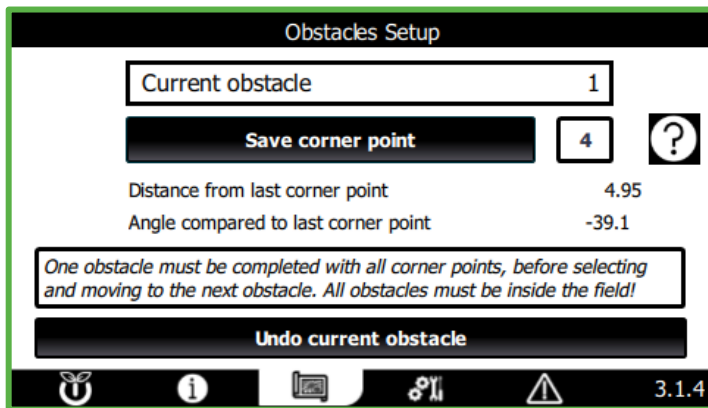
3.1.4 Obstacles



When the front GPS of the Robot is located on top of the first Obstacle Corner Point, press “Save Corner Point”.

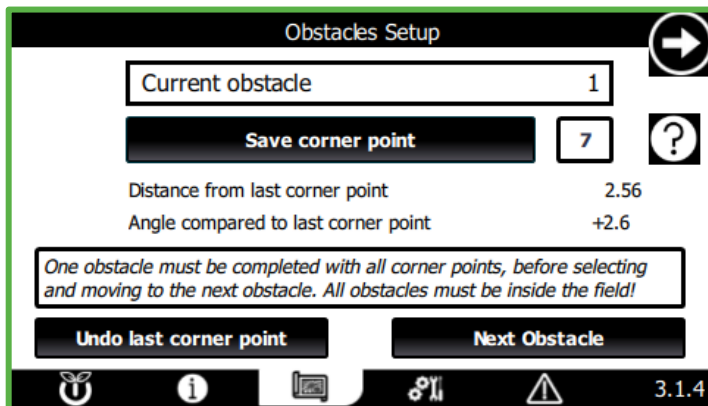


An obstacle requires a minimum of 3 corner points. Make sure adding an obstacle is entered completely before moving to and adding the next obstacle.



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.

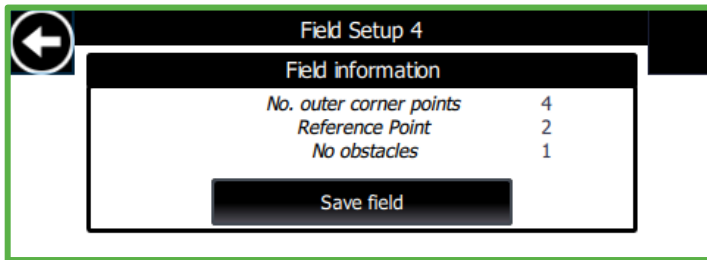
This function can be used to delete all obstacle corner points if necessary.



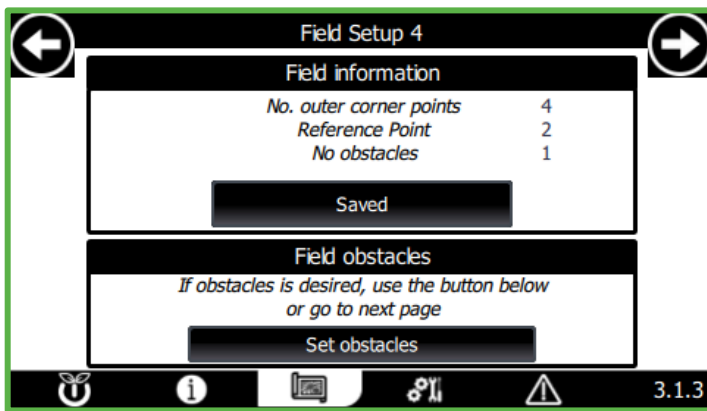
When all corner points surrounding the obstacle have been saved, either press “Next obstacle” if another obstacle exists, otherwise press the upper right



arrow. If next obstacle was pressed by mistake, then press “Undo current obstacle” and the “next” arrow will appear again.  
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”.

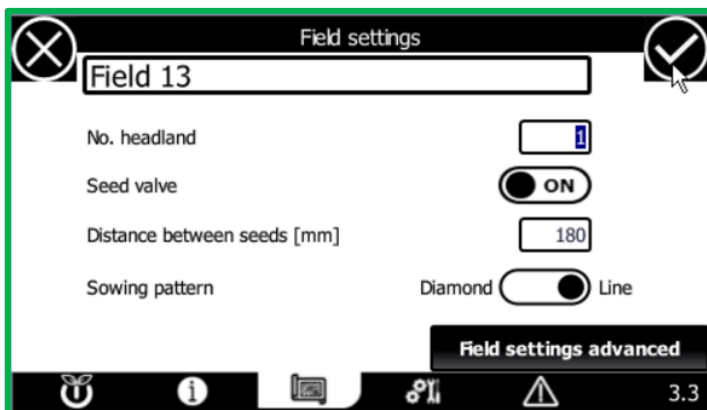


If at this point the field has been fully setup, by pressing the arrow in the top right corner of the HMI page, the user will enter the page “3.1.3 Field Setup 4”. For guidance, see the next section.



8

Now that the field has been set up, the user must validate or adjust the Field settings. This is done on Page: 3.3 Field Settings as illustrated below.

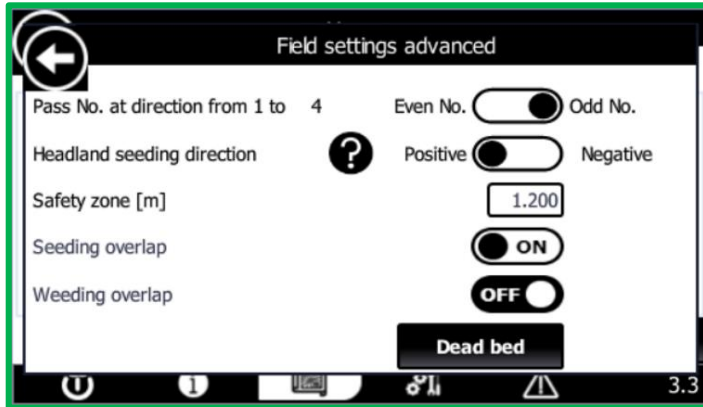


- a. No. headland: Choose how many full rounds of headlands the robot must seed. Each headland will have a width equal to the working width of the robot. i.e., with a working width of 3 meters and 3 headlands, the total headland width will be 9 meters.
- b. Seed valve: Turning this ON means the robot will seed the field in portions (ranging from 1 to multiple). Turning this OFF allows the robot to carry out line seeding.
- c. Distance between seeds (mm): Enter the desired seeding distance from one seed to the next, measured in millimeters.

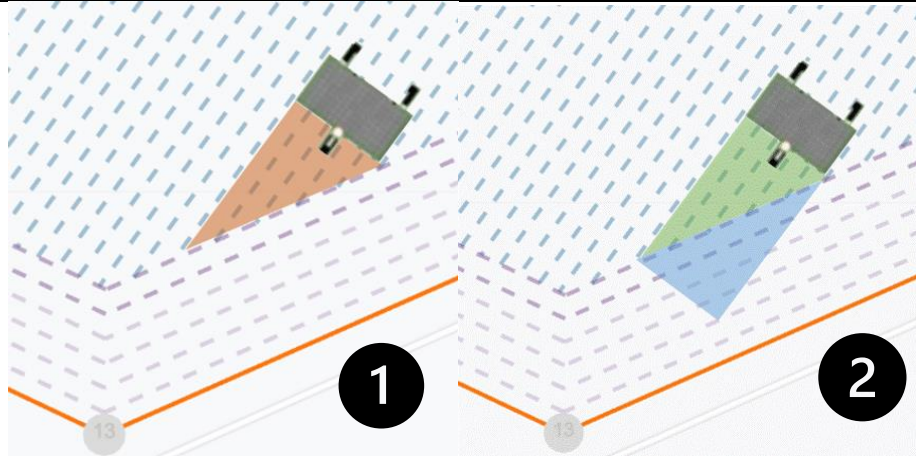
3.3 Field Settings

- d. Sowing pattern: Choose which seeding layout you prefer. You can either choose Line or Diamond.

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.

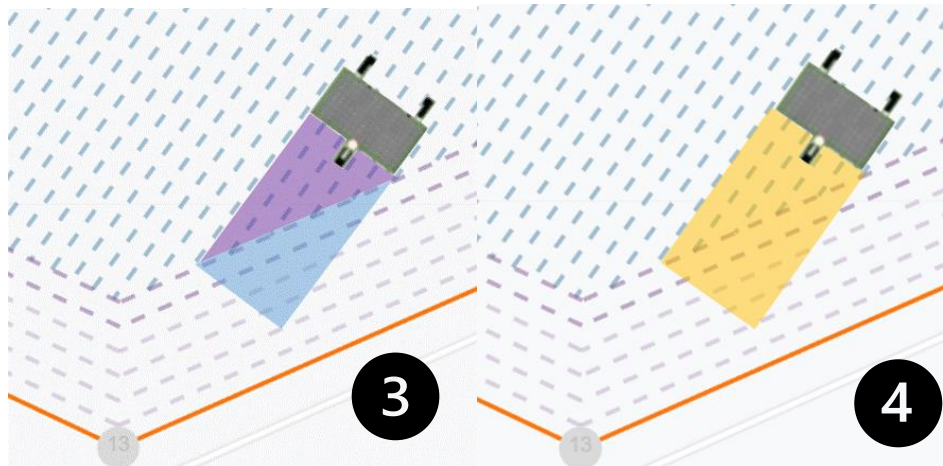


- a. Pass no. at direction from 1 to “Reference”: This is used to select whether the robot should run in even or odd passes compared to the direction of the reference line. When a reference point has been selected, this reference point will appear (in this case “4”).  
If **Odd No.** is selected, the 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.
- b. 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.
- c. Safety zone (m): This is a calculated value depending upon the working width of the robot. FarmDroid recommends never to change it.
- d. 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.
- e. 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.



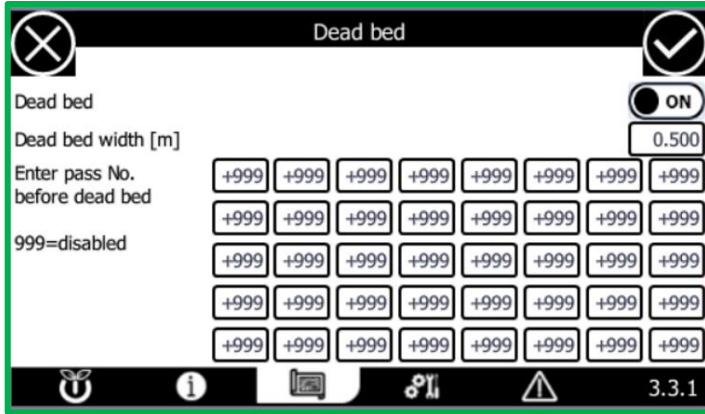
The third picture shows when the seeding overlap is turned ON, while the weeding overlap is turned OFF. Here, the small area in the pass would be seeded, however, the seeding in the headland would be wasted as the crops get removed during weeding in headland.

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

Once the settings have been reviewed and updated, the user can choose to add a dead bed, press “Dead bed”. This feature allows the user to add a desired space after entered passes. This space, called “Dead bed”, is left untreated. If the same pass No. is entered in two fields, the dead bed is twice the size of the entered dead bed width.

3.3.1 Dead bed

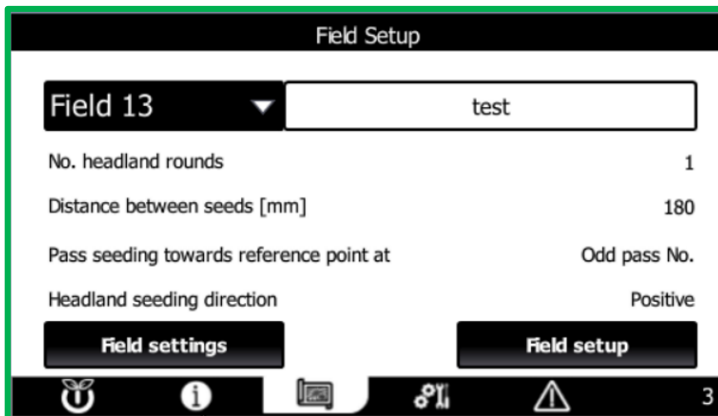


- a. Dead bed: Here you can turn ON/OFF the feature.
- b. Dead bed width (m): Set the width of the desired dead bed in meters.
- c. Enter pass No. before dead bed (999 = disabled): Enter the pass number before your desired dead bed. Remember the width of the dead bed when setting up.  
If the user wants to disable a field, enter “999”.

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 “Field settings”.

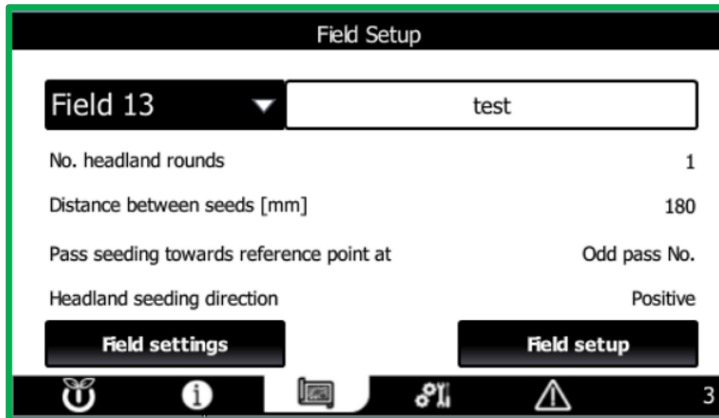


**i** It is of utmost importance that the seeding settings are not changed post commencing the seeding or during seeding of the specific field. If the seed distance is changed, this change will also apply for all previous planted seeds, thus resulting in the plants being weeded away when performing in-row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

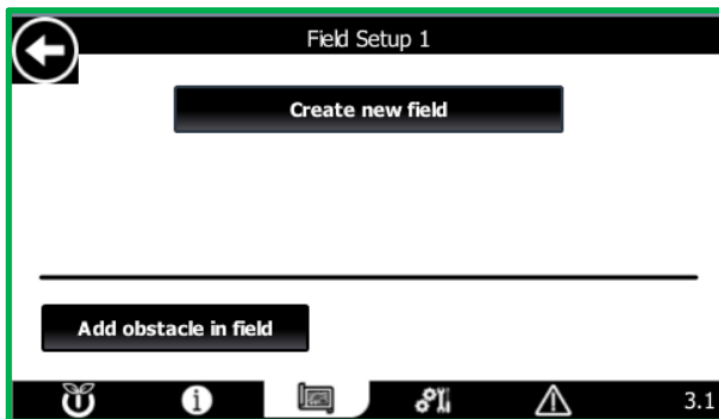
10

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 “Field setup”.

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

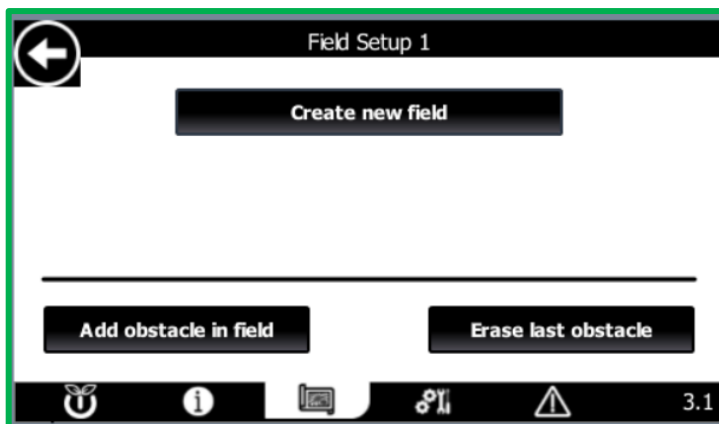


Press “Add obstacle in field”:



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”.

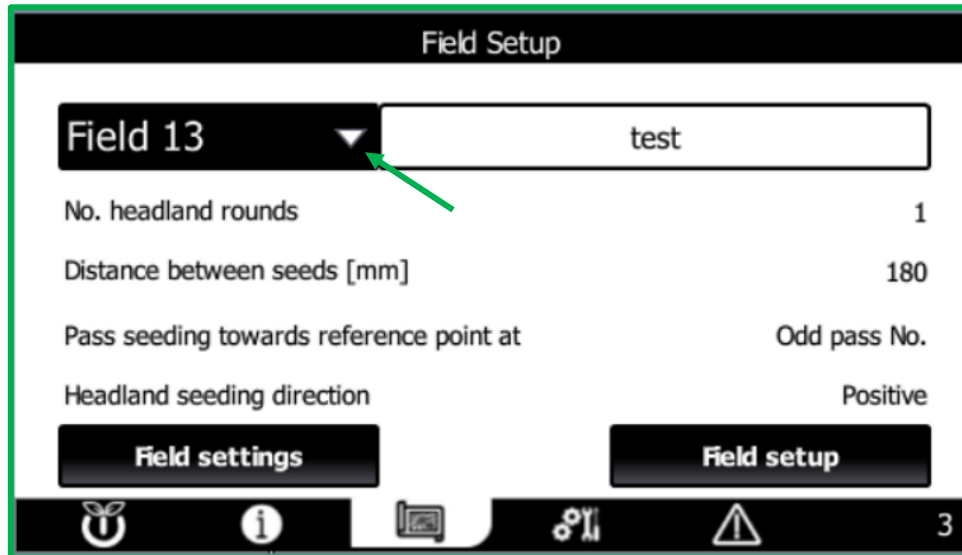


Now the last obstacle created is deleted.

## 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 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 or by using the remote operation options. 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 1 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 GPS or data connection. It solely requires for the safety functions to be fully functional.

When operating manually, it is possible to move the Robot 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 safety wire.

### 6.2 Highly Automated Operation

The Highly Automated operation function is the mostly used operation function. 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 GPS-RTK signal. When the batteries are sufficiently charged by the solar panels, and/or the GPS-RTK signal becomes available, the Robot will provide an acoustic signal and recommence 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 has occurred during Highly Automated mode, which has 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 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 User Application. 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 User Application. 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 moist, 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 and slopes.

### 6.5 Auto Load controller

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, 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 of the weather conditions and time of year the charging level can vary.

It is possible to extend the runtime by changing the Robot’s batteries when there is no more power on them, e.g. following a cloudy period. If 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.

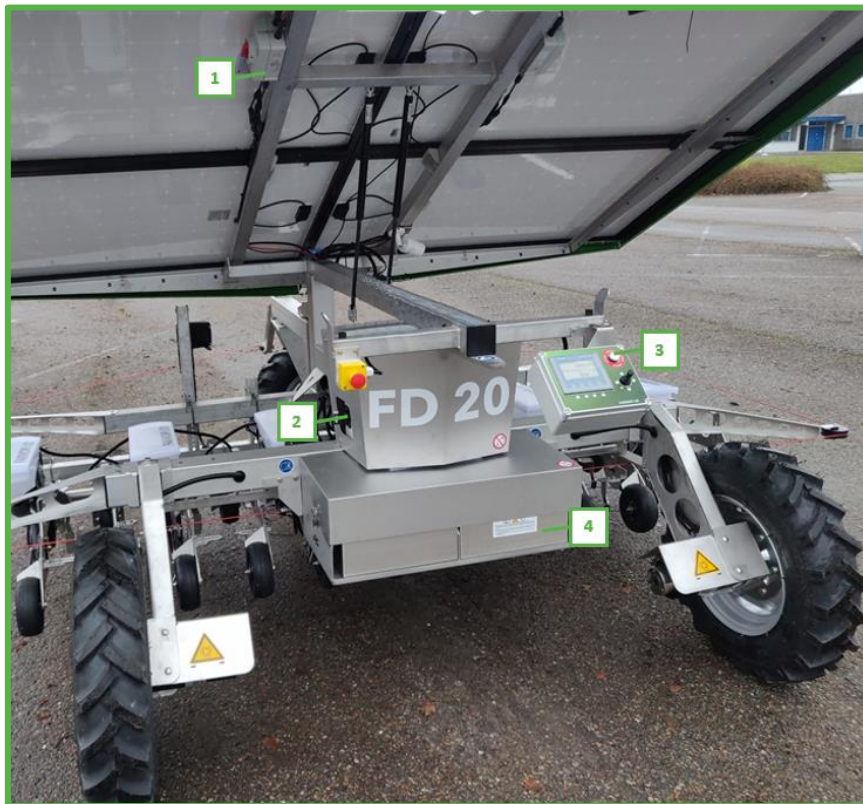


It is very important to disconnect the Robot's power supply BEFORE the batteries are dismantled. Otherwise, dangerous contact voltages may occur in the system induced by the solar panels. The power supply must be disconnected in the following order.

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

1. Disconnect the power supply for the solar panels [1]
2. Disconnect the power supply for the main board on the main switch [3] on the left side of the board.
3. Remove the battery cover to make the batteries accessible.
4. Remove the batteries [4] 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. The stop button lights up when pushed.

See the picture with an explanation below.



<b>1</b>	Switch for the solar panel section	<b>3</b>	Stop button on Operator Panel
<b>2</b>	Main switch on the main board	<b>4</b>	Batteries with battery plug connector



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




## 6.7 Seeding Settings

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



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			<p>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.</p> <p> Be aware that if the mechanical height is changed, setup changes in the HMI will also be required.</p> <p>At HMI page <b>4.1.9 Hitch Settings</b>, the used mounting hole, counted from the top of the bracket, must be entered. If the settings in the HMI are not set correctly, it can result in significant deviation in seed location between the passes, potentially making it impossible to weed in both directions.</p> <p> The mechanical height of the tool beam should not be adjusted during a season from commencement of seeding until weeding has been completed.</p>
Row distance			<p>The row distance can be adjusted by moving the individual trailers as required.</p> <p>The tool beams and the frame are marked at row distance of 450mm (225mm trailer distance) and 500mm (250mm trailer distance).</p> <p>Always make sure that both the active and passive trailers are in the desired position and secured tightly.</p> <p> 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 <b>4.1.3 Propulsion &amp; Run Settings</b>.</p>
Seeding depth			<p>The seeding depth is adjusted directly on the trailer by loosening the 8mm 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).</p>
Roller disc height			<p>The roller disc height in relation to the Coulter share can be adjusted by loosening the two 8mm bolts between the roller discs. A scale is cut in the roller disc adjustment bracket to ease similar adjustment across the rows.</p>
Soil scrape width and depth			<p>The soil scrape width is adjusted by loosening the two 6mm nuts on the arm.</p> <p>The depth is adjusted by loosening the 8mm bolt and adjusting the arm up and down.</p>

Possible Adjustments	Mech.	Elec.	Note
Seed wheel angle			<p>The angle of the seed wheel can be adjusted by loosening the electronics box and tilt the entire unit to the desired position.</p> <p>Depending on the seed type and whether it is desired to single-out or seed in clusters, the angle might have to be adjusted.</p>
Trailer pressure on the soil			<p>The trailer pressure can be adjusted via the HMI Page <b>4.1.9 Hitch Settings</b>.</p> <p>0% is a fully tightened spring and thereby the highest possible pressure on the ground. Weight distribution between front and back wheel is depending on the trailer spring configuration.</p>
Weight distribution on the trailer front/rear			<p>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.</p> <p>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.</p> <p>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.</p>
Allowable seed-sensor errors			<p>The allowed seed error threshold can be set in the HMI. The setting is available at two pages:</p> <p><b>2.1 Tool Information</b> – when in seeding mode</p> <p><b>4.1.2.0 Seed tool settings</b></p> <p>The set value represents the error percentage for the last 100 seed registrations.</p>
Seed distance and seeding direction			<p>On page <b>3.3 Finish Field and Seed Setup</b>, the seed distance, seeding direction and number of headlands can be set. The page can be accessed from <b>3. Field Selection and Information</b>.</p>

## 6.8 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 User Guidelines.

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 either removing the funnel or using the auto-empty function on HMI page <b>4.1.2.0 Seeding Tool Settings</b> .
Mount Funnel sealing ring			Remount the funnel including the sealing ring, so that the sealing surface 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 <b>4.1.2 Tool activation</b> . The weeding settings are performed at page <b>4.1.2.1 Weeding Tool Settings – Basic</b> . 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 on the rest position on the idle bracket.
Replace the soil scrapers with weeding wire kit			On all the active rows, remove the soil scrapers by loosening the two nuts on the horizontal bracket. Flip the support bracket around so that the horizontal part is in the wheel path. Install the weeding wire assembly in the desired position.
Move tool-section to weeding position			Loosen the four M8 nuts for the two tube clamps, on each tool section. Slide the tool sections to the correct marking on the frame. <b>Attention</b> use the 450 or 500mm “WEED” marking dependent of the row distance. 225mm Row distance = 450mm marking 250mm Row distance = 500mm marking
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 sideways to get the desired soil coverage.  <b>Attention:</b> 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.



## 6.9 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			<p>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.</p> <p> Be aware that if the mechanical height is changed, setup changes in the HMI will also be required.</p> <p>At HMI page <b>4.1.9 Hitch Settings</b>, the used mounting hole, counted from the top of the bracket, must be entered. If the settings in the HMI are not set correctly, it can result in significant deviation in seed location between the passes, potentially making it impossible to weed in both directions.</p> <p> The mechanical height of the tool beam should not be adjusted during a season from commencement of seeding until weeding has been completed.</p>
Weeding arms' out-of-row position			<p>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.</p> <p>Adjustments are made in the menu <b>4.1.2.1 Weeding Tool Settings – Basic</b>.</p> <p>Please refer to FarmDroid Guideline for more information.</p>
Weeding arms' in-row position			<p>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.</p> <p>Adjustments are made in the menu <b>4.1.2.1 Weeding Tool Settings – Basic</b>.</p> <p>Please refer to FarmDroid Guideline for more information.</p>
Non-weeding distance in front of the crop			<p>Adjustment of the non-weeding distance in front of, i.e. before the crop in mm.</p> <p>Adjustments are made in the menu <b>4.1.2.1 Weeding Tool Settings – Basic</b></p> <p>Please refer to FarmDroid Guideline for more information.</p>
Non-weeding distance behind crop			<p>Adjustment of the non-weeding distance behind the crop in mm.</p> <p>Adjustments are made in the menu <b>4.1.2.1 Weeding Tool Settings – Basic</b>.</p>

Possible Adjustments	Mech.	Elec	Note
			Please refer to FarmDroid Guideline for more information.
Weeding arm speed			Adjustment of the weeding arms' movement speed can be adjusted in 5 steps from minimum to maximum. Setting can help reduce soil movement around the plant
Weeding knife depth			The weeding knife depth can be adjusted by loosening the two M6 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 M8 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 coverage			The weeding wire distance to the crops (sideways) can be adjusted by loosening the two M6 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 trailer pressure can be adjusted via the HMI Page <b>4.1.9 Hitch Settings</b> . 0% is a fully tightened spring and thereby the highest possible pressure on the ground. 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 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 allows to adjust the hitch lowering point at the start of each pass as well as the raising point at the end of the pass. This makes it possible to adjust the overlap between the passes/headlands to fit the most desired weeding pattern at pass/headland intersections.

**6.10 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, if this function has been enabled. For safety reasons, it is not possible to reset the safety system remote, 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. if a threshold is reached, then this alarm can be reset remotely, and the robot can be restarted. If there is a real error, then the Robot will stop when the threshold is reached again. 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 Auto**, **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**.

**6.11 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.

Below is found relevant standard factory settings for mechanical robot and tool setup:

Trailer distance	Tool section – Seeding	Tool section – Weeding	Rear wheel distance	Working width
25cm	500mm Seeding mark	500mm Weeding mark	196cm, which is the most outer hole	3m*
22,5cm	450mm Seeding mark	450mm Weeding mark	176cm, which is the middle hole	2,7m*

\*This setting is entered on page **4.1.3 – Propulsion & Run Settings**

Please consult with 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.

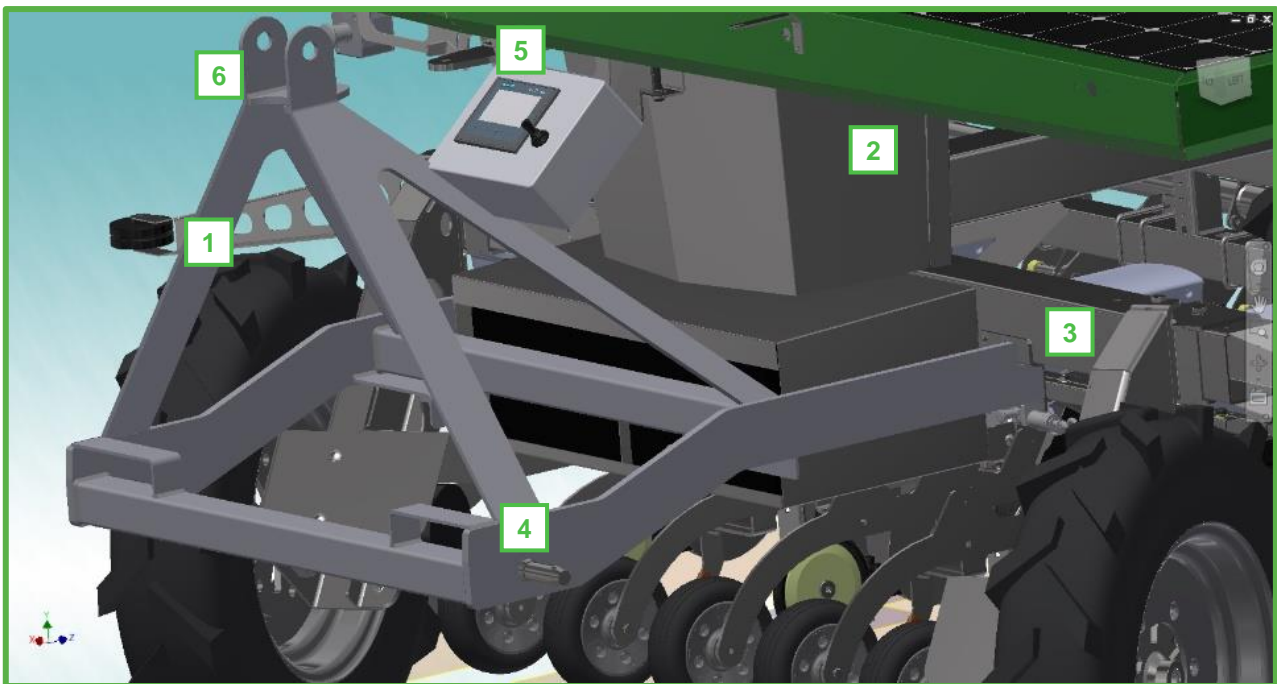


Be aware that the Field Bracket is solely allowed for moving the Robot on private areas and not on public roads.

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.

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 set the Robot to manual operation and then turn off both power sources before entering the Robot.

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, especially 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 at least 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 backlash in the rear wheel steering.	Auditory/visual check					Push the frame sideways, back, and forth. The backlash should be audible if present. Check the steering rods for unusual backlash. Change bushings if necessary. If the backlash 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 set the Robot to manual operation and then turn off both power sources before entering the Robot.

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 Sowing system or weeding motors	Auditory check					In case of errors contact your local distributor.
Check seed sensor contamination.	Visual check					Check all light sensors via the HMI screen. 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 backlash in the trailer supports.	Visual check					When the tools are lifted, push sideways, back, and forth on each of the trailer arms. The backlash should be visible if present. Check both ends of the connecting rods for abnormal backlash.  If the backlash is more than 1mm at any of the connecting points, replace the bushings in the connecting rod and the trailer connection point.
Check roller disc bearings	Visual check					Check the roller disc bearings for unusual wear and verify that all discs are spinning freely. (As default the discs are mechanically forced together in the front)

Task	Type	Daily	Weekly	Monthly	Yearly	Comments
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						<p>Perform a thorough inspection of the entire tool once a year.</p> <p>Check for loose bolts/nuts, cables, plastic surfaces etc.</p> <p>This should be performed by an authorized distributor</p>

### 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 set the Robot to manual operation and then turn off both power sources before entering the Robot.

Task	Type	Daily	Weekly	Monthly	Yearly	Comments
Wear on the in-row weeding knife.	Visual check					<p>Check for wear along edge of the weeding knife, especially around the hook.</p> <p>The weeding knife should be replaced when the blade is worn away.</p>
Wear on the connection arm on the weeding motor.	Visual check					<p>When the tools are lifted, gently rock the weeding arm back and forth to check the connection arm on the weeding motor for abnormal backlash.</p> <p>If the backlash 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.</p>
Wear on the hinges for the in-row weeding arm.	Visual check					<p>When the tools are lifted, gently rock the in-row weeding arm up and down to check for abnormal backlash.</p> <p>If the backlash is above 1,5mm at any of the two hinge points, replace the two bushings and/or the shaft if damaged.</p>

Task	Type	Daily	Weekly	Monthly	Yearly	Comments
Wear on the weeding springs	Visual check					Wear will be most visible close to the bends of the weeding spring. The weeding springs should be replaced if they are worn about halfway through or if they are broken.
Wear on locking plates holding the weeding springs	Visual check					Wear will be on the bottom edge of the locking plates. Replace if the bottom is worn away so that the bend of the weeding spring is exposed to the soil.
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.

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 set the Robot to manual operation and then turn off both power sources before entering the Robot.

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 visible 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 switching points 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 audible indicator with half-year intervals. Make sure to follow the instructions in the HMI.



It is of outmost 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, 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	<ol style="list-style-type: none"> <li>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.</li> <li>2. Avoid 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.</li> <li>3. It is highly recommended also to wash the remaining robot with low pressure cold water and a medium soft brush.</li> </ol> <div style="text-align: center;">  <p>Avoid high pressure cleaning of Batteries, electrical box, Solar Panel Charger.</p> </div>	
2	Safety Systems	<ol style="list-style-type: none"> <li>1. Check that all emergency stops, and safety wires are working. These should be tested and reset one by one.</li> </ol>	
3	Seeding System	<ol style="list-style-type: none"> <li>1. Place the seeding units in the seeding position to straighten out the transparent seeding tubes.</li> <li>2. Empty the seeding system and the seed boxes. Remove the seed boxes and funnels to verify that the system is emptied and clean the boxes using compressed air. When clean and dry, the boxes can be remounted.</li> <li>3. Clean the seed sensors using compressed air. Only use compressed air to clean the sensors as they are very sensitive to mechanical damage.</li> </ol>	
4	Weeding System	<ol style="list-style-type: none"> <li>1. Make a visual inspection of the weeding motors, bolts, the linkage, and weeding arms. If any wear is found on either parts, these should be replaced.</li> <li>2. If any bolts are found to be loose, these should be tightened.</li> <li>3. Check the connection plugs and cables for any damages.</li> </ol>	
5	Batteries	<ol style="list-style-type: none"> <li>1. Fully charge the batteries with an appropriate 24V LiNMC charger. With the charger approved and offered by FarmDroid this level is safely reached by an overnight charge.</li> <li>2. Disconnect and dismount the batteries from the Robot and store them above 10°C. If the Robot itself is stored above 10°C only disconnect the battery connectors.</li> <li>3. It is recommended to perform maintenance charging of the batteries using an appropriate 24V LiNMC charger every 6<sup>th</sup> month in storage.</li> </ol>	

#	Item	Description	Completed
6	Wheels and Gears	<ol style="list-style-type: none"><li>1. Perform a visual inspection of the propulsion motors and gears. Furthermore, check the gear shaft for any backlash by firmly grabbing the tires with your hands and rock the wheels back and forth.</li><li>2. If there are any damages to the coating of the motors or gears, these should be touched up by use of appropriate paint.</li></ol>	



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

## 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.

## 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 Error	<p>If the Robot has stopped because of a seeding error, check the following, in prioritized order.</p> <p> Before working inside the safety wire, the power must be turned off in the following order. <b>1.</b> Turn off the solar panels on the switch located on the underside of the solar panels. <b>2.</b> Turn off the main switch on the left side of the main switchboard. <b>Attention:</b> When turning on the power, the main switchboard must be turned on first, and then the solar panels, otherwise, the solar panels will not charge the batteries.</p> <p>Open the solar panels for easy access to the seeding tool and seed boxes.</p> <ol style="list-style-type: none"> <li>1. 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 a soft fabric that cannot scratch the surface of the light sensor.</li> <li>2. Check if there are seeds in all the seed containers.</li> <li>3. Check that the outlet of each seed box is properly inserted into the seed funnels.</li> <li>4. Check if the seeding valve is blocked or if any foreign obstacles are preventing the valve from operating. If so, these obstacles should be removed.</li> </ol> <p>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.</p> <p>Reset the safety wire and emergency stops if required.</p> <p>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.</p> <p>It is recommended to perform a manual function test to verify the problem has been solved. Go to page <b>4.3 Manual Function Test</b> in the HMI. Select the relevant tool and activate function test. The perform the following test.</p> <ol style="list-style-type: none"> <li>1. Activate the seed valve, by pressing it on and off 3-5 times. The seed valve should make a click each time it is activated and deactivated, otherwise the valve might be stuck open or blocked.</li> <li>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 the unit could be out of seeds or the system blocked between the seed disc and seed valve.</li> </ol>

Error	Guide
Weeding Arm Error	<p>If the robot has stopped on weeding arm errors then perform the following:</p> <ol style="list-style-type: none"> <li>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 4.</li> <li>2. Put the robot in Manual I the HMI. <ul style="list-style-type: none"> <li> Before working inside the safety wire, the power must be turned off in the following order. <b>1.</b> Turn off the solar panels on the switch located on the underside of the solar panels. <b>2.</b> Turn off the main switch on the left side of the main switchboard. <b>Attention:</b> 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.</li> </ul> </li> <li>3. Remove any foreign objects or obstacles. <p>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.</p> </li> <li>4. Perform a manual function test to verify the function of the weeding arm. Go to page <b>4.3 Manual Function Test</b> 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.</li> <li>5. Go to page <b>4.1.2.2 Weeding Tool Settings – Advanced</b>, 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.</li> </ol>
Robot Stuck	<p>If the robot stops on a “stuck”-alarm, the following should be checked.</p> <ol style="list-style-type: none"> <li>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. <ul style="list-style-type: none"> <li> Before performing any physical work on the robot or close proximity inspection, set the operation mode to Manual in the HMI.</li> </ul> </li> <li>2. Inspect the propulsion motors and gears for any foreign or entangled objects. If any objects are identified, continue to step 5.</li> <li>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.</li> <li>4. Turn off the power in the following order. <b>1.</b> Turn off the solar panels on the switch located on the underside of the solar panels. <b>2.</b> Turn off the main switch on the left side of the main switchboard. <b>Attention:</b> 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.</li> </ol>

Error	Guide
	<p>5. If present, remove any foreign objects or obstacles. Otherwise check the supply plugs for the faulty motor(s) are properly connected.</p> <p>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.</p> <p>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.</p> <p>If the problem is not resolved, the contact your distributor.</p>
<p>No RTK Signal</p>	<p>If the Robot does not have any RTK signal, then go to page <b>4.1.6 GPS</b> in the HMI. If the GPS data updates and the robot is connected to more than 10 satellites, without having RTK signal, then perform the following procedure:</p> <ol style="list-style-type: none"> <li>1. Restart the GPS-system by turning off and the 24v supply in the HMI on page <b>4.1</b>. After restart wait app. 2 minutes and see if the GPS coordinates update on HMI page <b>4.1.6 GPS</b>, and if the system receives RTK corrections. If this is not the case, then go to step two.</li> <li>2. Check if the Base Station is powered on.</li> <li>3. Restart the Base Station in accordance with the troubleshooting guide provided in the User manual Base Station v2.0.</li> </ol> <p>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.</p>
<p>Batteries and Solar Panels.</p>	<p>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.</p> <p>To verify if the solar panels are charging, complete the following steps:</p> <ol style="list-style-type: none"> <li>1. Place the robot outside in daylight.</li> <li>2. Turn off the solar panels on the switch located on the underside of the solar panels.</li> <li>3. Turn off the main switch on the left side of the main switchboard and wait for 10 seconds.</li> <li>4. Turn on the main switch on the left side of the main switchboard.</li> <li>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.</li> <li>6. In the HMI, go to 2. Run information and monitor the Battery Voltage.</li> <li>7. Turn on the switch for the solar panels and see if the battery voltage is increasing. If the power is not increasing, continue to step 8.</li> </ol>

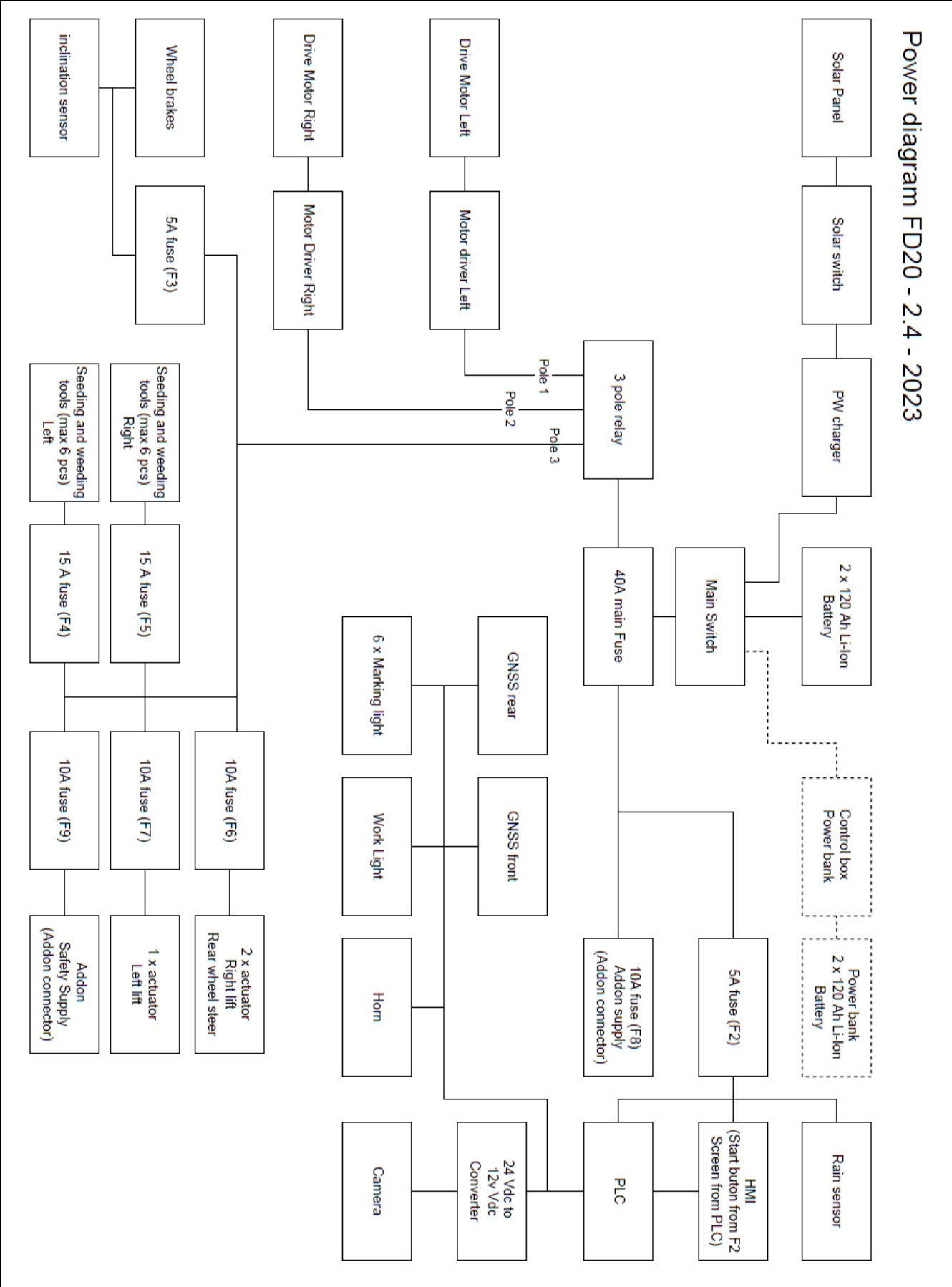
Error	Guide																																																		
	<p>8. On the charge controller verify the status of the LEDs. LED indication:</p> <ul style="list-style-type: none"> <li>● permanent on</li> <li>◎ blinking</li> <li>○ off</li> </ul> <p>Regular operation</p> <table border="1"> <thead> <tr> <th></th> <th>LEDs</th> <th>Bulk</th> <th>Absorption</th> <th>Float</th> </tr> </thead> <tbody> <tr> <td>Bulk (*1)</td> <td></td> <td>●</td> <td>○</td> <td>○</td> </tr> <tr> <td>Absorption</td> <td></td> <td>○</td> <td>●</td> <td>○</td> </tr> <tr> <td>Automatic equalisation (*2)</td> <td></td> <td>○</td> <td>●</td> <td>●</td> </tr> <tr> <td>Float</td> <td></td> <td>○</td> <td>○</td> <td>●</td> </tr> </tbody> </table> <p>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</p> <p>Fault situations</p> <table border="1"> <thead> <tr> <th></th> <th>LEDs</th> <th>Bulk</th> <th>Absorption</th> <th>Float</th> </tr> </thead> <tbody> <tr> <td>Charger temperature too high</td> <td></td> <td>○</td> <td>○</td> <td>◎</td> </tr> <tr> <td>Charger over-current</td> <td></td> <td>◎</td> <td>○</td> <td>◎</td> </tr> <tr> <td>Charger over-voltage</td> <td></td> <td>○</td> <td>◎</td> <td>◎</td> </tr> <tr> <td>Internal error (*3)</td> <td></td> <td>◎</td> <td>◎</td> <td>○</td> </tr> </tbody> </table> <p>Note (*3): E.g. calibration and/or settings data lost, current sensor issue.</p> <p>9. If the charge controller is in fault mode, please connect to the charger with the VictronConnect app, which is available for iOS &amp; Android devices. If the error relates to a setting, the issue would normally be solvable via the app.</p> <p>If the above does not solve the problem, the distributor must be contacted for professional support.</p>		LEDs	Bulk	Absorption	Float	Bulk (*1)		●	○	○	Absorption		○	●	○	Automatic equalisation (*2)		○	●	●	Float		○	○	●		LEDs	Bulk	Absorption	Float	Charger temperature too high		○	○	◎	Charger over-current		◎	○	◎	Charger over-voltage		○	◎	◎	Internal error (*3)		◎	◎	○
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Internal error (*3)		◎	◎	○																																															



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 by phone on the main number +45 8863 8766 or Direct +45 8863 8770.

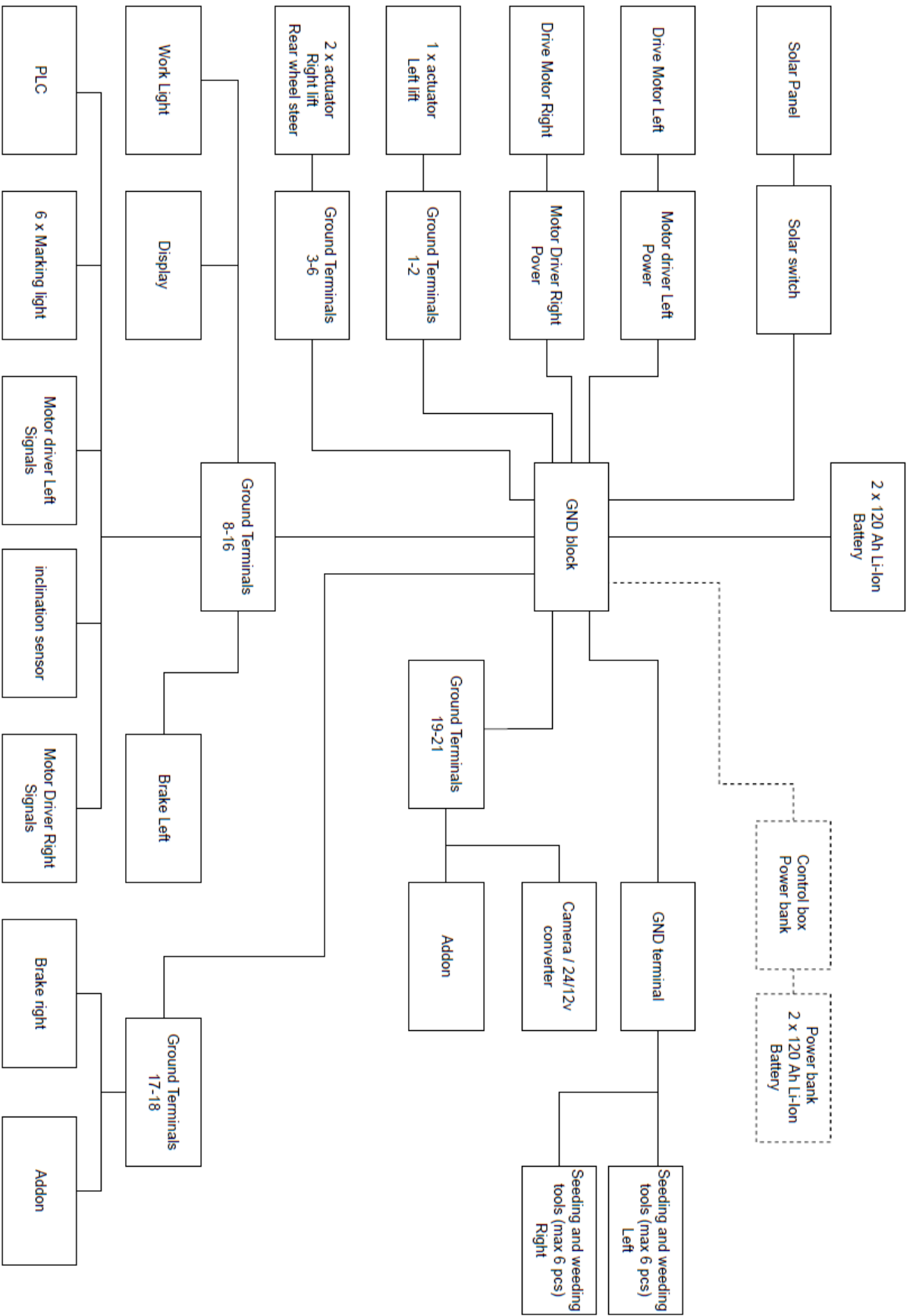
**Electrical Connections – Power Diagram FD20 v2.4**





Electrical Connections – Ground Diagram FD20 v2.4

Ground diagram FD20 - 2.4 - 2023



Electrical Connections – Electrical Box termination overview

