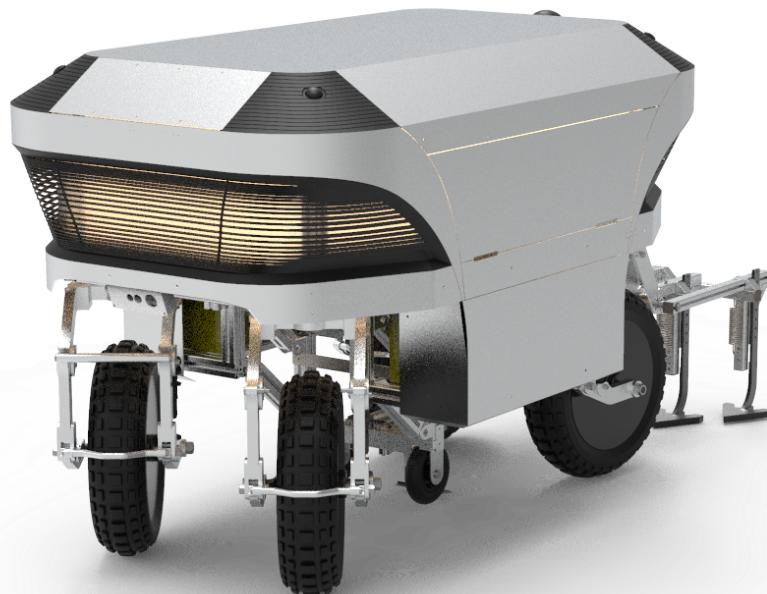




# Rowesys - Manual



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# 1. Lights



**White** Raspberry Pi has started: Ros master is ready



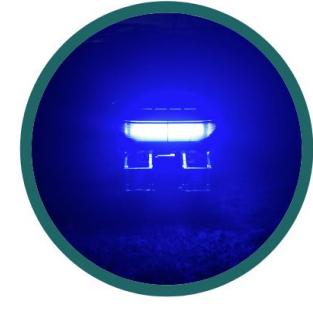
**Orange blinking** Robot is starting, waiting that motors are in position and communication works properly



**Red** Emergency Controller activated



**Green** Robot is in manual mode



**Blue** Robot is in autonomous mode



**Blue overall but yellow blinking on one side**  
Autonomous turn to the blinking side



**Yellow** Error information: It seems that the CAN driver is not installed anymore. It will be re-installed automatically.

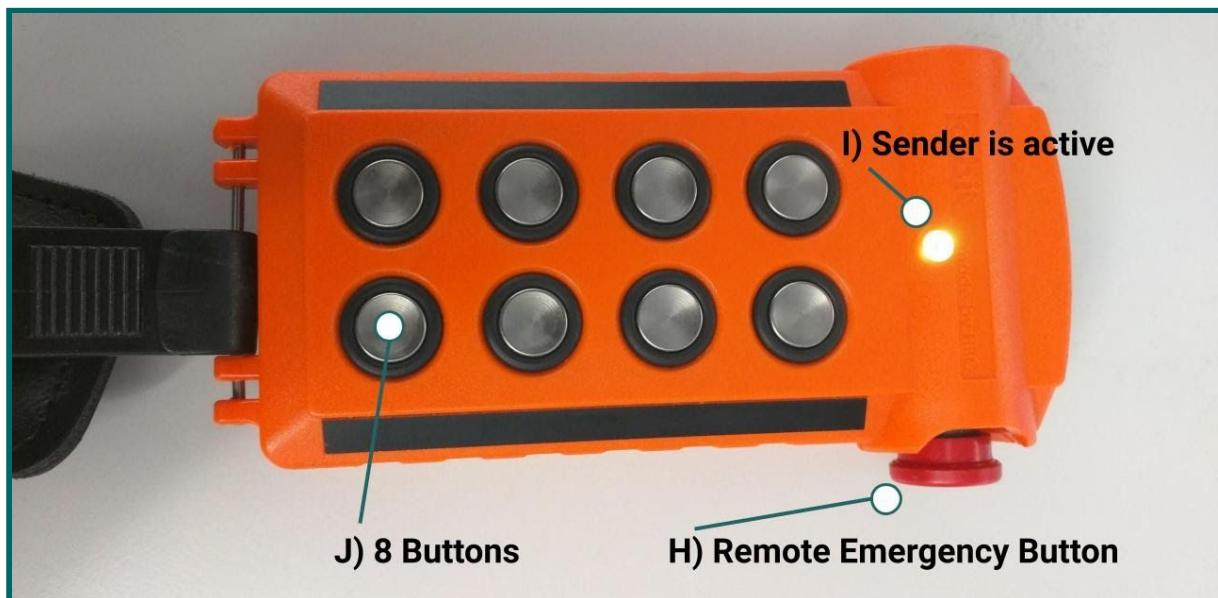


**Turquoise** The re-installation of the CAN driver was successful, the robot will start booting



**Red** The re-installation of the CAN driver was not successful, try to un- and re-plug the CAN to USB adapter at the Intel NUC.

## 2. Start System



**Be careful when starting the system.** The absolute encoders of the steering motors sometimes lose their position. In this case, the steering motors turn more than 180° and can damage the cables. If one wheel turns more than 90° away from the straight position after starting the software, press the remote emergency button and refer to the section "7. Dealing with Errors".

**After launching, the person that is responsible for operating the robot needs to be able to press the remote emergency button at any time. As long as the STO is activated, this person has to monitor the system without exception.**

To start the system, 6 steps are necessary.

1) Initialisation

Make sure that the 5 switches (C) are switched down. This avoids an overcurrent error when turning on the batteries.

2) Activate Remote Emergency Sender

Take the sender of the remote emergency system and pull the red button (H) out. A blinking LED (I) indicates that the sender is active.

Every ~10 minutes, a button (J) on the remote emergency sender has to be pressed. If for a time interval of 15 minutes no button is pressed, the sender turns off as a safety feature. If this happens, press a button (J) on the remote emergency sender and afterwards press the "Ethercat reset" button on the gamepad.

**The remote emergency sender has to be always with the person that operates the robot! In case of an emergency regarding the motors, press the red button (H) of the remote emergency sender to disconnect the motors from the power.**

3) Turn on Batteries

Press the battery button (A) for around 2 seconds until it shines green. This turns on the batteries.

4) Connect Electrical Components with Power

Switch the 5 switches (C) up to connect the electrical components with the power.

5) Turn on NUC and Connect Motors with Power

Press the button (D) to turn on the on-board computer. Press the button (E) to connect the motors with the power.

6) Turn on the Sound Box

Press the on/off button of the sound box (F) for audio feedback.

Now it takes around 2 minutes until the robot is ready.

- After 1:30 minutes the robot should glare white. This means that the Raspberry Pi is ready and the roscore (running on the Raspberry) has started.
- A few seconds afterwards, the robot should start blinking orange. This means that the ROS program on the NUC has started. The robot keeps blinking orange until the communication with all motors has been established and the wheels are in zero position.
- As soon as all wheels are in position, the robot should shine green to indicate that the robot is in manual mode and ready to be steered.

If the robot shines white for more than 1 minute, the auto start seems to be disabled. Press the green start button on the screen (G).

### 3. Shut down System

To shut down the system, do the steps to start the system in reverse order.

- 1) Press the *power off* button on the screen (G). As soon as the on/off button (D) of the NUC does not shine green anymore, the computer has shut down.
- 2) Now the motors and to the electrical components can be disconnected from power by pressing the button (E) and switching the switches (C) down.
- 3) Finally, the battery button (A) can be pressed to turn off the batteries.
- 4) Press the remote emergency button (H) when putting the sender away.

### 4. Safety

There are 3 safety levels.

#### 1) Software Motor Stop

If the motors do not behave as expected, one can press the RB button on the gamepad. The robot switches into the emergency controller and zero speed commands are sent to all motors. If the problem is on high-level side, this should stop the motors. Press the X button to leave the emergency mode.



#### 2) Remote Emergency Button

If the motors do not behave as expected and the RB emergency button is not working (e.g. because the connection to the gamepad is lost or there is a problem on low-level side) press the remote emergency button (H). This disconnects all motors from the power, the system should stop moving.

**Be careful, there are no brakes. If the robot is on a slope, it might drive downwards after disconnecting the power from the wheels!**



#### 3) Four Emergency Buttons

To disconnect the whole robot from the power, press one of the four emergency buttons. This turns off the batteries immediately and stops everything.



## 5. Charge Batteries

### 5.1. Robot Batteries (5h for 100%)

If the battery display (B) shows under-voltage (preferably even before), the batteries have to be charged. The following steps have to be performed in the given order.

**Be careful, do not plug in the cables randomly! Red to red (plus) and black to black (minus).**

- 1) Turn off the system
- 2) Connect the charging station with the charging outputs of the electrical box
- 3) Connect the white CAN cable of the battery with the CAN cable on the robot
- 4) Plug in the charging station in a socket



After plugging in the charging station, the batteries are turned on. If the batteries are charged completely, the charging station turns off and can be disconnected from the electrical box. First undo step 4) and disconnect the charging station from the socket. Afterwards you can disconnect the other parts.

### 5.2. Additional Batteries to Charge

The following batteries have to be charged or exchanged regularly.

- Remote Emergency Button (4h for 100%)  
The battery has power for around 2 days continuous operation. The sender vibrates and blinks in high frequency, if this battery is empty. Recharge it using the HBC charging station. This takes around 4 hours.
- Sound Box  
The sound box has power for around 1 day continuous usage. It can be charged using a normal micro USB cable.
- A/AAA Batteries  
The gamepad and the computer mouse are using normal A batteries. The keyboard uses AAA batteries. Exchange them, if they are empty.

## 6. Start Software

The system has to be turned on. If this is not the case, follow the steps in "Start System".

To start the software, just press the green arrow icon (G) on the NUC. To stop the software, press the red square icon (G) on the NUC.

If you want to start the software by your own, first make sure, that the software is not already running by pressing the red icon on the screen (G). This should turn off the led lights.

There are several launch files that can be launched.

You have to types "sudo -s" in the console where you start the launch file, as they require super user permission.

- `roslaunch rowesys_launch rowesys_all.launch`  
This starts the whole autonomous and manual pipeline. The robot can be operated manually and it can be switched to autonomous mode.
- `roslaunch rowesys_launch manual_drive.launch`  
This starts the manual mode.
- `roslaunch rowesys_launch manual_state_estimator.launch`  
This starts the manual mode as well as the state estimation (for testing).
- `roslaunch rowesys_launch manual_line_detection.launch`  
This starts the manual mode as well as the line detection with the state estimation (for testing).

After a launch file is launched, it takes 10 to 30 seconds until the communication with the motor drivers is established and the motors are in position. During this time, the system is blinking orange. A "system is ready" sound as well as green status lights inform the user as soon as the wheels are in position. From now on, the system can be operated using the gamepad.

To stop the system, go back to the terminal and press Ctrl+C. If this does not work for some reason and also the red stop icon (G) is not working, the on/off button of the NUC (D) can be used to shut down the NUC and stop the software.

# 7. Dealing with Errors

"Errors? Gits bi Rowesys nöd!"

anonymous Rowesys member, June 2020

This section will never be complete. It contains the most common errors that can happen and how to deal with them.

## Steering motors do not find their position when initializing system

This is the case, if an absolute encoder has lost its position.

- Press the remote emergency switch to stop the motors.
- Steer the wheel manually in the direction it has steered wrongly, until it is slightly more than 180° away from the straight position.
- Switch the encoder reset switch for the corresponding wheel on and off.
- Steer the wheel back by 90°.
- Switch the encoder reset switch on and off.
- Steer the wheel into the correct straight position.
- Switch the encoder reset switch on and off one last time. Now the encoder should have the correct position.
- Re-activate the remote emergency button and press the "Ethercat reset" button on the gamepad to activate the motors again. If this is not working, restart the software.



## Steering motors are after initialisation in non-zero position

The absolute encoders have the current position as zero position.

- Press the remote emergency button to disconnect the motors from power.
- Move the wheel that is not in zero position manually to straight zero position.
- Switch the reset switch on and off (see problem before).

- Re-activate the remote emergency button and press the "Ethercat reset" button on the gamepad to activate the motors again. If this is not working, restart the software.

#### Motors suddenly start steer although no driving input is given

This seems to be a problem with the Ethercat. Press the "Ethercat reset" button immediately once or twice. If this is not working, restart the software.

#### Turn is activated but robot keeps driving forward after end of row detection

This is most likely a problem with the state estimation. Restart the software.

#### Robot keeps driving in manual mode and does not react to gamepad inputs

The connection to the gamepad is lost. Make sure to stay in close distance to the robot, but maximal 10 m away.

#### Robot suddenly stops and motors are turned off

Probably the STO is triggered. Most likely no button on the remote emergency sender was pressed for more than 15 minutes. Press a button on the remote emergency sender and press afterwards the "Ethercat reset" button on the gamepad.

#### When trying to turn on the batteries, a "PRECHAR." error occurs on the battery display

Turn batteries off and ensure that the five switches are switched down. Then try again. If this does not work, unplug one battery at the electrical box and press the on/off button directly on this battery for 2 seconds. If the button shines green, plug in the battery again and do the same with the other battery.

#### When trying to charge the batteries, a "PRECHAR." error occurs on the battery display

The batteries have very low charge. Instead of connecting the charging station at the electrical box, you have to connect it directly with one battery. If this battery has charged completely, do the same with the other battery.

#### When trying to turn on the batteries, a "RELAIS +" error occurs on the battery display

Probably one of the four emergency buttons is pressed. Unpress it and try again.

#### When starting the robot, it does not blink orange, but first turquoise and than red

There is a problem with the CAN. The system re-installed the CAN driver (when the LEDs were turquoise), but this did not solve the problem. Try to unplug and plug in again the CAN adapter on the NUC and restart the program.

## Problems with auto start

If there are any problems regarding the auto start, disable it. Therefore you have to open the application “Startup Applications” and double click on “Rowesys Autostart”. Disable the auto start by changing the command path from “sudo /home/rowesys./rowesys\_autostart.sh” to “sudo /homea/rowesys./rowesys\_autostart.sh”. Now you can restart the NUC and press the green start button on the desktop after the NUC has started again to start the program. Make sure that the Raspberry Pi (master) is running. To enable auto start, just change the command back to “sudo /home/rowesys./rowesys\_autostart.sh”.

## 8. Passwords

The password for the Intel NUC is \*\*\*\* [ask the team].

The password for the router is \*\*\*\* [ask the team].

The password for the Raspberry Pi is \*\*\*\* [ask the team].

## 9. Contact

For further questions or problems please contact

- the team for general questions

rowesys@ethz.ch

- Timo Schönegger in urgent cases

timoscho@ethz.ch

This manual and the gamepad manual can be found under <https://rowesys.ethz.ch/manuals>.