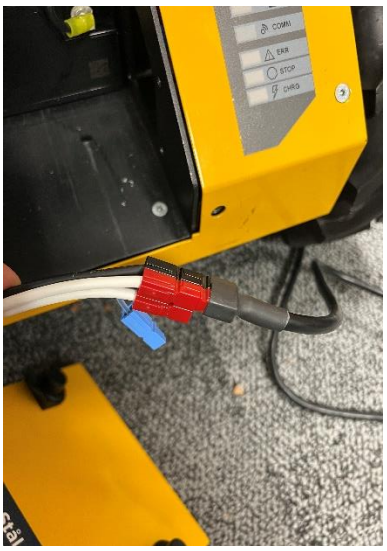
UGV Hardware Guide

1. Emergency Button:
   A compatible emergency button was investigated and it is mounted to the Husky control panel by pushing it into the embedded place on the panel. It works plug and play and no configuration is needed.

2. Husky Battery:
   Two batteries with 12V which are connected together in series to provide together 24V which is the functional voltage of the Husky. There are embedded sockets on the Husky to connect the batteries which are located on the Husky wall beside the battery placement.

   In order to charge the batteries, there is a specific charger that you can connect to the city electricity socket and on the other end of it there is a compatible connector that you can connect to the Husky battery. In the pictures below you can see how looks like the charger and how must it be connected to the batteries in order to charge them.



3. **NVIDIA Drive PX2 power system**

   On the PX2 power adapter it is indicated that its functional voltage is 12V with 25A, consequently it consumes 300W. A vehicle battery compatible with these specifications have been chosen.

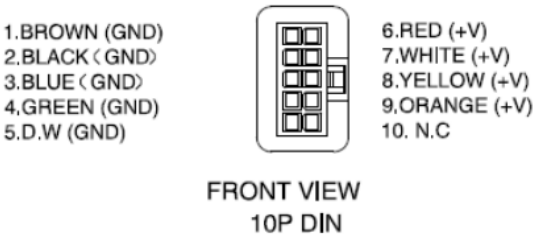
   In the PX2 Mechanical and Installation Guide provided by NVIDIA, a fuse and a diode with certain specifications are instructed to use for safety assurance of the PX2 in case of power supplying by a vehicle battery (see figure 6. Power Protection Diagram, NVIDIA DRIVE PX2 AUTOCHAUFFEUR MECHANICAL AND INSTALLATION GUIDE, Page 10). A schematic of how to connect the fuse and the diode is suggested as well.

   To make the power system more practical a power button was investigated instead unplugging the cable directly from the PX2 and it added to the powering circuit.

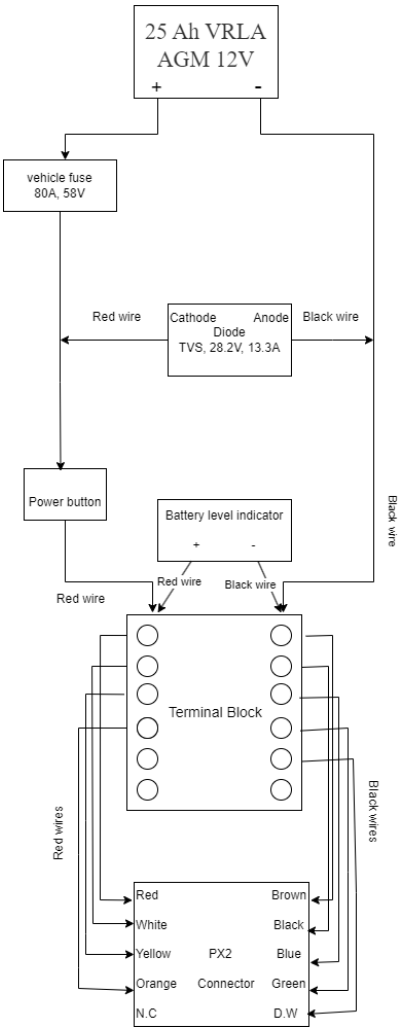
A voltage level indicator was investigated for safety of the PX2 and the battery health as well. The voltage level indicator has positive and negative pole which needs to be connected to the positive and negative pole of the battery respectively.

Because of the different wire type in the PX2 and the battery side a terminal block was investigated as a connection mechanism of the different wire types.

The PX2 connector pins is shown in the picture below. The voltage for each pin was investigated as well as measured via a multimeter which the result showed 12V for all positive voltage pins.



In the picture below it is shown how different components are connected to each other to make the power system of the PX2 works properly.



The PX2 battery is rechargeable and it can be easily charged by its charger called LEMANIAENERGY GX15. To charge the battery connect the charger to the city electricity socket and then connect the red wire of the charger to the positive pole (red) of the battery and the black wire to the negative pole (black) of the battery and click on the charge mode on the charger panel and finally click on the power button of the charger to start charging.

A panel is designed, printed and assembled beside the control panel of the Husky to make it easy to access the power button and voltage indicator of the PX2. See figure below.

4. Sick Lidar

The Lidar uses a female connector, M12, 5-pin, straight, A-coded at one end to connect to the lidar, and at the other end a special connector (see the link https://www.digikey.se/en/products/detail/weidm%C3%BCller/1748170000/459713) to connect to the embedded socket on the Husky for power supplying. The functional voltage range of the Sick Lidar is 10.8V DC- 30V DC according to the Sick webpage. (see https://www.sick.com/at/en/catalog/products/lidar-and-radar-sensors/lidar-sensors/lms1xx/lms111-10100/p/p109842) The power consumption of the lidar is 8W and heating is about 35W. The appropriate current for the lidar could be calculate by p = VI (p is power, V is voltage, I is current) which the result for the current will be 3A. The embedded socket on the Husky can provide 24V with maximum 5A which is appropriate to power supply the lidar.

The power cable of the lidar has four leads inside with different colors. Each lead has a different purpose that needs to be connected to the appropriate pin (positive or negative) to receive the correct voltage. (see https://www.sick.com/at/en/catalog/products/lidar-and-radar-sensors/lidar-sensors/lms1xx/lms111-10100/p/p109842 , https://www.sick.com/at/en/catalog/accessories/plug-connectors-and-cables/yf2a64-050xxxxleax/p/p315081?tab=detail) From the technical information on the Sick website it can be understand that White and brown leads must be connected to the positive voltage and black and blue leads to the negative voltage.

This lidar uses a separate cable for communication with the ITX-computer on the Husky. The cable has a male M12, 4-pin, D-coded at one end to connect to the lidar, and an RJ45, 4-pin connector at the other end to connect to the ITX-computer for data communication. See the pictures below for power and communication cables of the Sick lidar. A sensor placement is designed, printed, and assembled on the back bumper of the Husky.

5. RP Lidar A2:

A 360° laser range finder which has an adaptor module connected to it for power supply and data communication. can be connected to the minicomputer with a USB cable for both data communication and power supply. A sensor placement is designed, printed, and assembled on the from bumper of the Husky.

6. IMU

1st VN-200 which is a miniature, high-performance GNSS-Aided Inertial Navigation System (GNSS/INS) Global Navigation Sattelite Systems that combines 3-axis gyros, accelerometers and magnetometers, a high-sensitivity GNSS receiver, and advanced Kalman filtering

algorithms to provide optimal estimates of position, velocity and attitude. The board can be connected to the ITX computer with a USB cable for communication.

7. Camera

2st AR0231 cameras with appropriate cables for connecting to the NVIDIA DRIVE PX2. 2st camera placements are designed and printed to attach them to the Husky.

8. Landing Pad

The landing pad is designed, constructed, and mounted by help of the Makers in Västerås. It is not adjustable and the instruction for assemble and dissemble could be find in the Git file of the project.

9. Loading Area

The loading area is designed, constructed, and mounted by help of the Makers in Västerås. It is not adjustable and the instruction for assemble and dissemble could be find in the Git file of the project.

10. Tether

The tether system consists of a Power cable, a USB cable, and a safety rope, all held inside a protective shield. On the UAV side, two hooks are designed and embedded to attach the tether securely. The tether is fastened using a Follow Through Climbing Knot, a reliable and secure method of knotting. On the UGV side, however, there is no embedded hook.