Carnegie Mellon University
16681 MRSD Project
PCB Conceptual Design Proposal

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The Darkbot (Quadruped Robot for Assistive Search in Narrow and Cluttered Environment)

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Begin by describing the power needs of your system.

List the source(s) of electrical power and the subsystems to be powered. Be specific: for sources include the type with as much specificity as possible (for example, include battery chemistry, number of cells), and also specify voltage range and continuous/peak current output.

For the various subsystems receiving power list the required voltage range, whether regulation is required, and how much current it will draw continuously and in peak situations (don't neglect peaks that you don't intend but which are likely, like a stalled motor).

Per the completeness of our legged robot and the sensor compute payload provided by the AirLab, this PCB design is irrelevant to our original deliverables. Hence, we decided to design a PCB to power a SCD30 CO2/Temperature sensor which may be useful to provide some environment information in our indoor search and rescue use case.

This PCB with CO2/Temperature sensor should be able to monitor the temperature and CO2 concentration of the environment. If either of these two are above certain threshold, it would change its corresponding LED from green to red, as an alert. The data readings from the sensors can also be used and processed for other purposes.

The power source will be the main battery pack from the Unitree Go1 Edu robot. The battery pack is designed for the GO1 with a capacity of 6300 mAh and a voltage of 21.6 V with charge and discharge management. The battery pack features a high-performance battery and uses the advanced battery management system developed by Unitree to provide sufficient power for the GO1. The rated output is shown in Figure 1 below without specifying current output.

Technical specifications

parameter	Specification	Remark
Rated voltage (power supply)	22.2V	
Rated current (power supply)	无	Current jump
Rated voltage (charging)	25.2V	
Rated current (charging)	6A	
Rated Capacity	6000mAh,133.2Wh	
operation hours	约 1h	
frequency	4243.2–4742.4 MHz	

Figure 1. Unitree Go 1 Edu battery specs.

The 24V-10A power port on the robot will be powering AirLab's sensor compute payload that has Nvidia Orin, Velodyne Puck 3D LiDAR, IMU, and various RGB sensors. There are USB ports on the sensor payload that will be powering anduino board and the SCD30 sensor boards. These ports output standard 5V and up to 0.5A of supply.

The only subsystem component we need to power is the SCD30 sensor with the electrical requirement as shown below in Figure 2. And based on the number of maximal current of 75mA, it is unlikely to exeed to the rated maximum current supply for the aforementioned USB port.

Electrical Specifications	
Supply voltage	3.3 – 5.5 V
Average current @ 2 s measurement rate	17 mA
Max. current	75 mA

Figure 2. SCD30 sensor electrical requirements.

The answers to the key requirement questions are listed below:

1. **Number of connectors and current capacity of the connector (for example, if you have three motors you will likely need three connectors).**
    a. We only need to power the SCD30 board so we have only one input-output pair of connectors.
2. **For each source, detail if you plan to monitor input voltage, if you require a manual switch, and what the main overvoltage/reverse voltage protection will be.**
    a. We do not need to monitor the input voltage of the gas sensors.
    b. We do not need any manual switches.
    c. We DO need both overvoltage and reverse voltage protection just in case, implemented by a voltage regulator and a diode.
3. **If a subsystem requires a voltage regulating circuit, set a desired efficiency/cost, output voltage, and peak output current.**
    a. Desired efficiency = 60%
    b. Output voltage = 5V
    c. Peak output current = 0.5A
4. **If a subsystem requires more advanced control, like FETs or H-bridges, provide the peak output current and minimum/maximum required operating voltage.**
    a. We do not need advance control
5. **Detail any reverse voltage/overvoltage protection for the subsystem.**
    a. We will use one voltage regulator to make sure the input voltage to the sensor does not exceed 5V
    b. We will use one diode to ensure the direction of current flow
6. **Detail if you need to be able to control power to the subsystem (does your controller need to be able to enable/disable power to a given subsystem)**
    a. We do not need to implement the mechanism to individually control the ON/OFF of each subsystem since we only have one (sub)system.
7. **Detail if you plan to monitor the input or output voltages with the system controller, and whether you intend to provide visual indication (i.e., an LED) that power to a given subsystem is on.**
    a. We are not interested in the input voltages to the sensor board but we do need the readings from the analog reading from the sensors to interpret the physical environment.
    b. For both temperature and CO_2 concentration, we need LEDs to indicate whether it is safe for humans (RED = dangerous, GREEN = safe).