Requirements:

1. Operate 4 motors bidirectionally (two-way):
   - rated: 2 x DC Brushed motors (200 mA each at highest voltage of 1.1P) supplied with
   - : 2 x auxilliary motors (500mA each).
   - > these currents are the maximum we need to supply.
   - > the 1S1P battery has a normal voltage of 3.7V, max voltage of this battery is 4.2V (when fully charged)

Motor Driver Selection:

- > we need a driver that can handle the abovementioned ?
- > the motor driver should also support bidirectional control (forward & reverse motion) left & right
- DRV8833 → £0.6705
  - > Dual H-bridge motor driver.
  - > Supports up to 1.5A per channel

Power Supply:

1.4A
- > must supply 200 mA x 2 = 400 mA to the brushed DC motors
- > must supply 500 mA x 2 = 1000 mA to auxiliary motors.

* Recommendations:

- > Add flyback diodes ~~to~~ ~~add~~ across the motor terminals to protect the motor driver from voltage spikes caused by the motor's inductive loads.

→ Verifying DRV8833 as being suitable for solution:

total (P) for DC motors each: $P = VI = 4.2V \times 0,2A = 0,84W$

total (P) for Aux motors each: $P = VI = 4.2 \times 0,5A = 2.1W$

$$P_{total} = (0,84 \times 2) + (2.1W \times 2) = 5.88W$$

② Battery Monitoring

→ $0,5955

- Place an INA219 current sensor on the I2C bus to monitor the battery.
- Ensure proper configuration (A0 and A1 can't be on GND).

③ Battery Charging.

- Charge the battery from a 9V input pin.
- Implement 2 charging modes: 200mA ~ 600mA (± 100mA)

a) > Low charging mode: 200mA

b) > High charging mode: 600mA (± 100mA)

- Having two charging modes allow for flexibility.

a) > Slower charging

OTG pin. > Better battery health, especially if the battery is deeply discharged or if we want to extend its lifespan.

b) > Faster charging

> Useful when we need to recharge the battery quickly.

How to implement two charging Modes:

> the LiPo battery charging IC such as TP4056 supports programmable charging current.

> it allows us to set the charging current by adjusting the value of an external resistor.

TP4056-MS (Msksemi) ~> $0.0576 is the ideal solution bcz:

> It has a higher thermal regulation threshold (145°C)
> It supports programmable charging current up to 1000 mA, which is well above 200mA & 600 mA.
> which allows for better heat management.
> thus ensures safe operation even under higher power or high ambient temp
> We can use the PROG pin to set the charging current by selecting the appropriate resistor value:

~ 200 mA : $R_{PROG} = \frac{1100}{200} = 5.5k\Omega$.

~ 600 mA : $R_{PROG} = \frac{1100}{600} = 1.83k\Omega$.

- the 1100 mA value comes from the TP4056 datasheet & is used to calculate charging current based on resistor connected

> It has exposed thermal pad which improves heat dissipation & is ideal for compact designs.

(A) USB-C Integration — USB4105-GF-A ~> $1.0875

- involves integrating a USB-C connector into our Power Module to provide 9V output from the USB host.

- We need to include a USB-C receptable on our PCB to allow for connection to a USB-C cable.

(5) External Load Switching (Breadboard Assignment corrections)

Provide 2x Load external switching at 1A each (high-side connected to 5V)

→ these switches will each be connected to 5V and the load/external device

→ they should be controllable via a logic signal, GPIO from µP

We should use a P-Channel MOSFET. SI2301 → $0,050

which is ei P-MOSFET, SOT-23 package.

ST2301CDS-T1-GE3 ~> $0,0567

(6) Voltage Regulation.

Provide ei 3V3 (5% accuracy of 300mA max) and 5V out (5% accuracy of 1.5A max).

① → 3V3 output must deliver max 300mA current.

② → 5V output must deliver max 1500mA current.

① AP2112K-3.3TRG1 ~> $ 0,0687

② TPS562201DDCR ~> $0,0641

RT9193 LDO 3V3

- limitted current (300 mA)
- has high power dissipation if input voltage is higher than 3,3V/300mA {Inefficient for high current}

* May overheat if load approaches 300mA

AP2112K 3V3 {Alt

- 500 mA
- ± 2% accuracy.

LM2596SX-5.0_NOPB ~ 5V Buck Converter.

- Larger package (TO-263-5): May not fit compact PCB
- External components needed: Inductor, diode, capacitors increase BOM cost.

* Size may be problematic.

TPS562201

- 2A
* Smaller / cheaper.

⑦ ON/OFF Switch.

"Provide ON/OFF switch.
OFF state: Battery draws less than 30 μA
ON state: Can provide Robot with peak current 2A.
The switch needs to shut down 5V and 3V3"

Load Switch IC: AP22802AW5-7 ~> $0.1179

- High side MOSFET load switch.
- low leakage of < 1μA in OFF state
- 3A peak handling current.
- minimal voltage drop.

Controlled by GPIO, no manual switch needed.

Circuit Design for AP22802AW5-7:

Input (IN): Connect to battery (3.7V LiPo)
Out (OUT): Feeds 5V/3V3 regulators.
Enable (EN): Tie to STM32 GPIO (e.g PA0)
GND: Ground.