**PDN Voltage Drop and Power Loss Analysis (Absolute Maximum Values)**

**Voltage Drop**

* **24 V Rail**
  + Main MOSFET: **0.30 V**
  + Secondary MOSFETs (combined): **0.78 V**
  + Inductor: **0.01 V**
  + Other components – Negligible
  + Copper pours – 0.13V
  + 24V traces – 0.2V
  + **Total Voltage Drop (24 V rail): 1.42 V**
* **5 V Rail**
  + All components – Negligible
  + 5V traces – **0.1 V**
  + **Total Voltage Drop (5 V rail): 0.1 V**

**Power Loss**

* Main MOSFET: **30 W**
* Secondary MOSFETs (7 devices, each up to 23.4W): **163 W (absolute max)**
* ESD Diode: **24 µW (negligible)**
* Main Bulk Capacitor: **0.74 W**
* LC Filter: **0.74 W**
* Main Buck Converter: **3.73 W**
* Secondary Buck Converter: **6.75 W** (only one active at a time; take maximum = 6.75 W)
* Switch: **0.35 W**
* 5V traces 0.13W
* 24V traces 1.2W
* Copper pours 1.4W
* Other components: **0.10 W (lumped estimate)**

**Total Power Loss (worst-case, absolute maximum):**  
= 30 W (Main MOS) + 163 W (Secondary MOS, worst one) + 0.74 W (Bulk) + 0.74 W (LC filter) + 3.73 W (Main Buck) + 6.75 W (Secondary Buck) + 0.35 W (Switch) + 2.73W(copper)+ 0.10 W (Others)  
= **209.04 W (43% of battery per hour)**

**Notes**

* Considering changing the secondary mosfet to reduce the power and voltage drop.

Maybe we will switch to nmos with high side gate driver(much more complex but very low power loss)

**Normal case scenario**

* Taking 40% of stall current as normal working current and only 4 motors at outputs, net current becomes 40A. Voltage drop = 0.45V(approx.)
* Take main buck
* Power loss = 32W (6.7% of battery per hour)

**Constants**

* Copper resistivity (ρ) at ~20°C: **1.724×10⁻⁸ Ω·m**
* Copper temperature coefficient (α) ≈ **0.00393 /°C** (for temperature correction).
* 1 oz copper thickness: **t = 35 µm = 35×10⁻⁶ m**.
* Sheet resistance for 1 oz copper:  
  .

**Fundamental formulas**

**Trace resistance:**  
where = trace length (m), = width (m), = copper thickness (m).

* **Voltage drop (DC):**
* **Copper power loss:**
* **Sheet/plane resistance (squares):**  
  Number of squares (both in same units)
* **Plane loop approximation (VIN→GND):**  
  (often ≈ 2 × R\_plane if both planes identical and path similar)
* **Temperature correction:**
* **Approximate via barrel resistance (solid cylinder approx):**  
  , where (outer barrel OD and plated hole ID). Use actual via geometry for accuracy.