Power Board

N-pulse

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1 Introduction

The report is here on the purpose to explain all the steps that have been made to finish with the last version. Different aspect and propositions are discuss and explain why we use that technology or not. The purpose of this part of the project is to give the power that come from the battery to other device in the arm. for that we need to split in different branch with different voltage and current. The repartition is show in the figure1.

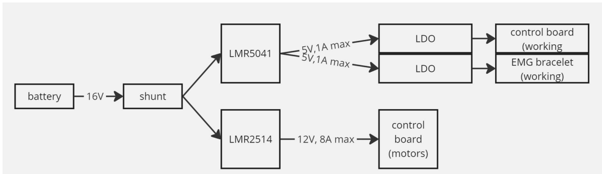

Figure 1: schematics

2 cahier des charges

input : 16.8V
output: 12V and 5V
size: the smallest possible
power dissipation : less important but the less will be the best to avoid that our composant burn or burn the owner.

3 different options investigated

- mirror of current

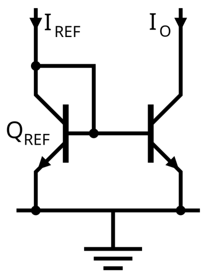

Figure 2: current mirror

The advantage is that it can be easily integrated in a PCB and a simple circuit. The reason why we didn't use this technology is the fact that the current is always the same. Even if the system need less current to work. To much current use the battery too fast and can make damage on the other part of the system.

- LDO
The LDO system is a way of decrease a voltage by heating. All the energy is dissipate in Watt around the component. If the voltage drop is to high the temperature can increase fast and can not be tolerable for a PCB in the arm. In the other hand, they are simple, inexpensive and the output have a really low noise voltage.

4 circuit 12V

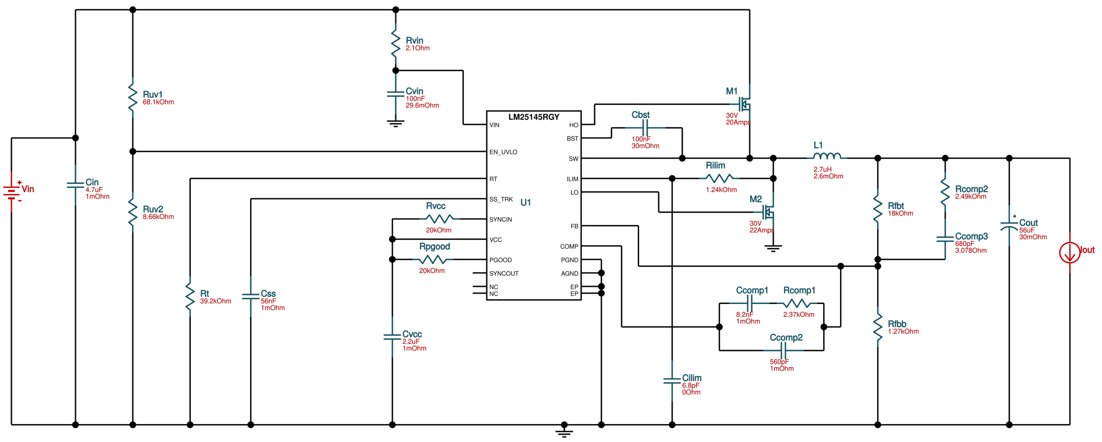

Figure 3: circuit 12V (8A) made by webench

This circuit is made to supply the motors of the arm and they work with 12V. To design the circuit, we had to estimated the current value that can possible pass in the branch. The motor have a stall current of 0.5A each and we use 7 or 8 motors. Finally, the max current if all the motors are on stall mode is 4A. To avoid to break the system if the current suddenly goes higher, the safety margin is from 2. That implie that the circuit should accept 8A.

4.1 proprieties of the circuit

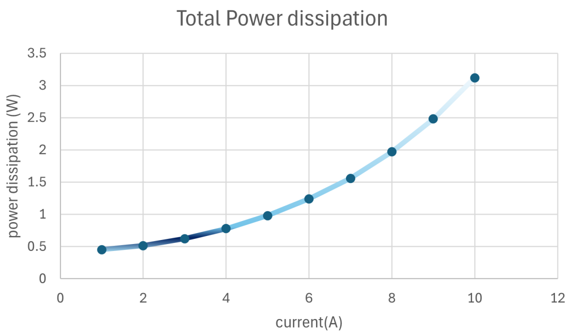

Figure 4: Caption

4.2 components

Category	model	values	mark	number	Figure3
Capacitors	GRM32ER71H475KA88L	4.7uF50V	murata electronics	1	C_{in}
resistor	CRCW040269K8FKED	69.8k	Vishay	1	R_{uv1}
resistor	CRCW06038K25FKEA	8.25k	Vishay	1	R_{uv2}
resistor	CRCW06032R10FKEA	2.10ohms	Vishay	1	R_{vin}
Condensator	CGA3E2X7R1H104K080AA	0.1uF	TDK	1	C_{vin}
Resistor	CRCW040239K2FKED	39.2k	Vishay	1	R_t
Condensator	GRM155R71C563KA88D	56nF	murata electronics	1	C_{ss}
Condensator	C1005X5R1V225K050BC	2.2uF	TDK	1	C_{vcc}
resistor	RC0603FR-0720KL	20k	Yageo	2	R_{vcc} R_{pgood}
Transitors	CSD17577Q3A	35A Id, 30V	texas instrument	1	M_2 M_1
condensator	GCM1555C1H100FA16D	10pF(echange)	Murata electronics	1	C_{bst}
Resistor	CRCW04021K24FKED	1.24k Ohms	Vishay	1	R_{ilim}
Condensator	GRM1885C2A100JA01D	10pF	murata electronics	1	C_{ilim}
Resistor	CRCW04022K37FKED	2.37k	Vishay	1	R_{comp1}
Condensator	GRM155R71C822KA01D	8200pF	Murata Electronics	1	C_{comp1}
Condensator	CGA2B2X7R1H681K050BA	680pF	TDK	1	C_{comp2}
Inductance	SER1360-272KLD	2.7uH	Coilcraft	1	L_1
Resistor	RC0603FR-0718KL	18k	Yageo	1	R_{fbt}
Resistor	CRCW04021K27FKED	1.27K	Vishay	1	R_{fbb}
Resistor	CRCW04022K49FKED	2.49k	vishay	1	R_{comp2}
Condensator	CGA2B2X7R1H681K050BA	680pF	TDK	1	C_{comp3}
Condensators	20SVPF56MX	56uF	Panasonic	1	C_{out}

- pin connectors
  We transfer all the current to the control board with 2 pins that will have a current max of 10A (worst case). The pin have a a pitch of 5mm

4.3 PCB traces

We need to be carefull with the traces to avoid that they burns. The current that pass in the trace heat the trace and if the resistance is to high the trace can burn after a certain time. The value of the current is an RMS value. To have security margins, we take the RMS current as 3.5A (the case where all the motors work at the maximum in the same time). The 8A will not burn our traces because it will occur only in the worst case and a really short time.
We can have multiple ways of impact the surface of the trace to reduce this resistance. The easiest is during the manufacturing with a change in the thickness (more common are 1oz and 2oz). The calculation depend on the ambiant temperature: we take 25°C. It depend on the temperature rise: we take 10°C. There is a calculation to find what to use.

$$A = \left(\frac{I}{k \cdot (T_{rise})^b}\right)^{\frac{1}{c}} \tag{1}$$

$$W = \frac{A}{t \cdot 1.378} \tag{2}$$

avec :

- A : surface
- W : trace width
- I : Current(A)
- k : Coefficient of proportion for internal layers : 0.024
- T_{rise} : Temperature rise
- b : empirical exposant for internal layers : 0.44
- c : correctionnal exposant for internal layers : 0.725
- t : thickness

Results

$$\text{thickness of } 1oz\text{: } W = 4,398786766mm$$
$$\text{thickness of } 2oz\text{: } W = 2,199393383mm$$

In our PCB, the big traces are only where the current can be high and the other traces are normal (=0.2mm)

5 circuit 5V

This circuit is made to supply the sensors and the control board himself and the EMG bracelet. For this part the current should not pass the 1A.

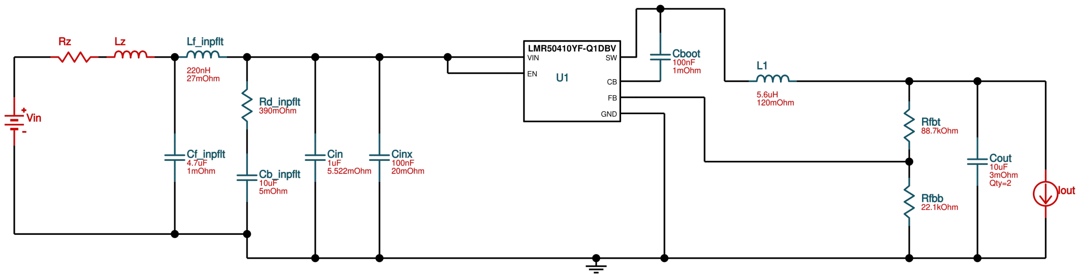

Figure 5: circuit 5V (1A) made by webench

5.1 components

Category	model	values	mark	number	Figure5
Inductor	NLCV32T-R33M-EFRD	0.33uH	TDK	1	$Lf_{inplift}$
Capacitors	GRM31CR71H475KA12L	4.7uF	murata elec	1	$Cf_{inplift}$
Resistor	CRCW04021R00FKED	1 ohm	Vishay	1	$Rd_{inplift}$
Capacitors	C3225X7S2A475M200AB	10uF	TDK	1	$Cb_{inplift}$
Capacitors	C1608X5R1E106M080AC	1uF	TDK	1	C_{in}
Capacitors	GRM188R72A104KA35J	0.1uF	murata elec	1	C_{inx}
Capacitors	GRM155R71C104KA88D	0.1uF	murata elec	1	C_{boot}
Inductor	74438336047	4.7uH	wurth electronic	1	$L1$
Resistor	CRCW040288K7FKED	88.7K	Vishay	1	R_{fbt}
Resistor	CRCW040222K1FKED	22.1K	Vishay	1	R_{fbb}
Capacitors	C0805C106K8PACTU	10uF	KEMET	2	C_{out}

6 fuse

This component is the one in which it's hard to choose the right one. all the component can tolerate a peak of current but not to much. The fuse that we have choosen can tolerate a bit of peak like shown in the figure6. Our model is the SF-1206HH120M-2. The nominal current is take to the max that the circuit can tolerate for a long time. All the components of the power board can tolerate 8A.

Electrical Characteristics

Model	Rated Current (Amps)	Fusing Time	Resistance (Ω) Typ.***	Rated Voltage	Interrupting Rating	Typical I²t (A²s) ****
SF-1206HH10M-2	10.0	Open within 5 sec. at 350 % rated current	0.0045	DC 24 V	DC 24 V 150 A	12.0
SF-1206HH12M-2	12.0		0.0039			19.0
SF-1206HH15M-2	15.0		0.0031		DC 24 V 200 A	34.0
SF-1206HH20M-2	20.0		0.0020			64.0
SF-1206HH25M-2	25.0		0.0016		DC 24 V 250 A	187.0
SF-1206HH30M-2	30.0		0.0012		DC 24 V 300 A	270.0

*** Resistance value measured with ≤10 % rated current at 25 °C ambient.
**** Melting I²t calculated at 1000 % of current rating.

Figure 6: fuse caractéristic

7 final PCB

We have a PCB with 4 layers due to the fact that some traces should pass on layer 3 to avoid to cross with others. On the 3 layers, there is only traces that can have 8A and the bottom layer have some small traces that we should do to manage all the traces.
size: 50mm x 35.5mm x 7mm
The 4 holes are to fix the PCB inside the arm and the four holes are M3

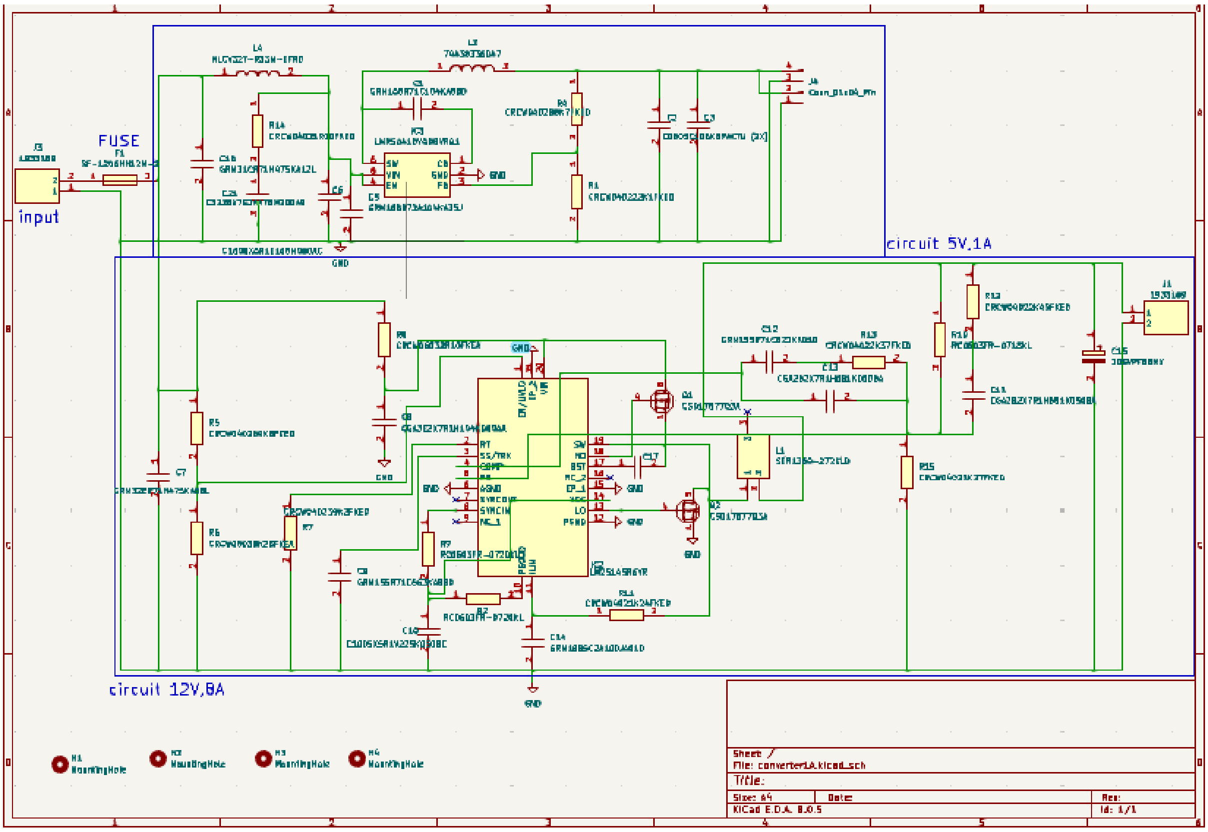

Figure 7: schematics circuit kicad

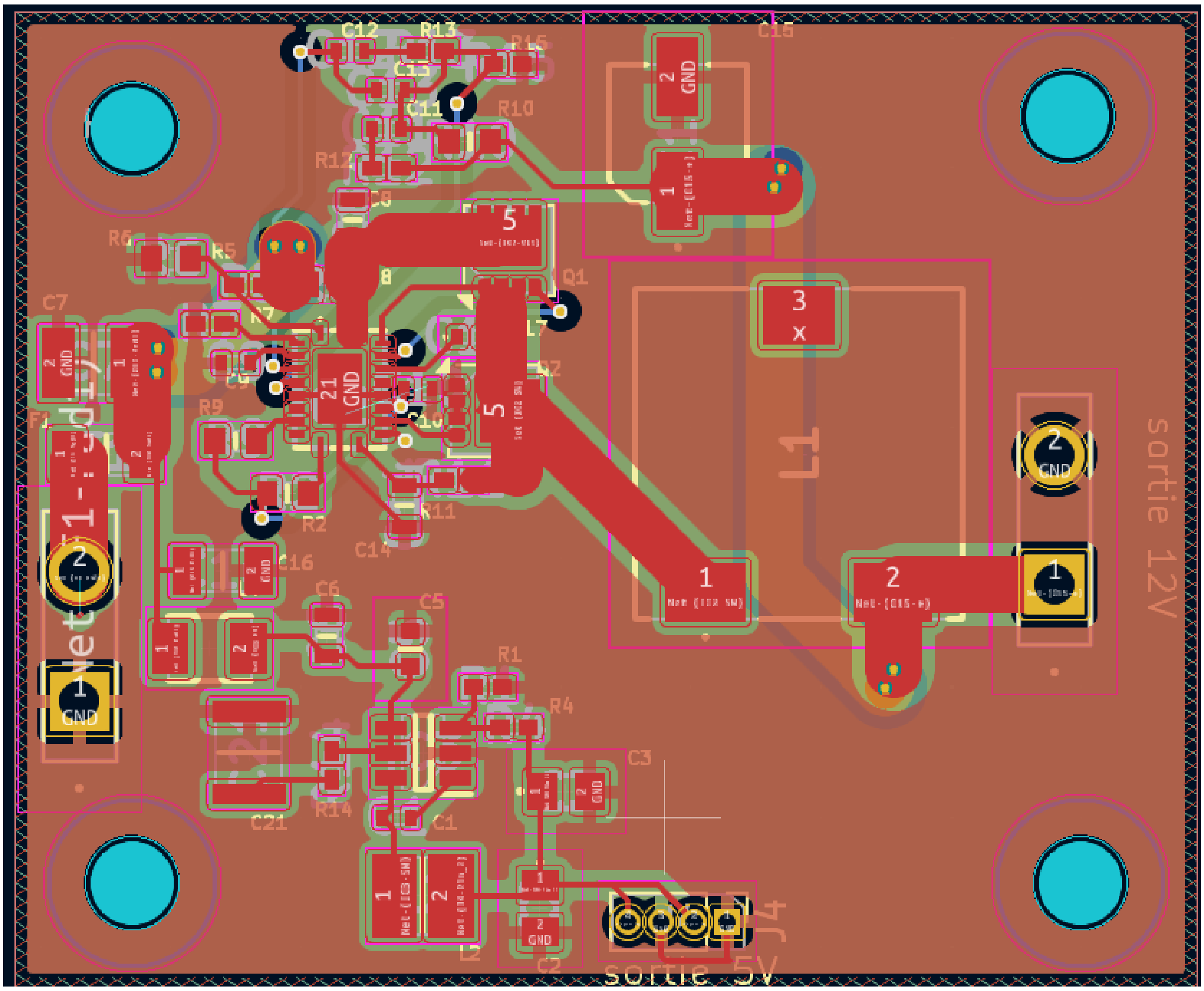

Figure 8: board PCB

8 Appendix

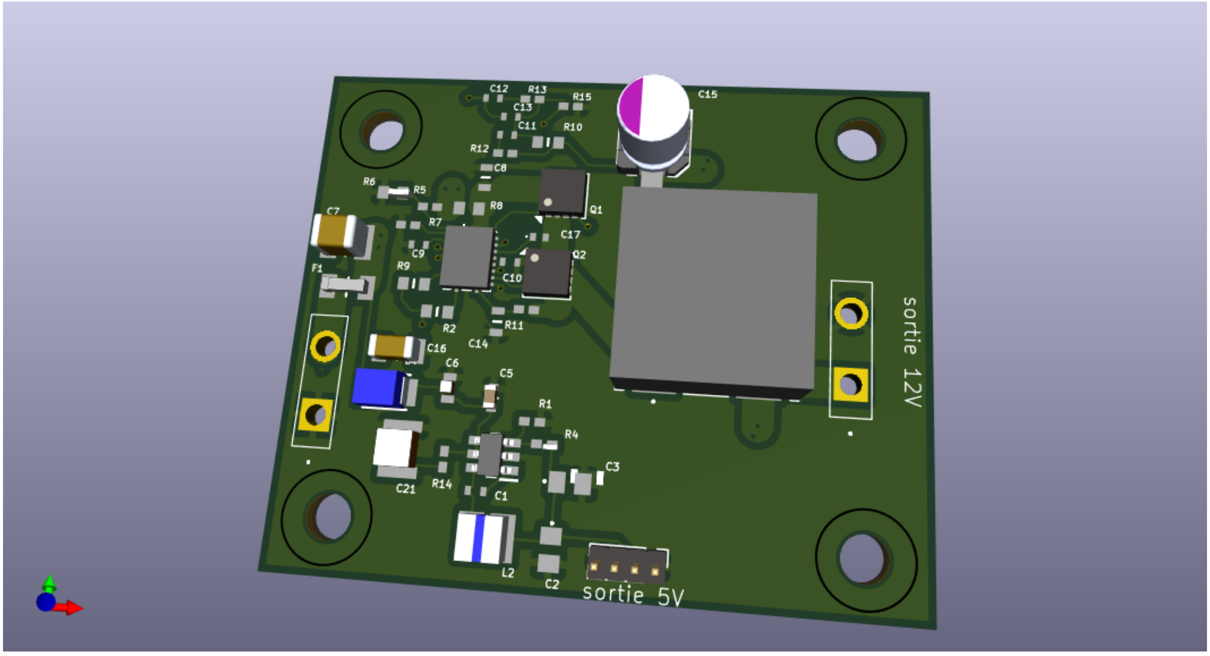

Figure 9: 3D PCB (with only the most importants elements)