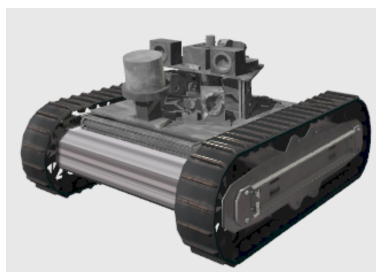
Marmotte
HD2 Robot platform
Technical Document



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by
Nicolas Antonucci
Electrical engineering intern at Norlab

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Abstract

Technical document showing the low level electronics as well as the ROS packages used to control the robot with a controller. Design techniques are shown to help reduce electrical noise as much as possible as well as information on some of the electrical connections. Schematics of the PCB designs are provided as well. This document will continue to evolve over the course of summer 2021. I thank you in advance for taking the time to read this document. I will be happy to answer any questions as well as take any feedback on the layout and execution of this document or make any changes if necessary. I can be reached at nicolas.antonucci.1@ulaval.ca.

Contents

List of Figures

Acronyms

PMM Power Management Module. 10

VDC Volts Direct Current. 10

1 Robot design

1.1 Platform

Figure 1: Platform

This is the HD2 Treaded Tank Robot Platform from superdroidrobots.com [1]. This particular model was chosen because of its robustness and its ability to easily cross many obstacle. One of the main objectives of this robot is to quickly and effectively provide reconnaissance of an unknown erea. Therefore our objectives for low level electronics and control is to have solid electrical connections that will withstand vibrations, heat and electrical noise as well as robust code that will not lag or glitch.

The platform is controled through the Roboclaw 2X30A motor controller from basicmicro, [2], [3], [4]. The motors used are the IG52-04 24VDC 285 RPM Gear Motors, [5], [6], 2 of them with encoders. Encoders are not needed for the other 2 as they are connected in line with the same track.

1.2 Block diagram

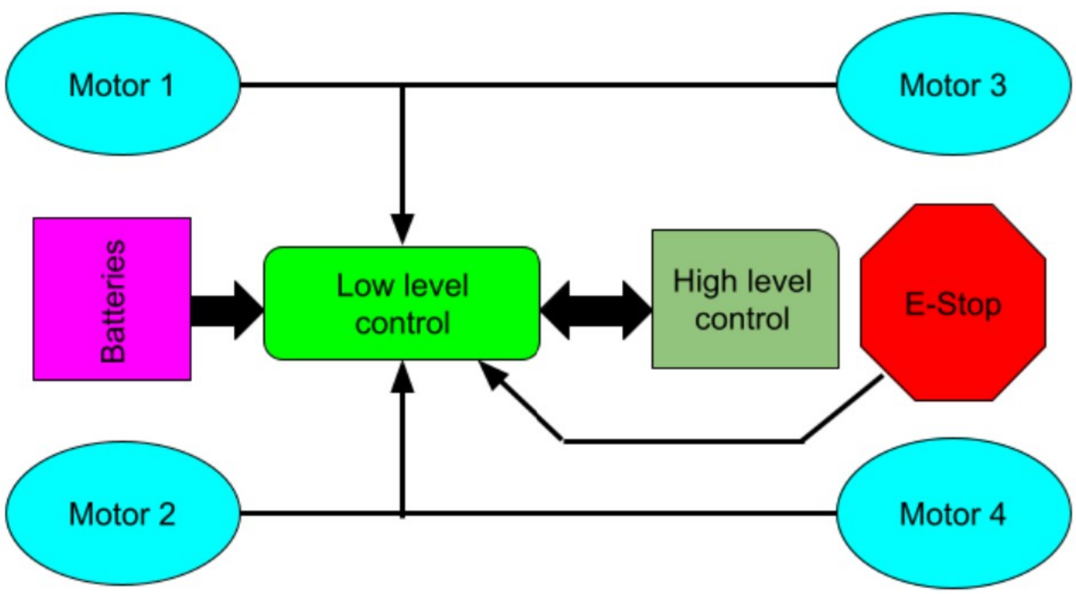


Figure 2: Low level block diagram

2 D.C. Geared motors

This next table shows the different motor configurations with their respective current draws and we can see our highlighted configuration at the bottom.

Motor Configuration			Approximate Current Draw[1] (total for all motors)			
Gross Weight limit[2]	Front Motors	Rear Motors	Driving Flat Straight	Pivot Turns on Grass	Pivot Turns on Concrete	Ascending Stairs
IG52-02 24VDC 103 RPM Gear Motor						
120lbs	2	0	3.5A	12A	8A	8A
200lbs	2	2	5A	13A	9A	8.5A
IG52-02 24VDC 290 RPM Gear Motor						
120lbs	2	2	11A	40A	21A	20A
IG52-04 24VDC 285 RPM Gear Motor						
120lbs	2	0	5A	24A (~Stall)	9.5A	12.5A
200lbs	2	2	8.5A	22.5A	11.5A	16A

1. The current draw is approximate average. Higher inrush spikes, etc will be experienced.
2. The robot weighs about 60lbs with motors. The weight of the batteries, sensors, controllers, aux equipment, cargo, etc should be added to this to get the gross weight. The robot itself is designed to carry even more weight, but since its skid steering, turning in deep grass, carpet etc will be difficult with heavier loads. If using on smooth surfaces, dirt or other low friction surfaces, pivot turning with heavier loads can be achieved.

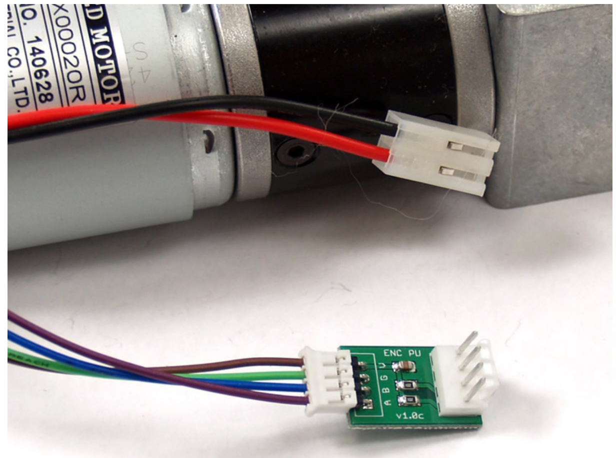
Figure 3: Motor config

During the wiring of the motors we were careful to install ferrite beads as close as possible to each motor. We also twisted the positive and negative wires together. These actions help us reduce electrical noise from the motors. The encoders require a $1K\Omega$ pull up resistor to VCC as you can see in the following pictures and we made sure to shrink wrap these connections to ensure a reliable connection. In the following pictures we can also see electrical characteristics for the encoders.

Figure 4: Motor wires

Motor

Pull up resistor attached

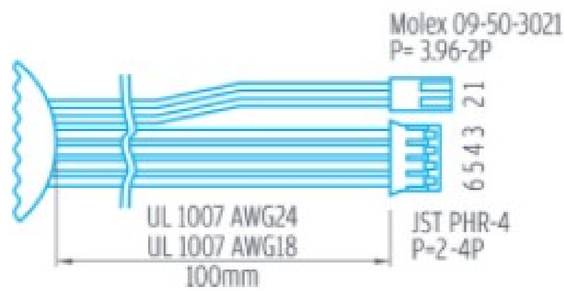


Cable layout

Two Channel Encoder Connections

1. Black : - Motor
2. Red : + Motor
3. Brown : Hall Sensor Vcc
4. Green : Hall Sensor GND
5. Blue : Hall Sensor A Vout
6. Purple : Hall Sensor B Vout

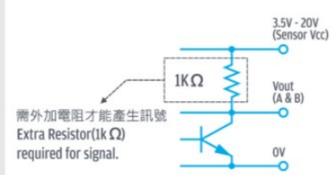
Schematic



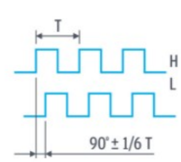
Electrical caracteristics

規格特性 Characteristics	代號 Symbol	測試條件 Test conditions	極小 Min.	基準 Ref.	最大 Max.	單位 Units
輸入電壓 Supply voltage	Vcc	- -	3.5	-	20	V
輸出飽和電壓 Output saturation voltage	Vce (sat)	Vcc = 14V ; IC = 20mA	-	300	700	mV
輸出漏電電流 Output leakage current	Icex	Vcc = 14V ; Vcc = 14V	-	< 0.1	10	µA
輸入電流 Supply current	Ice	Vcc = 20V Output open	-	5	10	mA
輸出上升時間 Output rise time	tr	Vcc = 14V ; R_L = 820 Ω ; C_L = 20pF	-	0.3	1.5	µS
輸出下降時間 Output fall time	tr	Vcc = 14V ; R_L = 820 Ω ; C_L = 20pF	-	0.3	1.5	µS

輸出電路
Output circuit



輸出波形
Output wave



3 Roboclaw 2x30A Motor Controller

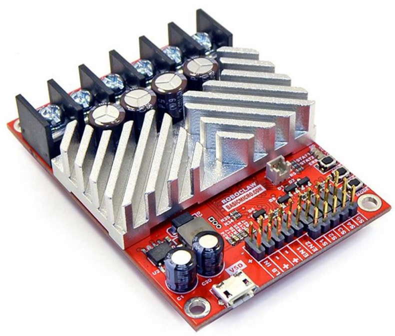
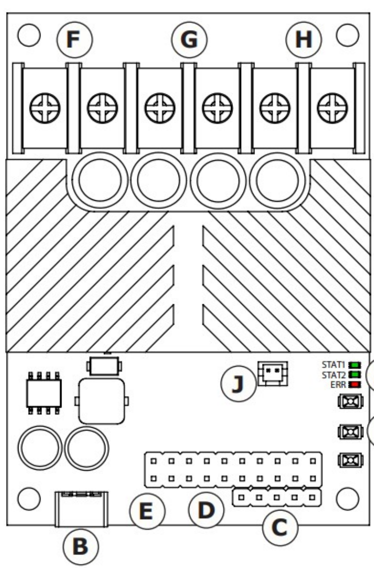
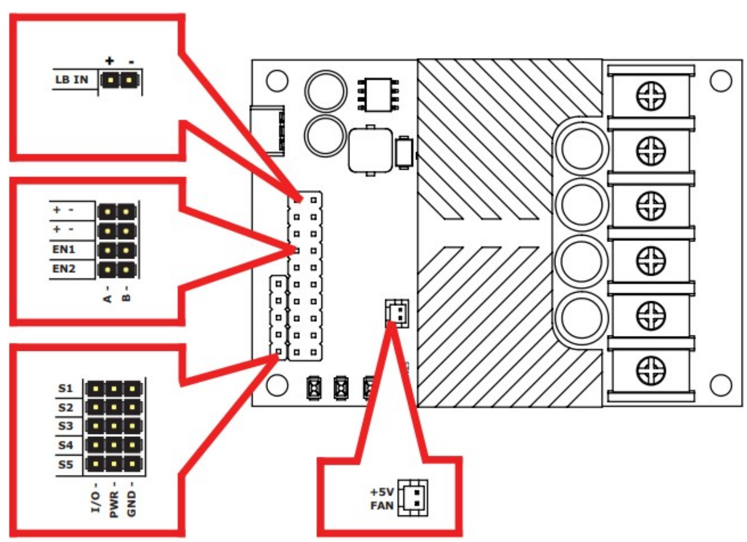


Figure 5: Motor Controller

Hardware overview



Control interface



- Connect batteries to the main terminal (G).
- Connect encoder through pull up resistor chip to pins in section D.
- See schematic below for details.
- For initial tests connect roboclaw through usb to computer (batteries have to be connected to roboclaw to function). Use motion studio [7] to check if motors and sensors work.

ID	Function	DESCRIPTION
A	Status LEDs	Provides RoboClaw status information.
B	USB Port	Communicate with RoboClaw via USB.
C	Control Inputs	S1,S2,S3,S4 and S5 control inputs.
D	Encoder Inputs	Dual encoder input and power pins.
E	Logic Battery	Logic battery jumper setup and logic battery power input.
F	Motor Channel 1	Motor driver output screw terminals for channel 1.
G	Main Battery	Main battery screw terminal input.
H	Motor Channel 2	Motor driver output screw terminals for channel 2.
I	Setup Buttons	Configure RoboClaw. Can bypass and use IonMotion PC setup utility.
J	Fan Control	Automatic fan control. 5VDC Fan. On at 45°C and off at 35°C

Figure 6: Hardware overview reference table

NAME	UART TTL	ANALOG	R/C PULSE	FLIP SWITCH	E-STOP	HOME	LIMIT	V-CLAMP	Encoder
S1	RX	Motor 1	Motor 1						
S2	TX	Motor 2	Motor 2						
S3				X	X			X	
S4					X	Motor 1	Motor 1	X	
S5					X	Motor 2	Motor 2	X	
EN1									Motor 1
EN2									Motor 2
+5V									
FAN									

Figure 7: Control interface reference table

Characteristic	Min	Typ	Max	Rating
Main Battery	6		34	VDC
Logic Battery	6	12	34	VDC
Maximum External Current Draw (BEC)			3	A
Motor Current Per Channel		30(2)	60(1,2)	A
Motor Current Bridged		60(2)	120(1,2)	
On Resistance		4.3		mOhm
Logic Circuit Current Draw		30mA		mA
Input Impedance		100		Ω
Input	0		5	VDC
Input Low	-0.3		0.8	VDC
Input High	2		5	VDC
I/O Output Voltage	0		3.3	VDC
Digital and Analog Input Voltage			5	VDC
Analog Useful Range	0		2	VDC
Analog Resolution		1		mV
Pulse Width	1		2	mS
Encoder Counters		32		Bits
Encoder Frequency			9,800,000	PPS
RS232 Baud Rate (Note 3)			460,800	Bits/s
RS232 Time Out (Note 3)	10			ms
Temperature Range	-40	40	100	°C
Temperature Protection Range	85		100	°C
Humidity Range			100 (4)	%

Figure 8: Electrical specifications

4 Safety wiring and power up

4.1 Basic recommendations

This is the basic safety diagram given in the roboclaw user manual to install a protection against too high of a power output as well as a return path for energy generated by the motors in a situation where the vehicle would be pushed while the battery is unconnected for example.

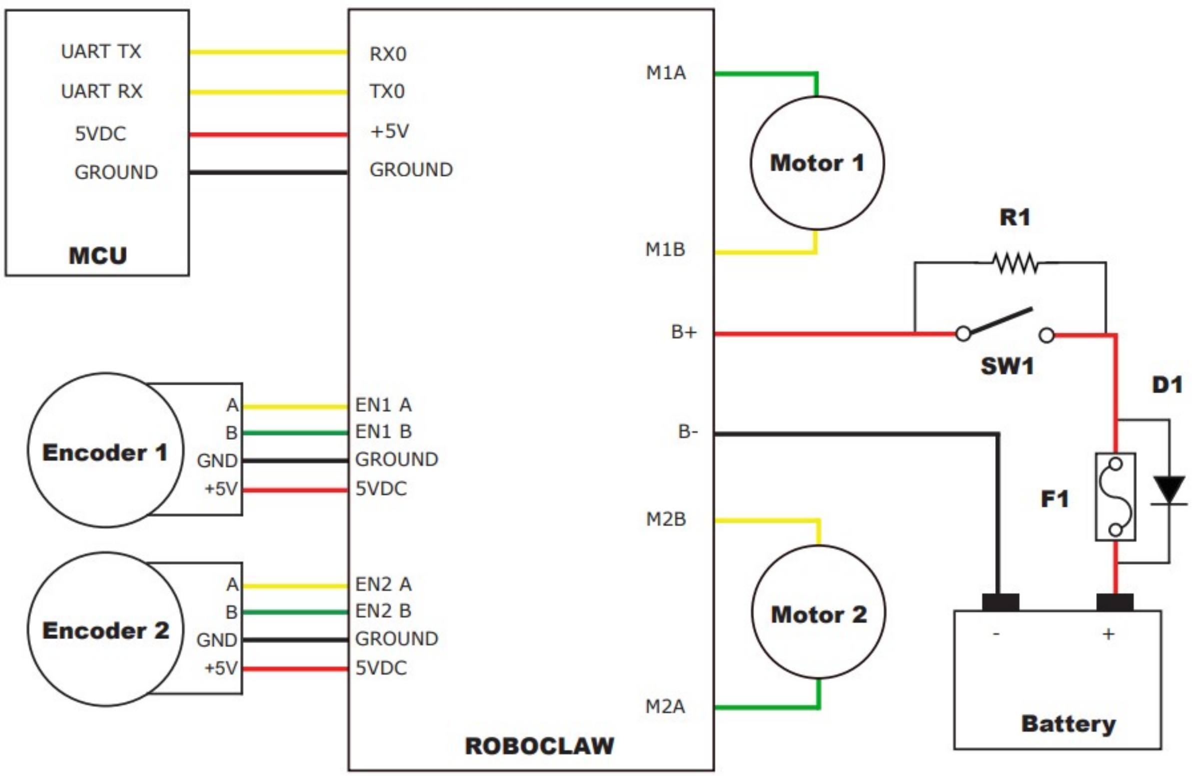


Figure 9: Safety wiring

We have decided to go a little further with this and we will explain this in the next subsection.

4.2 Marmotte Power Management Module

We have decided to design a PMM with a time delay to be able to power up the capacitors on the roboclaw slowly rather than smack it with 27 VDC instantly. In this process, we use a 555 timer with a potentiometer and are able to have a delay of about 8 seconds before we activate the automotive relay. The potentiometer enables us to have a longer or shorter delay revolving around our initial calculations of a 47 KΩ resistor to the threshold pin of the 555 timer. The following schematic shows our PMM.

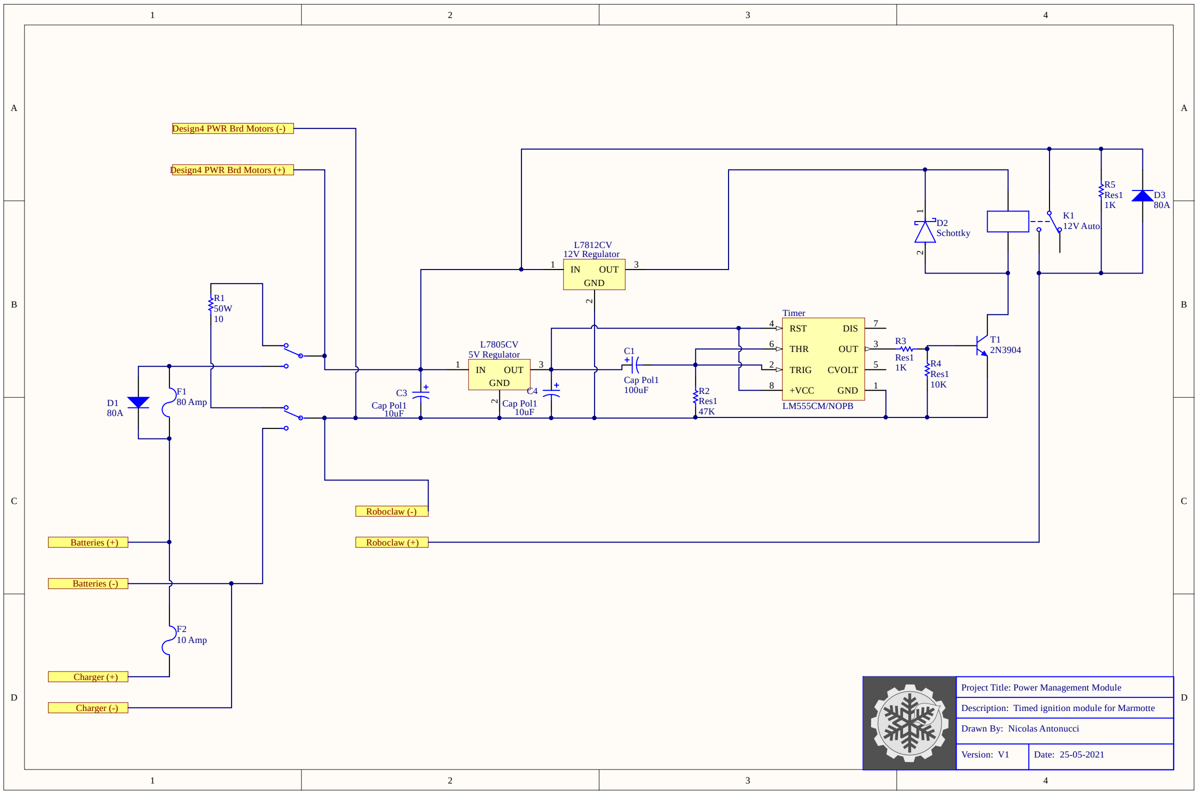


Figure 10: Power Management Module Schematic

As can be seen on the left side of the schematic, we provide a path back to the negative input of the roboclaw through a 50W 10Ω resistor when the batteries are disconnected and straight back to the positive battery connector through a power diode when they are connected as shown in the user manual safety wiring diagram.

4.3 E-Stop Module

5 ROS Driver

6 Remote Control

References

[1] *Hd2 robot webpage*, https://www.superdroidrobots.com/shop/item.aspx/hd2-treaded-atr-tank-robot-platform/789/, 2021.

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[3] *Roboclaw datasheet*, https://downloads.basicmicro.com/docs/roboclaw_datasheet_2x30A.pdf, 2021.

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[7] *Windows control program for the roboclaw*, https://www.basicmicro.com/downloads, Download this for initial setup of the roboclaw, Last visited: June/2021.