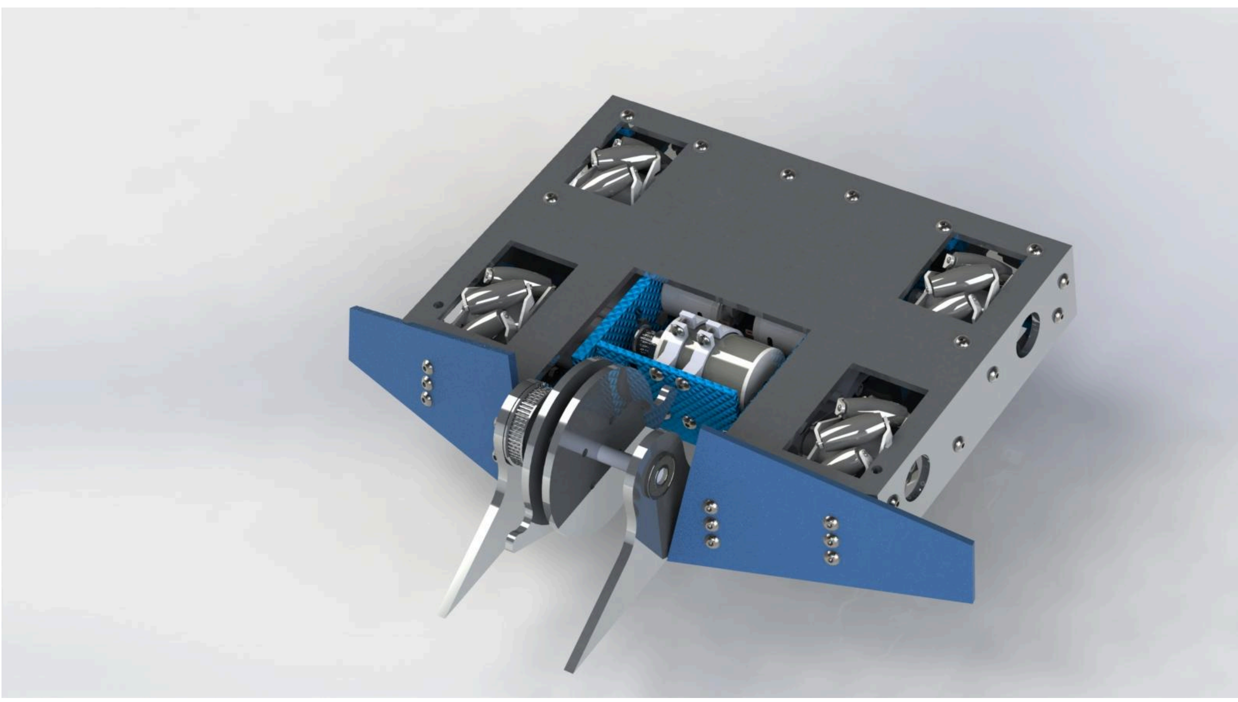
Introduction and Overview

Battle Bot Design Overview

This document outlines the design and features of a custom built battle bot, designed for robust performance in competitive environments. The bot is engineered with precision, focusing on high mobility and effective combat capabilities. Its frame is constructed from high-grade aluminum, chosen for its excellent strength-to-weight ratio, enhancing the bot's agility and impact resilience.

Weight and Dimensions:

- **Total Weight:** 3 kg
- **Material:** Aluminum
- **Overall Dimensions:** 21 cm X 20 cm



Frame Construction and Features

Aluminum Frame Construction

The frame of the battle bot serves as the skeleton to which all other components are attached and protected. It is crafted from aluminum, which provides a light yet sturdy base for the operational components and weaponry. The design incorporates a series of reinforcements at critical stress points to prevent deformation under combat conditions.

Materials and Fabrication

- **Aluminum Frame:** The primary structure is built using aluminum, known for its light weight and high strength, forming the core framework that supports all critical components and systems.
- **3D-Printed Components:** Select parts of the battle bot are fabricated using advanced 3D printing technology. Materials such as ABS or PLA are chosen for these parts due to their light weight and ease of printing.

Benefits of Hybrid Construction

- **Customization and Flexibility:** The ability to quickly produce 3D-printed components allows for rapid prototyping and testing of parts, enabling continuous improvement and customization of the bot.
- **Cost-Effective Solutions:** Utilizing 3D printing reduces the cost associated with small batch production of complex parts, making it economically viable to design parts that perfectly fit the bot's needs without the need for expensive tooling or molds.

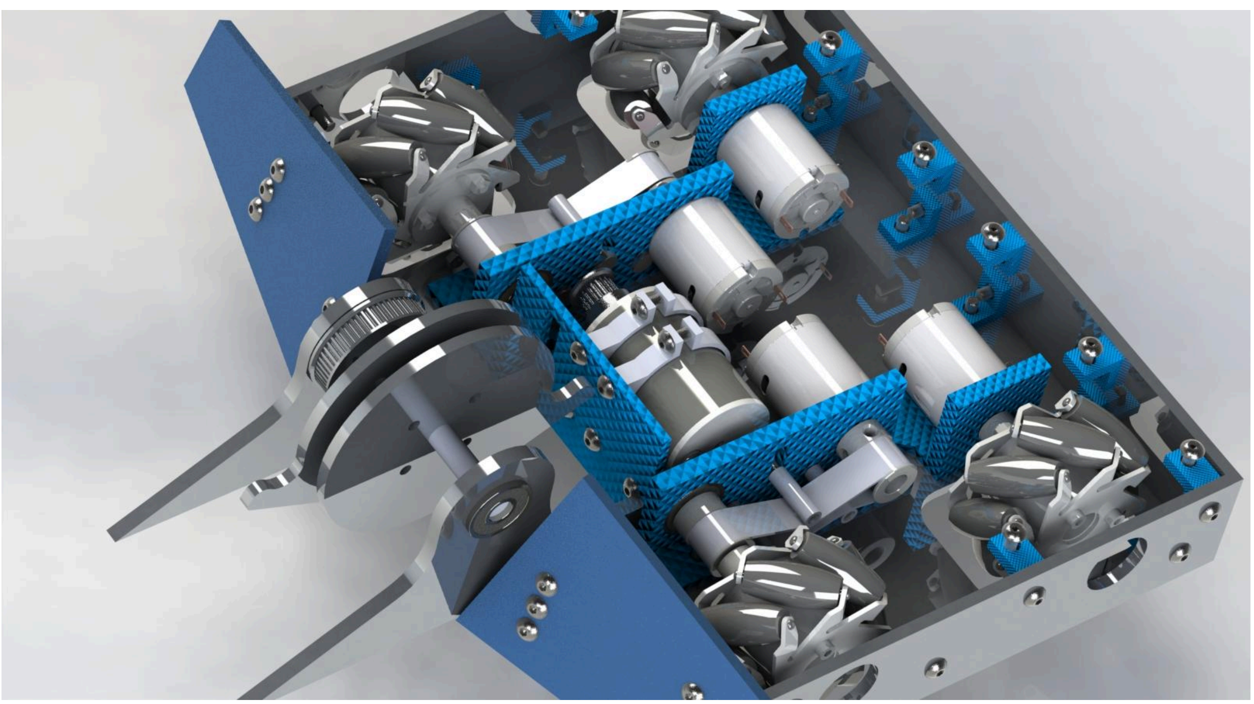
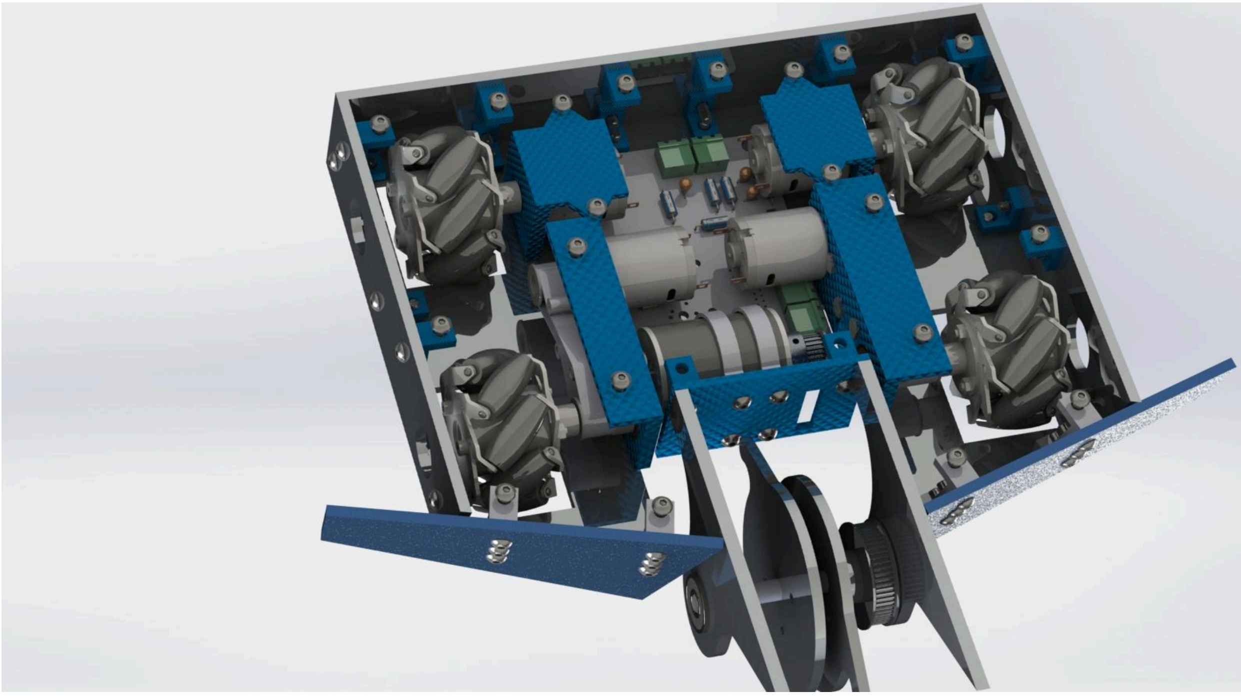


Figure 2: Detailed Overhead View



.**Figure 3: Detailed downhead View**

Tool System Details

Tool System Integration

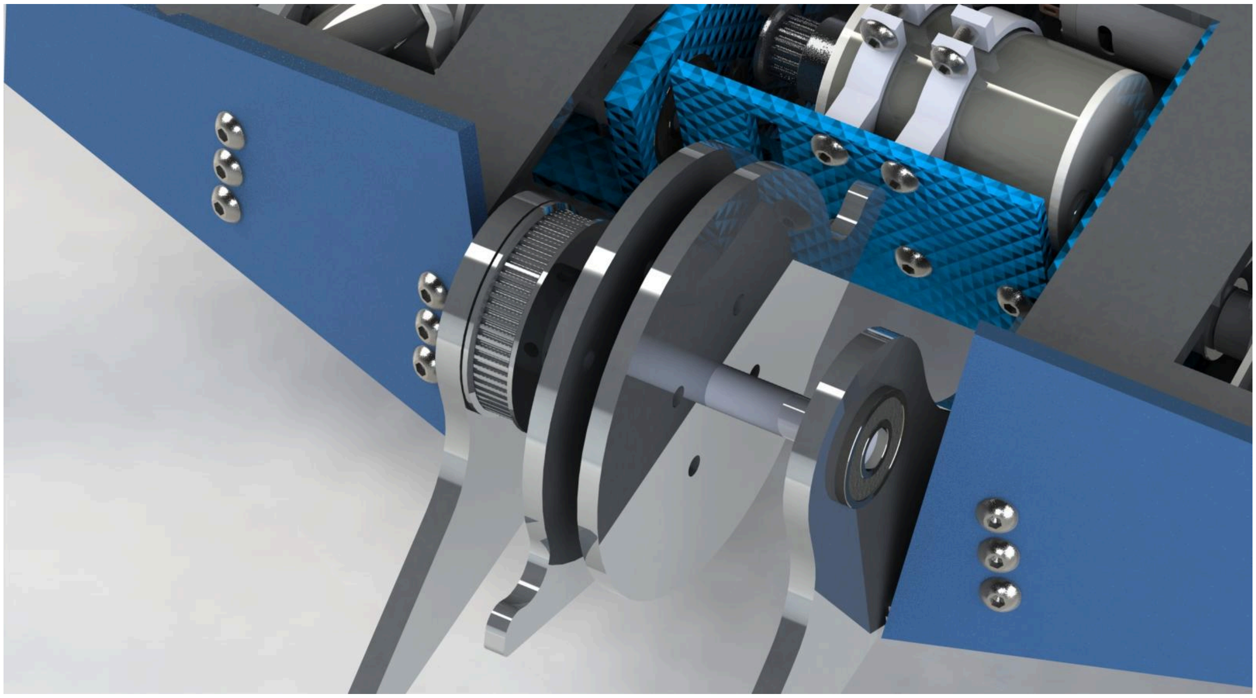
The primary weapon system of the battle bot is a centrally mounted spinning blade, designed to deliver high-impact hits to opponents. This weapon is powered by a dedicated motor, with the blade assembly made from hardened steel to withstand the rigors of combat.

Tool Specifications:

1. **Blade Material:** Hardened steel
2. **Motor Type:** High-torque electric motor capable of rapid acceleration to maximum speed within seconds.
3. **Mounting:** The blade is mounted on a reinforced axle connected directly to the motor, with shock-absorbing materials used to reduce vibration and stress on the motor bearings.

Operational Capabilities:

- **Spin Rate:** Capable of reaching speeds up to 5000 RPM.
- **Impact Resistance:** Engineered to maintain functionality even after significant impacts, with easy-access features for quick field repairs.



.Figure 4: close look to the tool mechanism

Electrical component :

The links of every component i will mention will be on the references , plus this is not the PCB components , this is just hard electrical components like motors , controller , etc …

Component	Description	Quantity	Unit Price	Total Price
DC Motor High Speed Electric Brush	12V 100W Motor 5000RPM High Speed Electric Brush Scooter Motor R6493 RC Car	1	$57.39	$57.39
775 High Power DC Motor	DC 12V-24V, 3200 RPM, Large Torque Motor Ball Bearing	4	$16.32	$60
GoolRC Flysky FS-i6X Transmitter	2.4GHz 10CH AFHDS 2A RC Transmitter with FS-iA6B Receiver	1	$46.99	$16.00
CNHL 2200mAh 3S Lipo Battery	30C 11.1V with Dean Plug, Pack of 2	1	$55.00	$55.00

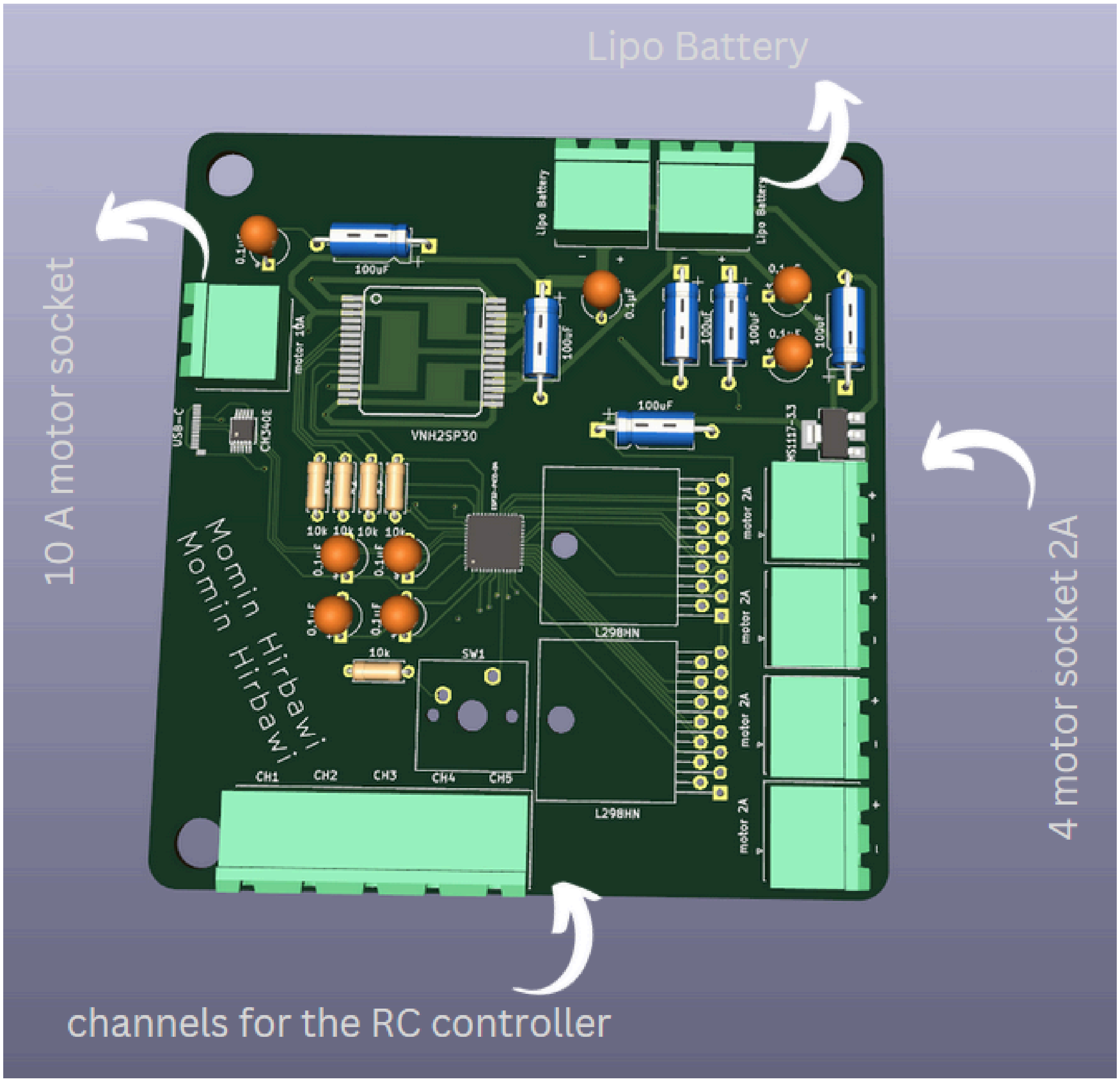
Premium 97mm Mecanum Wheel	Omni Directional Tire with Metal 6mm Coupling	1 Set	$43.99	$43.99
Zeberoxyz GT2 Synchronous Wheel Set	20&60 Teeth 8mm Bore with 200mm Width 6mm Belt	1 Set	$12.89	$12.89
150g 3D Printed PLA Plastic	Material for custom parts	150g	$9.40	$9.40
2.300 kg Aluminum Material	For structural components	2.300 kg	$76	$76

Table 1 : components

The PCB Design

Overview

This PCB i made is supposed to control the battle bot completely using the FS-i6X controller , by using driver ic's for controlling the 5 motors , while the 4 wheels motors should be slower and with a less torque than the weapon motor , so i decided to use 2A DC motor for the wheels and 10A dc motor for the weapon motor , controlled by the main MUC that is (Esp32 - Peco-D4) this esp is supposed to take the signals from the 5 channels from the controller and then convert to a PWM signals to use them with the drivers



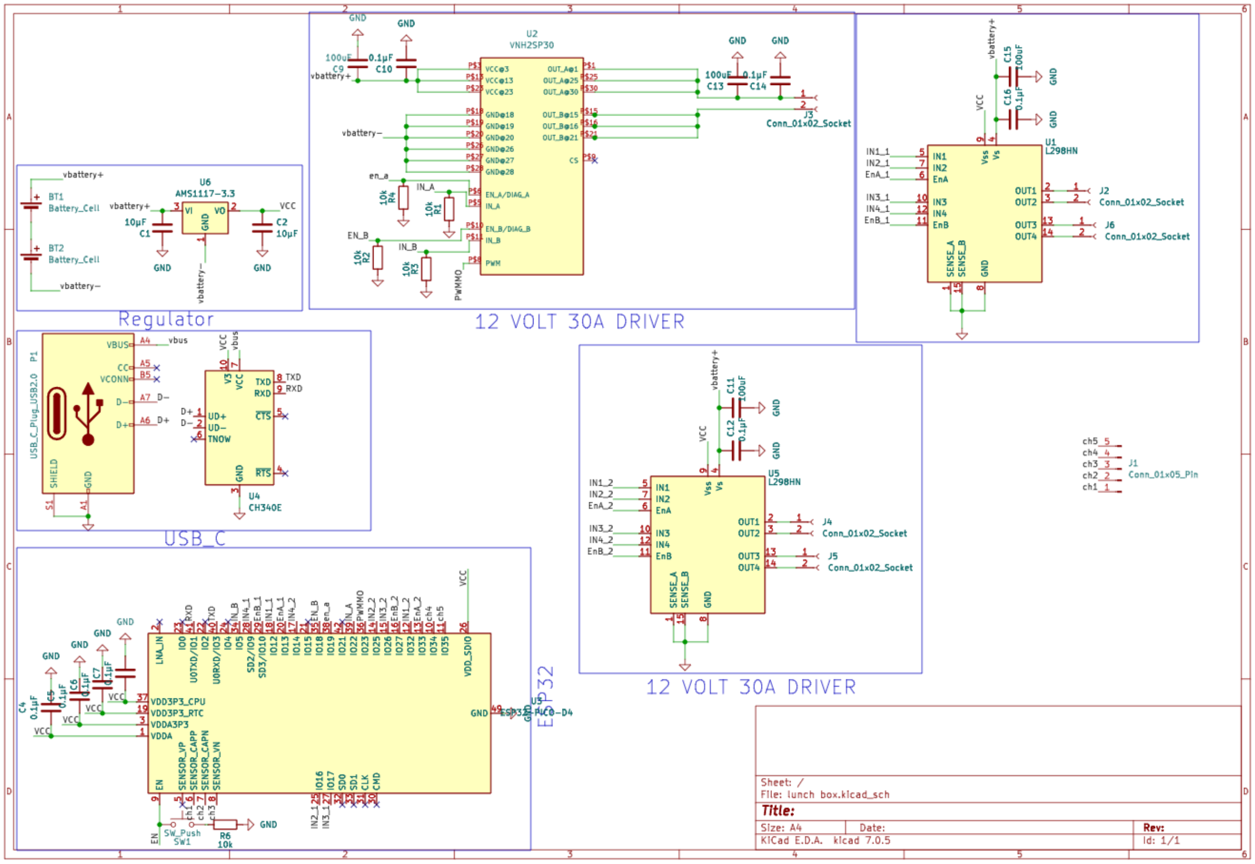
.**Figure 5: PCB 3d layouy**

Components and connections

Here is the components and its Function in this Project and the main pins wiring , also you can check the schematic design for more understanding , components in table 1 , and schematic design in figure 6

Component	Description	Function in Project	Main Pins
U3 (ESP32-PICO-D4)	Microcontroller	Central processing unit that handles control logic, motor commands, and sensor inputs.	VDDA, IO34-IO35, IO32-IO33, GND, additional IO pins for sensor and actuator control
U1, U5 (L298HN)	Motor Driver	Controls the four wheel motors, allowing precise movement and speed adjustments.	IN1, IN2, IN3, IN4, EnA, EnB, OUT1, OUT2, OUT3, OUT4, Vs, Vss
U2 (VNH2SP30)	Motor Driver	Manages the high-current weapon motor, providing necessary torque and speed.	IN_A, IN_B, PWM, CS, OUT_A, OUT_B, VCC, GND
U6 (AMS1117-3.3)	Voltage Regulator	Supplies a stable 3.3V power to low-power components on the board.	VI (Input Voltage), VO (Output Voltage), GND
U4 (CH340E)	USB to Serial Converter	Enables programming and communication between the microcontroller and a computer.	TXD, RXD, VCC, GND, D+, D-, UD+
C1, C10-C16	Capacitors	Stabilize voltage and filter noise in the power supply to various components.	- (Connected across power and ground pins of associated components)
R1, R2, R3, R4, R6	Resistors	Employed for pulling up/down inputs and limiting current to protect other components.	- (Connected in line or across signals and power for biasing and protection)
J1, J2, J3, J4, J5, J6	Connectors	Provide interfaces for external connections to motors, power sources, and other peripherals.	- (Pin numbers vary by connector type and usage in the design)
SW1	Switch	Used to enable the microcontroller, typically controlling the power state or activation of the system.	- (Connected to the enable pin on the MCU)
FS-i6X Channels (CH1-CH5)	Control Channels	Interface for receiving signals from the FS-i6X transmitter, used for controlling various functions like movement and weapons.	CH1 to CH5 connected to corresponding input pins on the microcontroller for processing

Table 2 : PCB components and wiring



.**Figure 6: schematic design**

Power Management Components

1. AMS1117-3.3 Voltage Regulator (U6)

- **Function:** Provides stable 3.3V output for low-power devices.
- **Current Handling:** Up to 1A, supporting the microcontroller and sensors.
- **Integration:** Positioned near power inputs with filtering capacitors to ensure smooth operation.

2. VNH2SP30 Motor Driver

- **Function:** Drives the weapon motor.
- **Current Handling:** 30A continuous, suitable for the 10A required by the weapon.
- **Integration:** Includes extensive heat sinking to manage high current loads, crucial for the weapon's operation.

3. Dual L298HN Motor Drivers

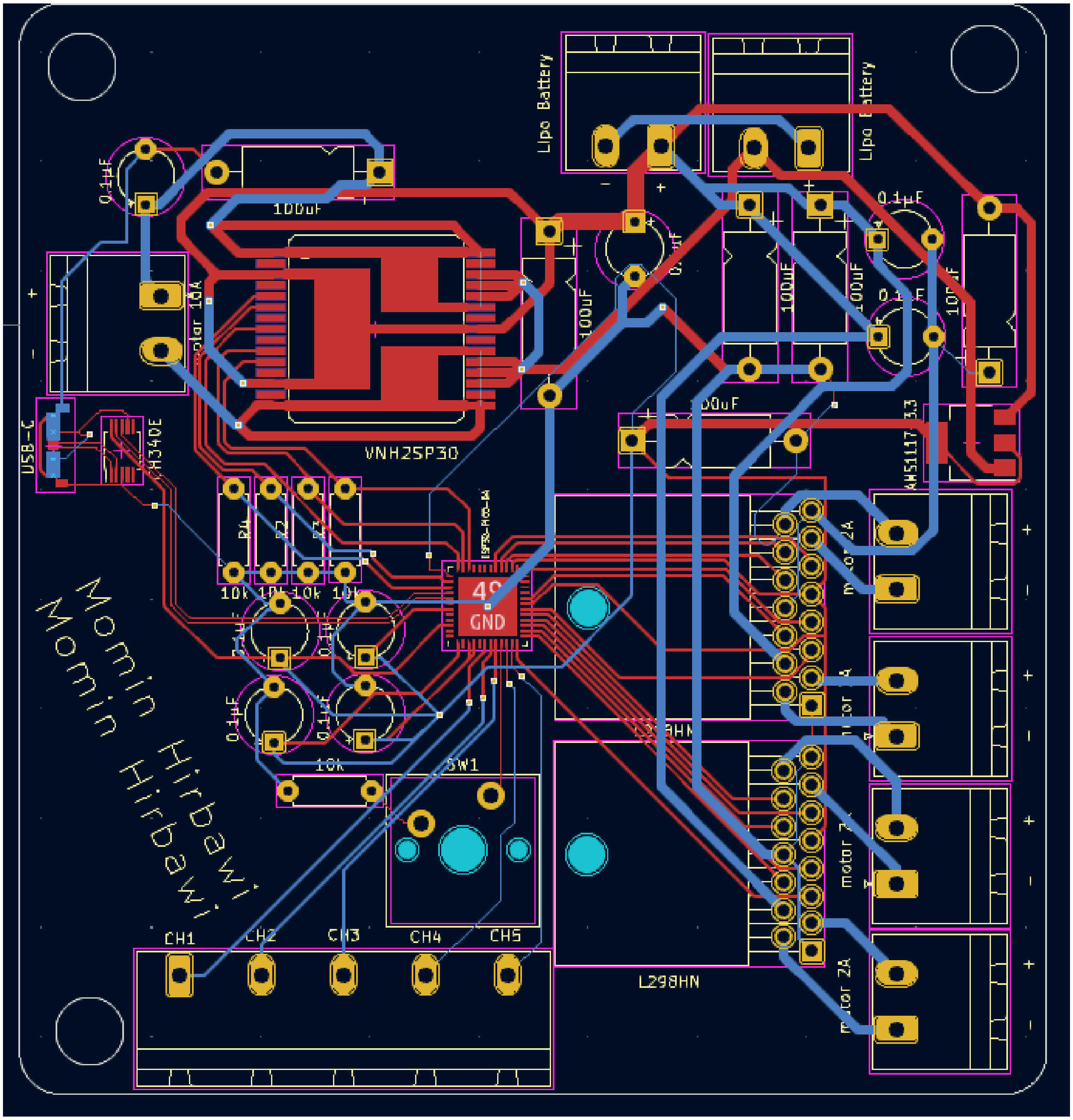
- **Function:** Independently controls four wheel motors.
- **Current Handling:** 2A per channel, aligning with the wheel motors' 2A requirement.
- **Integration:** Each driver is equipped with dedicated capacitors for voltage stabilization and noise filtering.

4. ESP32-PICO-D4 MCU (U3)

- **Function:** Acts as the central processing unit, handling logic, sensor input, and motor control commands.
- **Power Supply:** Powered by the AMS1117-3.3 to maintain a reliable 3.3V.
- **Role:** Crucial for interpreting control signals and managing operational states of the battle bot.

In the PCB design for the battle bot, special attention has been paid to the trace widths to ensure they can handle the required currents without excessive heat buildup or voltage drop. For the motor traces that need to support up to 2 amps, a trace width of 0.8 mm is used. This width is calculated based on standard PCB design guidelines which recommend sufficient width to handle the current with an allowable temperature rise of 10°C to 20°C. For the more demanding application of the weapon motor, which requires up to 10 amps, the trace width is increased to 2.5 mm. This specification ensures that the traces can safely conduct higher currents, calculated using the IPC-2221 standard, which provides formulas for determining the trace width based on the expected current load and the copper thickness, typically 1 oz/ft^2 for standard PCBs. By adhering to these guidelines, the PCB is designed to ensure reliability and efficiency in powering both the movement and weaponry systems of the bot, crucial for optimal performance in competitive scenarios.

This PCB, measuring 10 cm by 9.5 cm, employs a concise 2-layer design, with top and bottom layers facilitating efficient routing of power and signal traces. The use of vias is optimized to connect traces between these layers effectively, enhancing the electrical performance and compactness of the design. Thicker traces on the power layer support high-current applications, vital for the motor drivers managing wheel and weapon motors. The layout also ensures that all connectors and critical components are easily accessible, which is crucial for maintenance and troubleshooting in competitive environments.



.Figure 4: PCB design

Coding

This is an arduino code because we are using peco d4 :

```
#include <ESP32Servo.h>
#include <FlySkyIBus.h>

const int enA1Pin = 13
const int in1_1Pin = 12;
const int in2_1Pin = 16;
const int enB1Pin = 10;
const int in3_1Pin = 17;
const int in4_1Pin = 9;

const int enA2Pin = 33;
const int in1_2Pin = 32;
const int in2_2Pin = 25;
const int enB2Pin = 27;
const int in3_2Pin = 26;
const int in4_2Pin = 14;

const int enBPin = 35;
const int inBPin = 5;
const int inAPin = 22;
const int pwmPin = 23;

const int gunMotorPin = 19;

const int enableSwitchPin = 9;

const int pwmFreq = 5000;
const int pwmResolution = 8;

const int ch1 = 0;
const int ch2 = 1;
const int ch3 = 2;
const int ch4 = 3;
const int ch5 = 4;

void setup() {
  Serial.begin(115200);
```

```
  IBus.begin(Serial1, 115200);

  ledcSetup(0, pwmFreq, pwmResolution);
  ledcSetup(1, pwmFreq, pwmResolution);
  ledcSetup(2, pwmFreq, pwmResolution);
  ledcSetup(3, pwmFreq, pwmResolution);
  ledcSetup(4, pwmFreq, pwmResolution);
  ledcSetup(5, pwmFreq, pwmResolution);
  ledcSetup(6, pwmFreq, pwmResolution);

  ledcAttachPin(enA1Pin, 0);
  ledcAttachPin(enB1Pin, 1);
  ledcAttachPin(enA2Pin, 2);
  ledcAttachPin(enB2Pin, 3);
  ledcAttachPin(gunMotorPin, 4);
  ledcAttachPin(pwmPin, 5);

  pinMode(in1_1Pin, OUTPUT);
  pinMode(in2_1Pin, OUTPUT);
  pinMode(in3_1Pin, OUTPUT);
  pinMode(in4_1Pin, OUTPUT);
  pinMode(in1_2Pin, OUTPUT);
  pinMode(in2_2Pin, OUTPUT);
  pinMode(in3_2Pin, OUTPUT);
  pinMode(in4_2Pin, OUTPUT);
  pinMode(inBPin, OUTPUT);
  pinMode(inAPin, OUTPUT);

  pinMode(enableSwitchPin, INPUT);
}

void loop() {

  bool isEnabled = digitalRead(enableSwitchPin);

  if (isEnabled) {

      int throttle = IBus.readChannel(ch1);
      int steering = IBus.readChannel(ch2);
      int strafe = IBus.readChannel(ch3);
      int rotation = IBus.readChannel(ch4);
      int gunControl = IBus.readChannel(ch5);
```

```
    throttle = map(throttle, 1000, 2000, -255, 255);
    steering = map(steering, 1000, 2000, -255, 255);
    strafe = map(strafe, 1000, 2000, -255, 255);
    rotation = map(rotation, 1000, 2000, -255, 255);
    gunControl = map(gunControl, 1000, 2000, 0, 255);


    int motor1Speed = throttle + steering + strafe - rotation;
    int motor2Speed = throttle - steering - strafe - rotation;
    int motor3Speed = throttle - steering + strafe + rotation;
    int motor4Speed = throttle + steering - strafe + rotation;

    motor1Speed = constrain(motor1Speed, 0, 255);
    motor2Speed = constrain(motor2Speed, 0, 255);
    motor3Speed = constrain(motor3Speed, 0, 255);
    motor4Speed = constrain(motor4Speed, 0, 255);

    ledcWrite(0, motor1Speed);
    ledcWrite(1, motor2Speed);
    ledcWrite(2, motor3Speed);
    ledcWrite(3, motor4Speed);
    ledcWrite(4, gunControl);
    ledcWrite(5, gunControl);

    digitalWrite(in1_1Pin, motor1Speed > 0);
    digitalWrite(in2_1Pin, motor1Speed < 0);
    digitalWrite(in3_1Pin, motor2Speed > 0);
    digitalWrite(in4_1Pin, motor2Speed < 0);
    digitalWrite(in1_2Pin, motor3Speed > 0);
    digitalWrite(in2_2Pin, motor3Speed < 0);
    digitalWrite(in3_2Pin, motor4Speed > 0);
    digitalWrite(in4_2Pin, motor4Speed < 0);
    digitalWrite(inAPin, gunControl > 0);
    digitalWrite(inBPin, gunControl < 0);


    Serial.print("Throttle: "); Serial.print(throttle);
    Serial.print(" Steering: "); Serial.print(steering);
    Serial.print(" Strafe: "); Serial.print(strafe);
    Serial.print(" Rotation: "); Serial.print(rotation);
    Serial.print(" Gun: "); Serial.println(gunControl);
} else {
```

```
      ledcWrite(0, 0);
      ledcWrite(1, 0);
      ledcWrite(2, 0);
      ledcWrite(3, 0);
      ledcWrite(4, 0);
      ledcWrite(5, 0);
  }

  delay(20);
}
```

References:

1. High Power DC Motor - Detailed specifications and pricing for a high-torque motor suitable for robust applications such as battle bots. Available from Amazon. [Accessed: 2024-04-10]. Available at: https://www.amazon.com/Power-12V-24V-Torque-Bearing-Driver/dp/B086Z47DLJ
2. GoolRC Flysky FS-i6X Transmitter - A 2.4GHz 10CH transmitter with FS-iA6B Receiver for remote control applications. Available from Amazon. [Accessed: 2024-04-10]. Available at: https://www.amazon.com/dp/B0872QHMM3
3. CNHL 2200mAh 3S Lipo Battery - A 30C 11.1V lithium polymer battery with Dean Plug, commonly used for high-performance RC applications. Available from Amazon. [Accessed: 2024-04-10]. Available at: https://www.amazon.com/CNHL-2200mAh-Battery-Airplane-Quadcopter/dp/B0BTYPT4RT
4. Zeberoxyz GT2 Synchronous Wheel Set - Timing pulley and belt set for precise motion control in mechanical assemblies. Available from Amazon. [Accessed: 2024-04-10]. Available at: https://www.amazon.com/Zeberoxyz-Synchronous-Aluminum-Timing-20-60T-8B-6/dp/B08QZ4365D
5. Premium Mecanum Wheels - Omni-directional wheels for advanced maneuverability in robotics. Available from Amazon. [Accessed: 2024-04-10]. Available at: https://www.amazon.com/Directional-Coupling-Connector-Raspberry-Microbit/dp/B09KY6C5BG
6. STMicroelectronics VNH2SP30 Motor Driver - Specifications and datasheets for a robust motor driver. Available from SnapEDA. [Accessed: 2024-04-10]. Available at: https://www.snapeda.com/parts/VNH2SP30-E/STMicroelectronics/view-part/
7. STMicroelectronics L298N Motor Driver - Documentation for a dual full-bridge driver used for controlling DC motors. Available from SnapEDA. [Accessed: 2024-04-10]. Available at: https://www.snapeda.com/parts/L298N/STMicroelectronics/view-part/

8. Espressif Systems ESP32-PICO-D4 MCU - Technical specifications and details for the ESP32 microcontroller. Available from SnapEDA. [Accessed: 2024-04-10]. Available at: https://www.snapeda.com/parts/ESP32-PICO-D4/Espressif%20Systems/view-part/