

A

B

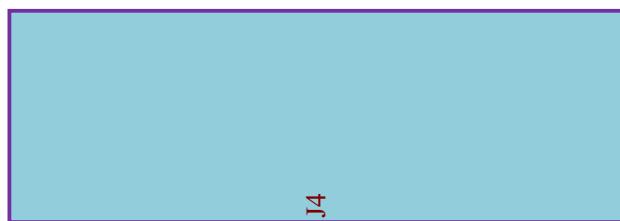
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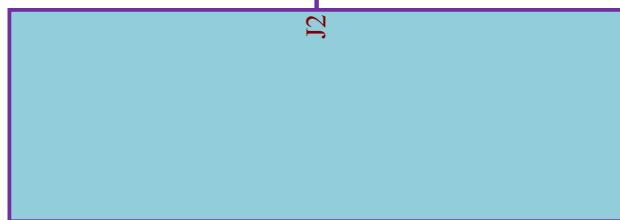
Control Board



14



Power Board



12



Designer's signature

Supervisor's signature

Sheet title: Main

Project title: Balancing Robot

Designer: Pedro Javier Belmonte Miñano

Date: 29/12/2021

Revision: v1

Sheet 1 of 1

Tecnologías de Circuitos Impresos  
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18014, Granada, Granada, Spain

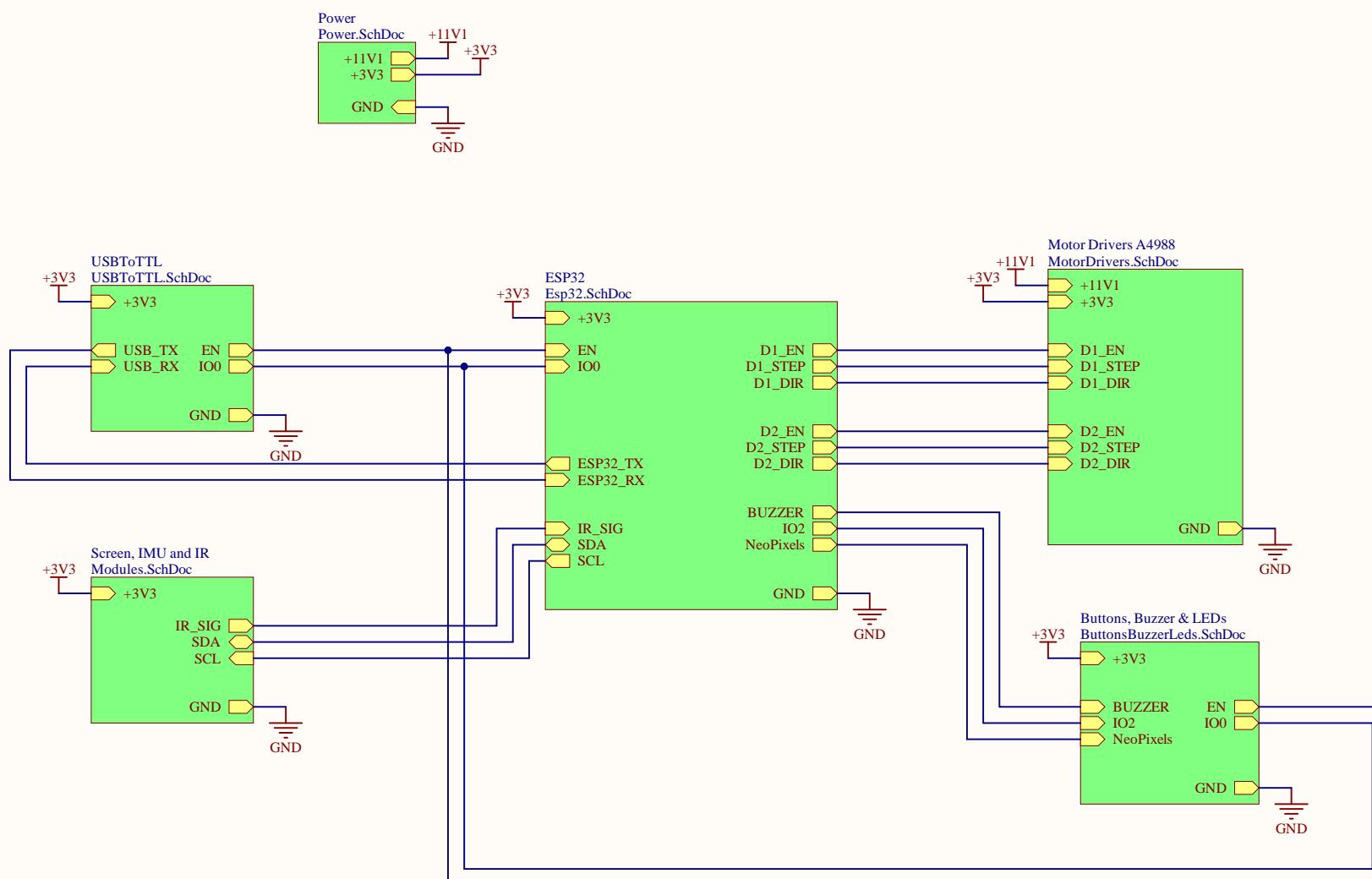


A

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Designer's signature

Supervisor's signature

Sheet title: **Control Board**Project title: **Balancing Robot**Designer: **Pedro Javier Belmonte Miñano**Date: **16/01/2022**Revision: **V 1**

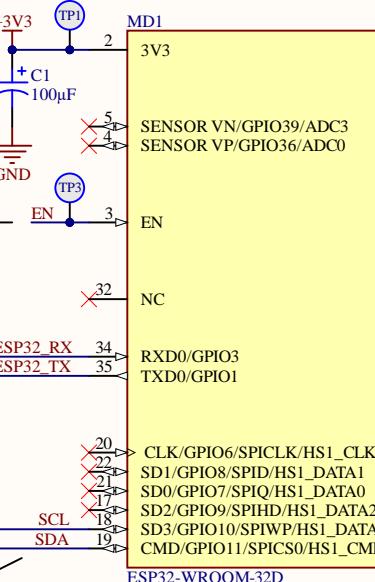
Sheet 1 of 7

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Granada, Spain



A

All Test points  
should have 1.5mm  
minimum diameter



EN - ESP32 Enable  
1 - Device On  
0 - Device Off

+3V3  
EN  
IO0  
IR\_SIG  
ESP32\_RX  
ESP32\_TX  
SDA  
SCL

The default I2C pins are GPIO 22  
(SCL) and GPIO 21 (SDA) but  
you can configure your code to  
use any other pins

#### ESP32-WROOM-32D Specifications:

##### Hardware:

- On-board clock: 40 MHz crystal
- Operating voltage: 2.7 3.6 V
- Operating current: 80 mA
- Minimum current delivered by power supply: 500 mA
- Operating temperature range: -40 °C +85 °C

##### Software:

- WiFi mode: Station/SoftAP/SoftAP+Station/P2P
- WiFi Security: WPA/WPA2/WPA2-Enterprise/WPS
- Encryption: AES/RSA/ECC/SHA
- Firmware upgrade: UART Download / OTA (download and write firmware via network or host)
- Network protocols: IPv4, IPv6, SSL, TCP/UDP/HTTP/FTP/MQTT

**PCB Antenna:**  
WiFi:  
- 802.11 b/g/n (802.11n up to 150 Mbps)  
- Frequency range: 2.4 2.5 GHz  
Bluetooth:  
- v4.2 BR/EDR and BLE specification  
- NZIF receiver with -97 dBm sensitivity  
- Class-1, class-2 and class-3 transmitter  
- AFH  
- Audio: CVSD and SBC  
  
!!!Do not put ground plane or route in the antenna!!!

TOUCH1/ADC11/GPIO0/IO0  
HS2\_DATA0/HSPWP/ADC12/GPIO2/IO2  
TOUCH0/HS1\_DATA1/HSPHD/ADC10/GPIO4/IO4  
HS1\_DATA6/VSPICSO/GPIO5/IO5  
TOUCH5/HS2\_DATA2/HSPIQ/ADC15/GPIO12/IO12  
TOUCH5/HS2\_CLK/HSPICLK/ADC16/GPIO13/IO13  
TOUCH6/HS2\_CLK/HSPICLK/ADC16/GPIO14/IO14  
TOUCH3/HS2\_CMD/HSPICSO/ADC13/GPIO15/IO15  
HS1\_DATA4/GPIO16/IO16  
HS1\_DATA5/GPIO17/IO17  
HS1\_DATA7/VSPICLK/GPIO18/IO18  
VSPIQ/GPIO19/IO19  
SDA/VSIHD/GPIO21/IO21  
SCL/SPIWP/GPIO22/IO22  
HS1\_STROBE/VSPID/GPIO23/IO23  
DAC\_1/ADC18/GPIO25/IO25  
DAC\_2/ADC19/GPIO26/IO26  
TOUCH7/ADC17/GPIO27/IO27  
TOUCH9/ADC4/GPIO32/IO32  
TOUCH8/ADC5/GPIO33/IO33  
ADC6/GPIO34/IO34  
ADC7/GPIO35/IO35



GND  
GND  
GND  
GND  
1  
15  
38  
39

IO0 - ESP32 GPIO0  
1 - SPI Mode  
0 - Boot Mode

D1_EN	D1_EN
D1_STEP	D1_STEP
D1_DIR	D1_DIR
D2_EN	D2_EN
D2_STEP	D2_STEP
D2_DIR	D2_DIR
BUZZER	BUZZER
IO2	IO2
NeoPixels	NeoPixels
GND	

Designer's signature

Supervisor's signature

Sheet title: **ESP 32**

Project title: **Balancing Robot**

Designer: **Pedro Javier Belmonte Miñao**

Date: **16/01/2022**

Revision: **V 1**

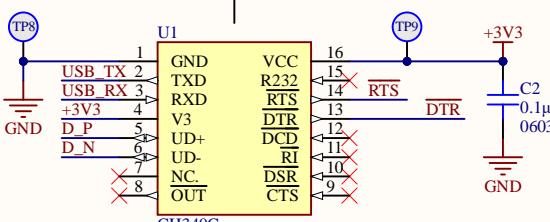
Sheet 2 of 7

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Granada, Spain

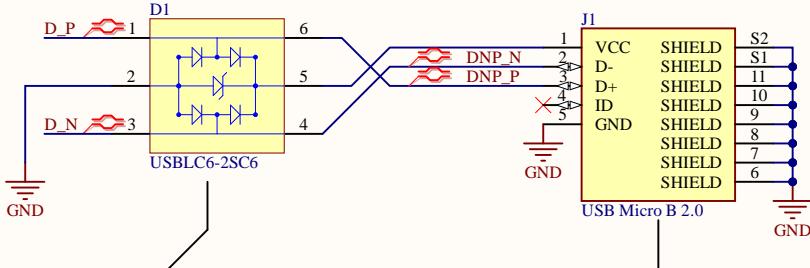


A

Model: CH340C  
Compatible with USB V2.0  
Support 5V and 3.3V power supply even 3V  
CH340C, CH340G and CH340B have built-in crystal and are compatibles.  
SOP-16 lead-free RoHS compliant package

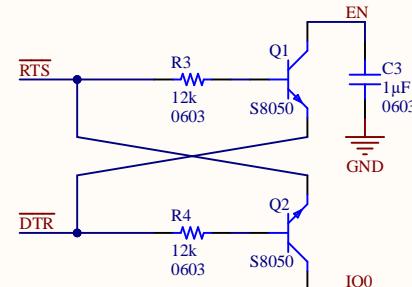
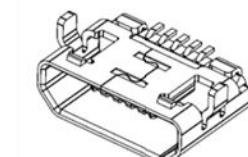


+3V3  
USB\_TX  
USB\_RX



ESD Protection Specifications:  
Case: SOT-23  
Breakdown Voltage: 6V  
Clamping Voltage: 17V  
Data Rate: 480 Mbps  
Direction: Unidirectional  
Leakage Current: 150nA  
Max Operating Temperature: 125 °C  
Min Operating Temperature: -40 °C  
Peak Pulse Current: 5A  
Working Voltage: 5V  
Lead Free: Yes

Female USB Type B 2.0 Connector  
Model: 1051640001  
Manufacturer: Molex  
Current - Maximum per Contact: 1.8 A, 1.0 A  
Voltage - Maximum 30V AC (RMS)



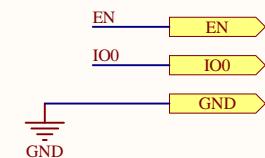
#### Auto Reset & Program Circuit

DTR	RTS	EN	IO0
1	1	1	1
0	0	1	1
1	0	0	1
0	1	1	0

Normal Mode  
Normal Mode  
Reset  
Program Mode

EN - ESP32 Enable  
1 - Device On  
0 - Device Off

IO0 - ESP32 GPIO0  
1 - SPI Mode  
0 - Boot Mode



Designer's signature

Sheet title: **USB To TTL**Project title: **Balancing Robot**

Supervisor's signature

Designer: **Pedro Javier Belmonte Miñao**Date: **16/01/2022**Revision: **V 1**

Sheet 3 of 7

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A

104

B

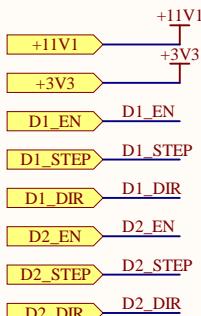
104

6

104

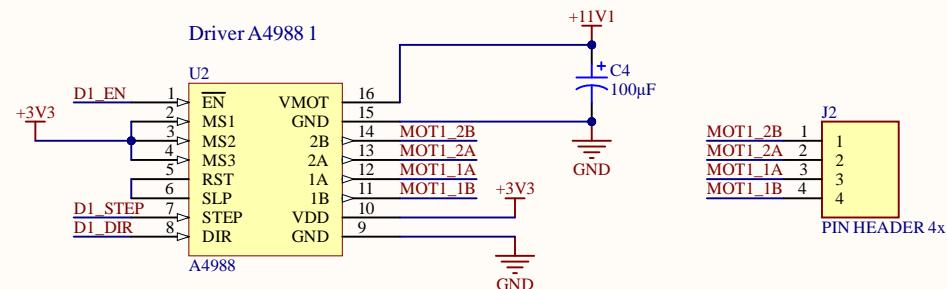
D

1

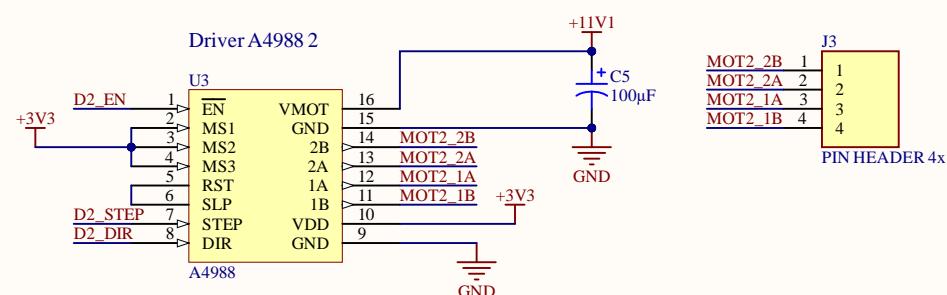


A4988 Stepper Motor Driver Carrier  
Minimum operating voltage: 8 V  
Maximum operating voltage: 35 V  
Continuous current per phase: 1 A  
Maximum current per phase: 2 A  
Minimum logic voltage: 3 V  
Maximum logic voltage: 5.5 V  
Operating Ambient Temperature: -20 85 °C  
Storage Temperature: -55 150 °C  
Microstep resolutions: full, 1/2, 1/4, 1/8 and 1/16  
Reverse voltage protection: No  
Bulk packaged: No  
Header pins soldered: No

A4988 become hot when a lot of current draw from them if it is more than 1.5 A. It automatically shutdown at max temp.



A4988 become hot when a lot of current draw from them if it is more than 1.5 A. It automatically shutdown at max temp.



GND

Microstepping Resolution Table			
MS1	MS2	MS3	Resolution
LOW	LOW	LOW	FULL
HIGH	LOW	LOW	1/2
LOW	HIGH	LOW	1/4
HIGH	HIGH	LOW	1/8
HIGH	HIGH	HIGH	1/16

Designer's signature	Sheet title: <b>Motor Drivers A4988</b>			<i>Tecnologías de Circuitos Impresos Grado en Ingeniería de Tecnologías de Telecommunicación ETSIIT, University of Granada C/ Periodista Daniel Saucedo Aranda, s/n, 18014, Granada, Granada, Spain</i>
Supervisor's signature	Project title: <b>Balancing Robot</b>			
	Designer: <b>Pedro Javier Belmonte Miñano</b>			
	Date: <b>16/01/2022</b>	Revision: <b>V1</b>	Sheet <b>4</b> of <b>7</b>	 <b>BELMONTE</b> <b>ELECTRONICS</b>

A

A

B

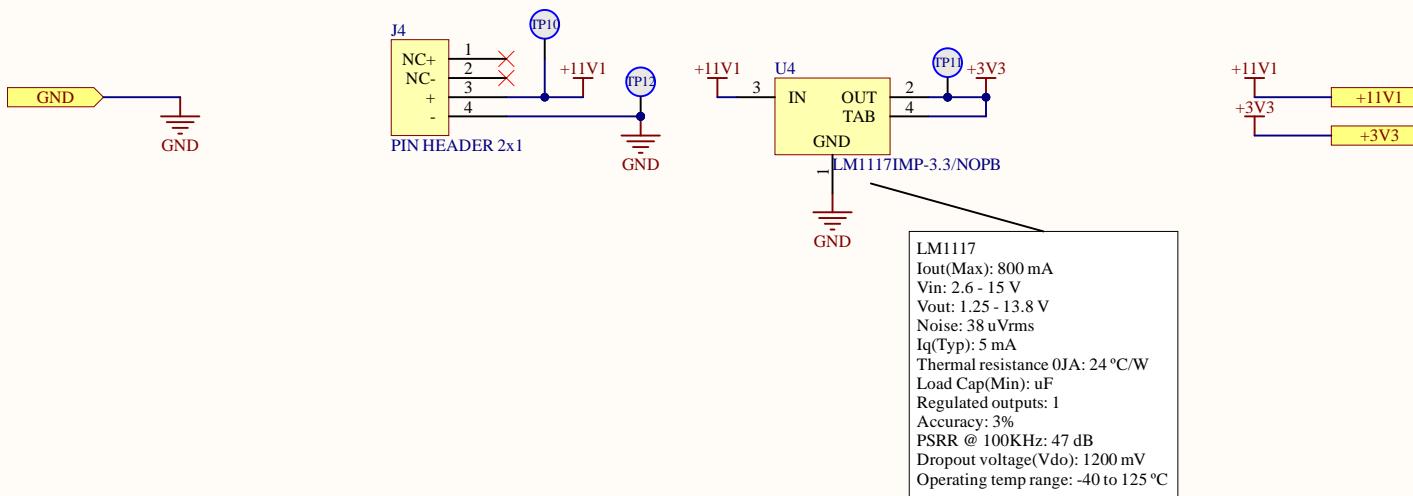
B

C

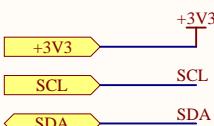
C

D

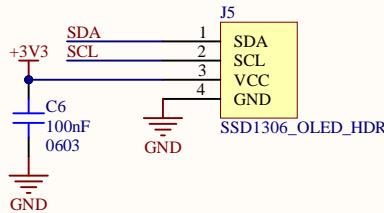
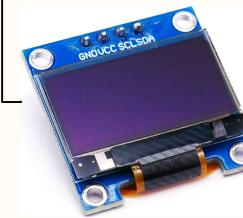
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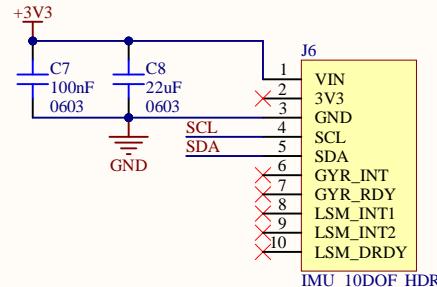
Designer's signature	Sheet title: <b>Power</b>			<i>P. Javier Belmonte Miñano</i>	Tecnologías de Circuitos Impresos Grado en Ingeniería de Tecnologías de Telecomunicación ETSIIT, University of Granada C/ Periodista Daniel Saucedo Aranda, s/n, 18014, Granada, Spain
Project title:	<b>Balancing Robot</b>				
Supervisor's signature	Designer: <b>Pedro Javier Belmonte Miñano</b>			<i>P. Javier Belmonte Miñano</i>	Date: <b>16/01/2022</b>   Revision: <b>V 1</b>   Sheet 5 of 7
Date:	<b>16/01/2022</b>	Revision:	<b>V 1</b>		

**INPUT****SSD1306 OLED HDR Screen 128x64**

The connection to the I2C of the ESP32 does not need pull up resistors as the OLED is connected between the IMU (which already has pull up resistors) and the SDA and SCL of the ESP32.

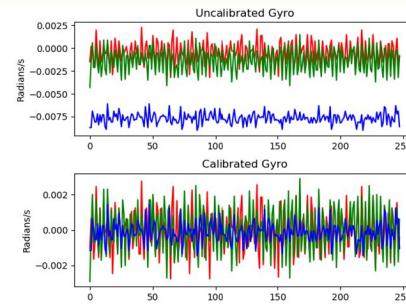
**REAL MODEL****DATASHEET**

	OLED SCREEN
POWER SUPPLY	1.65 to 3.3 V
SEGMENT MAXIMUM SOURCE CURRENT	1.25 to 1.6 V
COMMON MAXIMUM SINK CURRENT	940 nm
AMBIENT TEMPERATURE RANGE	-40 to +85 °C

**Adafruit IMU 10 DOF****DATASHEET**

L3GD20	
SUPPLY VOLTAGE	2.4 to 3.6 V
CURRENT CONSUMPTION	5 µA to 6.1 mA
OPERATING TEMPERATURE	-40 to +85 °C
MEASUREMENT RANGE	±250 to ±2000 dps (degrees per second)
SENSITIVITY	250 dps → 8.75 mdps/digit 500 dps → 17.5 mdps/digit 2000 dps → 70 mdps/digit

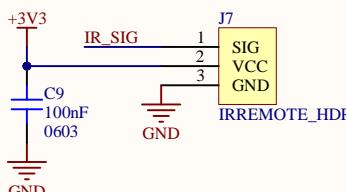
LSM303DLHC	
SUPPLY VOLTAGE	2.16 to 3.16 V
CURRENT CONSUMPTION	1 to 110 µA
OPERATING TEMPERATURE	-40 to +85 °C
MAGNETIC RESOLUTION	2 m gauss
LINEAR ACCEL. ZERO-G LEVEL OFFSET ACCURACY	± 60 mg

**GYROSCOPE CALIBRATION COMPARISON CHART:****REAL MODEL**

The labels GYR\_RDY, GYR\_INT, LSM\_INT\_1, LSM\_INT\_2, LSM\_DRDY are for extra settings (WE DO NOT USE THEM)

**Infrared Remote Receiver KY-022****REAL MODEL****DATASHEET**

Operating Voltage	2.7 to 5.5V
Operating Current	0.4 to 1.5mA
Reception Distance	18 meters
Reception Angle	±45°
Ambient Light Filter	up to 500 Lux
Carrier Frequency	38 kHz

**OUTPUT**

Designer's signature

Sheet title: **Screen, LED and IR**

Project title: **Balancing Robot**

Supervisor's signature

Designer: **Pedro Javier Belmonte Miñano**

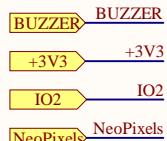
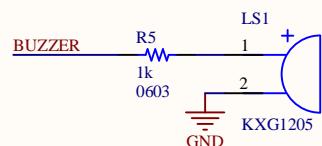
Date: **16/01/2022**

Revision: **V 1**

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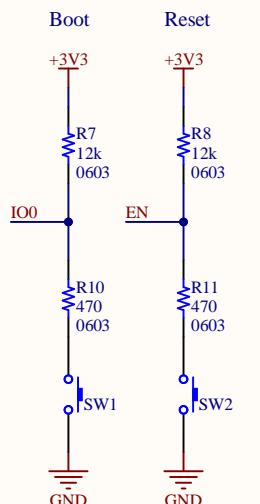
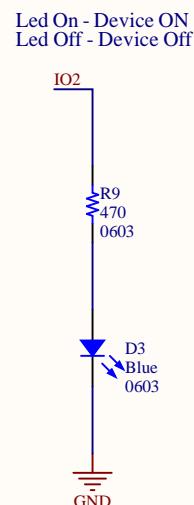
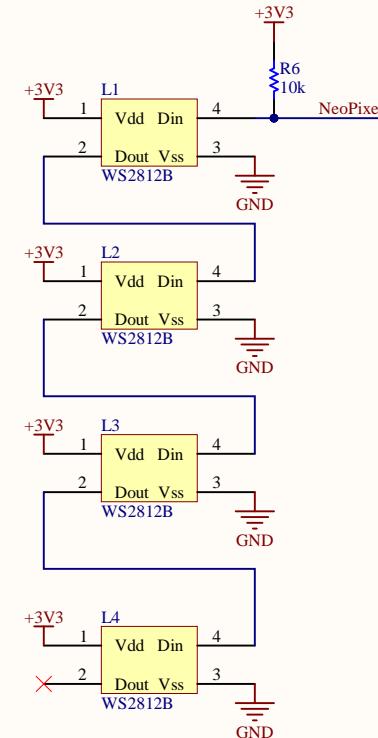


**INPUT****MAGNETIC BUZZER KXG1205****REAL MODEL**

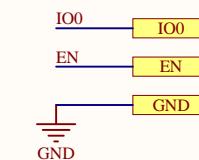
The magnetic buzzer works through PWM signal reading.  
To get the maximum volume we must select the PWM to the 50%, but it will also consume the maximum current, so it is better to select 20-30%.

**DATASHEET**

KXG1205	
RATED VOLTAGE	5 V
OPERATING VOLTAGE	3 to 8 V
MEAN CURRENT (square)	Max. 45 mA
SOUND OUTPUT (typ)	92 dBA
OPERATING TEMPERATURE	-30 TO 70 °C

**BUTTONS****DEVICE STATE LED****CORNER LEDs**

WS2812B Intelligent control LED integrated light source  
- Power supply voltage: 3.5-5.3V  
- Input voltage: -0.5V +0.5V  
- Operation temperature: -25 +80 °C  
- Storage temperature range: -40 +105 °C

**OUTPUT**

Designer's signature

Sheet title: **Buzzer and LEDs**

Project title: **Balancing Robot**

Supervisor's signature

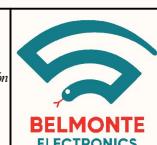
Designer: **Pedro Javier Belmonte Miñano**

Date: **16/01/2022**

Revision: **V 1**

Sheet **7** of **7**

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Granada, Spain



A

A

B

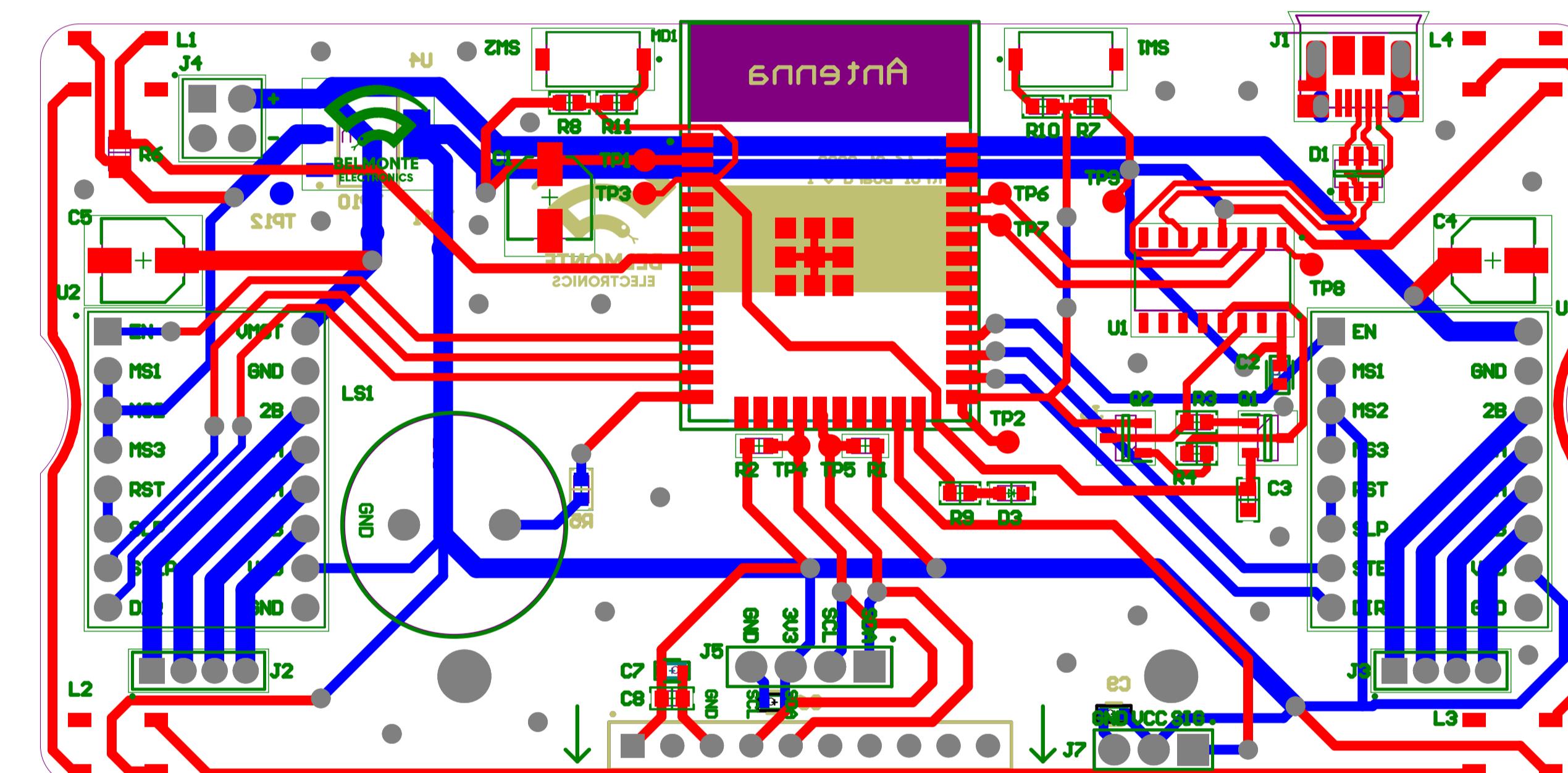
B

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C

D

D



Designer's signature:

D /

**Supervisor's signature**

Sheet title: Control Board Pcb

# Project title: Balancing Robot

**Designer:** Pedro Javier Belmonte

**Tecnologias de Circuitos  
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A

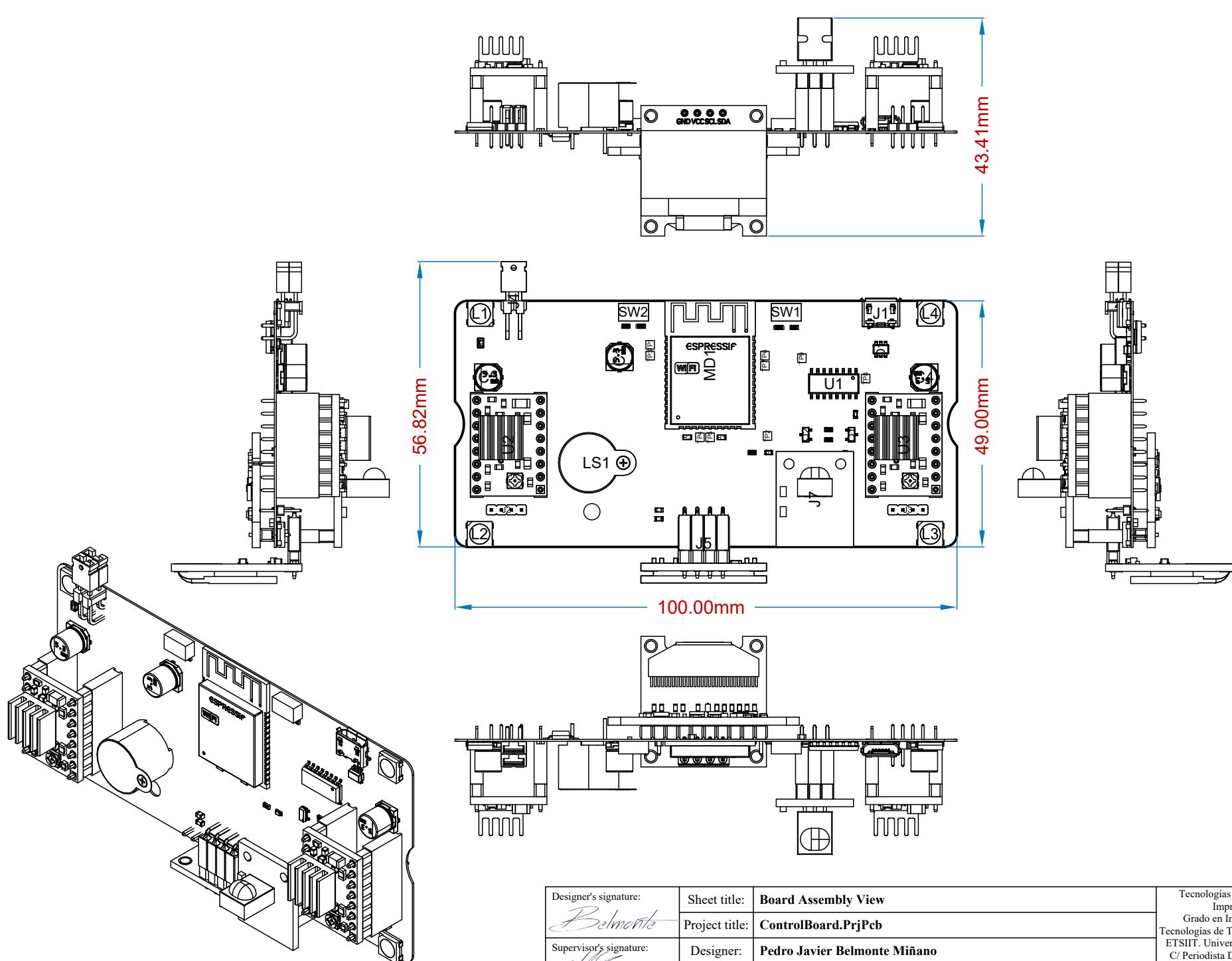
B

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F

Designer's signature:  
*Belmonte*Sheet title:  
**Board Assembly View**Project title:  
**ControlBoard.PnjPcb**Supervisor's signature:  
*C Garcia*Designer:  
**Pedro Javier Belmonte Miñano**

Size: A4

Scale: 1:1

Date: 16/01/2022

Revision: V 1

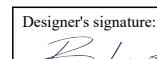
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Granada, Spain



## Bill Of Materials

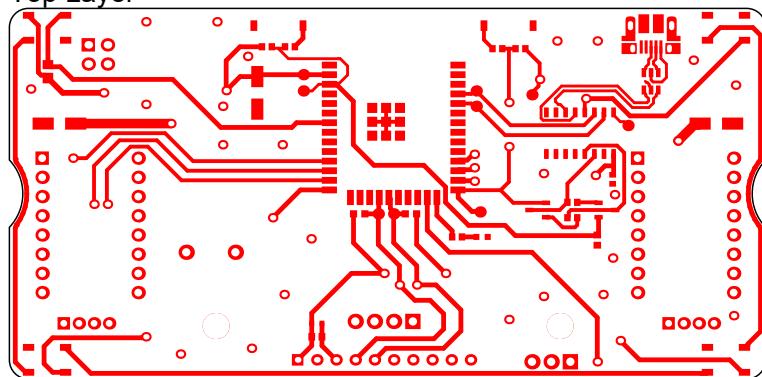
Designator	Quantity	Value	Category	Size	Description
C1, C4, C5	3	100 $\mu$ F	Cap	0603	CAP ALUM 100UF 4V 2000H
C2	1	0.1 $\mu$ F	Cap	0603	CAP CER 0.1UF 50V X7R 0603
C3	1	1 $\mu$ F	Cap	0603	CAP CER 0603 1UF 16V X7R 10%
C6, C7, C9	3	0.1 $\mu$ F	Cap	0603	CAP CER 0.1UF 6.3V X7R 0603
C8	1	22 $\mu$ F	Cap	0603	CAP CER 22UF 4V X5R 0603
D1	1		Diode		Very low capacitance ESD protection, 3.5 pF, -40 to 125 degC, 6-Pin SOT23, RoHS, Tape and Reel
D3	1	Blue	LED	0603	LED BLUE 0603 SMD
J1	1		Connectors		USB - micro B USB 2.0 Receptacle Connector 5 Position Surface Mount, Right Angle; Through Hole
J2, J3	2				Connector
J4	1				M20-9950245 Pin Connector
J5	1		OLED Screen		CONN HDR 4POS 0.1 TIN PCB
J6	1		IMU		CONN HDR 10POS 0.1 TIN PCB
J7	1		IR Receiver		CONN HDR 3POS 0.1 GOLD PCB
L1, L2, L3, L4	4		LED		Intelligentcontrol LED integrated light source WS2812B
LS1	1				BUZZER KXG1205
MD1	1		Chip		WIFI MODULE 32MBITS SPI FLASH
Q1, Q2	2				Transistor
R1, R2	2	4.7 k $\Omega$	Res	0603	Precision Thick Film Chip Resistor, 4.7 KOhm, +/- 1%, -55 to 155 degC, 0603 (1608 Metric), RoHS, Tape and Reel
R3, R4, R7, R8	4	12 k $\Omega$	Res	0603	RES 12K OHM 5% 1/10W 0603
R5	1	1 k $\Omega$	Res	0603	RES SMD 1K OHM 1% 1/4W 0603
R6	1	10k			Resistor
R9, R10, R11	3	470 $\Omega$	Res	0603	RES 470 OHM 5% 1/10W 0603
SW1, SW2	2				FSMSM Push Button Switch, 50 mA, -35 to 85 degC, 2-Pin SMD, RoHS, Tape and Reel
U1	1		Chip		USB to serial chip CH340
U2, U3	2		Motor Driver		Pololu A4988 Stepper Motor Driver Carrier
U4	1		Voltage Regulator		800mA Low-Dropout Linear Regulator, 4-pin SOT-223, Pb-Free

Designer's signature:  
Sheet title:  
**Bill Of Materials**Project title:  
**ControlBoard.PpjPcb**Supervisor's signature:  
Designer:  
**Pedro Javier Belmonte Miñano**

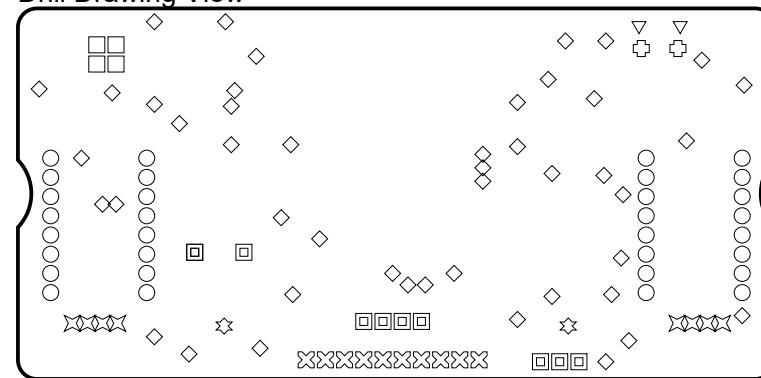
Size: A4 Scale: 1:1 Date: 16/01/2022 Revision: V1 Sheet 2 of 3

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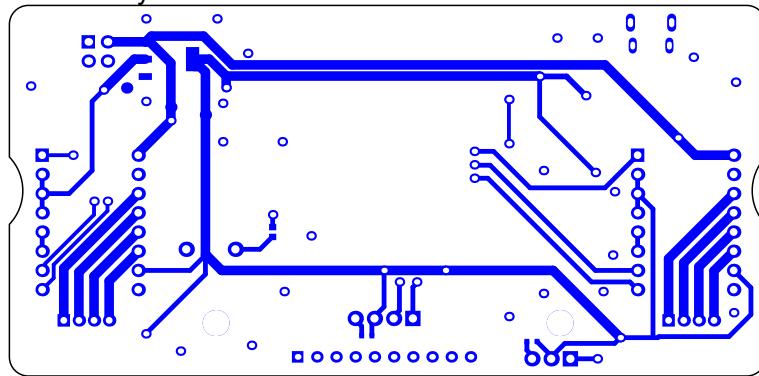
Top Layer



Drill Drawing View



Bottom Layer



Drill Table

Symbol	Count	Hole Size	Plated	Hole Tolerance
+	2	0.65mm	Plated	
▽	2	0.70mm	Plated	
◇	46	0.71mm	Plated	
×	10	0.76mm	Plated	
✖	8	0.90mm	Plated	
□	4	1.02mm	Plated	
○	32	1.02mm	Plated	
■	10	1.10mm	Plated	
✳	2	3.44mm	Plated	
116 Total				

Designer's signature:  
Supervisor's signature:  

Sheet title:

Project title:

Designer:

Size:

Scale:

Date:

Revision:

Sheet

**Fabrication View****ControlBoard.PnjPcb****Pedro Javier Belmonte Miñano****A4****1:1****16/01/2022****V 1****3 of 3**

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A

A

B

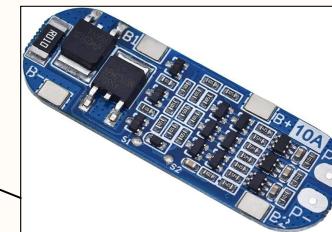
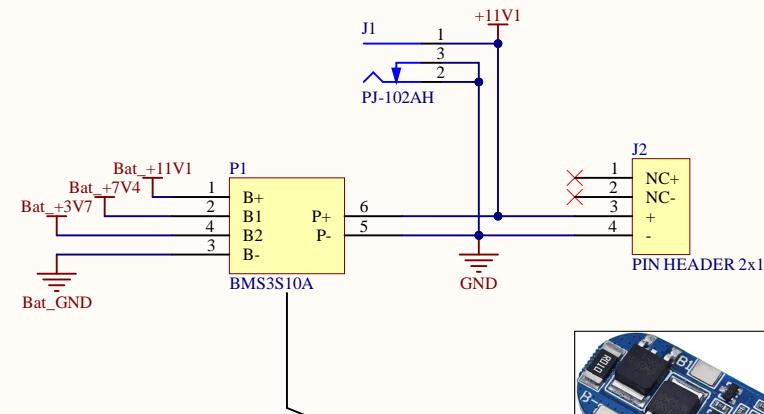
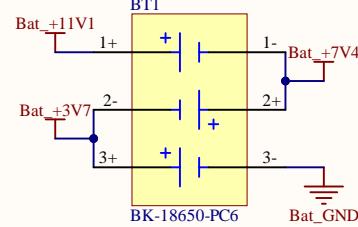
B

C

C

D

D



Model: BMS HX-3S-FL10  
Size: 53\*17\*4 mm  
Max Working Current: 6-8 A  
Instant Max Working Current: 10-13 A  
Charging Voltage: 12.6-13 V  
Working Temperature: -40° C - +50° C

Designer's signature	Sheet title: <b>Bottom Board</b>			<i>[Signature]</i>	Tecnologías de Circuitos Impresos Grado en Ingeniería de Tecnologías de Telecomunicación ETSIIT, University of Granada C/ Periodista Daniel Saucedo Aranda, s/n, 18014, Granada, Granada, Spain
Project title: <b>Balancing Robot</b>					
Supervisor's signature	Designer: <b>Pedro Javier Belmonte Miñano</b>			<i>[Signature]</i>	
Date: <b>16/01/2022</b>	Revision: <b>V 1</b>	Sheet 1 of 1			



A

A

B

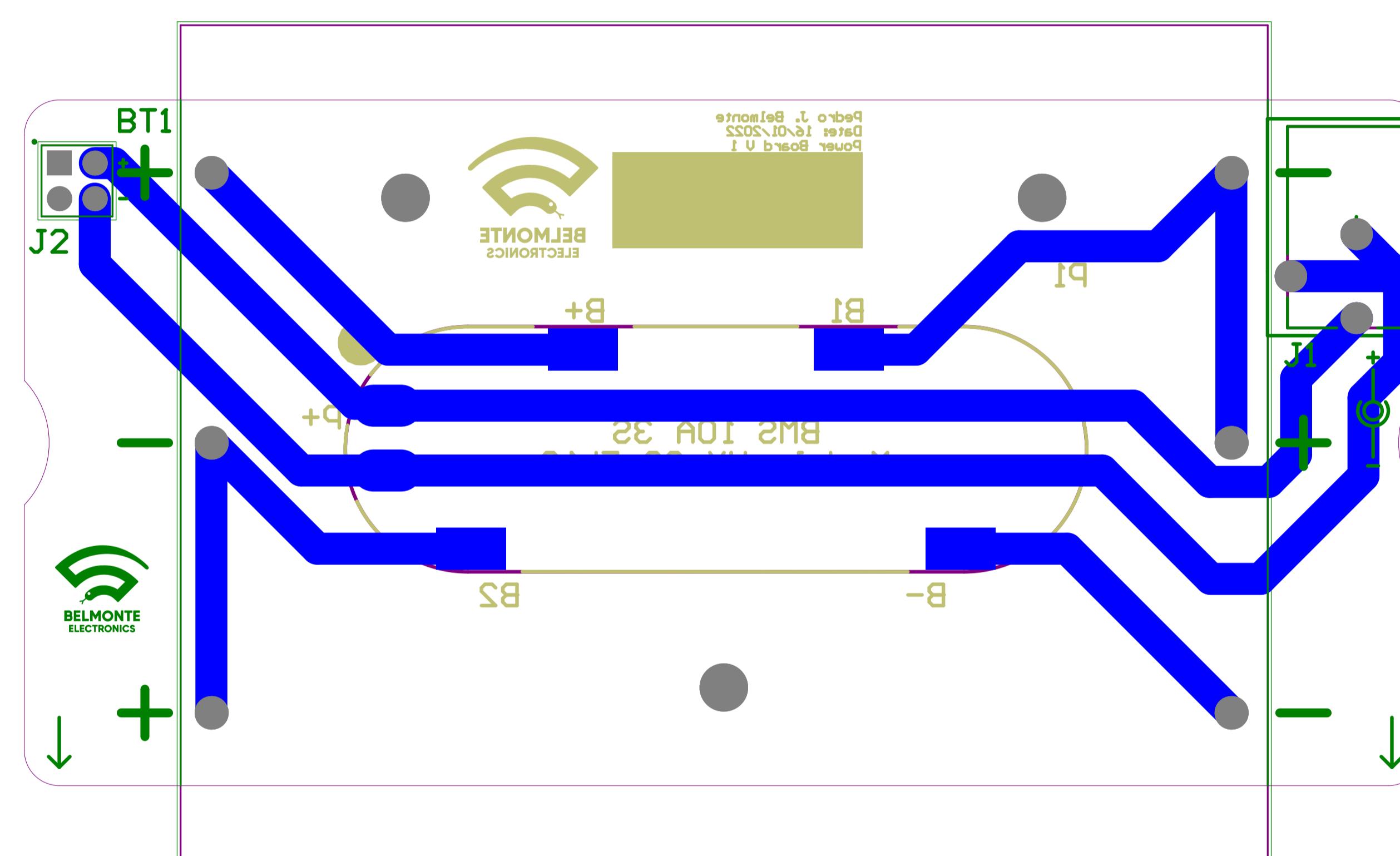
B

C

C

D

D



Designer's signature:

Sheet title: Control Board Pcb

Supervisor's signature:

Project title: Balancing Robot

Designer: Pedro Javier Belmonte

Date: 16-01-2020 | Revision: V1 | Sheet 1

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Granada, Spain



A

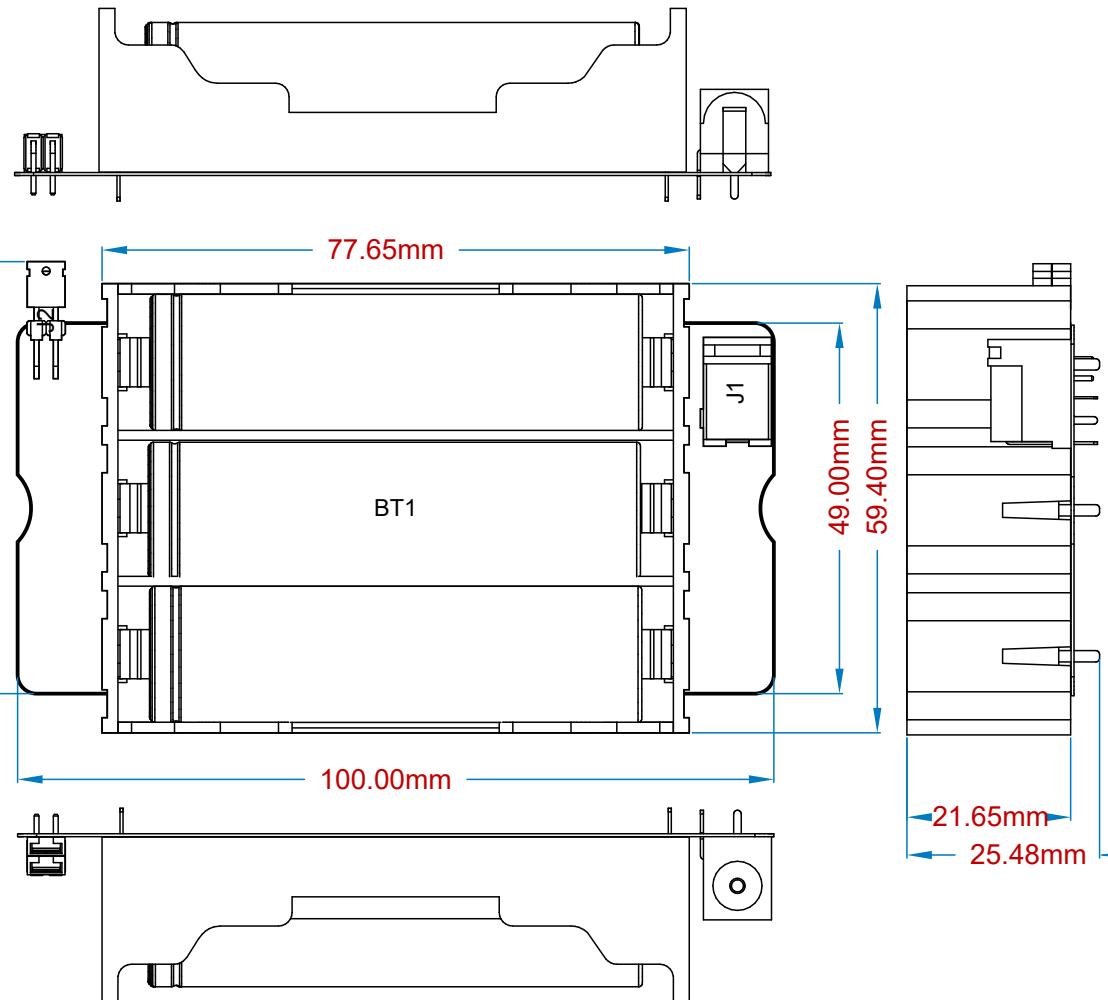
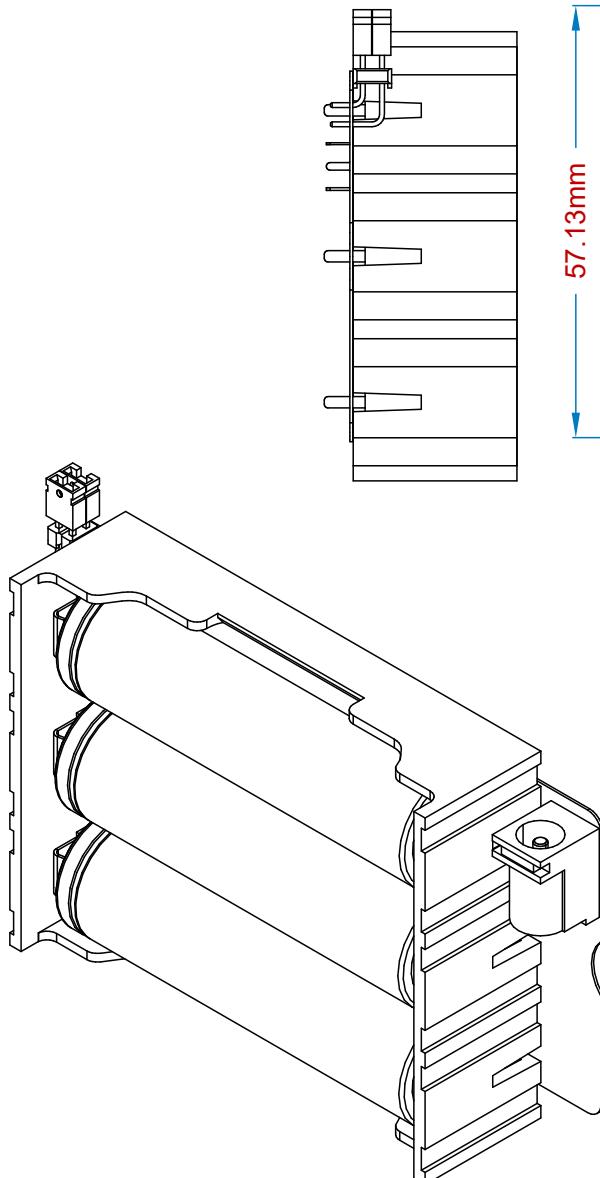
B

C

D

E

F



#### Bill Of Materials

Line #	Designator	Comment	Quantity
1	BT1	BK-18650-PC6	1
2	J1	PJ-102AH	1
3	J2	PIN HEADER 2x1	1
4	P1	BMS3S10A	1

Designer's signature:  
Supervisor's signature:  

Sheet title:

Board Assembly View

Project title:

PowerBoard.PjrPcb

Designer:

Pedro Javier Belmonte Miñano

Size:

A4

Scale:

1:1

Date:

16/01/2022

Revision:

V 1

Sheet 1 of 2

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A

B

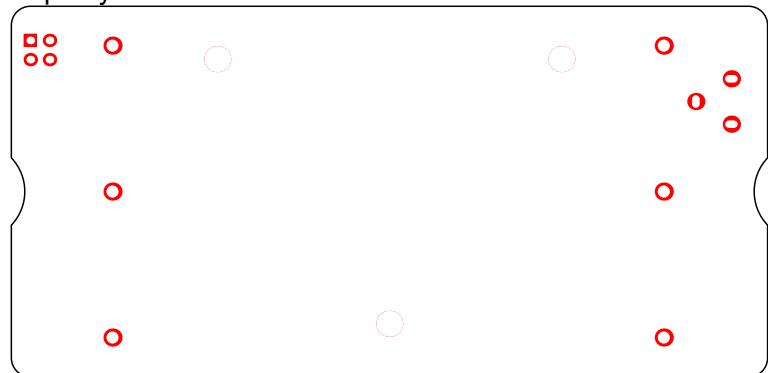
C

D

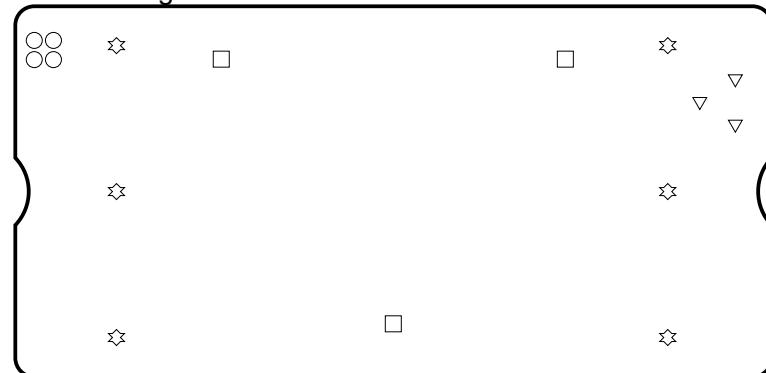
E

F

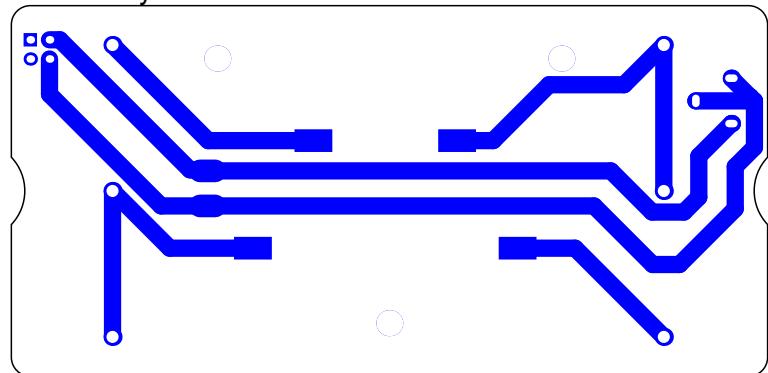
Top Layer



Drill Drawing View



Bottom Layer



Drill Table

Symbol	Count	Hole Size	Plated
▽	3	1.00mm	Plated
○	4	1.02mm	Plated
◊	6	1.60mm	Plated
□	3	3.44mm	Plated
16 Total			

A

B

C

D

E

F

Designer's signature:  

Project title:

Sheet title:

**Fabrication View**Supervisor's signature:  

Project title:

**PowerBoard.PjrPcb**

Designer:

**Pedro Javier Belmonte Miñano**

Size: A4

Scale: 1:1

Date: 16/01/2022

Revision: V 1

Sheet 2 of 2

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