Signoff – 12/13/21 - Robotic Arm

Monday, November 15, 2021 3:05 PM

Robot Arm - $399.00

https://www.robotshop.com/en/lynxmotion-al5d-pltw-robotic-arm-assembled.html

Servo Shield - $17.50

https://www.adafruit.com/product/1411

Robotic Arm:

The team plans to utilize the robotic arm to grab the beads off the tree and place said beads into a magazine to be loaded into the shooting mechanism. One reason for choosing the Lynxmotion AL5D is for the 5 degrees of freedom. There is one servo motor for the shoulder joint, one for the elbow joint, one for the wrist, one for the wrist turning motion and one for th gripping mechanism (end effector). The shoulder, elbow, wrist and turning motion can all move 180 degrees. The end effector has the capability to open to 1.25 inches. The opening length is perfect for grabbing hanging beads off the tree.

*****Side Note********

The link provided is a combination of the assembled robotic arm and wrist extension instead of buying the parts separately.

Math Justification:

Robot arm extended straight up

Height without extension add on	18.5”
Height with extension add on	19.8250”

With these specifications the team can solve for the height needed on the chassis to be

With these specifications the team can solve for the height needed on the chassis to be able to reach the tree branch.

Height of Chassis Minimum without extension	3”
Height of Chassis Minimum with extension	1.6750”

The next values will be calculated using the code below. The distance from the tree to the robotic arm will be varied to verify how far the robot can be and still reach the tree limb. The below graphs show the lengths that can be achieved with the Lynxmotion AL5D Robotic Arm. The values across the top show the height at which the base of the robotic arm is sitting on the gameboard. The values down the side of the graph show the distance away the base of the arm is from the tree. Both values can be seen in blue. Number values in red show lengths that the robot cannot reach from the given height and distance. Number values seen in yellow appear -0.25 inches away from the max arm reach distance. Number values seen in green are distances that the robot can reach from the given height and distance.

Robot Chassis Height	1	2	3	4	5
Inches Away From Tree	********** No Extension Arm Len				
3	20.7183	19.74294	18.7417	17.7553	16.7705
3.25	20.756	19.769	18.7833	17.7992	16.817
3.5	20.7966	19.8116	18.8282	17.8466	16.8671
3.75	20.8402	19.8573	18.8762	17.8973	16.9208
4	20.8866	19.906	18.9275	17.9513	16.9779
4.25	20.9359	19.9578	18.9819	18.0087	17.0386
4.5	20.9881	20.0125	19.0394	18.0693	17.1026
4.75	21.0431	20.0702	19.1001	18.1332	17.1701
5	21.1009	20.1308	19.138	18.2003	17.2409
5.25	21.1616	20.1944	19.2305	18.2705	17.3151
5.5	21.225	20.2608	19.3003	18.3439	17.3925
5.75	21.2911	20.3301	19.373	18.4204	17.4732

	6	6.5	7	7.5
gth = 16.5"**********				
	15.7877	15.2971	14.8071	14.3178
	15.8371	15.348	14.8598	14.3723
	15.8902	15.4029	14.9164	14.4309
	15.9472	15.4616	14.9771	14.4935
	16.0078	15.5242	15.0416	14.5602
	16.0721	15.5905	15.11	14.6309
	16.14	15.6605	15.1822	14.7054
	16.2115	15.7341	15.2582	14.7839
	16.2865	15.8114	15.3379	14.8661
	16.365	15.8922	15.4212	14.952
	16.4469	15.9765	15.5081	15.0416
	16.5322	16.0643	15.5985	15.1348

6	21.36	20.4022	19.4487	18.5	17.557
6.25	21.4316	20.4771	19.5272	18.5826	17.644
6.5	21.5058	20.5548	19.6087	18.6682	17.7341
6.75	21.5827	20.6352	19.693	18.7567	17.8273
7					17.9234
7.25					
7.5					

Robot Chassis Height	1	2	3	4	5
Inches Away From Tree	********** Extension Added Arm Le				
3	20.7183	19.74294	18.7417	17.7553	16.7705
3.25	20.756	19.769	18.7833	17.7992	16.817
3.5	20.7966	19.8116	18.8282	17.8466	16.8671
3.75	20.8402	19.8573	18.8762	17.8973	16.9208
4	20.8866	19.906	18.9275	17.9513	16.9779
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6.5	21.5058	20.5548	19.6087	18.6682	17.7341
6.75	21.5827	20.6352	19.693	18.7567	17.8273
7					17.9234

16.6208	16.1555	15.6924	15.2315
16.7126	16.25	15.7896	15.3317
16.8077	16.3478	15.8902	15.4353
16.906	16.4488	15.9941	15.5423
17.0074	16.5529	16.1012	15.6525
17.1118	16.6602	16.2115	15.7659
17.2192	16.7705	16.3248	15.8824

6	6.5	7	7.5
ngth = 17.825"**********			
15.7877	15.2971	14.8071	14.3178
15.8371	15.348	14.8598	14.3723
15.8902	15.4029	14.9164	14.4309
15.9472	15.4616	14.9771	14.4935
16.0078	15.5242	15.0416	14.5602
16.0721	15.5905	15.11	14.6309
16.14	15.6605	15.1822	14.7054
16.2115	15.7341	15.2582	14.7839
16.2865	15.8114	15.3379	14.8661
16.365	15.8922	15.4212	14.952
16.4469	15.9765	15.5081	15.0416
16.5322	16.0643	15.5985	15.1348
16.6208	16.1555	15.6924	15.2315
16.7126	16.25	15.7896	15.3317
16.8077	16.3478	15.8902	15.4353
16.906	16.4488	15.9941	15.5423
17.0074	16.5529	16.1012	15.6525

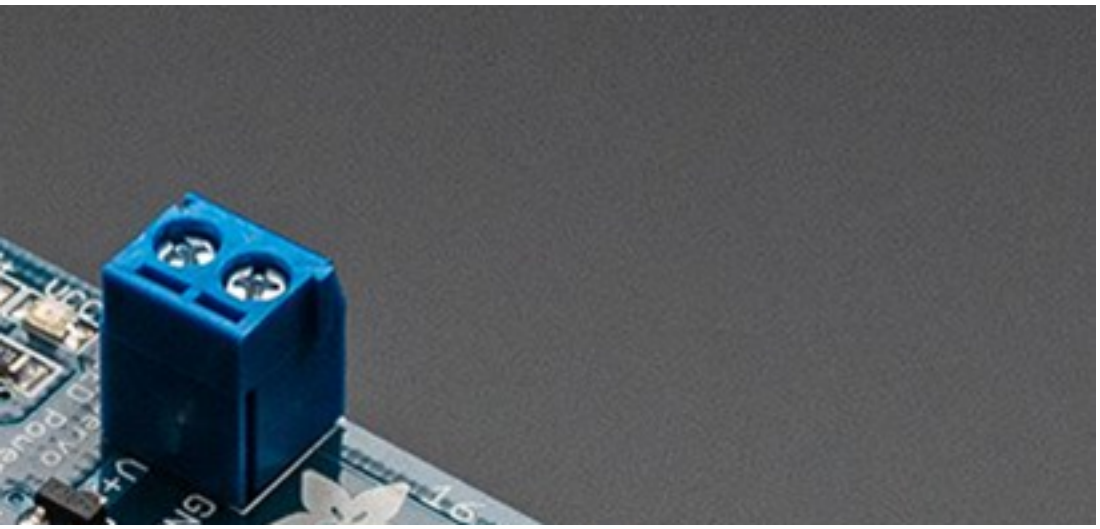
7.25					
7.5					

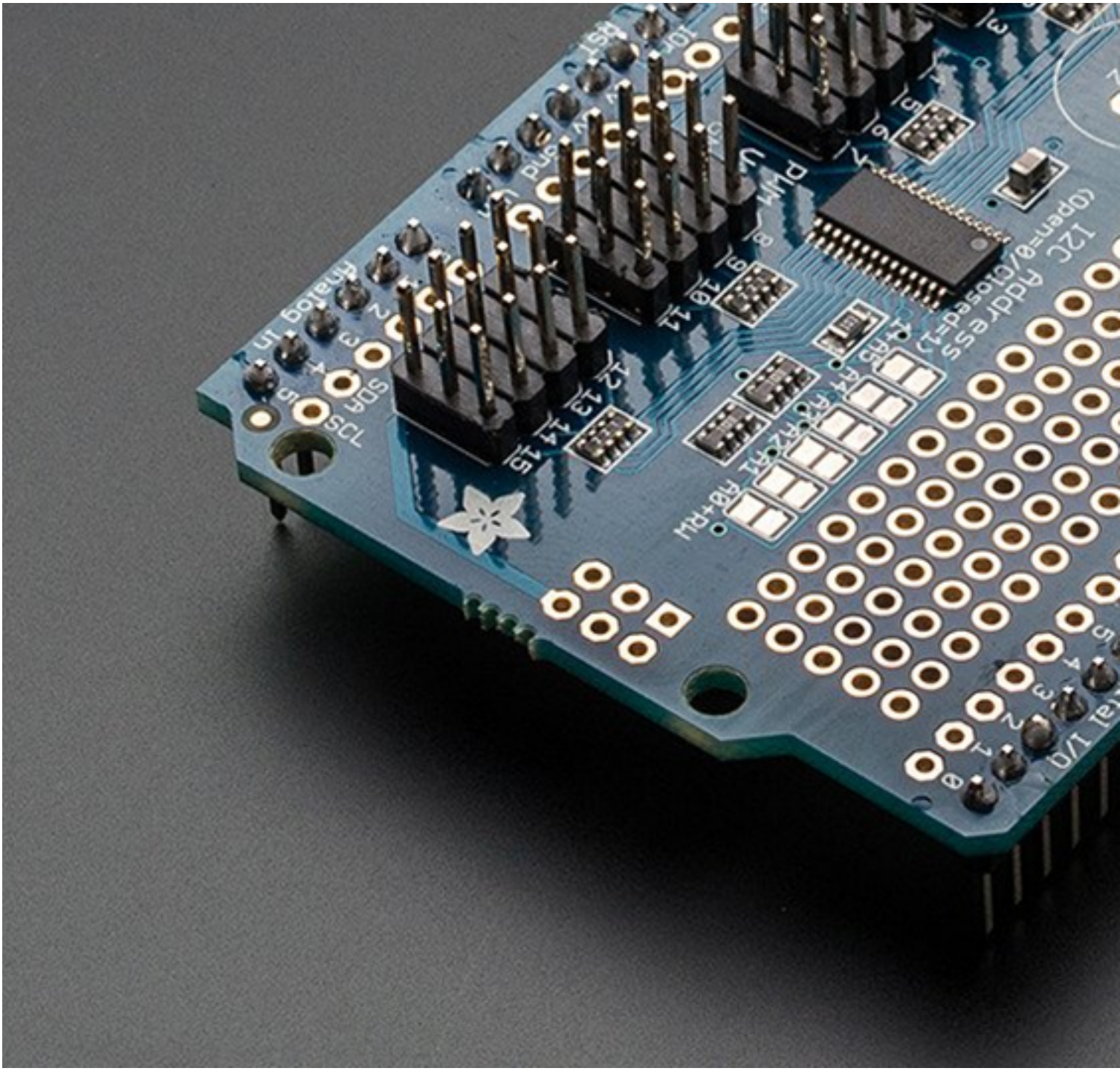
There are two big takeaways from the two figures above. For one, the robot arm becomes more versatile when the extension is added. For instance, the robotic arm could only be 5.5 inches away from the tree; however, the extension to the arm allows the robot to be 7.5 inches away from the tree. The next big takeaway is that the robot arm can accomplish the needed task of grabbing the beads from the tree. The Lynxmotion AL5D also gives the team options about chassis height placement. The most versatile placement is having the arm at 7.5 inches above the chassis. To do this, the team will have to have the robot start in a resting position that points down within the robot. The team will still be able to fully utilize the robot arm at 6.5 inches if chassis design does not permit the 7.5 inch starting position. The exact placement of the robotic arm will be seen in the CAD model presented with the chassis.

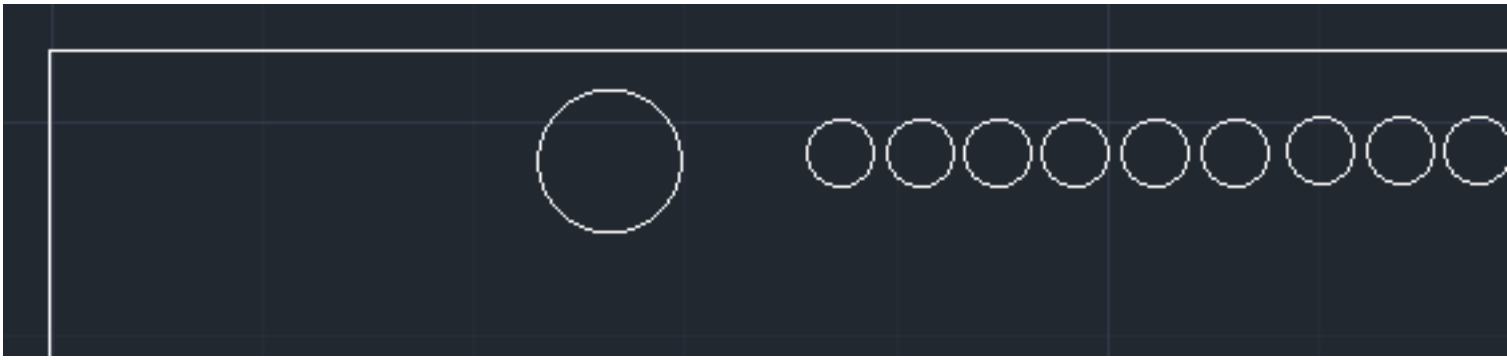
Electrical Justification:

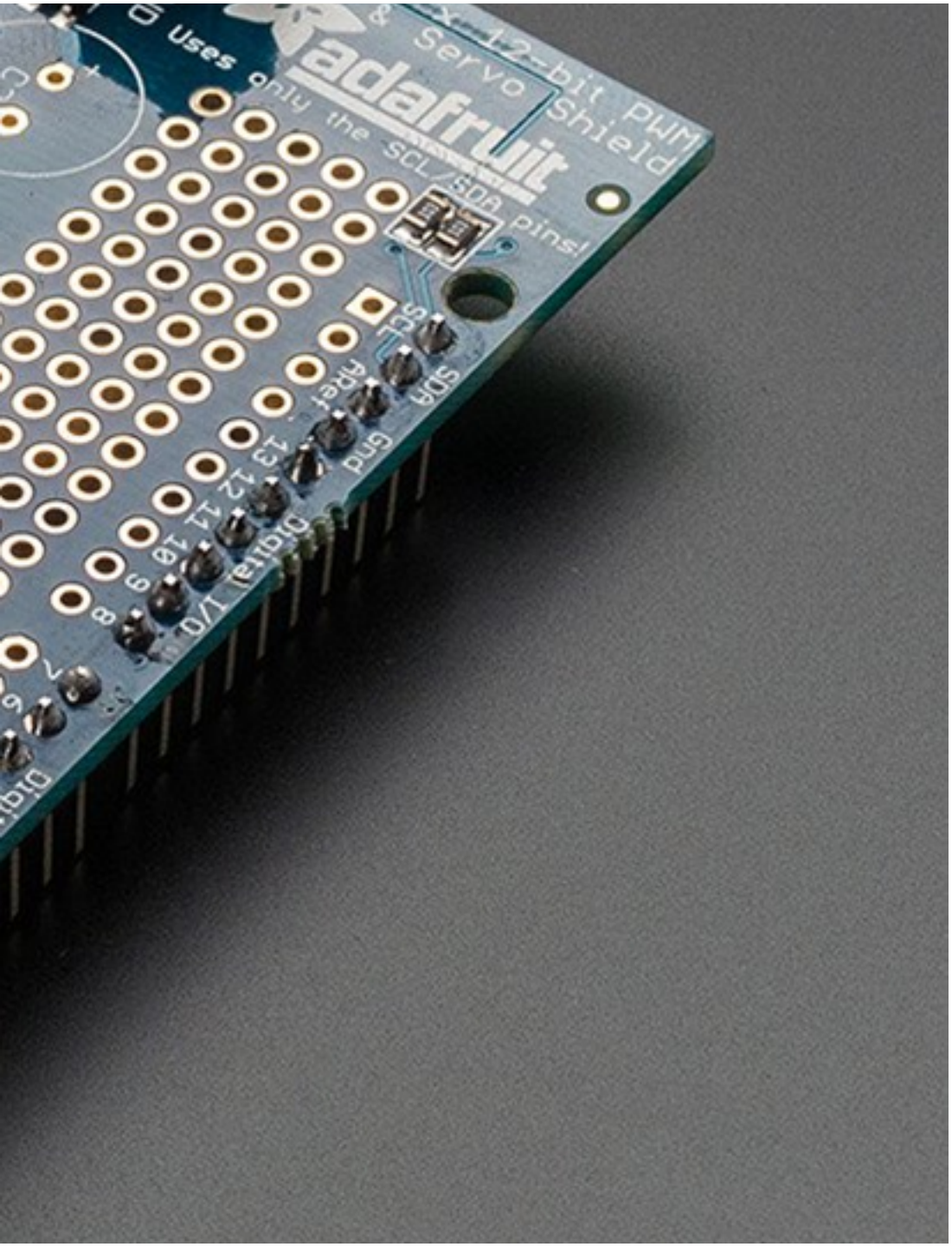
Each servo motor has three wires. Black for ground, red for power (4.8-6V) and yellow for the PWM signal. The best way to control the servo motors will be through the utilization of the Adafruit 16-Channel 12-bit PWM/Servo Shield – 12C interface. The board will easily plug into our Arduino MEGA based the design. Through this, the team will be able to control each of the servo motors while also providing reverse polarity protection. The following image came from the product provider.

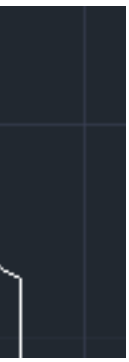
	17.1118	16.6602	16.2115	15.7659
	17.2192	16.7705	16.3248	15.8824

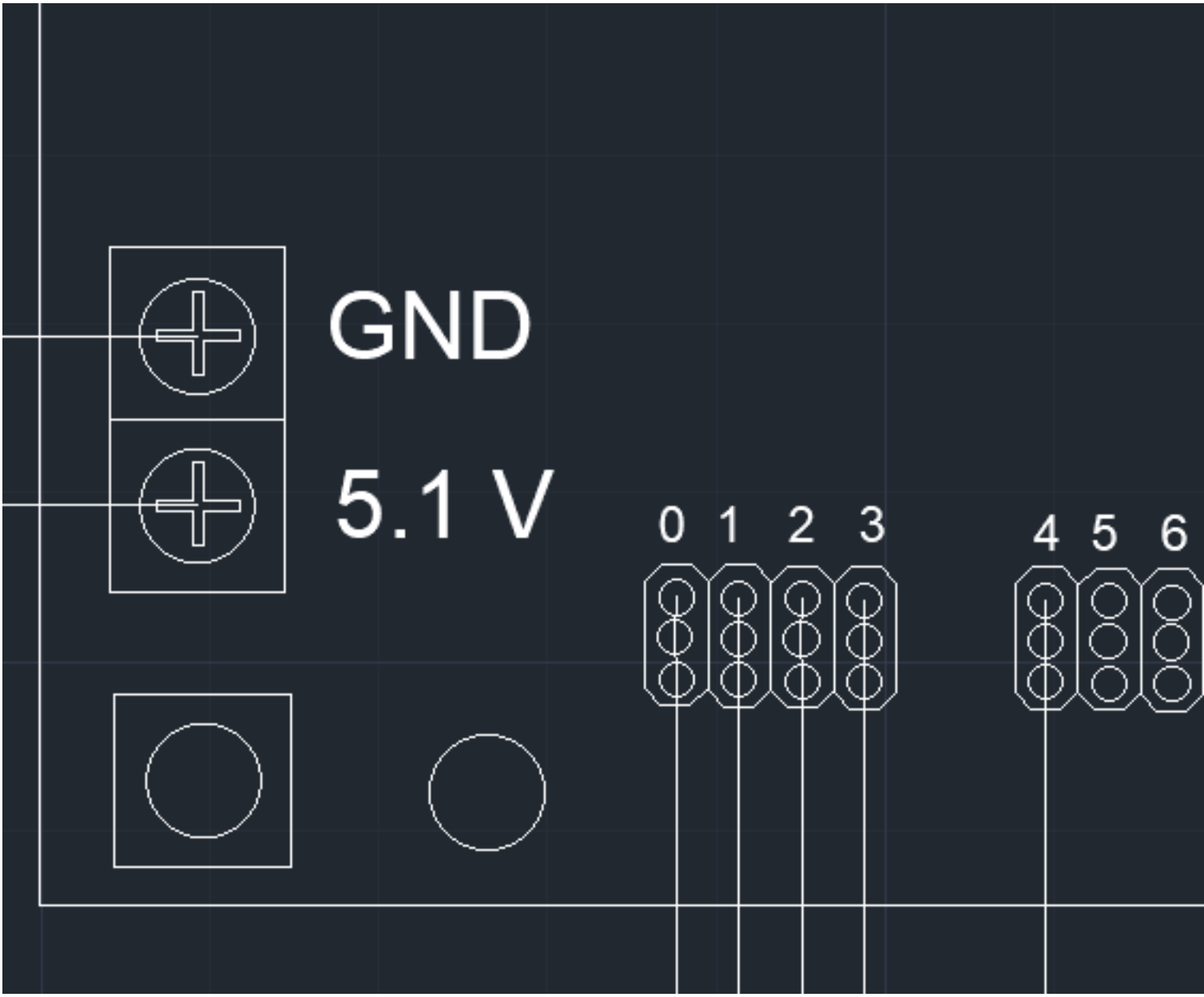


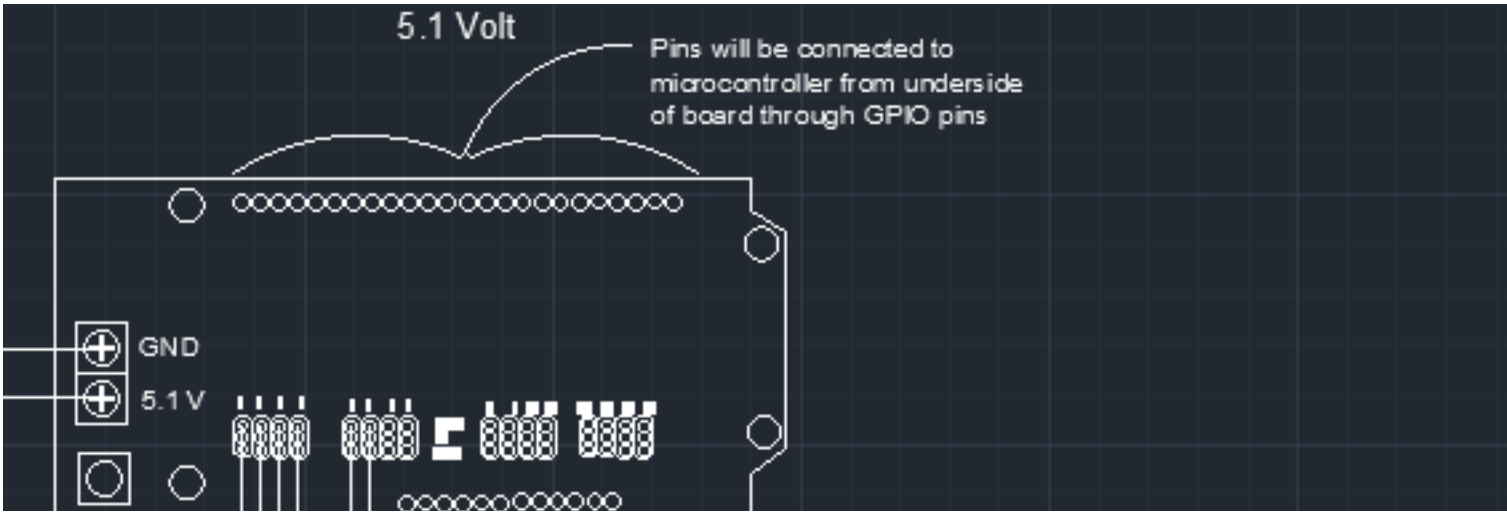

Analog In
SDA
SCL
PWM
I2C Address
(open=0/closed=1)

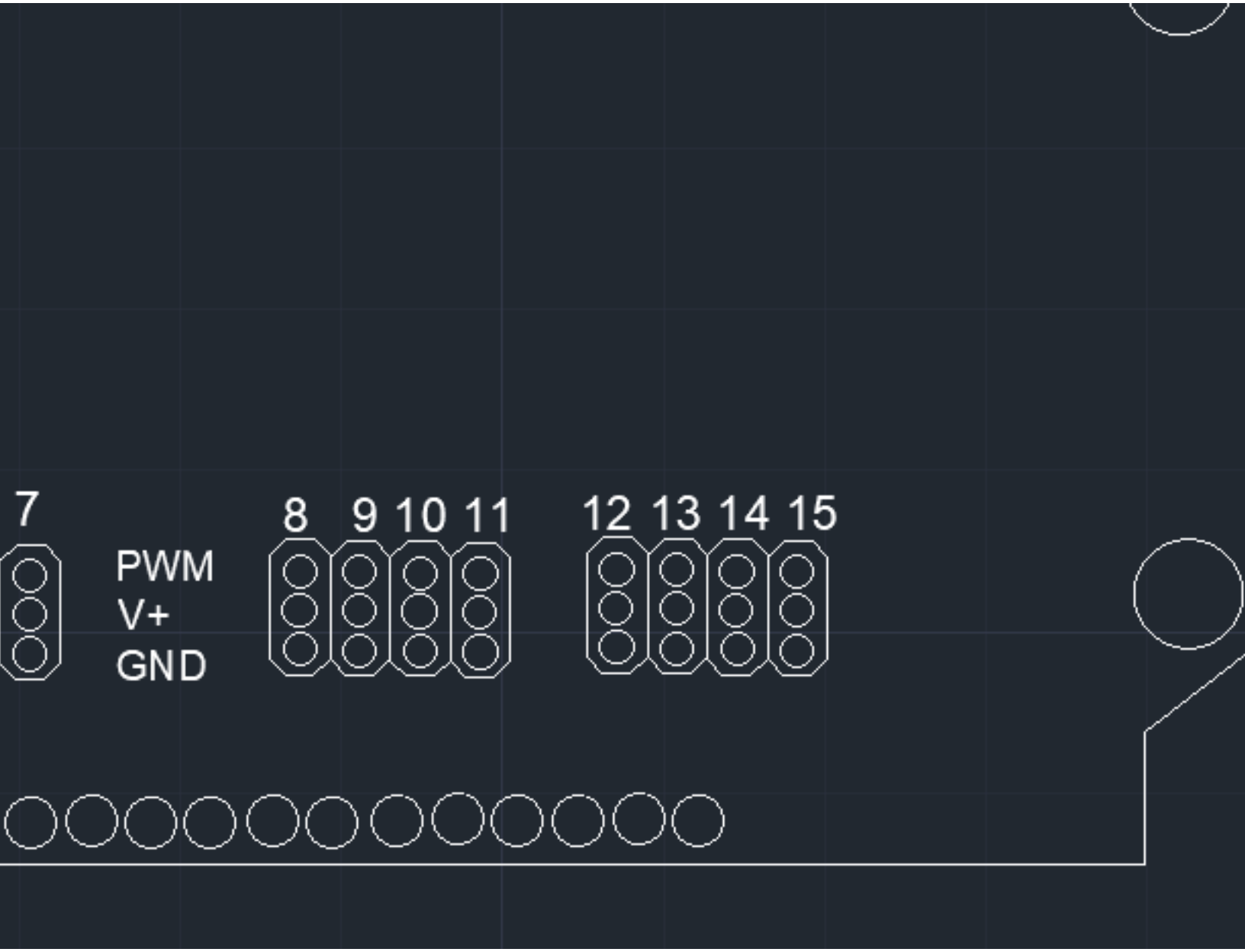


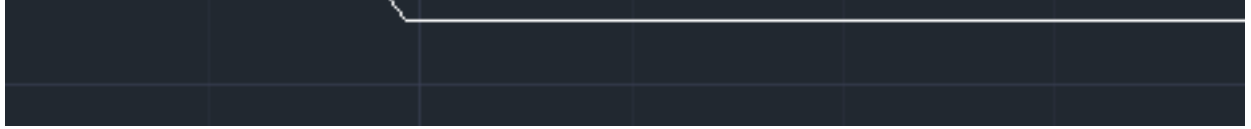

Uses only the SCL/SDA pins!
adafruit
16-bit PWM
Servo Shield
SCL
SDA
Gnd
Digital I/O

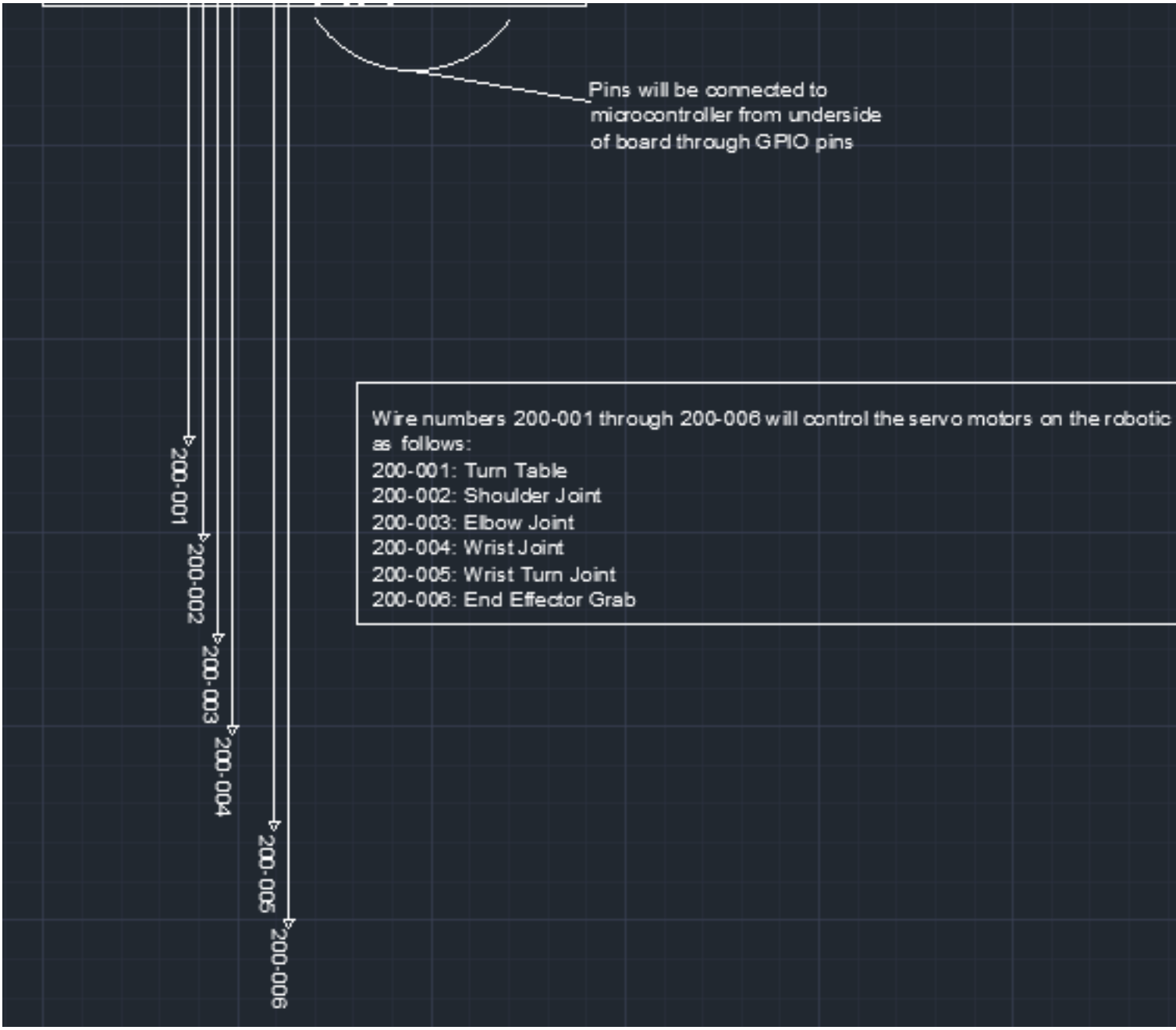



GND
5.1 V
0 1 2 3
4 5 6

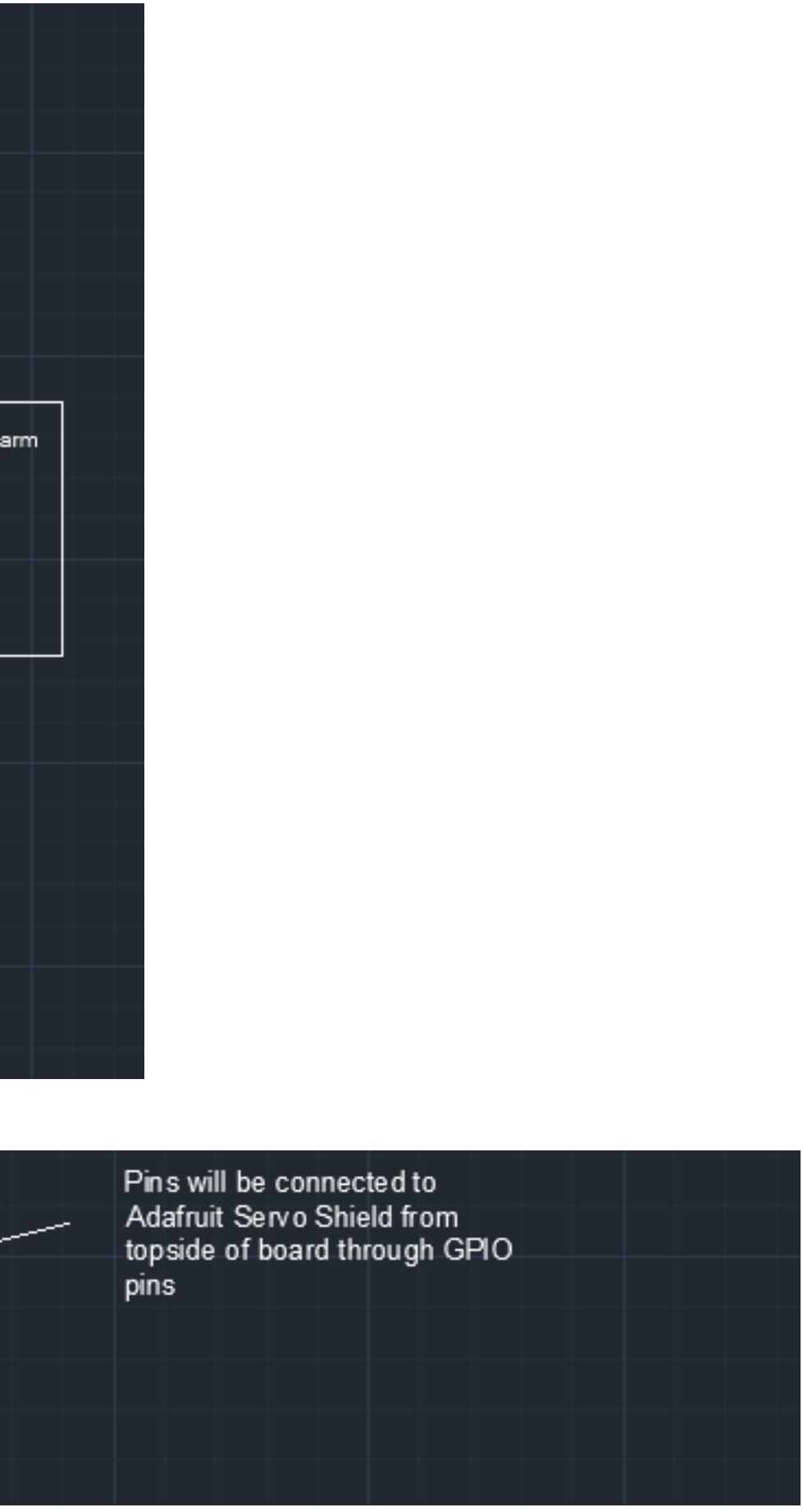

5.1 Volt
Pins will be connected to microcontroller from underside of board through GPIO pins
GND
5.1 V

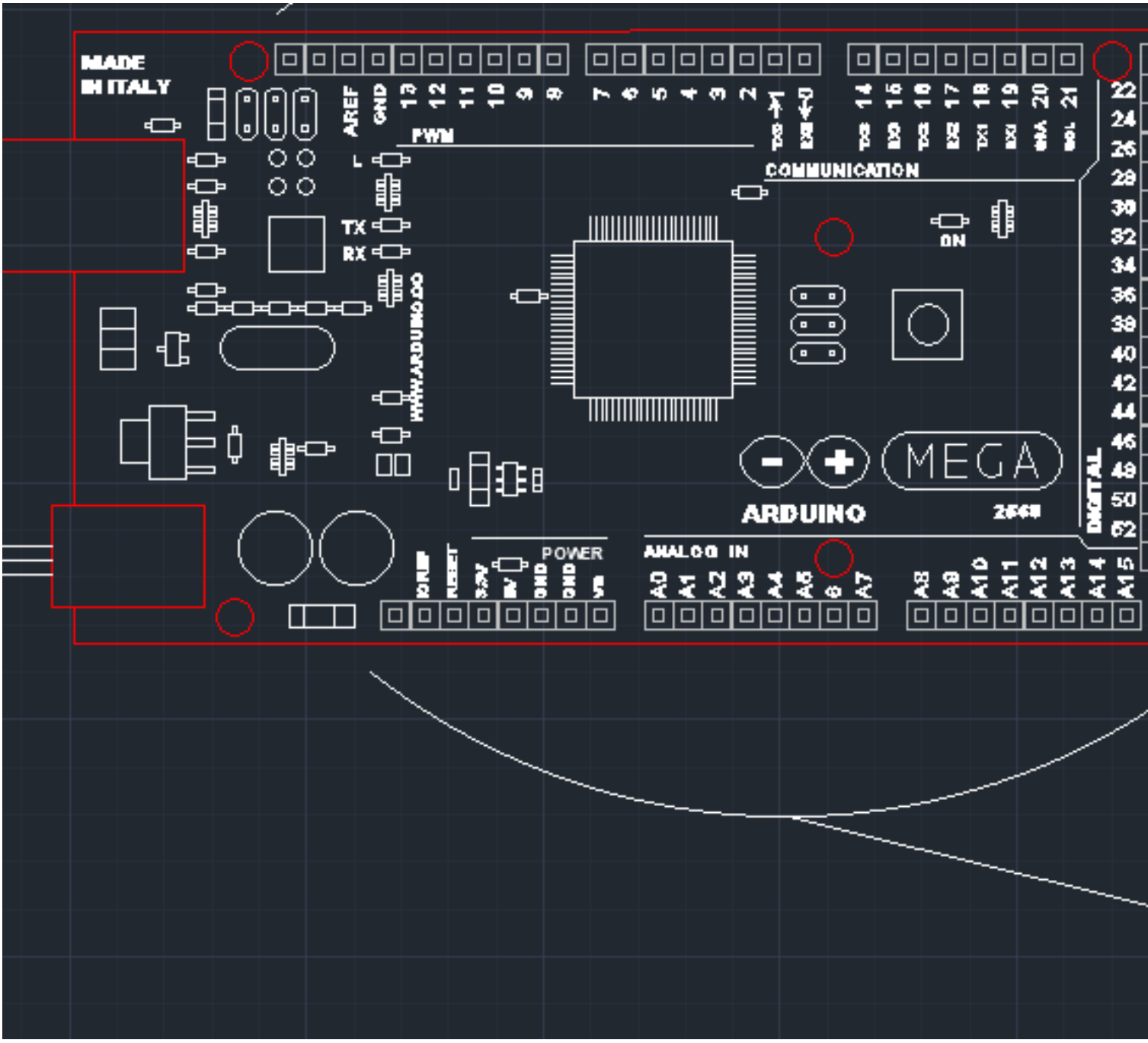

7
PWM
V+
GND
8 9 10 11
12 13 14 15




Pins will be connected to microcontroller from underside of board through GPIO pins
Wire numbers 200-001 through 200-006 will control the servo motors on the robotic as follows:
200-001: Turn Table
200-002: Shoulder Joint
200-003: Elbow Joint
200-004: Wrist Joint
200-005: Wrist Turn Joint
200-006: End Effector Grab
200-001
200-002
200-003
200-004
200-005
200-006


Arduino Mega
7 Volt


arm
Pins will be connected to
Adafruit Servo Shield from
topside of board through GPIO
pins



The team will use the first six three-set pins (0,1,2,3,4,5) to control the robotic arm. The board itself will be powered from the 5.1 V power bus (2-2). The servo shield board will use the outer rim pins, located on the top and bottom of the board, to plug into the Arduino MEGA. By doing this, the team will be able to give the desired PWM signals to the board. The PWM signals will need to be communicated to the board in duration that last between 0.5ms to 2.5ms followed by a delay between 20ms to 30ms. The servo motors then translate the signal through onboard electronics. The pulse will need to be repeated for the servo to hold the desired position. For these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Pins will be connected to
Adafruit Servo Shield from
topside of board through GPIO
pins