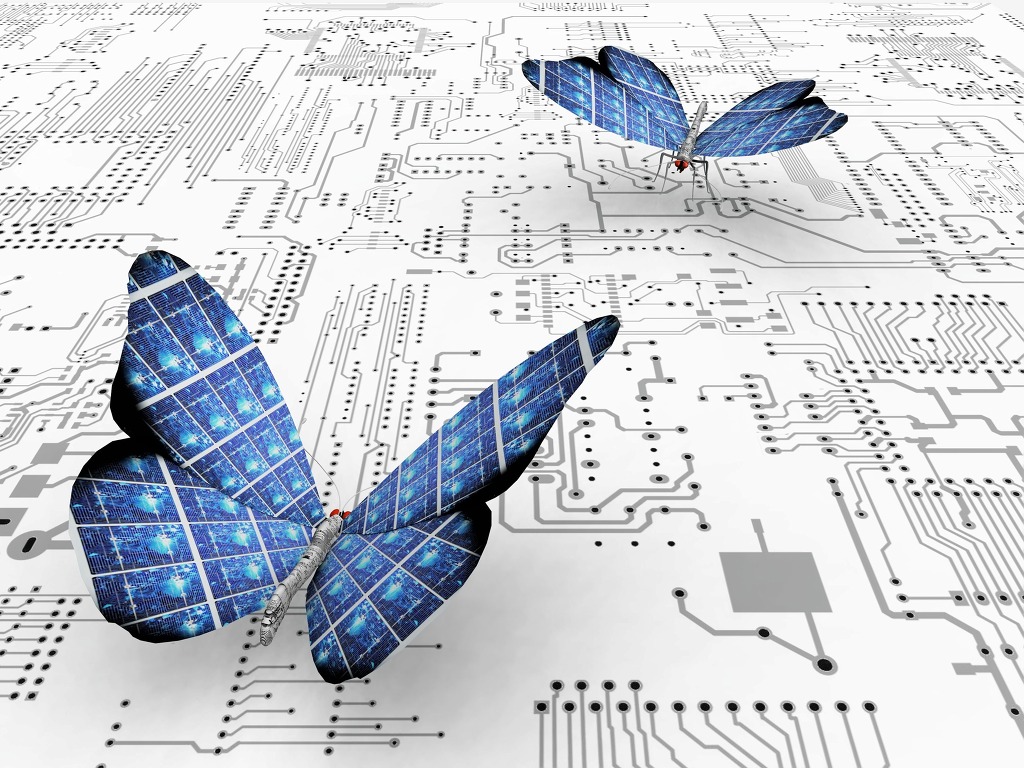
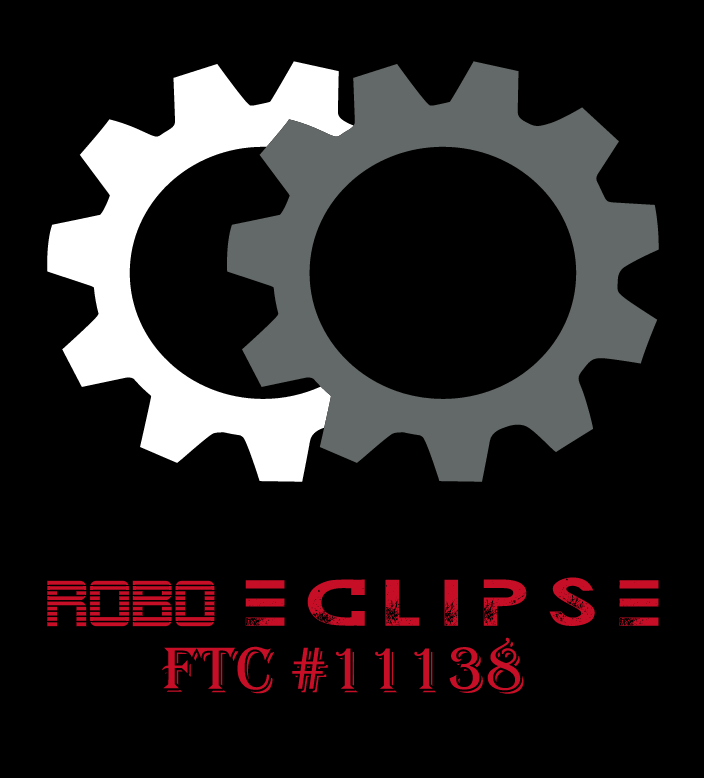
Electrical Engineering Notebook





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# **Executive Summary**

In this notebook, we will explain all the sensors, servos, motors and robot controller that we used to run our robot things about their performance. We used sensors, motors and servo motors to enhance the performance of our robot. We used gyro sensors, and color sensors. We also used multiple types of color sensors and motors so that our robot can be more consistent and accurate. Although we mostly only used one type of servo sensor, we tested other servos to find the best version that is stronger and better.

# **Sensors**

The sensors we use on our robot:

|  |  |  |
| --- | --- | --- |
|  | **Sensor We Use in Robot** | **How we use it** |
| **Brand & Model** | **Adafruit BNO055 Absolute Orientation Sensor-or-Gyro Sensor** | **We use Gyro Sensors so that the direction and turn is correct, and the robot does not turn less or too much, improving the accuracy and precision of our robot.** |
| **Picture** | [Image result for adafruit gyro sensor](https://www.bing.com/images/search?view=detailV2&ccid=dCgpp3K8&id=287257F7CC549863BB39E06C0F06F88C2F96E725&q=adafruit+gyro+sensor&simid=608009079386998481&selectedIndex=2) |
| **Data Output** | Absolute Orientation (Euler Vector, 100Hz)  Three axis orientation data based on a 360° sphere  Absolute Orientation (Quaternion, 100 Hz)  Four-point quaternion output for more accurate data manipulation  Angular Velocity Vector(100Hz)  Three axis of 'rotation speed' in rad/s  Acceleration Vector(100Hz)  Three axis of acceleration (gravity + linear motion) in m/s^2  Magnetic Field Strength Vector(20Hz)  Three axis of magnetic field sensing in micro Tesla (uT)  Linear Acceleration Vector(100Hz)  Three axis of linear acceleration data (acceleration minus gravity) in m/s^2  Gravity Vector(100Hz)  Three axis of gravitational acceleration (minus any movement) in m/s^2  Temperature(1H)  Ambient temperature in degrees Celsius | |

|  |  |  |
| --- | --- | --- |
|  | **Sensor We Use in Robot** | **How we use it** |
| **Brand & Model** | **Modern Robotic Color Sensor (45-2018)** | **We use this color sensor to detect the color on the beacon to determine which button to press. Without this sensor, our robot could accidently click the wrong button and score points for the opposing team.** |
| **Picture** |  |
| **Color Channel Values** | |  |  | | --- | --- | | Address | Function | | 0x03 | Command | | 0x04 | Color Number | | 0x05 | Red Value | | 0x06 | Green Value | | 0x07 | Blue Value | | 0x08 | White Value | | |

|  |  |  |
| --- | --- | --- |
|  | **Sensor We Use in Robot** | **How we use it** |
| **Brand & Model** | **Modern Robotic Touch Sensor**  **(45-2007)** | **We use this touch sensor to detect when the arm hits the bottom. That makes it so that we know when to let go when we set the glyphs down and when we should lift the arm in autonomous while going off of the balancing stone.** |
| **Picture** | http://modernroboticsinc.com/content/images/thumbs/0000235_touch-sensor.png |
| **Actuator** | Actuator Length: 5 millimeters Actuator Depression Force: 150 grams | |

# **Motors and Servos**

## **Motor**

|  |  |  |
| --- | --- | --- |
| **Motor Maker/Model** | [**NeverRest 60 Gearmotor**](http://www.andymark.com/NeveRest-60-Gearmotor-p/am-3103.htm) | [**NeverRest 40 Gearmotor**](http://www.andymark.com/NeveRest-40-Gearmotor-p/am-2964a.htm) |
| **Physical Specs:** |  |  |
| Overall Length: | 133.5mm (5.26 in) | 133.5mm (5.26 in) |
| Maximum Diameter: | 37mm (1.46 in) | 37mm (1.46 in) |
| Output Shaft size: | 6mm (0.24 in) with 0.5mm deep flat | 6mm (0.24 in) with 0.5mm deep flat |
| Weight (lb.) | 12.128 oz. (0.758 lb.) | 0.75 lb |
| Mounting Holes: | M3 tapped holes, qty. 6, on a 31mm bolt circle | M3 tapped holes, qty. 6, on a 31mm bolt circle |
| Electrical Connection Geometry: | 6-pin connector for motor power and encoder contact | 6-pin connector for motor power and encoder contact |
| Gear Material: | Steel | Steel |
| Body Material: | Steel with plastic encoder housing | Steel with plastic encoder housing |
| Lubrication: | Included with gearbox | Included with gearbox |
| Shaft Hardness: | 45-50 Rockwell C (https://en.wikipedia.org/wiki/Rockwell\_scale) | 45-50 Rockwell |
| Wire Gauge: | 18 AWG | 18 AWG |
|  |  |  |
| **Theoretical Performance Specs:** |  |  |
| Gearbox Reduction: | **60：1** | **40:1** |
| Voltage: | 12-volt DC | same as #60 |
| No Load Free Speed, at gearbox output shaft (rpm): | 105 | 160 |
| Gearbox Output Power (W): | 14 | 14 |
| Stall Torque (OZ-IN) | 593 | 350 |
| Stall Current (A): | 11.5 | 11.5 |
| Force Needed to break Gearbox (Oz-in) |  | 1478 |
| Min. torque needed to back drive (oz-in) |  | 12.8 |
| Output counts per revolution of Output Shaft (cpr): | 1680 Pulses | 1120 (280 rises of channel A) |
| Performance Specs, mounted to AndyMark dyno |  |  |
| Max Speed (under load of dyno): (rpm) | 2.0 A | 129 rpm |
| No Load Current (under load of dyno): (amps) |  | 0.4 amps |
| Stall Current: (amps) |  | 11.5 amps |
| Stall Torque: (oz-in) |  | 396 oz-in |
| Max Output Power: 15 (Watts |  | 15 Watts |
| Time to Failure at Stall: 2 minutes, 54 seconds |  | 2 minutes, 54 seconds |
| Motor Case Temperature at Failure: 190 degrees F |  | 190 |
| **How we used it** | We use this motor for lifting the arm and the glyphs in the side bars which are attached to the arm. | We used the motor to power the driving wheels |

## 

## **Servo**

|  |  |  |
| --- | --- | --- |
| **Model** | **REV-41-1097** | [HS-485HB](https://www.servocity.com/hs-485hb-servo) |
| **General Description** | The Smart REV servo is unique due to its ability to have the positions set with a SRS programmer. While most servos are limited to approximately 180 degrees absolute max, the Smart REV Servo have two modes. One is continuous rotation and the other is angular. With a flip of a switch on the SRS programmer, or a press of a couple of buttons, the mode and angle of rotation would be set, making it easy, convenient, and eliminate the need to fiddle with servo horns or linkages. This servo is also stronger than the [HS-485HB](https://www.servocity.com/hs-485hb-servo) as we learned after using it in our robot. This servo will save time by letting us use a programmer to set its rotation instead of manually changing it. Not only that, it has more strength than the other type of servo, so it is time efficient and stronger. Which is why we are replacing the HS-485HB servos with these. | Producing nearly 84 oz-in. of torque power, the 180-degree servo is one of the best choices for rugged robotic applications. This servo’s great performance and durability are a combination of Carbonite gears, high-performance circuitry, and a ball bearing-supported output shaft. Carbonite gearing is nearly four times stronger than nylon gears and provides virtually wear-free performance. Standard rotational range is 90 degrees, but it can be operated to 180 degrees with controllers capable of generating a pulse range from 600 µsec to 2400 µsec. |
| **Drawing and Images** |  |  |
| Dimensions | 40.2 mm x 20.0 mm x 38.0 mm | 1.57" x 0.78" x 1.49" (39.88 x 19.81 x 37.85mm) |
| Product Weight | 2.05 oz. (58 g) | 1.59 oz. (45 g) |
| Output Shaft Style | 25 T | 24 tooth (C1) spline |
| Voltage Range | 4.8 V – 7.4 V, 6 V nominal | 4.8V - 6.0V |
| No-Load Speed (4.8V) | N/A | 0.22sec/60° |
| No-Load Speed (6.0V) | 0.14 sec/60° | 0.18sec/60° |
| Stall Torque (4.8V) | 187 oz. (13.5kg) | 66.6 oz/in. (4.8kg.cm) |
| Stall Torque (6.0V) | 13.5 kg-cm / 187.8 oz-in | 83.3 oz/in. (6.0kg.cm) |
| Max PWM Signal Range (Standard) | 500–2500μs | 553-2425µsec |
| Travel per µs (out of box) | 1.57° | .102°/µsec |
| Max Travel (out of box) | 2826° | 190.5° |
| Pulse Amplitude | 3-5V | 3-5V |
| Operating Temperature | -20°C to +60°C | -20°C to +60°C |
| Current Drain - idle (4.8V) | 8mA | 8mA |
| Current Drain - idle (6.0V) | 8.7m | 8.8mA |
| Current Drain - no-load (4.8V) | 230mA | 150mA |
| Current Drain - no-load (6V) | 285mA | 180mA |
| Continuous Rotation Modifiable | Yes | Yes |
| Direction w/ Increasing PWM Signal | Clockwise | Clockwise |
| Deadband Width | 8µs | 8µs |
| Motor Type | 3 Pole Ferrite | 3 Pole Ferrite |
|  | Indirect Drive | Indirect Drive |
| Feedback Style | 5KO Potentiometer | 5KO Potentiometer |
| Output Shaft Support | Dual Ball Bearings | Top Ball Bearing, Bottom Bushing |
| Gear Type | Straight Cut Spur | Straight Cut Spur |
| Gear Material | Metal | Carbonite |
| Wire Length | 11.81" (300mm) | 11.81" (300mm) |
| Wire Gauge | 22AWG | 25AWG |
| **How we used it** | We used it to raise the jewel arm, move the sidebars for the glyphs. | We use this servo for the jewel flicker, but we are going to replace it with a more powerful servo. |

# 

# **Robot Controllers**

|  |  |  |
| --- | --- | --- |
|  | **Sensor We Use in Robot** | **How we use it** |
| **Brand & Model** | **REV Expansion Hub** | **We plug in all our things into two of these hubs. Our things are motors, servos, and sensors. The sensors include color sensors and gyro sensors. This Expansion Hub is better than our old system of Modern Robotics Controllers because this saves lots of room and keeps all the wires in one spot instead of having a motor controller, a servo controller, and another controller for sensors.** |
| **Picture** |  |

# **Phones**

We use Motorola G3 phones for our robots. Our driver station phone is black. The robot controller phone is also in black. Even though they have the same color, we can identify the phone by the tag we have on the back saying DT-11138 or RC-11138. We also have another pair of phones as backup and practice at meetings. Since some people may need to work on two different things, we have two sets of phones, so two groups can both work and get twice as much done. Also, when one set is charging, we can still use one, so we can still test our programs. Another reason would be because one set of phones may not work, so we use the other phone.

# **Game Pads**

We use Logitech controllers as our game pads in the robot game. We have two game pads and two drivers. One game pad steers and moves the robot, while the other controls the arm and sidebars for grabbing glyphs.

**Game Pad 1**

-Left joystick = Makes the robot move forwards, backwards, diagonally, or sideways.

-Right joystick = Makes the robot turn right and left.

-Button A = Raises jewel arm.

**Game Pad 2**

-Right joystick = Raises arm with side bars to put glyphs higher in the Cryptobox.

-Left joystick = Moves the linear slide when we attach one.

-A = Close slowly

-B = Open slowly