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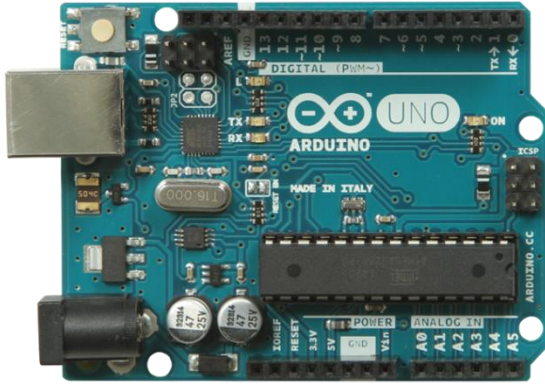


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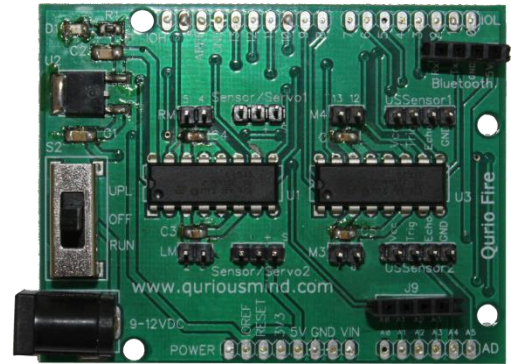
1. Bill of Material (BoM)

Part Pictures

The pictures below list all the material that is part of the Qurio Fire Robotics Kit.



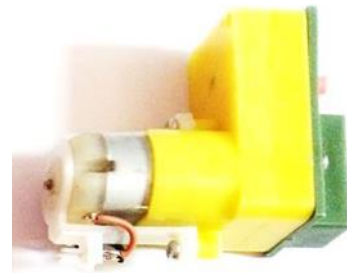
Arduino Uno Board



Qurio Fire (Advanced) Shield



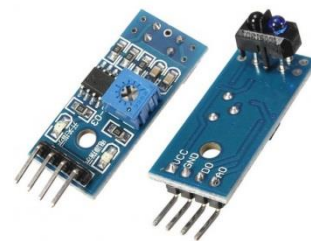
Wheel



DC Motor



Light Sensor



IR Sensor



Nut & Bolt M4 (0.5'), Nut & Bolt (M3)



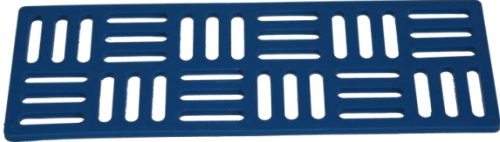
Motor Shaft



Connector Wires



Castor Wheel



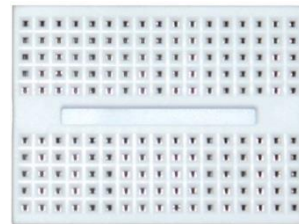
Rectangular Plates



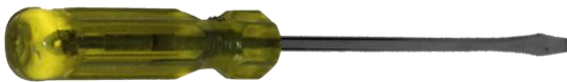
C Plates



6 Cell Battery Holder with DC Plug



Mini Breadboard



Screw Driver



Spanner



220 Ohm Resistor



LED



Bill of Material

Sl. No.	Part Description	Quantity
1	C Plate	2
2	Rectangular Plate	3
3	Single Bar	2
4	Wheel	2
5	Geared DC Motor	2
6	Motor Shaft	2
7	Castor Wheel	1
8	Arduino Uno	1
9	Qurio Fire shield	1
10	Mini Breadboard	1
11	IR Sensor	2
12	Light Sensor	1
13	Connecting Wires (Female – Female)	10
14	Connecting Wires (Male – Male)	10
15	M4 Bolts (0.5 inch) and Nuts	25
16	M3 Bolt and Nut (0.25 inch , 1.5 inch)	5 / 2
17	Spacers	6
18	Hubs	2
19	L Connector	6
20	Flat Rotator	2
21	Spanner	1
22	Screw Driver	1
23	6 Cell Battery Holder with DC plug	1
24	Resistor 220 Ohm and LED	1 each

** Uploading cable is not included in the kit. You will need to purchase appropriate uploading cable.*



2. Safety Instruction

Instructions for use of cells in battery holder

- ❖ Robotic Kit **Qurio Spark** and **Qurio REaCH** use 4 X 1.5 V AA cells.
- ❖ Robotics Kit **Qurio Fire** and **Qurio Kindle** use 6 X 1.5 V AA cells.
- ❖ Either Rechargeable or Non-rechargeable cells can be used.
- ❖ **STRICTLY FOLLOW BELOW INSTRUCTIONS** in connection with the use of and storage of cells
 - ❖ Ensure the cells are inserted properly in the battery holder. **Observe the polarity** while inserting the cells.
 - ❖ **REMOVE** cells from battery holder after use.
 - ❖ **REMOVE** exhausted cells from the battery holder immediately.
 - ❖ **DO NOT** mix new and used cells together.
 - ❖ **DO NOT** mix rechargeable and non-rechargeable cells together.
 - ❖ **DO NOT** try to charge non-rechargeable cells.
 - ❖ In case using rechargeable cells, **REMOVE** them from battery holder before putting them on charge.

Instructions for Parents and Children

- ❖ Robotic Kits make use of Screw Driver, Spanner and 1.5 V cells.
 - **Adults must supervise** children during the use of screw driver.
 - **Adults must supervise** children during inserting and replacing the cells.
 - Children must take care to point the screw driver away from body while tightening or loosening of bolts.
- ❖ Robotic kit includes BO2 Geared DC motor and designs that rotate making use of the motor.
 - Children must be extra careful while making / using the rotating assemblies.
 - **DO NOT** try to stop the rotating parts by hand.
- ❖ Robotic kit includes as few small parts such as Nuts, Bolts, Shaft Locks, Spacers
 - **DO NOT** put the parts in mouth as there is danger of swallowing the small parts.
- ❖ General instructions
 - Wash your hands properly after use of the kit.
 - **DO NOT** perform soldering without supervision of adults.



3. Downloading QuSport Android App

QuSport (Self Paced Online Robotics Tutorials) Android App provides detailed guidance through series of videos on learning Robotics Programming from comfort of your home. It comes FREE. You can find information about how to use Qurio Fire kit using the video tutorials provided in QuSport.

Download QuSport from the link given below

https://play.google.com/store/apps/details?id=appinventor.ai_nutan_jamsandekar.qusport&hl=en_IN&gl=US

4. Study of Electronic Components

Before we learn how to assemble Qurio Fire autonomous robot, it is very essential to study the electronics components included in the kit; such as Arduino Uno board and Qurio Fire Advanced shield for Arduino.

Arduino

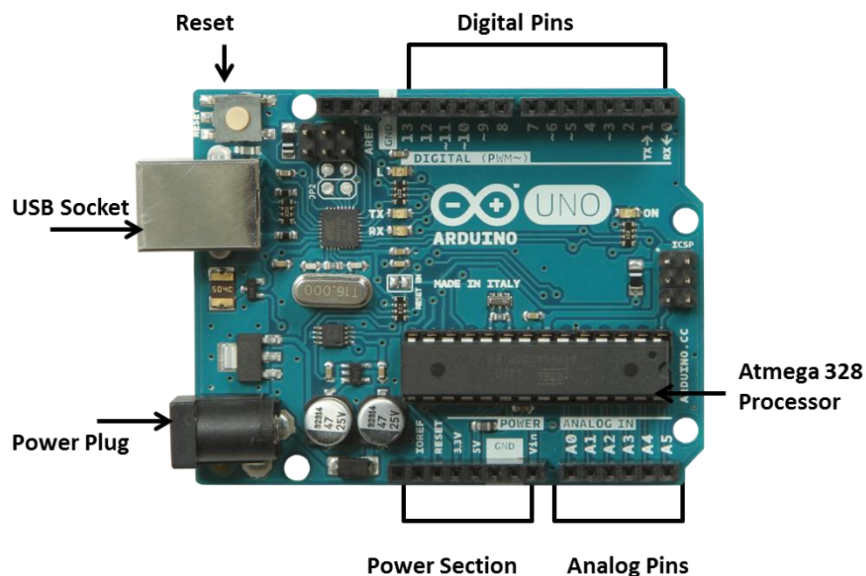
Arduino is a physical computing platform (or Embedded Computing Platform). A computing platform means combination of hardware architecture and a software framework which allows software to run.

The Arduino board we are using comprises of

- Arduino Uno board
- IDE (Integrated Development Environment)

With the help of this 'Arduino Physical Computing platform', we can interact with real world using various types of sensors and actuators (motors).

Arduino Uno Board



Arduino Uno Board

Atmega 328 Processor

This is the brain of the Arduino Uno board and is pre-programmed with Arduino bootloader. It accepts digital data via the input ports, processes the same and then sends results to output ports.



USB Socket

The USB connector can be connected to the Arduino board via USB socket provided. It performs 3 functions

- Supply power to Arduino board when it is connected to PC / Laptop
- Upload programs from PC / Laptop
- Send and receive data to and from PC / Laptop

Power Plug

External power is supplied to the Arduino board using the power connector connected at this plug. Arduino board can be supplied with 7V – 12 V power. In this kit we use 9V supply (6 X 1.5 V AA cells) to power Arduino board.

Power Section

Power section can be seen at the right side bottom of the board. It contains 6 sockets

- V_{in} – Pin to provide i/p voltage to the Arduino board which is used in the case of external DC power supply (7v-12v).
- GND - There two ground sockets
- 5V – This pin gives regulated voltage from voltage regulator which is present on the board.
- 3.3V – This pin provides 3.3 V supply generated by voltage regulator which is on the board.
- RESET - The Arduino microcontroller will reset itself when reset pin is connected to ground.

Analog Pins

This section has 6 analog input pins (A0 – A5) used to connect analog peripherals.

Digital Pins

This section has 14 digital pins numbered 0 – 13. These are input / output pins. Pin no. 3, 5, 6, 9, 10 and 11 are PWM pins.

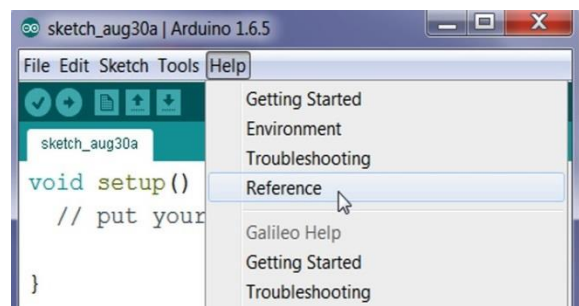
Arduino IDE

To write different Arduino programmes (sketches), one has to install the Arduino IDE (Integrated Development Environment).

One can download latest version of Arduino IDE free of cost from official site of Arduino

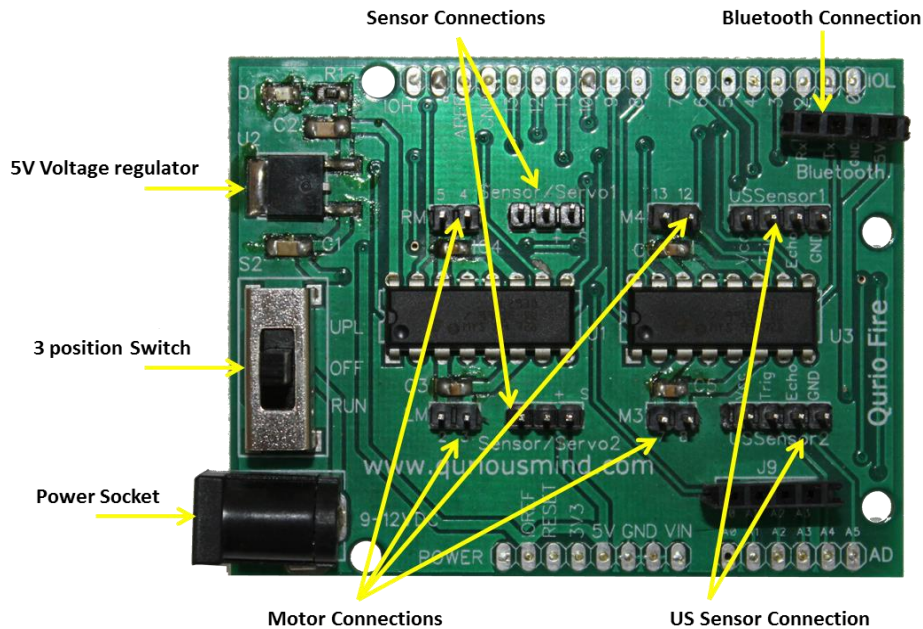
<http://arduino.cc/en/main/software>

With the help of the IDE, one can write different sketches (programs). The IDE converts these programs into instructions that Arduino board (Micro-controller) can understand. For information on Arduino programming select help in Arduino IDE and click on 'reference' Or go to <http://www.arduino.cc/en/Reference/HomePage>



Qurio Fire Shield

Shields are expansion boards that can be plugged on the top of the Arduino Board. Capabilities of Arduino Board can be increased by using Shields.



Qurio Fire Shield

The shield used in this kit comes with following additional items

5v voltage regulator

Separate 5v voltage regulator is used for motor driver IC L293D, and servo motors. External battery supply (**7v -12v**) is given to input of this 5v voltage regulator.

Three position switch

This switch controls supply of power to Arduino board, IC L293D etc.

- Position U – ‘Upload’ position. Switch is in put in this position while uploading the program into Arduino.
- Position O – ‘Off’ position. In this position external supply is not provided to Arduino as well as motor drivers. This intermittent position ensures that the program is reset before we start the execution of program.
- Position R – ‘Run’ position. In this position external power is provided to both Arduino and motor drivers. Operate the Robot while switch is in Position ‘R’.

Power Socket

9 V to 12 V external battery power can provided to the Arduino board through this socket.



Motor Connection

Four sets of 2 male pins are available to connect four DC motors. These motors are termed as Left, Right, Motor 3 and Motor 4. Following sections detail on how to connect these motors.

Servo / Sensor Connection

Two sets of 3 male pins are provided to connect either Servo motors or three pin Sensors. The pin marked '+' should be connected to Supply pin (Vcc) of sensors, pin marked '-' should be connected to ground (GND) pin while pin marked as 'S' should be connected to Output pin of sensor.

Ultra Sound Sensor Connection

Two sets of 4 male pins are provided to connect Ultra Sound Sensors.

Bluetooth Connection

A special port is provided to connect Bluetooth module HC-05. It connects BlueTooth to Arduino via digital pins 0 and 1 of Arduino.

Additional Components

Mini Breadboard

A 70 tie-point mini breadboard has 5 sockets in each row. These 5 sockets are interconnected.

Motor Connections

Following table shows the motor connection details.

Arduino Pin	Remarks
2	Controls Direction of Left Motor
3	
5	Controls Speed of the Left Motor
4	Controls Direction of Right Motor
7	
6	Controls Speed of Right Motor
8	Controls Direction of Motor 3
11	
9	Controls Speed of Motor 3
12	Controls Direction of Motor 4
13	
10	Controls Speed of Motor 4

Direction Control of DC Motor

The motor direction is controlled by providing following inputs to the Arduino.

Arduino Pin	2 / 4 / 8 / 12	3 / 7 / 11 / 13	5 / 6 / 9 / 10	Motor Direction
	HIGH	LOW	Speed	Clockwise
	LOW	HIGH	Speed	Anti-clockwise
	HIGH	HIGH	X	STOP



	LOW	LOW	X	STOP
	X	X	0	STOP

NOTE: 'X' means 'Does not Matter', which indicates that the input to this pin does not affect the output.

Speed Control of DC Motor

To control the speed of the motor, we provide a Pulse Width Modulated (PWM) input to 'Enable' pins of motor driver. A PWM input controls the amount of voltage provided to the motor by changing the time (T_o) for which the pulse is positive.

The input to the ENABLE pin in case of speed control is an analog input. The analog input values range from 0 – 255, with '0' being 0% of the motor speed and '255' being 100% of the motor speed.



5. Installation of Arduino IDE

To program our Robots using Arduino Uno board, we will need to first install the Arduino IDE and associated Drivers. Arduino IDE is used to write programs while the associated Drivers are used for communication between the Arduino Board and Computer.

Installing Arduino IDE

As for any installation, one will need the executable file of the software that needs to be installed. The installation file can be downloaded from official website of Arduino which is arduino.cc

Downloading Qurio Fire Libraries and Curious Mind extensions

You can download the Qurio Fire libraries and Curious Mind extension for mBlock from the link given here.

www.curiousmind.com/downloads.html



6. Uploading and using Qurio Fire Libraries

Adding Qurio Fire libraries to Arduino environment

For using the libraries you need to first add them to your Arduino IDE. Follow the below steps.

1. Open Arduino IDE.
2. Go to Sketch – Include Library – Add .ZIP file
3. Locate the file QurioFireMotor.zip and click on Open.
4. Arduino will give you message that the library is added.
5. Verify you can see the new library in Sketch – Include Library menu.
6. Follow same procedure to add Sensor libraries. (Use QurioFireSensor.zip)

Qurio Fire libraries

Qurio Fire comes with 2 libraries which will help you programming your robot with more ease.

- QurioFireMotor
- QurioFireSensor

QurioFireMotor Library

This library provides methods (commands) those can be used for controlling your vehicle (Platform) and/or individual motors. Use of Vehicle commands assume Left side wheel (When looked from behind the vehicle) is connected to Left Motor and Right side wheel is connected to Right Motor.

Details of the methods are as follows.

Method	Argument	Values	Description
forward	spdL, spdR	0-255, 0-255	Moves vehicle forward. spdL is the speed of left motor and spdr is the speed of right motor.
reverse	spdL, spdR	0-255, 0-255	Moves vehicle reverse, spdL is the speed of left motor and spdr is the speed of right motor.
vehStop	-	-	Stops the vehicle
hardRightTurn	spdL, spdR	0-255, 0-255	Turns vehicle right on the spot spdL is the speed of left motor and spdr is the speed of right motor. Turning radius will change depending upon the values provided.
hardLeftTurn	spdL, spdR	0-255, 0-255	Turns vehicle left on the spot spdL is the speed of left motor and spdr is the speed of right motor. Turning radius will change depending upon the values provided.
leftClk	spd	0 – 255	Rotates left motor clockwise at 'spd' speed
leftAclk	spd	0 – 255	Rotates left motor anticlockwise at 'spd' speed
leftStop	-	-	Stops Left motor



rightClk	spd	0 – 255	Rotates right motor clockwise at 'spd' speed
rightAclk	spd	0 – 255	Rotates right motor anticlockwise at 'spd' speed
rightStop	-	-	Stops Right motor
moveM3Clk	spd	0 – 255	Rotates motor 3 clockwise at 'spd' speed
moveM3Aclk	spd	0 – 255	Rotates motor 3 anticlockwise at 'spd' speed
stopM3	-	-	Stops motor 3
moveM4Clk	spd	0 – 255	Rotates motor 4 clockwise at 'spd' speed
moveM4Aclk	spd	0 – 255	Rotates motor 4 anticlockwise at 'spd' speed
stopM4	-	-	Stops motor 4

Refer 'Troubleshooting' if your methods do not work as given above.

QurioFireSensor Library

This library contains methods (commands) to read and return sensor values which can be used for taking decisions in autonomous robots. This library has following methods

- **getSensorValue** – Returns the reading of sensors. This method can be used with IR sensor, Touch sensor and sound sensor.
- **getUsSensorValue** – This method reads the value of ultra sound sensor and returns the distance between the robot and any object.

Method	Argument	Values	Description
getSensorValue	inpin	A0 or A1	Argument is Arduino pin number to which sensor is connected. Allowed pin numbers are A0 and A1. Returns 'int' value
getUsSensorValue	trigpin, echopin	A2,A3 OR A4,A5	For using this method the Ultrasound sensor's 'echo pin' should be connected to pin 'A3/A5' 'trig pin' should be connected to pin 'A2/A4' of Arduino. Returns 'float' value

Using Qurio Fire libraries

After adding the libraries to Arduino environment, we can use the methods from those libraries. To use methods from above libraries, you need to include the library in your program just like you include Arduino.h.

e.g. To use QurioFireMotor library add following statement to your #include statements.

#include <QurioFireMotor.h>

Declare variable of type QurioFireMotor as follows, before setup section.

QurioFireMotor motor;

The class name QurioFireMotor should always be same; however the variable name can be of your choice. In above example the name used is motor.

Any method from above library should be called using the variable name, as follows.

motor.forward(255,255); motor.reverse(255,255); motor.vchStop()



Refer code examples to see how libraries are used.

Library Methods

If you would like to see what the library methods (commands) are doing you can check out the code at following location.

1. Find out your Arduino sketchbook location as follows.
 - a. File – Preferences – Sketchbook location in Settings tab.
2. Open Sketchbook location. (directory found above) in file explorer.
3. Open libraries folder.
4. You will find 2 folders with the names of the libraries. (QurioFireMotor and QurioFireSensor)
5. Open the folder. You will see 2 files inside. One .h file and a .cpp file. Open .cpp file to see the code.

***** The pin numbers to be used for various sensors mentioned under this section are valid only if you choose to use the Qurio Fire Libraries.***



7. Installing mBlock and adding Curious Mind Extensions

Refer the video tutorial in the QuSport Android App for installing mBlock and adding Curious Mind extensions.

mBlock version 3.4.1 is provided on the Google drive. Please note that 'Repeat' command does not work properly in Arduino for all other mBlock versions 3.4.X

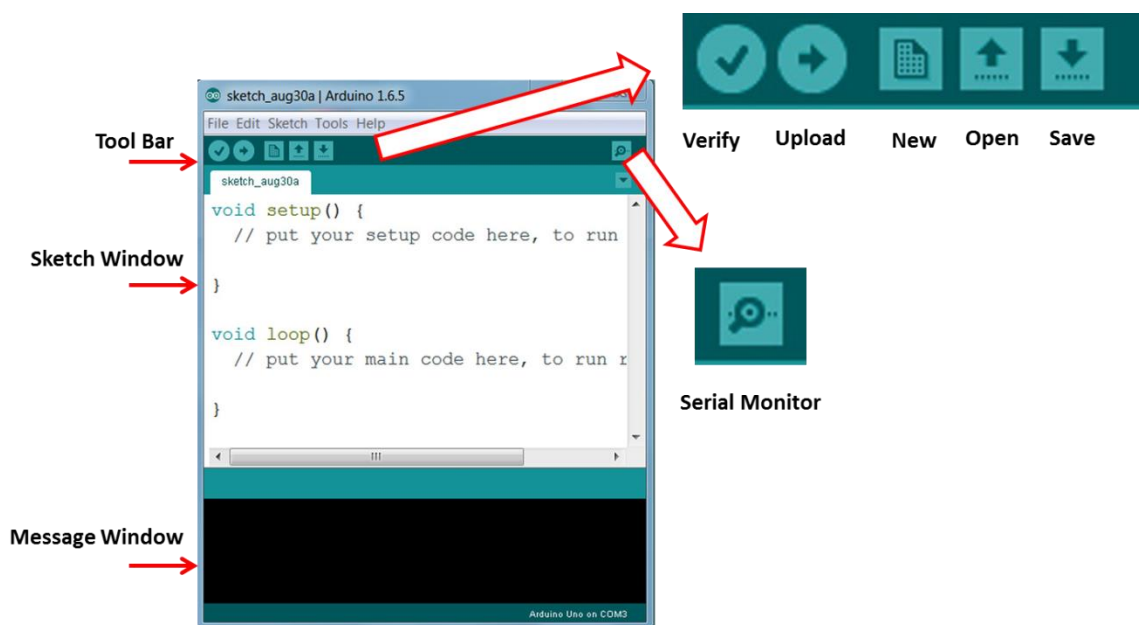
Please ensure that you are using Curious Mind extension version 2.0 This can be validated in Manage Extension popup.

8. Uploading First Arduino Sketch to Arduino Board

To upload a Sketch (program) onto the Arduino board, we will need to connect the computer (where we have our program) to the Arduino Board using a USB cable (*Uploading cable is not included in the kit. You will need to purchase appropriate uploading cable used for Arduino Uno*). USB cable is inserted in any of the USB ports on your computer and on the Arduino board side it is connected to the USB socket.

Arduino board will receive power supply from computer as soon as it is connected using a USB cable.

The Arduino IDE is divided into three main parts.



The buttons on the tool bar are used for performing various functions as given below

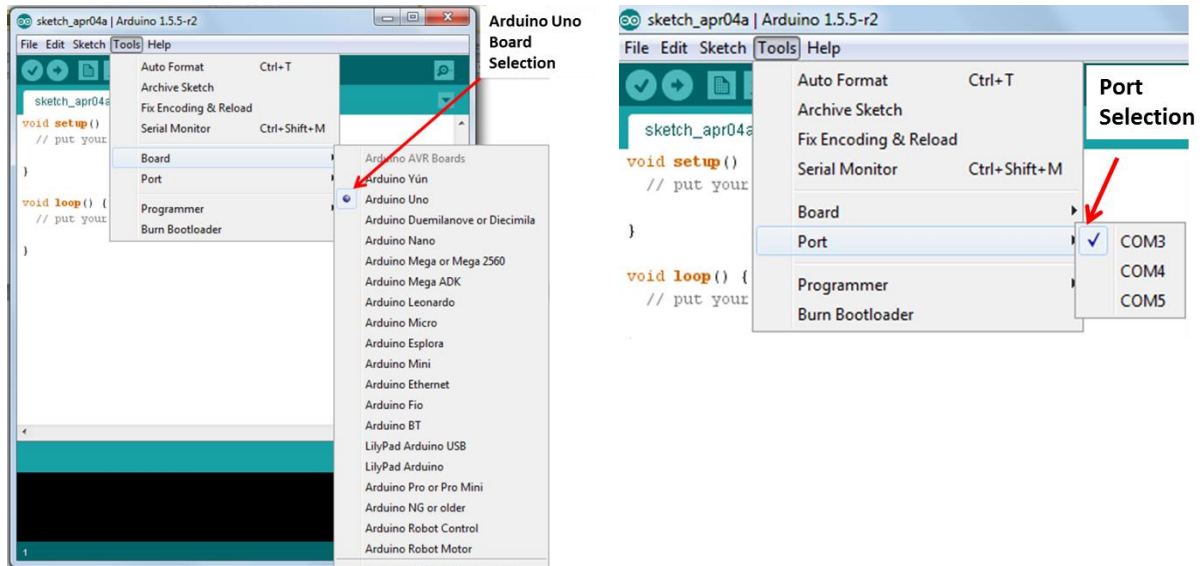
- Verify – This compiles (checks) the sketch for syntactical errors.
- Upload – This button is used to upload a sketch to the Arduino Board
- New – This button is used to create a new blank Sketch
- Open – This button is used to search and open an already available Sketch from sketchbook
- Save – This button is used to save the currently open Sketch to sketchbook
- Serial Monitor – This button opens a serial monitor which displays serial data being sent from Arduino board

To upload an Arduino program available on the computer you must have the Arduino IDE open. The current Sketch can be uploaded to the Arduino board connected by using the Upload button on the tool bar.



Before we press Upload button on the tool bar, we need to ensure that we have selected correct board and correct port (if already not selected) by going to Tools >> Board and Tools >> Port respectively as shown below.

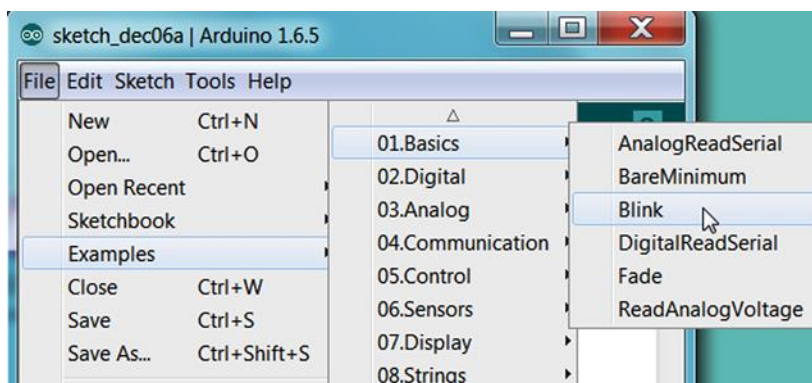
Since most of the computers have more than one USB port, it is advisable to check which port the Arduino board is connected. For this please refer the procedure given in section 4.



Once we chosen the correct board and correct port, just by clicking on the 'Upload' button will first *compile* the Sketch and if *no errors exist*, it will upload the Sketch into the Arduino board.

Before we begin writing any Sketches, we can upload the already existing 'Blink' Sketch onto the Arduino board and check if it is working fine.

To do this, go to Files >> Example >> Basics and select Blink



You can upload this Sketch into your Arduino Board. This Sketch makes the LED near pin 13 blink at an interval of 1 second. Check if this happens. If yes, then you are good to go...



9. Connecting Peripherals

Curio Fire advanced provides pins to directly connect 3 pin sensors (2 Qty.) OR Servo motors (2 Qty.), Ultrasound sensors (2 Qty.) and Bluetooth in addition to DC motors (4 Qty.).

Sensors help Robots to sense the surrounding and take an appropriate action based on the surrounding conditions.

Curio Fire comes with two types of sensors namely IR sensor (2) and Light sensor (1). You can integrate with Curio Fire; most other sensors available in market.

HC05 Bluetooth module can be connected to the shield directly.

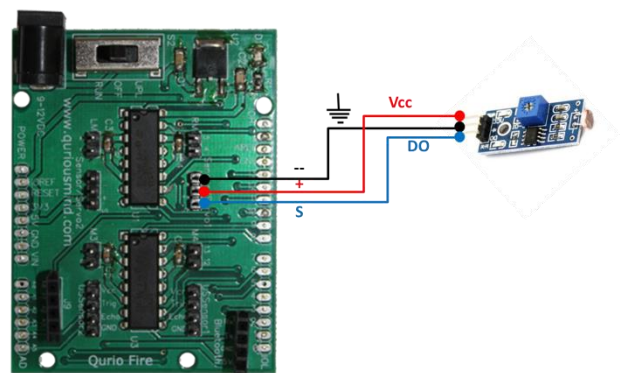
Connecting Sensors

Every kit comes up with F2F and M2M wires which can be used to connect to the sensor.

IR Sensor / Light Sensor (3 pin sensor)

IR / Light sensors (for that matter any 3 pin sensor) have three pins namely Vcc (+), GND (-) and OUTPUT (DO). The Sensor will be connected to the set of three pins named **Sensor/Servo 1** or **Sensor/Servo 2**. When the sensor is connected to Sensor / Servo 1 pins in the program we use A0 pin to read sensor value, while if it is connected to Sensor / Servo 2 pins then we use A1 to read sensor value.

Sensor Pin	Curio Fire Board Pin
Vcc	+
GND	-
DO	S

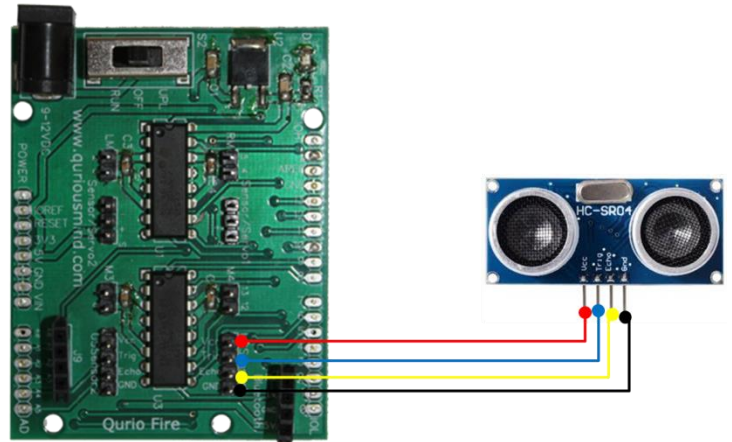


Ultrasound Sensor (NOT PART of the KIT)

Ultrasound sensors have four pins. They are Vcc, GND, Trigger (Trig) and Echo. The Vcc and GND pins will be connected to the 5V and GND pins of Arduino respectively. The Trigger and Echo pins will be connected to I/O pins provided on the shield.

The Sensor will be connected to the set of four pins named **US Sensor 1** or **US Sensor 2**. When the sensor is connected to **US Sensor 1** pins in the program we use A2 (Trig pin), A3 (echo pin) to read sensor value, while if it is connected to **US Sensor 2** pins in the program we use A4 (Trig pin), A5 (echo pin) to read sensor value.

Sensor Pin	Qurio Fire Board Pin
Vcc	VCC
GND	GND
TRIG	A2 OR A4
ECHO	A3 OR A5



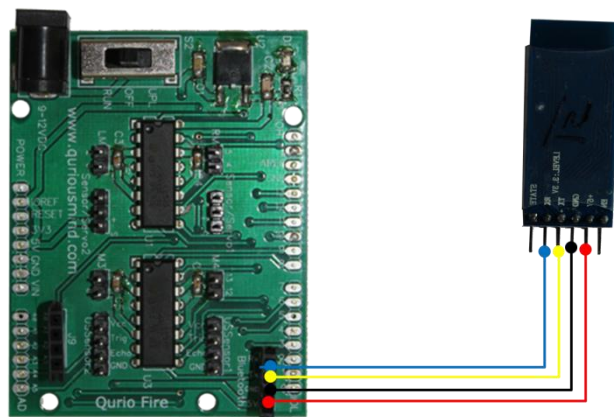
Ultrasonic sensor transmits Ultrasound frequency and receives the echo. It measures the time between the trigger and echo. As we know the speed of sound, we can then calculate the distance between the sensor and the object that returned the sound signal by using the time duration between the transmitted and received signal.

Ultrasonic sensor can be used to program various functionalities using its ability to calculate distance of the object (obstacle) from the sensor. A few of them are – Edge Avoider, Obstacle Avoider, and Obstacle Detector etc.

Connecting Bluetooth

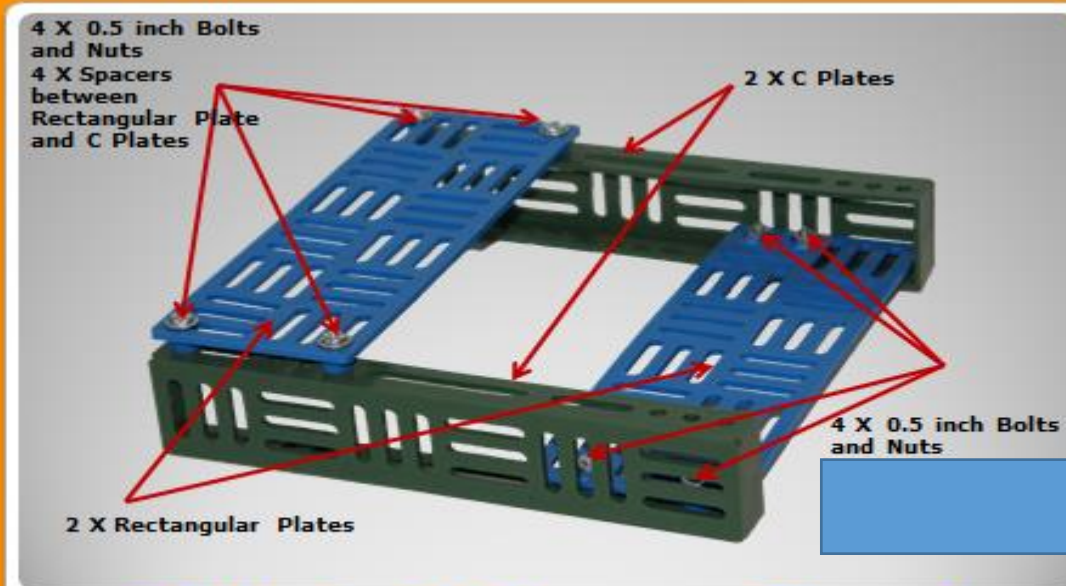
HC05 Bluetooth module can be directly inserted in the slot provided on the shield. It uses the default RX and TX pins (pin 0 and pin 1 respectively) of Arduino.

BlueTooth pin	Qurio Fire Board Pin
Vcc	VCC
GND	GND
Tx	Tx
Rx	Rx

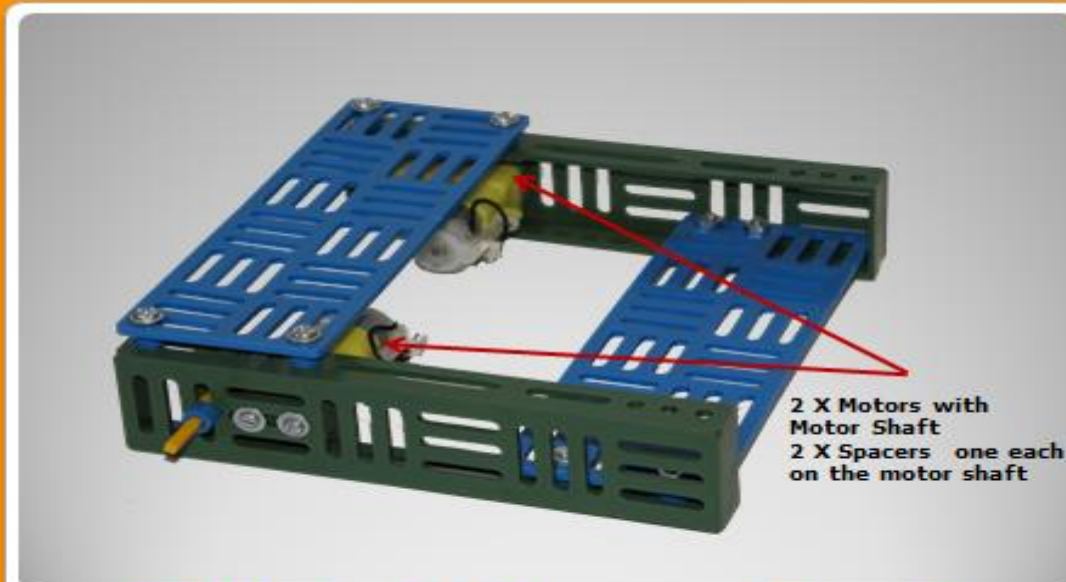


10. Constructing Vehicle Platform

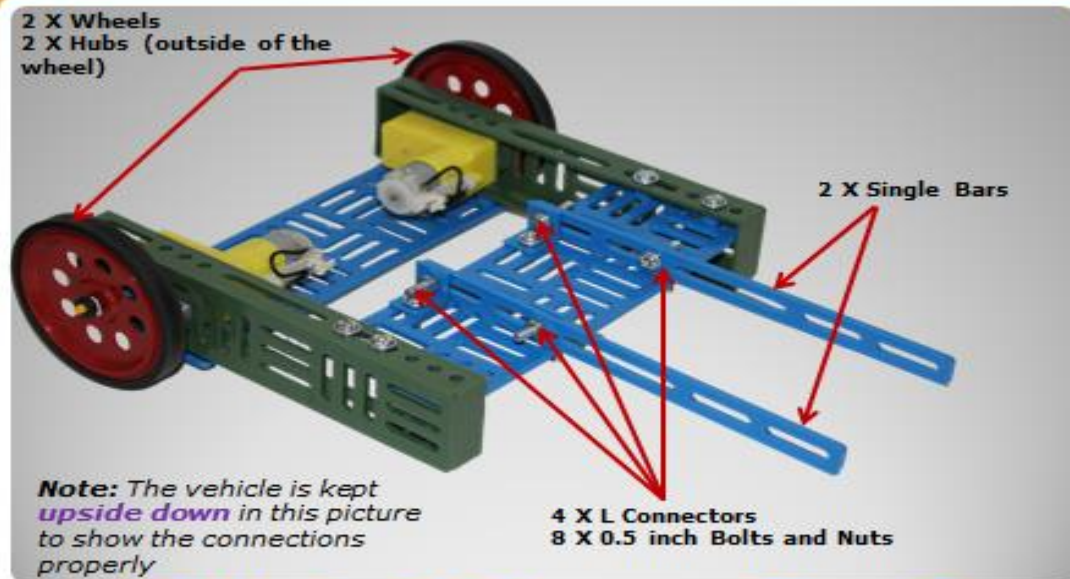
This section provides step by step instruction to construct a vehicle platform which can be used to test most of the initial programs.



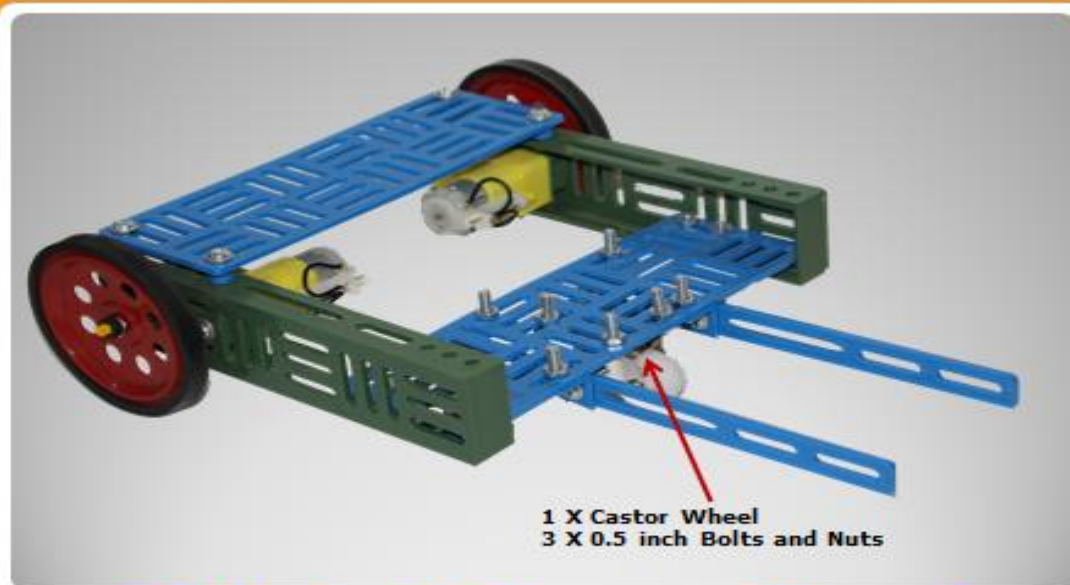
Vehicle Platform – Step 1



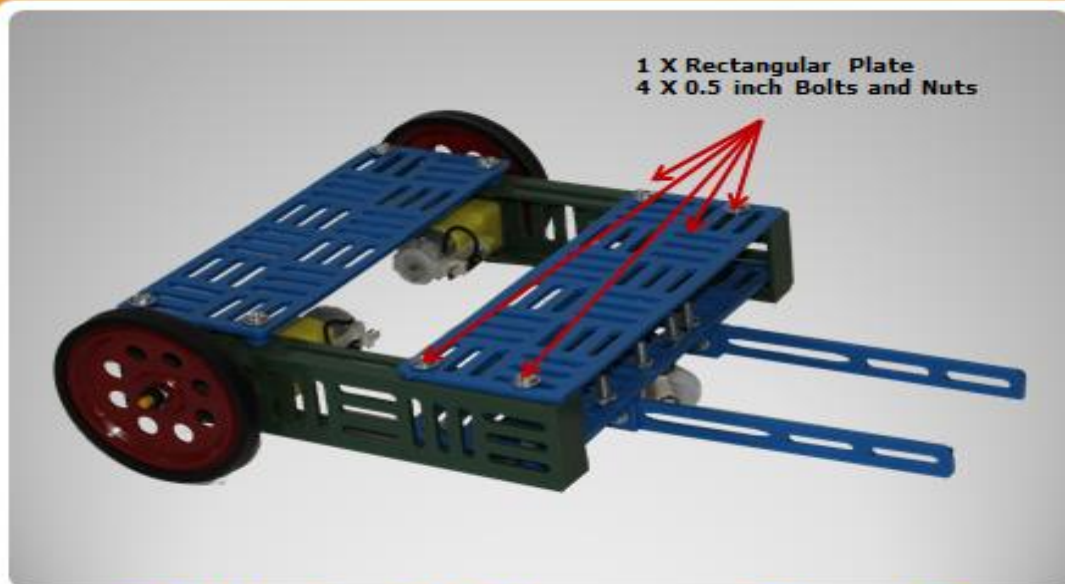
Vehicle Platform – Step 2



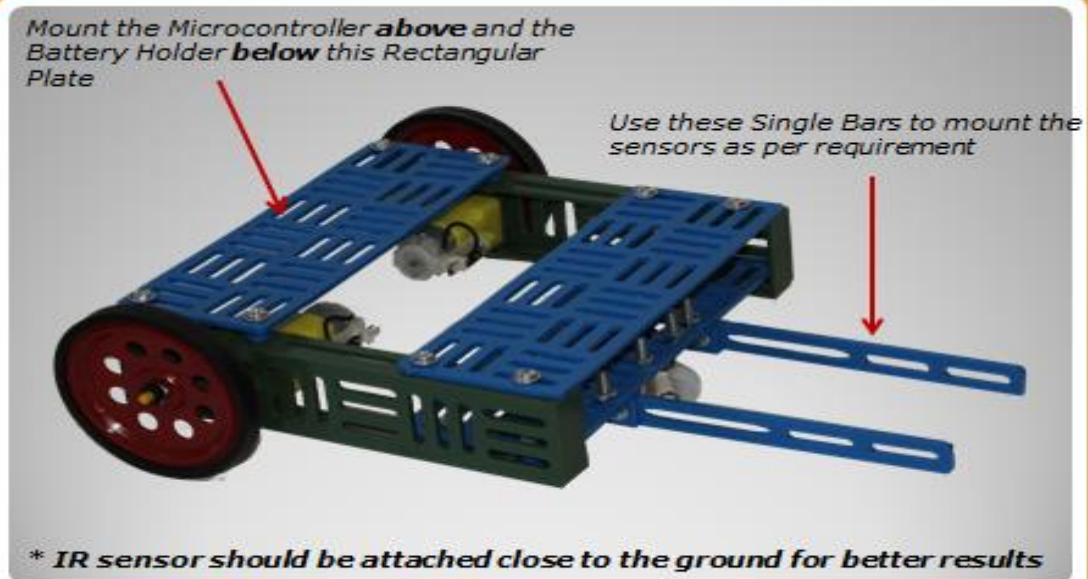
Vehicle Platform – Step 3



Vehicle Platform – Step 4



Vehicle Platform – Step 5



Vehicle Platform – Step 6



You can use your imagination to create alternative platforms. While creating a platform remember following points.

- Maximum weight should be placed close to the DC motors driving the vehicle.
- The vehicle should have sufficient space for mounting the microcontroller and battery holder.
- Make proper provision for attaching the sensors



11. Sample Programs

Following sample programs can be downloaded from Google drive link

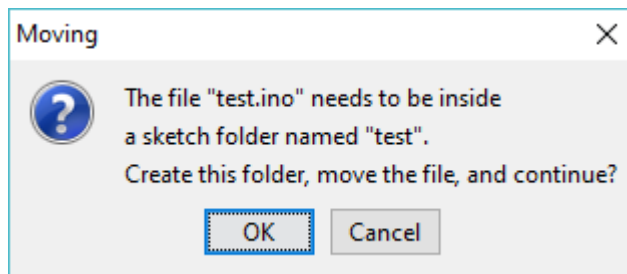
https://drive.google.com/drive/folders/1gAsS3sM1jZarMuo4Bbs4StVsH1EMEHs2?usp=share_link

- Simple Motor Programs
 - Vehicle Forward
 - Vehicle Reverse
 - Vehicle Turn
 - Figure of Eight
- Sensor Program
 - Line Follower
 - Edge Avoider
 - Obstacle Avoider

Using Programs provided

You can use these programs by opening them in Arduino IDE. Follow below steps for opening these programs in Arduino IDE.

- Download and Save programs to a location on your PC.
- Double click on the .ino file of the program to be opened.
- You will get a message like the one given below with the program name to be opened



- Click on 'Ok'

This will open program in Arduino IDE.

You can also open the Arduino IDE and then open the desired program using the File>>Open menu.

Once the program is uploaded, you can power up the Arduino by connecting the battery holder power plug to **power jack on the Qurio Fire Shield**.

DO NOT connect power plug to Arduino Uno power jack.



12. Trouble Shooting

My Robot reverses even when I have programmed it to move forward

- ❖ Check if you have connected Left Motor of the Robot to the Motor connection pins meant for Left Motor. If not, then correct the same.
- ❖ If the problem persists, change the polarity of the connection by reversing the wires at the shield end (exchange the wire positions) for both motors.
- ❖ If you are **NOT** using QurioFireMotor Library, then use appropriate Arduino commands and use the pin numbers as given under topic 'Motor Connection'.

My Robot turns even when I have programmed it to move forward / reverse

- ❖ If the vehicle turns left then change the polarity of Left Motor (by reversing the wires of that motor at the shield end).
- ❖ If the vehicle turns right then change the polarity of Right Motor (by reversing the wires of that motor at the shield end).
- ❖ If you are **NOT** using QurioFireMotor Library, then use appropriate Arduino commands and use the pin numbers as given under topic 'Motor Connection'.

My US sensor returns '0' value when motor starts

- ❖ Check continuity of connectors used.
- ❖ Check battery for low voltage. Battery voltage less than 9 V may not provide sufficient voltage to sensors when motors start.



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