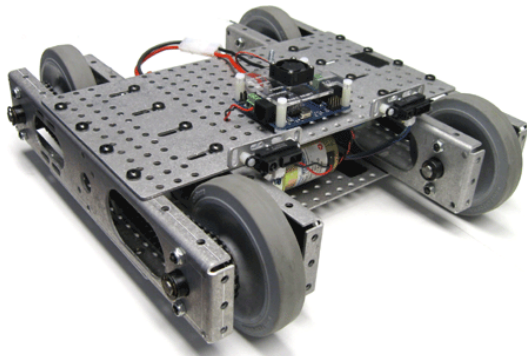


# Controlling a GEARS Robot with the HCM Module

More detailed instructions, including color photographs, are available the Machine Science website: [www.machinescience.org](http://www.machinescience.org)

## About the HCM Module

The High-Current Motor (HCM) Module provides high-current DC motor and solenoid control for any GEARS robot. The HCM Module can control up to two DC motors and up to two solenoids at a time. The unit's motor driver circuits are rated for up to 10 amps of continuous current and 30 amps peak current. The solenoid drivers are rated for 500 milliamps continuous current. Figure 1 shows a GEARS robot with the HCM Module.



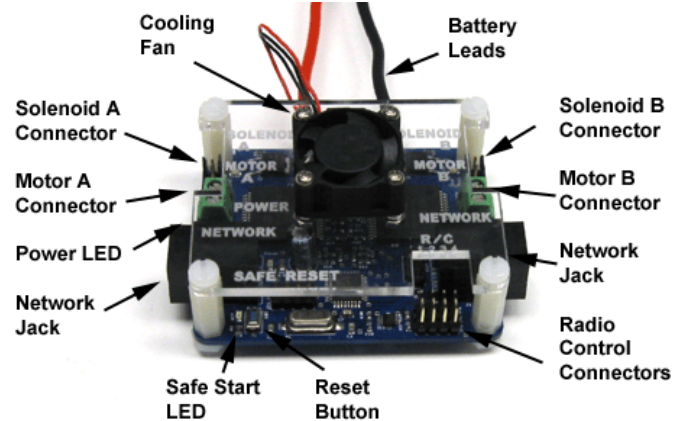
**Figure 1. Robot with HCM Module.**

The HCM Module offers two modes of operation: remote control and autonomous. In remote control mode, the HCM Module can be directly controlled using a PS2 game controller. A Master Module is not needed for this style of operation. In autonomous mode, you program the Master Module to send commands to the HCM Module. In this way, the motors and solenoids can respond autonomously to inputs such as distance sensor values. (Instructions for autonomous control are available online.)

## Learning Key Components

Before getting started, take a few minutes to examine the components on the HCM Module. These are labeled on the module's protective

cover, shown in Figure 2, and described in more detail below.



**Figure 2. HCM Module components.**

- *Motor (A, B):* These screw terminal connectors are for DC motor leads.
- *Solenoid (A, B):* These two non-polarized headers connect the HCM Module to solenoids.
- *R/C (1-4):* The four R/C headers can be used with four channels from a R/C receiver.
- *Motor LEDs (A, B):* The two LEDs next to each motor terminal indicate the speed and direction of each motor. Color indicates direction and intensity indicates speed.
- *Solenoid LEDs (A, B):* An LED next to each solenoid header indicates the state of the solenoid. Green indicates that the solenoid is powered.
- *Safe Start LED:* This LED indicates that all four channels are in the neutral zone.
- *Reset Button:* This button switch resets the code running on the HCM Module.
- *Network Jacks:* These RJ-25 connectors link the I/O Module to the Master Module and other expansion modules.
- *External Battery Leads:* The motors and solenoids are powered by an external battery that can be connected to the standard battery jack.
- *Cooling Fan:* The cooling fan spins continuously whenever the HCM Module's battery is connected.

**For complete XIPMods tutorials, including instructions for autonomous control, please refer to the Machine Science web site: [www.machinescience.org](http://www.machinescience.org).**

## Connecting the Motors

Connect the two leads from each GEARS motor to the HCM Module using the two screw terminals marked Motor A and Motor B. If you are using two motors in a robot, with the two motors facing in opposite directions, it is recommended that you align the red and black motor leads as shown in Figure 3. This will be useful when writing code to operate the HCM Module in autonomous mode.

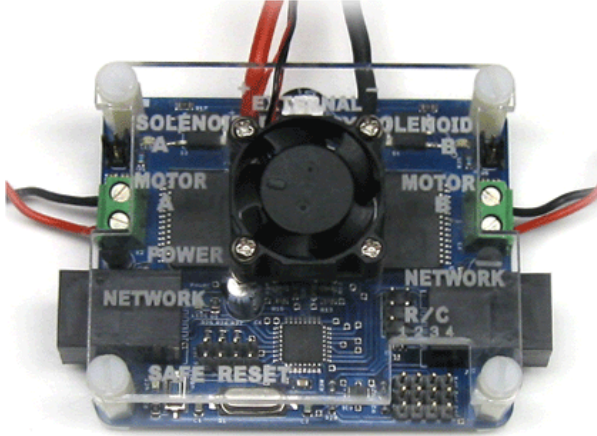


Figure 3. Connecting DC motors.

## Connecting the Solenoids

If you are using solenoids, connect their leads to the headers marked Solenoid A and Solenoid B. Figure 4 shows the connection for Solenoid A. Note that the leads on the solenoids are not polarized so you may connect them in either orientation.

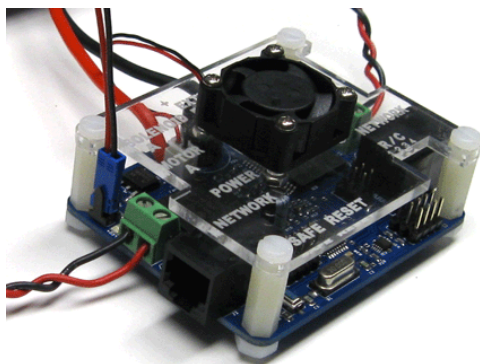


Figure 4. Connecting a solenoid.

## Powering the HCM Module

The motors and solenoids are powered by the heavy black and red wire leads that terminate in a polarized wire harness. This harness mates with the connectors found on many 6V to 16V hobby battery packs. For safety's sake, it is good practice to incorporate an ON-OFF switch into the circuit that supplies power to the motors, as shown in Figure 5. This switch should be mounted in an easily accessible position on the robot frame, so that power can be quickly shut off as needed.

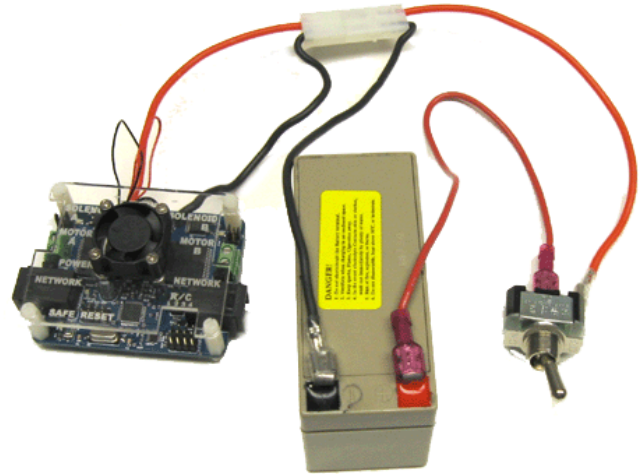


Figure 5. HCM Module with 12V battery.

HCM Modules shipped after April 2010 feature a battery eliminator circuit, which allows the motor/solenoid battery to power the HCM Module's electronics. Older HCM Modules must be connected to a Master Module, as the electronic circuits will draw power from the Master Module's battery. Whether powered by the battery eliminator circuit or by the Master Module's battery, the HCM Module's green power LED will light when the electronics are properly powered.

## Remote Control Mode

With the addition of a PS2 Controller Module, you can control the GEARS robot using a wireless controller and receiver designed for the Sony PlayStation2 (PS2) game system (Figure 6).



Figure 6. PS2 controller and receiver.

### Connecting the PS2 Module

The PS2 Module connects to the HCM Module with a snap-in network cable. Insert one end of the network cable into the PS2 Module and the other into the HCM Module, then plug the PS2 receiver into the PS2 module, as shown in Figure 7. Note that the cable has slightly different connectors at each end. Be sure to use the end with the proper connector for the PS2 Module.

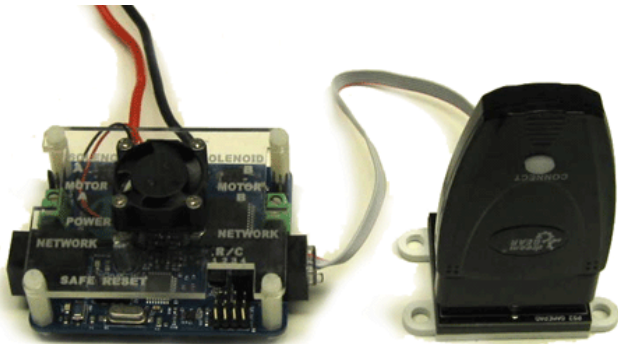


Figure 7. HCM connected to the R/C receiver.

### Monitoring the Wireless Connection

The Connect LED on the PS2 receiver indicates the status of the wireless connection between the two devices. If the LED is off, there is no power to the receiver. If the LED is flashing, the receiver has power, but there is no connection to the controller. If the LED is illuminated, a connection has been established. When setting up the wireless PS2 connection, make sure that both HCM Module and the PS2 controller have adequate power, and that both devices are switched on.

Note that *you must press the Analog button* on the controller to establish the wireless connection (Figure 8).



Figure 8. Indicator LEDs.

### Using the PS2 Controller

The default mode of operation for the PS2 Module and the HCM Module is a “tank drive” control scheme, whereby the left joystick position determines the speed and direction of Motor A, while the right joystick position determines the speed and direction of Motor B. For robots equipped with solenoids, the bottom left button on the front of the controller (button L2) triggers Solenoid A, while the bottom right button on the front of the controller (button R2) triggers Solenoid B.

An alternate control scheme may be accessed by holding down the Select button and pressing either the Cross or the Triangle button. In the alternate scheme, the right joystick position determines the speed and direction of both motors, while the left joystick position provides steering control.

**IMPORTANT NOTE: If the robot responds unpredictably to PS2 signals in either control scheme, it may be necessary to swap or reverse the polarity of the motor connections to the module.**