

Controlling a GEARS Robot with the HCM Module

More detailed instructions, including color photographs, are available the Machine Science website: 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.

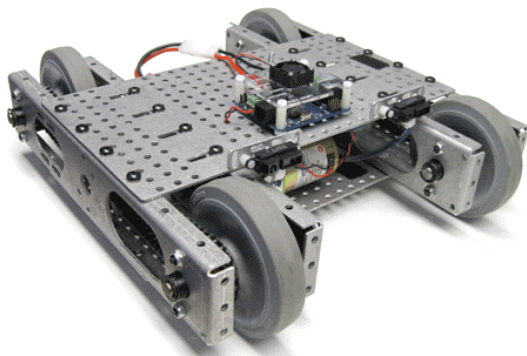


Figure 1. Robot with HCM Module.

The HCM Module offers two modes of operation: radio control (R/C) and autonomous. In R/C mode, the HCM Module can be directly controlled using a standard hobby R/C transmitter and receiver. A Master Module is not needed for R/C 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.

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.

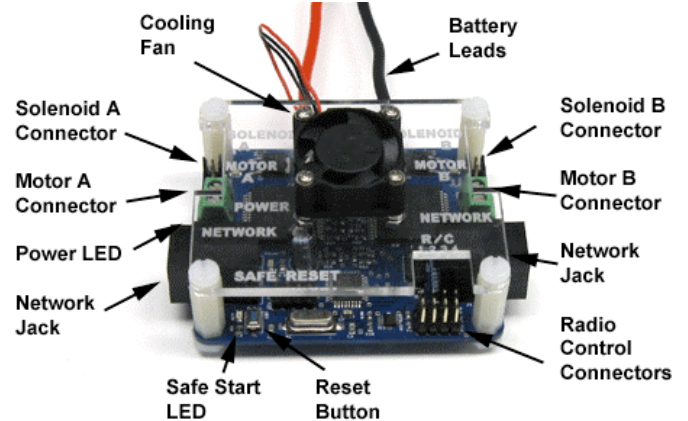


Figure 2. HCM Module components.

- *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.

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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.

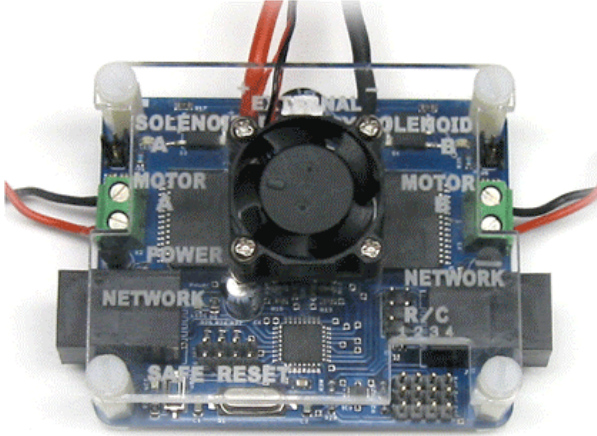


Figure 3. Connecting DC motors.

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.

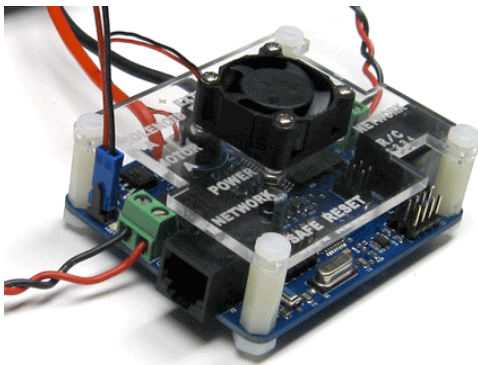


Figure 4. Connecting a solenoid.

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.

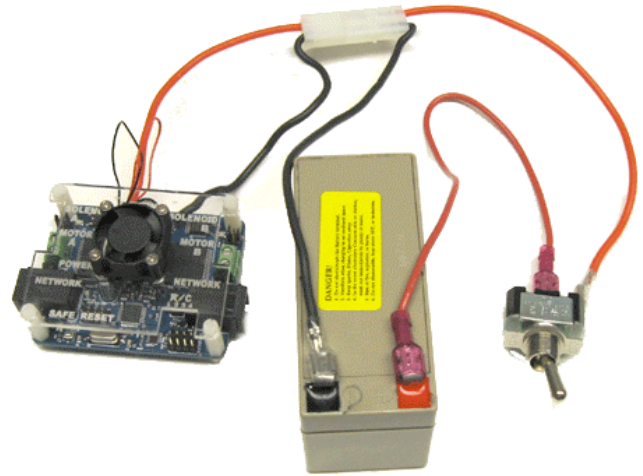


Figure 5. HCM Module with 12V battery.

HCM Modules shipped after April 2010 feature a battery eliminator circuit, which allows the motor/solenoid battery to power the HCM Module's electronics. This is particularly useful for R/C applications, which do not require the Master Module. 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.

Radio Control Mode

The HCM Module can be operated in radio control (R/C) mode, without the Master Module. In fact, R/C control is the HCM Module's default mode.

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Using this mode requires a standard R/C transmitter and receiver, like those shown in Figure 6.



Figure 6. R/C transmitter and receiver.

Connecting the R/C Receiver

Connect four output channels from the R/C receiver to the four headers marked R/C 1, 2, 3, and 4 on the HCM Module, using three-strand ribbon cables. (Even if you do not intend to use all four R/C channels, you *must* make connections to all four headers on the HCM Module in order for it to enter Safe Start mode in the next step.) Make sure you orient the cables as shown in Figure 7, with the black (ground) wire on each ribbon cable closest to the edge of the circuit board.

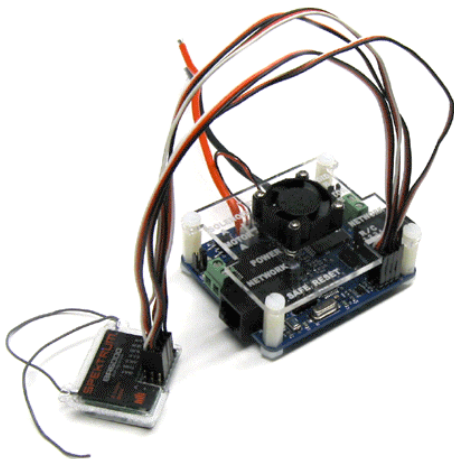


Figure 7. HCM connected to the R/C receiver.

The channels on the HCM Module are linked to the motors and solenoids, as shown in the table below.

R/C Channel	Control
1	Motor A
2	Motor B
3	Solenoid A
4	Solenoid B

There is no single correct way to connect the R/C receiver to the HCM Module. By reordering the connecting cables between the receiver and the module, you can implement "tank drive" for your robot (with the left joystick controlling the left motor, and the right joystick controlling the right motor). Alternatively, you can order the wires so that a single joystick controls both motors, while the other motor controls the solenoids. Figure 8 shows how the joysticks relate to the R/C channels on the R/C receiver (not the HCM Module).



Figure 8. Joysticks for Channels 1, 2, 3, and 4.

Using R/C Control

Once the Power LED is lit on your HCM Module, turn on the R/C transmitter. On most R/C receivers, an LED will indicate that a radio link has been established. After a few seconds, the orange Safe Start LED should light on your HCM Module, indicating that the module is ready to respond to R/C signals. The LED will light only if all four R/C headers are connected and in a neutral state, meaning that the joysticks are centered. This ensures that the initial commands from the transmitter hold the motors and solenoids still. If you do not see the Safe Start LED light after a few seconds, adjust the up-down and right-left trim adjustment levers for each joystick.

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