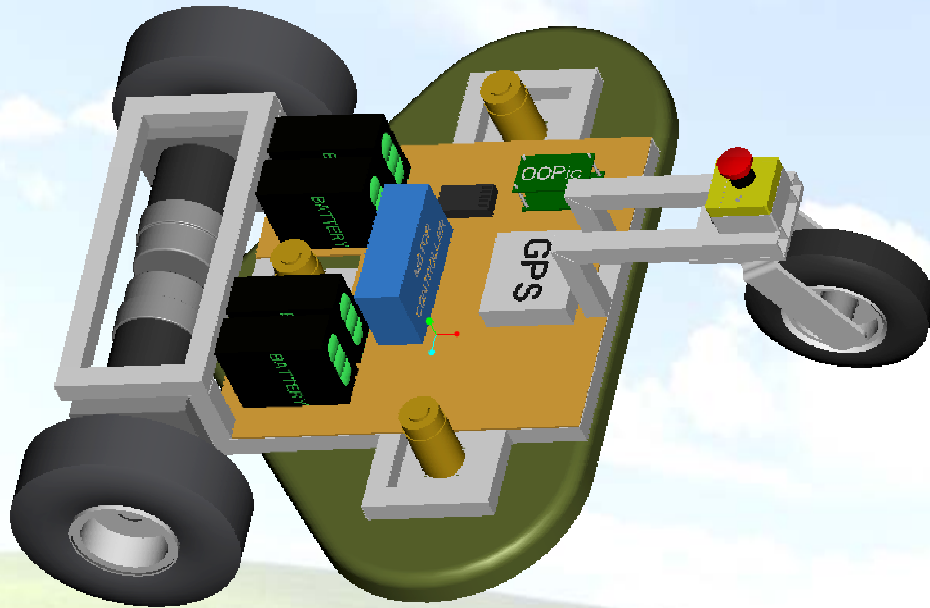


Autonomous Lawnmower

So much to mow, so little time.

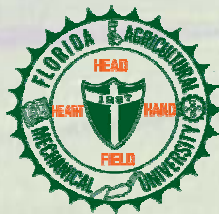
Operations Manual



April 6, 2006

Team #2

Robby Allbritton • Peter DeRoche
Alison Goodwin • Salina Songha



FAMU-FSU
College of Engineering
Fall 2005 – Spring 2006



Sponsored by:
Air Force Research Laboratory
at Eglin Air Force Base
Martin Eilders



Table of Contents

Chapter 1: IMPORTANT SAFETY INFORMATION

Chapter 2: AUTOMOW 2K6! : Getting to know your lawnmower

2.1: Familiarize yourself with the parts

Chapter 3: Charging the Batteries

3.1: Charging the batteries

3.2: Connecting batteries to lawnmower

Chapter 4: Shutting off Power

4.1 Manual kill switch

4.2 Wireless kill switch

4.3 Shutting off cutting mowers

Chapter 5: Turning on lawnmower

5.1 Turning on lawnmower

5.2 Turning on cutting mowers

5.3 Turning on the remote control

Chapter 6: Switching between manual and autonomous mode

6.1 Operating in autonomous mode

6.2 Operating in manual mode (various movements)

Chapter 7: Adjusting the position of the encoders

Chapter 8: Replacing the cutting mowers

8.1: Installing new cutting line into trimmer head

8.2 Removing entire trimmer head

Chapter 9: Installing and removing the cover

Chapter 10: Tracking with GPS

Chapter 11: Programming the autonomous lawnmower

11.1 Connecting the wires

11.2 Downloading a program

Chapter 12: Changing the direction of rotation of a 24V drive motor

Chapter 13: Testing the cutting motors without connecting to the on-board batteries

Chapter 14: Removing batteries from the chassis

Chapter 15: Trouble Shooting Guide

15.1: Troubleshooting the encoders

15.2: Troubleshooting GPS

15.3: Troubleshooting Programming

15.4 Drive wheels wobble during operation

15.5 Caster wheel does not spin freely

15.6 Caster wheel has low air pressure

15.7 Mower does not stop when bump switch is depressed

15.8 Mower will not power up

15.9 Only one drive motor operates

15.10 Battery charger will not charge a battery

15.11 Green light on OOPic will not light up

15.12 Servo switch will not operate

15.13 Excessive vibration occurs while cutter heads are spinning

15.14 Mower does not cut grass as it moves

Chapter 1: IMPORTANT SAFETY INFORMATION

- a. Read all safety information below before operating the autonomous lawnmower on your own.
- b. Follow all directions in the order in which they are listed within the manual.
- c. Heed all warnings, they are reiterated within the directions due to severity.
- d. Do not misplace safety information. Hold onto for future reference.
- e. Only operate the lawnmower outdoors in open areas.
- f. Do not ride the lawnmower.
- g. To reduce the risk of electric shock, do not remove cover.
- h. Do not operate lawnmower near large areas of water, for example pools.
- i. To prevent damage, which may result in fire or electric shock, do not expose this appliance to rain or moisture.
- j. Beware of all sharp edges.
- k. Do not stick your hands or extremities into the trimmer heads while the lawnmower is on or in motion.
- l. Do not connect a battery to a battery. It is hazardous to connect cross color wiring.
- m. Disconnect power before disconnecting/connecting any wiring.
- n. Program only when the servo is in the neutral position!
- o. Do not attempt to rewire or remove the kill switch.
- p. Maintain a distance of five feet between user and lawnmower while operating.
- q. Do not attempt to service the lawnmower on your own, seek a professional.
- r. Do not attempt to operate any machinery while intoxicated.

- s. Do not leave the lawnmower unattended when in operation.

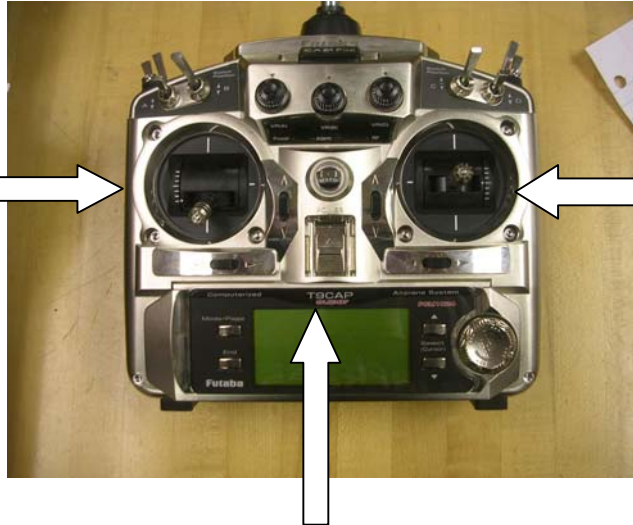
Chapter 2: AUTOMOW 2K6! : Getting to know your lawnmower

2.1: Familiarize yourself with parts

- Remote control

ROCKER SWITCH

Used to move from remote operation to autonomous and to turn lawnmower off



JOYSTICK

Used to control lawnmower when in remote control mode

POWER BUTTON

Used to turn remote control on or off

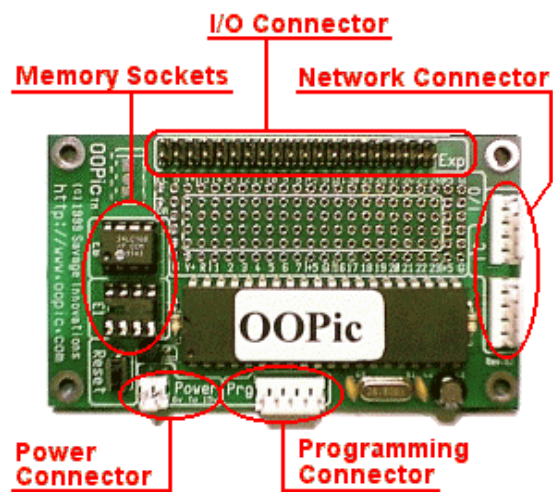
- Kill switches



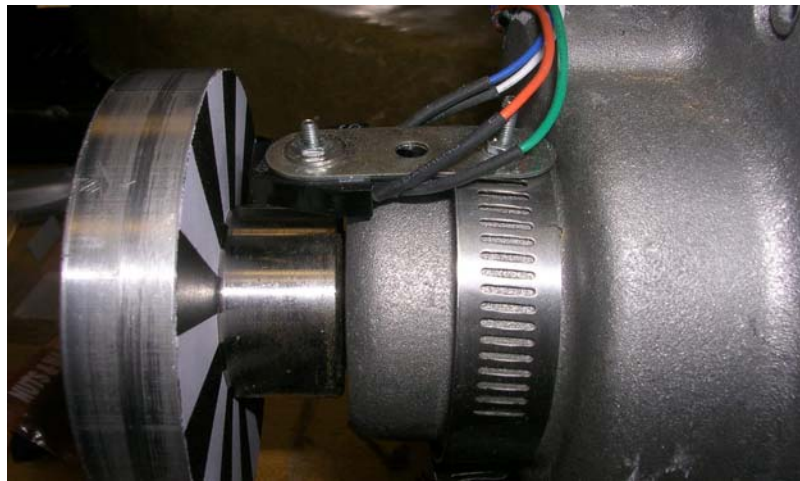
- Batteries and Charger



- OOPic II+ Microcontroller



- Encoder and wheel decal



- Remote Starter & Stopper



- A12 GPS Sensor and DS GPM Sensor and Antenna



Chapter 3: Charging the batteries

3.1: Charging the Batteries

In this chapter, you will learn how to charge the batteries prior to using the lawnmower. Follow these step-by-step instructions to charge your battery. Warning: Not idiot proof. Do not connect battery to battery by cross color wiring.



1. Disconnect power before disconnecting/connecting any wiring.
2. Clamp alligator clips to the plus V and minus V on twelve volt source. Make sure the red clip is connected to the +V and the black clip is connected to the -V.



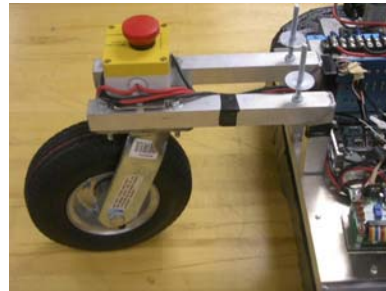
3. Plug in the battery extension cable, red and black cords, into the battery.
4. Plug in the volt source and set to twelve volts.
5. Plug in the battery cable into charger.



6. Plug the battery cable into the charger.
7. Set the charger to three amps.
8. Charger will beep when maximum voltage has been reached.
9. Disconnect battery extension cable from battery.
10. You have successfully accomplished fully charging the battery.

3.2: Connecting batteries in mower

1. Connect the power pole battery terminals to the kill switch, which can be found running on the left side underneath the mower toward the left front wheel.



Chapter 4: Shutting off power

4.1: Manual Kill Switch

In order to manually stop the lawnmower you must depress the red kill switch located at the front of the lawnmower. To restore the power pull the button as high as it will go.



4.2: Wireless Kill Switch

Press the off button on wireless remote.



4.3: Shutting off cutting mowers

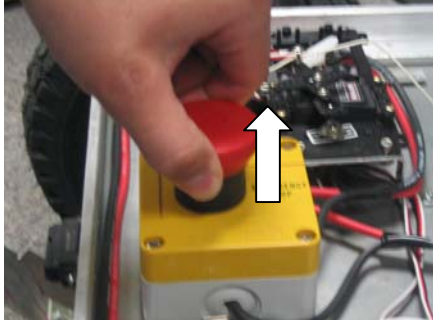
1. Turn the red kill switch key counter-clockwise. The red kill switch key is located at right side of the mower.
2. Once turned, remove key.
3. To restore power replace the key and turn clockwise.



Chapter 5: Turning on lawnmower

5.1: Turning on lawnmower

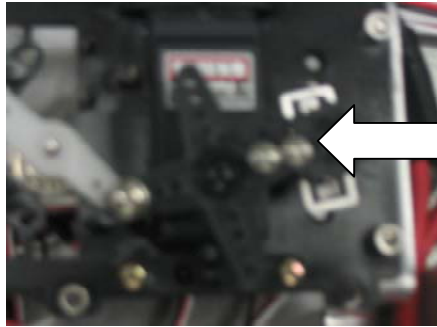
1. The emergency stop button must be up!



2. Press the “ON” button on the “ON/OFF” switch.
3. You will hear a click sound.

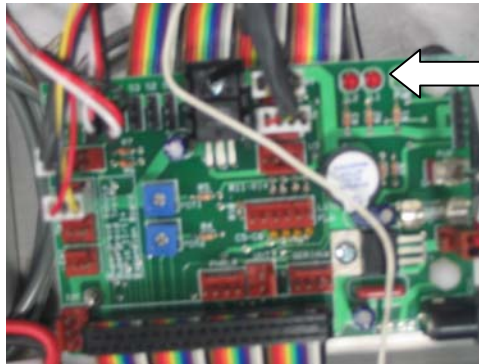


4. Verify the switch on the servo is in the neutral (middle) position.
5. Using the lawnmower in remote control mode, the servo switch needs to be in the “ON” position.



Neutral

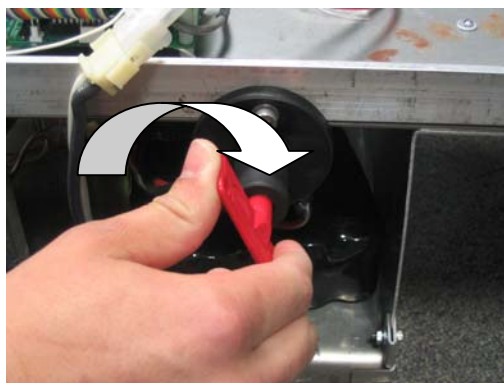
6. Switch the microprocessor on, a green light will appear.



Green light

5.2: Turning on cutting mowers

1. Turn the red kill switch key clockwise until it locks in place.
2. The trimmer will not operate unless this key is in place.



5.3: Turning on the remote control

1. Turn the remote controller power button on.
2. Stretch antenna on.



Chapter 6: Switching between manual and autonomous mode

6.1: Operating in autonomous mode

1. Power on the mower.
2. Turn on the remote control to guide the lawnmower.
3. Move left joystick to control the positioning of the servo.
4. With the position down the lawnmower is in autonomous mode.
5. When the position is up the lawnmower is in manual mode.

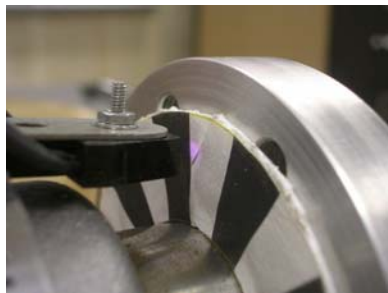
6.2: Operating in manual mode (various movements)

<i>Remote Control Movement</i>	<i>Movement of lawnmower</i>
Up	Forward
Down	Reverse
Left	Right Turn
Right	Left Turn



Chapter 7: Adjusting the position of the encoders

1. Loosen the pipe clamp.
2. Return it to desired position.
3. Adjust the distance from the encoder to the encoder wheel decal (black and white ring).
4. Adjust the sensor so that it maintains a constant distance from the wheel as the wheel spins.



Chapter 8: Replacing the cutter mowers



8.1: Installing new cutting line into trimmer head

1. Turn off the lawnmower.
2. Wait until the cutting mowers completely stop.
3. The plastic string cutters are easily detachable.
4. Simply slide in and out the plastic string trimmers from their casing in one direction.
5. Insert and pull out to desired length.

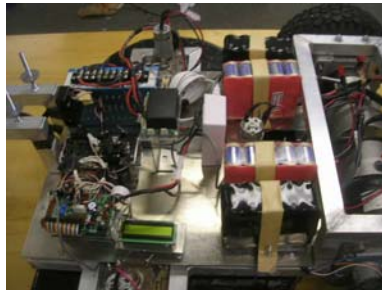
8.2: Removing entire trimmer head

1. Make sure the lawnmower is off.
2. Access the underneath of the mower.
3. Inside each trimmer head are four holes.
4. Undo the four bolts connected inside the trimmer head.
5. The trimmer head will disconnect from the deck cover.

Chapter 9: Installing and removing the cover

Here you will learn how to mount and dismount the cover of the electronics.

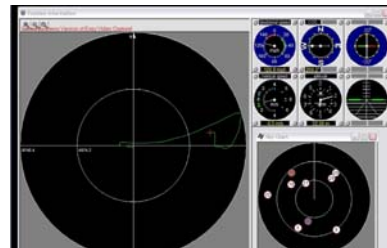
1. At all four corners of the cover are posts with bolts; over the front corners of the wheels, and in rear by the kill switch.
2. They contain washers and bolts.
3. Remove all of them.
4. The cover will come off.



Chapter 10: Tracking with the GPS



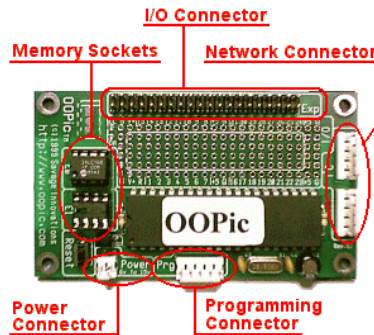
1. Make sure red light on GPS module is on.
2. If the red light is off then no power is being supplied to the GPS module.
3. If red light is on and the GPS module is not blinking then the GPS is not tracking.
4. If the red light is blinking rapidly then the GPS unit is tracking satellites while it is in motion.



Chapter 11: Programming the autonomous lawnmower

11.1: Connecting the wires

1. Connect OOPic II+ cable to programming port on OOPic II+



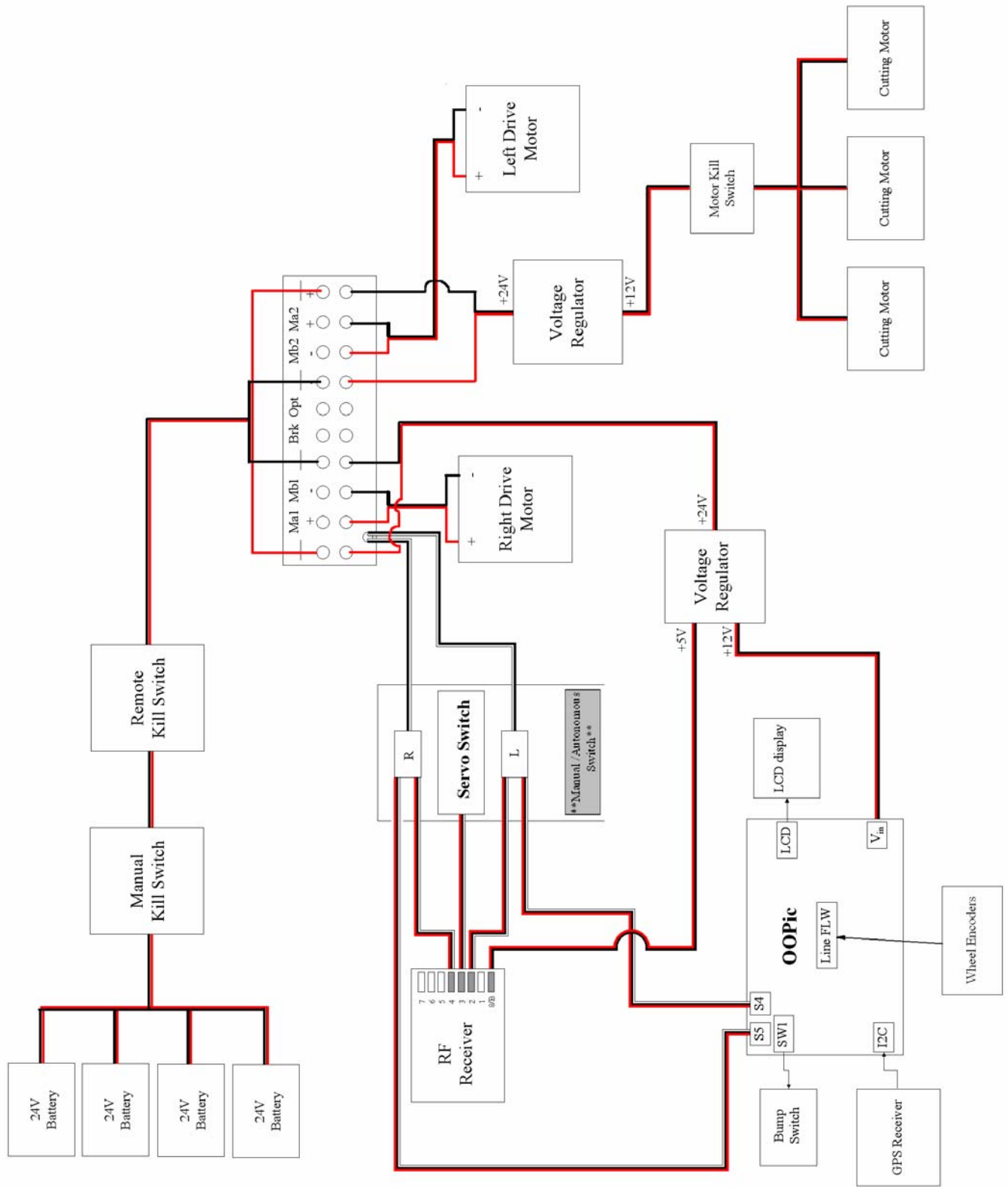
2. Connect OOPic II+ programming cable to a parallel port on CPU.



11.2: Downloading a program

1. Open your downloaded OOPic program on CPU.
2. *Use caution when downloading files for motors so that there is free space for the lawnmower to run.
3. Once opened...
 - a. If writing a new program
 - i. OOPic II+ opens blank screen
 - b. If opening a saved program,
 - i. click File → Open to browse files
 - ii. If so, file must be saved in CPU memory as “.usc”.

- iii. Press the arrow key in the toolbar or F5, the OOPic II+ will immediately begin downloading the program



Wiring Diagram

Chapter 12: Changing the direction of rotation of a 24V drive motor

1. Note the positions where the black and red lead wires are connected to the motor controller.
2. Loosen the positive and negative connections of the motor lead wires on the motor controller.
3. Remove both the red and the black leads from the motor controller.
4. Reconnect the red lead where the black lead had previously been connected and the black lead where the red lead had previously been connected.
5. Tighten the connection.
6. The motor will now rotate in the opposite direction.

Chapter 13: Testing the cutting motors without connecting to the on-board batteries

1. Turn the cutting motor kill switch key to the horizontal position and remove it.
2. Disconnect the cutting motor leads from the motor controller.
3. Connect the red lead to the V+ position on the 12V source used to charge the batteries.
4. Connect the black lead to the V- position on the 12V source.
5. Plug in the 12V source.
6. Replace the kill switch key and turn clockwise to the vertical position.
7. Motors should now be spinning.

Chapter 14: Removing batteries from the chassis

1. Loosen the screws that secures the battery strap to the electronics plate
2. Slide the battery out from under the strap

Chapter 15: Trouble Shooting Guide

15.1: Troubleshooting the encoders

1. If the encoders are not working properly check to make sure the encoders are .2 inches away from the wheel.
2. Also check to make sure the encoder decals are clean and free of dirt or stains. Check that encoder sensors are about 0.2" from encoder wheel decal.
3. Check the wiring connections.
4. Check the program for errors.

15.2: Troubleshooting GPS

1. Make sure that the GPS's view of the sky is not being obstructed, i.e. by a wall or because you're inside a building.

15.3: Troubleshooting Programming

1. If program is not downloading correctly check for errors.
2. Check under Tools → target device→ that version OOPic FirmwareVerB.2.x+ is checked.
3. Make sure the correct programming language you're using is selected.
 - a. Tools → Language → Select your language, Basic or Java or C.
4. Make sure all components are properly attached via the wiring diagram.
5. Ensure the program is properly downloaded without error.
6. If all wires are properly connected and the program is properly downloaded try restarting.

15.4 Drive wheels wobble during operation

1. Tighten bolts connecting wheel hub to the bolt plate.
2. Tighten bolts connecting the bolt plate to the drive motor.

15.5 Caster wheel does not spin freely

1. Ensure there is nothing hindering the rotation (i.e. string, or grass clippings, etc.)
2. Lubricate the axel.

15.6 Caster wheel has low air pressure

1. Check for leaks in the tire.
2. If there are no leaks, fill with air to the desired firmness.
3. If leaks are found, patch them or replace the tire.

15.7 Mower does not stop when bump switch is depressed

1. Check for damage to the switch.
2. Check for debris hindering the operation of the switch.
3. Check the program for errors

15.8 Mower will not power up

1. Charge the batteries.
2. Check wiring connections.
3. Check that kill switches are not activated.
4. Check for continuity through electrical components.

15.9 Only one drive motor operates

1. Check that servo switches are in the correct position for the desired mode of operation. Switches should always be in opposite positions.
2. Check wiring connections.

3. Check the program for errors.

15.10 Battery charger will not charge a battery

1. Check that the voltage of the battery is greater than 3 volts. NOTE: The charger will not recognize the battery if its voltage is less than 3 volts.
2. Check that the 12V source is plugged in.
3. Check that the charger is connected properly to the 12V source.
4. Check for damage to the charger.
5. Check for damage to the battery connectors.

15.11 Green light on OOPic will not light up

1. Allow the OOPic to cool down if it has been exposed to direct sunlight or heat for too long.
2. Check the wiring connections.
3. Charge the batteries.
4. Check that the voltage regulator is not damaged.

15.12 Servo switch will not operate

1. Check the wiring connections.
2. Check that voltage regulator is not damaged.
3. Check that the remote controller is turned on.
4. Check that the frequency crystal in the RF receiver matches the frequency crystal in the remote controller.

15.13 Excessive vibration occurs while cutter heads are spinning

1. Check that proper shaft alignment.
2. Check that no foreign object is stuck to the cutter heads.

3. Check that the four pieces of cutting line are of equal length on each cutter head.
4. Check for damage to the cutter heads.
5. Tighten the screws that secure the cutter head to the bolt plate.

15.14 Mower does not cut grass as it moves

1. Check that the grass is tall enough to be cut by the cutter heads.
2. Adjust the cutter heads to a height lower than the tops of the blades of grass.
3. Check that the cutting line has not been damaged.
4. Check that the cutting motors are operating correctly.