The radio subsystem of the robot provides the control link between a human operator and the robot. Commands are issued through a pair of joysticks and buttons on the Radio Transmitter, and sent via radio signal to the Radio Receiver on the robot. In this way, the robot can be controlled via a combination of manual and autonomous methods.

radio

squarebot radio subsystem parts & assembly

The Radio Subsystem provides the link between the robot and the human operator. Commands are entered through the joysticks and buttons on the Radio Transmitter, and sent through the air via FM radio waves to the Radio Receiver mounted on the robot.
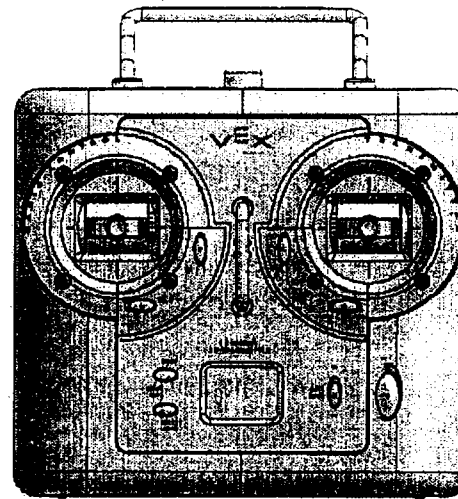
1 Collect and identify the parts from the list of materials below:

materials	qty
radio transmitter	1
transmitter antenna	1
radio receiver	1
receiver crystal (75MHz)	1
8-32 hex screw, ¼"	4
keps nut	4

Refer to full-size illustrations of all of the components on the following page

squarebot radio subsystem parts & assembly, continued
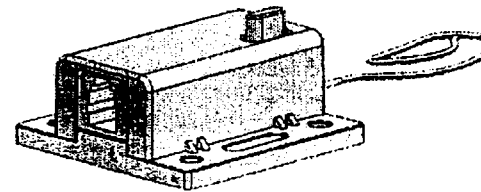
transmitter x 1

transmitter antenna x 1

50% of actual size

50% of actual size

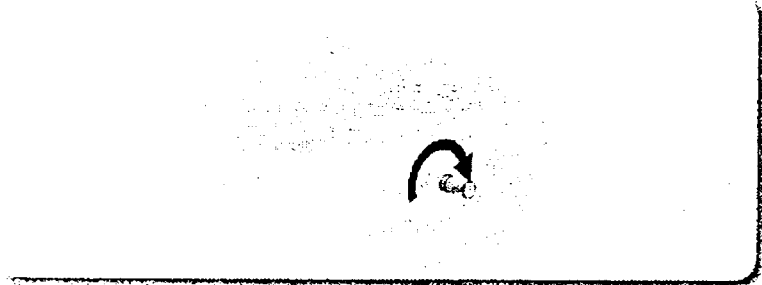receiver x 1

8-32 hex screw, ¼" x 4

keps nut x 4

Actual size

squarebot radio subsystem parts & assembly, continued

2 Attach the antenna to the Transmitter:

Insert the antenna into the hole on the top of the Transmitter body. There is a screw inside the Transmitter housing (at the bottom of the hole), and a threaded screw hole at the base of the antenna. Push the antenna in until you feel the antenna come into contact with the screw, then start twisting the base of the antenna clockwise until it is firmly locked in position. Twist only the bottom most segment of the antenna, as the others will spin freely and not actually screw the antenna in properly.

squarebot radio subsystem parts & assembly, continued

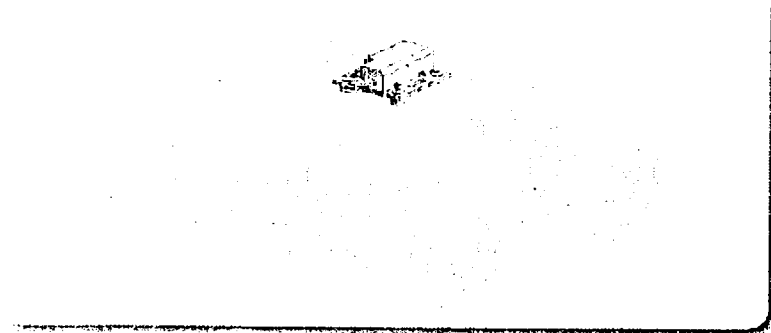**3 Attach the Radio Receiver Module to the robot:**

Position the receiver module on top of the the SquareBot deck, and secure it with four ¾" screws and keps nuts.
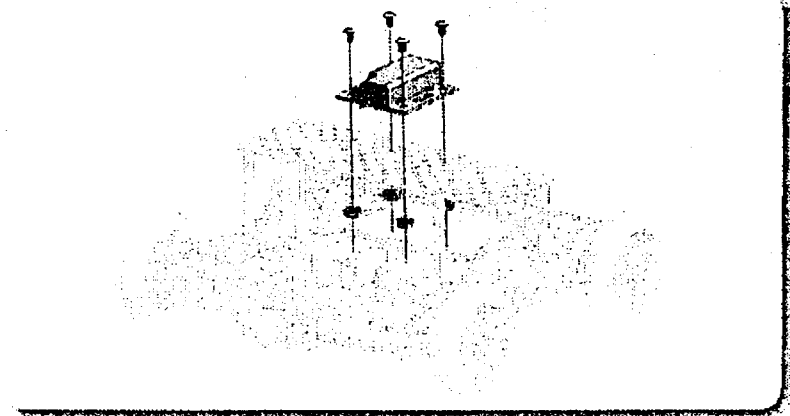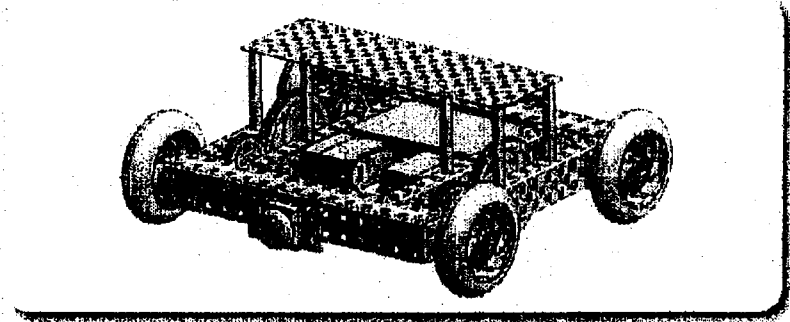
squarebot radio subsystem parts & assembly, continued

3 For receiver assembly, continued:

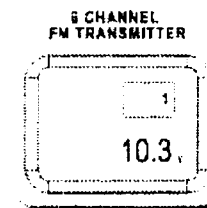The installed receiver module should look like this:

radio subsystem

Basic Controller Operation

The Radio Transmitter joysticks can be configured to work in two basic configurations. To check or switch between configurations, follow these instructions:

1. Turn on the Transmitter by pushing the power switch to the ON position.

6 CHANNEL FM TRANSMITTER

1

10.3

2. Enter the menu on the transmitter by holding down both the Mode and Select buttons next to the LCD until the menu opens.

6 CHANNEL FM TRANSMITTER

CONFIG

1
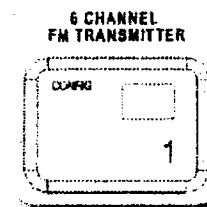
3. Enter "DRIV" mode by pressing the Mode button until DRIV is displayed on the left side (it's the last mode).

6 CHANNEL FM TRANSMITTER

DRIVE 23
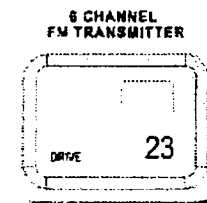
4. The current driving mode is displayed. This will be either "23" or "12". Press either the + or – on the data input button on the right side of the LCD to switch between these two modes. The two modes are explained on the following pages.

6 CHANNEL FM TRANSMITTER

DRIVE 12
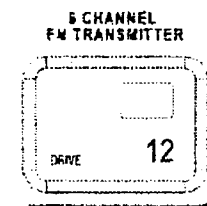
radio subsystem, continued

Configuration 1:
Tank-style control ("23" mode – default)

Note: Make sure there are no jumper clips on Analog/Digital Ports 13, 14, 15, or 16 on the Robot Controller, otherwise your robot's controls will behave differently from what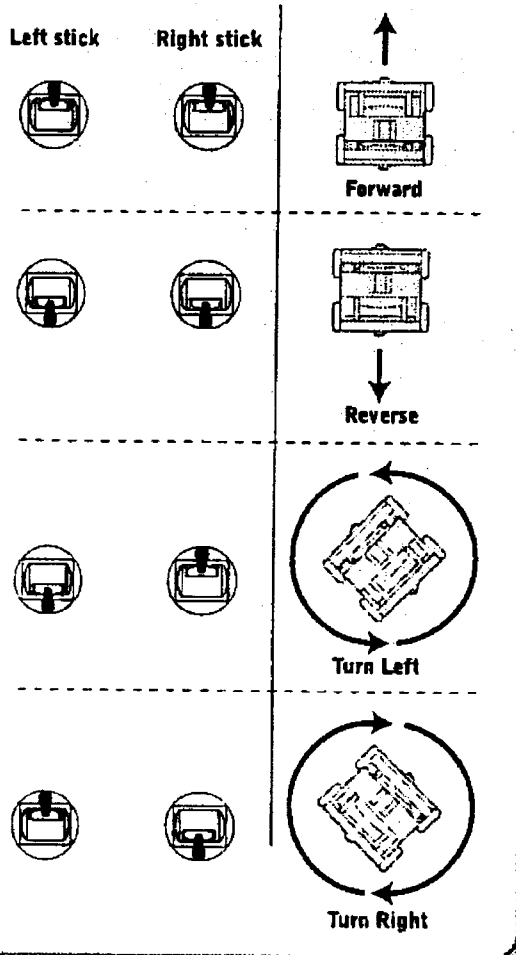 is listed here in this section. For details on how to use these jumpers to configure advanced control features, visit the Logic and Control Subsystem chapter.

This control configuration uses the vertical axes of both sticks to control the two motors independently. The name "23 mode" comes from the fact that the vertical axis of the right stick is "Control Channel 2", and the vertical axis of the left stick is "Control Channel 3", hence axes 2 and 3 ("23") are being used to drive.

In this configuration, the left stick controls the motor attached to Motor Port 3, and the right stick controls the motor attached to Motor Port 2.

Warning: Always make sure the transmitter is turned on and functioning before turning on the robot! If the transmitter is not on when the receiver is activated, the receiver may accidentally interpret other radio waves in the air as commands and cause the robot to move unexpectedly!

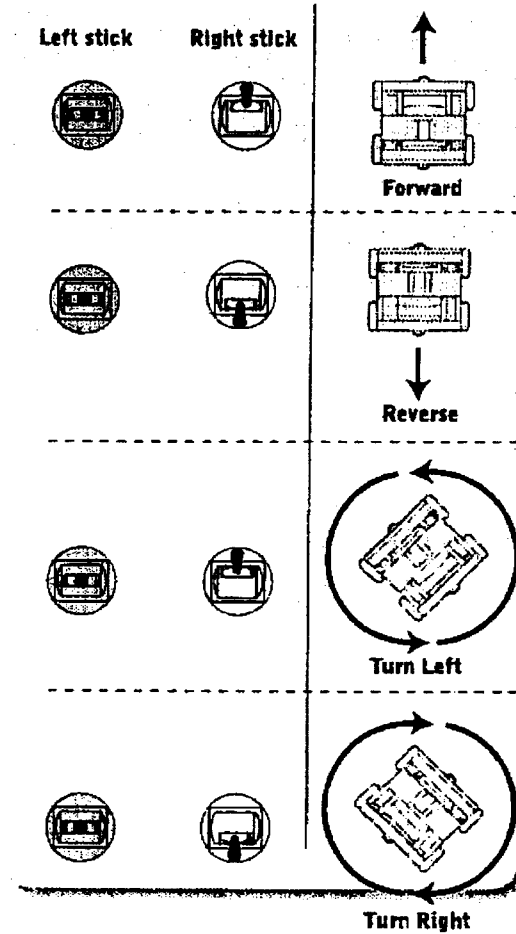| Left stick	Right stick	
		Forward
		Reverse
		Turn Left
		Turn Right

---

radio subsystem, continued

Configuration 2:
Arcade-style control ("12" mode)

Note: Make sure there are no jumper clips on Analog/Digital Ports 13, 14, 15, or 16 on the Robot Controller, otherwise your robot's controls will behave differently from what is listed here in this section. For details on how to use these jumpers to configure advanced control features, visit the Logic and Control Subsystem chapter.

This control configuration uses only the right joystick to control both forward/back motion and turning motion. The name "12 mode" comes from the fact that the horizontal axis of the right stick is "Control Channel 1", and the vertical axis is "Control Channel 2", hence axes 1 and 2 ("12") are being used to drive.

In this configuration, the right stick controls both throttle and turning.

Left stick	Right stick	
		Forward
		Reverse
		Turn Left
		Turn Right

Controller Trim

Channel 3
(Y-axis)

Channel 2
(Y-axis)

Channel 4
(X-axis)

Channel 1
(X-axis)

Channel 3
trim
button

Channel 2
trim
button

Channel 4
trim
button

Channel 1
trim
button
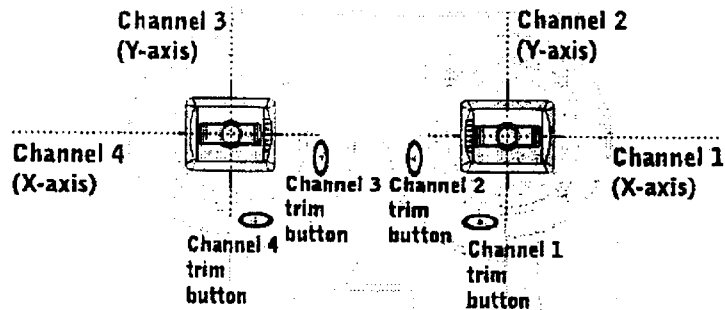
Because the sticks on the transmitter are analog electromechanical devices that operate directly on circuit voltage, there is the distinct possibility that the sticks will become miscalibrated. This happens when the sticks start delivering different voltages than what the controller expects for a given position.

In order to counteract this problem, there are manual adjustment buttons on the transmitter that allow you to recalibrate or "recenter" the controller. These can be adjusted so that the voltages match up correctly again on the stick.

Note that each stick's position actually breaks down into two separate measurements. One of them indicates how far left and right the stick is (the horizontal, or "X", axis), and the other measures where it is with respect to the vertical, or "Y", axis. These four axes (two axes times two sticks) can become miscalibrated separately, so you may need to adjust each of them independently.

Conveniently, each axis is assigned a number (which corresponds with the "control channel" that it works on), so there should be no confusion between about which axis or stick is which.
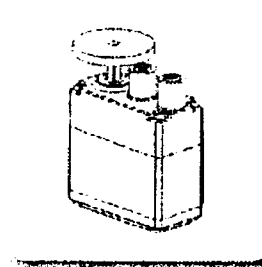
Controller Trim, continued

To calibrate the sticks:

1. Release both control sticks so they return to their neutral positions.

2. Hold the robot (or just the motors, if they are not mounted) up in the air so you can see whether the motors are turning or not, and whether the servomotors are in the centered positions or not.

3. If you see a motor turning or a servomotor not centered, follow the wire back to the Robot Controller to see which port it is plugged into.
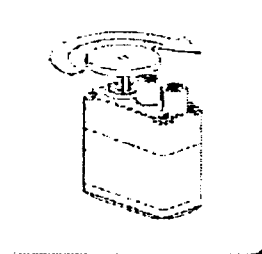
4. Consult the Joystick Mappings section to see which controller axis controls that particular port (this will depend on the Driving mode you are in).

5. Push either direction on the Trim Button for that axis to try and correct the problem.
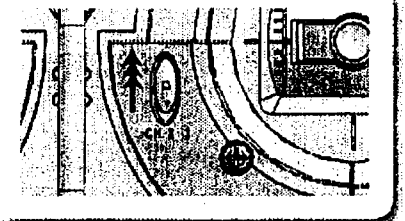
6. Check if the motors slowed down or got closer to center. If they did, then keep pushing the button in that direction until they are stopped/centered; if they get faster or farther from center, push the other way on the trim button instead.

7. If you cannot get the motors to stop because the "stop" position seems to be in between two trim settings, finer adjustments are available. Go into the menu (hold both the Select and Mode buttons for one second), and adjust the appropriate channel from the TRIM menu (push Mode until TRIM is displayed, then Select until the channel you want is displayed, then use the Data Input lever on the right to make adjustments).
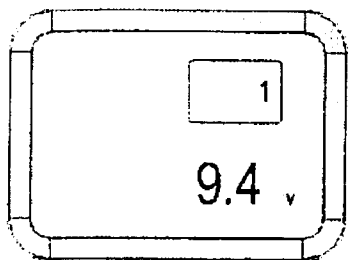
6 CHANNEL FM TRANSMITTER

CH   1

TRIM   ↕   0
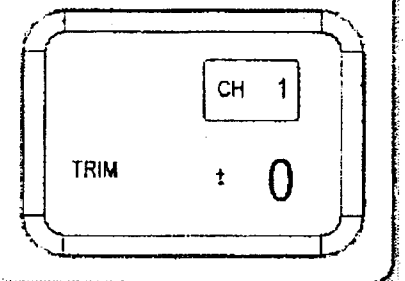
Transmitter Battery Voltage

```
      6 CHANNEL
    FM TRANSMITTER

            1


        9.4 v
```

In normal operation, the transmitter displays two numbers on the LCD screen: the configuration number (see Appendix G), and the battery voltage on the transmitter. Note that this screen only displays the battery power left on the transmitter, and not the robot! There is no way to monitor the robot's battery voltage using this display, so you will need to watch separately for problems arising from low robot battery power.

The transmitter's power begins to decrease at approximately 9.4V on the display. If you are at 9.4V or less, consider stopping and recharging the transmitter batteries. If the voltage reaches 8.9V, you have about 10 minutes left before you hit low voltage, so you should stop if possible. The transmitter hits low voltage at 8.5V on the display. At this point, you will hear a beeping sound, a low battery indicator will appear, and performance will begin to degrade significantly. You should stop and recharge the batteries at this point.

Note that if you continue to run the battery down to a very low voltage, you risk damage to the battery pack (or rechargeable AA cells). See the Power Subsystem Background Information for details.

|	
9.4V	Batteries somewhat low. You will need to stop soon.
8.9V	Batteries very low (10 minutes or less remaining), stop unless absolutely necessary.
8.5V (Low battery indicator comes on, controller sounds warning beep)	Batteries depleted. Stop now.

Stick Mode

Stick Mode configuration is accessed differently from the other menus. To access this mode, you must hold down Mode and Select while turning the controller on, rather than pressing them once it is already on.

The only option you can change is the Stick Mode, between "2" and "1". 2 is the default, and you should leave it this way unless you have a specific reason for changing it. Setting the Stick Mode to 1 will swap axes 2 and 3, so the vertical axis of the left stick becomes channel 2, and the vertical axis of the right stick becomes channel 3. Unless you have a good reason to change this, you should leave the Stick Mode on 2.

- -

Tether Port

Sometimes for diagnostic purposes, it may be useful to plug the transmitter directly into the robot controller, and eliminate the need for the Radio Receiver and radio wave transmission. This would help you determine, for instance, whether radio interference is at fault for your robot behaving strangely, or if some other factor is to blame.

In order to use the tether feature, you will need to purchase a cable. Any telephone handset extension cable should work (the cable that goes from the handset to the base of a corded phone, not the cable that goes from the phone to the wall).
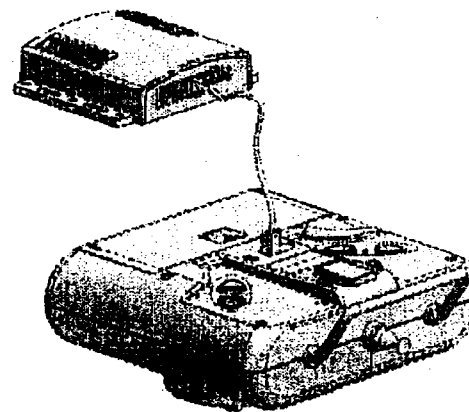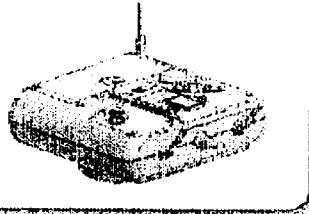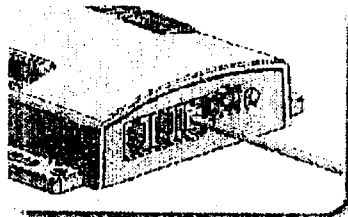
radio subsystem, continued

Tether Port, continued
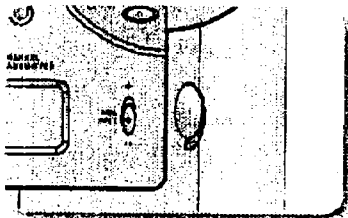
To use the tether feature:

1. Hook up one end of the cable to the back of your Radio Transmitter, in the port marked "Tether Port".
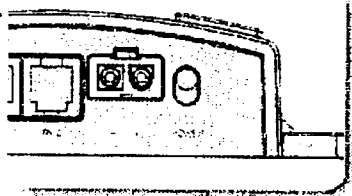
2. Plug the other end directly into the Rx1 port of your Robot Controller.

3. Turn the Transmitter on by pushing the power switch on the Transmitter to the ON position.

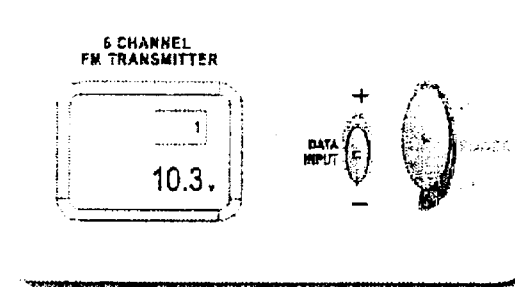4. Turn the Robot Controller on by flipping the power switch on the Robot Controller to the ON position.

5. Test your robot. The controls should operate exactly as they would remotely over radio, but without the possibility of radio interference or other similar issues.

radio subsystem, continued

Tips

Always turn the Transmitter on before powering up the robot. If the transmitter is not on when the receiver is activated, the receiver may accidentally interpret other radio waves in the air as commands and cause the robot to move unexpectedly!

```
      6 CHANNEL
    FM TRANSMITTER
                              +
          1                 DATA
                            INPUT
        10.3.                 −
```

Radio waves radiate out from the sides of the transmitter antenna, not from the tip. For this reason, you will get the best range and performance from your transmitter if you don't point it directly at your robot.
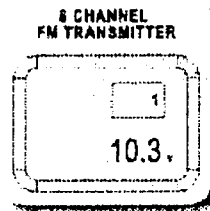
radio subsystem, continued

Tips, continued

If you accidentally change a setting on your controller that you didn't want to change, you can reset the controls through the CONFIG menu.

1. Turn the transmitter on by pushing the power switch into the ON position.

8 CHANNEL
FM TRANSMITTER

1

10.3,

2. Hold down the Mode and Select buttons for two seconds until the menu appears. CONFIG should be selected by default.

8 CHANNEL
FM TRANSMITTER

CONFIG

1
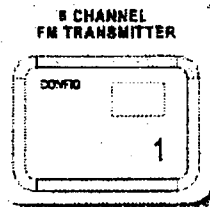
3. If you wish to reset the data for a different robot configuration, press the + button on the Data Input button until the configuration number you want is displayed. If you are not using multiple configurations (see Appendix G), then ignore this step.

8 CHANNEL
FM TRANSMITTER

CONFIG

1
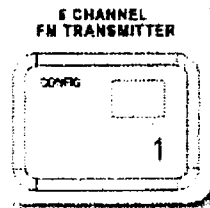
4. Press the Select button. The letters CL (for "clear") should appear.

8 CHANNEL
FM TRANSMITTER

CONFIG   1

CL
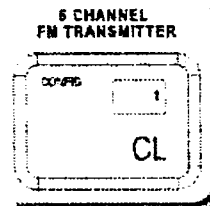
5. Hold either the + or − on the Data Input button for 2 seconds to reset the controls for the selected config number. The Transmitter will beep when the configuration is reset.

---

radio subsystem, continued

Tips, continued

Remember that the transmitter does not monitor robot battery voltage, only its own transmitter battery. Watch the robot to see if it seems to be low on power.

If more than one robot is operating in the same area, be sure that the robots are operating on different frequencies or their commands will interfere with each other (see Frequency Crystals in Background Information in this chapter).

If you own more than one set of frequency crystals, be sure that the crystal in your transmitter matches the crystal in your receiver (see Frequency Crystals in Background Information in this chapter).

When electrons accelerate, they radiate an electromagnetic signal that moves at the speed of light. By accelerating and decelerating electrons in a controlled pattern, a wave pattern can be generated in the radiated electromagnetic field. These are called electromagnetic waves. Electromagnetic waves move at the speed of light, and are therefore very good at carrying information quickly from one place to another.
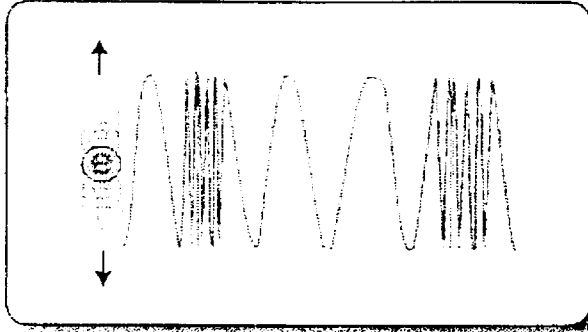
Frequency-Modulated Signals

The Vex Radio Transmitter uses an electromagnetic wave with a certain frequency to transmit data to the radio control receiver. Frequency modulation (FM) is a way of encoding information in wave patterns such as these.

Waves have several basic properties, including amplitude and frequency. In frequency modulation, the frequency of the basic ("carrier") wave is modified by combining it with another ("signal", or "modulating") wave, producing a final wave that looks irregular, but is really carrying the data from the signal wave on top of the carrier wave.
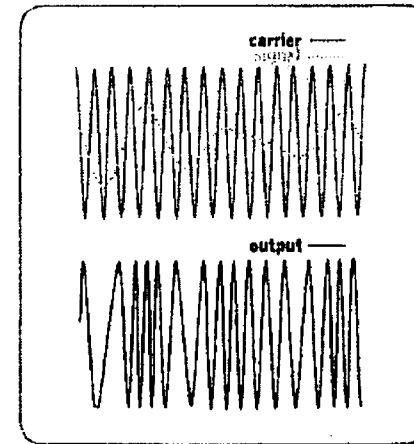
FM is less susceptible to interference than other methods, such as amplitude modulation (AM) or direct transmission of the signal wave.

carrier ——
signal ·······

output ——

The FCC Wants You to Know

This equipment has been tested and found to comply with the limits for radio controlled devices, pursuant to Part 15 and Part 95 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Consult your local electronics store or an experienced radio/TV technician for help.
- If you cannot eliminate the interference, the FCC requires that you stop using your R/C transmitter.

Warning: Changes or modifications note expressly approved by Innovation One may cause interference and void the user's authority to operate the equipment. Only use authorized crystals designed for use with the Vex Robotics Design System RF Receiver.

Important: The EPA certified RBRC® Battery Recycling Seal on the nickel-cadmium (Ni-Cd) battery indicates Innovation One voluntarily participates in an industry program that collects and recycles NiCd batteries at the end of their useful life, when taken out of service in the United States or Canada. The RBRC program provides a convenient alternative to placing used Ni-Cd batteries into the trash or the municipal waste stream, which may be illegal in your area. Please call 1-800-8-battery for information on Ni-Cd battery recycling and disposal bans/restrictions in your area. Innovation One's involvement in this program is part of the company's commitment to preserving our environment and conserving our natural resources.

Limited 90-day Warranty

This product is warranted by Innovation One against manufacturing defects in material and workmanship under normal use for ninety (90) days from the date of purchase from authorized Innovation One dealers. For complete warranty details and exclusions, check with your dealer.

Innovation One, Inc.
350 North Henderson Street
Fort Worth, TX 76102

11/04

Printed in China

The actual product may vary from images depicted in this Inventor's Guide.

Inventor's Guide

1/19/05 4:08:04 PM

Job #	G_05_00050	Bleed:	(0 in, 0 in, 0 in, 0 in)	Print Scale:	100	Links	Inks
Filename	Master TOC color_r1.indd	Trim:	(8.5 in, 11 in)	Date:	1/19/05 4:08 PM	VEX_1C_K_sm.eps, RBRC_icon_bw [Converted].eps	■ Process Black ■ Process Magenta Process Yellow ■ Process Cyan
Technician:	whurst1-42125	Live:					