

Radio Control: the ABCs of R/C

One of the most interesting electronics-related hobbies is radio-controlled model building and operating. Whether it's a model airplane, boat or car, there's nothing quite like being able to control its movements with a mere touch of a control box lever. Here's a rundown of what's what in the exciting world of R/C.

by Timothy J. and George Myers



Although some R/C units are designed exclusively for use with just one kind of model, most can be used for controlling planes, boats and cars. And since the receiver can be moved from model to model, a single transmitter-receiver set can be used to control scores of different models.

Radio-controlled models are expensive, complicated and difficult to operate, right? *Wrong!!* You can operate boats, cars, tanks, trucks, hovercraft and airplanes with two-channel R/C systems that cost less than \$100. Since the radio can be moved from one model to another with little difficulty, the first cost is the big one and \$150 will get you into operation. The next model can cost less than \$25.

Since this is an electronics magazine, let's start with the electronics. All R/C systems have the same functional elements, as shown in Figure 1, so let's take a superficial look at their properties.

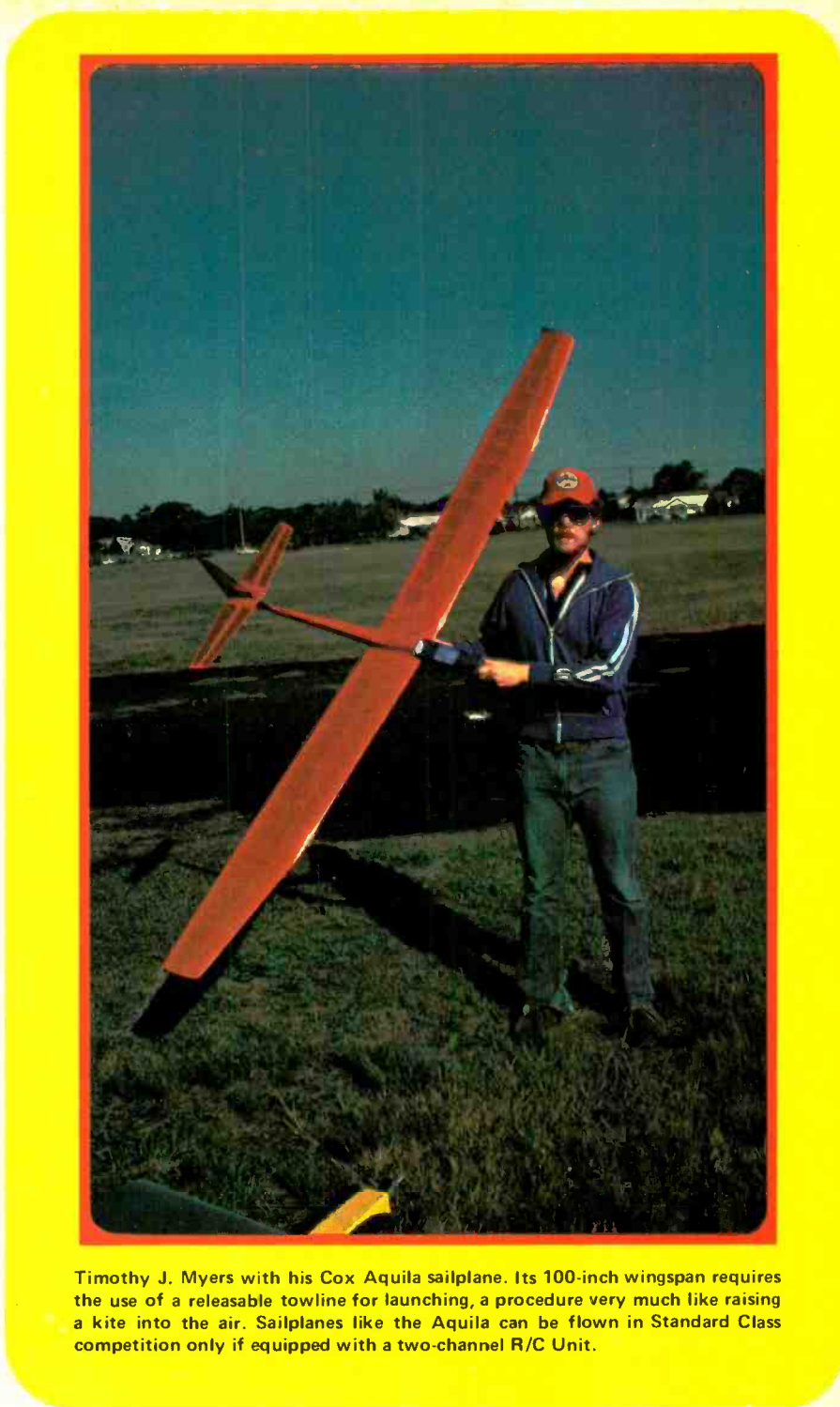
■ **Transmitter**—this is a crystal-controlled oscillator, keyed On and Off by a modulator connected to the control levers. Since we are speaking exclusively of two-channel systems in this article, there will be either two control levers, or a single lever that operates left and right in one control function, and up and down in the other. The unit contains batteries for power, an on/off switch, some kind of rf output meter, and a whip antenna about 1 meter long. It weighs about a pound and a half.

The output power depends on the frequency. Units operating in the Citizens Band (27MHz), are restricted to 5 watts maximum power. Ham operators in the 6-meter band can use up to 1000 watts, but few ever use more than 5 watts. Units operating in the 72 to 75 MHz portion of the Personal Radio Service are restricted to $\frac{3}{4}$ watts. You will need a Class C Citizens Radio Service License to legally operate a transmitter in the 27 MHz and 72 MHz band. You can get yours by simply filling in a Form 505 and mailing it to the Federal Communications Commission, Gettysburg, PA, 17326. If you are over 12 years of age the license will be received in the return mail in 4 to 6 weeks. A Technicians license is required to operate in the 6-meter (50-54 MHz) ham band.

■ **Receiver**—this is your basic battery-powered, crystal-controlled superheterodyne receiver, combined with a demodulator to separate the control signals out to the two servos.

■ **Servo**—the servo is the muscle for the system. Two servos will be provided with a two-channel system. Each servo contains a tiny dc electric motor, gears to increase the motor torque, a position-sensing potentiometer, and an error-signal amplifier. The function of all these parts is to make it possible for the output arm position to follow the position of the control levers on the transmitter.

■ **Batteries**—R/C systems will be provided with either of two types of batteries: alkaline dry cells, or rechargeable nickel-cadmium cells. The cheapest systems are cheap because they require dry cells, but none are provided. Addition of nickel-cadmium batteries, with a match-



Timothy J. Myers with his Cox Aquila sailplane. Its 100-inch wingspan requires the use of a releasable towline for launching, a procedure very much like raising a kite into the air. Sailplanes like the Aquila can be flown in Standard Class competition only if equipped with a two-channel R/C Unit.

ing charger, increases system cost by \$40 to \$60. This looks like a lot of money only until you buy the third or fourth set of dry cells at about \$7.50 a set. You decide what your pocket can manage.

Building your own

Most electronics like to build their own equipment. The catalogs and magazines listed in the following charts will point you toward many manufacturers that offer kits and components for R/C. Complete systems in kit form are offered by ACE R/C Inc., Charlies R/C Goodies,

the Heath Company, and Royal Electronics Inc. We've built many of these systems and have always found that they work as well as the guy who built them. If you can read English, follow instructions, and know which end of the soldering iron is cool, you can do it!

Now that you've built your R/C system, what can you do with it? If your model is a tank, car, truck, hovercraft, sailboat or powerboat, you can steer it right and left, and make it go fast and slow, forward, stop and reverse. If you have built an airplane, you can command it to pitch nose up and nose down,

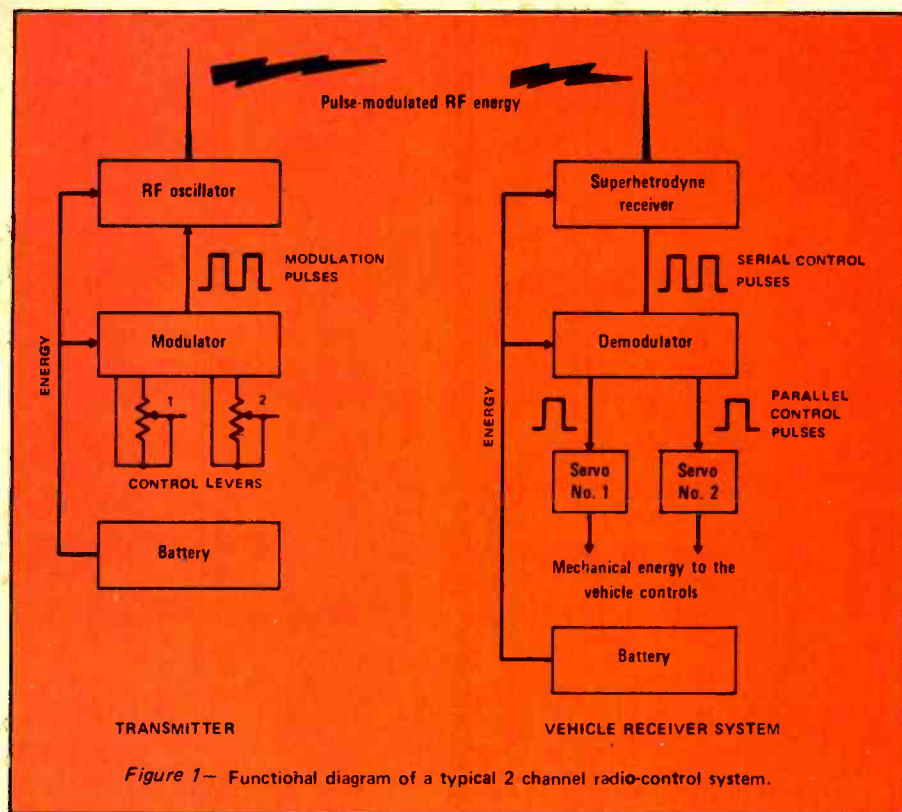


Figure 1— Functional diagram of a typical 2 channel radio-control system.

and roll left and right. With these two control functions, you can make the models do just about anything that the full-scale vehicles do.

Assuming that you want to teach yourself, the simplest model to begin with is an R/C tank. It will introduce you to the fact that when the model turns from "going away" to "coming back" left and right seem to be exchanged! This is no small mental obstacle to overcome.

With a tank, any time you get confused you can just shut down the motor and wait for your nerves to settle down. Then you can think through the problem, and learn to overcome it.

A good way to look at the situation is to imagine that you are always steering the far side of the vehicle. Going away, that's quite natural. You move the lever to the right and the vehicle goes right. Coming back, you move the stick to the right and the vehicle goes to its right, which is your left! To get back on track push the control lever the way that you want the far side to go. Now, when you want the vehicle to go to your right, you will automatically push the control lever to the left, which is correct.

The next level of difficulty is the motor-car. Everything works the same way as on the tank, but faster. You'll rapidly learn that you must have a planned course in mind before setting the vehicle in motion. There won't be enough time to simply see what the car is doing, then react to correct it.

Model car racing is a highly-organized matter in some parts of the country, with regularly-scheduled competitions. Peo-

ple come from miles around to race against one another, and the clock, on race courses that simulate drag-strips, the Indy 500, Road America and other well-known tracks.

Sail boats too

Perhaps you want more of a challenge, but not that much. You might try R/C sailboating. "Stop" only has relative meaning to a sailboat! Winds, tides and currents keep moving, so you'll have to learn to coordinate your control inputs with Mother Nature's inputs and to anticipate the result. From outside, sailboats look graceful and slow, but any skipper will tell you that they provide their share of sweaty palm experiences. Sailboats are raced in competition, just like cars.

The logical progression from sailboats is to power-boats—for some people. Power-boats go faster, which gives them some advantage over Mother Nature, but the speed introduces its own problems. Races are regularly scheduled all over the country, during the warm months.

At this point we should stop and point out that servos come in a wide variety of shapes and sizes. The reason is that control forces are different in the various applications. The sail control winch on a model sailboat doesn't have to move very fast, but it has to hold against some pretty strong wind forces, and it has to take up a lot of rope to change the set of the sails from close-hauled to free-running. Special servos are available from many of the listed manufacturers, but you might want to start with an RS

Systems Inc. catalog, if sailing is your interest.

Power-boats need a very powerful servo to control the rudder. The KPS-16H servo from Kraft Systems Inc. is widely regarded as one of the best for this purpose. It also serves well as the steering servo for model racing cars. Some applications require very tiny servos, and the Kraft KPS-18, the Cannon Micro, and the Futaba S-20 are among the smallest available.

You should consider the uses planned for your R/C system when ordering its complement of servos. Some manufacturers use 2-channel systems as low-priced attention-getters, and therefore allow you no options. When you contact the manufacturers tell them that George & Tin Myers referred you to them in the pages of Modern Electronics. They like to know things like that, and it helps us to get their cooperation when we are seeking information for articles like this. Don't forget, now!

Wild blue yonder

Ultimately, you'll have trained your eye-hand coordination to deal with left/right reversals, and trained yourself to plan ahead and to anticipate the disturbances of Mother Nature. Then you'll be ready to try model airplanes. Flying requires continuous attention and continuous motion. Instead of thinking "stop," you must think "prepare to go there next". Planning has to become all-important. You don't want it said of you that "He was so far behind the airplane that he didn't get to the accident until the dust had settled!"

Two controls are sufficient to guide all types of models from a ready-to-fly—radio supplied and installed—trainer to the monster build-it-from-a-kit sailplane. Two-channel R/C systems, by the way, are the only type allowed for a class of racing called $\frac{1}{2}$ a pylon. It's extremely popular all over the United States.

The reason for the popularity of this class of racing is that the airplanes are cheap, durable and flyable by novices. The Aquila sailplane is also a member of the two-channel fraternity, and standard class sailplane competitions, restricted to two-channel control, are very popular wherever sailplanes are flown. The Aquila usually wins, and is the current World Record holder in its class. Flights of over an hour duration are fairly common with this model.

The engine in the Cox Centurian trainer is not controlled. You start the engine, launch the airplane, and fly it until the engine is out of fuel and has stopped. Then you have a glider! It takes a little planning to be in a good part of the sky from which to make your approach and landing. That's why I said that you have to think "go there next" at all times.



Les Shine launches his Cox Q-Tee airplane with one hand while maintaining radio control with the other. The plane is highly maneuverable, permitting its use in relatively small areas.

At this point, we should have convinced you that you really can get into R/C with less than a \$200 investment, and that you won't be buying a useless inferior product when you do it. So now is the time to talk about prices. We have been quoting list prices.

Is paying list price justified, when we all know that discounts are available?

Well, this is how we rationalize the situation. If you buy from a dealer who maintains a stock of spare parts, and who is willing to take the time to explain things and advise you when you are ready to make a purchase, then payment of list price is justified. On the other hand, if the dealer is simply handing sealed boxes over the counter, and will send you through the mail to the manufacturer for anything from a single screw to a complete set of batteries, then a discount is justified. If the service falls someplace in between, then so should the prices. We think that this is a reasonable way to assess what is being offered.

What's a fair price

If you are really going to join the hobby, your biggest need will be information. We have listed some of the national organizations for various facets of the hobby, and some of the periodicals. Look up your interest there, and invest in some information. When you are ready to buy, take a look at some of the catalogs listed. They make great wish-books. Then trot on down to your local hobby dealer and see what he or she can do for you.

One of the biggest services he offers is to put the stock out where you can examine it. Another big advantage is that he stocks fuel. You'll find this very important when you consider the freight charges, if you were to order it through the mail.

Another consideration, when you are ready to make a purchase, is the frequency on which you will operate. Some

of the available frequencies are restricted by law to the operation of model airplanes. This is done for safety. When an airplane is high in the sky, its receiver can see transmitters far in the distance.

You wouldn't want to shoot down someone's airplane every time you put a car on the track, or a boat in the water, would you? Of course not. People who fly make a deliberate effort to insure that flying sites are far enough apart to insure that these accidents won't happen. So study the frequency assignments and ponder the uses you plan for your system, before you specify the operating frequency.

Some hobby dealers who offer catalogs

Ace R/C Inc., Box 511H, Higginsville, Missouri, 64037 (all types of engines, kits and electronic parts)

Sig Manufacturing Co. Inc., Route 1, Box 1, Montezuma, Iowa, 50171 (airplane kits, accessories and tools)

Jomac Products, Inc., 12702 NE 124th Street, Kirkland, WA, 98033 (R/C race cars and equipment)

Peerless Corp., 3919 M Street, Philadelphia, Pa. 19124 (R/C boats, cars and planes, and accessories)

Astro Flight, Inc., 13377 Beach Ave., Venice, CA, 90291 (specializing in electric motors, batteries and accessories)

Hobby Lobby International, Route 3, Franklin Pike Circle, Brentwood, TN, 37027 (airplanes, engines, radios, equipment—discounted)

R/C model magazines

Model Aviation, Academy of Model Aeronautics, 815 Fifteenth St., NW Washington, DC, 20005

Model Airplane News, 1 North Broadway, White Plains, NY, 10601

Model Builder, 621 West Nineteenth St, Costa Mesa, CA 92627 (all models)

Flying Models, P.O. Box 700, Newton, New Jersey, 07860 (includes boats)

R/C Modeler, P.O. Box 487, Sierra Madre, CA, 91024 (all models)

R/C Sportsman, P.O. Box 11247, Reno, Nevada, 89510 (a newspaper)

Some R/C modelling organizations

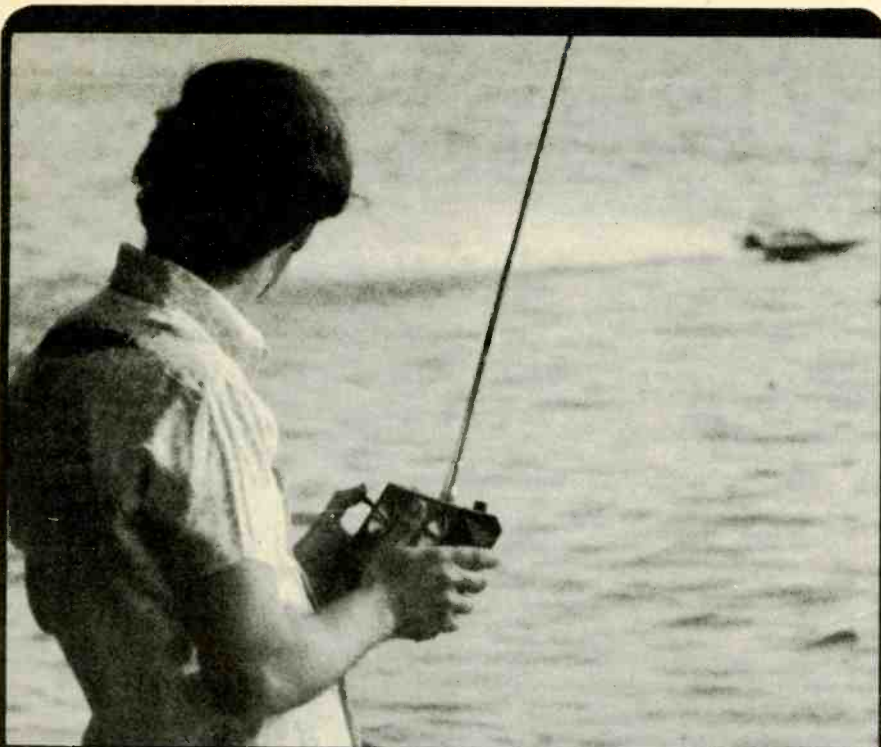
Academy of Model Aeronautics, 815 Fifteenth Street NW, Washington DC, 20005

National Soaring Society, 1042 Embury St. Pacific Palisades, CA, 90272

IMPBA (International Miniature Power Boat Association), 24310 Prairie Lane, Warren, Michigan, 48089



Charles Gianetto holds a Cox Cessna Centurian trainer while his brother Michael checks out the controls. The Cox Centurian comes almost ready to fly with its muffled engine installed, control push rods in place and provisions for the R/C receiver molding into the all-styrofoam interior. It's the ideal beginners plane.



Controlling a power boat model can be as tricky as driving the real thing. The Futaba Industries Model FP-2GA radio, being used here by Bill Dieckmann, is very popular with the boat people.

At this point, we feel it important to note that many parts of the country suffer from radio interference on some of the assigned frequencies. This is due to many causes. The 27 MHz band is crowded with people who operate equipment that spatters into the R/C-only bands accidentally or intentionally. There is also widespread use of illegal high-power linear amplifiers. Because of this, we do not recommend 27 MHz sets for aircraft. They may be perfectly acceptable for boats and cars, however. This is because the receiver antenna in such vehicles is close to the earth, where it is shielded somewhat from interference of all kinds.

Government interference

The PRS (72-75 MHz) frequencies are free from the interference of CB'ers, but not from the government. Lately, the Feds have seen fit to issue large numbers of licenses to voice stations rated at 200 and 300 watts, and operating exactly on the R/C frequencies. We recommend that you talk to your local dealer, and to R/C modelers in the vicinity, before making your purchase. You'll soon learn which frequencies to avoid.

Frequencies assigned as R/C channels

The Academy of Model Aeronautics has designated colored pennants to be fastened to the transmitter antenna for the purpose of identifying the channel in use. These colors are now used in all phases of the hobby. An asterisk is used to show the frequencies reserved for model aircraft exclusively. All of the other frequencies are shared among all types of models.

27 MHz band

use triangular pennants

- 26.995 - Brown
- 27.045 - Red
- 27.095 - Orange
- 27.145 - Yellow
- 27.195 - Green
- 27.255 - Blue

50 to 54 MHz band

use 1" x 16" colored ribbons

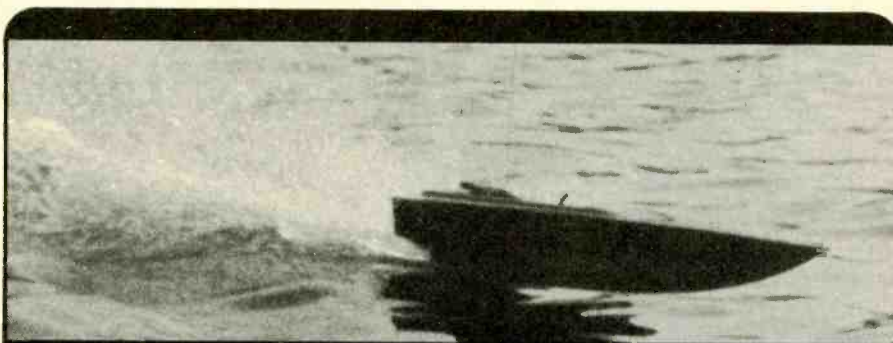
- 53.10 - Black & Brown
 - 53.20 - Black & Red
 - 53.30 - Black & Orange
 - 53.40 - Black & Yellow
 - 53.50 - Black & Green
- for super-regenerative receivers
- 51.20 - Black & Light Blue
 - 52.04 - Black & Violet

72-76 MHz band

use 1" x 16" colored ribbons

- * 72.08 - White & Brown
- 72.16 - White & Blue
- * 72.24 - White & Red
- 72.32 - White & Violet
- * 72.40 - White & Orange
- 72.96 - White & Yellow
- * 75.64 - White & Green

This list from the Official Model Aircraft Regulations for 1978/79 is used with the permission of the Academy of Model Aeronautics



While you may think of R/C boating only in terms of slow moving sailboats, there's plenty of fast action in the power boat circuit. These racing boats really move!

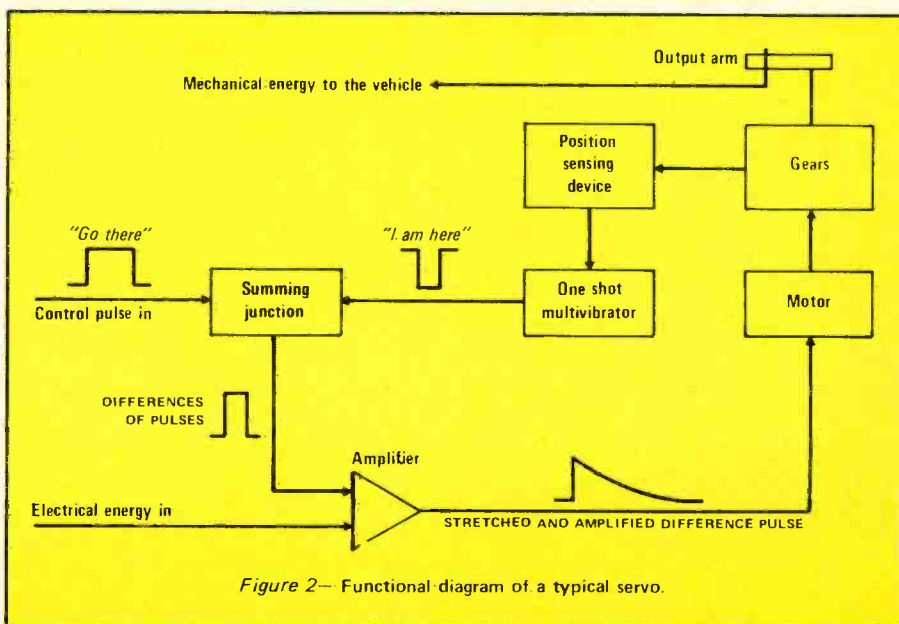


Figure 2— Functional diagram of a typical servo.

If interference appears, complain to the FCC, documenting it as well as possible. They'll politely tell you that there's

nothing that they can do, but if enough modelers complain in a given area and time, they might feel or become inspired

to find a way. One thing is dead certain: They won't do a thing for people who DON'T complain! 

Two and Three Channel Radio Control Equipment

Listed in alphabetical order

ACE R/C Inc.

Box 511H
Higginsville, Missouri 64037
Attention: Mr. Paul Runge
Digital Commander R/C kit—capability of three channels. Two servos included. Transmitter has a dry 9 volt battery. NiCad receiver battery pack with charger. Kit price \$119.95 with standard size (ACE/Bantam) servos. \$124.95 with Dunham D-5 servos.

Cannon Electronics Corp.

13400-26 Saticoy Street
North Hollywood, California 91605
Attention: Mr. Bill Cannon
Cannon Mini Sport System (Model 810B-22A) is a two channel system with two servos with all dry batteries. NiCads can be added later. Five full channels can be added with simple factory update. \$119.95.

Cannon Super Mini System (Model 820-22A) two channel system with two servos (Dunham D-5 Micro size). Two channel weight of 3.2 ounces includes a 100 MAH NiCad receiver battery pack. Transmitter has NiCads as well. \$199.95.

Charles R/C Goodies

P.O. Box 192
Van Nuys, California 91408
Attention: Mrs. Charlie Cannon
Essentially a kit version of the Cannon equipment. Three channel kit with two standard servos (one already assembled). Transmitter uses nine dry alkaline batteries. Receiver pack is NiCad with a charger. \$109.95 with standard servos or \$124.95 with Dunham D-5 micro servos.

Cox Hobbies Inc.

1505 East Warner Ave.
Santa Ana, California 92702
Attention: Mr. Lee Renaud
All systems mentioned here have two servos and use eight dry alkaline batteries in the transmitter and four more alkaline batteries in the receiver pack. NiCad packs can be purchased at a later time.
Model 8021 has a wheel control and throttle lever expressly set up for R/C cars and boats. (27 MHz frequencies only)
Model 8020 has two stick (separate) transmitter. For the Mode I flyers.
Model 8022 has single stick/two axis transmitter control. Best suited for model airplane control.
Model 8031 has single stick/two axis transmitter with a third channel available for throttle control.
Prices range from \$99.95 to \$109.95.

EK Products Inc.

3322 Stovall Street
Irving, Texas 75061
Attention: Mr. Bill Haga
Nimbus Sport Two is a two channel system with two servos and a single stick/two axis control using all dry batteries. Servos are the miniature EK-SM model. \$129.95.

Futaba Industries U.S.A.

630 Carob Street
Compton, California 90220
Attention: Mr. York Daimon
Model FP-2GA is a two channel system with two servos using two separate transmitter sticks (Mode I) and all dry batteries. \$99.95.

Heath Company

Benton Harbor, Michigan 49022
Three-channel system kit with two servos using NiCad batteries and plug-in frequency modules that is expandable by the kit builder to four channels at a later time. \$179.95

Hobby Lobby International Inc.

Route 3 Franklin Pike Circle
Brentwood, Tennessee 37027
Radio is manufactured for Hobby Lobby by EK Products and is a three channel system with two servos with 9 volt dry battery in the transmitter and four alkaline dry batteries in the receiver pack. \$120.

Hobby Shack Inc.

18480 Bandilier Circle
Fountain Valley, California 92708
Attention: Mr. Paul Bender
Aero Sport Two system (actually manufactured by Futaba Industries) is a two servo system with all dry batteries. NiCad batteries can be added to receiver at a later time. A great buy at \$75.

Kraft Systems Inc.

450 W. California Ave.
Vista, California 92083
Attention: Mr. Marty Barry
Model KP-2A Sport Series is a single stick/two axis control system using all dry batteries. Extremely reputable service is available throughout the country. \$130.

Model Rectifier Corp.

2500 Woodbridge Ave.
Edison, New Jersey 08817
Attention: Mr. Frank Ritota
Model 772 is a two channel system with a two control stick (Mode I) Transmitter that comes with dry batteries. NiCads can be easily added later. Receiver is also dry powered but NiCads can be purchased as an option later on. \$110.

Millcott Corp.

1420 Village Way, Unit E
Santa Ana, California 92705
Attention: Mr. Hugh Milligan
Single Stick Specialist Three is a three channel system using three servos and complete with NiCad batteries and charger. Has a special built-in mixer control for use with "V" tail aircraft. Highly specialized! \$275.

Pro Line Electronics Inc.

10632 N. 21st Ave.
Suite 11
Phoenix, Arizona 85029
Attention: Mr. Jerry Bonzo
Three channel Competition Series Model PLN-3-0 has three servos plus full NiCads. \$300.

Royal Electronics Inc.

3535 S. Irving
Englewood, Colorado 80110
Attention: Mr. Sid Gates
Kit system components which must be purchased individually. A two channel transmitter kit with NiCads is \$75. A two channel receiver kit (less connectors) is \$22. Servos and battery packs available to suit your needs.

RS Systems Inc.

5301 Holland Drive
Beltsville, Maryland 20705
Attention: Mr. Frank Goodwin
Model RS-3-S0 is a three channel system with two servos and full NiCads. \$235.

Tower Hobbies Inc.

P.O. Box 778
Champaign, Illinois 61820
Three channel system with two servos actually manufactured by Kraft Systems. Transmitter uses a 9 volt dry battery but can be converted to NiCads later on. Receiver comes with NiCad pack and charger. \$120.

World Engines Inc.

8960 Rossash Ave.
Cincinnati, Ohio 45236
Attention: Mr. Dave Brown
Expert Series two channel system has single stick control and comes complete with dry battery system for \$135 or with full NiCad system for \$180.